

# Hybrid ring: a candidate for the new light source of the Photon Factory

**Kentaro Harada<sup>a\*</sup>, Nobumasa Funamori<sup>b\*</sup>, Naoto Yamamoto<sup>a</sup>, Yoshito Shimosaki<sup>a</sup>, Tohru Honda<sup>a</sup>, Shunsuke Nozawa<sup>b</sup>, Hironori Nakao<sup>b</sup>, Yasuhiro Niwa<sup>b</sup>, Kenta Amemiya<sup>b</sup>, and Noriyuki Igarashi<sup>b</sup>**

<sup>a</sup>)Accelerator Laboratory and <sup>b</sup>)Institute of Materials Structure Science, KEK

Next year, the Photon Factory will celebrate the 40<sup>th</sup> anniversary of the first extraction of synchrotron-radiation beams from the PF ring in March 1982, while this year, KEK celebrates 50<sup>th</sup> anniversary. Although the PF/PF-AR are still active, it is time to design and build the new light source, to establish a new technical direction of ultimate tolerance based on the combination of ultimate flexibility and ultimate stability, not putting too much emphasis on low emittance. The improved tolerance make various new and novel experimental techniques possible .

Here, we propose the Hybrid Ring with a superconducting-linac injector as a highly flexible light source. It is designed to be operated with the coexistence of the storage (SR) bunches characterized by the performance of the ring, and the single-pass (SP) bunches characterized by the performance of the linac. Novel experiments can be performed by simultaneous use of the two beams, in addition to research with various experimental techniques utilizing the versatile SR beam and research in the field of ultrafast dynamics utilizing the ultrashort pulse of the SP beam. The extendability of the Hybrid Ring will allow it to be developed into a synchrotron-radiation complex. More information on the design of the Hybrid Ring will be shown at the symposium.

# Feature and Function of the Photon Factory

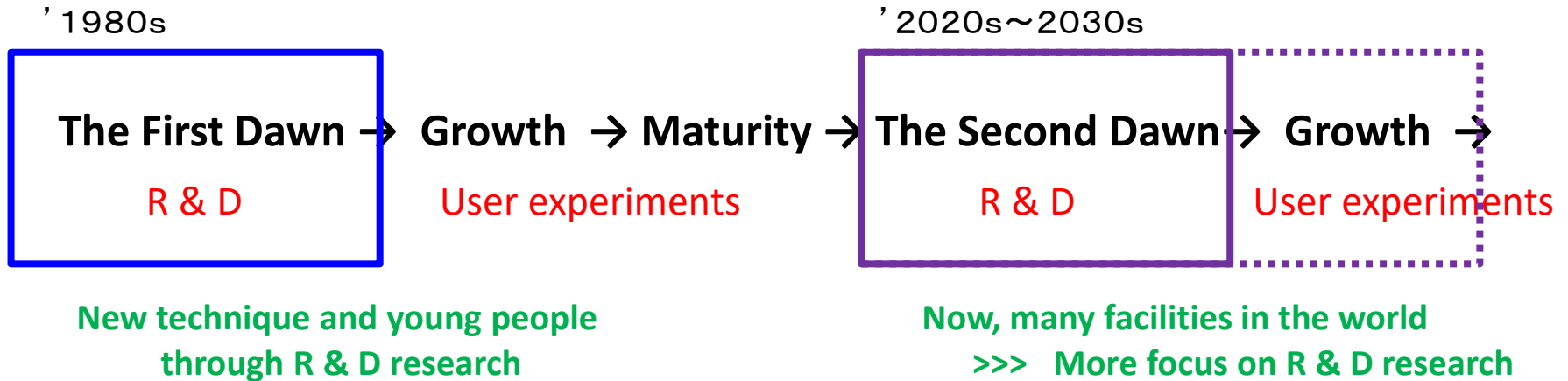
---

## Photon Factory

- puts emphasis on both technical originalities and scientific outputs  
General proposals are valid for two years, suitable to develop new experimental methods.
- allows easy access to beamline and apparatus by users  
Again, this encourages users to develop new experimental methods.
- has unique beamlines and operation modes  
e.g., Vertical-wiggler beamline at PF and fulltime single-bunch operation at PF-AR.
- receives strong support from world-class accelerator organization  
This makes unique and flexible operation of PF and PF-AR.

**Photon factory has been operated for nearly 40 years as a flexible multipurpose synchrotron-radiation facility under circumstances suitable for academic researches and human-resource developments. It has generated invaluable outputs in its history. However, it is time to re-recognize its mission and to strengthen its function.**

# Mission and the Second Dawn



## Mission of the Photon Factory

- To provide **new technique** and **young people** for the promotion of synchrotron-radiation science
- To support variety of user experiments as an advanced research infrastructure

**New organization to prepare  
the second dawn of synchrotron-radiation science**

# Direction of the Future Plan

---

We should construct and operate the facility ※ in which

Every researcher decides his/her research direction through research experience and pursues a new and unknown field.

