Central Japan Synchrotron Radiation Research Facility Project

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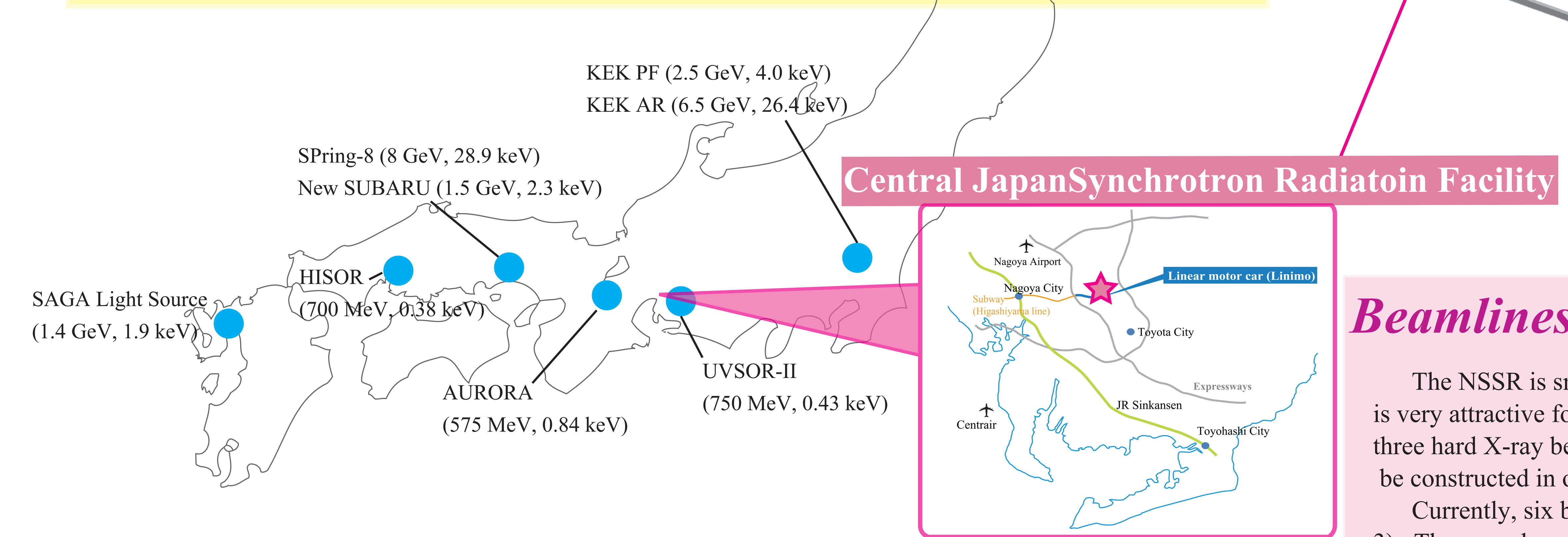
Introduction

Synchrotron Radiatoin (SR) Facility project has been proposed at Nagoya University since 1991. The basic idea was neither a large nor medium size ring, but a compact ring with the ability to supply hard X-rays. This idea was extended to "Photo-Science Nanofactory," consisting of an SR facility and advanced analysis equipments such as TEM, SEM, AES, and XRD. In the mean time, the Aichi Prefectural government has been planning a new research and development complex for industries and universities in the Central area of Japan and the "Photo-Science Nanofactory" plan has been considered to be the best fit to the Aichi project. Therefore, the Prefecture, Industries, Universities, and Research Institute in the Aichi area are working together to realize this plan.



