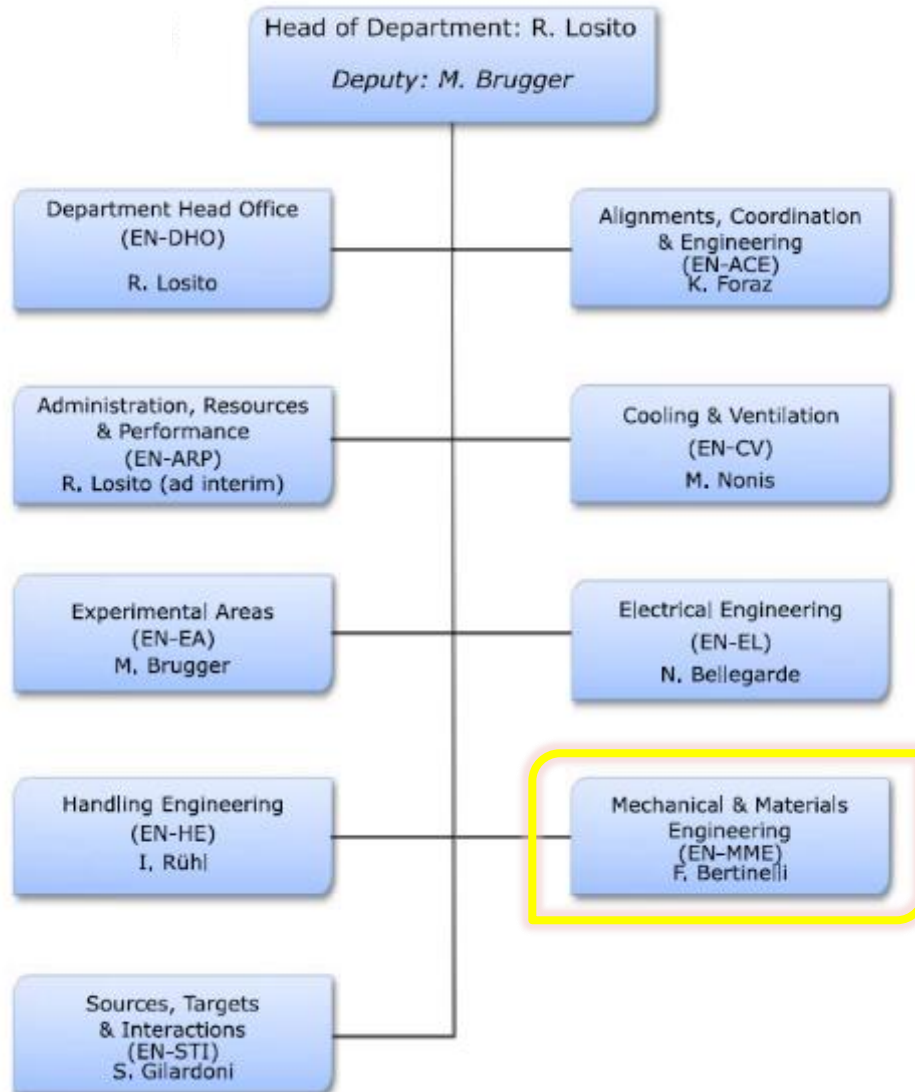




# CERN – ENGINEERING DEPARTMENT: Mechanical & Materials Engineering Group

A. Dallochio on behalf of EN-MME

# Engineering Dept. Structure

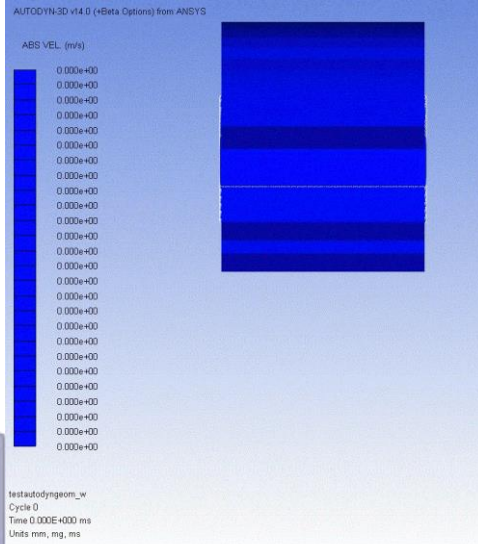


- Infrastructures
- Engineering
- Coordination
- Production

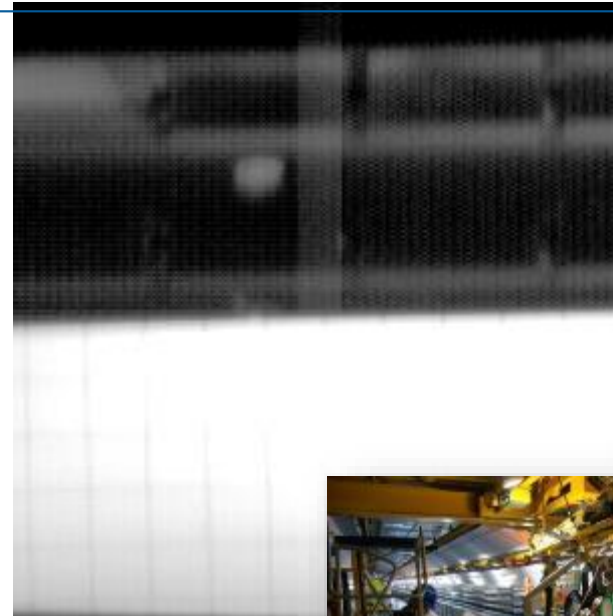
# EN-MME Mandate:

The mandate of the MME group is to provide to the CERN community specific engineering solutions combining mechanical design, production facilities and material sciences. This group owns, maintains and develops the 30 years old know-how on the mechanical construction of beam accelerators and physics detectors.

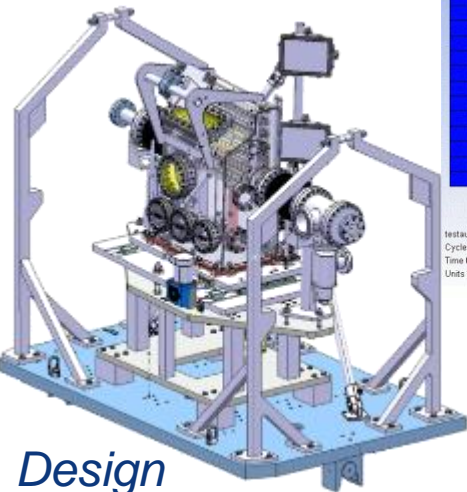
## Particle Beam Impact : comparison between simulation and experiment



*F.E. Calcs*



*Live Acquisition system by Mech. Lab*

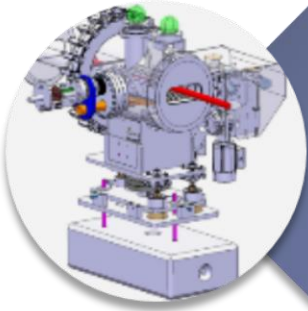


*Design*



*Manufacturing*

# EN-MME: Mechanical & Materials Engineering Group



## Engineering & Design

- Design Office:
  - 40 designers and engineers
  - CATIA / SmarTeam, ANSYS, LS-Dyna...
- Experimental Mechanics Lab.



## Production

- Mechanical workshop (4000 m<sup>2</sup>):
  - 50 technicians and engineers
  - CNC machining
  - Assembly & metal forming
  - Welding (TIG, MIG, electron beam, laser, vacuum brazing)
- **Technical Subcontracting Service (MME-FS)**



## Materials & Metrology

- Material science consultancy:
  - metallurgical analyses, microscopy, mechanical tests
- NDT: US, radiography, tomography
- Metrology: 350 m<sup>2</sup> lab. equipped with CMM.

