FROM RESEARCH TO INDUSTRY

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The HERMES - LLB outstation at the JULIC Neutron Platform

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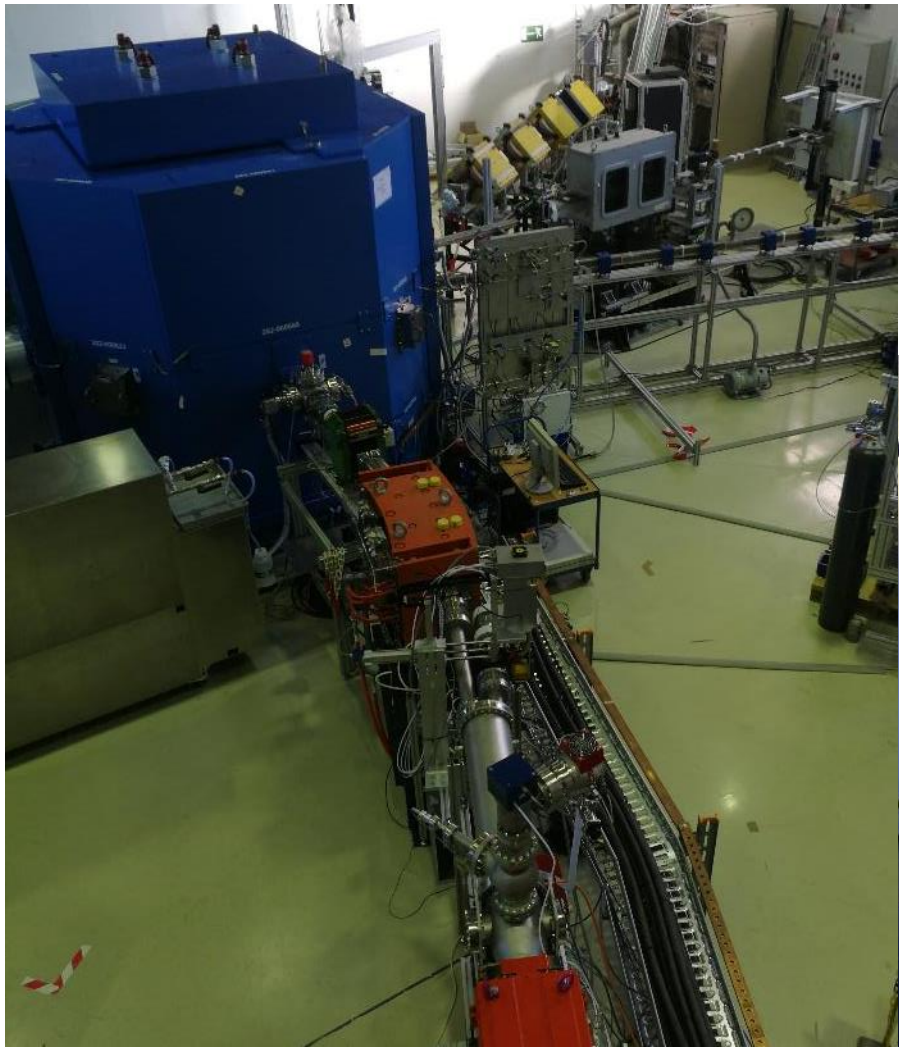
JULIC NEUTRON PLATFORM(JCNS)

TECHNOLOGY TEST PLATFORM FOR THE GERMAN HiCANS[1] PROJECT (HBS[2])

JULich Light Ion Cyclotron



JULIC(IKP)

- E : 45 MeV
- I_p : 6 µA
- τ_{pulse} : 100 µs – 2 s

1 High Current Compact Accelerator Neutron Source
2 High Brilliance Source (70 MeV, 90 mA)

JULIC NEUTRON PLATFORM(JCNS)

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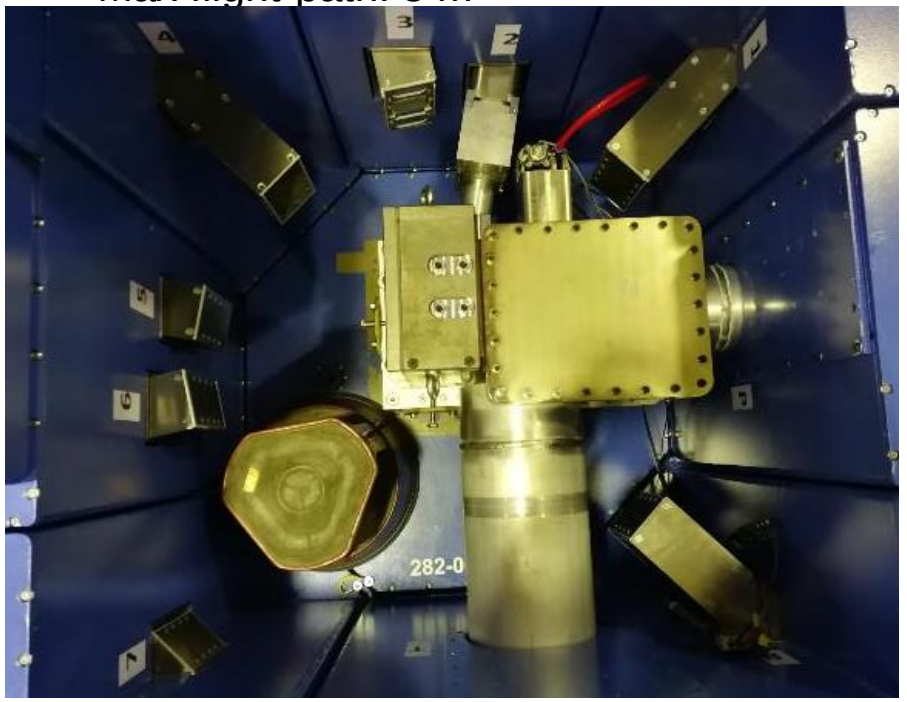
JUlich Light Ion Cyclotron

JULIC(IKP)

- E : 45 MeV
- I_p : 6 µA
- τ_{pulse} : 100 µs – 2 s

- Ta target (10 cm x 10 cm)
- Polyethylene moderator
- Pb reflector
- 8 extraction channels
- 2 cold moderators: CH_4 et para-H_2
- Max flight-path: 8 m



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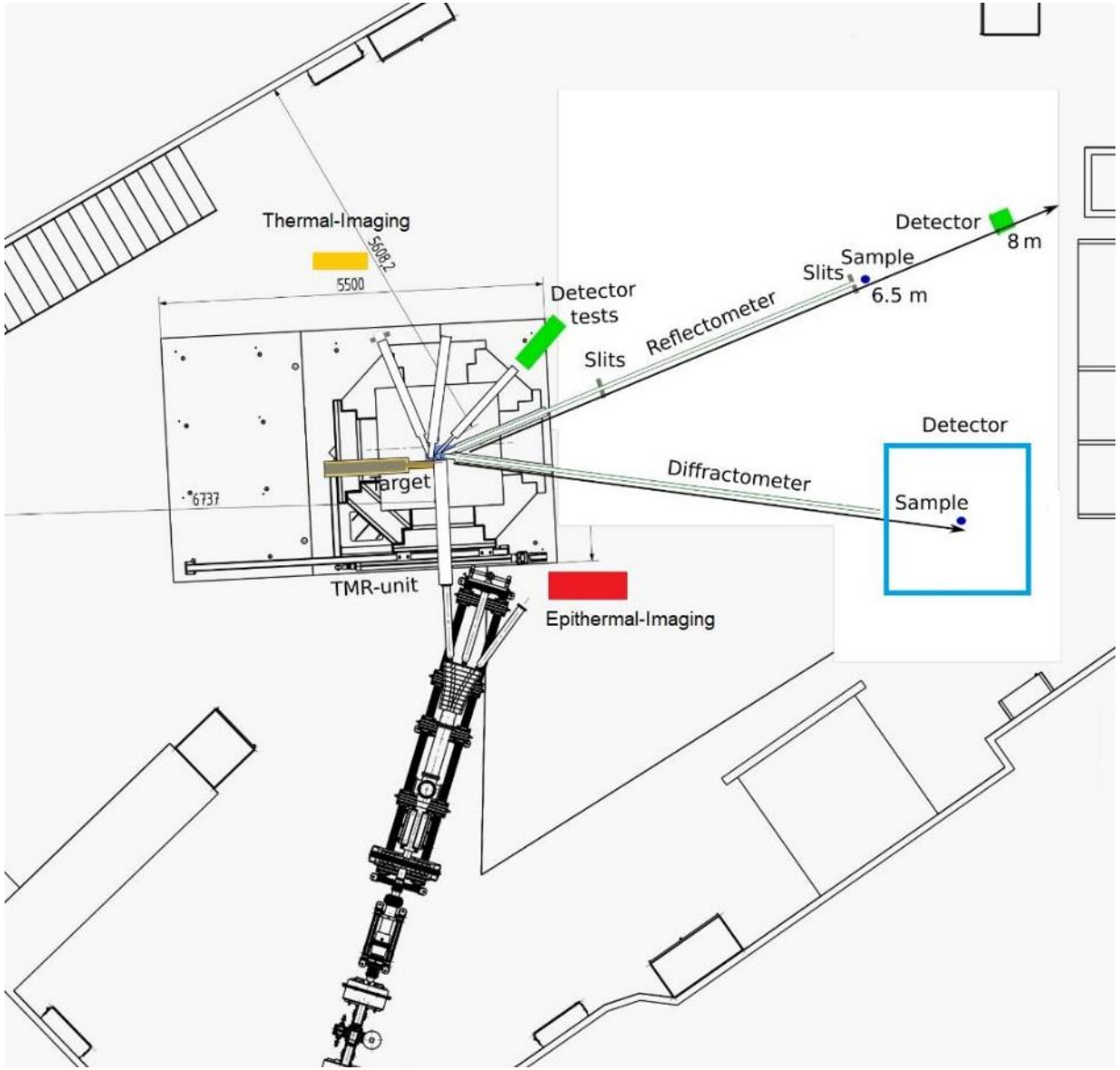
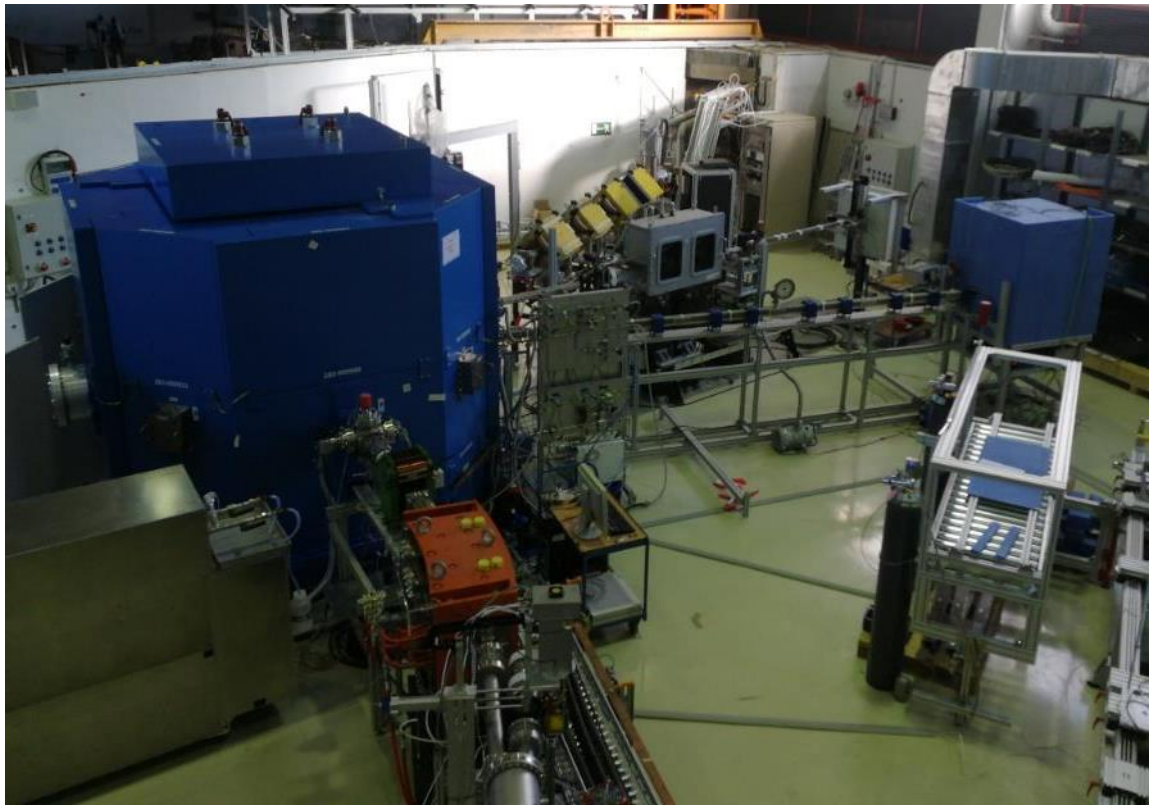
2 High Brilliance Source (70 MeV, 90 mA)

