THE HENRYK NIEWODNICZAŃSKI
INSTITUTE OF NUCLEAR PHYSICS
POLISH ACADEMY OF SCIENCES

Institute of Nuclear Physics
Polish Academy of Sciences

Dariusz Bocian

on behalf of Division of Scientific Equipment and Infrastructure Construction (DAI)

November 29, 2017 Kraków

Outline

- Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)
- Division of Scientific Equipment and Infrastructure Construction (DAI)
- Running & completed projects
- Future plans

IFJ PAN infrastructure

Infrastructure for ions acceleration, irradiation and imaging applied in interdisciplinary research in physics, medicine and related sciences:

- Proteus C-235 cyclotron
- Isochronous cyclotron AIC-144
- Van de Graaff accelerator
- Two-beam ion implanter
- Nanosecond pulsed source of neutrons
- Infrastructure for MR imaging at 9.4 T and 4.7 T
- SQUID magnetometer
- Helium liquefier

Infrastructure for solid state physics research (>30)

Infrastructure for life science research (>15)

Infrastructure for environmental monitoring and radiation dosimetry (>30)

more information:
http://eu-amici.eu/technology_infrastructure/ifj_pan

About DAI

The Division of Scientific Equipment and Infrastructure Construction (DAI) was established in 2007. Since then, DAI has been involved in various large international projects as well as in those carried out at IFJ PAN. The experience accumulated by DAI and other technical staff of IFJ PAN fall into the following categories:

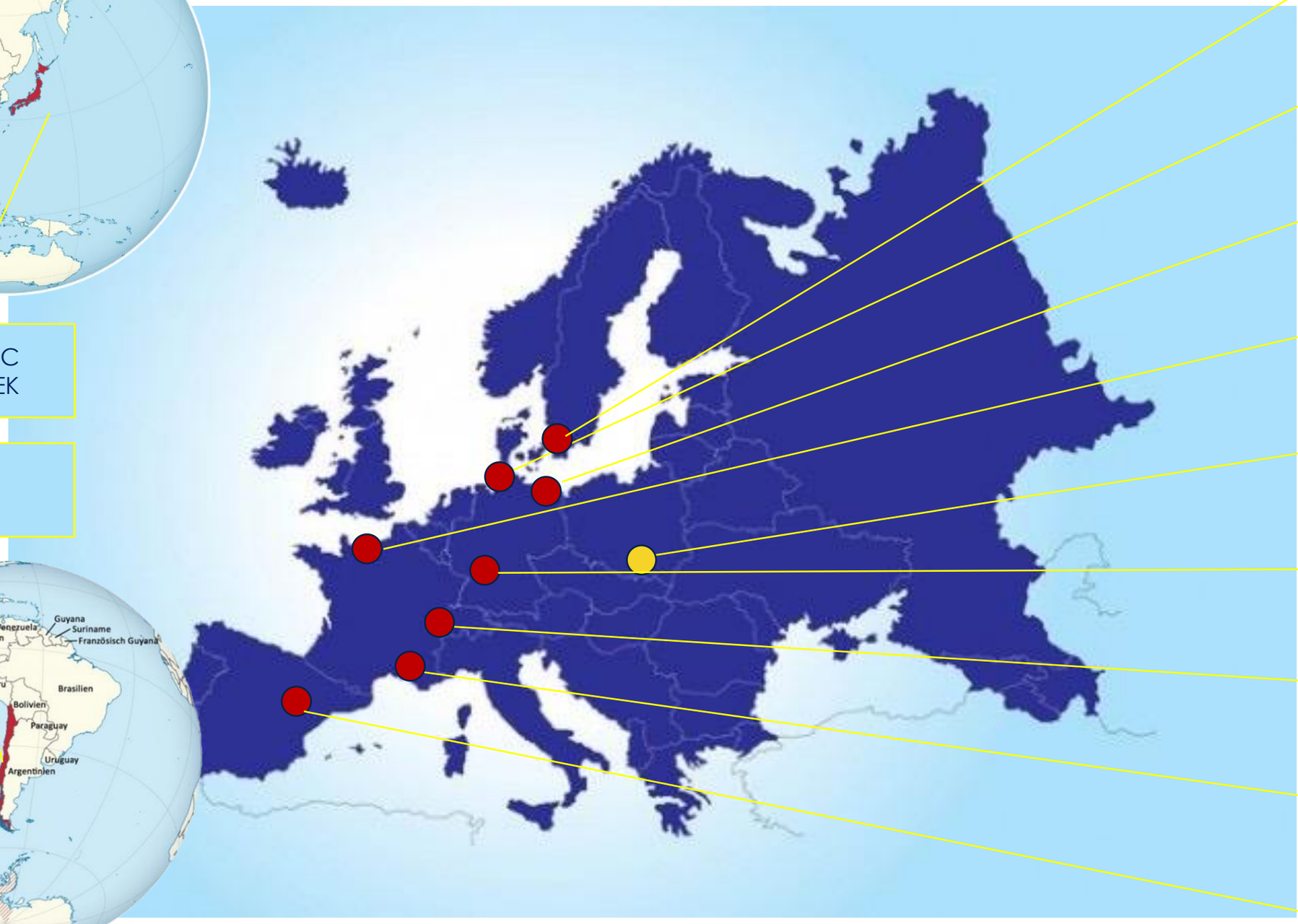
- Assembly & installation of the systems
- Quality Assurance
- Engineering & prototyping of mechanical and electronic/electrical equipment
- Software engineering, database and web applications development

Actually DAI staff: 38 research engineers (7 Ph.D.), 14 technicians and 2 administrative assistants.

DAI involvement in large infrastructures construction

T2K, J-PARC
BELLE 2, KEK

CTA
CHILE



ESS
LUND

E-XFEL
DESY

W7X
IPP GREIFSWALD

SPIRAL 2
GANIL

IFJ PAN
KRAKÓW

FAIR
DARMSTAT

LHC, ATLAS
CERN

ITER
CADARACHE

F4E
BARCELONA

Running & completed projects

AMICI	**Accelerator and Magnet Infrastructure for Cooperation and Innovation**		**2017 – 2019**
ATLAS	A Toroidal LHC ApparatuS	(24 FTE)	2005 – 2014
Belle 2 Experiment			2011 – 2012
CTA	Cherenkov Telescope Array	(47 FTE)	2009 – 2016
ESS	***European Spallation Source***	***(120 FTE)***	***2017 – 2022***
FAIR	**An International Facility for Antiproton and Ion Research**		**2011 – 2019**
ILC	International Linear Collider		2008 – 2011
ITER	International Thermonuclear Experimental Reactor		2010 – 2013
ITER HRNS	The High Resolution Neutron Spectrometer		2014 – 2016
ITER RNC	**Radial Neutron Camera**		**2011 – 2024**
LHC	**Large Hadron Collider**	**(195 FTE)**	**2005 – 2018**
LHC	*Large Hadron Collider LS2*	*(30 FTE)*	*2019 – 2020*
LHC	***Large Hadron Collider HiLumi***		***2017 – 2020***
Pierre AUGER Observatory		***(16 FTE)***	***2017 – 2018***
SPIRAL 2	Second-generation System On-line Production of Radioactive Ions		2015 – 2016
T2K	**Tokai to Kamioka**		**2007 – 2019**
W7-X	Stellarator Wendelstein 7-X	(54 FTE)	2007 – 2012
XFEL	European X-Ray Free-Electron Laser	(165 FTE)	2010 – 2016
XFEL	**Commissioning of European X-Ray Free-Electron Laser**		**2016 – 2019**

LHC *Quality assurance*

Acceptance tests of the LHC superconducting circuits and their instrumentation

- 1600 circuits
- 49600 voltage-taps
- 11000 quench heaters
- 3400 temperature sensors

Inspection of the LHC superconducting magnets' interconnections

- 12000 compensating bellows
- 3500 endoscopies of beam lines

Design, development and upgrades of electrical test equipment

Objectives

- Preparation of testing procedures
- Software development
  - data bases design
  - measurement applications
  - data analysis and reporting
  - maintenance and upgrades
- Electrical test equipment
  - Improvement of maintainability
  - Improvement of measurement precision
  - Construction of additional units
- Performing the electrical acceptance tests
- Inspecting the magnets' interconnections

Attainments

- Design and development of automatic measurement systems with associated database, control software and data analysis tools
  - 8 universal mobile test benches for electrical tests
  - 4 low voltage insulation monitoring systems
  - 5 mobile test benches for the 600 A energy extraction switches
- Discovery and treatment of 500 nonconformities

The team, as the first, performed measurements of very low resistance of main bus bar connections at cold (without necessity of opening interconnections between magnets). The measurement results were essential for CERN groups developing a new Quench Protection System.

Performance of acceptance tests of:

- ***cold magnets*** for a series (100), pre-series and prototype units
- ***superconducting cavities*** for a series (800) and pre-series units
- ***cryomodules*** for a series (100), pre-series and prototype units

on DESY infrastructure and delivering the corresponding tests reports.

Related objectives

- Preparation of testing procedures
- Commissioning and maintenance of test stands
- Software development
  - data bases design
  - measurement applications
  - data analysis and reporting
  - maintenance and upgrades

