NSLS-II Accelerator Systems Advisory Committee

Review
May 10-11, 2011
REPORT

Attendance

Present:
C. Biscari, R. M. Boyce, K. Finkelstein, D. Hartill, R. Hettel, P. Kuske, D. Mills

Absent:
G. Decker

1. Introduction: Requests for the Next ASAC meeting

It is certainly satisfying for the Committee members to observe the outstanding work and rapid progress of the NSLS-II Project. The quality of the presentations, the responsiveness of the NSLS-II Team and the careful and efficient handling of logistics have been excellent.

A large quantity of material was presented. Though the presentations were generally clear, the agenda was too full to permit extended dialog between the committee and presenters. The Committee suggests that NSLS-II consider a presentation schedule that includes parallel breakout sessions in the latter part of the day. If the presentations are posted far enough in advance, questions from all members of the committee can be relayed to the breakout sessions for discussion.

The Committee would like to see an update presentation on the x-ray diagnostics beamlines at the next ASAC meeting.

2. Responses to Charge

Is there sufficient progress with storage ring magnet production so that the end of production can be forecasted and are the schedule mitigation plans which are being implemented and planned still adequate to prevent major project delay?

The Committee was informed that most magnet first articles are accepted. The 35mm aperture dipole design is still undergoing modification to reduce deflection of the poles when energized. Some instances of coil-to-yoke short circuits in corrector magnets were reported. All magnets other than the 35mm dipole should begin mass production by June. The 35mm dipole should be in production by the end of the summer. To manage the risk of production delays, NSLS-II has authorized IHEP and BINP to prepare for production of magnets in parallel with the lagging vendors' efforts. In addition, NSLS-II is considering strategies for parallelizing alignment activities.

The ASAC supports the risk management measures described above. However it was unclear to the Committee whether there were well-defined "decision points", that is the considerations that would trigger the award of additional magnet production to backup vendors. It was not evident that the consequence of a hypothetical delay in a particular vendor's production had been used to forecast the completion of girder production

Is there sufficient progress with LINAC, Booster, Beam-transfer line and pulsed magnet systems to complete all these systems well before storage ring commissioning in May 2013?

Construction of the Linac and Booster appear to be on track. The linac-to-booster transport line is done, and component deliveries have begun. Completion of the transport line has been delayed by three months, reducing the time available for R&D activities with the linac. It was stated that sufficient time remains to commission the linac and transport.

The booster-to-storage ring transport line design is not yet completed. The Committee notes that the specifications for the pulse magnets in the storage ring are very ambitious, posing risks to commercial fabricators that will drive up their bids. The Committee recommends that NSLS-II consider the construction of a "day 1" or "year 1" injection kicker system with relaxed tolerances. "Relaxed tolerance" storage ring kickers could serve commissioning and early operations needs well. The Committee supports NSLS-II intentions to reach out to DIAMOND and the Swiss Light Source to exploit their long experience with control of injection disturbances during top-up operation. The Committee was impressed with the rapid startup and staffing of the NSLS-II in-house kicker prototyping effort.

Is there sufficient margin in the schedule for the beam position monitor systems and other critical diagnostics?

A schedule for production of beam position monitors was presented, but the Committee did not scrutinize the schedule in depth. Technical progress for the BPMs appeared to be very good, and results of the prototype tests at the Advanced Light Source were impressive. The use of a FPGA for signal processing will make it possible to correct measurements for bunch pattern variations and other conditions specific to NSLS-II operations in the future. The Committee recommends that NSLS-II continue to test the electronics at other labs such as DIAMOND and SOLEIL. Particular attention should be devoted to verifying that performance will not be degraded by electronics noise from the Storage Ring power supplies and other sources. The Committee debated the risks and benefits of continued development and consequent delay in production of these important electronics. On the one hand, tests to date indicate that NSLS-II sensitivity and stability specifications can be met with the present design. On the other hand, even better performance might be obtained with continued refinement of the RF section. The NSLS-II electronics will to set a new performance benchmark, important to high-brightness light sources around the world. Further performance improvements will be beneficial to both NSLS-II and the light source community in the longer term. NSLS-II may wish to buy more time for development by starting production of the present design for the booster, and delaying production of storage ring electronics to allocate time to further development and perhaps a revision of board layout.

