High Bandwidth damper

Input from W.Hölfe

Acknowledgement to all collaborators at SLAC, INFN, LBNL and CERNL

Presentation of recent MD results (J.Cesaratto):

http://www.slac.stanford.edu/~meeg/g_ecloud/Meetings/20120809/MDreview_Aug09.pdf

R&D and staged implementation: The Path (1)

Boundary conditions:
LS1: 2012
LS2: 2017+

Phase 1: The demonstrator → end 2012
goal: damp head tail motion of single bunch
existing equipment (amplifiers, BPWs as kicker and PU)
"drive experiments" successful
electronics (LARP), close FB loop before end of 2012

all design specifications for phase 2: end of 2012

Phase 2: New pick-up, new kicker, consolidated electronics,
higher power amplifiers,
preparation of LSS3 in LS1 for installation of equipment
at the end of LS1 or later in a short winter shutdown post-LS1
feedback on multi-bunch beam in presence of e-cloud
decide on final implementation and LSS3 vs. LSS5 before LS2

MD results obtained in 2012

- Synchronized excitation signal to the bunch.
- Established method by which time aligning can be performed quickly and reproducibly, using variable delay line.
- Excited the beam with band-filtered random noise.
- Excited beam to instability, different modes.

2012 MD slots still needed with LARP participation

- *LARP meeting in Frascati 14-16 November 2012*
- *1st slot:* Beginning of October or before above November LARP meeting*: fine timing, excitation of bunch in a train*
- 2nd slot: As late as possible, weeks 47 and 48 after LARP meeting: *tests of new hardware for "demonstrator" to close FB loop*

Other 2012 MD slots needed

- One dedicated MD with bunch trains at 25 ns
- MDs to check the developed hardware orbit compensation (Urs Wehrle)
- Note: any MDs next year (26 GeV) would be extremely useful (consolidated Hardware) for extended demonstrator tests and prototype specification.

Addressing the specific questions…

- **Which studies will still require significant MD time before LS1?**
  - **List of topics given above**
- **Is any study presently limited by instrumentation or diagnostics? Any improvement possible before LS1?**
  - **Limited by speed of HW development and availability, rather than intrinsic SPS instrumentation**
- **Is any study strongly relying on the installation and test of new hardware before LS1?**
  - **Yes – the single bunch 'demonstrator' studies require the HW for the feedback processing channel to be available…tight for end 2012**
- **How can we optimize the use of the remaining available MD time? Do we need to request for more?**
  - **The timing of the MD is most critical – as late as possible**
- **Which are the main motivations why we could benefit from the extension of the MD run into 2013?**
  - **Would be very useful indeed, as HW will arrive very late in the year. Increase time for measurement, reduce risk of missing deadline, …**

end

Job for high bandwidth feedback in SPS

cure transverse "single bunch" instabilities by feedback

two collective effects are limiting the
SPS performance as LHC injector

- e-cloud
- TMCI

similarities: both effects cause vertical *intra* bunch instability

high chromaticity suppresses instability to a certain extent

feedback expected to permit
running at low chromaticity and at intensities beyond which high chromaticity is an established cure

particular important to maintain small transverse emittances

synergy with PS and LHC

Transverse Feedback Systems in LHC and its injectors

Accelerator	Digital / analogue processing	Power / kicker / bandwidth	Status
PS Booster (protons) 50 MeV – 1.4 GeV kin. E. (future: 160 MeV to 2 GeV kin E) **no ecloud, long bunches**	multi turn injection from Linac 2 analogue beam offset signal suppression, analogue delay (cables & switches)	100 W, 50 Ω stripline Limited to 13 MHz in operation But built for 100 MHz bandwidth, baseband	H-plane: **used and required** V-plane: beam stable w/o FB **upgrade planned**
PS (protons, ions) 1.4 GeV – 25 GeV (kinetic E) (future injection at 2 GeV) **ecloud observed** **when beam bunched at 25 ns** **Spacing, coupled bunch**	digital system, synergy with LHC Damper for The low level digital processing **80 MHz clock frequency**	2 kW solid state power amplifier; 112 Ω stripline (0.9 m length), planned with ~30 MHz bandwidth in baseband, lower cut-off ~50 kHz	**2012 under commissioning** injection damping and feedback will be beneficial in particular for high intensity CNGS beams and LHC beams. Currently horizontal instabilities are cured by introducing coupling to the vertical plane which constrains the tunes
SPS (protons, ions) (14 – 450) GeV/c protons FT (26 – 450) GeV/c LHC beam **ecloud observed and is** **a potential limitation for 25 ns spacing**	digital notch filter and 1T-delay (Altera FPGA, **80 MHz clock**) commissioned in 2000/2001	tetrode amplifiers with two 30 kW tetrodes in push-pull directly coupled to a kicker (base band); feedback bandwidth ~10 kHz to 20 MHz	2001 upgraded for LHC beams H-plane: used in operation V-plane: used in operation **used and required for operation** above $5x10^{12}$ protons (max $\sim 5.5x10^{13}$ ppp accelerated)
SPS High Bandwidth Feedback	digital @ **4 – 5 GS/s clock**	under study, GHz BW	**Feasibility Study**
LHC (protons, ions) protons: 450 GeV/c – 7 TeV/c **ecloud observed and is a** **potential limtation for 25 ns spacing**	digital notch filter and 1T-delay, built-in diagnostics 14 bit DAC / DAC Altera FPGA, **40/80 MHz clock** 2 um rms resolution	tetrode amplifiers with two 30 kW tetrodes in push-pull directly coupled to kicker (base band) similar to SPS system 3 kHz -> 20 MHz	**2010 fully commissioned** injection damping feedback used in ramp and physics, essential