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study on a focusing, low-background neutron delivery system

approach:

define the beam, starting at the sample, by:

– size at the sample position

– divergence

– wavelength, $\Delta\lambda/\lambda$

and avoid everything else!

small samples (i.e. in the mm^2, mm^3 range)

focusing

low-background

filtering / beam-profiling far from the sample define the beam, starting at the sample

derivation of the beam line lay-out

- shading optics
- focusing optics

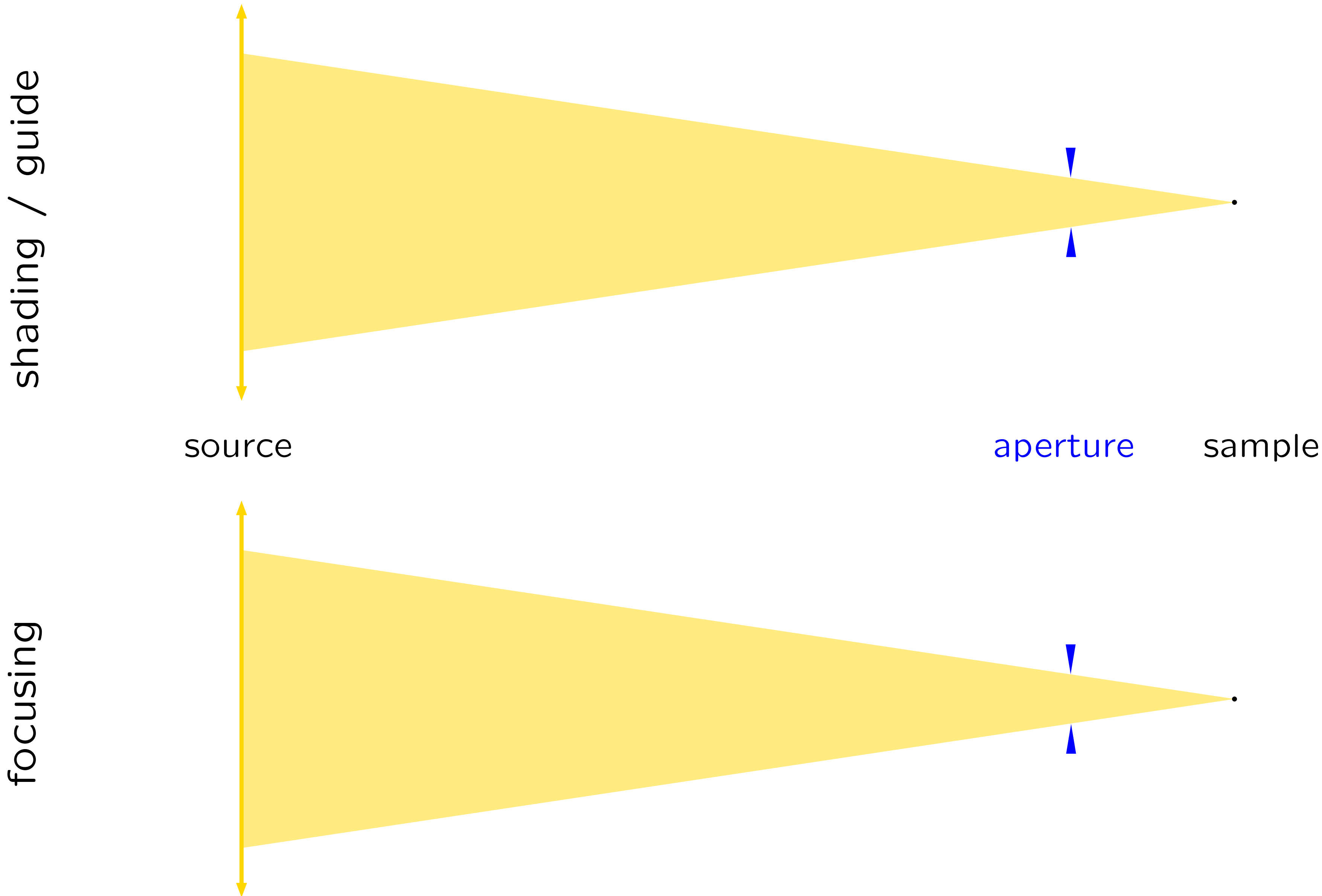
→ phase space

application to a reflectometer

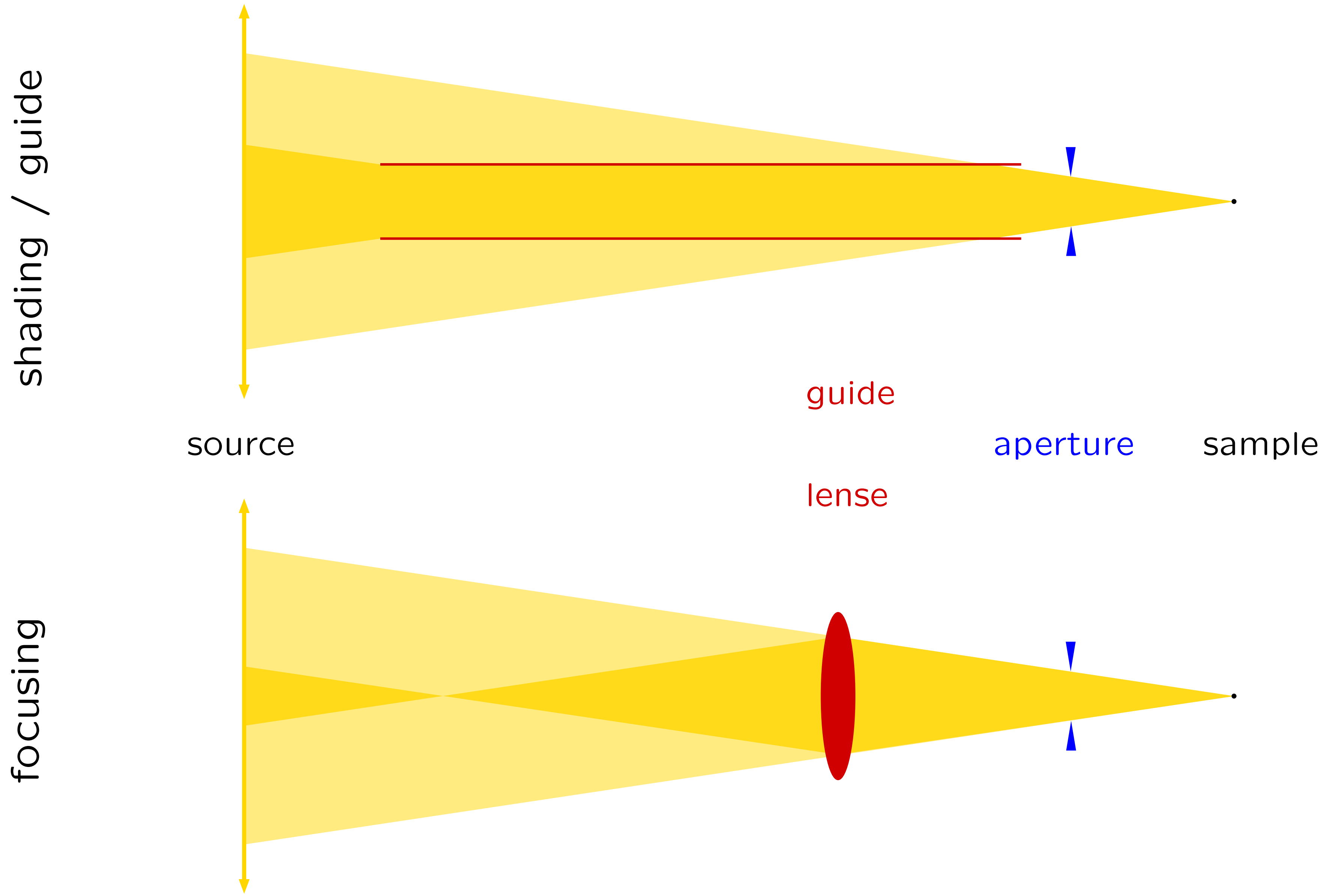
McStas simulations on the performance

extention to diffraction / spectroscopy

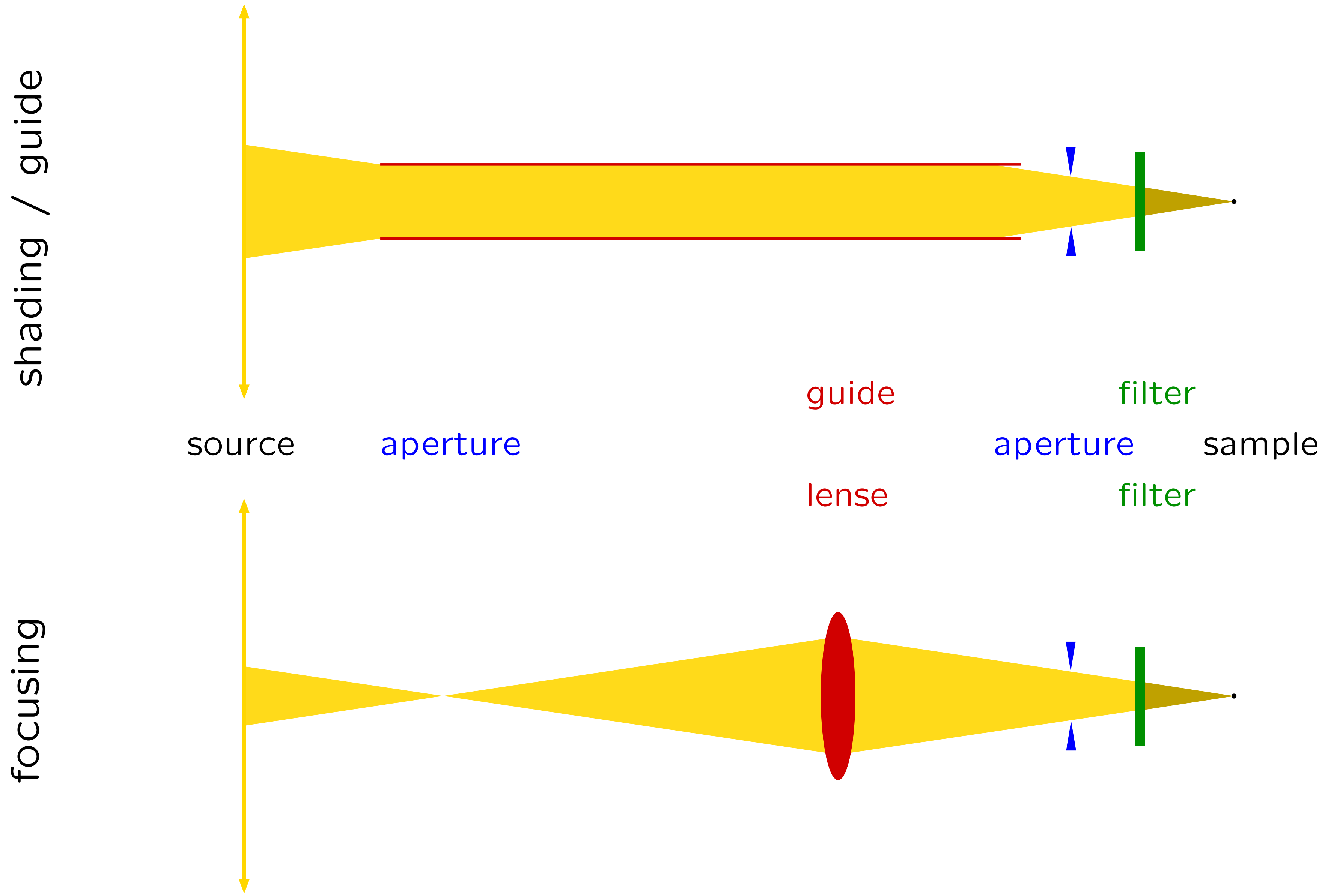
beam defined by • required beam divergence



