Adaptive optics – Monte Carlo simulations and first prototype

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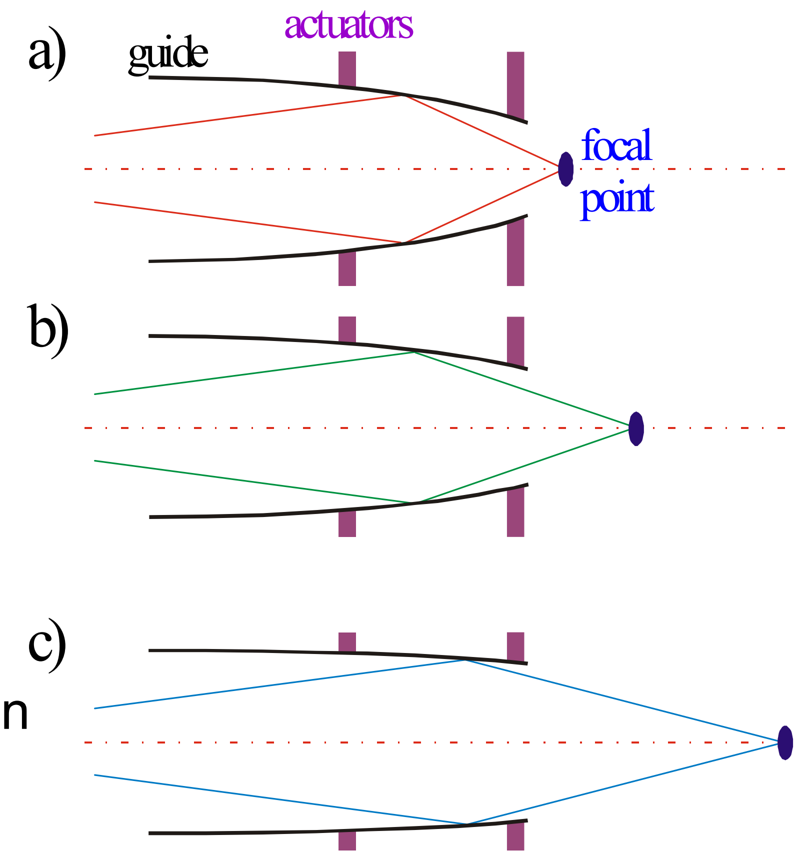
Motivation and goals

- to significantly increase the neutron flux
- well defined beam characteristics
- gain factor in intensity of over 30 compared to linear guides for small samples
- to obtain a focal point in the sub mm range for elastic and inelastic scattering on very small samples
- to reduce the scattering background during the extreme environment experiments: magnetic fields, high pressure

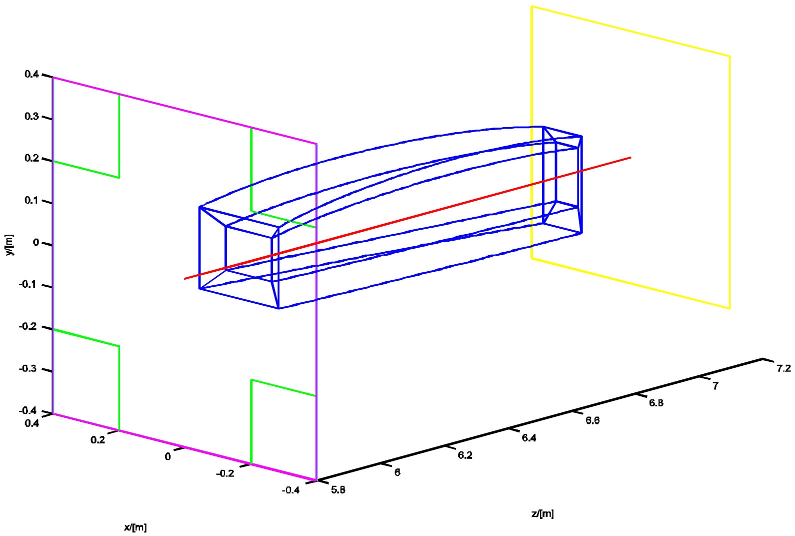
Adaptive optics



- possibility to align the focal point on tiny samples
- adaptation of beam size to the sample size
- optimization of the divergence of the neutron beam with respect to the sample

