TECHNOLOGY FOR EXCELLENT SCIENCE

PROF. DR. GHALEB NATOUR

ZEA-1 | Central Institute of Engineering, Electronics and Analytics | ZEA

Engineering and Technology | ZEA-1

Technology for Excellent Science

Faculty of Mechanical Engineering | RWTH AACHEN UNIVERSITY

FZJ INSTITUTES

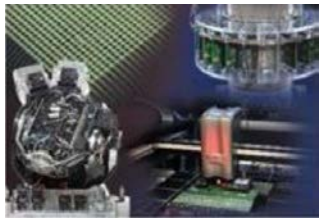
10 Institutes
(ar. 50 Sub-Institutes)

- Central Institute of Engineering, Electronics and Analytics (ZEA)
- Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C)
- Institute for Advanced Simulation (IAS)
- Institute of Bio- and Geosciences (IBG)
- Institute of Complex Systems (ICS)
- Institute of Energy and Climate Research (IEK)
- Institute of Neuroscience and Medicine (INM)
- Jülich Centre for Neutron Science (JCNS)
- Nuclear Physics Institute (IKP)
- Peter Grünberg Institute (PGI)

ZEA AT A GLANCE

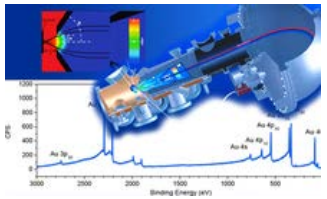
ZEA-1 Engineering and Technology (Prof. Dr. Ghaleb Natour)

- Design, Engineering, Manufacturing and Assembly
- Ca. 150 R&D Employees
- Partnership: with all 9 FZJ Institutes
- Affiliations with RWTH Aachen and FH Aachen



ZEA-2 Electronic Systems (Prof. Dr. Stefan van Waasen)

- Electronic Systm Engineering
- Ca. 70 R&D Employees
- Partnership: with 7 FZJ Institutes
- Affiliations with University Duisburg-Essen, RWTH Aachen



ZEA-3 Analytics (Dr. Stephan Küppers)

- Analytical Method Development and Service Provider
- Ca. 26 R&D Employees
- Partnership with 6 FZJ Institutes

250 Experts,
mechanical engineering, electronic systems and analytics
Partnership with all FZJ Institutes
affiliated with different Universities

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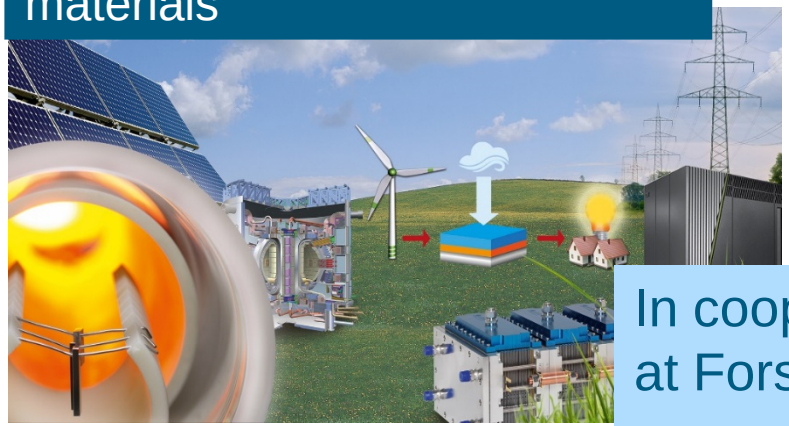
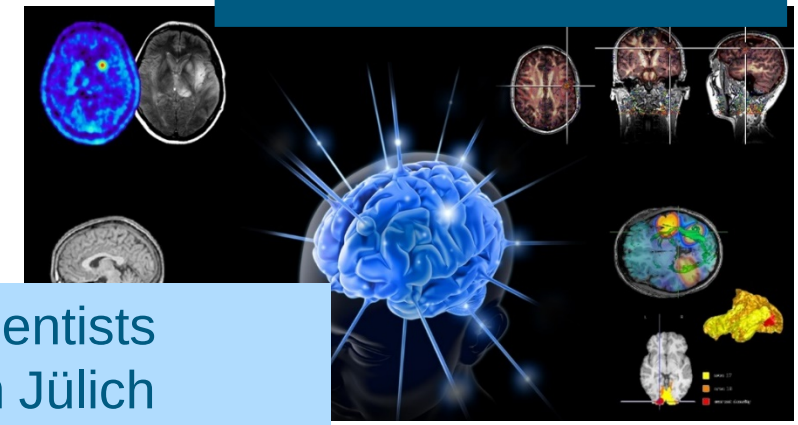
RESEARCH AT FZJ AND ZEA CONTRIBUTIONS

Energy conversion and storage materials



Brain and neuroscience



Information

In cooperation with scientists at Forschungszentrum Jülich

develops and builds:

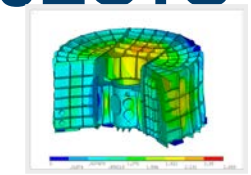
- Devices/Instruments
- Processes
- Measuring and control equipment
- Detector systems
- Imaging techniques

required for excellent science and are not available on the market

Atmosphere, climate resear / Earth and envirnoment

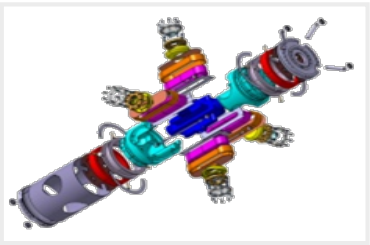
Nuclear physics Neutron science

OVERVIEW RESEARCH AREAS AND PROJECTS



Neutron Science (JCNS, MLZ-FRMII, SNS, ILL and ESS

- Instruments and Target components for advanced Neutron sources
- Choppers for Neutron scattering (magnetic bearing)



Hadron Physics (IKP, COSY, HESR, PANDA, PAX)

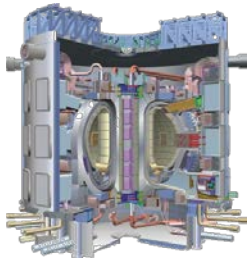
- Accelerator components (magnets, cooler units)
- Detector systems for Proton – and Antiproton beams

Neuro Science (INM: Institutes for Neuroscience and Medicine)

- Hardware and system aspects for MRT- PET- set ups

Climate (IEK: Institutes for Energy and Climate Research) GLORIA, HALO, PEGASOS

- Setups for investigatin of processes in the atmosphere, atmosphere simulation champers



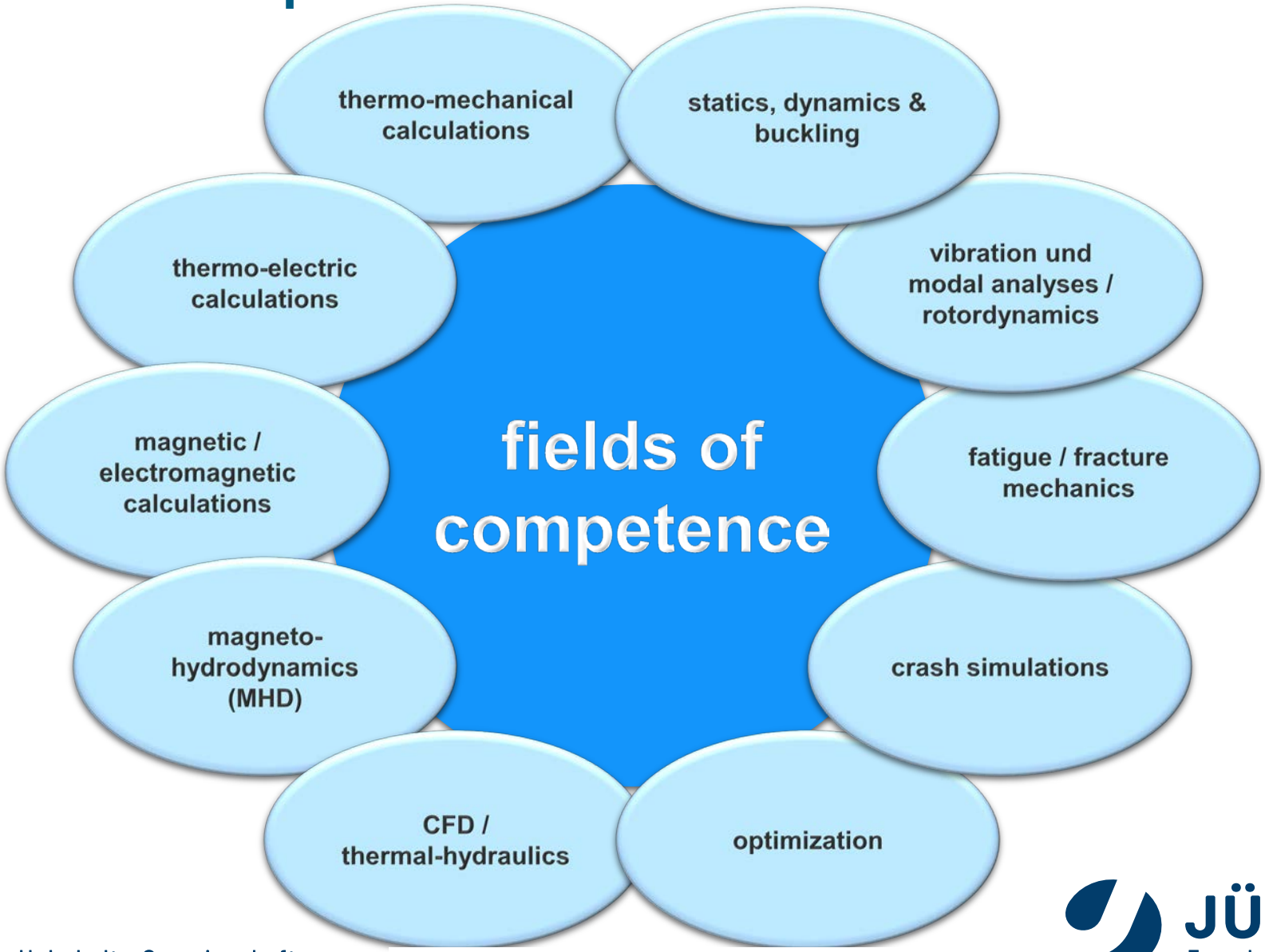
Energy (IEK: Institutes for Energy and Climate Research) W7-X, ITER

- Instruments for Nuclear Fusions Research
- material science and joining technologies and measurement technologies for photovoltaic, full cells, electrolysis and battery research