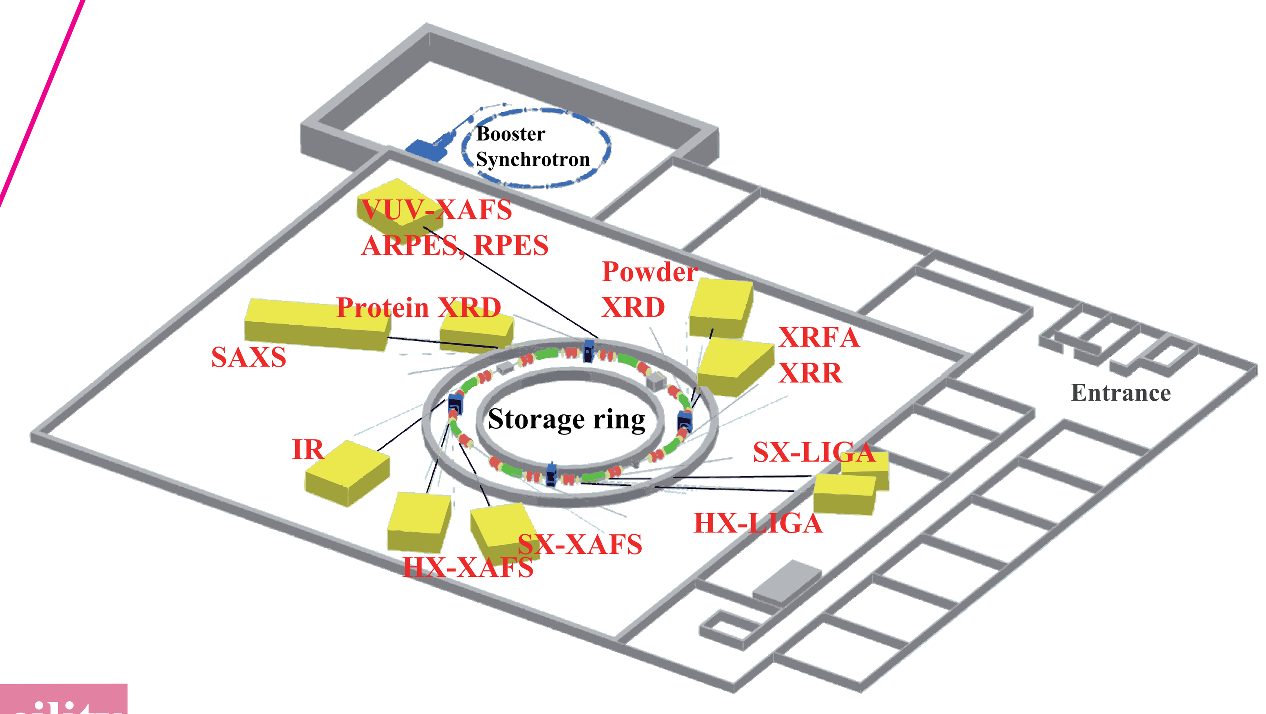


Figure 3. Schematic view of the floor plan

Beamlines

The NSSR is small but powerful enough to supply hard X-rays from four superbends, and it is very attractive for both academic studies and industrial applications. We can extract two or three hard X-ray beamlines from one superbend, so that more than 10 hard X-ray beamlines can be constructed in our facility.

Currently, six beamlines are under consideration to be constructed in the first phase (Table. 3). Those are beamlines for hard X-ray XAFS, soft X-ray XAFS, soft X-ray to ultraviolet spectroscopy, small angle scattering, X-ray diffraction, and X-ray fluorescence analysis.

Accelerators

The key equipment of the plan is a compact electron storage ring that is able to supply hard Xrays. The SR facility, consisting of accelerators, beamlines, peripheral equipments, and housing, has been designed at the Nagoya University Synchrotron Radiation Research Center. The layout of the storage ring called as NSSR (Nagoya University Small Synchrotron Radiation Ring) is shown in Figure 1. The energy, beam current and circumference are 1.2 GeV, more than 300 mA, and 62.4 m, respectively. The natural emittance is 53 nmrad.

