SINQ beamline BOA

Introduction

The operation of the new multi-purpose neutron beamline BOA (Beamline for neutron Optics and other Approaches) has started successfully in May 2011. This new beamline is a redesign of the former FUNSPIN beamline. BOA is a 18 m long instrument located at the beam channel 51 looking on the SINQ cold source. The primary polarization element (polarizing bender) of the former design was kept because research with polarized neutrons is of key interest in the neutron scattering community. The position of BOA close to the cold source is crucial for the performance of the instrument: the measured polarized flux is around $1x10^8$ n cm^{-2} s^{-1} mA^{-1}. The secondary instrument consists of a highly flexible geometry. It is equipped with three rotating axes with flexible translation tables and several aperture units. The maximum available free space is around 12 m, which allows new experiments presently not possible at SINQ. An area sensitive CCD camera system and optionally an He-3 neutron counter are available for the data acquisition.

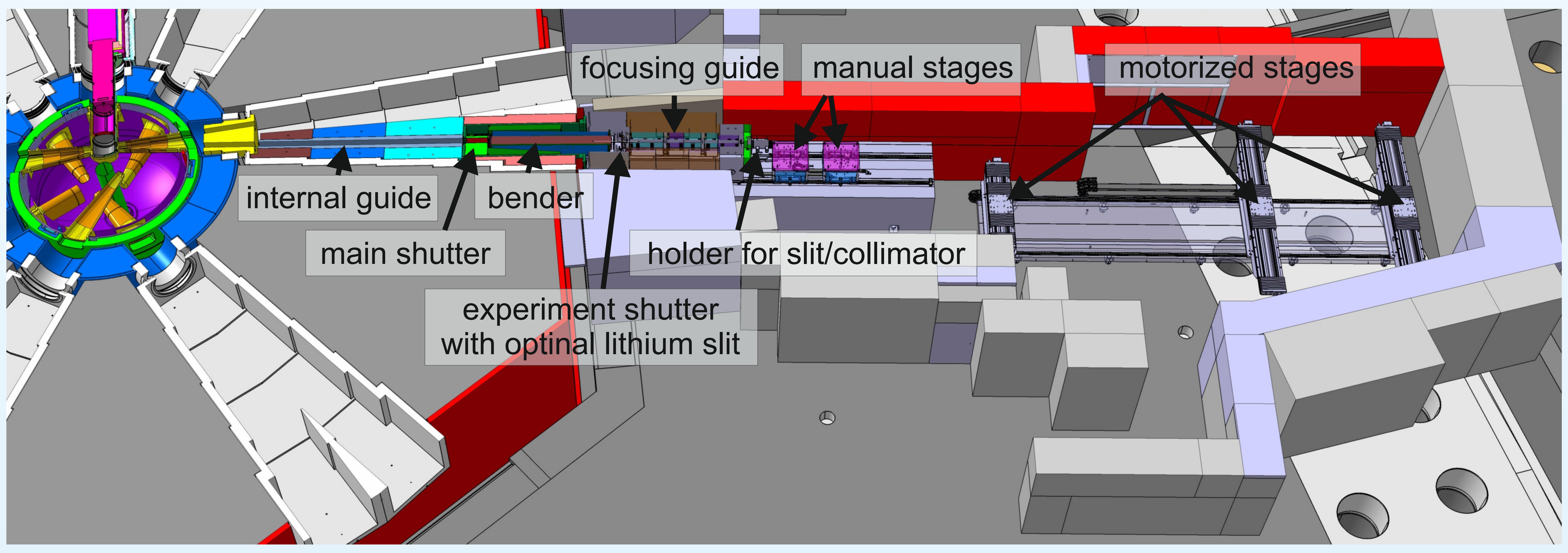
Beamline Layout

internal guide : rectangular linear guide
l= 2.7 m , w = 0.08m , h = 0.15 m , m=3.3

polarizing bender : 1.6 m long: 4 sections of 0.4 m
bending radius : 50 m (nominal 1.83 degree total)
mirrors of m = 3.3 (1^{st} section)
mirrors of m = 2 (2^{nd} 3^{rd} 4^{th} section)
magnetic field of 300 gauss with permanent magnets at top and button

linear horizontal focusing guide of m = 2 with magnetic guiding field (100 gauss):
entrance : w = 0.051m , h = 0.15 m
exit : w = 0.04 m , h = 0.15 m

holder for slit and collimator with magnetic guiding field: around 60 gauss (permanent magnets at top and button)



primary instrument : 2 manual stages (x)
secondary instrument : 3 motorized linear stages at (x and y)
1 rotation stage

