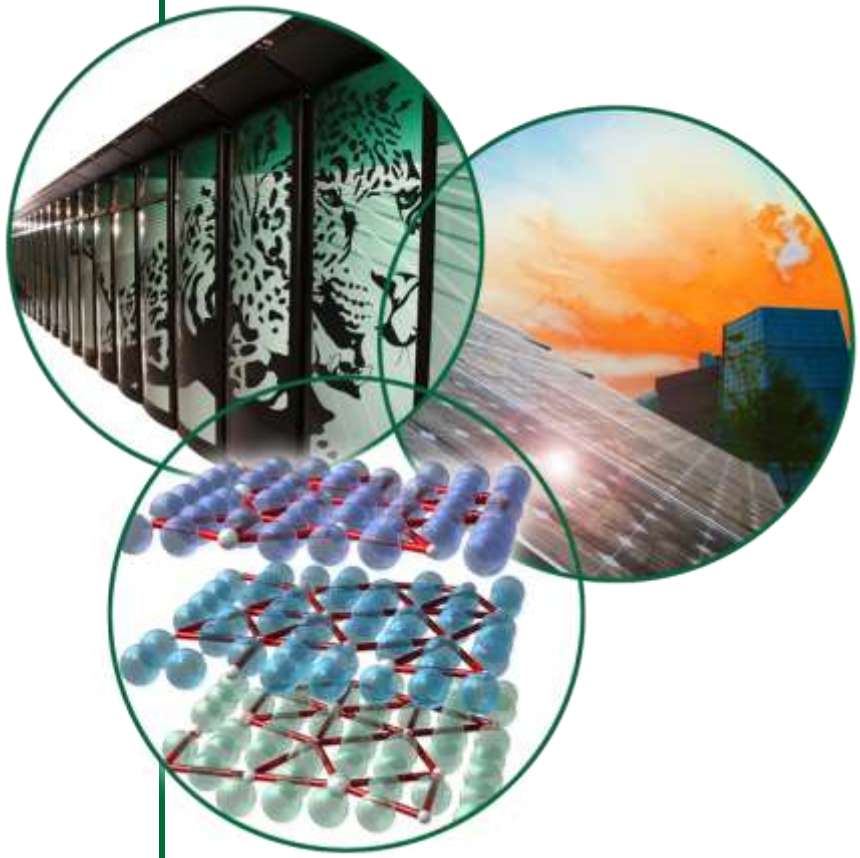
Neutron Facilities Development Overview and Plans

