Motivation

- Aim of this meeting:
  - Starting from a rough list based on the work package presentation "PSB commissioning with Linac4"
  - Brainstorming on Booster commissioning with Linac4
- Define commissioning preparations, important steps and milestones of Booster commissioning with Linac4:
  - What is required for the different stages?
    - Beam properties, hardware, instrumentation ….
  - Possible problems, we may encounter
    - Anticipate cures ?
  - Procedures to make progress …
    - Hardware and measurements required (present priority)
    - Applications
  - ➢ Implications on hardware required (in particular instrumentation)
  - Estimate time needed for Booster commissioning and compare to general Linac4 schedule
- Later (after this meeting):
  - Further discussions and/or (depending on progress)
  - presentations to a larger audience

Before Commissioning with Beam

- Commissioning of the hardware required:
  - Hardware specialists with operations team for new equipments
  - Preparation of the Booster for higher injection energy (magnetic cycle?)
- Characterisation of the Linac4 beam in the LBE/LBS measurement lines
  - Measurement accuracy required: emittance, Twiss parameter, absolute accuracy of energy, energy fluctuations (shot-to-shot, within one shot)?
  - If necessary re-match of the line upstream of LBE/LBS and/or BI line
    - What Linac4 beam properties are required to start Booster commissioning
- Generation of appropriate Linac4 beam time structure
  - Setting up of 3 MeV chopping (with the final system for long. painting?)
  - Synchronization with injection equipment, in particular distributor, and possibly instrumentation
- Transfer of the beam to the PSB injection region
  - Beam structure and intensities?
    - Just enough for diagnostics … to avoid activation

Commissioning to nominal Performance (1/2)

- Commissioning to nominal performance:
  - Booster able to provide beams, which had been available before with Linac2
  - Expected to last about three months (Linac4 master schedule)

- Transfer low intensity beam through the injection region and first few turns
  - Proper steering, view screen in foil position
  - Beam structure: ~Half a turn to create a beam structure visible with Booster pick-ups
  - Multi-turn acquisitions for a few pick-ups to determine closure of bumps
    - Possible problem: beam does not make several turns
    - How to improve closure of bumps in case this is needed?
  - Matching: rely on LBE measurement and theoretical line or matching monitor needed?
- Establish injection and circulating beam
  - No problem expected:
    - Will happen once injection trajectories and orbit are adjusted properly (Provided Booster lattice is o.k.)
    - Injection of coasting beams at the beginning (no RF voltage)
  - Bump heights … ?

Commissioning to nominal Performance (2/2)

- Beam capture (with first low intensities injected?), acceleration and first ejections:
  - Similar (may be slower) to present -> no particular problems expected
  - First capture (and thus injections) on flat bottom?
    - Improved adiabaticity by slower capture (direct space charge not an issue at that stage?)
  - Possibly adjust Linac4 energy spread (larger than the one required with painting)
  - Acceleration and ejection
- Increase intensity (after capture and acceleration ?)
  - Iteratively:
    - Increase length of Linac4 beam injected ….. wholes to reduce the average beam current required??
    - Fine tuning (working point …) to keep losses at an acceptable level (which intensities feasible with injection of coasting beam followed by capture)
  - critical items: beam loss measurement, interlocks, foil position for safe operation
- Injection of large energy spread beams (within commissioning to nominal performance?)
  - Injection into waiting (double harmonic?) bucket
  - No active longitudinal painting, but large energy spread to fill bucket (for intermediate intensities where painting is not practical)
  - To what extent can the energy spread be adjusted (by debuncher setting?)?

Commissioning to ultimate Performance (1/2)

- Commissioning to ultimate perf. (2nd stage of Booster commissioning with Linac4):
  - Aims at making profit of Linac4 to provide beams not yet possible with Linac2
  - Expected to start immediately after re-commissioning to nominal performance, i.e. about three months after starting the Booster with Linac4

- Setting up of first longitudinal painting
  - Setting up of energy ramping
  - Setting up of chopping for longitudinal painting
    - Verifications in LBS (spectrometer): time and energy resolution required?
    - Just complex application … or dedicated system to be commissioned
  - First longitudinal painting on flat bottom (easier)?
- Increase of intensity and/or beam brilliance by
  - Iteratively
    - Increase the number of injected turns and energy modulation periods
    - fine adjustments (e.g. dynamic working point) to optimize performance and to minimize beam loss
    - Verification that losses stay at acceptable level
  - Move to injection onto the ramp
  - Problems: excessive losses and activation?

Commissioning to ultimate Performance (2/2)

- Transfer of higher beam intensities to ISOLDE
  - May be done relatively quickly once high intensity can be accelerated
  - No dedicated setting up at high energy
- Setting up of single-batch PSB to PS transfer for nominal 25 ns LHC beams
  - Special longitudinal gymnastics in the PSB with increased intensities
  - Transfer to and gymnastics in the PS (fast blow-up and/or bunch rotation to limit duration with very large direct space charge tune shifts ..)
- Delivery of PS high intensity ("CNGS like") beams with improved performance
  - Can PS profit from better tunability of emittances (painting procedures, alleviated direct space charge forces)?