LHC e-cloud simulations Meeting – Draft Minutes

Date: 16 May 2011
Meeting Room: 6-2-004

Attendees: Gianluigi Arduini (GA), Chandra Bhat (CB), Humberto Maury Cuna (HM), Octavio Dominguez (OD), Elias Metral (EM), Giovanni Rumolo (GR), Frank Zimmermann (FZ)

Agenda

1) Comments on the minutes and actions of the last meeting (9th May 2011)
2) Update on arc heat-load simulations (more realistic filling pattern, larger R scan range), Humberto Maury
3) Update on benchmarking, Octavio Dominguez

Minutes and actions of the last meetings (9th April 2011)

Past Actions:

- Horizontal displacement of daughter particles, still pending (potential **ACTION** for Ubaldo Iriso or HM).

- LHC parameters had been sent to Fatih Yaman by FZ.

- FZ also contacted Kazuhito Ohmi, who agreed to perform the feedback simulations.

- Find someone from LARP or CERN for feedback simulation at CERN, still pending (**ACTION** → EM, WH, GR)

- SEY of 3 for some interconnects, still to be confirmed (**ACTION** → EM)

- Still outstanding are a number of **actions** for HM:

- Make plots in δ_{max}-R space showing contours for typical experimental heat loads.
- Investigate the ECLOUD behavior at SEY=2.2 and its parameter dependence (number of space-charge calculations, grid size).
- Simulate heat load for beam conditions during the 2010 scrubbing run with 9 x 12 bunches [heat load for this case was 40 mW/m initially].
- Look at the total number of e^- to check densities (strange behavior from the 4th batch for a dipole field at injection with SEY=2.4, R=0.4)

- Also outstanding is a study of the solenoid "resonance" effect (**ACTION** → OD), e.g. varying parameters like the bunch length and bunch spacing.

The rest of the actions had been done.

Update on Arc heat load simulation (Humberto Maury)

The results shown assume the same parameters as in the last meetings, but consider a new, more realistic filling pattern. This scheme consists of 6 batches, in groups of 2. The two batches of a group are separated by 200 ns (225 ns in reality, but the code allows only multiples of 50 ns) and the groups are separated by 1.1 μs.

Three different ways to calculate the heat load have been used: 1) computing the average over the first 2 batches; 2) computing the average over 6 batches with 200 ns spacing; and 3) computing the average over 6 batches with the new filling pattern (200ns/1.1μs spacing).

First, HM recalled the results from the last meeting at 3.5 TeV (average over the first 2 batches). Then the three results were compared. A filling factor of 0.13 is considered for the previous pattern while a value of 0.16 is considered for the new one. For all the cases shown (R=0.4, 0.5 and 0.6), the averages 1) and 2) set the lower and upper limits for the heat load respectively, the case 3) (the more realistic) being in between, as expected.

Next, HM presented the threshold values for multipacting for different values of R. A very simple rule can be observed for the relation between δ_{max} and R: rising R by 0.1, δ_{max} lowers by 0.1 at the threshold.

The plots showing the relation between the linear e^- density versus time some fluctuations can be observed. GA asked for the reason of these fluctuations. FZ answered that it could be caused by a noise problem in simulations and proposed to **study the fluctuations** by taking a certain case (e.g. R=0.6 and SEY=2.0) and applying variations on certain parameters (number of steps within the bunch, number of steps within the gap between bunches, number of macro particles, space charge computation steps…) to check the randomness effect on the level of fluctuations (**ACTION** → HM). The values for these parameters could also be included in the tables. OD said that for 3.5 TeV with 50 ns bunch spacing around 7500 steps for the space between bunches is necessary to obtain 10 points per e^- cyclotron revolution. Nevertheless, simulations with fewer points per revolution could also work sufficiently well.

OD asked whether at 3.5 TeV 1.1 μs spacing between trains is enough to clear the e- cloud, since the first batches of each double train looked all similar. FZ answered that at high energy this could be possible due to the much larger number of seed electrons compared to injection energy, since the surviving electrons from the last batch can be neglected. It could be interesting to

remake the plots in a logarithmic scale to see whether the first batches of each double train are indeed equal (**ACTION** → HM). FZ suggested that a possible explanation could be related to the survival of electrons in critical regions of the vacuum chamber and proposed to **launch simulations with 2, 4 and 6 batches** to see the **e^- energy distribution after each "double train"** passage (**ACTION** → HM). FZ proposes to also **look at the losses versus time** (from qlosswh.data file in ECLOUD) with and without energy cut (**ACTION** → HM).

EM said that the measured value for the heat load was 70 mW/m. It would be interesting to **include a horizontal line at this value** in further heat load plots to ease the comparison (**ACTION** → HM).

e^- cloud benchmarking update

OD presented new contour plots including lines coming from the second experiment carried out during the first shift of the scrubbing run (6/April/2011), for both raw and fitted data. A clear cut (solution) had not been found but it is possible to define a region within some error in SEY and R (around [1.9, 0.2]). The solution proposed in previous meetings [1.86, 0.25] is not far away from that region.

Only one gauge (VGI.141.6L4.B.PR) has been studied until now for comparison between both experiments (batch spacing and batch number variation). There are 170 equivalent gauges, so further checks to benchmark the method have to be done.

It was agreed that the real initial pressure should be taken into account for benchmarking simulations (relative ratios), while the final pressure should be used as input to take into account multi-turn effect. Since the effect of input pressure seems to have an important effect on the simulations at injection energy in a field free region, GA proposed to **redo linearity check plots with different initial pressures**, e.g. the pressure before the injection of the next batch, and the initial starting pressure to see the difference (**ACTION** → OD).

GA proposed to write a note summarizing the method and results achieved so far (**ACTION** → OD).

OD recalled that some uncertainties might come from the fact of working with 4 parameters. For example the ε_{max} value is being always 230 eV. Some investigations for this parameter had been done for 2010's measurements by OD, ε_{max} = 230 eV giving the most reliable result, but more tests should be carried out to achieve conclusions.

EM pointed out that apparently the solution achieved is almost the same as for the last year's scrubbing run and wondered if we are seeing any effect regarding a reduction of the SEY. GR said that through the scrubbing the desorption yield is also reduced and that could yield to a reduction of the pressure increase, as seen in the observations. The desorption yield should consider faster than the secondary emission yield.

FZ proposed to check the e^- energy distribution in arcs and straight sections, in particular their differences, expecting higher-energy electrons in the arcs (**ACTION** → HM, OD).

Next, the plan for an LMC presentation was discussed.

The next meeting will be announced in due time.

Reported by Octavio Dominguez and Frank Zimmermann