

SSRF

Shanghai Institute of Applied Physics

**Shanghai Synchrotron
Radiation Facility**

2009 Annual Report



Overview

Shanghai Synchrotron Radiation Facility (SSRF), a third-generation medium-energy synchrotron light source, is constructed as a national large scientific project with the joint efforts of the Chinese Academy of Sciences (CAS) and the Shanghai Municipal Government. Aimed at building a facility outperforming most existing synchrotron light sources, the project was ranked by the Shanghai Municipal Government as the major scientific project and one of the first-priority scientific and technological projects for promoting the city through science and education.

Located at 239 Zhangheng Road in Zhangjiang Hi-tech Park of Pudong New District, and occupying an area of 20 hectares, SSRF consists of a 150-MeV linac, a 3.5-GeV booster, a 3.5-GeV storage ring, and seven beamlines and experimental stations during Phase I, along with the utilities and supporting facilities.

With a capacity of over 60 beamlines and about 100 experimental stations, and as a world-class scientific platform, SSRF provides irreplaceable experimental tools for a wide range of basic and applied researches, and hi-tech R&D as well, in life science, materials science, earth and environmental sciences, nano-science and technology, medicine and pharmacy, chemistry and chemical engineering, microfabrication, etc. It is

bound to become an important innovation base of science and technology in China.

The SSRF project was approved in 2004 by the National Development and Reform Commission. The construction started with a ground-breaking ceremony on December 25, 2004. The civil work and the utilities were completed at the end of 2006. On December 24, 2007, the first electron beam at 3 GeV was stored and accumulated in the storage ring and the first synchrotron light was observed at SSRF. On September 30, 2008, 200 mA@3.5 GeV beams in lifetime of over 13 hours were obtained in the storage ring, thus fulfilling the major design specifications. In March 2009, commissioning of the Phase I beamlines was completed, marking a successful on-schedule completion of the SSRF project. The completion ceremony of the project was held on April 29, 2009 and SSRF started test operation on May 6, 2009 for opening to domestic users.

From October 22 to 23 and 26 to 27 in 2009, the CAS-organized technical test for SSRF was carried out. The results show that all the design specifications of SSRF were achieved or outperformed. On December 8, 2009, the completion of the SSRF project was officially accepted in the review and acceptance meeting organized by CAS.