Is the there sufficient progress with the control system in particular with hardware s for real time data communications systems, timing systems, and networking?

The Committee felt that control system development is on a good track. While extension of the EPICS-4 framework to higher-level applications is an important goal, it should be kept in mind that tools for rapid prototyping of high-level applications will be essential to the rapid achievement of world-leading performance by NSLS-II. For this reason, the Committee recommends that NSLS-II prepare to provide strong support of tools for rapid development of applications such as MATLab.

The Committee supports the concept of a comprehensive database. However caution and good judgment must be exercised to avoid a major investment of effort that either does not provide commensurate benefit or else creates a database that the organization will not keep updated. The Pareto principle applies here- 80-90% of the benefit of a comprehensive database will be achieved with 10-20% of the total effort. The last 10-20% of the benefit will likely demand much more effort. Furthermore, a small percentage of outdated information in the database will create suspicions deterring the unquestioned use of the database even if a majority of the data is up-to-date.

Are the plans for protecting vacuum and diagnostics components from synchrotron radiation adequate?

The Committee was convinced that NSLS-II efforts to define the synchrotron radiation protection strategy will produce a successful protection scheme. The committee was impressed with the rapid progress of the Synchrotron Radiation Protection task force. The SRP task force has carefully documented its methodology and conclusions, as demonstrated in the examples presented to the

Committee. The damping wigglers have been identified as demanding the shortest beam abort time. A FPGA-based equipment protection system, patterned on PETRA-III work, is being developed for NSLS-II.

The Committee recommends that the Task Force be expanded to add members from XFD who will be responsible for designing x-ray beamlines.

Now that the system design is sufficiently mature for outside review, the Committee repeats its recommendation that an external review of the equipment protection system.

The committee further recommends that NSLS-II consider defining and employing the minimum useful (as opposed to maximum safe) stored currents for commissioning activities when this is feasible.

Is there sufficient progress on the project insertion devices?

The undulator magnet lab is nearly complete, awaiting only the delivery of a flip-coil. Contracts have been awarded for three of the 6 insertion devices and solicitations for two more IDs are being prepared. The U22 device requires re-engineering the standard gap control to fit in the tunnel. As yet there is no complete conceptual design solution for combining canted-source capability with phase-shift polarization control. The scan rate specified for the SRX in-vacuum undulator appears to be very challenging. These items require additional resources, and the Committee recommends that the engineering support necessary to advance these designs be allocated.

Are assembly, installation and testing planned to sufficient detail and is the installation schedule realistic.

A seven-phase installation plan was presented to the Committee. The Committee did not delve into the details of the schedule. It was evident that the work plan for installation of utilities and girders was well thought-out. A plan for installation of the Injector was presented. The Booster installation will be supervised by the vendor after its 2/2012 delivery, with the goal of starting commissioning in 12/2012. The Storage Ring cavity schedule is impinging on the critical path for commissioning, and it may be necessary to consider the feasibility of installing PETRA 7-cell cavities for commissioning.

The installation workload ramps very quickly to over 100 FTEs. The Committee was told that appropriate steps for obtaining and training the necessary people were already being taken.

The Committee noted that the Storage Ring installation schedule was dated 1/2011, a time when there was still considerable uncertainty about magnet deliveries. The Committee strongly recommends that an installation updated schedule based on best- and worst-case magnet delivery schedules be prepared prior to the Lehman review. The plan should demonstrate clearly the strategy for installing complete or partial girders. The careful tracking of magnet production progress at the vendors must now be used to make judicious predictions of girder availability so that contingency plans can be enacted in time to provide the longest possible time for commissioning the Storage Ring in advance of CD-4.

Has there been sufficient progress in commissioning preparation?

Commissioning plans are well-advanced for this stage of the Project, and it is clear that the commissioning teams understand the process. A draft of the Linac Commissioning Plan provided to the

Committee. It demonstrates due consideration of the Accelerator Readiness Review process and the need to define the prerequisites and deliverables that the ARR review will expect.