The configuration of the storage ring is based on the Triple Bend with twelve bending magnets. Eight of them are normal conducting magnets (normal bends) of 1.4 T and four of them are 5 T superconducting magnets (superbends). The bending angle of them is 12 degrees and two or three hard X-ray beamlines can be constructed for each superbend. The flux from bending magnet is shown in Figure 4. The critical energy of the X-rays is 4.8 keV, which is close to that of KEK Photon Factory. The number of beamlines from normal bends is more than 16.

In addition, we will install an undulator and a wiggler in straight sections. In order to enable the top-up operation, the electron beam will be injected from a booster synchrotron with the full energy of 1.2 GeV. A 50 MeV linac will be used as an injector to the booster synchrotron.

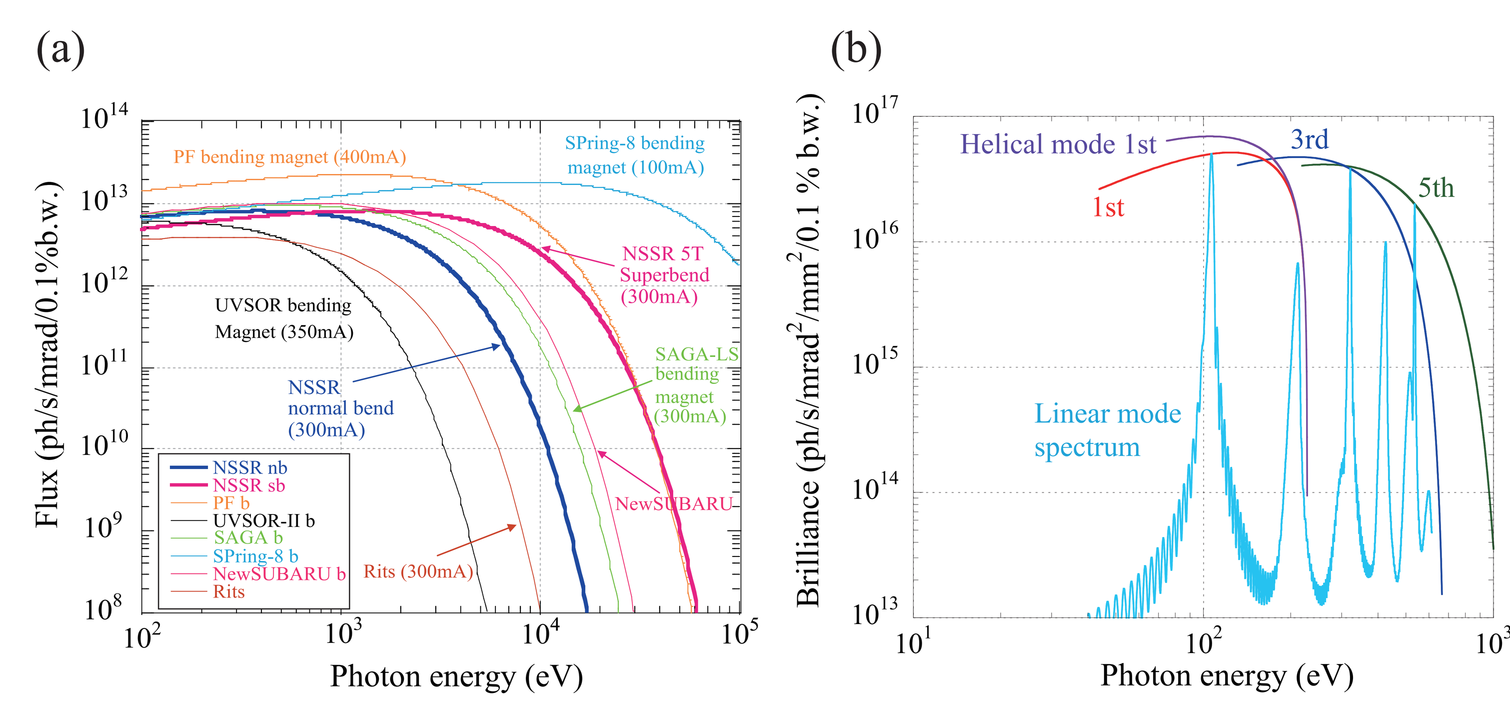


Figure 4. Spectra of photon flux from bending magnets (a) and brilliance from undulator (b)