Attainments

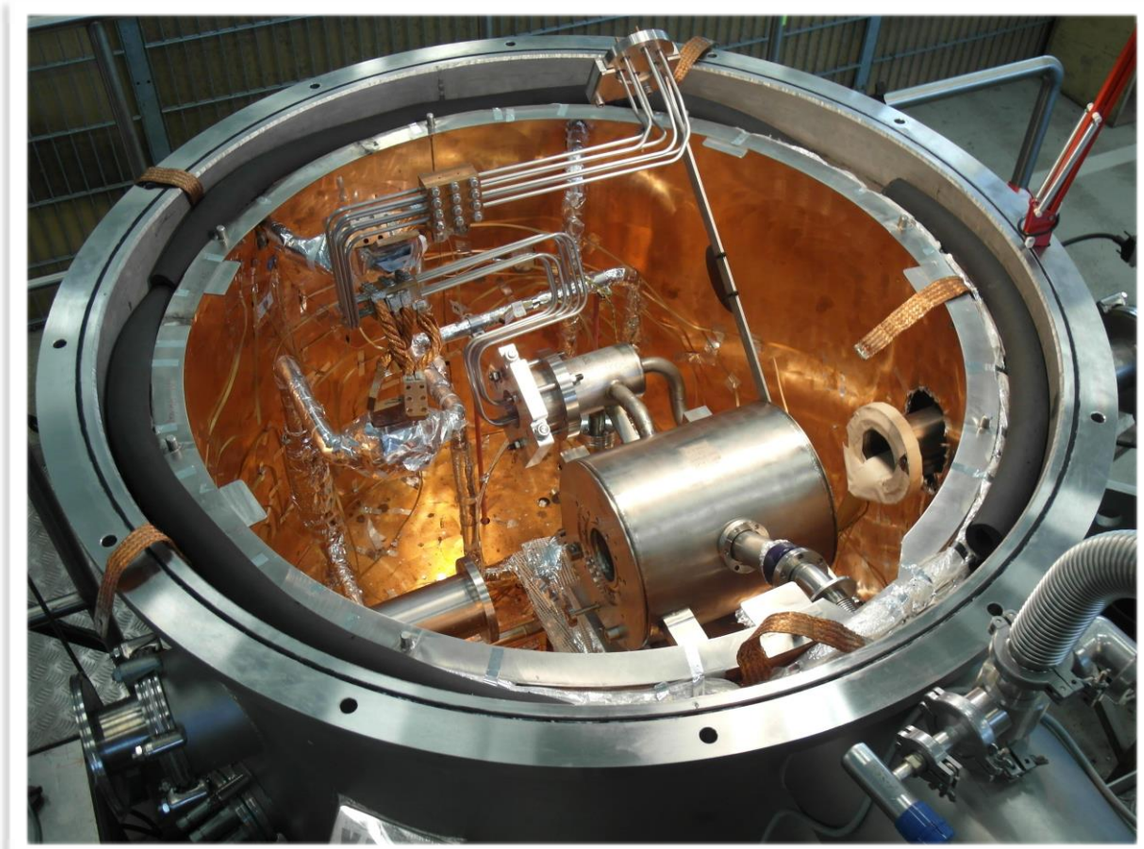
- Optimization of the cryomodule testing process
- Automatization of the cool down/warm up processes
- Design and prototyping of the mobile clean room
- Design and development of the test management software
- Development of Quality Control System

5 prototype and pre-series magnets tested

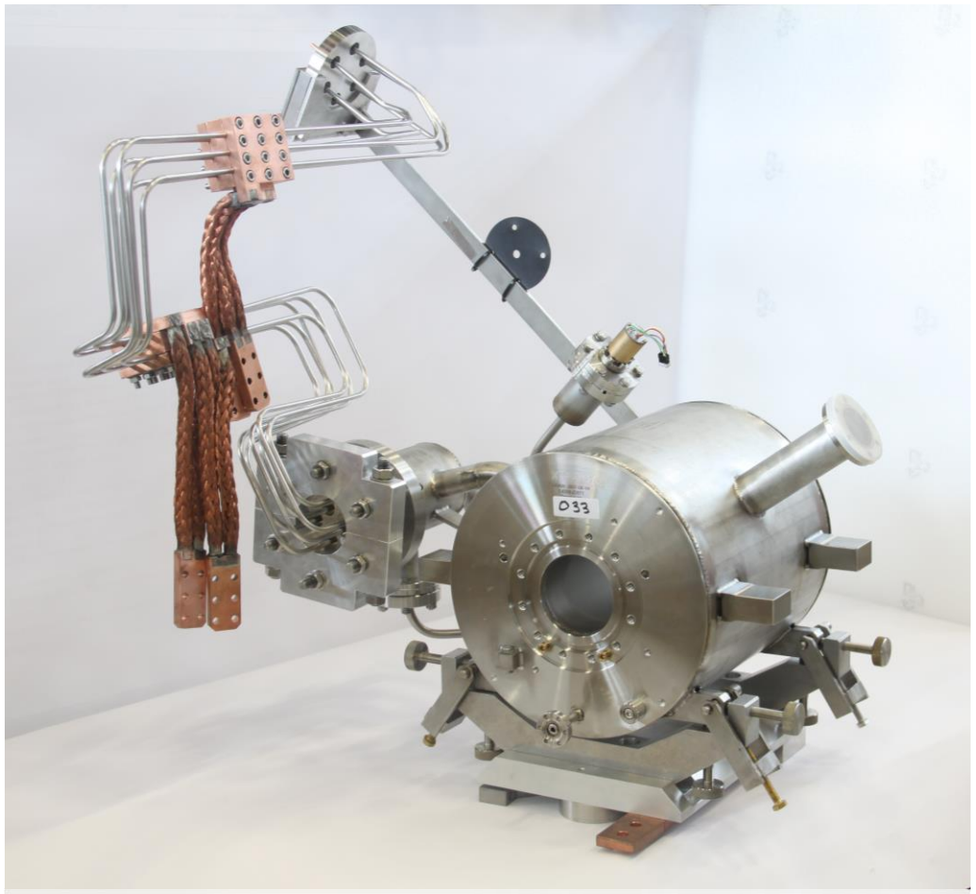
100 series magnets tested

database development and management

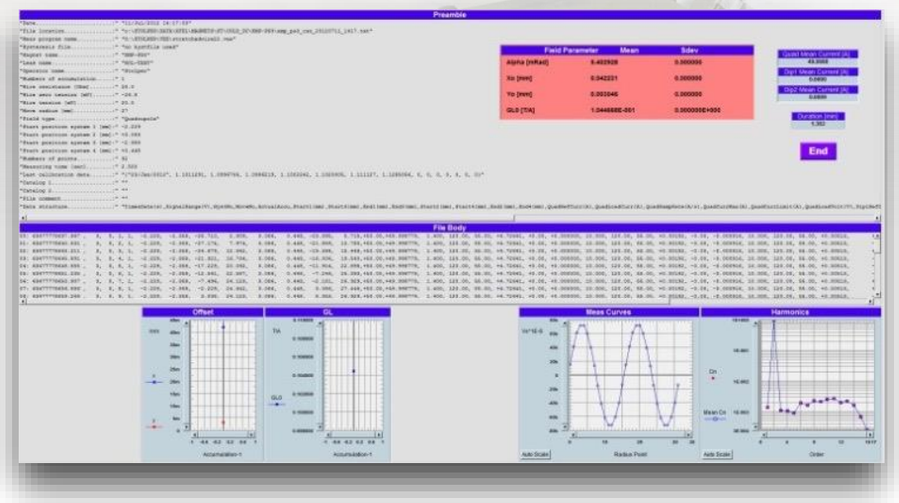
analysis software development



XFEL quadrupole inside the cryostat vessel



XFEL quadrupole magnet & software

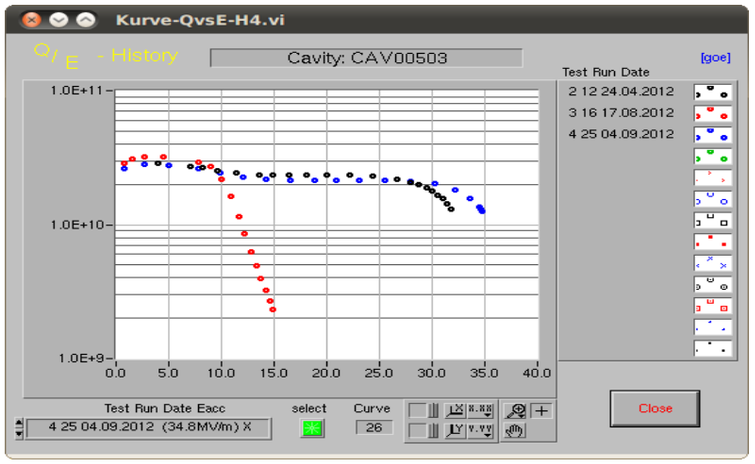


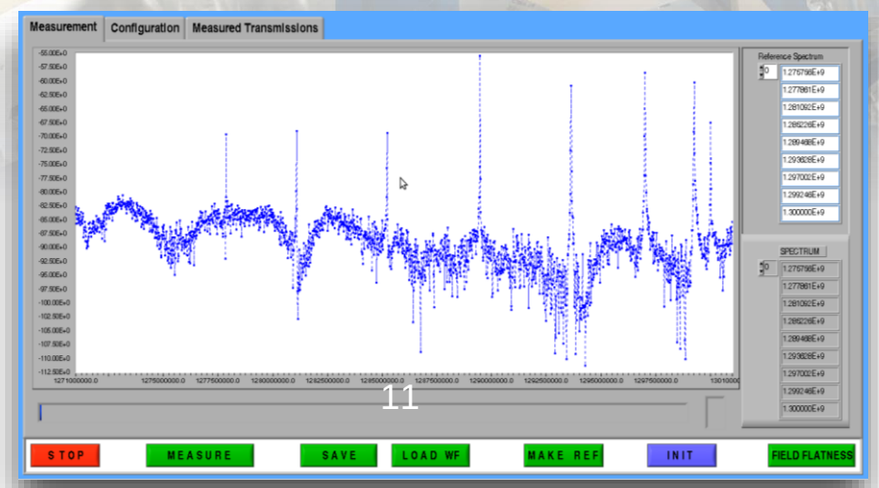
60 prototype and pre-series cavities tested

800 production cavities tested

analysis software development

Insertion of the cavity into the vertical cryostat

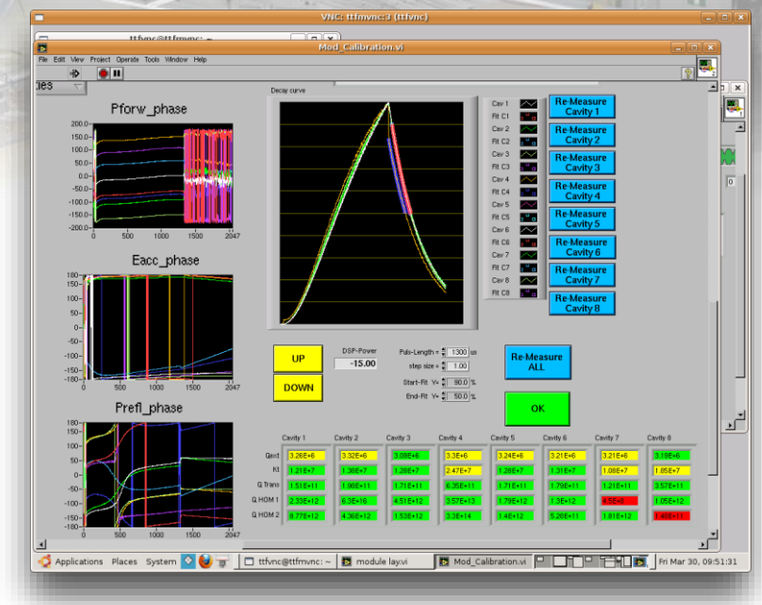




6 prototype & pre-series cryomodules tested

94 series cryomodules tested

Cryomodule on the test bench



Calibration coefficient and check quality factors of the couplers during cryomodule RF test

