New Beamlines for Siam Photon Source-II

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African Light Source Conference
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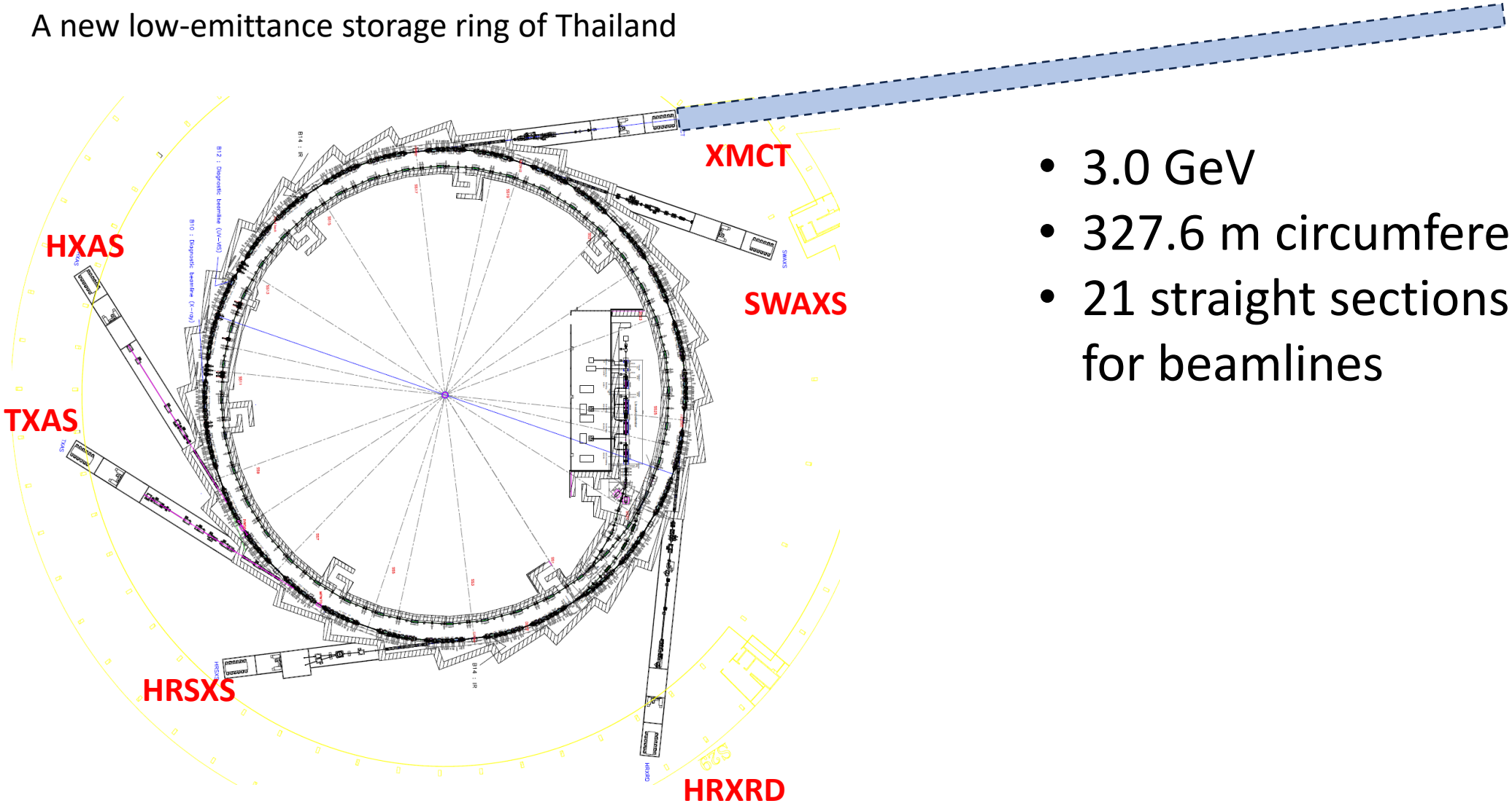
SPS-II Synchrotron

A new low-emittance storage ring of Thailand

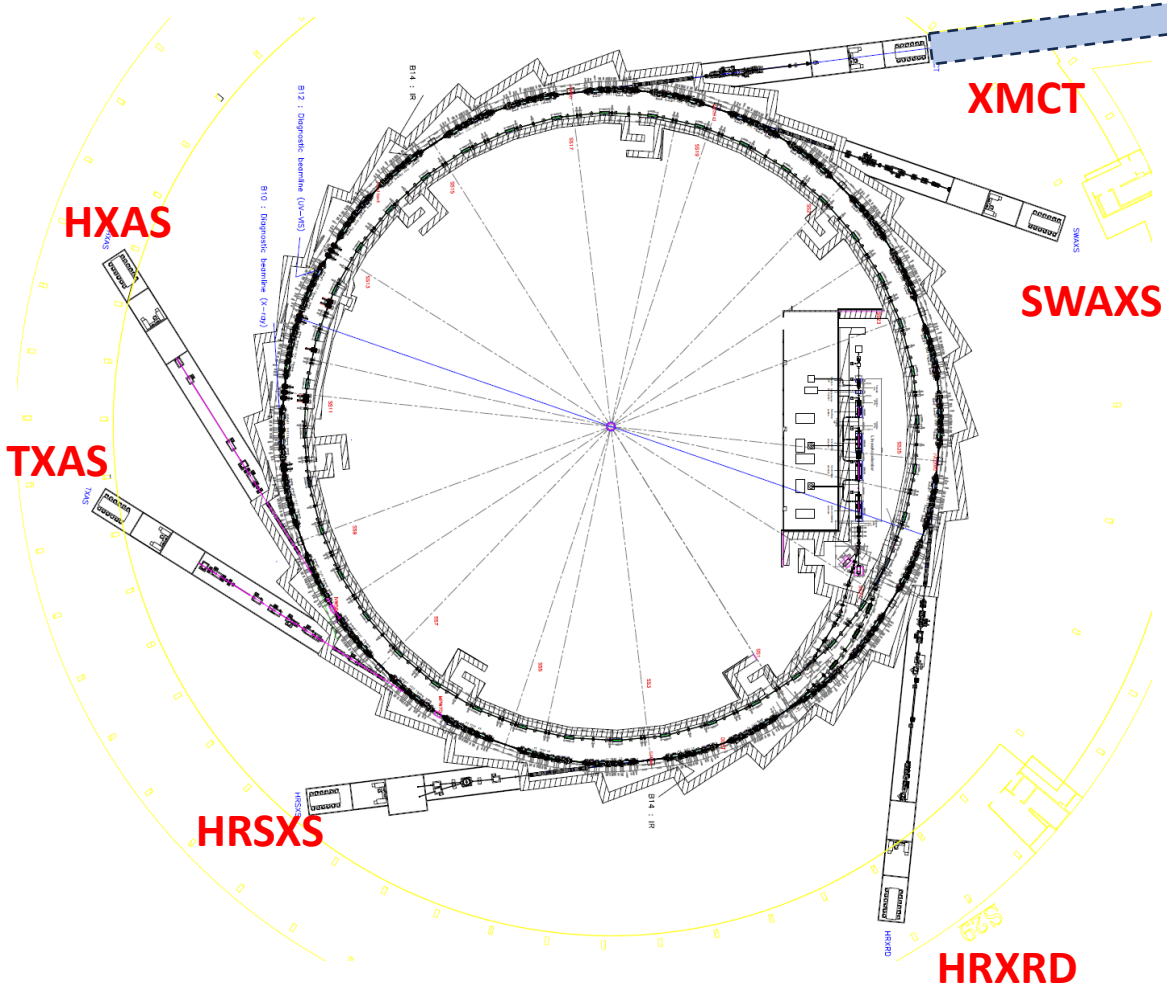


- 3.0 GeV
- 327.6 m circumference
- 21 straight sections available for beamlines

Siam Photon Source II

SPS-II Beamlines

No. of Phase-I beamlines: 7



Beamline Full name	
HRSXS	High-Resolution Soft X-ray Spectroscopy
TXAS	Tender X-ray Absorption Spectroscopy
HXAS	Hard X-ray Absorption Spectroscopy
XMCT	X-ray Microtomography
HRXRD/MX	High Resolution X-ray Diffraction & Macromolecular Crystallography
SWAXS	Small and Wide-Angle X-ray Scattering
GIXRD/TRXRF	Grazing-Incidence X-ray Scattering and Total Reflection Fluorescence

SPS-II Phase-I Beamline

Beamline	Full name (based on DDR 2019)	Energy range (keV)		Insertion device	Measurement
		Core	Best-effort		
HRSXS	High-Resolution Soft X-ray Spectroscopy	0.1-2.0	0.097-2.5	EPU64 (or 58) 1.344 m (revising)	NEXAFS, XMCD, PEEM, XPS, ARPES
TXAS	Tender X-ray Absorption Spectroscopy	1.8-10	1.0-13	IVW70 1.05m	XANES, EXAFS, Full-field X-ray Fluorescence
HXAS	Hard X-ray Absorption Spectroscopy	4-35	4-35	IVW50 2.0 m	XANES, EXAFS, quick XAFS (ms time scale)
XMCT	X-ray Microtomography	8-60	8-60	IVW50 2.0 m	CT of large biomaterials and large industrial samples
HRXRD/MX	High Resolution X-ray Diffraction & Macromolecular Crystallography	5-25	5-25	IVU20 3.0 m (revising length)	High resolution XRD and MX
SWAXS	Small and Wide-Angle X-ray Scattering	8-20	8-20	IVU20 3.0 m (revising length)	SAXS, WAXS
~~IR~~	~~Infrared spectroscopy & imaging~~	~~400-4000 cm~~	08.2023 – IR moved to Phase-II		~~IR microscopy~~
GIXRD/TRXRF	Grazing-Incidence X-ray Scattering and Total-Reflection Fluorescence	8-20	8-20	IVU20 3.0m	Diffraction of thin film, trace element, micro XRF

