New Synchrotron Radiation Research Facility Project in Aichi area of Japan

Y. Takashima
Synchrotron Radiation Research Center, Nagoya Univ.

- Introduction
  - Concept of the facility
  - Collaboration

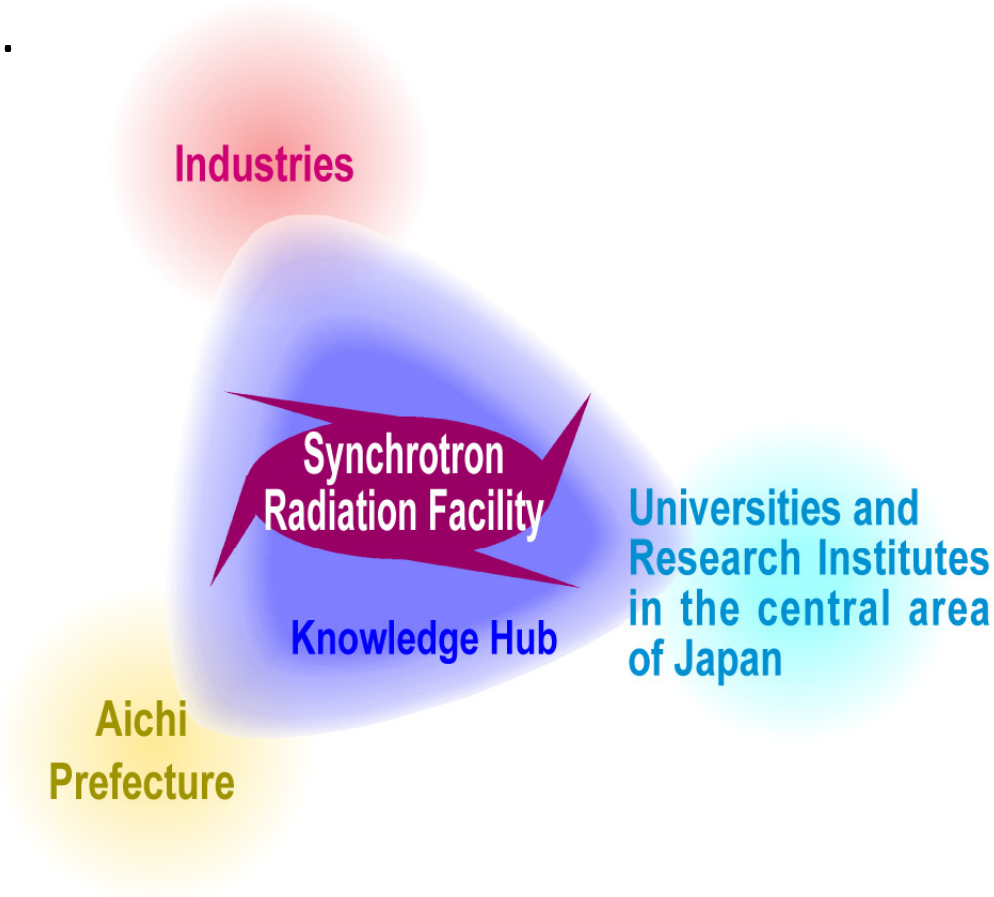
- Accelerator Complex
  - Injectors (Linac, Booster synchrotron)
  - Storage Ring
  - Superconducting Bending Magnet (Superbend)

- Radiations (for emulsion experiments)
  - Electron beam, gamma-ray

Introduction to the New Synchrotron Radiation Facility

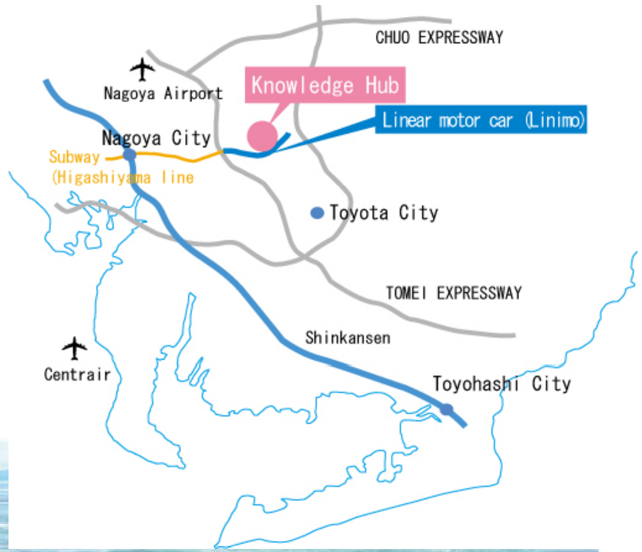
The planning of the Synchrotron Radiation Facility of Nagoya Univ. started in 1991. The basic idea of the facility was a compact electron storage ring with the ability to emit hard X-rays. We have been proposing a facility not only for basic research, but also for engineering and industry-oriented research and development. The idea was extended to "Photo-science Nano-factory" that is consisted of the synchrotron radiation facility as the core facility, those conventional but high level equipments such as Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), and XRD together with supporting system for research and experiments, i.e., an institute that gives clear solutions to the people who visited this institute.

