

8th Photon Factory Science Advisory Committee Meeting March 29-30, 2016

Executive Summary and Close-Out Remarks

SAC Committee Members:

Michael Borland (Advanced Photon Source, Argonne National Laboratory)

John Hill (NSLS-II, Brookhaven National Laboratory)

Mitsuhiro Hirai (Gunma University)

Yasuhiro Iwasawa (University of Electro-Communications Tokyo)

Ingolf Lindau (Stanford University) Chair

Mamoru Sato (Yokohama City University)

Masashi Takigawa (ISSP, The University of Tokyo)

Zhentang Zhao (Shanghai Synchrotron Radiation Facility) absent but provided written input

The Director of the Photon Factory, Murakami-san, charged the SAC to address a number of questions.

1. How does the PF-SAC evaluate the present status of the PF?

- PF remains a highly productive facility supporting many users. It should be very proud of its history and its accomplishments.
- The erosion in the budget over the last several years directly threatens the health of the facility and the productivity of beamlines.
- The performance of the facility is now well past being state-of-the-art and no longer addresses the needs of the most demanding research. It is important that it be replaced with a state-of-the-art light source as soon as possible. The PF-SAC recommends that KEK makes the KEK-LS its very highest priority in the coming years.
- It would be best for the Photon Factory if it could continue to run as long as possible, and with the maximum possible user hours, while effectively serving the needs of those users.
- In case the KEK-LS is approved it is important to carefully think through the transition to closing the PF. This will require balancing the productivity of existing beamlines (that are facing declining resources) against the needs for staff to move from PF to KEK-LS to design and construct the new beamlines. Early accommodation of existing users at other facilities will ease this transition.

1a. Does the PF-SAC have any advice on how to take measures against the poor financial condition?

The SAC is well aware that the PF management has taken a number of constructive actions in the past to mitigate the declining operation budget. The present SAC came up with a number of routes to respond to the financial situation:

- Consider getting user organizations from across Japan to write letters of support.
- Concentrate effort on the most productive, high-impact beamlines:
 - Further consolidation of which beamlines are operated by the facility.
 - Further classification of proposals, with concentrated user support for the most highly-rated proposals.
- Actively attempt to increase partnerships in the facility:
 - Explore new beamline partnerships with university and industry, also with other countries that might be interested in developing SR expertise (e.g. Africa) – PF has a successful track record with Australia and India.
 - Consider changing the deal; (50 % General Users) to encourage new partnerships on beamlines. For beamlines that are not a priority for PF, PF could offer that the partners get 75% of the time, for example.
 - Consider moving away from the model of a partnership in a single beamline. For example: would an industrial consortium consider paying a fraction of the power bill in return for access to a suite of beamlines rather than just one?

2. Are we moving in the right direction by changing the PF future plans?

The plans are proposed as follows:

the 3 GeV ERL project is stopped and
the 3 GeV SR LS project as a short and middle-term plan
and a linac based LS project as a long-term plan is started

- The committee supports the decision to stop work on the ERL design/construction and develop a state-of-the-art 3 GeV storage ring light source based on the following considerations:
 1. ERL technology is not ready to support construction of a new 3 GeV LS.
 2. The Hybrid MBA (Multi Band Achromat) lattice gives the near-term option to build a new 3 GeV LS. It gives equal or better brightness than a future ERL, higher flux than an ERL, and has fewer technical challenges than an ERL. The MBA concept has been studied in detail and recently shown to work at the MAX-IV 3 GeV storage ring.
- KEK-LS based on 3 GeV MBA lattice will enable the exploration of structure and dynamics over unprecedented length and time scales, enabling advances in materials science, life science, energy sciences and beyond. It would put KEK in a world-leading position and should be pursued with the very highest priority within KEK.
- The committee also supports the long-term plan to develop a linac-based source, specifically, a CW FEL.

3. How does the PF-SAC evaluate the KEK Light Source?

3.1 A. Is the design cutting-edge enough?

- A good deal of careful work and thought has been given to the design. It follows the design of ESRF with some interesting variations, such as short interior straight sections.
- A bolder design should be considered to “future proof” the new LS:
 1. Increase the circumference and/or number of cells so that few (or none) of existing 3 GeV LS can easily surpass your planned performance;
 2. Consider a 9BA design, which may give a factor of 2 reduction in emittance;
 3. Consider reverse bending magnets, which may give another factor of two.
- A series of design options should be created, from “easy” to extremely challenging, and a decision made based on risk and performance. The future users should be engaged early in discussions of this trade-off.

3.1 B. Are the future development items adequate?

- Attention should be given soon to vacuum design, impedance, and collective instabilities, which may have unexpected effects on, e.g., beam accumulation.
- Collaborations should be formed with other labs (e.g., MAX-IV, SIRIUS, APS), that have or are pursuing advanced vacuum system designs.
- Ground motion will affect not only the accelerator, but also the beamlines. Consideration of beamline stabilization should not be neglected.
- In addition to robust mechanical design, advanced photon BPMs will significantly improve beam stability.
- At present, it seems the need for large dynamic apertures is in part driven by the large effective linac emittance. This may unnecessarily restrict consideration of more challenging lattices.
- Understand user requirements for timing studies and how these may impact accelerator design, lifetime, etc.
- Use tracking-based multi-objective algorithms to optimize nonlinear dynamics.
- Considerable time on a mid-sized computing cluster will be needed for this and other beam dynamics work.
- Explore use of a lower-frequency rf system (e.g., MAX-IV) combined with a higher harmonic cavity to improve lifetime, fill patterns, and top-up interval and how this will impact experiments.
- Ensure that the impact of planned IDs on beam dynamics and emittance is thoroughly understood, including variation of emittance as gaps change.

