35t Management and Schedule Overview

Jim Stewart

35t Lessons Learned Review

6/2/2016

Content

- 35t History
- 35t Goals
- Challenges
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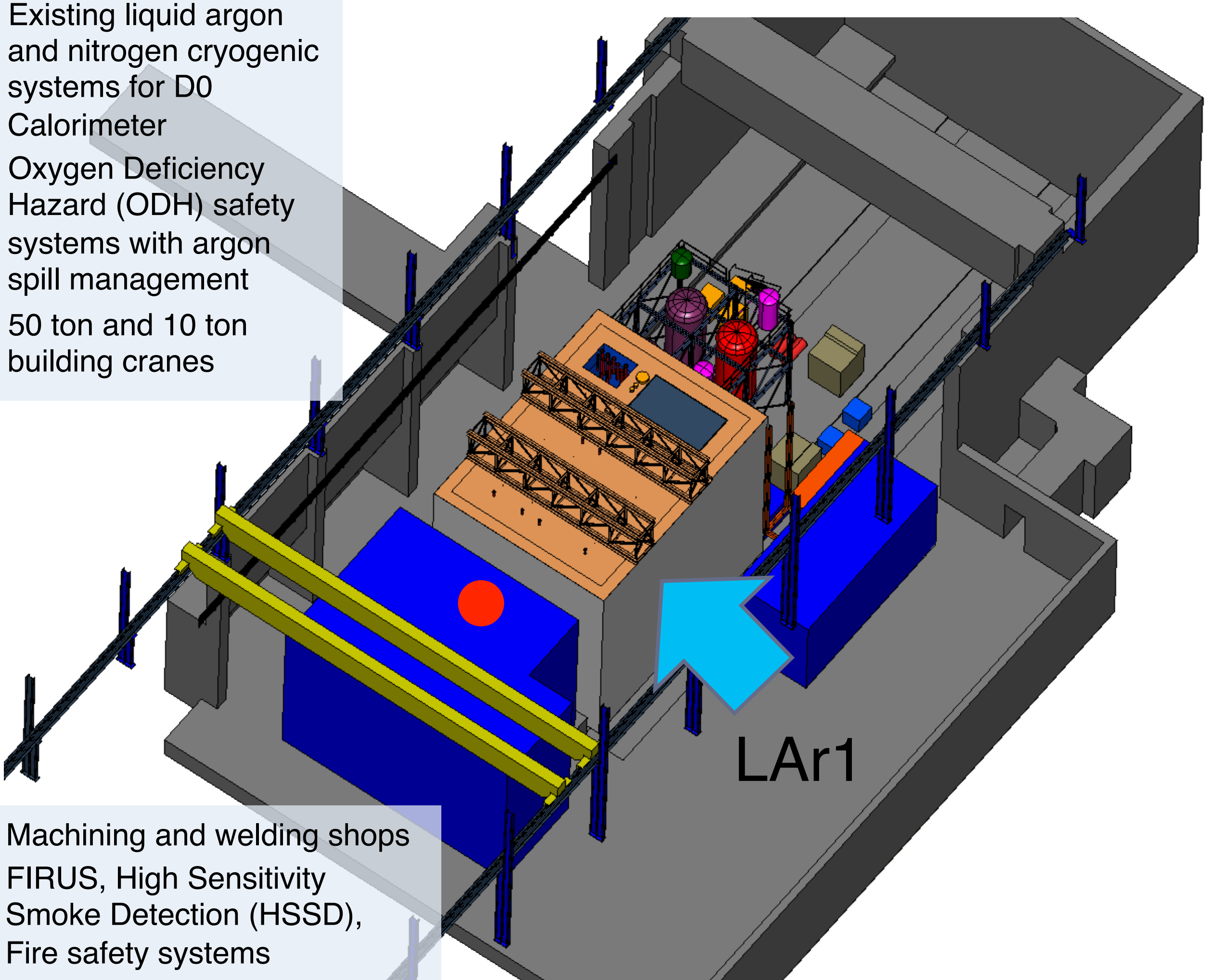
- Summary

LBNE Prototyping

- The original LBNE prototyping plan called for a membrane cryostat demonstrator called the 35t prototype and a large scale LAr-TPC prototype to verify the detector engineering design called LAr1.
- The 35t membrane cryostat was constructed in PC4 to make use of the LAPD cryogenic system and was envisioned to operate without a detector inside.
- The LAr1 Prototype was to be constructed at FNAL in the D0 assembly building and planned for cosmic ray data taking prior to CD-2.
- During the 2012 reconfiguration, where the LBNE far detector was reduced in scope and moved to the surface, LAr1 was removed from the project. (cost savings of $20M)

LAr1 Sited at D0 Assembly Building

- Existing liquid argon and nitrogen cryogenic systems for D0 Calorimeter
- Oxygen Deficiency Hazard (ODH) safety systems with argon spill management
- 50 ton and 10 ton building cranes



- Machining and welding shops
- FIRUS, High Sensitivity Smoke Detection (HSSD), Fire safety systems
- Emergency backup power diesel generator

