



# High-precision vacuum-brazing assemblies for customized cooling components

06.10.2022

# Company presentation

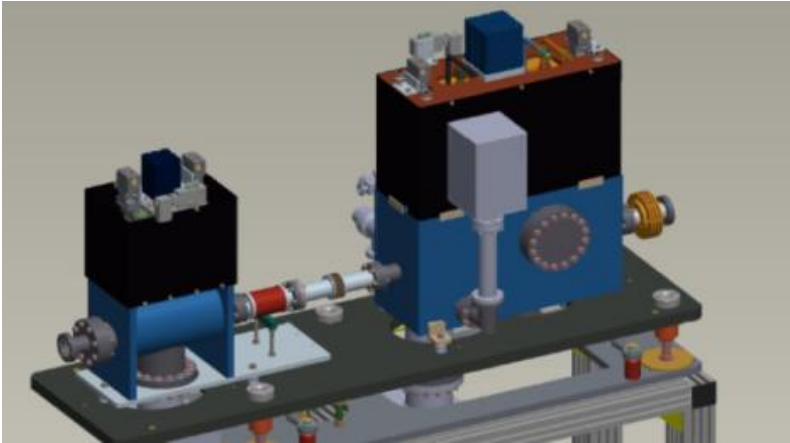
- Founded in 1953
- Over 30 years experience in vacuum technology and mechanics
- Family business for 3 generations
- Locations in Alzenau and Schöllkrippen (ca. 40 km to Frankfurt Airport)
- 60 employees (engineers, technicians etc.)



