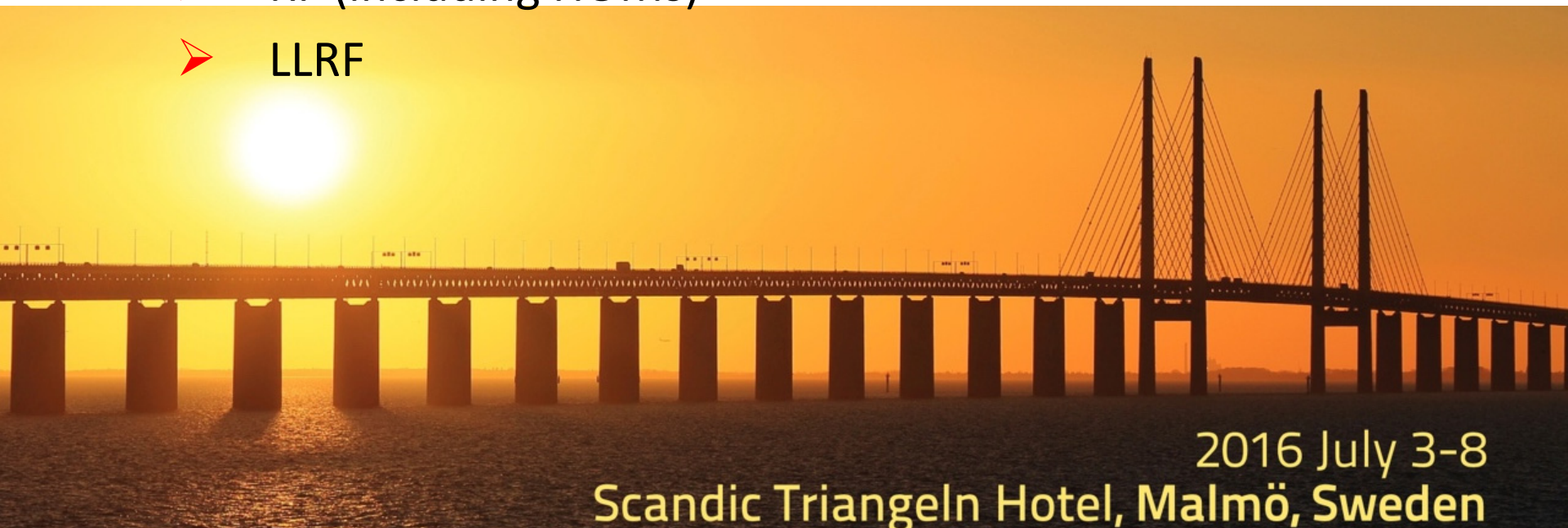
HB2016 - Malmö

Summary of the Working Group-C : Accelerator Systems

Sarah Cousineau, Luc Perrot

- Injection
- Extraction
- RF (including HOMs)
- LLRF



HB2016 : WG-C Accelerator Systems

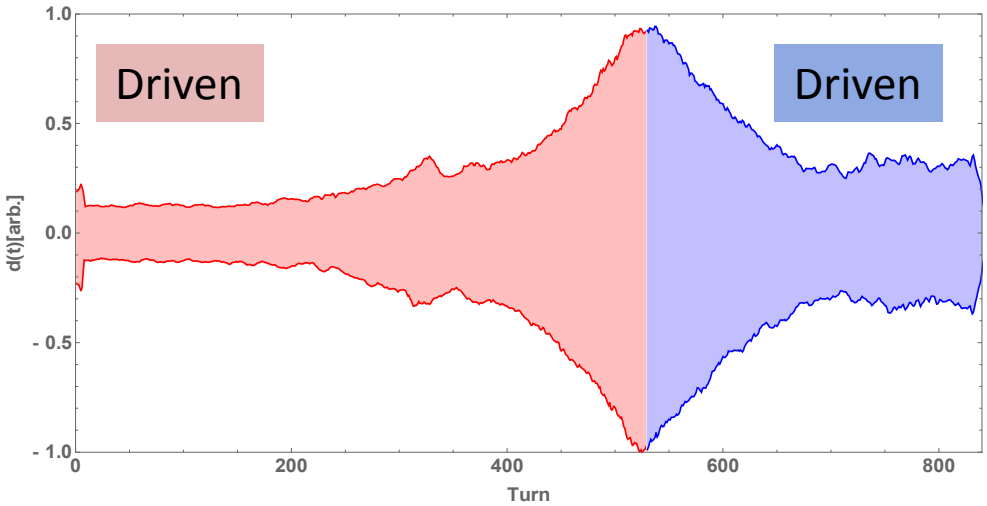
Tuesday 06/07/2016 session:

