CONSTRUCTION STATUS OF THE SSRF PROJECT

Z. T. Zhao, H. J. Xu, H. Ding for the SSRF Project Team
Shanghai Institute of Applied Physics, P.O.Box 800-204, Shanghai 201800, P. R.China

Abstract

The Shanghai Synchrotron Radiation Facility (SSRF), an intermediate energy third generation light source, is under construction at Zhang-Jiang Hi-Tech Park in Shanghai. Its main and auxiliary buildings are scheduled to be completed in October, 2006, and this is followed by the SSRF accelerator installations from October, 2006 to March, 2008. This paper presents the final design and the current construction status of the SSRF project.

INTRODUCTION

The SSRF complex consists of a full energy injector including a 150MeV linac and a 3.5GeV booster, a 3.5GeV storage ring with circumference of 432m and dozens of beamlines and experimental stations. Its main characteristics were reported elsewhere [1].

The SSRF construction is in progress with the target schedule of starting the user operation from April 2009. The SSRF building construction started in December 2004, and now the main building is in the phase of roof construction. Figure 1 shows the building appearance in May 2006. The construction of foundation piles and slabs has been completed and the accelerator tunnels are almost finished and can be accessed for machine installation from Oct. 2006. The main constructions of the auxiliary buildings, including utility buildings, a technical building, an office building, a cafeteria and a guest house, have been completed, and their architectural decorations are under way. All the SSRF building constructions will be finished at the end of 2006.

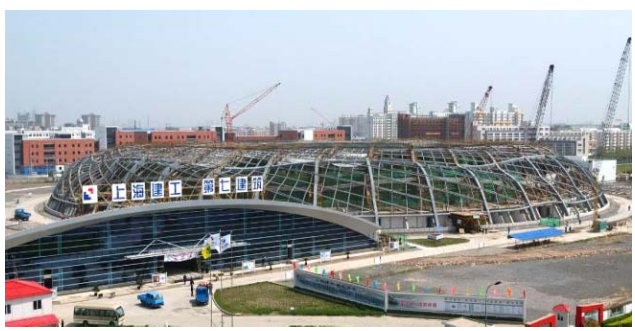

Figure 1: The SSRF main building, May 2006

The detailed SSRF accelerators engineering design has been performed in 2005, and in the mean time most major accelerator components have been contracted on schedule with manufacturers. These components are now under fabrications, first acceptance measurements and integration tests. To date about 50% of the machine capital budget has been committed, and many remaining contracts are still in progress.

STORAGE RING

Magnets and girders

The SSRF storage ring contains 40 dipoles, 200 quadrupoles and 140 sextupoles. The dipole and quadrupole magnets are under fabrication at the IHEP workshop, Beijing, and the magnetic measurements of the first magnets are in progress. The main magnetic field parameters are qualified within the specifications. The sextupoles are being manufactured at the SINR Workshop, Shanghai, the first 4 magnets have been measured with qualified main field parameters. Figure 2 shows the magnets in one of the storage ring sectors.

Figure 2: A mechanical sector of the SSRF storage ring

There are three steel girders and two concrete pedestals in each of the 20 storage ring arc cells, for supporting 10 quadrupoles, 7 sextupoles and 2 dipoles. The steel girders are 3.3 to 4.5m long each, and each steel girder consists of a steel plate and a welded steel structure with rectangular section, supported by 3 ball bearing and wedge jack combined adjusters and 3 accessorial fixed sticks. The prototypes of both concrete pedestals and longest steel girders have been built and tested, the eigen-frequency and vibration transfer function have been measured and analysed. The achieved lowest vibration frequency is around 20Hz, which is determined mainly by the weak adjusters.

Vacuum system

A decision was made on changing the vacuum chamber material from aluminium to stainless steel in April 2005, then it followed by making three phased stainless steel vacuum chamber prototypes. The last full scale prototype for one arc cell were completed in May 2006, it is qualified within almost of all the specifications. One arc

vacuum chamber cell is about 14m long and consists of 6 sections of stainless steel antechambers with lengths of about 1.42m to 2.97m each. In each arc cell, two DN150 RF shielded bellows are used to connect the two end chambers and the one middle straight chamber, each end chamber comprises two or three short stainless steel chambers with hard connection of rectangular flanges.

