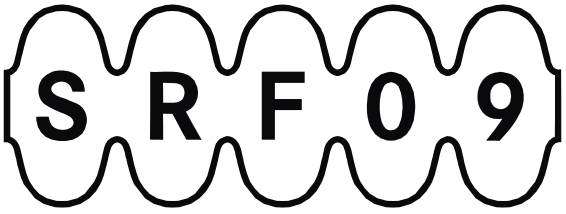

Berlin · Dresden

14th International Conference on RF Superconductivity

September 20-25, 2009

Conference Programme and Abstracts

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Welcome

On behalf of the International Program Committee (IPC), which forms the organizing committee for the SRF Conference Series, I am pleased to welcome you to the 14th International Conference on RF Superconductivity in Berlin and Dresden. This series has a proud tradition that started in 1980 as a Workshop in Karlsruhe. Since then it has grown continuously, with over 250 registrants and paper contributions this year, and its world-wide impact is undeniable. Given its growing size and scope, the IPC recently decided to change the wording in the name from "Workshop" to "Conference."

The conference programme is described in this booklet. The IPC, under the chairmanship of Dr. Dieter Proch, has made every effort to develop a varied and interesting programme. A mixture of plenary talks, poster sessions and "hot topic" discussion sessions are designed to stimulate discourse and maintain the workshop roots of this conference. An industrial exhibit on the first two days helps to enhance the interaction between researchers and industry. And, importantly, to attract and educate students new to the field of SRF, a three-day Tutorial Programme is being offered for which over 80 people registered!

In closing, I would like to thank the IPC and in particular the Local Organizing Committees at the Helmholtz Zentrum Berlin (HZB) and the Forschungszentrum Rossendorf (FZD) with Wolfgang Anders and Peter Michel as Chairs. We gratefully acknowledge the sponsorship support we received from several institutional and industrial partners listed on the covers, which enabled us to award generous travel grants to several students.

I am very happy that you can join us in the fascinating cities of Berlin and Dresden, and wish you an enjoyable and fruitful conference.

Jens Knobloch
SRF 2009 Conference Chairman

General Information on the Conference

International Program Committee

D. Proch, DESY (IPC Chair)
C. Antoine, Saclay
J. Chen, Peking University
J. Delayen, Jefferson Lab (JACoW Liaison)
H. Edwards, Fermilab
W. Hartung, MSU
M. Kelly, ANL
P. Kneisel, Jefferson Lab
J. Knobloch, HZB (Conference Chair)
R. Losito, CERN
S. Noguchi, KEK
H. Padamsee, Cornell University
V. Palmieri, INFN-LNL & Padua University
T. Tajima, LANL

Proceedings Editors

M. Abo-Bakr (HZB)
B. Kuske (HZB)
A. Liebezeit (FZD)
S. Voronenko (HZB)
V. Schaa (GSI)

Local Organizing Committee

J. Knobloch (HZB) Conference Chair
W. Anders (HZB) LOC Chair

P. Michel (FZD) LOC Co-Chair
M. Abo-Bakr (HZB)
A. Arnold (FZD)
T. Frederking, HZB
N. Neumann (HZB) Secretary - Berlin
P. Joehnk (FZD)
T. Kamps (HZB)
O. Kugeler (HZB)
B. Kuske (HZB)
R. Müller (HZB)
A. Neumann (HZB)
P. Neumann (FZD) Secretary - Dresden
T. Quast (HZB)
A. Salhi (HZB) Secretary - Berlin
J. Teichert (FZD)

Conference Venue

dbb Forum Berlin
Friedrichstrasse 169/170
D-10117 Berlin

Opening Hours Registration Desk

Sunday: 16:00-20:00
Monday, Tuesday, Thursday: 7:45-18:00
Wednesday: Closed
Friday: 7:45-13:30

Opening Hours Proceedings Office

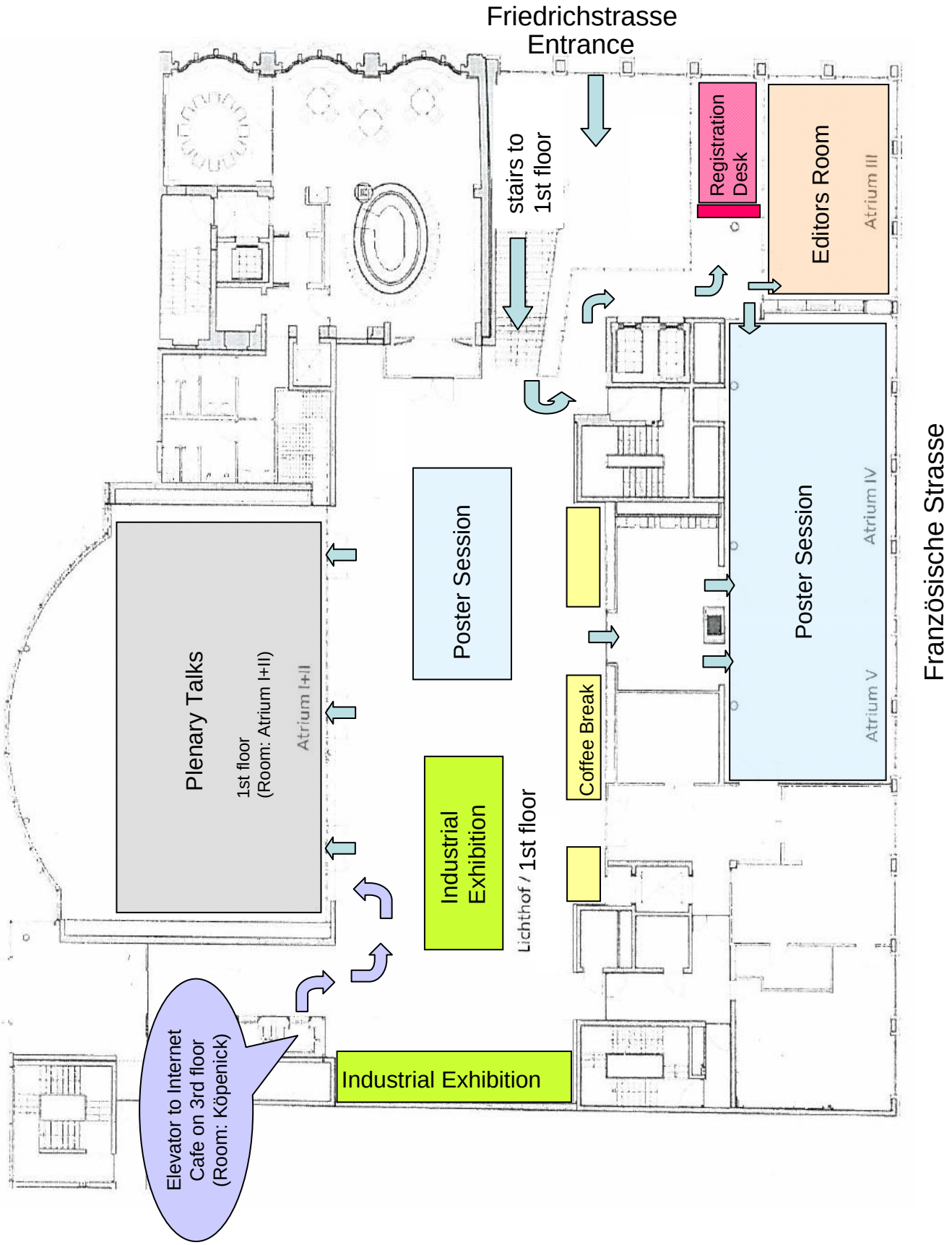
Monday, Tuesday, Thursday: 8:00-18:00
Wednesday: Closed
Friday: 8:00-13:30

Conference Phone & Fax

(September 20-25 only)
Registration Phone: +49 30/ 4081 4610
Registration Fax: +49 30/ 4081 4620

Floorplan of the Conference Venue

(dbb Forum)



Information on Berlin

In 2009, Berlin celebrates the 20th anniversary of the fall of the Berlin wall that had divided the city for nearly three decades. Today only a few segments of the wall are left, e.g. at Potsdamer Platz or at the East Side Gallery (close to Ostbahnhof). Yet, the Brandenburger Tor, starting at the promenade Unter den Linden, remains an important symbol of both the city's division and its reunification. Berlin features many historic buildings, such as the German Opera House, the Berliner Dom (Cathedral) or the Reichstag, as well as some new, award winning architecture at Potsdamer Platz, and many innovative buildings scattered across the city. You will find thriving areas in all parts of the city, with every district having its own, unique flair: *Mitte* provides a top of the range shopping area on Friedrichstrasse and Unter den Linden, while *Prenzlauer Berg* offers bars and restaurants for all tastes. The district of *Kreuzberg* (Mehringdamm, in the lower part of the map), again, invites you to feel its busy, multicultural atmosphere.

Restaurants

Aigner Gendarmenmarkt
Französische Straße 25
10117 Berlin
Telephone: 030/ 203 75 18 50
High price range
Directly at the Gendarmenmarkt,
offspring of the legendary Aigner in Vienna.
(walking distance)

Amici Miei
Mehringdamm 40
10961 Berlin
Telephone: 030/ 74684121
Italian Diner/ Restaurant
(Mehringdamm: four stops on U6, direction Alt-Mariendorf)

Amrit II
Oranienburger Straße 45
10117 Berlin
Telephone: 030/ 28 88 48 40
Low to medium price range
Indian dishes in busy Oranienburger Strasse.
(Oranienburger Tor: two stops away on U6, direction Alt-Tegel)

Borchardt
Französische Straße 47
10117 Berlin
Telephone: 030/ 81 88 62 62
High price range, reservations are a must
(walking distance)

Brasserie Am Gendarmenmarkt
Taubenstraße 30
10117 Berlin
Medium price range
French cuising at the Gendarmenmarkt
(walking distance)

Curry 36
Mehringdamm 36
10961 Berlin
Famous Currywurst Shop, open 24h
(Mehringdamm: four stops on U6, direction Alt-Mariendorf)

Die Zwölf Apostel
Georgenstraße 2
10117 Berlin
Telephone: 030/ 201 02 22 Low to medium price range,
special lunch deals
Opulently decorated Italian restaurant.
(walking distance/ Friedrichstrasse: one stop away on U6, direction Alt-Tegel)

Maredo
Unter den Linden 36-38
10117 Berlin
Telephone: 030/ 20 64 78 71
Medium price rangeSteak house chain
(walking distance)

Pan Asia
Rosenthaler Strasse 38
10178 Berlin
Telephone: 030/ 27908811
Spacious restaurant, glutamate-free cuisine
(Oranienburger Tor: two stops away on U6, direction Alt-Tegel)

Operncafé
Unter den Linden 5
10117 Berlin
Telephone: 030/ 20 26 83
Medium price range
Large outdoor area, selection of finest cakes
(walking distance)

VAU
Jägerstraße 54
10117 Berlin
Telephone 030/ 202 97 30
High price range
Reservations are a must.
(walking distance)

dbb Forum: Conference Venue
Point of Departure for Boat Tour
Radisson SAS Hotel: Dinner Location
0 200 400 600 800 1000 m
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Nordhafen-brücke
Heidestr.
Schwartzkopff-str.
Bernauer Str.
Arkona-platz
Kollwitz-platz
Gedenkstätte Berliner Mauer
Berlin-Spandauer Schifffahrtskanal
Chaussee-str.
Brunnen-str.
Zions-kirch-platz
Senefelder-platz
Nordbahnhof
Veteranen-str.
Volkspark Weinbergsweg
Teuto-burger Platz
Zinnowitzer Str.
Invaliden-str.
Rosenthaler Platz
Schönhauser Allee
Metzer Str.
Invaliden-park
Koppen-platz
Prenzlauer Berg
Sandkrug-brücke
Robert-Koch-Platz
Hannoversche Str.
Tor-str.
Rosa-Luxemburg-Platz
Universitätskliniken der Charité
Humboldt-hafen
Oranien-burger Tor
Neue Synagoge
Weinmeisterstr.
Hauptbahnhof
Hugo-Preuß-Brücke
Hackesche Höfe
Münzstr.
Oranienburger Str.
Hackescher Markt
Alexanderplatz
Monbijou-park
Alt Moabit
Kapelleufer
Reinhardt-str.
Weiden-damm-brücke
Berliner Ensemble
Moltke-brücke
Kronprinzen-brücke
Bundestag
Museumsinsel
Fernsehturm
Kanzler-park
Bundes-kanzleramt
Spree
Friedrichstr.
Karl-Marx-Allee
Schilling-str.
Haus der Kulturen der Welt
Reichstagsgebäude
Marschall-brücke
Deutsches Historisches Museum
Dom
Marx-Engels-Forum
Rotes Rathaus
Kloster-str.
John-Foster-Dulles-Allee
Scheidemann-str.
Sowjet. Ehrenmal
Pariser Platz
Unter den Linden
Staatsoper
Liebknecht-brücke
Schloß-platz
Nikolai-viertel
Jannowitz-brücke
Straße des 17. Juni
Brandenburger Tor
Französische Str.
Werderscher Markt
Stralauer Str.
Mühlendamm
Holzmarkt-str.
Tiergarten
Behrenstr.
Denkmal für die ermordeten Juden Europas
Gendarmenmarkt
Hausvogtei-platz
Fischer-insel
Märkisches Museum
Mohrenstr.
Stadt-mitte
Gertrauden-str.
Brücken-str.
Lennéstr.
Voß-str.
Leipziger Str.
Spittel-markt
Köpenicker Str.
Tiergarten-str.
Philharmonie
Kultur-forum
Leipziger Platz
Potsdamer Platz
Haus am Checkpoint Charlie
Heinrich-Heine-Str.
Michael-kirch-platz
Neue National-galerie
Marlene-Dietrich-Platz
Zimmerstr.
Rudi-Dutschke-Str.
Martin-Gropius-Bau
Kochstr.
Oranienstr.
Reichpietsch-ufer
Schöneberger Ufer
Mendelssohn-Bartholdy-Park
Anhalter Str.
Engel-becken
Moritzplatz
Oranienplatz
Magde-burger Platz
Lützowstr.
Anhalter Bahnhof
Jüdisches Museum
Kurfürstenstr.
Gleisdreieck
Mehringplatz
Hallesches Tor
Prinzenstr.
Kottbusser Tor
Skalitzer Str.
Bülowstr.
Möckern-brücke
Deutsches Technik-museum
Gitschiner Str.
Zossener Brücke
Waterloo-ufer
Wassertor-platz
Böckler-park
Baerwald-brücke
Blücher-str.
Urbanhafen
Admiral-brücke
Kottbusser Brücke
Mehringdamm
Schönlein-str.
Goebenstr.
Yorckstr.
Yorckstr./Großgörschen-str.
Gneisenau-str.
Urbanstr.
Kleistpark
Hohen-staufen-platz
Bergmannstr.
Marheinecke-platz
Südstern
Viktoriapark
Chamisso-platz
Monumenten-str.
Julius-Leber-Brücke
Kolonnen-brücke
Katzbach-str.
Platz der Luftbrücke
Kolonnenstr.
Dudenstr.
Columbiadamm
Gustav-Müller-Platz
General-Pape-Str.
Loewenhardtdamm
Boelcke-str.
Manfred-von-Richthofen-Str.
Tempelhofer Damm
ehem. Flughafen Tempelhof

General Information on Germany

Time Zone

GMT/UTC + 2 (Central European Summer Time).

Electric Current, Plug Details and Internet Access

Germany uses 230V, which is standard across Europe. Therefore, a converter will be needed in order to use American 110V devices. American, UK, and Asian plugs will not fit and you will need an adapter with two circular metal pins to plug your devices into an electrical outlet. Bringing a laptop to Germany is simple: most run on both 110 volts, as in North America, or 230 volts, as found throughout Europe. Here, the Internet is easily accessible from hot spots or Internet cafes. There will be WLAN access and Internet accessibility in the conference venue. Passwords and other info will be available on arrival.

Climate

The climate varies across Germany. Berlin lies in the north east of the country, where the landscape is rather flat and the climate is not subject to dramatic changes.
The most reliably good weather is from May to October, yet, it is not unusual for a sunny day to quickly cloud over and turn into a rainy day (or vice versa), so bear this in mind and be prepared for all eventualities. Average temperatures in September are 18°C / 64°F during the day and 9°C / 48°F during the night.

Money Matters

The currency used in Germany is the Euro.

ATMs/ Banks:

ATMs are readily available in Germany and often in all major languages. They are located at bank branches, in shopping areas or even train stations. Major credit and debit cards, along with all other bank cards carrying the PLUS and NYCE symbols, are universally accepted. After office hours, indoor bank ATMs are sometimes only accessible by first sliding your bank card through the card reader.

Credit Cards:

Credit cards are commonly accepted in Germany, although they are not often used for everyday expenses (e.g. grocery stores). Restaurants, hotels, stores, train stations and other places regularly frequented by tourists will almost always accept them. Look for a sign on the door.

Tipping:

Hotels, restaurants, cafes or bars do not charge a separate service fee, as is common in some countries, but it is customary to tip service personnel. In restaurants, cafes and bars 10% is the average, but feel free to express your degree of satisfaction by tipping less or more. Tip taxi drivers about 5% while porters and others who assist you with baggage receive one Euro per item.

Hours of Business

Most stores in Germany open from Monday through to Saturday between 9 a.m. and 10 a.m. and close between 6 p.m. and 8 p.m. On Sunday almost all stores are closed, the exceptions being gas stations and convenience stores, which sell selective food items as well as snacks and beverages. Note that a wide selection of stores in the train stations Friedrichstrasse and Hauptbahnhof are open on Sundays.

VAT Refunds & Tax-Free Shopping

Prices stated for goods and services in Germany always include a 19% value added tax (VAT).
Some or all of the VAT may be refundable for goods purchased at stores displaying the “Tax Free for Tourists” sign. You will receive a tax-free form upon making a purchase. Before leaving the country and before checking any luggage, present the purchased goods, the tax-free form and your receipt to German customs officials. They will certify the form as proof of legal export. You may then obtain a cash refund at one of the Tax-Free Shopping Service counters located at all major border crossings, airports, ferry ports and train stations.

Insurance, Liability

The organizers of SRF09 do not accept liability for individual medical, travel or personal insurance, and participants are strongly advised to arrange their own personal insurance. Reciprocal agreements for free medical treatment exist between certain European countries.

Scientific Programme: Tutorials

Overview tutorials will be held prior to the conference, Sept. 17 – 19, in Dresden.

Thursday, September 17

9:30 **Welcome R. Sauerbrey**, Scientific Director *FZD*
9:45 **Lecture 1: Basic Principles of RF Superconductivity and SC Cavities** H. Padamsee, *Cornell University*
11:10 **Lecture 2: High-beta Cavity Design** K. Saito, *KEK*
12:20 **Lecture 3: Low and Intermediate Beta Cavity Design** A. Facco, *INFN Legnano*
14:40 **Lecture 4: SC Cavity Material, Fabrication and QA** W. Singer, *DESY*
16:00 **Lecture 5: Cavity Preparation and Limits in Cavity Performance** J. Mammosser, *ORN*

Friday, September 18

9:00 **Lecture 6: LLRF Control Systems and Tuning Systems** C. Hovater, *JLAB*
10:10 **Lecture 7: Design and Fabrication Issues of High Power and Higher Order Modes Coupler for Superconducting Cavities.** S. Noguchi, *KEK*
11:30 **Lecture 8: RF Power Sources** J. Jacob, *ESRF*
12:40 **Guided ELBE Tour**
15:00 **Lecture 9: Methods and Simulation Tools for Cavity Design** U. van Rienen, *Rostock University*
16:20 **Lecture 10: Fundamentals of Superconductivity, High-T SC, Trends and Application** L. Schultz, *IFW Dresden*

Saturday, September 19

9:00 **Lecture 11: Operational Aspects of SC RF Cavities with Beam** S. Belomestnykh, *Cornell University*
10:10 **Lecture 12: Fundamentals of Cryomodule Design and Module Engineering** N. Ohuchi, *KEK*
11:30 **Lecture 13: He Refrigerators for Accelerators** Ch. Haberstroh, *Dresden University*

Scientific Programme: Conference

Monday, September 21

Session 1: ProgressReports/ Ongoing Projects I
(Chair: Jia-er Chen – *NSFC*)

9:00 **SRF2009: Welcome & Logistics** (30min) Anke Kaysser-Pyzalla, Jens Knobloch *Helmholtz-Zentrum Berlin für Materialien und Energie GmbH*
9:30 **FLASH** (25min) Katja Honkavaara – *DESY*
9:55 **The European XFEL Based on Superconducting Technology** (25min) Hans Weise - *DESY*

Session 2: Progress Reports/Ongoing Projects II
(Chair: Shuichi Noguchi – *KEK*)

10:40 **Third Harmonic System at Fermilab/FLASH** Elvin Robert Harms - *Fermilab*
11:00 **Jlab Upgrade and High Current Cavity Developments** Joseph Preble - *JLAB*
11:25 **Overview of Superconducting Photoinjectors** Andre Arnold – *FZD*
11:50 **High-current ERL Injector** Matthias Liepe - *CLASSE*
12:15 **SRF System Operation of the ALICE ERL Facility** Peter McIntosh - *STFC/DL/ASTeC*
12:40 **ERL Prototype at BNL** Ilan Ben-Zvi - *BNL*

Session 3: Progress Reports/Ongoing Projects III
(Chair: Michael Kelly – *ANL*)

14:00 **TESLA Technology in China** Jia-er Chen – *NSFC*
14:40 **Impact of CARE-SRF on FLASH/XFEL and Other Projects** Dieter Proch - *DESY*
15:05 **Superconducting PAUL Trap for Antiprotons** Daniel Barna - *University of Tokyo*
15:20 **The ATLAS Energy Upgrade Cryomodule** Joel D. Fuerst - *ANL*
15:40 **The MSU/NSCL Re-Accelerator ReA3** Oliver Karl Kester - *NSCL*

Session 4: Progress Reports/Ongoing Projects IV
(Chair: Walter Hartung – *NSCL*)

16:30 **SNS & Upgrade** John David Mammosser - *ORNL*
16:50 **STF STATUS AND PLANS** Hitoshi Hayano - *KEK*
17:10 **SPIRAL2** Tomas Junquera - *IPN*
17:30 **The SARAF CW 40 MeV Proton/Deuteron Accelerator** Israel Mardor - *Soreq NRC*
17:45 **ISAC-II: Status of the 20 MV Upgrade** Robert Edward Laxdal - *TRIUMF*

Tuesday, September 22

Session 1: Basic SRF R&D I
(Chair: Vincenzo Palmieri - *INFN/LNL*)

8:30 **High Field Q-slope and the Baking Effect** Gianluigi Ciovati - *JLAB*
8:50 **Crystalline microstructure role in the high-field Q-slope** Alexander S Romanenko - *CLASSE*
9:05 **Advances in Material Studies for SRF** Thomas R. Bieler - *Michigan State University*
9:30 **Review of Results from Temperature Mapping and Subsequent Cavity Inspections** Wolf-Dietrich Moeller - *DESY*
9:50 **Locating Quenches with 2nd Sound** Zachary Alan Conway - *CLASSE*

10:05 **Basic Understanding for the Various Causes of Quench** David Meidlinger - *CLASSE*

Session 2: Basic SRF R&D II

(Chair: Claire Antoine – *CEA*)

10:40 **Review of Optical Inspection Methods and** Results Ken Watanabe - *KEK*
10:55 **Near-Field Microwave Microscopy of Superconducting Materials** Steven Mark Anlage – *UMD*
11:10 **RF Characterization of Superconducting Samples** Tobias Junginger - *MPI-K*
11:25 **Point Contact Tunnelling at the SC Gap Before/After Baking & Atomic Layer Deposition** Thomas Proslier - *IIT*
11:45 **Microstructure Studies of Nb** Derek C Baars - *Michigan State University*
12:00 **A15 Nb3Sn Films by Multilayer Sputtering & Review of SRF Tests** Antonio Alessandro Rossi - *INFN/LNL*
12:15 **A15 Superconductors by Thermal Diffusion in 6 GHz Cavities** Silvia Maria Deambrosis - *INFN/LNL*
12:30 **Review of RF Properties of NbN and MgB2 Thin Coating on Nb Samples and Cavities** Grigory V. Eremeev - *CLASSE*

Poster Session I

14:00-17:00 (Including Coffee Break)
Progress Reports and Ongoing Projects
Future Projects
Operating Experience with SRF Accelerators
Measurement Techniques
Cavity Performance Limiting Mechanisms
Material Studies

Hot Topics

17:00 **Hot Topic I: Module and Coupler Production: A View from Industry** Dieter Proch – *DESY*
18:00 **Hot Topic II: Is Niobium at the End of the Road? At What Front Should We Do Battle?** Hasan Padamsee & Peter Kneisel - *Cornell University & JLab*

Thursday, September 24

Session 1: SRF Technology R&D I

(Chair: Hasan Padamsee - *Cornell University*)

8:30 **Characterization of Ingot Material for SRF Cavity Production** Jayanta Mondal - *BARC*
8:45 **Basic Studies for Process Parameter Developmenst for EP/HPR/Snow Cleaning** Detlef Reschke - *DESY*
9:05 **Electropolishing without HF: Ready for Cavity Treatment? - What Are the Naked Facts?** Vincenzo Palmieri - *INFN/LNL*
9:25 **Progress With Large Grain Cavities & Seamless Cavities** Waldemar Singer - *DESY*
9:50 **Multi-wire Slicing of Large Grain Ingot Material** Kenji Saito - *KEK*
10:05 **New Cavity Shape Developments for Low Beta Applications** Holger Podlech - *IAP*

Session 2: SRF Technology R&D II

(Chair: Tsuyoshi Tajima – *LANL*)

10:40 **New Cavity Shape Developments for Crabbing Applications** Graeme Burt - *Cockcroft Institute*
11:00 **Advances and Performance of Input Couplers at KEK** Eiji Kako - *KEK*
11:20 **Results from ANL/FNAL and Weld Zone Quenching** Genfa Wu - *Fermilab*

11:40 **SPIRAL2 cryomodules: Status and First Test Results** Guillaume Olry - *IPN*
12:00 **Indian Cavity Fabrication Facility & Test Results** Prakash N Potukuchi - *IUAC*
12:20 **Lessons Learned from the 9 mA Test** Brian Chase - *Fermilab*

Poster Session II

14:00-17:00 (Including Coffee Break)
Cavity Design
Ancillary Systems
Cavity Preparation and Production
High Current Issues and Beam Dynamics

Friday, September 25

Session 1: Future Projects I
(Chair: Jean Roger Delayen – *JLAB*)

8:30 **Project X** Robert Kephart - *Fermilab*
8:50 **FRIB: A New Accelerator Facility for the Production of Rare Isotope Beams** Richard York - *NSCL*
9:10 **5GeV 100 mA ERL** Georg H. Hoffstaetter - *CLASSE*
9:30 **Compact ERL Linac** Kensei Umemori – *KEK*
9:45 **The Superconducting Prototype Linac for IFMIF** Pierre Bosland - *CEA*
10:00 **e- linac for RIB** Shane Rupert Koscielniak - *TRIUMF*

Session 2: Future Projects II
(Chair: Jens Knobloch - *Helmholtz-Zentrum Berlin für Materialien und Energie GmbH*)

10:40 **Future SRF-Linac Based Light Sources: Initiatives and Issues** Joseph Bisognano - *UW-Madison/SRC*
11:05 **The ESS SC linear accelerator** Mats Lindroos - *ESS-S*
11:25 **HIE-Isolde: The Superconducting RIB Linac at CERN** Matteo Pasini - *Instituut voor Kern- en Stralingsfysica, K. U. Leuven*
11:45 **SPL** Roland Garoby - *CERN*
12:05 **J-PARC Upgrade** Nobuo Ouchi - *JAEA/J-PARC*
12:25 **ILC** Kaoru Yokoya – *KEK*
12:50 **Student Awards and End of Conference**

Industrial Exhibition

A vital and integral part of the conference will be an industrial exhibit taking place during the first two days of the conference (September 21 and 22). It is designed to encourage the communication and collaboration between the SRF community and related industrial partners.

Scientific Tours

Laboratory Tour at Forschungszentrum Dresden

There will be an excursion on Wednesday, Sept. 23 to the historic city of Dresden. Two tours are being offered. Tour A first visits the Forschungszentrum Dresden where you have the opportunity to visit the ELBE free electron laser, before travelling to Dresden city centre. Prior to the ELBE tour, a special plenary session will be held.

Tour B will go directly to Dresden city centre, allowing you to explore the city's many historic sites individually.

Both tours will join again mid-afternoon at the newly restored Frauenkirche (Dresden's most popular church landmark) for an organ concert.

Buses will leave at 8:00 from the dbb Forum.

Social Programme

Registration and Welcome

Registration opens on Sunday, September 20, at 16:00 at the conference site dbb Forum (→see map). A reception with buffet will take place between 18:00 and 21:00.

Excursion to Dresden

On Wednesday, September 23, there will be an excursion to Dresden including an organ concert in the famous and newly restored Frauenkirche. Participation in the Laboratory Tour at Forschungszentrum Dresden Rossendorf is optional. (→ See Laboratory Tour at Forschungszentrum Dresden) Please join the tour that you have chosen in your JACOW registration.

Buses will leave at 8:00 from the dbb Forum.

Conference Dinner & Boat Tour

There will be a conference dinner on Thursday, September 24, 20:00 at the Radisson SAS Hotel next to the Berliner Dom (Berlin Cathedral) (→ see map).

The dinner is preceded by a traditional boat trip. This will take place on the Spree, one of the city's three rivers. It will lead through the historic part of Berlin starting at Friedrichstrasse, passing the Reichstag, the government district, the Federal Chancellery, the congress hall, the Bellevue Castle and the district of *Moabit*. The boat will turn at Spreekreuz and return via the museum island, ending at the Berliner Dom, right next to the dinner venue.

The boat's name is MS Sachsen and she will be berthed at Friedrichstrasse/ Am Weidendamm (→ see map), roughly 700 meters north of the conference venue. It can be reached by simply walking north on Friedrichstrasse until you reach the Spree River or by taking the subway U6 from U Französische Strasse to U Friedrichstrasse (direction Alt-Tegel). The boat tour starts at 17:45 and will take approximately two hours.

