Flexible Sample Environments for the Investigation of Soft Matter for Implementation at the ESS

Development of a Sample Environment for

In-situ Dynamic Light Scattering (DLS) / Diffusing Wave Spectroscopy (DWS) with Small Angle Neutron Scattering (SANS)

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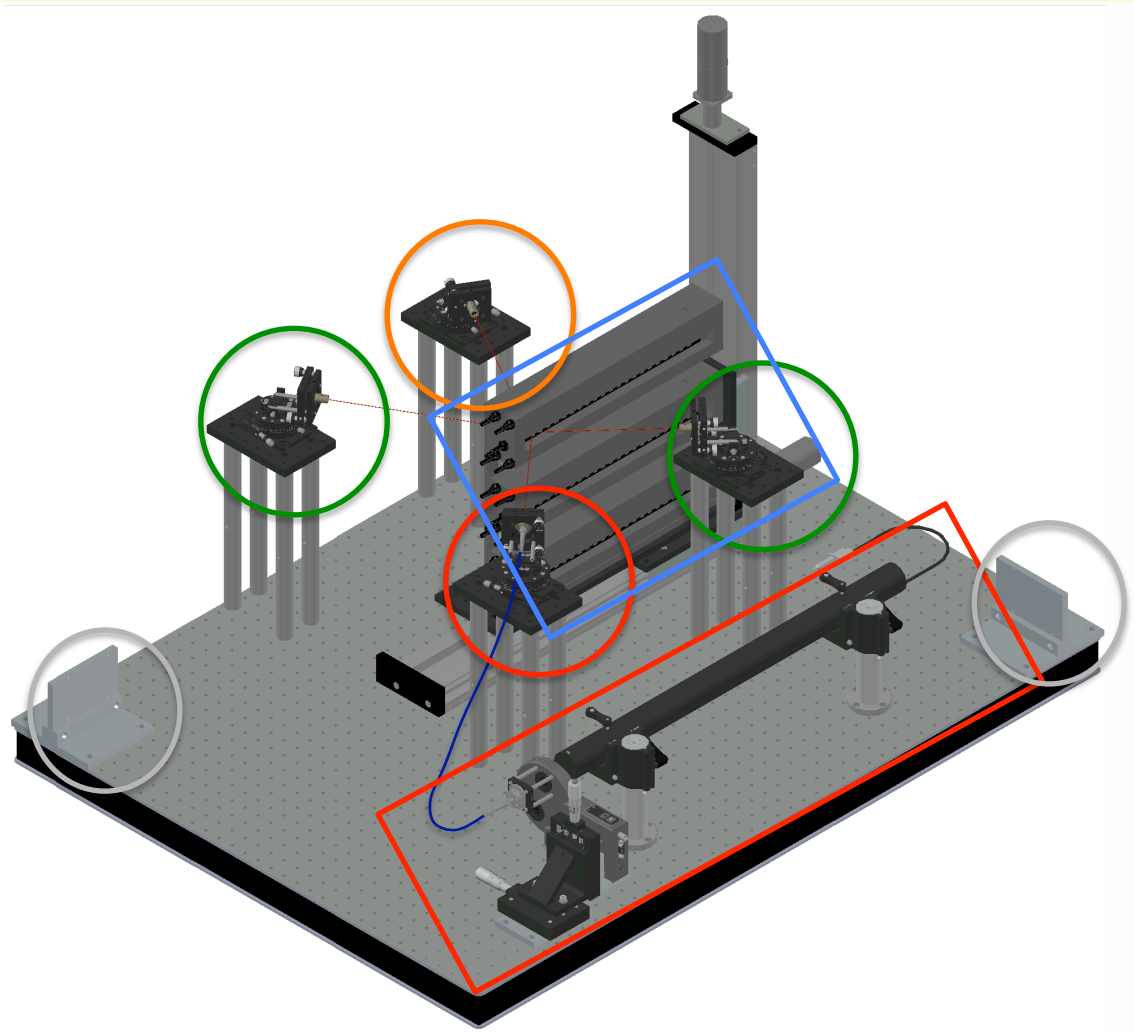
Design of in-situ DLS / DWS Sample Environment