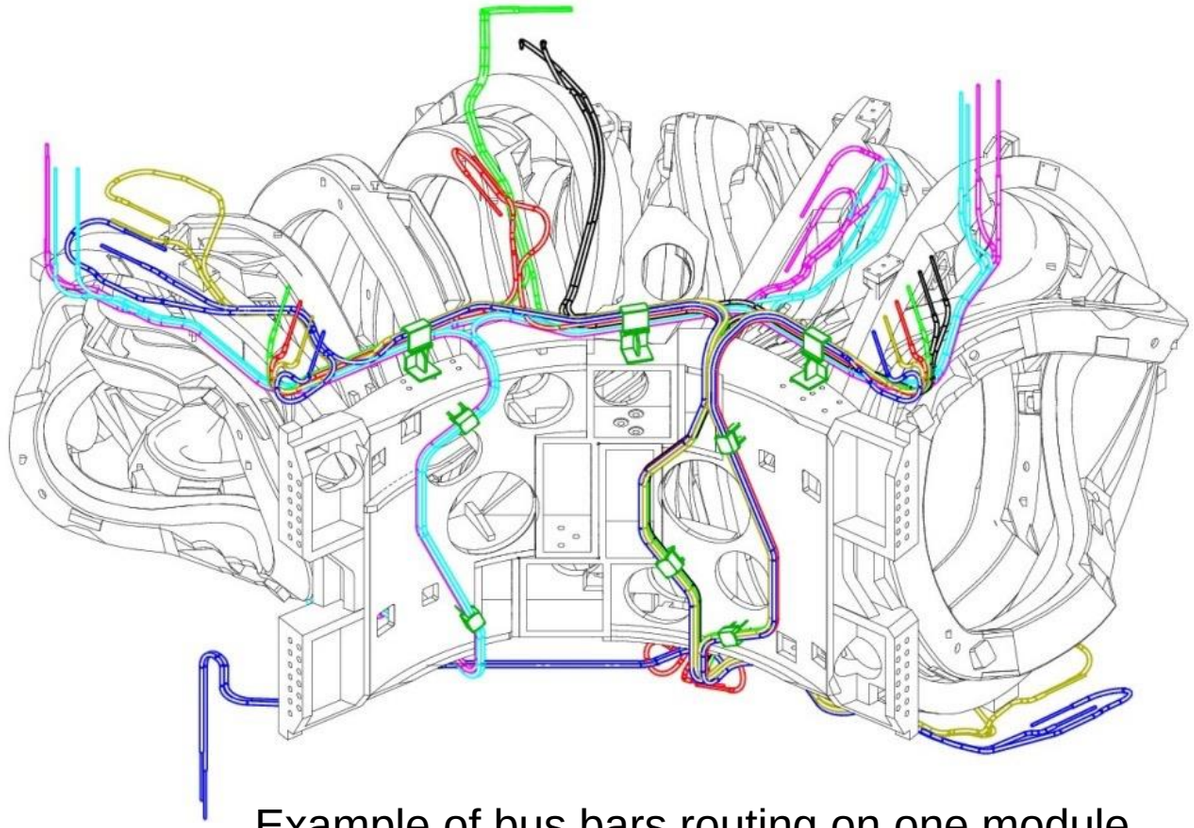
Leak test of vacuum pipes

W7-X *Installation of the bus bar systems*

Installation of the bus bar systems powering superconducting coils on all five W7-X modules.

Making joints of the bus bar systems on the neighboring modules.

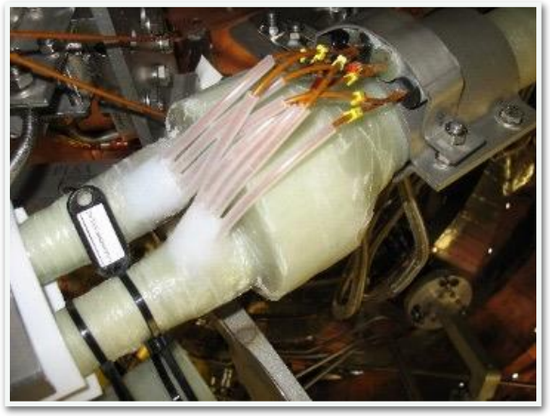
Manufacturing and delivery to IPP Greifswald of mechanical components for polichromators (30 sets).



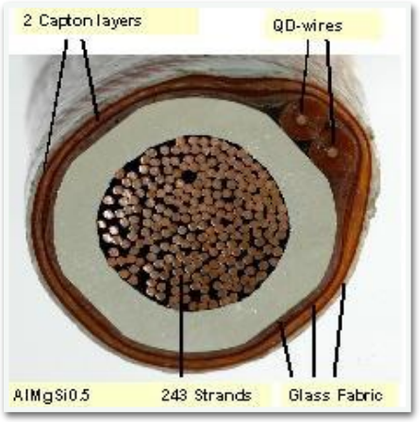
Example of bus bars routing on one module

Installation of 24 bus bars on the module and final shaping of the bus bar ends

Module Separation Plane
set of six joints painted and clamped



Improvement of the protection of the quench detection voltage taps

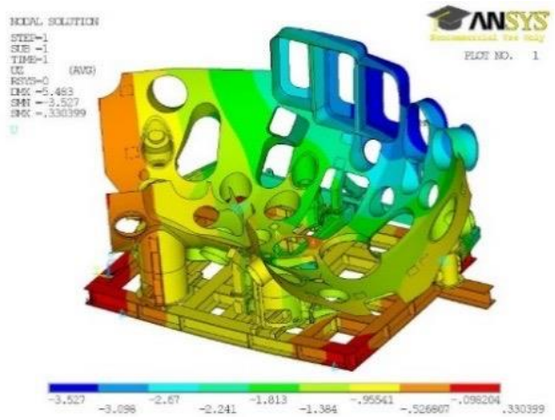


Bus bar cross section

Electrical insulation of the assembled joints (divided into three steps)

All joints (184) passed successfully tightness and HV tests

Electrical connection of 81 triplets

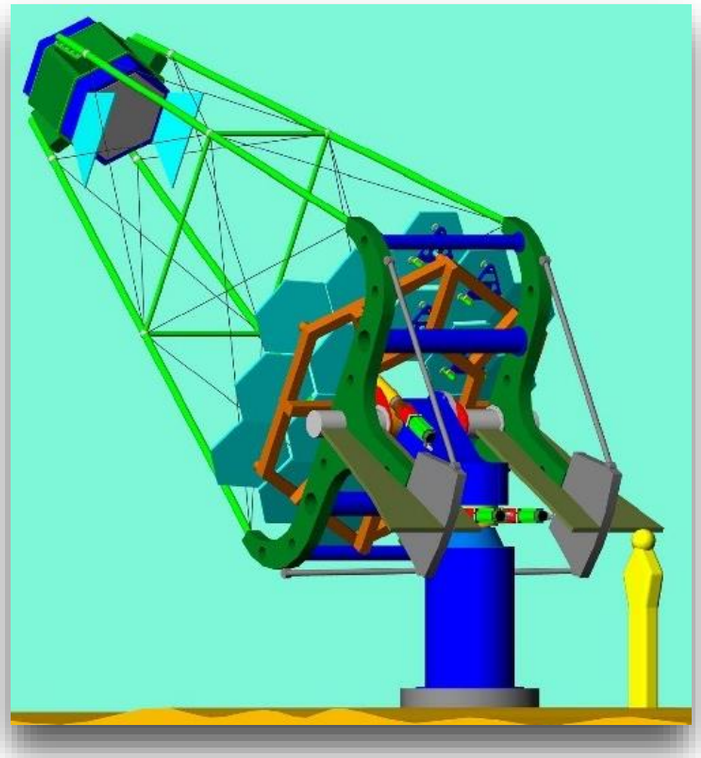


CTA *Prototype of the small size telescope D-C SST*

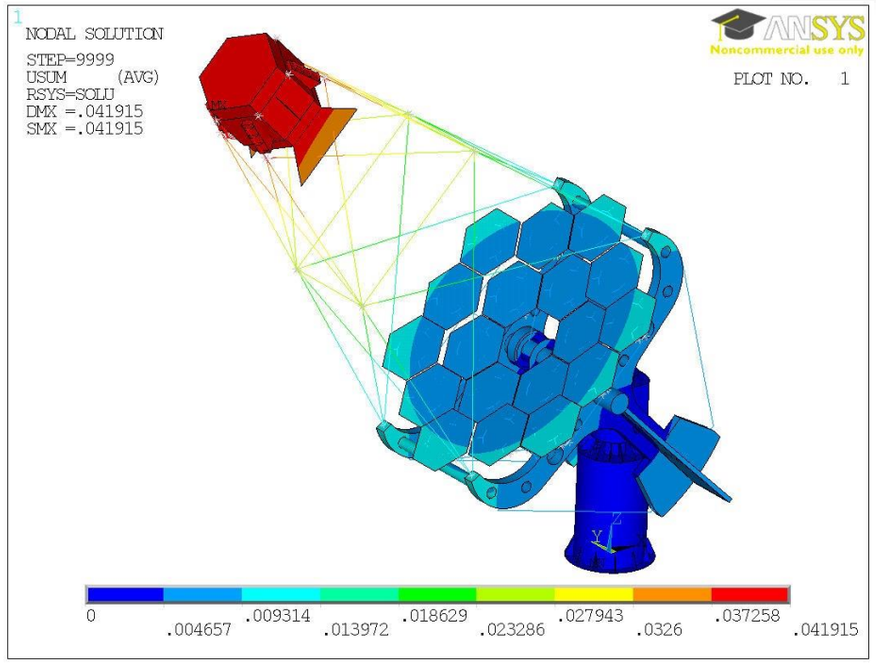
Design and prototyping of Davis – Cotton (D-C) telescope structures.

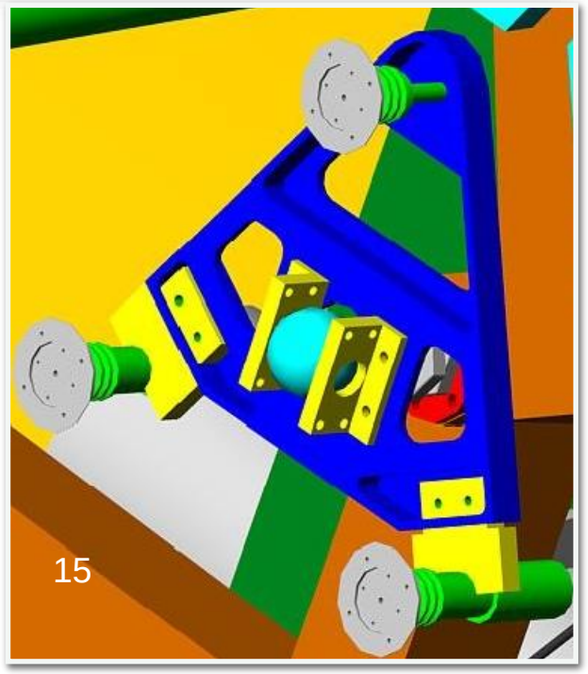
IFJ PAN provided a complete design of three Small Size Telescope (SST) structures of various mirror dish diameters (6m, 7.6m, 4m).