JULIC NEUTRON PLATFORM



5 BEAMLINES

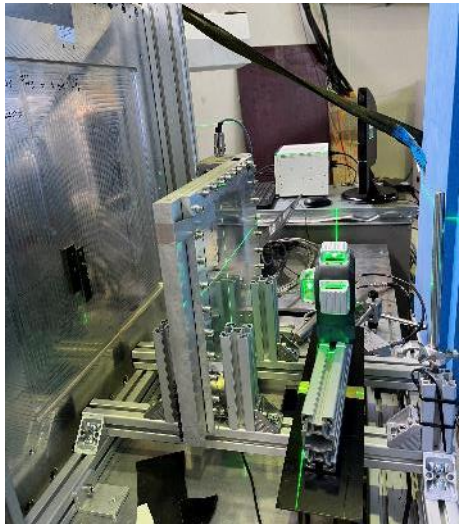
- Neutron reflectometer (HERMES)
- Prompt Gamma Neutron Activation Analysis (TOAD)
- Detector test station
- Thermal neutrons imaging station
- Epithermal neutrons imaging station

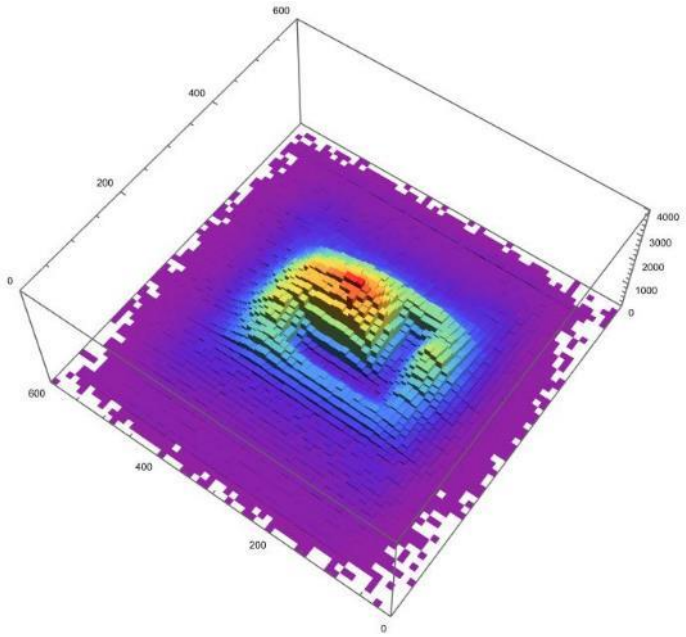


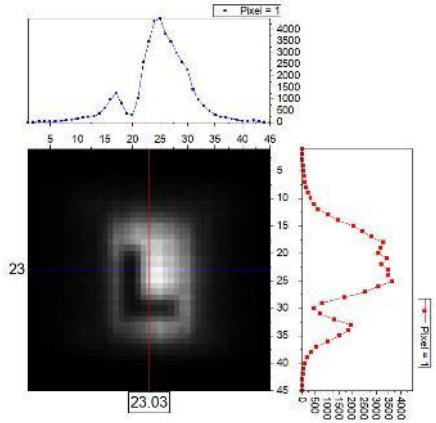
BEAMLINES AT JNP

DETECTOR TEST STATION

$^{10}B_4C$-monitors filled with 1 bar Ar/CO_2 and Ar/CF_4
^{6}Li-“L”-mask



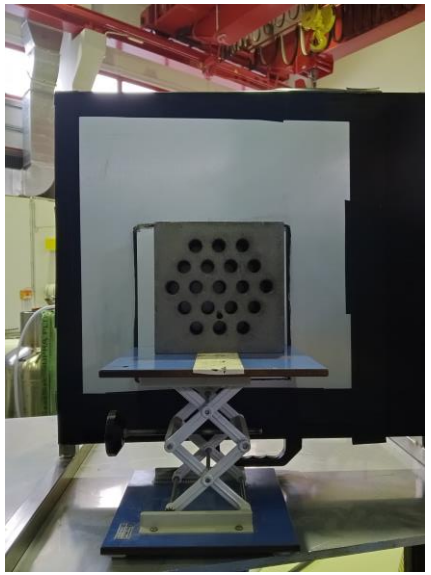


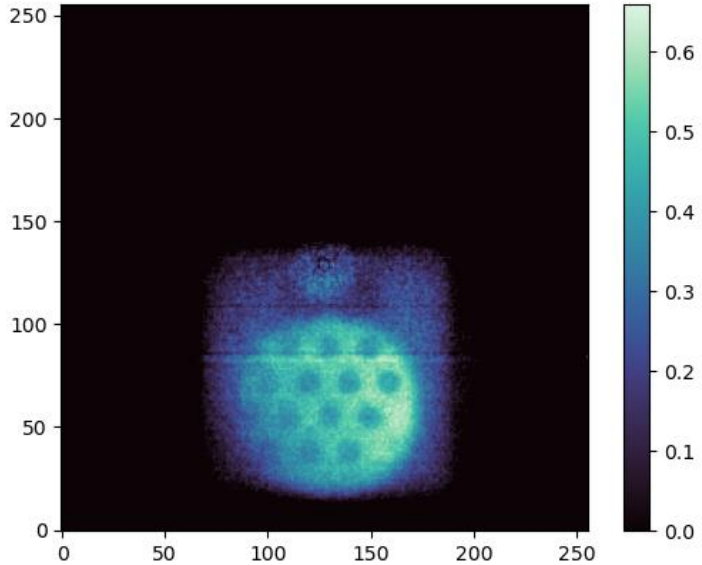


G. Nowak
J. Plewka
C. Jacobsen
R. Kumar
J. Fenske

Helmholtz-Zentrum hereon

EPITHERMAL NEUTRONS IMAGING STATION





Flat panel detector with a graphite block as a sample.