Savings compared to new building and infrastructure ~ 10 MM$ and ~ 2 years

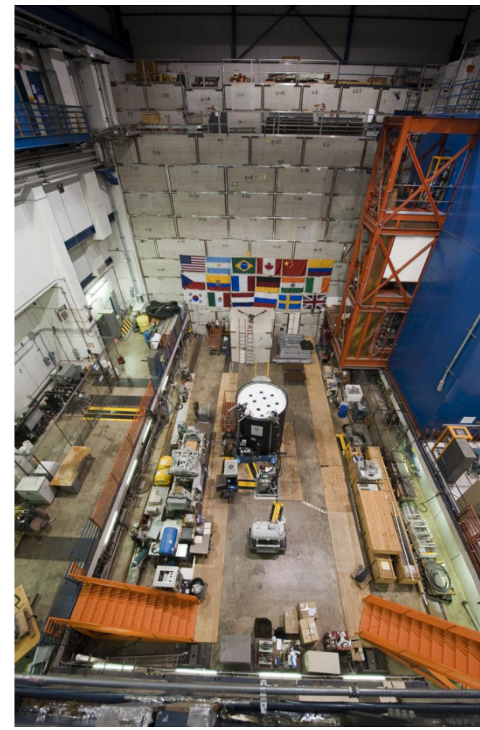


Photo of the D0 assembly pit taken from the viewpoint of the red dot

LAr1 Cryostat – Outer Shell

Guard rails on cryostat top not shown

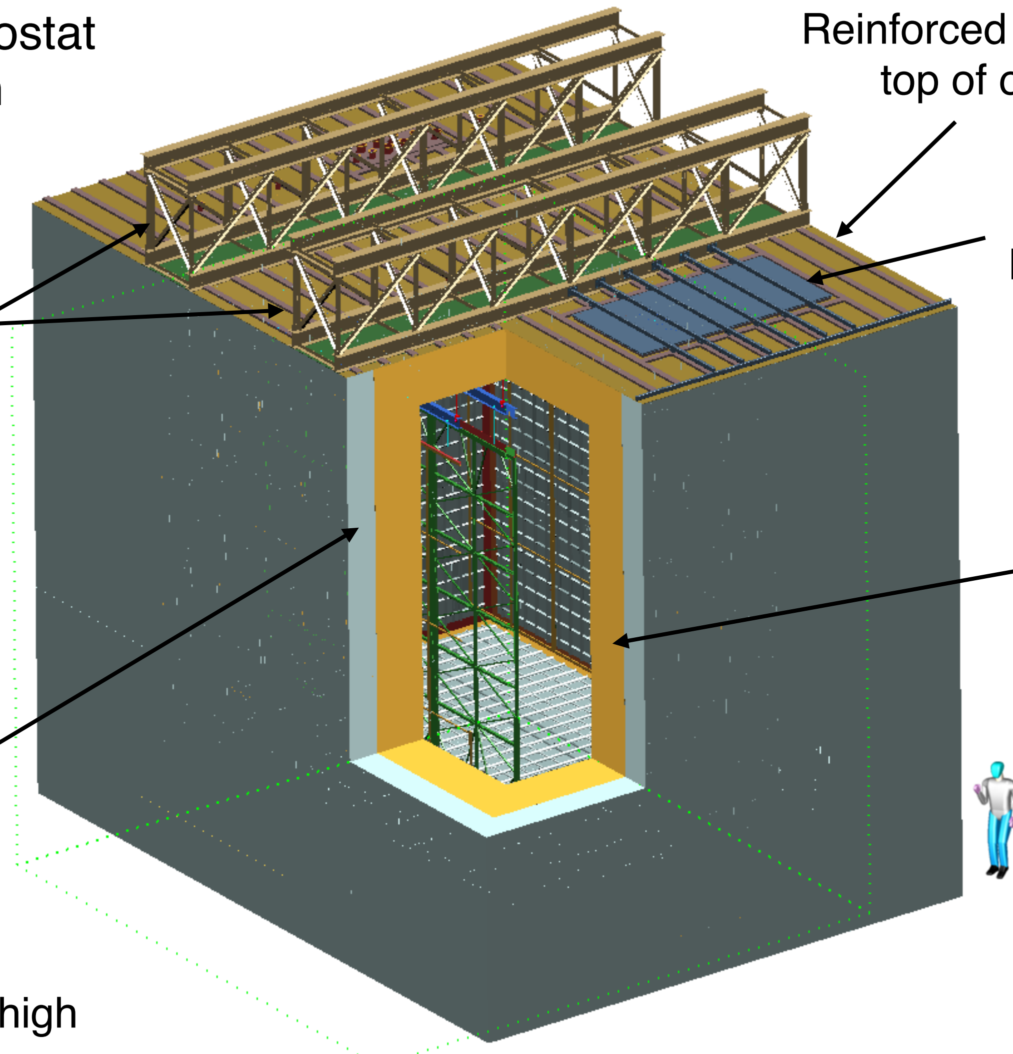
Reinforced steel plate for top of outer shell

Access hatch braced with beams

Trusses at same 5 m ctr-ctr spacing as LAr-FD provide same cable/rack arrangement as a zone of LAr-FD

0.8 m thick foam insulation

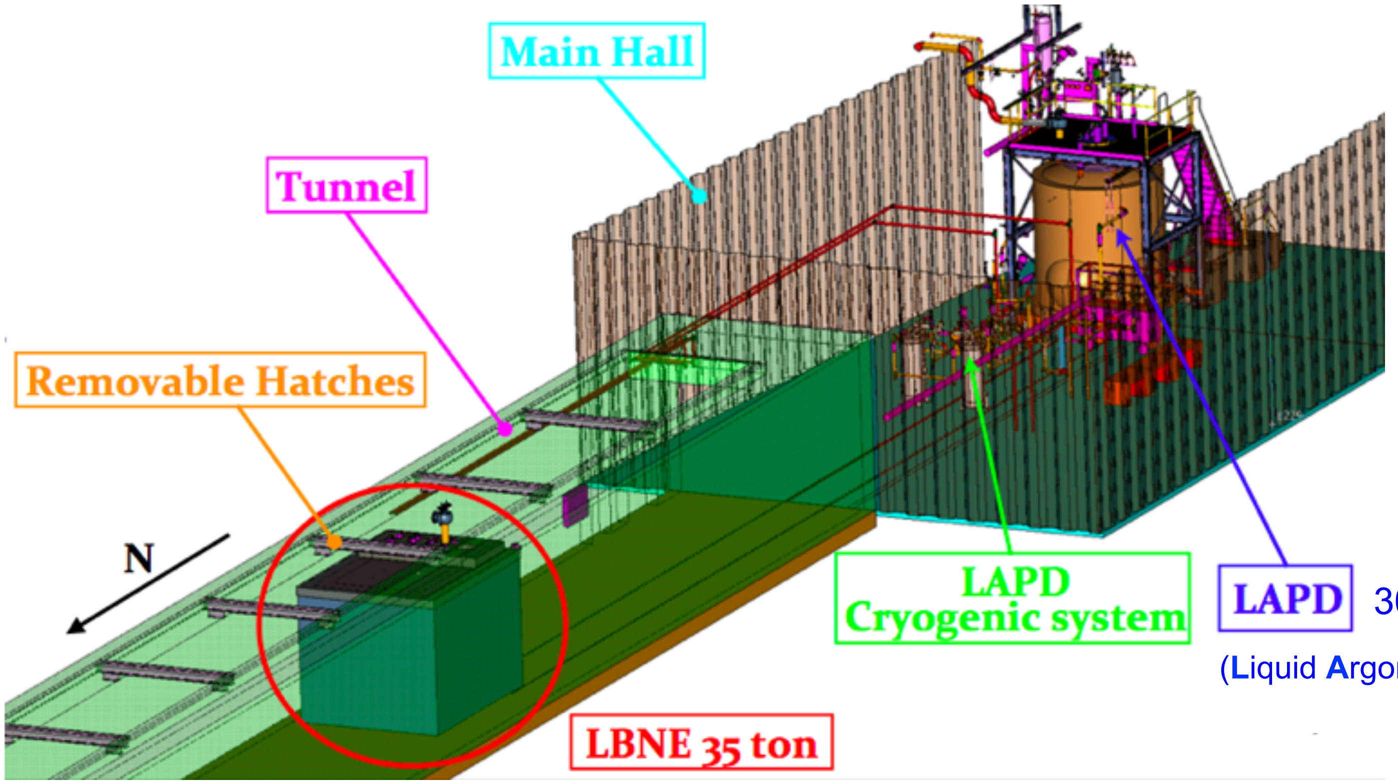
Reinforced concrete for bottom and sides of outer shell



