Minutes of the combined meeting of the SPS Upgrade Study Group and Task Force on 22 April 2010

Present: G. Arduini, J. Bauche, J. Borburgh, S. Calatroni, F. Caspers, P. Chiggiato, S. Federmann, R. Garoby, B. Goddard, V. Mertens, E. Metral, G. Rumolo, B. Salvant, E. Shaposhnikova, M. Taborelli, C. Yin Vallgren, U. Wienands

Excused: E. Ciapala

• Preliminary proposal for an SPS upgrade planning - V. Mertens

The time slots presented for the SPS upgrade were given by S. Myers. To fulfill this time frame a lot of resources will be required on a short time scale According to this planning practically all studies should be concluded before the middle of 2011 (for coatings - at the end of this year). The estimates of resources presented have a large error bar and strongly depend on the option chosen for realisation (at least for coating). The total cost varies from 46 MCHF with coating inside magnets (option I) to 60 MCHF with coating of new chambers (option II). Coating during two shutdowns (2011-2013) - option I - doesn't look impossible if all resources are available. According to J. Bauche for option II about 100 people should be trained to do the work in 2 shifts during a few months per year, CERN manpower is not taken into account.

Discussion. If the problem of coating quality is solved by replacing the vacuum chamber inside the magnets by the new one, the problem with ageing is still an issue to be understood. For the new vacuum chamber more possibilities should be considered:

(1) copper coating to reduce resistive wall impedance (present contribution to the total impedance of 20 MOhm/m is around 3 MOhm/m - B. Salvant);

(2) clearing electrodes (Fritz has new ideas, which nevertheless require some time for investigation) could be installed on the sides.

High bandwidth transverse FB for TMCI also needs more manpower resources for extensive feasibility studies.

For the ZS no hardware modifications are foreseen at the moment. The test-bed with two spare tanks will be probably installed (if needed) in the SPS during the next shutdown.

• Update on coatings for the SPS - M. Taborelli

The MBB magnet was cut open and inspected in the lab. The coating thickness (as seen from liner coated at the same time) varies from 1800 nm at the one edge to 430 nm at the other with a minimum of 180 nm in the middle. This explains the different colors of coating produced inside the magnet. Larger thickness is also associated with higher Hydrogen concentration. Unfortunately the endoscopy did not show much.

Next steps are to insert magnets with a vacuum chamber coated in the lab instead of the present coated magnets (MBB51530 and MBB51550). The new coating looks good (all black) and covers all the surface (is it good for vacuum? - if needed only fraction can be coated) For magnetic measurements the coil will be sliding at the edges (+/- 4 cm outside should be OK).

→ The old coated magnets could be installed in the SPS in a different position (without mw diagnostic) to continue the longterm stability test.

The large amount of cleaning water required for option I coating is a big problem. The latest information is that only a few liters (with cubic meters needed) can be used per magnet. Using plasma cleaning may help (gas instead of water). Storage of the old (and radioactive) vacuum chamber (option II) is probably less critical.

Use of Tungsten wire (Fritz) is better for the multipacting test stand in the SPS dipole (power reduction below 100 W).

Clearing electrodes should be reconsidered for the coating option with magnet opening. This could be done with a plasma sprayed insulating strip (Fritz, Edgar).

Next week MD: correlation of the e-cloud signal in liners and beam loss, pressure measurements between liners (StSt) and coated magnets, fast pressure measurements. The StSt liners and chambers connecting them will be replaced by coated elements for future MDs (W22 or W30).

• **E-cloud estimate from microwave measurements - S. Federmann, F. Caspers, E. Mahner**

The peak e-cloud density was evaluated from the measured phase modulation signal to test once more the reliability of the data obtained in the presence of some inter-modulation distortion. The phase shift measured by the microwave transmission method is related to the integrated e-cloud density while the peak value is obtained from the theoretical model for the phase shift in a plasma waveguide. Taking into account the SPS duty cycle (the lengths of the LHC batches and gaps between them) as well as e-cloud build-up distance from simulations (1 μs for the 1st batch and 1.6 μs for others) the measured integrated values can be converted to the peak values. Finally, after applying corresponding corrections (2.9 dB for 4 batches) the value of 1.5×10^{12} e/m^3 has been obtained.

• **Electron cloud simulations for the SPS electrostatic septum (ZS) - G. Rumolo**

The e-cloud build-up was studied in the ZS geometry for cases without any external fields, with the usual voltages in the ion trap and with a solenoid field (as a possible remedy against the e-cloud). During the operation the cathode is at -220 kV. There are wires (part of the grounded anode) separating this cathode from the circulating beam. The ion traps inside the anode have a voltage of -3 kV and -6 kV. Many observations with the 25 ns spaced beam suggest that despite the expected clearing effect of the ion traps there is e-cloud in the ZS. Simulations confirm that in the absence of clearing voltages the e-cloud build-up becomes significant (10^{10} e/m) for SEY above 1.7. Nominal voltages should suppress e-cloud for SEY at least up to 2.0. It has been found that a clearing voltage in the range from 500 V to 4 kV should suppress e-cloud formation. The solenoid field (from 20 G to 110 G) alone has an effect similar to the ion trap voltage. However the presence of this solenoid field in addition to the nominal ion trap voltage seems to enhance the e-cloud build-up (up to 10^8 e/m).

Intensive studies of the ZS behaviour are planned during the coming SPS MD.

• **A new MKE concept for SPS?**

An open C-kicker design should allow the limitations of the present kickers to be avoided. In

this case the beam is placed before extraction into a smaller gap which allows a higher kick strength and therefore reduced number of magnet units (from 5 to 3). Beam will see its impedance only at the highest energy for a short time (50 ms for LHC beam and 100 ms for CNGS beam with the present rise-time of 200 ms). Note that TMCI scales with energy as η (slip factor). Appropriate shielding should be foreseen already in the initial design (F. Caspers). The present design is for LSS4 and it would be similar for LSS6. In total 4 enlarged aperture quadrupoles will be needed to accommodate the changes due to the new kickers. These are preliminary estimates and more studies will be needed to have a full design.

• **Planning of the SPS MD week 17 - E. Metral**

The injector accelerator schedule for 2010 (V1.6) has 7 large MD blocks which coincide (3 first days) with the LHC technical stops. All of them (except the first one) also have an injector stop lasting from 12 hours (4 times) to 48 hours. Time used during the dedicated MD block by the UA9 experiment is then compensated by time shared with LHC filling (on request). The first MD in week 17 is considered as a scrubbing run with acceleration to 450 GeV (as last year). The detailed parameters (number of batches, energy and RF voltage) depend on limitations from the ZS (and other magnets). One of the purposes of this MD is to see the correlation between beam losses and e-cloud signal during the scrubbing. The analysis of the previous results (the 2008 scrubbing run) done by Cristina doesn't show any significant correlation. This year the scrubbing effect could be even less due to the short shutdown and smaller ring venting. It was suggested to try and minimise scrubbing effect during setting-up time.

The next MD in week 22 will be devoted to LHC beam with intensity above nominal.

• The next meeting will be on **20 May 2010** at 15:30.

Preliminary agenda:
Recent results on coatings and coating systems - M. Taborelli
E-cloud measurements from the scrubbing run - C. Y. Vallgren
Results for ZS and different SPS kickers from MD W17 (MKE, MKDH) - ?
Update on the SPS transverse impedance - E. Metral

Elena Shaposhnikova, 30.04.2010