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Upgrade of mirror positioning system and sample area of KWS-3 instrument

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Overview

- Motivation for KWS3-Upgrade
- New mirror positioning system
- Compact Mirror Chamber and Apertures
- Sample Area Upgrade (main station)
- Platform improvement
- Upgrade KWS3 schedule
- Summary

KWS3

Klein-Winkel-Streuapparatur
(Small-angle neutron scattering instrument)

- Tool to study structures and particles with sizes just above the atomic scale between 1 and 100 nanometers (nm) in soft matter, scientific material and biological sample. KWS3 is located in the neutron guide hall West of FRM-II.

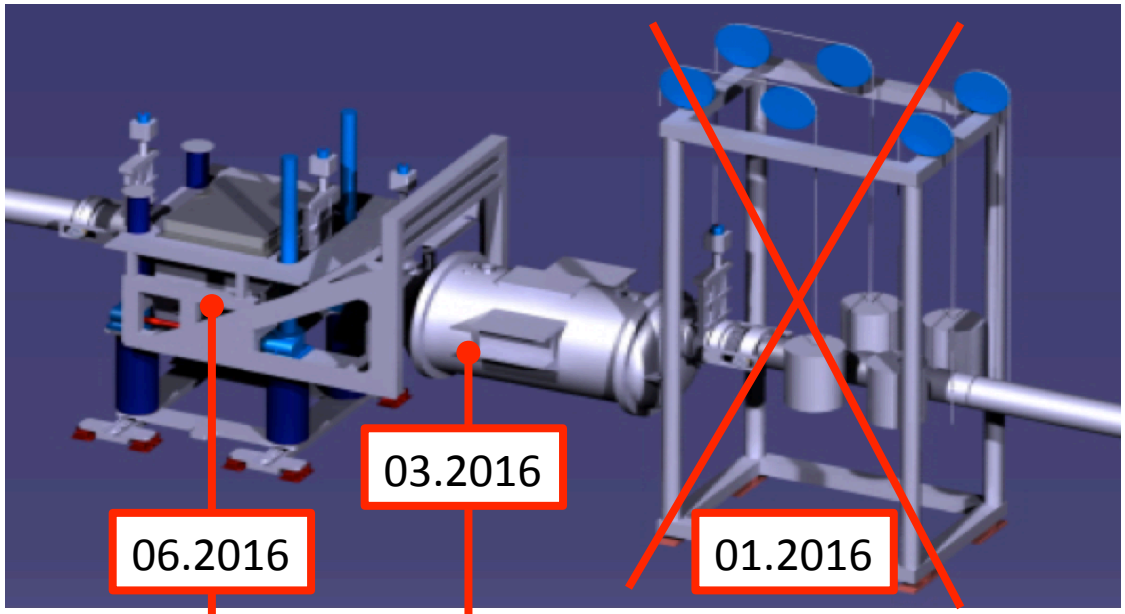
- With the help of neutron scattering at KWS-3 and KWS-1 has been shown that CO_2 can include more than one hundred millennia in deep geological formations* – an important contribution to avoid catastrophic climate change. A good example, that research with neutrons have real global impact.

*"*Observational evidence confirms modelling of the long-term integrity of CO2-reservoir caprocks"* (Nature communications 28.07.16 N. Kampman, A. Busch, V. Pipich at. all.)

