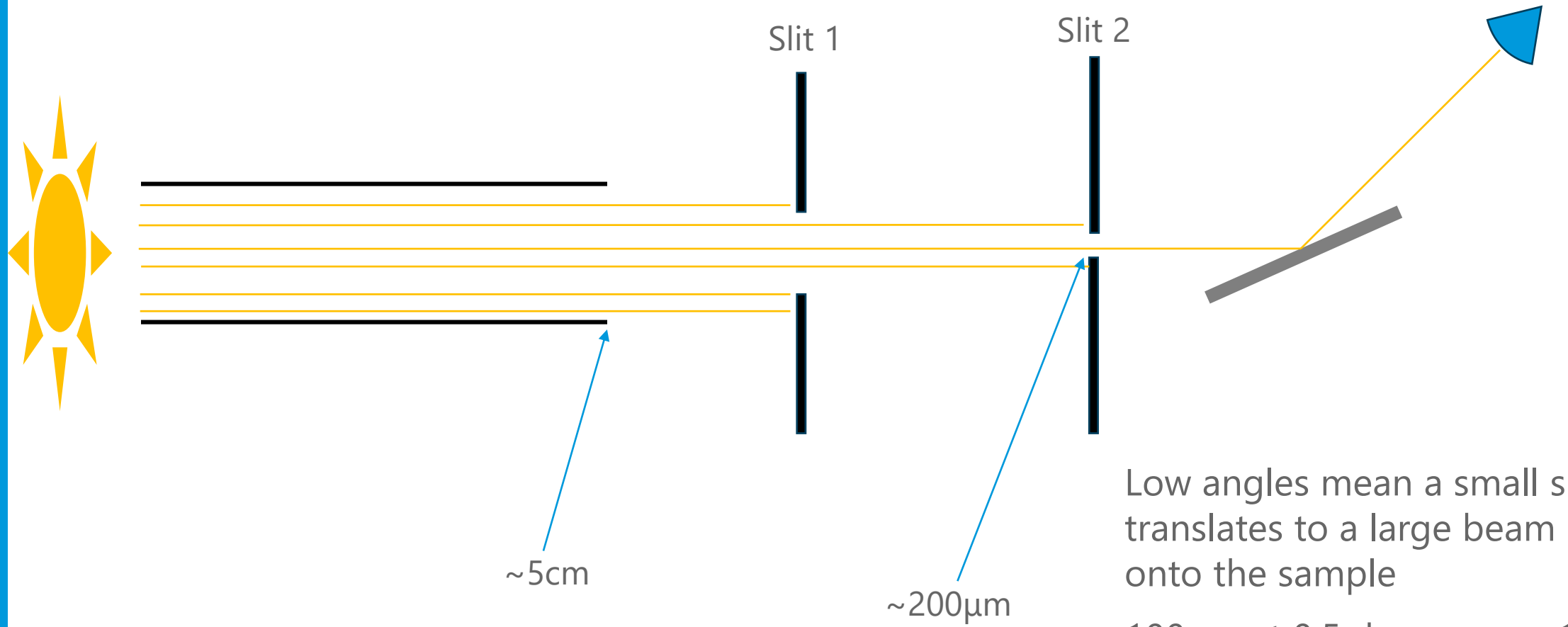
The ESTIA beamline

PRESENTED BY JOS COOPER

Neutron Reflectometry

Instruments



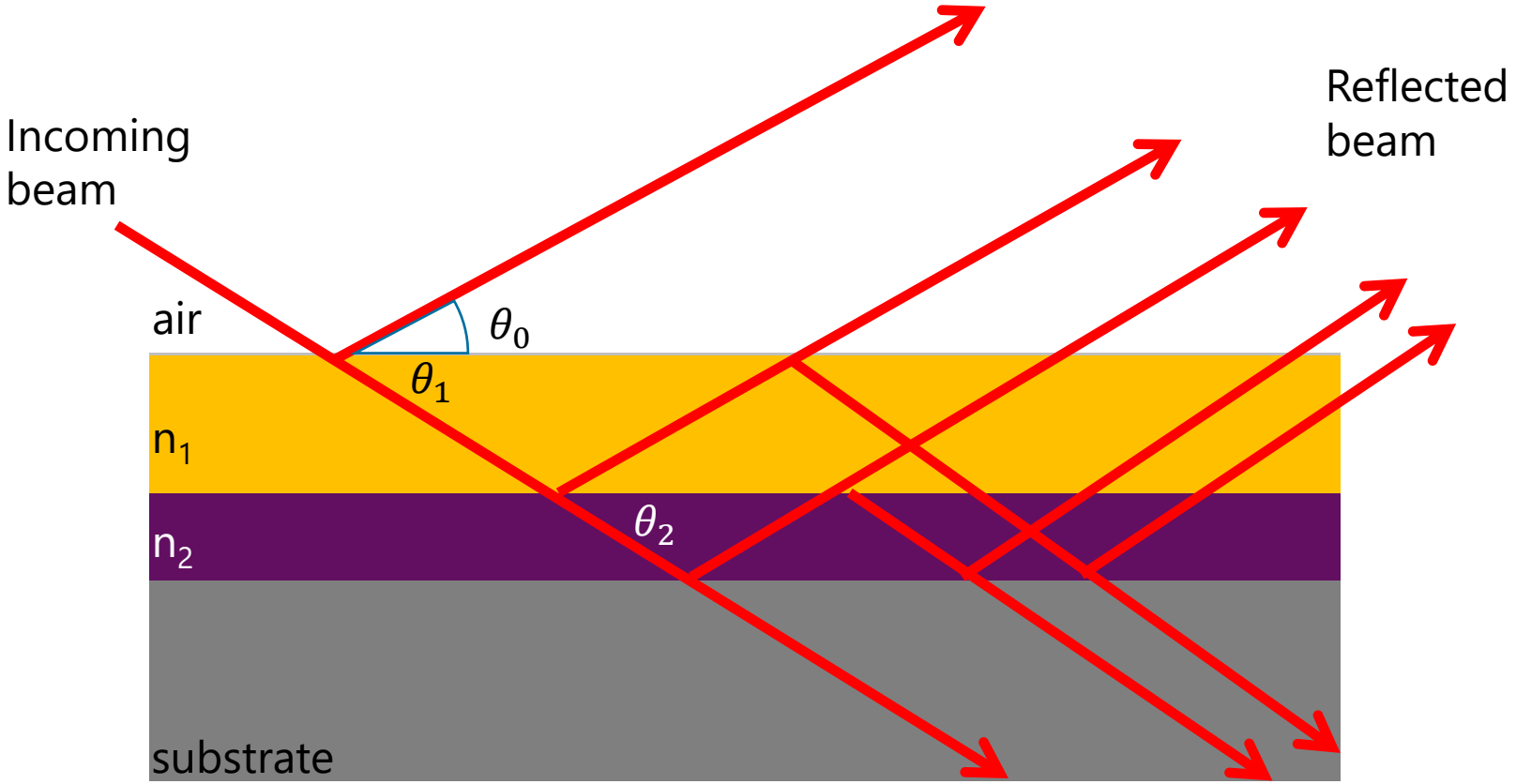
Low angles mean a small slit 2 gap translates to a large beam projection onto the sample

