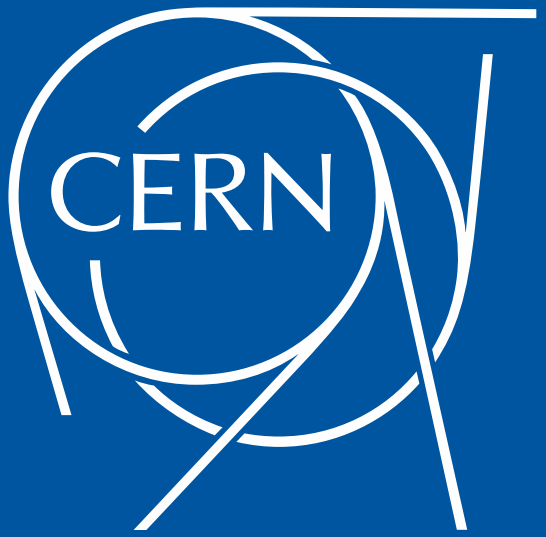

CERN

# Technology Department

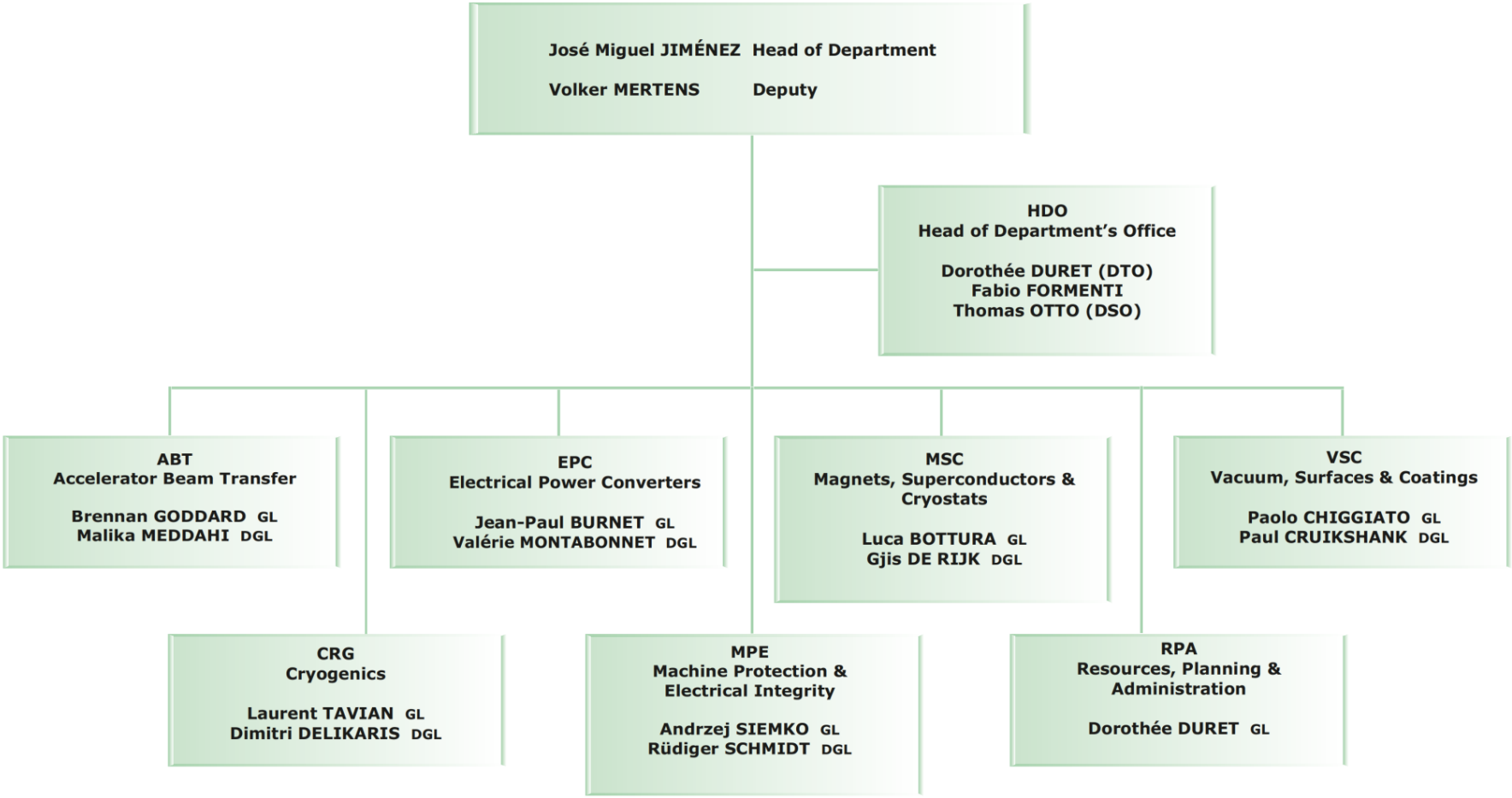
**In the frame of the Accelerators & Technology Sector at CERN, the Technology Department is responsible for technologies specifically related to existing particle accelerators, facilities and future projects**

