STATUS OF THE SNS TARGET SYSTEMS

John Haines

October 10, 2005

The Spallation Neutron Source

- SNS will be the world's most powerful pulsed spallation source
- Overall the project is ~95% complete
- Within budget and schedule constraints, $1.4B and June 2006 completion

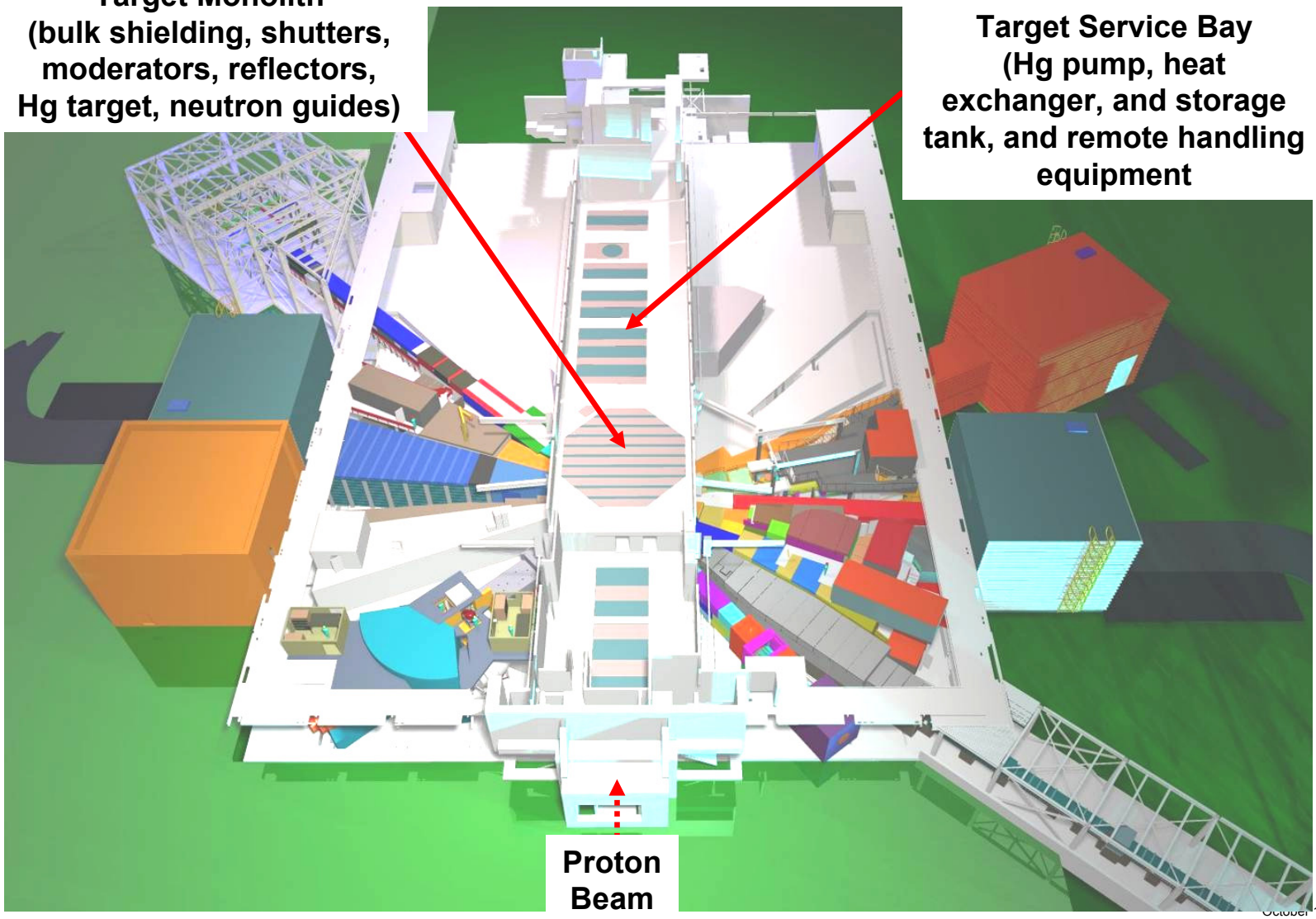
Technical Parameters

• Beam power	> 1 MW
• Beam energy	1 GeV
• Pulse repetition rate	60 Hz
• Pulse length	700 ns
• Neutron beam ports	24

