Minutes of the meeting of the SPS Upgrade Study Group on 24 June 2010

Present: M. Barnes, J. Bauche, C. Bhat, S. Federmann, R. Garoby, W. Hofle, G. Rumolo, B. Salvant, E. Shaposhnikova, M. Taborelli, C. Yin Vallgren

Excused: G. Arduini, F. Caspers, V. Mertens, E. Metral

• Highlights from IPAC'10 - M. Taborelli

Clearing electrodes, under development in the KEKB, are very efficient for e-cloud suppression in wigglers while in a vacuum chamber (with anti-chamber) only suppression by a factor 2 was achieved, probably due to the insufficient width of these electrodes. In addition, the geometry of the chamber could be also important. A factor 10 suppression by clearing electrodes was obtained in simulations done by Demma, - a factor to be compared with the 10000 difference in the e-cloud signal for the StSt and a-C surface. Comparison of DLC and TiN coatings (SEY=1.8) with copper surface (SEY=2) done at KEKB has also been presented at this conference. No information on studies of ageing was available so far. Plans for a double (copper for impedance plus carbon for SEY) coating in-situ in RHIC were presented by W. Fisher.

Presentations of C. Yin Vallgren and S. Federmann attracted the attention of people from different labs.

• News on the TMCI and SPS transverse impedance - B. Salvant

Simulations of the transverse bunch motion at SPS injection in a double RF system with 2 MV at 200 MHz and 500 kV at 800 MHz including effect of the transverse SPS impedance show that the instability threshold in a double RF system is lower than in a single. It is 1.1×10^{11} in bunch-shortening mode, 1.4×10^{11} in bunch-lengthening mode and 1.5×10^{11} in a single RF. However after 4000 turns some high frequency oscillations also start to grow on the longitudinal bunch profile leading to bunch length increase. Needs more studies.

Adding the 800 MHz impedance (simulations were done for one section) to the SPS impedance model doesn't seem to give noticeable effect on transverse bunch motion, tune shift with intensity or the TMCI threshold.

It is planned to import more new elements into the SPS impedance model (ZS, MSE) as well as implement new features to the HEADTAIL code (transverse feedback, longitudinal impedance).

→ Question related to the new vacuum chamber of the SPS to be coated and installed inside all SPS magnets - how much would the copper chamber modify the instability threshold?

Answering to the question of Wolfgang, the future SPS transverse feedback system should be able to damp frequencies up to 1 GHz which have been observed during the TMCI instability (for short bunches). The instability can also develop during a fraction of the synchrotron period.

• Summary of MD W22. Plan for other MDs and coatings - M. Taborelli

For most elements under observation the static pressure in W22 was the same as in W17 except between the recently installed a-C liners (2 days before MD) and the coated vacuum chamber where it was almost two order of magnitude higher than with the StSt liner and vacuum chamber (MD W17). Comparison of the dynamic pressure rise for these two MDs was done for 4 batches with

nominal intensity, however it seems that it was smaller for all elements, probably due to the higher capture beam losses in W22. More data is needed during the next MD in which case we should keep these two liners untouched. With ultimate intensities in the ring the signal in the ECM with a-C liner, normalised to the beam intensity, was not very different from that of the nominal intensity beam with one and two LHC batches of 72 bunches. However with 3 ultimate batches a very noisy signal (with both positive and negative peaks) was measured on all a-C detectors together with a strong pressure increase. Could this observation be explained by ions? Dynamic pressure increase in all coated and uncoated reference magnets showed the same behaviour for three ultimate batches as for two. More than 12 h technical stop is required for the liner exchange. This time can be taken from the SPS MD time since it is important for studies during this MD.

Measurements of the radiation level under the passerelle give hopeful results for the installation of the RGA (Residual Gas Analyser).

Two chambers are coated and ready to be inserted into MBBs. There are still some worries concerning contamination during magnet assembly and magnetic measurements. A new coil with a better support is under development (Jeremie).

Very rough surfaces are required for the clearing electrodes adherence. Apparently this is even sufficient for significant e-cloud suppression without any clearing voltage.