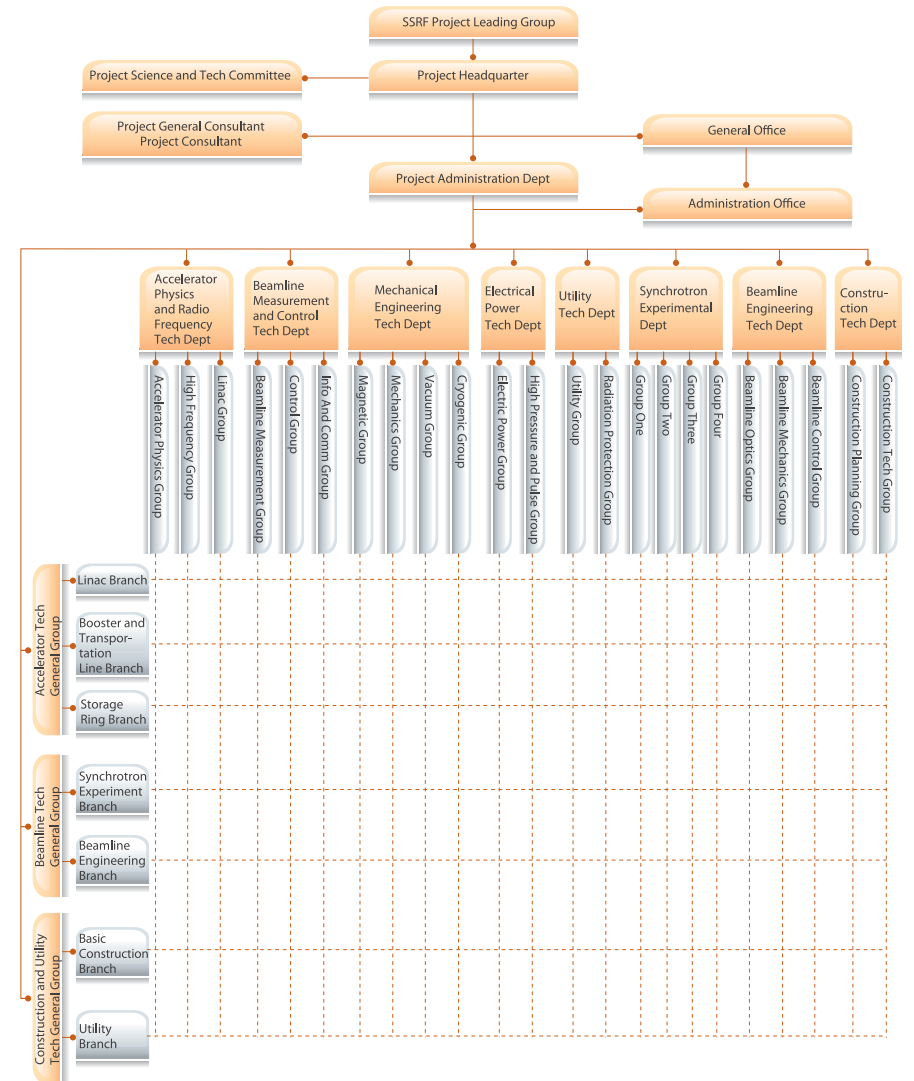


• The night scene of SSRF

Project Organizations

The Leading Board	President: Lu Yongxiang	Vice President: Han Zheng
The Science and Technology Committee	Director: Fang Shouxian	Deputy Director: Xian Dingchang, Yang Fujia, Chen Shenyu
The Project-Steering Board	Director: Jiang Mianheng	Deputy Director: Yang Xiong
General Advisor	Chen Shenyu	
Directors of the Project	Director: Xu Hongjie	Vice Directors: Zhao Zhentang, Ding Hao

Organization chart



Construction, operation and upgrading

Construction, performance test and evaluation

The SSRF construction began on December 25, 2004 when a ground-breaking ceremony was held. Under the support from the leaders of the nation, and from the project leading board and the project-steering board, the SSRF project proceeded smoothly. The building constructions for the accelerators and utilities were completed at the end of 2006. The linac was commissioned from May to July, 2007 and all the design specifications were achieved. The commissioning of the booster began on September 30, 2007; the electron beams were accelerated to 3.5 GeV on October 5; and the designed specifications were finally achieved in July 2008. On December 24, 2007, the SSRF team succeeded in running 3 GeV beam bunches in the storage ring and observing the synchrotron radiation light, and the major design specifications of the storage ring were finally achieved by September 30, 2008.



• Linac



• Booster



• Storage ring

On January 28, 2009, the installation of the first in-vacuum undulator designed for the storage ring by SSRF was completed. The commissioning of the BL15U1 beamline (for hard X-ray micro-focusing and applications) began on February 6 and its first target was reached in 3.5 hours with the delivery of beam onto sample position. The commissioning of the BL17U1 beamline for macromolecular crystallography, the last one among Phase I beamlines, began on March 7, following the installation of the second in-vacuum undulator. This marks the on-schedule end of the construction tasks of SSRF.



• The in-vacuum undulator designed by SSRF



• The BL15U station



• The BL17U station

On April 29, 2009, an official dedication ceremony was held at SSRF. On May 6, 2009 SSRF began opening to domestic users. On July 18, the storage ring reached the highest current of 300 mA at 3.5 GeV.



• The dedication ceremony

On October 22 to 23 and 26 to 27, 2009, technology evaluations were organized by the CAS Bureau of Basic Science. The overall performance and key technology of the linac, the booster, the storage ring, the beamlines and the utilities were tested onsite. And the evaluation committee agreed that all the design specifications of SSRF were met or exceeded.



• Technology test of SSRF

On December 8, 2009, completion of the SSRF project was accepted by the review and evaluation committee co-organized by the Bureau of Basic Science, and Bureau of Planning and Finance, CAS. The committee members agreed unanimously that the SSRF project team has done an excellent job in finishing the task assigned by the National Development and Reform Commission, and the project was completed in high quality, on schedule and in balanced budget, rendering the SSRF project a unique position as a model of large science project in China, and as one of the most advanced synchrotron facilities in the world.

Based on all these results, the national acceptance on completion of the SSRF project was done soon in January of 2010.