Exterior dimensions
10.3 x 13.4 x 11.8 m high

Location of 35-ton Prototype--PC4 Beamline @FNAL

- 35-ton Cryostat shares purification system with LAPD
  - At any one time, only one of the two systems may be running
- LAr can be shifted back & forth between LAPD & 35-ton

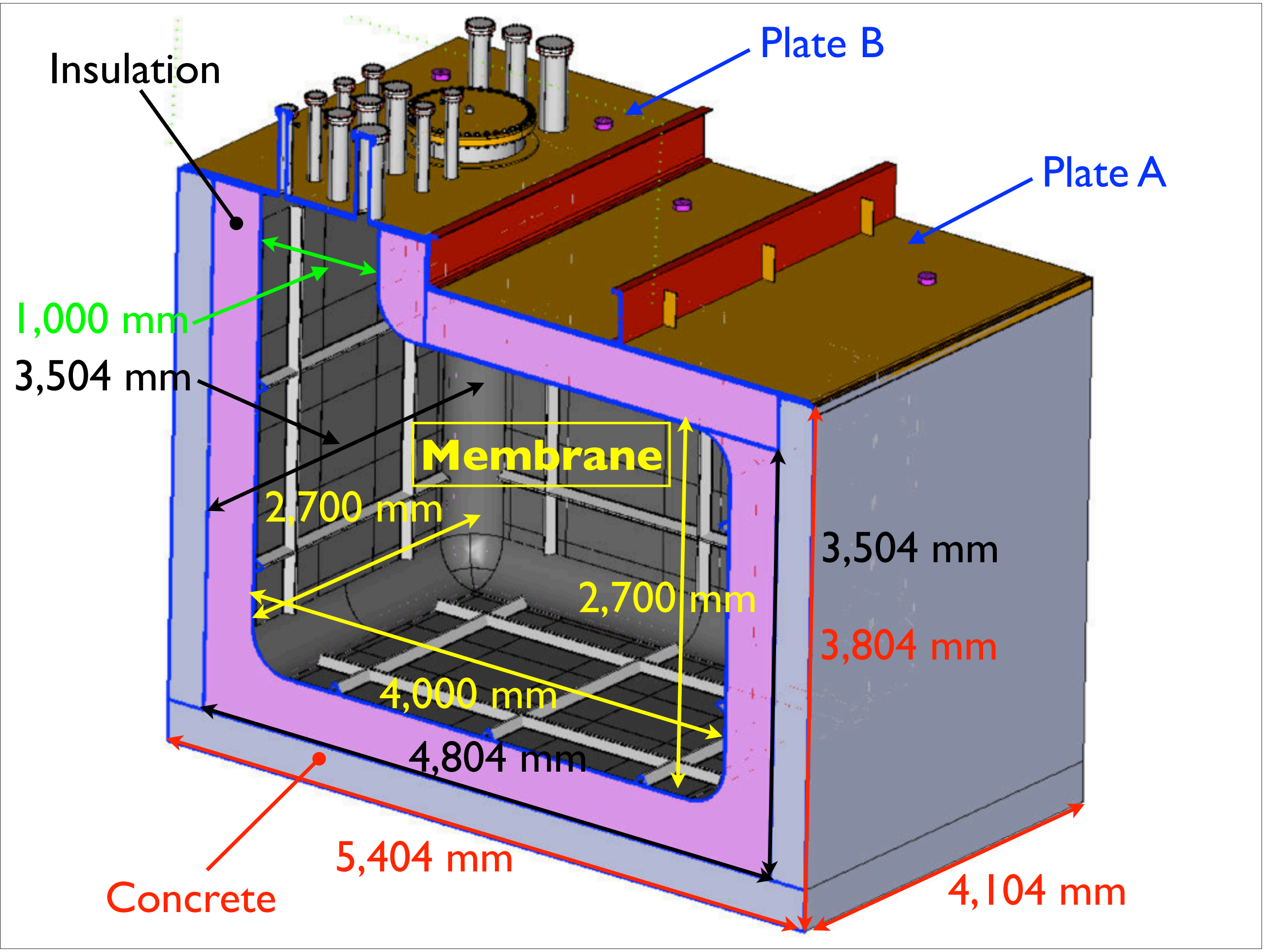


30 ton

(**L**iquid **A**rgon **P**urity **D**emonstrator)

35 t prototype cryostat

IHI construction



Proof of principal in LAr applications

Benchmarks cryostat performance

Develops procedures

Develops purging and commissioning planning

Available for detector prototyping

Addresses recommendation CRYO-01

Details in A Hahn's prototyping talk

35t phase I

- The 35t Phase one system operated from 11/2013 to 3/2014.
- It demonstrated that high purity can be achieved using a membrane cryostat. (2.5ms electron lifetime)
- Developed local expertise in dealing with membrane cryostat companies.

