Minutes of the combined meeting of the SPS Upgrade Study Group and Task Force on 25 March 2010

Present: G. Arduini, R. Assmann, J. Bauche, S. Calatroni, F. Caspers, P. Chiggiato, S. Federmann, R. Garoby, W. Hofle, M. Jimenez, E. Mahner, V. Mertens, E. Metral, S. Myers, G. Rumolo, B. Salvant, E. Shaposhnikova, M. Taborelli, C. Yin Vallgren

Excused: E. Ciapala

• ZS limitation - V. Mertens

The limitation imposed by the ZS vacuum (interlock) for high intensity LHC beams in the SPS is under study by the ABT Group. It looks as if charging of the ion-trap clearing electrodes makes them inefficient. It is planned to install two spare tanks in the SPS (LSS6) for studies. A solenoid around the ZS tank could potentially suppress the multipacting; this might be tested first on these spares. Simulations will be done by G. Rumolo.

• Collimation in SPS? - R. Assmann

This is a very preliminary study based on experience with the LHC prototype collimators installed in the SPS since 2004.

The main purposes of collimation in the SPS could be

- localisation of beam losses and activation
- clean scraping of the LHC beam
- passive and active (with fast BLMs) protection of the SPS machine

The classical system would be more simple than that used in the LHC and can consist of separate betatron and momentum cleaning systems having one primary and two secondary collimators per plane (9 total plus 2 spares), cost (4 ± 2) MCHF. The main challenge is the very high number of operational cycles stressing the mechanical parts. Grease should make life easier: this needs studies. One fellow/staff will be required for a design work.

Bake-out of collimators (M. Jimenez) which requires sectorisation of the vacuum system should be taken into account in the cost estimation (up to 1 MCHF for the distributed version, less if combined in one location). Cost of the shielding around this area should also be included.

A lot of money is invested in collimation in other warm high power machines (SNS).

• SPS Upgrade. - S. Myers

The priority list of the SPS intensity limitations was discussed. Since the e-cloud is considered to be the main SPS beam quality limitation S. Myers encouraged the team to aim for the SPS chamber coating during the 2011/2012 shutdown.

• Update on coatings for the SPS - M. Taborelli

In the liners the e-cloud signal from the carbon coating is $10^{-3} - 10^{-4}$ times smaller than that from the StSt and ageing is very low.

Last year the coated dipole magnets had similar dynamic pressure behaviour to the uncoated magnets, suppression of the e-cloud by at least factor 10 was observed with the microwave trans-

mission measurements. This factor is expected since only 90% of the magnet length was coated.

Different ageing is observed for carbon coated surfaces in liners and removable sample. They were coated with the same (good) coating system, but the latter was first exposed for months to air and then to the e-cloud in the ring (from the opposite, uncoated, side of the chamber).

The proposal presented for multipacting measurements in the lab of the coated magnet (with and without magnetic field), based on reflected power or SW excitation (F. Caspers), is strongly supported. This could also be one of the possible techniques for quality control (we have only endoscopy at the moment).

Among many other ongoing activities the results from the cut-open dipole chamber and the ion tests in Linac3 should give important additional information.

This year the pressure measured with 1 batch of 50 ns spaced bunches between two newly installed uncoated magnets in the same region (51480) is significantly higher than that between the coated magnets, where it is still higher than in the reference uncoated magnets.

M. Jimenez suggested installing for tests in the SPS magnets having new vacuum chambers coated under optimum conditions to see the effect of the coating system (quality). For pressure measurements we need two magnets each time.

It is too late to install new coated magnets during the next 2010/2011 shutdown if we want to find the best solution to be used for magnet coating during the 2011/2012 shutdown.

→ More manpower and efforts are required to coat and install magnets earlier (during this year).

According to the ECLOUD simulations (G. Rumolo) the nominal LHC intensity with 25 ns spaced beam is the worst situation for the MBB magnets with the MBA and other magnets coming next as intensity increases. The 50 ns spaced beam has a higher threshold (SEY of 1.6-1.7) but scrubbing is also slower. With this spacing a beam with emittance as low as 1 μm was obtained using the double-batch injection scheme in the PS. Emittance of 2.5 μs was measured last year with a single batch injection (E. Metral). S. Myers noted that usually the designed luminosity in colliders is achieved but not necessarily with the set of parameters which was foreseen.

• TMCI intensity thresholds for LHC bunch(es) in the SPS - E. Metral

During MD studies a single bunch with intensity close to ultimate was injected into the SPS. It was stable with positive chromaticity but the exact emittances are not known. These results agree with predictions from the HEADTAIL simulations. Increasing the chromaticity or the voltage at injection should help but for the LHC beam this leads to slow losses along the SPS flat bottom. A positive effect can also be expected from operation in a double RF system which is used in any case in the SPS for longitudinal beam stability. Transverse feedback is another possible tool used in VEPP-4 and LEP in the past. TMCI exists with many bunches and the combined effect of the e-cloud and traditional impedance should be studied in detail. Very high chromaticities ($\xi_x = 0.2$, $\xi_v = 0.4$) are indeed required for the nominal LHC beam in the SPS and beam losses are also significant ($\sim 10\%$).

→ Measurements with ultimate (or higher) single bunch intensity with well controlled bunch parameters close to the LHC nominal values (in collaboration with PSB/PS experts).

A lot of efforts went into obtaining the transverse impedance model of the SPS (measurements, simulations). This model continues to evolve, but at the moment still seems to include only 60% of the measured impedance in the vertical plane (comparison with measured tune shift). Interesting features (stable and unstable regions) of TMCI behaviour with intensity could already be seen in simulations using the realistic SPS impedance model. Impedance reduction would still be the proper way to fight against this instability. For this, the main contributors should first be identified and this work is ongoing.

To have more accurate predictions direct space charge as well as synchrotron and betatron frequency spreads should also be included in simulations.

- The next meeting (joint with the Task Force on SPS upgrade) will be on **22 April 2010** at 15:30.

Preliminary agenda:

Recent results on coatings - M. Taborelli

E-cloud estimate from mw measurements - S. Federmann

Correlation of beam loss and e-cloud from 2008 scrubbing run - C. Y. Vallgren

Planning of the scrubbing run in the SPS - E. Metral/E. Shaposhnikova

Elena Shaposhnikova, 30.03.2010