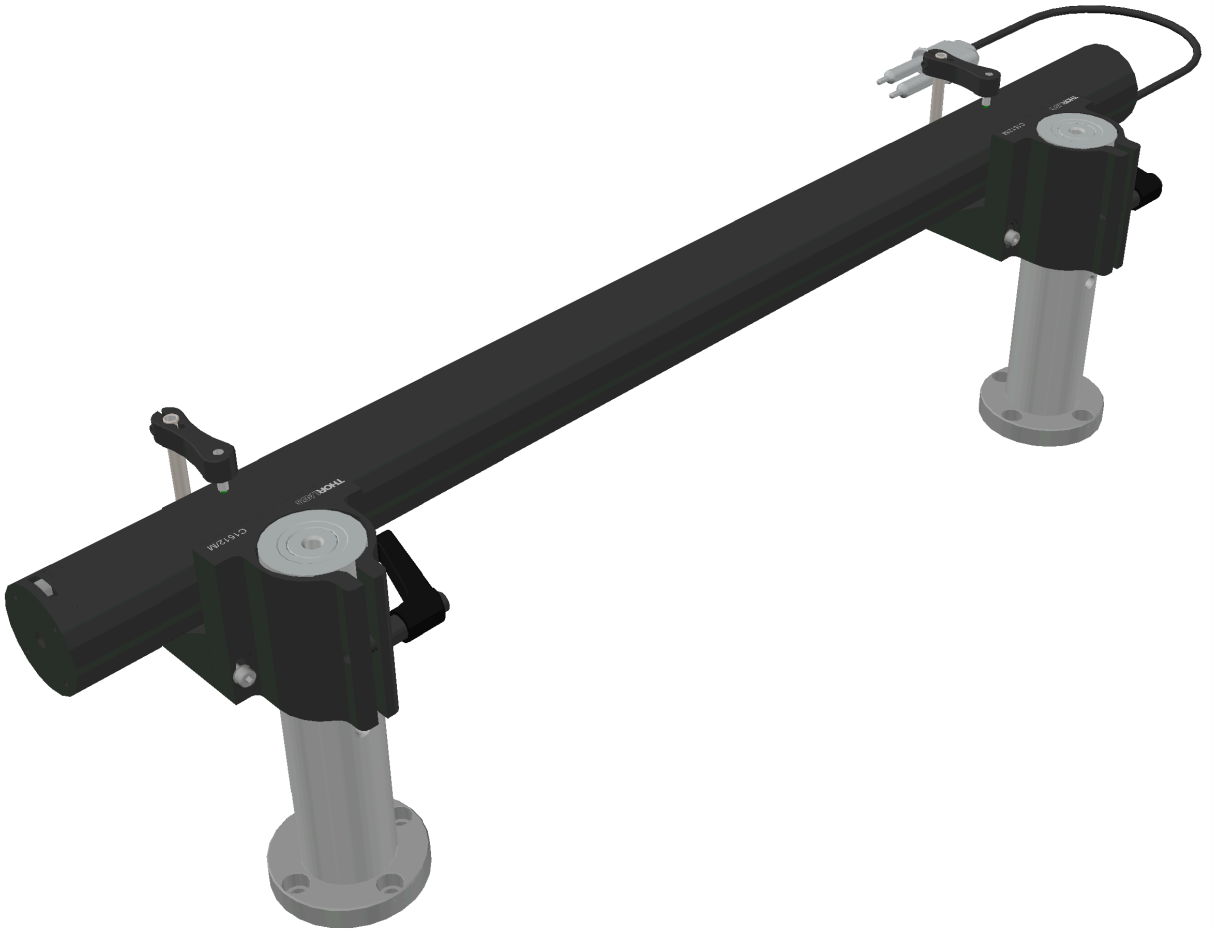
Overview



- Incident laser beam
- Sample Changer with temperature control on x,z-translation stage
- 2-angle DLS setup
- DWS setup (optional),
- 3 Mounts for 2 single photon counting mounting modules, each

Design of in-situ DLS / DWS Sample Environment

Laser

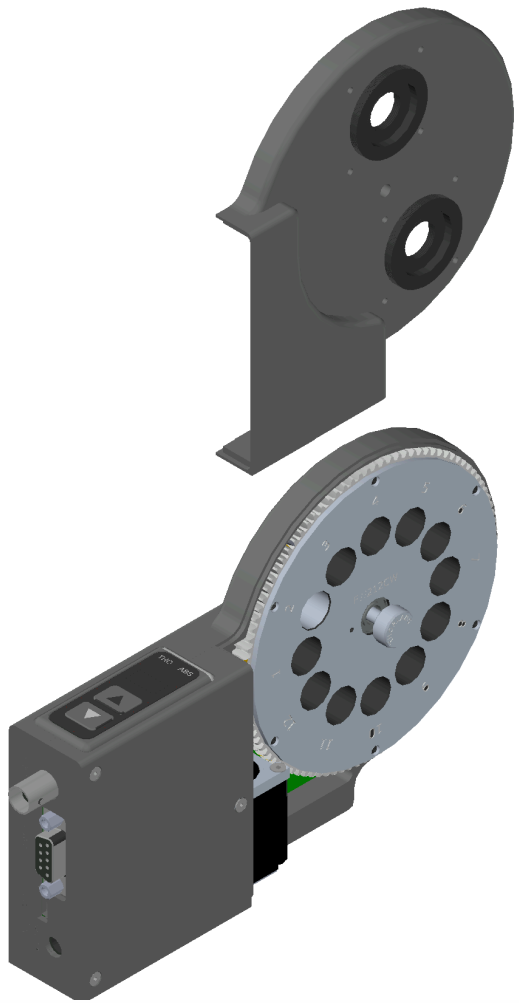


Helium-Neon Laser

- λ=632.8 nm
- *P*=21 mW
- High beam stability
- Polarization ratio 500:1
- Mounting:
  - 2 posts
  - Post bases with counter bored holes → exact positioning
  - V-clamps
  - Height ≈ 16 cm