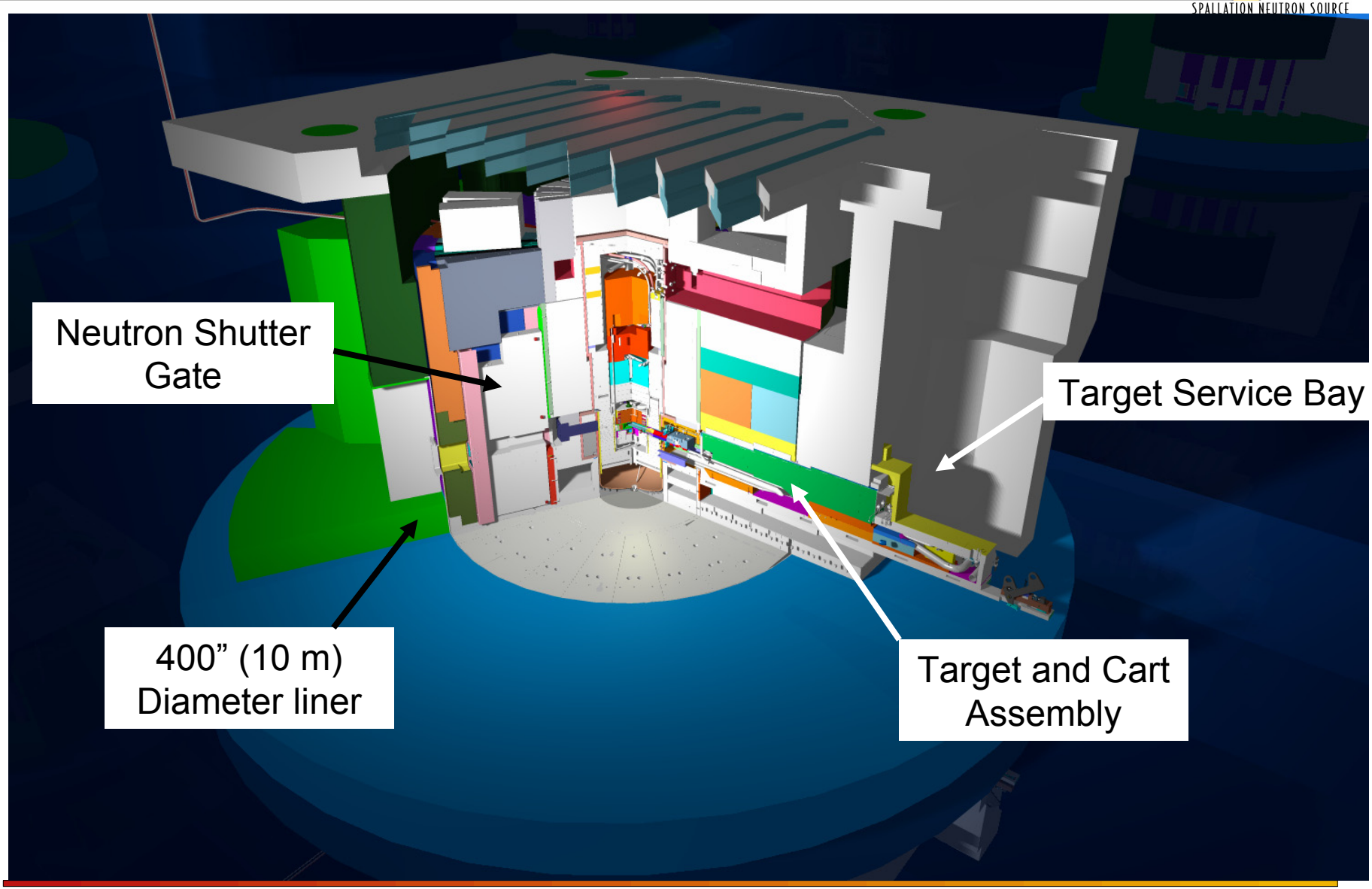
Technical Scope of Target Systems

- Target
  - Mercury
  - Replaceable Vessel
- Moderator
  - Wing configuration
  - One ambient water
  - Three cryogenic supercritical H_2
- Reflector
  - Be
- Vessel Systems
  - Encloses components that need to be replaced routinely
- Target Systems Shielding
  - Steel
  - Vertical Shutters
- Target Systems Utilities
  - Heavy & light water
  - He and vacuum
- Remote Handling Systems
  - Target module
  - Mercury process equipment
  - Reflector/moderator plugs
  - Proton beam window
  - Shutters/Neutron guide inserts
- Local I&C
- Beam Dumps
  - LINAC dump
  - Ring injection dump
  - Ring extraction dump
- Neutronics and shielding analysis for entire SNS complex