3 slit wheels: manual movement, different rectangular slits and pinholes (made of ^{10}B-Aluminium)

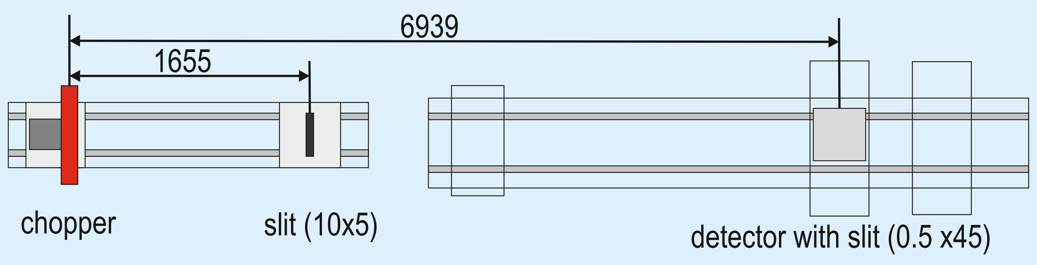
3 rectangular slits: motorized (cabling not finished yet)

1 He3 – counter : final shielding in production

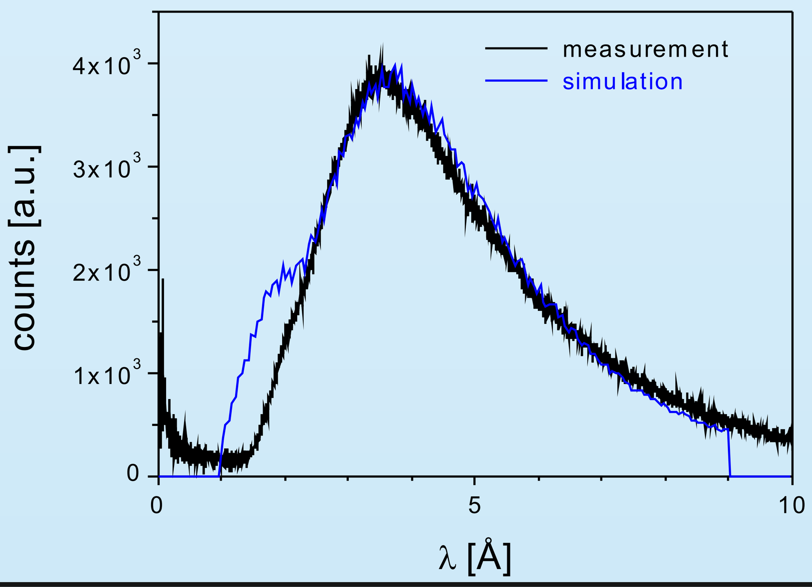
1 CCD-detector system: Andor IKON M with 50mm objective (1024x1024 Pixel)
3 different ^{6}LiF scintillator are available (50 ,100 and 200 µm)

