Remote Handling Systems Startup and Testing

And

Some Reflections on High Power Target Stations

Mark Rennich

Impact of Higher Power on Remote Handling

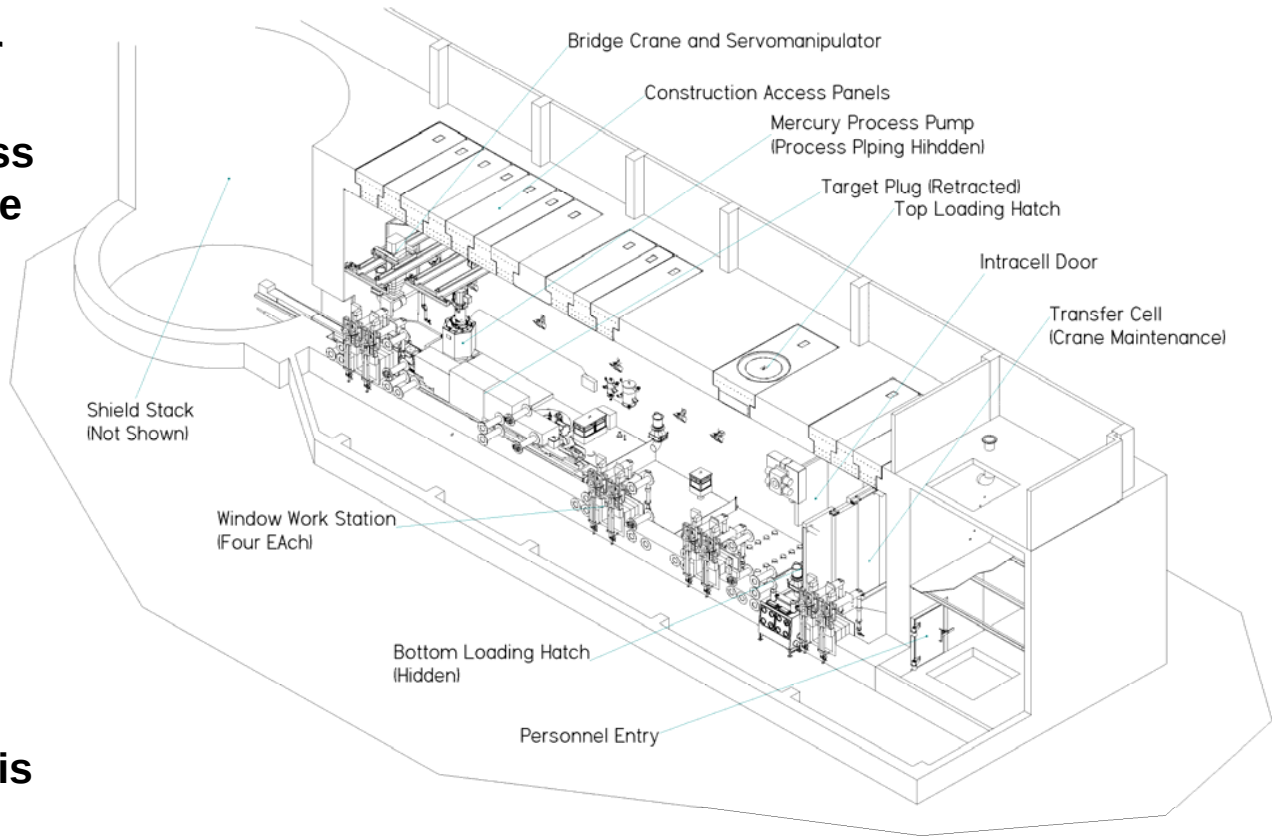
- Higher Power increases remote handling cost and complexity in two ways.
  - Higher Power → Larger Process → Larger Tooling → Larger Cell
  - Higher Power → Shorter Equipment Life → More Tooling → Larger Cell
- Consequently, a higher power target station should not be considered an incremental scale-up of the existing SNS target facility.

Target Service Bay Configuration

The target service bay is designed primarily for target change-out; however, other process components (e.g., core vessel inserts) are processed to waste through the cell.