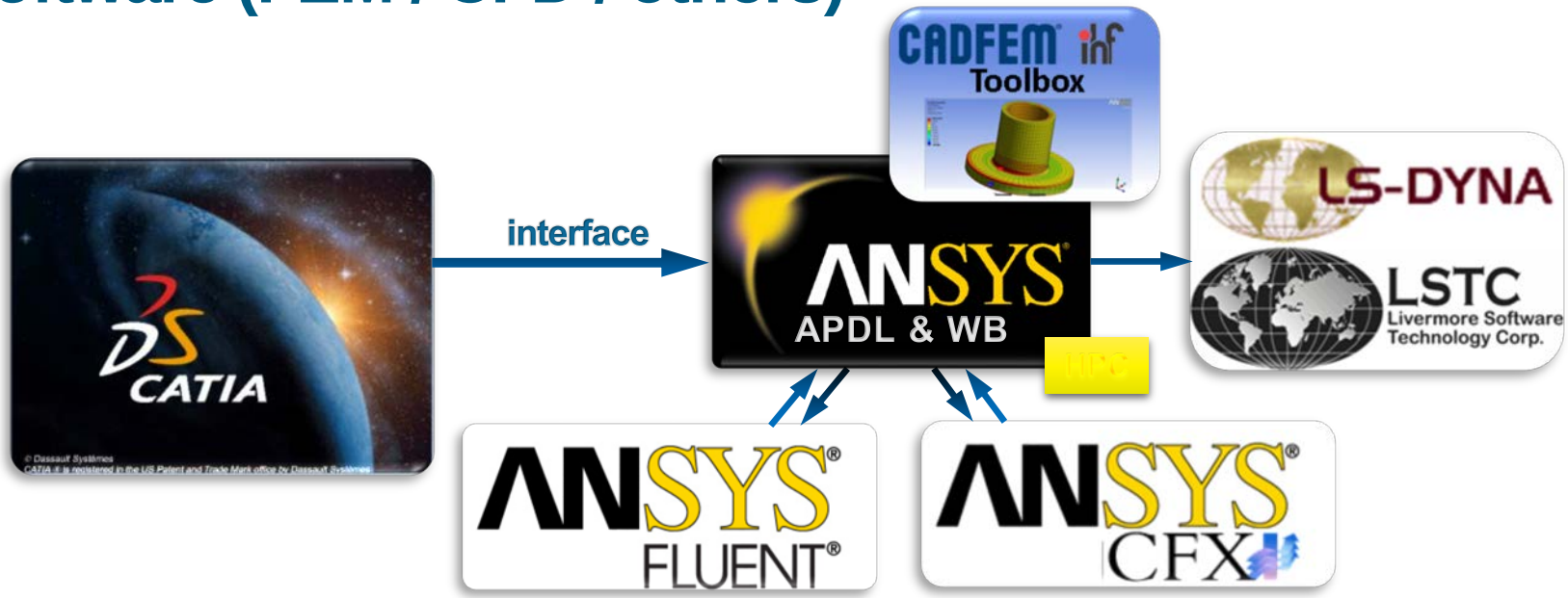
Bio-Geo Science (IBG: Institute for Bio- und Geo Science)

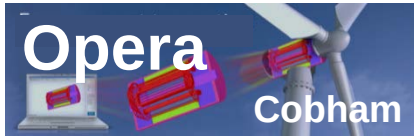
- Equipment and instrumentation for plant and soil investigations

Simulation and calculation
Fields of Competence

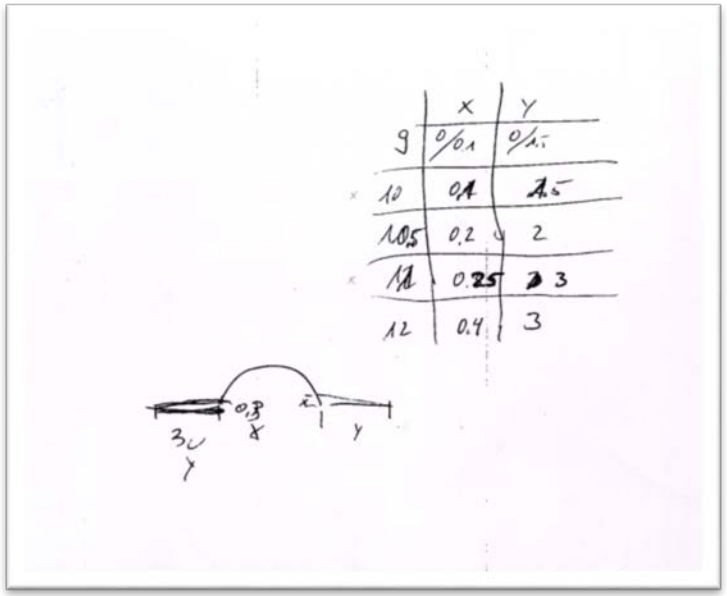


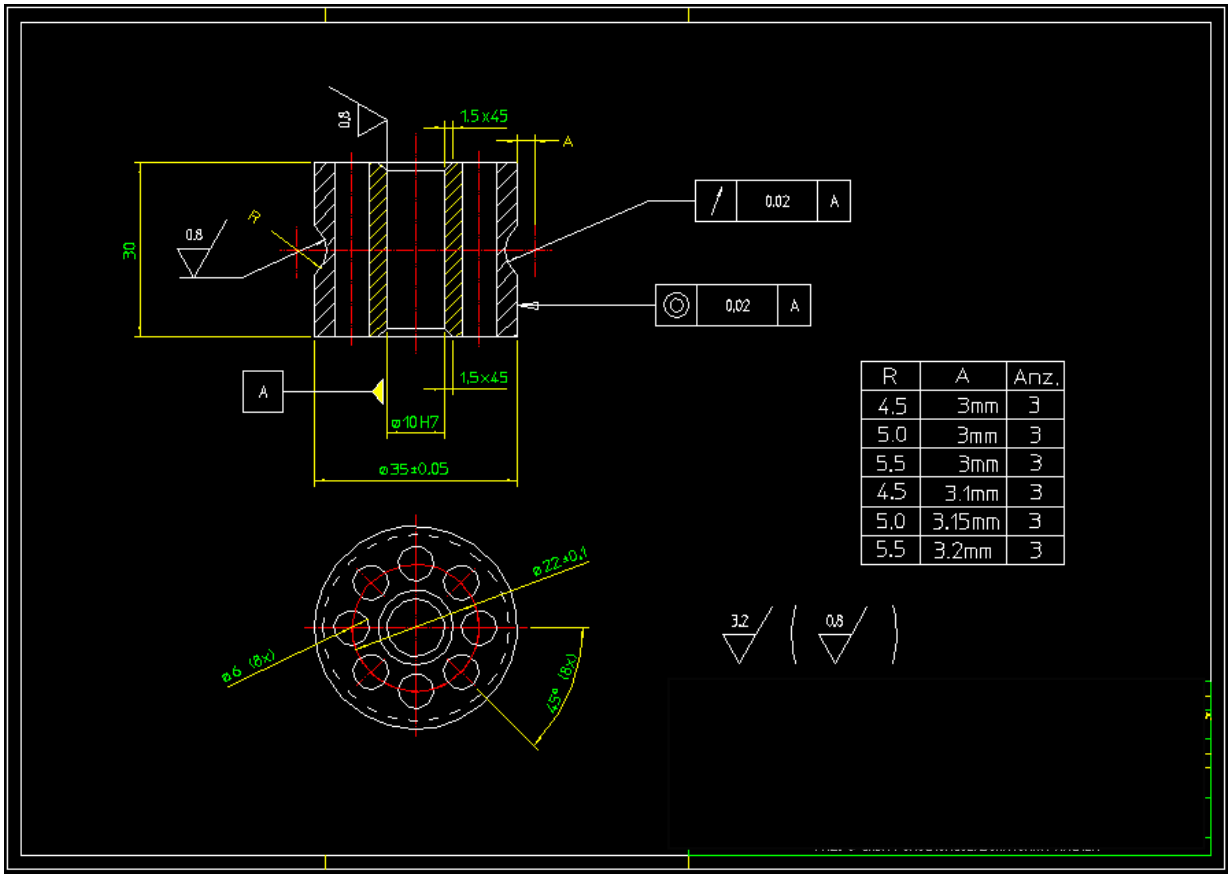
Calculations and numerical Simulation Software (FEM / CFD / others)





TRANSLATION OF ABSTRACT IDEAS





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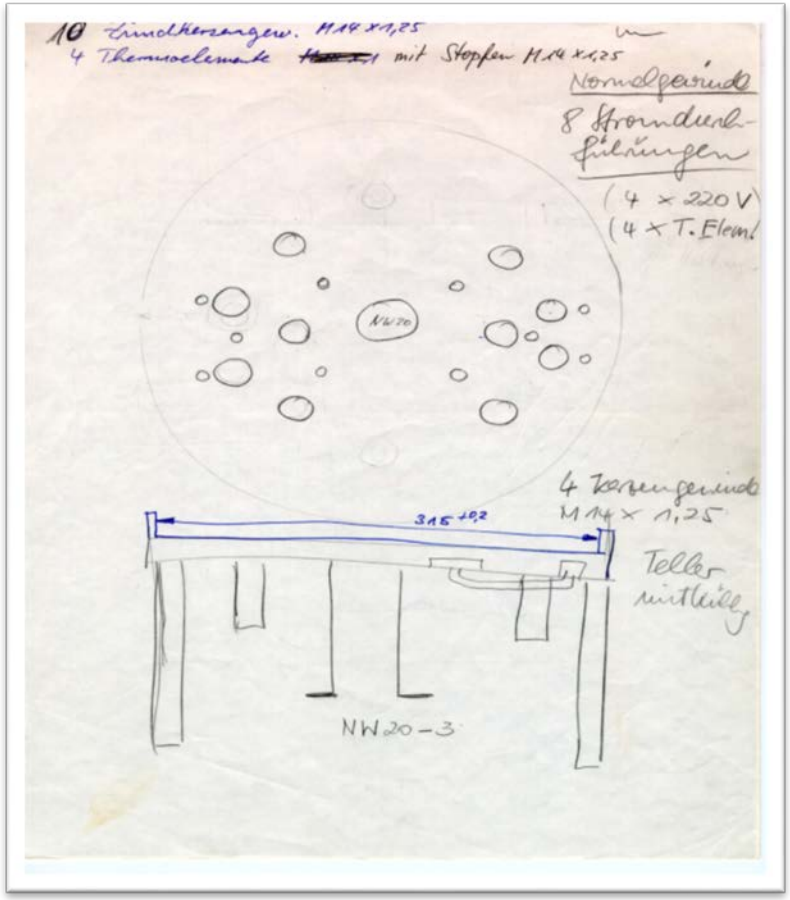
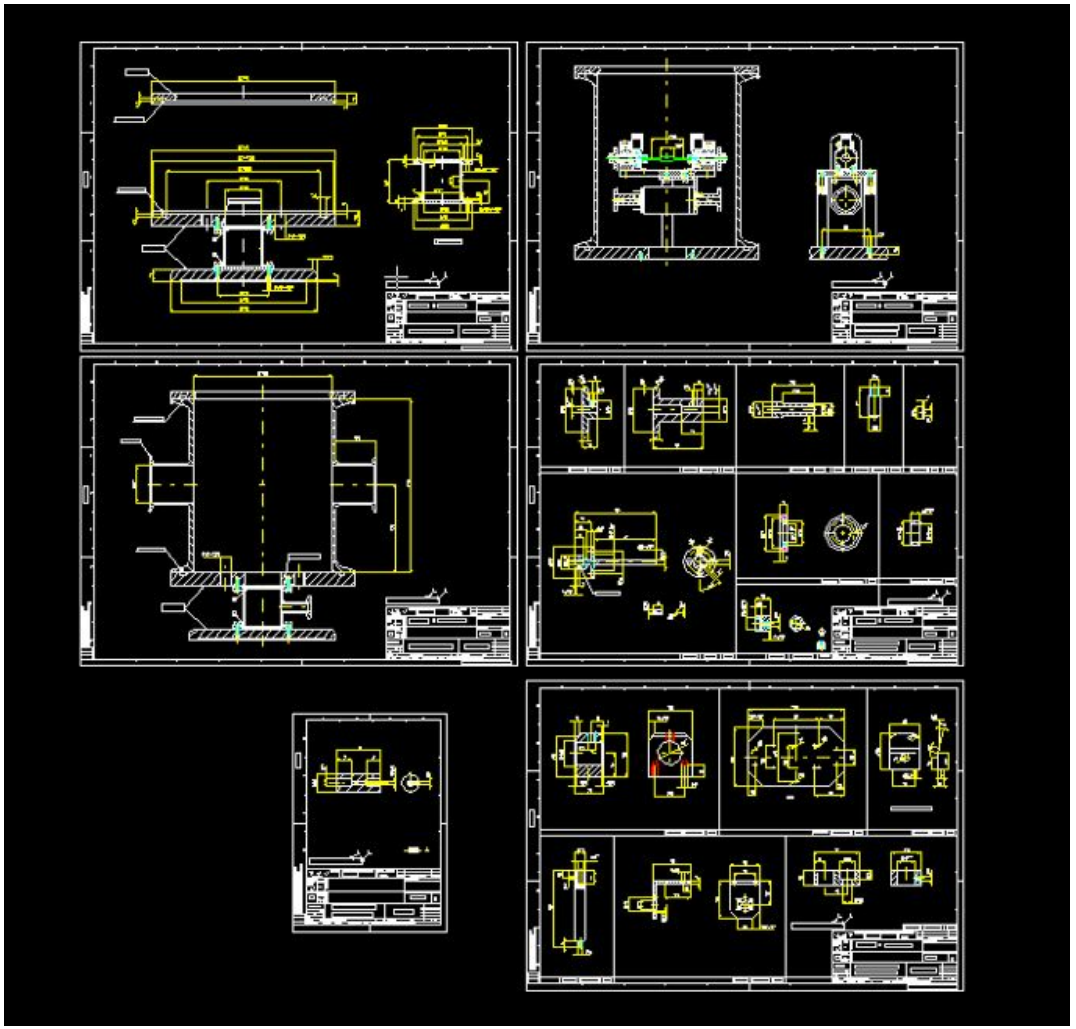




