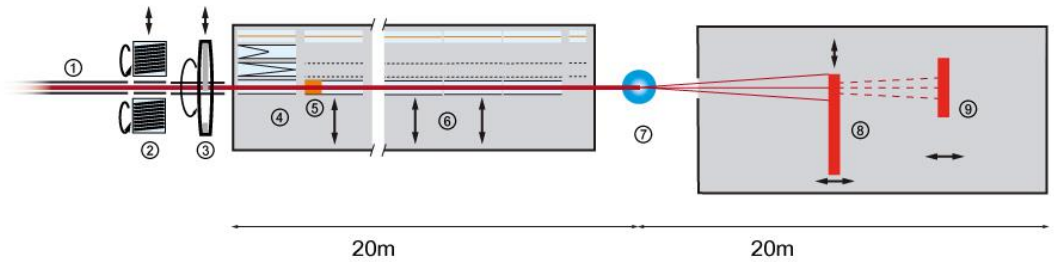
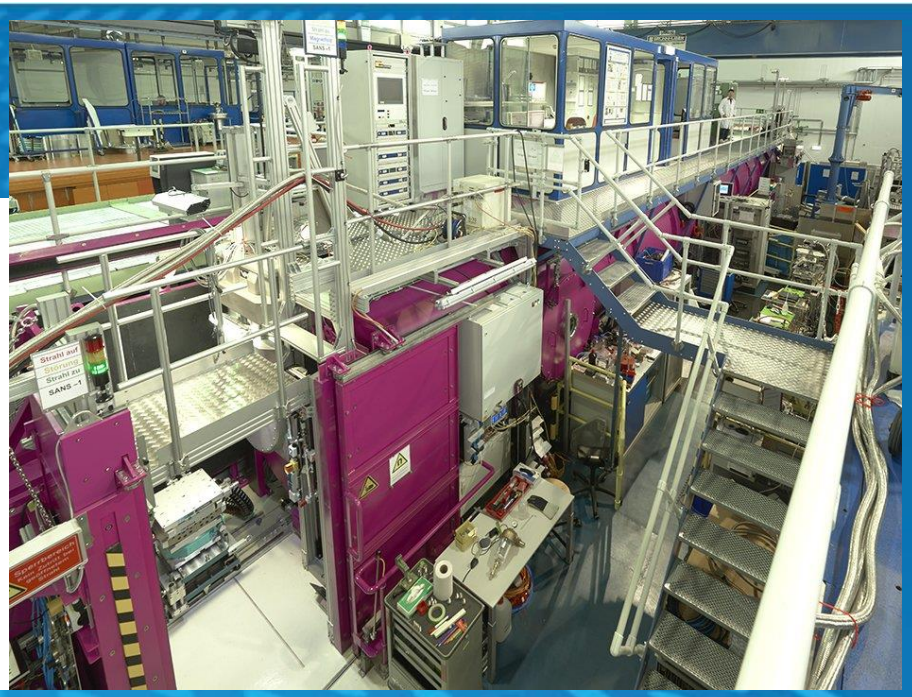
Experience of exploitation of instrument SANS1 at MLZ: advantages and disadvantages

Sven-Arne Siegfried



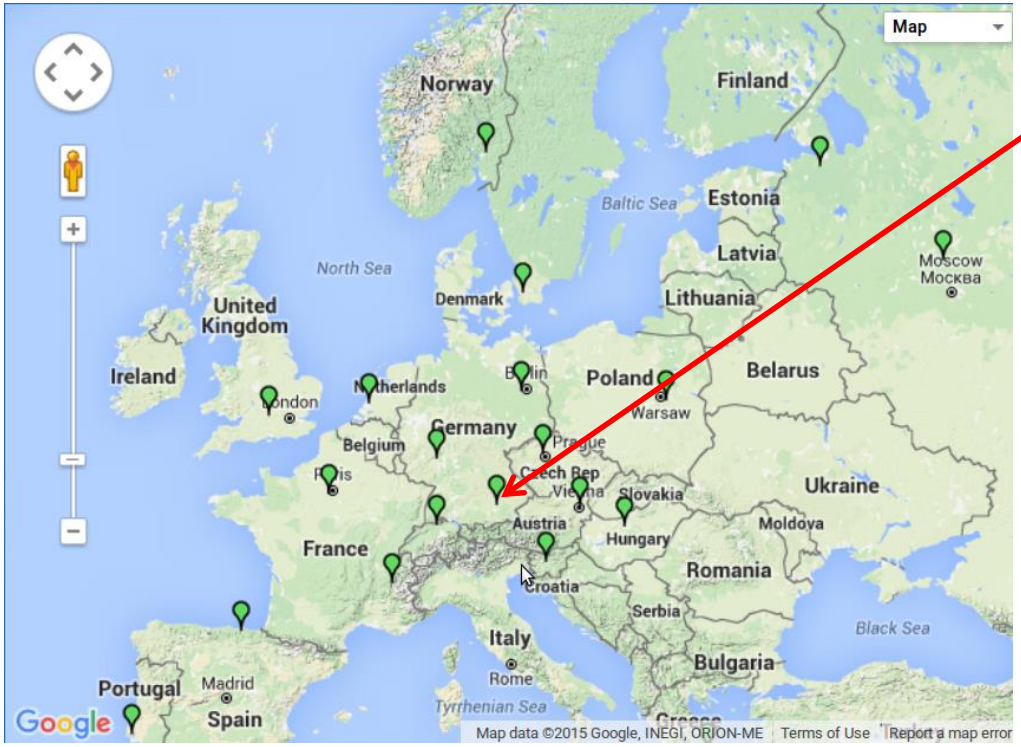
① Neutron guide NL4a
② Velocity selector 1+2
③ TISANE Chopper
④ Changeable polarisers
⑤ Spin flipper
⑥ 4 collimation sections 19 m (neutron guide, collimation slits)
⑦ Sample position
⑧ Position sensitive area detector, 1 x 1 m²
⑨ High resolution position-sensitive area detector, 0.5 x 0.5 m² (installation 2016)



