Scientific-technical infrastructure for the research with neutrons and prominent projects at Helmholtz-Zentrum Berlin

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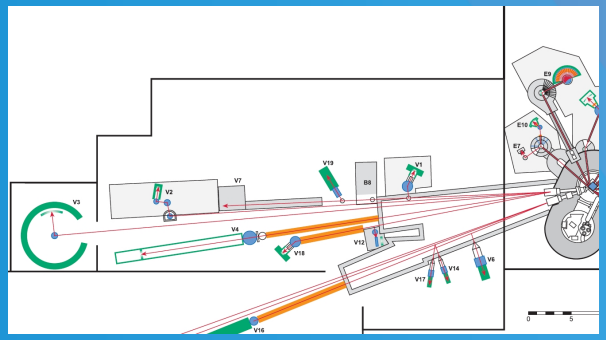

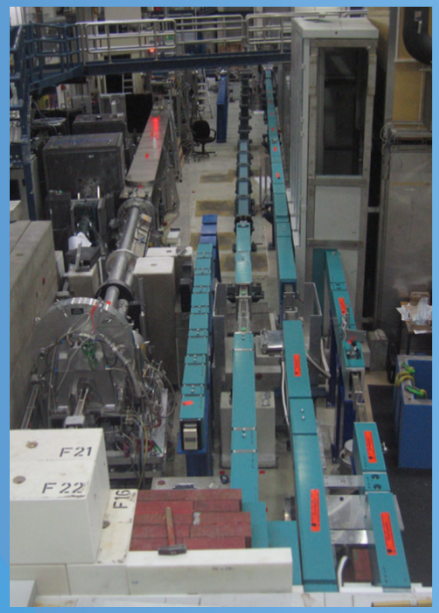

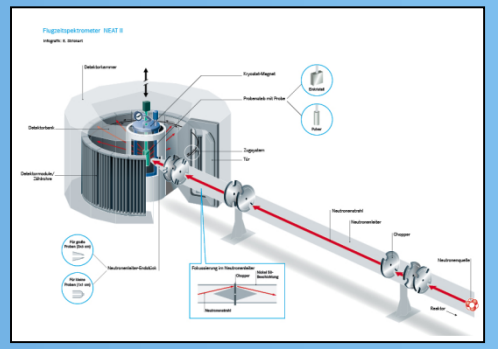

Outline

- **HZB Facility Overview**
  - **Large Scale Facilities**
  - **Neutron Instruments**
- **Organisational Structure**
- **Scientific-Technical Capabilities**
  - **User Service**
  - **Central Services**
- **Recent and ongoing Projects**
  - **New Cold Source Moderator Cell**
  - **Neutron Guide Upgrade**

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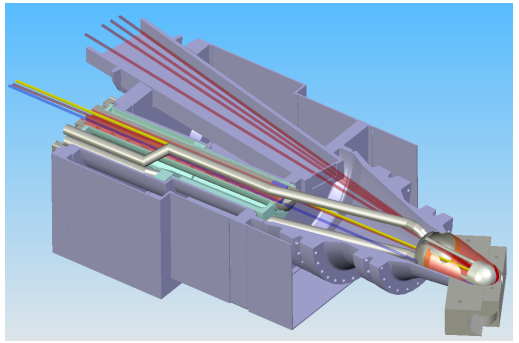
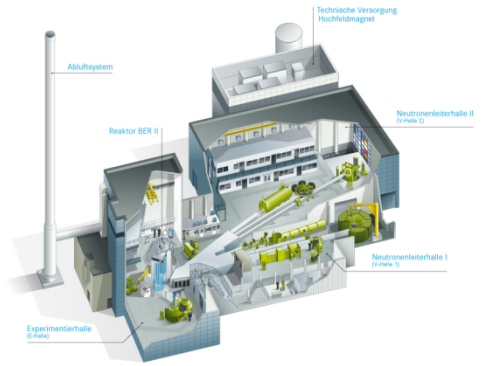
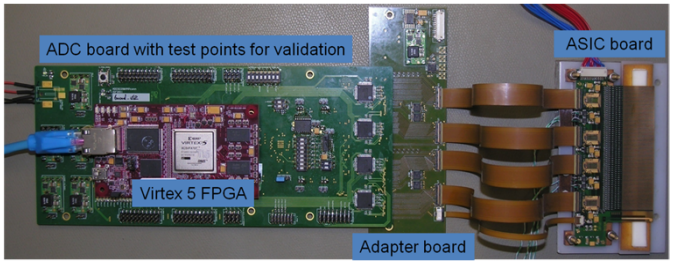
- **Project Management**
- **Summary**







Large Scale Facilities at HZB

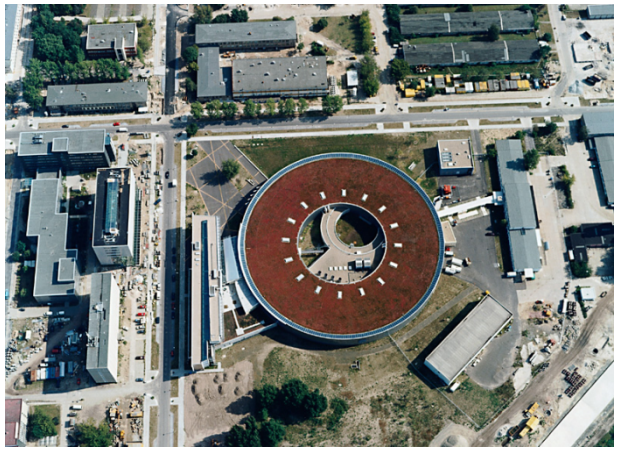
HZB operates two large scale facilities for the investigation of matter which complement each other:

Research reactor BER II

⇒ **Neutrons**
0.9Å < λ < 30Å (cold source)

