Science and Technology Facilities Council

Planned Upgrade of the Primary Spectrometer of OSIRIS

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ISIS Neutron and Muon Source

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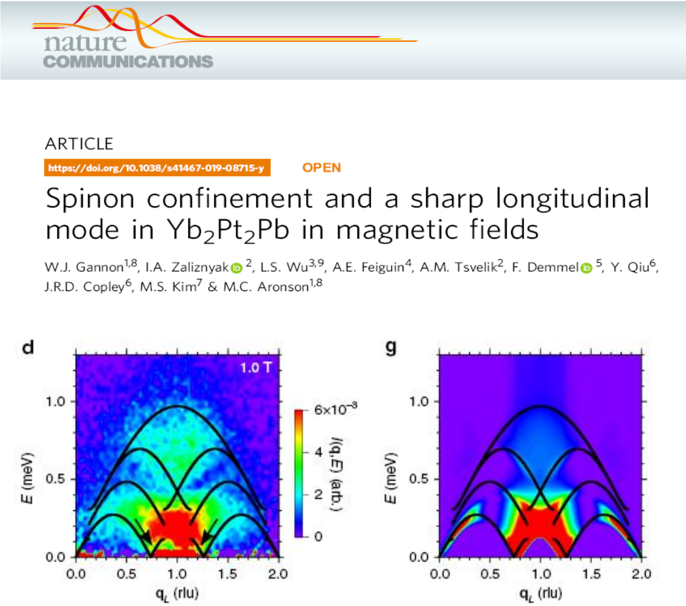
OSIRIS for low energy spectroscopy, quasielastic scattering, and long wavelength diffraction

Energy materials: electrode & electrolyte, barocaloric and solar cell materials

Condensed and soft matter physics, catalysis, advanced materials

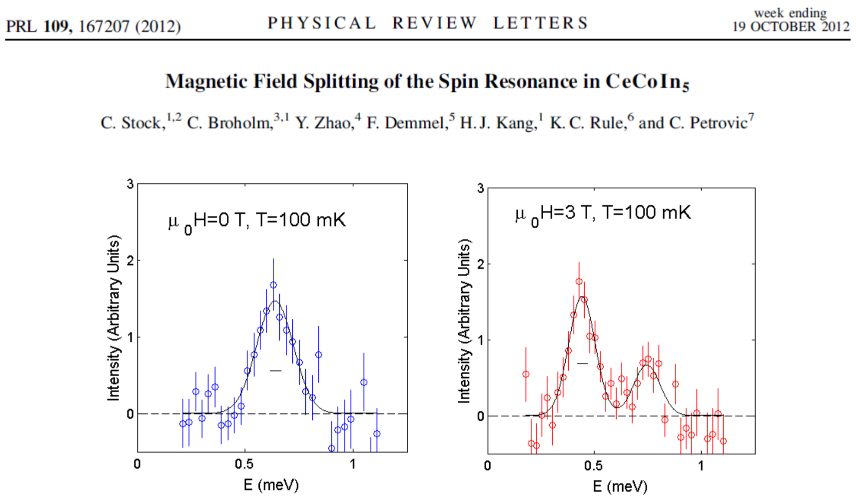

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-08715-y OPEN

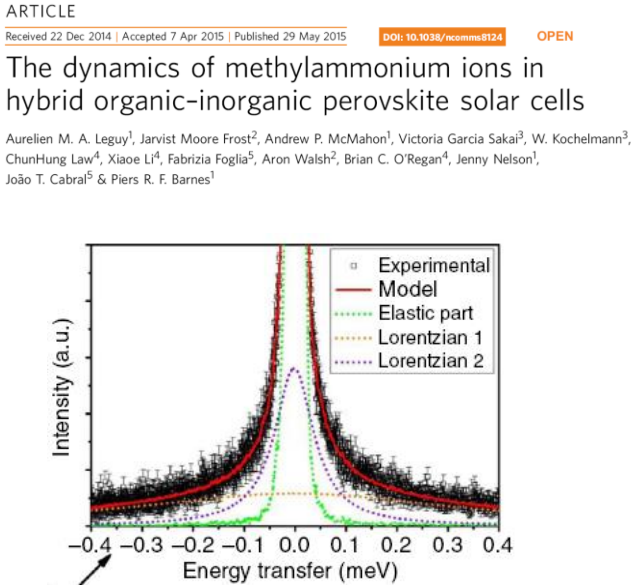
Spinon confinement and a sharp longitudinal mode in Yb_2Pt_2Pb in magnetic fields

W.J. Gannon[1,8], I.A. Zaliznyak[2], L.S. Wu[3,9], A.E. Feiguin[4], A.M. Tsvelik[2], F. Demmel[5], Y. Qiu[6], J.R.D. Copley[6], M.S. Kim[7] & M.C. Aronson[1,8]


PRL 109, 167207 (2012) PHYSICAL REVIEW LETTERS week ending 19 OCTOBER 2012

Magnetic Field Splitting of the Spin Resonance in $CeCoIn_5$

C. Stock,[1,2] C. Broholm,[3,1] Y. Zhao,[4] F. Demmel,[5] H.J. Kang,[1] K.C. Rule,[6] and C. Petrovic[7]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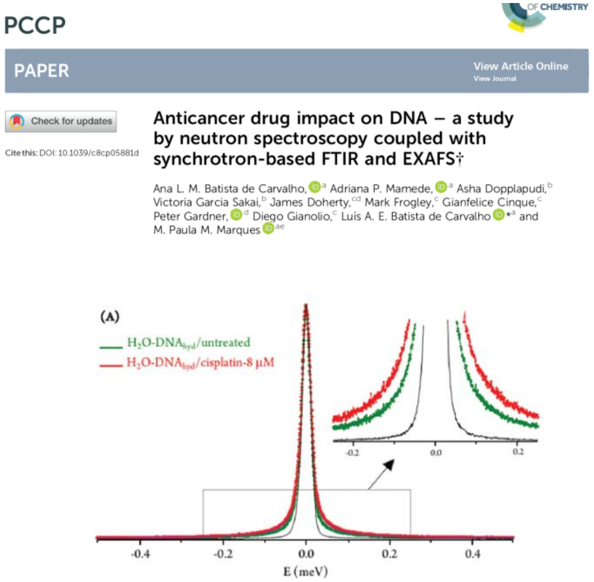
The dynamics of methylammonium ions in hybrid organic–inorganic perovskite solar cells

Aurelien M. A. Leguy[1], Jarvist Moore Frost[2], Andrew P. McMahon[1], Victoria Garcia Sakai[3], W. Kochelmann[3], ChunHung Law[4], Xiaoe Li[4], Fabrizia Foglia[5], Aron Walsh[2], Brian C. O'Regan[4], Jenny Nelson[1], João T. Cabral[5] & Piers R. F. Barnes[1]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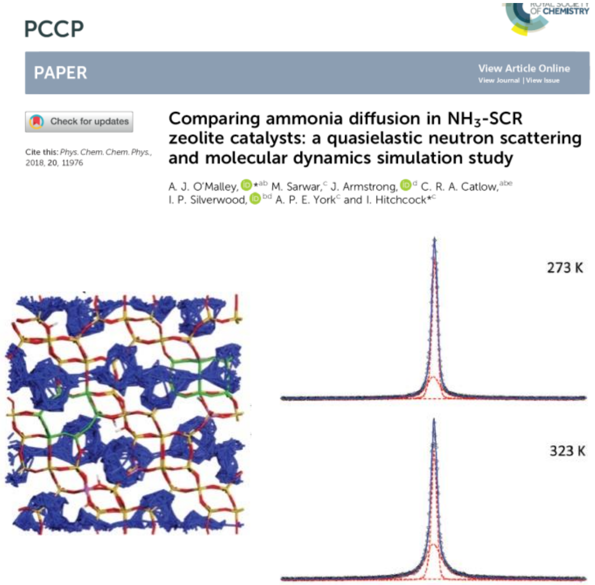
Anticancer drug impact on DNA – a study by neutron spectroscopy coupled with synchrotron-based FTIR and EXAFS†

Ana L. M. Batista de Carvalho, Adriana P. Mamede, Asha Dopplapudi, Victoria Garcia Sakai, James Doherty, Mark Frogley, Gianfelice Cinque, Peter Gardner, Diego Gianolio, Luis A. E. Batista de Carvalho and M. Paula M. Marques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Comparing ammonia diffusion in NH_3-SCR zeolite catalysts: a quasielastic neutron scattering and molecular dynamics simulation study

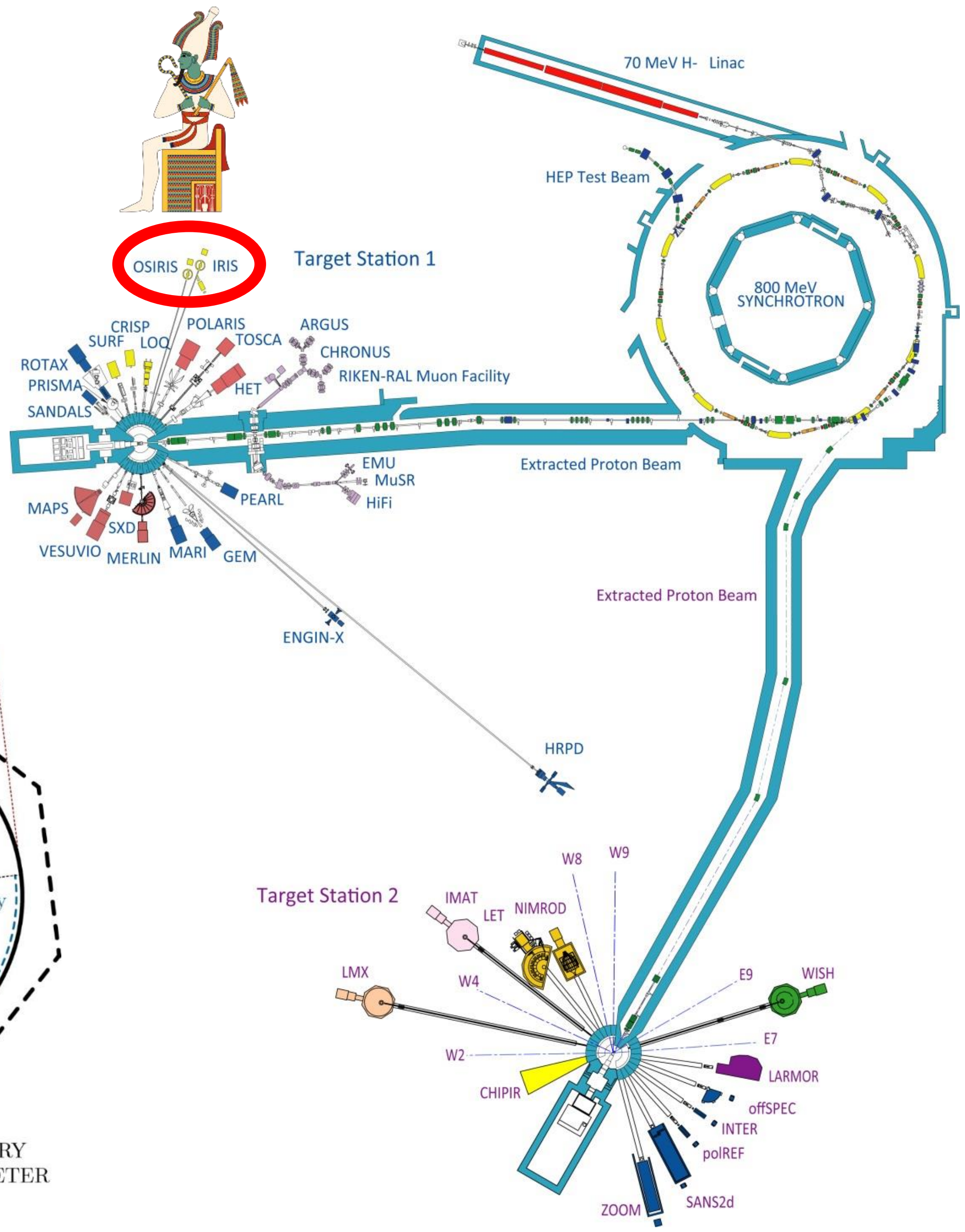
A. J. O'Malley, M. Sarwar, J. Armstrong, C. R. A. Catlow, I. P. Silverwood, A. P. E. York and I. Hitchcock

