Summary WG-B

D. Raparia, P.A.P Nghiem, Z. Li
Summary WG B

Number of Talks  18 + 2 (WG C)
Number poster  16
General beam dynamics  3
Projects design  15
Facility report  2
Main observation:
No need for EP from beam physics point of view – large "white areas"!

Questions:
1. Are the colored regions (stop-bands) always of concern?
2. Are the "white" regions (EP or non-EP) safe?
3. Crossing speed of resonances?
4. Is a single chart enough?
5. What is the physics meaning of the EP condition $\varepsilon_z k_z : \varepsilon_x k_x = 1$
6. ...

Charts indicate (colored) regions, where space charge coupling (by low order space charge modes) may occur.
Regime 1: Crossing of main stop-band ($k_{oz}=69^0$)

**crossing speed dependent**

Crossing over 5 FODO cells $k_{ox}=85^0...65^0$
- slight exchange
- too fast!

Crossing over 20 FODO cells $k_{ox}=85^0...65^0$
- leads to ~EP
- notice about 2x less swing in $k_z/k_x$

\[ \frac{E_z}{E_x} = \frac{\varepsilon_z k_z}{\varepsilon_x k_x} = 3 \]

\[ \frac{E_z}{E_x} : 2.6 \rightarrow 1 \text{ (EP)} \]
Complex behaviour far beyond \( k_{oz} = 69^0 \)

splitting of transverse emittances – x-y away from initial EP!

Crossing over 100 FODO cells

\( k_{ox} = 85^0 \ldots 45^0 \)

- full exchange, splitting of x and y

\[
\begin{align*}
\frac{E_z}{E_x} & : 2.6 \rightarrow 1 \rightarrow 2 \\
\frac{E_z}{E_y} & : 2.6 \rightarrow 1 \rightarrow 1.2 \\
\frac{E_x}{E_y} & : 1 \rightarrow 1 \rightarrow 0.6 \\
\end{align*}
\]

- Dynamical tune behavior confirms charts - white regions "safe" → EP not necessary!
- Emittance exchange depends on crossing speed (inversely proportional) of resonance stop-bands
- On resonances emittance evolution "towards" EP, but sometimes complex details (splitting of transverse emittances)
- Additional physics **not** addressed by stability charts:
  - Structure resonances or instabilities – how slow tune change?
  - Robustness against mismatch & errors?
  - ...

\[\varepsilon_x "attracted" by \varepsilon_z!\]
Equiption Reality or Swindle
J. M. Gagniel (GNANIL)

• Raises question about validity equipartition
• We had long discussion about it, he summarize as follows
  1- The linac beams are out of the EQP theorem validity limit, to apply the “EQP rule” designing a linac is a mistake
  2- The application of the “EQP rule” do not prevent emittance exchanges induced by coupling resonances
  3- Safe tunes with beam footprints out of the coupling resonances can be found more easily when the “EQP rule” is not respected
Equipartition Reality or Swindle (cont.)

4- The constraint imposed by the “EQP rule” on a linac design can lead to a non optimized beam dynamics and higher construction and operation costs
5- The question of energy exchange / emittance transfer must be analyzed as done in circular machines (tune diagram, evaluation of the excitation strength)
6- The “modern physics” tools developed to characterize the level of disorder (chaos) present in nonlinear Hamiltonian systems could be applied to characterize and optimize our beams

(Service offer !)
Definition of Halo- P.A.P Nghiem

The diffusion equation
\[ \frac{dn}{dt} = D \Delta n \]
states that the diffusion is maximum where the Laplacian of the density is maximum: this is the border between the two parts

1 dimension: max of the second derivative
n dimensions: max of the Laplacian

Once the limit core-halo is defined, the halo can be characterised by
- its size / whole size
- the number of particles within it / whole number of particles

- Halo size (%) or/and NbrPart (%) seem to correspond to Emittance growth
- Even seem to be more detailed beam description, more pertinent than Emittance
Beam Loss Mechanisms in High Intensity Facility- M.A. Plum (ORNL)

- There are many different and interesting beam loss mechanisms in high-intensity H\(^+\) and H\(^-\) linacs
  - Intra-beam stripping
  - Residual gas stripping
  - H\(^+\) capture and acceleration
  - Field stripping
  - Black body radiation stripping
  - Dark current from ion source
  - Beam halo/tails (resonances, collective effects, etc.)
  - RF and/or ion source turn on/off transients
Integral SCL losses estimation: 4x10^{-5} fractional loss

