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Brief Overview of the ASD Integrated Test Stand, Activities and Hazards

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[This document includes Pre-CD-2/3 preliminary estimates.](#)

ITS Overview

The ITS venue provides the first opportunity to fully assemble and test the performance of the injector; integrate, assemble and test four modules; measure the severity of the Beam Break-Up instability and perform the first set of beam measurements. Figure 1 shows a high level configuration of the ITS without the system of overhead cable management trays. The final configuration will integrate the injector, 4 modules (12 accelerator cells), 264 SSPP Line Replaceable Units (LRUs), global controls, data acquisition, and a subset of the downstream transport, Table 1. This was chosen because it provides the minimum accelerator cells required to measure the Beam Break-Up (BBU) instability and perform measurements required to validate the ASD beam transport computer models, which are priority measurements for commissioning.

The ITS venue also provides the opportunity for ASD to validate, optimize and update procedures for assembly, installation and operations along with the first opportunity for NNSS staff to demonstrate proficiency and independence from Laboratory partners. In addition to the integration and operations of major ASD systems, the ITS provides a venue to perform verification and validation testing for a subset of smaller systems and equipment. There is an opportunity to reconfigure and evaluate the Scorpius Safety Interlock System. Virtual Timing and Firing evaluations can also be performed. The amount of testing, however, is bounded by the schedule, and priority activities at the ITS need to be defined by the Technical Director, Commissioning Manager and Technical Leads, ideally before CD-2/3 submittal.

Figure 1: (Left) Conceptual illustration of the Accelerator, Pulsed Power and cable management system. (Right) High level view of the ITS (injector, 4 cell modules and 264 LRUs).

Schedule Estimate as of October 2020

[illegible]

Table 1: List of major components of the ITS, along with diagnostics that will be used during commissioning activities.

Responsible Team	System	QTY
SSPP		
LLNL	25 kV Injector LRUs	168
LLNL	25 kV Accelerator LRUs	96
	Total LRUs	264
Pulsed Power Cabling		
LLNL	Injector Cables	1680
LLNL	Accelerator Cables	960
	Total Cables	2640
SNL	Injector (full)	1
Accelerator		
LANL	Accelerator Modules (12 cells)	4
Global Controls		
LANL	Controls and Data Acquisition	Subset
Safety Interlock System (SIS)		
NNSS	Reconfigured U1a SIS	1
DST		
LANL	Beam Stop	1
LANL	BPM(s)	2
LANL	Transport Solenoid(s)	2
LANL	Cruncher	1
LANL	Spinning Wheel	1
Permanently Installed Diagnostics		
LANL	BPMs	TBD
LANL	Time Resolved OTR Imaging (with actuator)	1
LANL	Time Resolved Cherenkov Imaging (with actuator)	TBD
LLNL	2 MeV Time Resolved Beam Energy Analyzer	1
SNL	Pyrometer	1
Specialized Diagnostics		
LLNL	Slit-Harp	1
LANL	Tickler	1
LANL	4.4 MeV Time Resolved Magnet Spectrometer	1
LANL	Diamagnetic Loop	1
LANL	ITS Beam Plug	1

Installation Activities

It is assumed that all facility retrofit activities will be complete prior to the installation of ASD systems, hardware and equipment. Installation at the ITS will be challenging due to a number of reasons. The installation of a large number of ASD systems, hardware and equipment will require a detailed logistics plan, with plans in place to adapt to disruptions. The ITS is also one of three synchronous installation activities, with the other two occurring at the Scorpius Support Lab (Area-6, Building 922) and the other at U1a. Lab and NNSS staff will be spread across the three builds in order to complete installations and validation testing. Space for receiving, assembly and temporary storage have yet to be finalized. Table 2 lists the major installation activities.

Table 2: List of major ITS installation activities.

[illegible]

System Staging and Testing Areas

In order to operate the ITS, a number of pre-requisite activities and systems validation and verification (V&V) tests must be performed. V&V testing will be performed on ASD systems and hardware as it arrives. Staging and test areas are being considered for both A1-4803 and A1-4600. Such plans are only conceptual at this point but will be formally developed in FY21. We do expect three test stands at the ITS: LRU testing, accelerator module testing and SWAT.