N. Schmidt
E. Mauerhofer
T. Gutberlet
T. Brückel

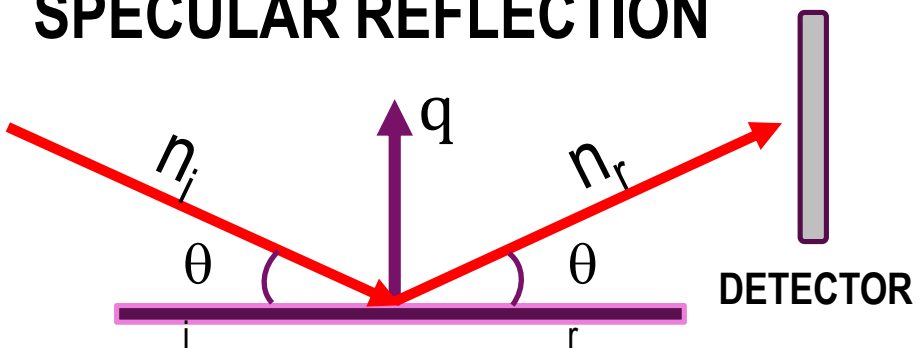
Jülich Centre for Neutron Science

NEUTRON REFLECTOMETRY

SMALL-ANGLE SCATTERING TECHNIQUE ➡ GRAZING INCIDENCE

Useful for surfaces, interfaces, multilayers

SPECULAR REFLECTION



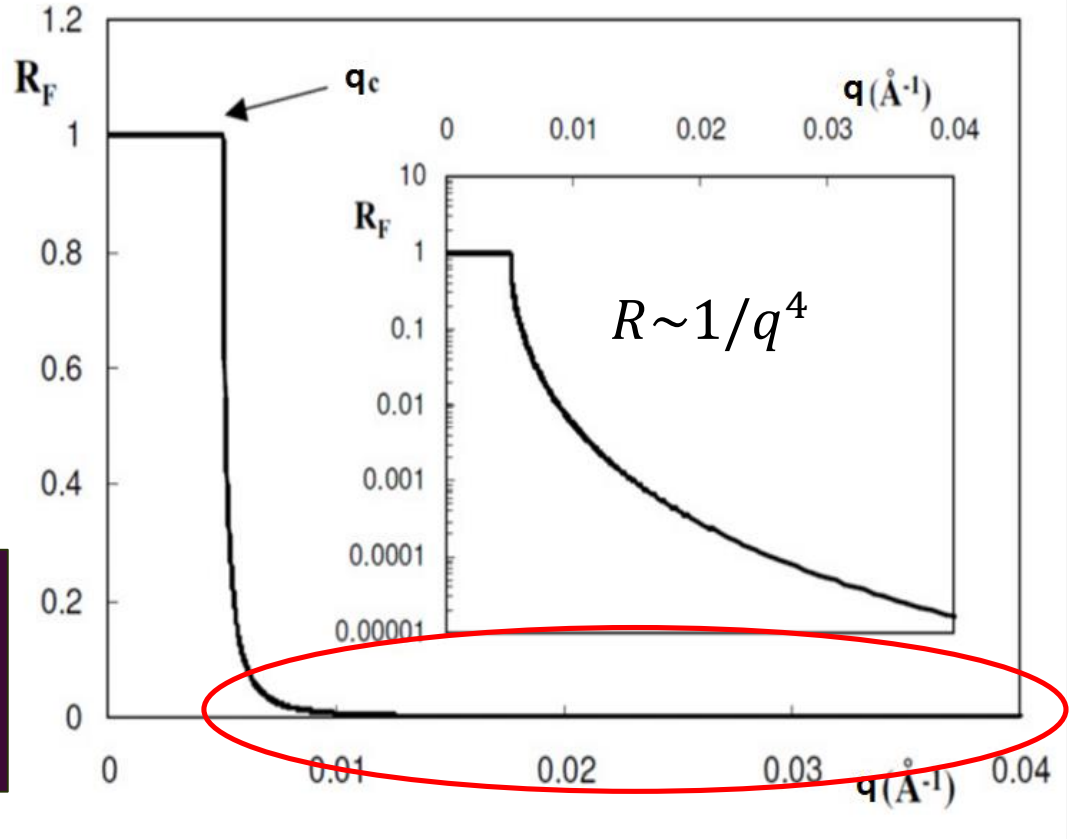
Reflectivity

$$R = \frac{I_r}{I_i}$$

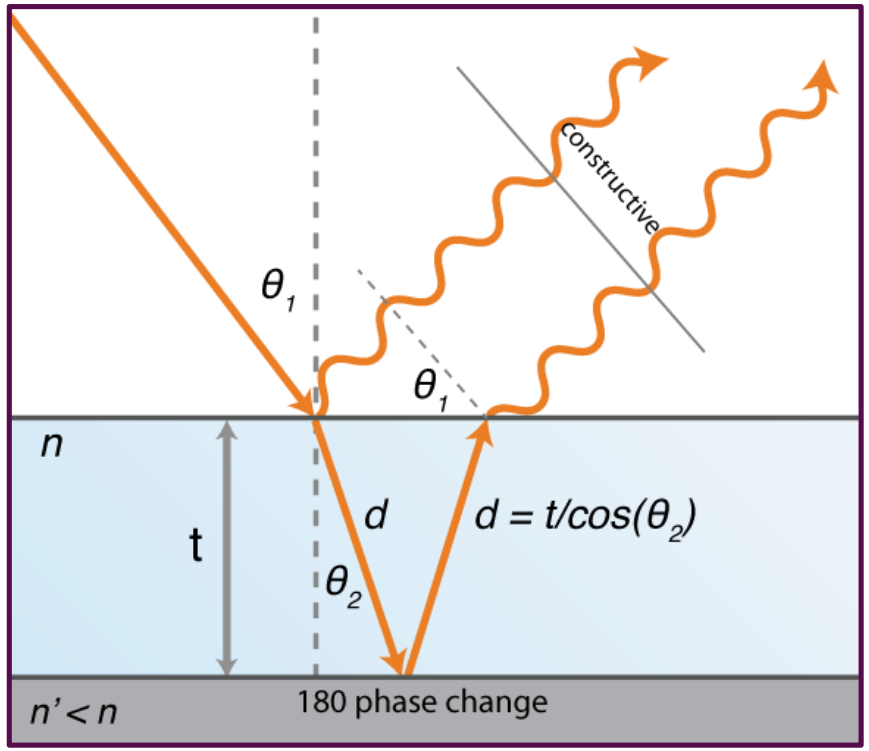
Momentum transfer

$$q = \frac{4\pi}{\lambda} sin(\theta)$$

Air/Si

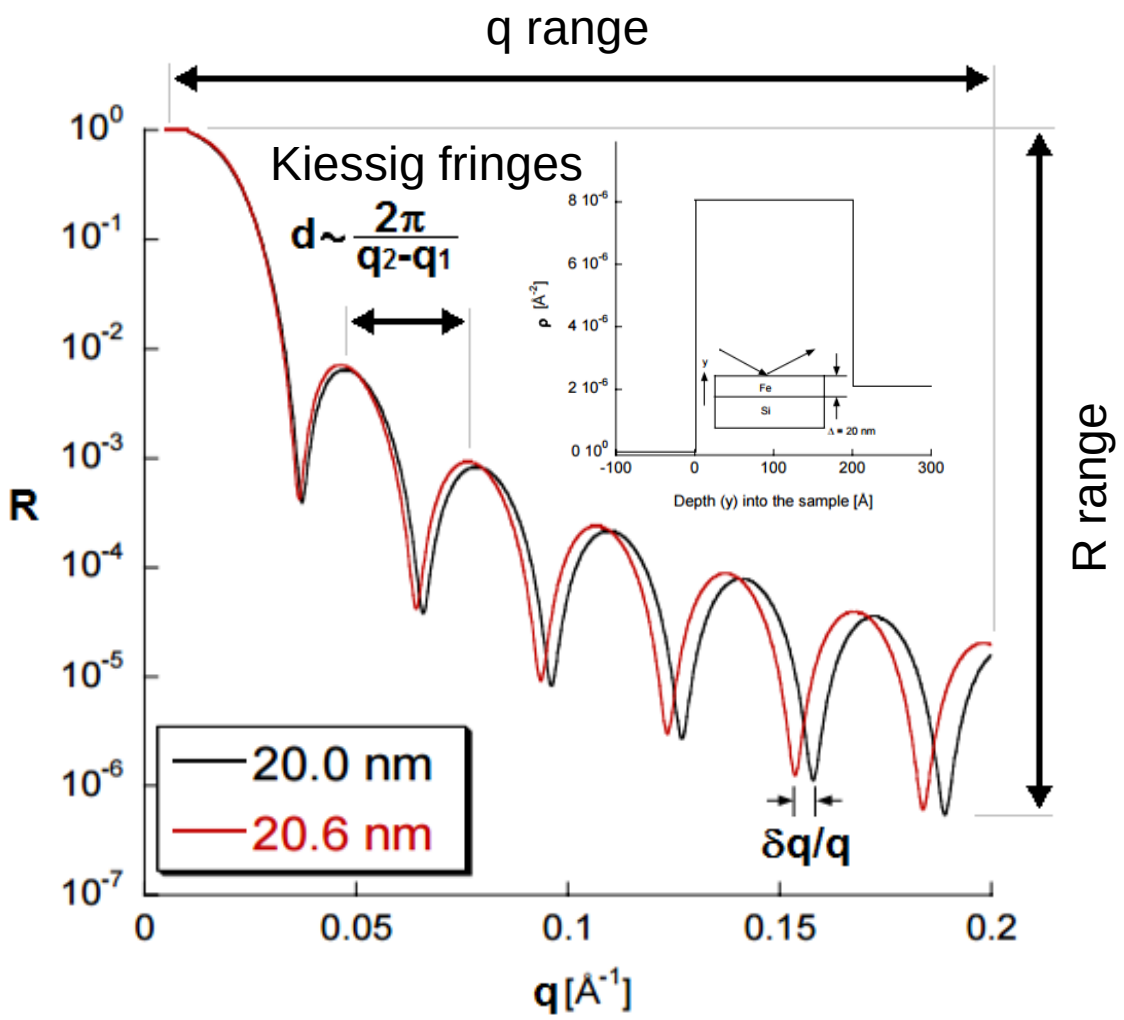


NEUTRON REFLECTOMETRY



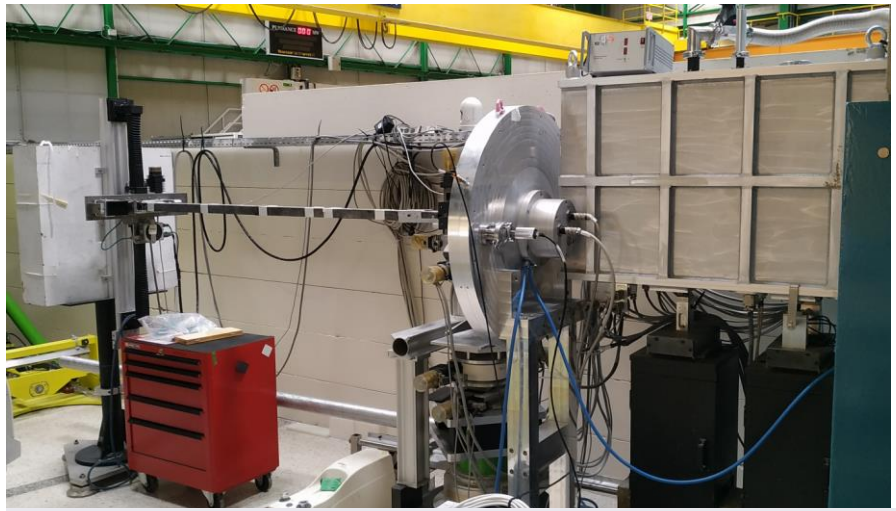
Resolution

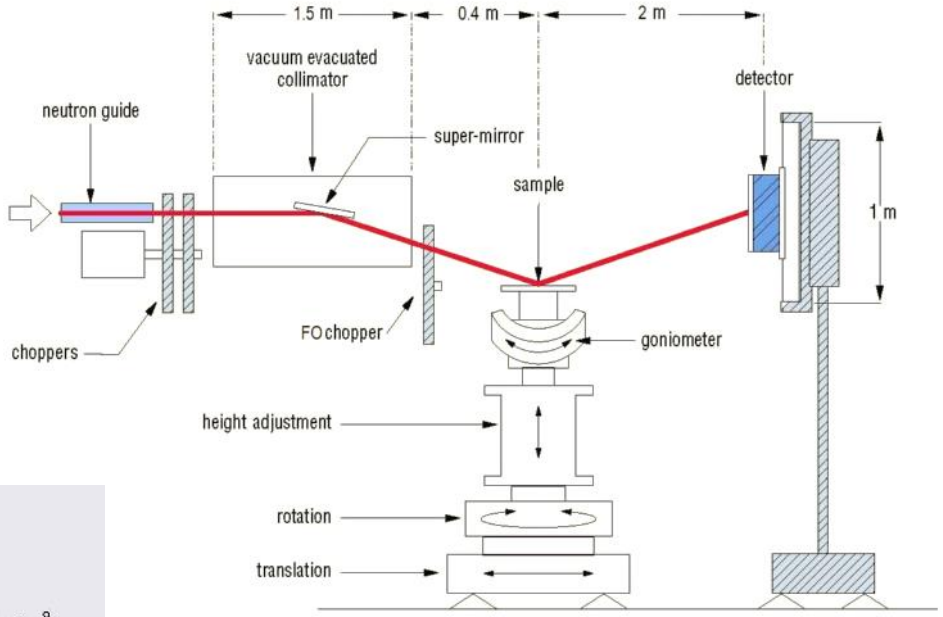
$$(\delta q/q)^2=(\delta\lambda/\lambda)^2+(\delta\theta/\theta)^2$$



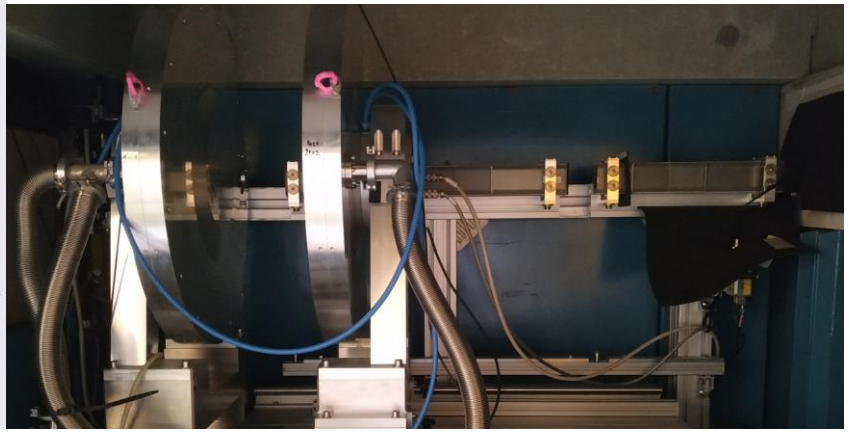
HERMES

TIME-OF-FLIGTH HORIZONTAL REFLECTOMETER (G6-2)





Distance chopper to detector	6.25 m
Distance sample to detector	2 m
Wavelength range	3 Å to 25 Å
Wavelength resolution	fixed $\Delta\lambda$ from 0.1 Å to 1 Å
Angular range	0.1° to 6°
Angular resolution	0.007° to 0.15°