# Key technologies

## All-in-one solutions

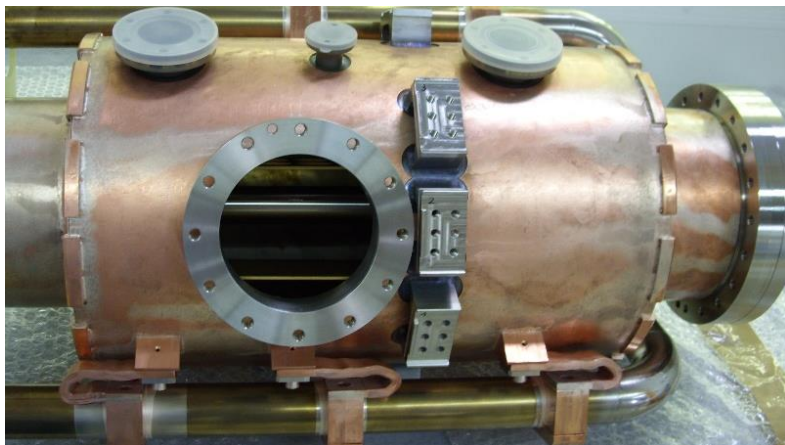
Engineering



Machining



Joining



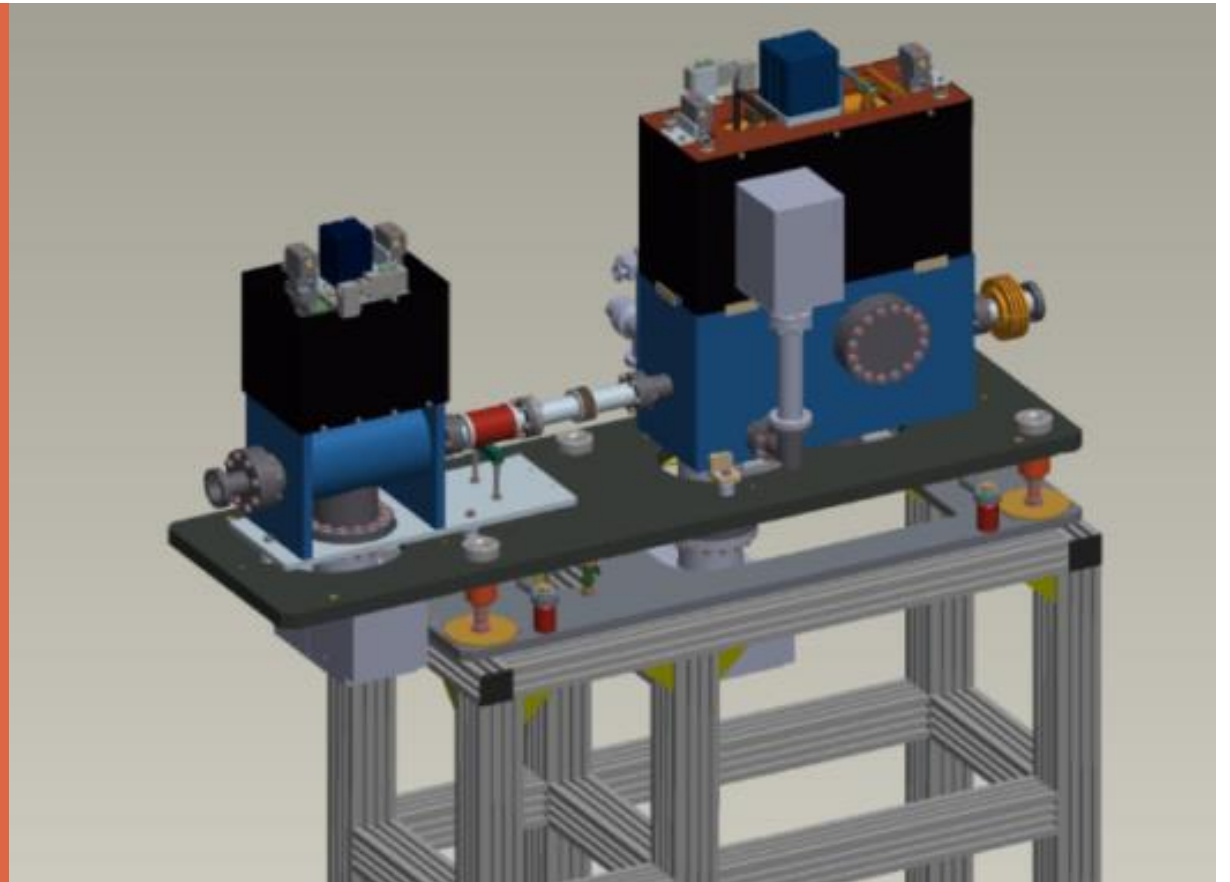
Assembly



# Research and Development

- Mechanical design with SolidWorks and Creo
- Thermal simulations
- Process development and qualification
- Feasibility studies
- Manufacturing engineering

