LoKI
A Broad Band High Flux SANS Instrument for the ESS

A Jackson, K Kanaki, R Hall-Wilton, P Bentley and K Andersen

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EUROPEAN SPALLATION SOURCE

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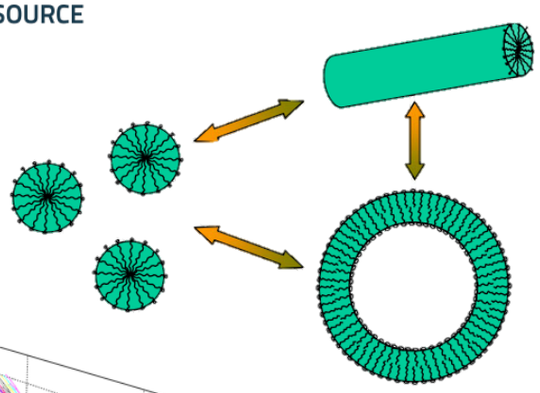

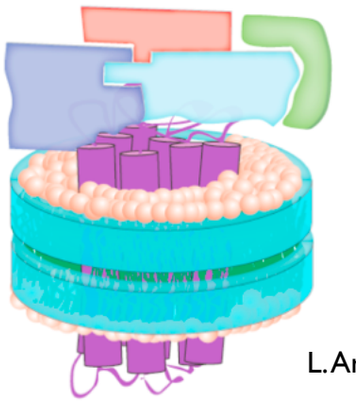

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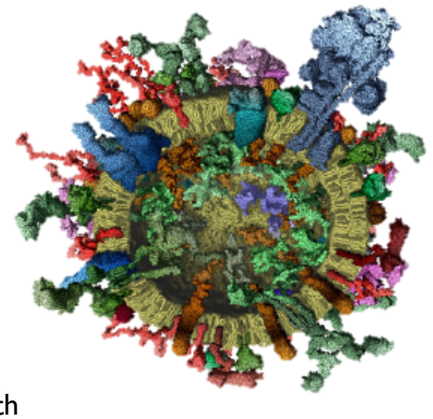
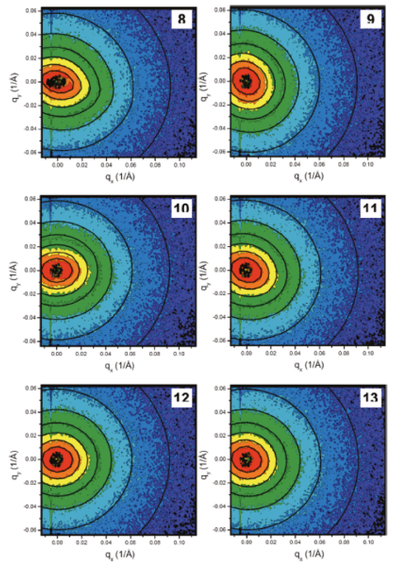
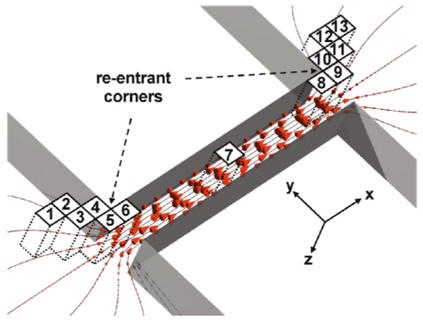
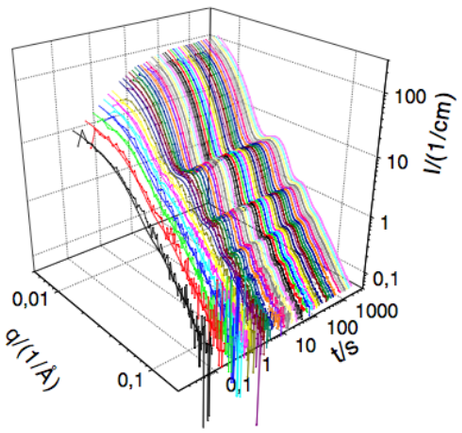






Clarke et al. (2010) Macromolecules 43, 1539



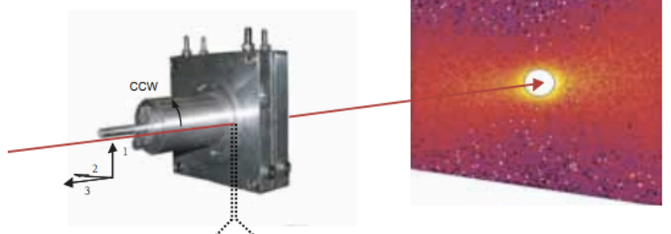
Bressel et al. (2010) Coll. and Polym. Sci. 288, 827

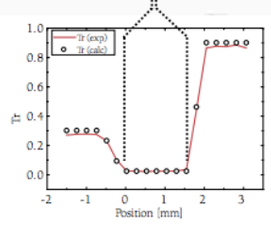
Bio-molecular Complexes

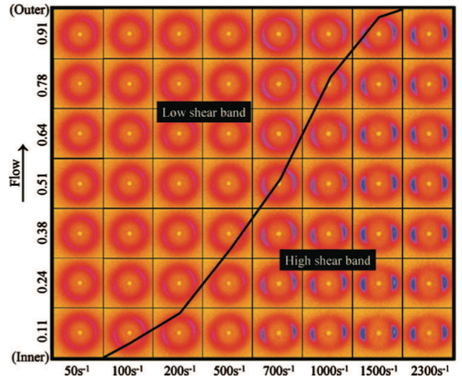
Kinetics

Complexity & Heterogeneity

Flow Mapping

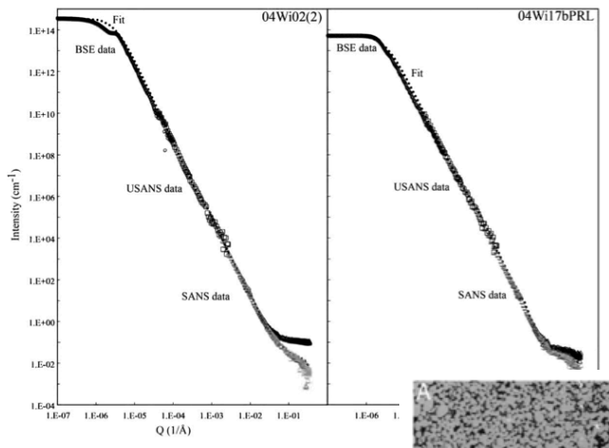


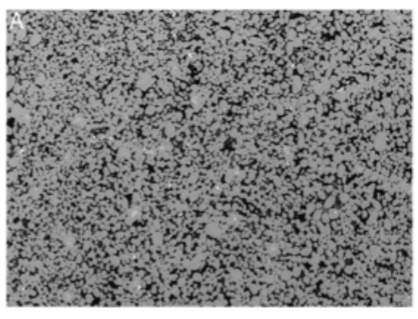




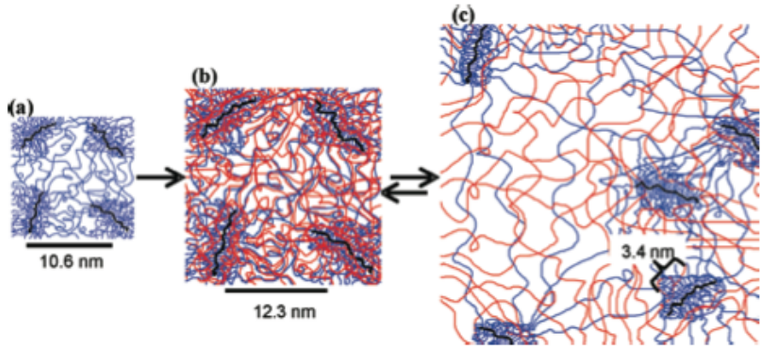
Helgeson et al. (2009) J. Rheol 53, 727

Hierarchical Structures





Anovitz et al. (2012) In Press.



