Electron cloud coherent and incoherent effects - Status on 23/08/2019

1. 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.
    - Done for single bunch stability and for the arcs: **presented by A. Romano at the WP2 meeting on 3/10/2017** (https://indico.cern.ch/event/668032/). Additional presentation in Madrid at the Annual Meeting (https://indico.cern.ch/event/647714/contributions/2646113/attachments/1558570/2453796/HLLHC_Collaboration_meeting.pptx). 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. **Action: Gianni.** This has been presented in Madrid (https://indico.cern.ch/event/647714/contributions/2646113/attachments/1558570/2453796/HLLHC_Collaboration_meeting.pptx) and instabilities can appear only for LHC bunch population but in that case chromaticity can be used to stabilize the beam.
        - We invested a large fraction of the last 12 months in numerical convergence studies (full Bologna cluster running 24/7)
        - Now we have a recipe and we know that simulations done with Annalisa (based on "traditional" numerical settings) were severely undersampled:
            - Simulations with correct sampling are very long (months)
            - They requires many slices that need to be treated sequentially → not possible to parallelize further
        - We are redoing the scans systematically, including parameter scans at injection (voltage, Q', octupoles)
            - It takes a lot of time (defined by the available computing resources)
            - Now we are just studying the effect of quadrupoles (most critical). This study should be finished by the end of the year. Main results should be available earlier (~October).
        - Infrastructure for these simulations consolidated in 2019 (created reference repository, including test cases to verify the different features)
        - Then we will need to look at dipoles and drift. With present computing resources (800 cores dedicated 24/7 in Bologna) this will require until 2020.
            - We are investigating with IT the possibility of running these simulations also on HTCondor at CERN (would increase resources by ~50%, helpful but not a game-changer). For this we would need special arrangements with IT (guarantee that simulation run over months with high priority) and development of "management tools on our side"

        [Work being done mainly by L. Sabato]

    - Study of coupled bunch stability in the arcs and IRs: **Action Gianni. This should include the stability at injection and the parameter phase space (i.e. optimum settings octupoles/chromaticity to stabilize the beam with acceptable DA)**

- As mentioned before we are doing large octupoles/chromaticity scans **for single-bunch instabilities**. For coupled-bunch instabilities this is not really feasible (would require a huge amount of computing resources).
- What is feasible and is being done is to:
  1. compare LHC vs HL-LHC intensity
  2. ADT ON/OFF. Each point requires >1000 CPU cores for a week.
- We could give an update ~second-half of November
- As discussed at the beginning of this year, the code required consolidation and reorganization → this is now mostly done and a reference repository has been created.

[L. Mether and myself working on this]

- The electron cloud instability threshold resulting by electron cloud in the triplet/matching sections should be estimated for different coating scenarios. **Action: Gianni**
  - As shown at the previous action review, we have very basic simulations that show that in the absence of coating of the triplets, we would be unstable.
    - I would also expect severe incoherent effects (based on 2018 experience).
  - From simple scalings the matching sections should play a minor role on stability.
  - It is very difficult to go more in detail and it would require the computing resources that are now using to characterize the stability from the arcs (the two cannot really be done in parallel).
  - I propose not to attack this for now and come back to it, if needed, when the arcs stability characterization is solid.

2. 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): **Action: Gianni**

- Ongoing (K. Paraschou), is developing a technique to include e-cloud kick in sixtrack-like simulations (working with sixtracklib). We could give an update towards the end of 2019.
- K. Paraschou with the help of J. Malewicz (summer student) is using sixtracklib to study lifetime evolution in collisions (tracking full LHC lattice with beam-beam).

  → Simulated 0.5h (20M turns) of beam time with enough resolution to estimate losses.

3. **From WP2 meeting on 11/6/2019 (https://indico.cern.ch/event/823530/). Gianni** proposed to analyze available data on electron cloud build-up and potentially correlated emittance blow-up (Action: **Gianni**)
   - Presentation scheduled for 24 September