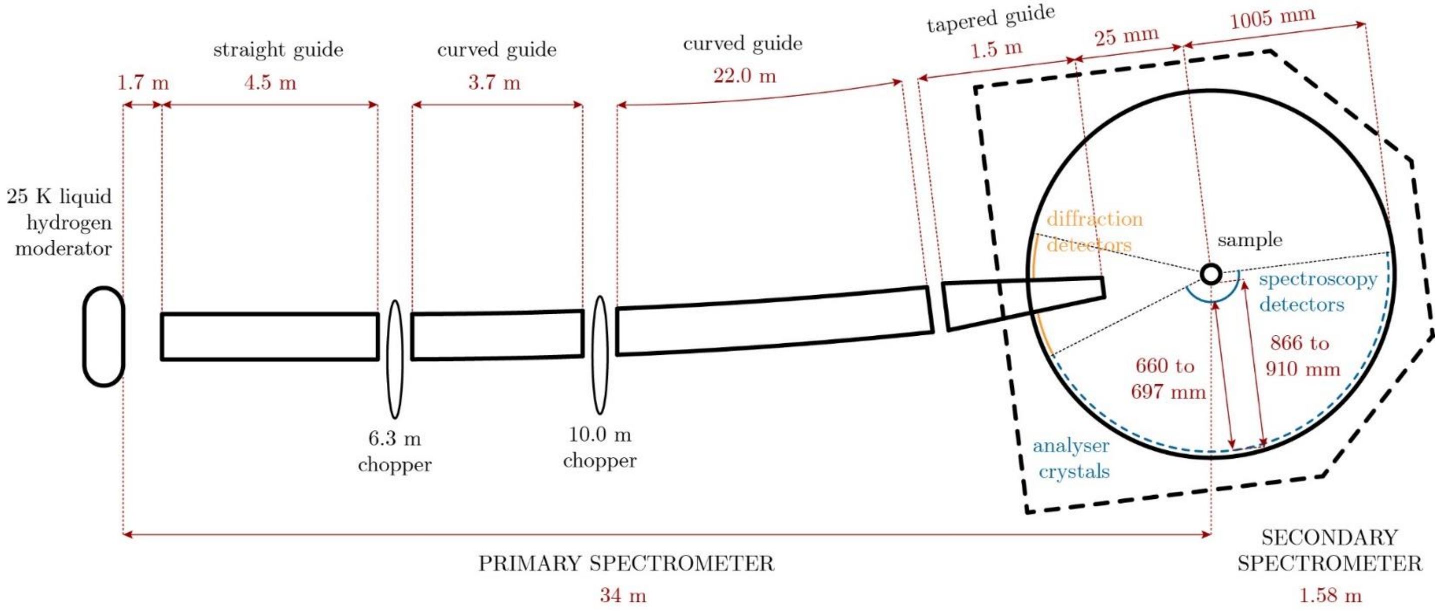
Introduction to OSIRIS

OSIRIS is a cold-neutron, indirect-geometry, time-of-flight spectrometer

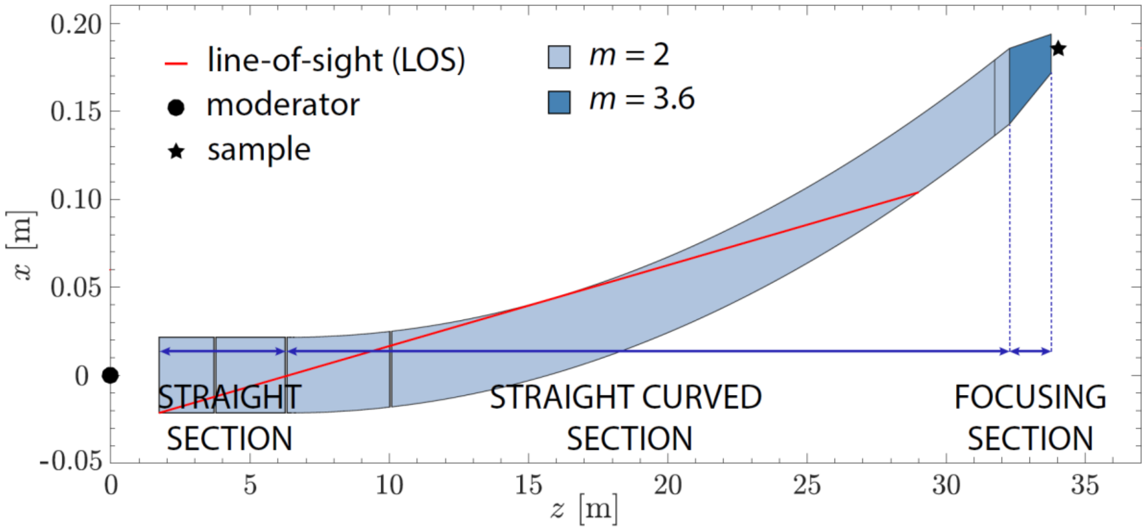
- Built in 1997
- Spectroscopy since 2002
- Beryllium filter in 2014

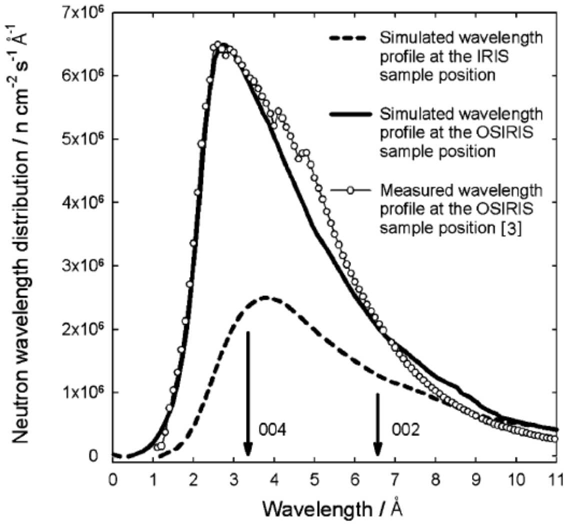
- North side of TS-1 (50 Hz repetition rate)
- H_2 moderator (incident wavelength 2–20 Å)

