NOνA Project Overview

John Cooper
Project Manager

January 12, 2009

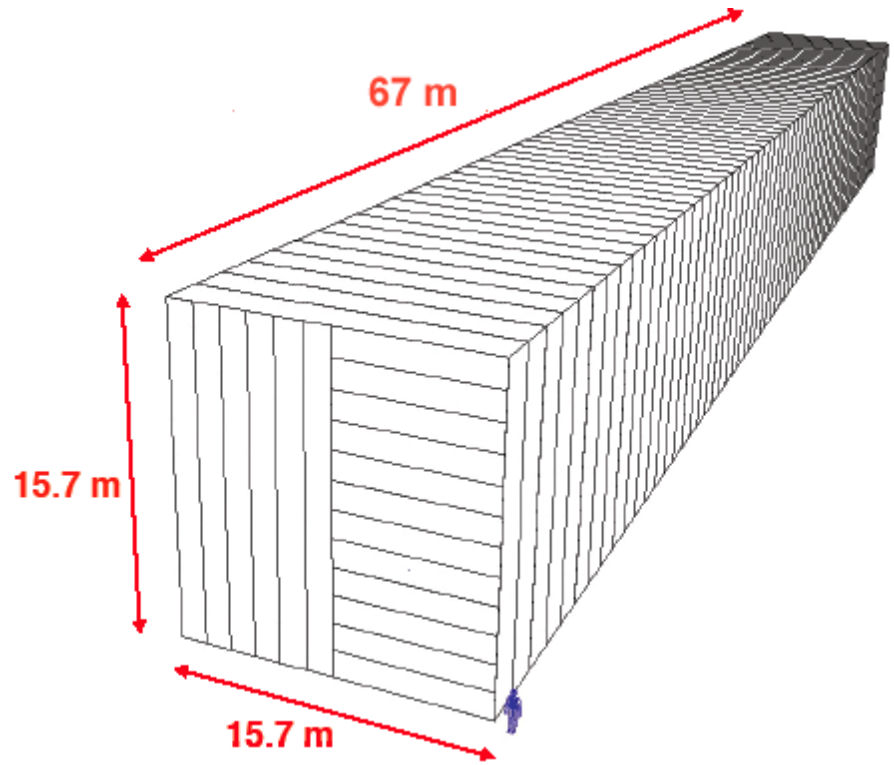
Project Overview

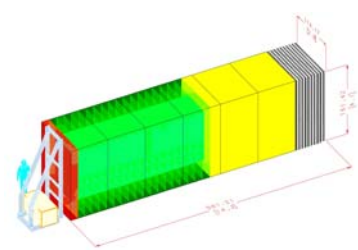
- **NOνA** = **N**uMI **O**ff-Axis ν_e **A**ppearance
  - and **NuMI = Neu**trinos at the **M**ain **I**njector
- We are looking for muon neutrinos changing (oscillating) to electron neutrinos
  - Theory describes this by a parameter = "$\sin^2(2\ \theta_{13})$"
- We are looking for 2 GeV muon neutrinos to oscillate into electron neutrinos over a distance of 810 km from Fermilab
  - Off-Axis by 0.25° gets us a 2 GeV beam of neutrinos
  - The oscillation peaks at (810 km / 2 GeV), related to neutrino masses
    - The fact that neutrinos have any mass at all is a very new discovery
  - The neutrinos go underground from Fermilab to Minnesota
    - Underground is OK since neutrinos don't interact often with matter.
- We need:
  - A Far Detector (near the US/Canada border) to discriminate between the two types of neutrino interactions.
    - And it has to be big to see any events at all since neutrinos don't interact often with matter
    - This is a greenfield site, so building a detector hall is a big part of the project
  - A Near Detector at Fermilab must measure the neutrino components in the NuMI beam before any oscillations occur
    - It is much closer to the beam origin and sees a larger rate, therefore it can be small
  - All the beam (number of protons) we can get on the NuMI target (interactions make neutrinos)
    - More beam gives more events
    - This requires an upgrade to the Fermilab accelerator complex

NOvA and θ_{13}

(ν_μ from NuMI oscillate to ν_e)

- Baseline
  - as seen 810 km away Northern Minnesota
  - New building
- Beam
  - 700 kW or 36 x 10^{20} protons over 6 yrs
- Far Detector
  - 930 planes of liquid scintillator contained in PVC cells, glued together for a total mass of 14,000 metric tons (14 kilotons).
  - Looking for a 15 to 100 event signal
  - Backgrounds (~22 events) are <u>important</u>
- Near Detector
  - Small new cavern at Fermilab, 300 ft underground
  - 215 tons made with the same technology
  - tells us the beam composition <u>before</u> oscillations (about half the background is ν_e in the beam)





NOvA Project History

- **November 28, 2005 DOE CD-0 approved**
- **April 4, 2006 DOE CD-1 Review to validate conceptual design & cost estimate.**
  - Project presented $ 197–256 M cost range for 25 kiloton detector with best estimate at $247M.
  - Results: Overall, the committee judged that the project was ready for CD-1. the Conceptual Design Report was deemed complete and comprehensive. The cost and schedule ranges were appropriate.
- **December 20, 2006 OMB instructs DOE to combine NOvA detector & "Proton Plan 2"** (original name for the accelerator part of NOvA)
  - New TPC set at $ 260 M by Jan 1.(!)
  - Took several months for two projects to be combined into one team and one schedule
- **May 11, 2007 CD-1 approved by Ray Orbach**
  - Cost range of $ 244 – 293 M for a 20 kiloton detector, now includes Accelerator part
  - TPC guidance set at $ 260 M, "best case earned contingency to allow for 20 kilotons"
  - Phased CD-3a / 3b planned, CD-4 in FY13
- **June 19, 2007 DOE-FSO / Fermilab Directorate Joint Review of NOvA EVMS**
  - Results: overall consensus was that the NOvA project had a considerable amount of the performance management system already in place, and was only lacking a few products or further development of existing materials.

NOvA Project History continued

- **October 23-25, 2007 DOE CD-2/3a Review (IPR)**
  - Integral cost and year by year obligation profile matched funding profile ($260M TPC)
  - Results: Main conclusion of the review was that the project was ready for CD-2 but needed additional flexibility either in scope or cost.
    - CD-3a list of critical path and long leadtime items endorsed.
  - Discussions with OHEP resulted in a new cap of $ 270 M and an agreement to write the PEP for a 14 kt base scope but leave Open Plan RLS at 15 kt.
- **November 26-30, 2007 DOE OECM CD-2 (EIR)**
  - Reviewed the same RLS and cost as the IPR review in October ($ 260 M, 15 kt)
  - Results: Overall conclusion was that the project could be successfully executed and the performance baseline validated once the project team resolved the 5 major findings and had an acceptable plan in progress to resolve the other 18 findings.
    - 5 major findings resolved by December 15, 2007.

- **Scheduled, then cancelled: Dec 19, 2007 DOE CD-2 ESAAB**
  - **FY08 Omnibus Bill: "zero for NOvA"**
  - **January, 2008: shutdown of project**
    - **Fermilab people assigned to other tasks**

NOvA Project History continued

- **February, 2008: OHEP asks us to re-plan for FY09 start**
  - President's FY09 budget has NOvA at $ 37 M
  - We were given a new funding profile from OHEP
  - TPC increased to $ 278 M to include one more year of escalation
  - Project to restart on Feb 1, 2009, allowed for a Continuing Resolution in FY09

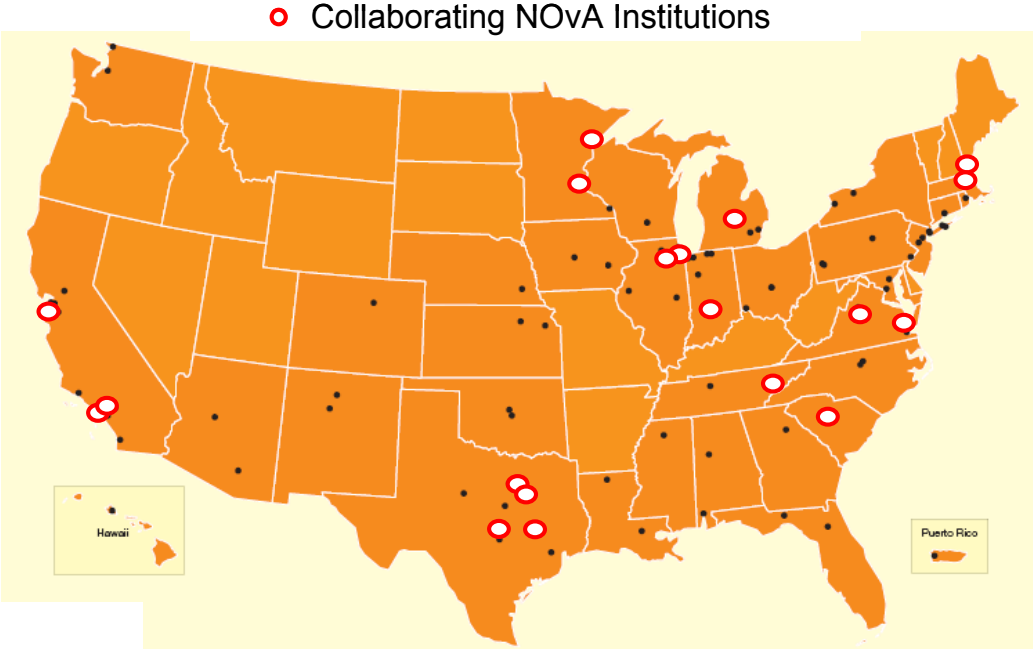
- **April 30 Lehman CD-2 mini-Review**
  - Results: Overall, judged that the project was ready for CD-2. The project had revised the project cost and schedule following being zeroed out in the FY 2008 budget.
- **June-Aug Interactions with EIR, Evidence Files, CD-2 mini-Review**
  - Project provided Evidence Files for 5 major findings and 11 findings
  - August 6 Out-Brief Result: The project team's response to the CAP recommendations was generally satisfactory, and the resulting documents were updated appropriately. The revised project planning and documentation was sufficient for CD-2, Approve Performance Baseline.

NOvA Project History continued

- **July 1, 2008 President signs Supplementary Appropriations Bill**
  - July 3 this results in $ 9.5 M for a NOvA restart
  - Funds in August fin plan to Fermilab ($9.234 M after SBIR tax)
  - We agree with OHEP to attempt an early restart by advancing our Feb 1, 2009 scheduled items to Sept 1, 2008
    - Restart proves difficult since personnel were scattered to other projects in the interim
    - Got to about 50% strength during Sept-Oct
    - Not back to full strength until early December
- **August 19, 2008 ESAAB for CD-2**
  - Board recommends approval
- **September 15, 2008 CD-2 approved by Ray Orbach**
- **October 1, 2008 FY09 Continuing Resolution begins**
  - NOvA gets $ 11.5 M during this 5 month CR ($3M Coop Agree, $8.5M Fermilab)
  - Combined with the carryover from FY08 Supplementary, we have $ 19.4 M
  - We intend to advance the Feb 1, 2009 tasks as much as possible and not do massive change requests on the PMB again until the FY09 final overall budget is known (March?). Probably will adjust for our CD-3b Review sometime in spring/summer
- **October 24, 2008 CD-3a approved by Dennis Kovar**
  - $ 19 M of items for NOvA (but limited during CR to ~$8.2M in MIE)

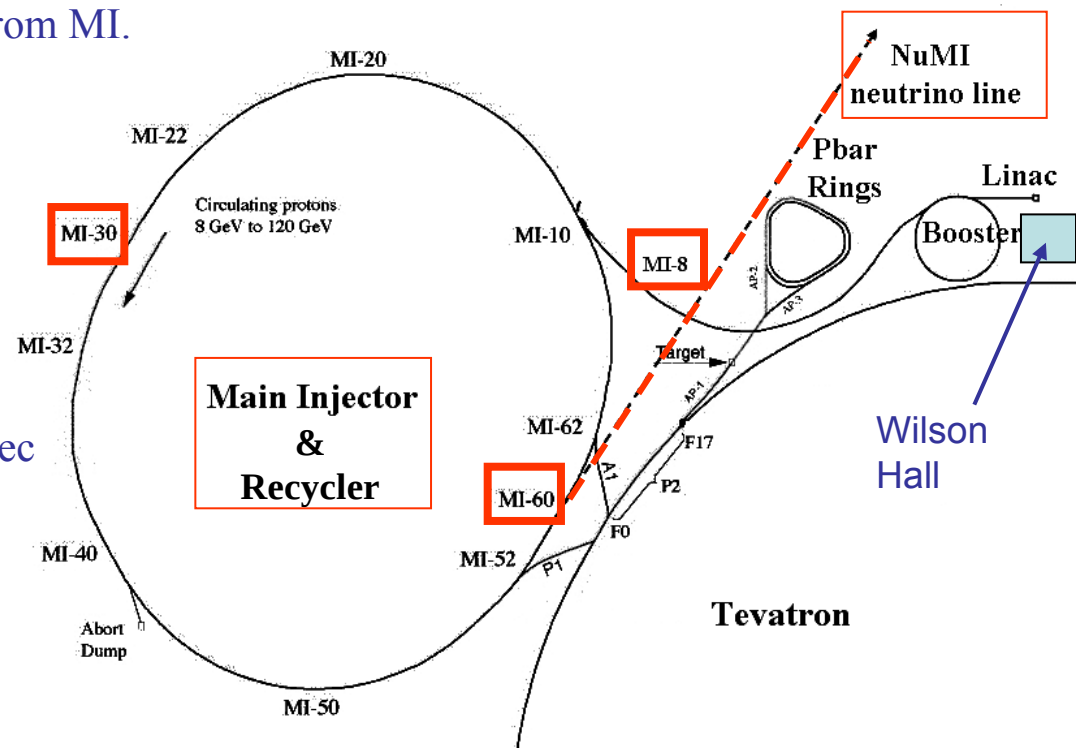
Our Organization is related to the Work

- FRA is an association of 104 universities and other national labs in 34 states
  - ~1300 scientists in the U.S., another 1,000 around the world
- 19 of the U.S. institutions are on NOvA
  - 107 scientists and engineers from U.S. institutions outside Fermilab are on NOvA
  - 74 are from Fermilab, 8 others from outside the U.S.
- **This is very much a collaborative effort**
  - **We collaborate because we are all interested in doing the science**
  - **We rely on one another for technical expertise across the project scope**