Measured SCL losses (2-7)x10^{-5} fractional loss

\[ \frac{dn}{dt} \propto \sigma \cdot n^2 \]
SCL Losses vs. Peak Current

• $^-$ beam loss is up to 20 times lower than $^+$ beam loss

• Normalized $^-$ beam loss is proportional to ion source current, consistent with IBSt expectations

Technical Challenges in Multi MW linacs
V. A. Lebedev (Fermilab)

Spallation Neutron sources
- SNS (Oakridge, USA): 1 MW, 0.9 GeV, 38 mA with 5.1%DF, 0.85 ms@60 Hz
- ESS – (Lund, Sweden): 5 MW, 2.5 GeV, 50 mA, 4% DF, 2.86 ms @ 14 Hz
- CSNS (China): 0.1 MW, 81 MeV H- DTL + 1.6 GeV RCS

ADS – Accelerator driven systems
- MYRRA (Belgium): 2.4 MW, 0.6 GeV, 4 mA, CW
- Indian ADS: 30 MW, 1 GeV, 30 mA,CW
- China ADS: P>>1 MW, 1.5 GeV SC linac to support operation of 1 GW reactor

Physics intensity frontier
- SPL (CERN): 4 MW, 5 GeV, 40 mA, 0.4 ms with 100%DF, 0.4 ms@50 Hz
- Project X (Fermilab, USA) – 3 MW, 3 GeV, 1 mA*, CW + 8 GeV pulsed linac
  * Bunch population corresponds to 10 mA @ 325 MHz
- FRIB – 0.4 MW, >0.2 GeV/u , 0.65 mA el. current of multi-charged ions
Introduction (continue)

Typical SC Proton Linac Layout

- Ion source → LEBT → RFQ → MEBT → Warm linac → SC linac → Target

- 30–70 kV → 2–3 MeV → 2–150 MeV → 0.6–8 GeV

- Length of warm linac is decreasing with development of SC technology
  - SNS: DTL to 87 MeV, CCL to 186 MeV
    - SC part starts with elliptic cavities
      - The only technology “trustable” in ~2004
  - ESS: DTL accelerates to 50 MeV
    - SC part starts with triple spoke
  - Project X linac
    - SC part starts after RFQ

- Project X linac has largest number of different cavity types
  - Most diverse machine compared to other proposed project
Due to bunch-by-bunch chopping Project X has long & complex MEBT

- Triplet focusing with ~90 deg. phase advance per cell
  - minimizes beam sizes and creates “smooth” focusing
    ⇒ small emittance growth
- Three RF cavities: 162 MHz, 100 kV (amplitude)
- Two kickers to obtain acceptable voltage (power)
  - Kickers are separated by 180 deg in betatron phase
- Incoming H⁻ beam brings large volume of H₂ : 5 mA = 4.4·10⁻⁴ l·torr/s
  - Differential pumping (Ø10 mm)
    • to reduce gas flux from absorber to SC cavities
Project X SRF Linac Technology Map

5 types of SC cavities are required for Stage I

<table>
<thead>
<tr>
<th>Section</th>
<th>Freq</th>
<th>Energy (MeV)</th>
<th>Cav/mag/CM</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWR (β=0.1)</td>
<td>162.5</td>
<td>2.1-11</td>
<td>8/8/1</td>
<td>HWR, solenoid</td>
</tr>
<tr>
<td>SSR1 (β=0.22)</td>
<td>325</td>
<td>11-38</td>
<td>16/8/2</td>
<td>SSR, solenoid</td>
</tr>
<tr>
<td>SSR2 (β=0.47)</td>
<td>325</td>
<td>38-177</td>
<td>36/20/4</td>
<td>SSR, solenoid</td>
</tr>
<tr>
<td>LB 650(β=0.61)</td>
<td>650</td>
<td>177-467</td>
<td>30/10/5</td>
<td>5-cell elliptical, doublet</td>
</tr>
<tr>
<td>HB 650(β=0.9)</td>
<td>650</td>
<td>467-2000</td>
<td>96/12/12</td>
<td>5-cell elliptical, doublet</td>
</tr>
<tr>
<td>ILC-CW(β=1.0)</td>
<td>1300</td>
<td>2000-3000</td>
<td>72/9/9</td>
<td>9-cell elliptical, quad</td>
</tr>
<tr>
<td>ILC-pulsed(β=1.0)</td>
<td>1300</td>
<td>3000-8000</td>
<td>224/28/28</td>
<td>9-cell elliptical, quad</td>
</tr>
</tbody>
</table>
**SC Linac Beam Dynamics**