→ CAD model of a beamline front end



# Precision machining

- CAD/CAM programming
- 5-axis milling
- CNC turning
- Surface finishing



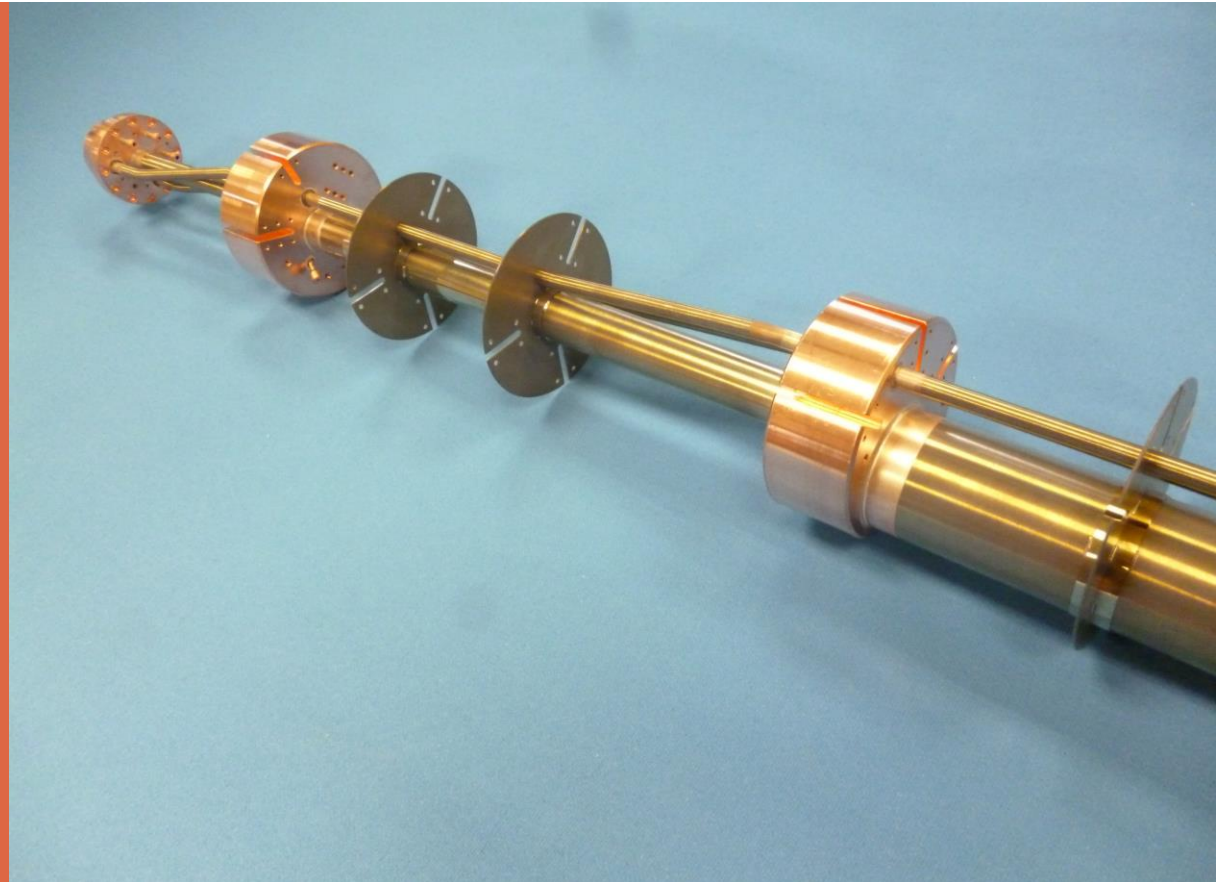
→ 5-axis machining of copper



# Joining technologies

- Vacuum brazing
- Laser welding
- TIG welding
- Flame brazing
- Soldering
- Shrinking

→ Brazed and welded sample tubing



# Vacuum brazing

Furnace technologies:

- Graphite furnace, full metal furnace

Usable volume:

- From 300 x 300 x 400 mm up to 900 x 900 x 1.800 mm

Process conditions:

- Temperatures up to 1600 °C
- Base pressures up to 10<sup>-6</sup> mbar

Process gases: N<sub>2</sub>, H<sub>2</sub>, Ar

→ View into brazing shopfloor



# Assembly

- Assembly of small and large components for HV and UHV applications
- Cleanroom ISO class 7, with tent up to ISO class 3
- Particle-free cleaning
- Electro-mechanical assemblies