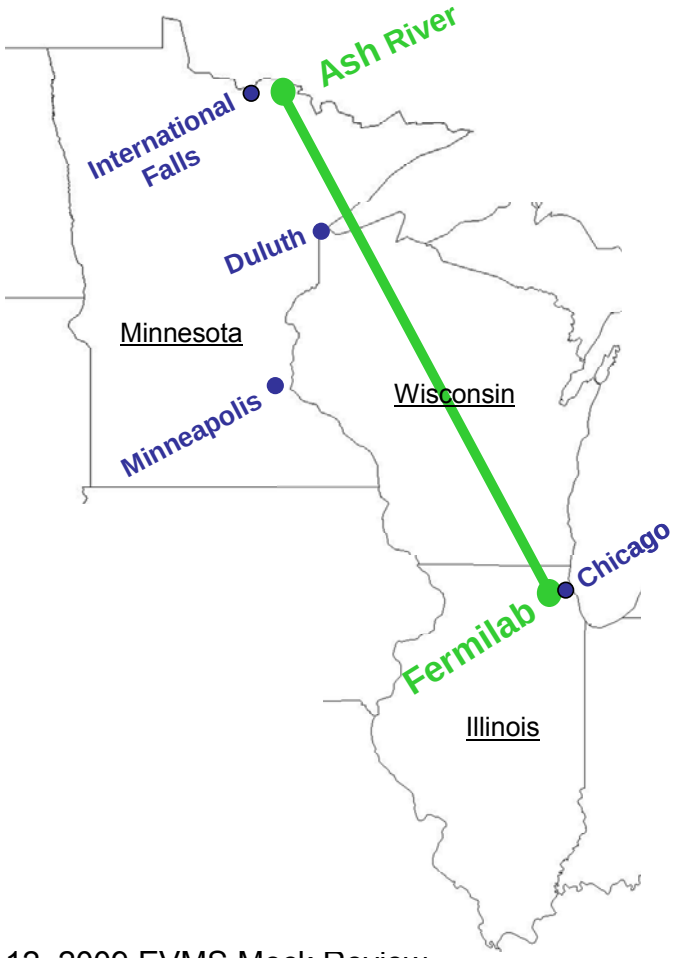
Accelerator and NuMI Upgrades

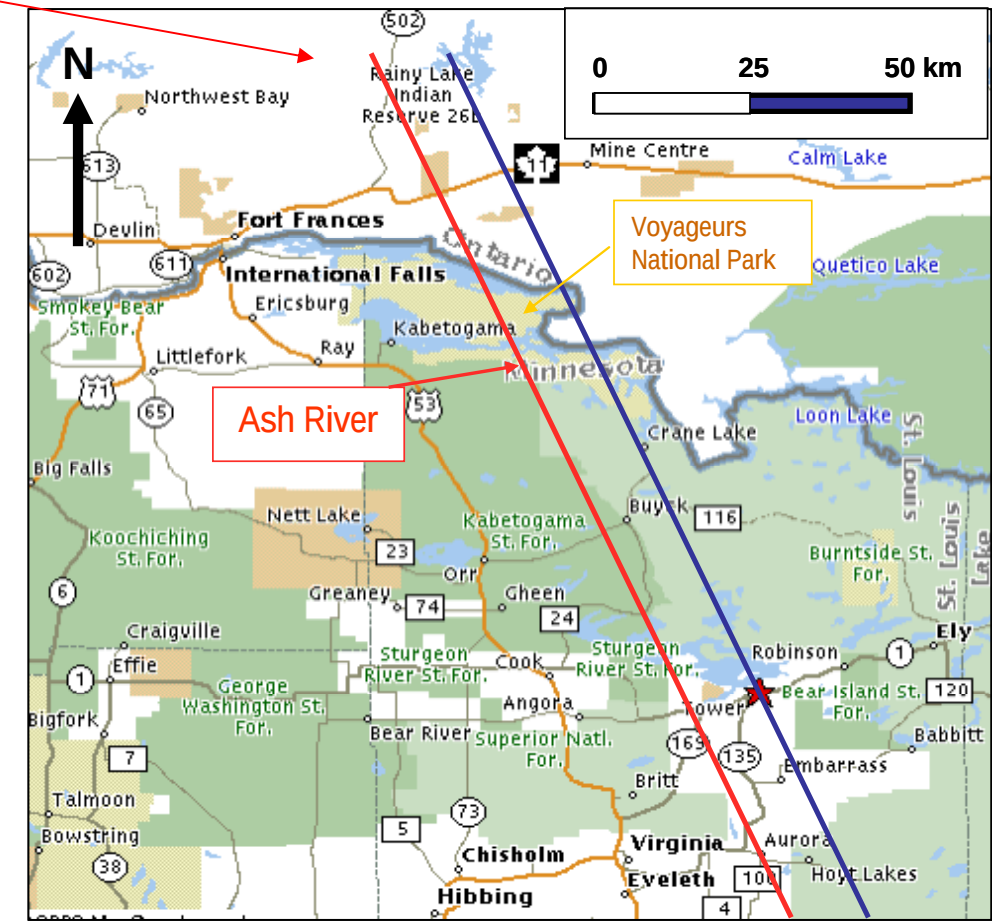
- **NOvA adds items to an extensive existing accelerator infrastructure**
  - **Fermilab is the lead institution here**
- Recycler at Fermilab
  - gets converted from anti-proton storage ring to a proton storage ring/ pre-injector into the Main Injector (MI) once the Tevatron Collider program ends
  - New injection and extraction lines to/from MI.
  - These lines (+ abort) require 4 new kicker systems
- Main Injector at Fermilab
  - Cycle time reduced from 2.2 sec to 1.5 sec since stack in Recycler
  - Reduce further to 1.33 seconds with 2 more RF stations at MI-60 204 GeV/sec → 240 GeV/sec
- NuMI Beamline
  - New target, move horn,…
- **Result:**
  - **Increase beam power from 400 kW to 700 kW.**



Ash River Site

- Farthest site from Fermilab within the US and accessible by road
  - 810.5 km from Fermilab, just 1.5 miles south of Voyageur National Park
  - 11.8 km west (red line) of the NuMI beam (blue line) & 14.6 milliradians off-axis.





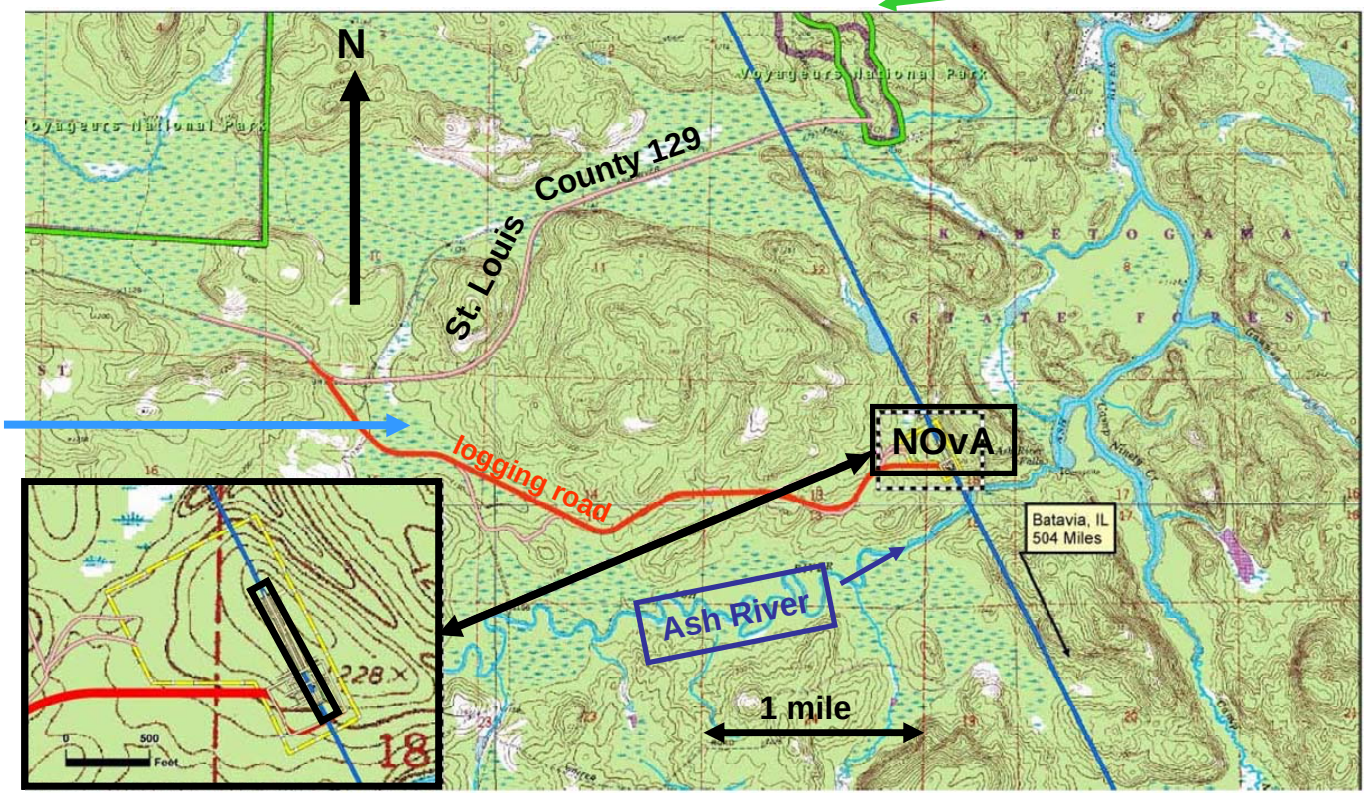
Ash River Site (Fermilab and U of Minnesota lead)

- The 3.6 mile access road has a complete design and is ready for bid:
  - roadbed, utility corridor, approximately follows an existing dirt logging road
  - curves straightened, borings done all along the route
  - ~ 40 drawings

National Park boundaries

wetlands

NOvA site is on a hill



Far Detector Building

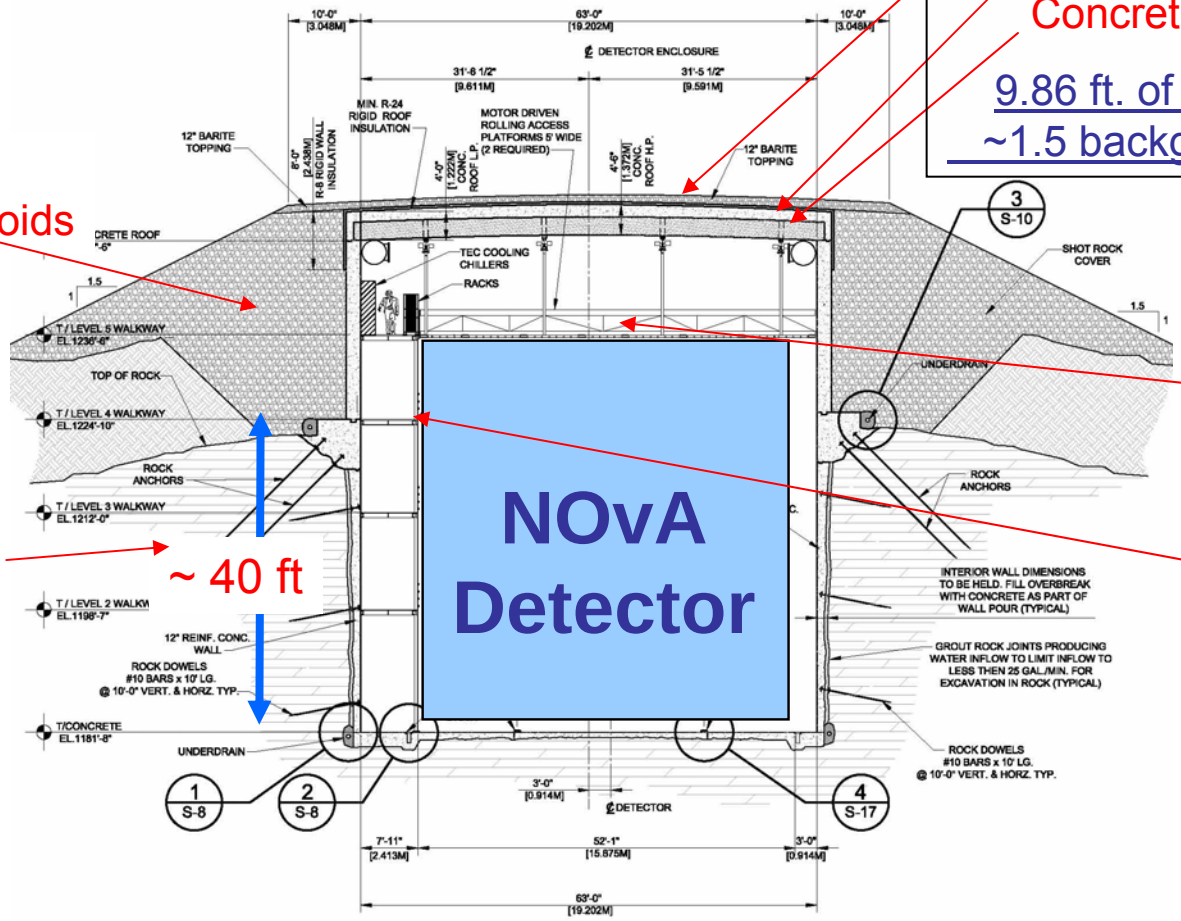
(Fermilab and U of Minn lead)

Cross section as seen by the neutrino beam
63 ft wide by 71 ft high by 471 ft into the page

6 inches barite
Cast Concrete
Concrete Planks

9.86 ft. of earth equivalent
~1.5 background event in 6 yrs

Excavated granite with voids



Rolling access bridges

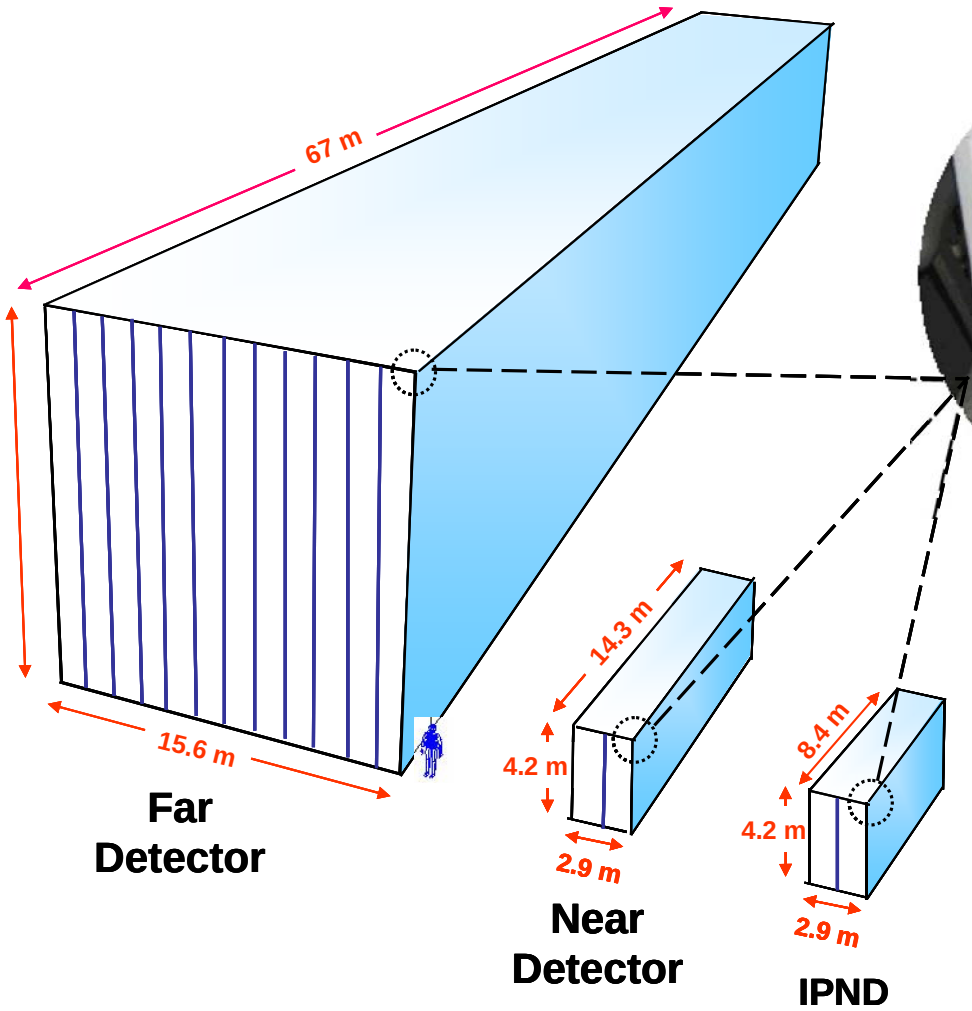
Solid granite (bathtub for 100% secondary containment)

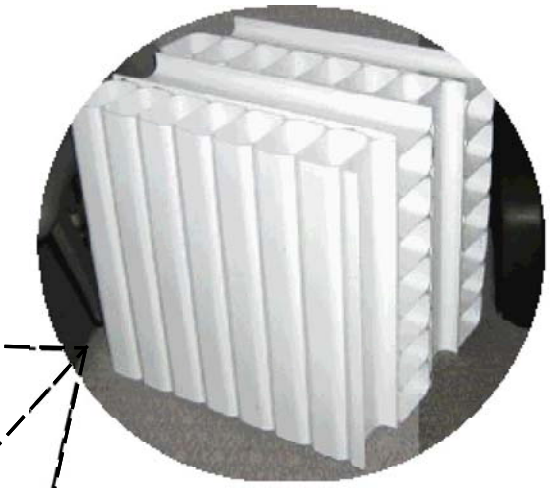
4 catwalks, electronics on top catwalk

Environmental Assessment Status

- The DOE NEPA Compliance Officer agreed to a final "pre-approval draft" EA on March 26, 2008
- DOE - FSO sent the draft out for public comment on March 27 with comments due by April 30.
  - Three simple comments easily handled.
    - Illinois EPA, "no objections", reminds us of required stormwater permit
    - US Army Corps of Engineers, 3 comments on wetlands area calculations
    - Keweenaw Bay Indian Community (Michigan), "no interests regarding religious or cultural sites documented at this time in the proposed project areas", but wants to be notified if we find any.
- **The FONSI signed on June 11, 2008**
- **US ACE Wetlands Permit issued December 24, 2008**

