Practical Days @ CERN
Normal Conducting Magnets

Part 1: Magnet Technology, Production and Testing

***Tuesday 11th & Wednesday 12th March 2025**, 9:00 – 16:15*

jeremie.bauche@cern.ch

Outline

- Normal Conducting Magnets at CERN
  - Magnet group
  - Magnet patrimony
  - NCM mission and opportunities
- Program and Organization of Magnet Practical Works
  - Magnet Technology, Production and Testing
  - Magnetic Measurements (see next talk from L. Fiscarelli)

JOINT UNIVERSITIES ACCELERATOR SCHOOL

GAO
Group Assistant's Office

SANDELL Sonja

TE-MSC
Magnets, Superconductors and Cryostats

GL: MILANESE Attilio
DGL: BALLARINO Amalia

~150 persons (staff, fellows, students)

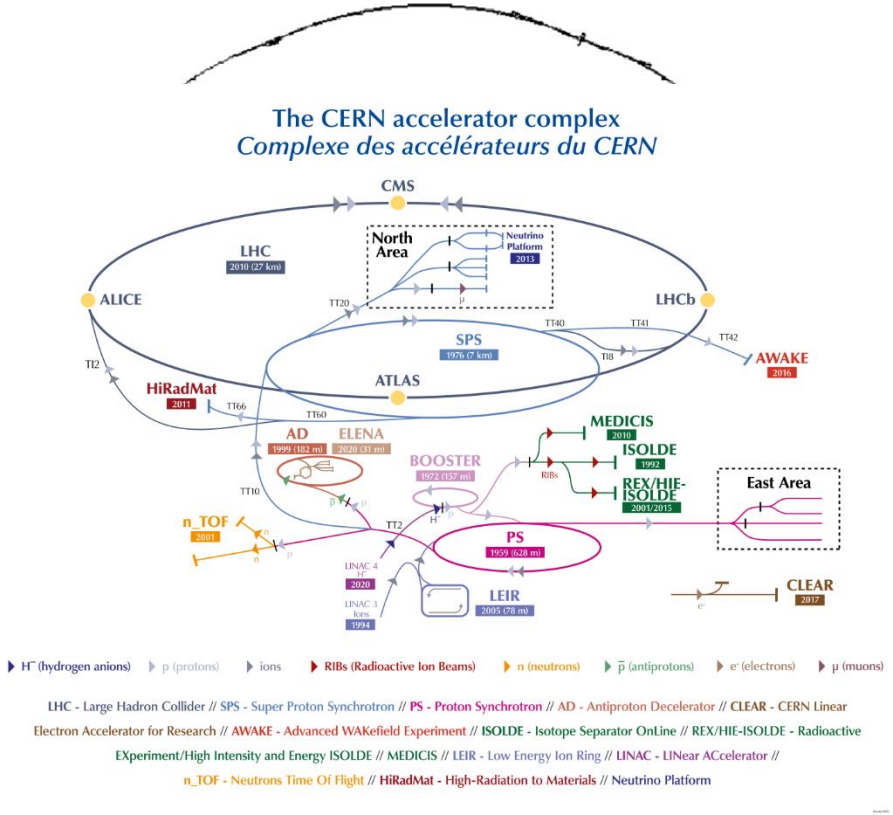
CERN

TE-MSC-CMI Cryostats & Machine Integration	TE-MSC-HSD High Temperature Superconductors & Devices	TE-MSC-LMF Large Sc Magnet Facility	TE-MSC-LSC Low Temperature Superconductors & Characterization	TE-MSC-NCM Normal Conducting Magnets	TE-MSC-SMT Superconducting Magnet Technology	TE-MSC-MMM Magnetic Measurements & Modelling	TE-MSC-MQA Magnetic Qualifications & Analysis
SAVARY Frederic	BALLARINO Amalia	IZQUIERDO BERMUDEZ Susana	BOUTBOUL Thierry	SCHOERLING Daniel	TODESCO Ezio	BUZIO Marco	WILLERING Gerard
STAFF							
DESCHAMPS Jean-Baptiste DIAZ VEZ Ruth DUARTE RAMOS Delio LECLERCQ Yann MCINTYRE Sean MESSINA Noel MOULEYRE Jeremy PASDELOUP Florian STRUIK Michael	BARTH Christian BASKYS Algirdas CAREIL Marc-Philippe GHARIB Alain HURTE Julien MAZET Jacky PERINI Diego ROWLAND Maxwell	AXENSALVA Jerome BAMPTON Tavis BAUDIN Lucie BECLE Steve Thierry BOURCEY Nicolas EYRAUD Nicolas FAVIER Ludovic FERRADAS TROITINO Jose GRAND-CLEMENT Ludovic LE NAOUR Sandrine LUSA Nicholas LUZIEUX Sebastien POZZOBON Marc PRIN Herve TRIQUET Stephane VIEITEZ SUAREZ Andres	BONASIA Angelo FLEITER Jerome GAUTHERON Emma GIRARDOT Florian HOPKINS Simon JACQUOT Pierre-Francois MALABAILA Marina VANDEN CRAEN Arnaud	BAUCHE Jeremie BODART Dominique CATHERINE Pascal COT Cyril Pierre CRETIN Alexandre CRETTIEZ Olivier DUMAS Maxime GERARD Delphine