The D-C SST structure with the mirror dish diameter of 4m was manufactured in the Polish industry in 2013.



Commissioning and parameter validation at IFJ PAN





Design and calculations performed at IFJ PAN

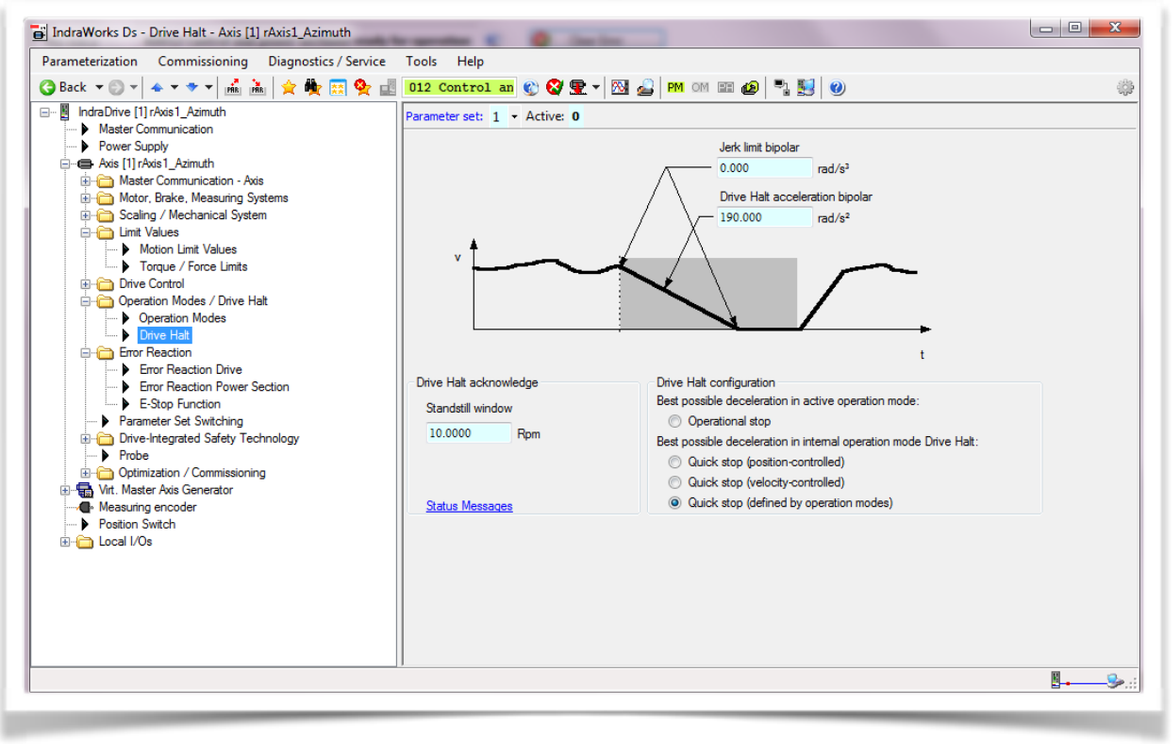
CTA D-C SST control system

Telescope operations:

- tracking
- positioning
- joging
- parking/initializing

Three levels of safety:

- mechanical end-switches
- electronic end-switches
- software limitation

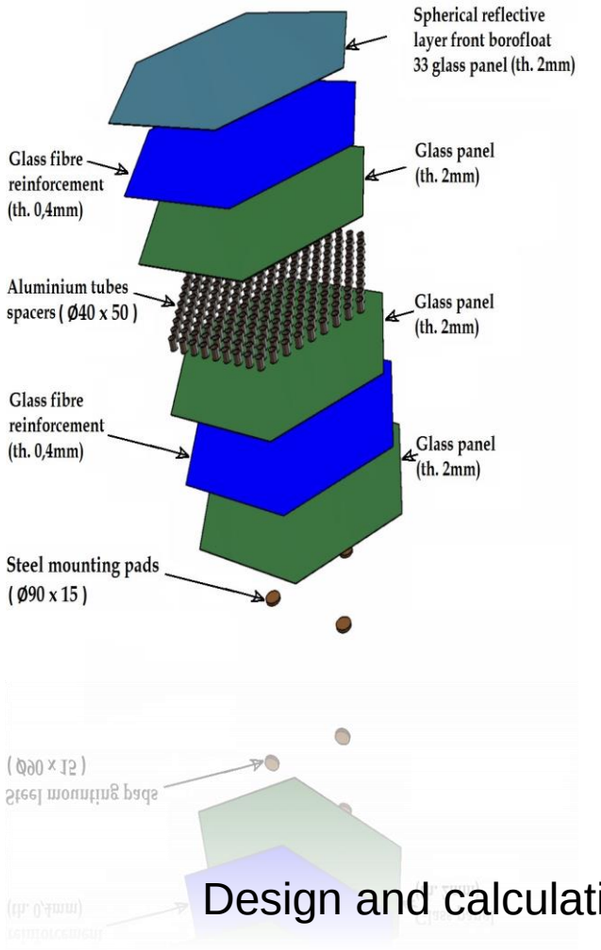


CTA *Mirror prototypes for the medium size telescope MST*

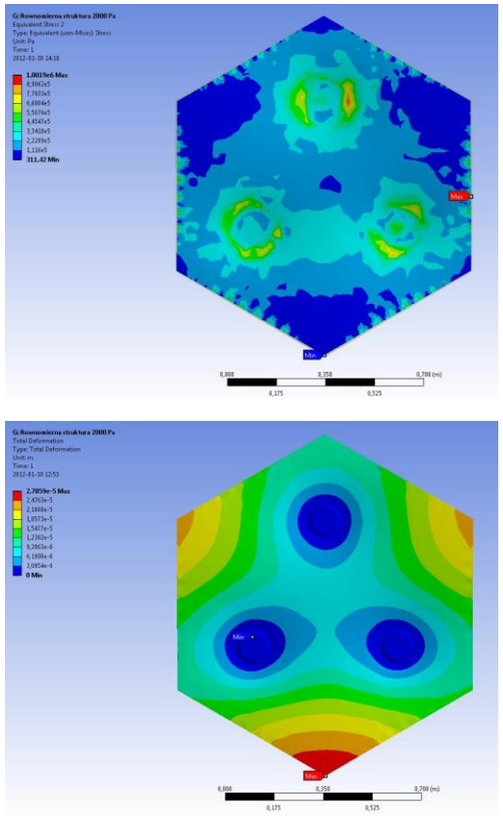
The open structure mirrors prototypes were built for the Medium Size Telescope (MST) and tested by CTA laboratories. Due to the test results IFJ PAN was recommended to build 100 mirrors for MST.

The size of the MST mirrors is 1.2m (flat-to-flat) and the curvature radius 32m.

One production line was completed at IFJ PAN and 60 mirrors delivered so far.

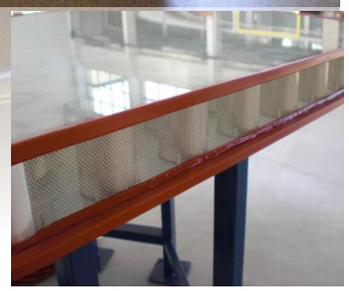


Design and calculations at IFJ PAN

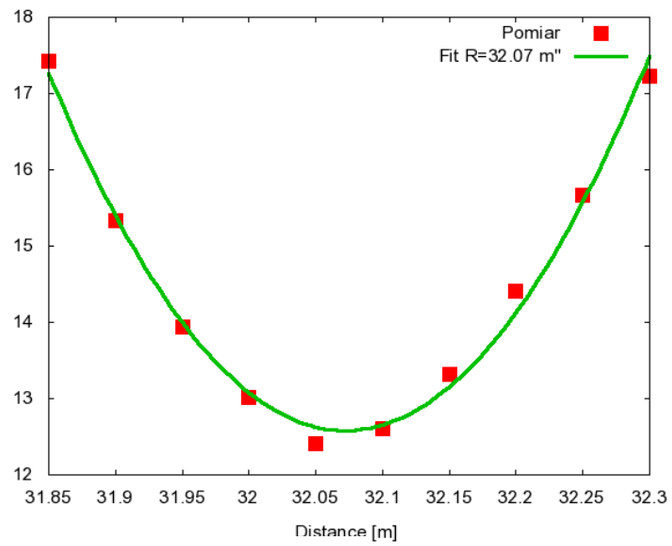


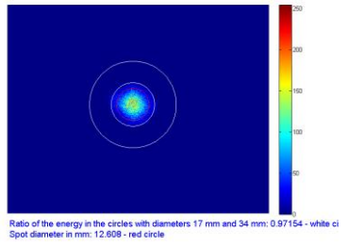
Design and calculations at IFJ PAN

Manufactured at IFJ PAN

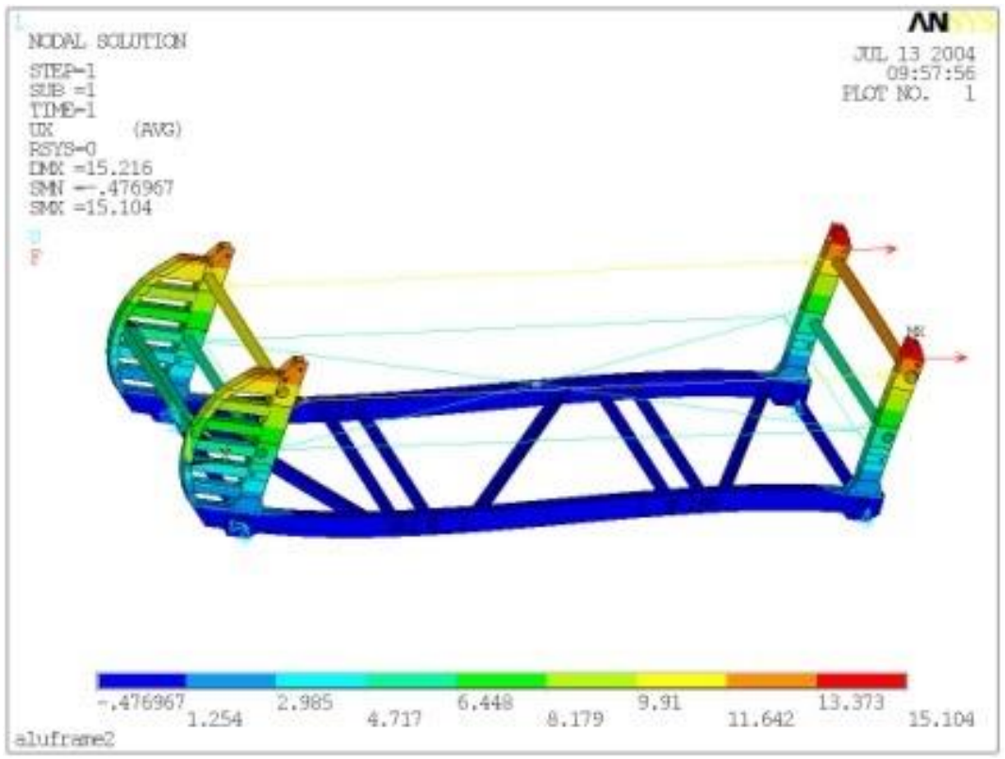


Manufactured at IFJ PAN





Pre-testing at IFJ PAN



Conception of installation method, design and calculation of frames

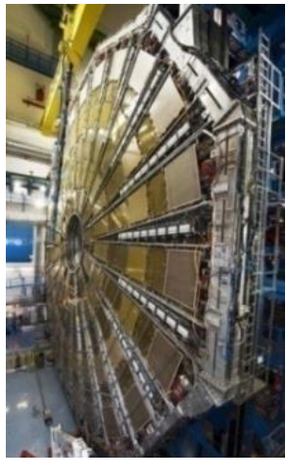
One type of the frames manufactured at IFJ PAN