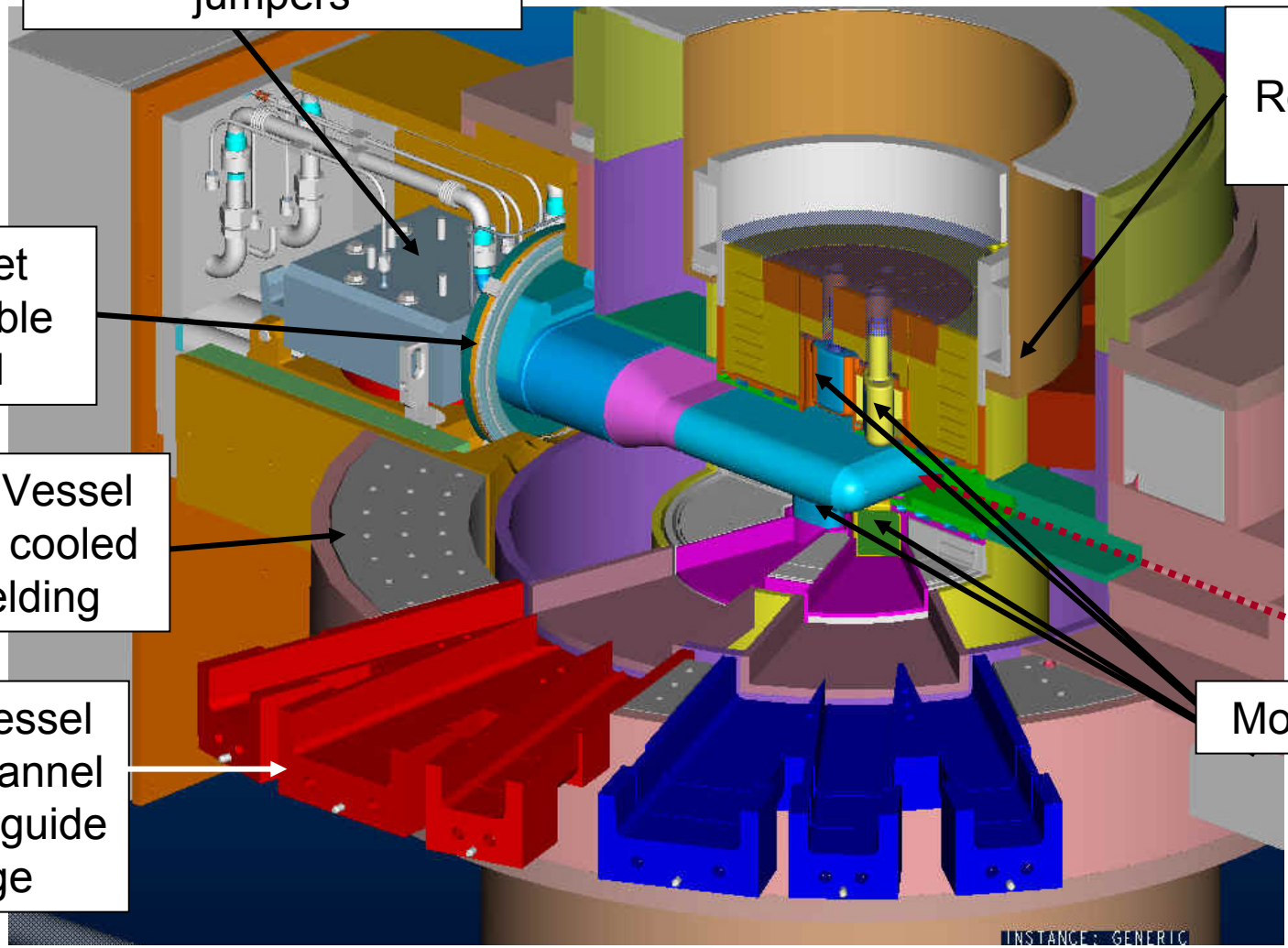
SNS Target Building Layout



Target Monolith 3-D Model



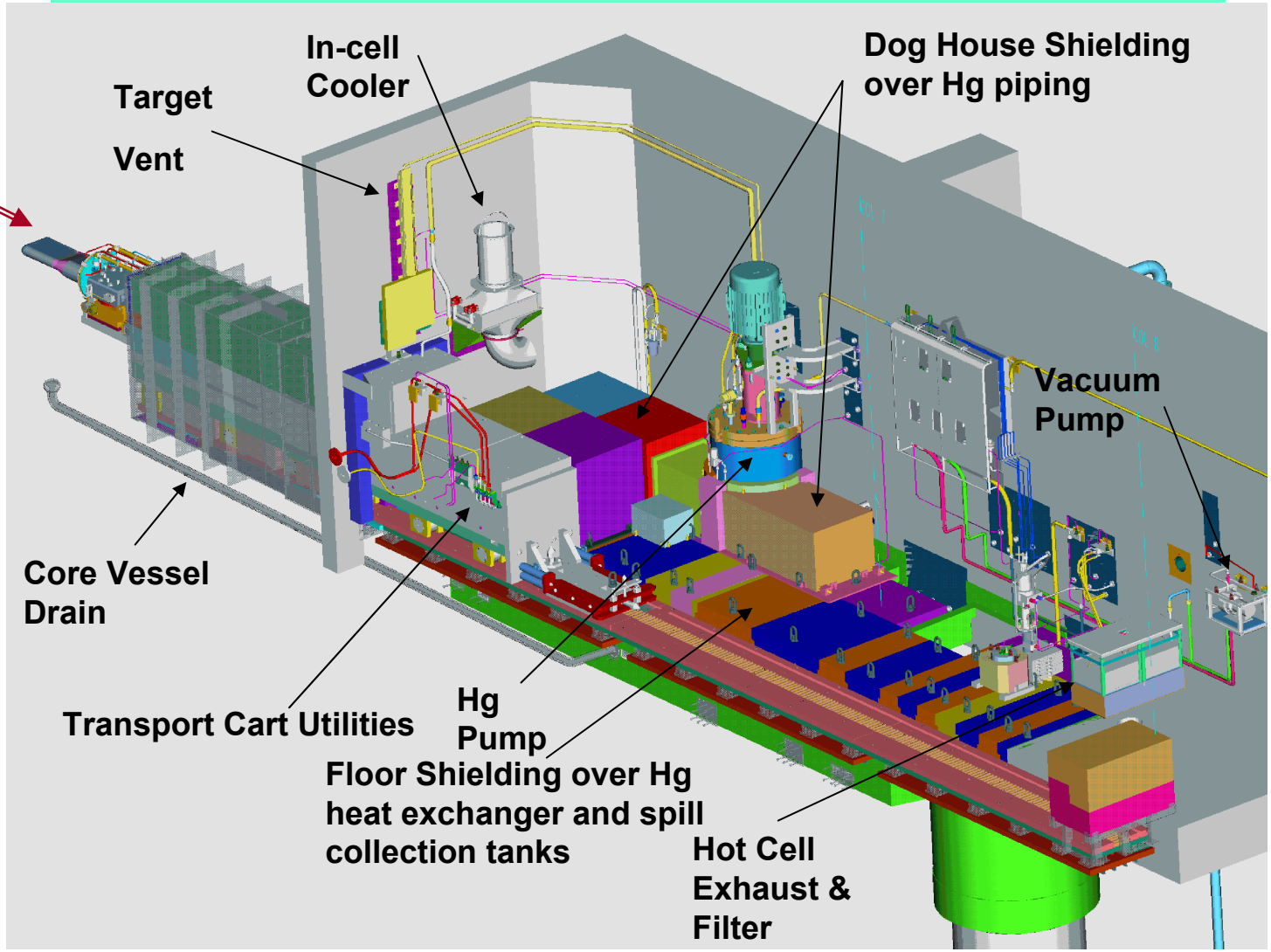
Target Region Within Core Vessel



October 10, 2005

Target Process System Is Located in a Hot Cell

Target flow loop contains 20 tons of mercury

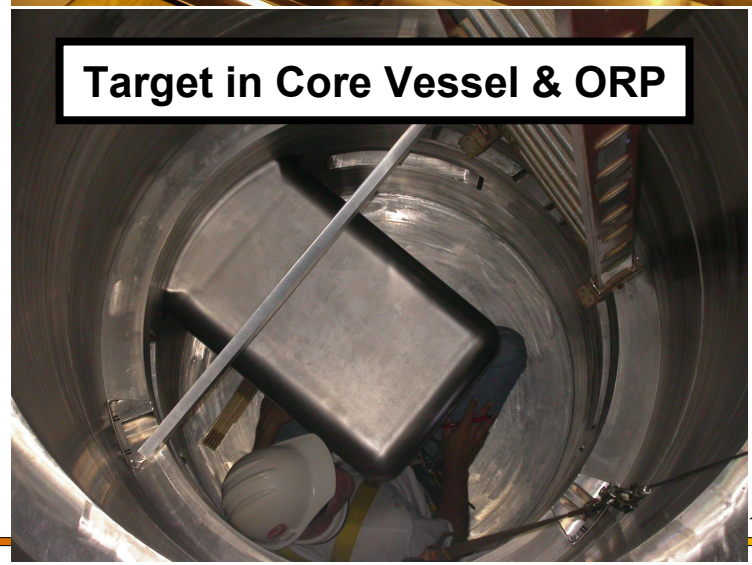


