2006 Linear Accelerator Conference

Conference Guide

Argonne NATIONAL LABORATORY

OAK RIDGE National Laboratory

SNS SPALLATION NEUTRON SOURCE

Linac 06

2006 Linear Accelerator Conference

August 21-25, 2006

Knoxville Convention Center
Knoxville, Tennessee, USA

www.sns.gov/linac06/

Hosted by:

Oak Ridge National Laboratory/Spallation Neutron Source
managed by UT-Battelle, LLC, under
contract DE-AC05-000R22725 for the U.S. Department of Energy

Argonne National Laboratory
managed by the University of Chicago for the U.S. Department of Energy

Acknowledgments

The Linac06 Organizing Committee, Scientific Program Committee, and Local Organizing Committee would like to acknowledge and thank the following for their sponsorship and support:

Argonne National Laboratory
National Science Foundation
Oak Ridge National Laboratory
U.S. Department of Energy

Contents

Welcome!

On behalf of the LINAC06 Organizing Committee, Program Committee, and Local Organizing Committee, I would like to welcome you to the Knoxville Convention Center (KCC), Knoxville, Tennessee, USA. This venue is in proximity to Oak Ridge National Laboratory (ORNL) and the Spallation Neutron Source (SNS).

Judging from the response to the invitation for papers, we will have many participants from several countries and many interesting presentations to look forward to.

An industrial exhibit will be open Monday and Tuesday from 8:00 a.m. until 6:00 p.m. and Wednesday and Thursday from 8:00 a.m. to 12:00 p.m. The exhibit booths will be set up on the KCC Park Concourse, across from the poster presentations, allowing everyone ample time to examine their products and discuss new developments and innovations. An exhibitor list is on page 12.

In closing, I would like to thank the 2006 Linac International Organizing Committee, Program Committee, and Local Organizing Committee for making this conference a success. We gratefully acknowledge support from the hosting laboratories, Argonne National Laboratory and SNS at ORNL.

We are glad you can join us here in Knoxville and hope that you enjoy your time at the 2006 Linac Conference.

Sincerely,

Norbert Holtkamp, ORNL/SNS
Linac 2006 Conference Chair

Key Contacts

Norbert Holtkamp (ORNL/SNS), Chair
Marion White (ANL/APS), Program Chair
Stuart Henderson (ORNL/SNS),
Local Organizing Committee Chair
Kathy Rosenbalm (ORNL/SNS),
Conference Coordinator

Local Organizing Committee

Stuart Henderson, Chair
Kathy Rosenbalm, Conference Coordinator,
Publicity, and Public Relations
Janet Bivens, Finance
Dan Ciarlette, Information Technology Services
Craig Deibele, Industrial Exhibits
Al Ekkebus, Tours
Dave Gurd, Consultant
Charlie Horak, Proceedings, Publications,
and Web Services
Muriel Johnson, Hospitality
Pam Kite, Satellite Meetings
Doris Shubert, Registration

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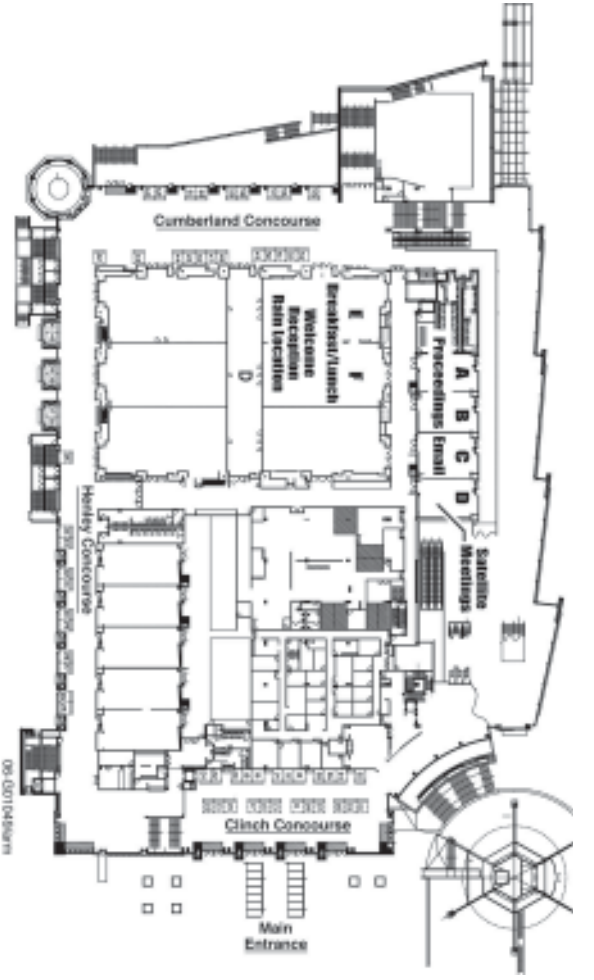
H. Weise, DESY
M. White, ANL/APS

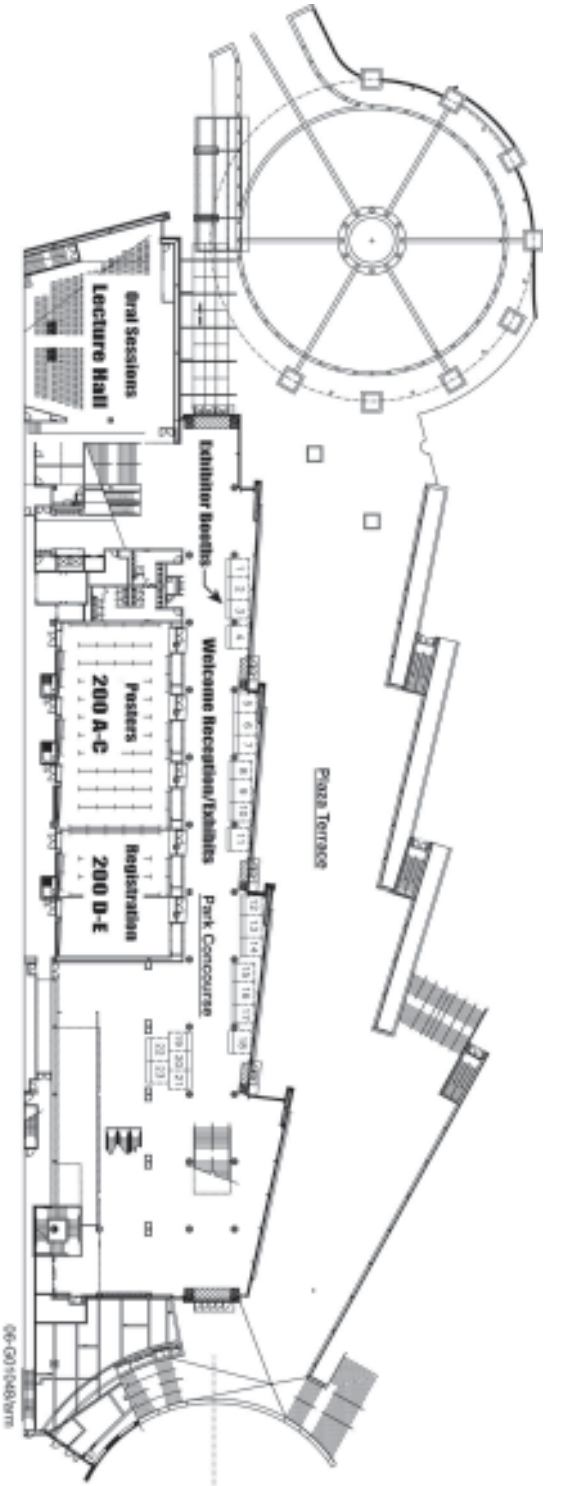
Venue

Knoxville Convention Center (KCC)
www.kccsmg.com
701 Henley Street
Knoxville, TN, USA 37902
Phone: (865) KCC-KNOX (522.5669)
Fax: (865) 329.0422

Mailing Address:
P.O. Box 2543
Knoxville, TN, USA 37901-2543



3rd Floor Knoxville Convention Center



2nd Floor Knoxville Convention Center

Transportation During the Conference

The Knoxville Trolley Service will provide free transportation to and from downtown hotels, restaurants, and the KCC. A schedule is provided in your conference portfolio. More details and schedules are available online at www.ci.knoxville.tn.us/kat/web%20pages/Trolley/Trolley_Map.asp.

In addition, public buses run in the downtown and surrounding areas. For more information see www.ci.knoxville.tn.us/kat/web%20pages/home.asp. Limited taxi service is also available in the downtown area.

Registration

Registration is located on the second floor in rooms 200 D & E (off the Park Concourse). Registration hours are:

Sunday	5:00 p.m. - 7:30 p.m.
Monday	8:00 a.m. - 5:00 p.m.
Tuesday	8:00 a.m. - 5:00 p.m.
Wednesday	8:00 a.m. - 12:00 p.m.
Thursday	8:00 a.m. - 5:00 p.m.

A message board is located near the registration desk.

Your registration fee includes attendance at all technical sessions of the conference, the conference guidebook, and one copy of the proceedings on CD-ROM. Registration also includes the welcome reception, coffee breaks, breakfasts and lunches, dinner at the Wednesday outing and Thursday banquet. All receptions and the conference banquet are being sponsored by nonfederal sources.

The fee for registration after June 15 is $690 USD. For participants whose registration fees have not been paid in full, payment may be made

at the registration desk by credit card, check, or cash. Students and retirees can register for $50.

Attendees are required to wear their badges at all Linac06-sponsored events.

Internet Café

An e-mail room is located in Room 300 C. It contains laptops, a black and white printer, and wireless access. Hours are:

Sunday	5:00 p.m. - 7:30 p.m.
Monday	8:00 a.m. - 6:00 p.m.
Tuesday	8:00 a.m. - 6:00 p.m.
Wednesday	8:00 a.m. - 12:30 p.m.
Thursday	8:00 a.m. - 6:00 p.m.
Friday	8:00 a.m. - 1:00 p.m.

The Internet Café also includes an area where speakers can preview/test their presentations. Please note that all speakers must give their presentations with the computer system set up in the Lecture Hall. Use of individual laptops cannot be accommodated.

Proceedings Office

The Proceedings Office is located in Rooms 300 A & B. Editorial staff will process papers before and during the conference.

The paper submission deadline was Wednesday, August 16. Authors are requested to come by the Proceedings Office to check on their papers via the status board that will be located in or near the Proceedings Office. Authors are also requested to bring a hard copy of their paper to the Proceedings Office upon arrival at the conference.

Proceedings Office hours:

Sunday	3:00 p.m. - 5:30 p.m.
Monday	8:30 a.m. - 6:00 p.m.
Tuesday	8:30 a.m. - 6:00 p.m.
Wednesday	8:30 a.m. - 12:00 p.m.
Thursday	8:30 a.m. - 6:00 p.m.
Friday	8:30 a.m. - 11:00 p.m.

The conference proceedings will be published on CD-ROM and on the Joint Accelerator Conferences Web Site (JACoW): accelconf.web.cern.ch/accelconf/.

Industrial Exhibitors and Sponsors

Set up for industrial exhibits begins at 9:00 a.m., Sunday, August 20. Hours are as follows:

Monday	8:00 a.m. - 6:00 p.m.
Tuesday	8:00 a.m. - 6:00 p.m.
Wednesday	8:00 a.m. - 12:00 p.m.
Thursday	8:00 a.m. - 12:00 p.m.

Exhibitors and sponsors registered at press time (booth numbers are shown in parentheses):

Accel Instruments, GmbH (1)
Accelsoft, Inc. (3)
Advanced Energy Systems, Inc. (11)
American Magnetics
Amuneal Manufacturing Corporation (4)
Babcock Noell (7)
Brush Wellman (14)
CAEN Technologies, Inc. (18)
Communications and Power Industries, Inc. (5)
The Ferrite Company (22-23)
Goodfellow Corporation (8)
Hi-Tech Manufacturing, Inc. (16)
Institute of Physics
L-3 Communications (19)
Leybold Vacuum USA (21)
Linac Systems, LLC
Major Tool & Machine, Inc.(6)

MegaIndustries, LLC (17)
Metalex Manufacturing, Inc. (9)
Minarik Corp. (13)
Muon Inc.
Tektronix (10)
Thales (12)
Toshiba Electron Tubes & Devices Co., Ltd. (2)
VAT Inc. (15)
W.C. Heraeus GmbH

A complete listing of exhibitors is also on the web at www.sns.gov/linac06/vendors.shtml

Security and Insurance

Participants are asked not to leave their belongings unattended and to wear their conference badges at all LINAC06-sponsored events. The conference organizers cannot accept liability for personal injuries sustained or for loss or damage to participants' (or companions') personal property during the conference.

Special Events

Sunday Welcome Reception

A welcome reception will be held outside on the KCC Plaza Terrace from 5:00 p.m. to 7:30 p.m. In case of rain, the reception will be held in Rooms 300 E & F. All registrants are invited to attend.

Wednesday Special Events

Wednesday afternoon activities at the Tellico Yacht Club will include lunch, party barge lake rides, swimming, musical entertainment, and dinner. Transportation will be provided by coach bus. If you have special transportation needs, please contact someone at the registration desk.

As part of the Tellico Yacht Club activities, golf will be available for the additional fee of $21.50 (cart and green fees). Tee time will be 2:30 p.m. Club rental will be available for $30.00 per person. The party barge is limited to 90 participants per cruise time. The following departure times may be adjusted by conference staff depending upon demand:

1:30 p.m. - 3:30 p.m.
4:00 p.m. - 6:00 p.m.
7:30 p.m. - 9:30 p.m.

Thursday Special Event

The conference banquet will be at 7:00 p.m. at the Foundry (two blocks from the KCC).

Satellite Meeting

Linac 2006 International Organizing Committee
Tuesday, August 22, 6:30 p.m.
Rotunda Room

Companion Programs

Companion tours are available during and after the conference and are being handled by the Knoxville Tourism and Sports Corporation. Pickup points for the companion tours will be at the KCC.

Activities during the conference:

Monday:

Tour Ripley's Aquarium and Ripley's Believe It or Not Museum, plus have free time in the quaint town of Gatlinburg for shopping and lunch (not included in package price). Price is $77 for adults and $66 for children ages 4-11. Price includes deluxe motor-coach transportation, guide & escort, and admission to both attractions.

Tuesday:

Tour Fort Loudon, the Lost Sea (package price includes picnic lunch), and Mayfield Dairy. Price is $68 for adults and $62 for children ages 4-11. Price includes deluxe motor-coach transportation, historical guide & escort, and admission to the Lost Sea and Mayfield Dairy.

Thursday:

Shopping in Pigeon Forge at Tanger Five Oaks Outlet Mall. Price of $43 per person includes deluxe motor-coach transportation and guide & escort service.

Student Travel Awards

The National Science Foundation has sponsored grants to worthy students to help defray their travel costs. Awards were made to the following students:

Alexander Brandt, DESY
Andrea Franchi, GSI
Michael Galonska, GSI
Francesco Grespan, INFN
Wojciech Jalmuzna, DESY
Jianjian Li, Illinois Institute of Technology
David Meidlinger, MSU
Mandi Meidlinger, MSU
Piero Antonio Posocco, INFN

Scientific Program

The schedule included herein details the scientific program with the program code, title, and authors of each paper (only publicly available information will be discussed). Full texts of the abstracts are included here.

Oral Sessions

All oral sessions will be in the 2nd floor Lecture Hall. A preview/testing area is available for speakers in the Internet Café, Room 300 C. *Please note that all speakers must give their presentations from the computer systems set up in the ballrooms. Use of individual laptops cannot be accommodated.*

Poster Sessions

All poster sessions will be in Rooms 200 A-C. Posters should be in place by the beginning of the session and should be taken down at the end of each session.

Authors are reminded that no contributions are accepted for publication only. Any paper accepted for presentation that is not presented at the conference will be excluded from the proceedings.

The Scientific Program Committee reserves the right to refuse papers for publication that have not been properly presented or staffed in the poster sessions. Manuscripts of contributions to the proceedings (or enlargements of them) are not considered to be posters, and papers presented in this way will not be accepted for publication.

Identification of Contributions

The date and type of presentation for each contribution in the program can be easily identified from the program code, which is composed as follows:

- The first two letters of the day: Mo, Tu, We, Th, Fr.
- For oral sessions, the third letter indicates the order of the session (1, 2, or 3).
- For posters sessions, the third letter is a P.

Monday, August 21

8:30-10:30 Oral Session MO1
2nd Floor Lecture Hall

8:30 Welcome and Announcements

9:00 Particle Physics and the Responsible Use of Public Resources
Harold Shapiro

9:30 Commissioning and Initial Operating Experience with the SNS-1 GeV-Linac
Stuart Henderson

10:00 Commissioning of the J-PARC Linac
Yoshishige Yamazaki

10:30-11:00 Coffee Break

11:00-12:20 Oral Session MO2
2nd Floor Lecture Hall

11:00 Status of the CLIC Test Facility
Gunther Geschonke

11:20 Energy Doubling in a Plasma Wakefield Accelerator
Rasmus Ischebeck

11:40 High-Power RF Sources
Ed Wright

12:00 Status of Berlin X-FEL, Pohang X-FEL, and Trieste X-FEL
Jens Knobloch

12:20-1:40 Lunch Break

1:40-2:30 Oral Session MO3

1:40 Intense Heavy Ion Beam Production with ECR Sources
Santo Gammino

2:00 Overview of the TEM-Class Superconducting Cavities for Proton and Ion Acceleration
Michael Kelly

2:30-5:30 Monday Poster Session
Rooms 200 A-C

Tuesday, August 22

8:30-10:30 Oral Session TU1
2nd Floor Lecture Hall

8:30 International Linear Collider R&D at Fermilab
Shekhar Mishra

9:00 Technologies Toward a 100-kW Free-Electric Laser
Dinh Nguyen

9:30 Modern Electron Induction Linacs
Raymond Scarpetti

10:00 Development of High Current, High-Duty-Factor H-Injectors
Martin Stockli

10:30-11:00 Coffee Break

11:00-12:20 Oral Session TU2
2nd Floor Lecture Hall

11:00 The 12-GeV CEBAF Upgrade Project
Arne Freyberger

11:20 Laser-Based Heavy Ion Production
Masahiro Okamura

11:40 BSNS Linac Design
Shinian Fu

12:00 Results on the Beam Commissioning of the Superconducting RFQ of the New LNL Injector
Andrea Pisent

12:20-1:40 Lunch Break

1:40-2:30 Oral Session TU3
2nd Floor Lecture Hall

1:40 High-Current Proton Beam Investigation at the SILHI-LEBT at CEA/Saclay
Ralph Hollinger

2:00 Industrial Production Aspects of Linac Components
Tony Favale

2:30-5:30 Tuesday Poster Session
Rooms 200 A-C

Wednesday, August 23

8:30-10:30 Oral Session WE1
2nd Floor Lecture Hall

8:30 Overview of Energy Recovered Linacs
Vladimir Litvinenko

9:00 The 4GLS at Daresbury
Hywel Owen

9:30 The TTF/VUV-FEL as the Prototype for the European XFEL Project
Hans Weise

10:00 Cryomodules for Energy-Recovery Linacs
Matthias Liepe

10:30-11:00 Coffee Break

11:00-12:40 Oral Session WE2
2nd Floor Lecture Hall

11:00 Neutralized Drift Compression Exp-eri ments (NDCX)
Prabir Roy

11:20 SNS Transverse and Longitudinal Laser Profile Monitor Design, Implementation, Results, and Improvement Plans
Saeed Assadi

11:40 LLRF Systems for Modern Linacs: Design and Performance
Alexander Brandt

12:00 100-MeV, High-Duty Factor Proton Linac Development at KAERI
Yong-Sub Cho

12:20 HOM Damping and Power Extraction from Superconducting Cavities
Jacek Sekutowicz

12:40 Lunch and Outing

Thursday, August 24

8:30-10:30 Oral Session TH1
2nd Floor Lecture Hall

8:30 The Linac Coherent Light Source (LCLS) Accelerator
Juhao Wu

9:00 Cryomodule Test Facilities and Multi cell Cavity Performance for the ILC
Hitoshi Hayano

9:30 Initial Commissioning Results from the ISAC-II SC Linac
Robert Laxdal

10:00 A 70-MeV Proton Linac for the FAIR Facility Based on CH-Cavities
Ulrich Ratzinger

10:30-11:00 Coffee Break

11:00-12:20 Oral Session TH2
2nd Floor Lecture Hall

11:00 High-Power Couplers for Linear Accelerators
Alessandro Variola

11:20 Timing and Synchronization in Large-Scale Linear Accelerators
Mario Ferianis

11:40 Recent Developments in Pulsed High-Power Systems
David Anderson

12:00 Nuclear Photo-Science and Applications with Thomson-Radiated Extreme X-Ray (T-REX) Sources
Chris Barty

12:20-1:40 Lunch Break

Schedule continues on next page

Thursday, August 24 *(cont.)*

1:40-2:30 Oral Session TH3
2nd Floor Lecture Hall

1:40 Photoinjectors R&D for Future Light Sources and Linear Colliders
Philippe Piot

2:00 Normal-Conducting Energy Recuperator
Alexander Matveenko

2:30-5:30 Thursday Poster Session
Rooms 200 A-C

7:00 Banquet at The Foundry

Friday, August 25

8:30-10:30 Oral Session FR1
2nd Floor Lecture Hall

8:30 High-Quality GeV-Level Electron Beams from Laser Plasma Accelerators
Eric Esarey

9:00 Spring-8 Compact SASE Source
Tsumoru Shintake

9:30 Front-End Development for High-Power Proton Accelerators in Europe
Alan Letchford

10:00 Recent Developments in SRF Cavity Science and Performance
Gianluigi Ciovati

10:30-11:00 Coffee Break

11:00-1:00 Oral Session FR2
2nd Floor Lecture Hall

11:00 Radioactive Ion Beam Production and Development at ISAC
Pierre Bricault

11:20 2K or Not 2K
Isidoro Campisi

11:40 New Materials and Designs for High-Power, Fast-Phase Shifters
Robyn Madrak

12:00 Science Case for Energy Recovery Linac X-Ray Sources
Sol Gruner

12:30 Closing Remarks
2nd Floor Lecture Hall

3:00-5:00 SNS Laboratory Tour

Monday Oral Session, MO1
2nd Floor Lecture Hall, 8:30 a.m.
Session Chair - Marion White, ANL/APS

8:30 **Welcome and Announcements**

9:00 **MO100 – Particle Physics and the Responsible Use of Public Resources**
Harold Shapiro (Princeton University)
No abstract submitted.

9:30 **MO101 – Commissioning and Initial Operating Experience with the SNS 1-GeV Linac**
Stuart Henderson (ORNL, Oak Ridge, Tennessee)
The Spallation Neutron Source accelerator complex consists of a 2.5 MeV H- front-end injector system, a 186 MeV normal-conducting linear accelerator, a 1 GeV superconducting linear accelerator, an accumulator ring and associated beam transport lines. The SNS linac was commissioned in five discrete runs, starting in 2002 and completed in 2005. The remainder of the accelerator complex was commissioned in early 2006. With the completed commissioning of the SNS accelerator, the linac has begun initial low-power operations. In the course of beam commissioning, most beam performance parameters and beam intensity goals were achieved at low duty factor. A number of beam dynamics measurements have been performed, including emittance evolution and sensitivity to mismatch of the input beam. The beam commissioning results, achieved beam performance and initial operating experience of the SNS linac will be presented.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. DOE.

10:00 **MO102 – Commission of the J-PARC Linac**
Yoshishige Yamazaki
No abstract submitted.

Monday Oral Session, MO2
2nd Floor Lecture Hall, 11:00 a.m.
Session Chair - Yoshishige Yamazaki

11:00 **MO201 – Status of the CLIC Test Facility (CTF3)**
Günther Geschonke (CERN, Geneva)
The CTF3 project, being built within the framework of an international collaboration involving more than 12 institutions, is advancing as planned. To date, the electron linac with its sub-harmonic bunching system, the magnetic chicane for bunch-length variations, and the Delay Loop have been installed. The 1.5 GHz sub-harmonic bunching system with fast phase switching allows the longitudinal position of the bunches to be changed every 140 ns. This phase-coded beam has been successfully injected into the Delay Loop using an RF deflector and bunch interleaving of 140 ns long sub-bunch trains which double the bunch repetition frequency has been demonstrated in the extraction line. In addition to its role as a test bed for the CLIC RF power source, CTF3 is being used as a source of high-power RF at 30 GHz for the testing of CLIC accelerating structures. In this power-generating mode, about 100 MW of 30 GHz power is routinely extracted from the beam half-way up the linac by special-purpose power-extracting structures and transported to the high-gradient test area by low-loss waveguides. This paper describes the overall status of the CTF3 project and outlines the plans for the future.

11:20 **MO202 – Energy Doubling in a Plasma Wakefield Accelerator**
Rasmus Ischebeck
No abstract submitted.

11:40 **MO203 – High-Power RF Sources**
Edward Wright (CPI, Palo Alto, California)
Vacuum electron devices continue to play a major role in most high-power RF accelerator systems. They provide continuous wave power to megawatt levels and pulsed power to hundreds of megawatts, at frequencies ranging from HF to millimeter wave. Power grid tubes, Tetrodes, are used for high-power accelerators operating in the HF and VHF frequency bands. Klystrons, multiple-beam klystrons (MBK's) and inductive output tubes (IOT's) take over as the amplifier-of-choice above 300 MHz, while a number of low-power systems utilize magnetron oscillators. A shift in technology, from klystrons to IOTs, has begun for many systems in the 300 MHz to 1500 MHz frequency range due to the IOTs improved efficiency and linearity. In the frequency range from 2.8 GHz to 18 GHz the klystron is king. In the millimeter frequency range gyro-klystrons are available. These technologies will be described, and developments and future trends discussed.

12:00 **MO204 – Status of the Berlin X-FEL, Pohang X-FEL, and Trieste X-FEL**
Jens Knobloch
No abstract submitted.

Monday Oral Session, MO3
2nd Floor Lecture Hall, 1:40 p.m.
Session Chair - Won Namkung

1:40 **MO301 – Intense Heavy-Ion Beam Production with ECR Sources**
Santo Gammino, Luigi Celona, Giovanni Ciavola, Fabrizio Consoli, David Mascali (INFN/LNS, Catania), Sebastiano Barbarino, Fabio Maimone (Catania University, Catania)
An average increase of about one order of magnitude per decade in the performance of ECR ion sources was obtained up to now since the time of pioneering experiment of R. Geller at CEA Grenoble and this trend is not deemed to get the saturation at least in the next decade, according to the increased availability of powerful magnets and microwave generators. Electron density above 1013 cm-3 can be obtained by 28 GHz microwave heating, but only an adequate plasma trap may allow to exploit that plasma for heavy elements ionization. A study about the optimization of the magnetic field and of the other different parameters affecting the ECRIS plasma is presented, with a special emphasis on the coupling of microwaves to plasma. Long-term perspectives are presented finally, with an analysis of the possibilities opened by higher frequency generators, as 60 GHz gyro-TWTs, with the use of moderate confinement trap, by combining the large plasma density with larger escape rates in order to get larger ion beam currents.

2:00 **MO302 – Overview of TEM-Class Superconducting Cavities for Proton and Ion Acceleration**
Michael Kelly (ANL, Argonne, Illinois)
Superconducting (SC) TEM-class cavities have been developed at laboratories and institututions

worldwide for cw and pulsed proton and ion linac applications. New geometries spanning nearly the full velocity range from $0.1 < v/c < 0.8$ include co-axial quarter- and half-wave and single- and multi-spoke cavities. Optimized designs have large beam acceptance, high shunt impedance and good microphonics properties. Rapidly evolving and improving clean surface processing techniques have been applied to TEM cavities where achieved surface fields and rf losses are comparable to the best results presently achieved in elliptical cavity designs. Recent results for a three-spoke cavity following hydrogen degassing after fabrication show very low rf losses even at high accelerating fields and now open the possibility for substantially reduced effective cryogenic load in 2 Kelvin, rather than the historically-used 4 Kelvin, operation. At present performance levels, SC TEM-class cavities constitute the technology of choice for most ion linac applications requiring cavities up to or beyond 60 percent of the speed-of-light.

This work was supported by the U.S. Department of Energy under Contract No. W-31-109-ENG-38.

Monday Poster Session, MOP
Rooms 200 A-C, 2:30-5:30 p.m.
Session Chair: Alwin Schempp, IAP

MOP001 – Pressurized Hydrogen-Filled Linacs for Muon Cooling

Rolland Paul Johnson, Mohammad Alsharo'a, Pierrick M. Hanlet, Robert Hartline, Moyses Kuchnir, Kevin Paul (Muons, Inc, Batavia), Charles Ankenbrandt, Alfred Moretti, Milorad Popovic (Fermilab, Batavia, Illinois), Katsuya Yonehara (Fermilab, Batavia, Illinois; Illinois Institute of Technology, Chicago, Illinois),

Daniel Kaplan (Illinois Institute of Technology, Chicago, Illinois)
New techniques for muon ionization cooling require low-Z energy absorber, strong magnetic fields for focusing and emittance exchange, and high gradient RF cavities to replace the energy lost in the absorber. RF cavities pressurized with hydrogen gas are being developed to provide the most muon beam cooling possible in the short lifetime of the muon. We report the status of the cavity development, including the breakdown suppression due to the gas and new results showing that pressurized cavities show no degradation of performance in strong magnetic fields. We also comment on the development of the designs of the associated muon cooling linacs.

Supported in part by the U.S. Dept. of Energy through the Univ. Research Association under contract DE-AC35-89ER40486 and through STTR grants DE-FG02-03ER83722 and DE-FG02-05ER86252

MOP002 – Efficient Long-Pulse, Fully Loaded CTF3 Linac Operation

Peter Urschütz, Hans-Heinrich Braun, Roberto Corsini, Steffen Doebert, Erk Jensen, Frank Tecker (CERN, Geneva)
An efficient RF to beam energy transfer in the accelerating structures of the drive beam is on of the key points of the Compact Linear Collider (CLIC) RF power source. For this, the structures are fully beam-loaded, i.e., the accelerating gradient is nearly zero at the downstream end of each structure. In this way, about 97% of the RF energy can be transferred to the beam. To demonstrate this mode of operation, 1500 ns long beam pulses are accelerated in eight fully loaded structures in the CLIC Test Facility (CTF3) Linac. In the paper we present the results of experimental studies on this mode of operation, compare them with theoretical predictions and discuss its potential use in CLIC.

MOP003 – Muon Acceleration in a Proton Driver Linac

Milorad Popovic (Fermilab, Batavia, Illinois), Rolland Paul Johnson (Muons, Inc, Batavia)

A future Fermilab proton driver* based on TESLA superconducting linac modules can provide protons to produce the muons and also accelerate the muons to be used for a neutrino factory or muon collider. Recent advances in muon cooling** imply muon emittances that are compatible with the 1300 MHz accelerating structures that are the basis for the ILC design. In the example discussed here, H- ions are accelerated to 8 GeV in the superconducting linac, then stripped, stored and bunched in a ring while the linac cavities are rephased for muon acceleration. Then the protons are extracted from the ring to produce pions and muons which are cooled in about six hundred meters, accelerated to a few GeV and injected into the linac at the point for acceleration to add 7 GeV. By recirculating the muons in the constant frequency section of such a proton driver linac, even higher energies can be achieved quickly so that losses from muon decay are minimized. By adding additional refrigeration and RF power, the repetition rate of the linac can be increased to make large increases in the average flux of a neutrino factory and the average luminosity of a muon collider.

*G. W. Foster and J. A. MacLachlan, Proceedings of LINAC 2002, Gyeongju, Korea.
**R. P. Johnson et al., Pressurized Hydrogen-filled Linacs for Muon Cooling, this conference.

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MOP004 – GeV Laser Wakefield Acceleration and Injection Control at LOASIS

Cameron Guy Robinson Geddes, Eric Esarey, Wim Leemans, Pierre Michel, Bob Nagler, Kei Nakamura, Guillaume Plateau, Carl Bernhardt Schroeder, Brad Shadwick, Csaba Toth, Jeroen Van Tilborg (LBNL, Berkeley, California), Simon Hooker (OXFORDphysics, Oxford, Oxon), David L. Bruhwiler, John R. Cary (Tech-X, Boulder, Colorado), Estelle Michel (University of Nevada, Reno, Reno, Nevada)

Experiments at the LOASIS laboratory of LBNL have demonstrated production of GeV electron beams with low energy spread and divergence from laser wakefield acceleration. The pondermotive force of a 40 TW laser pulse guided by a 3 cm capillary discharge plasma density channel drove an intense plasma wave (wakefield), producing acceleration gradients on the order of 50 GV/m. Electrons were trapped from the background plasma and accelerated. Beam energy was increased from 100 to 1000 MeV*, compared to earlier experiments**, by using a longer guiding channel at low density, demonstrating the anticipated scaling to higher beam energies. Particle simulations are used to understand the trapping and acceleration mechanisms. Other experiments and simulations are also underway to control injection of particles into the wake, and hence improve beam quality and stability further. Recent experimental and simulation results from channel guided laser acceleration, and initial injection results, will be presented.

*W.P. Leemans et al, submitted.
**C.G.R. Geddes et al, Nature, Sept 2004, p 538.

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MOP005 – Beam Dynamics for Intense L-band Electron Linac

Sang-Hoon Kim, Moo-Hyun Cho, Sugn-ik Moon, Won Namkung (POSTECH, Pohang, Kyungbuk), Jong-Seok Oh (PAL, Pohang, Kyungbuk)

We designed a traveling-wave accelerating structure for an intense L-band electron linac for irradiation applications. It is capable to produce 10 MeV electron beams of 30 kW. Accelerating and bunching cavities based on the 2ð/3 mode are designed by SUPERFISH and ANSYS codes. With simulation results on beam dynamics by the PARMELA code, we determined the accelerating structure as five bunching cavities and twenty-six accelerating cavities. The pre-buncher and bunching cavities are designed to bunch electron beams for efficient acceleration and transmission. Solenoids placed from the E-gun to the end of bunching cavities focus the beams against the space-charge effect due to high intensity. As the result, the beam transmission rate is 89% and the beam radius is 10.2 mm with the beam emittance of 7.7 mm-mrad at the end of the accelerating structure. In this paper, we present detailed beam dynamics with simulation results.

Work supported by KAPRA.

MOP006 – A Bunch Compressor for the CLIC Main Beam

Frank Stulle, Andreas Adelmann, Marco Pedrozzi (PSI, Villigen)

The second bunch compressor chicane in the main beam line of the multi TeV linear collider CLIC is foreseen to compress the electron bunches from 250 um to 30 um. It is specified that the emittance growth in this chicane, which is mainly due to incoherent and coherent synchrotron radiation, should not exceed 30 nm rad in the horizontal plane and 1 nm rad in the vertical plane. To achieve these values the chicane layout and the optics functions have been optimized and

the influence of shielding due to the vacuum chamber including resistive wall wake fields has been studied. A chicane layout and the corresponding electron beam parameters are presented, which allow to preserve the emittance within the specifications.

This work is supported by the Commission of the European Communities under the 6th Framework Programme "Structuring the European Research Area", contract number RIDS-011899.

MOP007 – Turnaround Loop and Chicane for Bunch Compression and Path Length tuning in the CLIC Drive Beam

Frank Stulle, Andreas Adelmann, Marco Pedrozzi (PSI, Villigen)

The phase feedback of the CLIC drive beam consists of phase and energy measurement stations in front of the turn around loops and chicanes for bunch compression and path length correction behind the loops. The chicanes are foreseen to compress the bunches from 4 mm to 0.4 mm and should allow a path length tuning of at least 0.1 mm. Suitable layouts for the turn around loops and the chicanes and results of beam dynamics simulations including incoherent and coherent synchrotron radiation are presented.

This work is supported by the Commission of the European Communities under the 6th Framework Programme "Structuring the European Research Area", contract number RIDS-011899.

MOP008 – Design and Performance of Optics for Multi-Energy Injector Linac

Yukiyoshi Ohnishi, Kazuro Furukawa, Naoko Iida, Takuya Kamitani, Mitsuo Kikuchi, Yujiro Ogawa, Masanori Satoh, Kazue Yokoyama (KEK, Ibaraki)

Injector linac provides injection beams for four storage rings, KEKB high energy electron ring(HER), KEKB low energy positron

ring(LER), PF-AR electron ring, and PF electron ring. The injection beams for these rings have different energies and intensities. Recently, a requirement of simultaneous injection among these rings arises to make a top-up injection possible. Magnetic fields of DC magnets to confine the beam to the accelerating structures can not be changed between pulse to pulse, although the beam energy can be controlled by fast rf phase shifters of klystrons. This implies that common magnetic fields of bending magnets and quadrupole magnets should be utilized to deliver beams having different characteristics. Therefore, we have designed multi-energy optics for KEKB high energy electron ring(8 GeV, 1 nC/pulse) and PF electron ring(2.5 GeV, 0.1 nC/pulse) and present a performance of the multi-energy injector linac.

MOP009 – Dragon-I Linear Induction Accelerator

Jianjun Deng, Nianan Cheng, Guangsheng Dai, Zhiyong Dai, Bonan Ding, Jin Li, Jinshui Shi, Huacen Wang, Kaizhi Zhang, Linwen Zhang (CAEP/IFP, Mainyang, Sichuan)

The best quality induction linac in the world, named Dragon-I, has been built at Institute of Fluid Physics, China Academy of Engineering Physics. It can produce 2.5~3kA high current electron beam with energy of 20MeV and pulse width of 70ns. The spot size of about 1mm diameter has been achieved with beam current greater than 2.5kA.The design of Dragon-I facility is introduced briefly. The commissioning and results of Dragon-I are presented in the paper including the most recent time resolved measurements of beam parameters.

MOP010 – Massive Parallel Wakefield Computation with Moving Window for Short Bunches in Long Structures

Wolfgang F.O. Müller, Xiaoting Dong, Erion Gjonaj, Robert Hampel, Mikko K. Kärkkäinen,

Thomas Lau, Thomas Weiland (TEMF, Darmstadt)
The X-FEL project and the ILC require a high quality beam with ultra short bunches. The knowledge of the short-range wakefields in the TESLA cavities and the collimators is needed to predict the beam quality in terms of the single bunch energy spread and emittance. Especially for the high energy collimators these calculations are limited by numerical dispersion. Earlier we presented wake field calculations for short bunches in long structures for rotationally symmetric components with the code ECHO. Now we present first results from our new wake field code in fully 3D. To calculate the effect of the longitudinal and transverse wakefields we have used the time domain numerical approach. For sufficient resolution of the geometric boundaries and the short bunches (down to the nm-range), huge computational resources are needed. Thus in 3D massive parallelisation of the code is necessary. In addition we used the technique of a moving grid, which gives access also to very long structures, i.e. a complete module of eight TESLA cells or a high energy collimator.