Position of the surface	horizontal
Horizontal beam size at the sample	25 mm
Vertical beam size at the sample	0.5 mm to 10 mm
Detection	^{3}He
Maximum intensity	1000 count.sec^{-1} Å^{-1} at 3.5 Å
Background	1 count.hour^{-1} Å^{-1}
Minimum measurable reflectivity	5.10^{-6}
Typical acquisition time :	4 h - 8 h (soft matter)



WHY DID WE INSTALLED HERMES AT THE JULIC NEUTRON PLATFORM?

1. TO TEST THE VIABILITY OF NEUTRONS INSTRUMENTATION AT HICANS

2. IT'S A "SIMPLE" INSTRUMENT

- Few parts
- Modular
- Small footprint (A < 8m^2)

3. WELL SUITED FOR TESTING

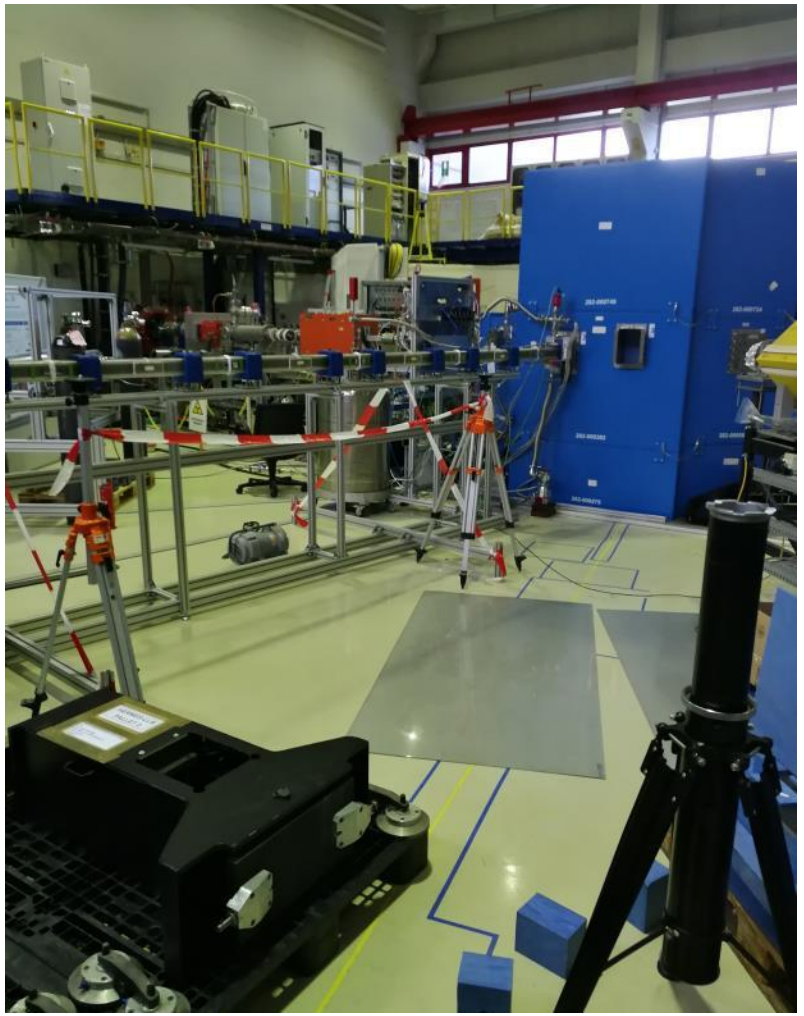
- Pulse length adapted to the required resolution
- Useful spectrum
- Performance directly linked to the background

4. BIG SAMPLES (1 CM^2 ⟶ 100 CM^2)

DISASSEMBLY AND INSTALLATION OF HERMES AT FZJ

ORPHÉE REACTOR

JULIC NEUTRON PLATFORM



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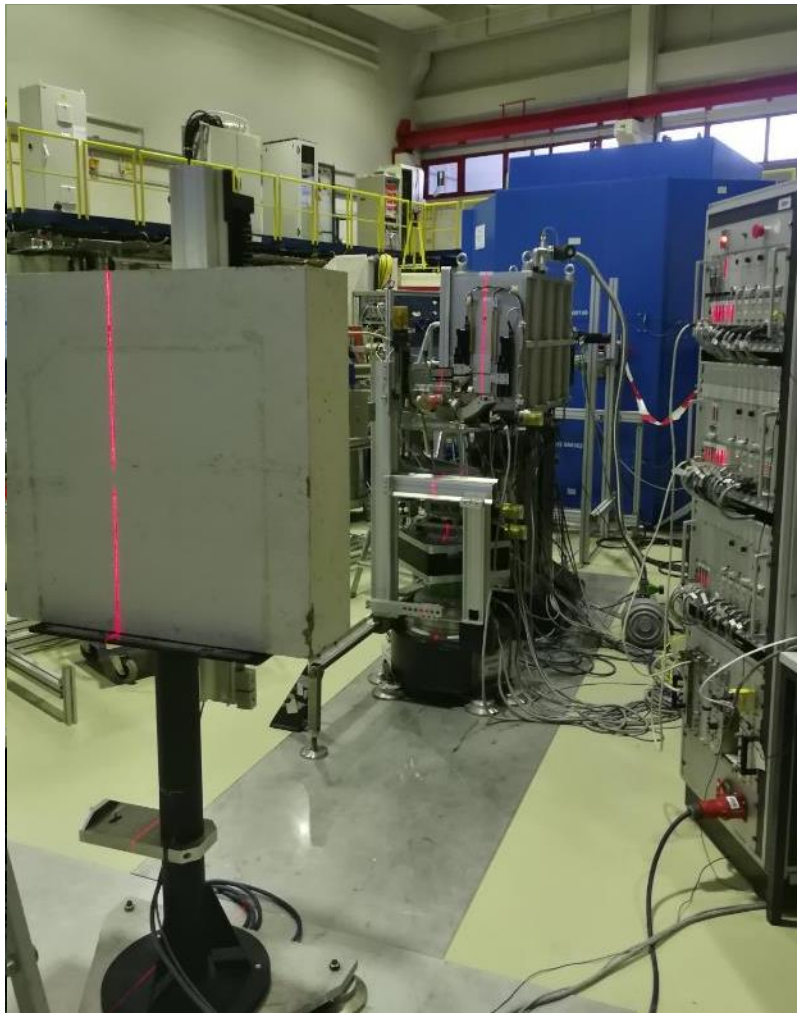
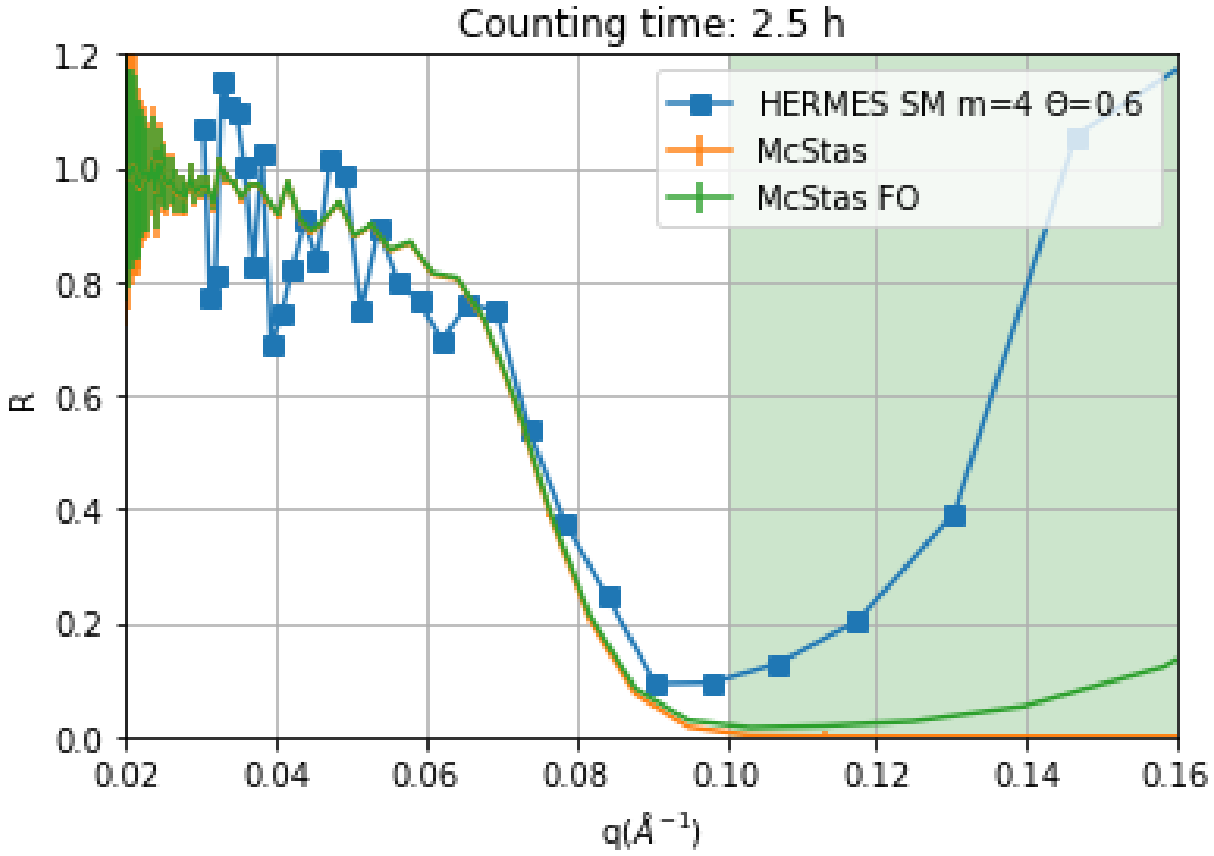