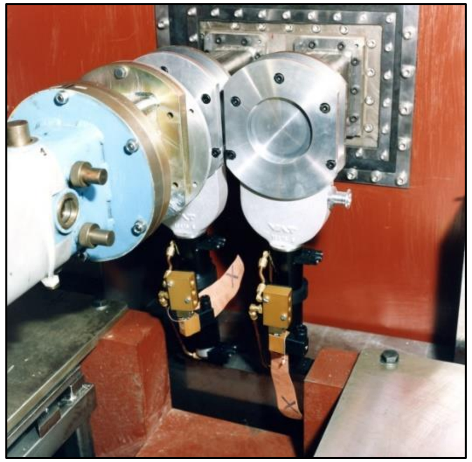




OSIRIS primary spectrometer





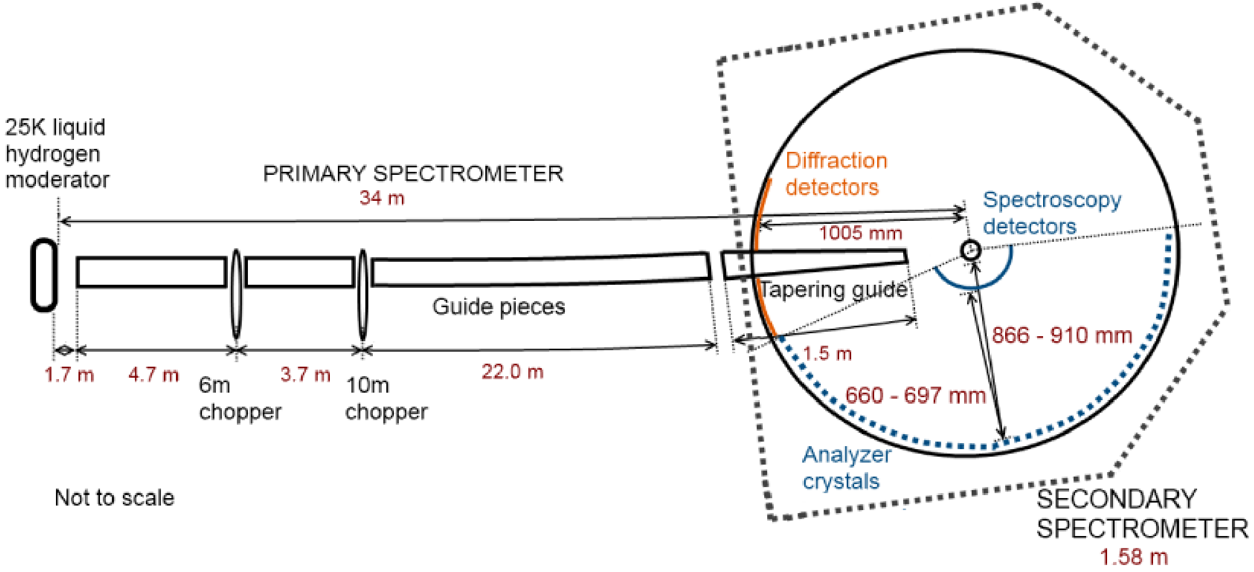


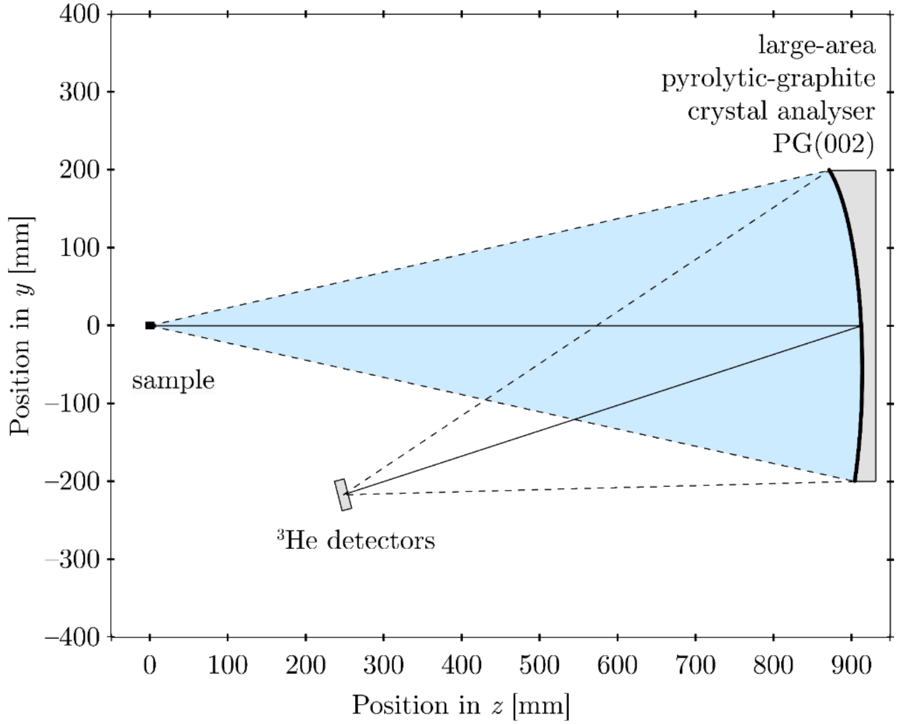
- 32 m long supermirror guide (*m* = 2)
- Curved to suppress direct line-of-sight (2 km radius)
- 1.5 m long tapered focusing section (*m* = 3.6)
- Two disc-choppers (bandwidth, frame overlap) at 6.3 m and 10 m
- Shared shutter and insert sections with IRIS

OSIRIS secondary spectrometer

- Backscattering diffraction bank
- PG analyser (9000 1 cm^2 tiles) in near backscattering position (83–87°), radial collimator with moveable beryllium filter

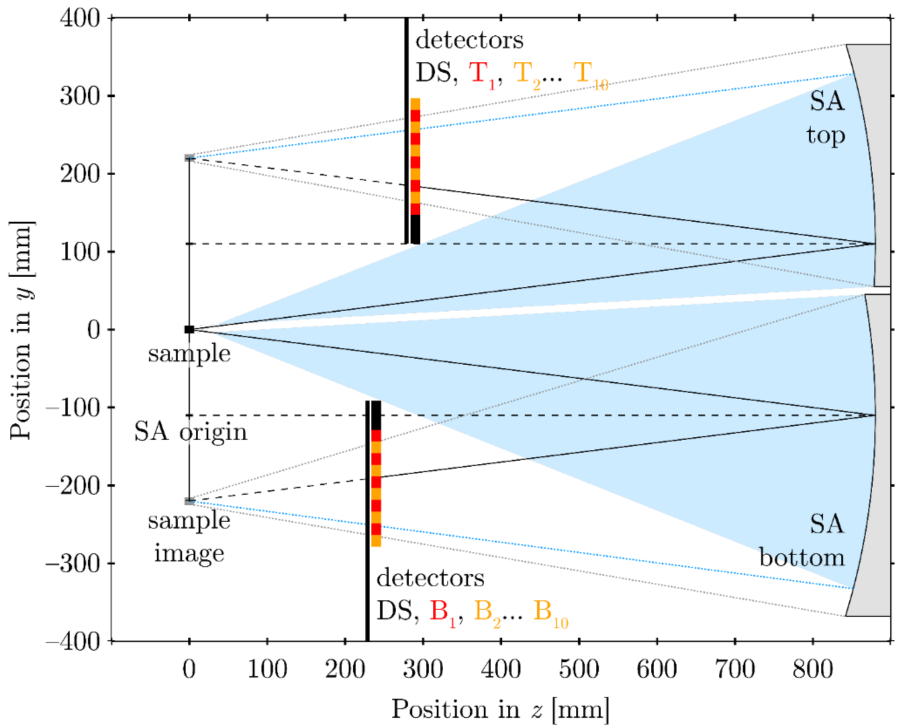
	FWHM (μeV)	ΔE range (meV)	Q max ($Å^{-1}$)
PG002	24.5	± 0.5	1.8
PG004	99	± 4	3.6





OSIRIS secondary spectrometer

- Backscattering diffraction bank
- PG analyser with beryllium filter
- Silicon analyser (in construction, fall 2024), for simultaneous operation with PG



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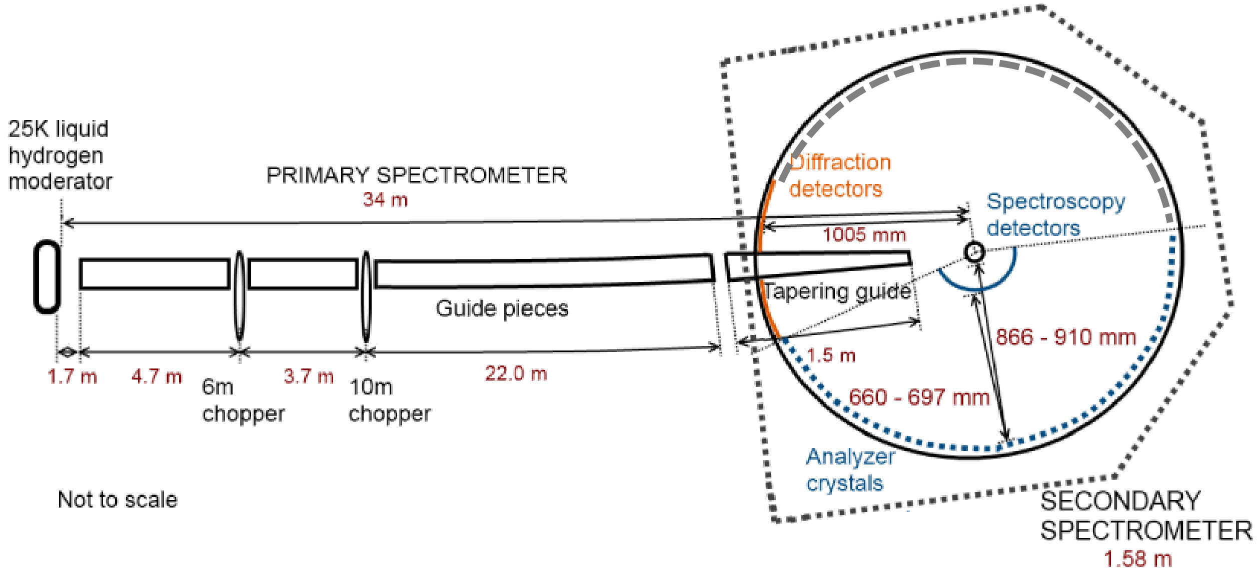


	FWHM (μeV)	ΔE range (meV)	Q max ($Å^{-1}$)
Si111	11.1	± 0.6	1.9
Si333	78	± 15	5.8