beamline control software: SICS, CCD-system was implemented by M. Könnecke

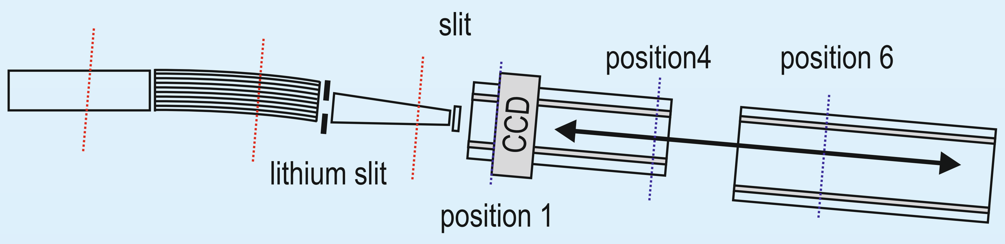
Wavelength Spectrum



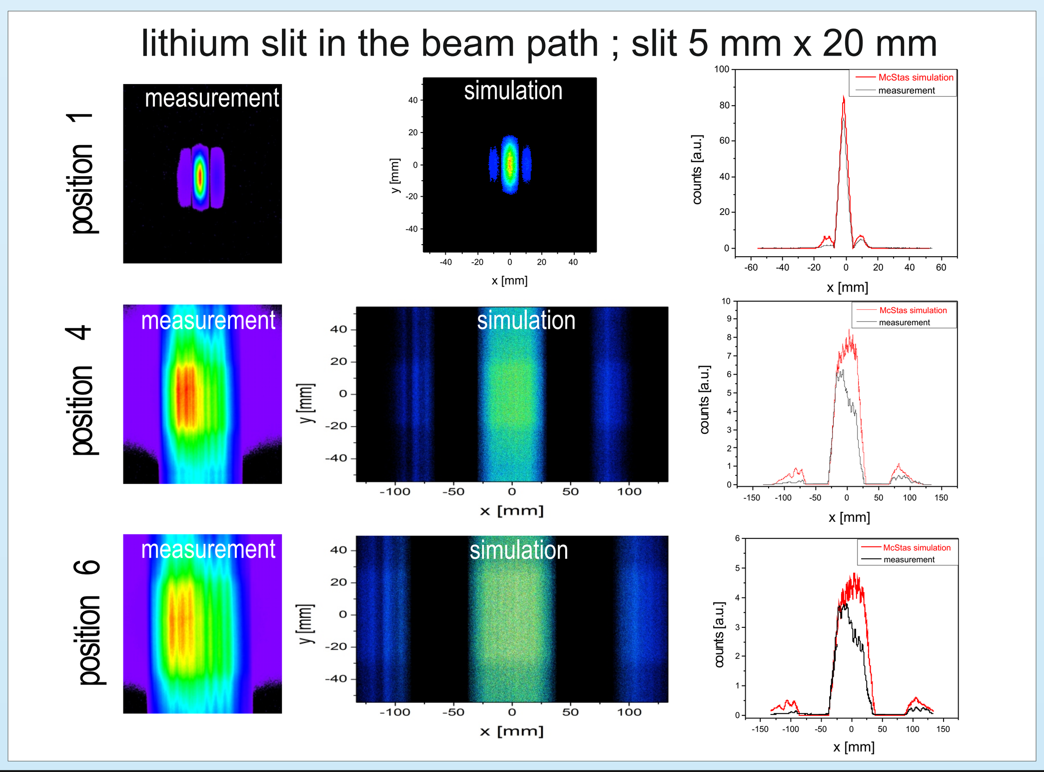
The wavelength spectrum was measured with a chopper system shown in the sceme. The slits in the beam path and in front of the detector were necessary to reduce the intensity to a level where the MCA of the detector delivered a correct spectrum. The measured spectrum is cold and has a maximum at 3.5 Angstroem. All the higher energies are eleminated by the opicts of the beamline.
The McStas simulation for this set up delivered also a cold spectrum with a maximum at slightly longer wavelength, which can be explained by the air absorbtion in the measurement.