3. Commentary on Presented Material

Introduction and Overview

Findings: Steve Dierker welcomed the Committee and presented a status overview. The NSLS-II Project is 52% complete. The Project is experiencing its peak spending rate in FY2011: $245M for the year. This averages to $1M per workday for the year. The project has revised its baseline to add more than $16M for effort on accelerator systems. Magnet production has been delayed to address issues revealed in measurements of prototypes and first articles. Taking into account these delays, the Project early finish date is March 2014, well ahead of the June 2015 DOE milestone for commissioning the facility.

Ferdinand Willecke presented an overview of Accelerator Systems. He reported substantial progress in top-up safety analysis, using tracking techniques that speed the process. He stated the analysis is now complete.

Field tolerances of storage ring magnets were re-examined, and it has proven possible to relax tolerances on most magnets (the large aperture magnets at high dispersion points retain the original tight tolerances).

All aluminum extrusions for the Storage Ring are delivered. The injector building is behind schedule; beneficial occupancy is expected in June. Inconel chambers have been removed from the vacuum system design.

A second RF transmitter has been ordered. This was an option on the “scope addition” list of options for use of contingency as risks are retired.

99 Magnets for the Storage Ring have been received, of which 47 have been accepted for installation.

80% of the “large” or critical procurements have been awarded.

Comments: Excellent progress has been reported. NSLS-II Management has focused considerable attention on magnet production issues. Very good progress has been made in many areas. New flexibilities of storage ring lattice have been identified; lattice solutions have been identified which provide good dynamic aperture wit positive chromaticity or with low horizontal beta in the long straights. Top-up safety and hardware protection requirements have been studied extensively.

Recommendations: None

Magnet Production

Findings: The NSLS-II is acquiring 916 storage ring magnets being produced by multiple vendors with varying degrees of success as has been reported in many previous reviews. The project to date has invested a considerable amount of effort to help direct the vendors toward a successful conclusion; they have assigned a full time magnet production manager to provide focused oversight to the production issues as well as assigning engineers and consultants to each vendor.

The release of final magnet production to the vendors is nearing completion with the anticipated date of June 2011 for all multipole magnets, final production release for the 90mm dipole has been issued, and the 35mm dipole release is expected around August pending resolution of core de-lamination issues.

The Schedule Performance Index for Accelerator Systems has been 0.85 from July 2010 through March 2011. This is characterized as a three-month delay for Accelerator Systems, because a three-month schedule shift of the BCWP curve would make it lay on top of the BCWS curve. However magnet production is approximately 6 months behind schedule. In many instances these delays due to deviations from specifications, uncovered during inspection and testing of first articles.

Steve Dierker assigned Satoshi Ozaki as manager for magnet production toward end of 2010. NSLS-II has assigned engineers and hired expert consultants to perform intensive vendor oversight,

The Buckley large aperture quad first article has been accepted. The large-aperture sextupole first article is not accepted yet.

The Buckley 90mm aperture dipole is received and under test. The 35mm aperture dipole first article has been tested and accepted, however the next 3 dipoles have developed cracks in their cores; production has stopped. The suspected cause is poor strength of the glue bond between laminations.

Tesla Quads: slow vendor response, progress towards May 20 PRR promising; two new magnets in BNL measurements now.

Initial problems were encountered with field reproducibility of BINP quads after splitting. A copper bar wedged between poles seems to have remedied this problem; magnet measurements are underway to confirm the problem is resolved.

IHEP sextupoles were released for production. Quality control issues were identified and addressed. They were caused by insufficient control of the manufacturing steps.

Production of Danfysik sextupoles progresses at a rate of 14/month. So far, 25% have been delivered. Presently production is halted due to tooling upgrades required to maintain quality of stacking.

Production of Everson correctors proceeds at a satisfactory rate. There have been instances of coil-to-yoke shorts; these are not considered serious and will be repaired at BNL. So far, 22 of these magnets will need a simple fix.