All hot cell operations must be performed fully remote. This is complicated by two factors:

1. **The mercury process is large, and**
2. **Mercury handling and containment will be difficult.**



SNS Target Building Hot Cell

Hot Cell Design

- In many ways the target service bay has a conventional arrangement
  - Window workstations for repetitive operations such as target change-out and waste handling
  - High density concrete walls (40” thick}
  - HEPA ventilation, and etc

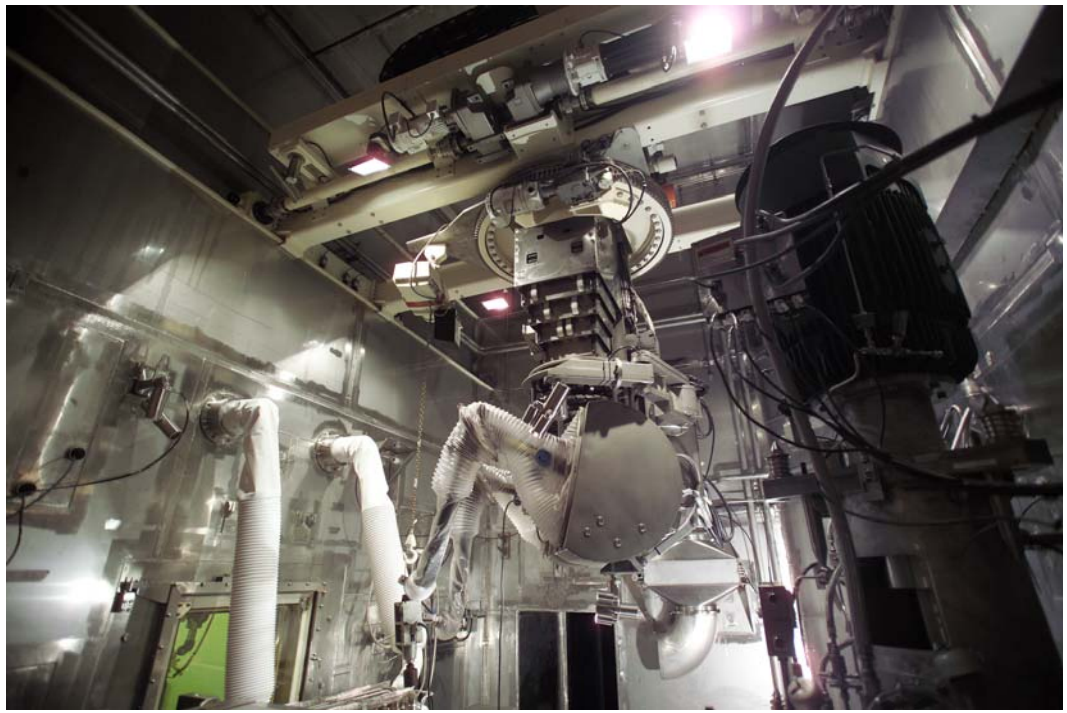
- Significant SNS differences are:
  - Large mercury absorber system
  - Large coverage robotic manipulators

Target replacement WWS is elevated to match target position inside the hot cell

Hot Cell Crane and Servomanipulator

Most process components are beyond the reach of MSMs and are maintained by the in-cell remote handling system:

- **Overhead bridge crane (7.5 ton)**
- **Servomanipulator and transporter with 500 lb. Aux hoist**
- **Tools and lift fixtures**

