# Meeting of LIU SPS-BD WG on 14.09.2017

Present

Elena Shaposhnikova, Rama Calaga, Patrick Kramer, Joël Repond, Heiko Damerau, Verena Kain, Hannes Bartosik, Alexandre Lasheen, M. Patecki, M. Schwarz, Michele Carla’, Aaron Farricker.

Agenda

1. Results of the recent MDs on beam losses – M. Schwarz
2. Measurements of beam instabilities during ramp with FB off – J. Repond
3. AOB – H. Bartosik, A. Lasheen, P. Kramer

Foreword

* A review of the SPS injection losses is scheduled for the end of November.
* Previous action: The addition of the new HOM coupler in one/two cavities in particle simulations shows no measurable effect on beam stability. **E. Shaposhnikova**: It is still useful to try the installation during YETS 2017.

Actions

* **Scrubbing run**: Monday 9th of October (24 hours), Wednesday 11th of October (16 hours). Plan the possible measurements of the losses/instabilities.
* **ABP**: Measurements of losses on SPS flat bottom with respect to tune shift must be reproduced with the LHC 25 ns beam. Measurements of transverse emittance needed, wire-scanner can now measure bunch by bunch.
* **M. Schwarz**: Measurement of losses in single RF. Understand the higher losses in the first bunch.
* **M. Schwarz**: Study the effect of the phase-loop on losses along the batch.

1. **– Results of the recent MDs on beam losses – M. Schwarz**

This talk presents the last MD measurements regarding the losses in the SPS at injection and along the flat bottom. The focus is put on the losses on the long flat bottom and measurements tend to suggest that the losses are related to a limitation in momentum aperture.

* Current knowledge: two types of losses on the SPS flat bottom.
  + Fast losses at injection, possibly due to:
    - Transverse emittance.
    - Longitudinal effects (S-shape, uncaptured beam).
    - Noise/limitations in the low-level RF system.
  + Linear decrease of intensity along the flat bottom (focus of this talk), possibly due to:
    - Limitation of momentum aperture.
    - Bucket full after filamentation. Its acceptance can be limited by intensity effects, low-level RF noise, magnetic B field decay.
* Comparison of losses between Q20 and Q22 optics shows no significant difference even though the momentum aperture is smaller for Q20.
  + Same experimental conditions for the two beams, measured simultaneously.
  + Total transmission after acceleration comparable.
  + **E. Shaposhnikova**: For an increasing intensity, less losses observed in the past with Q22 optics compared to Q20. On the contrary, the last set of measurements does not exhibit this difference (related to emittance or difference in injected intensity?).
    - Losses at injection were observed with Q22 optic during the MD while the data plotted shows higher intensity in Q22 (1% difference) 🡪 Plot with intensity at injection and not after a few milliseconds.
* Observation of modulations in intensity along the flat bottom (suggested by Fritz):
  + Linear decrease removed from the data and a FFT applied.
  + A peak at half of the Nyquist frequency is observed.
    - No explanation.
    - **E. Shaposhnikova**: T. Bohl sees this peak in measurement for a long time.
    - **A. Farricker**: Possible oscillation in the measurement device giving a contribution at half of the sampling frequency.
    - **A. Lasheen**: quadrupole frequency under-sampled?
    - 🡪 Appears systematically in measurements.
* Effect of 200 MHz voltage along the flat bottom (capture at 4.5 MV):
  + Increase/decrease voltage 🡪 losses increase.
    - 3 MV: Since the bucket is already partially full at 4.5 MV, a smaller acceptance gives more losses.
    - 7 MV: Bucket height and momentum aperture are comparable 🡪 losses. Note that particles are recaptured when the voltage increases and therefore the intensity inside the beam follows the BCT exactly.
* Relative losses in first bunch higher than the following 🡪 need to be understood.
  + The measurements are done using two RF but it is known that the first and the last bunch see the worst phase of the 800 MHz voltage compared to the rest of the beam 🡪 The measurement should be done using a single RF.
* Relative losses of the first 12 bunches are lower than the rest of the batch.
  + Effect of phase-loop?
  + It has been seen that moving the sampling of the phase-loop to the center of the batch mitigates slightly the losses 🡪 this measurement must be reproduced.
* **E. Shaposhnikova**: Two possible mechanisms limiting the transmission:
  + Limitation of momentum aperture.
  + Reduced bucket area due to beam-loading.
* BCMS (smaller emittance) vs 25ns beam 🡪 significant reduction of losses with BCMS beam.
  + 🡪 Supports a limitation of momentum aperture.
* Observation: Smaller transverse emittance 🡪 losses less significant after injection but then the rate increases.
  + Transverse measurements necessary.
  + **H. Bartosik**: The measurements have been taken but not yet analyzed.
* **E. Shaposhnikova**: With a proper model of the feedback, it would be possible to reproduce in simulation the pattern observed of the losses along the batch. Low flat bottom voltage should be used to avoid as much as possible the aperture limitation.

