Introduction of the Service Evaluation Beamline in SILF,IASF

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Abstract

Beamline Service Evaluation is a designed high energy X-ray beamline of SILF for imaging, diffraction and scattering, which will operate at energies of 30-100 keV. This beamline is designed to be suitable for experiments, which utilize: high-energy X-rays, time-resolved in situ measurements, monochromatic or polychromatic ("white beam") X-rays imaging and diffraction techniques, including their combination during one experiment. This beamline is designed not only for academic research but also for industrial oriented experiments.

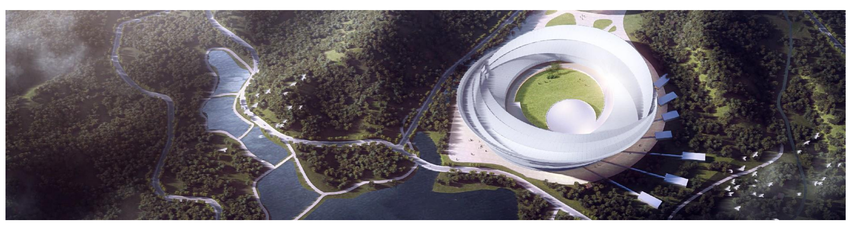
About IASF

Institute of Advanced Science Facilities, Shenzhen (IASF) is a multi-disciplinary research institute responsible for Shenzhen's large-scale science facilities' whole life cycle planning, construction, operation, and maintenance.

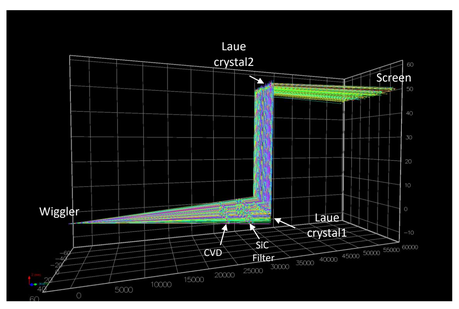
At the primary phase, There are two active infrastructure projects are being funded, and they are in the stage of designing and construction; one is the Shenzhen Innovation Light-source Facility (SILF), and the other one is the Shenzhen Superconducting Soft-X-ray Free Electron Laser (S^3FEL).

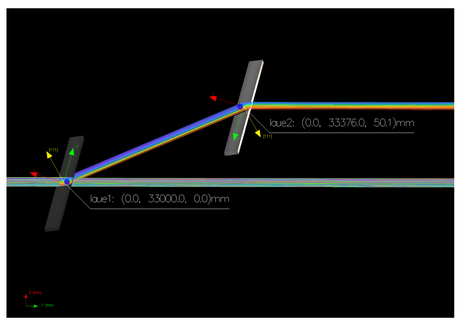
SILF is a diffraction-limited synchrotron radiation facility that has a fourth-generation diffraction-limited storage ring with an electron energy of 3 GeV at a low emittance of 50-150 pm·rad, and it provides photons with a broad range of energy from 4 meV to 160 keV.

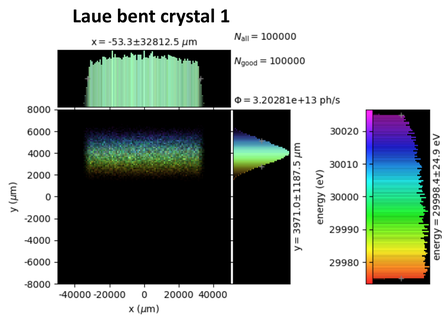
S^3FEL is a high repetition rate soft-X-ray super-conducting free-electron laser facility that consists of a 2.5 GeV CW superconducting linear accelerator and four initial undulator lines, which aims at generating X-Rays between 40 eV and 1 keV at rates up to 1MHz.