HAALIEN Haavard NEWBOROUGH Antony PERRIN-BONNET Gregory SCHWARZ Philip THONET Pierre VON FREEDEN Luke	CARLON ZURITA Alejandro CHAGANTI Pavan CLEMENT Sebastien COTE Dominique FERNANDES Carlos FOUSSAT Arnaud Pascal HAZIOT Ariel Elie KARPPINEN Mikko MAURY Gregory PEREZ Juan Carlos PICCIN Roland PINCOT Francois-Olivier RIZZO Pietro Antonio SCHEUERLEIN Christian URSCHELER Cedric	BELTRON MERCADILLO Ricardo BONORA-TAM Matthias CHRITIN Regis DEFERNE Guy DUNKEL Olaf FISCARELLI Lucio GILOTEAUX David MARTINEZ HERNANDEZ Unai PETRONE Carlo RUSSENSCHUCK Stephan	BOCZAN Michael Steven DITSCH Olivier Claude FEUVRIER Jerome JUBERG Stian MANGIAROTTI Franco Julio NINET Gaelle Marie PICHON Guillaume Pierre VIRET Patrick
FELL/GRAD							
GARCIA ROBLES Diego PRYCE William SANCHIS ORTOLA Victorio SPATHOPOULOS Stefanos	GAL Norbert JAY-BRETONVILLE Paul KRAMER Tim LAZARIDOU Aikaterini MORISI Simone PEREZ MARTINEZ Rita SABA Aisha VOGL Christian	QUASSOLO Penelope Matilde STRAARUP Simon TOFTE Hans Christian TUROCY Marek	AVRONSART Julien BAUMANN Josef PRESMANES CARDAMA Javier	DEVECI Halil GARCIA-AGUIRREBEITIA SANCHEZ Ignacio GAWEDZKI Marcin GILL Alastair KEY SANCHEZ Raul NEIDHART Andre NIEBERLE Patrick	BEN EL CAID Federico FERNANDEZ MORA Elena GEIGER Kieran Paul HERNANDO IRISARRI Gonzalo OSUNA Javier PARRAGH David PEREZ DE LAZARRAGA VIGUTI Ignacio SALA Nicola SCHENK Vincent	DIAMANTIS Konstantinos DI CAPUA Vincenzo GANESH Abhishek PENTELLA Mariano ROGACKI Piotr Tomasz	DIAS GONCALVES Roberto
	VAN INGEN Frederik	BREINER Thomas	BIJLSMA Jeroen KUCZYNSKA Joanna		GOWRISHANKAR Sachin LANZONI Enrico WOLF Lukas	BELLELLI Alberto MACCARI Jacopo OESTERBRO Rasmus PRAZNOVSKY Martin TAUPADEL Marcus TSIOLAKIS Christoforos	JACOBS Mathjis

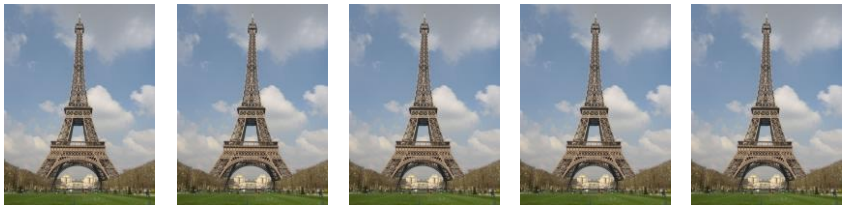
Superconducting Magnets

Normal Conducting Magnets

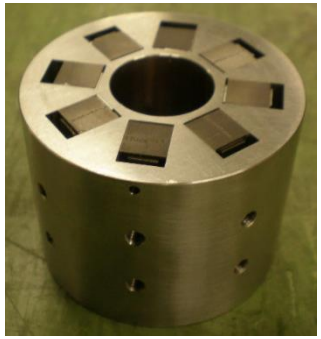
CERN Normal Conducting Magnets



- **About 20 km of beam lines in >20 different machines, all interconnected**
- **~ 4500 installed magnets + ~ 2000 stored magnets → 50 000 tons**



