

# TECHNICAL CHALLENGES OF ACCELERATOR COMPONENTS

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on behalf of CERN EN/MME

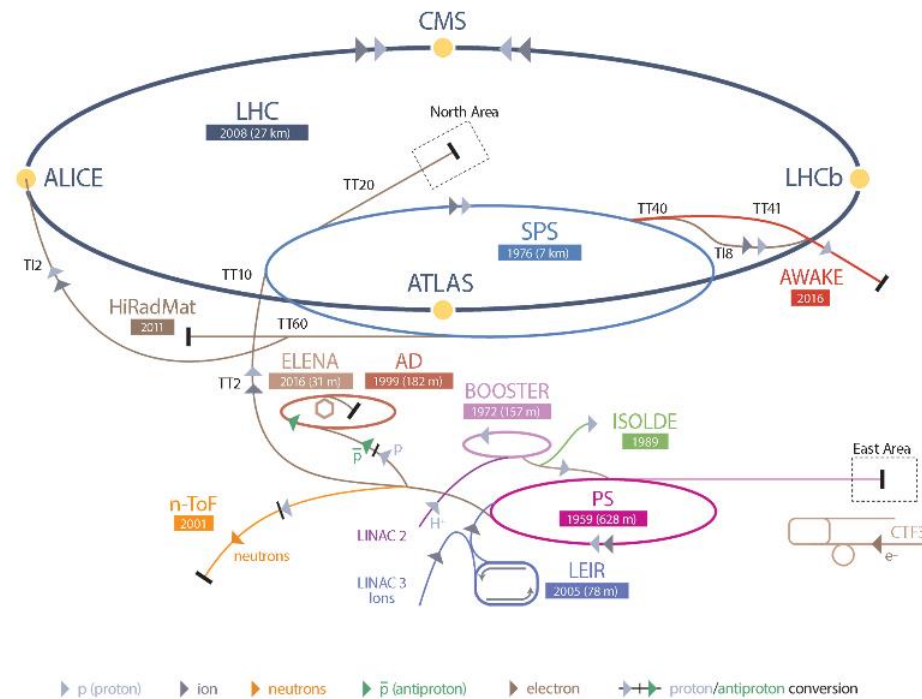


ENGINEERING  
DEPARTMENT

# CERN EN-MME GROUP

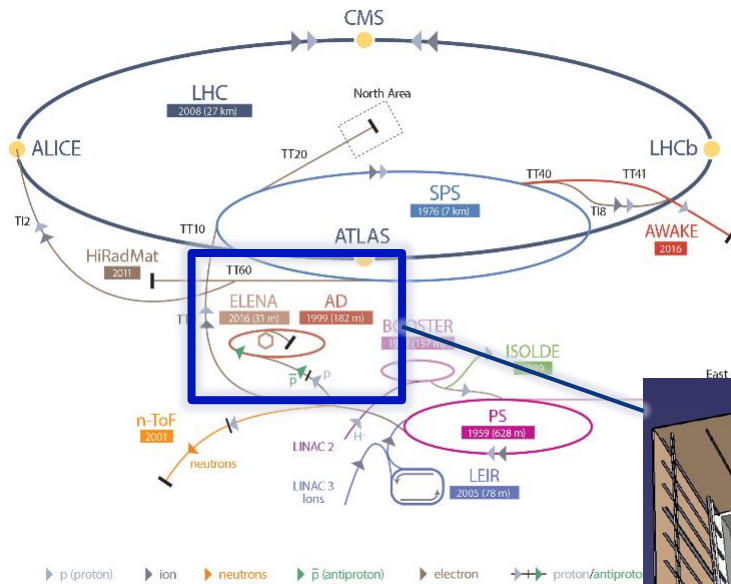
*“The mandate of the MME group is to provide to the CERN community specific engineering solutions combining mechanical design, fabrication and material sciences.”*

