

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P	Proton Power Upgrade (PPU) Project	The SNS PPU project is to design, build, install and test the equipment necessary to double the accelerator power from 1.4MW to 2.8MW and to deliver a 2.0 MW qualified target.	John Galambos	Mark Champion	All deliverable necessary to meet KPP Requirements and CD-4 Completion criteria
P.01	PPU Project Management	Mark Champion			
P.01.01	Project Management	Mark Champion			N/A- Effort only
P.01.01.01	Management	Effort and M&S required to support the management team in managing the project. Instrumentation & Controls (I&C) Management is included in this WBS. Includes computers, office fees, temporary storage space for technical equipment, and travel of the PPU management team in this WBS. Does not include L2 manager travel in support of specific procurements. Space charges and clerical support costs covered by SNS org burden. Does not include costs for assembly space.	Mark Champion	Mark Champion	
P.01.01.02	Project Reviews	Costs to conduct/host Directors and OPA project reviews. Includes travel costs for reviewers, M&S costs for reviews including duplication of material, posters, equipment/facility rental, clean-up, etc.	Wayne Steffey	Mark Champion	
P.01.02	Project Support	Wayne Steffey			N/A- Effort only
P.01.02.01	Project Controls	Includes all costs required to run the project controls activities for the project. Includes effort and licenses. Travel included for staff presentations, participation at conferences, professional society mtgs, project reviews.	Wayne Steffey	Wayne Steffey	
P.01.02.02	Finance	Finance effort is included in SNS org burden.	Lindsey Hicks	Wayne Steffey	
P.01.02.03	Procurement	Includes matrix procurement management effort to coordinate PPU overall procurement efforts. Buyer effort is estimated with each procurement.	Markus Camfield	Wayne Steffey	
P.01.02.04	HR / Recruitment	HR effort included in SNS org burden. This WBS includes travel for interviewees and an estimate for relocation costs.	Michelle Mazerolle	Wayne Steffey	
P.01.02.05	Communications	Includes small effort to support publication efforts.	Amy Keller	Wayne Steffey	
P.01.02.06	Systems Engineering	Includes effort for the project systems engineer for Interface Management. No M&S or travel expenses associated with this effort.	Mark Champion	Wayne Steffey	
P.01.02.07	Technical Director	Includes effort for the project technical director. No M&S or travel expenses associated with this effort.	Sang-Ho Kim	Wayne Steffey	
P.01.02.08	Installation Coordination	Includes effort required for the project installation coordinator to manage installation efforts across all systems. This includes the management of the service request orders (SROs) with the time and materials contractor, allocation of craft across several concurrent SROs (in coordination with contractor superintendent) and management of all the material assets required for installation (tools, forklifts, consumables, etc.), Level of Effort (LOE) support craft (Laborers, Carpenters, etc.), building Information modeling – supporting QC for installation, and equipment transportation. This does not include the effort for technical oversight of the installation tasks nor the costs for the materials being installed (e.g. piping, cabling, etc. are to be estimated within the appropriate technical system). Construction contractor oversight, general tools and equipment rental that cannot be associated with subprojects is included. Cost for storage of components prior to installation is included in this WBS. Existing space at SNS will be reconfigured for FY20 storage needs, and PPU will partially fund the needed shelving for this reconfiguration. Additional storage space will be provided by ORNL beginning in FY21. Transportation of equipment from the additional storage space to SNS is included.	John Kristy	Wayne Steffey	
P.01.03	ESH&Q	Sam McKenzie			N/A- Effort only
P.01.03.01	ES&H	Includes effort to support required environmental and safety documentation and to provide safety oversight during construction and installation. Travel is included for environmental safety and health.	Sam McKenzie	Sam McKenzie	
P.01.03.02	QA	Includes effort and travel (vendor visits) for support of PPU QA activities.	Bryan Robertson	Sam McKenzie	
P.02	SCL Systems	Matt Howell			
P.02.01	Management and System Integration	Matt Howell			N/A- Effort only
P.02.01.01	Management and System Integration - SCL Systems	Includes management of SCL systems, administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within subsystem. Management of the partner laboratory and all travel related to this management will be contained in this WBS element.	Matt Howell	Matt Howell	
P.02.02	Cavities	John Mammosser			Deliver 28 high beta cavities
P.02.02.01	Management and System Integration	John Mammosser			
P.02.02.01.01	Management and System Integration - Cavities	Includes management of the Cavities system, administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within subsystem.	John Mammosser	John Mammosser	
P.02.02.02	Cavity Procurement	John Mammosser			
P.02.02.02.02	Design - Cavity Procurement	This WBS includes development and transferring of process improvements to the cavity vendor identified during the qualification process aimed at improving performance and reducing errors.	John Mammosser	John Mammosser	

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P.02.02.04	Cavity Reprocessing	John Mammosser			
P.02.02.04.03	Procure/Fab - Cavity Reprocessing	This scope includes reprocessing of cavities at the partner laboratory (rinsing only).	John Mammosser	John Mammosser	
P.02.02.05	Coupler Acquisition	Yoon Kang			
P.02.02.05.02	Design - Coupler Acquisition	Vibration modal analysis to determine if the increase in the PPU coupler wall thickness has a detrimental effect on either the frequency or amplitude of coupler tip vibration. This is important to understand in relation to potential vacuum leaks that could result during coupler and/or cryomodule shipping. Analysis will compare the PPU coupler to the original SNS coupler and will also assess potential damping schemes. Benchtop testing with an instrumented coupler tip will be used to verify modal analysis and damping schemes.	Brian Degraff	John Mammosser	
P.02.02.05.05	Testing - Coupler Acquisition	Coupler processing assembly and testing for 30 couplers is included.	Yoon Kang	John Mammosser	
P.02.02.07	HTA Testing	Brian Degraff			
P.02.02.07.02	Design - HTA Testing	Design of an upgrade to the HTA for operability improvements.	Brian Degraff	John Mammosser	
P.02.02.07.05	Testing - HTA Testing	Integrated horizontal test of production cavities and couplers to verify performance. There are three tests of integrated cavities and couplers in horizontal cryostat.	Brian Degraff	John Mammosser	
P.02.02.08	Coupler Waveguide Transition	Yoon Kang			
P.02.02.08.03	Procure/Fab - Coupler Waveguide Transition	This element includes specification, procurement, and incoming inspection of the twenty-eight RF coupler waveguide transitions. This equipment includes the waveguide brackets, top hat, gas barrier, and the flexible waveguide piece. Upon receiving these items, this WBS element manager shall coordinate delivery of these parts to the manager of Final Cryomodule Assembly. All specifications and receipt inspections shall be captured in the project folder and in document control. This will be performed by SNS personnel.	Yoon Kang	John Mammosser	
P.02.03	Cryomodule Integration (Partner Laboratory Scope)	Ed Daly			Deliver 7 high beta cryomodules
P.02.03.01	Partner Laboratory Component Development	Ed Daly			
P.02.03.01.01	Design	Produce design in support of SNS PPU HB cryomodules that meet SNS PPU performance requirements, are in accordance with JLab and ORNL safety requirements, and minimize costs to a level that does not compromise integrity and function. Perform and develop calculations, analyses, models, drawings, and specifications as required.	Ed Daly	Matt Howell	
P.02.03.01.04	Assemble & Test	Cavity/helium vessel preparation and qualification required for the production of 7 SNS PPU HB cryomodules. 30 qualified dressed cavities with completed production travelers as associated reports and documentation. Assembly of cavity strings, 7 cold masses, and 7 spaceframe/thermal shields with travelers completed and associated reports and documentation. Effort to cryogenically test and ship final cryomodules to SNS. Additional testing effort as defined in the SOW will also be included in this WBS. 7 fully assembled cryomodules (7) delivered to ORNL/SNS with travelers completed and associated reports and documentation.	Ed Daly	Matt Howell	
P.02.03.01.05	8th Cryomodule	Procurement of hardware to fabricate one spare PPU high beta cryomodule. Cavity/helium vessel preparation and qualification required for the production of 1 spare SNS PPU HB cryomodule. 2 qualified dressed cavities with completed production travelers as associated reports and documentation. Assembly of cavity strings, 1 cold mass, and 1 spaceframe/thermal shield with travelers completed and associated reports and documentation. Effort to cryogenically test and ship spare cryomodule to SNS. Additional testing effort as defined in the SOW will also be included in this WBS. 1 fully assembled spare cryomodule delivered to ORNL/SNS with travelers completed and associated reports and documentation.	Ed Daly	Matt Howell	
P.02.04	Cryogenics	Brian Degraff			Deliver u-tubes, actuators and platforms for 7 new cryomodules
P.02.04.01	Management and System Integration	Brian Degraff			
P.02.04.01.01	Management and System Integration - Cryogenics	Management of the cryogenics system, administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within subsystem.	Brian Degraff	Brian Degraff	
P.02.04.02	Cryogenic Components	Brian Degraff			

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P.02.04.02.03	Procure/Fab - Cryogenic Components	The scope of this WBS element is to procure and fabricate all components associated with the u-tubes to connect the cryomodules to the transfer lines. This includes the u-tubes themselves, any missing chevrons, any missing valve actuators, and platforms to allow access on the transfer lines to install the u-tubes. Specifications will be developed for the u-tubes and the fabrication of these will be competitively bid. Any lessons learned in constructing u-tubes in the past will be incorporated into the drawings that will be part of the specification. It is anticipated that these components would be let to a local vendor. This eases travel obligations and more easily allows for inspection by SNS staff during the fabrication process. Upon receiving these components, an incoming receipt should be conducted. Any discrepancies or deviations from specification should be noted and recorded in the project folder and document control. The discrepancies should be resolved prior to delivering parts outside of this WBS element.	Brian Degraff	Brian Degraff	
P.02.04.02.04	Installation - Cryogenic Components	Install U-Tubes, U-Tube connections and the JT motor drives. Also includes installation of the transfer line platform.	Brian Degraff	Brian Degraff	
P.02.04.03	Cryogenics System Testing and Development	Brian Degraff			