John Haines

AAC Meeting

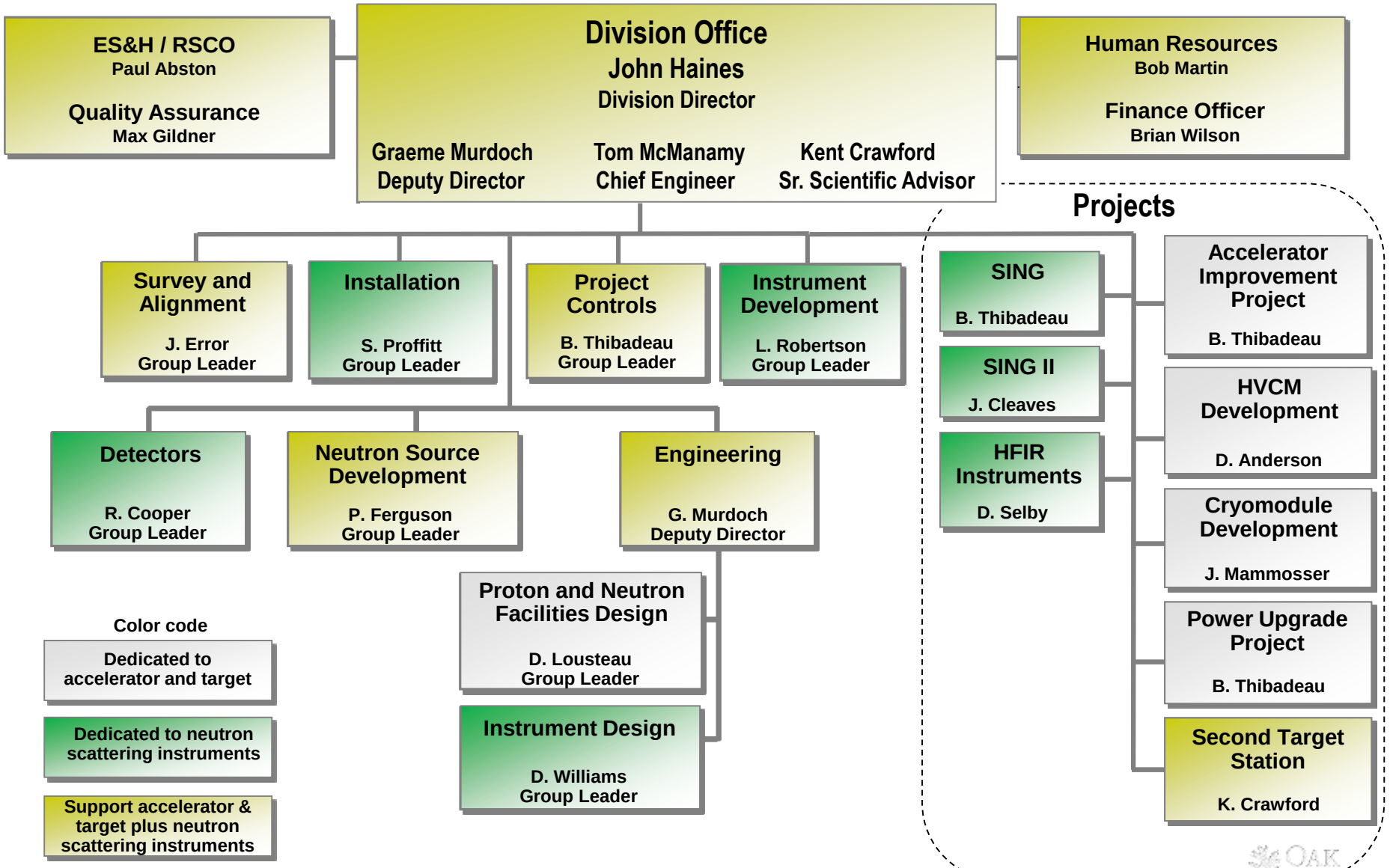
February 2, 2010



U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

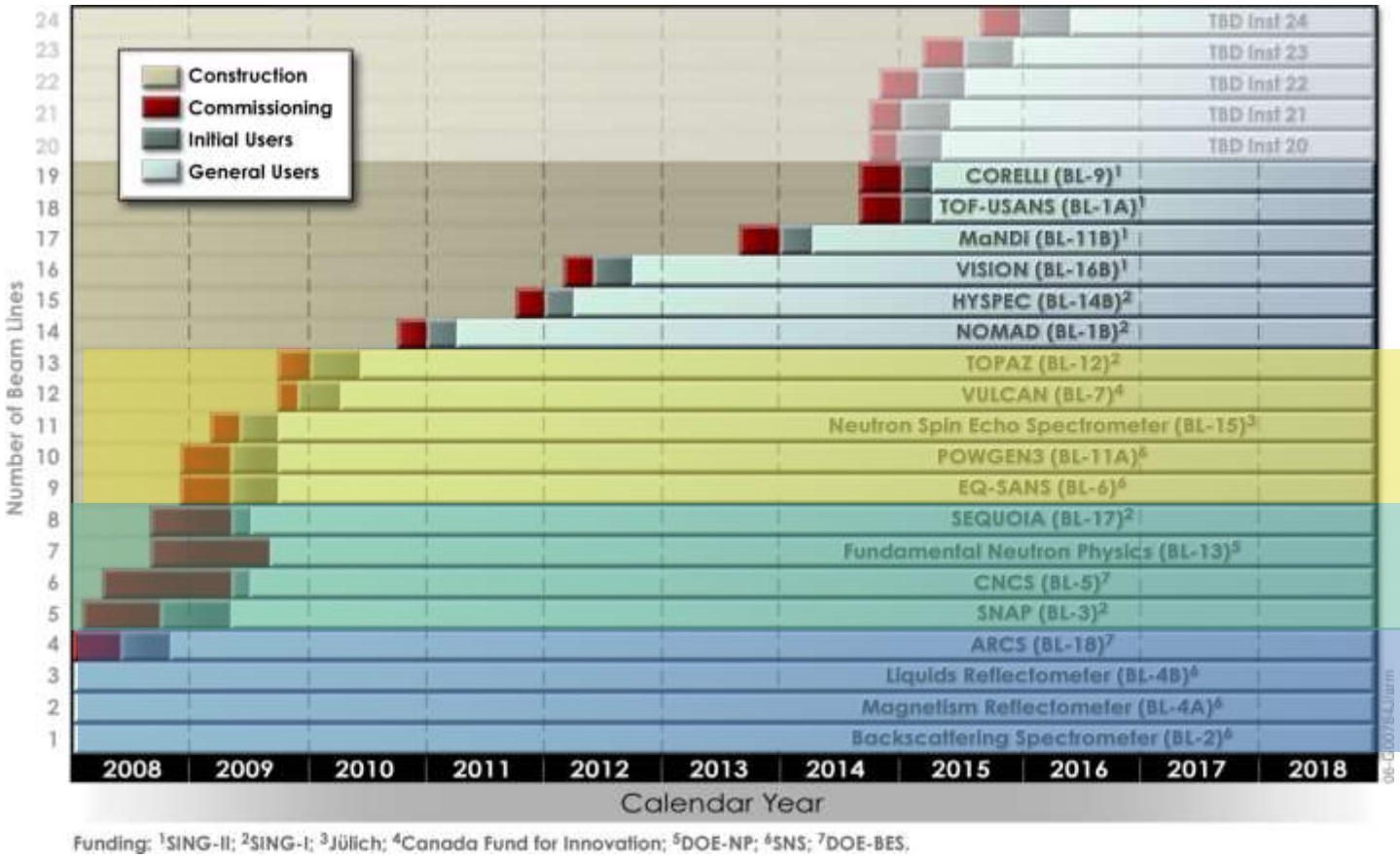
Neutron Facilities Development Division



Outline

- Highlights and plans
  - Neutron scattering instrument completion
  - Target systems related development:
    - Hg target
    - Remote handling
    - Moderator and reflector
  - NFDD accelerator development activities:
    - Cryomodule
    - HVCM
  - Accelerator and target facility improvements and upgrades
- Concluding remarks