CERN's Accelerator Complex



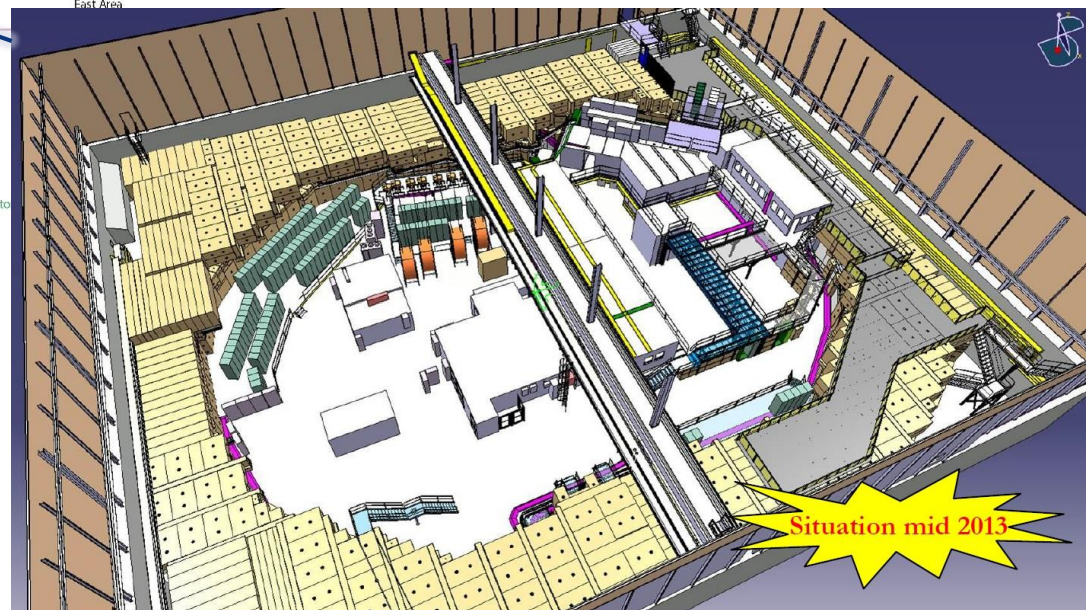
# NEW ACCELERATOR

CERN's Accelerator Complex

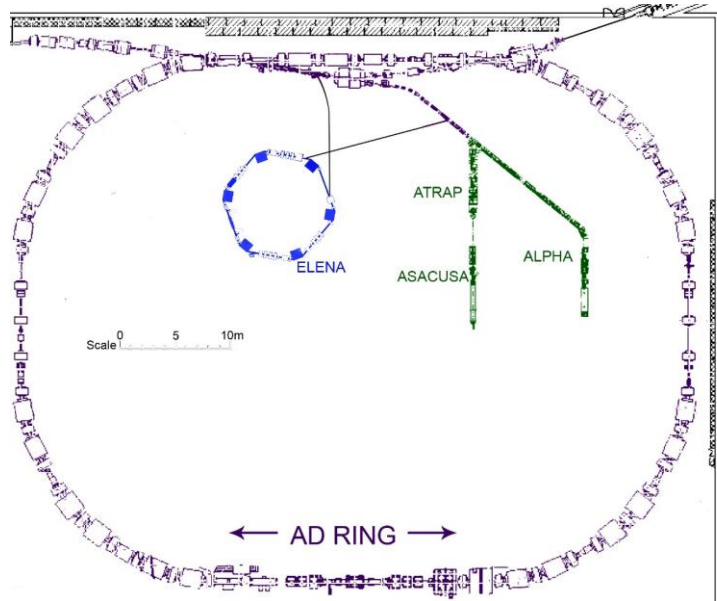


**ELENA:**

- PROPOSAL 1980's
- PROJECT LAUNCH 2011
- 1<sup>ST</sup> BEAM 2016



# FIRST VERSION



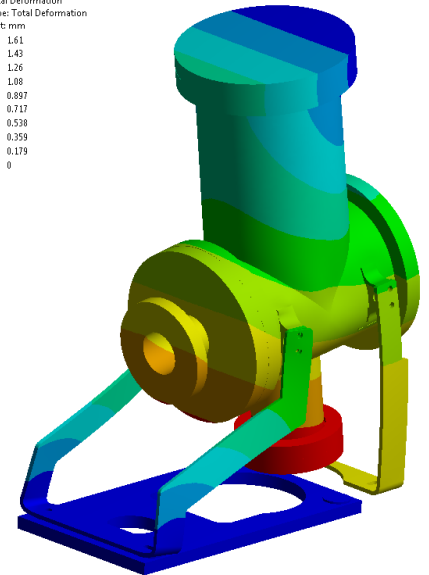
## MME CONTRIBUTION:

