

The inception of Estia and the Selene guide concept

Jochen Stahn



Estia early science workshop
2025-12-09

2007 NOP workshop at PSI

- **REFocus** by Frederic Ott
- elliptic guides & optics by P. Boeni et al.

2008 Ven workshop on ESS instruments



ideal reflectometer length: 16 m

lots of ideas about

- focusing
- multiplexing
- in-phase tilting
- fast moving slits . . .

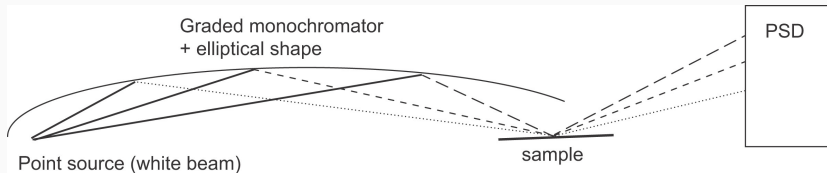
2009 real world

- graded parabolic monochromatic reflector

REFocus

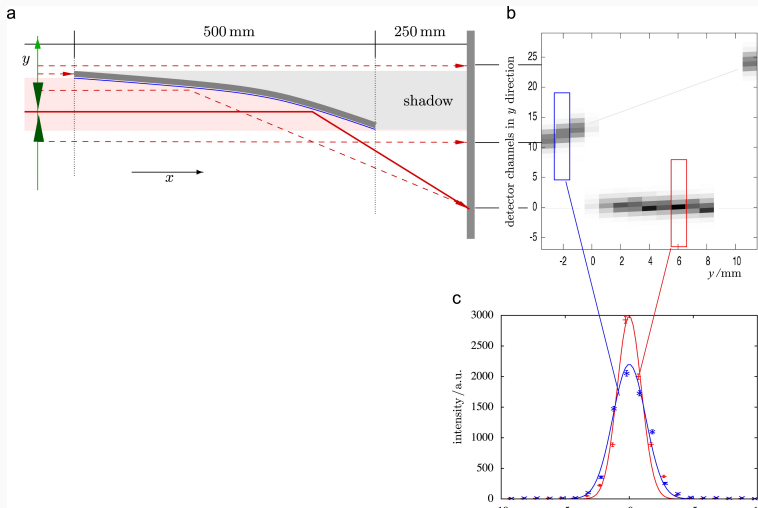
by F. Ott & A. Menelle N.I.M. A 586 23, 2008

- for reflectometry on a **continuous** source with **high divergence**
- $\lambda = \lambda(\alpha_f = \alpha_i)$ resolved by detector



focusing gradient *monochromator*

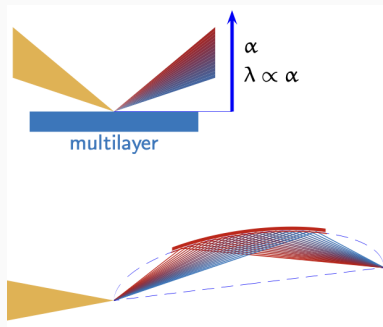
M. Schneider & J. Stahn: N.I.M. A **610** 530, 2009



dilemma of the graded monochromator

high reflectivity vs. high resolution (Δq)

