PRESENT STATUS OF SRRC

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ABSTRACT

The Synchrotron Radiation Research Center (SRRC) has been established to construct and operate a 1.3 GeV third generation synchrotron radiation facility at Hsinchu, Taiwan, Republic of China. Following is a brief report on its present status.

I. INTRODUCTION

A. Site

Hsinchu is about 75 kilometer south of Taipei. SRRC is located at the northwest bound of the Hsinchu Science-Based Industrial Park in the vicinity of two leading technical universities, namely, the National Tsing Hua University and the National Chiao Tung University, and the leading Industrial and Technological Research Institutes of Taiwan. The SRRC site is triangular in shape with an area of 15 hectares.

B. General Characteristics of SRRC

The SRRC synchrotron layout is shown in Figure 1. The Booster and the Storage Ring Buildings are in a lower and upper level with a height difference of 4 m between them. The Booster and the Storage Ring are connected by a 70 m BTS (Booster-to-Storage Ring) transport line. The injection system consists of an electron gun, a 50 MeV linac and a 1.3 GeV booster synchrotron. The storage ring is characterized by a circumference of 120 m, a 6-fold symmetry, and 6 straight sections, with each 6 m long.

The major parameters of the injector and the storage ring are given in Table 1 and Table 2 respectively.

Table 1 Design Parameters of the Injector

Linac energy	50 MeV
Linac current (multi-bunch mode, average current)	30 mA
Booster energy	1.3 GeV
Booster current	5 mA
Booster pulse rate	10 Hz (for positron option)

