THE LANSCE REFURBISHMENT (LANSCE-R) PROJECT

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Abstract

At the core of the Los Alamos Neutron Science Center (LANSCE) accelerator lies an 800-MeV proton linac that drives user facilities for isotope production, proton radiography, ultra-cold neutrons, weapons neutron research and for various sciences using neutron scattering. LANSCE is in the planning phase of a refurbishment project that will sustain reliable facility operations well into the next decade.

The general goals for LANSCE-R are to (1) preserve dependable operation of the linac and (2) increase the cost effectiveness of operations. Requirements can be met for overall beam intensity, availability, and reliability with long-term sustainability and minimal disruption to scheduled user programs.

The baseline refurbishment project consists of replacing the 201 MHz RF systems, upgrading a substantial fraction of the 805 MHz RF systems, updating the control system, and replacing or improving a variety of diagnostics and accelerator subsystems.

INTRODUCTION

The LANSCE User Facility is capable of simultaneously accelerating protons or negative hydrogen ions to beam powers of up to 800 kW. A beam switchyard allows tailored time-structured beams to be delivered to five distinct experimental areas. A layout of the facility is shown in Figure 1.

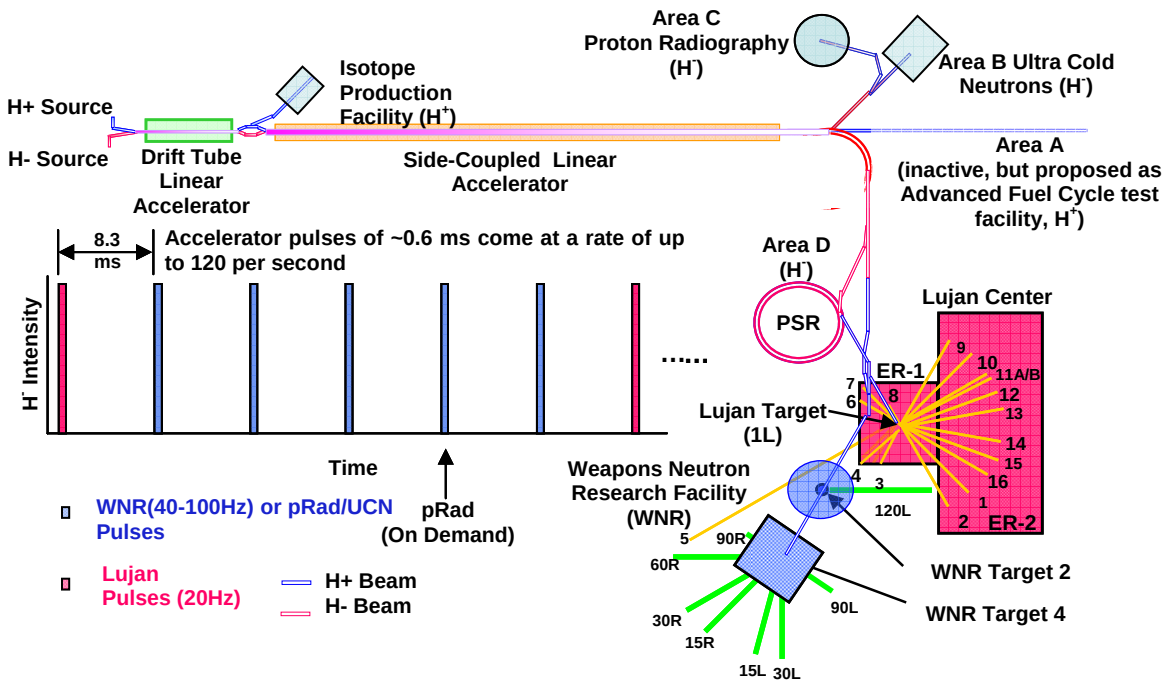

Figure 1: Schematic representation of the LANSCE User Facility at TA-53

Vision and Goals

LANSCE produces one of the highest beam currents in the world of medium energy protons to irradiate experimental targets directly or to produce intense pulses of spallation neutrons. LANSCE performs state-of-the-art experiments in proton radiography, nuclear science, and materials science. The LANSCE Refurbishment Project (LANSCE-R) received "Approval of Critical Decision (CD)-0, Approve Mission Need" from the NNSA Administrator on December 27, 2006. As a result, the LANSCE User Facility will continue to be the premier neutron science facility at Los Alamos National Laboratory.

