NSLS-II Accelerator Systems Advisory Committee Review FEBRUARY 1-2, 2012 REPORT

Attendance

Present:
C. Biscari, R. M. Boyce, G. Decker, K. Finkelstein, J. Galayda, D. Hartill, P. Kuske, D. Mills

Absent:
R. Hettel

Executive Summary & Recommendations

The Committee was impressed with the overall progress of accelerator systems since the last review. Production of practically all magnets is underway and the two-shift girder alignment operation has begun. Booster deliveries are on the way. Controls and high-level applications appear to be in very good shape.

- Continue monitoring the late Tesla quadrupole magnet deliveries
- Re-evaluate the impact of late quadrupole deliveries on the girder installation plan. Consider incorporating late magnet deliveries into the schedule as a post girder installation process; determine date at which time this plan needs to be implemented.
- Avoid a premature decision to install a Petra cavity for early storage ring commissioning. Assess the likelihood that achieving the design performance will take longer if this path is followed
- Balance the risk of time lost installing and commissioning a temporary RF cavity against possible benefits and risk retirement that would result from earlier commissioning of diagnostics, beam position monitors and orbit control systems.
- Either by modeling and analysis or else risk assessment, make an explicit decision as soon as possible regarding the need for additional machining of vacuum chambers to accommodate high beam power density.
- At earliest opportunity, assess the impact of pulsed elements, (e.g. modulators) on instrumentation readbacks; lessons learned should be propagated to the downstream machine installations. This can and should be pursued as soon as the pulsed elements come on line.
- Continue refining the plan for source size measurement with the x-ray camera.

- Develop a plan for energy spread measurements
- Continue refining the plan for diamond screen x-ray beam position monitor.
- Take full advantage of experiences gained at other laboratories with this type of XBPM
- Evaluate the resource loaded schedule and area specific installation activities to determine if the installation rate can be increased to meet the planned completion date.
- Evaluate the schedule impact if the installation rate remains at baseline plan
- The committee recommends that whenever new information is desired by the commissioning team than the signals should be delivered to the control room by the network and through the control system.
- Patch panels for analog signals in the (temporary) control room should be avoided. This does and will put additional load on the control system group.
- Maintain the strong coordinating connections between the Controls Group and other groups.
- Define an effective way to integrate survey and real-time building HVAC temperature data into the controls system.
- Consider raising priority of automation of the injector if commissioning proceeds as rapidly as we anticipate.
- If budget is available, start hiring and training additional NSLS-II operators early
- Encourage development of engineering high-level applications
- Review plans for staging controlled beam losses for shielding verification

Introduction: Requests for the Next ASAC meeting

Perhaps the Committee chairman is to be blamed for not budgeting the committee's time with sufficient care; however the fact remains that very little time was available to the committee for discussion of findings, concerns and recommendations, and the closeout commentary was less complete than it should have been. The Committee could function more effectively if it had more time to discuss the presented material and its findings prior to closeout. This might be achieved by several means:

- Schedule all presentations on the first day, perhaps with parallel sessions in the afternoon.
- Schedule a later closeout (this would require an additional night's stay for many members).

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 still adequate to prevent major project delay?

Production rate of all varieties of the SR magnets has improved significantly since the last review and the end of production can be forecast from all vendors with the exception of Tesla. The Tesla quadrupole schedule is lagging at the time of the review; only 17 quadrupoles delivered out of a planned 53 since

May 2011. Tesla had difficulty in coil production but is currently making progress with 10 magnets reported complete at their facility in January.

Assess the status of magnet-girder-vacuum integration with regard to the plan to complete girder installation by the end of 2012 and start commissioning in June 2013.

Girder integration is well-planned and on its way, with adequate building space allocated and labor assigned. Girder integration has just started second shift work. Due consideration has been given to training second-shift personnel. The desired production rate of two girder assemblies per week has not been met yet, but is within reach: 1.5 girders are produced per week now. Two-shift production should make it possible to meet and exceed the goal. A further production increase to six-day/week operation is an option if production must be accelerated further.

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 June 2013?

The linac is certainly coming along nicely. The booster appears to be on schedule; delivery of systems and components has just begun. The Linac and Booster installations are currently on track and are scheduled to be complete by October 2012. Transfer line magnets are now in full production and will be available to meet the scheduled installation dates. Injection hardware is still in development. The prototype Storage Ring kicker is showing very promising performance. The ceramic chambers for kickers are now on order. The Committee found no reason to doubt that the injector will be available to support Storage Ring commissioning in June 2013. However it is too early to discount schedule risks until booster hardware installation is underway and pulse magnet development has reached the stage of reliability testing.