Design of in-situ DLS / DWS Sample Environment

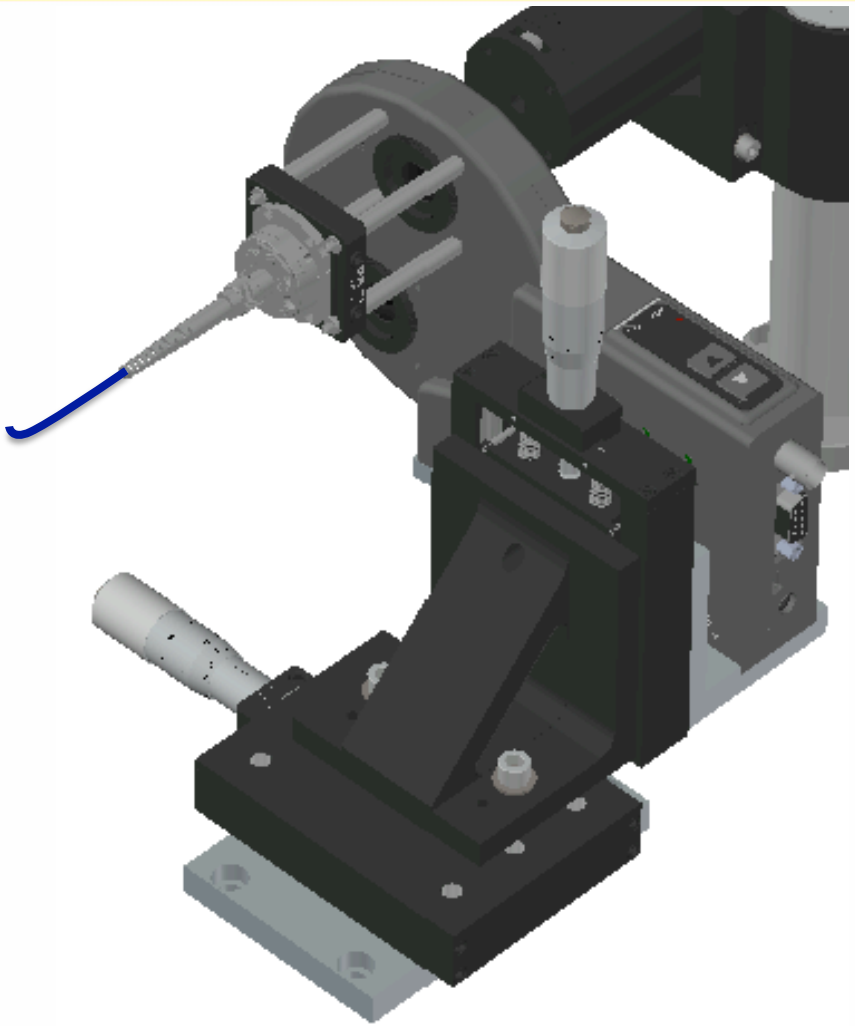
Motorized Filter Wheel



- **Attenuator**
  - 10 positions filled with neutral density filters with increasing optical density
  - 1 position for free laser beam
- **Shutter**
  - 1 position blocked with plug
- External control via RS 232 interface
  → External control of laser beam: on/off
  → Connected to interlock system of beamline

Design of in-situ DLS / DWS Sample Environment

Fiberport

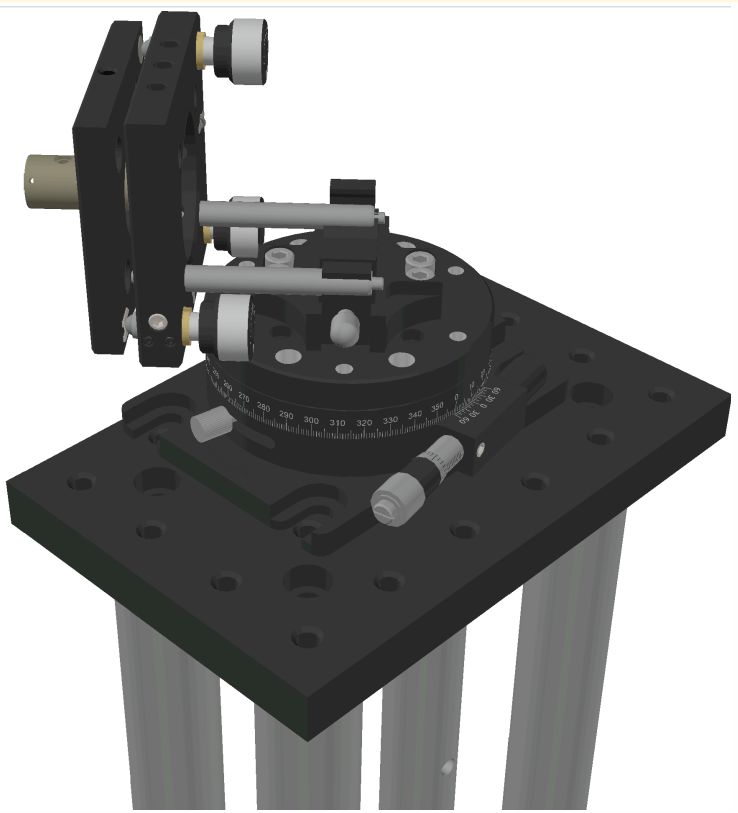


→ Coupling laser light into polarizing maintaining single mode fiber

- 5 degrees of freedom
  → high coupling efficiency
- Directly mounted to filter wheel via cage system
  → centred position to filter wheel
- Filter wheel mounted to x,z-translation stage
  → Alignment of fiberport (and filter wheel) with respect to laser beam