Every researcher flowers as an excellent principal investigator with his/her originality.

※We have already started the improvements of user programs and other administrative systems, prior to light sources and beamlines.

**In the promotion of the future plan of the Photon Factory,**

**We would like to establish a new technical direction of ultimate tolerance based on the combination of ultimate flexibility and ultimate stability, not putting too much emphasis on low emittance. The improved tolerance make various new and novel experimental techniques possible at beamlines. R & D researches are essential at the second dawn of SR science.**

# Hybrid Ring with Superconducting LINAC

## Ultimately Tunable Ring for Both Versatile and Cutting-Edge Applications

To pursue the new direction of future plan, we have started the consideration of hybrid ring, in which Storage (SR) and Single-Pass (SP) bunches coexist.

The hybrid ring will make the following experiments possible.

1. **Sophisticated experiments with the versatile SR beam**
2. **Pico & femto-second dynamic experiments with the ultrashort and ultrabright SP beam**
3. **New types of experiments with the simultaneous use of SP & SR beams**

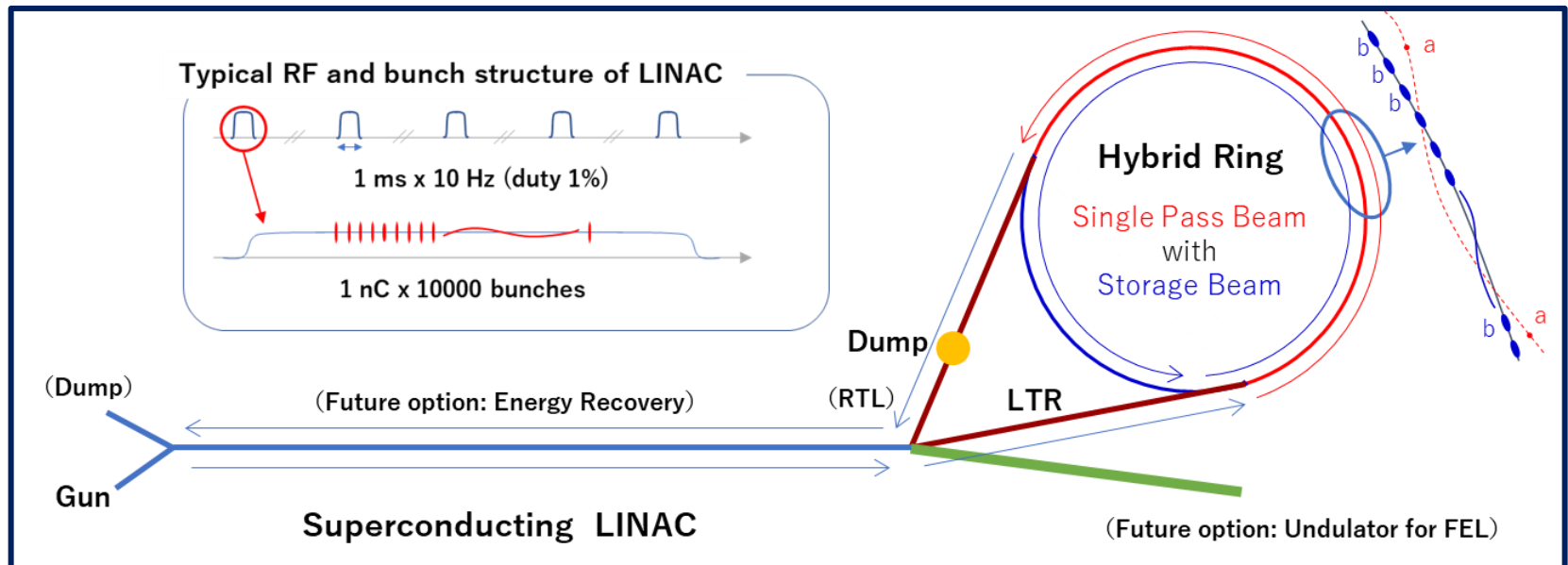
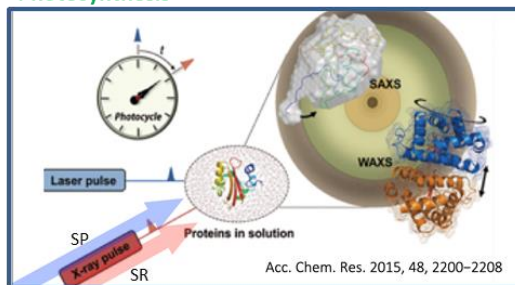


Fig. 1. Concept of the hybrid ring with superconducting LINAC.

