Upgrade of KWS1
Polarizer changer for KWS 1

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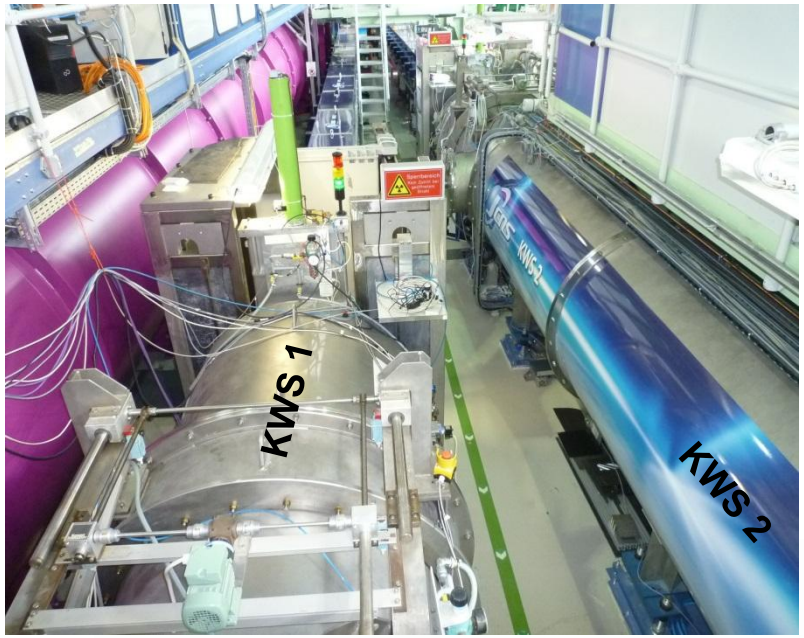
Overview

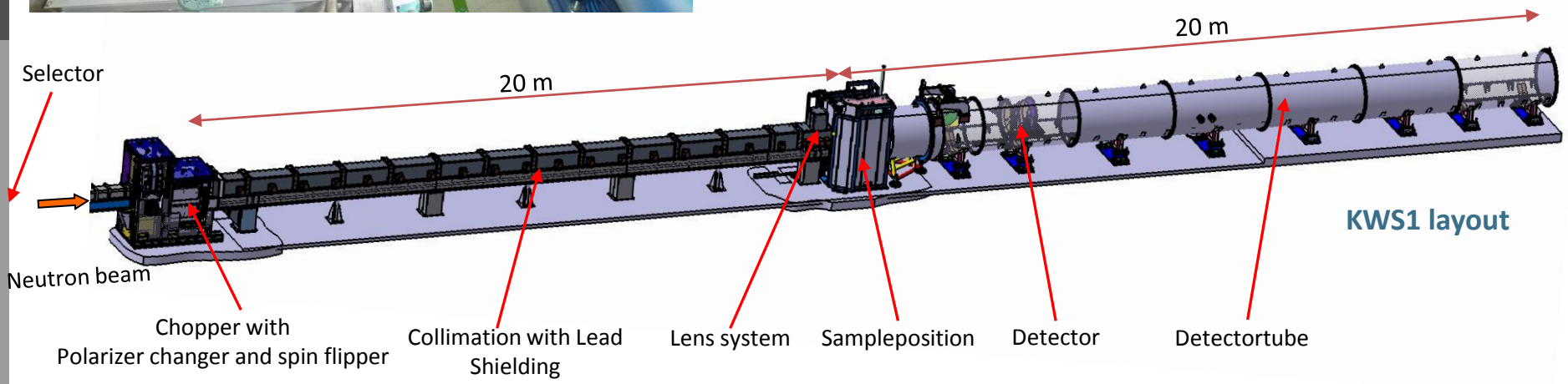
- Upgrade of KWS1
- Polarizer changer requirements, technical data, electronic data
- Polarizer changer technical issues
- Test installation at ZEA-1 in FZ-Jülich
- Installation polarizer and chopper in the Neutron Guide Hall West at FRMII
- Conclusions

KWS 1

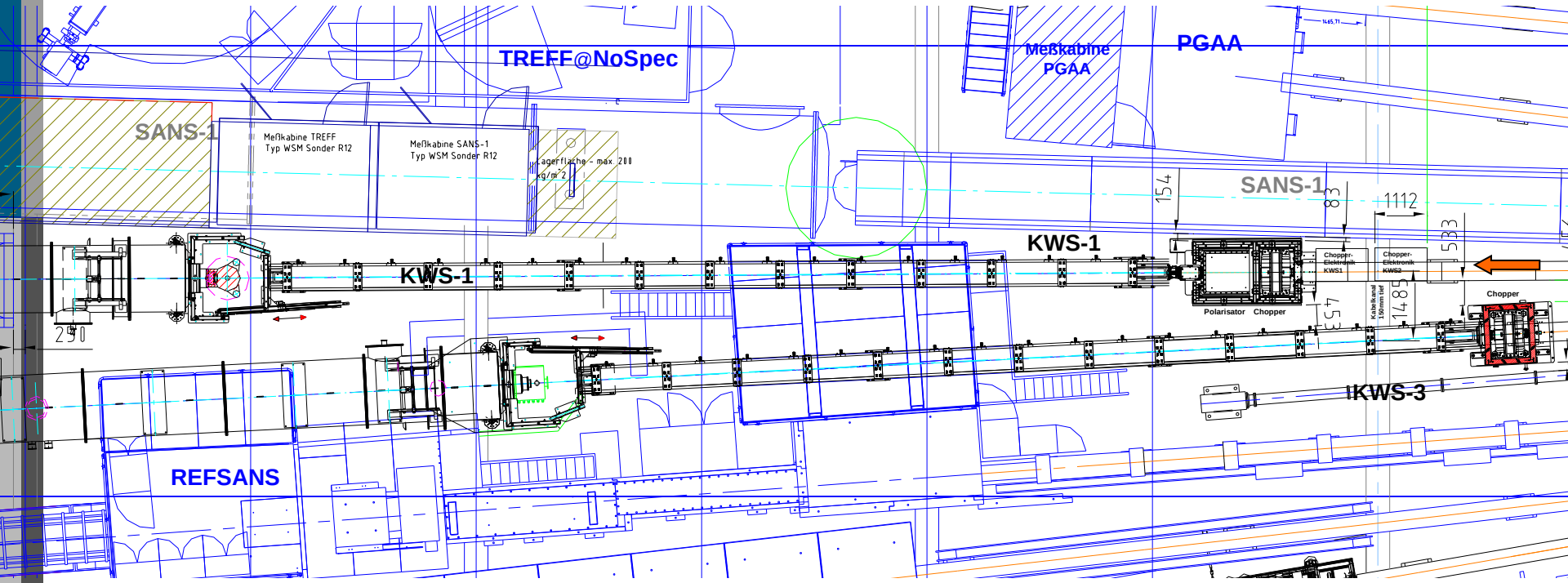
Klein-Winkel-Streuapparatur
Small Angle Neutron Scattering Instrument



- Tool to study structures and particles in the nano- to micrometer range in soft matter, material sciences and biology.
- KWS 1 is supplied with cold neutrons from a cold source inside the moderator vessel of the FRMII reactor.



Location of KWS 1

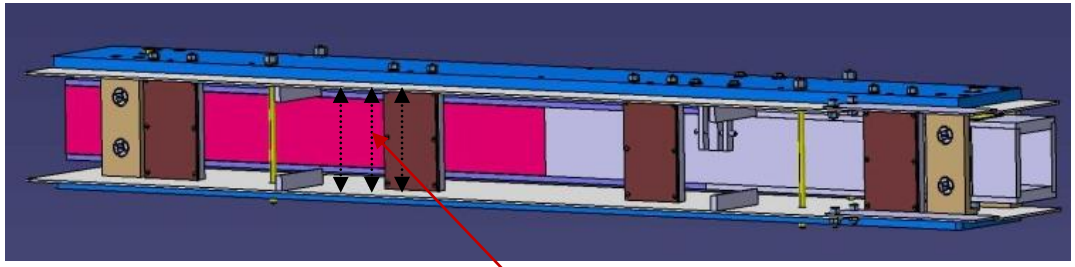


The instrument is located in the neutron guide west of FRM II on the NL3b ‘S-shaped’ neutron guide.
The instrument was successfully commissioned in 2009 and since then it has been in routine user operation.
In 2013 the KWS1 instrument was upgraded, from its active collimation apertures to the detector cabling.

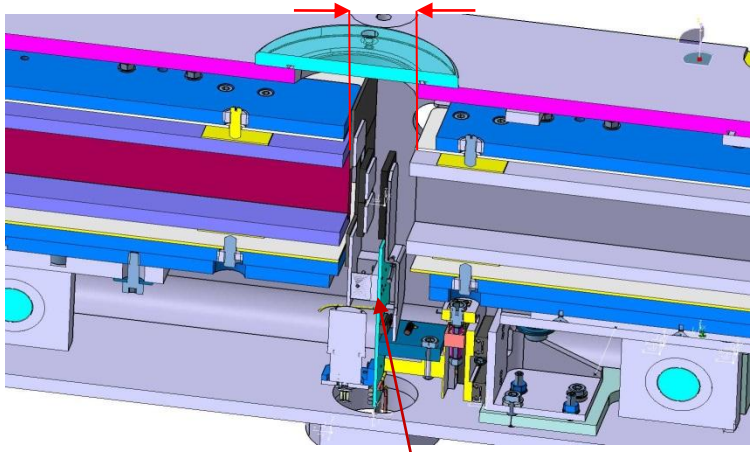
Upgrade of KWS 1

- The main goal of the upgrade was to focus the use of the KWS-1 in the field of magnetism and magnetic materials.
- As a result of this upgrade phase the instrument obtained a suite of new components including:
  - new-generation active collimation apertures and collimation carriages;
  - chopper, which allows changing the wavelength resolution of the incoming neutron beam;
  - polarizer, which allows polarized neutron experiments;
  - radio-frequency spin flipper of large cross section to flip neutron polarization;
  - lenses, which enable an increase in the neutron flux on the sample for use in experiments that require small measurement times;
  - sample position, with nonmagnetic translational sample table and the Hexapod (Oelhydraulik Hagenbuch AG Switzerland) with a load of 500kg.