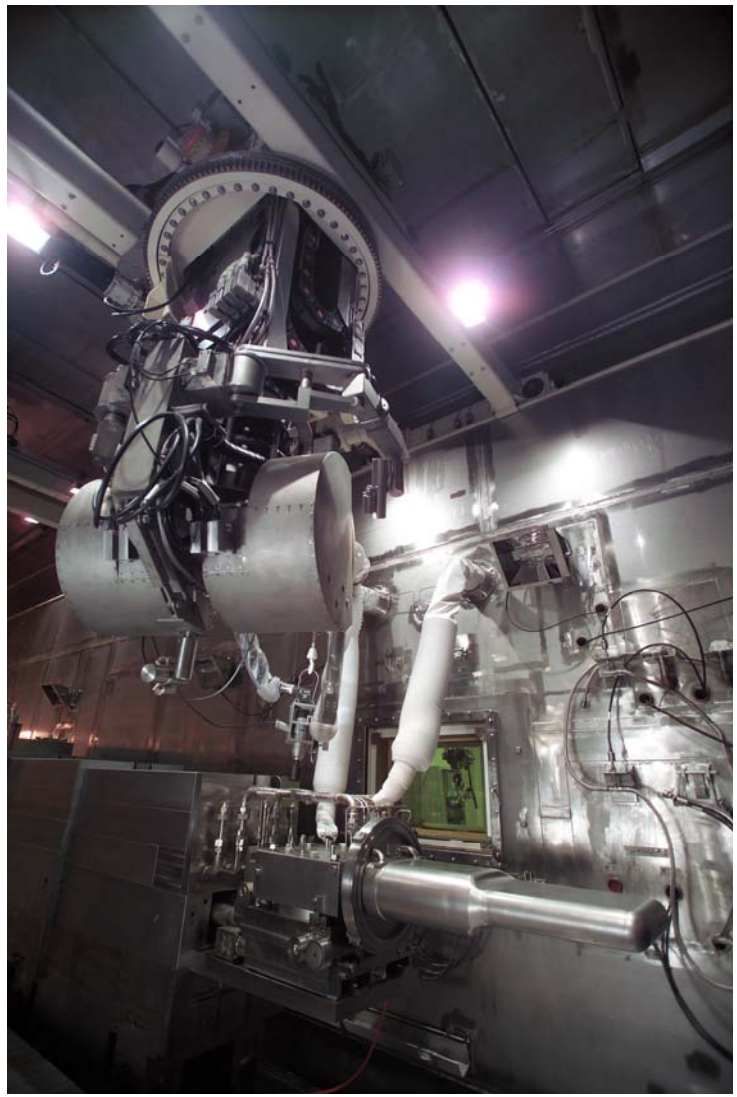


The servomanipulator positioned at window workstation #1. Note the bridges are mounted on stepped corbels to enable the crane and servo to have close wall approaches. The right side corbels also provide space for the 12" bridge crane cable track and the 24" servo cable track.

Telerob EMSM 2B Servomanipulator

The servomanipulator is the defining feature of the SNS hot cell.. Dexterous Servomanipulator Reduces the Need for Special Component Handling Features and Provides for Full Cell and Process Coverage

- Dexterous, high performance servomanipulator
- Dual arm configuration
- Master arm position control with Force Feedback
- Digital Control
- 50 lb Continuous Capacity/100 lb peak.
- Three On-Board CCTV Cameras
- 500 lbs Aux Hoist



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Achilles Tendon

- Commitment to the bridge mounted servomanipulator requires an intense focus on reliability and maintainability.
  - Cable care and management is THE issue.
    - Access
    - Replacement (all or none)
    - Damage (radiation and mechanical)
    - Noise
  - Recovery from In-process Mechanical and Electrical Failures
    - SNS has redundant drives
    - SNS does not have tethers
    - SNS does not have towing

Control Room

Fully remote robotic operation requires a control room with Telerob master station in the background; video wall to left and four subsystem controllers in the foreground. The monitor wall can have any mix of camera views. Close proximity of the bridge system operator and master operator was a key goal.