- Strong space charge effects in Project X SC linac
- Bunch population corresponds to 10 mA beam current at 325 MHz
  - 80% bunches are chopped out & RFQ at half frequency (162.5 MHz)
  - Nearly the same beam brightness as at the SNS

Current 5 mA@162.5 MHz; Energy: 2.1 MeV – 10.8 MeV – 22.1 MeV

- **SC - CS transition between cryomodules**
- **Moderate emittance growth - 40% - transverse; 60% - longitudinal**
Conclusions

- SC linacs look as a great technology for the multi-MW proton accelerators
- Recent improvements in surface treatment greatly improved Q values for SC cavities and push operating gradient beyond 20 MV/m
  - At 1.3 GHz the Q-value of $7.5 \times 10^{10}$ at 2 K and at a 20 MV/m were achieved (A. Romanenko, A. Grassellino, 2012, Fermilab)
- There are no insurmountable physics or engineering problems to be overcame
  - Making cavities still require extensive R&D
  - Getting experience in the SRF design and development is irreplaceable for any organization making and/or developing SRF cavities
- These SRF developments will affect many fields
  - HEP, Nuclear energy, solid state and nuclear physics, chemistry, biology ...
Beam dynamics of ESS

Warm linac: M. Comunian (INFN/LNL)
Superconducting linac: M. Eshraqi (ESS)

Particle species: p
Energy: 2.5 GeV
Current: 50 mA
Average power: 5 MW
Peak power: 125 MW
Pulse length: 2.86 ms
Rep rate: 14 Hz
Max cavity surface field: 40 MV/m
Operating time: 5200 h/year
Reliability (all facility): 95%
From the May 2012 baseline, the MEBT was extended to include:
- Fast chopper
- Beam instrumentation
- Collimation
Statistical runs are performed to check the sensitivity of the linac to real life error.

**RULES OF THUMB II**

Phase advance per transverse period is limited to $87^\circ$.

Phase advance per meter is smooth and monotonic.

Tune depression stays right above 0.4 along the linac.

Statistical runs are performed to check the sensitivity of the linac to real life error.
Linac4 Beam dynamics and Commissioning Strategy  
J-B. Lallement et al (CERN)

- A new 160 MeV H⁻ ion linac, injector of PS Booster.

![Linac4 Beam dynamics and Commissioning Strategy diagram](Image)
Linac4 present status

- H- source presently under commissioning.
- RFQ delivered, RF bead-pulls performed.
- DTL, Tank1 assembled.
- First CCDTL modules delivered in October.
- PIMS modules ready from next year.
- Tunnel ready for machine installation.
Commissioning Planning

- 3 and 12 MeV from mid 2013
- 50 MeV from 2014
- 100 MeV mid 2014
- 160 MeV 2015
- 160 MeV tests and reliability run 2015-16
END to end Beam Dynamics design Optimization for CSNS Linac – J. Peng (IHEP)

Beam current 15mA(1\textsuperscript{st} phase), 30mA(2\textsuperscript{nd} phase)
Macro-pulse width 420\,\mu s
Repetition rate 25\,Hz
Duty factor 1.05%
Chopping rate 50%
Optimization: (1) remove Chopper from MEBT
(2) DTL lattice change FD to FFDD

Old design: the MEBT comprises of a chopper, two 324MHz buncher cavities and eight quadrupole magnets

New design: the MEBT comprises of two 324MHz buncher cavities and ten quadrupole magnets
Summary

- In the old design, the beam loss in the 1st DTL tank was found serious while all errors applied. The reason to this problem was that we don’t consider halo formation and emittance growth in the MEBT while optimizing DTL geometric parameters. So end-to-end simulation must be conducted before reaching a final design.

- Two transverse focusing lattices have been compared, namely FD and FFDD focusing lattice. FFDD lattice was finally chosen for its lower quadrupole gradient and smaller beam loss rate compared with FD one.