→ Low particle cleaning of UHV component

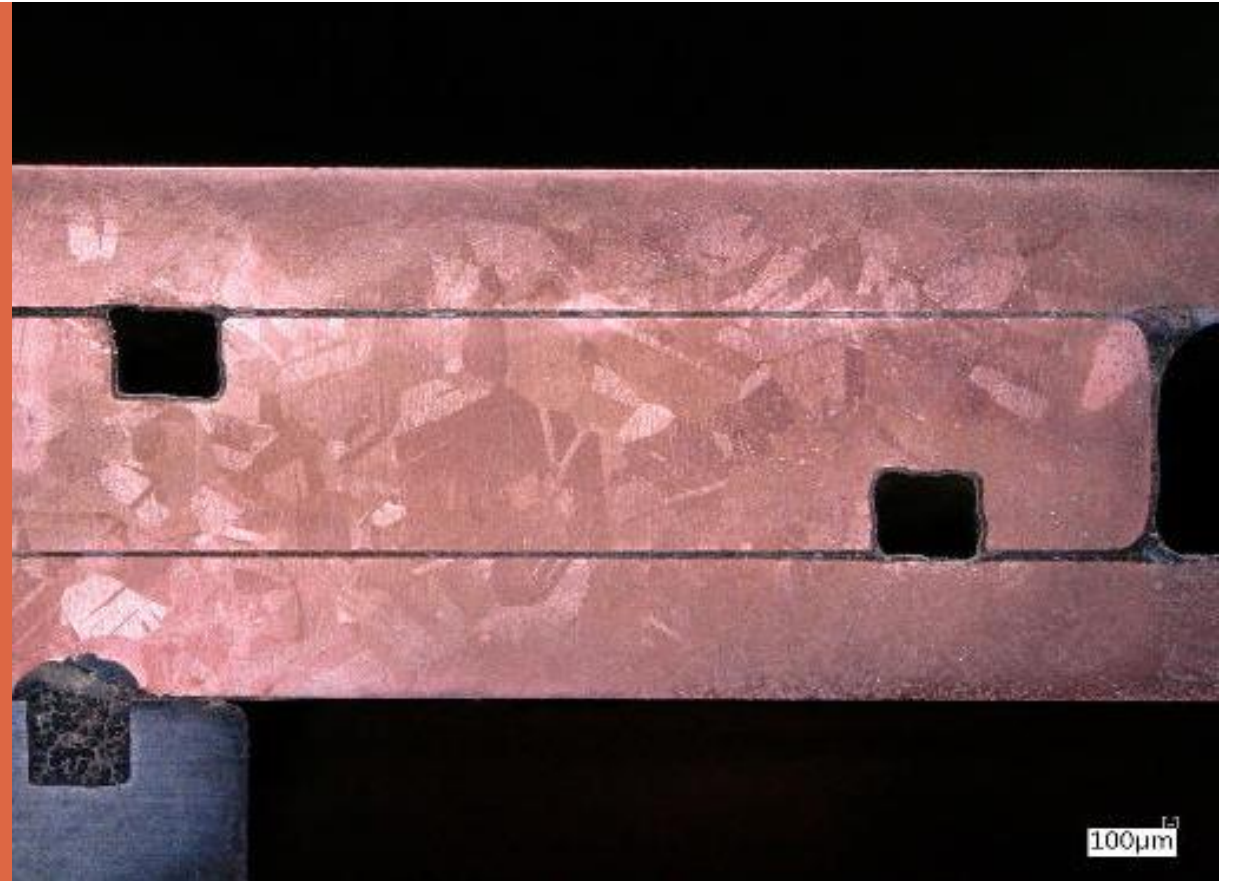




# Tests and documentation

Helium leakage test  
Flow-through test  
Quantitative residual gas analysis  
Metallographic analysis  
Permeability measurement  
Particle counting

