

## WBS Dictionary for Project 7.05; HEX Beamline Partner Portfolio.

Last update: 21-Mar-2019, prior to FDR. Addition of deliverables.

### **7.5.01 Management and Support**

Performance of management and support activities, including labor, materials, travel, and fixed costs associated with management and support functions, consisting of;

- Beamline Lead Scientist and Scientist
- Project / Construction management, including Liaison Engineers,
- Administrative support,
- ES&H,
- QA,
- Configuration management,
- Business operations,
- Project controls, and
- Document control.

Note: the procurement professional labor is typically included in the BNL material burden and is not be included in this WBS.

This WBS also includes all project level meetings and reviews, (whether sponsor or DOE mandated, or not), BAT meetings, and IRR hosting and associated organizational costs including travel).

CAD workstation software, Cobra and Primavera P6 licenses (apportioned).

Deliverables:

Review of procurement, design, and installation documents to ensure all work is planned and done in accordance with BNL requirements. Oversight of installation activities by BNL or contract vendors. NEPA evaluation, Hazard Analysis, checking and archiving of vendor end item documentation, vault drawings, Operations documentation (ie configuration control checklists, procedures/work instructions, etc). Installation and testing documentation.

Creation of project/design review reports, Project plans and IRR preparation

### **7.5.02 Design**

#### 7.5.02.01 Conceptual Integrated Design

Conceptual integrated design and analysis of the beamline optical system, including appropriate simulations, necessary to deliver the sought photon beam parameters.

Conceptual design and analysis of the endstation, including appropriate simulations, necessary to deliver its sought capabilities.

#### 7.5.02.02 Preliminary Integrated Design

Preliminary integrated design and analysis of the beamline optical system, including appropriate simulations and radiological ray tracing, necessary to deliver the sought photon beam parameters. Preliminary design and analysis of the end-station, including appropriate simulations and radiological ray tracing if needed, necessary to

deliver its sought capabilities.

Completion of this activity allows commencement of procurement activity for the long lead time items (hutches, optics, etc.).

The basic conceptual design of all three branches of the beamline is to be included.7.5.02.03 Final Integrated Design

Final design and analysis of the integrated beamline optical system and the integrated end station(s), including appropriate simulations and x-ray ray tracing necessary to deliver the sought photon beam parameters.

Safety write-up with a detailed listing and discussion of the hazards present in the full beamline project as part of the FDR report.

X-ray radiation shielding calculations for all enclosures and transport pipe (these may have to be re-run as the final designs of the enclosures and transport pipe are completed.

Completion of this activity allows all remaining procurement activities to commence.

Deliverable: completion and satisfactory review of the final design report by a team of experts.

### **7.5.03 Beamline Construction**

#### **7.5.03.01 Photon Delivery System Final Detailed Specification, Procurement, Detailed Design and Fabrication.**

Final detailed component level design, specification, procurement, and fabrication, of photon delivery sub-systems. These include the beamline optical systems upstream of the end-station (including their housings, supports, and manipulation systems), apertures and beam definition and conditioning systems, beam diagnostic/visualization systems, beam transport system, vacuum system\*, cooling/heating and temperature stabilization systems associated with individual photon delivery system components, and shielding systems (exclusive of radiological enclosures) that include collimators, masks, shields (eg for secondary Bremsstrahlung), shutters, and beam stops.

This will include relevant beamline component design reviews and Factory Acceptance Testing, with associated travel costs, where applicable.

\* The ion pumps, gauges, valves to be included with the beamline components procurement(s), HOWEVER, the pump and gauge controllers and vacuum cables / connectors will be procured directly by NSLS-II.

Deliverable: complete photon delivery system, delivered to NSLS-II site.

#### **7.5.03.02 Photon Delivery System Assembly, Installation, and Testing**

The on-site assembly, installation, and testing of photon delivery sub-systems and integrated system. This also includes the following;

- EEI of all electrical equipment.
- Inspection of vacuum and cryogenic equipment by staff from the Safety Engineering Group.
- Filing of as-built drawings and preparation for the IRR.
- Personal Protective Equipment, including safety shoes and safety glasses, for Project team members.

- Component survey and associated reporting for safety critical components and other components, as required.

Deliverable: completed assembly, installation and testing (without beam) of the photon delivery system. This also requires substantial completion of controls work (7.05.06.01).