Waters et. al (2011) Macromolecules 44 5776

Goals

A broad Q range, high flux SANS instrument for soft matter and bio-science.

Science Based Goals

- Rapid data collection / short counting times to enable kinetics
- Probe broad size range to examine hierarchical structures
- Small sample volumes for scanning and biological samples
- Integrated flexible sample environment for non-equilibrium studies
- Simplicity of operation to allow users to focus on science

Goals

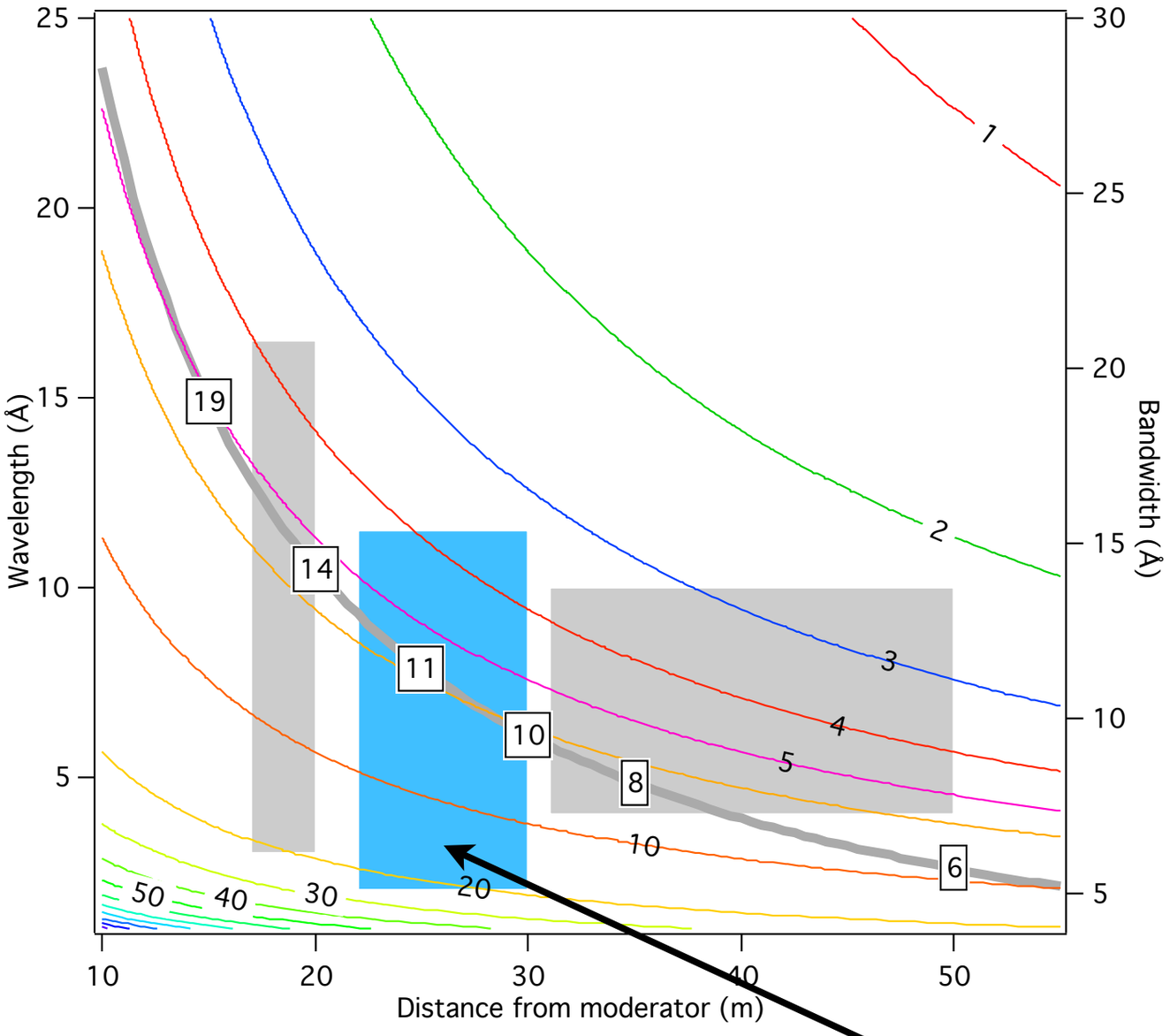
A broad Q range, high flux SANS instrument for soft matter and bio-science.

Technological Goals

- Broad simultaneous Q range of at least 1000x (< 0.001 $Å^{-1}$ to > 1 $Å^{-1}$)
- Good Q resolution over the whole Q range
- High flux making best use of ESS source
- Optimized use of new detector technologies

Goals

A broad Q range, high flux SANS instrument for soft matter and bio-science.



Design Constraints

- Avoid line-of-sight (background)
- Bandwidth vs Time Resolution (Q resolution)
- Space (sample environment)

