

# EN & TE Departments

Germany @ CERN April 2021

# ENgineering department - Organigramm



**EN Engineering**

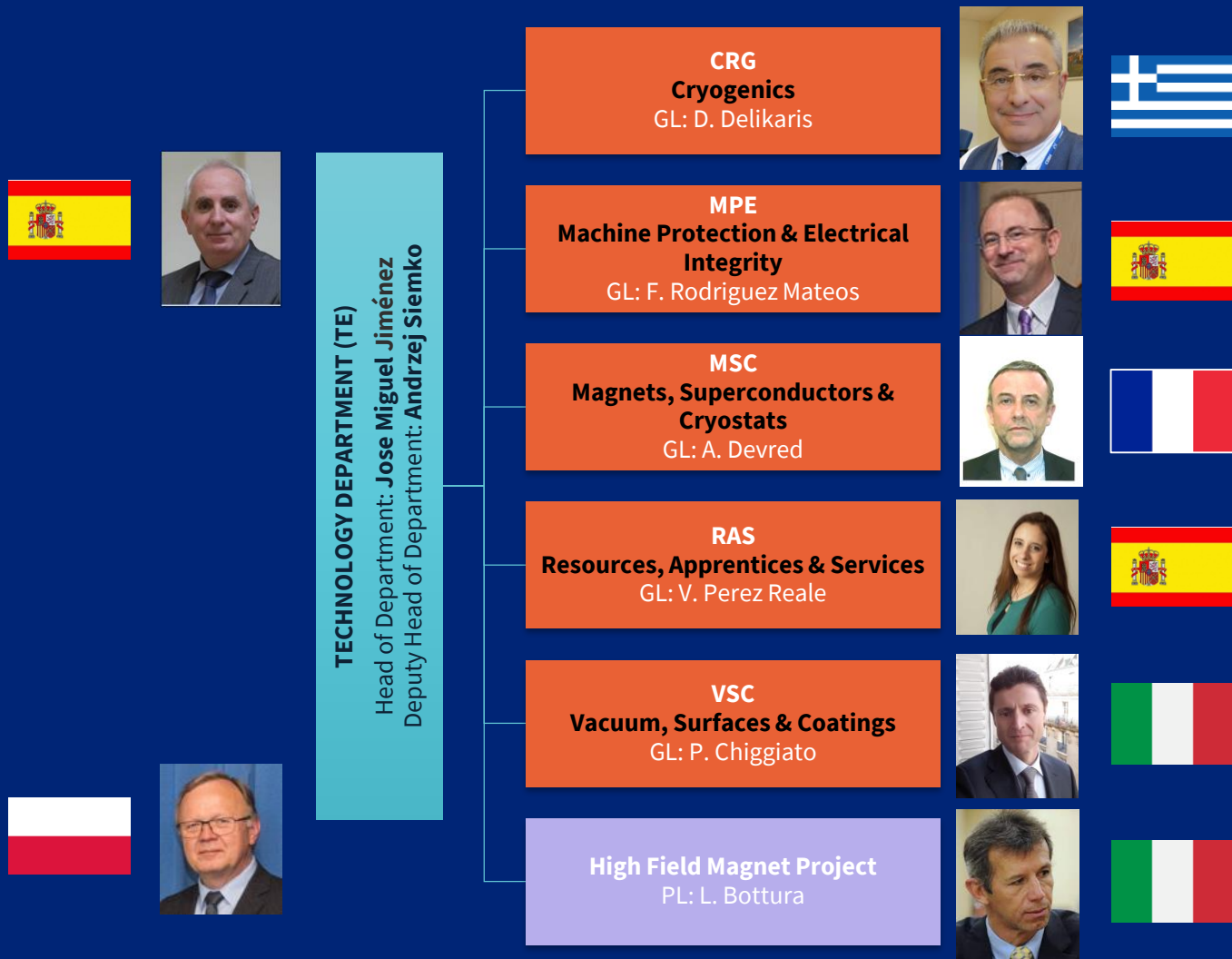
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DDH: M. Nonis*