NSLS-II has made back-up plans for magnet production at BINP and IHEP if the production rate of acceptable magnets cannot be increased sufficiently at Buckley and TESLA. NSLS-II is also making contingency plans to measure all magnets to assure quality and recover schedule.

Comments: NSLS-II has taken all prudent steps to remedy problems with quality and production rate of magnets. This has required considerable effort by both NSLS-II management and staff; this effort is deserving of recognition. Every project has problems of this nature in one area or another, requiring speed and care to resolve. These problems will make entertaining stories to recount when NSLS-II is serving thousands of happy users. Regarding booster magnets, past experience suggests that Stangenes is not likely to develop measurement capability for their dipole contract.

Recommendations:

- Define firm decision points for all future remedial actions, including conditions for NOT enacting these actions and deadline dates for enactment if conditions are not met:
    - Second-source production
    - Extra girder alignment stations
    - Expanded BNL measurement program
    - Revised girder installation strategy

Progress with Linac and RF

Findings: The RF systems for NSLS-II consist of two 9 m RF straights each with two 500 MHz single cell superconducting RF cavities (initially only one RF straight will be equipped) for the storage ring. The cavities will each be powered by a 300 kW klystron. The booster will have one 7-cell cavity powered by a 80 kW IOT amplifier. The 200 MeV linac will have four 5.2 m long travelling wave structures powered by two 42 MW klystrons with solid state modulators. The RF transmitters have been ordered for both the storage ring and the booster.

3rd harmonic superconducting cavity (passive) has been constructed by Niowave. This cavity is for bunch lengthening.

Solid state modulators use IGBT's that are switching only 1.2 kV. 15 nC/bunch is the real challenge for the linac and will require feed forward to compensate for the beam loading.

Linac front end is delayed by three months but the overall schedule is still ahead of schedule.

Scandinova Modulator production is underway with some design modes to satisfy BNL safety and reliability requirements

The 540 kVA 55 kV power supply for the storage ring transmitter has a 1.2 kHz subharmonic possible so they changed the switching frequency to around 100 kHz. The Canadian Light Source has been used as

the test bed for the low level RF system it has a similar power supply. These tests demonstrated the need to change the filtering and switching frequency of the power supply.

The input coupling of the cavities was changed to give a loaded Q of 65000 by adjusting the waveguide tongue.

Linde has been awarded the contract to provide a turnkey cryosystem with a 850 W cold box.

The pressure stability specification is +- 2 mbar for the LHe and +- 50 mbar for the LN2

The start of the 500 MHz superconducting cavity delivery date is close to when it is needed so need to track carefully.

Comments: There is good progress on all the RF systems. The new digital low level RF control system for the storage ring cavities has been tested at the Canadian Light Source and has shown excellent performance. The Canadian Light Source uses the same 500 MHz superconducting RF cavities so these tests also demonstrate the ability of the electronics to handle the microphonics of the cavities.

The superconducting 3rd harmonic bunch lengthening cavity has been produced as a nearly complete system by Niowave BNL will install HOM dampers and commission the system. This has been a very productive SBIR collaboration.

Generally, the NSLS-II RF systems are in good shape.

Recommendation: Continue to monitor AES progress as they construct the 500 MHz superconducting cavity system.

Progress with Booster and Transfer Lines

Findings: Budker received the booster contract in May 2010; a final design review was held in February 2011. First articles are due from Budker in July 2011. Export control issues are being resolved. Booster commissioning is scheduled for February 2013. The production of all booster magnets by Budker is well underway. The project has identified booster dipole field quality to be a risk and is taking steps to mitigate it by working to implement a 14-Hall probe array and laser tracker measurement system. A senior consultant, formerly with the SLS, has been contracted to help assure adequate field quality.

Budker is producing most of the booster vacuum chambers. NSLS-II is producing some straight section chambers and is responsible for purchasing all vacuum pumps, controllers and gauges.

