e-cloud activities

e-cloud: coherent and incoherent effects

Action

The **electron cloud instability** threshold based on estimates of the electron cloud density in the **main dipoles/quadrupoles** should be made for the nominal parameters. Limit of stability for different values of the SEY.

a. Done for single bunch stability and for the arcs: presented by **A. Romano at the WP2 meeting on 3/10/2017** In summary for single bunch we do not expect instabilities at injection energy for HL-LHC bunch population. The stability for the lower intensities (those typical at the end of the fill should be also studied.

b. This has been presented in Madrid and **instabilities can appear only for LHC bunch population but in that case chromaticity can be used to stabilize the beam**.

Status and next steps:

People involved: L. Sabato, G. Iadarola

- Empirical **recipe for numerical parameters** (number of slices, number of particles) found in the past seems **not to be accurate enough for the LHC 7 TeV regime**:
  - Performing **systematic convergence scans** (taking full cluster in Bologna at moment)
- Investigating impact of **beta function in the arcs** (ATS squeeze). Plan to study also the role of **longitudinal parameters at injection** (RF voltage, bunch length)
- **Software infrastructure** for these studies (job definition, submission and management) to be consolidated (at the moment quite time-consuming and error-prone)
- Plan to work also on **better understanding** these instabilities (in depth analyses of simulation data, simplified models)

Aim at publishing a **document on e-cloud single bunch stability** by the end of LS2

e-cloud: coherent and incoherent effects

Action

The electron cloud **instability threshold** resulting by electron cloud in **the triplet/matching sections** should be estimated for different coating scenarios.

Status and next steps:

People involved: L. Sabato, G. Iadarola

- **Inner triplets**
  - **Numerically very challenging** (strong localized kicks introduce artificial emittance blow-up)
  - We are studying a **simplified case** (field-free, uniform e-cloud density)
    - → We can show that **in the absence of coating the beam can be unstable**
    - → Trying to get cleaner simulations
  - More detailed studies would be demanding in terms of effort and computing resources → Low priority as coating is in the baseline
- **Matching sections:**
  - Never studied explicitly. Scaling from arc case, the effect should be small
  - We could try to **better quantify** (and add a paragraph in the document on the arc stability)

e-cloud: coherent and incoherent effects

Action

Study of **coupled bunch stability** in the arcs and IRs

Status and next steps:

People involved: L. Mether (?), G. Iadarola

- **PyECLOUD-PyHEADTAIL suite extended to coupled bunch case**
  - Test runs performed on CERN-HPC cluster
- **Next steps:**
  - Further **development** (better instrument the simulation, implement damper, generation of bunches on multiple cores)
  - First **"real" simulation studies**
  - Comparison against **simplified models**

e-cloud: coherent and incoherent effects

Action

Study of **incoherent effects** in the presence of electron clouds in the LHC (is the asymmetry in **lifetime B1/B2 relate to electron cloud effects** in the triplets and in particular to the asymmetry in heat load observed left/right of point 5.

Status and next steps:

People involved: K. Paraschou, G. Iadarola

- Not much experience on incoherent effects from e-cloud (at CERN or elsewhere)
- **K. Paraschou** selected as doctoral student to work on this
- **Presently** consolidating tools to estimate **footprints using PyHEADTAIL:**
  - Integrated **NAFF library** from Sofia
  - **Being applied** to study **losses observed in 2018** during squeeze and in collision
- **Next steps:**
  - **Literature** review (what has been done and what we can learn)
  - Acquire some first experience with longer single particle **tracking** in the presence of a **recorded e-cloud map**
    - Start with **PyHEADTAIL** and then move to **SixTrackLib** (being developed by Martin and Riccardo). GPUs might help for these studies.
  - Interpolation of a **3D field map can break symplecticity**
    - Try to define **theoretical framework** for this kind of simulations (profiting of existing work made for space charge, e.g. by Ji Qiang)

e-cloud: build-up

Action

In the **crab cavities**. Make a first study with no RF field?

Status and next steps:

People involved: L. Giacomel (DOCT Jan 19), G. Iadarola, LBNL coll. (J.L. Vay, M Furman)

- We will attack the problem using the WARP-POSINST code in collaboration with LBNL
  - **3D and full EM** simulation
- L. Giacomel will spend a **part of his contract in Berkeley**
- **Preparatory work** already ongoing:
  - Furman-Pivi secondary emission model being implemented in PyECLOUD (E. Wulff) to be able to make direct benchmarks

e-cloud: build-up

Action

- Understanding of the origin of the **difference in heat load among sectors**
- Possible **hybrid schemes** for start-up or back-up scenario and estimated luminosity. Presented in Chamonix 2018 **Need to be documented in a note**.

