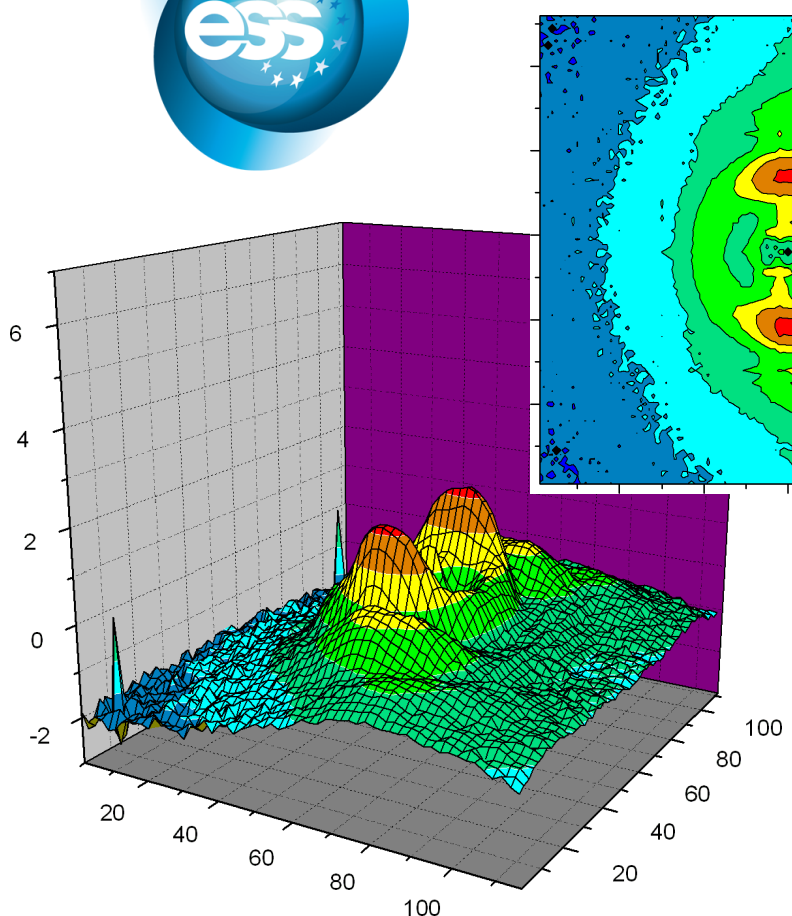
The proposal of SKADI –
a high intensity SANS with optional focusing optics

H. Frielinghaus, S. Jaksch
J. Jestin



Laboratoire Léon Brillouin

Jülich Centre for Neutron Science

Workshop

The Science Case

for the

High Intensity SANS

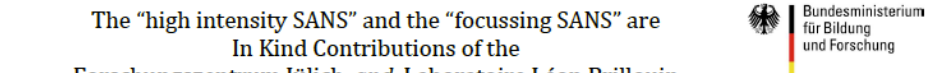
and

Focussing SANS

21 - 24 May 2013

Gustav Stresemann Institut (Bonn)

Organization: Henrich Frielinghaus, Jacques Jestin



Possible layout of the High Intensity SANS at the ESS

The "high intensity SANS" and the "focussing SANS" are
In Kind Contributions of the
Forschungszentrum Jülich *and* Laboratoire Léon Brillouin

GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

Collaborations:

LLB, J. Jestin: Detectors, USANS

Delft, W. Bouwman: SESANS

KFKI, G. Kali: Choppers, TISANE

ESS, A. Jackson: Benchmarking

ASI, Amsterdam: Detectors

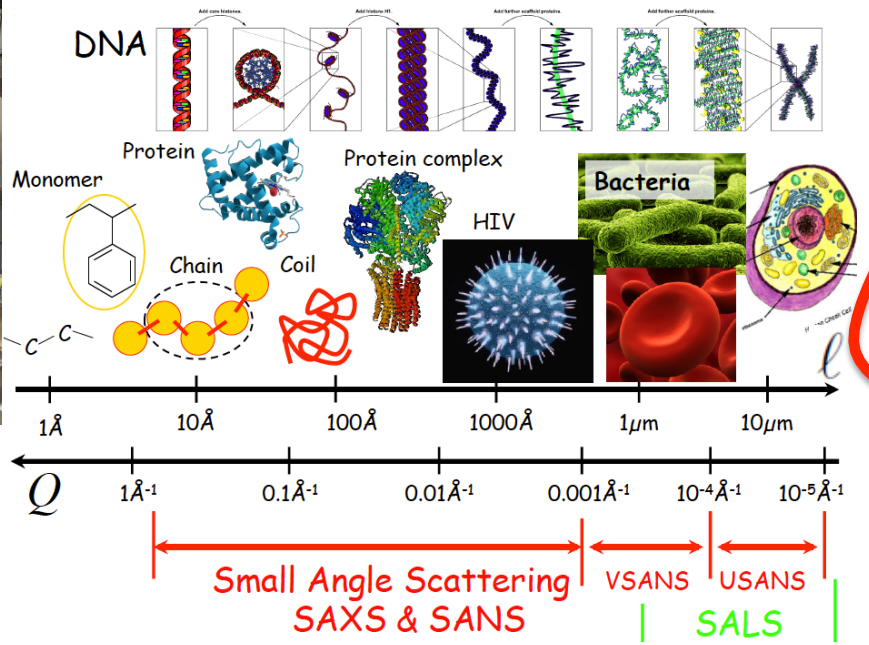
DENEX, R. Kampmann: Detectors

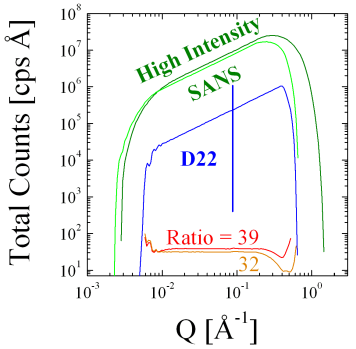
FRM, K. Zeitlhack: Detectors

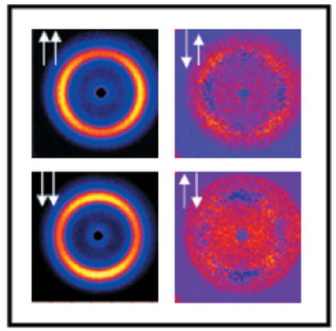
Letters of Interest: 69+1

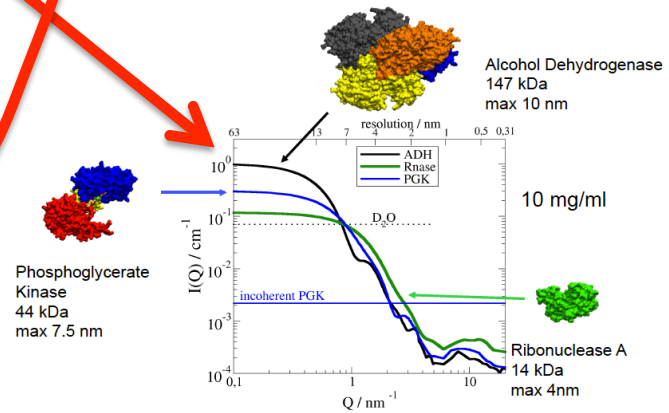
Features of SKADI

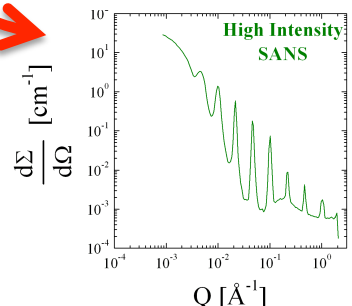
- Highest possible intensities
- Polarization
- Wide Q-range
- Extended Q-range to few 10^{-5}Å (VSANS) and 10^{-6}Å (SESANS)
- Large customized sample environment