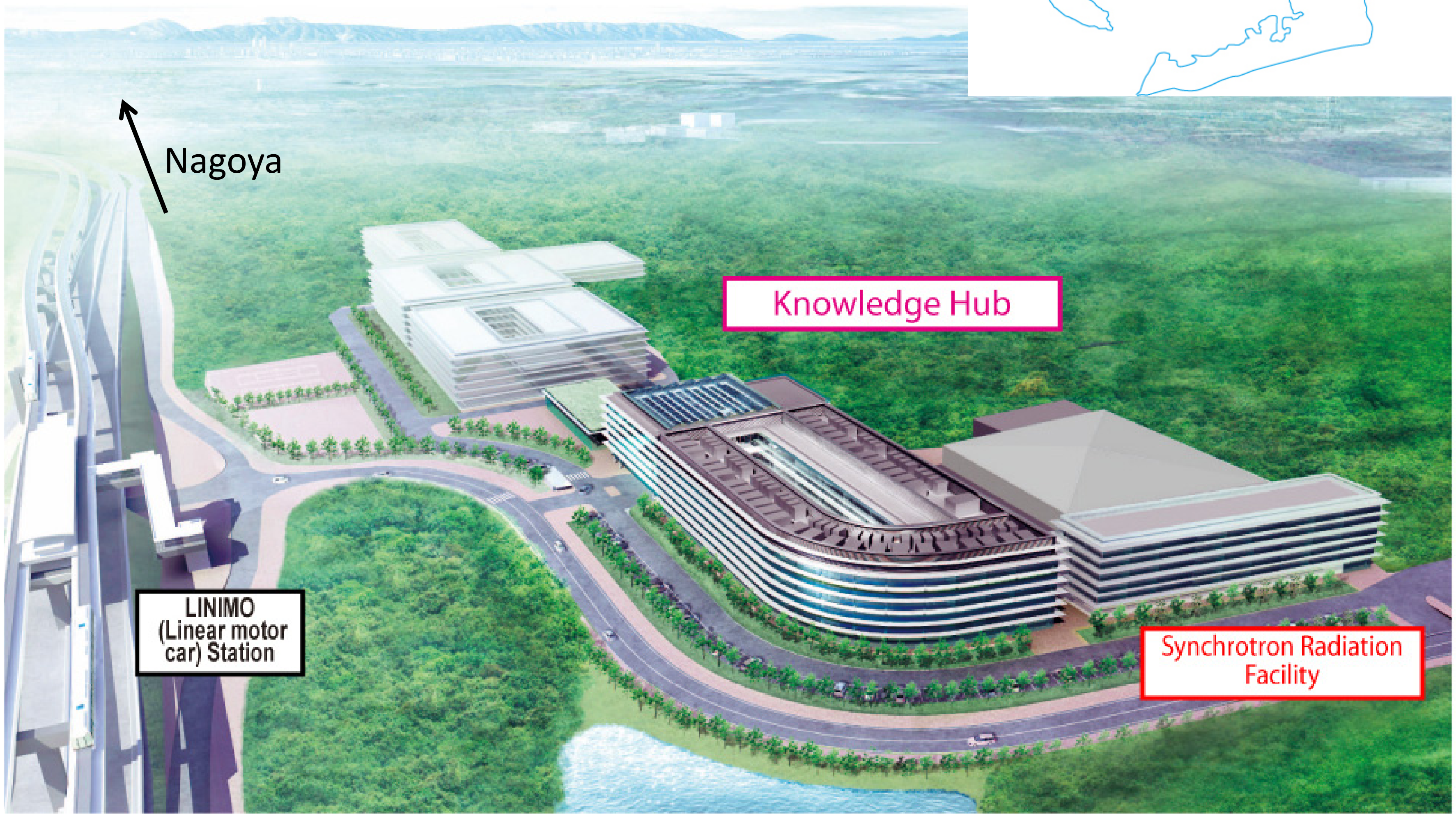
In the mean time, the Aichi Prefectural Goverment has been planning “Knowledge Hub” that creates and publicizes new technologies and innovations for the next generation industries. The “Photo-science Nano-factory” plan was understood to be the best fit to the “Knowledge Hub” plan. The Prefecture, Industries, Universities, and Research Institutes in the Aichi area are working together to realize this plan.



