# Electron cloud meeting #54, 23/03/2018

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## Arising matters (G. Iadarola):

- The simulation study performed by G. Skripka to compare different coating options for the TDIS were presented at the HL-LHC WP2 meeting on the 20th of March. There was no objection to the proposal of coating the metallic jaws and the beam screen of the devices.
- A new version of PyECLOUD (v7.0.0) was released which includes the development work done by Lotta, enabling buildup simulations with multiple ion clouds.

## LHC beam screens: cryo status for 2018 (B. Bradu)

Benjamin reported on the work done to improve the heat load measurements and the cryo feed-forward control:

- The calibration work to estimate the rangeability of the valves for all the beam screen circuits has been completed for all the arcs and the Long Straight Sections (LSS). The estimation could not be completed for 11 Stand-Alone Magnets, including Q5R2 and Q6L8, which are being considered for aC coating in LS2. As a result of this work, the error on the average heat load for the eight arcs is reduced below 3%, while the r.m.s. error at a cell-by-cell level is reduced below 10%.
- All electrical heaters have been tested. 38 of them show erratic behavior between 40 W and 120 W. For 11 heaters, instead, it is impossible to apply more than 40 W; in these 11 cells the beam-screen regeneration is impossible. No correlation is found between the faulty heaters and the corresponding heat load, with respect to the average of the corresponding arc.
- Some modifications have been applied in the heat load calculation procedures:
    - For the circuits in which the valve reangeability could not be measured the system now publishes zeros. During the meeting it was proposed to publish the calculated values nevertheless in order to spot changes in heat load. The sign of the published values could be inverted in order to clearly mark that there is a problem in these circuits.
    - Previously the calculation for D2Q4, Q5, Q6, D4Q5, D3 was assuming a wrong piping configuration. This is now corrected.
    - For the instrumented cells the heat load is computed separately for the two beams. A method to take into account the mass-flow asymmetry in the two lines has been developed and is being tested.

- In 2018 we will have individual Feed-Forward controls on all arc and SAM circuits. The system has been tested in 2017, but only with 8b+4e beams. The start-up settings for 2018 were inferred from 2017 data.

**First results from PyECLOUD simulations with measured SEY curves (L. Bitsikokos)**

Loizos presented first results of PyECLOUD simulations performed using SEY curves from lab measurements (many thanks to Valentine and team for providing these data):

- The main objective is to compare the usual model for the Secondary Electron Yield as implemented in PyECLOUD against recent measurements of the SEY curve.
- The SEY is typically divided in two components, the elastic (electrons elastically scattered by the chamber's wall) and the true secondaries.
- There is also a dependence on the angle of incidence of the impacting electrons, which arises as a shift of the energy corresponding to the maximum SEY (Emax shift) and a scaling of the SEY curve (delta scale). The possibility of enabling and disabling these dependencies in PyECLOUD was implemented for the purpose of this study.
- The lab measurements are made for normal electron incidence and do not distinguish between elastics and true secondaries. For this reason, as a first step, we simulate the usual EC model with all the elastics treated as true secondaries and we disable the dependence of the SEY on the angle of incidence.
- Simulations have been performed for dipole magnets and drift regions for bunch intensities in the interval 0.1- 2.5 x $10^{11}$ p/b.
- The heat load dependence on the intensity is plotted for every measured SEY curve (corresponding a certain delta max for the usual EC model).
- For larger SEYs (small scrubbing dose applied), the results show a visible difference between the usual model and the simulations based on lab data. These correspond to a visible difference between the measured and modeled SEY curves, both in the low and high energy regions. This difference becomes smaller as the $SEY_{max}$ lowers, with the heat-load dependency on the intensity eventually flattening above 1e11p/b.
- In general, neglecting the angular dependencies and the peculiar behavior of the elastic interactions, the usual EC model is a good approximation for a large part of the SEY curves.
- As a next step, the effect of the angular dependence and the elastics needs to be further investigated. Then the study will have to be extended to quadrupole magnets.

- Input from the lab measurements concerning the energy spectrum of the emitted electrons will be very useful.

**Buildup Simulations with 25 ns and 50 ns Beams for Large SEY (L. Sabato)**

- Recent heat-load localization measurements by the cryogenic teams seem to point to very high heat-load densities (> 10 W/m) with 25 ns spacing, which are compatible only with very large $SEY_{max}$ values (>2.0). Luca performed buildup simulations comparing 25ns and 50 ns beams in these conditions.
- In the case of a dipole magnets, the multipacting threshold is found to be $\delta_{max}\approx1.25$ for the bunch spacing 25 ns and $\delta_{max}\approx1.75$ for the bunch spacing 50 ns. Above the 50 ns multipacting threshold, the heat load ratio between the 50 ns and the 25 ns case increases as a function of $\delta_{max}$ reaching about 0.2 for $\delta_{max}=3.5$.
- In the case of a drift section, the multipacting threshold is found to be $\delta_{max}\approx1.25$ for the bunch spacing 25 ns and $\delta\approx2$ for the bunch spacing 50 ns. Above the 50 ns multipacting threshold the heat load ratio between the 50 ns and the 25 ns cases increases as a function of $\delta_{max}$ reaching about 0.2 for $\delta_{max}=3.5$, similarly to the dipole case.
- In the case of quadrupole magnets, the heat load is larger than the previous cases and so is the ratio between 50 ns and 25 ns, which reaches 0.35.
- In these simulations, the $\delta_{max}$ parameter has been scanned while for the other properties of the surface the usual model based on measurements made on copper has been used. The sensitivity on these parameters should also be studied. As a first step the study has been repeated with a different number of elastic electrons (setting the parameter $R_0$ to 0.3 instead of the usual 0.7). In this case the ratio between 50 ns and 25 ns is found to be significantly smaller.

GI, LB & LS, 23 Mar 2018.