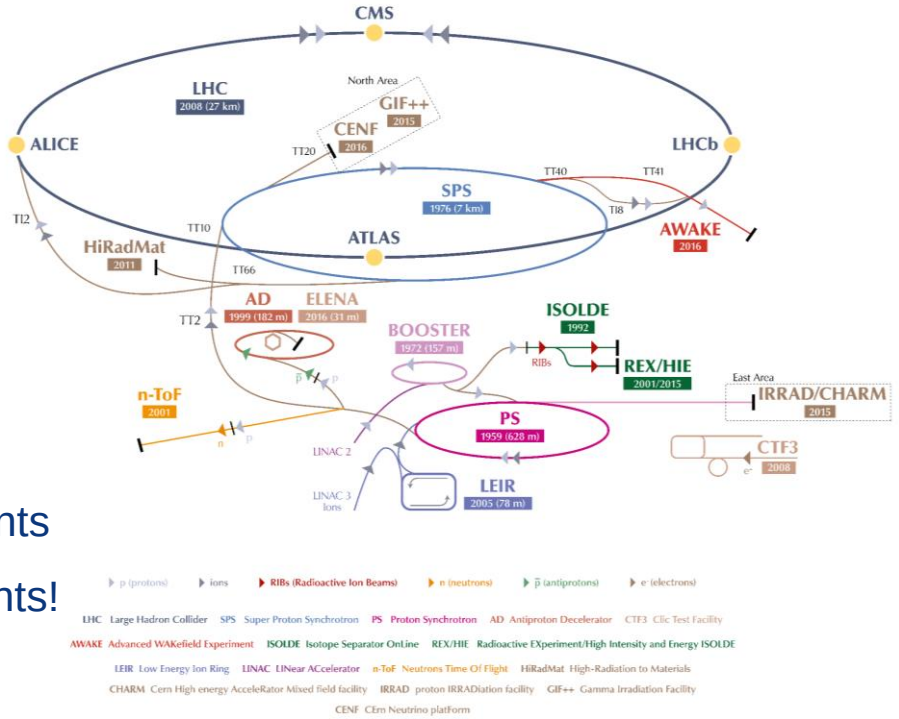
# Mechanical Engineering of Accelerator Components and Peripherals

Antti Kolehmainen, Tommi Mikkola and Tuukka Lehtinen
on behalf of CERN EN-MME

# 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."*

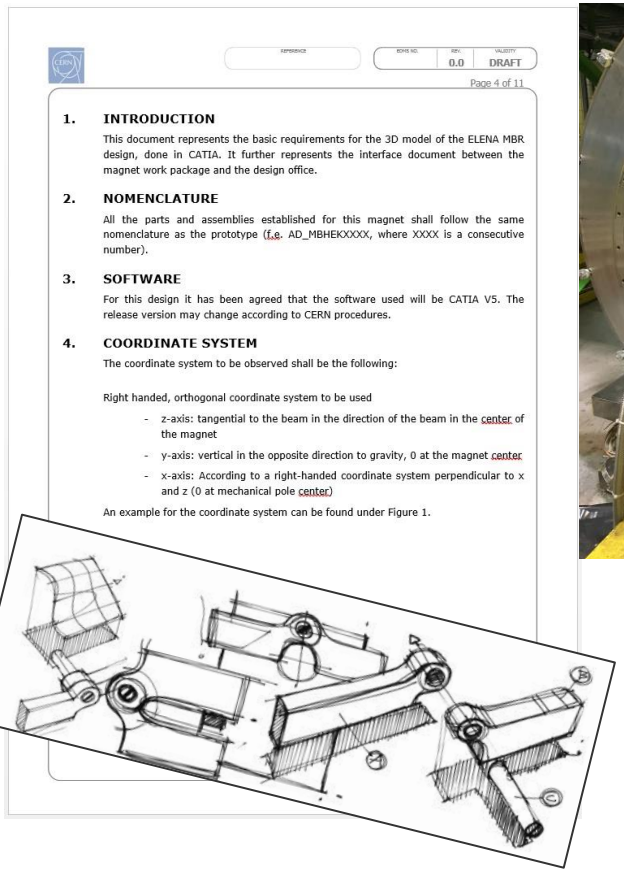
- EN-MME group size roughly 180 people
- Our main activities are:
  - Mechanical design
  - Engineering calculations and simulations
  - Production and sourcing
  - Material development
  - Mechanical and geometrical measurements
- We work on all the machines and experiments!