• The international review meeting

Operation and opening to users

As China's scientific platform for promoting the national innovation ability, SSRF opens to all users from fundamental and applied researches, hi-tech development and other fields. The SSRF national science center (in preparation) at SINAP is in charge of user operation, and users can have the beamtime via an application-review-approval procedure.

An application should be sent to the users' office of SSRF, outlining the purpose and necessity of the proposed research program, and describing the experiment to be performed on a beamline of SSRF, together with the technical route and the needed beamtime in hours. The applications are reviewed and evaluated by the SSRF user committee, which gives comments on an application for its approval or rejection, and allocates beamtimes to the approved program proposals. The SSRF national science center is in charge

of arranging the beamtime allocated by the committee, and providing the beamtime and experimental conditions for users.

In December 2008, seven expert groups were established, each consisting of 8 to 10 influential experts in synchrotron radiation experiments. Having been providing advice to SSRF in developing the Phase-I beamlines, they are responsible for reviewing the user applications before the user committee is officially formed.

Referring to the experiences of relevant light sources in the world, the SSRF has formulated a series of regulations and procedures for using the beamlines. They include the principles

for beamtime allocation; management of users' experiment programs from the application to program-ending; trainings on radiation protection, fire control, experimental station operation, and operation of the public experimental facilities; safety checks on radiation samples, animal experiment, etc.; and user support and service in terms of lodging, public office, etc.



• The 1st workshop of beamline experts and seminar for beamline users

It was planned that SSRF would provide 2000 operation hours to the users in 2009, and a total of 14,000-h beamtime with the seven beamlines for 200–230 research programs performed by users in 800 person-times.

In 2009, SSRF received 582 applications, with a total beamtime requirement of about 45,000 hours. Each application was evaluated by three experts in a relevant expert group. The program importance, experimental feasibility and rationality of the applied beamtime were evaluated, and suggestions were made on approval of the program and beamtime allocation. The 531 applications were approved. According to recommendations of the experts, and opening schedule of SSRF, 2164.8 shifts (8 h x 2164.8 = 17318 h) were assigned to the research programs.

Beginning from May 6, 2009, the seven Phase I beamlines provided 14428 hours in 2009 to 395 research programs by 932 individuals in 1520 user-visits, from 100 institutions including 46 universities and 43 research institutes (the rest are other institutions and companies). The fields of research cover life science, condensed matter physics, chemistry, materials science, environmental science, earth science, geo-archaeology, medicine and pharmacy, etc.

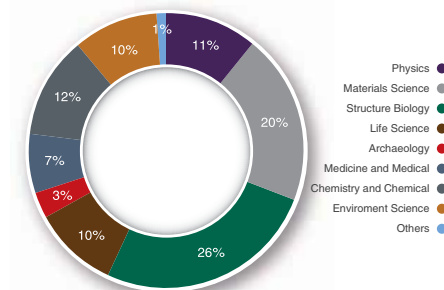
Annual operation data:

- ▶ Total operation time: 7226.5 h
- ▶ Machine study time: 2305.75 h
- ▶ User time: 2093.95 h

Annual users' beamtime data:

- ▶ Beamlines: 7
- ▶ Experimental stations: 7
- ▶ User institutions: 100
- ▶ Programs: 395
- ▶ User numbers: 932

Distribution of users' research fields (2009)



Publications

No.	Beamline	Group Head	Affiliation	Journal
1	BL17U1	Xu Yanhui	Fudan University	Genes & Development
2	BL17U1	Shi Yigong	Tsinghua University	PNAS, 2009, 106, 14837-14842
3	BL17U1	Liu Zhijie	Institute of Biophysics, CAS	Cancer Research, 2009, 69: (18)
4	BL17U1	Ding Jianping	Shanghai Institutes for Biological Sciences, CAS	Journal of Immunology
5	BL17U1	Chen Zhongzhou	China Agricultural University	Cell Research
6	BL16B1	Li Liangbin	University of Science and Technology of China	Macromolecules
7	BL17U1	Shen Yuequan	Nankai University	Journal of Structural Biology
8	BL15U1	Feng Weiyue	Institute of High Energy Physics, CAS	J. Anal. Atom. Spectrom
9	BL14W1	Jiang Jianzhong	Zhejiang University	Applied Physics Letters 95, 183112 2009 (1)
10	BL16B1	Zheng Sixun	Shanghai Jiaotong Univ.	European Polymer Journal 45 (2009) 3326-3338
11	BL17U1	Li Shentao	Capital Medical University	Protein Expression and Purification; (2009)
12	BL17U1	Cui Zhongli	Nanjing Agricultural Univ.	Acta Cryst. (2009). F65
13	BL13W1	Zhu Maoyan	Nanjing Institute of Geology and paleontology, CAS	Physics (2009)
14	BL13W1	Xu Xuemin	Shanghai JiaoTong University	Nuclear Techniques (2009)
15	BL13W1	Luo Shuqian	Capital Medical University	Journal of Clinical Rehabilitative Tissue Engineering Research