P.02.04.03.02	Design - Cryogenics System Testing and Development	Each time a cryomodule is added to the tunnel, the control sequences for the cryogenic system will need to be upgraded. A full check out of those sequences will be required to turn the system back over to operations. The scope of this WBS element is to identify all of the affected sequences, work with the programmers to modify the sequences, and create test plans that verify that overall system performance is not compromised by the addition of a cryomodule. All test plans and copies of the upgraded sequences shall be recorded in the project folder and in document control.	Karen White	Karen White	
P.02.04.03.04	Installation - Cryogenics System Testing and Development	The commissioning and troubleshooting of the automated sequences required to transition the LINAC, including new cryomodules 31 & 32, 29 & 30, and 25, 27 & 28, from 4K operations to 2K operations. The scope of this WBS element is a refinement of the sequences affected during the design phase.	Brian Degraff	Brian Degraff	
P.02.05	Utility Systems	Chris Stone			Deliver ion pumps and turbomolecular pumps
P.02.05.01	Management and System Integration	Chris Stone			
P.02.05.01.01	Management and System Integration - Utility Systems	Labor costs associated with management of the RF vacuum system scope.	Chris Stone	Chris Stone	
P.02.05.02	Beamline Vacuum	Chris Stone			
P.02.05.02.02	Design - Beamline Vacuum	The scope of this element is design of all necessary hardware for the beam line vacuum system. This includes ion pump controllers, ion pumps, fast valves controls, compressed air line to valves, and vacuum gauges.	Chris Stone	Chris Stone	
P.02.05.02.03	Procure/Fab - Beamline Vacuum	The scope of this element is to procure all necessary hardware for the beam line vacuum system. This includes ion pump controllers, ion pumps, fast valves controls, compressed air line to valves, and vacuum gauges. All equipment information shall be captured in the project folder and in document control.	Chris Stone	Chris Stone	
P.02.05.02.04	Installation - Beamline Vacuum	The scope of this element is to install all necessary hardware for the beam line vacuum system. This includes ion pump controllers, ion pumps, fast valves controls, compressed air line to valves, and vacuum gauges. The manager of this WBS element will be required to work closely with the manager of WBS element P.02.06.03.04, Installation Cryomodule in Tunnel because many of these items will overlap in schedule.	Chris Stone	Chris Stone	
P.02.05.03	Insulating Vacuum System	Chris Stone			
P.02.05.03.02	Design - Insulating Vacuum System	The scope of this WBS element includes the design of the insulating vacuum system for cryomodules in the tunnel. This system will keep the insulating vacuum below 1x10 ⁻⁴ torr during operation in the event that a cryomodule leaks.	Chris Stone	Chris Stone	
P.02.05.03.03	Procure/Fab - Insulating Vacuum System	The scope of this WBS element includes the procurement of the insulating vacuum system for cryomodules in the tunnel. This system will keep the insulating vacuum below 1x10 ⁻⁴ torr during operation in the event that a cryomodule leaks.	Chris Stone	Chris Stone	
P.02.05.03.04	Installation - Insulating Vacuum System	The scope of this WBS element includes the installation of the insulating vacuum system for cryomodules in the tunnel. This system will keep the insulating vacuum below 1x10 ⁻⁴ torr during operation in the event that a cryomodule leaks.	Chris Stone	Chris Stone	
P.02.05.04	Water Systems	Klent Pope			
P.02.05.04.03	Procure/Fab - Water Systems	The scope of this element is to procure the cooling water hoses and instruments associated with the fundamental power couplers. It is anticipated that this system will be very similar to the one currently employed in the Linac tunnel.	Klent Pope	Chris Stone	

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P.02.05.04.04	Installation - Water Systems	The scope of this element is to install the cooling water hoses and instruments associated with the fundamental power couplers. It is anticipated that this system will be very similar to the one currently employed in the Linac tunnel.	Klent Pope	Chris Stone	
P.02.06	System Integration	John Mammosser			N/A- Effort only
P.02.06.01	Management and System Integration	John Mammosser			
P.02.06.01.01	Management and System Integration - System Integration	Management of System Integration, administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within subsystem.	John Mammosser	John Mammosser	
P.02.06.02	Completed Cryomodule Testing	John Mammosser			
P.02.06.02.05	Testing - Completed Cryomodule Testing	The scope of the completed cryomodule testing is to test and qualify the cryomodule in the RFTF test cave for installation in the tunnel. All associated installation of the cryomodule in the test cave along with instrument check out are part of the scope of this WBS element. The cavities in the cryomodule will each be tested individually. At the conclusion of testing, the manager of this WBS element will declare the cryomodule ready for installation in the Linac tunnel or not. If the cryomodule does not meet specification for installation, the WBS element manager shall convene a committee and determine the root cause for the lack of performance and implement a plan to rectify the situation. Transportation of the tested cryomodule to storage is included in this WBS element.	John Mammosser	John Mammosser	
P.02.06.03	Cryomodule in Tunnel	John Mammosser			
P.02.06.03.03	Procure/Fab - Cryomodule in Tunnel	Procurement of all ancillary supplies required for this installation are covered in this WBS element. The support stands are copies of the existing stands in the tunnel and will be submitted to vendors as a build to print bid.	John Mammosser	John Mammosser	
P.02.06.03.04	Installation - Cryomodule in Tunnel	The scope of this WBS element is to install the cryomodules in the Linac tunnel. This portion of the WBS will contain the installation of the cryomodule support stands and the modification of the existing beam pipe supports while coordinating with electrical for the move of the cable tray. Much of this element requires interfacing with other groups such as RF, beam diagnostics, survey and alignment, riggers, operators, and others. This scope also includes the transportation of the cryomodule to the Linac tunnel. Upon completing the installation of the cryomodule in the Linac tunnel, the cryomodule will be turned over to the Cryomodule Testing in Tunnel team.	John Mammosser	John Mammosser	
P.02.06.04	Cryomodule Testing in Tunnel	John Mammosser			
P.02.06.04.05	Testing	The scope of this element is to conduct testing of the cryomodule in the Linac tunnel. All test results will be captured in the project folder and in document control. When the testing is complete, the manager of this WBS element will turn the cryomodule over to the manager of WBS element, Cryogenics System Testing and Development. Upon completion of the cryogenic testing, the cryomodule will be officially turned over to operations.	John Mammosser	John Mammosser	
P.02.06.05	Plasma Process MB Cryomodule in Tunnel	John Mammosser			
P.02.06.05.04	Installation - Plasma Process MB Cryomodule in Tunnel	The scope of this WBS element contains the processing of the Plasma Processing MB Cryomodules.	Marc Doleans	John Mammosser	
P.02.07	SCL Controls	Karen White			N/A- Integrated controls
P.02.07.01	Management and System Integration	Aaron Coleman			
P.02.07.01.01	Management and System Integration - SCL Controls	Costs for management of SCL Controls, including administrative support dedicated to system, travel and M&S. Includes integrated testing within subsystem.	Aaron Coleman	Karen White	
P.02.07.02	Linac Beamline Vacuum Controls	Derrick Williams			
P.02.07.02.02	Design - Linac Beamline Vacuum Controls	Design linac beamline vacuum controls architecture, interface systems, and develop factory acceptance tests.	Derrick Williams	Karen White	
P.02.07.02.04	Installation - Linac Beamline Vacuum Controls	Perform linac beamline vacuum controls system installation and integration testing.	Derrick Williams	Karen White	
P.02.07.03	Linac Insulating Vacuum System Controls	Derrick Williams			
P.02.07.03.02	Design - Linac Insulating Vacuum System Controls	Design linac insulating vacuum controls architecture, interface systems, and develop factory acceptance tests.	Derrick Williams	Karen White	
P.02.07.03.04	Installation - Linac Insulating Vacuum System Controls	Perform linac insulating vacuum controls installation and integration testing.	Derrick Williams	Karen White	

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P.02.07.04	Cryomodule Controls	Aaron Coleman			
P.02.07.04.02	Design - Cryomodule Controls	Design cryomodule controls. Signals to be covered include liquid level signals, diode cryogenic temperature sensors, helium pressure transducers, coupler window heaters, cavity heaters, and JT valve controls. Develop factory acceptance tests.	Aaron Coleman	Karen White	
P.02.07.04.04	Installation - Cryomodule Controls	Install cryomodule controls equipment in the Klystron Gallery, and perform integration testing.	Aaron Coleman	Karen White	
P.03	RF Systems	John Moss			
P.03.01	Management and System Integration	John Moss			N/A- Effort only
P.03.01.01	Management and System Integration - RF Systems	Management of the HPRF systems scope.	John Moss	John Moss	
P.03.02	SCL HPRF	John Moss			Deliver 28 805MHz, 700kW peak output power klystrons, 28 high power waveguide circulators, 28 high power loads and 5 transmitter racks and cooling carts
P.03.02.01	Management and System Integration	John Moss			
P.03.02.01.01	Management and System Integration - SCL HPRF	Management of the HPRF systems scope in the cold Linac.	John Moss	John Moss	
P.03.02.02	Transmitters (SCL)	John Moss			
P.03.02.02.02	Design - Transmitters (SCL)	Determine requirements for the transmitters, write specifications, and work with vendors to implement design. Scope includes the development, interface, implementation, and integration of the transmitters design. Execute a design subcontract with an A/E firm to perform an integrated 3D design of the klystron gallery including conventional facilities, technical water cooling systems, and RF systems using Building Information Modeling (BIM) tools. Travel included for review of vendor design and to witness factory acceptance test of the XMTR-31 and Klystron Tanks.	John Moss	John Moss	
P.03.02.02.04	Installation - Transmitters (SCL)	Install and test transmitters. Integrate with LLRF, HVCMs, klystrons, waveguide, circulators and rf loads. Scope includes supervision, integration, schedule and test during installation of the transmitters.	John Moss	John Moss	
P.03.02.03	Klystrons (SCL)	John Moss			
P.03.02.03.02	Design - Klystrons (SCL)	Determine the requirements for the klystrons. Write specifications and work with vendors to implement design. Scope includes design, interface, implementation, and integration.	John Moss	John Moss	
P.03.02.03.03	Procure/Fab - Klystrons (SCL)	Procure 16 klystrons to support Transmitters 28, 27 and 25. Scope includes manage, purchase, receipt, storage, and delivery for installation. Travel included to monitor fabrication.	John Moss	John Moss	
P.03.02.03.04	Installation - Klystrons (SCL)	Install and test klystrons. Integrate with LLRF, transmitters, HVCMs, waveguide, circulators and rf loads. Scope includes supervision, integration and testing.	John Moss	John Moss	
