High Energy Accelerator Research Organization (KEK)
Institute of Materials Structure Science (IMSS)
Photon Factory

Report from the 3rd Meeting of the Photon Factory International Science Advisory Committee (ISAC)

December 16-17, 2008

Introduction, ISAC Process and Report Organization

The Photon Factory International Science Advisory Committee (ISAC) was chartered by the Institute of Materials Structure Science (IMSS) of the High Energy Accelerator Research Organization (KEK) with providing ongoing advice on the operations and strategic planning for the Photon Factory (PF). The ISAC meeting on December 16-17, 2008 was the third meeting for this Committee and was held at KEK.

In advance of the meeting, ISAC was provided written information, including copies of many of the presentations and a list of 8 questions that it was asked to specifically consider during the review (list is included in the Appendix as item 3.). ISAC heard a series of technical and scientific presentations that provided the information and background for its discussions and recommendations. Following questions and discussion, ISAC met in closed session and formulated its observations, conclusions and recommendations. ISAC reached unanimous agreement on the material presented in the closeout to the management of the IMSS and PF held on Wednesday morning, March 17.

This written report summarizes ISAC's findings and recommendations organized by (and in order of) each of the questions given to ISAC by Management. In the following eight sections are more details and elaboration of the topics in the same order that they were presented in the verbal closeout with IMSS and PF management. The Appendix contains a list of the ISAC members of the Review Committee, the Agenda of the ISAC meeting, and the list of 8 questions provided by management.

1. Question 1 – Overall strategy and progress of BL refurbishment program

Following the recommendations by ISAC, PF has decommissioned or rearranged less active BLs for new, more productive ones which align with the strategic goals of PF and IMSS and serve more optimally the needs of the PF scientific user community. The decommissioning of 27 less active beam lines and implementation of 18 new beam lines in Phase I is progressing very well. ISAC believes that the use of the long IDs for SXR beam lines is providing competitive performance to other 3rd generation sources internationally and will serve the Japanese SXR community increasingly well in the future.

ISAC appreciates the effort of PF management and PF staff to aggressively pursue this program which was endorsed 3 years ago, especially in light of limited manpower and funding, and strongly encourages that it be completed, perhaps with even more aggressive goals. In particular, given the approximately flat operations budgets, ISAC remains quite concerned about the ratio of staff scientists to number of beam lines and end stations and urges that PF and KEK management seek every means to improve this situation. Even after the major changes that have been made, only 39 scientific staff currently serve as many as 60 stations and this is well below what is optimal.

2. Question 2 – BL 16

ISAC was pleased to learn from Dr. K. Amemiya about the excellent progress on BL-16 since the last meeting in March, 2008. The first beam from the new APPLE II undulator

(linear polarization) was extracted in May, 2008; the first XMCD spectra (circular polarization) were obtained in June, 2008. The beamline was opened to user experiments in October, 2008. And at the time of ISAC's meeting, horizontal/vertical polarization had been achieved.

ISAC congratulates the PF management for being successful in obtaining external funding from MEXT for the second APPLE II undulator that is expected to be implemented in the summer of 2010 for the fast (10 Hz) polarization switching scheme.

Dr. Amemiya showed excellent performance characteristics of the beamline in its present configuration and also presented the first very impressive scientific results. With the implementation of the second APPLE II undulator, this beamline will be beyond the present state-of-the-art worldwide and will position PF for world-leading research in scientific fields where PF and Japan traditionally have been very strong. This beamline is an excellent example of the success of the PF management to focus on scientific areas of excellence at PF, in this case science involving surface/interfaces, correlated materials and novel complex materials. BL-16 will be an important asset for the newly established Condensed Matter Research Center under the leadership of Dr. Y. Murakami.

Dr. Amemiya has demonstrated excellent leadership in the commissioning and initial operation of the beamline. He has a team with wide scientific and engineering experience. The beamline has 5 technically very advanced experimental stations with demanding performance characteristics. ISAC therefore advises the PF management to pay close attention to the required manpower for efficient operation in serving a broad user community that undoubtedly will find this beamline extremely attractive. ISAC does note that the goals and missions of the beamline are very ambitious, covering many science areas with this single beamline having several end-stations and instruments. It is recommended to carefully plan and focus the program to have the maximum scientific impact.

ISAC takes note of the fact that Dr. Amemiya has implemented a novel and very clever scheme that controls the photon flux from the two APPLE II undulators to be exactly the same on the sample. This is of great importance for high quality data collection in the fast polarization switching scheme, a feature that contributes to make this beamline unique worldwide.