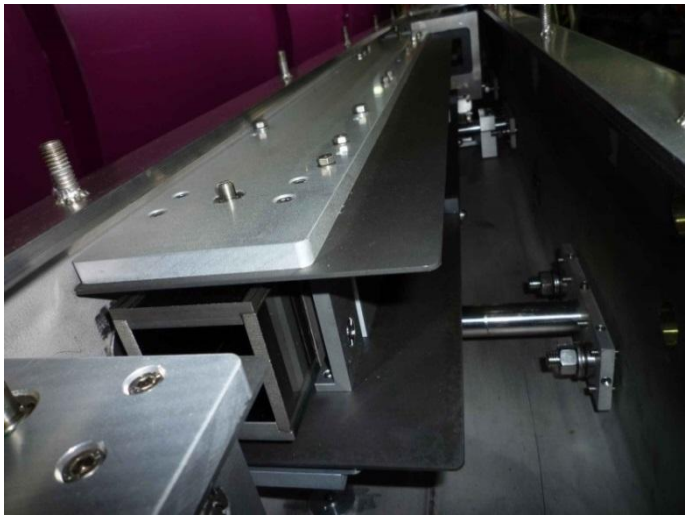
Upgrade of KWS 1
collimation carriages

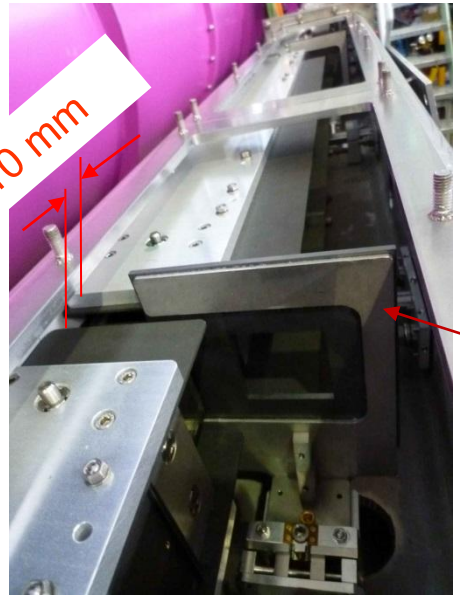


permanent magnetic field of
15 Gauss



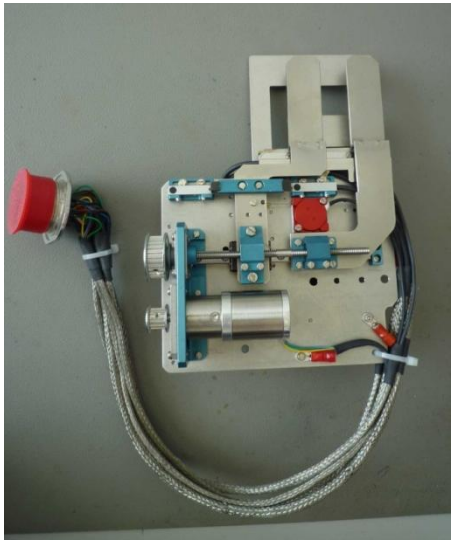
Active apertures

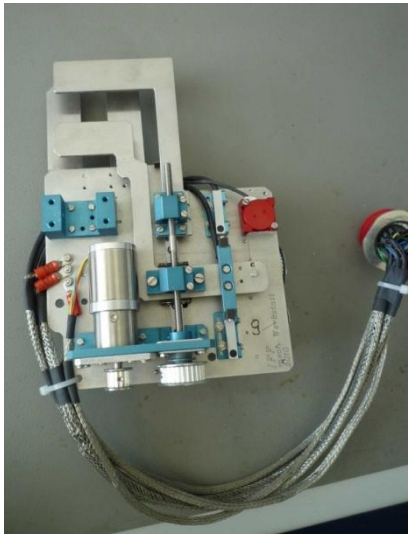




Passive apertures

Upgrade of KWS 1
active collimation apertures

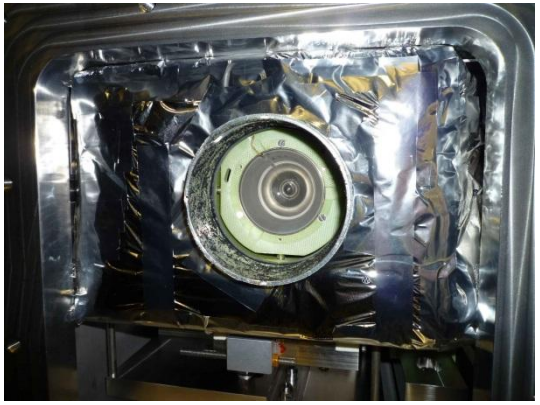


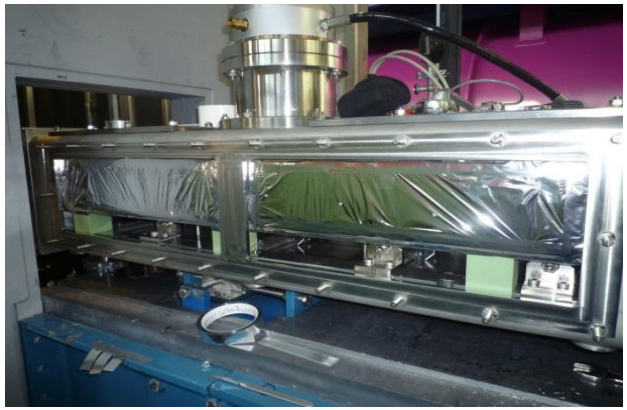


active collimation apertures in the Pos. 2m, 8m, 14m, 20m of collimation

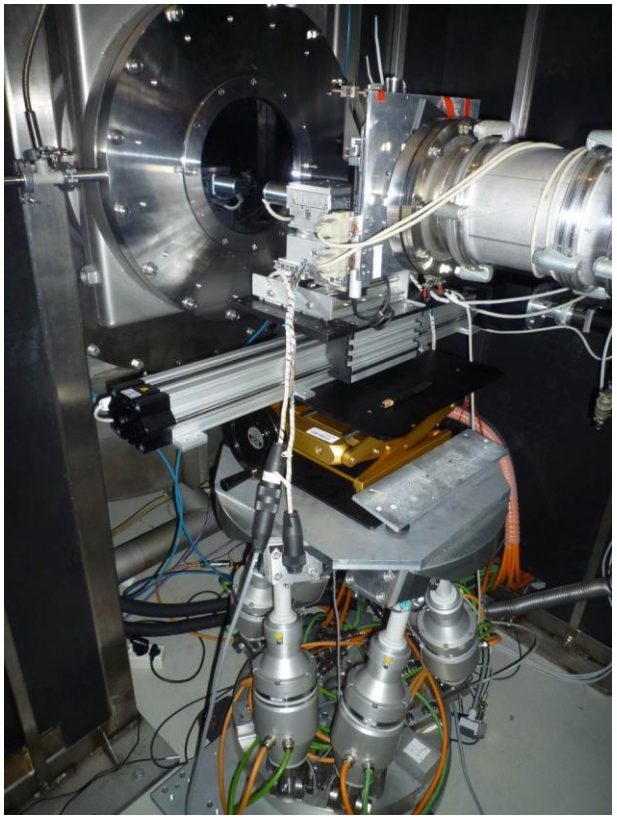
Upgrade of KWS 1

- Lens system of 26 concave lenses (single crystal magnesium fluoride MgF2), in three lens packages of 4 pieces, 6 pieces, 16 pieces, independent from each other, can be positioned in the beam.
- Lenses are cooled to about 70K to minimize phonon scattering.





Upgrade of KWS 1
Sample Position



• A sample table for conventional SANS experiments and a nonmagnetic hexapod, specially designed to carry heavy magnets, for experiments with magnetic samples.

