NOvA Project Status

John Cooper & Ron Ray

September 6, 2006

Interactions with DOE

- August 21 with Mike Procario
  - Discussed Cooperative Agreement / MIE split
  - Mike agrees that we could do this each FY
    - Takes Decker to sign-off, so do it thoughtfully
    - Gives project more flexibility since can think about the building in phases
      - E.g. first phase is final design + build access road, so only need appropriate contingency for each. And leftover contingency can be applied to the next year's needs.

Interactions with DOE

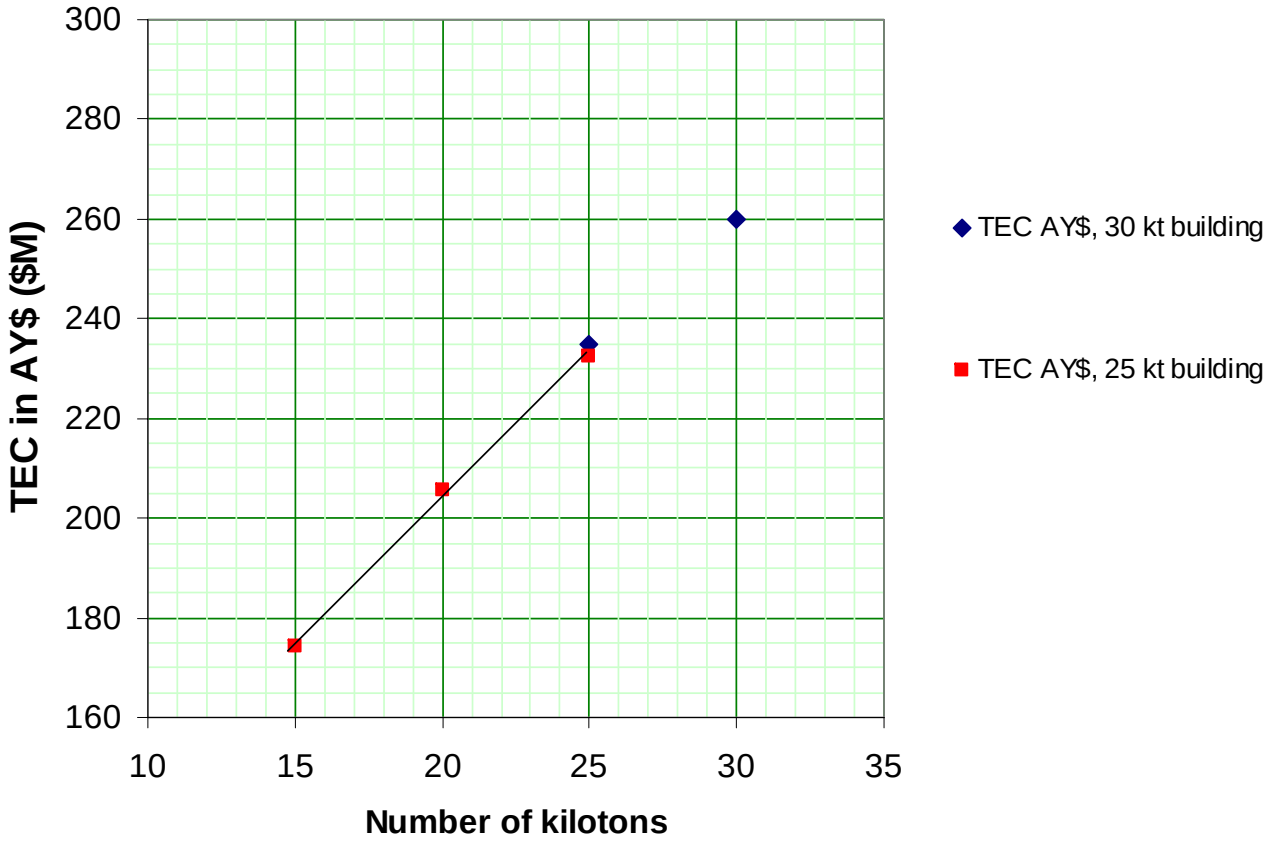
- August 22, 28, 30, September 1,5 with Mike Procario
  - Unsolicited proposal status
    - Presumably details earlier in meeting from Mike
    - Have Marvin Marshak in the loop.
  - Effect on CD-1 sign-off.
    - Have to modify Acquisition Strategy, but that is thought to be possible
      - Might be a delay if Orbach might want to see proposal and the Determination of Noncompetitive Financial Assistance before signing

Interactions with DOE

- August 31 with Ron Lutha, Steve Webster, Dennis Wilson
  - Looked at a draft NOvA Procurement Plan for mineral oil only
    - Details difficult because we may try several paths for the best price
      - Exercise option if time scale allows (some are Nov 07)
      - Re-bid, even get multiple vendors for 30-90 day deliveries
      - Re-bid, but still indexed due to 2008 bids for 2010-12 deliveries.
      - Likely Fermilab Master Contracts
  - We agree to have a draft full procurement plan for the commodities by the Directors CD-2 review
    - DOE may use it to smooth the way for later reviews
    - Get a final plan (with its uncertainties) in place for CD-2 and EIR

We are not out of the woods on cost

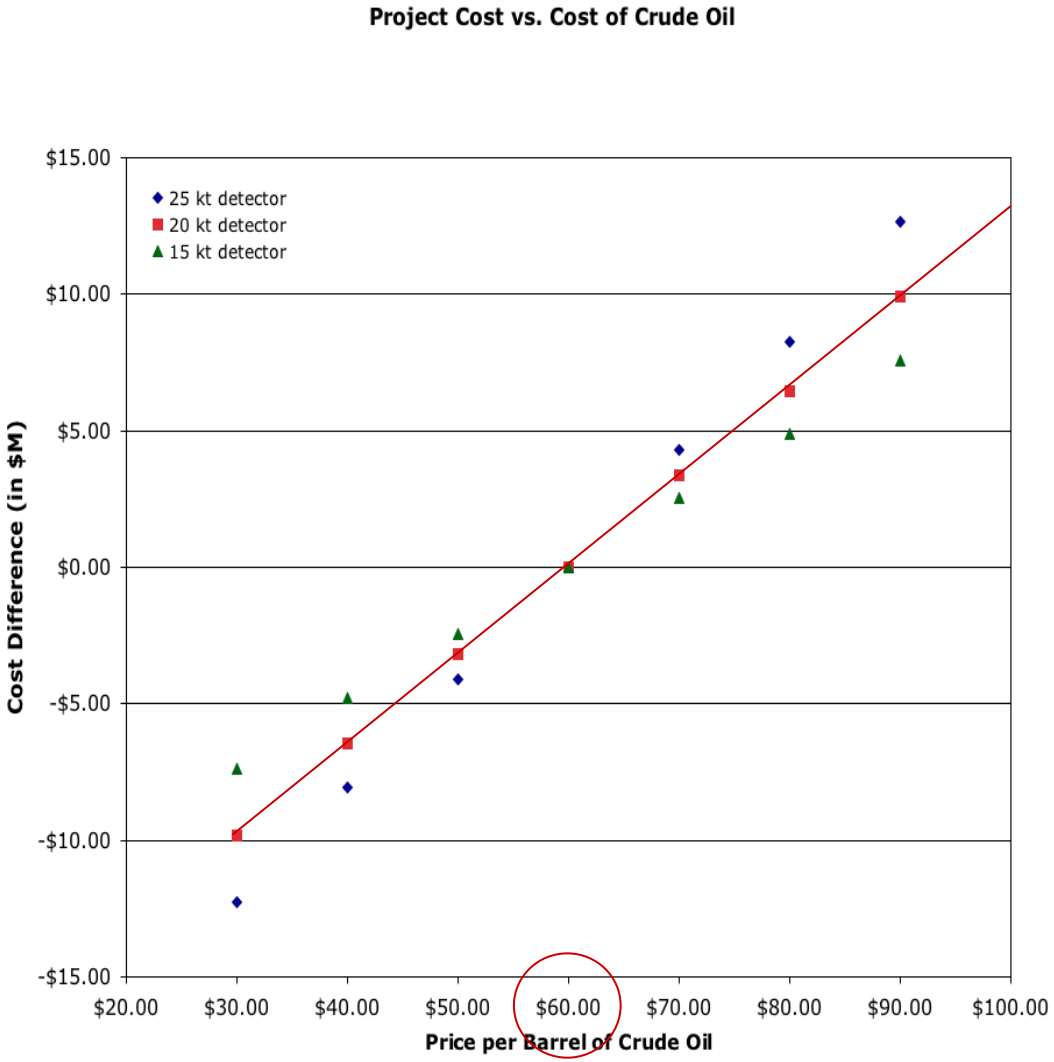
- **Robin Staffin holds to a Cost cap at $ 200 M**
  - Simple scaling of our CD-1 (25 kt in a 30 kt building) cost
  - indicates a 20 kt detector in a 25 kt building is <u>almost</u> affordable at $ 205.6 M



