LHC ecloud simulations Meeting

Date: 07 January 2011
Meeting Room: 6-2-008

Attendees: Chandra Bhat, Elias Metral, Giovanni Rumolo, Kevin Shing Bruce Li, Humberto Maury Cuna, Frank Zimmermann

Excused: Octavio Dominguez Sanchez de La Blanca

Minutes and actions from the previous meeting:
Elias Metral asked about a previous comment by Frank Zimmermann on the **two spikes in the tune signal**, evidenced by **Kevin Li's simulations**, which appeared similar to observations at the SPS and KEKB. He raised the question whether the observed signals were coherent or incoherent. Frank Zimmermann pointed to a previous analytical matrix model by Karel Cornelis (probably at ECLOUD04) to explain the tune splitting at the SPS. The old Cornelis model and the SPS & KEKB observations are to be checked (***ACTION Kevin Li***)
The **SPS bunch pattern** quoted by Gianluigi Arduini for past e-cloud studies (page 1 in his list of tasks) looked very irregular, which complicates the simulations. Giulia Bellodi and Giovanni Rumolo had tried to perform ECLOUD simulations with this pattern, but they had found it to be impossible to simulate the full ring with this pattern; some approximation should be made in order to be able to simulate only a fraction of the ring.

Kevin Li presented an update on LHC electron cloud instability studies.
He had performed HEADTAIL simulations for 450 GeV and 4 TeV without a dipole field (runs for 7 TeV and with dipoles were still to be done).
The cloud density was taken to be 6e11 m^-3. The e- were distributed uniformly on a rectangular grid, extending over +/-10 sigma. The longitudinal emittance was set to eps_z=0.8 eVs.
When comparing with Elena Benedetto's past results, one should be aware that she had also done some simulations including a dipole field. Another, certain difference was that the transverse emittance assumed by Kevin Li was lower than in past simulations by Elena Benedetto (2.5 micron instead of 3.75 micron).
The **effect of the emittance and magnetic field on the instability threshold** should be investigated next (***ACTION Kevin Li***).
The instability threshold at 450 GeV was found to be at Nb=4e10 for 6e11 m^-3 (Elena Benedetto had 6e10). A chromaticity of 20 suppresses the instability.
For the 4 TeV case, parameters from the 7 November run were considered, with only 7 cavities active, a bunch length of sigma_z=0.0577 m, and 7.94 MV total RF voltage.
Frank Zimmermann was astonished that the **total bunch length** had been only **0.77 ns**. He asked why this had been so much smaller than 1.2 ns which had been the standard value during most of the SPS operation in the fall. The reason was not known, but 0.77 ns had apparently been measured at this time.
Perform 4-TeV simulations for a bunch length of 1.2 ns in preparation for 2011 run & study effect of longitudinal emittance on the threshold (***ACTION Kevin Li***).

The threshold density at 4 TeV was found to be between 5 and 7e11 m^-3, which was slightly higher than at 450 GeV, but this could be related to the small longitudinal threshold.
There was one bunch intensity case, Nb=1e11, where the beam was extremely unstable, at 4 TeV. At Nb=11.5e10 there was a good stability again.
Also at 450 GeV the dependence on the bunch intensity was not monotonic, but there was much less of a sharp resonance.
Frank Zimmermann commented that the 450-GeV dependence was probably related to the variation of the regular TMCI instability threshold with the product of impedance frequency and bunch length, which had a minimum when the rms bunch length was of the order of the resonator impedance frequency. In the case of the electron cloud as Nb was changed the "impedance" frequency and (omega_e sigmaz) also changed. The case at 4 TeV looked different and might be related to the finite size of the electron cloud.
Change size of the cloud to see if instability at Nb=1e11 disappears (***ACTION Kevin Li***)
Dipole simulations are most important. At some point one should cross-check with simulation using the real e- distribution from ECLOUD, with stripes in a magnetic field.
Chromaticity at 4 TeV was as effective in suppressing the instability as at 450 GeV (but the e-density considered in this scan almost at the instability threshold).

Frank Zimmermann replotted the simulation results with 50 and 75-ns spacing from Humbero Maury Cuna as threshold curved in SEY-*R* space. Two points for 75-ns spacing should be confirmed. Simulations should also be done for R=0. Later it would be nice to add data for 25-ns spacing.
Previous results from Humberto Maury on the effect of the magnetic field on the threshold and on the central e- density appeared to be in possible contradiction. This point should be further investigated, e.g. by looking also at the total number of electrons in the latter case.

Frank Zimmermann reported progress and test results on calculating the electron-cloud **coupled-bunch wake field with** a slightly modified version of **ECLOUD**. The coupled wake has a **self wake component and it changes sign along most bunches** (driving higher order instabilities) as had been found by Daniel Schulte in the past. There was also evidence for a **skew wake**, which however must be either due to numerical noise or indicate a bug in the code as pointed out by Daniel Schulte after the meeting. The code can also calculate the nonlinear part of wake field at different transverse amplitudes. Deriving the **instability thresholds** from these simulation results is a topic for future work.

Frank Zimmermann announced a two-week visit by Ubaldo Iriso from CELLS for the study of scrubbing scenarios with a map approach in the second half of January and a 3.5-weeks visit by Giuliano Franchetti for modeling the incoherent electron-cloud effect from mid February.

Giovanni Rumolo reported the preliminary planning and draft agenda for a **CERN-GSI AccNet EuroLumi 1-day mini-workshop at CERN on 7 March**, focused on electron-cloud studies at CERN and GSI.

The next meeting will be held on Monday 17 January.

Reported by Frank Zimmermann