Minutes of the 2nd meeting of the SPS Upgrade Study Team on **10 May 2007**

Present: G. Arduini, F. Caspers, K. Cornelis, S. Calatroni, P. Chiggiato, M. Jimenez, T. Kroyer, G. Rumolo, M. Taborelli, E. Shaposhnikova, F. Zimmermann

• **Mandate of the PAF Study Team on SPS upgrade - E. Shaposhnikova**

Main goals of the the SPSU Study Team formulated in the mandate issued by the PAF WG (R. Garoby) are (1) to reliably provide the LHC with the beam required for reaching ten times the nominal luminosity and (2) to provide optimum use of possibilities offered by the new injectors both for the LHC and for other SPS users. The Study Team is expected to identify limitations in the existing SPS and study and propose solutions to overcome them with the cost and planning of proposed actions published in Design Report in 2010.

The time scale for the upgrade of the SPS vacuum chamber was discussed with the conclusion that the e-cloud is already identified as a main SPS performance limitation even for the nominal LHC intensity. Measures to improve the situation can be taken as soon as they have been found (and funded). Taking into account that any changes in vacuum chamber can be done only during shutdowns, the work will last a few years and ideally should be done in parallel with the consolidation of the SPS magnets already foreseen.

• **Dependence of the e-cloud instability threshold on energy at the SPS - G. Rumolo**

HEADTAIL simulations have been performed for comparison with results of MD on e-cloud vertical instability at different beam energies (24.10.2006). Measurements done at 26 GeV were used for calibration of the SEY value (1.35). Then the simulations are in agreement with measurements done at 50.2 GeV and 105 GeV (stable beam), but predict an instability at 450 GeV which was not observed. Possible explanation is related to a non-adiabatic voltage reduction on the flat top (from 4.5 MV to 500 kV) leading to beam losses and presence of the uncaptured beam.

First measurements in 2007 will be performed in week 23, before the scrubbing run. A difference around 20% is expected for thresholds at 26 and 37 GeV/c. Up to 50% change in the threshold should be observed at 55 GeV, during MD planned for week 34. Karel reported about preparation of the special magnetic cycle based on the LHC cycle with a long flat portion at 55 GeV with ramping up to 270 GeV (this gives possibility to dump higher intensities).

• **A retrofittable electron cloud suppression insert for the SPS - F. Caspers and T. Kroyer**

The proposed solutions for the e-cloud problem in the SPS are based on an insertable thin metal sheet with U-shape (width of 0.1-0.3 mm and length of 6 m). These stainless steel copper-coated inserts may have cleaning electrode (20 mm wide enamel strip with highly resistive film layer of 15 μm on the top) in the center and grooves and/or TiN coating on the rest of the surface, also perforated for vacuum requirements. This insert will lead to the vertical aperture reduction of less than 0.5 mm.

The idea of inserts, obviously very attractive from an implementation point of view, caused some doubts from operation experience due to free edges of inserts. Nevertheless the concept of cleaning

electrodes presents the most radical solution against e-cloud and should be further pursued. First of all it needs to be verified for its clearing efficiency and impedance. Miguel reminded us about the existence in the SPS of unused cables and feedthroughs from ion pumps which can be probably re-used for the electrodes.

• **Surface characterization and SEY measurements - M. Taborelli**

Different methods and set-ups for SEY measurements were discussed. With proper choice (constant or variable e-gun energy, variable retarding potential, collector geometry...) these measurements could provide important information on incidence angle dependence, minimum primary energy and energy distribution of electrons. The estimated cost of the measurement set-up, which includes e-gun, home made flood gun, manipulator, data acquisition system and UHV components, is around 100 kCHF.

This set-up would allow the best TiN composition to be found in the lab in 2007 followed by measurements with beam in the ring in 2008. This set-up can be used to study other surface treatments (e.g. grooves) and for other CERN accelerators (PS2 and LHC).

• **TiN sputtering technique - S. Calatroni**

Reactive sputtering for TiN coating was studied for vacuum chambers in SLAC, BNL and KEKB. The best TiN composition seems to be with ratio 1:1. Good quality was obtained with a closed cycle starting at low pressure, raising the pressure and then back. Smooth surface with "gold" color seems to have higher SEY than "brown" rougher surface. Composition control over the cross section presents a difficult practical problem. A cylindrical geometry can be coated with the existing hardware. The SPS vacuum chambers inside magnets have an elliptical shape and maybe a special cathode shape can be used. On the other hand the coating in the limited central area could be also sufficient.

• **General discussion**

The TiN coating should provide an SEY better than 1.3 since this value can be obtained in the present SPS after a scrubbing run. From literature one can hope for values below 1.0. The long term behavior of the TiN coating is also the open question. The surface roughness could be another parameter to play with for SEY reduction, however one should remember that pumping speed is limited in the SPS by vacuum port shielding.

Different samples produced and tested in the lab during this year should be installed inside the strip detectors and tested with beam in 2008. To compare under the same conditions TiN coating, grooves and cleaning electrodes, three detectors are needed. Only two exist at the moment in the SPS. Some help from BI is required for electronics.

Elena Shaposhnikova, 15.05.2007