# National Synchrotron Light Source II

# Project Progress Report

## May 2010

Shortly after sunrise on May 31, roofing materials have been staged (pentant 1) and the crane is poised to position more trusses.

report due date:
June 20, 2010

**Steve Dierker**
NSLS-II Project Director

**Brookhaven National Laboratory**
Upton, New York 11973

## OVERALL ASSESSMENT

The National Synchrotron Light Source II project maintained excellent technical progress and satisfactory cost and schedule performances in May. Overall, the project is on schedule and on budget with no major issues.

Conventional facilities construction continues to be slightly ahead of schedule. Concrete work for the storage ring tunnel in the Ring Building is nearing completion, and structural steel erection continues to advance rapidly. Roof insulation is being installed, and the installation of underground utilities and mobilization of the chilled water piping contractor are well underway. The chilled water plant expansion and chilled water piping work are also advancing well.

Excellent progress in all areas of Accelerator Systems continued, maintaining most of its cost and schedule goals in May except for a slight delay in the delivery of production magnets. The booster contract was awarded and the production of magnets, girders, vacuum system components, power supplies, and electronics is making excellent progress.

The preliminary designs of the six project beamlines are proceeding well, with a particular emphasis on completing the engineering designs for major long-lead procurement items by this fall. Excellent progress continued in optics R&D.

The projected early completion date for the project remains February 2014, with the critical path going through the fabrication followed by installation and commissioning of the accelerator systems.

Activities funded by the American Recovery and Reinvestment Act (ARRA) continue to be on schedule and on budget.

## SCHEDULED EVENTS 2010 – 2011

| | |
|---|---|
| Beamline Development Workshops (13) | April–June |
| Final Design Review of NSLS-II PPE | June 9 |
| Utility System Design Reviews (2) | June |
| Radiation Safety Workshop | June 22–23 |
| Final Design Reviews: Electrical System & Power Supplies (3) | May–July |
| Magnet Production Readiness Reviews (7) | July–Aug. |
| Beamline Access Team (BAT) meetings (6) | July |
| Scientific Advisory Cttee (SAC) Proposal Review meetings (7) | July |
| Timing and Fast Orbit Feedback Workshop | July |
| Synch. Light Diagnostics & Multi-Bunch Fdbk System Review | July 15-16 |
| Light Sources Directorate SAC meeting | Aug. 12–13 |
| DOE Mini-review of NSLS-II | Aug. 25 |
| NSLS-II Conventional Facilities Advisory Cttee (CFAC) meeting | Oct. 5–6 |
| NSLS-II Accelerator Systems Advisory Cttee (ASAC) meeting | Oct. 14–15 |
| NSLS-II Prelim. Design Rev. (PDR) of Experimental Facilities | Oct. 19-20 |
| DOE Review of NSLS-II | Nov. 16–18 |
| Project Advisory Committee (PAC) | Feb. 9-11, 2011 |

## ACCELERATOR SYSTEMS DIVISION (ASD)

Accelerator Systems Division held a three-day internal design review in May with an emphasis on integration and interfaces between the accelerator subsystems. It was concluded that the overall progress and status are satisfactory, but a few issues were identified which need additional attention. They are as follows: (1) Integration between high level controls software and subsystem software implementation needs to be revisited in light of recent advances in the subsystem designs. (2) The correlation between the width of the cutout in the dipole chamber, which is located downstream of the damping wigglers, and the response time of the equipment protection system needs to be re-evaluated for the extreme case of the damping wiggler beam getting out of control. (3) A task force was assigned in order to more tightly coordinate synchrotron radiation protection issues.

All technical issues encountered by the magnet vendors while producing first article magnets have been resolved. The first article sextupole magnet (produced by IHEP, with known issues) was delivered in late May (Fig. 1). Measurements at the magnet test facility confirmed that this magnet does not quite meet the full specifications.

Fig 1: The first IHEP production magnet arrived in Bldg. 902 for measurements.

The magnet test facility is being prepared for full-scale operations. The static and flow pump assembly to be used for incoming magnet inspection was completed, and the magnet measurement stands are being modernized with updated electronic measurement equipment.

Vacuum chamber production is making excellent progress with the additional delivery of chambers for girder 4 (central girder) and girder 5 (downstream dipole). Three S4 chambers were completed, and welding of the S5 dipole chambers has begun. Over a dozen new dipole extrusions were bent and measured. The design of transfer line bending chambers is underway. The production of inconel chambers in industry is slowed while issues with welding and machining are resolved.

Prototype RF shielded bellows were successfully installed at one APS straight section for a higher order mode (HOM) heating study. The procurement process for Ti-sublimation pumps and ion pump power supplies has begun.

Testing of the prototype power supply controller was successfully completed and design is being finalized for procurement. Production of the regulator board for the corrector supply has started and the design of the two-channel power supply interface was completed. Testing of the DCCTs is in progress, with 96 units tested so far. There are 1,400 DCCTs modules in house and 460 to be delivered. The order for the equipment enclosure systems is being placed and detailed design of the AC power interface was completed.

Significant progress was made in RF BPM work. Eight digital and five analog electronics boards have been assembled for further testing and fine tuning, and to support the production of software interfaces. Performance of the components is quite promising, with extremely low noise levels that significantly surpass the values achieved by commercial electronics. A cascade of issues with RF button production was successfully resolved. The gap between the chamber and RF button needed to be increased to streamline assembly. This caused a significant impedance issue, which was mitigated by integrating an RF shield into the button assembly. An issue with mechanical tolerances of the vacuum seal also has been resolved and the production of RF buttons will resume soon.

The order for 100,000 feet of flexible BPM cable has been placed. Significant effort was spent evaluating a test instrument that will be used during the cable termination process. The use of a TDR CT-100HF unit will ensure the RF BPM cable phase match to within 25 ps and will reveal any cracks or bad connections in the cable or the connector. The RF shields that are required for suppressing HOMs in the vacuum chamber have been produced and delivered.

A traveler system for inspecting incoming girders and performing acceptance measurements has been produced. The first two storage ring girders were received and inspected. Tests of the magnet yaw and position fixtures were completed. Precision electronic inclinometers proved to be unreliable and are being replaced with precision spirit levels. A second Hamar Laser system for girder assembly has been received.

Plans for the mechanical utilities piping in the storage ring are near completion. The statement of work for the procurement of storage ring tunnel DI water piping was completed, and design and fabrication of the prototype DI water station were also completed.