Installation of muon chambers at CERN

Cooling systems:

- Assembly, installation and commissioning of two cooling stations for Muon and general-purpose application, including connection of Big and Small Wheels
- Piping, connection and commissioning of the cooling system of End-cap Toroid diffusion pumps

Cooling stations



Big Wheel

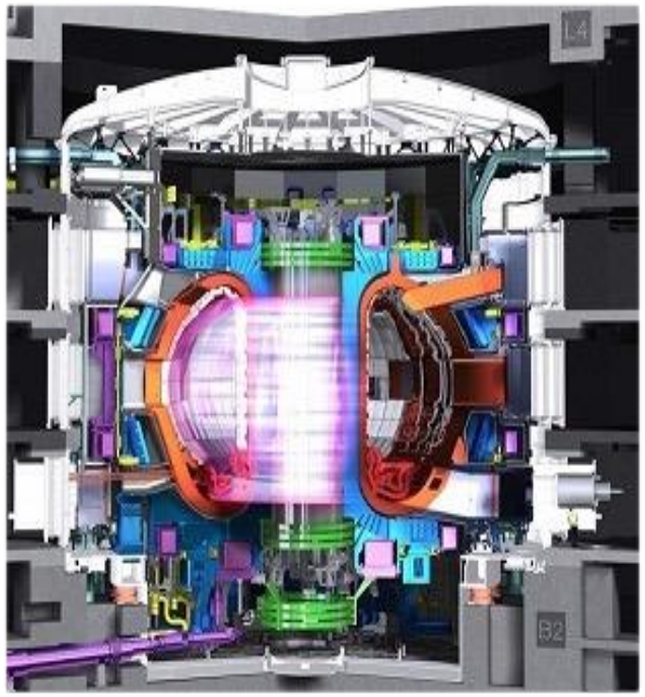
Muon Barrel piping

Gas systems:

- Big Wheels and Small Wheels piping, connection to the distribution racks including leak tests
- TGC EIL4 piping from distribution racks to the chambers
- MDT EO wheels - piping from gas racks to distribution manifolds
- Muon Barrel –piping from gas racks to the distribution manifolds

T2K *Module design and installation procedure*

- Construction of T2K magnet mock-up enabling vertical and horizontal slit configuration
- Elaboration and verification of the methods how to stabilize position of SMRD modules in the magnet including module assembly procedure
- Elaboration and verification of module installation procedures including cable handling
- Design and fabrication of module assembly components (IFJ PAN and industry)
- Design and fabrication of assembly/installation tools
- Training of people, participation to and supervision of module assembly and installation



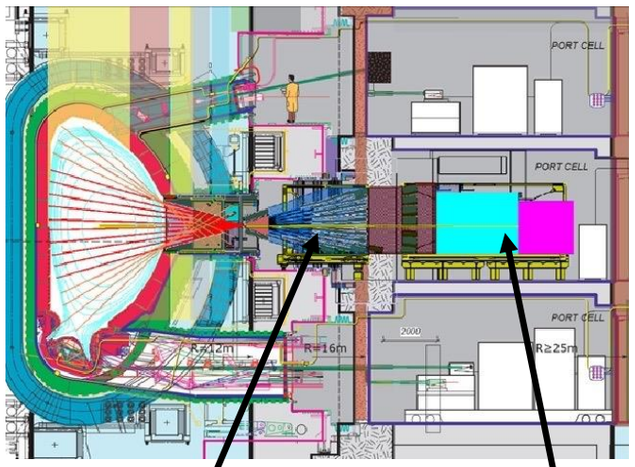
2010-2013: FEM analysis for infrastructure components

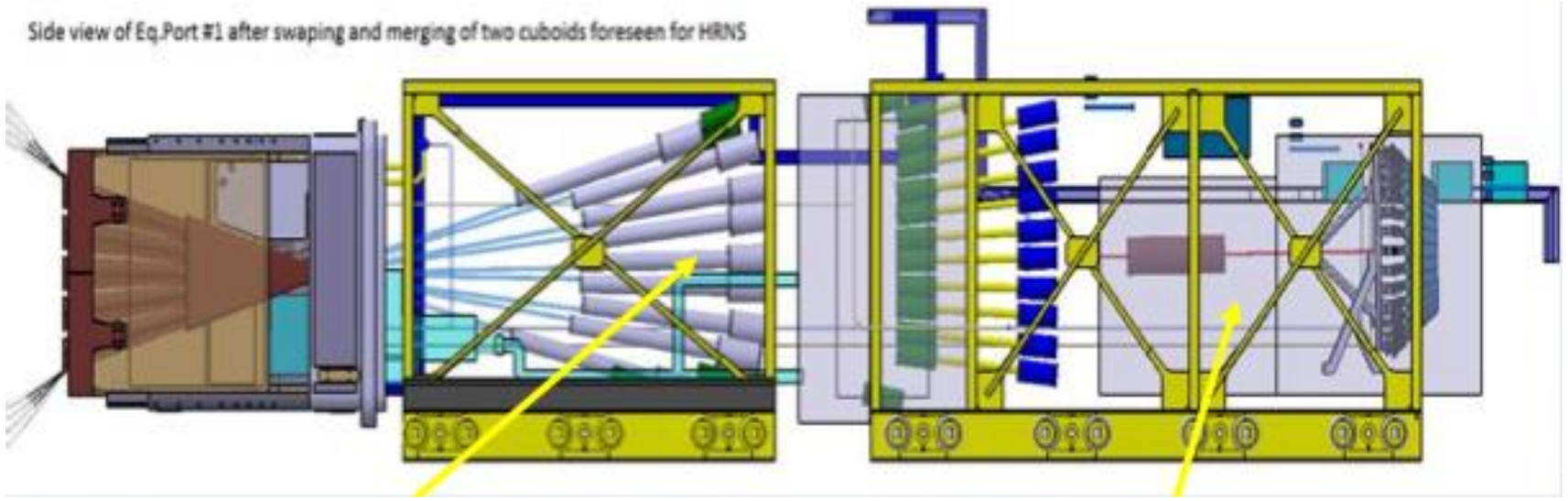
- nonlinear static effects and materials fatigue analyses
- dynamic analyses for seismic loads

2013-2018: Radial Neutron Camera (RNC)

2014-2016: High Resolution Neutron Spectrometer (HRNS)

Localization of the instruments



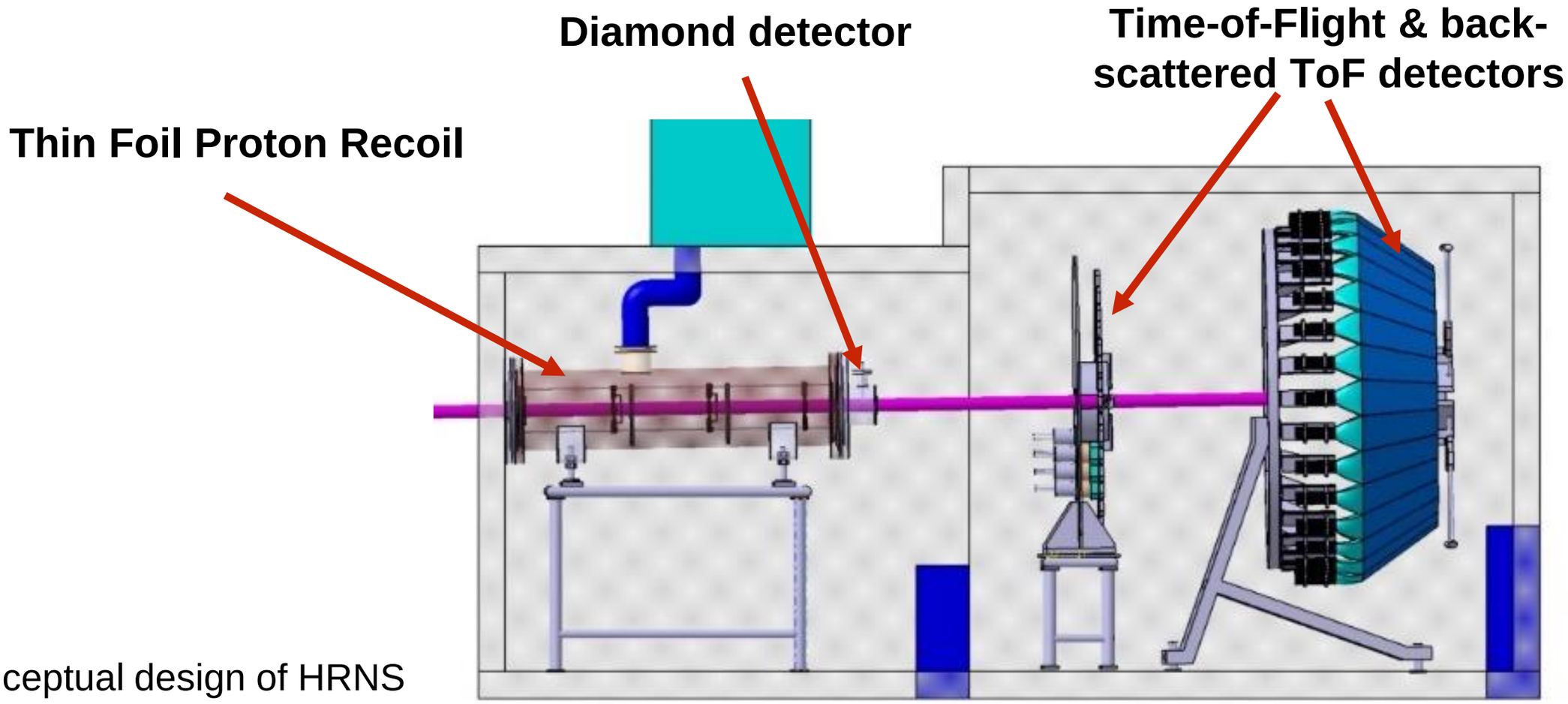


Radial Neutron Camera (RNC)
provides the neutron emissivity in a poloidal cross section of a deuterium-deuterium or a deuterium- tritium ITER plasma.