# Subcontracting Service:

	Invoiced Jobs					
	2011	2012	2013	2014	2015	2016
<i>Subcontracting MME-FS (MCHF)</i>	5.9	7.0	7.9	9.0	8.2	~10

**~2000 contracts/year in close collaboration with IPT Dept.**

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

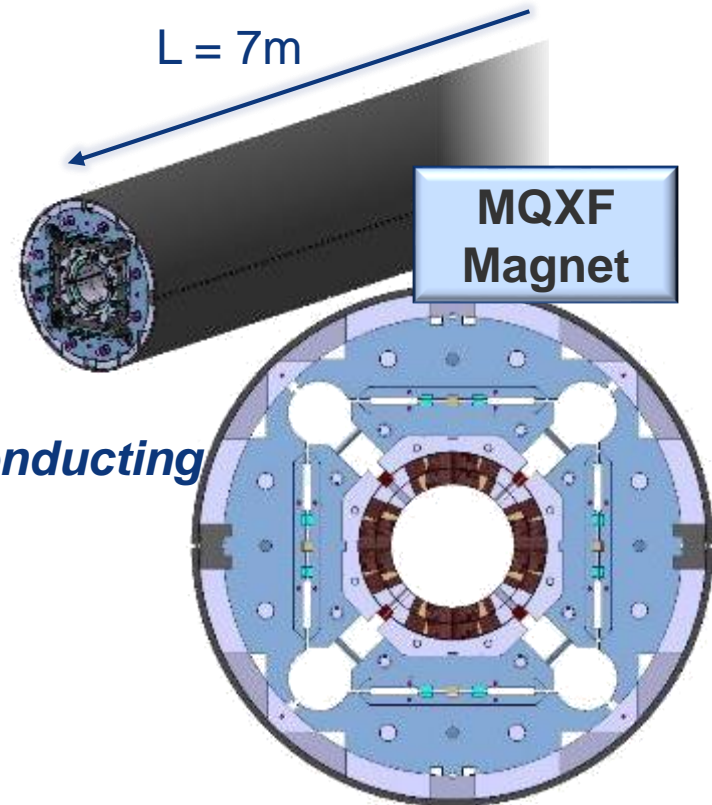
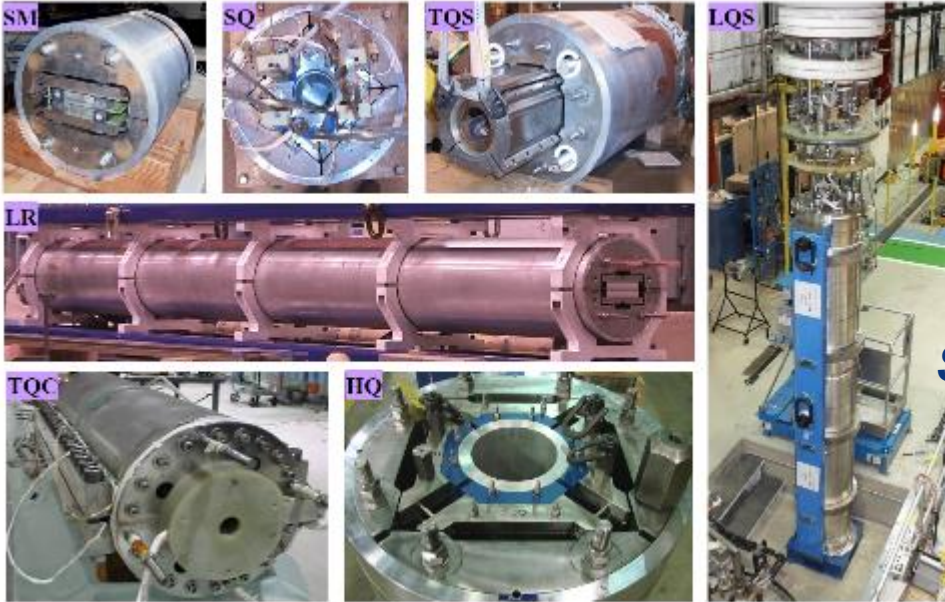
Subcontracting:

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

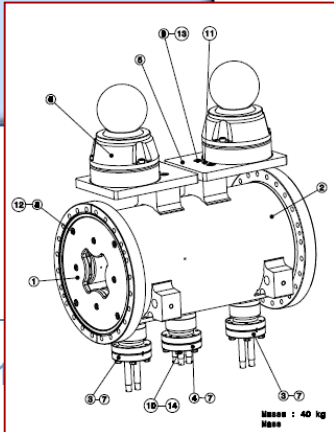
# **MME Subcontracting Service: Core & recent activities Europe wide**



# Magnets



**ELENA – Series production of electrostatic quadrupoles (x60). Synergy between EN-MME Workshop and NO-RS suppliers.**



Prototypes & small series of different magnets

- High precision CNC of small to large equipment
- Stamping, wire cut of laminations
- Cryostats

# SC Magnets: Tools

Large Precise Tools for Magnet assembly

MQXF



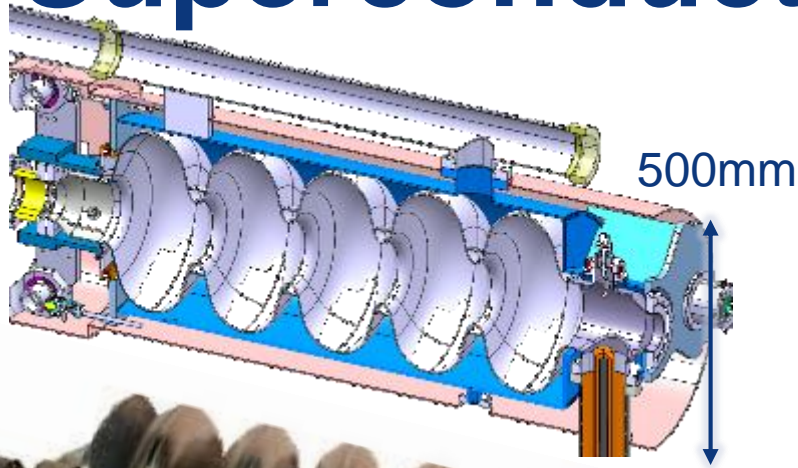
Rotating Table for SC magnets assembly



FRESCA: Magnet impregnation tool.  
(BE Supplier)



# Superconducting RF Cavities



**SPL Cavity**  
..Spinning..

Forming of Niobium Sheets  
Precision and surface quality of utmost importance for cavity performance



**CRAB Cavity**  
..Punching, extrusion, deep drawing by MME..  
Precise Tools

# Warm RF Cavities



First DTL girder



First full scale DTL tank segment (~2 m)