The storage ring BPM processors will be used in the booster. BPM buttons were purchased by NSLS-II and shipped to Budker. An in-flange Bergoz DCC T will be installed. 6 Beam screens were designed by

BINP and approved by NSLS-II, currently are in manufacturing plant. Diagnostics cabling and cable trays are designed; BPM cables are low-loss and will run in shielded tray.

The booster dipole power supply contract was awarded to Danfysik in December 2010. Other power supplies are being assembled at BINP. Full-energy orbit correction magnets will be driven with analog-controlled ramping power supplies.

Injection and extraction kicker prototype pulsed power supplies are complete and appear to meet the difficult 300-ns flat top constancy requirement for multibunch injection. The kicker magnet uses the "smart copper coil" design invented by Budker. Still, the project has identified the kicker pulser performance as a cost risk.

The booster will use a 7-cell 500 MHz RF cavity from Petra/DESY. The rest of the RF system is provided by NSLS-II.

The machine protection and control PLC logic is being developed in collaboration with Budker.

Booster utility and cable tray designs are either complete are near completion.

Transport lines are being developed and integrated by NSLS-II. The magnet contract was awarded to Stangenes in Oct 2010. The insertable screen contract was awarded to Radiabeam in March 2011. Vendors for the component supports and vacuum equipment have been identified and standard beam line components are in procurement. LTB beam dumps are being designed in-house and are 85% complete. The BTS and diagnostics beam line are still being designed. The LTB will be installed before the linac.

Magnet delivery from Stangenes has been identified as a risk, and steps are being taken to mitigate it. A consultant from SLAC has been hired to expedite production with biweekly visits to Stangenes, and a subset of magnets needed for linac commissioning has been expedited. The project is considering in-house transport line magnet measurement

A virtual transport line has been created for controls development. An IRMIS database is being developed.

Comments: Risks to the booster and transport line systems have been identified and mitigation measures appear to be adequate for now. The Committee urges the project to continue detailed communication with Budker on booster system interface issues.

The Committee notes that Stangenes, who is supplying the transport line magnets, is infamous for not measuring its magnets, even if promised, and suggests that the project pursue its own magnet measurement program.

Recommendation:

- The Committee recommends that NSLS-II consider the construction of a "day 1" or "year 1" injection kicker system with relaxed tolerances.

Pulsed Magnet Systems Status

Findings: In response to the September 2010 Review, the specifications for the pulsed magnets for the storage ring have been revised. The specifications for the kicker magnets now calls for a waveform amplitude variation < 0.1% and a timing jitter of < 1 nsec. For the septum magnet, the amplitude variation is < 0.01%, the timing jitter is < 10 nsec and the leakage flux is < 30 microtesla-meters. The roll of the kicker magnets will be remotely adjustable. These new specifications reflect those achieved at other modern storage rings.

Bids for the storage ring pulsed magnets were expected back by early June. Five potential vendors were contacted with the expectation of a positive response from several of these vendors.

The pulsed magnets for the booster are part of the contract with BINP for the booster and are under construction at BINP. The magnets are due to arrive at BNL by spring 2012.

To develop the necessary local expertise, a pulsed magnet laboratory is being setup. There has been rapid progress in setting up the laboratory. A prototype kicker magnet has been assembled along with a fast pulser and tests are underway.

Comments: The relaxing of the original very challenging specifications for the pulsed magnets for the storage ring will enable an evolutionary approach to commissioning the storage ring. It also means that more vendors will be interested in bidding to provide the magnets.

The Committee was very impressed by the rapid establishment of a pulsed magnet laboratory. The enables the training of the engineers and technicians to carry out the difficult measurements of the field quality of the pulsed magnets and in the design and operation of the pulsers needed to drive these magnets.

Recommendation: Continue to closely monitor the progress of the RFP's for the pulsed magnets for the storage ring to insure that there will be no delays in receiving these critical components.

Diagnostics and Instrumentation

Findings: An updated overview of the diagnostics for the injector and the storage ring was presented. There was only one minor modification: now there are 4 instead of previously 3 Fluorescent/OTR screens in the storage ring.

The instrumentation of the LTB-1 and especially the flags produced by RadiaBeam was described in more detail. According to plan their delivery is in accordance with the general time schedule for installation and commissioning.