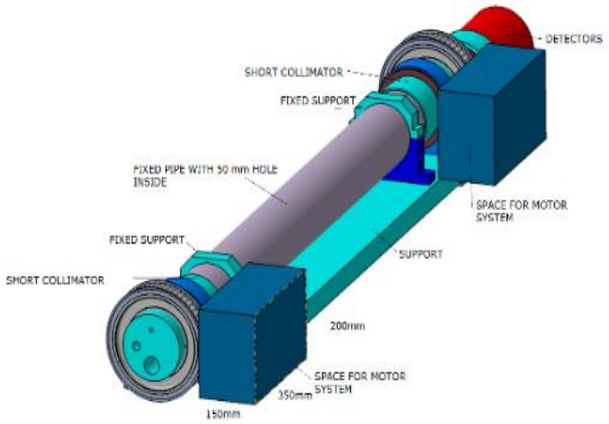
High Resolution Neutron Spectrometer (HRNS)
should determine the fuel ion ratio in the plasma core

DAI employees involved in HRNS project:

- System Design Engineer – main coordinator of all engineering aspects of the design
- CAD officer – leading role in design
- thermo-hydraulic analyses (cooling of the detector)
- electromagnetic analyses (shielding against magnetic field)



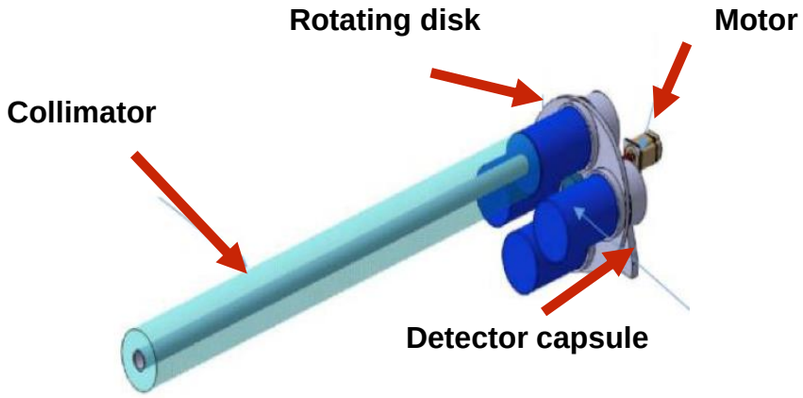
conceptual design of HRNS

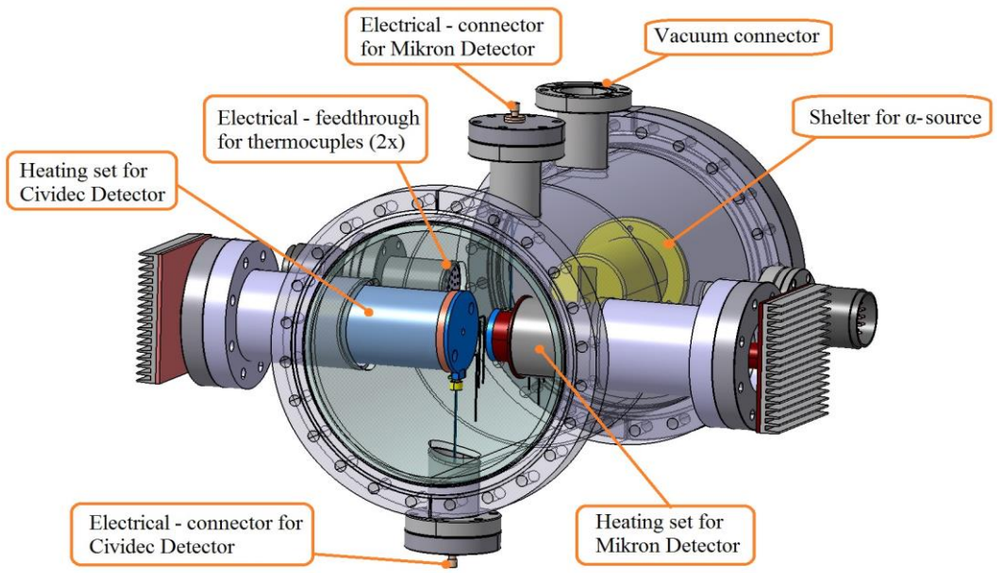


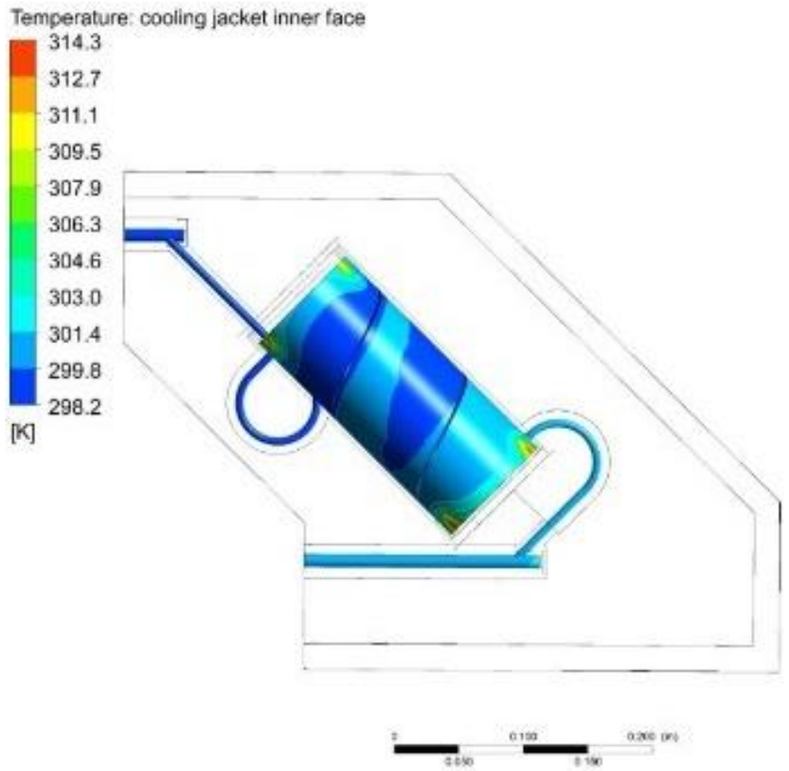
Adjustable collimator concept

DAI employees involved in RNC project:

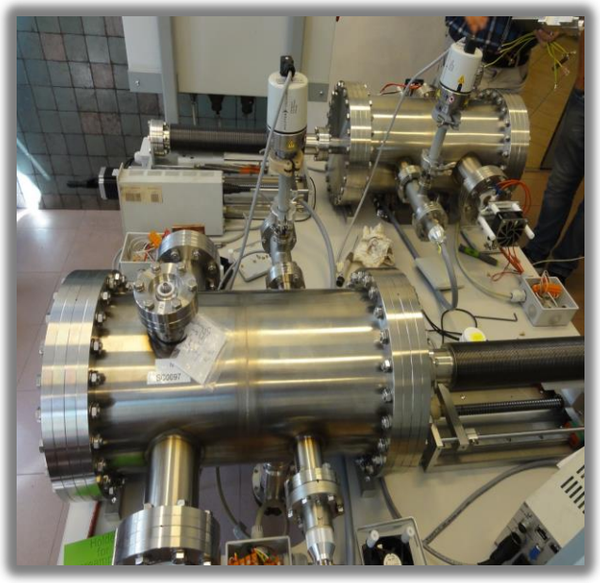
- thermo-hydraulic conceptual design and analyses (detector cooling systems)
- electromagnetic analyses (dynamic loads and magnetic shields)
- conceptual design of adjustable collimators and rotating detectors
- design, construction of test setup for thermal tests of diamond detectors
- CAD support

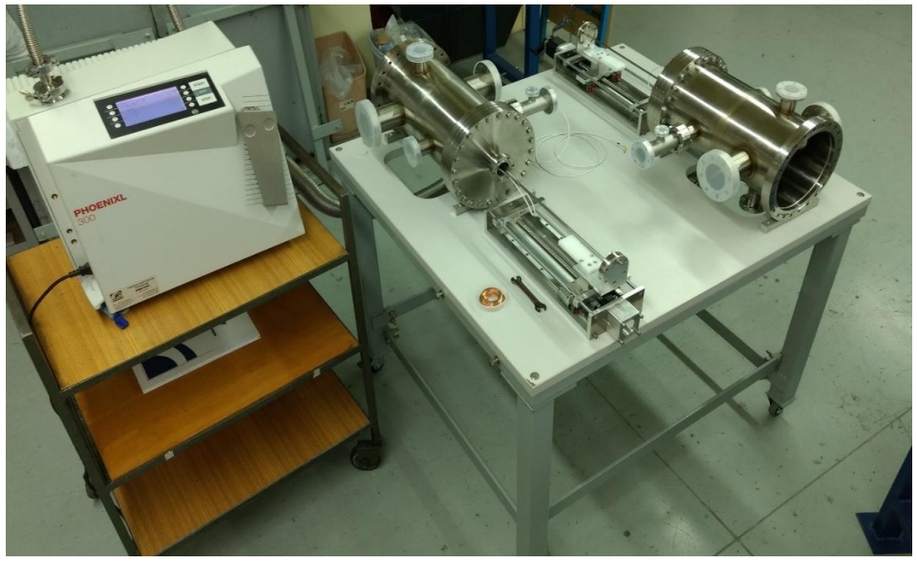






Cooling of RNC detectors capsule

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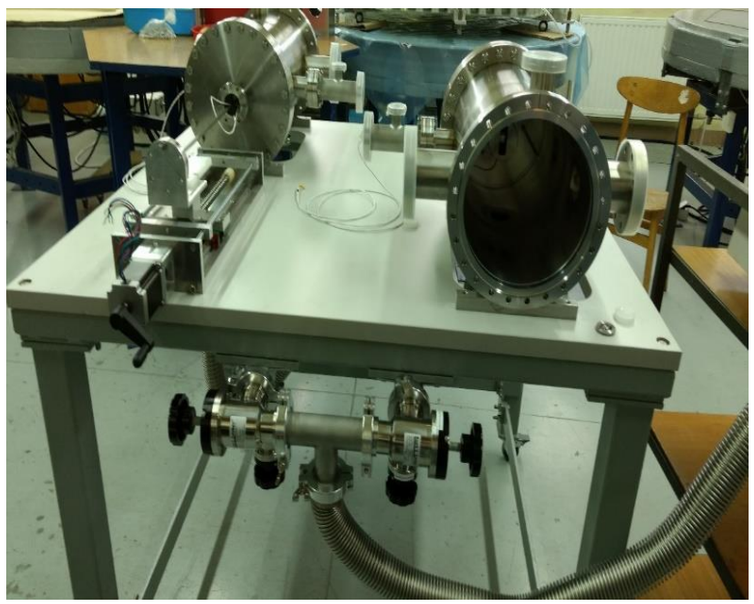
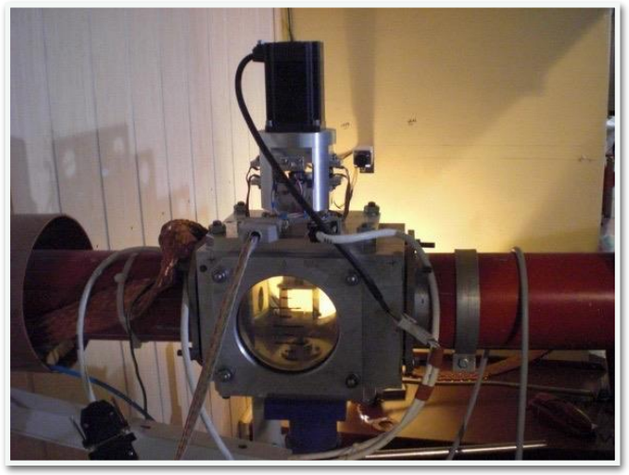