TOPAS
FIRST CUSTOMER/PARTNER INPUT

12.3.07

Raumplan:

1) Vakuumgefäß / Spektrometergehäuse

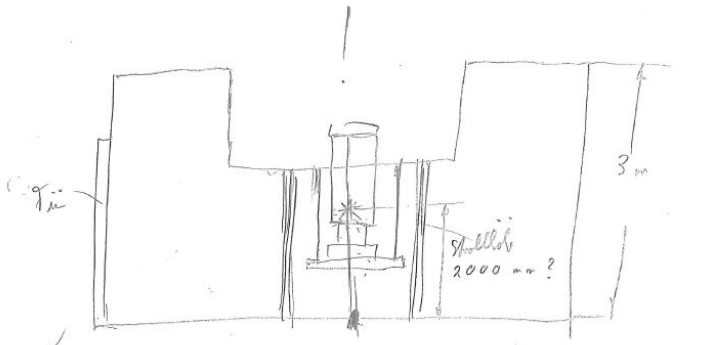
Ø: 6 m · Höhe ca. 3 m
Radius der Deckeltüren 2,5 m · Deckeldurchm. Ø 25 mm
Strahlöle in der Halle Höhe 2 m muß ermittelt werden.

Abschirmung: 200 mm PE-Platten mit Borcarbid
Bodenabschirmung mit PE-Platte (Dicke ?)
Decke muß auch mit 200 mm PE-Platten abgeschirmt werden.
Abschirmung gegen γ-Strahlung ist noch nicht entschieden. Muß noch festgelegt werden.

Alternatives Gelände:
Boden mit PE-Platten.
Doppelwandiges Gefäß mit Borwasser.
Keine Korrosion.

12.3.07

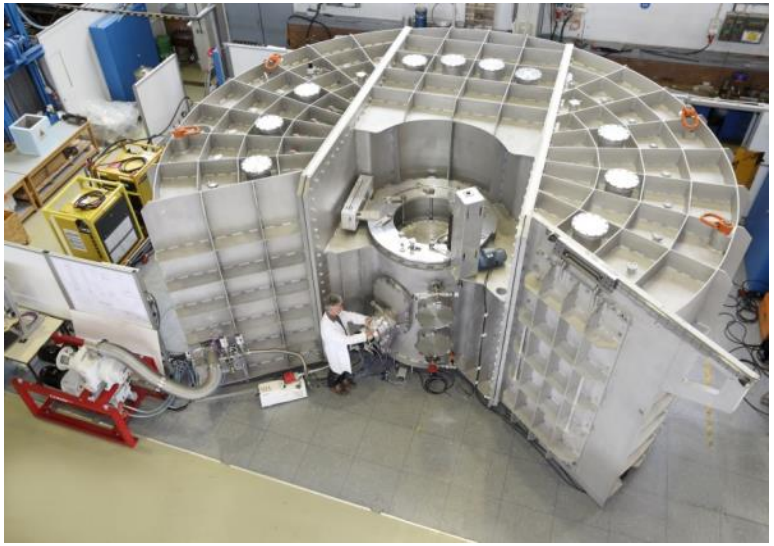
Spektrometergehäuse muß begehbar sein.
Seitliche Tür.



Probenumgebung:
Probe 1 cm³ muß gewährleistet sein, daß sie im Strahl steht.
Beweis: Detektor oder Manipulator
Hexapod

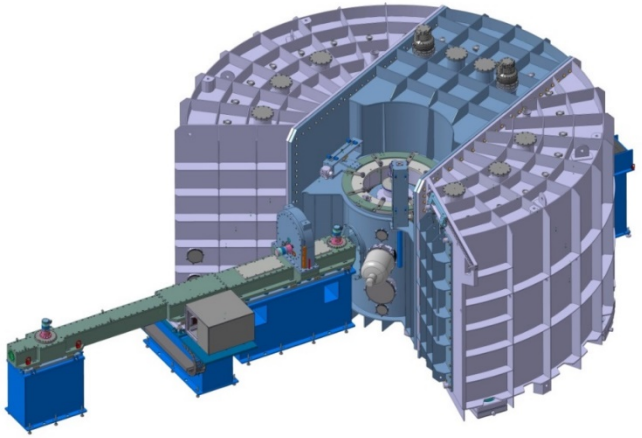
von oben.

Time Of Flight Polarization Analysis Spectrometer - TOPAS

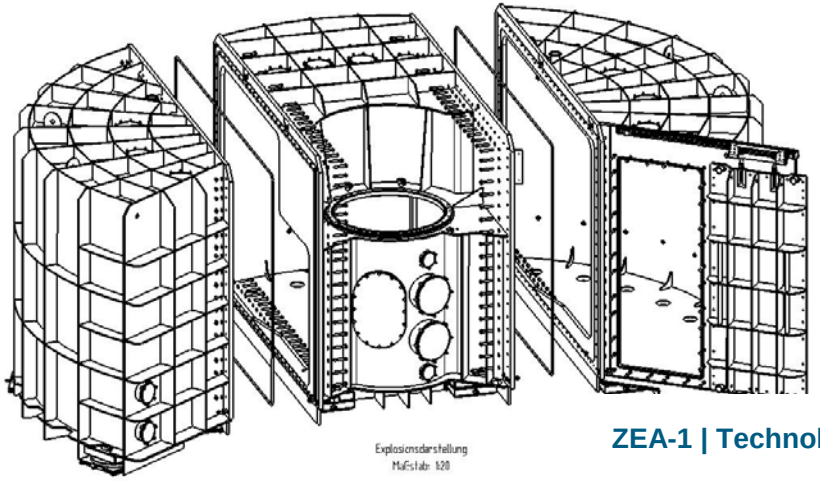


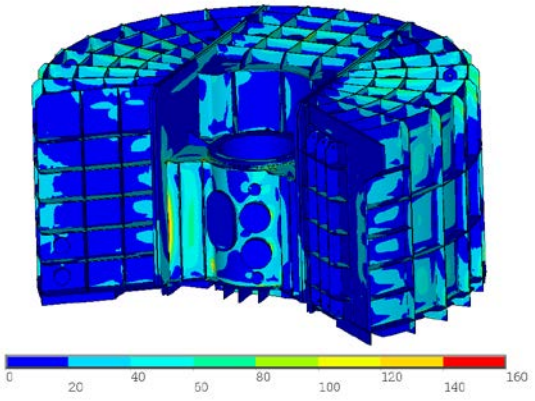
50 tons steel, 50m O-ring sealing ,
3 km welding seam
(deformation of 5mm at 4m length)

Ø 6,5m **Volume 76m³**



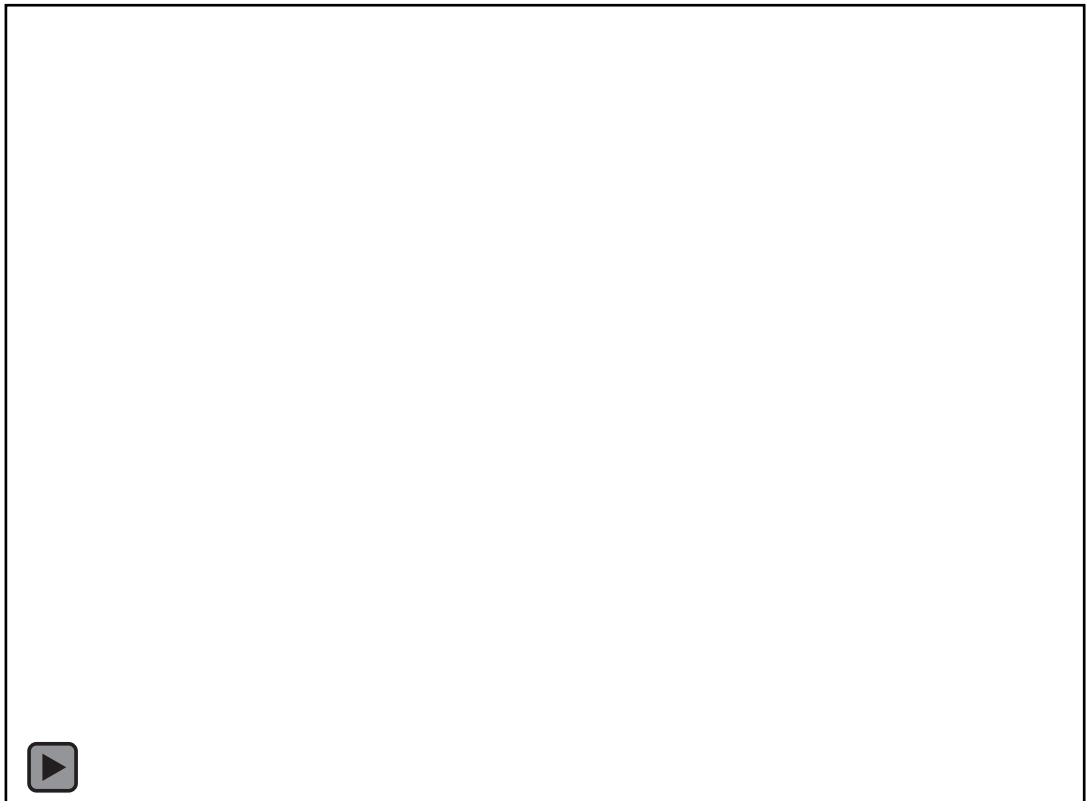
Vacuum < 10^{-5} mbar





ZEA-1 CONTRIBUTIONS

- Vacuum chamber
- Probe chamber
- Vacuum system
- Detector mountings
- Coil arrangement
- Chopper cascade
- Polarisation unit