SPS-II Phase-I Beamline

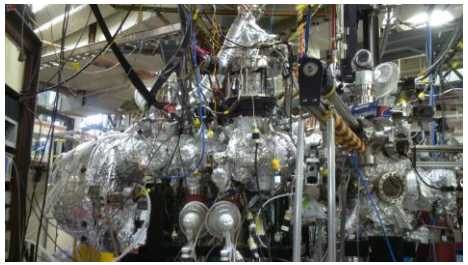
Beamline	Full name (based on DDR 2019)	Energy range (keV)		Insertion device	Smallest spot size HxV (μm)
		Core	Best-effort		
HRSXS	High-Resolution Soft X-ray Spectroscopy	0.1-2.0	0.097-2.5	EPU64 (or 58) 1.344 m (revising)	40 x 4
TXAS	Tender X-ray Absorption Spectroscopy	1.8-10	1.0-13	IVW70 1.05m	110 x 57
HXAS	Hard X-ray Absorption Spectroscopy	4-35	4-35	IVW50 2.0 m	124 x 118
XMCT	X-ray Microtomography	8-60	8-60	IVW50 2.0 m	Designed for large beam
HRXRD/MX	High Resolution X-ray Diffraction & Macromolecular Crystallography	5-25	5-25	IVU20 3.0 m (revising length)	2.1 x 0.6
SWAXS	Small and Wide-Angle X-ray Scattering	8-20	8-20	IVU20 3.0 m (revising length)	109 x 62
~~IR~~	~~Infrared spectroscopy & imaging~~	~~400-4000 cm^{-1}~~	08.2023 – IR moved to Phase-II		~~Used with nanoprobe (nm resolution)~~
GIXRD/TRXRF	Grazing-Incidence X-ray Scattering and Total-Reflection X-ray Fluorescence	8-20	8-20	IVU20 3.0m	5 x 5 microns

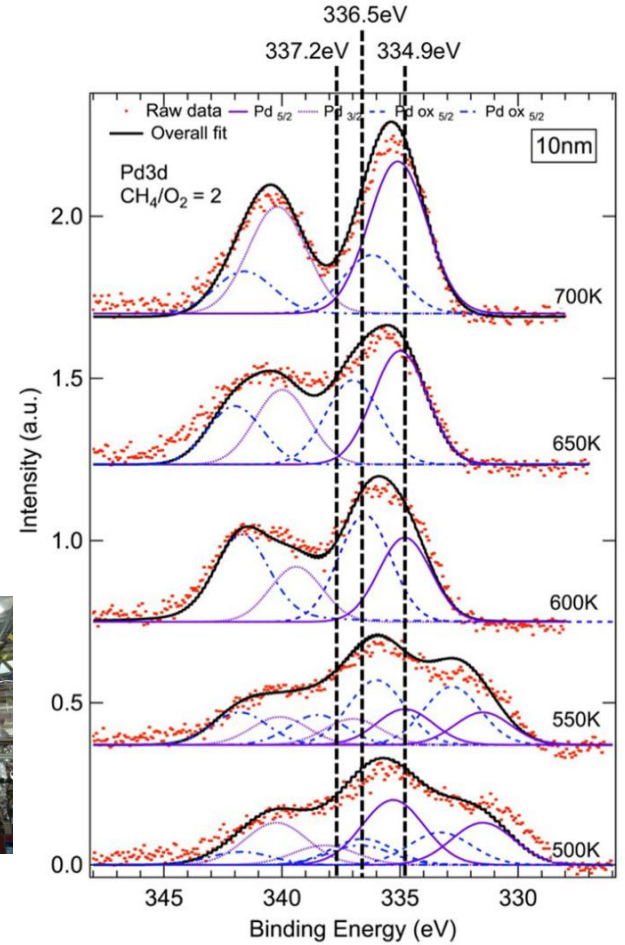
Scientific program

Environmental research - catalyst

Methane partial oxidation by Pd catalyst

https://www.thaitrainguide.com/2023/01/19/free-shuttle-bus-between-krung-thep-aphiwat-and-hua-lamphong-stations/

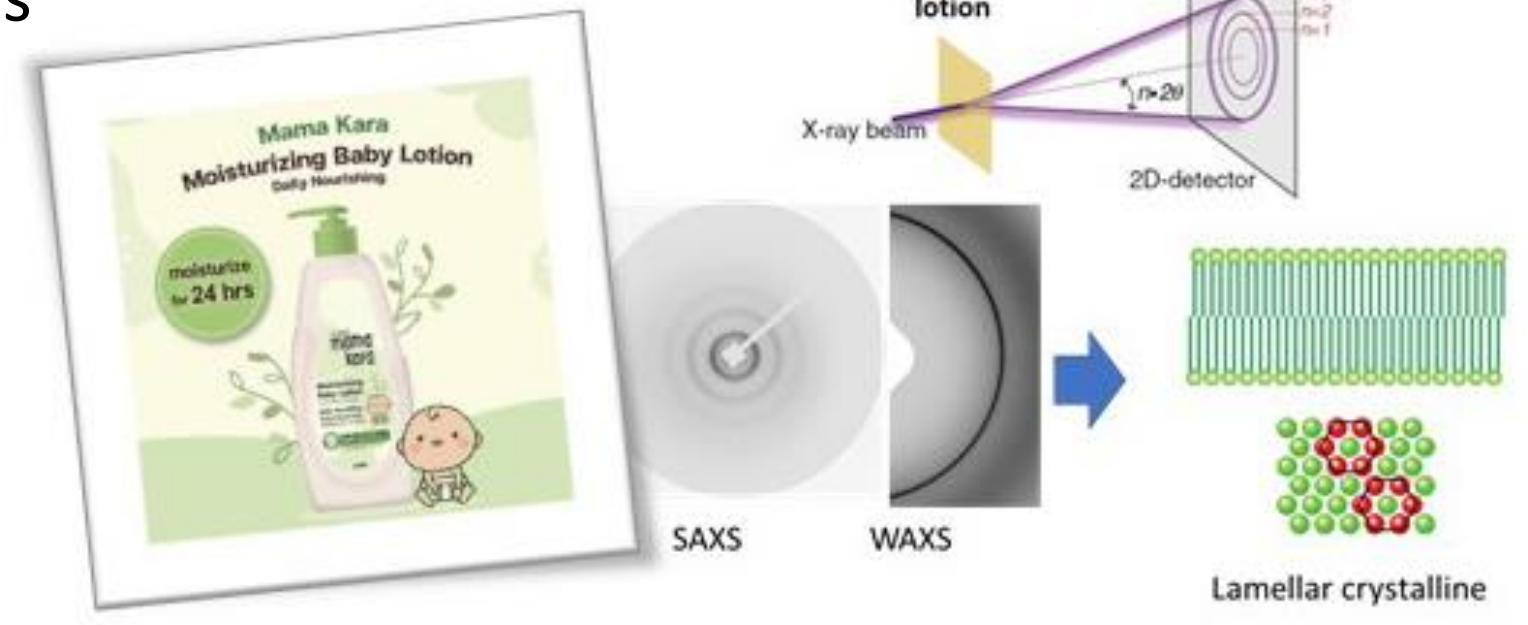




Price, R. et al. The Partial Oxidation of Methane Over Pd/Al2O3 Catalyst Nanoparticles Studied In-Situ by Near Ambient-Pressure X-ray Photoelectron Spectroscopy. Top Catal 59, 516–525 (2016).

Consumers products

- Polymers
- Hydrogels/aerogels
- Skin care and moisturizers



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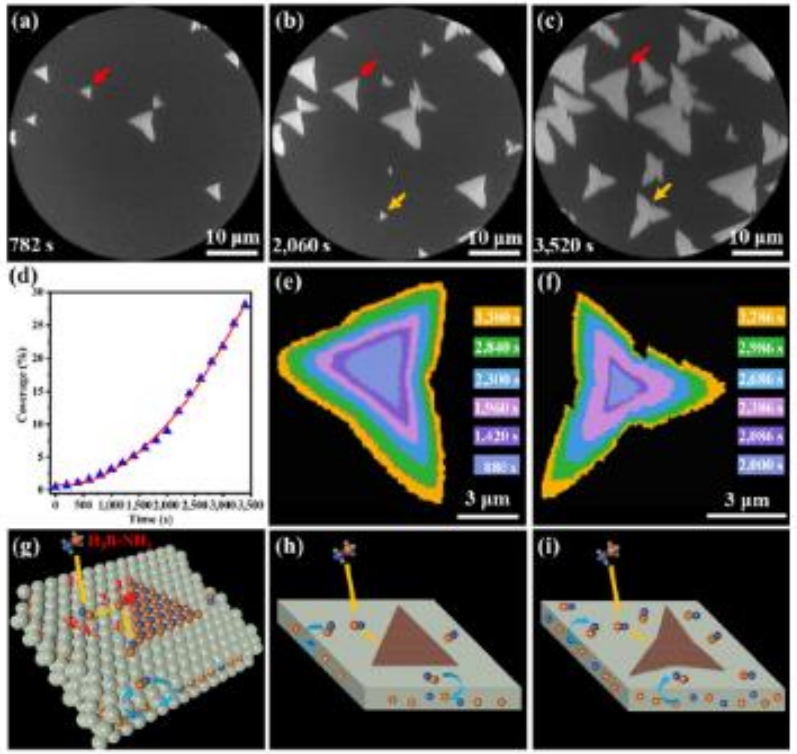
https://www.slri.or.th/en/list-research/580-slri-tested-%E2%80%9Cmama-kara%E2%80%9D-product-for-performance-in-building-up-skin-barrier.html

Thin films

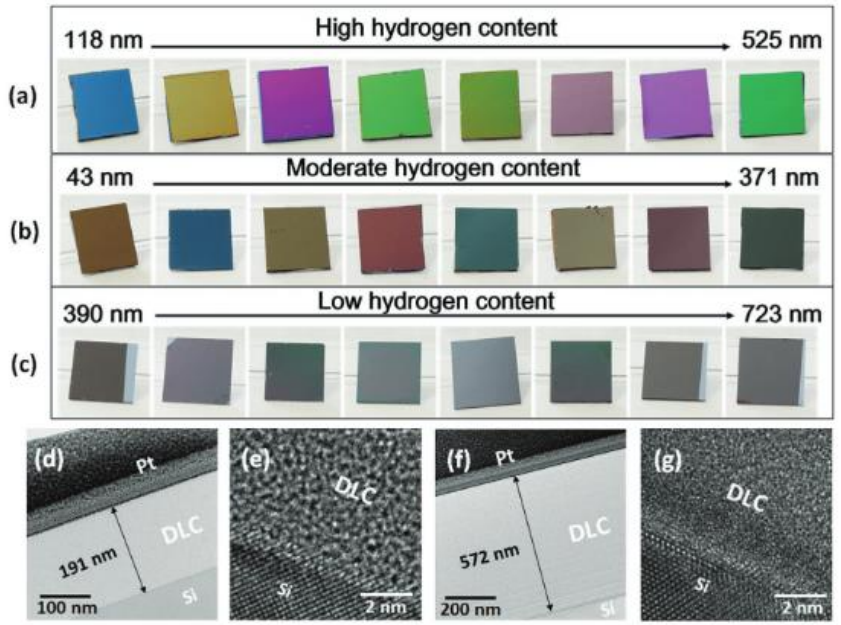
- Magnetic thin films
- 2-dimensional materials
- Strongly-correlated materials
- Perovskites
- Electronics

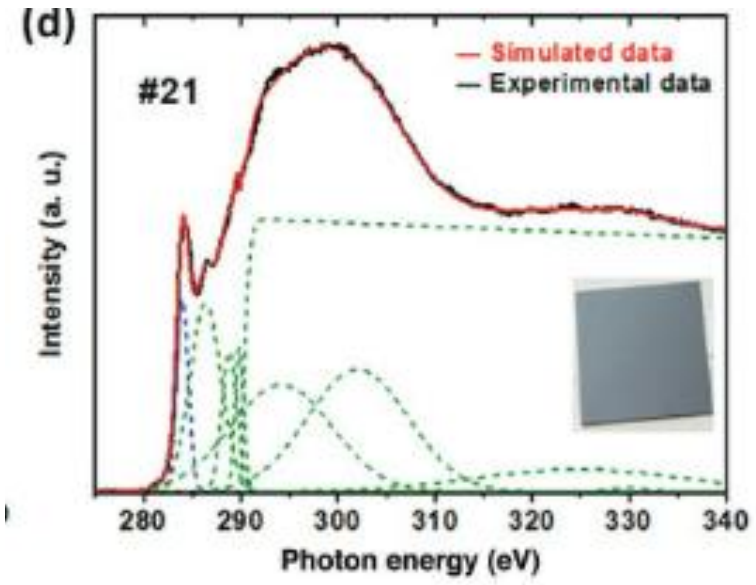


Graphene + h-BN growth on Ni(111)

Wei, W. *et al.* Dynamic observation of in-plane h-BN/graphene heterostructures growth on Ni(111). *Nano Res* **13**, 1789–1794 (2020).