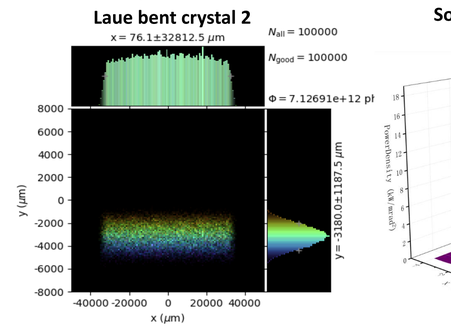


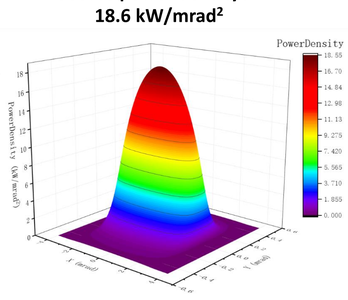
Beamline optics







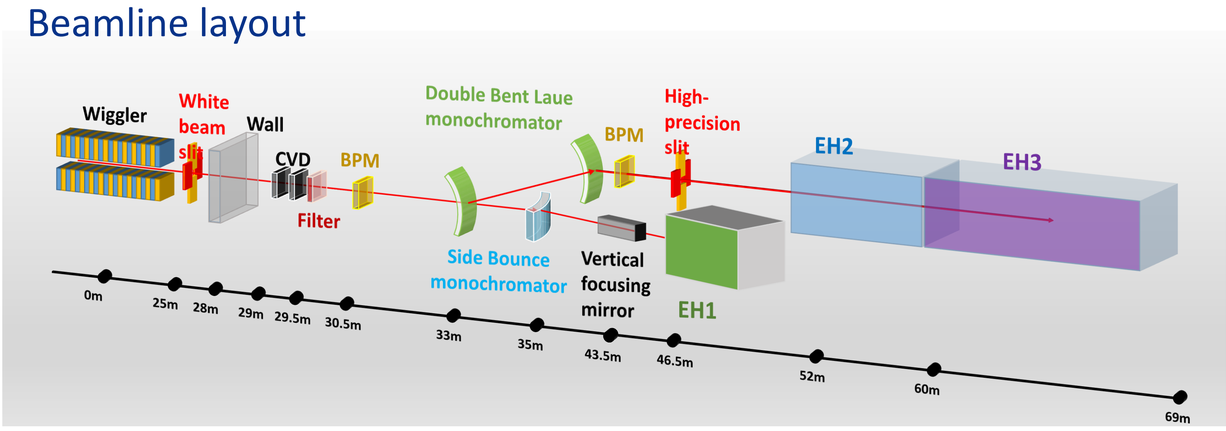




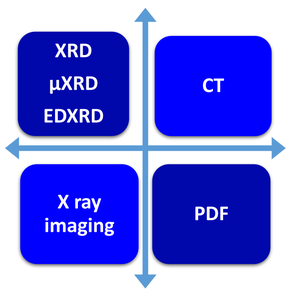
		transmission efficiency			
	Optics	**@30keV**	**@50keV**	**@70keV**	**@100keV**
25m	**White beam slit**	**100%**	**100%**	**100%**	**100%**
28.8m	**CVD**	**66.3%**	**74.0%**	**76.6%**	**78.8%**
29m	**SiC**	**50.7%**	**79.5%**	**86.3%**	**89.5%**
33m	**Laue Bent crystal 1 3mm**	**15.7%**	**34.8%**	**46.8%**	**53.7%**
33.376m	**Laue Bent crystal 2 3mm**	**22.2%**	**64.0%**	**86.1%**	**81.7%**
33.376m	**Energy Resolution**	**0.17%**	**0.26%**	**0.36%**	**0.51%**
Sample position	**Flux (ph/s)**	**7.12×10^{12}**	**2.62×10^{13}**	**1.29×10^{13}**	**1.45×10^{12}**
	Total efficiency	**1.2%**	**13%**	**26%**	**31%**