P.03.02.05	Circulators (SCL)	John Moss			
P.03.02.05.03	Procure/Fab	Procure circulators. Manage purchasing schedule, purchase, receipt, and acceptance testing.	John Moss	John Moss	
P.03.03	NCL HPRF	John Moss			N/A- Upgrades to existing components
P.03.03.01	Management and System Integration	John Moss			
P.03.03.01.01	Management and System Integration - NCL HPRF	Management of the HPRF systems scope for the Drift-tube Linac (DTL) section of the warm Linac.	John Moss	John Moss	
P.03.03.02	Transmitters (NCL)	John Moss			
P.03.03.02.02	Design - Transmitters (NCL)	Determine requirements for modifying the existing transmitters. Write specifications. Work with vendors to implement design. Scope includes development, interfacing, implementation, integration of the design.	John Moss	John Moss	
P.03.03.02.03	Procure/Fab - Transmitters (NCL)	Procure transmitter components. Scope includes manage purchasing schedule, procure, receipt, storage and delivery for installation.	John Moss	John Moss	
P.03.03.02.04	Installation - Transmitters (NCL)	Install and test transmitters. Integrate with LLRF, HVCMs, klystrons, waveguide, circulators and rf loads. Scope includes supervision, integration, scheduling and testing.	John Moss	John Moss	
P.03.03.03	Klystrons (NCL)	John Moss			
P.03.03.03.02	Design - Klystrons (NCL)	Determine requirements for the klystrons. Scope includes developing specifications and working with vendors to implement design. Also included is the development, interfacing, implementation, and integration of the design. Travel is included to attend design reviews and to witness factory acceptance tests of first articles.	John Moss	John Moss	

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P.03.03.03.03	Procure/Fab - Klystrons (NCL)	Procure three 3MW klystrons. Scope includes the procurement, receipt, storage and delivery for installation. Travel is included to monitor fabrication.	John Moss	John Moss	
P.03.03.03.04	Installation - Klystrons (NCL)	Install and test klystrons. Integrate with LLRF, transmitters, HVCMs, waveguide, circulators and rf loads. Scope includes supervision, integration and testing.	John Moss	John Moss	
P.03.03.04	Circulators (NCL)	Sung-Woo Lee			
P.03.03.04.02	Design - Circulators (NCL)	Scope includes the design of required upgrades for circulators.	Sung-Woo Lee	John Moss	
P.03.03.05	Glycol/Water Loads (NCL)	Sung-Woo Lee			
P.03.03.05.02	Design - Glycol/Water Loads (NCL)	Design required upgrades for glycol/water loads.	Sung-Woo Lee	John Moss	
P.03.04	LLRF	Mark Crofford			Deliver 28 805 MHz Low Level Radio Frequency(LLRF) control systems
P.03.04.01	Management and System Integration	Mark Crofford			
P.03.04.01.01	Management and System Integration - LLRF	Management of the LLRF scope required to support the design, development, and deployment of the PPU LLRF control systems. Travel is included to attend workshops and conferences.	Mark Crofford	Mark Crofford	
P.03.04.02	LLRF System	Mark Crofford			
P.03.04.02.02	Design - LLRF System	Determine the requirements for the new LLRF control systems. Write specifications, prototype systems, work with vendors to implement design. Also included is the development, interfacing, implementation, and integration of the design. Travel is included for preparation for and participation in the design reviews.	Mark Crofford	Mark Crofford	
P.03.04.02.03	Procure/Fab - LLRF System	Procure LLRF subassemblies. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	Mark Crofford	Mark Crofford	
P.03.04.02.04	Installation - LLRF System	Install and test LLRF assemblies. Integrate with HPRF, transmitters, klystrons, controls, vacuum, cryo, and water systems. Scope includes supervision, integration and testing.	Mark Crofford	Mark Crofford	
P.03.04.03	Arc Detectors	Mark Crofford			
P.03.04.03.02	Design - Arc Detectors	Determine the requirements for the LLRF Arc Detectors. Write specifications, prototype systems, work with vendors to implement design. Also included is the development, interfacing, implementation, and integration of the design.	Mark Crofford	Mark Crofford	
P.03.04.03.03	Procure/Fab - Arc Detectors	Procure LLRF Arc Detectors. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	Mark Crofford	Mark Crofford	
P.03.04.03.04	Installation - Arc Detectors	Install and test LLRF Arc Detectors. Integrate with HPRF, transmitters, klystrons, controls, and LLRF systems. Scope includes supervision, integration and testing.	Mark Crofford	Mark Crofford	
P.03.04.04	Reference Line	Chip Piller			
P.03.04.04.02	Design - Reference Line	Determine the requirements for the RF Reference System and LO distribution. Write specifications, prototype systems, work with vendors to implement design. Also included is the development, interfacing, implementation, and integration of the design.	Chip Piller	Mark Crofford	
P.03.04.04.03	Procure/Fab - Reference Line	Procure RF Reference System to include LO distribution. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	Chip Piller	Mark Crofford	
P.03.04.04.04	Installation - Reference Line	Install and test RF Reference System and LO distribution. Integrate with controls and LLRF systems. Scope includes supervision, integration and testing.	Chip Piller	Mark Crofford	
P.03.05	Existing Linac Modulators	Chris Pappas			N/A- Upgrades to existing components
P.03.05.01	Management and System Integration	Chris Pappas			
P.03.05.01.01	Management and System Integration - Existing Linac Modulators	Management of the Modulator Systems Scope required to support upgrades to the existing warm Linac RF systems necessary to support the increased current requirement.	Chris Pappas	Chris Pappas	
P.03.05.02	Modulator system	Chris Pappas			
P.03.05.02.02	Design	Evaluation of existing system and design of any modifications required to support the current increase.	Chris Pappas	Chris Pappas	
P.03.05.02.04	Installation - Modulator system	Installation and testing of any modulator modifications with 3.0 MW klystrons in Klystron Gallery.	Chris Pappas	Chris Pappas	
P.03.05.03	Modulator Control System	Mark Wezensky			
P.03.05.03.02	Design - Modulator Control System	Modify modulator control screens.	Mark Wezensky	Chris Pappas	
P.03.05.04	Modulator System Test Article and Development Activities	Chris Pappas			

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P.03.05.04.02	Design - Modulator System Test Article Development and Testing	Simulate performance of existing RFQ HVCM to support installation of three 3.0 MW klystrons. Define component changes required and complete design and procurement of test article and any components required to modify infrastructure. Procure dummy resistive load to mimic 3.0 MW klystron(s). Test components in SPTS. Quantify performance of new components and impact on operational parameters of other critical components in the upgraded DTL HVCMs to assess reliability. Some activities moved to P.03.05.06 after decision made to merge RFQ and DTL upgrade plans.	Chris Pappas	Chris Pappas	
P.03.05.05	Warm Linac Test HVCM	Chris Pappas			
P.03.05.05.02	Design - Warm Linac Test HVCM	Design, procure and install a new dedicated RF Annex High Voltage Converter Modulator (RFAX-Mod1). This effort is necessary to develop and test solutions for upgrading RFQ and DTL modulators and will also be used for RF coupler, window, klystron and cryomodule testing. This new modulator will leverage existing components and subsystems to the maximum extent possible to keep costs reasonable.	Chris Pappas	Chris Pappas	
P.03.05.06	Upgrade RFQ/DTL Modulators	Chris Pappas			
P.03.05.06.02	Design - Upgrade RFQ/DTL Modulators	Design of upgraded RFQ/DTL modulator to allow any of the existing SNS klystrons, or new 3 MW tubes to operate in any of location. Includes effort for analysis and design of the charging power supply (RFQ-Mod1 only), high voltage enclosure switch plates capacitor bank, and cabling, and the high voltage tank components and assemblies.	Chris Pappas	Chris Pappas	
P.03.05.06.03	Procure/Fab - Upgrade RFQ/DTL Modulators	Procurement and selection criteria analysis for all DC power supply and modulator system, fabricated parts, assemblies and component purchases. Includes system checkout and in-house qualification testing for technical equipment. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS. Includes misc. items such as cables, fibers, wire harnesses, conduits, cable trays, CO2 systems et al that are not part of a single subsystem.	Chris Pappas	Chris Pappas	
P.03.05.06.04	Installation - Upgrade RFQ/DTL Modulators	Install upgrades RFQ-Mod1, DTL-Mod3 and DTL-Mod5 integrated systems. Includes full power testing into available klystron loads.	Chris Pappas	Chris Pappas	
P.03.06	New Linac Modulators	David E. Anderson			Deliver 3 new modulator systems
P.03.06.01	Management and System Integration	David E. Anderson			
P.03.06.01.01	Management and System Integration - New Linac Modulators	Management support for the 3 new modulators and a hot spare that will be required to support the additional RF added to the Linac for the PPU cryomodules.	David E. Anderson	David E. Anderson	
P.03.06.02	Transformer	David E. Anderson			
P.03.06.02.02	Design - Transformer	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing associated subsystem. Modify design and/or capture as-built features in hardware and software. This includes system hardware as well as equipment required to bring power from the transformer to the 3 new HVCMs.	David E. Anderson	David E. Anderson	
P.03.06.02.03	Procure/Fab - Transformer and SCR	Procurement and selection criteria analysis for all subsystem, fabricated parts and component purchases for the SCL-Mod25 and SCL-Mod28 transformer and SCR systems. Includes factory acceptance testing and in-house qualification testing for technical equipment. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS. This includes system hardware for both the transformer and SCR systems, ORNL-directed SCR system upgrades and equipment required to bring power from the transformer to the SCR systems.	David E. Anderson	David E. Anderson	
P.03.06.02.04	Installation - Transformer	Install transformers and prepare for integrated testing.	David E. Anderson	David E. Anderson	
P.03.06.03	SCR System	David E. Anderson			
P.03.06.03.02	Design - SCR System	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing associated subsystem. Modify design and/or capture as-built features in hardware and software.	David E. Anderson	David E. Anderson	
P.03.06.03.03	Procure/Fab - SCR System	Processing of the procurement (Up to placing of the order) of fabricated parts and components for the SCL-Mod25 and SCL-Mod28 SCR systems. Actual fabrication and delivery is captured in WBS P.03.06.02.03.	David E. Anderson	David E. Anderson	
P.03.06.03.04	Installation - SCR System	Install the SCR system, prepare for integrated testing and perform control functions of SCR systems.	David E. Anderson	David E. Anderson	
P.03.06.04	Modulator System	David E. Anderson			
P.03.06.04.02	Design - Modulator System	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing associated subsystem. Modify design and/or capture as-built features in hardware and software. Update system fabrication drawings. Integrate design with new AIP-36 Renner oil circulation system.	David E. Anderson	David E. Anderson	
