Committee Report
NSLS-II Experimental Facilities Advisory Committee Meeting
May 10-11 2007

Members Present:

P. Dumas, SOLEIL Synchrotron
A. Joachimiak, ANL
W. Hendrickson, Columbia University
S. Mochrie, Yale University
M. Ramanathan, ANL
I. Robinson, University College, London

Members Absent:

A. Baron, SPring 8
M. Chance, Case Western Reserve University
J. Hastings, SLAC
G. Ice, ORNL
S. Kevan, University of Oregon
R. Liebermann, SUNY Stony Brook
F. Sette, ESRF
B. Stephenson, ANL

The NSLS II EFAC met on May 10 and 11, 2007 and heard presentations providing an overview of the current project status, including updates on plans for the initial suite of beamlines, the accelerator systems, and conventional facilities. We also heard detailed presentations on the Stability Task Force Report, on front ends, on ID beamline optics and damping wigglers, on the proposed initial beamlines, on the current status of planning for transitioning existing NSLS experimental programs to NSLS II, on plans for the Joint Photon Sciences Institute (JPSI), on undulator research and development, on IR chambers, and on efforts towards 1-nm focusing.

We learned of several important modifications to the project since the previous EFAC meeting, that have occurred mainly in response to the CD-1 review, including that the booster is now outside of the storage ring, that the Central Laboratory Office Building (CLOB) has been eliminated from the project for cost reasons, and, especially welcome, that the suite of initial insertion device beamlines is increased and now includes on undulator sources: a nanoprobe beamline, an inelastic x-ray scattering (IXS) beamline, a soft x-ray coherent scattering and imaging beamline, and a hard x-ray coherent scattering, coherent SAXS/XPCS beamline; and on damping wiggler sources: a powder diffraction beamline and a microprobe EXAFS beamline. In addition, now an essential component of the transition to NSLS II operations will be transitioning existing NSLS research efforts to NSLS II, which we also welcome.

The design of the facility building seems to have converged to a more-or-less final form. The current design seems satisfactory in most respects. The loss of the CLOB is regrettable. However the project proposes to use the current NSLS building for administrative and technical support functions as a sensible alternative. Nevertheless, moving the NSLS II as close as possible to the NSLS still leaves a substantial walking distance between the two buildings. The EFAC recommends that a covered walkway be provided between the two buildings to ameliorate the journey back and forth during inclement weather conditions. In order to facilitate and maintain accessibility and communication between the NSLS II user community and the NSLS II management, the EFAC strongly recommends that the possibility be explored of providing office space for the NSLS II Director and NSLS II Scientific Director within the NSLS II building itself.

The NSLS II has increased the size of the five LOBs around the facility. The current design provides for 72 offices and 6 laboratories serving a total of 6 sectors. For programs in material science-style programs, the EFAC feels that the overall LOB space planned is about right, however we feel that it would be wise to add one or two more labs per LOB at the cost of some office space. By contrast, for a state-of-the-art, high-throughput, biology program, the EFAC considers it highly likely that additional total space will be required, including more lab space and cold rooms, providing different temperatures. For reasons of expandability, in response to the biologists needs, the EFAC prefers the LOB design that configures the LOBs as a straight building, rather than wrapped around. Based on our experience at APS, the EFAC wonders whether the area currently-planned for LOB parking lots is sufficient, and we recommend that the area allocated to parking-lots be carefully reconsidered. Currently, access to the NSLS II experimental floor from the outside for truck deliveries is through an intermediate staging room. However, the access from the staging room to the main facility is through a normal access corridor. The EFAC recommends rearrangement of the access doors to the floor in the intermediate staging room to be in line with the outside door so that large equipment and, for example, large hutch components can be loaded and offloaded easily to and from the NSLS II floor.

