Bio-Science and Imaging Beamlines

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ID22 BioNX: Mi-Jeong Kwak[2] and Yeon-Gil Kim[2]
BM10 HEM: Yong Sung Park[2] and Jae-Hong Lim[2]

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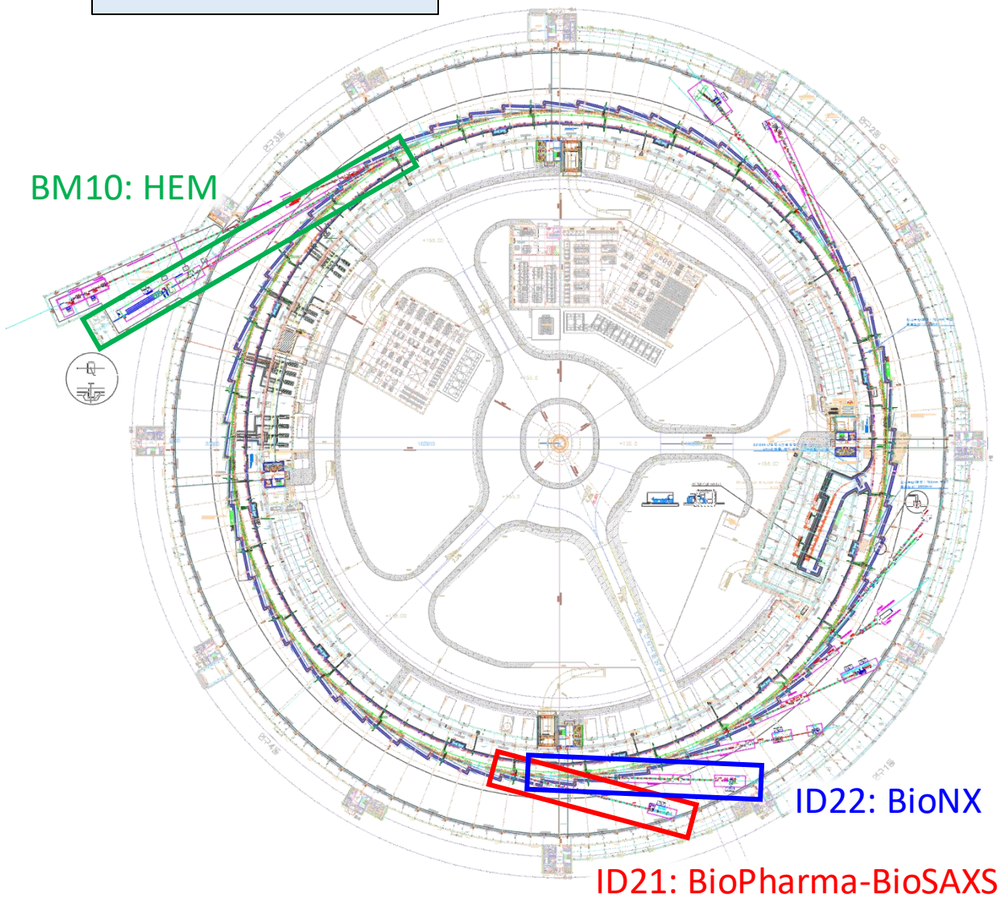
Nov. 5-6, 2025

Outline

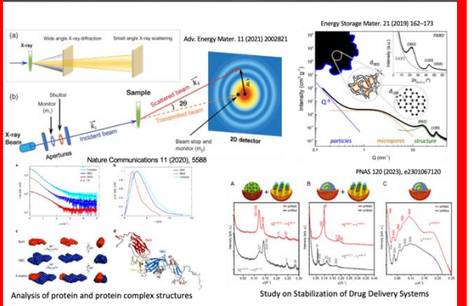
1. Overview
2. ID21 BioPharma-BioSAXS (Small angle X-ray Scattering)
3. ID22 BioNX (Bio Nano crystallography)
4. BM10 HEM (High Energy Microscopy)
5. Summary

1. Overview

Korea-4GSR Floor Plan

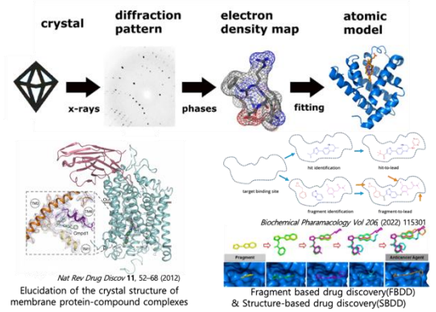


ID21 BioSAXS



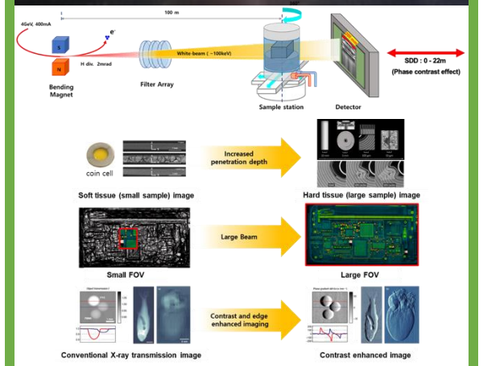
- High-throughput experiment
- Variable *q*-range vacuum chamber
- Efficiency / Convenience

ID22 BioNX



- High-throughput experiment
- Micro-focusing beam
- High flux, rapid beam resizing, stability

BM10 HEM



- High energy beam
- Large beam size
- X-ray phase contrast imaging

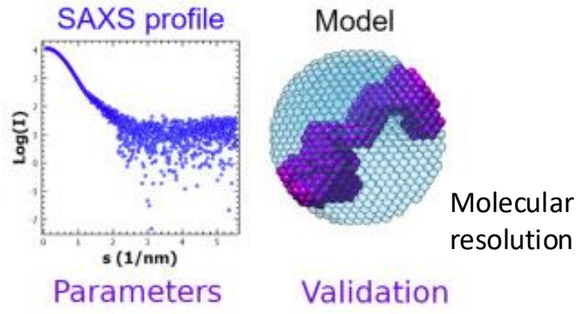
	BioSAXS	BioNX	HEM
Photon Source	IVU24	IVU20	BM (2T)
Energy Range (mainly)	8 ~ 23 keV (12)	8 ~ 25 keV (12.4 and 20)	20 ~ 150 keV
Beam Flux (ph/s)	> 5×10^{12}	> 1×10^{14}	~ 1×10^{13}
Beam Size (μm²) (H × V, FWHM)	• Partially Focused: ~ 200 × 200 • Focused: ~ 40 × 10	• 12.4 keV: 1 × 1 ~ 50 × 50 • 20 keV: 1 × 1 ~ 5 × 5	• 100m: 200 × 25 mm²
Spatial Resolution	8 ~ 3800 Å	0.5 ~ 1.55 Å	> 1.0 μm
Technique	SAXS/WAXS, SEC-SAXS	RSX, SSX, ISX, HTS* MX	Projection Imaging

1. Overview

Priority support for industries

Support for Academic R&D

ID21 BioSAXS



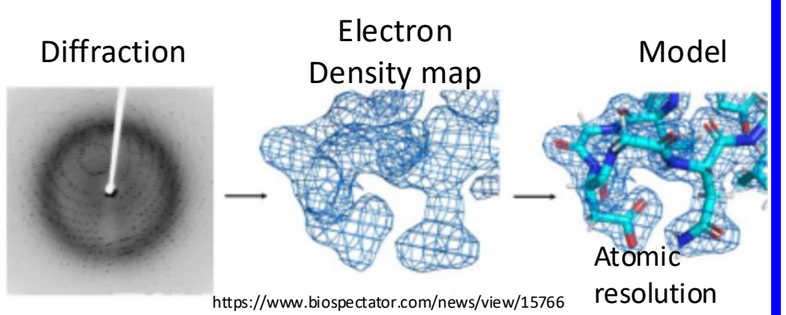
Current Research in Struc. Biol. (2020)

Sample: Biomacromolecules **in solution**

Design Keyword

1. q-vector optimizing layout
2. High-throughput (automatic sample exchange robot)
3. Convenience

ID22 BioNX



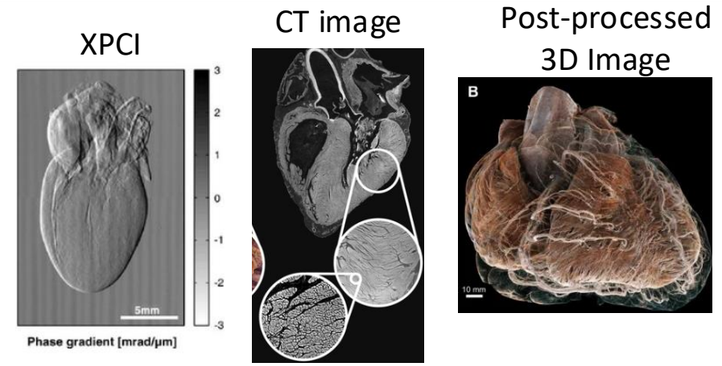
https://www.biospectator.com/news/view/15766

Sample: Biomacromolecules **as crystallized**

Design Keyword

1. Micro-focusing and pulsed beam
2. High flux, rapid beam resizing, stability
3. High-throughput (sample exchange robot)

BM10 HEM



Sample: Biological tissue, Battery, Electronic components, Developmental prototype, etc.

Design Keyword

1. High energy beam (increased penetration depth)
2. Large beam (fast scan time)
3. Phase contrast effect (edge enhanced imaging)

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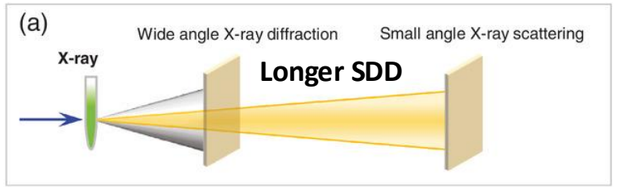
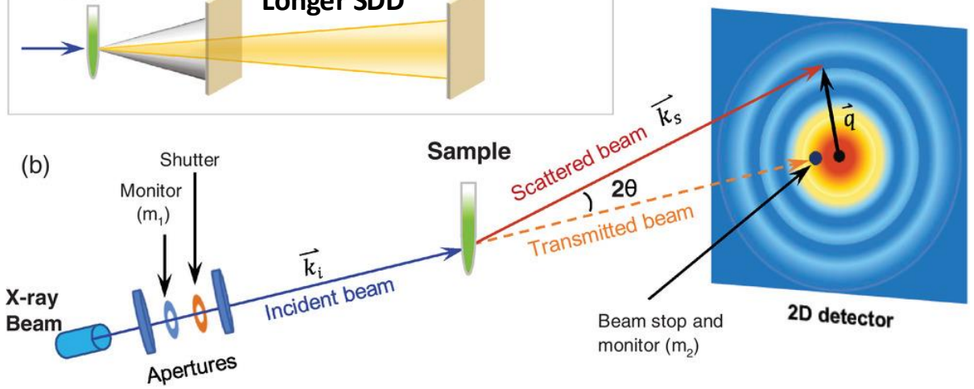
2. BioPharma-BioSAXS

Solution Small Angle X-ray Scattering (SAXS)



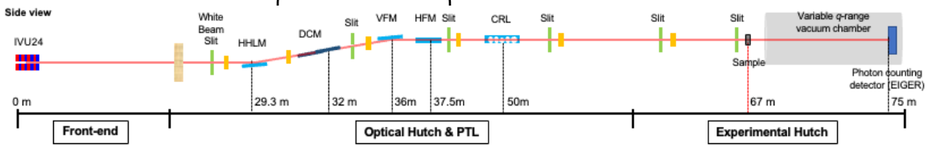
Adv. Energy Mater. 11 (2021) 2002821



Design Summary

1. q-vector optimizing layout

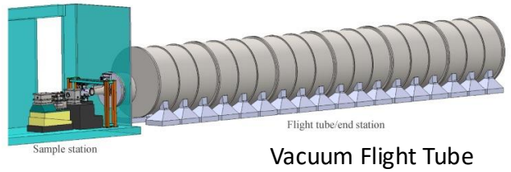
Main Optics components → Placed close to the source