Conclusion

•Detectors between 20 m and 30 m

Wavelength-Distance Space used by LoKI

Overview

Bender: r = 78 m
l = 4 m
4 channels
m = 3 to 4

Variable Opening Choppers

Frame Overlap Mirror

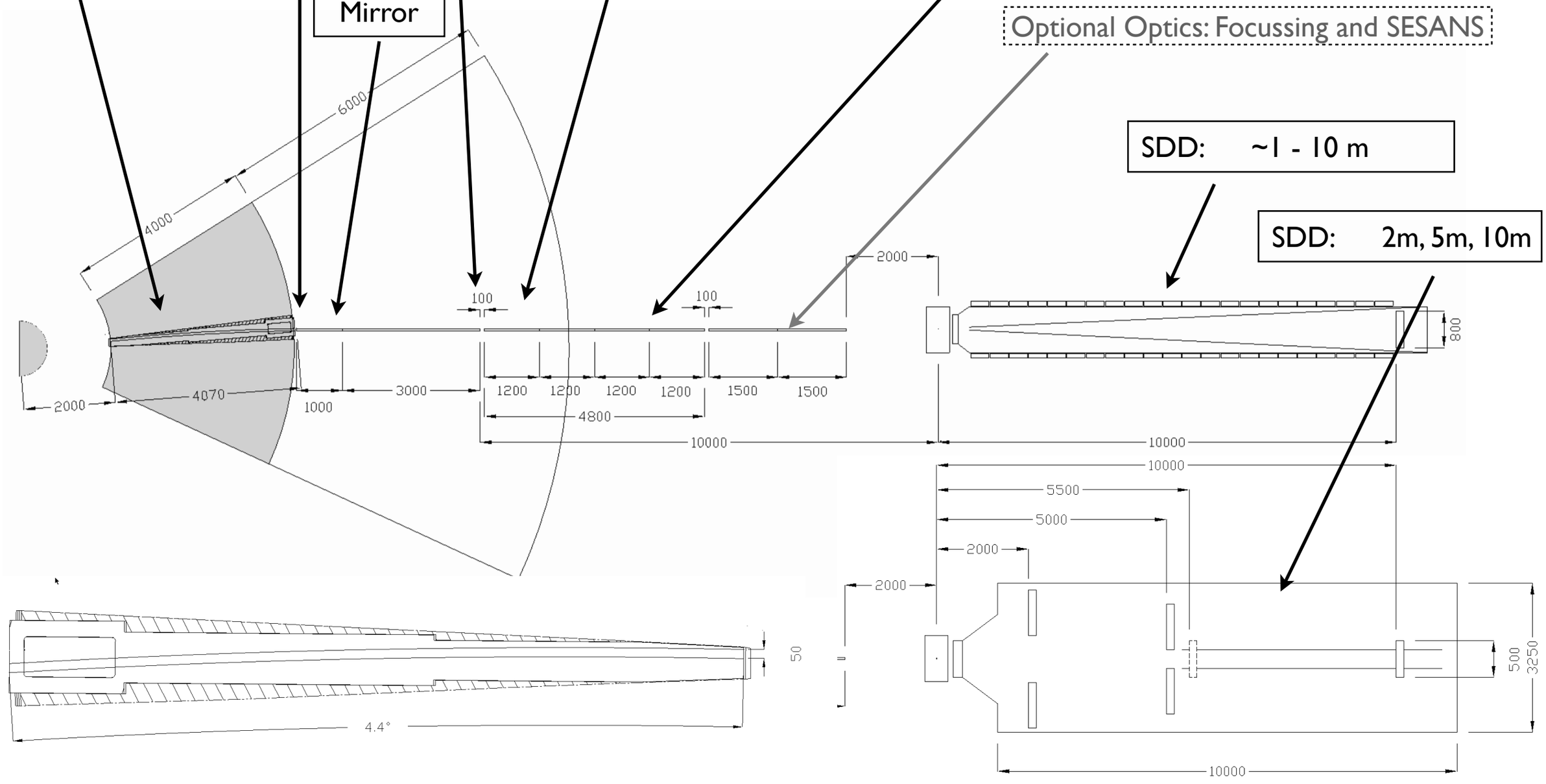
Guide: 3 cm x 3 cm
m=1

Collimation: Up to 10 m
A_1 = 20 mm, 10 mm, 8 mm, 4 mm

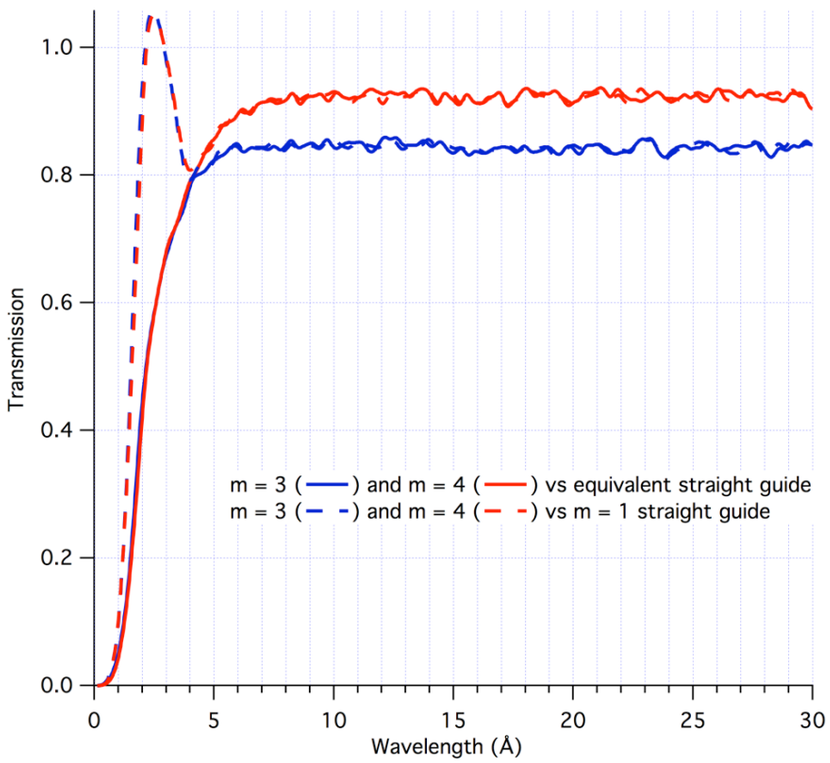
Optional Optics: Focussing and SESANS

SDD: ~1 - 10 m

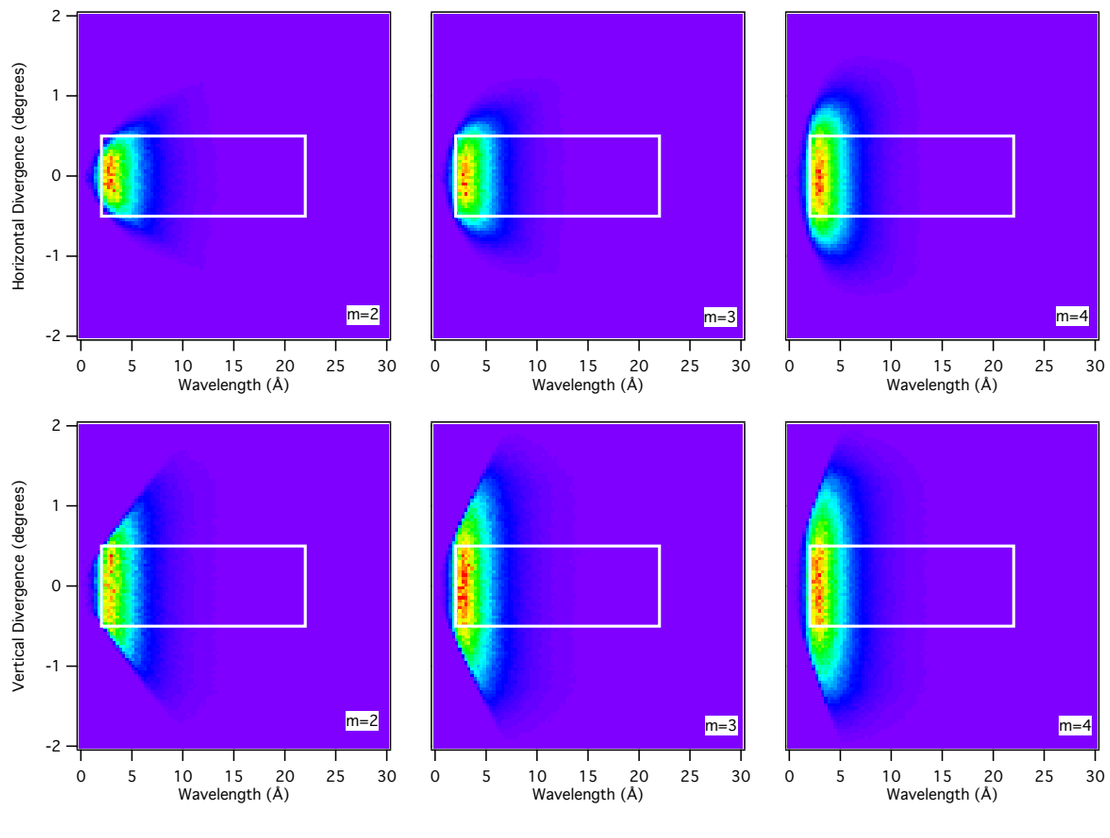
SDD: 2m, 5m, 10m

