LHC ecloud simulations Meeting

Date: 25 March 2011
Meeting Room: 6-2-008

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

Excused: Kevin Li

In response to request from Kevin Li, future meetings will be held on Thursdays at 4 pm, except for weeks of SPSU meeting (once per month).

Agenda

1) Comments on the minutes of the last two meetings
2) Follow up of the CERN-GSI e-cloud Workshop →GR
3) Review of plan for scrubbing run + Discussion → GA
4) Update on benchmarking → OD

Minutes and actions of the last meetings (25th February 2011)

There were no comments to the previous minutes.

The study on monotonic dependence of e- density and heat load on δ_{max} and N_b is ongoing (GR).

EM reported communication with Mariusz Sapinski.

OD had changed ε_{max}, without major changes with respect to finding a consistent solution. Further actions such us making plots for different pressures, performing a cross check with75-ns studies or doing an intensity scan have been postponed due to new results.

OD has communicated with the vacuum group to solve the question about the point at 6.85 μs. It seems this value was not taken during the MD, but during a further scrubbing run. We prefer not to use it since surface properties might have changed.

The vacuum group has also provided OD with different locations more suitable for the parameterization study. The work on these new locations is ongoing (OD).

GR had contacted Christina Yin Vallgren and Mauro Taborelli for a report on stripe observations within the SPS. These results had also been shown by Mauro Taborelli during the CERN-GSI e-cloud Workshop. GA pointed out that Karel Cornelis had done a scan up to 2.2 kG in SPS two weeks ago and there had still been stripes.

KL had shown the tune spread due to an e-cloud at the CERN-GSI e-cloud Workshop.

A collaboration of GF with vacuum group and KL was set up. EM commented that a there is a paper by Vincent Baglin on the installation of solenoids. FZ repeated the earlier suggestion to remove in ECLOUD the horizontal displacement for more than one daughter particle (potential ACTION for Ubaldo Iriso or HM). It would be interested that GF considers smaller tune spreads in his study.

HM will show corrected results at the next meeting.

Follow up of the CERN-GSI e-cloud Workshop

GR reported on the main points and actions for future coming from the CERN-GSI e-cloud Workshop, which took place on 7-8 March 2011 at CERN.

The first point was the long-term behavior of the beam under the action of an electron cloud. The new model plans to include elements with detailed pinch, including quadrupole pinch (to be followed by GF at GSI and KL and FZ at CERN).

It is also planned to build a 3D self-consistent calculation of e-cloud wake fields in order to quantify the energy loss and the influence of electron magnetic fields on transverse wakes. A small discussion on the importance of the electron magnetic field followed. The magnetic fields generated by moving electrons are been considered at GSI. Its influence on transverse wake fields has to be further studied to evaluate its importance (to be followed by GR at CERN and Fatih Yaman and Oliver Boine-Frankenheim at GSI). MBB dipole parameters have been already given to Fatih Yaman. FZ proposed also to sent him LHC parameters (beam pipe, beta functions, etc.) (ACTION → FZ, Fatih Yaman).

E-cloud build up simulations will continue exploring new regions in the ring. That will be followed by OD and vacuum group (Giuseppe Bregliozzi and Vincent Baglin). It will be also interesting to benchmark our simulations with Fedor Petrov's own code for SIS18 bunches.

Next, more open questions were suggested by GR:

- Is it efficient a high band-width feedback system?

Ohmi's feedback seems not to be efficient in damping the centroid motion.Wolfgang Hofle is concerned about the simulations of a wide-band feedback by Jean-Luc Vay and his US colleagues, in particular power level, closed orbit effect and initial displacement. Nevertheless, in the past L. Thompson had shown that such feedback can work for the SPS. A compromise between bandwidth and gain has to be found. Maybe Wolfgang Hofle could present the situation and describe the open issues & questions (ACTION?→ Wolfgang Hofle).

- Is there any experimental evidence of e-cloud fluctuations (temporal and spatial)?

- What is the change of ε_{max} during the scrubbing? How are the graphene layers formed and why conditioning is lost when venting? Are beams with high-energy electrons more effective for scrubbing or is the dose of electrons more important?

- Can the energy loss measured with the synchronous phase shift be explained by electron cloud simulations? It is also necessary to benchmark the synchronous-phase shift data with cryogenic measurements, which has already started.

- Further measurements assure that amorphous carbon does not lead to an electron-cloud build up in the PS, so why do we observe pressure rises in SPS which are the same as for uncoated regions?

- Other topics like coupled-bunch higher-order head-tail wakes and instabilities, role of the parameterization of rediffused electrons and initialization of electrons from gas ionization in simulations (positions and velocities) have to be further studied.