Bird's eye view

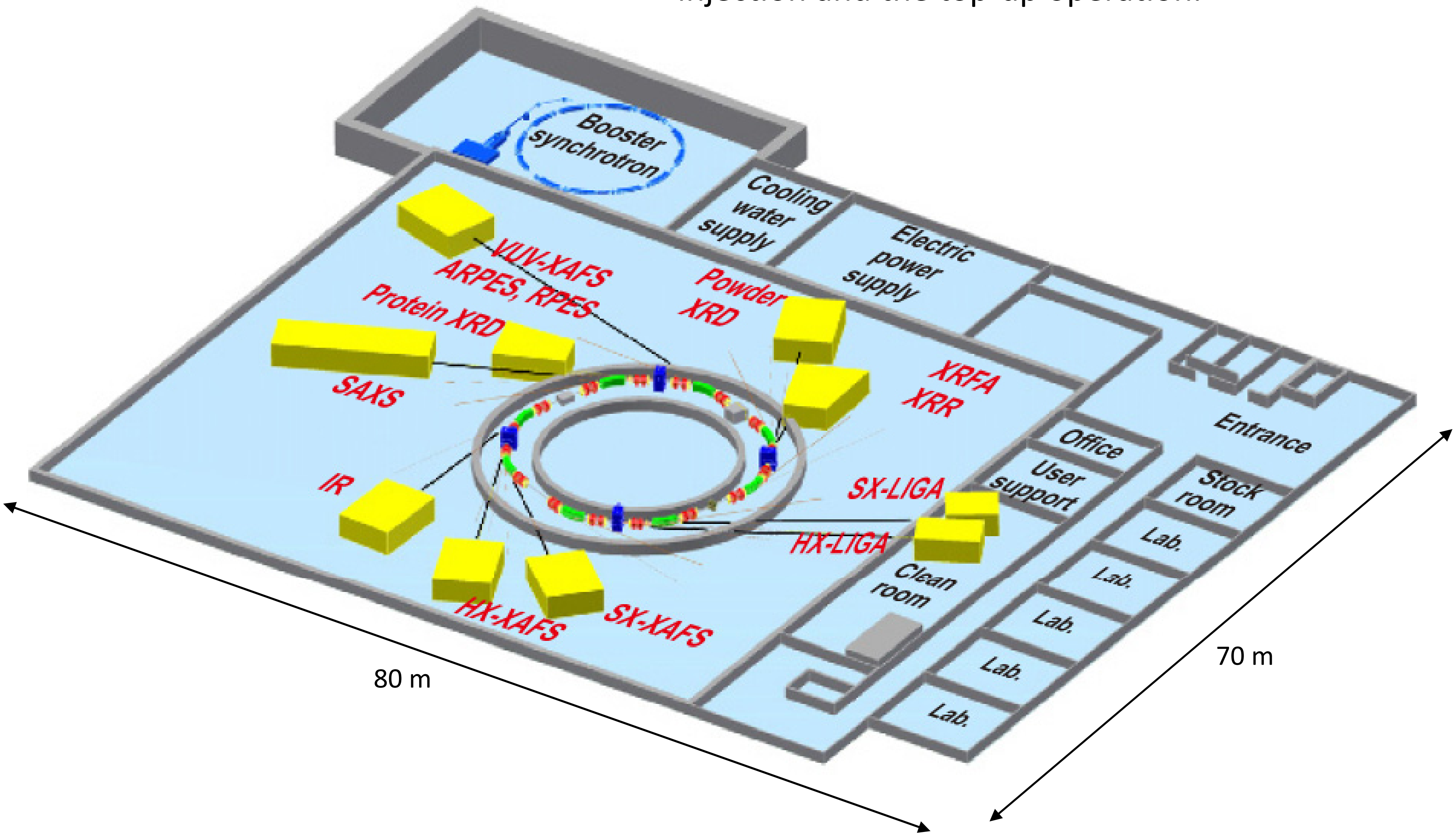
Knowledge Hub and Synchrotron Radiation Facility just in front of the LINIMO station. Other facilities form the Complex.