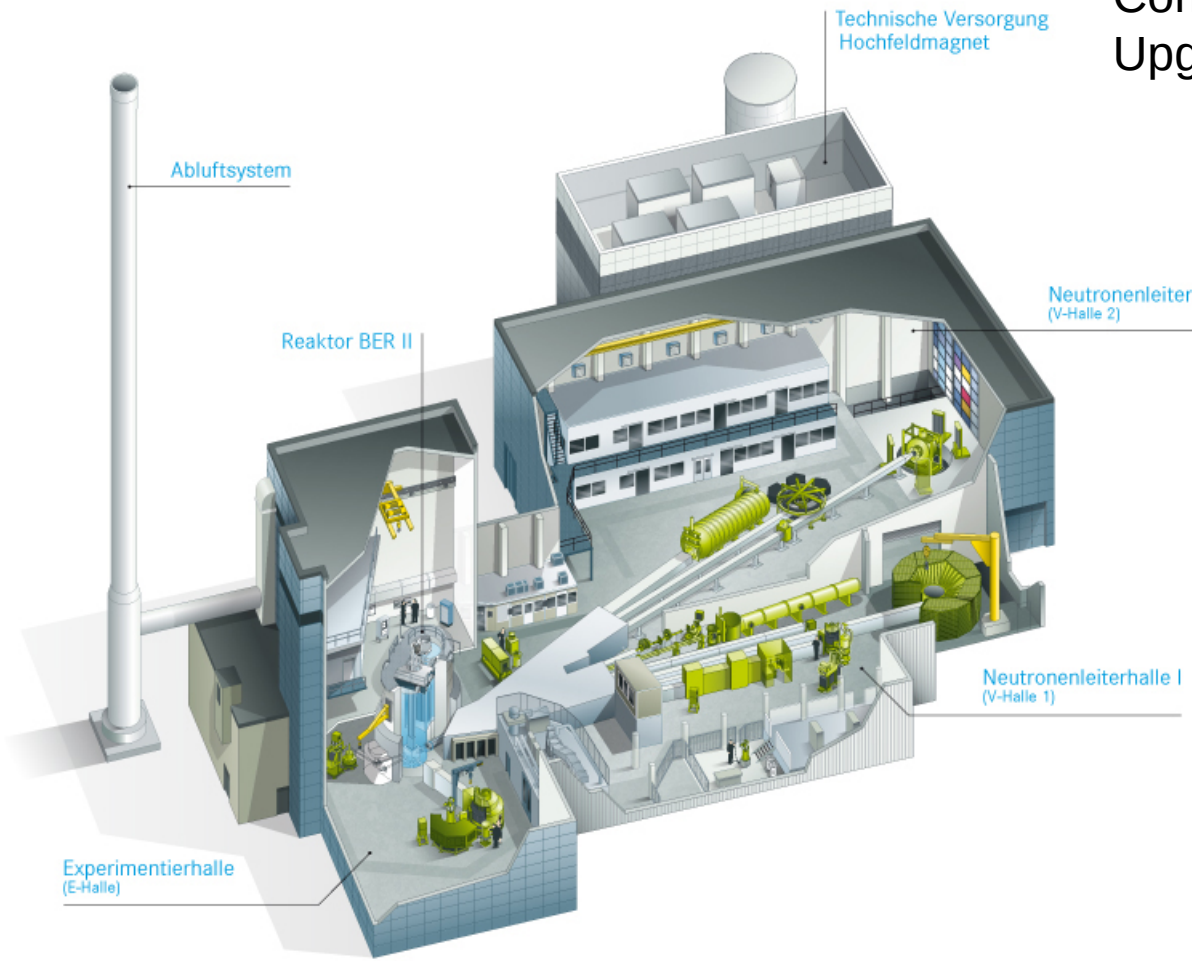
Use: ○ Mainly neutron scattering
○ Chemical analysis

Electron storage ring BESSY II



⇒ **Photons (synchrotron radiation)**
10pm (hard x-ray) < λ < 1mm (THz)
pulse lenghts 100fs; 2ps; 50ps
resolution 100pm
50 beamlines

