Impedance meeting  
2 November 2018

Presents:
D.Amorim (DA), S.Antipov (SAnt), S.Arsenyev (SArs), N.Biancacci (NB),
K.Brunner (KB), S.Calatroni (SC), E.Carideo (EC), A.Chmielinska (AC),
F.Giordano (FG), A.Kurtulus (AK), N.Mounet (NM), L.Teofili (LT),
V.Vlachodimitropoulos (VV)

The slides can be found at https://indico.cern.ch/event/766031/.

Design and realization of an RF impedance measurement system at cryogenic temperature (KB)

Kristof Brunner presented his PhD topic on the design and test of an impedance measurement device. This device would allow to measure surface impedance of different materials at cryogenic temperature and with a magnetic field.

In the past, measurements were performed by J. Tan et al. with a two rods method on the LHC beam screens. The PhD goal will be to improve those and allow measurements at cryogenic temperatures.

The first part of the thesis would be the realization of a table-top system which could operate at room temperature and at 77 K. The second part would be devoted to the construction of the system, that could then be used in FRESCA magnet.

SC added that this setup will also be interesting to study the impact of mechanical deformations on the device resonances.

NB asked if HTS (High Temperature Superconductors) are available and could be measured with this device. SC answered that some samples and a test device could be available next year. HTS tapes are commercially available: they can be kilometer long, \( \sim 10\) mm wide and the HTS coating itself is a few micrometers thick.

SArs asked when the LESS or amorphous carbon coating could be measured. SC answered that a FCC-hh type beam screen might be available before those coatings. These LESS and aC coating could be available next year. SArs pointed that there are now concerns over the FCC-hh beam screen impedance, and that this experiment will be very helpful.

Effect of the actual taper geometry on the overall impedance of LHC and HL-LHC and possible optimization (EC)

Emanuela Carideo presented her work on the impedance of LHC collimators tapers. Three kinds are used in the LHC collimators, differing by their angles and the embedded BPMs for some.

The impedance model uses Stupakov formula for flat tapers. It was compared to CST simulations, good agreement was reached except for the TCSPM type tapers.

The impact of the real taper geometry on the overall impedance was then estimated with the LHC and HL-LHC impedance models. The geometric impedance increases by \( \sim 1\% \) in the LHC case. For the HL-LHC case, the tapers geometric impedance is slightly decreased (\( \sim 1\% \) order).

Future work includes investigating the quadrupolar impedance and implementing the results in the LHC impedance model.
NB remarked that on slide 5, the impedance curves present some ringing. He suggested to check if the data is converged, using the longitudinal plane results. In this plane, there is less numerical noise, making the convergence check easier.

NB suggested to present the results at the Collimation Upgrade Specification Meeting. **Action:** EC to present the results at the ColUSM.

**On the optimal taper geometry (SAnt)**

Sergey Antipov showed a possible way to further reduce the geometric impedance of collimators tapers. The optimal function which minimizes the impedance depends on the collimator gap. As the collimators gap change, this solution is not the most flexible one.

A circular geometry provides a good compromise: it is close to the optimal function and does not depend on the collimator gap. The reduction in geometric impedance could reach 40% in the case of TCSPM tapers. However the possibility to machine this geometry with Molybdenum Graphite has to be checked.

EC is currently simulating this new geometry with CST but ran in some limitations. NB asked what were the issues encountered. SAnt answered that the geometry is quite complex and requires a large amount of mesh cells. NB suggested to try running the simulations on the HPC cluster, with which the number of mesh cells can be increased.

SArs suggested to use the optimal geometry in the most critical collimator gap. SAnt highlighted that the collimators all have different gap sizes, implying that each taper would have to be machined individually. Moreover the collimators gaps change over the years.

VV asked how the geometric impedance scales with the gap \( g \). SAnt answered that it scales as \( g^{-2} \).

NM remarked that the impact of the resistive wall should be evaluated: the beam is closer to the taper compared to the linear geometry (see slide 5). As the resistive wall impedance scales in \( g^{-3} \), the effect could be important and shadow the improvement made on the geometric impedance.

**Wakefield and Energy Dissipation Of Two Counter Rotating Beams: Preliminary Results (LT)**

Lorenzo Teofili presented the first results of heating simulations for devices with two circulating beams. This problem is essential for equipments such as the experiments vacuum chambers or the TDIS, with the latter experiencing RF heating issues.

The power loss is first computed for one beam and is then modified for the two beams case. The two beams can be delayed one from another, and a cross term taking into account the effect of the wakefield of one beam on the other appears.

The formulas obtained were compared to CST simulations, with a basic RF cavity geometry. The first simulations were done with separated beams, so that there would be no cross-effects between the beams.

The next simulations were done with different delays between the two beams. LT highlighted that the energy deposition with two beams can be up to four times higher than with a single beam. This mainly depends on the delay between the two beams passage.

The equations with two beams were then transformed to the frequency domain. However some discrepancies with respect to the time domain results were found, notably in the short range domain.

VV asked if the beams are simulated on the same path or separated. LT answered that for now they are on the same path, but they will be put on different trajectories.
VV asked if the longitudinal distribution deformation caused by the field generated by the other beam can be simulated. LT answered that the simulations showed assume the beams to be rigid, but this can be included in future CST simulations.

Validation of power loss computation of CST wakefield solver (FG)

Francesco Giordano presented the benchmarking work on CST power loss computation. The validation was performed on a simple structure for which an analytic solution exists. A resistive-wall dominated structure and a resonant cavity were used for the simulations.

For the resistive-wall case with a single bunch, a good agreement was reached between the power loss formula and CST simulations, with errors in the $\sim 1\%$ order (see slides 5 and 6).

The multi-bunch case was then presented, first for the resistive-wall structure. In this case, the CST/formula error is of the order of $\sim 5\%$. For the resonant cavity case, the error increases to 15%. For both geometries, only $\frac{1}{5\pi}$ of the beam filling scheme was simulated, since the pattern then repeats itself.

Update on PT100 measurement

Francesco Giordano presented, on behalf of Alessio Lagrimosa, an update on the PT100 temperature probes. This type of probe electromagnetically couples with the beam, generating false readings. A set-up was devised to try reproduce the beam passage and some coupling could be found. The measurement is however limited by the maximum current value and slope rate.

NB suggested to look into the multipacting tests that were performed by F. Caspers et al. In those measurements a thick wire sustaining a high peak power was used. The equipment might be reused for this kind of measurements, to approach a high power beam.

Minutes written by D. Amorim