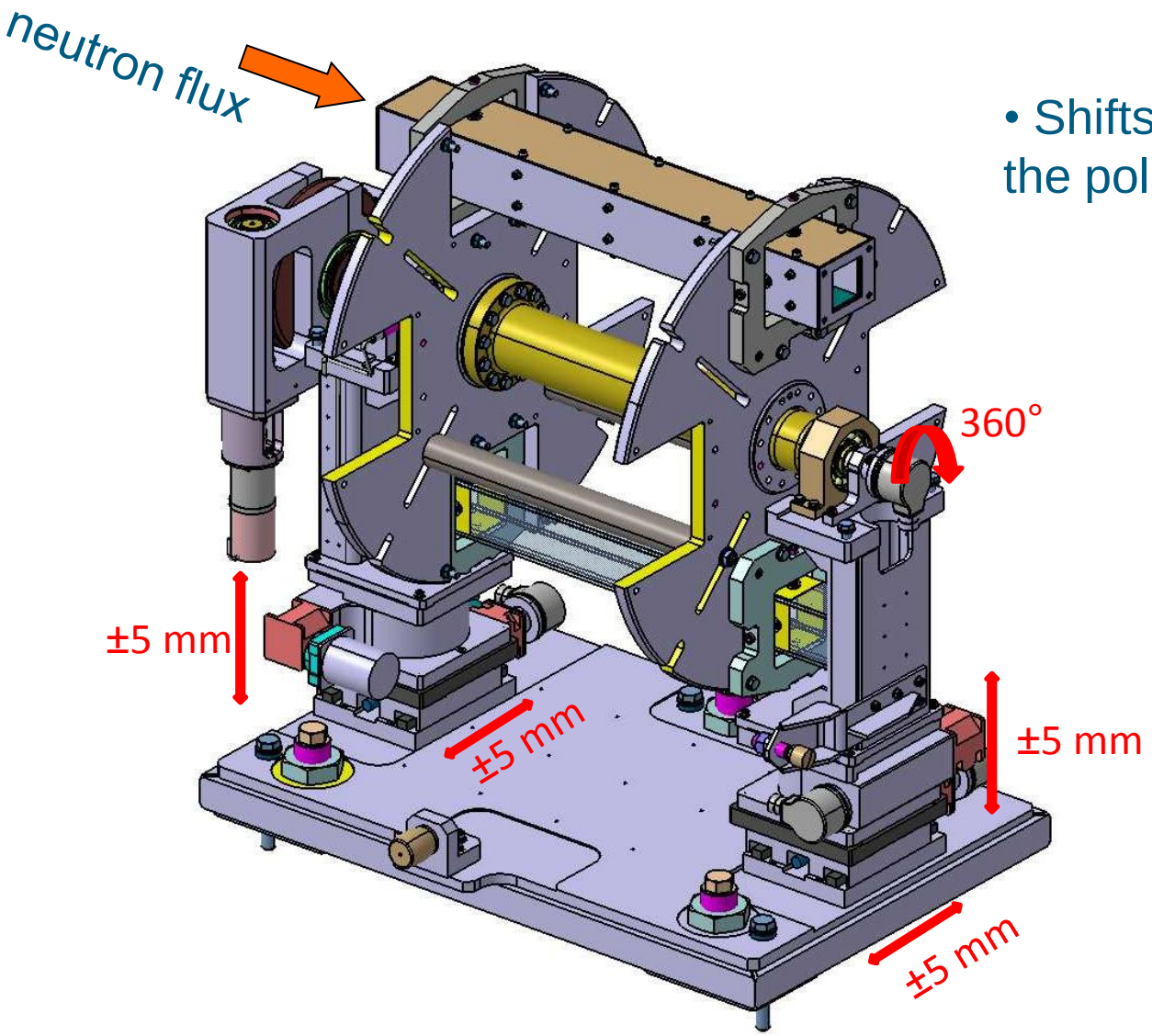
Polarizer changer requirements

• The main focus of this presentation part will be on challenges and experiences during the design, testing and installation phase of the Polarizer changer.

• Polarizer changer requirements:

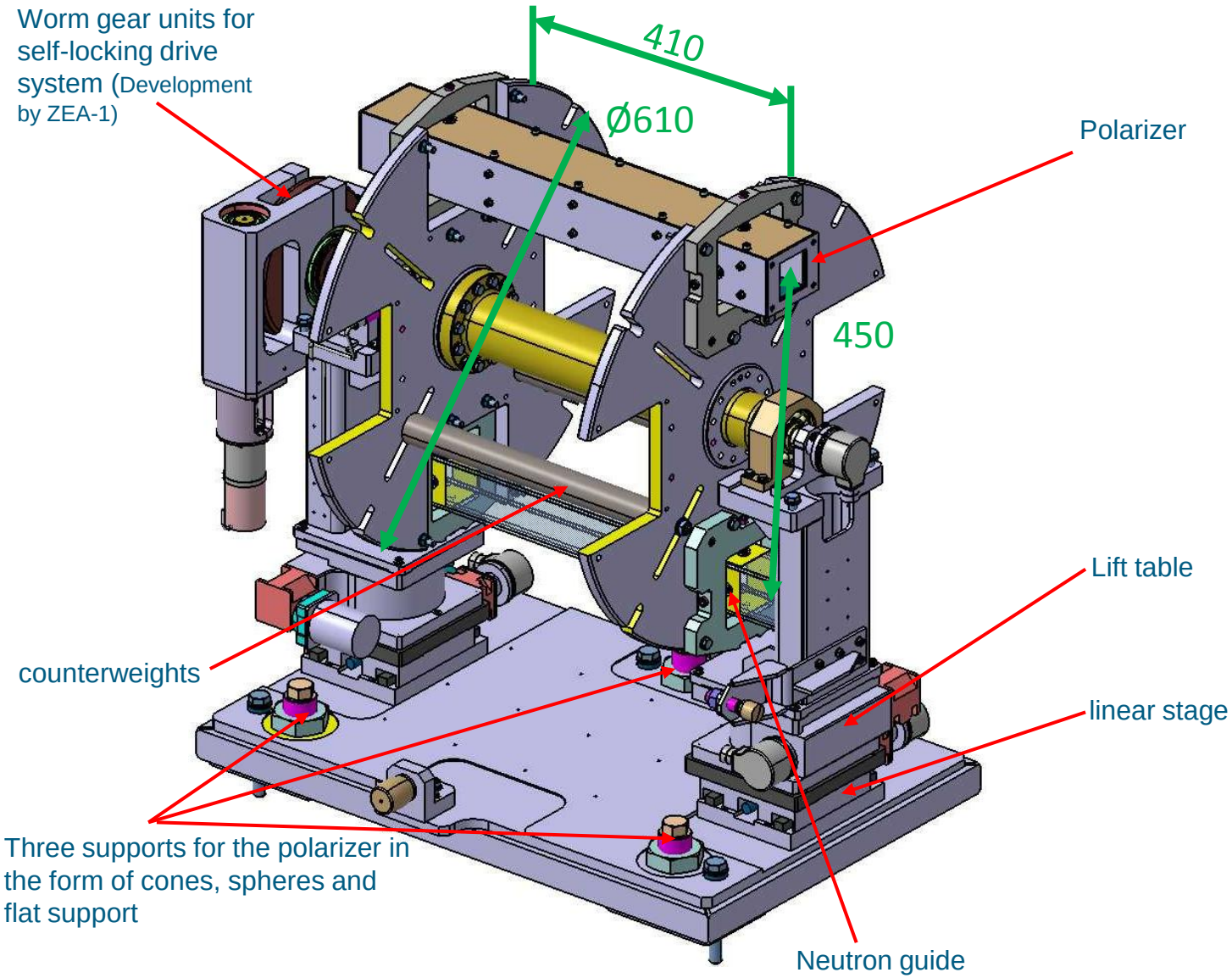
- Changer for 4 positions (neutron guide, polarizer and two reserve positions).
- Vacuum 10^{-3}mbar
- All components nonmagnetic
- Self-locking drive system
- Possibility of Polarizer adjustment during the neutron flux
- Linear repeatability for the horizontal and vertical axis +/- 30µm (human scalp hair 50 to 70µm)
- Accuracy of rotation of the rotor +/- 0,003°

Polarizer changer requirements

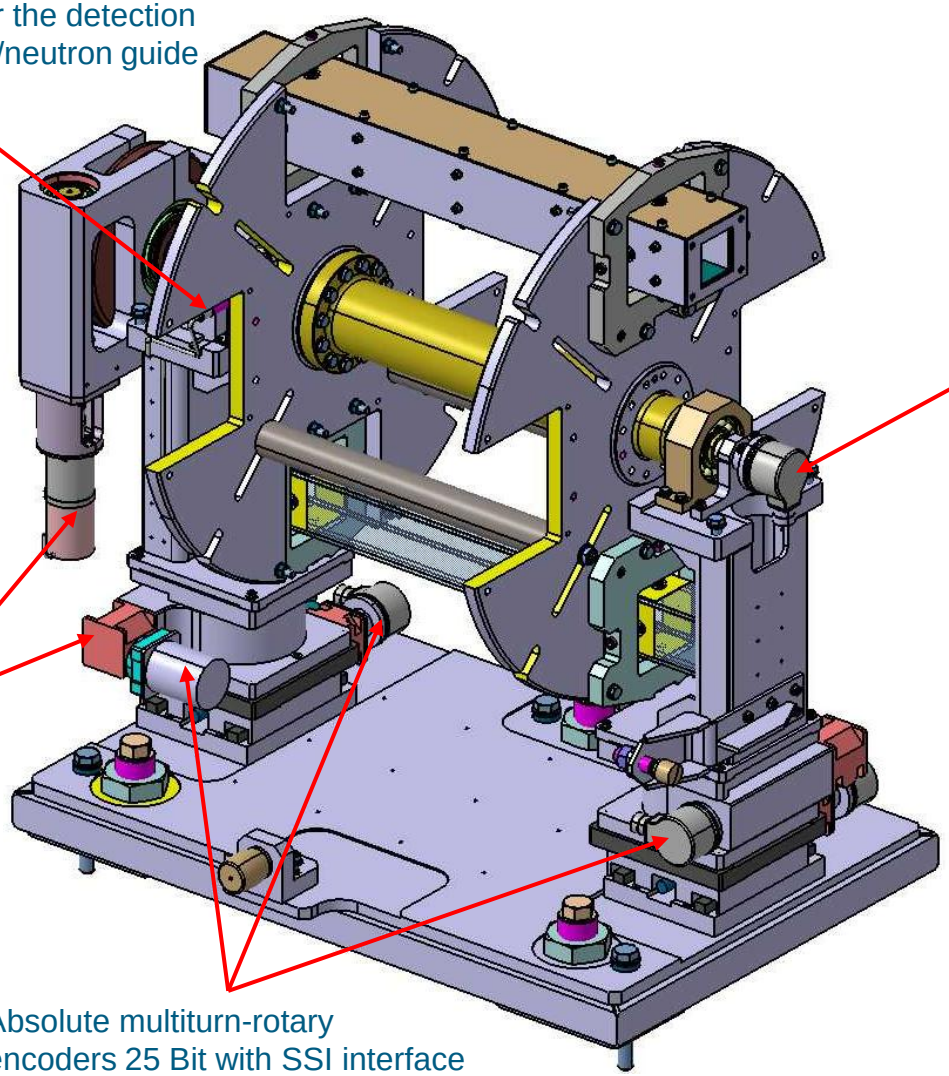


- Shifts for the positioning of the polarizer.