NOvA assembles 3 Detectors

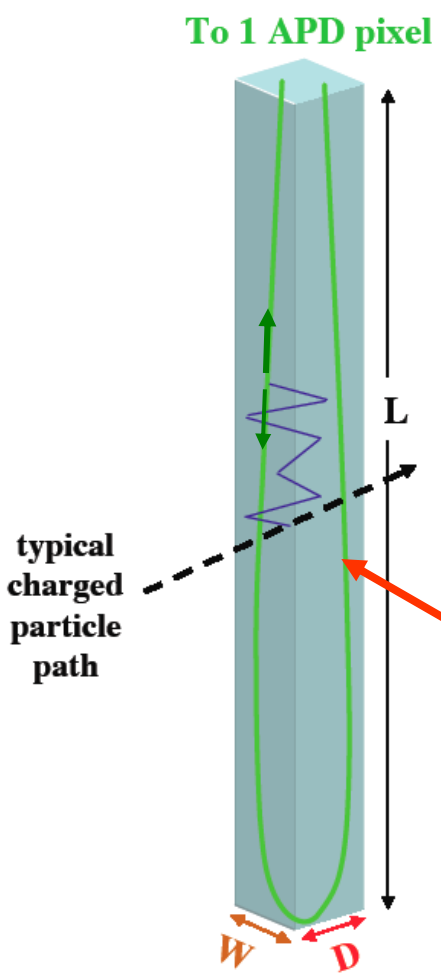




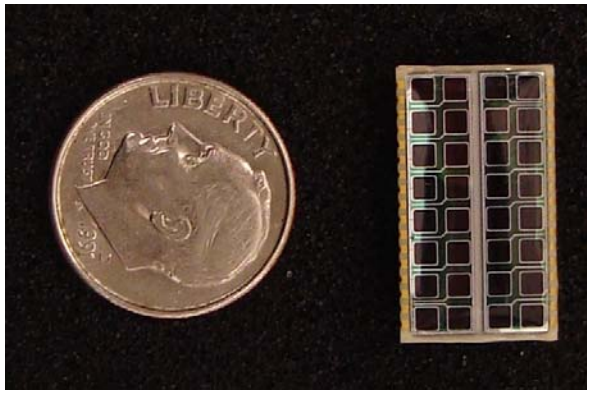
All have successive layers of vertical and horizontal cells bonded together with adhesive

- 14,000 ton **Far Detector**
  - 12 by 12 extrusion modules
  - 970 layers
- 222 ton **Near Detector**
  - 2 by 3 extrusion modules
  - 199 layers
- 90 ton Integration Prototype Near Detector (**IPND**), R&D goal in 2009-10
  - 2 by 3 extrusion modules
  - 124 layers, reuse all in Near Detector

NOνA Basic Detector Element



- Liquid scintillator in a highly reflective PVC cell
  - 4 cm wide, 6 cm deep, 15.7 m long
  - **15.7 m long = 53 feet** so it fits on a semi-trailer truck
  - **372,000 cells altogether**
  - Indiana + Fermilab – scintillator
  - ANL+ Fermilab – PVC



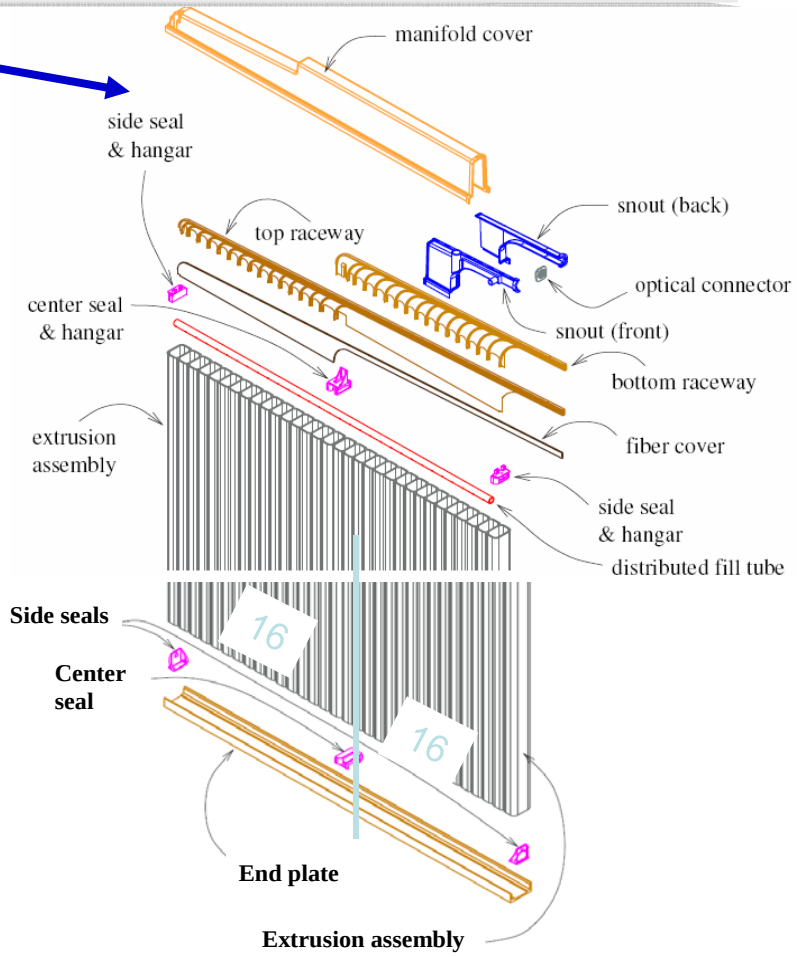
- Waveshifting Fiber
  - Light is collected in a 0.7 mm dia. wavelength-shifting fiber,
  - The fiber is U-shaped and both ends terminate in one pixel of a 32-pixel avalanche photodiode (APD), cooled to -15°C
  - **~13,000 kilometers of fiber**
  - Michigan State U – fiber
  - Caltech + Minnesota – APD

PVC Extrusions (ANL leads)

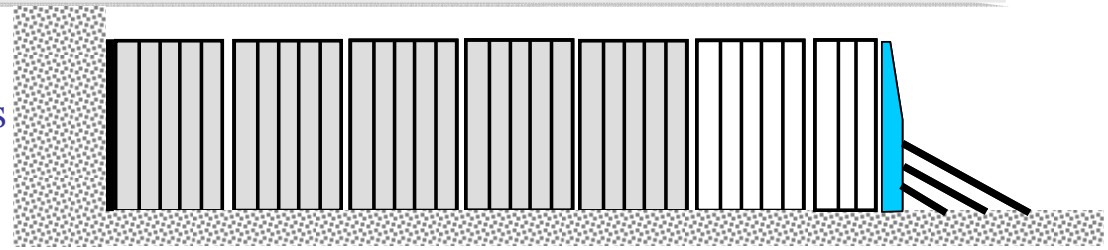
- Custom 16 cell PVC die built
- Custom PVC resin is extruded into 15 m long units.
  - 23 metric tons extruded so far
  - **4,300 tons** in final detector
  - Different resins, N-27 now final
  - QA/ QC in development on flatness, cell wall thickness, reflectivity
- Not easy to handle and manipulate 15 m long objects!

Extrusion Module details

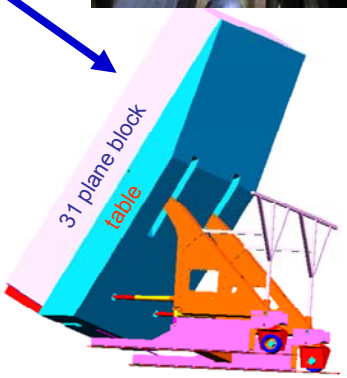
- **Extrusions assembled in to modules with complicated ends – module is primary containment vessel**
  - U of Minnesota, Twin Cities leads
  - Automated assembly **11,160 modules**
- **Modules ultimately filled with 3 million gallons of scintillator**
  - Mineral Oil, Pseudocumene, waveshifting powders
  - Indiana University leads
  - Early R&D blended 5 gallon samples, have now blended 4,500 gallon, intend to use a Toll Blender to blend the full 3 million gallons
- **Electronics** (Vertical Slice, Caltech)
  - Front End Boards
    - (**~12,000** required, Harvard)
    - APD integrated circuit on each (Fermilab)
  - Data Control Modules
    - **(~ 200** required, Fermilab)
    - Each collect serial data from 64 FEBs
  - Timing / Command
    - (**~10** required, Fermilab)



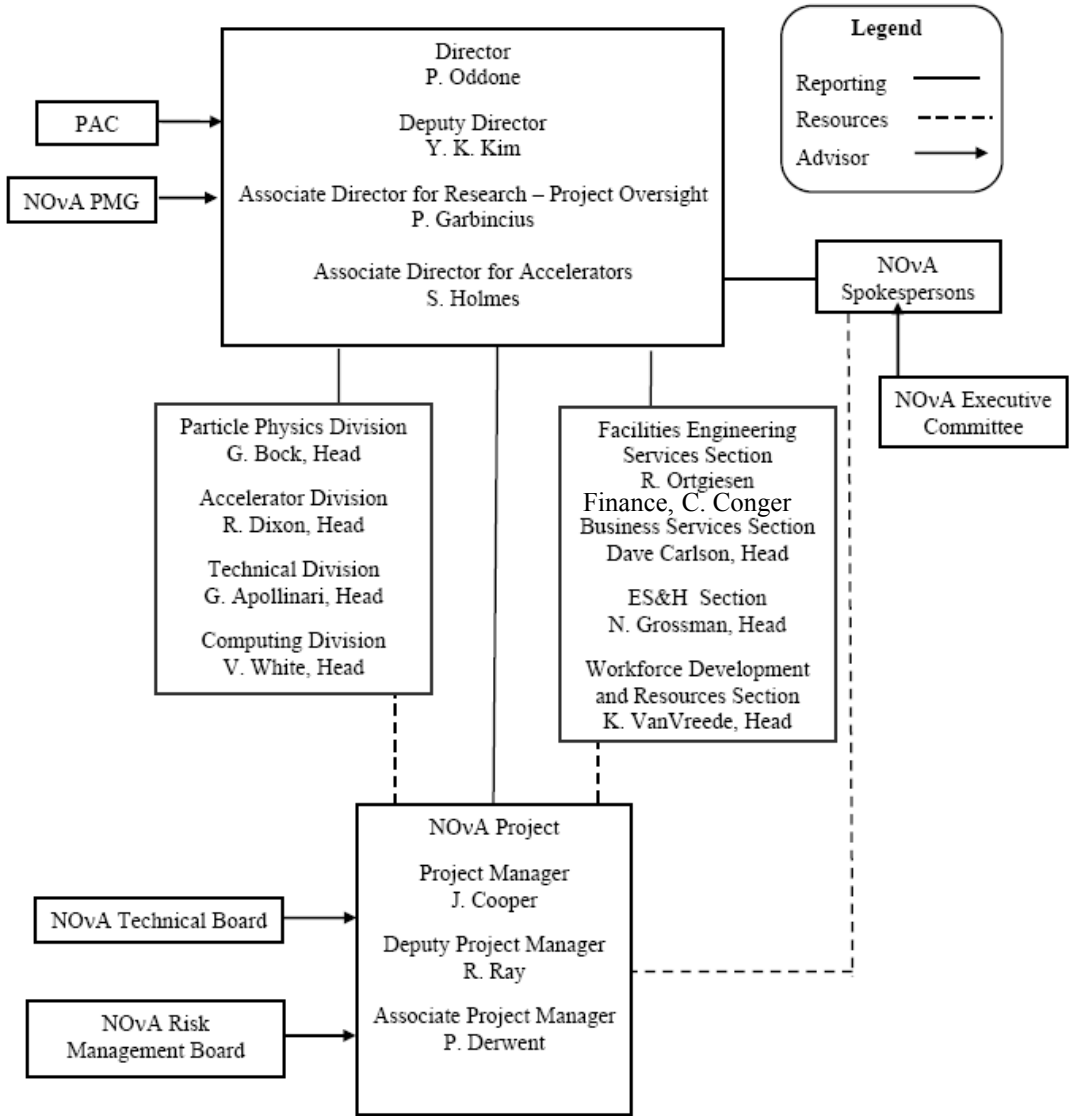
Detector Assembly



- Thirty blocks, each 31 planes
  - each plane with 12 extrusion modules
  - ANL, Fermilab design
- **Vacuum Lifter**
  - Being assembled at ANL
- **Adhesive Machine**
  - Being assembled at ANL
- **Pivoter** (Fermilab design)
  - External review complete
  - final design started
- Several **structure tests**
  - Near Detector Prototype completed
    - Early extrusions, built at ANL, tested with overpressure, compared with FEA
  - Full Height Pressure Test w scintillator
    - 2 modules at Fermilab, started
  - Full Size Assembly Prototype on floor
    - 8 layers, starting at ANL in February
  - Full Height Assembly Prototype (future)
    - Minnesota modules, glue 1/12th of a 31 plane block at ANL, protoype pivoter at Fermilab in CDF Building



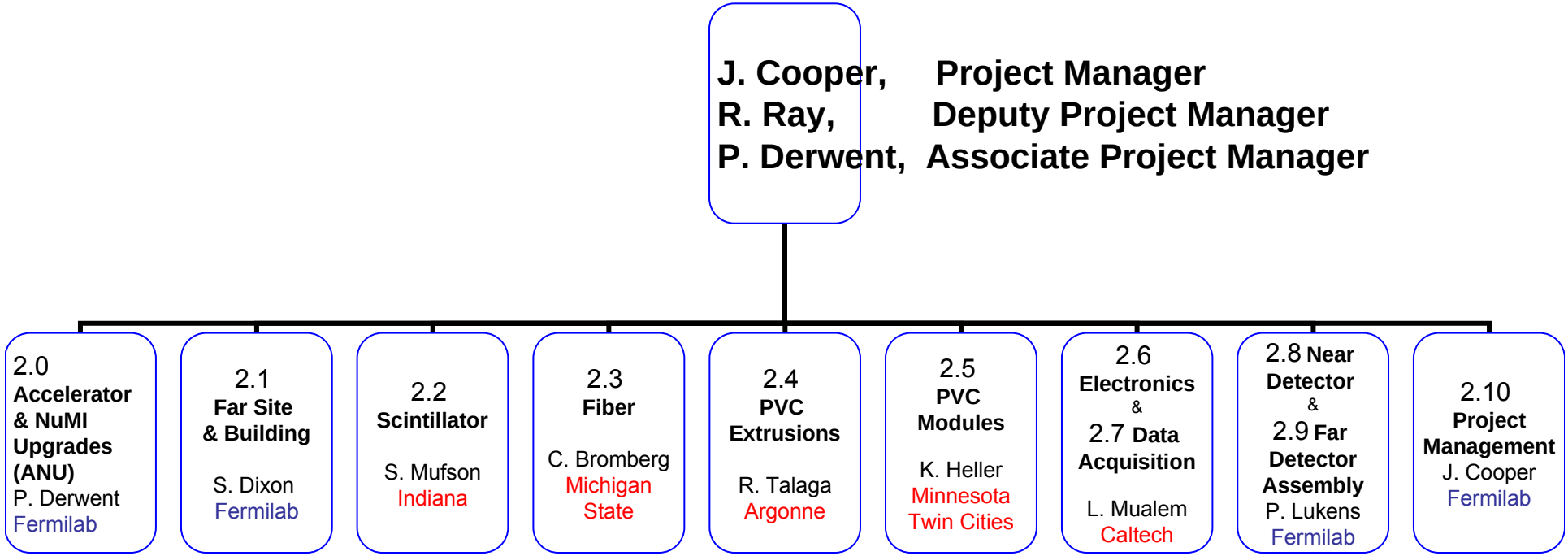
How NOvA Project fits in the FRA / Fermilab organization



NOvA WBS/OBS

(Work Breakdown Structure / Organizational Breakdown Structure)

- The WBS follows the work described on previous slides
  - also breaks down into similar value tasks
- The OBS follows the lead institutions for the work



These "Level 2" mangers are technical managers and CAMs

WBS 2.x for the construction project, similar WBS 1.x for R&D/Ops

WBS 1.8, 2.8 & 2.9 has an additional integration responsibility

Project Office Staff are mostly at Fermilab, but not exclusively at Fermilab

Dave Pushka, Mechanical Project Engineer
John Oliver (Harvard), Electronics Project Engineer
Anna Pla-Dalmau, Project Chemist

Suzanne Saxer, Project Financial Officer
Bill Freeman, Project Scheduler
Ken Domann, ANU scheduler
Harry Ferguson, Assistant Project Scheduler

Project Controls

Keith Schuh, ES&H Detector
Mike Andrews, ES&H Accelerator
Alan Wehmann, websites / document databases
Nancy Grossman, QA oversight, Risk Registry
Elaine McCluskey, Configuration Control, EVMS coordination
Bob Bernstein, Expediter & Document Coordinator
Jon Paley (Indiana), databases

People in light blue are moving on to other jobs and projects and will be replaced in the next few months.