EN-MME = Engineering Department – Mechanical and Materials Engineering

# Mechanical Design – Design Inputs

## Client specification



0.0 DRAFT

Page 4 of 11

**1. INTRODUCTION**

This document represents the basic requirements for the 3D model of the ELENA MBR design, done in CATIA. It further represents the interface document between the magnet work package and the design office.

**2. NOMENCLATURE**

All the parts and assemblies established for this magnet shall follow the same nomenclature as the prototype (f.e. AD_MBHEKXXXX, where XXXX is a consecutive number).

**3. SOFTWARE**

For this design it has been agreed that the software used will be CATIA V5. The release version may change according to CERN procedures.

**4. COORDINATE SYSTEM**

The coordinate system to be observed shall be the following:

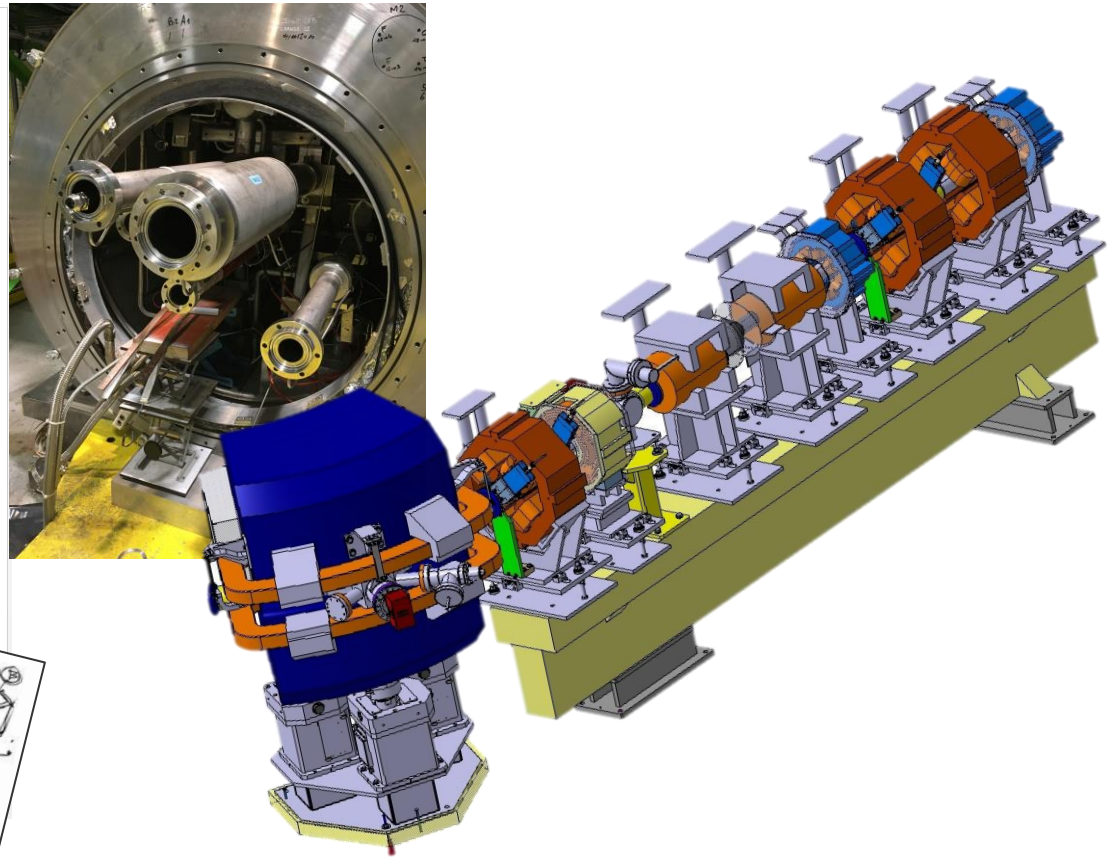
Right handed, orthogonal coordinate system to be used

- z-axis: tangential to the beam in the direction of the beam in the center of the magnet
- y-axis: vertical in the opposite direction to gravity, 0 at the magnet center
- x-axis: According to a right-handed coordinate system perpendicular to x and z (0 at mechanical pole center)

An example for the coordinate system can be found under Figure 1.