Completion of Instruments Continued at a Rapid Pace



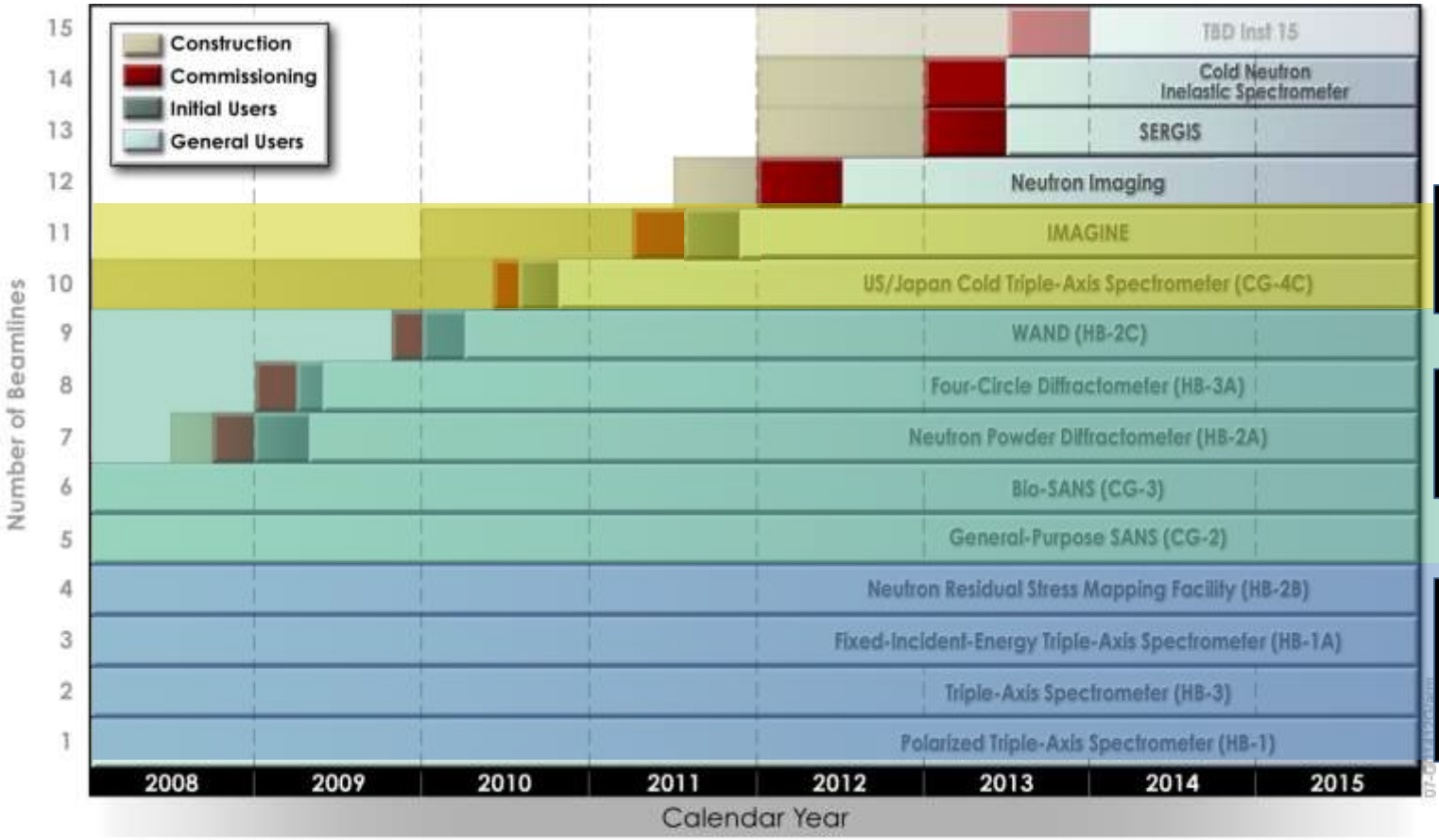
Funding: [1]SING-II; [2]SING-I; [3]Jülich; [4]Canada Fund for Innovation; [5]DOE-NP; [6]SNS; [7]DOE-BES.

13 operating now

8 operating before FY2009

4 instruments operating before 2008

Completion of Instruments Continued at a Rapid Pace (HFIR)