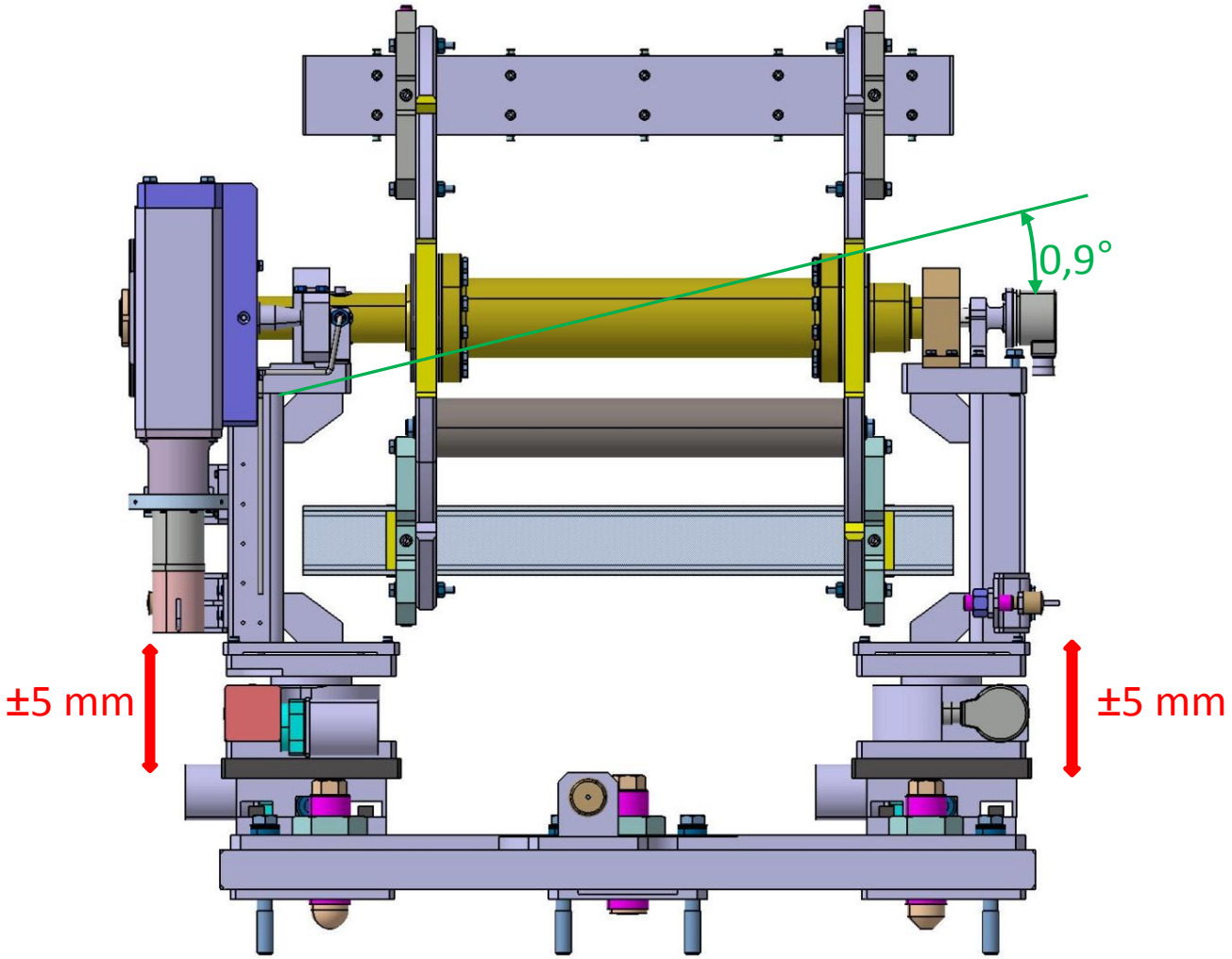
Polarizer changer technical data



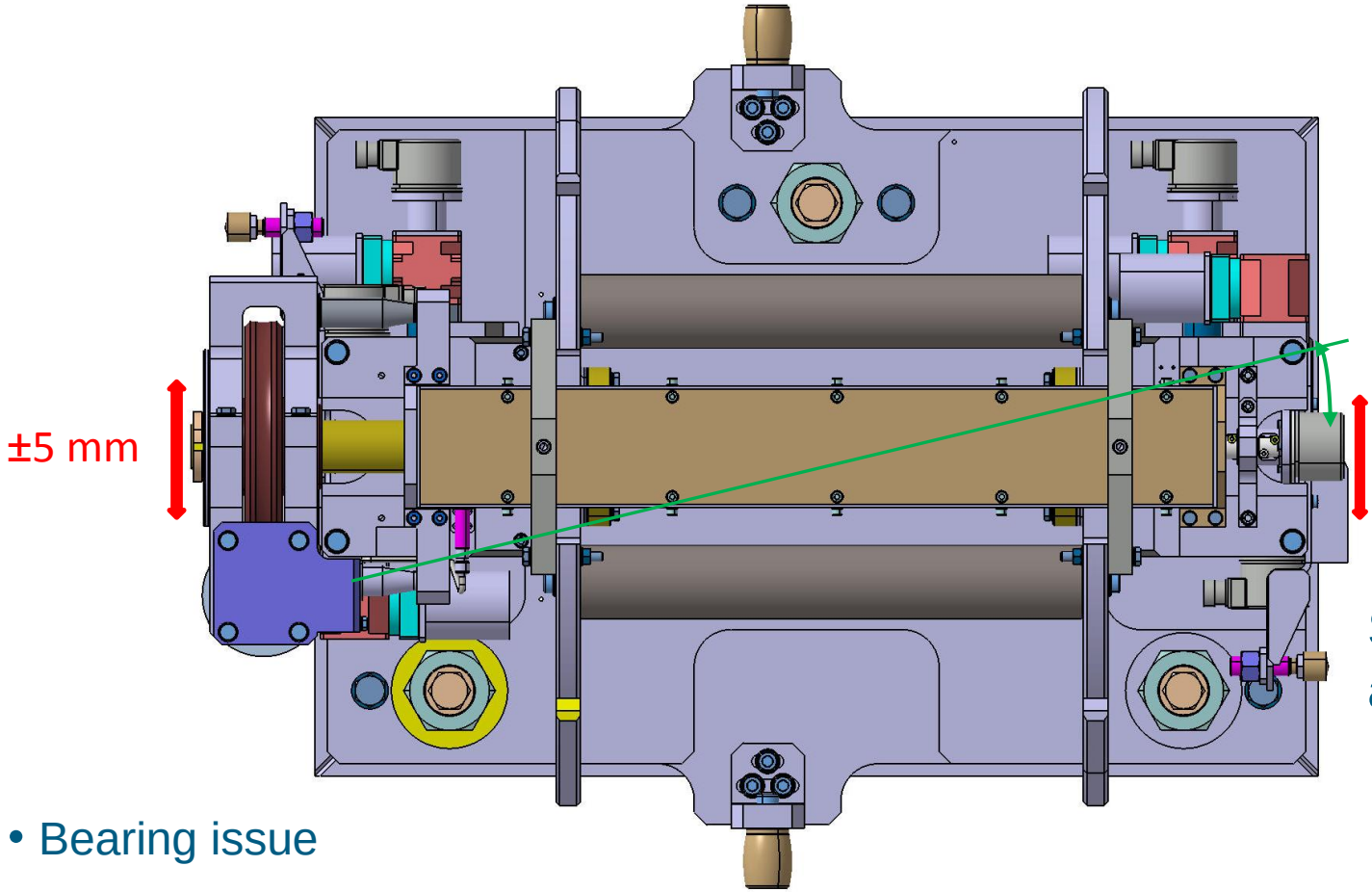
Polarizer changer electronical data



Polarizer changer technical issues



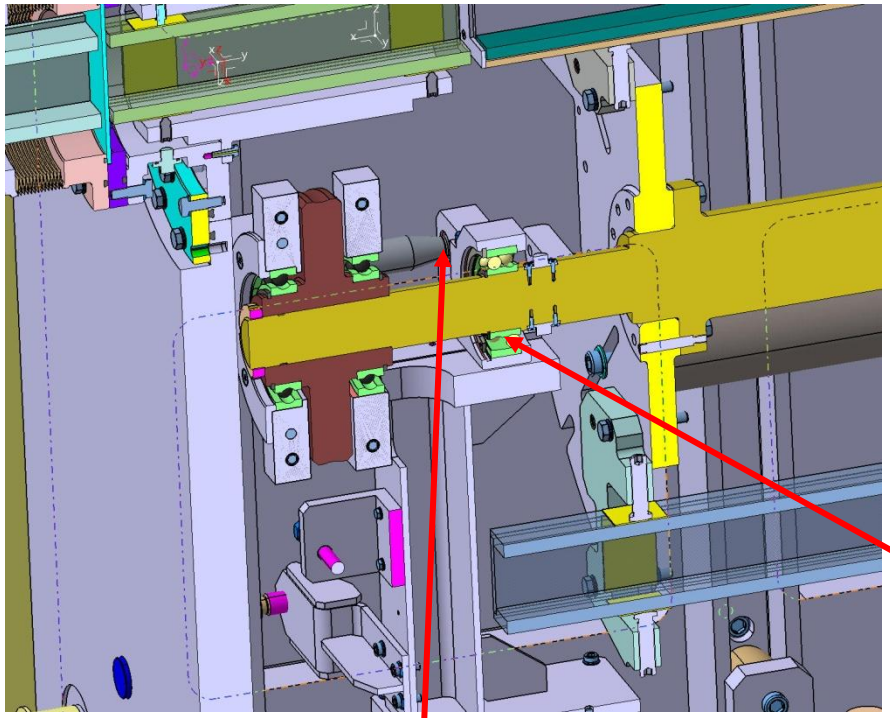
Polarizer changer technical issues

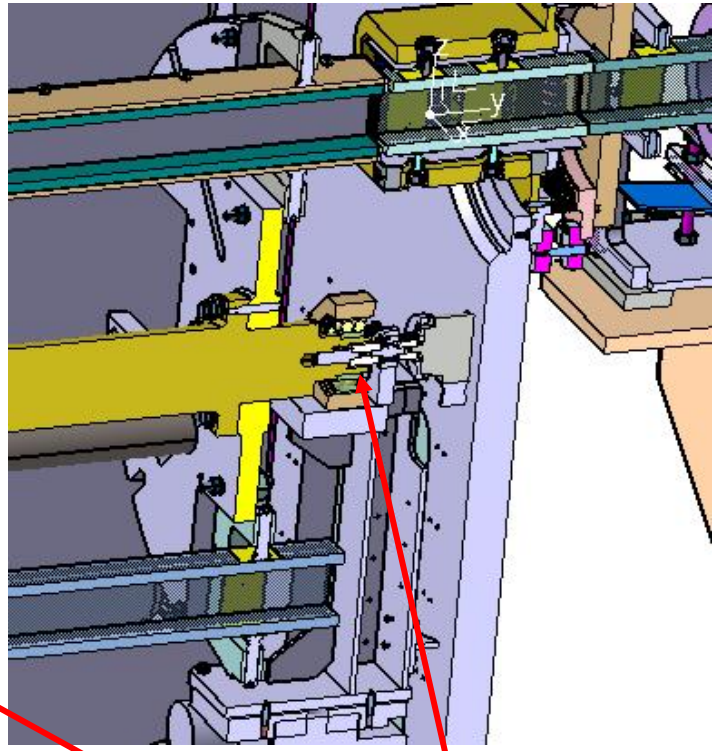


Space diagonal angle 1,28°

- Bearing issue
  - For using the rigid bearing, the axis cannot be moved
- Torque support issue