This work was partially funded by EUROTeV (RIDS-011899), EUROFEL (RIDS-011935), DFG (1239/22-3) and DESY Hamburg.

MOP011 – Features of Focusing System of LUE-200 Electron Linac

Anatoly Pavlovich Sumbaev, Vladimir Aleksandrov, Nikolay Kazarinov, Igor Meshkov, Vladimir Shevtsov, Alexey Tuzikov (JINR, Dubna, Moscow Region)
Features of focusing system of LUE-200 electron S-band linac for IREN neutron source (Franklab, JINR, Dubna) are discussed. The focusing system consists of a solenoidal field channel placed in region of an electron source and a first accelerating section and a quadrupole set in region of a second section and a transportation

channel. The system is intended for formation and transportation of an electron beam with 2 - 4 A current and energy in range 60 - 200 ÌeV.

MOP012 – The Upgrade Status and Commissioning of BEPCII Linac

Guoxi Pei (IHEP Beijing, Beijing)

BEPCII- an upgrade project of the BEPC is a factory type of e+e- collider. It requires its injector linac to have a higher beam energy (1.89 GeV) for on-energy injection and a higher beam current (40 mA e+ beam) for a higher injection rate (³50 mA/min.). In five months from May 1st of 2005, we've installed and upgraded major parts of the machine, and then it ran for busy BSRF operation. We took a limited time to commission the machine and got a preliminary but satisfied result, the positron beam at the linac end was about 60mA. Now the linac is running smoothly, almost all design goals were reached. In this paper, we'll present the upgrades for better beam quality, such as phasing system, beam feedback system, and report the present status of the BEPCII linac.

MOP013 – Low-Intensity, Pulsed-Beam Generation System Using the OPU Linac

Ryoichi Taniguchi, Takao Kojima, Shuichi Okuda, Yukio Tanaka (Osaka Prefecture University, Sakai)

An ultra low intensity pulsed electron beam generation system has been developed, which consists of an electron linear accelerator (linac), highly sensitive beam current monitors and beam profile monitors. The beam current has been attenuated to be about ten orders of magnitude weaker than the ordinary beam current by using several methods, e.g. the reduction of the cathode emission in an injector and the use of a narrow slit. The minimum beam charge so far obtained has been estimated to be about several attocoulomb in one beam macropulse. The beam from a linac is controllable, collimated and

synchronized with the trigger signal of the linac. The features are much advantageous compared with those of â-rays from radioisotopes which have been used in low intensity beam irradiation experiments. The final goal of this work is to generate a single electron beam.

MOP014 – Wakefields in the Linacs of the 4GLS

Roger Michael Jones (UMAN, Manchester; SLAC, Menlo Park, California), Peter McIntosh (CCLRC/DL/ASTeC, Daresbury, Warrington, Cheshire)

The 4GLS (Fourth Generation Light Source) at the Daresbury Laboratory is a proposed light source which utilises an energy recovery linac. The linac consist of TESLA-style cells with 7 cells per cavity. The process of re-circulating an electron beam through the accelerating cavities can lead to a resonant excitation of transverse modes which can give rise to a BBU (Beam Break Up) instability. These modes constitute the wake field excited by the electron beam. Modes that are trapped within a particular region of a cavity are a particular cause for concern. We investigate the dipole mode distribution and wake fields in these 7-cell cavities.

MOP015 – Linac Design for the FERMI Project

Gerardo D'Auria (ELETTRA, Basovizza, Trieste)

FERMI is a fourth generation light source under construction at Sincrotrone Trieste. This is based upon the conversion of the existing injector linac to a 1.2 GeV machine suitable to drive a seeded FEL. The linac will require significant improvements and the addition of several new accelerating modules. Important parameters are pulse to pulse energy stability and the jitter of the e-bunch time of arrival. This paper will cover the baseline design of the machine, as well as experimental results and the proposed technical solutions for the more critical sub-systems.

MOP016 – SRF Linac Solutions for 4GLS at Daresbury

Peter McIntosh, Douglas M. Dykes (CCLRC/DL/ASTeC, Daresbury, Warrington, Cheshire)

The proposed 4th Generation Light Source (4GLS) facility, anticipated to be located at Daresbury Laboratory in the UK, will extensively utilise Superconducting RF (SRF) Linacs for each stage of its multi-beam acceleration. IR, XUV and VUV FEL devices, and particularly the ability to combine these sources for users, provide a unique capability for this Energy Recovery Linac (ERL) based accelerator. The CW mode of operation for the SRF Linacs necessitates that adequate provision is made for delivering the required RF power and also damping of the beam induced HOMs to manageable levels. This paper outlines the RF requirements and proposed solutions for each of the 4GLS Linacs.

MOP017 – 4GLS Beam-Break-Up Investigations

Emma Wooldridge, Peter McIntosh (CCLRC/DL/ASTeC, Daresbury, Warrington, Cheshire)

Beam Break Up (BBU) thresholds have been studied as part of the Linac focusing scheme for the proposed 4GLS accelerator. A graded gradient focusing scheme, with a triplet of quadrupoles between each of the modules within the Linac has been chosen. These quadrupoles are set-up in a defocusing – focusing – defocusing format with strengths of -1/2k, k, -1/2k. This value of k was altered and the BBU thresholds for the machine calculated using various BBU codes. Alternate cavity designs have also been investigated using CST's Microwave Studio to see how the effects of higher order modes (HOMs) can be minimised whilst maintaining fundamental field flatness across theaccelerating cells. The number of cells/unit length and cell-to-cell geometries have also been parameterised and the corresponding BBU thresholds presented as a

function of cavity geometry, with the intention of providing an optimum solution for 4GLS.

MOP018 – Upgrading CEBAF to 12 GeV: Project Status

Leigh Harwood (Jefferson Lab, Newport News, Virginia)

Jefferson Lab is preparing to upgrade its 6 GeV Continuous Electron Beam Accelerator Facility (CEBAF) to 12 GeV as part of the 12 GeV Upgrade project. The doubled energy will significantly extend the scientific reach of the three existing Halls with upgraded experimental equipment, and will make possible a new research program in exotic mesons in a newly constructed fourth Hall. The acceleration of the present linacs will be roughly doubled through the addition of ten new cryomodules with performance ~5 times the original specification for CEBAF. The 2K helium plant will be roughly doubled; new rf systems, including digital controls, will be installed for the new cryomodules. The beam transport system's capability will be doubled by strongly leveraging existing hardware (without incurring significant saturation) but must be enhanced with some replacement magnets, new power supplies, one new recirculation arc, and a beamline to the new Hall. Critical Decision 1 was approved by DOE for this project in February 2006. Technical status for the accelerator systems including R&D will be presented as well as the status of the 12 GeV Upgrade Project as a whole.

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MOP019 – Methods to Increase the Energy Resolution at the S-DALINAC

Ralf Eichhorn, Asim Araz, Uwe Bonnes, Marco Brunken, Mykhaylo Gopych, Hans-Dieter Gräf, Stefan Paret, Markus Platz, Achim Richter (TU

Darmstadt, Darmstadt), Wolfgang F.O. Müller, Bastian Steiner, Thomas Weiland (TEMF, Darmstadt)

The S-DALINAC is a recirculating superconducting electron linac operating at 3 GHz. The accelerator delivers a cw beam with energies up to 130 MeV to serve electron scattering experiments where highest momentum resolutions, typ. below 1e-4 are required. Current activities aim to reduce the energy spread of the accelerator by two methods: Long term drifts, mainly a result of temperature drifts, will be corrected by a feedback system which measures the energy variation of the extracted beam continuously using rf-monitors. By means of time-of-flight analysis in a modified beamline a correction signal can be generated as a feedback for the rf control of the accelerating cavities. This system was set-up recently and first results will be reported. Furthermore, the influence of short term fluctuations, e.g. triggered by micro-phonics, on the electron energy can significantly be reduced utilizing the inherent stability of a microtron, if the synchronous phase and longitudinal dispersion are chosen properly. The concept, particle simulations and the experimental verification will be shown as well as necessary modifications to the recirculation scheme to use it in an all-day operation.

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MOP020 – Status of the PITZ Facility Upgrade

Anne Oppelt, Galina Asova, Juergen W. Baehr, Hans-Juergen Grabosch, Sergiy Khodyachykh, Sergey Korepanov, Mikhail Krasilnikov, Bagrat Petrosyan, Lazar Staykov, Frank Stephan (DESY Zeuthen, Zeuthen), Dieter Richter (BESSY GmbH, Berlin), Oleg Kalekin (Humboldt Universitaet zu Berlin, Berlin), Juliane Roensch (Uni HH, Hamburg)

The upgrade of the Photo Injector Test Facility at

DESY in Zeuthen towards the PITZ2 stage is continuously ongoing. In Spring 2006, an intermediate stage was taken into operation (PITZ1.6), including a new gun cavity that has been tuned and conditioned. Currently, three new emittance measurement systems are being installed along the beamline. After their commissioning, studies of the emittance conservation principle will be possible when using the available booster cavity. In the paper, the results of the RF commissioning of the new gun and the first beam measurements using recently installed diagnostics devices will be presented. The ongoing developments of further new diagnostics components will be discussed as well.

This work has partly been supported by the European Community, contracts RII3-CT-2004-506008 and 011935, and by the 'Impuls- und Vernetzungsfonds' of the Helmholtz Association, contract VH-FZ-005.

MOP021 – Recent Operation of the ORELA Electron LINAC at ORNL for Neutron Cross-Section Research

Tim Bigelow, Clint Ausmus, Dane Brashear, Mike Cauley, Klaus Guber, Jack Harvey, Paul Koehler, Roland Overton, John White (ORNL, Oak Ridge, Tennessee)

The ORNL electron LINAC, ORELA, began operation in 1969 and has been instrumental in providing improved neutron cross section data for many isotopes over the 0.002-60 MeV energy range. The ORELA utilizes a 4-30 ns <1000 Hz pulsed gridded electron gun, a 4 section RF Linac, and a water-cooled and moderated tantalum target to generate short neutron pulses. The short pulse lengths and long flight path provide high neutron energy resolution. Beam energy can range up to 180 MeV and a neutron production rate of up to 10e14 n/sec can be generated with 50 kW of beam power. Recent operation is a 8 ns, 525 Hz pulse and a target power of 5-10 kW.

RF power for the accelerator sections are provided by four 24 MW 1300 MHz klystrons. Recent activities have included improvements to the accelerator vacuum, klystrons, interlocks and other upgrades. The current ORELA program is focused on cross-section measurements for the Nuclear Criticality Safety Program and for nuclear astrophysics. Detection and data analysis capabilities have been developed for making highly accurate measurements of neutron capture, neutron total, (n,alpha), and (n,fission) cross sections simultaneously on different beam lines.

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MOP022 – Simulation and Design of a Small LIA Stand

Chuanxiang Tang, Cheng Cheng, Shuqing Liao (TUB, Beijing)

A small LIA experiment stand is designed and manufactured at Accelerator Lab, Tsinghua University. It consists of a thermal cathode DC gun, two induction acceleration cells, pulse power supply system, beam transportation and diagnostics. The electron gun can produce an electron beam of 80 ns, 1.2A and 80keV. Two induction cells accelerate beam energy up to 240keV. The time interval of each two pulses is 300 ns, and the beam pulse flat-top is 80ns. Simulations of the beam transportation by PARMELA code and the optimized results of the beam line will be presented in this paper.

MOP023 – Dispersion Correction of New Beam Transport Line from LINAC to Photon Factory in KEK

Naoko Iida, Mitsuo Kikuchi (KEK, Ibaraki)

The e+/e- injector LINAC in KEK usually injects into four rings which are Low Energy Ring(LER) of KEKB(3.5GeV/e+), High Energy Ring (HER)

of KEKB(8.0GeV/e-), Photon Factory(PF)(2.5GeV/e-) and Advanced Ring for pulse X-rays(PF-AR)(3.0GeV/e-). While LINAC continuously injects into LER and HER alternatively every about five minutes, both of KEKB rings usually storage almost full operating currents. Time for PF or PF-AR which includes switching time had taken about 20 minutes a several times in a day. This had made luminosity at KEKB lower. In summer of 2005, a part of transport line from LINAC to PF were renewed, in which a DC bending magnet only for PF apportions electron beam from the end of LINAC to the new line. We succeeded to reduce the occupancy time for PF injection to about five minutes and there is almost no affection to KEKB luminosity. In this paper optics of the new PF beam transport line is described. In practical performance there had been leakage magnetic field from ECS magnets in KEKB(e+) beam transport line neighboring the PF line. Furthermore we measured the horizontal dispersions along the line. We describe about the magnetic shielding and the optics correction.

MOP024 – Electromagnetic Green's-Function-Based Simulations of Photocathode Sources
Mark Hess, Chong Shik Park, Ling Zhu (IUCF, Bloomington, Indiana)
We show the results of beam simulations for photocathode sources using a newly developed Green's function based code called IRPSS (Indiana Rf Photocathode Source Simulator). In general, a fully electromagnetic treatment of space-charge fields within simulations of photocathode sources is typically difficult since the beam is most often tightly bunched. The problem is further complicated by the inclusion of nearby conducting structures, i.e. cathode and cavity walls, from which the fields are reflected. The entire problem can be solved self-consistently using an electromagnetic Green's function method. Since Green's functions are generated by

a Delta function source while simultaneously satisfying the boundary conditions of the system, they are an effective tool when solving for fields within photocathode source simulations. Using IRPSS we show the results of multiparticle simulations for a variety of photocathode source experiments.

This work is supported by the National Science Foundation.

MOP025 – Study on High-Current Multi-Bunch Beam Acceleration for KEKB Injector Linac

Mitsuhiro Yoshida, Hiroaki Katagiri, Yujiro Ogawa (KEK, Ibaraki)

The KEKB injector linac is usually operated to accelerate only two 10 nC electron bunches to generate positron, since more bunch cannot be equalized the beam energy using the conventional pulse compressor (SLED) and the simple phase modulation. The aim of this study is to find how to accelerate more bunches without any modification of high power RF distribution. One way is that a part of the acceleration units is used to compensate the beam energy difference. On the other hand, the recent electron linac is designed for the multi-bunch operation by compensating the beam loading. And this beam loading compensation method is usually realized by combining the output power of two or more klystrons. However our linac system consists of one 50 MW klystron in one acceleration unit, and eight klystrons are driven by a 100kW klystron. Another way to realize the multi-bunch acceleration in our linac is using the amplitude modulation of the klystron. This is realized using the I-Q modulation of the low level RF considering the non-linear characteristics of the total amplification system including klystrons. Further we developed a FPGA board with 100 MHz DACs and ADCs to realize this.

MOP026 – Beam Dynamics Studies in the CLIC Main Beam Injector Linac

Louis Rinolfi, Frank Tecker (CERN, Geneva), Arnaud Ferrari (UU/ISV, Uppsala)

The CLIC Main Injector Linac has to accelerate both electron and positron beams from 200 MeV up to 2.42 GeV before the injection into the pre-damping rings. The 26 accelerating structures are working at 1.875 GHz with a loaded gradient of 17 MV/m. A FODO lattice wrapping the accelerating structures at the beginning of the linac followed by a succession of triplet lattices between the accelerating structures is proposed. The optics parameters for the different matching sections along the linac are deduced. The large transverse emittances (9200 mm.mrad), bunch length (5 mm) and energy spread (7 MeV rms) for the positron beam impose constraints on the linac in order to reach acceptable characteristics at 2.42 GeV for the injection into the pre-damping ring. The use of a bunch compressor at the entrance of the linac is an option in order to achieve good performance in longitudinal and transverse planes. Tracking of both electron and positron beams in the linac has been performed and is presented.

MOP027 – KEK Injector Upgrade for Fast Beam-Mode Switch

Masanori Satoh (KEK, Ibaraki)

The 8-GeV electron/positron linac of KEK injects beams into the KEKB asymmetric collider rings designed for B-physics studies, and into PF and PF-AR light-source rings for material science. The linac provides high-intensity and high-stability beams, switching between injection modes more than hundred times a day. The performance of this accelerator complex is supported by accelerator studies and maintenance periods well-scheduled between operations for physics experiments. In order to further improve the performance, pulse-to-pulse switching of these beam modes is being planned for FY2005-2006.

MOP028 – Creation of Peaks in the Energy Spectrum of Laser-Produced Ions by Phase Rotation

Akira Noda, Hiroyuki Itoh, Yoshihisa Iwashita, Shu Nakamura, Toshiyuki Shirai, Hikaru Souda, Mikio Tanabe, Hiromu Tongu, Atsushi Yamazaki (Kyoto ICR, Uji, Kyoto), Hiroyuki Daido, Yukio Hayashi, Masataka Kado, Michiaki Mori, Mamiko Nishiuchi, Koichi Ogura, Satoshi Orimo, Akito Sagisaka, Akifumi Yogo (JAEA/ Kansai, Kizu-machi Souraku-gun Kyoto-fu), Atsushi Fukumi, Zhong Li (NIRS, Chiba-shi)

Efficient acceleration of ions with use of very high electromagnetic field created by a high power laser has been paid attention because of its attainable very high acceleration gradient. Its intensity, however, has exponentially decreases according to the increase of its energy, which causes essential difficulty for its real application. For the quality improvement of laser-produced ions in their energy spreads, a scheme to apply an additional RF electric field synchronous to the pulse laser, called "Phase Rotation",* has been applied to the ions produced from the thin foil target 3 and 5 mm, in thickness by irradiation of focused Ti:Sapphire laser with the wave length of 800 nm after optimization of the ion production process with use of real time observation of ion energy by TOF measurement.** Energy peaks with the spread of 7 % have been created in the energy spectrum at the positions depending on the relative phase between the pulse laser and the RF electric field. Possible application of "Phase Rotated" laser-produced ion beam is also to be discussed.

*A. Noda et al., Laser Physics, Vol. 16, No.4, pp.647-653(2006). ** S. Nakamura et al., to be submitted to Jpn. J. Appl. Phys.

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MOP029 – Laser Beat-Wave Microbunching of Realtivistic Electron Beam in the THz Range

Sergei Tochitsky, Chan Joshi, Claudio Pellegrini, Sven Reiche, James Rosenzweig, Chieh Sung (UCLA, Los Angeles, California)

Laser-driven plasma accelerators have recently demonstrated a ~1GeV energy gain of self-trapped electrons in a several-centimeter-long plasma channel. Potential staging of such devices will require external injection of an electron beam prebunched on the scale of 1-10 THz into a plasma accelerating structure or plasma LINAC. Seeded FEL/IFEL techniques can be used for modulation of the electron beam longitudinally on the radiation wavelength. However a seed source in this spectral range is not available. At the UCLA Neptune Laboratory a Laser Beat-Wave (LBW) microbunching experiment has begun. Interaction of the electron beam and the LBW results in ponderomotive acceleration and energy modulation on the THz scale. This stage is followed by a ballistic drift of the electrons, where the gained energy modulation transfers to the beam current modulation. Then the beam is sent into a 33-cm long undulator, where a coherent start-up of THz radiation takes place providing efficient bunching of the whole beam. The performance of LBW bunching is simulated and analyzed using 3D FEL code for the parameters of an existing photoinjector and two-wavelength TW CO2 laser system.

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MOP030 – An Upgrade to NSCL to Produce Intense Beams of Exotic Nuclei

Richard York, Marc Doleans, Terry L. Grimm, Walter Hartung, Felix Marti, Stan Owen Schriber, Xiaoyu Wu, Qiang Zhao (NSCL, East Lansing, Michigan)

A substantially less costly alternative to the Rare Isotope Accelerator (RIA) project has been developed at Michigan State University (MSU). By upgrading the existing facility at the National Superconducting Cyclotron Laboratory (NSCL), it will be possible to produce stable beams of heavy ions at energies of greater than 180 MeV/u with beam power in excess of >80 kW. The upgrade will utilize a cyclotron injector and superconducting driver linac at a base frequency of 80.5 MHz. Radioactive ion beams will be produced in a high-power target via particle fragmentation. A charge-stripping foil and multiple-charge-state acceleration will be used for the heavier ions. The 9 MeV/u injector will include an ECR source, a bunching system, and the existing K1200 superconducting cyclotron with axial injection. The superconducting driver linac will largely follow that proposed by MSU for RIA, using cavities already designed, prototyped, and demonstrated for RIA. The existing A1900 Fragmentation Separator and experimental areas will be used, along with a new gas stopper and reacceleration system.

MOP031 – Beam Distribution System for the MSU-RIA Driver Linac

Marc Doleans, Vladimir Andreev, Felix Marti, Xiaoyu Wu, Richard York (NSCL, East Lansing, Michigan)

The proposed Rare Isotope Accelerator (RIA) facility will deliver up to 400 kW of any stable isotope to multi-target areas to create radioactive ion beams using either Isotope Separation On Line or Particle Fragmentation methods. Operational and programmatic efficiency will be best served by a system that can simultaneously distribute the beam current over a large dynamic range to several targets. The proposed RIA beam switchyard uses an rf kicker-magnetic septum system to distribute the beam to multi-target areas on a micro-bunch by micro-bunch basis. The micro-bunches can be differentially loaded in

the RIA driver linac front end utilizing a scheme similar to that successfully used at Mainz and JLAB CEBAF facility. In these cases, consecutive electron micro-bunches are deflected by an rf kicker and their intensity separately adjusted through variable apertures with an identical second rf kicker returning the micro-bunches on-axis. The feasibility of using a similar system in RIA driver linac front end was explored. The overall concept of the RIA beam distribution system including the differential bunch loading system and the results of the beam dynamics studies will be presented.

This work is supported by the U.S. Department of Energy.

MOP032 – A Novel Method to Produce a Low Emittance Electron Beam

Raymond Patrick Fliller, Helen Edwards, James Santucci, Michael James Syphers (Fermilab, Batavia, Illinois)

A method is described in which a spiral laser pattern is generated onto the photo-cathode of an RF gun to produce a magnetized electron beam in the shape of the spiral. This beam is passed through a flat-beam transformation, which collapses the phase space of one degree of freedom (vertical, say) and results in a corresponding spiral distribution in the other (horizontal) phase space. Ultimately, using a FODO channel with suitable octupole fields, this spiral pattern can be "unwound'" in order to group the particles into a smaller region of the horizontal phase space, improving the overall brightness. In this paper we report on initial experiments at the Fermi/NICADD Photoinjector Laboratory to produce a flat beam with a spiral distribution in the transverse phase space of the larger dimension. We also discuss the design of an appropriate octupole channel and simulations of the resulting beam.

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MOP033 – The Operation Concept of SARAF

Israel Mardor, Dan Berkovits, Yair Grof, Hanoch Hirshfeld, Ami Nagler (Soreq NRC, Yavne), Christian Piel (ACCEL, Bergisch Gladbach), Oded Heber (Weizmann Institute of Science, Rehovot)

The Soreq Applied Research Accelerator Facility (SARAF) is a 5 - 40 MeV, 0.04 -2 mA proton/deuteron RF superconducting linear accelerator, which is under construction at Soreq NRC and is planned to start generating a beam by the end of 2010. SARAF will be a multi-user facility, whose main activities will be neutron physics and applications, radio-pharmaceuticals development and production, and basic nuclear physics research. The operational concept of SARAF will be 'one target at a time' and during irradiation, appropriate shielding will enable preparation and maintenance at other stations. This paper presents the planned facility operation program, the planned operations group, the location and layout of the main control room and the architecture of the main control system, including its interfaces with safety and applications. Emphasis is given to the design considerations for each of the discussed subjects.

MOP034 – Status of FS-FIR Project of the PAL

Jinhyuk Choi, Heung-Sik Kang, Tai-Hee Kang, In Soo Ko, Sung Ju Park, Chang-Mook Yim (PAL, Pohang, Kyungbuk)

At the Pohang Accelerator Laboratory (PAL), a femto-second far infrared radiation (fs-FIR) facility is under construction. It is a THz radiation source using 60-MeV electron linac, which consists of an S-band photocathode RF-gun with 1.6 cell cavity, two S-band accelerating

sturctures, two chicane bunch compressors, and a 1-m long planar undulator. We installed the gun and measured the characteristics. In this article, we will present the construction status of the fs-FIR facility as well as the simulation results and the measurement results of the electron gun.

Korean Ministry of Science and Technology.

MOP035 – Operational Aspects of High-Power Energy-Recovery Linacs

Stephen Vincent Benson, David Douglas, Pavel Evtushenko, Kevin Jordan, George R. Neil (Jefferson Lab, Newport News, Virginia)

We have been operating a high power energy recovery linac (ERL) at Jefferson Lab for several years. In the process we have learned quite a bit about both technical and physics limitations in high power ERLs. Several groups are now considering new ERLs that greatly increase either the energy, the current or both. We will present some of our findings on what to consider when designing, building, and operating a high power ERL. These include space charge effects, halo, magnetic field quality, RF stability, short bunch formation, coherent synchrotron radiation and it effect on the beam, beam breakup instabilities, higher order mode production, and diagnostic requirements.

This work supported by the ONR, the Joint Technology Office, the Army Night Vision Laboratory, the AFRL, the Commonwealth of Virginia, and by DOE Contract DE-AC05-84ER40150.

MOP036 – Status of the PAL-XFEL Project

In Soo Ko (PAL, Pohang, Kyungbuk)

PAL-XFEL, the new X-ray FEL machine that is going to be built at Pohang Accelerator Laboratory, is under intensive design study. The electron beam energy will be 3.7 ~ 4.0 GeV and the target

wavelength will be 0.3 nm. The results as well as the strategy and the difficulties in the PAL-XFEL design are presented in this paper.

Ministry of Science and Technology, Korea.

MOP037 – Applications of Time-of-Flight Measurements at VUV-FEL

Martin Kollewe, Klaus Floettmann (DESY, Hamburg)

As a prototype of the XFEL, VUV-FEL has been build and commissioned at DESY by an international collaboration. It is a linear electron accelerator with an undulator arrangement to produce laser pulses by the 'Self-Amplified Spontaneous Emission' (SASE) process. To generate the laser pulses, electron bunches are compressed in longitudinal direction to reach the necessary peak current of about 2.5 kA. To control the compression process a number of 'Phase Monitors' are installed at the accelerator. They measure the time of the bunch passages. Differences of the bunch passage times at different linac locations yield the 'Time-Of-Flight' (TOF) between these locations. The system is installed with regard to the planned installation of a further RF module operating at the third harmonic RF frequency. This 'third harmonic cavity' is required to optimize the longitudinal bunch charge distribution. Its effect is examined by the TOF measurements. The paper presents the Phase Monitor system to measure the TOF at VUV-FEL. The principle is shown, the determination of 'on-crest'-phases is demonstrated and first measurements of the momentum compaction coefficients, R56 and T566, are discussed.

MOP038 – 200-MHz, 1.5-MeV Deuteron RFQ Linac

Donald A. Swenson, W. Joel Starling (Linac Systems, Albuquerque, New Mexico)

A 200-MHz, 1.5-MeV deuteron RFQ linac system is under construction at Linac Systems.

The linac structure employs the four-bar, radial-strut design, where the four bars are supported by a series of radial struts emanating from the wall of a cylindrical cavity with four-pole symmetry. This structure looks and performs very much like the four-vane RFQ structure. This design is about twice the efficiency of the conventional four-bar RFQ design. Another important advantage of this design is that the dipole mode is higher in frequency than the quadrupole mode, thus eliminating any problems with the mixing of the dipole mode with the quadrupole mode. Injection of deuterons into the linac will be at 50 keV from a microwave ECR ion source. The linac structure is 2.72 meters long. The peak beam current out of the linac will be 20 mA. A pulse duty factor of 5% will yield an average beam current of 1 mA. The rf power requirement is 58 kW to excite the structure, plus 30 kW to accelerate the beam, for a total of 88 kW. This linac system is scheduled for completion in the spring of 2007.

MOP039 – The SPL (II) at CERN, a Superconducting 3.5-GeV H- Linac

Frank Gerigk (CERN, Geneva)

A revision of the physics needs and recent progress in the technology of superconducting (SC) RF cavities have triggered major changes in the design of a SC H- linac at CERN. With 4 - 5 MW beam power, the SPL can be the proton driver for a next generation ISOL-type radioactive beam facility ("EURISOL") and/or supply protons to a neutrino facility (conventional superbeam + beta-beam or neutrino factory). Furthermore the SPL can replace Linac2 and the PS booster, improving significantly the beam performance in terms of brightness, intensity, and reliability for the benefit of all proton users at CERN, including LHC and its luminosity upgrade. Compared with the first conceptual design, the beam energy is almost doubled (3.5 GeV instead of 2.2 GeV) while the length is

reduced by 40%. At a repetition rate of 50 Hz, the linac re-uses decommissioned 352.2 MHz RF equipment from LEP in the low-energy part. Beyond 90 MeV the RF frequency is doubled, and from 180 MeV onwards high-gradient SC bulk-niobium cavities accelerate the beam to its final energy of 3.5 GeV. This paper presents the overall design approach, together with the technical progress since the first conceptual design in 2000.

MOP040 – Design of the PEFP 100-MeV Linac

Ji-Ho Jang, Yong-Sub Cho, Ky Kim, Yong-Hwan Kim, Hyeok-Jung Kwon (KAERI, Daejon)

The Proton Engineering Frontier Project (PEFP) is constructing a 100 MeV proton linac in order to provide 20 MeV and 100 MeV proton beams. The linac consists of a 50 keV proton injector, a 3 MeV radio-frequency quadrupole (RFQ), a 20 MeV drift tube linac (DTL), a medium energy beam transport (MEBT), and the higher energy part (20 MeV ~ 100 MeV) of the 100 MeV DTL. The MEBT is located after the 20 MeV DTL in order to extract 20 MeV proton beams as well as to match the proton beam into the higher energy part of the linac. The 20 MeV part of the linac was completed and is now under beam test. The higher energy part of the PEFP linac was designed to operate with 8% beam duty and is now under construction. This brief report discusses the design of the PEFP 100MeV linac as well as the MEBT.

This work was supported by the 21C Frontier R&D program in Mnistry of Science and Technology of the Korean Government.

MOP041 – Test Results of the PEFP 20-MeV Proton Accelerator

Hyeok-Jung Kwon, Yong-Sub Cho, Hyun-Mi Choi, In-Seok Hong, Ji-Ho Jang, Han-Sung Kim, Yong-Hwan Kim, Kyung Tae Seol, Young-

Gi Song (KAERI, Daejon)
A 20 MeV proton accelerator has been developed by Proton Engineering Frontier Project (PEFP). The accelerator consists of a 50 keV proton injector, a 3 MeV radio frequency quadrupole (RFQ) and a 20 MeV DTL (Drift Tube Linac). The preliminary test is being performed at KAERI (Korea Atomic Energy Research Institute) site. A pulsed proton beam is extracted from the proton injector by switching the high voltage power supply of the ion source. The beam transmission rate through the RFQ was measured with respect to the vane voltage to set the operating point. The 20 MeV DTL consists of four tanks and the beam transmission characteristics have been checked for various parameters. In this paper, a test stand for a 20 MeV accelerator at KAERI site is introduced and the test results are discussed.

This work is supported by the 21C Frontier R&D program in the Ministry of Science and Technology of the Korean government.

MOP042 – Performance of Alternating-Phase-Focused IH-DTL

Yoshiyuki Iwata, Takashi Fujisawa, Satoru Hojo, Nobuyuki Miyahara, Takeshi Murakami, Masayuki Muramatsu, Hirotsugu Ogawa, Yukio Sakamoto, Satoru Yamada, Kazuo Yamamoto (NIRS, Chiba-shi), Tetsuya Fujimoto, Takeshi Takeuchi (AEC, Chiba), Toshinori Mitsumoto, Hiroshi Tsutsui (SHI, Tokyo)
Tumor therapy using HIMAC has been performed at NIRS since June 1994. With the successful clinical results over more than ten years, a number of projects to construct these complexes have been proposed over the world. Since existing heavy-ion linacs are large in size, the development of compact linacs would play a key role in designing compact and cost-effective complexes. Therefore, we designed a compact injector system consisting of RFQ and

Interdigital H-mode DTL (IH-DTL) having the frequency of 200 MHz. For the beam focusing of IH-DTL, the method of Alternating-Phase-Focusing (APF) was employed. By using APF, no focusing element in the cavity, such as quadrupole magnets, is needed. Having employed APF IH-DTL, the injector system is compact; the total length of two linacs is less than 6m. The injector system can accelerate carbon ions up to 4.0 AMeV. The construction and installation of RFQ and APF IH-DTL has completed, and the beam tests were performed. We succeeded to accelerate carbon ions with satisfactory beam intensity and emittances. The design and performance of RFQ and APF IH-DTL will be presented.

MOP043 – Upgrade of 1-MeV Heavy Ion ISR RFQ Accelerator

Yuanrong Lu, Jia-er Chen, Jia-Xun Fang, Shu Li Gao, Ju Fang Guo, Zhiyu Guo, Wei Guo Li, Shi Xiang Peng, Feng Qian, Zhi Zhong Song, Xueqing Yan, Jin Xiang Yu, Mao Lin Yu, Zhong Xi Yuan, Hong Lin Zhang, Kun Zhu (PKU/IHIP, Beijing)

The upgrade of 1 MeV ISR RFQ accelerator has been launched for exploring the possibilities of a few mA heavy ion beam acceleration and its applications on the material science, biological irradiation and RFQ-AMS carbon chronology. A new ECR ion source with extracting voltage of 22kV, and the LEBT matching section have been redesigned and tested to increase the injection beam current and to realize the beam matching. The experimental tests for the different operating parameters have been compared to the simulations by self developed code RFQDYN. The preliminary results will be presented in this paper.

MOP044 – The High-Intensity Superconducting Linac for the SPIRAL 2 Project at GANIL

Tomas Junquera (IPN, Orsay), Patrick Bertrand, Robin Ferdinand, Marcel Jacquemet (GANIL, Caen)

After a detailed design study phase (2003-2004), the Spiral 2 project at GANIL was officially approved in May 2005. The project group for the construction was launched in July 2005, with the participation of French laboratories (CEA, CNRS) and international partners. The Spiral 2 Driver Accelerator is composed of an injector (protons, deuterons and heavy ions with q/A=1/3), a room temperature RFQ, and a superconducting linac with two beta families of Quarter Wave Resonators. It will deliver high intensity beams for Radioactive Ions production by the ISOL method and stable heavy ions for nuclear and interdisciplinary physics. High intensity neutrons beams will also be delivered for irradiation and time of flight experiments. In this paper we focus on the High Intensity Driver Accelerator design and the results obtained with the first prototypes of several major components.

MOP045 – Performance of SNS Front End and Warm Linac

Alexander V. Aleksandrov, Saeed Assadi, Willem Blokland, Paul Chu, Sarah M. Cousineau, Viatcheslav V. Danilov, Craig Deibele, John Galambos, Stuart Henderson, Dong-o Jeon, Michael Plum, Andrei P. Shishlo, Martin P. Stockli (ORNL, Oak Ridge, Tennessee)

The Spallation Neutron Source accelerator systems will deliver a 1.0 GeV, 1.4 MW proton beam to a liquid mercury target for neutron scattering research. The accelerator complex consists of an H- injector, capable of producing one-ms-long pulses at 60Hz repetition rate with 38 mA peak current, a 1 GeV linear accelerator, an accumulator ring and associated transport lines. The 2.5MeV beam from the Front End is accelerated to 86 MeV in the Drift Tube Linac,

then to 185 MeV in a Coupled-Cavity Linac and finally to 1 GeV in the Superconducting Linac. With the completion of beam commissioning, the accelerator complex began operation in June 2006. Injector and warm linac performance results will be presented including transverse emittance evolution along the linac, longitudinal bunch profile measurements at the beginning and end of the linac, and the results of a beam loss study.

SNS is managed by UT-Battelle, LLC, under cntr. DE-AC05-00OR22725 for the U.S. DOE. SNS is a partnership of 6 national laboratories: Argonne, Brookhaven, Jefferson, Berkeley, Los Alamos and Oak Ridge.

MOP046 – Commissioning of the 7-MeV/u, 217-MHz Injector Linac for the Heavy Ion Cancer Therapy Facility at the University Clinics in Heidelberg

Bernhard Schlitt, Ralph BÃ¤r, Winfried Barth, Tibor Gerhard Fleck, Matthias Hoerr, Gerald Hutter, Carl M. Kleffner, Michael Tobias Maier, Andreas Peters, Marcus Schwickert, Klaus Tinschert, Wolfgang Vinzenz, Hartmut Vormann, Dieter Wilms (GSI, Darmstadt), Rainer Cee, Eike Feldmeier, Bernd Naas, Stefan Scheloske, Juergen Suhm, Sven Vollmer (HIT, Heidelberg), Alexander Bechtold, Gianluigi Clemente, Yuanrong Lu, Manuela Otto, Ulrich Ratzinger, Alwin Schempp, Rudolf Tiede (IAP, Frankfurt-am-Main)

A clinical synchrotron facility designed by GSI for cancer therapy using energetic proton and ion beams (C, He and O) is under construction at the university clinics in Heidelberg, Germany. In this contribution the current status of the injector linac is reported. The installation and commissioning of the linac is performed gradually in three steps for the ion sources and the LEBT, the 400 keV/u RFQ and the 7 MeV/u IH-type drift tube linac. Two powerful 14.5 GHz permanent

magnet ECR ion sources from PANTECHNIK as well as the LEBT and the linac RF system have been installed in Heidelberg between November 2005 and March 2006. A test bench with versatile beam diagnostics elements has been designed and installed for the commissioning phase. In April 2006 the two ion sources produced the first ion beams on the site. Extensive RFQ tests using proton beams have been performed at test benches at the IAP and at GSI already during 2004-2006. The 1.4 MW 217 MHz amplifier for the IH tank has also been commissioned at a test setup at GSI in advance to the installation in Heidelberg. The RF tuning of the 20 MV IH-DTL cavity is performed by the IAP in close cooperation with GSI.

