MINUTES

MQYYM MECHANICAL INSTRUMENTATION MEETING

SEPTEMBER 13TH 2017 AT CERN

Summary

The goals of this meeting were:

- to discuss the Stack measurements done at CEA on MQYYM cables and to define the compression test to be done at CERN on the same stacks
- to discuss the instrumentation of the coil rigidity measurement tool
- to define the mechanical instrumentation of MQYYM

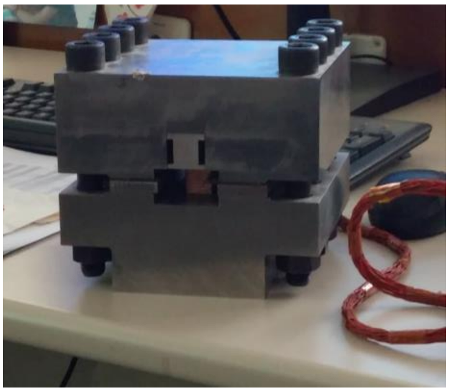
Participants: CERN: M. Guinchard (MG), A. Foussat (AF), P. Grosclaude (PG), Jose Luis Rudeiros (JLR)
Participants CEA : D. Simon (DS), H. Felice (HF)

Authors: H. Felice, D. Simon

Distribution:

1 STACK STIFFNESS MEASUREMENTS

- Presentation by DS of the stack measurements performed at CEA.
- Dimensional measurement of the h0 size of the samples (stack height) was found dependent on the operator. MG suggests to perform a dimensional measurement under press at low compression (typically 10 MPa).
- The compliance of the overall system press mold (measuring bar, mold, press…) wasn't taken into account by CEA team. MG insists on the importance of quantifying this effect.
- Presentation by MG of their measuring set up developped in particular for impregnated Nb_3Sn samples. The tooling has been analysed by FEA to determine the compliance of the system. As expected by design, it was shown that the compliance doesn't change in function of the sample material. The effect of friction is negligeable between the press and the sample. The FEA results were confirmed by the measurements of well known material (Al, Cu, G10). An average compliance of 0.091 µm/MPa was measured and used to correct experimental displacement measurements on the 11 T samples. In the case of impregnated samples, the compliance impact on the stiffness is of the order of 30%. With this set up and in the case of MQYY cable the compliance effect will be of the order of 3% (6 µm for 60 MPa (expected coil preload applied by mean of 0.3 mm collaring interference)). However the compliance of the CEA set up is unknown and should be measured.
- CEA samples have been shipped to CERN and should be delivered shortly. The samples are 10 cm long and should be recut to 20 mm long (sample size 20x18x9) to fit the CERN setup. Agreement that MG's team will remeasured the samples. The compliance of the set up with this new samples geometry should be reassessed by FEA calculation or experimentally (to be defined by MG's team).
- The test protocol should be defined in details by CEA team. Some items have been already discussed as the range of measurements (0-120 MPa), the number of cycles (3) and the measurement of the h0 dimension under 10 MPa. The creep (change of dimension under constant compression) will be measured at 60 MPa during 60 min. Some tests on stress relaxation (change of compression under constant dimension) are considered using an older set up (see picture below) (pending agreement with Paolo Fessia).



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- A cold test at 77 K hase been discussed and could happen on a longer time frame depending the availibility of the lab. Cooling done at 60 MPa anc load cycling around this load could be considered.
- A week of training will likely be organized by MG and PG to teach LBNL and PSI technicians gauge gluing technique, acquisition system… The dates have to be defined. The goal is to organize it by the end of the year. MG is willing to include CEA techs.

Action items:

- MG: Contact the person formerly in charge of the mechanical measurements lab to see if some MQM cable data are still available
- CEA should provide a test protocol including ramp rate, which sample to be used and all other items described before…