October 10, 2005

Mercury Target

Mercury vessel and water shroud (April 7, 2005)

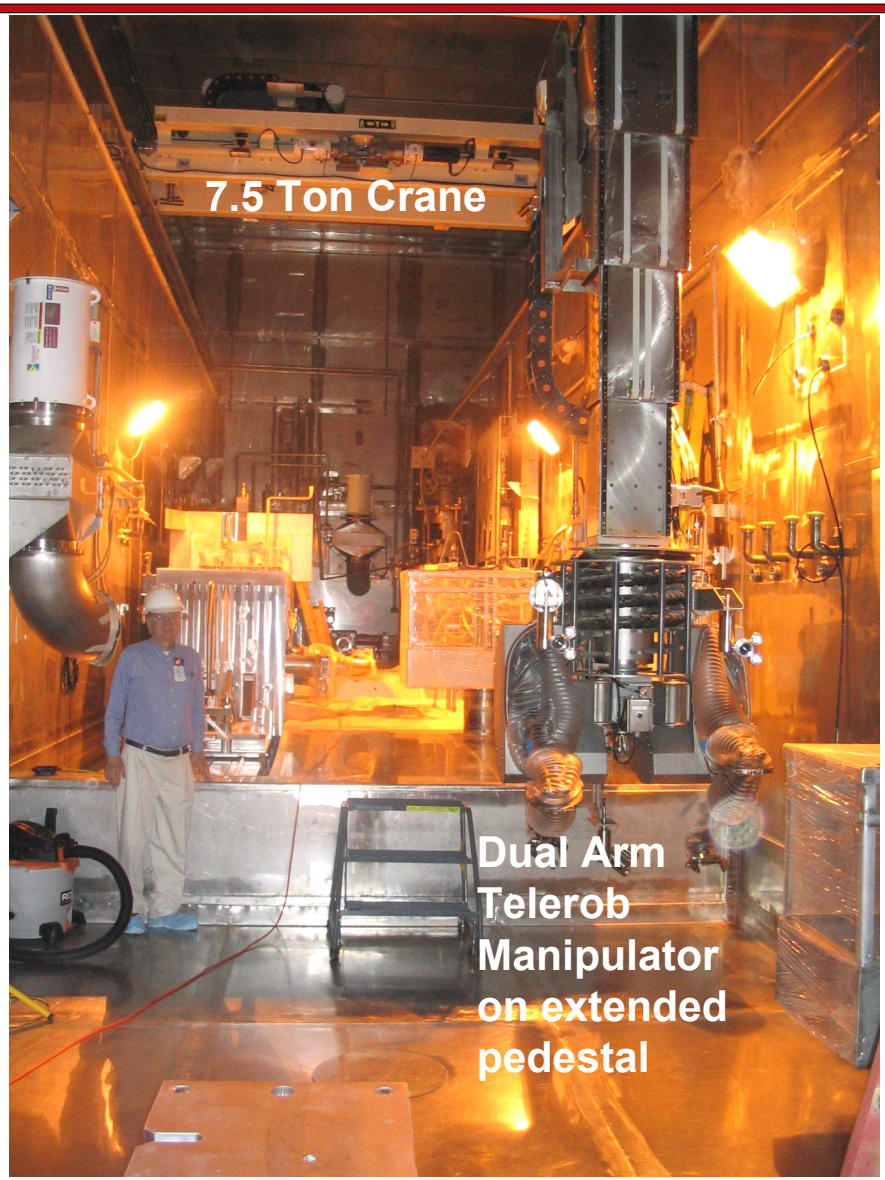
Target installed on Carriage

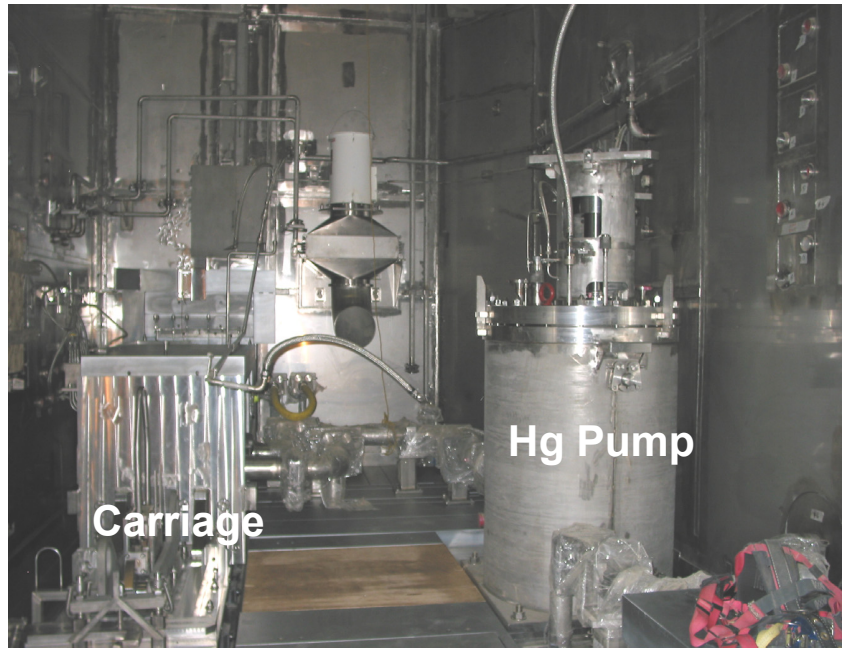


Target in Core Vessel & ORP

Installation on Carriage and insertion into the core vessel successfully demonstrated