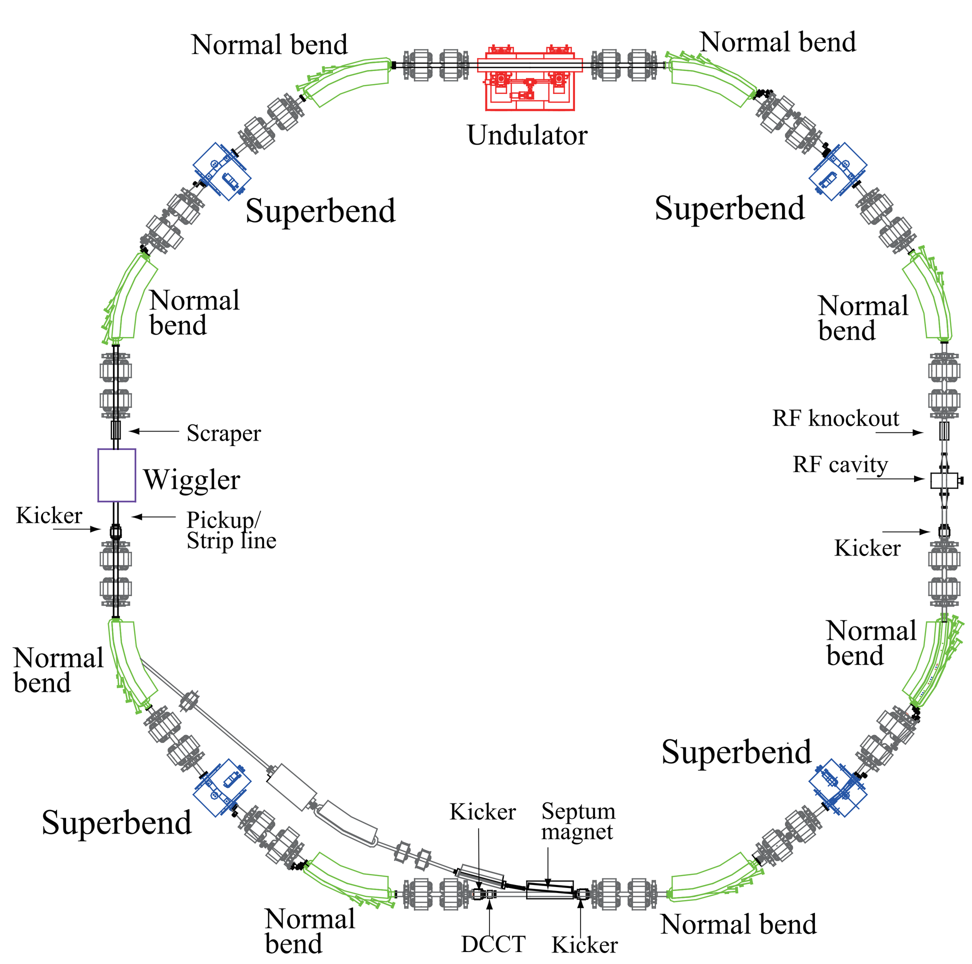


Figure 1. Layout design of NSSR

Table 1. Parameters of NSSR

Storage ring	
Beam energy	1.2 GeV
Current	> 300 mA
Circumference	62.4 m
Normal bend	1.4 T, 39° x 8
Super bend	5 T, 12° x 4
RF frequency	500 MHz
Natural emittance	53 nmrad
Magnetic lattice	Triple Bend Cell x 4
Straight section	2.8 m x 2
Booster synchrotron	
Max. beam energy	1.2 GeV
Circumference	38~50 m
RF frequency	500 MHz
Injector linac	
Beam energy	50 MeV
Current	100mA
RF frequency	2856 MHz