MOP047 – An RFQ-Decelerator for HITRAP
Benjamin Hofmann, Alwin Schempp (IAP, Frankfurt-am-Main), Oliver Karl Kester (GSI, Darmstadt)
The HITRAP linac at GSI will decelerate ions from 5 MeV/u to 6 keV/u for experiments with the large GSI Penning trap. The ions are decelerated at first in the existing experimental storage ring (ESR) down to an energy of 5 MeV/u and will be injected into a new Decelerator-Linac consisting of a IH-structure, which decelerates down to 500keV/u, and a 4-Rod RFQ , decelerating to 5 keV/u. The properties of the RFQ decelerator and the status of the project will be discussed.

MOP048 – Installation of the French High-Intensity Proton Injector at Saclay
Pierre-Yves Beauvais (CEA, Gif-sur-Yvette)
The installation of the French high intensity injector "IPHI" is in progress on the Saclay site. The proton source, RF power system, cooling plant, diagnostics line as well as shielding are now in place. The first sections of the RFQ cavity are installed on their supports. Commissioning is planned during the first half of 2007.

At the beginning of 2008, a beam chopper, developed at Cern, will be inserted between the RFQ and the diagnostics line and tested with a proton beam. At the end of 2008, part of IPHI will be moved from Saclay to Cern. New tests, intended for the LINAC4 project, will be carried out using a negative hydrogen beam. This paper describes the fabrication and assembly operations. The future of IPHI at Cern is evoked.

MOP049 – SPIRAL2 RFQ Prototype Results and RFQ Design

Robin Ferdinand (GANIL, Caen), Olivier Delferriere, Michel Desmons, Romuald Duperrier, Alain France, Didier Leboeuf, Olivier Piquet, Jean-Christian Toussaint (CEA, Gif-sur-Yvette), Yolanda Gómez-Martínez (LPSC, Grenoble)

The SPIRAL2 RFQ has been designed to accelerate a 5 mA deuteron beam (Q/A=1/2) or a 1 mA particle beam with q/A=1/3 up to 0.75 MeV/A at 88MHz. It will also accelerate proton beams. It is a CW machine which has to show stable operation, provide the required availability and reduce losses to a minimum in order to minimize the activation constraints. Extensive modelisation was done to ensure a good vane position under RF. The prototype of this 4-vane RFQ has been built and tested in INFN-LNS Catania and then 2 times in IN2P3-LPSC Grenoble. It allowed us to measure the vacuum quality, the RF field by X-ray measurements, the cavity displacement and the real vane displacement during the RF injection. Different techniques were used, including an innovative and effective CCD measurement with a 0.6 μm precision. Recent development of the RFQ will be presented. This paper outlines the different results.

MOP050 – Construction Plans for the LENS Proton Linac

Vladimir Peter Derenchuk, Alexander Bogdanov, William Philip Jones, Alexander Klyachko, Thomas Rinckel, Paul E. Sokol, Keith Solberg (IUCF, Bloomington, Indiana)

The Low Energy Neutron Source (LENS) at Indiana University will provide moderated neutrons in the meV energy range for materials and neutron physics research as well as MeV energy range neutrons for creating a high flux neutron test environment. Neutrons will be generated by colliding 13 MeV or 21 MeV protons with a Be target. Since December 2004, we have used an existing RFQ and DTL, we have been able to deliver a 0.5% duty factor a 10 mA, 7 MeV beam to a Be target mounted next to a frozen methane moderator*. By early 2007, an additional 7 MeV to 13 MeV DTL section will be added and klystrons will be used to power the RFQ and DTL sections. This will improve the output to 3% duty factor with 20 mA at 13 MeV. A new 75 keV, 150 mA proton injector and 100 mA, high duty factor RFQ is being constructed to replace the original 3 MeV RFQ at a later date. The peak beam current available from the new injector and RFQ will increase to 50 mA with a duty factor of at least 5% or up to 100 mA with lower duty factor. In addition, a 13 MeV to 22 MeV DTL is planned to boost the maximum instantaneous flux available from the neutron source up to about 10E12 n/s/cm^2.

V.P. Derenchuk, et al., "The LENS 7 MeV, 10 mA Proton Linac," PAC05, p. 3200.

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MOP051 – Development of an Intense Neutron Source FRANZ in Frankfurt
Oliver Meusel, Long Phi Chau, Ilja Mueller, Ulrich Ratzinger, Alwin Schempp, Klaus Volk, Chuan Zhang (IAP, Frankfurt-am-Main)
The Stern-Gerlach-Center recently founded at the University of Frankfurt gives the possibility for experiments in accelerator physic, astrophysic and material sience research. It is planned to develop an intense neutron generator within the next 4 years. The proton driver linac consists of a high voltage terminal already under construction to provide primary proton beam energies of max. 150 keV. A volume type ion source will deliver a DC beam current of 100-250 mA at a proton fraction of 90%. A low energy beam transport using two solenoids will inject the proton beam into an RFQ while a chopper at the entrance of the RFQ will create a pulse length of 50 ns and a repetition rate up to 250 kHz. A drift tube cavity for the variation of the beam energy in a range of 1.9 – 2.4 MeV will be installed downstream of the RFQ. Finally a bunch compressor of the Mobley type forms a proton pulse length of 1 ns at the Li target. The maximum energies of the neutrons being adjustable between 100 keV and 500 keV by the primary proton beam. The detailed concept of the high current injector, numerical simulation of beam transport and losses will be presented together with first experimental results.

MOP052 – First Performance Test of an Integrated RFQ-Drifttube-Combination
Alexander Bechtold, Manuela Otto, Alwin Schempp (IAP, Frankfurt-am-Main)
In the frame of a collaboration with the GSI in Darmstadt an RFQ-Drifttube-Combination for the Heidelberg cancer therapy center HICAT has been designed, built and successfully beam tested at the IAP Frankfurt. The integration and combination of both an RFQ and a rebunching drifttube unit inside a common cavity forming

one single resonant RF-structure has been realized for the first time with this machine. The results of the beam measurements and questions about the beam dynamics simulations have been investigated in detail with the code RFQSIM.

Work supported by the BMBF and GSI.

MOP053 – Construction of a High-Current RFQ for ADS Study

Shinian Fu, Shouxian Fang, Keyun Gong, Jian Li, Huafu Ouyang, Jiming Qiao, Taoguang Xu, Wenwu Xu, Xinan Xu, Yuan Yao, Huasun Zhang, Zhonghua Zhang (IHEP Beijing, Beijing), Xialing Guan (CIAE, Beijing)

A high current RFQ accelerator has been constructed in China for the basic study of Accelerator Driven Subcritical System. The ADS project is supported by a national program and aimed at the development of clean nuclear energy to meet of the rapid growth of the nuclear power plants in China. The 3.5MeV RFQ accelerator has been fabricated and installed. Field tuning and high power conditioning indicate a good agreement with our design. The beam commissioning with an ECR ion source is under development. This paper will present the recent progress in the construction and commissioning of the RFQ accelerator.

Work is supported by the national "973 Program."

MOP054 – Status of the SARAF Project

Ami Nagler, Dan Berkovits, Israel Mardor (Soreq NRC, Yavne), Kai Dunkel, Michael Pekeler, Christian Piel, Hanspeter Vogel, Peter vom Stein (ACCEL, Bergisch Gladbach)

Soreq NRC recently initiated the establishment of SARAF – Soreq Applied Research Accelerator Facility. SARAF will be a multi-user facility for basic, medical and biological research, non-destructive testing (NDT) and research, develop-

ment and production of radio-isotopes for pharmaceutical purposes. An on going major activity is research and development of high heat flux (up to 80 kW on a few cm2) irradiation targets. SARAF is based on a continuous wave (CW), proton/deuteron RF superconducting linear accelerator with variable energy (5–40 MeV) and current (0.04-2 mA). SARAF is designed to enable hands-on maintenance, which implies beam loss below 10-5 for the entire accelerator. The commissioning of the Phase I of SARAF (full current, energy up to 4-5 MeV) is taking place during 2006 at Soreq. This paper describes the SARAF project and presents commissioning of the normal conducting injector (i.e., ECR ion source and RFQ). Test results of the beta=0.09 half wave superconducting resonators are presented, and resonator geometry improvements with respect to electron multipacting behavior is discussed. An outlook on the project regarding reaching the final energy of 40 MeV is given.

MOP055 – Transport of LANSCE-Linac Beam to Proposed Materials Test Station
Barbara Blind (LANL, Los Alamos, New Mexico)
Refurbishment of Experimental Area A and installation of a Materials Test Station is planned at the Los Alamos Neutron Science Center (LANSCE). This paper describes the beamline to transport 800-MeV protons from the accelerator to Area A. The beamline has the minimum number of quadrupoles necessary to achieve the desired instantaneous beam parameters at the target, the appropriate beam-centroid excursions at the split target for painting the two target halves, and a beam-centroid crossover upstream of the target to facilitate shielding of upstream components from backstreaming neutrons. Options in the composition of the raster-magnet section represent trade-offs between the number of magnets and the severity of the effects of

magnet failures. Beam diagnostics are an integral part of the beamline design. Instantaneous and painted beam sizes at the target can be inferred by observing the beam at properly chosen upstream locations. A beamline spur to a tune-up beam dump is planned.

This work is supported by the U.S. Department of Energy under contract W-7405-ENG-36.

MOP056 – Continued Monitoring of the Conditioning of the FermiLab Linac 805-MHz Cavities

Elliott McCrory, Thomas K. Kroc, Alfred Moretti, Milorad Popovic (Fermilab, Batavia, Illinois)

We have reported previously on the conditioning of the high-gradient accelerating cavities in the Fermilab Linac. Automated measurements of the sparking rate have been recorded since 1994 and are reported here. The sparking rate has declined since the beginning, but there are indications that this rate may have leveled off now. The X-rays emitted by the cavities are continuing to decrease.

Work supported by the US Department of Energy, contract # DE-AC02-76CH0-3000.

MOP057 – A Cavity Fault Recovery System for the SNS Superconducting Cavity Linac

John Galambos (ORNL, Oak Ridge, Tennessee)

One of the advantages for the change of the Spallation Neutron Source (SNS) linac from copper to superconducting cavities, was the possibility of fault tolerance. Namely, the ability to rapidly recover from a cavity failure, retune the downstream cavities with minimal user disruption. While this is straightforward for electron machines, where beta is constant, it is more involved for the case of proton machines, where the beta changes appreciably throughout the Superconducting Linac (SCL). For SNS when the SCL is first turned on, each cavity's RF

amplitude and phase (relative to the beam) are determined with a beam based technique. Using this information a model calculated map of arrival time and phase setpoint for each cavity is constructed. In the case of cavity failure(s) the change in arrival time at downstream cavities can be calculated and the RF phases adjusted accordingly. Typical phase adjustments are in the 100 – 1000 degree range. This system has been tested on the SNS SCL in both controlled tests and a need based instance in which more than 10 cavity amplitudes were simultaneously reduced. This scheme and results will be discussed.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

MOP058 – Heavy-Ion-Beam Emittance Measurements at the GSI UNILAC

Wolfgang Bayer, Winfried Barth, Ludwig A. Dahl, Lars Groening, Stepan Yaramyshev (GSI, Darmstadt)

The GSI UNILAC, a linac for high current heavy ion beams, serves as an injector for the synchrotron SIS 18 and hence being a part of the future FAIR (Facility for Antiproton and Ion Research) project. The UNILAC post stripper section consists of an Alvarez accelerator with a final energy of 11.4 MeV/u. In order to meet the requirements of the FAIR project (15emA U28+, transversal normalised emittances of ex = 0.8 and ey = 2.5 mm mrad) a part of the UNILAC upgrade program is the increase of the beam brilliance. A detailed understanding of the correlation between space charge forces and focusing during acceleration of high intensity ion beams is necessary. A suited quantity to study is the beam brilliance dependency on the phase advances in the Alvarez section. Measurements are planned in 2006 and coincide with the beam dynamics work package of the European network for High Intensity Pulsed Proton Injector

(HIPPI). Results of the measurements are presented as well as corresponding beam dynamics simulations.

We acknowledge the support of the European Community-Research Infrastructure Activity under the FP6 Structuring the European Research Area Programme (CARE, contract number RII3-CT-2003-506395).

MOP059 – Long-Term Perspective for the UNLAC as a High-Current, Heavy-Ion Injector for the FAIR Accelerator Complex

Winfried Barth, Ludwig A. Dahl, Lars Groening (GSI, Darmstadt), Ulrich Ratzinger (IAP, Frankfurt-am-Main)

The present GSI-accelerator complex, consisting of the linear accelerator UNILAC and the heavy ion synchrotron SIS 18, is foreseen to serve as an U28+-injector for up to 10E+12 particles/s for FAIR. In 2003 and 2004 different hardware measures and careful fine tuning in all sections of the UNILAC resulted in an increase of the beam intensity to 9.5x1E+10 U27+ ions per 100 mks (max. pulse beam power of 0.5 MW). In addition a dedicated upgrade program for the UNILAC will be performed until 2009. It is intended to fill the SIS 18 up to the space charge limit of 2.7x10E+11 U28+ ions per cycle. After completion of the FAIR complex in 2015 the running time for the accelerator facility at least will be 20 years, while the UNILAC will then be in operation for more than 60 years as as a high duty factor heavy ion linac. Different proposals for a new advanced short pulse, heavy ion, high intensity, high energy linac, substituting the UNILAC as a synchrotron injector, will be discussed. This new "High Energy-UNILAC" has to meet the advanced FAIR requirements, will allow for complete multi-ion-operation and should provide for reliable beam operation in the future.

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MOP060 – A New LEBT and RFQ Radial Input Matcher for the UNILAC Front End

Ludwig A. Dahl, Winfried Barth, Stepan Yaramyshev (GSI, Darmstadt), Sergey Visotski, Igor Vorobyov (ITEP, Moscow)

The UNILAC heavy ion accelerator will serve as a high current injector for the future FAIR accelerator complex of GSI. This requires to inject 2.7x10E11 ions/0.1x10E-6s of U28+ into the existing synchrotron (SIS). Additionally, the UNILAC serves in multi beam operation experiments with high duty factor beams of different species. To meet all future demands a dedicated upgrade programme of the UNILAC is in work. This paper focuses on front end improvements. A new beam transport system will provide achromatic deflection and high mass resolution for the heavy ion beams from both existing ion source terminals. A new terminal for high current ion sources with a straight line solenoid based beam channel will be added. E.g. U3+ and U4+ ions with and a total beam current of 55mA will be injected into the RFQ for a maximum intensity yield of U4+-beam at the exit. To optimize the total front end beam transmission a redesigned radial input matcher of the RFQ is already implemented. It enables a smoother RFQ input matching of the high current beam resulting in smaller beam diameter and in lower particle losses. Beam measurements comparing old and new input radial matchers are presented.

Supported by the European Community INTAS Project Ref. no 03-54-3543.

MOP061 – The 70-MeV Proton Linac for the Facility for Antiproton and Ion Research FAIR

Lars Groening, Winfried Barth, Ludwig A. Dahl, Wolfgang Vinzenz, Stepan Yaramyshev (GSI, Darmstadt), Gianluigi Clemente, Ulrich Ratzinger, Alwin Schempp, Rudolf Tiede (IAP, Frankfurt-am-Main)

A significant part of the experimental program at FAIR is dedicated to pbar physics requiring up to 7×1010 cooled pbar per hour. Taking into account the pbar production and cooling rate, this is equivalent to a primary proton beam of 2×1016 protons per hour to be provided by a 70 MeV proton linac preceding two synchrotrons. It has do deliver a pulsed proton beam of 70 mA of 36 μs duration at a repetition rate of 4 Hz. The normalized transverse emittances must not exceed 2.3 mm mrad and the total relative momentum spread must be less than 0.1%. The normal conduction DTL comprises 12 Crossed-bar H-cavities (CH) fed by six rf-power sources in total. The basic layout of the linac as well as the overall cost estimate has been completed including several reviews by external committees. A technical report has been published in May 2006. This paper gives a general overview on the status of the project.

We acknowledge the support of the European Community – Research Infrastructure Activity under the FP6 "Structuring the European Research Area" program (CARE, contract number RII3-CT-2003-506395).

MOP062 – Development of the Lanzhou Heavy-Ion Linac

Yong Liu (IMP, Lanzhou)

A heavy-ion linac scenario is planned to be a part of the future multi-injectors system for the cooler- storage rings of the Heavy Ion Research Facilities in Lanzhou (HIRFL-CSR). The linac is a compact one that delivers heavy ion beams

(U28+ or U40+, to be decided yet) from a superconducting ECR ion source to the injection rigidity range of 1-3T·m of CSRm with 40 meters. It consists of a RFQ and IH-type DTL structures. The RFQ and the first DTL tank work at 100MHz, the subsequent DTL tanks at the double frequency. The optimization strategies concern about adiabaticity and high-current upgrade in the future. The primary design work is shown in this paper.

MOP063 – Deceleration of Highly Charged Ions for the HITRAP Project at GSI
Oliver Karl Kester, Winfried Barth, Ludwig A. Dahl, Frank Herfurth, Michael Kaiser, Hans-Jürgen Kluge, Christophor Kozhuharov, Wolfgang Quint (GSI, Darmstadt), Benjamin Hofmann, Ulrich Ratzinger, Andreas Christoph Sauer, Alwin Schempp (IAP, Frankfurt-am-Main)
The highly charged heavy ion trap (HITRAP) project at GSI is a funded mid term project and is planned to be operational end of 2007. Highly charged ions up to U92+ provided by the GSI accelerator facility will be decelerated from 4 MeV/u down to 6 keV/u and subsequently be injected into a large Penning trap for further deceleration and phase space cooling. The deceleration is done in a combination of the GSI experimental storage ring (ESR) and a linac based on an IH-structure and a RFQ. In front of the decelerator linac a double drift-buncher-system provides for phase focusing and a final de-buncher integrated in the RFQ-tank reduces the energy spread in order to improve the efficiency for beam capture in the cooler trap. The paper reports the beam dynamics design along the entire decelerator down to the trap injection point, as well as and the status of the cavities. Finally the time schedule and ESR and linac commissioning are discussed.

MOP064 – Study the Emittance Preservation of the Proposed ILC Main Linac Following the Earth Curvature

Nikolay Solyak, Shekhar Mishra, Jean-Francois Ostiguy, Kirti Ranjan, Alexander Valishev (Fermilab, Batavia, Illinois)

Recently, the International Linear Collider (ILC) Global Design Effort (GDE) group has adopted the Baseline Configuration Document (BCD) which outlines the basic configuration for the next-generation particle accelerator that will make electron and positron collide at energies well beyond the reach of the present accelerators. It is envisaged in BCD that the main linear accelerator (linac) of ILC will follow the earth curvature instead of being laser-straight. Beam based alignments will be imperative for preserving the small vertical beam emittances through the main linac. Various beam based algorithms have been developed during the last decade. However, most of the simulation studies assumed the straight geometry of the linac. In this work we have performed the simulation study of single bunch emittance dilution for the ILC main linac following the earth curvature, and also the implications of curved geometry on steering using the LIAR code. We have also investigated the sensitivity of these steering algorithms by taking into account the effect of various static misalignments on the emittance dilution performance of the ILC main linac.

Work is supported by DOE.

MOP065 – Beam Dynamics Aspects of the ILC Module Test Facility at Fermilab

Philippe Regis-Guy Piot (Northern Illinois University, DeKalb, Illinois)

Fermilab is planning the construction of an ILC module test facility whose primary mission is to test subsystems associated to the ILC proposal. This facility will eventually accelerate electron bunches produces by a photo-injector up to ~1

GeV. The injector is based on an upgrade of the soon-to-be-decommissioned Fermilab/NICADD photoinjector laboratory. Design philosophy and performances along with start-to-end simulations of the facility are discussed. We also explore the potential applications of the electron beam produced at this facility both for ILC-related R&D and beyond.

MOP066 – Wake Fields and Beam Dynamics Simulations for the 3.9-GHz Cavities of the ILC

Roger Michael Jones (UMAN, Manchester), Daniel Schulte (CERN, Geneva), Graeme Burt, Amos Christopher Dexter (Microwave Research Group, Lancaster)

Crab cavities are used for the ILC in order to increase the luminosity of the colliding beams. These cavities operate at the 3rd harmonic of the accelerating frequency (1.3GHz). We study the LOM (Lower Order Modes) and HOM (Higher Order Modes) excited by the beam. The corresponding wake field is calculated and simulations are conducted on the beam dynamics of the interaction of the wake field with the multi-bunch beam train.

MOP067 – Beam Dynamics and Higher Order Mode Wake Field Simulations in the ILC Main Linacs

Roger Michael Jones, Christopher Glasman (UMAN, Manchester)

The progress of approximately 3000 electron (and positron) bunches down the main linacs of the ILC (International Linear Collider) can readily give rise to dipole modes which distrupt the progress of the beam. We investigate the transverse modes which are excited and monitor the resulting emittance dilution which occurs down the linac. At present there are two design configurations for the ILC: the BCD (Baseline Configuration Design) and the ACD (Alternate Configuration Design). We investigate the wake

fields and beam dynamics for both configurations. In particular, the influence of trapped modes on the emittance of the beam is studied.

MOP068 – Beam-Loss Measurement and Simulation of Low-Energy SNS Linac
Saeed Assadi (ORNL, Oak Ridge, Tennessee), Alexander P. Zhukov (RAS/INR, Moscow)
We have installed a number of Neutron detectors from the MEBT to the end of CCL [186 MeV]. These detectors are made in collaboration with INR. In this paper we present our implementation and simulation of the losses by inserting Faraday Cups at different energies. We also calibrated neutron detectors and their high voltage dependence. The measured losses are simulated by 3-D transport codes during SCL commissioning. We also discuss future improvements such as interpreting the loss signal in terms of beam current lost in warm part of SNS linac with accurate longitudinal loss distribution as well as plan to automate voltage dependence of the neutron detectors. We compare two different sets of Beam Loss Monitors: Ionization Chambers (detecting X-ray and gamma radiation) and Photo-Multiplier Tubes with a neutron converter (detecting neutrons). We outline such combination is better way to deal with the beam losses than relying on detectors of one type.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

Tuesday Oral Session, TUI
2nd Floor Lecture Hall, 8:30 a.m.
Session Chair: Rod Keller, LBNL

8:30 **TU101 – The International Linear Collider Accelerator Project (ILC)**
Shekhar Mishra (Fermilab, Batavia, Illinois)
The International Linear Collider (ILC) is a proposed future international particle accelerator. It would create high-energy particle collisions between electrons and positrons. The ILC-GDE is developing the Reference Design Report for the ILC. All three regions of the world have focused R&D on Main Linac. Fermilab and SLAC (USA), DESY (Europe) and KEK (Japan) are taking lead role in the Main Linac design. These Main Linac R&D will be presented. Fermilab is a proposed site of the ILC in U.S.A. The ILC R&D at Fermilab in context with the International R&D will also be presented.

9:00 **TU102 – Technologies Toward a 100-kW Free-Electron Laser**
Dinh C. Nguyen (LANL, Los Alamos, New Mexico)
The challenges of a high-average-power (100 kW and above) FEL are not insurmountable. Some of these challenges however require technological solutions beyond the incremental improvements of existing mature technologies. Efforts are underway to develop novel technologies that could lead to a new level of FEL performance, e.g. 100-kW average power. These technologies include a high-average-current RF photo-injectors, spoke resonator RF cavities with energy recovery, high-gain amplifiers driven by high-brightness electron beams, beam-breakup

instability suppression, and new concepts of tapered wiggler designs, e.g. stair-step taper, for efficient energy extraction. In this talk, these technologies, potential benefits and issues will be discussed.

Work supported by the Office of Naval Research and the High-Energy Laser Joint Technology Office.

9:30 **TU103 – Modern Electron Induction Linacs**

Raymond David Scarpetti (LANL, Los Alamos, New Mexico)

Several high power induction linacs are in existence and a couple are being built around the world. Typically, they are capable of delivering about 100 micro-coulombs of e-beam to the target in a single burst and are built for radiographic application. DARHT 2nd Axis induction linac under construction at Los Alamos National Laboratory is the first of its kind, designed to deliver multiple e-beam pulses to the target. This incorporates the latest advances in the induction linac technology. An overview of the existing, as well as the DARHT induction linac, will be presented in this paper.

10:00 **TU1004 – Development of High-Current, High-Duty-Factor H- Injectors**

Martin P. Stockli (ORNL, Oak Ridge, Tennessee)

SNS, FNAL, and CERN have projects that require the production of H- beams with increased intensity and increased duty factors. The most demanding requirements are set by SNS, which plans to upgrade its power to 3 MW. This power level requires a LINAC peak current of 59 mA, which results from an RFQ input current between 67 and 95mA when injecting with rms-emittances between 0.20 and 0.35 Pi-mm-mrad, respectively. Predicted downstream losses exclude the use of higher emittance beams. Ion source lifetime and reliability requirements are

also stringent to meet the 99.5% availability goal for the injector of a user facility with 95% availability. LEBT options are currently being studied to optimally match the ion source output into the RFQ with a minimal distortion of the beam emittance. Several ion source and LEBT options under consideration will be discussed.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

Tuesday Oral Session, TU2
2nd Floor Lecture Hall, 11:00 a.m.
Session Chair: Curt Hovater, JLab

11:00 **TU201 – The 12-GeV CEBAF Upgrade Project**

Arne Freyberger, Jay Benesch, S. Alex Bogacz, Yu-Chiu Chao, Joseph Michael Grames, Leigh Harwood, Reza Kazimi, Geoffrey Arthur Krafft, Lia Merminga, Eduard Pozdeyev, Yves Roblin, Michael Spata, Mark Wiseman, Byung Chel Yunn, Yuhong Zhang (Jefferson Lab, Newport News, Virginia)

The status of the CEBAF recirculating linac upgrade from 6 GeV to 12 GeV is presented. This upgrade consists of an increase in machine energy by a factor of two and the addition of a new experimental hall [including new extraction region and transport line]. The doubling of the energy will be achieved by three means: added new high-gradient 7-cell cryomodules, refurbishment of existing cryomodules, and adding an extra pass through the linac. Beam requirements, beam physics issues including synchrotron radiation effects, and the expected beam properties will be presented. The talk will also present the beam optics for the 12 GeV upgrade includ-

ing optimization of multipass transport in the linacs.

Work supported by the U.S. Department of Energy under contract DE-AC05-84ER40150.

11:20 **TU202 – Laser-Based Heavy Ion Production**

Masahiro Okamura (RIKEN, Saitama)

We have focused on high brightness of induced plasma in Laser Ion Source (LIS) to provide intense highly charged ions efficiently. To take the advantage of the intrinsic density of the laser plasma, Direct Plasma Injection Scheme (DPIS) has been developed. The induced laser plasma has initial expanding velocity and can be delivered directly to the RFQ. Extraction electrodes and focusing devices in LEBT are not needed. Since 2004, a newly designed RFQ has been used to verify the capability of the new ion production scheme. We succeeded to accelerate 60 m A of Carbon beam and 60 mA of Aluminium beam. We have also tried to understand plasma properties of various species by measuring charge states distributions and time structures, and are now ready to accelerate heavier species. Currently Silver 15+ beam is planned to be accelerated. In the conference, design strategies and detailed techniques for the DPIS will be described based on the measured plasma properties of various elements and new findings obtained from recent acceleration experiments. The durability and the reproducibility will be also explained.

11:40 **TU203 – BSNS Linac Design**

Shinian Fu, Shouxian Fang (IHEP Beijing, Beijing), Jie Wei (BNL, Upton, Long Island, New York)

Beijing Spallation Neutron Source has been approved in principle by the Chinese government. BSNS can provide a beam power of 100kW on the target in the first phase, and then 200kW in the second phase. The accelerator complex of BSNS consists of an H- linac of 81MeV and a

rapid cycling synchrotron of 1.6GeV at 25Hz repetition rate. In the second phase, the linac energy will be upgraded to 134MeV and the average current will be doubled. The linac has been designed, and some R&D studies have been lunched under the support from Chinese Academy of Sciences. The linac comprises a H- ion source, an RFQ and a conventional DTL with EMQs. This paper will present our major design results and some progresses in the R&D of the linac.

Work performed under the auspices of the Chinese Academy of Sciences

12:00 **TU204 – Results on the Beam Commissioning of the Superconducting-RFQ of the New LNL Injector**

Andrea Pisent (INFN/LNL, Legnaro, Padova)

A new injector for the heavy ion superconducting linac ALPI has been built at LNL. This new accelerator, named PIAVE, is designed to accelerate ions with A/Q=<8.5 up to 1.2 MeV/u. The main components are an ECRIS source operating on a high voltage platform, a three harmonic buncher, a superconducting RFQ cryomodule containing two bulk niobium structures and two QWR cryomodules housing 4 cavities each. In the last year the injector has been commissioned, with O, Ar, Ne and Xe beams, and put into operation. The beam performances, and the results of longitudinal and transverse emittance measurements will be shown and compared with simulations. Neon and argon beams have been delivered to the experiments (after acceleration with PIAVE and ALPI) for a total of about 400 hours. It should be noted that this is the first superconducting RFQ in operation; the design opportunities offered by this technology for a wider field of applications will be briefly discussed. The heart of these opportunity is given by the high intervane voltage in a cw RFQ (PIAVE can operate cw with an intervane voltage higher than 250 kV).

Tuesday Oral Session, TU3
2nd Floor Lecture Hall, 1:40 p.m.
Session Chair: Dieter Trines, DESY

1:40 **TU301 – High-Current Proton Beam Investigation at the SILHI-LEBT at CEA/ Saclay**

Ralph Hollinger, Winfried Barth, Ludwig A. Dahl, Michael Galonska, Lars Groening (GSI, Darmstadt), Raphael Gobin (CEA, Gif-sur-Yvette), Oliver Meusel (IAP, Frankfurt-am-Main)

For the injection of a high current proton beam into the future proton LINAC at GSI for FAIR the ion source and the low energy beam transport system have to deliver a 100 mA proton beam with an energy of 95 keV within an acceptance of 0.3 mm mrad (normalized, rms) at the entrance of the RFQ. Besides the ion source a 2-solenoid focusing system is foreseen as an injection scheme for the subsequent RFQ. The beam parameters of the SILHI ion source and the 2-solenoid LEBT setup generally meet these requirements. Therefore joint emittance measurements on various beam parameters have been performed at the end of the LEBT system. In the frame work of the design study for the future proton LINAC it was a unique possibility to investigate the injection of a high current proton beam into a low energy beam transport system under the influence of space charge. The measurements reveal that a proton current of 100 mA can be achieved at the end of the LEBT while the emittance (95 %, rms, normalized) is as high as 0.3 to 0.5 mm mrad.

2:00 **TU302 – Industrial Aspects of Linac Components**

Anthony Favale (AES, Medford, NY)

The industrial aspects of producing linac components from the particle sources, the accelerator

structures, the magnet systems and RF systems will be discussed. The various aspects of working with national labs and universities will be covered. Such issues as to what type of Contract Form should be used; Organizational Conflict of Interest and Intellectual Property will be covered as well as how best to work with the labs and universities on SBIRs, CRADAs and Work for Others contract. Specific examples will be addressed including the unique issues for the ILC.

Tuesday Poster Session, TUP
Rooms 200 A-C, 2:30-5:30 p.m.
Session Chair: Deepak Raparia, BNL

TUP001 – Linac Automated Beam Phase Control System

Stanley Joseph Pasky, Michael Borland, Lester Erwin, Robert M. Lill, Nicholas Sereno (ANL, Argonne, Illinois)

Adjustment of the rf phase in a linear accelerator is crucial for maintaining optimal performance. If phasing is incorrect, the beam will in general have an energy error and increased energy spread. While an energy error can be readily detected and corrected using position readings from beam position monitors at dispersion locations, this is not helpful for correcting energy spread in a system with many possible phase errors. Uncorrected energy spread results in poor capture efficiency in downstream accelerators, such as the Advanced Photon Source (APS's) Particle Accumulator Ring (PAR) or Booster synchrotron. To address this issue, APS has implemented beam-to-rf phase detectors in the linac, along with software for automatic correction of phase errors. We discuss the design, implementation, and performance of these detectors and how they improved APS top-up operations.

Work supported by U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

TUP002 – High-Dynamic-Range Current Measurements in the Medium-Energy Beta Transport Line at the Spallation Neutron Source

Dirk Alan Bartkoski, Alexander V. Aleksandrov, David E. Anderson, Mark Crofford, Craig Deibele, Stuart Henderson, Jeffrey Patterson, Coles Sibley III, Anthony Webster (ORNL, Oak Ridge, Tennessee), Lisa Day (LANL, Los Alamos, New Mexico)

It is desired to measure the effectiveness of the LEBT (low energy beta transport) chopper system. Since this chopper is required to chop the H- beam to a 1% level, it is required therefore to accurately measure the beam during the chop. A system is developed with a high dynamic range that can both accurately measure the beam to tune the chopper system as well as provide an input to the MPS (machine protection system) to stop the beam in the event of a chopper system failure. A system description, beam based calibration, and beam measurements are included.

TUP003 – Spallation Neutron Source Linac Beam Position and Phase Monitor System

John F. Power, Mathew W. Stettler (LANL, Los Alamos, New Mexico), Alexander V. Aleksandrov, Saeed Assadi, Willem Blokland, Paul Chu, Craig Deibele, John Galambos, Cary D. Long, James Pogge, Anthony Webster (ORNL, Oak Ridge, Tennessee)

The SNS linac currently has 6x beam position monitors which allow the measurement of both beam position and phase from a single pickup. The signals from the pickup lobes are down converted from either 402.5MHz or 805 MHz to 50-MHz IF signals for processing. The IF signals

are synchronously sampled at 40 MHz to generate I and Q signals from which the beam position and phase are calculated. Each BPM sampling reference frequency is locked to a phase-stable 2.5 MHz signal distributed along the linac. The system is continuously calibrated by generating and measuring rf bursts in the processor that travel to the BPM pickup, reflect off of the shorted BPM lobes and return to the processor for re-measurement. The electronics are built in a PCI card format and controlled vith LabVIEW. Details of the system design and performance are presented.

TUP004 – Intense L-Band Electron Linac for Industrial Applications

Sugn-ik Moon, Moo-Hyun Cho, Sang-Hoon Kim, Won Namkung (POSTECH, Pohang, Kyungbuk), Jong-Seok Oh (PAL, Pohang, Kyungbuk)

An intense L-band traveling-wave electron linac is designed for irradiation applications. It is capable to produce 10 MeV electron beams of 30 kW. The operating energy is limited to prevent neutron production. On the other hand, the current is limited by the beam loading effect in the given structure. The accelerating structure operated with 2ð/3 mode is a constant-impedance and disk-loaded structure. We determined the optimum operating parameters by adjusting the duty factor, which was again governed by the available high-power pulsed klystron. The SUPERFISH code was used to design the accelerating and bunching cavities, and the PARMELA code produce the result of beam dynamics. For the cooling system design, the ANSYS code was used. In this paper, we present design details of an intense traveling-wave linac of 10 MeV, 30 kW by a 1.3 GHz, 25 MW pulsed klystron with the duty factor of 2.1x 10-3. And we also present cold tests of the prototype cavities.

Work supported by KAPRA.

TUP005 – Design of an RFQ-Based Neutron Source for Cargo Container Interrogation

John William Staples, Matt Hoff, Joe W. Kwan, Derun Li, Bernhard Ludewigt, Alessandro Ratti, Steve Virostek, Russell Wells (LBNL, Berkeley, California)

An RFQ-based neutron generator system is described that generates pulsed neutrons for the active screening of sea-land cargo containers for the detection of shielded special nuclear materials (SNM). A microwave-driven deuteron source is coupled to an electrostatic LEBT that injects a 40 mA D+-beam into a 6 MeV, 5.1 meter-long 200 MHz RFQ. The RFQ has a unique beam dynamics design and is capable of operating at duty factors of 5 to10% accelerating a D+ time-averaged current of up to 1.5 mA at 5% duty factor, including species and transmission loss. The beam is transported through a specially-designed thin-window into a 2-atmosphere deuterium gas target. A high-frequency dipole magnet is used to scan the beam over the long dimension of the 5 by 40 cm target window. The source will be capable of delivering a neutron flux of 2·107 n/(cm2·s) to the center of a cargo container. Details of the ion source, LEBT, RFQ beam dynamics and gas target design are presented.

This work was supported by the U. S. Department of Homeland Security under contract No. HSHQBP-05-X-00033

TUP006 – A Compact Low-Energy LINAC of 5 kW for Irradiation Application

Y. J. Pei (USTC/NSRL, Hefei, Anhui)

Low energy and high power electron LINAC has widely applied for medicine (radiation therapy, disposable sterilization, sanitation processes etc.), food sterilization and preservation, and so on. Many users of the field as mentioned above hope that the both size and weight of accelerator are reduced. A compact LINAC of 8MeV, 5kW

for food irradiation was described in this paper. The irradiation LINAC has be designed and run for irradiation applications, which is mainly composed of a grid-control electron gun, a traveling wave accelerating tube with a collinear load, scanning magnet and irradiation box with Ti foil window. A key component is a novel coaxal cavities load (collinear load) which made the LINAC to be compact and the size to be small. The irradiation facility of electron LINAC has run well. Its main running parameters are as following: Energy of 8-10 MeV Beam power of 3-5kW Scanning width of 500-800mm Uniform of dose is of ± 3 %.
Y.L.Hong, S.K.Lu, K.Jin, Y.X.Li, G.Y.Feng, Y.G.Zhou, K.Xuan, D.M.Jiang, L.G.Shen, S.Dong, Y.Z.Liu

TUP007 – Low-Energy Linacs and Their Applications in Tsinghua University
Chuanxiang Tang, Huaibi Chen, Yaohong Liu (TUB, Beijing)
During these years, several kinds of low energy linacs were developed for cargo inspection, non-destructive-test and irradiation in Tsinghua University cooperated with NUCTECH company. The newly finished interlaced pulse dual energy 9/6MeV linac for material distinguishing cargo inspection and several others will be described here. The beam dynamics simulation and the experiment results together with some applications of these linacs will be given in this paper.

TUP008 – The First Beam of a Photocathode RF Gun System in Tsinghua University
Chuanxiang Tang, Xiaozhong He, Wenhui Huang (TUB, Beijing)
A photocathode rf gun system is under developing in Tsinghua University for Thomson scattering. The microwave properties and the high power processing of this rf gun were finished. The UV laser system can provide a 266nm laser

pulse with 1~10ps and 200mJ photo energy per pulse. The beam experiments are under way. This paper gives a general description of this photocathode rf gun and its preparation. Also the results of first beam experiment will be given in it.