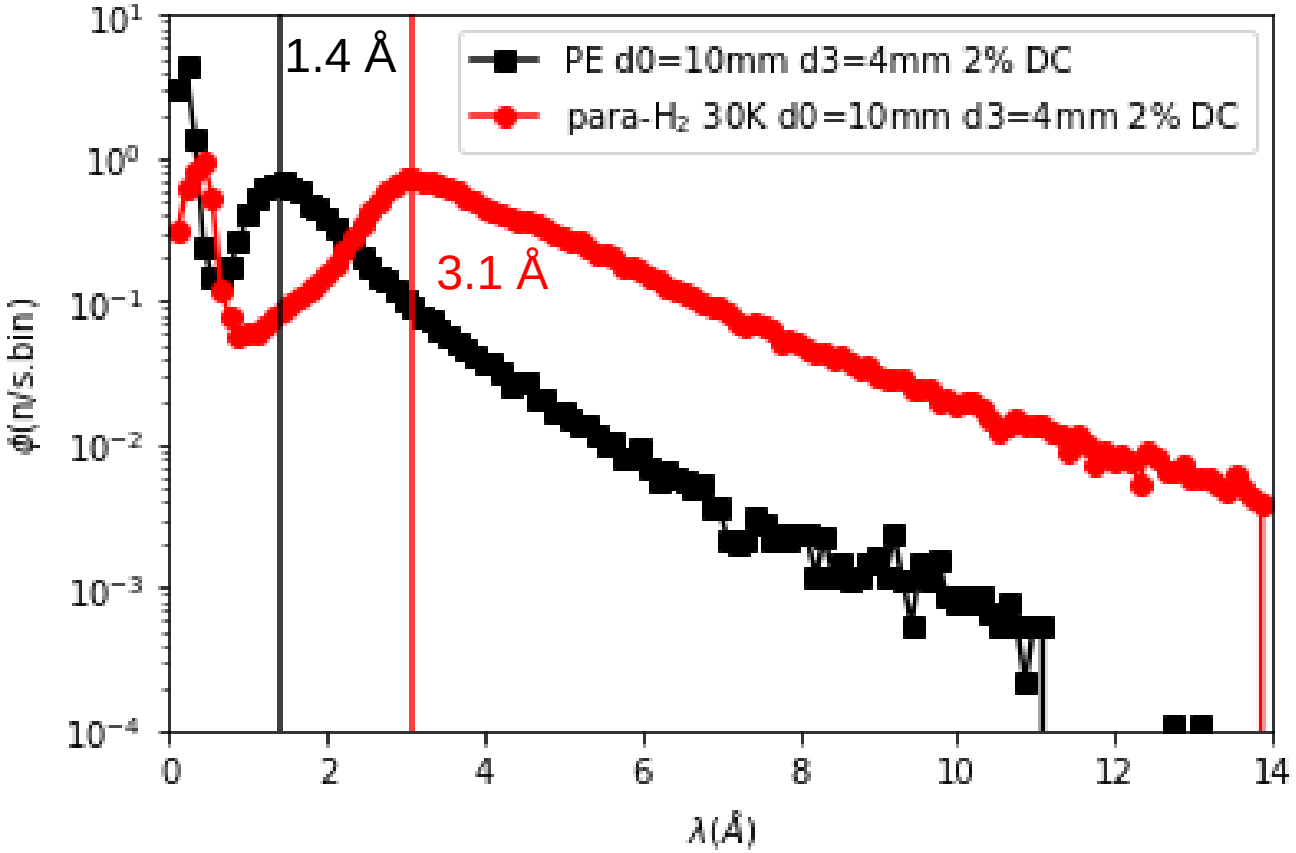
FIRST TESTS AT JNP (DEC-2022)

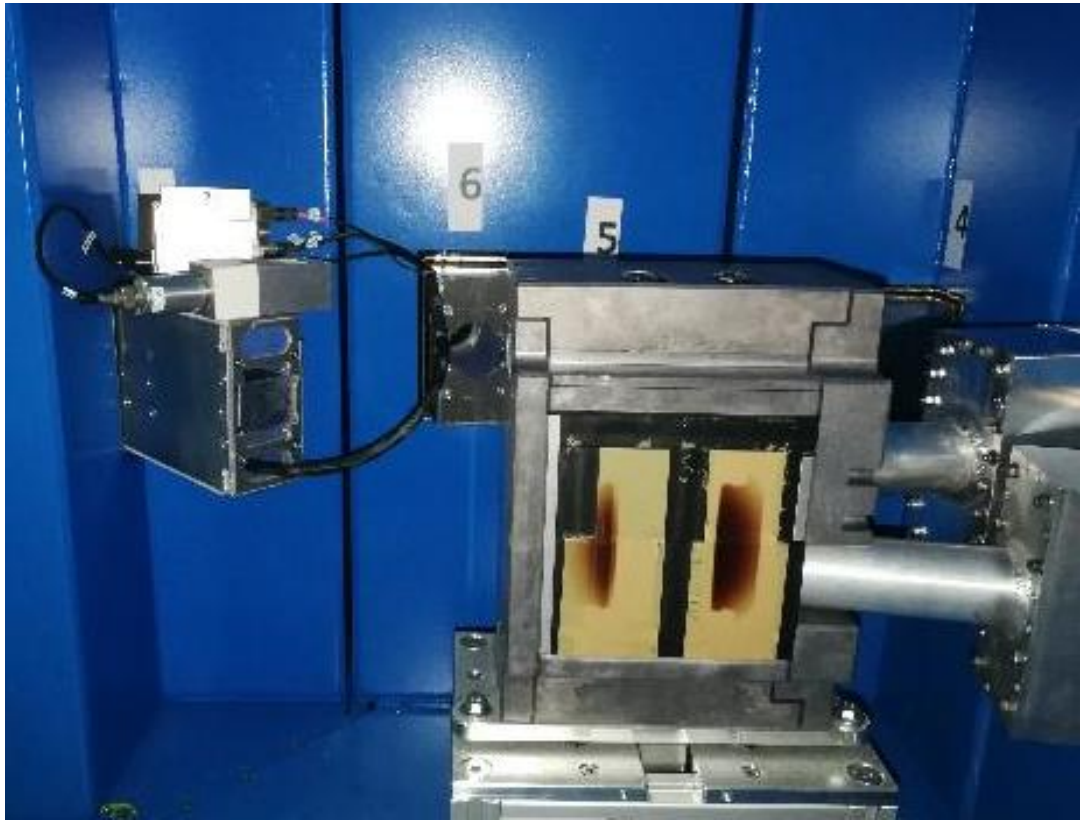
Control and acquisition : NICOS + Python
JULIC: 45 MeV, ~250 nA, 400 µs, 125 Hz, 5% duty-cycle