Diamond-like carbon (hard coating)





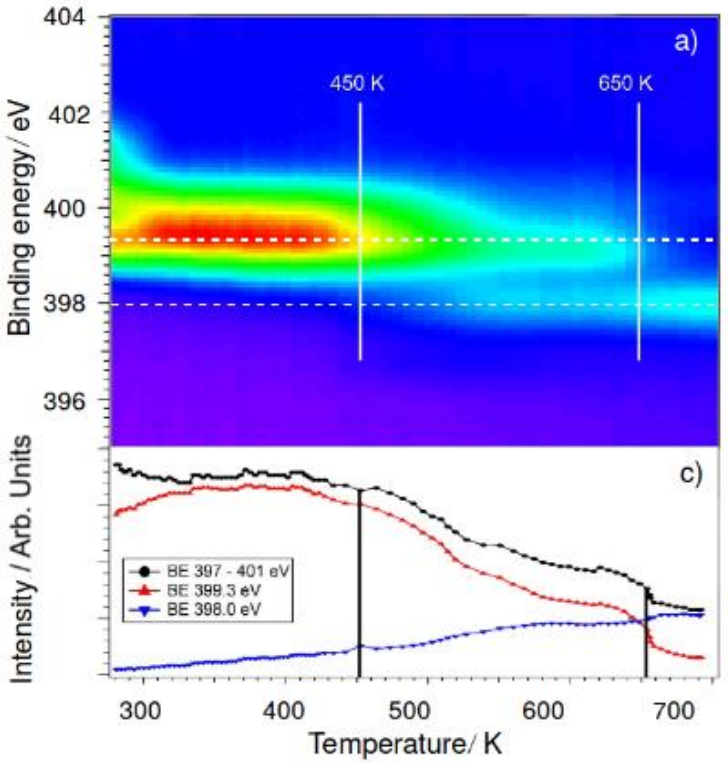
Colorful diamond-like carbon films from different micro/nanostructures, X Zhou,et al., Advanced Optical Materials 8 (11), 1902064

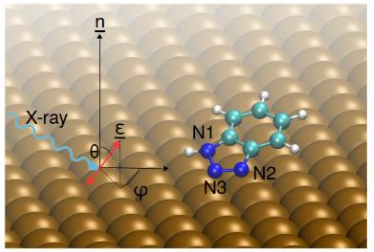
Cultural heritage

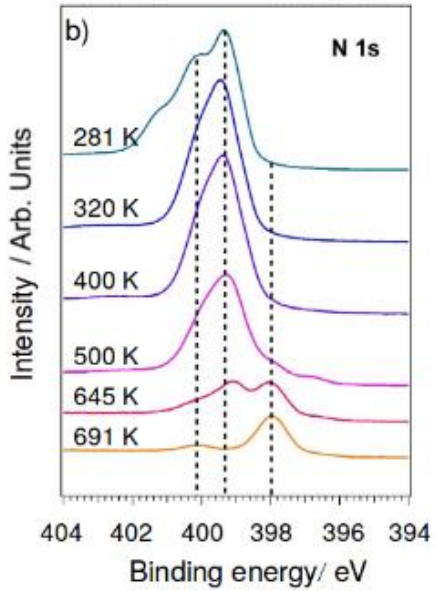
Prevention of oxidation on copper by BTAH

https://rotaxmetals.net/how-to-oxidize-copper/

Temperature-programmed XPS







Gattinoni, C.; Tsaousis, P.; Euaruksakul, C.; Price, R.; Duncan, D. A.; Pascal, T.; Prendergast, D.; Held, G.; Michaelides, A. Adsorption Behavior of Organic Molecules: A Study of Benzotriazole on Cu(111) with Spectroscopic and Theoretical Methods. Langmuir 2019, 35 (4), 882–893. https://doi.org/10.1021/acs.langmuir.8b03528.

Cultural heritage

Restoration of antique mirror mosaics at the Temple of the Emerald Buddha in Bangkok

Figure 5.18: Photographs of (left) antique mirror mosaics in the Temple of the Emerald Buddha on the base of the Kings' statues at the Royal Pantheon and (right), replica made by the research team at SLRI [46].

XAS at BL8 of SPS-I

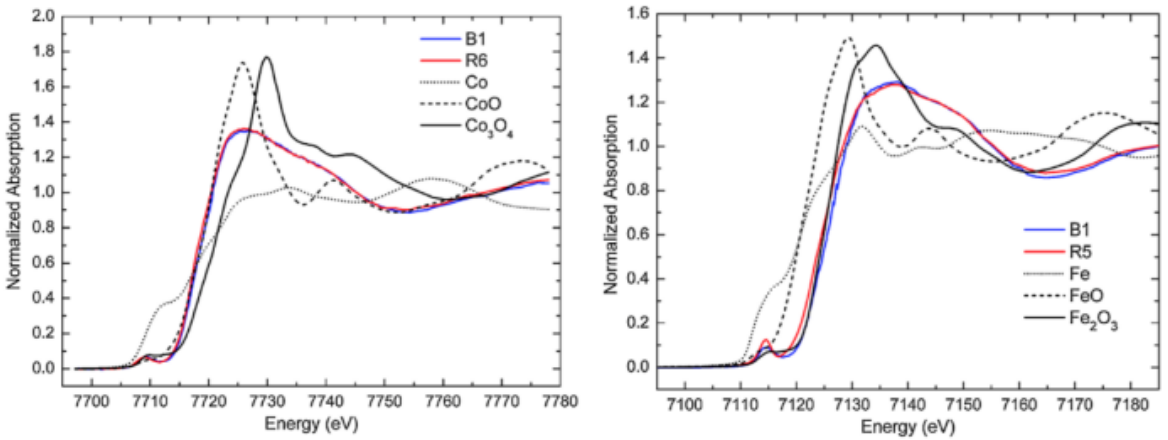
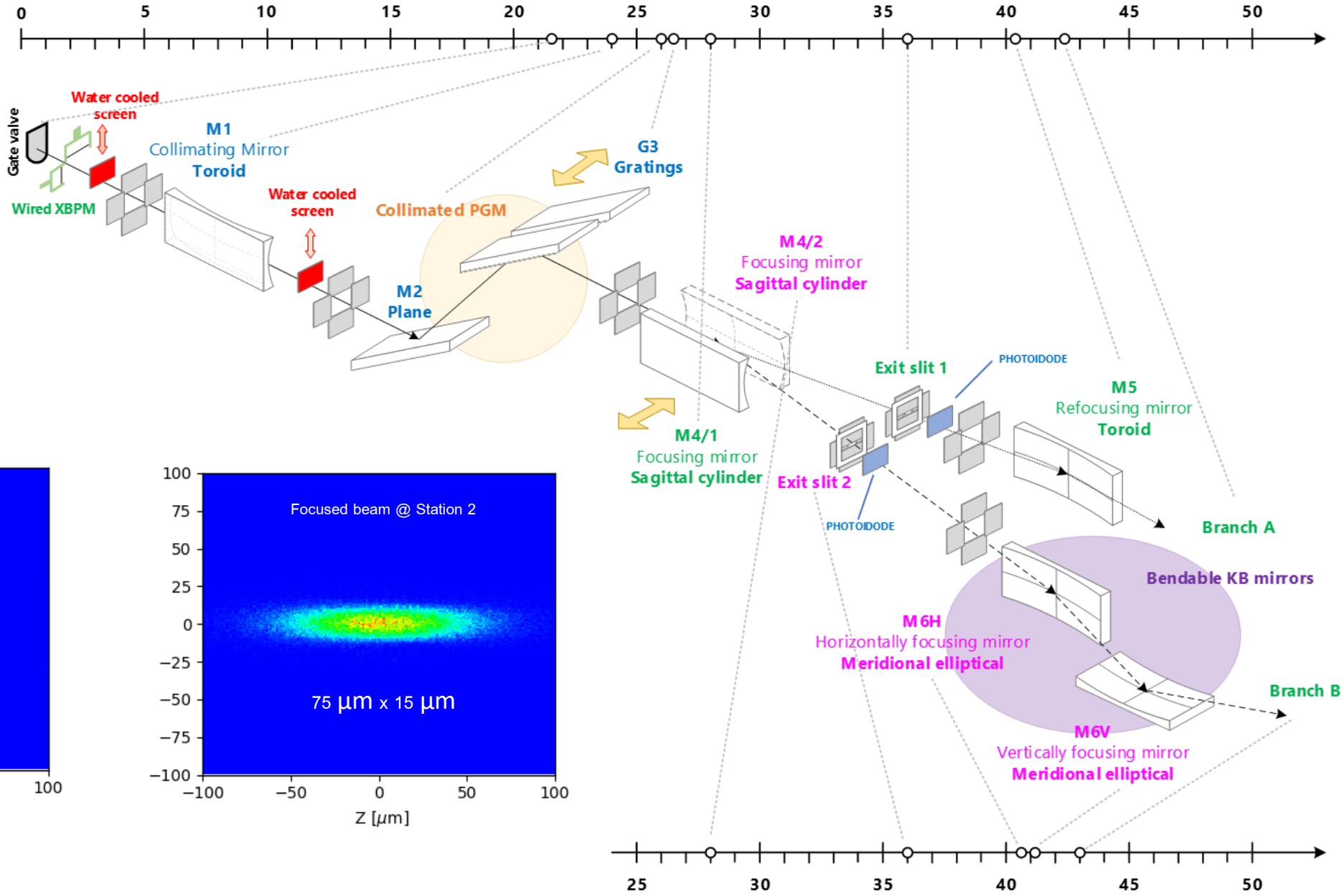