Supported by NCET

TUP009 – First Tests of the VUV-FEL Machine Protection System with Long Bunch Trains

Lars Fröhlich (Uni HH, Hamburg; DESY, Hamburg), Abdallah Hamdi, Michel Luong (CEA, Gif-sur-Yvette), Max Görler, Peter Göttlicher, Dirk Noelle, Dmytro Pugachov, Holger Schlarb, Siegfried Schreiber, Martin Staack, Matthias Werner (DESY, Hamburg)

The fast machine protection system of the VUV-FEL linac at DESY Hamburg interrupts the production of new bunches in case of too high losses. The loss detection is based on a system of photomultipliers and a measurement of the transmitted charge. During the first operation of the accelerator with macropulses of up to 300 bunches, the interplay of the components has been successfully tested, and issues requiring further improvement have been identified.

TUP010 – The Beam Halo Monitor of SARAF

Israel Mardor, Dan Berkovits, Yosef Eisen, Gustavo Haquin, Dan Hirschmann, Eli Meroz (Soreq NRC, Yavne), Michael Hass, Oded Heber, Yigal Shachar (Weizmann Institute of Science, Rehovot)

A main requirement for the SARAF accelerator is 'hands-on' maintenance, which implies a maximum beam loss of 1 nA per meter. In Phase I of SARAF (4-5 MeV ions at full current), we need to map the beam halo (BH) down to below 1 nA in order to predict, using beam dynamics calculations, the beam loss in the full accelerator. Mapping the halo of a 4 MeV, 2 mA ion beam

down to below 1 nA is unprecedented, so we developed a BH monitor, which incorporates a direct charge measurement and several nuclear techniques, including Rutherford scattering 197Au(p,p)197Au, 7Li(p,n)7Be leading to both neutrons and the radio-isotope 7Be (measured offline post irradiation) and 19F(p,alpha)16O leading to high energy gamma rays. The current is derived using published cross sections. In this paper, we present the SARAF Phase I BH monitor and describe the various measurement techniques. In addition, results of feasibility studies at the Pelletron accelerator of the Weizmann Institute are given. The results of the various current measurement techniques are consistent with the standard Pelletron Faraday Cup to better than 20%. This is sufficient for mapping the SARAF beam halo to the desired accuracy.

TUP011 – Upgrade of Beam Diagnostics in LEBT and MEBT of J-PARC LINAC

Susumu Sato, Tetsuo Tomisawa, Akira Ueno (JAEA/LINAC, Ibaraki-ken), Yasuhiro Kondo (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Hisashi Akikawa, Zenei Igarashi, Masanori Ikegami, Chikashi Kubota, Seishu Lee (KEK, Ibaraki)

After tests in Tsukuba-site, Front end part (from an ion source upto the first drift tube linac) of J-PARC LINAC was transported to Tokai-site. From the coming December, testing with H- beam is planned. After the tests in Tsukuba, a few beam current monitors are added in the low and the medium energy transport line, and those monitors are used for the machine- and the person-protection system. In this paper, design and roles of each monitor are described.

TUP012 – Beam-Position Monitor Calibration at the VUV-FEL Linac at DESY

Nicoleta Baboi, Pedro Castro, Jorgen Lund-Nielsen, Dirk Noelle, Thomas Traber (DESY,

Hamburg), Mikhail Krasilnikov, Wolfgang Riesch (DESY Zeuthen, Zeuthen)
In the VUV Free Electron Laser (FEL) facility at DESY more than 60 beam position monitors (BPM) with single bunch resolution are currently installed, and more are planned for future installation. Their calibration has been initially made by measuring each electronics board in the HF laboratory. However the ultimate calibration of each monitor is made by measuring its response to beam movement. This is a time-consuming procedure depending on the availability and accuracy of other components of the machine such as corrector magnets. On the other hand it has the advantage of getting in one measurement the answer of the monitor with all its components and of being independent of the monitor type. The calibration procedure and particularities for various types of BPMs in various parts of the linac will be discussed. The measurements of BPM offset to quadrupole centers will be compared to wire measurements on a test bench. The possibility to use only laboratory measurements for future accelerators, like the XFEL, as well as alternative calibration procedures with beam will be discussed.

TUP013 – Using Dipole Modes in Superconducting Accelerating Cavities for Beam-Position Monitoring

Nicoleta Baboi, Olaf Hensler (DESY, Hamburg), Olivier Napoly, Rita Paparella (CEA, Gif-sur-Yvette), Nathan Eddy, Sergei Nagaitsev (Fermilab, Batavia, Illinois), Josef Frisch, Stephen Molloy, Marc Ross (SLAC, Menlo Park, California)
Dipole modes have been shown to be successful diagnostics for the beam position in superconducting accelerating cavities at the VUV Free Electron Laser (FEL) facility at DESY. By help of downmixing electronics the signals from the two higher order mode couplers mounted on each cavity are monitored. Due to the non-symmetric

placement of the couplers and the overlapping of the two polarizations of the modes, the calibration is somewhat more complicated than in standard position monitors. A method based on the model independent analysis has been developed. The calibration measurements made at the VUV FEL will be presented.

Work supported in part by the US Department of Energy Contract DE-AC02-76SF00515

TUP014 – Electron Signal Detection for the Beam-Finder Wire of the Linac Coherent Light Source Undulator

Juhao Wu, Paul Emma, R. Clive Field (SLAC, Menlo Park, California)

The Linac Coherent Light Source (LCLS) is a SASE x-ray Free-Electron Laser (FEL) based on the final kilometer of the Stanford Linear Accelerator. The tight tolerances for positioning the electron beam close to the undulator axis calls for the introduction of Beam Finder Wire (BFW) device. A BFW device close to the upstream end of the undulator segment and a quadrupole close to the down stream end of the undulator segment will allow a beam-based undulator segment alignment. Based on the scattering of the electrons on the BFW, we can detect the electron signal in the main dump bends after the undulator to find the beam position. We propose to use a threshold Cherenkov counter for this purpose. According to the signal strength at such a Cherenkov counter, we then suggest choice of material and size for such a BFW device in the undulator.

Work supported by the U.S. Department of Energy under Contract No. DE-AC02-76SF00515.

TUP015 – Linac Coherent Light Source (LCLS) Bunch-Length Monitor Using Coherent Radiation

Juhao Wu, Paul Emma (SLAC, Menlo Park, California)

The Linac Coherent Light Source (LCLS) is a SASE x-ray Free-Electron Laser (FEL) based on the final kilometer of the Stanford Linear Accelerator. One of the most critical diagnostic devices is the bunch length monitor (BLM). We are planning to install BLM right after each compressor utilizing coherent radiation from the last bending magnet. We will calculate the signal strength, and simulate the signal propagation using well-accepted simulation tools in synchrotron radiation community in general, and THz radiation in particular. We will also discuss issues of optics layout, and detectors.

Work supported by the U.S. Department of Energy under Contract No. DE-AC02-76SF00515.

TUP016 – BPM DAQ System Using Fast Digital Oscilloscope

Masanori Satoh, Kazuro Furukawa, Tsuyoshi Suwada (KEK, Ibaraki)

The KEK injector linac is planned to be upgraded to perform the simultaneous injection for four rings (KEKB e-/ e+, PF and PF-AR rings). In this operation mode, each rf pulse accelerates the beam with different charge and energy by controlling the low-level rf phase. For this purpose, it is strongly required to improve the BPM DAQ system. In the current system, maximum DAQ rate is strictly limited by the oscilloscope performance, and it should be improved for the 50-Hz measurement. We made decision to replace the current DAQ system by the fast digital oscilloscope. In this presentation, the system description of the new DAQ system and the result of the performance test will be presented.

TUP017 – A Damper System for the Electron Cooling Beam in the Recycler

Philip Varghese, Brian Chase, Paul W Joireman (Fermilab, Batavia, Illinois)

The antiproton stacking rate in the Fermilab Recycler has been dramatically improved with the commissioning of the Electron Cooling system last year. Various disturbance sources such as mechanical vibrations in the Pelletron , power line fluctuations and coupling from beam ramps in the nearby Main Injector have added noise components in the electron beam position in the 0.5 to 200 Hz range. An AC coupled damping feedback loop with corrector coils for horizontal and vertical position correction at two upstream points from the BPMs was added to the existing BPM system . The system provides 10 – 20 dB damping in the frequency range above without interfering with other DC beam positioning control loops.

TUP018 – Low-Intensity Electron Beam Monitoring and Beam Applications at OPU Linac

Shuichi Okuda, Takao Kojima, Yukio Tanaka, Ryoichi Taniguchi (Osaka Prefecture University, Sakai)

Low intensity beams are generated with a 18 MeV S-band electron linac at Osaka Prefecture University (OPU). The minimum charge of electrons in a pulsed beam has been estimated to be about several attocoulomb. In order to measure the intensity and the profile of the beams with thermoluminescence dosimeters and two-dimensional radiation dosimeters, the characteristics of the dosimeters have been investigated by using the electron beams. For the charge of the beam above one picocoulomb, charge-sensitive type beam monitors have been used. The linear relation between the output signal of the dosimeter and the irradiation dose of the beam has been obtained. From the results it has been found that these dosimeters can be applied to monitoring the

low intensity electron beam. The beam applications under preparation are presented.

TUP019 – Resistive Wall Wake Fields in the High-Frequency AC Conductivity Regime
Roger Michael Jones (UMAN, Manchester), James Clarke, Duncan Scott (Cockcroft Institute, Warrington, Cheshire)
We investigate the resistive wall wake fields in both the main L-band linacs and positron source undulators of the ILC (International Linear Collider). The influence of a.c. conductivity on the beam impedance is studied in both systems. We focus on the influence of high frequencies on the impedance and the corresponding wake field. We include effects due the classical skin depth, anomalous skin depth, and the extreme anomalous skin depth. The wake field and corresponding energy spread induced in the beam is simulated for all three regimes.

TUP020 – THE J-PARC L3BT Monitor System for RCS Injection
Seishu Lee (KEK, Ibaraki)
The J-PARC linac-3GeV rapid cycling synchrotron (RCS) beam transport line (L3BT) monitor system will be used to tune the intensity of 5mA-50mA linac beam. The monitor system is composed of BPMs and multi wire profile scanners (MWPS) in L3BT line and RCS injection area. A non-destructive beam momentum spread monitor using a 4-stripline pickups is also developed in order to measure and control the momentum spread of linac beams. The spatial resolution of less than 0.3mm and momentum spread of less than 0.1% is required for RCS injection to avoid uncontrolled beam losses. In this paper, beam position monitor, profile monitor and momentum spread measurement for J-PARC linac is described. Preliminary results of beam size and m value measurement with quadrupole mode of the signal of 4-stripline BPMs in the KEK MEBT1 are also discussed.

TUP021 – Wire Scanners at J-PARC Linac
Hisashi Akikawa (KEK, Ibaraki)
We plan to install wire scanners for J-PARC linac in order to measure beam profile and emittance. They have been designed to capture electrons in H-, 7um-diameter carbon wires are used in 3MeV point and 30um-diameter tungsten wires are used for 50-181MeV point. We plan to set 36 wire scanners in linac and beam dumps. In this paper, we report the result of beam test with 3MeV beam at KEK and the calculation about signal and wire temperature.

TUP022 – Radiation Maintenance Scenario for J-PARC Beam Transport Collimator System
Masakazu Yoshioka (KEK, Ibaraki), Takao Oogoe, Masashi Shirakata, Yasunori Takeuchi, Masahiko Uota (KEK), Hiroshi Oki (Kaihatsu Sekkei Co. Ltd.)
A movable beam collimator system for the beam transport line between the RCS (Rapid Cycling Synchrotron) and 50 GeV Synchrotron of J-PARC has been fabricated, and installed into the accelerator tunnel. The paper describes radiation maintenance scenario for the collimator system by using the semi-remote handling technologies.

TUP023 – Beam-Size Measurements in the IPNS 50-MeV Transport Line Using Stripline BPMs
Jeffrey Craig Dooling, F. R. Brumwell, Lawrence Donley, Gerald McMichael, Vernon F. Stipp (ANL, Argonne, Illinois)
Continuing with the work started two years ago, the technique of using a two-beamlet model to measure beam size is presented. Beam signals are detected on terminated 50-ohm, stripline BPMs located in the transport line between the 50 MeV linac and rapid cycling synchrotron. Each BPM is constructed with four striplines: top, bottom, left and right. Using a fast-sampling oscilloscope to compare the signals from opposite strip lines

allows one to determine beam size assuming a two beamlet model. Measurements made with the two-beamlet approach are compared with other standard profile diagnostics such as wire-scanners, segmented Faraday cups, and scintillators. Advantages of the two-beamlet method are that it is non intrusive and does not require the presence of a background gas necessary for an IPM. Disadvantages of the technique are that it does not provide a detailed profile and the longitudinal beam pulse length must be short relative to the stripline length.

This work is supported by the US DOE under contract no. W-31-109-ENG-38.

TUP024 – "Oligo-Crystalin" Niobium / Large-Grain Niobium Discs, Directly Cut from Ingot
Bernd Spaniol (W.C. Heraeus GmbH, Hanau)
"Oligo-crystalin" Niobium ingots with very large grains (diameter more than 200 mm) can be perfectly used as start material to cut Niobium discs to form half-cells for SCRF cavities. Caused by the minimum of remaining grain boundaries, the properties of these discs are very promising for the use in SCRF cavities. In addition to the technical properties of such material also the cost benefit is promising. The new production way to cut the discs directly from the ingot is less expensive than the "traditional" sheet rolling process. As a positive side effect, the risk of contaminations is minimized due to the reduced number of production steps.

TUP025 – Optimization of Surface Treatment of High-Gradient Single-Cell Superconducting Cavities at KEK
Fumio Furuta, Yasuo Higashi, Toshiyasu Higo, Hitoshi Inoue, Sergey Kazakov, Hiroshi Matsumoto, Yuichi Morozumi, Robert Steell Orr, Takayuki Saeki, Kenji Saito, Masato Satoh, Kwnji Ueno, Hiroshi Yamaoka (KEK, Ibaraki)
We have continued the study of a series of single

cell superconducting cavities at KEK. These tests are aimed at establishing a prescription for a surface treatment that would reliably allow cavities to reach gradients in excess of 45 MV/m in vertical tests. The cavity profiles were all of the KEK Low Loss design, and were fabricated from deep drawn Niobium half shells using electron beam welding. The cavity initial surface preparation followed an established KEK procedure of centrifugal barrel polishing, high temperature annealing, light chemical polishing, electropolishing. and final a high pressure water rinse. Early results from this series test demonstrated that reaching gradients as high as 50 MV/m is feasible. However, the initial yield was of order 50%. In this paper we will discuss our studies of further improvement of the surface treatment aimed at increasing the yield.

TUP026 – Status of the XFEL Testcavity Program

Detlef Reschke, Arne Brinkmann, Jens Iversen, Waldemar Singer (DESY, Hamburg)

In preparation of the European XFEL-project a testcavity program of about 25 1.3GHz niobium single-cell cavities was launched at DESY beginning of 2005 in parallel to the accelerator nine-cell structure activities. After successful start-up of the DESY in-house fabrication main topics of the program are the optimisation of cavity electron beam welding preparation, the performance of large grain niobium and the qualification of further niobium vendors for cavity production. So far reproducibly all cavities (TESLA cell shape) exceed gradients of 30 MV/m at high Q-values. An electropolished mono-cell fabricated of large grain material reached 41 MV/m at Qo = 1.4e10. The present status and results of the program are presented.

We acknowledge the support of the European Community-Research Infrastructure Activity under FP6 “Structuring the European Research

Area" program (CARE, contract number RII3-CT-2003-506395).

TUP027 – Tests of Superconducting Materials in a High-Q RF Cavity

Christopher Dennis Nantista, Valery Dolgashev, Sami G. Tantawi (SLAC, Menlo Park, California), Peter Kneisel (Jefferson Lab, Newport News, Virginia), Yoshihisa Iwashita (Kyoto ICR, Uji, Kyoto), Tsuyoshi Tajima (LANL, Los Alamos, New Mexico), Alberto Canabal-Rey (NMSU, Las Cruces, New Mexico), Isidoro Enrico Campisi (ORNL, Oak Ridge, Tennessee)

Superconducting rf is of increasing importance in particle accelerators. We have developed a resonant copper cavity with high quality factor and an interchangeable wall for testing superconducting materials.* A compact TE01 mode launcher excites the azimuthally symmetric cavity mode, which allows a gap at the detachable wall and is free of surface electric fields that could cause field emission, multipactor, and rf breakdown. The shape of the cavity is tailored to focus magnetic field on the test wall, formed by a material sample. Working at X-band allows us to test small samples in a small available dewar, as well as taking advantage of available high power. We present results of cryogenic experiments conducted with this cavity. Low power tests allow characterization of the cavity parameters and their variation with temperature; high power tests allow determination of field limits for the superconducting samples. We describe our signal processing and analysis. Our experiments begin with reactor-grade niobium, followed by MgB2.

*C. Nantista et al., "Test Bed for Superconducting Materials," presented at the 2005 Particle Accelerator Conference, Knoxville, Tennessee, May 16-20, 2005; SLAC-PUB-11246.

Work supported by the U.S. Department of Energy under contract DE-AC02-76SF00515.

TUP028 – Some Analysis Results of the SNS SRF Cavity Dynamics and Statistics

Sang-Ho Kim, Isidoro Enrico Campisi, John Galambos (ORNL, Oak Ridge, Tennessee)

The commissioning of the SNS superconducting linac (SCL) was successfully done with performances well above expectations. The SRF cavities are operated in pulsed mode with some spreads of accelerating gradients up to about 20 MV/m. Modeling and analysis tool are prepared for the SRF cavity dynamics, which allows either simulations or verifications of the system such as cavity parameters, RF controls, and calibrations. SRF cavities are supposed to have field tilts whose amounts are hardly measurable. This factor would lead intrinsic uncertainties in determining cavity parameters. Statistics and uncertainties of the cavity parameters from these analyses are reported.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP029 – Performance and Early Operating Experience with the ISAC-II Cryogenic System

Robert Edward Laxdal, Willy Andersson, Igor Sekachev, Guy Stanford (TRIUMF, Vancouver)

A 500 W class refrigerator has been installed and commissioned at TRIUMF to cool the new 20MV superconducting linac. The refrigerator liquifies helium into a common supply dewar. The dewar feeds a common cold manifold and the five cryomodules are fed via parallel cold distribution circuits. The system operates at 4.5K. Measurements have been done to estimate the static loads of the cryomodules and the distribution system and to characterize plant performance. The paper will include a system description, performance results and early operating experience.

TUP030 – RF Cavity Performance and RF Infrastructure for the ISAC-II Superconducting Linac

Robert Edward Laxdal, Iouri Bylinskii, Ken Fong, Michael Laverty, Amiya Kumar Mitra, Thomas Ries, Qiwen Zheng, Vladimir Zviagintsev (TRIUMF, Vancouver)

The ISAC-II superconducting linac is presently being commissioned. Twenty cavities have been prepared and characterized in single cavity tests before mounting in the on-line cryomodules. The cavities are specified to operate at a challenging peak surface field of 30MV to supply an accelerating voltage of 1.1MV/cavity. The cavity bandwidth of +-20Hz is achieved by overcoupling while a mechanical tuner actively maintains the cavity frequency within this bandwidth. An overview of the rf systems will be given. We will describe the early operating experience and compare the cavity on-line performance with the single cavity characterizations.

TUP031 – Beam Dynamics Studies on the ISAC-II Superconducting Linac

Robert Edward Laxdal, Marco Marchetto (TRIUMF, Vancouver)

The ISAC-II superconducting linac is presently in the beam commissioning phase. The linac lattice consists of modules of four quarter wave cavities and one superconducting solenoid. Beam steerers between cryomodules compensate for steering effects due to misalignments in the solenoids. Beam dynamics aspects of linac commissioning will be highlighted.

TUP032 – Initial Results of Beam-Based SNS Cavity Calibrations

Yan Zhang, Isidoro Enrico Campisi, Paul Chu, John Galambos, Stuart Henderson, Dong-o Jeon, Kay-Uwe Kasemir, Andrei P. Shishlo (ORNL, Oak Ridge, Tennessee)

In the beam commissioning of the Spallation Neutron Source superconducting linac, two distinct beam-based superconducting cavity tune-up techniques were studied. One is based on time-of-flight signature matching (phase scan method), and the other is based on the beam-cavity interaction itself (drifting beam method). Both of them may be used to precisely calibrate the pickup probe of a SC cavity and determine the synchronous phase. The initial comparisons of the two techniques at SNS did not achieve the desired precision of 1% due to the influence of calibration errors, noise and coherent interfaces in the system. However, the initial results of beam-based SC cavity pickup probe calibrations agree within approximately 4%, which is comparable to the conventional RF calibrations.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP033 – Performance of High-Purity Niobium Cavities with Different Grain Sizes

Peter Kneisel, Swapan Chattopadhyay, Gianluigi Ciovati, Ganapati Myneni (Jefferson Lab, Newport News, Virginia)

Grain boundaries have for some time been suspected of influencing the performance of rf cavities made from high purity niobium by limiting the temperature dependent BCS surface resistance to a residual resistance because of impurity segregation and by causing field limitations due to flux penetration. We have carried out a comparative study of the rf behavior of 2.2 GHz TM010 cavities of identical shape, fabricated from single crystal niobium, niobium of grain sizes of the order of several cm2 and standard poly-crystalline material. This contribution reports about the results of the measurements of the temperature dependence of the surface resistance Rs(T) and the Q0 vs Eacc behavior at 2 K. From the analysis of the Rs(T)

data at low rf fields material parameters such as gap value, mean free path and residual resistance could be extracted. The dependence of the Q-value on rf field was analyzed with respect to the medium field Q-slope, "Q-drop" at high fields and the "quench" fields. The best performance resulted in a breakdown field of ~ 165 mT, corresponding to an accelerating gradient of Eacc ~ 45 MV/m.

Work supported by the U.S. DOE Contract No DE-AC05-84ER40150

TUP034 – Development of a Superconducting RF Module for Acceleration of Protons and Deuterons at Very Low Energy

Michael Pekeler, Christian Piel, Peter vom Stein (ACCEL, Bergisch Gladbach), Dan Berkovits, Israel Mardor, Ami Nagler (Soreq NRC, Yavne)

A prototype superconducting accelerating module housing six 176 MHz half wave resonators and three superconducting solenoids is currently under production at Accel as part of a 40 MeV linear accelerator at the Soreq NRC. The module will accelerate protons and deuterons from energy of 1.5 MeV/u up to 6.5 MeV. The design is based on a peak electric field gradient of 25 MV/m and maximum 10 W of power dissipation in the helium bath by each cavity. Main design considerations of the cavities, solenoids, tuners and couplers as well as for the module especially in view of assembly and alignment will be presented. First cold cavity test results obtained in Accel's new cold RF test facility will be presented. Prototypes of the tuner, helium vessel, solenoids and the couplers are under construction and partly under test.

TUP035 – Investigation of "Hot Spots" as a Function of Material Removal in a Large-Grain Niobium Cavity

Gianluigi Ciovati, Peter Kneisel (Jefferson Lab, Newport News, Virginia)

The performance of a single-cell cavity made of RRR > 200 large-grain niobium has been investigated as a function of material removal by buffered chemical polishing (BCP). Temperature maps of the cavity surface at 1.7 and 2 K were taken for each step of chemical etching and revealed several "hot-spots", which contribute to the degradation of the cavity quality factor as a function of the radio-frequency (RF) surface field. It was found that number of "hot-spots" decreased for larger material removal. Interestingly, the losses of the "hot-spots" at different locations evolved differently for successive material removal. The cavity achieved peak surface magnetic fields of about of 130 mT and was limited mostly by thermal quench. By measuring the temperature dependence of the surface resistance at low field between 4.2 K and 1.7 K, the variation of material parameters such as the ratio between the energy gap and the critical temperature, the residual resistance and the mean free path as a function of material removal could also be investigated. This contribution shows the results of the RF tests along with the temperature maps and the analysis of the losses caused by the "hot-spots".

Work supported by the U.S. DOE Contract No DE-AC05-84ER40150

TUP036 – Fabrication of Superconducting RF Cavities at DESY

Waldemar Singer (DESY, Hamburg)

An overview of fabrication of TESLA shape SC cavities at DESY is done. The majority of the RF cavities are produced from niobium sheet material by deep drawing and electron beam EB welding. Cavity fabrication from single crystal and large grain niobium is very promising. Several single cell and 9 - cell cavities are produced from large grain niobium of different suppliers. Accelerating gradient of 41 MV/m with high Q was achieved. Investigation has

shown that the definite enlargement of the discs diameter is possible by preserving the single crystal structure. Fabrication method of single crystal cavity of ILC like shape was proposed. A grain boundary free cavity even at the welding area can be produced by special preparation and welding. The build single crystal single cell cavity is in the preparation for the test. The developed method can be extended on fabrication of multi cell cavities. Fabrication of weld less cavities by hydroforming was developed in last years as a reasonable alternative especially for a big series. Several single cell and multi cell cavities are produced. High accelerating gradient of 42 MV/m with high Q was reached.

TUP037 – Possible Upgrade Paths for the LANSCE H- Injector

Lawrence Rybarcyk (LANL, Los Alamos, New Mexico)

The LANSCE linac presently provides both H- and H+ beams to several user facilities. The H- injector uses a cesiated, multi-cusp field, surface converter source operating at duty factors between 10 and 12%, coupled to a Cockcroft-Walton (CW) accelerator to provide peak beam currents of ~15 mA for the LANSCE linac. In an effort to raise the peak beam current available to the majority of the H- users, we are pursuing two options. The first is a low duty factor H- ion source and a 750 keV RFQ that would provide ~25 mA of peak current for use by the Lujan and pRad programs. The second is a low frequency buncher for the existing 80 keV beam transport located inside the CW dome that could provide about a factor of two increase in the peak beam current for the WNR program. This paper will present these two options.

This work is supported by the U. S. Department of Energy, Contract W-7405-ENG-36.

TUP038 – Status of the Sparc Photoinjector
Roberto Boni (INFN/LNF, Frascati (Roma))
The SPARC Project is starting the commissioning of its photo-injector. RF gun, RF sources, RF network and control, power supplies, emittance meter, beam diagnostics and control to measure the RF gun beam have been installed. The photocathode drive laser has been characterized in terms of pulse shape and quality. We will report also about first tests made on RF gun and on the emittance meter device. Additional R&D on X-band and S-band structures for velocity bunching are in progress, as well as studies on new photocathode materials . We will also discuss studies on solenoid field defects, beam based alignments and exotic electron bunch production via blow-out of short laser pulses.

TUP039 – Two-Charge-State Injector for a High Power Heavy-Ion Linac*
Nikolai Vinogradov (Northern Illinois University, DeKalb, Illinois), Vladislav N. Aseev, Peter Ostroumov, Robert Scott (ANL, Argonne, Illinois), Timur Kulevoy (ITEP, Moscow)
A permanent magnet (PM) ECR ion source and following low energy beam transport (LEBT) system with the capability to deliver two-charge-state heavy-ion beams (2Q-LEBT) for high-power linacs is being prototyped at Argonne. The injector consists of the PM ECR ion source, transport line with beam diagnostics including emittance measurements and a multi-harmonic buncher. Recently the ECR ion source has been installed on a high voltage platform to increase the accelerating voltage up to the design value of 100 kV. The unique feature of the 2Q-LEBT layout is that the charge separation is performed off of the platform after acceleration of a multi-component ion beam. This layout allows us to analyze and recombine two-charge-state beams using an achromatic bending system. Improvements of the PM ECR performance and beam optics studies based on measurements of various

heavy-ion beams will be discussed in this paper.
*This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. W-31-109-ENG-38

TUP040 – Progress on a Cryogenically Cooled RF Gun Polarized Electron Source
Raymond Patrick Fliller, Helen Edwards (Fermilab, Batavia, Illinois)
RF guns have proven useful in multiple accelerator applications. An RF gun capable of producing polarized electrons is an attractive electron source for the ILC or an electron-ion collider. Producing such a gun has proven elusive. The NEA GaAs photocathode needed for polarized electron production is damaged by the vacuum environment in an RF gun. Electron and ion backbombardment can also damage the cathode. These problems must be mitigated before producing an RF gun polarized electron source. In this paper we report continuing efforts to improve the vacuum environment in a normal conducting RF gun by cooling it with liquid Nitrogen after a high temperature vacuum bakeout. We also report on a design of a cathode preparation chamber to produce bulk GaAs photocathodes for testing in such a gun. Future directions are also discussed.

This work was supported by Universities Research Association Inc. under contract DE-AC02-76CH00300 with the U.S. DOE and by NICADD.

TUP041 – Characteristics of the Beam from the GTS-ECR Source in CERN's Ion Linac
Richard Scrivens, Johannes Broere, Ludovic Dumas, Charles E. Hill, Detlef Kuchler, Federico Roncarolo, Maurizio Vretenar (CERN, Geneva), Denis Hitz (CEA, Grenoble)
The ion injection chain for the LHC includes a new ECR ion source, in order to increase the ejected Pb ion intensity from Linac 3. The source

has delivered up to twice the intensity of lead 27+ when compared to the former ECR4 ion source. This report details the measurements of the beam quality through the Linac, and the characteristics of the energy ramping cavity which allows multi-turn injection in the momentum phase space in the following sychrotron.

TUP042 – A Proposal for the Post Acceleration, Matching, and Measuring of the H- Ion Beam for CERN's Linac 4

Richard Scrivens, Martin Jensen, Detlef Kuchler, Thomas Meinschad, Fredrik Wenander (CERN, Geneva)

CERN's proposed future Linac 4 is a 160 MeV H- Linac injecting into the Proton Sychrotron Booster. We propose that the ion source parameters (80mA, 500us pulse length, 2Hz repetition rate, 0.25 mm.mrad normalised emittance at 1 sigma) may be achieved by improving an existing 2MHz RF multicusp source. In this report, we explain the proposal to post-accelerate the beam from 35keV to 95keV, and to focus the beam into the RFQ with solenoids, with the aimof avoiding substantial emittance growth. Finally, details of the diagnostics required to test the source are given.

TUP043 – Emittance Measurements on the APS Ballistic Bunch Compression Injector

Yin-e Sun, John Wesley Lewellen (ANL, Argonne, Illinois)

The Advanced Photon Source (APS) ballistic bunch compression (BBC) injector is presently in use as a beam source for a number of experiments, including THz generation, beam position monitor testing for the Linac Coherent Light Source (LCLS), novel cathode testing, and radiation therapy source development. Both ps- and ns-pulse drive lasers are available for use with the injector, allowing single-bunch and multi-bunch, quasi-thermionic emission modes of operation, respectively. The beam emittance is an

important factor when selecting a beam source, even for low-energy applications such as the ones presently driven by the APS BBC gun. In this paper we present the results of emittance measurements on the BBC gun, using both the ps and ns drive lasers.

Supported by U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

TUP044 – Shunt Impedance Measurement of the APS BBC Injector

Yin-e Sun, John Wesley Lewellen (ANL, Argonne, Illinois)

The Advanced Photon Source (APS) ballistic bunch compression (BBC) injector is presently in use as a beam source for a number of experiments, including THz generation, beam position monitor testing for the Linac Coherent Light Source (LCLS), novel cathode testing, and radiation therapy source development. The APS BBC gun uses three independently powered and phased rf cavities, one cathode cell and two full cells, to provide beam energies from 2 – 10 MeV with variable energy spread, energy chirp, and, to an extent, bunch duration. The shunt impedance of an rf accelerator determines how effectively the accelerator can convert supplied rf power to accelerating gradient. The calculation of the shunt impedance can be complicated if the beam energy changes substantially during its transit through a cavity, such as in a cathode cell. We present the results of direct measurements of the shunt impedance of the APS BBC gun on an individual cavity basis, including the cathode cell, as well as report on achieved gradients. We also present a comparison of the measured shunt impedance with theoretical values calculated from the rf models of the cavities.

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TUP045 – Photothermal Cathode Measurements at the Advanced Photon Source
Yin-e Sun, John Wesley Lewellen (ANL, Argonne, Illinois), Donald Feldman (IREAP, College Park, Maryland)
The Advanced Photon Source (APS) ballistic bunch compression (BBC) injector presently uses an M-type thermionic dispenser cathode as a photocathode. This "photothermal" cathode offers substantial advantages over conventional metal photocathodes, including easy replacement and easy cleaning via the cathode's built-in heater. We present the results of quantum efficiency measurements as a function of cathode heater power, laser pulse energy, and applied rf field strength.

The work of Dr. Sun and Dr. Lewellen is supported by U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

TUP046 – Experimental Studies of Electrostatic and Magnetic Solenoid Focusing of Low-Energy, Heavy-Ion ECRIS Beams at the NSCL/MSU
Jeffry W. Stetson, Marc Doleans, Guillaume Machicoane, Felix Marti, Mathias Steiner, Xiaoyu Wu, Peter Andras Zavodszky (NSCL, East Lansing, Michigan)
Replacement of the focusing solenoids between both ECR Ion Sources and the beam analysis dipoles with electrostatic triplets has resulted in a large increase in net accelerator output. 2D emittance scans explain some but not all of this increase. Further improvement is anticipated with a new optical device consisting of an electrostatic quadrupole doublet-octupole-doublet-magnetic sextupole arrangement, which has been built and is being tested in place of a triplet. Motivations and results of measurements and operating experience are discussed.

This work has been supported by National Science Foundation under grant PHY-0110253

TUP047 – High-Brightness Electron Gun for X-ray Source II

Satoshi Ohsawa, Yasufumi Hozumi, Mitsuo Ikeda, Takashi Sugimura, Masafumi Tawada (KEK, Ibaraki), K. Kanno (AET Japan, Inc., Kawasaki-City)

A new electron-gun system has been developed in order to increase X-rays from a new type of a rotating target. In commercial X-ray sources electron beams usually hit the target at the outer part. Owing to deformation by centrifugal force, there has been a limit on the electron beam intensities. In order to overcome this difficulty, we developed a new injection system which bombards the inside of the rotating target. It has an advantage in that the heated-up part has supports back side against centrifugal force. This merit allows us to raise the electron beam intensity to give stronger X-rays. X-ray brightness on a fixed target has been measured utilizing a pulsed beam of 0.2ms, 1 kHz and 60keV or 78keV. We achieved the maximum brightness corresponding to 120kW/mm2 at 240mA in case of a DC beam.

TUP048 – Beam-Loading Effect in the Normal-Conducting ILC Positron Source Pre-Accelerator

Valentin Paramonov (RAS/INR, Moscow), Klaus Floettmann (DESY, Hamburg)

Significant positron bunch charge (several nC) in the ILC Positron Source results in high pulse beam loading for normal-conducting accelerating structures in Positron Pre-Accelerator (PPA). Time interval between bunches (~ 300 ns) is not negligibly small in comparison with accelerating structure time constant (rise time for Standing Wave (SW) or filling time for Traveling Wave (TW) options). As the result, beam loading effect has particularities both from stored energy

acceleration regime and continuous beam loading one. Taking into account particular PPA beam structure, beam loading effect is estimated for the present ILC base line parameters, both for SW and TW PPA options. Possible solutions for beam loading compensation are discussed.

TUP049 – Metal-Based Photocathodes For High-Brightness RF Photoinjectors

Luca Cultrera, Giancarlo Gatti, Franco Tazzioli (INFN/LNF, Frascati (Roma)), Carmen Ristoscu (INFLPR, Bucharest - Magurele), Alessio Perrone (INFN-Lecce, Lecce), Jerzy Langner (The Andrzej Soltan Institute for Nuclear Studies, Swierk/Otwock)

Advanced high brightness RF gun injectors require photocathodes with fast response, high quantum efficiency and good surface uniformity. Metal films deposited by various techniques on the gun back wall could satisfy these requirements. Two new deposition techniques have been recently proposed, i.e. pulsed laser ablation and vacuum arc. Several samples of various materials have been deposited by the two techniques: The emission performance and morphological changes induced on the cathode surface by laser beam are compared and discussed.

TUP050 – New Approaches for Undulator-Based Production of Circularly Polarized Photons and Positrons

Alexei Smirnov, David Yu (DULY Research Inc., Rancho Palos Verdes, California)

Linac-driven undulator technology and capabilities are considered for production of polarized positrons and polarized high-brightness X-rays. Challenging requirements for polarized positron production reveal a number of benefits of a microwave undulator compared with a conventional magnetic undulator: larger gap, simpler construction, shorter length, reduced requirements on tolerances and alignment. Two novel approaches are introduced for open and closed

structures: cross-polarized excitation of a circular waveguide and a twisted structure. For the CLIC project the microwave undulator becomes an integral part of the TBA, and as it is naturally powered by the same decelerator. Other applications include emittance dampers, synchrotron radiation sources, and FELs. Additionally the twisted undulator provides unique opportunity for studies of circular dichroism and multi-photon anomalous diffraction (MAD) in protein crystallography.

TUP051 – Wakefunction at Anomalous Dispersion

Alexei Smirnov, David Yu (DULY Research Inc., Rancho Palos Verdes, California)

Long-range wakefield is considered analytically and numerically when one of the modes has a group velocity exceeding the bunch velocity. Numerical results for the wakepotential clearly confirmed the presence of forerunning resonant field propagating ahead of the bunch. This new effect is of potential interest for study of dispersive properties in a wide range of frequencies of some periodic structures and media (including metamaterials, plasma and moving media), and can be exploited for use in particle sensors and diagnostics.

TUP052 – Femtosecond PWT Electron Photoinjector

Yan Luo, Ping Chen, Alexei Smirnov, David Yu (DULY Research Inc., Rancho Palos Verdes, California)

Ultra-short electron pulses can be generated with a femotosecond laser and accelerated with a compact Plane-Wave-Transformer (PWT) photoinjector to energy in the range of a few MeV to tens of Mev. Such pulses have wide applications in ultrafast sciences. Parmela simulations were performed to track the time evolution of the electron bunch. Optimization of the longitudinal space charge mesh was auto-

mated with an iterative process. Simple analytic model and Homdyn code were used along with Parmela simulations.

Work supported by DOE SBIR grants.