Assess the progress of accelerator installation. Are installation and integrated testing planned to sufficient detail and are labor resources and schedule realistic?

At the time of the review, 12 multipole girders and 2 dipole girders were installed. The Storage Ring RF transmitters and high power waveguide was also installed. The installation of booster infrastructure was well underway. Progress is rapid now; however installation started 12 months behind schedule while the completion of installation is forecast to slip only three months. The plan for installation and testing is very detailed. If the planned resources can be brought to bear, installation and integration will follow the schedule.

Is there sufficient progress with the RF systems, the control systems, beam position monitor systems and other critical diagnostic?

In all areas except the superconducting RF cavity, progress has been very good. The Committee believes that AES is competent to do the job, but there is a chance that completion of the cavity might delay the start of storage ring commissioning. The Committee was divided over whether a DESY multicell cavity should be installed to support commissioning if the SCRF cavity is delayed. Part of the Committee felt that too much effort would be wasted installing and commissioning this cavity, and that this effort would be better applied to other issues. Other members of the committee felt that the effort might be warranted to achieve early stored beam, thus making it possible to debug many important diagnostics, power supplies and controls systems essential to the start of operations. The NSLS-II team is already

committed to commissioning a PETRA cavity in the booster, so low-level RF controls must be designed and commissioned for this purpose anyway. It is the gut feeling of the Committee chairman that this is a magnitude-dependent issue: a three-month delay in first stored beam due to delayed delivery of SCRF might be barely acceptable whereas a six-month delay would be unacceptable.

The control system is making great progress and the development of accelerator physics applications are advancing nicely.

Continuous self-calibration has been implemented in the RFBPM electronics, and quoted stability results are excellent. This is a major step forward in diagnostics design, of interest to many in the field. The Committee would love to see more data at the next review.

Is there sufficient progress on the project insertion devices?
Progress here appears to be good. Meeting specifications of an in-vacuum vessel measurement system will be challenging; however successful development of this capability will constitute an important advance for NSLS-II and undulator design in general.

Comment on the state of planning for accelerator operations. Data on the commissioning plan was provided online; however there was insufficient time for the Committee to read and evaluate the material. The Committee chair urges NSLS-II management to begin hiring control room operators well in advance of the start of commissioning. Enlargement of the control room staff will likely be necessary even if the NSLS operators are all moved to NSLS-II, and basic training of new operators can begin while NSLS is still running.

3. Commentary on Presented Material

Introduction

Steve Dierker and Ferdinand Willeke welcomed the Committee and presented a Project Overview.

2011-2012 are the years of peak project activities. The Project did $211M of work in 2011; today the Project is 73% complete. Beneficial Occupancy of the entire ring building is imminent.

- Magnet production is now going well. Ring magnet production has reached 67% complete, and 50% of the SR magnets have been delivered to BNL.
- It was stated that, last year, installation began 3 months later than scheduled. It was also stated that installation is not falling further behind now. The need for additional labor is being addressed.
- There is still 14 months of float to the CD-4 milestone, and the Project has a very comfortable 31% contingency on the cost of work to go. Steve Dierker will endeavor to achieve the “early start” date for commissioning. He stated that this ASAC review is to emphasize installation and the transition to operations.

Accelerator Systems Overview

Findings:

- All major procurements in the Project baseline for accelerator systems are awarded, with one exception: an in-vacuum undulator IVU22.
- Production is well advanced for magnets and vacuum chambers. Installation of first accelerator components has been challenging. The Project has found it necessary to increase installation staffing and take over some work scope from contractors.
- The Project has deployed contingency to add scope; four additional insertion devices will be acquired for the NEXT and ABBIX beamlines. Two of the four are identical in design to devices already in the Project scope.
- 15 FTEs have been added to the installation/integration workforce to accelerate cable installation, survey and electronics installation.
- The linac is installed; the Accelerator Readiness Review is scheduled for 27 February, and linac commissioning will start in March.
- Deliveries of booster hardware from BINP have begun, and should be completed in April.
- The Storage Ring top-up safety analysis has been completed, and will be subject to a safety review in April.
- The Synchrotron Radiation Task Force has completed its analysis, and recommended that the mis-steering interlock be set to dump stored beam for mis-steering errors of 500 microns. Fabrication of the superconducting storage ring RF cavity was delayed as a result of out-of-specification niobium provided by Niowave.
- Testing and pressure vessel certification of the cavity Dewar is still posing some challenges.
- The low-level RF (LLRF) electronics have been tested at the Canadian Light Source. This FPGA-based system has demonstrated superior performance.
- BPM electronics tested again at ALS. The continuous calibration feature has been implemented in the latest prototype. Measurements have demonstrated better than 200 nm (300 nm) stability for reading vertical (horizontal) position.