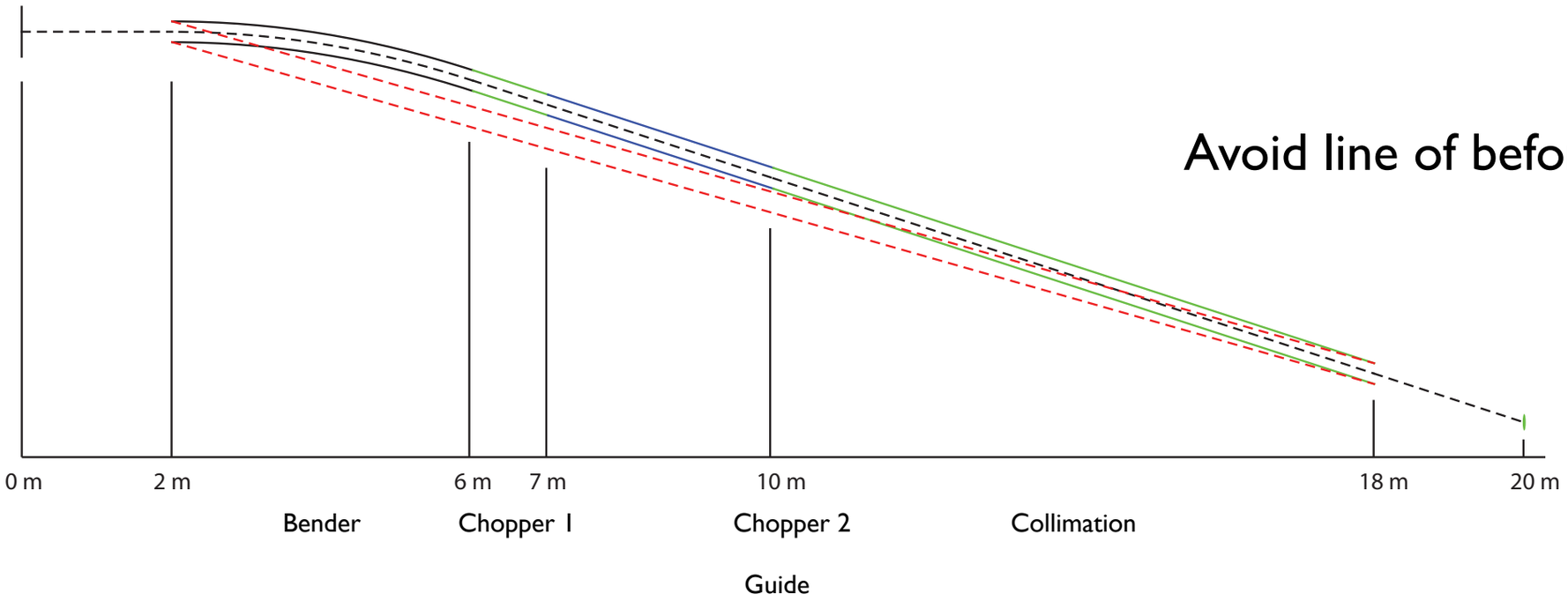


Bender Performance



- 78 m radius
- 4 m length
- 3 cm x 3 cm
- 4 channels
- m = 4

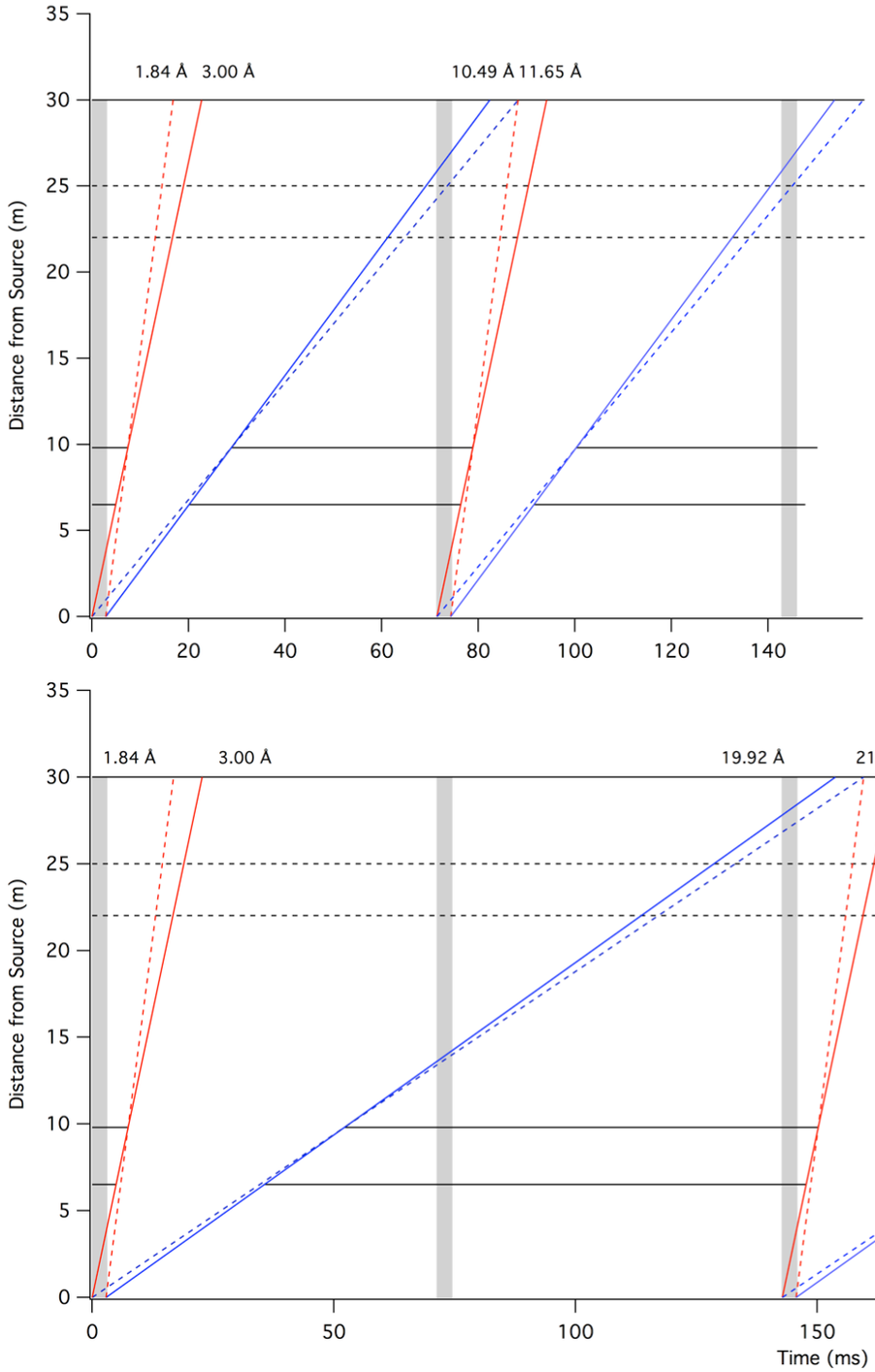




Avoid line of before start of collimation

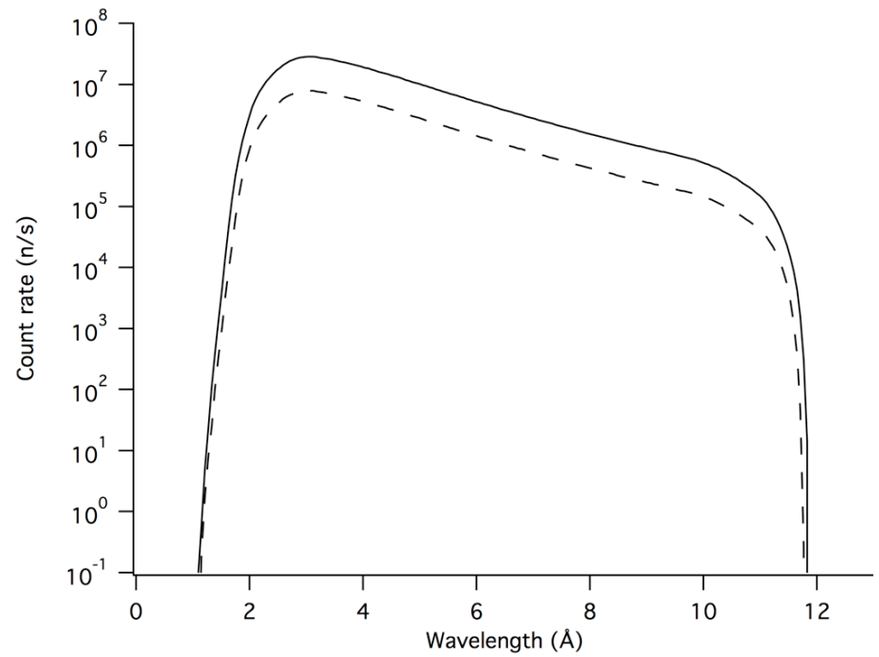
Wavelength Selection

Variable opening double disc choppers at 6.5 m and 9.8 m



14 Hz

3 - 10.5 Å



7 Hz

3 - 20 Å

Sample Position

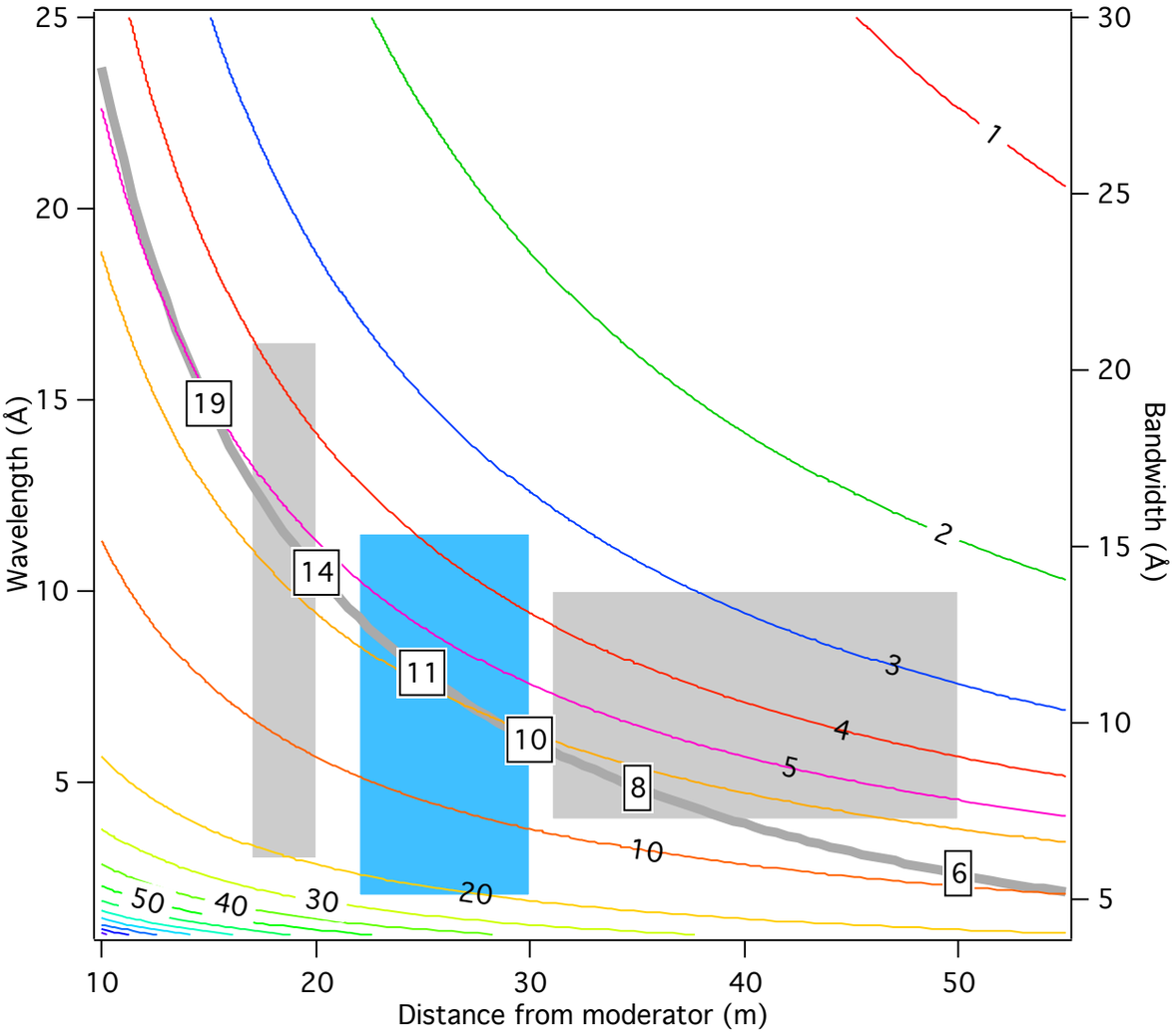
A **flexible** space with **2.5 m** along the beam and **3 m** perpendicular to the beam

