# Meeting of LIU SPS-BD WG on 16.11.2017

Present

Elena Shaposhnikova, Patrick Kramer, Joël Repond, Verena Kain, Hannes Bartosik, Markus Schwarz, Michele Carla’, Aaron Farricker, Christine Vollinger, Giulia Papotti, Fritz Casper, Thomas Bohl, Heiko Damerau, Alexandre Lasheen, Ezgi Sunar, Nasrin Nasresfahani, Mauro Taborelli.

Next meeting 14th of December

Agenda

1. News on the SPS impedance – A. Farricker
2. Update on HOM damping in 3-sections cavities – P. Kramer
3. Multipactor effect and vacuum considerations for the parallel line HOM coupler – N. Nasresfahani
4. Instability mode studies – J. Repond
5. Recent capture loss measurements – M. Schwarz
6. Uncaptured beam measurements – T. Bohl

Actions

* Simulations of the new impedance calculated by Aaron: Is there similar (to the injection pipe) contributions to the impedance of the machine that we should add before starting macro-particle simulations?
* Study the feasibility of removing the end-plates HOM couplers at 460 MHz in the 3-section cavities (impact on beam dynamics).
* **P. Kramer**: Estimate the detuning (of the fundamental passband) given by the endplate transverse HOM couplers at 460 MHz and their impedance reduction.
  + Introduce the 460 MHz transverse HOM coupler in CST simulations to observe the detuning of the fundamental passband and the efficiency of the damping. If the damping is not sufficient when the couplers are removed, an equivalent damping by other available ports has to be provided.
* Measurements required before and after YETS to assess the effectiveness of the new 630 MHz HOM coupler.

**1 – News on the SPS impedance – A. Farricker**

The beam dump will move during the long shutdown 2 and LSS1 will be restructured. This talk presents possible optimisation of the section to reduce its total impedance.

* Possible impedance reduction of the line:
  + Tapers can significantly reduce the impedance at high frequency (above 1 GHz).
  + Shielding of pumping ports gives no significant reduction if applied on top of the tapers.
  + Shielding of the sector valves reduces significantly the highest resonant peaks below 1.5 GHz.
  + The injection line gives significant impedance peaks around 630 MHz and 800 MHz.
    - Add 2% to the impedance of the 800 MHz RF system.
    - Add at 630 MHz the equivalent impedance of the HOM of one 3-section cavity.
    - Reduction of this impedance will require a substantial amount of work (and costs).
    - Particle tracking simulations may be needed to assess the impact of this impedance on the stability threshold
      * Search if there is some similar contribution to the impedance along the ring before starting to simulate.
* **E. Shaposhnikova**: The impedance model evolves continuously and it becomes hard to compare old and new macro-particle simulations. What is the status of the versioning (git) planned for our impedance models.
  + **A. Lasheen**: Discussions are ongoing about the tools needed between RF and beam dynamics experts. Time investment is needed.
  + **E. Shaposhnikova**: it becomes very important to keep track of the changes in the SPS impedance model.
* **E. Shaposhnikova**: How is it handle from the transverse point of view?
  + **H. Bartosik**: Mario Beck is now the person in charge of the transverse impedance model.
  + **E. Shaposhnikova**: We should find some synergy.

**2 – Update on HOM damping in 3-sections cavities – P. Kramer**

This talk presents an update on the possible damping schemes of the 3-section cavities after LS2 (630 MHz HOM).

* Requirements of a damping scheme for the 3-section cavities:
  + Sufficient damping of HOMs.
  + The main harmonic must be preserved.
  + Transverse HOM-damping must be preserved (sufficient number of ports available).
* Damping via the endplate HOM-ports:
  + HOM impedance reduction by a factor three in simulation.
  + Port already used by the 460 MHz transverse HOM couplers.
    - Will the damping of the transverse HOM be sufficient by removing the couplers in the 3-section cavities?
  + This coupler shifts the fundamental passband by 92 kHz.
    - This effect would appear in all 3-section cavities (4).
    - **E. Shaposhnikova**: The 4-section cavities will use a different damping scheme which does not suffer this shift. The total effect on the sum of all 6 cavities has to be studied to see if this shift can be accepted.
    - **N. Nasresfahani**: first question that has to be answered is if we remove 460 MHz probe do we have still enough damping?
    - **F. Casper**: This coupler could take a lot of power out of the cavity.
    - **E. Shaposhnikova**: What was the detuning of the 460 MHz couplers?
      * **P. Kramer**: More study are needed.
    - **E. Shaposhnikova**: At first approximation, 0.1 MHz seems significant, studies are needed.
      * Introduce in CST simulation the 460 MHz to see the detuning.
      * Estimate the damping of the 460 MHz HOM.
      * If damping not sufficient (or if we cannot answer), an equivalent damping by another port should be provided.
    - **H. Damerau**: How was the initial tuning done?
      * **P. Kramer**: On a per section basis, playing with the length of the stems.
* Damping via RF couplers fixed on the pumping ports.
  + Damping of the HOM impedance by a factor 3.1 achieved in simulations.
  + The grid of the pumping ports must be drilled.
    - To avoid if possible.
  + One coupler per cavity would be sufficient.
    - Factor 2.8 possible.
    - Additional couplers on the top ports necessary.
  + **N. Nasresfahani**: The loaded part of the couplers could be removed to keep only the perturbation of the geometry (presented in what follows).
  + **E. Shaposhnikova**: This option seems more feasible than the endplate coupler.
* Geometry perturbation at the location of the pumping ports.
  + Reduce the geometric factor R/Q especially of the 17pi/33-mode.
  + Damping of the HOM impedance by a factor 3 can be achieved.
  + The fundamental passband will be perturbed.
  + Measurement will be carried out on 1-section cavity to:
    - Assess the influence of the perturbation on the fundamental passband.
    - Measure the effectiveness of the mitigation.
    - Benchmark the simulations.
* **E. Shaposhnikova**: If the filter part of the coupler is not needed, would it be possible to weld a perturbation in another location than the pumping ports?
  + **P. Kramer**: If the electric fields of the HOMs have the correct magnitude in these locations yes, but every position would have to be studied in detail. The locations of the pumping ports were chosen so far, because of easier access and simpler installation of the perturbations.