Comments:

- It appears that all the hard work devoted to accelerating magnet production has paid off. The NSLS-II team has done an excellent job.
- The addition of installation staff and two-shift girder assembly are good choices by Project management.
- One committee member is aware of difficulties with pressure vessel certification on other BNL SCRF projects. It may be appropriate for BNL to examine whether the standards and procedures for pressure vessel qualification of SCRF Dewars need clarification or revision.

Recommendations:

- In deciding whether to install a Petra cavity in the Storage Ring in the event of delays in the SCRF cavity, balance the risk of time lost installing and commissioning a temporary RF cavity against

possible benefits and risk retirement that would result from earlier commissioning of diagnostics, beam position monitors and orbit control systems.

Power Supply and Power Distributions Systems Status

Findings:

- There are 997 power supply channels used for the storage ring
- The main dipole power supply is divided into two sections, with very low-noise 400 amp/600 volt power supplies. Applied Power Systems has been selected and the final design review is scheduled for mid-February. Controls and digital current regulator have been designed by BNL and components are in hand. Complete system installation by end of August likely.
- The rest of the power supply designs are done. Some procurement documentation remains to be completed.
- Procurements are well underway with most high-value contracts either complete or in the last stages of deliveries
- Test systems have been built for all major subsystems; all supplies meet or exceed specifications
- Power supplies for Linac phase 1 are ready for testing as soon as water is available (mid-February)
- The Storage Ring power supply installation sequence will depend on availability of different components, particularly cable harnesses.
- Procurement and installation schedule not ideal for pendant 1 but should be OK for rest of the machine

Comments:

- The committee has no special concerns with respect to the power supplies

Recommendations: None

Magnet Production

Findings:

- Production quantity: 300 Quads, 255 Sextupoles, 60 dipoles, 270 correctors; total 16 types and 885 units. The assignment of BNL contacts for each vendor was an important and very useful measure. Overall, magnet deliveries to BNL are 50% complete.
- Last ASAC on May 10-11, 2011; "...a few more months of ramp-up time is anticipated for others (vendors) to reach a routine production and delivery stage."
- As of 2/1/12, issues remain with only one vendor: Tesla's late quadrupole deliveries.

- Danfysik & IHEP are slightly behind on production goals set in May; Tesla is far behind schedule with only 17 Quads delivered out of a planned 53 since May 2011.
- The Project has identified end of February 2012 as deadline to release backup quad design to offset Tesla projection.
- BINP is the backup source for Tesla quads; the BINP magnets will be a few centimeters longer than Tesla quads, and cannot be placed at arbitrary locations. There is a contract in place with BINP to build 7 quads, with an option for 30 more; if the BINP quads are placed by a damping wiggler, the quads can be powered and set independently from the Tesla magnet strings.
- Tesla has produced 10 quads in January, only 1 delivered to BNL.
- The dipole core stacking and bonding jig was re-designed. Production started again. One dipole produced on the new jig has been delivered to BNL.

- Quad: 81 magnets measured (BINP, Tesla, Buckley), all good and acceptable. There have been no rejected quadrupoles thus far.
- Sextupole: 70 magnets measured by BNL; there are instances of field harmonics slightly out of spec but the magnets are deemed useable. One IHEP magnet has been rejected; it will be brought into tolerance by IHEP.
- Results of multipole measurements at BNL are close to data provided by the vendors, with the exception of IHEP magnets.
- Production of skew corrector coils is on hold; a prototype of new coils will be available 6 weeks after award.
- A magnet acquisition "lessons learned" workshop is scheduled for April 2012.
- The mix of magnets and their delivery dates will support the goal of 2 girders integrated per week. Magnet measurements demonstrate that field quality is satisfactory. The current delivery rate is consistent with goals for the start of commissioning.
- 3 magnetic measurement stations are running at BNL now.