For survey and alignment, the new Faro Arm and a Leica DNA03 level were procured. Girder profiling tests with four different trackers were also completed in the environmental room, with results showing excellent profiling within ±5 µm.

The search logic diagrams for the second safety systems chain have been laid out using the same logic as for the first chain. Parts for the EPICs interface test stand have been received. The order for the safety-rated programmable logic-controllers (PLCs) is in progress with procurement staff. The three prototype area monitors in operation at the NSLS are being logged via this EPICS IOC.

Solid state Scandinova modulators are being purchased for the enhanced performance of the linac. The modifications to the booster RF cavity cooling system have been completed, including a layout for the temperature sensors and cable wiring The Canadian Light Source (CLS) has successfully operated the NSLS-II digital controller system with beam in a low-alpha lattice for research that is sensitive to RF noise. This system has demonstrated performance superior to that of the original CLS system, in use for the past 5 years, and fully confirms the performance requirements of the controller through the first years of NSLS-II operations.

## EXPERIMENTAL FACILITIES DIVISION (XFD)

Experimental Facilities Division continued the preliminary design of the six project beamlines. The focus of design efforts is to ensure completion of the engineering designs for major beamline components, such as radiation enclosures, x-ray monochromators, and x-ray mirrors, that are necessary to start the procurements of long-lead-time components. An example is shown in Figure 2, illustrating the finite-element thermal analysis of an engineering design of a beryllium linear compound refractive lens system, to be used for collimating the incident x-ray beam for the Inelastic X-ray Scattering beamline. Other design efforts include the evaluation of a cryo-cooled specimen stage design for the Submicron Resolution X-ray Spectroscopy beamline, value engineering of the 50% design for the Hard X-ray Nanoprobe satellite building, and engineering design of the power filters for the X-ray Powder Diffraction beamline using a damping wiggler, among other activities.

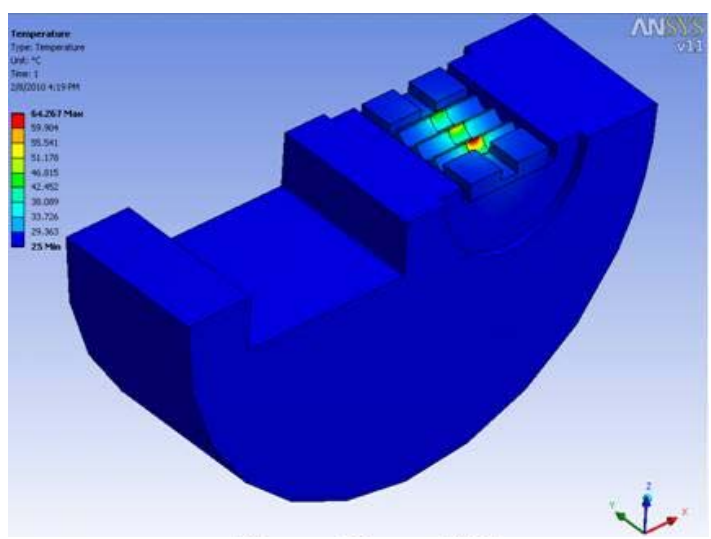



Figure 2. Finite element thermal analysis of an engineering design of a linear compound refractive lens made of beryllium, for the Inelastic X-ray Scattering (IXS) beamline.

In the area of optical metrology research and development, Dr. Mourad Idir from SOLEIL Synchrotron in France will be joining NSLS-II Experimental Facilities Division to lead the optical metrology effort. Dr. Idir is currently a lead scientist for the optical test and metrology beamline at SOLEIL, and has a wide range of expertise and experience in x-ray optics and metrology. He will play a major role in the development and operation of the optical metrology laboratory in the Experimental Facilities R&D area as well as the development of an at-wavelength metrology program at NSLS-II.

In nanofocusing x-ray optics R&D, significant progress was made in the development of reactive ion etching for sectioning multilayer Laue lenses (MLLs). Before this, MLLs have been fabricated using mechanical slicing and polishing, which is quite time-consuming and the yield is low. To solve this problem, NSLS-II has been pursuing reactive ion etching as an alternative way to section the MLLs. After many trials, an anisotropic reactive ion etching recipe has been developed by the NSLS-II team and a record-setting etch depth of greater than 10 micrometers has been achieved, with very smooth side walls. This development promises a more reliable way to fabricate MLLs and an easier way to mount MLLs for x-ray microscopic applications.

As part of the NSLS-II beamline development process for the next round of beamlines, NSLS-II coordinated with the scientific community to organize a series of thirteen Beamline Development Workshops to be held between April and June. The topics being discussed at these workshops range from high pressure materials science, nano electron spectroscopy, ultrafast and time-resolved science, soft matter research, liquid scattering, and x-ray scattering in biological applications, to coherent diffraction imaging, time-resolved full-field microscopy and imaging, x-ray spectroscopy, in-situ and resonant scattering, and inelastic scattering with hard and soft x-rays. These thirteen workshops are bringing together a large segment of the scientific user community and provide a forum for discussing the best approaches for developing cutting-edge experimental facilities at NSLS-II.

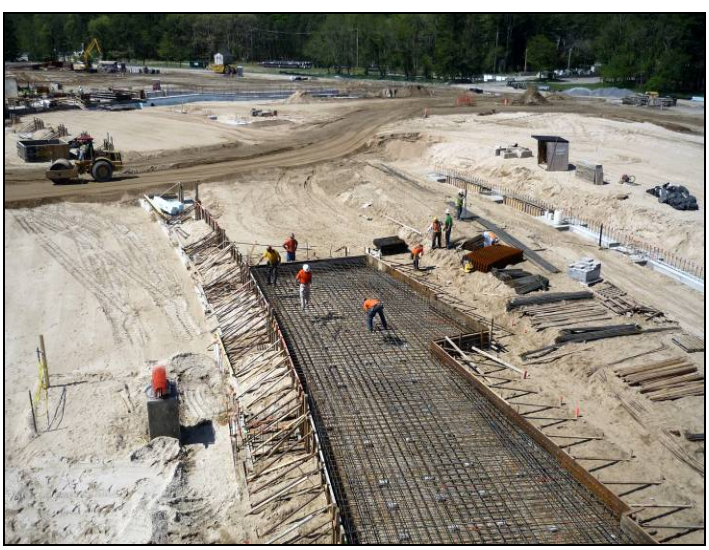


Figure 3. Early in May, formwork was prepped for the SR tunnel into pentant 5.