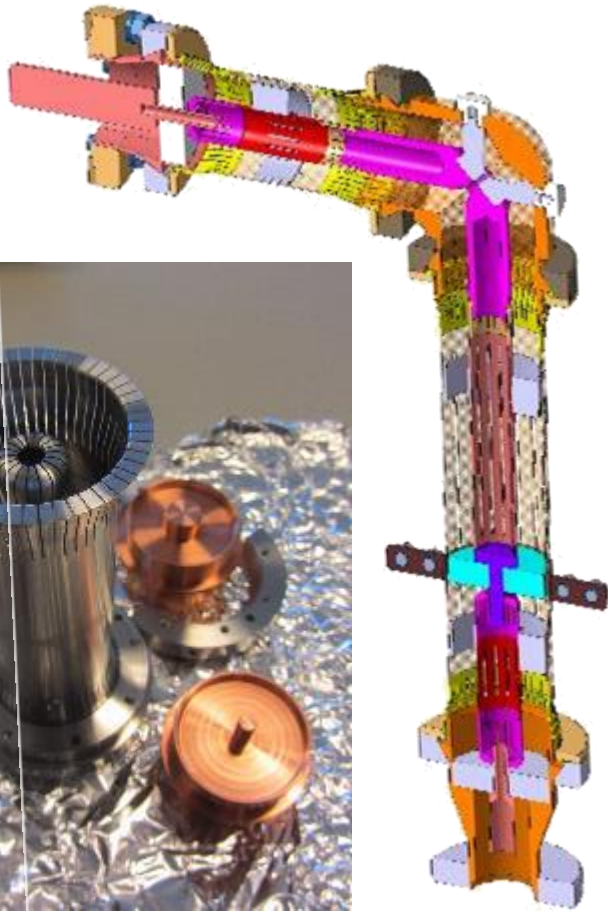
Precise Machining of Large Equipment



# Heterogeneous RF Equipment



**Ambient to  
Cryogenic  
RF Power Lines**

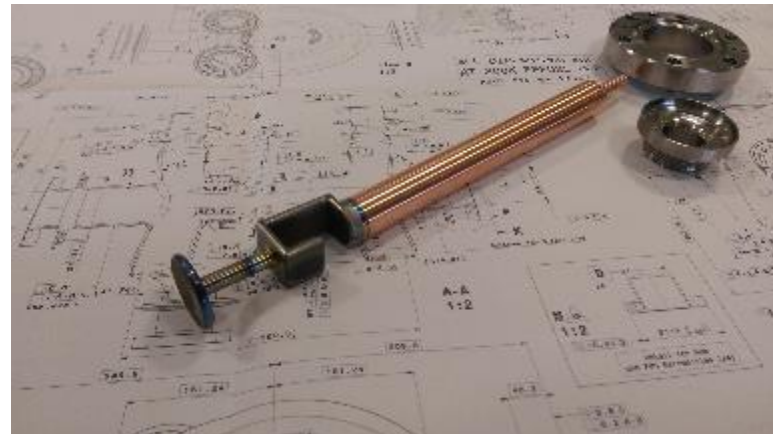


**CRAB Cavity  
RF Feedthrough:**



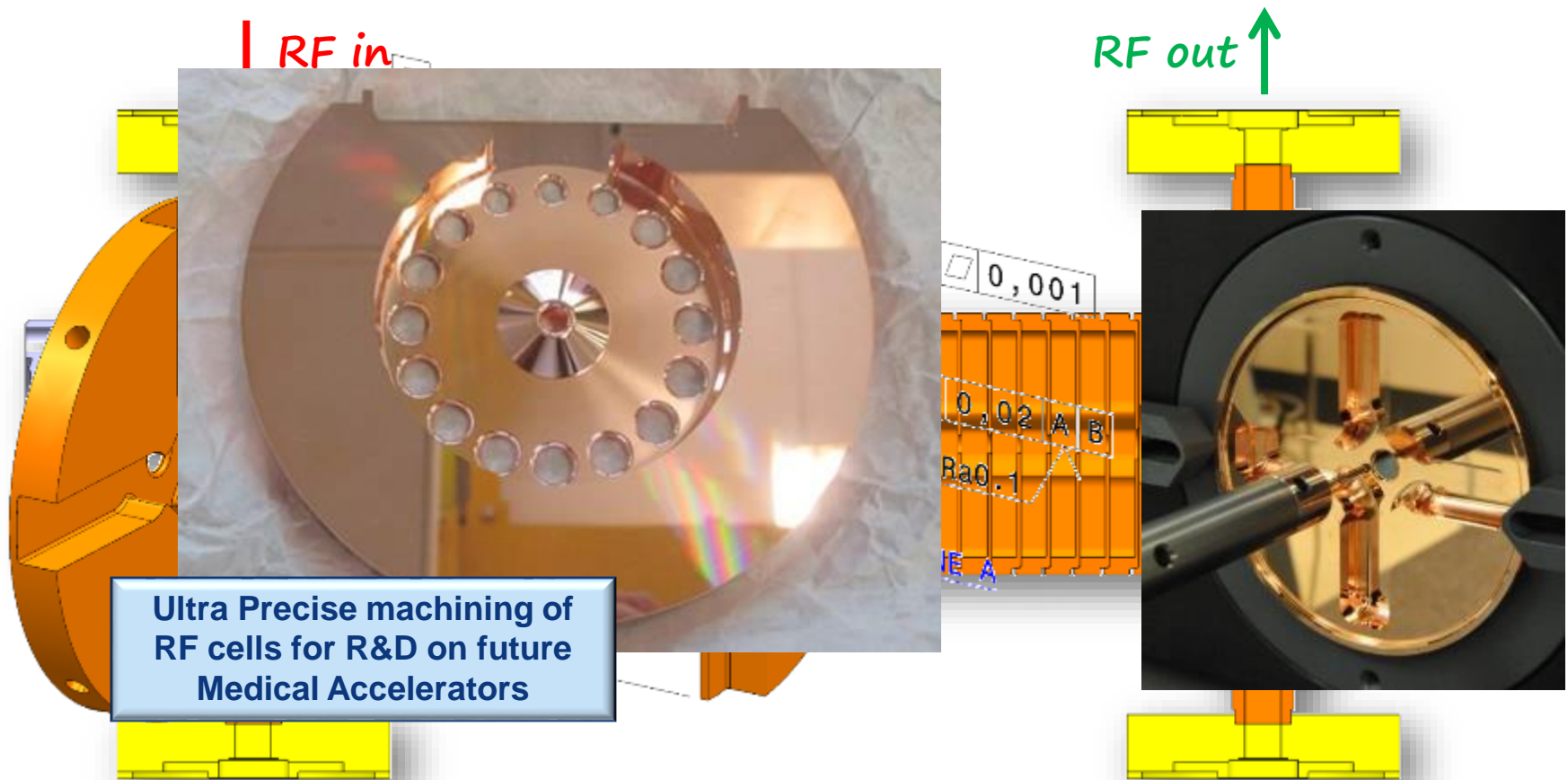
**Critical EB  
welding and  
Ceramic brazing  
in reduced  
volume**

**RF Antennas:  
Niobium machining and EB welding**



# Ultra precise machining

The design involves coupled RF cavities to transfer energy from a high-current, low-energy drive beam to a low-current, high-energy beam to be used in collisions.



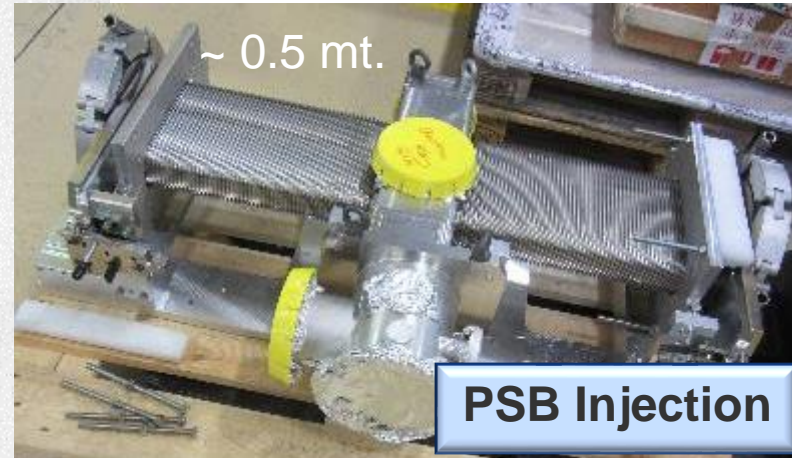
# Vacuum Chambers

Precise Shaping of Inconel & SS alloys into chambers of different sizes  
UHV Compliant Manufacturing

PSB Ring



~ 2 mt.



~ 0.5 mt.