#### 7.5.03.03 End-station System Final Instrument Specification, Procurement, and Fabrication

Final detailed instrument design, specification, procurement, and fabrication of end-station sub-systems and integrated system. These include sample housings, environments, visualization, and support and manipulation systems, detection systems, optical systems within the sample vessel and beam diagnostic/visualization and conditioning/definition/deflection components just before the sample (e.g. on the same support as the sample or contiguous with it) or between the sample and detector (e.g. crystal/grating/mirror-based analyzer or spectrometer system) including their housings, supports, and manipulation systems, vacuum system, and cooling/heating and temperature stabilization systems associated with end-station components. This will include relevant design reviews and Factory Acceptance Testing, with associated travel costs, where applicable.

Deliverable: End-station equipment, delivered to NSLS-II site.

#### 7.5.03.04 End-station System Assembly, Installation, Testing

On-site assembly, installation, and testing of end-station sub-systems and integrated system. EEI of all electrical equipment. Inspection of any associated vacuum and cryogenic equipment by staff from the Safety Engineering Group. This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed assembly, installation and testing (without beam) of the End-station equipment. This also requires substantial completion of controls work (7.05.06.01).

### **7.5.04 Beamline Infrastructure**

#### 7.5.04.01 Hutches

Design, specification, procurement, fabrication, assembly, installation, and testing of the required radiological enclosures, including the necessary hoist, air handling equipment, fans, labyrinths, doors, windows, and lights.

Scope includes A, C, D, E, F hutches. B-hutch descope prior to contract placement for budget reasons in Jan 2019.

Design, specification, procurement, fabrication, assembly, installation, and testing of required environmental cabins (not radiological enclosures) including the necessary ventilation, doors, windows, wiring, and lights. This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed hutches, installed, ready to start utilities installation and fully inspected with the exception of testing with x-ray beam.

#### 7.5.04.02 Mechanical Utilities

Design, specification, procurement, fabrication, assembly, installation, and testing of beamline mechanical utilities including

- structural utility support pylons and L-brackets,
- equipment racks (including heat exchangers, shelves, cable entry brushes and seals and temperature control hardware),
- DI water system (with appropriate flow/temperature instrumentation and automated isolation valves),
- process chilled water system,
- gaseous nitrogen and compressed air systems,
- exhaust system, and
- liquid nitrogen distribution systems (including all drops, interfaces, emergency shutoff system, and any phase separator etc).

This also includes filing of as-built drawings, safety reviews and oversight, and preparation for the IRR.

Deliverable: completed mechanical utilities, installed, ready to commence beamline equipment installation and fully inspected with the exception of testing with installed components.

#### 7.5.04.03 Electrical Utilities

Design, specification, procurement, fabrication, assembly, installation, and testing of beamline electrical utilities (110V, 208V) including;

- cable trays, conduits, utility power cables, power outlets, boxes and circuit breaker panels,
- provisioning of power to equipment racks,
- installation of all conduit and boxes for the Oxygen Deficiency Hazard (ODH) system
- UPS system for the beamline
- hutch smoke detectors
- Installation of the beamline SAF monitors and conduit.

This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed electrical utilities, installed, ready to commence beamline equipment installation and fully inspected with the exception of testing with installed components.

#### 7.5.04.04 Equipment Protection System

Design, specification, procurement, fabrication, assembly, installation, and testing of Equipment Protection System (EPS) including PLC, wiring, and custom sensors, and water leak detection system and integration of the rack smoke alarms. This scope includes the PLC software and cables/connectors to interface to the various water flow sensors, temperature sensors and the vacuum pump and gauge controllers used in the beamline (particularly in the white/pink beam sections). This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed Equipment Protection System, installed, connected to beamline equipment and fully tested and documented.

#### 7.5.04.05 Personnel Protection System

Design, specification, procurement, fabrication, assembly, installation, and testing of Personnel Protection System (PPS) including PLC, wiring, switches, locks, special interlocked personnel protective safeguards such as gates and light screens, and Human Machine Interface (HMI) panel. Also includes the in-house fabricated mounting plates for door switches, locks etc. This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed Personnel Protection System, installed, connected to equipment (door/labyrinth switches/locks, water flow and vacuum sensors (as applicable), shutters etc. To be fully certified and documented.

#### 7.5.04.06 Control Station and Associated Furniture

Design, specification, procurement, fabrication, assembly, installation, and testing of furniture for the beamline control station including partitions and their power and communications wiring.

Desktop computers, screens and printers.

This also includes the SAF monitors (hardware only). This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed Control Station and furniture installation.