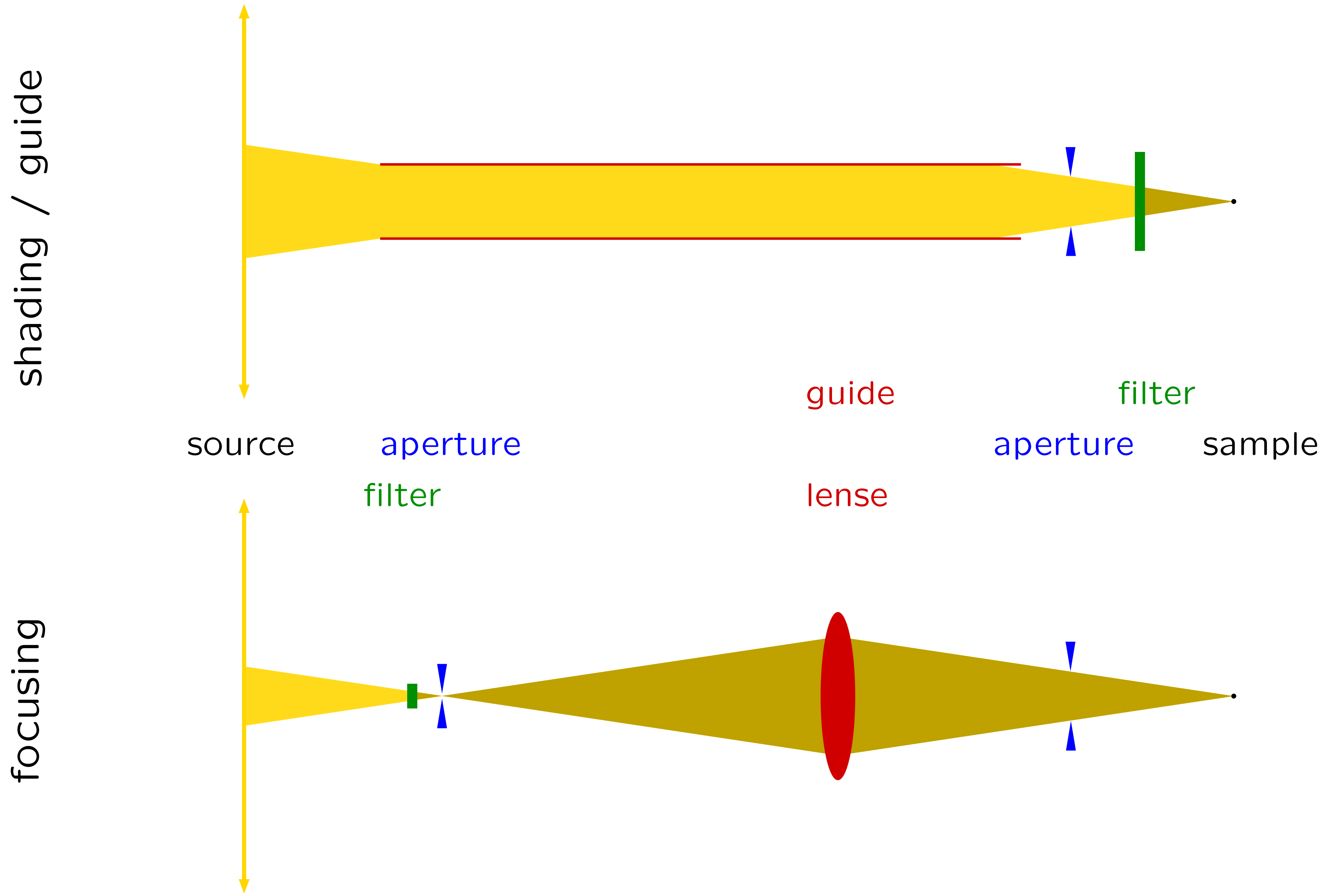
beam defined by • finite source size



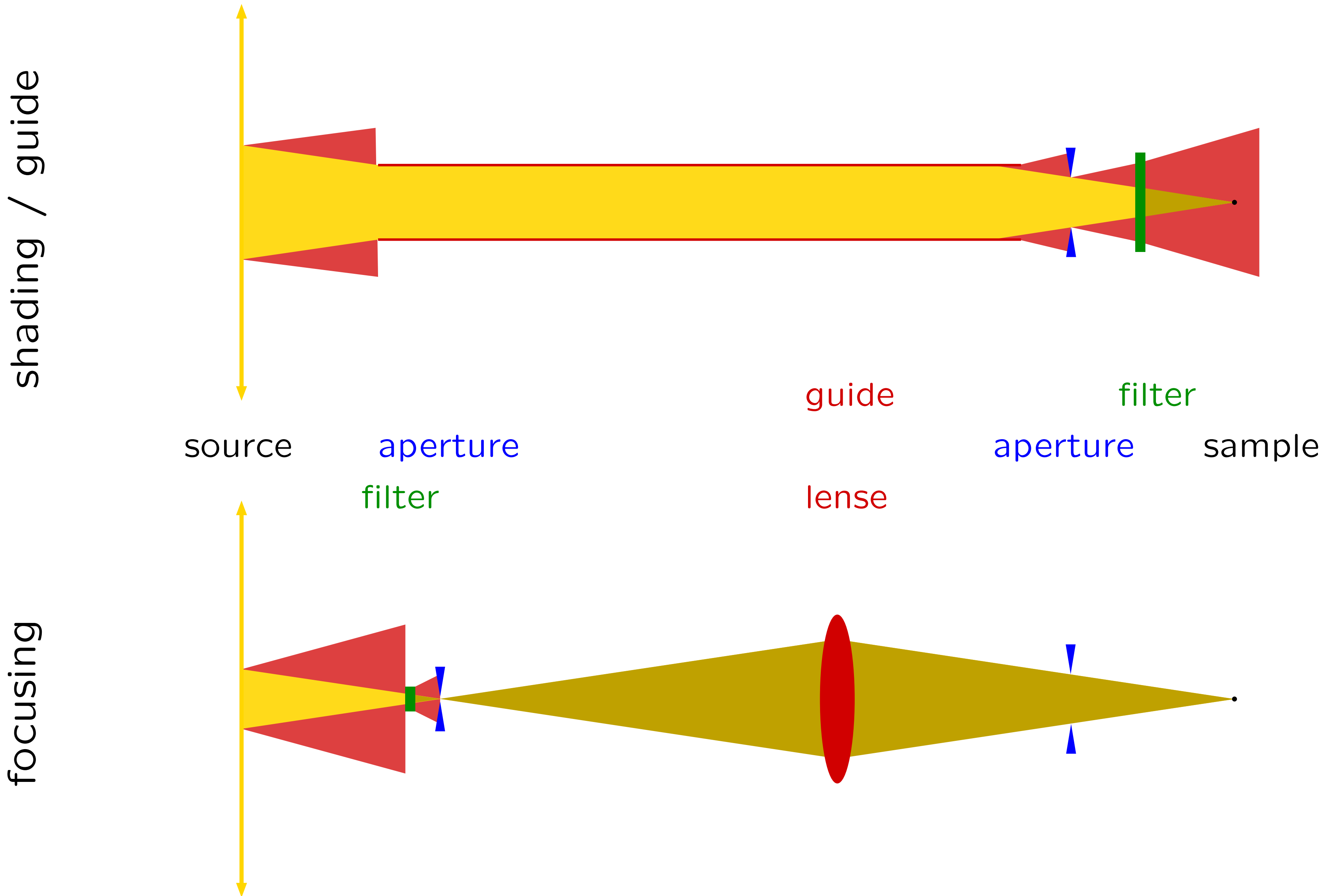
beam defined by • filtering (polarisation / monochromatisation)



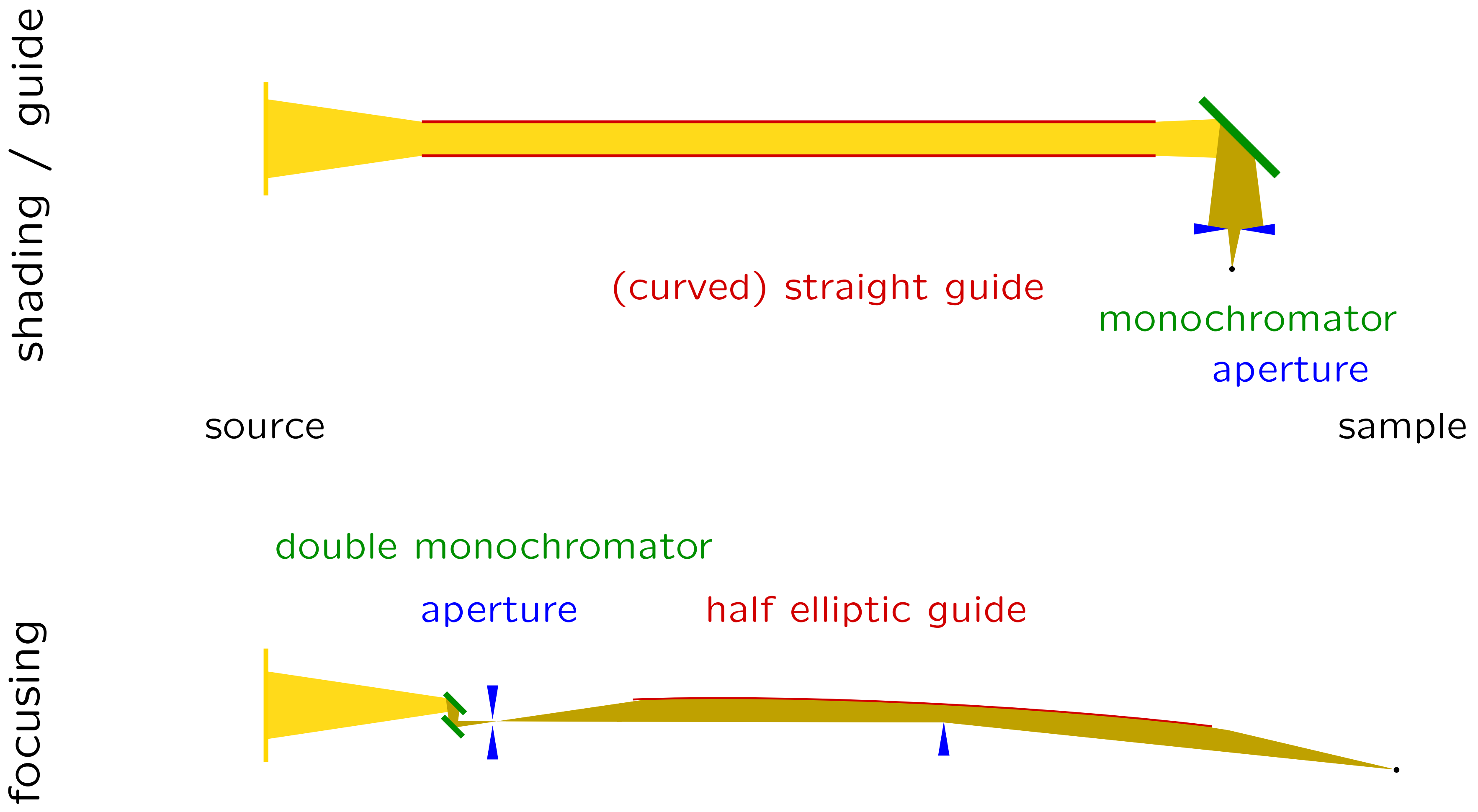
beam defined by • background / radiation issues