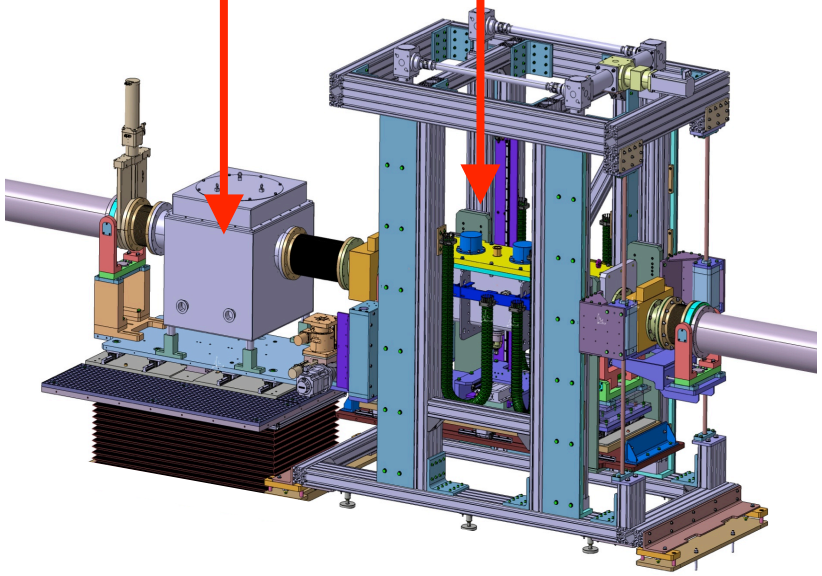
Motivation for KWS3-Upgrade

Neutron Guide Hall West -
historical pictures from “old” KWS3

Motivation for KWS3-Upgrade

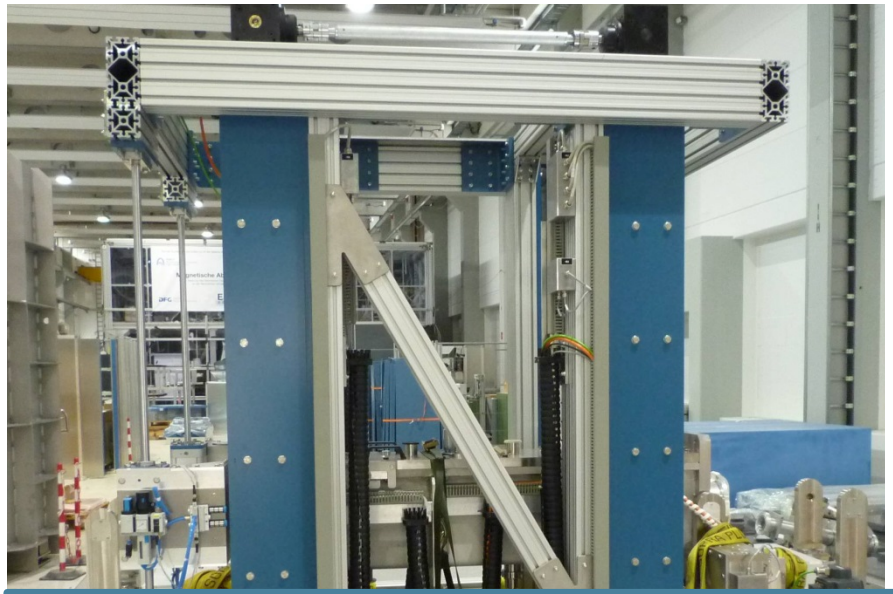


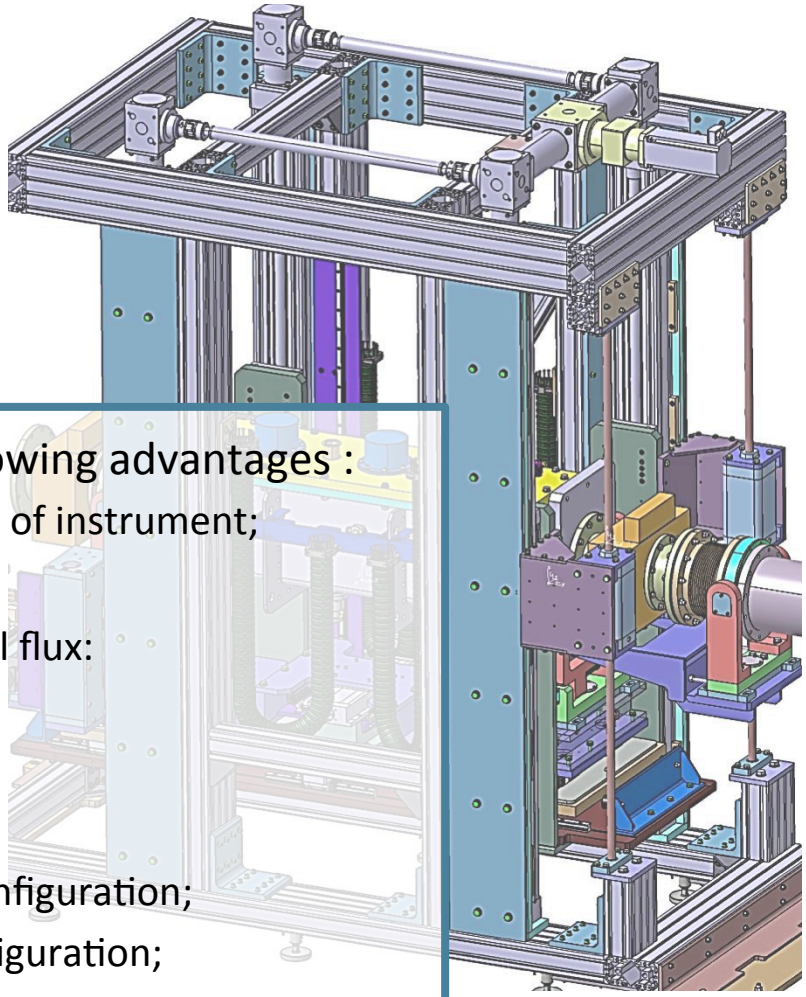
Before



After

New mirror positioning system

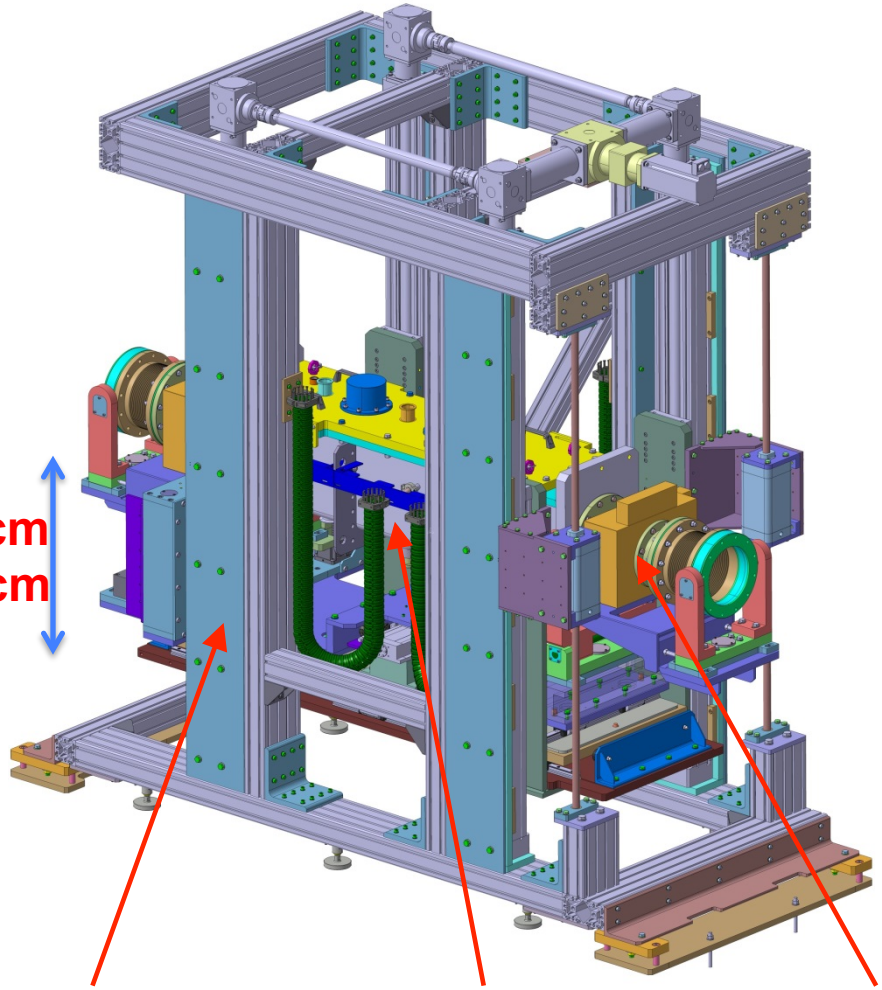


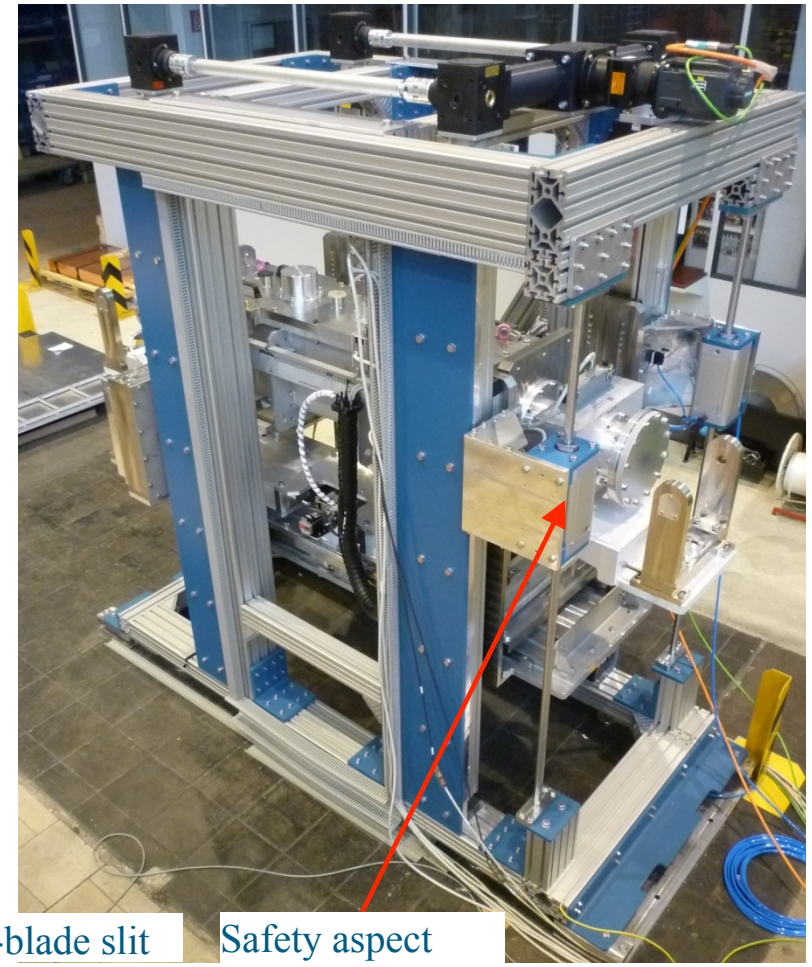


Through the upgrade we have achieved the following advantages :

- mechanical decoupling of focusing system and rest of instrument;
- easy-adjustment of the focus;
- possibility to select position of mirror with maximal flux:
  - in horizontal plane;
  - in vertical plane;
- vertical angulation:
  - -0.5° … 5° [0 … 0.12Å^{-1}] in “mirror-down” configuration;
  - -5° … 0.5° [-0.12 … 0 Å^{-1}] in “mirror-up” configuration;
- horizontal angulation: ±0.05°