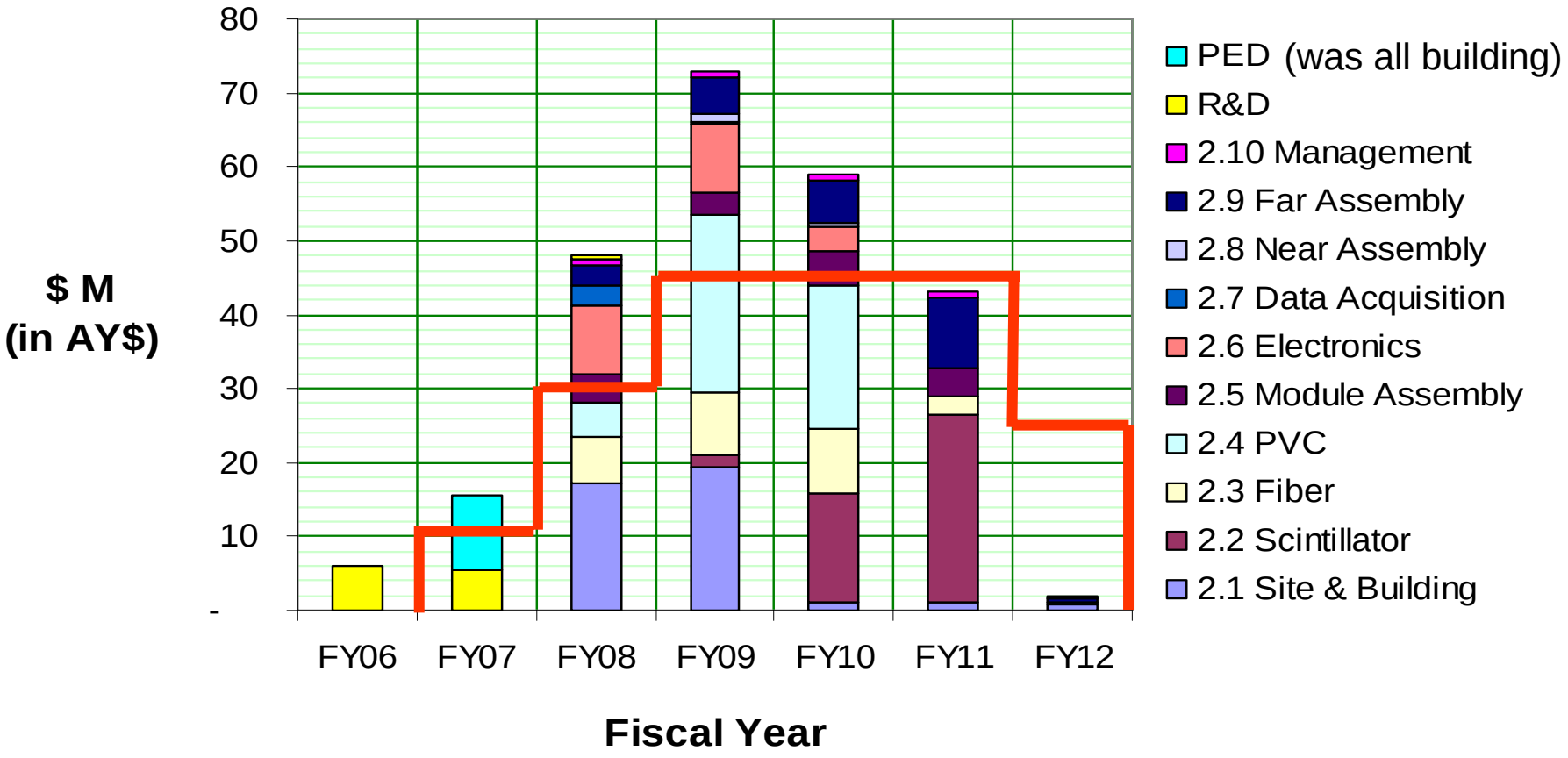
Crude Oil is not helping

- Ron has calculated our overall sensitivity to crude
  - NOvA cost changes
    ~ $ 333 K for every
    $1 change / barrel of crude

- Recall we assume $ 60 / bbl when we buy
  - Based on DOE Energy Information Administration forecast
  - Last week, Standard & Poor's made a similar forecast
  - Recall our contingency includes $ 97 / bbl