Design of in-situ DLS / DWS Sample Environment

Collimation Setup

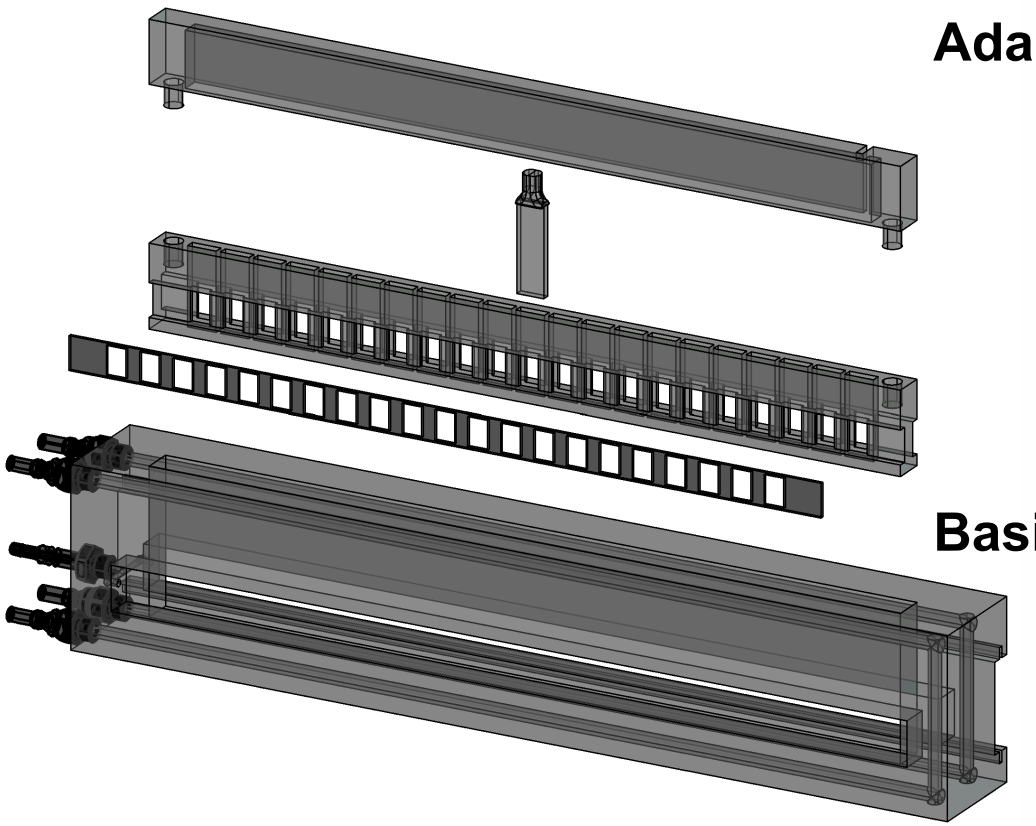


→ For incident laser beam and detection of scattered light

- Collimator
  - Mirror Mount with 2 degrees of freedom → straight laser beam
  - Cage System → centred positioning
  - High precision rotation stage → exact determination of scattering angle
  - Laser spot: ∅ ≈ 0.5 mm
  - Microfocus optics available
- Mounting
  - Small breadboard
  - 4 post: → Laser beam about same height as neutron beam

Design of in-situ DLS / DWS Sample Environment

Sample Changer



Adapter:

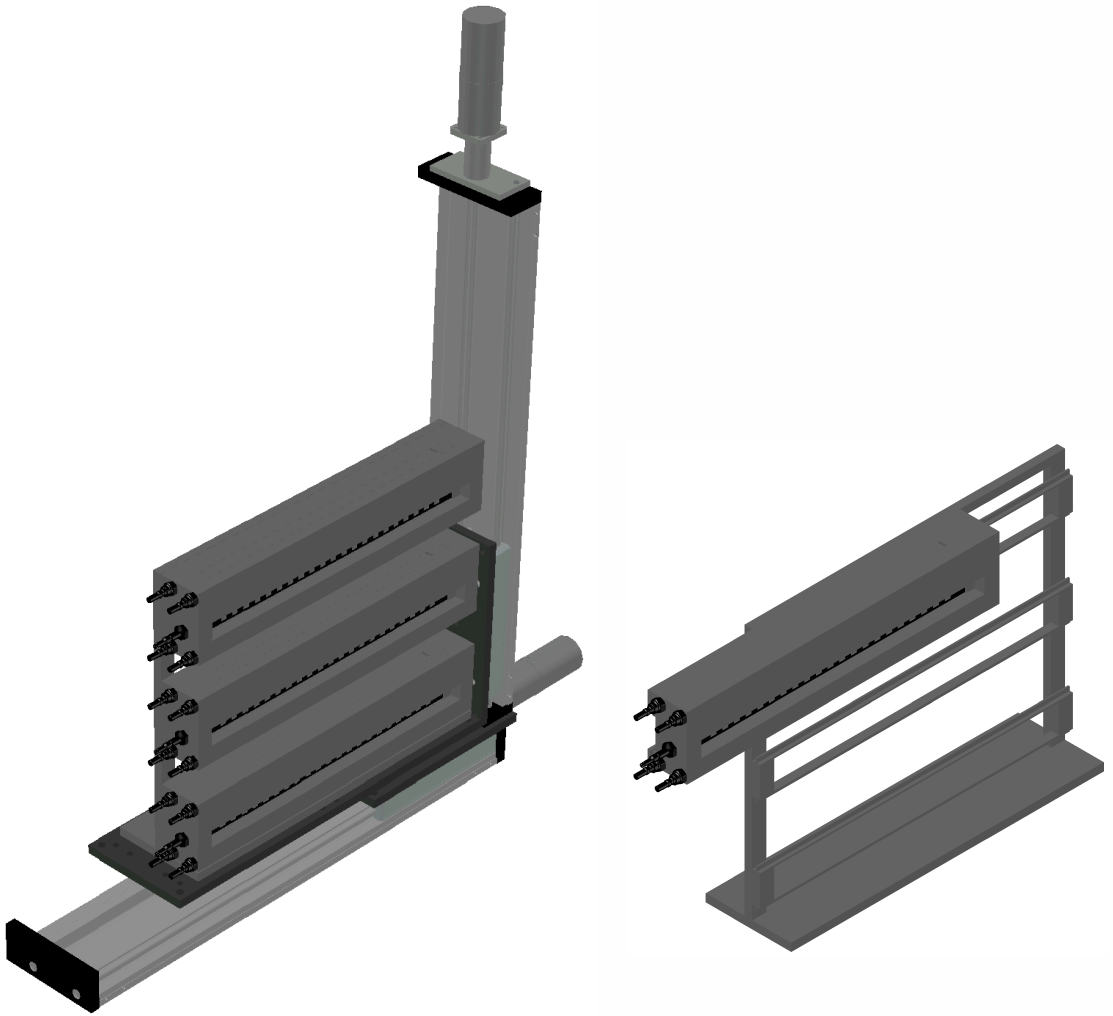
- Individual for different types of cells
- Temperature measurement inside cell
- Front side: Boron-PE mask
  → Absorption of diffuse neutrons
  → Window: 9x13 mm^2 (narrow cells)
- 20 sample cells

Basis Block:

- Temperature control
- Compressed air : → avoid water condensation during measurements below room temperature
- Window for neutron & laser beam: 20 mm high