- **Large variety: ~ 500 different types**



LINAC4 DTL PMQ, < 1 kg

LEIR main dipole, 60 tons

The MNC Section

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

- **Operation: maintenance and consolidation of existing machines**

2 dedicated radioactive workshops treating about 100 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 magnet and component production (prototyping)

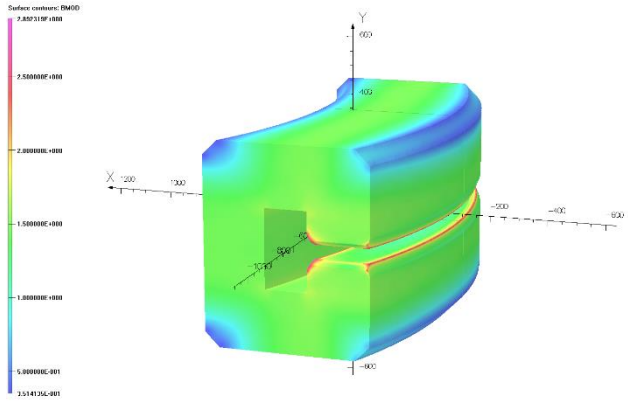
→ *upgrade of existing magnet systems (e.g. ISOLDE 2GeV, HL-LHC)*

→ *construction of new magnets (existing and future accelerators, like FCC-ee)*

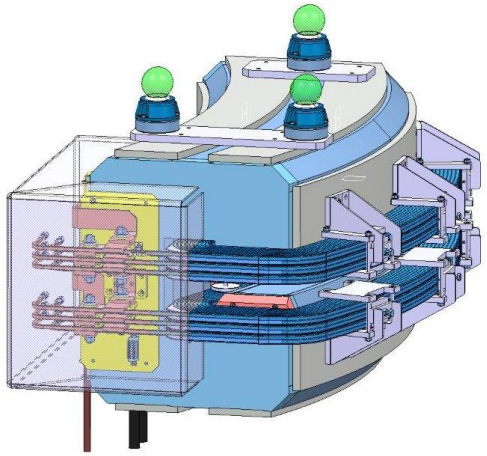
https://te-msc-ncm.web.cern.ch/

Operation and Maintenance

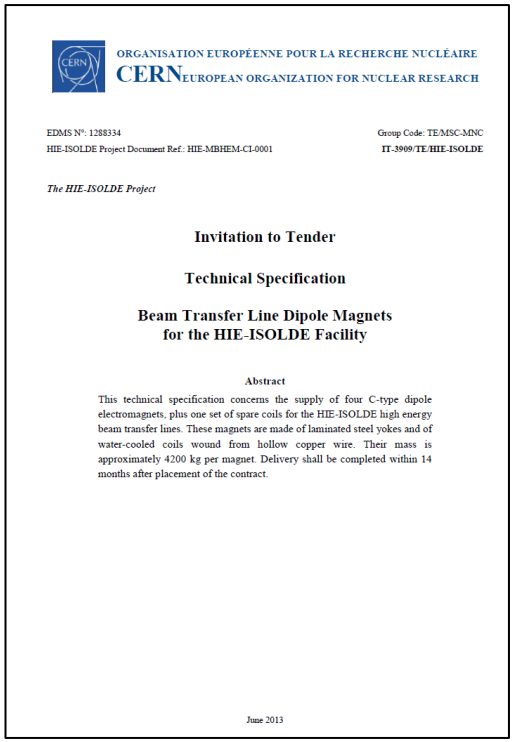
Design and Procurement



Magnetic design



Mechanical design



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

EDMS N°: 1288334 — Group Code: TE/MSC-MNC
HIE-ISOLDE Project Document Ref.: HIE-MBHEM-CI-0001 — IT-3909/TE/HIE-ISOLDE

