Fermilab

U.S. DEPARTMENT OF ENERGY | Office of Science

Fermilab SBN Program Planning and Facilities

Peter Wilson

Short-Baseline Neutrino Program Workshop

30 April 2014

Outline

- Why are we here?
- Our Questions
- Budget
- Schedule
- Examples of option analysis

Why we are here?

- Proposed SBN Program consists of up to three detectors located on the Booster Neutrino Beamline:
  - LAr1-ND located in/near the SciBooNE hall ~100m from target
  - MicroBooNE located in LArTF building at 470m
  - ICARUS located at ~700m near the MINOS surface building
  - A number of configurations of these detectors have been proposed.
- Primary goal of this workshop is to narrow down to one or possibly two configurations for further study
- We need to focus on:
  - Physics capabilities
  - R&D Benefits
  - Cost, must fit in budget (DOE) envelope
  - Schedule

Our Questions:

1. New alternative proposed layout: MicroBooNE as Near detector and ICARUS T600 as Far (500 m?): what are the benefits on physics reach, time schedule and cost?
2. Sensitivity assumptions: The sensitivities for nue appearance presented by the LAr1-ND and ICARUS collaborations seem to have some differences even when evaluating very similar configurations. In order to converge, it would be helpful to discover what creates this difference. Is it a difference in input assumptions or calculation methods?
3. Neutrino beam spectra at different distances from target.
4. Near Detector size: Do we gain in the physics capabilities by enlarging the ND? What are the cost and schedule implications of such a change?

Our Questions (cont):

- Location of ICARUS T600: Is the physics impacted by locating the FD at the surface, amounting to ~10m off-axis? What are the cost savings relative to locating on-axis?
- Far Detector size: Is it possible to increase mass at far detector with new module(s)? What impact would added mass at FD location have on physics reach?

- Think about these questions during today's sessions and consider:
  - Do we already have enough information to come to a conclusion now?
  - If not, what additional information do we need to reach a conclusion?

DOE SBN Budget

- Current expectation for DOE budget is ~$23M over 4-5 years (FY15-FY18 or FY19)
- Initial allocation assumed:
  - GPP for LAr1-ND building: not more than $3M
  - Design, Construct, Install LAr1-ND: $10M
  - GPP for ICARUS building: no more than $9.8M★
- Allocation did not account for Fermilab responsibilities on Integration and Installation of ICARUS
  - Integration: ensuring the detector/building interfaces will work AND ensuring that ICARUS cryogenic/mechanical systems pass Fermilab safety
  - Installation: putting all the parts together in the building

★ GPP funding (General Plant Project) has absolute cap at $10M

Fermilab

Where does the Money Come from?

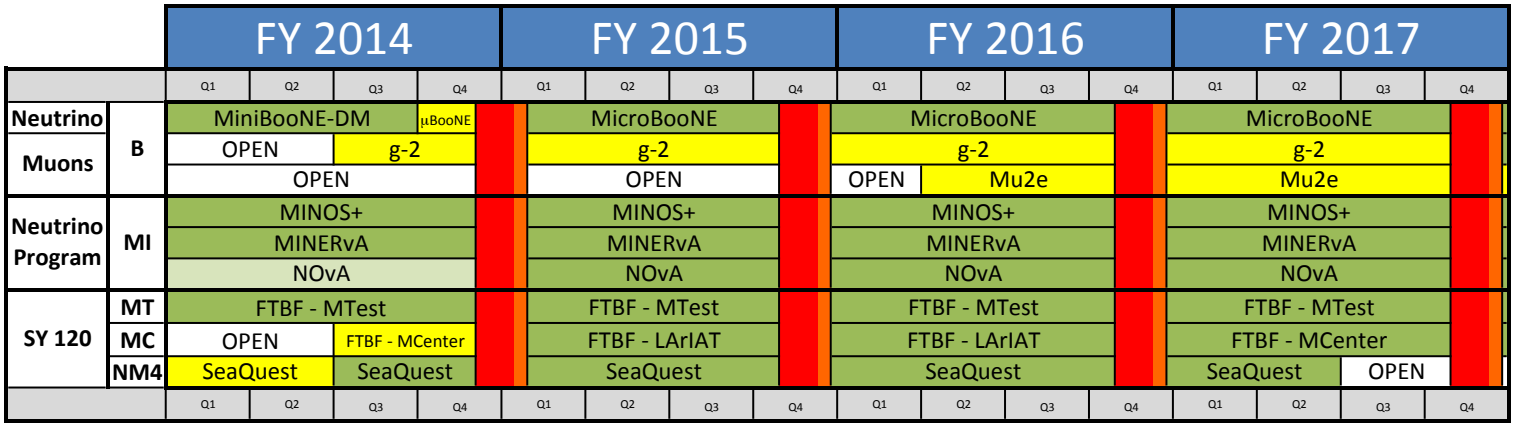
	Funding Source		
Component	DOE	Other US	Non-US
LAr1-ND			
Building	X		
Cryostat	X		
Cryo System	X		X
TPC		X	X
Electronics	X	X	
Integrate and Install	X		
ICARUS			
Building	X		
Cryostat			X
Cryo System			X
TPC			X
Electronics			X
Integrate and Install	X		X