GEMS German Engineering Materials Science Centre
MLZ Heinz Maier-Leibnitz Zentrum
Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research

Heinz Maier-Leibnitz Zentrum (MLZ)

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



MLZ
Heinz Maier-Leibnitz Zentrum

GEMS
German Engineering Materials Science Centre

JCNS
Jülich Centre for Neutron Science

MAX-PLANCK-GESELLSCHAFT

TUM
Technische Universität München

BGI
Bayerisches Geoinstitut

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

KIT
Karlsruher Institut für Technologie

LMU
LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

RWTH AACHEN UNIVERSITY

TECHNISCHE UNIVERSITÄT DRESDEN

Universität zu Köln

Universität der Bundeswehr München

TU Clausthal

Research-neutronen source Heinz Maier-Leibnitz (FRM II)

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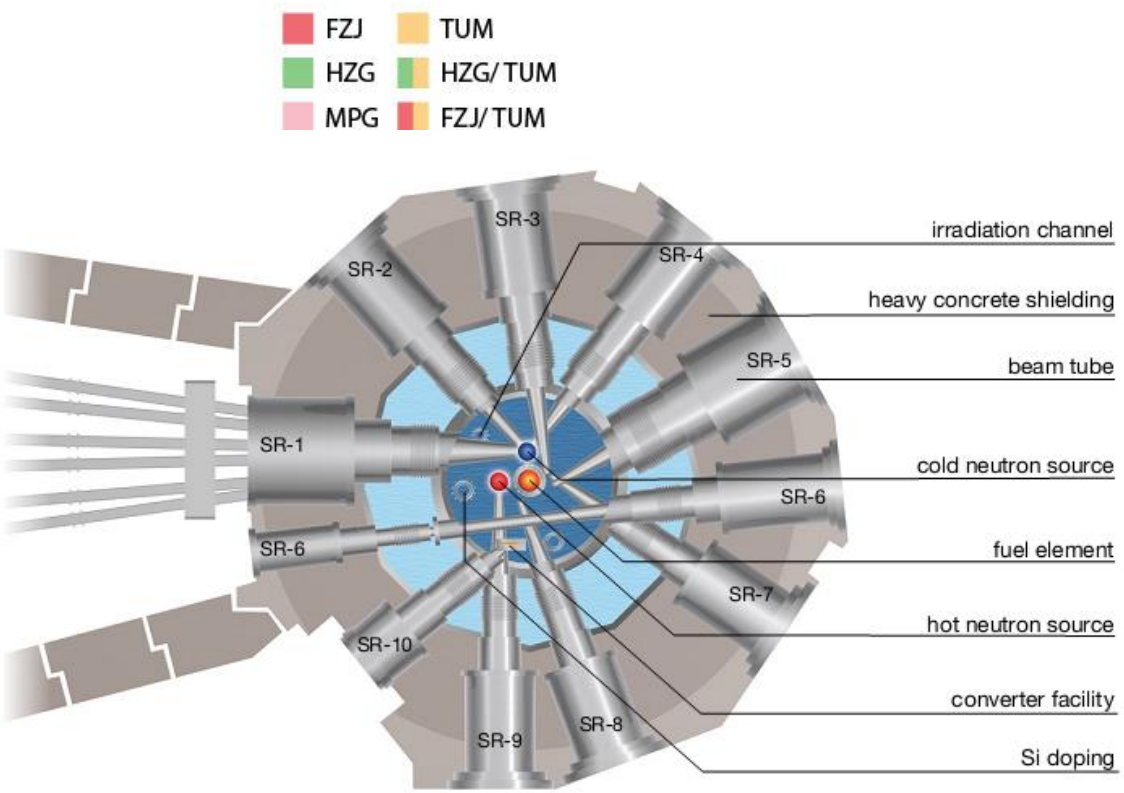
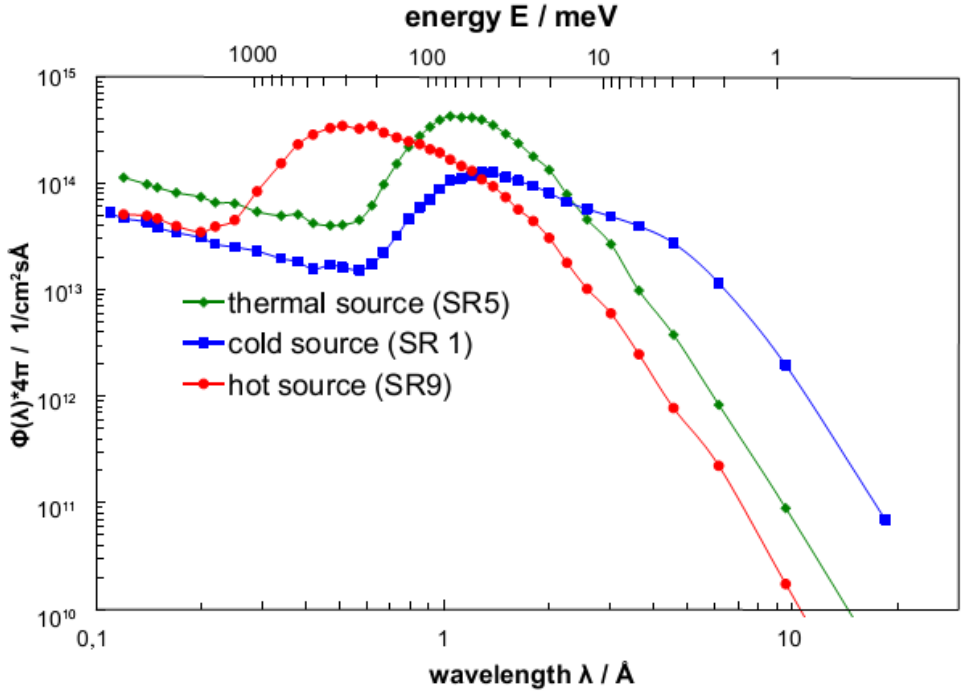