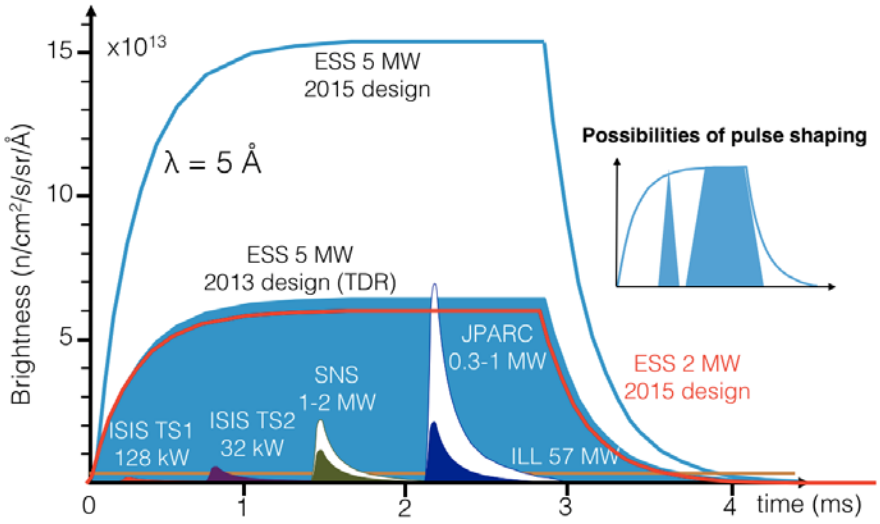
– Consulting
– Layout and design
– FEM calculations
– Material selection
– Manufacturing
  - welding
  - vacuum testing
  - machining
  - transport
– assembly at FZ Jülich
– control and automation
– testing/verification
– assembly at FRMII Garching

JÜLICH
Forschungszentrum

EUROPEAN SPALLATION SOURCE ESS Lund/Sweden

“world’s most powerful neutron source for enabling scientific breakthroughs in research related to materials, energy, health and the environment addressing some of the most important societal challenges of our time.”

1.84 B€ construction cost
40 European Partner institutions from 17 countries
Today 48% completed, expected start user program 2023



Brightness of ESS and different spallation spurces

ESS 3D Layout

Source: ESS www.esss.se

EUROPEAN SPALLATION SOURCE ESS

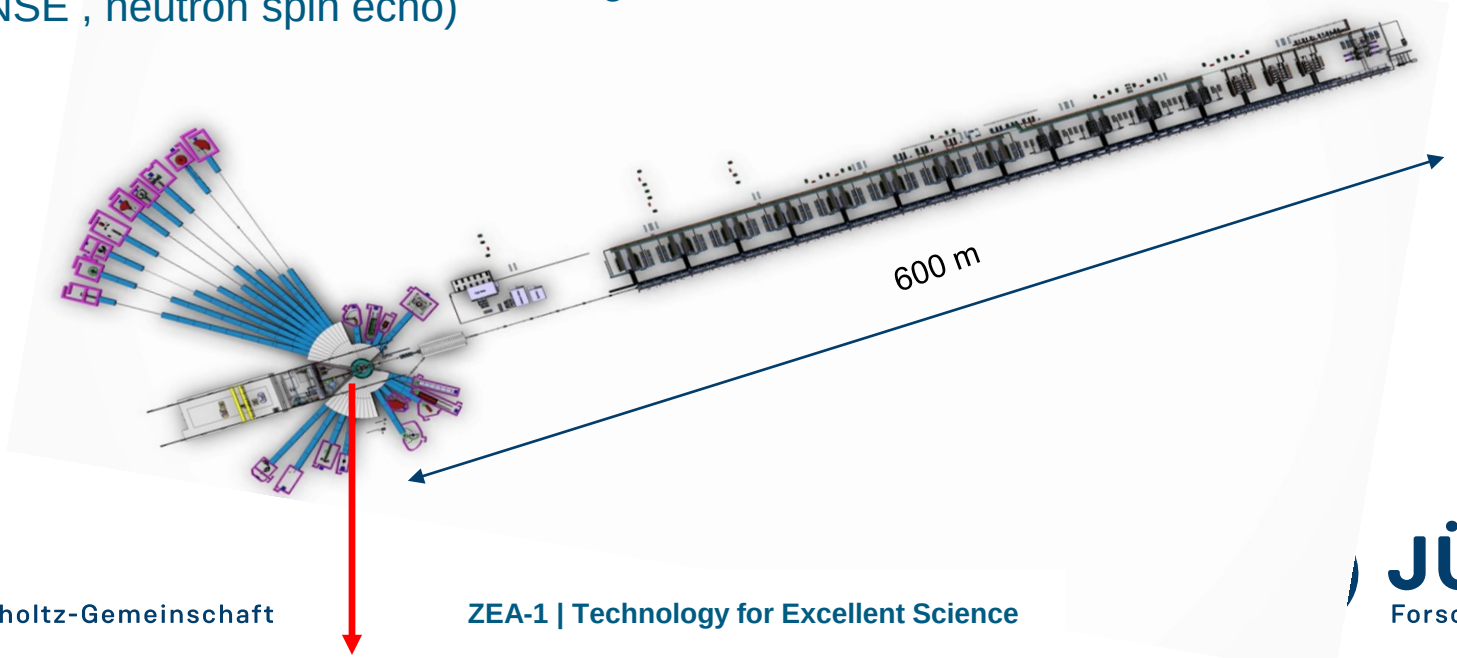
- Germany 10% of constr. Costs (180 Mio), 136 Mio IKC instrum.+target
- FZJ German coordination, ZEA-1, important partner
- ESS Industry Liaison Officer Germany

Instruments: JCNS/ZEA-1

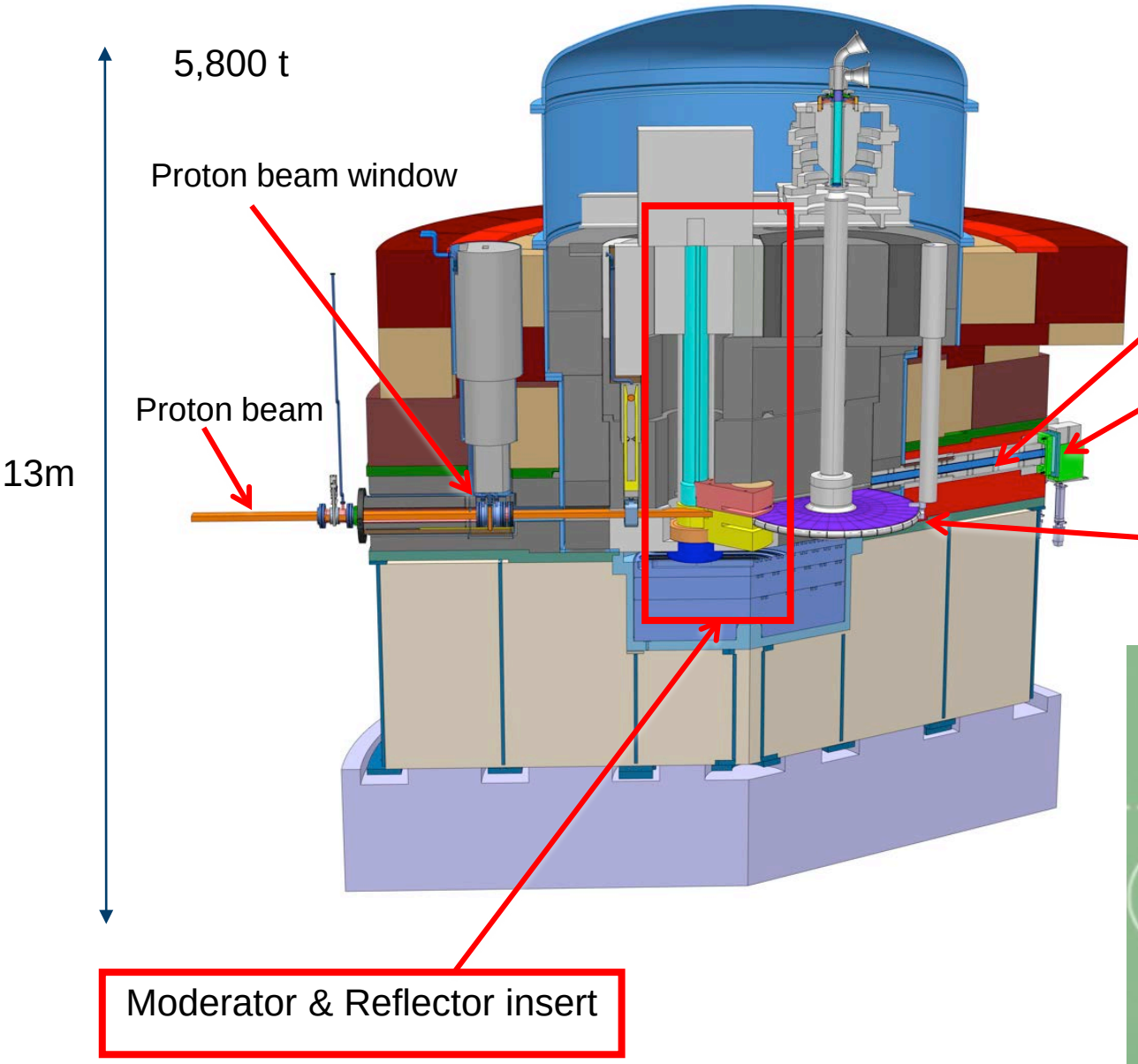
SKADI small angel scattering
DREAM, TOF difractometer
TREX, TOF polaris. spectrometer
(ESSENSE , neutron spin echo)

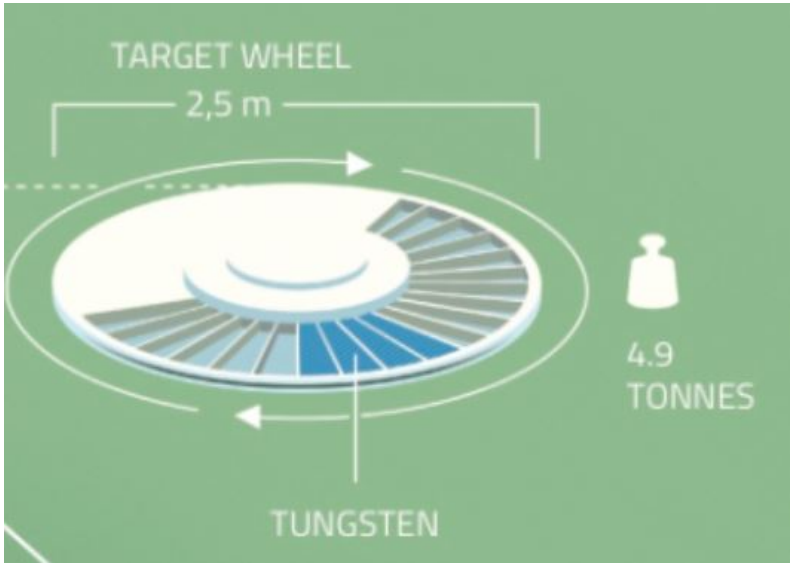
...

