The R&D programme on High Field Magnets (HFM)

Gijs de Rijk (CERN)

on behalf of the HFM collaboration

3rd December 2008

Outline

- **Motivation**
- **General structure**
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- **Task 2 Support studies**
- **Task 3 High field model**
- **Task 4 Very high field dipole insert**
- **Task 5 High Tc superconducting link**
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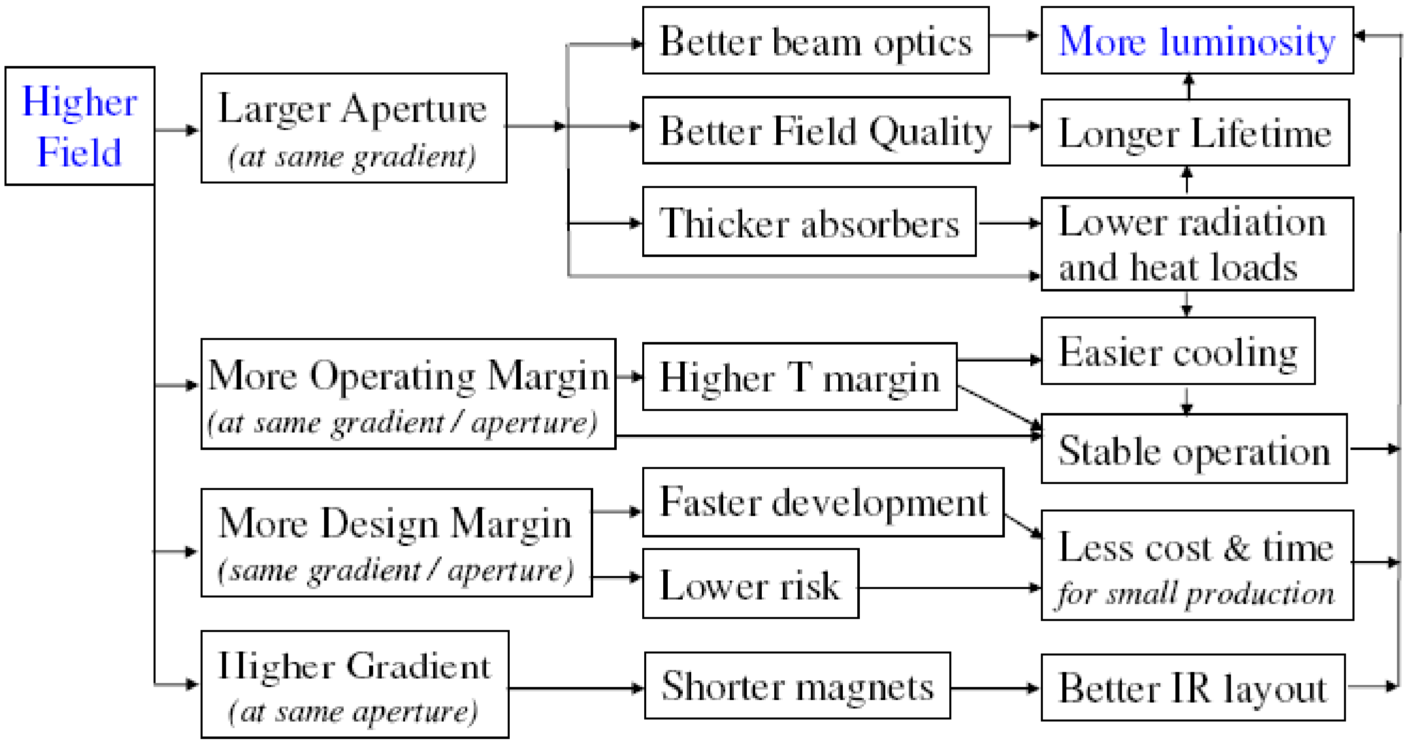
- **Now start…**

Motivation (1)

[motivation 1] HFM technology for LHC upgrade

Quadrupoles for the LHC Phase 2 Upgrade

High field technology provides design options to maximize luminosity



9th ICFA Seminar, October 28-31, 2008 R&D for High Field Magnets GianLuca Sabbi, LBNL

Motivation (2)

- In the US LARP (BNL, FNAL, LBNL) have started the development of large aperture high gradient Nb3Sn quadrupoles
- CERN will now join into this development effort
- We need to upgrade our cable test infrastructure for this :

upgrade of CERN MFRESCA cable test facility

(presently limited to 10 T, ϕ = 88 mm)

To: B = 13-15 T

ϕ = 88-100 mm

Imax = 30 kA with power convertor

Imax = 50 kA with transformer

- to offer unique services to the CERN and the entire applied superconductivity community.