3. Question 3 - CMRC

ISAC applauds the IMSS management for very aggressively pursuing the strategy to plan for the implementation of a second research institute (this one being in materials science). An outstanding Director-designate has been recruited (Prof. Y. Murakami) to lead CMRC. ISAC was pleased to hear from Prof. Murakami and was impressed with his vision for the CMRC at this early stage of formulation. ISAC also notes that providing expedient access for users to the integrated tools of CMRC will be highly attractive and will strengthen the overall program at PF.

ISAC felt that the 4 areas (or themes) chosen for the scientific focus were excellent and mapped well to strengths at IMSS, PF, J-PARC and more broadly in Japan. These four areas of Correlated Electron Matter, Surfaces/Interfaces, Soft Matter, and Matter under

Extreme Conditions are both important and relevant in view of current national and international scientific activities as well as the present scientific activities of PF.

Specific initial research targets were also described and again ISAC felt these to be an appropriate choice. ISAC observes that the new BL16, along with techniques developed at PF, can play an important role in enabling discovery in the planned research. In the area of self-organization, the planned collaboration with the Structure Biology Research Center (SBRC) has the potential to move this area rapidly forward. ISAC did note that in the area of high pressure science, there was already a world leading effort at SPring-8 and attention should be paid to achieving complementarity with those efforts and taking advantage of the relative strengths of each as they reflect the respective technical and scientific capabilities of the two facilities. ISAC does note that the CMRC science areas and their research foci are quite diverse and broad. It is recommended to choose and very carefully focus on key science research objectives and concentrate sufficient resources to develop and maintain world class, competitive efforts. This strategy is very important given the apparently limited manpower and budget.

IMSS management is strongly encouraged to hire the additional new staff members that will help make all four planned areas in the Center a success. We also note the important role that theory will continue to play in this area and suggest that a plan be developed to provide theory support and integration with the experimental program.

ISAC also encourages that CMRC should be open and seek to form an effective framework to facilitate a constant interaction with active outside research communities, including those at Spring-8, RIKEN and universities. The ongoing collaborations with RIKEN on the already identified research targets are especially encouraged.

In summary regarding CMRC, ISAC emphasizes that quantum beams, such as photon, neutron, muon and electron, are very powerful experimental tools to elucidate structure and understand function. This has been very clearly demonstrated in the studies of condensed matter, where the information on structure and electronic properties have led to the understanding of, and hence ability to predict and tailor, materials' properties. Such a paradigm is central to the success and impact of CMRC, operating under the umbrella of IMSS together with PF and the SBRC, and neutrons and muons at J-PARC. This is a visionary and important development for KEK and is expected to give rise to important discoveries, not only in basic science but also in applied sciences, especially related to those of energy and environment relevance. These are areas of vital importance to society and this fact should be stressed constantly.

4. Questions 4 and 5 – New Schemes and Education

PF management has found that the decommissioning of beamlines and stations, even of old and less competitive ones has turned out to be difficult in part due to the expectations of the users. Therefore, the PF management has considered other options for a continued operation of specific beamlines, but with a significantly reduced workload for the PF staff.

One such option is making users responsible for beamline operation. In fact, this mode is currently practiced at the PF, with 7 such beamlines being operated by users. However, the users are involved on a more or less voluntary basis without any formal agreements with

the PF or any established guidelines. The beamlines operated by users can be viewed as "public" beamlines, where the users accept the duties and responsibilities of PF beamline scientists. A deficiency in the current scheme is the missing link of the Working Groups to corresponding User Groups in the PF Users' Society. These User Groups represent the scientists working in 23 research fields at the PF. The PF proposes now to improve the policy for Working Groups by accepting only user groups for beamline operation, which are part of a User Group of the Users' Society. Further, such a Working Group will sign a three year contract with the PF. It will assume formal responsibility for the quality of science at the beamline, its usage and the training and education of new users. Then PF will finance maintenance and safety of the beamline proper. Support of the endstations will depend on an evaluation of the scientific output of the beamline and its attractiveness to established and new users. In addition, PF will support travel of the Working Group members and provide preferred access to beamtime analogous to the options of the PF beamline scientists.

ISAC supports the plan presented for user-operated beam lines. This represents a positive transition from an informal agreement with users to forming Working Groups that have a formal contract with the PF and are embedded in the User Groups of the PF Users' Society. The proposed evaluation process is critical to the success of this concept and it is essential that the PF maintain oversight. The WGs which are an integrated part of the User Groups are responsible for the scientific quality and support and education but it is again essential that PF provide oversight and review of this aspect.