High Power-Hot Cell Considerations

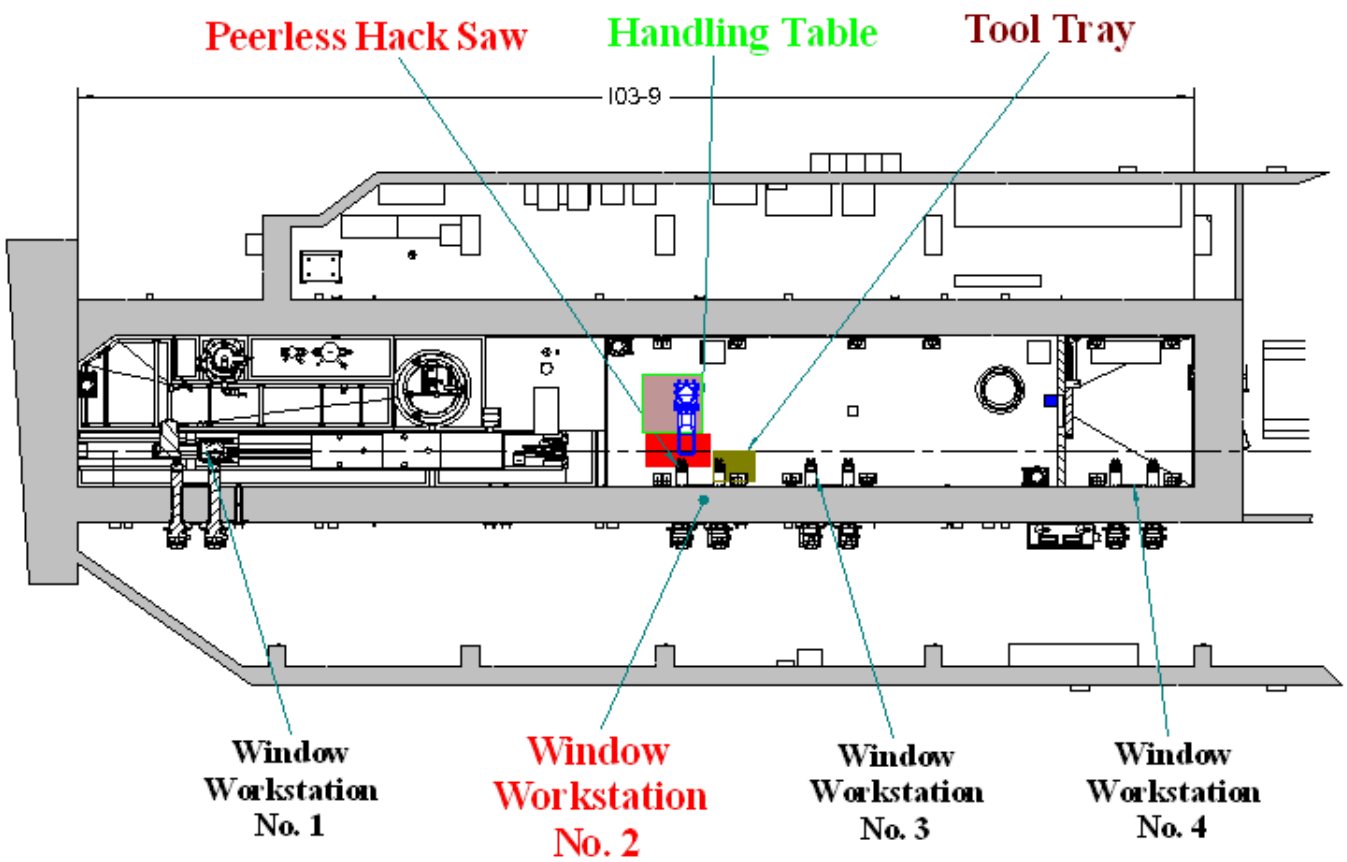
- A high power station will have to be larger to account for:
  - High capacity process system
  - Thicker internal shielding
  - Larger Tooling
- More frequent target change-out (?)
  - Increased Automation
  - Increased Storage
  - Tooling Redundancy
  - Parallel Process Design
  - Target Module Redundancy
- More waste handling of all types
  - Mercury vapor absorbers
  - Contaminated water treatment
  - Solid waste packaging and transport

Target Sampling

- A post irradiation target sampling program has been planned for SNS:
  - Detailed metallurgical studies will take place in specialized cells at ORNL.
  - The cells have limited mercury and radiation capability therefore spent targets will be cut and cleaned in the SNS target service bay.
  - Cutting operations are designed to permit progressively smaller sectioning; starting with “filleted” sections which will allow viewing of possible large area erosion patterns.
  - Tools will be available to open small flow channels for visual and metallurgical inspection.