PSB Injection

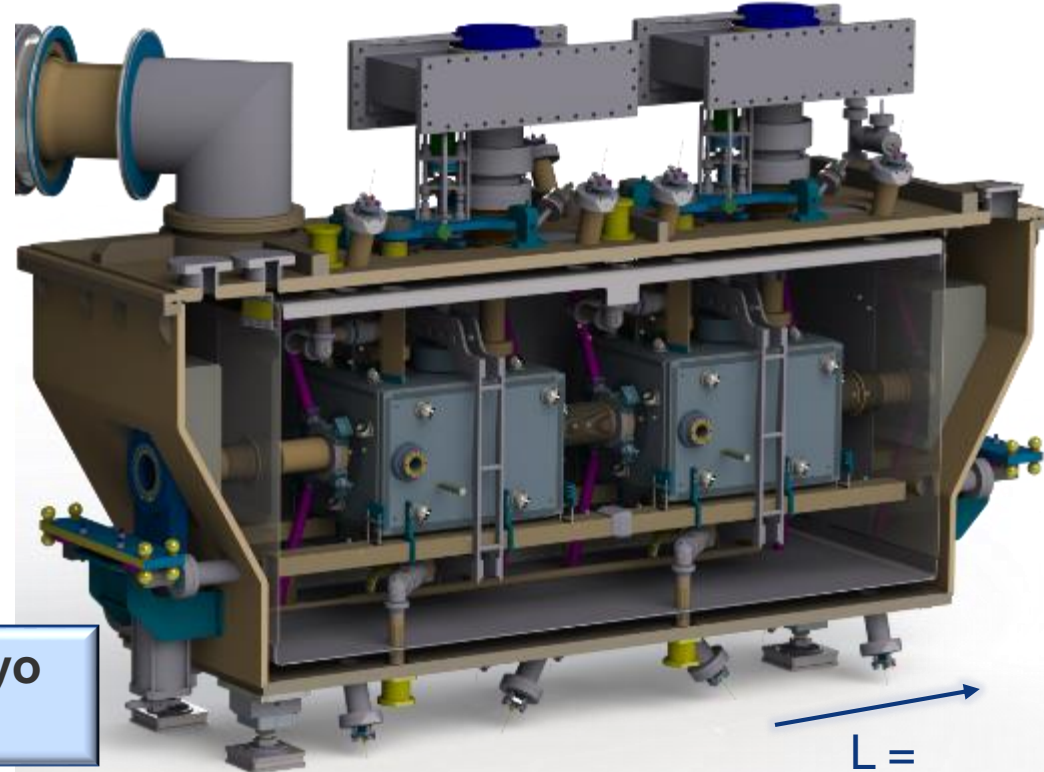
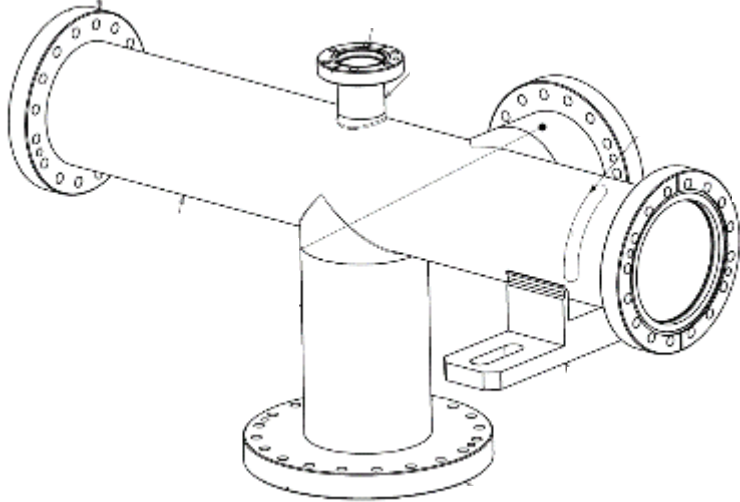
Hippodrome Edge welded bellows