Science Case of SKADI

- Fast Kinetics
- Crowded Systems (Multiple length scales)
- Magnetic Systems
- Detect smallest amounts of additives

Soft Matter

- Polymers
- Colloids
- Complex Fluids
- Thin Films
- Confinement

- Structure
- Self Assembly
- Phase Transitions
- Kinetics/Dynamics
- Excitations/Transport

Biology

- Proteins
- Complexes
- Systems/Cells
- Biomimetics

- Structure
- Fluctuations
- Kinetics

Magnetism

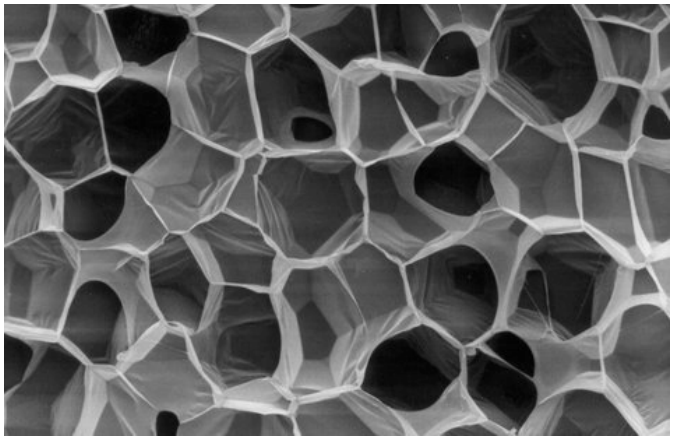
- Bulk Phenomena
- Thin Films
- Granular Materials
- Confined Geom.

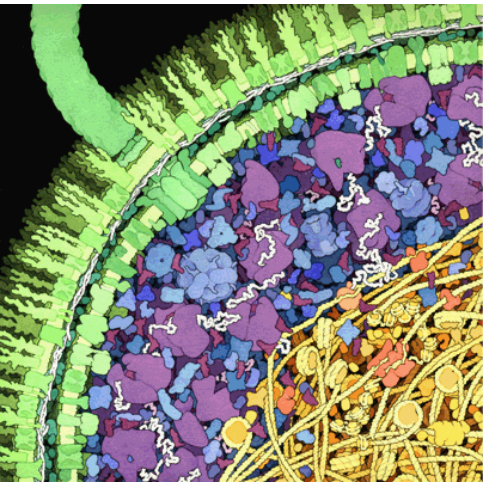
- Structure/Topology
- Phase Transitions
- Fluctuations
- Transport

Science Case of SKADI

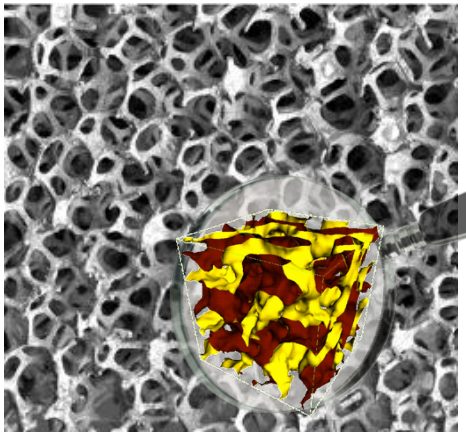
- Fast Kinetics
- Crowded Systems (Multiple length scales)
- Magnetic Systems
- Detect smallest amounts of additives

Nanofoams



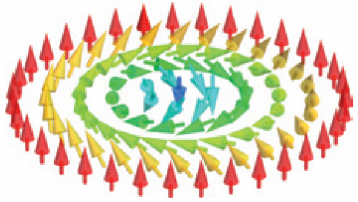


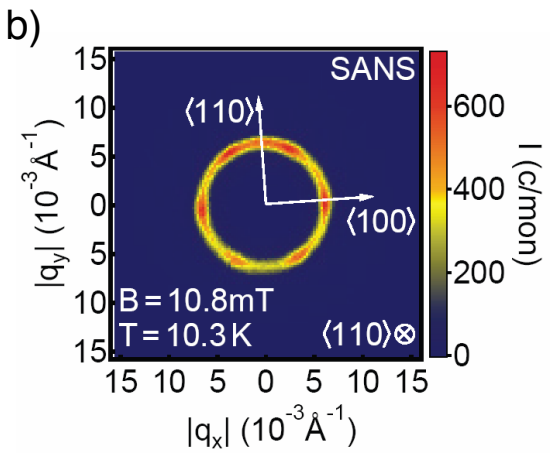
E. coli
(Goodsell)