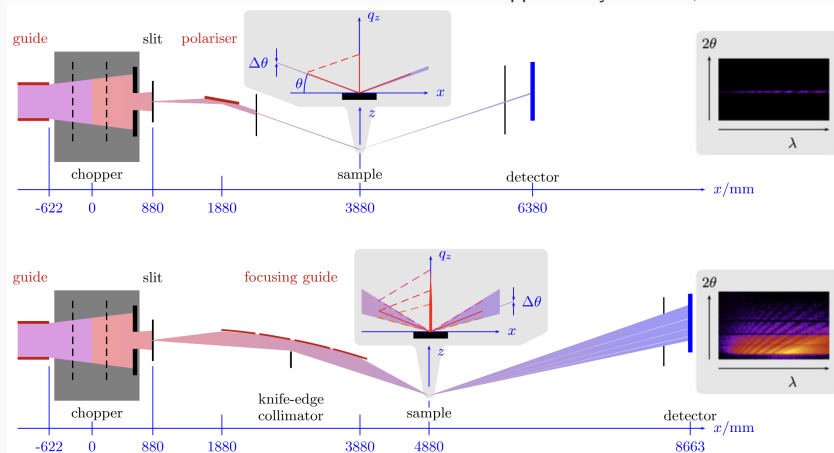
monochromator + elliptic reflector



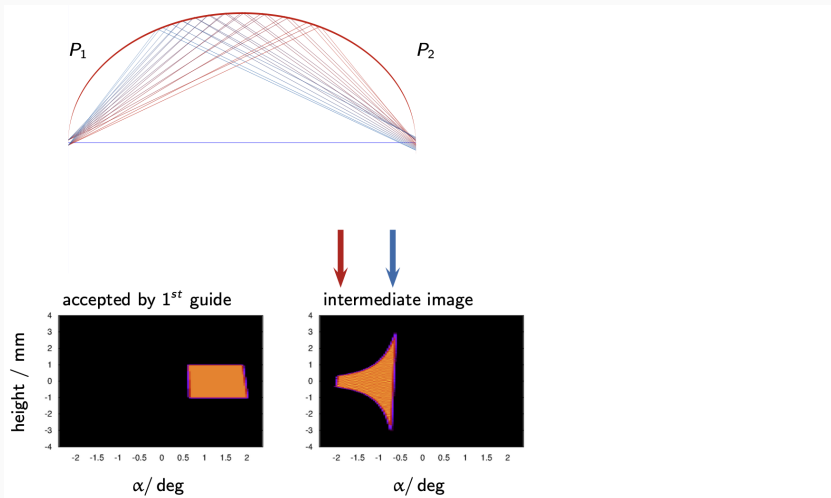
elliptic reflector for white beam

concept 2010: J. Stahn *et al.*: N.I.M. A **634** S12, 2011

measurements 2011: J. Stahn *et al.*: EPJ Applied Physics **58** 4, 2012



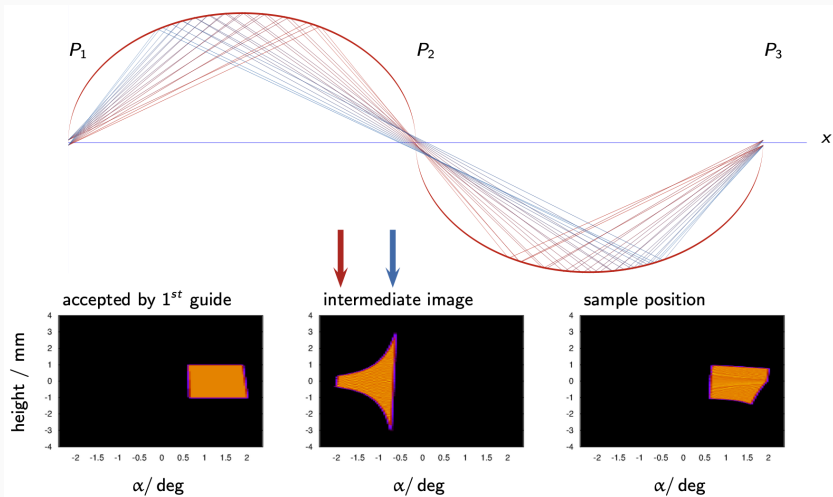
coma aberration of an elliptic reflector



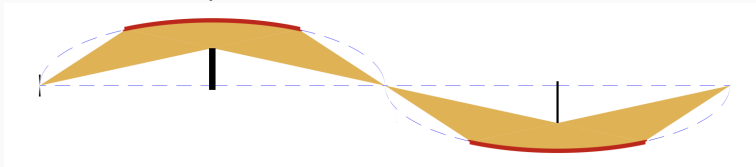
Me, solving the aberration problem



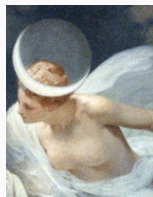
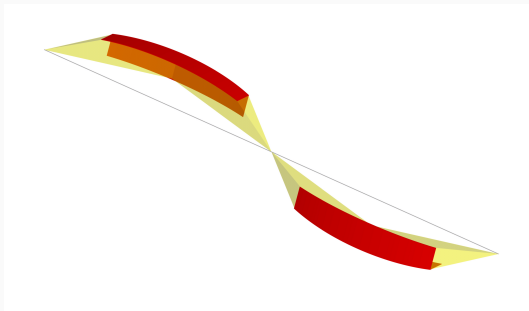
coma aberration of an elliptic reflector