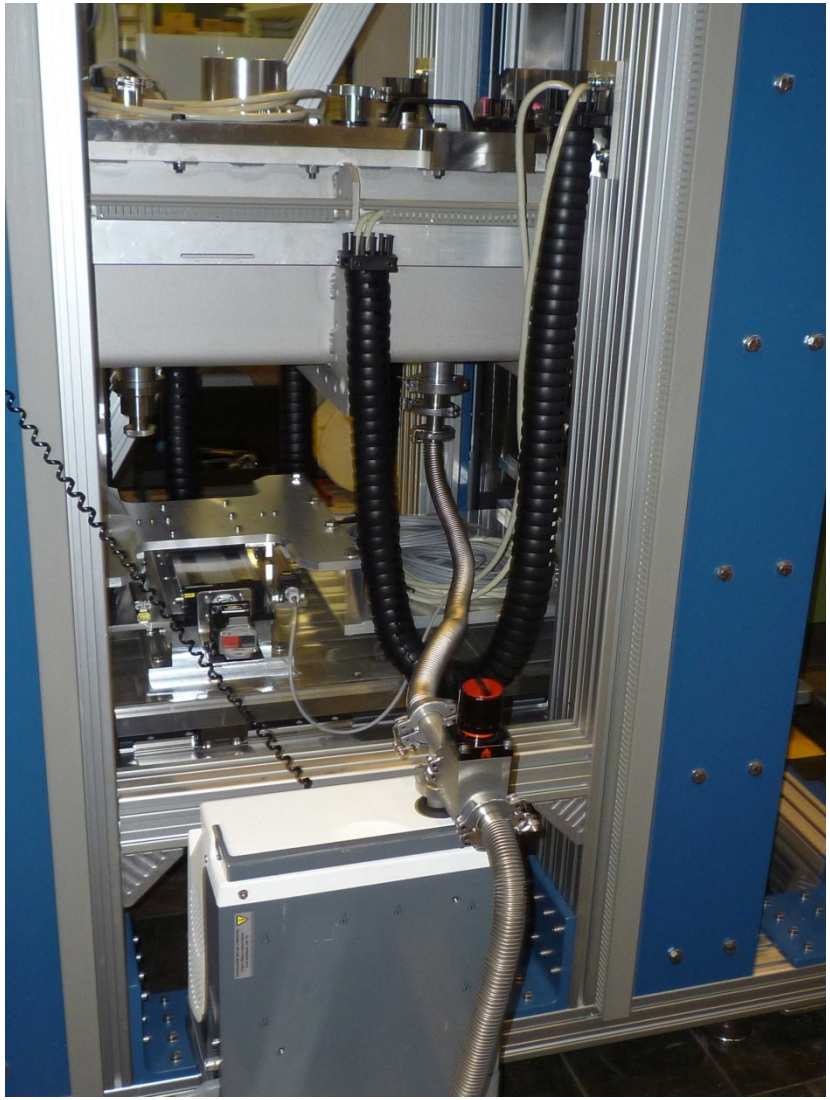
New mirror positioning system

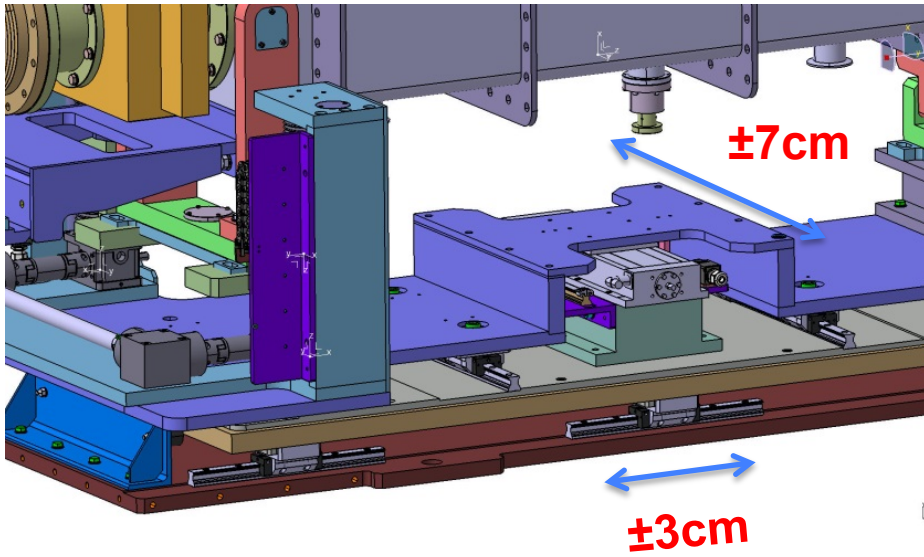




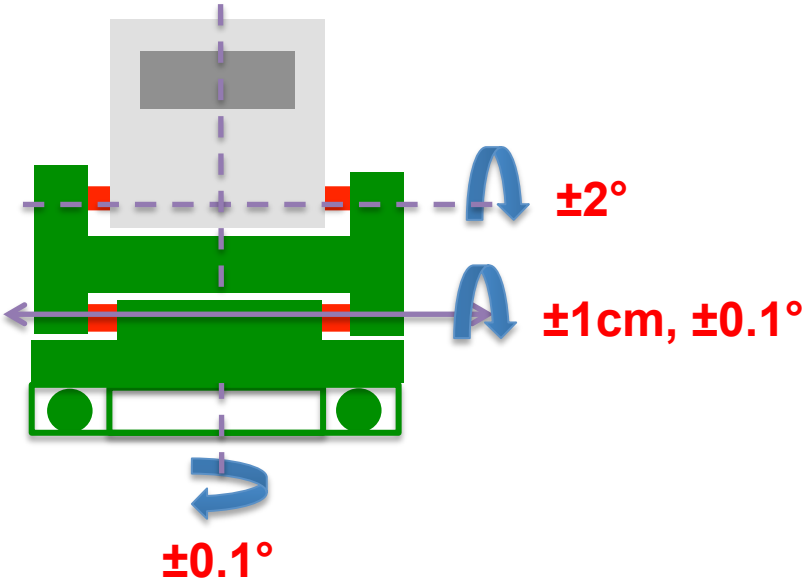
- Position of the vacuum chamber will be supported by the brake.
- The vacuum chamber would be hold by the brake even if the coupling should fail.