- End to end simulation has shown that the beam loss, emittance growth rate and the ratio of bore radius to rms beam size were acceptable along the linac, and now we reached a final design.
Beam dynamics of China ADS-Z. Li (IHEP)

Particle | Proton
--- | ---
Energy | 1.5 GeV
Current | 10 mA
Beam power | 15 MW
RF frequency | (162.5)/325/650 MHz
Duty factor | 100 %
Beam Loss | <1 W/m
Beam trips/year | <25000 <2500 <25
1s < t < 10s 10s < t < 5m t > 5m
End to End Simulation

RMS Emittance growth
15% in transverse;
40% in longitudinal;

Halo particles
Particle loss with errors;

MEBT2 and Input distribution!
Beam dynamics of the 13 MeV/50 mA proton linac for the compact pulse hadron source at Tsinghua University- Q. Z. Xing

Main parameters of the CPHS accelerator system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ion type</td>
<td>Proton</td>
</tr>
<tr>
<td>Beam power</td>
<td>16 kW</td>
</tr>
<tr>
<td>Beam energy</td>
<td>13 MeV</td>
</tr>
<tr>
<td>Average current</td>
<td>1.25 mA</td>
</tr>
<tr>
<td>Pulse repetition rate</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Protons per pulse</td>
<td>$1.56 \times 10^{14}$</td>
</tr>
<tr>
<td>Charges per pulse</td>
<td>$2.5 \times 10^{-5}$ C</td>
</tr>
<tr>
<td>Pulse energy</td>
<td>0.325 kJ</td>
</tr>
<tr>
<td>Pulse length</td>
<td>500 μs</td>
</tr>
<tr>
<td>Peak current</td>
<td>50 mA</td>
</tr>
<tr>
<td>Beam duty factor</td>
<td>2.5 %</td>
</tr>
<tr>
<td>RF frequency</td>
<td>325 MHz</td>
</tr>
<tr>
<td>Output energy of the ion source</td>
<td>50 keV</td>
</tr>
<tr>
<td>Output energy of the RFQ</td>
<td>3 MeV</td>
</tr>
<tr>
<td>Output energy of the DTL</td>
<td>13 MeV</td>
</tr>
</tbody>
</table>
• No MEBT,
• Beam dynamics simulation has been carried out by various codes for the CPHS Linac
• Field aberration of the solenoids is one main reason for the mismatching between the LEBT and RFQ
• With the particle distribution from the LEBT as input, the transmission rate in the RFQ decreases to about 85%
• Transmission in the DTL is almost 100% for the accelerated particles
• Simulation is being cross-checked by TRACK
• 400 kW cw machine with uncontrolled beam loss limited to < 1 W/m
• Beam energy on target ≥ 200 MeV/u
• Accelerate all varieties of stable ions → uranium is most challenging in design (two and five charge states before and after stripper)
• Minimize project construction costs → Compact double-folded layout
• Maintain potential enhancement → Energy upgrade, ISOL targets, light ion injector

Ready for civil construction start
FRIB Accelerator Beam Dynamics Challenges

- Simultaneous acceleration of multi-charge-state beams
  - Velocity equalizer and HV platform at LEBT
  - Variable cavity synchronous phase
  - Achromatic and isochronous bending optics design
  - Diagnostics and control capabilities to overlap multi-charge states

- Combined challenges of heavy-ion and high-power accelerator
  - Uncontrolled beam loss at 1 W/m (or 10^{-6}) level
  - ^1H: activation & shielding issues; ^238U: material damage & heat load

- Limited aperture of low-\(\beta\) accelerating structures

- Tolerate larger alignment error of “cold” elements in cryomodules
  - SC solenoid to be aligned to < 1 mm under cryogenic condition

- Stringent beam-on-target requirements
  - Requiring corresponding beam diagnostics and control
Acceleration and transportation of multi ion species through EBIS Preinjector- D. Raparia (BNL)
Ion Beam Delivered to NSRL and RHIC

<table>
<thead>
<tr>
<th>IONS</th>
<th>Q/m</th>
<th>delivered to</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^3\text{He}$</td>
<td>0.6667</td>
<td>AGS</td>
</tr>
<tr>
<td>$^4\text{He}^2$</td>
<td>0.5000</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{12}\text{C}^6$</td>
<td>0.5000</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{16}\text{O}^8$</td>
<td>0.5000</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^4\text{He}^1$</td>
<td>0.2500</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{20}\text{Ne}^+^5$</td>
<td>0.2500</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{40}\text{AR}^+^{10}$</td>
<td>0.2500</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{63}\text{Cu}^+^{11}$</td>
<td>0.1746</td>
<td>RHIC</td>
</tr>
<tr>
<td>$^{40}\text{AR}^+^{7}$</td>
<td>0.1750</td>
<td>AGS</td>
</tr>
<tr>
<td>$^{48}\text{Ti}^+^{9}$</td>
<td>0.1875</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{56}\text{Fe}^+^{10}$</td>
<td>0.1786</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{84}\text{Kr}^+^{20}$</td>
<td>0.2439</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{131}\text{Xe}^+^{30}$</td>
<td>0.2290</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{181}\text{Ta}^+^{40}$</td>
<td>0.2210</td>
<td>NSRL</td>
</tr>
<tr>
<td>$^{197}\text{Au}^+^{32}$</td>
<td>0.1624</td>
<td>RHIC, NSRL</td>
</tr>
<tr>
<td>$^{238}\text{U}^+^{39}$</td>
<td>0.1638</td>
<td>RHIC</td>
</tr>
</tbody>
</table>