→ Metallographic inspection of brazed joints

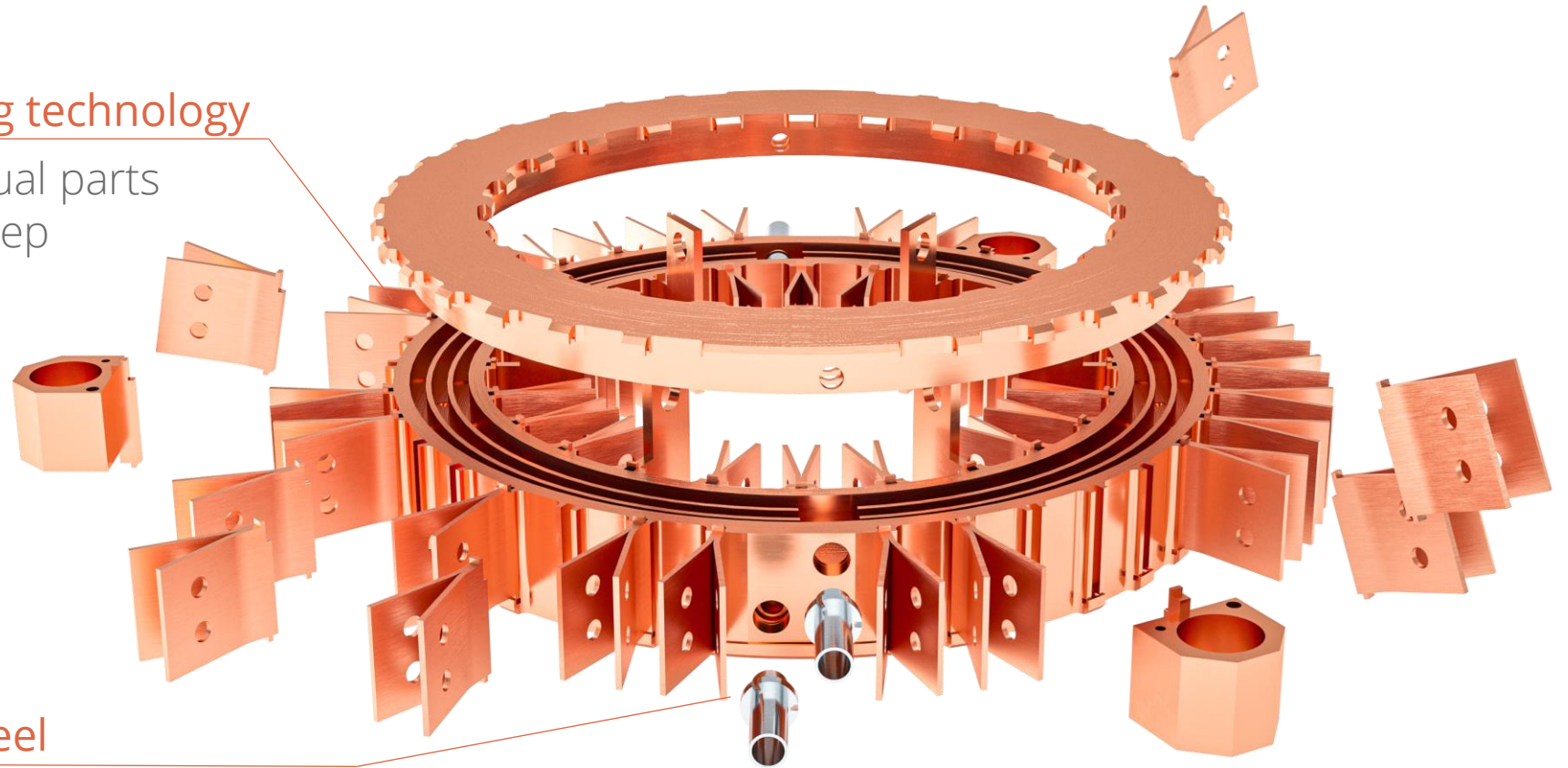


# Precise brazing of complex copper structures

## Cooling disc for a LHe cryostat

### High-precision brazing technology

More than 100 individual parts  
brazed in one single step

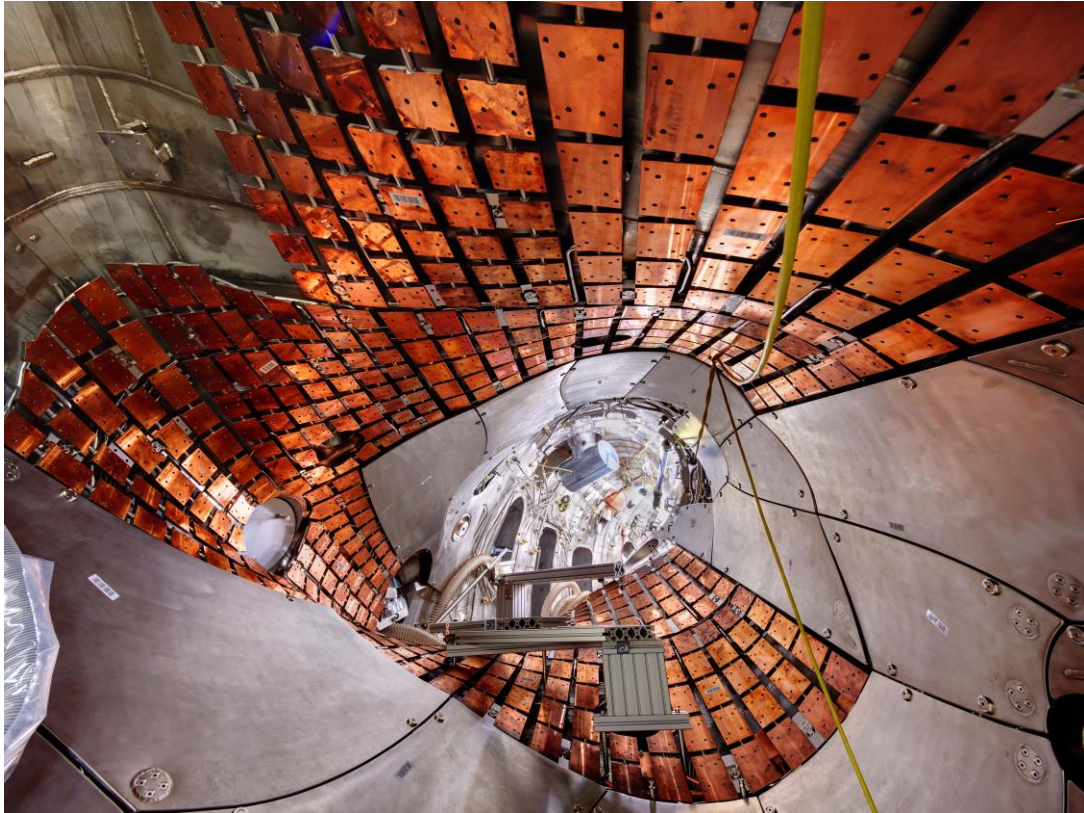


### Copper & stainless steel

Vacuum-brazed for high  
mechanical stability

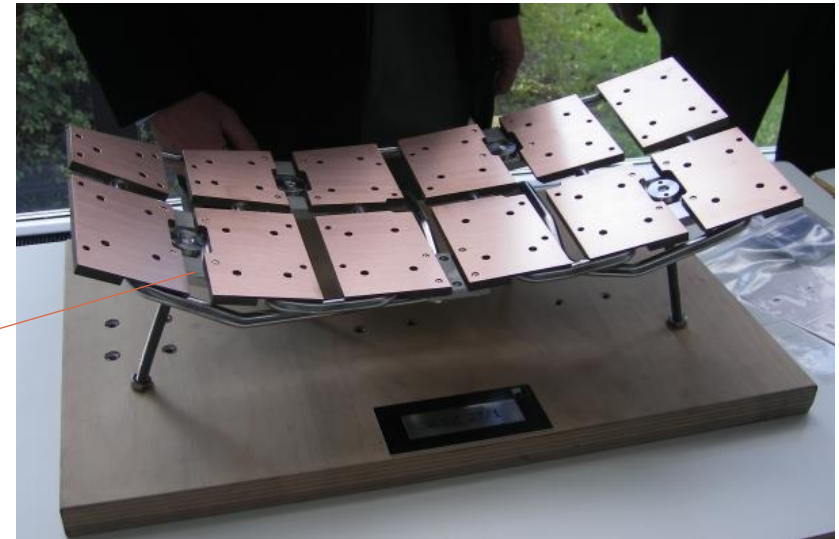