Adjust curvature of tapered guide by means of actuators
→ change focal length of the device

New McStas component

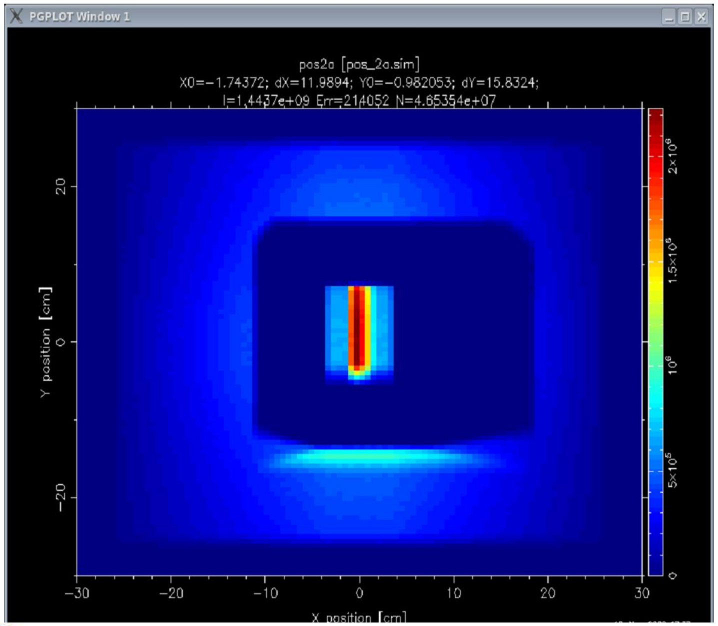


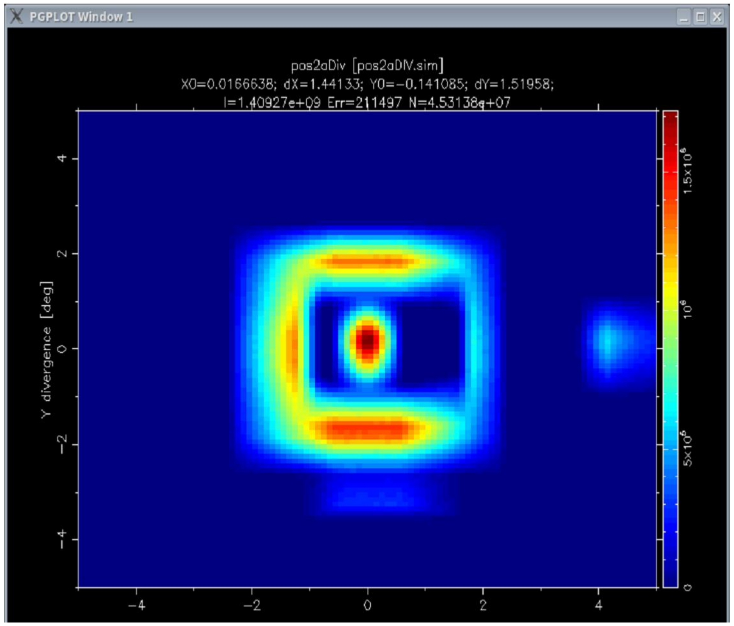
-different wall thickness

-truly curved

-different curvature for each wall

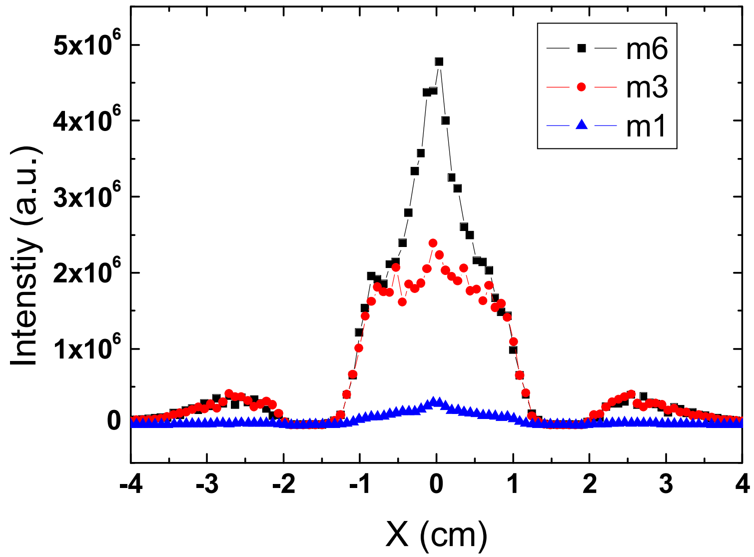
-transparent, absorbing or reflecting inner or outer walls