There are 9 photon absorbers, 9 TSP pumps and 11 SIP pumps installed in one storage ring arc cell. The vacuum chamber will be pre-baked before installation and there is no in-situ baking employed. The contracts of vacuum chambers, photon absorbers and vacuum pumps have been placed to two domestic industries at Shanghai and Hangzhou, and the fabrications are in progress. The chamber and absorber prototypes and the first pumps are integrated into an arc cell installation, and its vacuum has reached ~10^{-10} mbar. The fabrications are expected to be finished before July 2007.

RF system

The RF system has five main components, three 500MHz SRF cavity modules, three 310kW klystron amplifiers, a 650W liquid helium refrigerator, low level RF control and cryogenic control systems. The SRF cavity modules are located in a 12m long straight section, it will provide 2~6 MV accelerating voltage and about 600kW RF power to the 200~300mA electron beam which circulates in the storage ring. The SRF cavity modules are under construction at ACCEL Instruments GmbH Germany, the first one will be shipped to the SSRF site in April 2007 and the third one in August 2007. The RF klystron amplifiers have been contracted with THALES, France, the first set will be delivered to the SSRF site in November 2006 and its site acceptance is scheduled in April 2007. The cryogenic plant with cooling power of 650W at 4.2K is under construction in collaboration with Institute of Physical and Chemical Technology, CAS, the refrigerator is being manufactured at Air-Liquide, France and it will be shipped to the SSRF site in November 2006.

Power supplies and injection system

The power supplies are contracted with two Chinese industries. The 200 individual quadrupole power supplies rated at 280A/20-40V are being manufactured at Boxing Keyuan Electronic Tech. CO. Ltd., Beijing. The first power supply will be tested at SSRF in August 2006 and construction of all the power supplies will be completed in August 2007. The dipole magnet power supply rated at 850A/800V and sextupole magnet power supplies rated at 200-280A/100-290V are under fabrication at Xi'an Action Electronics CO. Ltd. Xian. A half scale dipole power supply and a full scale sextupole power supply will be completed in August 2006, and all the power supplies will be shipped to the SSRF site in September 2007. The SSRF power supplies are all digitally regulated, and the PSI type digital controllers are provided by DLS.

All the injection elements including two septa and four kickers are located in one of the 12m straight sections. The kicker system consisting of pulse magnets, ceramic vacuum chamber and pulsed power supply has been just contracted with ACCEL Instruments GmbH, Germany. The septum magnet prototype and its pulser are being manufactured at SKY Technology Development CO. Ltd, Shenyang and COWEMV Wuhu, and they will be tested in October 2006.

Beam diagnostics

Evaluations of the BPM prototypes and its associated electronics have been finished with a good agreement with the SSRF specification. Contracts of the 140 BPM electronics and 152 BPM feedthroughs and 152 button electrodes will be placed in July 2006. A DCCT sensor and its electronics from Bergoz are under evaluation together with a PXI voltage meter card from NI USA. A diagnostic beam line is being developed at SSRF, which contains a streak camera, a fast gated camera, two interferometers (horizontal and vertical) and a normal CCD. In addition, two stripline kickers and two profile monitors are under construction for the SSRF storage ring.

Installation

The installation of storage ring is scheduled to start in May 2007, while the preassembly and pre-alignment of the storage ring mechanical sectors will start in December 2006. The electric installation design and procedures of cabling and piping are under way.

INJECTION SYSTEM

Linac

In order to get high performance of the SSRF booster and highly stable operation of the SSRF linac, the linac energy is increased from 100MeV to 150MeV by adding one more 45MW pulsed klystron amplifier. All the major linac components are contracted out and under construction. A 500 MHz sub-harmonic buncher, a 3GHz fundamental buncher and four 3m accelerating sections are being fabricated at IHEP workshop and will be shipped to SSRF site for acceptance tests in November 2006. Three klystrons have been contracted with Toshiba Electron Tubes and Devices CO. Ltd., Japan, and they will be delivered to Shanghai in October 2006. Two modulators are under manufacture at COWEMV Wuhu. The 100kV electron gun, the linac microwave and waveguide system, control and diagnostics system are being developed and integrated in house. The linac installation is scheduled to start from November 2006, and the linac commissioning is expected to be conducted from April to July 2007.