- MATERIAL DEVELOPMENT
- SIMULATIONS

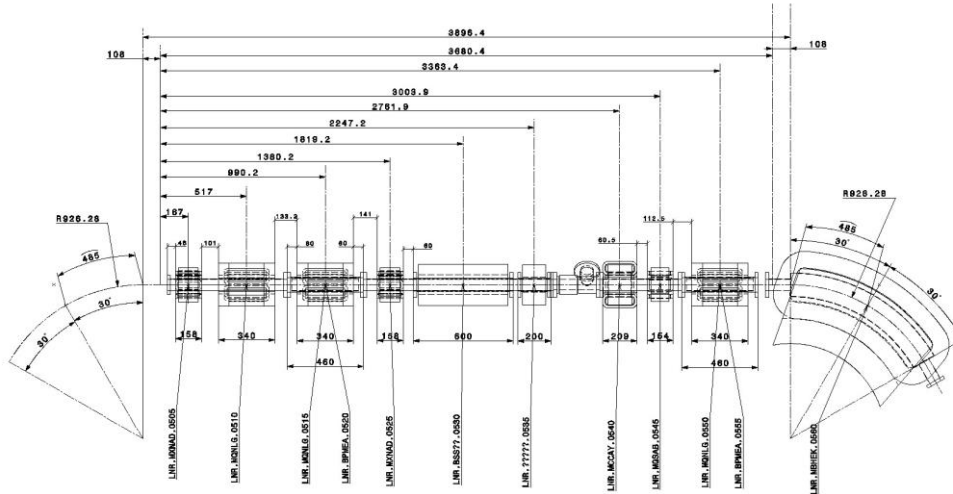


A: Static Structural  
Total Deformation  
Type: Total Deformation  
Unit: mm

1.61  
1.43  
1.26  
1.08  
0.897  
0.717  
0.538  
0.359  
0.179  
0

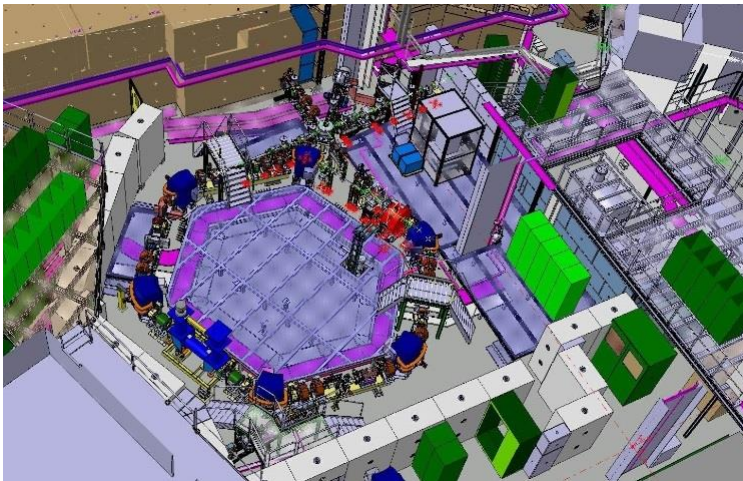


# DESIGN PHASE



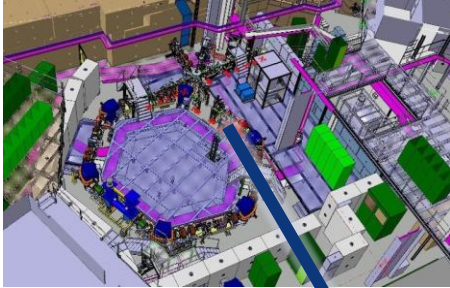
## EN-MME CONTRIBUTION:

1. DETAILED DESIGN OF THE EQUIPMENT
2. SOURCE SUPPLIERS FOR COMPONENTS
3. CONSULT THE EQUIPMENT OWNERS ON MANUFACTURING, PLAN MANUFACTURING OF THE REQUESTED EQUIPMENT



