Neutron Facilities Development Overview and Plans

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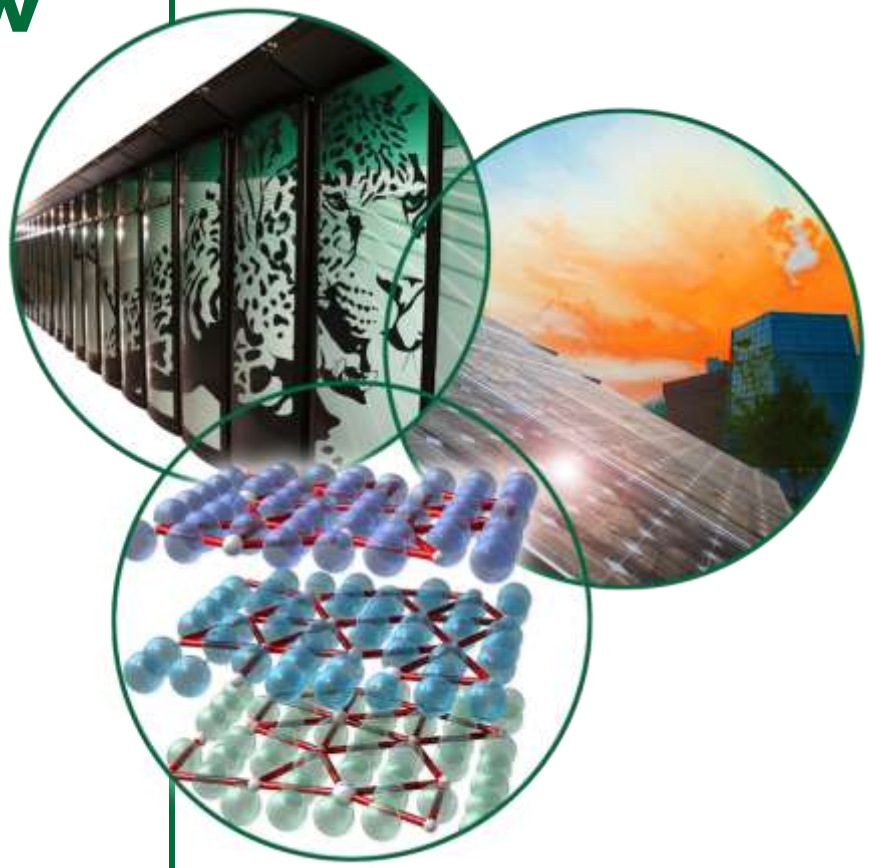
AAC Meeting