## CONVENTIONAL FACILITIES DIVISION (CFD)

Conventional facilities construction continued to accelerate in May, as concrete and steel installation continued on or ahead of schedule. Work on the building envelope is now underway and utility installation is ramping up. All of the other construction packages are also in active construction with the exception of the LOBs, which are awaiting contract award.

Concrete installation for the ring building is nearing completion of the storage ring tunnel (Fig. 3). Nearly all tunnel sections have been placed, except for the final floor, wall, and roof sections in pentant 5, which are being kept open to enable construction access to the interior courtyard of the building. Booster tunnel and linac walls for the injection building are also progressing rapidly, with all floor sections in place and wall sections following right behind.

The final major concrete task now underway is the floor in pentant 1, which is being readied for the first of many pours for the experimental floor (Fig. 4).

Figure 4. Site of the future experimental floor in pentant 1.

Erection of steel has now progressed to the end of pentant 4. The only steelwork that remains is for pentant 5 and the injection service building. Installation of the roof decking is now completed from pentant 1 to pentant 3.

Work on the building envelope began in May with the roofing for pentant 1. The installation of roof blocking, weatherproof membrane, and insulating block is progressing quickly.

The underground utility systems may ultimately become the critical path for the conventional facilities, as there is substantial coordination necessary to install all the utilities in the central courtyard. The general contractor has prepared a coordination plan for these utilities to ensure they can be properly installed in time for commissioning and start-up before the first beneficial occupancy date in February 2011. This work is progressing, as the systems for sanitary, steam and condensate, water, and chilled water piping are all underway in the courtyard of the ring building.

The chilled water plant expansion continues to make excellent progress as the building envelope nears completion: all piping in the basement pipe tunnel is in place, and most major equipment items (pumps, valves, etc.) have been installed. The cooling tower cells are ready and the condenser water piping has been installed between the cooling tower and the central plant. Installation of the electrical gear is lagging slightly but is expected to catch up in the next two months.

The chilled water piping package got underway in earnest during May, with excavation of the intersection of Rowland Ave. and Rochester St. Wet taps for the 36-in. chilled water mains are being installed, and the 24-in. supply and return lines will be installed from these taps to the NSLS-II site.

The electrical substation expansion made excellent progress during the month, with completion of yard work and concrete work in preparation for delivery of the transformer.

The procurement package for recommendation of award of the LOB contract is being routed for approval. Approval of the accelerated LOB construction contract is expected in July, enabling the start of construction in August, approximately 14 months ahead of the original schedule.

## ENVIRONMENT, SAFETY, AND HEALTH (ESH)

Prototype radiation monitors have been purchased and installed on the NSLS experimental floor for evaluation. These instruments have been connected to the local area network to permit online record-keeping and observation of their performance; data collection and analysis are ongoing.

Supplementary shielding analyses for the linac/booster injection shutters, linac beam dumps, booster beam dump, and injection/extraction septa have been completed. Engineering designs for beam dumps and injection/extraction septa also are ready. The ratchet wall shielding and collimator shielding for six project beamlines have been designed and are ready for procurement work to begin. Ratchet wall shielding designs for another 54 front ends are in progress. It has been decided to fit lead shielding for all 60 ratchet walls. Supplementary shielding for the one diagnostic beamline has been specified.

FLUKA Monte Carlo simulations for the thin copper injection scrapers have been completed. Additional shielding for the scrapers inside the storage ring has been specified.

FLUKA simulations for top-off injection have been completed and a draft document, "Radiological Considerations of Top-Off Operations at NSLS-II," has been written. Based on the simulations, top-off injection interlock options are being finalized.

The radiation safety workshop will be held June 22–23, with xperts from APS, SSRL, ALS, and BNL participating in the discussions. The objective is to gain feedback and lessons learned from radiation safety experts in the complex. Workshop topics include shielding, top-off, interlocks and interlocking strategies, beam loss control, and monitoring.

## PROCUREMENT ACTIVITIES

The booster contract was awarded on May 7, 2010. Laboratory Office Buildings (LOB) proposal evaluations were completed in mid May. Final award of the LOB contract is pending BNL and DOE approval; an announcement is anticipated in July.

## COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.01 and the cumulative Schedule Performance Index (SPI) is 0.97, both well within the acceptable range.

Progress during May in most areas of the project was on schedule and on budget. The current-month CPI (0.88) and SPI (0.79) are primarily due to delay in the delivery of storage ring production magnets and catch-up in vacuum chamber production. There are no associated cost and schedule impacts or issues.

Ring building construction continues to be ahead of schedule, with the critical path for the project (see the milestone schedule on p. 7) passing through accelerator vacuum chamber welding; girder integration, survey and alignment; then through accelerator installation, testing, and commissioning. Ring building construction and the booster and linac fabrication/delivery schedules are all about 1–2 months off the critical path. The projected early completion date remains at February 2014—a full 16 months prior to the CD-4 milestone, the project completion date of June 2015.

## RECENT HIRES

Gabriele Bassi – Associate Physicist, Collective Effects, ASD
Mourad Idir – Physicist, X-ray Mirror Metrology, XFD
John McCaffrey – Technician, Mechanical Engineering, ASD
Shweta Saraf – Applications Engineer, Controls, ASD
Maria Schmidt – Apps Engineer, Business Systems Development, PSD