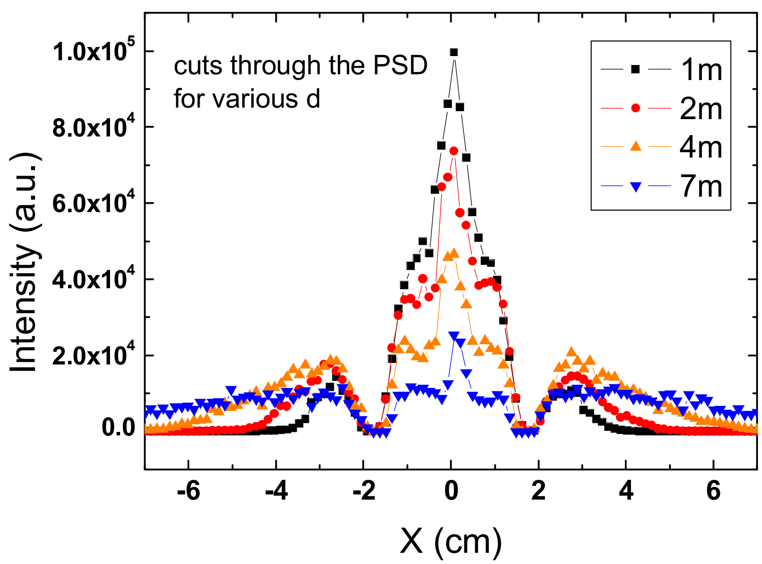
One dimensional simulations

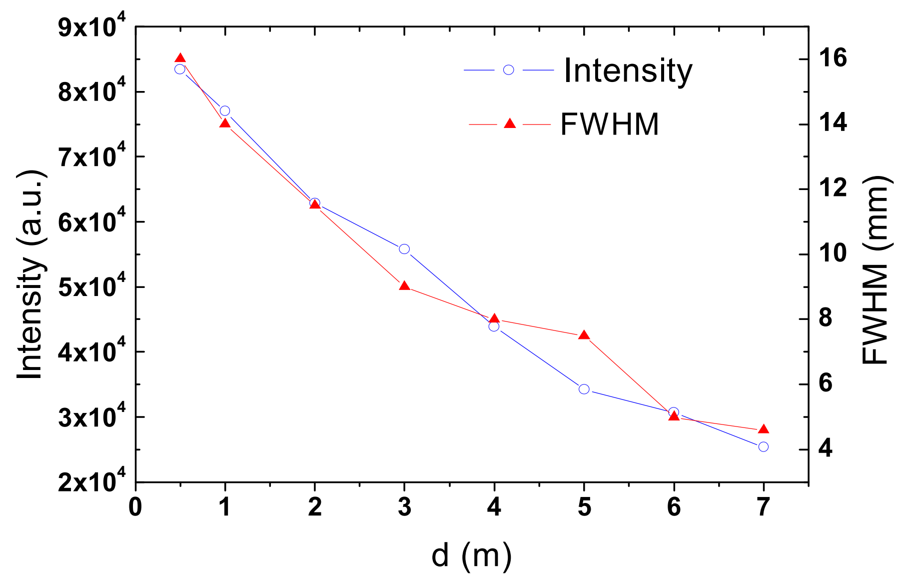
$\lambda = 5$ Å



Intensity increases with increasing m value of the coating due to reflection of neutrons with higher angle of incidence