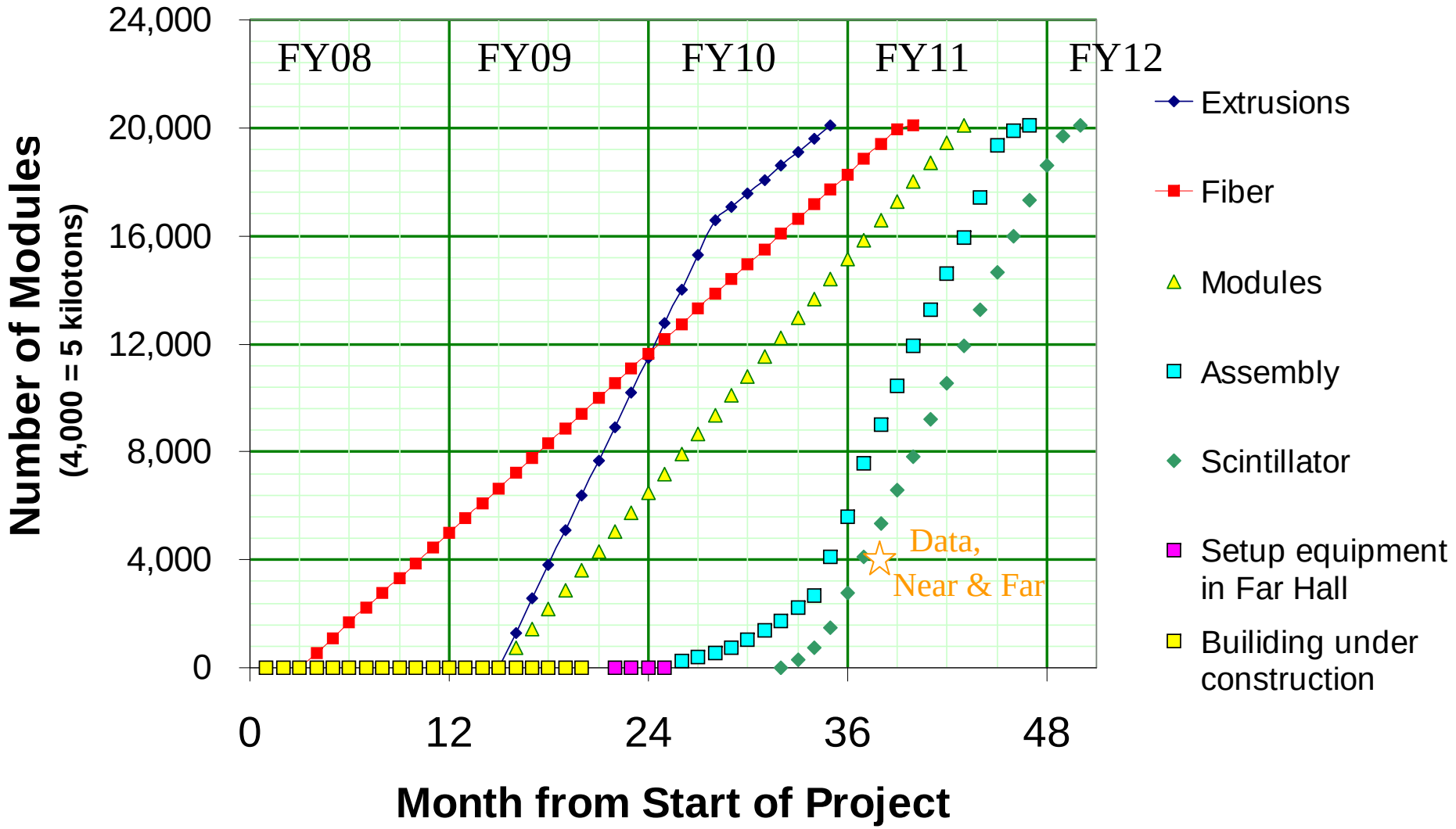


Initial **DOE Funding Profile** does not match our CD-1 Cost & Schedule



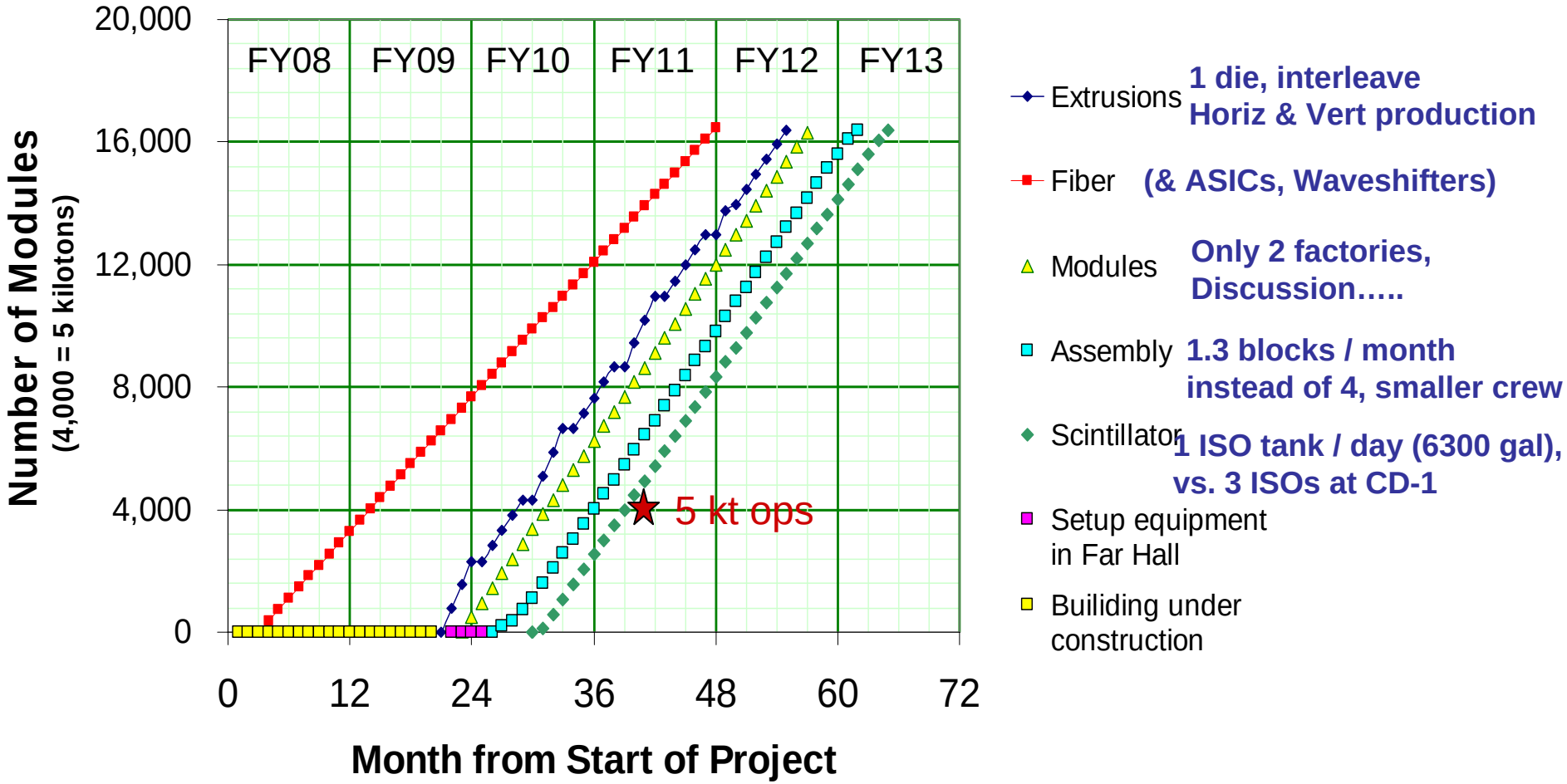
- CD-1 was 25 kt, so the integral in this figure was $ 235 M
- Some things will have to move later in time (building can't be later)
- There must be an exact match for CD-2