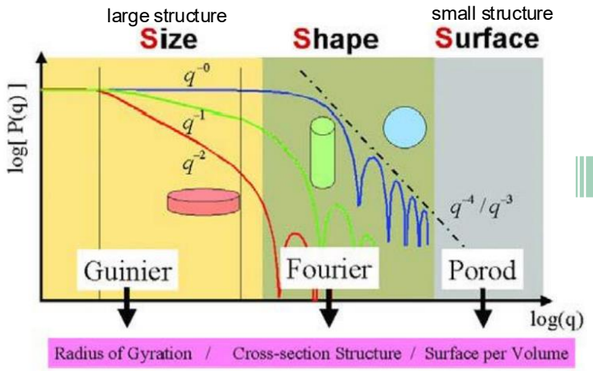
2. High-throughput

Automatic Sample Exchanger Robot

3. Convenience

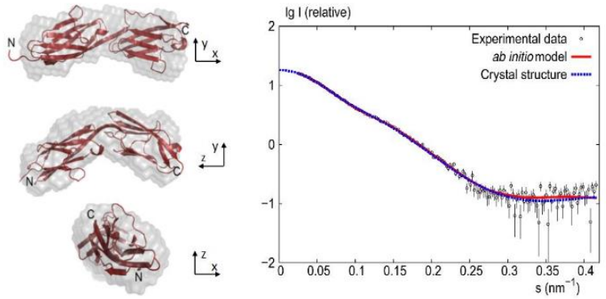


Vacuum Flight Tube



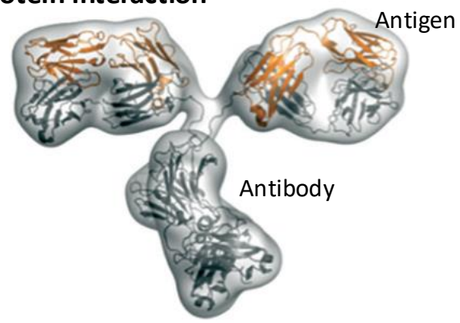
1. **Size of particle**
   $I(q) \sim \exp(-q^2R_g^2/3)$
2. **Form of particle**
   $I(q) \sim q^{-1\sim-2}$
3. **Surface structure**
   $I(q) \sim q^{-4}$

Protein structure characterization in solution



https://biorontech.com/biosaxs

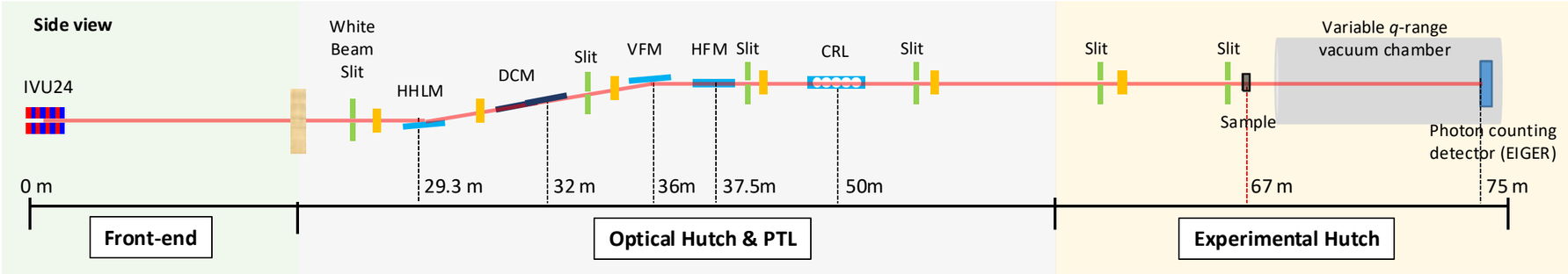
Protein-Protein interaction



ESRF homepage

2. BioPharma-BioSAXS

Beamline Layout



Specification

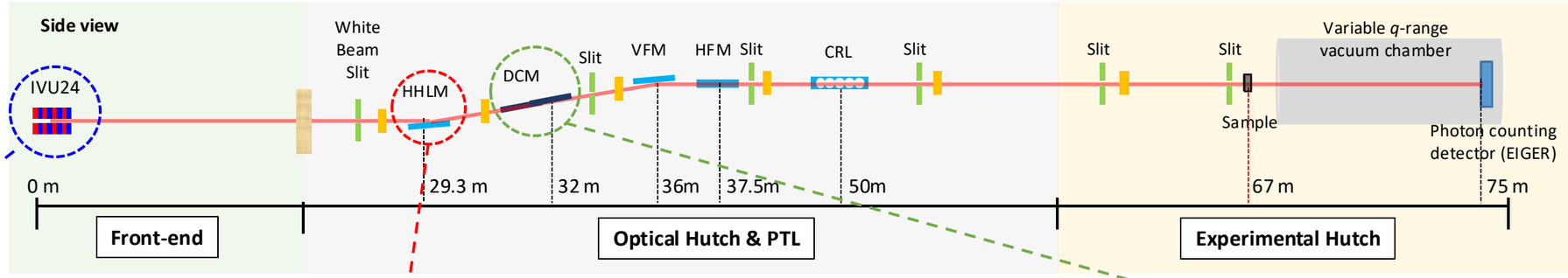
Beamline	ID21 BioPharma-BioSAXS
Light source	In Vacuum Undulator 24 (3m)
Energy range [keV] (mainly)	8 ~ 23 (12)
Energy resolution (ΔE/E)	< 2 x 10^{-4}
Techniques	Solution SAXS
Beam size at sample (μm²) H × V, FWHM	~ 200μm × 200μm ~ 40μm × 10μm
Beam flux (ph/s)	~ 5 × 10^{12}

Beamline Features

- As an industry-prioritized beamline, an **automated sample exchange robot** will be implemented to enable high-throughput experiments.
- **A large vacuum chamber including the detector** allows rapid adjustment of the sample-to-detector distance from 0.5 to 8 meters, enabling efficient analysis of samples with various sizes.
- The system is designed to **perform experiments under a wide range of conditions**—such as pH, temperature, and denaturant concentration for studies on the 3D structure and stability of biomolecular proteins.

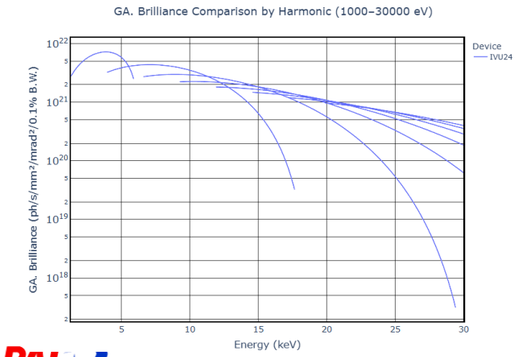
2. BioPharma-BioSAXS

Beamline Layout

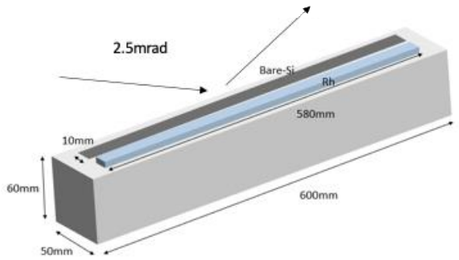


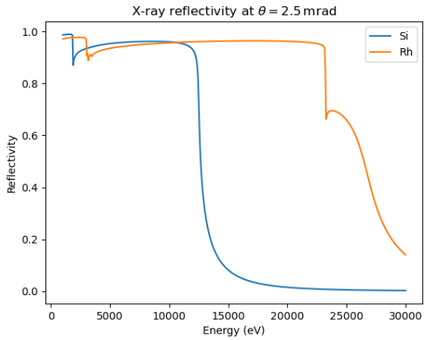
1. In-Vacuum Undulator (IVU24)

Total Length	3 m
Period Length	24 mm
Period Number	125
Deflection Constant	2.745 @ 5 mm of gap
Max. Magnetic Field	1.225T @ 5 mm of gap
Total power	17.9 kW @ 5 mm of gap
Max. power density	165.4 kW/mrad2 @ 5 mm of gap



2. High Heat Load Mirror (HHLM)





Specification	HHLM
Distance from Source	29.3 m
Incident Angle	2.5 mrad
Shape	Plane
Beam Size (H x V)	1.353 x 1.287 mm^2
Footprint (H x V, 4σ)	1.35 x 515 mm^2
Substrate Size (L x W x H)	600 x 50 x 60 mm^3
Coating material	Rh(50nm), Bare-Si
Roughness(R.M.S.)	< 0.5 nm
Slope error(R.M.S.)	< 0.2 μrad (tangential) / < 0.5 μrad (sagittal)
Absorbed Power (W)	53.7(Rh), 156.7(Bare-Si)
Max. Power Density (W/mm²)	0.185(Rh), 0.338(Bare-Si)

→ **Reducing the heat of the white beam**

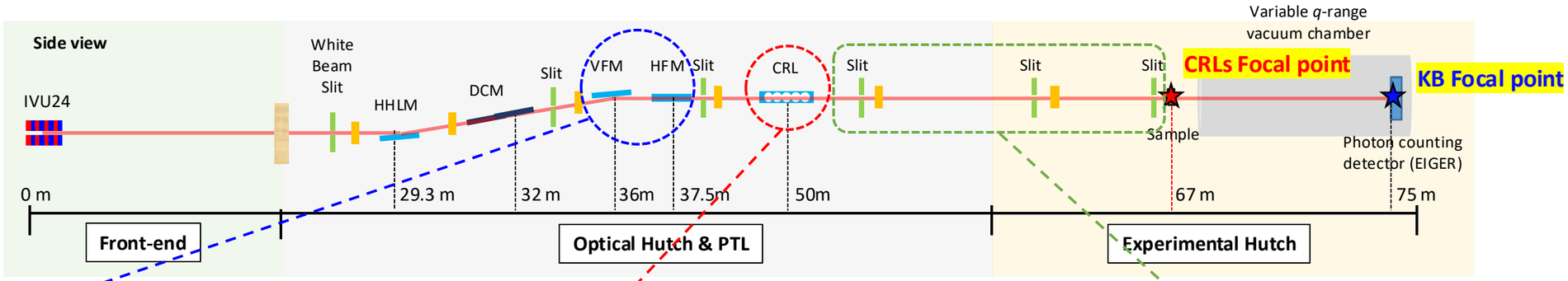
3. Horizontal-Double Crystals Monochromator (H-DCM)

Specification	1st Crystal	2nd Crystal
Shape	Plane	
Footprint (4σ) (maximum)	1.42 x 7.77 mm^2	1.43 x 7.79 mm^2
Size	60(L) x 25(W) x 50(H) mm^3	150(L) x 25(W) x 30(H) mm^3
Substrate	Si<111>	
Energy resolution	$< 2 \times 10^{-4}$	
Bragg angle	4.9° (23 keV) ~14.3° (8 keV)	
Slope error (R.M.S.)	< 1 μrad	
Roughness (R.M.S.)	< 0.1 ~ 0.2nm	

→ **Monochromatize the beam with high stability**

2. BioPharma-BioSAXS

Beamline Layout

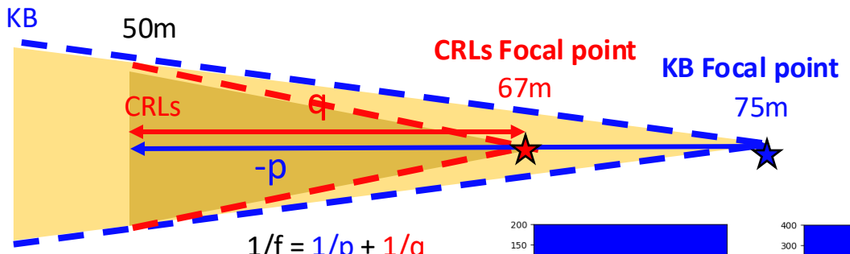


Focusing Optics

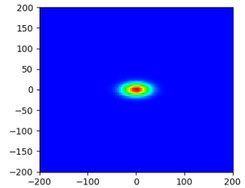
3-1. KB mirror

Specification	Vertical focusing	Horizontal focusing
Distance from source	36 m	37.5 m
Shape	Elliptical cylinder	Elliptical cylinder
Beam size @ ~12keV	1.59 x 1.66 mm^2	1.60 x 1.69 mm^2
Footprint (4σ) @ ~12keV	1.59 x 665 mm^2	1.60 x 675 mm^2
Substrate Size (L x W x H)	700 x 50 x 60 mm^3	700 x 50 x 60 mm^3
Substrate material	Si	
Coating material	Rh(50nm)	
Incident angle	2.5mrad	
p, q parameter	p: 36m q: 39m	p: 37.5m q: 37.5m
Slope error (R.M.S.)	< 0.2μrad (tangential), < 0.5μrad (sagittal)	
Roughness (R.M.S.)	0.5nm	

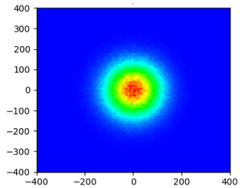
3-2. CRL (Compound Refractive Lens)



Energy (keV)	Number of lenses			
	600 μm	1000 μm	2500 μm	6000 μm
9	1	0	0	1
12	3	0	0	1
20	1	3	0	3