February 24, 2009



U.S. DEPARTMENT OF ENERGY

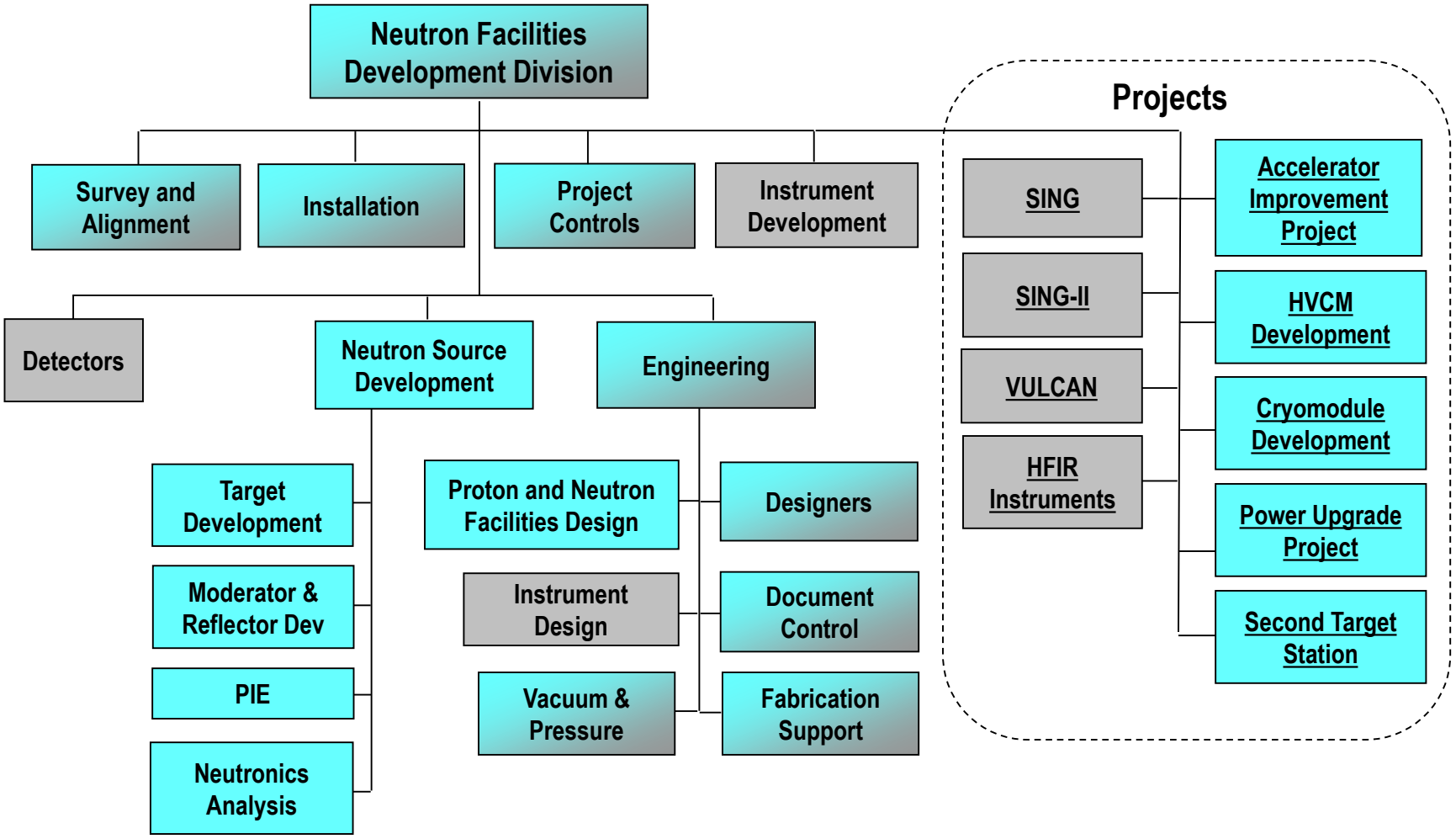
OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