**2 – Measurements of beam instabilities during ramp with FB off – J. Repond**

This talk presents the last set of LHC beam measurements related to instabilities during ramp and the instability threshold. The measurements were done using a single RF for 12 bunches without feed-back and feed-forward to observe the effect of the longitudinal damper on the stability threshold. The time dependence of the instability threshold is studied as well.

* Operational/CBA voltage program used and different emittances.
* The effect of the longitudinal damper on the instability threshold is negligible for 12 bunches.
  + 🡪 LD can be neglected in simulation.
* The time dependence of the instability threshold along the acceleration cycle is similar to the analytical prediction.
  + 🡪 Could be used to disentangle the effects of the 200 MHz main harmonic and the 630 MHz HOM during ramp.

**3 – AOB – A. Lasheen, H. Bartosik, P. Kramer**

* A. Lasheen: **Tomography in the SPS after injection**.
  + Comparison between single and multi-bunch.
    - Single: Parabolic bunch, core dense and tails negligible.
    - Multi: Not parabolic anymore, core with a “banana shape”, large tails 🡪 Fill the bucket after filamentation.
* H. Bartosik: **Losses on SPS flat bottom and chromaticity**.
  + BCMS beam, constant bucket area 0.6 eVs and 135 billion particles per bunch.
    - In the horizontal and vertical plan, the total transmission is weakly affected by a tune shift between 0 and 0.4 ()
    - For a tune shift of 0.8, losses double in horizontal plan and 50% increase in vertical plan.
  + Octupole scan: LOF parameters ( ) 🡪 induces amplitude tuning.
    - The total transmission is weakly affected by a LOF parameter between -3 and 5.
    - For larger positive or negative values, the beam is destroyed.
  + 🡪 A change in the nominal chromaticity or the current in the octupoles will not improve significantly the total transmission.
  + The chromatic detuning is strong, small margin for the chromaticity.
  + **E. Shaposhnikova**: Actual optimal values based on experience, parameter space limited but possibly a better operational working point in parameter space exists.
  + **E. Shaposhnikova**: How this result changes with the 25 ns beam? 🡪 The measurement must be reproduced with the LHC 25 ns beam.
* P. Kramer: **New HOM damping scheme for three-section cavity**.
  + The longitudinal 630 MHz HOM coupler was designed for a single section and performs efficiently in this case.
  + In the three-section cavity, the coupler breaks the top/bottom symmetry and introduces additional high impedance modes. The more couplers are placed in the cavity, the higher becomes the quality factor of the 17pi/33 mode which is pushed in the lower part of the cavity.
  + The coupling of the new probe (four-section) with this mode has to be investigated.
  + Possible other mitigation that is being investigated: reduce the length of the probe.
  + As the field profiles of the HOMs in the three- and four-section cavities differ, the performance of newly proposed probes has to be investigated in detail on both configurations.

Minutes written by J. Repond