Point of Departure for Boat Tour

Stern und Kreis Schiffahrt GmbH
Friedrichstraße/ Am Weidendamm
D-10117 Berlin

Dinner Location

Radisson SAS Hotel
Karl-Liebknecht-Straße 3
D-10178 Berlin

Poster Session Info

Poster sessions are scheduled Tuesday and Thursday afternoon, from 14:00 to 17:00. Coffee and biscuits will be served during the poster sessions from 15:30 to 16:00. Please refer to the conference programme for the topics presented each day. Since poster sessions are a focal point of the conference, and with the objective of making the sessions as attractive, successful and rewarding as possible, authors of posters are strongly encouraged to take particular care in their preparation. Each poster is displayed on one board: The usable area on the poster board is 124 cm (roughly 48") wide and 98 cm (roughly 38") high. An ISO A0 sized (118.9cm x 84.1cm) poster will fit landscape on the board, an ANSI E (44" x 34") as well. Velcro dots and push pins will be available for mounting posters. Posters can be mounted anytime during the morning (from the first coffee break on). Please remove your poster after the poster session. After each poster session all leftover posters will be removed.

Paper Contribution

Deadline for all uploads of conference papers is midnight (CEST) September 20, 2009.
No submissions will be accepted at the conference.
The SRF conference series has adopted the Joint Accelerator Conferences Website (JACoW) standard for publication of their proceedings. Detailed formatting requirements are given on the JACoW website. These requirements are also implemented within the JACoW templates which contain styles that will automatically ensure correct typesetting and layout. Templates exist for Word (PC and MAC) and LaTeX. All authors are requested to use the JACoW templates!

Contributed papers may be up to 5 pages long.
Papers for invited talks may be up to 7 pages.

Paper Editing Process after Submission

Since 2007 the proceedings of the International SRF conference series are published by JACoW, the Joint Accelerator Conferences Website. To ensure the most reliable access to the conference proceedings on the JACoW website all papers have to meet some formal criteria, specified by JACoW. Within an editing process every paper's JACoW compatibility / conformity is checked and only papers passing this process successfully will be published in the conference proceedings. This process is briefly described here.

After the paper submission deadline on September 20 the conference editors start to perform the paper checks and conversions according to the JACoW publishing requirements. As result from the editing process colour dots are assigned, describing the status of your paper:

- green dot: The paper is ready for publication.
- yellow dot: changes or corrections have been made (on the PDF or the original WORD/LaTeX source file) and the author should contact the proceedings office to proof-read the modified version.
- red dot: a major problem occurred - maybe a file is missing or is corrupt and the paper cannot be processed. The author should contact the proceedings office as soon as possible to see one of the editors.

You can check the status of your paper(s) either on the electronic "Dot Board" – a monitor in the editor office or online by logging into your conference account (https://oraweb.cern.ch/pls/srf2009/profile.html). Your paper is ready to be published in the conference proceedings when it is assigned a green editor dot.

Contribution to PRST-AB

In addition to the "normal" proceedings, SRF2009 has arranged with Physical Review Special Topics Accelerators and Beams (PRST-AB) to have a special edition for SRF2009 and we encourage everybody to submit suitable papers to that journal. The submission deadline for inclusion in the special edition is Nov. 30, 2009.

Here are some requirements:
The papers for publication in PRST-AB cannot be identical to that appearing in the proceedings but must include additional information. This does not mean that there must be new data or results. Additional details or analysis of the same experimental results ARE acceptable. The papers will go through the same review process as other submissions to PRST-AB and must be submitted in a similar way by the author to PRST-AB. During submission, indicate that you would like your paper to be included in the SRF09 Special Edition.

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MOOAAU — Progress Reports/Ongoing Projects I

MOOAAU01

FLASH

K. Honkavaara (DESY)

FLASH, the FEL user facility at DESY (Hamburg, Germany), is operated with an electron beam energy up to 1 GeV corresponding to a photon wavelength down to 6.5 nm. FLASH consists of an electron source to generate a high quality electron beam, a superconducting linac of six TESLA type accelerating modules, and an undulator section to produce laser like coherent FEL radiation. About half of the beam time is scheduled for the FEL users, and the rest is for accelerator and FEL physics studies. Experience gathered at FLASH is important not only for further improvements of the FLASH facility itself, but also for the European XFEL and for the ILC R&D effort.

MOOAAU02

The European XFEL Based on Superconducting Technology

H. Weise (DESY)

The internationally organized European XFEL free-electron laser is under construction at the Deutsches Elektronen-Synchrotron (DESY). Compared to present-day synchrotron radiation sources, its peak brilliance will be more than 100 million times higher, the radiation has a high degree of transverse coherence, and the pulse duration is reduced from the 100 picosecond range down to the 10 fs time domain. The possible wavelength will be down to 0.1 nm. The electron beam energy of up to 17.5 GeV will be achieved by using superconducting accelerator technology. The project is the first large scale application of the TESLA technology developed over the last 15 years. The talk will briefly summarize the XFEL design before presenting details about the status of the superconducting linac. The international collaboration with its contributions will be described. Final prototyping, industrialization and new infrastructure are the actual challenges.

MOOBAU — Progress Reports/Ongoing Projects II

Third Harmonic System at Fermilab/FLASH

E.R. Harms, T.T. Arkan, V.T. Bocean, H.T. Edwards, M.H. Foley, J. Grimm, A. Hocker, T.N. Khabiboulline, M.W. McGee, D.V. Mitchell, A.M. Rowe, N. Solyak (Fermilab) K. Jensch, G. Kreps, W.-D. Moeller, E. Vogel (DESY)

A 4-cavity 3.9 GHz cryomodule has been constructed at Fermilab and delivered to DESY. Its intended use is to linearize the non -linear beam energy-time profile produced by the 1.3 GHz accelerating gradient and thus improve the operating characteristics of FLASH for its users. First cold testing of the module is expected in the near future prior to its installation. We will report on the performance of the cavities, assembly and transport of the module as well as anticipated testing, installation, and commissioning plans.

Jlab Upgrade and High Current Cavity Developments

J.P. Preble, R.A. Rimmer (JLAB)

We present the status and recent results from the development of new SRF cavities for the CEBAF 12 GeV upgrade and for future light source applications. The JLab 12 GeV upgrade requires ten new high-performance CW cryomodules. These will each contain eight 7-cell cavities of a "low-loss" design with HOM damping sufficient for ~1mA of continuous current. Jlab has fabricated and tested a number of such cavities and demonstrated compliance with all 12 GeV project requirements with conventional BCP cavity processing. Recently we have also electro-polished several cavities of this type and shown significantly better performance than the standard BCP. This processing method could provide improved operational margin and lower cryogenic loads at the CEBAF working point. For future light source applications such as FELs or ERLs, cavities with higher beam current capability are desirable. Jlab has developed a high-current cavity for such applications with a cell shape optimized to minimize HOM power extraction and maximize the BBU threshold. We report on latest tests of this design and on plans to assemble a 2-cavity cryomodule for testing with beam in the recirculation loop of the JLab FEL.

Overview of Superconducting Photoinjectors

A. Arnold, J. Teichert (FZD)

The success of most of the proposed electron accelerator projects for future FELs, ERLs or 4th generation light sources is contingent upon the development of an appropriate source to generate the electrons with an unprecedented combination of high-brightness, low emittance and high average current. An elegant way is to combine the high brightness of RF guns with the superconducting technology. This concept was first proposed at the University of Wuppertal*. In 2002, the successful operation of a SRF photo-injector could be demonstrated at FZD for the 1st time**. However, this type of injectors is still in the R&D phase. Challenges are the design of the cavity with its specific geometry, the choice of the photocathode type, its life time, a possible cavity contamination, the problems on coupling of high-average power into the cavity and the risk of beam excitation of higher order cavity modes. During the last years several R&D projects have been launched. Most of them pursue different approaches to deal with these issues. This contribution gives an overview on the progress of the SRF photo-injector development based on the most prominent projects in the world.
* H. Piel et al., FEL'88, Jerusalem, Israel, 1988.

Chair: S. Noguchi, KEK (Ibaraki)

** D. Janssen, et al., Nucl. Instr. and Meth. A507 (2002) 314.

MOOBAU04

High-current ERL Injector

M. Liepe (CLASSE)

Cornell University has developed and fabricated a novel SRF injector cryomodule for the acceleration of the high current (100 mA), low emittance beam in the Cornell ERL injector prototype. The injector cryomodule is based on superconducting rf technology with five 2-cell rf cavities operated in the cw mode. To support the acceleration of a low energy, ultra low emittance, high current beam, the beam tubes on one side of the cavities have been enlarged to propagate Higher-Order-Mode power from the cavities to broadband RF absorbers located at 80 K between the cavities. Each cavity is surrounded by a LHe vessel and equipped with a frequency tuner including fast piezo-driven fine tuners for fast frequency control. The cryomodule provides the support and precise alignment for the cavity string, the 80 K cooling of the HOM loads, and the 2 K LHe cryogenic system for the high cw heat load of the cavities. In this presentation results of the commissioning phase of this cryomodule will be reported.

MOOBAU05

SRF System Operation of the ALICE ERL Facility

P.A. McIntosh (STFC/DL/ASTeC)

ALICE (Accelerators and Lasers in Combined Experiments) is a 35 MeV energy recovery linac based light source. ALICE is being developed as an experimental test-bed for a broad suite of science and technology activities that make use of electron acceleration and ultra-short pulse laser techniques. ALICE utilises two super-conducting radio frequency (SRF) cryomodules, each with two identical 9-cell, 1.3 GHz cavities that are powered by 5 inductive output tubes (IOTs) from 3 different commercial suppliers. The experience gained in both commissioning these systems and ultimately operating for energy recovery is presented. Developments for a new ERL cryomodule upgrade for ALICE are also described.

MOOBAU06

ERL Prototype at BNL

I. Ben-Zvi (BNL)

A prototype ampere-class superconducting energy recovery linac (ERL) is under advanced construction at BNL. Its motivation, design, special features and status will be described. The Collider-Accelerator Department at BNL, which operates RHIC, is planning an electron-ion collider called eRHIC. The eRHIC electron beam will be provided by a multi-pass superconducting ERL. At the highest energy and luminosity, eRHIC will have 5 passes at 260 mA, whereas an intermediate version of eRHIC (called MeRHIC) will have 3 passes at 50 mA. To test the feasibility of such an ampere-class ERL we are constructing a prototype ERL designed to operate at up to 500 mA average current. The BNL R&D ERL will serve as a test bed for eRHIC. It will operate at 703.75 MHz. Its special features are an SRF laser photocathode RF gun designed to deliver 2 MeV at 500 mA, a high QE multi-alkaline cathode preparation and load-lock system, an emittance-preserving merging system, and a highly damped 5-cell 20 MeV ERL cavity. Tests at the ERL will include high-current handling, coherent emissions, and emittance performance. The ERL will also serve as a platform to study HOM damping issues.

MOOCAU — Progress Reports/Ongoing Projects III

TESLA Technology in China

J.E. Chen (NSFC) K.X. Liu, K. Zhao (PKU/IHIP)

Considerable progress has been made in China with TESLA technology since SRF 2007. As a mid-term goal, Peking University is striving for constructing an ERL test facility to provide coherent radiation. A cryomodule of an upgraded DC-SRF injector with a 3.5 cell cavity of large grain niobium was designed and constructed for this purpose. The field gradient of the injector cavity in the vertical test at J-Lab is reported as 23.5MV/m. A cryomodule consisting of a China made 9-cell TESLA type cavity is also presented. As the helium liquefier system produced by the Linde Company is being commissioned, it is expected that the PKU test facility will be able to provide 15-20 MeV high quality e-beam at an operating temperature of 2K early next year. Apart from PKU, IHEP started a program to build a short cryomodule consisting of a 1.3GHz 9-cell cavity and related components to serve as a horizontal test stand under the frame of ILC collaboration. The R&D of a 500MHz single-cell Nb cavity module as a spare SRF component of the colliding ring is also in progress. In order to manipulate the beam bunch length on the SSRF ring, 1.5 GHz single cell SRF cavities are being developed at SAIP.

Impact of CARE-SRF on FLASH/XFEL and Other Projects

D. Proch (DESY)

CARE (Coordinated Accelerator Research in Europe) describes a collaboration which aimed at improvements of existing accelerator facilities. It was supported by the European commission in the framework of FP6. The dominant R&D activities within CARE were related to superconducting accelerator systems, especially TTF / FLASH. This report will describe the different SRF activities (cavity fabrication technologies, surface treatments and inspection, industrialisation of electro-polishing, coupler and tuner developments, Low Level RF concepts and beam diagnostics). The most important advances will be high lighted and the impact to new or future SRF accelerator systems will be concluded.

Superconducting PAUL Trap for Antiprotons

D. Barna (University of Tokyo)

In the framework of the Asacusa experiment at the CERN Antiproton Decelerator (AD) we are developing a linear superconducting Paul-trap to capture and cool the antiprotons emerging from our RFQ decelerator and further slowed down when passing through a degrader foil window to about Ekin ~ 5-10 keV. In this talk the linear Paul-trap design and results with a test cavity will be discussed.

The ATLAS Energy Upgrade Cryomodule

J.D. Fuerst (ANL)

A new cryomodule containing seven drift-tube-loaded quarter-wave resonant cavities has been added to the ATLAS heavy ion linac at Argonne National Laboratory. Initial operation with beam took place this summer. The module provided a

stable 14.7 MV of accelerating potential (2.1 MV/cavity), a record for cavities at this beta. This paper describes cavity, cryomodule, and subsystem performance. A report on the final assembly, commissioning and operational experience is also given.

The MSU/NSCL Re-Accelerator ReA3

O.K. Kester, D. Bazin, C. Benatti, J. Bierwagen, G. Bollen, S. Bricker, S. Chouhan, C. Compton, K. Davidson, J. DeLauter, M. Doleans, T . Glasmacher, W. Hartung, M. J. Johnson, F. Marti, J. Ottarson, J. Popielarski, L. Popielarski, M. Portillo, D. Sanderson, S. Schwarz, N. Verhanovitz, J. J. Vincent, J. Wlodarczak, X. Wu, R.C. York, A. Zeller, Q. Zhao (NSCL)

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is currently constructing its new reaccelerated beam facility- ReA3. ReA3 will provide unique low energy rare isotope beams by stopping fast, separated rare isotopes in different stopping systems, and then reaccelerating them in a linac. ReA3 will provide pioneering beams for research in one of the pillars of the next-generation rare isotope facility FRIB that will be hosted at MSU. The main components of ReA3 are a linear cryogenic gas cell to stop the fast beams produced by projectile fragmentation, an Electron Beam Ion Trap (EBIT) charge state booster, a compact accelerator using a room temperature RFQ and a superconducting linac using quarter wave resonators. An achromatic beam transport and distribution line towards the new experimental area will complete ReA3. Beams from ReA3 will range in energy from 0.3 to 6 MeV/u. The maximum energy is 3 MeV/u for heavy nuclei such as uranium, and 6 MeV/u for ions with A<50 as the charge state of the ions can be adjusted by the EBIT. The overall concept and status of ReA3 will be presented in particular emphasizing on the SRF-linac.

MOODAU — Progress Reports/Ongoing Projects IV

SNS & Upgrade

J. Mammosser (ORNL)

no abstract received

STF Status and Plans

H. Hayano (KEK)

The superconducting RF test facility (STF) in KEK is aiming to promote R&D of superconducting linear accelerator to be used in the International Linear Collider (ILC). The phas·10^{-1} STF construction was completed in 2008. They included high power RF operation of four 1.3GHz SC cavities in the short-cryostat and infrastructure construction to support the superconducting accelerator module fabrication. The new phase, STF phas·10^{-2} plan is aiming to realize ILC RF unit construction and demonstration its performance together with preparation and study of industrial production. We will construct 12m-long ILC-RDR cryomodules including total 26 superconducting cavities and 1 SC quadrupole magnet. It has also ILC structure electron beam generated by a photo-cathode RF gun and conditioned by following two SC capture cavities. Phas·10^{-2} also includes the compact bright X-ray source development referred as `quantum beam project' which is founded by the MEXT as an intermediate milestone. The industrialization of cavity fabrication and cost reduction is also one of the targets of this phas·10^{-2} construction. This paper summarized the STF phas·10^{-1} results and conclusion, and plans of phas·10^{-2}.

SPIRAL2

T. Junquera (IPN)

Spiral 2 is a new European facility for Radioactive Ion Beams being constructed at the GANIL laboratory (Caen, France). Based in a High Intensity multi-ion Accelerator Driver, delivering beams to a High Power Production system (converter, target, and ion source), producing and post-accelerating Radioactive Ion Beams with intensities never reached before. The preliminary safety report was released at the beginning of 2009, initiating the official nuclear licensing procedures. Detailed studies of buildings, tunnels, and associated infrastructures were also finalized, allowing to initiate ground works in 2010. The major components of the accelerator (injectors and SC Linac), have been presently ordered. Description and expected performances of the Driver Superconducting Linac Accelerator will be given, with details on the more innovative components like SC cavities, cryomodules, cryogenic systems, etc. The first operation is scheduled for 2012 with an initial experimental program prepared in the framework of an European Project, together with many other international collaborating partners.

MOODAU04

The SARAF CW 40 MeV Proton/Deuteron Accelerator

I. Mardor, D. Berkovits, I. Gertz, A. Grin, G. Lempert, A. Perry, J. Rodnizki, L. Weissman (Soreq NRC) K. Dunkel, M. Pekeler, C. Piel, P. vom Stein (RI Research Instruments GmbH)

The Soreq Applied Research Accelerator Facility, SARAF, is currently under construction at Soreq NRC. SARAF is based on a continuous wave (CW), proton/deuteron RF SC linac with variable energy (5–40 MeV) and current (0.04-2 mA). Phase I of SARAF consists of a 20 keV/u ECR ion source, a low energy beam transport, a 4-rod RFQ, a medium energy (1.5 MeV/u) transport, a superconducting module housing 6 half-wave resonators and 3 superconducting solenoids, a diagnostic plate and a beam dump. Phase II will include 5 additional SC modules. The RFQ is in routine operation with protons since 2008 and has been further operated with molecular hydrogen and deuterons at low duty cycle. RF conditioning of the RFQ to enable deuteron CW acceleration is on going. The RF fields and dynamic cryogenic losses of the superconducting module have been measured with a VCO and the phase and amplitude stability at high fields has been measured with the SARAF LLRF system. Furthermore, proton and deuteron beams have been accelerated through the superconducting module. These were the first ever ion beams to be accelerated through half-wave resonators. Recent SARAF Phase I commissioning results will be presented.

MOODAU05

ISAC-II: Status of the 20 MV Upgrade

R.E. Laxdal (TRIUMF)

The ISAC-II superconducting heavy ion linac, commissioned in 2006, consists of twenty quarter wave cavities housed in five cryomodules. An upgrade of the linac is ongoing that will see the addition of twenty more quarter wave cavities in three cryomodules by the end of 2009. The status of the upgrade will be reported.

TUOAAU — Basic SRF R&D I

High Field Q-slope and the Baking Effect

G. Ciovati (JLAB)

The performance of SRF cavities made of bulk Nb at high fields (peak surface magnetic field greater than about 90 mT) is characterized by exponentially increasing rf losses (high-field Q-slope), in the absence of field emission, which are often mitigated by a low temperature (100-140 ^{o}C, 12-48h) baking. In this contribution, recent experimental results and phenomenological models to explain this effect will be briefly reviewed. New experimental results on the high-field Q-slope will be presented for cavities that had been heat treated at high temperature in the presence of a small partial pressure of nitrogen. Improvement of the cavity performances have been obtained, while surface analysis measurements on Nb samples treated with the cavities revealed significantly lower hydrogen concentration than for samples that followed standard cavity treatments.

Crystalline Microstructure Role in the High-Field Q-Slope

A. Romanenko (CLASSE)

High field Q-slope in niobium cavities is presently not understood. In this contribution we present experimental data that point toward the possible role of crystalline lattice defects (i.e. dislocations) in the HFQS. In addition, TEM and EELS investigations on samples cut from electropolished HFQS-limited cavities are presented.

Advances in Material Studies for SRF

T.R. Bieler (Michigan State University)

In the past decade, use of high purity Nb has enabled high Q (efficiency) values to be achieved in superconducting radio frequency (SRF) cavities, which enables design of more powerful accelerators and new concepts for benchtop accelerators. Fundamental understanding of the physical metallurgy of Nb that enables these achievements is beginning to shed light on where the challenges lie for reproducible and cost-effective production of high performance SRF cavities. Recent studies of dislocation substructure development and effects of recrystallization arising from welding and heat treatments and their correlations with Q are reviewed. Clearly, microstructural control throughout the manufacturing process is needed to insure that choices made for formability of complex shapes will also lead to optimal function of the cavity. With better fundamental understanding of the effects of dislocation substructure evolution and recrystallization on electron and phonon conduction, as well as the interior surface state, it will be possible to design optimal processing paths for cost-effective performance using approaches such as hydroforming, which minimizes or eliminates welds in a cavity.

TUOAAU04

Review of Results from Temperature Mapping and Subsequent Cavity Inspections

W.-D. Moeller (DESY)

Temperature mapping systems are used since many years to locate performance limiting defects on superconducting cavities during the RF measurements. In order to investigate the nature of such defects non-destructive optical inspection systems are in use. Due to better quality control of the niobium material and welds as well as the preparation steps the limitations could be pushed up to gradients higher than 30MV/m. According to the higher gradients and therefore smaller defects new methods of detecting and visual inspection are developed in the recent past. This paper gives an overview of the recent developments of such systems and findings on the RF surfaces of superconducting cavities.

TUOAAU05

Locating Quenches with 2nd Sound

Z.A. Conway, D.L. Hartill, H. Padamsee, E.N. Smith (CLASSE)

Superconducting RF cavity quench location is presently a cumbersome procedure requiring two or more expensive cold tests with large arrays of thermometers. One cold test identifies the cell-pair involved via quench field measurements. A second test follows with numerous fixed thermometers attached to the culprit cell-pair to identify the particular cell. A third measurement with many localized thermometers is necessary to zoom in on the quench spot. By operating superconducting RF cavities at temperatures below the lambda point the second sound wave emanating from the location where quench occurred can be utilized to triangulate on the quench-spot. Here a method which utilizes a few (e.g. 8) oscillating superleak transducers (OST) to detect the He-II second sound wave driven by the defect induced quench is discussed. Results characterizing defect location with He-II second sound wave OST detection, corroborating measurements with carbon thermometers, and second sound aided cavity repairs will be presented.

TUOAAU06

Basic Understanding for the Various Causes of Quench

D. Meidlinger (CLASSE)

The maximum possible CW accelerating gradient in a superconducting cavity is often limited by a quench caused by a small defect on the RF surface. Sometimes the defect takes the form of a large (on the order of 100 microns) pit in the surface. In addition, the quench field for a pit is generally lower than for a normal-conducting defect with the same size. A brief survey of previous work and current theories on the nature and causes of quench is given, including recent theories on the quench mechanism of niobium pits.

TUOBAU — Basic SRF R&D II

Review of Optical Inspection Methods and Results

K. Watanabe, H. Hayano, E. Kako, S. Noguchi, T. Shishido, Y. Yamamoto (KEK) Y. Iwashita (Kyoto ICR) Y. Kikuchi (Tohoku Gakuin University)

The inspection of inner surface of the superconducting rf cavities is essential in achieving high accelerating gradient. The high resolution camera system developed by Kyoto-KEK collaboration is a good tool to survey defect locations and to analyze a defect shapes in the inner surface of the cavities for boost accelerating gradient yield of 1.3 GHz superconducting 9-cell cavities. The heights or depths of observed surface defects can be estimated by examining the patterns of shades which are created by the lighting system which allows to illuminate the cavity surfaces with varying light angles by selecting a series of strip-line illuminators in steps. A good correlation has been so far observed between the hot spots localized by thermometry measurements in the vertical test and the positions of surface defects found by this system. The cavity surface study with this camera system started in FY2008, and so far, the ACCEL, ZANON, AES and MHI cavities have been examined in KEK, DESY and FNAL. Other camera systems for cavity inspection are developed in J-Lab, LosAlamos and Cornell etc. The optical inspection methods and result will be presented.

Near-Field Microwave Microscopy of Superconducting Materials

S. M. Anlage (UMD)

The high-field performance of SRF cavities can be limited by breakdown events below the intrinsic limiting surface fields of Nb, and there is evidence that these breakdown events are localized in space inside the cavity. Also, there is a lack of detailed understanding of the causal links between surface treatments and ultimate RF performance at low temperatures. We have developed a family of near-field `microwave microscopes' for super-resolution quantitative imaging of materials properties, including superconducting nonlinearities [1]. We propose two specific microscopic approaches to addressing materials issues in Nb. First, a spatially-resolved local microwave probe that operates at SRF frequencies and temperatures would be very helpful to discover the microscopic origins of breakdown. Second, RF Laser Scanning Microscopy (LSM) has allowed visualization of RF current flow and sources of nonlinear RF response in superconducting devices with micro-meter spatial resolution [2]. The LSM can be used in conjunction with surface preparation and characterization techniques to create links between physical and chemical processing steps and ultimate cryogenic microwave performance.

[1] S. M. Anlage, et al., in Scanning Probe Microscopy, Vol. 1, ed. S. V. Kalinin (Springer, New York, 2007), p. 215.

[2] A. P. Zhuravel, et al., Low Temp. Phys. 32, 592 (2006).

RF Characterization of Superconducting Samples

T. Junginger, W. Weingarten (CERN) **T. Junginger** (MPI-K) C.P. Welsch (Cockcroft Institute)

The surface resistance RS of superconducting cavities can be obtained by measuring the unloaded quality factor Q0. RS can vary strongly over the cavity surface but the value obtained is only an average over the whole surface. Furthermore surface analysis tools are difficult to apply inside a

cavity. A more convenient way consists of investigating small samples. They can be cheaply manufactured and easily duplicated. RF cavities excited in the TE011 mode with a sample attached as the cover plate are often used for material characterization. However, there is the drawback of relatively large size at the frequencies of interest concerning accelerator applications. At CERN a compact Quadrupole Resonator has been developed for the RF characterization of superconducting materials at 400 MHz. In addition the resonator can also be excited at multiple integers of this frequency. Besides RS it enables determination of the critical RF magnetic field, the thermal conductivity and the penetration depth of the attached samples, at different temperatures. The features of the resonator will be compared with those of similar RF devices and first results will be presented.

TUOBAU04

Point Contact Tunnelling at the SC Gap Before/After Baking & Atomic Layer Deposition

Th. Proslier (IIT)

We have shown previously that magnetic niobium oxides can influence the superconducting density of states at the surface of cavity-grade niobium coupons. We will present recent results obtained by Point Contact Tunneling spectroscopy (PCT) on coupons removed from hot and cold spots in a niobium cavity, as well as a comparative study of magnetic oxides on mild baked/unbaked electropolished coupons. We will also describe recent results obtained from coated cavities, ALD films properties and new materials using Atomic Layer Deposition (ALD).

TUOBAU05

Microstructure Studies of Nb

D.C. Baars (Michigan State University)

Superconducting radio frequency (SRF) cavities are often formed from fine-grain niobium sheet produced by forging and rolling of ingots that contain very large grains. Texture heterogeneity is consistently observed in such sheets, and is related to heterogeneous deformation and recrystallization of the large grains in the ingot. Relationships between the deformed, recovered, and recrystallized microstructures are required to eventually produce a homogeneous recrystallization texture. Effects of dislocations and grain boundaries on recrystallization and recovery are examined in several kinds of samples: Differently oriented single crystal and bicrystal samples deformed by uniaxial tension and heat treated, and a bicrystal rolled to various reductions and then heat treated. Active slip systems, dislocation substructures, recovery, and recrystallization will be examined by orientation imaging microscopy at incremental stages of deformation, and compared with crystal plasticity model predictions, to determine the influence of dislocation substructure on the orientations of recrystallized grains.

TUOBAU06

A15 Nb3Sn Films by Multilayer Sputtering & Review of SRF Tests

A.A. Rossi, S.M. Deambrosis, V. Rampazzo, V. Rupp, S. Stark, F. Stivanello (INFN/LNL) V. Palmieri (Univ. degli Studi di Padova) R.G. Sharma (IUAC)

The common limitation of systems conceived for the RF characterization of samples consists in the difficulty of scaling the measured results to the real resonator. The revolutionary idea consists in the production of small resonators (6GHz) completely equal in shape to the real scale model. Performing RF tests on a large amount of cavities it is possible to study alternative thin film superconducting materials, traditional and innovative surface treatments. In this framework Nb3Sn films are deposited on the internal surface of 6GHz cavities through the multilayer sputtering method. A UHV magnetron sputtering technique in a post magnetron configuration has been used. A Nb-Sn cathode is maintained in a fixed position, while the 6GHz resonator can be moved up and down thanks to a linear feedtrough.

The external coil is mounted in the cathode zone. The cavity is then annealed at 960°C for a few hours (UHV) to obtain the stoichiometric A15 phase. The surface resistance is evaluated through the cavity quality factor measurement at 4.2 K.

A15 Superconductors by Thermal Diffusion in 6 GHz Cavities

S.M. Deambrosis, V. Rampazzo, A.A. Rossi, V. Rupp, S. Stark, F. Stivanello (INFN/LNL) V. Palmieri (Univ. degli Studi di Padova) R.G. Sharma (IUAC)

Nb3Sn has been produced using the liquid tin diffusion method. A bulk Nb 6 GHz cavity is introduced into molten Sn (dipping step) and heat treated (annealing step). The process temperature must be higher than 930°C, to avoid the formation of spurious low Tc phases. The experimental procedure has been progressively modified to obtain a homogeneous, stoichometric and compact film with satisfactory superconducting properties. The "hybrid" process is particularly promising: the sample annealing is partly performed in Sn vapour, partly in vacuum (Tc = 16-17 K and deltaTc = 0,3-0.5 K, no residual Sn traces on the sample surface, no Sn rich phases). A hundred of small 6 GHz cavities, completely equal in shape to the real scale model, were built. Having good results with A15 samples, doesn't mean obtaining performant Nb3Sn superconducting resonators. Several Nb3Sn 6 GHz cavities have been produced and tested with encouraging results.

Review of RF Properties of NbN and MgB2 Thin Coating on Nb Samples and Cavities

G.V. Eremeev (CLASSE)

In the recent years, RF cavity performance has reached close to the theoretical limit for bulk niobium. Striving for further improvement in RF cavity performance for future accelerator projects has brought a renewed research interest to superconducting materials other than niobium. Higher-Tc superconductors suitable for SRF applications are being investigated in different laboratories, universities and companies around the world. In my talk I will focus on two of the prospective superconductors, NbN and MgB2, presenting the coating methods and RF properties at low and high fields.