Beginning of 35t Phase II

- The phase II prototype originated immediately before the DOE LBNE CD-1 review to partially replace LAr1.
- It made use of the 35t cryostat and cryogenic system prototype which was nearing completion at the time.
- It had to be designed around the existing infrastructure and limitations of the 35t cryostat.
- It was intended to test as many as possible of the aspects of the single-phase detector that were new to the far detector.

Original 35-Ton Phase 2 Goals

Build a complete functional reduced-scale sized TPC with Photon Detectors inside the 35-ton cryostat.

- TPC components will closely resemble the full size counterparts.
- APAs will incorporate either
  - functional photon detectors
  - or mockups with real photon detectors behind a transparent cathode.
- Goals of this prototype TPC
  - Validate the design of nearly all TPC components (at a small scale); testing the integrity of all components and their interconnects in LAr.
  - Study the performance of the wire wrapping readout scheme, and the impact of the gaps between APA modules.
  - Study the electronics noise contribution from potential sources: acoustic, pump, flow driven wire or field cage motion, high voltage ripple coupling, coupling between digital and analog circuits, etc.
  - Study the positive ion space charge distortion on muon tracks, and its dependency on drift field and fluid flow pattern.

•Expect run in mid-2014 through end 2014.

Delayed 15 month in 2 yr plan much of this due to the phase I delays

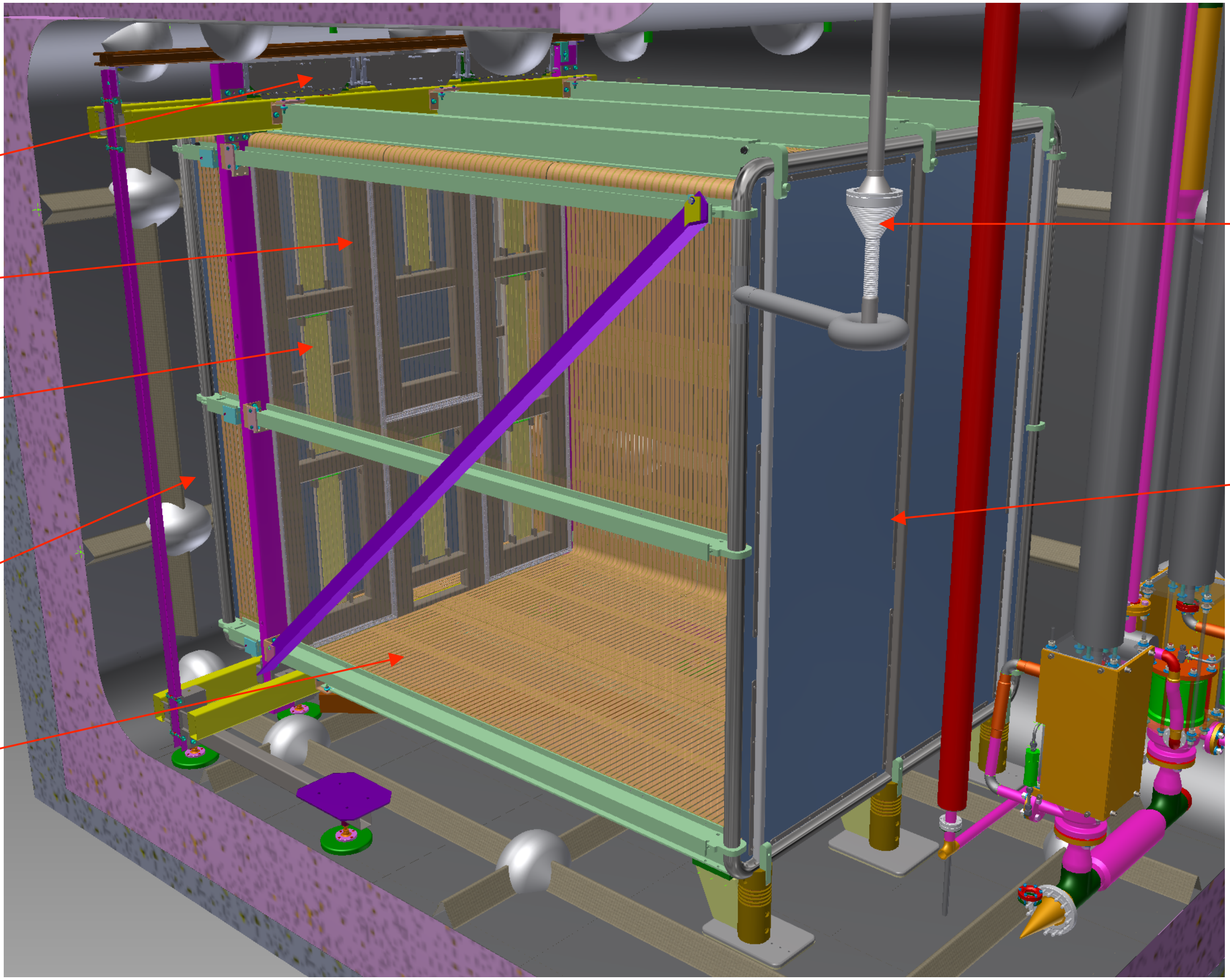
35t Phase II Goals continued

- Demonstrate first operation of a COLD ADC designed for long cryogenics operation.
- Develop a triggerless DAQ suitable for proton decay and supernova physics.
- Develop and test the photon detectors and readout.
- Integrate the photon system with the TPC readout.
- Develop the charge readout with electronics capable of data processing outside the cryostat.

Constraints and Challenges

- The detector had to fit in the existing 35t cryostat
  - The cryostat was not designed for running with a detector so the grounding was not designed optimally.
  - The detector had to fit in the very small existing opening.
  - The detector size had to fit the cryostat interior which lead to two drift regions 2.2m and 0.26m.
    - Wanted data from both sides of the APA and a large drift as similar to the far detector as possible.
- The cost had to be kept low to fit in the funding profile.
- The schedule had to match the planned CD-2 date.