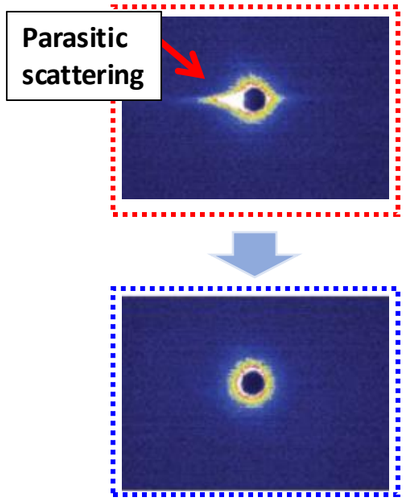
Focused mode (KB + CRL)
~ 40 x 10 μm^2



Partially-focused mode (KB only)
~ 200 x 200 μm^2

4. 3-slit system

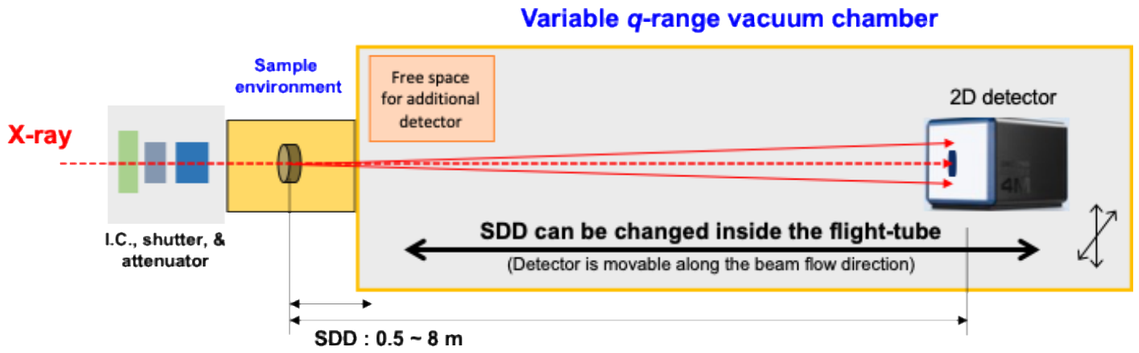
- Removing the parasitic scattering



2. BioPharma-BioSAXS

End-Station

◆ Rapid sample to detector distance (SDD) changing system
– <u>Sample fixed, Detector move</u>



- **Time reduction** for sample to detector distance (SDD) change
- By fixing the sample environment position, it is easy to install **robot system** and build **applied experiment tools**
- **Improvement of data quality** owing to minimizing air scattering (background)

~ 0.33 electrons /Å^3 (water)
~ 0.43 electrons /Å^3 (biomolecules)

Vacuum chamber examples

Example; 12 ID-B, APS

13A BioSAXS, TPS

12ID-B, SAXS, NSLS-II

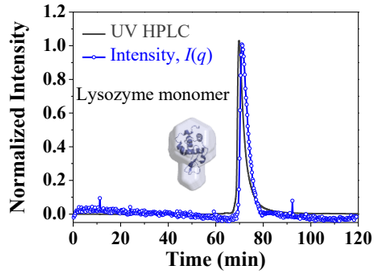
◆ Automated Sample Exchanger Robot

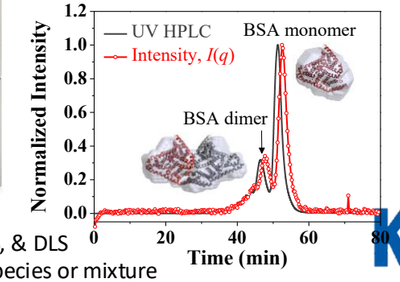
ARINAX BioSAXS

High-throughput experiments:
~ 50 samples / 1 hour

Performances	
Solution transfer volume	5 to 200 uL
Typical cycle time - loading/unloading - cleaning (wash, rinse, dry)	50 s 15 s / 15 s 20 s
Controls	
Sample exposure modes	Static Flow (0.05 to 20 uL/s)
Temperature	Exposure (2 ~ 60 °C) Storage (4 ~ 40 °C)
Dimension (W x H x D)	
Main unit (robot)	550 x 800 x 1100 mm^3

◆ Size-Exclusion Chromatography (SEC)-SAXS





- Continuous-flow in-line sample purification

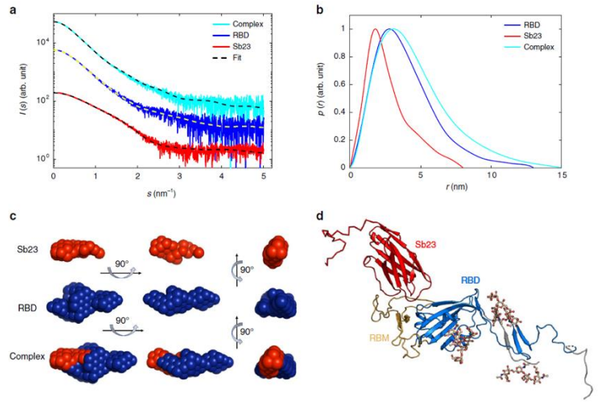
In-line purification of solution

- Agilent infinity 1260 system, RI, UV, MALS, & DLS
- Separation and Analysis of polydisperse species or mixture

2. BioPharma-BioSAXS

Beamline Applications

Conformational Ensembles of Flexible Protein

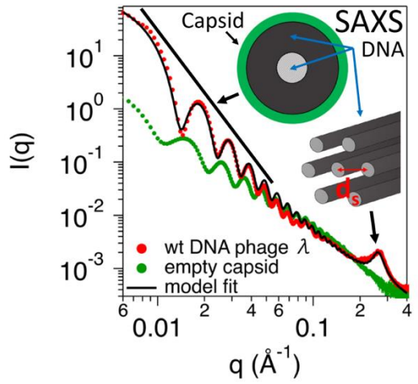


Nature Communications 11, 5588 (2020)

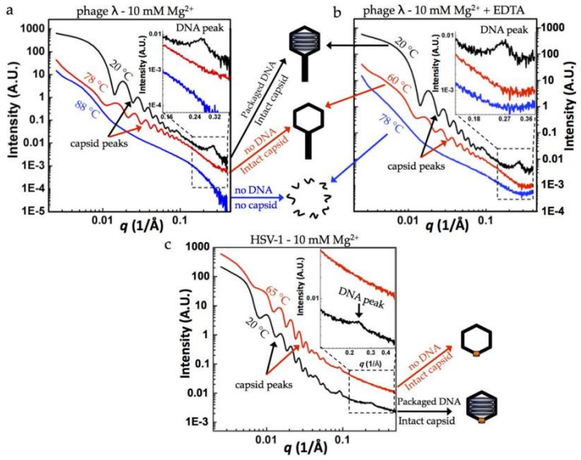
Table 1 Data collection and structure statistics for SAXS analysis.

Data collection parameters	Sb23	RBD	Sb23+RBD
Data collection parameters			
Instrument	EMBL P12 (PETRA III, DESY, Hamburg)		
Beam geometry (mm²)	0.2 × 0.12		
Wavelength (nm)	0.124		
s range (nm⁻¹)	0.03–5.0		
Exposure time (s)	4 (20 × 0.2 s)		
Temperature (K)	293		
Concentration range (mg ml⁻¹)	0.37–4.0		
Structural parameters			
R_g (nm) (from $P(r)$)	2.2 ± 0.1	3.2 ± 0.2	3.7 ± 0.2
R_g (nm) (from Guinier plot)	2.1 ± 0.1	3.1 ± 0.2	3.5 ± 0.2
D_{max} (nm)	8.0 ± 0.5	13 ± 1	15 ± 1
Porod volume estimate, V_p (nm³)	20 ± 2	66 ± 2	86 ± 5
Molecular weight determination (kDa)			
From Porod volume (V_p/~1.6)	13 ± 1	37 ± 5	54 ± 3
From consensus Bayesian assessment	15 ± 3	41 ± 1	53 ± 6
From $I(0)$	21 ± 2	33 ± 9	62 ± 9
Calculated monomeric MW from sequence	15.7	32.2	47.9
Software employed			
Primary data reduction	SASFLOW	SASFLOW	SASFLOW
Data processing	PRIMUS	PRIMUS	PRIMUS
Rigid body modeling	CORAL	CORAL	SASREF
Computation of model intensities	CRYSOL	CRYSOL	CRYSOL
3D graphics representations	PYMOL	PYMOL	PYMOL

DNA & Capsid structure



PNAS 120, e2220518120 (2023)



Journal of Virology 89, 9288-9298 (2015)

Industrial application

Therapeutic Antibody

ex) **Tracking structure of antibody molecules in solution**

Company: Boehringer
Facility: ESRF
Sample: Antibody molecule in solution

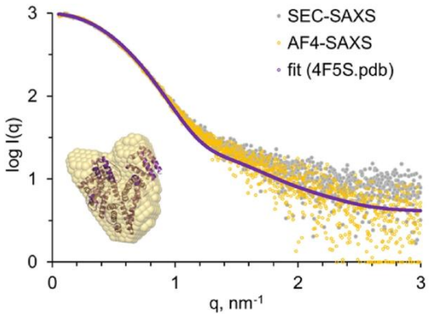
Other cases

Antibody type (Company) – Beamline, year

1. IgG1 mAb (Genetech) - SSRL BL4-2, 2024
2. Pembrolizumab (Merch & Co.) – Diamond B21, 2024
3. TrYbe (UCB Pharma) – ESRF BM29, 2023
4. IgG1 mAb2 (Eli Lilly x UT Austin) – CHESS ID7A, 2023

⋮

mRNA-LNP



Sci Rep 13 15764 (Sep 2023)

Quantitative size-resolved characterization of mRNA nanoparticles

Company: BioNTech SE
Facility: PETRA III - P12
Sample: mRNA-LPX (clinical cancer vaccine candidate)

Other cases

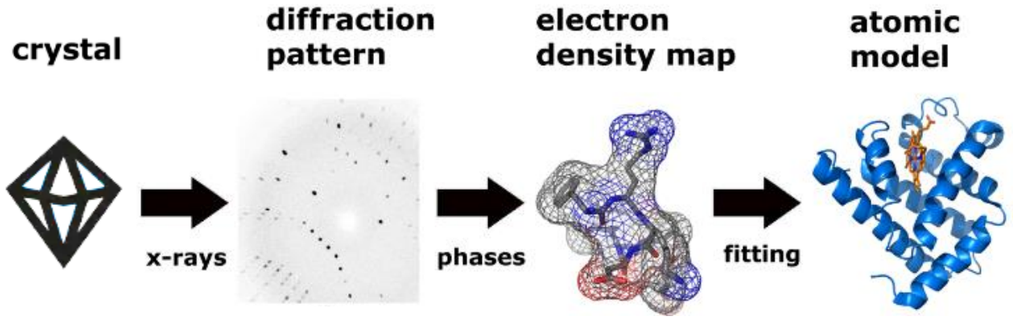
Sample type (Company) – Beamline, year

1. IMP-1 saRNA vaccine (CPI) – Diamond B21, 2023
2. ASO loaded LNP library (Genetech/Roche)– ALS 12.3.1, 2023
3. mRNA-LNP (AstraZeneca)– MAX IV SAXS, 2024
4. Moderna bivalent vaccine (Moderna) – NSLS-II I22, 2024

⋮

3. Bio Nano crystallography

Macromolecular crystallography (MX)



The atomic resolution structure of the biomacromolecules

Protein DNA/RNA Complex

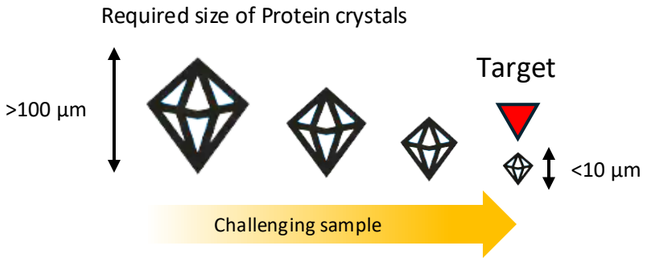
Users

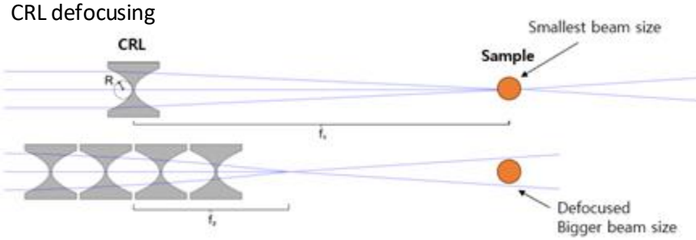
Academia
Protein structure and function

Industry
Structure based drug discovery (SBDD)