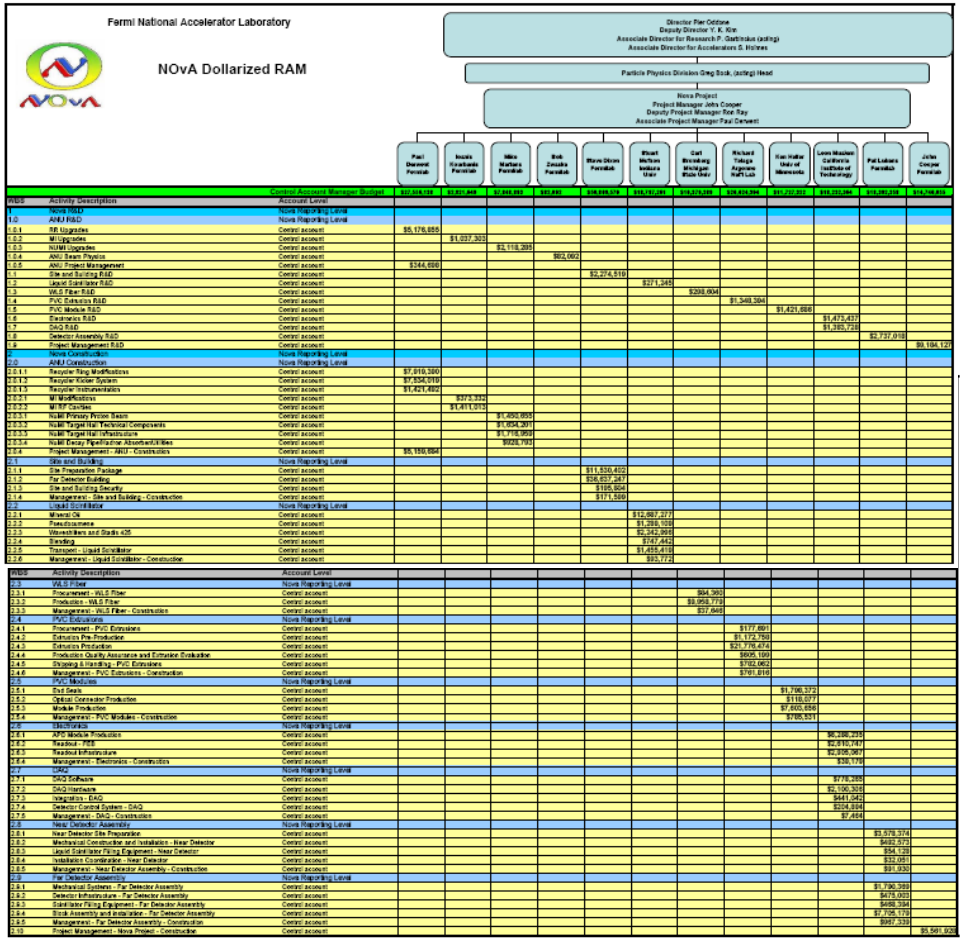
Dollarized RAM (12 CAMs)

- **67 Control Accounts, 12 CAMs**
  - **All Level 2 in WBS + Accelerator WBS Level 2 divided into 4 Level 3s**

- Derwent -- $ 27.5 M
- Kourbanis- $ 2.8 M
- Martens --- $ 7.8 M
- Zwaska --- $ 0.1 M

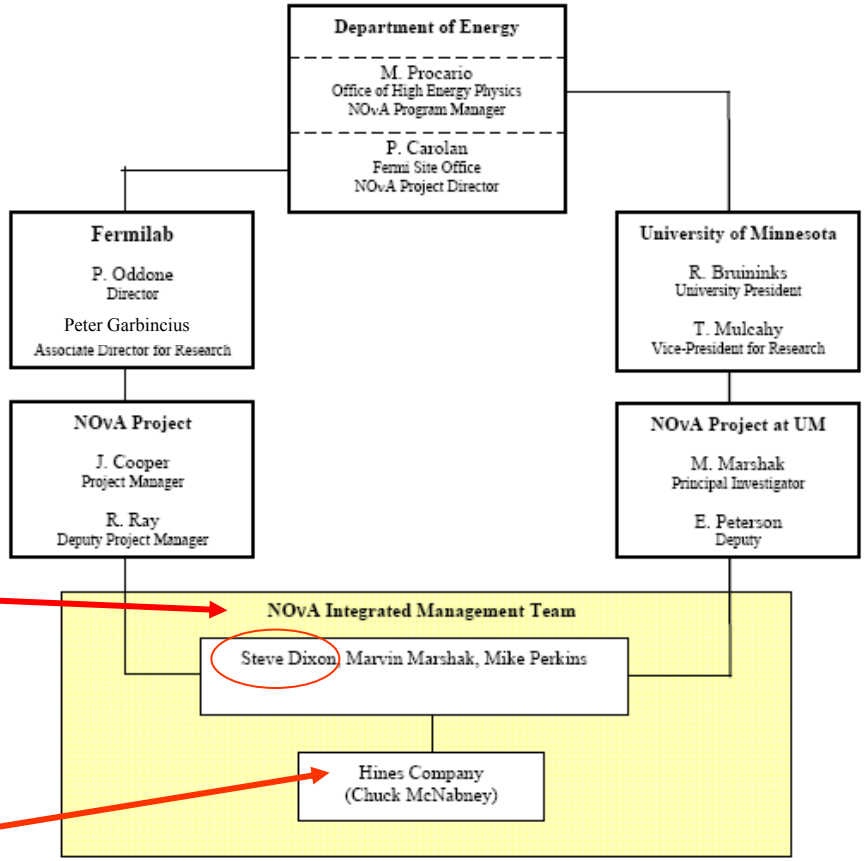
CAMs include three Level 3s

- Dixon ------ $ 50.8 M
- Mufson ---- $ 18.8 M
- Bromberg - $ 10.4 M
- Talaga ----- $ 26.6 M
- Heller ----- $ 11.7 M
- Mualem --- $ 18.2 M
- Lukens ---- $ 18.4 M
- Cooper ---- $ 14.7 M



Ash River Organizational Wrinkle

- The University of Minnesota received a DOE Cooperative Agreement grant for the building (Marvin Marshak is P.I.)
  - UM acquired the land and easements for the access road
  - UM will own and operate the building
- Official part of the Acquisition Strategy adopted as part of the CD-1 approval on May 11, 2007
  - An MOU between UM and the Fermilab Project were part of the scope of work
- The signed MOU is in place
  - Integrated Construction Team
  - Use U of Minn procurement rules, but consensus with Project on larger questions, e.g. AE design firm, major contractors
    - Succeeded on "project management" firm
  - In the MOU, U of Minn agreed to and now reports monthly to Project Office
  - Earned Value computation is being done



Work Authorization

- Project Office authorizes work through Work Authorization Documents
  - Approved by Scheduler, Financial Officer, CAM, Project Manager
  - Example on next slide
- WAD must be in place before a control account, any of its subsidiary Work Packages (not cost accounts) and associated Fermilab task accounts can be opened
  - Suzanne Saxer (Field Financial Officer) is responsible for checking the prerequisites
  - We actually have 67 Control Accounts and then another ~200 Work Packages (not Cost Accounts) below the Control Account level.
    - Actual costs are accumulated at the Work Package (not Cost Account) level & roll up to the Control Accounts.
- Labor at Fermilab is effort reported to open Fermilab cost accounts
  - Monthly Effort reports from all divisions available to CAMs for checking the data
- Moving funds outside of Fermilab also requires Purchase Order and
  - Memorandum of Understanding (MOU)
    - Over-arching document describing expected contributions and responsibilities of institutions
    - Signed by Fermilab and the Institution's management
  - Statement of Work (SOW)
    - One for each FY detailing amounts expected to be funded by Fermilab
    - Signed by Fermilab, Institution's management, <u>and the CAM</u>

WADs

CONTROL ACCOUNT PLAN/WORK AUTHORIZATION FORM
NOvA Project

Control Account Title: Site Preparation Package

Control Account Number: 2.1.1

Work Breakdown Structure Element: WBS 2.1.1

Period of Performance: 27Sep07 to 05Nov09

Current Authorized Budget (in AY$ with all burdening): $11,530,402

This Work Authorization, including all attachments, represents the agreement between t Project Manager and Control Account Manager (CAM) to perform, or to have performe efforts defined by the following:

1.) A WBS Dictionary sheet that defines the scope of work for this WBS element/Control Account. If additional definition is warranted, or required for a particular WBS elemen (e.g., QA reasons, Work Orders for third party services, etc) attach applicable documentation.
2.) A detailed Control Account schedule showing all work packages and planning package
3.) A detailed resource report by WBS and schedule activity.
4.) Budgeted cost by month

This Work Authorization is for the lifecycle of the project. Funding will be authorized incrementally based on schedule status and funding availability, and communicated by other mea to CAMs.

In addition to the CAMs approval of all third party commitments (i.e., Memorandums of Understanding (MOU) with other institutions, purchase orders, and subcontracts), the following is required:

- Commitments must be approved by the Project Manager for all R&D work > $1000, and for construction work where commitments values are greater than $10,000.
- To move funds to collaborating institutions, the CAM is to see that the following is in place befo executing the purchase order:
  - MOU with the collaborating institution, singed by both parties, including the Project Manager.
  - Statement of Work, one for each fiscal year (FY), detailing the amounts expected to be funded during that FY. SOW signatures must include the CAM and the Project Manager.
  - This Work Authorization with all approvals.

Any change to this document will be implemented through the Change Control procedures.

Approvals will be done through the NOVA DocDB on the Work Authorization Document file.

Signature chain will be Scheduler, Financial Officer, Control Account Manager, and Project Manager.

Control account task codes may not be opened without a signed work authorization form

NOVA Document 3322-v2
[NOvA DocDB Home]

Work Authorization Document for Control Account 2.1.1
(Document Status: Approved)

Document #:
NOVA-doc-3322-v2
Document type:
Work Authorization
Submitted by:
Elaine McCluskey
Updated by:
Elaine McCluskey
Document Created:
24 Oct 2008, 11:20
Contents Revised:
01 Dec 2008, 12:53
DB Info Revised:
01 Dec 2008, 12:53

Update Document
Update DB Info
Add Files
Watch Document

Abstract:
This document contains files or links to other files in NOVA-docdb that constitute this Work Authorization Document.

Files in Document:

- NOVA Budgeted Cost by Month by CA 2.1.1.pdf (29.7 kB)
- NOvA WAD form CA 2.1.1.doc (79.5 kB)
- WBS Dictionary 1.1, 2.1.pdf (7.7 kB)
- WP Schedule for Control Account (WAD Gantt CA_2.1.1.pdf, 58.1 kB)

Get all files as tar.gz, zip.

Topics:

- Project Management:Work Authorization

Authors:

- Steve Dixon

Keywords:
control_account

Notes and Changes:
updated WAD form, added budgeted cost by month, added signoffs

Referenced by:

- NOVA-doc-3401: CAM Notebook for 2.1.1 (Approved)

Signoffs:

- Suzanne L. Saxer (signature complete)
  - William S. Freeman (signature complete)
    - Steven Dixon 880343 (signature complete)
      - John W. Cooper 937155 Remove Signature

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Fermi National Accelerator Laboratory

MOUs and SOWs

	WBS (incl. associated 1.x)	MOU	FY08 SOW	FY09 SOW
Coop Agreement	2.1	18-Dec-07		
Transition to CA, U of Minn	2.1	19-Jan-07	24-Jul-08	
Indiana U - Astrophysics	2.2,2.6	17-Jul-08	22-Aug-08	16-Dec-08
Indiana U - Physics	2.9	12-Nov-07		10-Nov-08
Michigan State	2.3	28-Aug-08	22-Aug-08	
Argonne	2.4,2.8,2.9	16-Oct-07	22-Aug-08	27-Aug-08
U of Minn	2.5,2.6	14-Feb-08	26-Aug-08	
CalTech	2.6	13-Jun-08	20-Jun-08	
Harvard	2.6	22-Aug-08	26-Aug-08	
U of Virginia	2.6	15-Oct-08		
Duluth		8-Nov-07		

MOUs and SOWs

- Example text on EVMS from MOU:

III. Reporting, Costs and Schedule

1. Reporting

MSU will document as NOvA notes the procedures, analyses and results obtained as this work progresses. MSU will provide material for NOvA Project monthly reports in a timely fashion, including descriptive material, financial reporting, monthly task status reports and information needed for the NOvA Project's monthly earned value management analysis.

2. Estimated Costs and Schedule

MSU and Fermilab will jointly develop annual Statements of Work to provide detailed descriptions of the work covered by this MOU, including cost and schedule estimates. MSU will monitor the progress of this work in order to provide ample notice of projected deviations from the cost and schedule estimates. If it is determined that additional funds will be needed, the Fermilab NOvA Project Manager will evaluate available options and, in consultation with MSU, determine the best means of supplying the required resources.

- From SOW:

III. Reporting, Costs and Schedule

1. Reporting

The IU HEAP group will document the procedures, analyses and results obtained as NOvA notes as this work progresses. IU HEAP will provide material for NOvA Project monthly reports in a timely fashion, including descriptive material, financial reporting, monthly task status reports and information needed for the NOvA Project's monthly earned value management analysis.

Signatures on MOUs & SOWs

- Michigan State MOU

Approvals

The following concur in the terms of this Memorandum of Understanding.
These terms will be updated as appropriate in Amendments to this Memorandum.

Institutional Approvals:

Carl Bromberg 8/23/08
C. Bromberg, Prof., MSU (date)

S. D. Mahanti 8/25/08
S. D. Mahanti, Prof. and Associate Chair, Physics and Astronomy Dept., MSU

27 aug 08
E. Pedawi, Con&Gr Admr/S, MSU Contracts and Grants Administration

8/28/08
J. Cooper – NOvA Project Manager, Fermilab – date

8/29/08
G. Bock – Acting Particle Physics Division Head, Fermilab – date

9/2/08
P. Garbincius – Associate Director for Research for Project Oversight, Fermilab – date

- Argonne FY09 SOW

IV. Approvals

The following concur in the terms of this Statement of Work.
These terms may be updated as appropriate in Amendments to this document.

Institutional Approvals

27 August 2008
D. Ayres - NOvA Group Leader, HEP Division, Argonne National Laboratory - date

8/27/2008
H. Weerts - HEP Division Director, Argonne National Laboratory - date

8/27/08
J. Cooper - NOvA Project Manager, Fermilab - date

8/28/08
G. Bock – Particle Physics Division Head (acting), Fermilab - date

9/2/08
P. Garbincius – Associate Director for Research for Project Oversight, Fermilab - date

NOvA Project Cost Account Manager Approvals

27 Aug 08
P. Lukens – Detector Assembly (WBS 1.8, 2.8, 2.9) - date

8/27/08
R. Talaga – PVC Extrusions (WBS 1.4, 2.4) - date

CAMs

MOU on Cooperative Agreement

- EVMS text:

V. Narrative and Financial Reporting to the NOvA Project Office

The Fermilab NOvA Project is responsible for monthly reporting to the DOE of the project status and will include UM information on the CA in these narrative and financial status reports. NOvA Project change control procedures will be exercised by the Fermilab NOvA Project Office using the allocation of contingency information provided by UM. NOvA Change Control procedures require reporting to DOE when the sum of contingency usage passes certain thresholds, so a running total of all contingency usage is required.

UM will provide monthly reports, as well as episodic updates on NOvA construction activities. Reports will include both narrative and quantitative construction and financial data.

Monthly reports will include detailed descriptions of contingency accounts, including allocations of CA contingency and remaining CA contingency. UM will report individually and, as soon as possible, on all allocations of contingency less than $10,000. Whenever possible, UM will seek consultation with Fermilab NOvA Project Management on contingency allocations in excess of $10,000, in advance of such allocation.

