CABLE DESIGN AND R&D FOR NED

D. LEROY / CERN
INTRODUCTION

MAGNET PRELIMINARY DESIGN

STRAND

CABLE

PROGRAM
INTRODUCTION

- The Nb3Sn conductor development is a work package in the NED proposal.

- A preliminary design of a large-aperture (up to 88 mm), high-field (up to 15 T), Nb₃Sn dipole magnet has been made to derive meaningful conductor specifications.

- Within the limited funding, it was then decided to concentrate on two routes: (1) Powder In Tube (PIT) and (2) Internal Tin (ITD).

- A technical specification will be written according to CERN procedures.

- The high current densities in the 15-T range represent a new technical challenge for the European superconductor industry,
which will invest in this ambitious program.

**MEASUREMENTS**

- Wire critical current measurements (following a standardized protocol) will be performed at:
  - CEA/Saclay,
  - INFN-Milano/LASA
  - Twente University

- Wire magnetization measurements at INFN-Genova.

- The cable critical currents will be measured at Twente University.
Magnet Overall Structure

iron yoke

collars

mm

111

96

70

44

23

23

15

300

25

3

3

436

411

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Flux lines

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Forces

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Load line

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MAGNET CHARACTERISTICS

Magnet with 2 types of cables

Cable 1: 34 X 1.35 mmϕ, Cu/SC = 1/1   Cable 2: 40 X 1.15 mmϕ, Cu/SC = 2

Bo = 14.85T   Bp = 15.7T   P₁ = 144M Pa   P₂ = 167 M Pa
L = 4.36mH   W₀ = 1810 kJ/m   Fₓ = 16.2MN/m   Fz = 1.8MN

Magnet with one type of cable

Cable: 36 X 1.25mmϕ, Cu/Sc = 1.25

Bo = 14.2T   Bp = 15.24T   P₁ = 132.5M Pa   P₂ = 160 M Pa
L = 4.23mH   W₀ = 1621kJ/m   Fₓ = 15M N/m   Fz = 1.6MN

With a total cable degradation at pressure: 10%   Bo = 14T   Bp = 15T
15%   Bo = 13.9T   Bp = 14.9T

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Strand Characteristics

Wire diameter       1.25mm

Cu/nonCu           1.25

Jc at 15T,4.2K      1500 A/mm²

Filament size       <50 μm (no flux jump)
                    Collective barrier in ITD not suitable

Coating             NiSn electrolytic (to be tested)

RRR Cu              >100 after strand annealing for Cu stress relaxation
Cable Characteristics (Preliminary)

Dimensions preliminary 2.25 X 2.375 X 22.5 mm

Compaction thin edge 10%

Compaction thick edge 5%

Cabling at 86% filing factor, to have 88% after reaction to limit the effect on cable mid-thickness of the ~ 3% volume expansion

Degradation due to cabling 3 to 6 %

Degradation at 150M Pa : 7 to 10%
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I T D (Alstom)

PIT (SMI)
PROGRAM FOR NED CONDUCTOR

- Increase of the Sn content to obtain a large number of small grains and a content > than 24% homogenously distributed
- Decrease the filament size to decrease the reaction time and moderates the growing of the grains
- Additives in the raw materials
- Process suitable for large production. Billets of circa 70kgs
- Testing of wires to measure the strain impact
  - A working group will make the standardization of the electrical characterization (A. den Ouden)