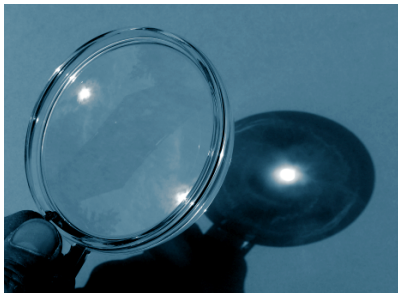
PAUL SCHERRER INSTITUT

Jochen Stahn Laboratory for Neutron Scattering



Estia focusing reflectometer

lay-out

beam extraction

shielding and

optics

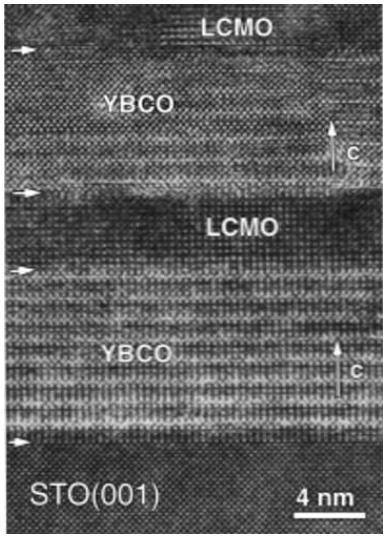
ESS workshop on neutron optics and shielding
03., 04. 09. 2014, Lund, Sweden

Estia

focusing reflectometer

main science case:

determination of structural and magnetic depth-profiles near the surface



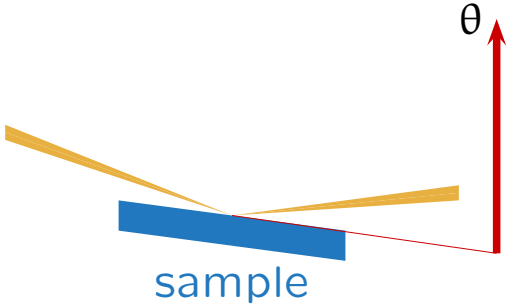
typical samples:

thin coatings on $1 \times 1\,\mathrm{mm}^2$ to $10 \times 50\,\mathrm{mm}^2$ substrates

geometry:

angle of incidence $\theta = 0.1^\circ \ldots 20^\circ$

$\Rightarrow$ samle *height* $= 2\,\mu\mathrm{m} \ldots 10\,\mathrm{mm}$



Selene guide

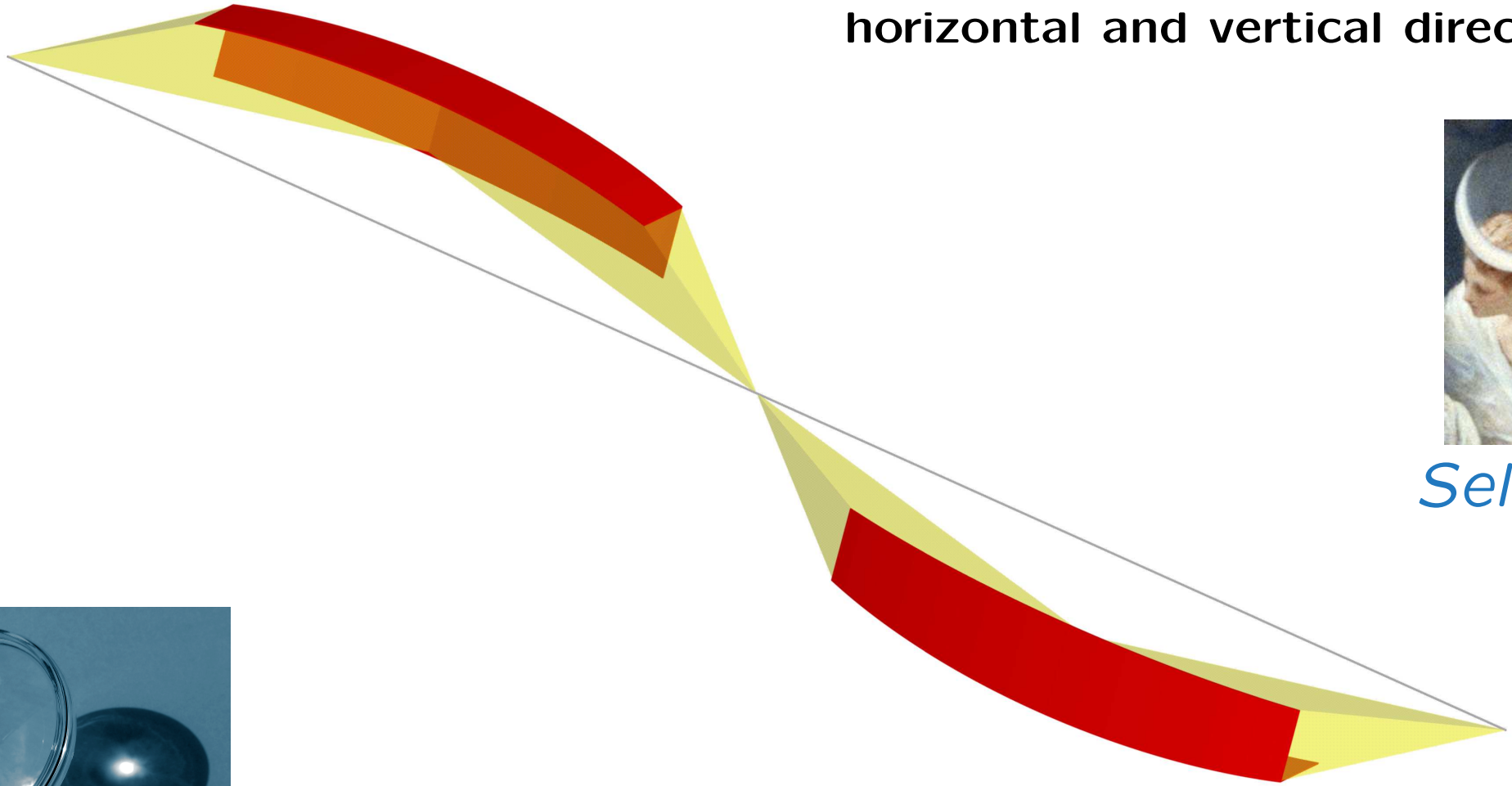
point-to-point focusing

with

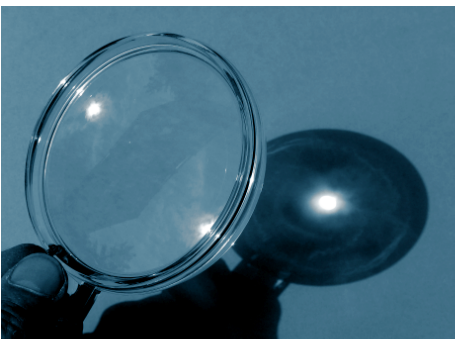
2 subsequent elliptical reflectors

for

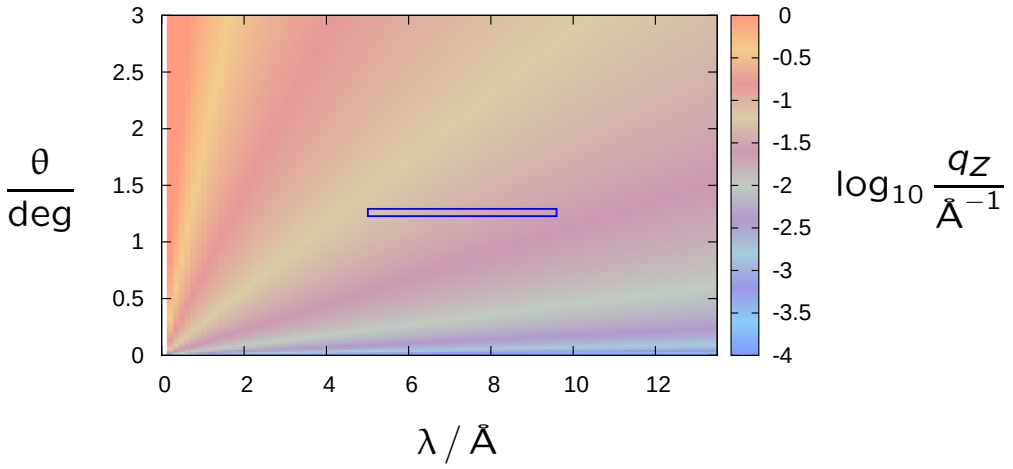
horizontal and vertical direction



Selene



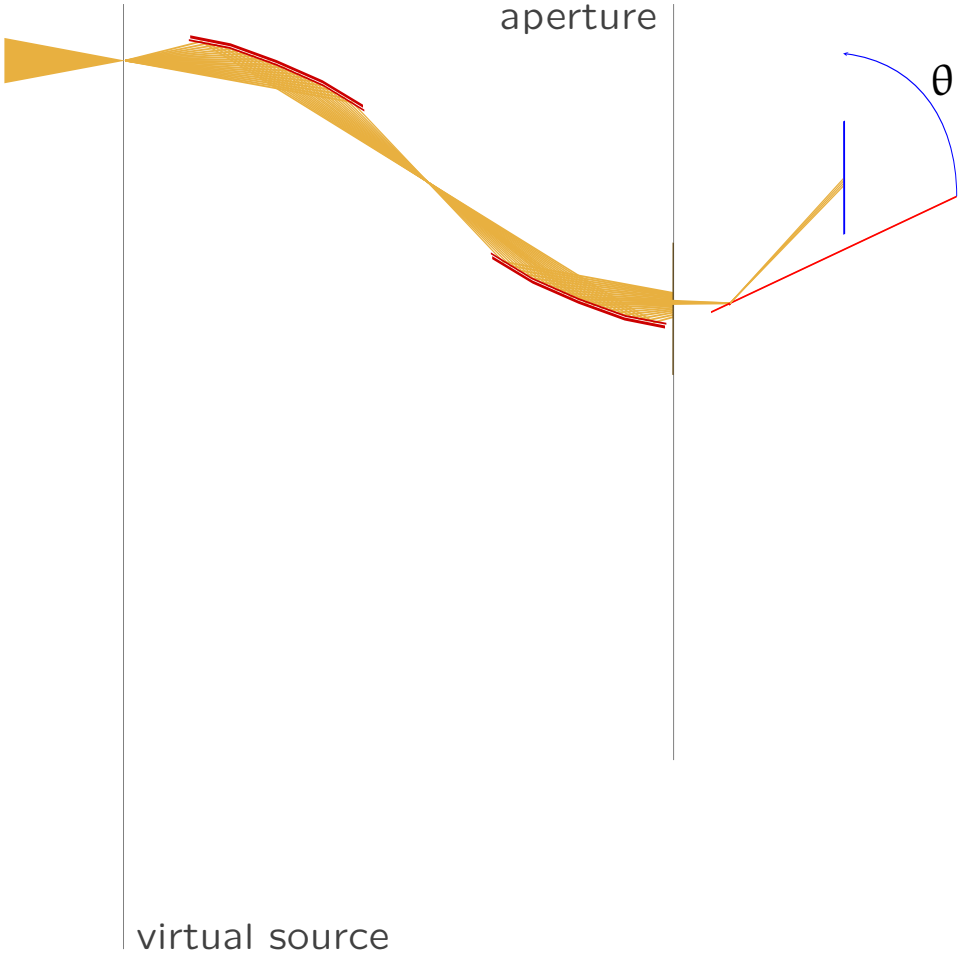
operation modes



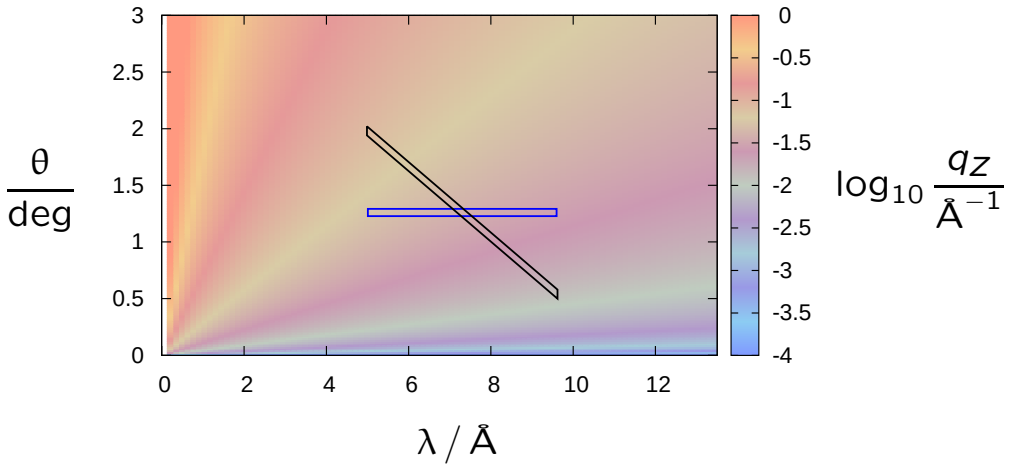
almost conventional reflectivity

= TOF

- defined foot-print
- off-specular reflectivity



operation modes



almost conventional reflectivity

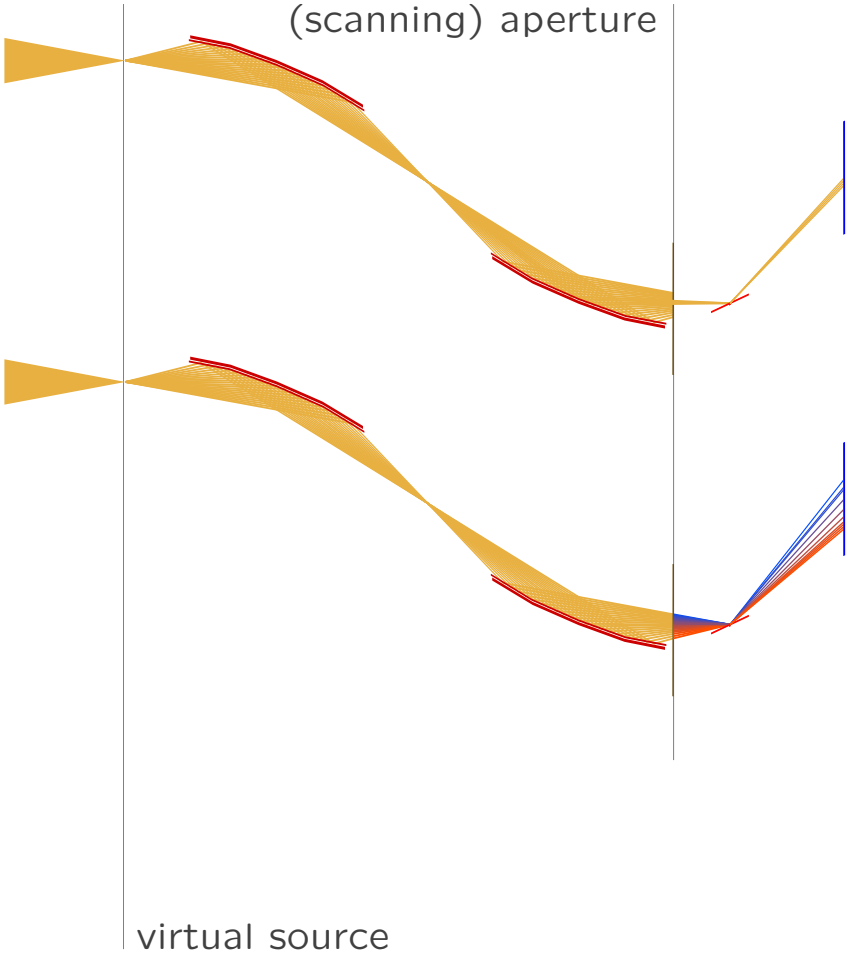
= TOF

- defined foot-print
- off-specular reflectivity

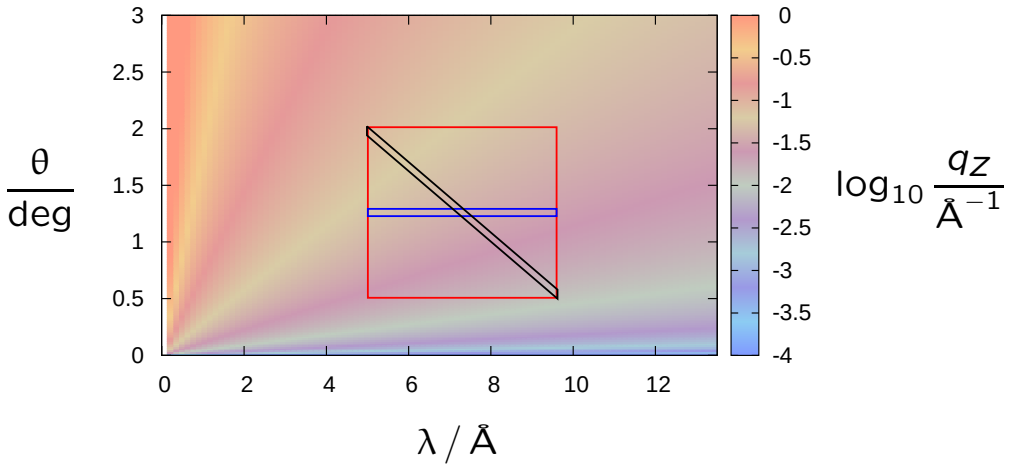
λ-θ-encoding

= TOF(θ)

- wider q_z-range
- constant $\Delta q/q$



operation modes



almost conventional reflectivity

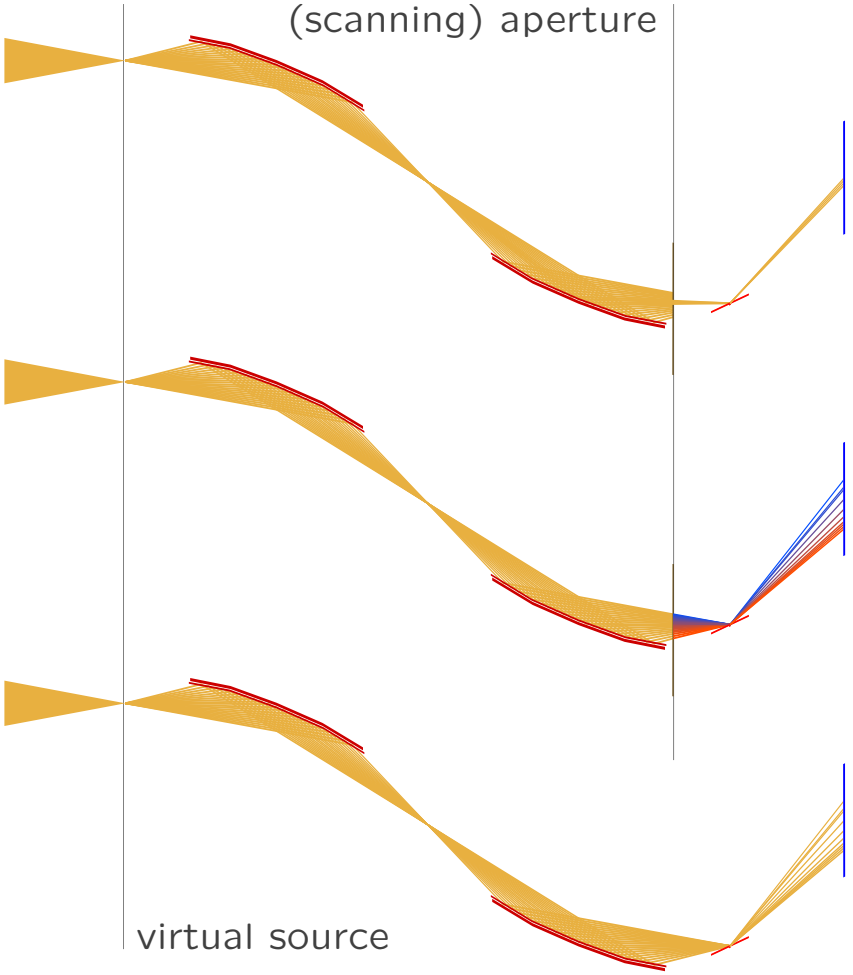
= TOF
- defined foot-print
- off-specular reflectivity