The main domains (key technologies) of activities cover:

- magnets (superconducting, normal conducting, fast pulsed magnets, electrostatic and magnetic septa),
- their machine integration and protection
- power converters
- cryogenics
- high and ultra-high vacuum systems, coatings and surface treatments

The Technology Department equally provides support to the experimental detectors, for cryogenics, vacuum, coatings, surface treatments and power converters

# TECHNOLOGY DEPARTMENT



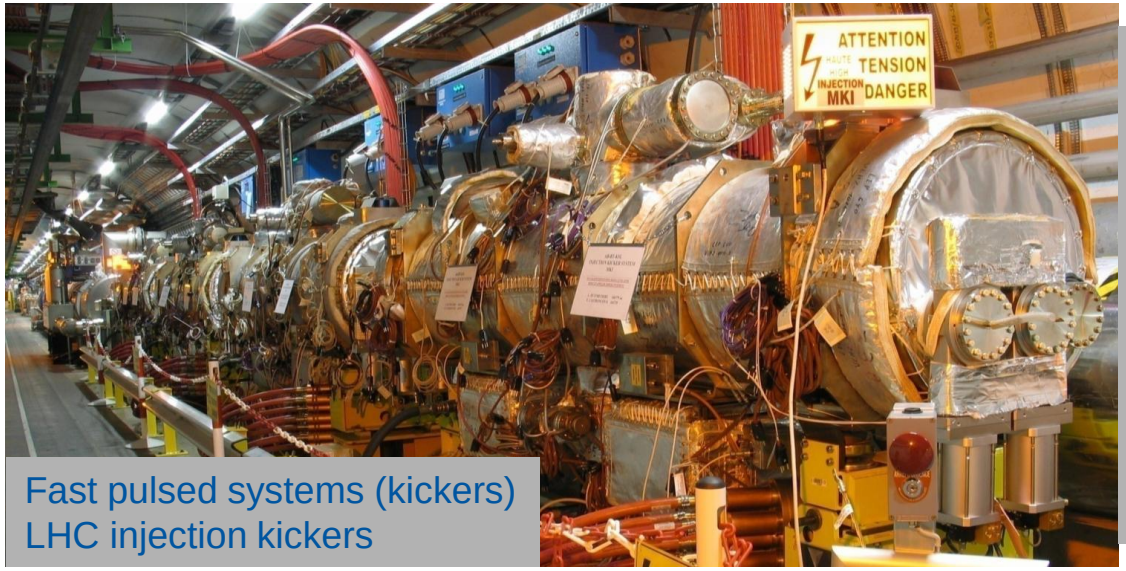

March 2014

# Accelerator Beam Transfer group (TE-ABT)

Conception, design, development, construction, installation, operation and maintenance of the injection and extraction equipment in the accelerator complex, beam transfer lines between accelerators up to primary targets and beam dump systems, including studies for future projects