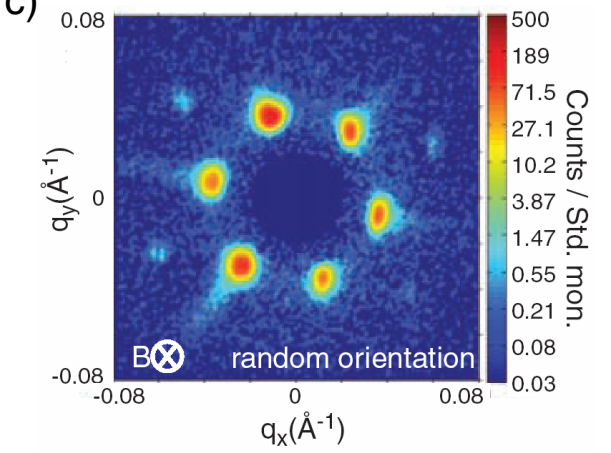


μE in Pores

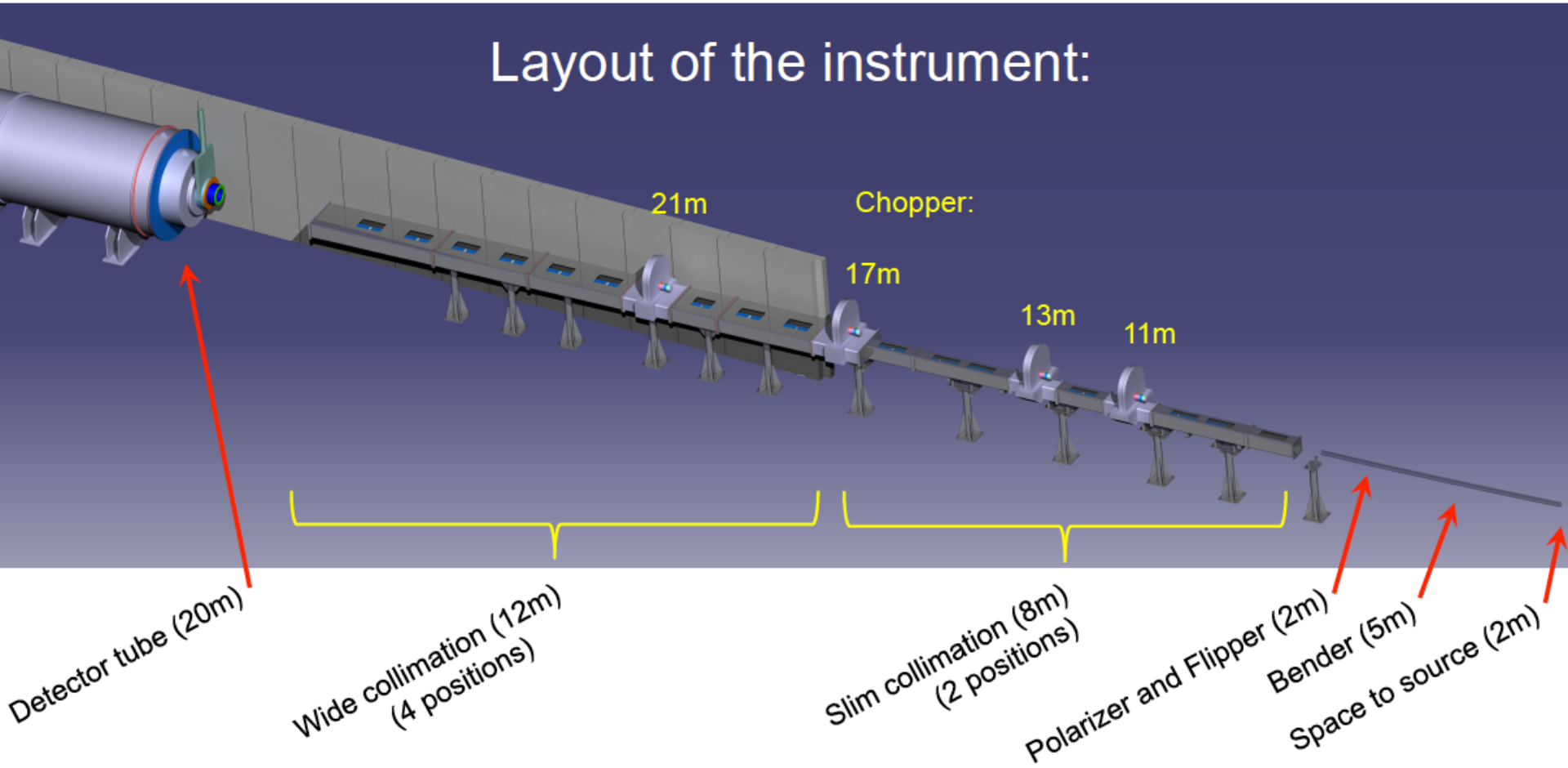
Skyrmions



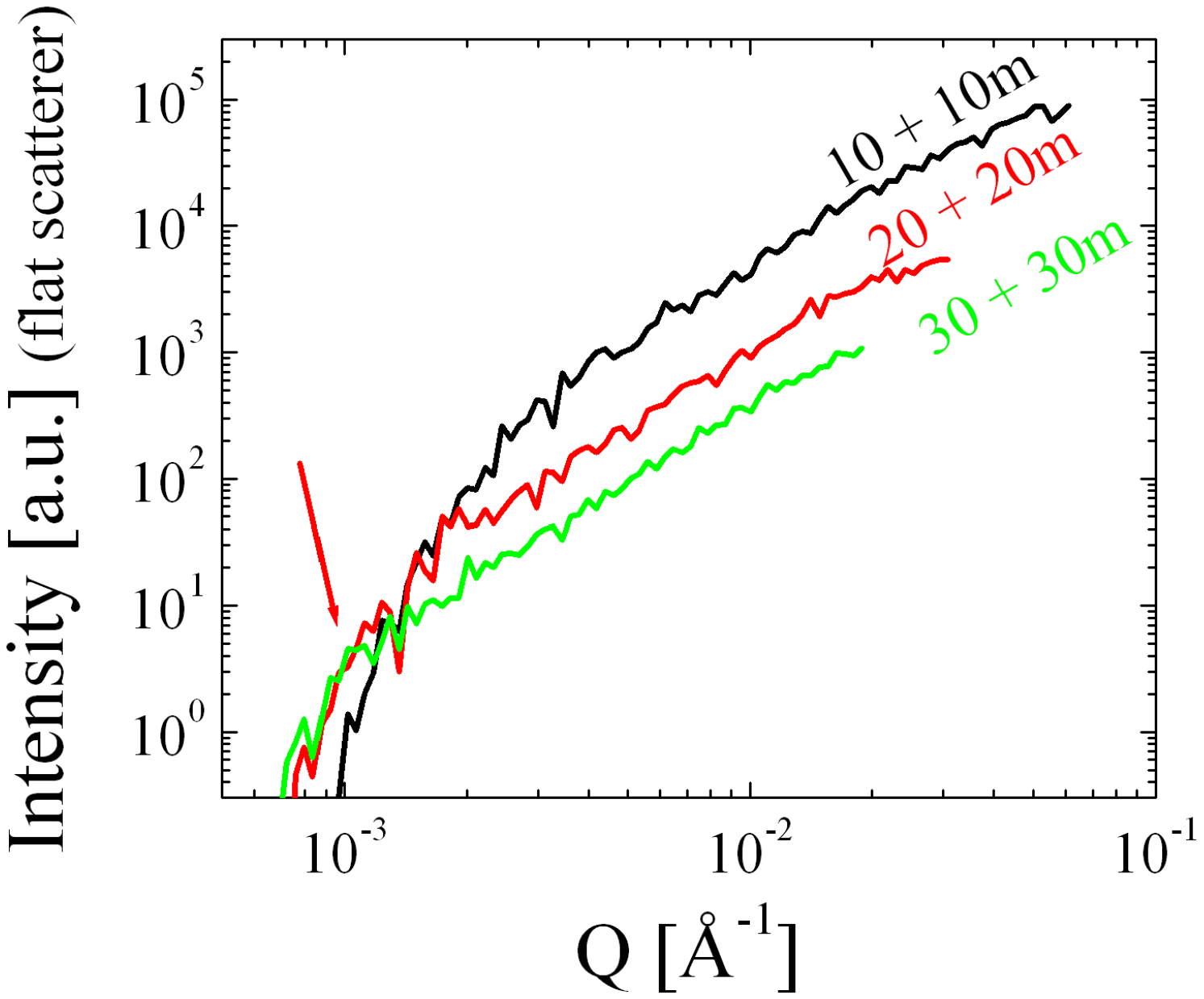




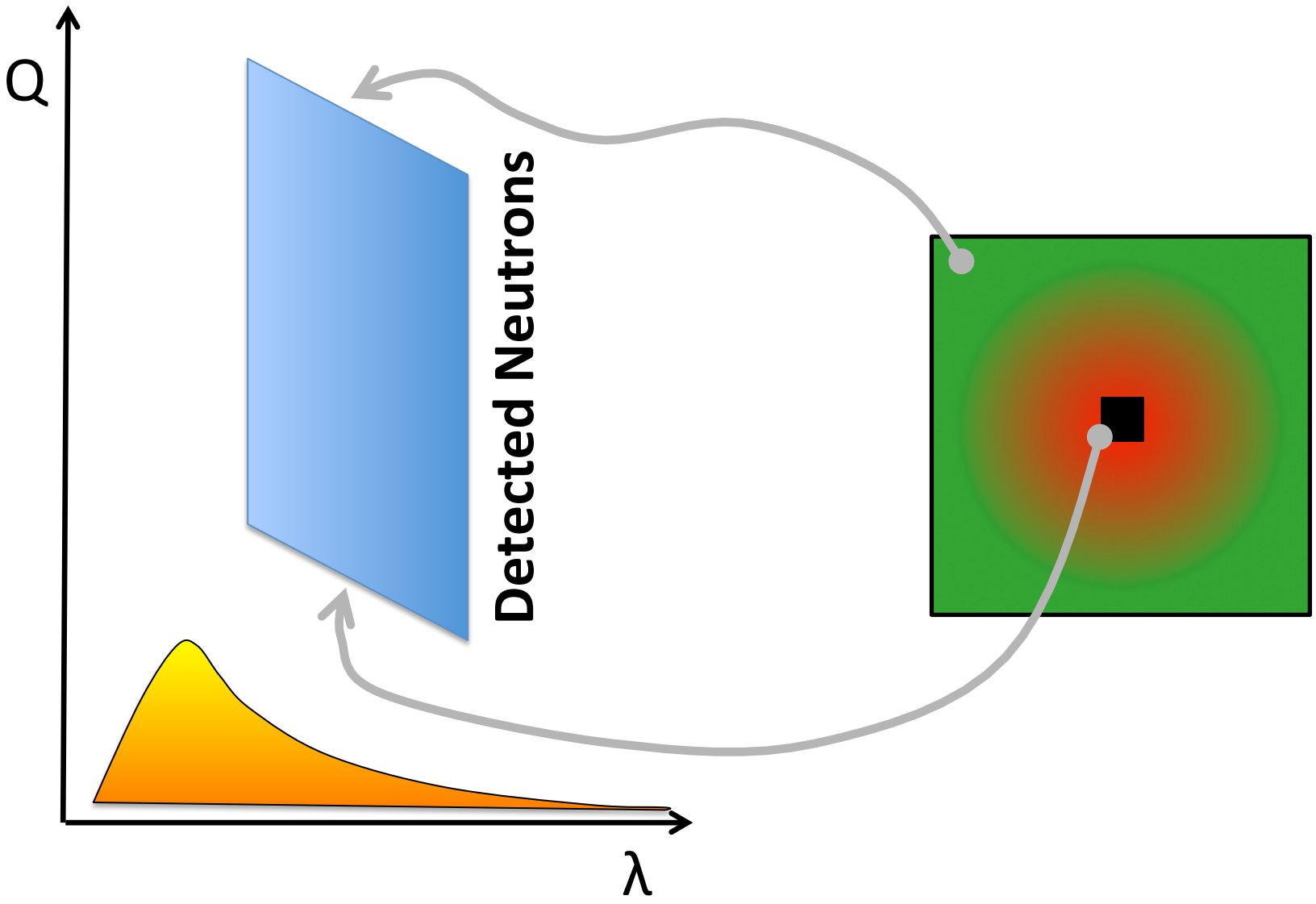
Layout of the instrument:



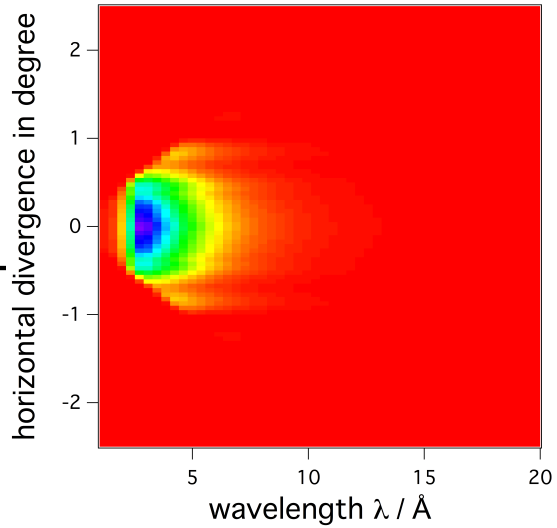
Why 20 + 20m ???


Intensity [a.u.] (flat scatterer)
10^5
10^4
10^3
10^2
10^1
10^0
10^{-3}
10^{-2}
10^{-1}
Q [Å^{-1}]
10 + 10m
20 + 20m
30 + 30m

Theoretical Considerations of Wavelength Band



Bender Layout



transmission in a.u.