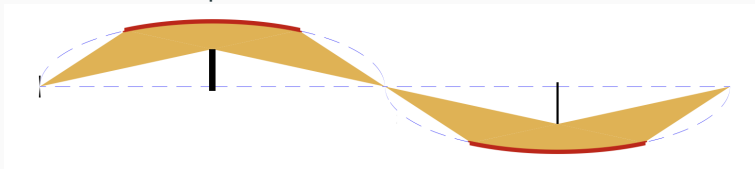
the **Selene** concept 2012



J. Stahn, U. Filges & T. Panzner: EPJ Applied Physics **58** 4, 2012



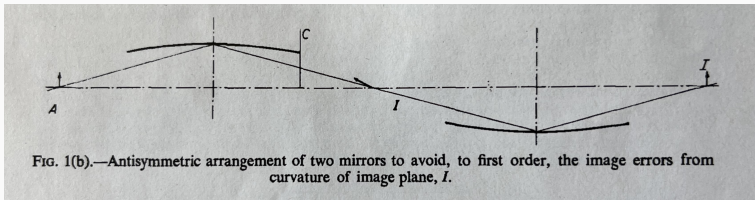
the Selene concept 2012



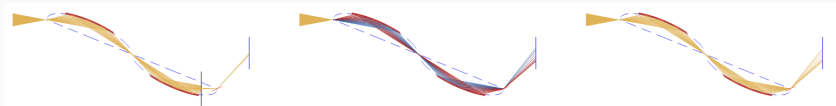
H. Maier-Leibnitz & T. Springer

Reactor Science and Technology **17** 217, 1963

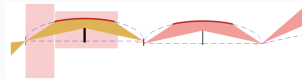
The use of neutron optical devices on beam-hole experiments



for



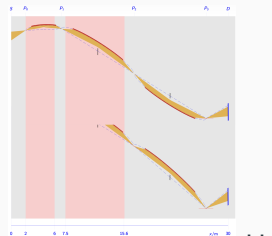
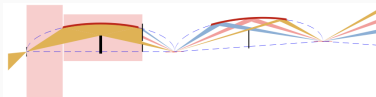
- pulsed sources, hard matter, fast measurements, high-resolution



- continuous sources



- soft matter



design approach

- what is **required at the sample** position?
 λ , $\Delta\theta$, footprint, ...
- how can one exclude everything else?
 $\Rightarrow$ filter as early as possible
- control footprint and divergence independently
 $\Rightarrow$ optics to map a *virtual source area* to the sample

main relations of a Selene optics:

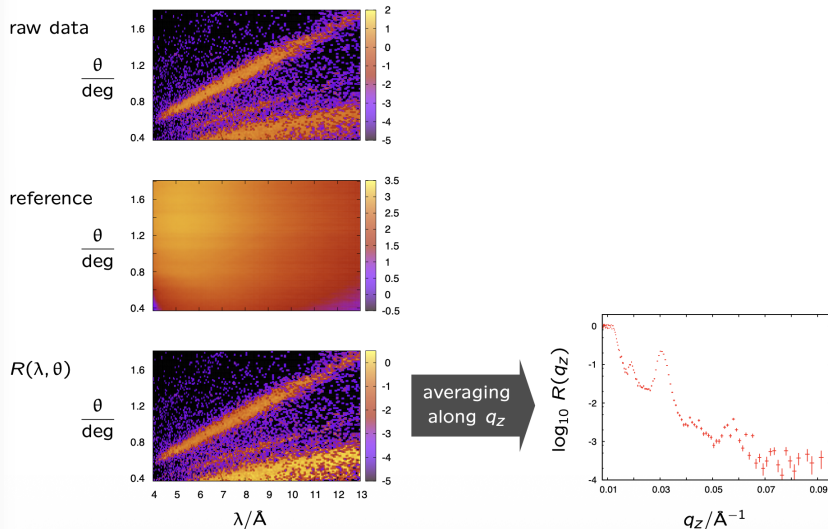
$$b/a = 0.012 \Delta\theta \quad [\Delta\theta] = \text{deg}$$

$$m \approx 8\Delta\theta/\lambda_{\min} \quad [\lambda] = \text{\AA}$$

$$z \approx 2.2 \cdot 10^{-3} \Delta\theta a \quad [a] = [z] = \text{mm}$$

$$\lambda_{\max} \approx 10^5 / a \quad \rightarrow \text{gravity}$$

TOF + divergent beam — the measurement principle



Paul Scherrer Institut



Swiss-Danish instrument development



WP 2

Selene

focusing reflectometer



Jochen Stahn

WHGA / 142
tel.: 2518

2011 - 2013:

various concepts for **hard-** and
soft-matter reflectometers

team:

me

Ursula Hansen

Tobias Panzner

Panos Korelis

Marité Cardenas

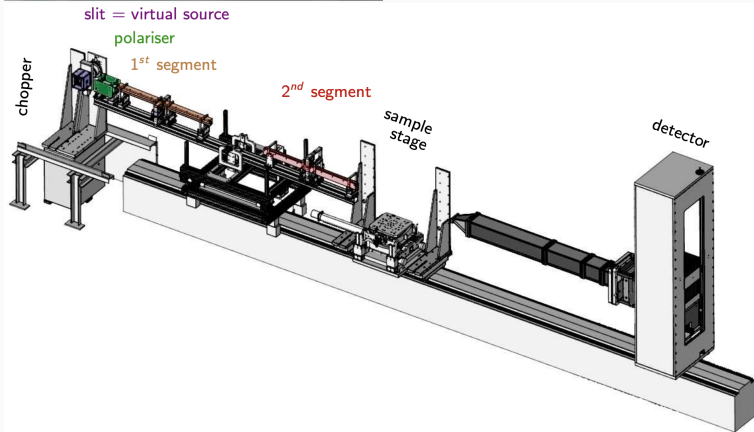
Beate Klösgen

Selene prototype on Boa and Amor

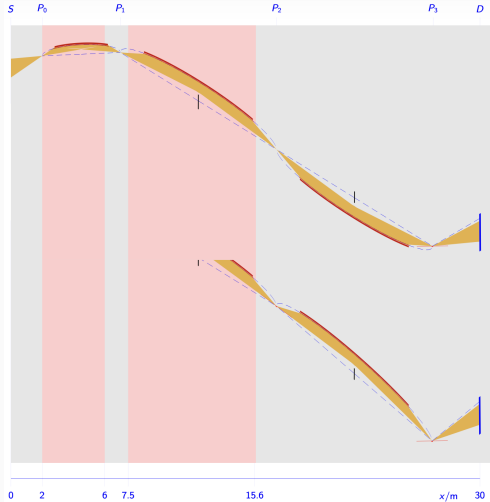


add-on

used for 6 years
on Amor



the liquid / soft matter reflectometer



Ursula Hansen

terminated in 2012

some ideas went to Freia

the hard matter reflectometer Estia

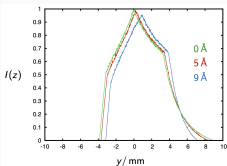
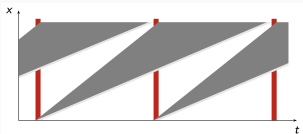
- STAP reports
- progress reports
- ESS report forms
- IKON and STAP meetings
- lots of design changes

(bunker radius, shutter, *beer can* to *pancake*)

“Can you tell me by the end of the week how a moderator size change . . . affects your instrument?”