TUPPO — Tuesday Postersession

TUPPO001

SRF Electron Gun Development for Future Light Sources

T. Kamps, W. Anders, A. Frahm, J. Knobloch, O. Kugeler, A. Neumann, T. Quast, M. Schenk, M. Schuster (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II) M. Dirsat (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH) P. Kneisel (JLAB) R. Nietubyc (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk) T. Rao, J. Smedley (BNL) J.K. Sekutowicz (DESY) J. Teichert (FZD) I. Will (MBI)

In this paper we describe the R&D roadmap at HZB for the development of a high-brightness, high average current SRF electron gun for an energy-recovery linac based synchrotron radiation source.

TUPPO002

IHEP 1.3 GHz SC RF Technology R&D Progress

J. Gao, Y.L. Chi, J.P. Dai, S.P. Li, W.M. Pan, Y. Sun, J.Y. Zhai (IHEP Beijing)

IHEP has started the ``1.3 GHz SCRF Accelerating Unit and Horizontal Test Stand Project'' since early 2009. The SCRF Accelerating Unit contains a 9-cell 1.3 GHz superconducting cavity, a short cryomodule, a high power input coupler, a tuner, a low level RF system and a high power RF source, etc. This unit will also serve as a Horizontal Test Stand (HTS) for new components R&D. Recent progress of the components R&D is presented, as well as the key SCRF facilities design and commissioning, i.e. the CBP machine, pretuning machine and BCP facility for 9-cell cavities.

TUPPO003

Tests of the Low Beta Cavities and Cryomodules for the SPIRAL 2 LINAC

P. Bosland (CEA)

The iRFU institute of CEA Saclay is in charge of the 12 low beta cryomodules that will be installed on the first section of the SPIRAL2 superconducting LINAC. Each cryomodule houses a single QWR cavity at 88MHz cooled with liquid helium at 4.5K. The RF full power tests were performed on the qualifying cryomodule at the end of 2008 and the beginning of 2009, and the two first cavities of the series cavity were tested in vertical cryostat before the summer 2009. A summary of these tests and the present status of this project are reported.

TUPPO004

The Cornell University ILC Program

Z.A. Conway, E.P. Chojnacki, D.L. Hartill, G.H. Hoffstaetter, M. Liepe, H. Padamsee, A. Romanenko, J. Sears (CLASSE)

Cornell University's superconducting cavity development program is one contributor to the global collaborative effort on critical SRF R&D for the ILC. We conduct R&D in support of the baseline cavity development as well as several alternate cavity development paths. For the baseline program we are preparing and testing ILC cavities. We have developed a new quench detection system and successfully applied it to ILC 9-cell and 1-cell cavities to find quench producing defects, which were characterized with subsequent optical examination. We have successfully repaired a 9-cell cavity using tumbling to raise the accelerating gradient

from 15 to above 30 MV/m. We have identified quench producing defects in single-cell cavities using our large-scale thermometry system and subsequently extracted and inspected the defect region with an SEM. For the alternate R&D, we are developing reentrant cavity shapes with 70 mm and 60 mm apertures, and a simpler, potentially faster and less expensive electropolishing method called vertical electropolishing. We are also assisting in developing new cavity vendors by rapidly testing single-cell cavities they produced to qualify their fabrication methods.

Superconducting Accelerating Modules Tests at DESY

D. Kostin, A. Goessel, K. Jensch, W.-D. Moeller (DESY)

The 9-cell TESLA type superconducting cavity based accelerating module is one of the key elements of the successfully operating FLASH linear accelerator at DESY as well as of the XFEL. The next FLASH 1.2 GeV upgrade modules and new XFEL prototype module have been assembled and tested on Cryo Module Test Bench (CMTB) at DESY. Results of these tests are presented and discussed.

Activities On SC Cavities and First 2K Operation at the Forschungszentrum Juelich

R. Stassen, F.M. Esser, H. Singer (FZJ) R. Eichhorn (TU Darmstadt)

Since many years, sc cavities have been designed and tested in Juelich: The 5-cell elliptical prototype cavity for the ESS was measured in a horizontal cryostat. A vertical test cryostat was installed to characterise the Halve Wave Resonators (HWRs) for the COSY linac project and several spoke-type cavities. During the measurements of the 352 MHz, tripple-spoke cavity (designed and built within the Hippi collaboration) a 2K operation was established using some refurbished pumps from the University of Wuppertal. First experiences with the 2 K operation, sometimes hindered by thermo-acoustic oscillations and the final results of the 352 MHz spoke-cavity will be presented. Furthermore we will report on the cryomodule performance, build for the Half Wave Resonators. Currently one prototype cavity was completed with a titanium helium cover and installed into the cryostat. The whole system with one cavity is now ready for first RF test.

Experimental Result of Lorentz Detuning in STF Phas·10^{-1} at KEK-STF

Y. Yamamoto, H. Hayano, E. Kako, T. Matsumoto, S. Michizono, T. Miura, S. Noguchi, M. Satoh, T. Shishido, K. Watanabe (KEK)

The Cryomodule test was finished at KEK-STF (Superconducting rf Test Facility) on December/2008. The four 9-cell cavities (MHI#1 -#4) were installed into it and measured around 2K for totally a few months. MHI#2 cavity achieved around 32 MV/m (29 MV/m at vertical test) with the feed-back and the others around 20 MV/m. During the high power test with a klystron, the Lorenz detuning was observed and measured for these cavities. Generally, the Lorentz detuning is almost compensated by setting the offset of the cavity frequency in advance (pre-detuning) and driving the Piezo actuator with an optimum condition. The optimum driving condition for Piezo actuator was obtained, which controlled the detuning frequency of the cavity within ±30Hz. MHI#2 cavity was stably operated around 30 MV/m with Piezo compensation for several hours. During this operation, the r.m.s. of the detuning frequency was about 5Hz and the peak-to-peak of the gradient at the flat-top was below 0.1%. The ``Two Modes Model'' was devised to offer the physics explanation for the observational results of the Lorentz detuning. It was found that this model is valid, since it reproduces the real data.

TUPPO008

Construction of a 700 MHz Prototypical Cryomodule for the EUROTRANS ADS Proton Linear Accelerator

F. Bouly, J.-L. Biarrotte, P. Blache, S. Bousson, C. Commeaux, P. Duthil, C. Joly, J. Lesrel (IPN) S. Barbanotti, A. Bosotti, P.M. Michelato, L. Monaco, R. Paparella, P. Pierini (INFN/LASA) M. Souli (GANIL)

Accelerator Driven system (ADS) are being considered for their potential use in the transmutation of nuclear waste. Such a device typically requires a 600MeV to 1GeV accelerator delivering a beam of few mA intensity. Because of the induced thermal stress to the subcritical core, the high-power proton LINAC will have to fulfill stringent reliability requirements, with less than a dozen of unwanted beam trips per year. One working package of the EUROTRANS project* is dedicated to the design, realization and tests of a prototypical cryomodule for the LINAC high energy section equipped with a 5 cells superconducting cavity and its tuning system. Developed at INFN, this RF cryogenic device will be tested at IPNO, early 2010. We will describe the status of the R&D activities, regarding the cryogenic system, the cavity, the power coupler, the doorknob transition and the RF source developed by Thales Electron Devices. Then, we will review the foreseen experimental reliability characterization of the cryomodule with its RF control system in nominal operating conditions.

TUPPO009

Status of the ALPI Low-Beta Upgrade

A. Facco, F. Scarpa (INFN/LNL) Y. Ma (CIAE)

The low-beta section of the ALPI linac at Laboratori Nazionali di Legnaro is being upgraded in order to raise the cavity operation gradient from 3 to 5 MV/m. This allows to increase the linac energy gain by about 10 MV with a rather limited investment. The cavities, working at 80 MHz, require a 3 dB rf bandwidth of 15 Hz to be locked in the presence of the large Helium pressure fluctuations in ALPI. Their gradient at the nominal 7 W power, although above 6 MV/m in the test cryostats, is presently kept at 3 MV/m in operation, limited by the maximum available rf power in the linac. The upgrade requires the modification of the cryostats, to allow liquid Nitrogen cooling of couplers and thus a larger rf power to the cavities from new, 1 kW amplifiers. A prototype cryostat with four new, beta=0.047 QWRs have been constructed and tested on line. The first test results will be reported and discussed.

TUPPO010

Superconducting RF Activities at LANL

T. Tajima, G.V. Eremeev (LANL)

Activities related to superconducting RF at LANL in the last 2 years are presented. They include developments of a full cavity thermometry system for standard 1.3 GHz 9-cell cavities, a surface inspection system and high-gradient SRF cavities at 805 MHz, the frequency at which LANL's 800-MeV proton accelerator operates, in order to boost the energy to ~1.2 GeV with only 2 cryomodules. Additionally, we have been studying thin-film superconductors coated on Nb separated by an insulator to increase achievable surface magnetic field for very high accelerating gradient (hopefully ~100 MV/m or higher) to realize a compact accelerator system. High gradient SRF cavities would benefit such applications as the International Linear Collider (ILC), XFELs and cargo interrogation systems using proton or muon beams,

Production Cavities and Cryomodules for a Heavy Ion Re-accelerator at Michigan State University

W. Hartung, J. Bierwagen, S. Bricker, C. Compton, J. DeLauter, M. J. Johnson, O.K. Kester, F. Marti, D. Norton, J. Popielarski, L. Popielarski, N. Verhanovitz, J. Wlodarczak, R.C. York (NSCL) A. Facco (INFN/LNL) E.N. Zaplatin (FZJ)

A superconducting linac for re-acceleration of exotic ions is being constructed at Michigan State University (MSU). The re-accelerator will initially be used by the MSU Coupled Cyclotron Facility; it will later become part of the Facility for Rare Isotope Beams at MSU. The re-accelerator will include two types of superconducting quarter-wave resonators (QWRs) to accelerate from 0.6 MeV per nucleon (MeV/u) to up to 3 MeV/u for uranium ("ReA3"), with a subsequent upgrade path to 12 MeV/u ("ReA12"). The QWRs (80.5 MHz, optimum beta = 0.041 and 0.085, made from bulk niobium) are similar to the cavities used at INFN-Legnaro for ALPI and PIAVE. They include stiffening elements and passive dampers to mitigate fluctuations in the resonant frequency. Eight beta = 0.041 QWRs have been fabricated; welding of the helium vessels and RF testing is in progress. Another eight beta = 0.085 QWRs are needed. Three cryomodules are needed to reach 3 MeV/u. Fabrication and assembly of the first cryomodule (the rebuncher, with one beta = 0.041 QWR and two superconducting solenoids) is complete. This paper will cover production efforts, test results so far, and future plans.

A 3.5-Cell DC-SC Photo-Injector of Peking University

J. Dai (PKU/IHIP)

A 3.5-cell laser-driven DC-SC photocathode injector will be brought into operation at Peking University soon. This is a compact electron gun integrating a DC Pierce gun with a 1.3GHz 3+1/2 cell superconducting cavity. This 3.5-cell injector will be operated in macro-pulse mode with 100pC and 26MHz pulse repetition. It would also allow CW operation if the liquid He supplying is enough. The injector will provide high-quality electron beams with a final electron energy of about 5MeV, bunch length of 3ps and the emittance of 1.2mmmrad (transverse uniform, longitude gaussion). Ultimately, this facility could provide high-quality electron beam for PKU-FEL, and it also could be a Tera-Hz source with about 300 um wavelength.
daijin@pku.edu.cn

3.5-Cell Superconducting Cavity for DC-SC Photoinjector at Peking University

J.K. Hao, X.Y. Lu, S.W. Quan, W. Xu, B.C. Zhang, K. Zhao, F. Zhu (PKU/IHIP)

DC-SC photocathode injector was upgraded for Peking University Free Electron Laser (PKU-FEL) facility. A 3.5-cell superconducting cavity is the key component of the DC-SC photoinjector. Design and simulation of the 3.5-cell cavity was finished. Two 3.5-cell SRF cavities was fabricated at Peking University. One is made of large grain niobium and the other is made of fine grain niobium. All the material are from Ningxia OTIC. After BCP treatment and 1250 C post purification by Peking University, the 3.5-cell LG cavity was sent to Jlab for test. Due to the special structure , the cavity was treated with BCP, 800 C degassing and HPR at Jlab. The Eacc of the cavity reached 23 MV/m with $Q=1.2\cdot10^{10}$ at highest gradient. The 3.5-cell LG Nb cavity was installed to the new DC-SC photoinjector and will be tested with the cryomodule for the next step.

TUPPO014

PLS-II Superconducting RF System

S. An, M.-H. Chun, Y.D. Joo, M.H. Jung, H.-S. Kang, H.-G. Kim, I.S. Park, K.-H. Park, Y.U. Sohn, I.H. Yu (PAL)

A superconducting radio frequency (SRF) elliptical cavity is decided for accelerating a CW electron beam with energy of 3.0 GeV and current of 400 mA in the PLS-II storage ring. The cavity is working at the temperature of 4.4 K and at a frequency of 500 MHz. Three single-cell cavities will be installed into one and a half long-straight sections of the PLS-II storage ring tunnel. Each cavity is powered by one set of high power source, and controlled by one set of digital LLRF and control system. Three cryomodules are cooled by a cryogenic plant of 700 W. In this paper, the cryomodules, high power system, LLRF and control system, and cryogenic system for PLS-II RF system have been introduced.

TUPPO015

Overview of High Gradient SRF R&D for ILC Cavities at Jefferson Lab

R.L. Geng (JLAB)

We report the progress on high gradient R&D of ILC cavities at Jefferson Lab since the Beijing workshop. Routine 9-cell cavity EP processing and testing has been enhanced with added surface mapping and T-mapping instrumentations. Field emission and quench behaviors of electropolished 9-cell cavities are studied. EP process continues to be optimized, resulting in advanced procedures and hence improved cavity performance. Several 9-cell cavities reached 35 MV/m after the first light EP processing. Field-emission-free performance has been demonstrated in a 9-cell cavity. 1-cell cavity studies explore new techniques for defect removal as well as advanced integrated cavity processing. Surface studies of niobium samples electropolished together with real cavities provide new insight into the nature of field emitters.

TUPPO016

A New ATLAS Efficiency and Intensity Upgrade Project

P.N. Ostroumov, J.D. Fuerst, M.P. Kelly, B. Mustapha (ANL)

The ATLAS facility provides beams of essentially all stable isotopes at energies above the Coulomb barrier for nuclear physics research. We have developed a two-stage ATLAS upgrade plan which includes the replacement of aging split-ring cavities by high-performance quarter-wave resonators (QWR) capable of accelerating ~100 pμA ion beams. The first stage of the upgrade project funded through the American Recovery and Reinvestment Act includes accelerator efficiency increase by adding a new RFQ injector, development and construction of a new cryomodule containing up to 3 SC solenoids and 8 QWRs. A new 72.75 MHz resonator is designed for an optimum ion velocity β=0.075. To achieve record high accelerating voltage ~2.5 MV at this very low velocity range, EM properties of the resonator are highly optimized to reduce peak surface fields. The resonator will be equipped with a piezoelectric fast tuner and capacitive coupler to transmit several kilowatts of RF power. The vast experience gained during the development, commissioning and operation of the ATLAS energy upgrade cryomodule [1] will be applied for the design of the new cryomodule.
[1] J. Fuerst. ATLAS Energy Upgrade Cryomodule, these Proceedings.

BERLinPro – a Prototype ERL for Future Synchrotron Light Sources

W. Anders, M. Abo-Bakr, T. Kamps, J. Knobloch, O. Kugeler, B.C. Kuske, A.N. Matveenko, A. Meseck, A. Neumann, T. Quast (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II)

The HZB (previously BESSY) was the first institution in Germany to build and operate a dedicated synchrotron light source (BESSY I). About 10 years ago BESSY-II, a third generation synchrotron light source, was commissioned. Presently, HZB is developing a design for a future multi-user light source as a successor to BESSY II and to enable "next-generation" experiments. Such a facility will be based on the energy-recovery-linac (ERL) principle. Although ERL facilities exist for the IR and THz range their moderate parameters (current, emittance, energy) are insufficient for x-ray sources. HZB is therefore proposing to build a prototype ERL facility (BERLinPro) that will demonstrate high current and low emittance operation at 100 MeV. BERLinPro is intended to bring ERL technology to maturity so that it can be employed for x-ray light sources. This paper presents an overview of the projects and the key components of the facility.

SRF Development Towards a 50MeV Electron Linac at TRIUMF

R.E. Laxdal (TRIUMF)

TRIUMF is embarking on the design and production of a 50MeV high intensity (10mA) superconducting electron linac at 1.3GHz. The linac is intended to produce radioactive ion beams for the TRIUMF/ISAC facility through photo-fission on an actinide target. TRIUMF has just been awarded 17M$ by a Canadian funding source to complete a first phase of the project by 2013. To this end we are beginning cavity prototyping with a local company. In addition a small single cell test cryostat has recently been commissioned using a cavity loaned from Fermilab. The beam dynamics of the linac has now defined the specification of the injector cryomodule (ICM) that will accelerate the electron beam from 100keV to 10MeV. A collaboration with VECC in Kolkata is in progress with the goal of producing two ICMs for beam test in 2011. All aspects of the SRF developments towards 1.3GHz will be reported.

Operational Experience of Diamond`s Superconducting Cavities

M. Jensen, P. Gu, M. Maddock, P.J. Marten, S.A. Pande, S. Rains, A.F. Rankin, D. Spink, A.V. Watkins (Diamond)

The Diamond Light Source has been operating with users since January 2007. From the start, the cavities suffered with a high number of trips, but recently significant improvements in reliability have been achieved. We report here operational data, initially with a single cavity, and later with two installed cavities. We describe our observations during cavity conditioning and present a variety of diagnostics which were installed to identify the origin of the trips. Additionally, we present data specific to the cavity design including sensitivity to changes in helium bath pressure and LN2 supply pressure.

TUPPO020

CC2 Operational Experience at NML

Y.M. Pischalnikov, W. Schappert (Fermilab)

The first SRF cavity operational at the ILCTA/NML at Fermilab is Capture Cavity II. CCII will become part of photo-injector for ILCTA/NML facility. Initial results of vibration measurements, Lorentz force detuning and active microphonics compensation will be presented.

TUPPO021

Cryomodule Tests in STF Phas·10^{-1} at KEK

E. Kako, H. Hayano, S. Noguchi, M. Satoh, T. Shishido, K. Watanabe, Y. Yamamoto (KEK)

A 6-m cryomodule, which includes for Tesla-like 9-cell cavities, was assembled and tested at 2 K in 2008. A cavity package consists of a 9-cell niobium cavity with two HOM couplers, an input coupler with a cold and a warm rf window, and a frequency tuning system with a mechanical and a piezo tuner. One of the cavities achieved a stable pulsed operation at 32 MV/m higher than the target operating gradient for ILC. Compensation of Lorentz force detuning at 31 MV/m was successfully demonstrated by using piezo tuner and pre-detuning.

TUPPO022

Status of KEKB Superconducting Cavities and Study for Future SKEKB

Y. Morita, K. Akai, T. Furuya, A. Kabe, S. Mitsunobu, M. Nishiwaki, S. Takano (KEK)

Status of KEKB Superconducting Cavities and Study for Future SKEKB Y.Morita, S.Mitsunobu, T.Furuya, S.Takano, M.Nishiwaki, A.Kabe, T.Tanaka and K.Akai KEK With superconducting crab cavity, 8 superconducting accelerating cavities were stably operated last two years and KEKB luminosity reached the world records of 2.1×10^{34}. For future Super KEK B-Factory(SKEKB) we study a high power input coupler of 600kW, HOM dampers of more than 30 kW and a cavity operation with reversed phase position for high power loading with very low voltage in case of a normal phase condition. The reversed phase experiment at 150 mA of a beam current in KEKB shows potential for the low voltage and high power application.

TUPPO023

High Power Test Results of LL Cavity Package in STF0.5 Program at KEK

K. Saito, F. Furuta, Y. Higashi, T. Saeki (KEK)

We have successfully made high power test with a LL cavity package in the STF0.5 program at KEK in January to March 2008. One LL cavity package was installed in a cryomodule which could include four packages maximum. This module has been successfully operated at 15-18MV/m. In this paper, we will report the results on the cavity performance, high power capacitive coupled input coupler performance and Lorenz detuning compensated piezo tuner and ball screw mechanical tuner.

Cold Leak Problems Related to HELICOFLEX Gaskets and Recent Results from the S-DALINAC

R. Eichhorn, A. Araz, J. Conrad, F. Hug, M. Konrad, T. Kuerzeder, A. Kuhl, C. Liebig, F. Schlander, S.T. Sievers (TU Darmstadt)

During the last two years, the S-DALINAC operation suffered severely from cold leaks. These leakages were hard to localize and vanished sometimes without any obvious reason or showed up again depending on the thermo-cycle. Finally, the gaskets, sealing the cavity against the helium reservoir, were found to be the reason for this behaviour. We will report on the findings itself, the systematic becoming obvious and the solution chosen to ensure tightness in the future. Moreover, we will give a status report on two ongoing projects in Darmstadt. First the injector upgrade where a new cryo-module is built, housing two cavities and improved power couplers and secondly the cavity performance improvement by heat treatment at 850 C in an UHV oven.

Operational Experience with the IUAC Linac

A. Rai, J. Antony, S. Babu, J. Chacko, A. Choudhury, G.K. Chowdhury, T.S. Datta, R.N. Dutt, S. Ghosh, R. Joshi, D. Kanjilal, S. Kar, M. Kumar, D.S. Mathuria, R. Mehta, K.K. Mistri, A. Pandey, P. Patra, P.N. Potukuchi, A. Roy, B.K. Sahu, A. Sarkar, S.S. Sonti, J. Zacharias (IUAC)

The superconducting heavy ion LINAC at the Inter University Accelerator Centre (IUAC) has now been operational for over a year. The LINAC will augment the energy from the existing 15 UD Pelletron accelerator. It is designed to have three accelerating modules, each housing eight Niobium Quarter Wave Resonators (QWR), a superbuncher housing a single QWR and a rebuncher housing two QWR's. Presently one accelerating module, the superbuncher and the rebuncher are operational. The other two modules are in an advanced stage of fabrication. In a recent operation several ion beams (from 12C to 107Ag) from the Pelletron were further accelerated through the first LINAC module and delivered for scheduled experiments. The energy gain from the LINAC, which was primarily dictated by the requirements of the experiment, was in the range of 2.5–3.5 MeV per charge state. The time widths achieved at the LINAC entrance and at the target locations were of the order of 200 and 350ps respectively. Details of the operational experience, results, problems encountered and the improvements that are being planned, will be presented.

Tests of ELBE RF-Components with Increased RF-Power

H. Buettig, A. Arnold, A. Buechner, M. Freitag, U. Lehnert, P. Michel, R. Schurig, J. Teichert, J. Voigtländer, A. Winter (FZD)

The RF-system of the superconducting electron LINAC ELBE (40 MeV, 1 mA CW) is in permanent operation since 2001 without mentionable problems but it is not completely free of RF-trips. Experience gained within eight years of operation shows that the better the RF-components were conditioned the better is their electrical stability during long time operation. To be prepared for a future ELBE upgrade several test benches have been built to study the performance of RF-amplifiers, RF-couplers and waveguide windows. A resonant ring (travelling wave resonator) allows component tests with RF power up to 100 kW in continuous wave (CW) mode and 200 kW in pulsed mode. The ring, driven by a 10 kW CW klystron is equipped with different sensors to detect light, temperatures and to produce infrared images of waveguide windows. A test bench with a waveguide sliding short is used to run component tests at full reflections (all phases). In 2008 the prototype

of a 30 kW IOT–based RF transmitter was installed and connected to an ELBE cavity. The experience gained during routine FEL operation is used to improve the design of the high voltage power converter of the IOT transmitter.

TUPPO027

The Properties of Normal Conducting Cathodes in FZD Superconducting Cavity

R. Xiang, A. Arnold, H. Buettig, D. Janssen, M. Justus, U. Lehnert, P. Michel, P. Murcek, A. Schamlott, Ch. Schneider, R. Schurig, J. Teichert (FZD) T. Kamps, J. Rudolph, M. Schenk (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II) F. Staufenbiel (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH) I. Will (MBI)

The superconducting rf photoinjector (SRF photoinjector) is one of the latest application of SC technology in the accelerator field. Since superconducting cathodes with high QE are not available up to now, normal conducting cathode material is the main choice for the SRF photoinjectors. However, the compatibility between the cathode and the cavity is one of the challenges for this concept. The SRF gun with Cs2Te cathode has been successfully operated under the collaboration of BESSY, DESY, FZD, and MBI. In this paper, some experience gained in the gun commissioning will be concluded. The results of the properties of Cs2Te photo cathodes in the cavity will be presented, such as the Q.E., life time, regeneracy, dark current and thermal emittance. At the same time, the cavity quality is showed to be steady before and after the cathode working.

TUPPO028

Operation Status of SRF Systems in the Storage Ring of SSRF

H.T. Hou, Z. Li, C. Luo, D.Q. Mao, Zh.G. Zhang, X. Zheng (SINAP) M. Chen, Z.Q. Feng, **H.T. Hou**, J.F. Liu, S.J. Zhao, Y.B. Zhao (Shanghai KEY Laboratory of Cryogenics & Superconducting RF Technology)

The superconducting RF system has been operated successfully in the storage ring of SSRF since July, 2008. The Superconducting RF modules integrated with 310 kW transmitters and digital Low Level Radio Frequency (LLRF) control systems are used to provide about 4.5 MV cavity voltages for 3.5GeV electron beam. The operation status of SRF systems are mainly reported here, the problems we met are analyzed, and also the operation with normal conducting cavity systems is introduced briefly. The challenge for us is to improve the system reliability and machine performance.

TUPPO029

Status Review of SARAF PSM

A. Perry, D. Berkovits, I. Gertz, I. Mardor, J. Rodnizki, L. Weissman (Soreq NRC) B. Aminov (CRE) K. Dunkel, M. Pekeler, C. Piel, D. Trompetter, P. vom Stein (RI Research Instruments GmbH)

Soreq Applied Research Accelerator Facility (SARAF) is a 176 MHz linac, currently under commissioning at Soreq NRC. Phase 1 of the accelerator includes a Prototype Superconducting Module (PSM), containing 6 half wave resonators. Over the last year some progress has been made in the commissioning of the PSM: a. For the first time a 3 mA pulsed proton beam was accelerated up to 2.2 MeV by a few of the resonators. Several diagnostic modules were used to measure the output beam and tune the resonators. b. Extensive investigation of the module was performed in order to analyze sources of microphonics. In addition, the tuner response was studied. c. He processing was applied, successfully reducing field emission.

Operation of SOLEIL with the Two 352 MHz Cryomodules in the Storage Ring

N. Guillotin, H.D. Dias, M.D. Diop, M.E. El Ajjouri, J.L. Labelle, R.L. Lopes, M.L.M. Louvet-Monsanglant, P. Marchand, C.M. Monnot, F. Ribeiro, T. Ruan, R. Sreedharan (SOLEIL)

In the SOLEIL storage ring, two cryomodules provide to the electron beam an accelerating voltage of 4 MV and a power of 575 kW at 352 MHz. Each cryomodule contains a pair of superconducting cavities, cooled with liquid Helium at 4°K, supplied by a single 350 W liquefier. The RF power is provided by 4 solid state amplifiers, each delivering a maximum of 180 kW. The parasitic impedances of the high order modes are strongly attenuated by means of four coaxial couplers, located on the tube connecting the two cavities. The first cryomodule, operational since September 2006, has allowed storing beam current up to 300 mA. The second cryomodule, manufactured by ACCEL (Germany), was implemented in May 2008. After more than one year of running with the two cryomodules, the first operation results are reported.

Microphonics in the ATLAS Upgrade Cryomodule

M.P. Kelly, J.D. Fuerst, S.M. Gerbick, M. Kedzie, S.W.T. MacDonald, S.I. Sharamentov, G.P. Zinkann (ANL)

Microphonics measurements have been performed on the recently commissioned ATLAS upgrade cryomodule which holds seven new beta=0.145 quarter-wave cavities operating at 10^9 MHz. Tests have been performed at the full operational fields with an average gradient EACC=8.3 MV/m and VACC=2.1 MV/cavity, a record for cavities at this beta. In the commissioning run of the cryomodule with cavities at full gradient, RMS frequency jitter ranged from 1-2 Hz RMS. With a VCX fast tuner on each cavity configured for a tuning window of 35 Hz there is essentially no ``out-of-lock'' due to microphonics. Measurements were performed with the cryostat attached to the ATLAS 4.5 Kelvin liquid helium refrigeration system. The quarter-wave cavities themselves are equipped with a passive mechanical vibration damper so that low-lying mechanical modes which couple to the cavity RF fields contribute only a little to the total microphonics. Rather, at useful accelerating fields most of the modest frequency jitter is due to relatively low frequency pressure oscillations in the helium bath due to pool boiling. Future plans for fast tuning on the next ATLAS upgrade cryomodule are discussed.

A Simple Second Sound Detection Technique for SRF Cavities

M.P. Kelly, M. Kedzie (ANL) Z.C. Liu (PKU/IHIP)

A simple technique based on an in-situ moveable germanium resistance thermometer is used to measure the quench location in a superconducting (SC) cavity in superfluid liquid helium. SRF cavities are very often limited in operating field level by thermal instability manifesting as a transient "quench" of the electromagnetic field. The field energy is transferred into the superfluid helium bath as a heat pulse and may be detected as a wave of phonons at a thermometer. The germanium thermometer technique was developed at Argonne three decades ago and used to measure time-of-flight of the second-sound to locate defects in split-ring resonators for the ATLAS SC linac at Argonne. The present goal is to extend and adapt the second-sound diagnostic technique in a simple, easy-to-use and cost effective way for use with cavities under development today. These include for example, the 9-cell, 1.3 GHz SC cavities, as well as, reduced beta superconducting cavities such as half-wave and quarter-wave structures.

