Session II on Tuesday, July 9th , "Electro-mechanical modelling"

Within this session three presentations were made by Drs. J. Ferradas Troitino (CERN), D.M. Araujo (CERN) and A. Nijhuis (Univ. Twente)

Ferradas presentation focussed on the mechanical analysis of the CERN/LHC MXSF low beta quadrupole magnet for the High Luminosity project during a protected quench (by using quench heaters during a quench at nominal current). The work presented summarized the whole methodology followed in the chain of analysis needed to reach the 2D and 3D mechanical analysis. In particular, details about the thermal and electro-magnetic analysis during quench transients were given in some details. To be noted that the different models used in the analysis chain were validated with experimental measurements separately. The mechanical analyses presented were mainly those derived with a ANSYS 2D plane stress model. These are being extended to 3D but such results are still preliminary and are being reviewed by the authors. The key findings show that in the straight section (where the 2D model is most representative) a Von Mises peak stress of about 150 MPa is found, this being primarily dominated by the azimuthal component. The position of the mechanical hot spot is not related to the thermal hot spot but, rather, to the overall temperature field at the end of the transient. These key findings are not altered by parameters variations such as RRR, detection/validation time, cu:sc ratio, etc. 3D findings seem to confirm the 2D plane stress results although the 3D model results are still being reviewed.

Araujo presentation focussed on the comparison of three different Maxwell-tensor based formulation for the calculation of magnetic forces in the iron region of the HepDipo magnet design which is undergoing at CERN in collaboration with others groups. The main findings of the study is the under-estimation by commercial the software ANSYS (which is widely used in both HEP ad well as in the fusion community) of the magnetic forces computation in the iron pole that, in turn, lead to an underestimation of the stresses up to 15%.

Nijhuis presentation focussed on the benchmark of FE models simulating the stress state during bending experiments of a RebCo tape within a Conductor On Round Core (CORC) configuration. In particular, the FE models were used to study the impact of some key parameters such as the CORC core diameter, winding angle, tape geometry and friction tape-core on cable performances (in particular with respect to the tape irreversible strain limit of +0.45%). The mechanical model used in the study was derived paying attention to the main production and load steps that might significantly affected the RebCo tape mechanical behaviour and a good matching between measured and computed intrinsic strain values was indeed obtained. Nevertheless, the study highlighted that even for relatively simple CORC configurations (i.e. single tape), complex stress/strain field occur (e.g. experiments on simplified CORC configuration reveal necessity of thorough investigation of strain/friction and electrical potential distribution over tape profile and role of core conductance). It was highlighted that FE model so far shows that increased I_c under bending is possible (<10%). On the other hand, insulated core CORC samples, were tested to assess the current sharing with copper core, and so far don't show increase in I_c. Experimental results on contact resistance shows changes with cool down cycles. Work is in progress on this very interesting subject that blends complex experimental and computation mechanics features.