ISAC notes that this scheme with the WGs should not be used to postpone the decommissioning of non-productive BLs. ISAC also stresses the importance of maintaining an independent peer review process that ensures the quality of science at user operated beamlines. ISAC believes that there will still be some effort required from the PF scientific staff for this scheme to be successful and provide the local contacts. Such beamlines are still costly to operate even if they are not extensively involving PF beamline scientists. Allocating such resources must be justified by the science output like for all other beamlines.

Another concept proposed by the PF management for using beamlines involves establishing beamlines dedicated to education. There are several reasons to do that, namely, to involve more university professors in PF-research, to demonstrate the accessibility of the PF facility, to promote PF scientists to adjunct positions at universities and, last not least, to attract and train first class students. The process would start with an agreement between the PF and a university on education of undergraduate and graduate students using PF beamlines. One option is that the university assumes responsibility for a beamline and operates it with university personnel. The university could even involve faculty that are less productive in science but feels comfortable in using high-tech installations for education. Such a University Group operation of beamlines would also support other external users similar to the Working Group approach. Other beam lines at PF could be also used for education, however, for a rather limited access time only. Long term projects such as research for a PhD thesis would still likely require a standard proposal and be channelled through the regular PF evaluation and admission process.

Education is an objective of pivotal importance for our society and future sustainability.

Increased participation of PF in education will attract new students, prepare future users, improve the visibility of PF in the public, and add career opportunities at academia for PF scientists. However, the best way to use synchrotron facilities in education remains a question yet to be definitively answered. Several facilities have made significant efforts to extend their activities in education beyond well established master thesis and PhD thesis work, mostly with limited success. While ISAC welcomes the new PF education initiative it remains cautious on the likelihood of success. ISAC therefore advises the PF management to begin with a test case for monitoring the effort required by PF beamline scientists (who will clearly need to help with preparing written documents, by teaching and by supporting the logistics) and compare it to the involvement and dedication of professors and students. Different schemes can range from lab-course type concepts with student teams conducting synchrotron radiation experiments to individual hands-on education of students. Another option could be carrying out experiments in the classroom by remote access. In any case, supervision far beyond the usually accepted levels will be essential. Finally, scientist at the PF must be identified and accept responsibility for such an education program including preparation of written material for the students, introductory courses at the university and the overall logistics. If these factors are formulated into a new scheme for higher education using synchrotron radiation, it may even provide PF with access to additional funding sources in collaboration with participating universities.

In summary, ISAC believes that the proposed educational-related BL operations could provide an important addition to the PF in light of its National role in education by augmenting BL operations in a WG type concept, opening additional career opportunities for PF scientists in academia, attracting bright students, developing important new courses for education and possibly providing access to additional funding sources.

5. Question 6 - Compact ERL

The 5 GeV ERL light source is critical to the future scientific productivity and reputation of KEK and the broader science community in Japan. ISAC acknowledges excellent process in completing and publishing the CDR for the compact ERL (c-ERL), developing internal and external collaborations, and developing critical technologies. However, ISAC feels that the multi-year schedule for construction and commissioning of the c-CERL is too long. A goal to start commissioning all aspects of c-CERL beginning in late 2010 should be aggressively pursued. The infrastructure construction for the c-ERL should take no longer than one year and the accelerator itself should be built within 12-18 months. A goal to start commissioning all aspects of the c-ERL beginning in late 2010 should be adopted.

The project office has made outstanding progress over the course of the last year. Major project management milestones over the past year included 1) publishing the conceptual design report for c-ERL in early 2008, 2) strengthening and exercising collaborations both inside and outside Japan and preparing a new MOU with Argonne National Laboratory, and 3) securing substantial supplemental budget funds to begin reconstruction of the East Counter Hall and the infrastructure built out. Major technical milestones and on-going major developments include 1) progress on the photocathode DC gun, including building a beamline for measuring electron source properties; 2) realizing a drive laser for the gun at 100 MHz and moving to upgrade to 1.3 GHz; 3) designing and fabricating on-site

superconducting cavities, including testing a main linac cavity with ultra-high Q at an accelerating voltage of 37 MV/m; and 4) building injector cavities with HOM couplers adopted from proven DESY-type designs; and 5) building 9-cell main linac cavity and carrying out a first vertical test. An example of the ingenuity of this group is shown by the development of the segmented insulator tube for 500 kV, whose design is being copied and evaluated by the Cornell group to overcome problems they've encountered with insulator breakdown in their ultra-high voltage photoinjector. This shows the benefits of multifaceted international collaborations and how the KEK ERL project office can be a strong contributor.

