High Energy Photon Source

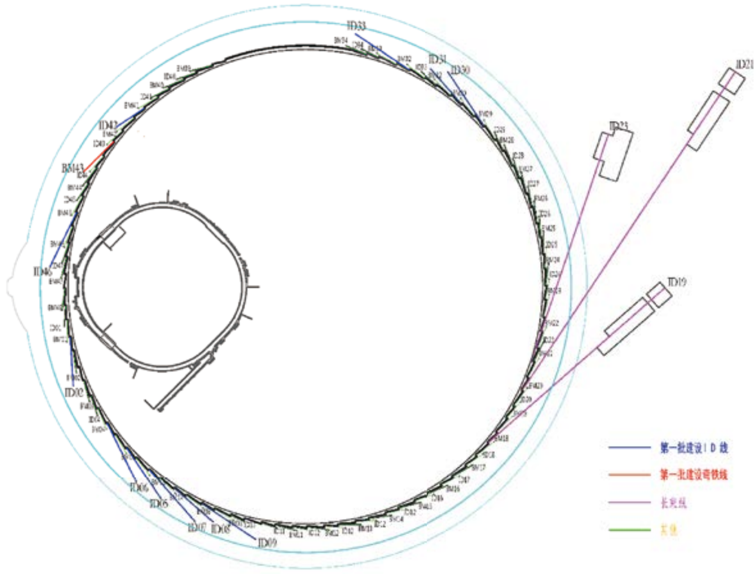
Address book

Institute: Institute of High Energy Physics (IHEP), CAS
Address: 19B Yuquan Road, Shijingshan disctrict, Beijing
Post Code: 100049
TEL: 010-88235967
Website: english.ihep.cas.cn/heps/index.html
Contact: yuanmy@ihep.ac.cn

Overview

The high energy photon source (HEPS), under construction since 2019, is located in the northern core area of Huairou Science City (HSC) and is one of HSC's large scientific facilities. When it is commissioned, HEPS will not only be the first high-energy light source in China but also one of the brightest fourth-generation synchrotron radiation facilities in the world.

HEPS complex buildings resemble a magnifying glass, thus aptly symbolizing the role of HEPS as a powerful tool for characterizing microstructure of matters. And as one of the key projects listed in the 13th Five-year Plan for national major scientific and technological infrastructure construction, HEPS is an important platform for original and innovative research in the fields of basic science and engineering research. HEPS project, undertaken by Institute of High Energy Physics, Chinese Academy of Sciences, comprises of accelerators, beamlines and



Layout for 14 public beamlines of HEPS phase I

utility facilities. The estimated construction period is scheduled for six and a half years.

The storage ring of HEPS is 1360.4m in circumference. Its electron energy is 6GeV and the brightness is more than 1×10^{22} phs/s/mm^2/mrad^2/0.1%BW. By using a 7-Bending Achromatic (7BA) lattice, the horizontal emittance of the electron beam can surpass 60pm•rad, which is the main feature of the fourth-generation diffraction limited light source.

HEPS could accommodate more than 90 high-performance beamlines and stations. Phase I involves construction of 14 user beamlines and stations for researchers in the fields of engineering materials, energy materials, environment research, health study and medicine development, and catalyst in petrochemistry industry, among others. HEPS will provide high-energy, high-brilliance, high-coherence synchrotron light with energies up to 300 keV and more, with the capability for nm spatial resolution, ps time resolution, and meV energy resolution. While providing conventional technical support for general users, HEPS will also operate as a platform for in-situ and operando investigation of real-time structure evolution of the engineering materials with multi-scale and multimodal X-ray probes, which will enable breakthrough in design and manipulation of such materials to meet the requirement from national development strategies and urgent core industrial needs.