Cold source

- T = 25 K
- Volume of moderator chamber: 25 l
- Volume of liquid D_2: 12 l
- Mass of D_2 in cold source: 2.4 kg
- Cold moderator pressure: 1.5 bar
- 18 instruments fed by cold source

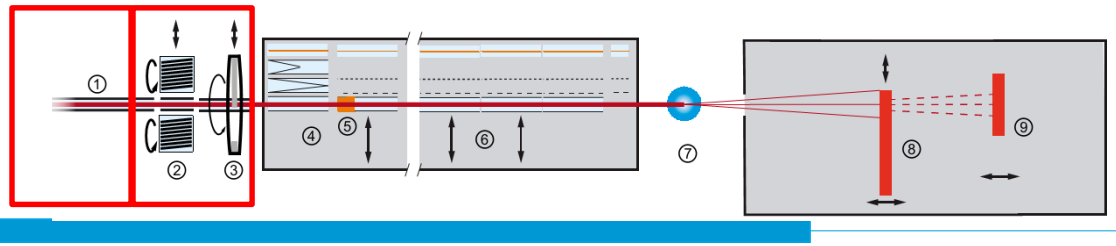


Reactor main parameters

- Thermal power: 20 MW
- Max. undisturbed thermal neutron flux density: $8 \cdot 10^{14}$ n/cm^{-2} s^{-1}
- 10 horizontal; 2 tilted beam tubes
- D_2O moderator
- H_2O cooling water

Instruments

- 26 instrumen
- 6 instrument



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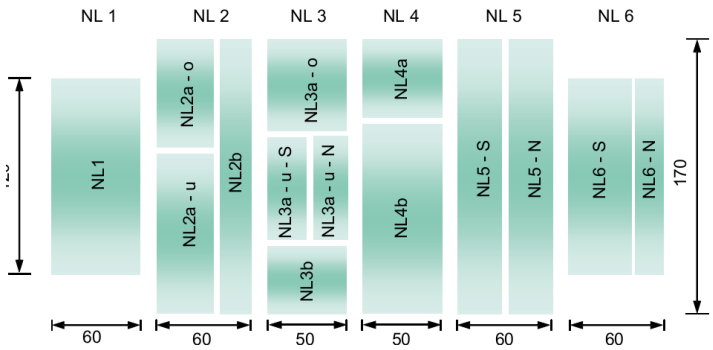
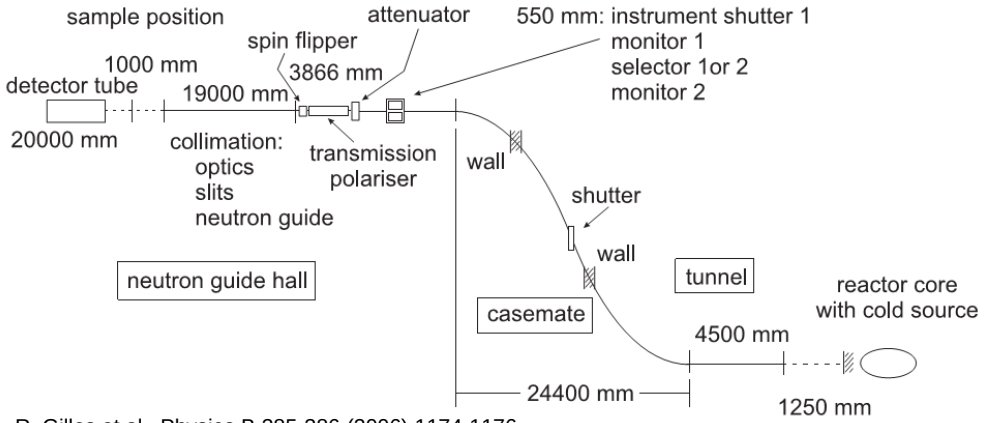


Guide	NL4a
Length (m)	34
Section (mm²)	50 × 50
Coating up to	m = 2.0
Curvature (m)	480
Instrument(s)	SANS-1

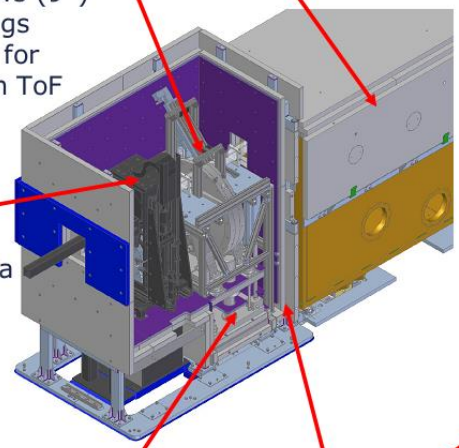


R. Gilles et al., Physica B 385-386 (2006) 1174-1176.

vertical S-shaped guide → cut off at λ_c= 3 Å

Astrium counter rotating double chopper:

- 20.000 rpm
- 14 equal windows (9°)
- Magnetic bearings
- Master chopper for later upgrade on ToF