Design of in-situ DLS / DWS Sample Environment

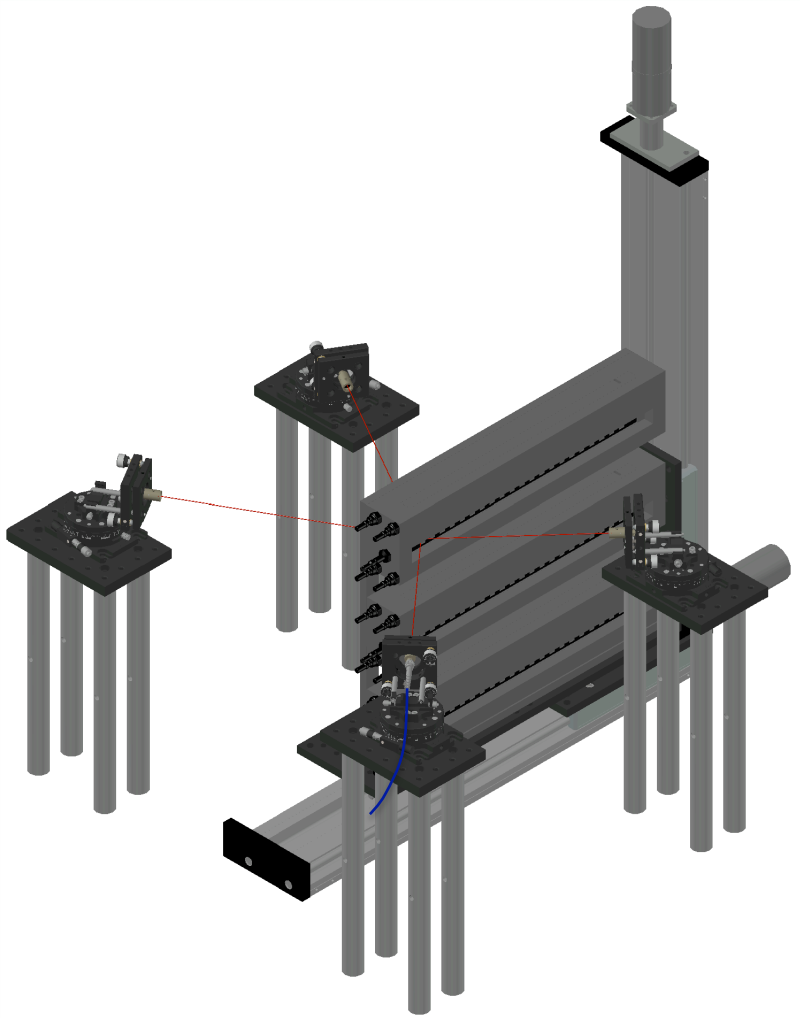
Sample Changer



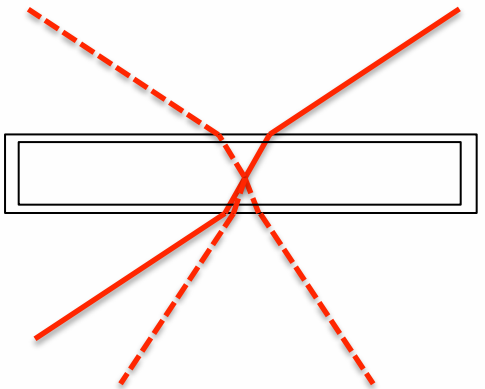
- 3 individual sample changers
- Mounted on rack with rails
  → offline preparation
- Build out of $AlMg_{4.5}Mn_{0.7}$
  → low activation by neutrons
- Current Design:
  Max. 60 samples
- On x,z-translation stage
  → Height of laser beam fixed
  → Independent z-movement

Design of in-situ DLS / DWS Sample Environment

Scattering Angles



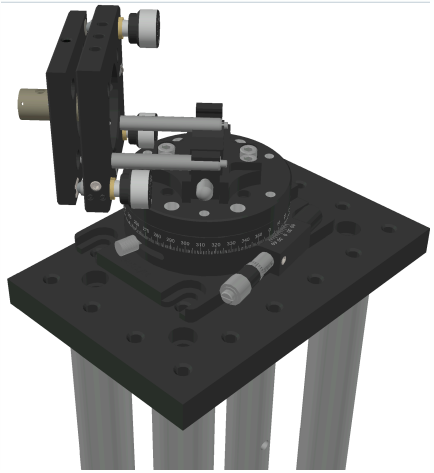
→ Correction for refraction at air-glass interface:



- DLS:
  - $\theta \approx 120°$ ($q \approx 2.3 \times 10^{-3}$ Å^{-1})
  - $\theta \approx 51°$ ($q \approx 1.1 \times 10^{-3}$ Å^{-1})
- DWS (transmission mode):
  - $\theta \approx 10°$ ($q \approx 2.3 \times 10^{-4}$ Å^{-1})

Design of in-situ DLS / DWS Sample Environment

Detection, Analysis and Measurement Software

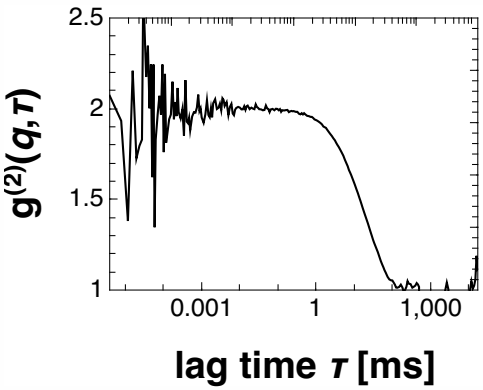


Detection (Collimation Setup):

→ Split of detected scattered light by 50/50 single mode fiber coupler

Analysis:

→ 2 single photon counting modules (SPCMs)



Measurement Software:[1]

