



Practical Work @ CERN Normal Conducting Magnets

Part 1: Magnet Technology, Production and Testing

Thursday 1st & Friday 2nd March 2018, 9:00 – 17:00

jeremie.bauche@cern.ch

Outline

- Normal Conducting Magnets at CERN
- Program and Organization of Magnet Practical Works
 - Magnet Technology, Production and Testing
 - Magnetic Measurements

TE-MSC

Magnets, Superconductors & Cryostats Staff Members

~100 staff members
~ 30 fellows
~ 20 students
~ 50 associates
~ 50 industrial contractors
+ some more externals

L. BOTTURA Group Leader
A. DEVRED Deputy Group Leader

Group Leader Office: L. BOTTURA
G. DE RIJK
J.Ph. TOCK
E. TODESCO
D. TOMMASINI

Secretariat: C. HERVET
L. ORMESHER

Cryostats & Machine Integration CMI

V. PARMA

G. BARLOW
A. BASTARD
J.B. DESCHAMPS
D.L. DUARTE RAMOS
S. LE NAOUR
Y. LECLERCQ
M. SOUCHET
M. STRUIK
J.Ph. TOCK
A. VANDE CRAEN
L. WILLIAMS

Large SC Magnet Facility LMF

F. SAVARY

J. AXENSALVA
T.A. BAMPTON
M. DURET
D. ETIEMBRE
R. FAES
L. FAVIER
A. FOUSSAT
D. GERARD
J. GOMES DE FARIA
L. GRAND-CLEMENT
J.M. HUBERT
F. LACKNER
Ch. LOFFLER
S. LUZIEUX
M. POZZOBON
H. PRIN
R. PRINCIPE
C. SCHEUERLEIN
S. TRIQUET

SC Magnet Design & Technology MDT

G. DE RIJK

N. BOURCEY
S. CLEMENT
D. COTE
C. FERNANDES
P. FERRACIN
R. GAUTHIER
P. HAGEN
S. IZQUIERDO BERMUDEZ
G. KIRBY
G. MAURY
J. MAZET
A. MUSSO
J. PEREZ
F. PINCOT
D. SCHOERLING
S. SEQUEIRA LOPES
E. TODESCO

Magnetic Measurements MM

S. RUSSENSCHUCK

R. BELTRON MERCADILLO
M. BUZIO
R. CHRITIN
G. DEFERNE
O. DUNKEL
L. FISCARELLI
J. GARCIA PEREZ
D. GILOTEAUX
C. PETRONE
T. ZICKLER

Magnets Normal Conducting MNC

D. TOMMASINI

J. BAUCHE
D. BODART
M. BRUYAS
P. CATHERINE
O. CRETTEZ
M. DUMAS
C. LOPEZ
R. LOPEZ
A. MILANESE
A. NEWBOROUGH
G. PERRIN-BONNET
A. RUSSO
P. SCHWARZ
P. THONET

Superconductors & Devices SC D

A. BALLARINO

A. BONASIA
B. BORDINI
P. DENIS
J. FLEITER
A. GHARIB
S. HOPKINS
J. HURTE
A. JACQUEMOD
P. JACQUOT
S. LAURENT
M. MALABAILA
G. PEIRO
P. RETZ
D. RICHTER