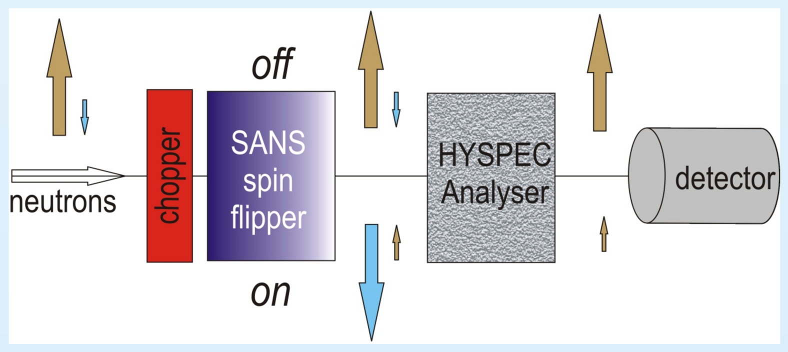
Beam Profiles

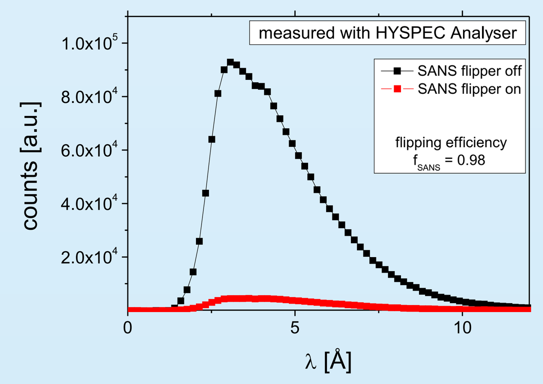


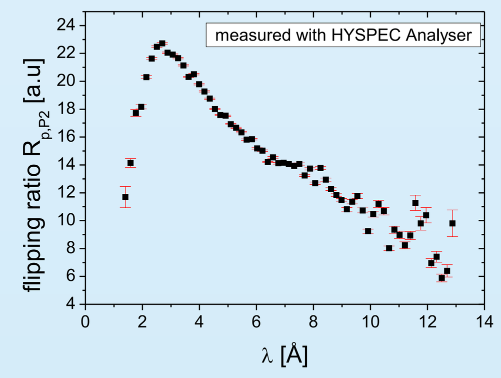
The beam profiles have been measured with different combinations of the lithium slit at the entrance and a slit at the exit of the focusing guide. If the second slit becomes small it acts like a pinhole as was observed in the example below. The McStas simulations reproduce the peak positions well. The intensity mismatch is due to some unknown behavior in the beam path not included in the simulations.