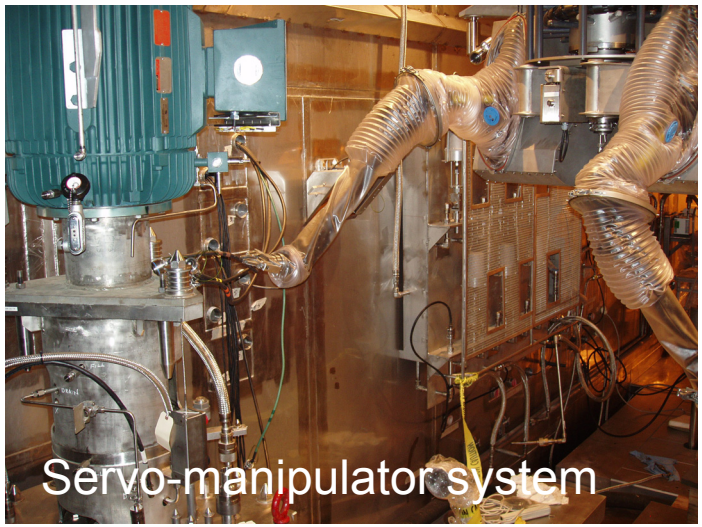
Target Service Bay





- Stainless-steel lined hot cell
- Remote handling manipulators
- 7.5 ton crane
- Remote handling testing has started