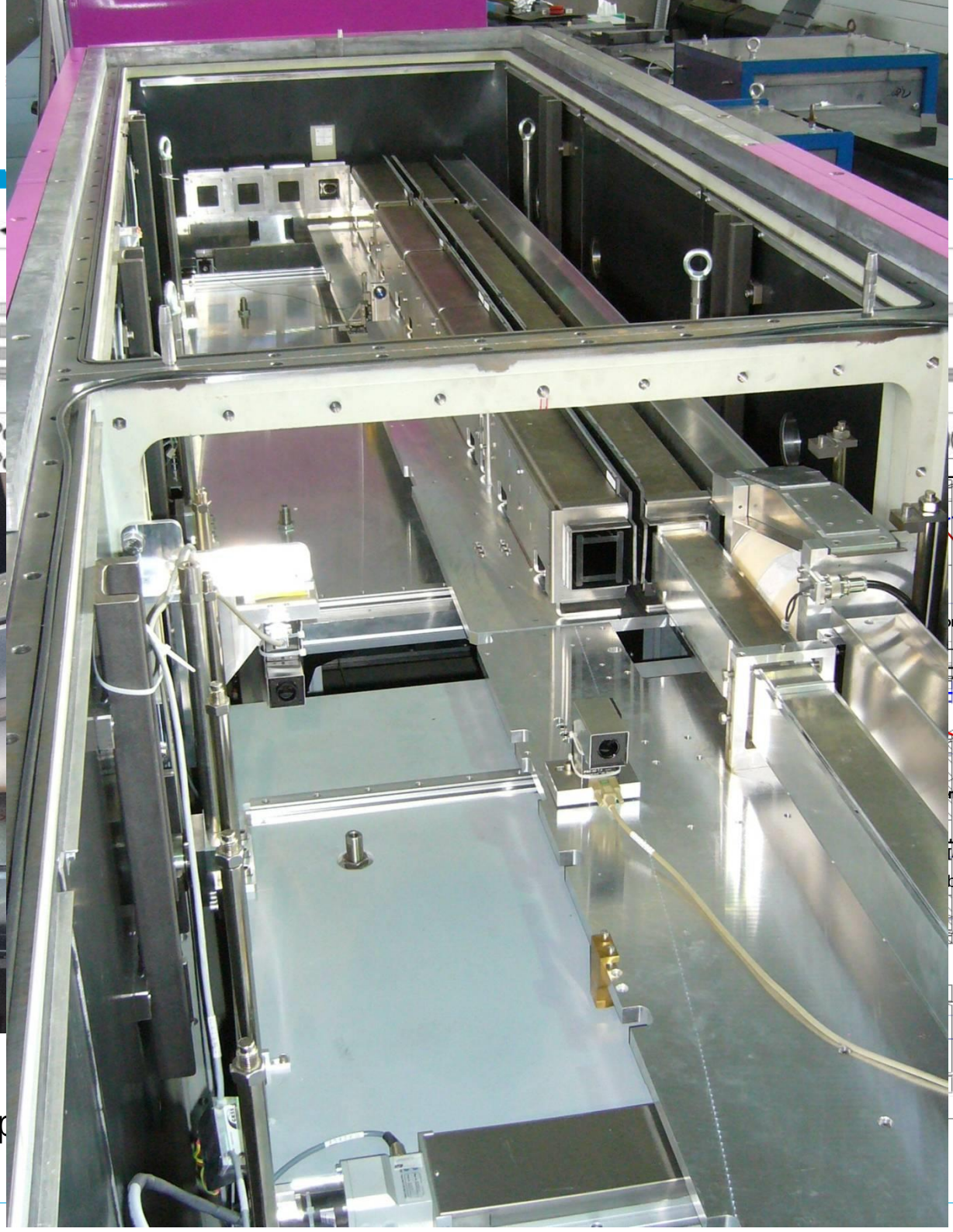
Setup of the shielding: 05/2014

Comissioning: 10/2015

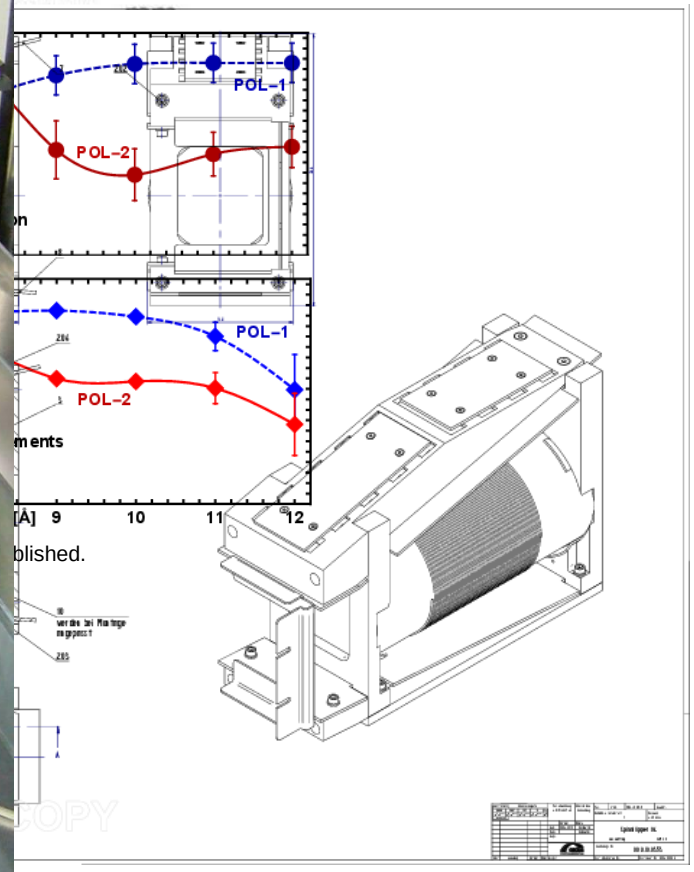
Comparison of flux and resolution for different selectors.