11 operational before 2012

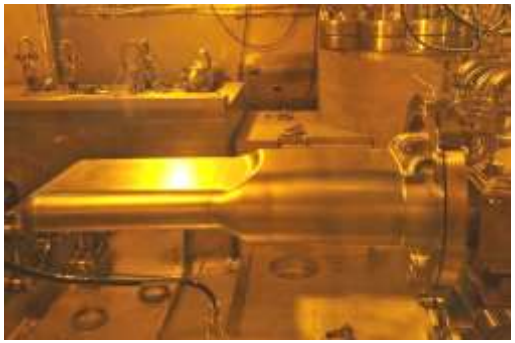
9 currently operating

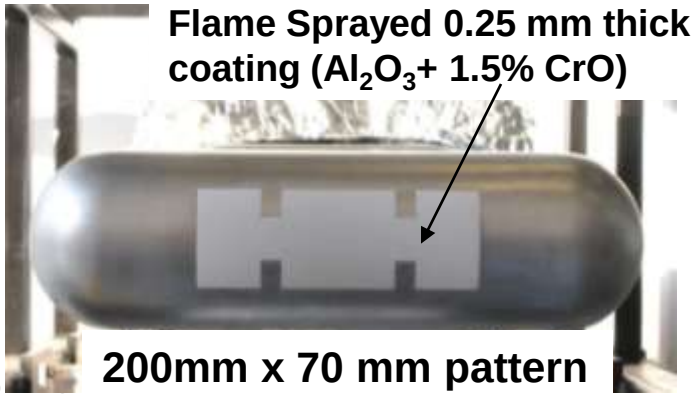
4 instruments operating before 2007

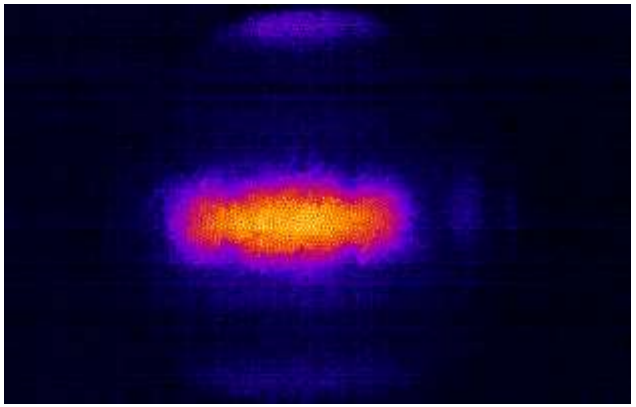
CG-1 Development Beamline in commissioning now

Target Systems and Remote Handling

- **Accomplishments:**
  - Replaced first target & proton beam window (PBW)
  - Placed contract for spare Hg-water heat exchanger
  - Deployed Target Imaging System
- **Plans:**
  - Receive 3rd PBW and initiate procurement of 4th
  - Replace next target module
  - Procure tooling needed for inner reflector plug replacement
  - Verify target module can operate at 1.4 MW
  - Begin conceptual design for next generation target





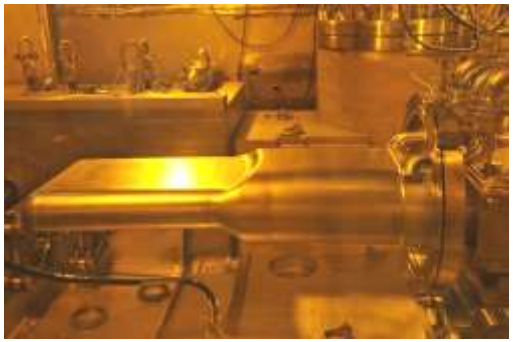


Target Imaging System

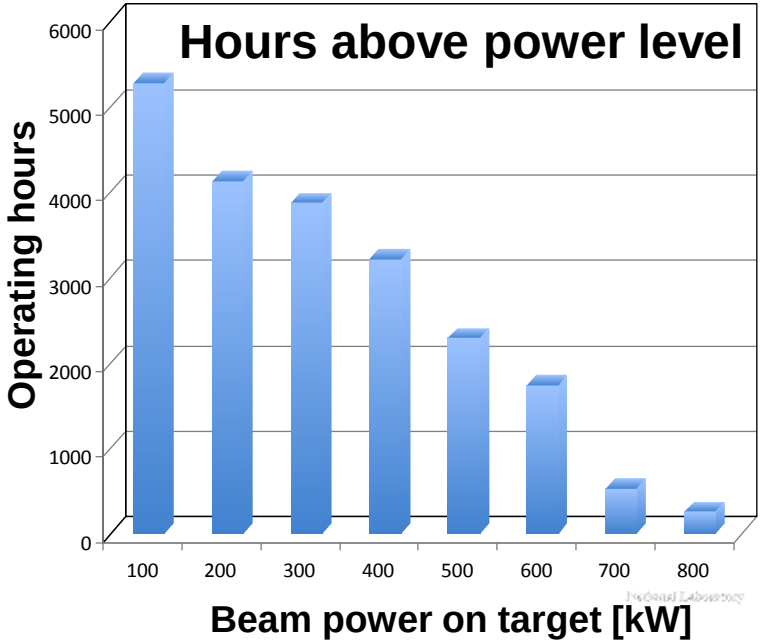
Mercury target module lifetime remains uncertain

- First target module replaced during July 2009 shutdown
  - Exceeded original dpa goal of 5 dpa (reached ~ 8 dpa), but still do not know how long the target will last at high power
- Plan to run the next few targets to end-of-life, i.e. mercury leaks from primary container to its water-cooled shroud (or 10 dpa)
  - If cavitation damage limits lifetime, we will operate at a power level consistent with using four targets/year
  - 3 spares on hand, 3 more by end of 2010