TUPPO033

A Multiplexed RTD Temperature Map System for Multi-cell SRF Cavities

E.P. Chojnacki (CLASSE)

Temperature maps of the walls of operating SRF cavities are useful for research purposes and cavity production testing. Such mapping systems using RTD temperature sensors have been in use for single-cell cavities for many years. For multi-cell cavities, such as a 9-cell ILC cavity, having two wire leads per sensor becomes unmanageable for the desired 5,000 sensors in a vertical test cryostat. In recent years, multiplexed systems have been explored to reduce the wire count. A new technique to perform multiplexing of the sensors with no switching components inside the cryostat will be described. For N sensors placed on a cavity having wires routed using ribbon cables having M conductors, the number of wires to be routed out of the cryostat using this technique would typically be (4*N/M). Details of the switching circuitry, signal conditioning circuitry, the RTD sensor boards, and tests will be presented.

TUPPO034

Design of a TE-Type Cavity for Testing Superconducting Material Samples

Y. Xie, J.H. Hinnefeld, M. Liepe (CLASSE)

To further the understanding of the r.f. performance of niobium and alternative superconducting materials such as MgB2, high field tests of material samples inserted into host microwave cavities are potentially highly beneficial. In this paper we present results from a detailed design study of such superconducting sample host cavities. The focus of the design work has been on maximizing the ratio of sample surface magnetic field to host cavity maximum surface field, on multiple mode operation to study frequency dependent effects, on mechanical stability of the host cavity under atmospheric pressure, and on choke joints between the sample plates and the host cavity.

TUPPO035

Optical Inspection of SRF Cavities at DESY

S. Aderhold (DESY)

Since last year, the prototype of a camera system, developed at KEK/Kyoto University, for the optical inspection of the inner surface of cavities is available at DESY. Its variable-angle illumination system provides sufficient contrast for an in-situ search for surface defects in high resolution. Such defects may limit the gradient when causing a quench. A large sample of prototype cavities for the European XFEL has been inspected and provides a large inventory of data for analysis. The comparison of features in the optical inspection and hotspots in the temperature mapping during RF-measurements give evidence for correlations. Consecutive inspections of cavities in different stages of the surface preparation process allow a monitoring of the evolution of surface defects.

TUPPO036

Excitation of Parasitic Modes in CW Cold Tests of 1.3 GHz TESLA-Type Cavities

G. Kreps, A. Goessel, D. Kostin, W.-D. Moeller, D. Proch, K. Twarowski (DESY)

The CW test of the 9 cell TESLA-type cavity in liquid helium bath at 2 K gives the cavity performance data for the cavity acceptance. The excitation of parasitic modes of the operating pass band is an error source for the cavity gradient and quality factor determination. The excitation of the parasitic modes in the operating pass band has been observed in 81 CW cold tests out of 170 and in 41 cavities under test out of 65 since 2006. The ramp up time of the parasitic mode depends strongly on the Qload of the input antenna.

Some modes are exited in the combination with electron emission but others (7/9 Pi) have large amplitude without any attribute of field emission (x-ray or e^- current at pick up). The growing up function of parasitic modes is different from the cavity response on the outside excitation but it describes a positive feed-back system. The relation of this effect to the field emission as well as to other test parameters has been investigated and is described in this paper.

Towards an Automated Optical Inspection System

D.A. Sergatskov (Fermilab) E. Toropov (MIPT)

An optical inspection system developed at KEK/Kyoto University allows us to obtain a high resolution image the inner surface of the Tesla-style SRF cavities. In many, cases the thermometrically identified quench location also have some peculiar optical features that can be labeled as a "defect." Thus, an optical system like that can become a quality assurance (QA) tool that pre-screens the cavities prior to expensive cryogenic testing. At the moment, many of the camera operations – scene selection, focusing, advancing camera through the cavity, done manually. It is also up to the operator to flag potential defects. To become a true QA tool on production scale, all those operations should be automated. We present our approach and progress towards this goal.

Vertical Test System and T-mapping/X-ray-mapping at KEK-STF

Y. Yamamoto, H. Hayano, E. Kako, S. Noguchi, H. Sakai, M. Satoh, T. Shishido, K. Umemori, K. Watanabe (KEK)

New vertical test system was constructed at KEK-STF in 2008. Pilot test for system check including surface treatment process (Electro-Polishing) was successful using AES#001 cavity, which was on loan from FNAL, because the gradient was increased from 15.7 MV/m to 21.8 MV/m. After that, vertical test for MHI cavities is routinely done, which goal is to achieve above 35 MV/m. New cavity diagnostic system was recently completed for vertical testing of 9-cell L-band superconducting cavities, which is composed of T-mapping and X-ray-mapping. The present system is based on 352 carbon resistors for T-mapping, and 82 PIN photo diodes for detecting emission of X-rays. While most of the sensors are attached to the cavity exterior in a predetermined regular pattern, some sensors can be strategically placed at non-regular positions so as to watch the areas which are considered ``suspicious'' as per the surface inspection done prior to vertical testing (pinpoint attachment). Although the T-mapping system identified perfectly the heating location in every vertical test, there was no correlation between the heating location and the suspicious spot.

Development of a TE011 Cavity for Thin-Films Study – Presentation of the Setup

G. Martinet, S. Blivet, M. Fouaidy (IPN)

Bulk niobium cavities have quite reached their maximum performances. Maximum accelerating field reached is above 35-40 MV/m on a multi-cell cavity at 1.8 Kelvin and it is reasonable to achieve 25-30MV/m with high reliability. The question of increasing the accelerating gradient in a significant way is runnig regarding the huge amount of units required for new projects (16000 units for ILC). A promissing solution is to use thin films of new materials deposited on copper or niobium. In order to investigate the behaviour of these materials for the accelerating cavities, we have delopped a dedicated setup based on thermometric methode and a TE011 cavity. We present here the design of the setup, the cavity design and the sensitivity of the method expected for the surface resistance measurement of materials under RF field.

TUPPO040

R&D of Nondestructive Inspection Systems for SRF Cavities

Y. Iwashita, H. Fujisawa, H. Tongu (Kyoto ICR) H. Hayano, K. Watanabe, Y. Yamamoto (KEK)

Some nondestructive inspection systems are investigated for SRF cavities. It includes improvements of optical inspection, development of temperature mapping, eddy current testing, etc. All these are heading for high resolution feature. These efforts will be presented.

TUPPO041

TEM Study of Niobium Surfaces Treated by Different Polishing Techniques

A.T. Wu (JLAB)

TEM cross-section observation on Nb surfaces has been a challenge to our superconducting radio frequency (SRF) community due to the highly reactive nature of Nb. Although it was demonstrated in an early attempt1 that under a suitable sample preparation procedure reasonably clear cross-section images of Nb could be obtained, to the best of our knowledge good atomically resolved images had never been obtained. In this report, it is shown that by modifying the sample preparation procedure adopted in reference 1 it is possible to obtain good cross-section images of Nb surfaces with atomic resolution routinely. Surface atomic structures of Nb samples prepared by buffered electropolishing (BEP), buffered chemical polishing (BCP), and an untreated sample will be reported and compared.
1: A.T. Wu, Proc. of the 11th SRF Workshop, Germany, (2003), ThP13

TUPPO042

RF Surface Impedance Measurement of Polycrystalline and Large Grain Nb Disk Sample at 7.5 GHz

B. Xiao, R.L. Geng, M.J. Kelley, F. Marhauser, H.L. Phillips, C.E. Reece, H. Wang (JLAB) **B. Xiao** (The College of William and Mary)

A Surface Impedance Characterization (SIC) system has been proposed at the 2005 SRF workshop and recently updated as detailed at the 2009 PAC conference. Currently the SIC system can measure samples in a temperature range from 2K to 20K exposed to an RF magnetic flux density of less than 3mT. We report on new results of a BCP etched large grain Nb sample measured with this system as compared with previous results of a BCP etched polycrystalline Nb sample. The design of an upgraded SIC system for use at higher magnetic flux densities is on the way to more efficiently investigate correlations between local material characteristics and associated SRF properties, both for preparation studies of bulk niobium and also new thin film SRF developments.

TUPPO043

A Method of Evaluating Multilayer Films for SRF Applications

D.L. Bowring (UVa) H.L. Phillips (JLAB)

The lower critical magnetic field of an SRF cavity may be increased by screening the interior fields from the cavity bulk. This screening could be accomplished by coating the interior of a cavity with alternating layers of insulator and superconductor, each of which is thinner than the London penetration depth of the superconductor*. We have developed a method for measuring the behavior of such a multilayer system. A superconducting disk resonator is deposited on top of a small multilayer sample. The small sample approach allows for flexibility in the evaluation of many different materials and configurations. The onset of magnetic flux penetration in the superconductor can be observed from the change in

resonator Q and the detection of flux flow voltages. Since the disk resonator applies a known field to the multilayer system, the lower critical magnetic field of the system may be measured. This poster presents design analysis and preliminary data from an experimental program for multilayer film evaluation.
*A. Gurevich, Applied Physics Letters 88, 012511 (2006).

Novel UHV Scanning Anode Field Emission Microscope (SAFEM) for Dark Current Investigations on Photocathodes

A. Navitski, G. Mueller (Bergische Universität Wuppertal) K. Floettmann, S. Lederer (DESY)

One major issue of operating laser driven rf guns with high duty cycles as electron sources for free electron lasers like FLASH or the future European XFEL is the dark current emitted from the gun body and the photocathode. It is lost at various places along the beam line and part of it even reaches the undulator. When dark current is lost electromagnetic radiation and neutrons are created and may damage diagnostic components and electronic devices close to the beam line. Imperfect photocathode regions with enhanced field emission and their contact area to the rf cavity are considered as main dark current sources at typical electric surface fields of about 100 MV/m. We have constructed a novel UHV scanning anode field emission microscope (SAFEM) as part of the systematic quality control of freshly prepared photocathodes at DESY. It is designed to achieve dc surface fields of at least 200 MV/m. In addition it provides the localization of field emitters with a spatial resolution of about 1 μm. In this contribution we report on completed construction and actual commissioning tests of the SAFEM.

Surface Roughness and Correlated Enhanced Field Emission Investigations of Electropolished Niobium Samples

A. Navitski, S. Lagotzky, G. Mueller (Bergische Universität Wuppertal) D. Reschke, X. Singer (DESY)

Enhanced field emission (EFE) from particulate contaminations or surface irregularities is one of the main field limitations of the high gradient superconducting niobium cavities required for XFEL and ILC [1]. While the number density and size of particulates on metal surfaces can be much reduced by high pressure water rinsing, dry ice cleaning [2] and clean room assembly of the accelerator modules, the influence of surface defects of the actually electropolished and electron-beam-welded Nb surfaces on EFE has been less studied yet. Therefore, we have systematically measured the surface roughness of typically prepared Nb samples some of which were cut out of a nine-cell cavity by means of optical profilometry and AFM. Pits up to 800 μm diameter with crater-like centers (~Ø100μm) and sharp rims (5-10 μm height) as well as scratch-like protrusions up to 10 μm in height were found even on mirror-like surfaces. In the iris-weld region an absolute surface roughness up to 10 μm was determined. In order to study the EFE expected for such defects, correlated field emission scanning microscopy (FESM) and high resolution SEM images will be performed on selected samples after HPR at DESY.
[1] A. Dangwal et al., Phys. Rev. ST Accel. Beams 12, 023501 (2009).

[2] A. Dangwal et al., J. Appl. Phys. 10^2, 044903 (2007).

TUPPO046

Benchmarking Simulations of Multipactor in Rectangular Waveguides Using CST-Particle Studio

G. Burt, R.G. Carter, A.C. Dexter, B.D.S. Hall, J. Smith (Cockcroft Institute, Lancaster University) P. Goudket (STFC/DL/ASTeC)

Multipactor can be a limiting factor in the design on many SRF cavities, however this is often a difficult phenomena to numerically model. In order to study the reliability of various codes we have undertaken to study the simulation of multipactor in rectangular waveguides and to compare this to experimental results obtained in previous work. In this paper we present the simulation results using CST-Particle Studio.

TUPPO047

Positron Annihilation Spectroscopy on Nb Samples

B. Visentin (CEA) M.F. Barthe, V. Moineau (CNRS Orléans)

A decade after the `baking effect'' discovery [*], the quest to understand this effect and its correlated question about the High Field Q-slope origin, goes on at Saclay. SIMS analyses and ``fast baking'' experiments in Oxygen free atmosphere [**] have shown since then that interstitial oxygen diffusion is not involved in baking phenomenon. In this paper we will describe preliminary experiments performed on niobium samples by means of positron annihilation radiation Doppler broadening spectroscopy. Experimental results reveal many vacancy sites and help us to give a new interpretation of the ``baking effect''.

[*] ``Improvement of Superconducting Cavity Performances'', 6th EPAC (1998): TUP07B

[**] ``Optimization of Baking Parameters for Electropolished Cavities'', 13th SRF Workshop(2007): TUP69

TUPPO048

Thermal Modeling of Ring-Type Defects

Y. Xie, M. Liepe, D. Meidlinger, H. Padamsee (CLASSE)

A ring-type defect could be a better model for quench caused by the sharp boundary segment of a pure niobium pit. The relationship between quench field and inner radius of a ring-type defect is presented based on calculations of an improved ring-type defect model. Comparison between ring-type defects and disk-type defects model is also presented.

TUPPO049

Relationship Between Defects Pre-Heating and Defects Size

Y. Xie, H. Padamsee, A. Romanenko (CLASSE)

Pit-like structures are defect candidates that cause cavity quenches. Thermometry and SEM examination results of two such pit candidates are presented. The observed and simulated correlations between defects size and pre-heating temperature near the defect region at helium side can provide useful information about the effective defect size and resistance. Calculations based on a disk-type defect model suggest that the observed pit is much larger than the actual normal conducting region responsible for initiating the quench. This finding is consistent with the sharp edge segments of the pit as the possible regions responsible.

TESLA Type 9-Cell Cavities Continuous Wave Tests

D. Kostin, W.-D. Moeller, J.K. Sekutowicz, K. Twarowski (DESY)

TESLA 9-cell cavity was designed a decade ago for pulse operation at duty factor of a few percents. Recently, numerous coherent and synchrotron light sources projects base their driving superconducting linacs on this design assuming operation in a continuous wave (CW) mode at rather high gradients. We have performed CW tests of a standard 9-cell TESLA cavities installed in helium vessel and fully equipped with the standard TESLA-TTF auxiliaries, main coupler and both Higher Order Mode (HOM) couplers in the horizontal test cryostat to find out a limit in the CW operation. Tests details and results are presented and discussed.

Analysis of RF Results of Recent Nine-Cell Cavities at DESY

D. Reschke, L. Lilje, H. Weise (DESY)

About 50 nine-cell cavities of the recent fine-grain niobium cavity productions have been analysed with respect to maximum gradient and critical field emission onset in the first and final vertical acceptance test, respectively. Parameters of the analysis were the manufacturer of the cavities, the location of the main EP (=> industry or in-house), the final surface treatment (=> final 40μm EP or short 10μm "flash" BCP) and the cavity preparation strategy (=> vertical acceptance test with or without He-Tank welded). Moreover the effect of a re-processing of field emission loaded cavities by additional ultra pure high pressure water rinsing has been investigated.

On the Field Dependent Surface Resistance Observed in Superconducting Niobium Cavities

W. Weingarten (CERN)

Individual niobium superconducting RF (SRF) cavities for accelerator application are nowadays performing up till the believed limitations (surface magnetic field B of ~ 200 mT and a low field surface resistance Rs of a few nΩ). It is also observed that Rs may increase with B (dubbed Q-slope/Q-drop). A theoretical expression for this increase was derived from the two-fluid model, depending on typical parameters such as the electrical conductivity, penetration depth, temperature T, frequency f, A least square fit of measured data against the theoretical expression for Rs allowed to determine these parameters and to compare them with generally accepted values. The measured data consisted of about 1400 quadruples (Rs, B, f, T) collected from cavity tests of a very broad provenience in shape, cell number, frequency, surface treatment, niobium quality With this approach it is hoped that stochastic factors cancel out and that the fundamental parameters of the niobium metal prevail. A quantitative explanation for the Q-slope/ Q-drop is proposed which is based on the number of normal electrons located at the uppermost niobium surface layer that increases with T and B.

Manipulating the Intrinsic Quality Factor by Thermal Cycling and Magnetic Fields

O. Kugeler, W. Anders, J. Knobloch, A. Neumann, D. Pflückhahn, S. Rotterdam, S. Voronenko (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II)

For CW applications of superconducting cavities, obtaining a high quality factor is an important issue, since the required cryogenic power drops inversely proportional to Q0. Q0 is limited only by BCS-losses and static

losses, i.e. impurities and trapped magnetic flux. With sufficient magnetic shielding for TESLA type cavities, typical values of $2*10^{10}$ are being achieved at 1.8K operating temperature. The flux trapping was monitored by cooling the cavity at different ambient magnetic fields. In another experiment we have observed a significant increase in the Q0 value of up to 50% when subjecting the cavity to an additional cryogenic cooling cycle. Quantitative results are being presented and possible explanations for the effects are being discussed.

TUPPO054

Transient Analysis of Dynamic Lorentz Force Deformation and Detuning

Y. Morozumi (KEK)

Most superconducting accelerator structures are usually made of thin niobium shells and are subject to deformation by Lorentz forces, resulting in a significant frequency detuning because of their large Q factors. Deformation and detuning are, however, slow and limited in a pulsed operation. Transient behaviors of the structure deformation and detuning will be presented on an example of a high gradient model of the ILC accelerator structure.

TUPPO055

Status of 9-cell Superconducting Cavity Development for ERL Project in Japan

K. Umemori, T. Furuya, H. Sakai, T. Takahashi (KEK) M. Sawamura (JAEA/ERL) K. Shinoe (ISSP/SRL)

The 9-cell superconducting cavities have been developed for realizing the high current ERLs. Along with high accelerating gradient of 15-20 MV/m, strong HOM damping is also important issue for ERL main linacs, to avoid the Beam Breakup instabilities. For this aim, cavity cell shapes were optimized with large iris diameter, and large diameter beampipe HOM dampers were applied for effective HOM damping. Eccentric fluted beampipe structure was also proposed for damping of quadrupole HOMs. A prototype of niobium 9-cell cavity was fabricated. After a series of surface treatments, vertical tests were performed for the cavity. At present, the accelerating gradient is limited to 16-17MV/m due to field emissions. A developed rotating X-ray mapping system was used at the measurements and observed some X-ray traces. It is a powerful tool to locate a place of an emitter. We report on these activities with focus on the results of vertical testing.

TUPPO056

SC Cavity System for ERL Injector at KEK

K. Watanabe, E. Kako, S. Noguchi, M. Satoh, T. Shishido, K. Umemori, Y. Yamamoto (KEK)

Development of a SC Cavity Injector Cryomodule for the compact ERL (Energy-Recovery Linac) is being continued at KEK since 2006. An injector for cERL is required to accelerate a CW electron beam of 100mA to 10MeV. In this application, critical hardware components are not cavities but RF input couplers and HOM dampers. Several combinations of number of cavity and cells per cavity were examined, and a three 2-cell cavity system was chosen for cERL. Each cavity is drove by two input couplers to reduce required power handling capacity and also to compensate coupler kick. HOM coupler scheme was chosen for HOM damping, and 4 or 5 HOM couplers are put on beam pipes of each cavity. Because of simplicity cavities are cooled by jacket scheme. Two proto-type 2-cell cavities (#01 and #02) and two input couplers for compact ERL were fabricated in 2007 and 2008. The vertical test of #01 cavity with HOM pickup probe was carried out at April 2009. The result of vertical test and schedule will be reported.

Recent Results of Vertical Test for S1-Global project at KEK-STF

Y. Yamamoto, H. Hayano, E. Kako, S. Noguchi, H. Sakai, M. Satoh, T. Shishido, K. Umemori, K. Watanabe (KEK)

A new vertical test (VT) facility was built in KEK-STF (Superconducting rf Test Facility) and in operation since July/2008. Vertical test for S1-Global project is regularly done using MHI#5-#9 cavities, which were newly fabricated in Japan in 2008-2009. In this paper, we report the recent results of vertical test and discuss on cause of field limitation in these tests. For identifying the cause of the filed limitation, it is crucial to check the correlation between pass-band mode measurement and T-mapping. In the pass-band mode measurement, the achievable gradient for each cell is obtained by using seven pass-band modes from π to $3\pi/9$. MHI#5 cavity achieved 27.1 MV/m at third VT and was limited by the thermal quenching due to defect or contamination. Although MHI#6 cavity had almost same results as MHI#5 in first and second VT, third VT was not completed due to cable breakdown. On May/2009, Electro-Polishing acid was exchanged for new one. After that, many brown stains were observed in the interior surface of MHI#6, #7 and #8 cavities. Such a phenomenon appeared for the first time at STF and the investigation for it is thoroughly being done at present.

The Challenge of Monte Carlo Method for Two Sided Multipactor.

M. Mostajeran, M. Lamehi Rachti (IPM)

Superconducting RF cavities have been used in modern accelerators. SRF cavities have the limitation on maximum RF voltage and maximum delivered RF power. The major limitation comes from Multipacting in the cavity and waveguide. To design a Multipacting-free RF structure, numerical tracing calculations are required. Here, Monte-Carlo method within a plane parallel model is employed using a wide range of parameters. For more accurate predictions, a long history of electron trajectories between two parallel plats is investigated. Simulations give us fast convergence when we are far from the avalanche threshold. However it is very difficult to get such convergence when we are close to the avalanche threshold. In the present work, we demonstrate how we can cope with this difficulty.

Gradient Limiting Defects in 9-Cell Cavities EP Processed and RF Tested at Jefferson Lab

R.L. Geng, G. Ciovati, A.C. Crawford (JLAB)

Several 9-cell cavities electropolished and tested at Jefferson Lab are found to be quench limited. Pass-band mode excitation measurements provide the first clue of candidate cells responsible for the quench limit. A second RF test with thermometers attached to the equator region of candidate cells (typically only 2 candidates) reveals a hot spot caused by excessive heating of the operational defect and hence determines its location. High resolution optical tools inspect the RF surface corresponding to the hot spot to image and document the defect. All defects in cavities quench limited ~ 20 MV/m are sub-mm sized irregularities near but outside of the equator EBW. In contrast, no observable irregularities are found in some other cavities that are quench limited ~ 30 MV/m. These two types of quench limited cavities have different response to a second EP processing. In this paper, we will give a summary of the test result and attempts to catalog the observed defects.

TUPPO060

Exploring Defect Removal by Using Local Electron-Beam Treatment

R.L. Geng, W.A. Clemens (JLAB)

Recent data show that under-performing 9-cell cavities are often limited below 20 MV/m by only one sub-mm sized defect in one cell with other 8 cell already reaching very high gradients. This kind of quench limit is insensitive to repeated EP processing. An efficient method of defect removal is expected to be useful to improve gradient performance and hence gradient yield of expensive 9-cell cavities. We have been exploring a local electron-beam treatment technique as a potential method of defect removal and hence gradient performance improvement. Initial studies with niobium samples as well as half-cells are encouraging. Studies with 1-cell cavities are underway. We report the preliminary results of this study.

TUPPO061

Improved SRF Performance Due to Surface Treatment of Nb

R. Myneni, G. Ciovati (JLAB) D. Griffis, P. Maheswari, F.A. Stevie (NCSU AIF) M. Rigsbee (Materials Science and Engineering)

As part of a continuing study to characterize the surface of niobium used in SRF cavities, a surface treatment using vacuum furnace baking has been found to improve cavity performance. The niobium was treated in a vacuum furnace with a heat treatment process up to 800^{o}C that includes a 400^{o}C exposure to nitrogen. The resulting surface showed improvement of the cavity quality factor both at low and high accelerating gradients. Secondary Ion Mass Spectrometry (SIMS) and Transmission Electron Microscopy (TEM) analyses were used to characterize the surface. SIMS analyses were obtained by sputter removal of niobium with primary beams of oxygen or cesium and showed that the heat treated sample had significantly less hydrogen than a control sample. In addition, the heat treated sample has a significantly higher sputtering rate. It appears that the sputtering rate difference is the result of reduced hardness since increasing hydrogen content has been correlated with increasing hardness. Hydrogen removed during the heat treatment is not replaced by hydrogen in the atmosphere. The results have implications for further work to improve SRF cavity performance.

TUPPO062

Medium Field Q-Slope Studies in Quarter Wave Cavities

A. Grassellino (University of Pennsylvania)

The quality factor of superconducting radio-frequency niobium cavities decreases with the applied RF field in the medium field range. The medium field Q-slope effect has been investigated by many authors but models, most commonly including thermal feedback, do not fully explain experimental evidence. In this contribution we analyze medium field Q-slope data measured on ISAC-II low beta quarter wave cavities at 4.2K and 2K. The data is compared with a model that, in addition to thermal feedback of the surface temperature, takes into account the reduction of the critical temperature with the applied magnetic field. This hypothesis is tested adding two surface heaters on the LHe side of the cavity in the high magnetic field region and obtaining Q-curves at different heater power levels. The temperature increase of the RF surface due to the heater power is directly measured using a test niobium chamber. A model to explain the experimental results is presented with conclusions concerning the thermal feedback mechanism and on the relationship between the critical temperature field dependence and the Q-slope.

Comparison of Buffered Chemical Polished and Electropolished 3.9 GHz Cavities

H.T. Edwards, C.A. Cooper, M. Ge, I.G. Gonin, E.R. Harms, T.N. Khabiboulline, N. Solyak (Fermilab)

Five 3.9 GHz 9 cell cavities have been measured for the DESY FLASH module. These cavities were BCP processed and reached gradients of typically about 25 MV/m with Q drop starting at about 20 MV/m. Recently one cell cavities have been processed with EP and at least one has tested to a gradient of 30 MV/m with Q drop starting at about 25 MV/m. We will compare the results and give an update to the thermal analysis in relation to global thermal breakdown at 3.9 GHz.

Augmentation of Cavity Optical Inspection by Replicas

M. Ge, D. Burk, L. Cooley, D.T. Hicks, C. Thompson, G. Wu (Fermilab)

Although cavity optical inspection systems provide a huge amount of visual information, the amount of topographic information is limited. Here, we report the use of a two -component, silicone-based RTV polymer to make replicas without degradation of cavity performance. No release agent was necessary, and the application of the polymer could easily be coordinated with the optical cavity images. We show profilometry scans for replicas, which yield interesting details associated with equator welds and weld pits. For instance, a "cat eye" feature is found to correspond to a bowl-shaped pit with a small peak in the center, a rather more complicated geometry than has been indicated before. The replicas provide contour information that can be used to evaluate mechanisms by which pits and other features limit RF performance. Also, the greater detail provided by replicas and profilometry allows more quantitative comparisons to be made between different surface etching techniques. We assess shrinkage and find that dimensions are accurate to 0.1 micrometer. We also show that performance is maintained in a single-cell cavity after application of the replica followed by rinsing.

Magnetic Field Enhancement of Geometric Defect in SRF Cavities

G. Wu, M. Ge (Fermilab)

The combination of surface profilometer scanning and replica technique revealed cavity defects with dramatic detail. Magnetic field enhancement is calculated based on these real cavity defects. Thermal feed back model was used to understand the geometric effect of defects and cavity performance.

Oxygen diffusion in RRR Niobium

G. Wu, M. Ge (Fermilab)

Past oxygen diffusion measurements were mostly conducted with commercial grade niobium. RRR measurement of furnace treated niobium samples showed the oxygen diffusion rate in high purity niobium can be much higher than past measurements. Samples were baked in furnace at various temperatures and subsequently etched incrementally before RRR measurement. Compared to the oxygen concentration of reference niobium sample, a new O diffusion constant can be estimated by the RRR method.

TUPPO067

Microstructural and Microchemical Analyses of Eddy-Current Scan Defects in Niobium Sheets

A.M. Bastidos, D. Burk, L. Cooley, C.A. Cooper, K. Ewald, D.T. Hicks, R. Pirovano, R. Schuessler, C. Thompson (Fermilab)

Niobium sheets used to make SRF cavities are routinely subjected to eddy-current scanning (ECS) as part of quality control. This study examined several sheets that did not pass ECS examination, indicating the presence of defects of >200 μm in size and depth below the niobium surface at some locations. Through a mapping system, the defective areas were identified and cut out by water jet machining for analysis. After degreasing and an ultrasonic bath, metallography was performed with hand-held micrometers to remove 100-300 μm of material from the surface in increments of 25 μm. At each interval, the coupons were ultrasonically cleaned and inspected by optical microscopy, scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDS) with elemental mapping. Light-element contaminants were predominantly found in the scans after accounting for possible artifacts of cutting grit (garnet) and metallography (diamond, silicon carbide, tungsten carbide); iron and tantalum have so far been absent. This suggests that the chief contaminants picked up by ECS are residues of cutting and grinding media, water contaminants, and dusts in the rolling mill.

TUPPO068

Energetic Condensation Growth of MgB2 Thin-Films for SRF Applications

M. Krishnan, B.L. Bures, K.Y. Wilson Elliott (AASC) A.V. Gurevich (NHMFL) J. Jiang, D.C. Larbalestier (ASC) H.L. Phillips, C.E. Reece, A-M. Valente-Feliciano (JLAB)

We report single-step vacuum growth of a stoichiometric superconducting thin film of MgB2, using AASC's cathodic arc deposition process. Energetic condensation using cathodic arcs produces non-equilibrium fast ions (~50-100eV) that allow growth modes on relatively low temperature substrates. We have demonstrated a film Tc of 34K with MgB2 by depositing at 275 ^{o}C in a single step, from a stoichiometric, solid MgB2 source. In a subsequent experiment, the single-step coated samples (on c-plane sapphire) were ex-situ annealed. Post-deposition anneal temperature ranged from 825–900K, for 15 minutes. The annealed film also showed a transition at 30K. An MgB2 film was also deposited over a 50mm diameter circle on a Buffered Chemically Polished Niobium substrate for future RF evaluation in a cavity. The depositions spanned a range of substrate temperatures from 550-675 K. The films began to change in appearance form silver to black as substrate temperature was increased, indicating a decreasing magnesium content in the films. Future plans are to reduce oxygen contamination and to use our filtered cathodic arc to deposit smoother films

TUPPO069

Energetic Condensation Growth ff Nb Thin-Films for SRF Applications

M. Krishnan, B.L. Bures, K.Y. Wilson Elliott (AASC) H.L. Phillips, C.E. Reece, A-M. Valente-Feliciano, B. Xiao, X. Zhao (JLAB) K.I. Seo (NSU)

AASC, JLab and NSU conduct research into SRF thin-film coatings by first characterizing properties such as morphology, grain size, crystalline structure, defects, and impurities, then measuring Tc and RRR, and following this with `in-cavity' RF measurements of the Surface Impedance of the films at cryogenic temperatures. These progressive steps are essential to eventual design and measurement of SRF accelerator structures at high fields. We have recently produced Nb superconducting thin-films with crystal grain sizes ~50μm using our proprietary CEDTM cathodic arc technique. RRR of ~129 at Tc of 9.2K was measured in a film grown on a-plane sapphire heated to 400oC. At 20oC, the RRR dropped to ~4. Energetic condensation using cathodic arcs produces non-equilibrium fast ions

(~50-100eV). These ion energies are much higher than typical sputtering energies. When such energetic condensation is complemented by substrate biasing (to ~200-300eV) the incident ion energy is further increased, allowing growth modes that would otherwise require much higher substrate temperatures. Data are presented for pure Nb films using SEM, EBSD, XRD and a Surface Impedance Characterization RF cavity.