Comments

- The committee commends the persistent pressure the project has placed on the magnet vendors and their ability to communicate and work with them to bring the production schedule to a foreseeable closure.
- The project continues to forecast a production rate of 18 magnets per month from Tesla beginning in February 2012 which, from past history, may be optimistic. The project has addressed the impact of late magnet deliveries and integration with installed girders; this alternative should be dusted off and reviewed again as it may still become a reality.
- At some point in the presentations, it was mentioned that AC response measurements for the corrector magnets had not been done on production magnets. Given the importance of the orbit control system, it might be appropriate to perform such measurements (including vacuum chamber) on selected examples of the correctors.

Recommendations

- Continue monitoring the late Tesla quadrupole magnet deliveries
- Re-evaluate the impact of late quadrupole deliveries on installation of girders
- Determine if installation of magnets on installed girders will be necessary.

RF Systems Status

Findings:

- Linac and Storage Ring transmitter installation is nearly complete with integrated testing underway. Commissioning will soon begin.
- Booster transmitter final acceptance testing scheduled for early March
- The booster 7-cell cavity is ready for high power test in the new RF blockhouse
- 500 MHz cryomodule design ready for final design review next week
- Nb delivery to AES projected for March. Tooling for Nb component fabrication complete
- First cryomodule scheduled for delivery in February 2013
- RF window test stand design complete. Windows will be tested to 300 kW using the 300 kW klystron amplifier at BNL in the RF blockhouse
- Digital low level RF system working very well and will be improved with a new pc board layout
- Storage Ring Cryo-System final design review this week (LINDE)
- Landau Cavity work re-established and will need ferrite beam tube dampers

Comments:

- Linac and Storage Ring transmitters are in good shape
- Booster RF system is on track for both installation and commissioning
- 500 MHz 300 kW transmitter is ahead of schedule and will be available for testing the windows for the cavities
- The digital low level RF control system developed by BNL is performing as well as other state of the digital control systems as demonstrated by tests at the Canadian Light Source
- The first cryomodule is scheduled for delivery in February 2013
- The RF window test stand design is complete. Windows will be tested to full power using the 300 kW klystron amplifier at BNL in the RF blockhouse
- Digital low level RF system working very well and will be improved with a new pc board layout
- Present schedule for the 500 MHz superconducting cryomodule has slipped by ~ 3 months due to quality problems with Nb procured by the vendor. This situation must be monitored closely to avoid any further schedule slip.

Recommendation

- Avoid a premature decision to install a Petra cavity for early storage ring commissioning. Assess the likelihood that achieving the design performance will take longer if this path is followed

Vacuum Systems Status

Findings:

- In general, progress on vacuum systems is well-advanced for all of the injector machines and for the storage ring. All bending magnet chambers, drift pipes and vacuum components are now available for the Linac-Booster Transport Line (LBT). Phase I vacuum installation for the LBT is completed and interlocks and interface to Linac are being checked out. The detailed layout for the Booster-Storage Ring Transport Line has been completed and fabrication of some components has begun.

- Budker Institute, who is supplying a semi-turnkey Booster, has completed all arc vacuum chambers (36 stainless steel chambers). The ceramic kicker chambers have been received at Budker and septum chambers are being fabricated at Budker as well.
- The storage ring vacuum system is also proceeding. Machining of the 150 aluminum multipole and dipole vacuum chambers is complete, welding at APS will be completed in February, and chamber assembly will be completed in July. Over 80% of the chambers are assembled. Fifteen of the fast corrector chambers, made of Inconel, have been completed. For commissioning, the multipole chamber extrusions will be used for the straight sections. Production of these chambers has been started. Production of the "day-1/2" straight section chambers has been started. The contract for the damping wiggler chambers has been placed.

- Approximately 150 RF shielded bellows will be required for the storage ring. These reflect an improved design as compared to the device tested at APS and more than 20% of the required number have been completed.

- Absorber (sticks, crotches, flanges, etc.) production is underway. There have been several hitches in this area (vendor mistakes on crotch absorbers, for instance) including the problem of the (bent) copper cooling tubing not always maintain 100% contact with the Glidcop absorber when welded, but the staff are aware of this and working to mitigate this problem.

- All pumps, valves, and gauge controllers are in house. .

- It was reported that ray tracing and thermal calculations for the planned post-project-phase insertion device sources had not been started due to lack of resources. Further, it was suggested that it may be necessary to machine a channel in certain dipole chambers to provide adequate clearance to the radiation fan.