P.03.06.04.03	Procure/Fab - Modulator System	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing associated subsystem. Modify design and/or capture as-built features in hardware and software. Update system fabrication drawings. Integrate design with new AIP-36 Renner oil circulation system.	David E. Anderson	David E. Anderson	
P.03.06.04.04	Installation - Modulator System	Install modulator system and associated interfaces.	David E. Anderson	David E. Anderson	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.03.06.05	Modulator Control System	Mark Wezensky			
P.03.06.05.02	Design - Modulator Control System	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing associated subsystem. Develop new digital and auxiliary input/output modules to support new FPGA modules. Update controller program to be compatible with new hardware. Modify design and/or capture as-built features in hardware and software.	Mark Wezensky	David E. Anderson	
P.03.06.05.03	Procure/Fab - Modulator Control System	Procurement and selection criteria analysis for all subsystem, fabricated parts and component purchases. Includes factory acceptance testing and in-house qualification testing for technical equipment. Provides for some cables and custom chassis. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS.	Mark Wezensky	David E. Anderson	
P.03.06.05.04	Installation - Modulator Control System	Provides for assembly of custom hardware and PXI equipment. Provides for installation of software and system updates. Install modulator control system. Perform initial testing and checkout of controller.	Mark Wezensky	David E. Anderson	
P.03.06.06	Integrated System	David E. Anderson			
P.03.06.06.02	Design - Integrated System	Develop engineering documentation for analyzing, fabricating, assembling, procuring, testing, and installing the modulator system. Modify design and/or capture as-built features in hardware and software. Provide engineering cost optimization and analysis/design of alternative topologies. Conduct final design review of system.	David E. Anderson	David E. Anderson	
P.03.06.06.03	Procure/Fab - Integrated System	Procurement and selection criteria of test equipment to perform testing and checkout of modulator systems. Note: This work was de-scoped via PCR LL-2021-15, the account has been closed.	David E. Anderson	David E. Anderson	
P.03.06.06.04	Installation - Integrated System	Install new linac modulators integrated system. Includes all testing, up to full power testing into klystron load. At completion, system ready to support operations.	David E. Anderson	David E. Anderson	
P.03.06.07	Modulator Test Article & Testing	Dennis Solley			
P.03.06.07.02	Design - Modulator Test Article & Testing	Design test article components for alternate topology HVCM (AT-HVCM). Testing, assembly and installation of HV tank components and subassemblies. Test the 3rd generation prototype and quantify performance. Perform long-term testing to assess reliability and thermal performance.	Dennis Solley	David E. Anderson	
P.03.07	Utilities	Greg Norman			Deliver new water cooling system (KL06) / Upgrades to existing components
P.03.07.01	Management and System Integration	Greg Norman			
P.03.07.01.01	Management and System Integration - Utilities	Management of the utility scope required for any modifications to existing RF equipment in the DTL or cold Linac and for support of the additional RF required for the additional cryomodules.	Greg Norman	Greg Norman	
P.03.07.02	Water Utilities, New Cold Linac SCL RF Cooling System (KL-06)	Greg Norman			
P.03.07.02.02	Design - Water Utilities - New Cold Linac SCL RF Cooling System (KL-06)	Support AE Design of new KL06 pump room equipment, and piping from KL06 to the TRCCs and modulators, from the TRCCs to the RF Equipment. Controls are covered in WBS P.03.08.03.	Greg Norman	Greg Norman	
P.03.07.02.04	Installation - Water Utilities - New Cold Linac SCL RF Cooling System (KL-06)	Install klystron gallery DI Water tie-ins to RF equipment and complete all required functional/system tests. Installation of KL06 pump room equipment, electrical, instrumentation and piping, and all klystron gallery DI water piping for the TRCC Carts and RF equipment is under C.F. WBS P.10.06.02.01.03.01 (Klystron Gallery Construction).	Greg Norman	Greg Norman	
P.03.07.03	Water Utilities - Modify Existing RFQ/DTL RF Cooling System (KL-04)	Greg Norman			
P.03.07.03.02	Design - Water Utilities - Modify Existing RFQ/DTL RF Cooling System (KL-04)	Mechanical and Electrical Design of modifications to KL-04 DI cooling system to install larger pumps and increase motor size to 150 HP. Design interconnection piping from TRCCs to the two new 3.0 MW klystrons and associated RF equipment feeding DTL-3, DTL-4 and DTL-5.	Greg Norman	Greg Norman	
P.03.07.03.03	Procure/Fab - Water Utilities - Modify Existing RFQ/DTL RF Cooling System (KL-04)	Procure all required KL-04 materials including larger pumps, 150 HP motors and VFD's, and electrical feed equipment and wiring. Complete all required acceptance testing.	Greg Norman	Greg Norman	
P.03.07.03.04	Installation - Water Utilities - Modify Existing RFQ/DTL RF Cooling System (KL-04)	Install larger pumps. Modify pump bases and piping to accommodate larger 150 HP motors. Install 150 HP motors, breakers, VFD's and new wiring from the MCC to the motors. Complete all required functional/system tests.	Greg Norman	Greg Norman	
P.03.07.07	Electrical	William Barnett			
P.03.07.07.02	Design - Electrical	Design cable tray and distribution systems for technical equipment. Verification of cables approvals, processing of cables into the approved cable list, entry into the cable database and assignment of cable numbers. Developing Bill of Materials (BOMs) for cables and electrical equipment.	William Barnett	Greg Norman	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.03.07.07.03	Procure/Fab - Electrical	Procure LLRF, Cryo, diagnostic and controls racks. Procure standard control cabling for vacuum, Cryo, diagnostic, PPS, as well as vacuum connectors.	William Barnett	Greg Norman	
P.03.07.07.04	Installation - Electrical	Install and testing of technical equipment and instrument racks, waveguide, circulators, loads for HPRF [TR] & LLRF [RFC], technical equipment tray from CF to instrument racks, AC distribution service to technical equipment and racks. Installation and testing of ground plane for all technical equipment and racks, and technical system cables for HPRF [TR], LLRF [RFC], HVCM [MEC], diagnostic, PPS, MPS, network, timing and vacuum operation.	William Barnett	Greg Norman	
P.03.08	RF Controls	Karen White			N/A- Integrated controls
P.03.08.01	Management and System Integration	Alan Justice			
P.03.08.01.01	Management and System Integration - RF Controls	Manage implementation of HPRF and LLRF Controls.	Alan Justice	Karen White	
P.03.08.02	Linac RF Controls	Alan Justice			
P.03.08.02.02	Design - Linac RF Controls	Design LLRF and HPRF controls architecture, develop corresponding software.	Alan Justice	Karen White	
P.03.08.02.03	Procure/Fab - Linac RF Controls	Procure and fabricate LLRF and HPRF controls hardware (not including the soft IOC servers and transmitter software testing which were moved to P.10.3.8.2 as part of the LLPs).	Alan Justice	Karen White	
P.03.08.02.04	Installation - Linac RF Controls	Install HPRF, and LLRF control equipment and perform integration testing.	Alan Justice	Karen White	
P.03.08.03	Linac Water System Controls	Derrick Williams			
P.03.08.03.02	Design - Linac Water System Controls	Design pump loop controls and develop factory acceptance test criteria.	Derrick Williams	Karen White	
P.03.08.03.04	Installation - Linac Water System Controls	Perform system installation, cabling and integration testing.	Derrick Williams	Karen White	
P.03.09	RF/SCL Global Controls	Karen White			N/A- Integrated controls
P.03.09.01	Management and System Integration	Alan Justice			
P.03.09.01.01	Management and System Integration	Labor costs associated with management of the RF/SCL Global Controls scope.	Alan Justice	Karen White	
P.03.09.02	Linac/SCL Timing/MPS	Alan Justice			
P.03.09.02.02	Design - Linac/SCL Timing/MPS	Design required timing and machine protection systems.	Alan Justice	Karen White	
P.03.09.02.03	Procure/Fab - Linac/SCL Timing/MPS	Assembly, testing and software configuration of timing and machine protection system equipment. (Hardware procurements were moved to WBS P.10.3.9.2 as part of LLPs)	Alan Justice	Karen White	
P.03.09.02.04	Installation - Linac/SCL Timing/MPS	Install hardware, cabling and perform integration testing.	Alan Justice	Karen White	
P.03.09.03	Linac/SCL Protection System	Kelly Mahoney			
P.03.09.03.02	Design - Linac/SCL Protection System	Design required personnel protection systems.	Kelly Mahoney	Karen White	
P.03.09.03.04	Installation - Linac/SCL Protection System	Install hardware, cabling and perform integration testing and certification.	Kelly Mahoney	Karen White	
P.03.09.04	Linac/SCL Networking and Computing Infrastructure	Alan Justice			
P.03.09.04.02	Design - Linac/SCL Networking and Computing Infrastructure	Design required networking and computing infrastructure equipment.	Alan Justice	Karen White	
P.03.09.04.03	Procure/Fab - Linac/SCL Networking and Computing Infrastructure	Procure networking and computing infrastructure equipment. Develop corresponding software and factory acceptance testing.	Alan Justice	Karen White	
P.03.09.04.04	Installation - Linac/SCL Networking and Computing Infrastructure	Install hardware and cabling and perform integration testing.	Alan Justice	Karen White	
P.04	Ring Systems	Nick Evans			
P.04.01	Management and System Integration	Nick Evans			N/A- Effort only
P.04.01.01	Management and System Integration - Ring Systems	Management of Ring System scope. Travel is included to attend conferences.	Nick Evans	Nick Evans	
P.04.01.02	Design	Nick Evans			
P.04.01.02.01	System Design Reviews - Ring System	Preliminary and final design reviews for the Ring System. Estimate includes coordination, presentation preparation, staff to attend the design reviews and comment resolution. Travel is included for external reviewers.	Nick Evans	Nick Evans	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.04.02	Injection Region	Robert Saethre			Deliver 2 new chicane magnets and 1 new injection dump septum magnet . Deliver 8 upgraded injection kicker power supplies. Deliver 1 new injection dump quadrupole magnet.
P.04.02.01	Management and System Integration	Robert Saethre			
P.04.02.01.01	Management and System Integration - Injection Region	Management of the injection region scope.	Robert Saethre	Robert Saethre	
P.04.02.02	Injection Region Magnets	Robert Saethre			
P.04.02.02.02	Design - Injection Region Magnets	Design new DH_A11 and DH_A12 (#2 & #3) chicane magnets and support stands. Design replacement injection dump septum magnet and support stand. Includes material specification and acceptance testing criteria. Beam optics studies needed to benchmark the injection dump beam line, and then to determine the optimum placement of an additional quadrupole magnet (which will be a clone of an existing design), and an additional wire scanner. Travel is included for design reviews conducted at the partner lab facility.	Robert Saethre	Robert Saethre	