Fermilab Experiment Schedule

Fermilab Program Planning

Fermilab Accelerator Experiments' Run Schedule

12-Feb-14

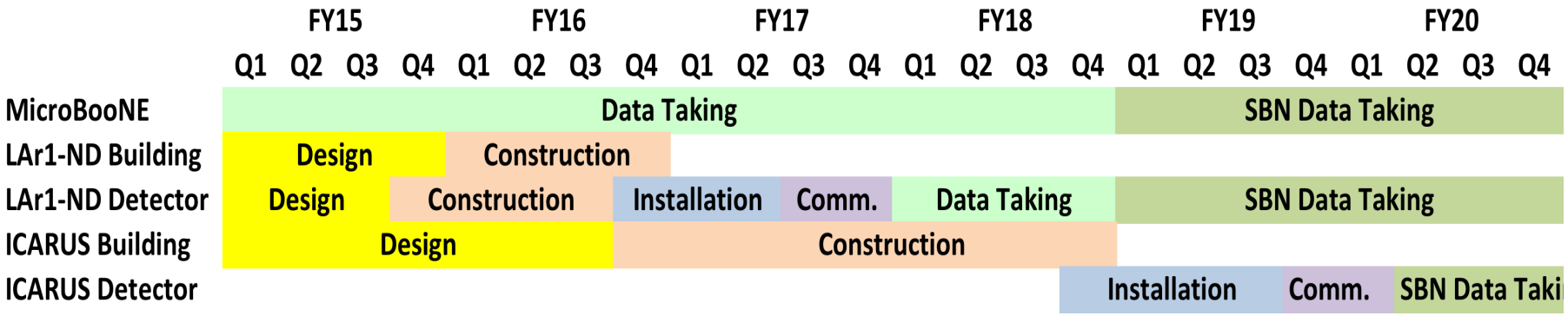


RUN/DATA	Anticipate mid-year maintenance shutdowns of 6 week + 2 weeks commissioning
STARTUP/COMMISSIONING	NOvA CD-4 end of Nov 2014, MicroBooNE first beam for commissioning July 2014
INSTALLATION/COMMISSIONING	MicroBooNE "installation" start defined as time when BNB target reinstalled.
M&D (SHUTDOWN)	g-2 and Mu2e installations defined as starting when buildings ready.
INSTALLATION & RUNNING	Continued MINERvA & MINOS+ running through FY07 assumed - to be reviewed

SBN Building Schedules

- Cannot move faster than buildings can be built
- Based on recent Fermilab experience, construction times from start of conceptual design to beneficial occupancy:
  - Near (LAr1-ND) building ~2 years
  - Far (ICARUS) building ~4 years
  - Need to include schedule contingency on top of these numbers
  - More details in Steve Dixon's talk
- To get buildings done need to get requirements agreed to early: reduce schedule and cost risk
- Need clearly defined prioritized requirements:
  - Items absolutely required to make detector work
  - Items that ease installation or provide contingency (eg Crane)
  - Items that provide future capability (eg bigger Crane)