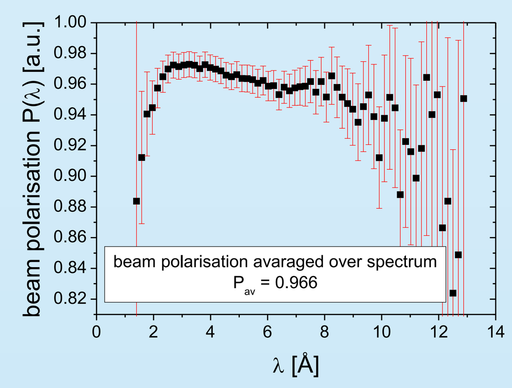


Polarisation



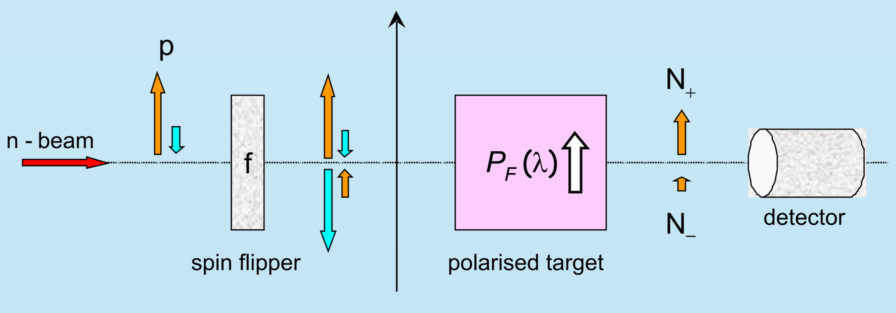




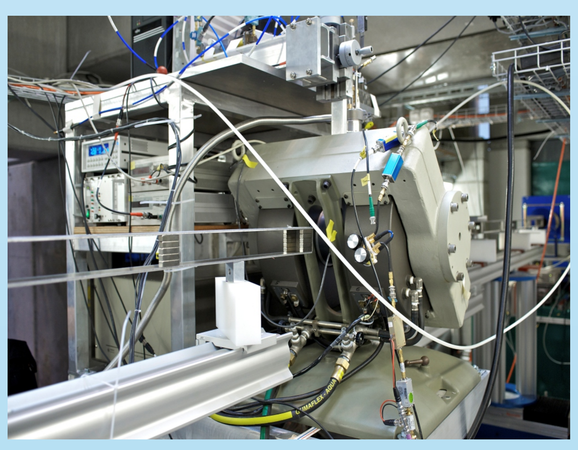


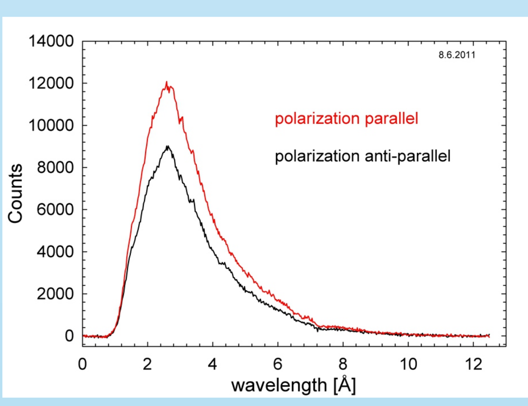
The set up for the polarized measurements is shown in the scheme above. The spectrum measurements with flipper on and off show that the beam is highly polarized. The flipping ratio has a maximum between 2 and 3 Angstroem. The beam polarisation averaged over the whole spectrum has been determined to be 96.6 %.

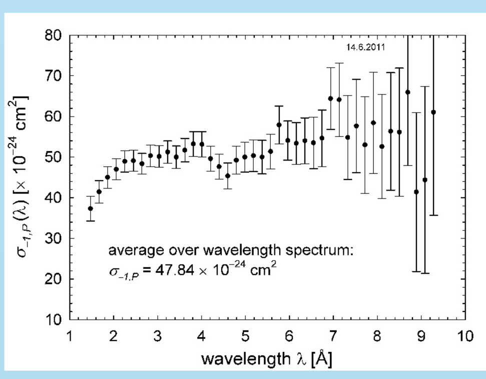
Experiment I : polarized proton spin filter



The spin dependence of the neutron proton nuclear interaction can be exploited to build a spin filter operating efficiently over the whole energy range of neutrons from meV to keV. In a test of principle experiment a polarized proton target based on a novel dynamic nuclear polarization (DNP) process has been used to spin filter the white beam at BOA. The system operates at only 0.3 T and 100 K.



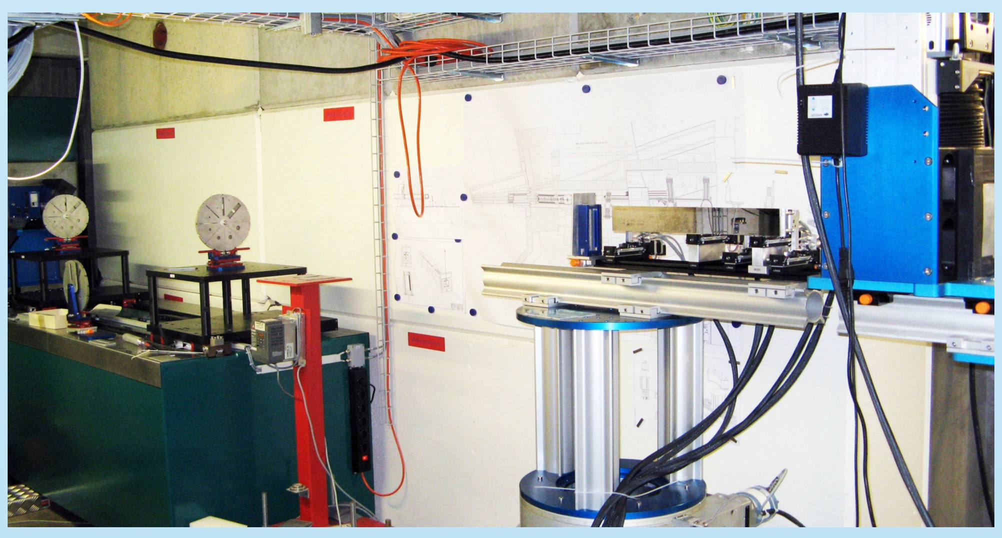


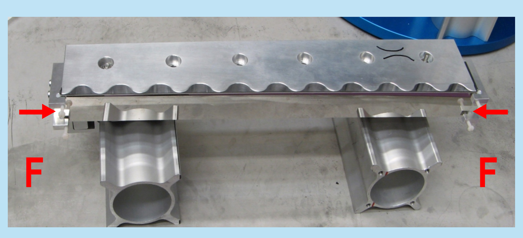


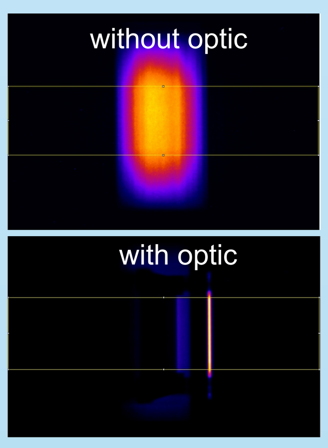
The polarization cross section σ_P has been determined over the whole wavelength range.