Status and next steps:

People involved: G. Skripka, E. Wulff, G. Iadarola

- Being **followed within the BIHL Task Force**, hope to gain important information during LS2.
- **Working on improving the model** based on data collected in MD during 2018.
- A **document** with the **simulation results** for the arcs has been drafted (by Galina). It includes simulations for **25 ns and 8b+4e**. We could add a section on the hybrid schemes. (could come in the first part of 2019).
- We could prepare a **second document** reviewing in detail the results of **MD and comparing systematically against simulations**.

e-cloud: build-up

Action

- **New TDIS:** updated estimates have been presented on 28/3/2017 (https://indico.cern.ch/event/625668/). Need to document in a note.

Status

People involved: G. Skripka, G. Iadarola

- **Recommendations given** and integrated in the present design (a-C coating of beam screen and metallic jaws)
- Note published: CERN-ACC-NOTE-2018-0060

Action

- Electron cloud build up in the **collimators** as a function of the collimator opening

Status

People involved: E. Wulff, G. Skripka, G. Iadarola

- A simulation study was performed (https://indico.cern.ch/event/754131/)
- It shows that for operational gaps SEY thresholds are quite high

e-cloud: build-up

People involved: G. Skripka, G. Iadarola

Action

- Buildup in **Y-chambers** in IR1/2/5/8

Status

- No special feature expected. We could simulate the geometry if needed.
- We should check if coating (NEG) is foreseen

Action

- Impact of the connection of **Q4 and Q5** to the arc cryogenics and potential need of a-C coating

Status

- Simulations to assess the effect already exist
- Impact ~250 W/side (3% of the capacity).

Action

- Electron cloud **build-up in the triplet BPMs**

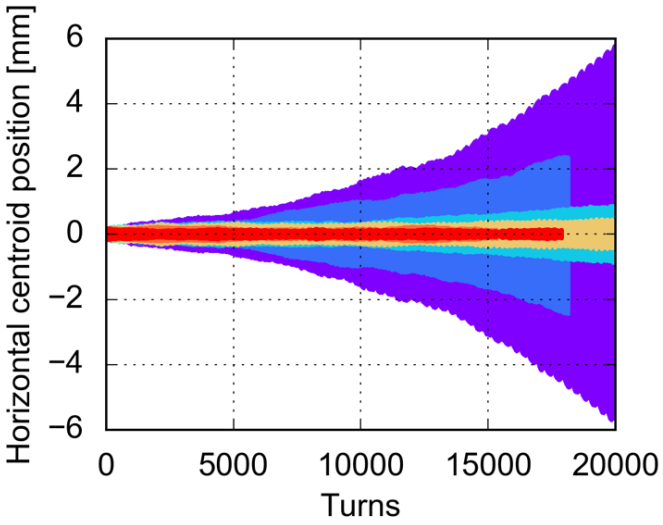
Status

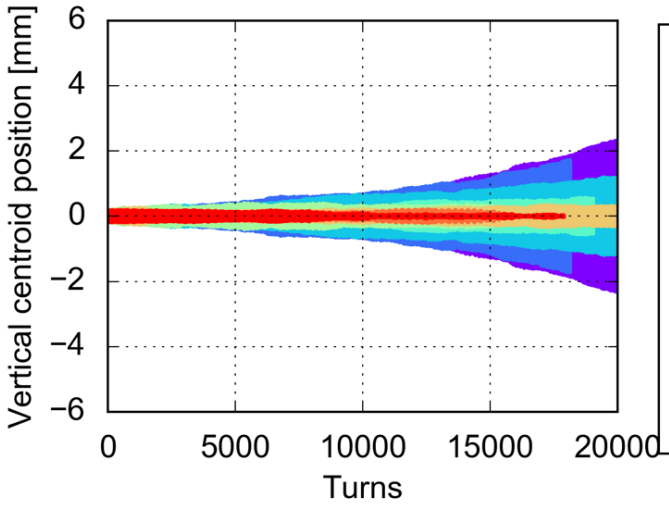
- What kind of input is needed?
- First estimates can be made using existing simulations
- Could be refined using the present layout

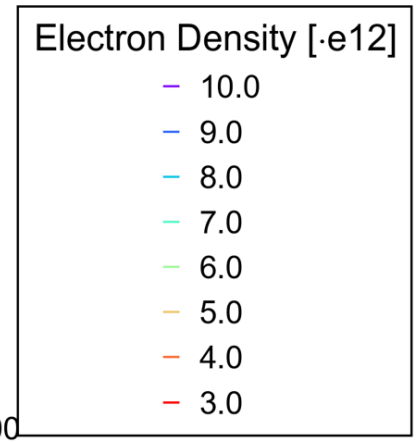
Instability simulations (L. Sabato)

Inner triplet

Segments = 8 Device fraction = 0.01 betax,y = 12 km







Buildup simulations (G. Skripka)