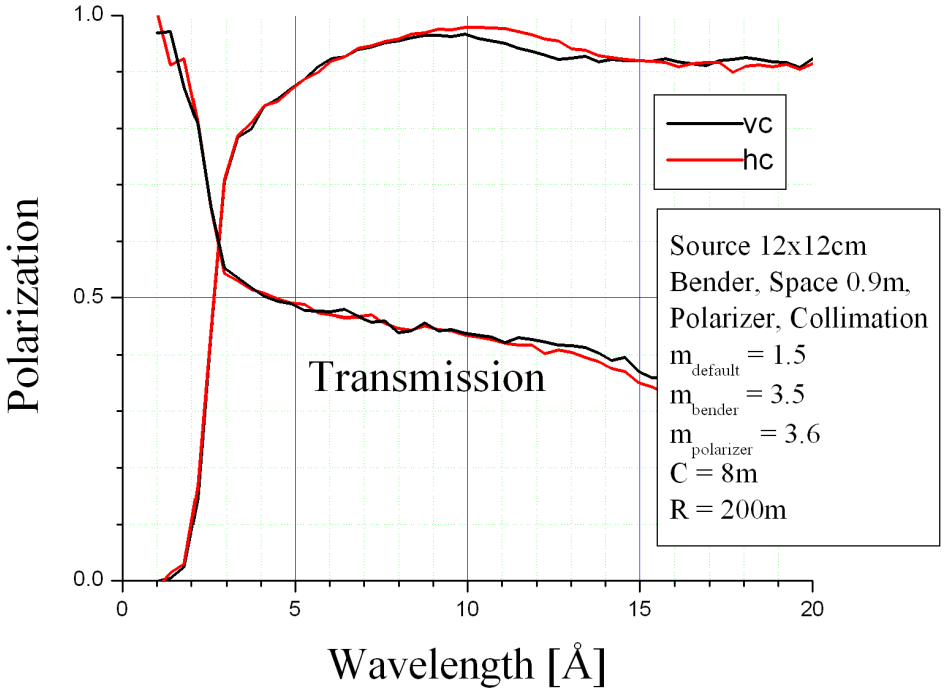
1.2
1.0
0.8
0.6
0.4
0.2
0.0

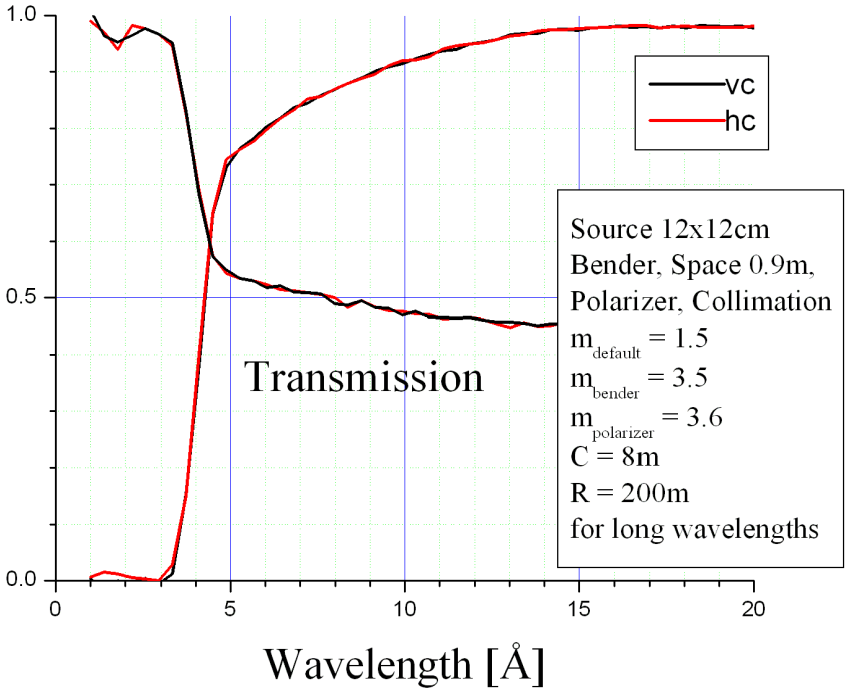
high collimation
low collimation

0.0
0.5
1.0
1.5
2.0
2.5

$R^{-1} / 10^{-2} m^{-1}$

Polarizer Layout





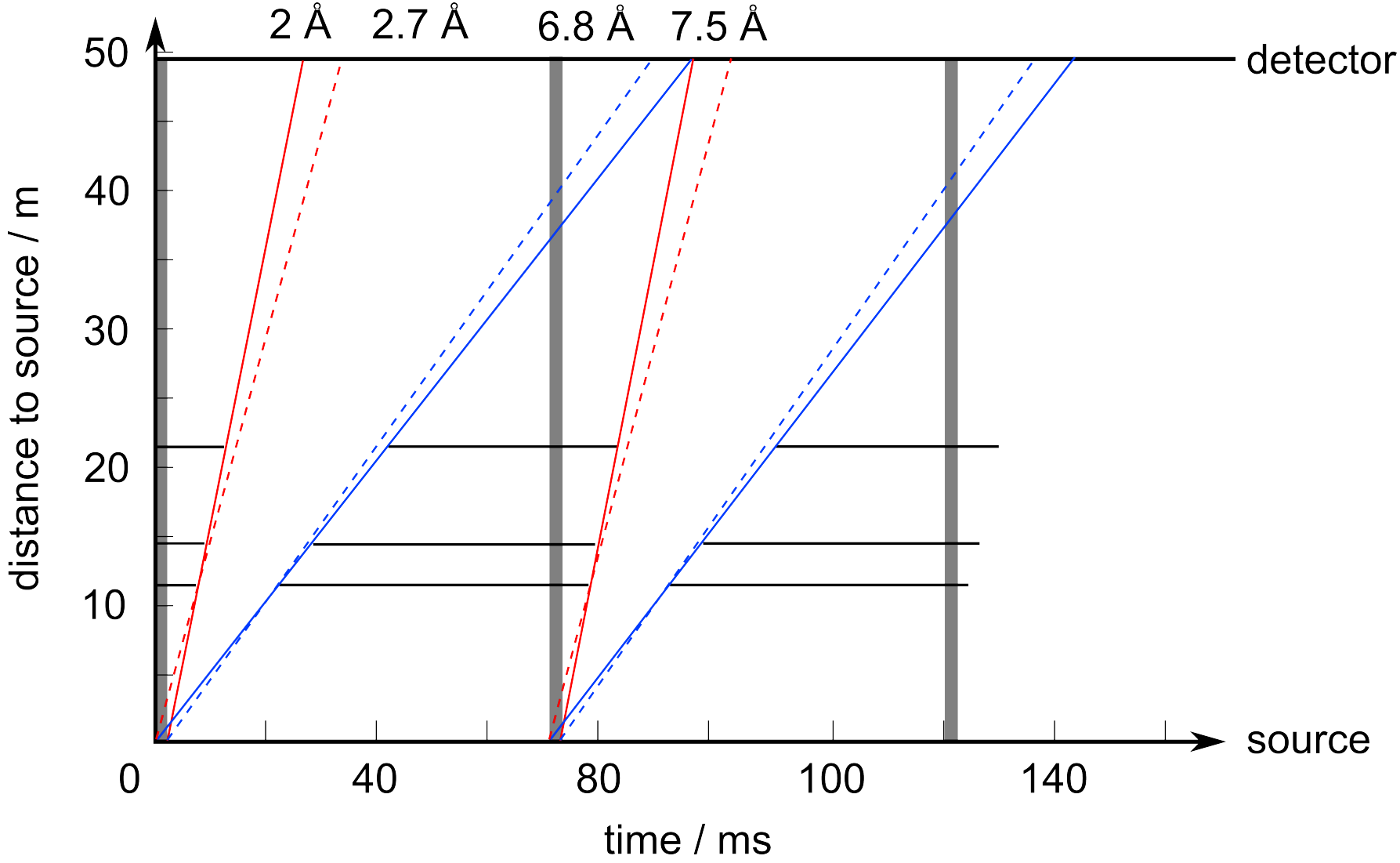
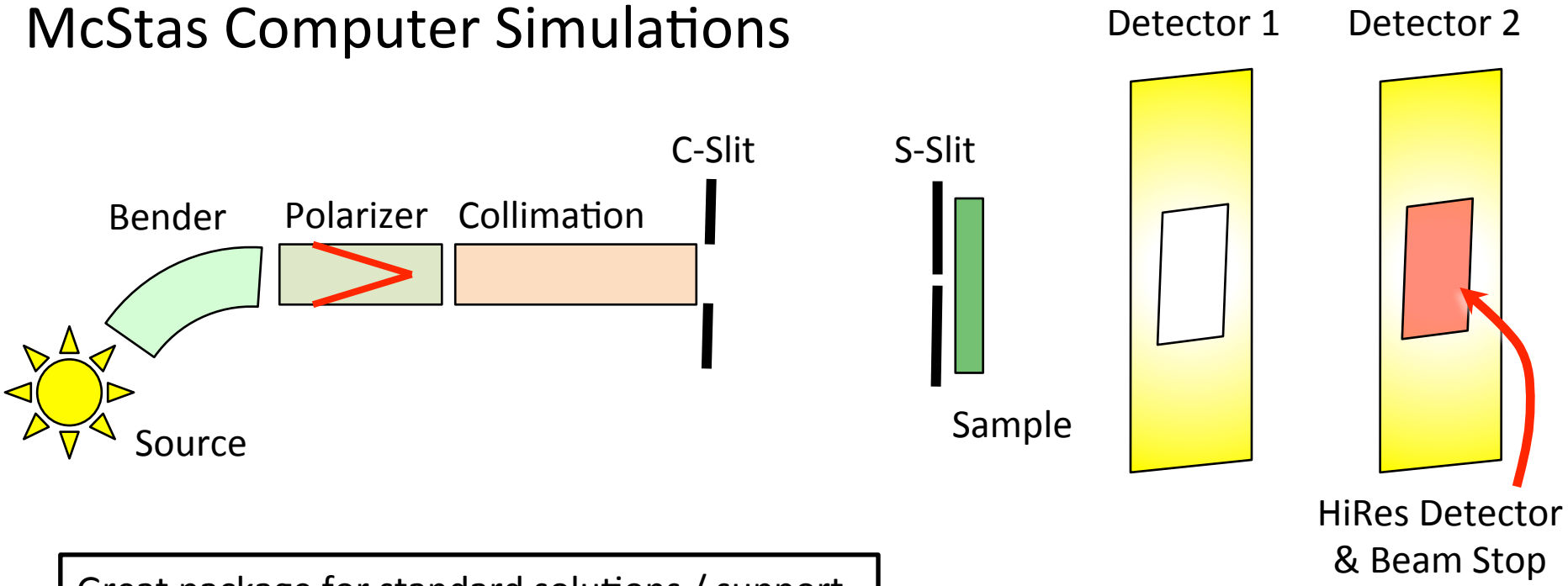

2 Å
2.7 Å
6.8 Å
7.5 Å
detector
source
50
40
30
20
10
distance to source / m
0
40
80
100
140
time / ms

Figure of Merit (FOM)

$$\mathrm{FOM} = \sum \frac{I_{\mathrm{peak}}}{\sigma_Q(Q)}$$

McStas Computer Simulations



Great package for standard solutions / support.

- Source
- Bender
- Polarizer
- Collimation
- Slits
- NEW: Choppers

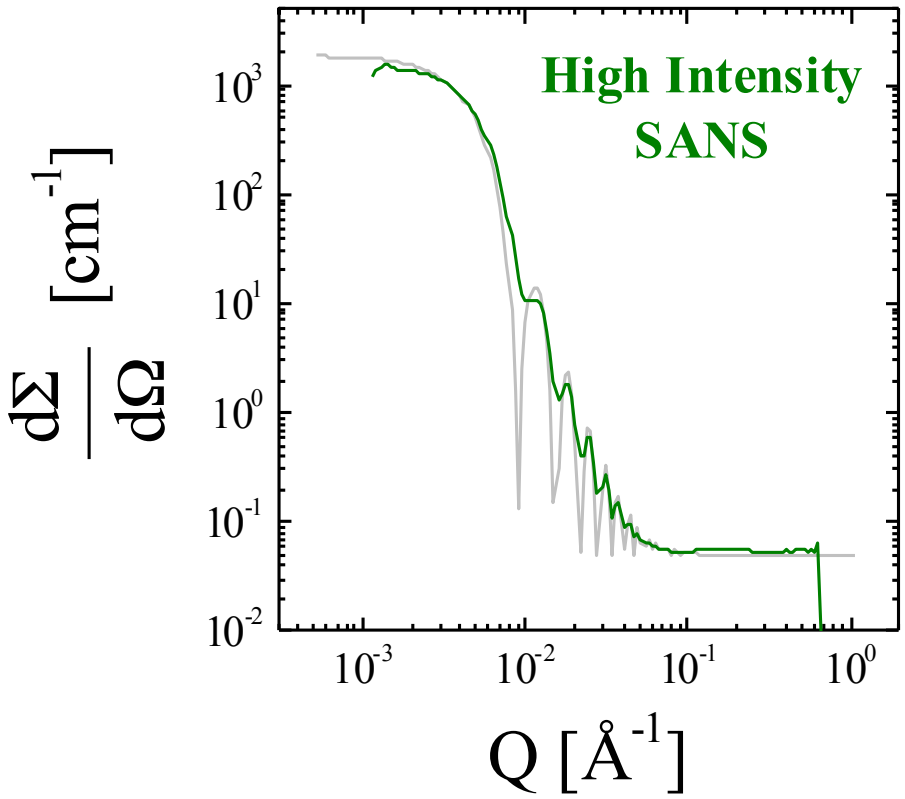
Own development for dedicated elements.