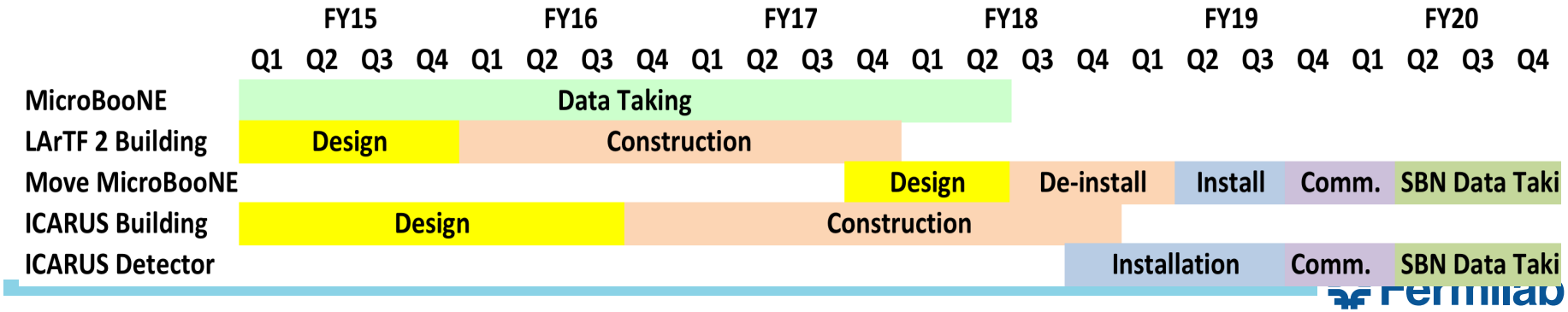
Possible SBN Timeline



- Assumes approved MicroBooNE run of 6.6E20 POT delivered in 3-4 years

Example Option Analysis: MicroBooNE as near detector

- Proposal: After approved 3 year run move MicroBooNE to near detector location (~100m)
- What is needed:
  - New “LArTF2” hall @100m - ~$6M, 2 years construction
  - Disassemble MicroBooNE and reinstall in new location. Guesstimate 18 months at a cost of $2-3M
  - Total cost about $10M
- Positives: existing detector, presumably well understood
- Negatives: No data for 18-24 months, no R&D opportunity



Example: Near Detector Size Options

