SYNCHRONIZATION LINAC4 - PSB

E. Benedetto,
Discussions with: M.E. Angoletta, C. Carli, A. Findlay, B. Mikulec, J.L. Sanchez Alvarez,
Outline

• Intro
• Status of the discussions
• Planning
• Conclusions

• References:

A. Blas,
PSB with Linac4 – RF matching,
Presentation at LIU-PSB meeting 24/4/2013

C. Carli et al.,
Synchronization between Linac4 and PS Booster,
CERN-ATS-Note-2010-052
Introduction: why to synchronize L4-PSB?

- Chopper will allow injection into PSB bucket
  - Reduced losses @injection due to a not-so-adiabatic capture
  - Need synchronization with Train-RF to inject (BeamON) at the right phase and have BeamOFF when the unstable phase is.

- Longitudinal painting (for high intensity beams)
  - To fill homogeneously the longitudinal phase space
  - Energy modulation + chopping pattern to be defined per ring
  - Energy spread to be adjusted by Debuncher

- 1 to 150 turns injected
- LHC beams 20-30 turns
- ~60% chopping factor (in h=1+2)
How to synchronize

1. Energy matching:
   - mean Linac4 energy is fixed and result of optimization
   - PSB RF frequency and B-field adjusted to center the beam in the vacuum chamber and to adjust the synchrotron energy to the given Linac4 energy

S. Hancock, Tomography at Injection in the PSB, CERN-ACC-NOTE-2016-0040
How to synchronize

2. RF frequency Reference generated:
   • Rings synchronized among themselves
   • Signal sent to the Chopper, Debuncher and distributor

3. Injection into an accelerating bucket (non zero Bdot)
   → Drift in the synchronous energy
   → Drift in the Frev
   → Drift in the Bfield (1.2G/100turns, B_inj=2311G)
   → Drift in the mean radial position

Allowed: $\Delta r \sim 1\text{mm}$, $\Delta E \sim 20\text{keV}$, $\Delta B \sim 1.7\text{G}$, $\Delta f \sim 45\text{Hz}$

Solution:
• RF frequency is kept constant and Bfield is adjusted with BdI
• Transition from F_inj to B-train

Recently improvement deployed in the PSB LLRF, by M.E. Angeletta
How to synchronize

Injection at a fixed frequency (100 turns injected)
Longitudinal painting

- Need to define (PPM):
  - Voltage in PIMs cavities 11+12
  - Debuncher amplitude and phase
  - Chopping pattern
- OP cruise control application (see JLSA presentation) should deal with differences:
  - From one ring to the next (e.g. EAST+Tof parasite)
  - For different Users (PPM)
  - From one shot to the next (i.e. variation # turns, Interlock, External conditions)
What else? …a look at the transverse plane

- KSWs need to be synchronized with Start Injection
- BSWs, Q-strips are less stringent, since ~5ms

- Bdl need:
  - To be synchronized with Start injection
  - To pulse twice in a cycle

- Again it should be incorporated in the OP cruise control application
Summary and Next steps

• Very good references, but dating from 2010 and 2013
• A lot of expertise, but few people about to retire
• This is the status of the discussions one-to-one so far… (still need to talk to A.Blas and other experts, though!).

Plan:
• Start a series of meetings, ~every 2 weeks:
  • The first tentatively planned for the 20\textsuperscript{th} of October.
• Write an up-to-date reference document (EDMS):
  • First draft by ~end of 2016
Back-up solution…

- In case of an early connection/ early stage of the commissioning…
- Inject in coast + adiabatic capture (like today)
- Inject in a stationary bucket
LHC Injectors Upgrade