EBIS pre-injector provided Au, U and Cu beam for RHIC Run 12 and tens ions species to NSRL

Acceleration and transport of multi ion species seen in the EBIS pre-injector and Booster

EBIS pre-injector is very stable, reliable and reproducible
PXIE – Front-End of the Project X CW linac
PXIE should deliver 1 mA CW beam to ~25 MeV energy
  – Arbitrary bunch pattern (5 mA from Ion Source-> 1 mA at the beam dump)
PXIE includes:
  – 5 mA ion source
  – LEBT with pre-chopper
  – 2.1 MeV 162.5 MHz RFQ
  – MEBT with bunch-by-bunch chopper and 11 kW beam dump
  – Two SC cryo-modules: HW -162.5 MHz & SSR1 – 325 MHz
  – Diagnostics Section and 50 kW beam Dump

PXIE schematic layout. The total facility length is about 40 m.
Beam Dynamics studies of H- beam chopping in the LEBT for project X-Q. Ji (LBNL)

- PXIE H- ion source has been tested at LBNL. Beam current, emittance, and stability all meet the functional specification requirements.
- A two-solenoid magnetic lens LEBT has been proposed.
- Time-dependent WARP 3D simulations of particle interactions, such as electron detachment, charge exchange, H- ionizations etc. in the LEBT are still ongoing. Preliminary results showed that, from the chopper to the entrance of RFQ, emittance increases ~ 20%.
- Chopper simulation benchmark experiment has been performed at various pulse duty factor and repetition rate. A collection of emittance and twiss parameter data have been taken, which are ready to be used in benchmarking WARP 3D simulations.
RFQ Beam dynamics design for large science facility and accelerator driven systems C. Zhang (IAP)

**FAIR Proton RFQ vs. SNS RFQ**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>SNS</th>
<th>FAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ion</td>
<td>H⁻</td>
<td>H⁺</td>
</tr>
<tr>
<td>Duty cycle [%]</td>
<td>6.2</td>
<td>0.0144</td>
</tr>
<tr>
<td>$I_{\text{peak}}$ [mA]</td>
<td>~60 (35)</td>
<td>45 70 100</td>
</tr>
<tr>
<td>$f$ [MHz]</td>
<td>402.5</td>
<td>325.44</td>
</tr>
<tr>
<td>$W_{\text{in}}$ [MeV]</td>
<td>0.065</td>
<td>0.095</td>
</tr>
<tr>
<td>$W_{\text{out}}$ [MeV]</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>$U$ [kV]</td>
<td>83</td>
<td>80</td>
</tr>
<tr>
<td>$\epsilon_{\text{in}}$ [π mm mrad]</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>$\epsilon_{\text{out}}$ [π mm mrad]</td>
<td>0.21 0.21</td>
<td>0.30 0.30 0.30 0.31</td>
</tr>
<tr>
<td>$\epsilon_{\text{out}}^{\text{longi.}}$ [π MeV deg]</td>
<td>0.103</td>
<td>0.163 0.153 0.152</td>
</tr>
<tr>
<td>$L$ [m]</td>
<td>3.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Transmission [%]</td>
<td>~90</td>
<td>98.7 97.2 95.3</td>
</tr>
</tbody>
</table>

For accelerated particles only

C. Zhang, A. Schempp, NIM-A 2009
Using Step –like nonlinear magnet for uniformization at IFMIF Target- Z. Yang (IHEP)

- To create uniform beam on target step like nonlinear magnet is suggested which dose the better job.