- **Low flux**
- **High background**

PARA-H_2 COLD MODERATOR



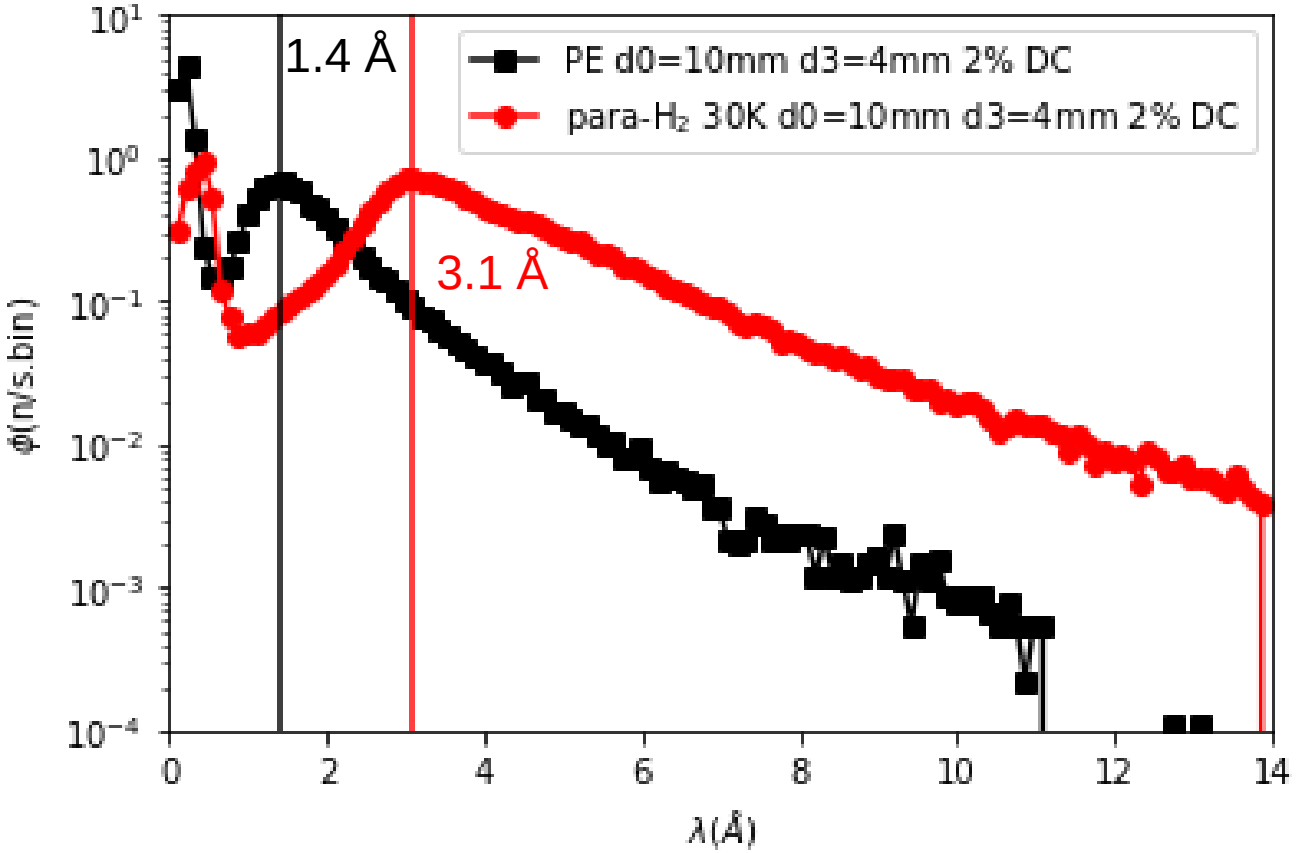


Total counts$_{PE}$ (1.0Å - 12.0Å) in 1h: 27702

Total counts$_{para-H_2}$ (1.0Å - 12.0Å) in 1h: 63827

X 2.3

PARA-H_2 COLD MODERATOR



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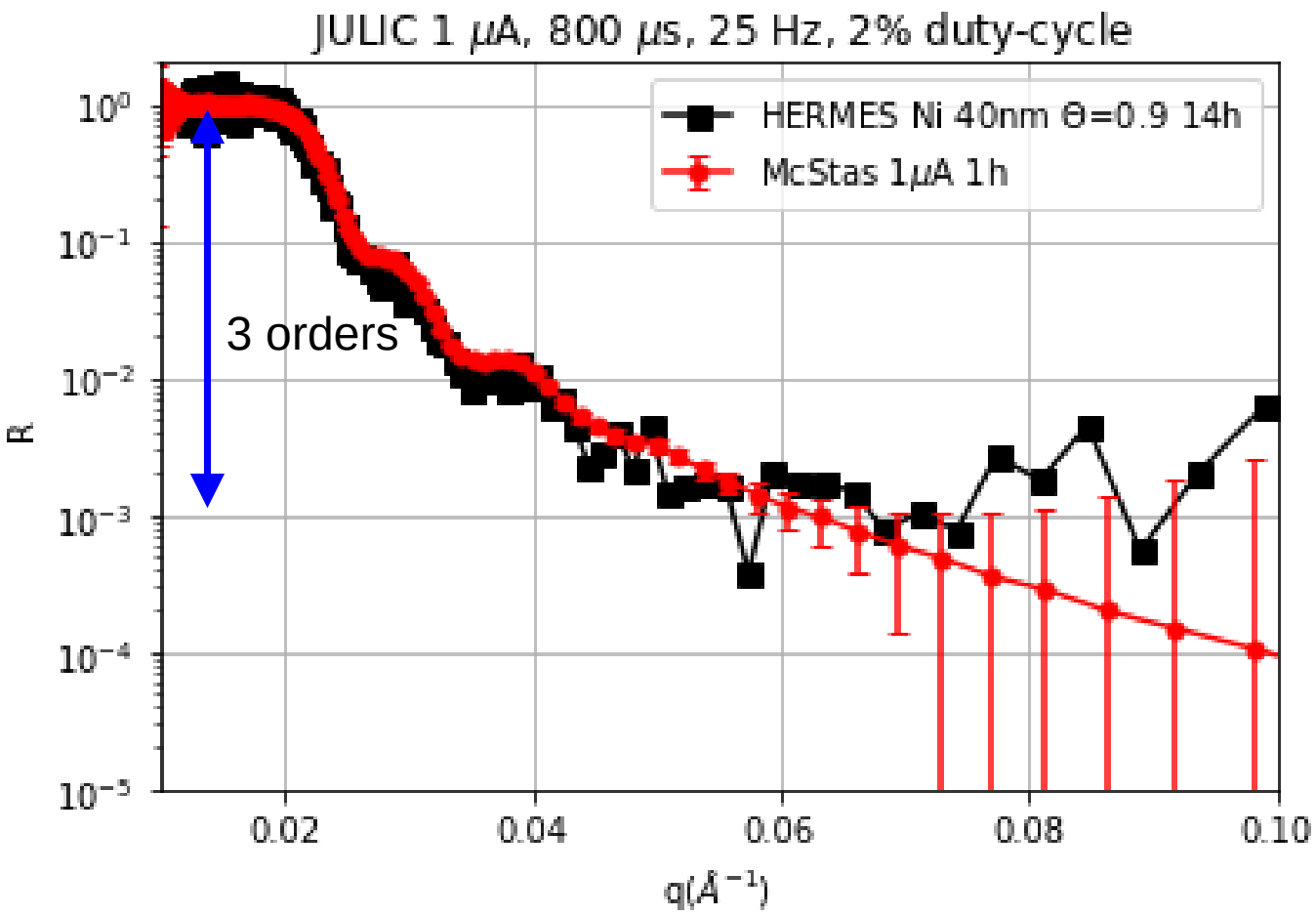
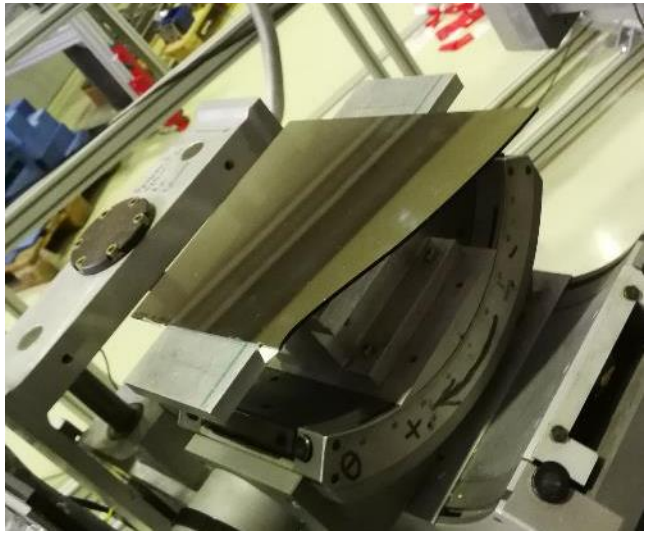
2023 EXPERIMENTS (JULY)

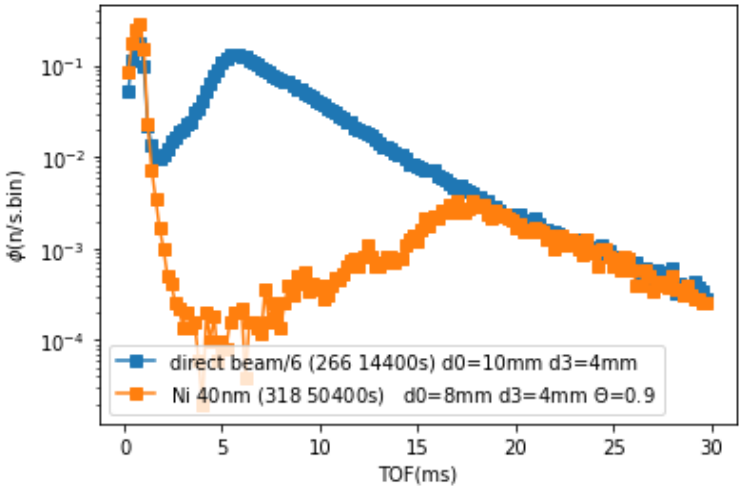
40 nm Ni on Si (“3”cm x 10cm)