- Example of "authorized undefined work"
- Required for field changes in construction
- But equivalent to "Level 3" work of the project

XI. Approvals

Marvin L. Marshak, University of Minnesota, School of Physics and Astronomy

12/18/07
Tim Mulcahy, Vice-President for Research

12/12/2007
Allen Goldman, University of Minnesota, Head, School of Physics and Astronomy

12.14.07
Michael Perkins, University of Minnesota, Associate Vice President, Capital Planning and Construction Management

Steven L. Crouch 12/13/07
Steven Crouch, Dean, Institute of Technology

12/7/07
John Cooper, Fermilab, NOvA Project Manager

10 Dec 07
James Strait, Fermilab, Head, Particle Physics Division

Hugh Montgomery, Fermilab, Associate Director for Research

- No SOW in this case
  - Instead OHEP → CH → Minnesota,
  - OHEP consults with Project Manager
  - Initial grant, can amend once later in year

Deeper detail on Coop Agree, RAM

- See NOVA-doc-3544 for Change Control procedure
- See Responsibility matrix below for Reporting requirements (NOVA-doc-2996)

NOvA COOPERATIVE AGREEMENT INTEGRATED PROJECT TEAM RESPONSIBILITY MATRIX

	U. S. Department of Energy	Fermi National Accelerator Laboratory			University of Minnesota						
		NOvA Project Office	WBS 2.1		Physics	Capital Planning and Project Management	Building Code Division	Environment Health and Safety	Hines		
	P. Carolan	J. Cooper	S. Dixon	M. Olson	M. Marshak	M. Perkins	S. Holm	J. Dalgleish	C. McNabney	Burns and McDonnell	Resident Engineer
Title 2 (Design Phase)											
Procurement Phase		Approve A/E Selection	Draft A/E RFP scope Approve A/E Selection		Approve A/E Selection Record of MOU concensus	Review A/E RFP Scope Issue RFP Approve A/E Selection Establish Purchase Order with A/E			Review A/E RFP Scope Approve A/E Selection assist w/ contracting	Submit proposal	
Direction of A/E			Provide Technical Design Requirements approve change orders Interface with Fermilab	development of construction documents, drawing and exhibits		Approve change orders			Review Technical Design Requirements Issue change orders Interface with University of Minnesota development of construction documents, drawings, exhibits	Review of University standards.	
A/E Cost Tracking & Control			Monitor design progress Track Fermilab Costs Approve A/E Invoices			pay A/E invoices			Monitor design progress Track University of Minnesota Costs Approve A/E Invoices	Report design progress.	
Change Control for Design		approve changes to design performance baseline	submit changes to design performance baseline to NOvA Project	Identify changes to the design performance baseline	Identify changes to the design performance baseline	Identify changes to the design performance baseline	Identify changes to the design performance baseline		Identify changes to the design performance baseline	Identify changes to the design performance baseline	
Title 2 (Design) Coordination			Participate in Design Coordination Meetings Issue Meeting Minutes (Post on DocDB) Gather/Distribute Information within Fermilab	Chair Design Coordination Meetings Develop Meeting Minutes					Participate in Design Coordination Meetings Gather/Distribute Information within University of Minnesota	Develop Meeting Minutes	
Design Reviews		Review documents, provide feedback	Issue Design Reviews within Fermilab and NOvA Project	Coordinates review, recieves comment and issues resolution	Review documents, provide feedback	Review documents, provide feedback	Review documents, provide feedback		Issue Design Reviews within University of Minnesota	Support University review	
Value Management		Participate in Value Management Meetings	Participate in Value Management Meetings	Participate in Value Management Meetings	Participate in Value Management Meetings				Chairs Value Management Meetings	Participate	
Design sign-off											
Project Reporting		periodic updates to Lab management	provide input for periodic updates to Lab management Prepare Monthly Level 2 Report						provide input for periodic updates to Lab management Provide monthly narrative and financial reporting to the Fermilab NOvA Project Office		
			Maintain FESS project files			Maintain CPM project files			Maintain Hines project files	Maintain A/E project records.	records.

Legend	
	indicates initiator of action
	indicates approval action required

List of Acronyms	
A/E	architectural / structural consultant
BO	beneficial occupancy
CCB	change control board
CM	construction manager
ICE	independent cost estimate
NTP	notice to proceed
PM	project manager
PO	purchase order
QA	quality assurance
RFI	request for information
RFP	request for proposal
SET	source evaluation team

Change Control Process

- NOvA change control is described in NOVA-doc-131
  - To date the PM has signed all CRs regardless of thresholds, controlling startup

	Secretarial Acquisition Executive (Level 0-A) Deputy Secretary	Acquisition Executive (Level 0-B) SC-1	Associate Director OHEP (Level 1)	DOE NOvA Federal Project Director (Level 2)	Fermilab Associate Director (Level 3)	NOvA Project Manager (Level 4)	Subproject Manager (Level 5) CAM
Technical	A change in scope that affects the ability to meet a Key Performance Parameter (KPP) and the ability to satisfy the mission need.	A change in scope that affects the ability to meet a KPP and the ability to satisfy the mission need.	Any change in the KPPs as referenced in PEP section 3.2.	Any significant change to the technical scope (as described in PEP sect. 5) that affect ES&H requirements or meeting Project Closeout definitions in PEP Table 7.2.	Major technical changes that are significant departures from the technical baseline. Changes that affect ES&H or impact PoT projections by more than 10%. Out-of-scope changes to upgrade physics capabilities.	Related technical changes to multiple subprojects that do not diminish performance	Minor technical changes to a single subproject that does not diminish performance
Schedule	≥ 6 month (cumulative) delay in the CD-4 completion date.	a 3 to 6 month (cumulative) delay in the CD-4 project completion date.	Any change to a level 1 milestone > 3 months, or up to a 3 month delay in CD-4 project completion date .	Any change to a Level 2 milestone > 1 month or a Level 1 milestone < 3 months.	Any change that results in the delay of a Level 3 Director's milestone.	Any change that results in the delay of a Level 4 milestone by more than one month.	Any change that results in the delay of a Level 5 milestone by more than one month
Cost	Increase in excess of $25M or 25% (cumulative) of the CD-2 Total Project Cost baseline.	Any increase in the CD-2 Total Project Cost baseline.	Any change in Total Estimated Cost or Total Project Cost.	Any cumulative use of contingency of > $1M.	Increase in the cost of a single item by more than $250k. Increase in the Project base cost exceeding $500k during the previous 12 months.	Increase in the cost of a single item by more than $100k.	Increase in the cost of a single item by more than $25k.

NOTE: INFORMATION FOR LEVEL 0 – LEVEL 2 CHANGES IS COPIED FROM THE PROJECT EXECUTION PLAN

Log of Changes (full log available)

- We do this in an Access database so we can keep track of the sum of changes to date for thresholds

NOVA Change Request Report by Approval Status

CR #	CO Title	Prel Cost Impact (no contingency)	Prel Sch Impact	Final Cost Impact (no contingency)	Final Schedule Impact	Date Closed	Awaiting
Changes with Status:	**Approved by PM**						
1	Near Detector Prototype ASIC	($50,572.00)		($51,849.94)	none	3/18/2008	
2	IPND ASIC Production	($54,868.00)		($55,833.39)	none	3/18/2008	
3	ASIC Prototype II	$55,680.00		$55,913.32	none	3/18/2008	
4	IPND FEB Production	$25,810.00		$27,366.92	none	3/18/2008	
7	Produce Electronics Box	($13,000.00)		($10,220.00)	none	3/18/2008	
47	Rearrange Scintillator Production Blending Study Resources	($1,845.00)	none	($1,812.54)	none	10/14/2008	
48	Revised ADCW Magnet Modification Plan	$76,372.00	none	$76,904.56	none	11/4/2008	
50	ANU - Moving Test Magnet Tasks, Adding New Trimming Task, and Removing RQN Magnet Fabrication	$1,531.00	none	$1,526.64	none	12/12/2008	
	Total Prelim Cost:	$373,255.25	**Total Final Cost:**	$363,575.97			

Tuesday, December 23, 2008 Page 3 of 5

Log of Changes (full log available NOVA-doc-3191)

- List requiring Associate Director or FPD approval so far

CR #	CO Title	Prel Cost Impact (no contingency)	Prel Sch Impact	Final Cost Impact (no contingency)	Final Schedule Impact	Date Closed	Awaiting
Changes with Status:	**Final Approval**						
14	OP Errata - WBS 2.10 - Add Admin Asst	$557,909.44	none	$557,909.44	none	3/4/2008	
17	OP Errata - Class 2 - 43 small changes correcting discrepancies btwn RLS and BOEs	$192,755.00		$280,173.16	none	8/19/2008	
24	FY08 Subproject Management Task Changes	$0.00		($1,455,648.67)		8/19/2008	
26	Removing Gap Clearing Kicker R&D from NOVA Project	($1,554,444.00)		($1,633,197.18)		8/19/2008	
33	WLS Fiber Procurement FY Budget Adjustments	($707,230.00)	delay due to funds reduction	($707,240.00)	various	8/19/2008	
35	Global Schedule and Budget Updates to Unstarted tasks due to FY08/FY09 funding delay and Selected Scope Adjustments	$6,898,578.00	various due to funding delay	$6,783,802.00	various	8/19/2008	
49	ANU Horn 2 Relocation - Change to Salvage Steel for Shielding	($385,249.00)	none	($384,667.69)	none	11/21/2008	
	Total Prelim Cost:	$5,002,319.44	**Total Final Cost:**	$3,441,131.06			

Example Change Request

- #26

NOvA Project Office — **CHANGE REQUEST RECORD**

NOvA-CR No.	26
Related NOvA-DCN No.	
Date Initiated	3/11/2008
Date Revised:	4/14/2008
Date Closed	
Level of Change	L4 (NOVA PM)
Status	In Process
Awaiting:	Freeman

PRELIMINARY

Cost Impact: ($1,567,719.00) 1,554,444

Schedule Impact:

PM GO-AHEAD 4/14/08 DATE

FINAL APPROVAL <1,633,197.18> Cobra 5/30/08

Final Cost Impact: ~~$0.00~~ from Project Financial Officer

Final Schedule Impact: from Project Scheduler

L2 MANAGER	8.7.08 DATE
PROJECT MANAGER	8/7/08 DATE
FINANCIAL OFFICER	5/30/08 DATE
SCHEDULER	5/14/08 DATE
ASSOCIATE DIRECTOR FOR RESEARCH (IF REQ'D)	8/19/08 DATE
DOE FEDERAL PROJECT DIRECTOR (IF REQ'D)	8/19/08 DATE

SUBMITTED INFORMATION

CR Title: Removing Gap Clearing Kicker R&D from NOVA Project

Change Type: ☑ Technical ☑ Cost ☑ Schedule ☐ Other

Initiator Name: N Grossman

Initiator Email: grossman@fnal.gov

Affected WBS #'s: various

Change Description: This change removes the R&D for the Gap Clearing Kicker construction for ANU from the NOVA Project. This work, important for reducing radiation activiation at MI-10 in general, will be undertaken with laboratory operating funds, and is expected to be installed in the Main Injector.

CR File found in NOVA-doc- 3088

BUDGET INFORMATION ($FY07 unburdened)

MS Cost Before Change:

MS Cost After Change:

Labor Resource Type: (one resource per line) Hours Before Change: Hours After Change:

Log of Changes (full log available)

- Changes in progress

CR #	CO Title	Prel Cost Impact (no contingency)	Prel Sch Impact	Final Cost Impact (no contingency)	Final Schedule Impact	Date Closed	Awaiting
Changes with Status:	**Inactive**						
27	Move FY08 Management Labor from R&D to MIE	$0.00	none	$0.00		8/8/2008	
34	Project Management Task Adjustments	$0.00		$0.00		8/7/2008	
	Total Prelim Cost:	$0.00	**Total Final Cost:**	$0.00			
Changes with Status:	**Prelim Approval**						
51	Cost Adjustment for Prototype Scintillator Filling Equipment	$13,350.00	none	$13,403.75	none		Lukens
52	Procure New Sealant Dispensing Equipment	$100,881.00	none	$100,484.69	none		Lukens
	Total Prelim Cost:	$114,231.00	**Total Final Cost:**	$113,888.44			
Changes with Status:	**Submitted**						
53	Kicker PFL Frames	$0.00		$0.00			Freeman
54	ANU Beam Tube Brazing Changes	$0.00		$0.00			Freeman
55	Leak Checking System for IPND	$0.00		$0.00			Freeman
	Total Prelim Cost:	$0.00	**Total Final Cost:**	$0.00			

Planning and Scheduling Process

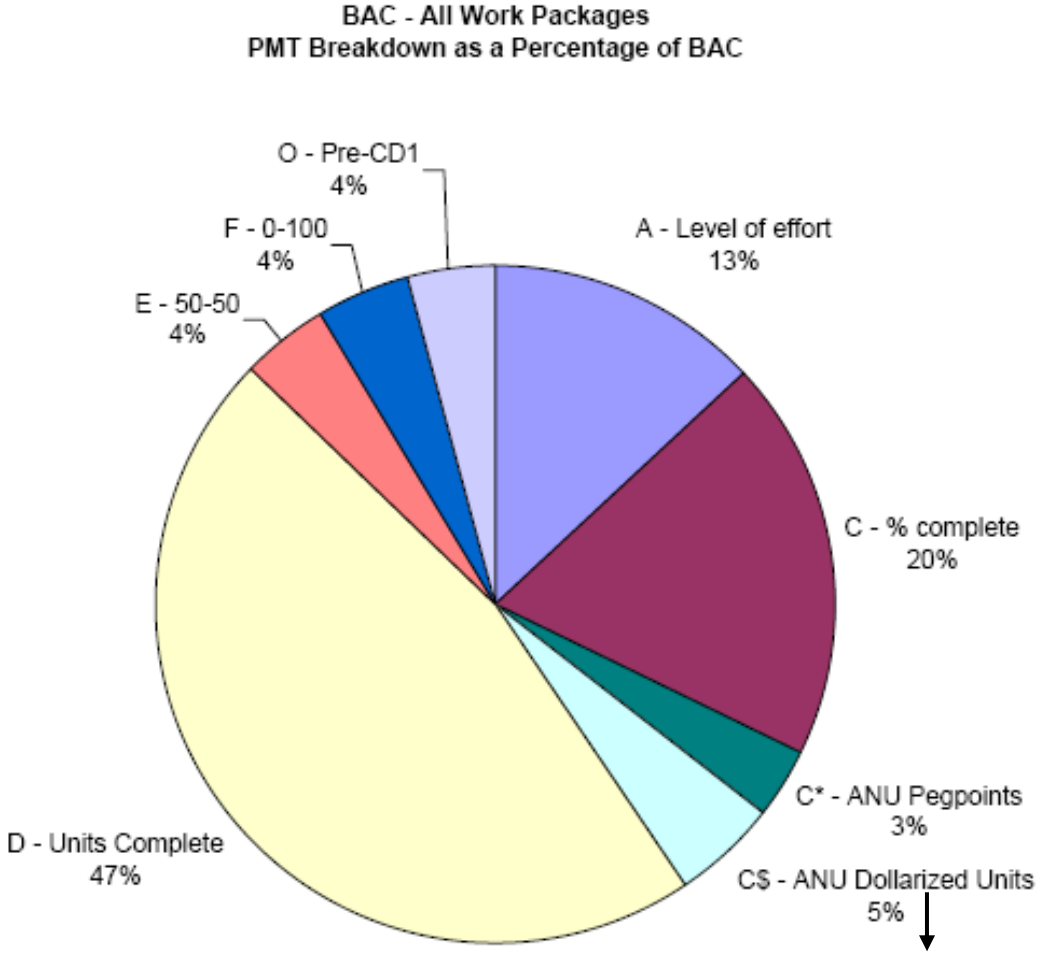
- We use Open Plan, our schedule has ~ 5,000 tasks and milestones
- **Scheduling Guidelines given to CAMs:**
  - Instructed by the Project Manager to provide best estimates for the duration of every task
  - There should be no hidden contingency in the schedule
  - Tasks with schedule uncertainty should have estimated cost contingency designed to speed up the work commensurate with the risk
    - We do have ~250 documented risks and a Risk Registry
- See **NOvA Key Assumptions** document (NOVA-doc-2954) for more details
  - This also has cost assumptions:
    - estimating instructions, labor cost assumptions, materials & services cost assumptions, escalation assumptions, cost guidance from DOE (funding profile), indirect cost assumptions at universities
  - Other key technical assumptions:
    - expectations from other Fermilab efforts assumed as pre-requisites to NOvA, risk of PVC structure,…
  - Other scheduling guidelines:
    - critical path guidance, assumed CD dates, assumptions about the Fermilab operating schedule since NOvA installation must fit within periodic shutdowns