Polarizer changer technical issues



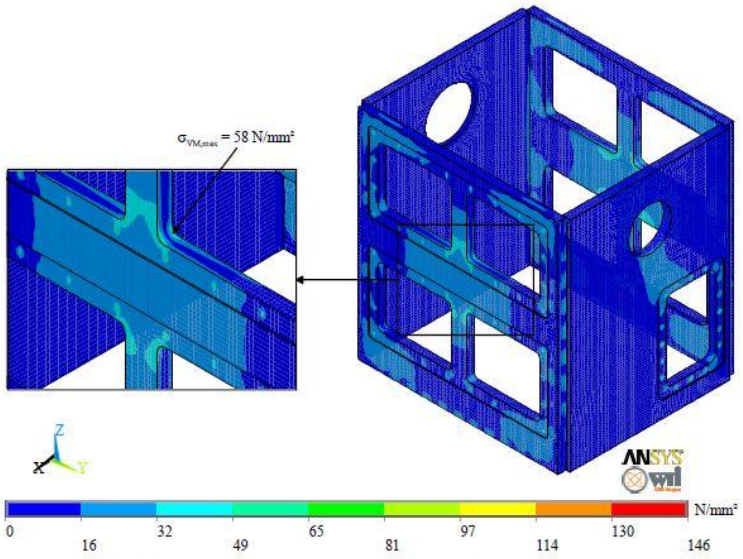


Torque support in the spherical form

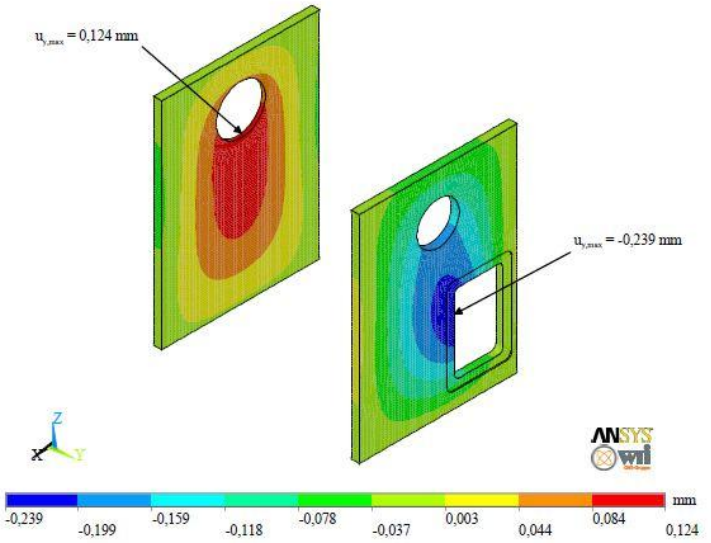
Aligning ball bearings with allowable inclination of 2,5°