• Insertion of 2 MBBs with new coated vacuum chambers during technical stop week 35 - J. Bauche

The technical stop of 12h in week 29 is not sufficient for any magnet exchange. It could be used if stretched sufficiently for the liner exchange (to be discussed and decided at MD planning meeting with Elias). Access in week 35 is scheduled from 8:00 on 30.08 till 20:00 on 31.08. The MBB magnet in position 60290 has a water leak and must be replaced. The proposal is to insert two "old" coated magnets which are now in positions 51530-51550 into this place (and 60270) to continue ageing tests. Their place, equipped with the microwave diagnostics, will be used for newly coated magnets. There are also one or two quadrupoles to be replaced which make the whole intervention work very tight.

Silke would like to have the RF shields removed from the pumping ports with antennas to increase signal to noise ratio, especially for transmission measurements over the two magnets. In principle this should be then also done for the reference magnets, which means at least one extra MBB magnet removal during week 35. The present configuration is to be checked on photos (taken by Silke) and drawings.

• Observations during MD of June 2nd to June 3rd, 2010 and future plans for SPS kickers - M. Barnes

The table presented summarises the temperature and pressure increase of the most critical magnets during MD W22 with ultimate intensity. It was necessary to stop the beam 3 times to permit cool-down of the MKE4. The MKE6 magnet (with serigraphy) had very high outgassing (maximum pressure of 9×10^{-7}) but conditioning effect has been observed as well. MKPs suffered from the outgassing in TIDVG (situated nearby) during beam dumps.

It is planned to shorten the period of the installation of 5 serigraphed MKE4 magnets from 3 to

2 shutdowns. To complete this work during the 2011/2012 shutdown requires significant manpower. The SEY of the silver paint and ferrite will be measured (Mauro) to study the reasons for outgassing of the MKE6. Transverse and longitudinal impedances of the MKP are currently being measured.

• **Preliminary results of SPS MD week 22 - E. Shaposhnikova**

Maximum intensity injected into the SPS was 1.88×10^{11}/bunch. Longitudinal emittance was 0.38-0.4 eVs and transverse emittance 5 μm. A large variation in bunch length across the batch was observed both for the injected beam and on the flat top. Some slope could be seen already in the injected bunch length (from 4.5 ns at head to 3.5 at the tail of the PS batch). Bunch length on FT: 1.6 ns average (over batch) and 1.8 ns maximum.

During this MD nothing was broken but some issues with MOPOS and FBCT were seen. Maximum bunch intensity achieved at 450 GeV is 1.6×10^{11}/bunch for one batch in the ring. Increasing the number of batches led to a decrease in bunch intensity on the FT with approximately 1.52×10^{11}/bunch for 2 batches in the ring, 1.48×10^{11}/bunch for 3 batches and 1.4×10^{11}/bunch for 4 batches. Capture losses were reduced after modification of the voltage program through the cycle. Already 24 bunches were unstable longitudinally on the flat bottom even with the 800 MHz on. No direct e-cloud observations were possible due to absence of the reference StSt liner.

Main issues to investigate during the next MDS with "above nominal" intensity are

- beam losses
- transverse emittance blow-up during the ramp (from 5 to 10 μm in MD W22)
- longitudinal beam instability (on flat bottom and flat top)
- e-cloud scaling with intensity

The priority list of future MDs presented starts with studies of a-C coatings since the problem of ageing of some a-C samples has not yet been understood. Limitations for "above nominal" intensity are the second in the list. In future MDs we should increase intensity in steps which unfortunately means more work in the injectors but gives hope of using the nominal beam settings as a good starting point for adjustments at higher intensities. For the single bunch a maximum intensity with nominal bunch parameters is required to study the parameter space of the TMCI (dependence of threshold on chromaticity, RF settings and other parameters). This is an urgent topic due to the need to give specifications for the wide-band transverse feedback proposed for damping this instability. The non-monotonic dependence of the e-cloud instability on intensity predicted in simulations (Giovanni) is also an important topic. The minimum threshold which is around the nominal LHC intensity is even better pronounced for a 50 ns spaced beam, but the maximum intensity per bunch could be limited in the PS. Beam stability in a double RF system is another important research area. Since the sources of both longitudinal and transverse instabilities are still not exactly known, more beam measurements aimed at identification of guilty impedances are necessary in future.

• The next meeting will be on **29 July 2010** at 15:30.

Preliminary agenda:

Possible reduction of gamma transition in the SPS - Y. Papaphilippou

Results of MD W35 - G. Rumolo
Recent results on coatings and coating systems - M. Taborelli
News on TMCI in the SPS - B. Salvant

Elena Shaposhnikova, 29.06.2010