λ-θ-encoding

= TOF(θ)
- wider q_z-range
- constant $\Delta q/q$

high-intensity specular reflectivity

= TOF × θ-dispersive
- split-second t-resolution
- screening of parameter space



Estia — new lay-out

horizontal scattering plane

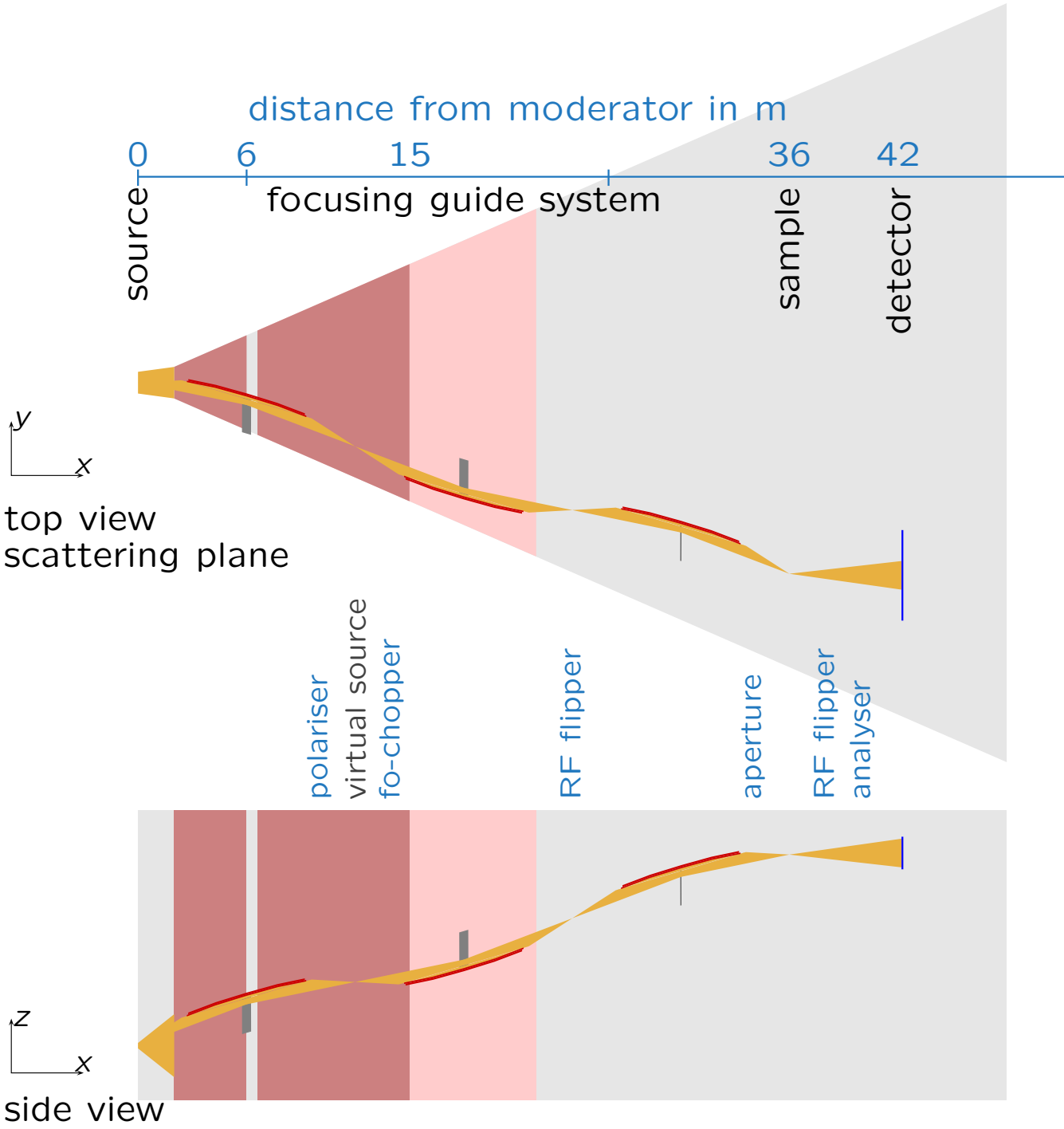
sample size $< 10 \times 50\,\mathrm{mm}^2$

feeder + *Selene* guide

beam-direction:

Selene: parallel off-set

feeder: inclination
& declination



moderator and beam-extraction

moderator-size:

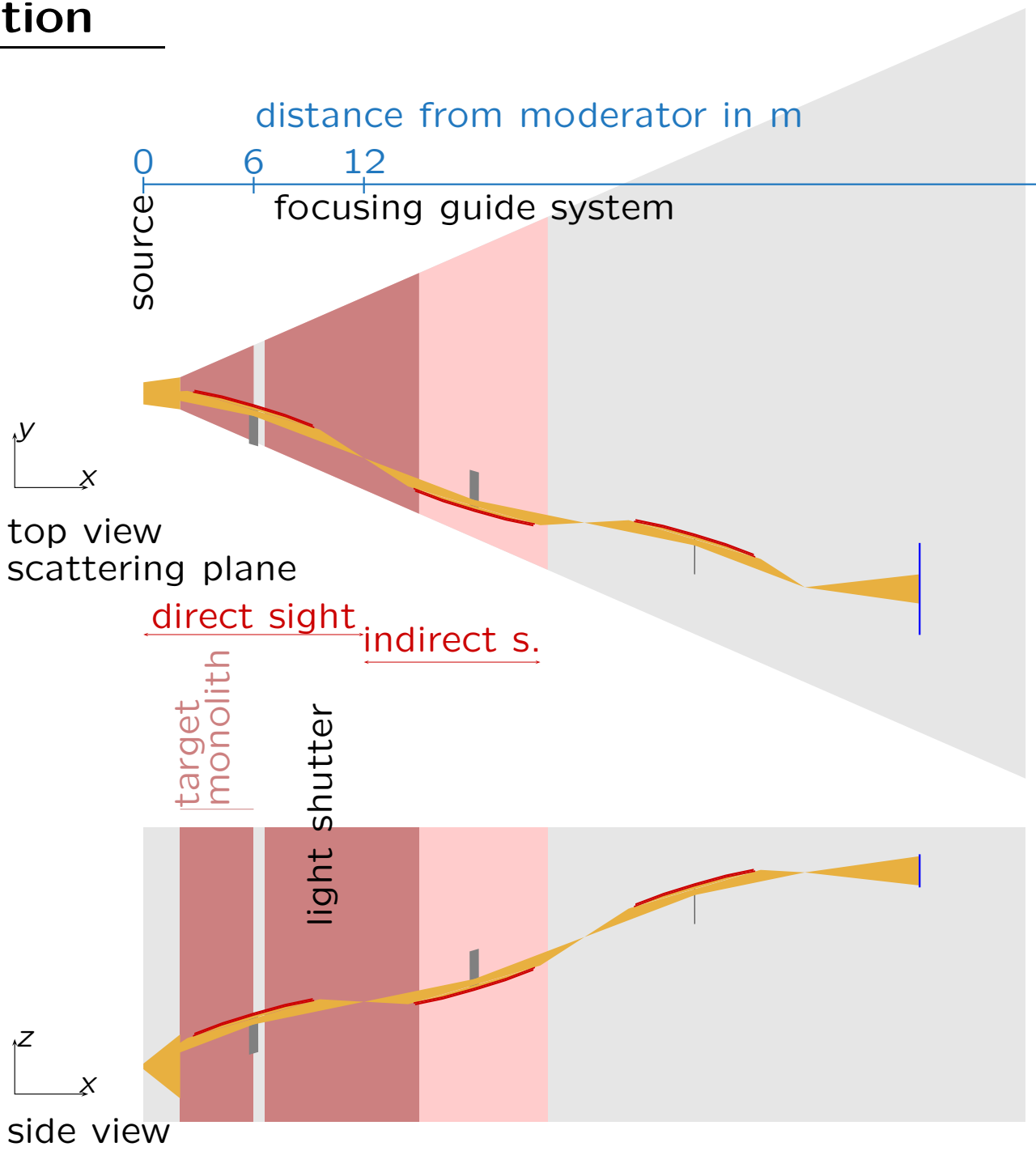
the smaller the better

i.e. $\approx 3\,\mathrm{cm}$ high

feeder:

1/2 *Selene* guide

12 m focal-point-distance

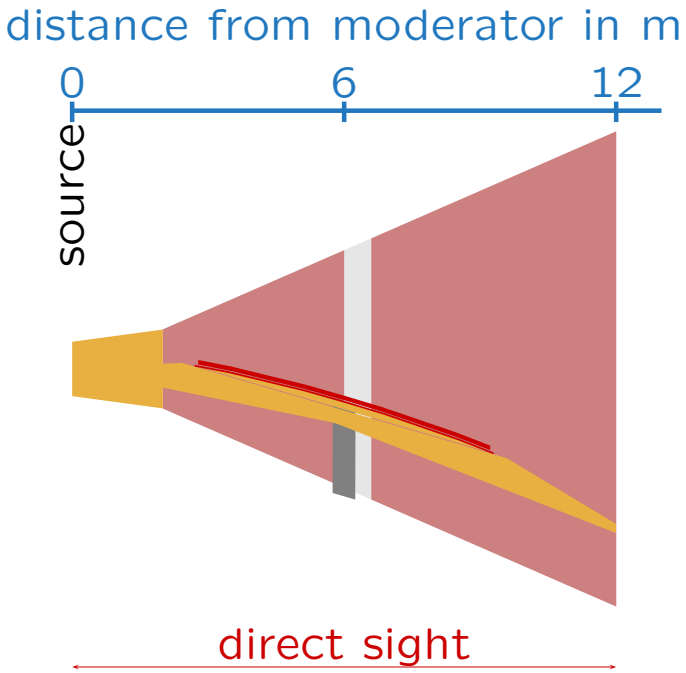


moderator and beam-extraction

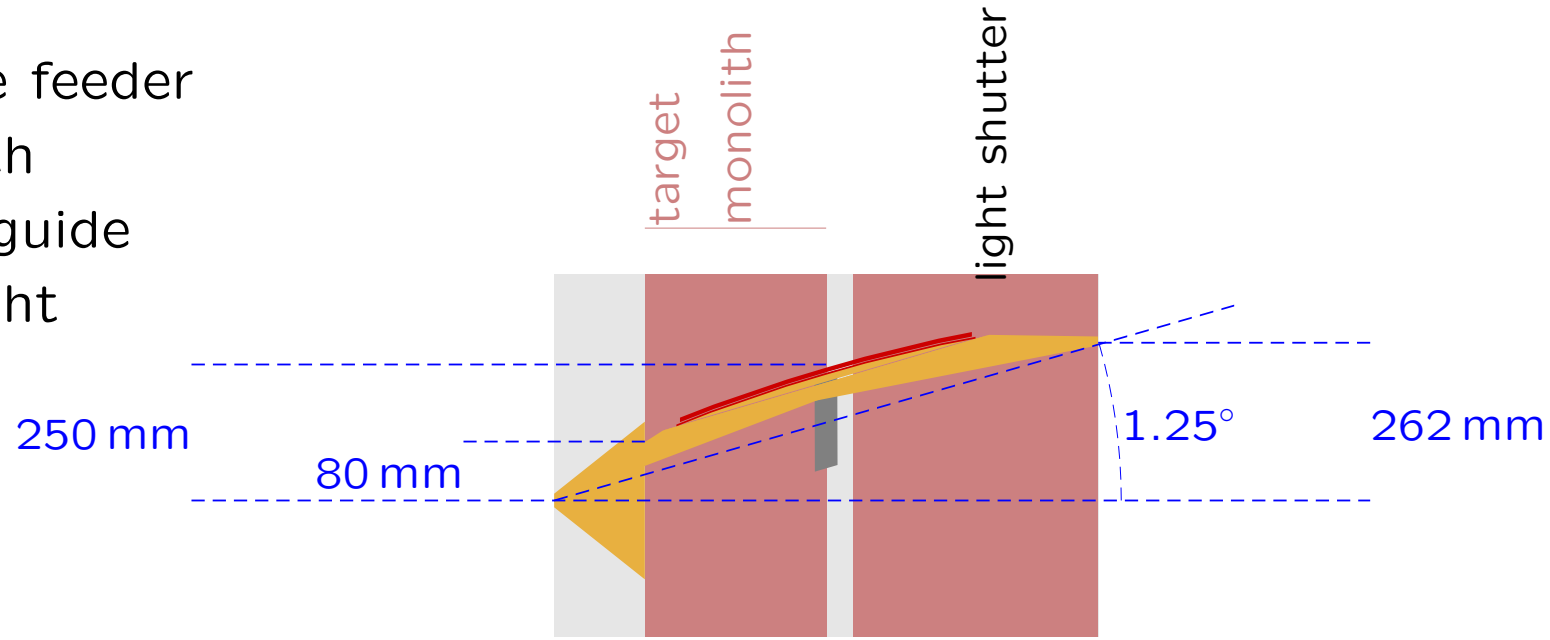
geometry

entrance aperture ($x = 2\,\mathrm{m}$)
$\approx 70 \times 70\,\mathrm{mm}^2$

exit aperture ($x = 11\,\mathrm{m}$)
$\approx 15 \times 15\,\mathrm{mm}^2$



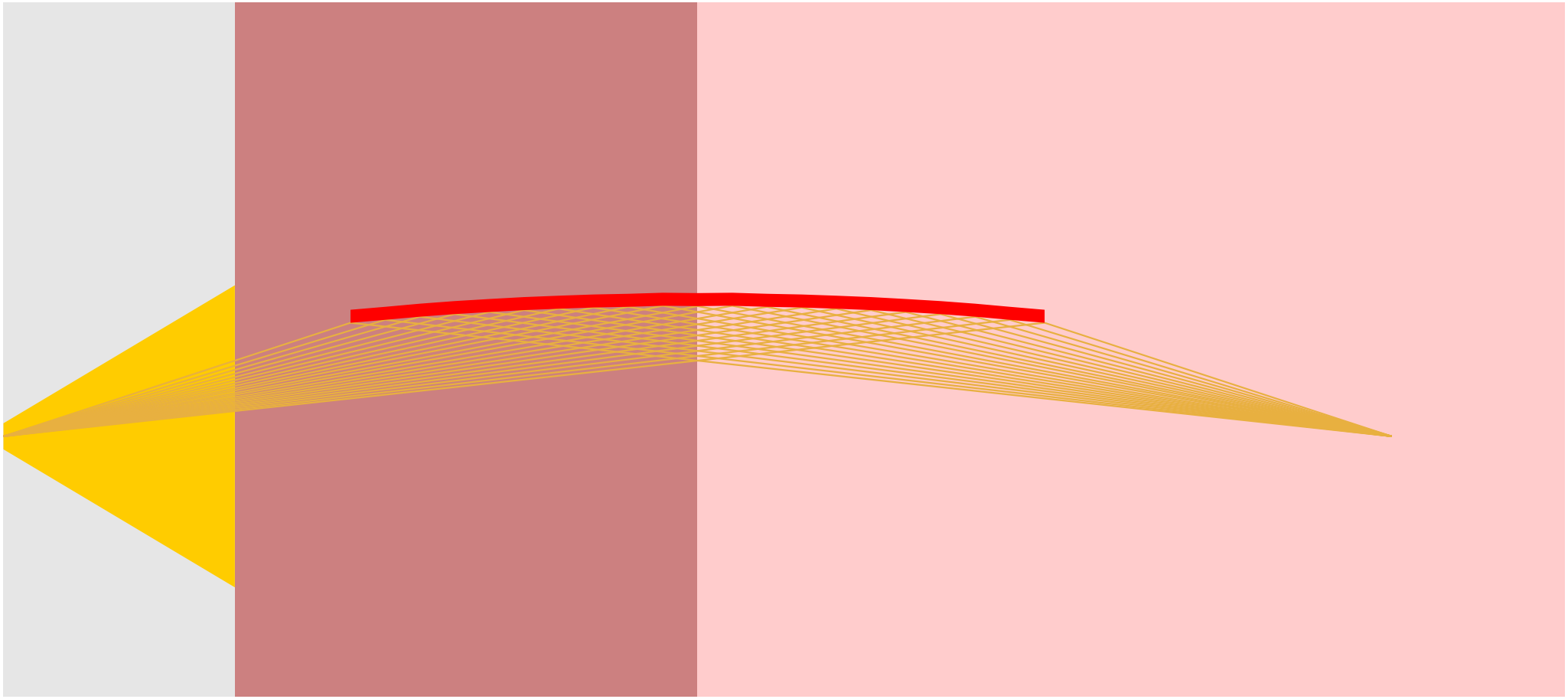
inclination of the feeder
in conflict with
- doghnut guide
- inset height