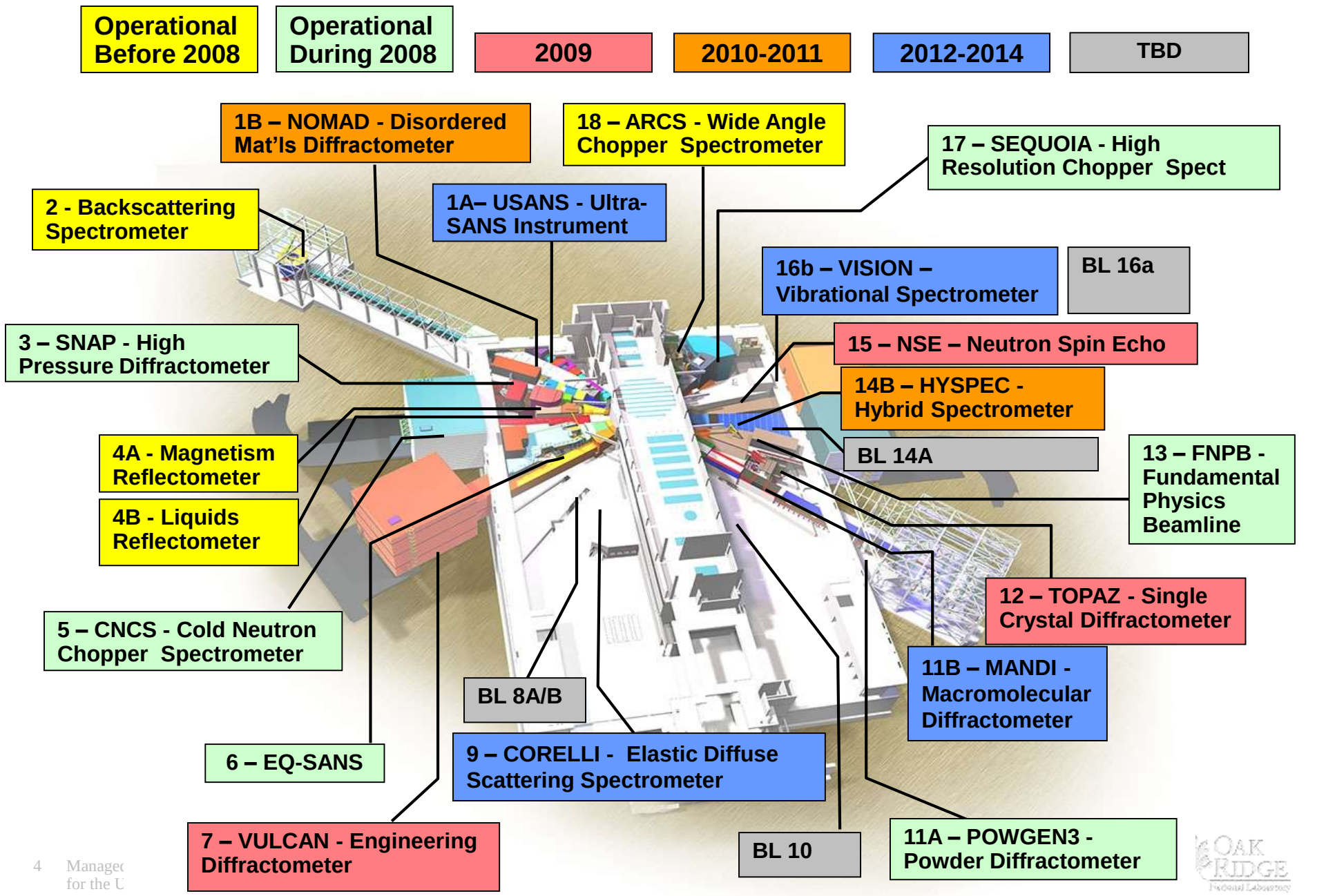
Outline

- Highlights since last AAC meeting
- Status and plans
  - Mercury target update
  - Neutron source improvements
  - Accelerator and target facility improvements and upgrades
- Concluding remarks

NFDD Organization Supports Project and Development Mission

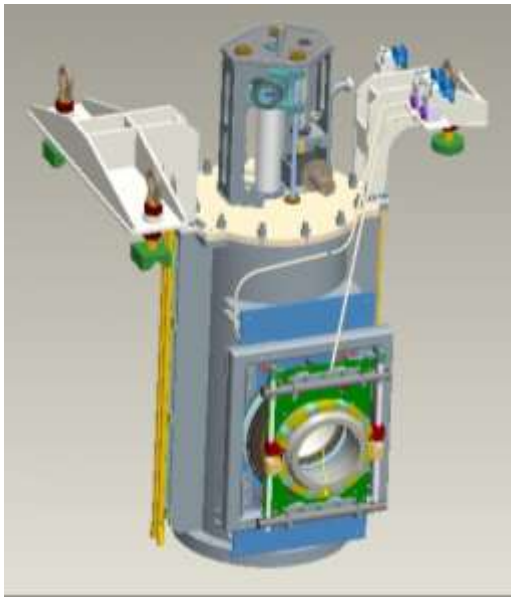


SNS Instrument Plan



Accelerator and Target Highlights

- Handling casks & tooling for shutter replacements delivered; 3 operational shutters installed (plugs removed)
- New HARP mechanism delivered & remote handling tooling designs completed
- New magnetic LEBT designed & under assembly
- Received Post-Irradiation Examination (PIE) tools + arranged for examining target samples in ORNL hot cells
- Spare Hg pump & proton beam window delivered
- Awarded contract for spare inner reflector plug