**HDO  
Head of Department Office**

*Assistant: S. Escaffre*

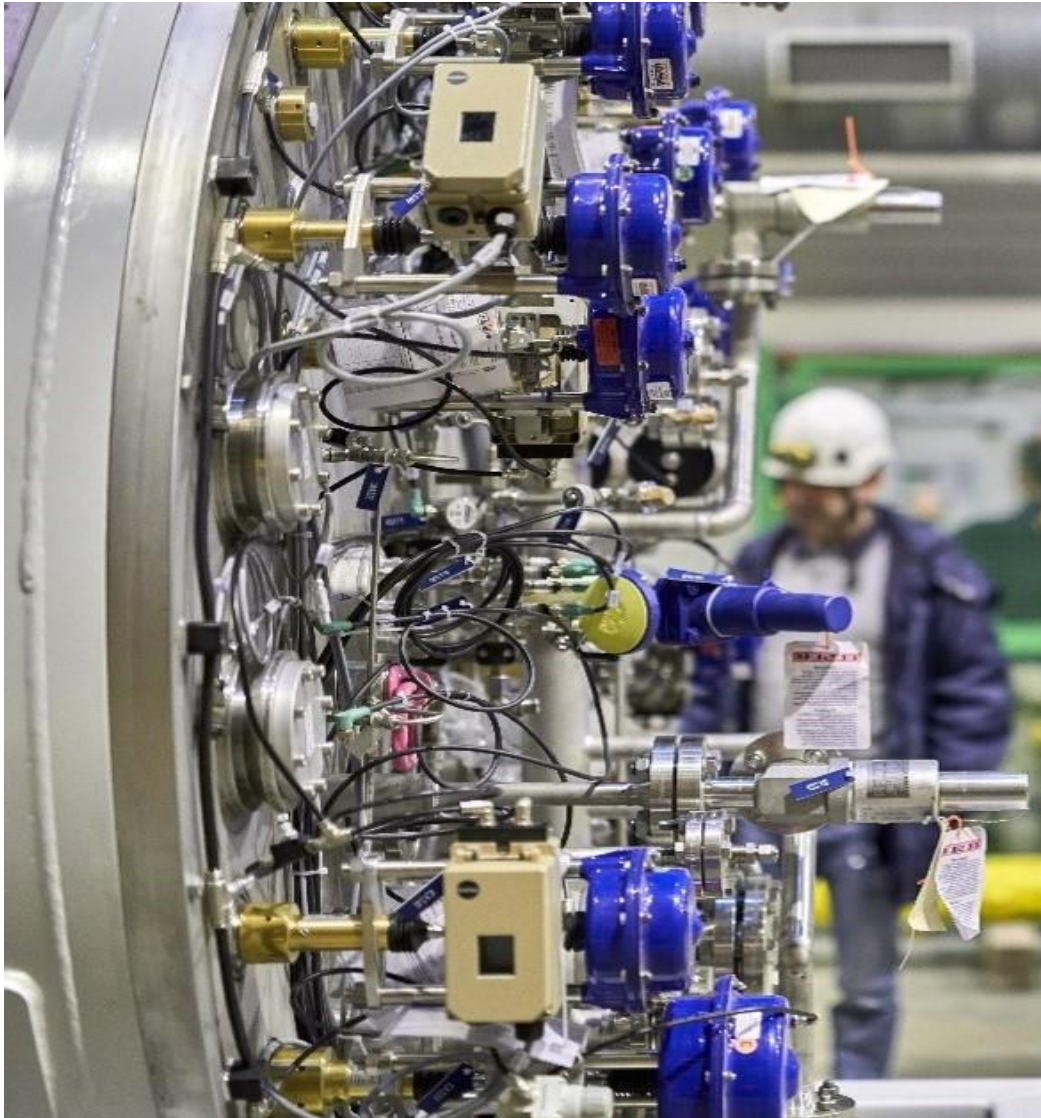


# TEchnology department - Organigramm





# Examples of Cryogenic systems



Upgrade of sc cables & wires test facility in B163



B163 CDS with cold box and control cabinets



B163, F1 and F2 GMP and control field boxes

Upgrade of central helium liquefier B165



Central Purifier – Upgrade of HP Storage



Buffers, LN2 tank and 20'000 ft dewar



B165 LN2 Valve Box

New 35 g/s helium liquefier for SM18



New helium Cold Box in SM18



B180/FAIR test facilities



Jumper Connections - installation



CWU2 - installation



LN<sub>2</sub> storage tank - installation



CWU2 - internal

Neutrino platform facilities



NP-01: former ICARUS



NP-01: argon condensers



© CERN, CERN-SPSC-2020-011 ; SPSC-SR-270



# Example of Machine Protection systems



*Bdg 377 – 13kA EE systems test area*



*Cluster D in SM18 with MPE hardware*



*CLIQ Lab in Bdg 180*



*uQDS chassis*



*CLIQ Prototypes*



*Vacuum Switch*

# Main areas of TE procurements

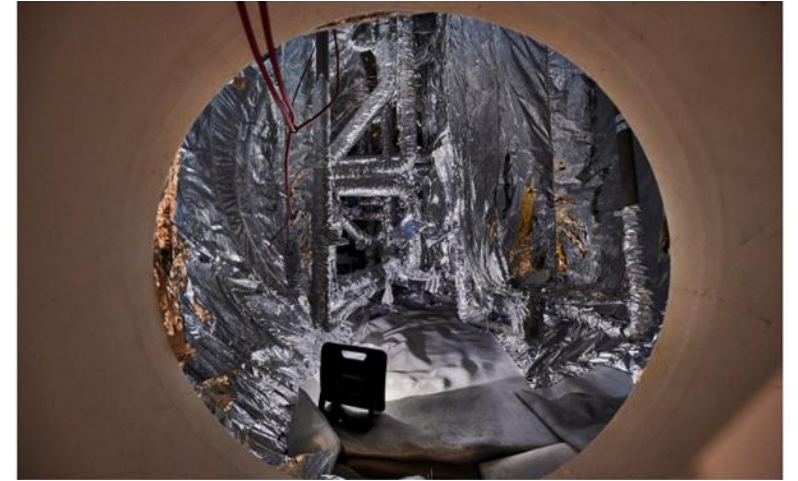
## ➤ Cryogenics

- Spares and consumable for CryoPlants (Liquid Helium and Argon) such as compressors, turbines, filters, etc.
- Cryogenic transfer lines including valve boxes and heat exchangers

## ➤ Machine Protection and Electrical integrity

- Control's and diagnostics chassis or electronic cards
- Arcing switches and related control's chassis
- Capacitors for quench protection systems

**Procured directly in MS+AMS**



# Main areas of TE procurements

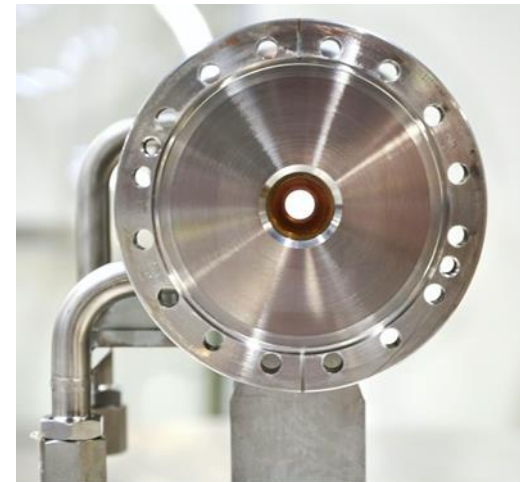
## ➤ Magnets, Superconductors & Cryostats

- Steel and iron for magnet applications
- Copper wire and bars and superconducting wire for coil and bus bar manufacturing
- Large variety of small metallic and non-metallic parts for magnet assembly
- Cryostats for magnets and test benches
- Instrumentation for magnetic field measurements

## ➤ Vacuum, Surface & Coatings

- Vacuum gauges, valves and related instrumentation
- Pumps of all type from primary to UHV ranges with associated power supplies and instrumentation
- Diagnostic tools such as residual gas analyser, leak detectors.
- Laboratory components e- guns, manipulators, special chambers.