The EFAC commends the NSLS accelerator team for the clever 3-pole wiggler (TPW) concept. TPWs will provide a significantly higher flux at hard x-ray energies than the NSLS II soft bend magnets. In fact, the TPW hard-x-ray flux is comparable to that at current NSLS BM lines – and so will be well matched to many programs transferring from the NSLS -- but the brightness is 100 times higher. The growth in the lattice length and the 10% emittance increase caused by the TPW, the EFAC deem acceptable. With regard to extra-long straight sections, the EFAC notes that key NSLS II experiments are either brightness- or flux-limited. For such experiments (which include nanoprobe, imaging, XPCS and IXS) the factor of 2 or 3 increase promised by a longer undulator are very appealing. Therefore, we urge continued examination of the feasibility of extra-long undulators, while endorsing the decision to consider the standard DBA30 as the CD 2 baseline. Purposed to two beamlines, canted damping wigglers, each viewed on-axis, provide many-fold higher brightness than an uncanted arrangement, viewed off-axis, although the total flux is similar for both cases. The downside of canted wigglers is that they contribute somewhat to an increased beam emittance. Nevertheless on balance, the EFAC recommends that canted wigglers be employed for damping wiggler straights that will be utilized by two beamlines. For a source with the highest possible brightness, the EFAC endorses an NSLS II ring energy of 3.0 GeV. The EFAC is happy with the work done so far on the question of building stability, especially regarding the floor. The planned use of long beamlines at NSLS-II places special demands on stability. EFAC commends the consultation with Spring8, where there have been severe problems related to long beamlines and we recommend continuing contacts to try to find out exactly what kind of instability is causing problems. In the end, we wonder whether ensuring the stability of long beamline may lead to special civil engineering requirements on the long-beamline out-stations, and in their connection to the main building.

With regard to front ends, the NSLS II project intends to capitalize on lessons learned at other facilities, and is basing the NSLS II front end on tested designs. In addition, some simplifications are envisioned, which will provide for some cost savings throughout the life of the project in easier operation and maintenance. Wiggler fan radiation limited to +- 3 m rad for an uncanted wiggler and limited to +- 2.3 mrad for wigglers canted at 2 mrad is deemed acceptable by the EFAC. Overall, The mechanical engineering group seems to have a good handle on the heat load issues and are making use of experimental data in pushing the envelop for the heat load on masks and shutters.

The high-heat load created by the NSLS II damping wigglers is also the toughest case for beamline optics, but, by somewhat limiting the footprint on a silicon monochromator with apertures, and by controlling the silicon temperature to where the silicon thermal expansion is close to zero, the high-heat load currently seems manageable.

The EFAC is delighted by the increased number of beamlines now in the project scope and endorses the specific suite of project beamlines envisioned: on undulator sources: a nanoprobe beamline, an inelastic x-ray scattering (IXS) beamline, a soft x-ray coherent scattering and imaging beamline, and a hard x-ray coherent scattering, coherent SAXS/XPCS beamline; and on damping wiggler sources: a powder diffraction beamline and a microprobe EXAFS beamline which both exploit the unique capabilities of NSLS II and meet the needs of a large section of the NSLS user community.

However, we note that conspicuously missing from this list, but corresponding to a major user base at the NSLS and nationally, is an insertion device beamline for protein and macromolecular crystallography (PX). Although we understand that such a beamline cannot be part of the construction project scope, an important recommendation of the EFAC is that it become a key goal of the overall NSLS II effort that a state-of-the-art beamline for PX be operational as soon as NSLS II itself becomes operational. We believe that this will be important in maintaining and increasing the number of PX users at NSLS/NSLS II. To succeed in this goal will require a concerted effort by the existing NSLS PX and biology community. To facilitate such an effort, we recommend the appointment of an NSLS/NSLS II staff person – a Biology “Tzar” or “Tzarina” -- with responsibility for organizing a community effort to define what the biology program at the NSLS II will look like. For the final shape of the NSLS II biology capabilities, we envision an integrated suite of biology beamlines with a range of capabilities, including, for example, a beamline for crystal screening with advanced robotic capabilities, a beamline for high-throughput “routine” structure determination, a beamline for IR studies, a beamline for near-UV circular dichroism (CD) and micro-CD, and a beamline for determining the most challenging crystallography measurements for samples with large-unit-cells and small crystal sizes, which might be the ID line in the initial line-up.