Superconducting Magnet Test Facilities TF

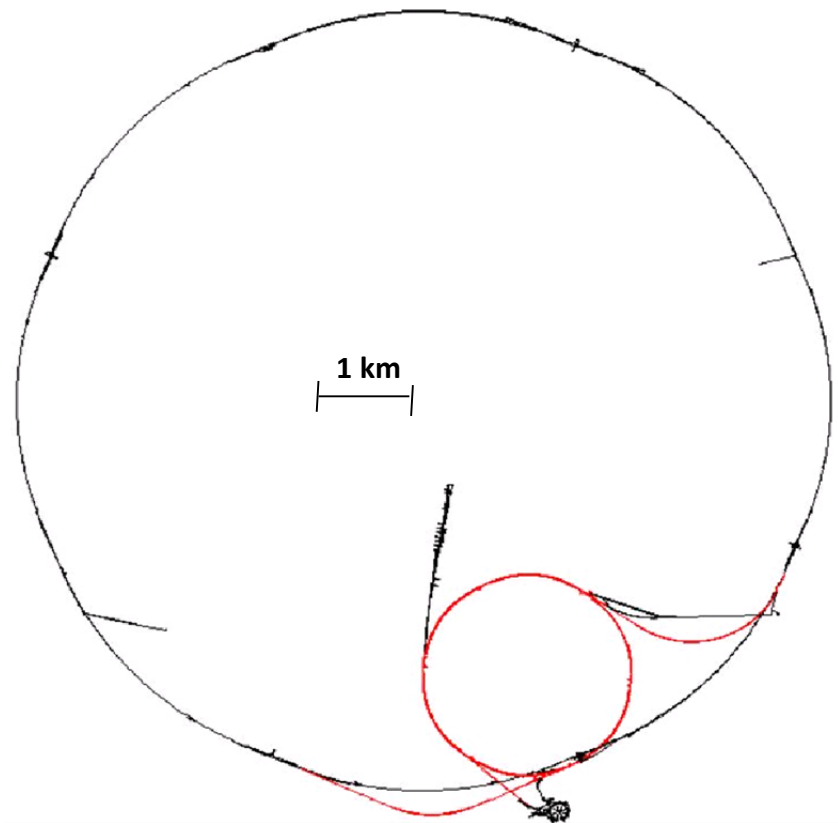
M. BAJKO

H.M.BAJAS
M. CHARRONDIERE
O. DITSCH
J. FEUVRIER
C. GILOUX
G. NINET
M.A.PASCAL
P. VIRET
G.P. WILLERING

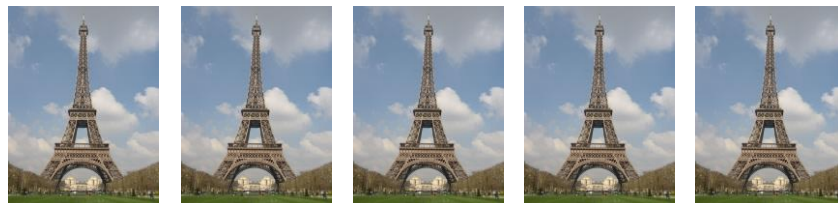
Dealing with
Superconducting Magnets

Dealing with Normal
Conducting Magnets

CERN Normal Conducting Magnets



- About 20 km of beam lines in 16 different machines, all interconnected
- ~ 5000 installed magnets + ~ 2000 stored magnets → 50 000 tons



- Large variety: ~ 500 different types



LINAC4 DTL PMQ, < 1 kg

LEIR main dipole, 60 tons

LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKEfield Experiment ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials

The MNC Section

Design, procurement/manufacture, maintenance, consolidation, and upgrades of the normal conducting magnets in the accelerators, transfer lines and experimental areas

- **Operation:** maintenance and consolidation of existing machines
 - *2 dedicated workshops treating about 100 radioactive magnets/year*
 - *maintenance of installed magnets in the accelerators*
 - *interventions during physics run to minimize beam downtime*
- **Projects:** upgrades and new beam lines
 - *2 dedicated workshops for prototyping, tests and measurements*
 - *modification or construction of new magnets for machine upgrades (LIU, HL-LHC) or new beam lines (LINAC 4, ELENA, HIE-ISOLDE, AWAKE...)*