Design Summary

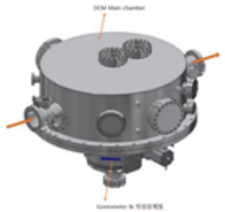
1. Micro-focusing beam
2. High flux





3. Rapid beam resizing

4. Stability



Horizontally bounced Monochromator

5. Pulsed beam

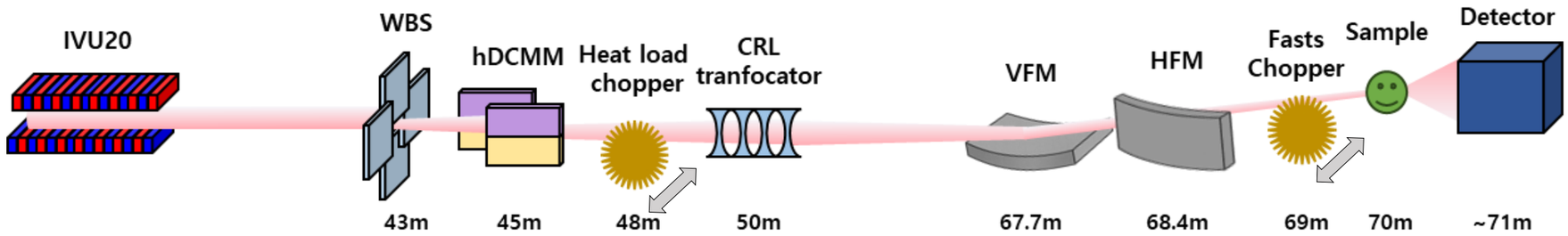
Beam chopper

6. High-throughput

Sample exchange robot system

3. Bio Nano crystallography

Beamline Layout



Specification

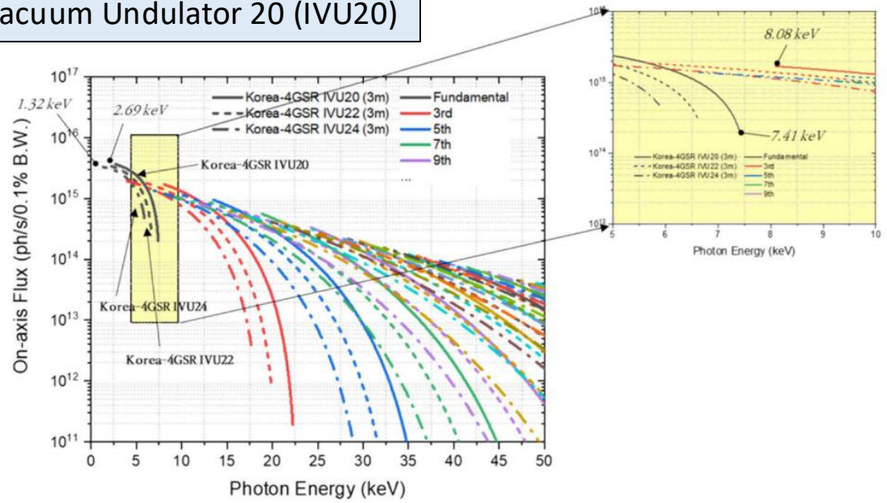
Beamline	ID22 BioNX
Light source	IVU20 (3 m)
Photon energy (keV)	8 – 25 (12.4, 20 keV mainly)
Wavelength (Å)	0.5~1.55
Energy resolution (ΔE/E)	< 2 x 10^{-4} (DCM), ~1% (DMM)
Beam size at sample (μm²)	1x1 ~ 50x50 @ 12.4 keV 1x1 ~ 5x5 @ 20 keV
Photon flux (ph/s)	>10^{14}
Techniques	RSX, SSX, ISX, HTS* MX
Measurement speed	>100 Hz
Processing capacity	600 crystals/day
Auxiliary Facilities	On-site sample preparation laboratory

Beamline Science

1. **Micro-crystallography**
2. **Room-temperature crystallography**
3. **Automated high-throughput screening for drug discovery**

3. Bio Nano crystallography

In Vacuum Undulator 20 (IVU20)

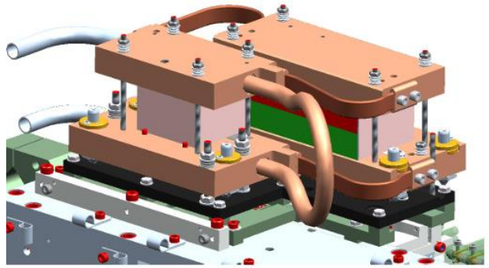


IVU Type	IVU20	IVU22	IVU24
On-Axis Flux	Best	90% of IVU20's between 10-30 keV	80% of IVU20's between 10-25 keV
Coherent Flux	Best	80% of IVU20's between 10-30 keV	60% of IVU20's beween 10-30 keV
Spectral Continuity	Missing/compromised between 7.41 keV and 8.08 keV	Perfect at gap size <5.58 mm	Perfect at gap size <6.46 mm
Heat Load on Beamline by Off-Axis Radiation	Best: 12 kW at the minimum gap size	15 kW at the minimum gap size	17 kW at the minimum gap size

Ha, *et al.*, JKPS (2024)

- ✓ **High flux**
- ✓ **Low heat load**
- ✓ **Missing 7.41 keV and 8.08 keV (limited the usage of this range) (Cobalt (7.7 keV) energy scan range)**

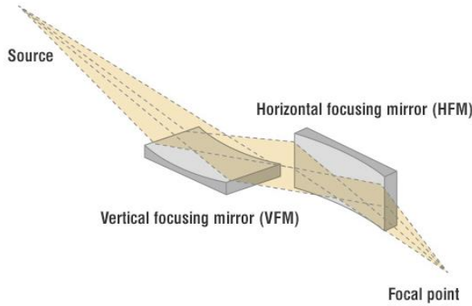
Optics Features



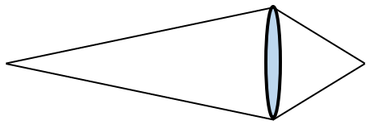
Combined horizontal DCMM
Si(111) crystal
Ru/B4C multilayer

Compound refractive lens (CRL)
Diamond lens (large aperture)

Beam chopper
Titanium disk
~230 Hz, ~90 us pulsed beam



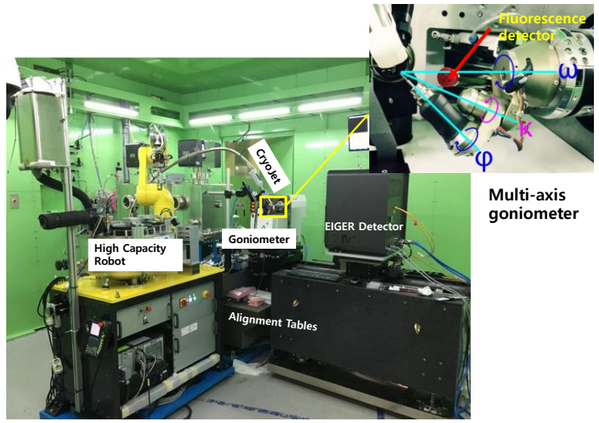
Elliptical mirrors
Si/Rh/Pt coating



One stage direct focusing
full beam
Simplifying optics
Improved manageability

3. Bio Nano crystallography

End-Station



Multi-axis goniometer

Layout

High precision diffractometer

- Sphere of confusion: 100 nm
- Raster scan at 15 mm/s
- Rotation speed: 720 deg/s
- Easy to change various goniometer heads

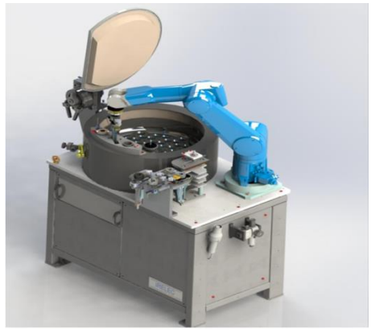
Silicon drift X-ray detector

- X-ray fluorescence
- Element scan

EIGER2 XE 16M

- Frame rate: 560 Hz (16 bit), 700 Hz (8 bit)
- Active area: 311 x 328 mm2
- Energy range: 6-40 keV

High-Capacity Sample Exchange Robot



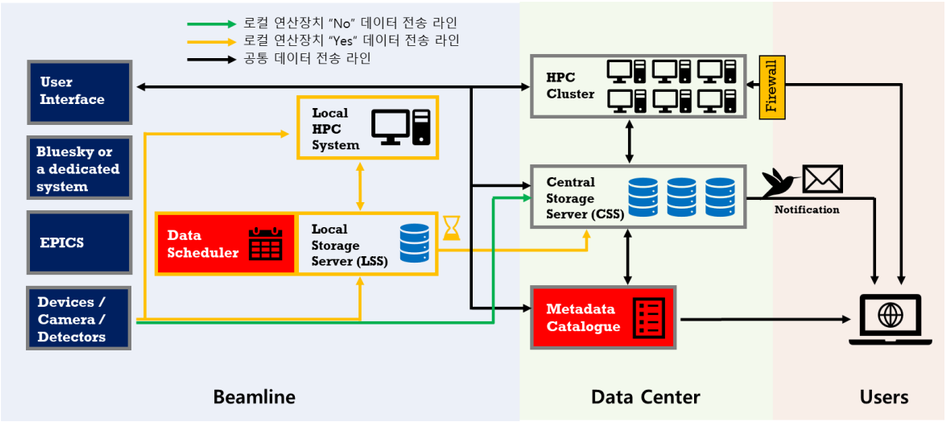
592 sample/storage chamber
~600 sample/day

DAQ

Data acquisition/management

Web-based User Interface (WUI)
Remote access

Computing infrastructure



- **Local HPC system and data center**

3. Bio Nano crystallography

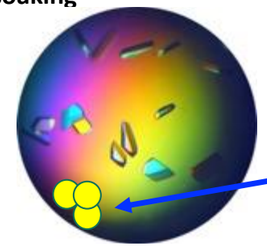
Sample Preparation Laboratory

~ fragment library
on ECHO plates
(ex. 1200 fragments)

Precise, Accurate, and Efficient Liquid transfer using sound

~ Soaking fragments into crystal drops on plate
~ 30 sec for 100 fragments (one crystallization plate)
~ singleton soaking

~ Crystallization Plates
(ex. 1200 crystal drops)



~ 2 µL

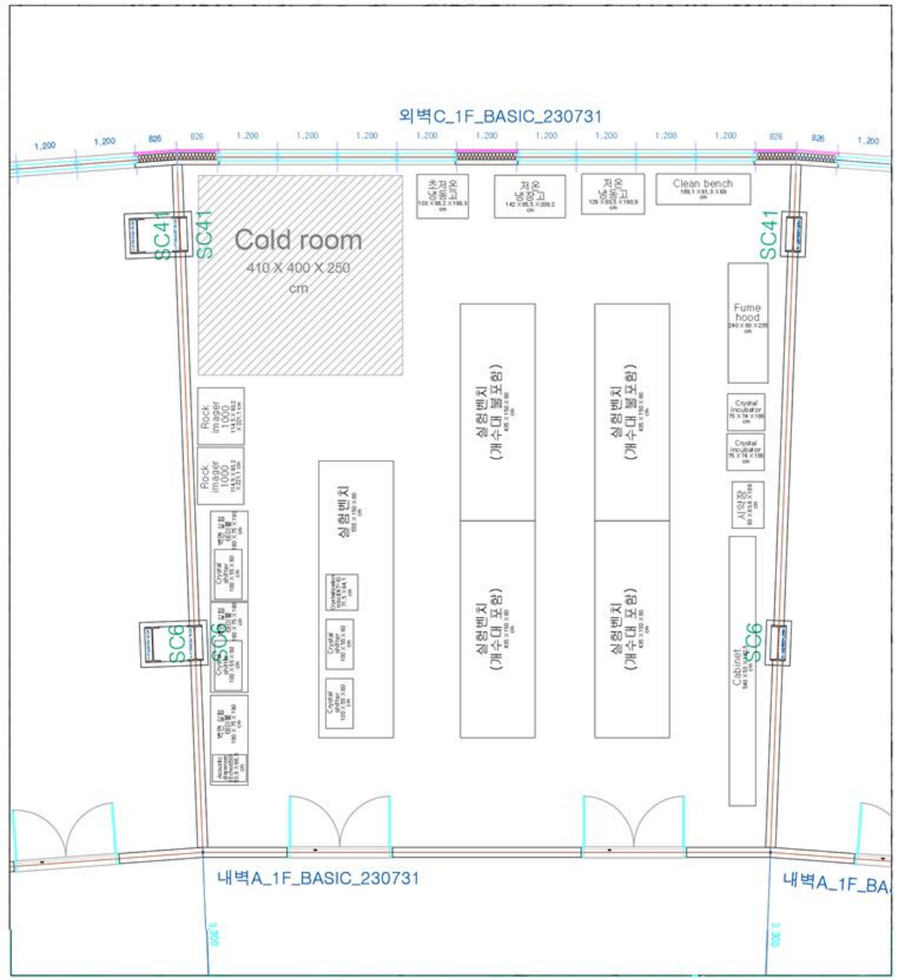
Shooting fragment solution
(~ 100 nL)

Crystallization robot

Crystal imaging system

- **Facility for sample preparation of FBDD experiment**
- **Support drug discovery experiment**

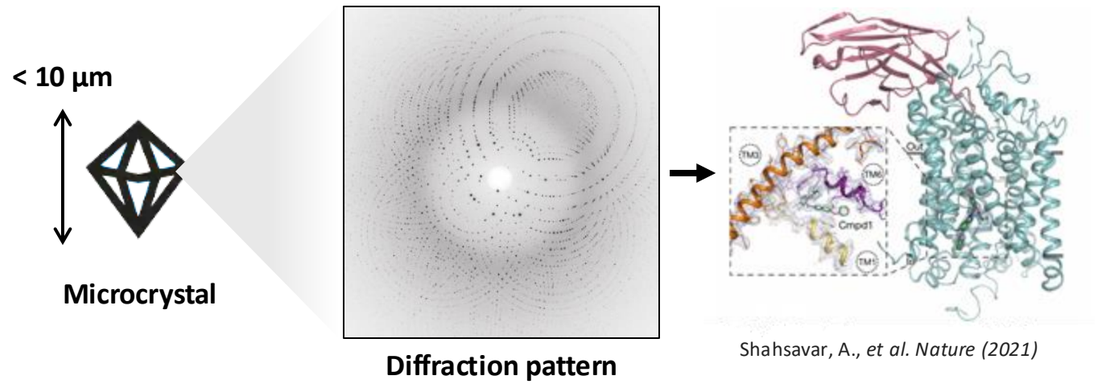
Floor plan of sample preparation laboratory