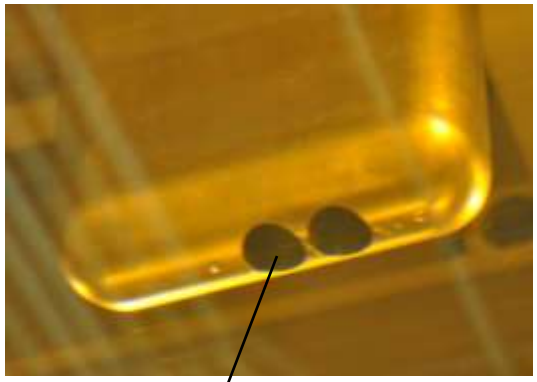
1st Target in 2006

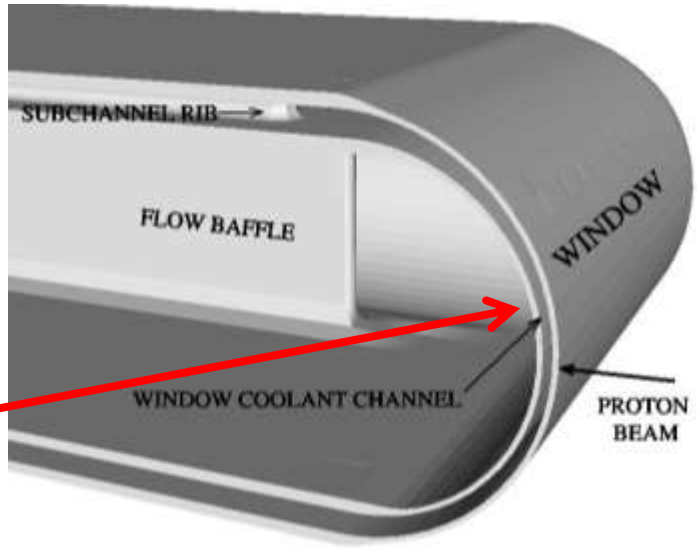


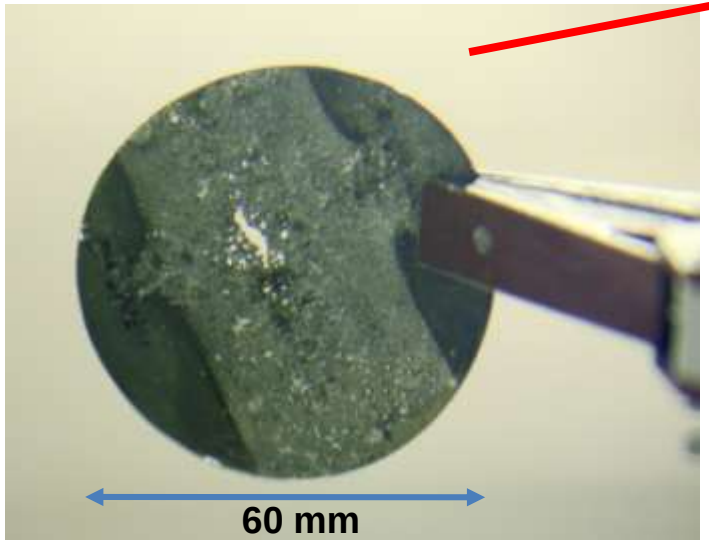
1st Target after removal



Initial Results of Post-Irradiation Examination of Hg Target Module





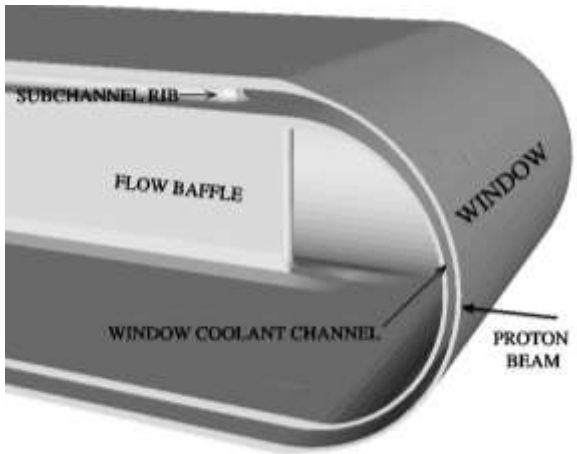


Inner surface of wall between bulk Hg and small channel

- Cavitation damage phenomenon confirmed in real target
- Outer wall fully intact, inner wall at off-center location shows little or no damage
- Damage region appears to correlate with low Hg flow velocity