Next, two movies describing the behavior of stripes inside a magnetic field were presented (already shown by Mauro Taborelli during the Workshop). The magnetic field was ramped to a maximum value of 0.12 T. There is a strong variation of the stripes (number and intensity) as a function of magnetic field. A change of bunch length during the cycle is also observed. The integration time of the detectors typically extends from few ms to 100 ms. Longitudinal blow up in SPS was carried out, as usual in the SPS, but no controlled transverse blow up was present in this experiment.

Review of plan for scrubbing run + Discussion

GA reported on a possible strategy for the scrubbing run, which will start approximately around the 4th April and last for 8-10 days. The main goals of this run are: 1. Reduce δ_{max} to allow operation with 75 ns and possibly 50 ns bunch spacing without significant pressure rises, with acceptable heat loads and with minimum emittance blow up; 2. Allow for a fast ramp-up with 75 ns or possibly 50 ns beams up to 900 – 1400 bunches in steps of 100-200 bunches per step; 3. Allow early detection of issues for high intensity operation (RF, UFOs, etc.).

Next, some requirements for injectors and LHC were suggested (e.g. relaxation of vacuum and cryo thresholds). During the first 3 days trains of 36 bunches (50 ns bunch spacing) were proposed since the scrubbing effect might be more significant initially. The idea is to start with few trains with variable batch spacing and then increase the number of trains until the machine is filled. A reduction of the bunch length could enhance the scrubbing. EM asked about the effect on the latter parameter. FZ answered that in the past the simulated effect was small for the LHC. EM argued that maybe the influence of the length gets bigger when it is close to a certain threshold, as it happens with transverse emittances.

During the 4th day an evaluation of the sensitivity to orbit distortion and radial position at injection energy should be carried out. Afterwards a process of ramping, squeezing and colliding with 50 ns beams (with as many bunches as achievable with 75 ns) will take place. For this ramp the vacuum interlock levels will be restored to nominal settings.

The 5th, 6th and 7th days will be devoted to operation with 25 ns bunch spacing up to 2000 bunches if pressure rises, heat loads and instabilities allow to do it.

During the 8th, and in principle last, day some experiences will be repeated to check the quality of the scrubbing. First the ramp/squeeze/collision process will be redone to qualify the scrubbing effect at top energy. Then, the pressure rise measurements of the first day will be repeated with the same filling scheme, using groups of bunch-train pairs of varying distance, to benchmark the simulation code and determine effect on SEY and reflectivity.

After the scrubbing run the following criteria will be taken into account for the decision to progress during 2011 operation with 75 or 50 ns:

- 50 ns if scrubbing has occurred with 25 ns bunch spacing.
- 50 ns if pressures after injection of ~1400 bunches with 50 ns spacing are in the range of 10^{-8} mbar or lower.
- 75 ns in case neither of the previous two points has been achieved.

Further details on the scrubbing plan as well as the relevant measurements to do will be discussed during the next ICE meeting (30th March 2011). EM proposes to write a note summarizing results from last year.

Update on benchmarking

OD reported on the new approach used for the parameterization of the pipe properties. First, he commented on the features of the new locations suggested by Giuseppe Bregliozzi (better accuracy for with ionization gauges, bigger number of gauges, easier comparison, etc.). OD commented also some problems that we may find for this study with the present measurements (different starting pressures for different batch spacing, unclear behavior for long batch spacing, unstabilized pressure, etc.). A first selection of 11 gauges has been done from the 173 per beam that exist in the ring. A set of preference criteria was shown to justify the decision of starting with the gauge VGI.141.6L4.B.PR. From Pressure vs. Time plots taken during the MD of fall 2010 it seems that after 10 μs batch spacing there is almost no effect on the pressure. The results obtained for this location indicate that δ_{max}~1.85 and R~0.25. Nevertheless when doing a zoom into the area surrounding these values the results are not consistent. FZ pointed out that maybe the fluctuations dominate when doing a “zoom” in a certain smaller region and the resolution for this kind of study has to be considered in a bigger frame for this reason. FZ added that this lack

of consistency could arrive from a bad fitting and proposed to find a 2^{nd} or 3^{rd} order surface fitting for the raw pressure increases, before taking their ratio, and see if we get a better agreement.

To conclude, an ideal MD scenario cannot be scheduled because of lack of time, but the filling schemes proposed by EM and GA seem to be sufficient for the purposes of this study.

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The next meeting will be announced in due time.

Reported by Octavio Dominguez and Frank Zimmermann