Comments:

- While full thermal analyses may be unrealistic due to limited resources, it would be helpful to move forward with some of the ray tracing to identify any new chamber locations most likely to see high power density. If replacement chambers with machined channels will be needed it would be better to know as soon as possible.

Recommendation:

- Either by modeling and analysis or else risk assessment, make an explicit decision as soon as possible regarding the need for additional machining.

Instrumentation Status

Findings:

- The installation of the diagnostics components in the LTB line went very smooth and on time according to the initial plans.
- All instruments are connected to the control system and software for the support of the commissioning of the transfer line is available.
- This will certainly allow RI and PPT to commission the linac successfully and verifying the specified key parameters like charge, bunch pattern, longitudinal and transverse beam emittance. Based on the experience with the already installed instrumentation in the LTB line, the committee is convinced that the installation and implementation of the instrumentation for the other parts of the accelerator facility will proceed according to plan as well.

Comments:

- We heard about the status of other diagnostic components only as side remarks in other presentations. Most of the components seem to be available as required: ICTs, FCTs, DC current transformers, BPM heads, amplifiers and electronics for the bunch-by-bunch feedback, and so on.
- Additional tests of the digital BPM electronics at the ALS were performed in November and have apparently not shed any additional light on the reason why noise of the measured beam positions is still different in the horizontal and vertical planes. Subsequent to the review, the Committee was informed that the cause of the difference in noise floor has been tracked to the PC board layout. It will not be fixed in the production run, due to schedule considerations and to the performance being judged satisfactory.
- It was reported that no impact of the fill pattern on the beam position was observed.
- The committee is not sure whether in view of these results the pilot tone calibration is still worked on and whether it is required at all.
- No additional information on particle beam instrumentation was presented.

Recommendation:

- At earliest opportunity, assess the impact of pulsed elements, (e.g. modulators) on instrumentation readbacks; lessons learned should be propagated to the downstream machine installations. This can and should be pursued as soon as the pulsed elements come on line.

X-Ray Diagnostics

Findings:

- The presentation this time focused on three areas; (1) the pin-hole/compound refractive lens camera set-up for source size measurements, (2) diamond fluorescence screens, and (3) photoemission-based x-ray beam position monitors.

Pin-hole/Compound Refractive Lens Camera for Emittance Measurements:

- Electron beam emittance will be measured by a pin-hole camera arrangement. The spatial resolution with slits is expected to be < 10 microns. With the compound refractive lens (CRL) installed, the resolution is expected go to about 1 micron at 20 keV. The goal is to select slit size and CRL parameters so a single CCD measures both horizontal and vertical source emittance. Current thinking is to install the camera in the front end.

Diamond Fluorescence Screens

- The use of diamond screens for monitoring the position of x-ray beams from the IDs seems like a straightforward approach. CVD diamond films have been used successfully on the PETRA III beamlines. Can CVD films withstand the power and possible thermal shock associated with NSLS-II high current operation?

Photoemission-based X-ray Beam Position Monitors

- The front end diagnostics will include x-ray beam position monitors (XBPMs) that will have tungsten blades. Thermal and vibration stability analyses look promising. Optimization of the design is continuing.

Comments:

- There were two recommendations from the last review. We are happy with the responses (shown below).
    1) The Committee recommends that the Task Force be expanded to add members from XFD who will be responsible for designing x-ray beamlines.
       Oleg Tchoubar is a member of the taskforce and a member of the experimental division.
    2) The Committee repeats its recommendation that an external review of the equipment protection system.
       The EPS systems will be reviewed after the formal review of Top-Off safety systems.
- Although one of the objectives of the x-ray diagnostics is the measurement of the particle beam energy spread, that was not discussed in this review.
- It was not clear from the presentation if the success of Petra III diamond screen ID beam alignment will carry over directly to NSLS II (i.e., would BM radiation obscure ID beam image, etc.).

- The reviewers had several comments/concerns regarding the XBPMs including: mis-steering survivability had not yet been addressed, why tungsten blades being employed (as they absorb much of the ID power near the surface) and effects of contamination by stray radiation/ID gap dependence was not yet addressed.
- The reviewers had a concern regarding placing the CCD camera in high radiation environment – will this be a problem? If a camera fails inside the shield wall, replacement may have to wait until the next maintenance day. The designers should consider whether this constraint is acceptable. Experience at CHESS (>400mA/2 beam operation): CCD video camera life is >6 months if camera is heavily shielded, view is through one or more 1st-surface mirrors, and camera position is far off electron orbit plane.