**Procured directly or through EN-MME in MS+AMS**





# EN-MME Mechanical Workshop

## Core mission is to provide service the Organization in case of:

- Urgent needs (repairing, tunnel interventions, urgent fabrication...)
- Prototypes / proof of principle
- Multi-technology fabrication projects

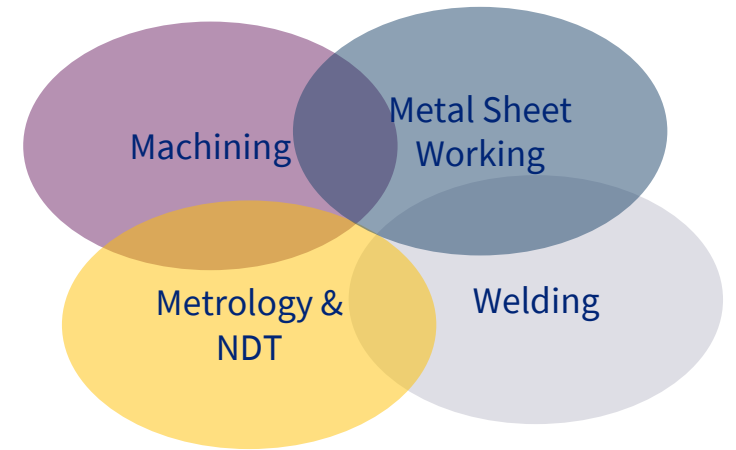
## 2000÷2500 contracts/year

In close collaboration with IPT Dept, providing for balanced industrial return

## Quota represents ~ 40% of overall production for mechanical components @ CERN

## Subcontracting:

- ~ 35% of semi-finished parts
- ~ 65% of finished / turnkey components



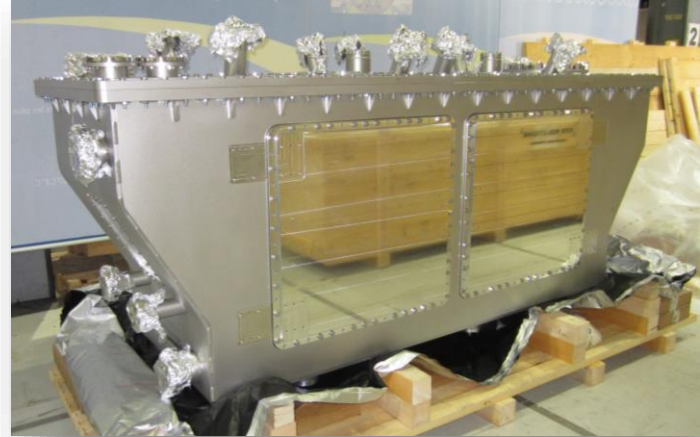


# Always on the lookout for: Precision Vacuum Components

- *Precision forming (Rolling, Bending, Extrusions..)*
- *Vacuum brazing & heat treatments*
- *Electron beam welding*
- *Precise machining*
- *Metrology*
- *UHV capabilities*

## *Materials:*

- *Stainless Steel*
- *Inconel*
- *Titanium*
- *Aluminum*



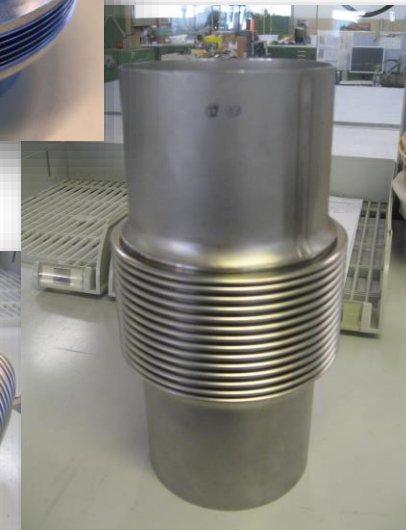
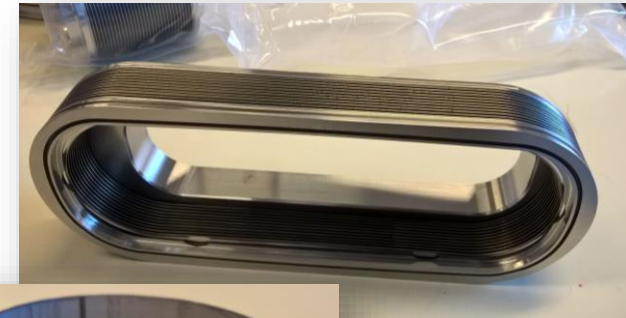
# Always on the lookout for: Bellows

...UHV, cryogenics, pressure equipment...

Typical Dimensions: ~ Ø60, Ø80÷Ø120, ~Ø160

<i>Edge-welded</i>	Avg. per year (2014÷2017)	Peak year (2016)
<i>Number of POs</i>	13	15
<i>Envelope (kCHF)</i>	70	130

<i>Hydroformed</i>	Avg. per year (2014÷2017)	Peak year (2016)
<i>Number of POs</i>	18	30
<i>Envelope (kCHF)</i>	160	290



# Always on the lookout for: Plastics & Composites

	Avg. per year (2014÷2017)	Peak year (2017)
Number of POs	115	160
Envelope (kCHF)	370	460

- Magnet shims
- Insulators, spacers
- Standard components (washers, screws)
- Tools for assembly and protection
- ...