35ton TPC System Overview

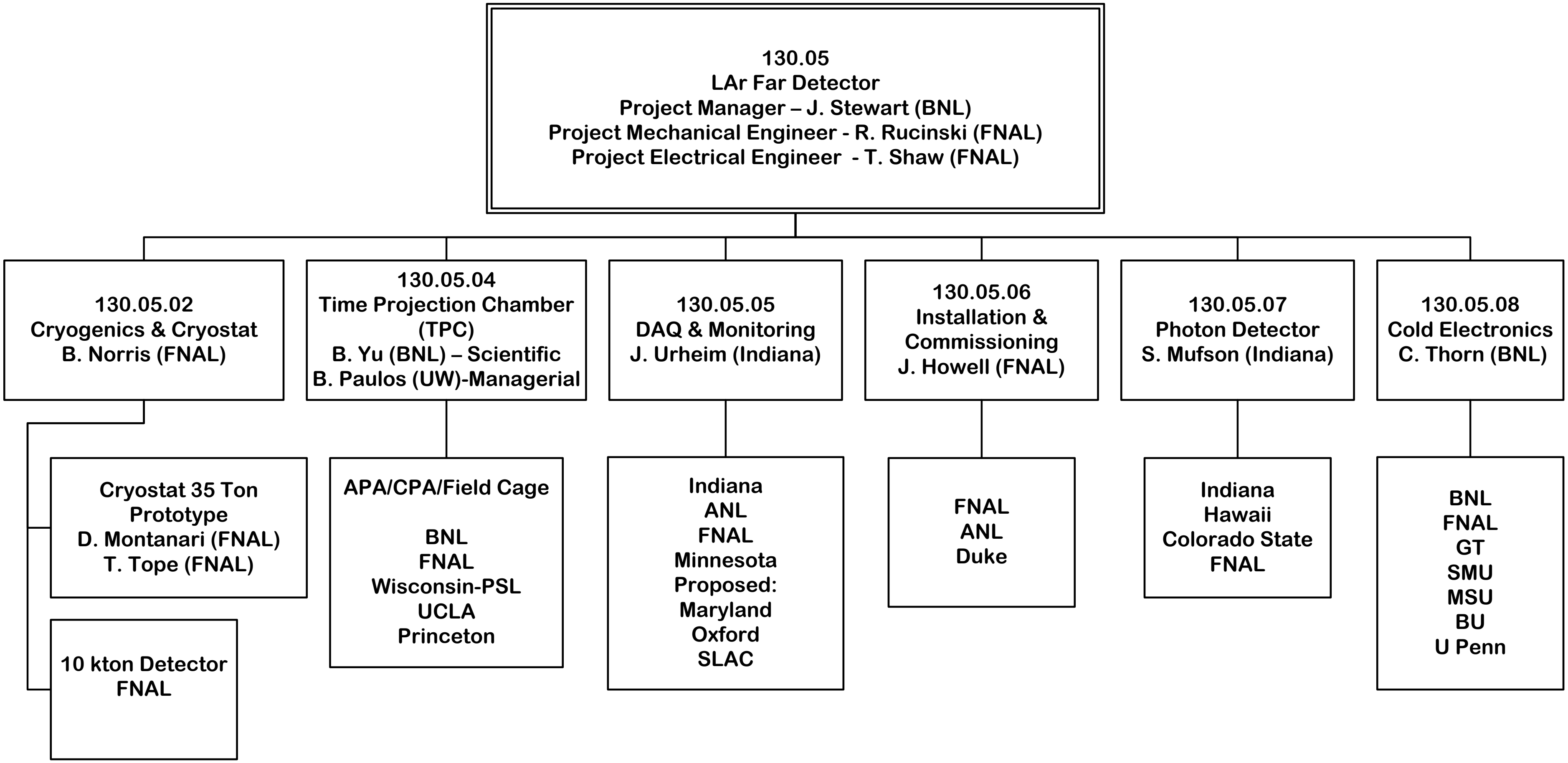


External cosmic ray counters on top and sides of the cryostat to provide through muon triggers.