100µm at 0.5 degrees = >11.5 mm footprint

Lots of lost neutrons, large footprints on samples

Neutron Reflectometry

Basics

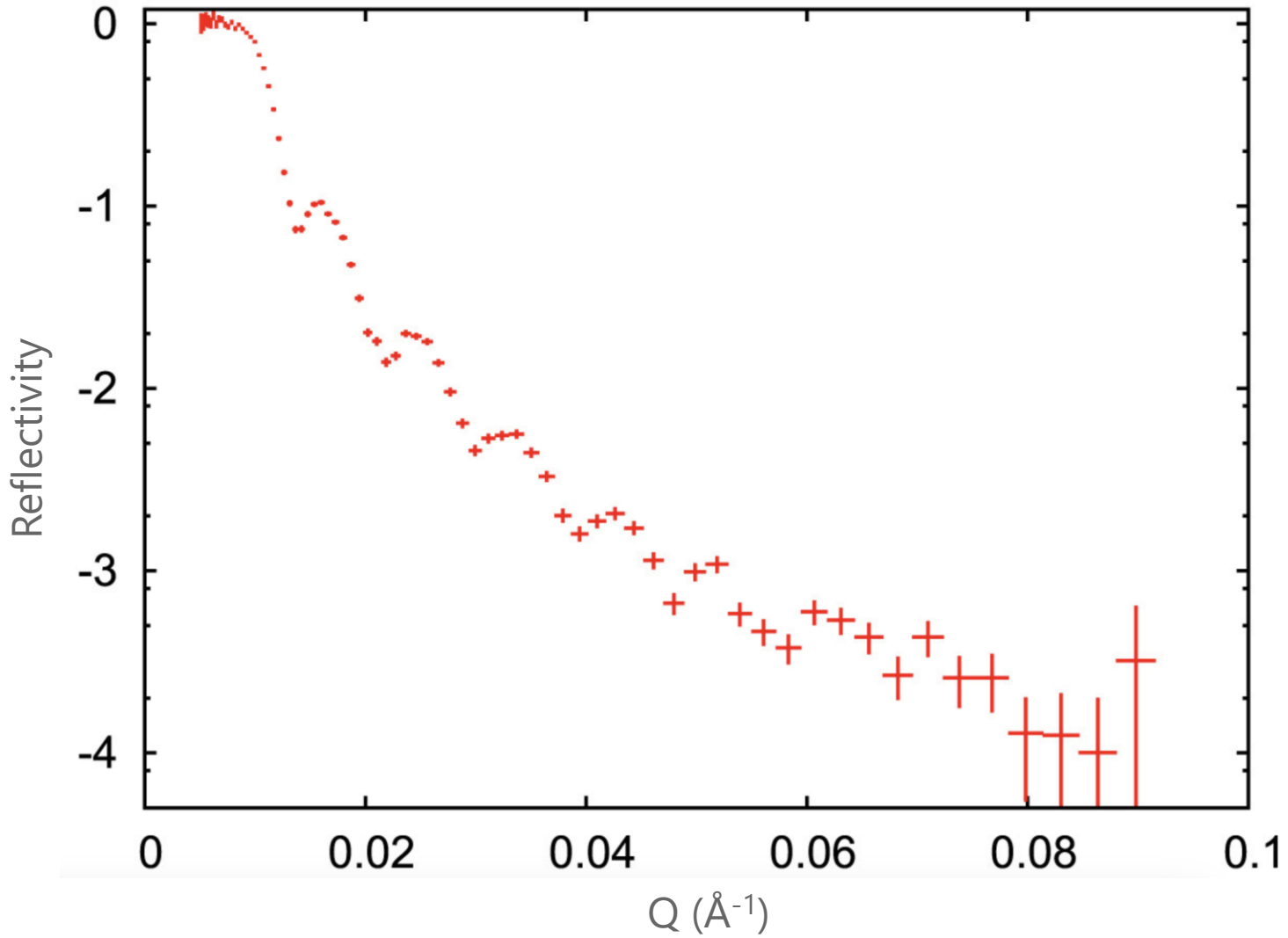


$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$Q = \frac{4\pi \sin\theta}{\lambda}$$

$$n\lambda \neq 2d \sin\theta$$

Neutron Reflectometry



Neutron Reflectometry

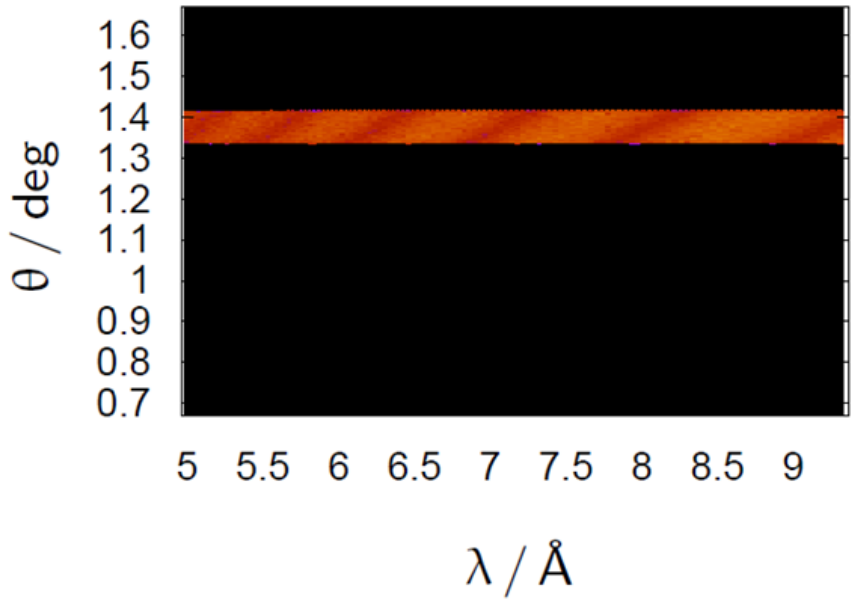
Instruments

$$Q = \frac{4\pi \sin\theta}{\lambda}$$

Time of Flight

A range of wavelengths at a fixed angle:

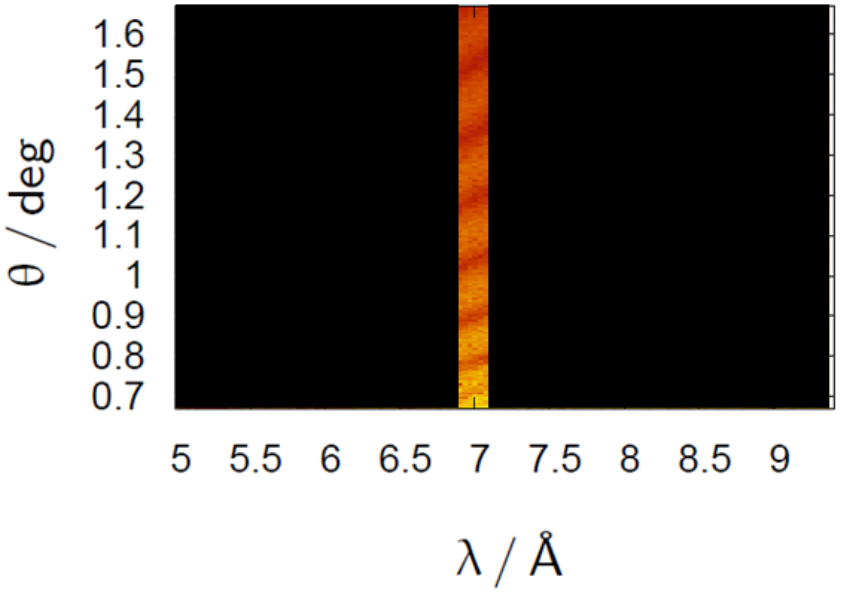
$$[Q_{min}, Q_{max}] = \frac{4\pi \sin\theta}{[\lambda_{max}, \lambda_{min}]}$$



Monochromatic

A range of measured angles at a fixed wavelength:

$$[Q_{min}, Q_{max}] = \frac{4\pi \sin[\theta_{min}, \theta_{max}]}{\lambda}$$



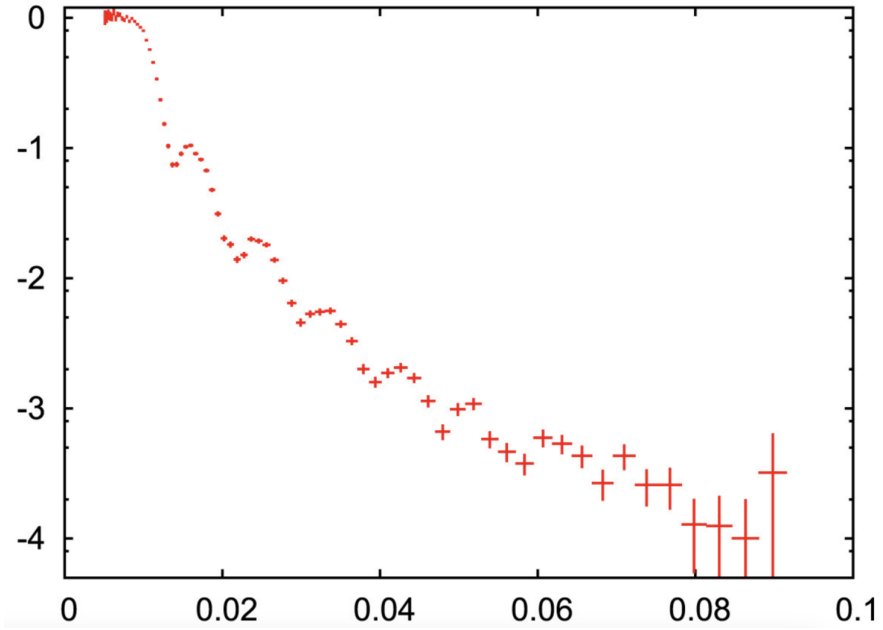
Selene Guide Concept

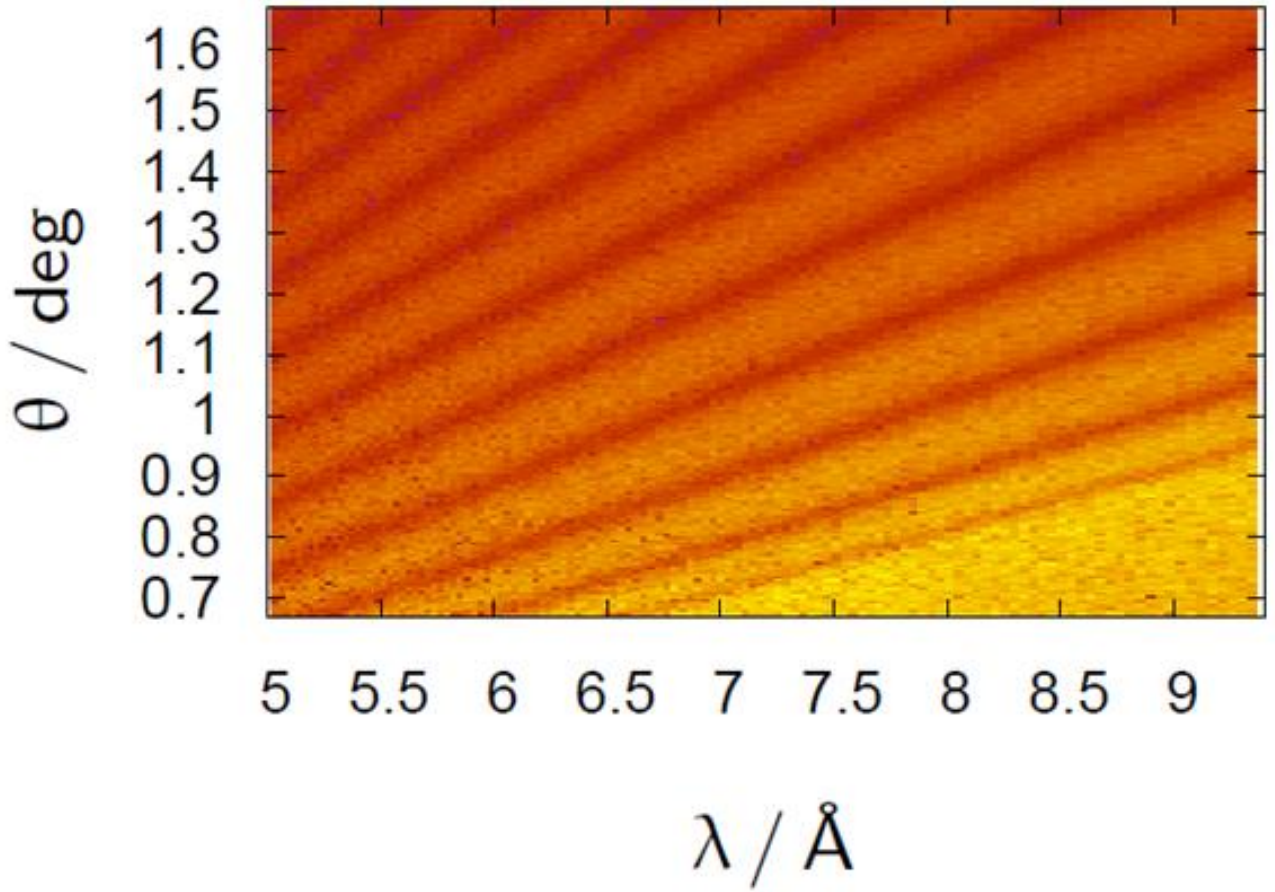
Instruments

$$Q = \frac{4\pi \sin\theta}{\lambda}$$

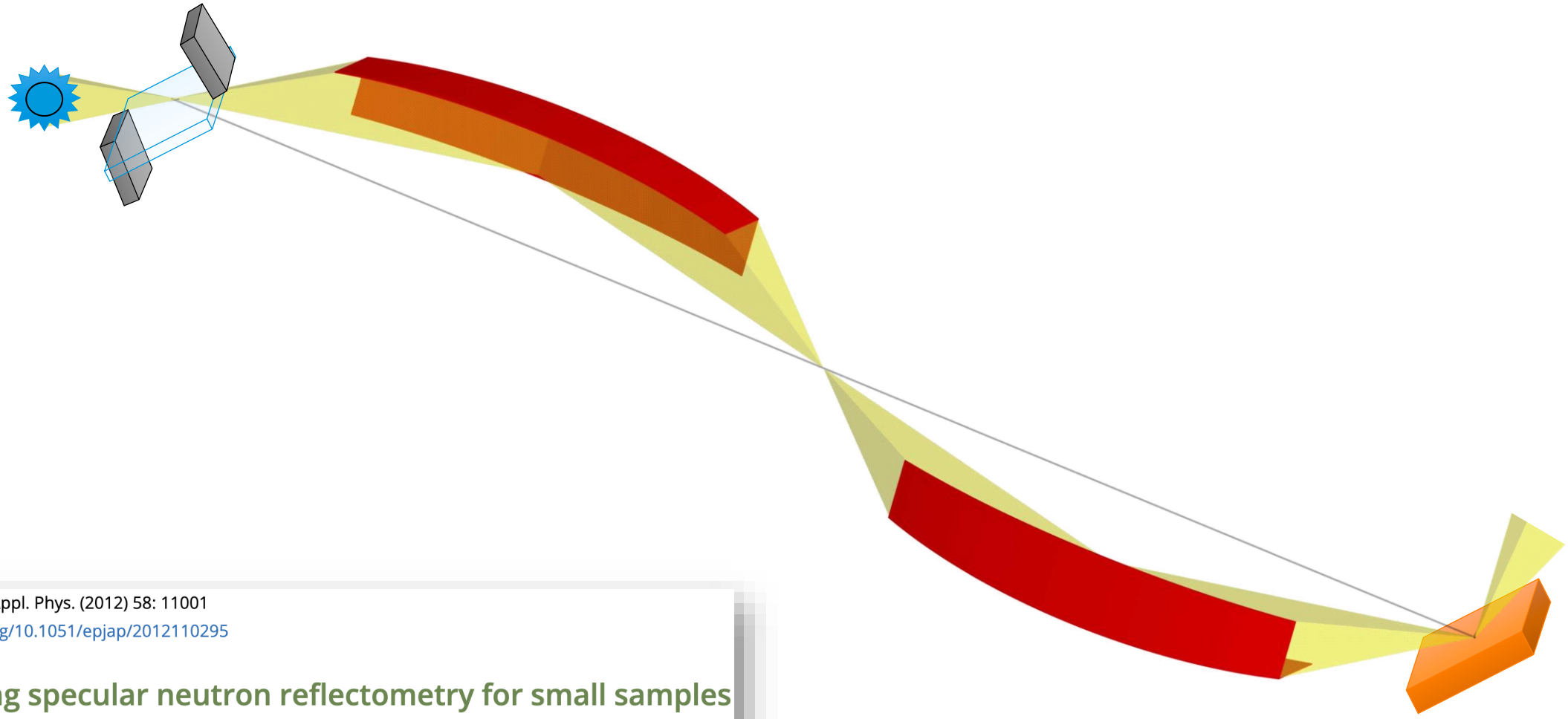
Selene guide on a ToF source:

$$[Q_{min}, Q_{max}] = \frac{4\pi \sin[\theta_{min}, \theta_{max}]}{[\lambda_{max}, \lambda_{min}]}$$