Operation and Maintenance

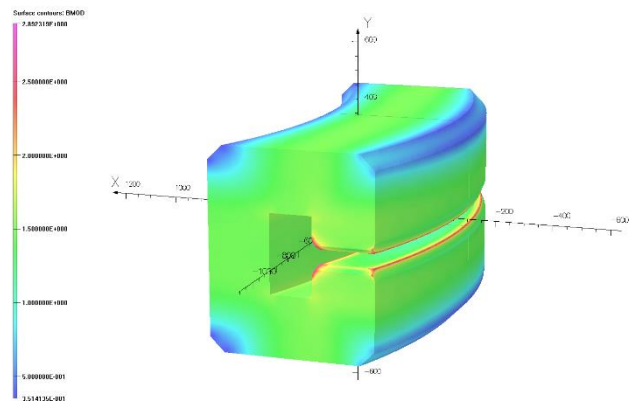


CERTIFICATION

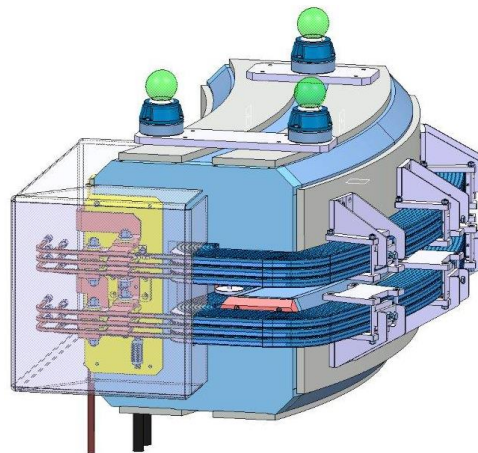
MAGNET ASSEMBLY

REFURBISHMENT

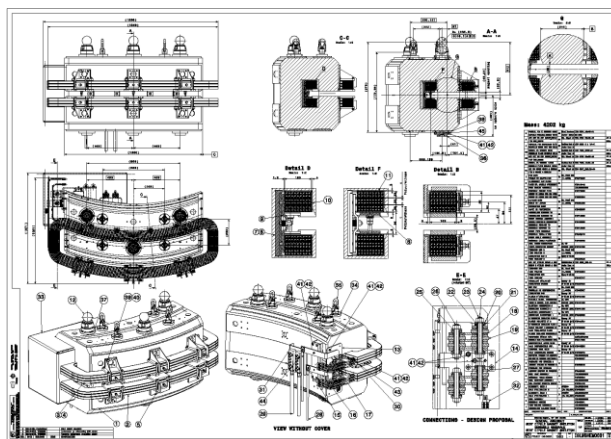
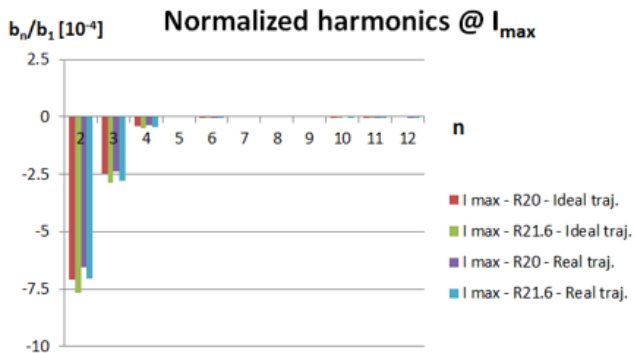
Design and Procurement



Magnetic design



Mechanical design



ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
 CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

EDMS N°: 1288334
HIE-ISOLDE Project Document Ref.: HIE-MBHEM-CL0001

Group Code: TE4MSC-MNC
IT-3969 TE HIE-ISOLDE

The HIE-ISOLDE Project

Invitation to Tender

Technical Specification

Beam Transfer Line Dipole Magnets for the HIE-ISOLDE Facility

Abstract

This technical specification concerns the supply of four C-type dipole electromagnets, plus one set of spare coils for the HIE-ISOLDE high energy beam transfer lines. These magnets are made of laminated steel yokes and of water-cooled coils wound from hollow copper wire. Their mass is approximately 4200 kg per magnet. Delivery shall be completed within 14 months after placement of the contract.