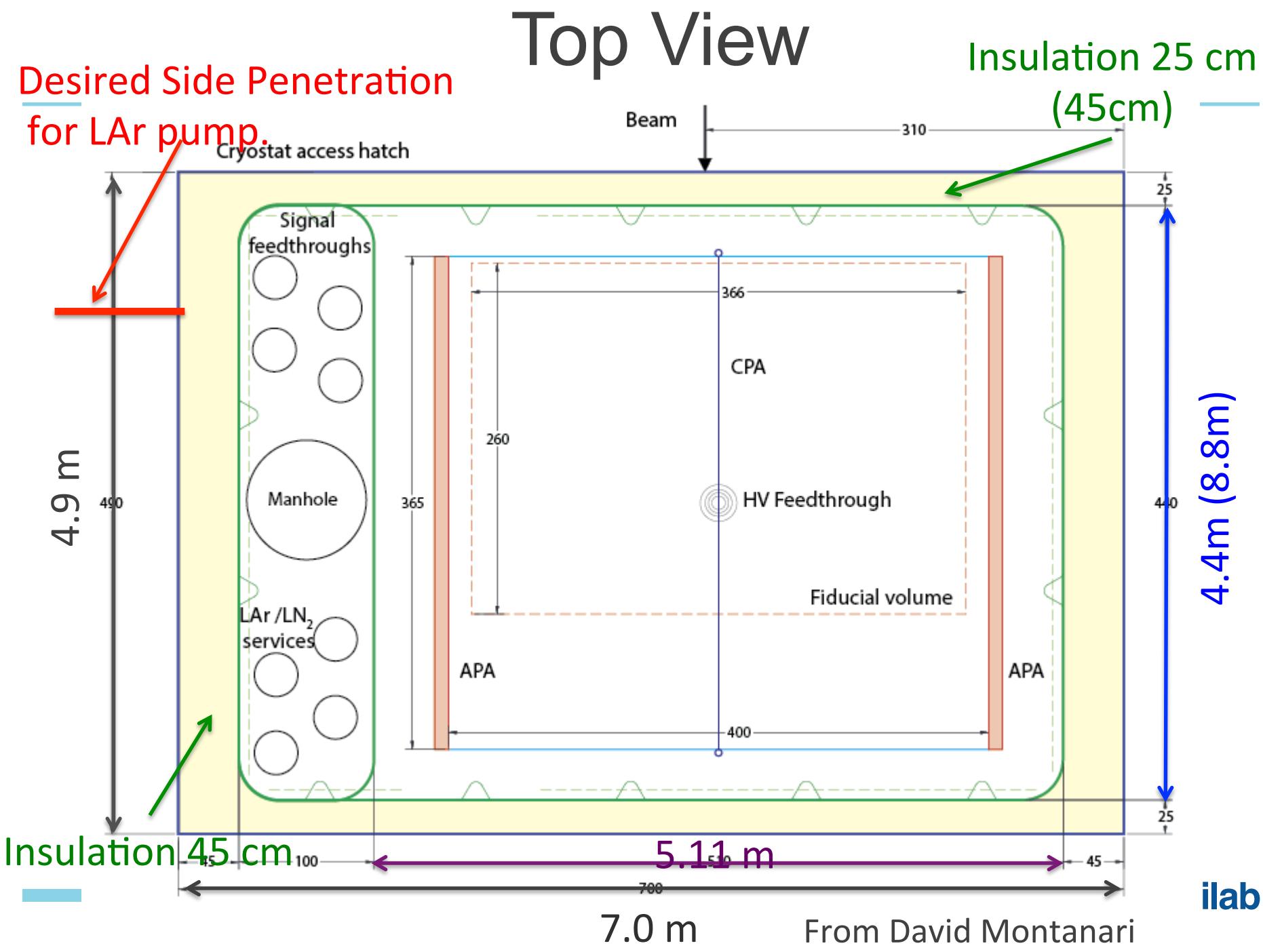
- LAr1-ND Proposed membrane cryostat installed in SciBooNE enclosure for ~150t LAr
  - Need building modifications for cryostat mechanics
  - Need wall heating for concrete
  - Need space for cryogenics
  - Limited fiducial volume, not very deep along beam
- Option 1: modify existing enclosure and add surface structure to house cryogenics system. Costed two building sizes (see Steve's talk).
- Option 2: build new adjacent enclosure designed for cryostat, use existing enclosure for cryogenics system. Costed enclosure for cryostat twice as long as SciBooNE (see Steve Dixon talk)