SIEMENS
SIMATIC HMI
TOUCH
Program name:
TCT
Program state:
Preheating
Source
Heating pos
Measure pos
Temp det 1
+31.5 °C
Temp det 2
+178.0 °C
Program step:
0
Cycle no:
0
basic
Start
Pause
Meas. req
Time to stop: 1970-01-01 00:00:00
Config
F1
F2
F3
F4

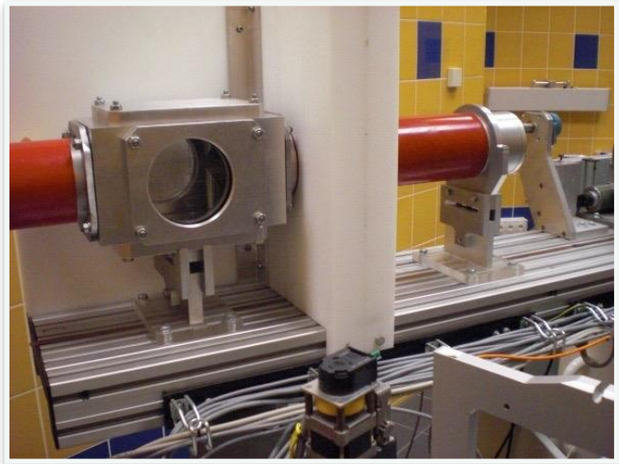
Design, manufacturing and installation

Adjustable supports for x-ray lamps



Device for immediate proton beam cut-off, so called shutter

Holders for digital x-ray recorders



Supports for the end of beam line

Support of the optical bench and its positioning system

Range discriminators and beam collimators

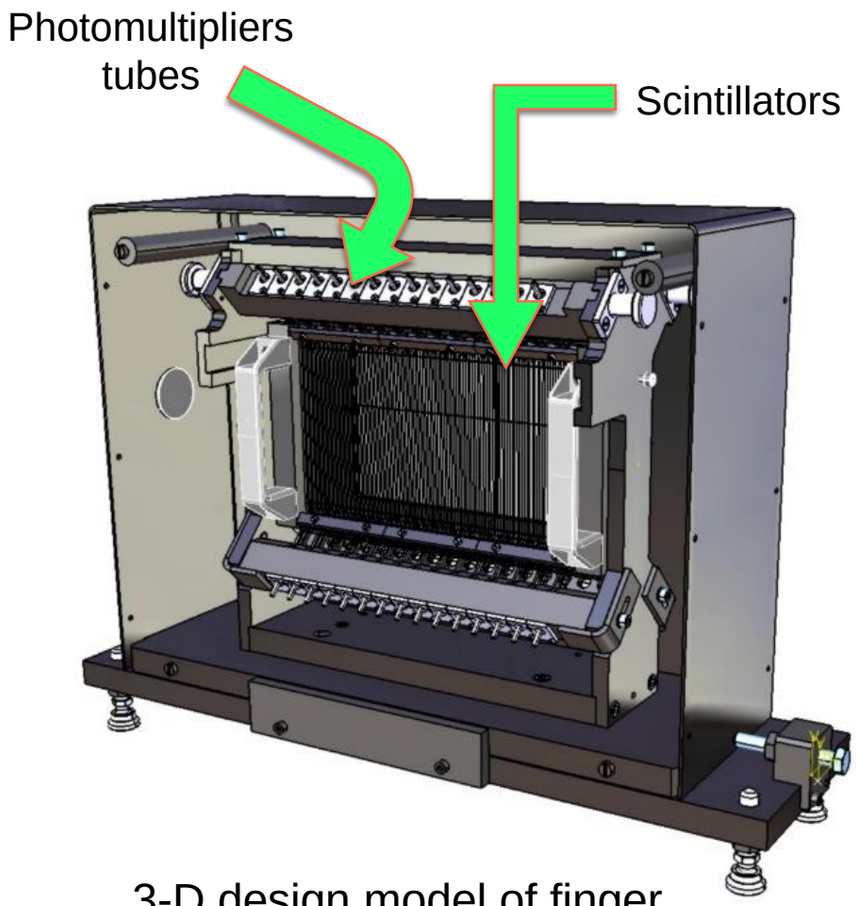
ACR plate fixtures in the X-ray positioning system

Fixtures of XYZ scanner and water phantom on the ETC (Eye Therapy Chair)

CCB Equipment for the eye treatment set up

Proton radiotherapy setup (at cyclotron PROTEUS 235)

Finger detector at GSI Darmstadt



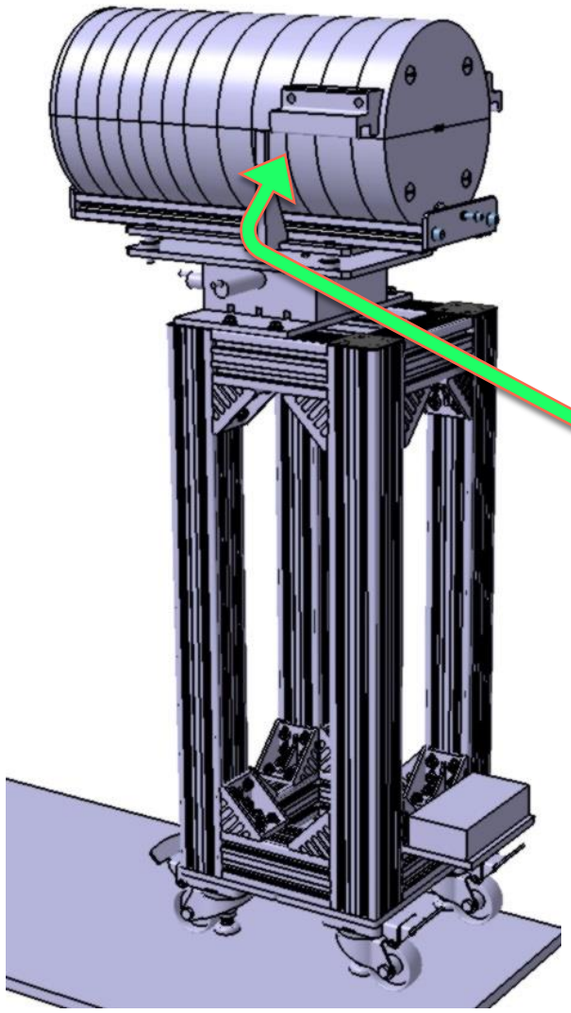
3-D design model of finger detector with detection elements and regulating system (open housting)

Conception mechanics for one detector and manufacturing (completed in 2012)

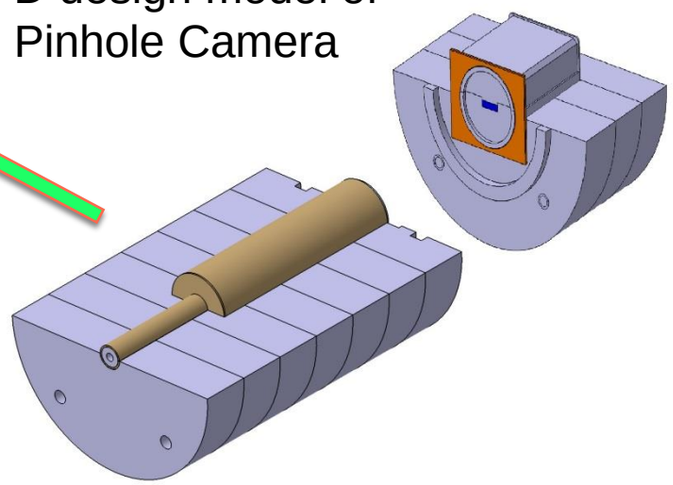
Finished mechanical components of finger detector

Neutron Pinhole Camera

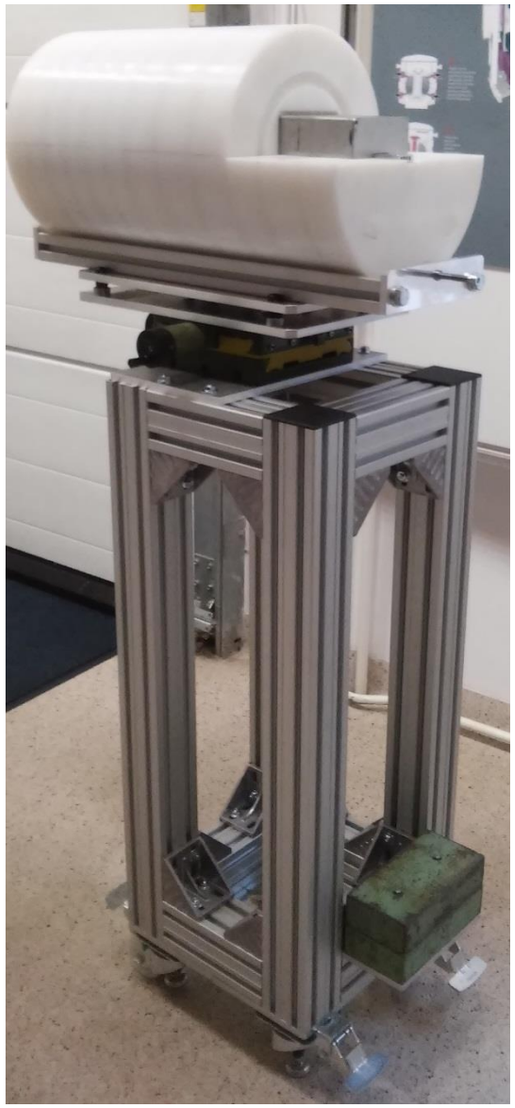
Design, manufacturing and installation



3-D design model of Pinhole Camera



The neutron pinhole camera dedicated to the PF-24 (Plasma Focus) device at IFJ PAN. The device will be used for the investigation of the spatial and temporal distributions of DD neutrons from the PF-24 source.