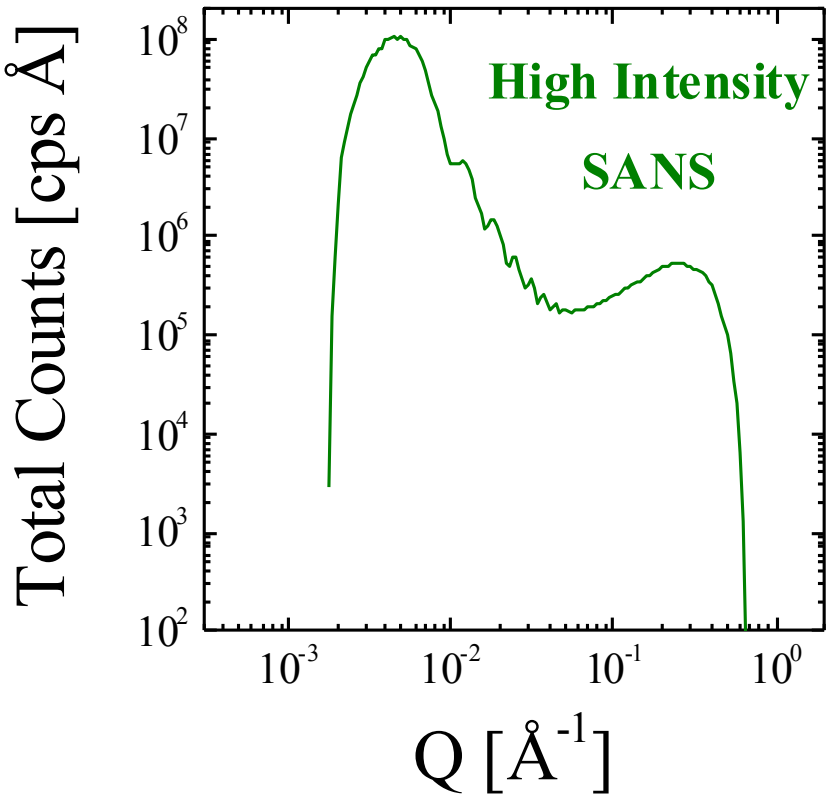
- Sample (SANS)
- Detectors (TOF analysis, absolute calibration)
- Beam treatment