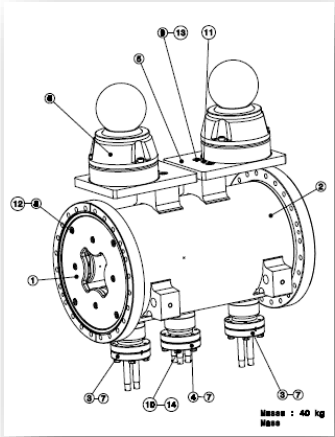
## Materials:

- POM, PP, Plexi, PVC
- PE at different densities
- PEEK, PTFE, PVDF, VESPEL
- EPGCxxx





# Magnets parts procured by EN-MME

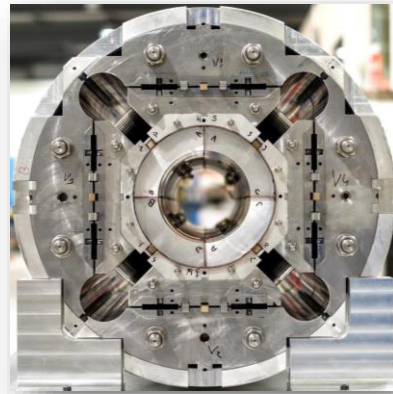
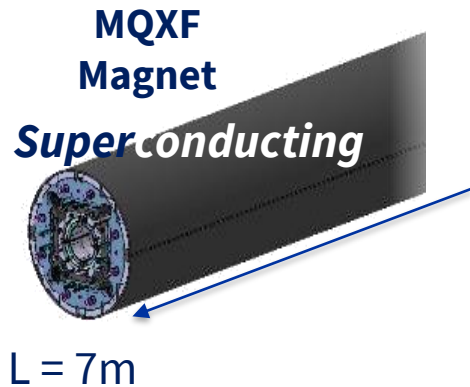


Prototypes & small series of different magnets

**ELENA – Series production of electrostatic quadrupoles (x60).  
Synergy between EN-MME Workshop and EU suppliers.**

- *High precision CNC of small to large equipment*
  - *Stamping, wire cut of laminations*
  - *Cryostats*
- ..5 axes CNC machining, turning, EDM..*