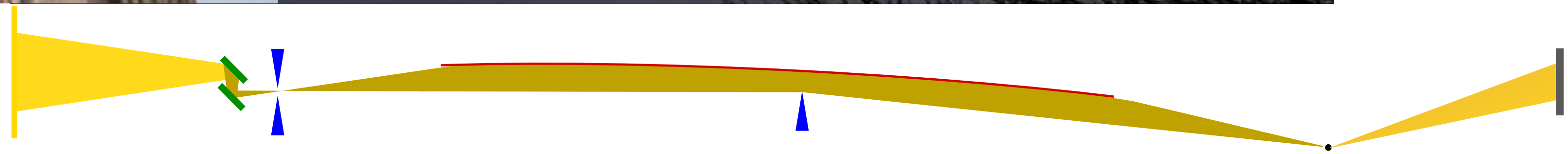
background / radiation issues



realisation



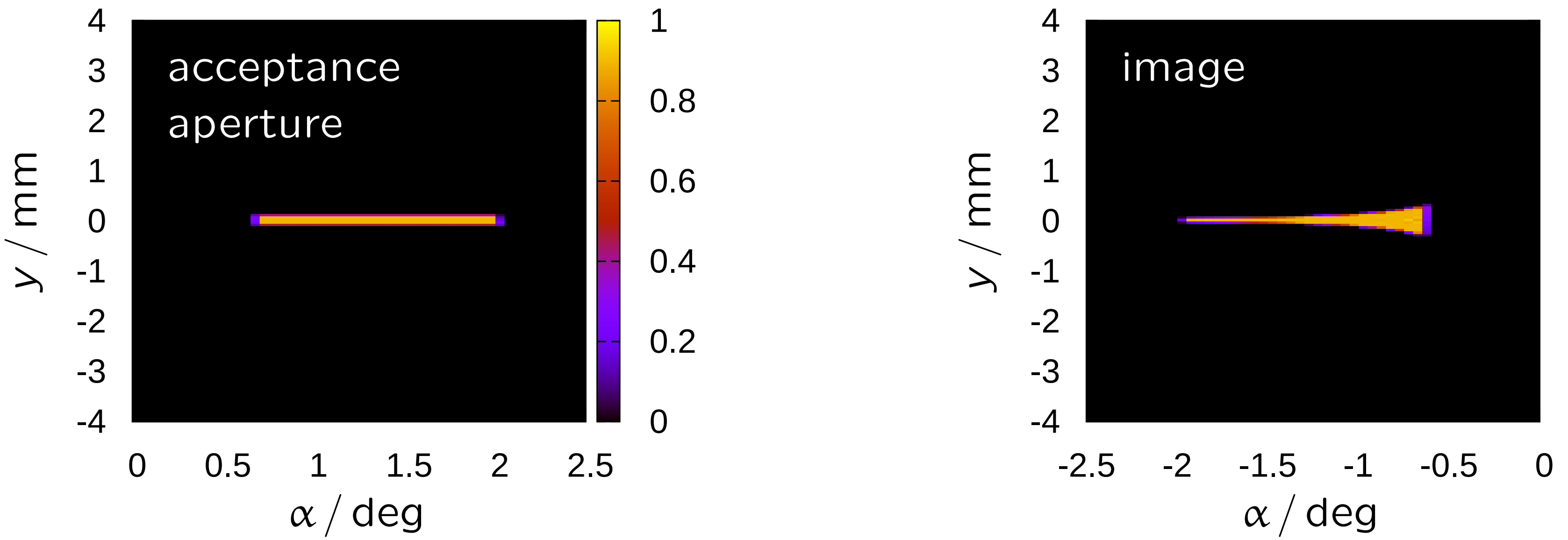

selene
titan goddess of the moon



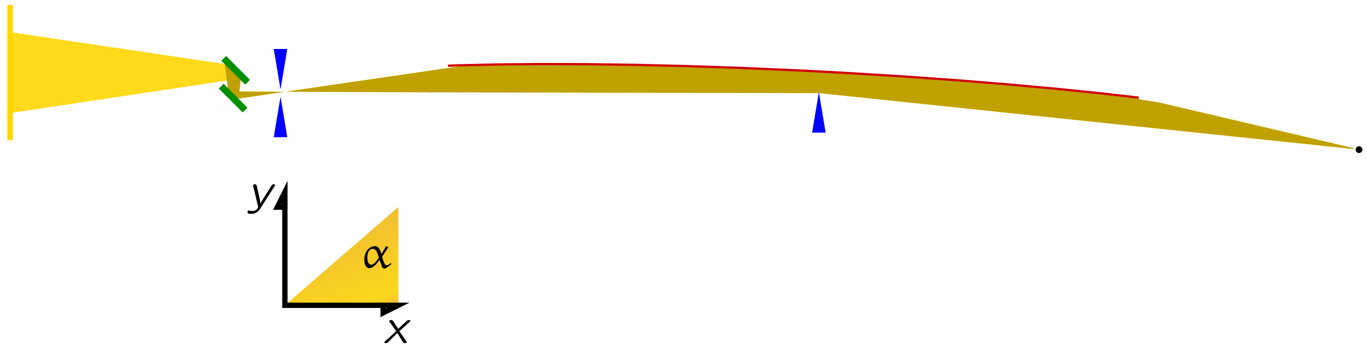
what happens to phase space?

better: what happens with the divergence?

slit: high emmittance
aperture = 0.2 mm



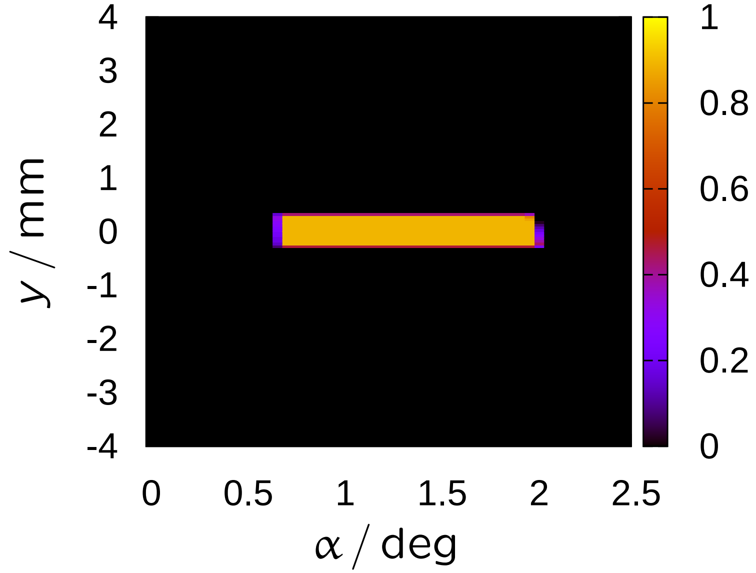
focusing

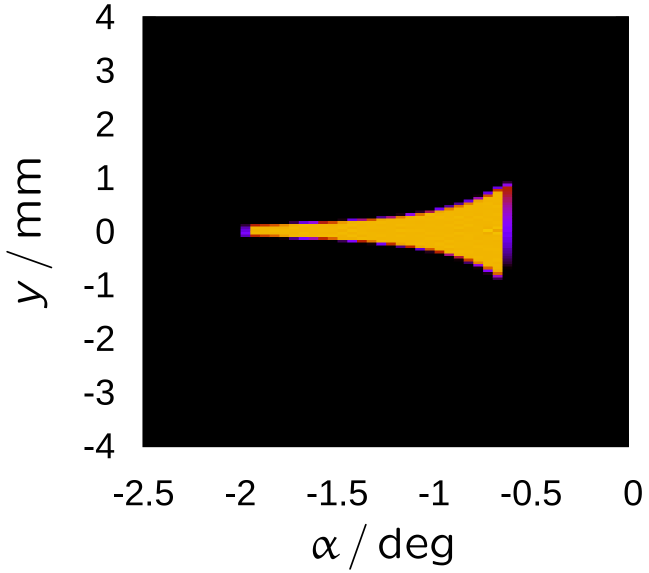


what happens to phase space?

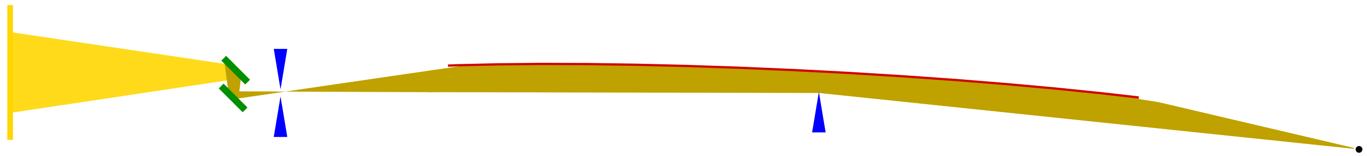
better: what happens with the divergence?

slit: high emmittance
aperture = 0.6 mm





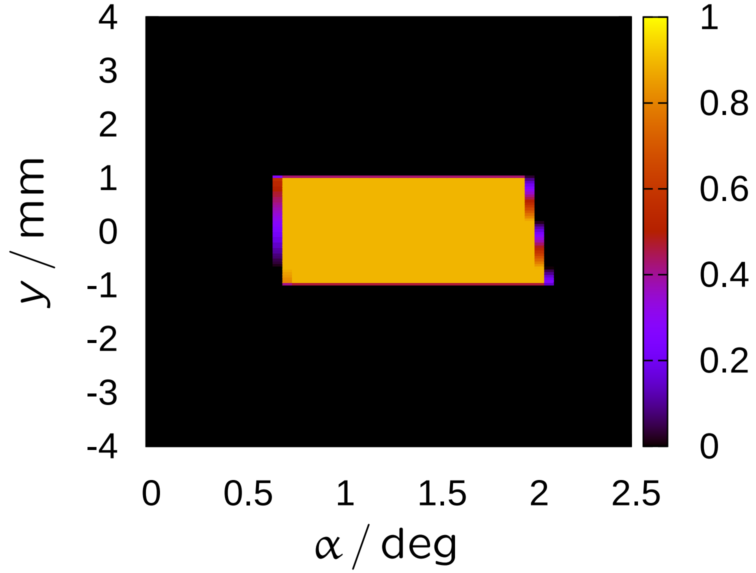
focusing

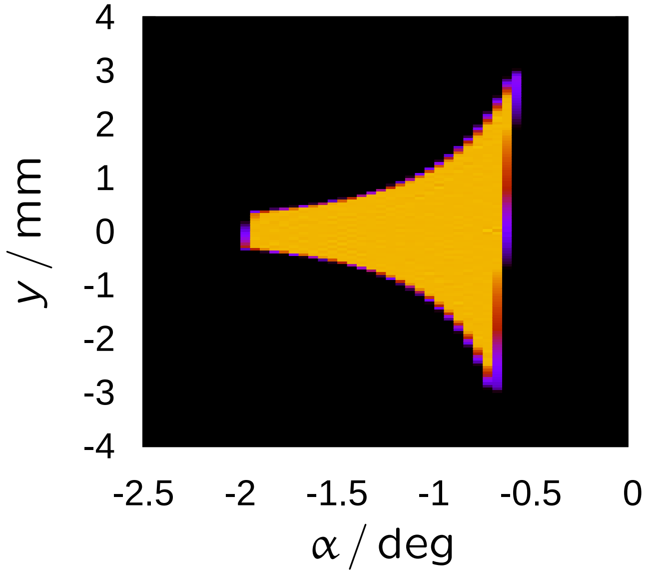


what happens to phase space?