Benchmarking: High Intensity SANS at C8, D8 D1.6

entrance aperture 3x3cm^2

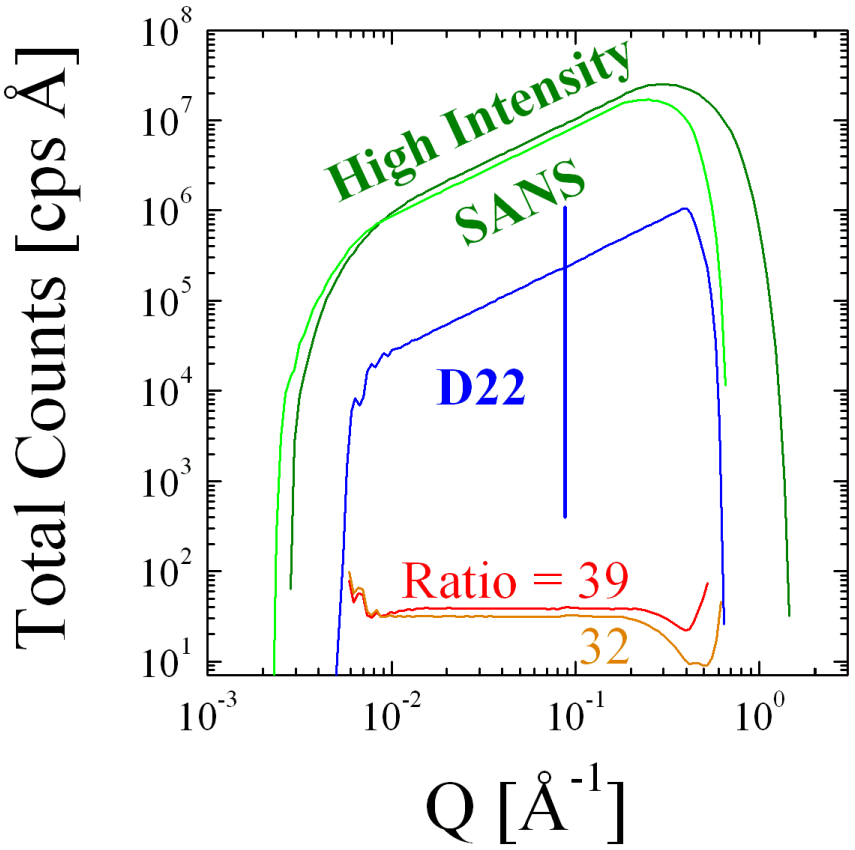
Colloids with 500A diameter



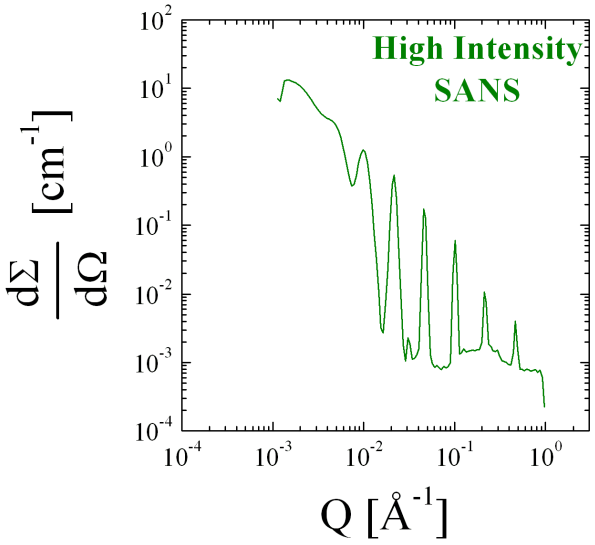


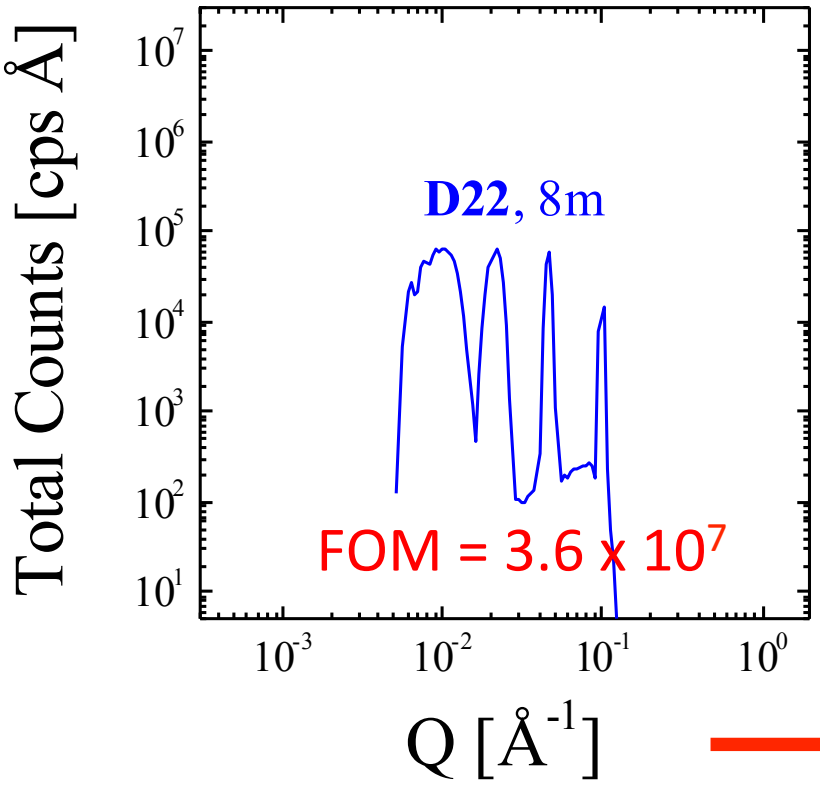
Benchmarking: D22 and High Intensity SANS now both 5x5cm EA

Water

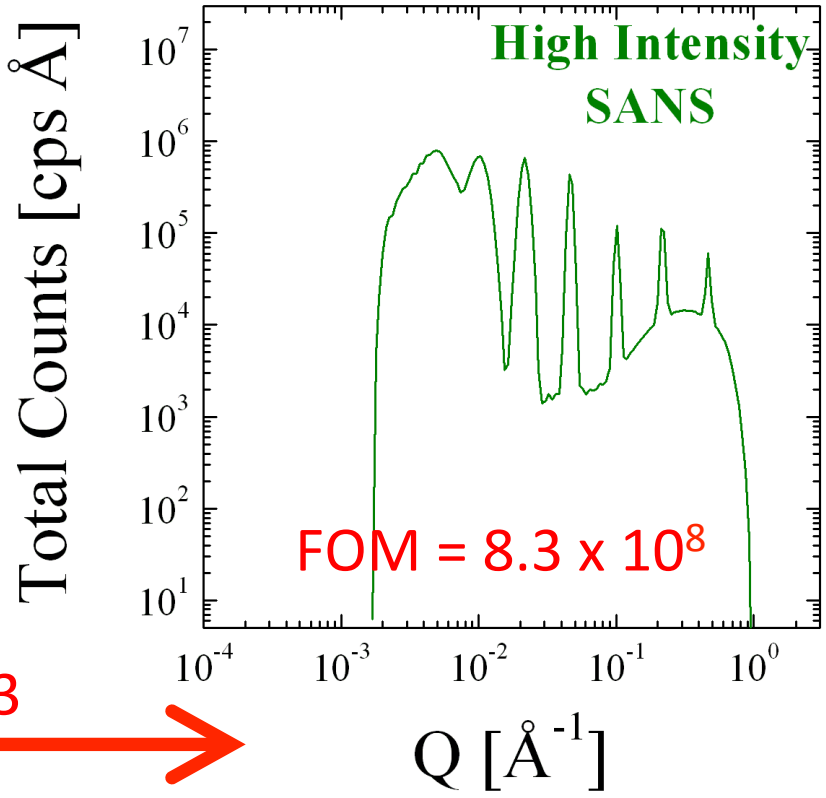


Benchmarking: D22 and High Intensity SANS





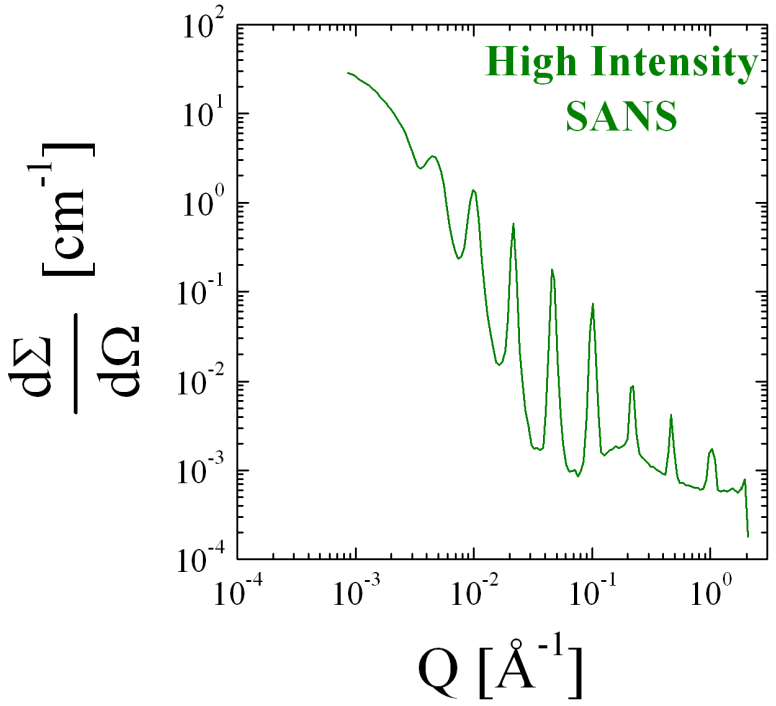
x 23



Extending the Q-range:

Detector slight mismatch, only every 2nd pulse

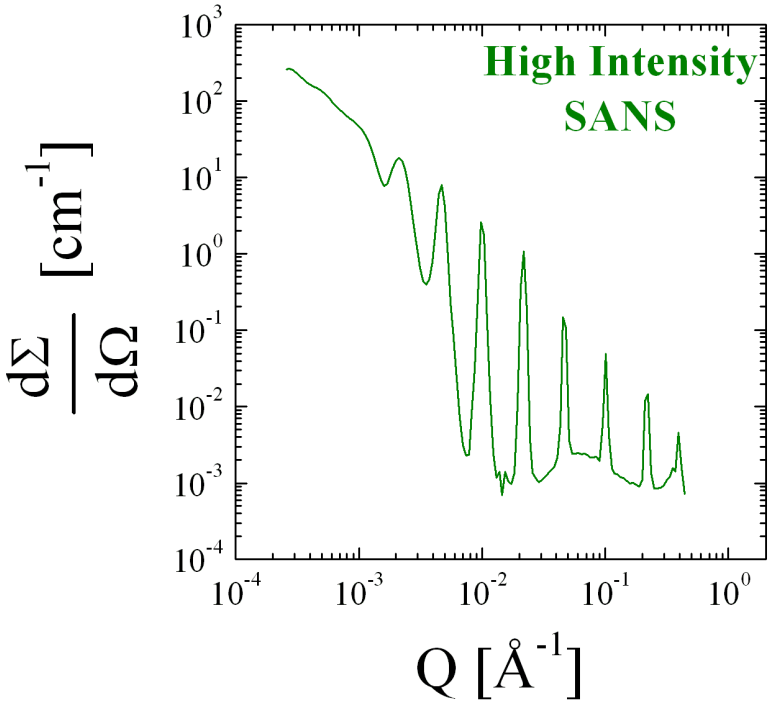
C8,D8m – 2 .. 16.4 A band



FOM = 5.4 x 10^8

(15x D22)