# Vacuum brazing in reliable quality

Heat shield tiles for fusion research (W7X)



## Reliable and repeatable processes

Continuous production of > 8000 pcs over 2 years



## Material combinations

Full-surface vacuum-brazing of copper plates to stainless steel pipes

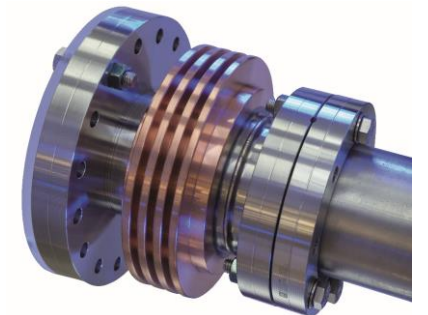
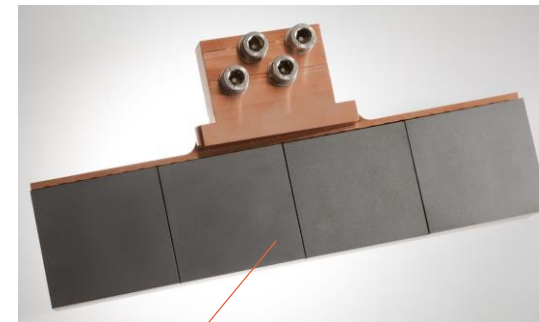
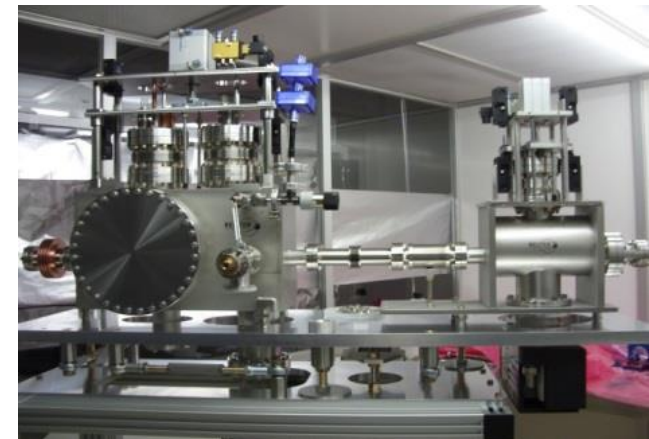