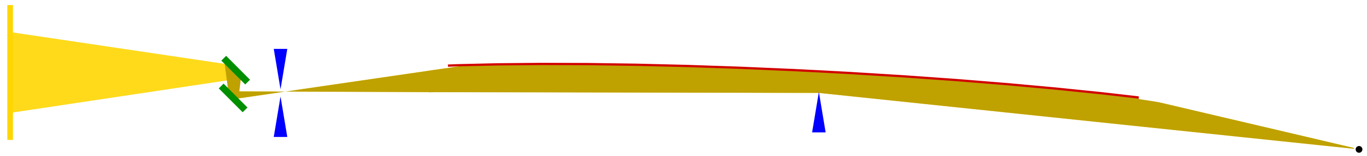
better: what happens with the divergence?

slit: high emmittance
aperture = 2.0 mm





focusing

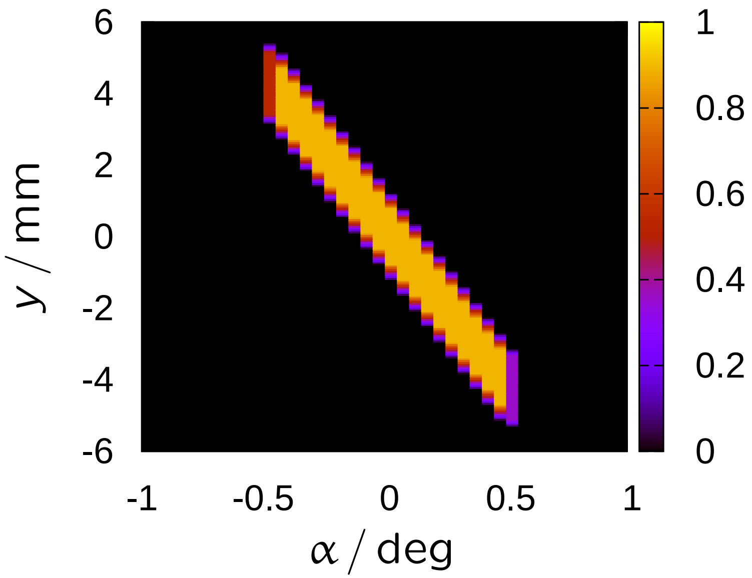


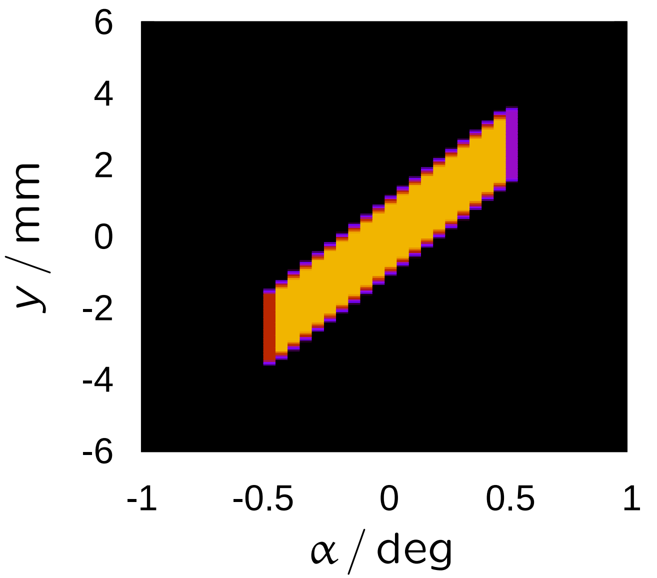
⇒ a *nice* phase space element requires a sample aperture

what happens to phase space?

comparison to a straight guide / diaphragm set-up

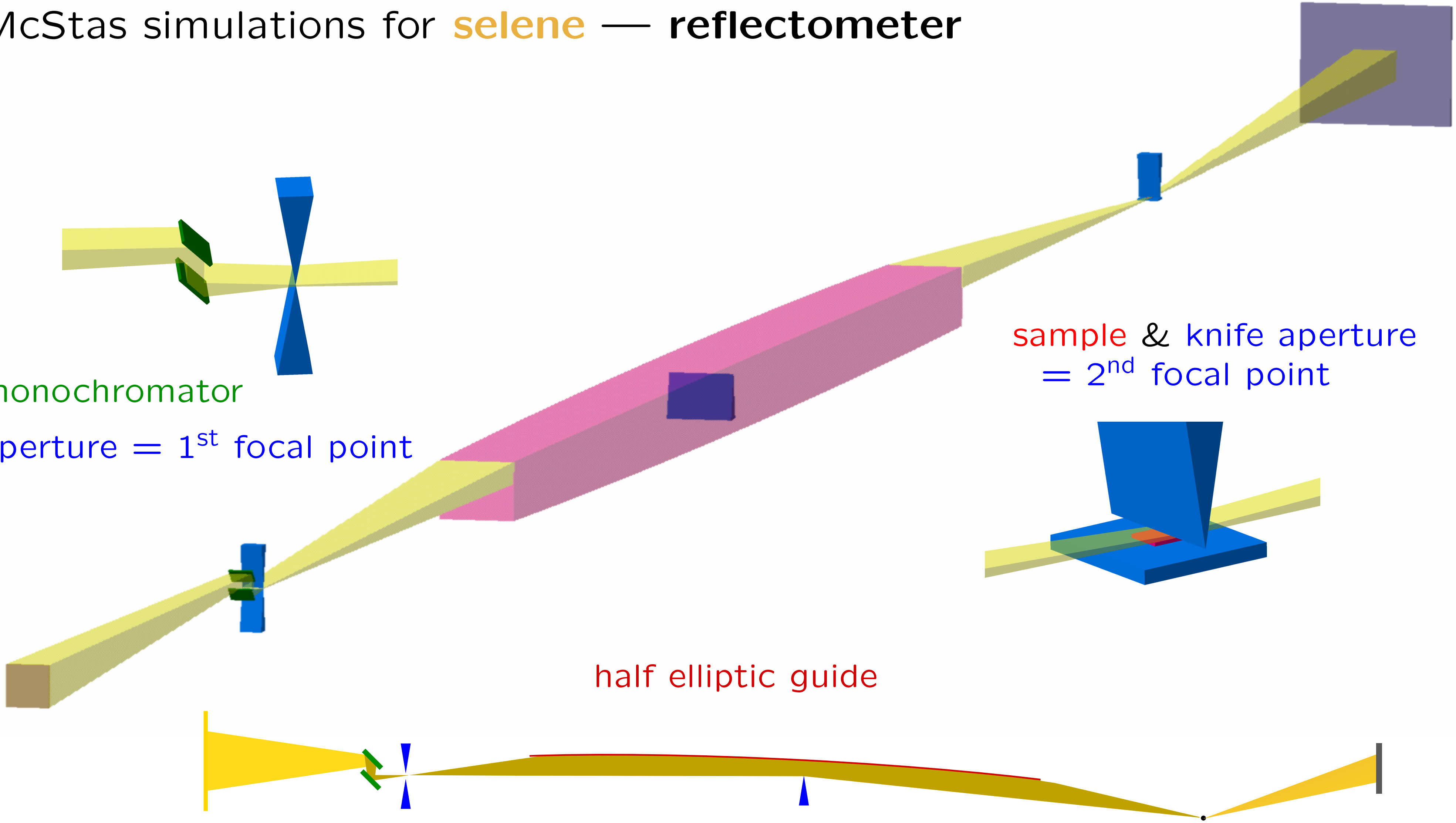
guide: emmittance $= \pm 0.5^\circ$
slit: aperture $= 2.0\,\text{mm}$





shading

McStas simulations for selene — **reflectometer**



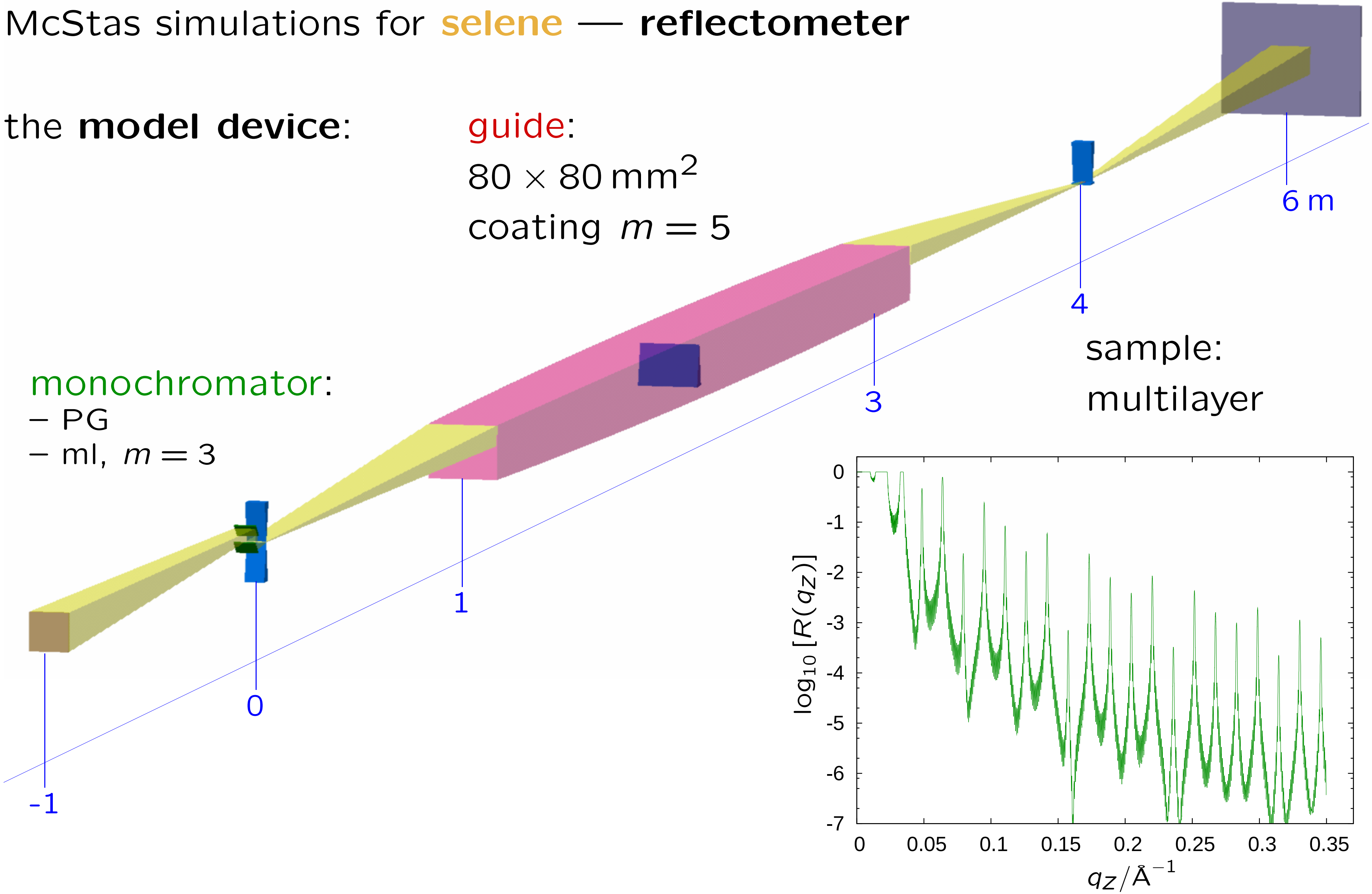
McStas simulations for selene — reflectometer

