The 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

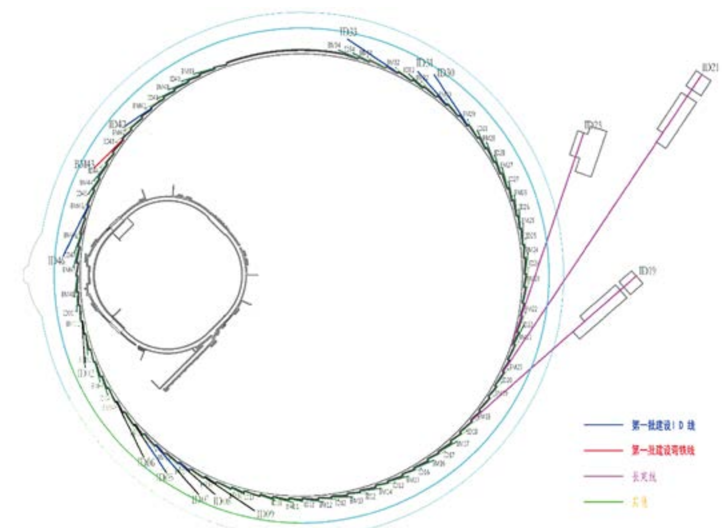
Overview

The high energy photon source (HEPS), as one of large scientific facilities, started its construction in June, 2019, in the northern core area of HUAIROU Sciences City. HEPS would be not only the first high-energy light source in China but also the brightest fourth-generation synchrotron radiation facility in the world when it goes into commission.

The overall building looks like a magnifying glass, which means HEPS is a powerful tool for characterizing microstructure. 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 to support original and innovative research in the fields of basic science and engineering science. HEPS project is constructed by Institute of High Energy Physics, Chinese Academy of Sciences. The construction contents comprise accelerators, beamlines and auxiliary facilities. The estimated construction period is six and a half years.

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

More than 90 high-performance beamlines and stations can be constructed in the experimental hall of HEPS. In the first phase, there are 14 public beamlines and stations for users in the research fields of engineering materials, energy and environment, medicine and food industry, petrochemistry and chemical industry, et al. HEPS can provide highly brilliant and highly coherent X-rays with photon energy up to 300keV, and has capabilities of nm spatial resolution, ps time resolution, and meV energy resolving. While providing conventional technical support for the general users, HEPS will operate as a platform to analyze the structures, as well as the evolution of structures of engineering materials in the whole process, by in-situ, multi-dimensional and real-time observation, to provide the information for the design and regulation of functional materials, and to serve the researches relating to the national development strategies and urgent core-like needs of industry.



the layout of 14 public beamlines built in HEPS phase I

the list of 14 public beamlines built in HEPS phase I

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	√			√	√	√	

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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

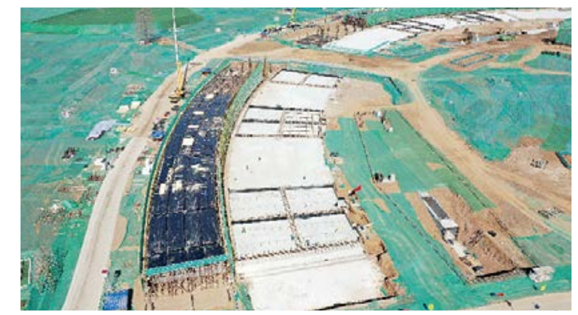
In 2020, the HEPS team overcame the impact of the epidemic and HEPS project was carried out on schedule, which pioneered to return to work in mid-February, the first one of HUAIROU Science City. The foundation of the main Ring building, filled with 3m-thick plain concrete to attenuate the ground vibration, was accomplished and the steel structure construction had reached its end. The roof-sealing works for Booster RF hall, utility building, and users experiment building were conducted successively. A total of 270,000 cubic meters of concrete placement, 19,000 tons of steel reinforcement tying, and 5,000 tons of steel structure installation had been completed this year.


An aerial view of HEPS project site (photo in Jan. 2020)


An aerial view of HEPS project site (photo in Dec. 2020)

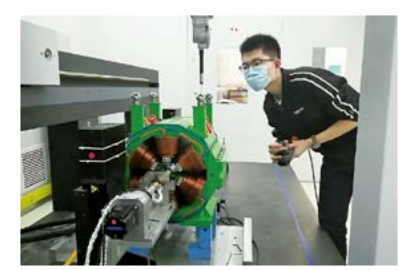

The RF hall sealed its roof atop the concrete and steel frame on Apr.30, 2020.


Roof-sealing work for the utility building was conducted on May 18, 2020.