3. Bio Nano crystallography

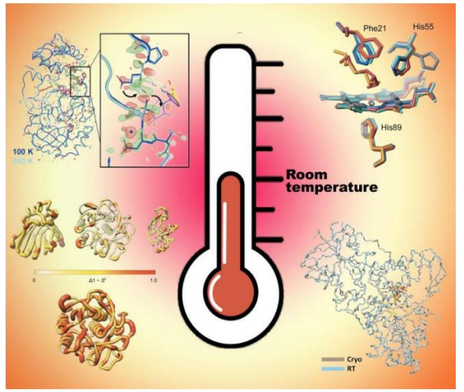
Beamline Applications

High-quality data from microcrystal



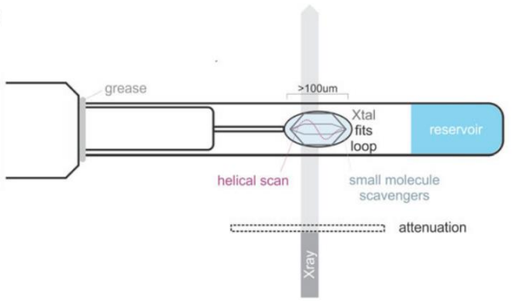
Shahsavar, A., *et al. Nature (2021)*

Room-temperature crystallography



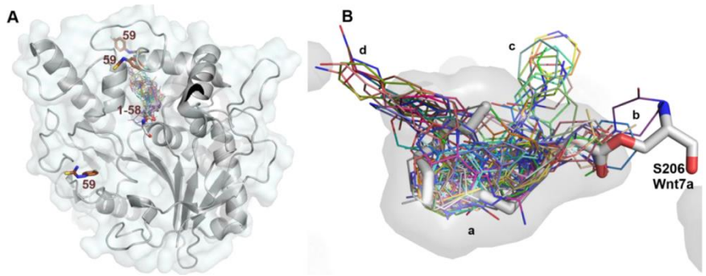
Steiner, R. A., *Struct. Biol*. (2023)

Data collection using capillary tool



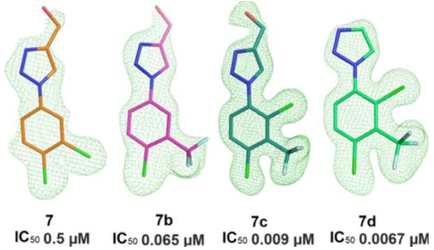
Fischer, M., *Quarterly Reviews of Biophysics* (2021)

Drug discovery



Merged structures of the bound fragments in the enzymatic pocket

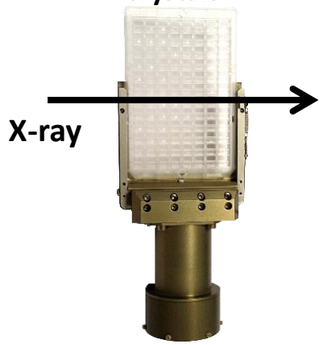
Optimization



Zhao, Y., *et al. ACS Chem. Neuro. (2022)*

Quick screening of initial crystal

Initial screened crystals



Diffraction or not?

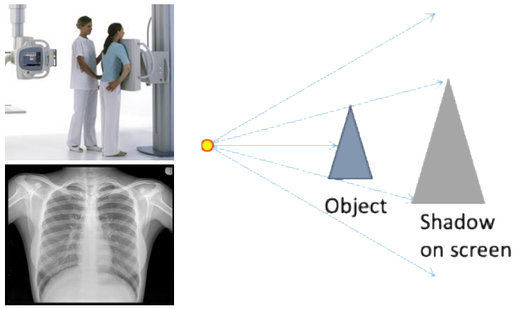
4. High Energy Microscopy

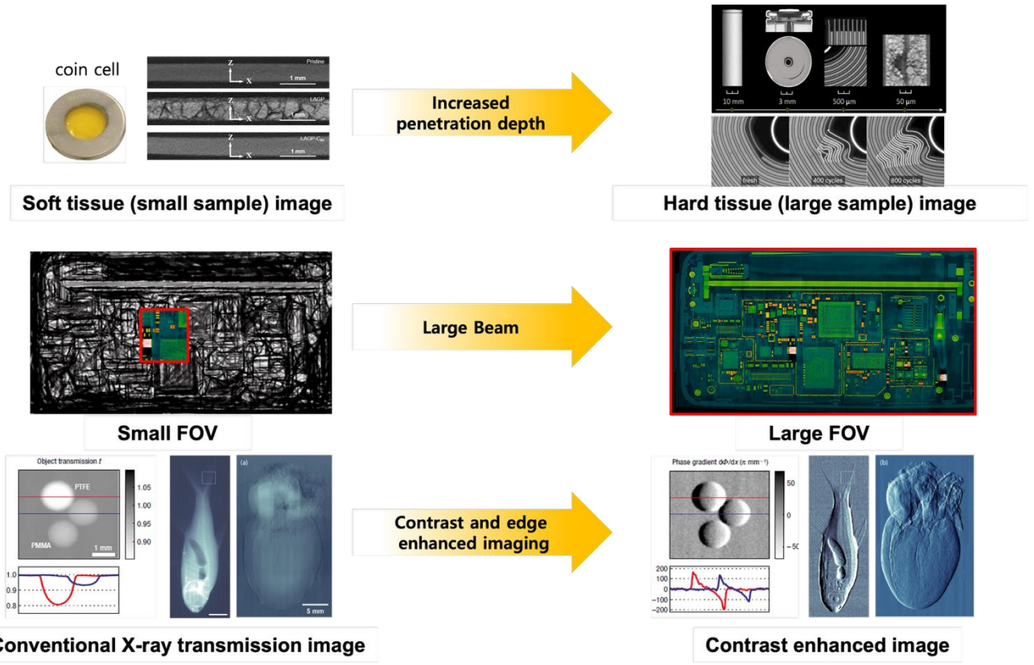
Projection imaging

Synchrotron source

- High photon flux
  - ➢ Fast scan
  - ➢ In situ/operando imaging studies
- High resolution imaging

Conventional projection image

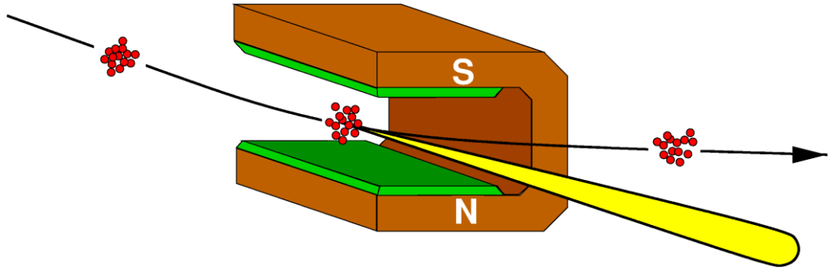




Design Summary

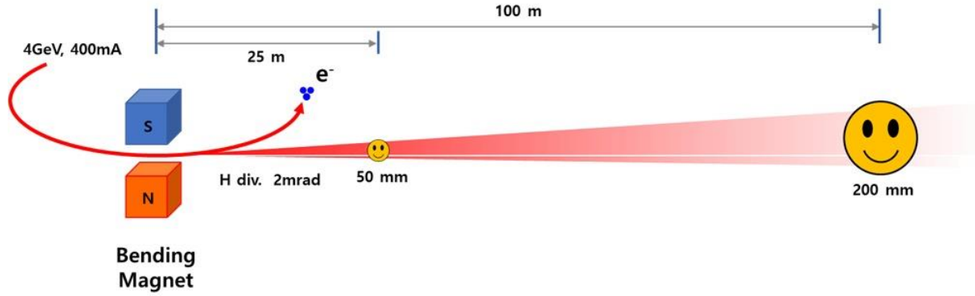
1. High energy beam

Light source:
Bending magnet



2. Large beam

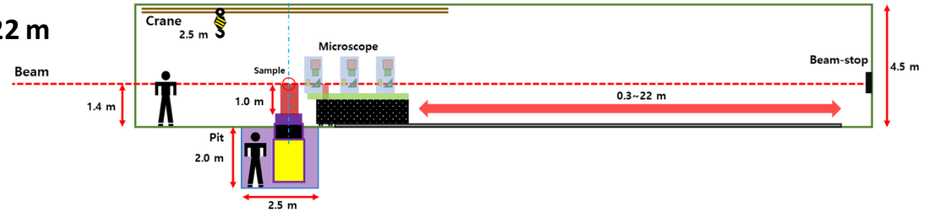
Long beamline: 123 m



3. Phase contrast effect

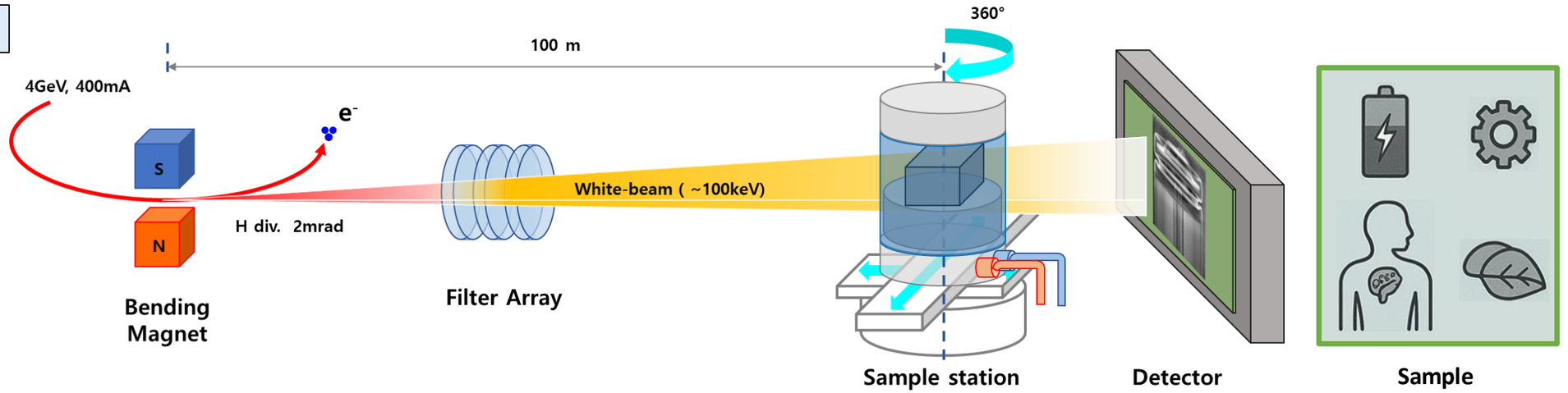
End-station design

SDD: 0.3~22 m



4. High Energy Microscopy

Beamline Layout



Specification

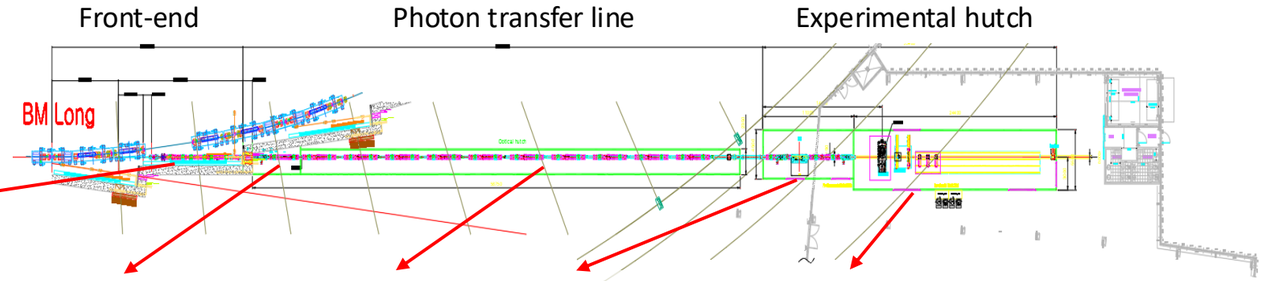
Beamline	BM10 HEM
Light Source	Bending Magnet (2T)
Photon energy	20 ~ 150 keV (E_c:21.2 keV)
Beam size (FWHM)	200 mm x 25 mm @ 100 m
SDD	< 22 m
Spatial resolution	> 1.0 um
Technique	Projection imaging
Sample space	a few m (100 kg)