the **model device**:

guide:
$80 \times 80\,\text{mm}^2$
coating $m = 5$

monochromator:
– PG
– ml, $m = 3$

sample:
multilayer



new **McStas component**

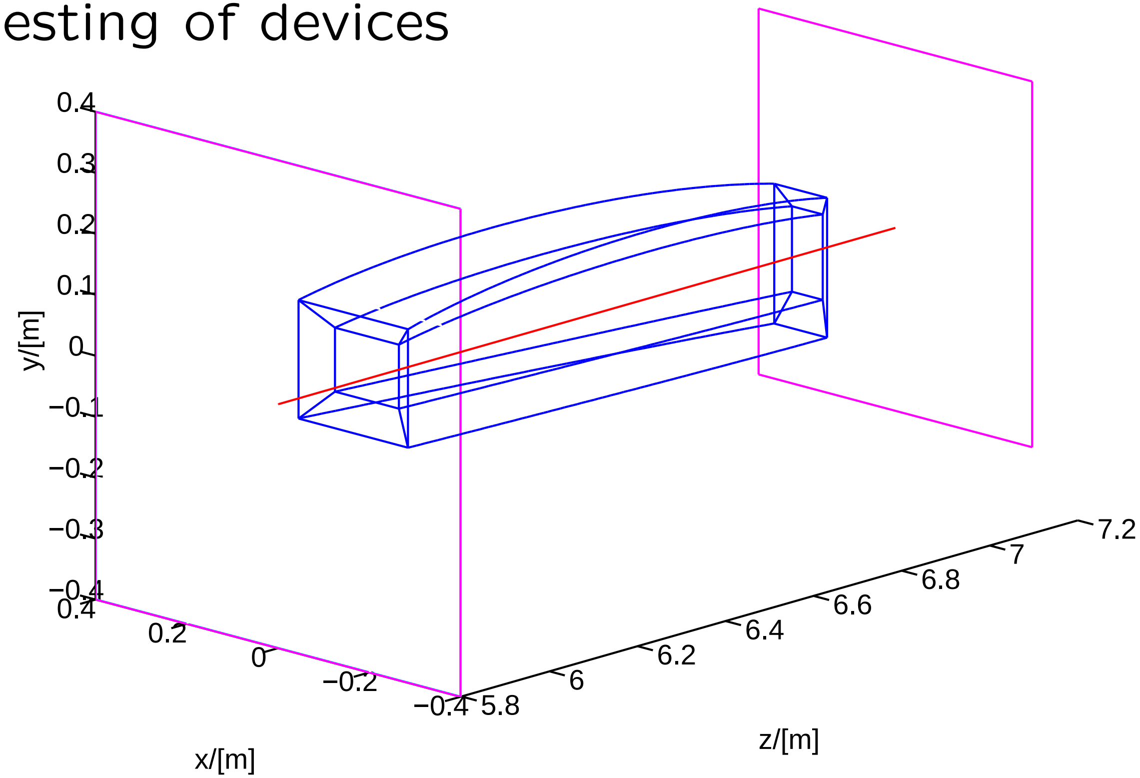
– true curvature

– all surfaces with individual properties

– individual shapes

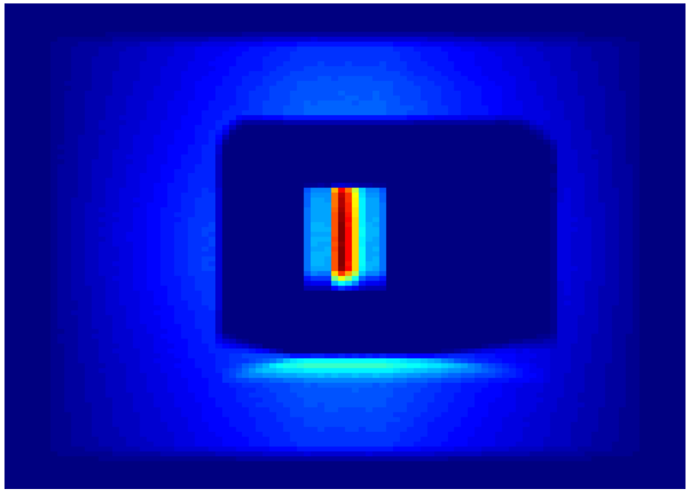
– neutrons can pass by

– nesting of devices

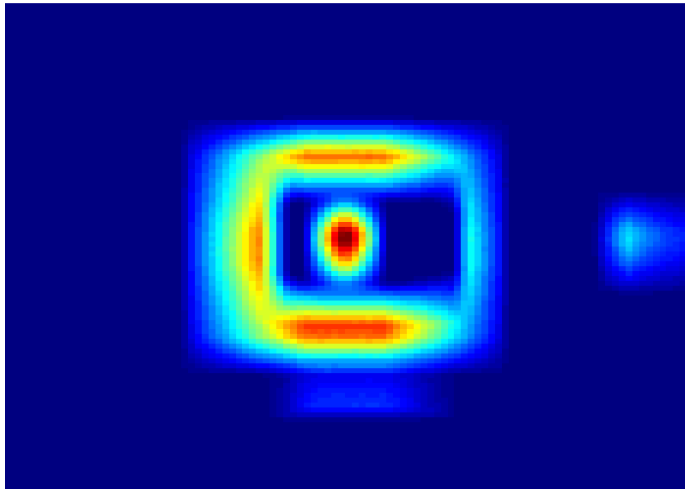


to come:

– off-specular reflectivity



position monitor



divergence monitor

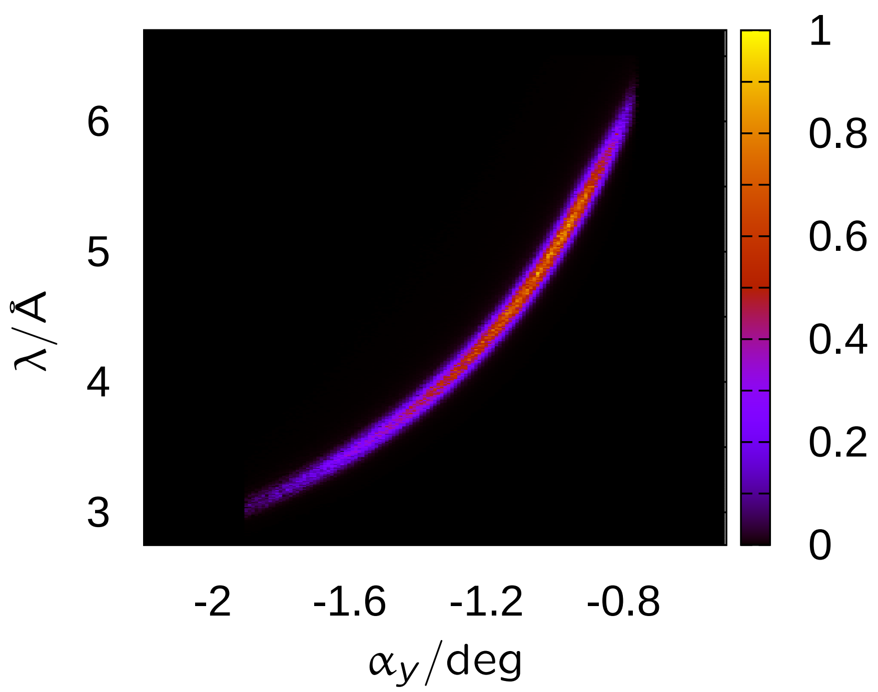
McStas simulations for selene — **reflectometer**
using a **ml monochromator** ($m = 3$)

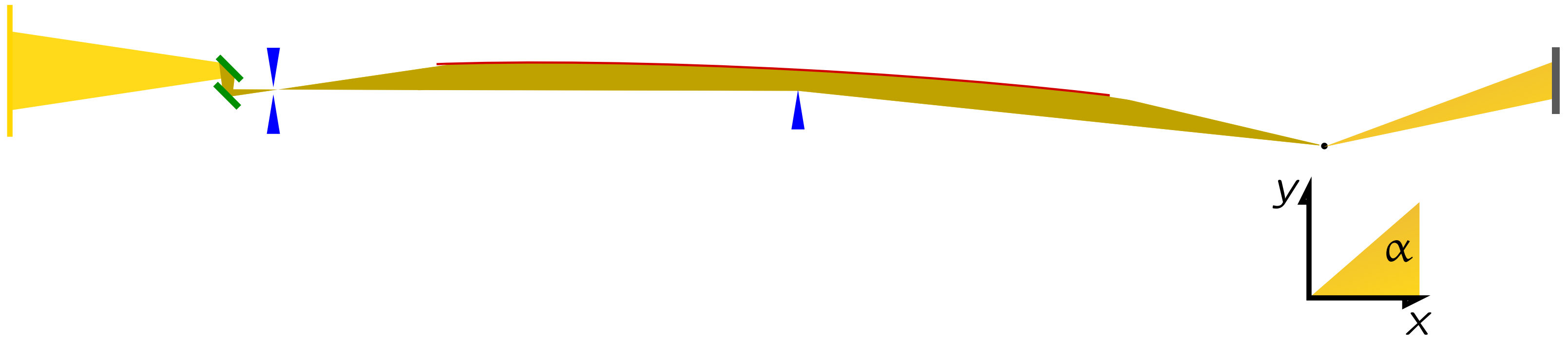
incident angle on the ml: $0 \ldots 2^\circ$

with $\lambda \propto \sin \alpha_\text{i}$

acceptance of the guide:
$\Delta\alpha = 1.3^\circ$

$\Rightarrow \lambda$ vs. incident angle at sample poaition



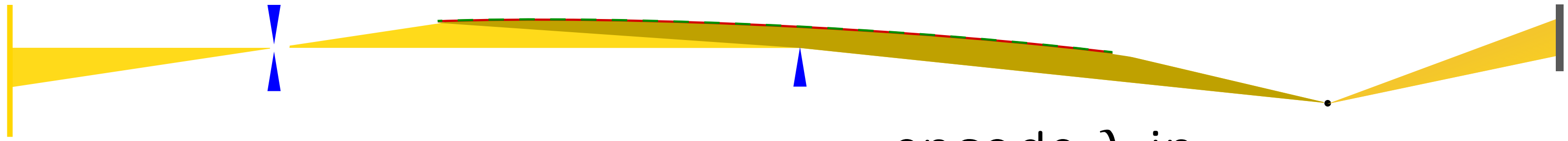


McStas simulations for selene — **reflectometer**
using a **ml monochromator** ($m = 3$)