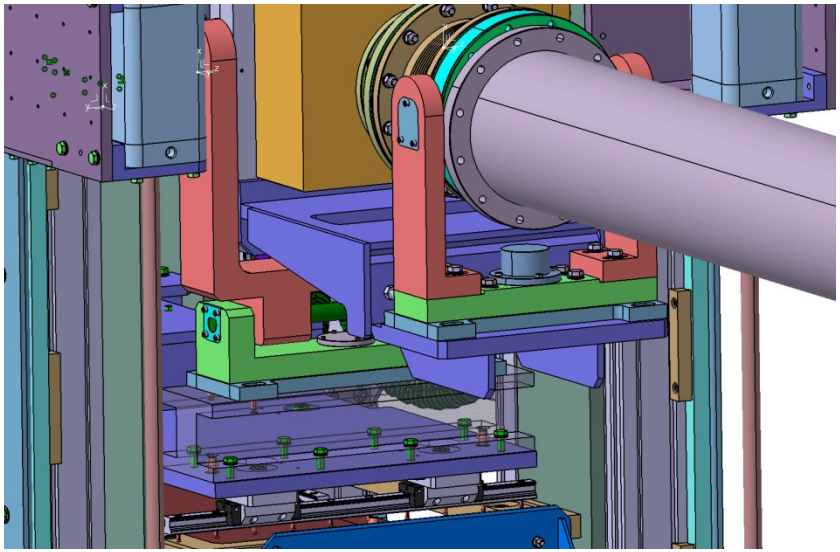
New mirror positioning system



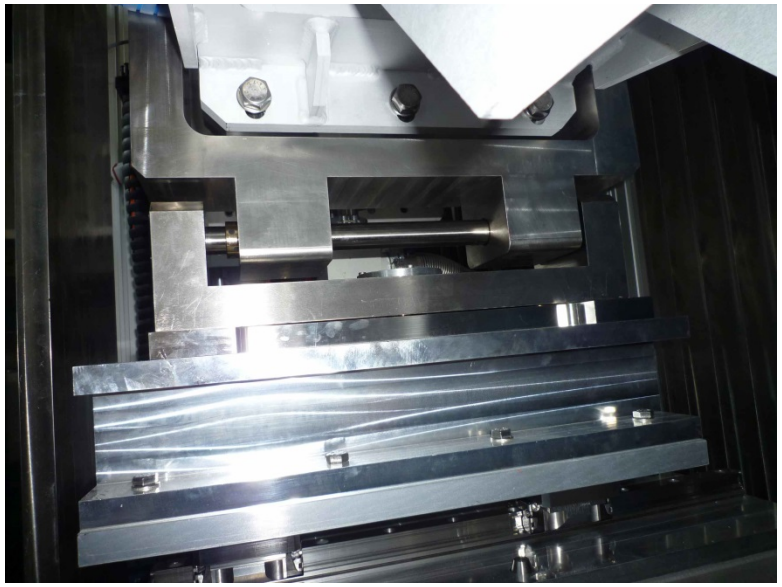


New mirror positioning system

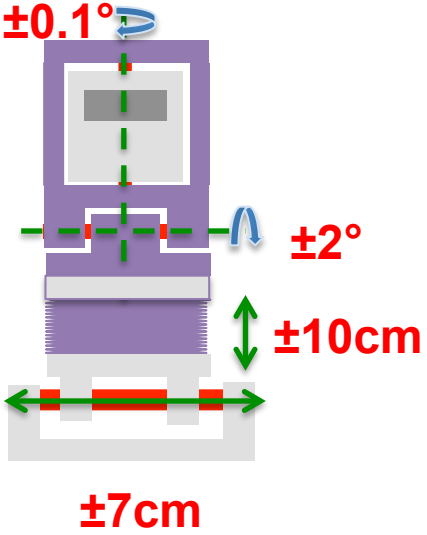


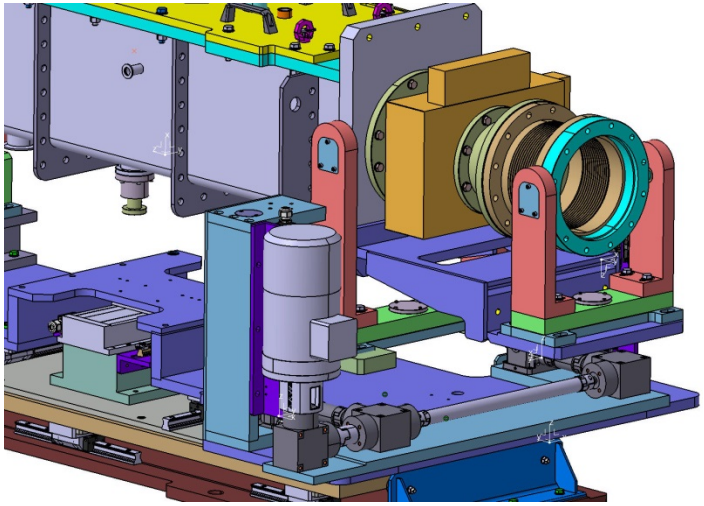


beam entry

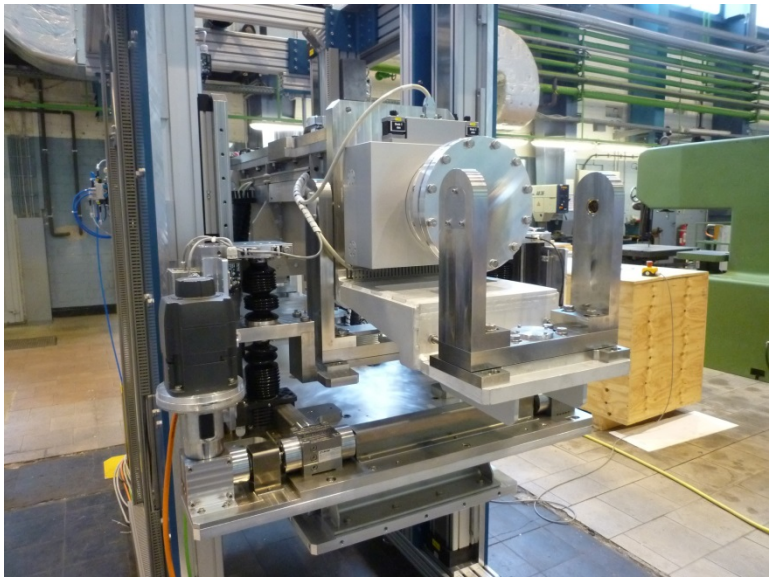


New mirror positioning system





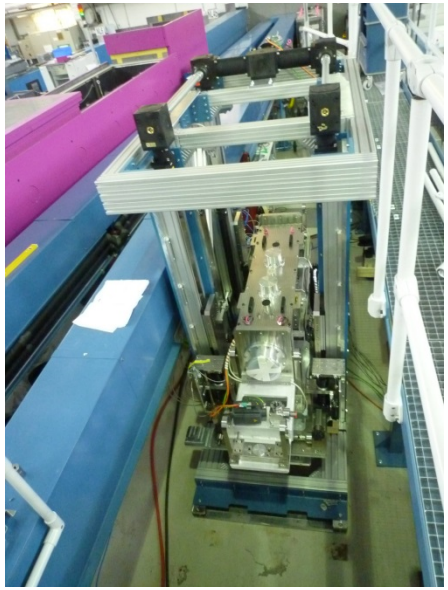
beam exit

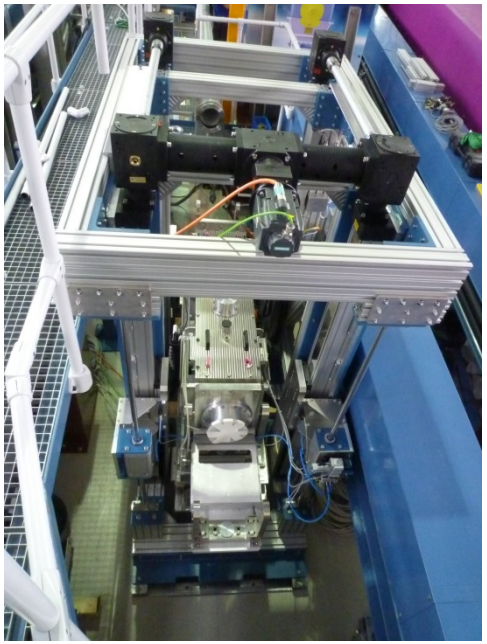


New mirror positioning system

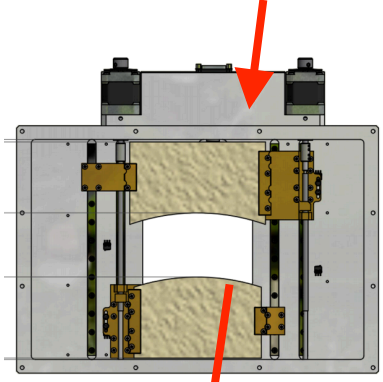
- New mirror positioning system: mechanics, electrics, programs installation in Garching (March 2016)

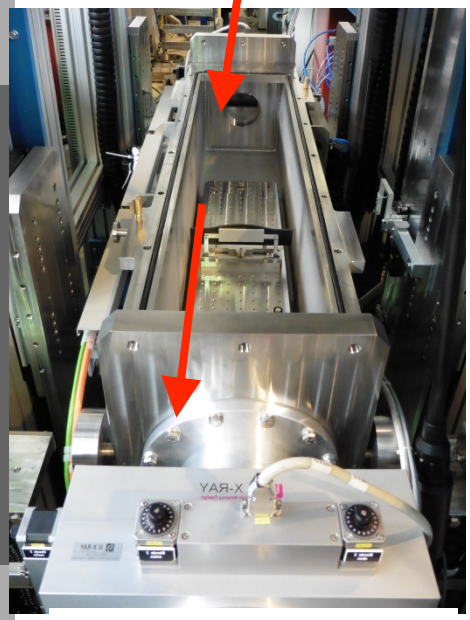
-Befor, we have tested each component of this system in Forschungszentrum Jülich

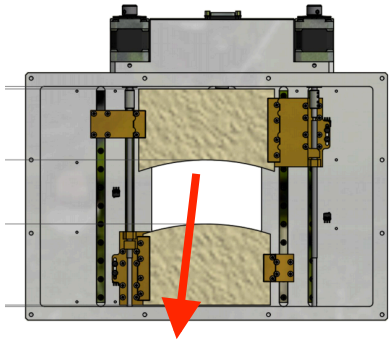




Mirror Chamber and Apertures

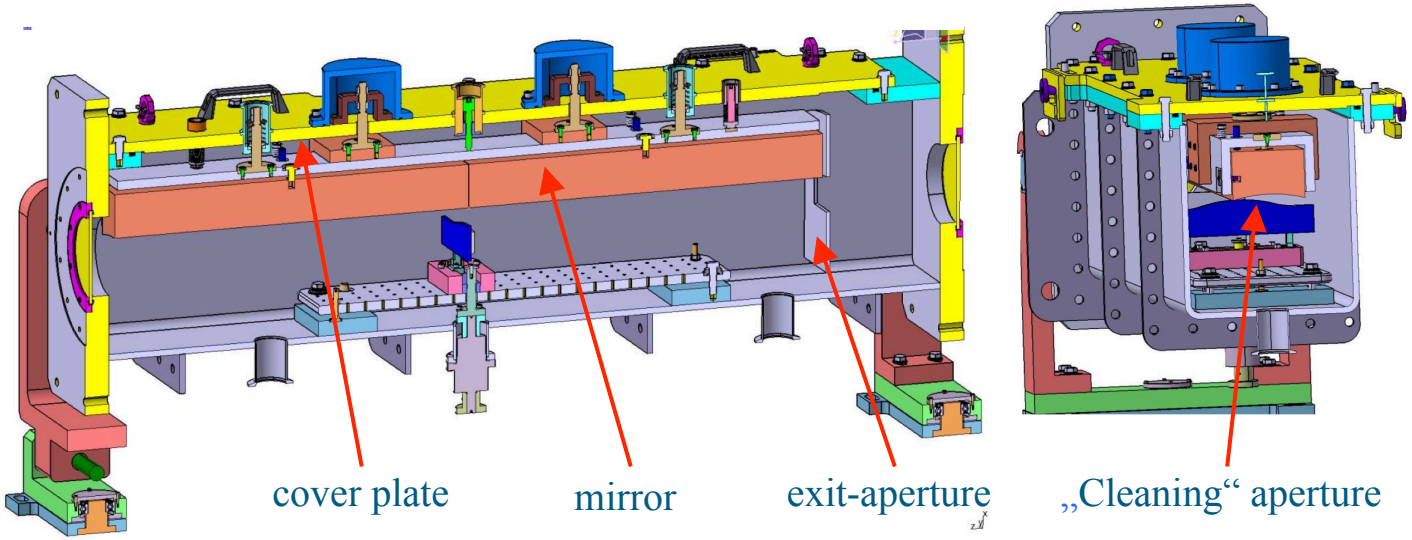




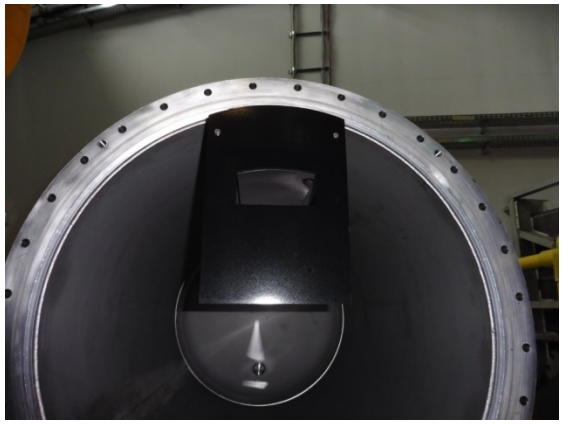


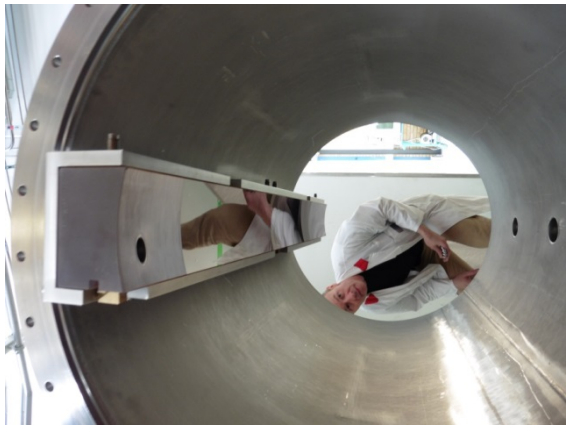
Through the upgrade we have achieved the following advantages:

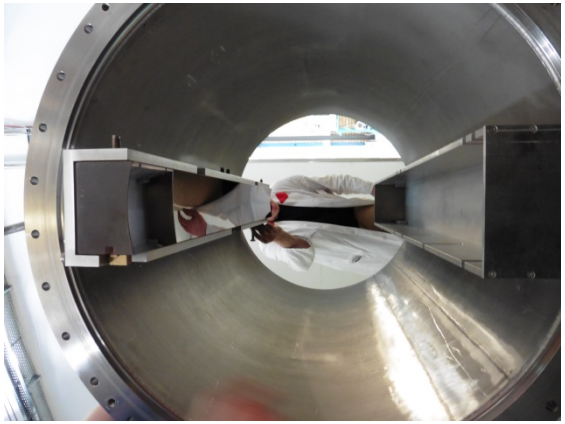
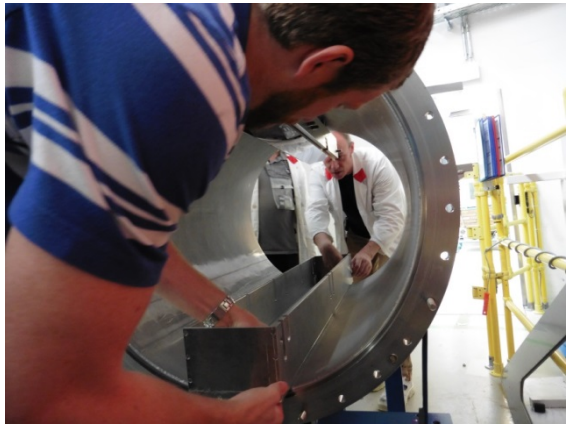
- "compact" mirror chamber body;
- mirror is fixed at cover-plate, easy and safe installation;
- sapphire windows , separated vacuum, preventing of mirror damaging;
- adoption of old mirror-fixing-model with 3-point-adjustment;
- ready for guiding-field: inside or outside;
- new system of beam "definition". "Clean" beam with new apertures:
  - 4-blade aperture with mirror profile in front of the mirror;
  - 4-blade aperture with mirror profile after the mirror;
  - 1-blade aperture with mirror profile in the middle of the mirror;