Selene Guide Concept



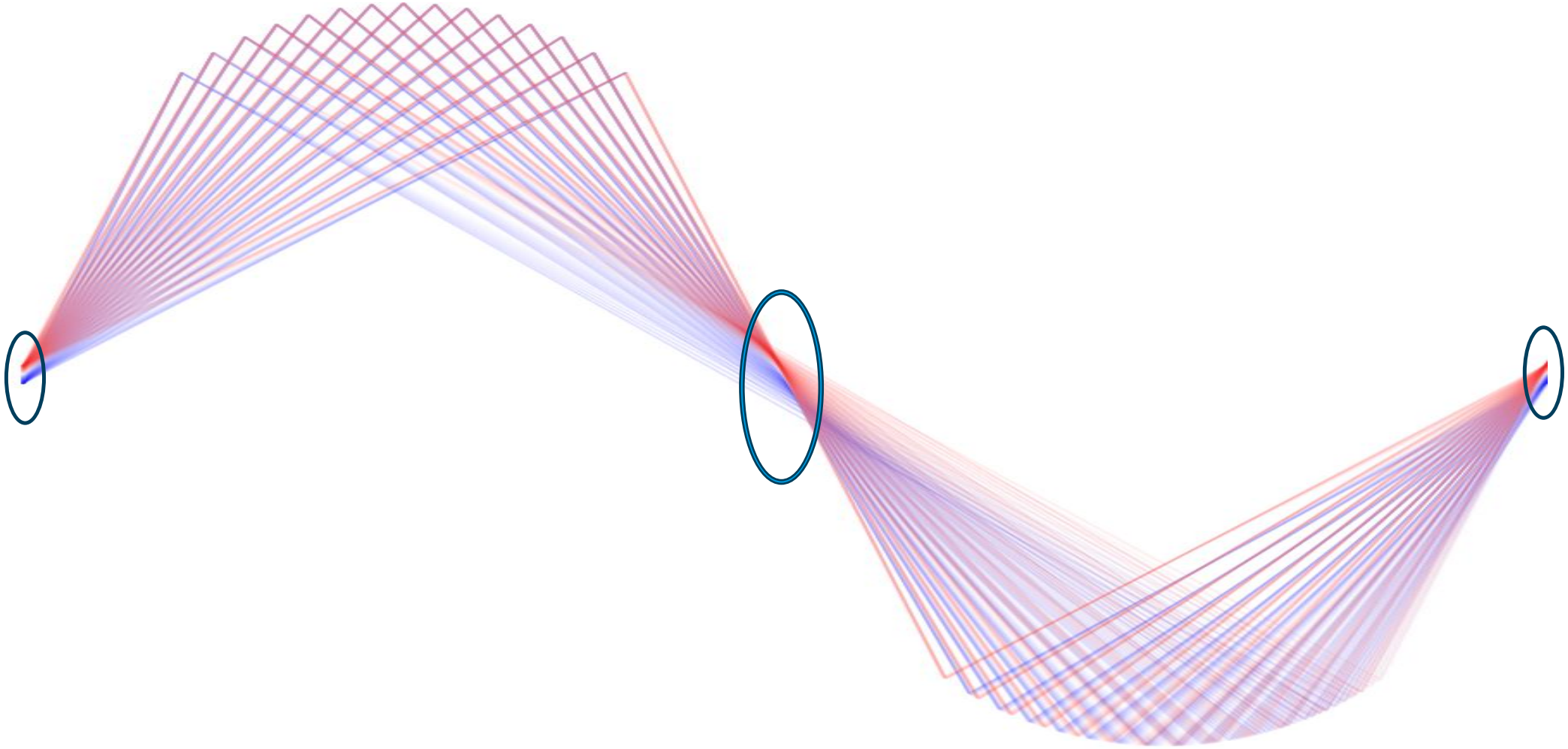
Eur. Phys. J. Appl. Phys. (2012) 58: 11001
https://doi.org/10.1051/epjap/2012110295

Focusing specular neutron reflectometry for small samples

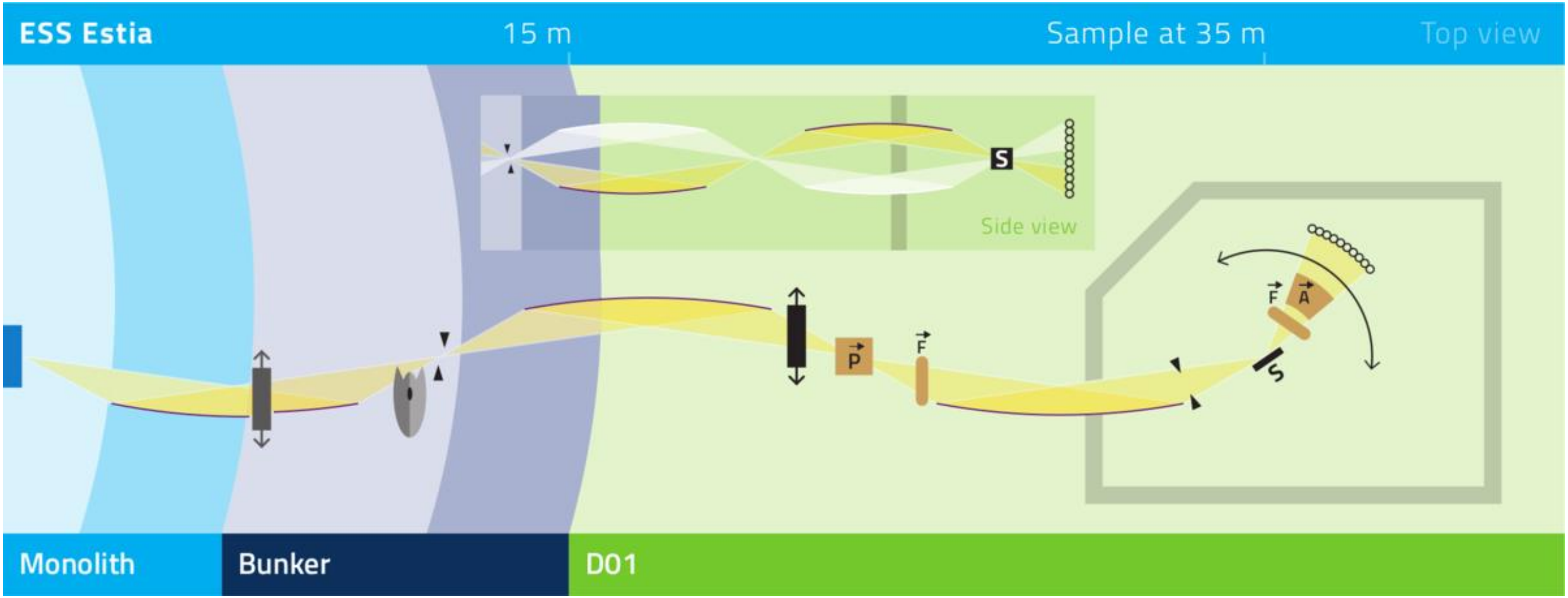
J. Stahn[1a], U. Filges[2] and T. Panzner[2]

Selene Guide Concept

Coma Aberration



The ESTIA Instrument



ESTIA

Science Case

- Magnetic systems
  - Small samples with polarisation
- *In operando* measurements
  - High flux
- High throughput measurements of e.g. biological samples
  - Low backgrounds

A reflectometer generally wants most of these features but having Selene guides and polarisation built into its heart allows ESTIA to focus on its abilities

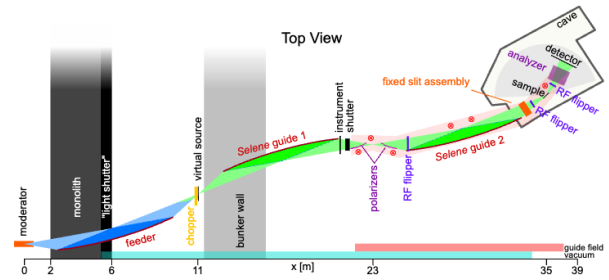


Figure 3.2: *Estia* instrument overview

EUROPEAN SPALLATION SOURCE

Concept of Operations for Polarized Reflectometer (Estia)