## Space limitations and interfaces



All project parties participate in defining design inputs!

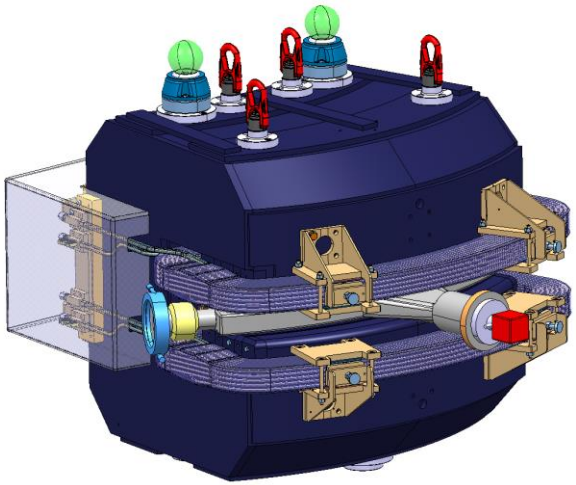
# Mechanical Design – Process

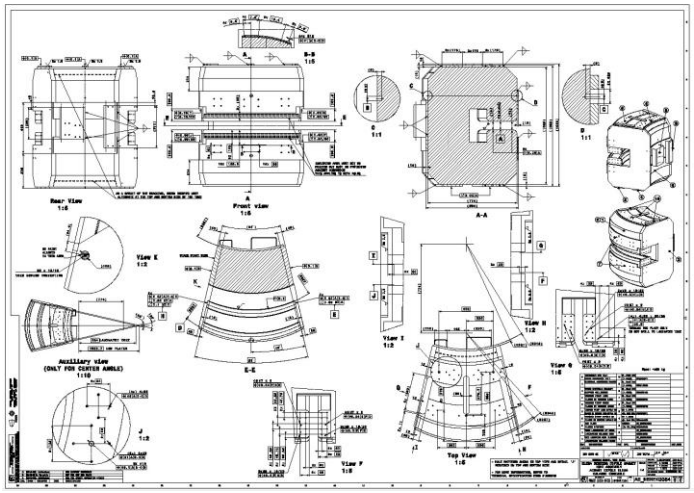
Iteration:

- Designer – Client
- Analysis, simulation
- Integration
- Manufacturing

Deliverables:

- 2D drawings
- 3D models
- Supporting documents, such as analysis or measurement reports





# Engineering Calculations and Simulations

**Why**: To guide design work, to meet requirements, and to assess safety

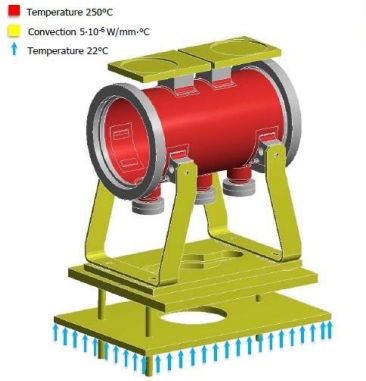
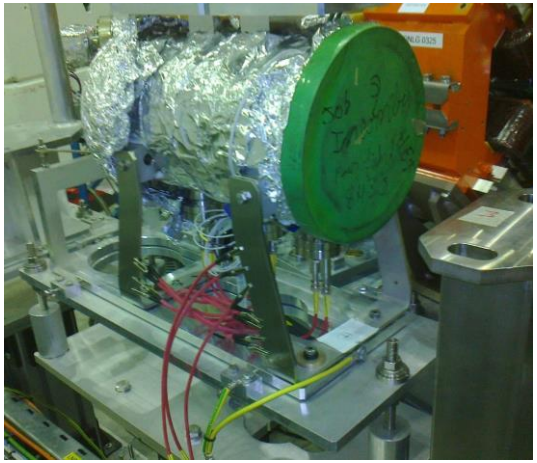



Figure 5 – Thermal boundary conditions for the quadrupole


Figure 6 - Boundary conditions and loads for the structural analysis.