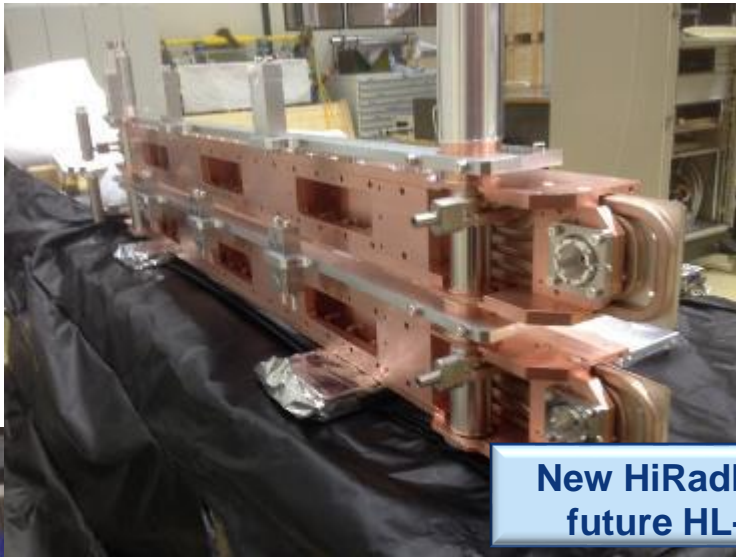
# Vacuum Chambers

Shaping / Extrusion / Welding of UHV  
Stainless steel Chambers & Vessels

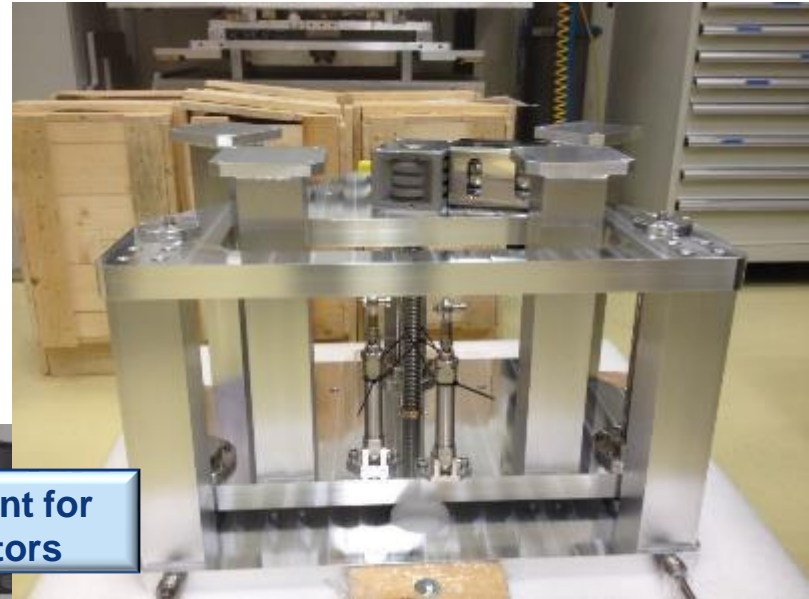


**Crab Cavity Cryo  
Vessel**

# Collimators:



New HiRadMat Experiment for future HL-LHC Collimators

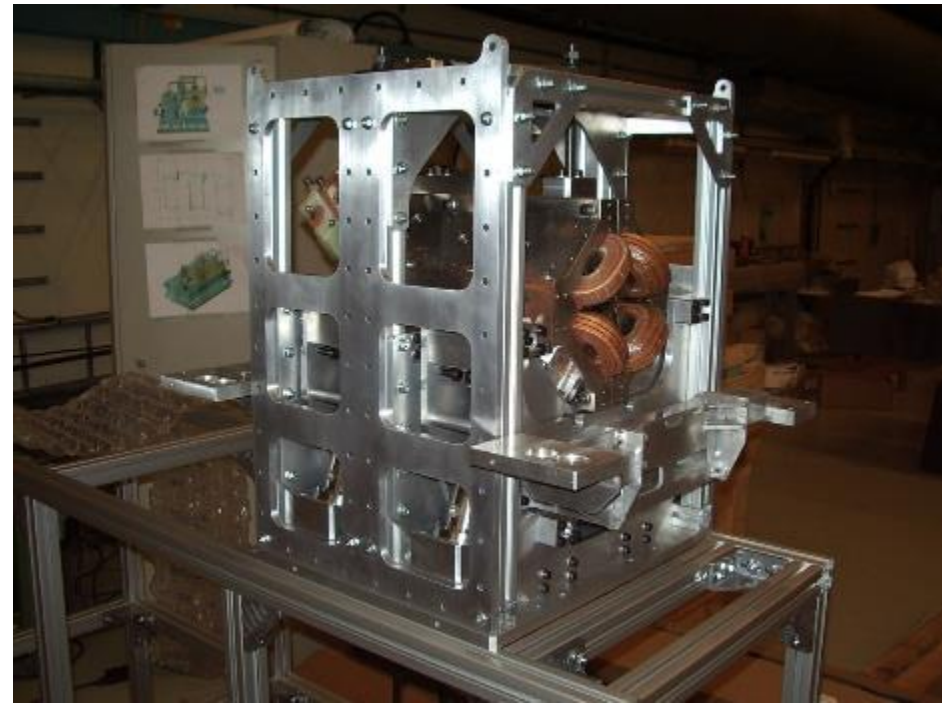




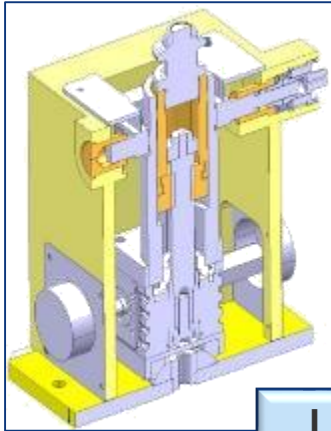
# Beam Lines & Positioning Systems



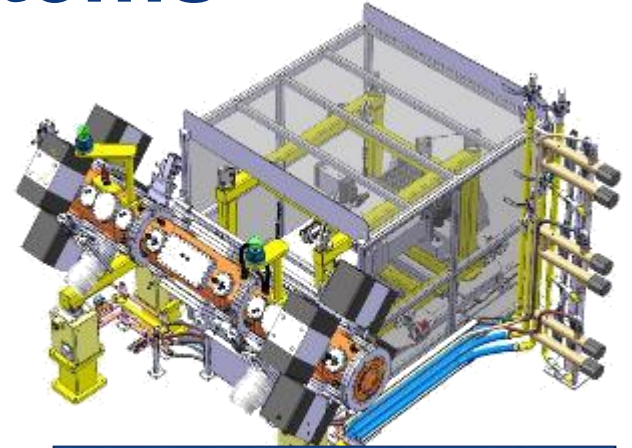
Alignment for small particle detector



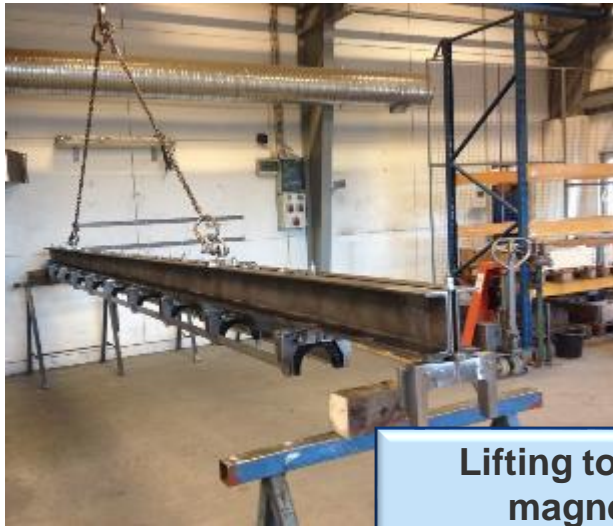
# Transport & Support Systems



Linac 4 jacks



RFQ detailed assembly including ridge-line support and cooling distribution



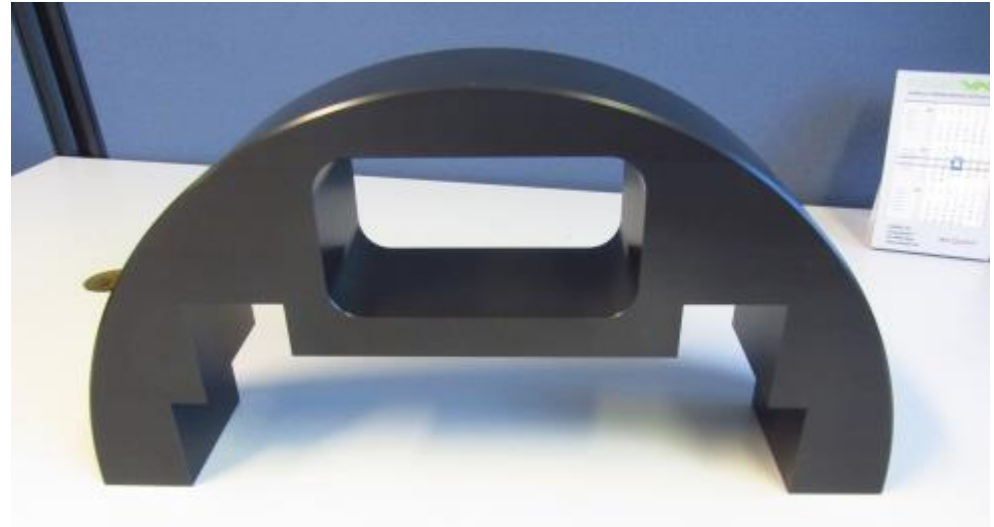
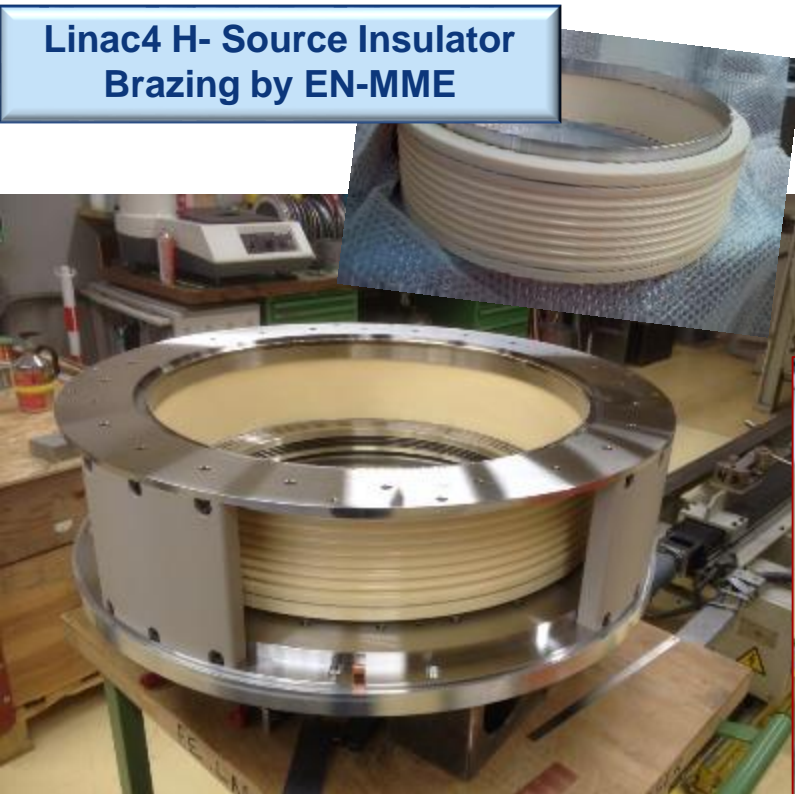
Lifting tool for magnets