CD-1 Schedule: Graphical Form



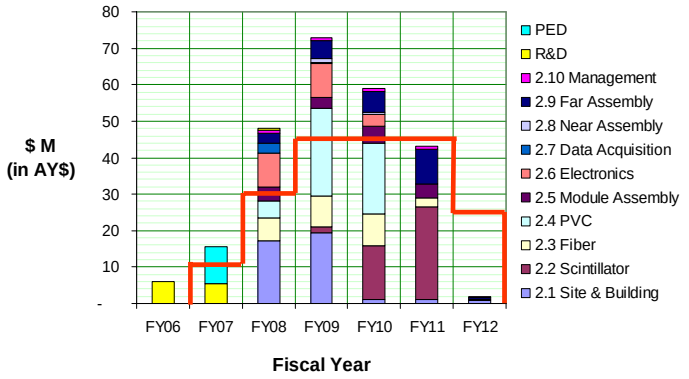
A conceptual Stretched Schedule

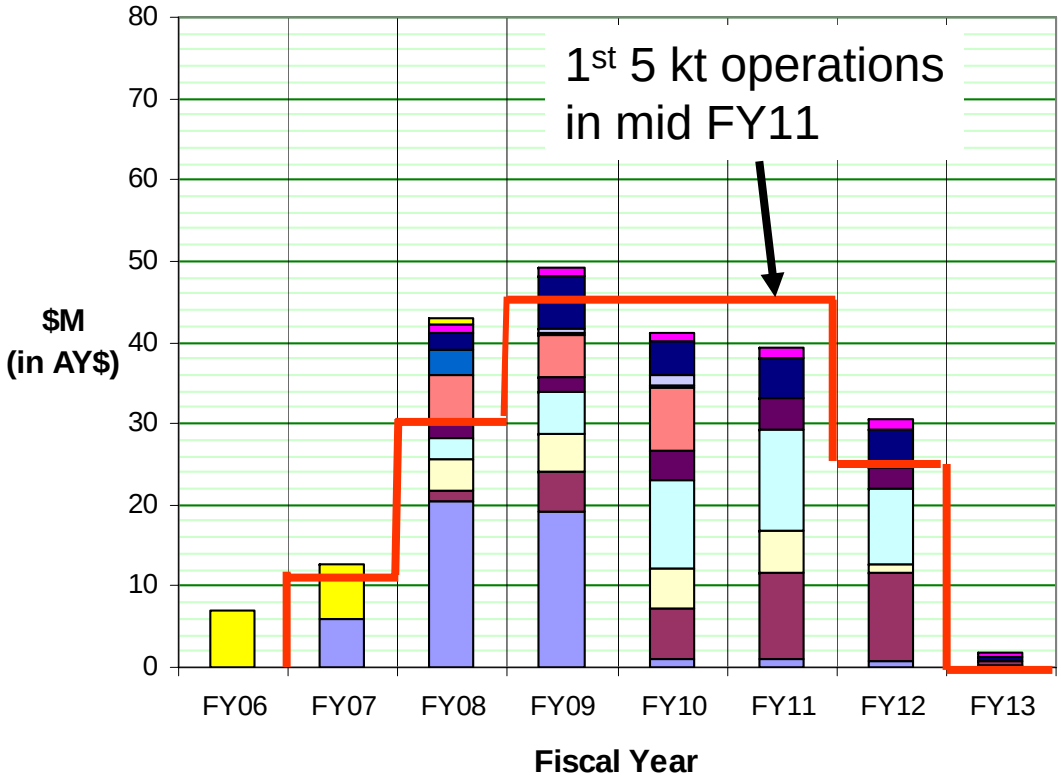
- Trying to match the funding profile



Funding profile of stretched schedule

- Includes cheaper fiber, lower PVC contingency, 2 factories, APD delay
- Stretching increases escalated costs
- Total is now $ 210.3 M vs. $ 205.6 M





In addition to items on previous slide:

Moved some of APDs out of FY08, need to move more

Need to move DAQ out of FY08

Comments:
Profile, FF

Still ways to cut costs

- Balance fiber diameter / scint. Mix / PVC reflectivity for 20 p.e. at far end and lowest cost
  - 0.7 mm fiber vs. 0.8 mm could save $ 2.2 M (unburdened)
  - PVC reflectivity might just balance
  - Increase scintillator light with more pseudocumene, under $ 0.4 M to compensate

- Building
  - Fewer exits, no crane, …you have heard from Steve Dixon
  - Overburden thickness
    - New simulation indicates 1.3 m @ 2.5 g/cc could be enough (vs. 2 m as in CDR)
    - But no way to recover if we are wrong (Risk discussion is next)
    - Looking at barite loaded concrete (Gary's idea)

Risk Management

- We are actively tracking 5 formal risks following our Risk Management Plan
  - Our Risk Management Board considered the status of all 5 on Aug 31.
- 1 – shear stress on plane to plane adhesive
  - Already went to stronger epoxy, roughened PVC, thicker vertical PVC, 31 plane (not 32) plane blocks, got back to safety factor (SF) of 5
  - Led to outside engineering review which endorsed our changes
  - Some question that adhesive peel stress may also be a worry
    - As the PVC bulges, the epoxy takes on a curved profile subject to peel
      - This in fact was the source of selecting a SF of 5 as the target, based on standard engineering texts.
    - Actual models under test with epoxy
    - FEA under way to predict model behavior
      - initial preliminary results predict SF of ~ 4.5
  - RF welding may offer a stronger bond that epoxy
    - Req in system to evaluate Ashland RF bonding scheme
    - Will test small structural parts for shear, peel, tensile strength, eventually test models as with epoxy

Risk Management continued

- 2 – static charge build-up when filling detector with scintillator
  - Identified in spring 2006, Risk tracking form in August 2006
  - Mitigation under study / planned
    - Distribution system in grounded metal, not PVC
    - Inert module atmosphere while filling
    - Reduce ignition sources
      - Add anti-static agent,
        - » but this reduces light, has unknown lifetime effects
        - » 2 ppm required to meet an industry standard for a "semi-conductive fluid", i.e. no hazard charge levels except for aerosols
      - Control splash filling, no freefall of liquid
        - » Avoid aerosol formation
      - Provide discharge path inside PVC modules