**3 – Multipactor effect and vacuum considerations for the parallel line HOM coupler – N. Nasresfahani**

The talk presents the latest update on the new damping coupler of the 4-section cavity, analyzing the multipactor effect on the new probe.

* The field pattern of the 630 MHz HOM is favourable for initiating a multipactor effect.
  + The field strength of the 630 MHz HOM has to be 1.12 times larger than the one of the main mode (post-LS2) to have vacuum breakdown.
  + **F. Casper and M. Taborelli**: How accurate are these numbers? They seem too low.
    - **N. Nasresfahani**: The model is the same used for Klystron. It is reliable but the worst case scenario is used.
* Multipactor effect will not appear for fundamental passband because of unfavorable field pattern.
* The prototypes of the new coupler are ready to be used but the exact positioning of the flange has to be examined before assembling them.
* **E. Shaposhnikova**: Is a final simulation with all the couplers planned?
  + **N. Nasresfahani**: Yes, but the reduction factor will be measured before.
* **E. Shaposhnikova**: Measurements should be done before and after the YETS to assess (if possible) the effectiveness of the new couplers.
  + Measurements of signal from feedback loop.
  + Measurements of induced voltage in the cavity which will be equipped with the new coupler.

**4 – Instability mode studies – J. Repond**

The 630 MHz HOM will have the lowest stability threshold after upgrade but in the actual configuration of the machine it is close to the one of the vacuum flanges. Precise measurements have been acquired for an unstable beam on flat top to observe if we can distinguish the source of the instability in measurements.

* The bunch exhibits non-rigid dipole and quadrupole oscillations.
* From analytical estimations, the 630 MHz HOM will excites mainly dipolar and quadrupolar modes.
* Tomography of the bunch shows a large density of particles at high amplitude oscillating.
* Simulations shows a good agreement with measurements.
* The instability is very likely to be caused by the 630 MHz HOM.
* **E. Shaposhnikova**: Measurements with a CBA voltage program should be effectuated to confirm the result.
  + Longer bunches will excites different harmonics.

**5 – Recent capture loss measurements – M. Schwarz**

MDs measurements have been carried-out scanning the capture voltage for different intensities, measuring the capture losses. This talk presents the results obtained during this session together with the results obtained from the post-acceleration in the PS.

* Post-acceleration and shaving in the PS reduce significantly (totally?) the amount of uncaptured beam
* **E. Shaposhnikova**: The losses in the first milliseconds should be analyzed as well not only the uncaptured beam before and after the kick at two seconds.
  + Bunches coming from PS with a larger delta p/p could lose a lot of particles before the kick at two seconds.
* Voltage and intensity scan exhibits larger emittance (with larger intensity) of the bunches extracted from the PS.
  + With higher voltage the curves of losses saturates at different values for different intensities.
* **T. Bohl**: Strong oscillations are observed in the loss pattern along the batch. Can you comment on that?
  + **G. Papotti**: Modulation of the bunch intensity from the PSB are observed.
  + **A. Lasheen**: bunch by bunch intensity was optimized but emittance can be slightly different.

**6 – Uncaptured beam measurements – T. Bohl**

Report of observations made last year about uncaptured beam on a special cycle (20 seconds long with two ramps with an intermediate flat top), BCMS 48 bunches with an intensity of .

* **G. Papotti**: In today measurement (16th of November), we have observed:
  + An improvement of the losses by 1.5% by correcting the chromaticity.
  + Half a percent increase in losses when someone added a cycle at the end of the supercycle.
    - PS sensitive to the supercycle.
  + The feedback may deteriorate the injection phase of the RF.
  + 🡪 Measurements from different day should not be compared at the percent level.
* Measurements show that uncaptured beam needs two seconds to move away from the batch.
  + Consolidate the loss measurements with a tune kick at two seconds.
* When the uncaptured beam is kicked out of the ring, particles continue to spill out of the buckets.
* **H. Bartosik**: can we estimate the intensity in the uncaptured beam from this measurement?
  + **T. Bohl**: Difficult because delta p/p (of the uncaptured beam) has to be known 🡪 assumptions needed.
  + **E. Shaposhnikova**: Momentum aperture could be used as a maximum delta p/p.
* **E. Shaposhnikova**: This measurement very much confirm the picture of the losses
  + Uncaptured beam at injection due to bunch shape.
  + Particles spilling out of the buckets due to momentum aperture, intensity effects.
  + The only way to reduce these losses is to reduce the density of particle close to the separatrix.
* **H. Bartosik**: Will it be possible to extract high intensity with post acceleration next year (with the new amplifiers)?
  + **H. Damerau**: It is very likely but it depends on the commissioning of the power supply.
* **E. Shaposhnikova**: Measurements with 3x80MHz in PS possible for next year?
  + **H. Damerau**: The baseline is to have all three 80 MHz cavity fully equipped and ready. But realistically not for next year.

Minutes written by J. Repond