TUP053 – An Elemental Cs-System for the SNS Ion Source

Robert Welton, Syd Nails Murray, Martin P. Stockli (ORNL, Oak Ridge, Tennessee), Doug Moehs (Fermilab, Batavia, Illinois)

The ion source employed in the Spallation Neutron Source* (SNS) is an RF-driven, Cs-enhanced, multi-cusp H- source. To date, the source has been successfully utilized in the commissioning of the SNS accelerator producing 10-40 mA. Presently, Cs is dispensed within the source using Cs2CrO4 cartridges located in an air heated/cooled cylindrical collar surrounding the outlet aperture. The temperature of the collar is elevated to release Cs into the source. Typically, this process can only be repeated 2-3 times before the Cs is depleted and the source needs to be replaced. In addition, the dispensers are subject to poisoning by the residual gases in the source leading to beam decay. This is especially problematic at high duty-factor. This report describes the design of an elemental Cs system incorporating an external reservoir based on the proven Fermilab system. Source performance is characterized and compared for both the original and the elemental Cs systems.

*SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP054 – A Helicon Plasma Generator for the SNS H- Ion Source

Robert Welton, Richard Howell Goulding, Syd Nails Murray, Martin P. Stockli (ORNL, Oak Ridge, Tennessee)

The H- ion source employed in the Spallation Neutron Source* (SNS) is an RF-driven, multi-

cusp source, which utilizes a helical antenna to inductively couple power into the source plasma. To date, the source has been successfully utilized in the commissioning of the SNS accelerator producing 10-40 mA of H- with duty-factors of ~0.1%. Ultimately, the SNS facility will require beam duty-factors of 6% and ~60 mA of H- injecting the linac. This may require currents of up to ~100 mA from the source depending on the ion source emittance. To date, the SNS source has only delivered sustained currents of ~33 mA at full duty factor. Therefore, we are developing plasma generators capable of achieving much higher plasma densities. Plasmas generated through helicon-wave coupling can develop densities up to 100 times greater than those produced by conventional inductive coupling. This report presents an initial design and discusses considerations for a source which combines the forward portion of the SNS source with a helicon system. The helicon system consists largely of components retrofitted from the proven hydrogen VASIMR system employed in space propulsion.

*SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP055 – Enhancing the H- Yield from the SNS Ion Source Using a Plasma Gun

Robert Welton, Syd Nails Murray, Martin P. Stockli (ORNL, Oak Ridge, Tennessee), Jerry Carr (New Affiliation Request Pending,)

The ion source developed for the Spallation Neutron Source (SNS) is an RF-driven, multi-cusp source designed to produce ~ 40 mA of H- with a normalized rms emittance of less than 0.2 pi mm mrad. To date, the source has been successfully utilized in the commissioning of the SNS accelerator producing 10-40 mA of H- with duty-factors of ~0.1%. Recently, we found the H- yield from the source could be increased dramati-

cally with the introduction of streaming plasma particles injected into the primary RF plasma from a hemispherical glow discharge chamber located in the rear of the source. In some cases, a 50% increase in the H- beam current was observed. The system also eliminated the need for other plasma ignition systems like a secondary low-power RF generator. This report details the design of the plasma gun as well as the parametric dependence of H- current on source operating conditions. Comparisons are made with and without the gun energized. Finally, an off-line test stand was employed to characterize the plasma current emitted directly from the gun as well as perform lifetime characterization.
SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP056 – The Development of a High-Power, External Antenna, H- Ion Source for the SNS
Robert Welton, Syd Nails Murray, Martin P. Stockli (ORNL, Oak Ridge, Tennessee), Jens Peters (DESY, Hamburg)
The ion source developed for the Spallation Neutron Source* (SNS) is a radio frequency, multi-cusp H- source, which utilizes an internal antenna immersed within the source plasma. To date, the source has been utilized successfully in commissioning of the SNS accelerator delivering 10 - 40 mA with duty-factors of ~0.1% for periods of several weeks. Ultimately, the SNS facility will require beam currents of ~60 mA at 6% duty-factor. Tests have shown that the internal antenna is susceptible to failure at this duty-factor. Currently, two ion sources are being developed which feature ceramic plasma chambers surrounded by an external antenna. The first is a low-power, test version which employs a high-inductance external antenna and produces considerably higher H- beam currents than the original SNS source when both are operated without Cs. The second is a high-power version

which features a Faraday shield with an integrated magnetic confinement structure and is designed to operate at full duty factor. The performance of this source should also greatly exceed that of the present SNS source. Details of the design and the measured performance of each source are discussed.

*SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP057 – A 1+2(1/2) Cell Polarized Electron PWT Photoinjector for the ILC

David Yu, Yan Luo, Alexei Smirnov (DULY Research Inc., Rancho Palos Verdes, California), Ivan Vasilyevich Bazarov (Cornell University, Ithaca, New York), Raymond Patrick Fliller (Fermilab, Batavia, Illinois), Philippe Regis-Guy Piot (Northern Illinois University, DeKalb, Illinois)

The International Linear Collider (ILC) needs a polarized electron beam with a low transverse emittance. High spin-polarization (>85%) is attainable with a GaAs photocathode illuminated by a circularly polarized laser. Low emittance is achievable with an rf photoinjector. DULY Research has been developing an rf photoinjector called the Plane Wave Transformer (PWT) which may be suitable as a polarized electron source for the ILC. A 1+2(1/2) cell, L-band PWT photoinjector with a coaxial rf coupler is proposed for testing the survivability of GaAs cathode. It is planned to produce a high-aspect-ratio beam using a round-to-flat-beam transformation. In addition to its large vacuum conductance, the modified PWT has a perforated stainless steel sieve as a cavity wall, making it easy to pump the structure to better than 10^{-11} Torr at the photocathode. An L-band PWT gun can achieve a low emittance (0.45 mm-mrad for a 0.8nC round beam) with a low operating peak field (<25MV/m). A low peak field is beneficial

for the survivability of the GaAs photocathode because electron backstreaming is greatly mitigated.

Work supported by U.S. Department of Energy Small Business Innovation Research grants.

TUP058 – The RF Design of a HOM Polarized RF Gun for the ILC

Juwen W. Wang, James E. Clendenin, Eric R. Colby, Roger Heering Miller (SLAC, Menlo Park, California), John Wesley Lewellen (ANL, Argonne, Illinois)

The ILC requires a polarized electron beam. While a highly polarized beam can be produced by a GaAs-type cathode in a DC gun of the type currently in use at SLAC, JLAB and elsewhere, the ILC injector system can be simplified and made more efficient if a GaAs-type cathode can be combined with a low emittance RF gun. Since this type of cathode is known to be extremely sensitive to contamination including back bombardment by ions, any successful polarized RF gun must have a significantly improved operating vacuum compared to existing RF guns. We present a new RF design for an L-Band NC RF gun for the ILC polarized electron source. This design incorporates a higher order mode (HOM) structure, whose chief virtue in this application is an improved conductance for vacuum pumping on the cathode. Both 2-D and 3-D models have been used to optimize the RF parameters with two principal goals: first to minimize the required RF power; second to reduce the peak surface field relative to the field at the cathode in order to suppress field emitted electron bombardment. The beam properties have been simulated initially using PARMELA. Vacuum and cooling considerations for this design are discussed.

Work supported by U.S. Department of Energy, contract DE-AC02-76SF00515 (SLAC), W-31-109-ENG-38 (ANL) and DE-AC02-76ER00881 (UW).

TUP059 – Photoinjector Production of a Flat Beam with Transverse Emittance Ratio of 100

Philippe Regis-Guy Piot (Fermilab, Batavia, Illinois), Kwang-Je Kim, Yin-e Sun (ANL, Argonne, Illinois)

The generation of a flat electron beam directly from a photoinjector is an attractive alternative to the electron damping ring as envisioned for linear colliders. It also has potential applications to light sources such as the generation of ultrashort x-ray pulses or Smith-Purcell free electron lasers. In this paper, we report on the experimental generation of a flat beam with a measured transverse emittance ratio of 100±20 for a bunch charge of ~0.5~nC*. The experimental data, obtained at the Fermilab/NICADD Photoinjector Laboratory, are compared with numerical simulations and the expected scaling laws. Possible improvement of the experiment along with application for such a flat beams are discussed

* P. Piot, Y.-E. Sun and K.-J. Kim, Phys. Rev. ST Accel. Beams 9, 031001 (2006)

TUP060 – Status of the EBIS Project at Brookhaven

James Alessi, Donald Barton, Edward Beebe, Steven Bellavia, Omar Gould, Ahovi Kponou, Robert Lambiase, Edward Lessard, Robert Lockey, Vincent LoDestro, Michael Mapes, Daniel McCafferty, Thomas Nehring, Al Pendzick, Alexander I. Pikin, Deepak Raparia, John Ritter, Joseph Scaduto, Louis Snydstrup, Charles Theisen, Michelle Wilinski, Alex Zaltsman (BNL, Upton, Long Island, New York)

The EBIS Project at Brookhaven National Laboratory will replace the Tandem Van de Graaff accelerators with an Electron Beam Ion Source, an RFQ, and short linac, as the heavy ion preinjector for RHIC. This project, jointly funded by DOE and NASA, will provide a modern preinjector which will have increased flexibility in providing beams to the various

programs running simultaneously, will be capable of providing beams not presently available for RHIC and the NASA Space Radiation Laboratory, and will be simpler and less costly to operate. Presently in the first year of the four-year project, the detailed design is nearly complete, and some major procurements have been placed. The overall status of the project will be presented, as well as some unique features in the design, and results from the R&D using the prototype EBIS.

Work performed under the auspices of the U.S. Department of Energy and the U.S. National Aeronautics and Space Administration.

TUP061 – The HERA RF-Driven Multicusp H- Ion Source

Jens Peters (DESY, Hamburg)

The HERA RF-Volume Source is the only source that delivered routinely a H – current of 40 mA without Cs. This current has been improved to 60 mA. For HERA a pulse length of less than 200 μsec is necessary. It was possible to demonstrate a pulse length of 3 msec with the HERA source at DESY in a cooperation with SNS, FNAL and CERN. RF H- sources are now in permanent use for accelerators like HERA or SNS. The reliability of these sources becomes very important. Special techniques for a reliable external RF coupling to the plasma, ignition, filter field, collar transition for extraction and electron dumping have been developed at DESY. The physics of the extraction plasma region was the subject of very detailed investigations with special sets of collars, cones and Langmuir probes.

The support of EEC (Contract HPRI-CT-2001-50021) is gratefully acknowledged.

TUP062 – Emittance Optimization in TTF2 RF Photoinjector

Yujong Kim (DU/FEL, Durham, North Carolina)

To get lasing and saturation at FEL facilities, we should generate high quality electron beams with a low emittance, a high peak current, and a low energy spread. Generally, the RF photoinjector is a key component to generate such a high quality beams. During DESY TESLA Test Facility phase 2 (TTF2) commissioning, we optimized our L-band RF photoinjector and bunch compressor by comparing measurement results and simulation ones. In this paper, we describe our optimization experiences to get about 1.2 mm.mrad transverse normalized emittance for 1.0 nC single bunch charge and 4.4 ps RMS bunch length from TTF2 RF photoinjector.

TESLA Test Facility FEL Team.

TUP063 – Commissioning Experiences of New S-Band RF Gun for the Mark III FEL Facility

Yujong Kim, Glenn Edwards, Mark Emamian, J. Gustavsson, Steven M. Hartman, Owen Oakeley, Gary Swift, Patrick Walter Wallace, Ping Wang, Y. K. Wu (DU/FEL, Durham, North Carolina)

At the Free Electron Laser (FEL) Laboratory of Duke University, there is an S-band linac based Mark III FEL facility which can supply coherent FEL photon in the infrared wavelength range. To supply high quality electron beams and to have excellent pulse structure, we installed one S-band RF gun with the LaB6 cathode for the Mark III FEL facility in 2005. Its longest macropulse length is about 6 us, and maximum repetition rates of macropulse and micropulse are 15 Hz and 2856 MHz, respectively. Therefore our new RF GUN can generate maximum 17142 bunches within a bunch train and maximum 257130 bunches within one second. In this paper, we describe recent commissioning experiences of our

newly installed S-band RF GUN for the Mark III FEL facility.

TUP064 – Adaptive Three-Dimensional RMS Envelope Simulation in the SAD Accelerator Modeling Environment

Christopher K. Allen (LANL, Los Alamos, New Mexico), Kazuro Furukawa, Masanori Ikegami, Katsunobu Oide (KEK, Ibaraki)

The capability for three-dimensional RMS envelope simulation, including space charge, has been implemented in the SAD accelerator modeling environment used at KEK. The SAD (for Strategic Accelerator Design) modeling system consists of a compiled simulation engine, an in-house scripting language SADScript, and user interface support both in Tcl/tk script and SADScript. The RMS envelope simulator is implemented primarily in the SADScript language, which much resembles the Mathematica language. The dynamics within the model are similar to that used by TRACE3D, TRANSPORT, and XAL. Specifically, the symmetric matrix of all second-order beam moments is propagated using a linear beam optics model for the beamline. However, the current simulation engine employs an adaptive space-charge algorithm which actively adjusts the solution integration to maintain a specified accuracy, as well as imposing the symplectic condition. It is designed to keep the integration step size as large as possible while enforcing that the residual solution error remain below a given tolerance. The paper concentrates primarily on the adaptive nature of the RMS simulation, since this is the novel feature.

Work supported by the High Energy Accelerator Research Organization (KEK), Tsukuba, Japan

TUP065 – Longitudinal Beam Dynamic Simulation of SPIN

Bastian Steiner, Wolfgang F.O. Müller, Nutapong Somjit, Thomas Weiland (TEMF, Darmstadt), Ralf Eichhorn, Joachim Enders, Christoph Heßler, Achim Richter, Markus Roth (TU Darmstadt, Darmstadt)

In future, a polarized gun will extend the experiment possibilities of the superconducting recirculating linear electron accelerator S-DALINAC. Therefore a new injector has to be designed where a new 100 keV polarized source SPIN will be added to the present unpolarized thermionic source. A polarization degree of 80%, a mean current of 60 uA and a 3 GHz cw structure are required. All features of the new source will be tested and measured at an offset beam line. The longitudinal beam dynamics of the injector are studied. The electron bunch length behind the gun is about 50 ps. The electrons has to be bunched to 5 ps for capturing the electrons to the main linac. Therefore a chopper/prebuncher system based on the devices used at MAMI is designed. The system consists of a harmonic chopper cavity, a slit, a first and a second harmonic prebuncher. The recent simulation results will be presented here.

Work supported by DFG under contract SFB 634 and GRK 410

TUP066 – Particle Dynamics Calculations and Emittance Measurements at the FETS

Jürgen Klaus Pozimski, Simon Jolly (Imperial College of Science and Technology, London), Dan Faircloth, Alan Letchford (CCLRC/RAL/ISIS, Chilton, Didcot, Oxon), John Back (University of Warwick, Coventry)

High power proton accelerators in the MW range have many applications including drivers for spallation neutron sources, neutrino factories, transmuters (for transmuting long-lived nuclear waste products) and energy amplifiers. In order

to contribute to the development of HPPAs, to prepare the way for an ISIS upgrade and to contribute to the UK design effort on neutrino factories, a front end test stand (FETS) is being constructed at the Rutherford Appleton Laboratory (RAL) in the UK. The aim of the front end test stand is to demonstrate the production of a 60 mA, 2 ms, 50 pps chopped beam at 3 MeV with sufficient beam quality. An overview on the status of the project together with the results of numerical simulations of the particle dynamics from the ion source to the RFQ exit will be presented. The particle distributions gained from the particle dynamics simulations will be compared with recent measurements of the transversal beam emittance behind the ion source and the results discussed.

TUP067 – Tune-up Scenario for Debuncher System in J-PARC L3BT

Masanori Ikegami, Zenei Igarashi, Seishu Lee (KEK, Ibaraki), Tomohiro Ohkawa (JAEA, Ibaraki-ken), Akira Ueno (JAEA/LINAC, Ibaraki-ken)

We plan to start beam commissioning of J-PARC linac and the succeeding beam transport line in December 2006. The beam transport line, to which we refer as L3BT, has two key functionalities to satisfy the requirements for the succeeding ring injection. One is to reduce the momentum jitter and momentum spread, and the other is to scrape off the transverse tail. To realize the former functionality, a debuncher system is installed in L3BT which enables longitudinal gymnastics of the beam to reduce the momentum spread at the ring injection. In this presentation, the tune-up scenario for the debuncher system is presented together with simulation results on the effects of debuncher system.

TUP068 – Tuning Strategy for Transverse Collimator in J-PARC L3BT

Masanori Ikegami, Hisashi Akikawa, Seishu Lee (KEK, Ibaraki), Tomohiro Ohkawa (JAEA, Ibaraki-ken), Hiroyuki Ao, Susumu Sato, Akira Ueno (JAEA/LINAC, Ibaraki-ken)

We plan to start beam commissioning of J-PARC linac and the succeeding beam transport line in December 2006. The beam transport line, to which we refer as L3BT, has two key functionalities to satisfy the requirements for the succeeding ring injection. One is to reduce the momentum jitter and momentum spread, and the other is to scrape off the transverse tail. To realize the latter functionality, a transverse collimator system is installed in L3BT which consists of four horizontal and four vertical collimators. In this presentation, the tuning strategy for the transverse collimator system is presented together with the main features of the collimator system.

TUP069 – Beam Dynamics Study of BSNS DTL Linac

Jun Peng, Shinian Fu, Zhiri Sun (IHEP Beijing, Beijing)

A description is given to the drift-tube-linac (DTL) of the Beijing Spallation Neutron Source (BSNS). The DTL accelerate a 3MeV, 30mA H- beam from the RFQ to the LRBT. Tank body and drift tube configuration design using the SUPERFISH code has enabled efficient optimization of the effective shunt impedance and avoided high surface field. Accelerating cells design and particle tracking were made by using PARMILA code. Special emphasis is given to the transverse focusing system design, which was compared with two usual schemes, constant phase focusing and equipartitioning focusing. Details of beam dynamics analysis will be presented in this paper.

Work performed under the auspices of the Chinese Academy of Sciences.

TUP070 – Comparison of Phase Scan vs Acceptance Scan for the SNS DTL
Dong-o Jeon (ORNL, Oak Ridge, Tennessee)
There are two widely used techniques for setting the rf set-point of the Drift Tube Linac (DTL). The Phase Scan and the Acceptance Scan techniques were applied to the SNS DTL and were benchmarked against each other. Commissioning data indicate that both techniques produce quite consistent results and the model used is quite accurate. Both of the models are based on multiparticle tracking with space charge effects.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP071 – Beam-Loading Effects on Phase Scan for the Superconducting Cavities
Dong-o Jeon, Isidoro Enrico Campisi, Stuart Henderson, Sang-Ho Kim, Yan Zhang (ORNL, Oak Ridge, Tennessee)
When the beam is passing through superconducting cavities, it excites beam induced field in cavities. A systematic study was performed to study the beam loading effects by the nonrelativistic beam for beta = 0.81 superconducting cavities of the SNS linac. The analysis indicates that the induced field level is quite close to the estimation and its effect on the phase scan is consistent with the model.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP072 – Beam Dynamics Studies of the 8-GeV Superconducting H- Linac

Peter Ostroumov, Vladislav N. Aseev, Brahim Mustapha (ANL, Argonne, Illinois)

A 8-GeV H-minus linac has been proposed to enhance the accelerator complex at Fermilab as a high-intensity neutrino source.* The linac is based on 430 independently phased superconducting cavities. The front-end of the linac (up to 420 MeV) operating at 325 MHz is based on RIA-type multi-spoke cavities. The rest of the linac (from 420 MeV to 8 GeV) uses ILC-type elliptical cavities. We have performed large scale end-to-end beam dynamics simulations of the driver linac using the code TRACK** including all sources of machine errors and detailed beam loss analysis. The results of these simulations will be presented and discussed.

* G.W. Foster and J.A. MacLachlan, Proceedings of LINAC-2002, p.826. ** V.N. Aseev et al, Proceedings of PAC-05, Knoxville, Tennessee, May 16-20, 2005.

This work was supported by the U.S. Department of Energy under Contract No. W-31-109-ENG-38

TUP073 – Simulations of RF Errors in the SNS Superconducting Linac

Yan Zhang, Stuart Henderson (ORNL, Oak Ridge, Tennessee)

Minimizing beam emittance growth in the SNS superconducting linac due to RF errors, either correlated or uncorrelated, is essential since it can lead to beam loss in the linac and in the downstream ring. From multi-particle simulation studies of both matched and mismatched linac lattices, for the design peak beam current of 38 mA, as well as a typical commissioning beam current of 20 mA, we conclude that the linac may tolerate much higher non-correlated RF errors, especially in the second half of the superconducting linac, where errors in synchronous phase up to 10 degrees and that of cavity field amplitude

up to 10% is acceptable. However, tolerance to correlated RF errors in the linac is within only 0.5 degree and 0.5 %, from simulations using a simple longitudinal linac model. Beam parameter measurement results acquired during linac beam commissioning confirmed the simulations.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP074 – Beam Dynamics Simulations of the SARAF Accelerator Including Error Propagation and Implications for the EURISOL Project

Jacob Rodnizki, Dan Berkovits, Keren Lavie, Israel Mardor, Asher Shor, Yariv Yanai (Soreq NRC, Yavne), Kai Dunkel, Christian Piel (ACCEL, Bergisch Gladbach), Alberto Facco (INFN/LNL, Legnaro, Padova), Vladimir Zviagintsev (TRIUMF, Vancouver)

Beam dynamics simulations of the SARAF (Soreq Applied Research Accelerator) superconducting RF linear accelerator have bean performed in order to establish the linear accelerator design. The multi-particle simulation includes 3D realistic electromagnetic field distributions, space charge forces and fabrication, misalignment and operation errors. A 4 mA deuteron beam is accelerated up to 40 MeV with a moderated rms emittance growth and a high real-estate acceleration gradient of 2 MeV/m. An envelope of 40,000 macro-particles is kept under a radius of 11 mm, well below the beam pipe bore radius. The accelerator design for SARAF is proposed as an injector for the EURISOL driver accelerator. The basic Accel 176 MHZ beta0=0.09 and beta0=0.15 HWR lattice was extended to 90 MeV based on the LNL 352 MHZ beta0=0.31 HWR. The matching between both lattices ensures smooth transition and the possibility to extend the accelerator to the required EURISOL ion energy.

TUP075 – Automatic Transverse and Longitudinal Tuning of Single- and Multiple-Charge-State Ion Beams

Brahim Mustapha, Peter Ostroumov (ANL, Argonne, Illinois)

Extensive end-to-end beam dynamics simulations of the RIA driver linac using the code TRACK and including all sources of machine errors and detailed beam loss analysis* showed that the losses could be significantly reduced for a fine-tuned linac. For this purpose we have developed an automatic longitudinal tuning proceedure for multiple charge state heavy-ion beams.** For a complete tuning tool, we have recently developed an automatic transverse tuning proceedure to produce smooth transverse beam dynamics by minimizing the RMS beam sizes after each focusing period. We have also extended the automatic longitudinal proceedure to produce smooth longitudinal beam dynamics for single and multiple charge state ion beams. In addition to improving an existing tune, this powerful automatic beam tuning tool can be used to retune the linac and restore the beam after one or more elements failures and to develop new tunes for ion beams with different Q/A ratios. After presenting the method, the results from some applications will be presented and discussed.
* P. Ostroumov, V. Assev and B. Mustapha, Phys. Rev. ST-AB 7 (2004) 090101 ** B. Mustapha and P. Ostroumov, Phys. Rev. ST-AB 8 (2005) 090101

This work was supported by the U.S. Department of Energy under Contract No. W-31-109-ENG-38.

TUP076 – First TRACK Simulations of the SNS Linac

Brahim Mustapha, Vladislav N. Aseev, Peter Ostroumov, Jin Xu (ANL, Argonne, Illinois), Stuart Henderson (ORNL, Oak Ridge, Tennessee)

In an effort to benchmark the code TRACK* against the recent commissionnig data from the SNS linac, we started updating the code TRACK to support SNS-type elements like DTL's and CCL's. 2D electric field tables were computed using SUPERFISH and 3D magnetic fields from PMQ's were calculated using EMS-Studio. A special DTL routine was implemented and successfully tested. The first results of TRACK simulations using a realistic beam will be presented. A comparison with the code PARMILA will also be presented and discussed.
* "TRACK: The New Beam Dynamics code", V.N. Aseev et al, in Proceedings of PAC-05 Conference, Knoxville, Tennessee, May 16-20, 2005.
This work was supported by the U.S. Department of Energy under Contract No. W-31-109-ENG-38

TUP077 – Transverse Beam Matching and Correction Procedures in INR Linac
Sergey Bragin, Alexander Feschenko, Oleg Grekhov, Natalia Lebedeva, Vladimir Mikhailov, Alexander Nikolaevich Mirzojan, Vasili Moiseev, Olga Volodkevich (RAS/INR, Moscow)
An interactive procedure for the transverse beam matching and correction has been developed and implemented in several areas of INR Linac. The profile measurements are used for determination of the main transverse beam parameters. These data are applied for calculation the dipole correction currents and quadrupole gradients to transport the beam with minimum sizes and off axis displacements. The user friendly interface and graphics support has been developed for data treatment and beam behavior presentation. The proposed algorithm of beam matching, beam steering and data treatment is discussed. Some experimental and simulation results for different INR Linac operation modes are presented.

TUP078 – Status of the End-to-End Beam Dynamics Simulations for the GSI UNILAC
Winfried Barth, Wolfgang Bayer, Ludwig A. Dahl, Lars Groening, Stepan Yaramyshev (GSI, Darmstadt)
The heavy ion high current GSI linac UNILAC serves as an injector for the synchrotron SIS18. The UNILAC mainly consists of a High Current Injector (HSI), the stripper section at 1.4 MeV/u, and the Alvarez postaccelerator (11.4 MeV/u). During the last years the systematic experimental and numerical studies resulted in an increase of the U73+ beam intensity of up to a factor of seven. The needs of the FAIR project (Facility for Antiproton and Ion Research at Darmstadt) require further improvement of the beam brilliance coming from UNILAC up to a factor of five. End-to-end beam dynamics simulations with the DYNAMION code have already been started. The general goal is to establish a simulation tool which can calculate the impact of the planned upgrade measures on the performance of the whole UNILAC. The results of the HSI calculations including influence of the beam intensity on the beam parameters (current, emittance, Twiss-parameters) at the stripper section are presented. Recent calculations and measurements of the beam matching to the Alvarez section under space charge conditions are discussed in the paper.

INTAS (project 03-54-3543)

TUP079 – RIAPMTQ/IMPACT: Beam-Dynamics Simulation Tool for RIA
Thomas Wangler, James Billen, Robert Garnett (LANL, Los Alamos, New Mexico), Vladislav N. Aseev, Brahim Mustapha, Peter Ostroumov (ANL, Argonne, Illinois), Ji Qiang, Robert D. Ryne (LBNL, Berkeley, California), Marc Doleans, Dmitry Gorelov, Xiaoyu Wu, Richard York, Qiang Zhao (NSCL, East Lansing, Michi-

gan), Kenneth Crandall (TechSource, Santa Fe, New Mexico)
We describe a multiple-charge-state simulation-code package for end-to-end computer simulations of the RIA heavy-ion driver linac, extending from the low-energy beam transport after the ECR source to the end of the linac. The work is being performed by a collaboration including LANL, LBNL, ANL, and MSU. The package consists of two codes, the code RIAPMTQ for the linac front end including the LEBT, RFQ, and MEBT, and the code IMPACT for the superconducting linac. This code package has been benchmarked for rms beam properties against previously existing codes at ANL and MSU. The simulation tool will allow high-statistics runs on parallel supercomputing platforms, such as NERSC, as well as runs on desktop PC computers for low-statistics design work. It will address an important near-term need for the RIA project, allowing evaluations of candidate designs with respect to beam-dynamics performance including beam losses, which can be compared with predictions of other existing simulation codes.

This work is supported by the U.S. Department of Energy, DOE contract number W-7405-ENG-36

TUP080 – Tuning the Magnetic Transport of an Induction Linac Using Emittance

Timothy Lee Houck (LLNL, Livermore), Paul Wargo (Bechtel Nevada, Los Alamos, New Mexico), Charles Brown, Mike Ong, Arthur Paul, Jan-Mark Zentler (LLNL, Livermore, California)
The Lawrence Livermore National Laboratory Flash X-Ray (FXR) machine is a linear induction accelerator used to produce a nominal 20-MeV, 3-kA, 60-ns pulse width electron beam for hydrodynamic radiographs. A common figure of merit for this type of radiographic machine is the

x-ray dose divided by the spot area on the bremsstrahlung converter. Several characteristics of the beam affect the minimum attainable x-ray spot size. The most significant are emittance, chromatic aberration, and beam motion. FXR is in the midst of a multi-year optimization project to reduce the spot size. This paper describes the effort to reduce beam emittance by adjusting the fields of the transport solenoids. If the magnetic transport is not correct, the beam will be mismatched and undergo envelop oscillations increasing the emittance. We measure the divergence and radius of the beam in a drift section after the accelerator by imaging the optical transition radiation (OTR) and beam envelope on a foil. These measurements are combined with transport simulations to calculate an emittance. Relative changes in the emittance can be quickly estimated allowing for an efficient, real-time study.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

TUP081 – Impact of a RF Frequency Change on the Longitudinal Beam Dynamics

Romuald Duperrier, Didier Uriot (CEA, Gif-sur-Yvette), Nicolas Pichoff (CEA, Bruyères-le-Châtel)

A frequency jump in a high-intensity linac could have some impact on the longitudinal beam dynamics and could therefore introduce some filamentation and even some beam loss if the transition is not done properly. This point is especially important when comparisons of cavity performances are performed. We show in this paper two techniques in order to render transparent for the beam such frequency jump. A few examples which show the efficiency of the two techniques are given.

TUP082 – Development of a Parallel Finite Element Particle-In-Cell Code

Arno E. Candel, Andreas C. Kabel, Kwok Ko, Zenghai Li, Cho-Kuen Ng, Ravindra Uplenchwar (SLAC, Menlo Park, California)

While electromagnetic field solvers have long progressed from structured to unstructured grids for superior resolution of geometric surfaces, almost all existing Particle-In-Cell (PIC) codes still employ the finite difference (FD) method based on structured grids. More recently, parallel implementations have allowed FD PIC codes to further reduce the mesh size for improved field accuracy, albeit at great computational cost. Under the DOE SciDAC program, SLAC has embarked on the development of a parallel PIC code that is formulated self consistently on the finite element (FE) grid. It uses higher-order basis functions for field representation and quadratic approximation of the boundaries. We will report on the progress of a 2D implementation, the comparison with FD PIC codes in efficiency and accuracy, and its application to the LCLS RF gun for which the effects of space charge and wakefields can be accurately computed for the first time. Parallelization strategies and the extension to the fully 3D case will be discussed.

Work supported by DOE contract DE-AC02-76SF00515

TUP083 – Development of High-Power RF Vector Modulator Employing TEM Ferrite Phase Shifters

Yoon W. Kang, Mark Stuart Champion, Sang-Ho Kim, Michael P. McCarthy, Alexandre Vasilievich Vassioutchenko, Joshua Lee Wilson (ORNL, Oak Ridge, Tennessee)

Construction and installation of cavity RF power distribution system in a high power superconducting RF accelerator can have cost savings if a fan-out configuration that feeds many cavities

with a single high power klystron is realized. The configuration however requires independent control of RF amplitudes and phases to the cavities to perform properly. A prototype high power RF vector modulator for the control is built and tested. The vector modulator employs a quadrature hybrid and two fast ferrite phase shifters in square coaxial TEM transmission lines. The square coaxial format can provide the power handling capability and thermal stability. RF properties of the design and result of high power system testing of the design are presented.

This work was supported by SNS through UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP084 – Drifting Beam Application for SNS Superconducting Cavity Setting

Paul Chu, Yan Zhang (ORNL, Oak Ridge, Tennessee)

A software application for tuning superconducting linac cavity has been developed and tested at the Spallation Neutron Source (SNS). The application is based on the drifting beam method and the XAL online model. The drifting beam method and the application were proved to be consistent with other cavity tuning method during the SNS commissioning runs. Detail algorithm and data acquisition for the application will be presented.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

TUP085 – Beam Simulations for the RIA Driver Linac Using Advanced Beam Dynamics Simulations Tool: RIAPMTQ/IMPACT

Qiang Zhao, Marc Doleans, Dmitry Gorelov, Felix Marti, Xiaoyu Wu, Richard York (NSCL, East Lansing, Michigan), Ji Qiang (LBNL, Berkeley, California)

Previous end-to-end three-dimensional (3D) beam dynamics simulation studies at Michigan State University (MSU) utilizing the LANA code and including experimentally-based ion source beam parameters, alignment and rf errors, and the effect of charge-stripping foils have indicated that the MSU Rare Isotope Accelerator (RIA) driver linac has adequate transverse and longitudinal acceptances to accelerate light and heavy ions to final energies of ³ 400 MeV/u with beam powers of 100 to 400 kW. Recently, to evaluate beam dynamics performance under various error scenarios with high statistics, the end-to-end 3D beam dynamics simulation studies for the driver linac were performed on the high performance parallel computers at MSU using the parallel code IMPACT that is an element of the advanced beam dynamics simulation tool: RIAPMTQ/IMPACT. The results of these beam dynamics studies will be presented.

This work is supported by the U.S. Department of Energy

TUP086 – Status of Linac Code Benchmarking within the HIPPI Project

Andrea Franchi, Wolfgang Bayer, Giuliano Franchetti, Lars Groening, Ingo Hofmann, Anna Orzhekovskaya, Stepan Yaramyshev, Xuejun Yin (GSI, Darmstadt), Romuald Duperrier, Didier Uriot (CEA, Gif-sur-Yvette), Giulia Bellodi, Frank Gerigk, Alessandra Maria Lombardi, Torsten Mütze (CERN, Geneva), Gianluigi Clemente, Andreas Christoph Sauer, Rudolf Tiede (IAP, Frankfurt-am-Main)

In the framework of the European network HIPPI (High Intensity Pulsed Proton Injectors) a linac code comparison and benchmarking program have been promoted. An intermediate goal is to compare different space charge solvers and lattice modelling implemented in each code in preparation of experimental validations from future measurements to be carried out at the

UNILAC of GSI. In the last two years a series of different tests and comparisons among several codes (DYNAMION, HALODYN, IMPACT, LORASAR, PARMILA, PATRAN, PATH and TOUTATIS) have been undertaken. The quality of Poisson solvers has been evaluated and a number of code adjustments has been carried out to obtain the best agreement in terms of RMS moments. In this paper we report on the status of this program.

This work has been supported by the European Community-Research Infrastructure Activity under the FP6 "Structuring the European Research Area" programme (CARE, contract number RII3-CT-2003-506395).

TUP087 – Ion Beam Charge Stripping-Foil Model for Beam Dynamics Simulation

Dmitry Gorelov, Felix Marti (NSCL, East Lansing, Michigan)

An efficient computer model for the stripping foil simulation was proposed at NSCL/MSU as part of the Rare Isotope Accelerator (RIA) development. The model was successfully implemented in the LANA beam dynamics simulation code. Later this model was also included in the IMPACT code as well as in some other beam dynamics simulation tools. The derivation of the algorithm is presented and the application of the model for the uranium beam stripping simulation in context of the RIA driver linac studies at NSCL/MSU is analysed in the paper.

This work was supported by the U.S. Department of Energy.

TUP088 – Benchmarking of Simulation Codes TRACK (ANL) and ASTRA (DESY) for the FNAL High-Intensity Proton Source

Jean-Paul Carneiro (Fermilab, Batavia, Illinois)

The FNAL High Intensity Proton Source is an 8-GeV superconducting H-minus Linac conceived

with the primary mission of enabling 2 MW beam power from the Main Injector at 120 GeV for the Fermilab neutrino program. The main tool used for the design of this accelerator is the beam dynamics code TRACK developed by Argonne National Laboratory to fulfill the requirements of proton and heavy-ion linacs. ASTRA, developed by DESY (Hamburg, Germany) and mainly used for the design of electron photo-injectors, also offers the possibility to simulate acceleration of hydrogen ions. Benchmarking of TRACK and ASTRA is presented in this paper for a zero current and a 30 mA beam from the exit of the RFQ (2.5 MeV) to the end of the accelerating section (8 GeV).

TUP089 – Computer Simulations of a High-Current Proton Beam at the SILHI-LEBT
Michael Galonska (GSI, Darmstadt; IAP, Frankfurt-am-Main), Raphael Gobin (CEA, Gif-sur-Yvette), Ralph Hollinger (GSI, Darmstadt)
For the injection of a proton beam into the future proton LINAC for FAIR the ion source and the low energy beam transport system have to deliver a 100 mA proton beam with an energy of 95 keV at the entrance of the RFQ within an acceptance of 0.3 p mm mrad (normalized, rms). A 2-solenoid focusing system is foreseen as an injection scheme. The beam parameters of the SILHI ion source and the 2-solenoid LEBT setup at CEA/Saclay fulfill these requirements. Therefore joint emittance measurements on various beam parameters have been performed at the end of 2005. This article presents the computer simulations of the ion source extraction and LEBT, which supplemented these measurements using the KOBRA3-INP computer code in order to study the influence of space charge effects. These simulations have been performed for various solenoid settings and for different space charge compensation degrees clearly revealing that the ion beam transport within the LEBT is influenced by space charge forces.

TUP090 – Advances of NPK LUTS Contraband-Detection System Project
Yuri Svistunov, Andrey M Fialkovsky, Yuriy Gavrish, Alexander Sidorov, Michael Vorogushin (NIIEFA, St. Petersburg)
Principle and project of NPK LUTS contraband detection technological complex (CDTC) was presented by authors at EPAC 2002. This paper reviews researches connected with 433 MHz ion linacs creation for the last four years. Main part is description of designing and testing of RFQ and APF resonators. State of affairs of other CDTC system is described briefly.

This work supported by Russian Federation Agency of Atomic Energy.

TUP091 – Choice of Ion Linac as Neutron Generator for Contraband-Detection System
Yuri Svistunov, Michael Vorogushin (NIIEFA, St. Petersburg), Dmitri Sergeevich Semenov, Boris Vodennikov (Scientific Research Institute of Pulse Technique, Moscow)
8 Mev proton linac and 4 Mev deuteron linac with working frequency 433 MHz are considered as neutron generator for detection system of explosive and fission. Required beam parameters, target materials, pulsed modulation and detection methods are discussed. Possible schemes of accelerating system of contraband detection complex are proposed. One supposes using of RFQ for deuteron linac and RFQ with IH cavity as proton one. Choice is determined by some few criterions: cost, sizes, safety, hardness of manufacturing and tuning.