Regarding the scientific case, that for the c-ERL is narrow, but sufficient, since the main purpose of the project is to develop critical accelerator technologies needed for a full-scale light source. At present only two potential science drivers have been identified as users of terahertz and inverse Compton radiation. Although these sources have some exemplary qualities, ISAC has not been presented with compelling end-user science that would be uniquely enabled by the c-ERL source. This is not a critical comment, though, because the most compelling scientific case for the c-ERL is to identify, develop and test critical accelerator technologies needed to prove the feasibility of a 5 GeV ERL full-scale light source. This project also has the potential to advance and impact many accelerator efforts, including technologies of interest to KEK scientists applicable to the international linear collider.

Regarding the 5 GeV ERL, developing the science case has just begun and has a good trajectory. Organizing workshops, identifying grand scientific challenges that can be addressed by an ERL light source, and gathering input from a wide community of potential users will lead to a successful plan. The ERL project office should also use this process to help identify critical technical issues for using ERL beams such as x-ray optics, beamline, specimen handling procedures, detector and data collection strategies. Detailed concepts are missing at present but will be needed for frontier experiments in the future.

The ERL project office should be commended for assembling a "brainstorming" committee that includes scientists who are experts in a wide variety of fields that should have interest in ERL, including resonant magnetic scattering, time-resolved, catalysis, small-angle x-ray scattering, coherent diffraction and accelerator physics, among others, and includes persons from both inside and outside KEK. This committee should choose topics and help organize wide-ranging community workshops that will help identify key areas of scientific inquiry enabled by the ERL technology and the ERL light source. Although this committee is only scheduled at present to meet a few times, it might be advantageous for the ERL project to continue this committee as a formal body that helps shape and coordinate the writing of the scientific case for the 5 GeV ERL.

ISAC notes that the c-ERL will provide unique but rather limited capabilities and it cannot replace the broad scientific opportunities currently provided by beam lines and instruments on PF and PF-AR. Again, we emphasize that a main initial purpose of the c-ERL is to develop critical accelerator technologies needed for the larger 5 GeV ERL. Option should be maintained for future upgrade of c-ERL to provide access in the VUV range.

6. Question 7 - Management Scheme

Regarding the plan for a new deputy director and simultaneous appointment of the management team for 3-year terms, ISAC is fully supportive and endorses this approach. ISAC sees that photon science is an integral part of technical and scientific activity on the KEK campus and contributes significantly to the overall success and reputation of the National laboratory.

In the near term, construction of the c-ERL has to have extremely high priority for KEK to provide opportunity for a long term, internationally competitive future for photon science on the KEK campus. Success in this endeavor will provide the platform to develop the world's first 5 GeV x-ray ERL. Successfully accomplishing this major goal will require a broad and integrated effort on the KEK site and this topic is addressed in ISAC's comments and recommendations regarding the machine division in Section 7.

7. Questions 8 - Machine Division

The progress in the implementation of the top-up mode was relatively modest in the past year. Hopefully during the forthcoming winter shutdown, the remaining preparation needed for the top-up mode of operation of PF storage ring can be completed and PF will be able to start delivering constant current beam in the next FY. ISAC strongly endorses this new operational mode and making it available to PF users as soon as possible.

ISAC recognizes possible significant benefits for both the PF user community and KEK-PF staff, from the proposed merger of the PF Light Source Division into the KEK Accelerator Laboratory where it would become Division #5. This move will definitely enhance KEK's ability to better coordinate new accelerator projects, such as ERL prototype, as well to insure success of the future large-scale 5GeV ERL-type SR source on the KEK campus. Thus, ISAC strongly endorses the merger.

At the same time, ISAC strongly recommends setting up a mechanism that would preserve the high standards of the operations culture established over decades by the PF accelerator Division and strongly required by the PF user community. One possible mechanism to help with such preservation could be to set and measure against yearly operational goals for both PF storage rings, such as: less than 3% downtime for PF-SR and less than 6% downtime for PF-AR. These goals should become true measure of effectiveness of the KEK operation and be considered as top priority items on KEK DG priority list.

As it was pointed out to ISAC by presenters, the proposed merger would set up a system of business relationships within KEK somewhat analogous to those that already exist (*e.g*. the Accelerator Laboratory and Institute of Particle and Nuclear Studies). ISAC recommends to PF management that they analyze the history and the status of existing organization, extract constructive lessons from that and try to avoid obvious and well-recognized stumbling blocks in the process of reorganization. ISAC strongly supports PF management intent to call in the near future for the ISAC accelerator subcommittee meeting that could be quite helpful at such critical moment of the PF transformation.

8. Other Conclusions and Comments

ISAC notes that the leadership of IMSS, the PF and the existing and proposed institutes is outstanding and is providing the needed vision, strategic and tactical approaches to maintain and further develop an integrated program on the KEK site which has a national and (in chosen areas) world leading nature.