specular reflectometer similar to the **ReFOCUS** concept by F. Ott

the elliptic guide
has a (graded)
monochromating coating

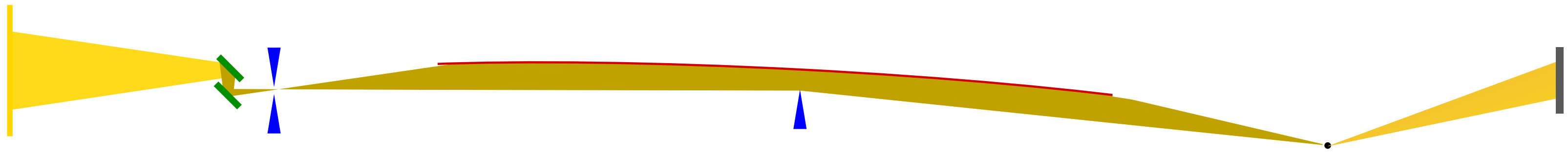
ReFOCUS



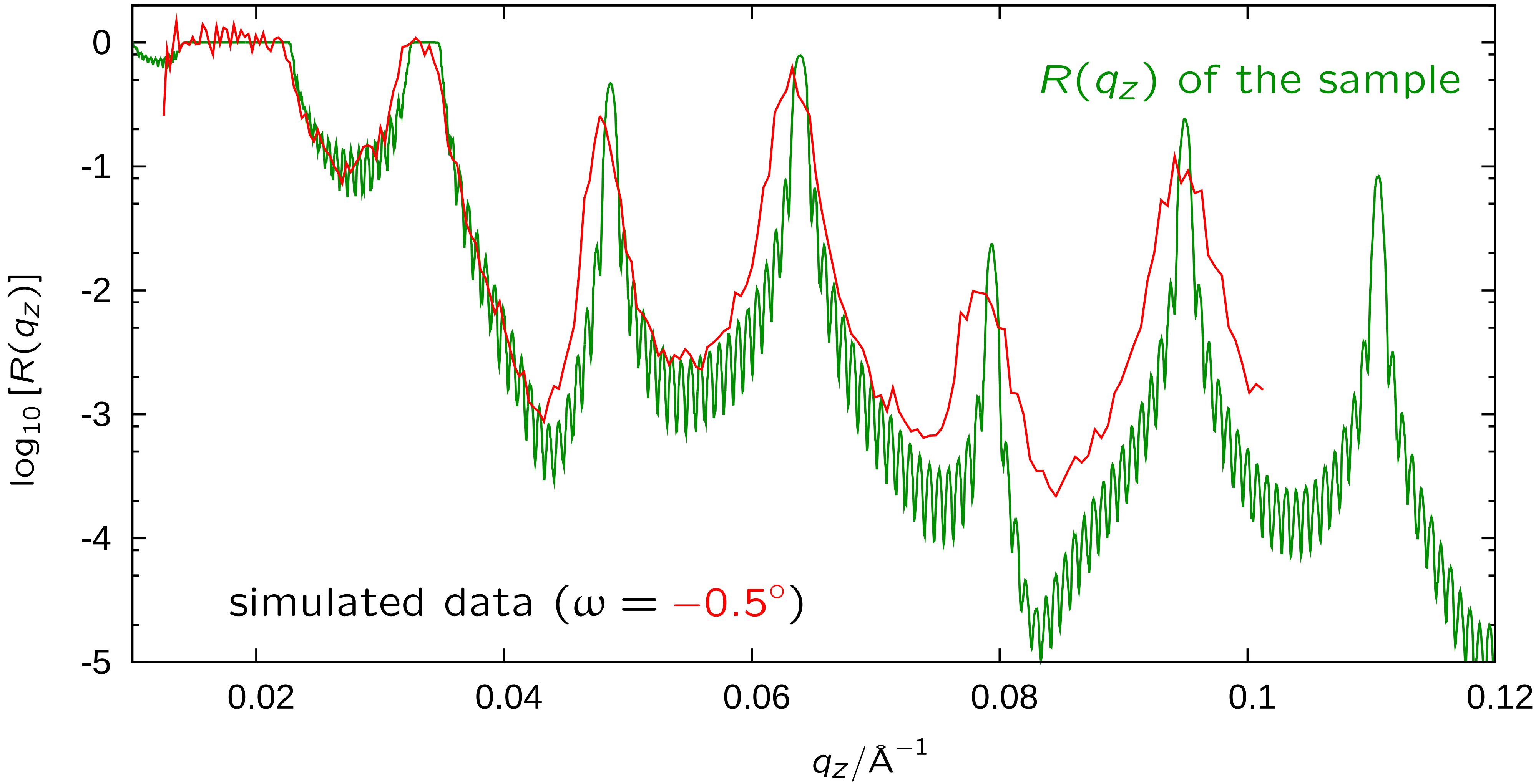
encode λ in α_i

resolve $q_z(\lambda, \alpha_i)$ with
an area detector

selene

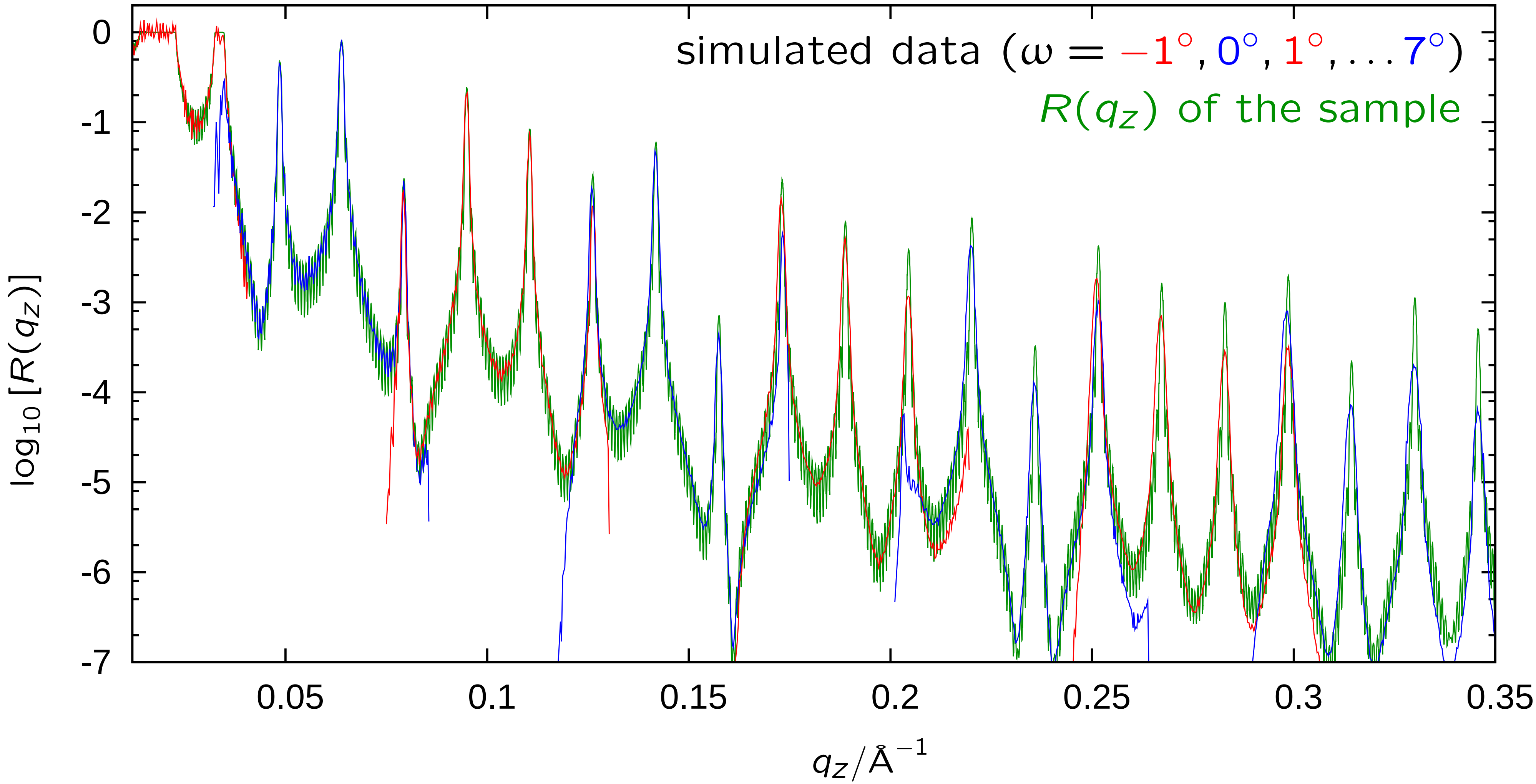


McStas simulations for selene — **reflectometer**
using a **ml monochromator** ($m = 3$)



measured with 1 angular setting, only $\Delta q_z \approx 3 \cdot 10^{-3}\,\text{Å}^{-1}$

McStas simulations for selene — **reflectometer**
using a **PG monochromator** ($\Delta\alpha = 0.16^\circ$)