- a few MCStas simulations
- lots of cycling

the hard matter reflectometer Estia

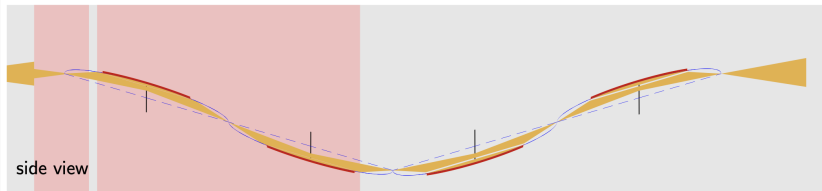


design criteria
before acceptance

- performance
- avoid proton prompt
- shielding
- space

distance from moderator in m

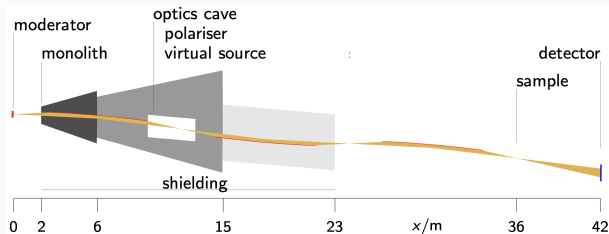
0 6 26 52 58



the hard matter reflectometer Estia

design criteria after acceptance: - make it **cheaper**

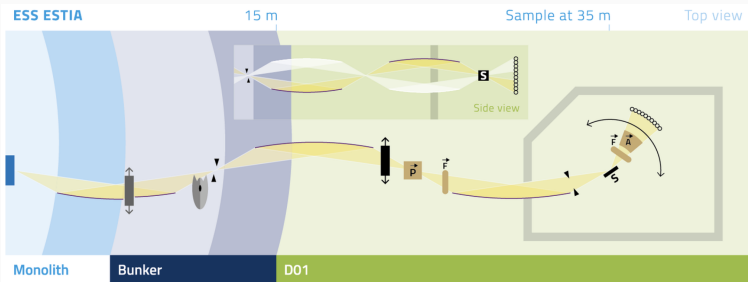
1. shorten and go for 1 feeder, only



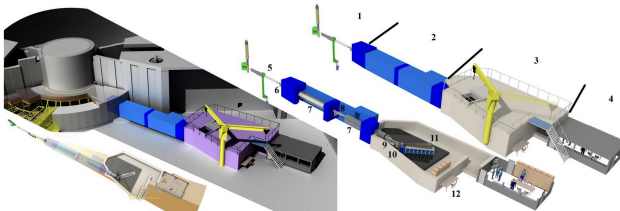
2. find someone who can realise the instrument



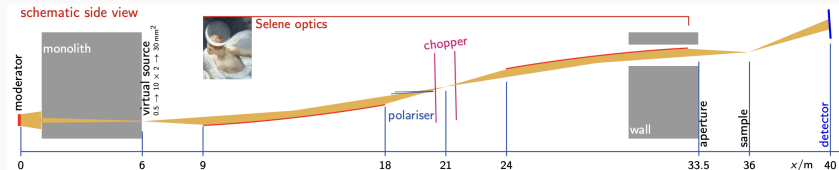
the hard matter reflectometer Estia



Schematic drawing of ESS ESTIA instrument.



2019 replacement of the old guide with a Selene optics



half-way operational since 2021

used for testing:

- measurement schemes
- polariser, monitor, MB detector
- counting chain
- data reduction

and for

- user experiments

the Selene optics



1 of 6 units, each with 6 guide elements

as a test facility for ESS

- MB detector: huge success!
- CDT monitor: not working (on the software side)
- polariser: works very good here, Estia will get an adapted copy
- NICOS: still lot of work to be done for easy user operation
- filewriter: still using version 1.0.0
 - looking forward to upgrade
- test experiments:
 - hard matter: good
 - soft matter: failure
 - (intrinsic background and hardware problems)
- data reduction: Amor scheme was realised in `scipp`

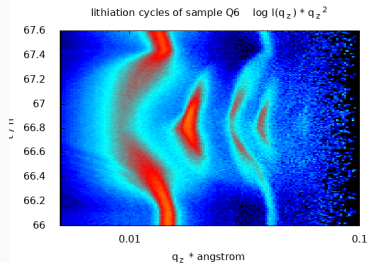
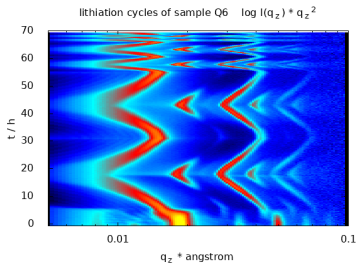
experiences

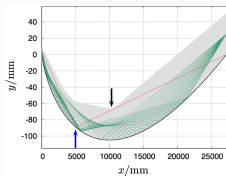
- alignment, data collection and reduction are complicated for (new) users
⇒ high demand for support until routines are established
- high-intensity mode works very good for solid samples
- high off-specular or diffuse scattering make data fitting difficult in wide-divergence mode
(solid-liquid cells, trough, sample environment)

experiences

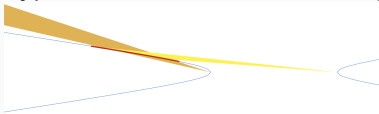
recent measurement:

- lithiation cycles of a multilayer electrode
- area: 20 mm²
- time resolution: 10 min and 30 s

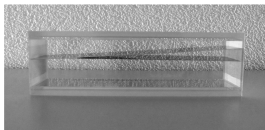
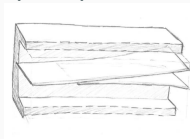




- spiral guide as feeder
- hyperbolic reflector for focusing on the detector



- spiral polariser



→ Jos