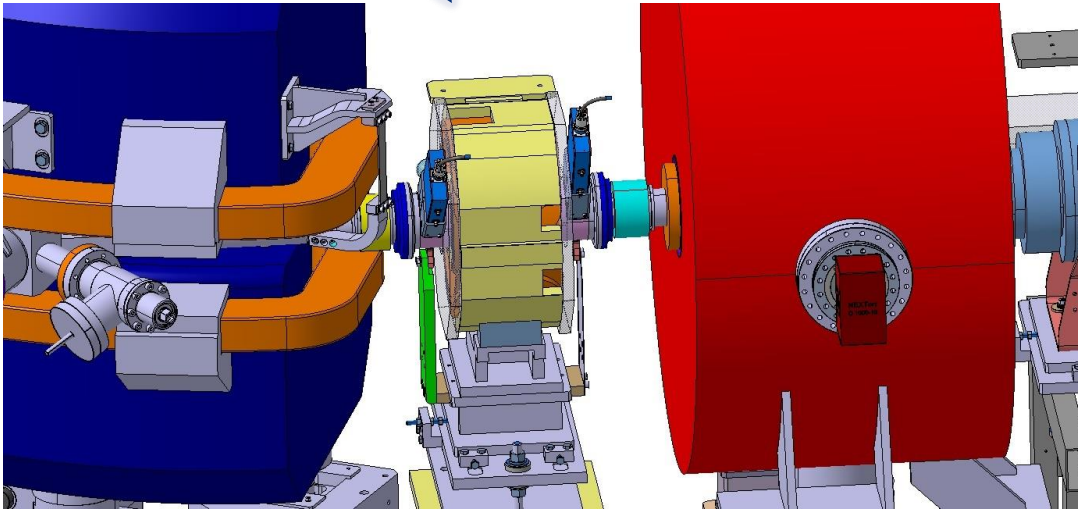


# INTEGRATION

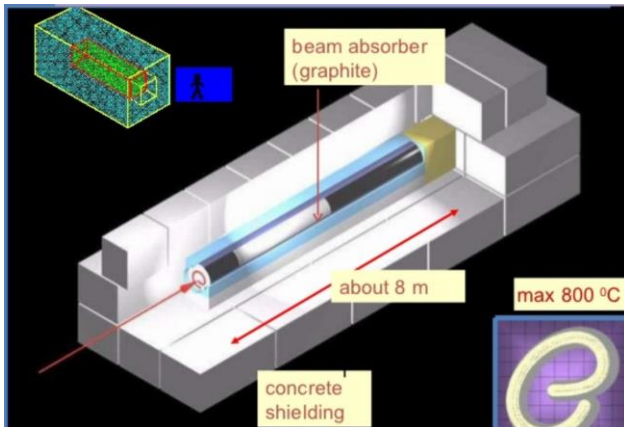


## CHALLENGES:

- LIMITED SPACE
- MANAGE ALL THE COMPONENTS
  - FOLLOW-UP OF THE DESIGN
  - WORK TOGETHER WITH EVERYONE INVOLVED



# BEAM AND MAGNET ENERGY

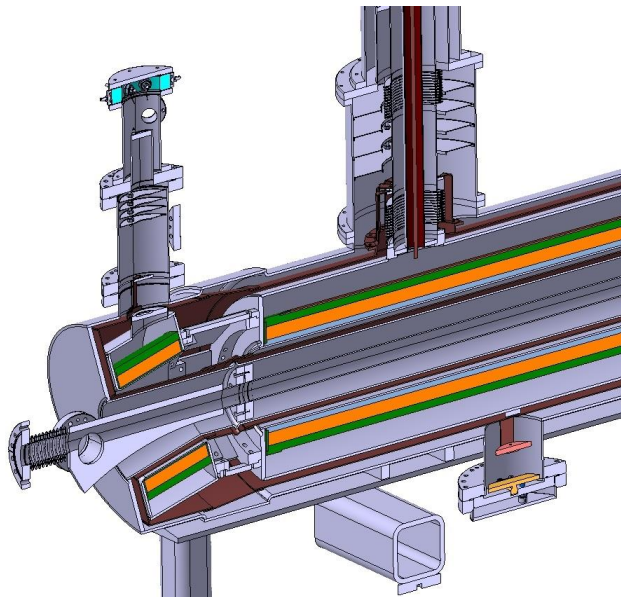


ONE LHC BEAM ENERGY ~ TGV TRAIN

DILUTE THE BEAM -> SPREAD INTO A GRAPHITE CYLINDER (EN-MME MATERIAL DEVELOPMENT)