Characterization of Superconducting Multilayer Samples

C.Z. Antoine, A. Aguilal, S. Berry (CEA) S. Bouat, J.C. Villegier (Commisariat à l'Energie Atomique (CEA)) A.V. Gurevich (NHMFL) G. Lamura (CNR-INFM-LAMIA)

Best RF bulk niobium accelerating cavities have nearly reached their ultimate limits at rf equatorial magnetic field H ~ 200 mT close to the thermodynamic critical field Hc. In 2006 Gurevich proposed to use nanoscale layers of superconducting materials with high values of Hc > HcNb for magnetic shielding of bulk niobium to increase the breakdown magnetic field inside SC RF cavities. Depositing good quality layers inside a whole cavity is rather difficult; we have made high quality samples with the techniques used for the preparation of superconducting electronics circuits and characterized these samples by PPMS, SQUID, and X-ray reflectivity. The dc magnetisation curves of 250 nm thick Nb film have been measured, with and without a magnetron sputtered coating of a single or multiple stack of 15 nm MgO and 25 nm NbN layers. The Nb samples with/without the coating clearly exhibit different behaviours. Because SQUID measurements are influenced by edge and shape effects we propose to develop a specific local magnetic measurement of HC1 based on ac third harmonic analysis in order to reveal the screening effect of multilayers.

Reducing Electropolishing Time with Chemical-Mechanical Polishing

C.Z. Antoine, A. Aguilal (CEA) R. Crooks (Black Laboratories, L.L.C.)

Before reaching optimal results, one needs to remove 150-200 μm by electropolishing inside niobium RF cavities, probably because the existence of a damage layer on the Nb sheet surface. Reducing the amount of electropolishing to a final light treatment would be a way to decrease both costs and risks for large projects such as ILC. We have evaluated the thickness of the damage layer after various deformations steps by observing the density of etching figures after several light chemical etches. Complementary observations with EBSD are also presented. Deep drawing brings further and deeper damage in particular in the equator region where the friction against the forming dye is the highest. Welding also influences the damage distribution. ``Chemical-mechanical'' polishing, a technique initially developed for the preparation of TEM samples, is a way to prepare surfaces with a very thin damage layer. It is also now applied industrially to wafer preparation and optical lenses. We think that chemical mechanical polishing of half cells before welding would be a way to decrease the thickness of the final etching for the preparation of RF Nb cavities.

Exploring the Maximum Superheating Field of Niobium

N.R.A. Valles, Z.A. Conway, M. Liepe (CLASSE)

The RF superheating magnetic field of superconducting niobium was measured with a 1.3 GHz re-entrant cavity at several points in the temperature range from 1.9K to 4.2K. This experimental data is used to discriminate between two competing theories for the temperature dependent behavior of the RF superheating field. Measurements were made with <250 μs high power pulses (HPP, MW). Our test incorporated oscillating superleak transducers to determine the cavity quench

locations and characterize changes and the migrations of the quench locations during processing. Using a vertically electropolished cavity, the temperature dependence of the superheating field was found to agree with Ginzburg-Landau predictions to within 10% down to a temperature of 4.2K; whereas prior to this experiment, theory and experiment only agreed at temperatures greater than 6.2K. We also used finite element methods to simulate the internal heating of the cavity, allowing for a more accurate measurement of superheating field as a function of temperature.

TUPPO073

Surface Investigation of Samples Extracted From Prototype Cavities for European XFEL

W. Singer, S. Aderhold, A. Ermakov, X. Singer, K. Twarowski (DESY) P.M. Michelato, L. Monaco (INFN/LASA) F. Schoelz (W.C. Heraeus GmbH COPY, Materials Technology Dept.)

Few cavities of the 4th and 6th cavity generation treated accordingly the XFEL recipe have shown performance of ca. 15 MV/m caused by thermal break down without field emission. Effort to post purify some cavities with titanium, that was successfully applied for FLASH cavities, did not improve the performance. The T-map analysis detected the quench areas mainly close to the equator. Optical control by high resolution camera and non-destructive X-Ray radiography have been applied and allowed to monitor the defects in some cases with good correlation to T-map observation. In order to get more detailed information of defects some samples have been extracted from cavity and investigated by light microscope, SEM, EDX and Auger spectroscopy. The detected distinctions are discussed

TUPPO074

Structure of the Electron Beam Welding Connections

X. Singer, A. Ermakov, A. Matheisen, A. Schmidt, W. Singer (DESY)

The structure, properties and welding parameters of Nb55%Ti -Ti and Nb55%Ti-Nb connection of cavities for XFEL are investigated. These are for example the welding connections of conical disc with helium tank rings (bellow unit and reduction ring) and of conical disc with reference ring. Several samples have been prepared using the electron beam welding equipment of DESY and Lufthansa Technik AG. The metallographic structure analysis, EDX, measurement of gas content, Vickers hardness HV, RRR and electrical resistance measurement have been done. Properties of the welding connection Nb55%Ti-Nb present mainly the bcc body-centered cubic ß-phase according the phase diagram of NbTi alloy. The HV changes rather uniformly, annealing at 1400°C does not lead to changes of the behaviour. The small maximum of the critical superconducting temperature Tc in agreement with the element distribution in the welding connection is observed. Properties of the welding connection Nb55%Ti-Ti present the mixture of the bcc ß-phase and the hexagonal α-phase. Maximum of the HV and increased hydrogen content in the welding connection was observed.

TUPPO075

Surface Morphology of Welding PITs on HAZ of Electropolished Nb

Z.H. Sung, S.R. Boland, D.C. Larbalestier, A. Polyanskii (ASC) P.J. Lee (NHMFL)

Combined investigation with newly-developed cavity surface optical inspection and typical T-mapping system have shown that pits in the Nb in the heat-affected zones (HAZ) of electron welds are a source for the thermal breakdown of the surface superconducting state during strong RF operation. Magnetic fields flowing over the cavity surface in RF fields could be enhanced above the critical field when passing over the rim of such topological features. Hence, better understanding the mechanism of local magnetic field enhancement on the pits is being addressed. We have performed a quantitative study, using high resolution confocal laser scanning microscopy, of pit topology in the HAZ of electropolished Nb coupons prepared at FNAL.

We also performed a preliminarily investigation into the effect of PITs on superconductivity with magneto-optical imaging but did not observe a change in flux penetration under DC field. In addition, pits on the HAZ of welds of FNAL cavity TE1AE004 were topologically studied after making a replica of this pit with silicone molding.

Evidence for Suppressed Superconductivity by Direct Transport Measurements of the Critical Current Density Across Buffered Chemical Polished Grain Boundaries of SRF Quality Niobium

Z.H. Sung, D.C. Larbalestier, A. Polyanskii (ASC) A.V. Gurevich, P.J. Lee (NHMFL)

We extracted bi-crystals from large-grain SRF-quality Nb and examined current transport through the single grain boundary (GB) using magneto-optical (MO) imaging, measurements of surface topology, and direct transport across the GB in the superconducting state, and by transmission electron microscopy of the same GB. We have observed preferential flux penetration along GB both by MO imaging and by flux flow characteristics of the inter-granular transport. Using techniques developed for high-Tc superconductors [1], we explored the depairing critical current density of Nb grain boudnary, finding significant similarities, and also some difference, from the flux flow state of hybrid Abrikosov-Josephson vortices in low angle GBs of YBCO. Our data indicate that pinning of vortices along GBs is weaker than pinning of vortices in the grains, which may indicate suppressed superfluid density on GBs, which thus can contribute to enhanced rf losses in hotspots on the surface of Nb cavities.

[1] A. Gurevich et al., Phys. Rev. Lett. 88, 097001-4 (2002)

Superconducting Thin Films on Metals by Pulse Laser Deposition at KEK

S. Mitsunobu, S. Inagaki, M. Yoshida (KEK)

Superconducting Thin Films on Metals by Pulse Laser deposition at KEK S.Mitsunobu, S.Inagaki, M.Yoshida, K.Saito, H.Nakanishi and M.Wake KEK At KEK, the test of MgB2 thin films on Cu, Ti and Nb by Pulse Laser Deposition(PLD) method based on a fabrication method developed by NIMS have been studied and RF surface resistances have been measured. The direct deposition of MgB2 film on Nb showed two step decrease of the surface resistance. For a TM010 cavity, formed MgB2 films showed no superconductivity at this time due to different heat treatment conditions from disk samples, so we cutting cavity quadruple and one of them used as target. And heat treated as usual. This quadruple shows superconducting transition.

Interaction Niobium Oxide and Superconductivity

Th. Proslier (IIT) J. Norem (ANL)

The interactions between niobium oxides and superconducting niobium are complex and non-trivial. We will present a summary of the results obtained by PCT on cavity-grade coupons that suggest magnetism as a possible cause for non-ideal cavity performances. Atomic Layer Deposition and a high temperature baking has been used as a technique to improve the superconducting properties of niobium and protect it from oxidation. Data from an Alumina coated Cavity test before and after a High temperature baking will be presented. We will present as well a study of the damaged induced by High Pressure Rinsing on Nb coupons.

TUPPO080

X-ray Pole Figure Analysis on Fiber Textured Epitaxial Niobium Films ror SRF Cavities

K.I. Seo (NSU) B.L. Bures, M. Krishnan, K.Y. Wilson Elliott (AASC) H.L. Phillips, C.E. Reece, A-M. Valente-Feliciano, X. Zhao (JLAB)

Single and large grain Nb films are of interest to reduce the cost of SRF cavities. The structural properties and SRF potential of Nb films obtained by coaxial energetic deposition (CEDTM) in an ultra-high vacuum process are compared and discussed. The CEDTM is a hybrid technique with both energetic ion deposition and implantation phases based on cathodic arc plasma sources, which are copious generators of condensable energetic (20-200 eV), multiply charged ions from metal or alloy cathodes. The X-ray pole figure of the thin films revealed grain orientations on Nb films grown at different substrate temperatures that indicate good structural and electrical properties. Single crystalline 1-10- epilayers of Nb films are grown on a-plane sapphire substrates at 400 degreeC, but at lower temperature, there are two kinds of twins in which the grains are rotated by ~45 degree about the film normal. RRR of ~129 and Tc=9.2K were measured on a Nb film on a-plane sapphire substrate at 400 degreeC, dropping to ~4 on a room temperature substrate.

TUPPO081

Analysis of the Topographic Transformation of Nb Surface Under Controlled EP Conditions

H. Tian, C.E. Reece, W. Sommer, O. Trofimova (JLAB) L. Zhao (The College of William and Mary)

As the field requirements of niobium SRF cavities approach fundamental material limits, there is increased interest in understanding the details of topographical influences on realized performance limitations. In this study, a set of samples representing 24 different starting conditions used in cavity processing has been assembled. This set includes fine grain, large grain, and single crystal Nb samples under EBW'ed, hand ground, and CBP with a variety of stones, the latter provided by KEK colleagues. Sample topography has been carefully characterized in both the initial condition and after removal of 30 microns via controlled-parameter EP. A power spectral density (PSD) approach based on Fourier analysis of surface topography*, stylus profilometry and atomic force microscopy (AFM) are used to distinguish the scale-dependent smoothing effects. The detailed topographic transformation of Nb surface with the varied starting state Nb surface (CBP/ EBW) is reported. This study will help to identify optimum EP parameter sets for controlled and reproducible surface leveling of Nb for cavity production.

* ``Surface Roughness Characterization of Niobium Subjected to Incremental BCP and EP Processing Steps'' , Hui Tian, G. Ribeill, Charles E. Reece, and Michael J. Kelley. Proceedings of SRF2007.

TUPPO082

Development of SIMS Standards for Measurement of H, C, O, N in Nb

H. Tian, R. Myneni, C.E. Reece (JLAB) D. Griffis, P. Maheswari, F.A. Stevie (NCSU AIF) M.J. Kelley (The College of William and Mary)

Performance of SRF cavities depends on material within the shallow RF penetration depth. C, N, and O are of particular interest as interstitial contaminants and earlier work suggested very high H concentration*. Secondary Ion Mass Spectrometry (SIMS) has the sensitivity to quantitatively measure these species in the region of interest. However, standards for quantitative SIMS analysis of these elements in Nb did not exist. Initial attempts to develop an ion implanted standard were unsuccessful because of the roughness of the Nb surface. In this study, Nb samples were specially chemical mechanical polished and then subsequently treated with a light BCP. The result is a surface finish suitable for SIMS analysis and implantation standards. Ion implants of C, N, O, and deuterium (D) were obtained in Nb (and simultaneously in Si for dose verification). D was implanted to characterize H, and to avoid the high H background. The results show that D is apparently very mobile in Nb, and

another approach will be required to quantify this element. This multi-element standard has already been of great benefit in characterization of C, O, and N in polycrystalline and large grain Nb**.

* A. D. Batchelor, et al. Proc. Single Crystal Niobium Technology Workshop, Brazil, AIP Conf. Proc., Melville, NY (2007) 72-83.

** P. Maheshwari, et al. Surface and Interface Analysis (in press)

Plasma Etching of a Single-Cell RF Cavity – Asymmetric Electronegative Discharge

A-M. Valente-Feliciano, H.L. Phillips (JLAB) S. Popovic, M. Raskovic, J. Upadhyay, L. Vuskovic (ODU)

We are pursuing the use of low cost, environmentally friendly dry etching of SRF cavities in an Ar/Cl2 discharge. We have successfully demonstrated on flat samples that etching rates are comparable to the commonly used wet processes, such as BCP or EP. The geometry of bulk Nb SRF cavities involves the use of an asymmetric RF discharge configuration for plasma etching. The asymmetry in the surface area of driven and grounded electrodes creates a difference in the voltage drop over the plasma sheath attached to the driven electrode and the plasma sheath attached to the cavity surface. To study these asymmetric discharges, a single cell cavity has been specially designed with 20 holes symmetrically placed over the cell. This setup can be used for both diagnostics and sample etching purposes. Radially and spectrally resolved profiles of optical intensity of the discharge are combined with direct etched surface diagnostics to obtain an optimum combination of etching rates, roughness and homogeneity in a variety of discharge types, conditions, and sequences.

RF and Structural Characterization of New SRF Films

A-M. Valente-Feliciano, H.L. Phillips, C.E. Reece, X. Zhao (JLAB) D. Gu (ODU) R.A. Lukaszew, B. Xiao (The College of William and Mary) K.I. Seo (NSU)

In the past years, energetic vacuum deposition methods have been developed in different laboratories to improve Nb/Cu technology for superconducting cavities. JLab is pursuing energetic condensation deposition via Electron Cyclotron Resonance. As part of this study, the influence of the deposition energy on the material and RF properties of the Nb thin film is investigated. The film surface and structure analyses are conducted with various techniques like X-ray diffraction, Transmission Electron Microscopy, Auger Electron Spectroscopy and RHEED. The microwave properties of the films are characterized on 50 mm disk samples with a 7.5 GHz surface impedance characterization system. This paper presents surface impedance measurements in correlation with surface and material characterization for Nb films produced on copper substrates with different bias voltages and also highlights emerging opportunities for developing multi-layer SRF films with a new deposition system.

TUPPO085

Modification on Surface Oxide Layer Structure and Surface Morphology of Niobium by GCIB Treatments

A.T. Wu (JLAB)

Recently, it was demonstrated* that significant reductions in field emission on Nb surfaces could be achieved by means of a new surface treatment technique called gas cluster ion beam (GCIB). Further study revealed that GCIB treatments could also modify surface irregularities and remove surface asperities leading to a smoother surface finish as demonstrated through measurements using a 3-D profilometer, an atomic force microscope, and a scanning electron microscope. These experimental observations were supported by computer simulation via atomistic molecular dynamics and a phenomenological surface dynamics. Measurements employing a secondary ion mass spectrometry found that GCIB could also alter Nb surface oxide layer structure. Possible implications of the experimental results on the performance of Nb superconducting radio frequency cavities treated by GCIB will be discussed.
*: A.T. Wu et al, invited contribution to the book ``Neural Computation and Particle Accelerators: Research, Technology, and Applications'', NOVA Science Publishers, New York, USA, 2009, In press

TUPPO086

Surface Characterization of Niobium Samples Electropolished Together with Real Cavities

X. Zhao, R.L. Geng (JLAB) Y. Funahashi, H. Hayano, S. Kato, M. Nishiwaki, T. Saeki, M. Sawabe, K. Ueno, K. Watanabe (KEK) P.V. Tyagi (GUAS/AS)

We report the results of surface characterization of niobium samples electropolished together with single-cell niobium cavities. These witness samples were located in three regions of the cavity, namely at the equator, the iris and the beam-pipe respectively. Auger electron spectroscopy (AES) was utilized to probe the chemical composition of the topmost four atomic layers. Scanning electron microscopy with energy dispersive x-ray for elemental analysis (SEM/EDX) was used to observe the surface topography and chemical composition at the micrometer scale. A few atomic layers of sulfur (S) were found covering the samples non-uniformly. Niobium oxide granules with a sharp geometry were observed on every sample. Some Nb-O granules appeared to also contain sulfur.

TUPPO087

Study of Etching Pits in a Large-Grain Single Cell Bulk Nb Cavity

X. Zhao, G. Ciovati, C.E. Reece, A.T. Wu (JLAB)

This paper reports an on-going surface study of a superconducting radio frequency resonant cavity made of large-grain bulk niobium, which experienced anomalous RF energy loss in the medium field range. "Hot" and "cold" spots were identified via in-situ thermometry mapping of the BCP-etched single-cell cavity. The cavity was cut apart for surface investigation via high resolution electron microscopy (SEM), electron-back scattering diffraction microscopy (EBSD), optical microscopy, and three dimensional profilometry. Etching pits with clearly discernable crystal facets were observed in both "hotspot" and "coldspot" specimens. They were found in-grain, at bi-crystal boundaries, and on tri-crystal junctions. Two types of pits were observed with significantly different geometrical features, as observed with high resolution SEM. All "coldspots" examined had qualitatively low density of etching pits or very shallow pits at tri-crystal bound

A New Method for Calculating Magnetic Field Strength

R.M. Kriske (University of Minnesota)

A new method is presented to calculate the magnetic field generated by superconducting magnets. This method is based on a novel mathematical function that is specific to RF and certain exotic magnetic materials. This has application to Particle Accelerators in that it gives very precise field strengths.

THOAAU — SRF Technology R&D I

THOAAU01

Characterization of Ingot Material for SRF Cavity Production

J. Mondal (BARC)

In recent years, large-grain/single-crystal niobium has become a viable alternative to the standard fine grain (ASTM grain size>6), high purity (RRR) niobium for the fabrication of high-performance SRF cavities for particle accelerators In this contribution we present the results of a systematic study of the superconducting properties of samples obtained from four Niobium ingots (from CBMM, Brazil) of different purity. Measurements of bulk magnetization, surface pinning, critical temperature and thermal conductivity have been carried out on the samples subjected to different surface treatments such as buffered chemical polishing (BCP), 600C heat treatment, and low temperature baking (LTB). A correlation has been established between the LTB and the ratio of Hc3/Hc2. In addition, the phonon peak in the thermal conductivity data is suppressed by the presence of trapped magnetic vortices in the samples

THOAAU02

Basic Studies for Process Parameter Developmenst for EP/HPR/Snow Cleaning

D. Reschke (DESY)

Surface removal by electropolishing (EP) and final cleaning by High Pressure Ultra Pure water rinsing (HPR) are baseline technologies in order to achieve reproducible high surface field in superconducting niobium cavities. In the last years the standard horizontal EP process applying hydrofluoric (HF) and sulfuric acid (H2SO4) has been transferred to industry at KEK and DESY successfully. Alternative approaches based on the HF/H2SO4 mixture are vertical EP (Cornell University, CEA Saclay) as well as low voltage EP (CEA Saclay). As an alternative approach electrolytes free of HF are under investigation (INFN Legnaro, Accel Co/DESY and others). HPR has been established with various mechanical set-ups, water pressures, nozzle configurations and nozzle designs worldwide. Carbon dioxid (CO2) snow is an additional cleaning approach developed at DESY. In contradiction to HPR it is a dry cleaning process, which allows the cleaning of water sensitive components as well as horizontal cleaning of niobium accelerator cavities. The recent developments of these processes will be discussed.

THOAAU03

Electropolishing without HF: Ready for Cavity Treatment? - What Are the Naked Facts?

V. Palmieri, V. Rampazzo, V. Rupp, F. Stivanello (INFN/LNL) G. Mondin, D. Rizzetto (Univ. degli Studi di Padova)

Among possible Surface Treatments, Electropolishing (EP) occupies a key role, because is the cleanest way for removing hundreds of microns of material. The standard recipe for Niobium EP foresees the utilization of a mixture of H2SO4 and HF. Literature results are excellent, however the EP of thousands of cavities could become an industrial nightmare from the point of view of security at work. HF is not like other highly corrosive acids: if it gets in contact with skin, pain is not felt, but F- ions begin to pass through, searching for the bone calcium. Up to little time ago, it was common opinion that Niobium EP without HF was impossible, unless of explosive mixtures based on perchloric acid. This is not true anymore! Since a few years a green chemistry based on ionic liquids has come to the fore, and our group was the first to EP Niobium by a harmless mixture of Choline Chloride and Urea heated around 150°C. If compared to the HF based recipe, ionic liquids provide higher etching rate and lower surface roughness. In this talk, the application to 6GHz cavity EP will be reported and the addition of a secret third "magic" component to Choline Chloride and Urea will also be revealed.

Progress With Large Grain Cavities & Seamless Cavities

W. Singer (DESY)

R&D on cavities fabricated from large grain LG niobium discs explores its potential for the industrial fabrication. Basic material properties, comparing LG material to standard sheet niobium, material availability, production and preparation aspects (what is the appropriate treatment for reasonable and stably reproducible accelerating gradient) are under investigation. Several laboratories successfully RF tested many single cell LG cavities. Eleven 9-cell LG resonators produced at the company ACCEL from W.C. HERAEUS discs are in the preparation and partially RF tested at DESY. Technological aspects of seamless tube fabrication and cavity production by hydroforming reached good progress in last years. Problems of multi cell cavity fabrication from bulk niobium are mainly solved. Several two cell- and three cell- niobium cavities have been produced by hydroforming at DESY. A 9-cell cavity of the TESLA shape has been completed from three sub-sections at company ZANON. The cavity reached an accelerating gradient of Eacc = 30.3 MV/m after DESY EP treatment. Two new 9-cell hydroformed cavities in completion work at the company E. ZANON

Multi-wire Slicing of Large Grain Ingot Material

K. Saito (KEK)

The promising cavity performance has been confirmed on the niobium large grain cavity at many laboratories: Jlab, DESY, and IHEP/ KEK in last 4 years R&D. The gradient over 35MV/m can be expected. The niobium materials for these cavity fabrications were sliced by EDM or combination of sawing and surface machining, which are rather expensive and no way for massive production like ILC. We have developed multi-wire slicing method applying silicon wafer technology. This technology could produce 150 circular sheets in 45 hrs with very smooth surface. So far we demonstrated 60 sheets slicing in 45hrs. Next 100 sheets slicing is under way. In this talk we will present the results and some result on the cavity test fabricated this slice materials.

New Cavity Shape Developments for Low Beta Applications

H. Podlech, M. Amberg, M. Busch, F.D. Dziuba, H. Klein, U. Ratzinger (IAP)

There is an increasing interest world wide in proton and ion linear accelerators for the low and medium energy range. Many of these accelerators will be operated at high duty cycles up to 100%. Superconducting cavities are favourable or sometimes even technologically necessary. Using conventional low beta cavities (quarter wave, half wave) leads to a large number of cavities and sub-systems because of the small number of accelerating cells per cavity. The recently developed superconducting CH-cavity is the first multi-cell cavity for low beta applications. A prototype cavity (19 cells, beta=0.1) has been tested with effective gradiends of 7 MV/m. Presently two optimized CH-cavities are under construction (beta=0.15, 325 MHz, 7-cell and beta=0.059, 217 MHz, 15 cells). Both cavities will be fully equipped with cryo-module, tuning systems and high power couplers. It is planned to test both cavities with beam at GSI, Darmstadt. The talk covers the development of the superconducting CH-cavity, different applications and fututre plans.

THOBAU — SRF Technology R&D II

THOBAU01

New Cavity Shape Developments for Crabbing Applications

G. Burt (Cockcroft Institute, Lancaster University)

Deflecting mode cavities are required in several accelerators for use as crab cavities in colliders and light sources and as separators. The space requirements for these applications are extremely tight due to two or more beamlines being close together. In addition the dipole mode cavities have lower and same order modes in addition to higher order modes which require damping to very low Q values. A number of designs are proposed for compact and/or strongly damped SRF crab cavities. This paper will discuss various coaxial type crab cavities which allow the design of compact crab cavities operating at frequencies below 500 MHz. In addition a number of novel damping schemes will be shown and evaluation of these designs including multipacting will be discussed.

THOBAU02

Advances and Performance of Input Couplers at KEK

E. Kako (KEK)

High power tests of the STF cryomodule including four MHI cavities and STF-1 input couplers were carried out at KEK. The maximum input rf power of 360 kW was successfully transfered to the cavity operated at high gradients at 2 K. After the cryomodule tests, the conditioning test of the coupler at room temperature was carried out, and rf processing up to 650 kW (1.5 ms and 5 Hz) was achieved. TTF-V couplers were shipped from LAL to KEK, and the high power test was carried out at KEK-STF. Rf processing up to 2 MW in the short pulse of 400 us (5 Hz) and 1 MW in the long pulse of 1.5 ms (5Hz) was demonstrated. The results of the coupler processing at KEK will be reproted in this talk.

THOBAU03

Results from ANL/FNAL and Weld Zone Quenching

G. Wu (Fermilab)

Series of single cell and 9-cell cavities have been processed at ANL/FNAL facility. Those cavities represented major cavity and niobium material vendors. All cavity defects are characterized by temperature mapping and replica technique. Most of the defects are located in or next to the electron beam weld zone. Majority of the cavities reached high gradient despite of the defects located in high magnetic field region.

THOBAU04

SPIRAL2 Cryomodules: Status and First Test Results

G. Olry (IPN)

The SPIRAL2 superconducting linac will be composed of 19 cryomodules of 2 different types: 12 cryomodules type A housing one QWR each (beta 0.07, 88 MHz,) followed by 7 cryomodules type B housing a couple of QWRs each (beta 0.12, 88 MHz). Two prototypes (one type A and one type B) have been constructed and successfully tested in 2009. The test results will be presented, as well as, the status on cavities and cryomodules production.

Indian Cavity Fabrication Facility & Test Results

P.N. Potukuchi (IUAC)

The superconducting cavity resonator fabrication facility, the first and presently the only one in India, was commissioned at the Inter-University Accelerator Centre (IUAC) in 2002. It consists of an electron beam welding machine, electropolishing laboratory, high vacuum furnace and test cryostat. In the first phase one quarter wave resonator (QWR) was fabricated and tested. In off line tests it performed at 5 MV/m at 6 W. In the second phase two more QWRs were built. In cold tests both resonators exceeded the nominal design goal and one of them performed at 4.4 MV/m at 6 W. Production of 15 QWRs for the 2nd and 3rd modules is now nearing completion. In addition, several resonators have been successfully repaired and restored. All the QWRs in the first linac module have been retrofitted with a new design of Nb-SS transition assembly. IUAC has also taken up the construction of two niobium single spoke resonators for Fermi Lab, USA. IUAC and Raja Ramanna Centre for Advanced Technology, India are jointly constructing a Tesla-type single cell cavity in niobium. This paper will present details of the facility, fabrication, test results and present status of the projects.

Lessons Learned from the 9 mA Test

B. Chase (Fermilab)

The ILC Reference Design Report specification pushes the operating envelope in many dimensions of RF power and control. The goal of the ``9 mA Test'' is demonstrate the feasibility of the ILC Reference Design RF Unit by operating the DESY FLASH accelerator as close to ILC operating conditions as possible. This test is a collaborative effort between DESY, KEK, Fermilab, Argonne and SLAC and has been staged over the last two years, with the most recent tests taking place in September 2009. Test results and analysis as related to the ILC design are presented.

THPPO — Thursday Postersession

THPPO001

Design and Copper Prototyping of a High-Current 5-cell Superconducting RF Cavity *

R. Nassiri (AAI/ANL)

We are considering the development of a fourth-generation hard x-ray source to meet future scientific needs of the hard x-ray user community. This work focuses on the design of an optimized 5-cell structure well-suited for a high-energy; high-beam current Energy Recovery Linac. The cavity design parameters are based on the Advanced Photon Source (APS) storage ring nominal 7-GeV and 100-mA beam operation. A high-current 5-cell CW superconducting cavity operating at 1.4 GHz has been designed. In order to achieve high current, the cavity shape has been optimized and large end-cell beam pipes have been adopted. The beam break-up (BBU) threshold of the cavity has been estimated using the code TDBBU1 which indicates a high threshold for a 7-GeV Energy Recovery Linac model. A copper prototype cavity is being fabricated that uses half-cell modules, initially assembled by clamping the cells together. We will report on the cold-model measurements including the higher-order modes and will compare the measurements with the simulation results.
* Work supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357.

THPPO002

Time Domain Simulation of HOM Damping of KEK-ERL Cavity

Y.-C. Chae (ANL)

We report the time-domain simulation of HOMs excited by the ring beam in azimuthal charge distribution. The goal is to verify the effectiveness of HOM damping via wakefield simulation excited by the beam. For definite study we applied this technique to the recently designed 9-cell superconducting cavity for an energy recovery linear accelerator (ERL) at KEK. In the main linac of KEK-ERL two beams, with a beam current of up to 100 mA each, will excite significant HOM power in the superconducting RF cavities. In order to damp the HOMs of monopole, dipole, and quadrupole the large beam pipe with eccentric flute was employed as an evolution from the TESLA cavity. The effectiveness was confirmed by the numerical simulation in frequency domain as well as by the measurement. We present the independent results of KEK-ERL cavity by a time-domain simulation in comparison with the bare TESLA cavity regarding HOM damping.