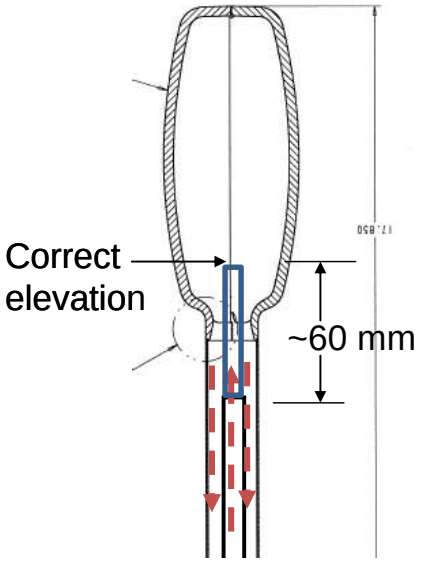
Hg Target Development Plans

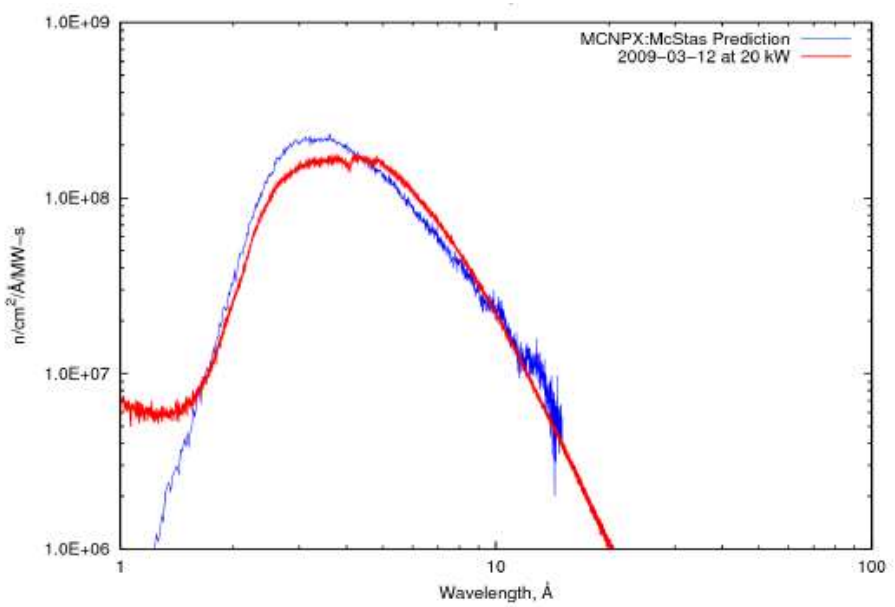
- Inaugurate new mercury laboratory in SNS Experiment Hall
- Continue to pursue gas injection schemes for mitigating cavitation damage
- Obtain samples of first spent SNS target vessel and perform Post-Irradiation Examination
- Next generation target
  - Planned target design mods, which would have eliminated the small Hg-filled channel, terminated
    - In-beam tests at LANL-WNR facility showed no increased damage in in this channel
    - This result was also supported with early examinations of spent target
  - Target engineering and development teams working together to implement a new plan for a next generation target



Moderator and Reflector Development

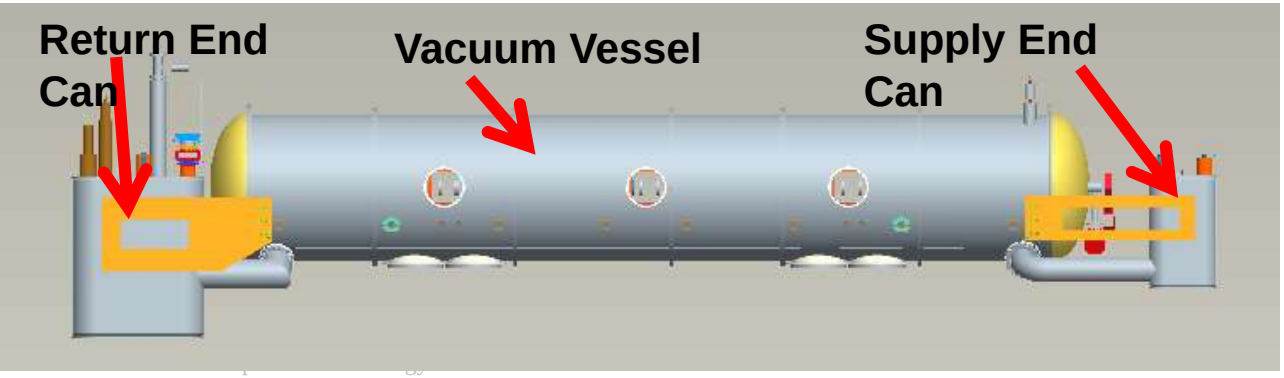
- **Highlight**
  - **Deployed stent to repair bottom-downstream cryogenic hydrogen moderator and confirmed neutronic performance**
  - **Developed understanding of refrigerator capacity degradation – contamination build-up clogging He loop adsorber**
- **Plans**
  - **Establish moderator development laboratory**
  - **Continue advanced moderator testing and modeling**





Cryomodule Development

- Highlights
  - Completed detailed design for spare high beta cryomodule
  - Processed four cavities required for spare HB cryomodule at J-Lab
- Plans
  - Conduct cryomodule design review
  - Complete spare high-beta cryomodule assembly



Cavity Number	Emax (MV/m)
HB53	17.6
HB58	17.2
HB56	17.5
HB54	13.0

HVCM Development

- Highlights
  - Installed new HVCM
  - HVCM test stand completed in HEBT Service Building
  - Installed new HVCM capacitors
  - Workshop with experts held yesterday to gather advice on approach and plans
- Plans
  - Complete IGBT gate drive upgrade
  - Develop new HVCM controller first article

Accelerator Engineering/Accelerator Improvement Projects

- Highlights
  - New magnetic LEBT being assembled
  - MEBT scraper and chopper completed and installed
  - New momentum dump designed and fabricated; installation in progress
  - Designed new primary and secondary foil strippers, components in manufacturing/assembly
  - Received new HARP mechanism assembly and remote tooling for HARP replacement
- Plans
  - Complete the first spare high-beta cryomodule
  - Install new momentum dump
  - Complete testing of HARP mechanism
  - Complete manufacture and installation of primary and secondary stripper foil assemblies
  - Complete design and procurement and installation of RID aperture increase
  - Award contract for spare RFQ