Floor plan

Beamlines and laboratories located on the first floor. Four superconducting bending magnets, an undulator, and a wiggler are installed. A booster synchrotron is also installed for the full energy injection and the top-up operation.

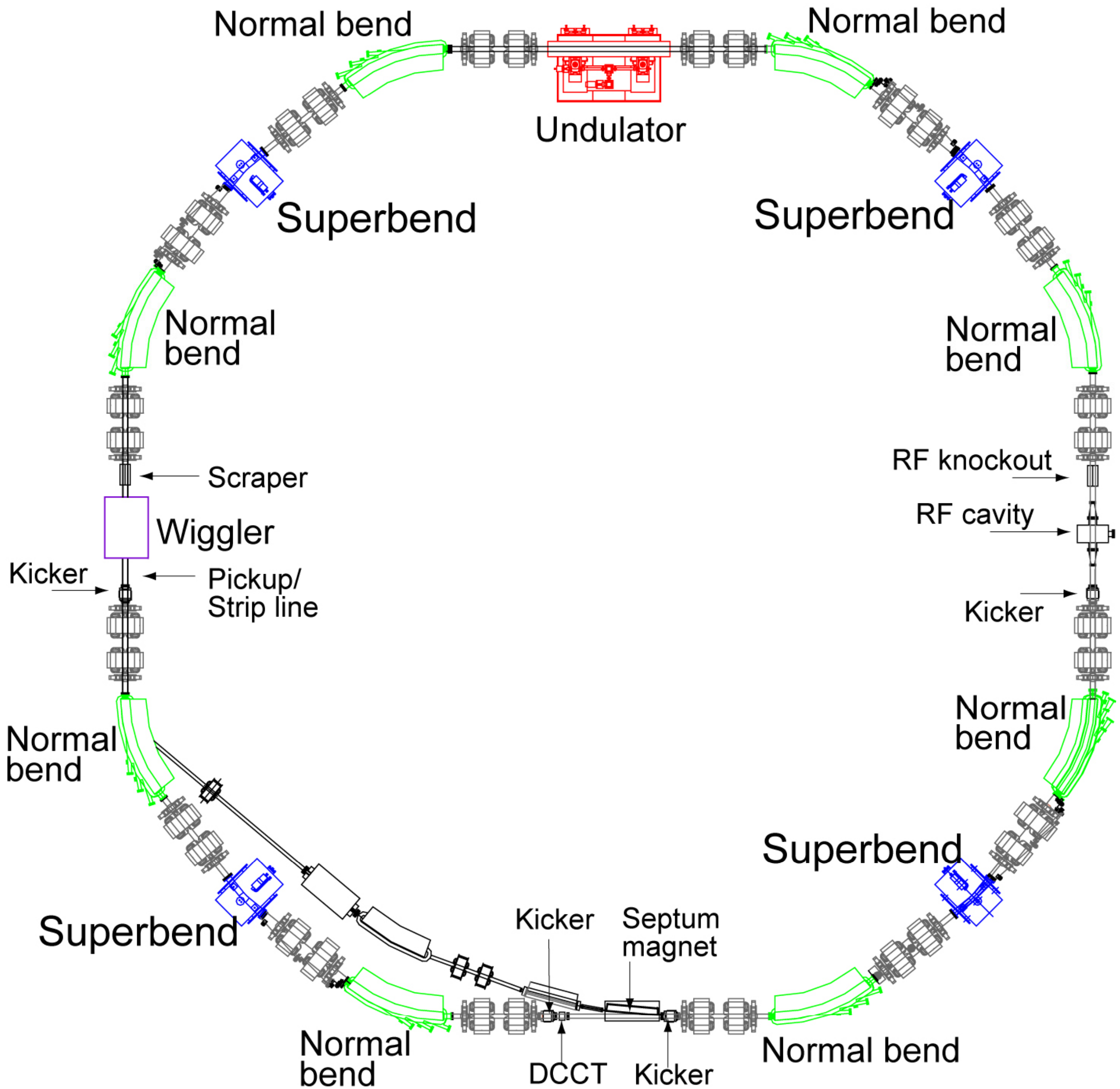


Basic Parameters

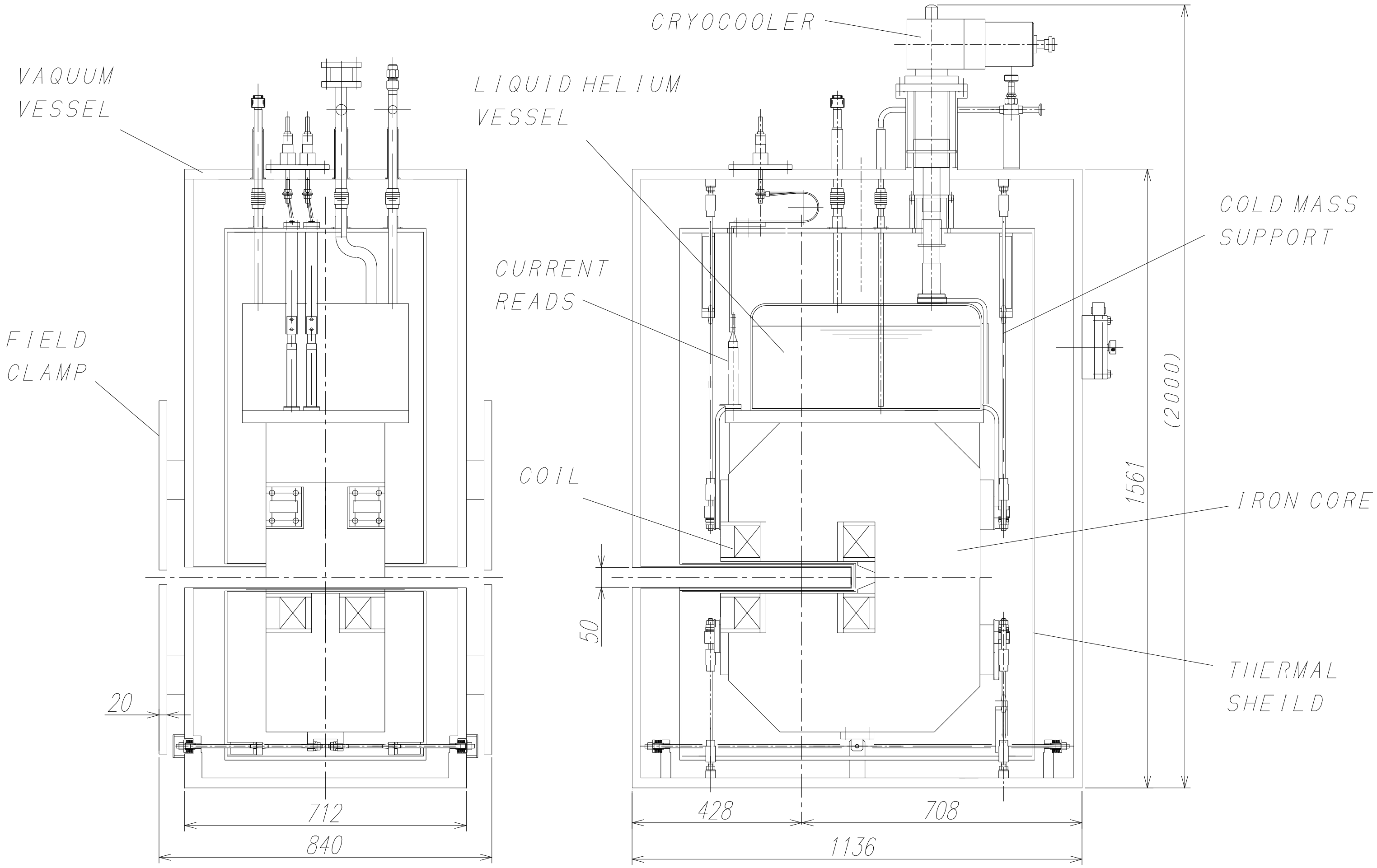
Storage ring	
Beam energy	1.2 GeV
Current	300 mA
Circumference	62.4 m
Normal bend	1.4 T, 39° ×8
Superbend	5 T, 12° ×4
RF frequency	500 MHz
Klystron power	100 kW
Natural emittance	53 nmrad
Magnetic lattice	Triple Bend Cell ×4
Straight section	2.8 m×2
Booster synchrotron	
Max. beam energy	1.2 GeV
Bending magnet	1.1 T
Circumference	38.4 m
RF frequency	500 MHz
Injector linac	
Beam energy	50 MeV
Current	100 mA
Repetition rate	1 Hz
RF frequency	2856 MH