Example LAr1-ND Cryostat Parameters (129m^3)

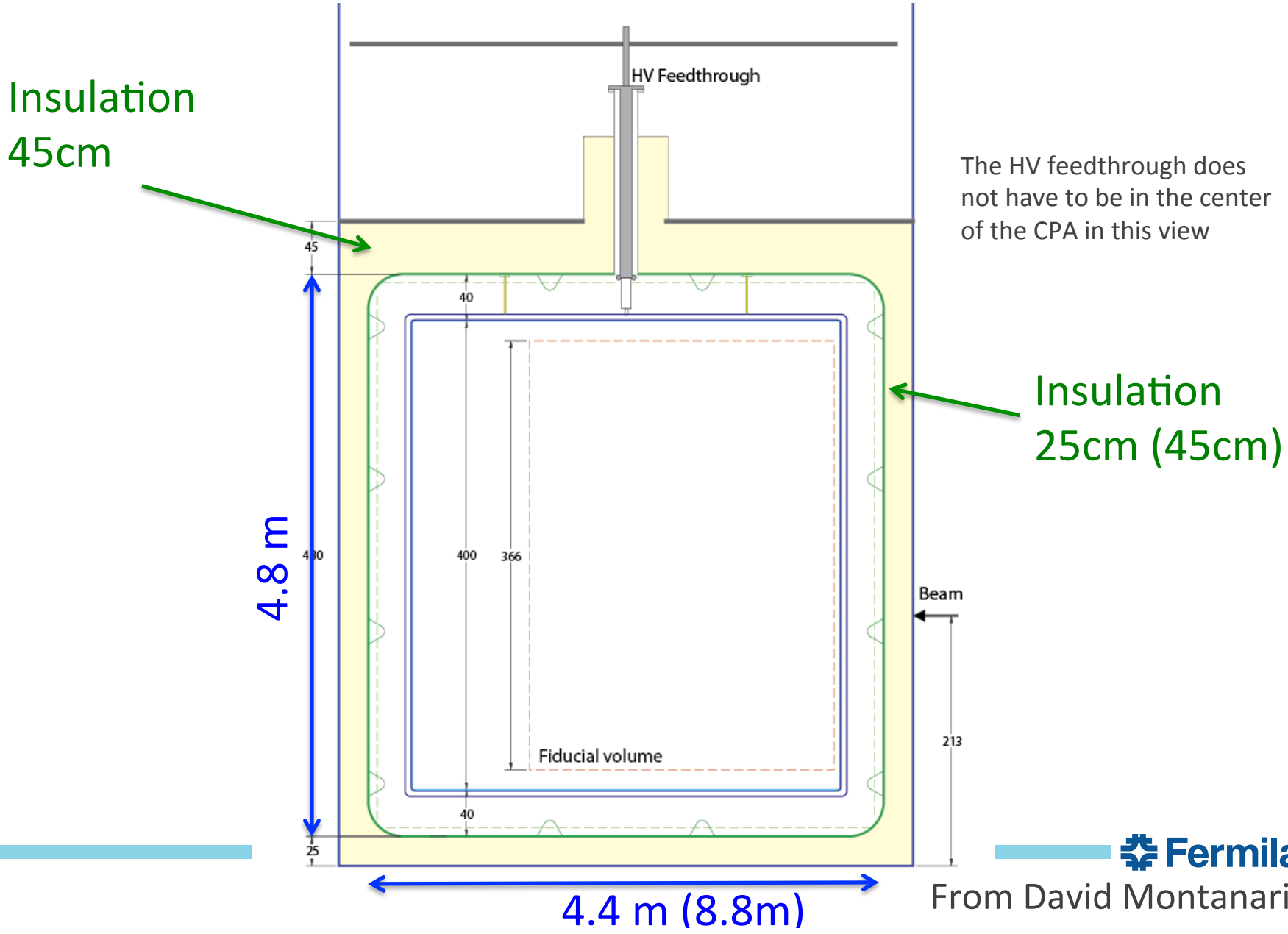
Parameter	Value
Type of structure	Membrane cryostat inside a concrete pit
Outside reinforcement	Existing or new concrete pit
Cryostat Volume	129 m^3
Fluid	Liquid Argon (LAr)
Liquid Argon total mass	180 ton
Inner dimensions (flat plate to flat plate)	4.4 m (W) x 6.1 m (L) x 4.8 m (H)
Depth of liquid argon	4.8 m (All the gas in the "neck" region on the side)
Insulation (different thicknesses to match the size of the existing pit)	0.25 m (bottom), 0.45 m (top) 0.45 m (beam left/right), 0.25 m (beam upstream/downstream)
Primary membrane	SS 304/304L
Operating gas pressure	1.0 psig (~70 mbar)
Vacuum	No vacuum
Design Pressure	3.0 psig (~207 mbar)
Design Temperature	77 K (liquid Nitrogen temperature for convenience)
Penetrations	One through the insulation and all the others through the neck region.
Duration	10 years
Thermal cycles	10 complete cycles (cool down and total warm up)