Research reactor BER II



Commissioning (5 MW) 1973
Upgrade (10 MW) 1985 – 1991

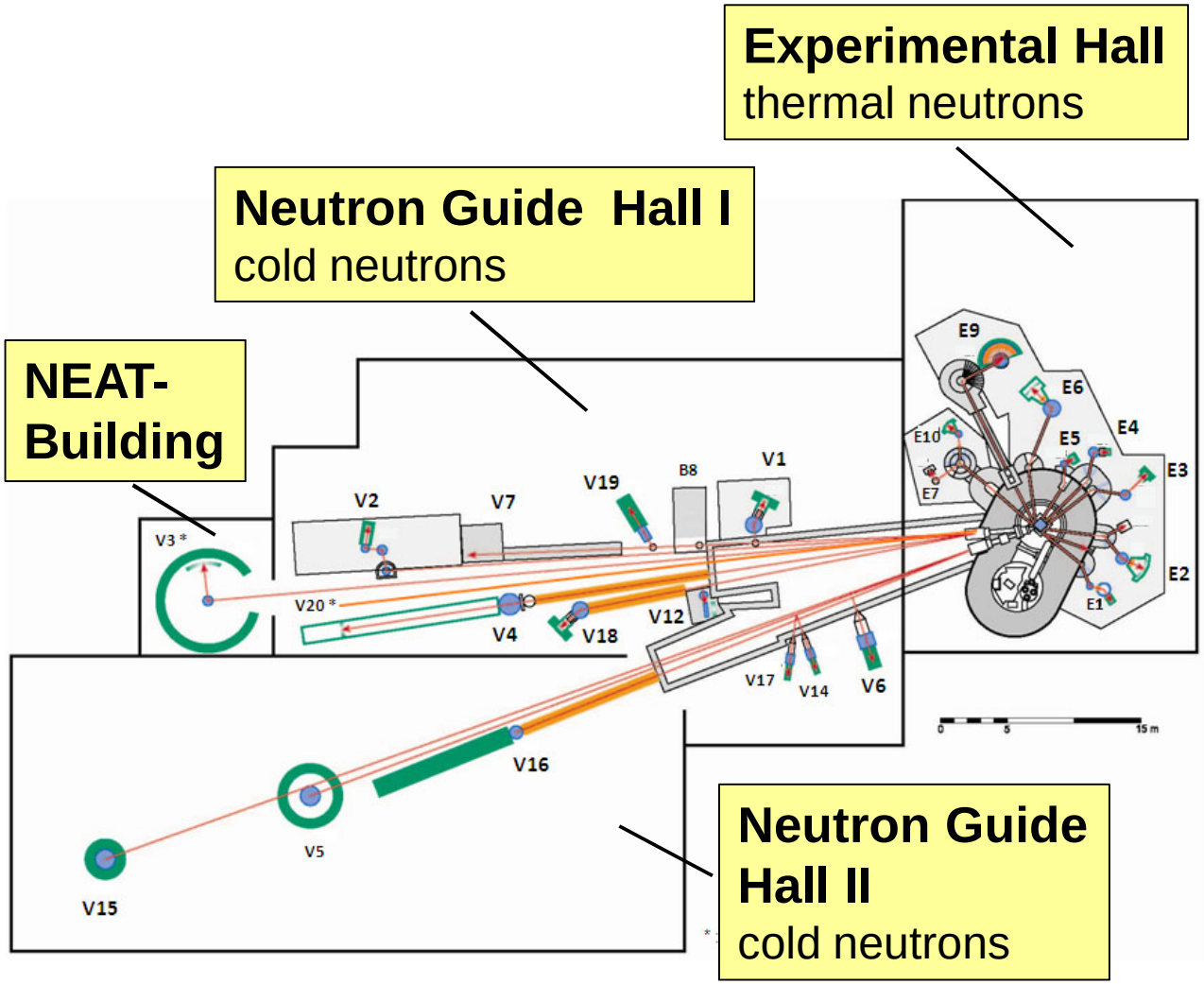
Swimming pool reactor
light water moderated
2 pools,
each ∅3.5m × 11m

10^{14} neutrons cm^{-2} s^{-1} (core)

Cold Source
⇒ long wavelengths for
- e.g. soft matter
- SANS, TOF, ….