A coarse pentant-wise schedule for the cabling and installation of electronics was shown to the committee.

Detailed plans were presented for the distribution of diagnostic components in ID straight sections showing that quite some space will be available for the tune monitor, the transverse bunch-by-bunch feedback system, and pinger magnets. The distribution of BPMs and their supporting structures in these sections depend on the vacuum chamber apertures and the type of ID designated in the straights.

The in-house BPM development is in a sufficiently advanced state and proceeds according to plan. Successful beam tests at the ALS with the new digital front end (DFE) and the analog front end (AFE) spin 3 showed already a resolution 5 times better than specified. The results of a long term stability test in a thermally stable rack without the pilot tone correction technique were below the specification for the storage ring but fully compatible with the injector specification. The beam based resolution measurements with larger integration intervals showed an increasingly noisier vertical than horizontal beam position. This was attributed to the AFE. If time permits this problem should be sorted out before the large number of AFEs is ordered for the storage ring BPMs in October 2011.

Comments: The instrumentation for the NSLS-II, especially the RF-BPMs have made the promised but nevertheless impressive progress since the last meeting. The technical progress with the DFE and AFE is obvious: results obtained with beam-based tests of the resolution at the ALS in the turn-by-turn, the fast and the slow orbit acquisition mode are world records. This digital BPM system will set new standards.

Further beam-based experiments should be performed in order to assess the intensity and fill pattern dependence of the measured beam positions. If necessary the FPGA could be used for the compensation.

The presented schedule on overall diagnostics looks reasonable and there might even be margin for a further iteration on the AFE.

The rather large space reserved for diagnostics in some of the ID straight sections is remarkable: there are all together 4.8 m for tune monitor, bunch-by-bunch feedback, and pinger magnets. None of these systems can be abandoned but the required installations could be designed and made considerably shorter. In this context it is even more remarkable that it seems to be impossible to reserve 1 m of space in a suitable straight section adjacent to an ID for the installation of the equivalent of "pulsed sextupole" injection at some later date. This really would allow NSLS-II to perform top-up-injections without any

beam orbit perturbation in the future. This is mandatory for a light source with such a small emittance and high brilliance and never ever will be possible with the chosen traditional 4 kicker injection scheme.

Recommendations:

- Tests of the RF-BPMs should be done in a noisy environment (switching PS, pulsing of fast magnets, etc) and by using the final BPM power supplies.
- NSLS-II should consider implementation of the digital BPMs in their current status in the booster while continuing the work on the storage ring BPMs. The enlarged vertical noise and any malfunctioning of components of the system should be investigated, understood and if possible cured before installation in the storage ring. Board layout changes can be time-consuming and the benefits and the risks of continued development should be assessed. Already now NSLS-II is leading the world in the area of digital RF-BPMs
- The ASAC would like to be updated on synchrotron light diagnostic beam lines and photon BPMs.

Vacuum and Synchrotron Radiation Protection

Findings: Much progress has been made in the area of Synchrotron Radiation Protection since the last review (October 2010) when the SRP task force had recently been established. Considerable documentation is now available, describing the work of the SRP task force. A strategy - SRP Work Flow for Passive Protection Cases – was presented & several specific examples illustrate how "safe conditions" (maximum current) is estimated. Terminology for geometrically defining regions of safe ID beam illumination & required EPS (equipment protection systems; the AIE or "Active Interlock Envelope"), based on material properties, SR power, and e- trajectory are now available.

Studies indicate that, for bend magnet radiation, exposed hardware is passively safe at 50 mA. The worst case is set by radiation from the damping wiggler (DW), when it hits the downstream edge of the aluminum vacuum chamber (vertical angle = 1.5 mrad); a maximum permissible EPS response time (to dump the e- beam) was determined to be approximately 1msec. The Equipment Protection System will use field programmable gate arrays (based on PETRA-III work) with response time < 1 msec. The system is still under development. The required response time can be greatly improved if copper inserts are installed at the end of the DW vacuum chamber. The response time will increase to ~12 msec. This has been implemented for the new design of DW Vacuum Chamber. The maximum safe operation current for which no EPS is required has been estimated at 2 mA for the DW Vacuum Chamber.