Recommendations:

- Continue refining the plan for source size measurement with the x-ray camera.
- Develop a plan for energy spread measurements
- Continue refining the plan for diamond screen x-ray beam position monitor.
- Take full advantage of experiences gained at other laboratories with this type of XBPM

Accelerator Physics Progress

Findings:

- The commissioning team includes 14 people, with defined tasks of interface with engineering groups and implementing dynamic control of technical systems
- Preparation for commissioning and operation is well under control, including high-level applications. There has been a fruitful collaboration between Controls and Physics groups.
- High-dynamic-range Cherenkov detectors for beam loss monitoring have been tested, and are sensitive to beam dump losses of 3mC/sec
- The Physics Group has assembled a detailed Impedance budget calculation and an in-house CBI simulation code.

Comments:

- The committee endorses the Accelerator Physics group working plan, even if expressing some concern on the non-linear lattice flexibility, to face the different insertion devices, and their different gap apertures
- Decision on day-1 rf cavity to be taken the soonest

Recommendation: None

Injector Status

Findings:

- The installation of the Gun and the Linac is being finished, almost ready for commissioning to start in March-April 2012
- First beam from gun has been measured in the test stand (230pC, 20 mm mrad)
- Booster (turn-key from BINP) production is proceeding, including kickers and septa; first girders have arrived. Delivery are scheduled to be finished in Sept 12
- The first part of the LBT installed; integrated hardware tests have begun.
- 2° LBT port and BST magnet design are completed and ready for procurement, with the goal of delivery in June 2012; vacuum chambers are still being designed
- 5 Kickers will be built in-house.
- Septum magnets are in construction at Danfysik

Comments

- The committee has no special concerns in Injector readiness as stated by the general schedule, supported by the on site visit

- In order to meet the schedule a fast completion of the few last element designs (vacuum chambers) and continuous monitoring of all vendors involved in Injector components construction is needed.

Recommendations: None

Magnet Girder Integration

Findings:

- Girder assembly building is established; considered adequate for the planned work but space is tight.
- 111 out of 150 girders fabricated, some held by vendors per contract and deliver as needed by BNL.
- Magnet mechanical inspections are routinely done
- Integration steps are well laid out
- Two girders are routinely stored in final measurement room for temperature soaking; this saves time.
- Started 2nd shift in mid January, working out learning curve to increase efficiency; re-assigned day laborers to swing shift.
- 2 girders per week is the goal, not yet achieved; however only into 2nd shift for 2 weeks so far; will work 6th day (overtime) to meet goal if necessary.

Comments:

- The Girder integration is well planned and executed with adequate building space allocated and labor assigned. Girder integration has just started second shift work and is learning the process

necessary to increase efficiency. The rate of two girder assembly per week plan has not been met yet, but they are extremely close with achievement of 1-1.5 girders per week now. Second shift should raise this to meet the goal leaving overtime (day 6) as their contingency.

- The magnet-girder-vacuum integration schedule is using the most recent magnet delivery dates, including the late Tesla magnet deliveries in October 2012. The Project should continue to arrange the girder integration schedule to mitigate the impact of late magnet deliveries.
- The Committee commends the Project's persistent pressure placed on the magnet vendors to bring the production schedule to a successful closure.
- The project continues to forecast a production rate of 18 magnets per month from Tesla beginning in February 2012 which, from past history, appears to be optimistic. The project has addressed the impact of late magnet deliveries and integration of late deliveries onto already installed girders. This alternative solution should be reviewed again to consider if it needs to be incorporated into the schedule now.

Recommendations:

- Continue effort toward mitigating the late Tesla quadrupole magnet deliveries
- Re-evaluate the impact of late quadrupole deliveries on the girder installation plan. Consider incorporating late magnet deliveries into the schedule as a post girder installation process; determine date at which time this plan needs to be implemented.