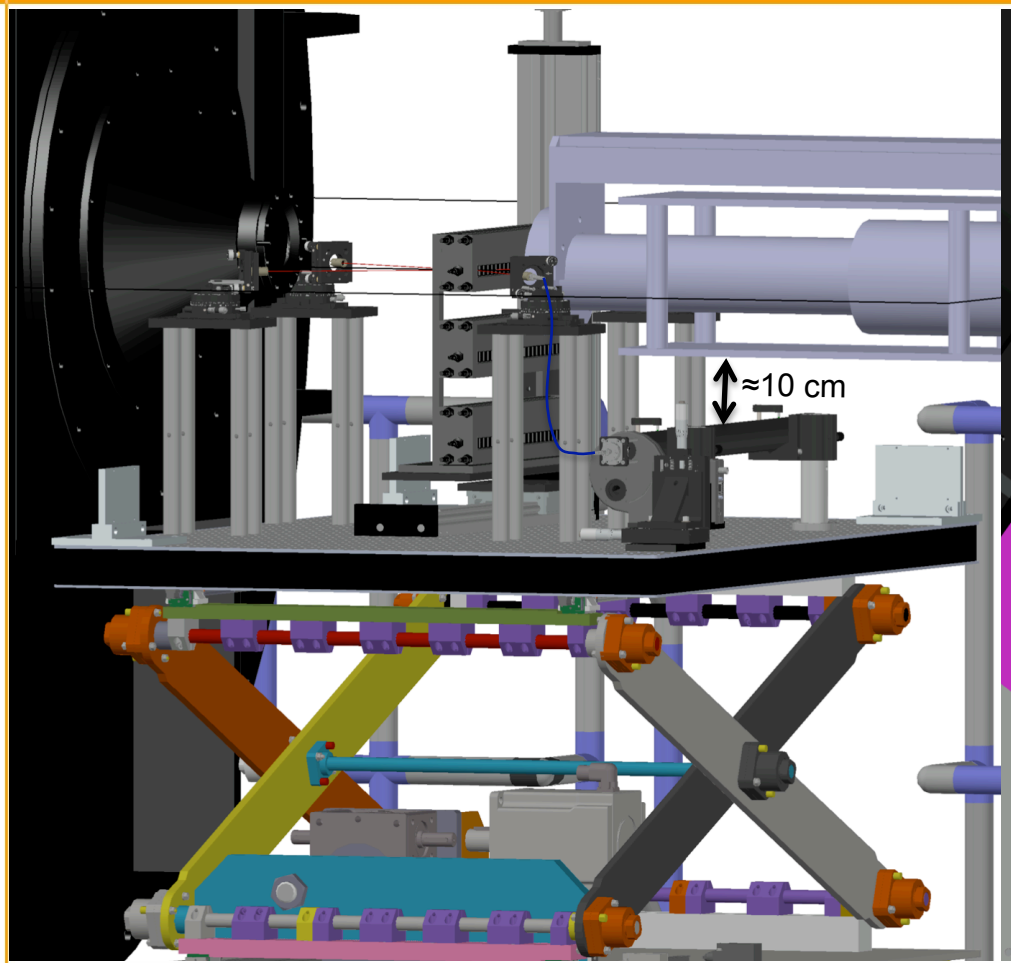
→ Hardware photon correlator: general-purpose field-programmable gate array (FPGA) development board

→ Windows GUI: developed in C#

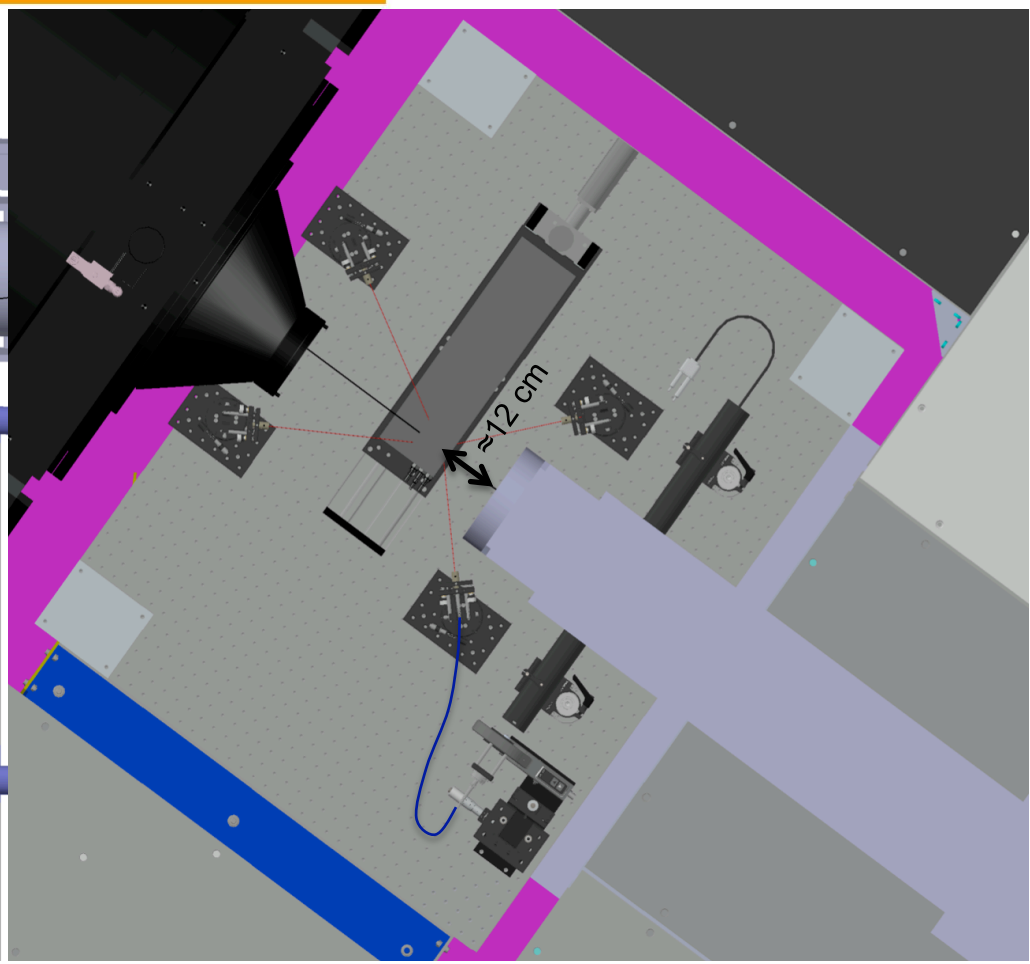
[1] Kalinin, S., Kühnemuth, R., Vardanyan, H., & Seidel, C. A. M. (2012). Note: A 4 ns hardware photon correlator based on a general-purpose field-programmable gate array development board implemented in a compact setup for fluorescence correlation spectroscopy. Review of Scientific Instruments, 83(9), 096105. http://doi.org/10.1063/1.4753994

