Review on PSB 160 MeV H- Injection

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Closeout

by P. Cruikshank, M. Giovannozzi,
D. Johnson, B. Jones, B. Pine, M. Plum, D. Tommasini

Overall

- The world's most complex ring injection system is about to become more complex…
- But if anyone can do it, CERN can
- No show stoppers found in the material that was presented
- Very high quality work
- Thank you for the excellent presentations and the great hospitality

PSB H- Injection Concept

- Congratulations on a design that meets the extremely tight space constraints.
- The maintainability, accessibility, upgradability will be difficult in this area.
- If there is a significant advantage, it may be reasonable to consider building shorter main dipole magnets to free up some space.
- Concern about non-zero dispersion option, due to linac energy jitter and longitudinal painting causing the injected beam to move on the foil
- We believe it is important to have a good understanding of the PSB optics prior to installation. Suggest measuring lattice functions prior to installation. Need to have this capability after installation anyway.
- Also could benchmark simulations of existing ring. Space charge simulations and benchmarking would be useful.

Chicane Magnets

- Biggest issue in this project seems to be the chicane magnets.
- These magnets create large lattice distortions, due to a vertical quad component, which needs compensation. The present design also requires large (0.8 m^3) transformers in the tunnel.
- Options discussed:
  - 16 supplies, which gives the maximum flexibility, but at a high cost
  - Put all chic. #1 magnets on one supply, etc. (4 supplies)
  - Put all chicanes in one ring on one supply (4 supplies total)
  - Optimization study needs to be performed.
- There were questions on the best way to correct the beam steering through the chicanes.
  - Are separate trim supplies and trim magnets required? (Case of multiple magnets on one supply)
  - Can this be done with the existing ring dipole correctors?

Chicane Magnets (cont.)

- Recommend 3D field calcs with all chicane magnets together from one main dipole to the next main dipole, followed by particle tracking through these fields.
- Recommend exploring the option of increasing the number turns on the chicane magnet windings and optimizing fall time (now 5 ms to allow quad compensation tracking). May be able to get rid of those big (0.8 m^3) transformers in the tunnel.

KSW Painting magnets

- Question: is it possible to reverse the bump to keep the beam off the foil?
- Suggest fabricating new kickers with RF screens (option 2). It seems the budget will accommodate this.

Internal H0/H- Dump

- Make dump as short as possible to improve aperture and clearance issues. Consider higher density materials and/or composite materials.
- Do not support dump on metal plate due to eddy current effects. Is it practical to have any support?
- Baking dump is a complication. Make sure that really need to do it. May just be able to use cooling system to heat. May be able to use beam to heat it. This will influence choice of graphite material.
- Four sigma clearance between dump and circulating beam seems tight. How well the injected beam angle can be measured and controlled is a related concern.
- Suggest evaluating contribution of the graphite dump to the machine impedance.

Injection foils and handling system

- The work to date is impressive to fit the mechanism into the available space
- Prototype foil changer seems to be working well. Some details left to work out (e.g. method to accommodate bellows sag).
- There was a lot of discussion on the idea of a mechanism with just one foil, with no clear consensus. May want to re-evaluate this issue.
- Make sure that can change one foil at a time

PSB H- Injection Vacuum analysis

- The design integration is a work in progress
- The graphite beam stop options need to be known so the material can be selected, and its outgassing properties characterized
- Make sure have vacuum monitoring and interlocks on all closed volumes

Beam instrumentation

- Make sure that have a good method to measure beta function and beta beating.
- Measuring (or estimating) the angle of the injected beam at the foil is desirable to ensure proper injection and clearance of the circulating beam at the dump. Maybe measure current on "polarizing rings," or may want to consider other methods such as segmented foils in front of the dump.
- Loss monitor coverage (~1 every 10 m, for two rings) seems a little thin.
- Video system to look at view screen and foil is very conceptual at this point and difficult to evaluate.
- Consider upgrading BPM system prior to installation to allow optics function measurements of existing machine.

Beam losses

- 5% beam loss predicted by simulations. This is high compared to other machines. Why?
- There was some discussion on a ring collimation system, with no clear consensus at this time. Outside the scope of this review.

Relative beam loss

	Injection	Acceleration	Extraction
PSR	0.15 - 0.20%	0	<0.03%
ISIS	1%	8%	0.01%
SNS	0.01%	0	<0.0005%
J-PARC RCS (design power)	0.05 - 0.1%	0.01 - 0.02%	<0.0005%
J-PARC MR (design power)	1.10%	0.40%	<0.0006%
PSB (LHC beam)	45 - 50%	2 - 3%	6-8%
PS (LHC beam)	<2%	<1%	1.0%
SPS (LHC beam)	3 - 4%	4 - 5%	0.1%
LHC	0.01 - 0.1%	0.1 - 0.2%	0.01 - 0.1%

Note: does not include beam loss in beam transport line collimators

Commissioning strategy and timeline

- Six months for installation and commissioning seems tight and has little to no contingency
- The greatest risk is in the commissioning due to the difficulty in predicting how long it will take. Commissioning schedule will likely be dominated by equipment performance and availability.
- Consider preparing for installation in advance. Need to finalize the remaining design choices in order to accomplish this.

Conclusions

- Project is in good shape for this stage of the game, for installation that could begin as early as 2015.
- Some systems are well along in the design phase, some are still conceptual.
- Some major decisions are still to be made
  - How to power the chicane magnets – 16 supplies, or 4 (all chicane #1's together, etc.) or 4 (all chicanes in 1 ring together)
  - Inconel vs. ceramic vacuum chambers
  - Can the wall be cut away to relieve the space constraints? This will have an impact on the design choices.
  - Suggest setting a deadline for when the outstanding designs should be complete