The HIE-ISOLDE Project

Invitation to Tender

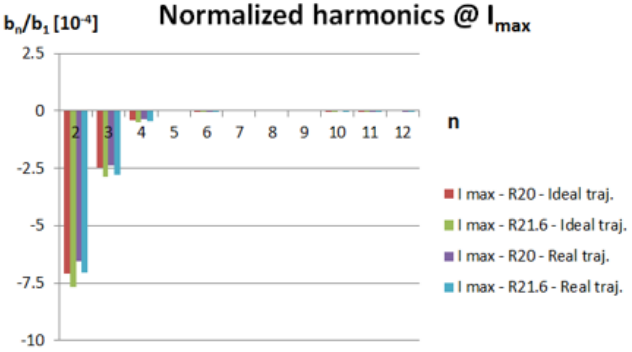
Technical Specification

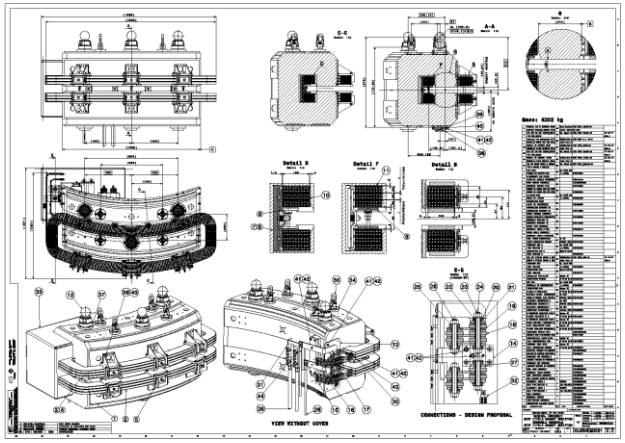
Beam Transfer Line Dipole Magnets for the HIE-ISOLDE Facility

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





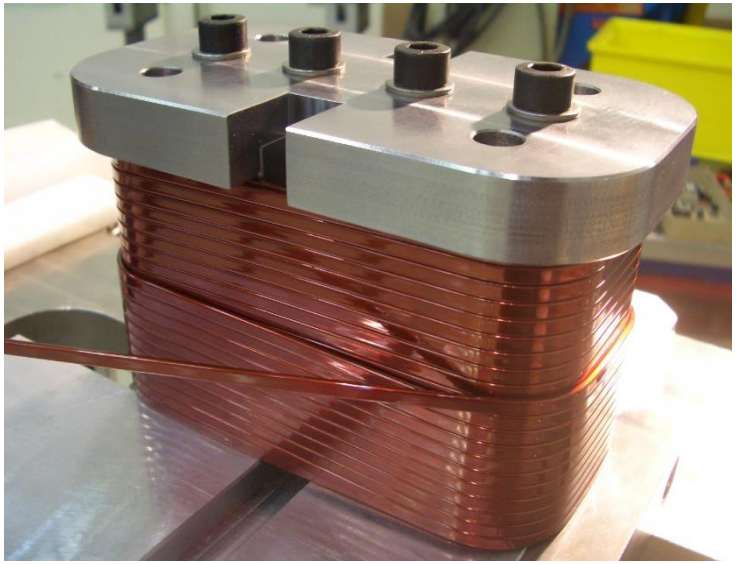
Specifications for manufacture;