From David Montanari

Top View

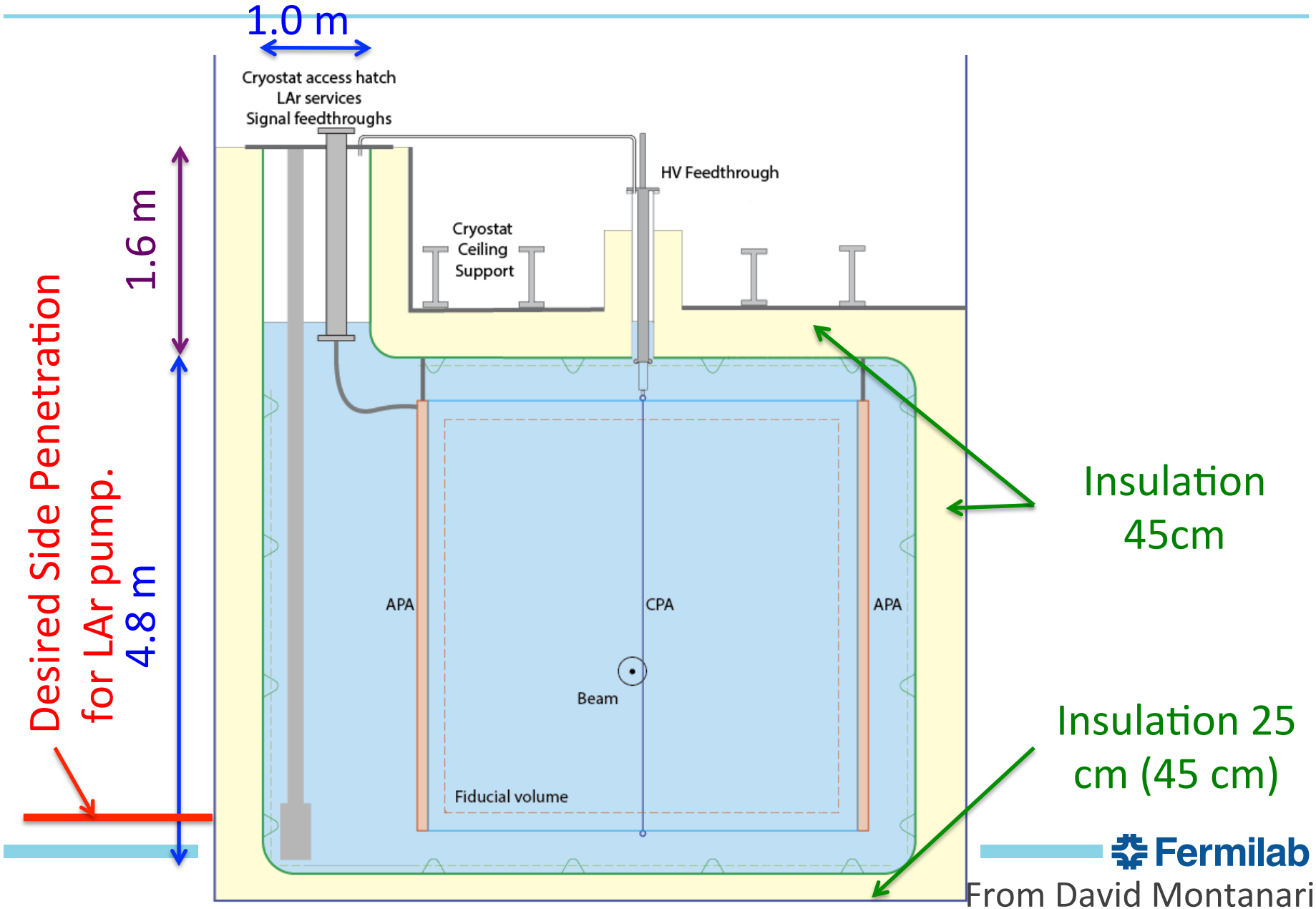

Desired Side Penetration for LAr pump.
Insulation 25 cm (45cm)
Beam
310
Cryostat access hatch
25
Signal feedthroughs
366
CPA
260
Manhole
365
HV Feedthrough
Fiducial volume
LAr /LN2 services
APA
APA
400
4.9 m
490
4.4m (8.8m)
440
25
Insulation 45 cm
45
100
5.11 m
510
45
700
7.0 m
From David Montanari
ilab