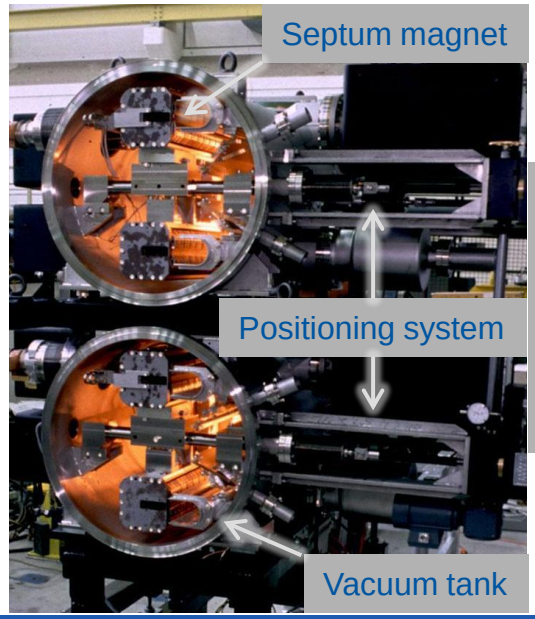
- pulsed magnets and associated high voltage pulse generators and transmission lines
- electrostatic and magnetic septa, including high voltage power supplies for electrostatic septa
- electrostatic lenses and deflectors for low-energy beam transfer lines
- protection devices
- associated equipment-level control systems and software

# Accelerator Beam Transfer group (TE-ABT)




Fast pulsed systems (kickers)
LHC injection kickers

- very short pulses (from100 ns to100 µs)
- high voltage (up to 80 kV), high current (up to 30 kA)
- high voltage assemblies and circuitry, switches (gas tubes or semiconductor), cables, connectors
- ultra high vacuum (down to $10^{-11}$ mbar), precision mechanics, brazing/welding techniques, various metals, surface coating, ceramic insulators and capacitors (in vacuum)



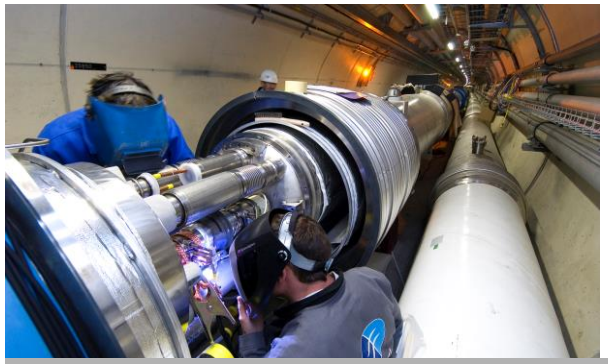

- high voltage (up to 300 kV) electrostatic devices (cables, switches, resistors)
- pulsed (ms to s), high current (up to 40 kA, 100 A/mm$^2$), thin water-cooled septum coils
- ultra high vacuum (down to $10^{-12}$ mbar), precision mechanics, precision positioning systems, brazing / welding techniques, various metals, surface coating, ceramic insulators

# Cryogenics Group (TE-CRG)

Design, construction, installation, operation & maintenance of cryogenic systems for accelerators and detectors

- Design, construction, commissioning, installation, operation and maintenance of the cryogenic systems for CERN accelerators and detectors
- Operation, maintenance and upgrade of cryogenic test facilities
- Support for low-temperature developments and tests at the Central Cryogenic Laboratory
- Supply of industrially provided cryogenic fluids on the CERN site
- Consultancy and support in cryogenic design and cryogenic instrumentation

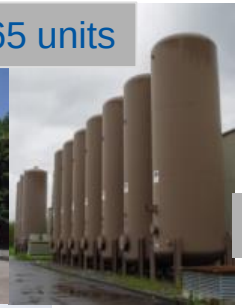
# Cryogenics Group (TE-CRG)



36’000 ton of cold mass (superconducting magnets) distributed over 26.7 km of the underground accelerator to be cooled at 1.9 K (superfluid helium)

Helium cryogenic plants @ 4.5 K & 1.8 K

58 units



65 units

Cryogenic fluids management

LHC helium inventory including strategic storage: 150 ton

Helium storage in gaseous phase

6 units

Helium storage in liquid phase

14 units

Liquid nitrogen storage

# Electrical Power Converters group (TE-EPC)

Design, development, procurement, construction, installation, operation and maintenance of electrical power systems for all accelerators, transfer lines, experimental areas and tests facilities at CERN