A system of sample environment pallets that can be quickly interchanged allowing offline setup of equipment

Space for magnets, rheometers and shear cells, pressure cells, sample changers, auto-sampling robots, flow-through cells ... whatever the user can think of!

Space for complementary measurement techniques

Detectors



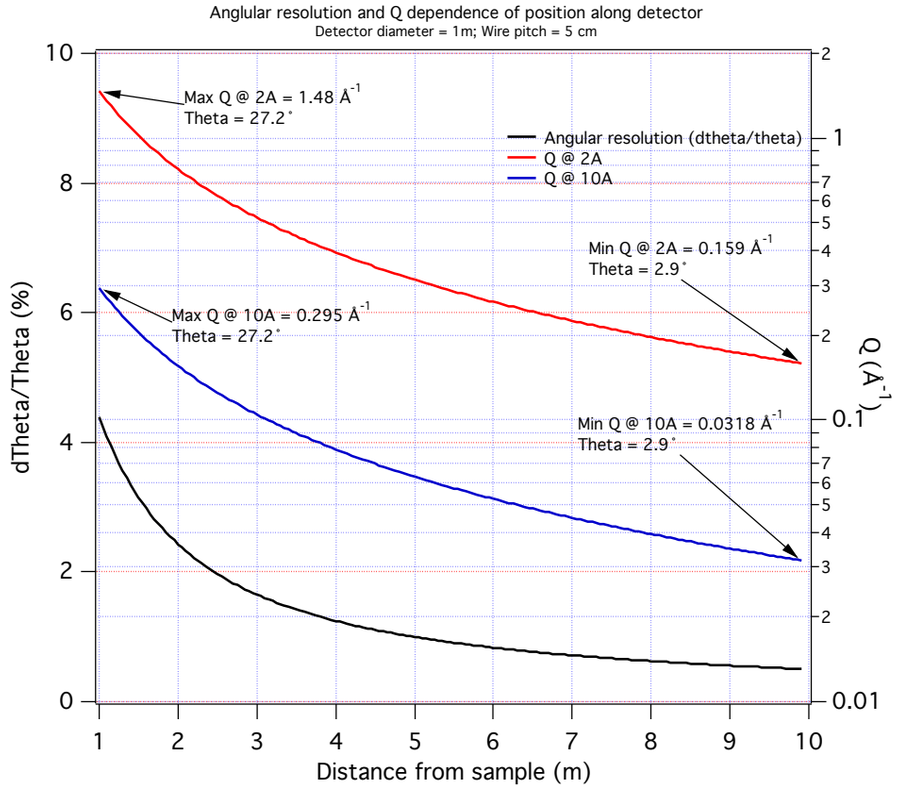
Require good Q resolution across whole Q range - high angle to reach high Q with long wavelengths.