Mirror Chamber and Apertures

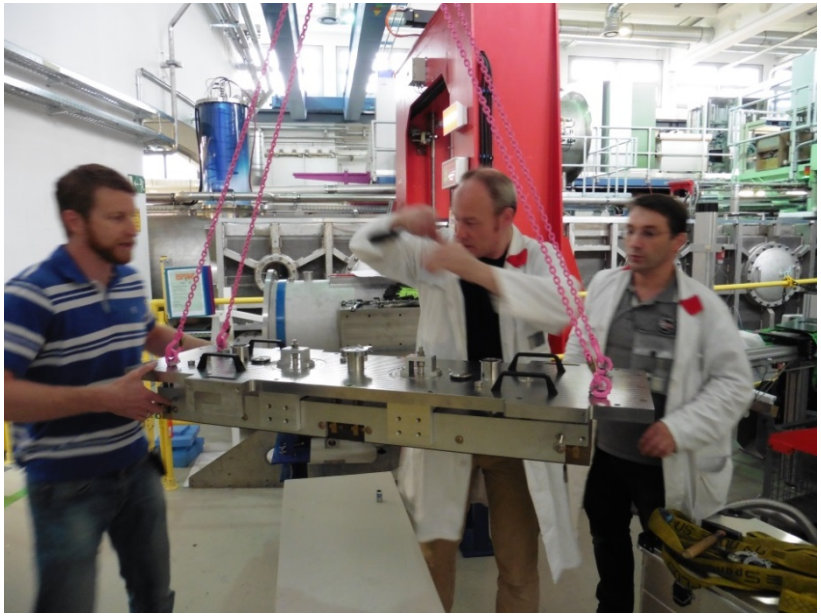


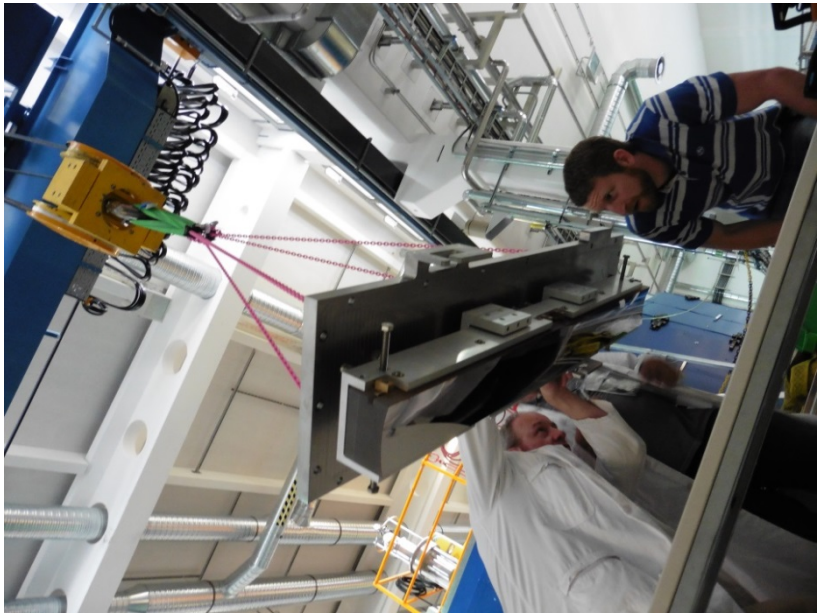


- The mirror is the “heart” of the system
- Smallest pollution can damage the surface of the mirror

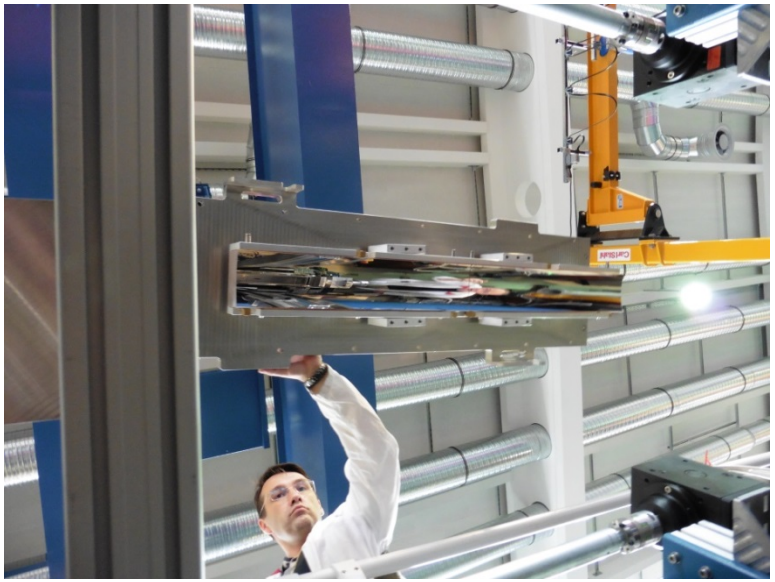
Mirror Chamber and Apertures





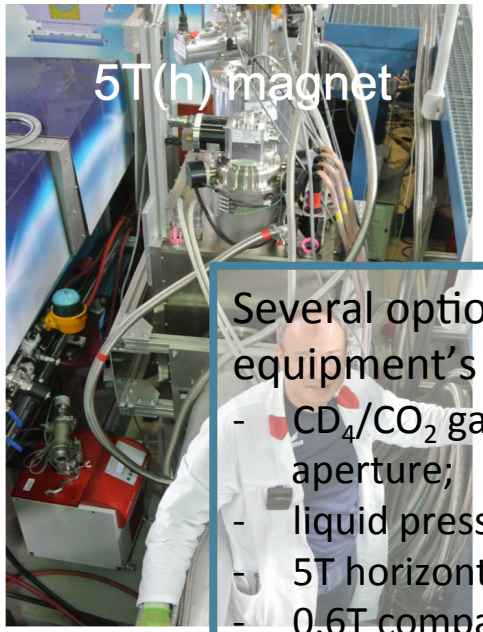
„Mirror transplatations surgeons“

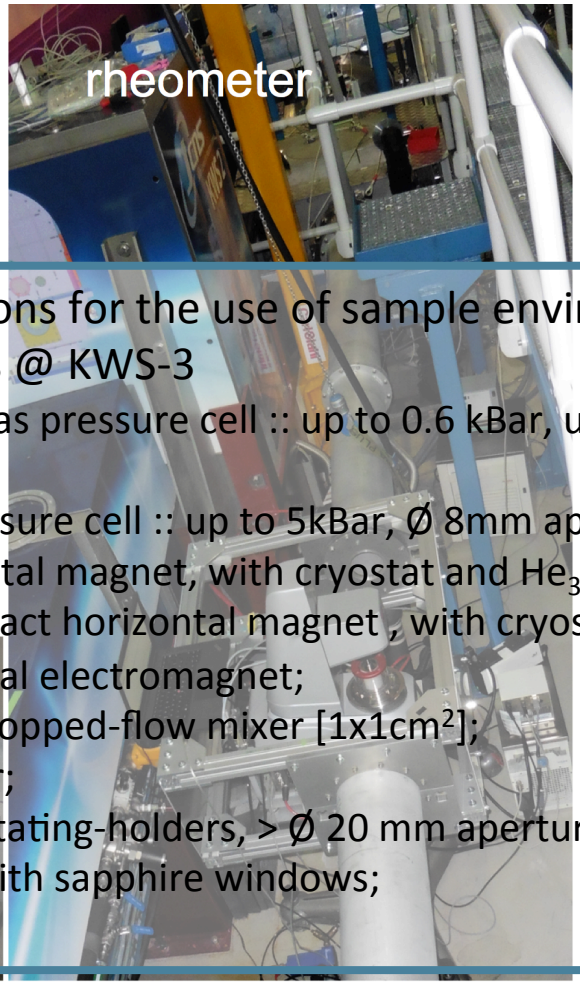
Simon Staringer Marco Goedel Harald Kusche
Coordinator

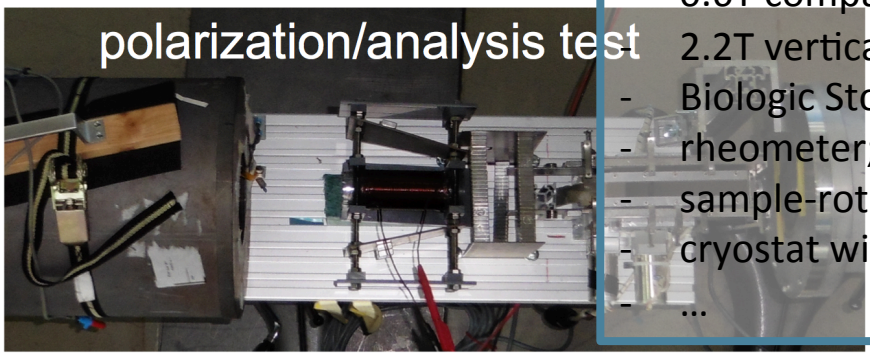


- Reconstruction of the mirror was very difficult, similar to “heart transplantation”.