Boundary conditions



Functional device

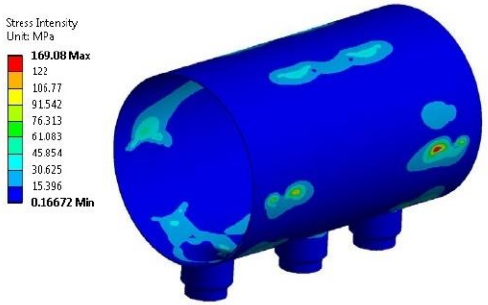



Figure 10 - Stress intensity for the vacuum vessel.

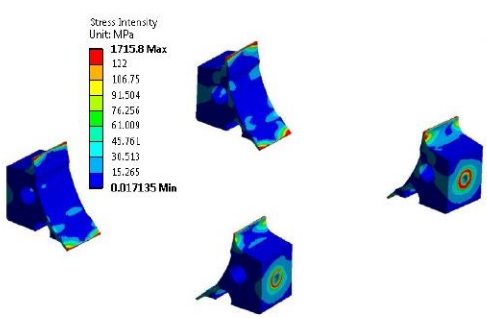
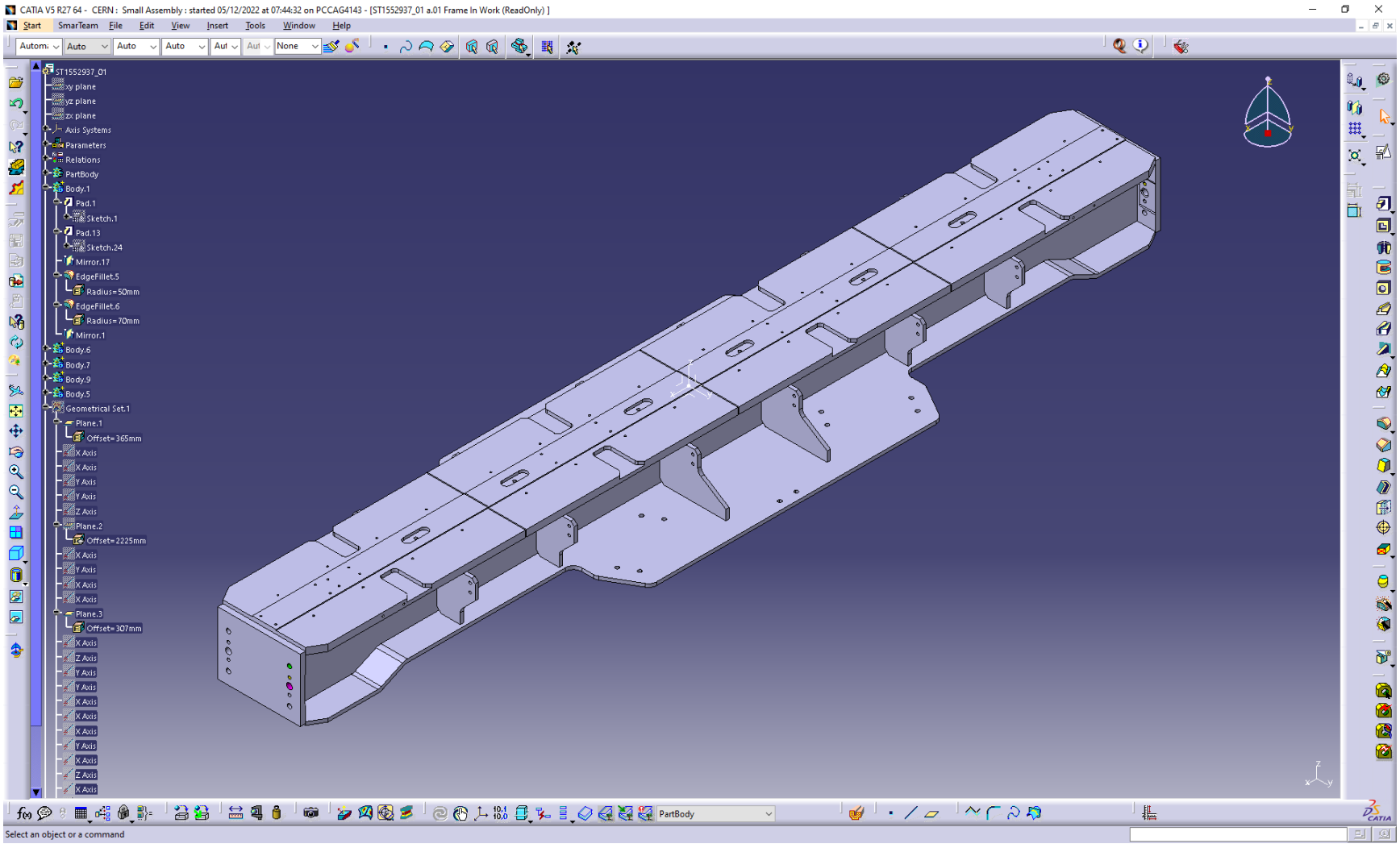