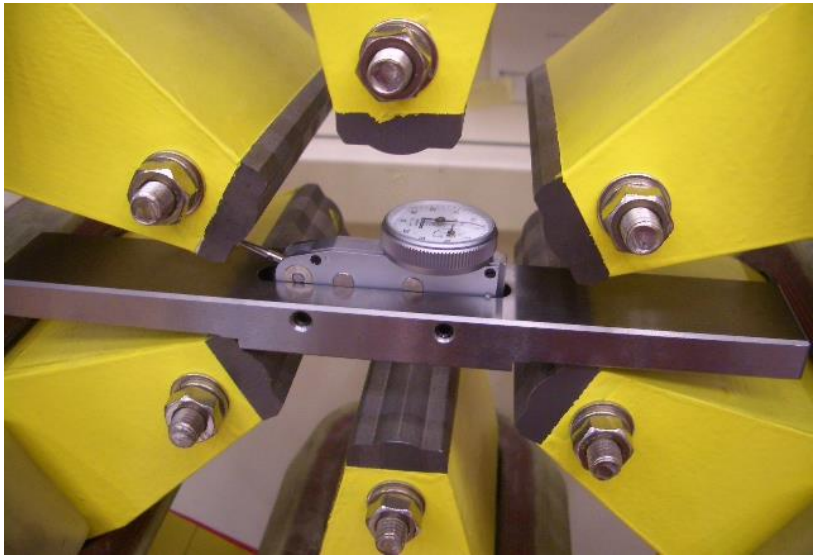
Production in house / in industry

Manufacture and Tests

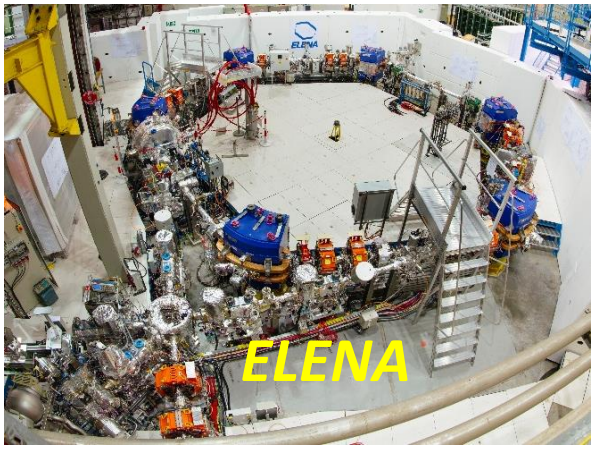
Manufacture

Tests and measurements



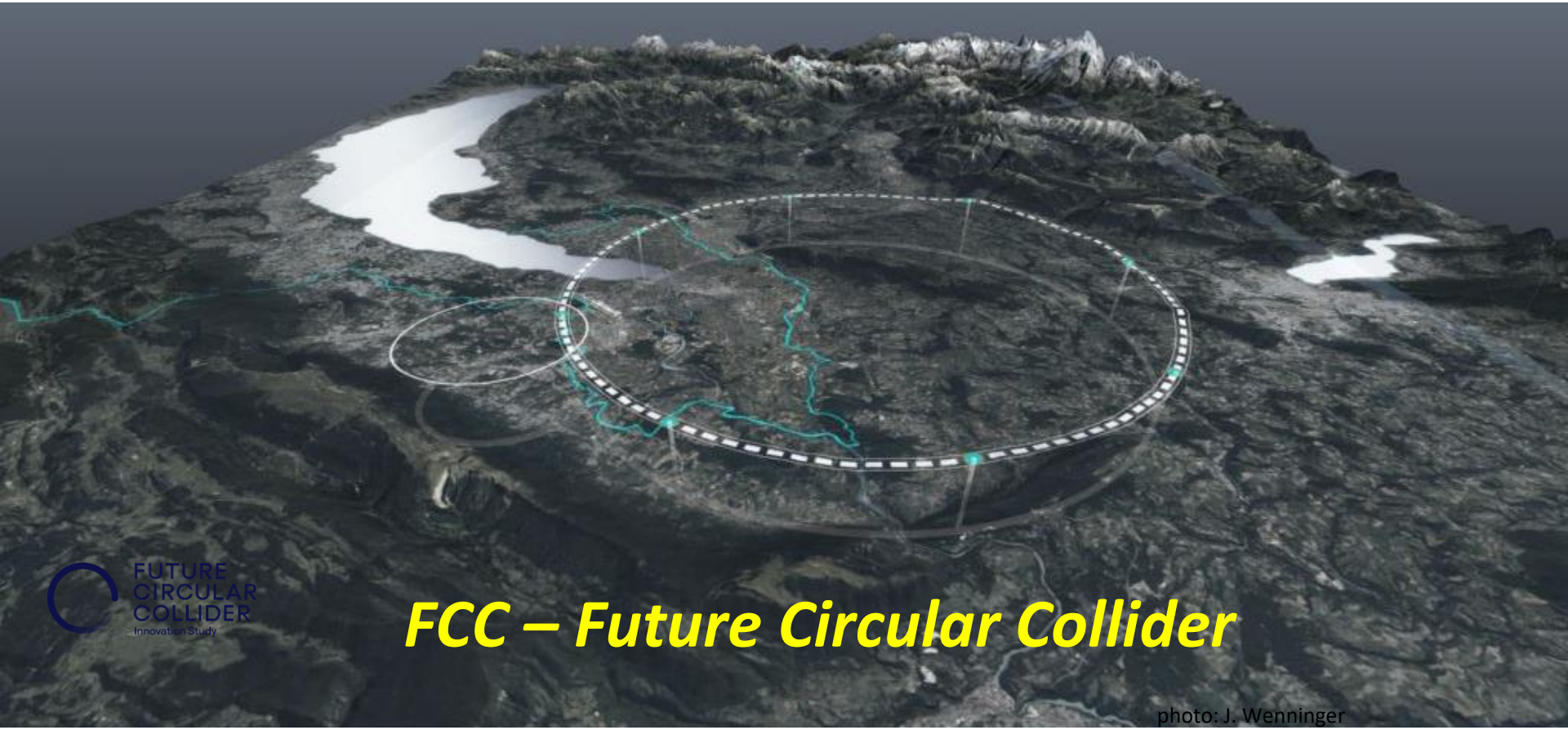


Projects – at CERN



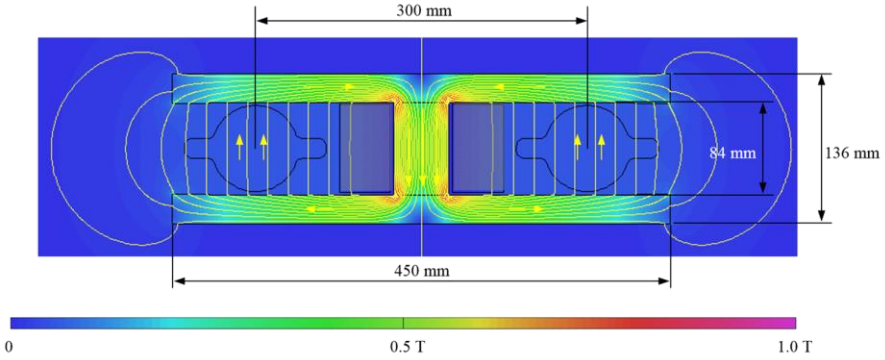
Projects – outside CERN

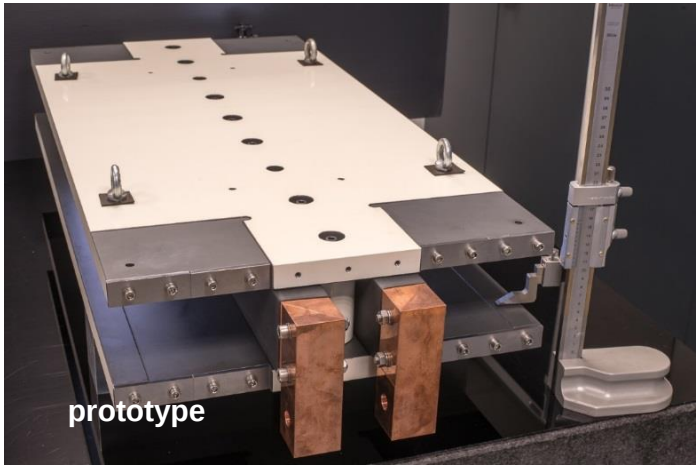
Projects – The Future