Risk Management continued

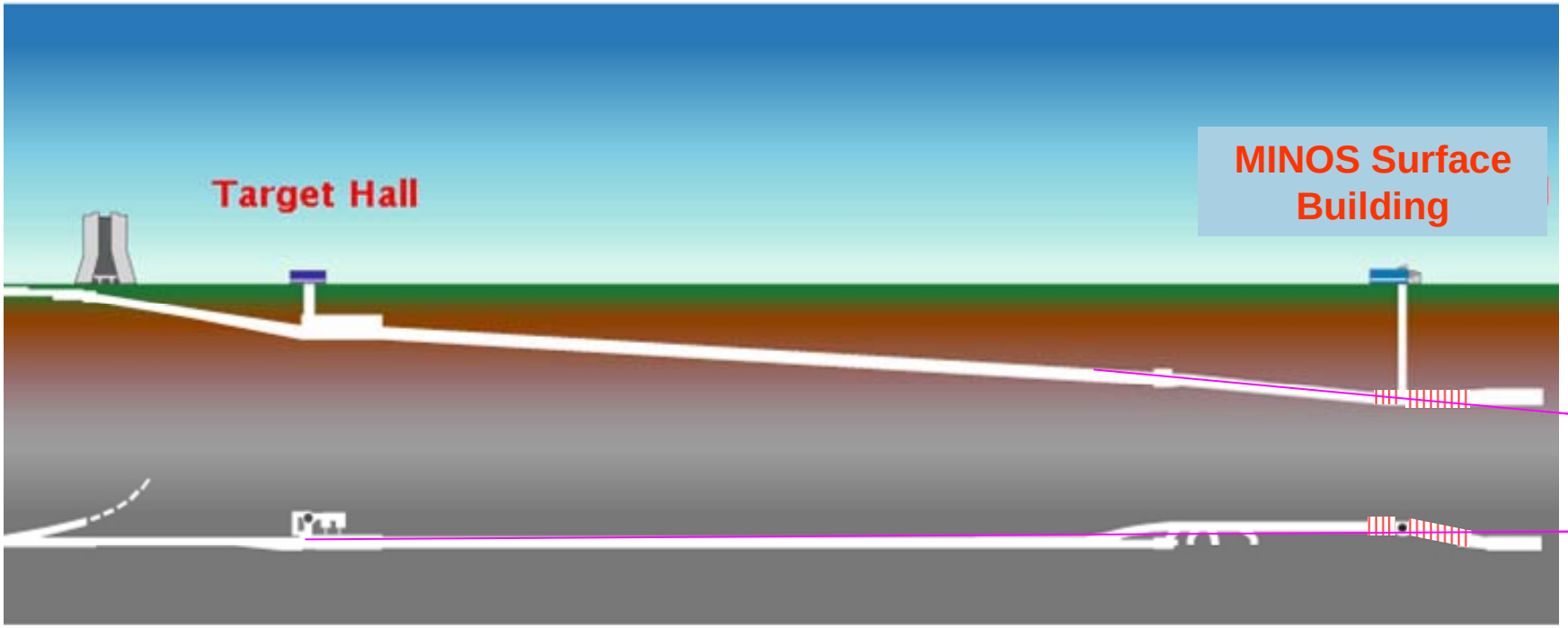
- 3 – Creep in PVC plastic over time could reduce SF of structure design
  - Risk tracking form in April 2006
  - Mitigation Strategy is to limit creep to a few years
    - Just during detector construction and filling
    - Once detector is complete, fill the gaps between the 44 blocks (each with 31 planes) with a “grout” to stop creep
      - Requires a second bookend
  - Problems:
    - Grout not identified
    - Installation method for grout not identified
    - Potential failure modes need more thought
      - Have looked at effect of one module losing all liquid, this is not a problem

Risk Management continued

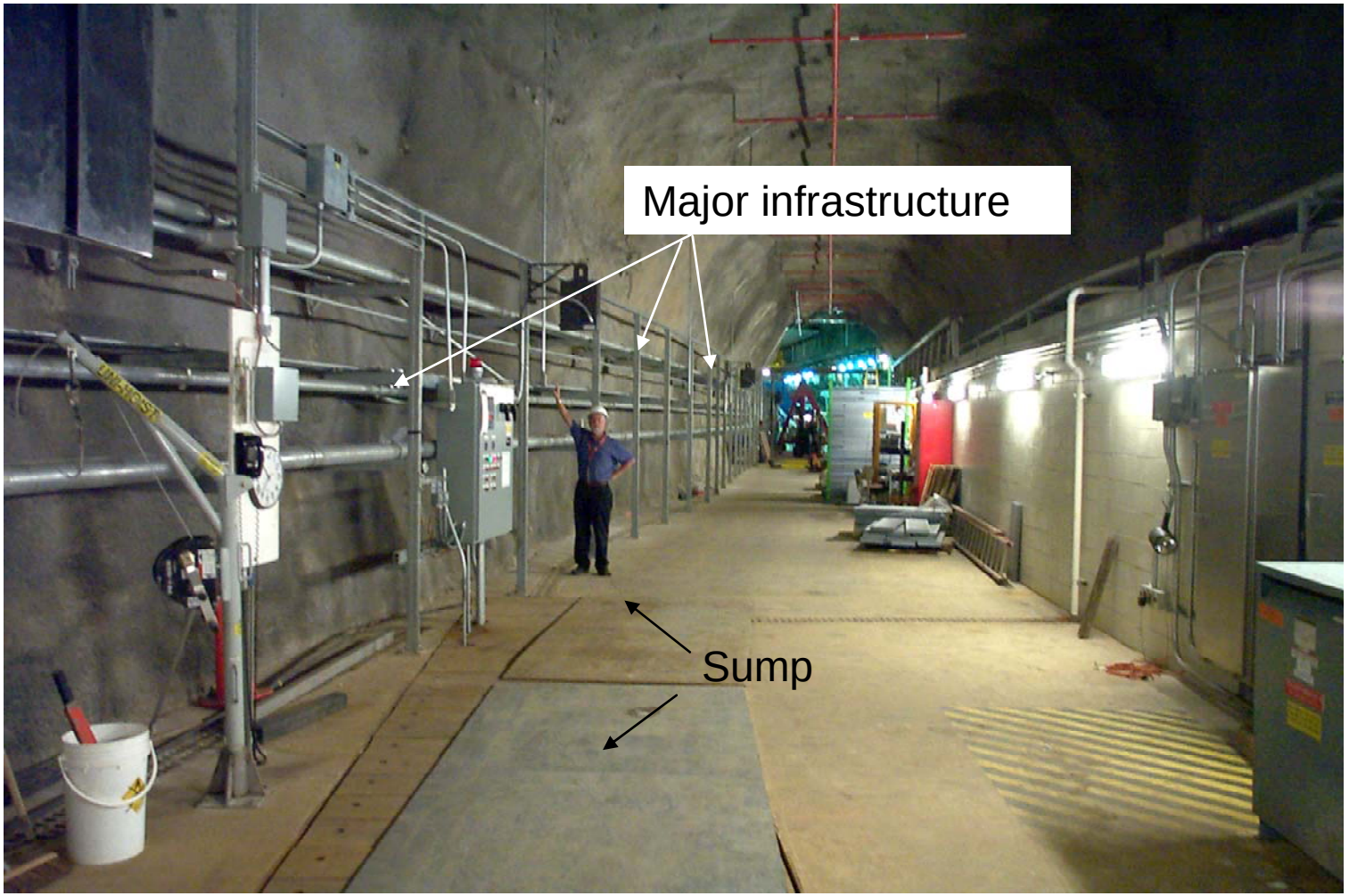
- 4 – Building overburden design may be too thick
  - Risk tracking form in August 2006
  - Scientific performance goal is 1 event (electromagnetic cosmic ray) faking a ν_e event in 6 years of running
  - CD-1 called for 2 m with density 2.5 g/cc
    - Realized by 3m with 2.8 g/cc granite and 40% voids
  - 1.32 m @ 2.5 g/cc may be sufficient – new simulation by Mark Messier
    - This opens up the possibility of a different building construction method, e.g concrete vs. steel
    - The point is that we may be spending too much money on a overburden.
  - But there is a counter risk: if we get it wrong, there is no obvious way to recover within the project scope after the fact.
  - New concept: use barite (Barium Sulfate) loaded concrete
    - Idea from Gary Feldman (he used it in Mark I)
    - Barite is more effective for than standard concrete by a factor of ~ 2.2 per unit mass for shielding photons.
      - Z is 56. Density is 4.5 g/cc.
      - X_0 is ~2.7 cm vs. granite at ~ 9.9 cm.
    - In a new design or in the old design
  - Steve Dixon evaluating costs of several designs / thicknesses