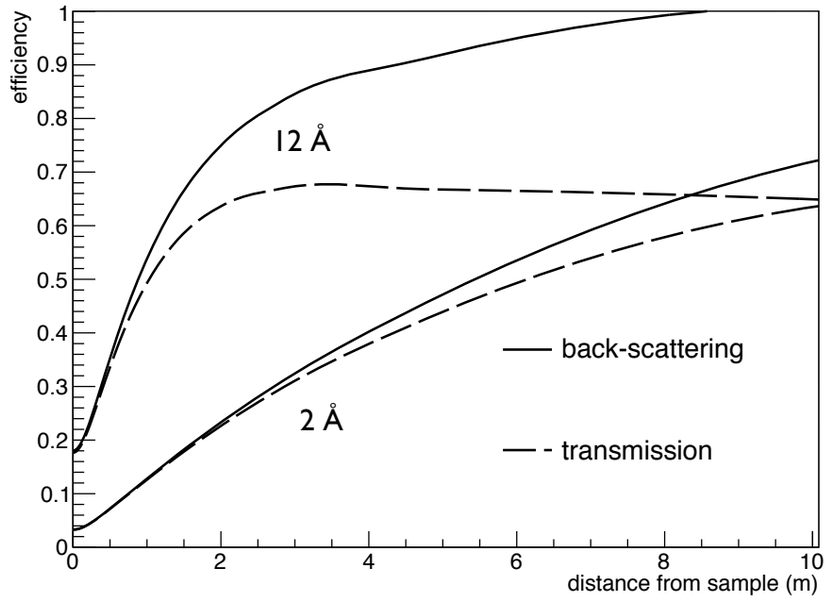
Need broad Q range - large solid angle of detectors and broad wavelength band.