THPPO003

Some Design Aspects of 704 MHz SRF Cavities

R. Calaga (BNL)

Recent developments in 704 MHz superconducting RF have prompted modification of the cavity design geared towards high average current with high accelerating gradient structures. Some aspects of improvement of accelerating gradient and efficient extraction of higher order mode power in this frequency range is discussed.

Wakefields in the Cornell ERL Injector SRF Module

R. Wolf, M. Liepe (CLASSE)

Cornell University is currently commissioning a novel, 100 mA electron injector for an energy-recovery linac based X-ray light source. Substantial wakefields will be generated by the short bunch, high current beam when it passes through the injector cryomodule, hosting five superconducting microwave cavities together with six broadband beam pipe microwave absorbers. In this paper we present wakefield and loss factor calculations for all components inside this cryomodule, including RF cavities, microwave absorbers, flanges, gate valves, and beam pipe radius transitions. The dependence on bunch length is discussed as well as a comparison of results from different numerical wakefield codes.

A General Perturbation Theory for Cavity Mode Field Patterns

D. Meidlinger (CLASSE)

The electric and magnetic field patterns of all modes in a cavity each form a complete set of eigenfunctions with the square of the mode angular frequency serving as the corresponding eigenvalue. Slater's theorem provides a formula for predicting the first-order shift in the eigenvalue when the cavity surface is deformed slightly. A similar formula for predicting the shift in the eigenfunction (i.e. the field pattern) is derived from first principles. With this formula, it is possible to apply perturbation theory to find higher-order corrections to both the frequencies and the field patterns of a deformed cavity.

Suppression of HOMs in a Multicell Superconducting Cavity for Cornell ERL

V.D. Shemelin (CLASSE)

Minimization of power of higher order modes (HOMs) in a multicell cavity was done using derivatives of the parameter defining losses with respect to geometric parameters of the cavity cells. For the Cornell Energy Recovery Linac most dangerous are dipole modes causing beam break-up (BBU). As a start point of optimization the shape with minimal losses at the fundamental mode was taken. Further changing the shape for better propagation of HOMs was done with degradation of the fundamental mode loss parameter within 1 %. Substantial improvement of the BBU parameter was achieved.

Comparison of Shapes of Multicell Cavity Cells

V.D. Shemelin (CLASSE)

Comparison of cell shapes for a multicell cavity can be made in terms of (1) the aperture radius for a given wave length, (2) the peak electric field normalized to acceleration field, and (3) the wall slope angle. All other important figures of merit, when this choice is done, become a matter of optimization. Several geometries of cells of superconducting cavities are compared from this standpoint.

THPPO008

Seven-Cell Cavity Optimization for Cornell's Energy Recovery Linac

N.R.A. Valles, M. Liepe (CLASSE)

This paper discusses the optimization methods used to design the seven-cell cavities in Cornell's high beam current (100 mA) Energy Recovery Linac. The center cells of the cavity were optimized for high R/Q*G of the fundamental mode to minimize the dynamic cryogenic load, for low electric peak surface fields to minimize the risk of electron field emission, and for increased "cell-to-cell coupling" of the higher order modes to reduce sensitivity to small cell shape errors. The end cells and beam tube sections of the cavity were subsequently optimized to maximize higher order mode damping and thereby increase the beam break up current above the envisioned operating current of 100 mA. The design was then subjected to cell shape perturbations simulating manufacturing variation, and the higher order mode parameter of these imperfect cavities were finally used in beam tracking simulations to determine a realistic estimate for the beam break up current of the ERL main linac.

THPPO009

Input Coupler for Main Linac of Cornell ERL

V. Veshcherevich, S.A. Belomestnykh (CLASSE)

Main linac cryomodule of the Cornell ERL consists of 7-cell cavities operating at 1300 MHz in CW mode. Each cavity has a single coaxial type input coupler with fixed coupling, Qext = 2×10^7. The input coupler will operate at RF power up to 5 kW at full reflection. The coupler design is based on the design of TTF-III input coupler with appropriate modifications and with taking into account the Cornell experience with couplers for ERL Injector. Unlike that of the TTF-III coupler, the cold assembly of the ERL main linac input coupler does not have bellows, which makes it stiff so the antenna orientation is not changing during cool down. Mechanical flexibility, necessary to accommodate large lateral movement of the cavity inside the vacuum vessel during cool down, is achieved by using two bellows insertions both in inner and outer tubes of warm coaxial line. The inner tube of the warm coaxial line is cooled with air to improve power handling capability.

THPPO010

The HIE-ISOLDE Superconducting Cavities: Mechanical Design and Fabrication

S. Calatroni, M. Lindroos, M. Pasini, D. Ramos, T. Tardy, T. Trilhe (CERN) V. Palmieri (INFN/LNL)

The HIE-ISOLDE superconducting linac at CERN will be based on 101.28 MHz niobium sputtered copper Quarter Wave Resonators, which will be installed downstream of the present REX-ISOLDE linac. The current design considers two basic cavity geometries (geometric beta of 6.3% and 10.3%). We report here on the choices for the mechanical design of the high beta cavities, as well as on the specific details of the fabrication of the first copper prototype.

THPPO011

Design, Fabrication and Testing of Single Spoke Resonators at Fermilab

L. Ristori, G. Apollinari, I.G. Gonin, T.N. Khabiboulline, A. Mukherjee, J.P. Ozelis, D.A. Sergatskov, R. L. Wagner, R.C. Webber (Fermilab)

The Fermilab High Intensity Neutrino Source (HINS) Linac R&D program is building a 60 MeV superconducting H^- linac. The Linac incorporates SC solenoids, high power

RF vector modulators and SC spoke-type accelerating cavities starting at 10 MeV. This will be the first application and demonstration of any of these technologies in a low-energy, high-intensity proton/H^- linac. The HINS effort is relevant to a high intensity, SC H^- linac that might serve the next generation of neutrino physics and muon storage ring/collider experiments. Three types of superconducting resonators are used in the linac front end. Single Spoke Resonators typ$\cdot 10^{-1}$ (SSR1) at Beta=0.2, Single Spoke Resonators typ$\cdot 10^{-2}$ (SSR2) at Beta=0.4 and Triple Spoke Resonators (TSR) at Beta=0.6. In this paper we present the RF design, the mechanical design, the fabrication, the chemistry and testing of the first two SSR1 prototype cavities that were built. The design and testing of the input coupler and the tuning mechanism are also discussed.

SCRF Cavities for CW Option of Project X Linac

N. Solyak, I.G. Gonin, T.N. Khabiboulline, A. Lunin, N. Perunov, V.P. Yakovlev (Fermilab)

Alternative option of Project X is based on the CW SC 2GeV Linac with the average current 1mA. Possible option of the CW Linac considered in the paper includes low energy part consisted of a few families SC Spoke cavities (from 2.5 MeV to 466 MeV) and high energy part consisted of 2 types of elliptical cavities (v/c=0.81 and v/c=1). Requirements and designed parameters of cavities are considered.

THPPO012

Structural Analyses of MSU Quarter-Wave Resonators

E.N. Zaplatin (FZJ) C. Compton, W. Hartung, M. J. Johnson, F. Marti, J.C. Oliva, J. Popielarski, R.C. York (NSCL)

A superconducting linac for re-acceleration of exotic ions is under development at Michigan State University. Two types of superconducting quarter-wave resonators (80.5 MHz, optimum beta = 0.041 and 0.085) will be used for re-acceleration to energies of up to 3 MeV per nucleon initially, with a subsequent upgrade path to 12 MeV per nucleon. Structural design is an important aspect of the overall cavity and cryomodule implementation. The structural design must include stiffening elements, the tuning mechanism, and the helium vessel. The main mechanical design optimization goal is to minimize the shift in the cavity's resonant frequency due to the Lorentz force, bath pressure fluctuations, and microphonic excitation. Structural analyses of the MSU quarter-wave resonators will be presented in this paper. Stiffening measures will be explored. The numerical predictions will be compared to test results on prototype cavities.

THPPO013

SC Half-Wave Conical Resonator Investigations

E.N. Zaplatin (FZJ)

In the low energy part of accelerators the magnets usually alternate accelerating cavities. For these particle energies Half-Wave Resonators are considered. Such layout allows enlargement of the peripherical cavity volume containing RF magnetic field. This results in decreasing the cavity peak surface magnetic field Bpk/Eacc by the factor of two. Additionally, an enlarged dome volume allows an installation of magnetic tuner for cavity frequency adjustment without affection of Bpk/Eacc. The paper reports the results of superconducting Half-Wave Resonator shape developments. A magnetic plunger for cavity frequency tune is investigated. Different cavity shape modifications are suitable also for close situated cavities. The results are applicable for SC RF Quarter-Wave Resonators.

THPPO014

THPPO015

IFMIF-EVEDA SC beta=0.094 Half-Wave Resonator Study

E.N. Zaplatin (FZJ) P. Bosland, P. Bredy, N. Grouas, P. Hardy, J. Migne, A. Mosnier, F. Orsini, J. Plouin (CEA)

The driver of the International Fusion Material Irradiation Facility (IFMIF) consists of two 125 mA, 40 MeV cw deuteron accelerators [1-2]. A superconducting option for the 5 to 40 MeV linac based on Half-Wave Resonators (HWR) has been chosen. The first cryomodule houses 8 The driver of the International Fusion Material Irradiation Facility (IFMIF) consists of two 125 mA, 40 MeV cw deuteron accelerators. A superconducting option for the 5 to 40 MeV linac based on Half-Wave Resonators (HWR) has been chosen. The first cryomodule houses 8 HWR's with resonant frequency of 175 MHz and geometric beta=v/c=0.094. This paper describes the RF design of half-wave length resonator together with structural analyses. Detailed simulations of resonance multipactor discharge in HWR are presented. Due to the required high coupling, the power coupler is located in mid-plane of the cavity. Several cavity tuning options were investigated: the capacitive tuner located in mid-plane and opposite to the power coupler port offers a large tuning range and will be tested first.

THPPO016

Progress in Superconducting CH-Cavity Development

M. Busch, F.D. Dziuba, H. Podlech, U. Ratzinger (IAP)

The superconducting CH-Cavity (Crossbar H-Mode) is the first multi-cell drift tube cavity for the low and medium energy range of proton and ion linacs. A 19 cell, beta = 0.1 prototype cavity has been developed, fabricated and tested successfully with a voltage of 5.6 MV corresponding to gradients of 7 MV/m. The construction of a new superconducting 325 MHz 7-gap CH-cavity has started. The new cavity has an optimized geometry regarding tuning possibilities, high power RF coupling, minimized end cell lengths and possibilities for surface preparation. Additional RF, thermal and mechanical simulations are performed. After low power tests it is planned to test this cavity with a 10 mA, 11.4 MeV/u (beta = 0.15) beam delivered by the Unilac at GSI.

THPPO017

Development of Superconducting CH-Cavities for the EUROTRANS Injector Linac

F.D. Dziuba, M. Busch, H. Klein, H. Podlech, U. Ratzinger, C. Zhang (IAP)

The CH-structure (Crossbar-H-mode) is a superconducting cavity for the low and medium energy range operated in the H21-mode. Due to its well designed geometry and by using the special KONUS (KOmbinierte NUll Grad Struktur) beam dynamics the superconducting CH-cavity is an excellent candidate for the efficient acceleration in high power proton and ion accelerators. One of many possible applications for this kind of superconducting RF cavity is the EUROTRANS project (EUROpean Research Programme for the TRANSmutation of High Level Nuclear Waste in an Accelerator Driven System, 600 MeV, 352 MHz). A prototype cavity has been developed and tested successfully with a gradient of 7 MV/m. At present a new superconducting CH-cavity with improved geometry for high power applications is under construction. The status of the cavity development related to EUROTRANS is presented.

Simulating Higher Order Modes in a String of Multi-Cell Accelerating Structures

Y. Morozumi (KEK)

Damping of higher order modes is crucial to beam stability in the main linacs of the International Linear Collider. Studies so far tend to focus on trapped modes in a single 9-cell structure model alone both in simulation and in measurement. Because of difficulty of realistic modeling of multiple 9-cell structures, propagating modes beyond cut-off frequencies are left untouched. An attempt and its results of simulating a full spectrum of higher order modes in a long string of 9-cell structures will be presented.

Improved Performance of the SC Ladder Resonator, a Novel Structure for the Very Low Beta Part of High Current Linacs

G. Bisoffi, A. Palmieri, A.M. Porcellato, S. Stark (INFN/LNL)

A novel superconducting (sc) structure, called Ladder resonator [1], was proposed, in order to accelerate a high intensity proton beam within the energy range of 5–20 MeV. The first Q-curves were affected by a serious electron-beam welding inconvenience, discovered at a later stage. After repairing the resonator, the Q-values at low field improved by around a factor 4. Present value of the achievable accelerating field is limited by the availability of liquid He, in relationship with the time needed to condition both RFE and FE at 4,2 K. The path to reach the design performance is also discussed in the paper. [1] URL: http://link.aps.org/doi/10.110^3/PhysRevSTAB.6.040101

Design Optimisation of the EURISOL Driver Low-beta Cavities

A. Facco, F. Scarpa (INFN/LNL) Y. Ma (CIAE) V. Zvyagintsev (TRIUMF)

The low-beta section of the EURISOL driver linac is based on 176 MHz superconducting half-wave resonators (HWR) with beta=0.09 and beta=0.16. These cavities are an evolution of the 352 MHz ones previously developed in the same framework, having similar dimensions and components except for their length. They are characterized by a double wall, all niobium structure with light weight, good mechanical stiffness and a side tuner cooled by thermal conduction. In the view of using common vacuum cryostats, the 176 MHz cavities design has been modified by including a removable tuner, and both tuning range and mechanical stability could be further improved. Design characteristics and mechanical optimization will be presented and discussed.

Design of a 450 MHz Beta=0.2 Single Spoke Cavity at PKU

Z.Y. Yao, X.Y. Lu, K. Zhao (PKU/IHIP)

The design of a 450MHz β=0.2 superconducting single spoke cavity has been finished at Peking University. For most current test results, the performance limitation in a spoke cavity is the thermal-magnetic quench with little or no field emission, the major goal of geometry optimization is minimizing Bpk. In this poster, the optimization of the spoke cavity is described in detail. The RF simulation gives the optimum RF parameters Epk/Eacc=2.65 and Bpk/Eacc=5.22mT/(MV/m). Low Bpk/Eacc will provide a high gradient cavity. The mechanical properties of the cavity are also studied by simulation. Stiff ribs are used to offer a credible mechanical stability. The impacts of mechanical errors on cavity RF

performance are analyzed. Conclusion shows that single spoke cavity is robust with respect to mechanical errors, and gives directions on cavity fabrication. Fabrication art has been fixed. Considering reducing welding connections at peak magnetic field area, the art has been improved, and the cross-sections of spoke bar and cavity barrel are formed by deep drawing without welding. The processing is under going now.

THPPO022

Modified 3+1/2 Cell SC Cavity Made of Large Grain Niobium for the FZD SRF Photoinjector

P. Murcek, A. Arnold, H. Buettig, P. Michel, J. Teichert, R. Xiang (FZD)

An SRF photoinjector has been successfully tested in FZD under the collaboration of BESSY, DESY, FZD, and MBI. In order to improve the gun cavity quality and thus reach a higher gradient, a new 3+1/2 superconducting cavity is being fabricated in cooperation with JLab. The modified cavity is made of large grain niobium, composed of one filter choke, one special designed half-cell (gun-cell) and three TESLA cavities. In this paper, the main updates of the new cavity design will be explained in detail. The deformation of the filter choke and the gun-cell, which is caused by pressure fluctuation in the He-line and also by the effect of the Lorentz force, will be minimized by stiffening between the filter choke and the gun-cell. Meanwhile, the cathode hole in the choke and gun-cell is enlarged for better rinsing. To simplify assembly, the NbTi pick-up will be welded directly on the wall of filter choke.

THPPO023

Design Optimization of Superconducting Parallel-Bar Cavities*

J.R. Delayen (JLAB, ODU) S.U. De Silva (ODU)

The parallel-bar structure is a new superconducting geometry [1] whose features and properties may have significant advantages over conventional superconducting deflecting and crabbing cavities for a number of applications. Jefferson Lab is in need for a 499 MHz, 11 GeV rf separator as part of its 12 GeV upgrade program. We report on design optimization studies performed to-date for this and other applications.

[1] J. R. Delayen and H. Wang, " New compact TEM-type deflecting and crabbing rf structure", Phys. Rev. ST Accel. Beams 12, 062002 (2009)

THPPO024

High-Gradient SRF Cavity with Minimized Surface E.M. Fields and Superior Bandwidth for the ILC

R.M. Jones, N. Juntong (UMAN)

Results are presented on an alternative cavity to the ILC baseline design of TESLA-style SRF main accelerating linacs. This re-optimised shape enhances the bandwidth of the accelerating mode and has reduced surface electric and magnetic fields, compared to the baseline design and some current high gradient designs. Detailed simulations on the e.m. fields for the New Low Surface Field (NLSF) cavity, including end-cell and coupler designs, are reported. The re-distributed dipole mode distribution is also discussed.

Third Harmonic Cavity Modal Analysis

R.M. Jones, B. Szczesny (UMAN)

Modes in the third harmonic cavities, designed and fabricated by FNAL, are analysed and the sensitivity to frequency errors are assessed. A circuit model is employed to model both monopole and dipole bands. The monopole circuit model is enhanced to include successive cell coupling, in addition to the usual nearest neighbour cell coupling.

Compensation of Transverse Field Asymmetry in the High-Beta Quarter-Wave Resonator of the Hie-Isolde Linac at CERN

M.A. Fraser, A. D'Elia, R.M. Jones (UMAN) **M.A. Fraser** (CERN) M. Pasini (Instituut voor Kern- en Stralingsfysica, K. U. Leuven)

The superconducting upgrade of the REX -ISOLDE radioactive ion beam (RIB) post-accelerator at CERN will utilise a compact lattice comprising quarter-wave resonators (QWRs) and solenoids, accelerating beams in the mass range $2.5 < A/q < 4.5$ to over 10 MeV/u. The short and independently phased quarter-wave structures allow for the acceleration of RIBs over a variable velocity profile and provide an unrivalled longitudinal acceptance when coupled with solenoid focusing. The incorporation of the solenoids into the cryomodule shortens the linac, whilst maximising the transverse acceptance, but the application of solenoid focusing in the presence of asymmetric QWR fields can have consequences for the beam quality. The rotation of an asymmetric beam produces an effective emittance growth in the laboratory reference system. We present modifications of the cavity geometry to optimise the symmetry of the transverse fields in the high-beta QWR. A racetrack shaped beam port is analysed and a modification made to the inner conductor with a geometry that will enable a niobium film to be effectively sputtered onto the cavity surface.

HIE-ISOLDE High Beta Cavity Study and Measurement

A. D'Elia (CERN, UMAN), R.M. Jones (UMAN) M. Pasini (Instituut voor Kern- en Stralingsfysica, K. U. Leuven)

The upgrade of the ISOLDE machine at CERN foresees a superconducting linac based on two gap independently phased Nb sputtered Quarter Wave Resonators (QWRs) working at 101.28MHz and producing an accelerating field of 6MV/m on axis. A deep study of the fields in the cavity is fundamental in order to pin down the crucial e-m parameters of the structure such as peak fields, quality factor and e-m power dissipated on the cavity wall. Furthermore it is fundamental to provide for an efficient tuning system to the structure. In this paper the full list of the e-m cavity parameters will be reported. The tuning plate design and realization will be described. Finally the frequency measurements with and without tuner plate at room temperature will be presented.

Design and Characterization of the Power Coupler Line for HIE-ISOLDE High Beta Cavity

A. D'Elia (CERN, UMAN) M. Pasini (Instituut voor Kern- en Stralingsfysica, K. U. Leuven)

The first stage of the planned upgrade of the ISOLDE facility at CERN will provide a boost in beam energy from 3MeV/u up to 5.5MeV/u. In order to reach this goal, it is planned to install downstream the present structure, a superconducting linac based on two gap independently phased Nb

sputtered Quarter Wave Resonators (QWRs) working at 101.28MHz. The cavity parameters foresee to have a power dissipated on the cavity wall of 7W with a Q0=6.6×108 for an accelerating field of 6MV/m. The cavity will be fed via a moveable antenna that, in operating condition, is designed to reach a maximum overcoupled condition of a factor 200 (rms power flowing in the coupler line of 350W) in order to get a bandwidth at the resonant frequency of 30 Hz. It is also needed for this power coupler a wide dynamic range (Qext ranging from 10^4 to 109) for tests both at room temperature and in superconducting operating mode. Furthermore the sliding mechanism has to be ``dust free''. In the following, starting from e-m cavity parameters, the attention will be focused on the power coupler design and line analysis.

THPPO029

A Clean Pumping and Venting System for SRF Cavities and Cryomodules

S.M. Gerbick (ANL)

A system based on a pair of mass flow controllers has been used to evacuate and vent a clean cavity rf space. The mass-flow system is used in both single cavity testing and with the ATLAS upgrade cryomodule at Argonne. It is similar schematically to that already in use at DESY, however, it is very compact and maintains the capability to precisely control both the pump out and venting rates. Initial tests of the system with both the ATLAS single cavity test cryostat and the ATLAS upgrade cryomodule show that pump down and venting cycles may be performed without introducing substantial particulates into the cavity rf space. The system, together with the ANL top loading cryomodule design with easy access to individual cavities, will allow an individual cavity to be removed and replaced in a cryomodule string without the need to re-clean the entire string. This capability would also remove the need to test every cavity individually before installation into the string, constituting a major savings for large projects.

THPPO030

A Top Loading 2 Kelvin Test Cryostat for SRF Cavities

M. Kedzie (ANL)

A new large 2 Kelvin test cryostat is being commissioned at Argonne National Laboratory. This system will have a full time connection to the 4.5 Kelvin ATLAS refrigerator and, with integrated J-T heat exchanger, will allow continuous 2 Kelvin operation. The large diameter was chosen to accommodate essentially all of today's superconducting cavities and the top loading design facilitates clean room assembly. The commissioning run will be with a coaxial half wave cavity to be followed by testing with 1.3 GHz single-cell elliptical cavities. Details of the initial engineering cool down on the cryostat are presented.

THPPO031

HOM Absorber Development for BNL ERL Cryomodules

H. Hahn, I. Ben-Zvi, L.R. Hammons, W. Xu (BNL)

The development of Higher Order Mode dampers for a five-cell cavity is being persued at this laboratory. The physics needs and technical requirements for several future electron-ion collider projects are under study, which all involve Energy Recovery Linacs. The envisioned Ampere class currents make effective HOM damping mandatory which will be achieved with capacitive probes and inductive loops. Longitudinal space requirements constrain the space between the cavities in the linac chain. Two five-cell copper cavities are assembled with minimal separation to simulate the space available for fundamental power coupler, beam position pickup probe, and two HOM dampers. The location of the dampers is chosen in the connecting beam tubes to balance fundamental mode suppression and HOM damping. Measured and simulated Cu cavity results are compared with those for the ferrite-damped superconducting ERL.

Conditioning of the 1 MW 704 MHz Coaxial Power Coupler

G. Devanz, P. Carbonnier, S. Chel, M. Desmons, Y. Gasser, A. Hamdi, D. Roudier (CEA)

Coaxial 704 MHz power couplers have been developed for high intensity superconducting proton linacs. Projects like the Superconducting Proton Linac (SPL) at CERN or the European Spallation Source ESS require up to 1 MW pulsed power with a high duty cycle in the high energy section of superconducting elliptical cavities. One pair of couplers has been successfully conditioned on the 704 MHz test stand at Saclay at room temperature at a maximum power of 1.2 MW, with 2 ms pulses and 50 Hz repetition rate, equivalent to10% duty cycle. In order to test the coupler in realistic conditions with its cryogenic environment, we prepare a cold test with a cavity in the horizontal cryostat Cryholab.

Main Choices and Preliminary Design for the IFMIF RF Couplers

J. Plouin, P. Bosland, P. Bredy, M. Desmons, G. Devanz, H. Jenhani, A. Mohamed (CEA)

IFMIF is the future neutrons irradiation facility that aims to qualify advanced materials for the fusion reactors successor to ITER. The required neutrons flux is created from the irradiation of a lithium target by two high intensity deuteron ion beams (125 mA @ 40 MeV CW) produced by two parallel superconducting accelerators. The niobium cavities are Half Wave Resonators (HWR) at 175 MHz operating at 4.5K. All cavities are equipped with the same power coupler designed to transfer a maximum power of 200 kW in CW. The present phase of the project, IFMIF-EVEDA, is aimed to validate the technical options for IFMIF, by the construction of an accelerator prototype: 1 cryomodule with 8 HWRs and 8 couplers providing RF power up to 70 kW. Nevertheless, these couplers are designed to be able to operate at 200 kW, and they will be tested and conditioned at this power. This paper describes the overall operating requirements of these high power couplers, presents the main choices that have been made up to now and the RF design of the coupler components.

Cryogenic Heat Load of the Cornell ERL Main Linac Cryomodule

E.P. Chojnacki, S.S. Chapman, R.D. Ehrlich, E.N. Smith, V. Veshcherevich (CLASSE)

The proposed Cornell Energy Recovery Linac (ERL) will be a 5 GeV, 100 mA cw electron accelerator using SRF Cavities. The cryomodule design will be an extension of TTF technology. The cryogenic plant will be a significant portion of the ERL cost and an accurate estimate of the heat load is crucial to facility planning. A prototype main linac cryomodule is in the process of being designed. The configuration of the major module components is sufficiently known to allow calculation of the cryogenic heat loads to the helium cooling circuits of 1.8K, 5K, and an intermediate temperature in the vicinity of 80K. The results of ANSYS thermal modeling with nonlinear material properties will be presented along with analytic calculations to provide an itemization of the cryomodule heat loads. The optimal intermediate temperature will be shown to be just above 80K. The wall-plug power for the cryoplant will be estimated with COP's provided by major helium-refrigeration vendors.

THPPO035

DC Conductivity of RF Absorbing Materials

E.P. Chojnacki, R.D. Ehrlich, M. Liepe, J. Sears, E.N. Smith (CLASSE)

Broadband RF absorbing materials are frequently utilized in particle accelerator environments. There are stringent requirements placed on some of these absorbers in regard to vacuum compatibility, radiation compatibility, and particulate generation, especially for absorbers in close proximity to the beamline such as in some higher order mode (HOM) load designs. For RF absorbers located directly on the beamline, their DC conductivity must also be large enough to drain away static charge that may be deposited onto them, since such static charge could deflect the particle beam. Ceramics and ferrite materials have often been used for such RF absorbers, and SRF applications tend to extended their use to cryogenic temperatures. Unfortunately, the DC conductivity of these materials often drops precipitously with temperature and they become excellent insulators at cryogenic temperatures. The results of recent DC conductivity tests of several of these RF absorbing materials will be presented.

THPPO036

Carbon Nanotube RF Absorbing Materials

Q. Huang, T.B. Holland, A.K. Mukherjee (UCD) E.P. Chojnacki, M. Liepe, M. Malloy (CLASSE)

There are limited choices available for broadband RF absorbing materials compatible with particle accelerator beamline environments, such as for use in higher order mode (HOM) loads. Ceramics and ferrites that have the vacuum, radiation, and particulate compatibility tend to have strong RF absorption over only a decade of frequency once above 1 GHz. Further, their properties often change considerably at cryogenic temperatures for SRF applications. Mixing carbon nanotubes (CNT's) into a resin matrix has recently shown promise for providing a broader band of RF absorption. Development work has begun for mixing CNT's into a ceramic matrix for compatibility with cryogenic accelerator beamlines. The status of the material development and tests will be presented.

THPPO037

TiN Coating of RF Power Components for the European XFEL

A. Brinkmann, M. Lengkeit (DESY) J.A. Lorkiewicz (INFN-Roma II)

Thin TiN layers on surfaces of RF components have the ability to reduce secondary electron emission and multipactor effects. A new equipment was designed and built for mass production at DESY to generate TiN films by depostion of Ti vapor in low pressure ammonia ambience. This new setup was already transferred to industry for the XFEL RF coupler fabrication. The technical layout of the apparatus and results of REM/EDX surface analysis will be presented.

THPPO038

The RF-Power-Conditioning-System for the FLASH RF Main Couplers

A. Goessel, Th. Buettner, G. Grygiel, C. Mueller (DESY)

The main RF-Couplers for 1.3GHz TESLA-Type cavities in the FLASH linac need to go through several preparation and processing steps. The RF processing is usually done on coupler test stands (2 couplers pairwise), on a single coupler together with a superconducting cavity in the horizontal cavity test stand, on the module test stand (up to 8 cavities) or finally in FLASH. In FLASH one or more modules are connected to one klystron and are conditioned together. Therefore

the software was forked several times and merged during the last FLASH shutdown to one version, which is flexible enough to handle all these different test setups, without additional programming for IO hardware or the data handling. The system is based on LabView, DOOCS and Linux operating system. The working principle is shown, including a possible outlook for the XFEL cavity production and operation.

Development of a Remote-Controlled Coupler-Interlock for the XFEL Accelerator Module Test Facility (AMTF)

S. Kotthoff, A. Goessel, C. Mueller (DESY)

For the series production of XFEL cryo modules, it is planned to test all complete modules prior the installation in the XFEL tunnel. For the test stands in the Accelerator Module Test Facility (AMTF), we have developed a new technical interlock. The interlock allows the observation of 8 individual analog signals per device (like temperature, pressure, light, free electrons) and can be fully remote controlled. Each channel has its own upper and lower remote controlled thresholds. The channels will be customized with sensor specific module cards, which adapt the power needs and signal conditioning to the specifications of the different sensors. The local display is used as user interface and the little space requirement makes the device quit suitable. An overview of functionality, internal features, connectivity and extendability of the device is given.

Updates on 1.3 GHz Cavity Weld to Helium Tank and Application of the FMS

A. Schmidt, G. Kreps, A. Matheisen, H. Weitkaemper (DESY)

Super conducting resonators are cooled by liquid helium. For the application in accelerator modules most superconducting resonators are equipped with individual helium containers. During the welding of the helium tank to the super conducting resonator special care has to be taken not to change the resonator specific data like acceleration gradient, resonance frequency and the cell to cell distribution of the accelerating field. At DESY a tank welding process and an in situ field profile control system on the basis of the bead pull field profile measurements (FMS) is set up. We report on the experiences and results of the welding procedures and the application of the FMS at DESY.

