SLHC-PP

MILESTONE REPORT

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History of Changes

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The Preparatory Phase of the Large Hadron Collider upgrade (SLHC-PP) is a project co-funded by the European Commission in its 7th Framework Programme under the Grant Agreement n° 212114. SLHC-PP began in April 2008 and will run for 3 years.

1. EXCECUTIVE SUMMARY

As stated in the report of the second year, CERN and its partners had planned to advance the assembly of the 2-m-long model quadrupole magnets to meet a milestone where electrical tests prove the integrity of the collared coil.

Although the first production coils have been manufactured at CEA/Saclay and although all components have been procured from European Industry, the assembly of the 2-m-long collared coils rely on the full commissioning of the collaring press (see Deliverable 6.3.2), the calculation and experimental validation of the final coil size (Deliverable 6.2.2) and the assembly of the instrumented collar packs (Deliverable 6.2.1). All these activities have advanced successfully, but have not fully been completed. Therefore, the Milestone “Electrical Testing of Collared Coils” has not been met.

However, these electrical tests will be identical to the electrical acceptance test of the production coils themselves. These have been carried out at CEA/Saclay in March 2011 and are described hereunder. Inter-turn short circuits in the wound coil are difficult to measure with a high voltage applied to the main leads. Therefore a discharge test is performed and the decay curves are used as a reference. These decay curves are also presented in this report.

2. DESCRIPTION OF THE ELECTRICAL TESTS

For both inner and outer layer coils of the first production batch, five kinds of electrical tests were realized:

1) Coil resistance was measured between each cable extremities with a micro-ohmmeter; see Fig. 1, with a four wires technique, and calibrated on a 200 mΩ resistor after having measured the ambient temperature and humidity. As a reference, the length of cable used for winding the inner layer was 58 m + 2 m for interconnection. The cable length used for winding the outer layer was 66 m + 2 m for interconnections.

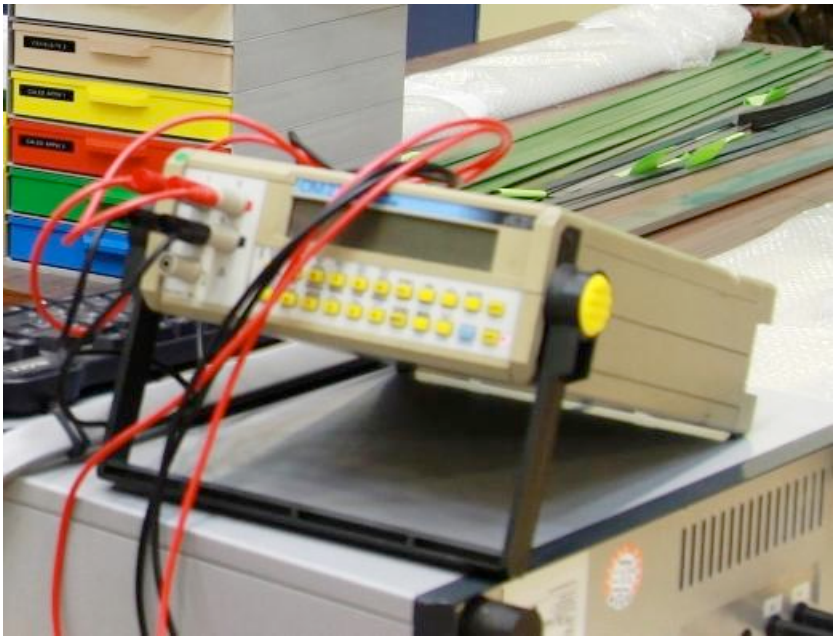

Fig. 1: Micro-ohmmeter OM21

2) Measurement of the insulation resistance between cable and angular wedges with a simple LCR meter.

3) Measurement of inductance with a simple LCR meter. CEA/Saclay are not equipped to make measures with 2 or 3 frequencies at this time.

4) Test with constant voltage (at 100 V, 500 V and 1kV) with a mega-ohmmeter to check for leakage currents to ground. Each cured layer is positioned on the grounded, metallic winding mandrel; see Fig. 2. Then the metallic coil protection sheet normally used in the curing mould is put on the coil and connected to ground.

5) A pulse tests is performed at 1 kV with a universal winding tester (SCHLEICH MTC2 200 nF) to check for interturn shorts.

Fig. 2: Inner layer positioned on its mandrel connected to ground

3. RESULTS OF ELECTRICAL TESTS

At 15.9°C and 58.4% rel. humidity, the resistances of the inner and outer layers are **66.52 mΩ** and **91.03 mΩ**.