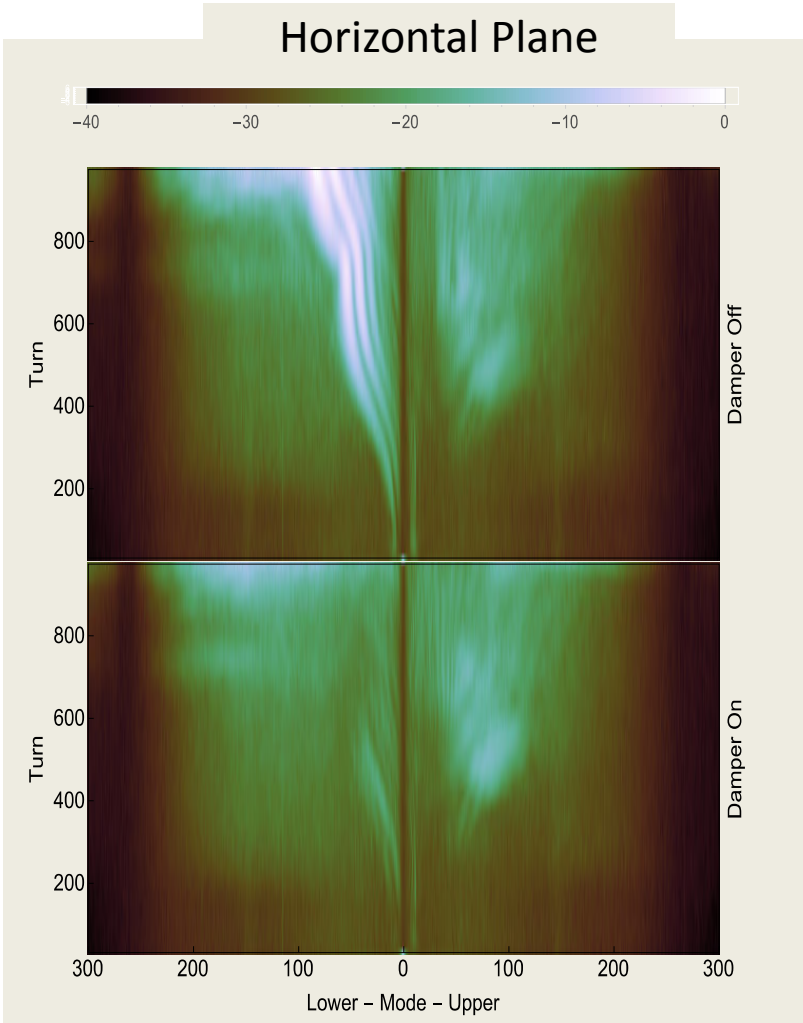
1. Nicholas John Evans (ORNL RAD, Oak Ridge, Tennessee) TUPM1X01 Broadband Feedback System for Instability Damping in the SNS Ring
2. Felix Marti (FRIB, East Lansing, Michigan), TUPM2X01 Heavy Ion Charge Stripping at FRIB
3. Chandra Bhat (Fermilab, Batavia, Illinois), TUPM3X01 R&D on Beam Injection and Bunching Schemes in the Fermilab Booster
4. Chiara Bracco (CERN, Geneva), TUPM4X01 LHC Injectors Upgrade for the HL-LHC
5. Shinichi Kato (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), TUPM5X01 Injection Painting Improvements in the J-PARC RCS
6. Michael Plum (ORNL, Oak Ridge, Tennessee), TUPM6X01 H- Charge Exchange Injection Issues at High Power
7. Pranab Kumar Saha (JAEA/J-PARC, Tokai-Mura, Naka-Gun, Ibaraki-Ken), TUPM7X01 An Experimental Plan for 400 MeV H- Stripping to Proton by Using Only Lasers in the J-PARC RCS
8. Sarah M. Cousineau (ORNL, Oak Ridge, Tennessee), TUPM8X01 First results of laser-assisted H- stripping of a 10 us, 1 GeV beam at the SNS accelerator

“Broadband Feedback System for the SNS Ring” (Nick Evans)

- e-p instability : beam interact with a cloud of e-
- No e-P instability at SNS for 1.4 MW.
- Feedback developed pre-emptively for future e-p induced instabiliy.
- Successfully damps driven instability in < 90 turns.