RADIATION IN CERTAIN AREAS

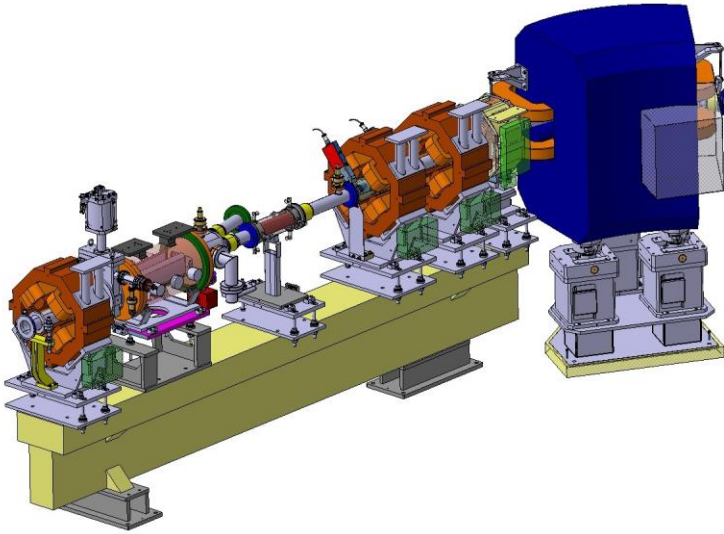
SUPERCONDUCTING MAGNETS INVOLVE CRYOGENICS, SUPERCONDUCTIVITY AND VACUUM IN ONE DEVICE



CHALLENGES:

- STOP THE HEAT LOAD – 1 W REMOVED FROM HELIUM NEEDS 1000 W IN ROOM TEMPERATURE
- RETAIN COILS WITH HIGH FORCES STATIC
  - 154 LHC DIPOLES STORED ENERGY ~ AIR-CRAFT CARRIER @ 20 km/h
- MANAGE THE THERMAL CONTRACTION/EXPANSION