Side View



From David Montanari

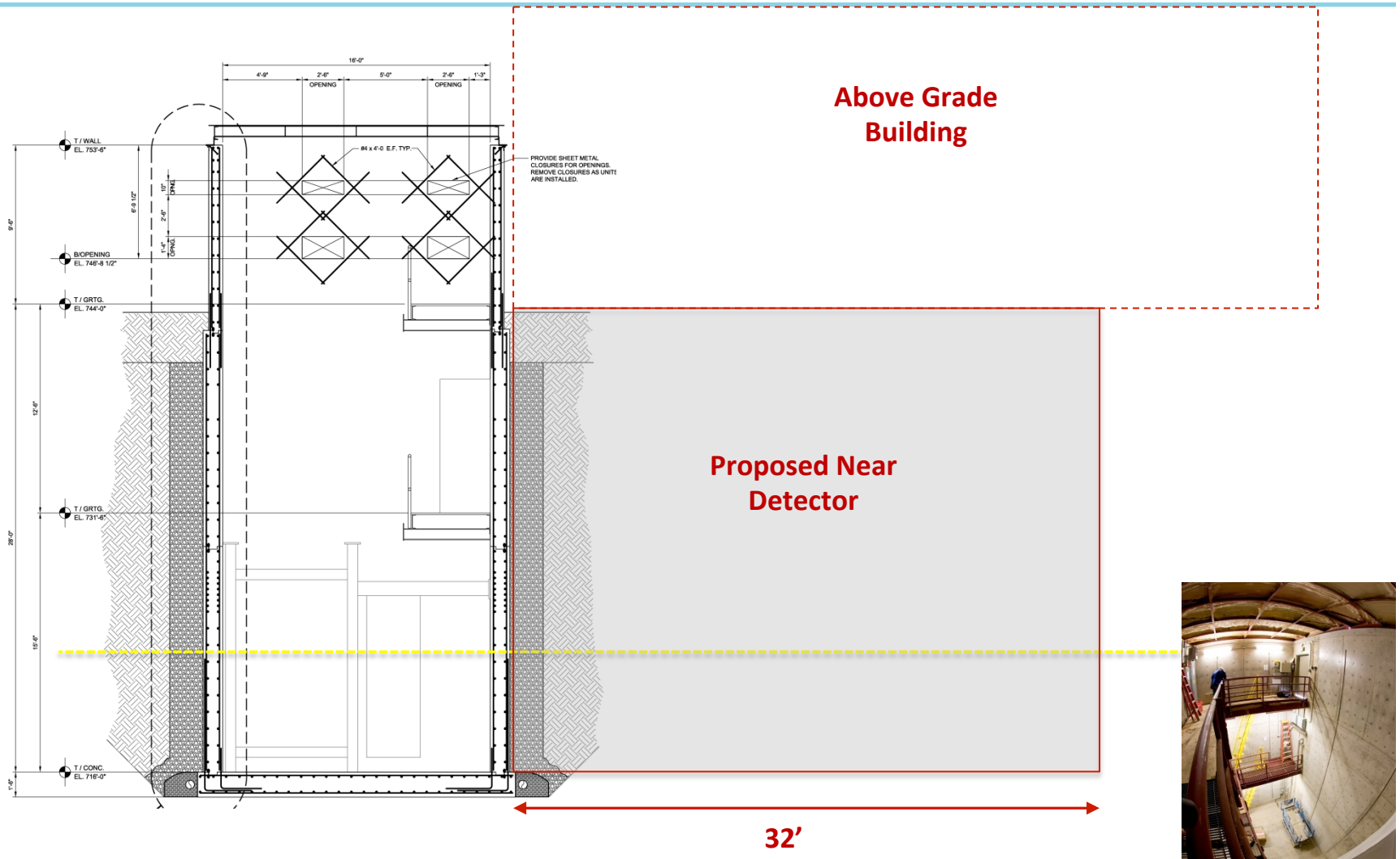
Back View



Fermilab

From David Montanari

Near Detector – 1st Pass



LAr1-ND Options - Cost Comparison

	Option 1	Option 2
Cryostat Location	SciBooNE	New Enclosure
Cryogenics Location	New Building	SciBooNE
Cryostat Size	129m3	258m3
Building Cost	$2.9-5.6M	$4.0M
Cryostat Cost	$1.8-4.2M	$2.2-5.8M
Building + Cryostat	$4.7-9.8M	$6.2-9.8M
Cyrogenics Cost	Assumed near Same	
TPC and Electronics	?	?

Example: ICARUS Location Options

- Need to keep far detector building cost at or below $9.8M to fit in GPP
- Initial cost range (Jan 2014) of $13.2M - $20.5M
  - Refine requirements to reduce cost (and contingency)
- Going off beam axis would reduce cost:
  - Surface building (7m higher) reduces cost by $1.4M-1.9M
  - Off axis, away from wetland (1.4^{o} or 17m west) reduces cost by $1.1M-1.6M and saves about 1 year of construction schedule
  - See Steve's talk for details
  - What is physics impact of being off axis?
- Possibly other (better) options for cost reductions. Need to keep open mind, look at requirements for detector installation and operation.

Summary

- Fermilab SBN program is an exciting opportunity for Physics and R&D for future LBNE program
- Budget constraints severely restrict what is possible
- We must make smart choices by focusing on:
  - Physics capabilities
  - R&D Benefits
  - Cost
  - Schedule
-