Introduction

Key drivers & constraints

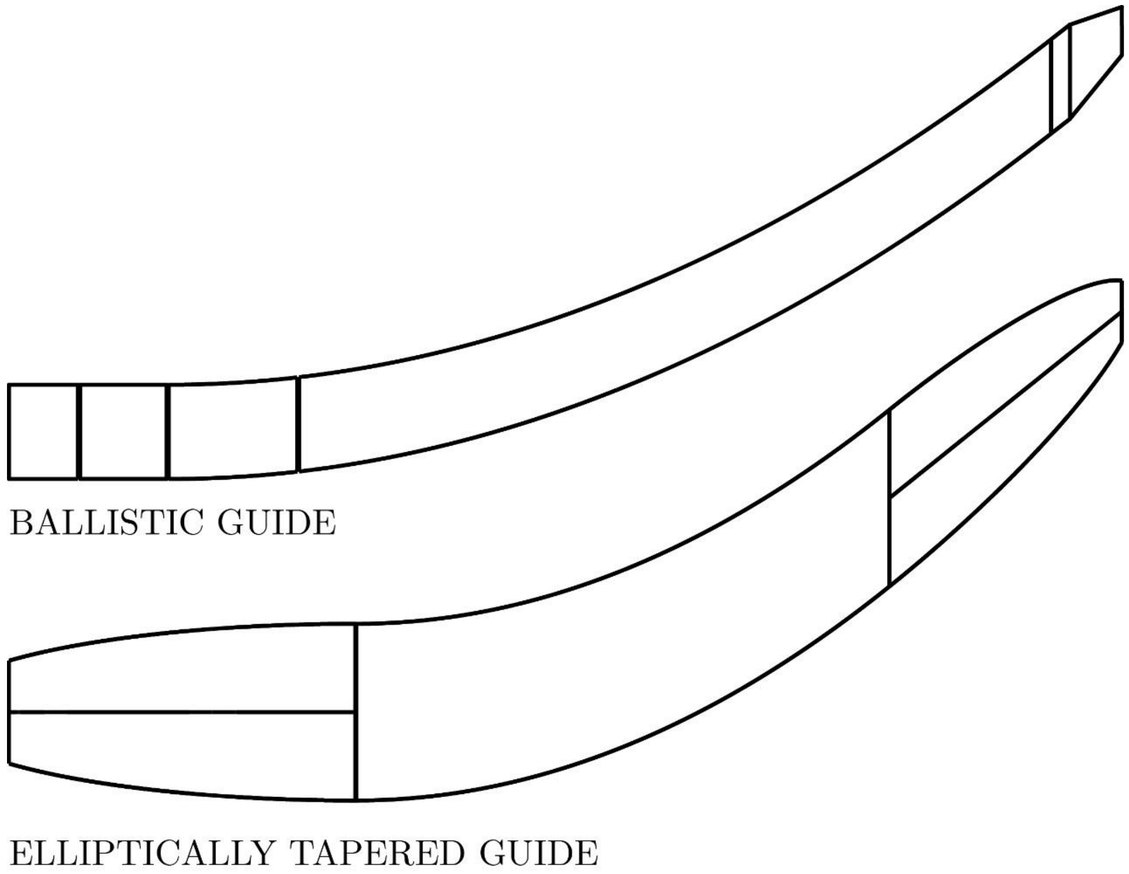
Design process

Performance comparison

Slit system

Chopper system

Conclusions

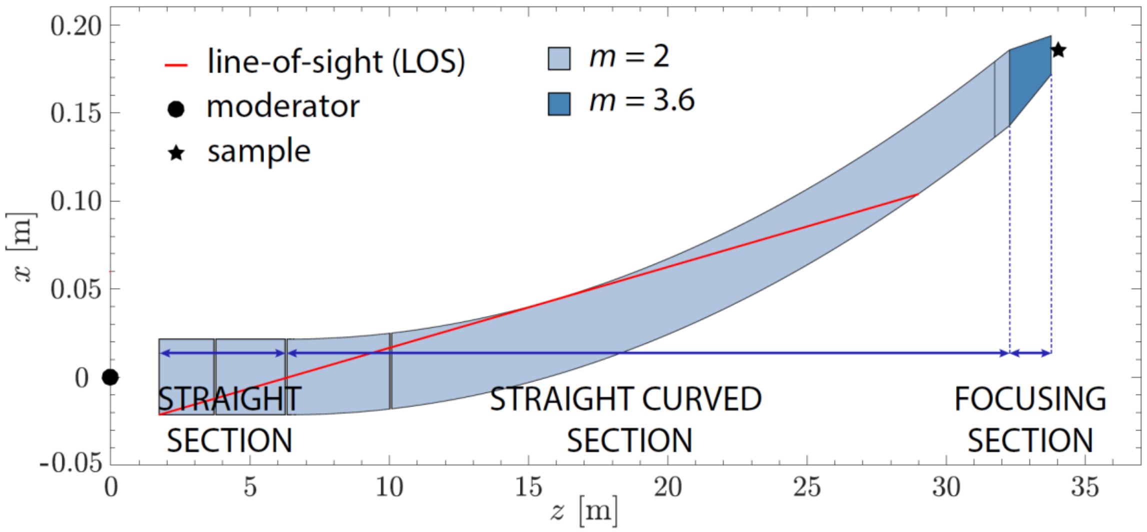


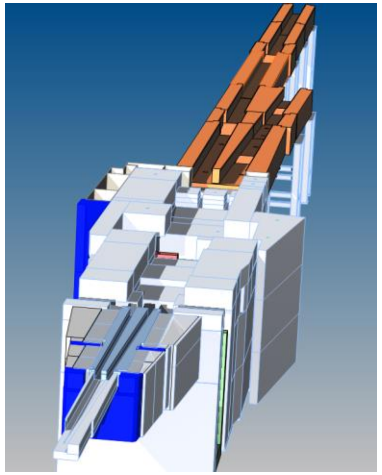
Key drivers

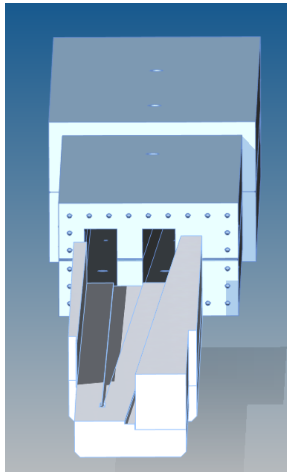
- Maximise the flux at sample position for large (2×3 cm^2) and small (1×1 cm^2) samples

Constraints

- Fixed sample position — *33.95 m total length, 18.6 cm deviation*
- No direct line-of-sight — *curved guide section*
- Guide height — *20 cm max height, 12 cm at entrance*
- Shared insert with IRIS — *full separation, or shortest possible shared section*







Present OSIRIS guide

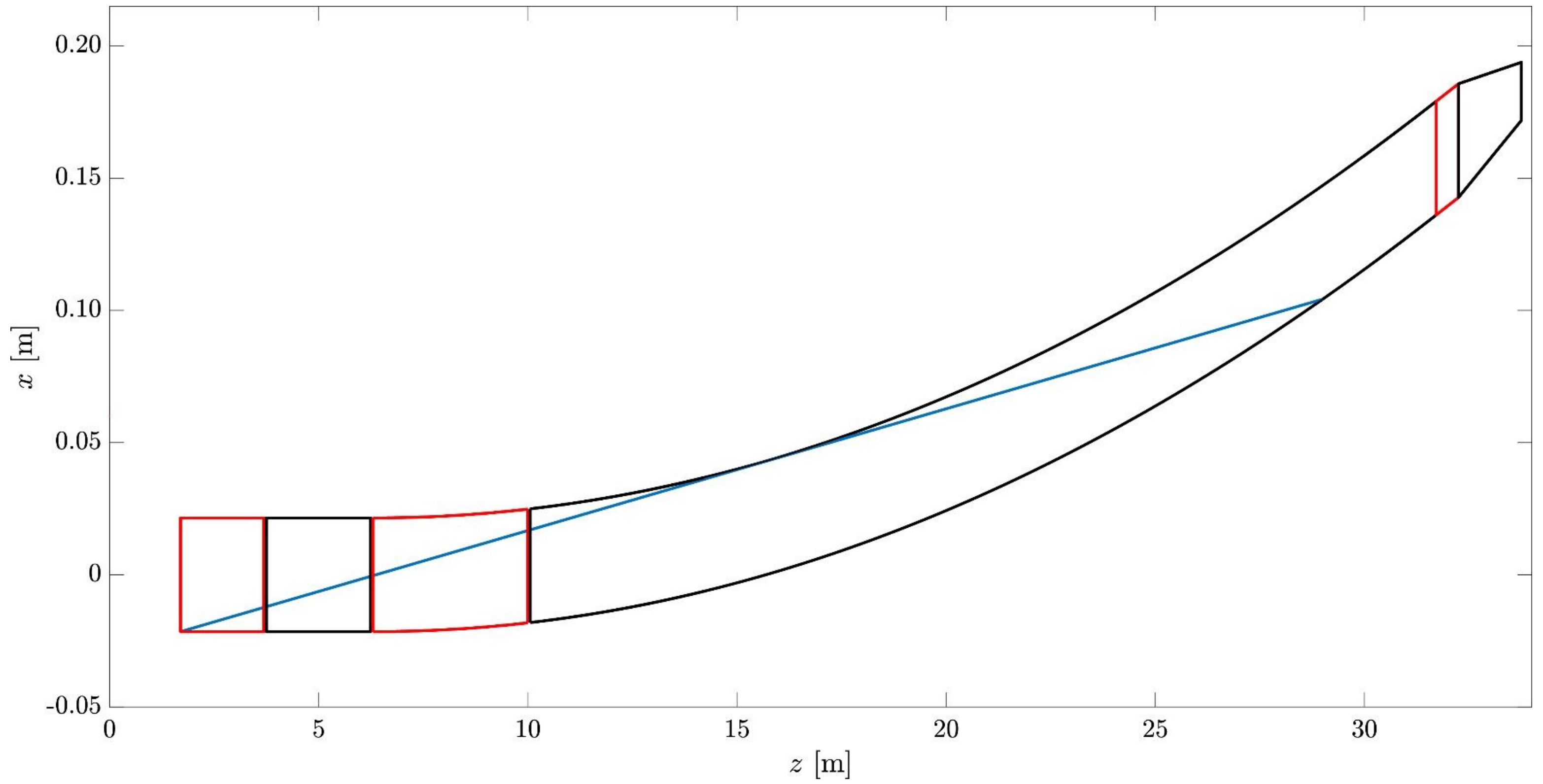
Total length 32 m, including

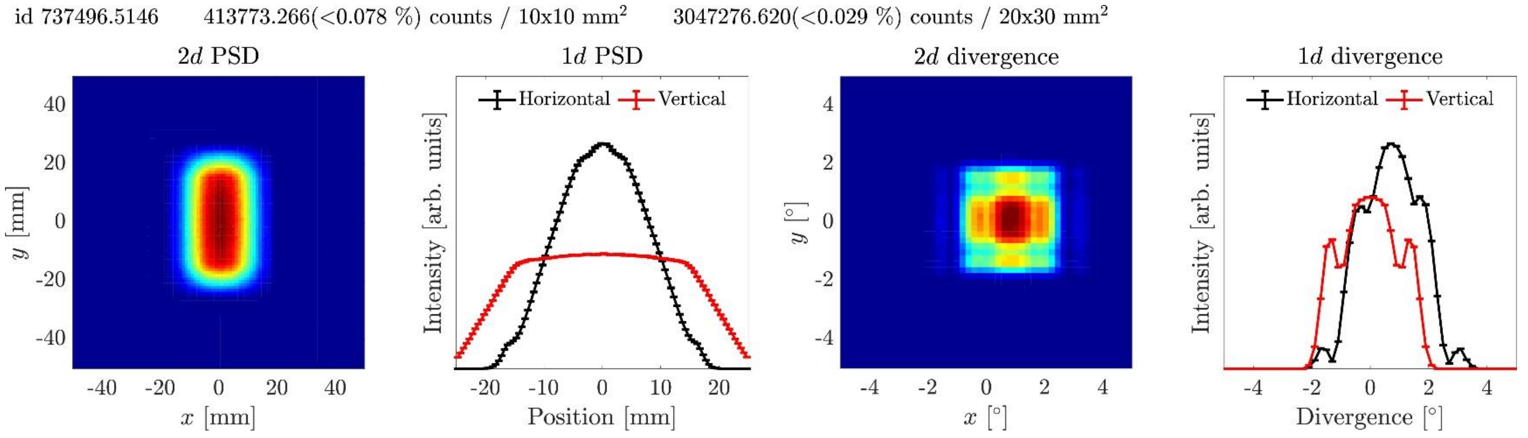
- straight section 4.5 m
- curved section 25.7 m (2050 m radius, cutoff λ = 1.9 Å)
- linear taper 1.5 m

Max. height 6.5 cm
Max. width 4.3 cm

McStas simulation

- incident neutron energy E_i = 1.4–4.0 meV (λ = 4.5–7.6 Å)
- intensities on 1×1 cm^2 and 2×3 cm^2 monitors used as reference