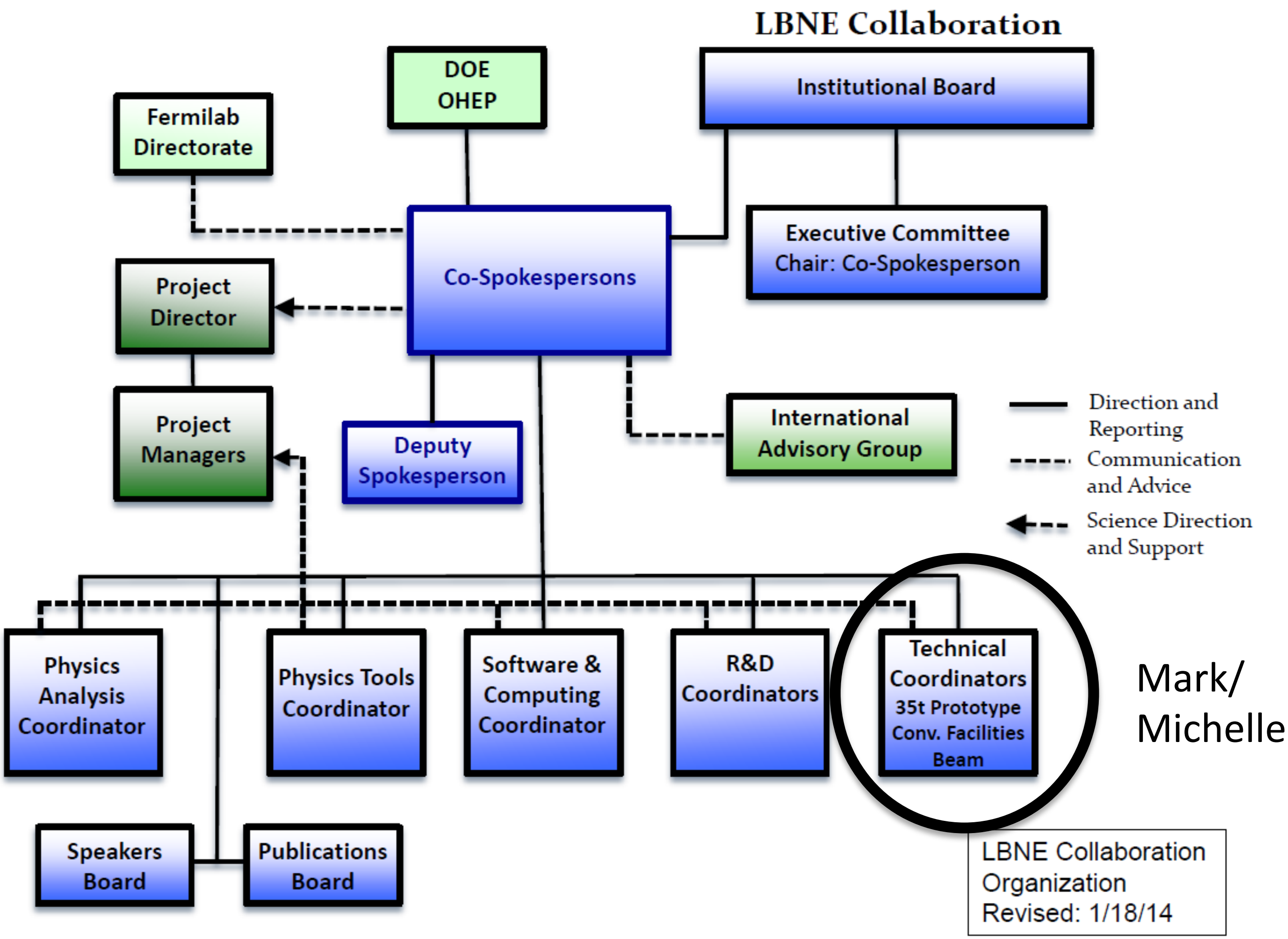
Management Introduction

- The 35t was organized under the LBNE Collaboration and DOE LBNE project.
- The detector construction was the responsibility of the LBNE project under the Far Detector Manager.
  - The L3 managers were responsible for delivering the detector components and installing them.
  - Alan Hahn was appointed as 35t Hardware coordinator by the project manager and was given responsibility for coordinating the installation and testing.
- The 35t operations and data analysis were assigned the responsibility of the 35t Technical Coordinators Michelle Stancari and Mark Convery
  - The 35t Technical coordinators were foreseen as effectively spokespeople for the 35t Phase II test

Organization at the CD-1Review



OLD LBNE Collaboration ORG.



Mark Convery and Michelle Stancari

6. The 35t prototype Collaboration Technical Coordinator

Charge of the 35t prototype Collaboration Technical Coordinator: *The 35t prototype CTC is responsible for the following:*

i. *Prioritize and maintain a schedule of collaboration activities regarding simulations, physics analysis.*

ii. *Prioritize and maintain a schedule of other collaboration service activities on the 35t prototype. These activities may include collaboration participation in assembly, commissioning, calibration, debugging, data-taking, shifts, etc.*

iii. *The responsibility of the 35t CTC shall including maintaining a database of contributions from the collaboration to the 35t prototyping.*

iv. *The 35t prototype CTC shall recruit collaboration personnel and resources by communicating with the institutional board members.*

v. *The 35t prototype CTC shall coordinate with the 35t prototype Level-3 manager as well as the liquid argon detector L-2 project manager. The 35t prototype CTC shall serve on the 35t technical board.*

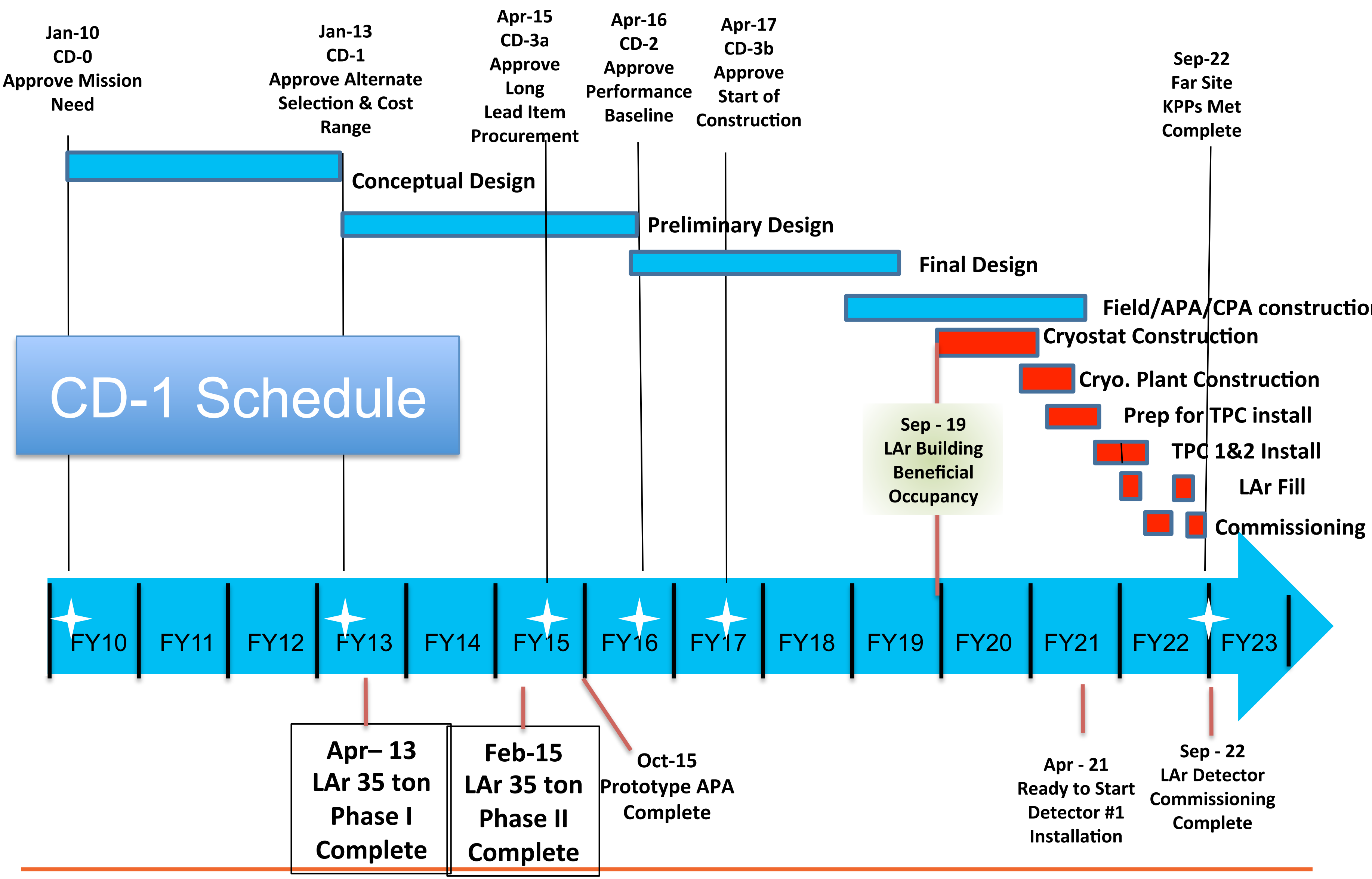
Docdb-6547
20 November 2014
M. Diwan
M. Goodman
R. J. Wilson