Motivation (3)

New magnets needed for the LHC phase 2 upgrade

- Quadrupoles for the low-beta insertions
- Corrector magnets for the low-beta insertions
- Early separation dipole (D0)

and possibly

- Dogleg dipoles for the cleaning insertions
- Q6 for cleaning insertions
- 10 m dipoles for the dispersion suppressors (room for collim.)

Getting ready when we will need HFM in LHC or for the upgrade: around y >2017

- The experience of LHC has shown that 10 years are needed to develop a technology and make it usable in real conditions.
- CARE, and HHH in particular has provided a unique background to unify the accelerator magnet community in Europe. EUCARD and further progress are based on the success of the HHH network and of the NED program

Motivation (4)

[motivation 2] High Tc superconducting links for SLHC

The SC current links in IP3 in the LHC pose a limitation due to the limited temperature margin of the Nb-Ti cables in the links as they pass very close to the collimators. To replace them with HTS links will solve this limitation.

[motivation 3] Technology for SC undulators

Short period SC undulators are needed for free electron lasers and for the positron source of future linear colliders. The required fields should be reachable with Nb_3Sn helical coils.

[motivation 3] Technology for Very High Field Magnets for the LHC Farthest Energy Frontier

CERN has a tunnel with the proper infrastructure when the Farthest Energy Frontier (30-40 TeV c.o.m. ➔ the "multi Tera scale") will be on the table in after 2020. For this magnets in the 20 T range will be needed for which nested HTS-Nb_3Sn coils are the only solution

Motivation (5)

Origins of the HFM WP:

The letter of intend to ESGARD on a HFM package by Lucio Rossi

Why in EuCARD in one WP :

1. Synergies in the technology (Nb3Sn and HTS)
2. Instead of doing 13 small size, small funding projects do 1 decently sized, correctly funded project
3. The know-how is distributed at the moment and needs to be brought together in order to advance.

General structure

HFM: Superconducting High Field Magnets for higher luminosities and energies

- 1 management task
- 1 studies task
- 4 design – construction tasks
- 13 participant institutes: CERN, CEA-DSM-Irfu, CNRS-Grenoble, COLUMBUS, DESY, BHTS, FZK, INFN-Milano, Politechnika Wroclawska, SOTON, STFC-RAL, Tampere University of Technology and Université de Genève
- 3 associated institutes: FNAL, LBNL and University of Twente

Task 1 Coordination and Communication

Task Leaders: Gijs de Rijk (CERN) & Francois Kircher (CEA-DSM-Irfu)

Participants: CERN, CEA-DSM-Irfu

This task is a basic requirement for each work package

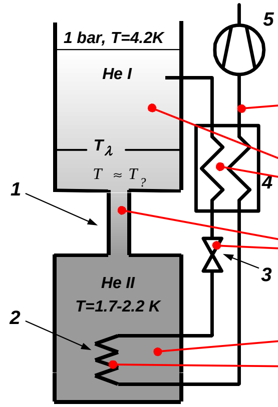
- Coordination and scheduling of the WP tasks
- monitoring the work, informing the project management and participants within the JRA
- WP budget follow-up

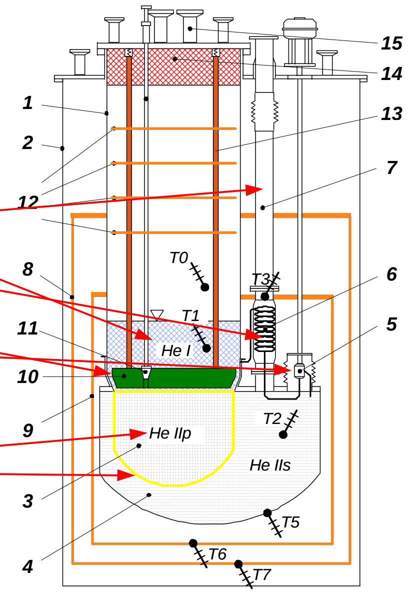
Task 2 Support studies

Task leader : Maciej Chorowski (Wroclaw Technical University)

Participants: Wroclaw Technical University, CEA-DSM-Irfu, CERN

- Certify radiation resistance of radiation resistant coil insulation and impregnation.
- Make a heat deposition and heat removal model for the dipole Nb_3Sn model with experimental validation and determine the thermal coil design parameters for the dipole model magnet.