Risk Management continued

- 5 – Near Detector is at an angle of 11^o to the neutrino beam in the MINOS access tunnel.
  - This may compromise event containment and event identification.
    - Risk form in August 2006 following realization in May and worries voiced by Gary
  - Mitigation studies underway
    - Simulations of all cases required
      - Line source effect in beam, finite detector size of Near Detector
    - Rotate the detector in the tunnel (see following 5 slides)
      - Gets us to 4.93^o
      - No issues of life safety identified
    - Cost to move utilities on the west side of the tunnel
      - Gets us to 2.30^o
    - Excavate a box out of the west side of the tunnel
      - Gets us to 0^o
    - Move utilities and rotate horizontally to 3^o.
      - Take out vertical angle of 3^o by raising front of Near Detector to compensate vertical beam angle
        - » Lean detector vs. stairstep scheme

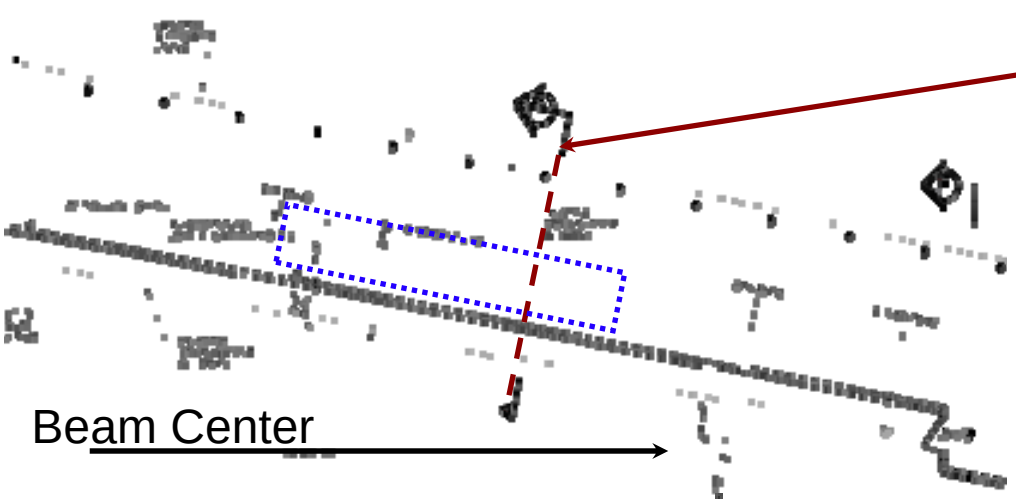

Target Hall
MINOS Surface Building

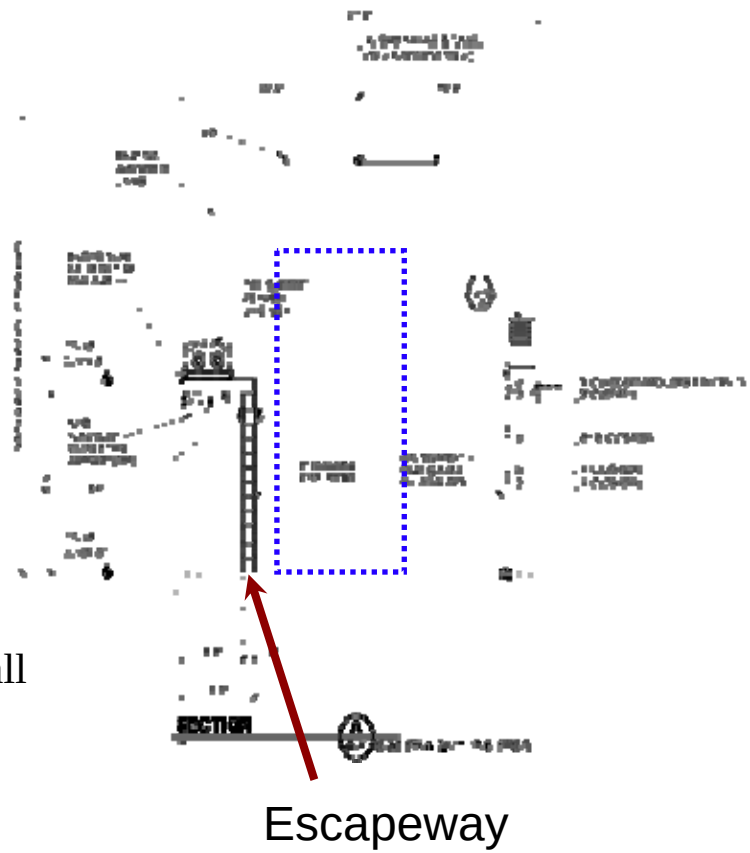
Looking Downstream from Shaft



Top of Escapeway looking upstream towards access shaft

A Closer Look





- Tunnel is roughly 6.4 m wide, and 6.2 m high
- Tunnel is oriented 11.15 degrees (in XZ plane) from beam
- Detector is 3.92 m high, 2.62 m wide, 14.4 m long (strips only, doesn't include manifolds)
- Escape passageway is 1.32 m wide
- Assume that the detector is up against the escapeway wall, Center is ~2.63 m from one wall, 3.77 m from the other wall
- Hall center is +0.57 m in X and 1.14 m in Y from detector center

What we need for CD-2 Review

NOvA Work List for CD-2 (red means new since last version)	Early Finish Date	Possible Late Finish Date	Actual Finish Date	comments
Cooperative Agreement				
Recipient Selected = Site Selection	1-Nov-06	15-Jan-07		May be earlier with unsolicited proposal
Negotiations concluded	15-Jan-07	1-Apr-07		Jan might be an early estimate for this even now?
NEPA				
Scoping Meeting	22-Jun-06		22-Jun-06	
Environmental Impacts Analysis Plan and 5 point timeline	29-Jun-06		20-Jul-06	after iterations on schedule with Sally Arnold
NEPA timeline in Envir. Impacts Analysis Plan				
Determine EA route	22-Jun-07		22-Jun-06	Siebach to Livengood
Notify Illinois, Wisconsin, Minnesota of EA intent	15-Jul-06		1-Aug-06	letters from Livengood
draft EA completed	1-Nov-06			
final EA ready	1-Dec-06	15-Jan-07		requires CA Recipient
State / Public Comment period	1-Jan-07	15-Feb-07		
FONSI drafted	1-Apr-07			not required for CD-2 REVIEW
FONSI issued	1-Jun-07			not required for CD-2 REVIEW
Minnesota Part				
RGU (Responsible Government Unit) in place	15-Jan-07			
Minnesota EAW (site specific)	15-Jan-07	1-Mar-07		This is after the 30 day comment period
Wetland Permit Processing by USACE	1-Apr-07	1-Dec-07		Need for construction, not for CD-2 review