Selector type	Specifications of ASTRIUM: Analytical resolution Δλ/λ (%)†	Monte Carlo simulation with *McStas*: Accessible wavelength range (Å)	No. of lamellae	Screwing angle (°)	Relative flux (%) and resolution Δλ/λ (%)†		Relative flux (%) and resolution Δλ/λ (%)‡	
Standard	10.3	≥ 4.5	72	48.3	100	11.1	100	10.6
High intensity	18.4	≥ 4.5	45	42.9	186	19.2	189	18.6
High resolution No. 1	7.9	≥ 4.5	120	39.0	70	9.3	68	7.6
High resolution No. 2	6.2	≥ 5.6	144	42.9	52	7.5	50	6.1
High resolution No. 3	5.6	≥ 6.4	144	48.3	43	6.6	42	5.6

R. Gilles et al.,J. Appl. Cryst. (2007). 40, s428–s432

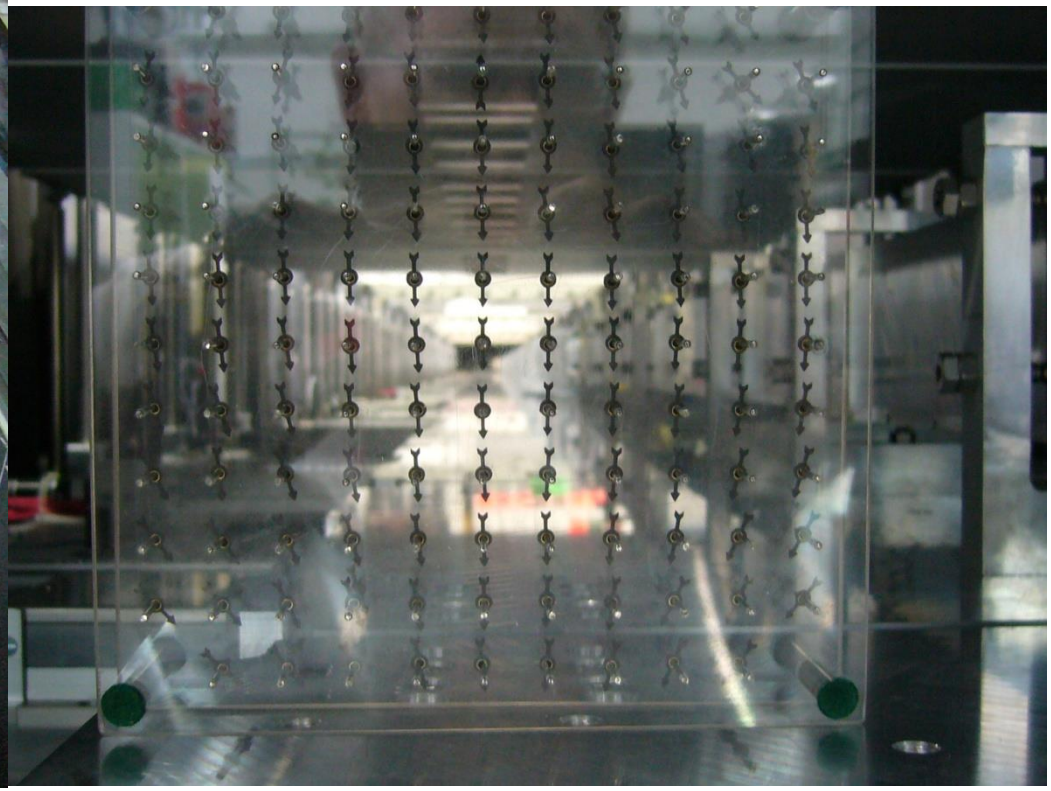



500
mm
1000
mm
sample
position
0 mm
500

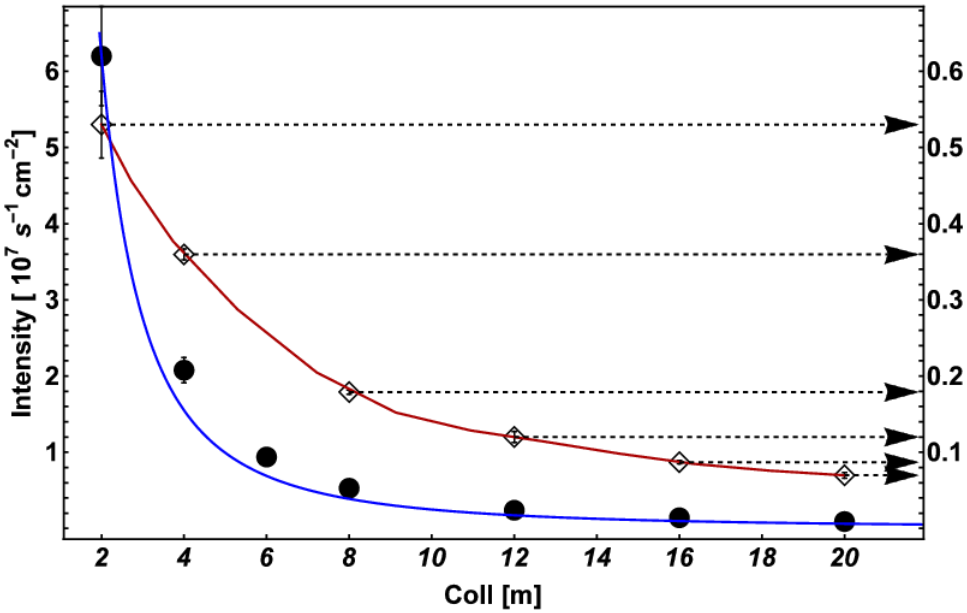

POL-1
POL-2
POL-1
POL-2
[Å] 9
10
11
12

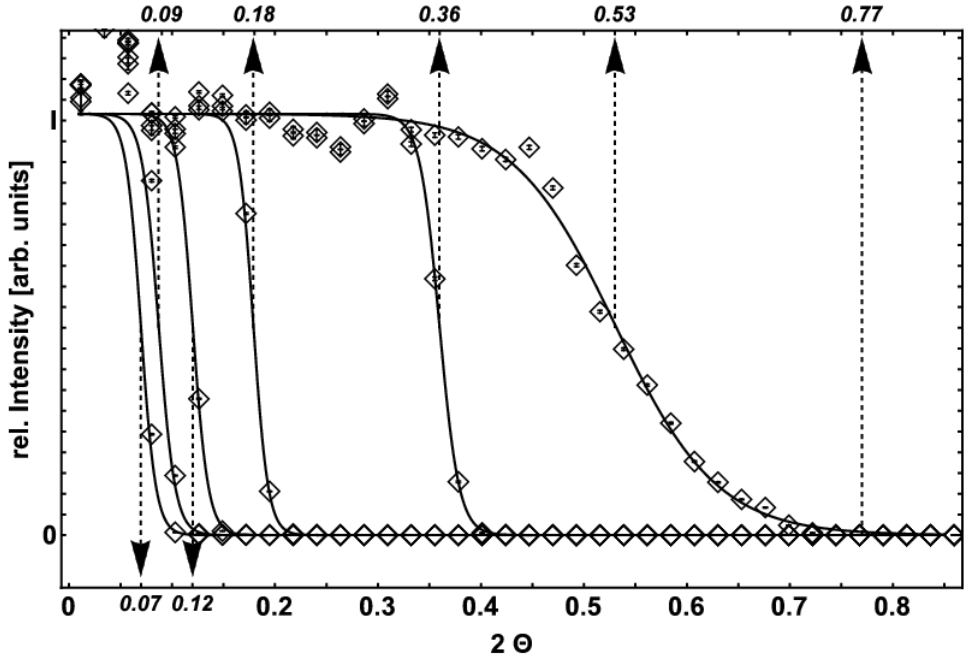
Flipp


NL1
NL2a
NL2b
NL3b
NL3a
NL4b
NL4a
NL5
NL6
NL6
AUF
ZU
STO



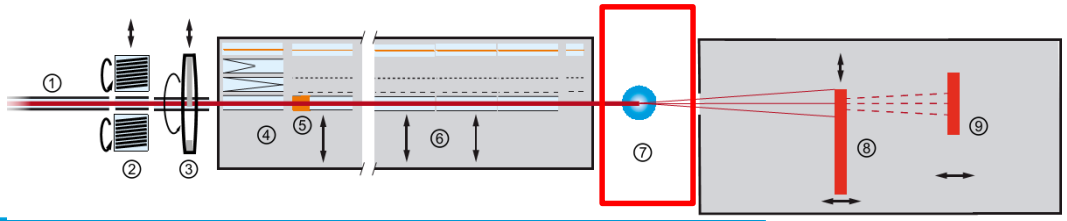
intensity & divergence





- 6 Å, maximum at 5.5 Å + 10 %

A. Heinemann et al., to be published.



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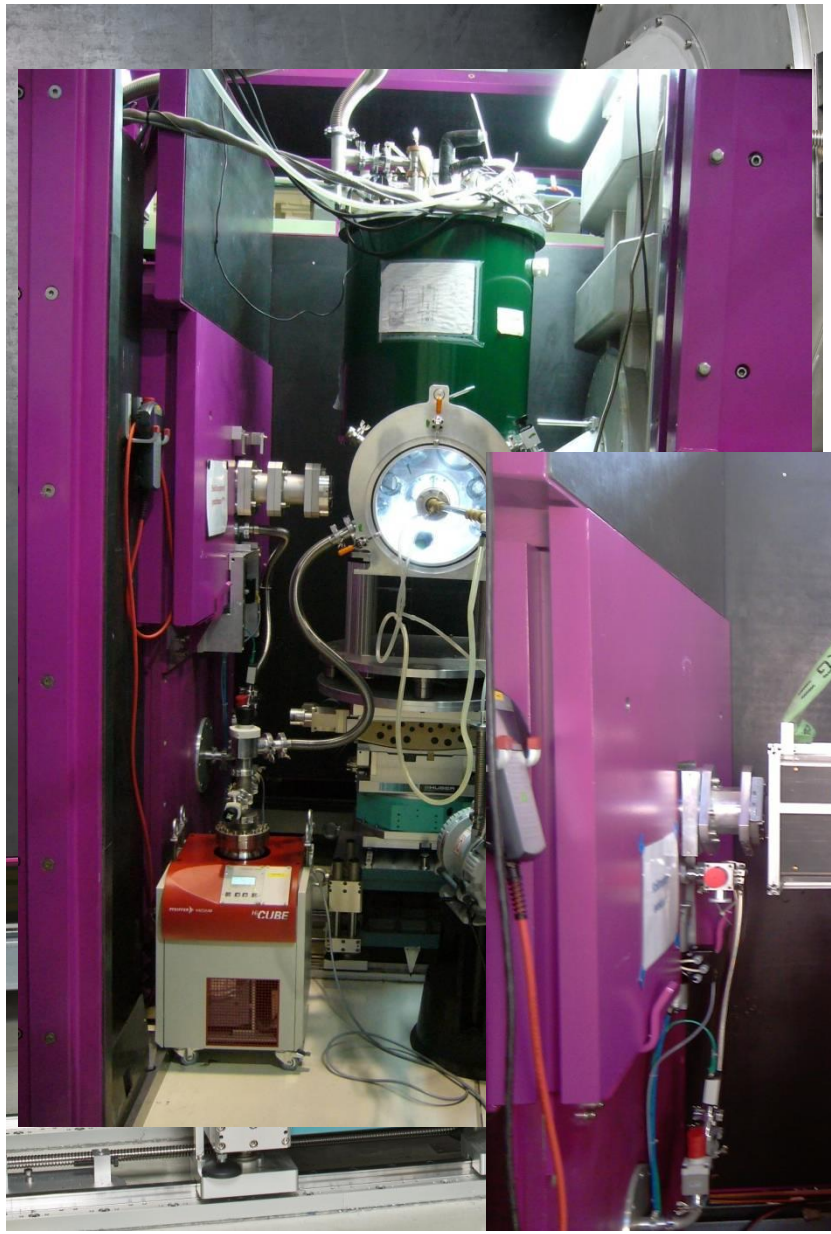
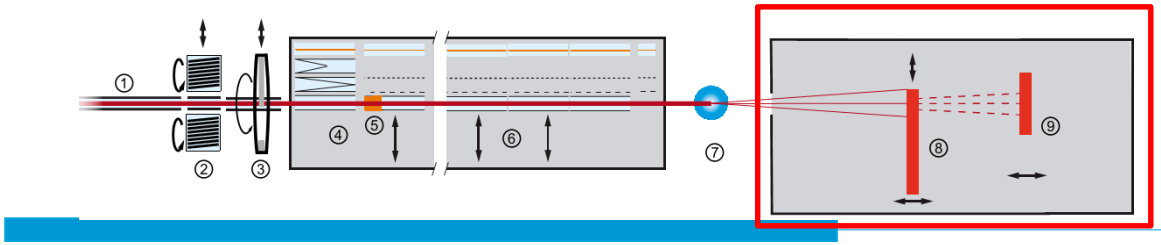
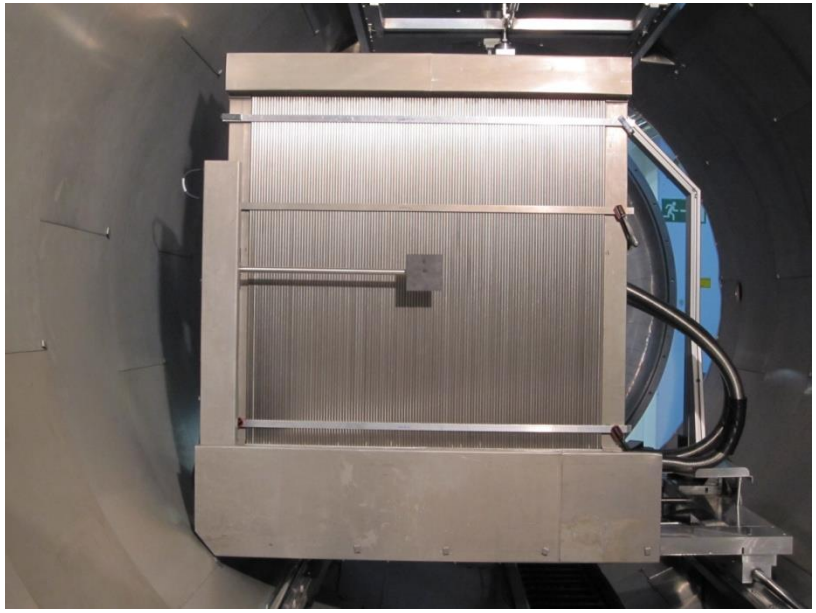