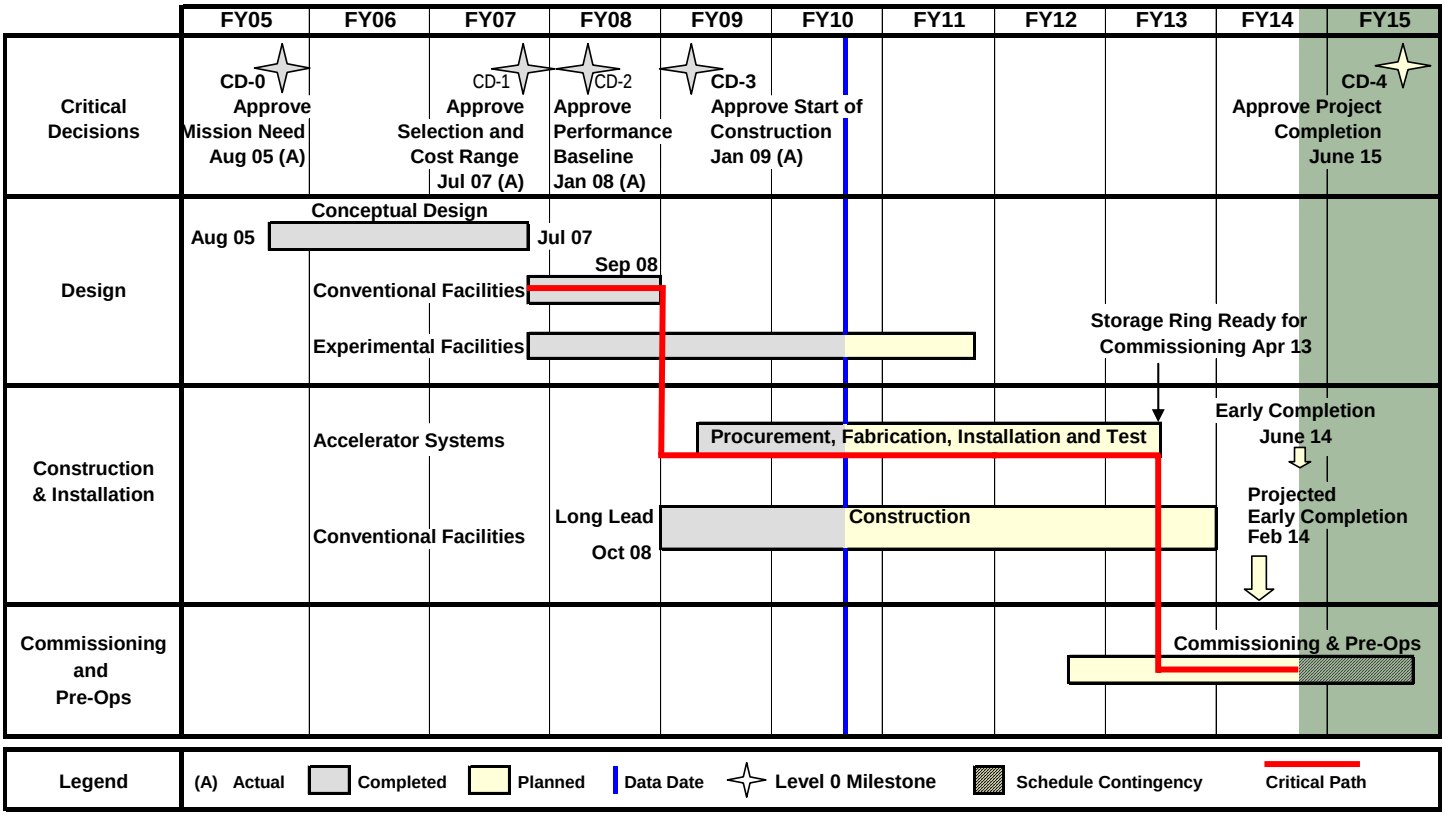
## RECENT PROJECT ACCOMPLISHMENTS

- In x-ray optics R&D for MLL, the NSLS-II team set a new anisotropic reactive ion etching record: >10 µm.
- Supplementary shielding analyses done for linac/booster injection shutters and beam dumps, and injection and extraction septa. Ratchet wall shielding designed.
- LOB proposal evaluations done, now in approval cycle.
- Booster contract awarded.
- First two storage ring girders received and inspected.
- Prototype RF shielded bellows installed at APS.
- RF BPM noise levels significantly lower than commercial models.

## PROJECT DESCRIPTION

The NSLS-II project is being carried out to design and build a world-class user facility for scientific research using synchrotron radiation. The project scope includes the design, construction, and installation of the accelerator hardware, civil construction, and experimental facilities required to produce a new synchrotron light source. It will be highly optimized to deliver ultra-high brightness and flux and exceptional beam stability. These capabilities will enable the study of material properties and functions down to a spatial resolution of 1 nm, energy resolution of 0.1 meV, and with the ultra-high sensitivity necessary to perform spectroscopy on a single atom.

## DOE Project Milestone Schedule

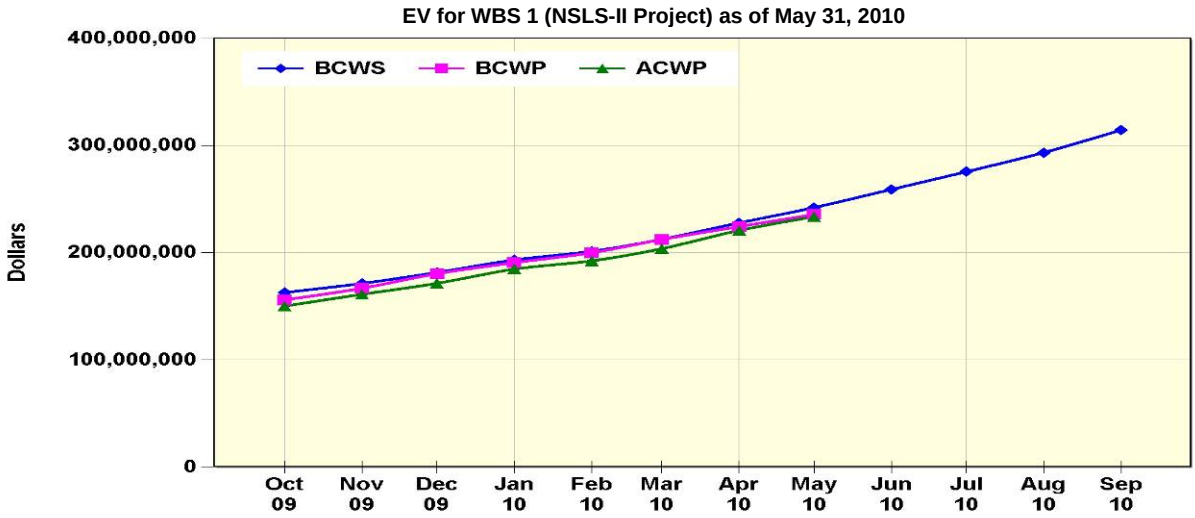



### Funding Profile

| | NSLS-II Funding Profile ($M) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fiscal Year | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | TOTAL |
| R&D | | | 3.0 | 20.0 | 10.0 | 2.0 | 0.8 | | | | | 35.8 |
| OPC | 1.0 | 4.8 | 19.0 | | | | | | | | | 24.8 |
| PED | | | 3.0 | 29.7 | 27.3 | | | | | | | 60.0 |
| Construction | | | | | 216.0 | 139.0 | 151.6 | 151.4 | 46.9 | 26.3 | | 731.2 |
| Pre-Ops | | | | | | | 0.7 | 7.7 | 24.4 | 22.4 | 5.0 | 60.2 |
| Total NSLS-II Project | 1.0 | 4.8 | 25.0 | 49.7 | 253.3 | 141.0 | 153.1 | 159.1 | 71.3 | 48.7 | 5.0 | 912.0 |