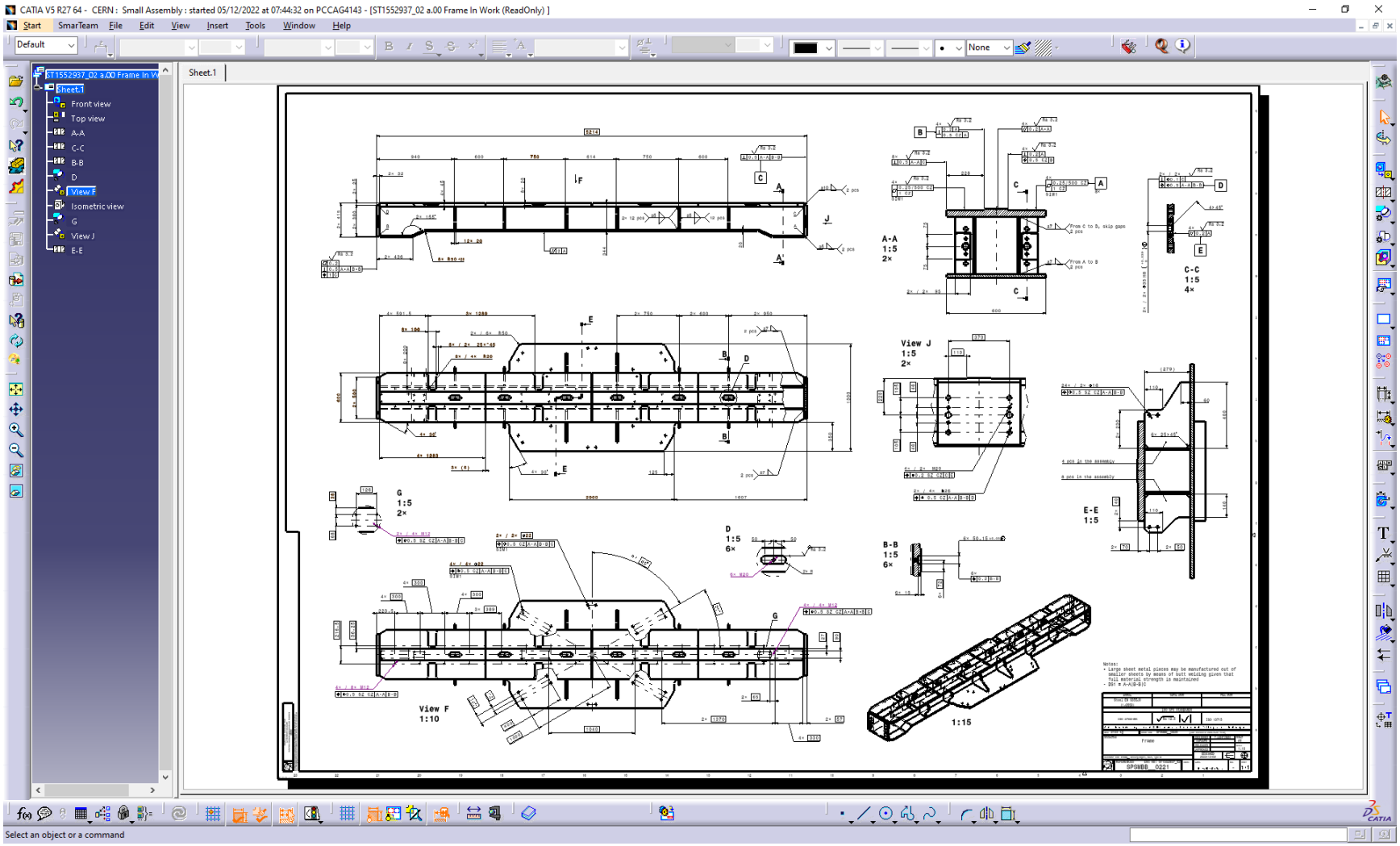

Figure 11 - Stress intensity for the welded connectors.