9 beam holes (thermal)
9 neutron guides (cold)
18 neutron instruments

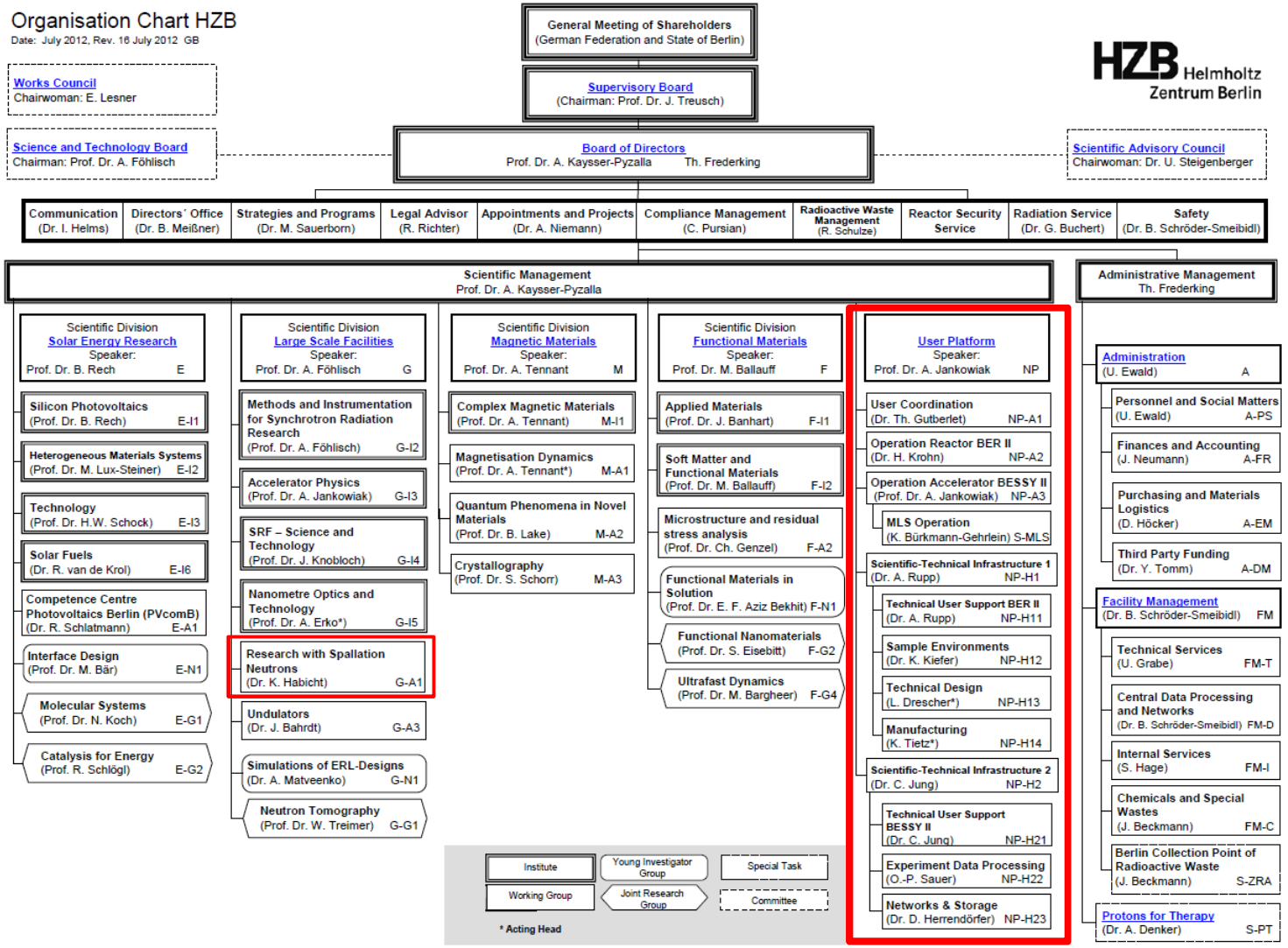
Neutron Instruments



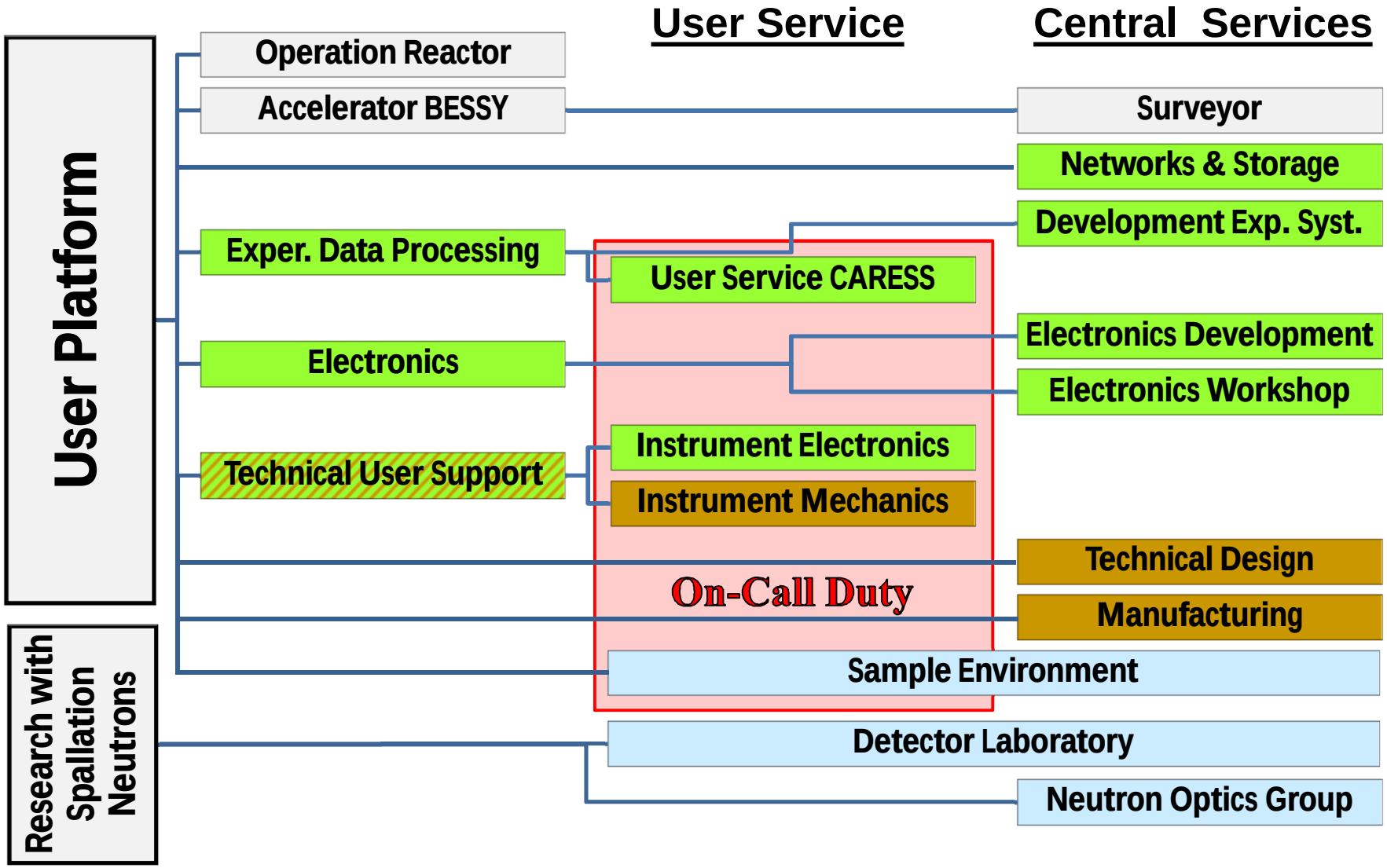
Instrumentation

- 7 Diffractometers
- 1 Triple-axis Spectrometer
- 2 Reflectometers
- 3 SANS instruments
- 2 Instruments for stress studies
- 3 Tomographie / Radiographie instruments
- 3 Instruments under construction

Organisation Chart



Scientific-Technical Infrastructure



Capabilities User Service

Instrument Mechanics at BER II

10 technicians

All mechanical work to operate neutron instruments

- Maintenance of neutron instruments
- Technical user support
- Technical advice to scientists

Instrument Electronics at BER II

2 engineers, 1 electrical mechanic

Servicing all electronic systems to operate neutron instruments

- Maintenance of instrument electronics
- Technical user support
- Development of instrument electronics
- Technical advice to scientists

Sample Environment

8 (10) persons

Operating a broad range of equipment to provide different sample environments

- Temperature T = 30 mK – 2000 K
- Magnetic field up to B = 17 T
- Pressure up to p = 1.5 GPa
- Mutually compatible

Lab for Magnetic Measurements

Options: heat capacity, heat conduction, magneto-caloric effect, magnetisation, resistivity, further under construction

DEGAS

Combines neutron scattering with in-situ-gas adsorption measurements

Capabilities Central Services (I)

Technical Design

5 designers, 3 draughtsmen, 1 planning engineer, students

Design of sophistcated (sub)units for experimental setups

- Complete engineering data
- Documentation
- Monitoring of manufacturing
- Support of commissioning
- Support of the user service

Software:
- Solid Works (CAD-software)
- COMSOL-Multiphysics (FE)