Views of NED cryostat (Courtesy M. Chorowski, WUT)

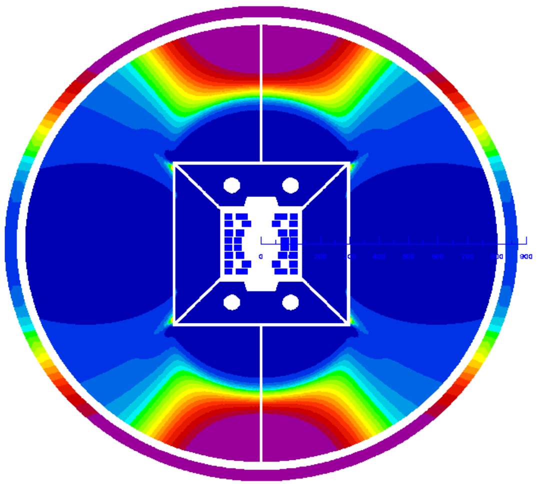
Task 3 High field model

Task Leader: Jean-Michel Rifflet (CEA-DSM-Ifru)

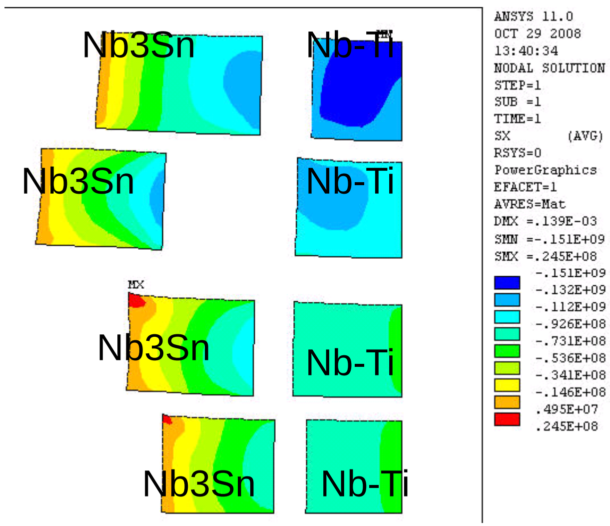
Participants: CEA-DSM-Irfu, CERN, Wroclaw Technical University

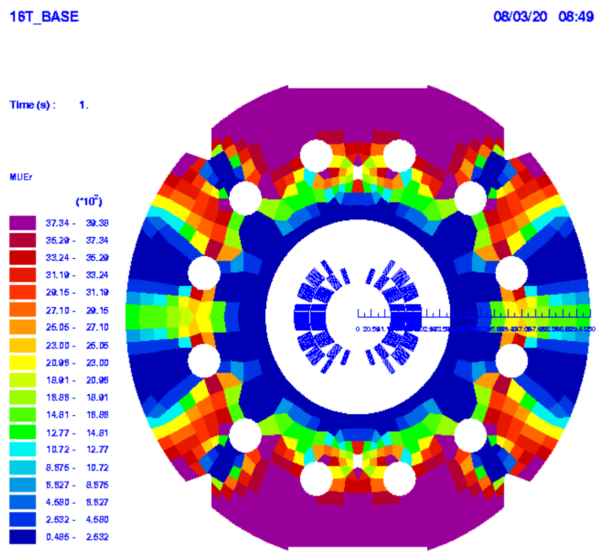
- Design, build and test a 1.5 m long, 100 mm aperture dipole model with a design field of 13 T using Nb_3Sn high current Rutherford cables.

