SPSU meeting 11/10/2011

**Present:** Theodoros Argyropoulos, Elias Métral, Giovanni Iardarola, Giovanni Rumolo, Silke Federmann, Wolfgang Hofle, Juan Esteban Muller, Hannes Bartosik, Helga Timko, Yannis Papaphilippou, Elena Shaposhnikova, Malika Meddahi, Mounir Mensi

**Excused:** B. Goddard, F. Caspers, G. Arduini, R. Garoby, M. Taborelli

1. **Malika Meddahi: LIU-SPS Beam loss - Protection - TLs WG**

Malika presented the mandate, the members, the schedule and the topics of the *Beam Loss, Protection, Transfer lines LIU-SPS Working Group.* The Minutes of the WG meetings are available in Indico and EDMS. For the last one see for example following links:

<https://indico.cern.ch/conferenceDisplay.py?confId=161020>

<https://edms.cern.ch/document/1168615/1>

1. **Silke Federmann: Electron cloud measurements with the microwave transmission method: results of MD run in week 19.**

Summary:

An MD in week 19 of 2011 was performed to understand the ambiguous results obtained in weeks 39 and 42 in 2010. Measurements from the last year could be reproduced reliably. The strange behavior observed with high carrier frequencies are believed to be due to interference with beam induced signals. New measurement setup works reliably – confirms all measurements obtained before with no signal increase visible in coated magnets and signal increase at each injection in uncoated magnet.

1. **Hannes Bartosik: Electron cloud effects in the SPS in nominal and low γt optics**

Summary:

The goal was to compare the Q20 and Q26 optics with respect to the electron cloud threshold, in particular to assess the scaling with the synchrotron tune Qs and the beta-function.

Hannes reminded important features to analyze Headtail simulations, in particular the difference between the simulations in the field free regions and dipoles and the need to scan the e-cloud density and not the bunch current due to odd effects at very high e- cloud density.

Simulations show that higher synchrotron tune helps stabilizing the beam (threshold increases linearly with Qs), but this threshold decreases with increasing beta function (scaling like 1/betayn with 0.5<n<1 in the case of the e-cloud in the dipoles). Comparing the two optics shows that the Q20 optics should be more stable than Q26 for the e- cloud instability, where an increase of the threshold by roughly a factor two can be expected at the SPS injection energy.

Discussion:

Elena proposed to assess the dependence of the instability threshold in the two optics for different values of chromaticity for the same intensity and electron cloud density.

Elias proposed to study the dependence of the threshold as a function of the bunch length in view of possible scrubbing scenarios.

Action for H. Bartosik -> scan the dependence of the instability threshold on the bunch length and find the chromaticity needed to stabilize the beam from the ECI with nominal intensity and e-cloud density of 1e12 /m3 in the two optics.

1. **Giovanni Iardarola: Different strategies of electron cloud enhancement for scrubbing**

Summary:

Several strategies for the enhanced scrubbing have been investigated: (1) 5 ns beam, (2) slip stacking scrubbing, (3) with addition of uncaptured beam and (4) asymmetric bunch splitting in PS. An efficient scrubbing should increase the electron dose over the region which generates electron cloud with the 25 ns nominal beam.

In this respect, the most promising method from simulations, seems to be the slip scrubbing (use slip stacking to interleave 2-4 last batches onto the first 2-4 batches, resulting in smaller bunch spacing – 5 ns and 20 ns or 10ns and 15 ns). The 10+15ns configuration seems more efficient than the 5+20ns and generates a significant increase in dose over the interesting region for 25ns (factor 2 to 3).

Injecting two batches of the standard CNGS beam into the SPS and capturing it in the 5 ns bucket should give a good enhancement of the scrubbing dose but the two stripes region scrubbed by this beam is unfortunately quite different than the two stripes region scrubbed by the 25ns beam.

The 5-10% uncaptured beam effect was observed in past MDs and was reproduced in simulations. A memory effect is observed from turn to turn with uncaptured beam but it disappears when there is a gap in the debunched beam. Looking at the 4 batch scheme with SEY=1.5, the saturation is reached anyway and the enhancement is small. A beneficial effect is however that full first batch contributes to scrubbing.

The PS splitting deregulation could generate strong asymmetry in bunch intensity. However the dependence of scrubbing efficiency on beam intensities is not monotonic and shows a maximum at ~8e11 p/b (due to the non monotonic dependence of SEY with incoming electron energy). The intensity variation around 1.1e11 p/b is therefore not expected to enhance scrubbing.

Discussion:

* Option 1: 5ns beam
  + Elena: 6e10 p/b at 5 ns spacing corresponds to local density with 3e11 p/b at 25ns and may be a problem for the RF system before upgrade (beam loading).
  + Wolfgang said it was tried before (transverse RW), but maybe it is already scrubbed. It would be interesting to repeat.
  + Alexey Burov said that the simulations agree with the expected scaling between saturation level and the bunch intensity.
  + Elias wondered if changing the intensity would change the scrubbed region.
* Option 2: Slip scrubbing:
  + Theodoros was studying the option to get higher bunch intensity at 50 ns bunch spacing by slip stacking using ESME. The problem is that a lot losses are expected (the RF frequencies for 2 beams should be controlled separately and this is not possible now).
  + Problems with FB, FF and longitudinal damper as well.
  + Transverse damper appeared to be a showstopper for slip stacking. Indeed there are two types of electronics. The ones that could work with different bunch spacings cannot work in the presence of e-cloud. In LHC, it only works with 25ns bunch spacing. Solenoids were put around pickups in 1999.
  + The original idea for scrubbing was to recapture bunches in adjacent buckets.
  + Wolfgang: slip stacking requires a lot of work from LLRF. Is it feasible? It would need 2 separate controls of RF system. It is very challenging.
* Option 3: Uncaptured beam
  + Multi-turn memory effect enables to reach saturation. It is great for SEY=1.3, but not so much for SEY=1.5.
  + However 4 batches are scrubbing instead of 3 and it could be a nice improvement if it is difficult to have 4 batches. It would also be more efficient as the 4th batch does not stay very long on flat bottom in nominal cycle.
  + This is a promising idea
  + Action for two Giovanni: assess the effect of voltage decrease on the e-cloud instability.
* Option 4: Inhomogeneous bunch intensities.
  + Not an option

The electron dose should be optimized during a certain time. The real figure of merit could be the integrated electron cloud density over 1 turn divided by the total charge in the machine.

What is the effect of energy? Not much is expected.  In fact, the magnetic field inside the SPS dipoles is 0.12 T at injection, and above 100 Gauss there is not much effect expected from a change of the magnetic field on the e-cloud build-up.

Elena: should there be a scrubbing run in the SPS to improve the transverse emittance blow-up if e-cloud is responsible for it? - Probably not.

Hannes: one could change the gamma transition in the other direction to change bunch length (there would be a problem with the quad energy).

Action 🡪 Propose realistic scenario to have debunched beam (one needs to decrease the capture voltage).

**Elena Shaposhnikova: MD proposals for 2012**

* Also presented at the last LIU-SPS meeting and discussed there
* Continue studies with 2 optics in parallel in 2012
* Priority list

Written by B. Salvant