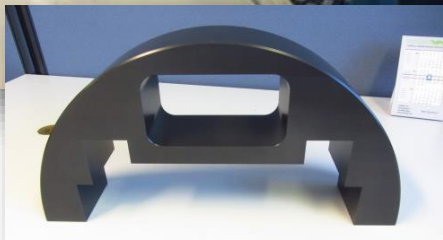
*..Titanium..*



# SC Magnets tools procured by EN-MME

Large Precise Tools for Magnet assembly

Rotating Table for SC magnets assembly



MQXF & FRESCA Magnet Impregnation & Curing Tools



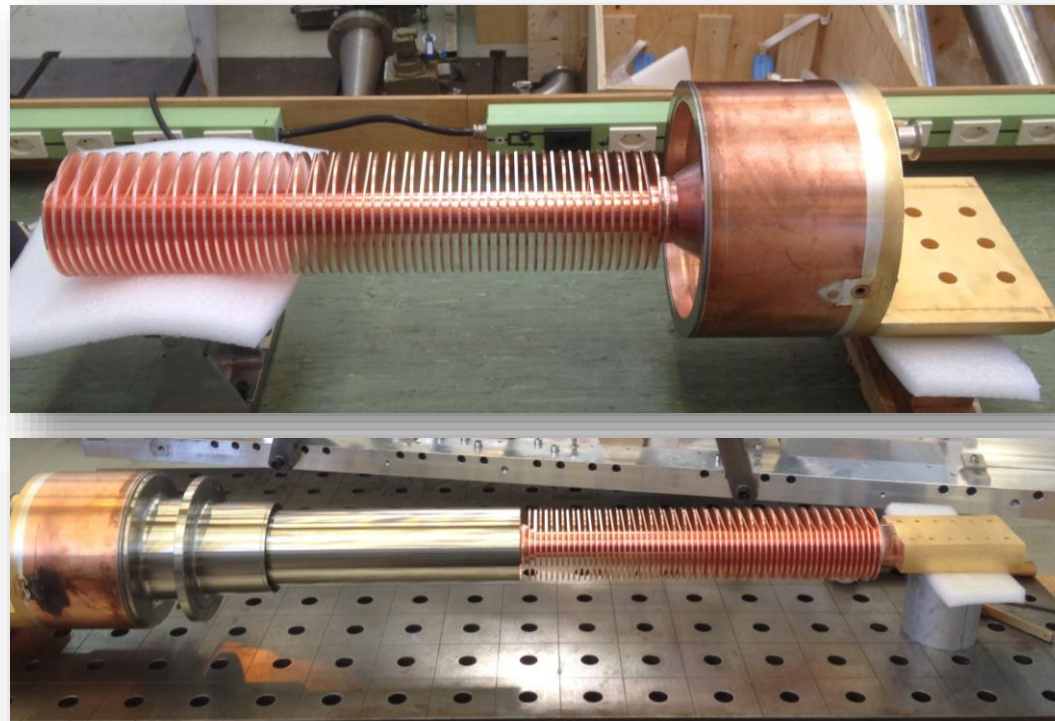


# Current Leads manufactured through EN-MME

Current leads 30kA Cluster D



*Multiple technologies, in house and outsourced fabrication*



*..Assembling phases..*

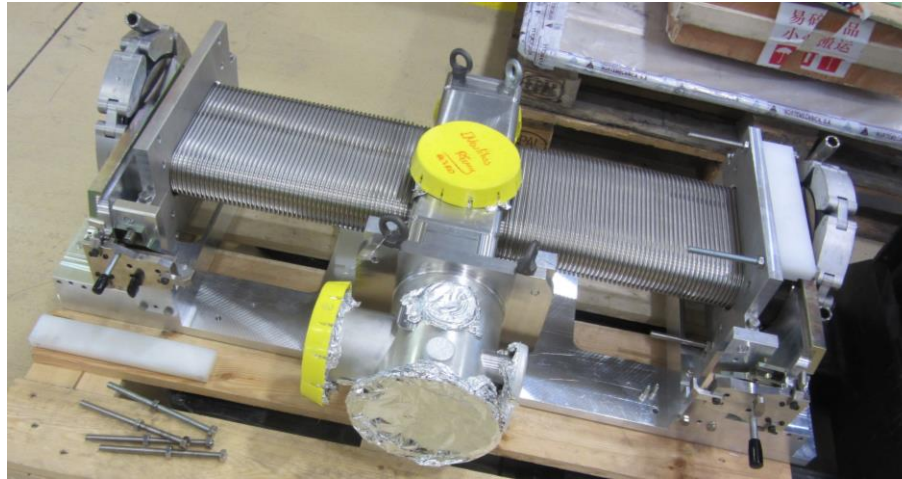


# Vacuum Chambers procured through EN-MME

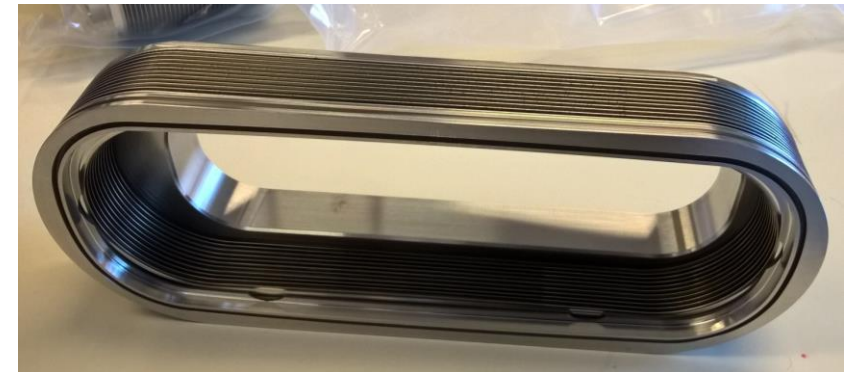


*PSB Ring*

- *Precise forming into chambers of different sizes*
- *Inconel & SS alloys*
- *UHV compliant fabrication*



*PSB Injection*



*Hippodrome edge-welded bellows*

# Vacuum Chambers procured through EN-MME

## Magnet Chambers

- *Concurrent forming + machining*
- *TIG welding*
- *Plasma welding*



## Beam Instrumentation Chambers

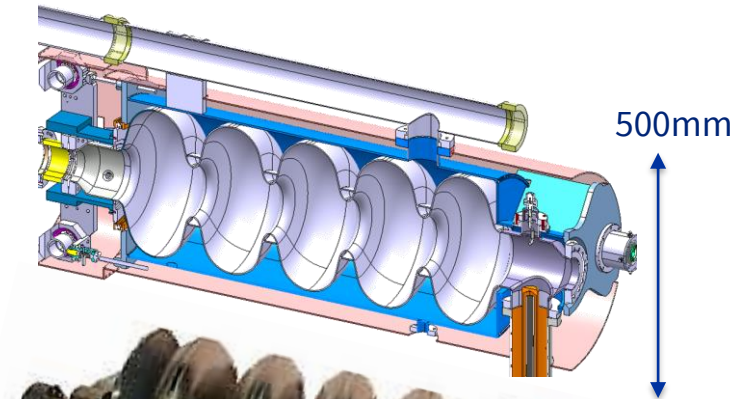
- *High-precision machining of 316LN*
- *Embedded CF flanges*





# Superconducting RF Cavities

- Prototype: .. Precise forming & joining of Niobium sheets (in-house).. **Precise Tools\***
- Series: 100% industry
- Precision and surface quality of utmost importance for cavity performance



SPL Cavity  
..Spinning..  
EB welding

CRAB Cavity





# Warm RF Cavities

## Precise Machining of Large Equipment



*Drift Tube LINAC: Girder*



*Drift Tube LINAC  
tank segment (~2 m)*

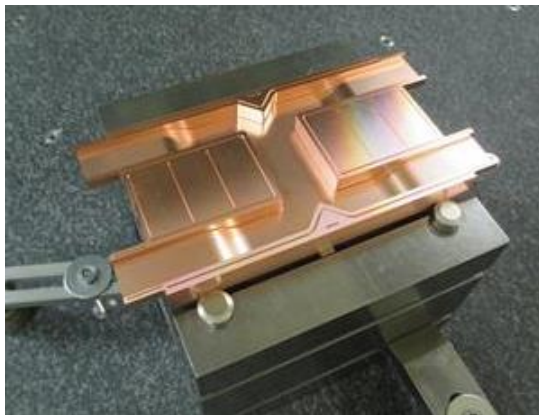
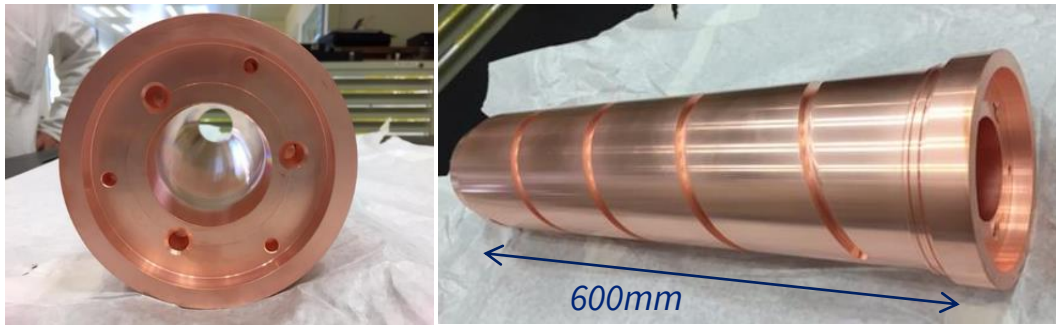