Scientific & Technical personnel and talent training



In 2009, SSRF has 358 staff members, including 159 senior researchers, 108 junior researchers, and 41 technicians for operation and daily maintenance.

The team includes also groups of postgraduate students. In the year, 27 Ph.D and 20 M.S programs were completed at SSRF, from a total of 146 postgraduate programs (43 for Ph.D), in addition to 3 postdoctoral programs.

Cooperation and exchange



International collaborations

SSRF has signed collaboration agreements with up to 20 synchrotron facilities and institutes. SSRF has taken part in the USA-PRC collaboration on high energy physics, and China-Japan core university collaboration project, through intensified exchange programs and mutual visits. SSRF and Lawrence Berkley National Laboratory have been in collaboration on superconductor undulators. As a CAS key project of international collaboration, SSRF has been working together with the Canadian and Australian synchrotron light sources in research of novel method for X-ray medical imaging, to establish at SSRF an advanced X-ray medical imaging research base, enabling Chinese scientists to explore the frontiers in information research, imaging method and applications, through international collaborations.



• Eastern Forum of Science and Technology

International seminars

- ▶ The 1st PAL-SSRF Joint Workshop;
- ▶ International Review Meeting of the SSRF Project;
- ▶ Shanghai Workshop of Sino-Swiss Synchrotron Collaboration;
- ▶ The 4th Asia-Oceania Forum for Synchrotron Radiation Research;
- ▶ SSRF-MAX Lab Workshop;
- ▶ China-UK Workshop on Application of Micro-nano Technology in Life Science;
- ▶ SINAP-Osaka University Joint Workshop 2009;
- ▶ Eastern Forum of Science and Technology
 - No. 136, Synchrotron Environmental Sciences;
 - No. 142, Physics and Technology of Advanced Undulator;
 - No. 143, X-ray Imaging and Industrial Applications.

National academic activities

The academic activities held at SSRF include:

- ▶ The 1st Workshop of Beamline Experts and Seminar for Beamline Users (six workshops for X-ray diffraction, SAXS, imaging and bio-medical application, XAFS, soft X-ray spectromicroscopy, and hard X-ray micro-focus);
- ▶ Workshop on Synchrotron Applications;
- ▶ The 1st User's Annual Meeting of SSRF;
- ▶ The 1st Annual Meeting of SSRF Operation;
- ▶ The Working Month of SSRF.



• Workshop on Synchrotron Applications

Bilateral collaboration meetings were held with Dalian Institute of Chemical Physics, CAS; Shanghai Institute of Microsystems and Information Technology, CAS; Institute of Electronics, CAS; Nanjing University; Shanghai Jiaotong University; and Northeastern University.

SSRF took part in the following events in 2009 for popularizing synchrotron science and technology:

From September 23 to October 11, the model of SSRF was displayed in the Exhibition of Scientific and Technical Achievements in Shanghai for the 60th Anniversary of the People's Republic of China.

From December to February 2010, the model of SSRF was displayed in the exhibition to celebrate the 60th Anniversary of CAS-Developing Sciences along with the Growth of New China. It was visited by Premier Wen Jiabao.

On December 26, SSRF organized the seminar of Exploring the Unknown World with SSRF in Shanghai Science and Technology Museum (SSTM), with an audience of about 100, including high school students, SSTM staff, and journalists.

Finally, about 4000 people at home and abroad paid about 100 visits to SSRF. Over 600 students from universities and high schools were among the visitors.



