**Meeting of LIU SPS-BD WG on 23/02/2012**

**Present:** Theodoros Argyopoulos, Hannes Bartosik, Holger Neupert, Giovanni Iadarola, Giovanni Rumolo, Juan Esteban Muller, Vittorio Vaccaro, Elena Shaposhnikova, Benoit Salvant, Adrian Ulsroed, Yannis Papaphilippou, Mauro Migliorati, Nicolo Biancacci, Fritz Caspers, Joachim Tuckmantel. Helga Timkó, Silke Federmann;

**Excused:** Thomas Bohl, Brennan

**Elena Shaposhnikova: Outcome from Chamonix 2012**

Summary:

One of the main outcomes of the Chamonix workshop is that LHC will be running at 4 TeV since it corresponds to the same risk of failure in the splices as running with 3.5 TeV in 2011. According to S.Myers the goal is to provide 13.5 fb-1 integrated luminosity to the experiments (the DG corrected to 15 fb-1) with around 10% increase of peak luminosity by reducing beta\*. There will be a scrubbing run in the LHC (with 25ns beam???) in the week after the scrubbing dedicated period in the SPS, which is scheduled for end of March. A variety of LHC upgrade scenarios were studied. However, as Elena remarked some of them would require substantial upgrade of the SPS, the so called SPS+, and this was not mentioned in Chamonix. Concerning the LHC filling, there will be no dedicated LHC filling cycle in the SPS in 2012. The main reason is that the ZS outgassing and sparking remains an operational limitation for high duty cycles of LHC beams in the SPS, even with reduced voltage. In addition, the effective gain of time in the LHC is limited as the usual time LHC stays at injection is quite long. On the other hand, considerable beam time for the physics users in the SPS would be lost. The analysis of the performance reach of the injectors after LS2 found that most likely not LIU requirements will be achieved after LS2, but maybe after LS3. In particular considering the so-called stretched goals. Concerning the period after LS1, it was found that there is no performance gain to be expected from the connection of Linca4 without the PSB upgrade. It was presented by M. Jiminez, that the coating of the SPS magnets with aC remains the baseline scenario for the SPS upgrade in the frame of LIU. Overall the Chamonix workshop was more concentrated on the 2012 run.

Discussion:

* As pointed out by Giovanni R., no performance gain can be expected in case of connecting Linac4 without the upgrade of the PS injection only under the assumption that the space charge tune spread in the PS is limited to ΔQ=-0.26, which is however not proven to be a hard limitation.

**Holger Neupert: Changes during shutdown 2011/2012**

Summary:

An access is scheduled for the 1st of March for installing the coated drift tubes (equipped with pick-ups and solenoids) in sector 520 together with the instrumentation related to the read-out of the vacuum gauges. A coated MBA magnet was moved. A setup of electron cloud monitors in the form of shielded pick-ups mounted on a vacuum chamber was installed in sector 530.

Discussion:

* Holger reminded us that there are presently 5 coated magnets in the SPS, 3 hollow cathode method coated and 2 Magnetron coated. Even though they are coated with different techniques, the resulting SEY should be quite similar.
* Elena explained that pressure rise observed close to coated vacuum chambers were suspected in the past to be related to coating technique, which however was not confirmed.

**Fritz Caspers: Status of the Microwave transmission setup**

Summary:

The equipment was checked on the surface but nothing was working. It will be made functional again during an access on the 1st of March.

Discussion:

* Elena pointed out that there are now 2 magnets between the antennas in contrast to a single magnet in the setup of previous experiments, which could affect the signal quality.
* Even though there all active electronics components were moved to the surface, it should be possible to reverse the microwave propagation direction.

**General discussion:**

* Benoit reported that Bruno Balhan?? is preparing experiments on the “test” ZS, where on both ends a sieve was installed for reducing the impedance seen by the beam. In the new configuration, the sieves will shield big parts of the tank. It is hoped to reduce heating of the ZS and facilitate operation. On the other hand the new setup does not allow measurements of the current through the ZS. MD time for detailed studies was already requested. First tests could be made during the scrubbing dedicated period end of March.
* Measurements of longitudinal impedance with single bunch beams will be performed during MDs in 2012.
* As explained by Mauro, an impedance model of the PS will be developed, starting with the major impedance sources. For the beginning, all transition pieces will be considered to be identical. The model will be refined at a later stage. Elena pointed out that a good knowledge of the (longitudinal) impedance in the PS is crucial for studying limitations in the bunch rotation at PS extraction and the beam transfer to the SPS. As remarked by Fritz, standing wave patterns have to be taken into account in the modeling of impedance.

**Giovanni Iadarola (and Hannes Bartosik): Preparation of scrubbing run**

Summary:

Goals of the scrubbing run are to quantitatively characterize scrubbing process and to identify the present conditioning of the ring and possibly scrub more. Electron cloud enhancing beam conditions will be studied using the nominal 25ns bunch spacing, which includes deliberately enhancing fraction of un-captured beam (5-10%), injection of more than 4 batches and higher bunch intensity.

In addition to the usual strip detectors, an experimental setup with shielded pick-ups will be (re-) installed in the SPS (a similar setup was used in previous e-cloud experiments in the PS). One of the two pick-ups is shielded and will be used for measuring the electron signal. The shielding is removed on a second pick-up for measuring the synchronized beam signal. The high bandwidth of these pick-ups should allow for a bunch-by-bunch resolution.

A vacuum chamber with a detector for slow electrons was installed, where an electrode on the opposite side of the chamber can be pulsed just after the bunch passage. The idea of this setup is to allow for electron cloud build-up keeping the electrode at zero potential and to study then the electron cloud decay by varying the delay between the bunch train passage and the biasing of the electrode.