P.04.02.02.03	Procure/Fab - Injection Region Magnets	Procure new DH_A11 and DH_A12 (#2 & #3) chicane magnets and injection dump septum magnet Perform all acceptance testing / qualification / magnet mapping activities required. Procure the injection dump beam line quadrupole magnet. Procure support stands for the chicane, injection dump septum and injection dump septum magnets. Travel included to monitor fabrication.	Robert Saethre	Robert Saethre	
P.04.02.02.04	Installation - Injection Region Magnets, Vacuum Systems, Stripper Foil Mechanisms	Replace the DH_A11 and DH_A12 (#2 & #3) chicane magnets, move the DH_A10 chicane magnet (#1), replace the injection dump septum magnet. Install the injection dump quadrupole magnet. Replace the chicane 2 (DH_A11) and chicane 3 (DH_A12) magnet vacuum chambers, move the chicane 1 (DH_A10) magnet, replace the injection dump septum magnet vacuum chambers, install the injection dump quadrupole magnet vacuum chambers. Install the new vacuum chambers within magnets. Install primary and secondary stripping foils systems. Install the new injection dump wire scanner system. Install new primary and secondary stripper foil mechanisms to be compatible with the new equipment in that area. Perform functional tests. Estimate includes installation supervision, survey and alignment, installation materials, etc. as applicable.	Jeremy Price	Robert Saethre	
P.04.02.03	Power Supplies	Robert Saethre			
P.04.02.03.02	Design - Power Supplies	Design of injection region power supplies. Travel is included for an external reviewer to attend design reviews.	Robert Saethre	Robert Saethre	
P.04.02.03.03	Procure/Fab - Power Supplies	Procure materials required to upgrade 8 injection kicker power supplies. Procure a power supply for the injection dump quadrupole magnet.	Robert Saethre	Robert Saethre	
P.04.02.03.04	Installation - Power Supplies	Upgrade 8 injection kicker power supplies. Install the power supply for the injection dump quadrupole magnet. Estimate includes installation supervision, survey and alignment, installation materials, etc. as applicable.	Robert Saethre	Robert Saethre	
P.04.02.04	Vacuum Systems	Charlotte Barbier			
P.04.02.04.02	Design - Vacuum Systems	Design new vacuum chambers for DH_A10, DH_A11, DH_A12, DH, A13 and the Injection Dump Septum magnet with bellows spools. Design the vacuum system for the injection dump quadrupole magnet. Design TiN coating system adapters. Includes material specification and acceptance testing criteria etc.	Jeremy Slade	Charlotte Barbier	
P.04.02.04.03	Procure/Fab - Vacuum Systems	Procure vacuum chambers for DH_A10, DH_A11, DH_A12, DH, A13, the injection dump septum magnet, and the injection dump quadrupole magnet, with bellows spools and TiN coating adapters. Acceptance test and TiN coat all vessels. Procure the new injection dump wire scanner system. Travel included to monitor fabrication.	Jeremy Slade	Charlotte Barbier	
P.04.02.05	Primary and Secondary Stripper Foil Mechanisms	Charlotte Barbier			
P.04.02.05.02	Design - Primary and Secondary Stripper Foil Mechanisms	Design primary and secondary stripper foil mechanisms. Includes material specification and acceptance testing criteria.	Charlotte Barbier	Charlotte Barbier	
P.04.02.05.03	Procure/Fab - Primary and Secondary Stripper Foil Mechanisms	Procure new primary and secondary stripper foil mechanisms to be compatible with the new equipment in that area	Charlotte Barbier	Charlotte Barbier	
P.04.03	Injection Dump	Charlotte Barbier			Deliver new view screen
P.04.03.01	Management and System Integration	David Willis			
P.04.03.01.01	Management and System Integration - Injection Dump	Management of the Injection Dump Imaging System.	David Willis	Charlotte Barbier	
P.04.03.02	Injection Dump Imaging System	David Willis			

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.04.03.02.02	Design - Injection Dump Imaging System	Design an imaging system that will measure beam position, beam size, and beam distribution at the entrance to the Ring Injection Dump.	David Willis	Charlotte Barbier	
P.04.03.02.03	Procure/Fab - Injection Dump Imaging System	Procure the injection dump imaging system.	David Willis	Charlotte Barbier	
P.04.03.02.04	Installation - Injection Dump Imaging System	Install the injection dump imaging system.	David Willis	Charlotte Barbier	
P.04.03.03	Injection Dump Engineering Review	Melissa Harvey			
P.04.03.03.02	Design - Injection Dump Engineering Review	Perform benchmark and scaling analyses to determine maximum power rating.	Melissa Harvey	Charlotte Barbier	
P.04.04	Extraction Region	Robert Saethre			Deliver 14 new extraction kicker power supplies
P.04.04.01	Management and System Integration	Robert Saethre			
P.04.04.01.01	Management and System Integration - Extraction Region	Management of the extraction region scope.	Robert Saethre	Robert Saethre	
P.04.04.02	Extraction Region Magnets	Robert Saethre			
P.04.04.02.02	Design - Extraction Region Magnets	Design required mods to extraction septum magnet (aka Lambertson) (pole shims and / or Z-bumps). Determine associated procurement/acceptance testing specifications.	Robert Saethre	Robert Saethre	
P.04.04.02.03	Procure/Fab - Extraction Region Magnets	Procure pole shims and / or Z-Bumps for the extraction septum magnet. Complete all acceptance testing.	Robert Saethre	Robert Saethre	
P.04.04.02.04	Installation - Extraction Region Magnets	Install modifications to extraction septum magnets (aka Lambertson). Includes installation of the vacuum pumps. Estimate includes installation supervision, survey and alignment, installation materials, etc. as applicable.	Robert Saethre	Robert Saethre	
P.04.04.03	Power Supplies	Robert Saethre			
P.04.04.03.02	Design - Power Supplies	Fabricate proof of concept, test and design of extraction kicker resonant charging power supply. Travel is included for external reviewers to attend the Resonant Charging Power Supply design reviews.	Robert Saethre	Robert Saethre	
P.04.04.03.03	Procure/Fab - Power Supplies	Procure fourteen new extraction kicker power supplies for the PFNs. Complete all acceptance testing.	Robert Saethre	Robert Saethre	
P.04.04.03.04	Installation - Power Supplies	Install new power supplies and test. Estimate includes installation supervision, survey and alignment, installation materials, etc. as applicable.	Robert Saethre	Robert Saethre	
P.04.05	Utilities	Greg Norman			Deliver new water cooling system (RN-03)
P.04.05.01	Management and System Integration	Greg Norman			
P.04.05.01.01	Management and System Integration - Utilities	Management of the utilities scope.	Greg Norman	Greg Norman	
P.04.05.02	Main Ring Dipole XFMR Upgrade	Greg Norman			
P.04.05.02.02	Design - Main Ring Dipole XFMR Upgrade	Design and prepare installation drawings for the transformer cooling fans.	Greg Norman	Greg Norman	
P.04.05.02.03	Procure/Fab - Main Ring Dipole XFMR Upgrade	Procure transformer cooling fan kits for the main ring dipole transformers.	Greg Norman	Greg Norman	
P.04.05.02.04	Installation - Main Ring Dipole XFMR Upgrade	Install cooling fan kits for the main ring dipole transformer.	Greg Norman	Greg Norman	
P.04.05.03	RN-03 DIW Cooling Upgrade	Greg Norman			
P.04.05.03.02	Design - RN-03 DIW Cooling Upgrade	The RN-03 Cooling System will be upgraded to provide increased cooling capacity. Standard duplex pump arrangement with one in service and one in active standby. Heat sink will be switched from TWR to CHW. Pump foundations will be structurally improved through installation of individual concrete bases vs. common steel base. Side stream cooling for RF power supplies will be demo'd and integrated into upgraded system. DIW conductivity control will be improved by addition of modulating valve. VFD's will be installed to improve electrical system and provide pressure control of pumps.	Greg Norman	Greg Norman	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.04.05.03.03	Procure/Fab/Installation - RN-03 DIW Cooling Upgrade	Procure upsized RN-03 cooling system components with piping. Includes procurement of two larger pumps, and parts required for modifying the DI water, chilled water, compressed air (CA), and drains. A new chilled water heat exchanger, TCV, and an automatic resistivity control valve will be procured. This WBS includes preparing SOWs and technical specifications of components, solicitation of bids, and review and award contract for construction. This WBS includes installation, support and supervision of upgraded RN-03 system components. This WBS includes the procurement of components and modification of RN-01 cooling system in the ring tunnel for the new injection dump quadrupole magnet, modification of RN-03 piping in RSB for the power supply cooling of new quadrupole magnet.	Greg Norman	Greg Norman	
P.04.05.03.05	Testing - RN-03 DIW Cooling Upgrade	System startup and testing will include leak test of the RN-03 cooling system, cleaning, functional testing, balancing, commissioning and turning the equipment over to operations. Scope includes development of testing procedures, operation and maintenance procedures, as built drawings, other document updates, and barcoding. This WBS includes the new injection dump quadrupole magnet and PS test and startup.	Greg Norman	Greg Norman	
P.04.05.04	PFN Room HVAC	Greg Norman			
P.04.05.04.02	Design - PFN Room HVAC	1. Write a scoping document to solicit a design bid, a design schedule, and a conceptual construction estimate 2. Award the task to an A/E through the BOA (Basic Order Agreement) 3. Conduct the A/E design process through phases: (a) 50%, (b) 90% and (c) Final 4. Conduct Final Design Review	Greg Norman	Greg Norman	
P.04.05.04.03	Procure/Fab - PFN Room HVAC	Procure/Fab HVAC system for PFN Room.	Greg Norman	Greg Norman	
P.04.05.04.04	Installation - PFN Room HVAC	Install HVAC system for PFN Room.	Greg Norman	Greg Norman	
P.04.06	Ring Control Systems	Karen White			N/A- Integrated controls
P.04.06.01	Management and System Integration	Derrick Williams			
P.04.06.01.01	Management and System Integration - Ring Control Systems	Management of the ring control systems.	Derrick Williams	Karen White	
P.04.06.02	Beam Power Limit System	Patrick Bong			
P.04.06.02.02	Design - Beam Power Limit System	Design credited beam power limit system to limit beam power on target to 2 MW. Provide 34 millisecond shut down in the event limit is reached. Travel is included for DO-154 training and for external reviewers to participate in design reviews.	Patrick Bong	Karen White	
P.04.06.02.03	Procure/Fab - Beam Power Limit System	Procure/fab beam power limit system. Travel is included to witness the factory acceptance test.	Patrick Bong	Karen White	
P.04.06.02.04	Installation - Beam Power Limit System	Install beam power limit system.	Patrick Bong	Karen White	
P.04.06.02.05	Testing and Certification - Beam Power Limit System	Test and certify beam power limit system.	Patrick Bong	Karen White	
P.04.06.03	Personnel Protection System	Kelly Mahoney			
P.04.06.03.02	Design - Personnel Protection System	Design required personnel protection systems. Develop factory acceptance testing. Includes additional PPS systems for the RTBT stub. Travel is included for external reviewers to participate in design reviews.	Kelly Mahoney	Karen White	
P.04.06.03.03	Procure/Fab - Personnel Protection System	Procure personnel protection system equipment. Develop corresponding software. Perform factory acceptance testing. Includes additional PPS systems for the RTBT stub.	Kelly Mahoney	Karen White	