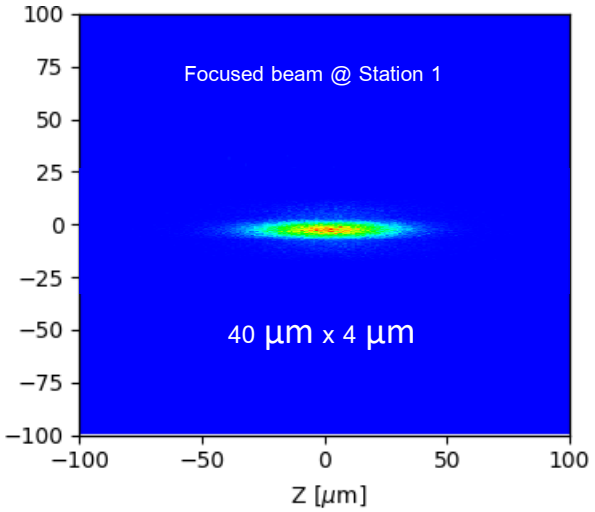
Figure 5.19: (Left) Co *K*-edge XANES spectra of the antique glass B1, reference glass R6, and cobalt standards (Co metal, CoO, and Co_3O_4). (Right) Fe *K*-edge XANES spectra of the antique glass B1, reference glass R6, and iron standards (Fe metal, FeO, and Fe_2O_3) [46].

Klysubun, W., Hauzenberger, C.A., Ravel, B., et al., 2015. Understanding the blue color in antique mosaic mirrored glass from the Temple of the Emerald Buddha, Thailand. X-Ray Spectrometry,44, 116-123.

