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
- sample (spot) size
- maximum divergence
- λ-range

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, measurements,
- time resolved studies,
- investigation of small, inhomogeneous or curved samples,
- focusing GISANS.

2 subsequent ellipses correct for coma aberration

half ellipse to obtain a gap-less phase space

for comparison: I(z, θ) map for a two-sided guide:

often, one branch can cover Δθ

operation modes:

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

wide q-range
- vary q with fixed sample position
- shift diaphragm between pulses
- suited for liquid surfaces
- low background
⇒ poster 3/4

high-intensity specular reflectivity
- energy- and angle-dispersive
- for fast scanning (T, H, E...
- if off-specular scattering is no problem
⇒ poster 2/4

angle/energy encoding
- use a ml-monochromator
- spectral analysis of the beam: \( \lambda \propto \theta \)
- large \( \lambda \) on small \( \theta \)
⇒ wide \( q \)-range
⇒ poster 2/4