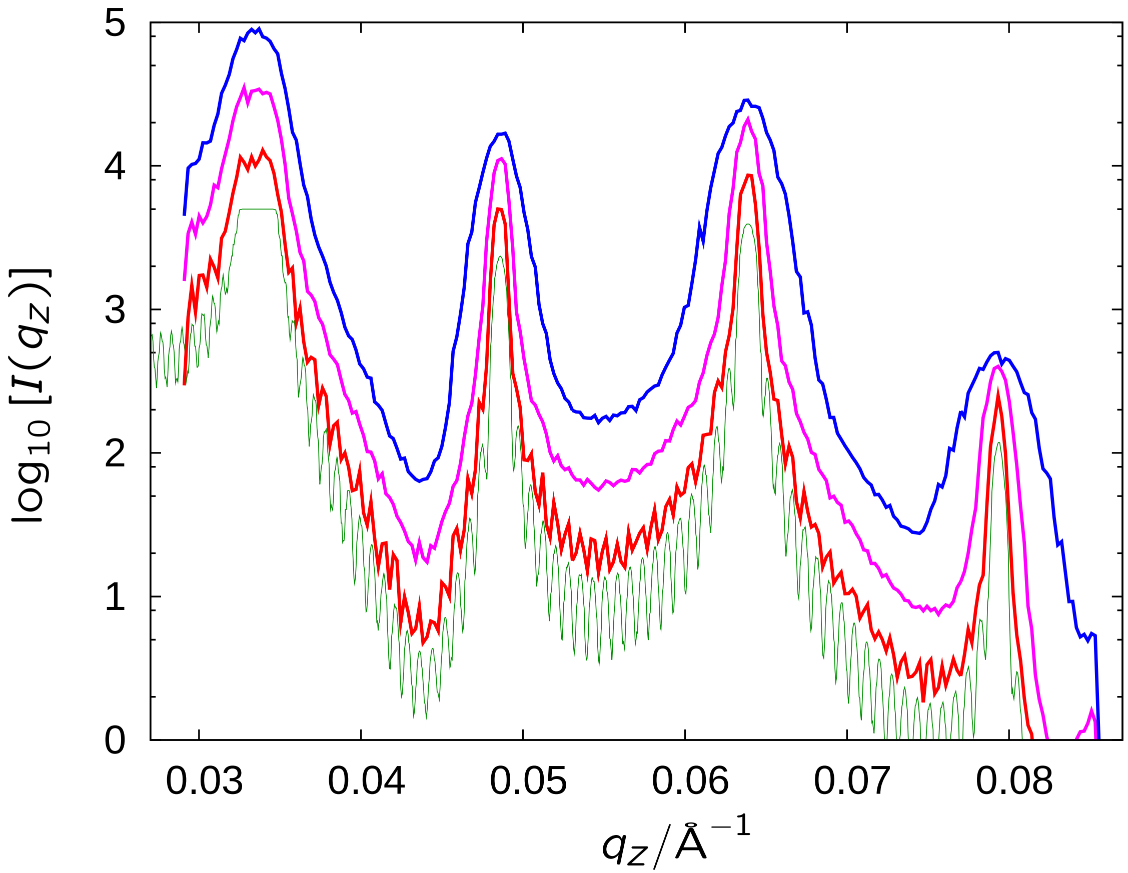


no illumination correction applied yet

McStas simulations for selene — **reflectometer**
using a **PG monochromator**

comparison: **mosaicity** of PG

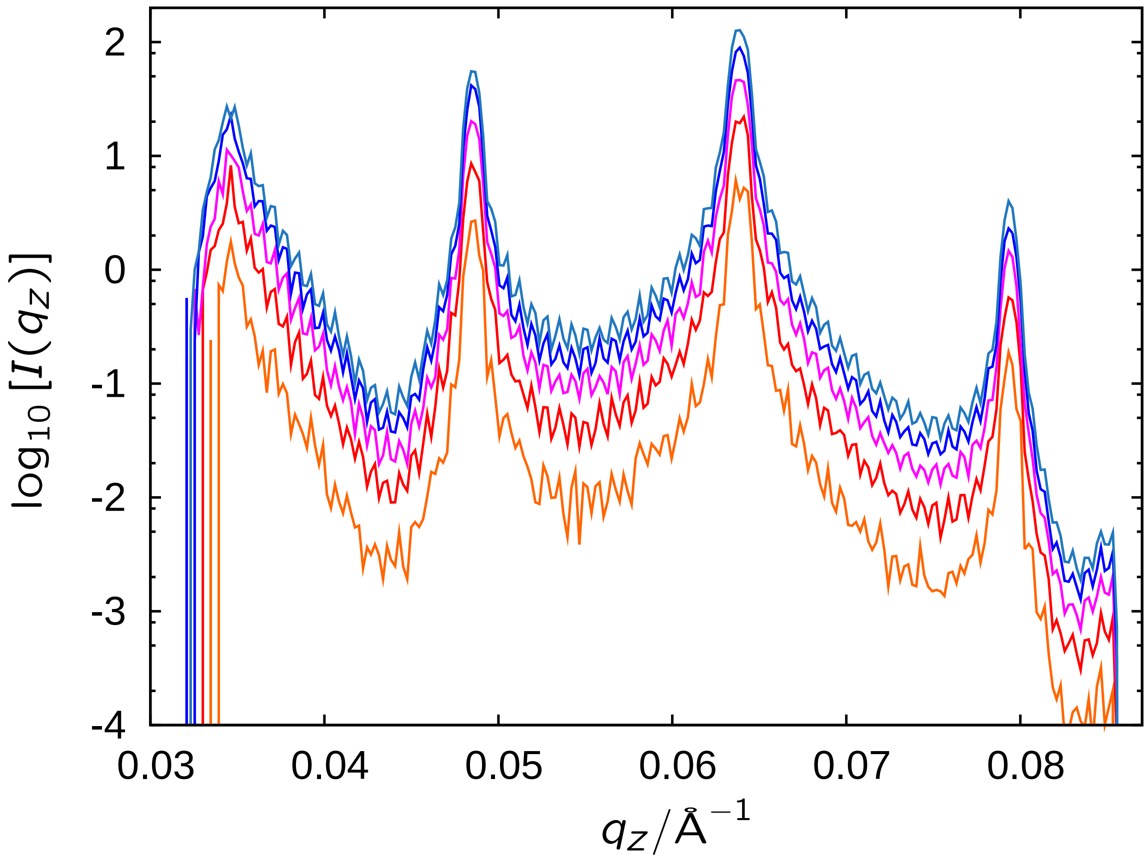
1.40°
0.50°
0.16°
sample



McStas simulations for selene — **reflectometer**
using a **PG monochromator** ($\Delta\alpha = 0.16^\circ$)

comparison: **sample sizes**

$10 \times 10\,\mathrm{mm}^2$
$8 \times 8\,\mathrm{mm}^2$
$6 \times 6\,\mathrm{mm}^2$
$4 \times 4\,\mathrm{mm}^2$
$2 \times 2\,\mathrm{mm}^2$

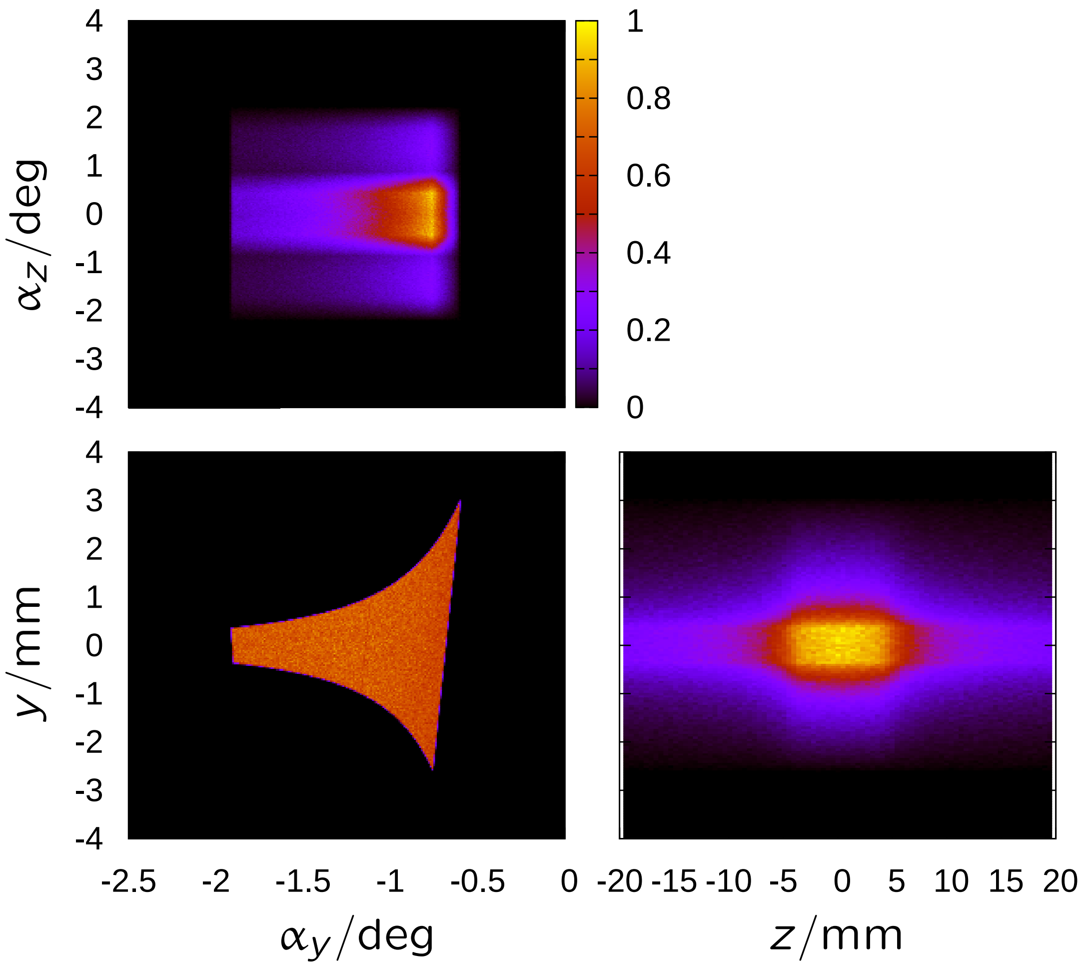


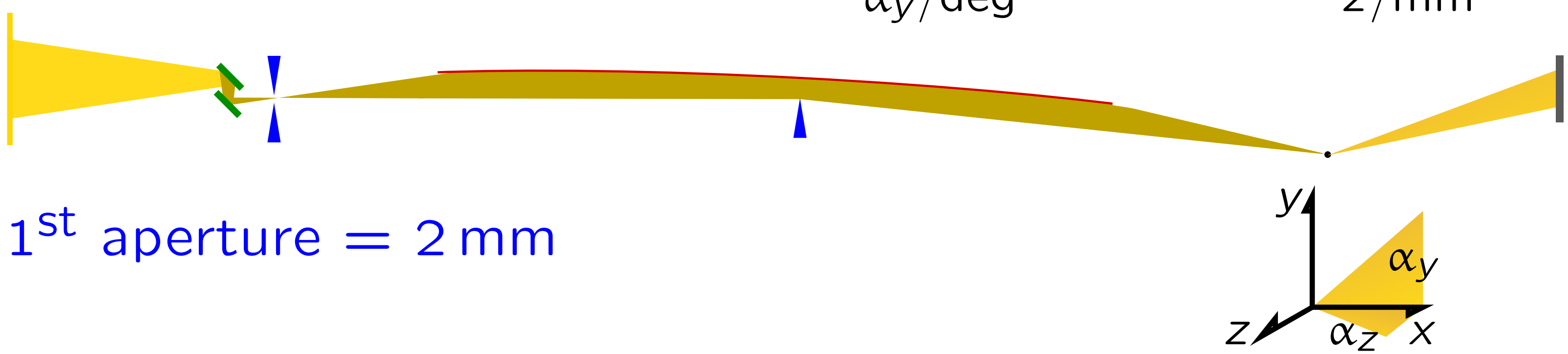
McStas simulations for **selene**

— **diffractometer**

using a **PG monochromator**

($\Delta\alpha = 0.5^\circ$)