Design process: Guide geometry

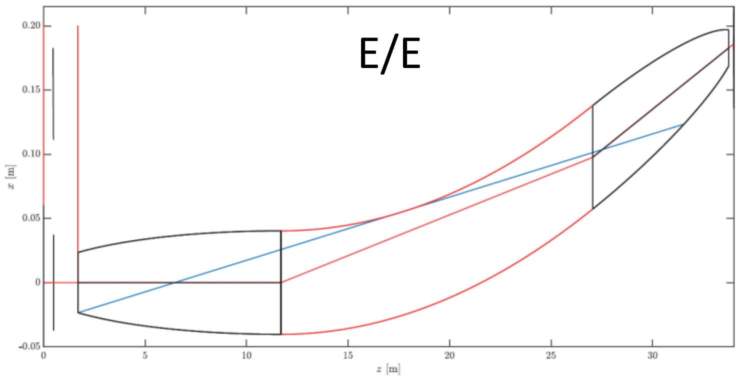
Guide geometry

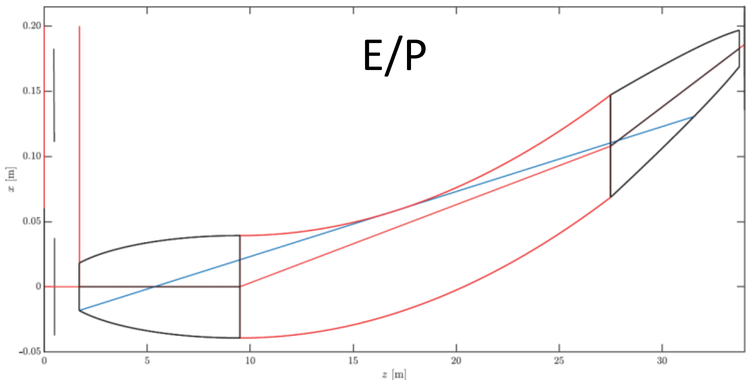
Curved guides with various taper geometries
- Linear
- Elliptic (half ellipse or truncated ellipse)
- Parabolic

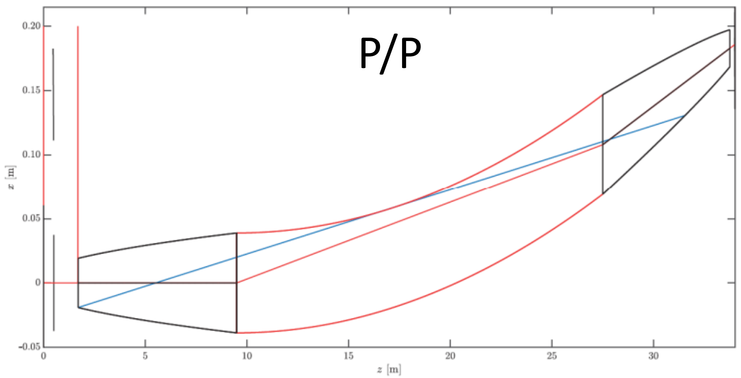
Curved guides with vertical/horizontal kinks

Double ellipse without curved section

Geometry	**LOS (m)**	**Gain over 1×1 cm^2**	**Gain over 2×3 cm^2**
Current OSIRIS guide	~4.0	1	1
Curved, elliptic/elliptic, default	2.2	4.3	3.9
Curved, elliptic/elliptic, reduced height	2.2	4.3	3.7
Curved, elliptic/elliptic, reduced R	2.2	4.5	4.2
Curved, elliptic/elliptic, reduced LOS	1.0	4.6	4.3
Curved, elliptic/elliptic, reduced height and R	2.2	4.5	3.9
Curved, parabolic/parabolic	2.2	2.6	2.4
Curved, parabolic/elliptic	2.2	3.3	3.1
Curved, elliptic/parabolic	2.2	3.1	3.0
Double-ellipse	0.8	3.6	3.3

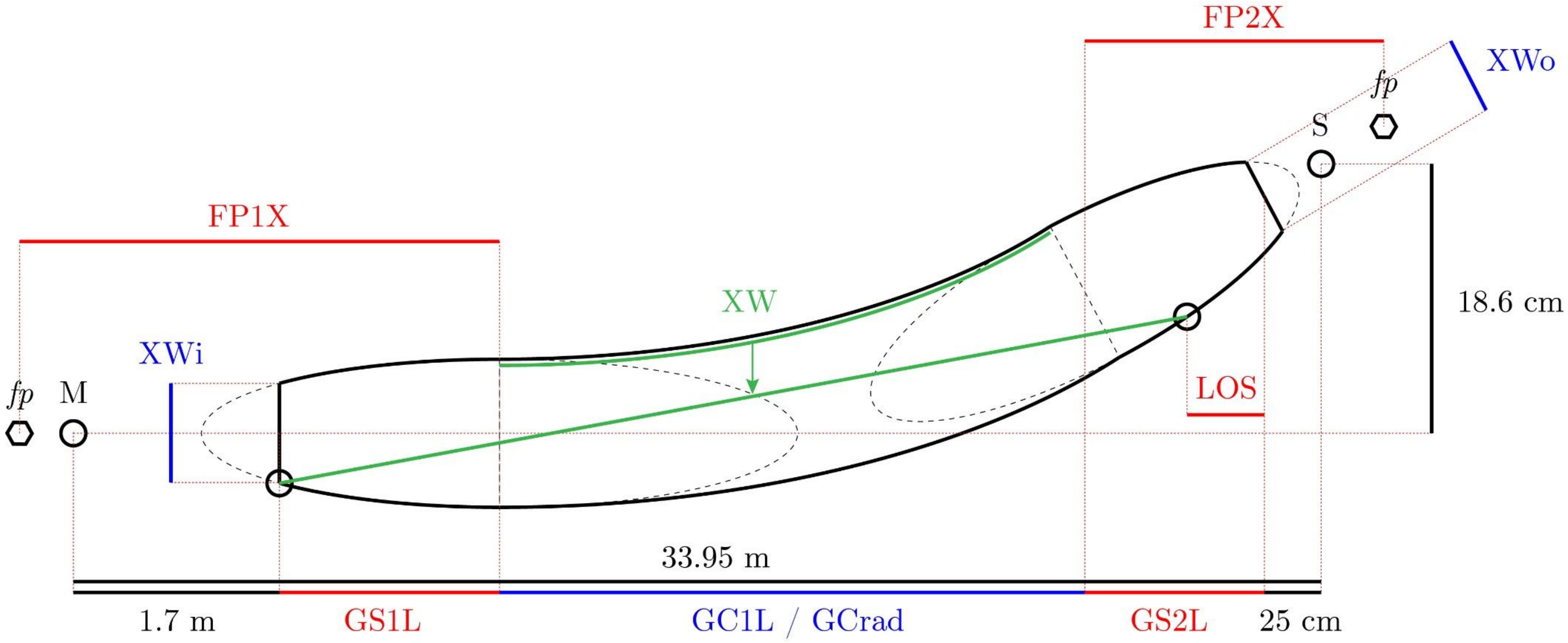




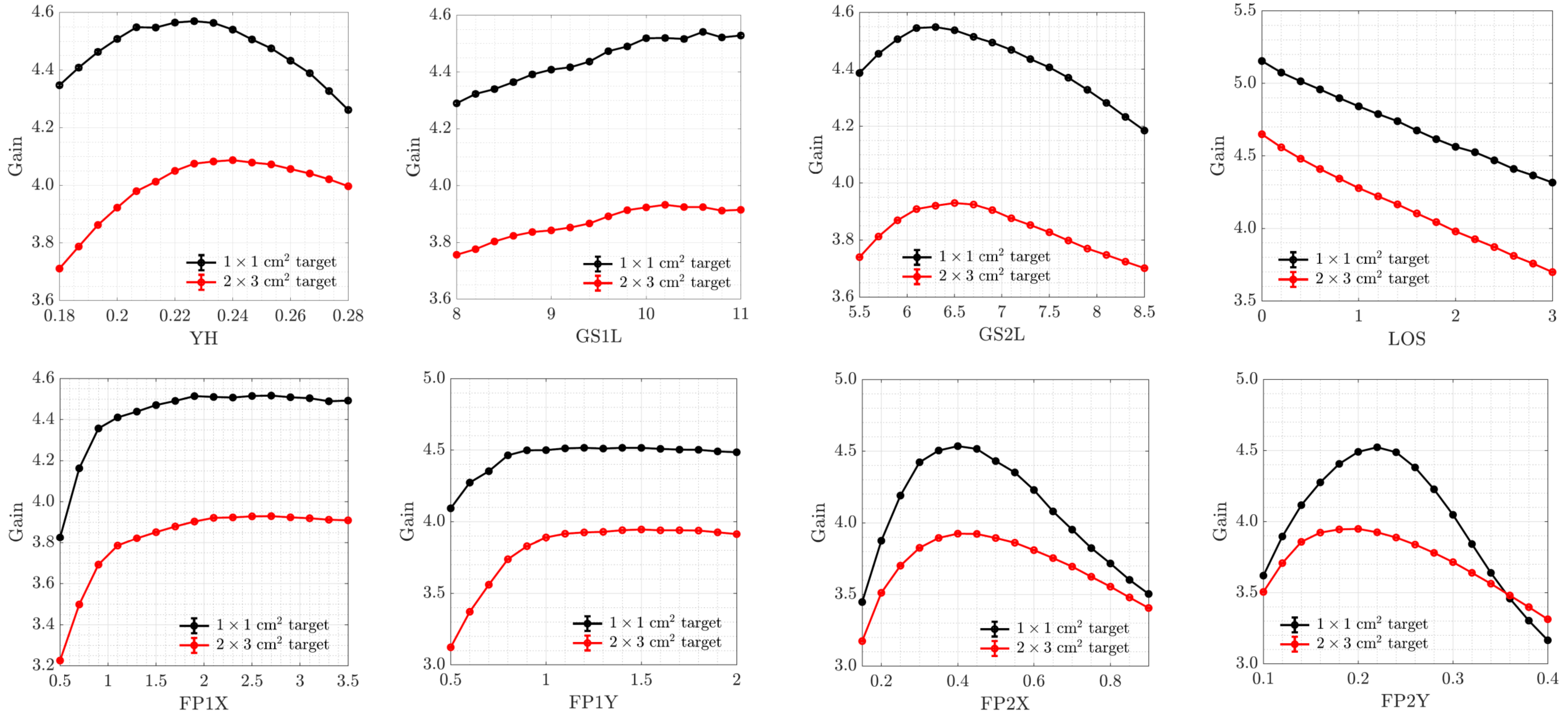


Elliptically tapered guide parameterisation

(1) Constraints on guide entrance and sample positions, and length of elliptic sections (GS1L / GS2L), determines the curved section length (GC1L) and curvature radius (GCrad)
(2) Elliptic sections defined by focal points along *x* and *y* (FP1X / FP1Y / FP2X / FP2Y) and guide width and height (XW / YH), defines guide width and height at entrance and exit (XWi, YHi, XWo, YHo)
(3) Distance at which the line-of-sight is intercepted from the exit (LOS), and XWi, determines XW