External processing of orders

Purchase of materials

Education of students

Manufacturing

26 mechanics, up to 20 apprentices

Manufacturing and assembly of complex scientific apparatus

Service and component manufacture for radiation protection areas

Technologies:

- CNC machining
- Welding: (stainless) steel, aluminum
- Laser welding
- Laser cutting
- Water jet cutting
- Vacuum brazing
- Vacuum testing
- Ultrasonic cleaning

Capabilities Central Services (II)

Electronics

3 development engineers, 5 electronic technicians

Development of analog and digital boards

Manufacture of electronic devices

Installation and service of process control systems

Experiment Data Processing

5 (15) persons + students

Development experiment systems

Development and servicing CARESS

Development and implementation of motor control systems

Detector Laboratory

5 scientists and engineers

Detector development

BF_3 detectors, MSGC (^{157}GD/CsI converter)

Setup and commissioning of complete detection systems

- Primary detectors
- Frontend electronics (amplifiers, discriminators)
- Interfaces for data aquisition
- Software: DeLiDAQ, Q-MesyDAQ

User support for a faultless operation

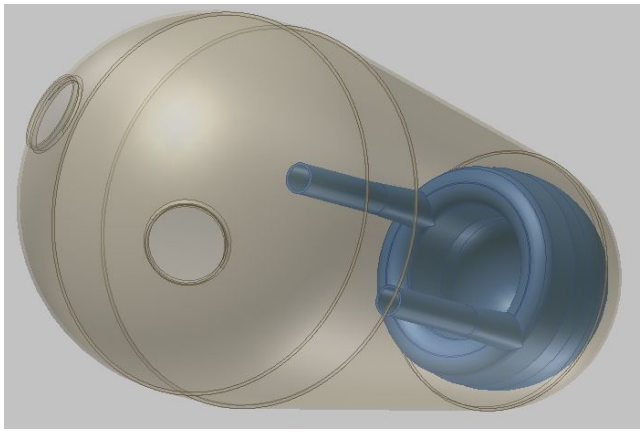
Advice to instrument scientists, simulation calculations

New Cold Source Moderator Cell

Exchange of the conical beamtube

Improved moderator cell design

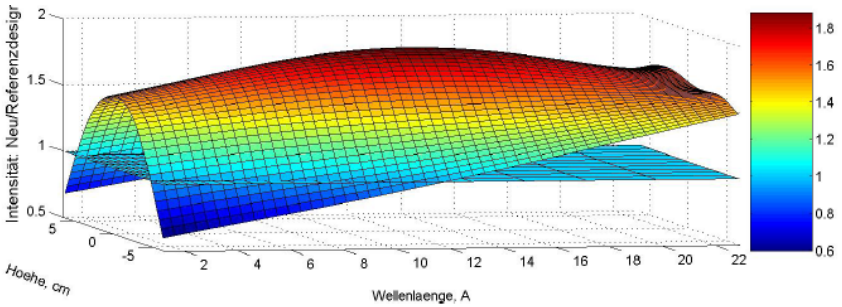
planning phase	**2006 - 2009**
training	**2009 – 2010**
„hot“ phase	**2010 - 2012**



MCNP optimized parameters:

- cell-core distance
- length of cylinder
- moderator thickness

50-60 % brilliance gain



Neutron Guide Upgrade

Period: 2009 – March 2012

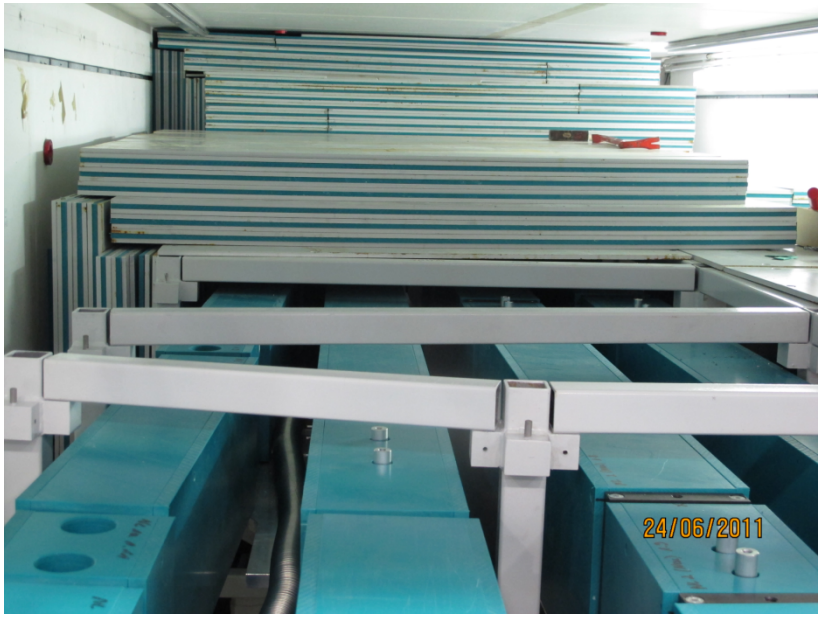
- 6 instead of 5 guides in NGH I
- Twice the total cross section
- m=3 coating instead of ^{58} Ni (m=1.2)