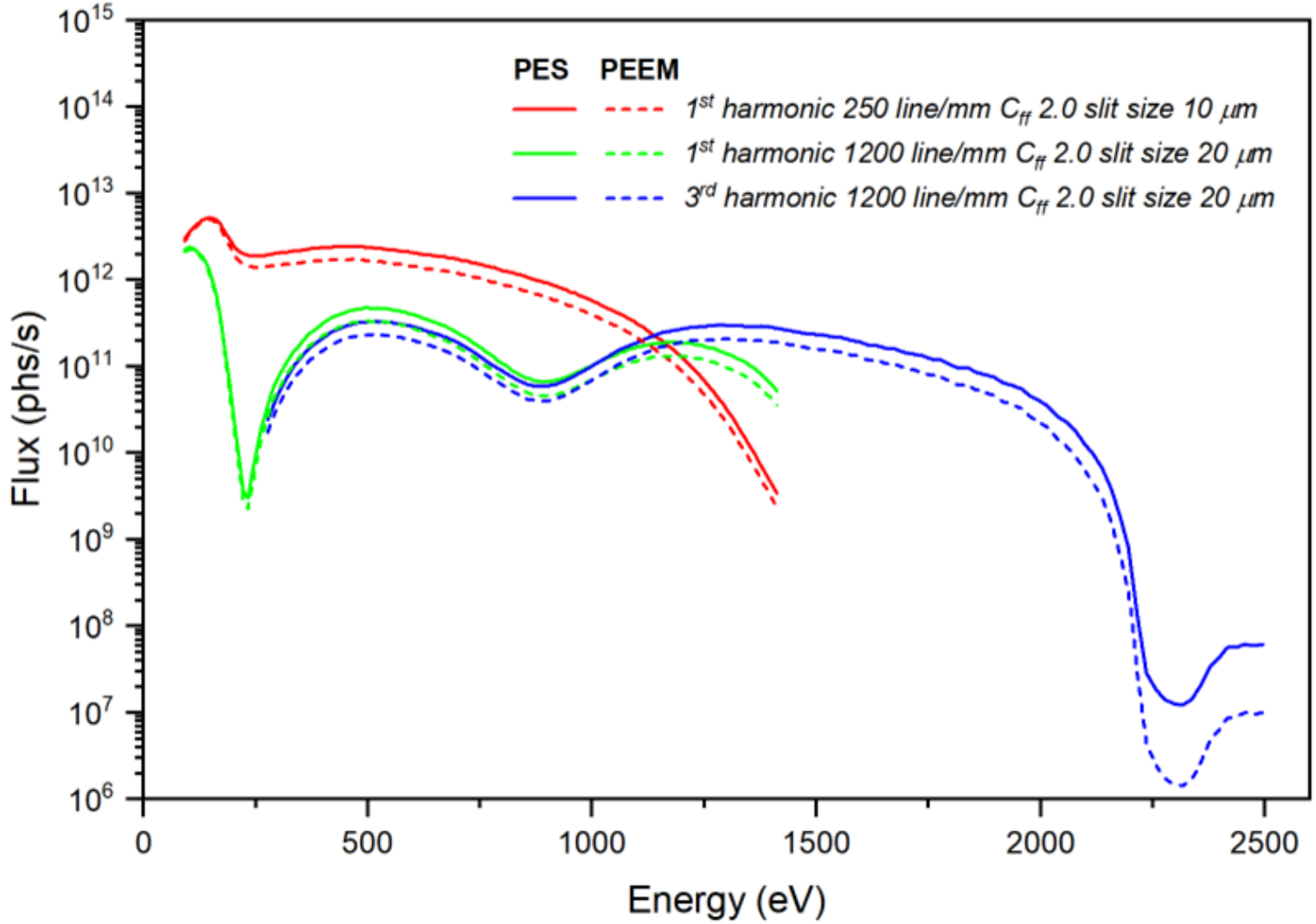
Beamline specifications

HRSXS Beamline

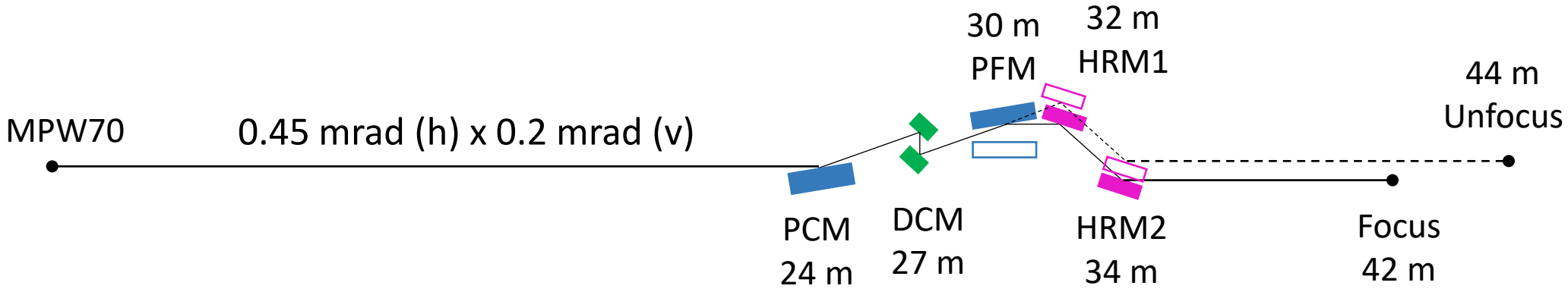


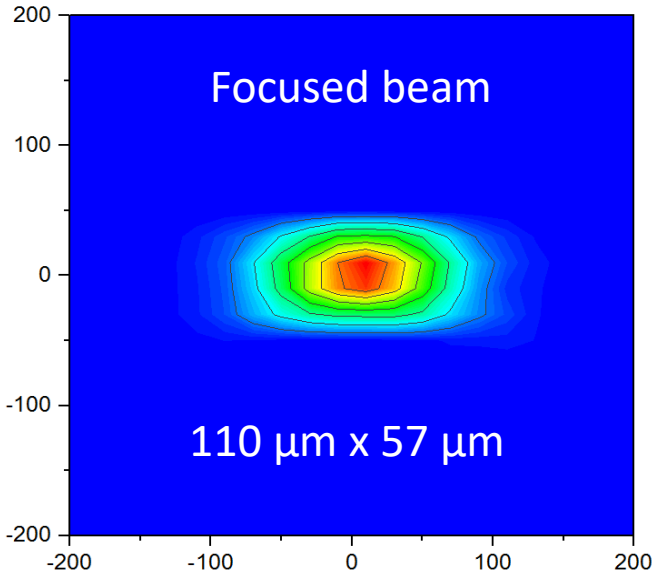


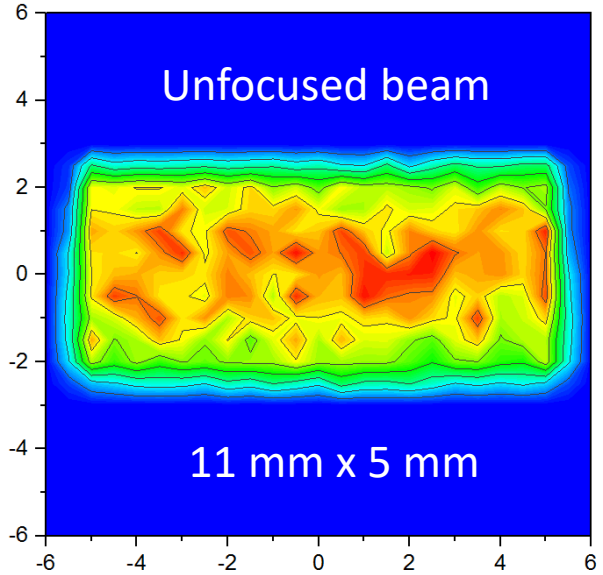
HRSXS Photon Flux



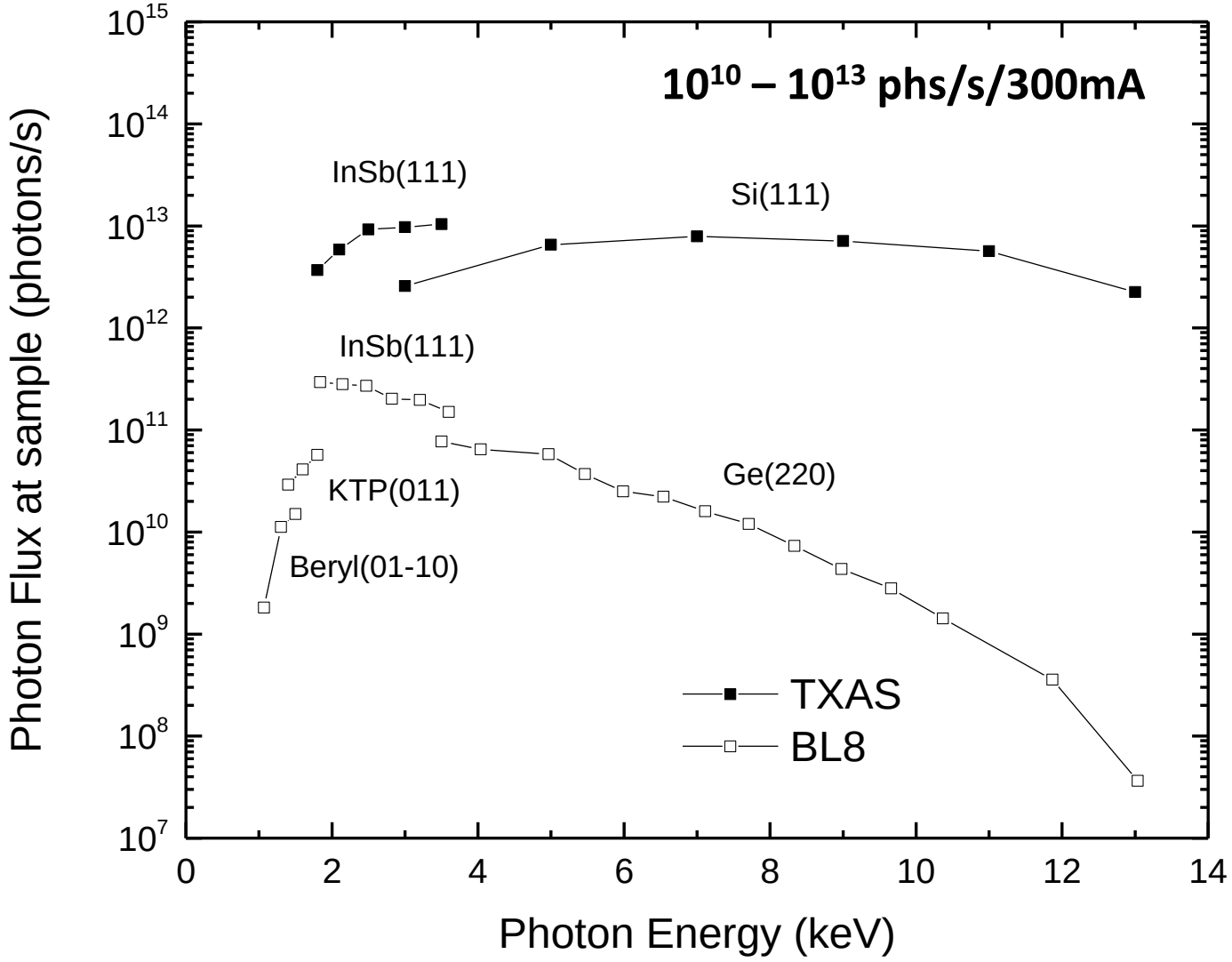