# Two-Beam Science with SP + SR Mode

## Photosynthesis

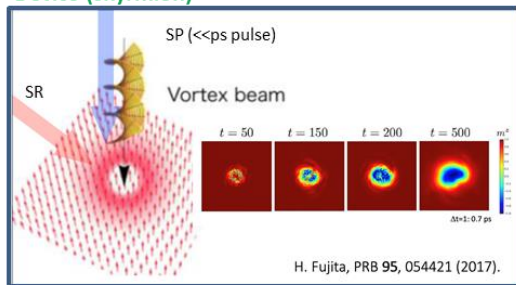


Multi temporal and spatial scale measurement of photoresponsive proteins

SP fs WAXS → molecular structural change  
SR ps/ns SAXS → domain motion

Biology · Chemistry

## Device (skyrmion)

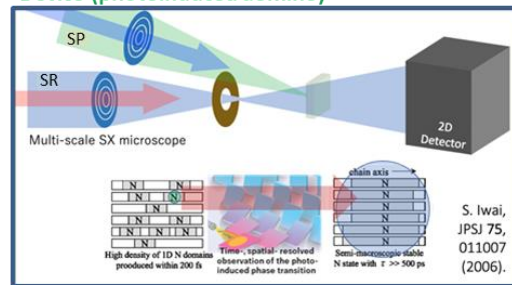


Observation of skyrmion generated with vortex X-ray

SP X-ray pump: nano focus, ultrashort pulse  
SR SX microscope → dynamics of skyrmion

Magnetism · Material

## Device (photoinduced domino)

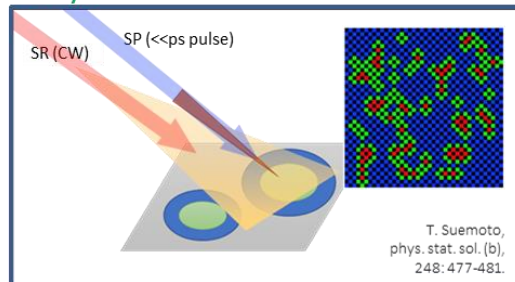


Visualizing the evolution of photo induced phase by the multi scale SX microscope

SP X-ray pump: nano focus, ultrashort pulse  
SR SX microscope → photoinduced domain

Physics · Material

## Catalyst

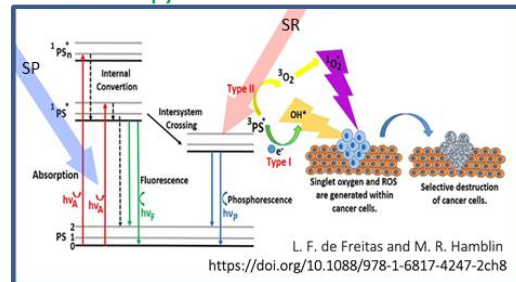


Independent time-resolved measurements for evolving domains

SP pump-probe measurements → local change  
SR CW imaging → domain move

Physics · Chemistry

## Cancer therapy

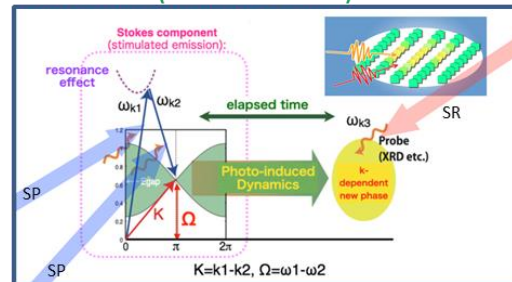


Development of photocatalytic materials for cancer treatment by photodynamic therapies

SP X-ray pump: transmittivity, absorption edge  
SR time-resolved XAFS → triplet excited state

Medical Application · Chemistry

## New material (stimulated Raman)



New state generation using momentum  $\neq 0$  excitation by X-ray stimulated Raman

SP X-ray stimulated Raman: 2 color, fs, high intensity  
SR time-resolved XRD → photoinduced phase

Nonlinear X-ray optics · Material

**Two X-ray probes:** By using the two beams as probes, it is possible to follow the behavior of the sample in a wide spatio-temporal hierarchical structure.

**X-ray pump & X-ray probe:** By utilizing the performance of the SP beam as a pump to create a unique state and using the SR beam as a probe, it is possible to follow the subsequent change in the sample.

**Thank you very much!**

More information on the design of the Hybrid Ring will be shown at the symposium.