Version 1.3

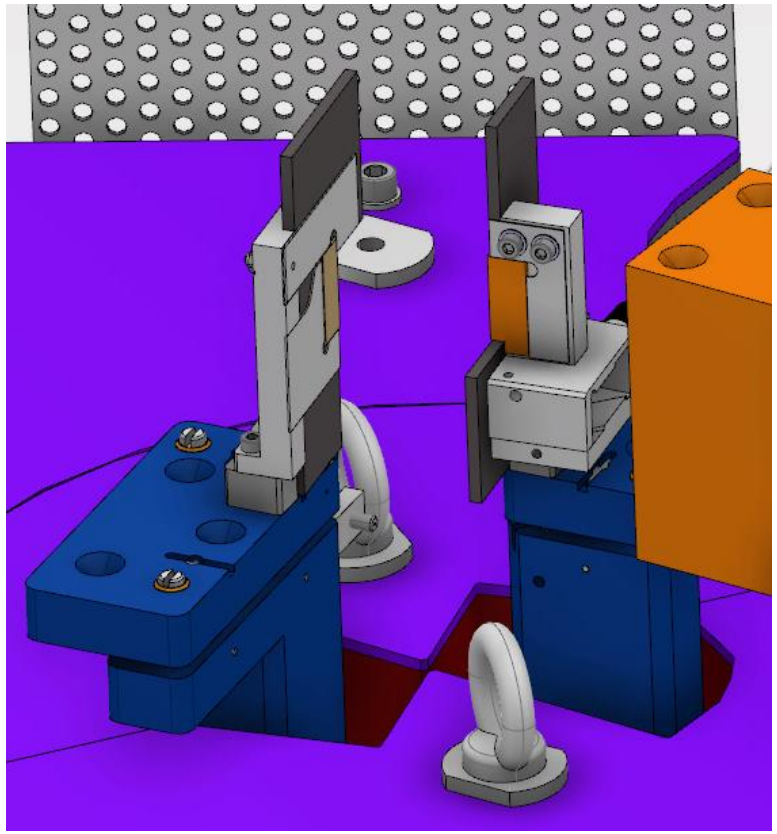
	Name	Affiliation
Authors	Artur Glavic, Sven Schütz	PSI
Reviewers	Jorgen Andersson	ESS
	Phil Bentley	ESS
	Thomas Gahl	ESS
	Francesco Piscitelli	ESS
	Hanna Wacklin	ESS
TG2 Review Committee	Shane Kennedy (Chair)	ESS
	Ken Andersen	ESS
	John Ankner	STAP
	Robert Cubitt	STAP
	Sylvain Désert	LLB
	Richard Hall-Wilton	ESS
	Arno Hiess	ESS
	Gábor László	ESS
	Iain Sutton	ESS
Approver	Andreas Shreyer	ESS

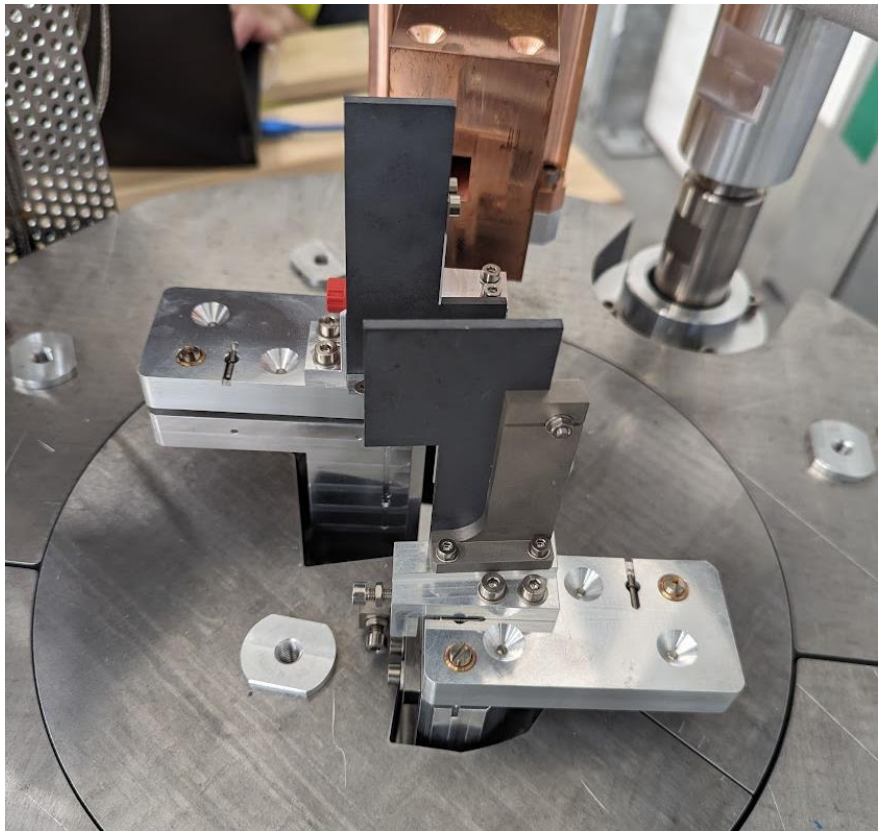
March 6, 2017

ESTIA

Small Samples

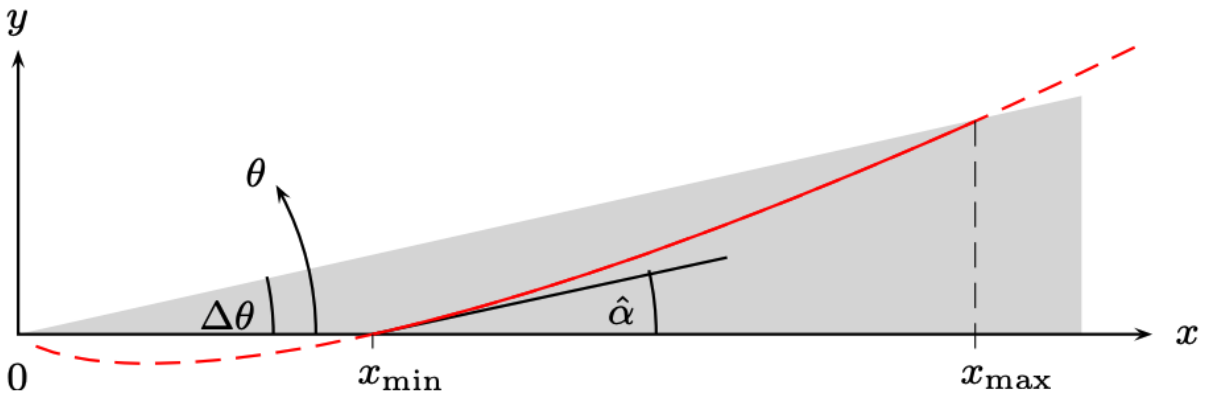
- The collimation on ESTIA is done at the “virtual source” – the point where we decide what neutrons to bring to the sample point (almost 30m from detector)
- 3D slit defines focus size - mirrors beam distribution on the sample point



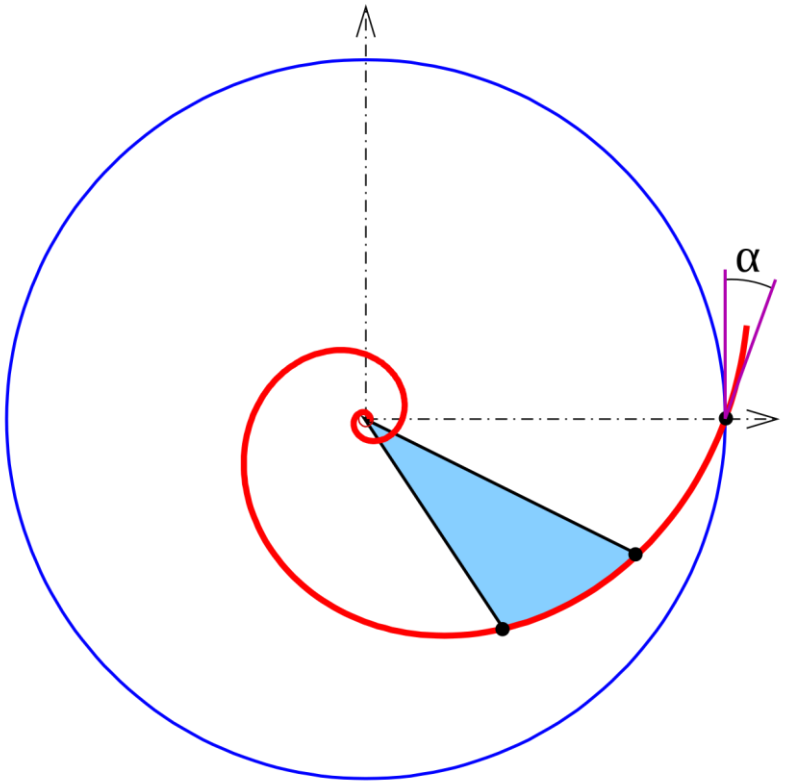


ESTIA

Polarisation



$$r = ae^{k\varphi}$$



Efficient polarization analysis for focusing neutron instruments

Jochen Stahn[1] and Artur Glavic[1]