1.3 GHz RF Nb Cavity to Ti Helium Vessel TIG Welding Process at Fermilab

J. Grimm (Fermilab)

Fermilab has developed a TIG welding procedure that will attach a 9-cell 1.3GHz niobium cavity to a titanium helium vessel. These welds were designed to meet ASME Boiler & Pressure Vessel Codes, Division 1 and are full penetration welds. The cavities produced will be used in Japan's s^{-1} Global cryomodule, Fermilab's Project X cryomodules, International Linear Collider and the current Type IV Cryomodules (T4CM). Discussed in further detail will include: Setting up electron beam weld parameters for Ti transition rings for the cavities. On-going work with U.S. vendors to produce reliable helium vessels that pass mechanical inspections, vacuum requirements and X-rays. Tooling requirements for the assembly and alignment of the cavity to the helium vessel. Settings that are applied to the Glovebox environment to produce the best quality TIG welds. What test measurements are taken throughout the process to monitor the cavity for excessive cell deformation due to the heat loads from the welding, and results from HTS on the fist dressed cavity.

THPPO042

SRF Main Linac Cryomodule Design at Fermilab

D.V. Mitchell (Fermilab)

Fermilab, in conjunction with our colleagues at KEK, RRCAT, and BARC, is developing several main linac SRF cryomodules in support of Fermilab's Project X and the International Linear Collider. The Type IV Cryomodule (T4CM) will allow Fermilab to design, fabricate, and test our first cryomodule completed entirely in the USA. This cryomodule will also probe the stability question of mounting a magnet system under the center, fixed support post. Using the T4CM as the baseline, Fermilab and our Indian colleagues are developing a ``unified'' cryomodule for Project X which will allow for options to mount up to three magnets with either beta1 or beta.81 cavities. Fermilab has also supported the development of the s^{-1} Global cryomodule which will be built and tested at KEK. Fermilab's commitment is to deliver two fully dressed cavities and all supporting components. To accomplish these designs, modern CAD tools using parametric designs, 3-D visualization JT files, and collaboration tools have been implemented. With these designs, Fermilab has spearheaded the effort to work collaboratively using a common database; DESY's EDMS.

THPPO043

A Tuner for a 325 MHz SRF Spoke Cavity

Y.M. Pischalnikov, E. Borissov, T.N. Khabiboulline, L. Ristori, W. Schappert (Fermilab)

Fermilab is developing 325 MHz SRF spoke cavities for the proposed High Intensity Neutrino Source. A compact fast/slow tuner has been developed to control Lorentz force detuning and compensate for liquid He pressure fluctuations. The design of a fast/slow tuner and a summary of results from warm tests of the tuner will be presented.

THPPO044

Tests of a Coaxial Blade Tuner at HTS/FNAL

Y.M. Pischalnikov, W. Schappert (Fermilab) A. Bosotti, C. Pagani, R. Paparella (INFN/LASA)

Fermilab is building Cryomodule 2 for the ILCTA facility in NML. A coaxial blade tuner has been chosen for the CM2 1.3GHz SRF cavities. A summary of results from cold tests of the tuner in the Fermilab Horizontal Test Stand will be presented.

THPPO045

High Stability CW IOT Transmitter for ERL and FEL Linacs

W. Anders, S. Klauke (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II) H.-G. Hoberg, G. Mielczarek, T. Westphal (BESSY GmbH)

Most proposals of fourth generation light sources are based on cw operated sc liancs used in a FEL or ERL. The required RF power is strongly amplitude modulated due to the fact, that microphonics in the sc cavities plays an importand role. The requirements for the stability of the RF field in the cavities are better than 0.1 deg phase and better than 0.1% amplitude. At the HZB a modular RF transmitter was developed with FUG, that can be used for IOT tubes for different power levels and frequencies. Special attention was taken to the stability in the case of AM modulation.

Warm Test of a Modified TTF-III Input Coupler up to 10 kW CW RF-power

O. Kugeler, W. Anders, A. Frahm, S. Klauke, J. Knobloch, A. Neumann, M. Rohloff, M. Schuster (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Elektronen-Speicherring BESSY II)

The TTF-III input coupler was designed for pulsed operation at average power levels up to 5 kW. For CW-applications, higher power levels are desirable. Previous investigations have identified the connection between 4K and 78K section as the bottleneck for maximum usable power level. We have modified this section of the coupler by including a gas cooling. This setup was tested in a coupler-test-stand at room temperature. We have achieved stable operation at power levels up to 10kW which is sufficient for the field levels that are to be reached in the BerlinPro ERL. The results can be regarded as a worst case scenario, since the heat conductivity of all involved materials is rising significantly upon cooling to operating temperatures.

Development of Input Power Coupler for ERL Main Linac in Japan

H. Sakai, T. Furuya, S. Sakanaka, T. Takahashi, K. Umemori (KEK) A. Ishii, N. Nakamura, K. Shinoe (ISSP/SRL) M. Sawamura (JAEA/ERL)

We started to develop an input coupler for a 1.3GHz ERL superconducting cavity. Required input power is about 20kW for the cavity acceleration field of 20MV/m and the beam current of 100 mA in energy recovery operation. The input coupler is designed based on the STF-BL input coupler and some modifications are applied to the design for the CW 20kW power operation. We fabricated input coupler components such as ceramic windows and bellows and carried out the high-power test of the components by using a 30kW IOT power source and a test stand constructed for the high-power test. In this report, we mainly describe the design strategy of the input coupler for the 1.3GHz CW superconducting cavity and results of the high-power test of ceramic window and bellows.

The Baseband Low Level RF Control for the S-DALINAC: A Flexible Solution for Other Frequencies?

R. Eichhorn, A. Araz, U. Bonnes, F. Hug, M. Konrad (TU Darmstadt) R. Stassen (FZJ)

The low level RF system for the S-DALINAC was developed 20 years ago and is still in operation. The RF-board converts the 3 GHz signals down to the baseband while the IF-board houses the special analogue control algorithm to control the 20-cell cavities. Both modules were redesigned, built and tested. The modulator and demodulator on the RF-board can be easily changed. Thus cavities operating at frequencies other than the S-DALINAC 3 GHz can be controlled with only minor modifications. A 6 GHz version, needed for a harmonic bunching system at the S-DALINAC and a 324 MHz solution to be used on a room temperature cavity at GSI will be presented. The IF-board is now based on a FPGA. In a first step the old control algorithm was successfully implemented in the FPGA and was already used together with the new RF-board as 1 to 1 copy of the old control system with some improvements. First results gained during the operation on a superconducting cavity will be presented. The flexibility of the FPGA allows now the implementation of optimized new algorithm.

THPPO049

A Fully Automated Device For Checking XFEL Piezo-Tuner Installation

A. Bosotti, R. Paparella (INFN/LASA) C. Albrecht, K. Jensch, L. Lilje (DESY)

The tuning system for XFEL SRF cavities is a device based on a double lever driven by a stepping motor with a gear box and a screw-nut system. The cavity is stretched by the tuner thus changing its resonant frequency. The tuner is also provided with fast tuning capability by means of two piezoceramic actuators, that compensate for cavity deformations that are responsible of frequency detuning. During industrial phase is mandatory to ensure a correct tuner assembling both for mechanical parts and actuators. This is provided by an automated device able to check the correctness of piezo-tuner installation on the cold mass string first and after installation in the cryostat, with very simple mounting requirements for the Module Assembling Team. In this paper this device is fully described, and first results on prototypes are shown together with its operation strategy.

THPPO050

Development of ERL HOM Absorber

M. Sawamura (JAEA/ERL) T. Furuya, H. Sakai, K. Umemori (KEK) K. Shinoe (ISSP/SRL)

HOM absorbers are one of the key components to determine the ERL cavity performance to reduce the HOM problem for the high current operation. When a beam line HOM damper is installed inside the cryomodule, the HOM damper is cooled down to liquid nitrogen temperature. The RF absorber used for the HOM damper is required to have good frequency and temperature properties. Some ferrites and ceramics are tested for permittivity and permeability of frequency-dependence and temperature-dependence measured with a GM refrigerator from room temperature to 40 K. The HOM damper is designed by optimizing the parameters such as length, thickness and position with microwave simulation codes. Test models of the HOM damper are being designed and fabricated to test the RF, mechanical, cooling and temperature properties.

THPPO051

Simple Multichannel Phase Supervising Circuit at ELBE

M. Kuntzsch, H. Buettig, P. Michel, R. Schurig, G.S. Staats (FZD)

For good operating the ELBE linear accelerator it is essential to have RF signals with high phase stability and purity on all cavities and buncher RF signals. Therefore a large number of low level RF control loops are used. But sometimes problems with these circuits occur. For further investigations a multichannel phase supervising device is required to have knowledge of phase noise and long term drifts. The circuit under development at ELBE allows the simultaneous phase measurement of up to 32 signals of 1.3 GHz (accelerator), 260 MHz (buncher) or 13 MHz (gun) frequency with 2 deg accuracy. Using an additionally 1.3 GHz PLL locked to the 13 MHz master oscillator (OCXO) of the machine as reference the phase measurement device is completely independent from the circuits used in the accelerator low level RF. Under normal conditions a programmable logic controller (SIMATIC) is used for data acquisition. This leads to approx. 5 measurements per second for all channels. But the measurement device is much faster, feeding the signals to a National Instruments PXI-6115 12-Bit, 10 MS/s/channel multifunction DAQ card enables also microphonic and phase noise measurements up to 10 kHz.

ILC Crab Cavity Vertical Test Results

C.D. Beard, P. Goudket (STFC/DL/ASTeC) P. K. Ambattu, G. Burt, A.C. Dexter, M.I. Tahir (Cockcroft Institute, Lancaster University)

A superconducting RF vertical test facility (VTF) has been constructed at Daresbury Laboratory to eneable the commisioning of a ILC Crab Cavity LLRF Control System. Two Single Cell 3.9 GHz dipole mode cavities are tested simulataneously to enable the evaluation of the LLRF control system. Carefull tuning of the cavities for frequency and external Q to enable a low noise oscillator to be utilised. Several tests have been performed throughout the past 12 months, each test enabling a much improved system performance. The system is described, and the latest performance of the system is presented.

Instrumentation and Control System for DICC

S.M. Pattalwar, R. Bate (STFC/DL/ASTeC) G. Cox, A. Oates (STFC/DL)

ALICE is a prototype ERL accelerator that is being developed at STFC Daresbury laboratory UK. Recently it has successfully demonstrated the energy recovery technique by accelerating an electron beam to more than 20 MeV. A new superconducting linac cryomodule is being developed for the operation in CW mode with high average beam current. ALICE will be used as a test bed for this new cryomodule, which will utilise cold helium gas to cool the radiation shield, HOM absorbers and the thermal intercepts for the high power RF input couplers as apposed to liquid nitrogen. The additional cooling power required at 80 K and 5 K will be provided by COOL-IT (a system for cooling to intermediate temperatures). All these modifications would require new instrumentation for diagnostics and control of the additional cryogenic processes, which will be integrated with the existing Linde cryogenic control system for ALICE. In this paper we present the additional instrumentation requirement with associated integration scheme in detail.

Solid State Amplifiers for Linear Accelerators at TRIUMF

A.K. Mitra, K. Fong, R.E. Laxdal, J. Lu, R.W. Shanks, Q. Zheng, V. Zvyagintsev (TRIUMF)

Solid state amplifiers are being used for linear accelerators at TRIUMF which are either being upgraded or under development. The Radioactive Ion Beam (RIB) facility at ISAC II which is being upgraded with additional 20 quarter wave superconducting bulk niobium cavities will employ twenty 141 MHz solid state amplifiers. A 650 MHz solid state amplifier for electron gun development and an 1.3 GHz solid state amplifier for characterization of an elliptical superconducting niobium cavity are being used for the 50 MeV electron linac being planned at TRIUMF.

Pressure Safety of JLAB 12GeV Upgrade Project Cryomodule

G. Cheng (JLAB) E. Daly (ITER)

This paper reviews pressure safety considerations, per the US Department of Energy 10CFR851 Final Rule, that are being implemented during construction of the 100 Megavolt Cryomodule (C100 CM) for Jefferson Lab's 12 GeV Upgrade Project. The C100 CM contains several essential subsystems that require pressure safety measures: piping in the supply and return end cans, piping in the thermal shield and the helium headers, the helium vessel assembly that includes high

RRR niobium cavities, the end cans, and the vacuum vessel. Due to the vessel sizes and pressure ranges, applicable national consensus code rules are applied. When national consensus codes are not applicable, equivalent design and fabrication approaches are identified and implemented. Considerations for design, material qualification, fabrication as well as inspection and examination are summarized. In addition, JLAB's methodologies for implementation of the 10 CFR 851 requirements are described.

THPPO056

High Power RF Tests on WR650 Pre-stressed Planar Windows

M. Stirbet, G.K. Davis, T.S. Elliott, L.K. King, T. Powers, R.A. Rimmer, R.L. Walker (JLAB)

A new planar, ceramic window intended to be used with WR650 waveguide fundamental power couplers at 1300 MHz or 1500 MHz has been developed. It is based on the pre-stressed planar window concept tested in PEP II and LEDA. A test stand that made use of the 100kW CW 1500 MHz RF system in the JLAB FEL was commissioned and used to apply up to 80 kW traveling wave (TW)to the windows. Two different types of RF windows (brazed and diffusion bonded ceramics) with design specification of 50 kW CW in TW mode were successfully tested both as a gas barrier (intended to operate up to 2 psi) and as a vacuum barrier. The vacuum windows were able to maintain UHV quality vacuum and were successfully operated in the 10^{-9} mbar range. An overview of the pre-stressed power windows, RF test stand, procedures and RF power testing results will be presented.

THPPO057

Update on Coaxial Coupling Scheme for ILC-Type Cavities

P. Kneisel (JLAB) J.K. Sekutowicz (DESY)

We have in the past reported about our efforts to develop a flangeable coaxial coupler for both HOM and fundamental coupling for 9-cell ILC-type cavities. The design of the coupler was done in a way, that the rf magnetic fields at the flange connection were minimized and only a field of <5 mT would be present for a magnetic field of 160 mT (Eacc ~ 35 MV/m) in the cavity. Even though we achieved reasonably high Q-values at low field, the cavity/coupler combination was limited to only ~ 7 MV/m in the cavity, where a thermally initiated degradation occurred. We believed that this limitation was caused by poor cooling of the shorting plate in the coaxial coupler; therefore, we have improved the cooling conditions by drilling radial cooling channels into the shorting plate. This paper reports about our experiences with the modified conditions.

THPPO058

Performance of 3-Cell Seamless Niobium Cavities

P. Kneisel, G. Ciovati (JLAB) I. Jelezov, W. Singer, X. Singer (DESY)

Performance of 3-Cell Seamless Niobium Cavities P. Kneisel, G.Ciovati, Jefferson Lab and X.Singer, W.Singer,,I. Jelezov, DESY In the last several months we have surface treated and cryogenically tested three TESLA-type 3-cell cavities, which had been manufactured at DESY as seamless assemblies by hydroforming. The cavities were completed at JLab with beam tube/flange assemblies. All three cavities performed very well after they had been post-purified with titanium at 1250C for 3 hrs. The cavities, two of which consisted of an end cell and 2 center cells and one was a center cell assembly, achieved gradients of Eacc = 32 MV/m, 34 MV/m and 35 MV/m without quenches. The performance was limited by the appearance of the ``Q-drop'' in the absence of field emission. This contribution reports about the various measurements undertaken with these cavities.

Improving Gradient and Q Performance of BCP Etched Cavities by Applying a Light EP

R.L. Geng, S. Castagnola, A.C. Crawford, D. Forehand, B.A. Golden, C.E. Reece, S. Williams (JLAB)

We have EP processed several multi-cell cavities previously heavy BCP etched. With a surprisingly light EP removal of less than 50 micron, all cavities have shown significant gradient and Q improvement. So far three cavities including two fine-grain niobium 7-cell CEBAF upgrade prototype cavities and one large-grain niobium 9-cell ILC cavities have been treated and tested. Both 7-cell cavities reached a quench limit without field emission. Another 7-cell cavity has been treated and is under RF test. We give a summary of the test results.

Evaluation of the Diffusion Coefficient of the Fluorine Ion during the Niobium Electropolishing of Superconducting Radio Frequency Cavities

H. Tian, C.E. Reece (JLAB)

Future accelerators, such as the envisioned international linear collider (ILC), require unprecedented cavity performance, which is strongly influenced by interior surface nano-smoothness. Electropolishing (EP) is the technique of choice to being developed for high–field SRF cavities. Previous study shows that the EP mechanism of Nb in 1:9 volume ratio of H2SO4/HF acid electrolyte proceeds by formation and dissolution of a compact salt film under F- diffusion-limited mass transport control*. We pursue an improved understanding of the microscopic conditions required for optimum surface leveling. The temperature-dependent viscosity of the standard electrolyte has been measured and, using a rotating Nb disk electrode, the diffusion coefficient of F- was measured at a variety of temperatures from 0C to 50C. In addition, data indicates that above 25C electrode kinetics becoming competitive with the mass transfer current limitation and increase dramatically with temperature. These findings are expected to guide the optimization of EP process parameters for achieving controlled, reproducible and uniform nano-smooth surface finishing for SRF cavities.
*H. Tian, S. G. Corcoran, C. E. Reece, M. J. Kelley, Journal of the Electrochemical Society, v 155, n 9, Sept. 2008, p 563-8

Exploration and Comparison of Hydrodynamic and Thermal Properties of Horizontal and Vertical Electropolishing Configurations with Various Boundary Conditions

C.E. Reece (JLAB)

Extending efforts reported at SRF2007, a model of the thermal and hydrodynamic flow conditions internal to an electropolishing niobium cavity has been developed using the commercial code CFDesign®. Building upon parametric studies with small niobium samples that highlighted the process sensitivity to local temperature and fluid flow conditions, we seek to gain predictive insight into processing methods which assure uniform controlled polishing – in both the traditional rotating horizontal configuration as well as the potentially more convenient vertical orientation. For present modeling runs, the temperature-dependent viscosity of the standard HF/H2SO4 electrolyte has been included. For the horizontal configuration, we have modeled the recent JLab-adopted reduced temperature and flow conditions used for ILC cavity processing and find improved thermal control and uniformity. For vertical EP, the amplitude and pattern of nominally steady-state internal convective flow under conditions of external wall cooling and no electrolyte circulation has been observed for both single-cell and 9-cell cavities. Opportunities for modeling an integrated next-generation system are being explored.

THPPO062

A Study of the Effectiveness of Particulate Cleaning Protocols on Intentionally Contaminated Niobium Surfaces

C.E. Reece, E. Ciancio, K.A. Keyes, D. Yang (JLAB)

Particulate contamination on the surface of SRF cavities limits their performance via the enhanced generation of field-emitted electrons. Considerable efforts are expended to actively clean and avoid such contamination on niobium surfaces. The protocols in active use have been developed via feedback from cavity testing. This approach has the risk of over-conservatively ratcheting an ever increasing complexity of methods tied to particular circumstances. A complementary and perhaps helpful approach is to quantitatively assess the effectiveness of candidate methods at removing intentional representative particulate contamination. Toward this end, we developed a standardized contamination protocol using water suspensions of Nb2O5 and SS 316 powders applied to BCP'd surfaces of standardized niobium samples yielding particle densities of order 200 particles/mm2. From these starting conditions, controlled application of high pressure water rinse, ultrasonic cleaning, or CO2 snow jet cleaning was applied and the resulting surfaces examined via SEM/scanning EDS with particle recognition software. Results of initial parametric variations of each will be reported.

THPPO063

Plasma Treatment of Bulk Niobium Surface for SRF Cavities - Optimization of the Experimental Conditions on Flat Samples

M. Raskovic, S. Popovic, J. Upadhyay, L. Vuskovic (ODU) H.L. Phillips, A-M. Valente-Feliciano (JLAB)

Accelerator performance, in particular the average accelerating field and the cavity quality factor, depends on the physical and chemical characteristics of the superconducting radio-frequency (SRF) cavity surface. Plasma based surface modification provides an excellent opportunity to eliminate non-superconductive pollutants in the penetration depth region and to remove mechanically damaged surface layer improving surface roughness. Here we show that plasma treatment of bulk Nb presents surface preparation method alternative to the commonly used BCP and EP methods. We have optimized the experimental conditions in the microwave glow discharge system and their influence on the Nb removal rate on the flat samples. We have achieved etching rates of 1.5 micro-m/min using only 3% Cl2 in the reactive mixture. Combining fast etching step with the moderate one, we have improved a surface roughness without exposing fresh sample surface to the environment. We will apply optimized experimental conditions to single cell cavities, in pursuing improvement of their RF performance.

THPPO064

Surface Treatments of Niobium by Buffered Electropolishing

A.T. Wu (JLAB)

Buffered electropolishing (BEP) is a Nb surface treatment technique developed at Jefferson Lab1. Experimental results obtained from flat Nb samples show2-4 that BEP can produce a surface finish much smoother than that produced by the conventional electropolishing (EP), while Nb removal rate can be as high as 4.67 μm/min. This new technique has been applied to the treatments of Nb SRF single cell cavity employing a vertical polishing system5 constructed at JLab as well as a horizontal polishing system at CEA Saclay. Preliminary results show that the accelerating gradient can reach 32 MV/m for a large grain cavity and 26.7 MV/m for a regular grain cavity. In this presentation, the latest progresses from the international collaboration between Peking University, CEA Saclay, and JLab on BEP will be summarized.

Significant Reduction in Field Emission on Niobium Surfaces after GCIB Treatments

THPPO065

A.T. Wu (JLAB)

Field emission is one of the major obstacles for achieving constantly high accelerating gradient for Nb superconducting radio frequency (SRF) cavities, although various techniques and procedures have been adopted trying to keep the inner surfaces of Nb SRF cavities clean and free from field emission in the past a couple of decades. In this report, it is shown that significant reductions in field emission on Nb surfaces can be achieved by means of a new surface treatment technique called gas cluster ion beam (GCIB). When a relevant treatment agent is selected with optimal treating parameters, it is demonstrated a reduction in field emission as much as 87.5% is possible through measurements using a home-made scanning field emission microscope. Possible mechanism regarding the suppression of field emission on Nb surfaces by GCIB treatments will be discussed.

Electropolishing at ANL/FNAL

THPPO066

M.P. Kelly, S.M. Gerbick (ANL) D.J. Bice, G. Wu (Fermilab)

A system for electropolishing of 1.3 GHz elliptical single- and nine-cell cavities is in operation at the joint ANL/FNAL cavity processing facility located at Argonne. The system is one peice of a larger 200 m2 complete single cavity processing and assembly facility which also includes clean rooms and high-pressure rinsing. Recently, the electropolishing system has been used to process a series of single and nine-cell cavities. For single cell cavities a good set of EP parameters has been demonstrated based on more than a half dozen complete processing and cold test cycles at ANL/FNAL. The lastest six single cell cavities each exceed EACC=35 MV/m and, at this gradient, have Q in the range $6x10^9$ - $1x10^{10}$. The first nine cell cavities electropolished at ANL have not yet reached similar fields (~23 MV/m-26 MV/m) and ongoing activities are focussed on demonstrating >30 MV/m in these cavities. Suitable nine cell EP parameters using the ANL/FNAL EP system including acid/water temperatures, flow rates, current, voltage, air flow etc. are all substantially different than for single-cell cavities and are discussed here.

Dumbbell Fabrication and Tuning of the IHEP Large Grain 9-Cell Cavity

THPPO067

J.Y. Zhai, J. Gao, J. Gu, Z.Q. Li, J. Yu, J.R. Zhang (IHEP Beijing) T.X. Zhao (TIPC)

As the key component of the ``IHEP 1.3 GHz SCRF Accelerating Unit and Horizontal Test Stand Project'', a low-loss shape bare tube 9-cell cavity using Ningxia large grain niobium is being fabricated at IHEP. This paper presents the fabrication procedure and frequency tuning method of the dumbbells of this cavity. Due to the special properties of the large grain material, several mechanical and RF problems were found and successfully solved. After equator welding, this cavity will be surface treated and tested late this year.

Electro-Chemical Comparisons between BEP and Standard EP of Niobium

THPPO068

F. Eozénou, S. Berry, J.-P. Charrier, Y. Gasser (CEA) A.T. Wu (JLAB)

Buffered Electrochemical Polishing (abbreviated as BEP) is a process developed at JLAB. It was shown that BEP can produce the smoothest niobium surface ever reported [*,**] with a very fast removal rate. Some encouraging results after BEP on single-cell cavities treated by a vertical set-up have also been reported [***]. Complementary experiments on flat Nb

samples have been carried out at CEA Saclay with a rotating disc electrode. Electrochemical Impedance Spectroscopy measurements were also performed. Experimental results obtained on BEP were compared with those achieved with the standard EP [****]. Differences in terms of fluorine diffusion and of surface film resistance between BEP and EP have been put forward. Studies are on going to understand if some poor RF test results obtained after BEP with a horizontal set-up as well as with a vertical one [***] are due to the modified electro-chemical mechanisms or the decreased quality of commercial electrolyte used.

*A.T. Wu et al, Applied Surface Science,253(2007)3041

**S. Jin et al, Proc. of 13th SRF Workshop SRF(2007)

***A.T. Wu et al, Proc. of PAC 2009, Vancouver(2009)

****F. Eozénou et al,This conference

THPPO069

More Information Concerning Electro-Polishing Mechanisms of Niobium in Hydrofluoric-Sulphuric Acid Mixtures

F. Eozénou, S. Berry, J.-P. Charrier, Y. Gasser (CEA)

The use of a rotating disc electrode for electrochemical measurements gives precious information concerning mass transport of species. Measurements were performed with a rotating niobium flat sample in HF-H2SO4 media. Intensity is found as a linear function of the square root of the rotation speed ω which is the signature of an electro-polishing (EP) controlled by the diffusion of the fluorine ion. The value of the related diffusion coefficient D has been estimated and D is in agreement with magnitudes reported for ionic species in different EP systems. D has also been found lower in aged mixtures. Electrochemical Impedance Spectroscopy measurements were also performed with a rotating disc electrode. Both voltamperemetric and also EIS measurements [*] prove the central role of fluorine during EP and show that EP mechanisms are modified with the aging of the bath. These criterions can be used to evaluate the quality of acids and to improve the life time of EP mixtures. However, a high fluorine content in niobium could be the origin of decreased performances noticed on single-cell cavities after EP, using modified parameters.

* F. Eozénou et al, CARE-Report-2008-022-SRF

THPPO070

Low-Voltage Electro-Polishing of SRF Cavities

F. Eozénou, C.Z. Antoine, S. Berry, J.-P. Charrier, Y. Gasser (CEA)
D. Reschke (DESY)

First promising results concerning Electro-Polishing at lower voltage of 5V (abbreviated as LV-EP) has previously been reported [*,**]. This effort is being pursued and a 1-cell Tesla Shape 1.3 GHz cavity has been dedicated to LV-EP and has reached improved gradient exceeding 39MV/m. Furthermore, a second cavity has alternately been electro-polished at 5V and 17V. It did not encounter any decrease in performance after LV-EP. This process is then especially promising for the treatment of large cavities for proton applications. Moreover, long-time EP experiments on niobium flat samples show that high-voltage EP is more likely to generate impurities in the EP mixture that might contaminate cavities. Some results will also be presented concerning efficient field emission removal by chloroform rinsing of 1-cell cavities.

* F. Eozénou et al, Proc. of 13th workshop on SRF, China, (2007) TUP80

** F. Eozénou et al, CARE-Report-2008-022-SRF

Development and Design of a RF-Measurement Machine for the European XFEL Cavity Fabrication

J. Iversen, Th. Buettner, A. Goessel, D. Klinke, G. Kreps, C. Mueller (DESY)

Radio frequency measurements on parts and subassemblies of superconducting cavities during its fabrication are a proper method of quality management and quality assurance. During the fabrication of 1.3 GHz cavities for FLASH, a simple device was used for measuring the half cells, dumb bells and endgroups. Because of the long test duration the device is not applicable for massproduction of 800 cavities. A semiautomated RF measurement machine was designed and built. This machine performs an easy load of the parts, consistent RF contacts, automated RF measurements and documentation. We describe the functionality of the RF-measurement machine and performance of the prototype during fabrication of 40 cavities for FLASH.

Experiences on Improved Cavity Preparation Cycles with a Vision on Industrialization of the Cavity Preparation

B. van der Horst, A. Matheisen, B. Petersen, A. Schmidt, M. Schmoekel, H. Weitkaemper (DESY)

Within the last decade the production and preparation of super conducting resonators became more and more stable at DESY. Two may stream cycles for the final surface preparation, the final surface removal by electro polishing (EP) and the final surface removal by a short buffered chemical polishing (BCP flash)are the baseline of cavity surface preparation at DESY. Basing on this positive development overtime and an industrialization of the processes a proposal for a reduced number of work steps was presented on the SRF 2007 workshop in Beijing. The proposed preparation line were applied two times fifteen resonators, origin from two different cavity suppliers. In addition two industrialized electro polishing facilities were started-up and served for the main surface removal by electro polishing. We present the experiences gained during this test cycle.

A New High Pressure Rinsing System Established at DESY

A. Matheisen, R. Bandelmann, K. Escherich, N. Krupka, H. Morales Zimmermann (DESY)

In 2007 a new of High Pressure Rinsing system was developed at DESY and is operational since 2008. Beside implementations of improvements on high pressure rinsing systems lay out, one goal of the design is to set up a prototype high pressure rinsing stand applicable in industry and in an industrial production line. After commissioning, the new high pressure rinsing stand became a standard hardware in use for the cavity preparation processes at DESY. We report on design specialties and experiences gained so far in more than 300 rinsing processes of about 2 hours length.

THPPO074

Mechanical Design of Automatic Cavity Tuning Machines

J.H. Thie, A. Goessel, J. Iversen, D. Klinke, G. Kreps, W.-D. Moeller, C. Mueller, D. Proch (DESY) R.H. Carcagno, T.N. Khabiboulline, S. Kotelnikov, A. Makulski, R. Nehring, J.M. Nogiec, M.C. Ross, W. Schappert (Fermilab)

A semi-automatic cavity tuning machine is used at DESY since 15 years to tune the field flatness and concentricity of the TESLA shape 9 cell cavities for FLASH. Based on this experience a further development work was done in a collaboration effort among FNAL, DESY and KEK to support the high throughput cavity fabrication necessary for the European XFEL and other SRF based future projects. Two of the four machines will be delivered to and operated by the cavity vendors for the tuning of the XFEL cavities. We describe the mechanical design and functionality of these machines and discuss the safety aspects for the operation at the industry.