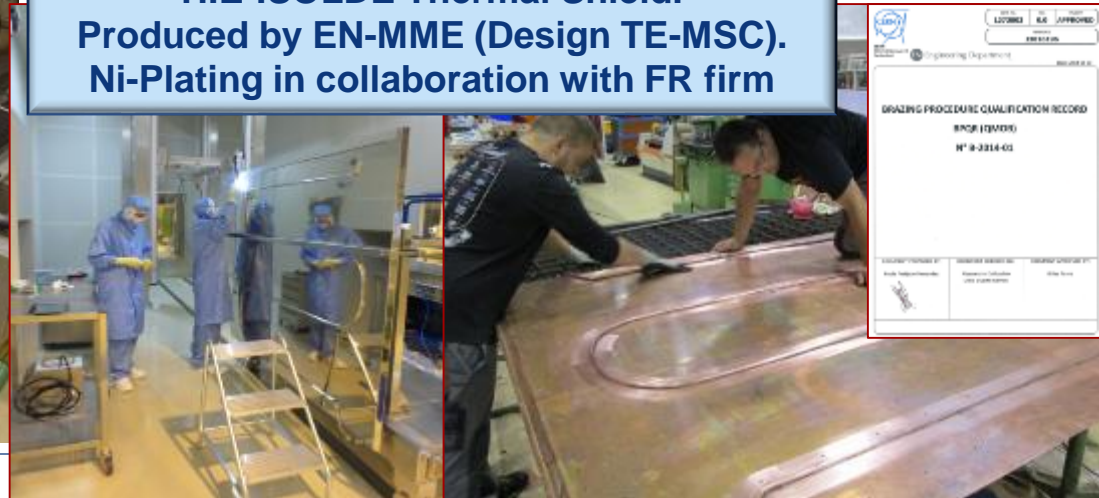


# MME Subcontracting Service: recent activities Europe wide

Linac4 H- Source Insulator  
Brazing by EN-MME



HIE-ISOLDE Thermal Shield.  
Produced by EN-MME (Design TE-MSC).  
Ni-Plating in collaboration with FR firm





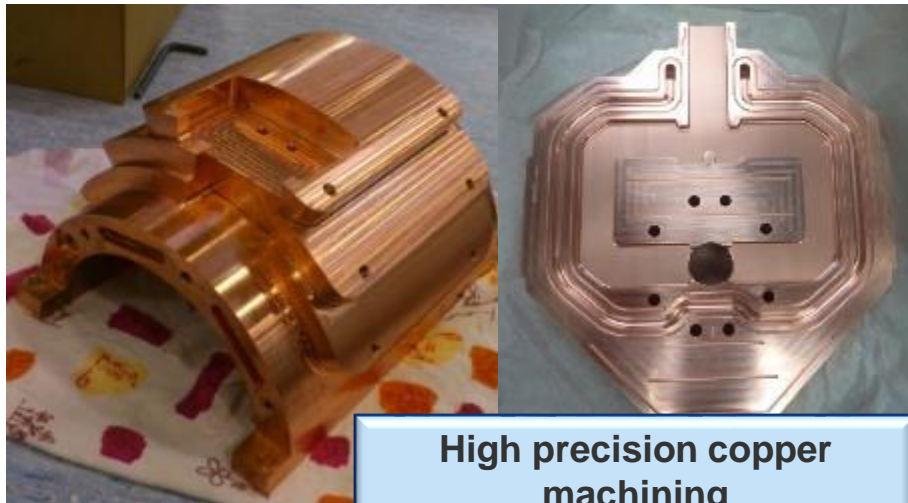
# MME Subcontracting Service: recent activities Europe wide



Large trolley for HIE-ISOLDE RF cavities installation into the clean room

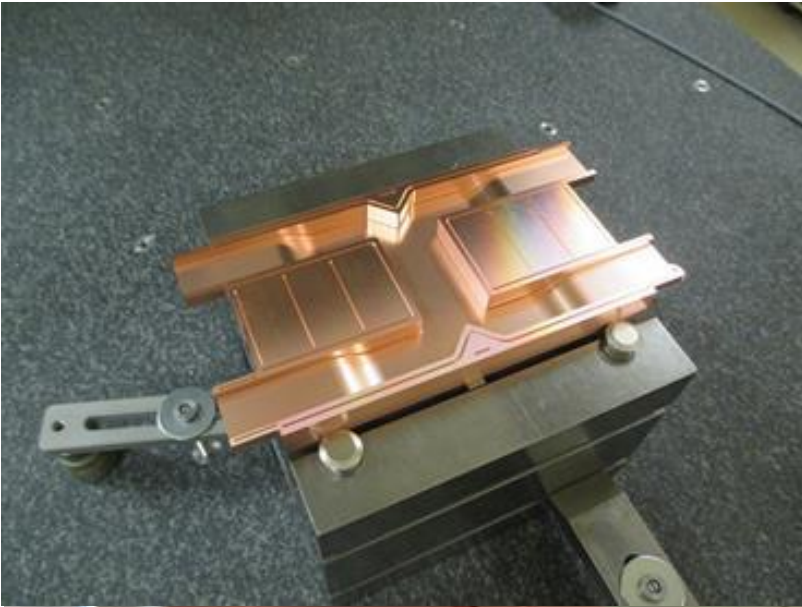


Large structure for clean room (HIE-ISOLDE project)

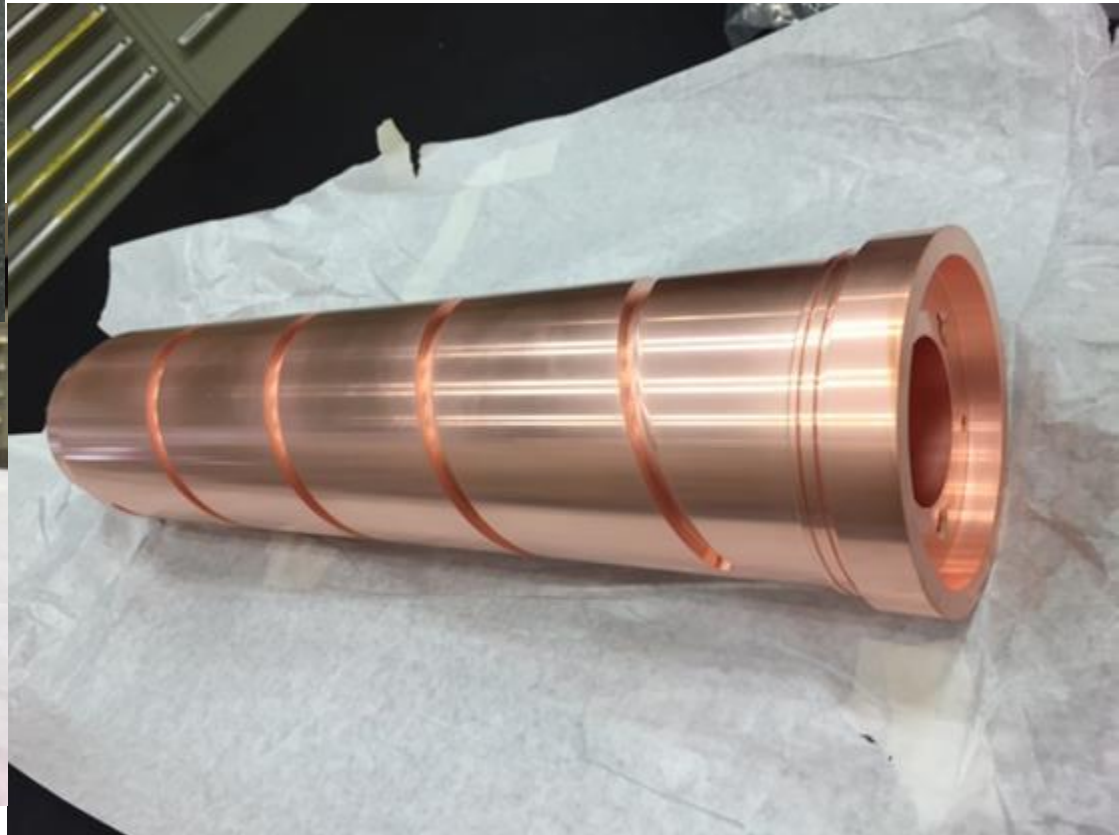
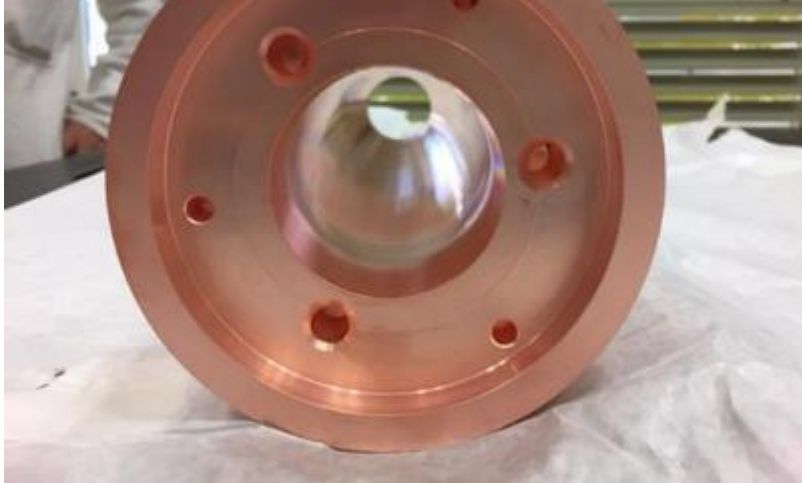