Storage Ring

Synchrotron light is produced by an electron storage ring. The energy, beam current and circumference are 1.2 GeV, more than 300mA, and 62.4 m, respectively. Four of twelve bending magnets are superconducting ones whose field strength is 5 T. More than ten hard X-ray beamlines can be constructed on this relatively small machine. The critical energy of the X-rays is 4.8 keV, which is close to that of KEK Photon Factory. The natural emittance is 53 nmrad. To introduce top-up injection, the light source is equipped with a full energy booster synchrotron. The ring has four straight sections, two of which are used for injection and RF acceleration, other two for insertion devices, an undulator and a hard X-ray superconducting wiggler.

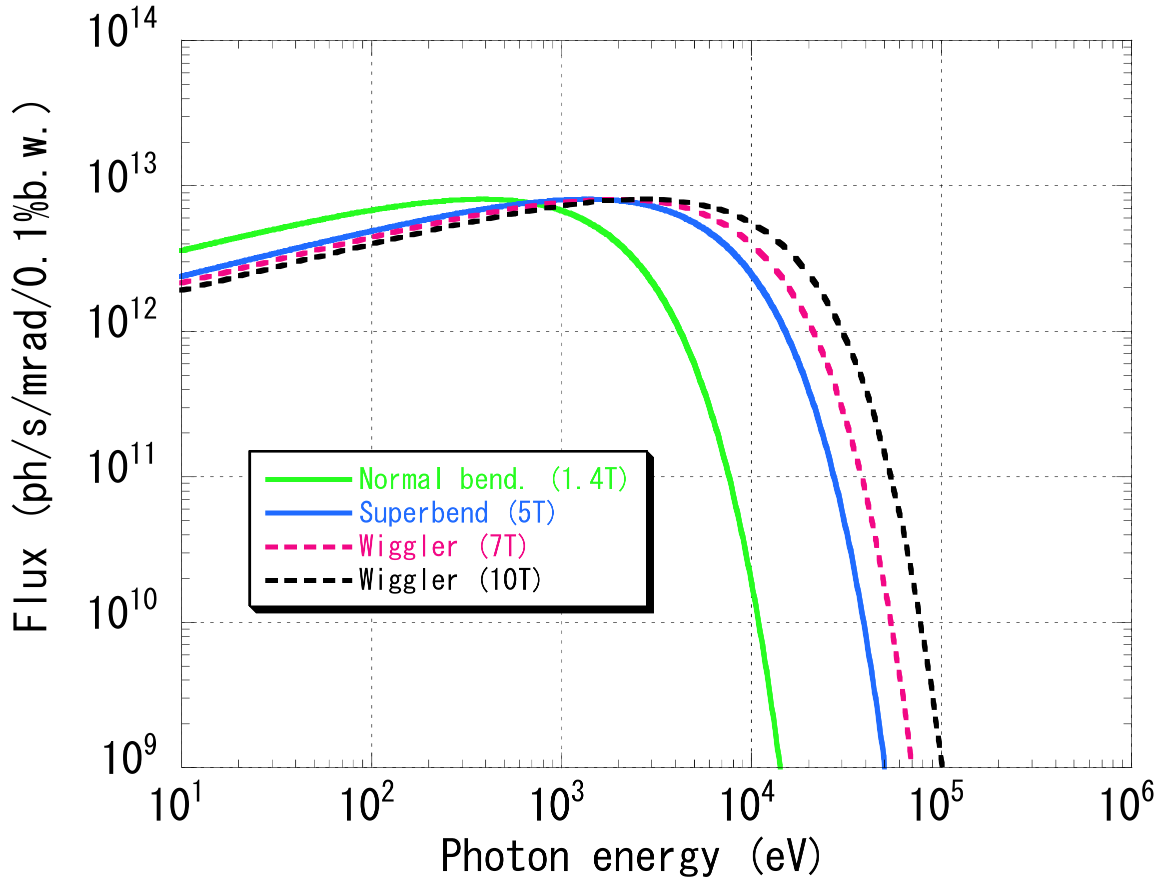


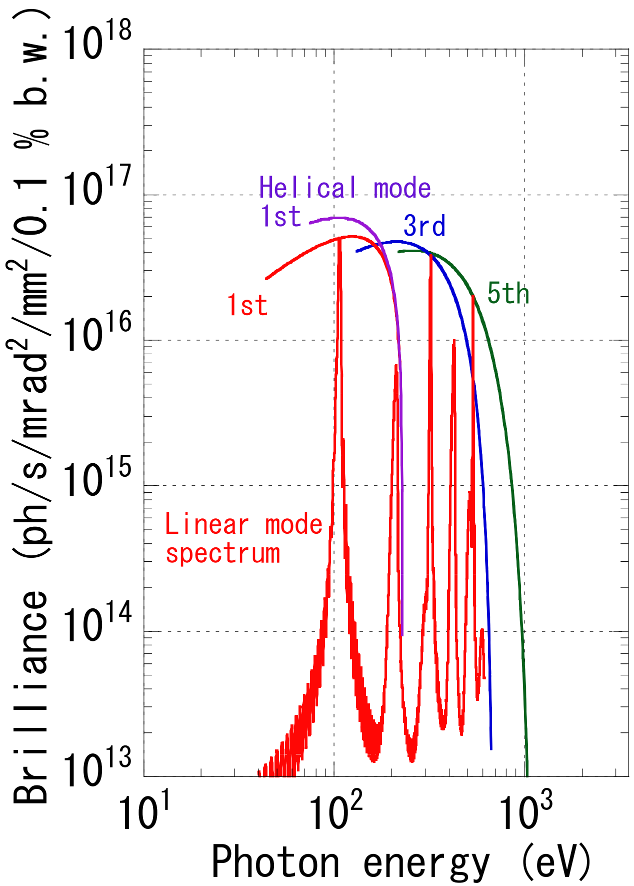
Superbend



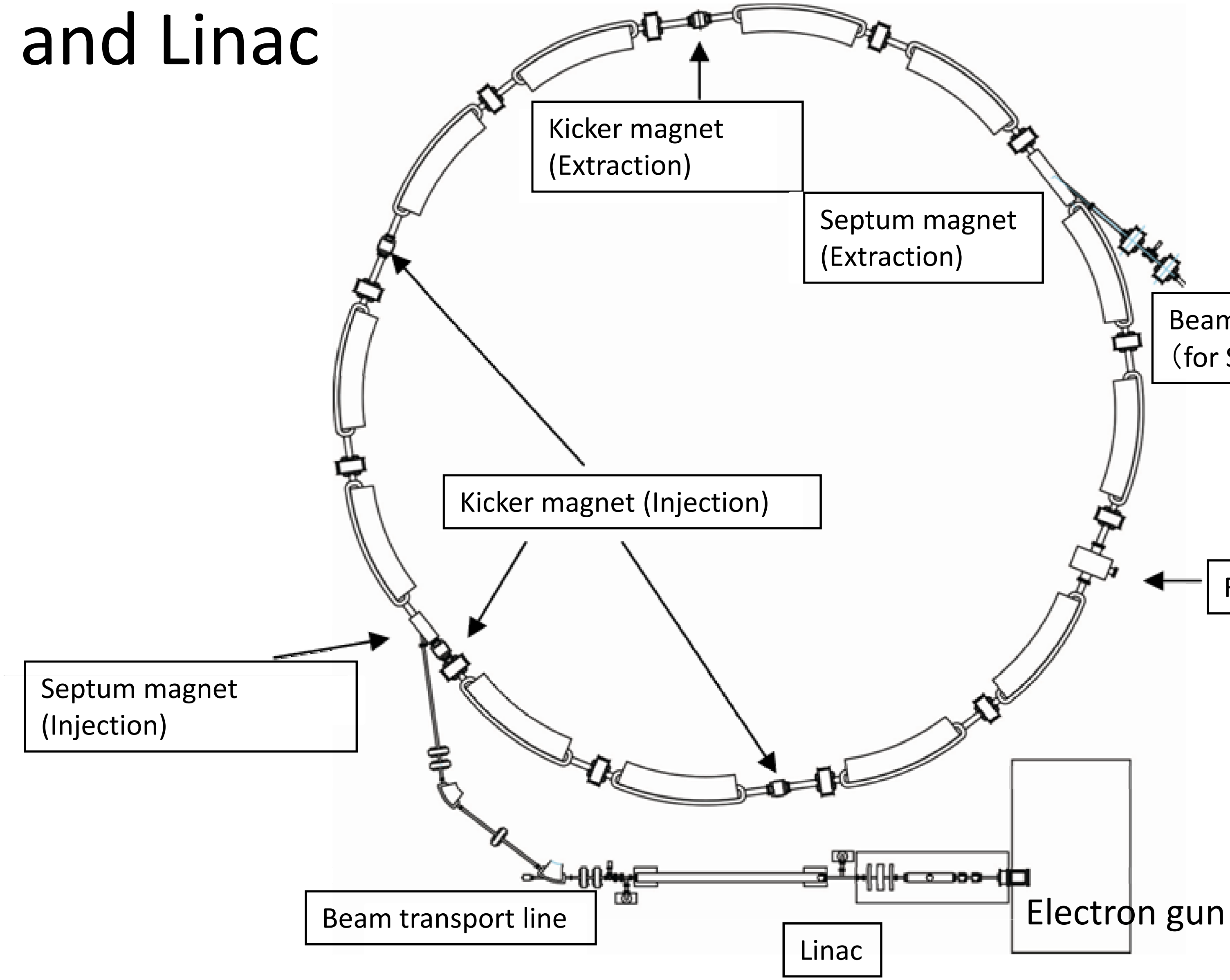
Since compact storage rings operate with a rather low energy, they usually cover from the VUV to the soft X-ray wavelength range. However, compact sources capable of delivering hard X-rays are very attractive. In order to conduct hard X-ray experiments such as XAFS, X-ray diffraction, and macromolecular crystallography, we designed to install 5T superconducting bending magnets (superbends) in our storage ring.