Mercury Target Highlights and Plans

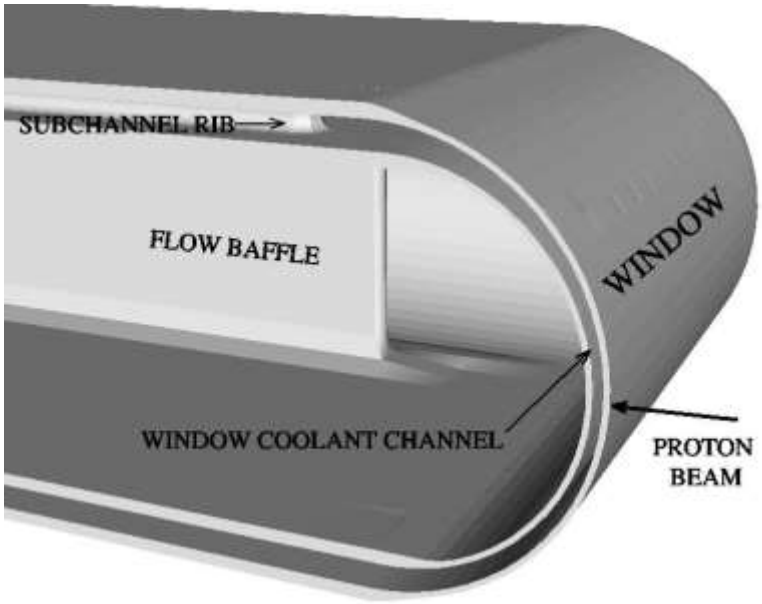
- Mercury target module lifetime remains uncertain
  - Original target module has reached ~ 5 dpa damage level!
    - Original goal was to achieve 5 dpa lifetime (~ 7 weeks at 2 MW)
    - Therefore we have exceeded the original fluence goal, but we still do not know how long the target will last at high power (SNS power level is currently 650 kW)
  - Still plan to run the first few targets to end-of-life, i.e., mercury leaks from primary container to its water-cooled shroud, but
    - If the 1st target does not reach its end of useful life by the July 2009 maintenance shutdown it will be removed (~ 9 dpa) to minimize impact on user program and keep radiation damage of water-cooled shroud within acceptable limits

Mercury Target Highlights and Plans (cont'd)

- First spare target module is staged for replacement, second spare is here, and third will be here soon
- Contracts are in place to procure seven more spares over the next two years from three different suppliers
  - Plan is to operate at a power level consistent with ≤ 4 target replacements per year

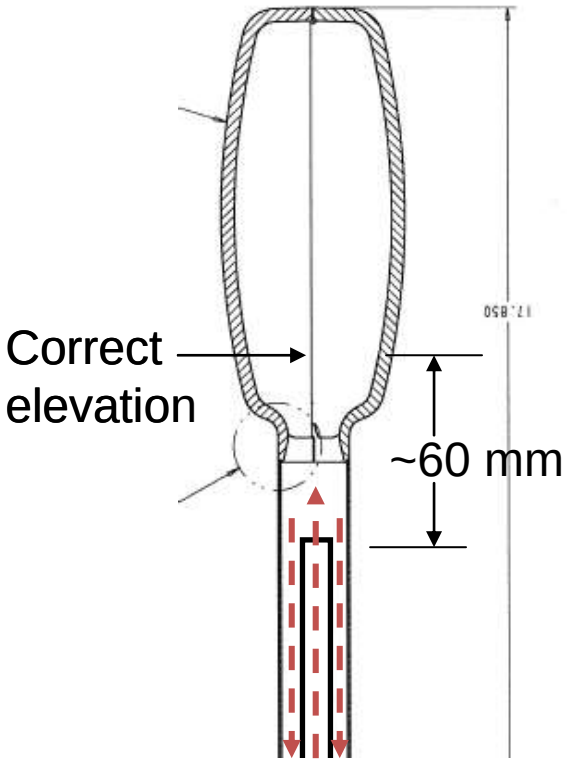
Mercury Target Highlights and Plans (cont'd)

- Meanwhile, cavitation damage mitigation R&D continues
  - Window vulnerability tests completed at LANSCE-WNR in July 2008 – specimens are being prepared for examination now
    - Decision point is near on whether to design Mark-II target that eliminates small Hg cooling passages in module
  - Progress on gas injection looks promising, but much work remains to optimize and implement system
    - Small gas bubbles and/or gas wall/curtain near wall
    - Collaborating with JAEA and RAL as well as several university and industrial partners
    - MIMTM testing of gas wall target concepts to 10^6 cycles