Accelerator Improvement Projects

- New AIP process has significantly improved performance
  - Semi-annual review with AIP Project Manager and leadership from RAD, NFDD, and DOE-ORO
  - Review progress; focus effort; reallocate funds; select new projects
- Since July 2006, 25 AIPs have been initiated and 12 have been completed
- Mainly focused on availabilty improvement

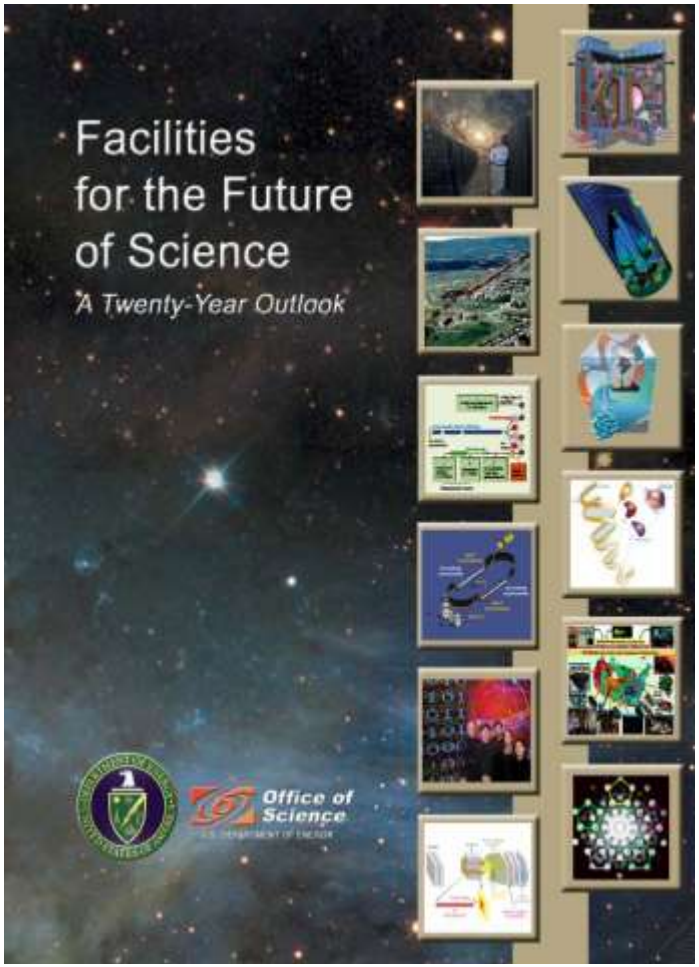
Active AIPs	% Complete	Budget ($k)
AIP-02 HVCM Upgrade	74%	1,883
AIP-04 Injection Region Upgrade	82%	1,937
AIP-06 Accelerator Cooling Upgrade	78%	1,864
AIP-13 SRF Cavity Processing Capability	53%	1,613
AIP-14 HVCM Fire Mitigation	82%	1,163
AIP16 Beam Instrumentation	77%	2,572
AIP-17 MEBT Rebuncher RF	40%	1,807
AIP-19 Timing Controls Systems	61%	566
AIP-20 Remote Handling	50%	3,274
AIP-22 CHL Cryogenic Return Line	46%	888
AIP-23 HEBT Momentum Dump	47%	1,412
AIP-24 RID Aperture	0%	633
AIP-25 Cryogenic Test Facility	0%	3,704

Planned FY10 AIP Starts
Additional CCL corrector power supplies
4500V IGBT AIP 09 Update
New Controller for HVCM
Front End Test Stand DI Water Cooling Systems
MPS Fast Protect Hardware Redesign
Ring Injection Dump View Screen

SNS Upgrade Plan

- SNS was designed from the outset to accommodate two major upgrades
  - Doubling the SNS proton beam power
  - Adding Second Target Station (STS)

- Both projects were included as very-high, mid-term priorities in the 2003 DOE-Office of Science Plan "Facilities for the Future of Science, A Twenty Year Outlook"



Power upgrade status and plan

- How do we plan to double the beam power?
  - Power Upgrade Project (PUP) increases the beam energy from 1 to 1.3 GeV
  - Beam current upgrade (60%) and target improvements accomplished through R&D and Accelerator Improvement Projects (referred to as CU AIPs)
- Critical Decision-1 (start preliminary design) for PUP approved in Jan 2009 and $2M provided in FY2010 budget
- FY2010 Plans: Establish PUP project team including Level 2 WBS element leaders and prepare for CD-2 (baseline) approval in FY2011
  - Propose optimized baseline design for the new PUP modulator system
  - Develop strategy for acquiring cryomodules
  - Conduct Preliminary Design Review for PUP
- CU AIPs start next year

SNS Second Target Station (STS)

- **Scope of STS includes design, build, install, test, and commission a second target station at SNS consisting of:**
  - **New spallation target and supporting systems**
  - **Extend the SNS accelerator systems**
  - **Conventional support buildings**
  - **Initial neutron beam instruments**