Photon intensity for SR users





Booster Synchrotron and Linac



Construction Schedule

2006 Basic design of the ring and the beamlines.
2007 Detailed specifications of the ring and the beamlines.

2008 Design of the buildings.
2009 Construction of the buildings.
2010 Construction of the ring and the beamlines.
2011 Construction of the ring and the beamlines.
Emission of the first synchrotron light.

Radiations (emulsion experiments)

- **Electron Beam**
  - Linac 50 MeV (100 mA, $6.2 \times 10^{11} e^-/sec$)
  - Booster Synchrotron 1.2 GeV (20 mA, $1.6 \times 10^{10} e^-/sec$)
- **Radiations caused by beam loss**

  Electromagnetic shower

  (Electrons, Gamma-rays < 1.2 GeV)
- **Bremsstrahlung** < 1.2 GeV

  Interaction of electron beam with residual gasses.
- **Laser-Compton gamma rays** ～30MeV

  Quasi monochromatic

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Using these radiations, the SR facility will be able to contribute to development of emulsion detectors.

Also, emulsion detector will contribute to accelerator physics.

Application (1)

Spatial distribution of beam loss

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Possibility of clearing
beam loss mechanism

Separate decay time constants due to

- Touschek effect
  (Beam loss by collisions between electrons in a bunch)
- Energy loss by bremsstrahlung

(Difficult by using normal current monitor)

Application (2)

Clear radiations around accelerators

- Particles
- Energies
- Directions

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Effective radiation shielding

Summary

Nagoya University has proposed a project of a new small synchrotron radiation facility for hard X-rays since 1991. The key equipment of the facility is a compact electron storage ring which can supply hard X-rays. The specifications of the project are as follows: the energy of the stored electron beam is 1.2 GeV, the circumference 62.4 m, and natural emittance 53 nm-rad. The configuration of the storage ring is based on the triple bend cell with twelve bending magnets. Eight of them are normal conducting magnets of 1.4 T, while four of them are superconducting ones (superbends) of 5 T. The bending angle of the superbend is 12 degrees and two or three hard X-ray beamlines can be constructed for each superbend. The electron beam is injected from a booster synchrotron with the energy of 1.2 GeV as full energy. A 50 MeV linac is used as an injector to the booster synchrotron. The project is now developed to “Central Japan Synchrotron Radiation Research Facility” as the principal facility of the project of Aichi prefecture “Knowledge Hub” to establish a new research center for technological innovation.