What we need for CD-2 Review, page 2

NOvA Work List for CD-2 (red means new since last version)	Early Finish Date	Possible Late Finish Date	Actual Finish Date	comments
Minnesota Part				
RGU (Responsible Government Unit) in place	**15-Jan-07**			
Minnesota EAW (site specific)	**15-Jan-07**	**1-Mar-07**		This is after the 30 day comment period
Wetland Permit Processing by USACE	**1-Apr-07**	**1-Dec-07**		Need for construction, not for CD-2 review
Fermilab NOvA Part				
draft Version Ch 3 Proposed Action: description, alternative				
Integration Prototype on surface	**31-Aug-06**		**31-Aug-06**	containment, FP
Near Detector in MINOS access tunnel	**31-Aug-06**		**31-Aug-06**	containment, FP, access issues
Scintillator Blending & Storage	**31-Aug-06**		**31-Aug-06**	containment, tranportation
Module Factory	**31-Aug-06**			adhesive ventilation
Block Raiser construction & tests with load	**31-Aug-06**			construction activity
Full scale prototype construction & test	**31-Aug-06**			construction activity
Full flat prototype for time & motion study	**31-Aug-06**			probably at ANL
Final Version (ties to date in NEPA timeline above)				
Integration Prototype on surface	**1-Nov-06**			containment, FP
Near Detector in MINOS access tunnel	**1-Nov-06**			containment, FP, access issues
Scintillator Blending & Storage	**1-Nov-06**			containment, tranportation
Module Factory	**1-Nov-06**			adhesive ventilation
Block Raiser construction & tests with load	**1-Nov-06**			construction activity
Full scale prototype construction & test	**1-Nov-06**			construction activity
Full flat prototype for time & motion study	**1-Nov-06**			probably at ANL
Fermilab Tritium Part				
Water Task Force report	**21-Sep-06**			
Site and Building				
Ash River Site				
EAW update	**1-Nov-06**	**1-Dec-06**		
Wetland Permit Application prepared	**1-Dec-06**			
Other Sites				
EAW	**1-Jul-07**	**30-Sep-07**		
Building				
Independent Cost & Schedule Review	**15-Sep-06**	**1-Sep-06**		
30% Drawings	**15-Dec-06**			req in process for first $ 260 K

What we need for CD-2 Review, page 3

NOvA Work List for CD-2 (red means new since last version)	Early Finish Date	Possible Late Finish Date	Actual Finish Date	comments
Liquid Scintillator				
Tests of commercial Tintometer	21-Jul-06		16-Aug-06	tagged, sent on to Indiana for tests, 7/17
Fermilab blending model description & cost	15-Aug-06			Ron has a draft 8/15
issue RFP for off-site blending	1-Aug-06	15-Oct-06		struggling with options, hiring consultants
RFP responses for off-site blending	1-Sep-06	15-Nov-06		6 wks for consultants to develop bid list
evaluate waveshifter concentration	15-Aug-06		16-Aug-06	
evaluate pseudocumene concentration	15-Aug-06		1-Apr-06	CDR likely has sufficient info
decide waveshifter/pseudocumene to match fiber diameter	9-Aug-06	1-Oct-06		likely will not change scintillator, only fiber & PVC
Wavelength Shifting Fiber				
Updated Kuraray quote	1-Jun-06	1-Jul-06	6-Jul-06	
evaluate fiber diameter	1-Aug-06	15-Sep-06		work in progress
evaluate fiber fragility in Module Assembly	15-Sep-06			
decide fiber diameter	9-Aug-06	1-Oct-06		
PVC Extrusions				
Choose die proof resin (NOvA-2)	5-May-06		5-Jun-06	
Proof 16 cell die at die manufacturer	26-Jun-06	31-Jul-06	24-Jul-06	done at Extrutech, not at die manufacturer
Tune 16 cell die at extruder	14-Jul-06	18-Aug-06	25-Jul-06	got samples but NOvA-2 resin clogged die
Rework die after initial tests	21-Aug-06			in progress
2nd test with new PVC resins and reworked die	1-Sep-06	18-Sep-06		
Issue RFP for 70,000 lb test resin + full detector option	5-Jun-06		23-Jun-06	but will have to do best & final, NOvA-2 clog
RFP responses for resin	5-Jun-06	21-Jul-06	21-Jul-06	able to update cost estimate
Issue RFP for 70,0000 lb resin, BEST and FINAL	1-Sep-06	25-Sep-06		hold, will update resin formula
Produce 3500 m of 16 cell material, horizontal, rutile	4-Aug-06	23-Oct-06		takes 8 days of production time, end 10/31
Measure mechanical properties of NOvA-2 in 16 cells	30-Sep-06	15-Oct-06		in progress but will repeat for new formula
React to measurements of 16-cell extrusions	31-Oct-06			
Issue P.O. to modify existing die for vertical extrusions	1-Sep-06		24-Aug-06	4 month turn around on existing die
Still would have anatase vs. rutile TiO2 choice hanging?	7-Sep-06			expect first anatase tests September 25
Order resin for 1500 m of 16 cell material in anatase	15-Aug-06	15-Oct-06		
Still would not have final 16 vs 32 cell decision				But would have work around concept/tests
RF welding test to make a 32 cell from two 16 cell objects	1-Nov-06			expect proposal any second
Die returns after modification for vertical extrusions	15-Jan-06			die not available during December

What we need for CD-2 Review, page 4

NOvA Work List for CD-2 (red means new since last version)	Early Finish Date	Possible Late Finish Date	Actual Finish Date	comments
PVC Modules				
final endplate design	31-Aug-06	15-Sep-06		modifying design
final manifold design	31-Aug-06	15-Sep-06		modifying design
adhesive choice	30-Sep-06			
adhesive vs. RF welding	1-Dec-06	1-Apr-07		
factory stringing machine and flycutting machine	1-Oct-06			have a prototypes but it needs tuning
factory flycutting machine	1-Oct-06		15-Jul-06	MINOS flycutter tested successfully
factory gluing machine	1-Nov-06			if glue, now injected so machine is simpler
final overflow tank design (now grouped and part of assembly)				
Time & Motion studies with 16 cell, 12 ft(early) & 53 ft(later) objects	15-Dec-06			
Electronics				
Receive 1st 10 APDs from Hamamatsu	1-Oct-06	30-Sep-06		new PC material tested, boards to them now
Get updated "target price" of APDs from Hamamatsu	1-Nov-06			
completed studies of front end ASIC	10-Aug-06		28-Aug-06	Fermilab tests done, packaging for user tests
Front End Board prototype II testing	6-Oct-06			
Data Acquisition				
prototype Data Concentrator tests complete	15-Dec-06			
Near Assembly				
Initial design of mechanical structure	19-Sep-06			Integration Prototype pushes this
Initial design of mechanical systems	19-Sep-06			
Far Assembly				
Validation of plane adhesive choice	16-May-06		11-Jul-06	3M-2216 is the choice
Tests of 3 plane assemblies with 3M2216 and 16-cell extrusions	?			Real validation is a test for peel and shear
RF welding, plane to plane, 4 plane test at Ashland	31-Oct-06	1-Dec-06		have Ashland proposal, August 16
settle baseline installation procedures	27-Jul-06	3-Oct-06		
Validation of structural design	17-Aug-06	24-Oct-06		
Initial designs of mechanical systems (access,light tightening,cooling,filling)	30-Sep-06	12-Nov-06		
Designs of mechanical systems & tooling	8-Jan-07			