*Assembled Cell-Coupled DTL*

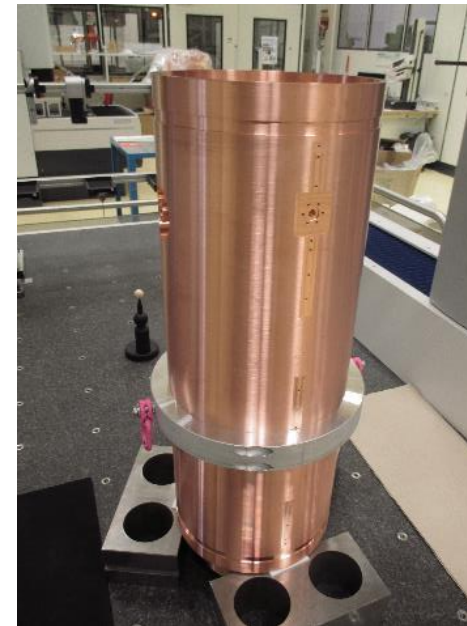
# Warm RF Cavities

## RF Pulse Compressor

*Turn/mill process on  
Cu OFE 3D forged*



**Copper  
Waveguide  
Coupler**



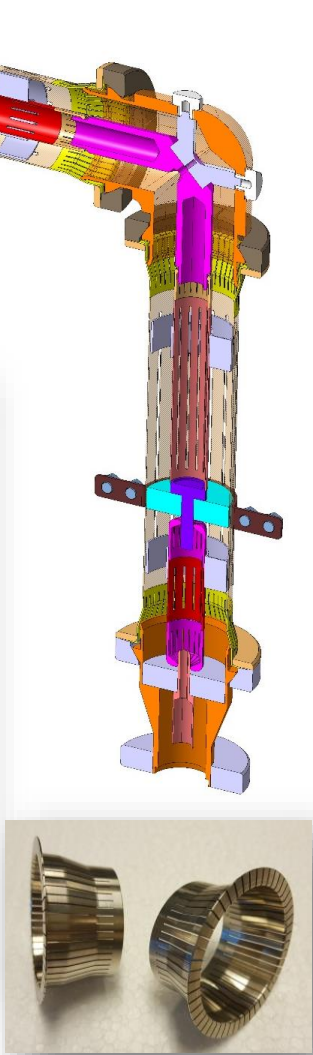
## HIE- Isolde Cavities

- *Long Overhang Machining from Monoblock Copper*
- *D320 x L900*
- *Tolerances in the tenth of mm..*



# Diverse RF Equipment

## RF Power Lines Ambient to Cryogenic



## CRAB Cavity: RF Feedthrough

- *EB welding & Ceramic brazing in reduced volume*
- *Machining*



## RF Antennas

*Niobium machining and Heterogeneous EB welding*

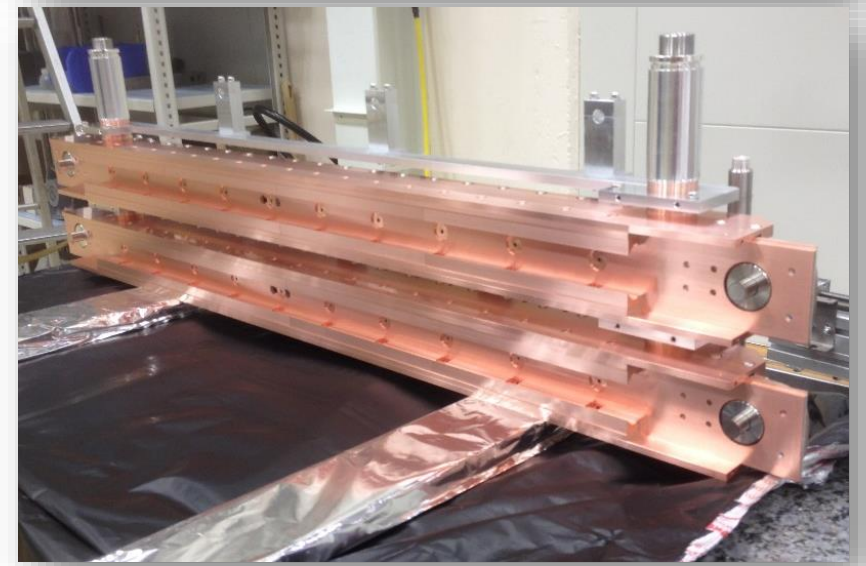
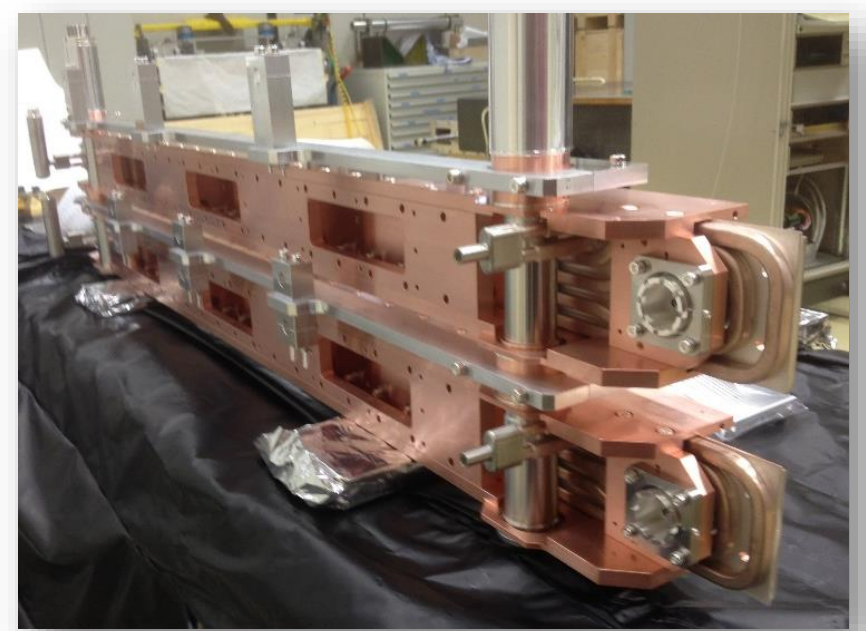
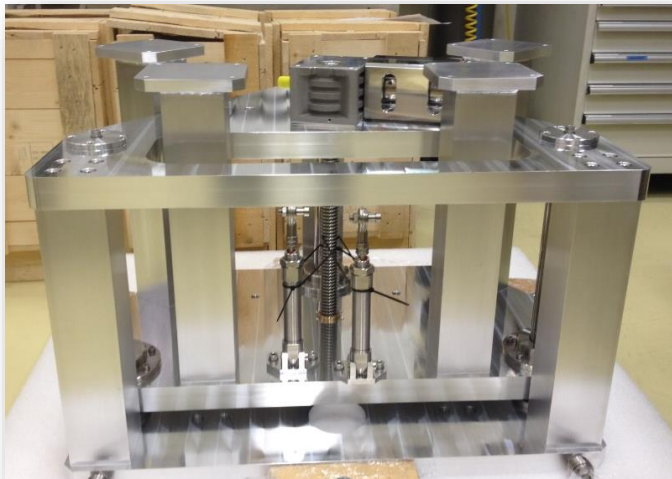