Table 1 HEPS phase I 14 public beamlines

NO.	Beamline	ID Type	Energy Range [keV]	Beta F.	National Demands	Industry	Energy and Enviornment for sustainable development	Frontier Science Field	High Energy	Low Emittance	Used widely
1	Hard X-ray nanoprobe multimodal beamline	CPMU	50~170	Low	√	√	√		√	√	√
2	Engineering materials beamline	IVU	4.8-40	Low			√	√	√	√	
3	Structural dynamics beamline	CPMU	20~60	Low	√	√		√	√	√	√
4	Hard X-ray coherent scattering beamline	IVU	7-40	Low				√	√	√	
5	Hard x-ray High resolution spectroscopy beamline	IVU	7~25	Low	√			√	√	√	
6	High pressure beamline	IVU	20-50	Low	√			√	√	√	√
7	Hard X-ray imaging beamline	CPMU	10-90	Low	√	√		√	√	√	√
		Wiggler	40-300					√	√		
8	X-ray absorption spectroscopy beamline	IAU	4.8-45	High			√	√			√
9	Low-dimensional structure probe beamline	IVU	4.8-40	Low	√		√	√			√
10	Microfocusing x-ray protein crystallography beamline	IAU	5~18	High	√		√	√			√
11	Pink beam SAXS beamline	IAU	8~12	High	√	√		√			√
12	High resolution nanoscale electronic structure beamline	APPLE-KNOT	0.1-2	High		√		√		√	√
13	Tender x-ray beamline	BM	2.1~7.8				√	√			√
14	Transmission X-ray microscopic beamline	IAU	5~15	High		√	√	√			√

Construction progress

In 2021, with the roof-sealing work for main ring building completed and the installation of electron gun finished, work on civil construction and installation for HEPS commenced in parallel.

Roof-sealing work for the main ring building completed on Jun.27, 2021.

An electron gun, HEPS's first piece of accelerator equipment, was installed in Linac tunnel on Jun. 28, 2021.

Attendees commemorated HEPS installation kickoff meeting on Jun. 28, 2021.

By the end of this year, 90% of the civil construction had been completed. The buildings, including utility building, linac tunnel and booster tunnel, were turned over for installation. Meanwhile, construction of ancillary buildings proceeded on schedule, with structures and roofs completed on Nov.18.

In 2021, batch procurement and manufacturing of equipment and devices were fully under way. Some of the equipment and devices had already been manufactured, tested and commissioned, and were entering the pre-installation preparation stage. The installation of the Linac and booster had been

An aerial shot of the HEPS project site taken in January 2021.

An aerial shot of the HEPS project site taken in December 2021.


High- and low-voltage switch cabinets during installation

started and were progressing smoothly. Prototypes of the storage ring magnets, RF system, power supply system, and injection and extraction devices had been developed and fully met the design requirements. Mass production of these equipment and devices then began. The electronics of IHEP-developed beam position monitor (BPM) had already proven its high performance through operations at the BEPCII. The optical design of the second group of Phase I beamlines, the beamlines for fully utilizing the merits of the HEPS in brightness and coherence, had been

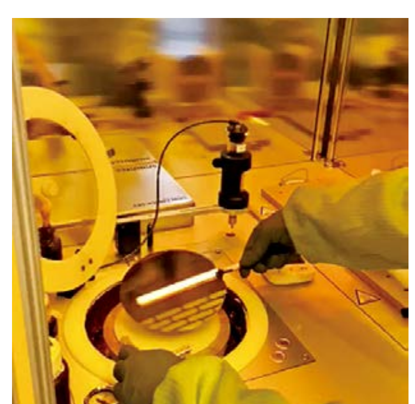

The solid-state power amplifier prototypes (166.6 MHz and 499.8 MHz) passed site acceptance tests on Oct. 15, 2021, and the series production was subsequently launched.


The bumper magnet was manufactured and joint tested with pulser.

