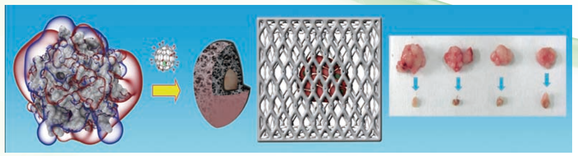
that endohedral metallofullerenol Gd@$C_{82}(OH)_{22}$ can successfully inhibit the activity and can also effectively block tumor growth in human pancreatic cancer xenografts in a nude mouse model. Apart from providing insights for a brand new design of nanomedicine for fatal diseases such as pancreatic cancer, these findings also imply that the pharmacokinetic action of nanoparticles could be markedly different from the traditional target-based molecular drugs.

According to worldwide studies of nanomedicine, nanoparticles can be directly used as drugs for tumor treatment. As a nanoparticle, the Gd@$C_{82}(OH)_{22}$ system was the first to be applied to pharmaceutical research. In 2012, a production line was established and the clinical research of low-toxic cancer drugs was in full swing.



>> Scientific Archaeology

The group of Archaeometry has developed nuclear analytical methods for the study of ancient Chinese ceramics. They have collected more than 10,000 specimens with specific origins and ages from about 30 typical kilns in China, and built a standard data base for scientific analysis with the merits of high reliability, good representativeness, broad utility and great quantity. Meanwhile, a set of powdered reference material and a set of solid ceramic reference material have been made especially for the study of ancient ceramics. In addition, they have developed the first open platform on the internet for sharing data on Chinese ancient ceramics and nuclear analysis.

The first standard reference materials of ancient ceramics in the world developed at IHEP, the first of its kind for the ancient ceramics studies.

Based on the analysis of large quantities of samples, they have tested and verified many arguments and surmises proposed by archaeologists, and also proposed some new academic viewpoints, resolving many archaeological problems on ceramics.

1. Answered the academic argument of whether the secret color porcelain in Yue Kiln of Zhejiang Province was fired purposely;
2. Provided important data to differentiate the firing time periods of ceramics from Li dipo & Shangdian Yaozhou Kiln in Shanxi Province;
3. Provided data of ceramics from Hutian Kiln, showed that the time for the appearance of the dual-recipe of Hutian Kiln are 300 years earlier than previous estimates;
4. Corrected the firing time of some white porcelains of Jingdezhen and celadons of Longquan Kiln unearthed in Maojiawan;
5. Established the scientific standard database for the provenance of Tang Sancai from different origins and the distinguishing standard of ancient Tang Sancai and modern fakes;
6. Developed the distinguishing standard for the fine white porcelain of three Kilns in Hebei Province;
7. Proposed more precise time periods for the fragments of celadons of Longquan Kiln in Zhejian Province, excavated in relics of Huaichengzheng River, Chuzhou District, Huai'an City, Jiangsu Province;
8. Initially established the scientific distinguishing standard for the blue and white porcelains of the Yuan Dynasty, the Doucai porcelains and the Wucai porcelains of the Ming Dynasty.

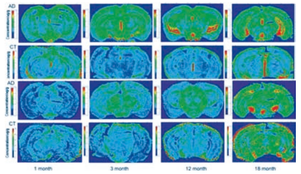
The largest and the most complete specimen bank of Chinese anceint ceramics

>> Research on Environmental Health and Safety

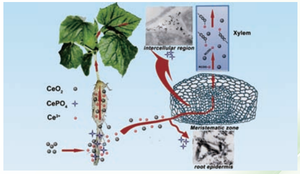
In the 1980s, IHEP launched research on health-related environmental science by using nuclear analytical techniques. It studies the environmental distribution of heavy metals (mercury, rare earth, lead, chromium, arsenic), organic halogens pollutants, and the chemical species and toxicology in plants and animals ranging from the macro-level to the animal's overall ecosystem.

Elevated mercury was found in crops and human bodies around a mercury mined area. Selenium supplementation could decrease mercury levels in crops and promote mercury excretion in mercury-exposed populations.

Chai Zhifang (fifth left), member of the Chinese Academy of Sciences, presented a special policy study on mercury management in China at the Annual Conference of China Council of International Cooperation on Environment and Development (CCICED).



Scientists found that as the age increases, transition metals will accumulate in specific brain regions of the APP transgenic mice, and metal metabolic abnormalities may act abnormally, which finally may cause the development of AD disease.

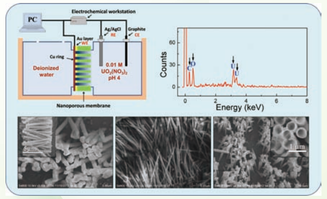


Studies have shown that ceria can be transformed under biological effects. The transport mechanism of nano-ceria in plants was first systematically studied.