June 2013

Specifications for
manufacture;
follow-up in industry

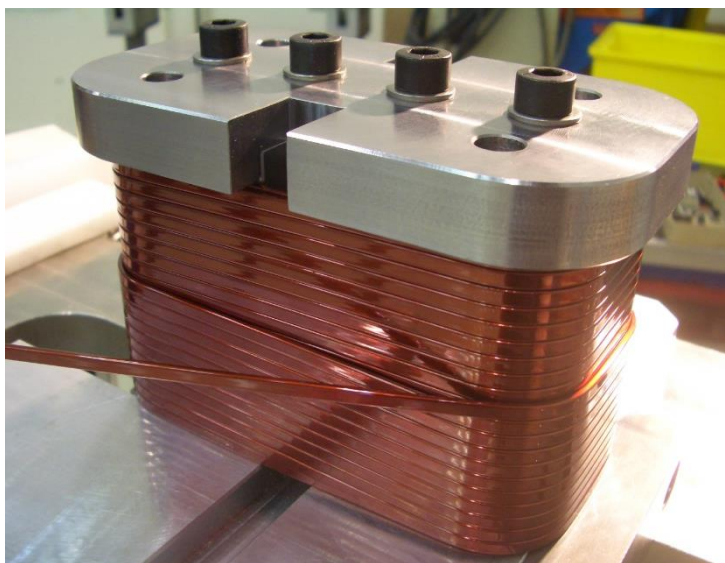
Manufacture and Tests



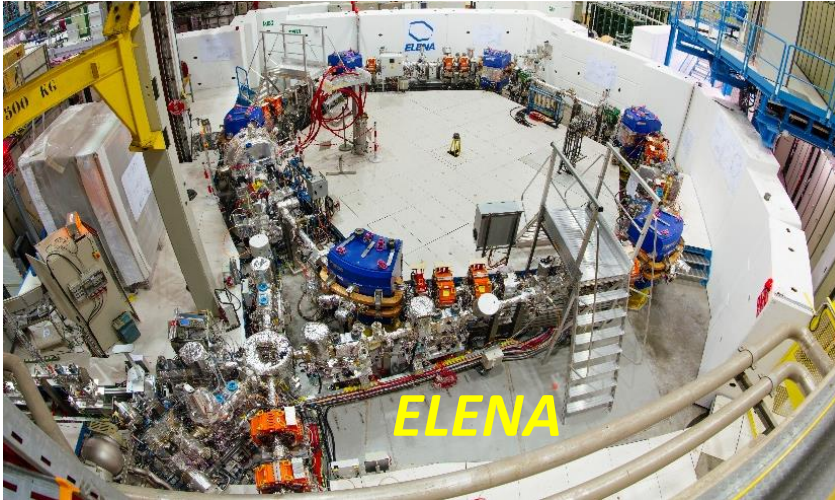
Manufacture



Tests and measurements



Projects – at CERN



Projects – outside CERN



The MNC Team



- *16 staff*
- *10 fellows, students, and associates*
- + 13 industrial contractors*



With more to come ...maybe you?

Program and Organization of Practical days

- 8 to 12 participants/days, shared in two groups
- Split into two half-day sessions
 - Magnet manufacture and testing
 - Magnetic measurements
- Hands-on practical work in CERN laboratories
- Guided by CERN magnet experts