⇒ **Overall gain factor: 2 - 5**

⇒ Total radiation increase by factor 20

⇓

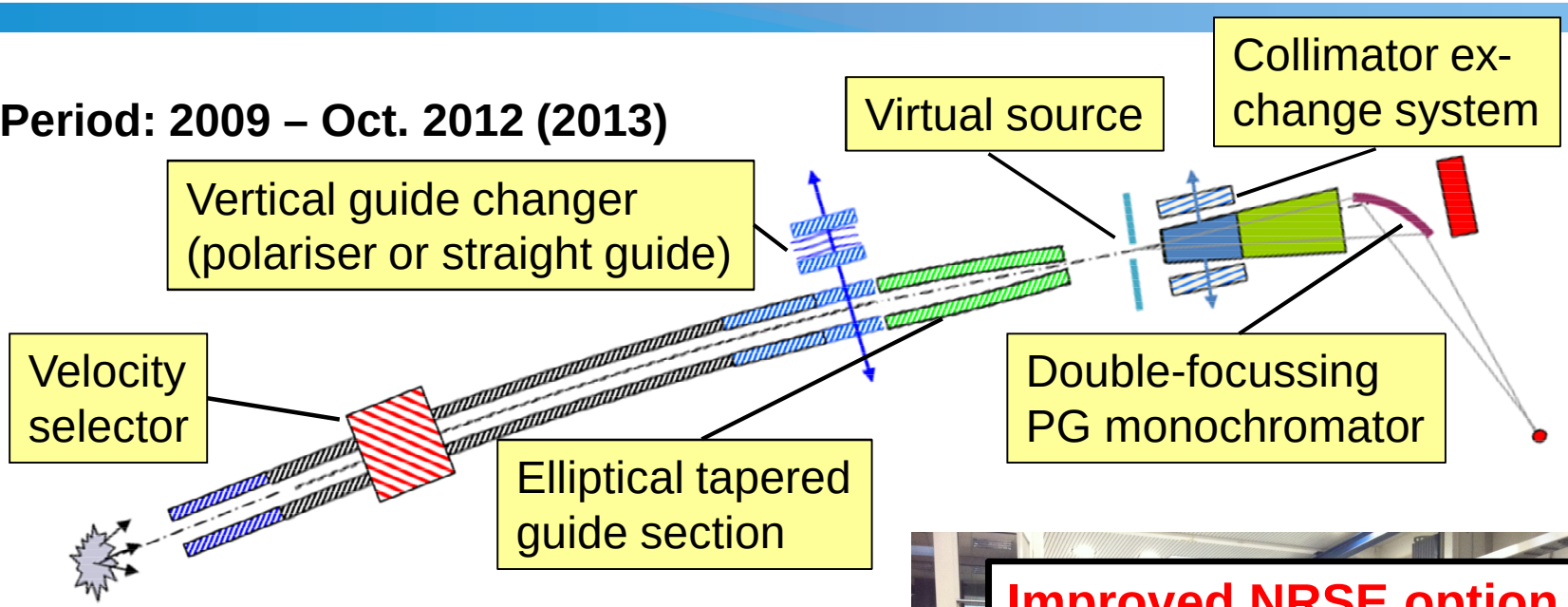
Sandwich-type shielding (bPE + Fe)

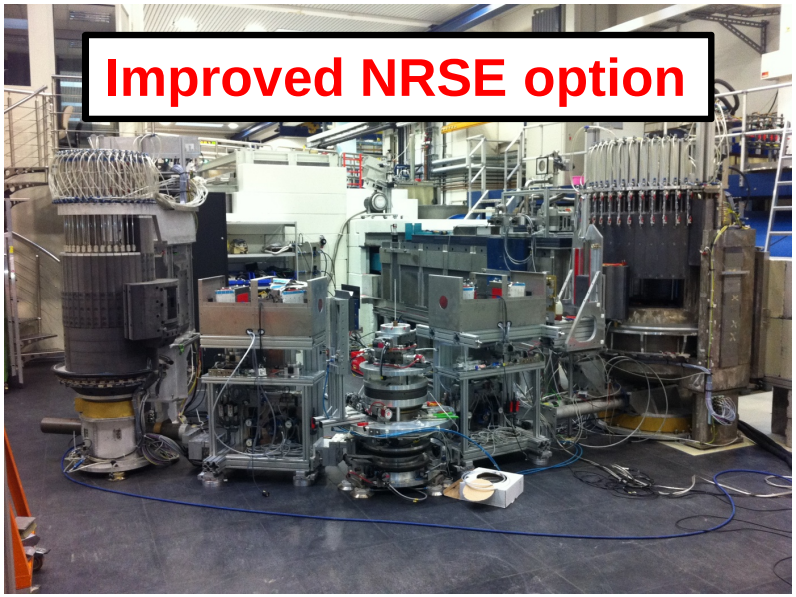


- Tight-fitting enclosure
- Higher radiation attenuation
- Enhanced flexibility

Upgraded Cold TAS FLEXX

Period: 2009 – Oct. 2012 (2013)