High precision copper machining

# MME Subcontracting Service: recent activities Europe wide

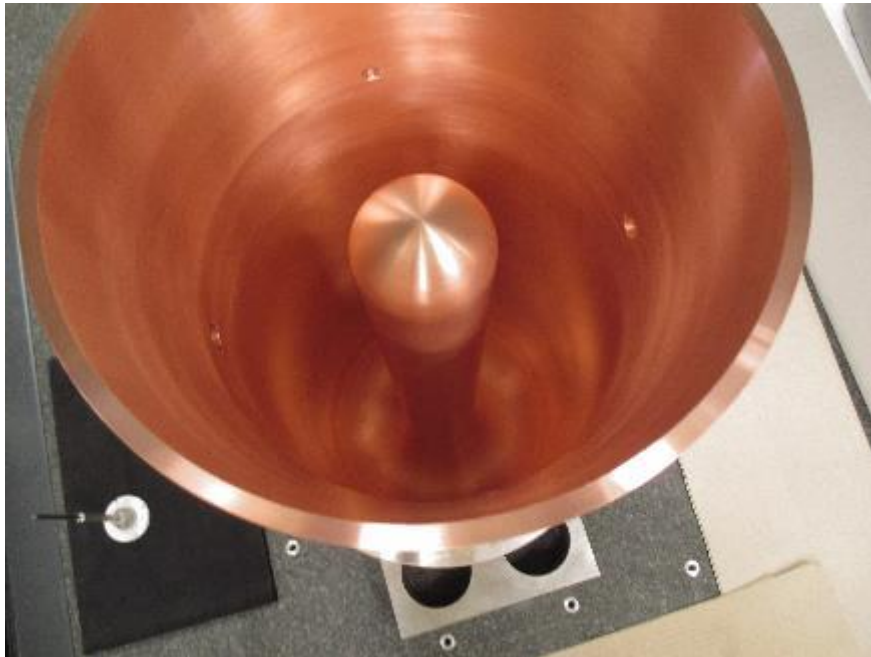


RF Pulse Compressor on Cu  
OFE 3D forged



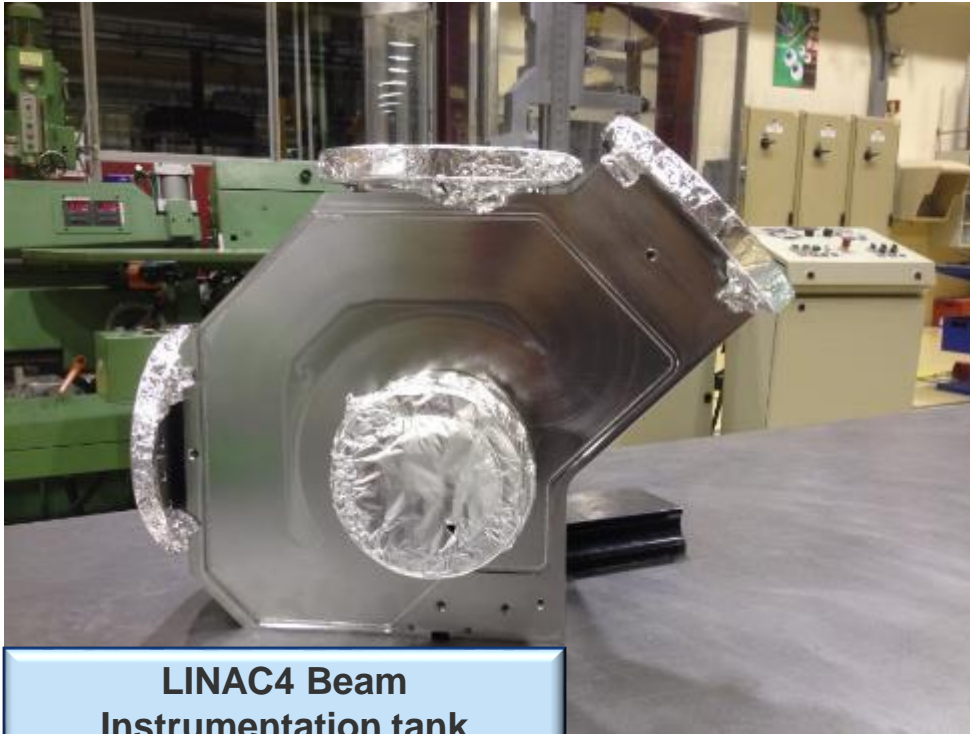
# MME Subcontracting Service: recent activities Europe wide