Two long vacuum chambers with circular cross section (159mm diameter) coated with aC and equipped with solenoids were installed for demonstrating that the e-cloud activity is suppressed. Attention will be paid also on pressure rise, previously observed close to coated chambers even without evidence of electron cloud activity.

A fresh StSt sample removable under vacuum was installed in a chamber similar to the MBB type. It should be removed right after the scrubbing run for measuring the SEY and therefore an access needs to be scheduled.

The model describing the interaction of the electrons with the wall are based on 5 parameters and the secondary electron energy spectrum. Two of these, the maximum SEY and the probability of reflection at zero energy change during the scrubbing and cannot be measured directly. It was demonstrated by simulations however that compatible combinations of R0 and SEY values can be found by measuring the variation of the integrated e-cloud signal as a function of the spacing between the third and the fourth batch (if saturation is reached within the second batch). For quantifying the scrubbing efficiency, also the accumulated e- dose has to be estimated. This will be done with the help of simulations, as it is difficult to relate the current in the e-cloud monitors within the magnetic field regions with the total electron flux on the walls.

It is important to understand if mechanisms other than residual gas ionization have to be considered for correctly modeling the build up (Electrons are created in the model only by residual gas ionization) by changing the vacuum conditions in the liners.

It is planned to perform measurements with different beam conditions (like delaying the last batch, un-captured beam, more batches, variation of bunch length). In addition to the measurements characterizing the electron cloud build-up, beam quality measurements and instability effects will be studied.

It is expected that 1-2 days will be needed for setup and conditioning of the replaced kickers. A full day (4th day of scrubbing period) dedicated to high intensity studies is foreseen in the planning. This will of course require the help of RF experts in the PS.

The standard cycle for scrubbing will be a long flat bottom cycle (around 30s). This cycle might be extended to a coast cycle for studying long-term evolution of e-cloud effects. An MD cycle based on the nominal LHC filling cycle will be used to study beam quality and electron cloud effects at high energy. Similar cycles might be needed for 50ns beams. It remains to be checked if the MD cycle can remain in the super-cycle while LHC is requesting beam.

Discussion:

* Elena mentioned that long-term effects of electron cloud should be studied with coast cycle. Past experiments showed a reduction of life-time and emittance growth along the bunch train and bunch shortening in coasting cycles. Similar experiments should be repeated as early as possible in the scrubbing run and repeated towards the end. Furthermore, observations of un-captured beam moving with respect to the RF-buckets may allow for an estimate of the beam energy loss.
* For some measurements a fast BCT signal over a full SPS turn will be needed.

**🡪 Action for scrubbing team: Check if fast BCT can be acquired over a full turn.**

* The electron cloud build up phase is hard to measure with the shielded pick-up due to the large noise level caused mainly by the long cable between the pick-up and the surface. Nevertheless, the S/N ratio could be improved by inserting a second grid in front of the pick-up, as suggested by Fritz. It was also advised to contact E. Mahner, as he has lots of experience from similar experiments done in the PS.

**🡪 Action for scrubbing team: Check if a second grid should be placed in front of the pick-up.**

* An access needs to be scheduled soon after the scrubbing run for retrieving the removable sample and measuring the SEY. Maybe the StSt liners should be removed as well right after the scrubbing period.
* Good knowledge of the beam parameters is crucial for the modeling of the electron cloud build-up. It should be decided how frequently beam parameters which cannot be monitored continuously (like bunch length) need to be measured. The same applies for the microwave transmission measurements.
* Seeding mechanisms for the electron cloud build-up will be studied by local variation of vacuum pressure. Ion pumps can be switched off for study purposes in the region of electron cloud monitors. Sublimation pumps can be used to decrease the pressure close to coated chambers in LSS6. Fritz mentioned that particle losses on the wall could also generate electrons, which represents another seeding mechanism. He pointed out that the electron seeding could also be enhanced with radioactive sources placed inside or close to the vacuum chamber.
* An important question concerns the super-cycle composition in the SPS during LHC filling. If the MD cycle used for the scrubbing studies cannot be played during LHC filling, large amount of MD time might be lost. In particular LHC will be in last phase of commissioning during the SPS scrubbing run and might rely on using the routine injection super-cycle (consisting SFTPRO and CNGS cycles).

**🡪 Action for scrubbing team: Clarify if the MD cycle can be used during LHC filling.**

* The possibility of having some period for conditioning before scrubbing run was discussed. At least the 50ns should be ready for LHC in any case, which will already condition the machine. It is however not clear at which point the 50ns beam will be available in the SPS. On the other hand it is not clear if the 25ns beam will be setup already before the scrubbing run. It was also realized that the last day of the scrubbing run as scheduled up to now (March 30th) collides with the joint LIU HL-LHC event. It was proposed by Hannes to move the scrubbing period such that it would start already on Friday 23rd instead of Monday 26th of March. In this way, the collision with the LIU event is avoided.

**🡪 Action for the scrubbing team: Clarify the availability of LHC beams in the SPS with OP. Check if the scrubbing run can be moved forward to start on Friday 23rd of March instead of Monday 26th.**

**Organizational matters:**

Mauro Taborelli is now in charge of the SPSU e-cloud working group.

We thank Benoit for his work as scientific secretary during 2011 up to the last meeting. Hannes Bartosik is the new scientific secretary.

The next SPSU BD meeting is scheduled for March 22nd

* Preliminary agenda
  + New results from PS-SPS transfer simulations (Helga Timkó)
  + Open action: Q20 optics for CNGS beam (Thomas Bohl)
  + Follow up on scrubbing run (Giovanni Iadarola, Hannes Bartosik)

An intermediate meeting for follow-up items related to the scrubbing run might be scheduled, possibly integrated in the SPSU e-cloud working group meeting.

Minutes written by Hannes Bartosik