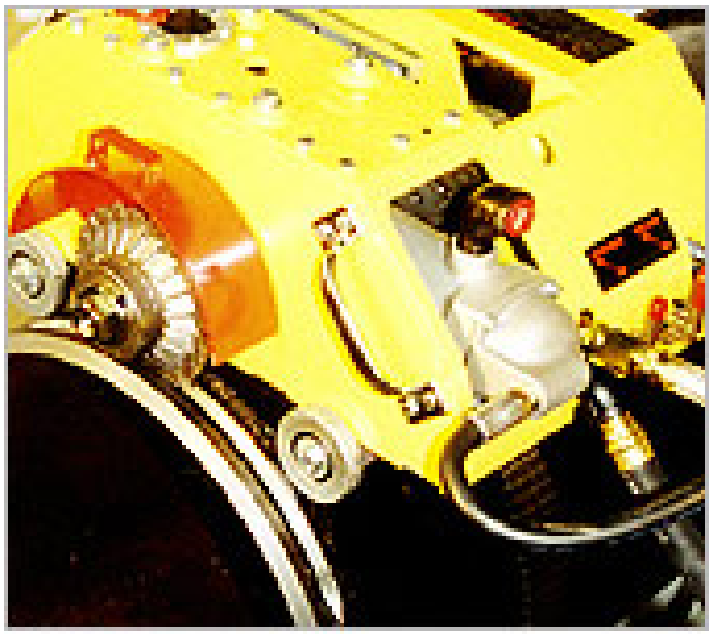
Sampling Station Layout

The target sampling station will require a significant portion of the target service bay



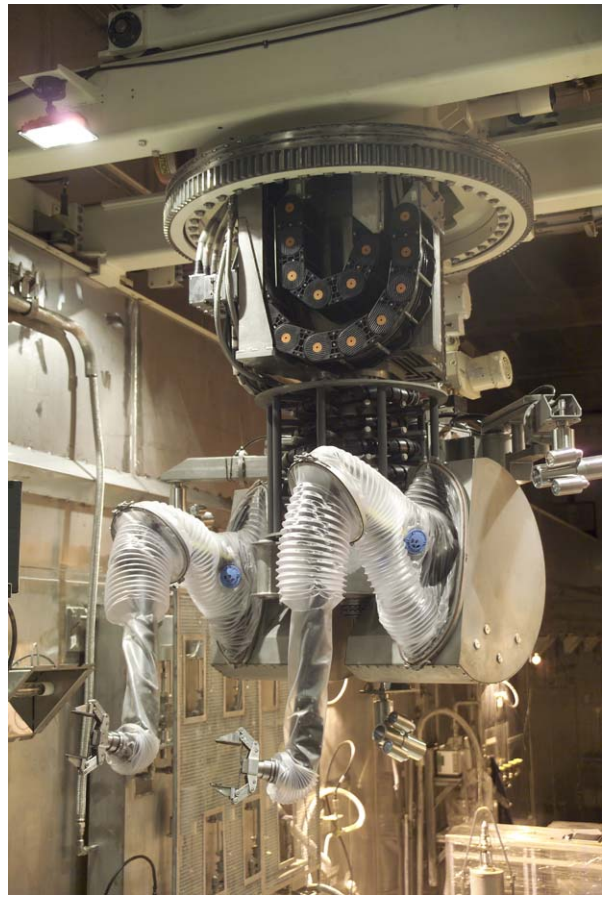
Target Sampling

Procurement of target sampling equipment has begun. Ideally, the sampling station will be ready prior to beam power ramp-up for easier installation and immediate service.