moderator and beam-extraction

shielding

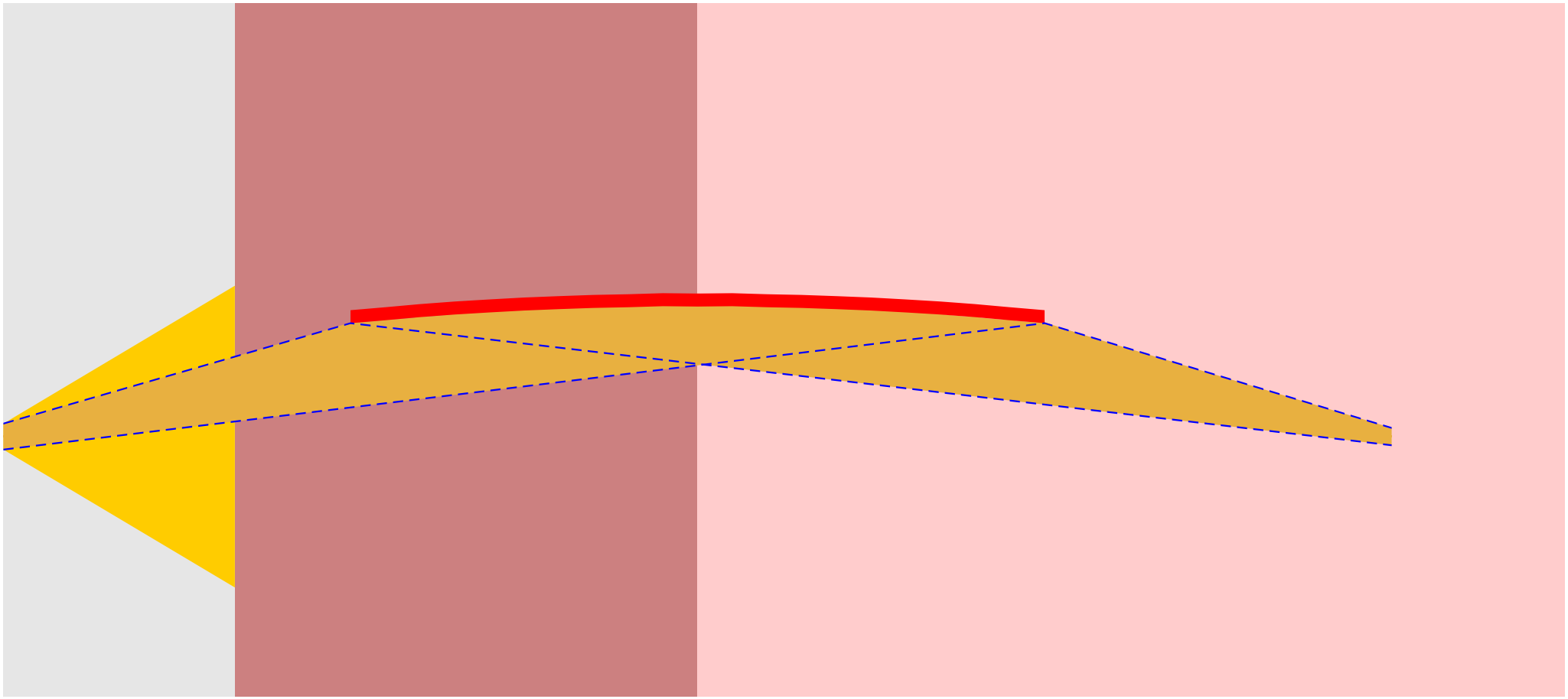
ideal trajectory



moderator and beam-extraction

shielding

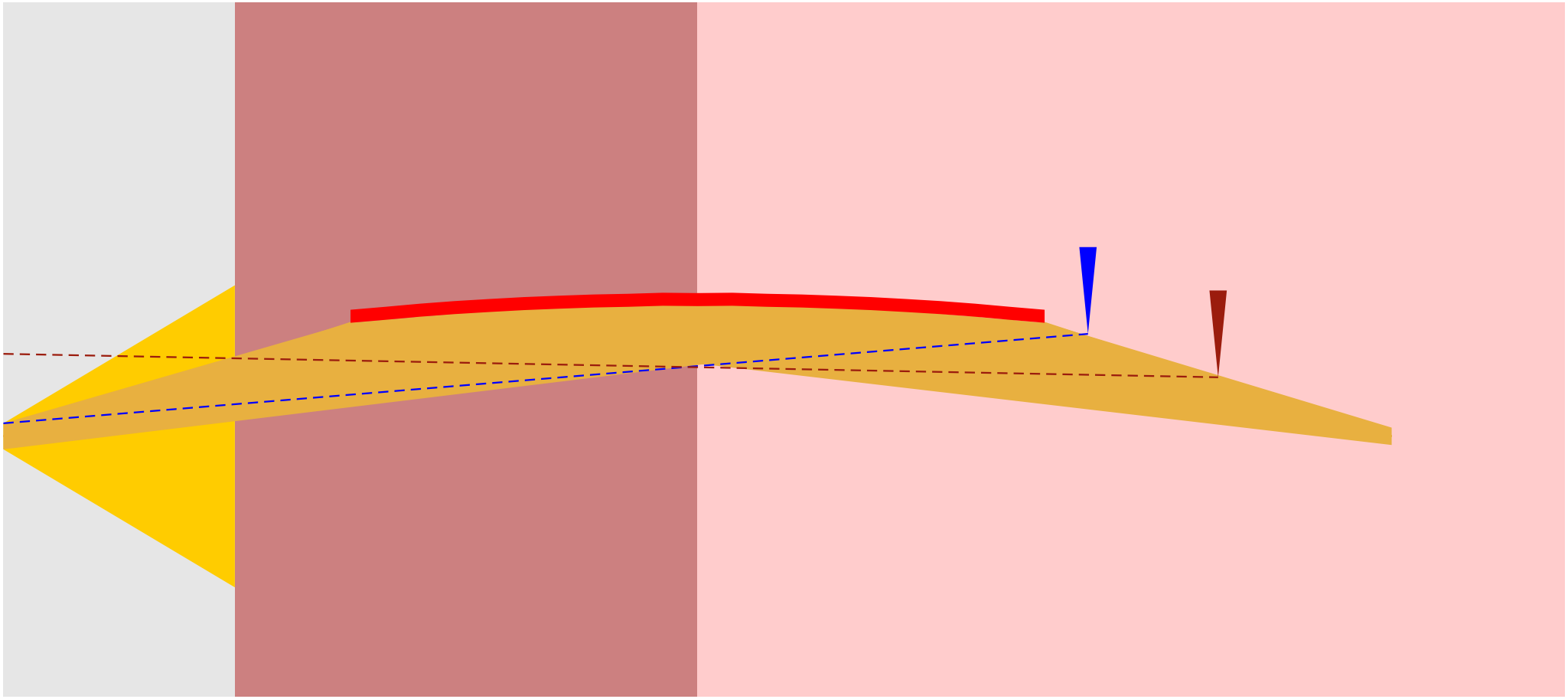
finite moderator (30 mm)
finite virtual source (20 mm)



moderator and beam-extraction

shielding

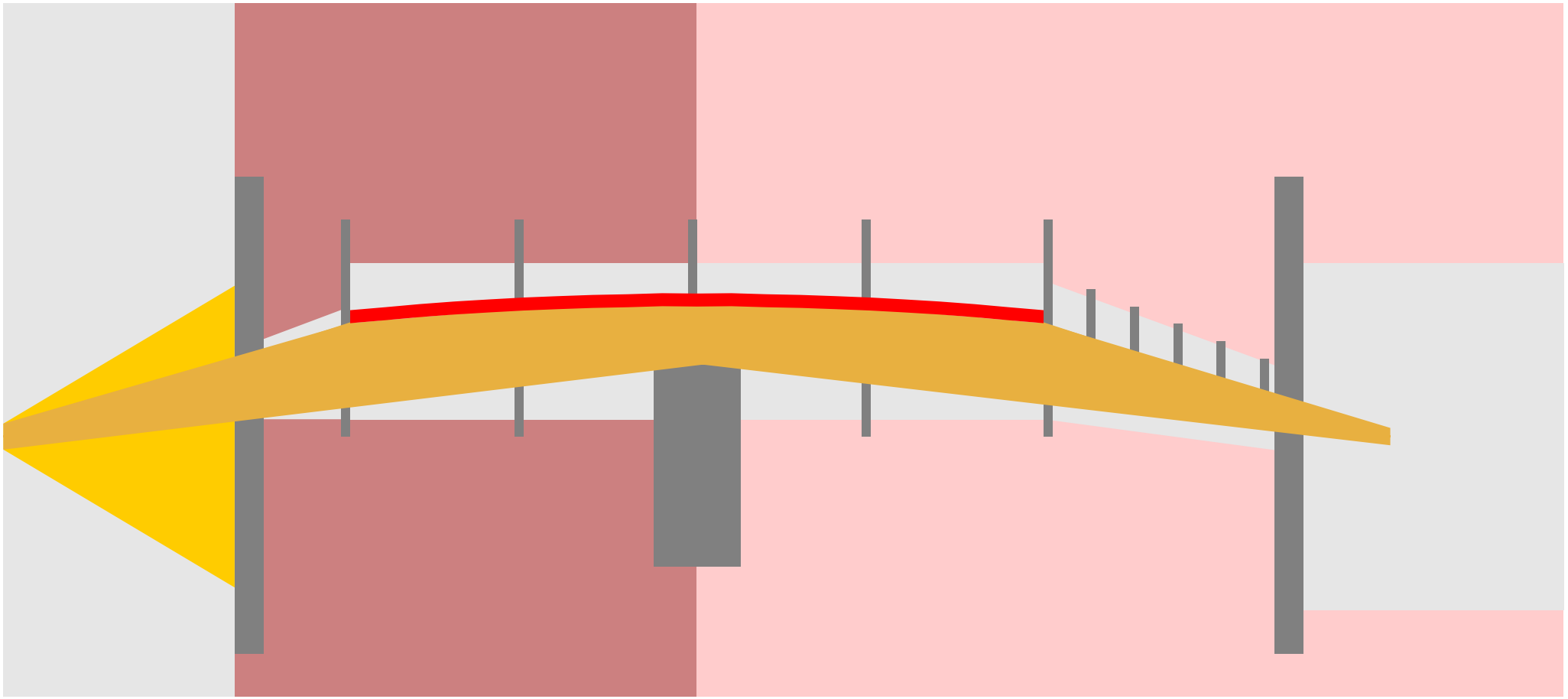
direct line-of-sight to moderator / target environment