Chopper systems: ZEA.1
moderator/reflector plugs: ZEA-1
numerical simulation, mechanical design, joining technology, materials u. extreme conditions, set of regulations, test and measurment

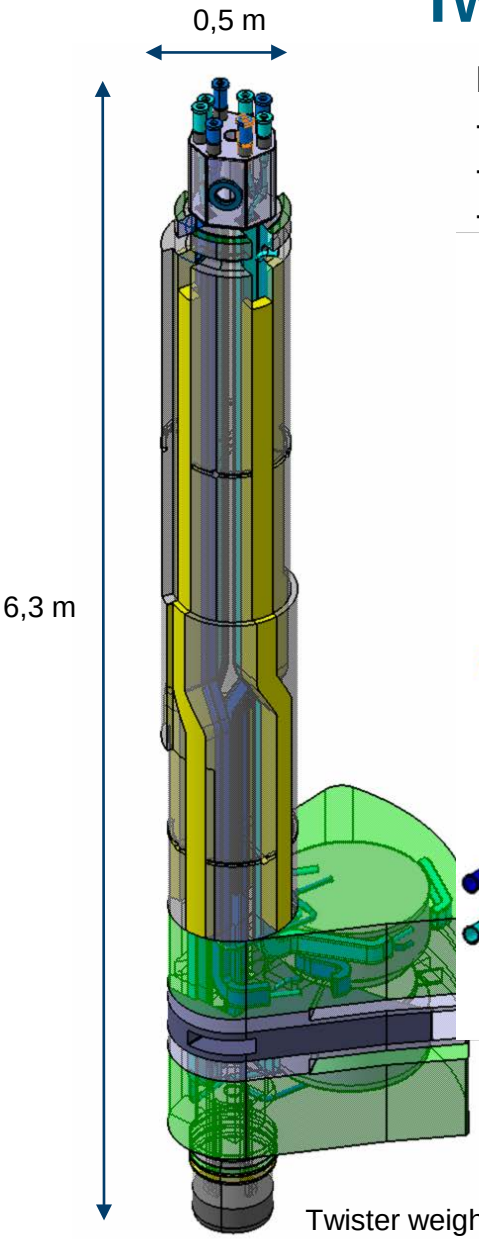


ESS Target Monolith

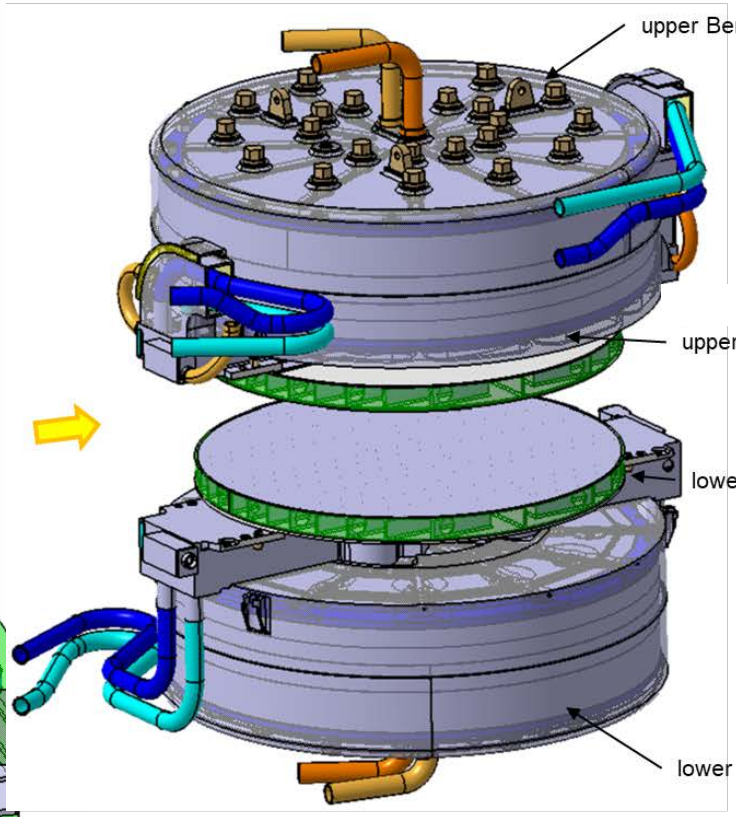




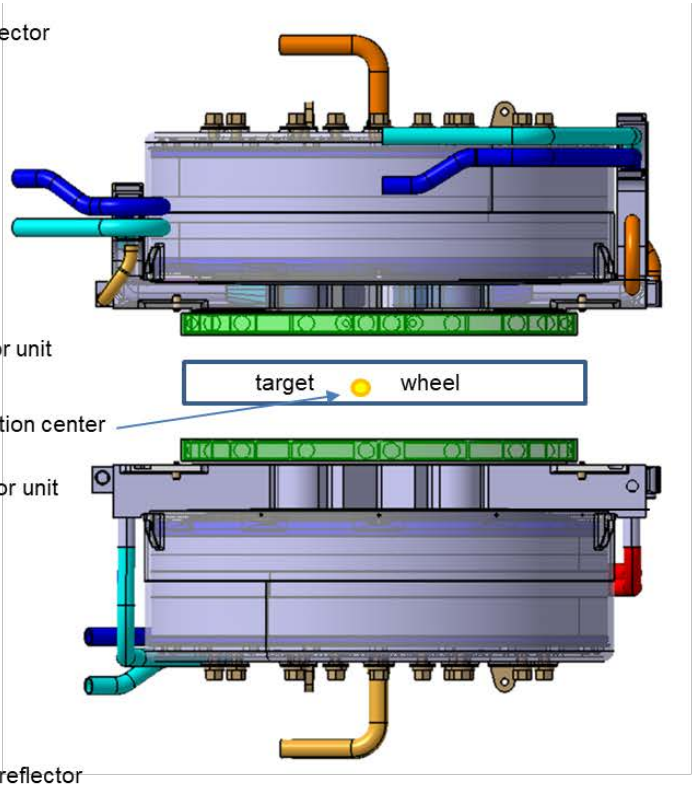
Twister: Moderator & Reflector Plug



Plug consists of
- twisting mechanism
- 2 Beryllium reflectros
- 2 moderator units Twister cost 5 M€



Isometric view



Side view

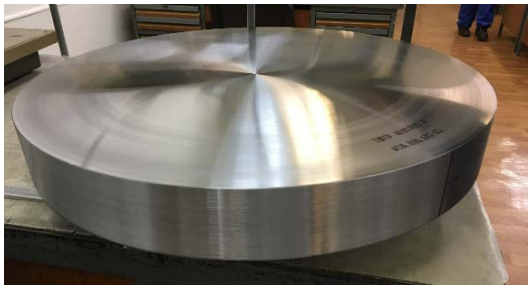
Twister weight: 13,5 t

Beryllium Reflector

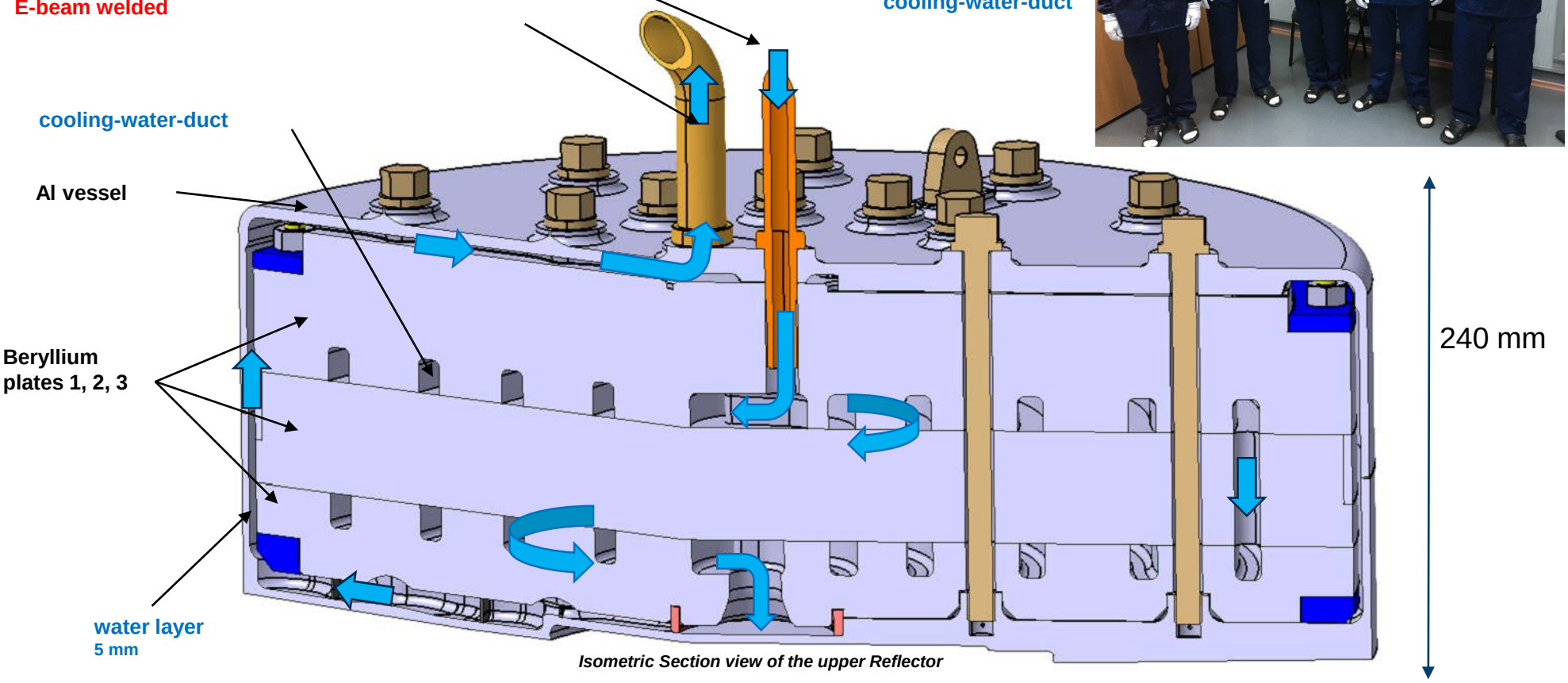
high strength Aluminum container
Strength needed for high pressure
Wall thickness as small as possible