# VACUUM



ULTRA HIGH VACUUM(UHV) =  $10^{-13}$  bar ~  
DEEP SPACE PRESSURE OR ~ 1/10 OF THE  
PRESSURE IN THE MOON

THE LOWER THE PRESSURE THE LESS  
UNWANTED COLLISIONS

MATERIAL REQUIREMENTS LEAD OFTEN TO  
STAINLESS STEEL OR COPPER

MATERIAL QUALITY CLOSELY FOLLOWED

TREATMENTS TO IMPROVE VACUUM

- VACUUM FIRING
- NEG COATING

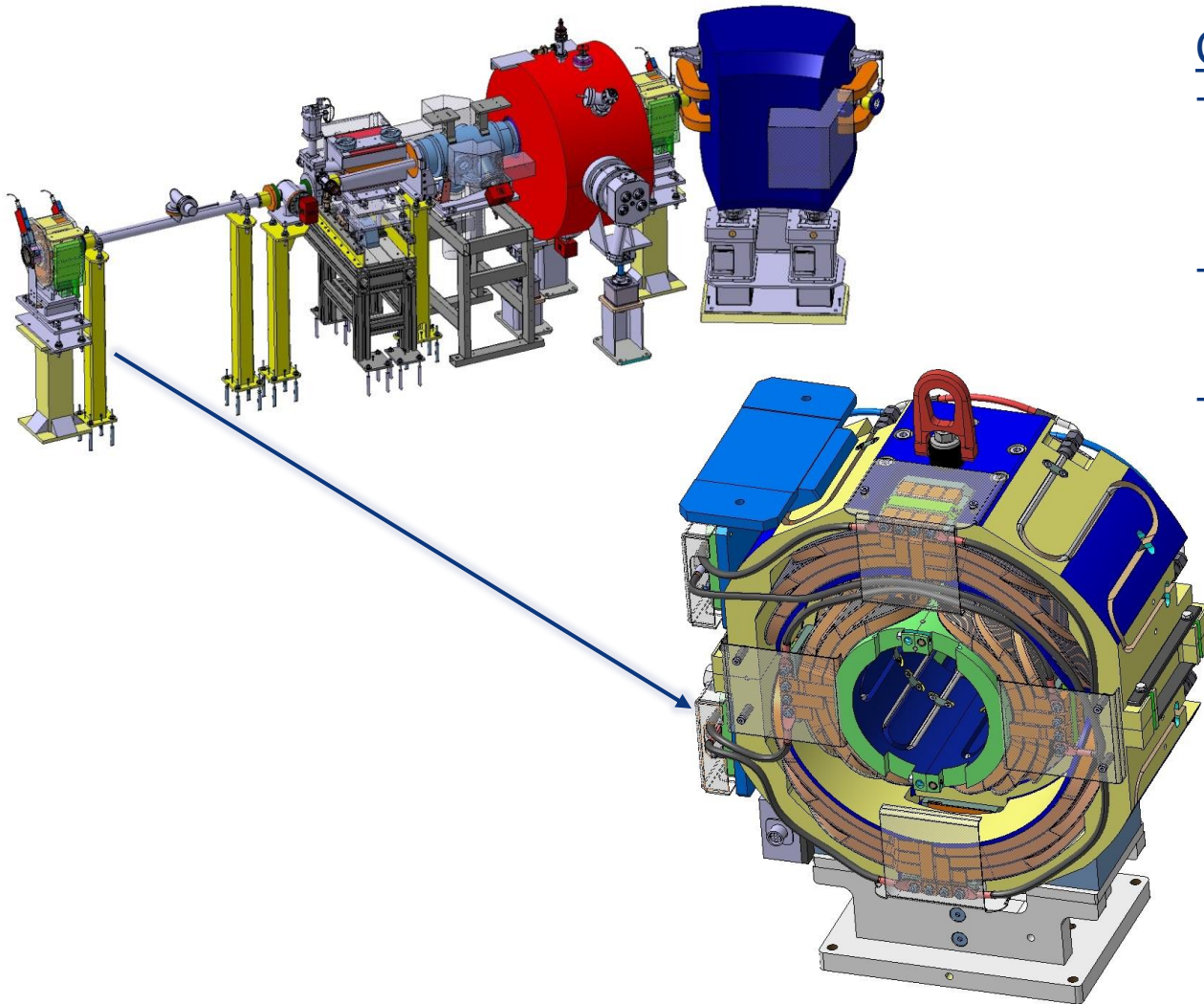
CRYO-PUMPING

FOR DESIGNER:

- THE LESS CONNECTIONS THE LESS  
POSSIBLE LEAKAGES
- AVOID TRAPPED VOLUMES



# GEOMETRIES



## CHALLENGES:

- COMPLEX GEOMETRY TO MODEL, DRAW AND MANUFACTURE
- TIGHT TOLERANCES, PERFECTION DESIRED
- DIFFERENT MATERIALS



# MANUFACTURING



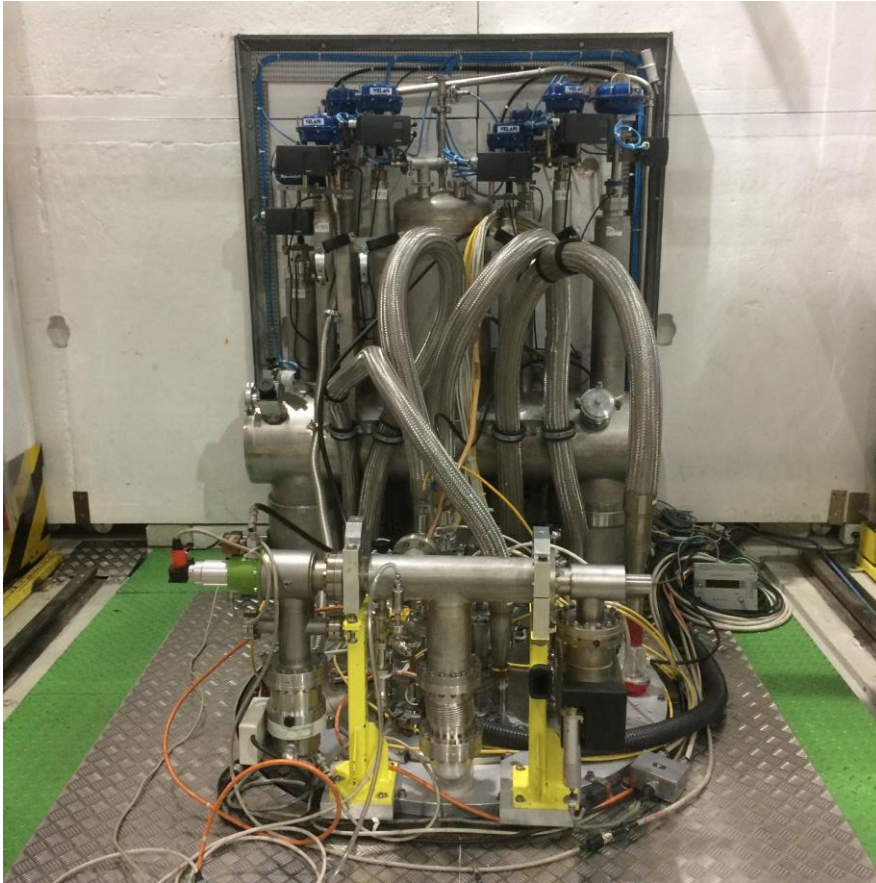
- FORM MATERIAL
- BEND / ROLL / DRAW

- REMOVE MATERIAL BY CUTTING
- ADDING DEGREES OF FREEDOM ALLOWS MORE COMPLEX GEOMETRIES



- WELDING AND BRAZING
- MELT PARTS TO BE JOINED LOCALLY

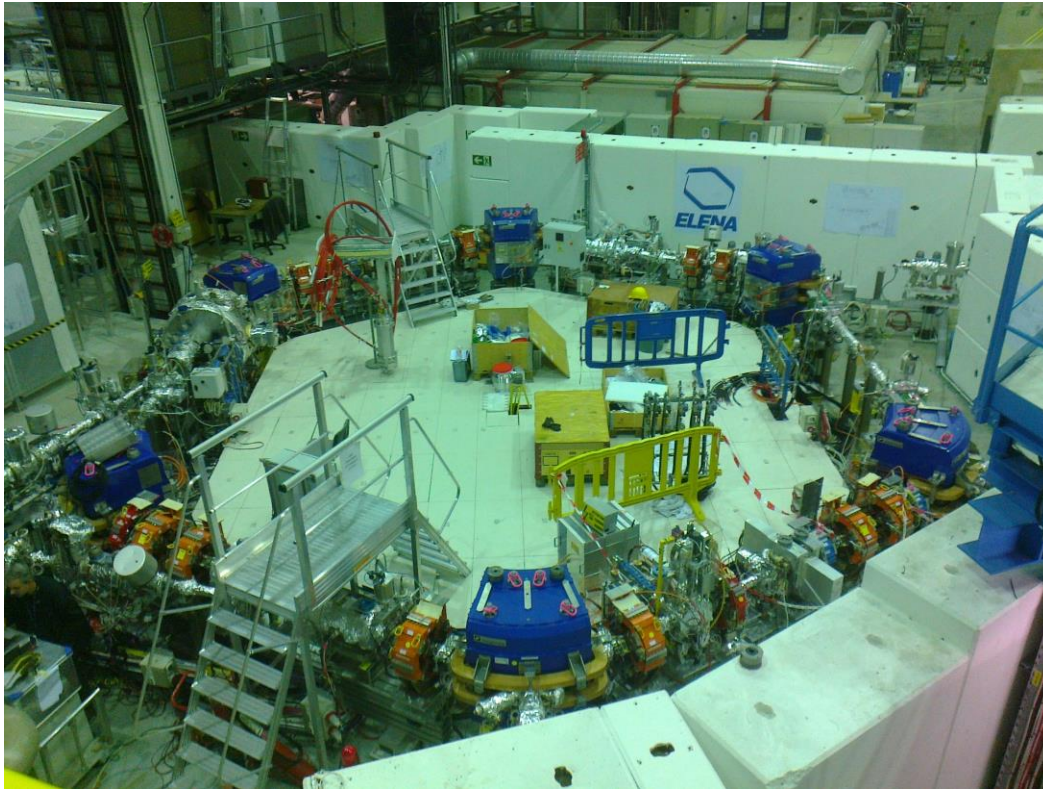
# MEASURING



- WHAT IS THE REQUIRED RESOLUTION?
- WE CAN GO TO 0.X  $\mu\text{m}$  (1/10 000 mm)
- FUNCTIONAL MEASUREMENT (RF/MAGNETIC FIELDS)
- VACUUM/LEAK TIGHTNESS



# INSTALLED ACCELERATOR



## EN-MME CONTRIBUTION:

- DELIVERY OF THE MANUFACTURED AND PURCHASED COMPONENTS
- INSTALLATION FOLLOW-UP AND SUPPORT
- COMPLETE THE DOCUMENTATION



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QUESTIONS / THANK YOU FOR YOUR ATTENTION



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