High spatial resolution at low angles to reach low Q

^{3}He (probably) **not** an option - count rate and availability

"Lined Tube" Detectors

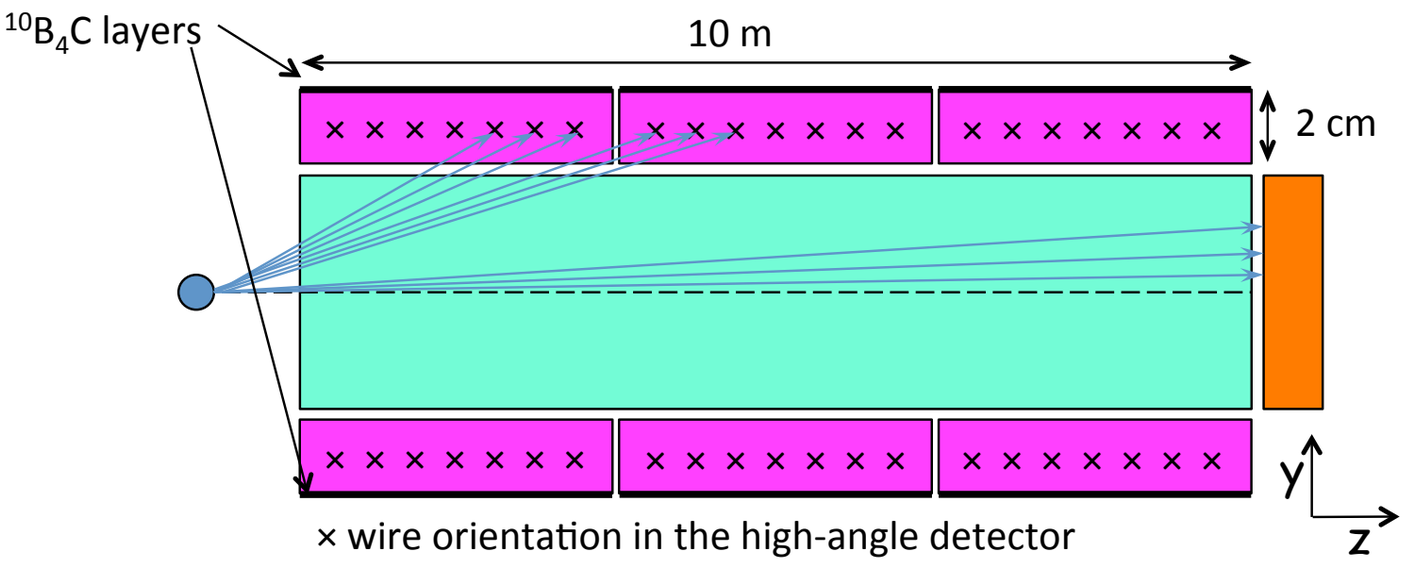


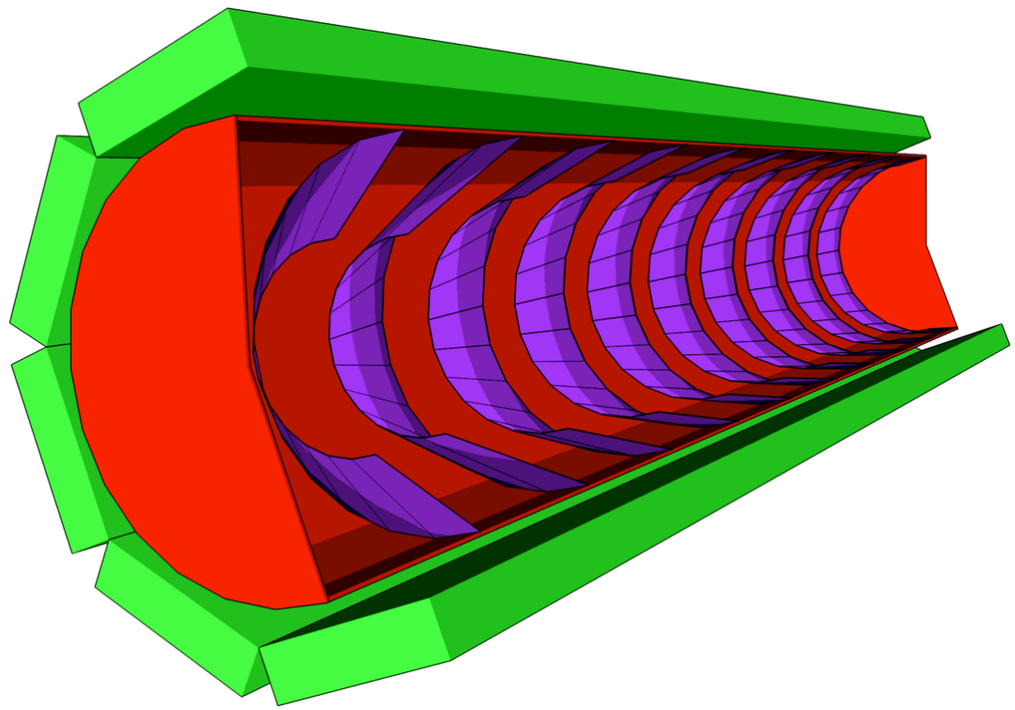


Q range of 1m diameter high angle detector

$0.03\ Å^{-1} < 1.0\ Å^{-1}$

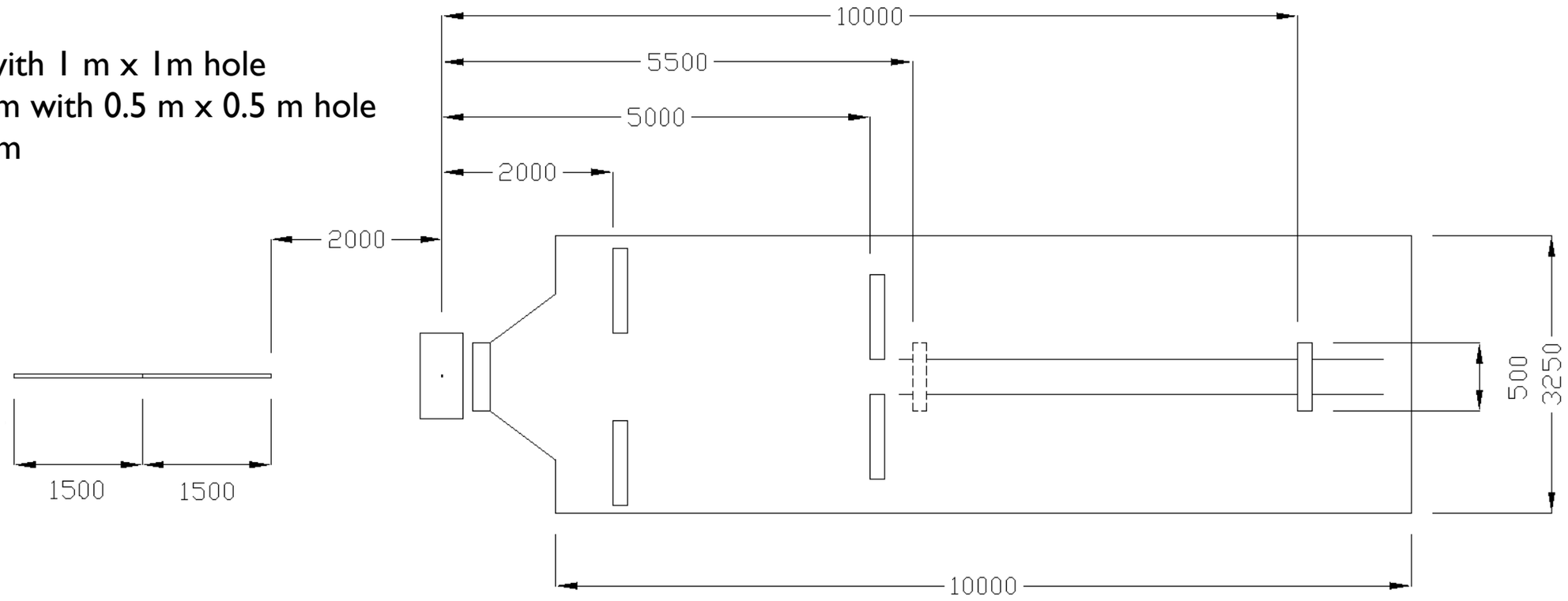
using 3Å - 10.5 Å neutrons

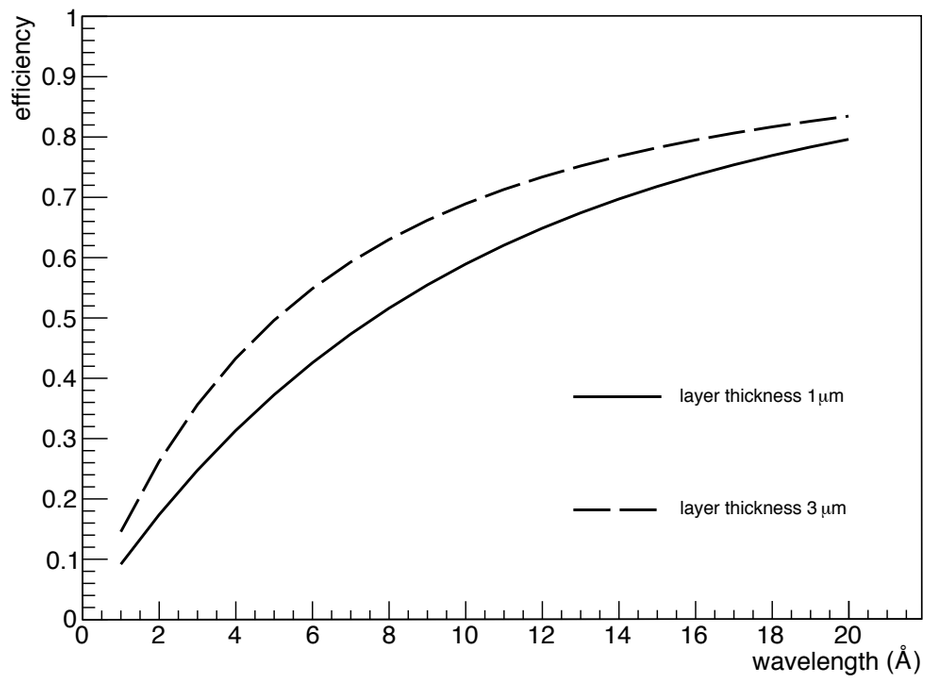




“Window Frame” Detectors

Front: 3 m x 3 m with 1 m x 1m hole
Middle: 2.4 m x 2.4 m with 0.5 m x 0.5 m hole
Back: 0.5 m x 0.5 m



