Electron cloud meeting #63, 30/11/2018 (indico)

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In situ SEY measurements at the SPS (V. Petit)

Valentine presented measurements performed using the in-situ SEY measurement setup a the SPS:

- The measurement device is installed at the BA5, in a field-free region. It consists in a cylinder which is partially exposed to the beam. The cylinder can be rotated to measure the SEY of the exposed part using an electron gun without breaking the beam vacuum.
- The configuration changed two times during Run 2:
    - A stainless steel drum was installed in LS1
    - The same portion of the drum was exposed to the beam during the 2015-16 runs.
    - In June 2017 the drum was rotated and a new portion of the surface was exposed to the beam. The part of exposed in the first two years stayed in the beam vacuum until February 2018.
    - In February 2018 a new drum was installed, made of Copper (OFE), degreased as done for the LHC beam screens.
- Measurements taken at different moments during Run 2 were compared. A clear conditioning effect is visible on the two materials. The maximum SEY decreases all over the exposed surface, the minimum being in the center of the chamber. With conditioning the E_{max} shifts towards lower energies, which is the opposite of what is observed in the lab.
- The maximum of the SEY curve saturates at ~1.55, already after 36 days of beam exposure. For longer exposition times the maximum of the curve remains constant but the shape continues to change. The fact that that the SEY_{max} does not decrease further could come either from a surface effect or from a suppression of the multipacting (the SEY gets close to the multipacting threshold, reducing the electron bombardment).
- The SEY is observed to increase when the surface is not exposed to the beam and kept in the beam vacuum.
- Visual inspection shows that the portion of surface that is exposed to the beam has changed color becoming significantly darker. This was stronger for the surface exposed two years and barely visible for the portions exposed for a shorter time. It is important to note that, despite this difference, the two surfaces were showing the same SEY.
- Chemical analysis performed after the extraction shows the same concentration of carbon on all surfaces (including the part not exposed to the beam).
- Nevertheless differences are observed in the XPS, showing a more graphitic structure in part exposed to the beam (as observed in the lab). At the edges (darkest area) the XPS background is different, probably due to different thickness. A different in thickness could also explain the difference in shape of the SEY curve.
- These observations suggest a significant presence of hydrocarbons in the SPS residual gas. This hypothesis would explain why changes in surface color are observed in the SPS but not in the LHC nor in the lab.

- After 2 weeks in air, the minimum δ_{max} measured on the sample was 1.6, while it was almost 1.7 under vacuum. One cannot exclude that in-situ measurement is not performed perfectly in the center of the trace, or that there is an effect of the different measuring setups In any case, the SEY increase after two weeks is small.
- During the meeting it was suggested to modify the experimental setup during LS2 by installing a foil made of a material having high SEY on the other side of the chamber, facing the sample. This would ensure that multipacting is never suppressed by conditioning and would allow probing how much the SEY can be reduced by beam-induced scrubbing.

SPS e-cloud detectors after LS2 (H. Neupert)

Holger presented status and plans for the SPS e-cloud measurement tools.

- During LS2 the e-cloud equipped presently installed in Point 5 will have to be moved to Point 1 (due to the installation of the new SPS beam dump). This includes: the "SEY drum", the four electron cloud monitors, the mobile sample, and the residual gas analyser (RGA, not functional at the moment).
- Concerning the electron cloud monitors:
  - o The four liners that are presently installed expose to the beam: LESS on copper, Copper, a-C coating on StSt (long term study, in SPS since 9 years), Cr_2O_3 on Al (study for LHC MKI coating).
  - o Investigations are ongoing about channels in short circuit and distorted signals observed in Run 2.
  - o New electronics is being developed by BE-BI together with a new software interface. This will allow to automatically adapt the amplifier gains. During the meeting it was suggested to keep the possibility of setting the gain manually.
  - o The dismantling of the BA5 installation will start on 15 January 2019. The e-cloud monitors will be vented and stored on the surface under atmospheric pressure (protected by aluminum foil and plastic covers) with the vacuum chambers (the monitors) in the magnets. The reinstallation at BA1 will take place in spring 2020.
  - o Some of the liners might be replaced: the old LESS surface could be replaced with a newly developed one. At the meeting it was agreed that the copper liner will be replaced by one in Stainless Steel, in order to be representative of the situation of the SPS after the shutdown.
  - o After LS2 the corresponding dipoles could be kept systematically ON during operation allowing for parasitic measurements and long-term conditioning studies in controlled conditions. Nowadays there is a SIS interlock checking that they are OFF, which needs to be masked during MDs. The implications of this change should be checker with the SPS-OP team.
- Further improvements that were discussed include:
  - o Reinstallation of an RGA to measure the gas composition during beam operation.
  - o Improvement of the transport system for mobile sample: improve the vacuum to UHV with a new pumping group (7000Euro) and NEG cartridge (4000Euro).
  - o Investigate the possibility of installing an e-cloud detector in a quadrupole.

Checkpointing for PyECLOUD buildup simulations (E. Wulff)

Eric presented a new feature that he implemented in PyECLOUD.

- A checkpointing function has been implemented, which allows the simulation to periodically save its state and to restart from the last saved state in case the simulation is interrupted (e.g. due to queue timeout or file system unavailability). This allows saving a lot of time especially for long simulations.
- The checkpointing feature is included in the version 7.6.0 of PyECLOUD.
- In order to start a simulation from a checkpoint, two things are needed: a simulation state containing a snapshot of all simulation parts; a file containing the output of the simulation up until the snapshot (the usual PyECLOUD output file).
- The checkpointing feature can be enabled using new optional input parameters that have been introduced in the input files (i.e. “checkpoint_folder”, “checkpoint_DT”, “copy_main_outp_folder”, “copy_main_outp_DT”.
- The code always checks for a saved checkpoint to restart from, if checkpoint_DT and checkpoint_folder are specified. If the checkpoint does not exist, the simulation will start from scratch. If checkpoint_DT is specified but not checkpoint_folder the simulation won’t run. copy_main_outp_folder does not have to be specified for the simulation to run. In case it isn’t, the code will look for an output file in the local folder.
- The new feature has been tested on a realistic simulation study in lxbatch (HTCondor).