Journal of Physics: Conference Series, Volume 862, International Conference on Polarised Neutrons for Condensed Matter Investigations (PNCMI 2016) 4–7 July 2016, Munich (Freising), Germany

Citation Jochen Stahn and Artur Glavic 2017 *J. Phys.: Conf. Ser.* **862** 012007

DOI 10.1088/1742-6596/862/1/012007

https://commons.wikimedia.org/w/index.php?curid=81406863

ESTIA

Polarisation

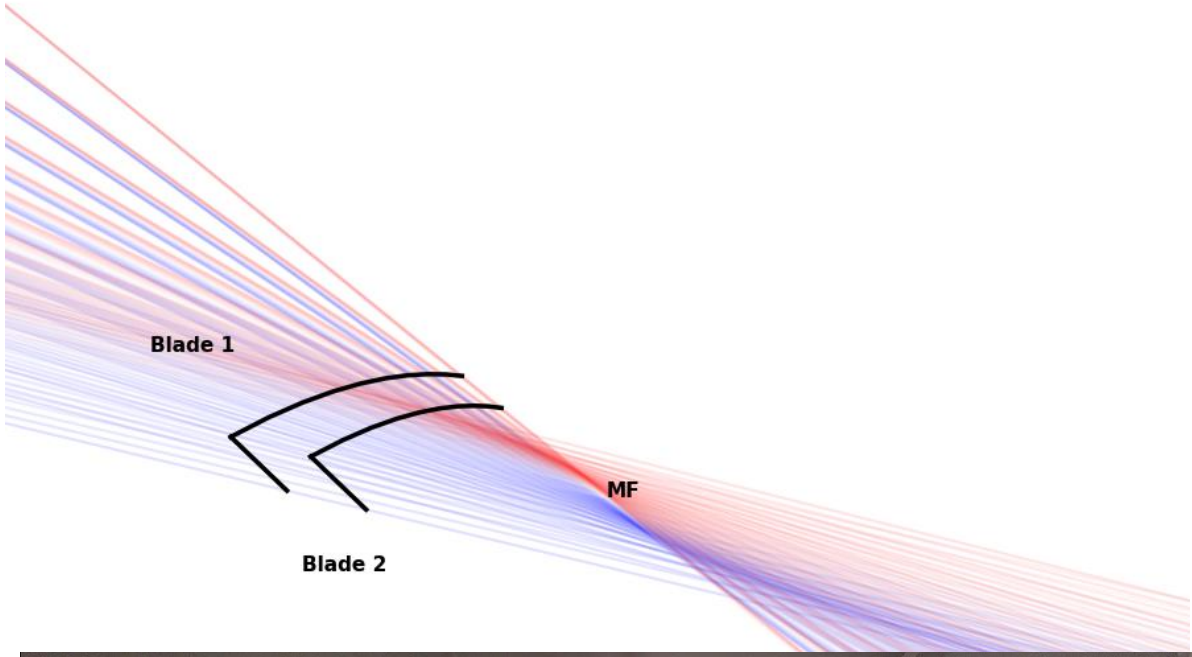
Two transmission polarisers in series

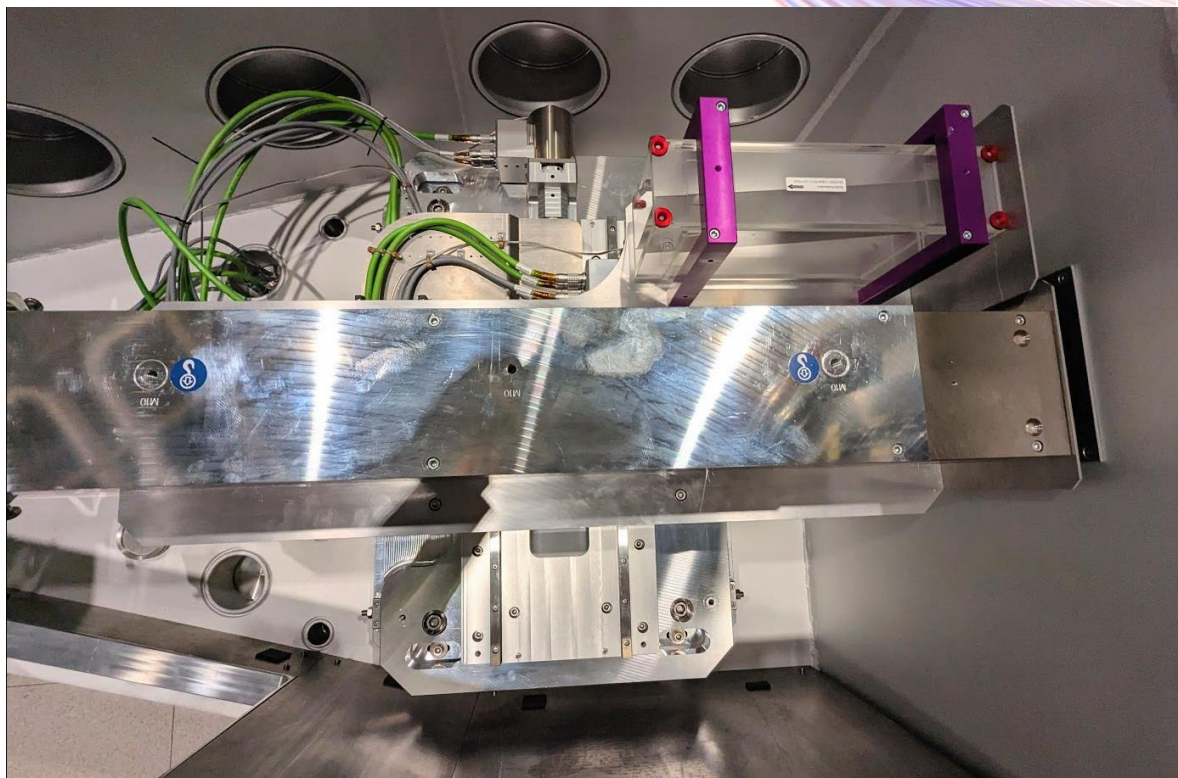
- Improved polarisation

Part logarithmic spiral and part linear

- Linear covers rays created by coma which are almost parallel
- Pointing backwards to make device shorter
- Both sides coated with m=5 Fe/Si

