LHC e-cloud simulations Meeting – Draft Minutes

Date: 10 August 2012
Meeting Room: 6-2-008

Attendees: Chandra Bhat (CB), Octavio Domínguez (OD), Giovanni Iadarola (GI), Humberto Maury (HM), Giovanni Rumolo (GR) and Frank Zimmermann (FZ).

Excused: Elias Metral (EM)

Agenda

1. Minutes and actions from the last meeting
2. ECLOUD vs. PyECLOUD at 450 GeV, **Octavio Dominguez**
3. ECLOUD vs. PyECLOUD - LHC scenarios, **Chandra Bhat**
4. The mystery of the missing photoelectons, **Humberto Maury**
5. AOB

Outstanding actions from the last meeting

Actions from the last meeting on 29 March:

- Some problems seen in the PyECLOUD – ECLOUD comparison had been understood. GI explained that the version of PyECLOUD used had not been adequate and had an implicit assumption of circular symmetry. The simulations, including for a long train w/o gap, of central density, line density and heat load, would be redone with the full version of PyECLOUD and ECLOUD (**ACTION HM**).

- HM will also repeat the simulations of multipacting thresholds at 25-ns spacing as a function of chamber radius using both ECLOUD and the complete version of PyECLOUD (**ACTION HM**)

- OD confirmed that the pressure assignment for the map computation had been correct.

ECLOUD vs PyECLOUD at 450 GeV

Octavio Dominguez first compared the build up simulated by both codes over the first few bunches considering the case of **gas ionization**. Initial seeds are the same, but PyECLOUD shows a plateau after the passage of the second (and in general for the first couple of bunches), whereas ECLOUD results exhibit a certain, non-zero slope. Also the build-up slope is different for the two cases at later times after a bunch passage (the slope being always bigger for PyECLOUD). The existence of the plateau in PyECLOUD was well explained during this meeting: GR suggested that the possible reason for not observing the plateau in ECLOUD could be due to the step size between bunches and this first slope could be the artifact of a linear interpolation. A later check by OD confirmed this suggestion.

ACTION → Redo the same simulation shown with a smaller time step between bunches to see whether in this case a plateau after the passage of the bunch is also observed in ECLOUD (OD).

ACTION: Look at x-y snapshot after the passage of the first bunches (OD).

ACTION: Turn off space charge in both codes and simulate build up for a few bunches (OD)

When looking at the last bunches of the batch, the saturated electron density is different for both codes. Saturation values are always greater in PyECLOUD. A certain time slippage can be also observed, which was explained by the difference between introducing as input parameter either the bunch spacing in units of distance (ECLOUD) or in units of time (PyECLOUD), and the associated numerical difference.

The different slope during the build-up phase for the two codes remained an open question.

Next, OD compared results from both codes for the pressure benchmarking studies.

Sensitivity to various parameters related to macroparticles generation was studied for the benchmarking. For ECLOUD "npepb" was varied. PyECLOUD cleaning-related parameters like "N_mp_regen" and "N_mp_refen_low" etc were explained, and varied. For ECLOUD there is some variation in the results, whereas for PyECLOUD almost no difference can be observed.

In summary, PyECLOUD seems to be more robust at least in terms of the parameters explored. Also sensitivity to grid dimensions has shown better results with PyECLOUD. The shape of the different ratio lines also is more stable with PyECLOUD.

ECLOUD vs PyECLOUD - LHC scenarios

Chandra Bhat started with the motivation for these studies: PyELOUD offered many advantages and he wanted to make sure that results from PyECLOUD are consistent with those of ECLOUD.
Longitudinal bunch profiles for the HL-LHC cases at 7 TeV were illustrated. Next, comparison between ECLOUD and PyECLOUD heat-load simulations for the same shape (Hofmann-Pedersen distribution) show an extremely good agreement, within 3 and 6%, depending on SEY values and primary photoelectron yield. Also the electron densities agree. These simulations were performed for the case of photoemission in a dipole field, either one or the other of which could be the important difference compared with OD's simulations.
Heat load numbers are delivered in slightly different formats for ECLOUD and PyECLOUD.

For the PS a comparison showed excellent agreement between PyECLOUD simulations and observations, considering changing bunch profiles.

ACTION: Run a comparison for field-free region and for gas ionization (CB)

ACTION: Run a comparison for a very low value of the SEY (CB)

The mystery of the missing photoelectrons

Humberto Maury first explained how the input rate of primary photoelectrons is computed. Both codes divide the PPE in two separated categories with different distributions (Gaussian within a narrow cone for PE created in a first impact of the photons and $\cos^2(\phi)$ for PE created by diffusely reflected photons). In a test done by CB, for ECLOUD the primary photoelectron yield appeared to be only about a 40% of the expected value. Additional simulations were performed to understand the discrepancy. Only 5 bunches were simulated for different values of the photon reflectivity (varying from 0 to 100%). The ratio of simulated to expected rate of primary electrons depends strongly on the photon reflectivity and never reaches 100%, whereas for PyECLOUD the numbers are close to 100% independently of the photon reflectivity value considered.

So some open questions remain, such as the fact of not obtaining the expected peak value in ECLOUD after the passage of a batch when the photoemission model is the same in both codes.

FZ mentioned that some heat-load benchmarking had been done in the past comparing ECLOUD and POSINST codes, with a good qualitative agreement. He suggested continuing the cross check between PyECLOUD and ECLOUD so as to include field-free regions and gas ionization.

ACTION: Compare photoelectron rate for zero dipole field in order to see that the difference in ECLOUD is not caused by electrons that do not contribute to the further build-up because they are bent back into the wall due to the strong magnetic field (HM).

ACTION: Repeat the simulation with a very short bunch, in order to launch all PEs in one step.

ACTION: Recompute the heat load prediction for LHC and HL-LHC with 25 ns bunch spacing using PyECLOUD (HM)

AOB

The next meeting will be held in September and announced in due time.

Reported by Octavio Dominguez and Frank Zimmermann