All bearings of ceramic

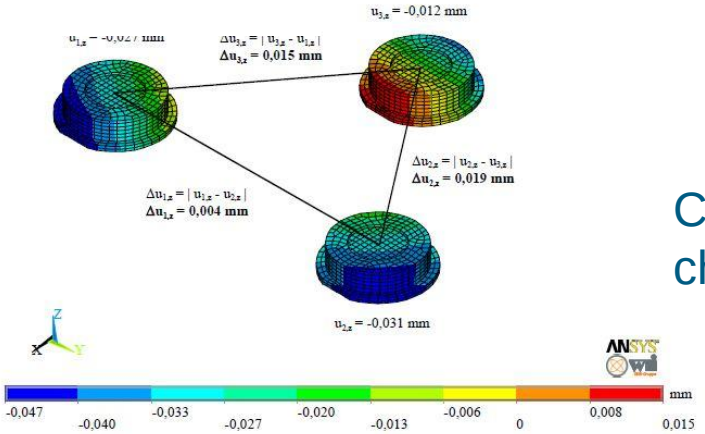
Polarizer changer technical issues



Equivalent stress in the longitudinal and frontal walls



Deformation of the frontal walls

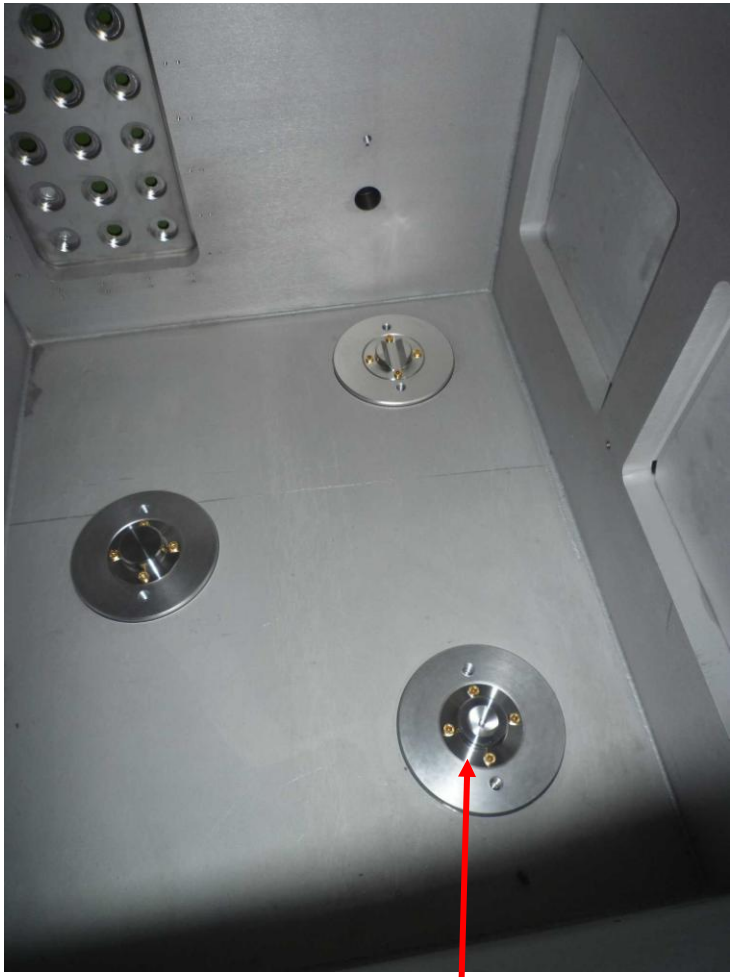


Calculation of the vacuum chamber

Deviation of the positions of the three supports for the polarizer in the bottom

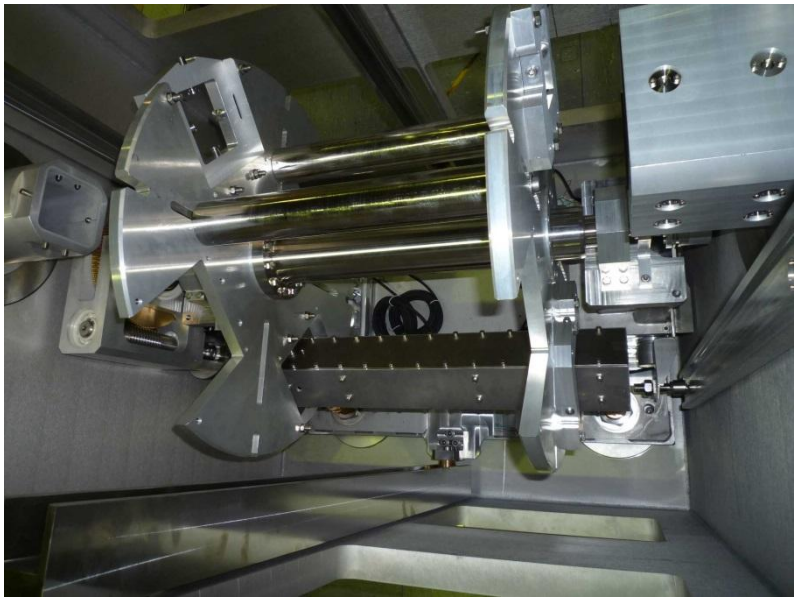
Polarizer changer technical issues

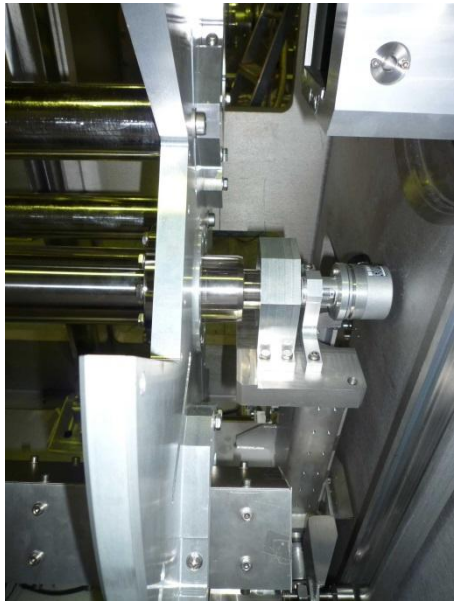
Fabrication of the vacuum chamber



Three supports for the polarizer in the form of cones, spheres and flat support

Test installation at ZEA-1





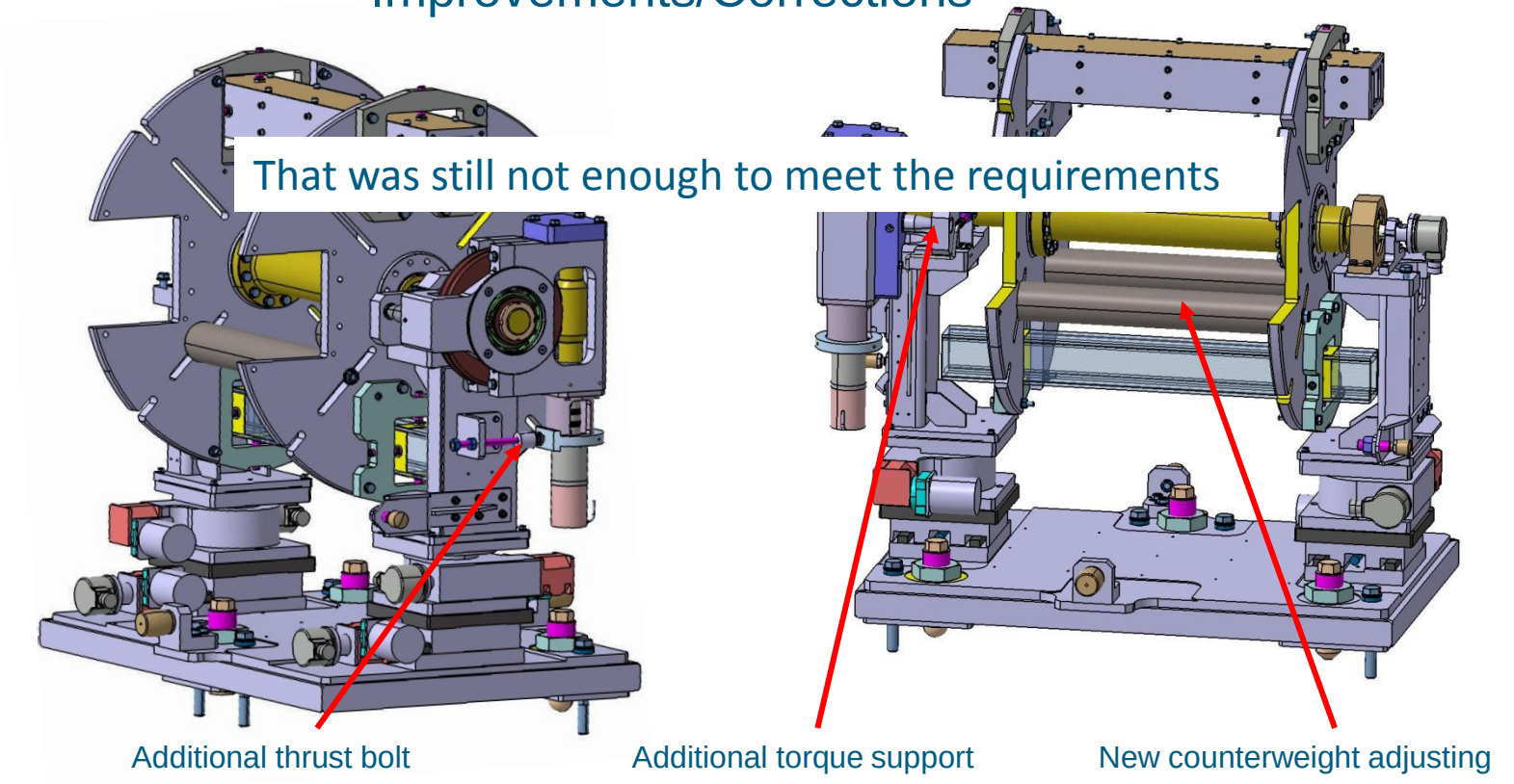
Test installation at ZEA-1

- The defined Positions repeatability of +/- 30µm accuracies were not achieved

- There have been achieved values of 150 to 300 µm. The values have been achieved randomly for no apparent pattern.

Improvements/Corrections

That was still not enough to meet the requirements



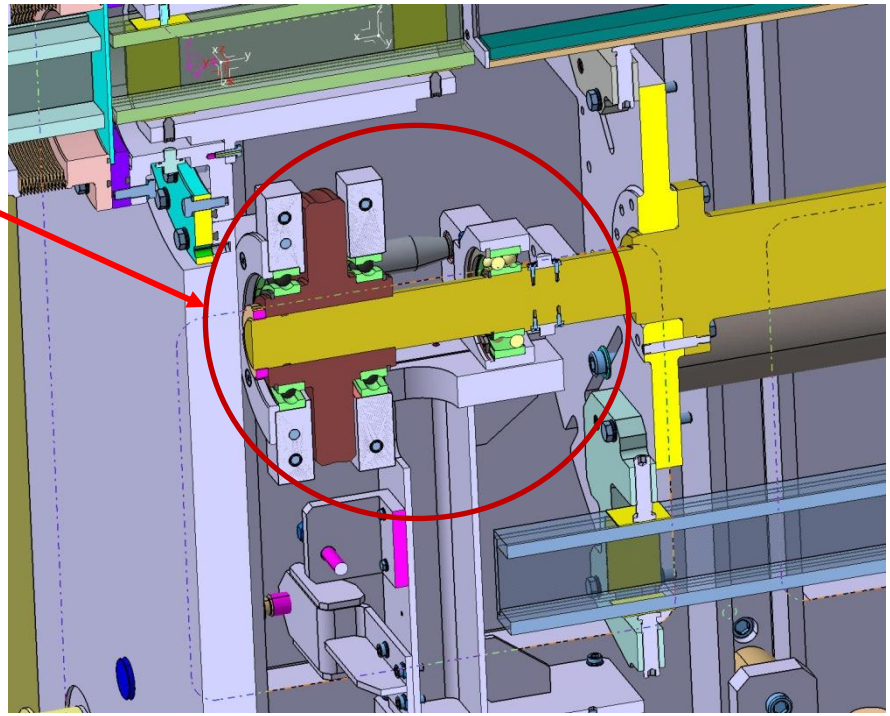
Additional thrust bolt

Additional torque support

New counterweight adjusting

Test installation at ZEA-1

Problem in this area, not enough stability



We have suspected that the ceramic bearings have too much play.

We decided to replace the ceramic bearing with steel bearings.

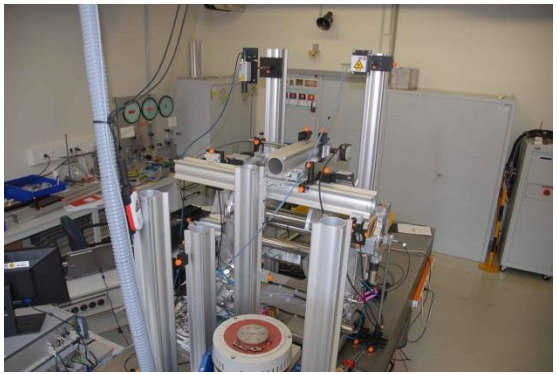
In this region, we do not have any polarized neutrons, thus the steel bearings are not influenced of the polarization.

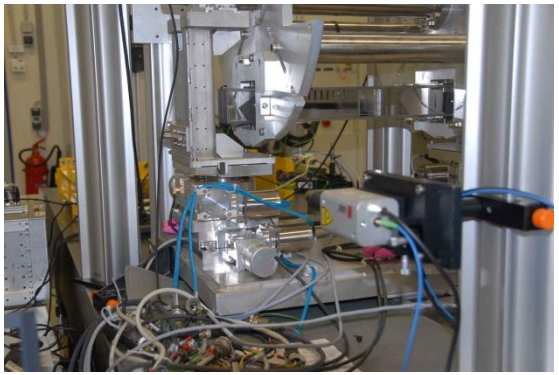
Test installation at ZEA-1

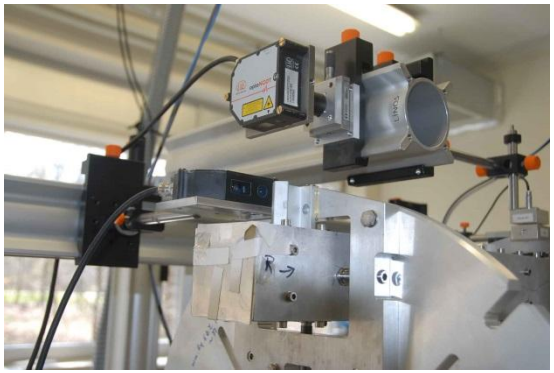
- We have installed the steel bearings. We had success. The repeatability of the changer was significantly better. But this we wanted to check exactly.

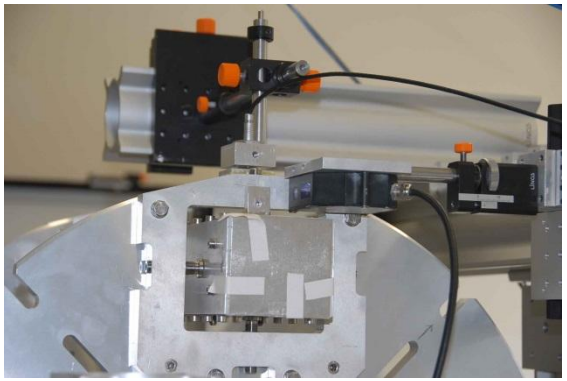
- We have decided to build the polarizer changer in our laboratory and precisely to check.