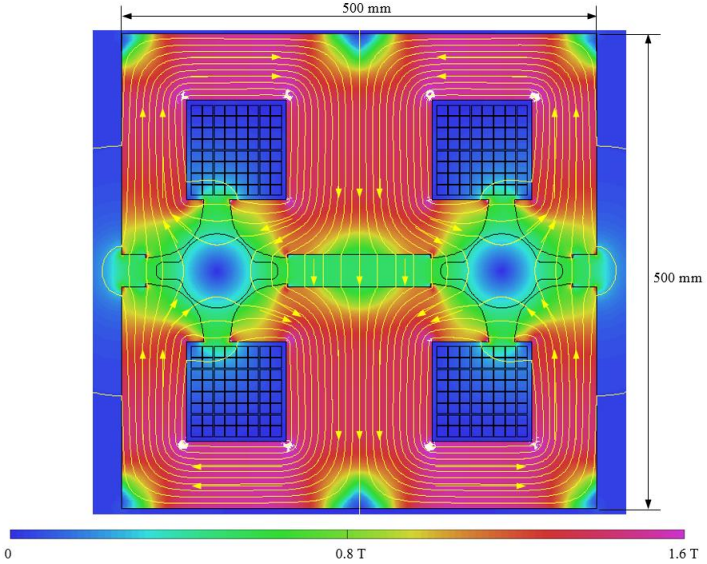
http://cern.ch/fcc

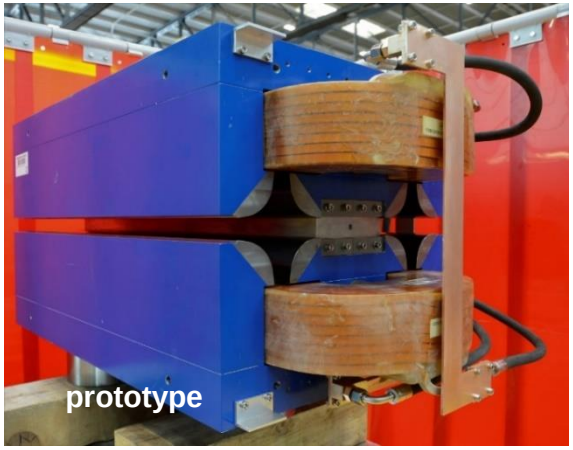
FCC energy efficient magnets





Twin-aperture dipole





Twin-aperture quadrupole

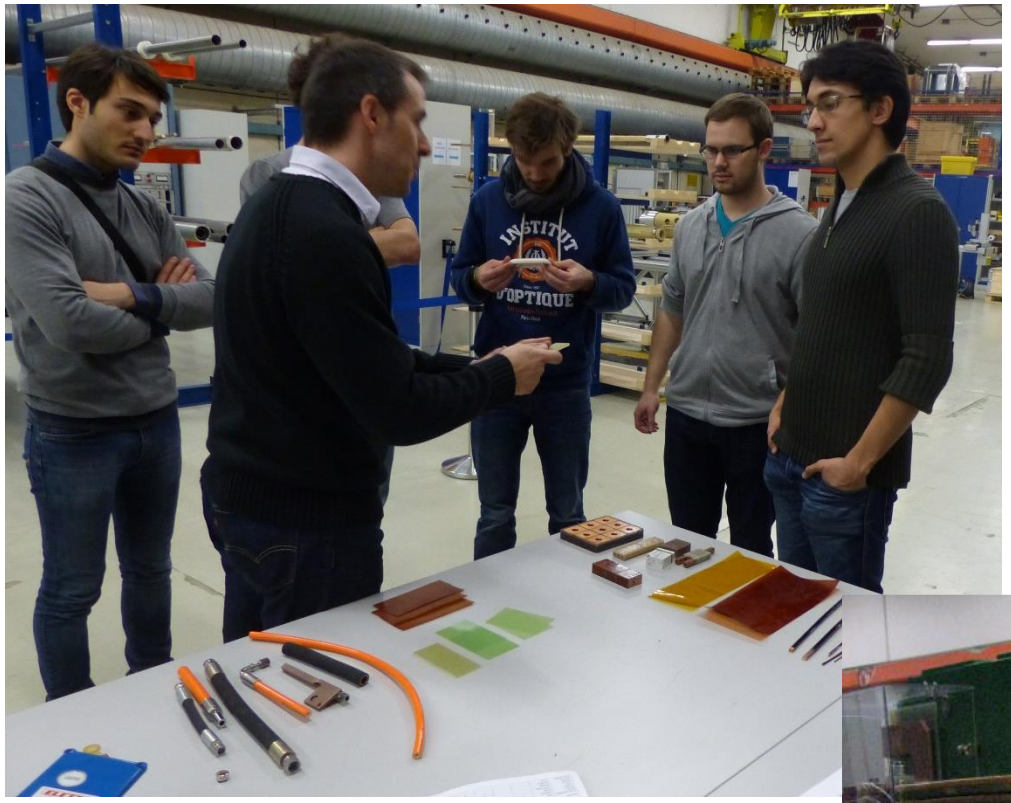
Program and Organization of Practical days

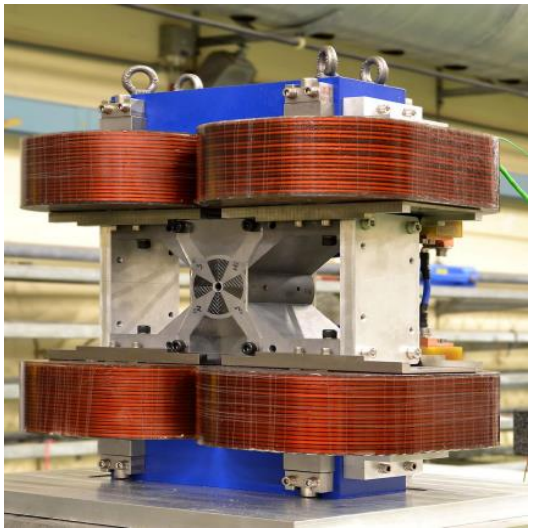
- Up to 12 participants/days, shared in two groups
- Split into two half-day sessions