Control & acquisition : NICOS

JULIC: 45 MeV, ~ 1 µA, 800 µs, 25 Hz, 2% duty-cycle, P_{target}=1 W







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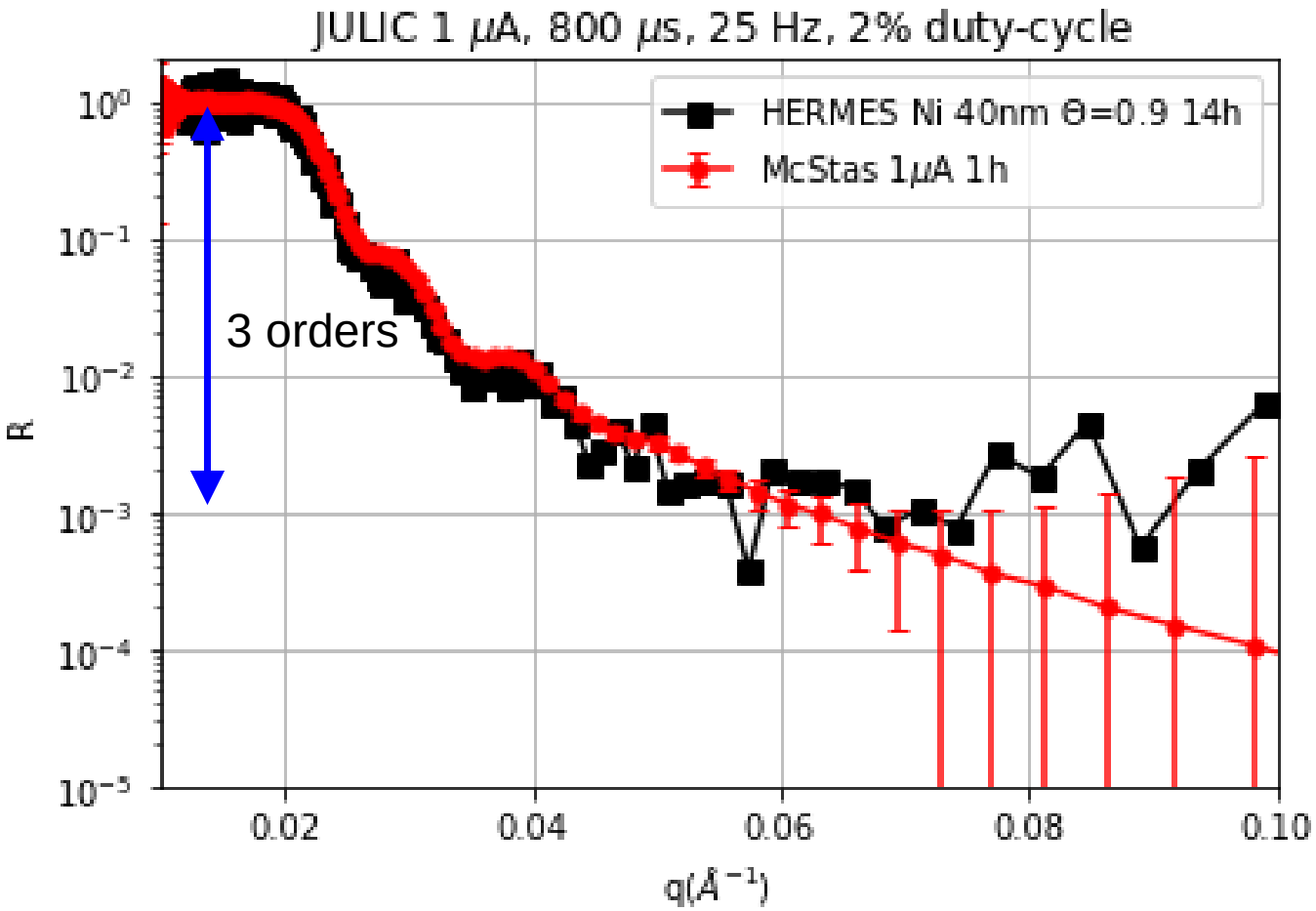


REALITY

$\phi_{detector}$ = 0.04 n/s.cm^2

SIMULATION

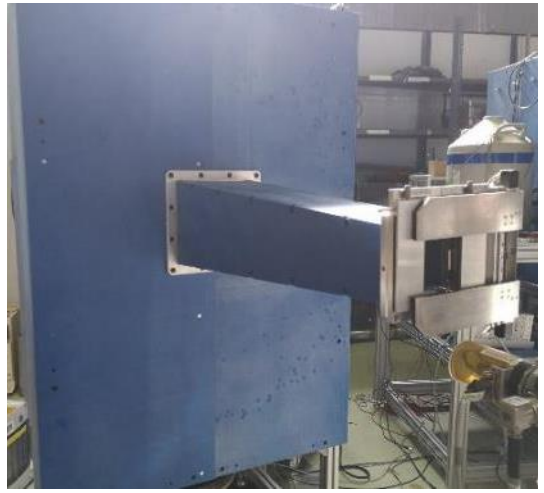
$\phi_{detector}$ = 0.4 n/s.cm^2 x 10

- **Non-optimized moderator geometry**
- **Background ➔ shielding**

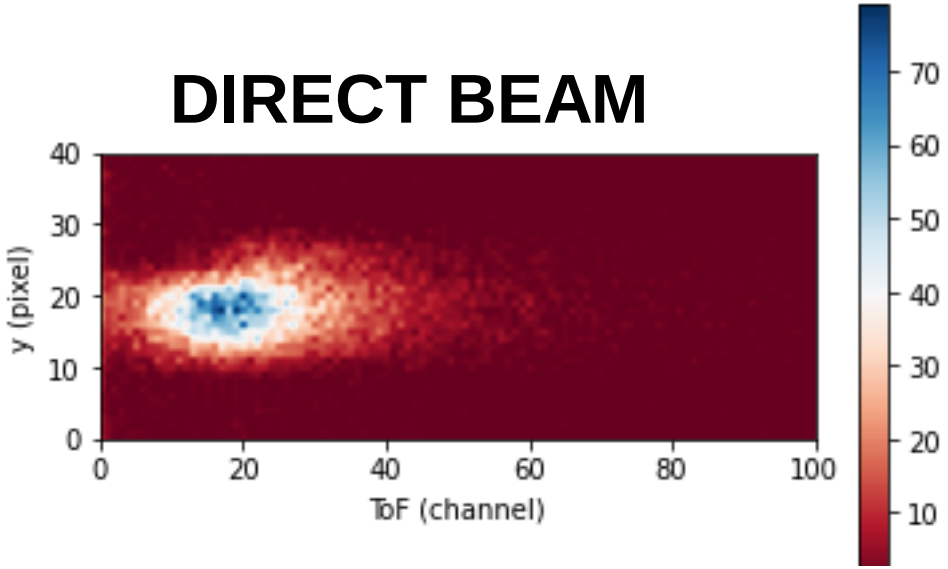
1 W ➔ 100 kW

- **Sample size: 10 cm^2➔ 1 cm**
- **Measuring time: 10 h ➔ 1h**
- **Reflectivity: 10^{-3} ➔ 10^{-6}**