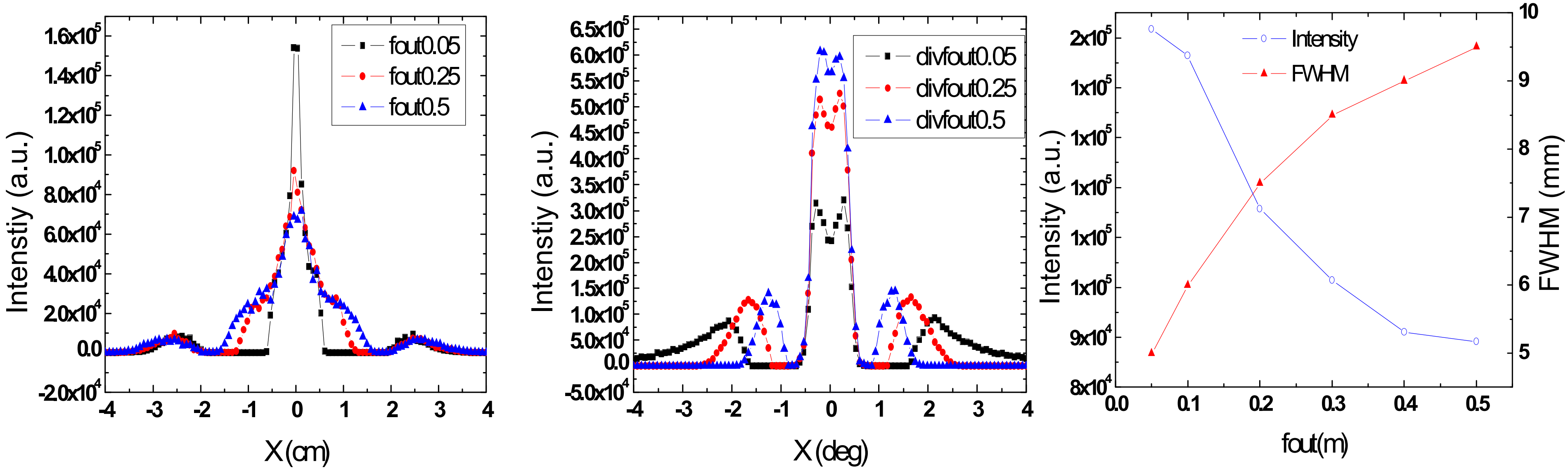
Variation of d (distance guide-entrance): divergence of incoming neutrons is changed





Simulations for various f_{out}

$\lambda = 5$ Å



Observation for decreasing f_{out}:

-increase in intensity

-increase of curvature of mirror

-decrease of width of beam (FWHM)

Example: f_{out}= 100 mm:

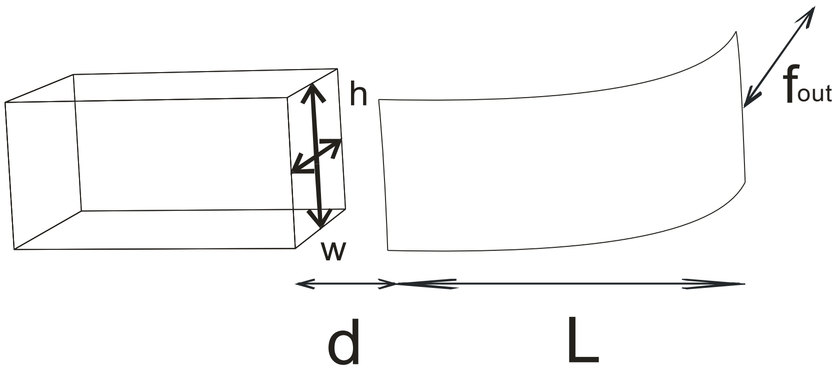
- FWHM = 6 mm
- flux: $1.7 \cdot 10^7$ neutrons$\cdot cm^{-2} \cdot s^{-1}$

Applications:

-at PSI:
- RITA
- DMC

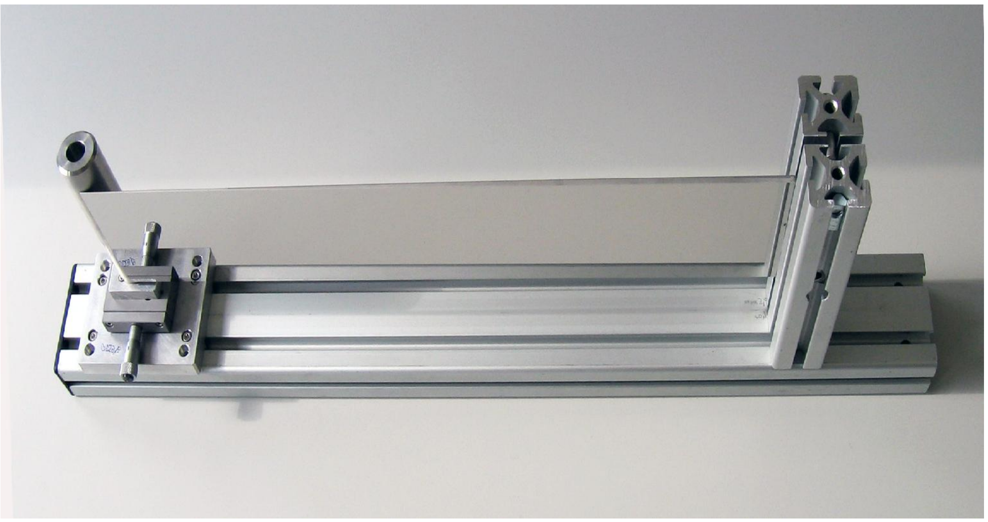
-at FRM II:
- TOFTOF
- MIRA

Development of prototype

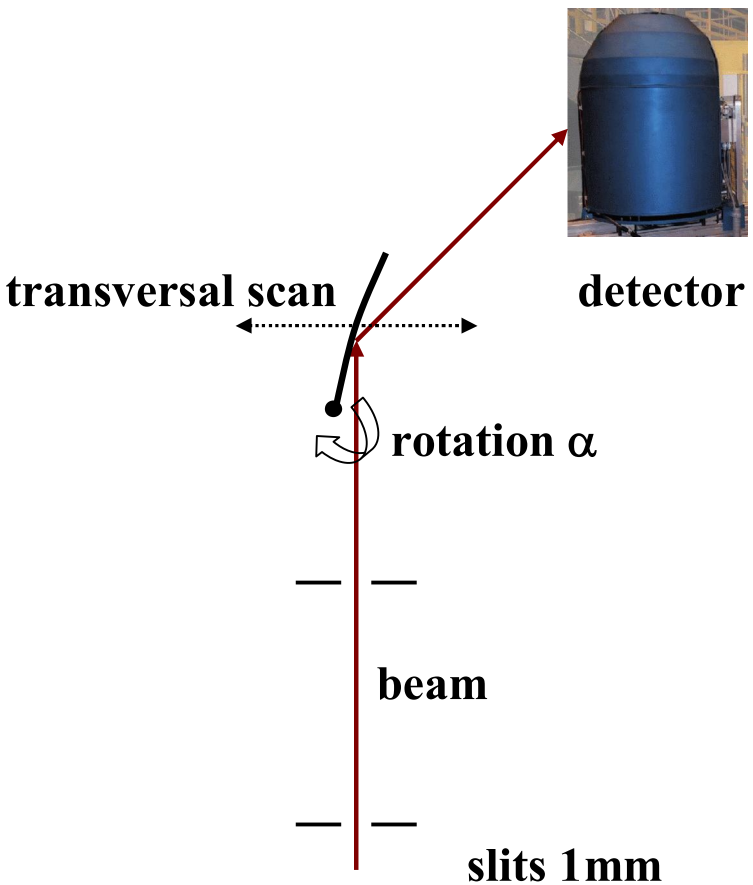


Prototype:

- coating on one side
- one point to press
- defined curvature



Experiment: Beam line Morpheus @ SINQ



Parallel beam: 1mm slits

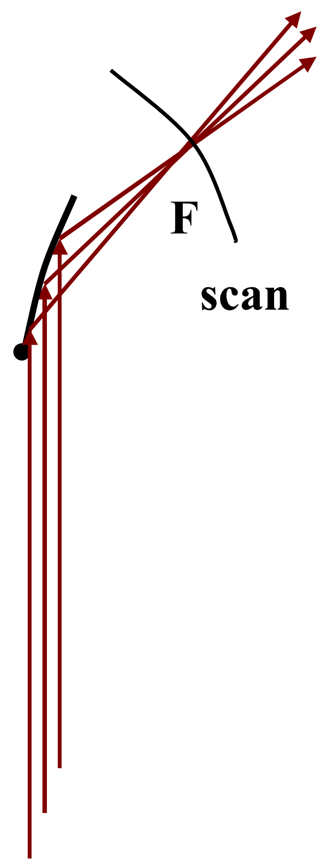
Rotation angle of mirror: 0 - 1.2 deg

2θ-scan: 0 - 3 deg

Detector at 230 mm from mirror

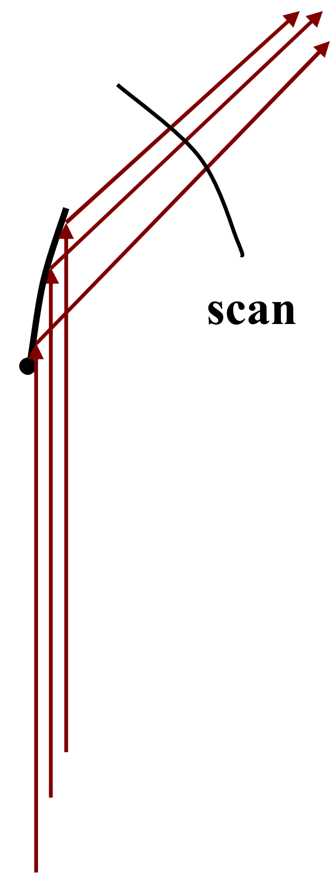
Experimental setup

rotation α do match movement x



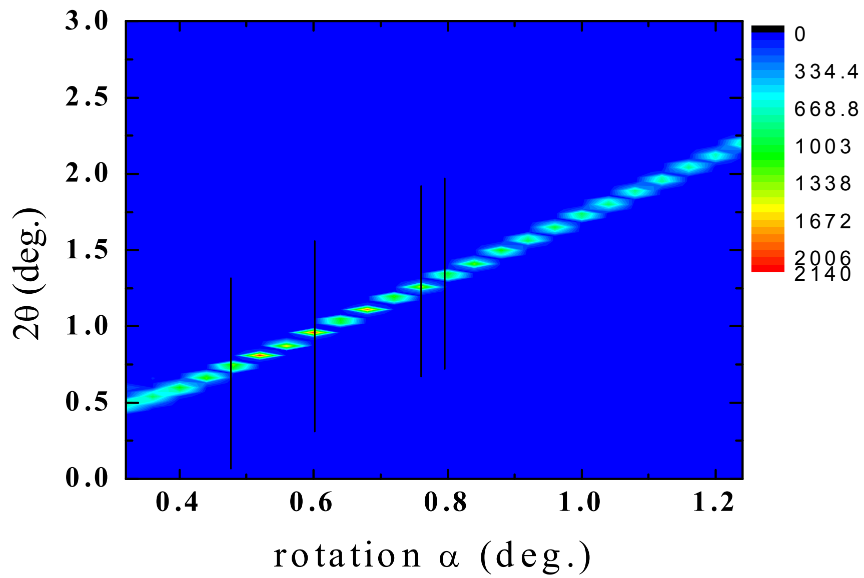
for different translation reflected beams appear at the same position on detector