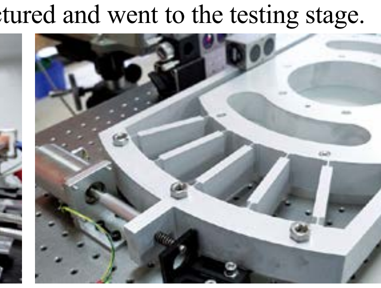

The main Ring Building (Session IV) (photo in Mar. 2020)


The main Ring Building (Session IV) (photo in Dec. 2020)

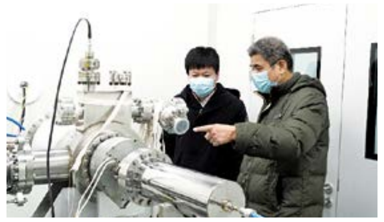
In 2020, scientific equipment purchases and fabrications were in full swing. The porotypes of the magnets, RF cavities, Linac power source and microwave equipment had been manufactured and the testing works were going on. The preparing of utilities to install on site had been completed. The engineering design of the first six beamlines went on progress and X-ray partially coherent optics theory was developed further. The pixel array detector engi-neering prototype based on through-silicon-via tech-nology (TSV), which was composed of 18 modules, was manufactured successfully. The Beam Position Monitor (BPM) electronics, developed by IHEP, operated successfully on BEPCII. The cathode-grid assembly porotype had been manufactured and went to the testing stage.

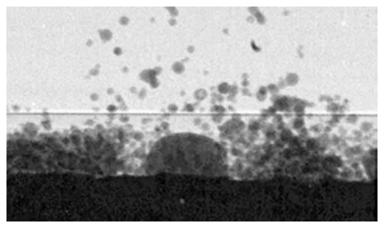

Sextupole prototype was under test. (The high order harmonics was measured to be less than 5×10^{-4}, which was one order of magnitude better than the design specification.)

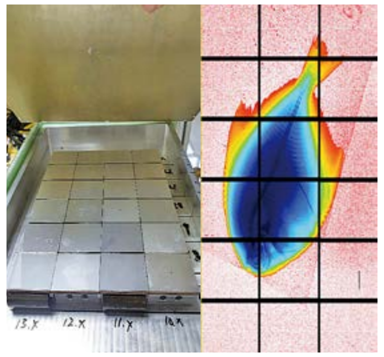

S-band accelerating structures with round-shape cell and internal water cooling had been successfully developed for the first time in China. Matching and cold tests had been completed, and high power test was in progress.


The step resolution of the high load and ultra-high angular resolution adjustment mechanism prototype, based on independent processing techniques for flexure hinge, was measured up to 300nrad@load of 70kg.


◁ Polishing remotely controlled by magnet field technology was developed to achieve channel-cut crystals with nanometer roughness and strain-free inner surface.


The cathode-grid assembly porotype developed by IHEP was under test.


The ultrafast detection of irreversible processes: in-situ, real time observation of 3D printing process of metals (90kfps, 10μs).


The pixel array detector engineering prototype based on through-silicon-via technology (TSV) and composed of 18 modules, was manufactured successfully and the gap between the modules was reduced from 9mm to 2.5mm.


The Beam Position Monitor (BPM) electronics, developed by the Institute of High Energy Physics, operated successfully on BEPCII. The beam position resolution of closed orbit distortion (COD) in the vertical direction was about 21nm by laboratory measurements.

Cooperation and exchange

To grasp the latest developments trends of science and technology to promote the design and construction, HEPS actively attended workshops and meeting online, such as EBS webinar and SFR-2020. And user meeting of engineer materials beamline was held in October to follow user requirements.

Besides, the reviews on Radiation Protection, Cryogenics, Power supply Systems and so on, were held according to its progress. And the internal review on the optical design of the first batch beamlines was completed.

Chronicle of events

Feb.10	The appointment of new HEPS project management was announced.
Apr. 13	Foundation filled with C15 plain concrete moved into a second phase.
Apr.30	The Booster RF hall sealed its roof atop the concrete and steel frame on Apr.30, 2020.
May 18	Roof-sealing work for the utility hall were conducted on May 18, 2020.
May 29	The first dipole and sextupole magnets for booster were accomplished on schedule.
Jul. 29	Domestically Made High-performance WR1800 Waveguide Directional Coupler Passed Essential Tests.
Aug.12	HEPS project work assignments were signed up.
Nov. 13	The TSV pixel array detector engineering prototype, composed of 18 modules, was manufactured successfully and the gap between the modules was reduced from 9mm to 2.5mm.