### Key Personnel

| Title | Name | Email | Phone |
|---|---|---|---|
| Federal Project Director | Frank Crescenzo | crescenzo@bnl.gov | 631-344-3433 |
| NSLS-II Project Director | Steve Dierker | dierker@bnl.gov | 631-344-4966 |




| Cumulative to Date (K$) | Oct 09 | Nov 09 | Dec 09 | Jan 10 | Feb 10 | Mar 10 | Apr 10 | May 10 | Jun 10 | Jul 10 | Aug 10 | Sep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 162,854 | 171,323 | 181,553 | 193,298 | 201,337 | 212,530 | 227,854 | 242,113 | 259,085 | 275,619 | 293,444 | 314,518 |
| BCWP | 155,908 | 166,818 | 180,426 | 190,699 | 199,953 | 212,325 | 224,378 | 235,636 | | | | |
| ACWP | 150,173 | 161,209 | 171,370 | 184,693 | 192,382 | 203,749 | 220,833 | 233,646 | | | | |

| Project as of 5/31/10 | Current Period | Cum-to-date |
|---|---|---|
| Plan (BCWS) $K | 14,259 | 242,113 |
| Earned (BCWP) $K | 11,258 | 235,636 |
| Actual (ACWP) $K | 12,813 | 233,646 |
| SV $K | -3,001 | -6,477 |
| CV $K | -1,555 | 1,990 |
| SPI | 0.79 | 0.97 |
| CPI | 0.88 | 1.01 |
| Budget at Completion $K (PMB (UB)) | | 762,771 |
| Planned % Complete | | 31.7% |
| Earned % Complete | | 30.9% |
| Mgmt Reserve/Cont as % of BAC remaining | | 28.3% |
| Mgmt Reserve/Cont as % of EAC remaining | | 27.0% |

The IPT can find further details on NSLS-II cost and schedule data at http://www.bnl.gov/nsls2/project/IPT/default.asp.

| Milestones – Near Term | Baseline | Done |
|---|---|---|
| L3-Begin Ring Building Steel Erection | 09/14/09 | ✓ |
| L3-External Tech. review of concept. design for project BLs done | 11/16/09 | ✓ |
| L3-Clean Room contract awarded | 12/30/09 | ✓ |
| L3-Linac contract awarded | 2/05/10 | ✓ |
| L3-APS Welding S2 ODD – first chamber ready for assembly | 3/17/10 | ✓ |
| L3-Pentant 1 structural steel erected | 3/31/10 | ✓ |
| L3-Initial test of new MLL deposition system completed | 6/30/10 | |
| L3-LOB construction contract awarded | 7/01/10 | |
| L3-LOB construction Notice to Proceed (NTP) issued | 7/01/10 | |
| L3-SR Magnet – Quads First Article ready for integration | 7/19/10 | |
| L2-Pentant 2 structural steel erected | 8/05/10 | |
| L3-Safety review of preliminary designs for project BLs completed | 8/30/10 | |
| L2-BAT Reviews of 100% prelim. designs for project BLs completed | 9/15/10 | |

L3 = Level 3 Milestone, L2 = Level 2

**Schedule Performance Index, Project to Date:**

**SPI** **0.97**

*Cause & Impact:* No reportable variance.
*Corrective Action:* None Required.

**Cost Performance Index, Project to Date:**

**CPI** **1.01**

*Cause & Impact:* No reportable variance.
*Corrective Action:* None Required.

ACWP = Actual Cost of Work Performed
BAC = Budget at Completion
BCWP = Budgeted Cost of Work Performed
BCWS = Budgeted Cost of Work Scheduled
CPI = Cost Performance Index (BCWP/ACWP)
EV = Earned Value
IPT = Integrated Project Team
PMB = Performance Measurement Baseline
SPI = Schedule Performance Index
WBS = Work Breakdown Structure

| SPI or CPI in the range of: | |
|---|---|
| | 0.9 – 1.15 is green |
| | 0.85 – 0.89 or 1.16 – 1.25 is yellow |
| | <0.85 or >1.25 is red |

Four PCRs were approved in May:

| PCR # | Area | Δcost | Title or Description | PCR # | Area | Δcost | Title or Description |
|---|---|---|---|---|---|---|---|
| 10_121 | CFD | $26K | Ring Bldg Miscellaneous Contract Changes – Part II (assigned undistributed budget to a WBS) | 10_144 | ASD | -$192K | ASD Injection Building Electrical Changes |
| 10_139 | CFD | $327K | CF Injection Building Electrical Changes | 10_147 | ASD | $N/A | CAM Change on WBS 1.03.06.04 |

## ARRA DETAILS

This Recovery Act project will provide advanced funding for NSLS-II construction, create jobs, and substantially reduce the cost and schedule risks for the project. The overall schedule for the Ring Building completion will not be accelerated; however, Recovery Act funds allow for re-ordering of the work sequence with a six-month acceleration of the injection building completion. Acceleration of the injection building allows for earlier installation and commissioning of the injector, which had been close to critical path. This addition of schedule float will significantly reduce the schedule risk for the accelerator. In addition, Recovery Act funds will accelerate completion of the Laboratory Office Buildings by 15 months, which will enable the project to maximize the cost advantage of the depressed construction market.

| ARRA$ as of 5/31/10 | Current Period | Cum-to-date |
|---|---|---|
| Plan (BCWS) $K | 5,015 | 52,596 |
| Earned (BCWP) $K | 5,063 | 53,541 |
| Actual (ACWP) $K | 5,286 | 50,474 |
| SV $K | 48 | -223 |
| CV $K | 945 | 3,067 |

| ARRA Milestones | | |
|---|---|---|
| Description | Baseline Date | Status |
| Install sanitary UG piping SB3 footings. | 12/08/09 | Completed 12/10/09. |
| Pour tunnel slab CL 018-024. | 12/14/09 | Completed 11/02/09. |
| Excavate booster svc bldg. foundations. | 12/24/09 | Completed 10/7/09. |
| Pour tunnel slab CL 024-030. | 12/30/09 | Completed 11/25/09. |
| Begin concrete tunnel roof pentant 1. | 12/10/09 | Completed 11/12/09. |
| Complete tunnel slab pentant 2. | 1/15/10 | Completed 1/15/10. |
| Pentant 2 tunnel walls complete. | 3/16/10 | Completed 3/11/10. |
| Begin steel erection pentant 1. | 4/14/10 | Completed 3/16/10. |
| Start metal decking for pentant 1 Service Building. | 5/12/10 | Completed 4/14/10. |
| Pentant 5 tunnel slab complete | 5/25/10 | In progress. Area left open for egress to interior of ring bldg will be closed in July. |

Blue text indicates new or revised text since last month's report.