The inductances of the inner and outer layers are **315 µH** and **491 µH**, respectively.

High voltage test of Inner layer to mandrel (ground potential) at 100 V, 500 V and 1 kV: No measureable leakage current. Inner layer to protection sheet (ground potential) at 500 V: The measured resistance is about 100 MΩ, which corresponds to a leakage current of 5 µA. The test was not repeated at 1 kV in order to avoid damage.

Fig. 3: Universal winding tester (SCHLEICH MTC2 200 nF)

High voltage test of outer layer to mandrel (ground potential) at 100 V, 500 V and 1 kV: No measurable leakage current. Outer layer to protection sheet (ground potential) at 100 V, 500 V and 1 kV: Also no measureable leakage current.

Pulse test at 1 kV: see Figs. 4 and 5. Sinusoidal curves are decaying smoothly; no shorts are therefore expected between cable turns for both layers.

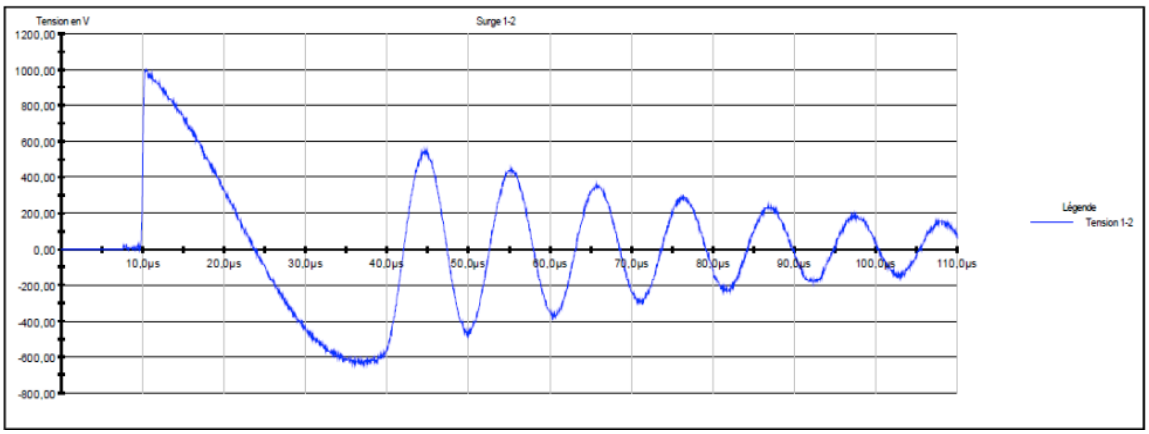

Fig. 4: Result of 1 kV pulse test on inner layer coil

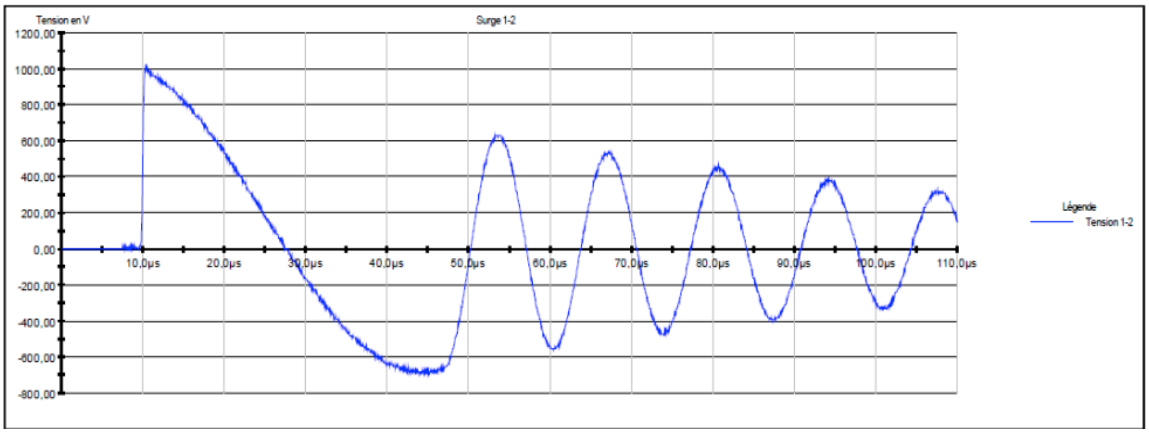

Fig. 5: Result of 1 kV pulse test on outer layer coil

4. CONCLUSION

The electrical tests of the first production coils have successfully been completed. They yield the reference for identical tests at the collared coils, once they will become available (Autumn of 2011).