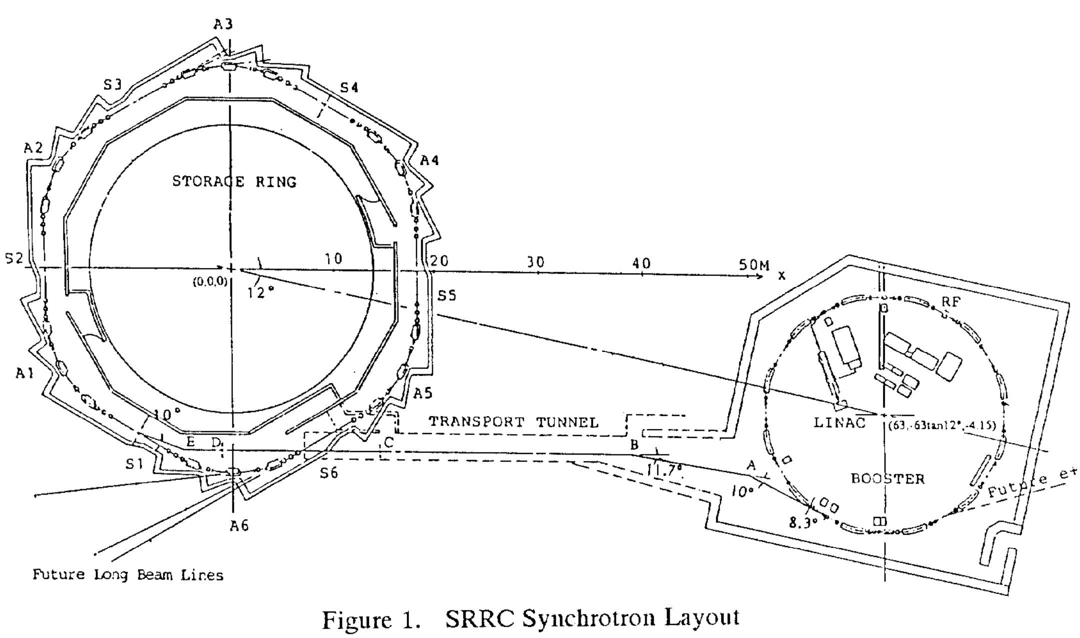


Figure 1. SRRC Synchrotron Layout

Table 2. Major Parameters of the Storage Ring

Lattice structure	TBA (combined function bending magnets)	
Nominal energy	1.3	GeV
Nominal circulating current, multibunch	200	mA
Number of stored electron, multibunch	$5\ 10^{11}$	
Nominal circulating current, single bunch	5	mA
Number of stored electron, single bunch	$1.25\ 10^{10}$	
Natural emittance	$1.92\ 10^{-8}$	m*rad
Natural energy spread, rms	$6.6\ 10^{-4}$	
Relative energy spread, rms		
Multibunch	$6.6\ 10^{-4}$	
Single bunch	$6.6\ 10^{-4}$	
Bunch length, rms (1σ), natural	7.4	mm
Bunch length, (2σ), natural	49	ps
Bunch length, (2σ), nominal current		
Multibunch	49	ps
Single bunch	49	ps
Beam lifetime, half-life		
Gas scattering lifetime at 1 n Torr		
20 mm vertical gap	39	hr
Touschek lifetime at nominal current		
Multibunch	19	hr
Single bunch	5.5	hr
Filling time		
Multibunch	10	sec
Few bunch	5	sec/bunch
Circumference	120	m
Orbital period	400.3	ns
Radio frequency	499.654	MHz
Harmonic number	200	
Nominal peak rf voltage	0.8	MV
Number of superperiods	6	
Insertion straight section length	6	m
Bending field	1.24	T
Bending radius	3.495	m
Injection energy	1.3	GeV
Number of dipoles	18	
Number of quadrupoles	48	
Number of sextupoles	24	
Momentum compaction factor	$6.78\ 10^{-3}$	
Betatron tunes		
Horizontal	7.18	
Vertical	4.13	
Synchrotron tune	$1.15\ 10^{-2}$	
Natural chromaticities		
Horizontal	-15.261	
Vertical	- 7.885	
Damping time		
Horizontal	10.691	ms
Vertical	14.397	ms
Longitudinal	8.708	ms
Envelope function beta x at insertion	10.52	m
Envelope function beta y at insertion	2.94	m
Beam size (1σ) at insertion middle		
Horizontal	0.428	mm
Vertical (10% emittance ratio)	0.428	mm
Critical photon energy (dipole)	1.39	keV

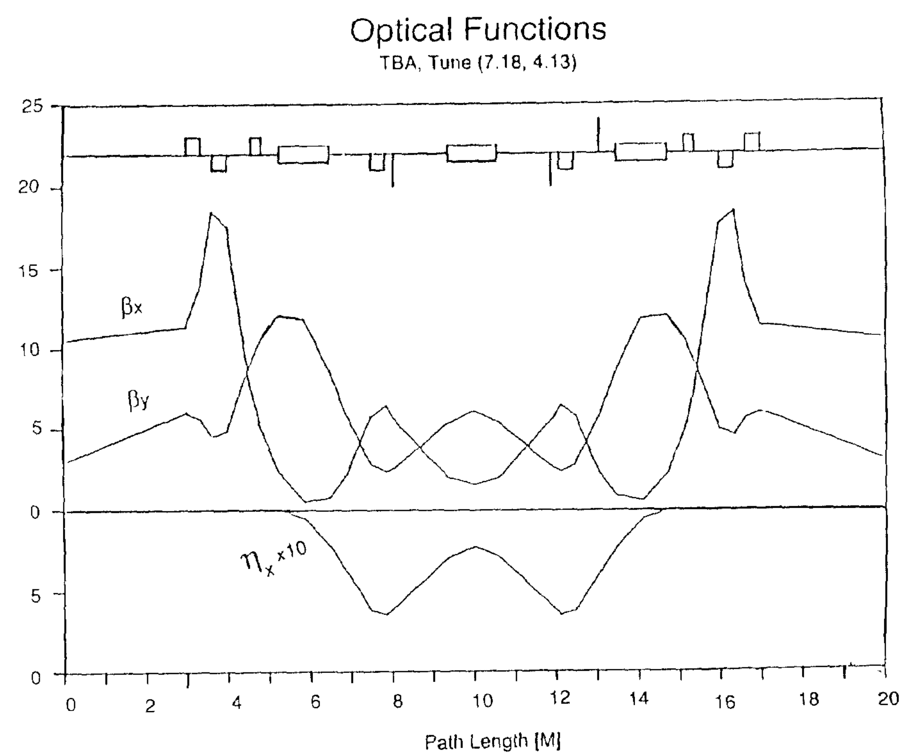


Figure 2. The Optical Functions of the Lattice for One Superperiod

The TBA lattice with horizontal emittance of 1.92×10^{-8} mrad was chosen for the ring. There are six superperiods. The optical functions of the lattice for one superperiod are shown in Figure 2.