C20,D20m – 4 .. 15 A band

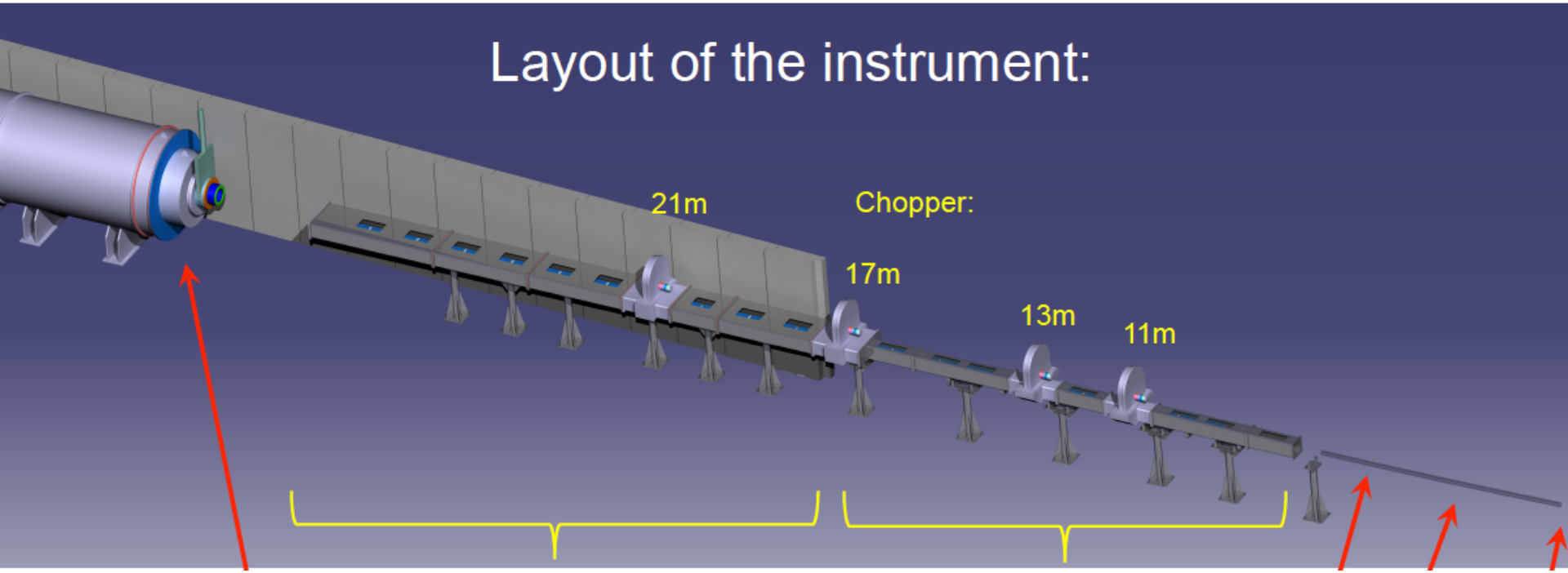


FOM = 5.2 x 10^8

Plugins:

High Resolution Options !!!

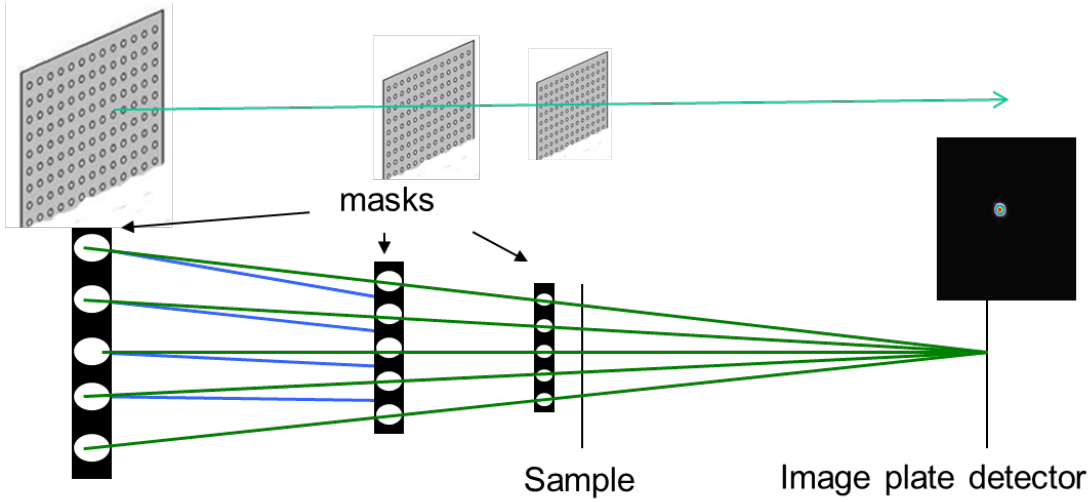
SESANS



Roomy Collimation

VSANS AT LLB: THE TPA SPECTROMETER

Multi-beam collimation setup, Q range ~2.10^{-4} – 10^{-2} $Å^{-1}$
N very small converging beams (1 mm) to get a factor N on the scattering intensity

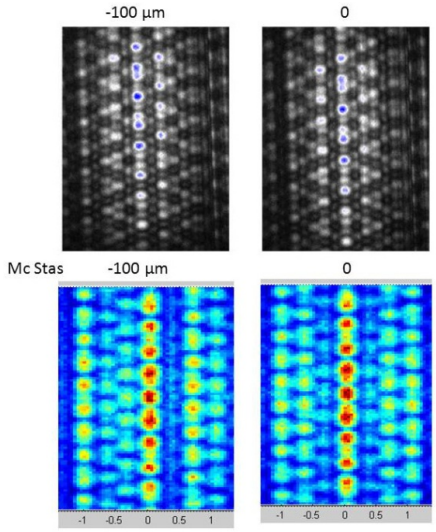


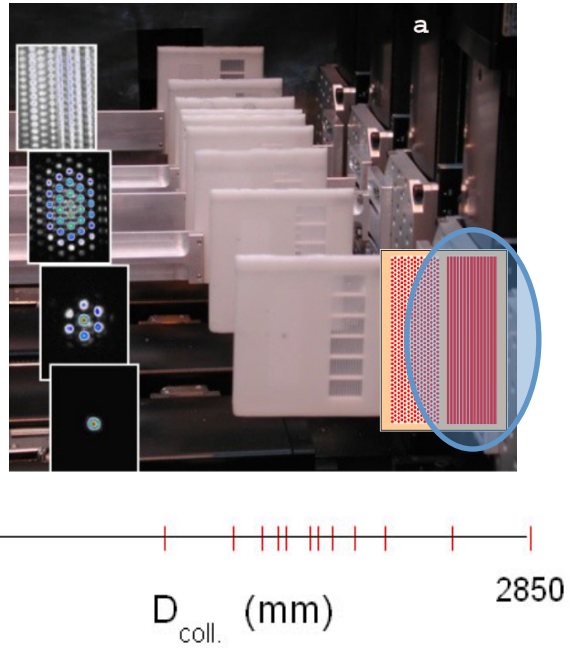
Using masks for focusing and prevent cross talks between imaginary channels

High definition (pixel size 150 µm) Image Plate detector (2300*2300 pixels)
Limited by the gamma radiation sensibility:

- Heavy concrete shielding around the detector tank
- ^{6}Li instead of ^{10}B and Cd at every strategic places of the instrument
- double super-mirror (m=3) mono-chromator to select λ from 5 to 15Å (FWHM=15%)

VSANS AT LLB: THE TPA SPECTROMETER





INNOVATIVE COLLIMATOR

Number of mask, sizes of holes and respective position between the masks have been calculated with McStas simulations

Optimized focusing for 13 masks of 600 circular holes with hexagonal order from 1.28 mm (1st mask) to 0.9 mm (13 st mask), aligned on a short distance below 3m

Gravity effects are corrected by vertical alignments

At the sample position, beam area is 25mm height and 7mm width

Vertical slits option (15 slits of 1.28 to 0.9 mm width) that enable to gain a factor around 50 on the intensity but needs deconvolution corrections.