This work supported by Russian Federation Agency of Atomic Energy.

TUP092 – Emittance Exchange at the Fermilab/NICADD Photoinjector
Timothy Koeth (Rutgers University, Piscataway, New Jersey), Richard Andrews, Donald

Edwards, Helen Edwards, Raymond Patrick Fliller, Michael James Syphers (Fermilab, Batavia, Illinois), Philippe Regis-Guy Piot (Northern Illinois University, DeKalb, Illinois)
An experiment to attempt the exchange of the transverse emittance with the longitudinal emittance of the Fermilab/NICADD PhotoInjector electron beam is being developed. The emittance exchange occurs by placing a TM110 mode RF cavity in the maximum dispersive region of a magnetic chicane. Properly employed, the cavity's longitudinal shearing Electric field zeros the momentum spread at the cost of generating a non-zero betatron oscillation amplitude. We report on the beam line modeling, beam line design, the RF cavity design, present status as well as the future program.

This work was supported by Universities Research Association Inc. under contract DE-AC02-76CH00300 with the U.S. DOE and by NICADD.

Wednesday Oral Session, WE1
2nd Floor Lecture Hall, 8:30 a.m.
Session Chair: Yanglai Cho, ANL

8:30 **WE101 – Overview of Energy Recovered Overview of Energy Recovered Linacs**
Vladimir N. Litvinenko (BNL, Upton, Long Island, New York)
Energy recovery linacs (ERL) is an emerging technology, which combines many of best qualities of both linear and circular accelerators. The ERLs promise to advance performances of future coherent and incoherent light sources, electron-hadron colliders and to establish new base for accelerators for very high brightness electron beams with ennourmous reactive beam power. This talk will be focused on progress with ERLs, on advances in the enabling technologies as well as on potential limitations of the technology.

Work performed under Contract Number DE-AC02-98CH10886 with the auspices of the US Department of Energy.

9:00 **WE102 – The 4GLS at Daresbury**
Hywel Owen (CCLRC/DL/ASTeC, Daresbury, Warrington, Cheshire)
4GLS is a next generation proposal for an advanced light source to be built at Daresbury Laboratory. The facility will consist of three integrated accelerator systems: a 25-60 MeV linear accelerator driving an Infra-Red Free-Electron Laser (FEL) at 13 MHz; a 750-950 MeV branch driving a 10-100 eV XUV-FEL at 1 kHz; a 600 MeV energy recovery linac carrying 100 mA current driving a suite of spontaneous sources at 1.3 GHz or a VUV-FEL (up to 10 eV)

at 4 MHz. The latter two accelerator systems share a common superconducting linac based on 1.3 GHz TESLA technology, which will simultaneously accelerate the two bunch types (1 nC and 77 pC) whilst decelerating the returning 77 pC bunches. This paper will outline the project and its key features, including the 35 MeV ERL Prototype accelerator presently being commissioned, and will discuss the accelerator physics and technology challenges to be explored in the present Design Study.

9:30 **WE103 – The TTF/VUV-FEL as the Prototype for the European XFEL Project**
Hans Weise (DESY, Hamburg)
The European X-ray Free-Electron Laser Facility (XFEL) is going to be built in an international collaboration at the Deutsches Elektronen-Synchrotron (DESY), Germany. The Technical Design Report was published recently. The official project start will be before end of this year. The new facility will offer photon beams at wavelengths as short as 1 Angstroem with highest peak brilliance being more than 100 million times higher than present day synchrotron radiation sources. The radiation has a high degree of transverse coherence and the pulse duration is reduced from ~100 picoseconds down to the ~10 femtosecond time domain. The overall layout of the XFEL will be described. This includes the envisaged operation parameters for the linear accelerator using superconducting TESLA technology. The complete design is based on the actually operated VUV Free-Electron Laser at DESY. Experience with the operation during first long user runs will be described in detail. Many of the different subsystems of the XFEL could be tested. Specially developed electron beam diagnostics was commissioned. A summary of the status of the XFEL preparation work will be given.

10:00 **WE104 – Cryomodules for Energy-Recovery Linacs**
Matthias Liepe (Cornell University, Ithaca, New York)
As transformational as the science with future Energy-Recovery Linacs will be, as manifold are the resulting challenges for accelerator science and technology. The driving engines of these particle accelerators are superconducting linacs, with planned total energy gains of up to several GeV. Continues cavity operation at 15 to 20 MV/m and envisioned beam currents of 100 mA and above are outside of present state-of-the-art. Significant R&D effort has been started at several institutes to develop superconducting cavity cryomodules supporting these parameters. Challenges include among others emittance preservation of high current, very low emittance beams, strong Higher-Order-Mode damping with very efficient HOM-power extraction, efficient CW cavity operation as well as high RF field stability. This paper/talk gives an overview of activities in this very exciting and challenging application of superconducting RF.

Work supported by NSF and Cornell University.

Wednesday Oral Session, WE2
2nd Floor Lecture Hall, 11:00 a.m.
Session Chair: Leonid Kravchuk

11:00 **WE201 – Neutralized Drift Compression Experiments (NDCX)**
Prabir Kumar Roy, Andre Anders, David Baca, Frank Bieniosek, C. M. Celata, Joshua Eugene Coleman, Shmuel Eylon, Wayne Greenway, Enrique Henestroza, Matthaeus Leitner, B. Grant Logan, Lou Reginato, Peter Seidl, William Waldron, Simon Yu (LBNL, Berkeley, California), John J. Barnard, Alex Friedman,

David Grote, William M. Sharp (LLNL, Livermore, California), Ronald Davidson, Philip Efthimion, Erik P. Gilson, Igor Kaganovich, Hong Qin, Adam Sefkow (PPPL, Princeton, New Jersey), Richard J. Briggs (SAIC, Alamo, California), Carsten Hilmar Thoma, Dale Welch (Voss Scientific, Albuquerque, New Mexico)
Intense ion beams offer an attractive approach to heating dense matter uniformly to extreme conditions, because their energy deposition is nearly classical and volumetric. Simultaneous transverse and longitudinal beam compression, in a neutralizing plasma medium, along with rapid beam acceleration, are being studied as a means of generating such beams, which will be used for warm dense matter (WDM), high energy density physics (HEDP), and fusion studies. Recently completed experiments on radial and longitudinal compression demonstrated significant enhancements in beam intensity. In parallel with beam compression studies, a new accelerator concept, the Pulse Line Ion Accelerator (PLIA), potentially offers cost-effective high-gradient ion beam acceleration at high line charge density. We report experimental results on beam neutralization, neutralized focusing, neutralized drift compression from a series of experiments. We also report energy gain and beam bunching in the first beam dynamics validation experiments exploring the PLIA.

This research was performed under the auspices of the U.S. Department of Energy by the LLNL, LBNL and the PPPL, under Contract Nos. W-7405-Eng-48, DE-AC02-05CH11231, and DE-AC02-76CH03073.

11:20 **WE202 – SNS Transverse and Longitudinal Laser Profile Monitor, Design, Implementation, Results, and Improvement Plans**
Saeed Assadi (ORNL, Oak Ridge, Tennessee)
SNS is using a Nd:YAG laser to measure trans-

verse profiles at nine-stations in the 186-1000 MeV Super-Conducting LINAC (SCL) and a Ti:Sapphire mode-locked laser to measure longitudinal profiles in the 2.5 MeV Medium Energy Beam Transport (MEBT). The laser beam is scanned across the H- beam to photo-neutralize narrow slices. The liberated electrons are directly collected to measure the transverse or longitudinal beam profiles. We have successfully measured the transverse and longitudinal profiles at all stations. The SCL laser system uses an optical transport line that is installed alongside the 300 meter super-conducting LINAC to deliver laser light at nine locations. Movement of the laser light in the optical transport system can lead to problems with the profile measurement. We are using telescopes to minimize the oscillations and active feedback system on mirrors to correct the drifts and movements. In this presentation we discuss our implementation and beam profiles measured during SCL commissioning. We also discuss future improvements, drift and vibration cancellation system, as well as plan to automate subsystems for both the transverse and the longitudinal profiles.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

11:40 **WE203 – LLRF Systems for Modern Linacs: Design and Performance**
Alexander Brandt (DESY, Hamburg)
Near-future linac projects put yet unreached requirements on the LLRF control hardware in both performance and manageability. Meeting their field stability targets requires a clear identification of all critical items along the LLRF control loop as well as knowledge of fundamental limitations. Large-scale systems demand for extended automation concepts. The experience gained with present systems as well as dedicated experiments deliver the basis for a design of

future systems. Digital hardware has evolved quickly over the past years and FPGAs became common not only in LLRF control. A high degree of digitization in various fields, as for example beam diagnostics, suggests to aim for a convergence of the digital platform designs. Channeling of efforts of different research laboratories may be the key to an affordable solution that meets all requirements and has a broad range of applications.

12:00 **WE204 – 100-MeV High-Duty-Factor Proton Linac Development at KAERI**
Yong-Sub Cho, Hyun-Mi Choi, In-Seok Hong, Ji-Ho Jang, Han-Sung Kim, Ky Kim, Yong-Hwan Kim, Hyeok-Jung Kwon, Kyung Tae Seol, Young-Gi Song (KAERI, Daejon)
The Proton Engineering Frontier Project (PEFP) is developing a 100 MeV high-duty-factor proton linac, which consists of a 50 keV proton injector, a 3 MeV radio frequency quadrupole, a 20 MeV drift tube linac, a 20 MeV beam transport line, a 100 MeV drift tube linac, and a 100 MeV beam transport line. It will supply proton beams of 20 MeV and 100 MeV to users for proton beam applications with the beam duty factor of 24% and 8% respectively. The 20 MeV front-end accelerator with CW RF systems had been constructed at KAERI test stand, and the rest part of the accelerator is being fabricated and will be installed in the new site at Gyeongju City. The preliminary results of the 20 MeV proton linac and the status of the 100 MeV proton linac will be presented.

Work supported by the 21C Frontier R&D program in Ministry of Science and Technology of the Korean Government.

12:20 **WE205 – HOM Damping and Power Extraction from Superconducting Cavities**
Jacek Sekutowicz (DESY, Hamburg)
Damping of Higher Order Modes plays an important role in achieving and preserving low emittance and low energy modulation of beams in accelerators based on the superconducting technology. In the overview, various damping schemes and damping devices and their advantages and disadvantages will be discussed.

Thursday Oral Session, THI
2nd Floor Lecture Hall, 8:30 a.m.
Session Chair: Paul Schmor, TRIUMF

8:30 **TH101 – The Linac Coherent Light Source (LCLS) Accelerator**
Juhao Wu, Paul Emma (SLAC, Menlo Park, California)
The Linac Coherent Light Source (LCLS) is a SASE x-ray Free-Electron Laser (FEL) based on the final kilometer of the Stanford Linear Accelerator. Such an FEL requires a high energy, high brightness electron beam to drive the FEL instability to saturation. When fed by an RF-photocathode gun, and modified to include two bunch compressor chicanes, the SLAC linac will provide such a high quality beam at 14 GeV and 1-micron normalized emittance. In this talk, we report on recent linac studies, including beam stability and tolerances, longitudinal and transverse feedback systems, conventional and time-resolved diagnostics, and beam collimation systems. Construction and installation of the injector through first bunch compressor will be complete by November 2006, and electron commissioning is scheduled to begin in December of that year.

Work supported by the U.S. Department of Energy under Contract No. DE-AC02-76SF00515.

9:00 **TH102 – Crymodule Test Facilities and Multicell Cavity Performance for the ILC**
Hitoshi Hayano (KEK, Ibaraki)
To address the ILC Main Linac gradient, which are greater than 35 MV/m at vertical test and greater than 31.5 MV/m in the operation of the cryomodule, ILC-GDE organized several task

forces in the R&D board. They are S0 task force, S1 task force, and S2 task force. The charge of S0 is to achieve 35 MV/m in the qualification with reasonable yield. S1 is to achieve 31.5 MV/m operation of cryomodule, and S2 is to estimate how large a test facility is required to test chain of crymodules and to make industrialization of cryomodule production. The paper reports the task force activities status together with existing R&D of multicell cavity performance and cryomodule test facility status.

9:30 **TH103 – Initial Commissioning Results from the ISAC-II SC Linac**
Robert Edward Laxdal (TRIUMF, Vancouver)
TRIUMF has installed 20MV of superconducting heavy ion linac as part of the first phase of the ISAC-II project. The linac consists of five cryomodules each with four 106MHz quarter wave cavities and one superconducting solenoid. The cavities and ancillaries operate cw with a demonstrated peak surface field exceeding 30MV/m at 7W rf cavity power. The solenoid produces fields up to 9T. In an initial beam test with a single module cavity performance exceeded design by over 20%. The full linac was installed by early 2006 with full linac beam commissioning tests starting in April 2006. The linac hardware will be described and the commissioning tests and results will be summarized.

10:00 **TH104 – A 70-MeV Proton Linac for the FAIR Facility Based on CH - Cavities**
Ulrich Ratzinger, Gianluigi Clemente, Christian Commenda, Holger Liebermann, Holger Podlech, Rudolf Tiede (IAP, Frankfurt-am-Main), Winfried Barth, Lars Groening (GSI, Darmstadt)
Future Accelerators for fundamental and for applied research will need a significant improvement in injector capabilities. This paper will describe the concept and the status of the 70 MeV, 70 mA proton injector for GSI - FAIR and

compare the CH - linac design with traditional DTL concepts. Improvements in the space charge routine of the LORASR code as well as CH - prototype cavity development and cavity grouping with respect to commercial 3 MW rf power amplifiers is reported. Additionally, the potential of robust superconducting low and medium energy high current linac sections will be explained on the basis of experimental results from a first 19 cell s.c. 350 MHz CH - prototype cavity.

EU contr.no. RII3-CT-2003-506395 BMBF contr.no. 06F134I GSI contr.no. F+E OF/RA1.

Thursday Oral Session, TH2
2nd Floor Lecture Hall, 11:00 a.m.
Session Chair: Gunther Geschonker, CERN

11:00 **TH201 – High-Power Couplers for Linear Accelerators**
Alessandro Variola (LAL, Orsay)
High power input couplers are a fundamental component of the linear accelerating structures and in particular of the superconducting structures. In fact, in this case, the power couplers function is not only the power transfer and the vacuum separation but includes also the thermal transition and the integrity of the cavity cleanliness. A lot of activity has been recently worked out in the framework of different project on both CW (KEK and Cornell) and pulsed (SNS and TTF) power couplers. Particular attention has been devoted to the design phase to take care about the thermo mechanical and electromagnetic performances, the multipacting thresholds, the preparation procedures and, last but not least, the cost that in the case of high energy linacs is a fundamental parameter. In this framework not only the design phase but also the conditioning of

the couplers has stimulated different studies. Partial reviews of the existing designs and of the couplers characteristics will be presented taking into account the different challenges.

11:20 **TH202 – Timing and Synchronization in Large-Scale Linear Accelerators**
Mario Ferianis (ELETTRA, Basovizza, Trieste)
New coherent light sources are based on large scale linear accelerator; the adopted single pass acceleration scheme allows the preservation of bunch 6D phase space leading to ultra short (<100fsFWHM) and ultra bright (average Brilliance = 1024 (1) ph/sec/mm2/mrad2/ 0.1%bw) pulses of coherent radiation in the DUV-x-ray regions. Femto-second lasers are deeply integrated in the electron bunch and photon pulse generation, in diagnostic set-ups and in time resolved experiments: the timing may be as low as 10% of pulse duration. The requirements on the stability of RF acceleration call for distribution of ultra-stable and ultra-low phase noise reference signal for the Low Level RF feedback loops. A non reversible breakthrough into the adoption of optical and O/E techniques is on-going which is taking advantage on five order of magnitude reduction in the period of the carrier. Being the current limit represented by the carrier-envelope stabilization techniques, sub-fs jitters have been demonstrated in the laboratory; the preservation of laboratory levels of jitters and stability over the whole accelerator premises is the next step. On-going efforts and results let us be optimistic.

Interim Report of the Scientific and Technical Issues (XFEL-STI) Working Group ona European XFEL facility in Hamburg, January 11, 2005.

11:40 **TH203 – Recent Developments in Pulsed High-Power Systems**
David E. Anderson (ORNL, Oak Ridge, Tennessee)

Pulsed power systems are inherent in any high power accelerator system. Applications include, among others, modulators for powering high power klystrons, pulsed power systems to drive linear induction accelerating cells, kicker magnet drivers for storage rings, and a wide variety of beam deflection and pulsed focusing systems. As with many enabling technologies, component limitations and materials properties dominate the engineering tradeoffs that must be made during the system design. An overview of the state-of-the-art in major components of pulsed power systems will be presented. An examination of how those components are being integrated into linac systems will also be performed and an overview of these systems shall be given. The relatively recent shift toward solid-state power electronics solutions to pulsed power engineering problems will be emphasized. Finally, some future trends in the field will be examined.

12:00 **TH204 – Nuclear Photo-Science and Applications with Thomson-Radiated Extreme X-Ray (T-REX) Sources**

Christopher Barty, Ray Beach, David Jeremy Gibson, Christian Hagmann, Fred V. Hartemann, Ed P. Hartouni, Jose Hernandez, Micah Johnson, Igor Jovanovic, Jennifer Klay, Dennis McNabb, Rick Norman, Miro Shverdin, Craig Siders, Ron Soltz, Page Stoutland, Aaron Matthew Tremaine (LLNL, Livermore, California), James Rosenzweig (UCLA, Los Angeles, California)

The Thomson scattering of picosecond and femtosecond duration laser pulses off of low emittance electron beams is an effective method of producing mono-chromatic, MeV-range gamma-rays with unprecedented peak brightness. With peak brightness at 1 MeV > 15 orders of magnitude beyond 3rd generation synchrotrons, these sources open the possibility for a host of new nuclear applications based on photons. In this presentation an overview of the requisite

photo-gun, short pulse laser and linear accelerator technologies required for production of high brightness gamma-rays will be presented. Potential applications of these unique sources of radiation will be discussed with particular emphasis given to the excitation and use of nuclear resonance fluorescence (NRF) for isotope detection and imaging of special nuclear materials of importance to homeland security.

This work was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

Thursday Oral Session, TH3
2nd Floor Lecture Hall, 1:40 p.m.
Session Chair: Tsumoru Shintake, RIKEN

1:40 **TH301 – Photoinjectors R&D for Future Light Sources and Linear Colliders**
Philippe Regis-Guy Piot (Northern Illinois University, DeKalb, Illinois)
Linac-driven light sources and linear proposed colliders require high brightness electron beams. In addition to the small emittances and high peak currents, linear colliders also require spin-polarization and possibly the generation of asymmetric beam in the two transverse degree-of-freedom. Other applications (e.g. high power free-electron lasers) call for high duty cycle and/or angular-momentum-dominated electron beams (electron cooling). We review on-going R&D programs aiming at the production of electron beams satisfying these various requirements. We especially discuss R&D on photoemission electron sources (especially based on radio-frequency gun) along with the possible use of emittance manipulation techniques.

Work supported by Universities Research Association Inc. under US DOE Contract No. DE-AC02-76CH00300 and by the Northern Illinois Center of Accelerator and Detector Development (NICADD).

2:00 **TH302 – Normal-Conducting Energy Recuperator**

Alexander Matveenko, Nikolay Vinokurov (BINP SB RAS, Novosibirsk)

Energy recovery linacs (ERLs) for different applications were discussed intensively at last decade. The normal conducting RF ERLs offer the possibility to provide high average currents at relatively low beam energies and long electron bunches. The comparison of normal conducting and superconducting RF is described briefly. To illustrate some interesting features of normal conducting ERLs some details of design, operational experience and prospects of the Novosibirsk FEL ERL are presented.

Thursday Poster Session, THP
Rooms 200 A-C, 2:30 - 5:30 p.m.
Session Chair: Charles Schmidt, FNAL

THP001 – Conceptual LLRF Design for the European X-FEL

Stefan Simrock, Valeri Ayvazyan, Alexander Brandt, Markus Huening, Waldemar Koprek, Frank Ludwig, Kay Rehlich, Elmar Vogel, Henning Christof Weddig (DESY, Hamburg), Tomasz Jezynski (TUL-DMCS, Lodz)

The LLRF System for the superconducting cavities of the European X-FEL must support an amplitude and phase stability of the accelerating fields of up to 0.01% and 0.01 deg. respectively. The stability must be achieved in pulsed operation with one klystron driving 32 cavities. This goal can only be achieved with low noise

downconverters for field detection, high gain feedback loops and sophisticated feedforward techniques. State-of-the art technology including analog multipliers for downconversion, fast ADCs (>100 MHz) with high resolution (up to 16 bit), and high performance data processing with FPGAs with low latency (few hundred ns) allow to meets these goals. The large number of input channels (>100 including probe, forward and reflected signal of each of the 32 cavities) and output channels (>34 including piezo tuners for each cavity) combined with the tremendous processing power requires a distributed architecture using Gigalink interfaces for low latency data exchange.

THP002 – Exception Detection and Handling for Digital RF Control Systems

Stefan Simrock, Valeri Ayvazyan, Alexander Brandt, Waldemar Koprek (DESY, Hamburg)

Exception detection and handling routines will play an important role in future large scale accelerator to ensure high availability and beam stability in presence of interlock trips, varying operational parameters, and operation close to the performance limit. For superconducting linacs typical examples for exception situations include cavity quenches, coupler and klystron gun sparcs, operation close to klystron saturation, and errors in vector-sum calibration. The goal is to identify all possible exception situations which will lead to performance degradation or downtime, detect these situations and take appropriate actions as necessary.

THP003 – Integrated Optical Timing and RF Reference Distribution System for Large-Scale Linear Accelerators

Axel Winter, Jan Becker, Kay Rehlich, Stefan Simrock (DESY, Hamburg), Florian Loehl (DESY, Hamburg; Uni HH, Hamburg)

Highly-stable timing and RF reference distribution systems are required to meet the tight

specifications in large scale accelerators for next generation light sources. In this paper, we present an approach based on the distribution of an optical pulse train from a mode-locked laser via timing stabilized fiber links. The timing information is contained in the precise repetition rate of the optical pulse train (~50 MHz), so RF can be extracted at end stations with a stability on the order of 10 fs. Less timing critical signals such as ADC clocks and trigger signals can be transmitted through the same stabilized fiber using a modulated cw laser operating at a different wavelength with sub-ps stability. As multiple wavelengths can propagate without interference through the fiber, it is also possible to integrate data communication in such a fiber system. This paper will review the timing system requirements and present a conceptual layout of an optical timing and reference frequency distribution system based on work done at MIT and DESY for the XFEL.

THP004 – Digital Low-Level RF Control Using Non-IQ Sampling

Hengjie Ma, Mark Stuart Champion (ORNL, Oak Ridge, Tennessee), Lawrence Doolittle (LBNL, Berkeley, California)

The success of digital feedback with synchronous IQ sampling for cavity field control in recent accelerator projects make this LLRF control scheme a popular choice. This short-period synchronous sampling does not, however, average out well-known defects in modern ADC and DAC hardware. That limits the achievable control precision for digital IQ LLRF controllers, while demands for precision are increasing for future accelerators such as International Linear Collider. For this reason, a collaborative effort is developing a digital LLRF control evaluation platform to experiment using coherent sampling with much longer synchronous periods, on the order of the cavity closed-loop bandwidth. This exercise will develop and test the hardware and

software needed to meet greater future RF control challenges.

US DOE

THP005 – Digital Control of Cavity Fields in the Spallation Neutron Source Superconducting Linac

Hengjie Ma, Mark Stuart Champion, Kay-Uwe Kasemir (ORNL, Oak Ridge, Tennessee), Alexander Brandt (DESY, Hamburg)

Control of the pulsed RF cavity fields in the Spallation Neutron Source (SNS) superconducting Linac uses both the real-time in-pulse feedback regulation and the pulse-to-pulse adaptive feed-forward compensation. This configuration is required to deal with the typical issues associated with superconducting cavities, such as the Lorentz force detuning, mechanical resonant modes, and cavity filling. The SNS Linac LLRF system was designed as a flexible and versatile all-digital implementation in order to accommodate the required control schemes. The digital hardware has successfully achieved an effective full-bandwidth digital feedback control due to low noise level and low data latency. The various methods and algorithms of the adaptive feed-forward control have also been developed for the controlled cavity filling, the cavity mechanical resonant mode suppression, and compensation of the strong beam loading.

U.S. DOE.

THP006 – Performance of Digital LLRF Field Control System for the J-PARC Linac

Shinichiro Michizono, Shozo Anami, Zhigao Fang, Seiya Yamaguchi (KEK, Ibaraki), Hiroyuki Suzuki (JAEA, Ibaraki-ken), Tetsuya Kobayashi (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken)

Twenty high power klystrons are installed in the J-PARC linac. The requirements for the rf field

stabilities are +-1% in amplitude and +-1 deg. in phase during a 500 us flat-top. In order to satisfy these requirements, we adopt the digital feedback and feed-forward system with FPGAs and a commercial DSP board. The FPGAs (Virtex-II 2000) enable a fast PI control for a vector sum of two cavity fields. The measured stability during rf pulse was +-0.15% in amplitude and +-0.15 deg in phase. The tuner control was successively operated by a way of the DSP board by measuring the phase difference between the cavity input wave and the cavity field. Beam loading effects were emulated using a beam-loading test box. By proper feed-forward, the rf stability was less than +-0.3% and +-.15 deg.

THP007 – Timing Distribution in Accelerators via Stabilized Optical Fiber Links

John Byrd, Lawrence Doolittle, Alessandro Ratti, John William Staples, Russell Wilcox (LBNL, Berkeley, California)

We present progress on fiber-optic based systems for highly stable distribution of timing signals for accelerators. This system has application for linac-based sources of ultrafast radiation which require sub-100 fsec synchronization or for very large accelerators such as the linear collider. The system is based on optical fiber links that are stabilized with an optical interferometer with RF and timing signals distributed as modulations on the optical carrier. We present measurements of the stability of this link over distances of several hundred meters and discuss issues for testing the link over 10 km.

This work was supported by the Director, Office of Science, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

THP008 – Detailed Modeling of the SNS RFQ Structure with CST Microwave Studio

Derun Li, John William Staples, Steve Virostek (LBNL, Berkeley, California)

We report detailed RF modeling on the SNS RFQ structure using CST Microwave Studio code. Due to the complexity of the RFQ structure, a three-dimensional model with large mesh ratio is required to adequately model the necessary details of the structure. Old 3-D codes are not capable of giving accurate predictions of resonant frequency and fields, or for including mode stabilizers and terminations. A physical prototype is needed to verify resonant frequency and field profile, including mode stabilizers and end terminations, which is expensive and time consuming. Taking advantage of CST Microwave Studio's new Perfect Boundary Approximation (PBA) technique, we constructed a 3-dimensional computational model based on the as-built SNS RFQ dimensions with pi-mode stabilizers, end cutbacks and tuners and simulated it in the frequency domain using the CST Eigenvalue Solver. Simulation results accurately predicted the resonant frequency and field distributions. We are applying the simulation technique to the design of another RFQ.

This work was supported by the Director, Office of Science, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

THP009 – Performance of Low-Level RF System for the J-PARC Linac

Tetsuya Kobayashi (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Etsuji Chishiro, Hiroyuki Suzuki (JAEA, Ibaraki-ken), Shozo Anami, Zhigao Fang, Yuji Fukui, Shinichiro Michizono, Seiya Yamaguchi (KEK, Ibaraki)

The J-PARC linac provides 181-MeV proton beam to the following 3-GeV rapid-cycling synchrotron at the first phase. This linac requires twenty-four RF systems (20 klystrons and 4 solid-state amplifiers), which operate at a 620-us pulse width, 50-Hz repetition rate and 324-MHz frequency. The installation of the RF systems was almost completed and the test operation was

started. The present status and the performance of the Low Level RF system and the RF Reference distribution system will be reported.

THP010 – Performance of Low-Level RF System for KEK-STF

Toshihiro Matsumoto, Shigeki Fukuda, Hiroaki Katagiri, Shinichiro Michizono, Yoshiharu Yano (KEK, Ibaraki)

At the electron linac of superconducting rf test facility(KEK-STF), an accelerating electric field of ±0.1% in amplitude and ±0.1degree in phase during a 800 us flat-top is required for low level rf system. Digital feedback system is adopted for flexibility of the feedback and feed-forward algorism implementation to accomplish these requirements. In order to carry out the efficient testing of the control system, rf system modelling with MATLAB/Simulink library is utilized for the investigation of the control method and cavity simulator using a FPGA board has been developed. The present status and the performance of the low level rf system for KEK-STF will be reported.

THP011 – High Gradient Operation with the CEBAF Upgrade RF Control System

Curt Hovater, Hai Dong, Alicia Hofler, John Musson, Tomasz Plawski (Jefferson Lab, Newport News, Virginia)

The CEBAF Accelerator at Jefferson Lab is presently a 6 GeV five pass electron accelerator consisting of two superconducting linacs joined by independent magnetic transport arcs. It is planned to increase the energy to 12 GeV with the addition of 10 new high gradient cryomodules (17+ MV/m). The higher gradients pose significant challenges beyond what the present analog low level RF (LLRF) control systems can handle reliably; therefore, a new LLRF control system is needed. A prototype system has been developed incorporating a large FPGA and using digital down and up conversion to minimize the need for

analog components. The new system is more flexible and less susceptible to drifts and component nonlinearities. Because resonance control is critical to reach high gradients quickly, the new cryomodules will include a piezoelectric tuner for each cavity, and the LLRF controls must incorporate both feedback and feed-forward methods to achieve optimal resonance control performance. This paper discusses development of the new RF system, system performance for phase and amplitude stability and resonance control under Lorentz detuning measured during recent tests on a prototype cryomodule.

This work was supported by the U.S. Department of Energy Contract Number DE-AC05-84-ER40150

THP012 – Adaptive Tuner Control in TRIUMF ISAC 2 Superconducting LINAC using Kalman Filter

Ken Fong, Michael Laverty, Qiwen Zheng (TRIUMF, Vancouver)

The TRIUMF ISAC 2 RF control system uses phase locking self-excited control. Amplitude, phase and frequency control is achieved with I/Q voltage injection, and forward RF power is minimized with a tuner feedback loop. The phase difference between the input coupler and the output pickup drives a velocity servo system to provide tuning control. However, the presence of microphonics in the cryomodule, although under control by the Quadrature loop, still presents a noisy interference on the phase difference for the tuner. The tuner will follow this noise and generate more microphonics as a result. A first-order Kalman filter is used for an estimation of the phase difference and reduces the movement of the tuner.

TRIUMF receives federal funding via a contribution agreement through the National Research Council of Canada.

THP013 – Adaptive Control of a SC Cavity Based on the Physical Parameters Identification

Tomasz Czarski, Wojciech Jalmuzna, Waldemar Koprek, Krzysztof Tadeusz Pozniak, Ryszard S. Romaniuk (Warsaw University of Technology, Warsaw), Stefan Simrock (DESY, Hamburg)

The paper presents preliminary results of SRF cavity control by FPGA system called "SIMCON". Algebraic model of the control system including calibration and correction procedure of the signal path was discussed. In particular, there were debated the following aspects of the automatic control procedures: compensation of the input offset, calibration of the cavity channel and correction of the klystron channel (linearization). Functional structure of FPGA based SIMCON board for LLRF Cavity Control System was explained. Alghoritm of adaptive control for cavity driven with FPGA controller supported by MATLAB system was discussed. Experimental results for 8 cavities of ACC1 module controlled by the SIMCON board were shown. The resuls lead to novel method of parameters identification of cavity system in noisy and no stationary conditions.

This work was supported by the European Community Research Infrastructure Activity under the FP6 program (CARE - Coordinated Accelerator Research in Europe, contract number RII3-CT-2003-506395).

THP014 – Accurate, Efficient Wakefield Simulation with the Parallel Finite Element Time-Domain Solver T3P

Cho-Kuen Ng, Arno E. Candel, Nathan T. Folwell, Andreas C. Kabel, Kwok Ko, Lie-Quan Lee, Zenghai Li, Ernesto Prudencio, Greg Schussman, Ravindra Uplenchwar (SLAC, Menlo Park, California)

Under the US DOE SciDAC project, SLAC has developed a 3D (2D) parallel finite element time-

domain code for accurate, efficient simulation of wakefields in large accelerator cavities of complex shapes. Named T3P (T2P), the code adopts an implicit scheme that is unconditionally stable, thereby avoiding the Courant condition limitation and thus allowing the use of larger time-steps to reduce simulation time. Built on the same spatial discretization infrastructure that supports the parallel finite element eigensolver Omega3P, it utilizes high fidelity tetrahedral (triangular) meshes and captures fine features through higher order basis functions and quadratic approximation of the geometry surface. The result is superior solution accuracy with far less mesh points than corresponding simulations on structured grids. Furthermore, parallelization provides access to supercomputers with large distributed memory while enabling faster execution through parallel speedup. Applications to the cavity design for the ILC main linac and the CEBAF 12-GeV upgrade as well as the study of the BPM for PEP-II are shown to demonstrate the efficacy of this approach.

Work supported by DOE contract DE-AC02-76SF00515.

THP015 – The Upgrade of the System of High Accuracy RF Phase Detecting and Regulating for Hefei 200-MeV Electron Linac

Sai Dong, Xiaodong He, Ge Li, Cong-Feng Wu, Yingui Zhou (USTC/NSRL, Hefei, Anhui)

The significance of the developing system of high accuracy RF phase detecting and regulating for linac is introduced. The importance of the RF phase state to stabilize beam energy is pointed out. The recent investigation result and the development of upgrade of this system for Hefei 200MeV electron linac are discussed. The experimental result shows that the RF phase can be stably adjusted within 0.5 degree in the on-line status for 200MeV linac.

THP016 – Active Compensation of Lorentz Force Detuning of a TTF 9-Cell Cavity in CRYHOLAB

Guillaume Devanz, Pierre Bosland, Michel Desmons, Eric Jacques, Michel Luong, Bernard Visentin (CEA, Gif-sur-Yvette)

Linear colliders and free-electron lasers projects based on the superconducting RF technology require high gradient pulsed operation of superconducting elliptical multicells. The cavities are subject to Lorentz force detuning which reflects on an increased RF power consumption when trying to stabilize the accelerating field during the beam passage. This pulsed detuning can be mechanically compensated using a fast piezoelectric tuner. A new tuner with integrated piezoelectric actuators has been developed in the framework of CARE/SRF european program. The tuning system has been tested on a fully equipped 9-cell TTF cavity in the CRYHOLAB horizontal cryostat using the pulsed 1.3 GHz 1 MW RF source. In virtue of the high pulse to pulse repeatability of the detuning, the compensation of Lorentz detuning was achieved successfully using a simple feed forward scheme.

THP017 – Magnet Hysteresis Control at LANSCE

Rodney C. McCrady, Roderich Keller (LANL, Los Alamos, New Mexico)

We have investigated the effects of magnet hysteresis in various beamlines at LANSCE (Los Alamos Neutron Science Center) and have developed procedures to control the effects. Particular challenges are presented by sets of magnets with parallel boosting and bucking windings on the same yoke powered by two families of supplies and by magnets whose fields are routinely reversed for different operating modes. The results of the procedures are more rapid recovery from power-off conditions and rapid switching between operating modes, with minimized re-tuning. The latter improvement has

been beneficial in controlling a beam instability that has adverse effects on the users' experiments.

This work is supported by the U.S. Department of Energy under contract W-7405-ENG-36.

THP018 – Hybrid Quadrupoles for the RAL Front-End Test Stand (FETS)

Dan Ciprian Plostinar (CCLRC/RAL/ASTeC, Chilton, Didcot, Oxon), Chris Thomas (CCLRC/RAL/ISIS, Chilton, Didcot, Oxon)

The proposed FETS project at RAL will test a fast beam chopper in a 3.0 MeV H- Medium Energy Beam Transport (MEBT) line. Space restrictions in the MEBT line place constraints on component length and drive the requirement to identify compact component configurations. A hybrid quadrupole design is proposed, consisting of a concentric combination of permanent magnet quadrupole (PMQ) and laminar conductor (Lambertson) electromagnetic quadrupole (EMQ) types. This structure combines the advantages of using a PMQ which is compact and provides a high gradient magnetic field, and field-adjustability by placing a printed circuit quadrupole inside the aperture of the PMQ. Suitability of this hybrid quadrupole design for use in drift tube LINACs is also investigated.

Work supported by the European Community-Research Infrastructure Activity under the FP6 "Structuring the European Research Area" programme (CARE, contract number RII3-CT-2003-506395).

THP019 – Commissioning of the Digital LLRF for the CEBAF Injector/Separator

Tomasz Plawski, Hai Dong, Curt Hovater, Larry King, George Lahti, John Musson (Jefferson Lab, Newport News, Virginia)

The design and production of the CEBAF accelerator 499 MHz digital Low-Level RF

control system has been completed. The first five systems were installed for use with the CEBAF Separator RF deflecting cavities operating at 499 MHz. The next four systems were installed in the injector on the chopping cavities (also 499 MHz deflecting cavities). The new LLRF system replaced an analog system that was over 15 years old. For initial testing an extensive acceptance plan along with a LLRF test stand was developed and incorporated to assure system performance as well as reliability. Various VHDL firmware was developed and modified to support operation of this system and included specific operational diagnostics. Once the acceptance tests were completed, the new systems were installed in the accelerator, in parallel with the existing analog LLRF, for extensive in-situ testing and comparison. After system commissioning, the new RF systems were assigned to the CEBAF accelerator and turned over to Accelerator Operations. This paper will address the VHDL firmware evolution, the automated tests and the performance measurements made through out the installation and commissioning process.

Work supported by the U.S. DOE Contract No DE-AC05-84ER40150.

