Minutes of the meeting of the SPS Upgrade Study Group on 29 July 2010

Present: G. Arduini, H. Bartosik, F. Caspers, S. Calatroni, S. Federmann, W. Hofle, V. Mertens, E. Metral, Y. Papaphilipou, G. Rumolo, B. Salvant, E. Shaposhnikova, M. Taborelli, C. Yin Vallgren

Excused: R. Garoby

- **Clearing electrodes - F. Zimmermann**

The sample of the clearing electrodes produced in the KEKB using plasma sprayed insulating strip, was demonstrated. The thickness of two layers is correspondingly 200 μm and 100 μm. It is planned to install them for e-cloud suppression in wigglers. Very rough surface is required for the clearing electrodes adherence, apparently even itself sufficient for significant e-cloud suppression. In the SPS they could be used only with a new vacuum chamber (on the bottom) unless some aperture can be sacrificed.

- **News on MPT - V. Mertens**

Recently Steve Myers has asked for updated estimates (with time profiles) for the potential SPS upgrades. Volker has received the required input from different people. Some time lines use a more relaxed schedule than in earlier estimations. More aggressive time scale will be more expensive, not taking into account potential issues with manpower. In addition, to be on proposed schedule some activities should already start in 2010. New estimations of Jeremie indicate that significantly larger workshop space is required for both options of magnet coating (2600 m^2 with and 800 m^2 without magnet opening). These findings have consequences for both cost and time lines.

- **Summary of MD w29 - G. Rumolo**

MD of w29 was shorter than initially planned due to need to exchange two magnets in the SPS. It started on Wednesday morning and finally only a 25 ns spaced beam was available (no beam with 50 ns spacing). Due to bad vacuum in the region of newly installed magnets four LHC batches could not be accelerated to the top energy (450 GeV/c). Maximum injected intensity was 1.5×10^{11}/bunch.

A 50 ns spaced beam with ultimate (1.9×10^{11}) bunch intensity was obtained in the PS (with practically nominal emittances) and can be used in the SPS during the next MD in w35 for the e-cloud tests.

- **Summary of MD w29 and progress with coatings - M. Taborelli**

The StSt liner was not finally installed since the pressure in the region of the e-cloud monitors was too high due to water outgassing from the Kapton sheet (this Kapton was not recently baked) on these two freshly inserted liners.

Very high (3 orders of magnitude more than on all others) outgassing and continuous conditioning was measured on newly installed (uncoated) magnet. Obviously this dipole was not sufficiently clean.

Static pressure was still higher between our coated magnets than between reference magnets. Dynamic pressure increase was observed in all coated and uncoated reference and new magnets for three batches with bunch intensity increased in 3 steps from 1.2×10^{11} to 1.5×10^{11} (measured at the end of flat bottom, 26 GeV/c).

Ageing studies. The SEY of the sample (CNe64) left for 7 weeks in the SPS vacuum below liner has increased from 0.9 to 1.15. For similar sample left in Al foil in lab the increase is to 1.05.

→ The liner coated simultaneously with the liner doesn't show ageing effect from the ECM signal, nevertheless its SEY should be measured in lab for comparison.

Two mobile samples, being both exposed to e-cloud, show different ageing in the center (SEY change to 1.55 and to 0.9) depending on the period of preliminary air exposure. However ageing of these two samples is the same (to 1.3) in the region which did not see e-cloud (edges). These facts are consistent with observations for other samples stored in the SPS vacuum, but not necessary with the liner CNe13, which was also first exposed to air and afterwords to beam. Indeed in coated liners irradiation by e-cloud is much less due to coating on both sides, different from mobile samples which have the StSt surface on the opposite wall.

→ More statistics is required to have reliable conclusions about factors important for ageing.

One coated chamber has been inserted into MBB. Two traces 70 mm apart (and some dust) were left by the coil inserted to clamp the two parts of the yoke before welding. No magnetic measurements were done on this magnet to avoid further pollution. We need two more spare magnets before technical stop of w35 (could be a problem). Full programme of magnet insertion and transfer was discussed, it can not be completed in less than 48 hours; 24 hours are required for installation of the two new liners (StSt and half a-C coated).