Our goal is to provide safe, secure, environmentally-compliant, cost-effective performance in beam delivery that meets or exceeds metrics prescribed by our customers.

Assumptions

Operation of the scientific program will continue during the refurbishment project in a tailored way to meet customer expectations to the extent possible while simultaneously implementing the refurbishment project during scheduled operational outages. Refurbishment elements will be pre-assembled, staged, and tested to the greatest extent possible prior to possible multi-shift installation evolutions.

STRATEGIES AND PROJECTS

Implementation Strategies

The overall implementation strategy is to integrate ongoing LANSCE User Facility operation with the execution of the LANSCE-R project. The operations organization for LANSCE is both well established and strong. Capital projects have a successful history of integration with the operating facility. The recent experience of integrating the construction of the Isotope Production Facility is an example of strong cooperation between a project and the operating facility.

The overall success of both LANSCE Operations and the LANSCE-R Project rests on the ability of the responsible organizations to retain and, where appropriate, develop the skilled technical staff needed to support ongoing operations, maintenance and related improvements as well as the conceptual, preliminary and final designs of LANSCE-R sub-systems, oversight of component procurement, acceptance testing, pre-installation assembly and testing, and final installation and commissioning.

The following key operational elements are essential for the integrated model to be successful:

- A commitment to schedule at least 3,000 hours of beam operation for users each fiscal year from FY2007 through FY2013 and beyond, with appropriate allocation of sole-use and beam development time.
- No more than one cold-start facility turn-on in each fiscal year.
- An appropriate distribution of extended outages of several months duration to accommodate both a modular approach to LANSCE-R sub-system installation and other operations-funded system improvements as well as appropriate cool-down times for routine maintenance on activated equipment in areas such as the Proton Storage Ring and the 1L Target.
- A disciplined approach to configuration management for accelerator and beam delivery systems to minimize return to service after short and extended outages.
- Continuous certification of the Radiation Security System to minimize the time required for resumption of production beam operation.

The following elements are essential for LANSCE-R to be successful:

- Proposed equipment and system upgrades are focused on those current LANSCE capabilities required to support Weapons Program needs.
- A design, acquisition, and assembly strategy that optimizes preparation for focused equipment installation during scheduled operational outages.
- An appropriate balance between refurbishment of the LANSCE User Facility real property and installed equipment through the Facility Infrastructure Recapitalization Program (FIRP) and refurbishment of essential accelerator sub-systems through the LANSCE-R project.
- A project execution time line that permits performance of the full scope of work in no more than five to seven years.

Facility and Infrastructure Projects

Weapons Program GPP funding and the Facility Infrastructure Recapitalization Program (FIRP) have effectively been used at the LANSCE User Facility to replace Radioactive Liquid Waste handling, cooling towers, and the chilled water plant to ensure that the real property and installed equipment remain capable of supporting long term operation through 2020. These projects have been completed on schedule and within budget, with the work being carefully planned within extended accelerator maintenance outages. Additional work is needed, and replacement of electrical distribution system, certain process water systems, heating water upgrades and an upgrade to a ventilation system are being undertaken in FY07.

A strong FIRP program is essential to underpin the ongoing success of LANSCE operations and the refurbishment scope planned in LANSCE-R. Out-year projects (FY08-FY11) encompass multiple electrical distribution system upgrades, process cooling water upgrades, roof replacements, and HVAC replacements.

LANSCE-R Scope

The scope that was included to support the Mission Need for the LANSCE-R Project will enhance cost effectiveness by system refurbishments or improvements that reduce operating costs and will improve decreasing facility reliability by replacing systems that have an impact of 15% or greater on reliability for those systems.