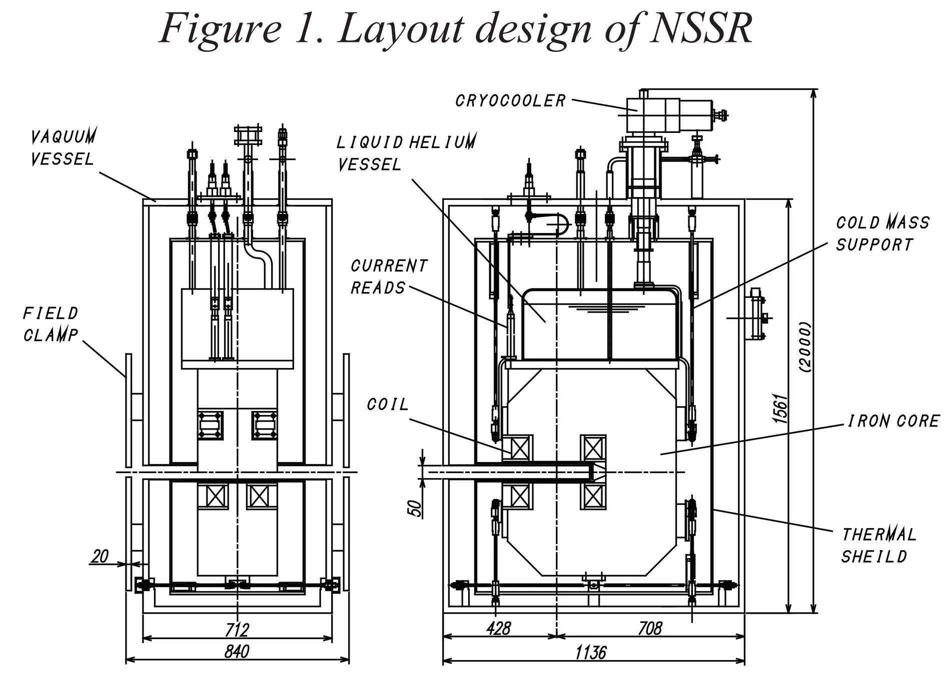


Figure 2. Shematic View of the superbend

Table 2. Parameters of the superbend

York type	1.2 GeV
Peak field	> 5 T
Bending angle	12° (1.2 GeV)
Size	
Length	< 950 mm
Hight	< 3000 mm
Width	< 900 mm

Table 3. Six beamlines constructed in the first phase

Beamlines	Energy Range	Source	Optics
Hard X-ray XAFS	5-20 keV	Superbend	CM-DXM-RFM
Soft X-ray XAFS	1-6 keV	Normal bend	CM-DXF-RFM
VUV & Photoemission Spectroscopy	0.03-1.5 keV	Undulator	VIAM
Small angle X-ray Scattering	5-20 keV	Superbend	TM-DXM
X-ray Diffraction	5-20 keV	Superbend	VCM-SDXM-VRFM
X-ray Fluorescence & Reflectivity	5-20 keV	Superbend	VFM-ASXM

CM:collimation mirror, DXM:plane 2 crystal monochromator, RFM:refocusing mirror, TM:toroidal mirror, VIAM:variable-included-angle Monk-Gillieson mounting monochromator, VCM:vertical collimating mirror, SDXM:sagittal focusing 2 crystal monochromator, VRFM:vertical refocusing mirror, ASXM:asymmetric 1 crystal monochromator.

Construction Schedule

2009. Construction of the buildings
2010. Constructoin of the ring
2011. Construction of the beamlines
The first light from NSSR