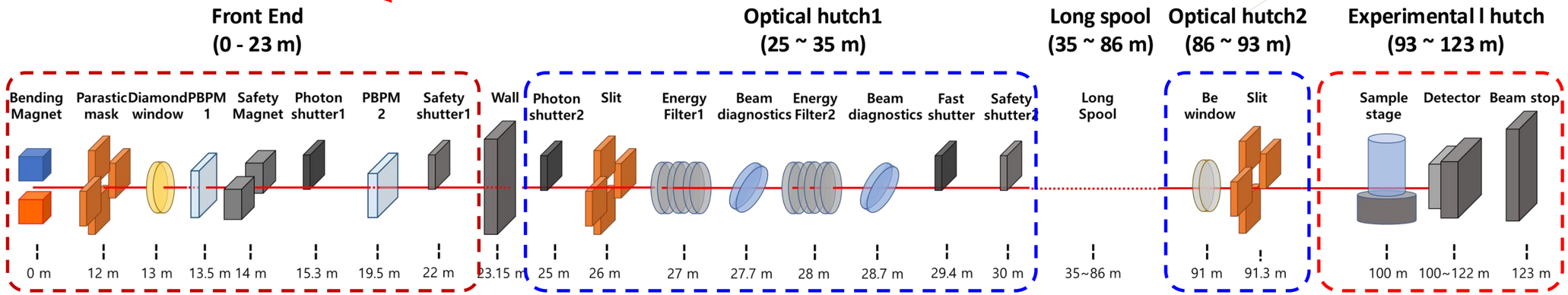
Beamline Science

- **High-energy beam: Energy & Materials applications**
- **Large beam size: Industrial applications**
- **Phase contrast effect: Bio-medical imaging**

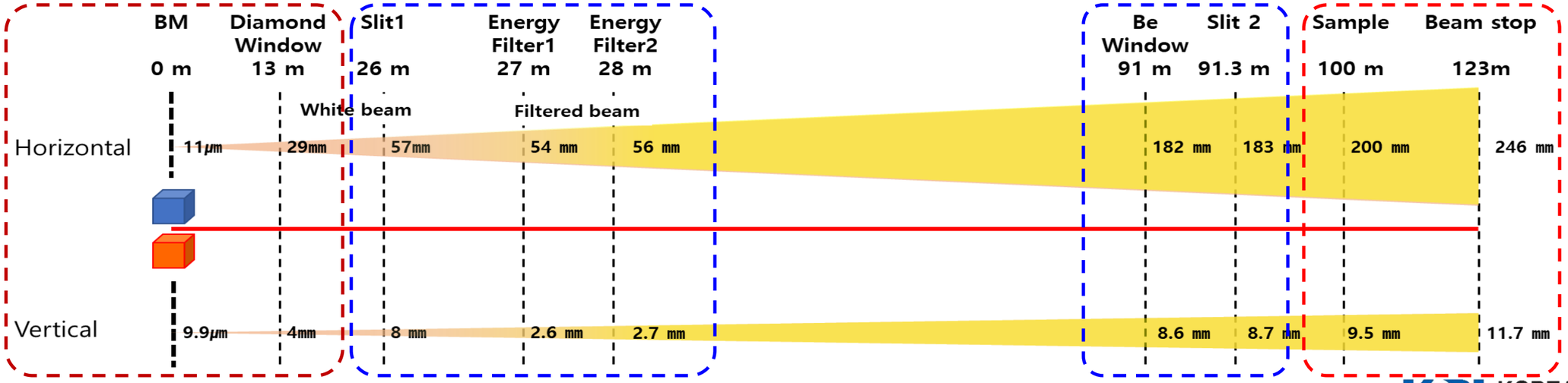
4. High Energy Microscopy

Beamline Layout



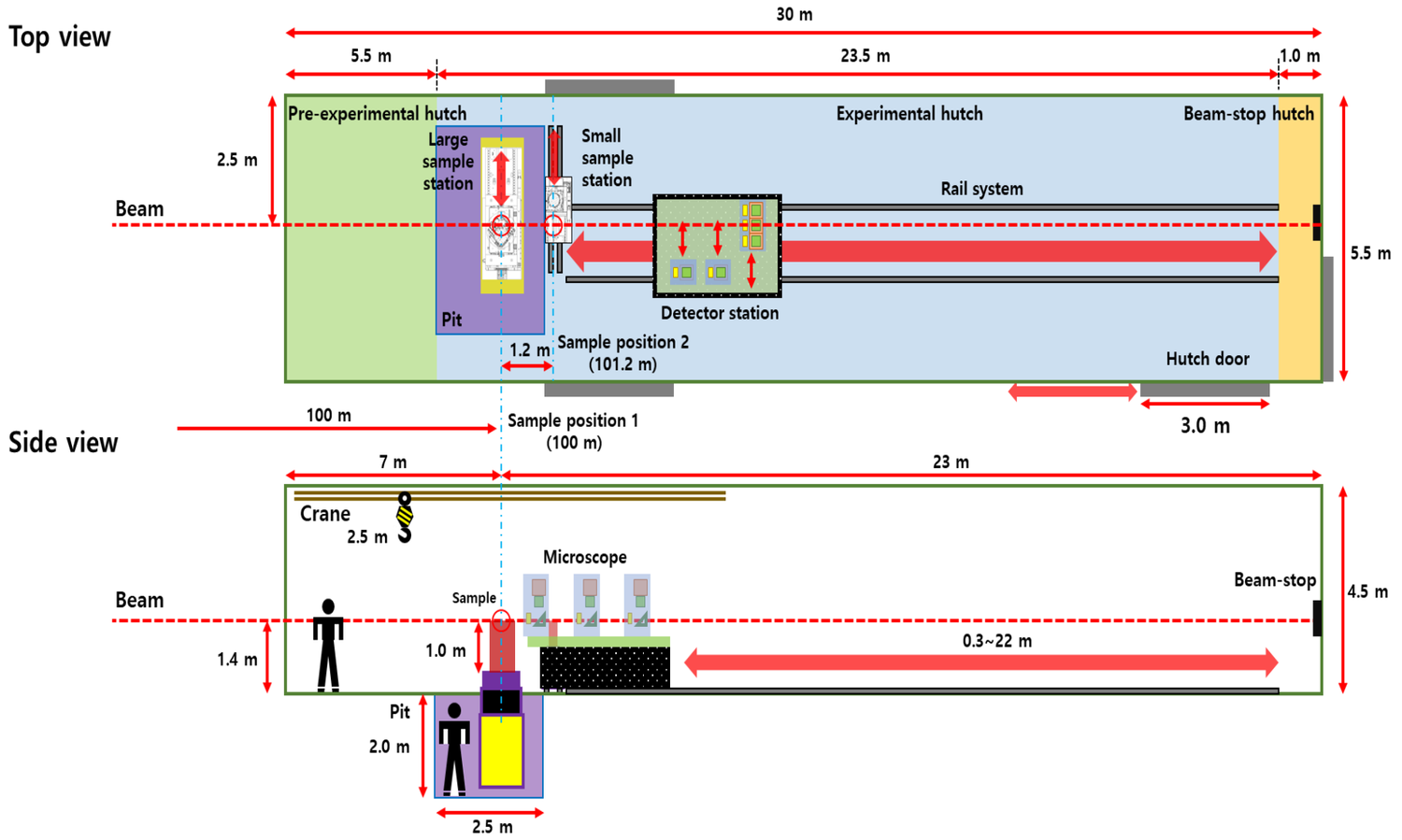


(Filtered polychromatic beam @ 80 keV)

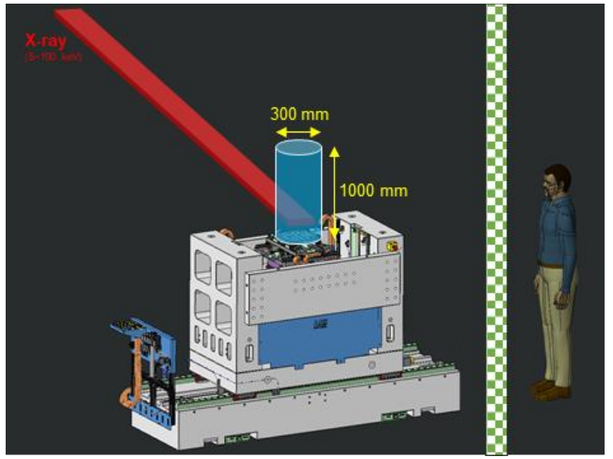


4. High Energy Microscopy

End-Station



➢ **Large sample station**



➢ **Large sample stage Specifications**

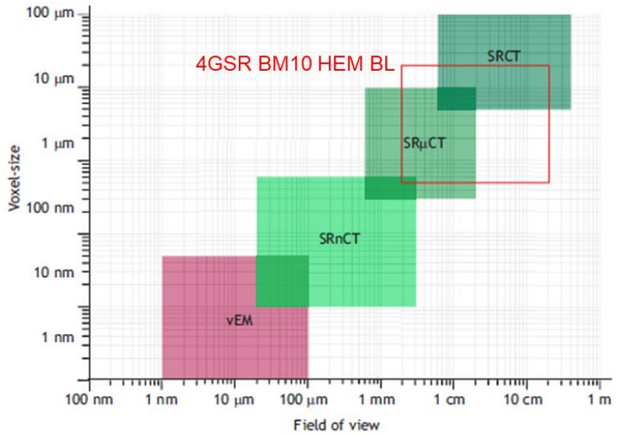
Data	Dimension
Sample weight	100 kg
Sample dimensions	H=1.0 m, D=0.3 m
Rotation stage	RT500S
Angular accuracy	< 2 arcsec
Max. speed	60 rpm

4. High Energy Microscopy

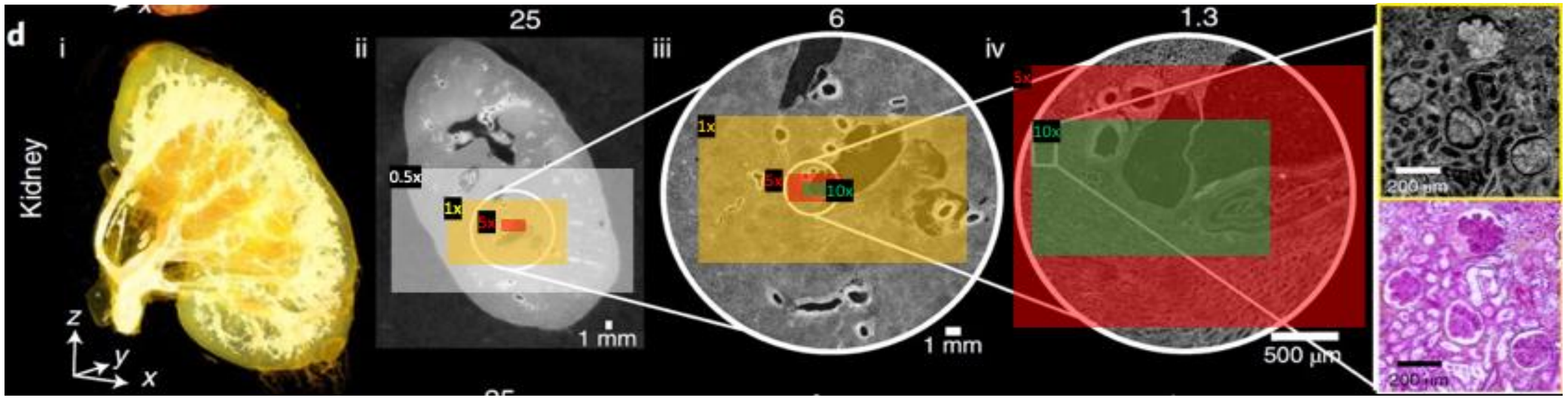
Multiple scale CT scan (Establishing a strategy of the collection of Large FOV image and Mass Data Process)

➢ **Image specification (4GSR BM10)**

X-ray microscope	Array detector	Single detector			
Field of View	200 x 25 mm^2	38 x 21 mm^2	19 x 11 mm^2	3.8 x 2.1 mm^2	1.9 x 1.1 mm^2
Magnification	0.25x	0.5x	1x	5x	10x
Pixel size	20 µm	9.2 µm	4.6 µm	0.92 µm	0.46 µm
Pixel number	26 million	9 million			
Data size	**52 MB/image**	**18 MB/image**			
3D data size	**205 GB/set**	**25 GB/set**			



Multiscale Phase-Contrast Tomography (ESRF-EBS BM18)

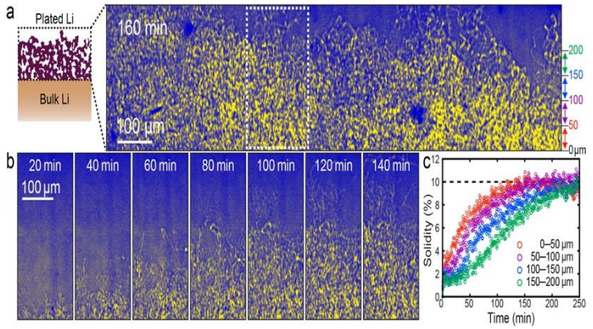


Walsh, C. L., et al. (2021). *Nature methods*, *18*(12), 1532-1541. Images taken at BM05, a predecessor beamline, at 60-80 keV