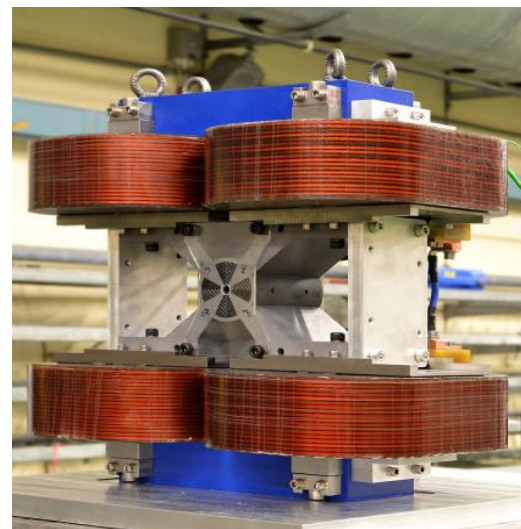
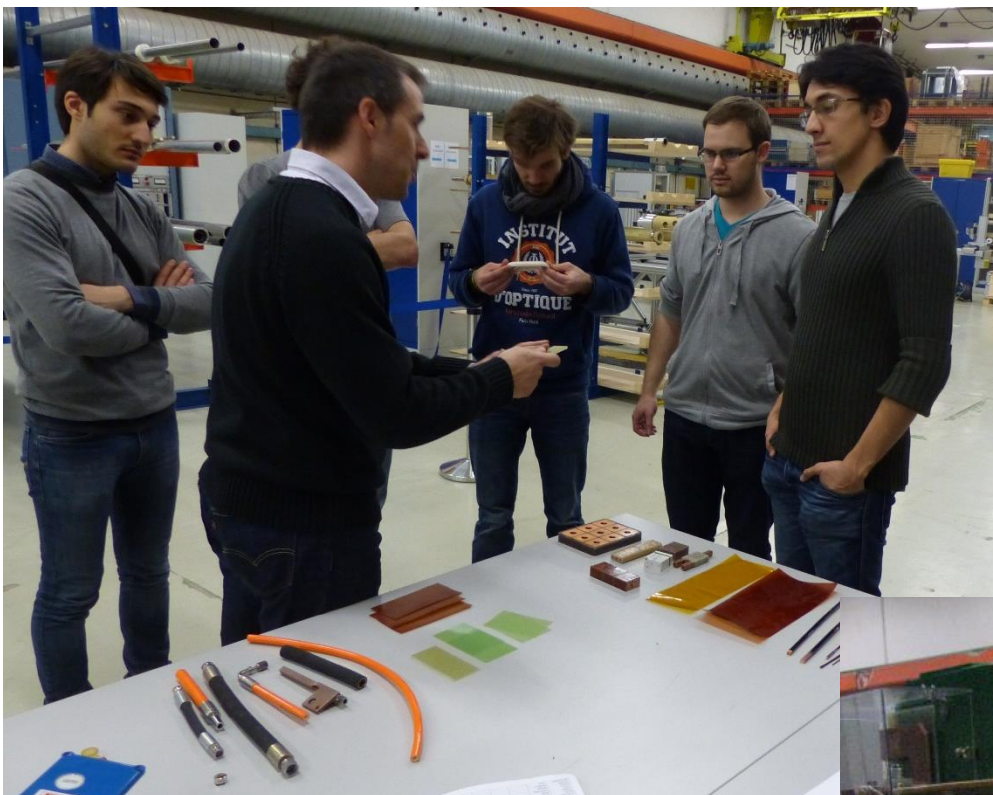
Magnet Manufacture and Testing

- Introduction to magnet manufacture (1h)
 - Materials for magnets
 - Magnet components
 - Manufacturing technologies
 - Yoke manufacturing
 - Coil winding and impregnation
 - Testing and measurement techniques
- Practical work in magnet test facility (2h30')
 - Participants will perform tests and measurements on recently built magnets
 - Measurements on systems and apparatus using instruments and **formulae*** learned during the theoretical courses

*See JUAS 2018 Indico page (<https://indico.cern.ch/event/683638/timetable/>):

- “Magnet analytical design formulae” → timetable 12 Feb., 15:00
- “Introduction to magnets” lecture → timetable 26 Feb., 9:00