moderator and beam-extraction

shielding

apertures and beam-stops

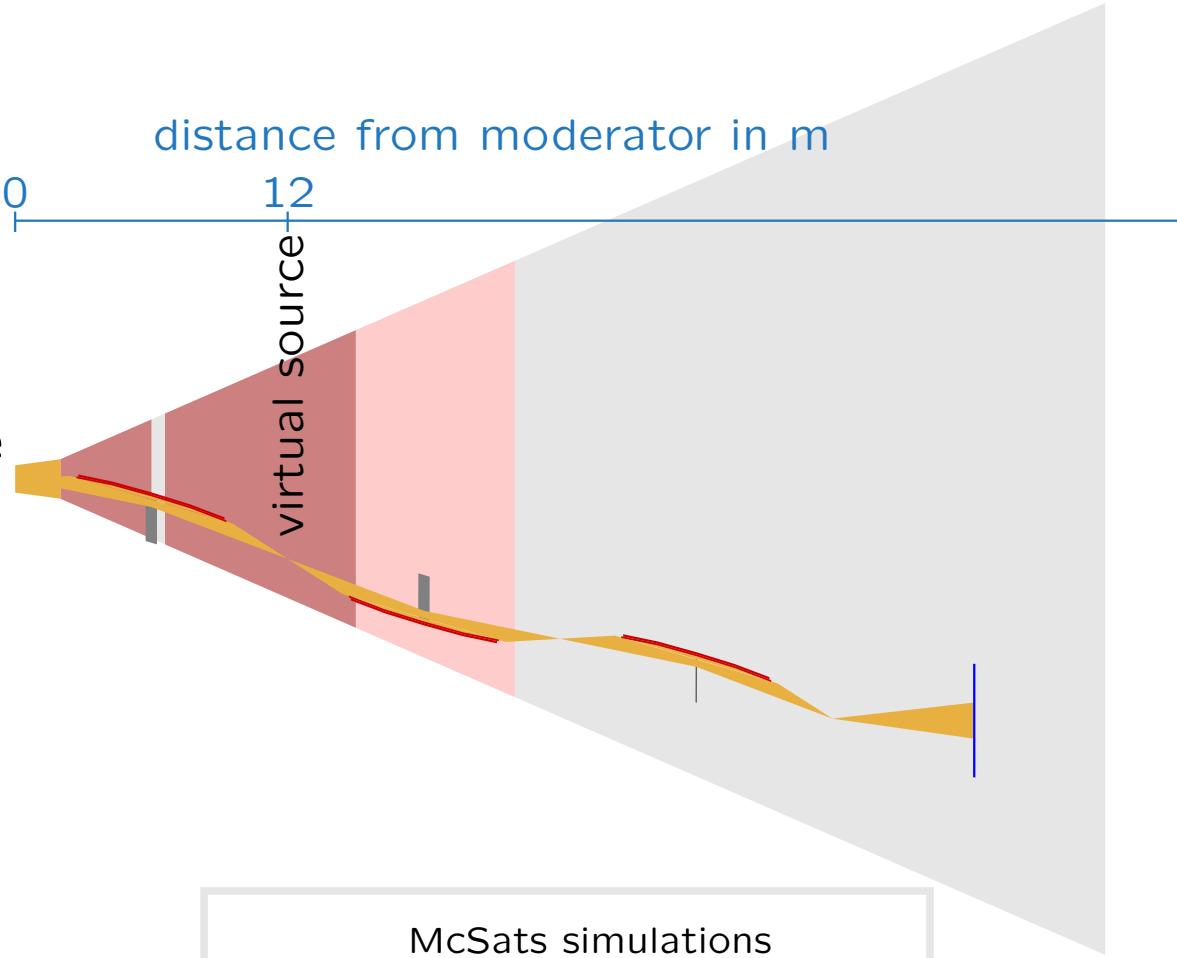


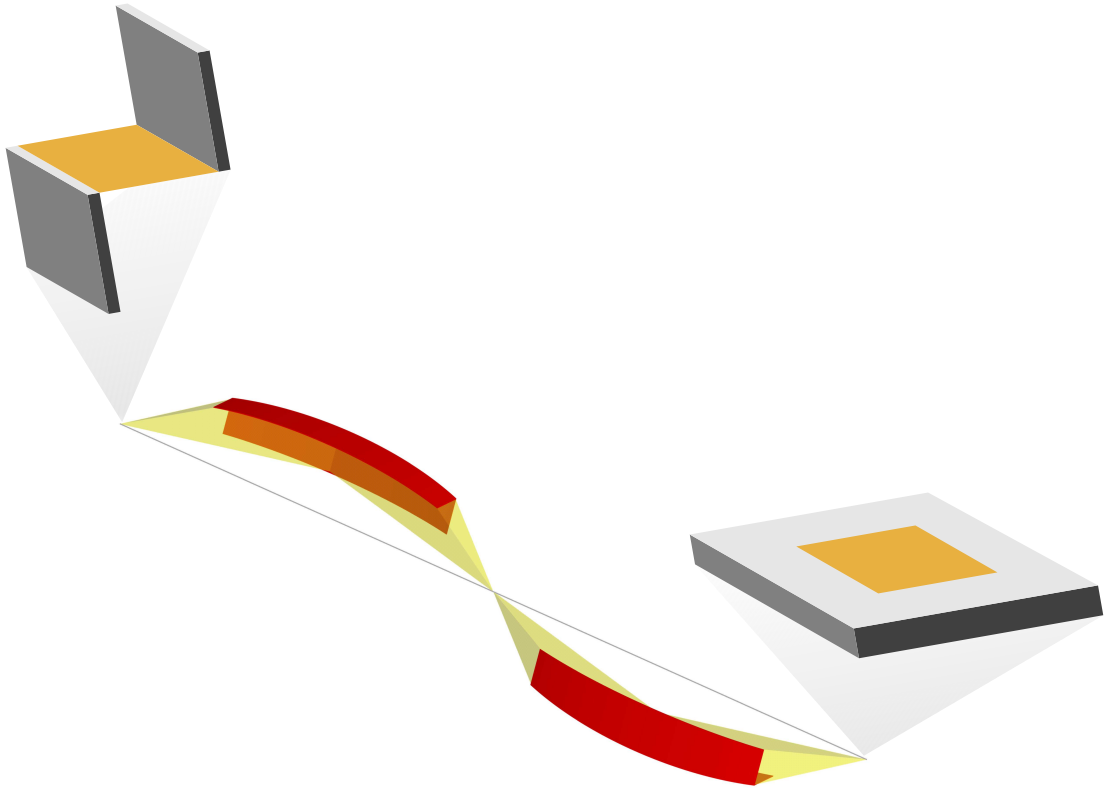
virtual source

a luminous field diaphragm defines

- shape
- size
- orientation

of the beam footprint on the sample

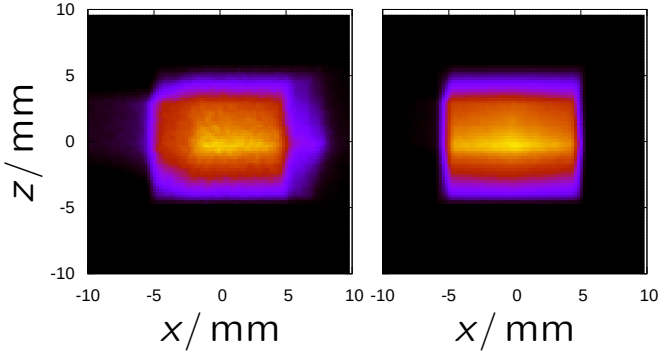




McSats simulations

$A = 10 \times 10\,\mathrm{mm}^2$

$\omega \in [0.2°, 1.7°]$ $\omega \in [6.1°, 7.6°]$



Selene guide

total length: 24 m

accuracy:

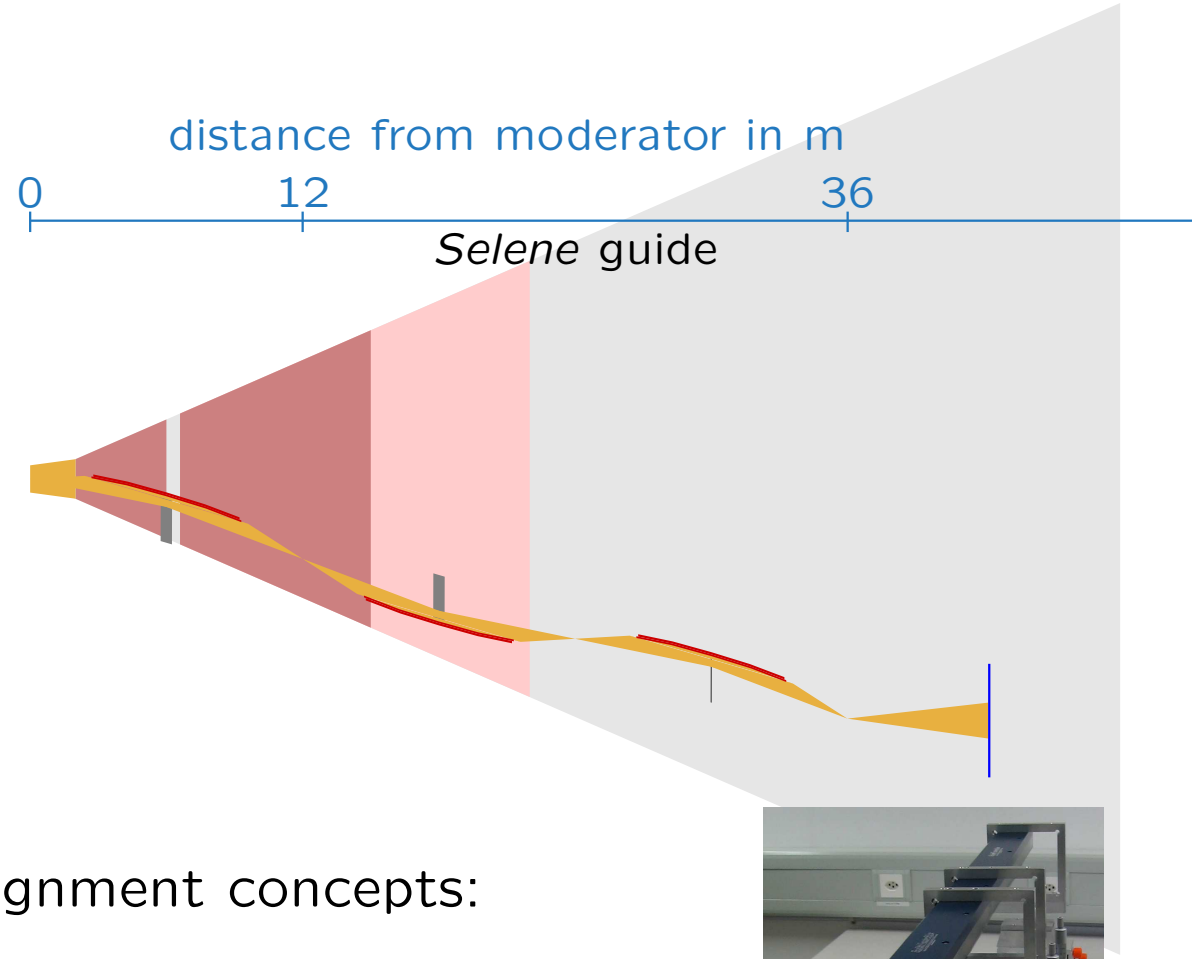
wavyness $< 10^{-5}$ rad

position $\approx 1\,\mu$m

$\Rightarrow$ precise alignment

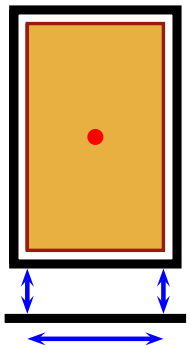
easy realignment

thermalisation (RT)

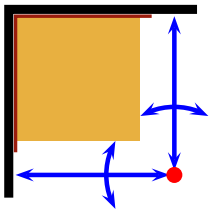


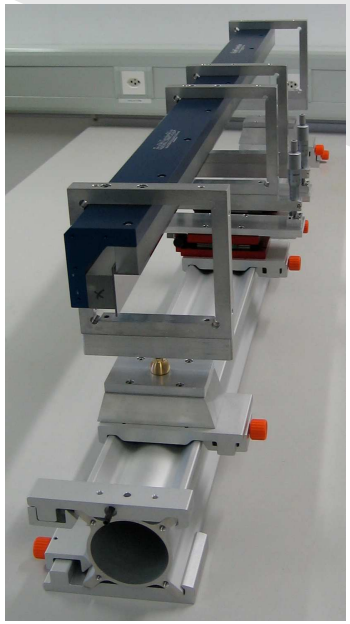
open construction allows for new alignment concepts:

conventional



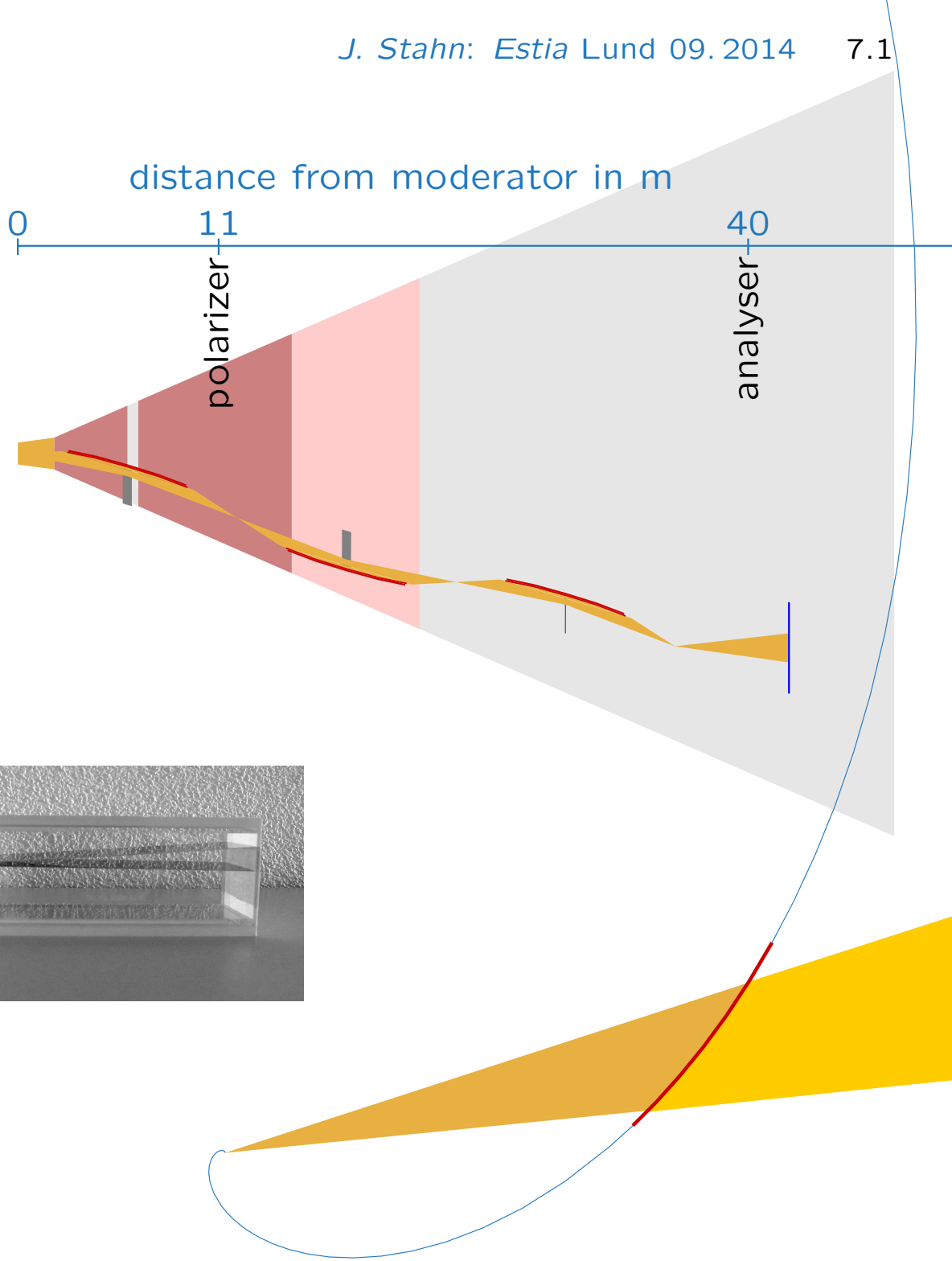
open guide





optics — polariser

logarithmic (= equiangular)
spiral reflector
λ- and spin-filtering



prototype:

- $\Delta\theta = 1.8°$
- for a $1 \times 50\,\mathrm{mm}^2$ virtual source
- 240 mm long
- $m = 4.2$ + Ni coating
- $\Rightarrow$ polarisation > 4 Å
  - $\lambda < 16$ Å
- build by SwissNeutronics

optics — scanning aperture

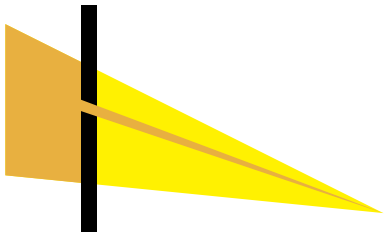
located behind the guide

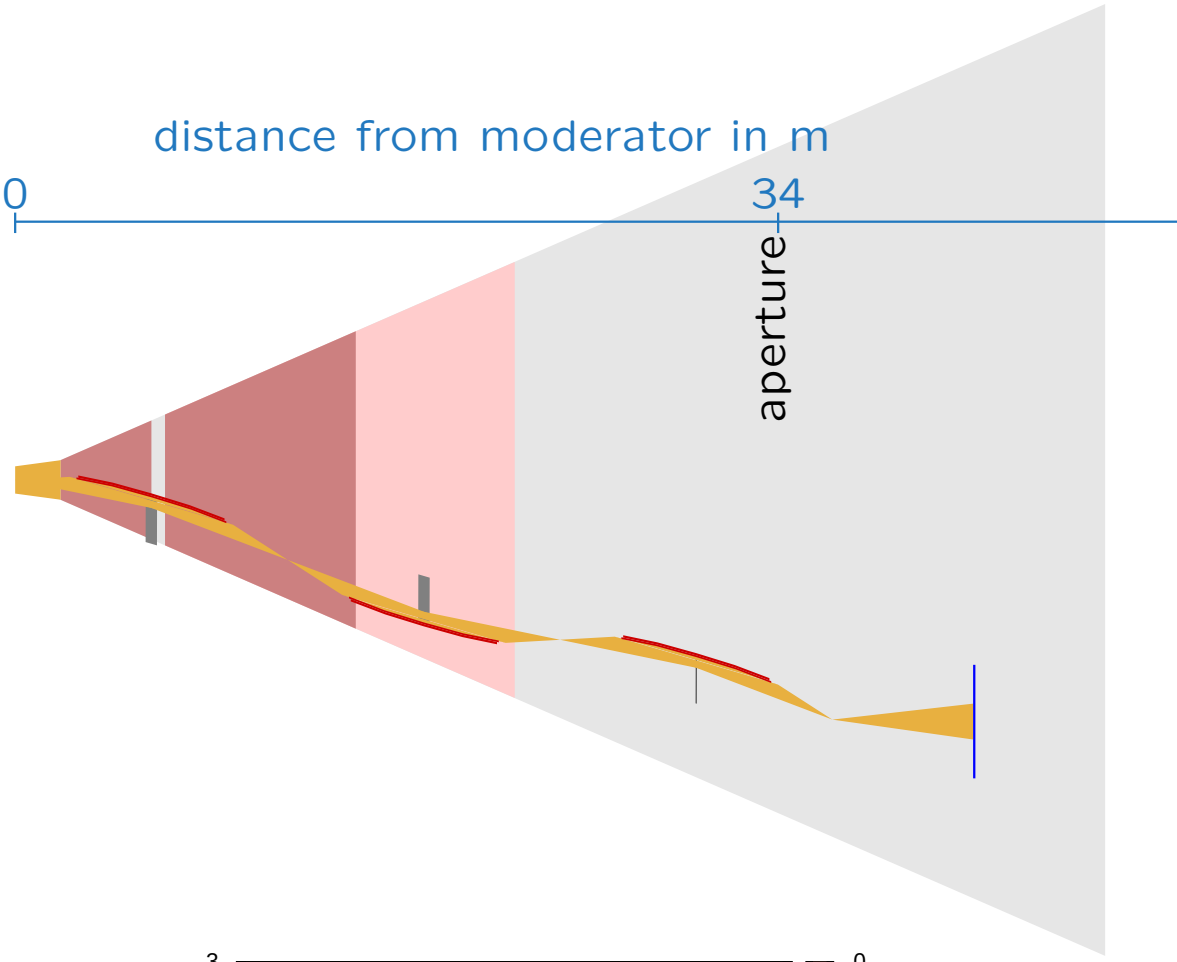
states:

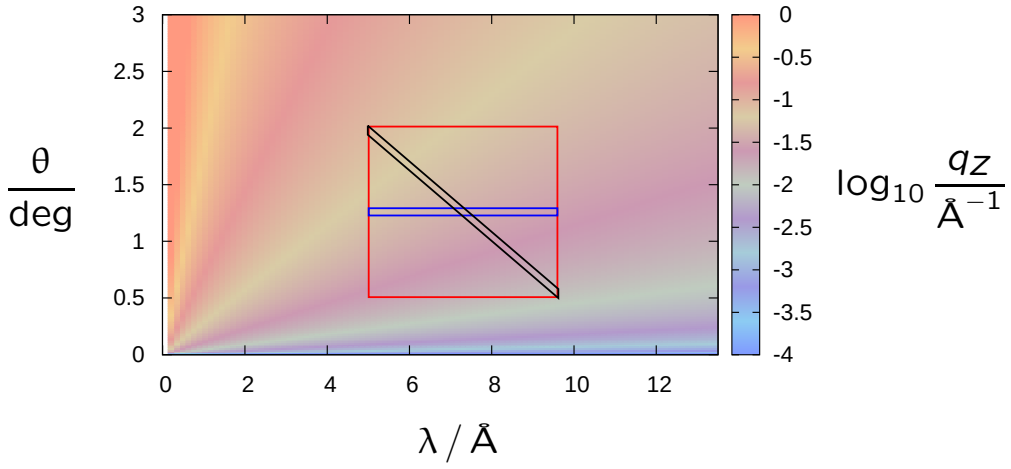
absent / open
⇒ high-intensity mode

in place, stationary
⇒ conventional mode

scanning
⇒ λ-θ encoding
periode 70 ms
span 60 mm
reset-time 15 ms

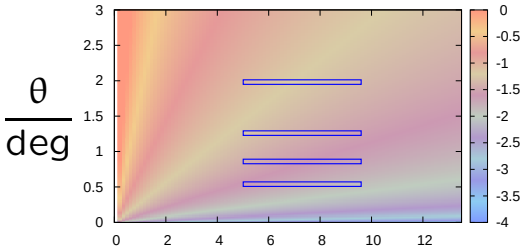




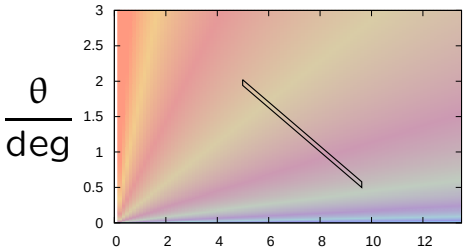


optics — scanning aperture

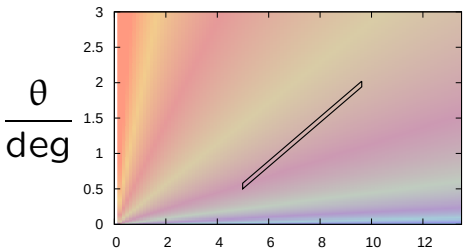
operation modes:



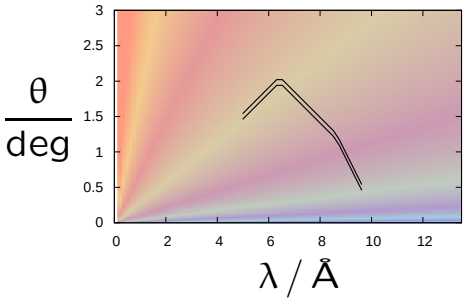
shift in between pulses
(see Freia)



linear scan during each pulse
large Δq_z



linear scan during each pulse
small Δq_z



fancy stuff
adapt q_z to $I(\lambda, \theta)$ and $R(q_z)$

optics — scanning aperture

needs to be developed!

max. speed:
$6\,\mathrm{ms}^{-1}$

max. path length:
60 mm

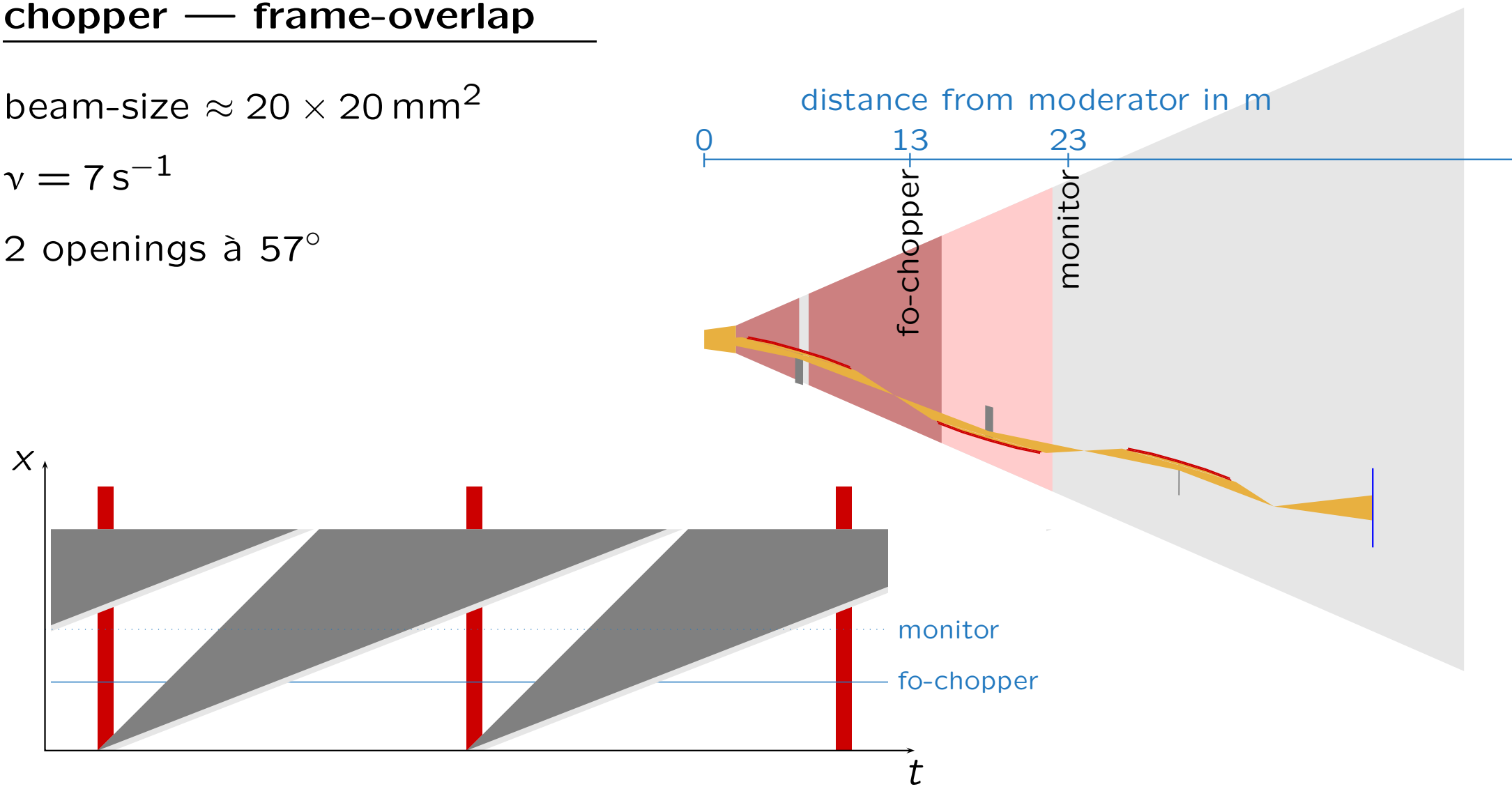
example:
praline-picking robots
running 24/7

chopper — frame-overlap

beam-size $\approx 20 \times 20\,\mathrm{mm}^2$

$\nu = 7\,\mathrm{s}^{-1}$

2 openings à 57°



fo-filter for higher harmonics in combination with polariser