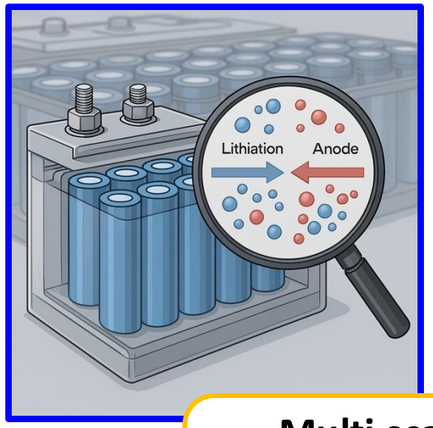
4. High Energy Microscopy

Beamline Applications

Energy Material Science

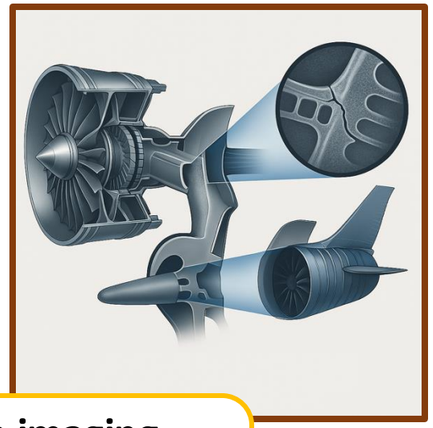


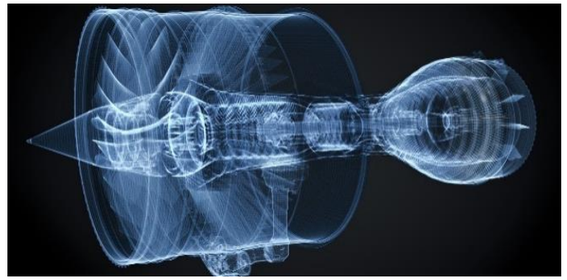
Seung-Ho Yu et al., *J. Am. Chem. Soc.* 41(21) 8441 (2019)



real-time observation of internal structural changes of batteries

Industrial Applications



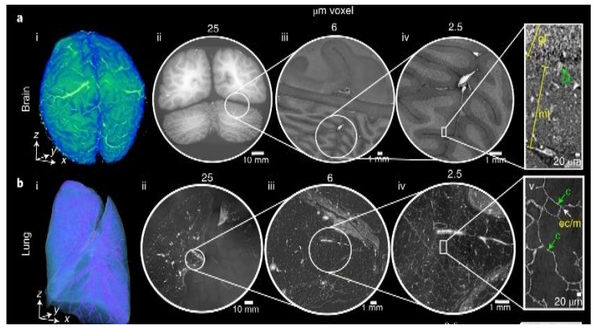


Dragoljub Vujić, Scientific-Technical Review,vol.LIII,no.2,(2003)

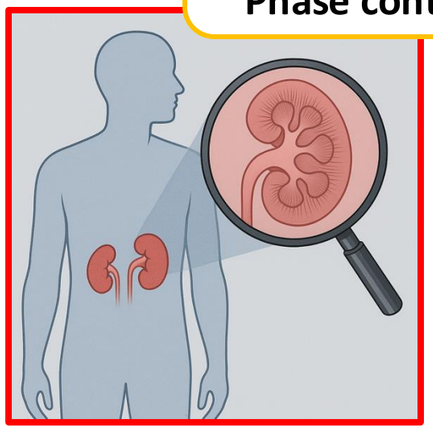
non-destructive inspection of internal defects in metal and composite components.

Multi scale imaging
In-situ X-ray imaging
Phase contrast imaging

Life Science

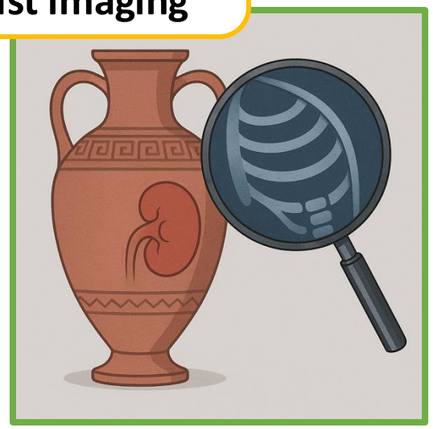


Walsh, C. L., et al. (2021). Nature methods, *18*(12), 1532-1541.



Visualizes fine biological structures with high-resolution phase-contrast imaging.

Cultural Heritage



불상 속 비밀, 관음보살좌상 (2019) 국립중앙 박물관

Reveals internal structures of cultural artifacts non-destructively for conservation and restoration.

Summary

	BioSAXS	BioNX	HEM
Photon Source	IVU24	IVU20	BM (2T)
Energy Range (mainly)	8 ~ 23 keV (12)	8 ~ 25 keV (12.4 and 20)	20 ~ 150 keV
Beam Flux (ph/s)	> 5×10^{12}	> 1×10^{14}	~ 1×10^{13}
Beam Size (μm²) (H × V, FWHM)	• Partially Focused: ~ 200 × 200 • Focused: ~ 40 × 10	• 12.4 keV: 1 × 1 ~ 50 × 50 • 20 keV: 1 × 1 ~ 5 × 5	• 100m: 200 × 25 mm^2
Spatial Resolution	8 ~ 3800 Å	0.5 ~ 1.55 Å	> 1.0 μm
Sample	Biomacromolecules in solution	Biomacromolecules as crystallized	Biological tissue, Battery, Electronic components, Developmental prototype, etc.
Technique	SAXS/WAXS, SEC-SAXS	RSX, SSX, ISX, HTS* MX	Projection Imaging

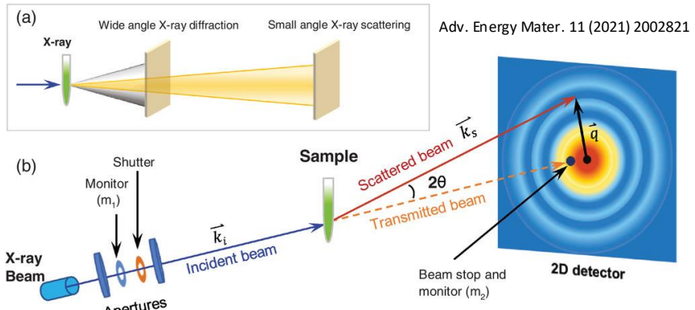
Thank You For Your Attention

ID21 BioPharma - Bio Small-Angle X-ray Scattering (SAXS)

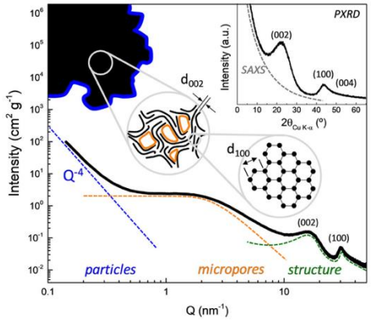
Priority to Industries

Study on 3D structural characteristics of biological molecule systems

Principle and application

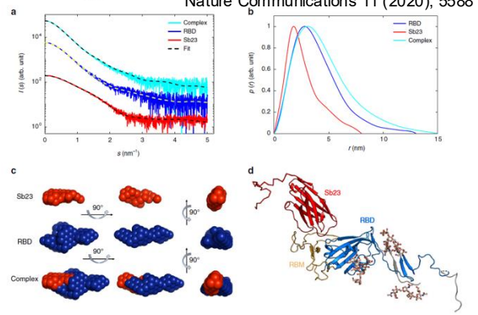


Adv. Energy Mater. 11 (2021) 2002821



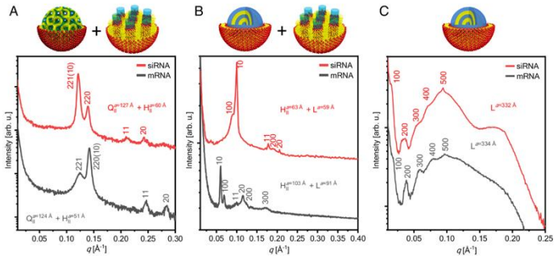
Energy Storage Mater. 21 (2019) 162–173

Nature Communications 11 (2020), 5588



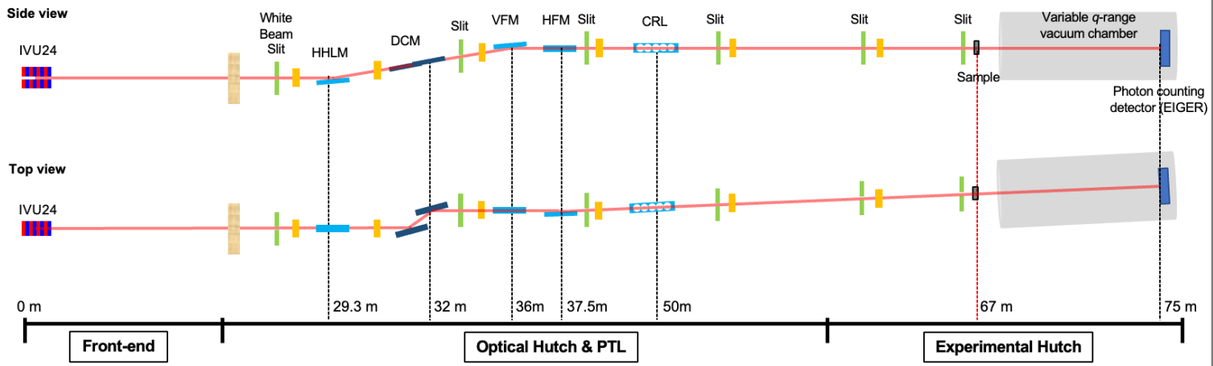
Analysis of protein and protein complex structures

PNAS 120 (2023), e2301067120



Study on Stabilization of Drug Delivery Systems

Beamline layout



Specification

Photon Source	In Vacuum Undulator 24
Energy Range	8 ~ 23 keV
Energy resolution	< 2 x 10^{-4}
Beam flux (ph/s)	~ 5 × 10^{12}
Beam size (μm²) H × V, FWHM	< 200 x 200 (partially focused mode) ~ 40 × 10 (focused mode)
Spatial resolution	8 ~ 3800 Å

Feature of Beamline

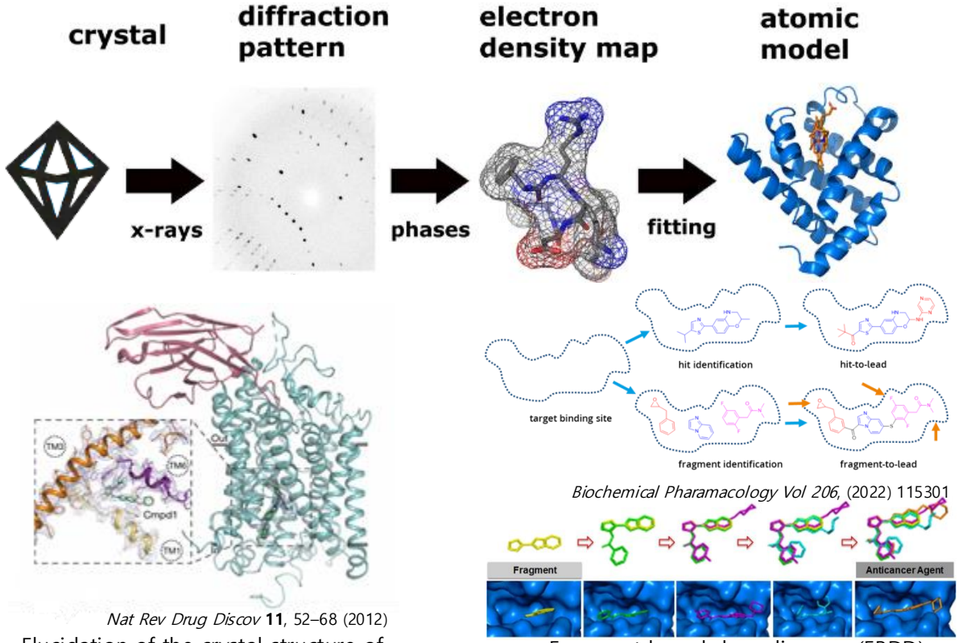
- Introduction of an automatic sample exchange robot to facilitate high-throughput experiments.
- Variable *q*-range vacuum chamber allows rapid adjustment of sample-to-detector distance within a range of 0.5 m to 8 m, enabling efficient analysis of various systems.
- Supporting various sample environments for the structural analysis of biological molecules.