  - Magnet manufacture and testing
  - Magnetic measurememements
- Hands-on practical work in CERN laboratories
- Guided by CERN magnet engineers

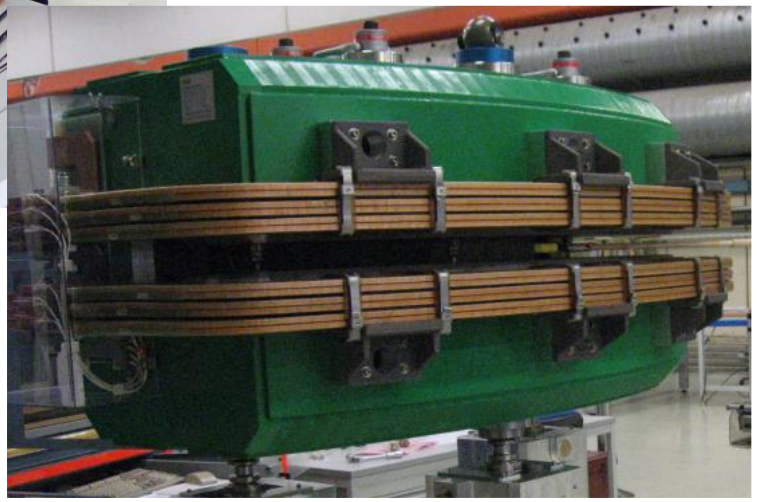
Magnet Manufacture and Testing

- 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 magnets
  - Measurements on systems and apparatus using instruments and formulae learned during the theoretical courses