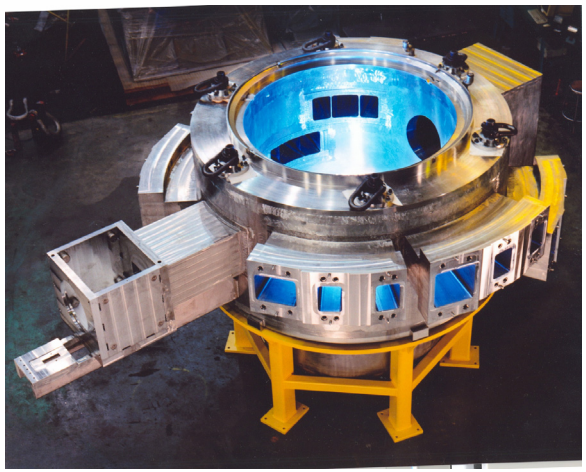
Installation - Remote Handling

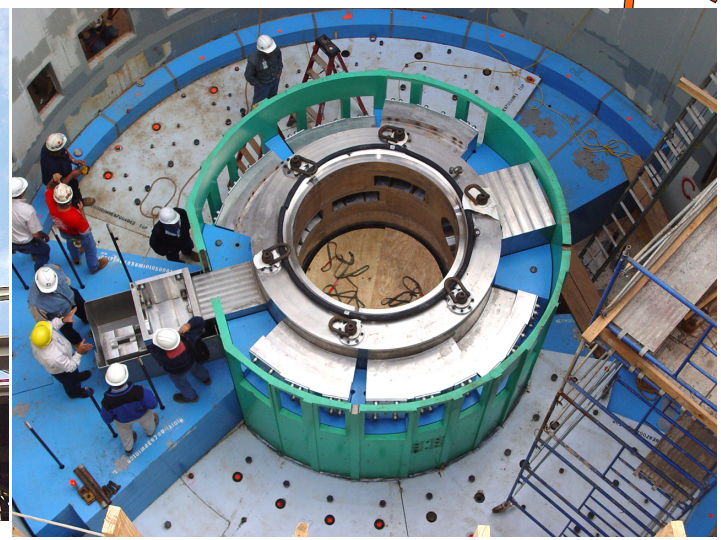

Servo-manipulator system

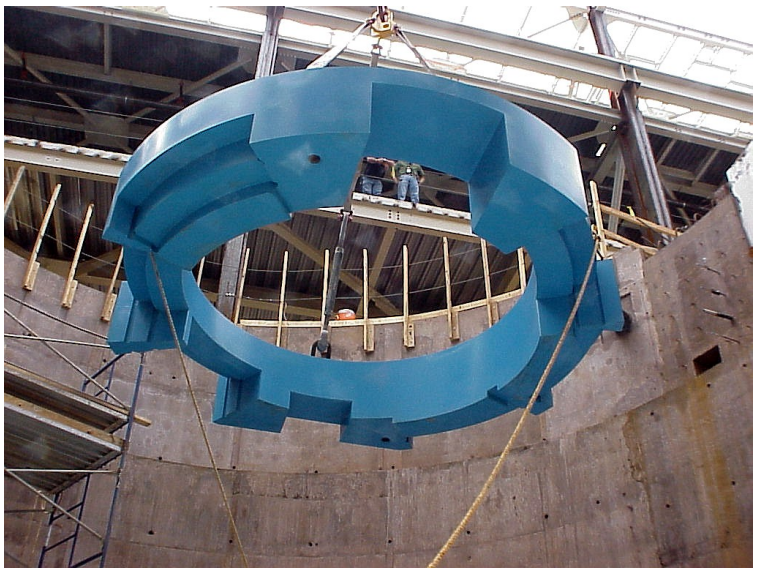

Manipulator Gallery

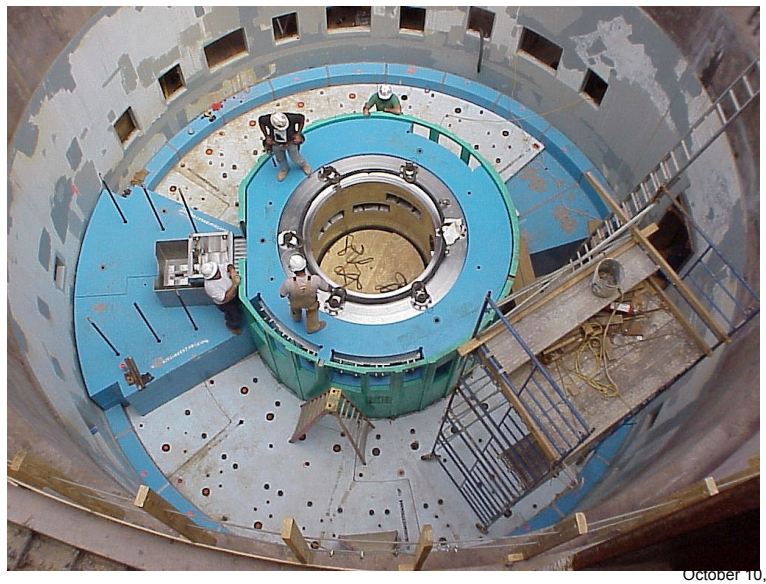

Remote handling control room

Target Monolith
Core Vessel and Shielding Installation Oct 2003



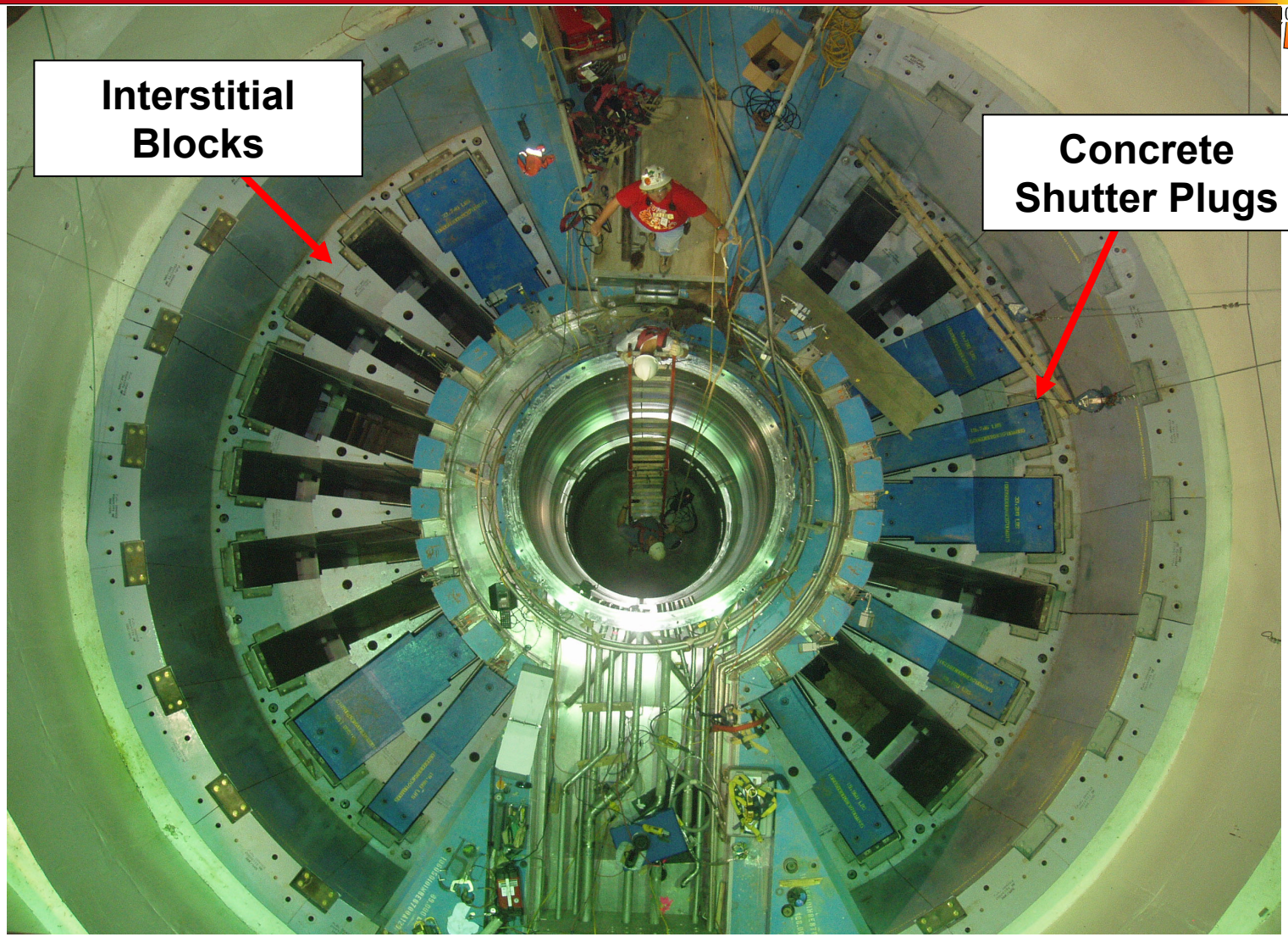






October 10, 2005

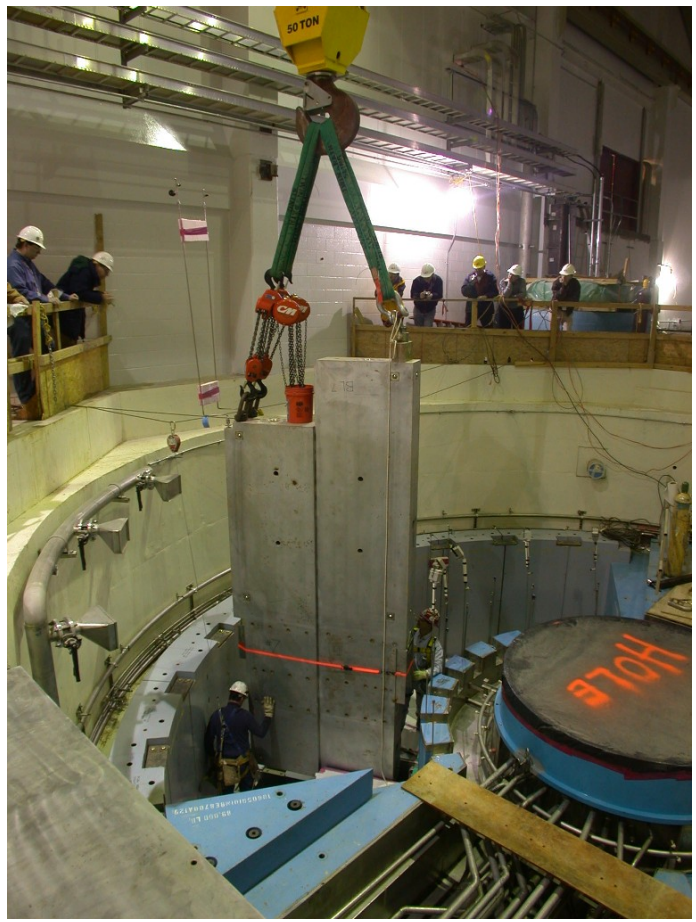
Monolith – October 2004



Installation of permanent shielding complete

October 10, 2005

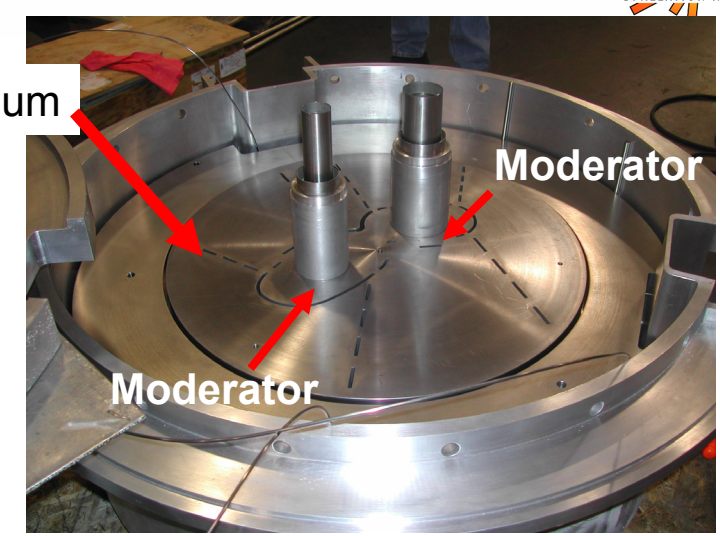