# Beam Intercepting Devices

## New HiRadMat Experiment for Future Collimators

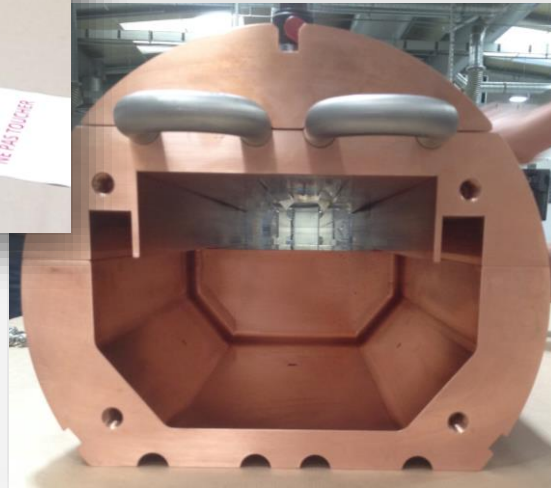
- *Precise machining (Copper, St. Steel)*
- *Actuation systems*
- *Brazing*
- *UHV compliancy*



# Beam Intercepting Devices: TIDVG4

Crash program in collaboration with BE-STI

Copper blocks: *Large CNC milling*



*Assembling  
..welding and tests  
in house..*



*Assembly inside tunnel*





# Main areas of Cooling and ventilation systems procurement

Installation, maintenance, spares:

- HVAC systems
- Primary cooling systems
- Water treatment station

**Procured directly in MS+AMS**



Heating, ventilation and air conditioning	> 1'500 units from 2'000 to 120'000 m <sup>3</sup> /h each
Compressed air	14 stations 200 km network

	km	m <sup>3</sup> /h
<i>Eurotunnel</i>	50	540'000
<i>LHC</i>	27	290'000

Cooling plants (raw, demin. water, C <sub>3</sub> F <sub>8</sub> , C <sub>6</sub> F <sub>14</sub> )	150
Pipelines	800 km
Hydrants	800 points
Cooling towers (450 MW)	22
Chilled water plants 6-12 °C (73 MW)	35
Water consumption (peak)	1'260 m <sup>3</sup> /h
Water network (3 pumping stations)	5'400 m <sup>3</sup> /h

*Equivalent to a small town of 25'000 inhabitants.  
Annual consumption reduced by 40% in last 8 yrs.*



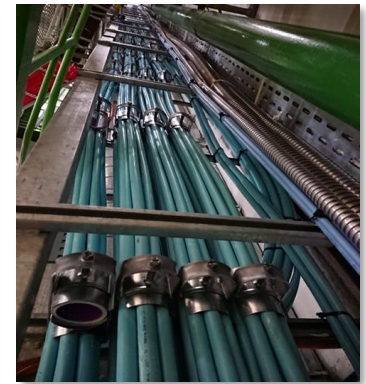
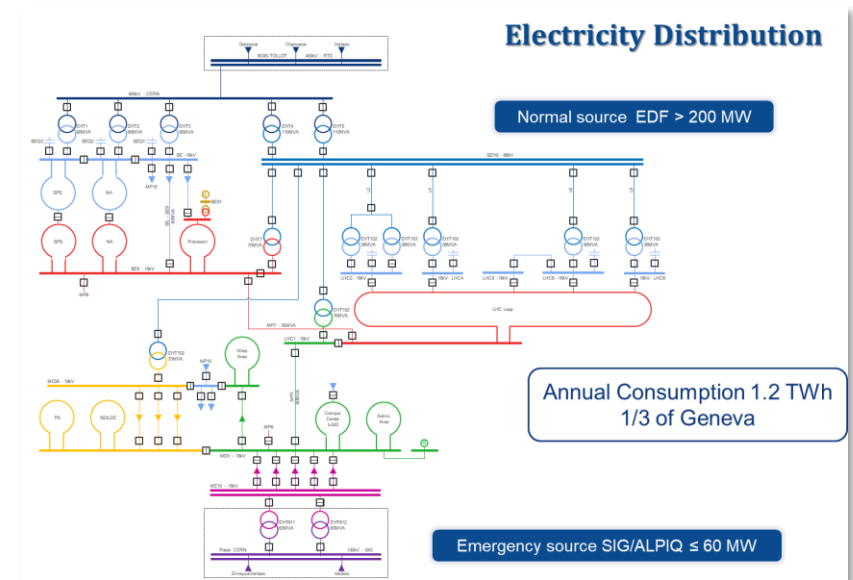
# Main areas of Electrical systems procurement