- Power converters for normal conducting and superconducting magnets
- Solid state klystron modulators
- Static Var Compensators
- The group provides expertise in the fields of power electronics, power quality, analogic and digital electronics, control system, high-precision current and voltage measurements

# Electrical Power Converters group (TE-EPC)

## Soft-switching modular power converters


1-quadrant power converters:

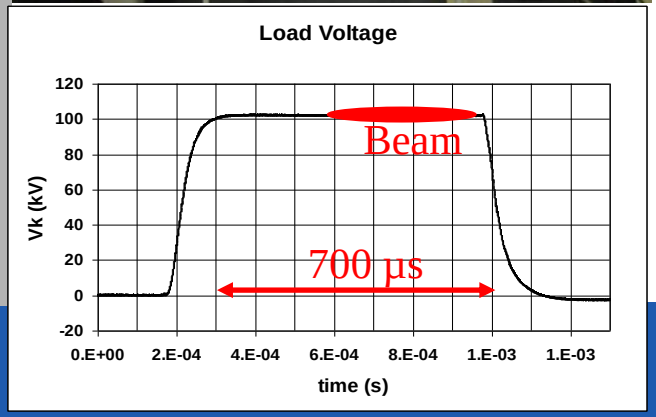
- [13kA,18V] : 5*[3.25kA,18V]
- [8kA,8V] : 5*[2kA,8V]
- [6kA,8V] : 4*[2kA,8V]
- [4kA,8V] : 3*[2kA,8V]

## Pulsed Klystron modulators for LINACs (new project Linac 4)

Peak power : 2 MW

Characteristics :

- output voltage : 100 kV
- output current : 20 A
- pulse length : 700 μs
- flat top stability : better than 1%
- 2 Hz repetition rate



# Machine Protection and Electrical Integrity group (TE-MPE)

Support LHC operation and maintain state-of-the art technology for magnet circuit protection and interlock systems for the present and future accelerators, magnet test facilities and CERN hosted experiments

- Provide a CERN central service for the layout, industrialization and production of electronics modules either based on industrial standards or fine pitch detector specific technologies. Make available expertise for application specific designs requiring R&D in the domains where CERN is at the forefront
- Responsibility for the electrical integrity of magnet circuits
- Responsibility for the electrical quality assurance (ELQA) during magnet interconnections and hardware commissioning as well as for electrical diagnostics and interventions during operation.
- Responsibility for the magnet protection system and machine interlocks for the CERN accelerator complex, during design, construction and exploitation.
- To guarantee permanence of expertise, follow the state-of-the-art and to develop knowledge for design, construction and operation of failsafe and reliable electronics

# Machine Protection and Electrical Integrity group (TE-MPE)

## Electrical Systems

Assembly of 13 kA circuit breakers and dump resistors capable of dissipating 700 MJ.

High current, radiation tolerant cold by-pass diodes for LHC main magnets.

600 A energy extraction system.

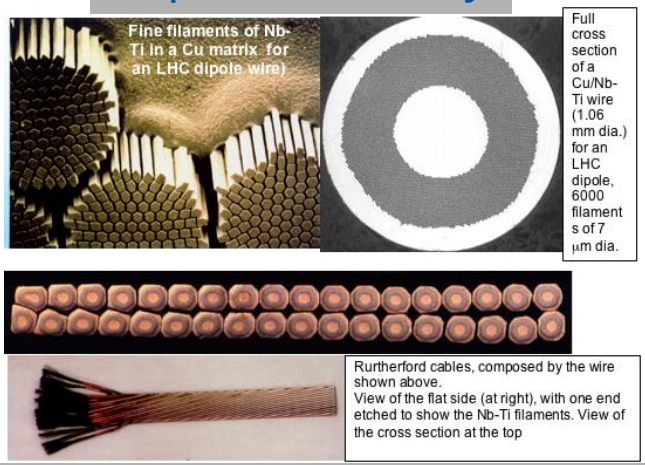
# Magnets, Superconductors and Cryostats (TE-MSC)