FRM II standard sample environment:

- Sample changer
- Low temperatures: cryo 3 K – 300 K (50 mK – 700 K)
- High temperatures: 2200 K
- High pressure: up to 7 Gpa
- Magnetic fields: up to 17 T
- Magic box

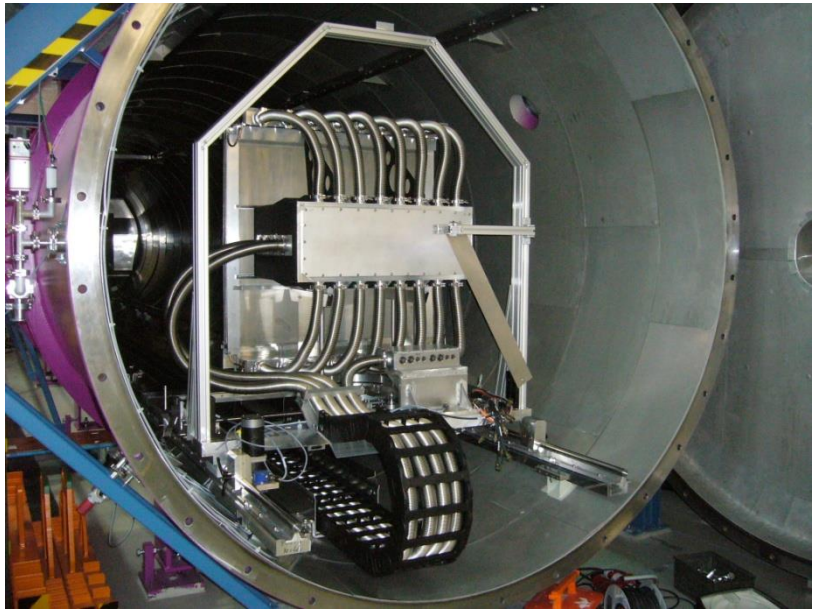
Ted Forgan et al., University of Birmingham





Primary:

- 128 He^3 position sensitive tubes
- Active area 1000 x 1020 mm^2
- 8 mm resolution
- 0.5 m lateral movement
- Counting capacity 1 MHz



Secondary:

- High resolution 3 mm
- Active area 500 x 500 mm^2
- Installed 2016

Instrument control & software

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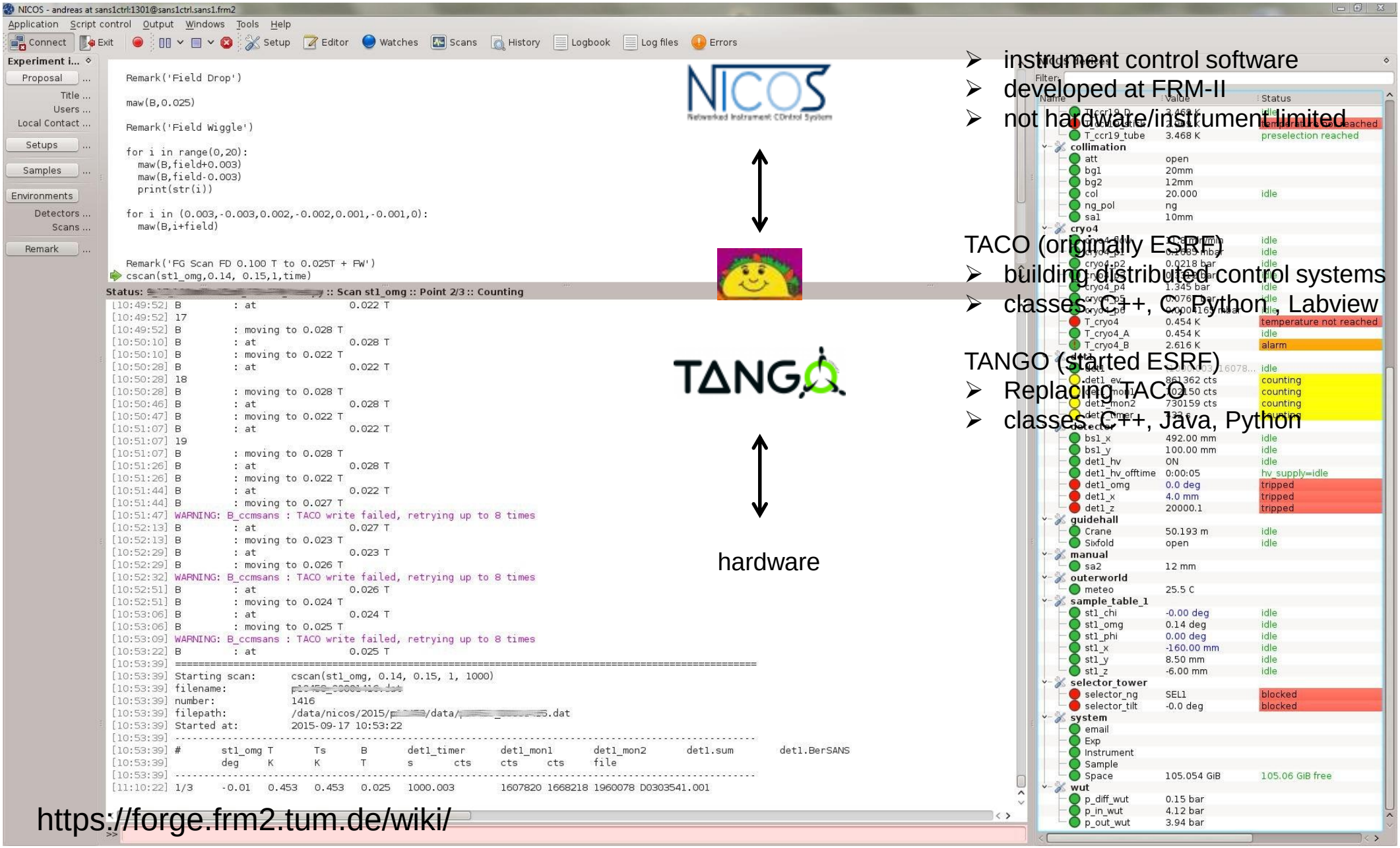


- instrument control software
- developed at FRM-II
- not hardware/instrument limited

TACO (originally ESRF)

- building distributed control systems
- classes: C++, Python, Labview

TANGO (started ESRF)

- Replacing TACO
- classes: C++, Java, Python

https://forge.frm2.tum.de/wiki/

Outlook: TISANE, MIEZE, TOF

Time

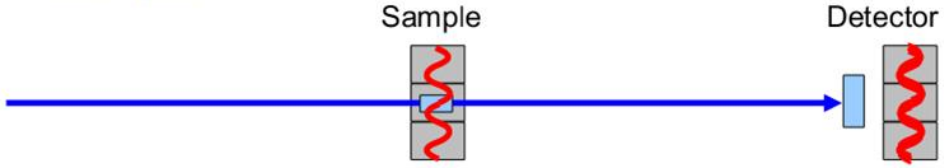
min - ms

ms - µs

µs - ps

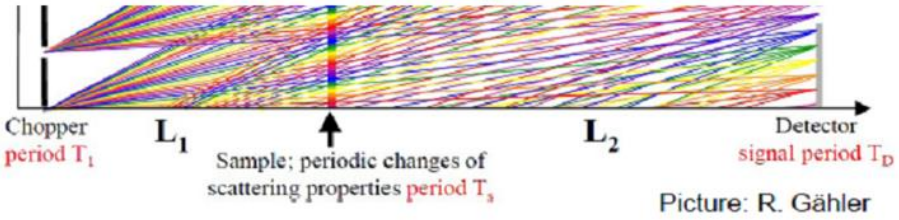
Stroboscopic SANS

SANS + stroboscopic excitation of the sample



TISANE Time Involved Small Angle Experiment

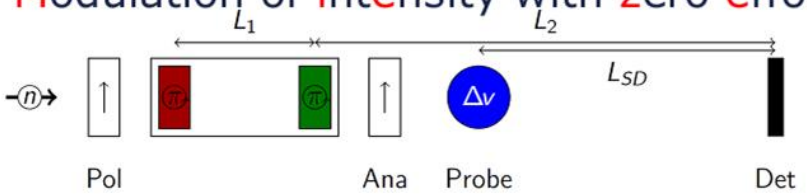
SANS + chopper + stroboscopic excitation of the sample



Picture: R. Gähler

MIEZE Modulation of Intensity Emerging with Zero-Effort

Spin echo technique:
Modulation of intensity with zero effort



External control parameter

Intrinsic dynamic behaviour $S(q,\tau)$

Magnetism
- Switching of multilayers
- Dynamic: magn. Domains
- Switching multiferroics
- Ferrofluids

Life Science
- Dynamics of biolog. react.
- Organic solar cells
- Polymer folding

Material Science

Vortex Matter

…

S. Mühlbauer, Greinau meeting 2015

summary

advantages:

- one of the best SANS machines worldwide
- high flux, low background
- flexible: broad application range
- good team ☺

disadvantages (minor):

- space: sample position, …
- accessibility: collimation, …
- missing remote shutter
- slit system: size, position, shape

things to keep in mind:

- keep it easy, no ‘swiss army knife’
- absolute encoder
- shielding
- plan the software/ instrument control early
- vacuum test chamber
- detector: high counting rate
- no dry cryos/ magnets – He return
- no shielded magnets

Acknowledgments

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

A. Heineman
S. Busch
A. Beldowski
O. Frank
A. Schreyer
…

S. Mühlbauer
A. Wilhelm
S. Semecky
R. Gilles
…

Thank you for your attention

Pictures: http://www.mlz-garching.de/files/experimental-facilities_online.pdf