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Selene-type reflectometer — principle

the challenge:

design a neutron reflectometer with the guide as an integral part of the instrument, i.e. several beam-shaping functions are realized by, or at the guide

the ansatz:

definition of the beam — e.g.
- sample (spot) size — below mm^2 to several cm^2
- maximum divergence — up to 3°
- λ-range — 3 Å to 12 Å

and prevention of all other neutrons

the idea:

use an imaging technique to **map a virtual source of the wanted characteristics to the sample**

the optics / guide:

The guide is made out of two subsequent reflectors of (the same) elliptic shape with a joining focal point. In comparison to conventional elliptic guides only one branch of the ellipse is used in the scattering plane (*Selene* concept)

As a consequence the phase space and the beam spot dimensions at the final focal point are almost identical to the situation at the virtual source. One can precisely and independently adjust the spot size by a diaphragm at the focal point, and the divergence by a diaphragm in between focal points, respectively.

A further advantage of this concept is that it prevents direct line of sight, and that (geometrically) only neutrons are transported which actually are desired at the sample. This means a **reduction of flux within the guide system** by at least 3 orders of magnitude.
⇒ less shielding required
⇒ reduced irradiation of sample environment
⇒ lower background

opportunities:

If applied to a reflectometer, this approach opens up opportunities for
- wide-q_z measurements,
- time resolved studies,
- investigation of small, inhomogeneous or curved samples,
- focusing GISANS.

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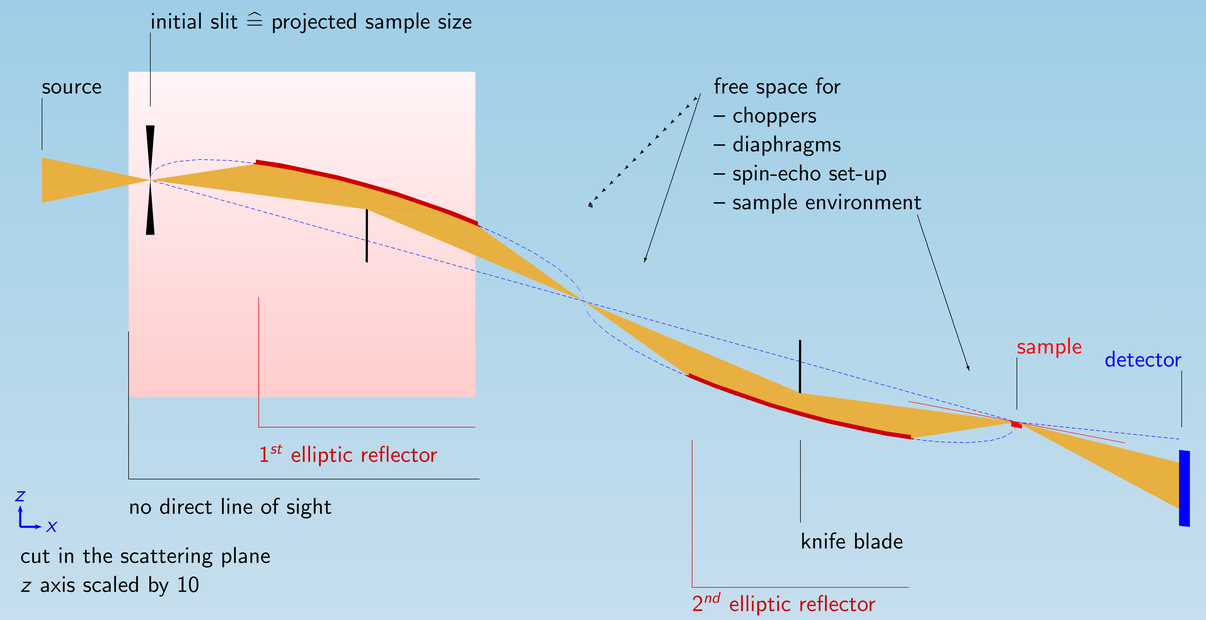
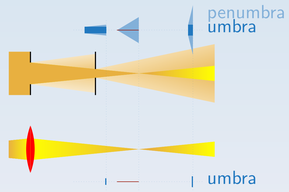
generic instrument lay-out:



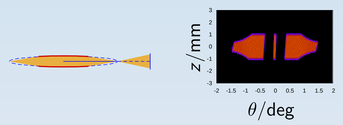
cut in the scattering plane
z axis scaled by 10

guide as imaging optics to allow for early beam definition
- footprint defined by initial slit(s)
- divergence adjusted by knife blade
- ⇒ no unwanted n trajectories
- ⇒ reduction of flux in the guide to $< 10^{-3}$
- same flux on sample as a conventional set-up

comparison focusing with slits
vs. refractive/reflective optics:



half ellipse to obtain a gap-less phase space
for comparison: $I(z,\theta)$ map for a two-sided guide:

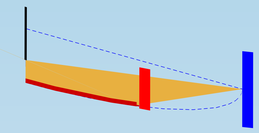


often, one branch can cover $\Delta\theta$

Selene:

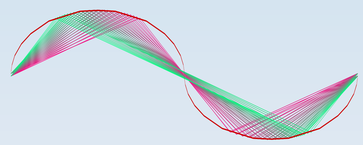
is the titan-goddess of the moon
the light-to-shadow border as seen from the earth forms **half an ellipse**

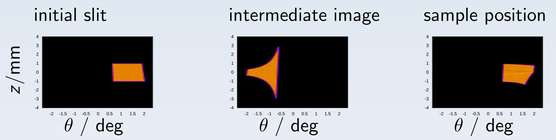
focusing GISANS



cut in the sample plane
- detector in the focal plane
- sample at the guide exit

2 subsequent ellipses correct for coma aberration



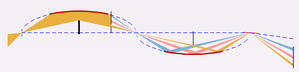


operation modes:

almost conventional

- beam is still convergent
- off-specular measurements are feasible

wide q-range



- vary θ with fixed sample position
- shift diaphragm between pulses
- → suited for liquid surfaces

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high-intensity specular reflectivity

- energy- and angle-dispersive
- for fast scanning (T, **H**, **E** ...)
- if off-specular scattering is no *problem*

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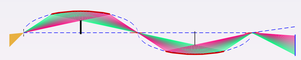
angle/energy encoding



- use a ml-monochromator
- spectral analysis of the beam: $\lambda \propto \theta$
- large λ on small θ ⇒ wide q_z-range

→ poster 2/4