# UHV assemblies for particle physics

Front ends for the beamlines at European XFEL

Engineering from scratch

According to customer specification



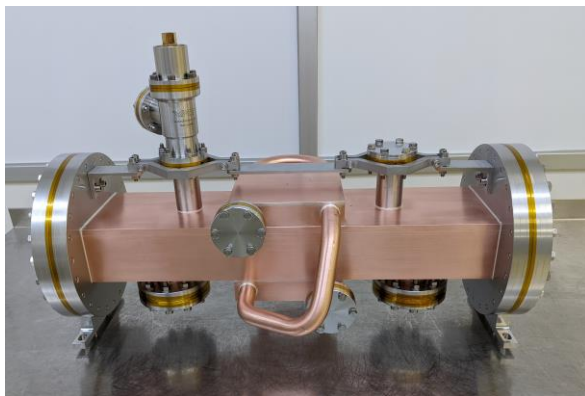
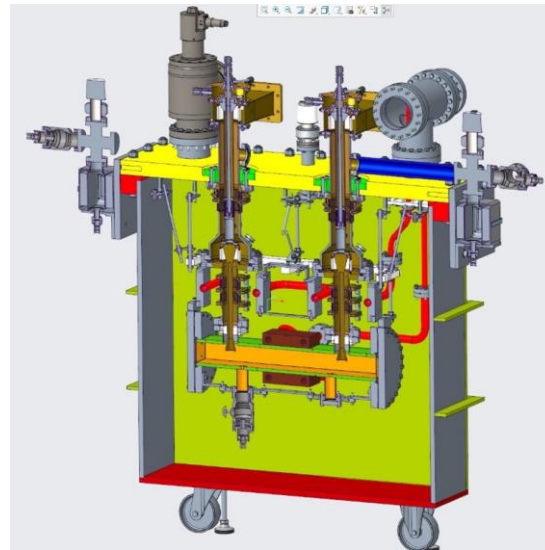
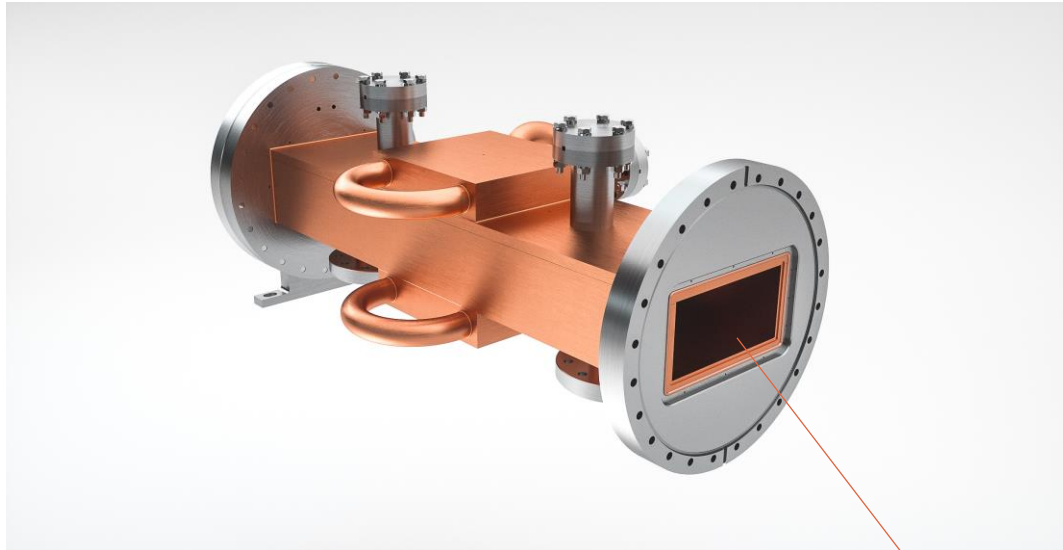
Different brazing combinations

Copper-B4C / copper-stainless steel



# Cryogenic solutions

## Test box for qualification of RF couplers



Precision machining  
of RF surfaces

UHV-suitable brazing & assembly  
Leak rate  $< 1E-10$  mbar $\cdot$ l/s



# SMEs in Big Science

## Challenges

- Very intensive communication in all project phases, especially during RFQs / tender phase
- Each science facility has its own purchasing conditions and requirements (sometimes changes are possible & desired, sometimes forbidden)
- Lot of implicit requirements – not everything is shown in drawings
- Combining industrial series production with Big Science works on the same machines requires good planning

# SMEs in Big Science

## Opportunities

- Increase knowledge and competence
- Participate in projects for tomorrow
- Good network

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