Elliptically tapered guide parameter dependencies



Chosen design: Elliptically tapered guide

Total length 32 m, including

- defocusing section 10.0 m
- curved section 15.3 m (1.2 km radius, cutoff λ = 1.7 Å)
- focusing section 6.7 m

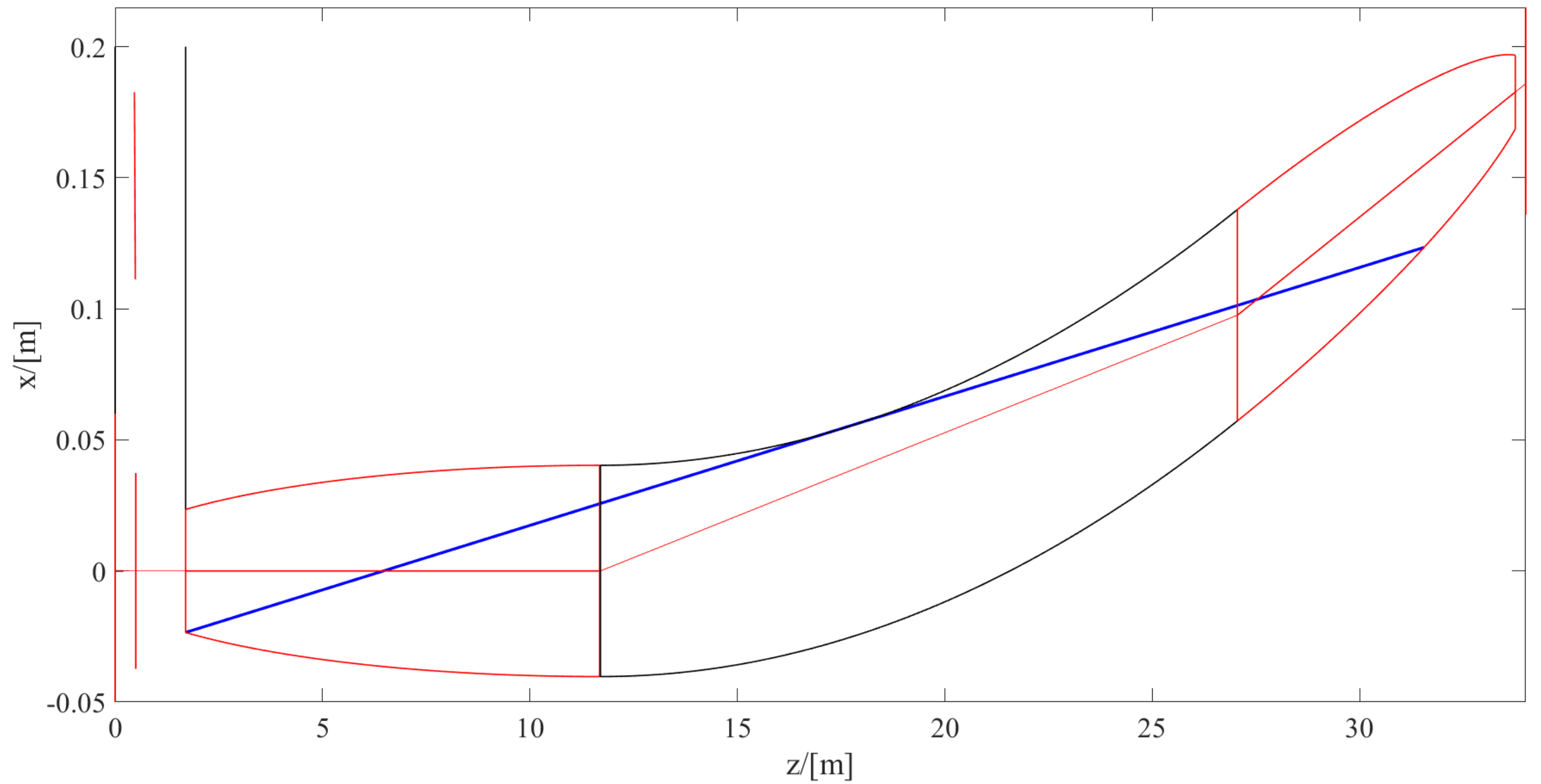
Max. height 20.0 cm
Max. width 8.1 cm
Similar line-of-site intercept point

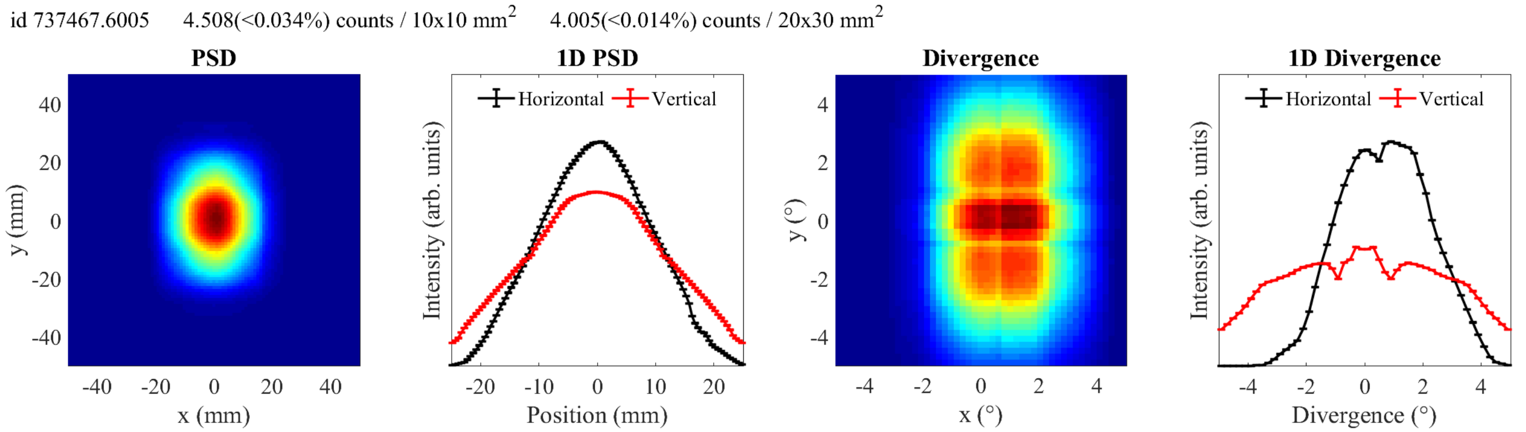
Coarse coating

- elliptic sections, *m* = 6
- curved section, *m* = 4

McStas simulation

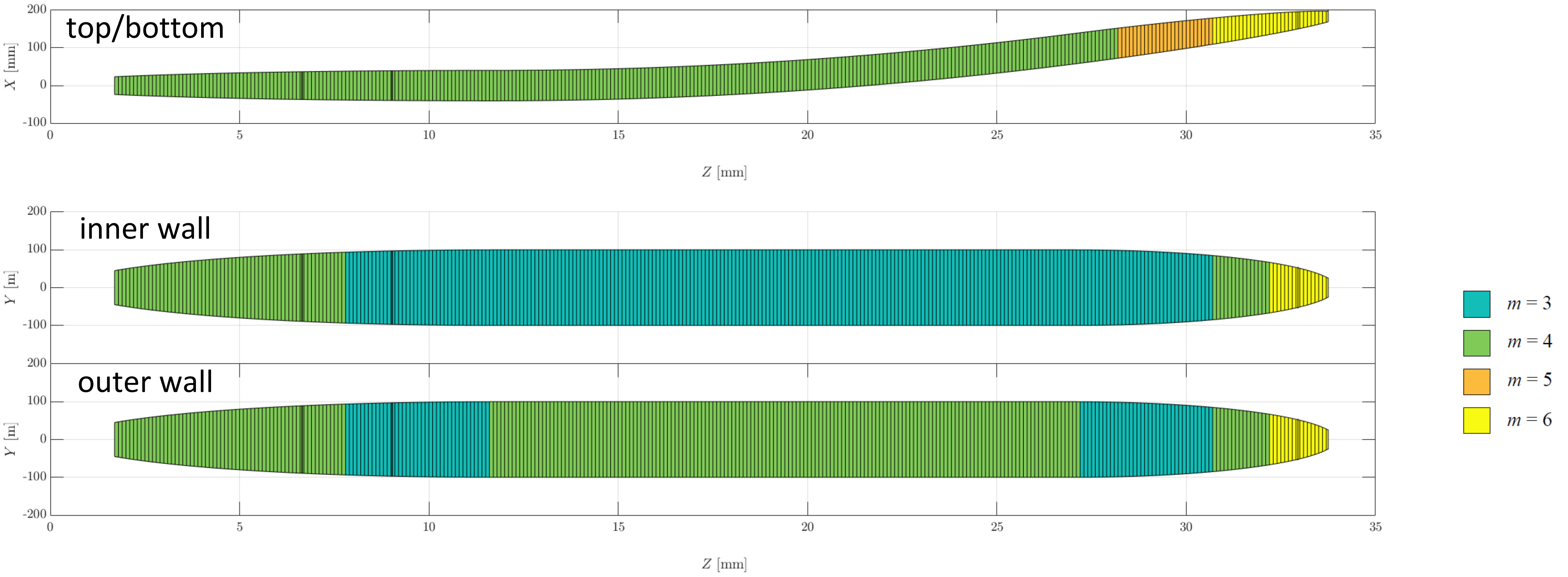
- gain (geometry only) in intensity of 4.5 for 1×1 cm^2 and 4.0 for 2×3 cm^2 samples