P.04.06.03.04	Installation - Personnel Protection System	Install hardware, cabling, perform integration testing and certification.	Kelly Mahoney	Karen White	
P.04.06.04	Ring Injection Section Controls	Derrick Williams			
P.04.06.04.02	Design - Ring Injection Section Controls	Design vacuum, magnet, primary and secondary stripper foil control systems equipment. Develop factory acceptance testing. Included RN-03 cooling controls.	Derrick Williams	Karen White	
P.04.06.04.03	Procure/Fab - Ring Injection Section Controls	Procure vacuum, magnet, primary and secondary stripper foil control system equipment. Develop corresponding software. Perform factory acceptance testing	Derrick Williams	Karen White	
P.04.06.04.04	Installation - Ring Injection Section Controls	Install hardware and cabling, and perform integration testing.	Derrick Williams	Karen White	
P.04.06.05	Ring Extraction Section Controls	Derrick Williams			
P.04.06.05.04	Installation - Ring Extraction Section Controls	Software EPICS development and perform EPICS integration testing.	Derrick Williams	Karen White	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.04.07	RTBT Stub	Nick Evans			N/A- Effort only
P.04.07.02	RTBT Stub Temporary Shielding	Nick Evans			
P.04.07.02.02	Design - RTBT Stub Temporary Shielding	Determine RTBT stub temporary shielding requirements and specifications.	Nick Evans	Nick Evans	
P.04.07.02.04	Installation - RTBT Stub Temporary Shielding	Install RTBT stub temporary shielding stack.	Nick Evans	Nick Evans	
P.04.07.03	RTBT Stub Earth Berm Shielding	Nick Evans			
P.04.07.03.02	Design - RTBT Stub Earth Berm Shielding	Determine RTBT stub earth berm shielding requirements and specifications.	Nick Evans	Nick Evans	
P.04.08	Accelerator Physics	Nick Evans			N/A- Effort only
P.04.08.01	Accelerator Physics	Nick Evans			
P.04.08.01.02	Design - Accelerator Physics	Beam dynamics simulations to support the Linac, ring, and target upgrades. Resolve beam physics issues and questions that arise during the project.	Nick Evans	Nick Evans	
P.05	First Target Station Systems	Bernie Riemer			
P.05.01	Management and System Integration	Bernie Riemer			N/A- Effort only
P.05.01.01	Management and System Integration - First Target Station Systems	Management of the FTS efforts to ensure 2MW capable target with supporting systems. QA support for FTS systems in excess of activities covered in P.1. Includes reviews of vendor submittals for targets & other equipment. NScD work control requires design reviews for new or modified equipment; this effort includes non-project ORNL personnel to conduct these reviews for all P.5 systems. Travel is included for review participation and to attend conferences.	Bernie Riemer	Bernie Riemer	
P.05.02	Neutronics	Franz Gallmeier			N/A- Effort only
P.05.02.01	Management and System Integration	Franz Gallmeier			
P.05.02.01.01	Management and System Integration - Neutronics	Manage implementation of neutronics evaluation of the energy increase to 1.3 GeV. Travel in included for one scientist involved in PPU tasks.	Franz Gallmeier	Franz Gallmeier	
P.05.02.02	Evaluations at 1.3 GeV (Neutronics)	Franz Gallmeier			
P.05.02.02.02	Design - Evaluations at 1.3 GeV (Neutronics)	Perform neutronics evaluation for power deposition and radiation damage rates at 1.3 GeV & 2 MW. Estimate total radiation damage in FTS systems hardware over 60 year lifespan. Evaluate dose rates outside monolith and neutron instruments.	Franz Gallmeier	Franz Gallmeier	
P.05.02.03	System Design Support	Franz Gallmeier			
P.05.02.03.02	Design - System Design Support	Power deposition evaluations and neutrons design support of FTS systems that are upgraded or modified for PPU operation.	Franz Gallmeier	Franz Gallmeier	
P.05.02.04	FTS Source Performance	Franz Gallmeier			
P.05.02.04.02	Design - FTS Source Performance	Evaluate FTS moderator source terms at 1.3 GeV & 2 MW.	Franz Gallmeier	Franz Gallmeier	
P.05.02.05	FTS Facility Support	Franz Gallmeier			
P.05.02.05.02	Design - FTS Facility Support	Estimate radionuclide inventory with 1.3 GeV operation and 60 year lifetime for facility environment and safety documentation. Neutronic analysis support for facility safety updates on FTS credited boundaries.	Franz Gallmeier	Franz Gallmeier	
P.05.03	Mercury Process Systems	Makayla Edwards			Deliver 1 gas liquid separator and pump tank overflow
P.05.03.01	Management and System Integration	Makayla Edwards			
P.05.03.01.01	Management and System Integration - Mercury Process Systems	Manage implementation of evaluation of the energy increase to 1.3 GeV on the Hg process systems. Management of the FTS mercury process systems.	Makayla Edwards	Makayla Edwards	
P.05.03.02	Evaluations at 1.3 GeV (Mercury Process Systems)	Makayla Edwards			
P.05.03.02.02	Design - Evaluations at 1.3 GeV (Mercury Process Systems)	Evaluation of the energy increase to 1.3 GeV on the Hg process systems.	Makayla Edwards	Makayla Edwards	
P.05.03.03	Hg Pump Tank Overflow	Makayla Edwards			
P.05.03.03.02	Design - Hg Pump Tank Overflow	Design mercury pump tank overflow and any necessary tooling to install a mercury pump tank overflow.	Makayla Edwards	Makayla Edwards	
P.05.03.03.03	Procure/Fab - Hg Pump Tank Overflow	Procure mercury pump tank overflow and any necessary tooling to install a mercury pump tank overflow. Travel included to monitor fabrication.	Makayla Edwards	Makayla Edwards	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.05.03.03.04	Installation - Hg Pump Tank Overflow	Install mercury pump tank overflow.	Makayla Edwards	Makayla Edwards	
P.05.03.04	Hg Return GLS	Makayla Edwards			
P.05.03.04.02	Design - Hg Return GLS	Design gas liquid separator and any necessary tooling to install a gas liquid separator.	Makayla Edwards	Makayla Edwards	
P.05.03.05	In-Cell Target Gas Supply Hardware	Makayla Edwards			
P.05.03.05.02	Design - In-Cell Target Gas Supply Hardware	Design in-cell gas supply hardware and any necessary tooling to install the gas supply hardware.	Makayla Edwards	Makayla Edwards	
P.05.03.05.03	Procure/Fab - In-Cell Target Gas Supply Hardware	Procure in-cell gas supply hardware and any necessary tooling to install the gas supply hardware. Travel included to monitor fabrication.	Makayla Edwards	Makayla Edwards	
P.05.03.05.04	Installation - In-Cell Target Gas Supply Hardware	Install in-cell gas supply hardware.	Makayla Edwards	Makayla Edwards	
P.05.04	Moderator Cryogenic Systems	Matt Williamson			Deliver 3 ortho/para converters and diagnostic systems. Relocate and expand the CMS hydrogen inventory.
P.05.04.01	Management and System Integration	Matt Williamson			
P.05.04.01.01	Management and System Integration - Moderator Cryogenic Systems	Manage addition of a LH2 ortho-->para catalyst to the moderator cryogenic system. Travel included for vendor visits and collaboration with J-PARC.	Matt Williamson	Matt Williamson	
P.05.04.02	Ortho-Para Hydrogen Converters	Matt Williamson			
P.05.04.02.02	Design - Ortho-Para Hydrogen Converters	Design components necessary to add ortho-para hydrogen catalyst.	Matt Williamson	Matt Williamson	
P.05.04.02.03	Procure/Fab - Ortho-Para Hydrogen Converters	Procure components necessary to add 3 ortho-para hydrogen catalysts including the vessel.	Matt Williamson	Matt Williamson	
P.05.04.02.04	Installation - Ortho-Para Hydrogen Converters	Install components necessary to add ortho-para hydrogen catalyst (including the vessel and required modifications to existing system).	Matt Williamson	Matt Williamson	
P.05.04.03	Ortho-Para Hydrogen Converter Diagnostics	Matt Williamson			
P.05.04.03.02	Design - Ortho-Para Hydrogen Converter Diagnostics	Design components necessary to add ortho-para hydrogen catalyst diagnostics.	Erik Iverson	Matt Williamson	
P.05.04.03.03	Procure/Fab - Ortho-Para Hydrogen Converter Diagnostics	Procure components necessary to add ortho-para hydrogen catalyst diagnostics.	Matt Williamson	Matt Williamson	
P.05.04.03.04	Installation - Ortho-Para Hydrogen Converter Diagnostics	Install components necessary to add ortho-para hydrogen catalyst diagnostics.	Matt Williamson	Matt Williamson	
P.05.04.04	Hydrogen Refill System Expansion and Relocation	Matt Williamson			
P.05.04.04.02	Design - Hydrogen Refill System Expansion and Relocation	Design of new mechanical components and plan for modification/relocation of existing system components to support detailing and progression to mechanical final design. Design of new logic and necessary hardware, plan for modification/relocation of existing system components to support detailing and progression to I&C final design. Complete any necessary redesign, issue final specifications and drawings to support solicitation of vendor bids and progression to procurement subtask.	Matt Williamson	Matt Williamson	
P.05.04.04.03	Procure/Fab - Hydrogen Refill System Expansion and Relocation	Procurement of components necessary to relocate and expand the HRS.	Matt Williamson	Matt Williamson	
P.05.04.04.04	Installation - Hydrogen Refill System Expansion and Relocation	Removal/relocation of existing components, installation of piping and ancillary utilities to suit new configuration, installation of new mechanical configuration, and commissioning of the expanded HRS.	Matt Williamson	Matt Williamson	
P.05.05	Vessel and Shielding Systems	Oscar Martinez			N/A- Effort only
P.05.05.01	Management and System Integration	Oscar Martinez			

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.05.05.01.01	Management and System Integration - Vessel and Shielding Systems	Manage implementation of evaluating (reflector) vessel systems and monolith shielding power limits at 1.3 GeV. 2.0 MW minimum power level goal. Includes core vessel, proton beam window, monolith shielding, internal cooling, and related controls. Does not include core vessel inserts or supporting utility systems. Engineering evaluations of outer reflector, vessel systems and monolith shielding from 1.3 GeV 2.0 MW heating and radiation damage. Includes core vessel, proton beam window, outer reflector, monolith shielding, internal cooling. If needed, specify changes in requirements to supporting utilities and controls. Does not include core vessel inserts or supporting utility systems. Establish new radiation damage limits on permanent components for 60 year lifetime. Travel is included for conference attendance.	Oscar Martinez	Oscar Martinez	
P.05.05.02	Evaluations at 1.3 GeV (Vessel and Shielding Systems)	Oscar Martinez			
P.05.05.02.02	Design - Evaluations at 1.3 GeV (Vessel and Shielding Systems)	Engineering evaluations of outer reflector, vessel systems and monolith shielding from 1.3 GeV 2.0 MW heating and radiation damage. Includes core vessel, proton beam window, outer reflector, monolith shielding, internal cooling. If needed, specify changes in requirements to supporting utilities and controls. Does not include core vessel inserts or supporting utility systems. Establish new radiation damage limits on permanent components for 60 year lifetime.	Oscar Martinez	Oscar Martinez	
P.05.06	Target Utility Systems	Erica Ahlschwede			Install required upgrades to existing hardware to support 2MW operation at 1.3 GeV and provide new hardware for new once-through gas supply to the Target wall and gas recirculating systems for gas injection to both Target bubblers and wall.