Booster

The 48 dipole magnets and girders are being fabricated at Kelin Shanghai, and the 56 quadrupole magnets and 46 sextupole magnets at USTC CHUANGXIN CO. Ltd., Hefei. The first magnets have been measured within the required specifications. Manufactures of these girders and magnets will be completed in November 2006, their

preassembly and installation on the SSRF site will start in December 2006.

The 6m long and 0.7mm thick stainless steel vacuum chamber is being manufactured at Northeast University, Shenyang. The first section including standard BPM part is qualified for releasing batch production in June 2006, and chamber fabrication will be finished in December 2006. As shown in figure 3, the vacuum chamber, girders and first magnets are integrated into a booster unit cell.

Figure 3: A SSRF booster unit cell

The booster RF system comprises two 5-cell 500MHz copper cavities and one 180kW klystron power amplifier. The copper cavities and the associated booster LLRF system are being constructed at ACCEL Instruments GmbH, and they are scheduled to be delivered to SSRF in February 2007. The 180kW RF power amplifier the SSRF installed in 2001 will be relocated to SSRF site in January 2007. The booster RF commissioning is scheduled to start from April 2007.

The dynamic magnet power supplies for the SSRF booster are also being manufactured at Xi'an Action Electronics Co. Ltd., the prototypes will be tested in September 2006 and all the booster power supplies will be delivered to SSRF before July 2007.

The injection (a septum and a kicker) and extraction magnets (a kicker, two septa and three bumpers) are being developed. The kicker and septum prototypes are under fabrication at SKY Technology Development CO. Ltd, Shenyang, they will be delivered to SSRF for tests in July 2006 and the formal construction will be carried out from August 2006 to January 2007. The design of booster extraction bumpers has been finished, and the construction contract will be placed in July 2006. The pulsers are under manufacture at COWEMV, Wuhu and will be ready for test in December 2006.

The main booster installation will be carried out from March to July 2007. It will be followed by equipment tests from July to September 2007. The booster beam commissioning is scheduled to start from October 2007.

Transfer lines

The engineering design of linac to booster (LTB) and booster to storage ring (BTS) transfer lines has been completed by the end of 2005. The dipoles, quadrupoles and correctors for both LTB and BTS, are under construction at IPP workshop, Hefei and Kelin Shanghai, the first magnets will be delivered for magnetic measurements in July 2006, and fabrications will be finished in September 2006. The contract of transfer line magnet power supplies will be placed in July 2006, the delivery of the power supplies is due to October 2006. In addition, other transfer line components, such as vacuum system, girders, beam diagnostics, beam stoppers and etc., are all under construction on schedule.

INSERTION DEVICES

There are seven beamlines and one branch beamline funded as first beamlines by the SSRF project, and among them six are based on insertion devices [2].

Design of the five insertion devices has been completed, table 1 shows their main parameters. The contract of the two in-vacuum undulators will be placed in July 2006, and they are expected to be delivered to SSRF 15 months later. Two wigglers and one EPU undulator will be developed in China with the joint efforts of SSRF and Chinese industries, and their installations in the SSRF storage ring are scheduled to start from October 2008.

Table 1: Main Parameters of first SSRF IDs

	Type	Period mm	N	Min.Gap mm	Peak Field T
EPU100	PPM	100	42	32	0.6 (By) 0.33(Bx)
IVU25-1	Hybrid	25	80	6	0.94
IVU25-2	Hybrid	25	80	6	0.94
W79	Hybrid	79	19	14	1.2
W140	Hybrid	140	8	14	1.94

MACHINE CONTROL SYSTEM

The EPICS based machine control system is under development at SSRF [3]. The procurement of hardware and software environments is being conducted, and the major engineering design of the machine control system has been completed. In the meantime the prototypes of timing system, vacuum and power supply controllers have been developed and evaluated, the machine and personnel safety interlock systems are under construction.

The SSRF data archive system adopts RDBMS for data storage and management. Now the high level accelerator application software is being set up at SSRF.

REFERENCES

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