LHC ecloud Simulations Meeting

Date: 11/26/2010
Meeting Room: 6-2-008

Attendees: Frank Zimmermann, Elias Metral, Giovanni Rumolo, Chandra Bhat, Humberto Maury Cuna, Octavio Dominguez Sanchez de La Blanca, Kevin Shing Bruce Li, Daniel Schulte

There were three presentations during the meeting.
1) Humberto Maury Cuna: Electron Cloud Simulations Updates
2) Kevin Li: LHC e-cloud studies- work plan
3) Octavio Dominguez Sanchez de La Blanca: e-cloud Simulations
General Info's: Elias Metral is giving a review talk next week at the LCM meeting on the LHC e-cloud related measurements and some preliminary analysis of the data.

1) Humberto Maury Cuna: Electron Cloud Simulations Updates
Humberto presented a summary of his recent ECLOUD simulation (work in progress) results for the LHC arcs with bunch spacing of 50 ns and 75 ns. This included the effect of the beam size, bunch length, vacuum pressure and the effect of B-field on e-cloud buildup etc. He also talked about his plans for future simulations.

The current simulations were primarily to benchmark the recent observations in the LHC beam with bunch spacing of 50 ns and 75 ns. For the simulations, bunch intensities and filling patterns were chosen identical to those of the LHC MD. The simulations were with Bunch Intensity= 0.9-1.3E11p/bunch, SEY=2.3 and 2.5, Reflectivity = 0.5, 0.75 and 1.0. Simulation results on "e-volume density" versus "Time (representing fill pattern around the LHC ring)" on 13 different cases were presented. The simulation shows that
1) For similar bunch intensities the 75 ns case produces about 1E4 less e-volume density than for the 50 ns case.
2) e-volume density at 0.9E11p/bunch is systematically higher than that at 1.3E11p/bunch for all values of R.
3) At 0.9E11, R=0.75 and 75 ns case relatively smaller e-cloud is predicted for the first two batches. Though e-cloud density almost dies it builds up much faster for the subsequent batches.
4) At higher intensities multipacting started showing up. It went down from 50 ns to the 75 ns case.

Effects of magnetic field: At higher magnetic field the e-cloud density went down and the SEY threshold increased.

Frank's remark: for lower field the multipacting may have gone up because the seed electrons were created inside the beam volume by gas ionization. The situation with primary photo-electrons due to synchrotron radiation might be different.

Effect of transverse beam size: The smaller the transverse size the higher will be the e-cloud. The dependence is nonlinear. Effect of bunch length: Changing the bunch length from 7.55 to 11.8 cm has little effect on the electron-cloud build up. The error due to limited statistics should be

estimated and included. Effect of pressure: The higher the pressure the larger the e-cloud density (Chandra, Elias, Frank: these simulations may need more careful examination because there were systematic wings or fluctuation in the presented plots, which might be related to the moment at which the density is calculated)
Generic simulation for LSSI chamber geometries are part of future simulations.

Frank, Elias suggested that Humberto should carry out simulations to scan *R* and delta in small steps and compare it with various LHC data to figure out their most probable values.

Further assignment to Humberto: calculate heat-load. Take a reasonable value of *R* and other parameters and find out for which value of SEY we get 20 mW/meter.

Points to be clarified:

- batch spacing in the MD: 225 ns or 250 ns?, 1.85 microsecond
- central density shown at which point (recommendation: plot it only just prior to the bunch passage)
- distribution of e-cloud for a field of 8.4 T and 0.54 T
- numerical error estimate
- effect of magnetic field
- linear increase in density for low SEY simply due to accumulation of ionization electrons or more than this?

2) Kevin Li: LHC e-cloud studies- work plan
Kevin's e-cloud simulation studies were also related to LHC issues. His plan are to scan energy in the range of .45 TeV- 7 TeV and e-cloud densities, bunch intensities, Chromaticities, tune footprint analysis and look for instability threshold. He presented results on the tune footprint from e-cloud 2D dynamics simulations. According to Frank, both SPS and KEKB have observed a splitting of betatron tune lines into two, similar to what would be expected from the simulated tune footprint.
Frank: urged on the necessity of simulation results up to the last but two lines in the 2nd slide of Kevin's presentation, for the Chamonix 2010 workshop.

3) **Octavio Dominguez Sanchez de La Blanca: e-cloud Simulations**
Octavio's simulations were mainly to address SPS e-cloud issues. His simulations were a) to SEY-scan as a function of bunch spacing, reflection coefficient R, b) dependence of different beam pipes and c) different beam emittances. He presented simulation results for
1) Beam with four batches at 450 GeV with SEY= 1.5, R=0.7 bunch spacing of 50 ns, NB=1.1E11/bunch and standard elliptical shape for the e-cloud monitor.
2) SEY versus bunch spacing for R=0.5 and 1.0.
Presented a comprehensive table of available SPS pipe shapes at the e-cloud monitors and known SEY at those locations. On SPS pipe shape Elias's remark was for smaller chamber size one needs to use larger SEY to find multipacting.
Currently, Octavio is re-doing some emittance scan of Giovanni. Frank commented that it may be interesting to scan the epsilon-max dependency on SEY. In the meeting it was pointed out that

there is some difference between LHC and SPS pipe materials, hence, this should be carefully addressed in the simulations.
Frank's comment: the earlier "discrepancy" between simulated thresholds for SPS and LHC was explained by two contributions, namely the differences in magnetic field and in vertical aperture.

Data on pressure rise during 50 ns bunches separation was presented. Elias suggested that it will be extremely interesting and important if data can be simulated. He suggested Octavio to take epsilon=230eV and simulate each of the points
Frank's suggestion was to create a set of simulations for R versus delta and take pressure as one of the parameters. In any case Frank suggests concentrating all effort on the LHC studies at least in immediate future to be ready for the Chamonix2011.

Additional remarks: One of the past investigations of Daniel showed that one can extract the higher-order coupled-bunch wake field from e-cloud simulations by computing the electric field due to a bunch displacement along the successive bunches.

Reported by Chandra Bhat

(with some addition & modifications by Frank Zimmermann)