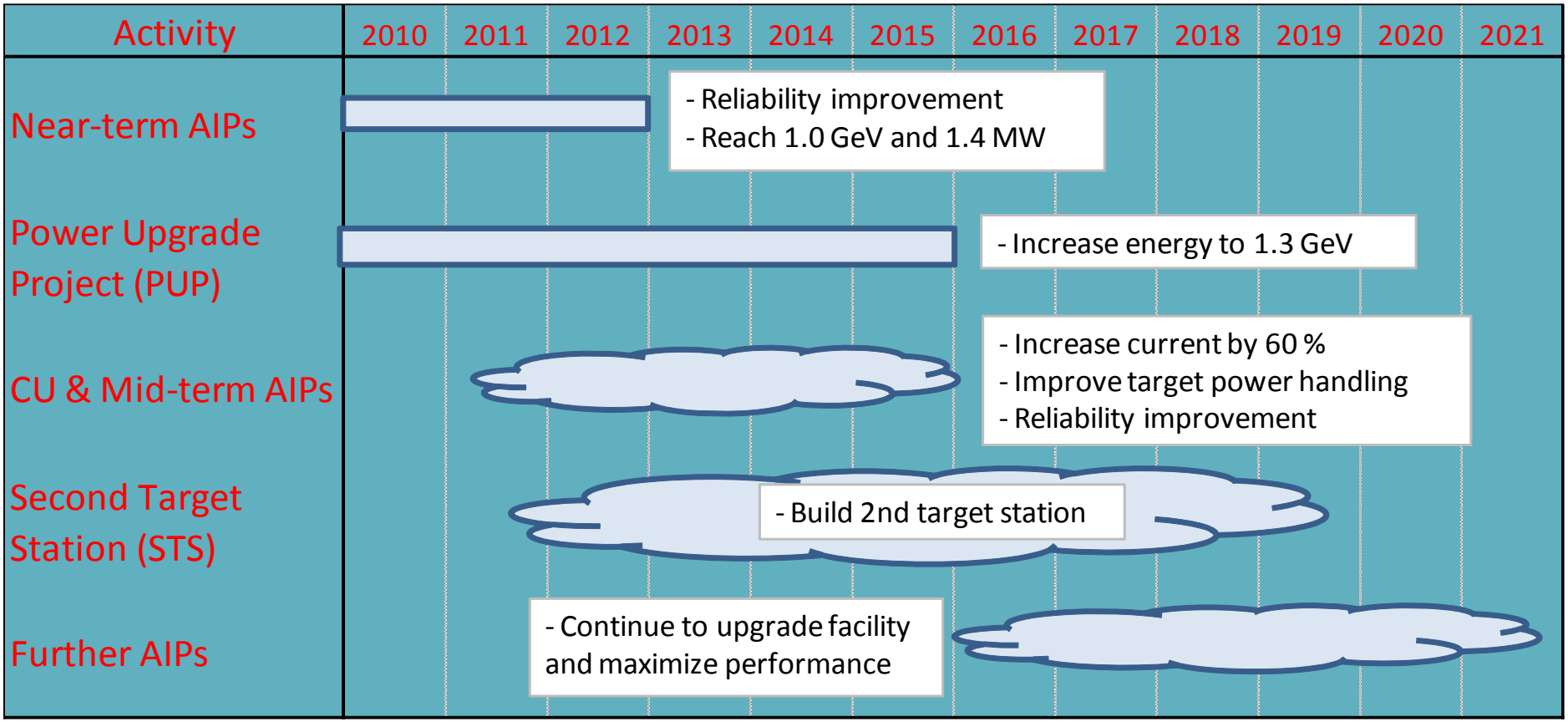
STS Project Status and Plans

- Optimized for intense beams of cold neutrons
  - Likely to operate in long-pulse mode, taking beam directly from linac
    - Higher power; greater reliability
    - Joint US-European workshop on optimizing instruments for long-pulse sources held Aug 26-28, '09
- Mission Need Critical Decision-0 approved in January 2009!
  - Current plan: Start construction project in 2012; complete in 2019; cost range of $800M to $1500M
- FY2010 efforts will focus on major decisions required to complete conceptual design
  - Facility interfaces
  - Pulse structure
  - Target type
  - Proton beam routing

STS Completion Planned for 2019

Milestone	Definition	Date
CD – 0	Approve Mission Need	Jan 09 A
CD – 1	Conceptual Design Complete	Mar 12
CD – 2	Approve Performance Baseline	Jun 13
CD – 3	Approve Start of Construction	Jun 14
CD – 4	Project Complete	Sep 19

SNS Improvement and Upgrade Goals and Timeline



Concluding Remarks

- Improvements and upgrades keeping pace with reliability and power ramp-up so far
- Target module lifetime remains uncertain, but minimally acceptable performance established
- Completion of the PUP, related R&D and AIP activities, and STS Project is required to realize the full scientific potential of SNS
  - PUP conceptual design completed (CD-1); CD-2 (baseline) within a year
  - STS Mission Need (CD-0) approved
- Issues and challenges:
  - Target lifetime uncertainty
  - Planning for aggressive STS schedule
  - Balancing priorities (especially between accelerator/target support vs. neutron science support)