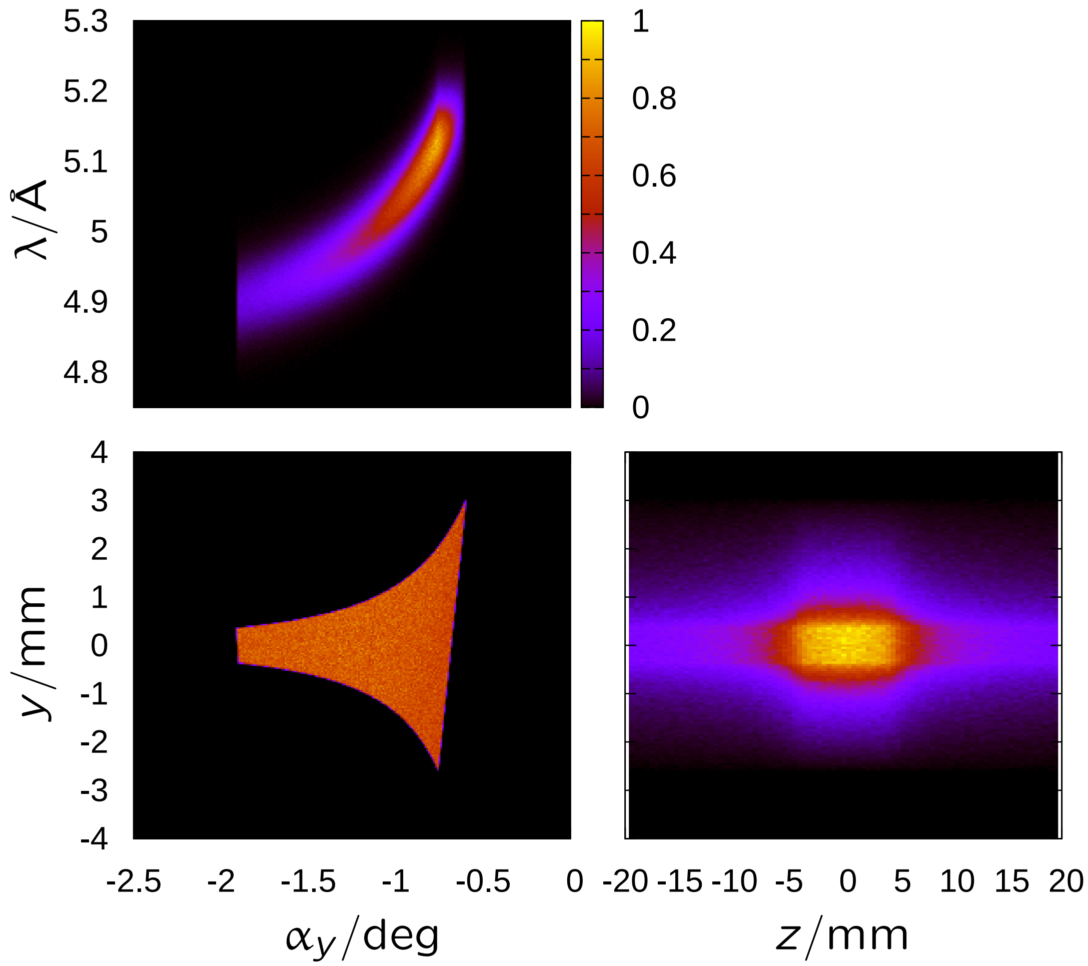


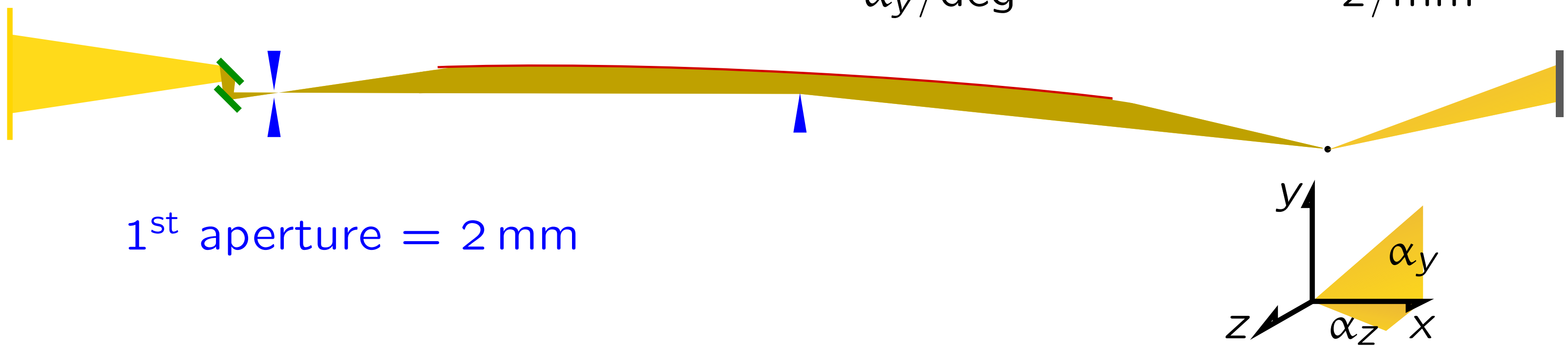


1st aperture = 2 mm

McStas simulations for **selene** — **diffractometer**

using a **PG monochromator** ($\Delta\alpha = 0.5°$)

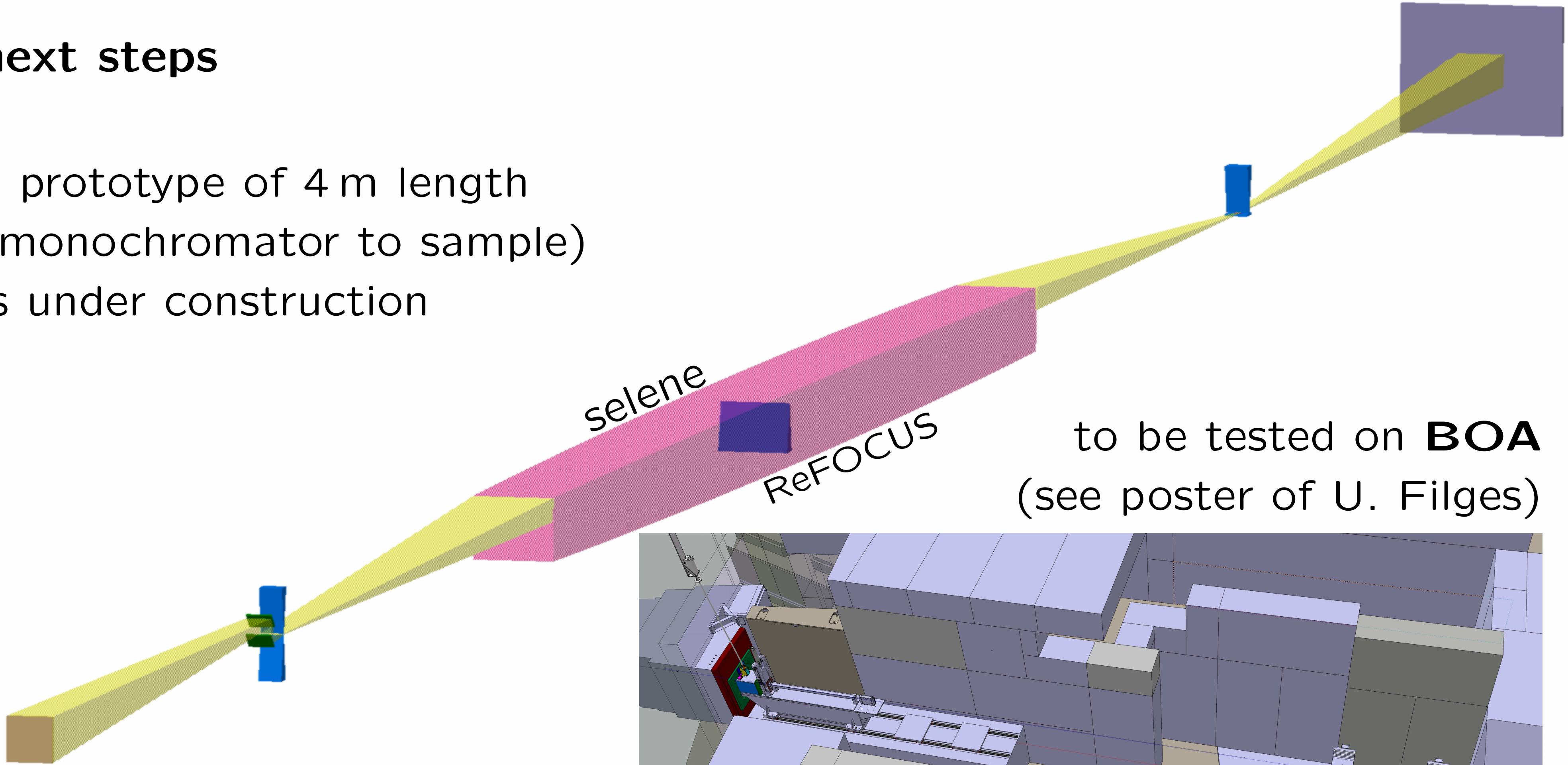




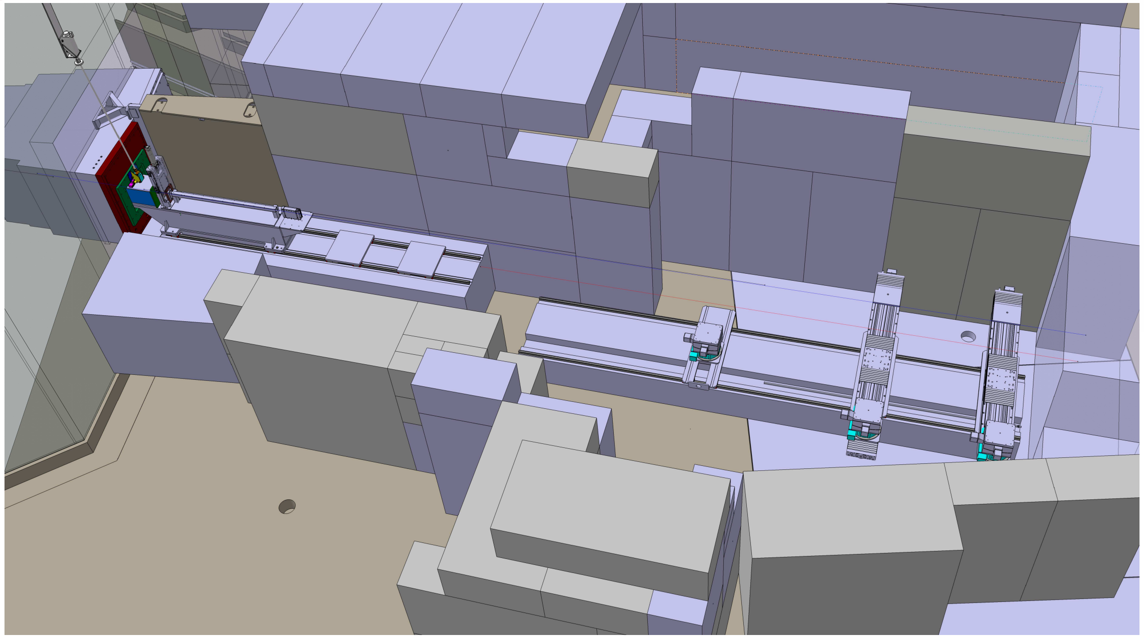
1^{st} aperture $= 2\,$mm

next steps

a prototype of 4 m length
(monochromator to sample)
is under construction



to be tested on **BOA**
(see poster of U. Filges)



to be used on AMOR

replacement of the guide of e.g. RITA II, SINQ

– old insert / first part of the straight guide can be reused

– monochromator in the 1st part of guide bunker

– guide ends within guide bunker

⇒ fixed sample position

⇒ large 2θ-range accessible

filter first:

+ reduction of radiation entering the guide to $< 1\%$
+ reduced n-background: saves shielding material
+ reduced radiation level: saves life!

○ no gain in flux!

– mechanical parts close to source

focusing guide:

+ reduces illumination of sample sourroundings
+ no direct view to source
+ allows for small monochromators ...

○ no gain in flux!

+ allows for q_z/α_f encoding

– asymetric phase space element
– does not work for *large* samples

thanks to

T. Panzer and U. Filges
for the McStas programmig and simulation work

C. Marcelot and L. Holitzner
for support in the test and design process

F. Ott
for the ReFOCUS concept — which triggered this work

P. Böni, U. Stuhr and C. Niedermayer
for long discussions

nmi3, MaNEP, SNF and SwissNeutronics
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YOU