The EFAC acknowledges the DOE’s rules for beamline access: All beamlines (both BES-funded and non-BES-funded) will supply at least 50% of the beamtime to GUs, staff beamtime will amount to no more than 20% of the beamtime, partner user beamtime will amount to no more than 30% of the beamtime. We endorse the concept and role of the Beamline Advisory Teams (BATs). In order to make becoming a BAT member sufficiently attractive, the EFAC strongly encourages provision for BAT members to be awarded beamline access for the first several years of operations. Specifically, we envision the BAT of the construction phase, morphing into Partner Users of the operations phase, with a corresponding allocation of beamtime. Because it generally takes some period of operations before a beamline is working at its full potential, we recommend an allocation of up to 30% of the beamtime for the first three or four years of operations. The exact allocation should depend on the extent of the BAT’s contributions.

The EFAC commends the NSLS-II project for its progress on the issue of transferring programs from NSLS I. The incorporation of 3PW's into the lattice will provide nice sources with the correct spectrum to welcome a good number of beamlines from the NSLS. We strongly endorse the appointment of a NSLS-to-NSLS-II transition manager. The planning so far for a selection procedure is interesting but will need further refinement. In particular, there should be clear announcements to the NSLS user community about the philosophy of beamline management at NSLS II (i.e. that there will no longer be PRTs, in particular), and concerning the procedures and criteria that will be followed by NSLS II management in determining which beamlines and/or programs to move from NSLS to NSLS-II. The EFAC anticipates that, while some beamlines will be transferable with minor modifications, others will require significant upgrades. In either case, transferred beamlines can be expected to serve a broader set of users than at the NSLS. Therefore, the selection of which equipment to transfer from which beamlines, and which equipment to upgrade should involve the entire community in. Because there may be competing visions for what to do, we recommend that the transfer process start with some method of 'outline' proposal and peer review, perhaps by EFAC, before any commitments are made concerning which beamlines to relocate from the NSLS to NSLS II.

With regard to the transfer timeline, the EFAC strongly recommends that all measures possible be taken to ensure that the transfer of beamlines can happen quickly. For such items as front ends, we recommend that funds be assigned from the project for the front ends of the beamlines to be transferred first. For long-lead-time upgrade items, such as mirrors, it may be that NSLS operations funds can sensibly be used. The current proposal to exclusively use 'early operations' funds -- available only from CD-4a -- could hold up the transfer schedule and risk losing the user community. Also, we feel it important to enhance the message/perception that transfer of operations and the user community from NSLS to NSLS II is a core mission of the NSLS II project. The appointment of a transition manager will help with this too.

EFAC requests that the plans and needs of existing PRTs be addressed on a case-by-case basis. We accept the constraints imposed by DOE, but we hope that some executive control and involvement can be retained by erstwhile PRT scientists. We are particularly concerned about the scientists at IBM, NIST, Exxon, NRL, and any remaining university-based PRT groups, and we recommend discussions start with each of these groups as soon as possible, with a status report at the next EFAC meeting. We are less concerned about DOE-funded PRT groups, such as BNL departments. In this case, it may be that use of joint appointments (e.g. a NSLS-II/Biology joint appointments or an NSLS-II-Materials Science joint appointment) can resolve many issues. We certainly do not wish to discourage other areas of DOE from continuing their support of synchrotron-based research at NSLS II.

The EFAC is excited about the prospect of the JPSI institute as currently envisioned. It will provide an important new way to engage the academic community in synchrotron-based science. We view it as especially important to create a mechanism for graduate students to become trained in the craft of planning, designing and executing synchrotron-based experiments. Such training is essential for creating the future scientific leaders in the synchrotron field. These are the people who will carry out the science possible at the NSLS II that we don't yet know about. In connection with JPSI, a topic of discussion among EFAC members was: Is there any mechanism that JPSI could institute that would induce local universities to make faculty appointments to scientists who will base their research at NSLS II, that the universities would otherwise would not make? The answer, several of us feel, is probably not. Because beamline funding, by DOE rules, now goes through the facility, a university can expect no special long-term monetary benefit from such an appointment. Neither does the promise of start-up funds from BNL seem likely to be a major inducement, because universities usually are able to put together generous start-up packages for the faculty that they want to hire. What is often more difficult and critical for university researchers is obtaining ongoing research funding and here proposals in the context of JPSI will be very attractive, since they may offer an avenue of funding that otherwise could be difficult to access and special credibility. Where JPSI may play a pivotal role in recruitment is to make more attractive an existing offer by a local university by offering a JPSI appointment and backing for a NSLS II-based research project.