Magnet Manufacture

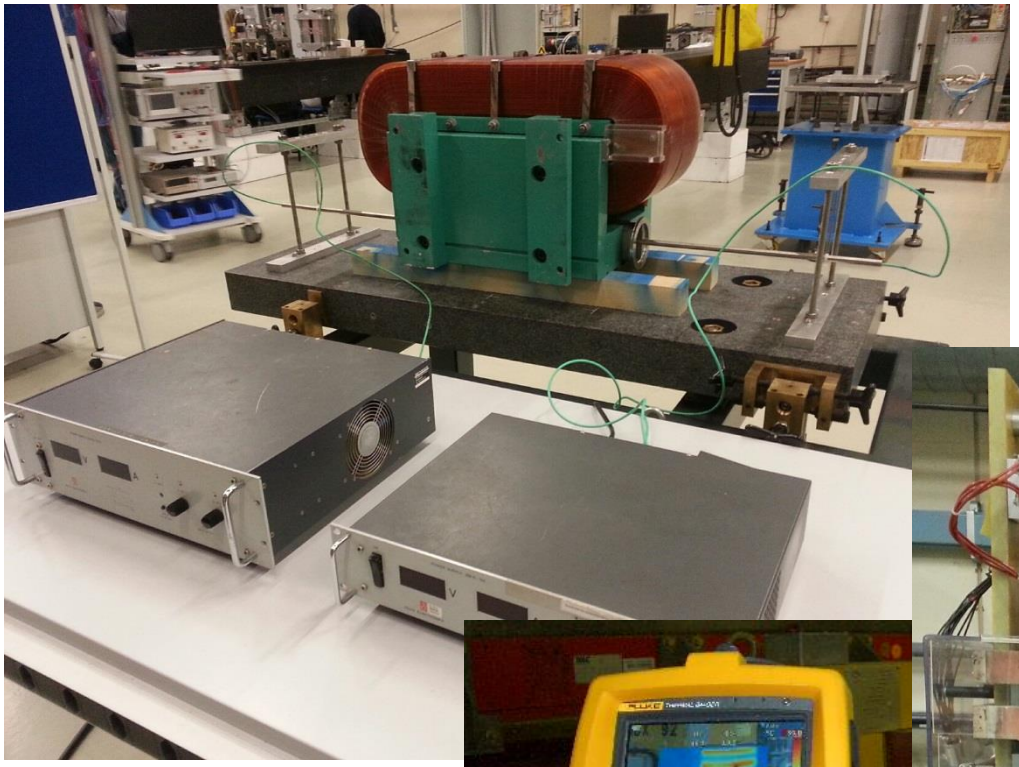






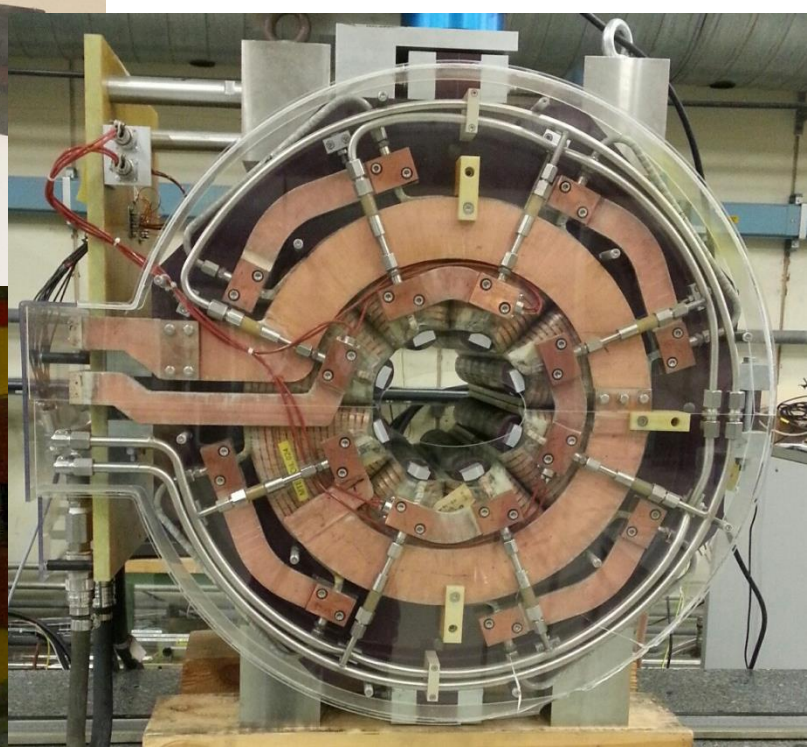
Materials, technologies, components, manufacturing processes, and assembly techniques

Magnet Testing and Practical Applications



Use of analytical formulae and measurements systems to calculate magnet parameters

Testing magnets to assess their functionnality and reliability



We are looking forward...

...to welcome you at CERN

... and unravel the mysteries of the magnets

...in a *relaxed* atmosphere!