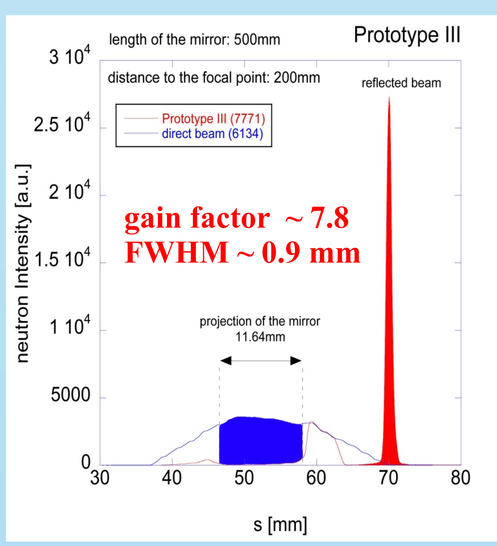
For more details see poster M. Haag et al.

Experiment II : adaptive neutron optics



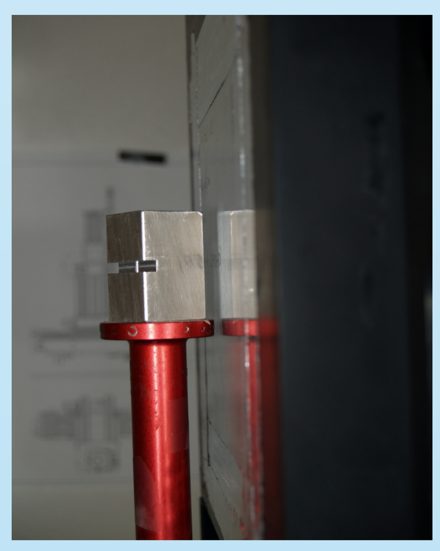


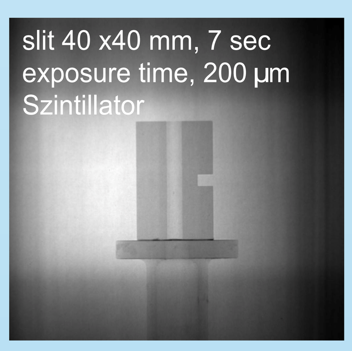


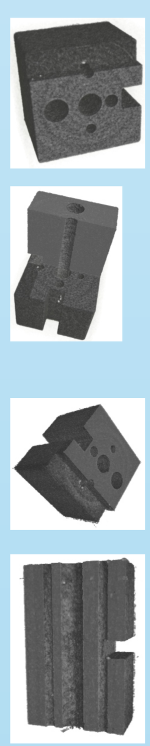


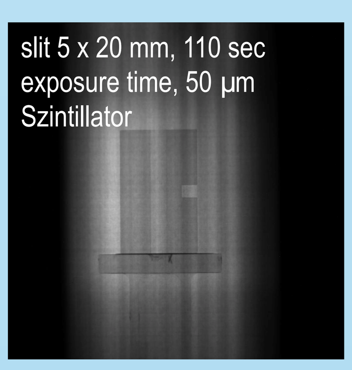
With a prototype adaptive neutron-optical device it was possible to achieve a tiny focal spot on small samples. By adapting the applied force, the y-position of the device and the angle of incidence, the neutrons could be focused in one dimension on a spot size of below 1mm yielding an intensity gain factor of 7.8 .

Experiment III : tomography









A first test tomography was performed on an aluminium cube of 2.5 x 2.5 x 5 cm with different drillings and slits. It was placed near to the camera on a big rotation stage. By using different slits after the focusing guide two different illumination functions have been prepared.
In both cases the reconstruction could be successfully done (Jan Hovind NIAG group of E. Lehmann).