Review on PSB 160 MeV H- Injection

Follow-up

PSB H- Injection Concept (Brennan)

See EDMS 1184275

- "Investigate building shorter main dipole magnets to free up some space" – interesting if can extract waste H0/H- beams, but concern on impact for overloaded MSC group and on machine lattice. Action 1: Investigate possible gains from shorter dipoles, conclude and decide – BG, WW for 16/12/11

See EDMS 1184275,

"Concern about non-zero dispersion option, due to linac energy jitter and longitudinal painting causing the injected beam to move on the foil". This is a known issue with impact on aperture and foil hits – can revisit aperture assumptions to make sure correctly accounted for. Presently long painting used in all simulations. Action 2: check apertures with longitudinal painting and jitter, at injection elements, present conclusions – CB, BG for 16/12/11

Comment CC

Spring 2014 : the PSB will restart with the new system

"Important to have a good understanding of the PSB optics prior to installation. Suggest measuring lattice functions prior to installation". This means need turn by turn BPMs for before LS2. Action 3: check with BI when BPM upgrade is planned – BM for 16/12/11

- "benchmark simulations of existing ring. Space charge simulations and benchmarking would be useful." Was attempted but not clear if conclusive – Action 4: dig out benchmarking simulations for present PSB – CC for 16/12/11

Chicane Magnets (Jan B, David N.)

- "Biggest issue in this project seems to be the chicane magnets. (and their powering)" Yes we agree – we need to decide this very quickly. Constraints are number of transformers, difficulty of >2 turns for BSW1, flexibility in powering (e.g. for bump closure but also for beam separation at dump). The proposal now is
  - a) all magnets individually powered
  - b) BSW1 to be 2 turns (2 x 1 turn half-magnets)
  - c) BSW2-4 to be 8 turns
  - d) 4x transformers installed in tunnel for BSW1
  - e) 12 x 'conventional' PC at 4kA for BSW2-4.
  - f) ceramic chambers

Comment DA

- Action 5: investigate whether magnets 2 and 3 powered in series gives enough flexibility, as an optimisation – BG, CC, CB for end Feb 2012
- Action 6: investigate whether powering all 4 rings (or 2 outer and 2 inner rings together) is acceptable, if KSW –ve bump works – BG, CC, CB for end Feb 2012
- Action 7: in view of feasibility et. agree on final chicane magnet concepts and powering proposal – JB, BB, DN, WW, BG, CC for end Fed 2012.

Chicane Magnets (cont.) (Jan B, David N.)

3D model simulations ongoing, preliminary results show no cross-talk between BSW magnets. Also there is no influence of the main dipoles to the BSW found. nevertheless, perturbations of the BSW1-4 magnets on the main dipole fields is very likely.

"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." Very good suggestion – now already launched with BB&JB. Seems easiest to make particle tracking (basic) inside OPERA – in absence of ORBIT-PTC. Action 8: complete 3D model of full injection region including ends of the adjacent dipoles, and use for basic particle tracking to validate trajectories, apertures and bump closure, and also effect of chicane on main dipole fields – BB/JB/BG for end Feb 2012

- "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." This goes together with decision on chicane powering and magnet types – fall time of 5 ms is not magical and just needs to be long enough to allow tracking by trim quads. The baseline ceramic chamber should be technologically possible. Action 9: summarise technical feasibility of ceramic chambers to confirm decision – WW/JB/VSC for 16/12/11.

Market Survey yielded several possitive replies.

KSW Painting magnets (Luis M.C.F.)

- "Is it possible to reverse the bump to keep the beam off the foil?" This is a nice idea – we would need about 30% of the nominal kick, in the other direction, for about 1 ms after injection (to give the 46 mm BSQ chicane time to fall by about 10 mm or 20%). It would mean we can relax a bit about only having the KSW to move the beam off the foil. Action 10: ABT experts to check feasibility of such a change, then present conclusions for decision on baseline – GG/CB/CC/BG for 16/12/11.
- "Suggest fabricating new kickers with RF screens (option 2). It seems the budget will accommodate this". Fully agree. Is there still some issue about choice of KSW powering? Action 11: investigate and decide powering schema, and formally decide on Option 2 (new KSW ex-vacuum magnets) – LCF/WW for 16/12/11

Reverse KSW bump seems feasible, a first solution was proposed by GG (see slides Current_generator_KSW_PSB_NegBump).
In principle any pulse length from 0 to many milliseconds is possible. The amplitude can be from 0 to several 100A. A slow decay to zero either linearly or exponentially (or any other function as long as it is slow) would also be possible.

Internal H0/H- Dump (Cesare)

- "Make dump as short as possible to improve aperture and clearance issues. Consider higher density materials and/or composite materials." Yes, agreed.
- "Do not support dump on metal plate due to eddy current effects. Is it practical to have any support?" Agree. Avoid in design
- "Baking dump is a complication. Make sure that we 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." Agree. Linked to vacuum performance of material.
- Action 12 – organise regular technical follow-up meetings of dump integration into BS4 with MME and BI, Monday meetings: WW for 16/12/11
- "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." Agree – need some realistic simulations of envelopes and trajectories in this region : Aperture at dump under realistic assumptions – needs 3D modeling of fields (include in actions 2 and 8)
- "Suggest evaluating contribution of the graphite dump to the machine impedance." Agree – but this is a general point for all injection elements: Action 13 - request estimates of impedance effects of new equipment with designs, and provide input to impedance team CC/WW for 16/12/11

Injection foils and handling system (Wim)

- "Idea of a mechanism with just one foil, with no clear consensus. May want to re-evaluate this issue". Design already well advanced based on initial specification including several foils – still seems preferable if possible. Also may need to mount BTV screen(s) on the foil changer (see BI part):
- Action 14 – clarify BTV design and integration with foil unit urgently (starting with regular follow-up meetings on Mondays) - WW/BG/JT/EB/RV/VSC for end Feb 2012
- Action 15 – organise controls changes for repetitive movement tests including stop/start for foil changer – WW/ABT-EC for 16/12/11
- "Make sure that can change one foil at a time". Agreed – needs to be done through the small BN150 port. Action 16 – investigate changing single foils with mock-up of changer unit – WW/RN for end Feb 2012

Mechanical design and modification of prototype has been completed for these tests, waiting for support from ABT-EC to modify the controls system.