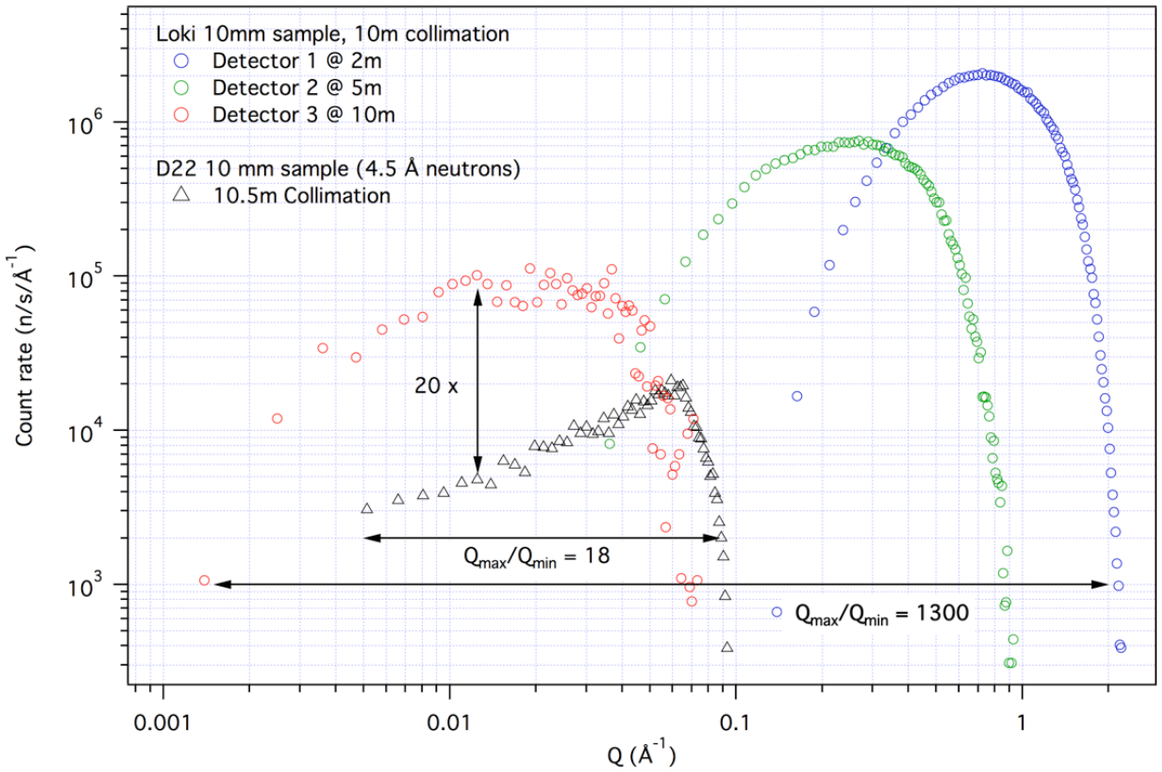


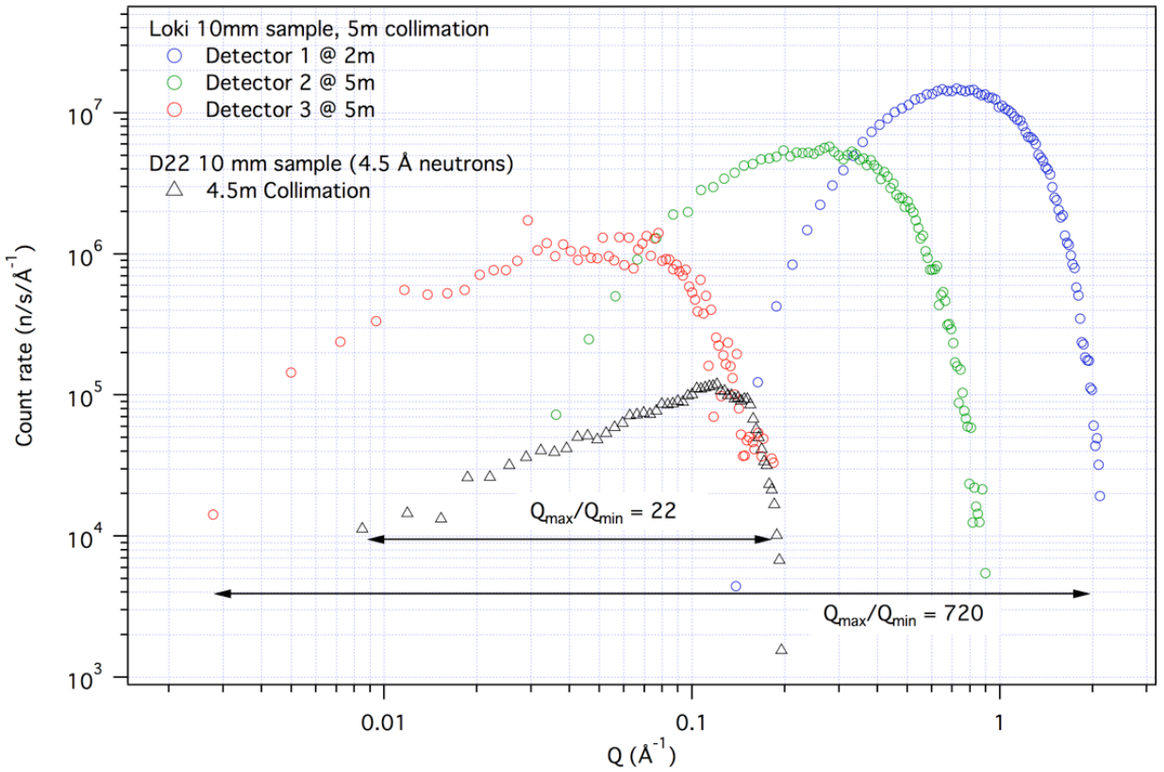
Ap2 Diam (mm)	L1 (m)	L2 (m)	$Q_{min}(\times 10^{-3}Å^{-1})$	Q_{max} ($Å^{-1}$)	Q_{max}/Q_{min}
10	2	5	7.63	1.66	218
5	2	5	3.82	1.66	435
4	2	5	1.53	1.66	1085
10	5	5	3.59	1.66	462
5	5	5	1.79	1.66	927
4	5	5	0.72	1.66	2305
10	10	10	1.79	1.66	927
5	10	10	0.90	1.66	1844
4	10	10	0.36	1.66	4611

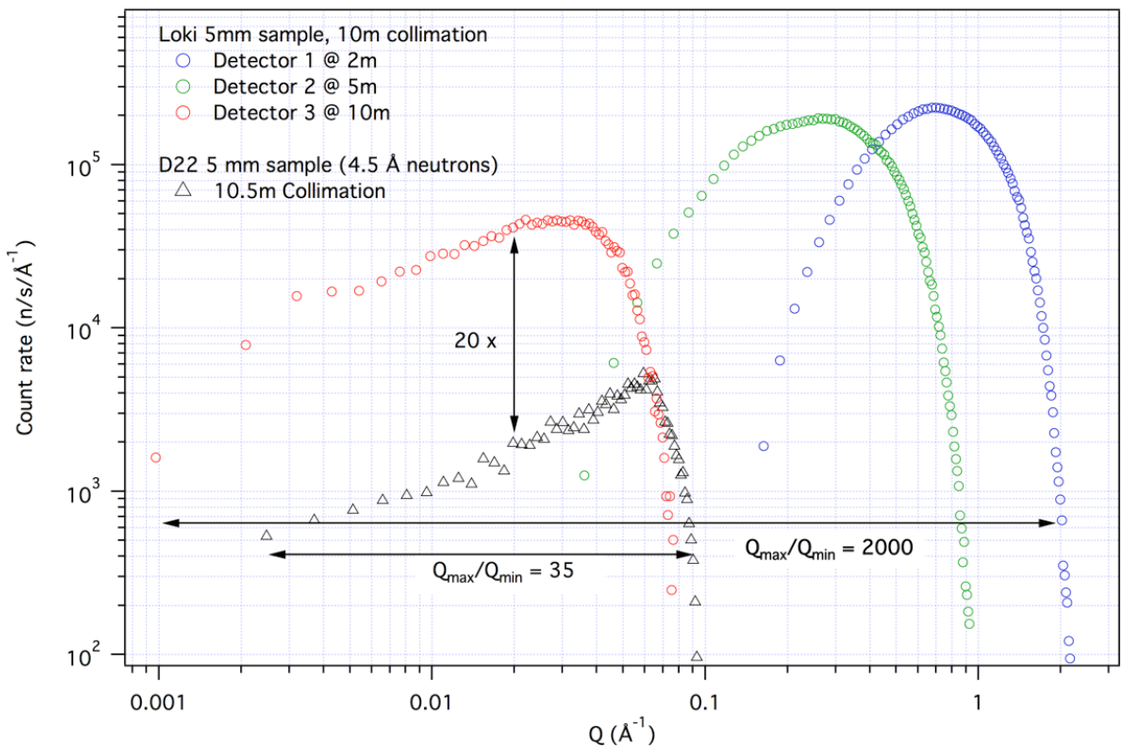
Accessible Q ranges with 3 Å - 10.5 Å neutrons

Performance

Scattering from 1mm H_2O using "Window Frame" detector layout







Summary

LoKI will provide

A **world leading** SANS instrument for the ESS with **high flux**, **wide simultaneous Q range**, a **flexible sample area** and opportunity for enhancement with focussing optics and spin-modulation techniques.

Beam sizes as small as **2mm** will be routinely accessible allowing small sample volumes and scanning experiments.

The ability to perform **“single-shot” kinetic** measurements on **sub-second** time scales

Questions?