Integrated Systems Testing

1. Engineering Develops An Initial Test Procedure For Review and Approval.
2. Engineering Verifies Tools and Equipment Are Ready For Test,
3. Operations Performs Initial Test and Makes Comments and Suggestions on Tooling and Procedure.
4. Approved Changes Are Implemented
5. A Final Round of Tests Are Completed and Approved.
6. The Operations Group Develops The Formal Operating Procedure



Integrated Systems Test Program

- The Importance Of Cold Testing Cannot Be Over Stated
  - Verify Functionality of Hot Cell Remote Handling Systems
  - Verify Maintainability of Hot Cell Process and Utility Systems
  - Train Operators
  - Develop Final Operating Procedures and Protocols
  - Complete The Hot Cell “Tool Kit”
  - Understand Maintenance Times
  - Document Future Equipment Improvements

- Keeping the Operators Operating Is Critical

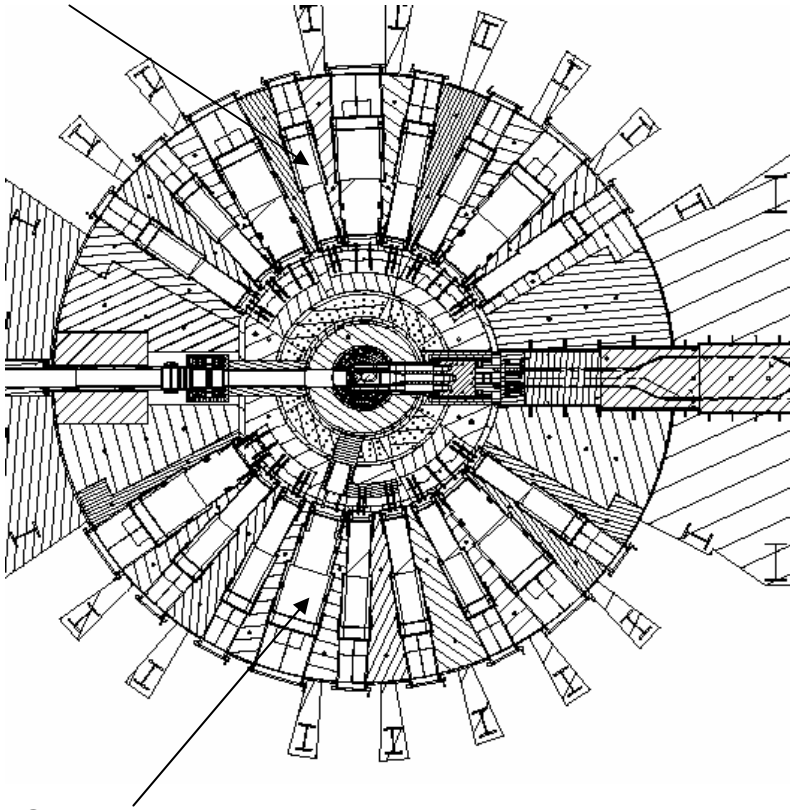
Testing

- The written testing procedures have worked well at highlighting equipment and tooling deficiencies prior to need. It is easy to overlook small items such as lanyards and lifting bales.
- Time pressures have driven the operations group to perform tests outside the program as partial equipment has become available. Operators need to stay busy.
- Operations group support for startup activities has taken time away from maintenance testing.
- Construction work (some by operators) in the cell has limited access for both operational and maintenance testing.
- Despite difficulties we learn more about the system every day and incorporated many improvements which should make operations more efficient in the future.

<u>The most important lesson is to have the operators in the cell doing work of all kinds as much as possible.</u>