Sample Area upgrade

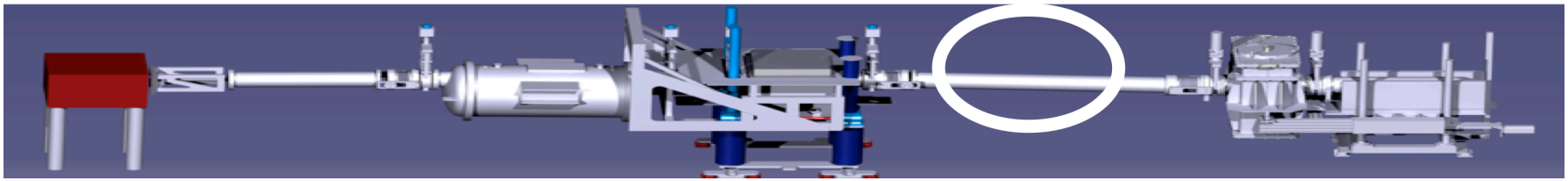




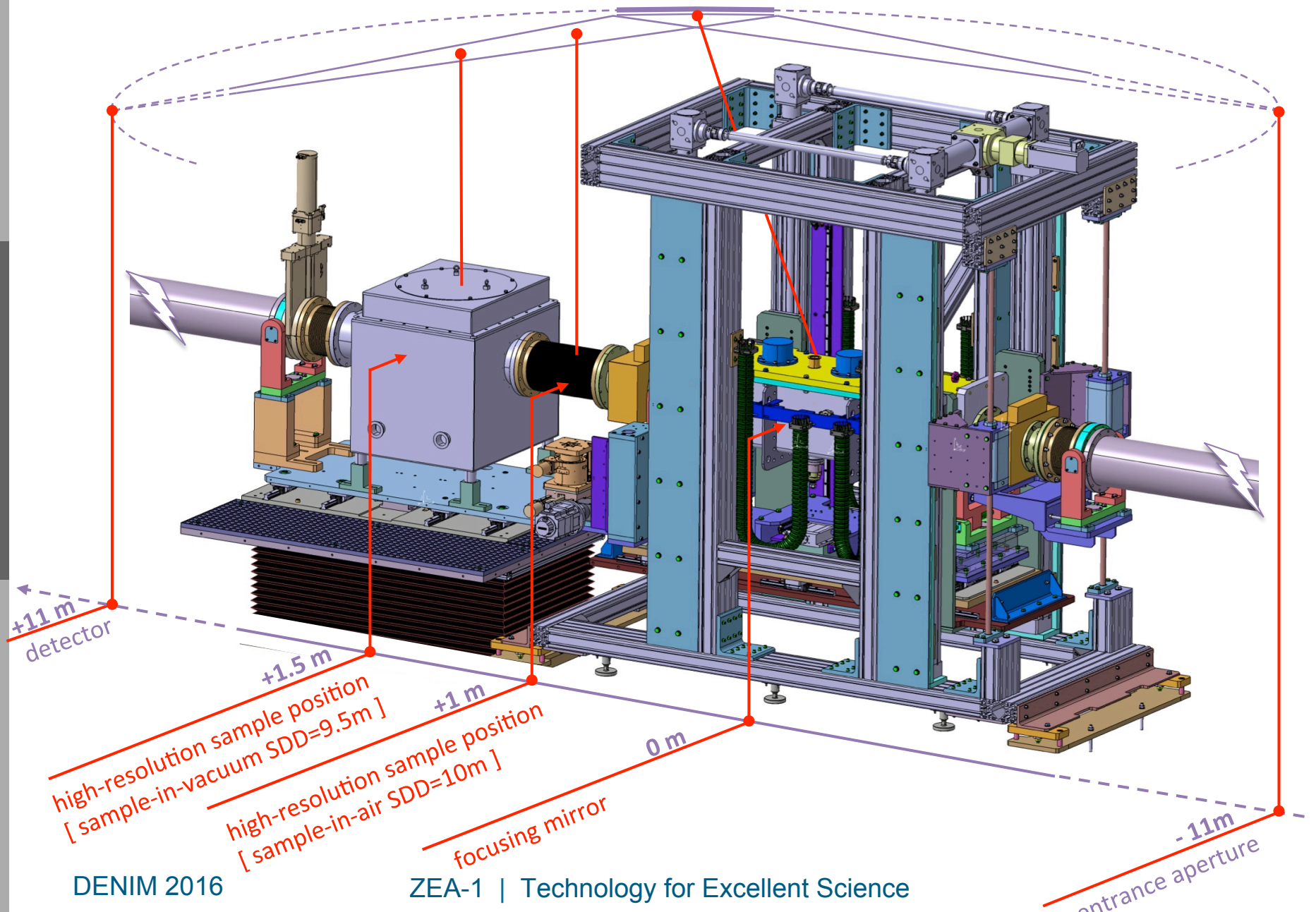


Several options for the use of sample environment equipment's @ KWS-3

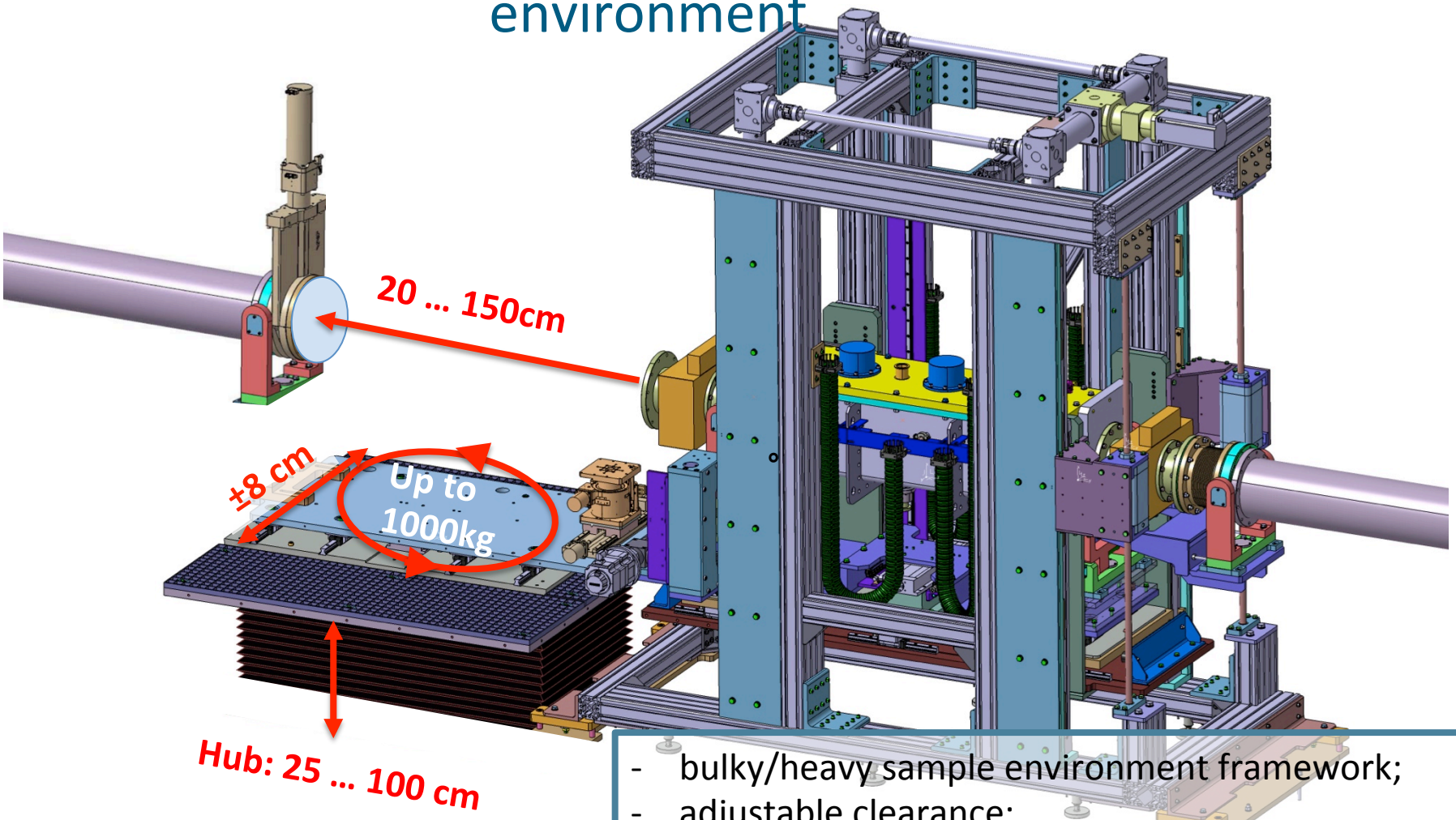
- CD_4/CO_2 gas pressure cell :: up to 0.6 kBar, up to 2x2cm^2 aperture;
- liquid pressure cell :: up to 5kBar, Ø 8mm aperture;
- 5T horizontal magnet, with cryostat and He_3-insert;
- 0.6T compact horizontal magnet , with cryostat and He_3-insert;
- 2.2T vertical electromagnet;
- Biologic Stopped-flow mixer [1x1cm^2];
- rheometer;
- sample-rotating-holders, > Ø 20 mm aperture;
- cryostat with sapphire windows;
- …