What we need for CD-2 Review, page 5

NOvA Work List for CD-2 (red means new since last version)	Early Finish Date	Possible Late Finish Date	Actual Finish Date	comments
Project Management				
final Project Execution Plan	**1-Aug-06**			Iterated with Lutha & Webster 7/11-12
final Project Management Plan				
final Configuration Management Document				
final Risk Management Plan				
draft Procurement Plan (partial)	**1-Aug-06**		**29-Aug-06**	request from Lutha
Procurement Plan	**21-Jan-07**			will have for Director's CD-2
draft Performance Management System Document (EVMS)	**21-Jul-06**		**23-Aug-06**	NOvA docdb #1084 (lab-wide plan)
final Performance Management System Document (EVMS)				
draft PSAD				
Outside Review Mechanical Structure: Creep Mitigation	**1-Sep-06**	**1-Nov-06**		may drop this review
1st draft Technical Design Report (blanks identified)	**1-Oct-06**			Project Office produces draft 1
2nd draft Technical Design Report (50% blanks filled)	**1-Nov-06**			updates from L2 Managers
final Technical Design Report	**15-Dec-06**			final updates, final edit by Project Office
draft construciton 20 kt Cost & Schedule matching funding profile	**10-Aug-06**		**15-Aug-06**	"match" is approximate
update R&D portion of C&S	**30-Sep-06**			track starting 10/1/06, might be final for CD-2
2nd draft construction 20 kt C & S following technical decisions	**1-Nov-06**			follows update of R&D, parallel TDR 2nd draft
nearly final C&S	**5-Dec-06**			
final Cost & Schedule	**15-Dec-06**	**12-Jan-07**		this would include full BOE & notes

Keith's NEPA table

	Status	Milestone date	Finish Date
Write Fermilab Environmental Evaluation Notification Form	Done	5 / 06	5 / 06
Concurrence	Waiting	6 / 06	
Determine Cooperative Agreement Recipient.	Waiting	?	
Determine Responsible Government Unit	Waiting	?	
Select Site	Waiting	?	
Prepare Enviornmental Assessment Worksheet	Waiting	?	
Tritium Issues resolved	Mike Martens of Steve Holmes task fource will provide information for EA	10/ 06	

	Status	John/Ron read draft	Final Draft	Milestone date	Finish Date
Write NOVA EA					
1. Introduction	Drafted	6-Jun-06		6 / 06	
2. Purpose and Need for Action	Drafted	6-Jun-06		6 / 06	
3. Description of Proposed Action, Including the Alternatives	**early draft done**	read, but not discussed yet		6 / 06	
3.1 Proposed Action	**early draft done**			6 / 06	
3.2 Range of Reasonable Alternatives	**early draft done**			6 / 06	
3.3 No Action Alternative	**early draft done**			6 / 06	
3.4 Describing Alternatives	**early draft done**			6 / 06	
4. Affected Environment				8 / 06	
5. Environmental Impacts (Effects)				8 / 06	
5.1 Impact Identification and Quantification				8 / 06	
5.2 Human Health Effects				8 / 06	
5.3 Biological Impacts				8 / 06	
5.4 Transportation Impacts				8 / 06	
5.5 Accident Analysis				8 / 06	
5.6 Environmental Justice				8 / 06	
5.7 Cumulative Impacts				8 / 06	
5.8 Compliance with Other Requirements				8 / 06	
5.8.1 Endangered Species Act				8 / 06	
5.8.2 Clean Air Conformity Requirements				8 / 06	
5.8.3 Floodplain and Wetland Environmental Review Requirements				8 / 06	
5.8.4 National Historic Preservation Act				8 / 06	
5.9 Mitigation				8 / 06	
5.10 Comparison of Impacts				8 / 06	
5.11 Conclusions in EAs and EISs				8 / 06	
6. List of Preparers, List of Agencies and Persons Consulted, and Distribution List				9 / 06	
7. Appendices, References, and Index				9 / 06	
8. Glossary				9 / 06	

Sufficient Project Personnel?

- **Administrative support high level full time**
  - Req is in the system -- Elaine Phillips reports HR looking at applications,
- **Help for monthly report startup**
  - Could be admin person?
- **More engineering on Block Raiser**
  - Final design, staged design allowing test phase?
  - Dave Pushka & Vic Guarino go back to basics before proceeding
    - Still talking, not yet agreeing, but still creeping closer to resolution
  - More PPD effort, FEAs ongoing
- **More engineering & help on Near Detector**
  - Have Karen Kephart, Peter Lucas, have ANL engineers (Guarino)
    - Issue with design/drafting, lack of access to Don Friend, first reported to PPD Eng Resource Mtg on July 17, PPD and Project continue to watch this
  - Leon Beverly? John Voirin? Both familiar with shaft & tunnel.
    - Installation transport, containment, fire protection, mobility
    - Leon toured MINOS access tunnel with Peter Lucas on August 30
      - Expecting his help on a cost estimate to move utilities
    - Will need FESS & Chris Laughton help on crude excavation costs in access tunnel

Sufficient Project Personnel? continued

- **Scintillator Blending**
  - Issues outlined on next slide -- On-site vs, Off-site models being considered
    - Still would do prototype blending for spring 2007 in house
    - Involve PPD process control group?
- **QA person, part time probably OK for now…..**
  - No progress
- **Electronics infrastructure and Slow Controls**
  - Italy for Slow controls, but when?, Leon Beverly for infrastructure?
  - Craig Dukes (Univ of Virginia) as new L3
    - understands Italians eventually, already working with them
  - John Oliver & Dave Pushka to look harder at the power & cooling issues across L2 boundaries – led to next bullet
  - New Cooling model proposed
    - Dave Pushka has suggested changing our design from water cooling of the TEC hot side to R-134a cooling with one cooling unit per detector block
      - Still in initial discussions within NOvA
      - Might need PPD Process Control group help for design

Scintillator Blending

- Blend at Fermilab
  - CD-1 cost estimate of $1.7 M for 25 kt.
- Different ***risks***
  - 750 ISO tanks = 6,341 gal
  - Done at home, we have to do it all
  - ES&H concerns
    - 191 rail cars mineral oil?
    - 40 ISO tanks of pseudocumene
    - Railroad bunching delivery
    - Might hold at storage facility?

- Hire a Toll Blender
  - One estimate of $5.3 M for 30 kt version
- Different ***risks***
  - Possibly 50,000 gal
  - Done elsewhere, hard to watch all operations
  - ES&H "hired"
    - 10 barges for mineral oil?
    - Can't navigate Jan/Feb
    - 26 day trip from Gulf

QA needed for both schemes:

What do we measure, how often , how long does it take (Chuck, Tom)

Then try to compare two methods. *May require expensive consultants*