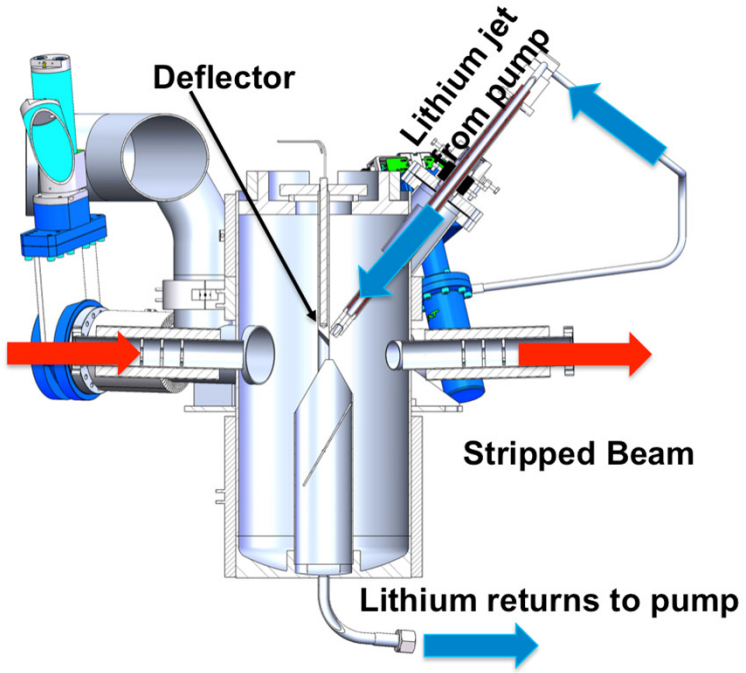
Driven then damped oscillation

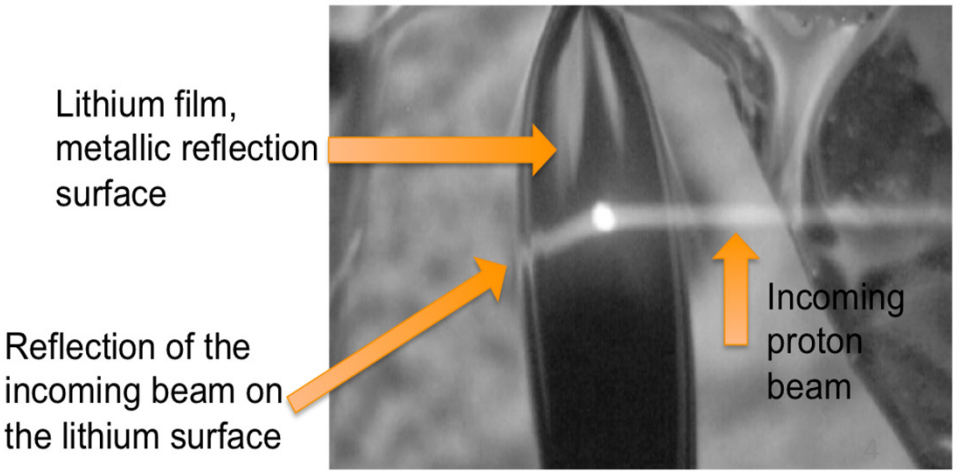




“Heavy Ion Stripping at FRIB” (Felix Marti)

- Lithium thin film under development for baseline heavy ion stripping in FRIB.
- Thin lithium film produced by high velocity jet.
- Successfully tested using LEDA proton source adapted for power density.
- Will be deployed in FRIB after initial commissioning of beam.





"R&D on Injection and Bunching Schemes in the Fermilab Booster" (Chandra Bhat)

- Moving to "Early Injection Scheme" - beam is captured in stationary buckets before acceleration.
- First implementation in 2015. Optimization through simulation + experiment in progress.

Potential of Early Injection Scheme

Parameter	PIP	PIP-II (After 2022)
Injection Energy (KE) (GeV)	0.4	0.8
Extraction Energy KE (GeV)	8	8
Injection Intensity (p/pulse)	4.52E12 (X~1.4)	6.63E12
Extraction Intensity (p/pulse)	4.3E12 (~6E12)	6.44E12
Number of Booster Turns	13 (18)	300
Efficiency (%)	95 (≥ 97)	97
Booster repetition rate (Hz)	15	20
Booster Beam Power at Extraction (kW)	94 (~130)	184
MI batches	12 every 1.33 sec	12 every 1.2 sec
NOvA beam power (kW)	700 (~950)	1200
Rate availability for other users (Hz)	5	8
Booster flux capability (protons/hr)	~ 2.3E17 (3.2E17)	~ 3.5E17

“LHC Injector Upgrade for the HL-LHC” (Chiara Bracco)

- LHC Injector chain will undergo several upgrades to support the HL-LHC project.
- Goal is to increase beam current and brightness:

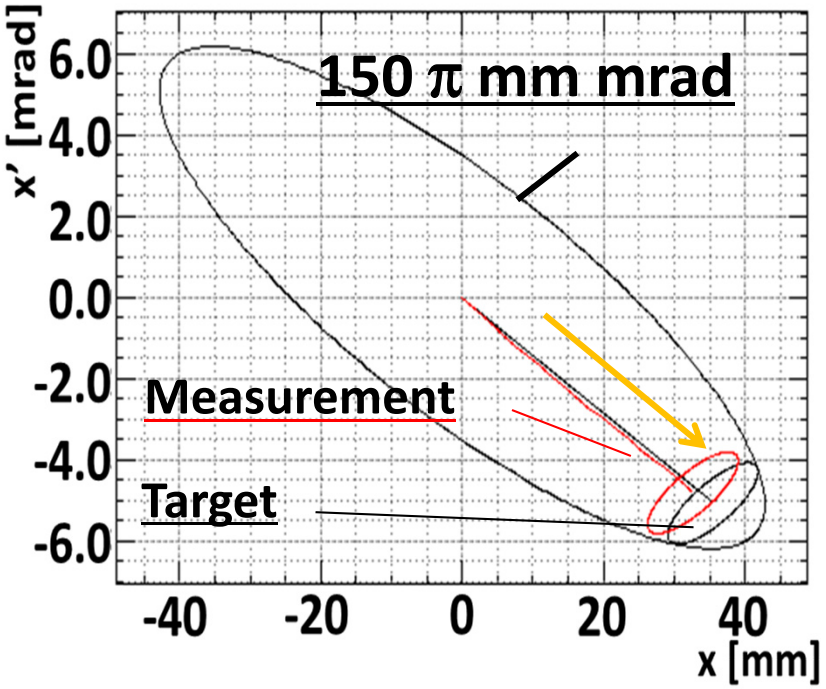
Parameters at 450 GeV	LHC nominal	HL-LHC standard	HL-LHC BCMS
p.p.b (n_b)	1.15e11	2.3e11	2.0e11
# bunches (N_b)	2808	2748	2604
ε [m rad]	7.3e-9	4.4e-9	2.9e-9
B(HL-LHC)/B(LHC)	1	5	10