LBNE COLLABORATION ORGANIZATION DOCUMENT
Fermilab Long-Baseline Neutrino Experiment

Project Schedule Development

- The L3 managers developed the Project schedule for the work needed to manufacture, test, and install the 35t Phase II detector.
  - This was develop immediately prior to the CD-1 review
- The Project schedule was reviewed by the project engineers and project manager.
- The schedule was aggressive given the large number of new developments needed.
- The data taking period was assumed to be 3 mo as was used for the ICARUS 10 t prototype.
- The RISK associated related to difficulties in the 35t run was estimated along with the cost of a second run.
  - The probability of needed a second run was estimated at 50-75% at a cost of $5M. (The cost would fund one year of the detector effort.)
  - The schedule called for a single run but second run was considered as a risk because until one had the first run it was not possible to determine what work would be needed to prepare a second run.

130.05 Liquid Argon Far Detector (LAr-FD)



Planning scientific effort.

- The 35t Technical coordinators developed a detailed list of tasks that needed to be accomplished by scientists.
- The manpower for each was estimated.
- The activities are presented at the collaboration and groups/ people were sought to take responsibility for the activities.
- This was effectively a ~200 line milestone based schedule.

Activity Name	Elasped Duration (days)	Notes	240.00	
	Includes weekends and holidays		total manpower estimate in FTE-years	Identified People
Chronological Summary of 35ton Phase 2				
Run Preparation			5.701	
Coordination	272	coordinate analysis and simulation activities for the 35 ton	0.813	FNAL (Stancari) SLAC (Convery)
Physics Tools Development			1.011	below
Simulations	364	generate samples of muons and other particles from cosmic showers. Compare different cosmogenic models/tunngs	0.544	Houston (Bhandari) + another person t.b.d.
Online/offline software filters		Identify and preserve events useful for data analysis. Sum of individual analysis efforts. Coordination/integration part of DAQ task.	0.268	below
Online data quality monitor		Software that produces histograms to monitor data quality and rates during the run	0.410	UT Arlington (Hadavand)
		Need a preliminary version of all analyses to evaluate during the run whether the data are sufficient and		

Results of Scientific Resource Planning

- Individuals were identified for most tasks
  - Only 1/4-1/5 of the people delivered what was promised
  - In some cases the schedule delay meant that the individuals availability no longer matched when the work needed done.
  - In some cases the either the difficulty of task or the capabilities of the individual and deliverable were misestimated.
- In general individuals who had ~20% of their time available found it difficult to get up to speed with the software tools unless they were local to FNAL.
- Often people misestimated the time they would have available.
- Competition with MicroBooNE for scientific effort was an issue.
- The most critical tasks were achieved.

Monitoring Hardware Progress

- The finish dates from the schedule activities were extracted into an excel spreadsheet and additional milestones were added to give more detail.
  - The March 13 2014 milestone table was 168 lines long and had a projected completion in 9 months.
  - The actual time needed to complete the work was 24 months.

	L3 task	L4 tasks	Activity	Milestone date
2	**Cryo**			
3		**Phase 1 Done**	Milestone	7-Feb-14
4		**Cryo Preparations for Phase 2**		
5			35T Cryostat Warm and open for entry	28-Mar-14
6			PrMs Reworked	21-Nov-14
7			Dielectric Flanges re-made	21-Nov-14
8			Vacuum Relief Valve leaks fixed	21-Nov-14
9			Manhole cover modified with extra ports	21-Nov-14
10		**Interior of Cryostat clear and ready for TPC insertion**		30-Sep-14
11		**Reinstall CryoComponents**		21-Nov-14
12		**Begin Ar Purge of 35T Cryostat**		1-Dec-14
13	**TPC**			
14		**APA**		
15			Fabrication of APA number 1, short lower completed	14-Mar-14
16			Mech Check APA & Dummy Boards	15-Feb-14
17			Ship first Wired APA to BNL	21-Mar-14

35 Phase II reviews

- The Project held two reviews of 35t Phase II
  - 35t Assembly and Testing Review
    - Review Date - June 16, 2014
    - https://web.fnal.gov/project/lbnearchive/reviews/35t%20Phase%202%20Detector%20Testing%20and%20Assembly%20Review/SitePages/Home.aspx
  - 35t Phase 2 Detector Installation Readiness Review
    - Review Date - Aug 25, 2014
    - https://web.fnal.gov/project/lbnearchive/35t%20Phase%202%20Detector%20Installation%20Readiness%20Review/SitePages/Home.aspx
    - Commission start milestone 9/25/15

Assembly and Testing Review Charge Questions

1. Are the goals for 35t Phase 2 prototype clearly stated? Do they address identified risks and design issues for the LBNE Far Detector?
2. Is the technical scope of the prototype TPC defined and documented to permit proceeding with fabrication, testing and assembly of each element?
3. Are the interfaces between TPC elements as well as between the prototype and the supporting external systems defined and documented?
4. Is the design adequately supported with labor resources through all institutions?
5. Is the installation schedule reasonable and coordinated with the design plan?

Reviewers :

Jeff Dolph, Rick Ford, Elaine McCluskey, Jim Stewart, and Rick Tesarek

Testing and Assembly Review Conclusions Summary - 4pg closeout

- Detector group felt that the resources were adequate.
- The electronics will be delayed beyond what is scheduled. Careful monitoring of progress was needed.
- The field cage schedule will be tight.
- Interface documentation needs improved.
- Lessons learned need to be documented.