Sample Area upgrade

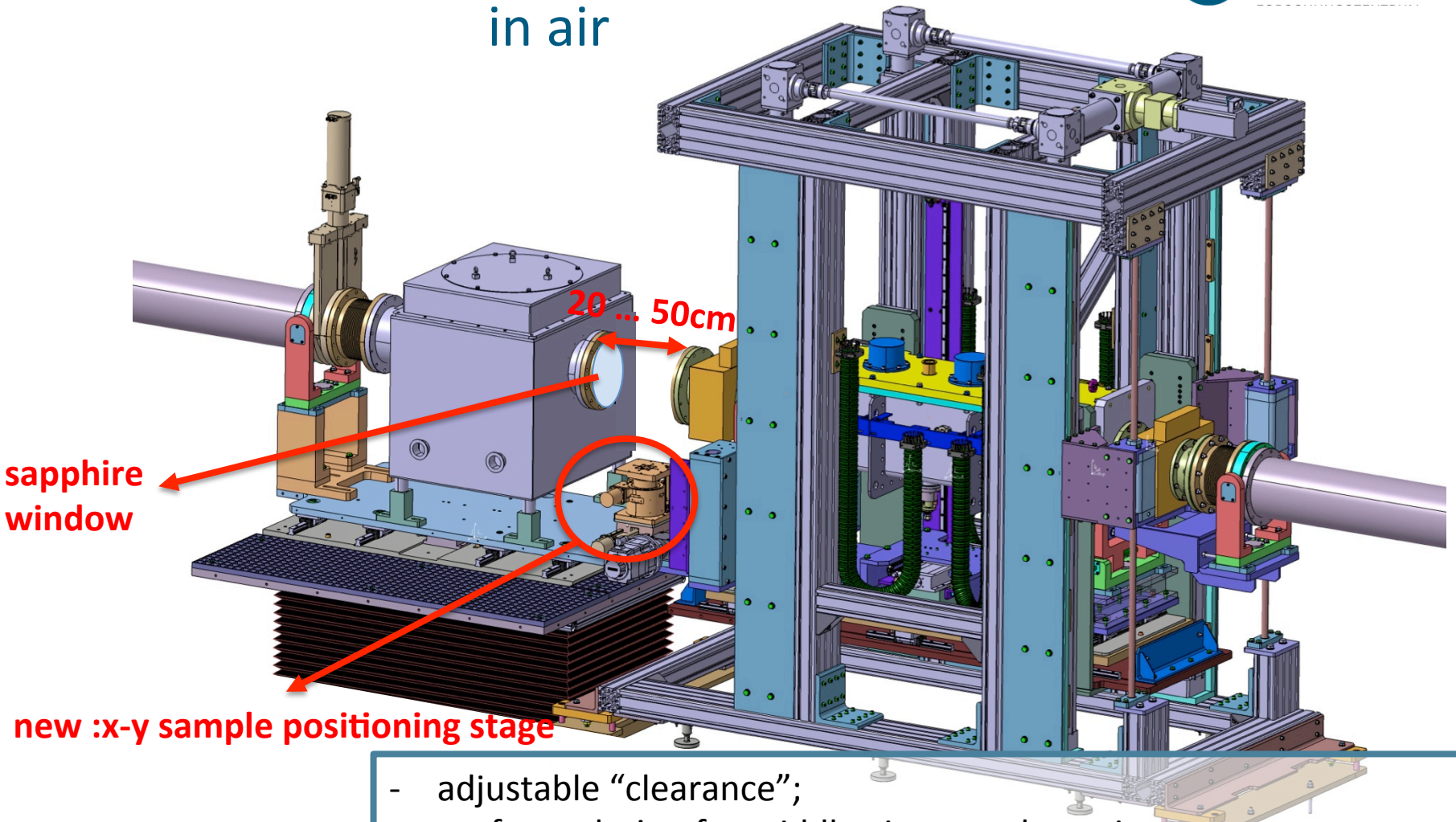


Sample Positioning of bulky/heavy sample environment



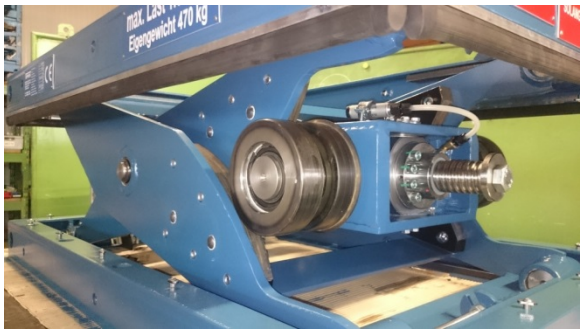
- bulky/heavy sample environment framework;
- adjustable clearance;
- up to 1000 kg;
- x,y- positioning + rotation;
- removable vacuum chamber;

High-Resolution Sample Position for samples in air



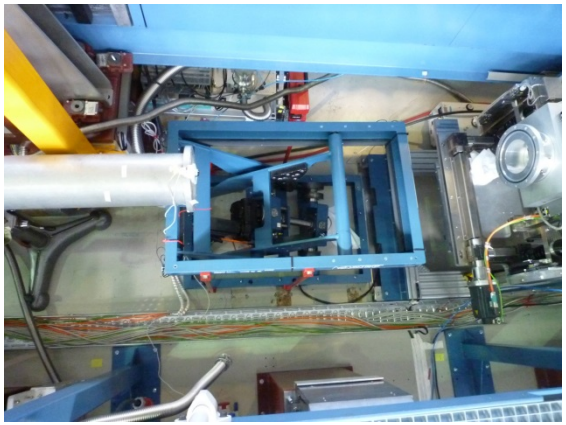
- adjustable “clearance”;
- perfect solution for middle-size sample environment:
  rheometers, pressure cells, magnets, cryostats, ovens, …
- >5% instrument resolution improvement;
- easy-access for mounting and sample-change;
- KWS-3 crane could support all actions here…

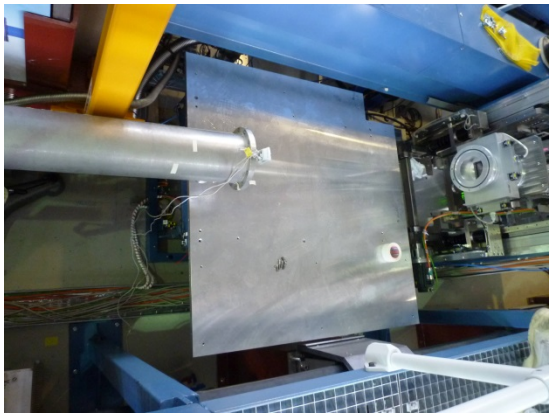
Sample Area upgrade lifting table (Com. ITWH)

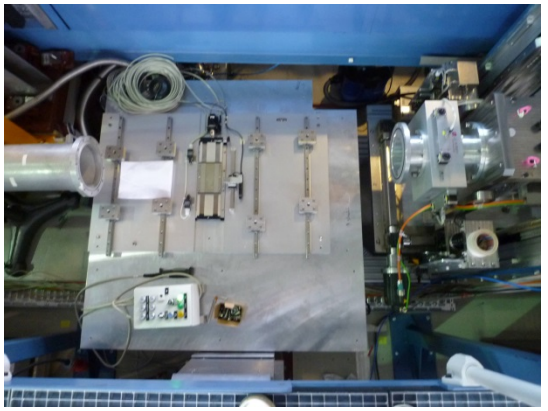


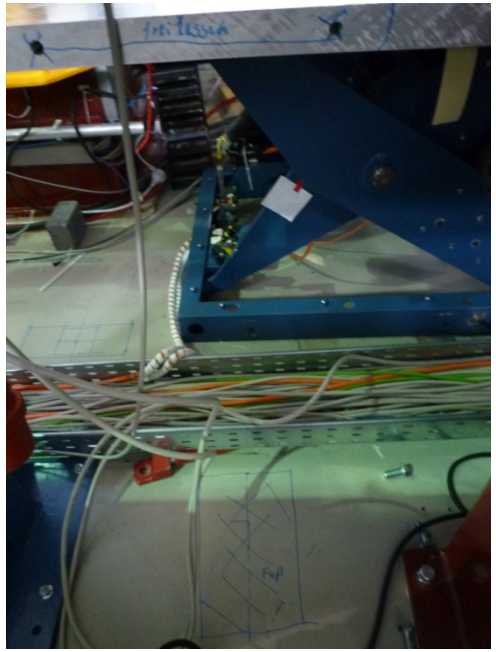
Payload:	1000 kg
Dimensions basic frame :	1,3 mx0,8 m
Lift height + reserve :	0,75 m
retracted height lift table:	0,17m
Lifting speed	50 mm/s
Positioning accuracy:	better as+/-0,5 mm