Normally not weldable
E-beam welded

Ø 700 mm , 160 Kg pure Be

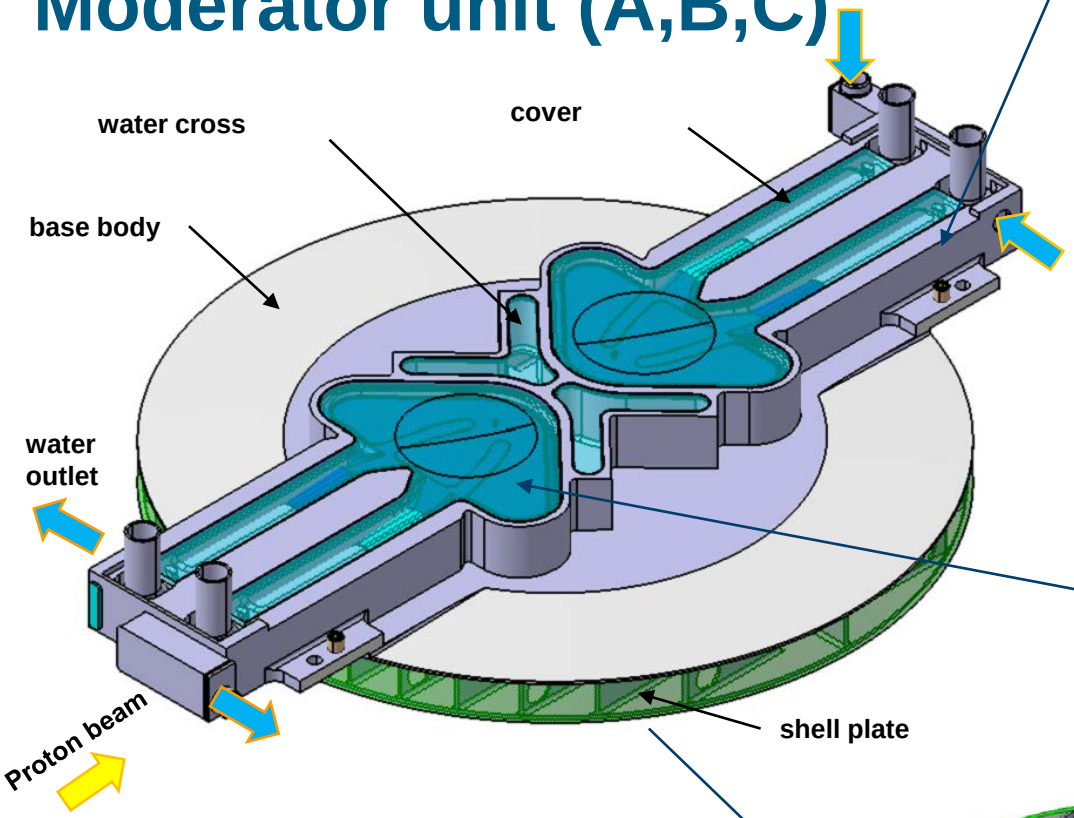


Beryllium plate 1

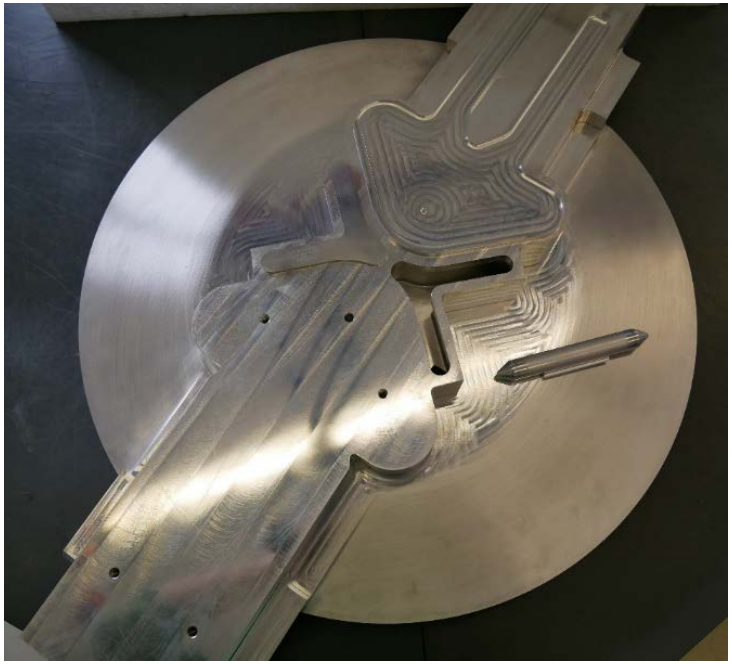


Isometric Section view of the upper Reflector

Moderator unit (A,B,C)



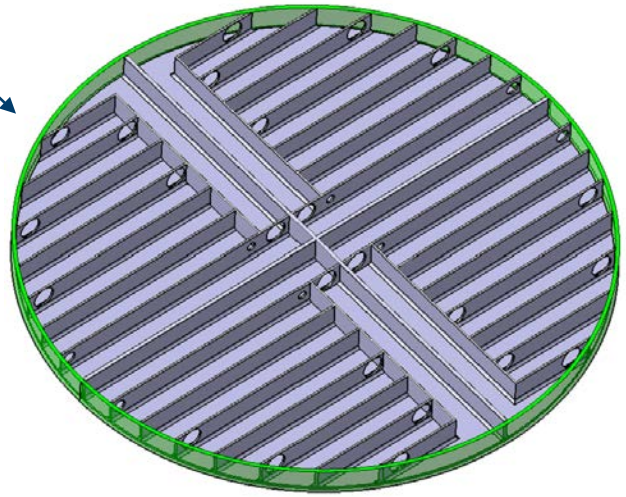
B- massiv Al housing



C- 2 cold (cooled with LH2) moderators

Moderation of neutrons
MeV → meV

A- Water cooled structure



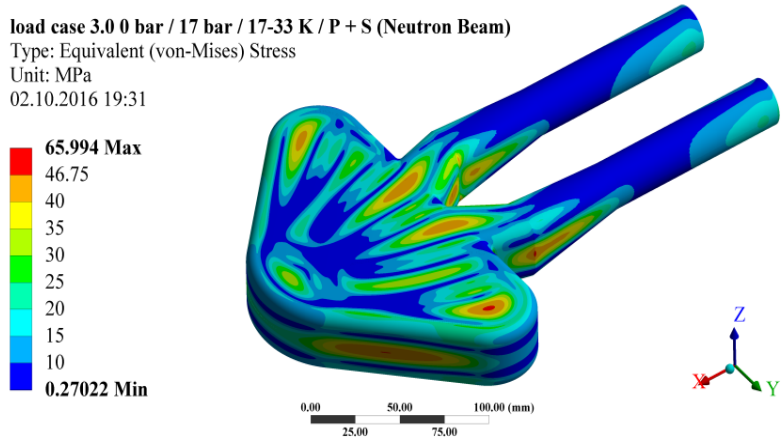
DEVSIGN AND MAKING OF COLD MODERATOR

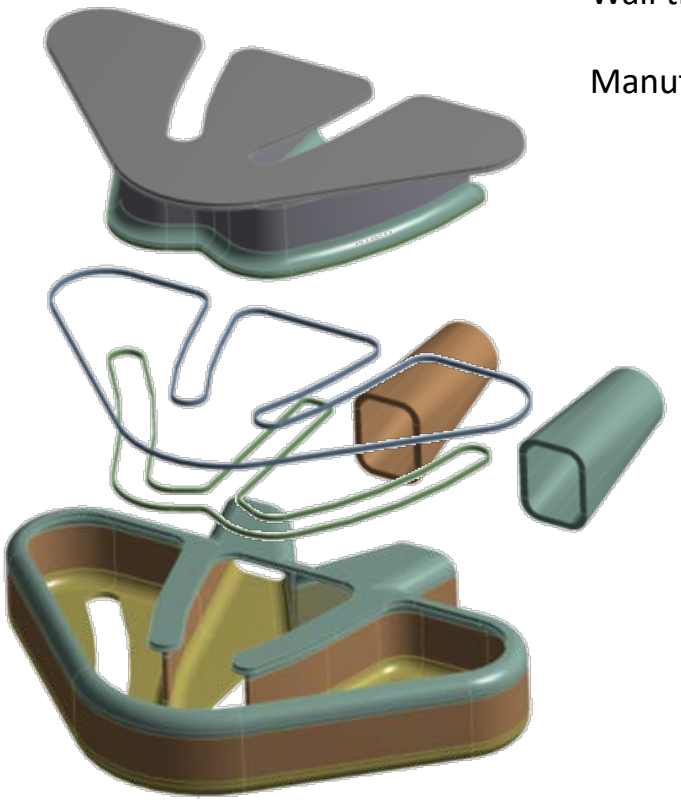
Material: Al 6061-T6 aluminum
Filler metal: AlSi12