8. PERFORMANCE DATA

| ARRA vs. REGUL Cost Account ITEM (1) | CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2) | BUDGETED COST WORK PERFORMED (3) | ACTUAL COST WORK PERFORMED (4) | VARIANCE SCHEDULE (5) | VARIANCE COST (6) | CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7) | BUDGETED COST WORK PERFORMED (8) | ACTUAL COST WORK PERFORMED (9) | VARIANCE SCHEDULE (10) | VARIANCE COST (11) | AT COMPLETION BUDGETED (14) | ESTIMATED (15) | VARIANCE (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ARRA | | | | | | | | | | | | | |
| 1.05.03.02.01 General Requirements | 44,173 | 44,173 | 44,173 | 0 | 0 | 4,771,867 | 4,774,442 | 2,773,639 | 2,575 | 2,000,803 | 5,311,623 | | |
| 1.05.03.02.02 Site Work | 58,643 | 85,668 | 56,486 | 27,025 | 29,182 | 3,147,705 | 2,860,549 | 2,624,700 | -287,156 | 235,849 | 3,611,419 | | |
| 1.05.03.02.03 Pentant 1 and Service Building | 900,705 | 758,888 | 759,086 | -141,816 | -198 | 7,384,889 | 7,779,525 | 7,814,714 | 394,636 | -35,188 | 19,087,984 | | |
| 1.05.03.02.04 Pentant 2 and Service Building | 171,358 | 244,553 | 253,576 | 73,196 | -9,023 | 6,034,398 | 6,532,647 | 6,635,042 | 498,249 | -102,395 | 15,500,390 | | |
| 1.05.03.02.05 Pentant 3 and Service Building | 355,201 | 581,230 | 741,140 | 226,029 | -159,910 | 4,984,991 | 5,404,706 | 5,537,520 | 419,715 | -132,814 | 10,191,839 | | |
| 1.05.03.02.06 Pentant 4 and Service Building | 163,118 | 47,130 | 72,510 | -115,988 | -25,380 | 935,798 | 1,031,750 | 1,042,048 | 95,952 | -10,298 | 2,506,217 | | |
| 1.05.03.02.07 Pentant 5 and Service Building | 35,820 | 824,279 | 824,282 | 788,458 | -3 | 2,987,933 | 4,091,285 | 3,997,022 | 1,103,352 | 94,264 | 7,157,605 | | |
| 1.05.03.02.08 Injection Building | 162,165 | 78,542 | 75,730 | -83,622 | 2,812 | 1,221,463 | 937,349 | 820,194 | -284,114 | 117,155 | 5,936,978 | | |
| 1.05.03.02.09 RF and Compressor Building | 1,512 | 57,114 | 56,047 | 55,602 | 1,067 | 1,300,455 | 1,344,113 | 1,419,727 | 43,658 | -75,614 | 4,679,710 | | |
| 1.05.03.02.10 Lobby | 2,674 | 315 | 252 | -2,359 | 63 | 108,263 | 167,549 | 165,106 | 59,286 | 2,443 | 3,005,569 | | |
| 1.05.03.02.11 Cooling Tower and Process Water | 134,036 | 819,779 | 819,716 | 685,743 | 63 | 294,443 | 1,097,345 | 1,090,522 | 802,901 | 6,823 | 4,451,828 | | |
| 1.05.03.02.12 Underground Mechanical Utilities | 819,919 | 667,987 | 675,865 | -151,931 | -7,878 | 4,580,300 | 4,986,944 | 4,921,102 | 406,645 | 65,843 | 8,573,121 | | |
| 1.05.03.02.13 Site Electrical Utilities | 166,881 | 88,296 | 88,296 | -78,585 | 0 | 6,200,917 | 6,243,712 | 6,114,209 | 42,795 | 129,504 | 9,411,720 | | |
| 1.05.03.02.14 LN2 and GN2 Systems | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 1.05.03.03 Electrical Substation and Feeder (Contract) | 437,003 | 60,955 | 66,691 | -376,048 | -5,736 | 2,300,439 | 1,642,902 | 1,486,861 | -657,537 | 156,041 | 2,943,143 | | |
| 1.05.03.04 Chilled Water Plant (Conract) | 1,493,966 | 554,355 | 752,468 | -939,611 | -198,113 | 6,187,892 | 4,495,977 | 4,031,341 | -1,691,915 | 464,636 | 9,200,000 | | |
| 1.05.03.06.01 LOB 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,817,013 | | |
| 1.05.03.06.02 LOB 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,817,018 | | |
| 1.05.03.06.03 LOB 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,273,022 | | |
| 1.05.03.07.01 HXN Sattelite Building Design | 67,681 | 150,000 | 0 | 82,319 | 150,000 | 154,348 | 150,000 | 0 | -4,348 | 150,000 | 300,000 | | |
| 1.05.03.07.02 HXN Satellite Building Construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,264,573 | | |
| 1.05.04 Integrated Controls & Communications | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| **ARRA Sub Total** | **5,014,853** | **5,063,265** | **5,286,318** | **48,412** | **-223,053** | **52,596,101** | **53,540,797** | **50,473,746** | **944,696** | **3,067,051** | **138,040,772** | | |
| **Undistributed Budget** | | | | | | | | | | | **960,032** | | |
| **ARRA Total** | **5,014,853** | **5,063,265** | **5,286,318** | **48,412** | **-223,053** | **52,596,101** | **53,540,797** | **50,473,746** | **944,696** | **3,067,051** | **139,000,804** | | |