The full LANSCE-R project will also eliminate the following sources of operational inefficiencies that should improve operational effectiveness:

- Single-point failures with an estimated time to repair of greater than 30 days,
- Equipment that is beyond its predicted end-of-life that could severely impact facility operations,
- Obsolete equipment for which no spare parts are available,
- ES&H or code compliance issues necessary to continue safe operation.

The baseline refurbishment project consists of replacing the 201 MHz RF systems, updating about 75% of the 805

MHz RF systems, modernizing the control system, and replacing or refurbishing a variety of diagnostics and accelerator subsystems.

The RF and power supply scope includes the following:

- Magnet Power Supplies – Approximately 12 different power supply replacement projects.
- Pulsed Power – Solid State Replacement for Ground Level Deflectors
- 201 MHz RF for the Drift Tube Linac – All new 201 RF except for High Voltage
- Low Level RF – All new LLRF in the 201 MHz and 805 MHz subsystems
- 805 MHz Klystrons – 4 sectors of new high efficiency klystrons and 1.5 sectors of new old style klystrons (leaving 1.5 sectors of klystrons not replaced)
- High Voltage Power Systems – 4 sectors of new high voltage systems.

The Instrumentation and Control scope includes the following:

- Replace Linac Beam Position Monitors and incorporate phase measurements
- Replace the Delta T system
- Replace 95 Wire scanners in the linac
- 18 IR loss monitor systems & 5 GD systems
- Replace VAXs and VAX applications
- Replace RICE systems (Remote Instrumentation Control systems)
- Replace Master Timer System.

The accelerator sub-systems scope includes the following:

- Cooling Water distribution and monitoring
- Vacuum system equipment and monitoring
- Linear accelerator copper structures, Drift Tubes.

The scope proposed in the Mission Need statement is a self-consistent approach to maintaining reliability and addressing single point failures in the LANSCE facility that serves the NNSA/SSP mission. It generally assumes that the current facility capability will be maintained. LANSCE-R includes only scope to support NNSA/SSP mission research at 120 Hz and 625 μs beam gate. It only includes beam delivery elements common to pRad, WNR and Lujan Center that all have NNSA/SSP mission deliverables. It does not include refurbishment of equipment /systems from the end of the accelerator to WNR and the Lujan Center, including Line D and the PSR. In addition, LANSCE-R does not include equipment changes to support current or future H+ operations to Isotope Production or Area A/MTS. This approach is consistent with guidance received from NNSA.

IMPLEMENTATION OF A SEVEN-YEAR PLAN FOR FY09-FY15

Operations Objectives for Project:

- Operate for approximately 3,000 hours exclusive of development, documentation, and sole use operation consistent with operations in FY2007.
- Retain key staff required to perform both operations and LANSCE-R implementation at the same time.

LANSCE-R Current Year – FY2007-8

- Conduct the agreed-upon scope of work for conceptual design and obtain approval of the final CD-1 data package. This will include project management, project controls, and technical writing in support of the CD-1 package development.

LANSCE-R Future Years – FY2009-15

Given the funding scenario that is ultimately determined, we will manage the work to be accomplished in each annual outage (each an identified subproject) to achieve the highest priority items first within budget and funding profile constraints, while making progress on all sub-projects.

Integration of new hardware will occur during the extended outages that occur each calendar year. These will be at least 3 months in duration, not to exceed 6 months, and will be integrated into the operating schedule well in advance. Installation, checkout and commissioning of the first module of upgraded 201 MHz RF systems will take place in FY11 with the next two modules to follow as soon as possible after that. Each outage will constitute a sub-project in itself that can be integrated with planned routine plant maintenance and scheduled FIRP projects. Each annual outage will include required activities with checkout and verification of interlock systems, operations manual updates, and commissioning time commensurate with extent of changes. For example, LLRF system testing requires availability of cooling water, RF power, and control system interfaces.

Ancillary system upgrades will be planned to minimize disruption, and will begin with systems that have the least impact to gain experience and improve project estimation for more complex installations. For example, network infrastructure should be put in place and commissioned before final upgrades are made to the Master Timing system. High voltage system work for refurbishment of the 805 MHz systems should precede acquisition and installation of new or rebuilt klystrons.