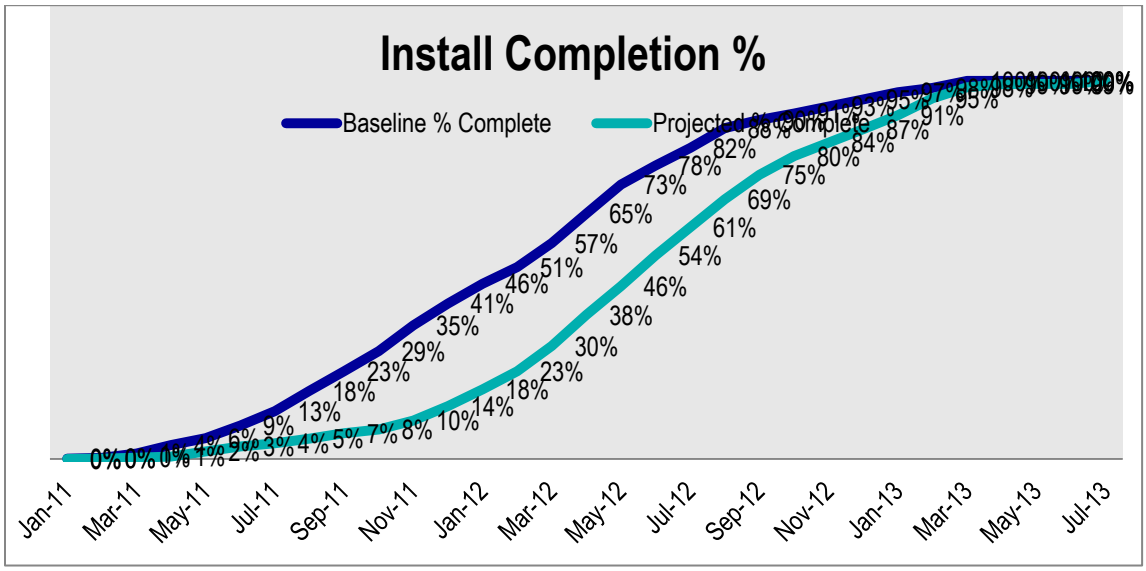
Installation and Integrated Testing Status and Plans

Findings:

- Booster (1.3.3.5.7): on baseline schedule for vendor supplied equipment
- Injection transport line (1.3.3.5.8): on schedule
- Girder Integration (1.3.4.9.1): tasks like water connections to dipole magnets has slipped about 12 months but still has 46 days of float.
- Magnet Girders (1.3.4.9.3): tasks are stacking to the right and changes effort profile.
- Power supply installation schedule shows a slip of 1 year from the baseline
- EPS (1.3.6.2.1): Pentant 1 shows 1 year slip
- All pentants now being done in Q3 & Q4 FY12; is this going to cause a resource problem?
- SR pendant 1 installation has started; 14 girders installed; cell 25 fully populated with magnets; all cables pulled and terminations are in process. Other Pendants started; P2, P3 & P4 starting in phased installation;
- High-level installation schedule status indicates 4 months behind schedule.
- At present, installation activities are on day shift only.
- SR RF systems installation is presently on schedule

Comments:

- The committee commends the successful efforts on the overall installation planning and work so far, much has been accomplished – but much is to be done
- The resource spread will play an important role in determining the final installation timeline
- The overall installation schedule shows activities that have slid to the right by up to 12 months due to delays and unknowns, however the end date of final installation has moved only 3 months. This shift suggests the need for a peak in resources that may not be attainable and needs to be studied carefully.
- Presentations indicated that the planned installation rate of girders can be increased to mitigate the schedule delay. A close review of the effort distribution and peak activities by area is required to ascertain if this advancement can be achieved



Recommendations:

- Evaluate the resource loaded schedule and area specific installation activities to determine if the installation rate can be increased to meet the planned completion date.
- Evaluate the schedule impact if the installation rate remains at baseline plan

Controls System Progress

Findings:

- The essential tools to support the commissioning are available: process alarm handler, electronic log book (OLOG), tracking ticket creation and viewing, IRMIS/relational data tools, configuration handling, multi channel viewer, water fall plot and so forth. The Control System Studio (CSS) is the operator console. It remains to be seen that EPICS-4 performs as robust as earlier EPICS versions in large facilities.
- It was stated that the personnel protection system is behind in some areas, and close attention has been given to assure system availability by the time of commissioning. The use of different

hardware and personnel from different groups for the two interlock chains assures the necessary reliable redundancy.

- Beam mis-steering interlocks are intended to use a 31st cell controller and FPGA development for this purpose is underway.