8. PERFORMANCE DATA

| WBS[2] / WBS[3] / Control Acct / ITEM (1) | CURRENT PERIOD: BUDGETED COST WORK SCHEDULED (2) | BUDGETED COST WORK PERFORMED (3) | ACTUAL COST WORK PERFORMED (4) | VARIANCE SCHEDULE (5) | VARIANCE COST (6) | CUMULATIVE TO DATE: BUDGETED COST WORK SCHEDULED (7) | BUDGETED COST WORK PERFORMED (8) | ACTUAL COST WORK PERFORMED (9) | VARIANCE SCHEDULE (10) | VARIANCE COST (11) | AT COMPLETION: BUDGETED (14) | ESTIMATED (15) | VARIANCE (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.01 Project Management** | | | | | | | | | | | | | |
| 1.01.01 Project Management | | | | | | | | | | | | | |
| WBS[3]Totals: | 145,892 | 145,892 | 95,446 | 0 | 50,446 | 3,609,325 | 3,609,325 | 3,728,459 | 0 | -119,134 | 7,445,412 | 7,503,242 | -57,831 |
| 1.01.02 Environmental, Safety & Health | | | | | | | | | | | | | |
| WBS[3]Totals: | 121,454 | 121,454 | 107,881 | 0 | 13,573 | 2,419,038 | 2,419,038 | 2,743,263 | 0 | -324,225 | 6,662,820 | 6,585,003 | 77,817 |
| 1.01.03 Project Support | | | | | | | | | | | | | |
| WBS[3]Totals: | 691,853 | 691,853 | 828,189 | 0 | -136,336 | 19,357,501 | 19,357,501 | 20,529,821 | -0 | -1,172,320 | 37,878,194 | 41,990,401 | -4,112,208 |
| 1.01.04 Quality Assurance | | | | | | | | | | | | | |
| WBS[3]Totals: | 51,705 | 51,705 | 60,859 | 0 | -9,154 | 1,437,649 | 1,437,649 | 1,085,967 | 0 | 351,683 | 3,073,212 | 3,073,212 | 0 |
| 1.01.05 Configuration Management & Document Control | | | | | | | | | | | | | |
| WBS[3]Totals: | 26,941 | 26,941 | 23,645 | 0 | 3,296 | 860,826 | 860,826 | 682,749 | 0 | 178,077 | 1,972,567 | 1,972,567 | 0 |
| **WBS[2]Totals:** | **1,037,845** | **1,037,845** | **1,116,020** | **0** | **-78,175** | **27,684,339** | **27,684,339** | **28,770,259** | **-0** | **-1,085,920** | **57,032,204** | **61,124,425** | **-4,092,221** |
| **1.02 R&D and Conceptual Design** | | | | | | | | | | | | | |
| 1.02.01 Accelerator Systems R&D | | | | | | | | | | | | | |
| WBS[3]Totals: | 100,586 | 119,373 | 9,793 | 18,787 | 109,580 | 10,359,759 | 9,555,698 | 9,340,462 | -804,061 | 215,236 | 11,460,076 | 11,460,076 | -0 |
| 1.02.02 Experimental Systems R&D | | | | | | | | | | | | | |
| WBS[3]Totals: | 264,405 | 318,734 | 519,777 | 54,328 | -201,043 | 13,297,262 | 13,146,639 | 12,448,729 | -150,623 | 697,910 | 19,166,550 | 19,163,545 | 3,005 |
| 1.02.03 Conceptual Design - Accelerator Systems | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 12,998,214 | 12,998,214 | 12,960,504 | 0 | 37,709 | 12,998,214 | 12,998,214 | 0 |
| 1.02.04 Conceptual Design - Experimental Facilities | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 709,445 | 709,445 | 712,450 | 0 | -3,005 | 709,445 | 712,450 | -3,005 |
| 1.02.05 Conceptual Design - Conventional Facilities | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 3,886,952 | 3,886,952 | 3,872,878 | 0 | 14,074 | 3,886,952 | 3,886,952 | 0 |
| 1.02.06 Conceptual Design - Project Management & Support | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 866 | 0 | -866 | 7,086,188 | 7,086,188 | 7,326,180 | 0 | -239,992 | 7,086,188 | 7,325,314 | -239,126 |
| 1.02.07 Project Management - R&D | | | | | | | | | | | | | |
| WBS[3]Totals: | 33,745 | 33,745 | 7,222 | 0 | 26,523 | 4,949,081 | 4,949,081 | 5,003,256 | 0 | -54,174 | 5,305,339 | 5,066,213 | 239,126 |
| **WBS[2]Totals:** | **398,736** | **471,851** | **537,658** | **73,115** | **-65,807** | **53,286,901** | **52,332,217** | **51,664,458** | **-954,684** | **667,759** | **60,612,763** | **60,612,763** | **1** |
| **1.03 Accelerator Systems** | | | | | | | | | | | | | |
| 1.03.01 Accelerator Systems Management | | | | | | | | | | | | | |
| WBS[3]Totals: | 85,835 | 85,835 | 123,763 | 0 | -37,928 | 2,895,194 | 2,895,194 | 3,051,097 | -0 | -155,903 | 6,019,099 | 6,019,099 | 0 |
| 1.03.02 Accelerator Physics | | | | | | | | | | | | | |
| WBS[3]Totals: | 209,098 | 209,098 | 265,795 | 0 | -56,697 | 4,485,160 | 4,485,160 | 4,094,601 | 0 | 390,560 | 10,071,767 | 10,071,767 | 0 |
| 1.03.03 Injection System | | | | | | | | | | | | | |
| WBS[3]Totals: | 377,984 | 155,807 | 199,915 | -222,177 | -44,108 | 4,234,133 | 3,128,894 | 2,869,090 | -1,105,239 | 259,804 | 42,499,624 | 42,691,324 | -191,700 |
| 1.03.04 Storage Ring | | | | | | | | | | | | | |
| WBS[3]Totals: | 3,103,031 | 1,152,326 | 2,236,164 | -1,950,705 | -1,083,837 | 29,903,491 | 25,006,337 | 26,497,266 | -4,897,154 | -1,490,928 | 148,615,851 | 153,229,879 | -4,614,028 |
| 1.03.05 Controls Systems | | | | | | | | | | | | | |
| WBS[3]Totals: | 343,974 | 269,949 | 262,509 | -74,026 | 7,440 | 6,079,078 | 4,841,592 | 4,963,462 | -1,237,485 | -121,870 | 20,207,065 | 20,207,065 | 0 |
| 1.03.06 Accelerator Safety Systems | | | | | | | | | | | | | |
| WBS[3]Totals: | 64,263 | 26,508 | 67,926 | -37,755 | -41,419 | 1,221,960 | 838,748 | 932,052 | -383,212 | -93,304 | 4,471,232 | 4,915,544 | -444,312 |