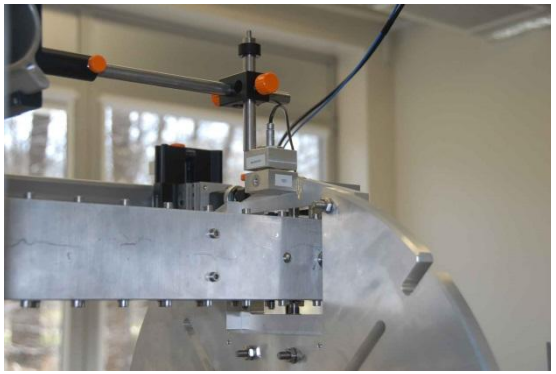
- Our test engineer U. Giesen has built a very complex test stand.









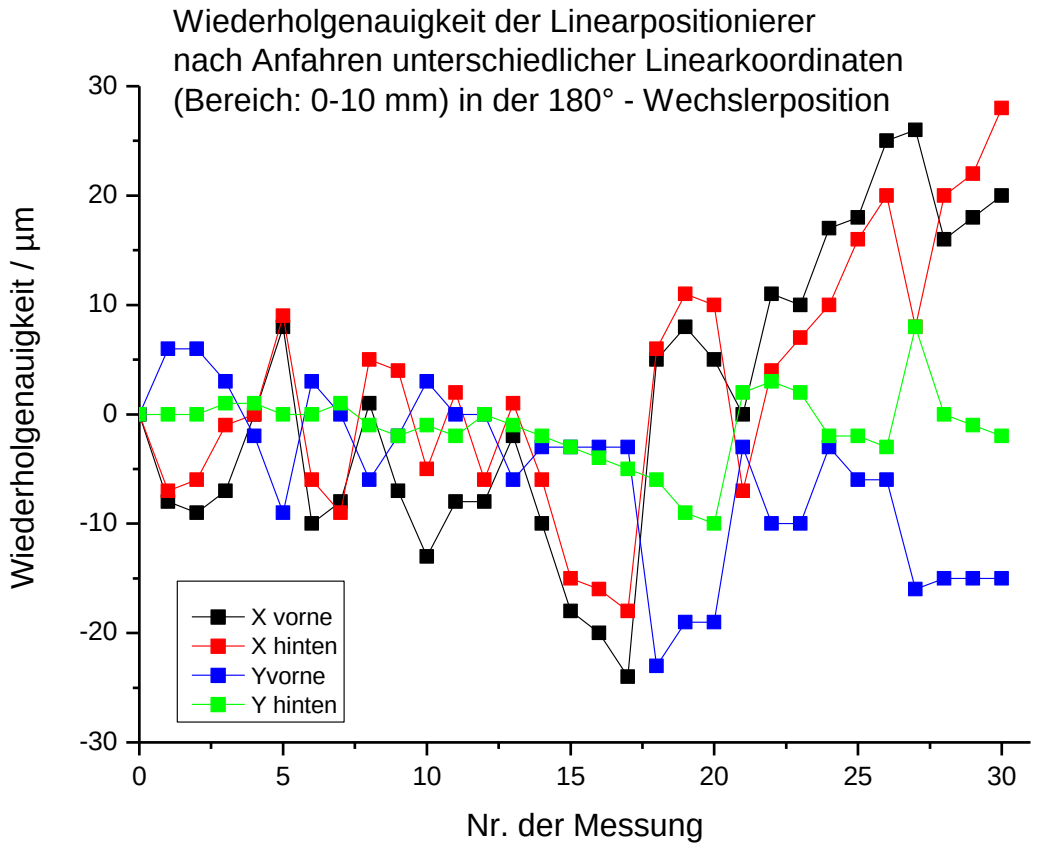


Test installation at ZEA-1

Due to the tests:

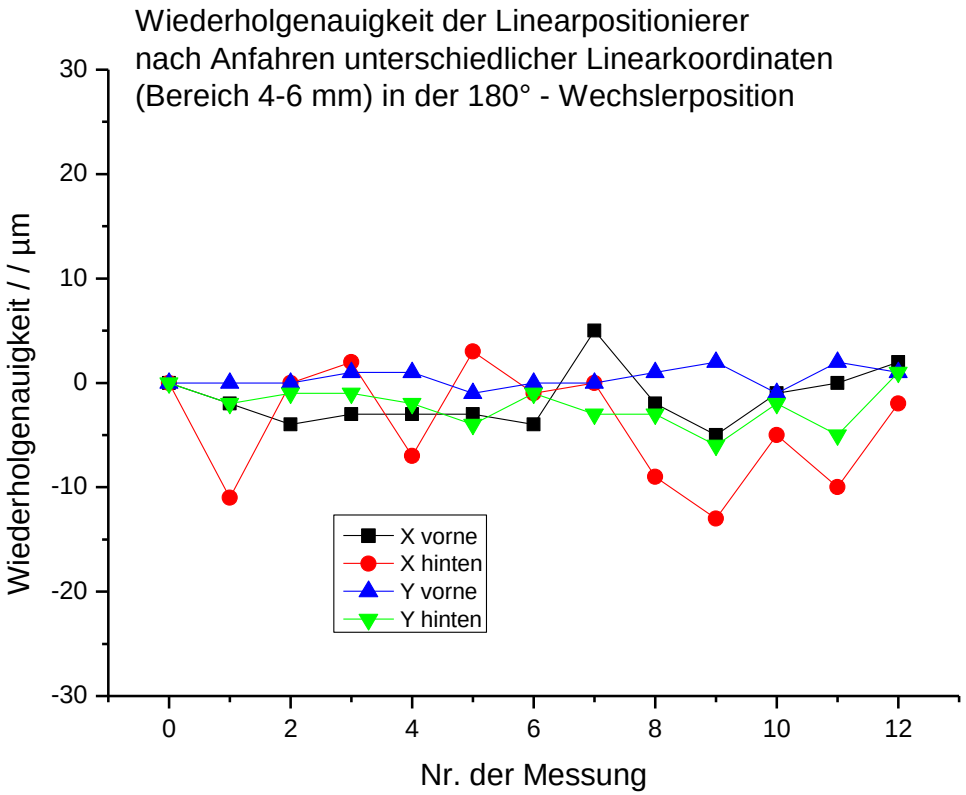
- The operating mode of the changer was optimized
- The sequences of movements were determined
- The moving velocities were optimized
- Because of the knowledge gained and data, automatic program was written by ZEA-2 for the movement of the changer. Thus, each position of polarizer changer can be stored and repeated

Test installation at ZEA-1



Repeatability of the linear positioner by starting different linear coordinates (range: 0-10mm) and the 180° position change

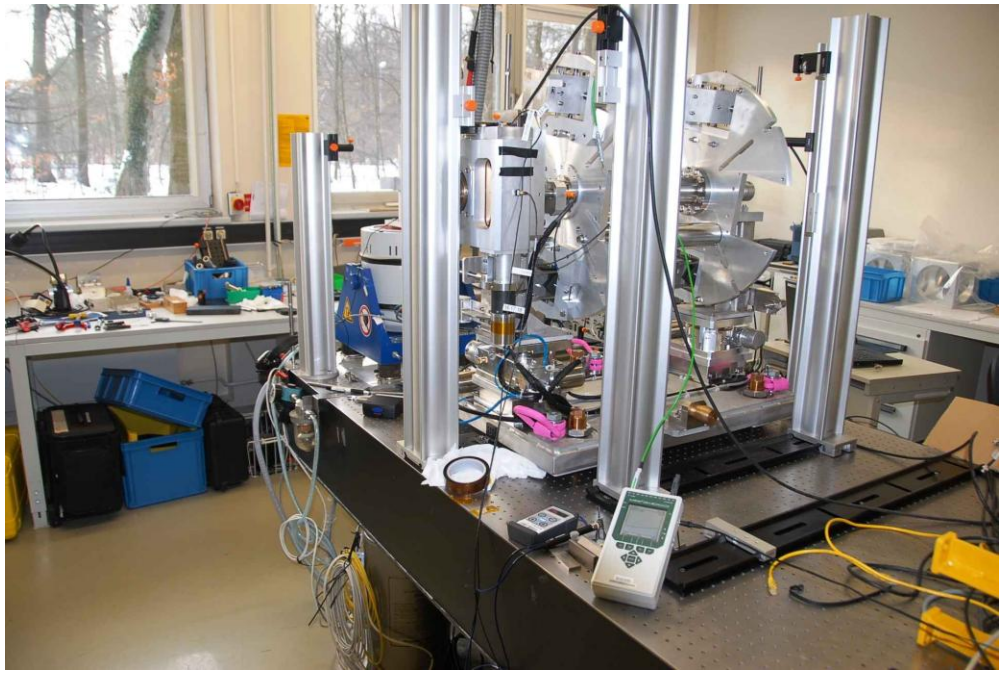
Test installation at ZEA-1



Repeatability of the linear positioner by starting different linear coordinates (range: 4-6mm) and the 180 ° position change

Accuracy of rotation of the rotor +/- 0,003° was achieved too.