Outer Reflector Plug and Shutters Have Been Installed

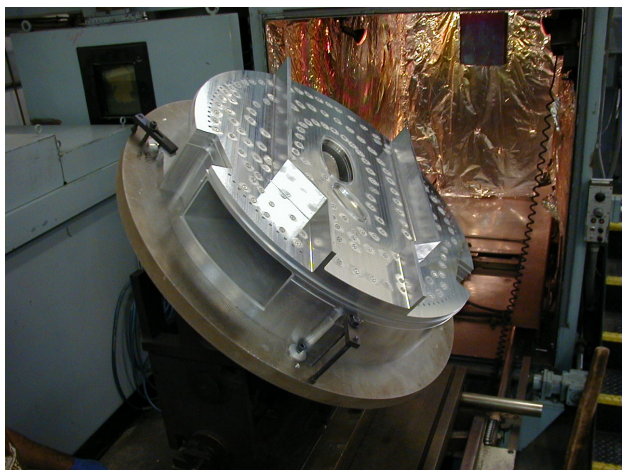


October 10, 2005

Moderator and Inner Reflector Plug in Fabrication

Insertion of moderator





E-Beam welding of split plate

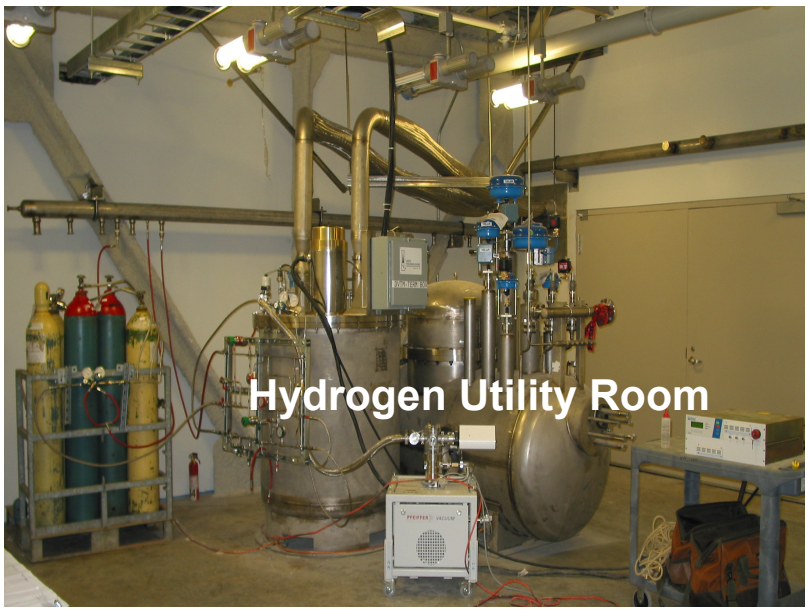
Supercritical H_2 Moderator

Inner Reflector Plug Assembly in Target Building

Cryogenic Moderator System

Compressor

Cold Box – 7.5 kW He System



- Helium refrigerator operated at < 20K
- Supercritical H_2 "mock-up" (DVTM) already operating
  - Accumulator concept for H_2 system pressure control validated
  - H_2 Circulators will be replaced