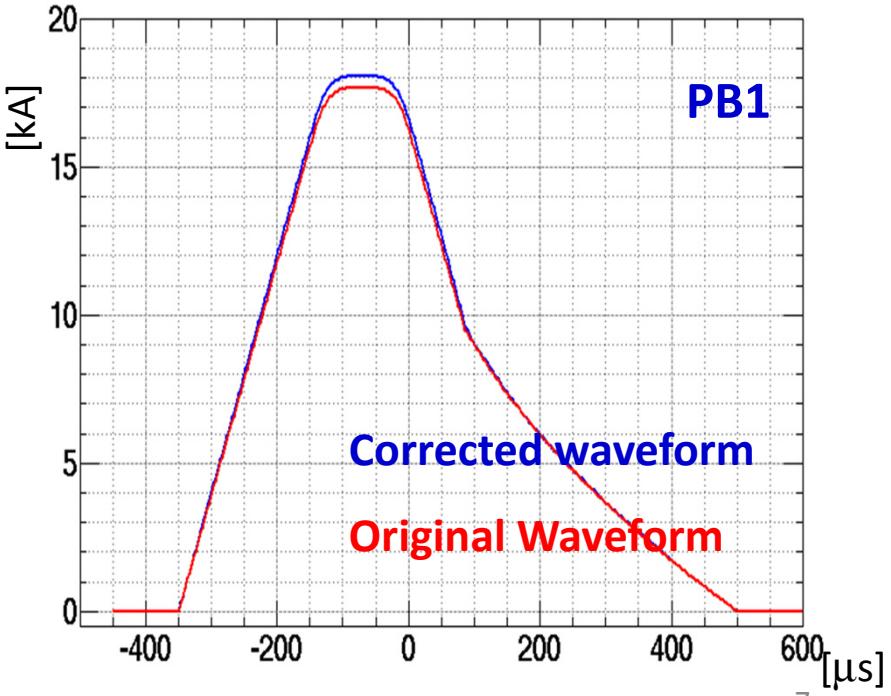
This talk focused on specific upgrades for:

- LINAC4 to PSB transfert line
- PSB: New H- charge exchange injection.
- PSB to PS: transfer and Injection at 2 GeV for protons
- SPS: Improved injection system and intercepting devices.

“Injection Painting Improvements in the JPARC RCS” (Sinichi Kato)

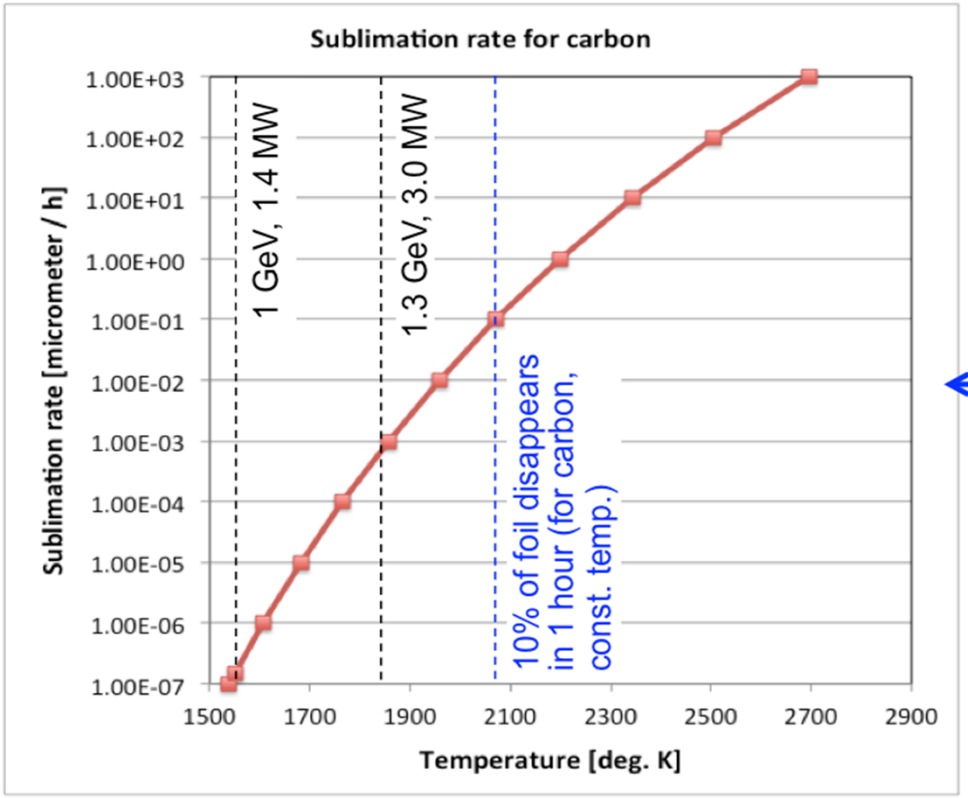
- Improved control of injection painting through response measurements and automated control of of injection magnets.
- Improved adjustment and control of painted beam area.