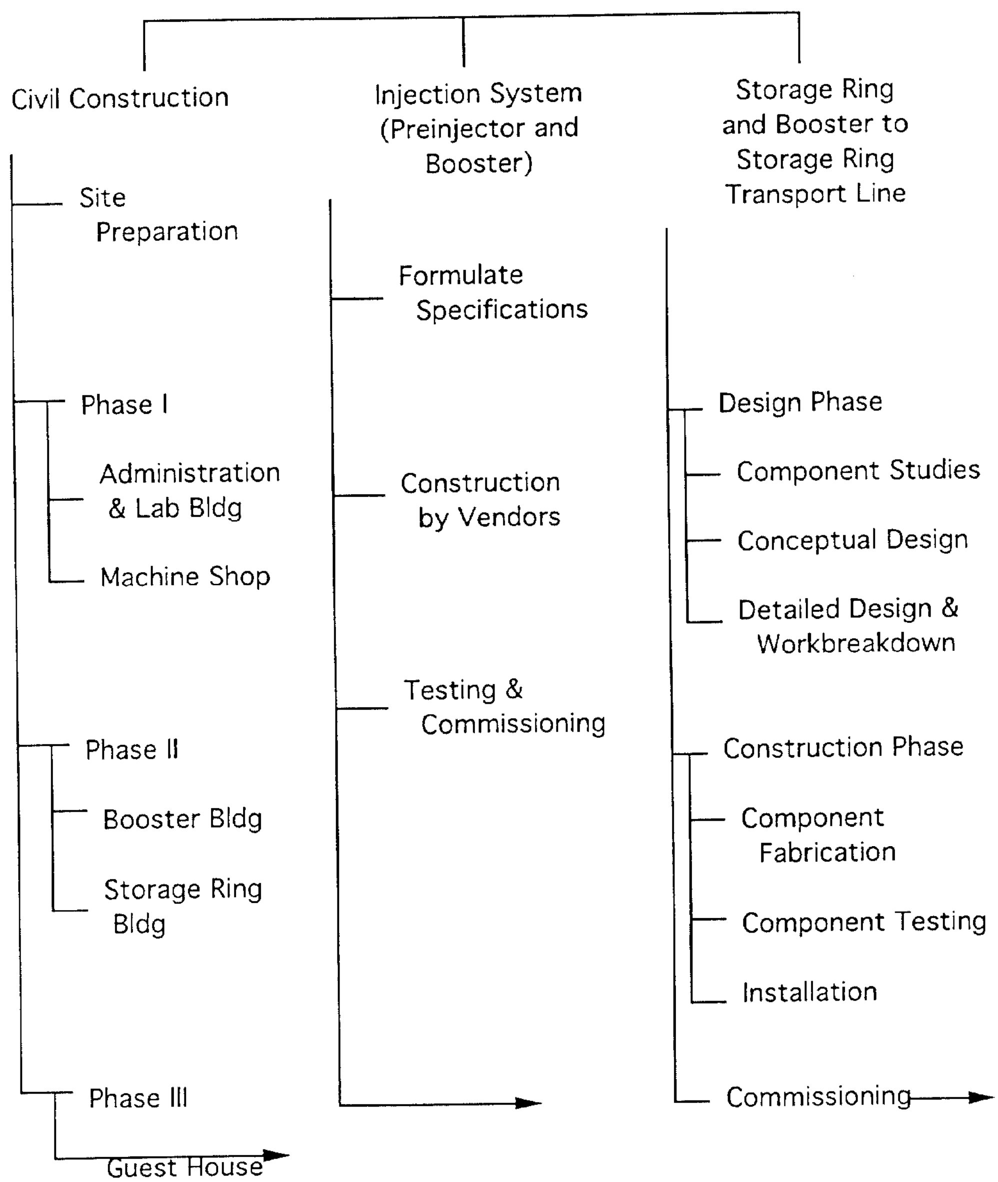
II. SRRC CONSTRUCTION OVERVIEW

An overview of the SRRC construction is shown in Table 3.

A. Civil Construction

The Phase I construction including the Administration and Lab Building and the Machine Shop was completed in May 1990. The entire staff move into the Hsinchu site in June 1990. The Phase II construction took about one and a half year. The Booster Building was completed in February 1991 just in time for the delivery of the injector components. The Storage Ring Building was completed in December 1991.

Table 3. SRRC Construction Overview



B. Injection System

The injection system was contracted out to Scanditronix AB, Sweden in August 1988. However, SRRC is fully responsible for the RF system of the booster synchrotron.

The SRRC staff has been operating the injection system since July 1992 with very satisfactory performance. Machine studies have been performed. Parameters of the booster are measured at the injection energy of 50 MeV. The results are in good agreement with the design values.