3.1 C. Should we organize the machine advisory committee to get more detailed technical suggestions?

The SAC strongly recommends the formation of a machine advisory committee (MAC). There are two compelling reasons for this:

1. There is a great deal of work on this topic world-wide and KEK can benefit from tapping into ideas and feedback from other laboratories.
2. A MAC will help increase the visibility of KEK work and staff at other facilities.

3.2 About science, optics, beamlines, operations, etc.

- A good science case was presented, but it is understandably fairly generic at this point in time. KEK should develop a few (5) specific high impact science examples made possible by KEK-LS.
- Optics calculations should be done using wavefront propagation and realistic slope errors as soon as possible to provide users with an understanding of actual performance, and to inform the machine design (e.g., round versus flat beams).
- Data management (acquisition, analysis and storage) will be a big issue at this new facility. Careful consideration of the requirements early on will be important in the long term success of the facility.
- An effort should be made to understand the detector requirements driven by the new facility and to fund appropriate R&D to meet these requirements.
- Next generation beamlines feature large end-stations and frequently go outside the experimental hall. This should be a design consideration from the start.

3.3 Can the KEK light source be the facility which leads the way in the growth and development of synchrotron radiation research in the world for the next two decades and counting?

- Potentially yes. To convince the value of the KEK light source for society, the SAC urges the management to propose several critical problems that can be solved by the new light source and bring large impact to the human life.
- The SAC further proposes to organize workshops joined by people among different fields and expertise to define the science to be pursued. In so doing include potential users from beyond existing PF community. Use that information to justify the specifications of the 3 GeV ring and beamlines.

3.4 Does the PF-SAC have any advice on how to launch the plan formulating a cooperative framework in Japan?

- The SAC is of the firm opinion that the new 3 GeV ring should be built based on the state-of-the-art technology available today, so that it can serve as the platform to advance the frontier of science for the next twenty years, including the research in industries.
- Considering that this probably will be the only 3rd generation medium-energy X-ray light source in Japan, the plan for the ring, beamlines and instruments, as well as the operation of the facility should be discussed and agreed by the nation-wide synchrotron community including academic, government and industrial users.

4. The long-term future plan

4.1 Does the PF-SAC support the direction to promote the linac-based light source as a long-term future plan?

- Yes, specifically, the committee supports development of a plan for a future linac-based CW FEL for two reasons: Beyond MBA storage rings, there is no other technology that promises such a dramatic improvement in light source characteristics. Unlike an ERL, extremely high performance does not require high average current.
- All existing facilities are based on pulsed operation, so pursuing CW operation provides a clear competitive advantage. KEK is in an excellent position to pursue a project of this kind.

4.2 Does the PF-SAC have suggestions for the R&D projects of the linac-based light source?

- Superconducting rf technology targeting reduced operating costs, e.g., high-Q developments and high-temperature operation.
- Gun technology for CW high-brightness beams.
- Form or strengthen collaborations with facilities offering best-in-class technologies to minimize R&D effort and risk.
- Contributing to world-wide developments will prepare KEK to develop a solid design when needed.

SAC Other Remarks and Comments

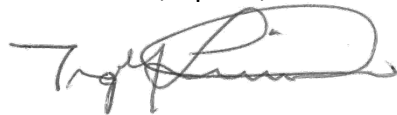
The SAC very much appreciated the presentation by Yamada-san on the organization and mission of the Institute of Materials Structure Science (IMSS). Okada-san gave an extensive review and status report on the activities at KEK that provided most valuable to provide the SAC with an understanding of the Photon Factory in a broader context. The Director of the Photon Factory, Murakami-san, presented an in-depth description of the status of the facility and background material for the proposed future direction. Murakami-san also gave the charge to the committee in a number of questions addressed in this report.

The KEK-LS project was presented in a series of talks by Nakao-san, Harada-san, Amemiya-san and Adachi-san covering the science case, the accelerator, beamlines and organization & operation, respectively. The plans for the future linac-based light source were given by Umemori-san and Adachi-san. These excellent talks were the backbone for the SAC in addressing the charge to the committee.

The SAC was very impressed by the well-prepared presentations and appreciated the frank and open discussions on the most crucial issues. Last, but not least, the SAC thanks the Photon Factory management and staff for their excellent logistical arrangements and support in preparation of the meeting. The great hospitality throughout the meeting was very much appreciated.

In concluding, the SAC notes that the Photon Factory has a long and distinguished history of leadership and productivity in accelerator technology and photon science. The SAC is convinced that PF's new direction is the right one and eagerly looks forward to seeing a world-leading light source created at KEK. Given the competitive nature of the field and the world-leading opportunity available at KEK, the SAC strongly feels that KEK-LS should be KEK's highest priority.

Stanford, April 7, 2016.



Ingolf Lindau
(Chair, on behalf of the SAC)