Target R&D Program Addressed Key Design and Operational Issues

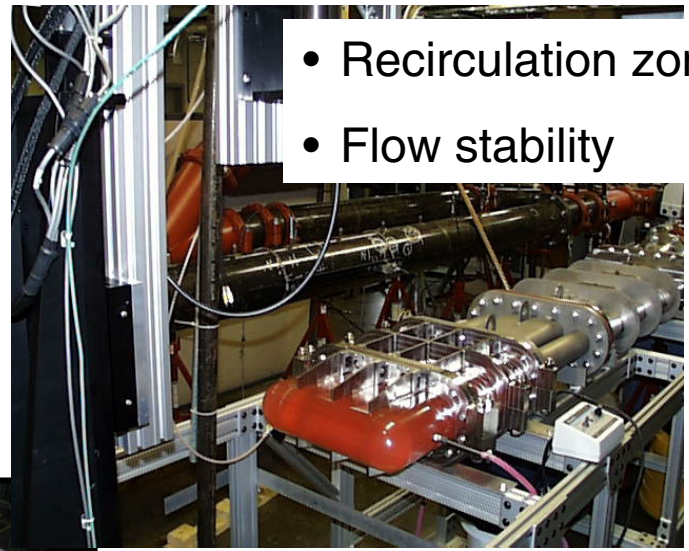
- Steady state power handling
- Thermal shock due to sub-microsecond proton pulse
- Materials issues
- Demonstration of mercury loop operation and remote handling

Three Thermal-Hydraulic Loops Were Constructed to Develop the Mercury Target

Mercury Thermal Hydraulic Loop (MTHL)

- Wettability
- Design data for target window
- Corrosion/erosion test

Water Thermal Hydraulic Loop (WTHL)



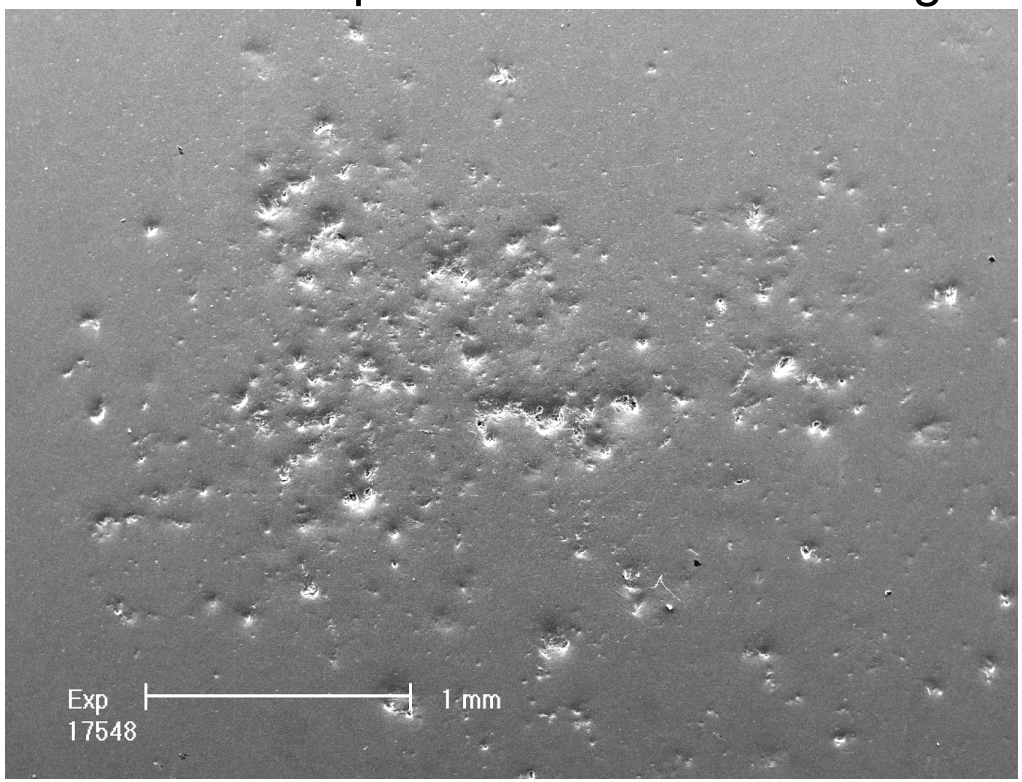
- Recirculation zone
- Flow stability

Target Test Facility (TTF)

- Full-scale loop
- Final CFD benchmark
- Verify Hg process equipment
- Operational experience

Cavitation Pitting Damage Remains a Concern

- Large tensile pressures occur due to reflections of compression waves from steel/air interface
  - These tensile pressures break (cavitate) the mercury
  - Damage is caused by violent collapse of cavitation bubbles under subsequent interaction with large compression waves



Damage in region with large pits for bare 316SS-LN diaphragm after July 2001 WNR tests

Development Goals and Plans

- Three-year plan developed:
  - Consistent with SNS power upgrade project schedule
  - Focuses on cavitation damage mitigation
- Goal - Extend target vessel lifetime and power handling capability
  - Damage erosion rate $\propto$ P4
- Plans for Post-Irradiation Examination (PIE) of spent targets in-place
  - Dismantle and cut target specimens from spent target
  - Transport to ORNL hot cell
  - PIE in ORNL hot cell
  - PIE preparation work begins this year $\Rightarrow$ ready for target PIE at the end of 2007

Critical Target Systems Milestone Dates

- Hg loaded into the system - November 2005
- Load hydrogen in moderators – November 2005
- Accelerator Readiness Review for Beam on Target – March 2006
- First beam on Target - April 2006

Summary

- Target Systems design is complete
- All major procurements completed except for some Hydrogen system components and shielding
- Installation nearly complete
- Test and checkout of systems has started
- On track with installation and testing for first beam on target by April 2006