ID22 Bio Nano crystallography (BioNX)

Public

High-throughput screening for rapid determination of protein-compound structures in drug discovery

Principle and application



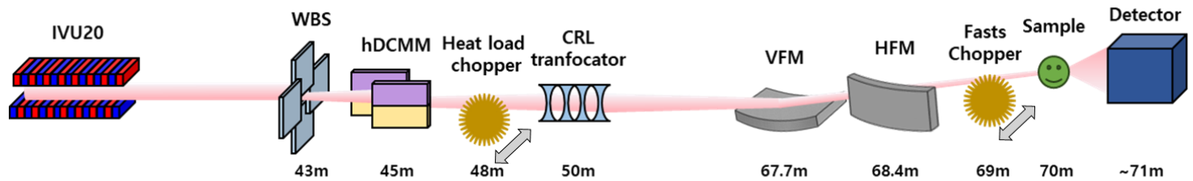
Nat Rev Drug Discov **11**, 52–68 (2012)

Elucidation of the crystal structure of membrane protein-compound complexes

Biochemical Pharamacology Vol 206, (2022) 115301

Fragment based drug discovery(FBDD)
& Structure-based drug discovery(SBDD)

Beamline layout



Specification

Photon Source	In Vacuum Undulator 20
Energy Range (mainly)	8 ~ 25 keV (12.4 and 20)
Energy resolution	< 2 x 10^{-4} (DCM), ~1% (DMM)
Beam flux (ph/s)	> 1 × 10^{14}
Beam size (μm²) **H × V, FWHM**	1x1 ~ 50x50 @ 12.4 keV 1x1 ~ 5x5 @ 20 keV
Spatial resolution	0.5 ~ 1.55 Å
Measurement frequency	> 100Hz

Feature of Beamline

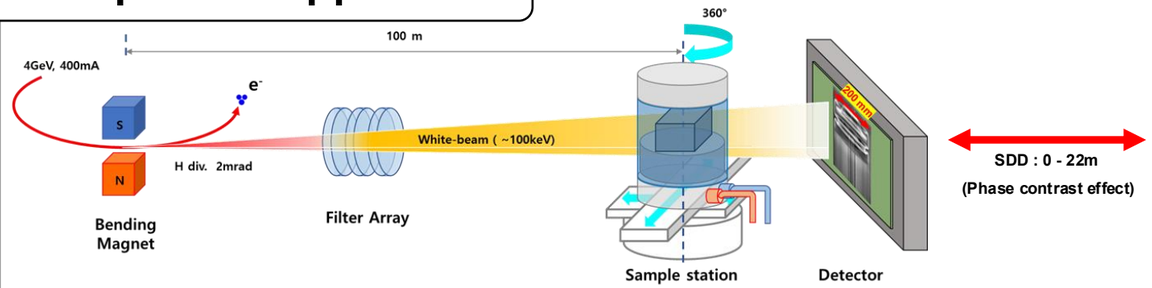
- Provide a minimum beam size of 1 micron and high beam flux, supporting serial and in-situ crystallography experiments. This enhances accessibility to challenging protein crystal samples.
- Supports high-throughput experiments with the introduction of the an automated sample exchange robot.
- Operates a sample preparation laboratory to support drug discovery research, such as fragment library screening

BM10 High Energy Microscopy

Public

High-quality multiscale 3D image analysis using phase contrast effects

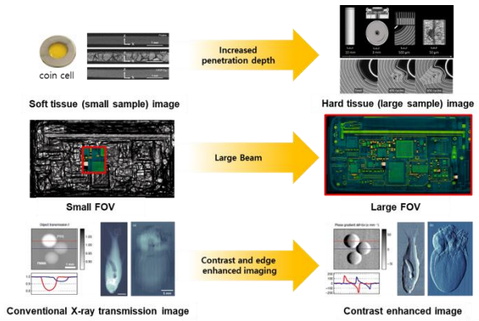
Principle and application



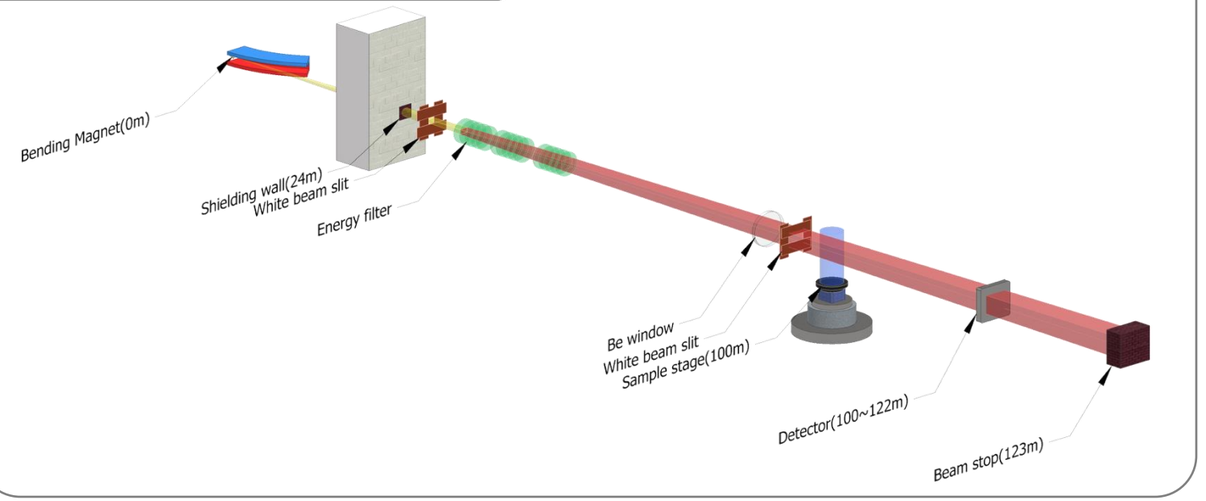
- High-energy beam
: Energy & Materials applications
(Increased penetration depth)

- Large beam size
: Industrial applications
(Large FOV, Fast scan time)

- Phase contrast effect
: Bio-medical imaging
(Contrast and edge enhanced imaging)



Beamline layout



Feature of Beamline

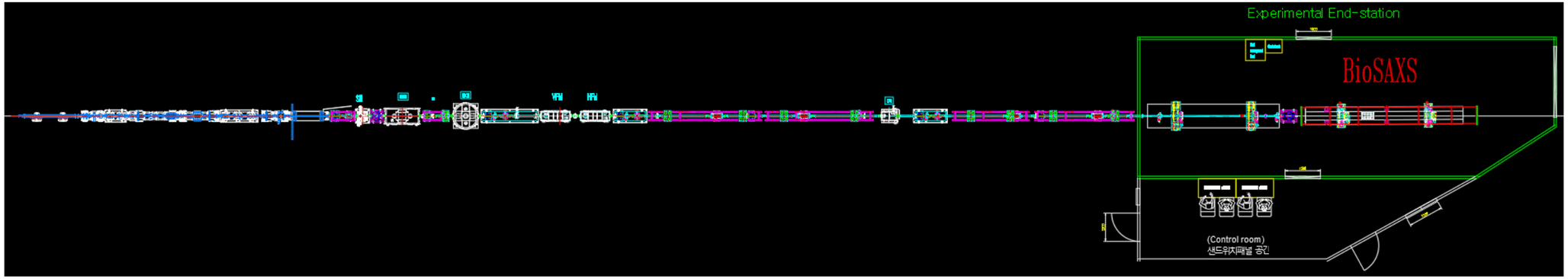
- The high energy microscope beamline is based on projection image utilizing high-energy X-ray beams above 100keV and a long beamline of over 100 meters.
- The bending magnet illuminates the sample at a distance of 100 m with a beam of 200 mm width and 25 mm height, and acquires a high quality projection image by phase contrast effect.
- Phase contrast imaging improves spatial resolution and contrast, allowing researchers to resolve finer structural details in three dimensional imaging and expand the range of observations in materials and biological specimens.

Specification

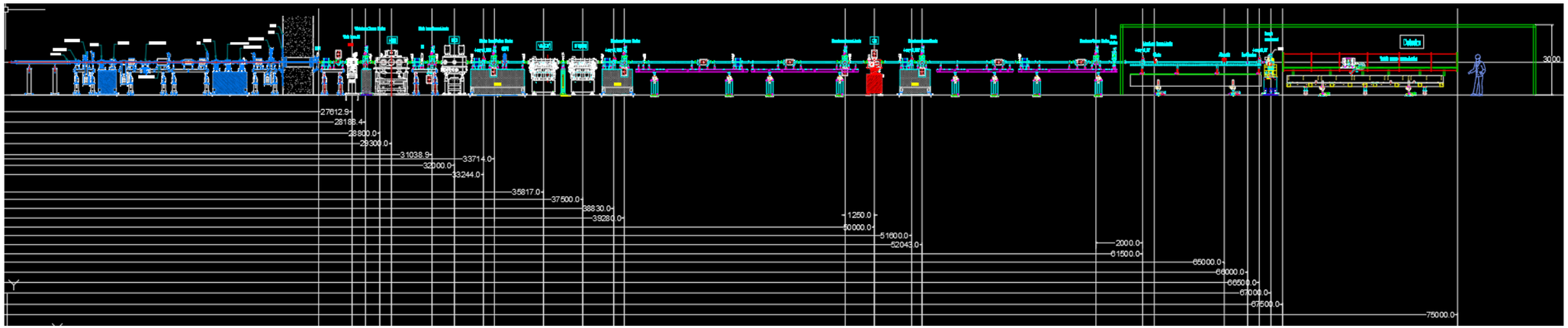
Photon Source	Bending Magnet (2 T)
Energy Range	20 ~ 150keV (E_c:21.2 keV)
Beam size (FWHM)	200mm x 25mm @ 100 m
Spatial resolution	> 1.0 um
Technique	Projection imaging
Sample dimensions	H=1.0 m, D=0.3 m (100 kg)

Design Drawing: BioSAXS

Top view

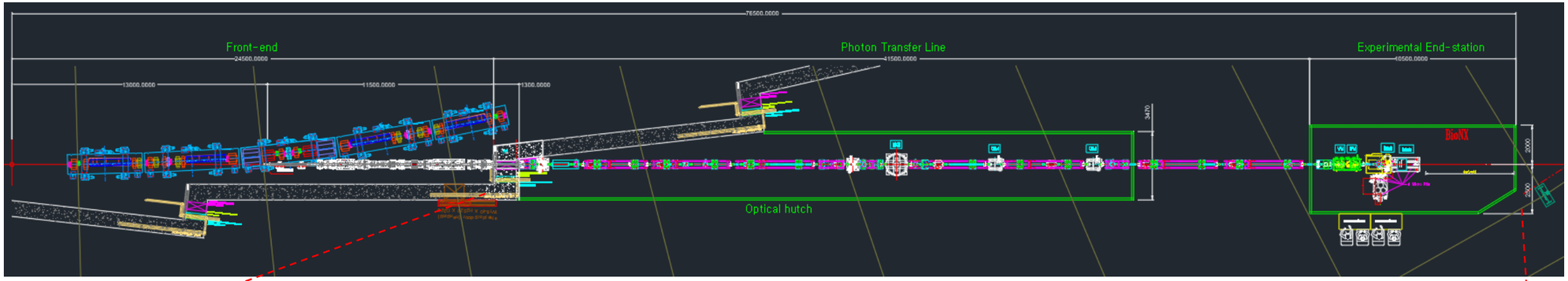


Side view



Design Drawing: BioNX

Top view

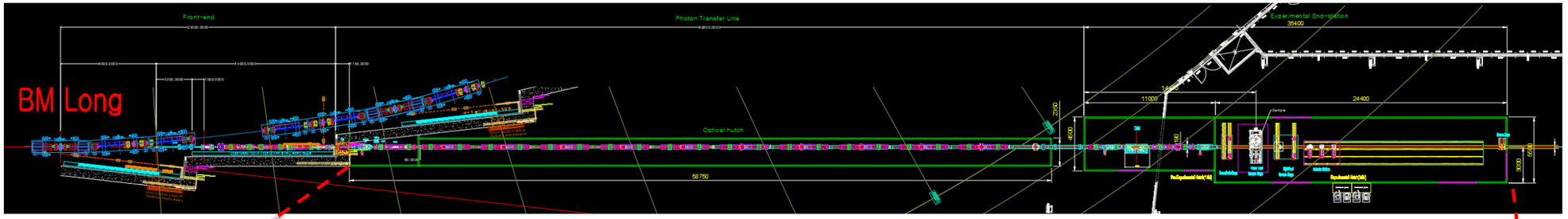


Side view

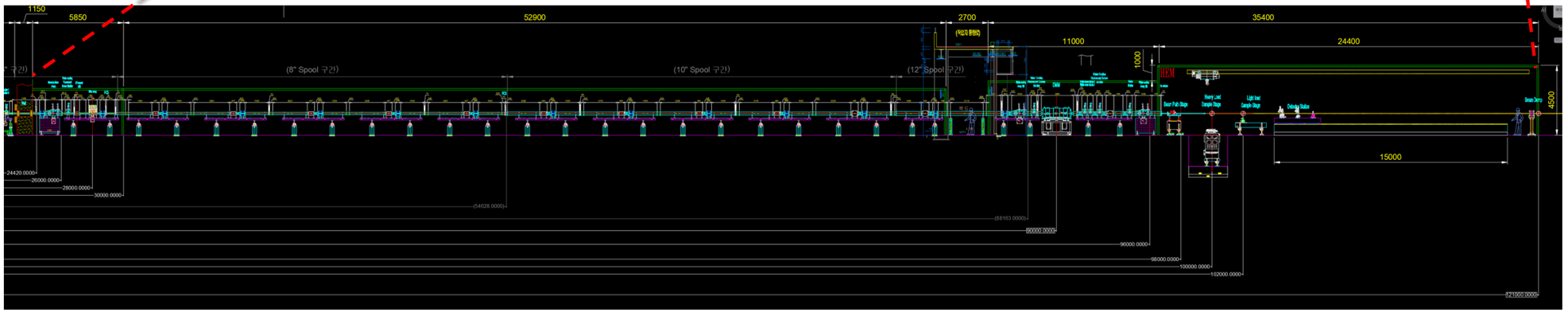
Optical hutch 31.1 m	Long spool 9 m	Experimental hutch 10.5 m

Design Drawing: HEM

Top view



Side view



Optical hutch1 10 m	Long spool 51 m	Optical hutch2 7 m	Experimental hutch 30 m