>> Research on Nuclear Energy Radiochemistry

In 2010, to solve the key radiochemical issues in the nuclear fuel cycle, the radiochemistry group for nuclear energy was established at IHEP. The major research directions are actinide chemistry, nuclear fuel chemistry and spent nuclear fuel reprocessing.

The research team carried out a series of basic research on the molten salt-based electrochemical separation technology, the separation of MA over lanthanides, novel functionalized nanomaterials, synthesis of actinide nanomaterials and their physical and chemical properties, etc.

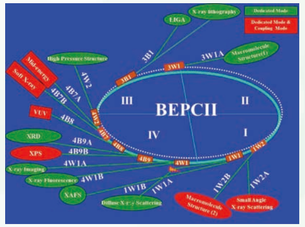


Multi-disciplinary Research

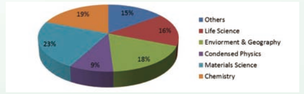
Institute of High Energy Physics

>>Beijing Synchrotron Radiation Facility (BSRF)

Synchrotron radiation is radiation that occurs when charged particles are accelerated in a curved path or orbit. It has a characteristic spectrum, covering wavelengths from microwaves to hard X-rays, from which users can select the wavelengths required for their experiment. Synchrotron radiation plays an important role in pure science and in emerging technologies. Since the 1970's, synchrotron radiation facilities have been built in Europe, America and Japan to serve as large research centers for cutting-edge research in multi-disciplinary science.



Beamline and Experimental Stations at BSRF



Areas of the BSRF users

There are currently 3 experimental halls（#12，#13，#15）, 5 insertion devices，14 beamlines and 14 experimental stations at BSRF. The synchrotron radiation light of BSRF covers energies from vacuum ultraviolet to hard X-rays, and supports many kinds of experimental techniques, such as X-ray Topography, X-ray Imaging, Small Angle X-ray Scattering, Diffuse X-ray Scattering, Biological Macromolecule Structure, X-ray Fluorescence Analysis，X-ray Absorption Fine Structure，Photoelectron Spectroscopy, Circular Dichroism Spectra, Soft X-ray Calibration, Mid-energy X-ray Optics, High Pressure Structure, LIGA and X-ray lithography. These have applications for many fundamental and applied research areas, such as Condensed Matter Physics, High Pressure Physics, Chemistry, Material Science, Biology, Goescience, Environmental Science, Micro-electronics, Micromachining, Metrology, Optics and Probing Techniques.

The accumulated experimental time for dedicated synchrotron radiation is at least three months per year. Additionally, six beamlines (Mid-energy X-ray Station, Soft X-ray Absorption Spectroscopy Station, Photoelectron Spectroscopy Station, Vacuum Ultraviolet Station, Small Angle X-ray Scattering Station and Macromolecular Crystallography Station) can also run parasitically while BEPCII is working on high energy physics. This is called a coupling mode, and supplies more experimental time to users. In total, BSRF can supply beamtime to upwards of 500 experiments for over 1000 users from more than 100 institutes and universities at home and abroad.

>>Intense Slow Positron Beamline

The positron annihilation technique is a specific nuclear analysis method for the investigation of the microstructure of new types of function materials that is sensitive to point defects on the atomic scale. Besides analyzing the depth distribution of point defects from the sample surface to bulk, the slow positron beam technique can also characterize the changes of defect configurations, and is widely used for defect studies of sample surfaces, film and the effect of irradiation damage in the field of materials.

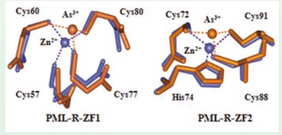
The only intense, slow positron beamline based on electron linear acceleration in China was built at the Institute of High Energy Physics in 2004. The Doppler broadening, coincidence Doppler broadening and lifetime measurements of positron annihilation were developed on this beamline. The positronium time of flight (Ps-TOF) measurement was established recently. These analysis methods provide a platform for the research of material science and condensed matter physics with international advanced level technical indexes. The beamline will be opening to the physical and material scientists worldwide, and further developments for related positron measurement technology are being studied.

>> Fruitful Results at BSRF

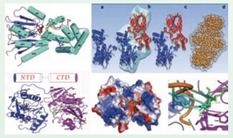
From 2007 to 2012, a series of research studies on protein structure and function were carried out at BSRF. Users published 943 scientific papers and accomplished a number of important scientific achievements.