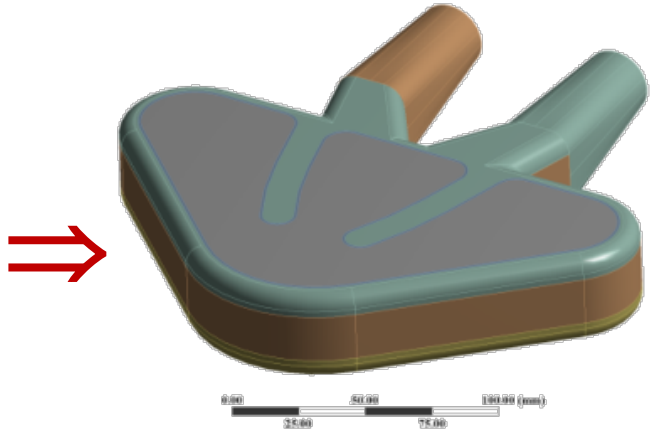
Wall thickness: 3.0 mm

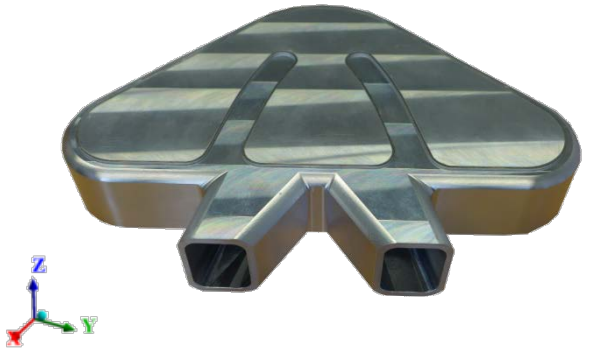
Manufacturing methods

- high speed milling
- wire-cut EDM
- laser beam cutting
- electron beam welding

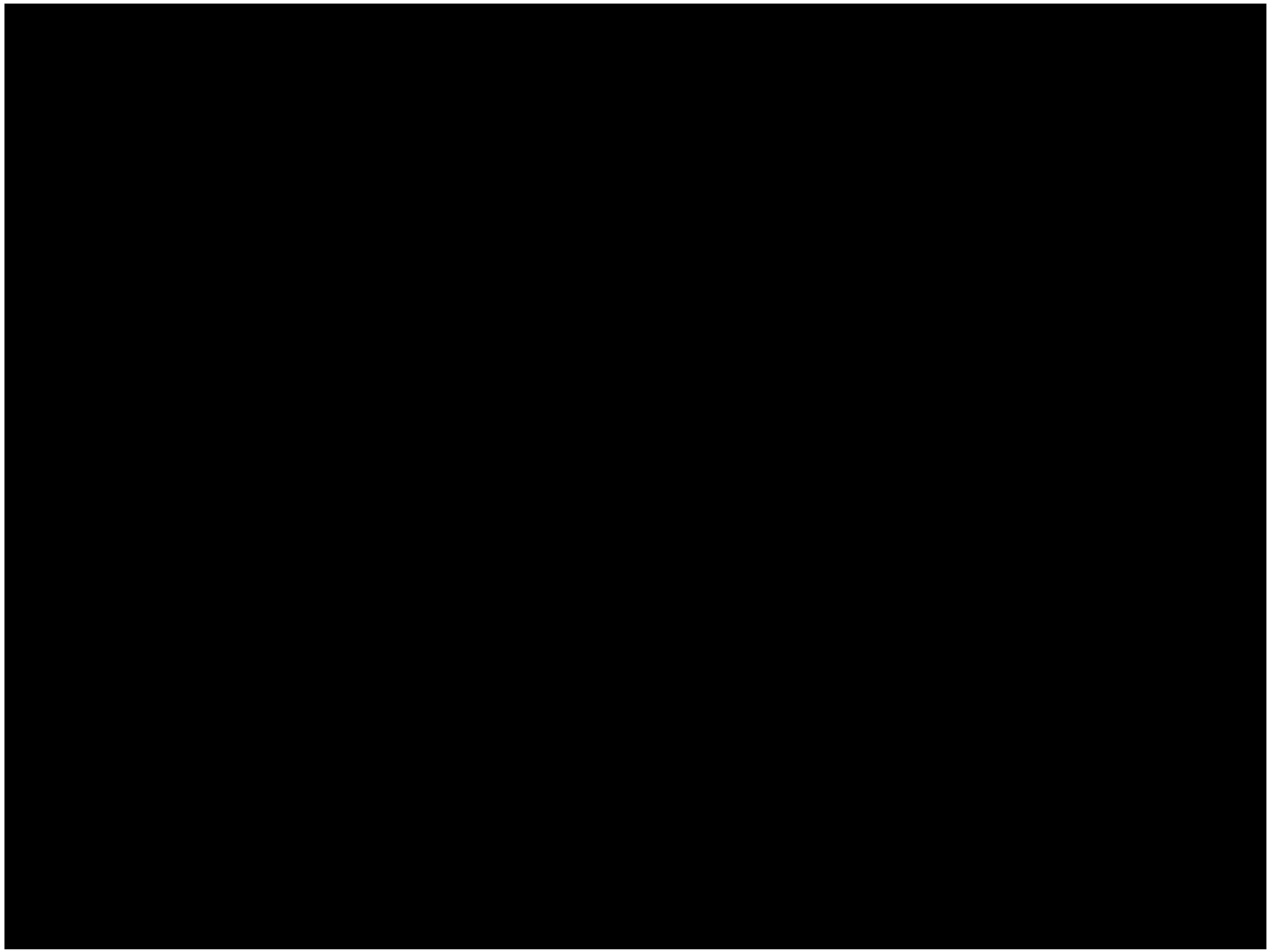




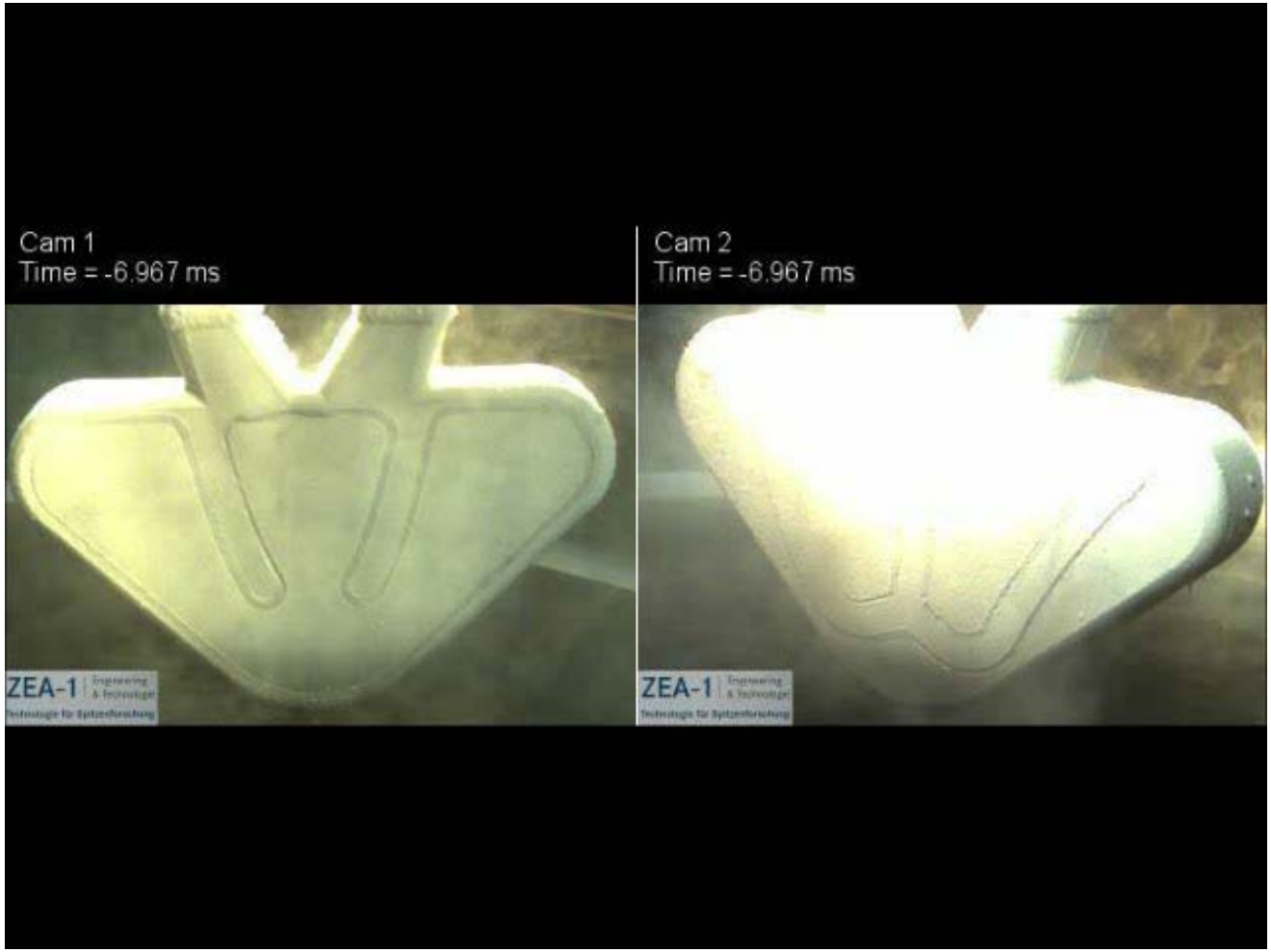




1st Burst test cold Moderator (water at room temperature)