Beamline characteristics

Beamline layout



Techniques



Characteristics

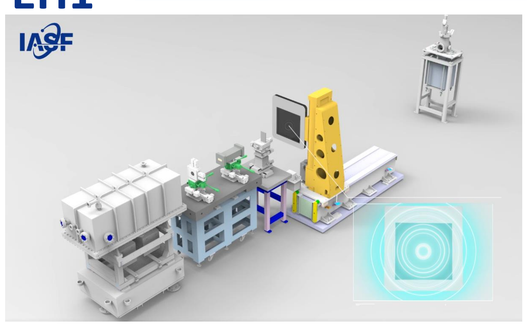
	Values
Energy range (keV)	30~100
Energy Resolution (ΔE/E)	5×10^{-3}@70keV@EH2
Photon flux (phs/s)	5×10^{12} @74.8keV@EH1 2×10^{12} @70keV@EH2 1×10^{12} @70keV@EH3
beam size (H × V)	≤0.25×0.1 mm² @EH1 ≥120×7.8 mm² @EH3

Experiment modes

	Beamtime estimation	Applied experiments	Samples
EH1 100 %	• PDF – 80 % • 3DXRD – 20 %	• PDF • Residual stress mesurement	• simple sample environment • single-test • low-quality powder, small size sample
EH2 20 %	• XRD- 20 %	• High through-put experiment • Corrosion • Creep	• multiple long-term measurements • medium size sample
EH3 80 %	• Xray imaging- 30 % • CT - 30 % • ED XRD– 20 %	• fatigue crack growth and failure • defect detection in materials and components • residual stress distribution	• large in-situ equipment • Customized rig • large size sample

Experimental hutches

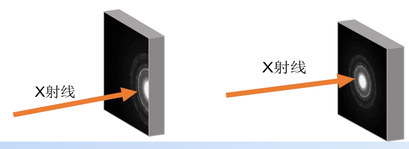
EH1



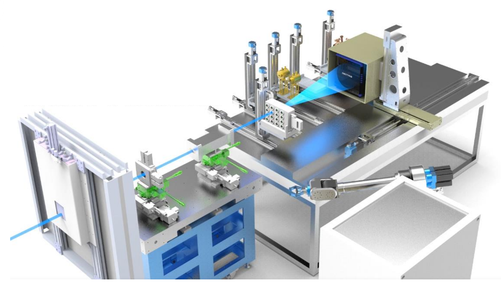
Cible tests： small size samples

Main techniques： PDF 、XRD、SAXS

Beam condition：
Monochromatic: 74.8keV
Focused size： 0.25×0.1 mm²



EH2



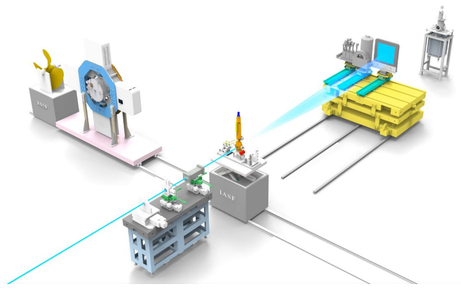
Cible tests： Long-term in-situ experiments such as corrosion and creep for medium size samples.

Test modes:
Several test samples will be fastened onto different rigs of the sample platform. The specific rig will be automatically moved to the beam position, according to the test program.

Main techniques： ED-XRD, XRD

Beam condition： 70-100keV； large beam size （104×6.8 mm²）

EH3



Cible tests : For large components such as additive manufacturing frames, components of vehicle batteries, etc. Suitable for customized engineering in-situ experimental devices .

Main techniques： ED XRD、XRD、X-ray Imaging、CT

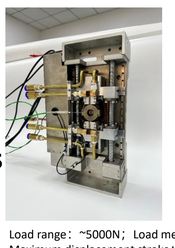
Beam condition： 70-100keV； large beam size （120×7.8 mm²）

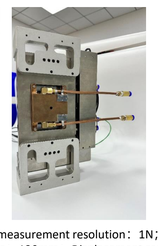
In-situ devices

High-low temperature fatigue testing machine

High-temperature melting simulation device

High-temperature tensile-compression-torsion testing device





Load range：~5000N； Load measurement resolution：1N；
Maximum displacement stroke：130mm； Displacement resolution：0.1μm；
temperature range：~1000℃； Temperature control accuracy：±2℃