The NSLS II project calls for new designs for small gap undulators which will require employing an in-vacuum design. In addition, to enhance the fields, NSLS II proposes to employ cryogenically-cooled magnets which can enhance the fields by about 20% over room temperature. NSLS II is also exploring the possibility of using new materials for these magnets. Design plans for using all in-vacuum motion is an excellent idea and is commended – however there are significant engineering challenges due to the large magnetic fields.

The beam in the machine is expected to have a small lifetime, and hence will operate in top-up mode. Accordingly, there will be significant beam losses, most of which can be expected to occur near the transition to the small gap at the IDs. Studies should be carried out to understand the damage to the magnets due to this beam loss – in particular, how their magnetic field is affected -- both for traditional magnetic materials and the for proposed new materials.

NSLS II is expected to operate with small emittance, and the beam stability will be a very important issue. Hence understanding the effect of the IDs on the beam is an important task. This will involve measuring the magnetic fields of the ID prior to installation and even providing some "shimming" to correct for field errors measured. This magnetic measurement will be a special challenge for the proposed in-vacuum undulators. The EFAC recommends that an earnest R&D effort be initiated in this area as it is essential that these IDs perform to design specifications for the success of the whole project.

The EFAC endorses the revised design of the dipole chambers for infrared extraction. The smaller vertical angle of the chamber interior in both conventional extraction (14 mrad V (avg.) by 50 mrad H) as well as for the large dipole extraction (42 mrad V (avg) by 50 mrad H-which gives unsurpassed far-IR performance for incoherent SR) represents a significant reduction of the chamber interior and a considerable design simplification. As a result, the modified dipole chambers more do-able. A possible cut-off effect on the long wavelength radiation emission, due to the reduced dimension of the interior of the chamber, does not seem to play a significant role.
Horizontal extraction, using a planar mirror inside the dipole chamber, is a more typical extraction geometry than that proposed previously, and is in use at several synchrotron facilities, which reinforces the notion that this scheme will result in the most efficient photon collection. This first mirror location inside the standard and large gap dipole chambers should not impact into the impedance. Calculations should be carried out as soon as possible to finalize the extraction geometry.

The heat load issue should be more carefully addressed. Of particular concern is the slotted option for the first mirror, which should be sized to restrict the heat load on the mirror to a reasonable power (10 to 40W). Any cooling system should be sure to minimize any source of mirror vibration. The slot in the first mirror could allow for a downstream soft x-ray beamline. The feasibility of this option should be investigated further, to ensure that it does not compromise the IR extraction.

An extraction mirror located inside the standard infrared dipole chamber may offer an alternative solution for beam extraction up to the ultraviolet energy domain (larger horizontal angle, closer distance to the source). The EFAC recommends that detailed calculations be carried out to investigate what is the minimum slot size that would be compatible with efficient UV beam extraction, while keeping the mirror cooling requirements reasonable. We request that the results of such calculations be presented at the next EFAC meeting.

The first mirror (M1) of the IR beamline is the most critical component, and several issues must be addressed at this stage. Due to the blackening of the first mirror, often observed at other synchrotron facilities, one might consider making the first mirror retractable for inspection and/or replacement, if necessary. The EFAC acknowledges that the retractable option of M1 is not the most favourable ones, since vibration isolation , position reproducibility, long travel motion for extraction M1 are all technically challenging, but, we believe, doable. Earlier decisions about the first mirror options may help initiating an R&D project in order to validate all the critical issues well before installation inside the dipole chamber. In particular, thermal sensors at the near edge of the slot might be considered for surveying any unexpected heat load, which would damage the first mirror.