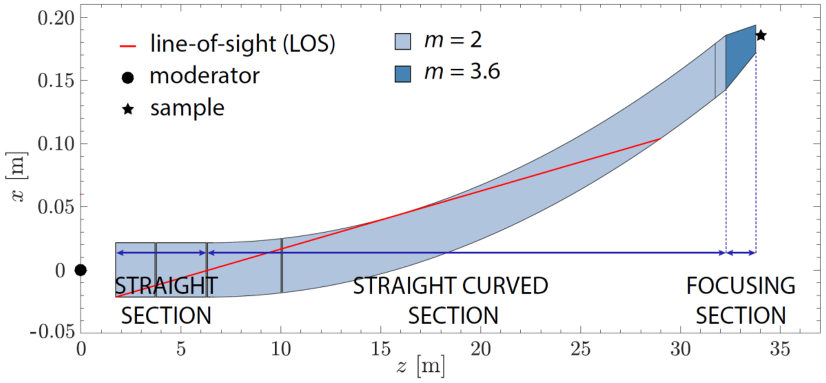


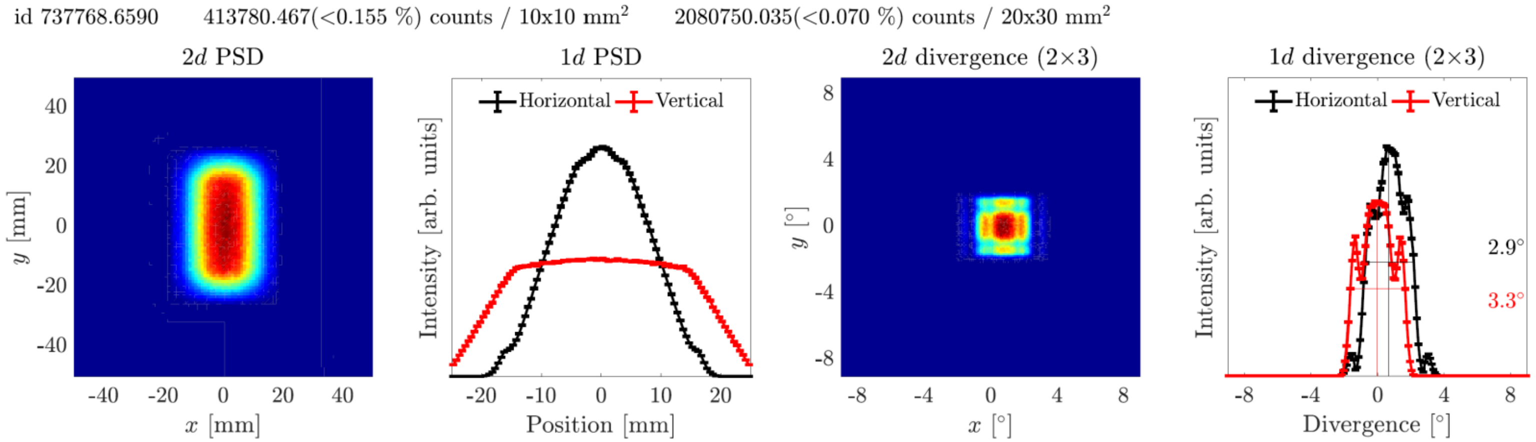
Coating profile

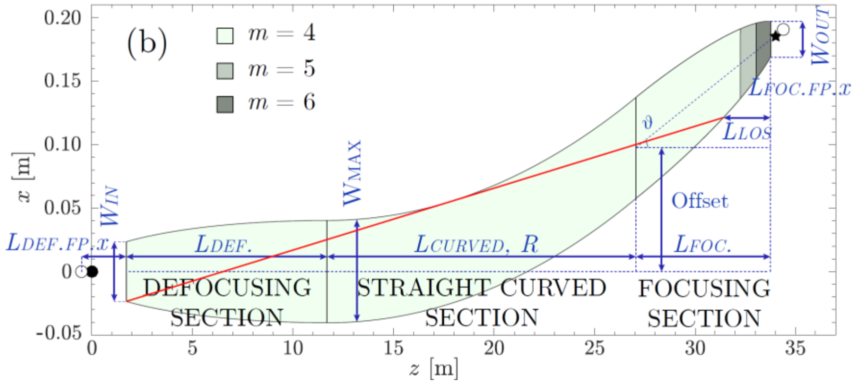
- Optimised for short wavelength neutrons (10–20 meV)
- Updated reflectivity profiles

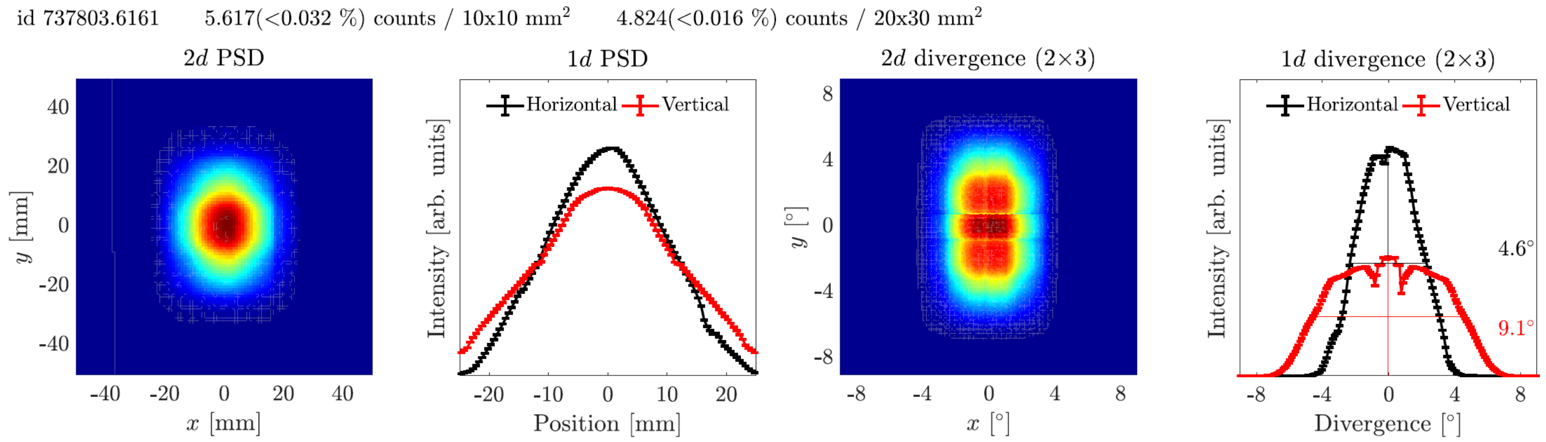


Beam profile



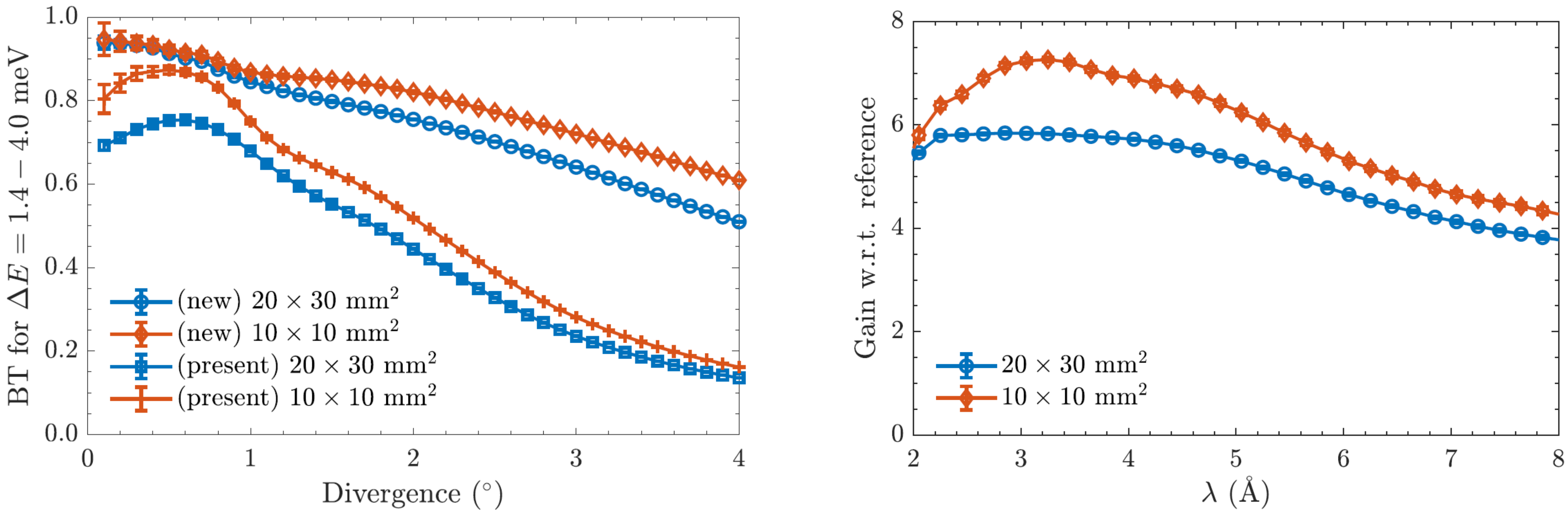






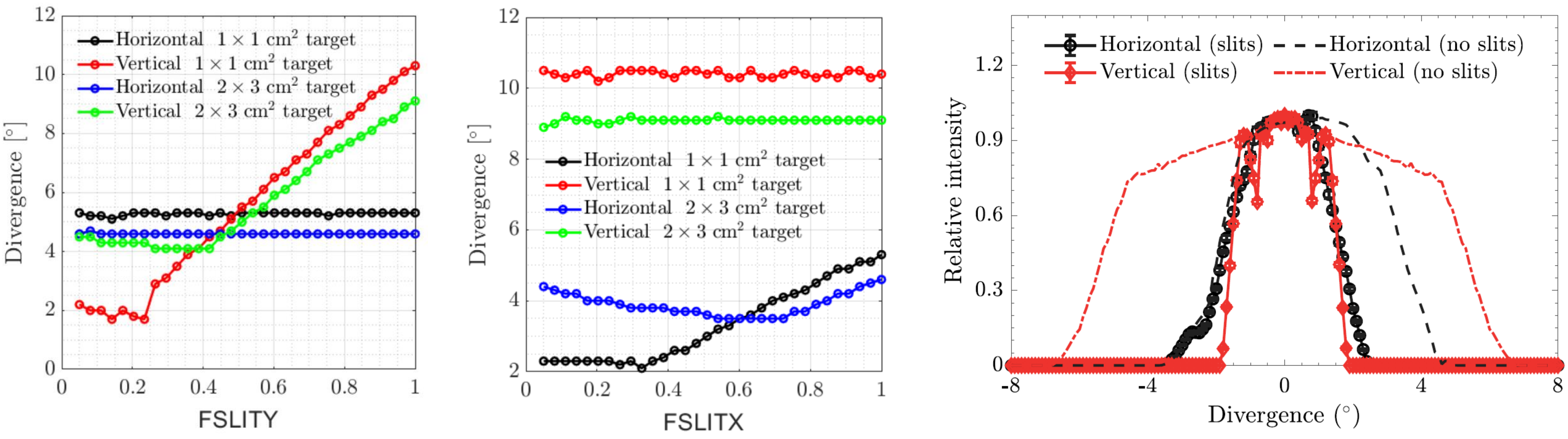
Brilliance transfer & gain factor

- Possibly higher gain since present guide degradation not accounted for
- Additional factor 2 from TS-1 moderator upgrade
- ➢ At least 10-fold increase in flux