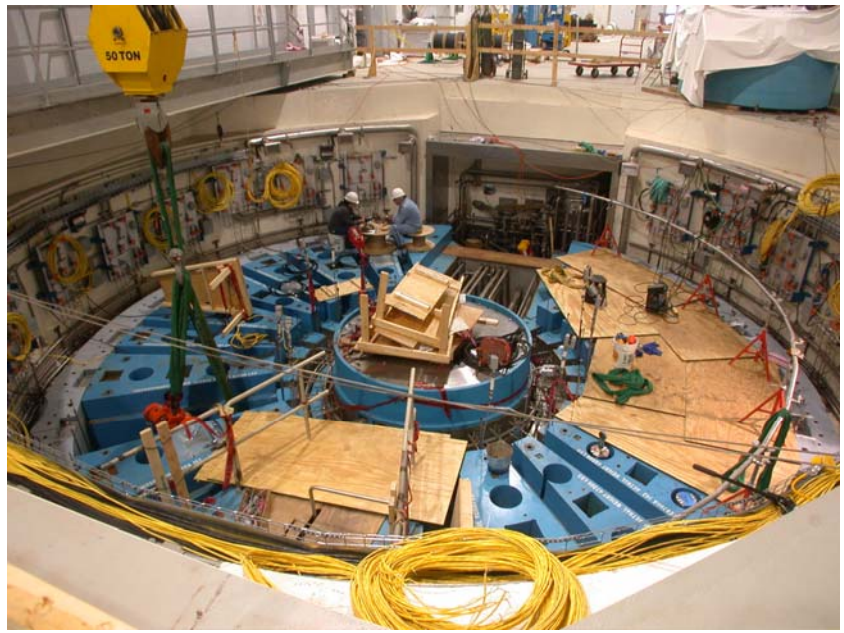
Plan View Of Shielding Monolith

Single Channel shutter

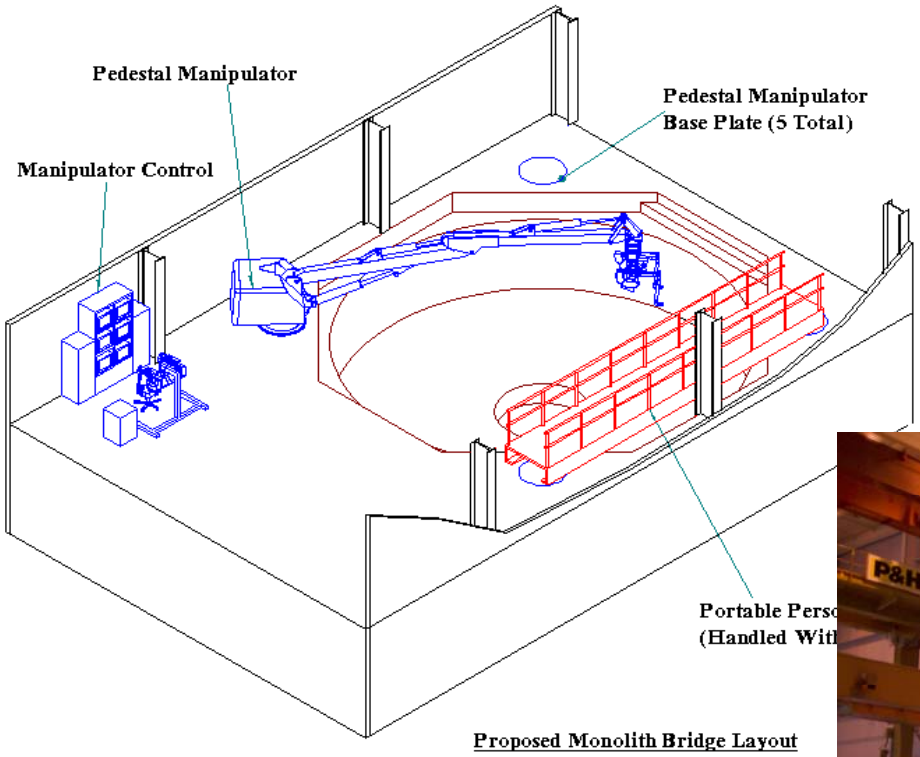


Multi-Channel shutter

There are 12 Single Channel shutters,
5 Multi Channel shutters,
1 Multi (30 inch travel) on BL4.



Pedestal Manipulator



The Pedestal Manipulator Is Required For Many Operations in the Shield Pit Including Pipe Disconnects, Rad Surveys, Installation of Temporary Local Shielding and Video Monitoring.

High Power Monolith Considerations

- The open top configuration of SNS is much less expensive than the proposed fixed shielding alternatives which may be necessary for a higher power system with high burn-up.
  - Permanent Shield Walls
  - Fixed Remote Handling Systems
- Core component cooling lines are large and therefore cause significant radiation leaks. A high power station could have difficulty with this problem with the larger piping array.
  - Substantial overhead shielding
  - Radiation resistant shutter drive components
- Larger cooling pipes will require significantly more space than the SNS array primarily due to need.
- May need to route moderator piping through the hot cell for more rapid change-out.