P.05.06.01	Management and System Integration	Erica Ahlschwede			
P.05.06.01.01	Management and System Integration - Target Utility Systems	Manage the evaluation of existing systems with respect to 1.3 GeV and gas injection and implement modifications required / evaluate existing systems with respect to 1.3 GeV and gas injection and implement modifications required. Travel is included for vendor visits.	Erica Ahlschwede	Erica Ahlschwede	
P.05.06.02	Evaluations at 1.3 GeV (Target Utility Systems)	Erica Ahlschwede			
P.05.06.02.02	Design - Evaluations at 1.3 GeV (Target Utility Systems)	Evaluate existing systems with respect to 1.3 GeV and gas injection and implement modifications required.	Lorelei Jacobs	Erica Ahlschwede	
P.05.06.03	Upgrades for 1.3 GeV systems	Erica Ahlschwede			
P.05.06.03.02	Design - Upgrades for 1.3 GeV Systems	Design components necessary to upgrade existing utility systems for operations at 1.3 GeV.	Lorelei Jacobs	Erica Ahlschwede	
P.05.06.04	Upgrades for Gas Injection	Erica Ahlschwede			
P.05.06.04.02	Design - Upgrades for Gas Injection	Design upgrades to existing utility systems and develop flowsheets and define new hardware required for a PPU recirculating gas injection system.	Lorelei Jacobs	Erica Ahlschwede	
P.05.06.04.03	Procure/Fab - Upgrades for Gas Injection	Procure components necessary to upgrade existing utility systems and implement a PPU recirculating gas injection system.	Lorelei Jacobs	Erica Ahlschwede	
P.05.06.04.04	Installation - Upgrades for Gas Injection	Install components necessary to upgrade existing utility systems and implement a PPU recirculating gas injection system.	Lorelei Jacobs	Erica Ahlschwede	
P.05.07	Instrument Systems	Oscar Martinez			N/A- Effort only
P.05.07.01	Management and System Integration	Oscar Martinez			
P.05.07.01.01	Management and System Integration - Instrument Systems	Manage implementation of evaluating FTS instrument systems power limits at 1.3 GeV. 2.0 MW minimum power level goal. Includes core vessel inserts or any other instrument hardware potentially limited by 1.3 GeV 2.0 MW operation. Engineering evaluations of close-in FTS instrument systems from 1.3 GeV 2.0 MW heating and radiation damage. Includes core vessel inserts. Update engineering documentation, especially those relevant to credited boundary components.	Oscar Martinez	Oscar Martinez	
P.05.07.02	Evaluations at 1.3 GeV (Instrument Systems)	Oscar Martinez			
P.05.07.02.02	Design - Evaluations at 1.3 GeV (Instrument Systems)	Engineering evaluations of close-in FTS instrument systems from 1.3 GeV 2.0 MW heating and radiation damage. Includes core vessel inserts. Update engineering documentation, especially those relevant to credited boundary components.	Oscar Martinez	Oscar Martinez	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.05.08	MOTS	Greg Stephens			Deliver 1 ambient temperature carbon adsorber, cryo-adsorber, molecular sieve skid and associated/required equipment
P.05.08.01	Management and System Integration	Greg Stephens			
P.05.08.01.01	Management and System Integration - MOTS	Manage implementation of additional MOTS delay bed, cryogenic adsorber redesign and the additional MOTS hardware required to support PPU gas injection	Greg Stephens	Greg Stephens	
P.05.08.02	Additional MOTS Delay Bed	Greg Stephens			
P.05.08.02.02	Design - Additional MOTS Delay Bed	Design additional MOTS delay bed.	Greg Stephens	Greg Stephens	
P.05.08.02.03	Procure/Fab - Additional MOTS Delay Bed	Procure additional MOTS delay bed. Travel is included to monitor fabrication.	Greg Stephens	Greg Stephens	
P.05.08.02.04	Installation - Additional MOTS Delay Bed	Install additional MOTS delay bed.	Greg Stephens	Greg Stephens	
P.05.08.03	MOTS Upgrades for Gas Injection	Greg Stephens			
P.05.08.03.02	Design - MOTS Upgrades for Gas Injection	MOTS evaluations and the design of MOTS upgrades required to support PPU gas injection.	Greg Stephens	Greg Stephens	
P.05.08.03.03	Procure/Fab - MOTS Upgrades for Gas Injection	Procure hardware for MOTS upgrades required to support PPU gas injection.	Greg Stephens	Greg Stephens	
P.05.08.03.04	Installation - MOTS Upgrades for Gas Injection	Install hardware for MOTS upgrades required to support PPU gas injection.	Greg Stephens	Greg Stephens	
P.05.08.04	MOTS Cold Trap and Shielding	Greg Stephens			
P.05.08.04.02	Design - MOTS Cold Trap and Shielding	Design cold trap and shield housing.	Greg Stephens	Greg Stephens	
P.05.08.04.03	Procure/Fab - MOTS Cold Trap and Shielding	Procure designed cold trap and shield housing components.	Greg Stephens	Greg Stephens	
P.05.08.04.04	Installation - MOTS Cold Trap and Shielding	Install designed cold trap and shield housing components.	Greg Stephens	Greg Stephens	
P.05.09	2 MW Target	Kevin Johns			Deliver 2 production targets and 1 production spare target
P.05.09.01	Management and System Integration	Kevin Johns			
P.05.09.01.01	Management and System Integration - 2 MW Target	Manage implementation of a target capable of 2MW operation with 1.3 GeV. Travel is included for conference attendance and for oversight during target module fabrication.	Kevin Johns	Kevin Johns	
P.05.09.02	Target Module	Kevin Johns			
P.05.09.02.01	Mercury Vessel (MV)	Kevin Johns			
P.05.09.02.01.02	Design - Mercury Vessel (MV)	Design and analysis of the target module mercury vessel capable of 2MW at 1.3 GeV. Design will include improved structural design, advanced gas injectors, and protective gas walls. The mercury vessel be procured and installed as part of Target Module Assembly.	Kevin Johns	Kevin Johns	
P.05.09.02.02	Bolt on Shroud (BOS)	Kevin Johns			
P.05.09.02.02.02	Design - Bolt on Shroud (BOS)	Design and analysis of the target module bolt on shroud to address energy change from 1 GeV to 1.3 GeV. Travel is included for design reviews.	Kevin Johns	Kevin Johns	
P.05.09.02.03	Target Module Assembly	Kevin Johns			
P.05.09.02.03.03	Procure/Fab - Target Module Assembly	Procurement of components needed for the target. Procure 2 production targets and 1 spare target module, including both mercury vessel and water cooled shroud. Includes purchase of ESR steel for MV and BOS; procurement of inflatable seal, target sensors, and target nose coating. Travel is included to monitor fabrication.	Kevin Johns	Kevin Johns	
P.05.09.02.03.04	Installation - Target Module Assembly	Install sensors on MV to measure target response to beam. Receipt inspection and testing of target after delivery. Installation of the target onto the target carriage for use.	Kevin Johns	Kevin Johns	
P.05.09.03	Supporting Hardware	Kevin Johns			
P.05.09.03.02	Design - Supporting Hardware	Design jumpers used to connect the target to gas supplies in the target carriage.	Kevin Johns	Kevin Johns	
P.05.09.03.03	Procure/Fab - Supporting Hardware	Procure jumpers.	Kevin Johns	Kevin Johns	
P.05.09.04	PPU Test Target	Kevin Johns			
P.05.09.04.02	Design - PPU Test Target	Design and fabricate two test targets. Travel is included for fabrication oversight of test articles.	Kevin Johns	Kevin Johns	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.05.10	Safety, Controls and Operations	Charlotte Barbier			Controls hardware and Software for FTS
P.05.10.01	Management and System Integration	Charlotte Barbier			
P.05.10.01.01	Management and System Integration - Safety, Controls and Operations	Manage controls, integration, generation and review of required safety documentation/operational procedures.	Charlotte Barbier	Charlotte Barbier	
P.05.10.02	System Integration for Safety Authorization	Jacob Platfoot			
P.05.10.02.02	Design - System Integration for Safety Authorization	Generation and review of required safety documentation to accommodate changes in the target systems. Travel is included for an external reviewer.	Jacob Platfoot	Jacob Platfoot	
P.05.10.03	Controls Integration	Charlotte Barbier			
P.05.10.03.02	Design - Controls Integration	Generation and review of required controls documentation to accommodate changes in the target systems.	Karen White	Karen White	
P.05.10.03.03	Procure/Fab - Controls Integration	Procurements for new/modification of existing control systems to accommodate changes in the target systems.	Karen White	Karen White	
P.05.10.03.04	Installation - Controls Integration	Installations for new/modification of existing control systems to accommodate changes in the target systems.	Karen White	Karen White	
P.05.10.04	Operating Procedures and Training	Greg Stephens			
P.05.10.04.02	Design - Operating Procedures and Training	Manage generation and review of new operational procedures and prepare required training materials for affected staff and execute the training.	Greg Stephens	Greg Stephens	
P.05.11	Gas Injection Development	Charlotte Barbier			N/A- Effort only
P.05.11.01	Management and System Integration - Gas Injection Development	Manage the development of gas injection. Does not include scope associated with orifice bubblers, injected gas rates <=2 SLPM or once-through gas supply. Includes high gas rate bubblers and protective gas walls; includes gas removal development for assuring safe and efficient Hg process loop operation. Includes operation of any test facilities, documentation of results, etc.	Charlotte Barbier	Charlotte Barbier	
P.05.11.02	Gas Injection	Charlotte Barbier			
P.05.11.02.02	Design - Gas Injection	Design, procure and install acrylic target and gas injection systems. Design, procure and install experimental target, gas injection systems and GLS. Travel included to test gas injection strategy on the new TTF Target (one trip) and the current target (one trip). Design exploration for GLS. Travel (international) included to perform simulation of the flow in the new TTF target.	Charlotte Barbier	Charlotte Barbier	
P.06	Conventional Facilities	Mark Connell			
P.06.01	Management and System Integration	Mark Connell			N/A- Effort only
P.06.01.01	Management and System Integration - Conventional Facilities	Management of conventional facilities. Scope includes administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within the subsystem.	Mark Connell	Mark Connell	
P.06.02	Building Modifications	Mark Connell			Construct a new pump room off of the Klystron Gallery and a short tunnel to connect the SNS RTBT to the future STS RTST.
P.06.02.01	Klystron Gallery Building Modifications	Robert Dean			
P.06.02.01.01	Management and System Integration - Klystron Gallery Building Modifications	Management of klystron gallery building modifications. Scope includes administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within the subsystem.	Robert Dean	Mark Connell	
P.06.02.01.02	Design - Klystron Gallery Building Modifications	Preliminary and final design for required modifications to Klystron Gallery utilities (power, chilled water, tower water, compressed air, structural modifications, new HVAC unit with EPICS controls). Includes new pump building shell and utilities for new pump skid.	Robert Dean	Mark Connell	
P.06.02.02	RTBT Modifications	Robert Dean			
P.06.02.02.01	Management and System Integration - RTBT Modifications	Management of RTBT modifications. Scope includes administrative support dedicated to system, travel and M&S that does not directly benefit one of the individual systems, and integrated testing within the subsystem.	Robert Dean	Mark Connell	
P.06.02.02.02	Design - RTBT Modifications	Preliminary and final design for required RTBT wall modifications to facilitate PPU RTST construction without requiring an extended outage for STS. No shielding or PPS is included. Travel is included for an external reviewer.	Robert Dean	Mark Connell	
P.06.02.02.03	Procure/Fab RTBT Modifications	Robert Dean			
P.06.02.02.03.01	Procure/Fab - RTBT Modifications (Non-LOE)	Procurement, fabrication and construction to complete the required scope. Incorporate as-built documentation and gather project documents.	Robert Dean	Mark Connell	
P.06.02.02.03.02	Procure/Fab - RTBT Modifications (LOE)	Construction and contract related support including management and system integration, FMD support, field support, and construction management and support.	Robert Dean	Mark Connell	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.06.02.03	Facility DI Water and HVAC Controls	Derrick Williams			
P.06.02.03.01	Management and System Integration - Facility DI Water and HVAC Controls	Manage implementation, installation and testing of HVAC controls.	Derrick Williams	Karen White	
P.06.02.03.02	Design - Facility DI Water and HVAC Controls	Design HVAC controls and develop factory acceptance test criteria.	Derrick Williams	Karen White	
P.06.02.03.03	Procure/Fab - Facility HVAC and Water Controls	Procure components and fabricate RTBT stub DI water and HVAC control panel. Scope also includes factory acceptance testing.	Derrick Williams	Karen White	