- Maintenance on electrical equipment on CERN sites: electrical sub-stations, transformers, Diesels, UPS
- Supply of UPS, 48V DC battery based systems, electrical switchgears, emergency power supply, High voltage protection relays, water cooled cables
- Installation work: Cabling (& decabling)
- Supply of Optical Fibre cables & associated hardware

**Procured directly in MS+AMS**



*New 400/66kV BE2 sub-station*



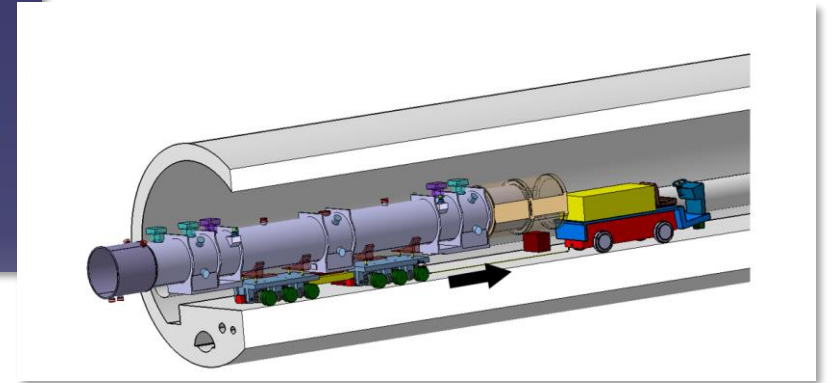
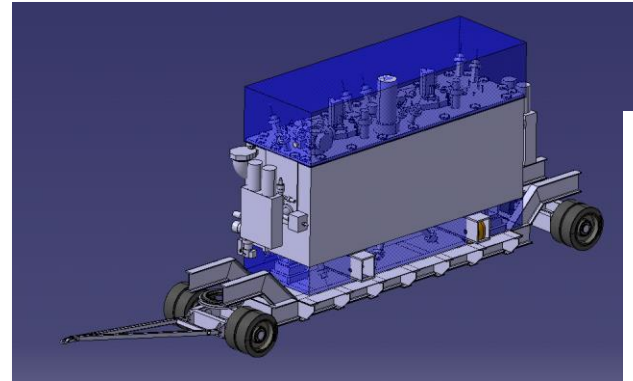
# Main areas of transport & handling procurement

- **Installation, maintenance**

- Special handling toolings
- Cranes
- Lifts

- **Transport & handling services**

- During LS2, ~300'000t transported



LHC cryomagnet transport



ALICE TPC transport

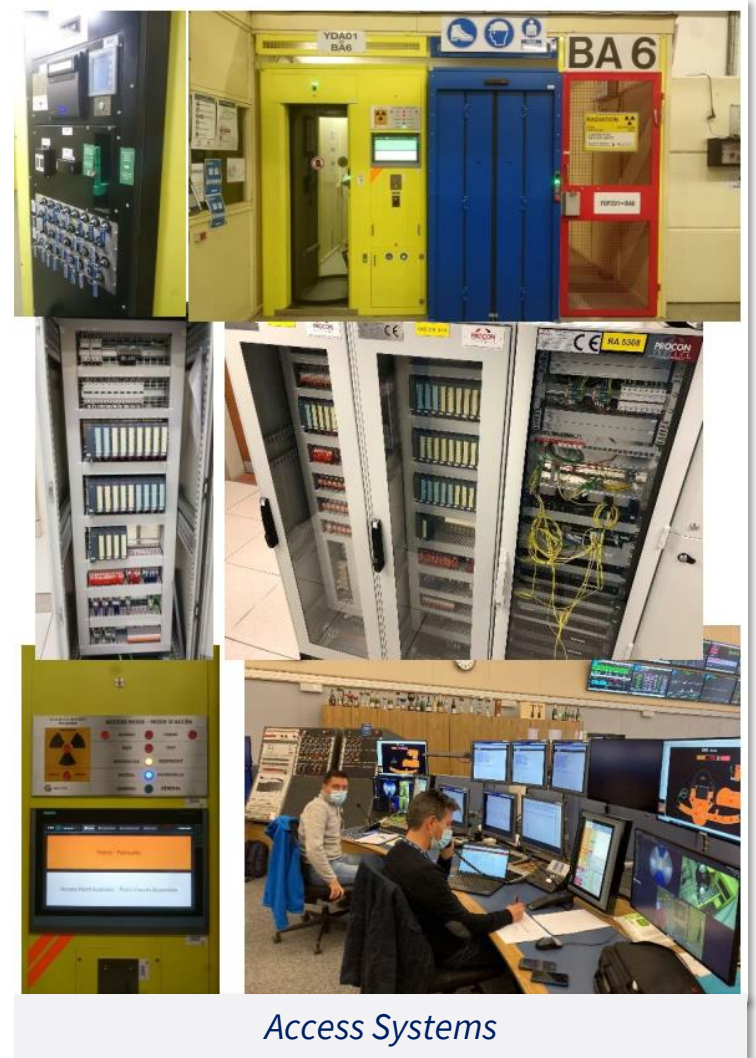


EHN2 new crane



# Main areas of Personnel Safety Systems

- **Scope:**
  - Fire and Gas/ODH detection, emergency phones and evacuation, alarm transmission and monitoring,
  - Interlocks to protect people radioactivity, X rays, lasers, electricity and cryogenics hazards,
  - Access control to all CERN conventional or nuclear facilities and sites,
  - Video surveillance, protection and intrusion detection,
  - Access data management applications.
- **Main future contracts**
  - MS4600/EN: Supply of industrial controls and safety systems
    - Upgrade & maintenance of personnel protection systems and industrial control systems at least until the end of LS3
  - CERN Safety Alarm System
  - SNIFFER systems







**Questions?**

*José Miguel Jimenez & Katy Foraz*