**HIE- Isolde Cavities:  
..Machining from Monoblock Copper  
D320 x L900  
Tolerances in the tenth of mm..**





# MME Subcontracting Service: recent activities Europe wide



LINAC4 Beam  
Instrumentation tank

Beam Instrument  
High-precision machining of  
316LN

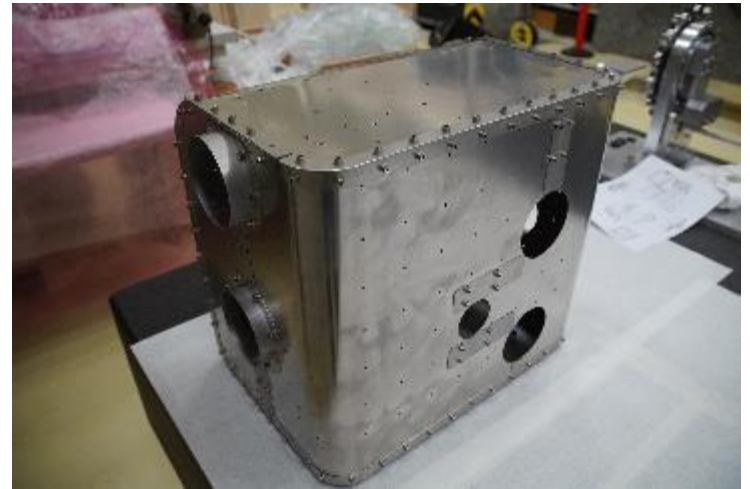


# MME Subcontracting Service: recent activities Europe wide



**Warm Magnetic Shield**  
MuMetal, 2m wide

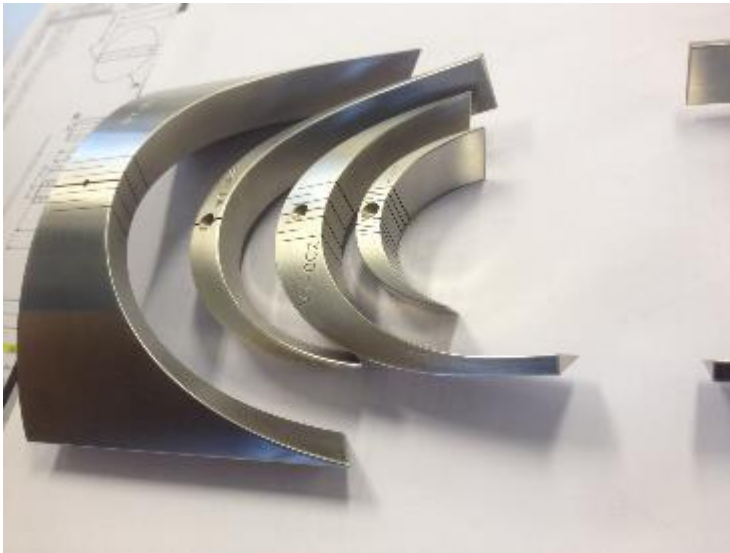
**Cryo Magnetic Shield**  
Cryophy, precise shaping and  
thermal treatment





# MQXFB MAGNETS

Components of coils



**End spacers**

..5 axes CNC machining, EDM..



**Poles**

..Titanium..

# SPS TIDVG4



**Copper blocks**  
..Large CNC milling  
machining..

Short time to produce this dump...

**Assembly**

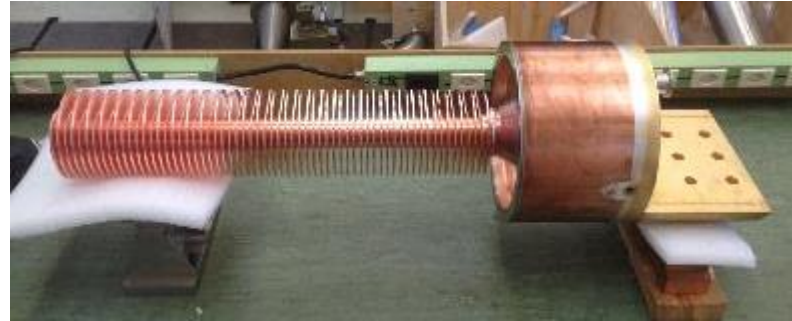


**Assembling**  
..welding and  
tests in house..

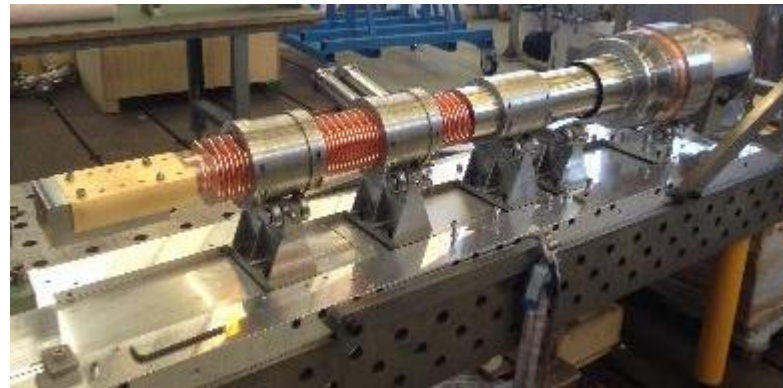


# CURRENT LEADS

Multi technologies, in house and outsourcing manufacturing



..Assembling phases..

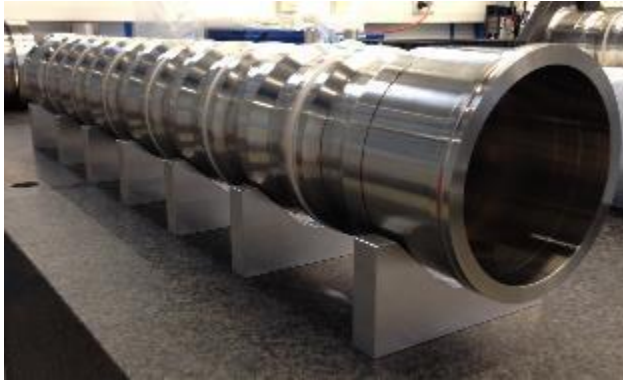


Current leads 30kA Cluster D



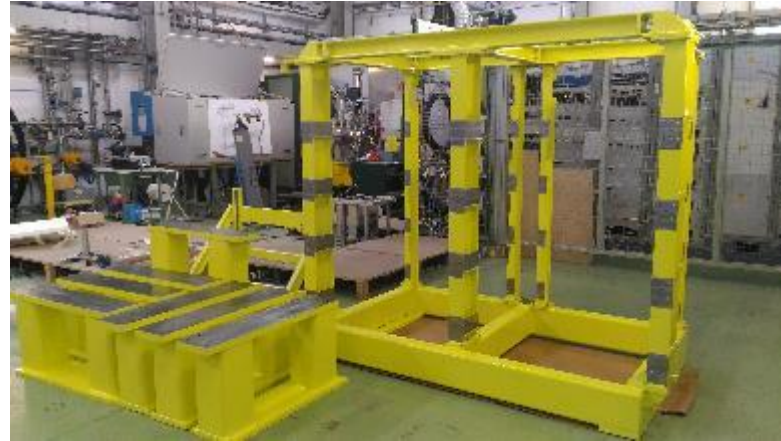
# FINEMET

... explanation...blablabla



## Cavity

Vacuum brazing, EB welding,  
Titanium coating, ceramics



## Structure



## Cooling copper discs



## Manifolds

# MME Subcontracting Service: what kind of skills are we looking for?

## Machining

High precision machining on large/very large components (Steel, Stainless steel, Al, Cu Alloys, Ti, W, Mo, Nb...)

Ultra precise machining on small/medium size components (Stainless steel, Cu Alloys, Al,)

Production and machining of ceramics and plastics (small, medium, large size)

EDM (wire erosion): all technologies providing precise tolerances and complex shapes.

## Various

Additive Manufacturing (especially with metals)

Thermal treatment (large components)

Surface treatments (cleaning, UHV cleaning, Ni coating, Si coating, Cu coating, anodization...)

Die forming (casting)

Pressure vessels: (construction, EU machine directive)

Lifting equipment : customized lifting equipment (calculation, detailed design, construction, CE certificate)

## Welding/Brazing

TIG/MIG

Welding of stainless steel (316, 316L/LN, 304)

Welding of aluminium

Welding of Cu/Brass and Cu Alloys

Welding of Titanium

Laser welding

Electron beam welding

Explosion bonding

Soldering

Vacuum brazing

## Metal Forming

Forging: particularly customized forged pieces (Stainless steel 316LN, Cu alloys, Al alloys...)

Extrusion

Casting (Iron and Aluminum)

Spin forming (Al, Cu, SS, Nb)

Punching, Fine Blanking, Deep Drawing



**Thank you for your attention**



ENGINEERING  
DEPARTMENT