TXAS Beamline





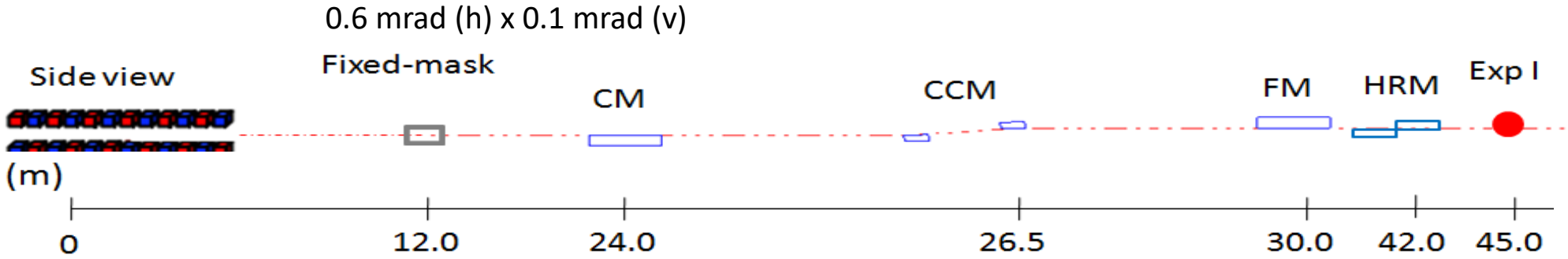


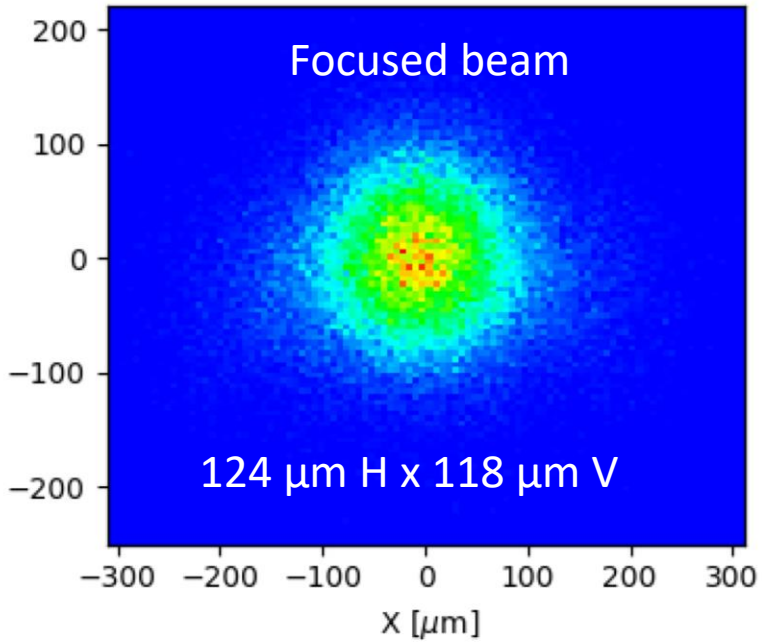
TXAS Photon Flux



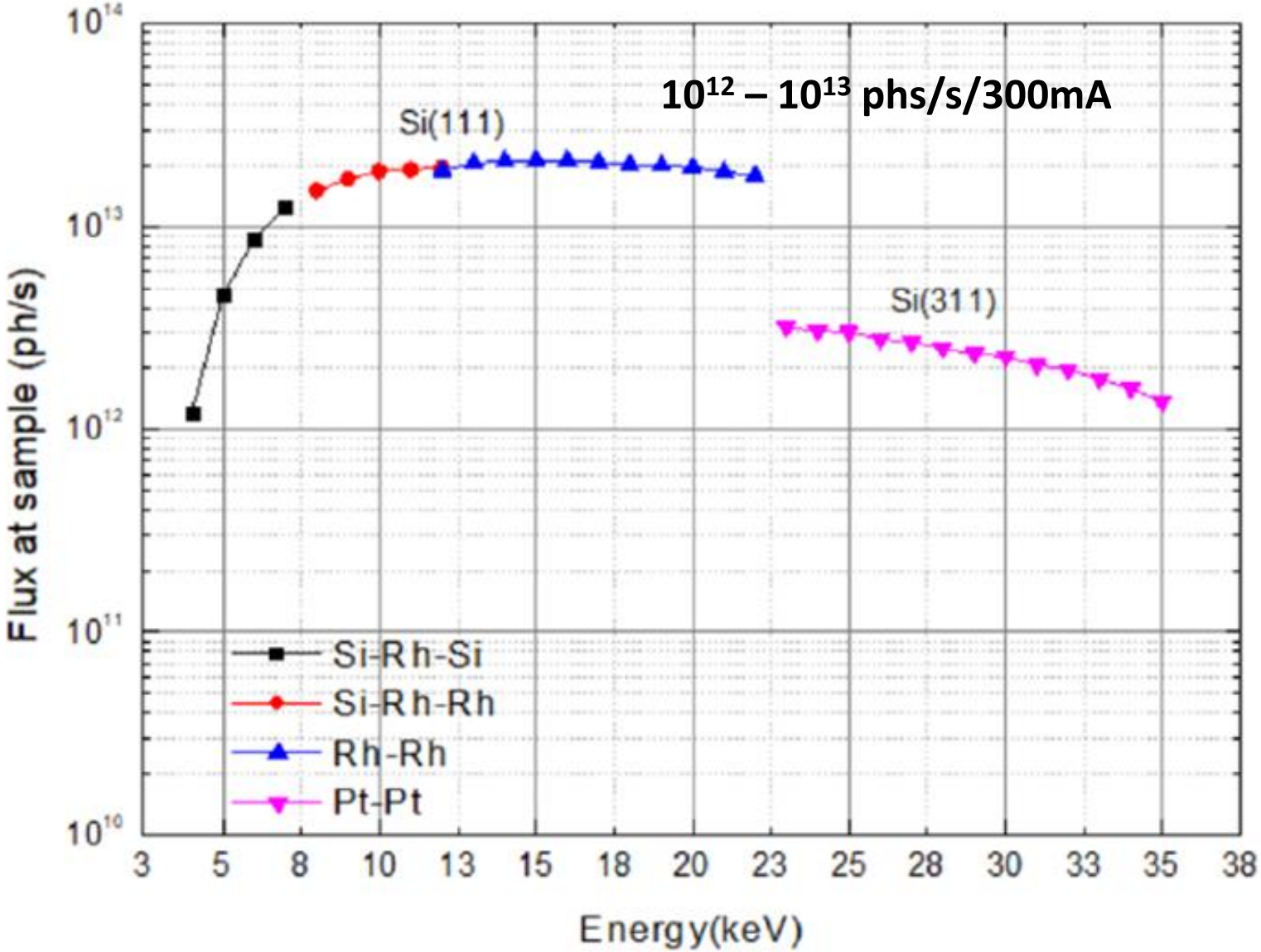
Siam Photon Source II

HXAS Beamline

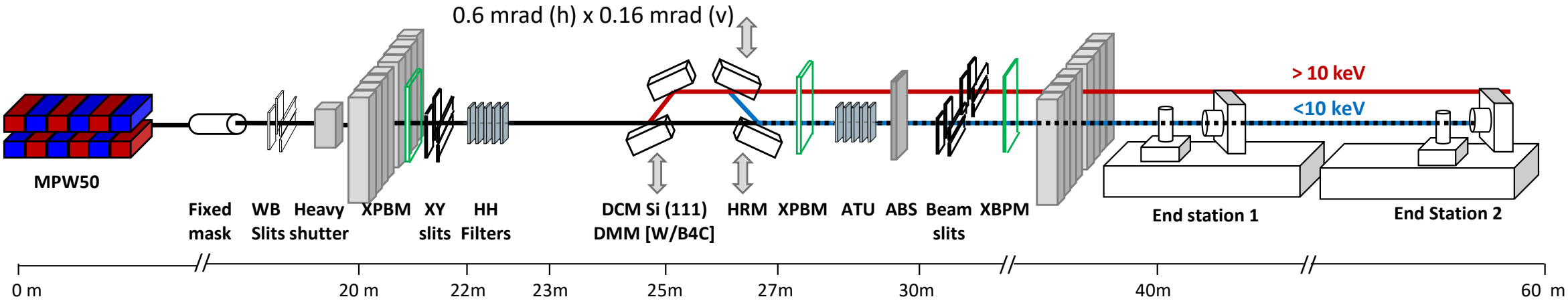


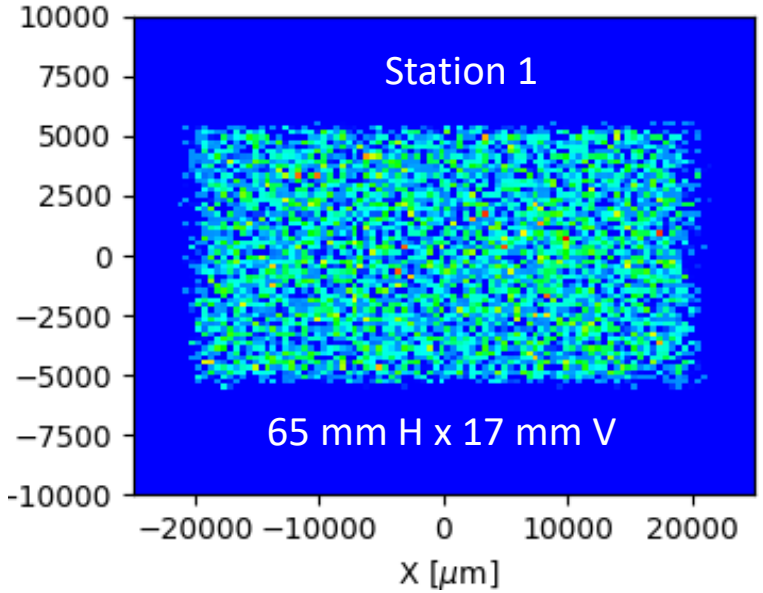