Neutron pinhole Camera manufactured at IFJ PAN

Medium and high beta cryomodule tests

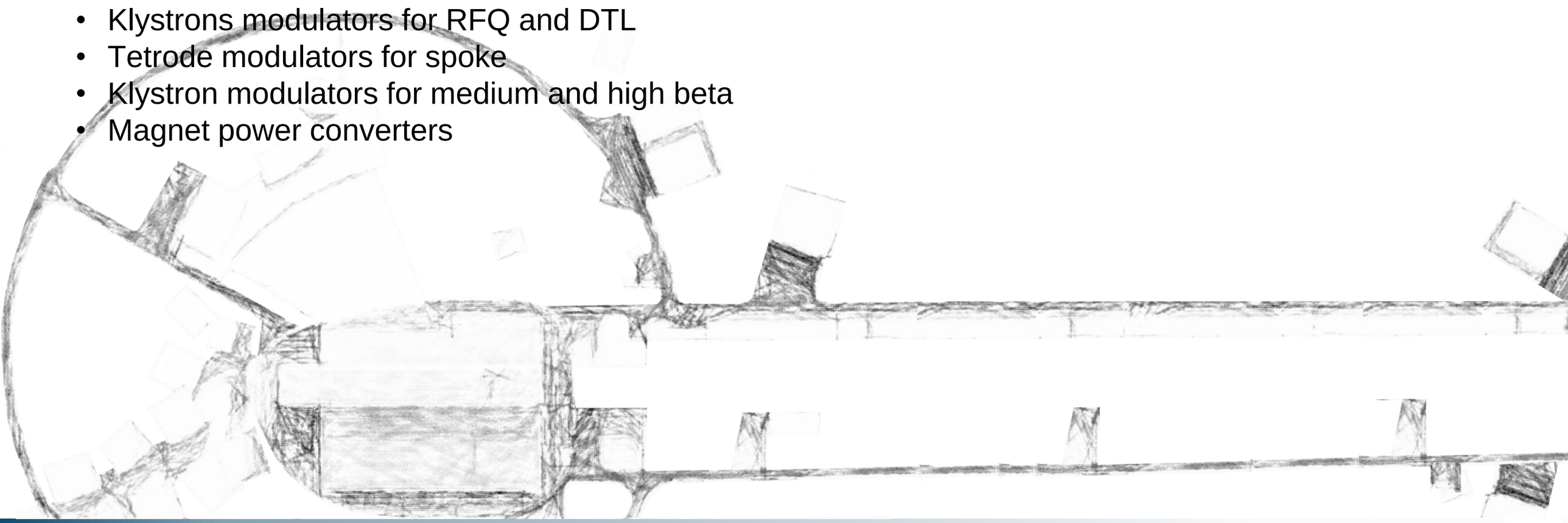
- Testing procedures consulting
- Commissioning of test stands
- Performing the cryomodules' tests

RF components installations and commissioning

- Stub waveguides
- LLRF and local protection system
- Distribution system
- High power amplifiers
- System level tests

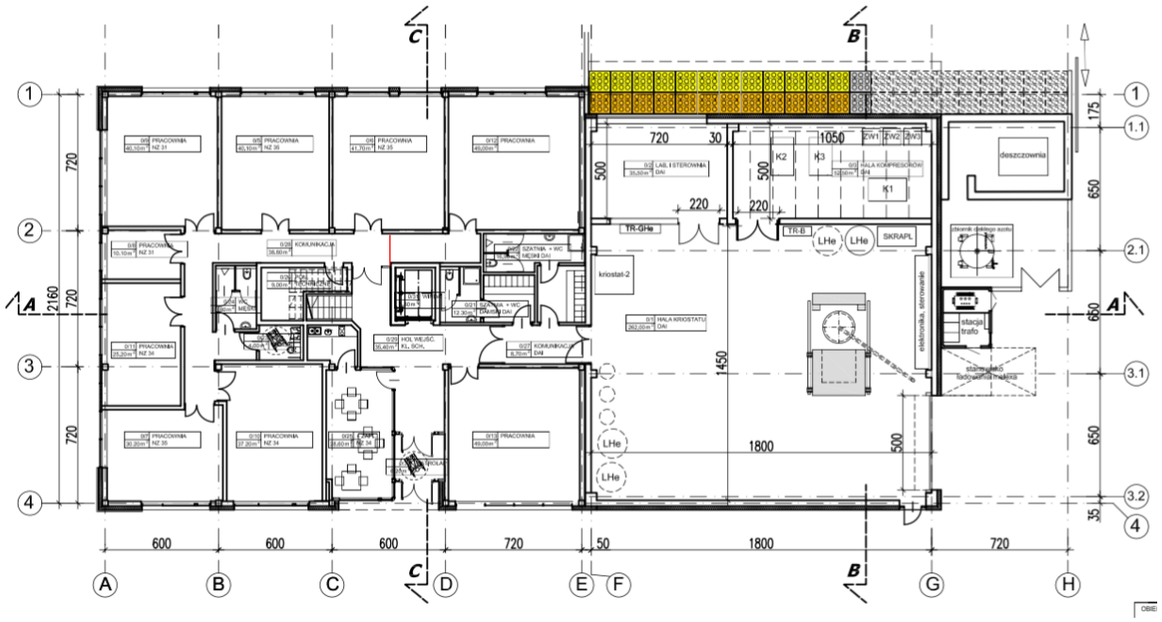
Power Converters installations and commissioning

- Klystrons modulators for RFQ and DTL
- Tetrode modulators for spoke
- Klystron modulators for medium and high beta
- Magnet power converters



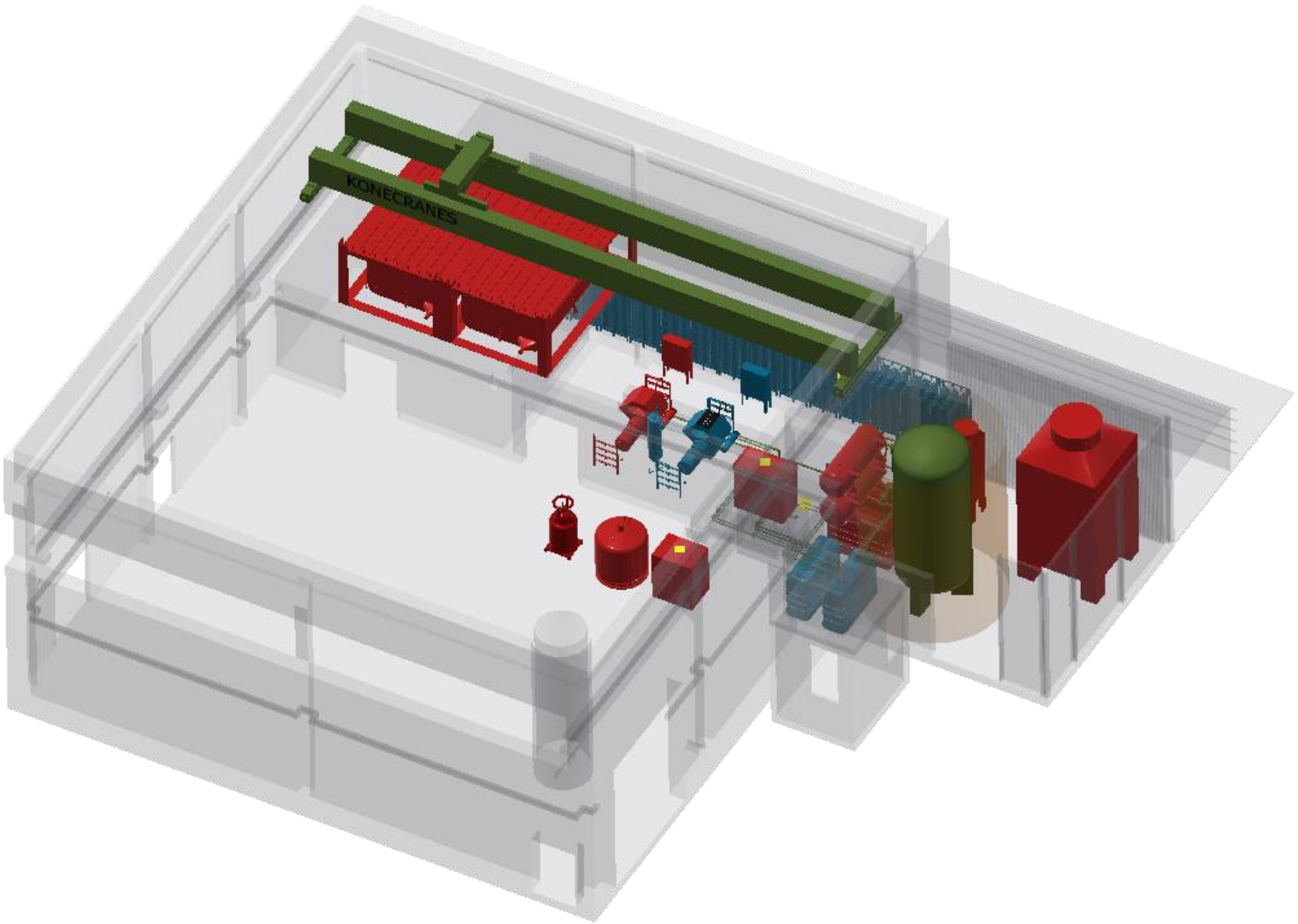
Infrastructure modernization and upgrade

- new testing facility:
  - 300m2 testing hall with 20T crane
  - 1000m2 laboratories and offices
- new testing facility equipment:
  - large vertical cryostat (3m x 1.4m)
  - small research cryostat (0.2m x 0.3m)
  - helium liquefier (35l/h LHe)



Evolution directions

- accelerator physics & technology
- design and prototyping instruments for neutron physics (ESS, ITER, DONES, …)
- beam diagnostics
- design, prototyping and testing of SC magnets
- superconductors technology


KONECRANES

We are open on involvements into new projects

Designing, prototyping and manufacturing instruments

Supporting research programs and projects

Experts in

- CAD (CATIA) projecting
- FEM (ANSYS) calculations
- Structural and seismic analysis
- Electromagnetic analysis
- Cryogenic and vacuum operations
- Electronic designing
- Composite materials
- Software development

Infrastructure

- Mechanical workshop with CNC machines (milling and lathe)
- Electronic workshop
- Climate chamber
- Helium liquefier
- *Cryostats*

Thank you.