PSB H- Injection Vacuum analysis

(Chiara P., Jan H.)

- "Make sure have vacuum monitoring and interlocks on all closed volumes" Good point. Action 17 – check vacuum layout and design, especially in foil changer region, and ensure all necessary control inputs are present – VSC/WW for 16/12/11

Comment JH

Beam instrumentation (Jocelyn)

- "Make sure that have a good method to measure beta function and beta beating. Consider prior to installation to allow measure existing machine."Needs turn-by-turn pickup data, which implies orbit system upgrade. Also excitation method (can only use injection oscillations at 160MeV). Action 18 – check expected availability/specs of turn-by-turn orbit data, check with optics measurement team about measuring betas, and also status (+future) of Q-kicker (to ABT?) – KH/BM for 16/12/11
- "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". Yes this is a good point – some ideas were suggested (using split foils or the dump measurement polarising rings). Action 19 – investigate with BI the possibilities of determining injected beam angle at foil – BG/CC/WW/JT for end Feb 2012
- "Loss monitor coverage (~1 every 10 m, for two rings) seems a little thin." This is not specifically linked to injection but should be followed up.
- Action 20 – review integration of BLMs in injection region – CZ/JT/WW/BG/BM/... for end Feb 2012
- "Video system to look at view screen and foil is very conceptual at this point and difficult to evaluate." Agreed – major issue - there is not even a basic engineering concept decided for this: Provide the design integrated with (and possibly using) the foil changer (see Action 14)

5% losses applies for an imperfect compensation of the perturbation induced by the chicane. Dominant losses for perfectly compensated chicane are longitudinal and likely limited to 1-2 %.

Beam losses (Christian)

"5% beam loss predicted by simulations. This is high compared to other machines. Why?" Also was stated that 'only' source of loss is foil scattering. Need to understand where the differences come from – are they from the simulation assumptions and parameters or real effects? Action 21: investigate (with experts from other machines) beam losses in simulation – what is fraction from foil scattering, are we using enough macroparticles CC/CB/new VIA for end Feb 2012 (later?)

- Action 22: what are effects of field imperfections in BSW magnets, and is proposed magnet quality acceptable – CC/new VIA, for end Feb 2012 (later?)
- "There was some discussion on a ring collimation system, with no clear consensus at this time. Outside the scope of this review." Still needs to be addressed (beamscope window?): Action 23 – find support from ABP (collimation?) for studies in PSB for ring collimation KH/CC for 16/12/11
- Injection line collimation was also discussed but not concluded on – was stated that it should be available for commissioning to make life easier: Action 24 – review need and plans for injection line collimation to reduce losses at injection elements and ease setting up – BG/CB/CC/STI for end Feb 2012.

Commissioning strategy and timeline (Bettina)

- "Six months for installation and commissioning seems tight and has little to no contingency. Consider preparing for installation in advance. Need to finalize the remaining design choices in order to accomplish this." Fully agree that this is a major concern – need to carefully plan to finalise design choices, plan production and testing, advance any possible installation or preparation work, and define equipment availability dates. Action 25 – define which design choices are still lacking and deadlines for decision – WW/BG/CC/BM/JB/DN/JT for 16/12/11

  Action 26 - organise installation and commissioning preparation meeting with all concerned groups; objective to produce draft planning, and to propose work for LS1 where possible – BM/WW/PB for end Fed 2012
- On related topic need to make sure all tools for commissioning are in place. Action 27 – identify and check status of all required commissioning tools with long lead times like OASIS signals –BM/BG for end Feb 2012

Conclusions

This is 'impossible' supporting wall of main cross-beam and complete dismantling of region would be required during intervention.

"How to power the chicane magnets – 16 supplies, or 4 (all chicane #1's together, etc.) or 4 (all chicanes in 1 ring together)". To decide – see Actions 5

"Inconel vs. ceramic vacuum chambers." Baseline is ceramic – this is decided, see Action 7

- "Can the [tunnel] wall be cut away to relieve the space constraints? This will have an impact on the design choices." To check. Action 28 – investigate civil engineering in injection region for more space – WW/BM/BG/NG/KH for 16/12/11
- "Suggest setting a deadline for when the outstanding designs should be complete" Yes agree – as apart of a larger review of milestones and key deadlines.
- Action 29 – organise meeting with BI responsibles (RJ/JT/EB/BD/RV) to ensure deadlines and criticality is clear – KH for 16/12/11.
- Action 30 – organise a follow-up meeting in March (when all these actions should be complete), and engineering review in June – BG/WW/BM/JB/CC for 16/12/11

Initial meeting on 20/12/11, follow-up meeting to be planned.

PSB H- Injection Recview follow-Up on 20 March, 16.00h, 513-1-024.