### **7.5.05 Accelerator Infrastructure**

#### 7.5.05.01 Front End

Design (including simulations and radiological ray tracing), specification, procurement, fabrication, assembly, installation, and testing of front end sub-systems and integrated system. These include the front end chambers, vacuum system, supports, apertures, slits, collimators, masks, stops (if applicable), shields, shutters, and diagnostics including flags and beam position monitors (if required). The necessary utilities, protection systems, and controls for the front end are included (eg slits, BPMs). This also includes filing of as-built drawings and IRR preparation.

Deliverable: completed Front End, installed, functionally tested with controls, documented and ready for testing with x-rays (FE shutter closed).

#### 7.5.05.02 Source

Design (including simulations and radiological ray tracing), specification, procurement, fabrication, assembly, installation, and testing of radiation source and associated hardware. This is a Superconducting Wiggler (SCW) required for high energy x-rays. All magnetic measurements for the device are included. The necessary device control hardware and software for the source with protection system(s) and rack mounting electrical panel, plus any trim coils and power supplies required for field correction shall be included. This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed Superconducting Wiggler System, tested and characterized in the ID test lab, installed in the storage ring, connected to the control system, run to field and fully tested and documented.

#### 7.5.05.03 Straight Section

Design (including simulations and radiological ray tracing), specification, procurement, fabrication, assembly, installation, and testing of accelerator straight section sub-systems and integrated system. These include;

- the straight section chamber(s),
- vacuum system,
- supports,
- masks and shields,
- diagnostics including beam position monitors,
- necessary utilities (including utility provisions to local interface points for the Insertion Device itself),
- protection systems, and controls for the straight section
- additional modifications to the SR to accommodate the large ID fan which may impact the dipole chamber and/or magnet yokes. Filing of as-built drawings and preparation for the IRR.

Deliverable: completed straight section, installed with the SCW, connected to ancillary equipment and fully tested and documented.

### 7.5.06 Beamline Controls

#### 7.5.06.01 Basic System Controls

Design, specification, procurement, fabrication, assembly, installation, configuration, and testing of photon delivery system and endstation control systems, including specifically:

- Fiber optic networks for beamline network and machine timing;
- Ethernet copper cabling for beamline networks
- Machine timing hardware (VME crate and EVR timing cards);
- Network switches, patch panels and associated Ethernet cables;
- EPICS IOC and Archiver computers;
- Motor controllers and associated connectors and cables, (for motors, encoders, piezos, network, etc) with connectors including population of the equipment racks;
- Serial to Ethernet hubs;
- EPICS PV Gateway installation and/or configuration as required for accelerator controls system access, including Accelerator, Front End, Insertion Devices control.
- Code management (Mercurial, Github, etc) of software and configuration data
- Filing of as-built drawings and preparation for the IRR.

These include operator consoles for control (to the engineering screen level), and an IOC database and software for controlling all Ethernet-based motors, serial devices, and non-safety PLCs.

Note: The controls for the Straight, Source and Front End are included within the relevant WBSs for this equipment.

Instrument applications (high level software) is included below.

Deliverable: completed beamline control system, installed, connected to beamline equipment and fully tested (with all motions demonstrated and CSS screens operational) and documented.

#### 7.5.06.02 Instrument Applications

Design, specification, procurement, fabrication, assembly, installation, and testing of photon delivery system and endstation instrument control applications, including specifically;

- experimental control workstations
- data processing and storage hardware and software
- experimental control software
- data acquisition equipment and software for detectors
- filing of as-built drawings and preparation for the IRR

Deliverable: completed instrument applications, installed with the necessary hardware ready to perform initial experiments, fully tested and documented.

### **7.5.07 Conventional Construction**

#### 7.5.07.01 Conventional Facilities Design and Bid Preparation

Design (by architect) and completion of all required design work prior to the bid document being released. Costs will include BNL staff labor and may also include design consultants and/or engagement of an external consulting architect. This also includes filing of as-built drawings and preparation for the IRR.

Deliverable: completed construction bid package ready to be posted on FedBizOpps.

#### 7.5.07.02 Conventional Facilities Construction

Construction contract as awarded to a contractor, or construction work performed by BNL staff.

Deliverable: completed conventional facilities contract with beneficial occupancy granted and punch-list work closed out or negotiated. Building and systems fully checked and documented.

#### 7.5.07.03 Building Construction Oversight

Costs include safety and engineering supervision of the contractor and all beneficial occupancy testing, as well as any punch-list completion costs (that are not borne by the Contractor).

Deliverable: completed conventional facilities contract with beneficial occupancy granted and punch-list work closed out. Building and systems fully checked and documented.