Schedule Development

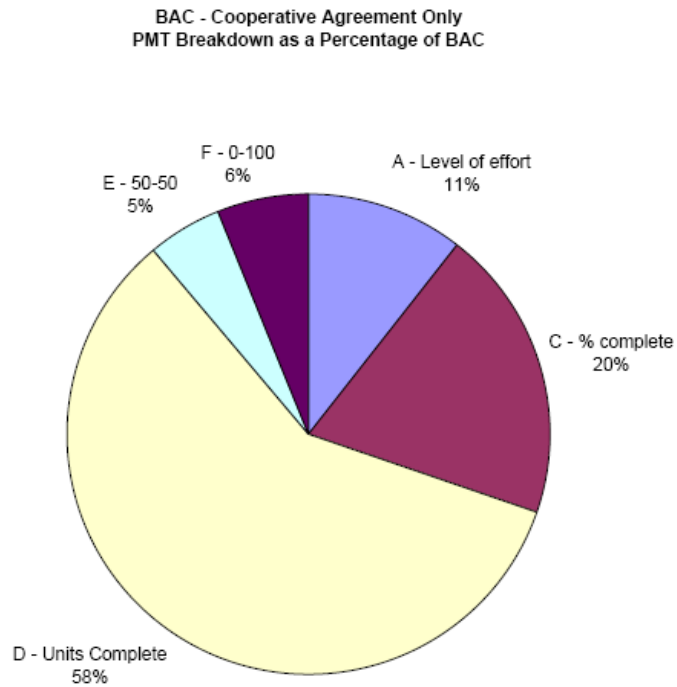
- Done by the CAMs, bottom up, linked all tasks
- Change Requests also cover schedule changes, not just cost changes (see slide #30 thresholds)
  - Addition of tasks, re-ordering of tasks
  - Prime example is the major re-work of our schedule to accommodate a funding driven shutdown of the project in Dec 2007 with a restart in Feb 2009 (later advanced to Aug 2008)
- Performance Measurement techniques set for each task.
  - We have a clear preference for objective units
    - Pounds of PVC, gallons of scintillator, meters of fiber, numbers of PVC modules built, numbers of electronics boards completed, numbers of detector blocks assembled at Ash River.
    - Numbers of accelerator modules of different types completed, tested
    - Cubic feet excavated for building, yards of concrete, ….
  - but we use all FRA allowed PMTs
    - Prefer to use 50-50 and 0-100 for short tasks, 1-2 months
    - % complete also used, sometimes with set points to define % amounts in advance
      - Used a little more by the accelerator people since they are adding small value to existing large objects in some cases and objective units aren't obvious
    - Level of Effort used primarily on management tasks

Performance Measurement Techniques

- $ value of PMT types used

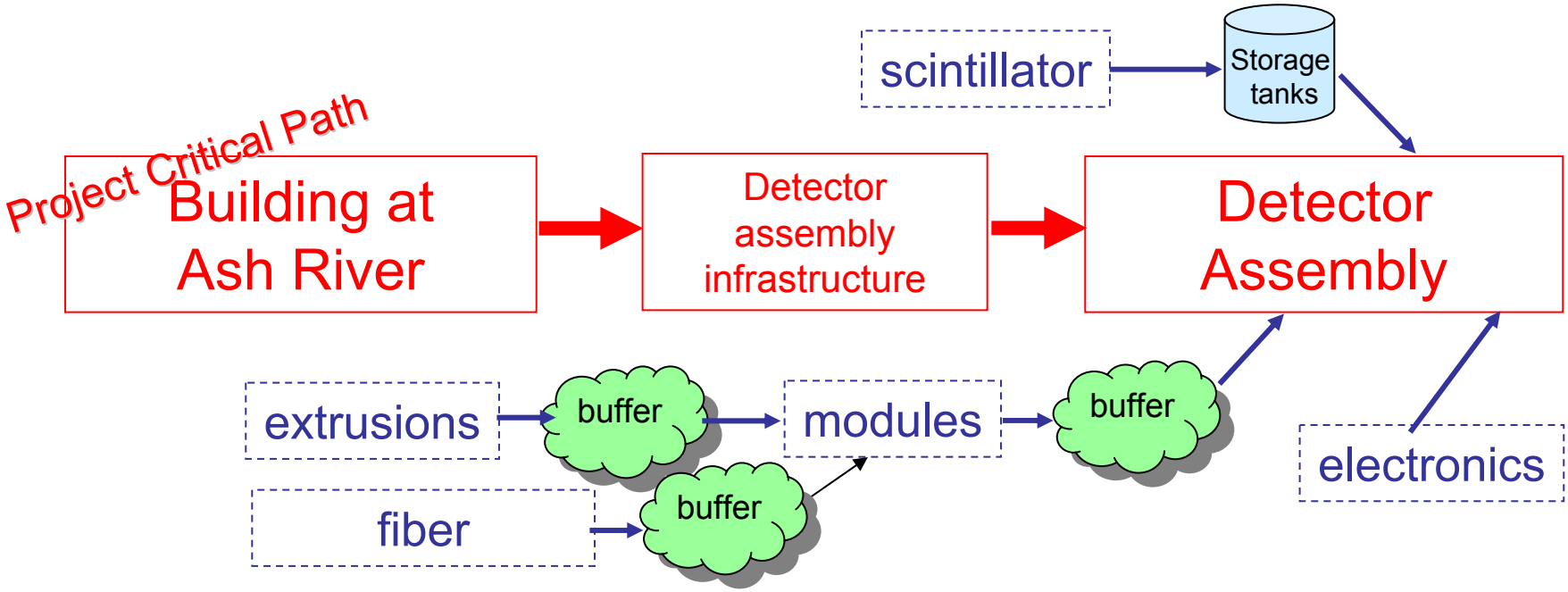


% = $ value of procured items received / total $. Used only on procurement tasks



Critical Path: Two parallel paths

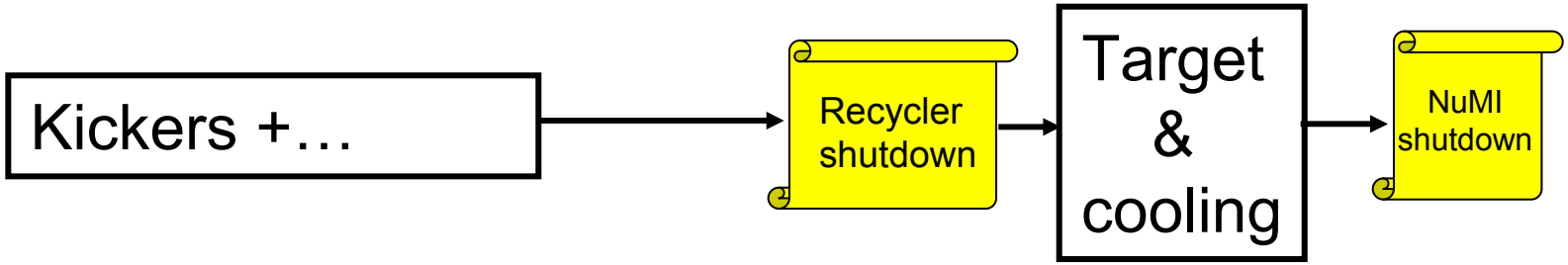
- **FIRST PATH:**
- We can't build the detector without a building at Ash River
  - Therefore we must push the building as fast as possible from the start



- **"Technical" <u>Project Critical Path</u>**
  is building, tools, then assembly at Ash River
  - Bill Freeman has done a complete critical path analysis of Open Plan and we understand the details of all these links and exactly what happens if we move one or more segments around in time
  - NEEDED this because out actual schedule is NOT technically driven. It is driven by the funding profile from DOE.

Schedule: SECOND parallel path

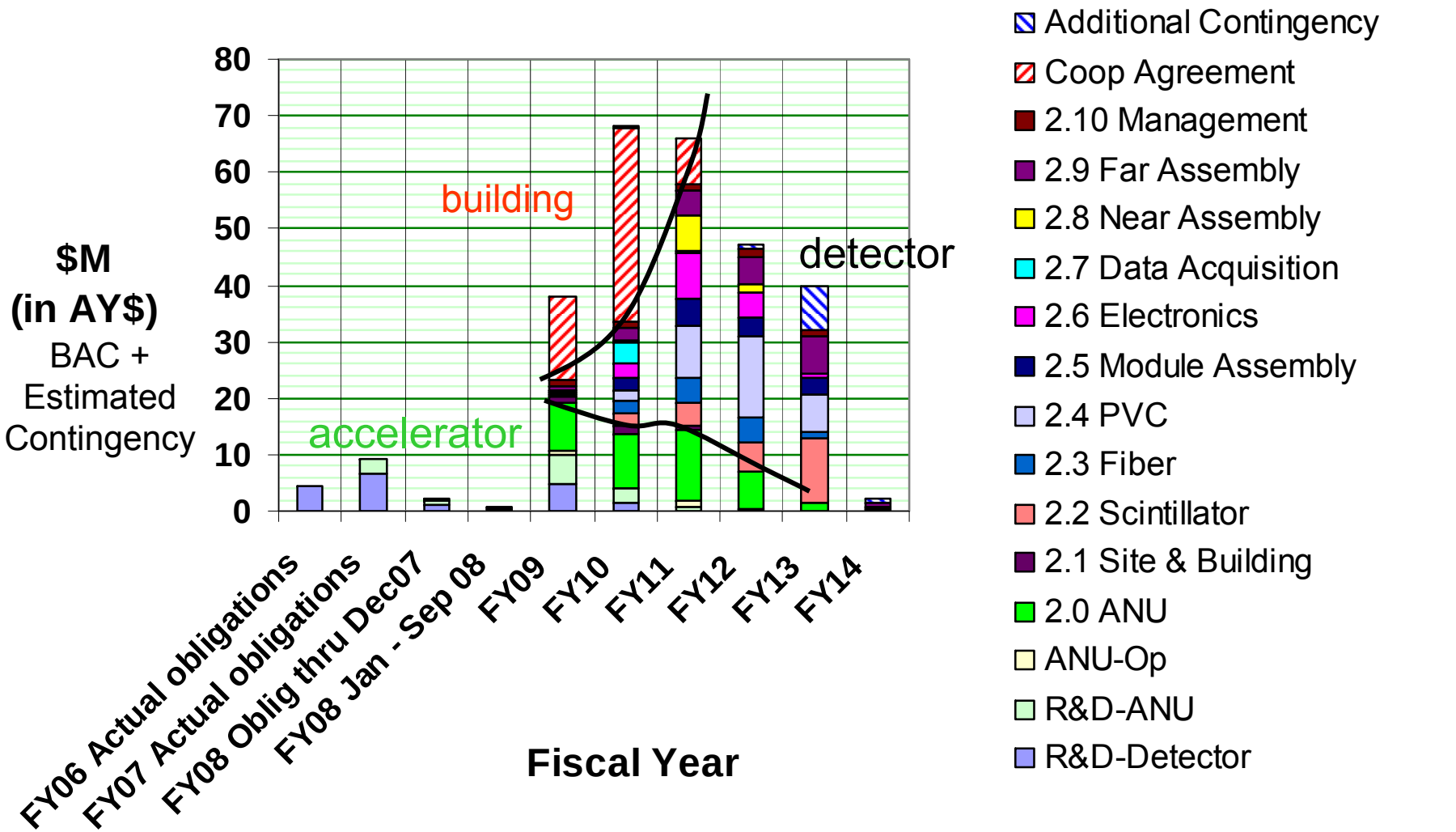
- Accelerator & NuMI upgrades use Fermilab Accelerator Division workforce, and all these people have additional operational responsibilities in the current Fermilab program.
  - So we have a leveled resource, leveled from outside the project
  - Given the operational uncertainties, we must push the Accelerator & NuMI as hard as possible and use the workforce to the fullest extent possible when available



- **The two parallel paths interact softly:**
  - Common contingency to ensure success
  - We want an operational neutrino beam after each shutdown so that commissioning of the detector can proceed for CD-4
  - But, commissioning of the accelerator upgrades from 400 kW to 700 kW is not required for CD-4

NOvA Baseline Funding Profile

(showing how the critical path is applied)



This is not a technically driven schedule

Accounting Procedures

- NOvA uses Fermilab's Oracle eBS (electronic Business Suite) for actual costs
- Accruals done in Oracle eBS
  - Material Management System module for goods received but not invoiced
  - Services and items not physically received at Fermilab (e.g. ANL) are also handled
- Effort Reporting & Payroll used for Fermilab labor
  - Labor at other institutions appears as M&S to us, but is "labor" in the Open Plan schedule
- Indirects are applied in Oracle eBS
  - Rates set at least annually by CFO, adjusted at fiscal year end to reflect actual indirect costs at Fermilab, may be adjusted at interim dates
  - opportunities for pass-through rates
  - cap on indirects for large purchase orders at $500K.
- Actual Costs are extracted from eBS and loaded into Cobra monthly
  - Cobra and eBS totals are reconciled

Accounting Procedures on the Cooperative Agreement

- Fermilab accounting system not used, need a procedure
- See NOVA-doc-3550

Monthly Accrual Reporting

- The University of Minnesota Development Manager, or designee, will provide monthly accruals for the costs expended by the Development Manager (Hines Interests), Architectural/Engineering Firms and Construction Contractors.
- The accruals will be broken down by NOvA Project Work Breakdown Structure (WBS) task.
- These accruals will normally be forwarded to the Fermilab by the 25th of each month.
- After review by the NOvA Project Control Account Manager for Site and Buildings, the NOvA Project Financial Officer will enter the accruals into the Fermilab Earned Value Cost Processor. Cobra

Monthly Cost Reporting

- The Principal Investigator for Cooperative Agreement, or designee, will provide backup data or reports to reflect costs paid that month.
- The reports (known as Summary Statement for Account) will be provided electronically at the completion of the normal University of Minnesota accounting period.

Reconciliation

- On a quarterly basis within the normal DOE reporting periods for the Cooperative Agreement, the Principal Investigator for Cooperative Agreement, or designee, will provide a copy of the University of Minnesota's Enterprise Financial Systems Report that details the actual costs applied against the Cooperative Agreement.
- The NOvA Project Financial Officer will reconcile the accruals with the quarterly report and adjust the cost reporting within the Fermilab Earned Value Cost Processor as required.

Variance Analysis Reports

- We did VARs across the project for the first time in October
  - Had done a couple with a NOvA implementation of EVMS thresholds back in May 2008
- These were reviewed extensively by me
  - and by Nancy Grossman (now Paul Derwent) for the accelerator part
- Reviewed all of them at a Technical Board Meeting (with all CAMs to look for impacts across separate Control Accounts)
  - Main example:
    - WBS 1.6 reported ahead and may impact IPND
    - WBS 1.7 reported behind, no software team available, working on solution, may impact IPND
    - Same CAM in both cases!

Variance Analysis Reports

October Level 2 Summary

- 22 VARs required

Report Period: Oct-08													
	3-Month Avg.					Cumulative							
Control Account	BCWS (AY$)	BCWP (AY$)	ACWP (AY$)	SPI	CPI	BCWS (AY$)	BCWP (AY$)	ACWP (AY$)	SV (AY$)	CV (AY$)	SPI	CPI	BAC (AY$)
R&D at Level 2													
1.0 ANU R&D	4,161	103,990	26,400	24.99	3.94	1,445,420	1,965,600	1,701,491	520,180	264,109	1.36	1.16	8,759,233
1.1 Site and Building R&D	222,667	218,956	151,012	0.98	1.45	1,944,545	2,221,182	938,760	276,637	1,282,422	1.14	2.37	2,274,519
1.2 Liquid Scintillator R&D	7,070	7,070	3,944	1.00	1.79	227,454	227,479	191,240	25	36,240	1.00	1.19	271,245
1.3 WLS Fiber R&D	15,641	14,898	2,252	0.95	6.62	120,892	118,662	131,032	-2,230	-12,370	0.98	0.91	298,604
1.4 PVC Extrusion R&D	1,933	1,933	5,404	1.00	0.36	925,639	925,639	928,907	0	-3,268	1.00	1.00	1,348,394
1.5 PVC Module R&D	6,876	15,353	53,359	2.23	0.29	540,108	501,356	821,792	-38,751	-320,435	0.93	0.61	1,421,686
1.6 Electronics R&D	2,777	8,443	3,801	3.04	2.22	273,209	282,390	409,087	9,181	-126,697	1.03	0.69	1,473,437
1.7 DAQ R&D			3,210	1.00	0.00	214,243	214,243	777,361	0	-563,118	1.00	0.28	1,383,728
1.8 Detector Assembly R&D	15,843	3,829	102,420	0.24	0.04	840,092	812,005	1,419,872	-28,087	-607,867	0.97	0.57	2,737,018
1.9 Project Management R&D	0	27	33,087	N/A	0.00	9,184,127	9,184,127	9,359,813	0	-175,686	1.00	0.98	9,184,127
Construction at Level 2													
2.0 ANU Construction			11,239	1.00	0.00	206,551	206,551	169,092	0	37,459	1.00	1.22	29,549,539
2.1 Site and Building	14,656	42,134	195,771	2.87	0.22	342,564	281,325	773,617	-61,239	-492,291	0.82	0.36	48,535,051
2.10 Project Management - Constructi	23,757	23,757	5,476	1.00	4.34	488,526	488,526	409,150	0	79,376	1.00	1.19	5,561,928
2.2 Liquid Scintillator				1.00	1.00	0	0	0	0	0	1.00	1.00	18,516,016
2.3 WLS Fiber				1.00	1.00	0	0	0	0	0	1.00	1.00	10,080,785
2.4 PVC Extrusions				1.00	1.00	0	0	0	0	0	1.00	1.00	25,276,000
2.5 PVC Modules	4,635	4,635		1.00	N/A	13,906	13,906	0	0	13,906	1.00	N/A	10,305,636
2.6 Electronics				1.00	1.00	0	0	0	0	0	1.00	1.00	11,843,228
2.7 DAQ				1.00	1.00	0	0	0	0	0	1.00	1.00	3,531,971
2.8 Near Detector Assembly		6,026		N/A	N/A	0	49,189	0	49,189	49,189	N/A	N/A	4,249,055
2.9 Far Detector Assembly	3,255	3,255		1.00	N/A	11,794	11,794	4,692	0	7,103	1.00	2.51	11,406,285
R&D Summary (1.0 - 1.9)	276,968	374,499	384,888	1.352	0.973	15,715,729	16,452,684	16,679,355	736,955	-226,671	1.047	0.986	29,151,990
Constr. Summary (2.0-2.10)	46,304	79,808	212,486	1.724	0.376	1,063,341	1,051,291	1,356,550	-12,050	-305,259	0.989	0.775	178,855,494
Project Summary	323,272	454,306	597,374	1.405	0.761	16,779,070	17,503,976	18,035,905	724,905	-531,929	1.043	0.971	208,007,484

Variance Analysis Report Example

- An example with
  - Zero BCWS
  - Zero BCWP
  - $500K of ACWP
- FYI, these are approved electronically by the CAM and the PM using NOVA-docdb
- Note corrective action anticipated!