Comments: Some progress has been made to address previous ASAC recommendations from the previous ASAC Meeting in October 2010:

- *"The issue of chamber heating by synchrotron radiation, and the strategy to protect the chambers, should be subjected to internal and external reviews on a routine basis."*
- *"X-ray beamline designers who will be tasked with the similar effort for the beamlines should get involved now as it will be a good learning process."*

The ASAC Committee feels that neither of these recommendations was fully implemented at the time of this review.

Recommendations: Since development in this area is far enough along, after some additional work on FPGA and clarification (better graphical illustration) for ID AIEs (slide 11),

- Conduct an external review by expert panel.
- ASAC continues to urge that XRD people become a part of SRP taskforce.

Progress in Insertion Devices

Findings: The ID table (6 ID baseline) has not changed since Oct 2010. Contracts are issued for 3 of 6 ID designs, work continues toward RFP for all but IVU22.

U22 ID (to be used for IXS) would be located in high beta straight section. The mechanical design is complicated because there is 127mm less space available (when compared to the low beta location) for the strong back support structure.

For the double EPU, a solution for magnets between and on either side of the IDs, that will produce BOTH canting & (separately) phase adjustment, has not been worked out.

X-ray users of the SRX-IVU want to scan gap at speed from 1-100um/sec while maintaining 2 degree phase error. This was said to be a very challenging requirement.

DW weight has increased by 10% - it requires an increase weight limit for equipment transport in the ring.

The ID magnet measurement facility (MMF) will be nearly complete with delivery of flip coil system (from ADC), expected at end of May; Helmholtz coil system has unexplained1 Hz noise issue. Outstanding issues to be addressed in R&D include the development of a conceptual design for an in-vacuum magnetic measurement system, a seal for the large-area door on the IVU vacuum enclosure, and vacuum preparation methods for PrFeB (cryogenic compatible permanent magnets).

Comments: The IVU22 wall clearance issue has been raised at ASAC reviews over a year ago. When will engineering resources be made available to redesign a gap control mechanism? The Committee did not get a clear picture of the timetable for resolution of this and other R&D issues.

Recommendations:

- Investigate effects, for RF cavity, of metal particle generation in IVU due to gap drive mechanisms INSIDE vacuum
- Investigate how to apply techniques, demonstrated by S. Temynik at Cornell, for bake out & heat treatment of PrFeB magnet arrays.

Accelerator Installation

Findings: Work Permit/authorization will be granted on a per-pendant basis. Work Plans for each ASD work group will be prepared in advance of installation. A Work Control Coordinator is assigned for each ASD work group. Daily meetings used for communication; weekly high level installation meetings are also planned Site access routes have been established, with tunnel and mezzanine paths identified. The installation schedule, prepared in January, recognizes a 2 month delay in start due to delayed beneficial occupancy of the first pentant. The planned end date was unchanged.

Installation phasing was described at a high level by major system. An installation labor profile shown with a peak of 100 FTE required in the period of Oct 2011-May 2012.

Seven work groups/packages were identified for storage ring installation: Utilities, PPS, Magnet/Girder assembly, vacuum system, power supplies, beam instrumentation and controls.

The Injector installation plan listed and included Utilities, Booster RF, LTB part 1, Linac, Booster, LTB part 2, and BTS. Booster installation is the responsibility of the vendor; booster delivery is expected in February 2012. The booster is to be ready for commissioning by December 2012.

Comments: A detailed schedule showing the assembly of each girder with magnets, alignment, infrastructure, vacuum chamber, and date for Ready for Installation (RFI) is needed to ascertain impact of late magnet delivery from vendor.

Recommendation:

- The Committee strongly recommends that an installation updated schedule based on best- and worst-case magnet delivery schedules be prepared prior to the Lehman review. The plan should demonstrate clearly the strategy for installing complete or partial girders
- A detailed full installation schedule was available for review but was dated January 2011 and marked "draft" and did not have girder install details, just full cells. An updated full installation schedule needs to be available by June 2011 before the DOE review.
    - Have a detailed P1 schedule showing all work and individual girder installation with a view over the next 5-6 months.