Neutron Source Development Plans

- Repair bottom downstream moderator
  - Hydrogen feedline falls short of moderator vessel, resulting in low flow in moderator
  - At high power, moderator has warm, low density hydrogen that results in very low neutron flux (< 20% of expected)
  - BLs 13-15 (FNPB, NSE, and HYSPEC) view this moderator
  - Plan to complete repair this week
  - Alternate strategy is replace the inner reflector plug/ moderator assembly, but this will take ~ 18 months
- Sample the first target container and initiate PIE in ORNLs hot cells
- Complete development and deploy target beam profile monitoring system in PBW



Accelerator Development Plans (NFDD)

- Cryomodules
  - Complete first spare HB cryomodule (10CFR851 compliant) in 2009
  - Support cryomodule repair and processing R&D
- HVCM Development
  - HVCM team recently formed to focus efforts on this critical issue
  - Complete HVCM test stand in HEBT Service Building
  - Identify more reliable, "gentler" failure mode replacement capacitors and evaluate alternative IGBT and thermal management solutions, e.g.
    - Complete design of new IGBT gate driver circuit and perform first-article testing to full average power
    - Develop next generation controller for HVCM system (w/ active fault compensation, real time timing signal adjustment)
    - Develop initial designs for fast disconnect switch for primary capacitor bank

Accelerator Improvement Projects

- **New process established to better manage and evaluate ongoing Accelerator Improvement Projects**
  - **Semi-annual review with AIP Project Manager and leadership from RAD, NFDD, and DOE-ORO**
  - **Review progress; focus effort; reallocate funds**

Project Name	% Complete	Budget ($k)
AIP-02 HVCM Upgrade	77%	1,703
AIP-04 Injection Region Upgrade	70%	1,747
AIP-06 Accelerator Cooling Upgrade	74%	2,047
AIP-08 LEBT Chopper Upgrade	79%	787
AIP-13 SRF Cavity Processing Capability	35%	1,561
AIP-14 HVCM Fire Mitigation	67%	1,203
AIP-15 CUB & CT Water Upgrades	83%	516
AIP16 Beam Instrumentation	44%	2,529
AIP-17 MEBT Rebuncher RF	30%	1,025
AIP-18 Vacuum Controls Systems	78%	530
AIP-19 Timing Controls Systems	22%	733
AIP-20 Remote Handling	27%	3,420
AIP-21 New HVCM	76%	2,119

Future AIPs
HEBT momentum dump
Cryo backup refrigerator
Cryo return line
Extraction kicker
RID aperture

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”

SNS Power Upgrade Plan

- Power upgrade plan has been revised
  - Formerly, Power Upgrade Project (PUP) doubled SNS power
  - DOE directed us to restructure the elements of the PUP
    - Proton energy increase to 1.3 GeV (30%) forms the new PUP
    - Beam current increase (60%) and target improvements will be accomplished through R&D and Accelerator Improvement Projects (AIPs)
- Conceptual design for PUP completed, and R&D underway
  - BES review held in August 2008 and Critical Decision-1 (start prelim design) approved in Jan 2009
- Net result of PUP + R&D + AIPs will be a doubling of the SNS beam power by 2016

SNS power upgrade major parameters

Nomenclature:

PUP = Beam energy upgrade from 1.0 to 1.3 GeV

R&D + AIP = Increase beam current by 60% & upgrade target to > 2 MW

Primary Scope Item	Initial SNS Capability	Upgrade
Kinetic energy (GeV)	1.0	1.3
Nine (9) additional high-beta cryomodules	12	21
Thirty-six (36) new RF systems	81	117
New, higher power target	≥ 1 MW	≥ 2 MW
RFQ output peak current (mA)	38	59