CONTRACT PERFORMANCE REPORT
FORMAT 5 - EXPLANATIONS AND PROBLEM ANALYSES

FORM APPROVED
OMB No. 0704-0188

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME Fermi National Accelerator Laboratory	a. NAME	a. NAME NOvA project as of Oct 31, 2008	a. FROM (YYYYMMDD) 2008/10/01
b. LOCATION (Address and ZIP Code) Batavia, Illinois	b. NUMBER	b. PHASE	b. TO (YYYYMMDD) 2008/10/31
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE (YYYYMMDD) NO X YES	

2.1.2 Far Detector Building

	BCWS	BCWP	ACWP	SV in $	SV in %	CV in $	CV %	SPI	CPI
Current:	0	0	502,763	0	0%	-502,763	-100%	1.00	0.00
3 Month Avg:			168,846	0	0%	-168,846	-100%	1.00	0.00
Cumulative:	12,457	12,457	583,909	0	0%	-571,452	-4587%	1.00	0.02
	BAC	EAC	VAC in $	VAC in %	CPI to BAC	CPI to EAC			
At Complete:	36,637,247	37,199,458	-562,212	-2%	1.02	1.00			

Thresholds Exceeded: 3 Month Ave Cost, Cumulative Cost

Explanation of Variance/Description of Problem:
In February 2008, as part of the adjustment to the funding interruptions in caused by the FY08 Omnibus Appropriations Bill, DOE instructed the NOvA Project to develop a rebaselined plan that included a 01FEB09 resumption of work activities. Subsequent funding under the FY08 Supplemental Appropriations Bill in July 2008 allowed the work activities associated with WBS 2.1.2 to resume earlier than anticipated.

The CPI variances are a primarily a result of beginning this EDIA task earlier than anticipated. This is due to starting work of this WBS element using FY07 carryover funds as a Project Manager sanctioned strategy to advance this critical path item. Since this is a Level of Effort task, there is no BCWS or BCWP until the task starts in the baseline schedule. However, ACWP has been accumulating since the task began ahead of schedule, leading to the large Cost Variance. This variance will begin to correct itself when the baselined task begins and may fully correct if the baselined task is completed ahead of schedule

Impact:
The cost variances are expected to remain through the completion of the task , resulting in a continued variance.

Corrective Action:
While The WBS 2.1.2 project team does not anticipate corrective action for the variances noted, the project team will continue to monitor the cost variances in coming months for possible correctable actions. In order to better track the schedule performance, the performance measurement technique for the Construction Phase EDIA support for WBS 2.1.2.3 and WBS 2.1.2.4 will be modified to a percent complete ("C").

Monthly Summary (to include technical causes of VARs, Impacts) and Corrective Action(s):
Starting the design of Far Detector Building Package earlier than scheduled has led to cost variances that are expected to remain. Selection of a level of effort performance measurement technique combined with early start dates has produced unreliable schedule information.

Prepared by: S. Dixon Date: 1/6/2009 Approved by: Date:

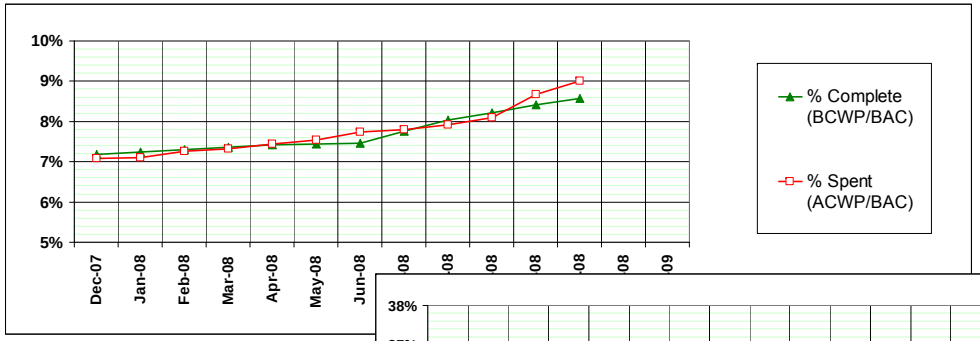
Variance Analysis – Oct Summary

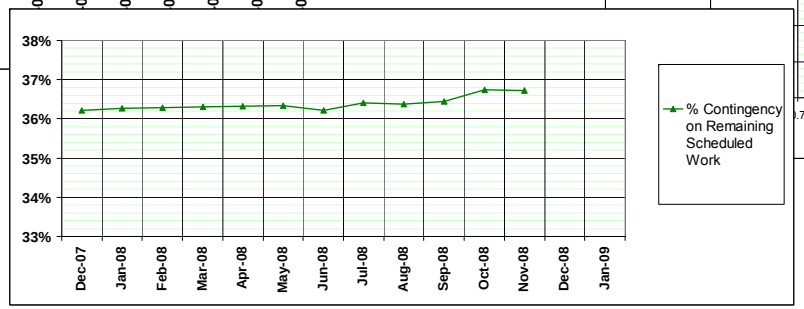
- **This first month of project wide VARs exposed other interesting problems:**
  - Several effort reporting errors discovered, people charging time to the wrong Control Account
    - One case ($17K) of a non-NOvA task reporting to a NOvA CA
    - Fermilab doesn't allow effort report changes in prior fiscal years, but cost transfers can be done to fix errors, espacially if the error involves a capital project. So we are working on these.
    - CAMs are now sensitized to watch the monthly effort reports that Project Controls provides
  - Cases of incorrect status and accrual information which we can correct in future months
  - Work accomplished under budget on one CA because highly skilled designers came available and did the work more quickly. Also suspect that the effort estimate is high – will watch to see if this persists and think about CR.
  - Work on the Full Size Assembly Prototype was done on WBS 1.5 without any tasks in the schedule.
    - The PM, 1.5 CAM and 1.8 CAM all knew and approved the work but we missed the lack of an appropriate task in the schedule. This was found in mid-December and all the work was completed in Oct, Nov, & 1st half of Dec.
    - Clear to all that rigorous monthly VARs would catch such errors in time to correct them.
  - Technical problems on WBS 1.8 have led to a -$600K CV on $840K of planned work.
    - This is R&D and we must complete it, no choice but to keep at it.

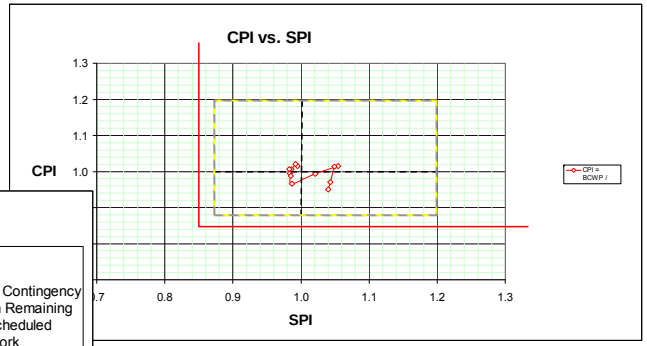
- **More examples in the October monthly report**

How do we use EV data?

- **Examples on the previous page indicate that the CAMs are quickly coming up to speed on vigilant oversight using our available reports.**
- **Have we taken any actions based on VARs?**
  - My prime example actually comes from last fall. Clear variance in R&D work CPI led me to scale back the scope of the Full Size Assembly Prototype from 10-12 layers to only 6.
- **I actually make various plots from the data each month**
  - Making the plots forces one to look at the data and think about it.
  - I expect many CAMs to start doing the same as they see the positive aspect of all this work
- **Our Open Plan Schedule has break point milestones in it where we decide if we should try for more than 14 kt.**
  - Will use EV data to determine if that makes sense, if we have earned any contingency.







Monthly EV Reports

- Files linked into the CAM notebooks:
  - NOVA-doc-1919 – Monthly Turnaround Reports in Open Plan
  - NOVA-doc-2844 – Monthly Open Plan Schedule Snapshots with Progress Info
  - NOVA-doc-942 – Monthly Open Plan Backup File
    - Some CAMs look directly into Open Plan, some use pdf snapshots above
  - NOVA-doc-3372 – Monthly CPRs from Cobra
    - CPR 1 by fund type + same G&A only
    - CPR 1 at Level 2 for the monthly report
    - CPR 1 by Control Account
    - CPR 1 by Work Package (not Cost Account)
    - CPR 5 which is then split and loaded into CAM Notebooks
    - BCWS, BCWP, ACWP vs. time by fund category
- Others
  - Project Monthly Reports
    - Includes narrative input from CAMs so that other CAMs and the Project Office are up to speed.

Monthly Reporting Timeline

(we are not meeting this goal yet)

T0 = end of the reporting month

Action	**Target (working days)**
-- Issue turnaround reports to L2 Managers/CAMS	T0 - 3 days
-- Change Request processing blackout period	T0 - 3 days to T0 + 11 days
-- Submit WBS Level 2 technical narratives to project office	T0 + 5 days
-- Submit completed turnaround reports to Project Office	T0 + 5 days
-- Validate progress information in turnaround reports	T0 + 7 days
-- Enter progress information into Open Plan	T0 + 8 days
-- Load status information into Cobra	T0 + 9 days
-- Validate information in Cobra	T0 + 10 days
-- Prepare and post Open Plan monthly reports	T0 + 10 days
-- Make Open Plan Backup file and Post in Doc DB	T0 + 10 days
-- Prepare and post Cobra monthly reports	T0 + 11 days
-- Process baseline changes in OP and Cobra	T0 + 12 days to T0 + 17 days
-- Submit completed variance analysis reports to Project Office	T0 + 14 days
-- Project Management Group (**PMG**) Meeting	**T0 + ~15 days**
-- Prepare change request status report	T0 + 17 days
-- Issue Monthly Report	T0 + 20 days

Contingency / Management Reserve

- NOvA does not use "Management Reserve"
- We have an effective $1M MR via the change control thresholds

	Secretarial Acquisition Executive (Level 0-A) Deputy Secretary	Acquisition Executive (Level 0-B) SC-1	Associate Director OHEP (Level 1)	DOE NOvA Federal Project Director (Level 2)	Fermilab Associate Director (Level 3)	NOvA Project Manager (Level 4)	Subproject Manager (Level 5) CAM
Technical	A change in scope that affects the ability to meet a Key Performance Parameter (KPP) and the ability to satisfy the mission need.	A change in scope that affects the ability to meet a KPP and the ability to satisfy the mission need.	Any change in the KPPs as referenced in PEP section 3.2.	Any significant change to the technical scope (as described in PEP sect. 5) that affect ES&H requirements or meeting Project Closeout definitions in PEP Table 7.2.	Major technical changes that are significant departures from the technical baseline. Changes that affect ES&H or impact PoT projections by more than 10%. Out-of-scope changes to upgrade physics capabilities.	Related technical changes to multiple subprojects that do not diminish performance	Minor technical changes to a single subproject that does not diminish performance
Schedule	≥ 6 month (cumulative) delay in the CD-4 completion date.	a 3 to 6 month (cumulative) delay in the CD-4 project completion date.	Any change to a level 1 milestone > 3 months, or up to a 3 month delay in CD-4 project completion date .	Any change to a Level 2 milestone > 1 month or a Level 1 milestone < 3 months.	Any change that results in the delay of a Level 3 Director's milestone.	Any change that results in the delay of a Level 4 milestone by more than one month.	Any change that results in the delay of a Level 5 milestone by more than one month
Cost	Increase in excess of $25M or 25% (cumulative) of the CD-2 Total Project Cost baseline.	Any increase in the CD-2 Total Project Cost baseline.	Any change in Total Estimated Cost or Total Project Cost.	Any cumulative use of contingency of > $1M.	Increase in the cost of a single item by more than $250k. Increase in the Project base cost exceeding $500k during the previous 12 months.	Increase in the cost of a single item by more than $100k.	Increase in the cost of a single item by more than $25k.

NOTE: INFORMATION FOR LEVEL 0 – LEVEL 2 CHANGES IS COPIED FROM THE PROJECT EXECUTION PLAN

Physicist labor

- Scientists at Fermilab and at all NOvA Collaboration Institutions are included as FTEs at no cost to the project
  - See Key Assumptions, NOVA-doc-3083and document from OHEP, NOVA-doc-3083

The only scientists whose salaries may be charged to projects are physicists who are high-level (e.g., WBS Level 1 or Level 2) managers on a particular project, in which case his or her time may be billed as part of project management costs. Any such arrangement is subject to approval by the federal project manager and the DOE Office of High Energy Physics.