HXAS Photon Flux

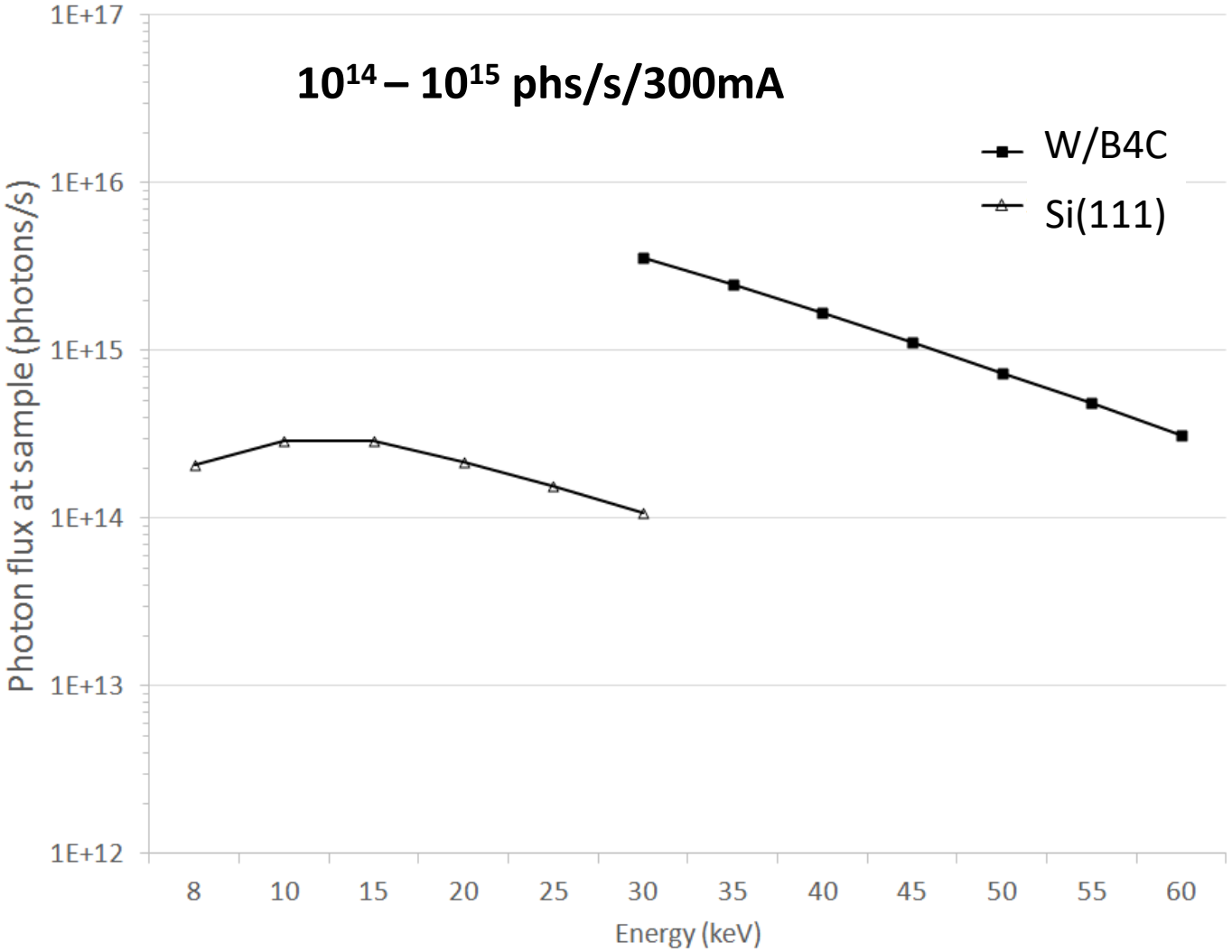


XMCT Beamline



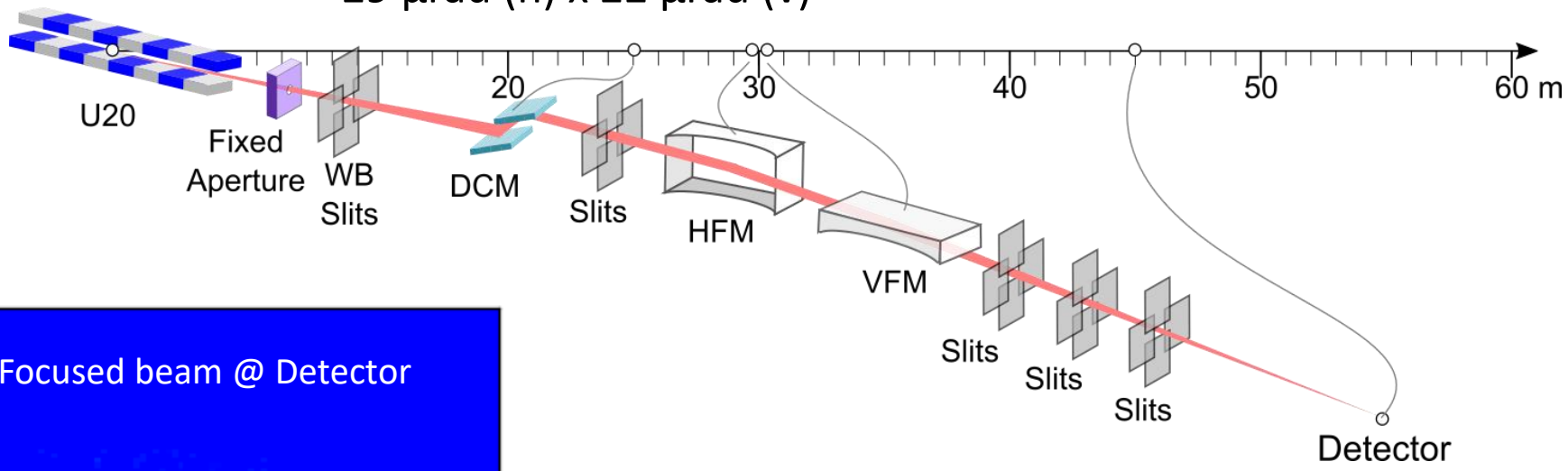


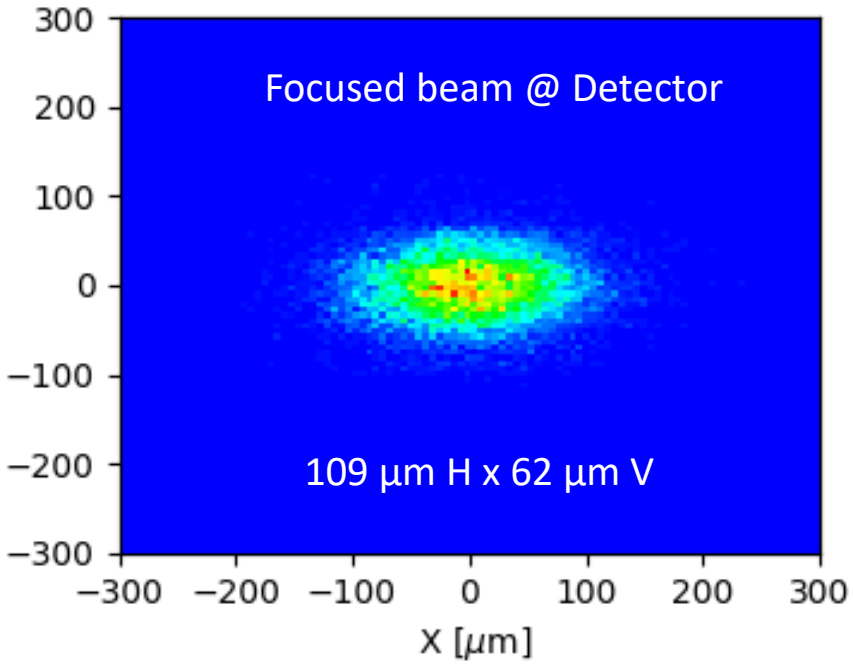
XMCT Photon Flux



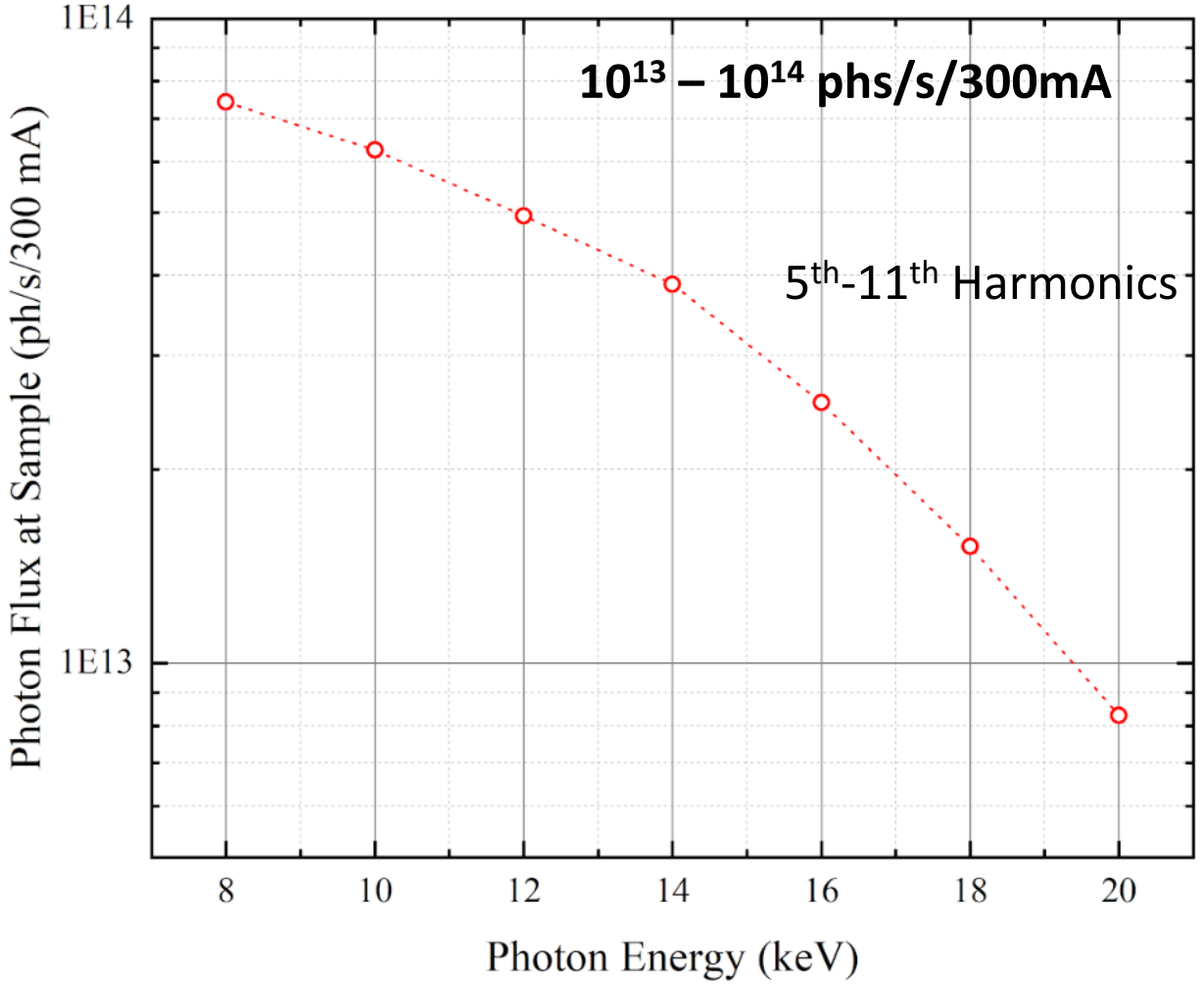
SWAXS Beamline

29 µrad (h) x 22 µrad (v)

