



LHC Injectors Upgrade





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MD planning 2016

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E. Benedetto

With input from: S. Albright; M. A. Angoletta; H. Bartosik; A. Blas; M. Cieslak-Kowalska; G.P. Di Giovanni, A. Findlay; V. Forte, M. Fraser, G. Guidoboni, M. Jaussi, B. Mikulec, J. Molendijk, Y. Papaphilippou, G. Rumolo, F. Schmidt, G. Sterbini, R. Tomas, A. Valdivieso.



Major questions LIU

- Can we produce 2.8 eVs longitudinal emittance beams, within 220 ns, and transfer them to the PS?
 - Longitudinal emittance blow-up
 - Risetime recombination kickers
 - (PS injection&capture)
- Brightness curve
 - Optimization, Measurements and Code benchmark
- What is the effect of multipoles on beams (emittance, tails, losses)?
 - Building PSB linear & non-linear model
- Losses control and minimization
- Beam instrumentation and Hardware in view of LIU



Longitudinal Dynamics / LLRF (1/2)

* Quoting Alan, “Good starting point” of the RF team requests

- Longitudinal Blow-Up Studies (**8 days**):
 - Testing new features for blow-up 180ns, 1.8eVs reached last year
 - Investigating blow-up reliability
 - Study of maximum blow-up possible with high and low intensity beams
- **Blow-up to 2.8eVs (220ns bunch length), of highest priority for LIU**
 - to ease Space-Charge requirements @ injection and meet LIU/HL-LHC parameters
- Supported by simulation and measurements (by Simon)
- Hollow-bunches





Longitudinal Dynamics / LLRF (2/2)

* Quoting Alan, "Good starting point" of the RF team requests

- Finemet Reliability Run Studies (8 days, start in Jun):
 - Recommission R0 beam control with ferrite cavities,
 - Recommission Finemet cavity to replace C02 &/or C04,
 - Set-up Finemet cavity as C04 replacement for a reliability run on R4 of the ISOLDE beams.
- Alternative Phase Pick-up Studies (4 days, any time May to Sep):
 - Investigate if the operational phase pick-up in 14L4 can be replaced by the phase pick-up in 8L1 for all 4 rings.
- Measuring Relative Phase Between C02 - C04 (4 days, any time May to Sep)
 - Investigate methods of measuring the relative phase between the C02 & C04 cavities.
- Development & Upgrade Of Low-Level (5 x 4h, in Apr and May):
- Transverse Feedback (10 x 4h in May-Jun):
 - Test of the new digital processing @ 160 MeV and @1.4GeV



Transverse dynamics & LIU beam brightness

- Brightness Curve Optimization
 - Assess 2016 performance.
 - Coherent settings among the different rings
- Measurements for code benchmark & validation simulated curve with L4
 - Emittance as a function of injected parameters (WP, position/angle (*), KWS slope, L2 current), parametric scans

(*) needs understanding of the fluctuations @ the injection PUs



Transverse Beam dynamics (1/2)

- Effect of multipoles on beams & building PSB optics model
 - Tune scans for loss-maps
 - LOCO studies
 - Non-linear chromaticity and detuning with amplitude
 - Effect of the half-integer and of the integer on beam
- Turn-by-turn beam position measurements
 - **BTMS commissioning**
 - AC dipole excitation or Qmeter kicker
 - Characterization of the machine, tune ripple, instability @ 160 MeV, $Q_x=0.3, \dots$ (for full resonance driving terms need full BTMS, i.e. all the PUs)





Transverse Beam dynamics (2/2)

- Tail repopulation MD
 - Shaved and large emittance (i.e. scraped) beams
 - Diffusion coefficients, validation pyOrbit
- Instability at C378 (...that's about 160 MeV!!!):
 - As a function of bunch intensity, bunch length, chromaticity
 - Record intra-bunch motion with TFB PickUp
 - Look at risetime with Qmeter PickUp
 - In view of new simulations with pyHeadTail (+impedance model from C. Zannini)



Transfer to the PS (1/2)

- Measuring recombination kickers rise time:
 - Limitations in bunch length transfer (is 220ns possible?)
 - Short bunches ($\sim 10\text{ns}$) to probe kicker function:
 - Produced by desynchronizing KFA.14, longitudinal shaving or resonance-driven bunch shortening
 - Assess resolution of BPM, BTVs in the line for small intensities
 - Profit also of PS instrumentation (BPM, BLM, wideband PU)
 - Nominal bunch & transverse tomography & SEM grids to reconstruct kicker waveform
 - Long bunches (220ns, low $\Delta p/p$), measure in PS & TLine
 - Inject & dump at 50 MeV
 - Measure risetime using microbunches from the linac at 200 MHz
 - Assess feasibility





Transfer to the PS (2/2)

- 160 MeV extract and dump:
 - Can we use it for L4 connection commissioning start-up?
 - Assess feasibility
 - Check optics @ low-energy
- Optics changes in the BTM line:
 - New optics by J. Abelleira's (seems promising also for current extraction @1.4GeV)
 - Check losses and emittance measurement systematically
- BTY optics model validation:
 - Kick response measurements



BI related MDs

- BTMS commissioning
 - Fundamental as the plan is to have the new electronics already in 2017
- MDs to understand fluctuations in the injection PUs
 - Optics degeneracy
 - Impact on injection
- Energy and energy spread at injection
 - Time of Flight measurement in the injection line
 - How to optimize debuncher settings
- Emittance measurements
 - Wire scanners along the cycle
 - Extraction SEM grids (comparison with WS & review optics model)
 - Emittance difference evaluation with different lab calibration curves and with online calibration



MD page for MD requests



Conclusions

- Preliminary plan
- Already a dense program!
- Most of the MDs:
 - rely on the collaboration between many groups and different experts.
 - will have a positive impact on the present machine/ LIU will profit of optimization on the present machine
- Please submit your requests to the official web-page:
<https://md-coord.web.cern.ch/app/#/>



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