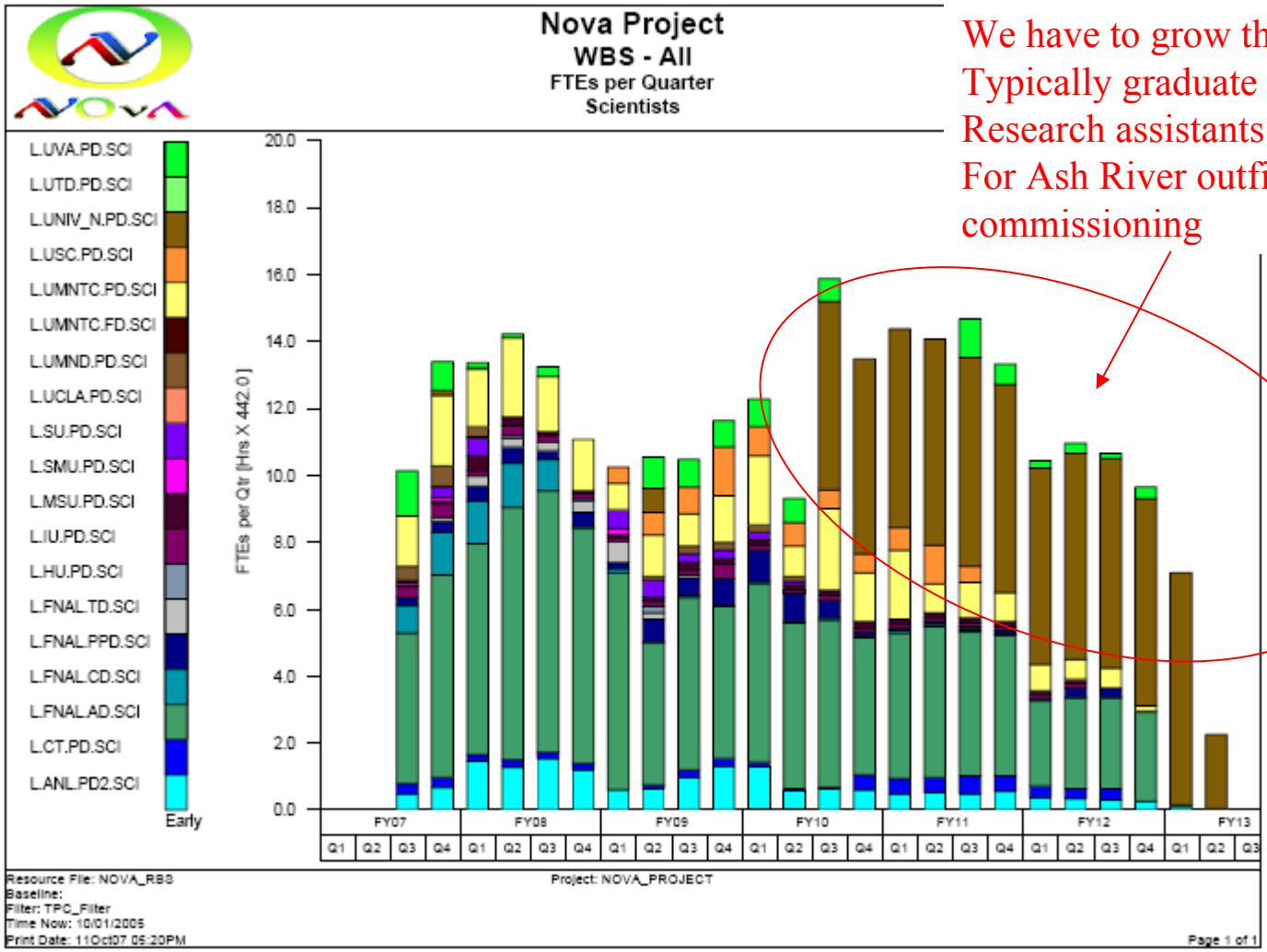
It has been the practice in the high energy physics program, particularly for detector fabrication projects, to utilize members of the scientific research collaboration to carry out some of the tasks in the fabrication project. This is done to exploit their expertise in the relevant detector technology and their knowledge of the ultimate use of the detectors. In general, these scientists are supported by a variety of different funding sources including DOE funds, NSF funds, and university funds. It is not possible to capture the labor costs that are not funded by DOE. In order to select scientists for project-related tasks based on their skills and expertise that they bring to the project, rather than their cost to the project, it is desirable to **not** capture the costs of any scientists who are members of the associated scientific collaboration in the project costs. The only exception this rule is when a physicist is working as a high-level (e.g., WBS Level 1 or Level 2) manager on a particular project, in which case his or her time may be billed as part of project management costs. Any such arrangement is subject to approval by the federal project manager and the DOE Office of High Energy Physics.

The goals of project management can still be met under the assumption that scientist labor costs are not in the TPC, by careful and explicit risk analysis of how the work assumed to be done by "off -project" scientists will be carried out if any of these scientists leave the project, or otherwise cannot deliver on their commitments.

We have a documented risks for managers, all have deputy scientists, therefore lowest priority risk

Physicist labor

- NOvA has scientists in Open Plan at $0.01 per hour just so we can extract the FTEs shown below
  - Hours but not rates are transferred to Cobra

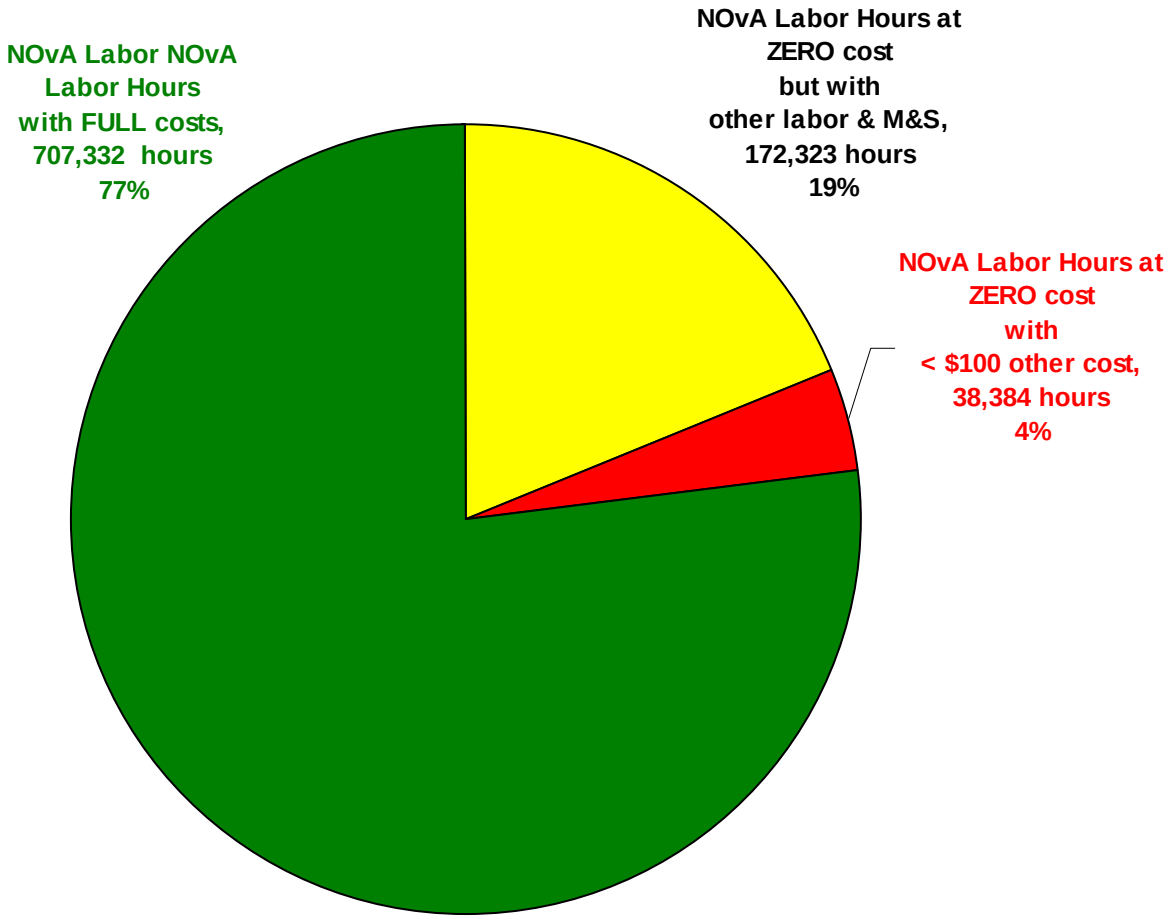


We have to grow these people, Typically graduate students and Research assistants (post-docs) For Ash River outfitting & commissioning

Physicist labor

Not dollarized, how do we do EVMS?

- 77% of labor hours are fully costed & trackable for earned value
  - 23% of hours are at zero cost
- 19% of "zero cost" labor hours come with other items to track earned value
  - Therefore track earned value by tracking completed tasks
- Only 4% of labor hours are "zero cost" and standing ~ alone
  - Value estimated at $3.2M with average burdened salary is $150K
  - To set a scale, $3M = 4% of project contingency if in worst case we had to pay for these scientists.

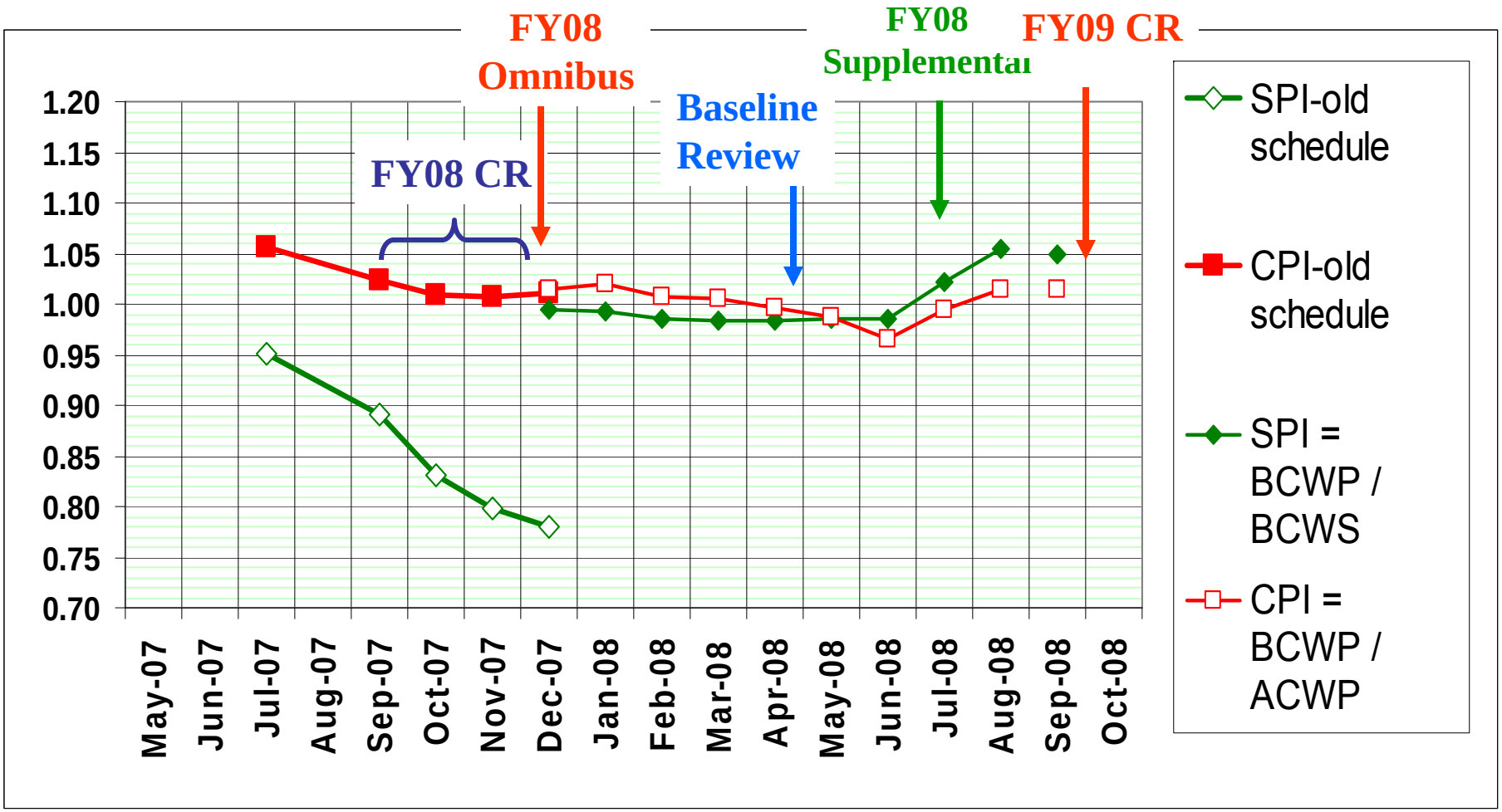


Crosswalk: NOvA EVMS

before & after FRA Policy & Procedures

EVMS OLD-NEW CROSSWALK for NOvA PROJECT		
EMVS Process	**Before October report**	**Starting with October report**
Define project by WBS	Used WBS structure	Same
Define the OBS	Used OBS	Same
Use control accounts	Had over 200 cost accounts	Reduced to 67 control accounts
Follow work authorization process	DOE to FRA and FRA to project processes in place and used	Implemented work authorizations for all control accounts from PM to CAMs
Create a schedule using milestones and estimated resources	Used Open Plan for resource-loaded schedule at the work package level	Same
Create a time phased budget	Used Open Plan information loaded into Cobra	Same
Prepare cost and schedule performance reports using information from the accounting system	Information from Oracle E Business Suite Project Costing Module (accounting system) as well as project statusing from Open Plan are inputted into Cobra to produce CPRs	Same
Perform variance analysis	Initiated as project lost funding in 2008	Restarted with October report
Report on variances	Thresholds were less stringent before FRA system, few reports produced	Reporting begun with FRA thresholds with October report
Create and issue monthly report	Narrative reporting since 2006, with CPRs and other information added since then	Variance analysis and reporting
Control indirect costs	Controlled by FRA/Fermilab COO	Same
Do corrective action based on EV information	In early stages since reporting just beginning when funding was lost in 2008	Started in earnest with October report
Revise EAC and look at variances at completion	Forecasting done during monthly statusing	Same
Use change control for revisions to the baseline	Have change control processes in place, used after CD-2 review, Dec 2007	Same

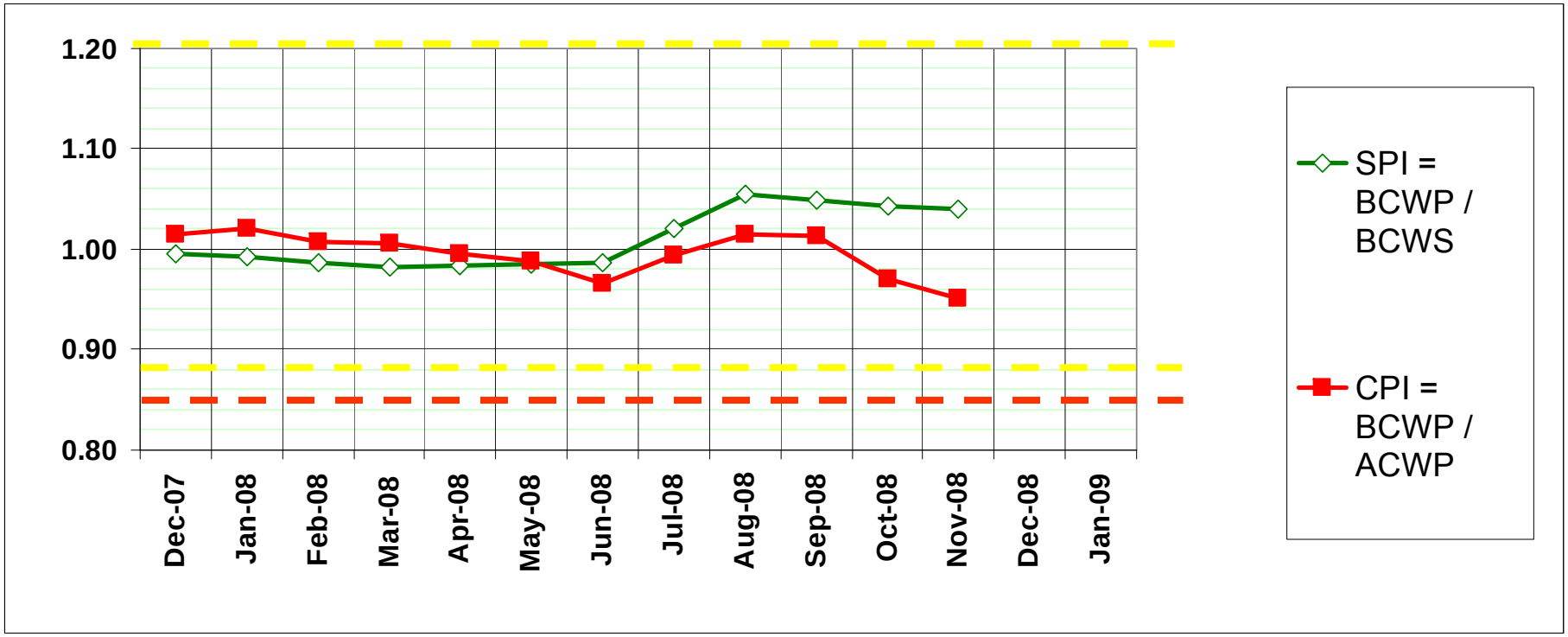
NOvA SPI & CPI plots



- We know from experience what it looks like when an index heads south
  - Fall 2007 reviews took more effort than planned, FY08 CR restrictions meant we couldn't hire more people to keep forward progress

Similar plot for just the last year

- Slightly ahead of baseline as expected,
  cost of work more than planned makes PM worry.



Summary

- **NOvA has a CD-2 baseline with a TPC of $ 278 M**
  - And has CD-3a for a limited $ 19 M set of critical path / long leadtime items
  - Expect a CD-3b Review spring / summer 2009,
    "when final design is complete"
  - Trying to match CD-3b to FRA EVMS Certification by Oct 1, 2009
    - This date is assumed in our baseline schedule, risks are documented

- **NOvA has spent ~ $ 16.8 M through FY08**
- **NOvA has ~ $ 19.4 M of funding authority during the FY09 Continuing Resolution**
- **NOvA is exercising FRA EVMS with the October report**
  - Some parts have been in place since CD-1 (May 07)
  - Most other parts came on line during calendar 2008
  - Some parts were tweaked in October to match the new Fermilab FRA Policy and Procedures.
    - Project-wide VARs were the last new addition for October