THPPO075

The HIE-ISOLDE Superconducting Cavities: Surface Treatment and Niobium Thin Film Coating

G. Lanza, S. Calatroni, L.M.A. Ferreira, A.E. Gustafsson, M. Lindroos, M. Pasini, T. Trilhe (CERN) V. Palmieri (INFN/LNL)

CERN has designed and prepared new facilities for the surface treatment and niobium sputter coating of the HIE-ISOLDE superconducting cavities. We describe here the design choices, as well as the results of the first surface treatments and test coatings.

THPPO076

Recent Developments in Electropolishing and Tumbling R&D at Fermilab

C.A. Cooper, J.S. Brandt, M. Ge, E.R. Harms, T.N. Khabiboulline (Fermilab) C. Boffo (BNG)

Fermi National Accelerator Lab is continuing to improve its infrastructure for research and development on the processing of superconducting radio frequency cavities. A single cell 3.9 GHz electropolishing tool built at Fermilab and operated at an industrial partner was recently commissioned. The EP tool was used to produce a single cell 3.9 GHz cavity that reached an accelerating gradient of 30 MV/m with a quality factor of $5x10^9$. A single cell 1.3 GHz cavity was also electropolished at the same industrial vendor using the vendor's vertical full-immersion technique. On their first and only attempt the vendor produced a single cell 1.3 GHz cavity that reached 30 MV/m with a quality factor of $1x10^{10}$. These results will be detailed along with preliminary tumbling results.

THPPO077

Alternative Cavity Cleaning Method

C.A. Cooper (Fermilab) A.T. Wu (JLAB)

As particle accelerating cavities reach new gradient limits the need for a reliable method to clean the inter surface of the cavities prior to assembly has become apparent. The standard way to clean the cavities is by ultrasonic rinsing, often with some type of solvent or surfactant, followed by a high pressure rinse with ultrapure water. The installed and operating cost of these systems typically prohibits sufficient redundancy and said systems are prone to contamination from pump failures or bacterial growth. The work presented here will show preliminary results on an alternative method for cleaning and protecting the surface of niobium samples using a polymeric thin film. The polymer is solvated so that

it can be applied with a brush or be sprayed on. The solvent then evaporates at standard temperature and pressure leaving behind a thin film that has enough strength to be peeled off.

Progress in Laser Re-melting of Cavity Defects

M. Ge, L. Cooley, T.H. Nicol, J. Ruan, G. Wu (Fermilab)

Weld pits and other large (>100 μm) defects in SRF cavities severely limit performance and may be the chief limitation in 1.3 GHz cavities with gradients below 20 MV/m. Remediation of defects by remelting has been proposed as a viable option. We are developing a new system, which allows re-melting the defects by laser pulses. Molten areas as large as about 1 mm diameter were produced, which can cover most defects observed in cavities. Using this system, a region with a 120 μm deep pit was reduced to a much flatter topology with a vertical range of 14 μm. Techniques to apply the beam inside a single-cell cavity have been developed, and we hope to report improvement of cavity performance after laser processing.

ILC and 3rd Harmonic Cavities RF QC at FNAL

T.N. Khabiboulline (Fermilab)

At FNAL we finished production of one cryomodule consist of four accelerating 3.9GHz cavities. Also ILC cryomodule #2 is under production. RF measurements and tuning procedures for 1.3 GHz and 3.9 GHz elliptical cavities during and after production are reported. HOM notch frequency measurements and calculations are described. Cavity cells electrical center measurements technique based on bead pull in operating frequency is reported.

Microbiologically Influenced Corrosion in the ANL/FNAL Ultra Pure Water High Pressure Rinse System

A.M. Rowe, A.M. Bastidos, D.J. Bice, C.A. Cooper, G. Wu (Fermilab)

Examination of a stainless steel end flange and Al-Mg vacuum seals following a high pressure rinse cycle on a 9-cell 1.3 GHz SRF cavity in the ANL/FNAL Superconducting Cavity Processing Facility, revealed a brownish spotted residue and dark organic flaky film on the flange and seals respectively. After an exhaustive examination of all ultra pure water distribution and high pressure rinse system components, microbiologically influenced corrosion in 316L stainless steel manifolds attached to the high pressure diaphragm pump was identified as the difficult to diagnose contamination source. Fourier transform infrared spectroscopy (FTIR) was used to identify the biological and corrosion byproduct contaminant retained in the 0.05 micron polysulphone final filter. A visual inspection of the manifolds using a borescope showed typical brown biomass nodules and brownish red patches near weld areas which confirmed the FTIR analysis.

Update on Quality Control of the Electro-Polishing Acid Mixture

C. Hartmann (Henkel)

Electro-polishing has become one of the leading surface preparation processes to reach high gradients in superconducting cavities. For industrialization and for reproducible results in the electro-polishing process a study on acid quality control and quality management was launched under the scope of the European investigations under the CARE. First

results of this acid management studies were presented at the TTC meeting 2006 and the JRI-SRF summary reports 2008. A second study with experimental results on the quality control methods proposed was launched where the different methods and instrumentations for acid quality control are studied in detail. We present the results of this following up investigations made on acid quality control for the electro-polishing mixture applied at DESY.

THPPO082

S0 Tight Loop Studies on ICHIRO 9-Cell Cavities

F. Furuta (KEK)

We have continued high gradient R&D of ICHIRO 9-cell cavities at KEK. ICHIRO 9-cell cavity #5 (I9#5) that has no end groups on beam tube to focus on high gradient sent to Jlab as S0 tight loop study. Surface treatments and vertical test were repeated 3 times at Jlab, and then I9#5 sent back to KEK. We also repeated surface treatments and test at KEK. Maximum gradients were 36.5MV/m at Jlab, and 33.7MV/m at KEK so far. Now we are struggling with the puzzle why the results of singles do not work well on 9-cell cavities.

THPPO083

Field Flatness Degradation Problems and Cure

F. Furuta (KEK)

Field flatness of ICHIRO 9-cell cavities was often degraded <70% after vertical test though it was tuned >96% before surface preparations. In order to find which process degrades flatness, we checked it at each step between EP processes to vertical test. By improving cavity jig and jig fittings, degradation of flatness was prevented <1% during jig fittings, transportations, handlings, surface rinsing and vertical tests. EP processes still degrade flatness about 5%. To cure this, we tried pri-tuning again after EP processes, then rinsed and measured. Gradient reached 33.7MV/m. Flatness of 94% was kept during this measurement. This procedure seems have no problem for cavity performance. Flatness level of >96% is in hand now. We are investigating why EP processes degrade flatness and how to prevent it.

THPPO084

50MV/m Recipe for ICHIRO End Groups with Ethanol Rinsing and Wiping

F. Furuta (KEK)

ICHIRO end single cell cavities that have HOM coupler and high power RF input port on beam tube did not reach high gradient of >40MV/m with our high yield surface preparation recipe for center cell shape singles. Gradients were limited around 18-33MVm by field emissions. For the complicate structures like HOM coupler, sulfur contaminations produced during EP processes seem sticky and hard to remove only by degreasing and HPR. We tried ethanol rinsing which can dissolve sulfur after EP process. We also tried aggressive rinsing of wiping with degreaser to remove contaminations mechanically. End single cell cavity with HOM coupler reached 48MV/m so far by modified recipe that include ethanol rinsing and wiping.

R&D for the Post-EP Processes of Superconducting RF Cavity

T. Saeki, Y. Funahashi, H. Hayano, S. Kato, M. Nishiwaki, M. Sawabe., K. Ueno, K. Watanabe (KEK) R.L. Geng (JLAB)

The Electro-Polishing (EP) process is the best candidate of final surface treatment for the production of ILC cavities. Nevertheless, the broad distribution of the gradient caused by field emitters in cavities is sitll a serious problem for the EP process. A candidate source of field emitter is the sulfur component which is produced in the EP process and remains the inner-surface of cavities. We studied the effect of Ethanole- and degreaser-rinse processes after the EP process by a unique method. Moreover, we tried test the sponge cleaning as the post EP process to remove the field emitter inside the cavcity. This article describe the results of series tests of the post-EP process at KEK.

Study on the Electro-Polishing of Nb Sample with Artificial Pits

T. Saeki, H. Hayano (KEK) R.L. Geng (JLAB)

The Electro-polishing (EP) process is the best candidate of final surface-treatment for the production of ILC cavities. Nevertheless, the development of defects on the inner-surface of the Superconducting RF cavity during EP process has not been studied by experimental method. We made artificial pits on the surface of a Nb sample-plate and observed the development of the pits after each step of 30um-EP process where 120um was removed by EP in total. This article describes the results of this Nb sample EP-test with artificial pits.

Horizontal High Presser Water Rinsing for KEKB Superconducting Cavity

S. Mitsunobu, A. Kabe, Y. Morita, M. Nishiwaki, S. Takano (KEK)

Horizontal High Pressure Water Rinsing for KEKB Superconducting Cavity S.Takano, S.Mitsunobu, Y.Morita, M.Nishiwaki and A.Kabe KEK Usually, high pressure water rinsing of superconducting cavities are done at vertical position to vent water and dusts smoothly. The cavities are set horizontally afterward. KEKB cavities have some possibility dust contamination at online tunnel. Horizontal high pressure water rinsing (HHPR) has possibility to clean the cavities at on line. We have been tested HHPR using KEKB proto type SC cavity with 60 bar ultra pure water and aspirator pumping system. Even without any baking, a performance of the cavity cleaned with HHPR measured by a vertical test achieved to 10 MV/m similar to one of before HHPR.

Nb/SUS Joint of Helium Vessel Base Plate for SRF Cavity Dressing

K. Saito, F. Furuta (KEK)

Different material joint is a key issue for dressing of the SRF cavity. So far the baseline design of ILC is to use titanium Helium vessel, however, it will make very complicated procedure point of high vessel regulation code. If material is changed to SUS316L from niobium at the place close to cavity, the regulation control will be more relaxed. We have developed the joining method niobium and SUS316L applying HIP technology, and demonstrated to work in the STF program. The result will be presented in this paper.

THPPO089

PAL Commission Research on LL 9-Cell Cavity and Results

K. Saito, F. Furuta (KEK)

KEK has contracted a commission research from PAL on LL 9-cell cavity in 2007-2009. In this research program, we have fabricated a L-band 9-cell cavity with LL shape and made the S0 tight loop study. In this paper, the fabrication and the test result will be presented.

THPPO090

Sulfur Generation Mechanism During Electropolishing with Niobium Cavities

K. Saito, F. Furuta (KEK)

Electropolishing is well known to have surfer contamination on niobium cavities. So far many efforts have been done in order to remove the contamination in the SRF community: H2O2 rinsing, Degreasing and Ethanol rinsing so on. Nobody understands the surfer generation mechanism, however recently we have found it. By the understating, we have taken a cure for our EP and no surfer has happened by naked eye inspection. In this pare we will present about the surfer generation mechanism and the cure.

THPPO091

Evolution of the Defects on the Niobium Surface during BCP and EP Treatments.

P.M. Michelato, L. Monaco (INFN/LASA)

In the cavity production process some defects may appear on the niobium surface, after the chemical and/or electrochemical processes, mainly in the region close to the equatorial weld and in the HAZ (Heat Affected Zone). We have produced defects on the Nb surface, with geometrical characteristics similar to the defects that may be produced during the mechanical machining of the cavity cells. We have investigated the evolution of these defects, during the usual chemical and electrochemical surface preparation stages.

THPPO092

XFEL Third Harmonic Superconducting Cavity Prototypes: Fabrication and Processing Experience

P. Pierini, A. Bosotti, P.M. Michelato, L. Monaco, R. Paparella, D. Sertore (INFN/LASA) E. Vogel (DESY)

Three superconducting 3.9 GHz cavity prototypes have been fabricated for the XFEL linac injector, with minor modifications to the RF structures built by FNAL for the FLASH linac. This paper describes the production procedures and RF preparation experience, the chemical processing and the plans for the vertical tests at INFN Milano for the characterization of the structures.

THPPO093

Superconducting Twin Quarter Wave Resonator for Acceleration of Low Beta Heavy Ions.

H. Kabumoto, N. Ishizaki, M. Matsuda, Y. Otokawa, S. Takeuchi (JAEA)

We have designed and fabricated a superconducting twin-quarter-wave resonator (Twin-QWR) made of niobium and copper for the acceleration of low velocity heavy

ions. The resonator has two inner conductors and three acceleration gaps which give a resonant frequency of 129.8 MHz and an optimum beam velocity of 6 % of the light velocity. Each inner conductor resonates like in a coaxial quarter-wave line resonator. The resonator was designed to have a separatable structure so that we could treat the inner conductors part fully made of high purity niobium apart from the outer conductor made of niobium and copper. We obtained an acceleration field gradient of 5.8 MV/m at an RF power input of 4 W.

Prototyping And Vertical Test For PEFP Low-Beta Elliptical Cavity

H.S. Kim, Y.-S. Cho, H.-J. Kwon (KAERI) S. An (PAL)

A superconducting RF cavity with a geometrical beta of 0.42 and a resonant frequency of 700 MHz has been designed to accelerate a proton beam above 100 MeV for an extended program of Proton Engineering Frontier Project (PEFP). The designed cavity is an elliptical shape with 5 cells stiffened by double-ring structure. A design accelerating gradient is 8.0 MV/m at the operating temperature of 4.2 K and a maximum duty factor is 9 %. In order to confirm the fabrication procedure and check the RF and mechanical properties of the designed cavity, two niobium prototypes are under development. One is a two-cell cavity mainly for a quick prototyping with the surface treatment study and the other is a five-cell cavity. For vertical test of the niobium cavities, test equipment such as a cryostat, RF amplifier and LLRF control system is under preparation. The status of the niobium protype development and preliminary results for the vertical test will be presented in this paper.

Physical and Mechanical Metallurgy of High Purity Nb for Cavity Fabrication

T.R. Bieler, D.C. Baars (Michigan State University) C. Compton (NSCL) N.T. Wright ((MSU))

The process of fabricating a cavity requires many processing steps that alter the physical state, and hence, the functional properties of high purity Nb used for SRF cavities. Recent investigations suggest that the defect state arising from impurities and dislocation substructure may affect high field Q slope and maximum achievable field. To understand the potential sources of defect states that may limit cavity performance (e.g. hot spots), the physical and mechanical history of Nb manipulation used to fabricate a cavity is examined, focusing on processes that introduce or remove impurities and lattice defects: Upon solidification, ingots have large grains with considerable dislocation content, as these grains have orientation gradients of several degrees per mm. Extraction of work pieces allows introduction of H and O, which can be distributed beneath the surface with mechanical working and welding. Etching, final anneals, and baking cause recovery and recrystallization, which removes or reduces defect and impurity content in specific ways that depend upon the detailed history of deformation and temperature from the time of solidification to final tuning of the cavity.

Study of Fast Buffered Electropolishing on Niobium Sheet

S. Jin (PKU/IHIP)

As a part of research on the fabrication of 9 -cell niobium cavity, a polishing technology based on Buffered Electro-polishing (BEP) was carried on by Peking University. Compared with traditional electro-polishing, it has distinct advantages especially in the polishing rate and polishing effect. Through improvement, the maximum mass removal rate could reach 4.66μm/min in our experiments. It was over 10 times higher than the polishing rate of traditional EP. Meanwhile, the surface RMS roughness was about 20nm. At present, we are under the research to apply this new technology to a demountable cavity and have got preliminary results.

THPPO098

Assembly Preparations for the International ERL Cryomodule at Daresbury Laboratory

P.A. McIntosh, R. Bate, C.D. Beard, S.M. Pattalwar (STFC/DL/ASTeC) S.A. Belomestnykh, E.P. Chojnacki, P. Quigley, V. Veshcherevich (CLASSE) A. Buechner, P. Michel (FZD) M.A. Cordwell, J. Strachan (STFC/DL) J.N. Corlett, D. Li, S.M. Lidia (LBNL) M. Liepe, H. Padamsee, J. Sears, V.D. Shemelin (Cornell University) D. Proch, J.K. Sekutowicz (DESY) T.I. Smith (NPS)

The collaborative development of an optimised cavity/cryomodule solution for application on ERL facilities has now progressed to final assembly and testing of the cavity string components and their subsequent cryomodule integration. This paper outlines the testing and verification processes for the various cryomodule sub-components and details the methodology utilised for final cavity string integration. The paper also highlights the modifications required to integrate this new cryomodule into the existing ALICE cryo-plant facility at Daresbury Laboratory.

THPPO099

Multiparticle Beam Dynamics Simulations for the ESS-Bilbao Superconducting Proton Accelerator

F.J. Bermejo (Bilbao, Faculty of Science and Technology) I. Bustinduy (ESS Bilbao) V. Etxebarria (University of the Basque Country, Faculty of Science and Technology) J. Lucas (Elytt Energy)

The paper reports on the first multi-particle simulations for the proton linear accelerator as proposed by the European Spallation Source-Bilbao is here described. The new machine concept which compies with recommendations made at the ESS-Bilbao Worksop on "MW-Spallation Sources: Current Challenges and Future Prospects" held at Bilbao on March 16-18, 2009 profits from advances registered within the field of high power accelerators during the last decade. The design of such a new accelerator layout heavily relies upon the use of low-to-medium beta superconducting spoke resonators and a high beta elliptical cavity section, both of which are already under development.

THPPO100

Higher Order Mode Beam Breakup Limits in the Superconducting Cavities of the SPL

M. Schuh (MPI-K, CERN), F. Gerigk, J. Tuckmantel (CERN) C.P. Welsch (Cockcroft Institute)

The Superconducting Proton Linac (SPL) at CERN is part of the planned injector upgrade of the LHC. Initially used at low duty cycle as LHC injector it has the potential to be upgraded as a high power proton driver for neutrino physics and/or radioactive ion beams. In this paper the influence of the beam parameters on the build-up of Higher Order Mode (HOM) voltages is studied together with their interaction on the beam. For this purpose we use bunch tracking simulations in the longitudinal and transverse plane in order to define Beam Break-Up (BBU) limits. These simulations take into account changing values for the HOM frequency spread and are carried out using various distances between the HOM frequencies and the main machine lines.

Control of Spurious Harmonic Resonances in the PLS-II Storage Ring Vacuum Chamber

Y.D. Joo, S. An, M.-H. Chun, M.H. Jung, H.-S. Kang, H.-G. Kim, I.S. Park, K.-H. Park, Y.U. Sohn, I.H. Yu (PAL)

A superconducting RF cavity is used in the storage ring of the Pohang Light Source upgrade project (PLS-II) at Pohang Accelerator Laboratory for increasing the electron beam current and energy from 2.5GeV/200mA to 3.0GeV/400mA. In order to meet the requirement of low beam emittance and high photon energies, the vacuum chambers in the storage ring need to be reconstructed. To control the spurious harmonic resonances' effect to beam position monitors (BPMs) in the PLS-II storage ring vacuum chamber, the TE mode distribution in vacuum chambers has been analyzed, and a proper method to control the strength of TE mode at the position of BPMs is obtained.

Beam Breakup Instability Suppression in Multi Cell SC RF Guns

V. Volkov (BINP SB RAS)

Beam breakup (BBU) instability analyzes in superconducting multi cell cavities [V. Volkov, Phys. Rev. ST Accel. Beams 12, 011301 (2009)] is extended to FZD like RF guns. Also, its BBU instability was studied numerically on base of dipole HOM analyzes and transverse beam dynamics. An effective way to suppress the BBU instability using TE mode RF focusing is presented and technically grounded. In that way, a widespread adoption of multi cell SC cavities in powerful RF guns with stable high currents is found to be essential able.

Dipole High Order Mode Analyses for FZD Like SC RF Guns

V. Volkov (BINP SB RAS)

Dipole High Order Mode (HOM) interactions with a beam in a superconducting RF gun (SC RF gun) could destroy the quality of the electron beam and incite it to breakdown. For FZD like SRF gun, the characteristics of dipole HOMs including trapped HOM are calculated up to the frequency of 7.5 GHz. The behavior of the calculated parameters versus cavity longitudinal deformations has been studied. With using of dynamics calculations, dipole coupling impedances taking into account a large scale particle velocity changing at different accelerating gradients in the RF gun has been numerically calculated.

FROAAU — Future Projects I

FROAAU01

Project X

R.D. Kephart (Fermilab)

Project X is the generic name for a new multi-MW Proton Source under development at Fermilab. This machine would enable a world-class 2 MW long baseline neutrino program via a new neutrino beam line pointed to DUSEL in Lead, SD. It would also enable a broad suite of rare decay experiments. Two versions of this machine are under consideration. ICD-1 consists of a pulsed 8 GeV 20 ma H^- linac made up of a 325 MHz spoke resonators to 420 MeV followed by a 1.3 GHz ILC-like linac with squeezed elliptical cavities to 1.3 GeV and velocity of light cavities to 8 GeV. H^- are injected into the Fermilab 8 GeV Recycler Ring where they are stripped then injected into the Main Injector for acceleration to 120 GeV each 1.4 sec. The linac pulses at 2.5 Hz such that additional linac pulses are available to supply 360 KW to an 8 GeV high intensity program. ICD-2 employs a 1 ma 2 GeV CW linac to provide 2 MW to the high intensity program with very flexible beam manipulation. Acceleration from 2-6 GeV acceleration could be either a pulsed linac similar to ICD-1 or a rapid cycling synchrotron. This talk will describe these configurations, infrastructure development, R&D, and design studies in progress.

FROAAU02

FRIB: A New Accelerator Facility for the Production of Rare Isotope Beams

R.C. York (NSCL)

The 2007 Long Range Plan for Nuclear Science had as one of its highest recommendations the ``construction of a Facility for Rare Isotope Beams (FRIB) a world-leading facility for the study of nuclear structure, reactions, and astrophysics. Experiments with the new isotopes produced at FRIB will lead to a comprehensive description of nuclei, elucidate the origin of the elements in the cosmos, provide an understanding of matter in the crust of neutron stars, and establish the scientific foundation for innovative applications of nuclear science to society.'' A superconducting heavy-ion driver linac will be used to provide stable beams of >200 MeV/u at beam powers up to 400 kW that will be used to produce rare isotopes. Experiments can be done with rare isotope beams at velocities similar the driver linac beam, at near zero velocities after stopping in a gas cell, or at intermediate velocities (0.3 to 12 MeV/u) through reacceleration. An overview of the design proposed for implementation of the DOE national users facility FRIB on the campus of Michigan State University will be presented.

FROAAU03

A 5GeV, 100mA ERL based on CW SRF

G.H. Hoffstaetter (CLASSE)

ERLs have the potential of producing linac quality beams with a beam power hitherto only achievable in rings. Such beams can, for example, power x-ray sources with extreme spectral brightness, colliders with increased luminosity, or electron cooler systems. Cornell plans to build an ERL for hard x-rays with a CW, 5GeV SRF linac for 100mA beam. Initial results from a prototype high-current, CW gun and SRF injector linac will be shown. Subjects that are investigated to prepare for construction of this x-ray ERL will be discussed.

Compact ERL Linac

K. Umemori, T. Furuya, E. Kako, S. Noguchi, H. Sakai, M. Satoh, T. Shishido, T. Takahashi, K. Watanabe, Y. Yamamoto (KEK) M. Sawamura (JAEA/ERL) K. Shinoe (ISSP/SRL)

A construction of the Compact ERL is planned in KEK, in order to test the key technology to realize the future ERL based X-ray light sources. The operation of 60-200 MeV beam energy and 100 mA beam current are proposed. The superconducting cavity is one of the key components and applied for the injector part and the main acceleration part. At the injector part, three 2-cell cavities accelerate the electron beams up to 5-10 MeV. Each cavity has two input couplers and fire HOM couplers. Large beam loading, however, requires the handling of more than 100 kW for each input coupler. The main linac part consists of 9-cell cavities, whose main issue is a suppression of the Beam Breakup instability. Strong HOM damping is realized by optimized cell shapes and large diameter of beampipes. Tests of these cavities and components have been actively performed. The design of cryomodules has been also under way. These statuses are reported.

The Superconducting Prototype LINAC for IFMIF

P. Bosland (CEA)

The development of the IFMIF accelerator prototype is in progress within the framework of the EVEDA phase (Engineering Validation and Engineering Design Activities). This prototype will be installed at Rokkasho (Japan) and will allow testing the key systems. The first warm section composed of the deuteron source, beam lines and RFQ will prepare the beam for the cryomodule (CW 125mA at 5 MeV). The 8 HWR superconducting cavities equipped with a 200kW power coupler will accelerate the beam up to the maximum energy of 9 MeV. The design of the IFMIF/EVEDA accelerator prototype is briefly presented, and the general layout of the cryomodule is detailed.

e^- Linac for RIB

S.R. Koscielniak (TRIUMF)

TRIUMF, in collaboration with university partners, proposes to construct a megawatt-class electron linear accelerator (e-linac) as a driver for U(γ,f) with rates up to 10^{13}–10^{14} fissions/sec for Rare Isotope Beams (RIB) for nuclear structure and astrophysics, and 9Be(γ,p)8Li for materials science. The emphasis would be on neutron-rich species. The 50 MeV, 10 mA, c.w. linac is based on TTF superconducting radiofrequency technology at 1.3 GHz & 2K. Many of the major sub-system components have been identified; where possible existing designs will be adopted. The first stage of the project, a 25 MeV, 5 mA, c.w. linac matching the isotope production target power-handling capability in the next five-year plan, is to be completed in 2013. The injector cryomodule (ICM)development, which is being fast tracked, is the subject of a scientific collaboration between TRIUMF and the VECC laboratory in Kolkata, India. The paper gives an overview of the accelerator design progress with emphasis on the ICM.

FROBAU — Future Projects II

FROBAU01

Future SRF-Linac Based Light Sources: Initiatives and Issues

J. Bisognano (UW-Madison/SRC)

After providing an overview of initiatives world-wide to develop SRF-linac-based light sources, the various issues that must be addressed to bring them to fruition will be highlighted.

FROBAU02

The ESS SC Linear Accelerator

M. Lindroos (CERN) S. Peggs (ESS-S)

In 2003 the joint European effort to design a European Spallation Source resulted in a set of reports. Two new proposed designs were presented at PAC09 by ESS-S and ESS-B. Both designs exploit synergies with projects such as SPL at CERN, eRHIC at BNL, and the EURISOL Design Study. Lund was agreed to be the ESS site in late May 2009. ESS-S then began to prepare for a coordinated European effort to update the design, and to prepare all legal and organisational matters that will be needed during the construction phase. The design update phase is expected to end in 2012. The present status of the preparatory work will be presented, together with an outline of future work. The baseline for the updated design will be presented and discussed. It delivers 5 MW of 2.5 GeV protons to a single target, in 2 ms long pulses with a 20 Hz repetition rate. Finally, potential future upgrades of power and intensity are considered, with the possibility of increasing the average beam power to as much as 7.5 MW, for delivery to one or perhaps two target stations.

FROBAU03

HIE-Isolde: The Superconducting RIB Linac at CERN

M. Pasini (CERN, Instituut voor Kern- en Stralingsfysica, K. U. Leuven)

In the frame of the upgrade of the ISOLDE facility at CERN, a R&D program on superconducting linac for Radioactive Ion Beams (RIBs) has started in 2008. The linac will be based on superconducting Quarter Wave Resonators (QWRs) and will make use of high field SC solenoids for the beam focusing. The sputtering technology has been chosen as the baseline technique for the cavity manufacturing and prototype and sputtering tests are in advanced state. A status report on the SC activities will be presented.

FROBAU04

SPL

R. Garoby (CERN)

The existing complex of accelerators at CERN is capable to provide the Large Hadron Collider (LHC) with the beam required to reach its nominal characteristics. Higher performance injectors will however be necessary to exceed this limit and maximize the physics reach of the LHC. As a first step, the construction of a new 160 MeV H^- linac (Linac4)

has started, and the study of a 4 GeV Superconducting Proton Linac (SPL) is being pursued in view of submitting a project proposal by mid-2012. The basic design choices of the SPL are described, as well as its potential interest for other physics programmes. The goals and plans of the on-going study are explained.

J-PARC Upgrade

N. Ouchi (JAEA/LINAC)

J-PARC is in the first phase now, which consists of three accelerators; linac, 3-GeV synchrotron, and 50-GeV synchrotron, and three experimental facilities; the Materials and Life Science Experimental Facility (MLF), the Hadron Experimental Facility, and the Neutrino Experimental Facility. Proton beams have reached to the all experimental facilities up to now, and user operation of MLF started in 2008. Superconducting proton linac (SCL) from 400 to 600 MeV and the Transmutation Experimental Facility are planned in the second construction phase. SCL will consist of 11 cryomodules and two 9-cell 972 MHz elliptical cavities will be installed in each cryomodule. As two cavities will be driven by one klystron, phase stability between two cavities under the Lorentz force detuning in the pulsed operation is most important issue to be developed. A prototype cryomodule was fabricated, which was designed to be less Lorentz force detuning, and two cavity excitation was tested. The phase stability at 2K is satisfactory acceptable, while it deteriorates at 4K due to the microphonic noise. Design of SCL and the experimental results of the prototype cryomodule are presented.

ILC

K. Yokoya (KEK)

The general status of the International Linear Collider (ILC) project will be presented. It will include the status of the various test facilities for the damping ring, final focus and superconducting acceleration. The design presented in the Reference Design Report published in summer 2007 is being revisted with mid 2010 as the target. The possible design change will also be described.

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An	Sun
Anders	Wolfgang
Anlage	Steven
Antoine	Claire
Araz	Asim
Arnold	Andre
Atieh	Said
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Baars	Derek
Barna	Daniel
Barth	Winfried
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Belomestnykh	Sergey
Ben-Zvi	Ilan
Berry	Stéphane
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Bouly	Frédéric
Bowring	Daniel
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Buerkmann-Gehrlein	Klaus
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Bustinduy	Ibon
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Carwardine	John
Chae	Yong-Chul
Champion	Mark
Chase	Brian
Chel	Stéphane
Chen	Jia-er
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Stirbet	Mircea

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Thie	Jan-Hendrik
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Valles	Nicholas
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