several concepts' are being studied already



Block coil design





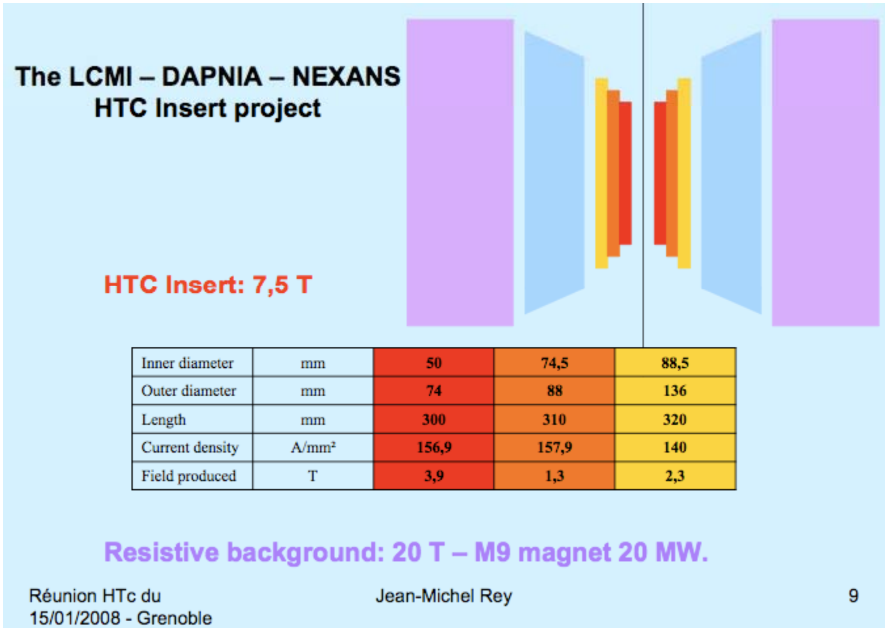
CosΘ design

Task 4 Very high field dipole insert

Task Leader: Pascal Tixador (CNRS Grenoble)

Participants: CNRS Grenoble, CEA-DSM-Irfu, FZK, INFN-Milano, Tampere University of Technology, UNIGE, Wroclaw Technical University

- Design, build and test HTS solenoid insert coils for a solenoid background magnet aiming at a field increase up to 6 T to progress on the knowledge of HTS coils, their winding and behaviour. This as in intermediate step towards a dipole insert.
- Design, build and test an HTS dipole insert coil for a dipole background magnet aiming at a field increase of about 6 T.



Inner diameter	mm	50	74,5	88,5
Outer diameter	mm	74	88	136
Length	mm	300	310	320
Current density	A/mm²	156,9	157,9	140
Field produced	T	3,9	1,3	2,3

Task 5 High Tc superconducting link

Task Leader: Amalia Ballarino (CERN)

Participants: CERN, Columbus, DESY, BHTS, University of Southampton

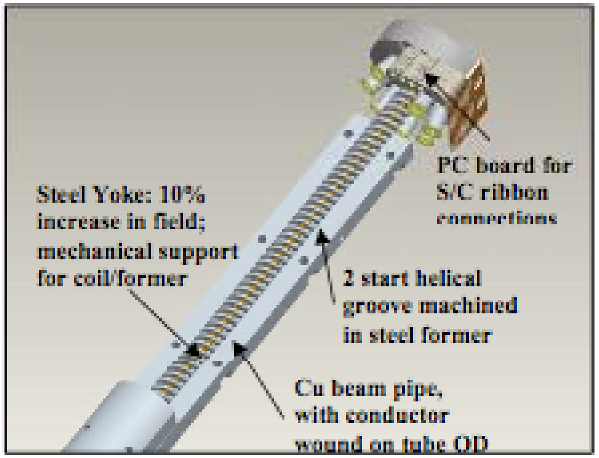
- Design of HTS bus: choice of HTS material definition of thermal conditions, requirements for stabilization and quench protection, modelling of quench propagation.
- Design. realization and test of electrical joints and electrical terminations.
- Mechanical design and assembly of a 20 m long superconducting link (26 pairs of 600 A).

Task 6 Short period helical superconducting undulator

Task Leader: Jim Clarke (STFC-DL)

Participant: STFC-DL

- Design, build and test a prototype helical coil undulator magnet with 11.5 mm period, high peak magnetic field in Nb_3Sn technology.



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Timetable

		1st YEAR												2nd YEAR											
		Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8		
				3			6			9			12			15			18			21			24
Task 7.1	HFM Coordination and communication											M												M
Task 7.2	Support studies											M												2M
Task 7.3	High Field Model																							
Task 7.4	Very high field dipole insert											M												M
Task 7.5	High Tc Superconducting Link																							
Task 7.6	Short period helical superconducting undulator																							

		3rd YEAR												4th YEAR											
		Q9			Q10			Q11			Q12			Q13			Q14			Q15			Q16		
				27			30			33			36			39			42			45			48
Task 7.1	HFM Coordination and communication											M												DM
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Task 7.5	High Tc Superconducting Link									M						D								
Task 7.6	Short period helical superconducting undulator											M												D

Now start…

- Official start 1 April 2009
- Until then we will have to set up a real collaboration
  - We already have “management” institutional contacts
  - We now need working groups per task
  - We need to get the scientific and technical people attached to the tasks
  - We need to make a detailed work plan per task
- During the next 3 months I will contact the participants and associates to set this up…