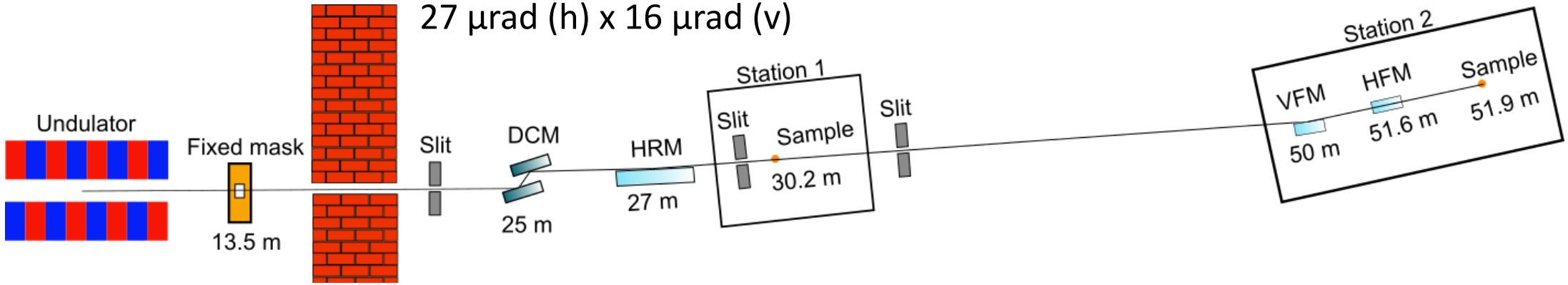


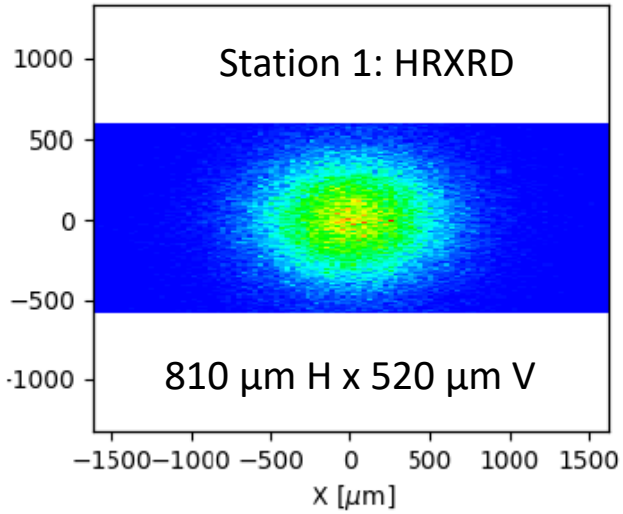


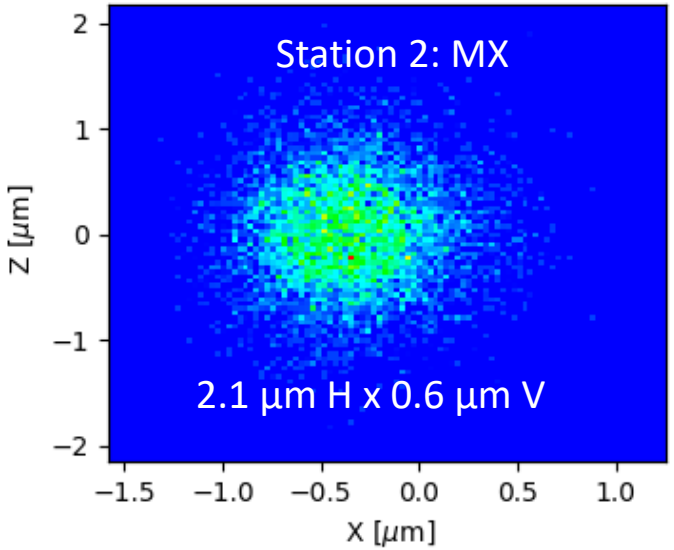
SWAXS Photon Flux



HRXRD/MX Beamline

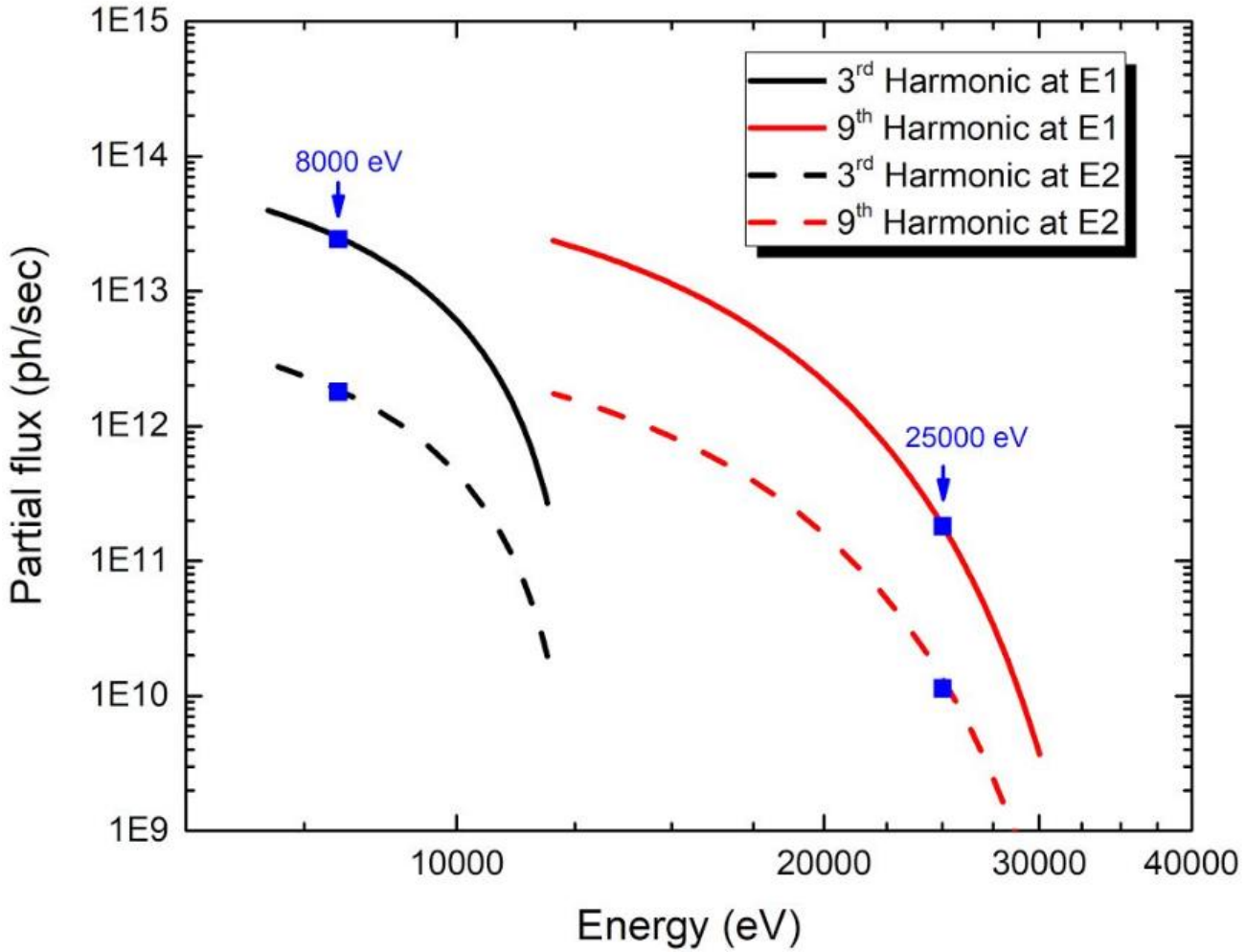




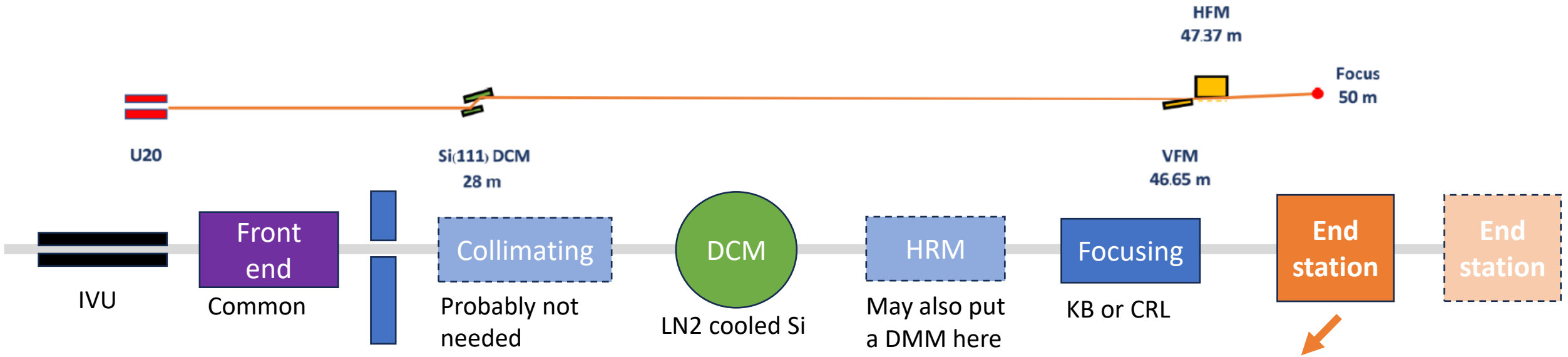


HRXRD/MX Photon Flux

HRXRD: 10^{10} – 10^{13} phs/s/300mA **MX: 10^{9} – 10^{12} phs/s/300mA**



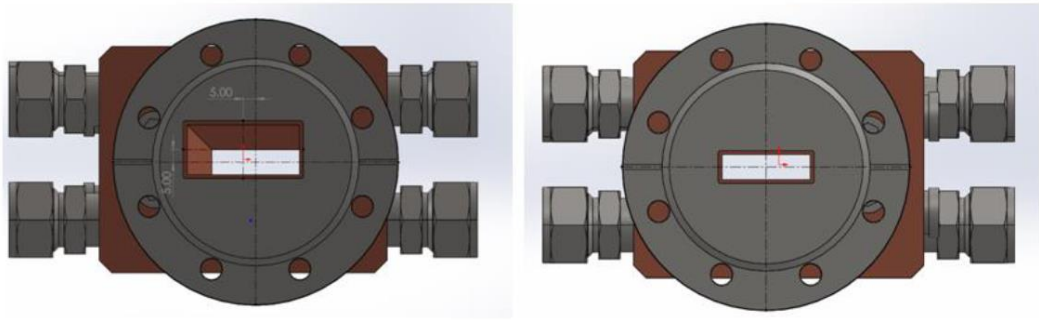
GIXRD/TRXRF

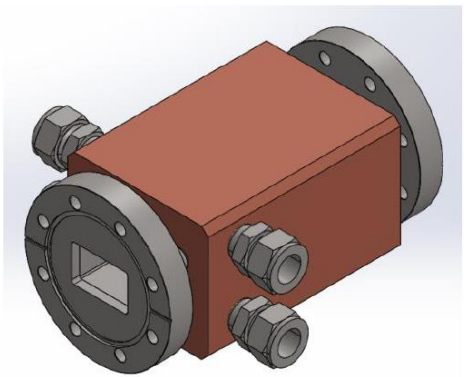


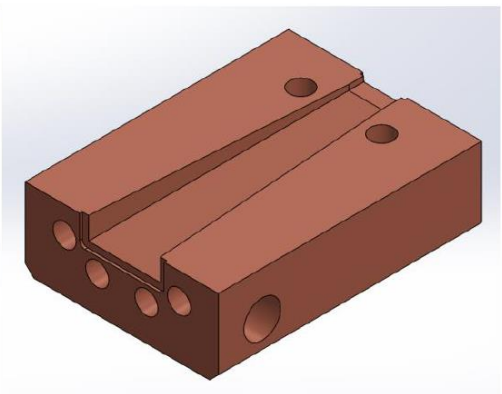
End station	Beam size	Flux	Source	Target energy	Notes	Applications	Users	Industry
GI XRD/TR XRF (dedicated for grazing incidence)	< 5 um (?)	1E13 ph/s	In vacuum undulator	8 keV ↑ hv liquid interface	SLRI had a pilot project for GI-XRD at BL7 if SPS-I	Atomic structure or phase of thin films, surface chemistry, trace element quantifications	There have been many requests, but SPS-I cannot yet provide the technique regularly	Energy (Perovskite solar cell), Food contamination

***As of Nov 2023, the conceptual design of GIXRD/TRXRF is on going**

Standardized front end design







X-Y Slits

Fixed mask

Based on TPS design

New things to expect

- More complicate beamline systems
- Computer control of everything with different looking interface (EPICS/Python base)
- More work to do to handle bright (heat load) and very small beam (micron)
- Tighter radiation safety
- More challenging development for next beamlines
- More users (+international) with high expectations

Capabilities building

Designer team

↓

Engineering support team

↑

Scientific program team

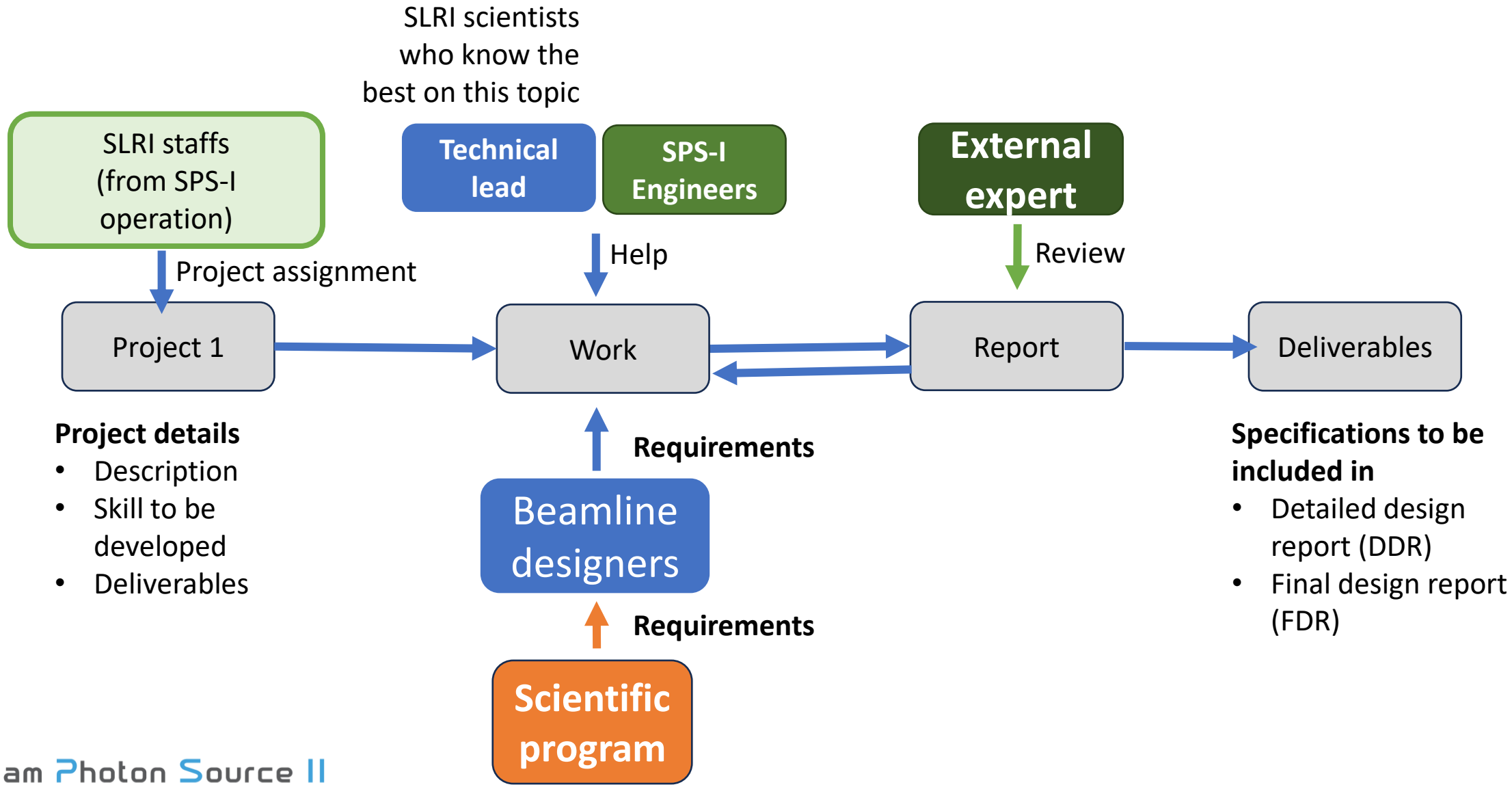
Work breakdown

Sources	Magnetic measurement				**Source power profile simulation**
	Magnet array design				
Front ends	Finite element analysis (FEA)				
	High-heat load materials				
Beamlines	**Optics**	Focusing scheme	Metrology	Handling (range and precision)	Vibration
		Energy filter	Harmonic suppression		**Mode switching**
	Diagnostic /control	Automation	Feedback	**Thermal effect compensation**	
	Mono	**Liquid nitrogen**		**Water**	**Floor and space management**
End-stations		**Sample environment**	**SAN**	**HPC**	
		Detector	**Data network**		
Integration		**Survey plan**	**Fiducialization**	**Vacuum**	**Air con**
			SR ray tracing	**EPS**	**Gas**
Radiation Safety		**Hutch**	**PSS**	**Bremsstrahlung shielding**	
					Compressed air
					Electricity
					Utilities

Rack/cable management

SPS-II Siam Photon Source II

Team building – On the job training



Summary

- Thailand is aiming to have a new synchrotron facility in <10 years
- The techniques provided by the new beamline will be focused on the researches that have the economic, industrial and social impacts to Thailand and Southeast Asia.
- SLRI will have put a lot of effort to build up technological and engineering skills of its staffs for the project to be successful.

Thank you for your time