CERN PLANS ON HIGH FIELD MAGNETS DEVELOPMENT

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Abstract

The talk covered a short status of the LHC installation, an overview of R&D directions on superconducting magnets beyond the start of the LHC specifically addressing high field magnets, and an overlook of already on-going activities at CERN.

SUPERCONDUCTING MAGNETS ACTIVITIES BEYOND THE LHC START

Introduction

We can distinguish the activities on superconducting magnets beyond the LHC start as :

- Needed & funded activities
  - magnet R&D in "The White Paper" 2008-2011 (6 year-version under study);
  - 20.5 MCHF + 73 FTE-Y in High Field Magnets (primarily Nb_3Sn but HTS also considered);
  - 1.5 MCHF + 7 FTE-y for Fast Cycled Magnets
  - magnet R&D in the FP7;
  - installation of "long" magnets facilities in 2008-2009.
- Desirable, not funded (yet) activities
  - triplet upgrade with NbTi
- Being considered
  - D0;
  - Q0;
  - undulators for beam diagnostics with lead ions;
  - wigglers for CLIC damping ring;
  - cycled magnets for PS2.

We will here specifically focus on high field magnet development.

High Field Magnets

There is a variety of needs for high field magnets, which can be summarized as follows :

- large aperture, high peak field low-beta insertion quadrupoles Q1-Q2-Q3;
- large aperture, high peak field correctors for low-beta insertions;
- high field (< 15 T) , any cost, dipole for Fresca upgrade;
- high field, compact, any cost, D0 dipole (with 2 beam-beam LR at 5 σ, > 7 m);
- very high field (15-25 T), low cost, dipole (LHC energy upgrade);
- use of temperature margin for large heat deposition (D1, Q0, D0);
- high peak field undulators for LHC lead ions beam diagnostics;
- high peak field wigglers for CLIC damping rings;
- open mid-plane dipoles for neutrino factories

R&D programs & topics

The High Field program at CERN, coordinated by G. de Rijk, involves the CERN White Paper Program, the FP7-IA-HFM program and collaborations with several research institutes worldwide CEA, CIEMAT, INFN, STFC-RAL, UNIGE, TWENTE UNIVERSITY, WROCLAW UNIVERSITY and the LARP laboratories.

The R&D topics under consideration are :

- Conductor
  - Develop stable, high Jc conductors
  - Magnetization
- Enabling technologies & support studies
  - Electromagnetic layouts
  - Mechanical structures
  - High thermal transfer insulation
  - Radiation resistant insulation
  - Model coils (solenoid-racetrack) to study insulation & thermal treatment
  - Prospect HTS possibilities (design and build a 20 T insert)
- Model magnets
  - Design build and tests short models (dipole, quad and corrector)
- Prototype magnet
  - Design build and test 4 m prototype (dipole or quad)

On-going activities

The are at least four R&D activities already on-going at CERN concerning high field magnets :

- development of an industrial European wire with a target Jc of 3000 A/mm2 @ 12 T at 4.2 K. In Europe two technologies having the potential of reaching the target are being explored : powder in tube (contract awarded to SMI) and internal tin diffusion (contract awarded to Alstom). The progress on both fronts are promising and allowed achieving a Jc of 2500 A/mm2 @ 12 T and 4.2 K with the powder in tube technology, and a Jc of 2100 A/mm2 @ 12 T and 4.2 K with the internal tin technology;
- "fast" thermal treatment of OST wires, showing enhanced stability and excellent Jc values (~3000 A/mm2 @ 12 T and 4.2 K) with a treatment of only 17 hours at 695°C;
- development of Nb3Sn undulators as synchrotron radiation sources for the beam profile monitors of the LHC run with lead ions. The short magnet period of only 14 cm, associated to a large aperture of 60 mm, requires a coil peak field of about 10 T to produce a magnetic field on the beam axis of 3 T;
- development of new concepts of Nb3Sn wire insulation, being experimented on mini dipole split-coils. The use of advanced ceramic insulations allowed the manufacture of a mini dipole reaching a short sample field of 12 Tesla at 4.2K with no training quenches. This insulation has the particularity to get fully hardened before the high temperature thermal treatment of the superconductor.