The LRU's require vertical and horizontal V&V testing, and their vertical height of ~10 feet makes A1-4803 the preferred testing area. Additionally, A1-4803 has cranes that can be used to install the stalk of the LRU, however the height of the LRU Racks limit crane use to outside the radiation shielding enclosure. The injector and accelerator modules will also require a staging area to perform V&V testing, which may be best suited in situ within the radiation enclosure. Figure 2 illustrates the ITS enclosed within concrete radiation shielding blocks (2 foot thick, 10 foot high). Space for a SWAT stand still needs to be determined for the ~10 foot high injector and accelerator modules, and the area will likely require a keep-out zone.

Figure 2: Concept of LRU staging and V&V testing area (red outline) in A1-4803.

Figure 3: Layout of A1-4600 with conceptual space allocations.

Beam Measurement Activities

The ITS will generate a 1.45 kA electron beam with a maximum energy of 4.4 MeV, which is below the photo-nuclear threshold energy of any nuclide at the ITS. ASD will utilize diagnostics used routinely on other Linear Induction Accelerator, such as DARHT and FXR, to perform beam measurements. The ultimate figure of merit for the Scorpius Accelerator is spot-size and dose, and beam performance parameters have been defined to provide performance criteria at a systems level, Table 3. Table 4 provides a list of integrated testing activities planned for the ITS venue and an initial best-guess of the required time.

Table 3: Beam performance parameters that will be measured at the injector, ITS and Scorpius (these are referred to as KPPs for Scorpius).

Performance Parameter	Injector	ITS	Scorpius
Beam Current	Yes	Yes	Yes
Beam Radius	Yes	Yes	Yes
Beam Convergence	Yes	Yes	Yes
Beam Centroid Position	Yes	Yes	Yes
Beam Emittance	Yes	Yes	Yes
Beam Energy (and energy spread)	Yes	Yes	Yes
Beam Break-Up Instability	No	Yes	Yes

Commissioning of ASD diagnostics at the ITS have not yet been determined.

Table 4: List of integrated testing activities planned for the ITS venue.

[illegible]

List of Hazards

Hazard	Description of Hazard	Mitigation of Hazard
Radioactive Materials	None	N/A
Radioactive Contamination	None	N/A
Radioactive Waste	None	N/A
Radiation Generating Devices	4.4 MeV Electron Accelerator	<p>10 foot high concrete radiation shielding enclosure, with chicane entrance and locked gate. The gate can be interlocked if required. Operators will sit within sight of the gate. Administrative and engineering controls will be developed to follow NNSS Radiation-Generating Device Control Program (CD-0441.006).</p> <p>A Preliminary Personnel Radiological Exposure Evaluation Report is waiting for LA-UR review.</p>
Chemicals	<ol style="list-style-type: none"> 1. Ethanol: 2 quarts 2. Alcohol wipes: 25 boxes - 3 gallons (30 – 9 inches x 9 inches x 0.02 inches 60% saturation wipes 16 mL each) 3. Isopropyl Alcohol: 4 - 5 quarts 4. Sodium Thiosulfate Powder: 1/2 lb. 5. Canned Air: 6 cans 6. Silicon Putty: 4 - 1.25 oz. tubes 7. Acetone: 2 quarts 8. Vacuum Grease: 2 - 10 oz. tubes 9. Sodium Hydroxide: 1 gallon 	Chemicals will be stored in a chemical storage cabinet.
Explosives	None	N/A
Electrical Energy	25 kV Pulsed Power Line Replaceable Units (264 total)	Engineered access control – please see mitigation of Radiation Generating Device above.
Pressurized Systems	70 psig	N/A, < 3,000 psig
Lasers	Fiber Optic Network	N/A, Class-I, -II
Biohazards	None	N/A
Unique Hazards	Direct Current Magnetic Fields, 400 G (0.04 T) Max. On-Axis	Engineered access control – please see mitigation of Radiation Generating Device above.
Fire	<ol style="list-style-type: none"> 1. A system of cable management trays will be constructed above the pulsed power and the accelerator, Figure 4 (below). The effectiveness of the fire suppression system may be decreased. 2. The injector and accelerator will require ~1000 gallons of oil, either Shell Diala or ExxonMobil Univolt (NFPA Hazard ID: Health: 1, Flammability: 1, Reactivity: 0). 	The fire suppression system may need to be routed underneath the cable management trays.