In-situ DLS / DWS Sample Environment in SKADI

Back View

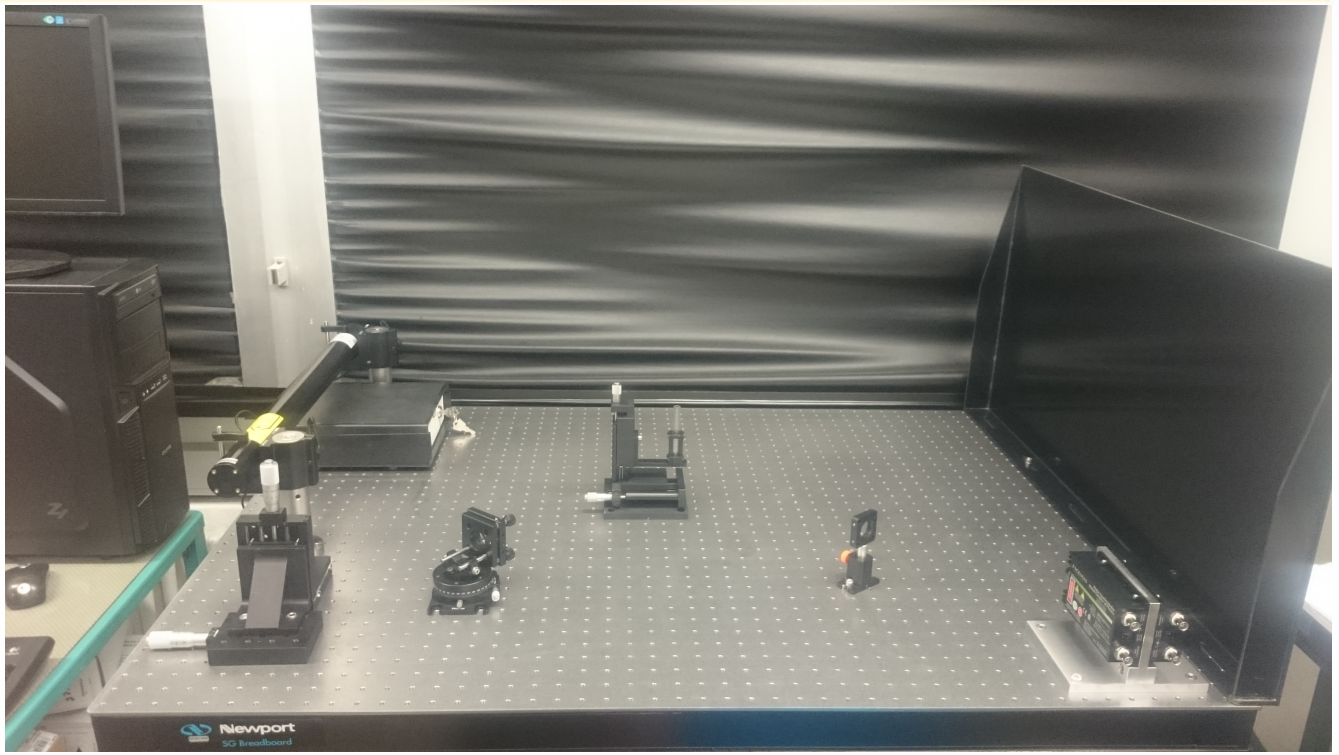


Top View



In-situ DLS / DWS Sample Environment

Current Progress – Lab Setup



Current Progress:

- Mechanical workshop: → Mount for filter wheel
- Fiber collimator arrived last week

In-situ DLS / DWS Sample Environment

Outlook – Problems – Needed Information

Outlook:

- Alignment of optical components for 1-angle DLS measurement
- First test measurements with 1-cell sample holder
- Start building the Sample changer
- Testing 2-angle DLS setup

Needed Information:

- Design of sample environment acceptable?
- Height of neutron beam over breadboard?
- 12 cm distance between neutron guide cone and sample acceptable?
- Which motorized stages with 40 cm travel distance for x,z-translation stage?
- Which quick release couplers available?

Problems:

- Running DLS software on Linux & implementation in instrument software
- Laser security

In-situ DLS / DWS Sample Environment

Thank you for your kind attention!