THP020 – Overview and Status of DARHT Second Axis Induction Cell Refurbishment

Juan Barraza (LANL, Los Alamos, New Mexico), Benjamin Arnold Prichard (SAIC, Los Alamos, New Mexico)

The induction cells of the Dual Axis Radiographic Hydro Test (DARHT) second axis facility at Los Alamos National Laboratory (LANL) are undergoing refurbishment with performance and reliability upgrades. The original cell design experienced shortcomings in the oil and vacuum regions that led to voltage breakdowns at low operating voltages. Changes to the oil and vacuum regions were successfully tested on six prototype cells, resulting in ap-

proval to begin refurbishment in June 2005. A refurbishment process was developed that is comprised of seven major activities, each including key measures that ensure high quality cell assemblies. Existing facilities were modified to improve refurbishment operations and to yield a production rate necessary to support the project schedule. Production of refurbished cells is proceeding as planned. Currently, twenty six refurbished accelerator cells are installed at DARHT in a Scaled Accelerator configuration that is performing early beam physics and conversion target studies. The 74-cell full scale accelerator will be completed in 2007. This paper presents an overview of refurbishment operations at LANL, lessons learned, and present status.

This work was supported by the US National Nuclear Security Agency and the US Department of Energy under contract W-7405-ENG-36.

THP021 – Study of Vacuum Insulator Flashover for Pulse Lengths of Multi-Microseconds

Timothy Lee Houck (LLNL, Livermore), Dave Goerz, Jalal Javedani, Eugene Lauer, Laura Tully, George Vogtlin (LLNL, Livermore, California)

We have studied the flashover of vacuum insulators for applications where high voltage conditioning of the insulator and electrodes is not practical and for pulse lengths on the order of several microseconds. The study was centered about experiments performed with a 100-kV, 10-ìs pulsed power system and supported by a combination of theoretical and computational modeling. The base line geometry for the experiments was a cylindrically symmetric, +45° insulator between flat electrodes. In the experiments, flashovers or breakdowns were localized by operating at field stresses slightly below the level needed for explosive emissions with the base line geometry. The electrodes and/or insulator were then seeded with an emission source,

e.g. a tuff of velvet, or a known mechanical defect. Our study differs from most vacuum insulator studies in that our emphasis was on flashovers originating at the anode triple junction as well as bulk breakdowns within the insulator. Various standard techniques were employed to suppress cathode-originating flashovers/breakdowns. We present the results of our experiments and discuss the capabilities of modeling insulator flashover.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

THP022 – Status of RF Sources in Super-Conducting RF Test Facility (STF) at KEK

Shigeki Fukuda, Mitsuo Akemoto, Hitoshi Hayano, Hiroaki Katagiri, Sergey Kazakov, Shuji Matsumoto, Toshihiro Matsumoto, Shinichiro Michizono, Hiromitsu Nakajima, Katsumi Nakao, Tetsuo Shidara, Tateru Takenaka, Yoshiharu Yano, Mitsuhiro Yoshida (KEK, Ibaraki)

Super-conducting rf test facility (STF) has been progessing in KEK since 2005. In this paper, we describe the current status of rf sources in STF. STF rf sources comprise of a long pulse modulator with bouncer circuit, a pulse transformer, an L-band 5MW klystron, power distribution system and low level rf system. We have completed the construction of the first rf system and have been testing for the system evaluation and for the coupler test of the super-conducting cavity. We have a schedule to feed a power to the cryomodule with 8 super-conducting cavities in December of 2006. We also describe the plan of the second rf sources of STF.

THP023 – Status of and Future Plan for the NSRL Microwave Power System

Lei Shang (USTC/NSRL, Hefei, Anhui)

In this paper, 20MW microwave power system for NSRL (National synchrotron radiation Laboratory) Linac is introduced. The power system includes five s-band 20MW klystrons and their modulators. In 2002, the klystron modulators and the control system were upgraded. Constant-current, switching power supplies were employed to replace the old conventional LC resonant charging facilities. The new system has run for four years and played an important role in the operation of the 200MeV LINAC. A new soft x-ray FEL project (HTF) is now proposed in NSRL, the energy of electron beam will be increase from 200MeV to 800MeV. Seven s-band 80 MW klystrons and modulators will be employed as the new microwave power sources. The low energy spread specification of the Linac sets a stringent requirement to the stability of the klystron modulators. The paper also presents the technical considerations and preliminary design of the new system.

THP024 – Development of Ultra-fast Silicon Switches and their Applications on Active X-Band, High-Power RF Compression Systems

Jiquan Guo, Sami G. Tantawi (SLAC, Menlo Park, California)

In this paper, we present the recent results of our research on the ultra-high power fast silicon RF switch and its application on active X-Band RF pulse compression systems. This switch is composed of a group of PIN diodes on a high purity silicon wafer inserted into a cylindrical waveguide operating in the TE01 mode. Switching is performed by injecting carriers into the bulk silicon through a high current pulse. A switch module is composed of the silicon switch, a circular waveguide T with the silicon switch at the center port and a movable short at the other end of silicon switch. The module can tune the S-

matrix of on and off states to desired value. Our current design uses a CMOS compatible process and the fabrication is accomplished at SNF (Stanford Nanofabrication Facility). The switch has achieved <300ns on time with ~3% loss on the wafer. The RF energy is stored in a room-temperature, high-Q 400 ns delay line; it is then extracted out of the line in a short time using the switch. The pulse compression system has a achieved a gain of 7, which is the ratio between output and input power. Power handling capability of the switch is estimated at the level of 10MW.

THP025 – R&D of the Long-Life Thyratron Tube

Hiroshi Matsumoto (KEK, Ibaraki), Jong-Seok Oh (PAL, Pohang, Kyungbuk)

Long lifetime over 50k hours for the thyratron is essential to provide the reasonable availability of the accelerator such as X-FEL and future e+e- linear collider. The lifetime and reliability of a solid-state device are not well confirmed yet. There are some examples that show long life of a thyratron. Many thyratrons were dead due to several common causes related to circuits and operation environment rather than intrinsic problems of a device itself. Several valuable feedback systems are easily adopted to enhance the lifetime. There are still unidentified questions to be verified in the thyratron. Close collaboration between laboratories and companies is strongly requested in order to improve the lifetime and performance of a thyratron.

THP026 – Results of High-Power Test of a New L-band Coupler with Capacitive Cold-Window

Hiroshi Matsumoto, Fumio Furuta, Sergey Kazakov, Takayuki Saeki, Kenji Saito (KEK, Ibaraki)

A new coupler, which has a simple modular structure for the ILC superconducting accelerator

structure was design at KEK and fabricated at TOSHIBA. It will be demonstrated the high power operation in May at KEK. We will report the low power measurement and the high power test results.

THP027 – Study of PPM-Focused X-band Pulse Klystron

Shuji Matsumoto, Mitsuo Akemoto, Shigeki Fukuda, Toshiyasu Higo, Hiroyuki Honma, Sergey Kazakov, Noboru Kudo, Hiromitsu Nakajima, Tetsuo Shidara, Mitsuhiro Yoshida (KEK, Ibaraki)

The R&D of PPM (Periodic Permanent Magnet)-focused X-band pulse klystrons has been conducted since 1999, originally for Global Linear Collider (GLC) project. So far six prototype tubes have been tested. Some of them successfully produce the power required in GLC (75MW, 1.6 micro sec pulse width). However their performance was not perfect as a GLC tube. The problems are the stability of RF output and the gun performance. Since GLC programs were terminated in 2004, some limited work on the improvement of the PPM tubes continues at X-Band Test Facility (XTF) in KEK. The work includes the test to evaluate the performance of revised (rebuilt) tubes as well as disassembling these tubes after the test for further inspection. Recent results are reported.

THP028 – Master Oscillator for Fermilab ILC Test Accelerator

Julien Branlard, Brian Chase, Ed Cullerton (Fermilab, Batavia, Illinois)

The low phase-noise master oscillator generates and distributes the various frequencies required for the LLRF system controlling ILCTA cavities. Two chassis have been developed for this design, generating the programmable frequencies and performing the distribution and amplification, respectively. It has been successfully used with the SNS and the DESY-SIMCON LLRF sys-

tems, driving two different superconducting cavities. The design approach and a full characterization of the master oscillator are presented in this paper. The measurement results include the frequency stability and the phase and amplitude noise spectrums of the multiple frequency outputs.

University Research Association and Department of Energy.

THP029 – Development of an RFQ Input Power Coupling System

Yoon W. Kang, Alexander V. Aleksandrov, Marianne M. Champion, Mark Stuart Champion, Mark Crofford, Paul Gibson, Thomas Hardek, Peter Ladd, Michael P. McCarthy, Alexandre Vasilievich Vassioutchenko (ORNL, Oak Ridge, Tennessee), Harald Lukas Haenichen (TU Darmstadt, Darmstadt)

An RF input coupler system is designed, manufactured, and tested for future upgrade of the coupling system of the RFQ in the SNS linac. The design employs two coaxial loops in vacuum side of two coaxial ceramic windows through coaxial transmission lines that are connected to a magic-T waveguide power splitter for 402.5 MHz operation. The couplers will be used with up to total 800 kW peak power at 8% duty cycle. RF properties of the system and fabricated structure along with vacuum and thermal properties are discussed. Two couplers are joined together through an evacuated bridge waveguide for high power RF processing. Result of the high power conditioning that is performed in the RF test facility of the SNS is presented.

This work was supported by SNS through UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

THP030 – Investigation of Ferroelectrics for High-Power RF Phase Shifters in Accelerator Systems

Yoon W. Kang, Joshua Lee Wilson (ORNL, Oak Ridge, Tennessee), Aly Fathy (University of Tennessee, Knoxville, Tennessee)

High power vector modulators enable independent control of RF power to each accelerating cavity, allowing a fan-out configuration to be used to power many cavities from a single high-power klystron. Previously, ferrite materials have been used in high-power phase shifters and vector modulators. It is shown that ferroelectric materials such as barium-strontium titanate (BST) can also be used in such tunable structures. Since ferroelectrics are controlled by an electric, rather than magnetic field, tuning can be faster than tuning a ferrite-loaded device. A BST-loaded coaxial structure is investigated theoretically and experimentally. Good high voltage performance is critical since DC biasing voltages of up to 80 kV can be impressed on the BST sections for tuning. It can also be seen that matching structures around the BST can improve performance over a wider range of amplitudes and phases.

This work was supported by SNS through UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

THP031 – Pulse Cables For XFEL-Modulators

Hans-Joerg Eckoldt (DESY, Hamburg)

For the XFEL, housed in a single tunnel, most of the modulators will be placed in a central modulator building outside of the tunnel. The pulse transformer and the klystrons will be positioned inside the tunnel near the superconducting linac. Therefore the energy has to be transported via pulse cables. These cables have lengths between 350m and 1.7 km. The power is up to 16.8 MW per pulse with a repetition rate of 10 Hz. In order

to keep the rise time short and match the klystron impedance four 25Ohm cables will be put in parallel. A tri-axial design was chosen to prevent magnetic field outside of the cables in order not to disturb electronics or electron beam. A prototype of the cable was produced in industry and delivered to DESY. A set of four 1.5km long parallel cables is in test at present at one of the modulators of the TTF/VUV-FEL at DESY. The cable design criteria and test results are presented in this paper.

THP032 – A Variable Directional Coupler for an Alternate ILC High-Power RF Distribution Scheme

Christopher Dennis Nantista, Chris Adolphsen (SLAC, Menlo Park, California)

We describe the design and functionality of an RF directional coupler for which the power division between the output ports is mechanically variable. In an alternate power distribution scheme for the ILC, power is delivered to cavities in pairs, through hybrids. Four pairs, or eight cavities, are fed from one waveguide feed, from which one fourth, one third, and one half of the power is coupled out at consecutive directional couplers. Three such feeds are powered by a single 10 MW klystron. Experience suggests that cavities considered useable will display some variation in the operational accelerating gradient they can sustain. With fixed distribution, the klystron power must be kept below the level at which the weakest cavity out of 24 receives its power limit. This problem can be solved by installing variable attenuators, but that means wasting precious power. With adjustable coupling, distribution can be optimized for more efficient use both of available power and of the accelerating cavities. This novel device, feeding cavities paired by similar performance, can provide such benefit to the ILC.

Work supported by the U.S. Department of Energy under contract DE-AC02-76SF00515.

THP033 – Pulsed RF Heating Particularities in Normal-Conducting L-band Cavities

Valentin Paramonov, Aino Konstantinovna Skasyrskaya (RAS/INR, Moscow), Frank Stephan (DESY Zeuthen, Zeuthen), Klaus Floettmann (DESY, Hamburg)

For present projects, such as X-FEL and ILC, the SC technology is chosen for the main linacs. However, in some special parts, NC cavities are applied, operating with high electric and magnetic fields. RF gun cavities with an electric field up to 60 MV/m at the photo cathode are now under development. Capture cavities in the ILC positron source should operate with an accelerating gradient of up to 15 MV/m, practically the same value (14 MV/m), as for the CDS booster cavity in the Photo Injector Test Facility at DESY in Zeuthen (PITZ). High field strength leads to high specific RF heat loading. In combination with long RF pulses (~ 1ms) it results in substantial surface temperature rise, small cavity shape deformations and measurable frequency shifts. In this report we discuss both particularities and some general regularities related to long pulse operation of L-band cavities. Results of 3D numerical simulations for cavity surface temperature, displacements distributions and corresponding frequency shifts for different cavities are presented and compared with existing experimental data. The presented results will give the input for cavities optimization and sub-systems improvements.

THP034 – Effective Standing-Wave RF Structure for Charged-Particle Beam Deflector

Valentin Paramonov, Leonid V. Kravchuk (RAS/INR, Moscow), Sergey Korepanov (DESY Zeuthen, Zeuthen)

In this report we describe new standing wave pi-mode rf structure for charged particles deflection. For L-band frequency range parameters of the proposed structure are compared with classical

TM110 mode deflecting cavity ones. With originating TE11n mode, our proposal has several times higher rf efficiency, one order wider pass-band and smaller (in times) transverse dimensions. The cavity design idea and typical are parameters are presented. Some particularities of the beam dynamics in the proposed structure are pointed out. Preferable field of structure application is discussed.

THP035 – Design on Accelerating Tube of High-Power Electron Linac for Irradiation Processing

Huachang Liu, Xiulong Wang (CIAE, Beijing), Shinian Fu (IHEP Beijing, Beijing)

There is an unstable phenomenon for high-power electron linacs for irradiation processing. The main source of the instability of this type of linac comes from the thermal effect of the accelerator tube under an intense heat load. If a lot of injected electrons are lost in the tube, they can cause an intense and uneven heat load on the tube that may deform the cavities of the accelerator tube and deviate the correct acceleration phase relationship. In this paper, a constant gradient accelerating structure is chosen to accelerate the electron beam, and the designed phase velocity is gradually increased along the tube. By adjusting the size of the accelerating cavities and the phase velocity function, a high capture-efficiency is reached. After a series of simulations studies, we obtained a 90% capture-efficiency, which minimizes the probability of the unstable phenomenon in the high power electron linac.

THP036 – Long-Pulse Modulator for the Superconducting RF Test Facility at KEK

Mitsuo Akemoto, Shigeki Fukuda, Hiroyuki Honma, Hiromitsu Nakajima, Tetsuo Shidara (KEK, Ibaraki)

A long-pulse modulator for the Superconducting RF Test Facility(STF) at KEK is under development now. The modulator is a direct-switched

type design with a bouncer circuit to compensate the output pulse droop, and operates the klystron up to 5 MW peak power, 1.5 ms rf pulse width and up to 5 pps repetition rate. The modulator is built by improving a klystron modulator system inherited from Power Reactor and Nuclear Fuel Corp. The design and specifications of the modulator as well as R&D status for ILC modulator are described.

THP037 – Wide-Range Frequency Compensation by Coaxial Ball-Screw Tuner

Toshiyasu Higo, Yasuo Higashi, Yuichi Morozumi, Kenji Saito, Kwnji Ueno, Hiroshi Yamaoka (KEK, Ibaraki)

Low-loss 9-cell 1.3GHz cavities are studied at KEK aiming at a high-gradient operation for the International Linear Collider. One of the most important issues to realize such a high gradient in a pulsed operation of super-conducting cavities is the issue of how to compensate the Lorentz detuning. The Lorentz detuning of the cavity amounts to 3kHz at 45MV/m acceleration field. None of the tuners to date have achieved this range. A coaxial ball-screw tuner was designed and proved to reach this level in the room temperature operation. The performance at liquid Nitrogen temperature is also studied. From these results, we try to evaluate the feasibility of the operation at 2K.

THP038 – Normal Conducting High-Gradient Studies at KEK

Toshiyasu Higo, Mitsuo Akemoto, Shigeki Fukuda, Yasuo Higashi, Noboru Kudo, Shuji Matsumoto, Koji Takata, Toshikazu Takatomi, Kwnji Ueno, Kazue Yokoyama (KEK, Ibaraki)

Normal-conducting high field studies have been pursued at XTF, a high power X-band RF facility of KEK developed for linear collider. Three traveling-wave structures developed for X-band linear collider were studied in high field of more than 70MV/m level. High-field characteris-

tic such as field emission properties and trip rate, etc. are studied carefully as the processing proceeds. Operation at 50MV/m level was found very stable while breakdowns happened once an hour or so at more than 70MV/m, indicating the approach to some critical point. This characteristics is discussed in conjunction with various author's trials to make a scaling law of severe breakdowns among power, pulse width and so on. Further basic studies on field/power limitation or robustness against breakdowns in various materials are planned using narrowed waveguide configuration. Unique features related to this study is also described.

THP039 – Status of the RF Systems for the SPIRAL2 Linac at the Beginning of the Construction Phase

Marco Di Giacomo, Bernard Ducoudret, Michel Tripon (GANIL, Caen), Philippe De Antoni, Philippe Galdemard, Michel Luong, Olivier Piquet (CEA, Gif-sur-Yvette)

The Spiral 2 project uses an RFQ and a superconductiong linac to accelerate high intensity beams of deuterons and heavier ions. The accelatoror frequency is 88 MHz. The construction phase was approved in Mai 2005 and the project organization was recently finalized. The RF Systems activity includes power amplifiers and control electronics for all the accelerator and some of the RF devices on the beam line: the slow and fast chopper and the rebunchers. The paper describes the status of the amplifiers prototypes, the architecture chosen for the digital LLRF and the preliminary studies on the other RF devices.

THP040 – New Concept of Small Delay Line Type RF Pulse Compressor Using Coupled Cavities

Mitsuhiro Yoshida (KEK, Ibaraki)

I propose a new concept for the RF pulse compressor using the coupled cavities to make a

small delay line. This new concept is a hybrid scheme of a cavity type and a delay line type of the RF pulse compressor. The delay line produces the pulse compression outputs through resultant RF beat between two inputs connected both ports of the coupled cavities. The time constant of the beat is matched to the time constant of the power flow of the coupled cavities. Further the special test stand for the coupled cavities was developed to easily adjust the resonant frequency of such high-Q coupled cavities.

THP041 – 400-kW RF Amplifier for a 201.5-MHz Deuteron RFQ Accelerator
Yuanrong Lu, Jia-er Chen, Jia-Xun Fang, Zhiyu Guo, Wei Guo Li, Xing Bang Wang, Xueqing Yan, Kun Zhu (PKU/IHIP, Beijing), Wei Li, Meng Qian (New Affiliation Request Pending,)
The dedicated 400kW RF amplifier with hypervaportron TH781 tetrode for a 201.5MHz Deuteron RFQ accelerator has been manufactured and tested successfully. It can deliver 400kW pulse power over RF frequency range from 199MHz to 203MHz with maximum pulse duration of 1ms and 10% duty cycle. The exciter with solid state transistors can output 1kW at both CW and pulse modes. The driver stage can output maximum 20kW. The dummy load with CW 50kW and peak to average ratio of 10 has been modified to fit the requirements of amplifier test measurements.

Supported by NSFC.

THP042 – Development of High-Current 201.5-MHz Deuteron RFQ Accelerator
Zhiyu Guo, Jia-er Chen, Jia-Xun Fang, Shu Li Gao, Ju Fang Guo, Wei Guo Li, Jian-Qin Lu, Yuanrong Lu, Shi Xiang Peng, Feng Qian, Zhi Zhong Song, Rong Xu, Xueqing Yan, Jin Xiang Yu, Kun Zhu (PKU/IHIP, Beijing), Chuan Zhang (IAP, Frankfurt-am-Main)

The beam dynamics for a 201.5MHz 50mA 2.0MeV Deuteron RFQ accelerator with duty cycle of 10% has been further improved by using equipartitioning method. The RFQ structure, mechanical design, thermal analysis and its cooling method have been investigated. The tuning of RF cavity for the field and other parameters has been simulated. A new developed ECR ion source and its setup have been completed and tested. The LEBT for the injection of RFQ is under the construction, and the HEBT at RFQ exit for the further applications has been designed and to be constructed in the near future. All the development results will be presented in this paper.

THP043 – The RF System of the Frascati Photo-Injector Sparc
Roberto Boni (INFN/LNF, Frascati (Roma)
The S-band linear accelerator SPARC is in advanced phase of installation and test at the INFN Frascati Laboratories. The purpose of the machine is to produce low emittance, high peak current electron beams to drive a SASE-FEL experiment. The SPARC RF system consists of an RF gun followed by 3 S-band room-temperature accelerating structures, supplied by 2 pulsed high power klystrons. The use of waveguide power attenuators and phase-shifters is foreseen to adjust independently the accelerating structures field amplitude and phase; this will be helpful for tuning the linac working point in the initial machine set-up. This paper reviews the experience in installation, RF conditioning, and commissioning of the normal conducting linac accelerating structures and RF subsystems.

THP044 – Design and Development of RF Structures for Linac4
Maurizio Vretenar, Nader Alharbi, Frank Gerigk, Matteo Pasini, Rolf Wegner (CERN, Geneva)

Linac4 is a new 160 MeV H- linac proposed at CERN to replace the 50 MeV Linac2 as injector to the PS Booster, with the goal of doubling its brightness and intensity. The present design foresees after RFQ and chopping line a sequence of three accelerating structures: a Drift Tube Linac (DTL) from 3 to 40 MeV, a Cell-Coupled DTL (CCDTL) to 90 MeV and a Side Coupled Linac (SCL) up to the final energy. The DTL and CCDTL operate at 352 MHz, while in the SCL the frequency is doubled to 704 MHz. Although the injection in the PS Booster requires only a low duty cycle, the accelerating structures are designed to operate at the high duty cycle required by a possible future extension to a high power linac driver for a neutrino facility. This paper presents the different accelerating structures, underlining the progress in the design of critical resonator elements, like post-couplers in the DTL, coupling slots in the CCDTL and bridge couplers for the SCL. Alternative structures to the SCL are analysed and compared. Prototyping progress for the different structures is reported, including the RF design of a DTL tank prototype and results of low and high power tests on a CCDTL prototype.

THP045 – Cell Shapes for Low Loss and High-Gradient Superconducting Cavities
Valery D. Shemelin (Cornell University, Ithaca, New York)
Some progress was recently achieved in usage of reentrant cavities for higher gradient. It can be shown that optimization of shape for low losses will also lead to the reentrant shape. Comparison of these two optimization goals is done. Dependences of the gradient and losses on the cell wall slope are analyzed. Shape of the end cells in a multicell cavity is discussed.

NSF

THP046 – Status of 3.9-GHz Deflecting-Mode Cavity

Leo Bellantoni, Helen Edwards, Mike H. Foley, Timergali N. Khabiboulline, Donald Mitchell, Allan Rowe, Nikolay Solyak (Fermilab, Batavia, Illinois), Philippe Goudket (CCLRC/DL/ASTeC, Daresbury, Warrington, Cheshire), Graeme Burt, Amos Christopher Dexter (Microwave Research Group, Lancaster), Timothy Koeth (Rutgers University, Piscataway, New Jersey), Chris Adolphsen, Zenghai Li (SLAC, Menlo Park, California)

The superconducting 3.9GHz deflecting mode cavity design which has been under development as a beam slice diagnostic is planned for use as the ILC crab cavity. We describe the applications and review the status of the R & D, giving both prototype test results and computational studies of beam interaction.

THP047 – Prototyping of a Single-Cell Half-Reentrant Superconducting Cavity

Mandi S. Meidlinger, John Bierwagen, Steve Bricker, Chris Compton, Terry L. Grimm, Walter Hartung, Matthew John Johnson, John Popielarski, Laura Saxton, Richard York (NSCL, East Lansing, Michigan), Evgeny Zaplatin (FZJ, Jülich)

As superconducting niobium cavities achieve higher gradients, it is anticipated they will reach a performance limit as the peak surface magnetic field approaches the critical magnetic field. “Low loss” and “reentrant” cavity designs are being studied at CEBAF, Cornell, DESY, and KEK, with the goal of reaching higher gradients via lower surface magnetic field, at the expense of higher surface electric field. At present, cavities must undergo chemical etching and high-pressure water rinsing to achieve good performance. It is not clear whether this can be done effectively and reliably for multi-cell low loss or reentrant cavities using traditional techniques. A “half-reentrant” cavity shape has been developed with

RF parameters similar to the low loss and reentrant cavities, but with the advantage that the surface preparation can be done easily with existing methods. Two prototype single-cell half-reentrant cavities are being fabricated at 1.3 GHz; the non-reentrant wall angle is 8 degrees, the beam tube radius is 29 mm, and the cell-to-cell coupling is 1.47%. The half-reentrant cavity design and the results and status of the prototyping effort will be presented.

THP048 – Band-Gap Structures of Rod-Loaded and Photonic Band-Gap Cavities
David Yu, Ping Chen, Alexei Smirnov, Rong Yi (DULY Research Inc., Rancho Palos Verdes, California)
The band-gap structures for rod loaded (RL) and photonic band gap (PBG) cavities are calculated with 2D and 3D frequency domain codes. It is shown that an RL cavity with a single circle of rods can exhibit similar behavior as a conventional single-defect PBG cavity. A systematic method of computing the unloaded Q factor using SUPERFISH has been implemented. Results are compared with GdfidL and Gd1 calculations.

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THP049 – LANSCE DTL Longitudinal Field Measurements at High Power
Gerald Owen Bolme, Steven Archuletta, Jerry Davis, Luis Lopez, John T.M. Lyles, Danny J. Vigil (LANL, Los Alamos, New Mexico)
Shifts in proton beam tuning were observed in the DTL portion of the Los Alamos Neutron Science Center (LANSCE) Accelerator corresponding with cooling system obstructions during the 2003 operational cycle. A diagnostic system was developed to measure longitudinal field changes at the operational field levels to confirm the source of the tune shifts and track the effectiveness of cooling system repairs. This paper

describes the diagnostic system and the results of field distribution measurements at high RF power in the accelerating structures.

THP050 – Study of HOM-IH Linac
Noriyosu Hayashizaki, Toshiyuki Hattori (RLNR, Tokyo)
An IH-type structure has higher shunt impedance in low beta range. The RF field is resonated in the fundamental TE mode and the lower resonant frequency is suitable for accelerating heavy ion from low energy. In order to apply this structure to intermediate beta range, we propose a higher order mode (HOM)-IH linac using the TE11n mode. Although the operating frequency becomes higher by using HOM, it is convenient to accelerate heavy ion beam of intermediate energy. The basic design for VHF band and the possibility are discussed.

THP051 – Status of 3.9-GHz Superconducting RF Cavity Technology at Fermilab
Helen Edwards, Tug Tacku Arkan, Harry Carter, Mike H. Foley, Elvin Robert Harms, Andrew Hocker, Timergali N. Khabiboulline, Donald Mitchell, Daniel Olis, Allan Rowe, Nikolay Solyak (Fermilab, Batavia, Illinois)
Fermilab is involved in an effort to design, build, test and deliver 3.9 GHz superconducting RF cavities with a goal to deliver one 'third harmonic' cryomodule containing four cavities in early 2007 for use at the DESY TTF III Project. The design gradient of these cavities is 19 MV/m. This effort involves design, fabrication, intermediate testing, assembly, and eventual delivery of the four cavity cryomodule. We report on all facets of this enterprise from design through future plans. Included will be early test results of single 9-cell cavities, lessons learned, and other findings.

This work was supported by Universities Research Association Inc. under contract DE-AC02-76CH00300 with the U.S. DOE.

THP052 – Tests Results of Beta 0.12 Quarter-Wave Resonator for the SPIRAL2 Superconducting Linac

Guillaume Olry, Sebastien Blivet, Sébastien Bousson, Tomas Junquera, Jean Lesrel, Franck Lutton, Guillaume Martinet, Herve Saugnac (IPN, Orsay)

New developments and tests have been carried out, at IPN-Orsay, on high beta 0.12, 88 MHz superconducting Quarter Wave Resonators. These resonators will be installed in the high beta section of the LINAC driver. RF tests results of the prototype cavity are reported. The fabrication of 2 pre-series cavities and their cryomodule is in progress in order to be ready for high power RF tests at 4.2 K at the beginning of 2007.

THP053 – Electromagnetic, Multipacting, and Thermal Simulations of a Power Coupler for 3.9-GHz Third-Harmonic Superconducting Cavities at Fermilab

Jianjian Li, Ivan V. Gonin, Timergali N. Khabiboulline, Daniel Olis, Nikolay Solyak (Fermilab, Batavia, Illinois), Thomas Wong (Illinois Institute of Technology, Chicago, Illinois)

3.9 GHz third harmonic superconducting cavities have been applied to increase the peak current of the bunch and compensate non-linear distortions in the longitudinal phase space due to cosine-like 1.3 GHz cavity voltage. In TTF3 (DESY) and upgraded Fermilab photo-injectors the third harmonic cavities will be installed to improve bunch performance. Power couplers are the most important and complicated components that connect to those cavities. From electromagnetic, multipacting, and thermal simulations of the power coupler, optimized designs have been achieved which can minimize potential problems ahead of final manufacture. This paper presents our recent work on those simulation areas. Six power couplers are being fabricated in industry

and will be delivered to Fermilab for further construction, test and process.

Work is supported by DOE.

THP054 – Spoke Cavity Developments for the EURISOL Driver

Sébastien Bousson, Jean-Luc Biarrotte, Franck Lutton, Guillaume Olry, Herve Saugnac, Philippe Szott (IPN, Orsay)

EURISOL is the next generation of Radioactive Ion Beam (RIB) facility which aims at the provision of high intensity beams of radioactive nuclei with variable energy, from a few keV to greater than 100 MeV per nucleon, at an intensity several orders of magnitude higher than those currently available. The driver of EURISOL has to accelerate protons at a final energy of 1 GeV and 5 mA current, but also deuterons at 200 MeV (total energy). For the intermediate energy part of the driver, a solution based on superconducting (SC) spoke cavities is under study at the IPN Orsay laboratory. In this paper are presented the results of beam dynamics simulations for the linac, experimental results on the beta 0.15 spoke cavity, as well as achievements on the power coupler and cold tuning system. A new horizontal cryostat for performing a test of a fully equipped spoke cavity is detailed and an optimized design for a new beta ~ 0.35 spoke prototype is also presented.

We acknowledge the financial support of the European Community under the FP6 “Research Infrastructure Action - Structuring the European Research Area” EURISOL DS Project, Contract no.515768 RIDS.

THP055 – High-Power Processing of the Couplers for 3.9-GHz Accelerating Cavity at Fermilab

Timergali N. Khabiboulline, Timothy Koeth, Jianjian Li, Daniel Olis, Allan Rowe, Nikolay

Solyak (Fermilab, Batavia, Illinois)
Superconducting 3.9 GHz accelerator cavities developed in frame of Fermilab-DESY ILC collaboration require power coupler, which can provide 50 kW power in 1.3 msec pulses with repetition rate up to 10 Hz. At Fermilab we finished development of the coupler including RF design, multipacting calculations and thermal analysis. Test stand was designed and manufactured for high power processing of the couplers. Six and couplers are manufactured in CPI, processed and tested in Fermilab. Coupler processing history and the high power test results are presented.

THP056 – Design of 325-MHz Single- and Triple-Spoke Resonators at FNAL
Ivan V. Gonin, Giorgio Apollinari, Timergali N. Khabiboulline, Giobatta Lanfranco, Gennady Romanov (Fermilab, Batavia, Illinois)
Within the framework of the High Intensity Neutrino Source (HINS), an 8 GeV proton linear accelerator at FNAL based on about 400 independently phased SC resonators has been proposed. In this paper the design of two 325 MHz Single Spoke Resonators (SSR1 at â=0.22 and SSR2 at â=0.4) and a 325 MHz Triple Spoke Resonator (TSR at â=0.62) for the linac front end is presented. We describe the optimization of the spoke resonator electromagnetic performance and the way the resonator structural integrity and shape is ensured. We show the mechanical design of the slow tuner mechanism and via a coupled ANSYS-MWS analysis we present the way the mechanism adjusts the resonator operating frequency. The power coupler RF design is also presented.

THP057 – Design of Normal-Conducting 325-MHz Crossbar H- Type Resonators at Final
Leonardo Ristori, Ivan V. Gonin, Timergali N. Khabiboulline, Gennady Romanov (Fermilab, Batavia, Illinois)

The proposed High Intensity Neutrino Source at FNAL utilizes 16 normal conducting resonators to accelerate H- and protons from 2.5 MeV up to 10 MeV energy (â=0.0744 to â=01422). In this paper the design of a 325 MHz Crossbar H-type normal conducting resonator at â=0.0744 is presented. We describe the optimization of the spoke resonator geometry and report the analysis of the resonator mechanical and electromagnetic performance. The design of the tuner system and the input coupler is also presented.

THP058 – Proposed LLRF Improvements for Fermilab 200-MHz Linac

Ed Cullerton, Trevor A. Butler, Vitali Tupikov (Fermilab, Batavia, Illinois)

As part of the three year Proton Plan at FermiLab to increase proton intensity and reduce radiation losses, the task of characterizing the complete LINAC RF system was undertaken. The current 200 MHz Drift Tube LINAC was designed and built over 30 years ago and does not meet the higher beam quality demands required under the new Proton Plan. Complete measurement data, used to characterize the system, has been developed along with a computer model. This model shows what improvements can be made to the current LLRF system to improve beam quality. The model includes RF driver amplifiers, a 5 MW 7835 triode power amplifier, the high voltage switch tube modulator, and the drift tube cavity. Complete system gain and bandwidth characterization data has been completed for the 7835 triode power amplifier, modulator and RF driver stages. This model will be a useful analysis tool for present and future LINAC systems and upgrades.

DOE

THP059 – Coaxial HOM Coupler Designs Tested on a Single-Cell Niobium Cavity

Peter Kneisel, Gianluigi Ciovati (Jefferson Lab, Newport News, Virginia), Jacek Sekutowicz (DESY, Hamburg)

Coaxial higher order mode (HOM) couplers have been developed for HERA cavities and are used in TESLA, SNS and Jlab upgrade cavities. The principle of operation is the rejection of the fundamental mode by the tunable filter of the coupler and the transmission of the HOMs. It has been recognized recently that inappropriate thermal designs of the feed through for the pick-up probe of the HOM coupler will not sufficiently carry away the heat generated in the probe tip by the fundamental mode fields, causing a built-up of the heating of the niobium probe tip and subsequently, a deterioration of the cavity quality factor has been observed in cw operation. An improvement of the situation has been realized by a better thermal design of the feed through incorporating a sapphire rf window.* An alternative is a modification of the coupler loop ("F" – part) with an extension towards the pick-up probe. This design has been tested on a single cell niobium cavity in comparison to a"standard TESLA" configuration. by measuring the Eacc behavior at 2 K.. The measurements clearly indicate that the modified version of the coupler loop is thermally much more stable than the standard version.

*C.Reece et al; http://accelconf.web.cern.ch/accelconf/, paper TPPT082.

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THP060 – Capture Cavity II at Fermilab

Timothy Koeth (Rutgers University, Piscataway, New Jersey), Ruben H. Carcagno, Brian Chase, Paul Czarapata, Helen Edwards, Raymond Patrick Fliller, Camille Ginsburg, Bruce M.

Hanna, Andrew Hocker, A. Klebaner, Michael Kucera, Mike McGee, Darryl Orris, Peter Prieto, John Reid, James Santucci, William Soyars, Cheng-Yang Tan (Fermilab, Batavia, Illinois)

Capture Cavity II is a 9-cell high gradient TESLA Superconducting cavity intended to upgrade the existing Fermilab Photoinjector electron beam energy from 15MeV to 40Mev. DESY provided the cavity which performed to 33MV/m. Beam tube component preparation and installation onto the cavity was completed at DESY. The cavity was shipped to FNAL under vacuum. Installation and testing of this cavity has provided an opportunity to demonstrate Fermilab's SCRF High Power Testing infrastructure. We report on the high power RF tests performed with Capture Cavity II at both 4.5K and 1.8K, Cryogenic System Performance, Piezo Electric based fast tuner, and low level RF control.

This work was supported by Universities Research Association Inc. under contract DE-AC02-76CH00300 with the U.S. DOE and by NICADD.

THP061 – High Field Test Results of Superconducting 3.9-GHz Accelerating Cavities at FNAL

Nikolay Solyak, Helen Edwards, Mike H. Foley, Camille Ginsburg, Timergali N. Khabiboulline, Donald Mitchell, Allan Rowe (Fermilab, Batavia, Illinois)

In frame of Fermilab-DESY ILC collaboration, we finished development of the superconducting third harmonic 3.9 GHz accelerating cavity for TTF-III project at DESY. Six cavities are manufactured, processed and tested. Cavity processing history and the high field test results in the vertical are presented. In this paper, we discuss the status of the cavity development and our future plans.

THP062 –SRF Cavity Designs for the International Linear Collider

Zenghai Li, Volkan Akcelik, Arno E. Candel, Lixin Ge, Andreas C. Kabel, Kwok Ko, Lie-Quan Lee, Cho-Kuen Ng, Ernesto Prudencio, Greg Schussman, Ravindra Uplenchwar, Liling Xiao (SLAC, Menlo Park, California)

SLAC is contributing to the design of SRF cavities for the International Linear Collider by performing highly accurate, high fidelity electromagnetic modeling using the advanced tools developed under the US DOE SciDAC program. The parallel finite element codes include the eigensolver Omega3P for calculating mode damping, the time-domain solver T3P for computing wakefields and the particle tracking code Track3P for simulating multipacting and dark current. We will present the results from their applications to the accelerating cavity for the ILC main linac including the baseline TDR design and the alternate Low-Loss and Ichiro designs, and also to the deflecting mode cavity for the interaction region. The important issues of HOM damping, mode rotation, cavity deformations, trapped modes and multipacting in these cavities will be addressed and discussed.

Work supported by DOE contract DE-AC02-76SF00515.