"H- Charge Exchange Injection Issues at High Power" (Mike Plum)

- SNS injection carefully designed to avoid H^0 excited state loss.
- Unexpected damage from convoy electrons in injection regions.
- Concerns over foil sublimation at future higher powers due to larger uncertainty in present foil temperatures.

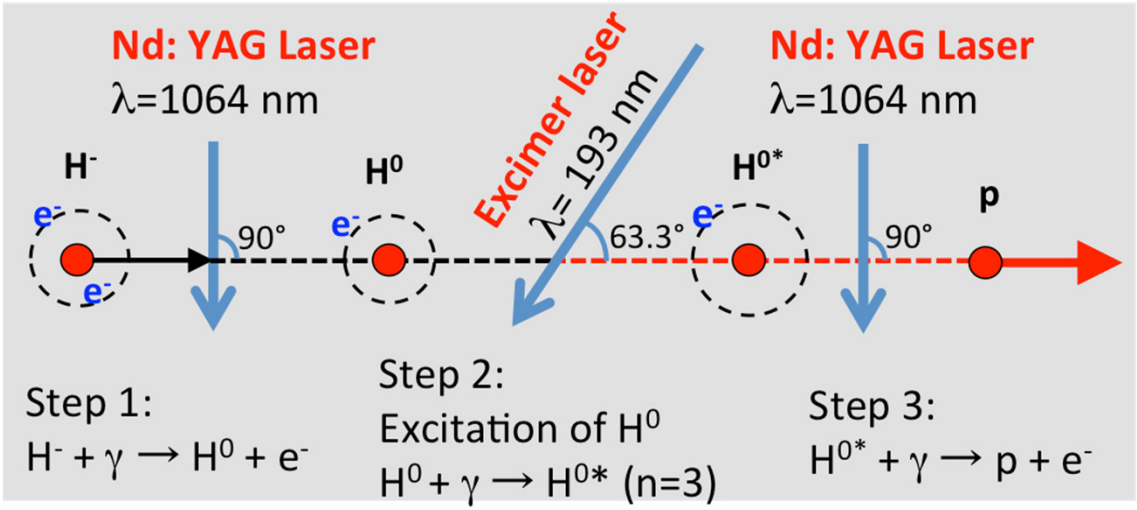


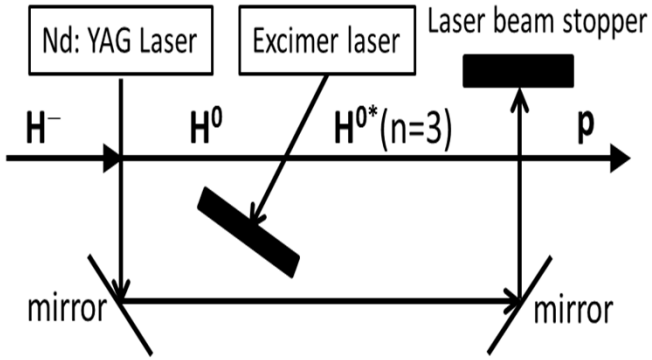
Sublimation rate increases by factor of 10,000 for 300 K temperature increase.

Note: Big error bars on predicted foil temperatures! Lots of assumptions.

Measurement of absolute foil temperature is in progress

"An Experimental Plan for 400 MeV H^- Stripping to Protons Using only Laser Systems" (Pranab Saha)