Test installation at ZEA-1



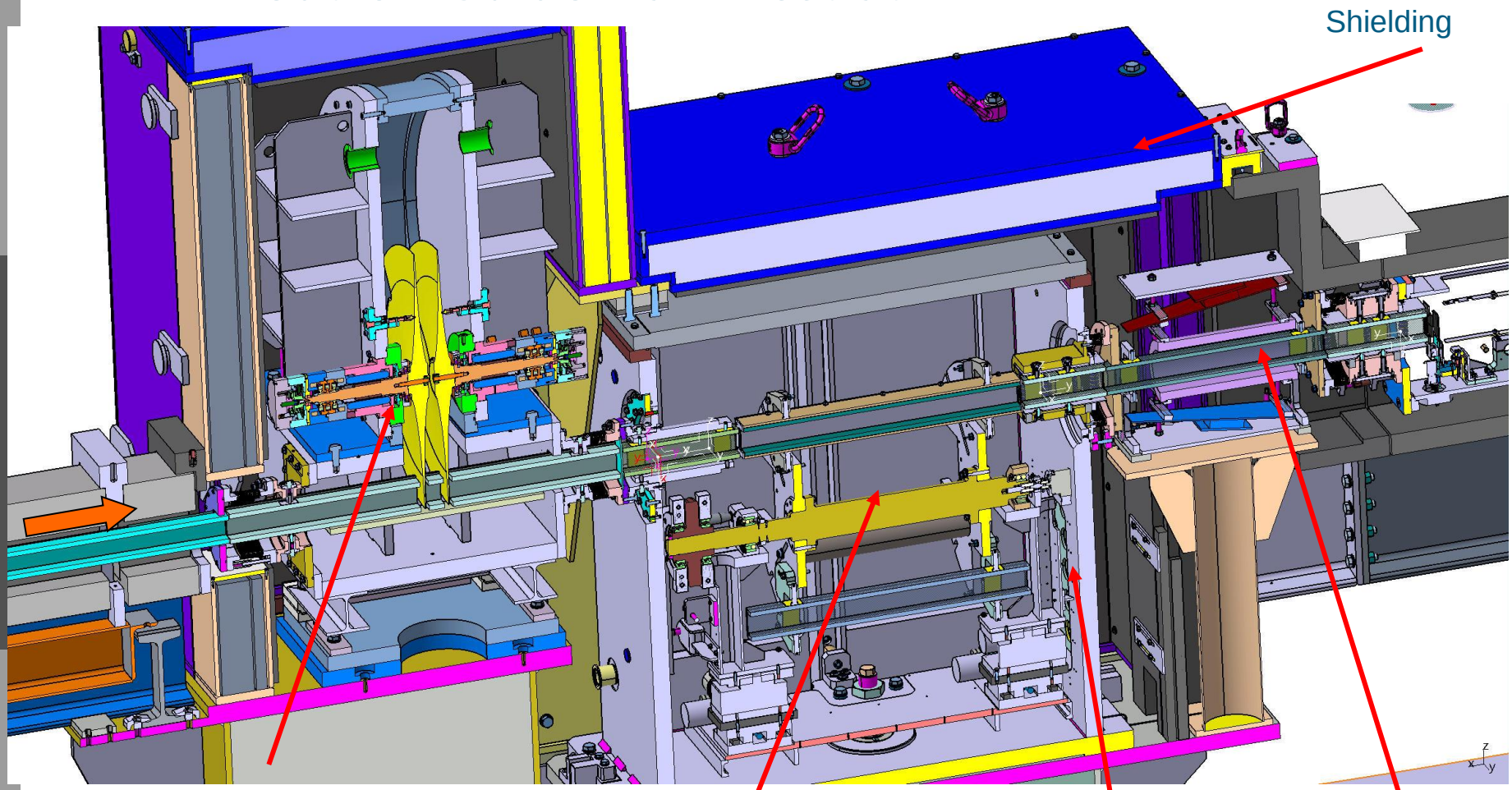
During one of the last measurements we have observed large measurements deviations. The deviations could not be correctly assigned, they occurred arbitrarily.

We have observed the measurements deviations during the standstill of the changer too.

At 100m distance from our laboratory was a construction site with a pneumatic hammer. Our instruments have measured the vibrations from the construction site.

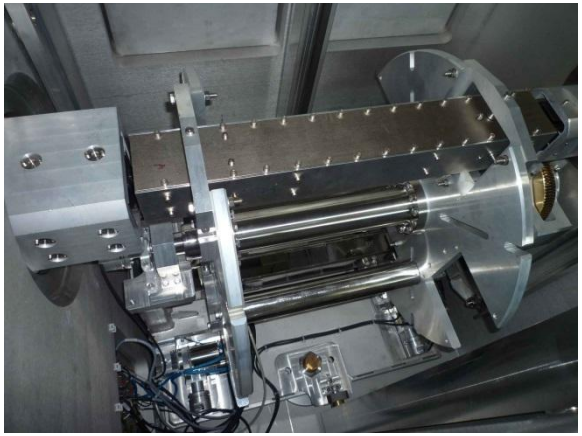
Installation polarizer and chopper in the Neutron Guide Hall West at FRMII

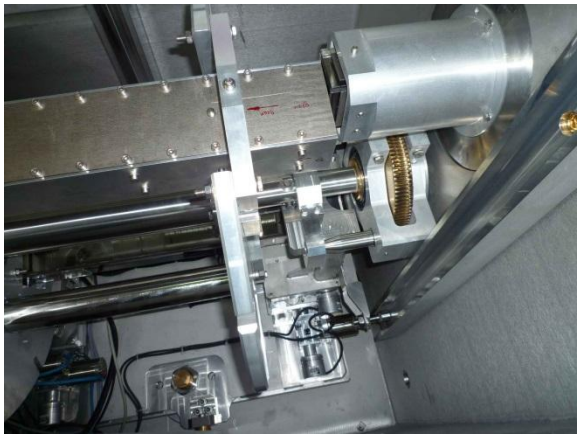
Installation polarizer and chopper in the Neutron Guide Hall West at FRMII



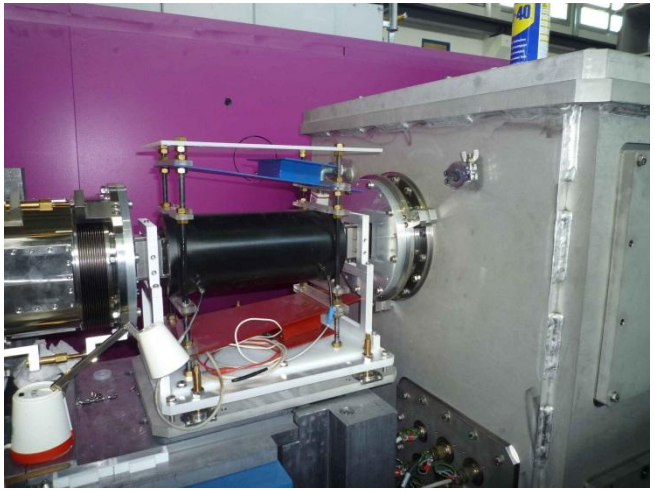
We have integrated the chopper, polarizer and flipper in one unit with common shielding.

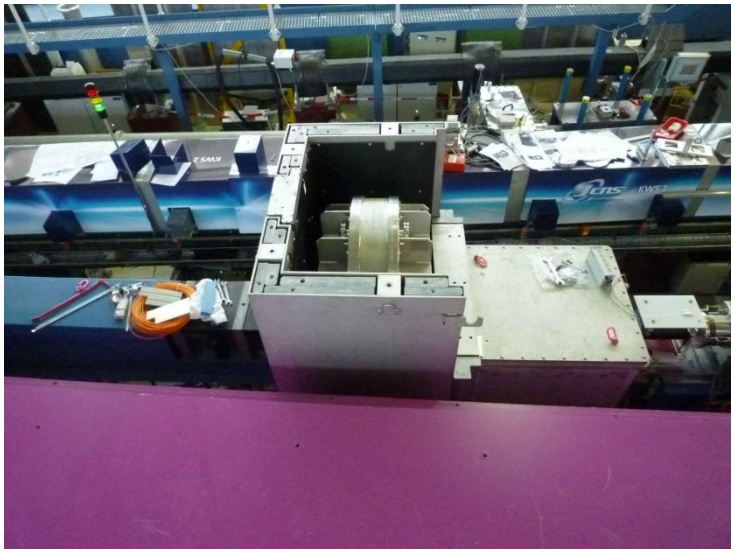
Installation polarizer and chopper in the Neutron Guide Hall West at FRMII





Installation polarizer and chopper in the Neutron Guide Hall West at FRMII



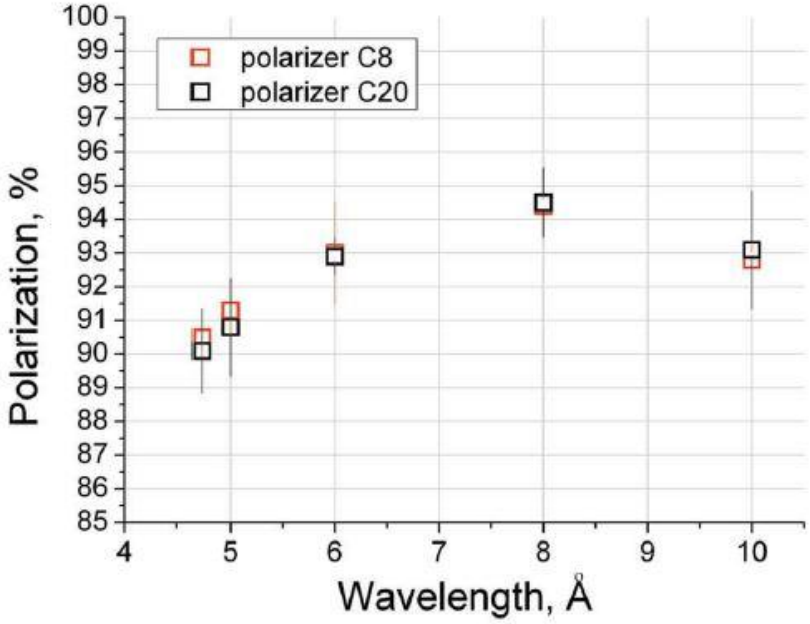


Installation polarizer and chopper in the Neutron Guide Hall West at FRMII

This is the present status of the Chopper and Polarizer changer

Conclusions

- For the accuracy of the polarizer changer very strict requirements were made by scientists.
- The development and construction was very challenging and difficult, because that system is “freely movable”.
- We have gained a lot of experience.
- Again it has been confirmed that it is very important to carry out tests in his own company before the delivery of the assembly.
- The measurements have shown that the polarizer and polarizer changer works very well.



Graph of beam polarization for different collimation settings and neutron wavelengths as obtained using the absolute 3He analyzer.

KWS-1 high-resolution small-angle neutron scattering instrument at JCNS: current state

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JÜLICH
FORSCHUNGSZENTRUM

Thank you for your attention