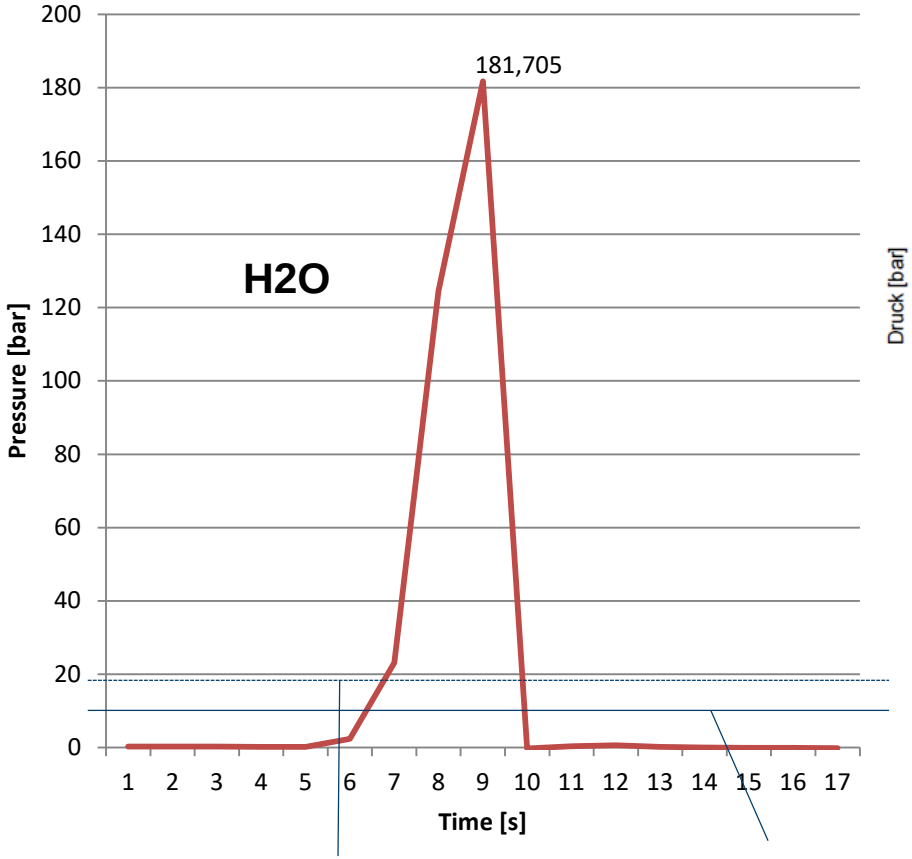


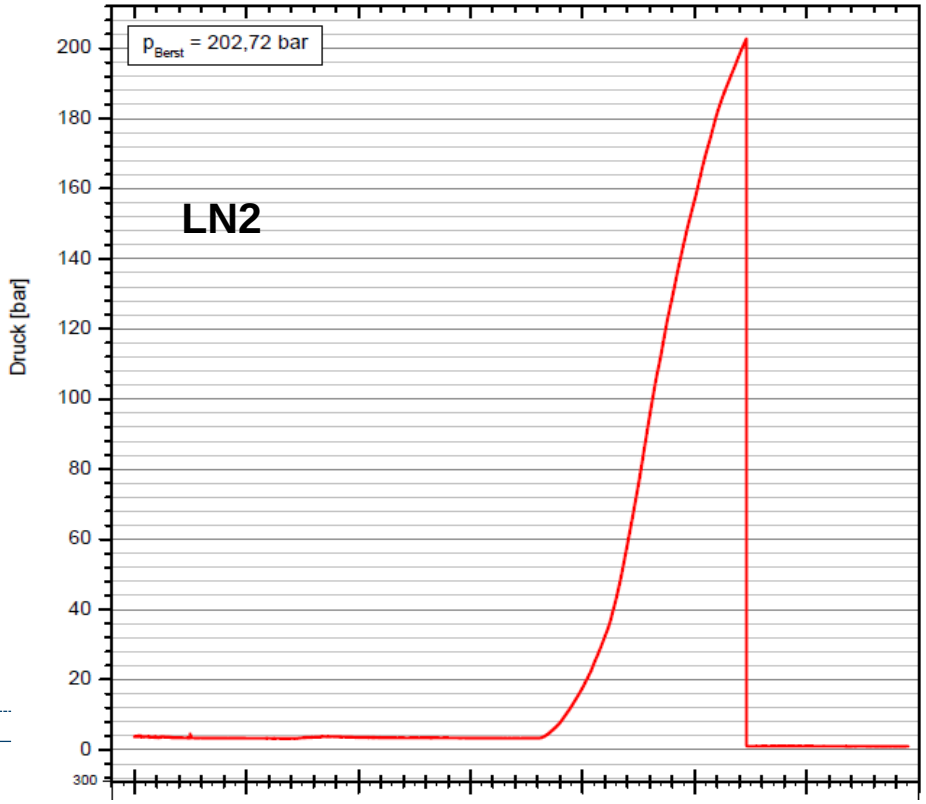
2nd Burst test cold Moderator (LN2)



≈10 m/s

Burst test summery





Design pressure
17 bar

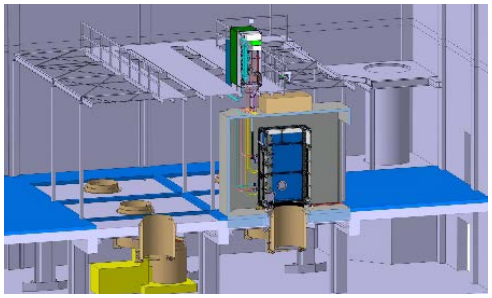
Operation pressure
10 bar

3D X-RAY of cold Moderator test vessel

AGRASIM

Partner institute: IBG-3

Agricultural Food Production Simulator



Experiment
Controlled environment with cutting edge measurements technologies
Real-time monitoring
Validation of numerical simulator

⟺

Modeling
Multi-scale model from molecule to field
Integration of new results into model
Simulation of system

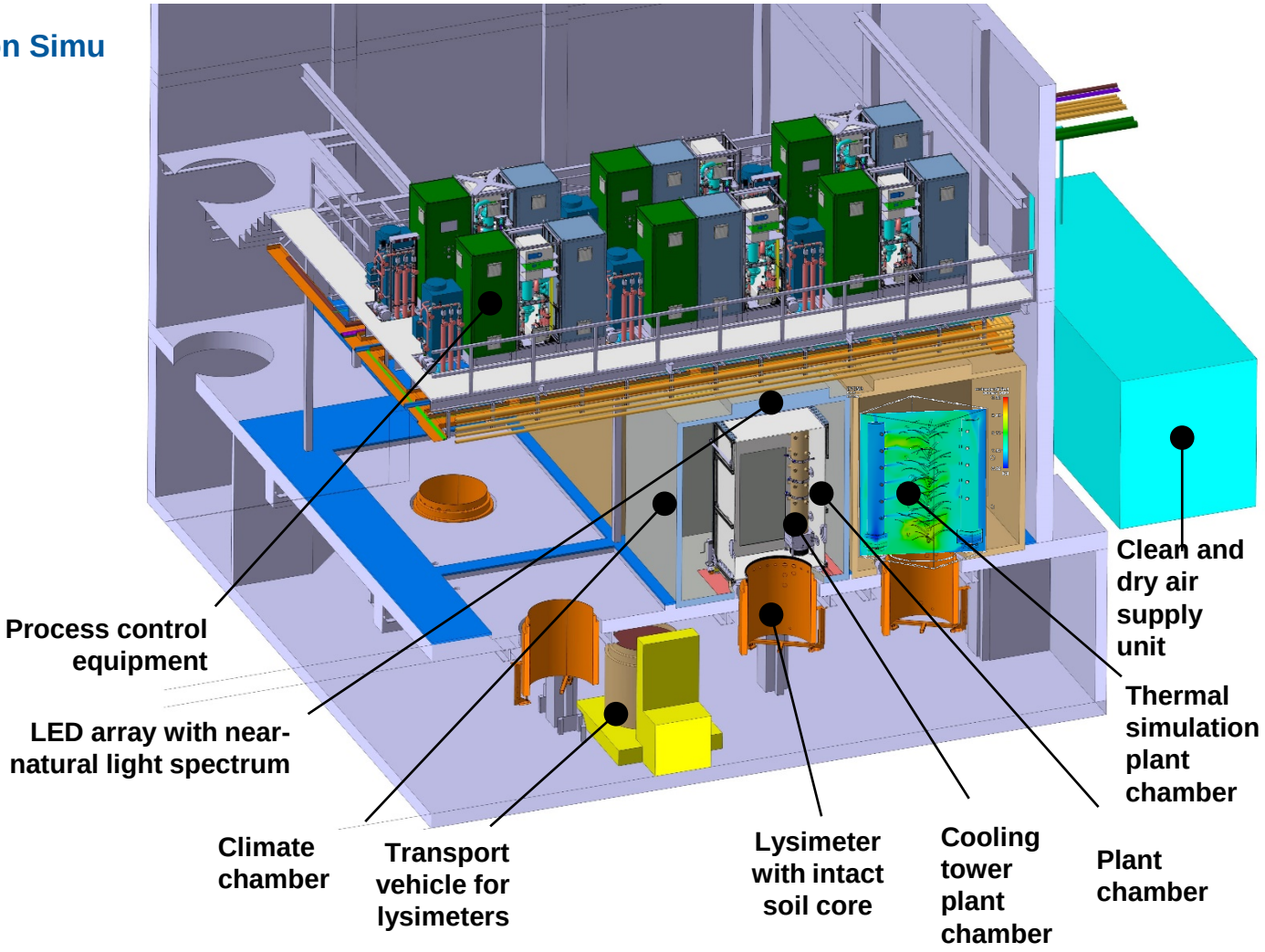
- Understanding soil-plant-atmosphere interactions
- Simulating future crop production in vivo and in silico
- Scientific basis for securing future agriculture production
- Contributing to a climate resilient bioeconomy

AGRASIM

Partner institute: IBG-3

Agricultural Food Production Simu

Overview of experimental setup



Technical challenges for ZEA-1:

- Developing the plant chamber with inert inner surfaces and a high capacity inert cooling system
- Developing of the process technology to fully control the environment in the plant chamber (e.g. establish different CO_2, O_3 and humidity levels)

Solution and realization:

- Concept development for the whole experiment
- Preliminary tests
- Construction and mechanical design
- Manufacture and assembly
- Prototype test

3D µfocus Computed Tomography

X-ray source test object Detector

2x2 m

up to 225 kV, 3 mA

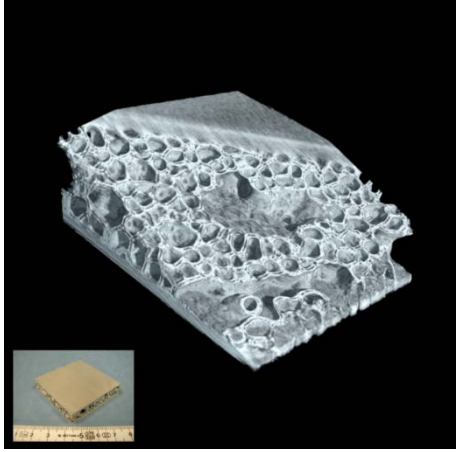
CSI digital flat panel detector
active surface 410 x 410 mm,
4096 x 4096 pixel

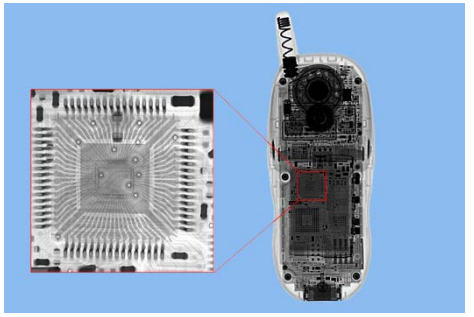
resolution 100 µm
positioning accuracy 1 µm

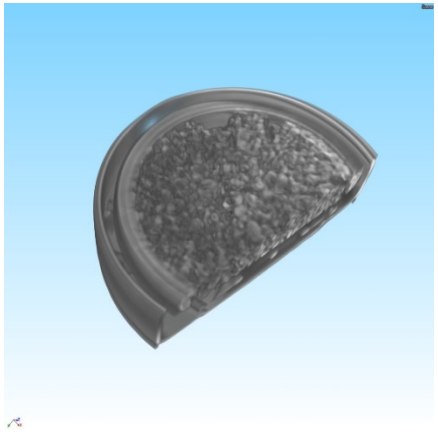
- “open” system for flexible use in a wide range of applications
- GPU based control and reconstruction system
- Fast final data reconstruction with high resolution
- Defect analysis by auto-segmentation

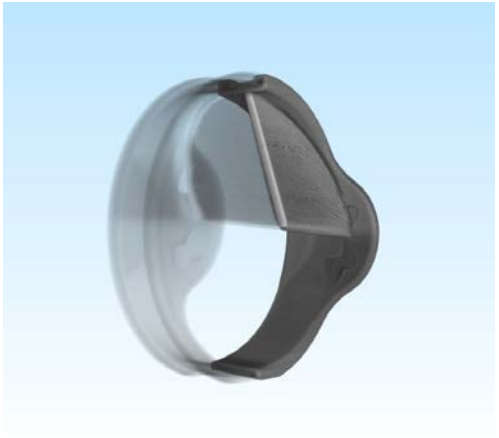
EXAMPELS OF USE OF 3D CT

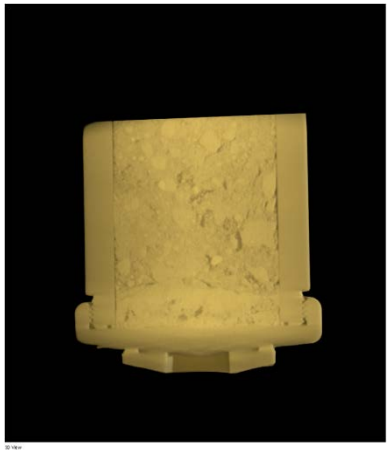
- Joining: welding seams, brazing connections, 3-D printed devices
- Porosity analysis, wall thikness determination, component dimension measurment
- Testing of leight metall components and ceramic materials (Automotive industry, Space and aviation , tooling …)
- Testing of PCBs and electronics components (Sensors, Valves, Switches …)
- Testing of plastic injection molded components











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