• **News on the TMCI in the SPS: injecting high intensity bunches - B. Salvant**

Very high intensity bunches (up to 3.5×10^{11}) were injected into the SPS with longitudinal emittance of (0.32-0.38) eVs. The 200 MHz voltage at 26 GeV/c was 1.8 MV with the 800 MHz RF system switched off. Maximum bunch intensity seen in the SPS after fast injection losses was 2.5×10^{11} for small (1.3 μm) transverse emittances and 3.2×10^{11} for emittances blown-up to 3.4 μm (?) with a BTV in the TL. Vertical chromaticity was 0.3, octupoles were on, tunes were the same for whole intensity range. After injection losses emittances became bigger by approximately factor 2. Decreasing the chromaticity on the flat bottom from 0.28 to 0.12 led to strong vertical coherent motion and sharp particle loss for a bunch intensity of 2.5×10^{11}.

Note that according to the numerical simulations (and theory) the TMCI threshold should be pushed up by a space charge effect, however losess can also be caused by a large space charge tune spread ($\Delta Q \sim 0.15$ for maximum intensity and nominal transverse emittances).

Main issue is still related to the MOPOS system since BPMs in sextants 1,2 and 5 should be disconnected (20 min/sextant) for bunch intensities higher than 1.6×10^{11}. The problem will be fixed by the BI Group in two months.

Next MDs: try and optimise conditions for certain intensity range (e.g. ultimate and then maximum).

• **Update of MD activity for high frequency SPS transverse feedback - W. Hofle**

The progress in acquiring good data for single- and multi-bunch transverse (vertical) instabilities during the MDs in w28 and w29 was presented. One of the aims was to make operational the wide-band PUs connected to OASIS. The detailed comparison of using OASIS (available in CCC) and scope DPO 4054 (in FC) was given. Data was taken for a 25 ns spaced beam, need to be analysed (with LARP participation). Signals acquired for high intensity single bunch show instability immediately after injection but have some unexplained so far second hump for both stable and unstable bunches.

- **Possible reduction of transition energy in the SPS - Y. Papaphilippou**

The thresholds of different instabilities (microwave, TMCI, longitudinal coupled bunch) are directly proportional to the slippage factor $\eta = 1/\gamma_t^2 - 1/\gamma^2$ which can be significantly increased by lowering a transition gamma in the SPS. Then high intensity beams for the CNGS and FT physics could be injected into the SPS above transition. This option was already considered in the past but no suitable optics solution could be found at that time. The transition energy can be affected by dispersion (and tune) modification. Only small increase in dispersion is required by using a conception of the resonant arc (multiple of 2π phase advance). With cell advance of 3/16 a transition gamma can be reduced to 18 (from 22.8) with reduced by 30% quadrupole strength (at maximum in the present optics). Other optics solutions for changing transition gamma in the wide range have also been studied however the resonant arc option seems to be the most promising. It doesn't require any hardware change and can be tested in the SPS MDs in the near future.

Main problem for using this optics could come from the fact that more voltage is required to have the same bunch length for constant longitudinal emittance. For $\gamma_t = 18$ this means potential need in voltage increase by a factor 3.5 on the flat bottom and 1.6 on the flat top. Presently, mismatched (too high) voltage is used at injection (2MV shortly increased to 3 MV) so we can try and see what can be done with a higher matched voltage. This should be the first test. However for acceleration and especially flat top the situation is also not obvious, since higher voltage would also be needed. We can see now if decrease in transition energy is sufficient to stabilize the beam in the absence of longitudinal emittance blow-up but most probably we will be limited in voltage to shorten bunches for the LHC 400 MHz RF system (even with RF upgrade foreseen at the moment). The present voltage limitation at nominal LHC intensity is 7.5 MV. For $\gamma_t = 18$ and emittance of 0.4 eVs the bunch length at extraction will be 1.5 ns (1.3 ns for $\gamma_t = 22.8$).

- The next meeting will be on **26 August 2010** at 15:30.

Preliminary agenda:
Coatings and coating systems - P. Costa Pinto
Results of high intensity single bunch MD - B. Salvant
New set-up for RF transmission measurements - S. Federmann
Planning of MD W35 - G. Rumolo

Elena Shaposhnikova, 8.08.2010