THP063 – First High-Power ACS Module for J-PARC Linac

Hiroyuki Ao, Kazuo Hasegawa, Koichiro Hirano, Takatoshi Morishita, Akira Ueno (JAEA/LINAC, Ibaraki-ken), Yoshishige Yamazaki (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Masanori Ikegami (KEK, Ibaraki), Valentin Paramonov (RAS/INR, Moscow)

J-PARC Linac will be commissioned with energy of 181-MeV using 50-keV ion source, 3-MeV RFQ, 50-MeV DTL and 181-MeV SDTL (Separated DTL) on December 2006. It is planed

to be upgraded by using 400-MeV ACS (Annular Coupled Structure), in a few years from the commissioning. The first high-power ACS module, which will be used as the first buncher between the SDTL and the ACS has been fabricated, and a few accelerating modules are also under fabrication until FY2006. Detail of cavity design and tuning procedure has been studied with RF simulation analysis and cold-model measurements. This paper describes RF measurement results, fabrication status, and related development items.

THP064 – Tuning a CW 4-Rod RFQ

Philipp Fischer, Alwin Schempp (IAP, Frankfurt-am-Main)

A 4-Rod RFQ has been built, which operates cw and will accelerate 5mA D beams up to 3 MeV. The length of the structure is 3.8 m, the power consumption as high as 250 kW. The tuning of a 4-Rod RFQ with 30 rf-cells at the frequency of 175 MHz is difficult, so procedures have been developed, to facilitate this work. The properties of the RFQ accelerator, the tuning procedure and the status of the project will be discussed.

Work supported by the Graduiertenkolleg "Physik und Technik von Beschleunigern."

THP065 – High-Gradient Generation in Dielectric-Loaded Wakefield Structures

Manoel Conde, Sergey P. Antipov, Felipe Franchini, Wei Gai, Feng Gao, Chunguang Jing, Richard Konecny, Wanming Liu, John Gorham Power, Haitao Wang, Zikri Yusof (ANL, Argonne, Illinois)

Dielectric loaded wakefield structures have potential to be used as high gradient accelerator components. Using the high current drive beam at the Argonne Wakefield Accelerator Facility, we employed cylindrical dielectric loaded wakefield structures to generate accelerating fields of up to 43 MV/m at 14 GHz. Short electron bunches (13

ps FWHM) of up to 86 nC are used to drive these fields, either as single bunches or as bunch trains. One of these structures consists of a 23 mm long cylindrical ceramic tube (cordierite) with a dielectric constant of 4.76, and inner diameter of 10 mm, inserted into a cylindrical copper waveguide. This standing-wave structure has a field probe near the outer edge of the dielectric to sample the RF fields generated by the electron bunches. The signal is sent to a mixer circuit, where the 14 GHz signal is down converted to 5 GHz and then sent to an oscilloscope. A similar structure, with smaller inner diameter and an operating frequency of 9 GHz, is ready for initial tests. Its accelerating fields will be twice as high as the fields in the 14 GHz structure, for the same bunch charge.

Work supported by the U.S. Department of Energy under contract No. W-31-109-ENG-38.

THP066 – Lorentz-Force Detuning Analysis for Low-Loss, Re-entrant and Half-Re-entrant Superconducting RF Cavities

Evgeny Zaplatin (FZJ, Jülich), Terry L. Grimm, Walter Hartung, Matthew John Johnson, Mandi S. Meidlinger, John Popielarski, Richard York (NSCL, East Lansing, Michigan)

The RF design of a superconducting elliptical cavity requires a trade-off in the optimization of the cell shape between the region of high electric field and the region of high magnetic field. In practice, the cavity performance may be limited not by the RF characteristics, but by detuning due to the Lorentz force, bath pressure fluctuations, or microphonics; Lorentz force detuning is of concern primarily for pulsed accelerators such as the proposed International Linear Collider. Hence the structural properties must also be taken into account in the cavity design. Several new cavity shapes are being developed in which the surface magnetic field is decreased relative to the TeSLA cavity shape, with the goal of reach-

ing a higher accelerating gradient. This study will compare the Lorentz force detuning characteristics of the TeSLA, "low-loss", "reentrant", and "half-reentrant" cavity middle cells, and explore possible methods for stiffening the structures.

THP067 – Status of the Tuner for the 19-Cell Superconducting CH Prototype Cavity

Christian Commenda, Holger Liebermann, Holger Podlech, Ulrich Ratzinger, Andreas Christoph Sauer (IAP, Frankfurt-am-Main), Kalliopi Dermati (GSI, Darmstadt)

The radio frequency tuning of the multi-cell superconducting CH structure for beta equal to 0.1 is investigated for a 19-cell niobium cavity operated at liquid helium temperature. By applying external mechanical forces the deformation of the structure is studied and the resulting change in frequency is analysed. The ruling equations of elasticity and the electromagnetic eigenvalue problem are solved by using commercial finite element tools. The quantitative results form the basis of an optimized tuning device. In order to guarantee a long lifetime of the cavity, fracture criteria are defined to avoid mechanical damage. Wherever possible the results are compared with experimental data obtained from measurements performed on the first CH prototype developed at the Institute of Applied Physics at Frankfurt. In addition a fast piezo device will be integrated into the slowly acting mechanical tuner. The whole system will operate in an existing horizontal cryostat for testing purposes.

THP068 – RF Characteristics of the SDTL for the J-PARC

Takashi Ito, Hiroyuki Asano, Takatoshi Morishita (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Takao Kato, Fujio Naito, Eiichi Takasaki, Hirokazu Tanaka (KEK, Ibaraki)

For the J-PARC linac, a Separated type DTL (SDTL) is used to accelerate an H- ion beam

from 50MeV to 191MeV. The SDTL consists of 32 tanks and the operating frequency is 324MHz. It has 4 drift tubes and 2 half tubes (5cells), 2 fix tuners, 1 movable tuner and 1 RF input coupler. The inner diameter is 520mm and the length is approximately from 1.5m (SDTL1) to 2.5m (SDTL32). The focusing magnets are set between the tanks. We have measured the RF characteristics of the SDTL tanks and adjusted the field distribution since last summer. The measured Q value was above 90% of ideal SUPERFIS value, the field distribution was adjusted within +/-1% for all the tanks. In this paper, the results of RF measurements of the SDTL tanks are described.

THP069 – DTL and SDTL Installation for the J-PARC

Fujio Naito, Eiichi Takasaki, Hirokazu Tanaka (KEK, Ibaraki), Hiroyuki Asano, Takashi Ito, Takatoshi Morishita (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken)

Three DTL tanks and 30 SDTL tanks have been installed precisely in the under-ground tunnel of the J-PARC project. The alignment of the tank was mainly done by using an alignment telescope. The distance of the center axis of the tank from the beam axis was measured by the telescope of which axis is in the beam line. The distance is minimized by adjusting the position of the tank on the stand. The beam axis in the tank is defined by the two optical target which are put on the template fixed on both ends of the tank cylinder for the DTL. After the installation of the tanks the movable tuners and the input couplers were also fixed on the tank. In the paper the measured tank position will be described in detail.

THP070 – Study of BSNS RFQ Design

Huafu Ouyang, Shinian Fu (IHEP Beijing, Beijing)

A new 324MHz RFQ used for the project of Beijing Spallation Neutron Source (BSNS) is being designed. The designed injection and output energy are 50keV, 3.0MeV, respectively. The designed pulsed current is 40mA though the required current of BSNS at its first stage is only 20mA. The pulsed width is 420 s with a 50% chopping ratio and repetition rate is 25Hz. The transverse structure of BSNS RFQ will be basically the same as the former RFQ used for ADS, but the length of 3.62m is shorter comparing to the length of 4.75m of the former. The beam dynamics design and the RF structure design of the RFQ will be presented in this paper.

Work is supported by Chinese Academy of Sciences.

THP071 – Design of the FAIR Proton Linac RF System

Wolfgang Vinzenz, Winfried Barth, Lars Groening, Heinz Ramakers (GSI, Darmstadt)

A 70 mA 70 MeV – proton linac is foreseen to serve, together with the existing SIS 18, as a proton injector for the new FAIR facility. It consists of six pairs CH-type cavities (requiring 2,5 MW pulse power each), one RFQ and two Buncher cavities. The commissioning of the proton linac is scheduled at 2012. On account of the big portion of costs for the RF system compared to the total cost of the proton linac (app. 30%) a design optimization has been made. Now each CH cavity and the RFQ are driven by a single klystron at 352 MHz. Power needs for the bunching cavities are in the region of 15 kW and 50 kW. Because of the very low duty factor (70 μs at 4 Hz) a new d.c. and pulsed power systems for the cathode and modulating anode have been designed and a prototype will be ordered within this year. For purposes to low level system tests, cavity tests and a full system test the assembly of a test bench will start in 2006 and will be completed (with CH prototype

cavity) in 2008. The complete RF scenario will be described.

THP072 – Fabrication and Low-Power Measurement of the J-PARC 50-mA RFQ Prototype

Yasuhiro Kondo (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Kazuo Hasegawa (JAEA, Ibaraki-ken), Akira Ueno (JAEA/LINAC, Ibaraki-ken)

In the Japan Proton Accelerator Research Complex (J-PARC) project, the beam commissioning of the H- linac will be started with a 30mA peak current. A 30mA type RFQ, which is developed for the former Japan Hadorn Facility (JHF) project, is used for the day-1 operation. However, it is required to accomplish the peak current of 50mA as soon as possible. For this purpose, we have developed an RFQ for the 50mA peak current, which is a four vane type RFQ and resonant frequency of which is 324MHz, same as the 30mA RFQ. In the R&D of this RFQ, we have adopted laser welding to join oxygen free copper blocks to be a cavity structure. The heat load of the laser welding can be more localized than that of the brazing, and the copper is not annealed, therefore, we think, it is possible to obtain more mechanical accuracy. We have developed a longitudinally 1/3 prototype cavity of the J-PARC 50mA RFQ. In this cavity, the distortion of the vane tips is measured to be less than 30 micro-meters, and the field uniformity of within 1% is obtained in a low power measurement after tuning. In this paper, we discuss about the fabrication and the low power measurement of this prototype cavity.

THP073 – High-Current Elliptical Cavity Design and Prototyping

David Meidlinger, John Bierwagen, Steve Bricker, Chris Compton, Terry L. Grimm, Walter Hartung, Matthew John Johnson, John

Popielarski, Laura Saxton (NSCL, East Lansing, Michigan)
Beam instabilities due to undamped higher-order modes (HOMs) in the cavities can limit the performance of high-current superconducting accelerators, such as energy recovery linacs. If the accelerator is designed such that the bunch frequency is equal to the accelerating mode frequency and the beam pipe radius is chosen such that the cutoff frequency is less than twice that of the accelerating mode, all of the monopole and dipole HOMs that can be driven by the beam can be well-damped. A 6-cell elliptical cavity for speed-of-light particles and a 2-cell elliptical injection cavity have been designed for high-current accelerator applications. Both cavities have an aperture 29% larger than the TeSLA cavity, at the expense of peak surface fields about 10% higher for the same gradient. The injection cavity has a geometric beta of 0.81 and was designed to accelerate electrons from 50 keV to 1 MeV, and the 6-cell cavity has a geometric beta of 1 for further acceleration. Both cavities are designed for the purpose of accelerating hundreds of milliamps without HOM-induced beam breakup and to operate at 2.45 GHz. The cavity designs and prototype injection cavity results will be presented.

THP074 – Status of the Room Temperature CH-DTL

Gianluigi Clemente, Holger Podlech, Ulrich Ratzinger, Rudolf Tiede (IAP, Frankfurt-am-Main), Sergey Minaev (ITEP, Moscow)
The CH cavity is a very promising cavity in the energy range from 3 to 150 AMeV: due to its high efficency it has been choosen to be the main linac of the new 70 MeV, 70 mA proton injector of FAIR. Since last year IAP has been performing intensive R&D investigations on such a new cavity: a first prototype is under construction to show the mechanical and the copper plating feasibility of that structure. Recently, new

solutions in order to feed multiple structures with only one klystron have been investigated: this paper describes in details those solutions together with the result of the first measurements performed on the prototype cavity. The achieved experience will be implemented in the design of the advanced production of the third and fourth tank of the GSI proton injector.

GSI - EU (CARE Contract No. RII-CT-2003-506395.

THP075 – RF Performance of a Superconducting S-Band Cavity Filled with Liquid Helium

Walter Hartung, John Bierwagen, Steve Bricker, Chris Compton, Terry L. Grimm, Matthew John Johnson, Daniel Pendell, John Popielarski, Laura Saxton, Richard York (NSCL, East Lansing, Michigan)

Copper RF cavities filled with hydrogen gas at high pressure have been studied recently by Muons, Inc. and IIT for simultaneous acceleration and ionisation cooling of a muon beam. A further step in this direction would be a superconducting RF cavity filled with liquid helium. One might imagine that this would make the cavity less vulnerable to thermal breakdown, field emission, and multipacting. A disadvantage is that magnetostatic focussing of the beam could not be done simultaneously. Preliminary RF testing has been done on a 2.45 GHz single-cell elliptical cavity filled with liquid helium. Low-field results indicate little or no increase in the power dissipation, consistent with predictions and measurements in the literature. The frequency shift with pressure for a cavity filled with saturated liquid is about 100 times greater than for a cavity under vacuum, consistent with published values of liquid helium permittivity as a function of temperature. Investigation of the high-field performance of a liquid-filled cavity is in progress.

THP076 – Prototyping of a Superconducting Elliptical Cavity for a Proton Linac

Walter Hartung, John Bierwagen, Steve Bricker, Chris Compton, Terry L. Grimm, Matthew John Johnson, David Meidlinger, John Popielarski, Laura Saxton, Richard York (NSCL, East Lansing, Michigan), G. William Foster, Ivan V. Gonin, Timergali N. Khabiboulline, Nikolay Solyak, Robert Wagner, Victor Yarba (Fermilab, Batavia, Illinois), Peter Kneisel (Jefferson Lab, Newport News, Virginia)

A superconducting cavity has been designed for acceleration of particles travelling at 81% the speed of light (beta = 0.81). Possible applications include the proposed Fermilab Proton Driver Linac. The cell shape is similar to the beta = 0.81 cavity for the Spallation Neutron Source Linac, but the resonant frequency is 1.3 GHz rather than 805 MHz and the beam tube diameter matches that of the 1.3 GHz cavity for the TeSLA Test Facility. Six single-cell prototypes are being fabricated and tested. Three of these cavities are being formed from standard high purity fine grain niobium sheet. The rest are being fabricated from large grain niobium, following up on the work at Jefferson Lab to investigate the potential of large grain material for cost savings and/or improved RF performance. The fabrication of two 7-cell cavity prototypes (one fine grain, one large grain) is planned. A status report on this prototyping effort will be presented.

THP077 – A High-Gradient Test of a 30-GHz Copper Accelerating Structure

Steffen Doebert, Roberto Corsini, Raquel Fandos, Alexej Grudiev, Erk Jensen, Trond Ramsvik, Jose Alberto Rodriguez, Jonathan Sladen, Igor Syratchev, Mauro Taborelli, Frank Tecker, Peter Urschütz, Ian Wilson, Walter Wuensch (CERN, Geneva), Öznur Mete (Ankara University, Tandogan, Ankara)

The CLIC study is investigating a number of different materials at different frequencies in

order to find ways to increase achievable accelerating gradient and to understand what are the important parameters for high-gradient operation. So far a series of rf tests have been made with a set of identical-geometry 30 GHz and X-band structures in copper, tungsten and molybdenum. A new test of a 30 GHz copper accelerating structure has been completed in CTF3 with pulse lengths up to 100 ns. The new results are presented and compared to the previous structures to determine dependencies of quantities such accelerating gradient, material, frequency, pulse length, power flow, conditioning rate, breakdown rate and surface damage.

THP078 – High-Gradient Test of a Tungsten-Iris X-Band Accelerator Structure at NLCTA
Steffen Doebert, Alexej Grudiev, Samuli Tapio Heikkinen, Jose Alberto Rodriguez, Igor Syratchev, Mauro Taborelli, Walter Wuensch (CERN, Geneva), Chris Adolphsen, Lisa Laurent (SLAC, Menlo Park, California)
The CLIC study group at CERN has built two X-band accelerating structures to be tested at SLAC in NLCTA. The structures consist of copper cells with insert irises made out of Molybdenum and Tungsten, clamped together and installed in a vacuum tank. These structures are exactly scaled versions from structures tested previously at 30 GHz and with short pulses (16 ns) in the CLIC Test Facility at CERN. At 30 GHz these structures reached gradients of 150 MV/m for Tungsten and 195 MV/m for Molybdenum. These experiments were designed to provide data on the dependence of rf breakdown on pulse length and frequency. This paper reports in particular on the high-gradient test of the tungsten-iris structure. At a pulse length of 16 ns a gradient of 125 MV/m was reached at X-band, 20 % lower than the 150 MV/m measured at 30 GHz in the CLIC Test Facility. The pulse length dependence and the dependence of the break down rate as a function of gradient were mea-

sured in detail. The results are compared to data obtained from the Molybdenum-Iris experiment at X-band which took place earlier as well as to 30 GHz data.

THP079 – High-Power Test of a 57-MHz CW RFQ

Peter Ostroumov, Albert Barcikowski, Brian Rusthoven, Sergey I. Sharamentov, Sushil Sharma, William F. Toter (ANL, Argonne, Illinois), John Rathke (AES, Princeton, New Jersey), Nikolai Vinogradov (Northern Illinois University, DeKalb, Illinois), Dale L. Schrage (TechSource, Santa Fe, New Mexico)

High power heavy-ion drivers require a CW low-frequency RFQ for initial acceleration. The technique of high-temperature furnace brazed OFE copper cavities has proven to be very reliable for the production of high-quality CW accelerating structures. By appropriate choice of the resonant structure for the RIA driver RFQ we have achieved moderate transverse dimensions of the cavity and high quality accelerating-focusing fields required for simultaneous acceleration of multiple charge state ion beams. In our application the RFQ must provide stable operation over a wide range of RF power levels. To demonstrate the technology and high-power operation we have built an engineering prototype of one-segment of the 57-MHz RFQ structure.* The RFQ is designed as a 100% OFE copper structure and fabricated with a two-step furnace brazing process. The brazing process was successful and the cavity was shown to be vacuum tight. The errors in the tip-to-tip distances of the vanes average less than 50 microns. The RF measurements show excellent electrical properties of the resonator with a measured unloaded Q equal to 95% of the simulated value. Currently high-power tests are being performed.

*J.W. Rathke et al., Preliminary Engineering Design of A 57.5 MHz CW RFQ for the RIA

Driver LINAC. Proc. of the LINAC-2002, p. 467.

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THP080 – Radiation Maintenance Scenario for J-PARC Beam Transport Collimator System

Masakazu Yoshioka, Hiroshi Oki, Takao Oogoe, Masashi Shirakata, Yasunori Takeuchi, Masahiko Uota (KEK, Ibaraki)

A movable beam collimator system for the beam transport line between the RCS (Rapid Cycling Synchrotron) and 50 GeV Synchrotron of J-PARC has been fabricated, and installed into the accelerator tunnel. The paper describes radiation maintenance scenario for the collimator system by using the semi-remote handling technologies.

THP081 – Study on Fault Scenarios of Coaxial Type HOM Couplers in SRF Cavities

Sang-Ho Kim, Isidoro Enrico Campisi, Fabio Casagrande, Mark Stuart Champion, Mark Crofford, Dong-o Jeon, Yoon W. Kang, Michael P. McCarthy, Daniel Stout (ORNL, Oak Ridge, Tennessee)

Coaxial type couplers are adopted in many superconducting radio-frequency (SRF) cavities to suppress higher order modes for beam dynamics and cryogenic loads issues. HERA (Hadron-Electron Ring Accelerator) and TTF (Tesla Test Facility) are equipped with this type coupler and showed successful performances. It is, however, under suspicion that a limitation or a fault could be initiated from this type of coupler at certain combinations between cavity operating conditions and engineering designs of the coupler. Some possible scenarios are summarized and also some observations in the SNS (Spallation Neutron Source) SRF cavities are also reported.

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy.

THP082 – Industrialization of TESLA-Type SRF Technology at ACCEL

Michael Pekeler (ACCEL, Bergisch Gladbach)

In the last 15 years the worldwide TESLA collaboration under the leadership of DESY performed successful developements of SRF technology for possible use in a future international linear collider (ILC). Today this technology is also the baseline for other demanding projects like the European X-FEL at DESY site, 4GLS at Daresbury, BESSY FEL, Cornell-ERL, FEL at Peking University and others. Through all these years ACCEL has followed and supported this tremendous developement by producing and processing SRF cavities, couplers and complete accelerator modules. The current ability and future prospects of ACCEL for manufacturing and processing such key components as well as turnkey SRF modules with guaranteed performance for such projects are described.

THP083 – Generation of Ellipsoidal Beam Through 3-D Pulse Shaping of a Photoinjector Drive Laser

Yuelin Li, John Wesley Lewellen (ANL, Argonne, Illinois)

Due to the linear space-charge force, an ellipsoidal beam is expected to have much smaller emittance in comparison with beams of other geometries, which is critical for many accelerator applications. Up to now, no practical way of generating such beams is available. In this paper we present a few schemes for 3-D laser pulse shaping that can be used to generate ellipsoidal laser pulses that in turn can be applied for generating ellipsoidal electron bunches from a photoinjector. Our simulations show that 3D laser pulse shaping can be realized through laser phase tailoring in combination with properly

designed refractive and diffractive optics. Performance of an electron beam generated from such shaped laser pulses is compared with that of the ideal flat-topped and Gaussian electron bunches by numerical simulation, showing improvement in both beam dynamics and performance.

Work supported by U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. W-31-109-ENG-38.

THP084 – Design of an 8-Gev H- Transport and Multiturn Injection System

David E. Johnson (Fermilab, Batavia, Illinois)

The baseline design of the transport and multiturn injection of 8 GeV H- to the FNAL Main Injector from a proposed 8 GeV superconducting linac will be discussed.

Work supported in part by the U.S. Dept. of Energy through the Univ. Research Association under contract DE-AC35-89ER40486.

THP085 – Transportation of the DTL/SDTL for the J-PARC

Takashi Ito (JAEA/LINAC, Ibaraki-ken), Hiroyuki Asano, Takatoshi Morishita (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), Takao Kato, Fujio Naito, Eiichi Takasaki, Hirokazu Tanaka, Kazuo Yoshino (KEK, Ibaraki), Zenzaburo Kabeya, Shinji Kakizaki, Kiichi Suzuki (MHI, Nagoya)

Three DTL tanks and 32 SDTL tanks for the Japan Proton Accelerator Research Complex (J-PARC) were assembled at KEK site. After the assembling, the aging of the DTL1 and 12 SDTL tanks and the beam acceleration test for the DTL1 was done. And then all the DTL and SDTL tanks have to be transported form KEK to JAEA. The distance is about 95km and special air suspension trailer is used. To confirm the effect to the accuracy of the drift tube alignment, we measured the displacement of the drift tube

positions before and after the transportation by using a hot model tank. As a result of the test, the displacement of the drift tubes by the transportation was less than 0.02mm which meets our requirements. Based on this result, all the DTL and SDTL tanks were transported form KEK to JAEA. In this paper, the transportation results of the hot model tank and the DTL/SDTL tanks are described.

THP086 – Mitigation of Power Loss Due to Skin Effect by Thin-Layered Film
Yoshihisa Iwashita (Kyoto ICR, Uji, Kyoto)
The AC current flows only on the metal surface, which is known as skin effect. The current concentration on the surface increases power loss. This results higher transmission loss of cable and degradation of Q in cavities. Skin effect on a metal film that is thinner than a skin depth is investigated starting from general derivation of skin depth on a bulk conductor. The reduction of the skin effect power loss with layered conductor films is reported and discussed.

THP087 – Status of C-band Accelerating Section Development in KEKB Injector Linac
Takuya Kamitani, Toshiyasu Higo, Mitsuo Ikeda, Kazuhisa Kakihara, Noboru Kudo, Satoshi Ohsawa, Takashi Sugimura, Toshikazu Takatomi, Kazue Yokoyama (KEK, Ibaraki)
This paper reports on C-band accelerating section development for future energy upgrade of the KEKB injector linac. Target field gradient is 42 MV/m, that is twice of the present S-band sections in the linac. Until now, we have developed four 1m-long sections based on a half-scale design of the S-band section with improvements in coupler cavity shape and in fabrication method. And the fifth accelerating section is in fabrication now. The four sections have already installed in the beam line of the linac. Together with a unit of C-band rf source (50 MW

klystron, pulse modulator, rf-pulse compressor) installed in the linac, we will perform an operation test of a model C-band accelerator module that has almost same configuration as a design module in the upgrade. Results of the long-term operation test and beam acceleration study will be described. And present status of development of the fifth accelerating section will also be given.

THP088 – Beam Loss and Shielding Strategy in the Design of High-Power Proton Linacs
Marta Felcini (CERN, Geneva)
High-power proton accelerators are in use at present and future facilities for fundamental and applied research, such as spallation neutron sources, radioactive ion beam facilities, neutrino factories and muon colliders, as well as accelerator driven systems for transmutation of nuclear waste. A critical issue in the design of high-power proton linacs is the minimization of beam loss, at the origin of material activation and damage of the machine components, as well as irradiation of the environment. A realistic knowledge of beam loss distributions is the necessary input for the design of reliable radiation shielding and for the planning of radiation protection measures which can ensure smooth and safe operation of the machine. A survey of present and expected performances of existing and planned high-power linacs is presented. Based on these performances, and using as an example the SPL and EURISOL proton driver design parameters, a study has been done of shielding design parameters as a function of beam loss intensity and localization along the accelerator. The results of this study are presented and their implication for the design of high-power proton linacs is discussed.

European Community under Framework Program 6.

THP089 – Testbench of the HICAT RFQ at GSI

Carl M. Kleffner, Ralph Baer, Winfried Barth, Michael Galonska, Frank Heymach, Ralph Hollinger, Gerald Hutter, Wolfgang Kaufmann, Michael Tobias Maier, Andreas Reiter, Bernhard Schlitt, Marcus Schwickert, Peter Spaedtke, Wolfgang Vinzenz (GSI, Darmstadt), Rainer Cee, Eike Feldmeier, Sven Vollmer (HIT, Heidelberg), Alexander Bechtold, Ulrich Ratzinger, Alwin Schempp (IAP, Frankfurt-am-Main)

In April 2006 the commissioning of the ion linac for the HICAT therapy facility in Heidelberg, Germany was started. In preparation of this commissioning process beam tests of the RFQ cavity with protons were carried out at GSI. The RFQ cavity for the HICAT facility was delivered to GSI in March 2005. The operation with an rf power up to 200 kW and a pulse width of 500 µsec could be accomplished successfully after a short time of rf-conditioning to assure the operation mode with carbon ions. A testbench for the RFQ cavity was constructed at GSI to allow for exact measurements of the output energy with the time of flight (ToF) method in addition to the beam tests at IAP Frankfurt. Due to the fact that the rebuncher is fully integrated into the RFQ rf-structure beam studies with different mechanical settings of the rebuncher had to be conducted. For each setting the effective voltage of the rebuncher could be estimated. The final mechanical setting was chosen with respect to required longitudinal matching to the IH structure behind of the RFQ.

THP090 – Initial Studies of 9-Cell High-Gradient Superconducting Cavities at KEK

Takayuki Saeki, Fumio Furuta, Hitoshi Hayano, Yasuo Higashi, Toshiyasu Higo, Hitoshi Inoue, Sergey Kazakov, Hiroshi Matsumoto, Yuichi Morozumi, Robert Steell Orr, Kenji Saito, Masato Satoh, Nobu Toge, Kwnji Ueno, Hiroshi Yamaoka, Kaoru Yokoya (KEK, Ibaraki)

Vertical tests of single cell cavities of the KEK Low Loss "Ichiro" design have established that gradients as high as 51 MV/m are feasible in principle. We have also performed vertical tests of 9-cell cavities. The internal surface was prepared according to the prescription developed in the single cell series test. In this paper we report results on the accelerating gradients achieved so far, an investigation of the possible presence of hydrogen "Q Disease," and other high-field related studies. We also present the measurement of the higher modes of the cavities.

THP091 – Experimental Study of Positron Production from Monocrystalline Targets at the KEKB Injector Linac

Tsuyoshi Suwada, Kazuro Furukawa, Takuya Kamitani, Masanori Satoh, Takashi Sugimura, Kensei Umemori (KEK, Ibaraki), Robert Chehab (LAL, Orsay), Katuhide Yoshida (Saga Synchrotron Light Source, Saga City), Alexander Potylitsyn (TPU, Tomsk)

Intense positron sources are widely investigated for the next-generation of linear colliders and B-factories. A new method utilizing an axially-oriented crystal as a positron-production target is one of the bright schemes since it provides a powerful photon source through channeling and coherent bremsstrahlung processes when high-energy electrons penetrate the target. A series of positron-production experiments with tungsten crystal alone and diamond target combined with an amorphous tungsten plate have been carried out at the KEKB injector linac. The tungsten crystals with different thicknesses (2.2, 5.3, 8.9, 12.0 and 14.2 mm) and the diamonds with different thicknesses (4.57 and 7.25 mm) were tested on a goniometer by using 4 and 8-GeV electron beams, respectively. The positron-production yields were measured with a magnetic spectrometer at the positron momentum of 10 and 20 MeV/c. In this report the experimental results are summarized on the enhancements of

the positron yield from these crystal targets compared to amorphous targets of the same thickness.

THP092 – Control System for a Limitation of an Integrated Amount of Beam Charges Delivered from the KEKB Injector Linac
Tsuyoshi Suwada, Kazuro Furukawa, Eiichi Kadokura, Masanori Satoh (KEK, Ibaraki)
A new control system is under construction for radiation safety at the KEKB injector linac. The control system restricts the integrated amount of the beam charges delivered from an electron gun in order to keep the radiation safety with high reliability in a daily operation of the linac. The old control system of the radiation safety has been working based on a software control implemented on a UNIX-based workstation. However, this control system is not possible to be implemented for the long-term linac operation with high reliability. The new control system comprises a charge-integration-type analog circuit mounted along with a CPU chip and a data acquisition system based on programmable logic controllers. The fast analog circuit can detect the beam-charge signals delivered from a wall-current monitor, and control the beam-abort trigger pulses pulse-by-pulse. The new hardware-based control system may stabilize the radiation safety control for the long-term linac operation. In this report the design of the new control system is described along with preliminary test results.

THP093 – Polyhedral Cavity for Superconducting Linacs
Peter M. McIntyre, Akhdiyor Sattarov (Texas A&M University, College Station, Texas)
A polyhedral cavity structure has been devised for use in superconducting linacs. It has the same ellipsoidal side contour as a TESLA cavity but is configured as a polyhedron in its end view. Each segment of the polyhedron consists of a Nb foil

bonded to a Cu wedge that has been machined to the desired ellipsoidal inner contour. There are no welds, and the seams between adjacent segments do not affect the high Q of the accelerating mode but block the azimuthal currents of deflecting modes. The power coupled into deflecting modes can be slot-coupled at the seams into dielectric-loaded waveguides integrated in the copper segments and conveyed to warm termination. The inner surface of each segment is accessible for polishing and characterization. It accommodates application of improved superconducting surfaces, such as the multi-layer thin-film Nb3Sn proposed by Gurevich. Refrigeration can be provided by gun-bored channels within the copper segments. The copper segments provide a rigid assembly that eliminates Lorentz detuning. The talk will discuss the mode properties and coupling strategies, the strategy for Nb/Cu bonding, and plans for building and testing of prototype cavities.

Friday Oral Session, FR1
2nd Floor Lecture Hall, 8:30 a.m.
Session Chair: Tom Wangler

8:30 **FR101 – High Quality GeV-Level Electron Beams from Laser Plasma Accelerators**
Eric Esarey (LBNL, Berkeley, California)
In 2004, three separate groups reported for the first time the production of high quality electron bunches from laser plasma accelerators in the 100 MeV range with narrow divergence and narrow energy spread [S.P.D. Mangles et al., C.G.R. Geddes et al., and J. Faure et al., Nature 30 Sep 2004]. These results were obtained using multi-ten TW lasers interacting with few-mm diameter gas jet targets. High quality electron bunches were generated by exciting plasma wakefields to sufficient amplitudes so as to self-trap electrons from the background plasma and accelerate these electrons over distances on the order of the dephasing length. Recently, the plasma was extended from a length of a few mm to a few cm by using a capillary discharge in experiments at LBNL in collaboration with Oxford University. Capillary discharges also enabled lower plasma densities, thus extending the dephasing length. This has resulted in the production of high quality electron bunches in the GeV-range. These results and the associated physics will be discussed.

This work was supported by DoE, DE-AC02-05CH11231.

9:00 **FR102 – Spring-8 Compact SASE Source**
Tsumoru Shintake (RIKEN, Sayo-gun, Japan)
The 8-GeV Japanese XFEL Project has been funded in 2006. Construction is scheduled 2006-2010, first beam in 2010. In order to develop technology required to XFEL, we have been

carrying out R&D program at RIKEN since 2002, where thelow emittance thirmionic-gun and various key technologies were developed. To verify technologies, SCSS Prototype Accelerator has been constructed. The first lasing was obserbed in the prototype accelerator at June 20 at 60 nm.

SCSS-Web Site: www-xfel.spring8.or.jp.

9:30 **FR103 – Front-End Development for High-Power Proton Accelerators in Europe**
Alan Letchford (CCLRC/RAL/ISIS, Chilton, Didcot, Oxon)
No abstract submitted.

10:00 **FR104 – Recent Developments in SRF Cavity Science and Performance**
Gianluigi Ciovati (Jefferson Lab, Newport News, Virginia)
The performances of SRF cavities made of high purity bulk niobium have been improving in the last few years and surface magnetic fields (Bp) close to the thermodynamic critical field of niobium have been achieved in a few cases. The recommendation made in 2004 in favor of SRF as the technology of choice for the International Linear Collider (ILC), requires to improve the reliability of multi-cell cavities operating at accelerating gradients (Eacc) of the order of 35 MV/m . Additionally, a better understanding of the present limitations to cavity performance, such as the high-field Q-drop is needed. This contribution presents some recent developments in SRF cavity science and performance. Among the most significant advances of the last few years, new cavity shapes with lower ratio Bp/Eacc were designed and tested. Cavities made of large-grain niobium became available, promising lower cost at comparable performance to standard fine-grain ones and several tests on single-cell cavities were done to gain a better understanding of high-field losses. In addition, studies

to improve the reliability of electropolishing are being carried out by several research groups.

Work supported by the U.S. DOE Contract No DE-AC05-84ER40150.

Friday Oral Session, FR2
2nd Floor Lecture Hall, 11:00 a.m.
Session Chair: Norbert Holtkamp, ORNL/SNS

11:00 **FR201 – Radioactive Ion Beam Production and Development at ISAC**
Pierre Gerard Bricault (TRIUMF, Vancouver)
The ISAC facility is operational since 1998, we utilize the proton beam from the TRIUMF H-cyclotron to produce the radioactive ion beams (RIB) via the isotopic separation on line (ISOL) method. The ISAC facility is designed to accommodate 100 μA proton beam at 500 MeV. Since beginning operation irradiation currents have progressively increased from initial values of ~ 1 μA to present levels of up to 75 μA on refractory metal foil targets and recently equally on composite carbide targets. Beyond the 50 μA limit the target has to be cooled. A new target equipped with fins has been developed that can sustain proton beam up to 100 μA. The RIB intensities depend not only on the target but also on the ability to produce ion beam. The ion sources design for on-line applications are extremely important because of the close contact with the target. They must sustain high radiation field and operate in a large gas pressure range. In order to produce a larger range of beam we are looking at other types, ECR, FEBIAD, negative and the laser ion sources. Report on the recent progress accomplished during the past years will be made.

TRIUMF receives federal funding via a contribution agreement through the National Research Council of Canada.

11:20 **FR202 – 2K or Not 2K**
Isidoro Campisi (ORNL, Oak Ridge, Tennessee)
Particle accelerators based on superconducting cavity technology operate mostly in CW mode and require the highest possible Qo and the lowest possible operating temperature, compatibly with the overall efficiency of the cryogenic plant. However, for pulsed accelerators conditions and parameters can exist, by which optimal performance can be reached at intermediate temperatures, without the need of operating below the helium lambda point. In the design of future facilities, this fact may lead to decreased facility costs and to simplified operation. The parameter space and the applicability of these criteria will be presented.

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11:40 **FR203 – New Materials and Designs for High-Power, Fast-Phase Shifters**
Robyn Leigh Madrak, Ding Sun, David Wildman (Fermilab, Batavia, Illinois), Ernest E. Cherbak, Douglas Horan (ANL, Argonne, Illinois)
In the 100 MeV H- Linac to be constructed at Fermilab, the use of fast ferrite high power phase shifters will allow all accelerating RF cavities to be driven by a single 2.5 MW, 325 MHz klystron. This results in substantial cost savings. The tuners are coaxial with aluminum doped Yttrium Iron Garnet (YIG) ferrite. In combination with branch line couplers, they will provide independent phase and amplitude control for each cavity. This is achieved by adjusting the solenoidal magnetic field applied to the ferrite. We report on our results in both low power (timing) and high power tests, for both 3'' and 1-5/8'' OD phase shifters. The low power measurements

demonstrate that the rate of phase shift is well within the spec of 1 degree/us. The high power tests were performed at the Advanced Photon Source at Argonne National Lab. We measured phase shifts and the failure point (applied power) for tuners in various configurations. In addition, we performed phase and amplitude measurements for a setup consisting of a 1-5/8'' OD phase shifter along with a prototype branch line coupler.

12:00 **FR204 – Science Case for Energy Recovery Linac X-Ray Sources**
Sol Michael Gruner (Cornell University, Ithaca, New York)
Energy Recovery Linacs (ERLs) have potential to produce hard x-ray beams that overcome many of the limitations of beams from storage ring sources. These include sufficiently small transverse emittances to provide x-ray beams with near unity transverse coherence at 10 keV, x-ray pulses shorter than 100 femtoseconds, and a small round source size that facilitates production of intense x-ray probe nanobeams. These are discussed in the context of the 5 GeV ERL being planned as an upgrade to the exiting storage ring at Cornell University. Projected characteristics of the machine, its possible x-ray beams will be presented. Examples of novel science that is enabled with the beams will be presented.

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12:30 **Closing Remarks**


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