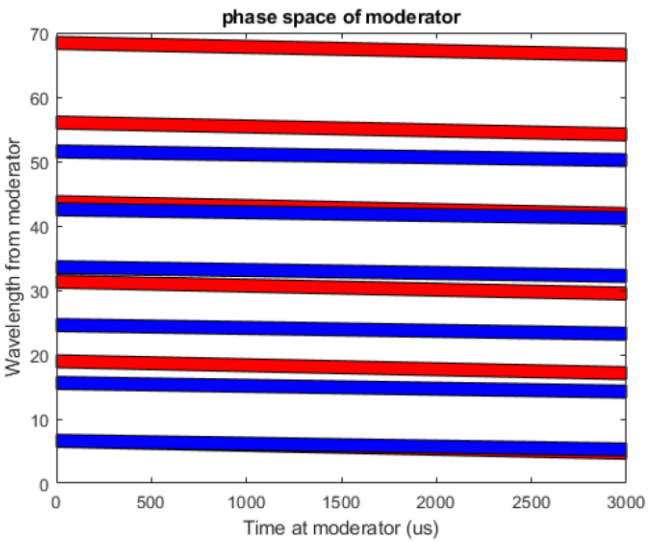
Slit system for single-crystal experiments

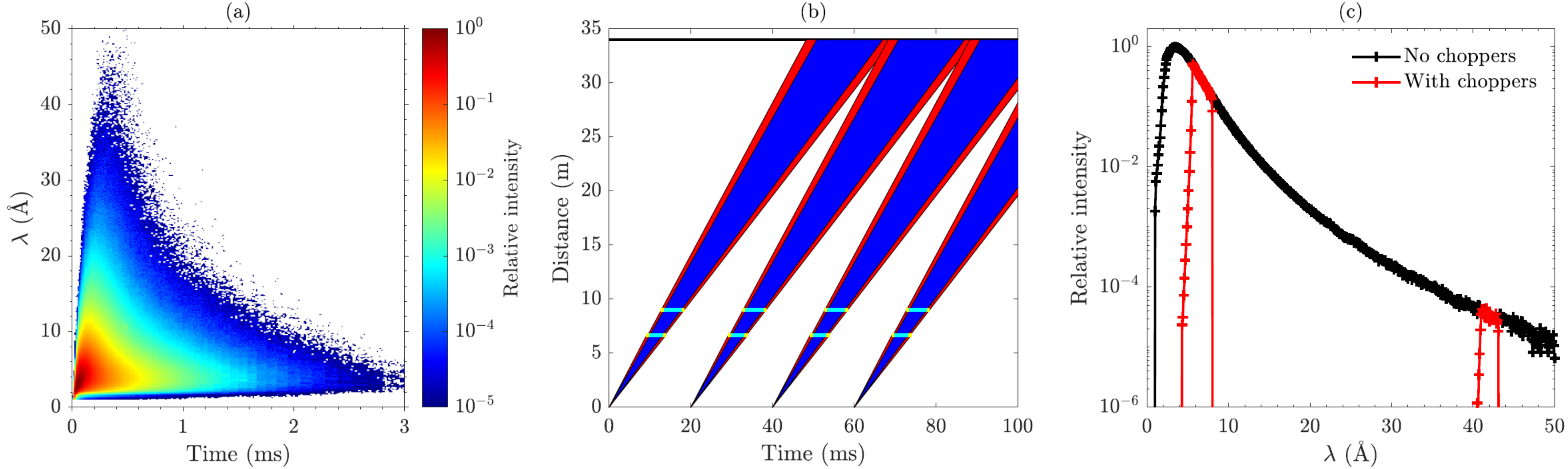
- Single slit at guide end, controlled divergence down to 4° for large samples, down to 2.5° for small samples
- Two slits, at guide exit & outside the tank, flexible control of the divergence down to 1° (for diffraction)



Chopper system

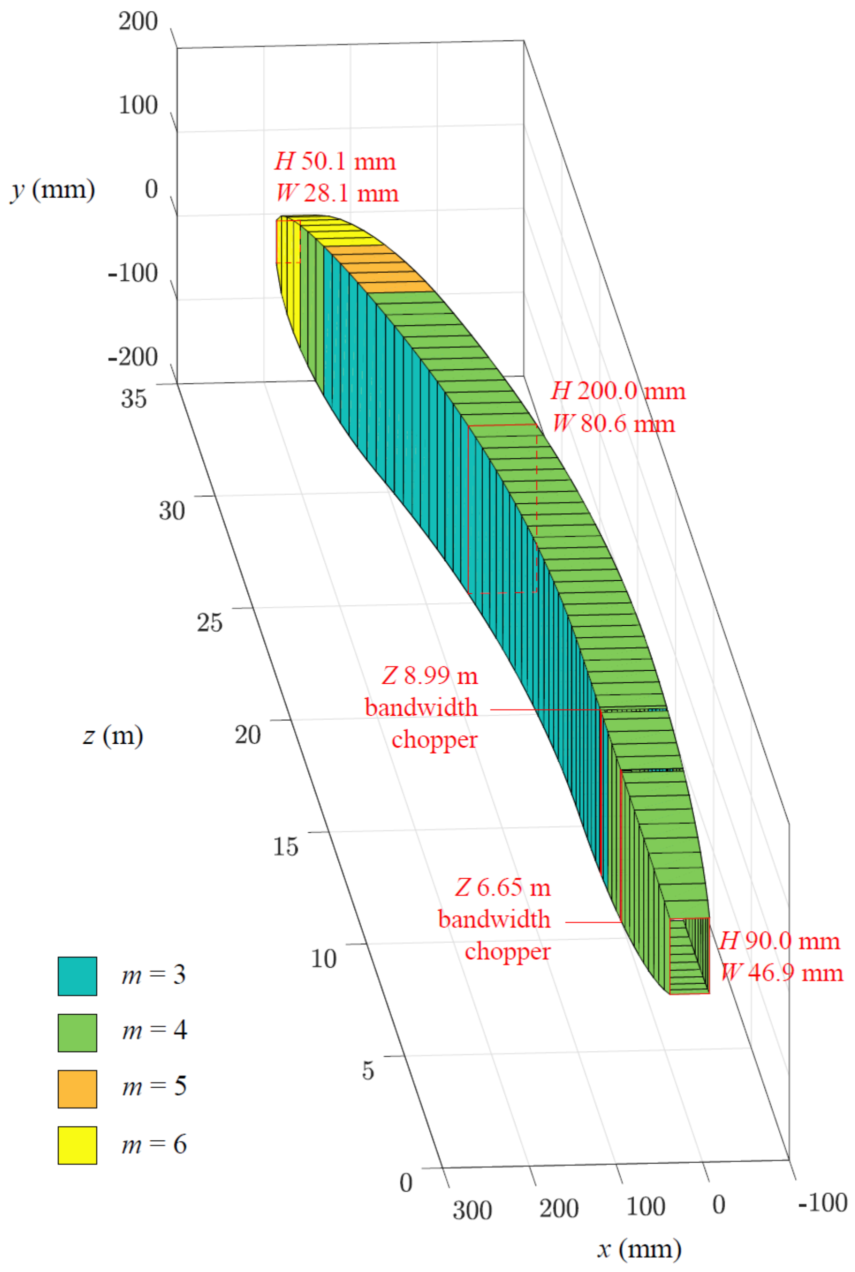
- Bandwidth chopper at 6.4–7.3 m, located at 3 o'clock, cuts height (180 mm)
- Frame overlap chopper at 8.8–15 m, located at 12 o'clock cuts width (81 mm)
- Counter-rotating discs at 6.65 m (∅ 810 mm) and 8.99 m (∅ 1000 mm)





OSIRIS primary spectrometer upgrade

- Curved guide with elliptically tapered defocusing and focusing sections
- Gain factors of 4.8–5.6 in the PG002/Si111 regime, probably 10+ including moderator upgrade and degradation of current guide
- Smaller beam spot
- Large divergence can be reduced with two-slit system
- Requires large counter-rotating disc choppers



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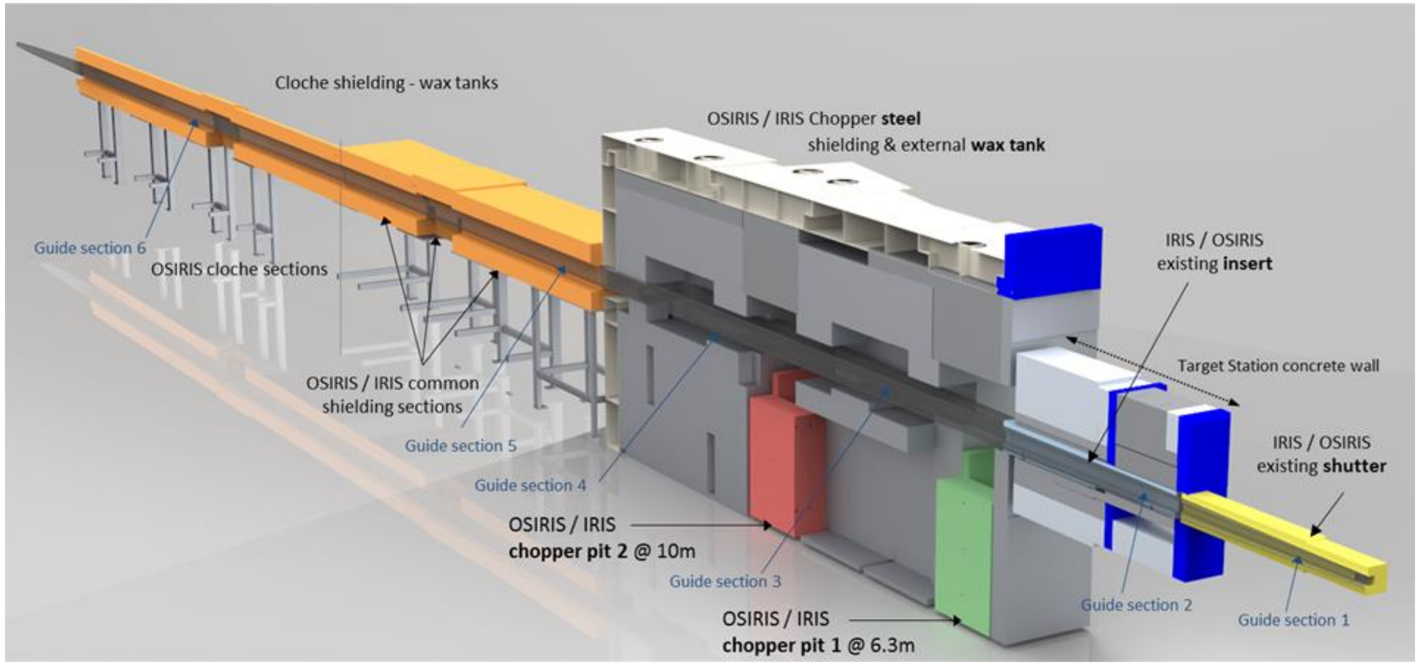

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