| 1.03.07 Insertion Devices | | | | | | | | | | | | | |
| WBS[3]Totals: | 25,667 | 124,008 | 106,425 | 98,341 | 17,582 | 1,603,591 | 1,246,753 | 855,837 | -356,838 | 390,916 | 24,613,697 | 26,363,698 | -1,750,000 |
| 1.03.08 Accelerator Fabrication Facilities | | | | | | | | | | | | | |
| WBS[3]Totals: | 79,220 | 115,986 | 120,830 | 36,766 | -4,844 | 6,092,389 | 4,704,402 | 4,678,026 | -1,387,987 | 26,376 | 6,961,411 | 6,961,411 | 0 |
| **WBS[2]Totals:** | **4,289,071** | **2,139,515** | **3,383,327** | **-2,149,555** | **-1,243,811** | **56,514,997** | **47,147,081** | **47,941,431** | **-9,367,916** | **-794,351** | **263,459,747** | **270,459,787** | **-7,000,040** |
| **1.04 Experimental Facilities** | | | | | | | | | | | | | |
| 1.04.01 Experimental Facilities Management | | | | | | | | | | | | | |
| WBS[3]Totals: | 108,205 | 108,205 | 148,349 | 0 | -40,144 | 2,389,389 | 2,389,389 | 2,778,294 | 0 | -388,905 | 4,828,335 | 6,376,107 | -1,547,771 |
| 1.04.02 Standard Local Controls & Data Acquisition Systems | | | | | | | | | | | | | |
| WBS[3]Totals: | 2,378 | 16,065 | 3,457 | 13,687 | 12,609 | 24,265 | 44,941 | 3,457 | 20,676 | 41,485 | 69,585 | 69,585 | 0 |
| 1.04.05 User Instruments | | | | | | | | | | | | | |
| WBS[3]Totals: | 268,914 | 189,290 | 354,045 | -79,625 | -164,756 | 5,019,944 | 4,803,514 | 4,066,270 | -216,430 | 737,244 | 62,008,511 | 63,164,172 | -1,155,661 |
| 1.04.06 Front End User Requirements Development | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 456 | 456 | 1,099 | -0 | -643 | 456 | 2,103 | -1,647 |
| 1.04.07 Optics Labs | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 10,794 | 0 | -10,794 | 843,917 | 645,243 | 610,569 | -198,674 | 34,674 | 2,072,162 | 1,960,440 | 111,722 |
| **WBS[2]Totals:** | **379,498** | **313,560** | **516,645** | **-65,938** | **-203,085** | **8,277,971** | **7,883,544** | **7,459,689** | **-394,427** | **423,854** | **68,979,050** | **71,572,407** | **-2,593,357** |
| **1.05 Conventional Facilities** | | | | | | | | | | | | | |
| 1.05.01 Conventional Facilities Management | | | | | | | | | | | | | |
| WBS[3]Totals: | 230,912 | 230,912 | 285,328 | 0 | -54,416 | 6,059,164 | 6,059,164 | 6,157,667 | 0 | -98,503 | 14,187,003 | 15,175,591 | -988,588 |
| 1.05.02 Conventional Facilities Engineering and Design | | | | | | | | | | | | | |
| WBS[3]Totals: | 107,334 | 245,803 | 5,712 | 138,469 | 240,090 | 19,116,859 | 19,123,677 | 17,821,022 | 6,818 | 1,302,655 | 22,563,410 | 22,563,410 | 0 |
| 1.05.03 Conventional Facilities Construction | | | | | | | | | | | | | |
| WBS[3]Totals: | 7,802,618 | 6,818,775 | 6,964,974 | -983,843 | -146,199 | 70,947,240 | 75,347,647 | 73,773,510 | 4,400,407 | 1,574,136 | 222,585,891 | 234,369,411 | -11,783,520 |
| 1.05.04 Integrated Controls & Communications | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 139,236 | 13,539 | 13,594 | -125,697 | -55 | 561,273 | 961,000 | -399,727 |
| 1.05.05 Standard Equipment | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,025,586 | 1,025,586 | 0 |
| 1.05.06 Conventional Facilities Commissioning | | | | | | | | | | | | | |
| WBS[3]Totals: | 12,860 | 0 | 3,508 | -12,860 | -3,508 | 86,311 | 45,000 | 44,557 | -41,311 | 443 | 578,000 | 578,000 | -0 |
| **WBS[2]Totals:** | **8,153,725** | **7,295,490** | **7,259,523** | **-858,235** | **35,968** | **96,348,810** | **100,589,027** | **97,810,351** | **4,240,217** | **2,778,676** | **261,501,163** | **274,672,998** | **-13,171,835** |
| **1.06 Pre-Operations** | | | | | | | | | | | | | |
| 1.06.01 Management - Pre Ops | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20,170,700 | 20,170,700 | 0 |
| 1.06.02 Accelerator Systems - Pre Ops | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17,071,591 | 17,071,591 | 0 |
| 1.06.03 Experimental Facilities - Pre Ops | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,823,660 | 4,310,560 | -486,900 |
| 1.06.04 Spares | | | | | | | | | | | | | |
| WBS[3]Totals: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,134,454 | 9,134,454 | 0 |
| **WBS[2]Totals:** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **50,200,405** | **50,687,305** | **-486,900** |
| Performance Measurement Baseline - PMB | 14,258,875 | 11,258,262 | 12,813,172 | -3,000,613 | -1,554,910 | 242,113,018 | 235,636,208 | 233,646,188 | -6,476,810 | 1,990,019 | 761,785,333 | 789,129,685 | -27,344,353 |
| Undistributed Budget | | | | | | | | | | | 985,635 | 0 | 985,635 |
| Sub Total | 14,258,875 | 11,258,262 | 12,813,172 | -3,000,613 | -1,554,910 | 242,113,018 | 235,636,208 | 233,646,188 | -6,476,810 | 1,990,019 | 762,770,968 | 789,129,685 | -26,358,718 |
| Contingency/Mangement Reserve | | | | | | | | | | | 149,229,032 | | |
| Total Project Cost -TPC | 14,258,875 | 11,258,262 | 12,813,172 | -3,000,613 | -1,554,910 | 242,113,018 | 235,636,208 | 233,646,188 | -6,476,810 | 1,990,019 | 912,000,000 | | |