ISAC continues to strongly endorse the efforts to identify outside sources of funding. Examples of success like those in the Structural Biology Research Center leverage tremendously on the PF budget and add significant scientific and technical opportunities. This could be also helpful in rapidly building up CMRC.

ISAC endorses the implementation of a rotation scheme for the members serving on the committee and urges that the next meeting date in about 9 months be established very soon.

ISAC thanks IMSS and PF staff for excellent help and organizational support to enable a most successful meeting.

Appendix – Contained in the Appendix to this ISAC Committee Report are the following:

1. List of ISAC members

2. Agenda of the ISAC Meeting – December 16-17, 2008

3. List of Questions provided to ISAC by PF Management

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1. List of the Members of the PF ISAC Committee

Ernest Fontes – Cornell High Energy Synchrotron Source

Hidetoshi Fukuyama – Tokyo University of Science

Efim Gluskin – Advance Photon Source

Keith Hodgson – Stanford University, Chairperson of Committee

Ingolf Lindau – Stanford University

Kunio Miki – Kyoto University

Toshiaki Ohta – Ritsumeikan University

M. Ree – Pohang Accelerator Laboratory

Volker Saile – University of Karlsruhe

Hiroyoshi Suematsu – Riken Harima Institute

2. Agenda of the 1st ISAC Committee Meeting

Third PF ISAC Meeting

Date: December 16 – 17, 2008

Place: Room 244, Building No.4, KEK

PROGRAM

Tuesday December 16th 2008

9:15-9:25	Introduction (O. Shimomura & K. Hodgson)
9:25-10:05	Charge to the PF-ISAC Updates on PF and PF-AR activities（budget & user operation） Response to the previous PF-ISAC Director's discretionary funds (2nd year) (S. Wakatsuki) (30 min + 10 min discussion)
10:05-10:30	Update on light sources (top-up operation & kickers for BL-16, second Apple-II) (T. Kasuga) (20 min + 5 min discussion)
10:30-10:55	Progress report on BL strategy and the new beam lines and consolidation of BLs (M. Nomura) (20 min + 5 min discussion)
10:55-11:15	Coffee break
11:15-11：40	New schemes for "user-operated" beam lines, beamlines and beam time for university education (M. Nomura) (20 min + 5 min discussion)
11:40-12:00	Progress and first experience of BL-16 (K. Amemiya) (20 min)
12:00-13:00	Lunch
13:00-13:30	Executive session <CLOSED>
13:30-14:10	Start-up of Condensed Matter Research Center (Y. Murakami) (40 min)
14:10-14:50	Science topics (20min x 2)

A) Structural basis for selective cleavage of Lys63-linked polyubiquitin chains by JAMM de-ubiquitinase (S. Fukai, Univ. of Tokyo)

B) Angle-resolved photoemission spectroscopy of complex oxides
(A. Fujimori, Univ. of Tokyo)

14:50-15:10	Coffee break
15:10-16:10	ERL project (H. Kawata & T. Kasuga) (40 min + 20 min discussion)
16:10-16:30	Organization of the IMSS/PF and the directorate for FY2009-11, relation between KEK Accel Lab and Machine Division (O. Shimomura & S. Wakatsuki) (20min)
16:30-17:00	Discussion with PF directorate and Director of CMRC <CLOSED>
17:00-18:00	Executive session (Fix next ISAC dates in FY2009) <CLOSED>
19:00	Dinner

Wednesday December 17th

09:00-11:00	Executive session (Shimomura, PF Directorate, Director of CMRC) (120min) <CLOSED>
11:00-11:30	Summary discussion (30min)

3. List of Questions provided to ISAC by PF Management

1) Is the overall strategy and progress of the beam line refurbishment program still valid and sufficiently efficient?

2) BL16 project: Are the range and choices of sciences covered by the BL16 project narrow or wide? Are the time-lines and priorities of beam line construction and commissioning appropriate?

3) How is the progress in establishing the Condensed Matter Research Center?
Is it focused enough, the selection of the fields appropriate, and team arrangements?

4) Are the new schemes proposed for user-operated beam lines reasonable?

5) Are we moving in the right direction by establishing education-oriented beam lines and a beam time allocation scheme?

6) Is the progress of the compact ERL development fast enough?
Are the efforts on developing ERL science case (both c-ERL and the high energy ERL) satisfactory? Are there any important areas of science being neglected?

7) Is the proposed management scheme for FY2009-2011 reasonable and workable for the next three years?

8) Are there any other critical factors to be considered concerning the merger between the Machine Division with the KEK Accelerator Laboratory, which is being discussed?