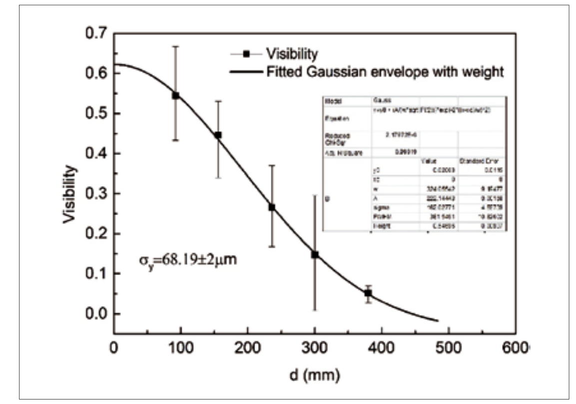

Mass production of the dipoles and sextupoles for the booster, the sextupoles for the storage ring were finished.


Power supplies were tested on progress in batches.

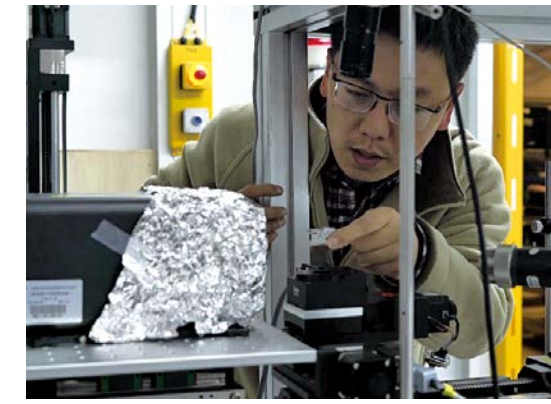

A prototype for an X-ray Raman scattering spectrometer was developed by IHEP. The energy resolution of the prototype was measured at 15873@9687eV using beamline 3W1 at BSRF.


The ASIC and Sensor designs for X-ray pixel array detector were completed, and the tape-out was on progress.

completed with breakthroughs in novel coherent analysis development, in application of dynamical diffraction in analysis of LAUE bent crystal for high energy monochromator design and so on. The procurement of key optical elements had started. The ASIC and sensor design for pixel array detector had been completed and the prototype for X-ray Raman scattering spectrometer had been tested online. The comprehensive data processing testbed for tomographic imaging experiments had finished its first integrated test in beamline. The optical metrology condition of multi-posture and multi-shape optics had been established.



The beam size was measured at 68.19±2μm in the wiggler on the BSRF beamline based on the grating Talbot effect. The brilliance was calculated as $2.9*10^{14}$phs/s/mm^2/mrad^2/0.1%BW.


The in-situ, real time characterization of the ultrafast melting and solidification process during additive manufacturing of a single crystal nickel specimen. The crystal rotation dynamics during the remelting process were captured with a time resolution of 1ms.

Cooperation and exchange

To grasp the latest development in new synchrotron sources to further promote the design and construction of HEPS, scientists and engineers actively attended online workshops and meetings organized by ESRF-EBS, PETRA IV, LNLS etc., and attend the online international conference like MEDSI-2020 as well.

In addition, reviews of the technical designs of insertion devices, mechanical engineering, and vacuum systems, etc. were conducted. Online international reviews of the optical design of the nanoprobe beamline and the coherent scattering beamline, two feature beamlines in Phase I, were completed.

Chronicle of events

- **Mar. 20** First 15 magnets transported to PAPS building in HUAIROU.
- **Apr. 13** Utility installation in NO.2 Hall commenced.
- **Jun. 1** Linac tunnel building was ready for equipment installation.
- **Jun. 27** Roof-sealing work for the main ring building was completed.
- **Jun. 28** The electron gun, first piece of HEPS accelerator equipment, was installed in Linac tunnel.
- **Nov. 5** Optical design of the second set of (eight) beamlines for phase I was completed.
- **Nov. 30** 294 sextupoles for storage ring passed factory acceptance tests.
- **Dec. 14** Booster tunnel building moved to installation phase.