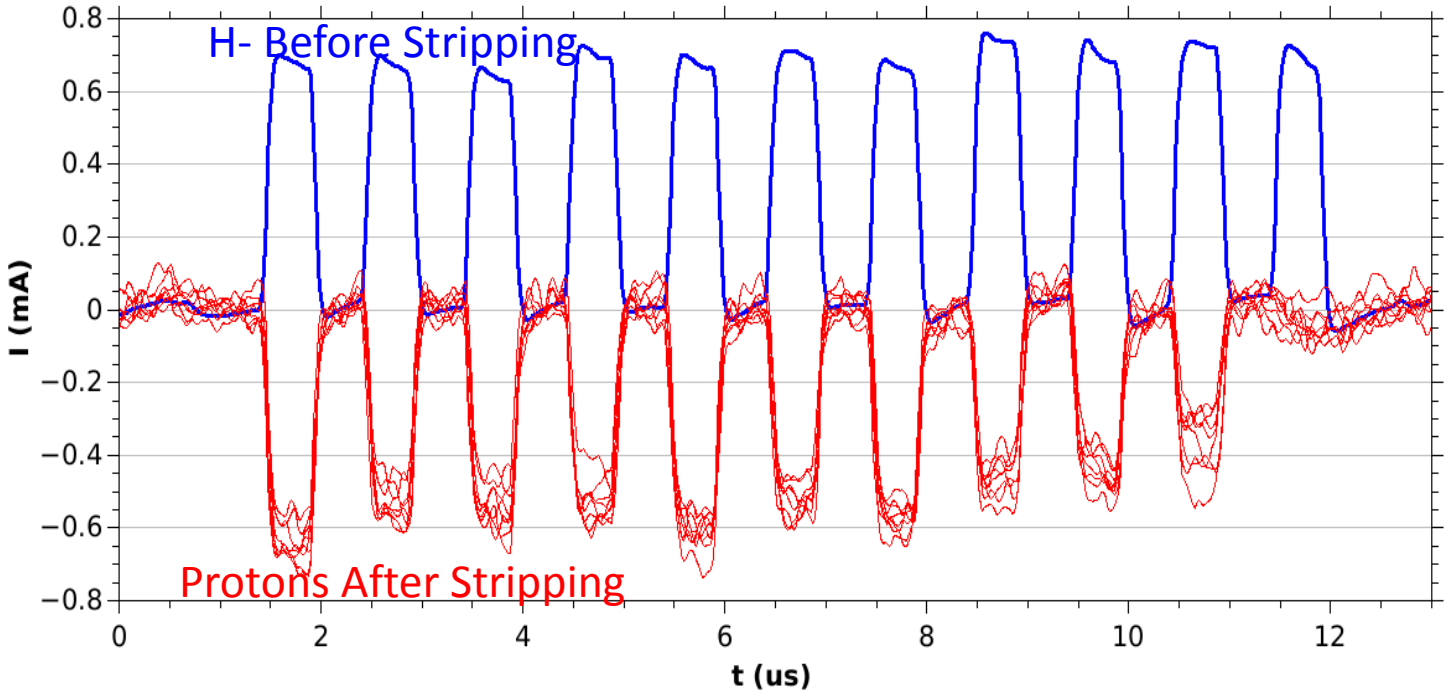


Setup for the POP experiment

- JPARC plans laser stripping proof-of-principle using laser only system.
- First step photo-detachment by laser confirmed.
- Target date for experiment is fall 2017.

“First Results of laser-assisted H- Stripping of a 10 µs, 1 GeV Beam at the SNS Accelerator” (Sarah Cousineau)

- Demonstrated laser-assisted H- stripping in march 2016:
  - 987 MeV
  - 10 us pulse
  - Stripping efficiency >90%



HB2016 : WG-C Accelerator Systems

Tuesday 06/07/2016 session:

Accelerator Systems Ring Session Areas of Focus:

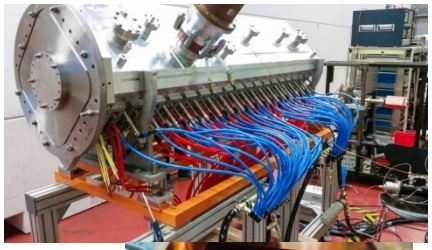
- Beam Instability Feedback
- Upgrades to Injectors
- H- Charge-Exchange Injection:
  - Challenges with H- Charge Injection
  - Injection Painting
  - Development of Laser-Assisted H- Stripping

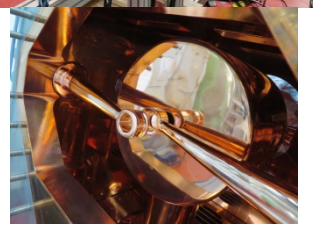
HB2016 : WG-C Accelerator Systems

Wednesday 07/07/2016 session:

1. Rudolf Tiede, IAP, Frankfurt am Main, A coupled RFQ-IH-DTL Cavity for FRANZ: A Challenge for RF Technology and Beam Dynamics. WEAM1Y01
2. Zhencheng Mu, IHEP, Beijing, Overview of the CSNS Linac LLRF and Operational Experiences During Beam Commissioning, WEAM2Y01
3. Qingzi Xing, Tsinghua University Beijing, Present Status of the High Current Linac at Tsinghua University and Its Applications, WEAM3Y01
4. Patxi Duthil, IPN Orsay, Design and prototyping of the Spoke Cryomodule for ESS, WEAM4Y01
5. Youjin Yuan, Institute of Modern Physics/Chinese Academy of Sciences, Lanzhou, Study of Analyzing and Matching of Mixed High Intensity Highly Charged Heavy Ion Beams, WEAM5Y01
6. Rama Calaga, CERN, Geneva, R&D on Crab Cavities for the HL-LHC, WEAM6Y01
7. Heine Dølrath Thomsen, Aarhus University, Aarhus, The Beam Delivery System of the European Spallation Source, WEAM7Y01

“A coupled RFQ-IH-DTL Cavity for FRANZ: A Challenge for RF Technology and Beam Dynamics” (Rudolf Tiede)





Outline:

- FRANZ Project Overview
- RFQ-DTL coupling: options, simulations, measurements
- Status RFQ and IH-DTL cavity
- Beam dynamics issues

Conclusions:

- New coupled RFQ-IH-DTL for the FRANZ project: proton at 50 mA from 120keV to 2MeV in CW operation.
- Basic structure parameters and characteristics of the coupled cavity operation defined
- Detailed numerical simulations done
- All components delivered (tuned and RF conditioned separately)
- Preparation for the coupled mode operation
- Extended error study is under preparation (feed back with the final results of the achieved coupled cavity tuning accuracy)

“Overview of the CSNS Linac LLRF and Operational Experiences During Beam Commissioning” (Zhencheng Mu)

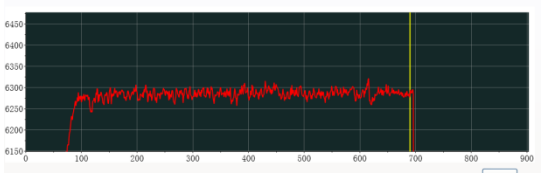
Outline:

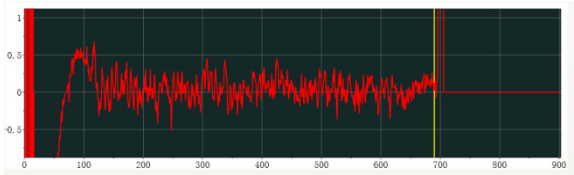
- CSNS Linac RF System
- Digital LLRF Control System
- Summary

The Linac RF power sources hall

Conclusions:

- Large work have been done : building, developments, fabs, installation, tests
- Two linear power supplies of the LLRF cabinet are ever broken, we need more time to decide if we should change them all.
- Long term stability of the LLRF system need time to test.
- In the future, improvement of the system with chassis and CPU, may be cPCI, vxworks OS.

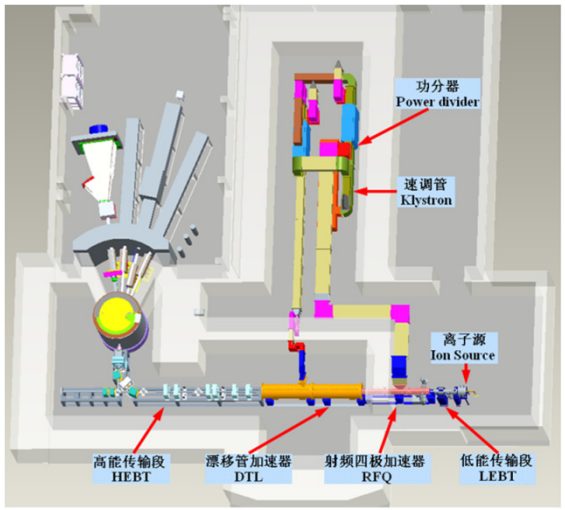




“Present Status of the High Current Linac at Tsinghua University and Its Applications” (Qingzi Xing)

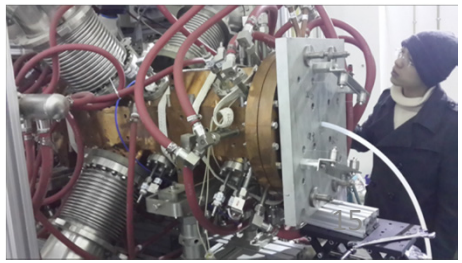
Outline:

- Compact Pulsed Hadron Source (CPHS) Linac configuration
- Operation Status
- Maintenance and Upgrade
- Applications

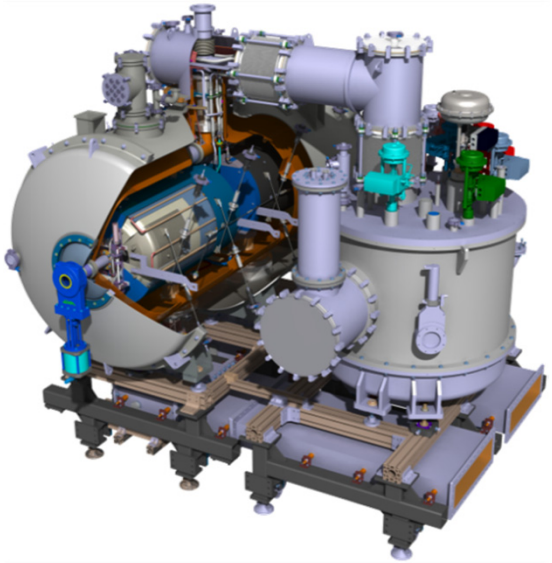


Conclusions:

- Users welcome to CPHS facility at Tsinghua University
- Facility provide 3 MeV proton beam and neutron beam
- A proton irradiation station is planned at the end of the straight line of HEBT
- The beam energy will be upgraded to 13 MeV in the year of 2017
- Challenge still exists for achieving the designed values



“Design and prototyping of the Spoke Cryomodule for ESS”
(Patxi Duthil)



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Outline:

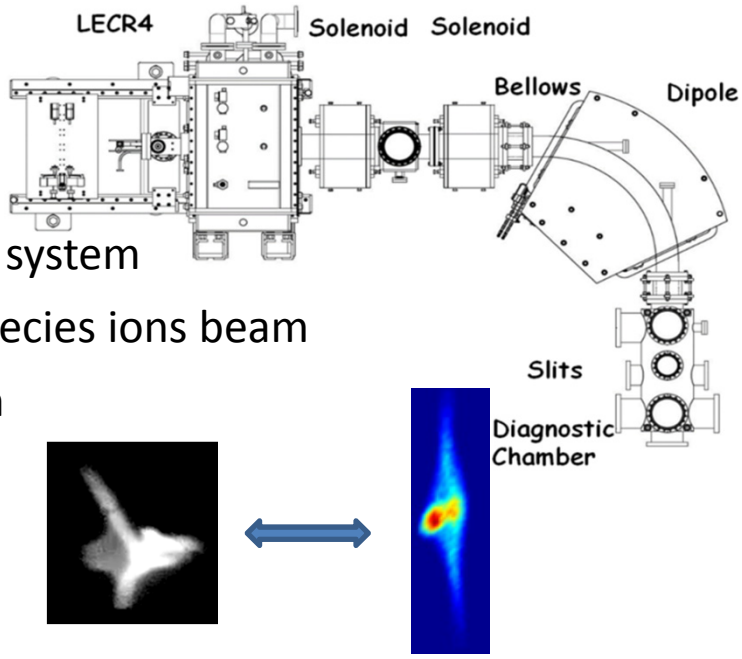
- Conception of ESS Spoke Cavities
- Status of the Superconducting Radio Frequency (SRF) spokes cryomodules