Device is almost 1m long

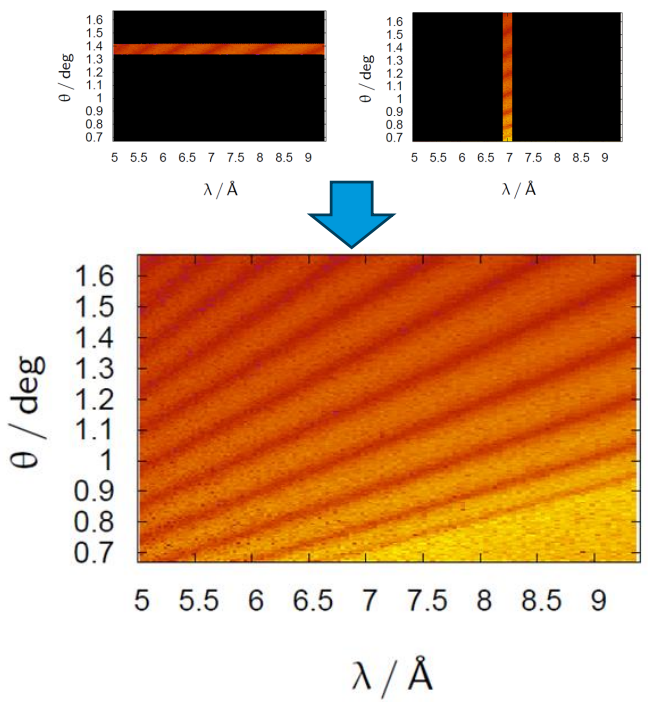




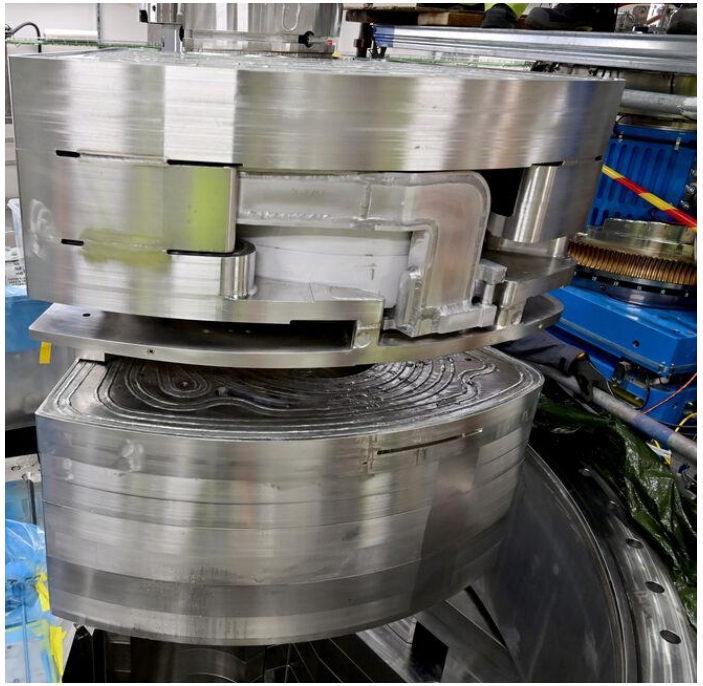
ESTIA

High flux

- Divergent beam covers much larger Q space resulting in equivalent flux gain
- Moderator design leads to flux gain over existing spallation sources
- Accelerator energy leads to flux gain over existing sources



~10x flux



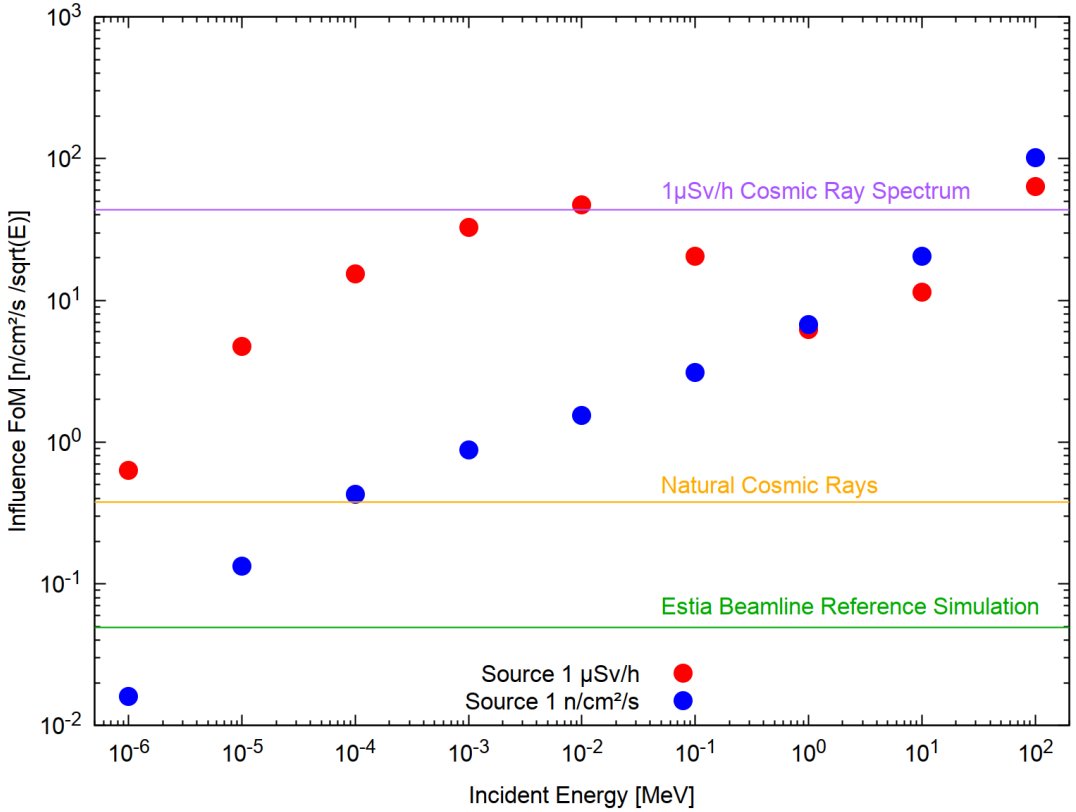
~10x flux

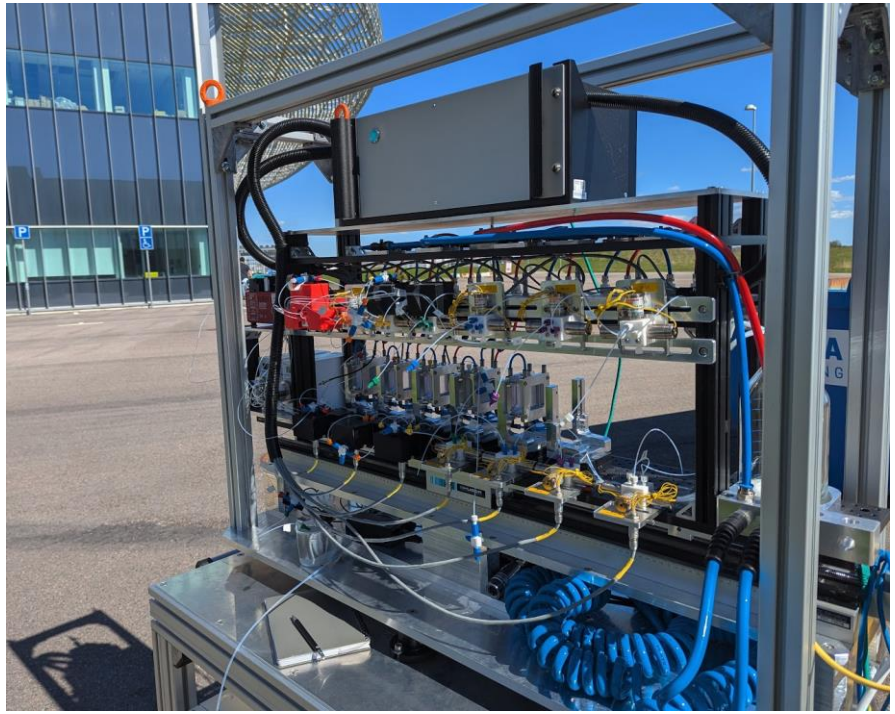
~5x flux

ESTIA

Low Backgrounds

- Elimination of line of sight three times from moderator/target
- Lots of shielding around the beam
- Enabling measurements solely of sample backgrounds





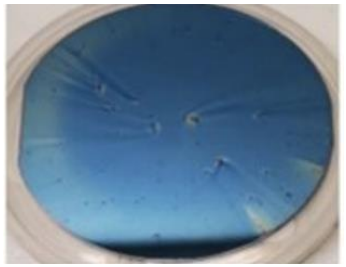
ESTIA

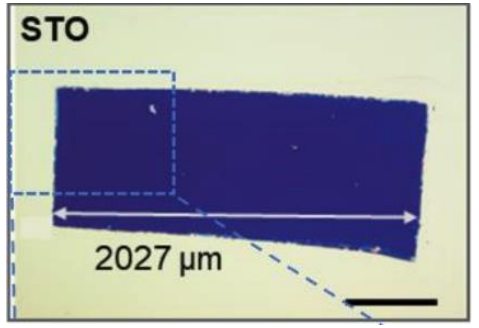
Science Case

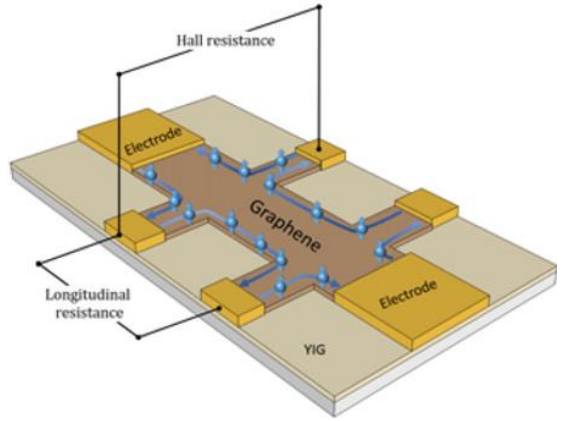
- Magnetic systems
  - Small samples with polarisation 
- *In operando* measurements
  - High flux 
- High throughput measurements of e.g. biological samples
  - Low backgrounds 