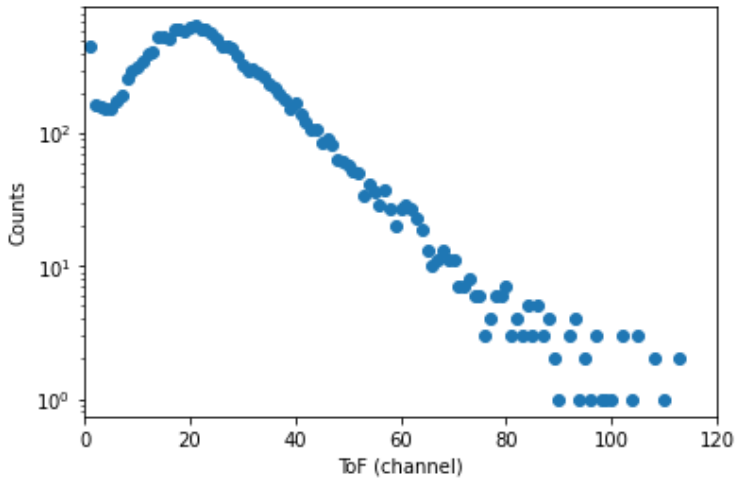
DENEX-POSITION SENSITIVE DETECTOR



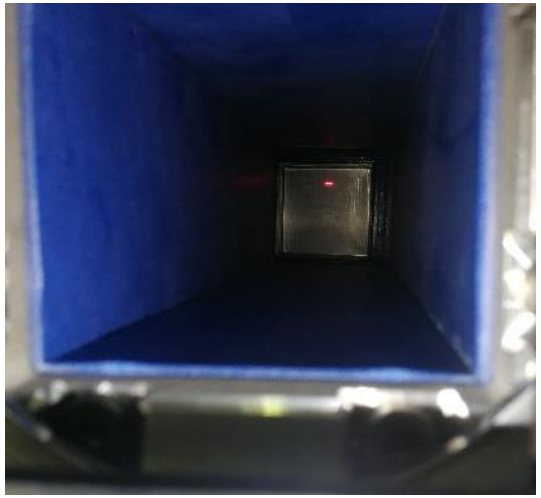
DIRECT BEAM



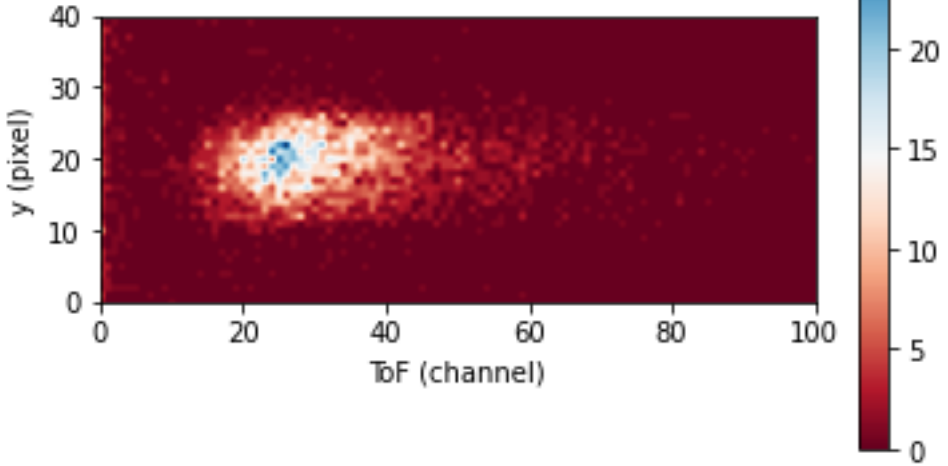
3ms 10Hz 1h



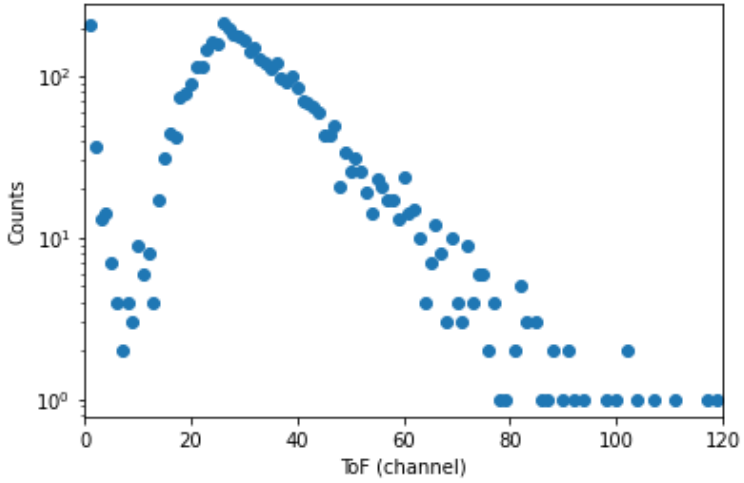
Total counts (active area): 16450



SM m=4

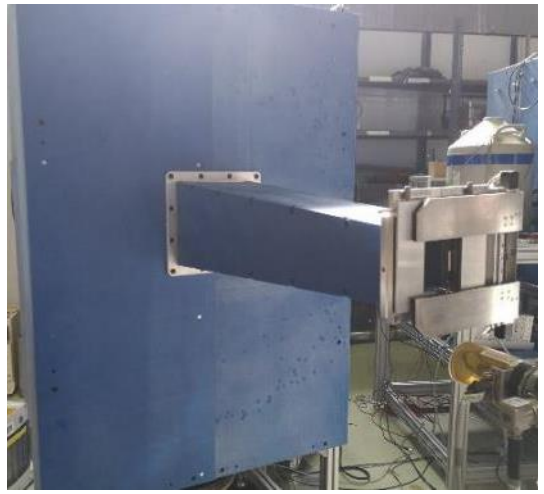


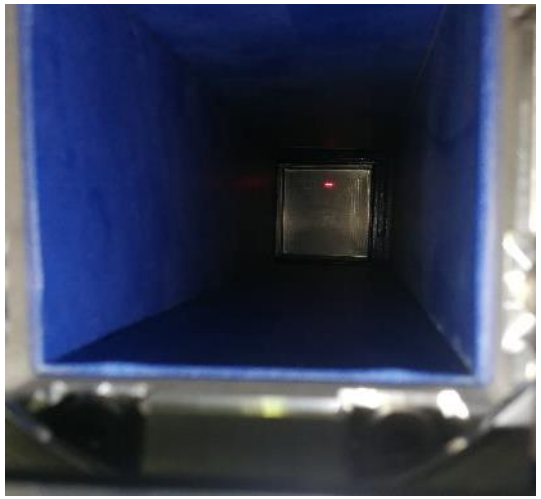
3ms 10Hz 1h



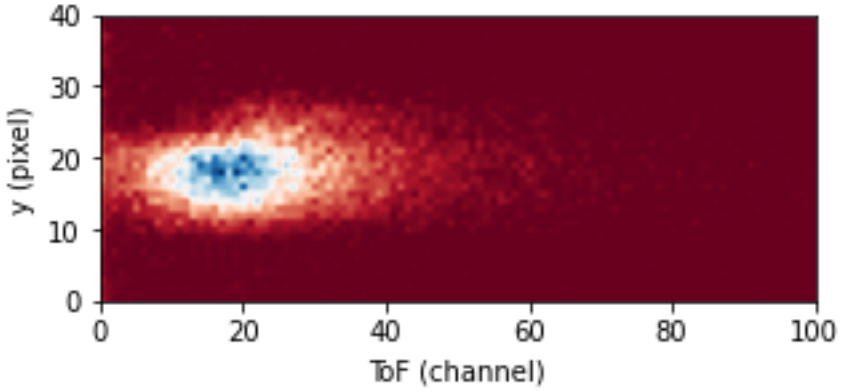
Total counts (active area): 4337

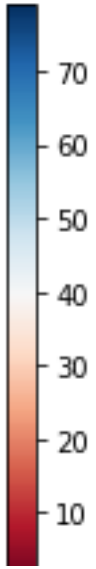
DENEX-POSITION SENSITIVE DETECTOR



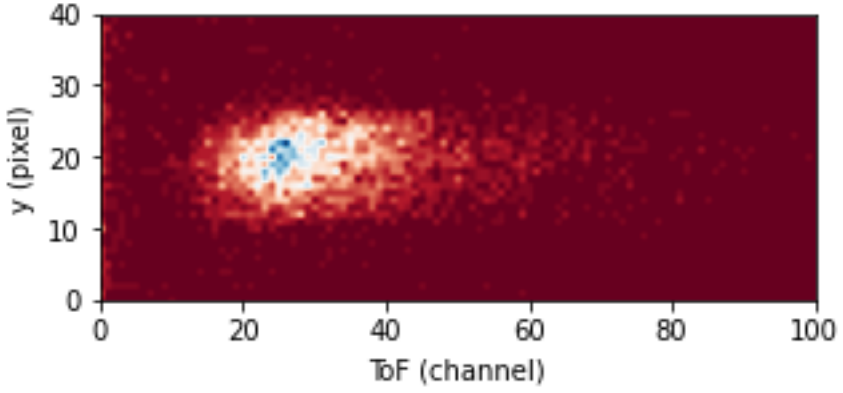


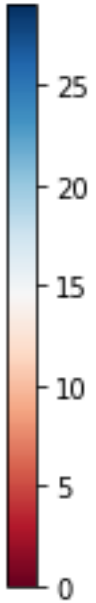
DIRECT BEAM

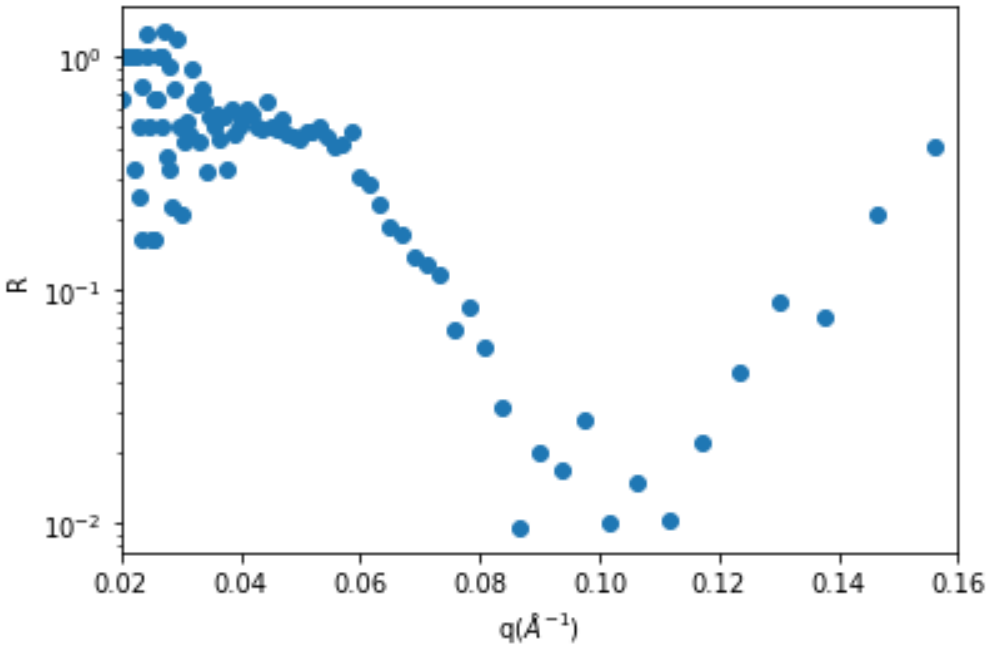




SM m=4





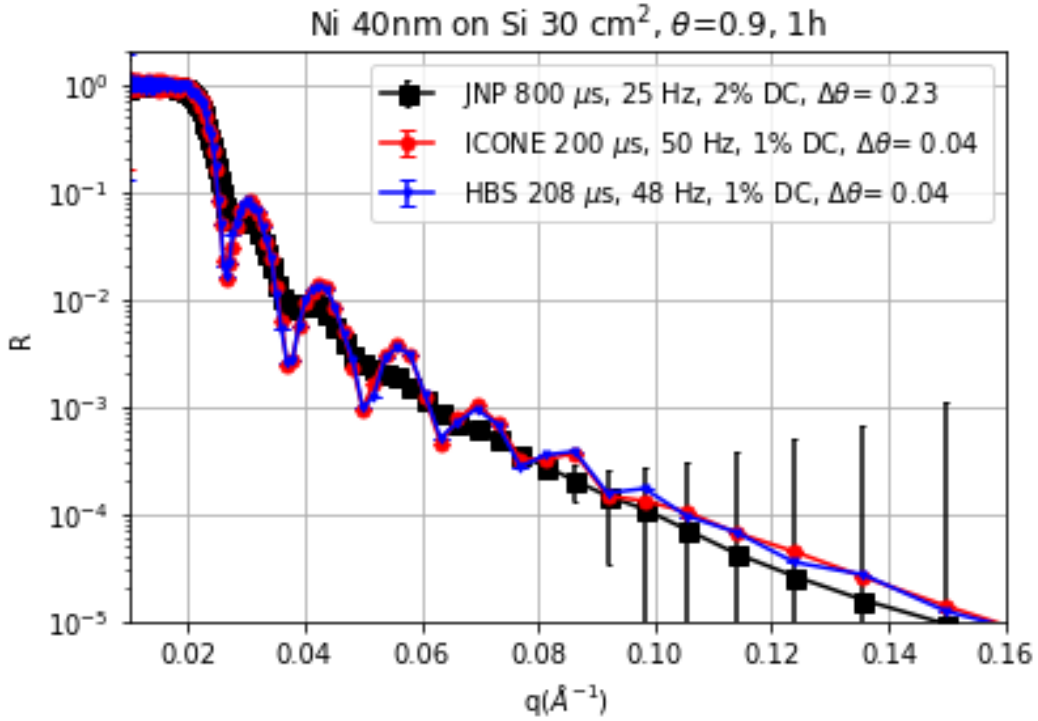


EXPECTED PERFORMANCE

ORPHÉE (14MW) at G6-2:

White beam: 1.7 10^9(1) n/s.cm^2

4% DC: 6.8 10^7(1) n/s.cm^2



Source	ϕ_{source} (n/s.cm^2)	ϕ_{sample} (n/s.cm^2)	$\phi_{detector}$ (n/s.cm^2)	
Δθ=0.23	McStas		Ni 40nm	m=4 SM
JNP (6μA, 2% DC)	30092(1)	429(1)	2.64(1)	91(1)
HBS (90mA, 2% DC)	1.49 10^9(1)	2.13 10^7(1)	1.32 10^5(1)	4.55 10^6(1)
ICONE (100mA, 4% DC)	7.44 10^8(1)	1.07 10^7(1)	6.62 10^4(1)	2.28 10^6(1)

*validated analitically and with Vitess

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ZEA-1 FZJ
-Yannick Beßler
-Max Hannot
-Eberhardt Rosenthal
-Ruben Rings

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?