Design, construction and measurements of superconducting and normal conducting magnets for the CERN accelerator complex

- Integration in the CERN accelerator complex, magnet cryostats and magnet quality control
- Support to operation of the accelerators for magnets, magnet performance, devices (current leads)
- Development of associated technologies, namely superconductors, insulation and polymers, superconducting electrical devices and magnetic measurements for present and future accelerators

# Magnets, Superconductors and Cryostats (TE-MSC)

## Superconductivity




LHC: 400 ton of high quality NbTi (47%);
Used in 1200 ton- 7000 km of Cu/NbTi cable;
20,000 measurements at 1.9 K

## HTS superconductors


Present LHC application: Ag/Bi-2223
Current : > 15 kA @ 50 K (expensive conductor)
LHC upgrade: new application with MgB2
Current : > 15 kA @ 20 K

## Magnets Test Facilities

12 cryogenic test benches for the LHC magnets nominally tested before underground installation (24h/24, 7d/7 operation)

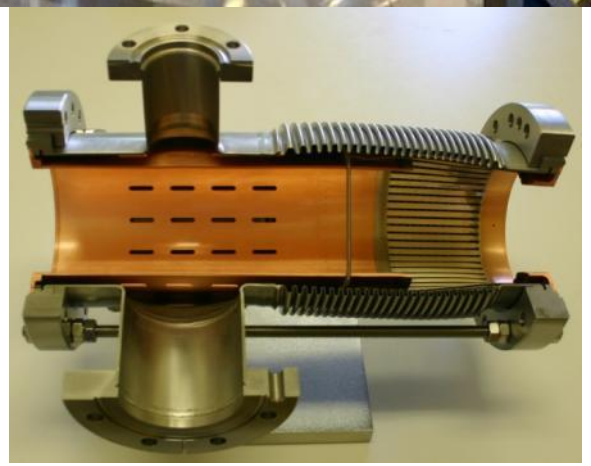
# Vacuum, Surfaces and Coatings (TE-VSC)

Design, construction, operation, maintenance and upgrade of high & ultra-high vacuum systems for accelerators and detectors;
Coatings, surfaces treatments, surface and chemical analysis for accelerators & detectors

- support on thin-walled vacuum chambers, windows and bellows compensation systems
- vacuum sealing and leak-tightness technology
- dynamic vacuum phenomena
- vacuum control systems, vacuum interlocks and monitoring tools
- expertise and support in the fields of:
  - Coatings, electroplating and surface cleaning techniques
  - UHV characterization of material and surfaces
  - Degassing analysis and treatments

# Vacuum, Surfaces and Coatings (TE-VSC)

## Vacuum Engineering for Accelerators



## Coatings and plasma processing

CERN-wide support and expertise to accelerators and detectors in the domain of thin film coatings

Thin film coating facilities with a special focus on physical deposition techniques: evaporation, diode and magnetron sputtering

Complex shape and all types of materials including a-C coatings

Specific techniques for plasma processing of surfaces, including plasma cleaning and glow discharge

Removal of hydrocarbon contamination on Beryllium beam pipes using an oxygen discharge

Expertise for numerical simulations of special cases of coatings, vacuum and plasmas

## Chemical and surface analysis

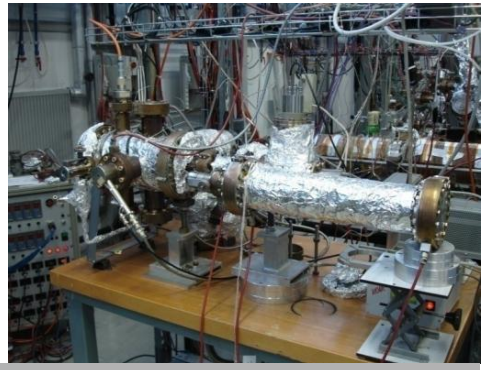
Surface and chemical analysis

Expertise in radiation damage of polymeric materials

Outgassing analysis (metals and polymers) and degassing treatments

Permeation in polymers and metals

Gas analysis by chromatographic techniques



Outgassing of amorphous carbon films

Thank you
for your attention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