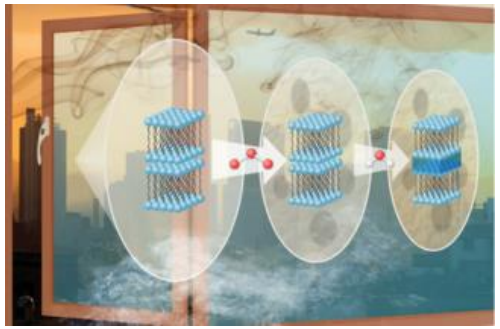
ESTIA Science

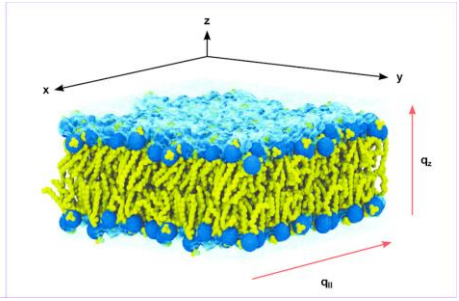
- Spin coated samples
  - Just measure the best spots!
- Freestanding oxide membranes
  - Only measure the membranes
- Working devices
- Atmospheric chemistry
- Surfactants – soaps/lubricants
- Lipid bilayers -biology
- Composition exploration studies
  - Co-sputtering or temperature gradients
- Li ion batteries
- Complex magnetic heterostructures
- Off specular and GI-SANS

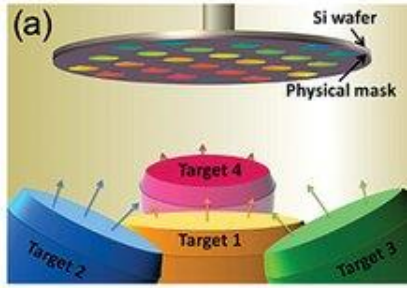


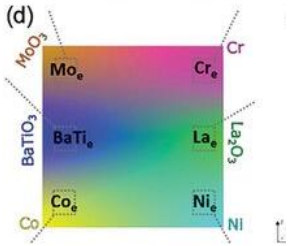


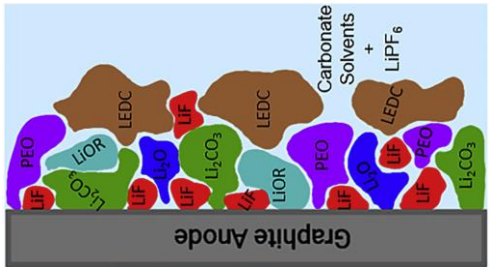


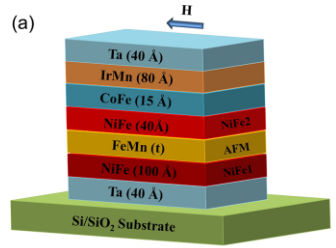


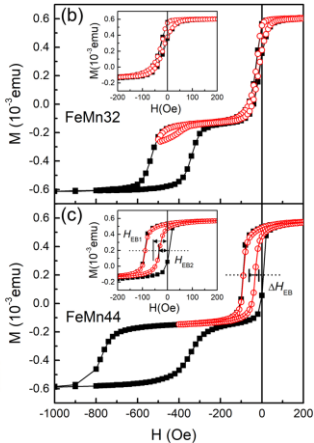












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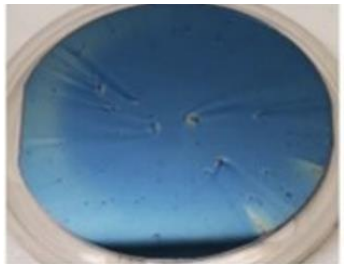

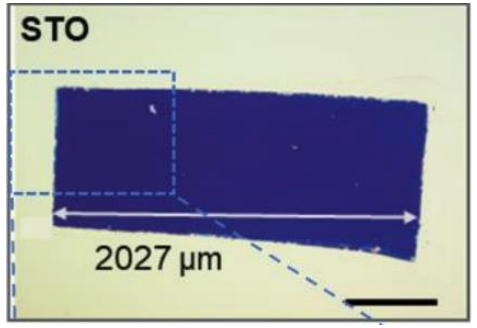

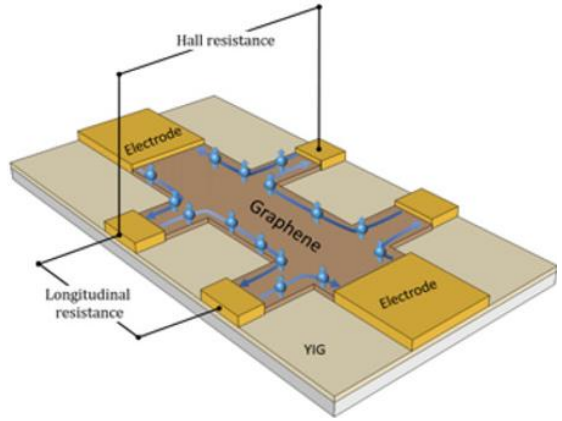

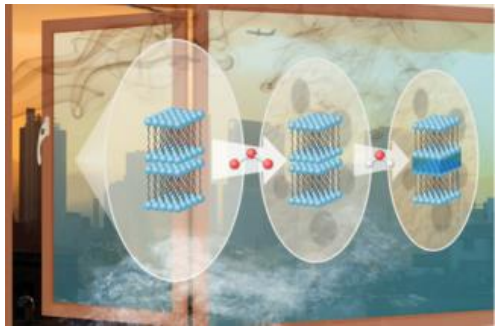

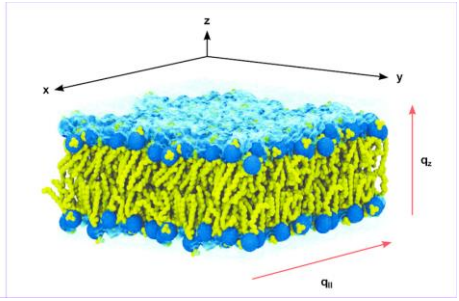

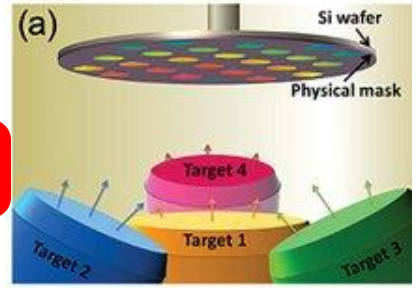

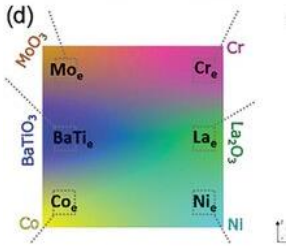

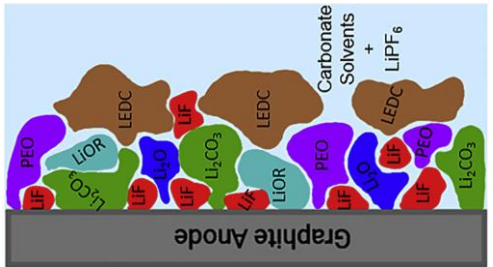

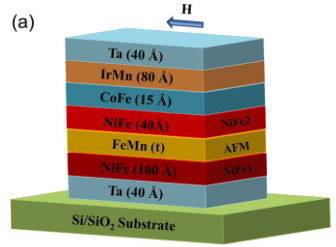

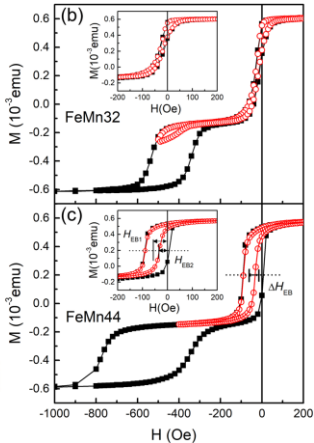

EUROPEAN
SPALLATION
SOURCE