• The 1st Annual Meeting of SSRF operation



• Popular science seminar

Chronicle of events



- Jan. 28** ○ Performance test of the first in-vacuum undulator designed by SSRF was finished and its installation in the storage ring began. The online test was done on February 3 and the first synchrotron radiation beam was successfully observed on February 4.
- Feb. 7** ○ Commissioning of the hard X-ray micro-focus and application beamline (BL15U1) was started at 18:00, and the first round testing goal was fulfilled at 21:30.
- Mar. 7** ○ Commissioning of the macromolecular crystallography beamline (BL17U1) began at 20:00, thus fulfilling the first round testing goal in two hours.
- Apr. 1** ○ A team of over 10 from Ministry of Environment Protection, headed by Minister Zhou Shengxian and Deputy Minister Li Ganjie inspected SSRF.
- Apr. 13-21** ○ A committee of 30 Chinese experts organized by the Science and Technology Committee of the SSRF project did onsite tests to check the performance of the linac, the booster, the storage ring and the beamlines. The SSRF performance parameters met or exceeded the design specifications, and the committee members acknowledged SSRF as a first-class facility compared with similar light sources in the world.
- Apr. 26-27** ○ The international evaluation meeting was organized by the Project Steering Board. Thirty-four experts at home and abroad participated in the evaluation meeting. SSRF was evaluated as a first-class light source in the world in terms of the design specifications achieved or outperformed.
- Apr. 28** ○ Directors' meeting of the Science and Technology Committee of the SSRF project was held in the morning at SSRF.
- Apr. 28** ○ The 4th Meeting of the Leading Board of the SSRF Project was held in the afternoon in Shanghai.
- Apr. 29** ○ A grand ceremony for the completion of SSRF was held at the site.
- Apr. 29** ○ Environmental protection status of SSRF was checked by the Ministry of Environmental Protection, which issued the Letter of Check and Acceptance to SSRF's work on environmental protection.
- May 6** ○ SSRF opened to the domestic users at the test operation stage.
- May 12** ○ The former Chinese leaders of Jiang Zemin and Zeng Qinghong visited SSRF.

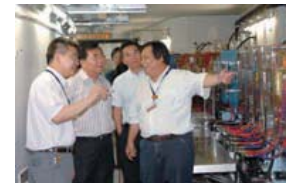


● The 4th meeting of the leading board of the SSRF project



● Jiang Zemin and Zeng Qinghong visit SSRF

- Jul. 18** ○ The storage ring ran 300 mA@3.5 GeV beam of 15 hours in lifetime, indicating that the toughest specification of the design was achieved.
- Jul. 20-23** ○ The 1st SSRF Annual Operation Meeting was held in Jiande, Zhejiang Province.
- Aug. 15** ○ Bai Chunli, Executive Vice President of CAS, visited SSRF and made encouraging remarks on the SSRF project.
- Sep. 9** ○ After checking the SSRF status of occupational disease prevention, the Shanghai Bureau of Hygiene issued the Letter of Check and Acceptance to the work of SSRF on occupational disease prevention.
- Oct. 11** ○ Zeng Peiyuan, former politburo member of the CCP Central Committee and vice premier, visited SSRF.
- Oct. 22-23 and 26-27** ○ Technology test of SSRF was organized by the CAS. The results show that SSRF has achieved or outperformed the design specifications.
- Oct. 29** ○ SSRF, together with the building complex around Tiananmen Square, and the Oriental Pearl TV Tower, has found its way into the One Hundred Classic and Magnificent Engineering Projects in 60 years of the People's Republic of China.
- Nov. 28-29** ○ The 1st Annual Users' Meeting was held, with an attendance of 326 of 80 institutions from China, Japan and Singapore.
- Nov. 29-Dec.1** ○ The 4th Asian-Oceania Forum on Synchrotron Radiation Research was held at SSRF. Participated by 160 scientists from 12 countries and regions, it is a great event of the synchrotron community in Asian and Oceania.
- Dec. 7-9** ○ The SSRF MAX-Lab Workshop was held at SSRF.
- Dec. 8** ○ Technology evaluation of SSRF was co-organized by the Fundamental Science Bureau and Planning and Finance Bureau, CAS.
- Dec. 28** ○ Completion of the SSRF project was in the top-ten pieces of news of the year in science and technology in China, an outcome of public appraisals, launched by the Science and Technology Daily and sponsored by Futian Motor Corp., among academicians, journalists and the readers.



● Bai Chunli, Vice President of CAS, visits SSRF



● Zeng Peiyuan Visits SSRF

SSRF



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