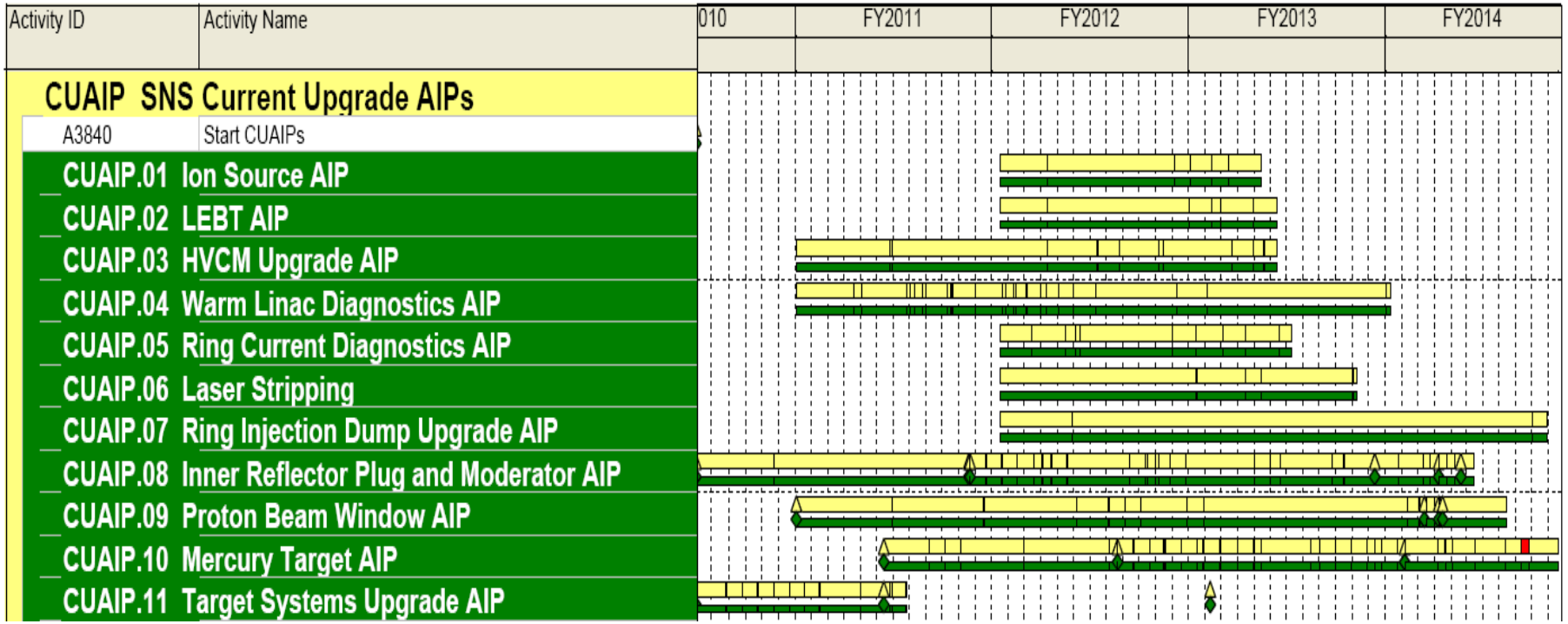
PUP project scope

R&D & AIPs funded from supplemental SNS operating budget

PUP Critical Decision Milestones

Milestone	Definition	Schedule Date
CD – 0	Mission Need	Nov 04A
CD – 1	Alternative Selection and Cost Range	Jan 09A
CD - 2	Performance Baseline	Dec 11
CD – 3A	Start of Long-Lead Procurements	Jan 12
CD – 3B	Start of Construction	Dec 12
CD – 4	Project Complete	Dec 15

Schedule For Power Upgrade-Related AIPs



Significant R&D efforts on mercury target and ion source are in progress

Projected Funding Need ($M)

	FY10	FY11	FY12	FY13	FY14	FY15	Total
PUP	0	4	18	39	21	10	**92**
CU AIPs	2	14	27	16	4	0	**63**
Operations	6	2	1	1	0	0	**10**
Total	**8**	**20**	**46**	**56**	**25**	**10**	**165**

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

- Mission Need Critical Decision-0 approved in January 2009!
  - Current plan: Start construction project in 2012; complete in 2019; cost range of $815M to $1150M
  - Prospects for earlier funding are leading us to consider accelerating this plan by two years (CD-1 in early FY2011)
    - Workforce planning to meet this aggressive goal is underway
- Major decisions required to complete conceptual design (CD-1)
  - Building site
  - Short vs. long pulse
  - Hg vs. rotating solid target
  - Target/moderator/reflector/beam line geometry

Concluding Remarks

- Accelerator and target improvements keeping pace with power ramp-up so far
- Target module lifetime remains uncertain, but minimally acceptable performance already established
- Successful 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 approved)
  - R&D on target and ion source underway; AIPs identified to achieve 60% current increase
  - STS Mission Need (CD-0) approved
- Issues and challenges:
  - Moderator repair
  - Target lifetime uncertainty
  - Planning for aggressive STS schedule