The complex structure of the SARS virus's main protease with inhibitor was measured at BSRF

The picture shows the high-resolution crystal structure of a spinach light-harvester complex, which elucidates the mechanism of energy transfer in photosynthesis. The diffraction data for the determination of its structure was collected at BSRF.

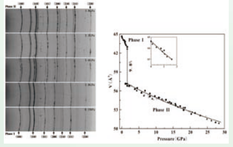


In the 1W1B - XAFS station, the Shanghai Institute of Hematology and State Key Laboratory of Medical Genomics successfully revealed the molecular mechanism of the arsenic agent in the treatment of acute promyelocytic leukemia by applying the BioXAS method.

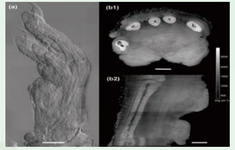


Structure-function studies of a series of proteins with important physiological roles were performed at the Beijing Synchrotron Radiation Facility (BSRF). Shown are the complex structures of two ribosomal nucleic acid (RNA), methyl transferases RsmH-AdoMet-cytidine and RlmG-AdoMet.

Synchrotron radiation phase contrast imaging studies were conducted at BSRF and the first sound domestic phase contrast imaging and CT research platform was established. Because of this, important progress was made in CT reconstruction theory. The results of imaging studies were applied to paleontology research and major issues in evolutionary paleontology were revealed.



Scientists discovered the isostructural phase transition in a cubic perovskite at the BSRF high pressure beam line. The left picture shows the X-ray patterns of the in-situ X-ray diffraction, and the right shows the P-V relationships of the cubic PbCrO3 (low- and high pressure) perovskite phases.

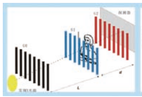


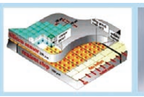
Scientists at BSRF present an innovative, highly sensitive X-ray tomographic phase-contrast imaging approach based on grating interferometry. The picture shows the result of a low dose and fast grating-based X-ray phase-contrast imaging of a rat paw.

>>X-Ray Optics and Technology Laboratory

The X-Ray Optics and Technology Laboratory was founded in December of 2012. The laboratory focuses on the development of cutting-edge X-ray optics, satisfies the needs of major national scientific researchers and projects, and aims at creating a world-class X-ray optics and technology research center. The major research directions of the laboratory include advanced X-ray imaging, measurement, modulation, detection, and X-ray micro-nano optical components.

Research directions:


advanced X-ray imaging theory and method


advanced X-ray detecting techniques


advanced X-ray modulation method


X-ray micro-nano optical components R&D

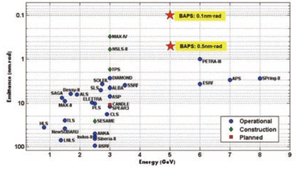

X-ray measurement studies and its application

>> BAPS

The BAPS beam energy is designed to be 5GeV. The emittance is currently better than 0.5nm•rad and can be upgraded to 0.1nm •rad, reaching the level of the world's most advanced light source.

The Beijing Advanced Photon Source is a high-energy synchrotron radiation light source. BAPS aims to satisfy the national strategic demands in science and technology and the needs for this innovation.


The Beijing Advanced Science and Innovation Center (BASIC) will be a world-class research center, relying on a number of interconnected large-scale science and technology facilities.



The comparison of emittance between BAPS and worldwide synchrotron radiation facilities

>>Research on the Biomedical Effects of Nanomaterials and Nanosafety

In 2001, an IHEP research team launched the study of nano-safety and established the first Laboratory for Biomedical Effects of Nanomaterials and Nanosafety in China. The laboratory mainly focuses on research of the biological effects of nanomaterials as well as safety concerns surrounding long-term nanotechnology developments and applications. The lab provides a center that combines chemical science, physics, biomedical science, and nano-science; creates a new integration of the traditional disciplines of chemistry, nano-science, biological, medical and toxicological sciences; cultivates and pools innovative talents; and constructs a high level of experimental techniques and a forum for international academic exchange.

In 2004, scientists found that the surface modified Gd-metallofullerene nanoparticles could effectively circumvent tumor resistance to cisplatin by reactivating endocytosis. During the past nine years, scientists have been working on animal tests and cell tests. The results suggest that Gd@C_{82}(OH)$_{22}$ nanoparticles overcome tumor resistance to cisplatin by increasing its intracellular accumulation through the mechanism of restoring defective endocytosis. The technology can be extended to other challenges related to multi-drug resistance often found in cancer treatments. Further research is still in progress. The engineered nanoparticle may provide a new strategy and solution to overcome hurdles in cancer treatment.Scientists found that endohedral Scientists found