C. Component Fabrication and Testing for the Storage Ring

A general account on this subject will be given here. A more detailed report can be found in another paper in these Proceedings entitled *"Construction and Commissioning of the SRRC Storage Ring"*.

Most of the vacuum chambers were made of aluminum. All the chambers are already fabricated and installed. One sextant section has been baked, tested and maintained at 4×10^{-11} Torr for more than six months. At present, without turning on the ion pumps, the vacuum pressure is about 10^{-8} Torr without beam, and about 10^{-7} Torr with a few mA stored beam current. Bakeout of the vacuum chamber will be carried out in June 1993. With the ion pumps turned on, the vacuum should improve greatly. Further improvement is also expected from synchrotron radiation cleaning.

There are three identical RF systems at SRRC. One for the booster and two for the storage ring. Six 500 MHz cavities were bought from DESY. The low level electronics and transmitters were constructed by SLAC and Mountain Technology, USA, respectively. SRRC is responsible for assembling the RF systems. The booster RF system became operative in December 1991. It is highly reliable. In more than 3300 accumulated operating hours, only four days were needed for checkup and maintenance. One of the RF system for the storage ring became operative in March 16, 1993.

There are 18 bending magnets, 48 quadrupoles, 24 sextupoles, 24 horizontal and 30 vertical correctors around the ring. The bending magnets are curved, combined function types. In addition, there are pulsed magnets, 4 kickers and 1 septum. All these magnets were designed, constructed and measured locally. All the magnets installed in the ring are within acceptable tolerances in terms of multipole errors.

We would like to refer the reader to another paper entitled *"Diagnostic Instrumentation System for the SRRC 1.3 GeV Synchrotron Radiation Light Source"* in these Proceedings which has the details of the control and diagnostic system of SRRC.

Installation and subsystem testing of the storage ring were completed March 1993. Major efforts were put in the survey and alignment. Accuracy of ≤ 0.2 mm at the quadrupole location has been achieved.

III. STORAGE RING COMMISSIONING

A brief summary of the commissioning of the SRRC storage ring as to date is given in Table 4.

Table 4. Commissioning Milestone

Feb 23, '93	First turn (On axis injection at 1.3 GeV)	
RF installation:		
	Feb 22, '93	Transmitter arrived
	Mar 16, '93	The first rf system worked
All four kickers installed		
Apr 2, '93	First few turns	
Apr 13, '93	First beam stored	
Apr 26, '93	BPMs became operative	
	Machine parameters study started	

At present, beam can be routinely stored with a current of a few mA with lifetime of ~ 30 minutes. Machine studies are carried out. Current and lifetime are presently limited by the vacuum. The vacuum is expected to greatly improve when the bakeout is carried out and the ion pumps are turned on.

Starting this May, the beam energy can be measured to an accuracy of $\leq 10^{-3}$. Synchrotron radiation from the stored beam has been observed. The bunch length of the beam was measured to be $\sigma \sim 42$ psec. Closed orbit distortions in both vertical and horizontal directions are measured by the BPMs. Application programs are used to make corrections. This indicates that both the hardware and software are working properly.

The dispersion function $\eta(s)$ and the momentum compaction factor α are measured showing results in good agreement with the design values. It has also been demonstrated that chromaticity can be corrected to $\xi \sim 0$ using the sextupole at the nominal strength.

In order to study the transverse dynamic features of the lattice, we have measured $\upsilon_x = 7.14$, $\upsilon_y = 4.17$ to compare with the design values (7.18, 4.13). The β_x, β_y function are also measured. The results are in very good agreement with the designed values.

With the measurement of the machine parameters, the first part of the commissioning phase has been completed. There will be a two-month shutdown for (i) bakeout of the chamber, (ii) installation of the three VUV photon beamlines, and (iii) continuing survey and alignement work. Further commissioning of the storage ring will start in July 1993. With the completion of commissioning and installation of the beamlines, the SRRC facility is expected to become operative in September 1993.

IV. ACKNOWLEDGEMENT

The success of the early stage commissioning of this rather complicated accelerating system is due to the excellent performance of the essential components and subsystems. However, without the hardwork and full commitment of the entire SRRC staff, this achievement could not have been possible. Our deepest gratitude and thankfulness also to all our friends abroad who have given us their invaluable advices and support which are essential for the project.

V. REFERENCES

[1] "SRRC Design Handbook", SRRC, April 28, 1989.
[2] "SRRC Status Report", SRRC, January 1993 Edition.
[3] "SRRC Status Report", SRRC, April 1993 Edition.