Electron cloud meeting #28, 17/03/2015

Participants: N. Biancacci, B. Bradu, K. Brodzinski, L. Carver, P. Costa Pinto, S. Claudet, G. Ferlin, G. Iadarola, K. Li, L. Mether, E. Métral, E. Rogez, A. Romano, G. Rumolo, B. Salvant, M. Schenk, J. Sopousek, C. Yin Vallgren.

Matters arising (G. Rumolo)

- This meeting is meant to be a first iteration in preparation of the LHC scrubbing run in 2016 and the following intensity ramp-up with 25 ns beams.
- The 2016 scrubbing run will take place in the second part of Week 17 from 28 April until 1 May. Based on the lessons learnt in 2015, the dedicated scrubbing will only last 4 days. Injections of 288 bunches from SPS are planned to be used, because long trains seem to help the efficiency of the scrubbing process. Some refresh scrubbing fills will be done during the first phase of the intensity ramp up, in which we know from experience that anyway part of the conditioning may get lost due to the low electron cloud operation. The rest of the scrubbing will happen with physics. During the run we might then get to a point in which we deem appropriate to try again scrubbing with doublets (i.e. the achieved scrubbing stage is such that we may reasonably hope to fill the machine with stable doublets and scrub the beam screen in the dipoles to SEY values below the threshold for 25 ns beams)
- **P. Costa Pinto** asked whether it might make sense to use low intensity doublets in case of limitations from instabilities. **G. Rumolo** replied that the area conditioned with the doublets would be much smaller compared to that covered with the standard beam, so scrubbing with doublets is only interesting if the intensity per doublet is high enough.
- **S. Claudet** remarked that in case of injections of 288 bunches stronger transients have to be expected on the beam screen temperatures. **G. Rumolo** replied that, as longer trains can significantly boost the scrubbing efficiency, their use should be pursued during the scrubbing run. Maybe some coefficient in the feedforward will need to be adjusted according to the new magnitude of the step. Then, of course we will be prepared to step back to less aggressive filling schemes as soon as the produced heat loads become intolerable for the cryogenic system.
- It has been discussed that we might want to run with some cells having higher beam screen temperature to check whether this has an effect on the efficiency of scrubbing. The idea would be to identify few cells that exhibit a similar behavior in terms of heat load at the beginning of the scrubbing run, and then warm up the beam screen of a subset of them in order to monitor then the scrubbing evolution for the two sets at different temperatures. **S. Claudet** commented that such a test can be envisaged during the scrubbing. In that case a larger cryogenic power for the cold masses will be needed due to increased heat load, which has to be estimated beforehand. We should limit the test to a few cells per sector

and select them among those with the 60 A current lead at the inlet of the beam screen cooling circuit.
- Concerning the MKIs, which limited the number of injections in Beam2 in 2105 because of the vacuum interlock at the tank D-Q5 interconnect at point 8, **C. Yin Vallgren** said that the NEG cartridges in the region have been regenerated. **G. Iadarola** suggested that the anti e-cloud solenoids at the MKI interconnects should be also tested before the scrubbing run.

Cryogenic system in 2016 (B. Bradu)

- Beam screen temperature is kept stably around 20 K, allowing for max values of 40 K during 30 minutes.
- Cryogenic power: the installed value is 116 W/hc, which becomes 160 W/hc due to the lower heat load on the cold mass. In 2015, however, sectors 78 and 23 were limited to 135 W/hc.
- Due to the time constants of the heat loads during injection, ramp and dump wrt to those of the beam screen circuit and refrigeration, the classic feedback controllers cannot manage correctly the fast transients and could lead to important overshoots.
- However, using an updated modeling (based on machine experience) of the heat load expected from electron cloud, as well as the same modeling as in the LHC DR for image currents and synchrotron radiation, it is possible to construct a feedforward control scheme for valves and heaters (which have about the same response time constant as the heat loads), which has been shown to produce very good results (both in simulations and deployed during the 2015 run). Coefficients can be adjusted taking into account the behavior of different sectors (cells) as well as over time taking into account the scrubbing effect. They probably will have to be re-adapted for the 2016 run.
- **K. Brodzinski** added that tests are being carried out to assess the available cooling capacity for the sectors 78 and 23. It is confirmed that sector 78 can reach the 160 W/hc, while 23 is still under test. It has been found that all the Q6s are close to the limit of their cooling capacity. Nevertheless, since no 120 A circuit is present in these magnets, there could be a possibility of relaxing the CryoMaintain levels, but this has to be studied in detail.

ADT ObsBox (L. Carver)

- This year, 3 new servers have been installed. Each server will process Q7 and Q9 pickups for each plane. The buffer for each pickup is now 60000 turns (although this can be changed depending on requirements).
- The data is now accessed via a FESA class, which has recently been made available. Once there is beam it is very straightforward to subscribe to the class to retrieve the data. Scripts will be much simpler in 2016 than 2015
- There will also be an additional 5th server that will maintain the functionality of the ObsBox in 2015, i.e. manual trigger with different numbers of turns.

- Super fast ADT diagnostics should hopefully be in place by end of April. Will follow up with Gerd.
- **G. Iadarola** asked if we have an estimate of the time required for the ObsBox to save the data. In principle during the scrubbing we will need to save at each injection, i.e. with a repetition time of about 30-40 sec. Also we should be equipped with a tool to plot "on line" at least a subset of bunches (as it was done in the past with the old buffer), in order to be able to observe instabilities and react accordingly. **L. Carver** answered that this has to be investigated. **G. Iadarola** added that it might be desirable to have the old buffer still available, while we acquire some experience with the ObsBox.

Heat load from impedance and synchrotron radiation (B. Salvant)

- Two options have been considered to estimate the impedance induced heat load: 1) use the full formula with the beam spectrum (with fBCT and BQM data and an assumed bunch distribution, e.g. Gaussian, or with the measured spectrum) and the full impedance model, or 2) use the simplified single bunch formula with thick wall resistive wall and then multiply by the number of bunches.
- Fill 4467 was used to test different methods for the heat load calculation. It turns out that using the full formula with fBCT and/or BQM data, or constant bunch-by-bunch intensity and length, or even using the simplified formula as in 2), the results are all within less than 1%. Only using the measured beam spectrum one would obtain a value of power loss ~20% larger than in the previous cases (probably depends on the type of distribution assumed). The calculation with the full formula is time consuming and its on-line implementation requires development.
- The simple formula implementation should profit from the framework of Timber variables used by Fixed displays, which is already available since 2015. It should become available before Easter, thanks to the help of BE-CO (Nikolay Tsvetkov)

AOB

- None.

Adjournment

Next electron cloud meeting will be taking place in April 2016, just before the scrubbing run.

GR & GI, 01/04/2016