- CEA should investigate CEA technician availibility

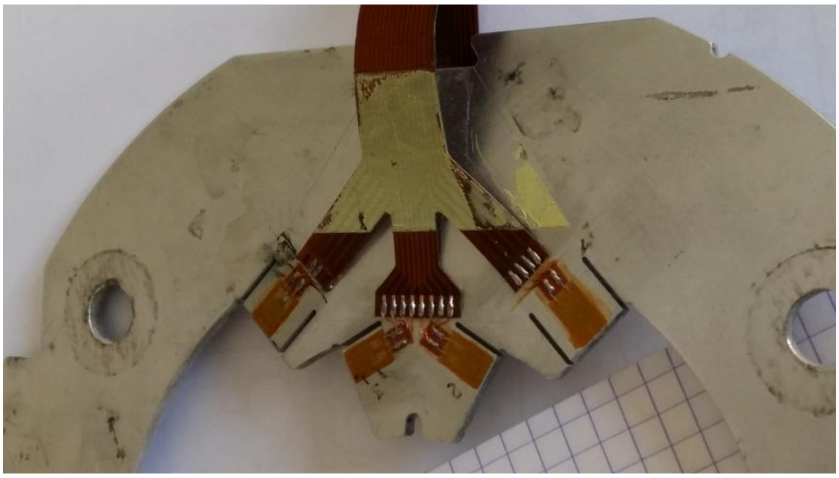
2 TOOLING FOR MECHANICAL COIL MEASUREMENTS

- CEA has presented the design of the coil measurement tooling based on the MQXC tooling already designed at CERN.
- The discussion aimed at defining the cost of the tooling and manpower required to instruments and calibrate the tools.
- After the measuring bar instrumentations, the gages will be calibrated in MG's lab.
- The calibration of the 927 press with the MQYY set up requires manpower. If 11 T project allows it, JLR could help. However the availability of a CEA technician would be helpful.
- MG pointed out that the part n°1 for the coil end measurement would be a huge overhead compared to the data extracted. It will double the time of instrumentation and calibration. CEA agrees and decide to remove this component and to rely only on measuring bars for both straight section and ends.
- JLR suggested to use only one piece for the pole parts and move the pole parts out of the press when the end will be measured.
- MG questioned the necessity of the tight tolerences outside the five test finger. CEA will check with Juan Carlos the tolerances.
- The materials for the dummy coils parts could be made both of Al and stainless steel to confirm the constitancy of the compliance.
- The level of stress in the measuring bars and sector wedges should be checked to be sure that it stays far from the yield stress (for stainless steel, operation at 10 to 20% of the yield stress should be a maximum to insure full elasticity).
- For the measuring bar the instrumentation have been defined. It will be composed of full bridges made of biaxial gages on each test finger (5 fingers x 4 bars x 2 sides = 40 gages).
- Check with Juan Carlos if the MCBX top is available and different from the 11T top. Need to locate the bottom block. The goal is for MG's team to be able to make the instrumentation connection box indepently from the 11T set up. This would also allow to switch easily from the MQYY to the 11T set-ups.

  Action items
- CEA: contact JCP to discuss tooling simplification and top block availability.
- CEA: FEA of the measuring bars

3 MAGNET INSTRUMENTATION

- Collar instrumention:
  - Collars are assembled one by one.
  - Proposol to instrument 4 collars (top/bottom/left/righ noses) at 3 given longitudinal positions (close to LE, at the center and close to RE) : 12 collars instrumented in total.
  - 2 biaxial gauges per face on one azimuthal side of the collar nose will be used (1 for the inner layer/ 1 for the outer layer) : 4 gauges/collars.
  - 48 biaxial gauges (XC11-1.5/350 HBM) in total. Dimensions: 6+3 (soldering pad) mm x 8.4 mm.
  - The homogeneity of the strain zone should be controled by adding slits to the nose (perpendicular to the pole turn and on the outer radius of each layer). (example on picture below)
  - Ansys analysis must be performed to define the slit length.



    - The mating collars must have grooves for the wires and for the gauges Remachining of the collars will be done at CERN or subcontracted locally at CERN. This can be rediscussed when we get closer to the collar instrumentation.
- Collar flange instrumentation
    - In oder to get a relative information on the force applied axially and its evolution during the magnet life, the collar flange will be instrumented with uniaxial quarter bridge. The location should be chosen to allow easy installation and should ensure a good sensitivity (a minimum strain of 20 to 30 $\mu\varepsilon$).
- Strain gages connectors are 3M connectors: male on the magnet side to allow fixing on the connection box. Fisher 40 pin are used on the DAQ side.
- Action items:
- Define slits by ANSYS analysis, define grooves for wire and gage: to be added on a drawing.
- Define the position of the gage on the collar flange (ANSYS + CAD).
- Define a way out of the magnet for the collar gages wire (groove in the yoke or in the flange).