rotation α do not match movement x

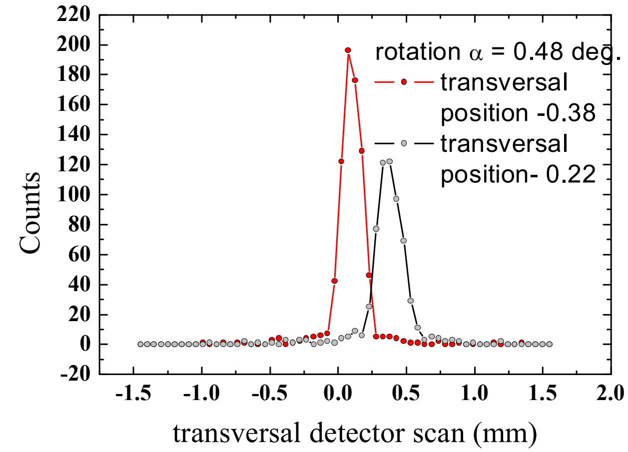


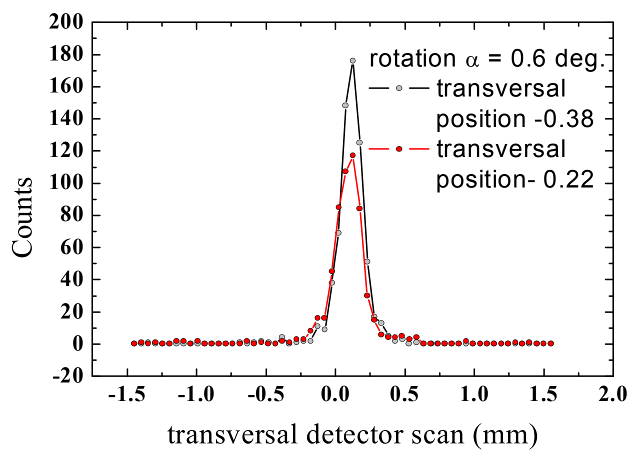
for different translation reflected beams appear at different position on detector