8 poles -r50 mm
Field on pole 0.30 T

Octupole

2 dipoles-r100 mm
Field on pole 0.040 T

Step-like magnet
High intensity aspect of J-park linac, including re-commissioning after earthquake- M. Ikaegami (KEK)

- In the beam commissioning of J-PARC linac after the earthquake, multipactor at an RF cavity forced us to operate with irregular RF settings some of which caused excess beam losses.
- We have performed particle simulation to reproduce the experimentally observed beam loss.
- **Simulation** has not fully reproduced the beam loss behavior, but it leads us to conclude that the beam loss is caused by satellite (proton?) particles.
- While it needs further study to confirm it, the particle simulation provides us with an important insight into the beam loss mechanism in the J-PARC linac beam commissioning.
Simulations and measurement in the high intensity LEBT with space charge compensation-N. Chauvin (CEA/IRFU)

Conclusions

- A PIC code (with SCC) has been used to design high intensity injectors.
- Simulations are compatibles with preliminary experimental results.
- Emittance at the end of the IFMIF injector are in the specifications.
- Nominal beam current in pulsed mode (20% duty cycle max.).
Intense High charge state heavy ion beam production for the advanced accelerators L. T. Sun (IMP)

- **ECRIS-**
  - SPIRAL2 (GANIL), France: **ECRIS**(*1emA Ar^{12+}*)
  - FAIR (GSI), Germany: **ECRIS** (*1emA U^{28+}*)
  - FRIB (MSU), USA: **ECRIS** (*270euA U^{33+} & U^{34+}*)
- **EBIS**
  - RHIC (BNL), USA: **EBIS** (*1.7emA Au^{32+}/10\mu s*)
- **LIS**
  - CERN CO\textsubscript{2} laser, $\lambda=10.6$ $\mu$m, 100 J, 1 Hz, Laser pulse 15-30 ns, Power density $10^{13}$ W/cm\textsuperscript{2}, Ion pulse 1-10 $\mu$s
  - BNL Nd: YAG Laser, f:100mm, 30cm from target, $\phi$:6mm
Posters

Study of HOMs and the associated instability for C-ADS Linac: P. Cheng et al
- HOM couples not need similar result were obtain at SNS linac

Dynamics of particles in a tilted solenoid focusing channel: H. Jiang et al

The study of beam distribution transformation by anti-symmetric multipole magnetic field: M. Jin

Study of Non-equi-partition lattice setting and IBS effects for J-park Linac Upgrade: Y. Liu
Upgrade part 190 MeV to 400 MeV, frequency jump of 3,
if one keep EP lattice the losses will increase due to IBS,
Non EP lattice (bigger beam) increase emittance (50%)
The analysis of stability optimization for superconducting section of C-ADS Injector II
Beam Dynamics studies for a proposed 800 MeV ISIS Upgrade Linac: D. C. Plostinar

MEBT2 design for the C-ADS: Z. Guo et al
- How to maintain achromaticity with space charge using two bunchers.

Design of C-ADS injector II MEBT I

Error analysis and correction Scheme in C-ADS injector: I C. Meng, et al

Compensation-remach for Major Element failure in rhw C-ADS: B. Sun et al
- possible, further continue, This a one the flexibility provided by SC linac

Physics Design for the C-ADS Main Linac with two different Injector Schemes: F. Yan
Discuss space charge effected associate with injector I (325 MHz) and Injector II (162.5 MHz)

Beam optics design of 1.5 GeV Transport Line in C-ADS with beam distribution transformation: H. L. Luo
- Compare two methods to create uniform distribution at target: raster system and use nonlinear magnets
Error and Tolerance Studies for injector II doe C-ADS: W. S. Wang

SSC linac end-to-end simulations and error analysis based on the Beampath code: X. H. Zhang

Medium Energy Beam Transport Design Update for ESS: I. Bustinduy

An Untraditional RFQ Physics design for HIAF: C. Li
Separate out functions of RFQ, i.e. bunching and acceleration, Multi-harmonic Buncher In the LEBT and RFQ with only acceleration section

Code
Development of the Linac design and tracking code PADSC: Y. L. Zhao

Report:
Experimental Results for Beam Halo at IHEP: H. F. Ouyang
Halo measurement in FODO line after RFQ
Discussion Topics

• J-park upgrade: EP vs IBS lattice
• Equipartition: reality or Swindle
• RFQ Beam Dynamics: emphasis of longitudinal beam quality
• Calculated vs empirical lattice
  Are operators tuning on halo?

Transition energy for Super conducting cavities
  In case of ESS transition chosen 80 MeV based on emittance growth
• High power vs high intensity
  Higher repetition rate, lower peak current, higher energy, usually fix target
  losses are concern, challenging engineering rather than beam dynamics
  Lower repetition rate, higher peak current, injection, emittance is figure of merit
• H- linac and P linac design issues
• Emittance grow (~20%) vs accelerator length (30m) In ESS Linac