Nb_3Sn QUADRIPOLE DEVELOPMENT AT CEA/SACLAY

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Abstract

CEA/Saclay is fabricating a Nb_3Sn quadrupole magnet. This magnet is aimed at learning the technology needed for using Nb_3Sn in accelerator magnets and its design is based on that of LHC main quadrupole. Particularities induced by the use of Nb_3Sn material in the fabrication process will be described and the current status of the development will be given.

INTRODUCTION

At the beginning of the eighties, a 90-mm-inner-bore Nb_3Sn dipole magnet reaching a 5.3 T central magnetic field was built at CEA/Saclay [1].

During the following years, the activity at CEA/Saclay in the field of accelerator magnets was mainly devoted to machines under construction: HERA (DESY, Hamburg), SSC (Dallas, USA) and LHC (CERN, Geneva). All these projects were based on Nb-Ti superconductor.

In the second half of the nineties, this R&D was reactivated and the construction of a Nb_3Sn quadrupole magnet was launched. This R&D activity suffered of an important lack of resources, mainly due to the priority given to the LHC project. Nevertheless, the construction of this quadrupole magnet is now nearly finished

Nb_3Sn QUADRUPOLE MAGNET

The main goal of this project is not to build a very performing magnet but to learn the technology of Nb_3Sn magnets. It was then decided to rely on the LHC main quadrupole [2] design in order to minimise the amount of new components and tooling, and to try to use process which could be transferred to industry. The model relies on the same coil geometry as the LHC arc quadrupole magnets, but without iron yoke. The nominal field gradient is 211 T/m at 11,870 A and 4.2 K, leading to a maximum field on conductors of 8.3 T. The model length is about 1 m.

COILS

The coils are wound from Nb_3Sn Rutherford-type cable insulated with S2 glass, heat-treated and impregnated with epoxy resin. This cable was developed in collaboration with Alstom/MSA [3] Due to the high sensitivity of Nb_3Sn to deformation after the heat-treatment, the so-called "wind, react and impregnate" method is used.

All coil components have to resist to the severe reaction heat treatment at 660° during 10 days. In particular, the end spacers are machined out of CuAl9. Their sharp edge can then destroy locally the fragile glass cloth insulation.

In total, 6 coils were wound. Two of them exhibited short circuits between turns after resin impregnation. After accurate localisation, the coils were repaired and one of them was used in the magnet assembly. Even if the repair was made with as much care as possible, we are not sure that the superconducting properties have not been degraded because Nb_3Sn is very sensitive to deformation. The answer to this question will be raised only during the cold tests.

MAGNET AND COLD MASS ASSEMBLY

The assembly of the Nb_3Sn coils is very similar to that of classical NbTi coils. Great care must however be taken during coils handling and when electrical joint between Nb_3Sn and NbTi cables used for coils interconnect are realized.

STATUS

The four selected coils are assembled and collared and the instrumentation wires are in place. The inertia tube surrounding the collared coil is mounted and being closed to form the cold mass, which will be installed in the horizontal Saclay's test facility during the next weeks. The cold test should start in summer 2008.

More detailed description of magnet construction and warm test will be presented at ASC 2008 conference in Chicago, USA.

CONCLUSION

The Saclay's Nb_3Sn quadrupole magnet fabrication will be finished in a few weeks. This fabrication has turned to be long and difficult and there is still a lot of work to perform in order to get a safe and reliable process.

The magnet cold test should start during summer. It will confirm that the construction was satisfactory and that the repairs on one coils have not degraded the superconducting behaviour of the Nb_3Sn.

Further development is planed for the coming years: CEA/Saclay will participate to the study and realization of a challenging 13 T dipole magnet in the framework of EUCard project submitted to European community [4].

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