- Own neutron guide, end position

⇒ Neutron optics tailored to particular instrument needs

+

- Increased neutron flux

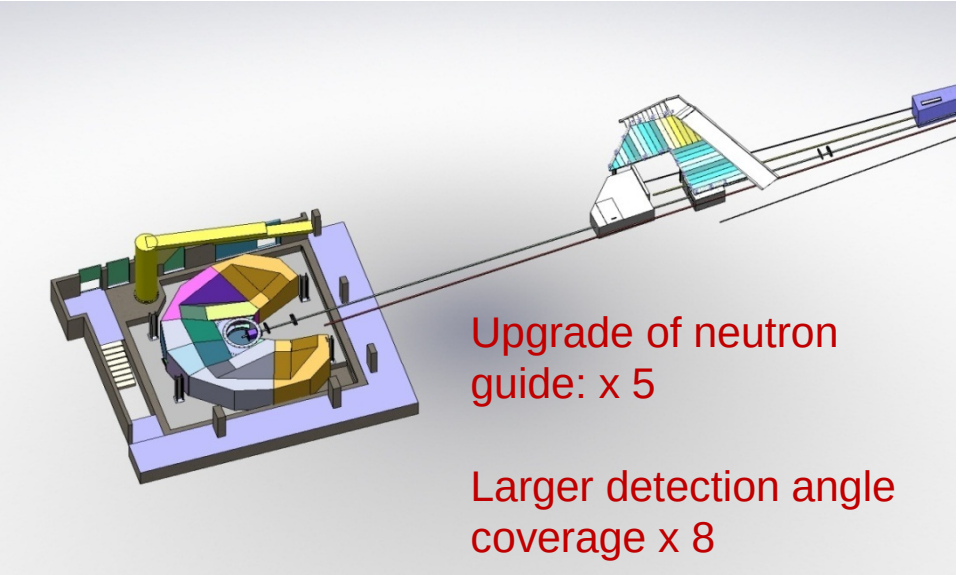
⇒ Increased wavelength range

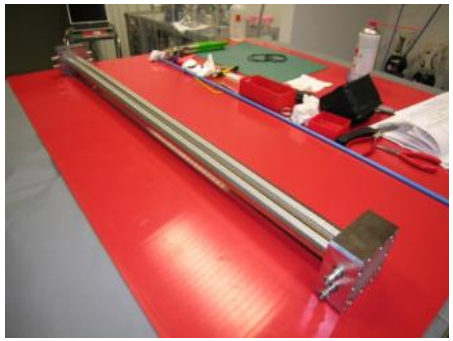
⇒ Larger wavevector + energy transfer

NEAT Upgrade Project

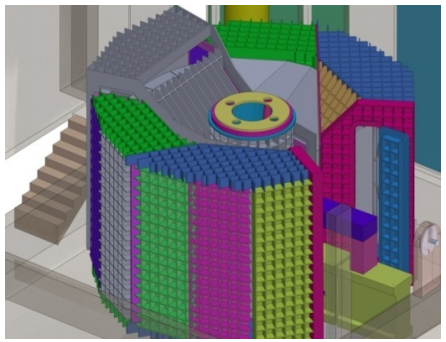
Period: 2010 – 2015

- Novel Materials
- Mapping of excitations in single crystals
- Chemical activity in biomolecules
- Complex sample environments

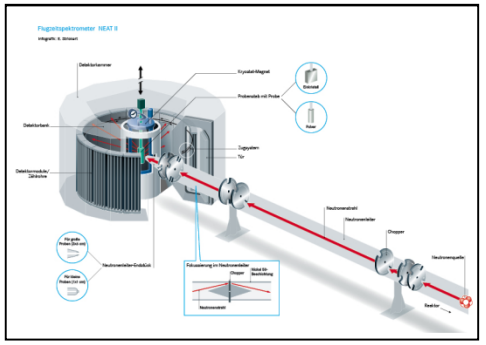




Position sensitive detectors with BF_3. Successful first tests



Non-magnetic detector chamber



New chopper system

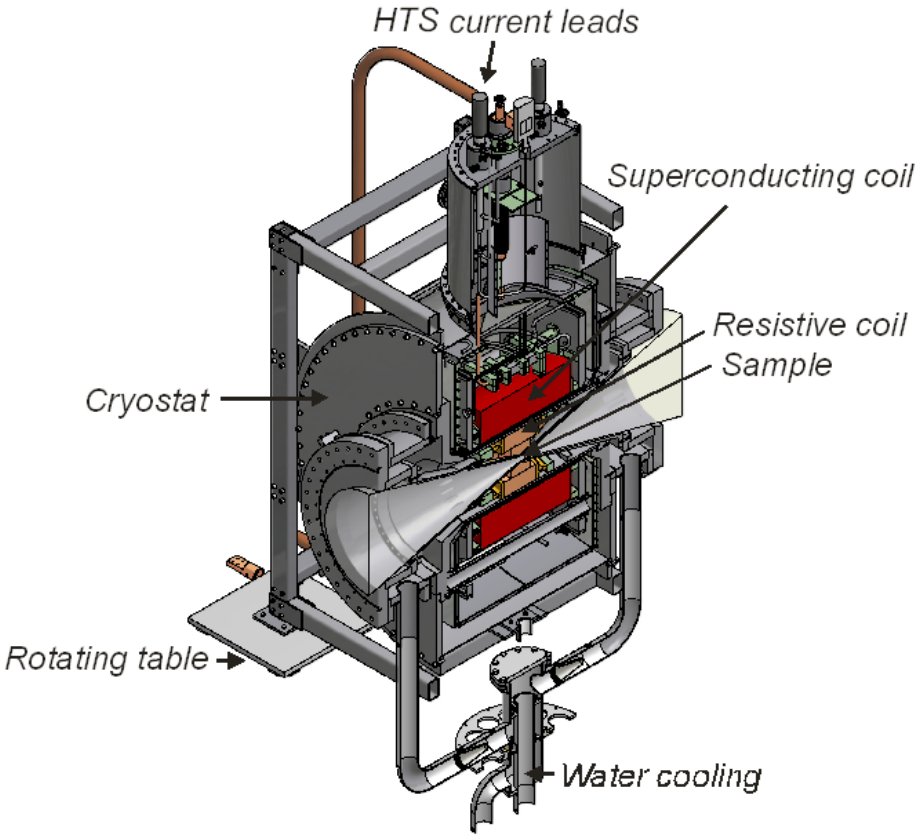
New building

High Field Magnet

Period: 2007 – 2014

Hybrid magnet + infrastructure

Central Field	**> 25 T (> 30) T**
Bore	**50 mm horizontal**
Opening Angle	**Conical ends, 30°**
Power Resistive Insert	**4 MW (8 MW)**
Field Homogeneity	**< 0.5% (20 mm x 20 mm Vol.)**
Operating Current	**20 kA**
Magnetic Field of Resistive Insert	**13 T – 19 T (4 MW / 8 MW)**
Magnetic Field of Supercond. Coil	**13 T**
Height	**~ 5 m**
Total Weight	**~ 30 t**
Cold Mass (4.5 K)	**~ 9 t**