In the early stage of optical design, and mirror mounting, alignment procedure should be discussed and external references issues addressed in close collaboration with Optics Group members. This will ease tremendously the alignment in a very constrained environment, and rechecking positions after mirror extraction and repositioning (if any)

The distance from the infrared source to the infrared instrument is quite long in conventional beamline set up (along the electron trajectory). This is not a problem in the mid-IR regime, as long as the optical elements are very well optimised and figure errors kept into the usual specifications (which are, however, less severe than for X-ray optics)
However, the large gap dipole will be dedicated to far-infrared. For efficient use of the long wavelength radiation (of hundreds of microns), and considering the large depth of the source for these energies, the design of the shortest beamline possible is recommended. Extraction perpendicular to the electron trajectory should be considered. In order to release the radioprotection constraints outside the tunnel wall, an extraction outside the tunnel, through the roof, should be worked out, as such extraction has been achieved satisfactorily at the ERSF facility.

The large gap dipole being situated before a 3 pole wiggler, a possible space constraint might come from the proximity of the extracted beam to the tunnel wall. This should be worked out rapidly, to validate the horizontal extraction, and to not further complicate the vertical deviation by the second mirror.

Folding the far-IR beamline perpendicular to the electron beam trajectory might end up with a space constraint while crossing the adjacent beamline. Careful beamline implementation, accounting for the far-IR beamline location should be investigated at this stage.

In considering future challenging scientific programs at NSLS-II, the combination of techniques should be also considered at early stage, since this might guide the implementation of adjacent beamlines. If manufacturing cost is not too much higher, installation of several mid-IR at other locations around the ring (in addition to the ones planned for the early phases of NSLS-II operations) would allow for program growth, including bending magnet VUV beamlines.

At this EFAC meeting, we did not hear a presentation concerning detectors. With the increased funds now projected to be available as a result of the CD 1 review, we trust that it will now be easier to allocated sufficient funds for detector development. For now, we repeat what we wrote in the last EFAC report: “We especially recognize the importance of developing highly-capable, special-purpose x-ray detectors in order to fully exploit the unique brilliance of NSLS II. Indeed the proposed detector projects may represent a new "smart" detector paradigm. Detector development has long lagged far behind the accelerator and optics portions of a synchrotron experiment, and we encourage a faster ramp-up of this program, even if that involves more resources." The EFAC requests to hear a presentation concerning detector development at our next meeting.

A key goal for NSLS II is to achieve a useful focused 1 nm-sized x-ray beam. To this end, we heard an update concerning the two possible routes to 1–nm-sized spot sizes that will be pursued as R&D efforts at the NSLS II: kinoform lenses and multi-layer Laue (MLL) lenses. Important progress towards focusing with kinoforms was reported. This included the achievement of a spot size of no more than 46 nm. In addition, theoretical questions described at the last EFAC meeting about the ultimate spot size achievable with kinoforms have been largely removed. We applaud the proposed hiring of a theoretician who will be able to further elucidate kinoform optical performance. Finally, we learned that more of the kinoform manufacturing is now occurring on-site. Overall, we are impressed by the progress made. There was less concrete progress to report on the MLL side, although hiring plans are well-advanced. We continue to believe that the successful development of MLL lenses capable of focusing to 1 nm presents a number of major materials growth challenges, including the precise engineering of the layer thicknesses, which smust vary over a wide range through the growth process and the precise engineering of the layer tilt, i.e. step density, which also varies through the growth process. Because of these challenges, we urge the establishment of key milestones for this effort to ensure that timely progress towards a deliverable 1-nm lens is made in this effort.

It seems clear that this and other NSLS optics R&D efforts would very greatly benefit from regular access to high-brilliance x-rays. To this end, the EFAC strongly recommends that NSLS II arrange for regular access to an APS optics beamline by agreement with the APS.

Finally, the EFAC requests that we get copies of the presentation at least one day prior to the EFAC meeting. We would also like to hear a summary of the most recent comments from the ASAC and CFAC at the start of each EFAC meeting.