Comments:

- As usual the control system seems to be in very good shape. Currently all goals are met. Many of the requested components are already interfaced to the control system. In the end all relevant information should be collected and handled by the control system. Is that true for the bunch-by-bunch feedback, the LLRF, the parameters of the conventional facility, and so on?
- It is expected that many additional "channels" will have to be opened during the early stages of the commissioning.
- Integration with the different technical groups is excellent, and should be maintained through the commissioning period into machine operation.
- Interfacing with conventional facilities and the survey group are areas that could be strengthened. It appears that the fast orbit feedback in the storage ring has no connection to the master oscillator for the adjustment of the path length of the electrons. Is that intended?

Recommendations:

- The committee recommends that whenever new information is desired by the commissioning team than the signals should be delivered to the control room by the network and through the control system.
- Patch panels for analog signals in the (temporary) control room should be avoided. This does and will put additional load on the control system group.
- Maintain the strong coordinating connections between the Controls Group and other groups.
- Define an effective way to integrate survey and real-time building HVAC temperature data into the controls system.

Insertion Devices Status

Findings:

Progress in acquisition of 6 primary IDs:

- Damping Wiggler prototype factory test 2/12, delivery schedule modified by magnet procurement delay but 1st article delivery expected 6/12, 5 more units to be delivered in increments limited by magnet block arrival at Danfysik. The 200 day schedule float should insure scheduled installation.
- Delivery of two EPUs expected Feb. 2013, reflecting a slight delay attributed to mechanical design adjustments, again float in schedule is sufficient for timely installation.
- A re-evaluation of EPU vacuum chamber is underway due to identification of a corrector strip damaged by NEG reactivation; a separate RFP for fabrication has been issued.

- U20 & U21 design contracts signed 12/20/2011. The Conceptual Design Review is complete; schedule calls for delivery of both IDs by April 2013.
- 3PW design was changed to limit cost by using damping wiggler PM blocks. Expect minor delivery delay from current expectation - June 2012.
- U22 – 4 bids have been received but results were not available at the time of this review.

ID measurement lab –

- All laboratory components are operational
- The in-vacuum measurement system has been contracted to Toyama; engineering challenges (e.g. vacuum lubrication) & design decisions are outstanding (R&D is beyond project scope).

Mis-steering of EPU beam:

- The problem was illustrated for the case of linear horizontal EPU operation
- In steady state – mitigation can be made by adjusting vertical beam pipe aperture.
- For transient mis-steering – the planned mitigation will use a Glidcop downstream transition (which can withstand maximum power for 10msec). Mis-steering will trigger a beam dump interlock arrangement, within approximately 1 msec.

Other progress:

- A hybrid ID assembly of 47CR PrFeB magnets (optimized for high field at low temperature) baked to 100C with peak to peak field reduction < 0.2%. Low T measurement is next step.

Comments:

- NSLS2 ID installation should not be impacted by delays due to 100+ day float in schedule.
- Questions raised in executive session: Would installation of many different ID designs lead to braking of lattice symmetry? How can such an eventuality be prepared for short of providing independent power supplies for each magnet element?
- Guiding the timely construction and delivery of 6 distinct ID designs, coming from multiple manufacturers, is a unique challenge for a US light source. A successful outcome will require diligent oversight by the insertion device group.

Recommendations: None

Planning for NSLS-II Commissioning and Operations

Findings:

- The formal readiness process for the linac is at an advanced stage.
- The linac readiness framework will set the framework for commissioning the downstream machines.
- High-level physics applications will be ready to support commissioning from the very beginning.

- The NSLS Operations Group is small, and can provide almost no support for NSLS-II commissioning.

Comments:

- It appears likely that, even after the NSLS rings are decommissioned and the NSLS operations staff is transferred to NSLS-II, more operators will be required. If this is the case, it would beneficial to hire these additional operators early so they can be trained by NSLS staff and participate in NSLS-II commissioning.
- Put explicit breaks in the commissioning schedule for hardware troubleshooting and installation
- Operations automation of the NSLS-II injectors is inevitable, since top-up operation of the storage ring is likely to be implemented as soon as practical.
- One member of the committee did a survey of the linac commissioning documentation. The surveyed documents did not mention explicit planning of staged beam losses at known locations for the purpose of verifying the shielding design and efficacy. It is possible the relevant document was overlooked in the survey. In any case it is good practice to carry out staged beam losses of suitably low charges to verify shielding, prior to concentrating on commissioning/verifying other technical functions.

Recommendations:

- Consider raising priority of automation of the injector if commissioning proceeds as rapidly as we anticipate.
- If budget is available, start hiring and training additional NSLS-II operators early
- Encourage development of engineering high-level applications
- Review plans for staging controlled beam losses for shielding verification