Conclusions:

Crymodule components: received and tested

- Cavities : 3 proto manufactured and well tested, Q_0 decrease observed after several thermal cycles
- Couplers : 4 prototypes manufactured : 1 failure/1conditioned/2 to be done
- Assemblies of subparts tested
- Assembly of the cryomodule started with a string of 2 mock-up cavities : test the assembly procedure, validate the magnetic shield and the cryogenic process
- Spoke prototype valve box: perfom the first cryogenic test at IPNO

“Study of Analyzing and Matching of Mixed High Intensity Highly Charged Heavy Ion Beams” (Youjin Yuan)



Outline: New HIRFL with new injectors

- Problems observed in the previous A/Q selection system
- PIC simulation of space charge effects of multi-species ions beam
- Modified A/Q selector for high intense ions beam
- Beam experiments

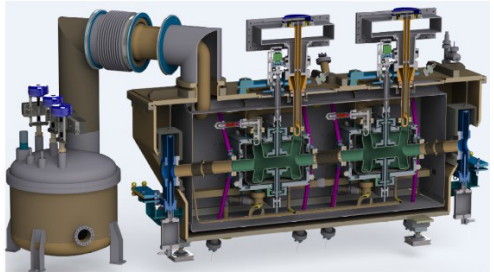
Conclusions:

- For high intensity high charge state ECRIS that required by future heavy ion accelerator projects, Q/A selector is still very challenging task.
- Space charge field of mixed heavy ion beams plays key role in the beam “hollow” formation.
- Double solenoid scheme is proved to be able to eliminate the beam “hollow” formation and reach good momentum resolution.

”R&D on Crab Cavities for the HL-LHC” (Rama Calaga)

Outline:

- Parameters and performances of the crab cavities for HL-LHC
- Prototyping, production, treatment
- He Vessel
- Tuner, coupler and amplifier
- Assembly
- SPS installation for tests



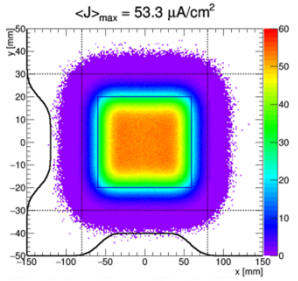
Conclusions:

- The R&D towards the SPS beam tests is a vital step before their implementation in the LHC.
- Several new & novel concepts for the cavity/cryomodule components due to complex requirements for the LHC
- The new class of deflecting cavities have become an important part of the SCRF community and will play a strong role in beam manipulations in many future machines

”The Beam Delivery System of the European Spallation Source”
(Heine Dølrath Thomsen)

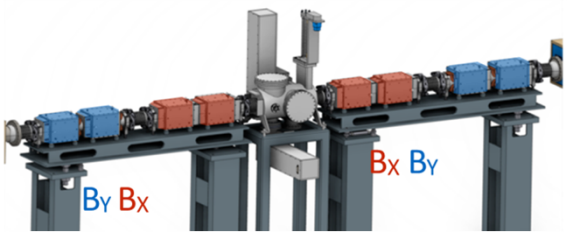
Outline:

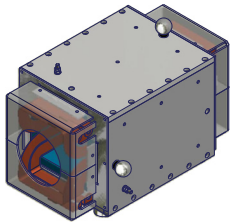
- Problematic of the high power beam to ESS on target
- Comparison of Raster Scanning Magnets (AC) % Non-Linear Magnets (DC)
- Specifications of the raster scanning magnet (RSM) system to ESS

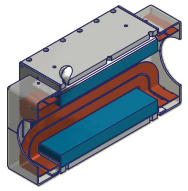


Conclusion:

- To concept of the uniform beam analyzed for ESS
- ESS raster experience :
  - Advantages: linear, intensity reduced considerably, decoupled tuning
  - Drawback: supply complexity, fault detection unit
- ESS fast raster magnet : redundancy (4dipoles X, 4 in Y), f=10kHz-40KHz, robust (according incident beam), useful for ADS
- 2 pre-series magnets will be available in 2017
- Full production of the system in 2018







HB2016 : WG-C Accelerator Systems

Wednesday 07/07/2016 session:

Remarks/Comments :

- Various project concern : FRANZ RFQ-IH-DTL, CSNS LLRF, status of the Tsinghua HI Linac, Spoke cavities for ESS, Upgrade of Q/A selector LEBT at IMP, crab-Cavity R&D at for HL-LHC, beam raster system for ESS
- Peoples and team are enthusiasts and motivated
- Not easy to make a transverse conclusion (may be except for the case to LEBT at IMP/CAS which can be linked with the conclusion to WG-B)