e-cloud activities
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.

**Action**

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.

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

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

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

- **PyECLUSION-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**
Study of **incoherent effects** in the presence of electron clouds in the LHC (is the asymmetry in lifetime $B_1/B_2$ relate to electron cloud effects) in the triplets and in particular to the asymmetry in heat load observed left/right of point 5.

**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)
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

Action

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

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**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**.
**Action**

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

**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](https://indico.cern.ch/event/754131/)

**Action**

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

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

- A simulation study was performed ([https://indico.cern.ch/event/754131/](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

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| • Buildup in **Y-chambers** in IR1/2/5/8 | • No special feature expected. We could simulate the geometry if needed.  
• We should check if coating (NEG) is foreseen |
| • Impact of the connection of **Q4 and Q5** to the arc cryogenics and potential need of a-C coating | • Simulations to assess the effect already exist  
• Impact ~250 W/side (3% of the capacity). |
| • Electron cloud **build-up in the triplet BPMs** | • 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)

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

Buildup simulations (G. Skripka)

Electron Density [-e12]
- 10.0
- 9.0
- 8.0
- 7.0
- 6.0
- 5.0
- 4.0
- 3.0

Inner triplet

SEY = 1.3