High field magnet

Period: 2007 – 2014

Challenges

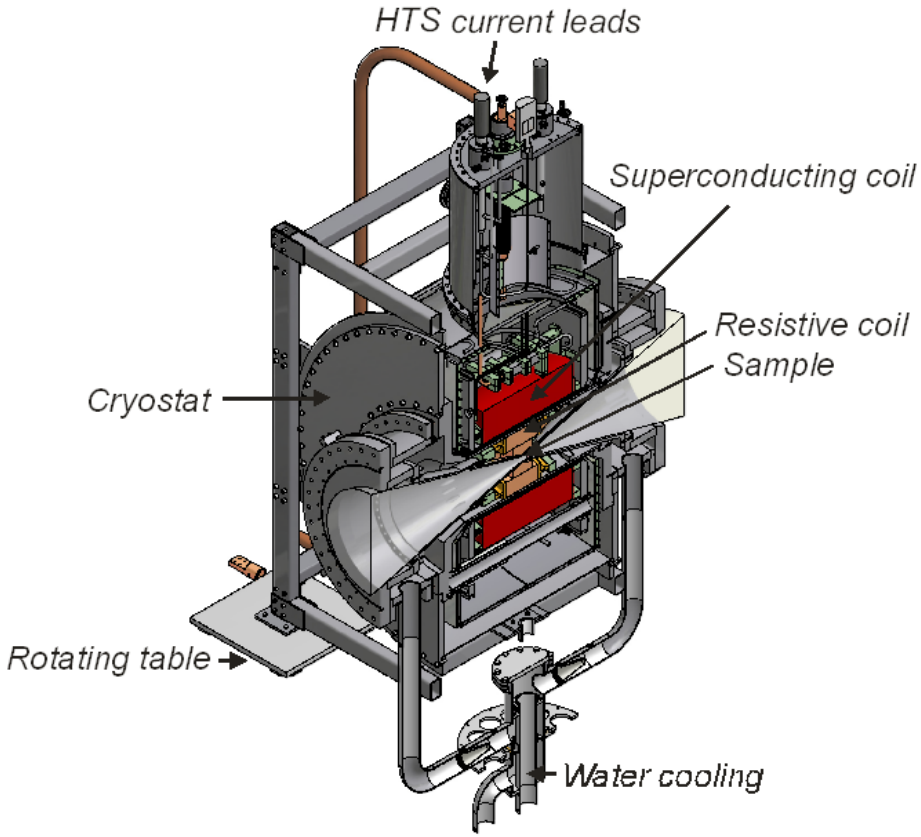
Design and Construction

Series-Connected System:

- SC coil (Cable-in-Conduit)
- Resistive Bitter coil

Operation

- 20 kA DC power supply
- Helium refrigerator
- High pressure cooling water
- 4 / 8 MW cooling power



ESS-Design-Update-Phase

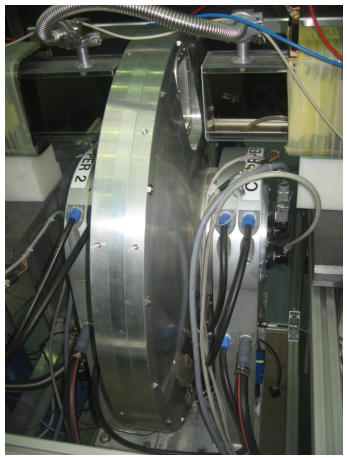
Period: 2010 – 2013

Testbeamline

Specific beamline to mimic the time structure of the ESS neutron pulses

Aim: Study components and instrument concepts under real conditions

Counter rotating chopper system



840rpm and 2520rpm

+ additional chopper systems

Variable distances!

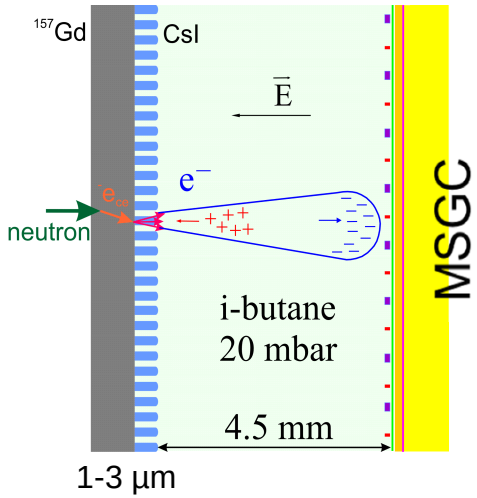
Further activities:

^{157}Gd-CsI MSGC Detectors

with high spatial resolution

Pos. resol. <0.5 mm
TOF resol. ~10 ns

Specific ASICs and ADC boards



Simulation Code Development

Concepts for Reflectometry, Neutron Radiography/Tomography, Extreme Sample Environment

Project management

Conventional mangament tools

- **Definition project structure**
- **Project schedule**

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Project coordinator

- **Support of the project leader**
- **Coordination**
- **Controlling**

Central document management system

Goals:

More efficiency due to

- Easier search
- Worldwide access
- Automatical communcation

…of information

Avoidance of errors by

- Centralisation
- Marking
- Traceability

…of documents

Tested and applied at the High Field Magnet project

Summary

Large Scale Facilities

- HZB operates two large scale facilities for the investigation of matter: research reactor BER II + electron storage ring BESSY II
- BER II provides 18 instruments in the user service with neutrons

Organisational Structure

- The scientific-technical infrastructure is largely centralised in the User Platform

Scientific-Technical Capabilities

- User service: Instrument Service Groups, CARESS User Service, SE, Detector Laboratory
- Central: Technical Design, Manufacturing, Electronics, SE, Detector Lab, Experiment Data Processing, Network & Storage, Neutron Optics, Survey

Recent and ongoing Projects

- New Cold Source, NG Upgrade, FLEXX, NEAT, HFM, ESS-Design

Acknowledgements

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Experiment Data Processing dept.
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Manufacturing dept.
Electronics group
Detector Laboratory
Neutron Optics group
Operation Reactor dept.
Neutron Guide Upgrade project team
FLEXX-Upgrade project team
NEAT-Upgrade project team
High Field Magnet project team
ESS Design-Update-Phase teams
⋮

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