

Impedance meeting  
6 April 2018

Presents:
D. Amorim (DA), S. Antipov (SAnt), S. Arsenyev (SArs), M. Beck (MB),  
N. Biancacci (NB), D. Carabajo (DC), E. Carideo (EC), F. Caspers (FC),  
A. Chmielinska (AC), A. Gilardi (AGil), F. Giordano (FG), I. Karpov (IK),  
D. Kodjaandreev (DK), G. Mazzacano (GM), E. Métal (EM), M. Migliorati (MM),  
B. Salvant (BS), D. Ventura (DV), V. Vlachodimitropoulos (VV).

The slides can be found at https://indico.cern.ch/event/719807/.

EM properties of ferrites above Curie temperature and impact on kicker performance (AC)

Agnieszka Chmielinska presented her results on the EM properties of ferrites when heated above their Curie temperature. This is of importance in the kickers: if the beam induced heating is too high, the ferrite yoke can exceed its Curie temperature and the beam deflection is degraded.

The EM properties of different ferrites were measured using the transmission line method and the short circuit method. The measurements were carried out at room temperature first. The material is assumed to be linear, homogeneous and isotropic. FC remarked that these methods can be extended to non-linear and non-homogeneous cases but with difficulty. A good agreement was reached between the two methods and the datasheets values. The $\varepsilon_r$ is almost constant for frequencies from DC to 400 MHz (slide 12). FC pointed that the coaxial line method is not good below 1 MHz for samples in the cm range. Toroids and loops should be used instead.

The samples were then heated to different temperatures and the short circuit method was used to characterize them. When heated, the CMD5005 ferrite permeability starts to drop at 150$^\circ$C and becomes zero at 175$^\circ$C. EM remarked that from slide 17, it seems that the ferrite properties start to change for temperatures well below the Curie temperature (before 75$^\circ$C). FC added that the Curie temperature is not always sharply defined: there is a temperature coefficient on the permeability.

The resulting measurements were used as input for CST simulations. The fit of the permeability vs. frequency curves in CST can pose problem. NB suggested to perform a first fit outside CST, then give this function to CST so it can perform its fitting on smoother data.

FC warned that the ferrites have a memory: the $\mu$ can be 20% higher depending on the magnetization/demagnetization history.

NB asked if the $\varepsilon$ was looked at during the temperature cycle. No, it was no possible as the short circuit method was used for its better precision. NB also questioned if the results are the same when going back to room temperature after the heating cycle: indeed the $S_{11}$ parameter came back to same value as before.

The temperature showed is the set one, not the temperature inside the sample. FC suggested that the internal temperature could be measured with the noise emitted by the ferrite, but the setup would be quite heavy.
**Discussion on ferrite choice for TDIS**

A discussion on the choice on the TDIS ferrites followed. FC pointed that a 1000°C vacuum firing might not be good idea in the presence of ferrites as they can become brittle and their electromagnetic properties might change. The $\mu$ and $\epsilon$ should be measured after the firing. DC also remarked that there can be a 30% fluctuation on the values from batch to batch. A measurement at one frequency could be done.

NB specified that having ferrites is interesting but their positioning needs to be studied to maximize their efficiency. FC added that magnetic or magnetizable stainless steel exist and they could help to increase the losses in a specific place. The Q values of an unwanted cavity can thus be reduced by construction. Building a small resonator out of these materials and studying their permeability in the 100 MHz to 1 GHz range could be interesting.

**AoB: New connector for wire measurements (AG)**

Antonio Gilardi presented a design for the connector used for wire measurements. This design allows one person to perform the setup while having a properly stretched wire. FC remarked that in the setup, one should use a brown resistor: they are less precise but have no inductance, contrary to the precision resistors.

*Minutes written by: D. Amorim*