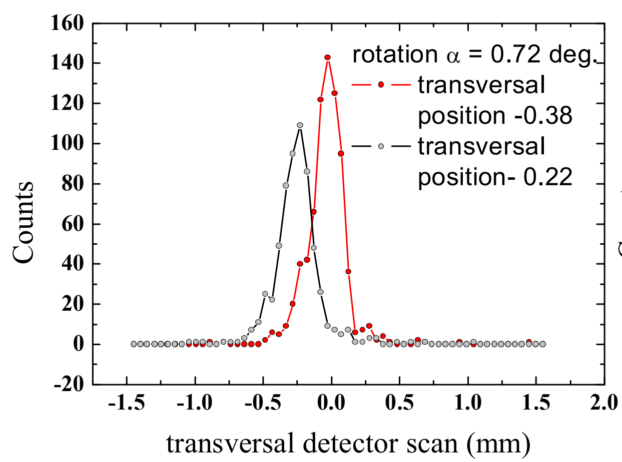
Experimental results

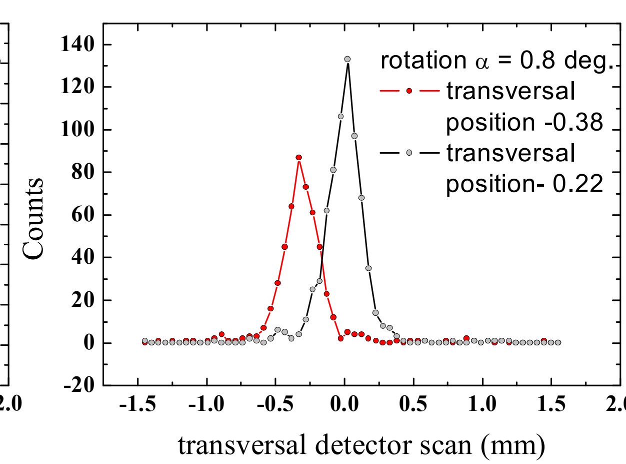


rotation matches x-shift of 2 mm
for rotation angle 0.6 deg







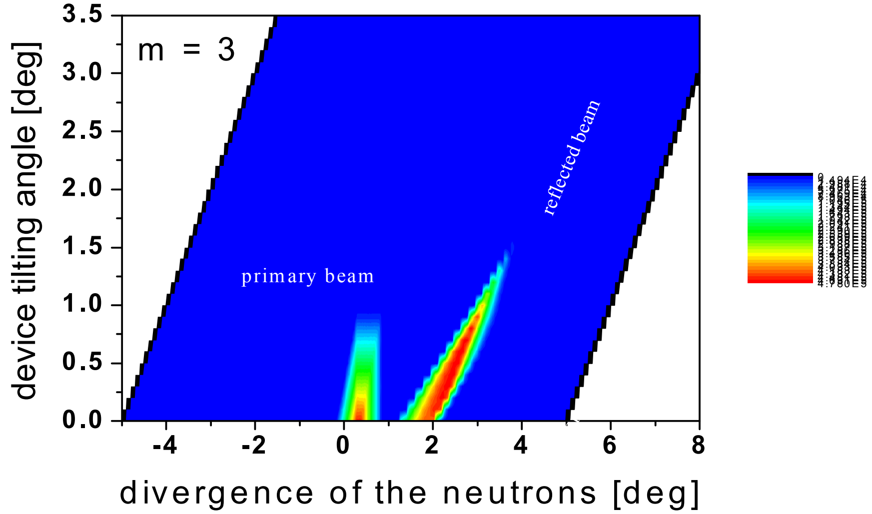


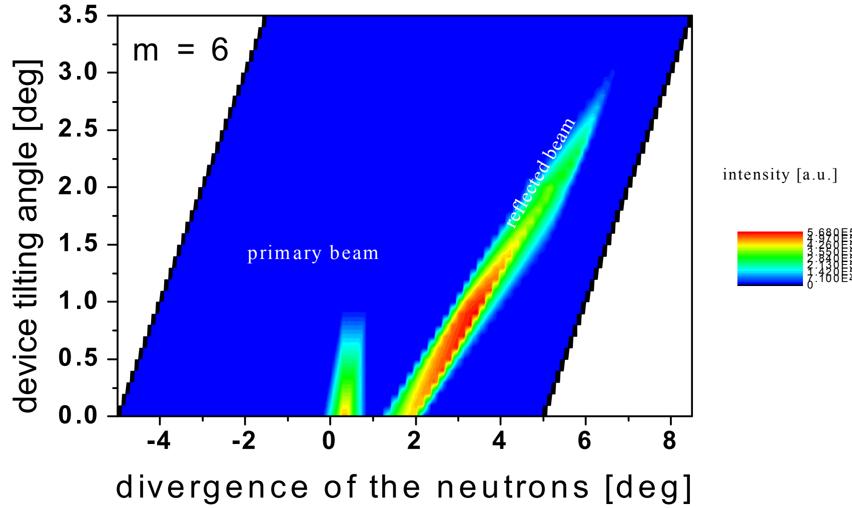
Conclusions: - one focal point observed
- the parabolic shape confirmed

Possible aplications

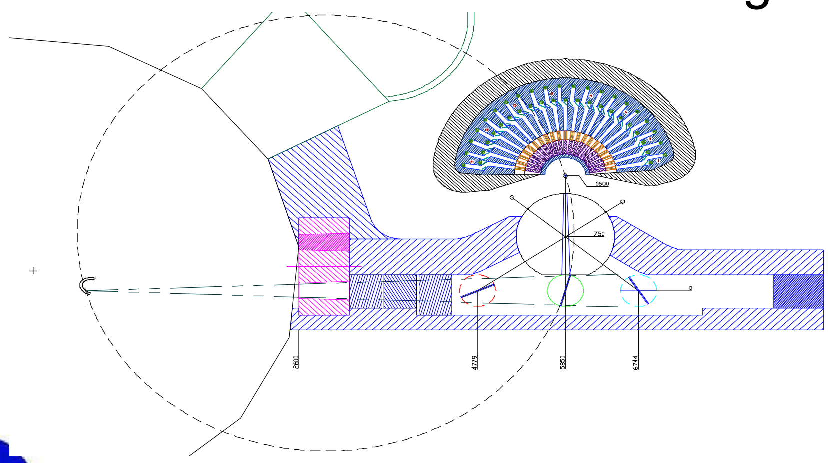
• bend beam away from primary beam by tilting component

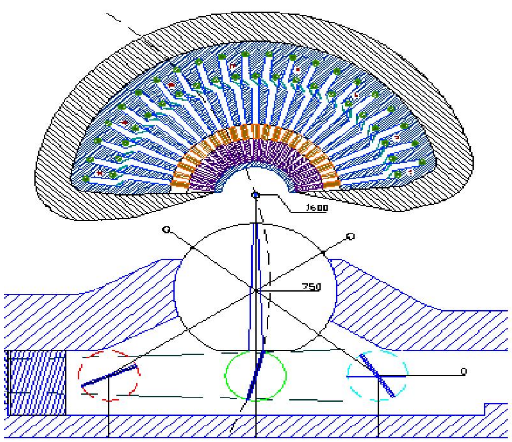
f_{out} = 0.3m, length = 0.5m, m = 3 and 6, d=1m





•MACS beamline at NIST – re-design of focusing linearly tapered guide





Tasks

Achieved

- Monte-Carlo simulations
- Assess of actuator performance
- Design of a device
- Construction of a demonstration and test device

To come

- Test and qualification of the test device
- Fabrication of device
- Programming the software for operation
- Setting up on spectrometer

Acknowledgements

nmi3

MaNEP
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Matériaux aux propriétés
électroniques exceptionnelles