Analysis results

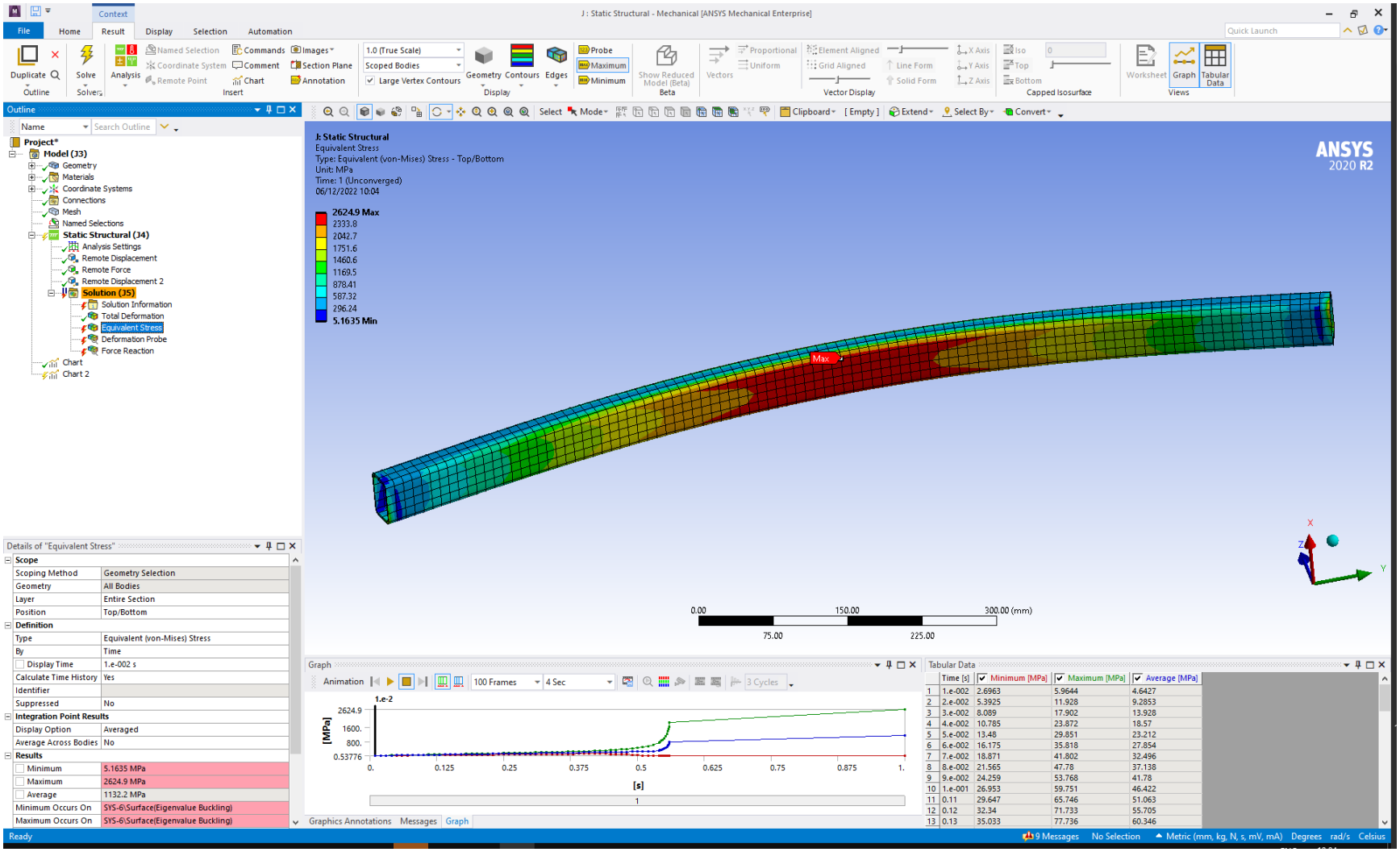
# CAE Tools - CATIA



# CAE Tools - CATIA

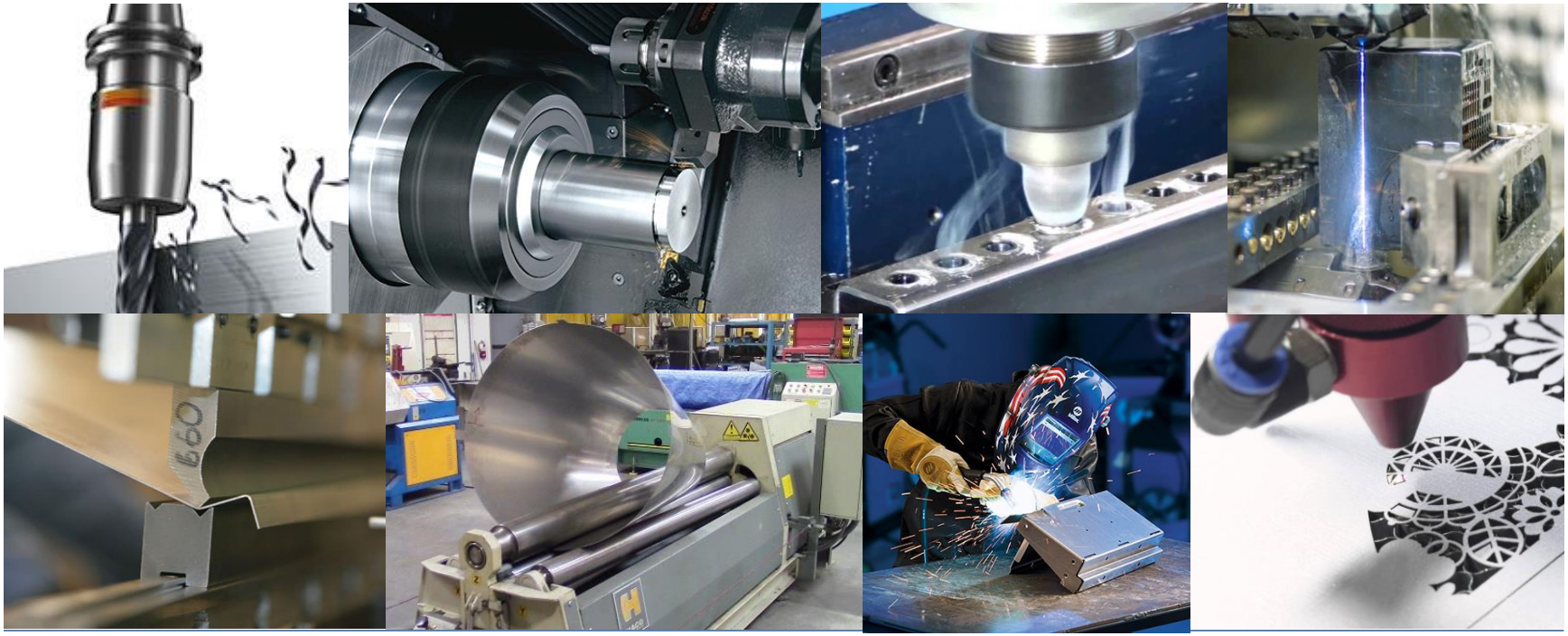


# CAE Tools - ANSYS



# Manufacturing and Production

- EN-MME operates three machine shops mostly for prototype and small series production
- Capabilities:
  - Machining: Milling, turning, drilling, cutting, grinding, electrical discharge machining, etc.
  - Forming: Sheet metal bending, rolling, punching, pressing, extrusion, etc.
  - Joining: Welding, brazing, soldering, etc.



# Material Development and Measurements

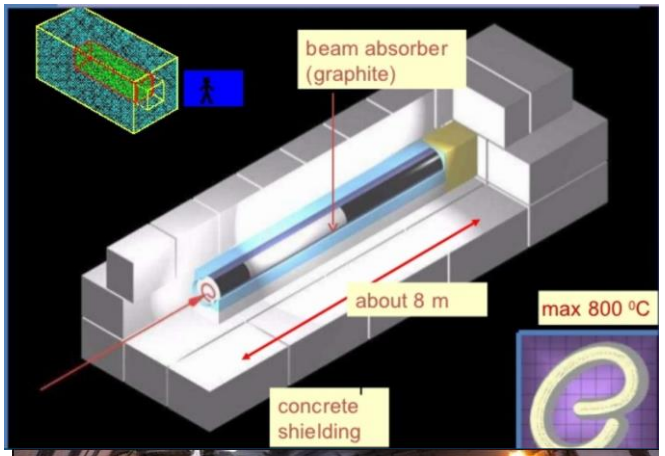
Material development examples:

- Graphites for beam impacts
- Stainless steel alloys for permeability

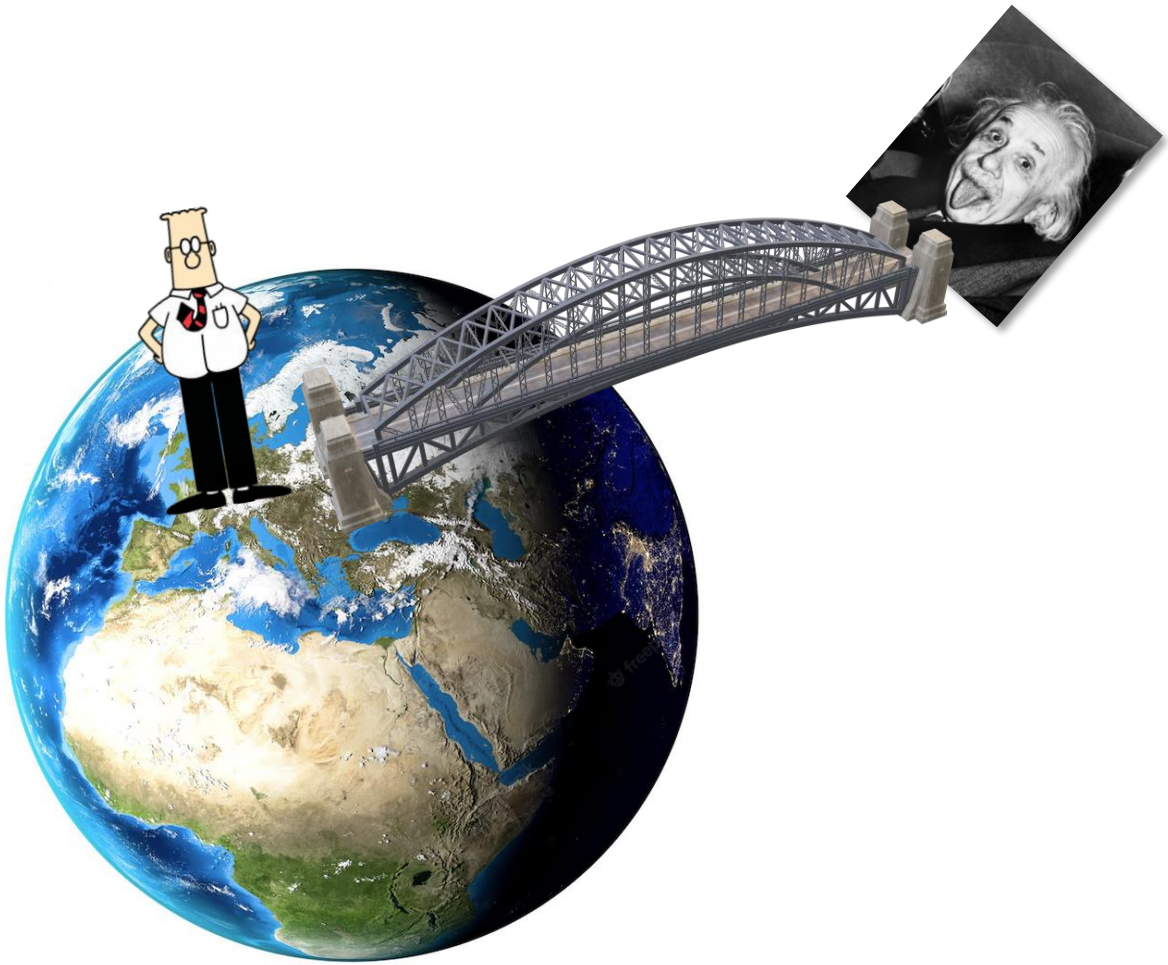
Mechanical measurement examples:

- Non-destructive testing: X-ray for LHC dipole magnets
- Destructive testing: Material tensile strength testing

Geometrical measurements: Verification of component compliance to specification (drawings and/or model)




# Challenges



Note! Bridge length varies between some micrometers to some parsecs...


# Questions!