Preparation for LINAC Commissioning

Findings

The analysis of the Operation Authorization Process for LINAC Commissioning is being thoughtfully addressed. A group of up to 15 people is involved in the authorization process, defining requirements for the Accelerator Readiness Review requested by DOE. The same people will later on prepare the necessary documents for the Booster and the Synchrotron commissioning authorizations.

The start-up of the LINAC Commissioning is foreseen in November 2011, to be finished by the end of the year, with contingency up to January 2012, allowed by the general schedule.

The commissioning of the Linac, which is being built and will be assembled at BNL by Research Instruments, will be carried out by RI people, responsible for reaching the nominal parameters, in close collaboration with NSLS-II team. The detailed schedule and the procedures are being defined by both teams.

The diagnostics and the measurements needed to reach the nominal parameter are already defined. High level application development is in progress, to be finished by end of May 2011, with time contingency for its utilization.

The draft document for NSLS-II Linac Commissioning, sent to the Committee after the meeting, will be used by the DOE Brookhaven Site Office (BHSO) to approve the beginning of commissioning operations of the Linac.

Comments

This first commissioning plan preparation is a useful test-bed for the whole system commissioning. It is mainly dedicated to define the prerequisites for safe commissioning rather than for rapid technical progress.

Recommendations

None.

Information Flow for Storage Ring Commissioning

Findings: The NSLS-II Controls Group has implemented a relational database (IRMIS) to archive and organize the information necessary to determine and change the optics, orbit, and all other aspects of the storage ring that are relevant to operations and R&D activities. NSLS-II is considering the use of IRMIS to manage a wider spectrum of information about the NSLS-II accelerator systems for use during commissioning and operations. The database is being developed. The Committee heard a general description of how this database could be used to support high-level applications for accelerator control. “Use case” examples for organizing data were presented for the general tasks of “accelerator physics interface to engineering”, “process for the official lattice”, “a systems engineering Wiki”, “engineering data requirements” (magnet measurement data, survey/alignment data), and “use the systems engineering Wiki for schema design”, and “leverage”. The presentation made a case for establishment of standard procedures for importing data that has been compiled in convenient electronic form (such as a spreadsheet) by a member of NSLS-II during construction or operation of NSLS-II so it might be easily and logically accessible for future automated applications, systems engineering design, data mining, etc.

Comments: The Committee endorses the general concept of electronic storage and organization of data collected during NSLS-II construction in a way that it can be accessed conveniently for simple and obviously useful purposes as well as potentially more sophisticated uses. However the Committee suggests that NSLS-II exercise caution before embarking on a program to solve more general problems of information management and system control (research in computer science and information technology) too far removed from the task at hand, commissioning NSLS-II.

The proposal takes advantage of database tools already developed by the Controls Group (primarily for the purpose of documenting, setting and monitoring the configuration of systems under EPICS control) to significantly expand the utility of the accelerator database by uploading a very wide variety of data that has been collected to ensure the quality of NSLS-II during construction and commissioning. It was not possible for the reviewers to gauge the scale of effort being proposed to complete the initial loading of the database, to maintain it, and to develop connections to existing accelerator design/control software or systems engineering applications that use this database; but the Committee reckons that a very significant change in habits and investment of effort will be involved for many NSLS-II groups. Furthermore, continued maintenance will be required as hardware is replaced or modified.

The payoff (benefit as compared to tools and data management at recently commissioned or modern operating facilities) was not spelled out in the presentation. Without sufficient effort applied, the payoff for this approach will likely not be realized until well after commissioning.

Recommendations:

- Develop an estimate of effort, materials and time required to bring each of the five “use cases” to the level of maturity required for commissioning and early operation.
- Compare this estimate to comparable efforts at other accelerator labs and confirm that these resources will be made available.
- Do not start a development program for data archiving and organization without management commitment of sufficient resources.