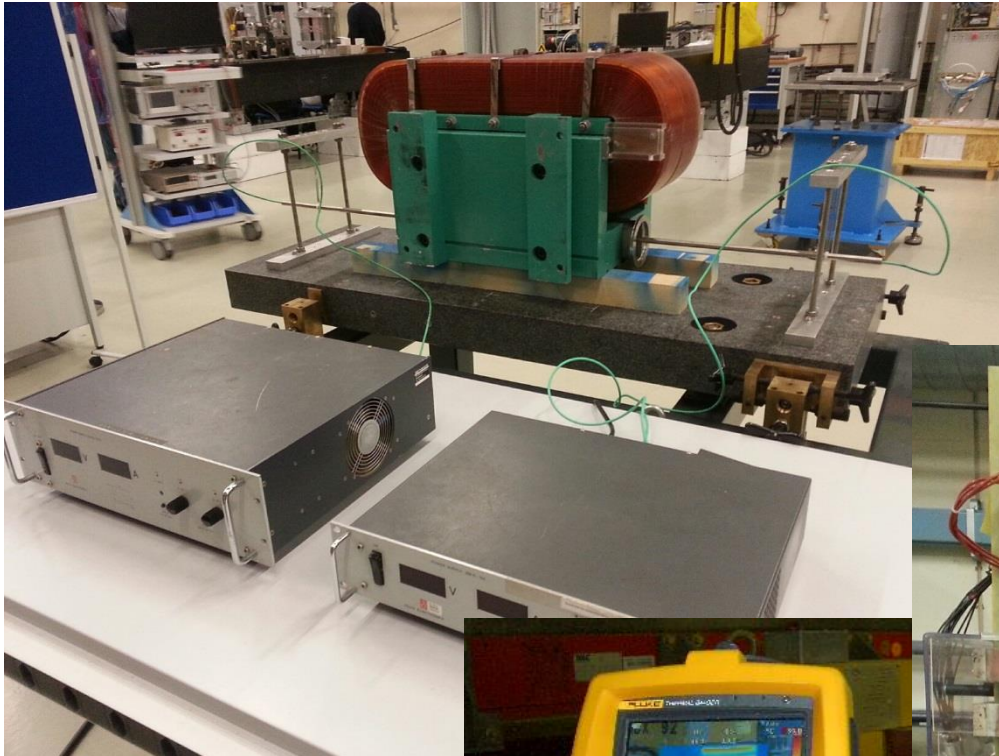
Magnet Manufacture



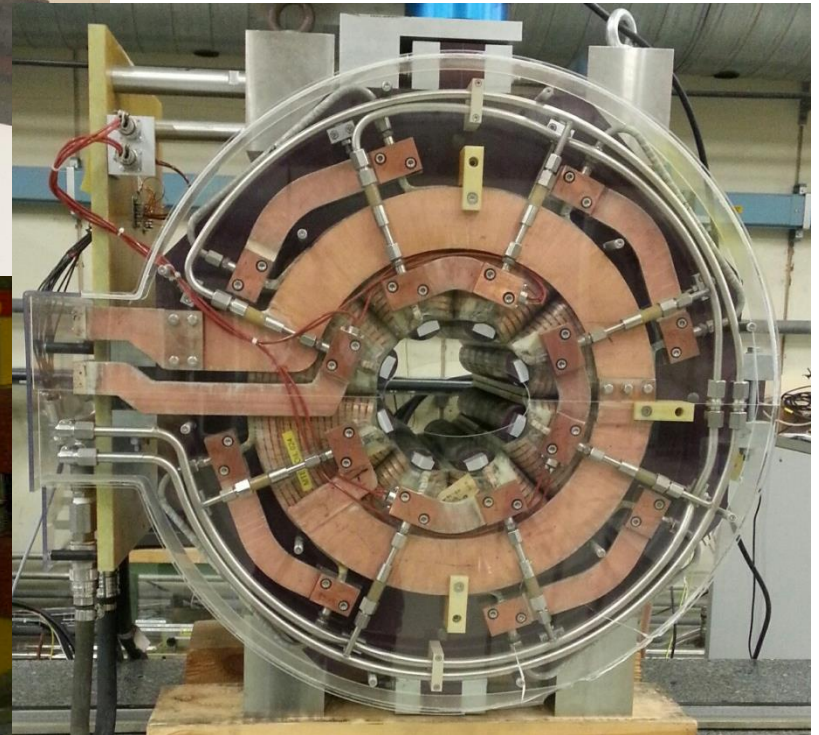
Materials, technologies,
components, manufacturing
processes, and assembly
techniques

Magnet Testing and Practical Applications

Use of analytical formulae and measurements systems to calculate magnet parameters



Testing magnets to assess their functionality and reliability



We are
looking
forward...



...to welcome
you at CERN

... and
unravel the
mysteries of
the magnets

...in a *relaxed* atmosphere!