Sample Area upgrade lifting table



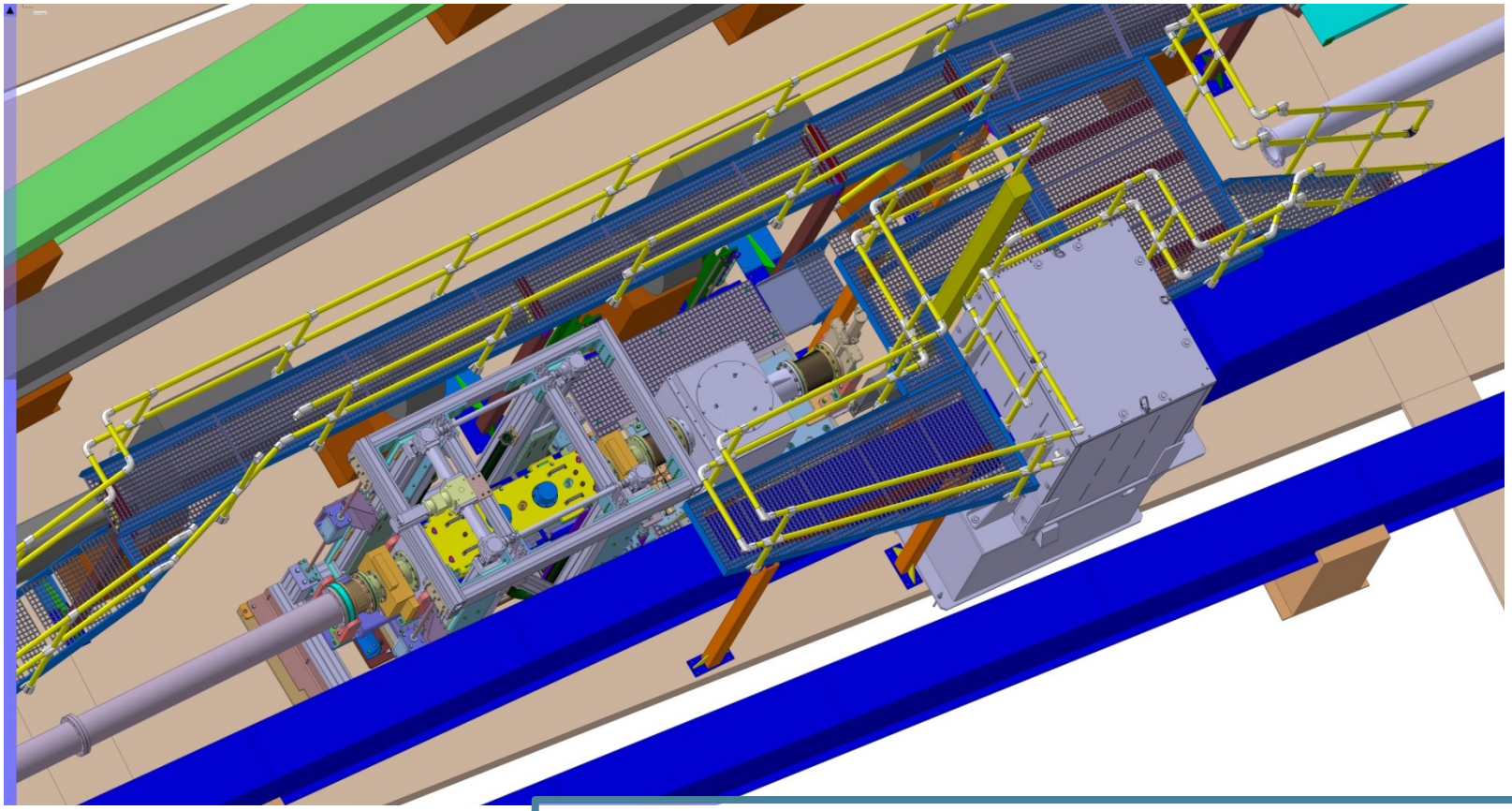






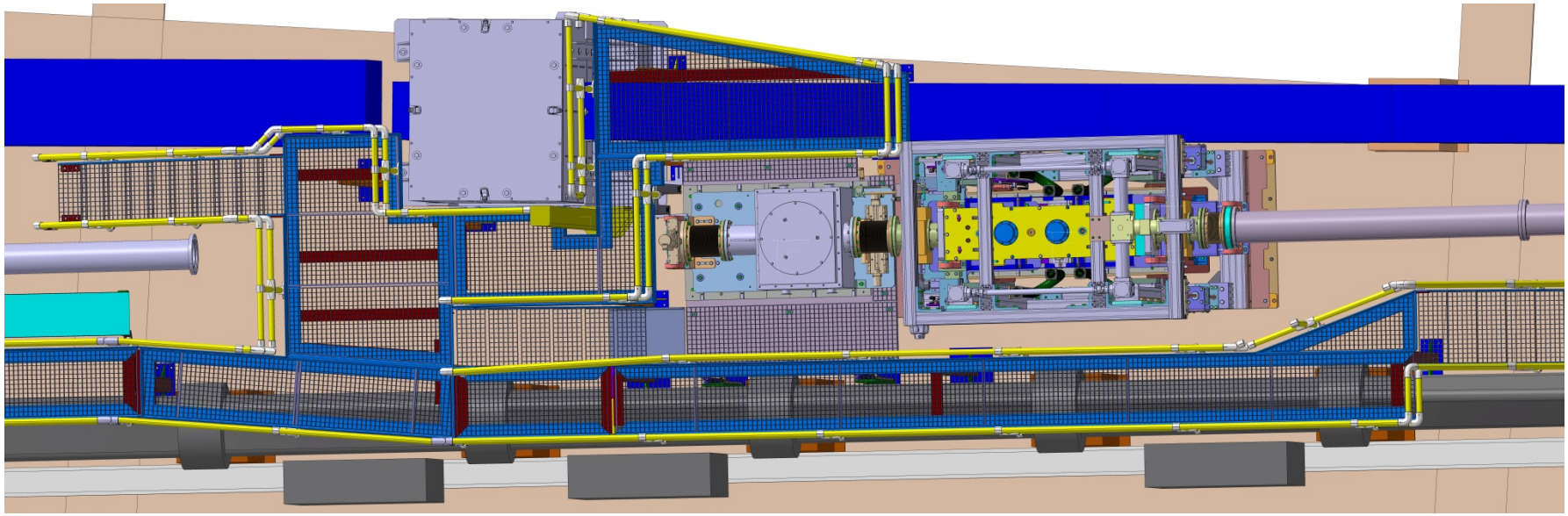
Lifting table mechanics and electrics installation - Juni 2016.
Comissioning and programing - Juni/ Juli 2016

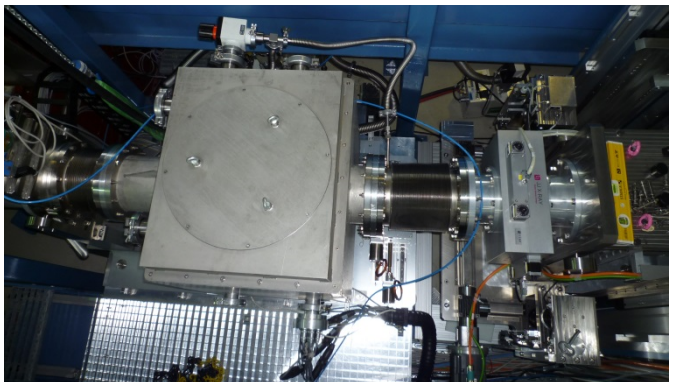
Platform improvement



- access to the sample position through the platform by a staircase
- improved accessibility;
- more space for off-beam sample environment parts;
- very efficient space usage;
- improved logistics…

Platform improvement





Upgrade of KWS3 – Schedule

• Development-Start of KWS3- New mirror positioning system with vacuum chamber	Feb. 2014
• Fabrication drawings	March-May 2015
• Manufacturing	March-Nov. 2015
• Assembling and Test at ZEA-1	Dec.-Feb. 2016
• Assembling and Commissioning in the NGH-West	March 2016

Upgrade of KWS3 – Schedule

• Development-Start of KWS3- Sample Area Upgrade with Platform improvement	Dez.2015
•Fabrication drawings	March-Apr. 2016
•Manufacturing	May-Jun. 2016
• Assembling in the NGH-West FRMII	Jun-Jul. 2016
• Warm test with neutrons	Aug. 2016

"On time, in budget" – 310k€ was charged / 290k€ was budgeted

Team core

JCNS Garching

Simon Staringer
Marco Gödel
Harald Kusche
Vladimir Ossovyi
Andreas Nebel
Rainer Bruchhaus
Zhendong Fu
Vitaliy Pipich

G-ELI

Manfred Bednarek
+ team

ZEA-1

Romuald Hanslik
Stephan Butterweck
Bernd Ottmann
Maximilian Marx

JCNS Jülich

Frank Suxdorf
Klaus Bussmann
Peter Harbott
Franz-Josef Kayser
Michael Glum
Harald Kleines
Rolf Möller

ZEA-2

Michael Wagener
Stefanie Keuler

Summary

- In this talk was presented the crucial upgrade of the mirror positioning system and sample area.

- Within this project the focusing system was redesigned and mechanically separated from sample area and detection part of the instrument in order to improve the stability of the focusing system, precision of the mirror positioning system and instrument resolution.

- Integration of two motorized 4-blade slit systems (just before and after mirror) and additional “cleaning” blade (below mirror) improved signal-to-noise ratio of the neutron beam.

- In addition, sample area was upgraded to improve access for mounting and sample-change, sample environment integration.

JÜLICH
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Thank you for your attention