P.06.02.03.04	Installation - Facility DI Water and HVAC Controls	Perform system installation, cabling and integration testing.	Derrick Williams	Karen White	
P.07	R&D	Nick Evans			
P.07.01	Gas Injection Development	Charlotte Barbier			N/A- Effort only
P.07.01.01	Management and System Integration - Gas Injection Development	Manage the development of gas injection. WBS element does not include scope associated with orifice bubblers, injected gas rates <=1 SLPM or once-through gas supply. Includes high gas rate bubblers and protective gas walls; includes gas removal development for assuring safe and efficient Hg process loop operation. Includes operation of any test facilities, documentation of results, etc.	Charlotte Barbier	Charlotte Barbier	
P.07.01.02	Gas Injection in Water	Design, procure and install acrylic target and gas injection systems.	Charlotte Barbier	Charlotte Barbier	
P.07.01.03	Gas Injection in Mercury	Design, procure and install experimental target, gas injection systems and GLS. Travel included to test gas injection strategy on the new TTF Target (one trip) and the current target (one trip).	Charlotte Barbier	Charlotte Barbier	
P.07.01.04	Numerical Simulations	Design exploration for GLS. Travel (international) included to perform simulation of the flow in the new TTF target.	Charlotte Barbier	Charlotte Barbier	
P.07.02	Foil Development	Nick Evans			N/A- Effort only
P.07.02.02	Design - Foil Development	Manage the work associated with testing foils in the lab for 2.0 MW level conditions and measuring the in-situ foil temperature.	Nick Evans	Nick Evans	
P.08	Pre-Ops	Glen Johns			
P.08.01	Commissioning	Glen Johns			
P.08.01.01	Commission PPU Components with Beam	Glen Johns			
P.08.01.01.05	Commissioning and Pre-Ops	Commissioning new PPU components with beam and Pre-Ops. Travel included to conduct ARRs.	Glen Johns	Glen Johns	
P.08.03	Regulatory Compliance	Glen Johns	Glen Johns	Glen Johns	
P.08.03.03	ARR Planning	Glen Johns			
P.08.03.03.01	Management and System Integration	Management support and planning/execution of the PPU Accelerator Readiness Reviews.	Glen Johns	Glen Johns	
P.09	Pre-CD-1 Activities	Pre-CD-1 Actual Costs			
P.09.01	Pre-CD-1 Activities	Pre-CD-1 Actual Costs			N/A- Actual costs prior to CD-1
P.09.01.01	FY16-FY18 P.01 Activities	FY16-FY18 efforts supporting PPU	John Galambos	Wayne Steffey	
P.09.01.02	FY16-FY18 P.02 Activities	FY16-FY18 efforts supporting PPU	Matt Howell	Wayne Steffey	
P.09.01.03	FY16-FY18 P.03 Activities	FY16-FY18 efforts supporting PPU	John Moss	Wayne Steffey	
P.09.01.04	FY16-FY18 P.04 Activities	FY16-FY18 efforts supporting PPU	Nick Evans	Wayne Steffey	
P.09.01.05	FY16-FY18 P.05 Activities	FY16-FY18 efforts supporting PPU	Bernie Riemer	Wayne Steffey	
P.09.01.06	FY16-FY18 P.06 Activities	FY16-FY18 efforts supporting PPU	Gary Bloom	Wayne Steffey	
P.09.01.07	FY16-FY18 P.07 Activities	FY16-FY18 efforts supporting PPU	Charlotte Barbier	Wayne Steffey	
P.10	Long Lead Procurements	John Galambos			
P.10.02	SCL Systems	Matt Howell			
P.10.02.01	Cavities & Material Scanning LLP	Matt Howell			
P.10.02.01.03	Procure/Fab - Cavities & Material Scanning LLP	Includes the procurement of PPU cavities with (30) +2 option, this cavity contract includes: Nb materials, QA steps of cell materials at DESY, processing and assembly of reference and production cavities ready for vertical testing, shipping of reference cavities to SNS and production cavities to JLAB. Travel to the vendor for setup of facilities, processing development and during production.	John Mammosser	John Mammosser	
P.10.02.02	VTA Qualification Hardware LLP	John Mammosser			
P.10.02.02.03	Procure/Fab - VTA Qualification Hardware LLP	Includes procurement of cavity test hardware and shipping boxes and shipping of reference cavities, shipping boxes and hardware to the vendor.	John Mammosser	John Mammosser	

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.10.02.04	Couplers LLP	John Mammosser			
P.10.02.04.03	Procure/Fab - Couplers LLP	Includes the procurement of inner and outer coupler components, modification to the Horizontal test apparatus cryostat. Includes the travel to the vendors for providing oversight during production.	John Mammosser	John Mammosser	
P.10.02.05	Couplers Acquisition	Yoon Kang			
P.10.02.05.03	Procure/Fab - Coupler Acquisition	The coupler acquisition WBS will be performed by SNS and includes the procurement and qualification of 30 new power coupler assemblies, procurement of coupler tooling and instrumentation, and misc. vacuum equipment.	Yoon Kang	John Mammosser	
P.10.02.07	Cryomodule Integration (Partner Laboratory Scope)	Ed Daly			
P.10.02.07.03	Procure/Fab - Cryomodule Integration (Partner Laboratory Scope)	Procurement of hardware to fabricate seven new PPU high beta cryomodules and other components defined in SOW.	Ed Daly	Matt Howell	
P.10.02.08	Cryomodule Testing	Jeffrey Saunders			
P.10.02.08.03	Procure/Fab - Cryomodule Testing	Procurement of cryomodule transport carts required for installation.	Jeffrey Saunders	Jeffrey Saunders	
P.10.02.09	Cryomodule in Tunnel	Jeffrey Saunders			
P.10.02.09.03	Procure/Fab - Cryomodule in Tunnel	Procurement of all ancillary supplies required for this installation are covered in this element of the WBS. The support stands are copies of the existing stands in the tunnel and will be submitted to vendors as a build to print bid.	Jeffrey Saunders	Jeffrey Saunders	
P.10.02.09.04	Installation	Includes installation of 7 cryomodule stands in the tunnel.	Jeffrey Saunders	Jeffrey Saunders	
P.10.02.10	Plasma Process MB Cryomodule	Ralph Afanador			
P.10.02.10.03	Procure/Fab - Plasma Process MB Cryomodule	Procurement of materials and supplies for MB plasma process.	Ralph Afanador	Jeffrey Saunders	
P.10.02.11	Linac Beamline Vacuum Controls	Derrick Williams			
P.10.02.11.03	Procure/Fab - Linac Beamline Vacuum Controls	Procure linac beamline vacuum controls equipment, develop required software, and execute factory acceptance testing.	Derrick Williams	Karen White	
P.10.02.12	Linac Insulating Vacuum System Controls	Derrick Williams			
P.10.02.12.03	Procure/Fab - Linac Insulating Vacuum System Controls	Procure linac insulating vacuum controls equipment, develop required software, and execute factory acceptance testing.	Derrick Williams	Karen White	
P.10.02.13	Cryomodule Controls	Aaron Coleman			
P.10.02.13.03	Procure/Fab - Cryomodule Controls	Procure cryomodule controls equipment, develop required cryomodule controls software, and execute factory acceptance testing.	Aaron Coleman	Karen White	
P.10.03	RF Systems	John Moss			
P.10.03.02	SCL HPRF	John Moss			
P.10.03.02.02	Transmitters (SCL)	John Moss			
P.10.03.02.02.03	Procure/Fab - Transmitters (SCL)	Procure 4 transmitters. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	John Moss	John Moss	
P.10.03.02.03	Klystrons (SCL)	John Moss			
P.10.03.02.03.03	Procure/Fab- Klystrons (SCL)	Procure klystrons to support first two transmitters. Manage purchase, receipt, storage, and delivery for installation. Travel included to monitor fabrication.	John Moss	John Moss	
P.10.03.02.04	Waveguide and Waveguide Components (SCL)	John Moss			
P.10.03.02.04.03	Procure/Fab - Waveguide and Waveguide Components (SCL)	Procure waveguide and waveguide components. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	John Moss	John Moss	
P.10.03.02.05	Circulators (SCL)	John Moss			
P.10.03.02.05.03	Procure/Fab - Circulators (SCL)	Procure 28 circulators. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	John Moss	John Moss	
P.10.03.02.06	Water Loads (SCL)	John Moss			
P.10.03.02.06.03	Procure/Fab - Water Loads (SCL)	Procure 28 loads. Manage purchasing schedule, purchase, receipt, storage and delivery for installation.	John Moss	John Moss	
P.10.03.06	New Linac Modulators	David E. Anderson			
P.10.03.06.02	Transformer New Linac Modulators)	David E. Anderson			

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.10.03.06.02.03	Procure/Fab - Transformer (New Linac Modulators)	Procurement and selection criteria analysis for all subsystem, fabricated parts and component purchases for a transformer system to support the first modulator system (SCL-Mod30). Includes factory acceptance testing and in-house qualification testing for technical equipment. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS. This includes system hardware as well as equipment required to bring power from the transformer to the HVCMs. Travel included for factory acceptance testing.	David E. Anderson	David E. Anderson	
P.10.03.06.03	SCR System	David E. Anderson			
P.10.03.06.03.03	Procure/Fab - SCR System	Procurement and selection criteria analysis for all subsystem, fabricated parts and component purchases for an SCR system to support the first modulator system (SCL-Mod30). Includes factory acceptance testing and in-house qualification testing for technical equipment. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS. Travel included for factory acceptance testing.	David E. Anderson	David E. Anderson	
P.10.03.06.04	Modulator System	David E. Anderson			
P.10.03.06.04.03	Procure/Fab - Modulator System	Procurement and selection criteria analysis for all subsystem, fabricated parts and component purchases for the modulator system in the cold Linac. Includes factory acceptance testing and in-house qualification testing for technical equipment. Provides for some field assembly and modifications of technical equipment not covered in the Installation WBS. Travel included to monitor fabrication and testing. Full average power testing into vendor-provided resistive load included.	David E. Anderson	David E. Anderson	
P.10.03.07	Utilities	Greg Norman			
P.10.03.07.02	Water Utilities, New Cold Linac SCL RF Cooling System (KL-06)	Greg Norman			
P.10.03.07.02.03	Procure/Fab - Water Utilities, New Cold Linac SCL RF Cooling System (KL-06)	Procure new KL06 Pumps and Heat Exchanger	Greg Norman	Greg Norman	
P.10.03.07.07	Electrical	William Barnett			
P.10.03.07.07.03	Procure/Fab - Electrical	Procure HPRF [TR] and LLRF [RFC] cables and HVCM cables and racks. Procure Beam Line Interface materials for Cryomodule installation, ground plane for technical equipment and all NON-CF cable tray and hardware for final installation of Technical Equipment Racks.	William Barnett	Greg Norman	
P.10.03.07.07.04	Installation - Electrical	Installation of Cryomodule Control BLI and Tray for all new cryomodules; relocation of existing vacuum diagnostics and Cryomodule cables and cable tray	William Barnett	Greg Norman	
P.10.03.08	RF Controls	Karen White			
P.10.03.08.02	Linac RF Controls	Alan Justice			
P.10.03.08.02.03	Procure/Fab - Linac RF Controls	Procurement and testing of HPRF soft IOC servers and transmitter testing software. Travel included to support factory acceptance testing.	Alan Justice	Karen White	
P.10.03.09	RF/SCL Global Controls	Karen White			
P.10.03.09.02	Linac/SCL Timing/MPS	Alan Justice			
P.10.03.09.02.03	Procure/Fab - Linac/SCL Timing/MPS	Procurement and factory acceptance testing of timing and machine protection system equipment.	Alan Justice	Karen White	
P.10.03.09.03	Linac/SCL Protection System	Kelly Mahoney			
P.10.03.09.03.03	Procure/Fab - Linac/SCL Protection System	Procurement and factory acceptance testing of personnel protection system equipment.	Kelly Mahoney	Karen White	
P.10.06	Conventional Facilities	Mark Connell			
P.10.06.02	Building Modifications	Mark Connell			
P.10.06.02.01	Klystron Gallery Building Modifications	Robert Dean			
P.10.06.02.01.03	Procure/Fab Klystron Gallery Building Modifications	Robert Dean			
P.10.06.02.01.03.01	Procure/Fab - Klystron Gallery Building Modifications (Non-LOE)	Procurement costs, equipment costs and construction costs to complete the required scope. Incorporate as-built documentation, gather project documents, operating manuals etc. Travel included for factory inspection of the medium voltage switches.	Robert Dean	Mark Connell	
P.10.06.02.01.03.02	Procure/Fab - Klystron Gallery Building Modifications (LOE)	Construction and contract related support including management and system integration, FMD support, field support, and construction management and support.	Robert Dean	Mark Connell	
P.10.06.02.03	Facility DI Water and HVAC Controls	Derrick Williams			

WBS	WBS Title	Description	Responsible Person	Control Account Manager (CAM)	Specific deliverables required for CD-4 completion
P.10.06.02.03.03	Procure/Fab - Facility HVAC and Water Controls	Procure components and fabricate DI Water and HVAC control Panel, Perform factory acceptance testing.	Derrick Williams	Karen White	