35t Phase 2 Detector Installation Readiness Review Charge

1. Are the installation plan and schedule documented?
2. Are the installation plan and schedule realistic for the work that needs to be done?
3. Are the necessary Fermilab approvals part of the plan and included in the schedule?
4. Are the elements of the TPC to be installed in the prototype fabricated or procured and at Fermilab? If not, will they be ready in the needed timeframe? (interpreted broadly)
5. Is there sufficient space for staging and storage during the installation process?
6. Is the need for spare parts during the prototype installation and operation understood and in the plan?
7. Are the improvements to the cryo system based on the Phase 1 operation ready to proceed?
8. Is the installation plan adequately supported with labor resources through all institutions?
9. Is the testing plan adequate?
10. Any other thoughts from the reviewers are welcome.

Reviewers:

Jeff Dolph, Rick Ford, Cat James , Elaine McCluskey, Jim Stewart, Rick Tesarek

Installation Readiness Review Conclusions:

- The schedule had sufficient detail.
- The schedule was very aggressive with no contingency.
  - Several components will likely be late.
- The installation plan showed very fragmented scientific effort and the review recommended determining potential availability.
- An operations resource plan was needed.
- More work on the testing plan was needed.

35t Phase II Execution

- Several of the key components of the detector were delayed.
  - Cold Electronics
  - Signal Feedthru
  - Warm TPC readout
  - Trigger Board
- The QA for the components was often inadequate.
- Component delivery delays meant that there was very little time for integration tests prior to detector installation.
- The delays meant that some of the people originally planed to assist in testing at FNAL were not available.
- There was very little manpower available to assist the local FNAL group in overseeing the assembling and testing.
  - Grounding errors were not detected promptly.

Scientific contribution to the detector commissioning and operations

- There was little involvement by scientists in the groups constructing the detector in testing, commissioning, and operations.
  - These groups focused on furthering the detector designs.
- The local presence at FNAL by the groups constructing the detector elements was poor. Often the operations relied on the local FNAL team (Alan and Michelle)
- Debugging was difficult with most experts remote.

DUNE and ProtoDUNE

- With the creation of DUNE and the support by CERN of the Neutrino platform large scale tests of both the single-phase and dual-phase detector in test beam became possible.
- The ProtoDUNE-SP detector will be built with full-scale elements usable for the DUNE far detector.
- As ProtoDUNE will test all the key detector components and will collect charge particle calibration data the collaboration decided to concentrate on preparing the ProtoDUNE detectors and not to pursue further development of 35-ton detector.
- However, an extensive series of noise studies are planned, first in the 35-ton cryostat and later at FNAL and BNL and then at CERN.

Key Lessons Learned

- A much stronger organizational structure is needed for ProtoDUNE.
- A strong local team is needed to insure success.
- The quality assurance must improve for all the detector elements.
- Extensive integration tests are needed to insure the detector operates as a system.
  - Full system tests with proper shielded enclosures are needed to verify the electronics/wire planes.
- Each detector component must have a greater commitment to the detector testing and operation.
- Support for local scientific effort is needed.

Summary

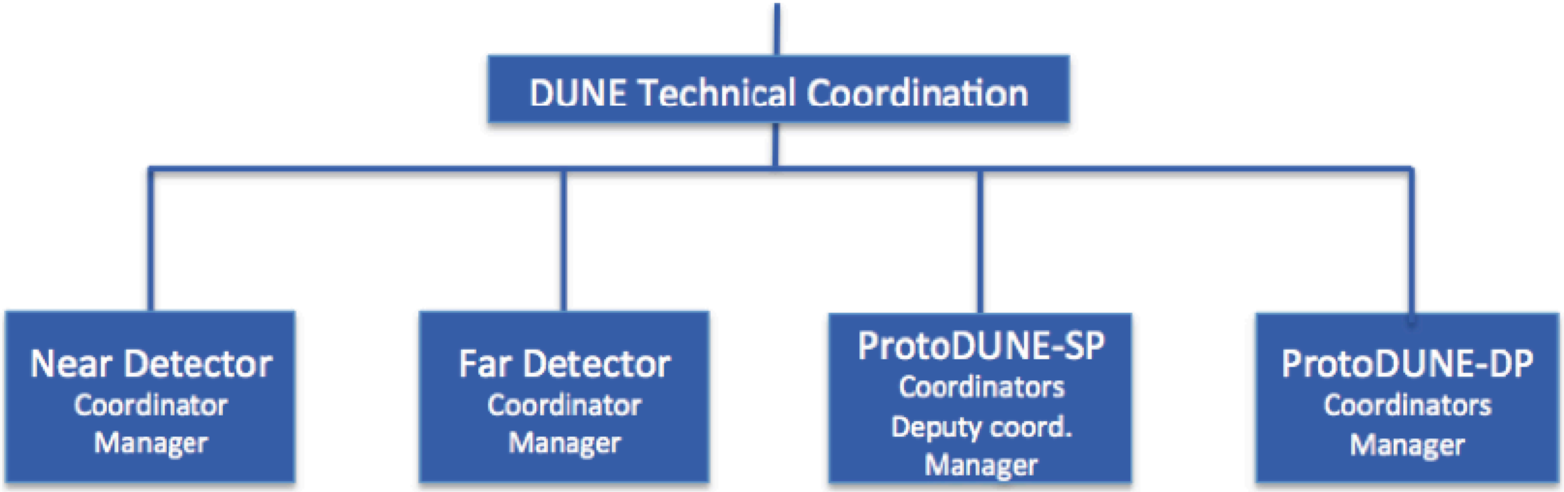
- The 35t management team did not have sufficient resources.
  - The ProtoDUNE-SP team is planned to be much stronger.
- The 35t schedule was very aggressive and as many components were newly developed there was not possibility to recover schedule.
- ProtoDUNE-SP schedule is also aggressive however we have benefited from testing many components in the 35t and have fewer new components.
- An extensive integration test is planned for ProtoDUNE-SP.
- A much stronger local team is planned to commission and operate ProtoDUNE-SP.

Backup

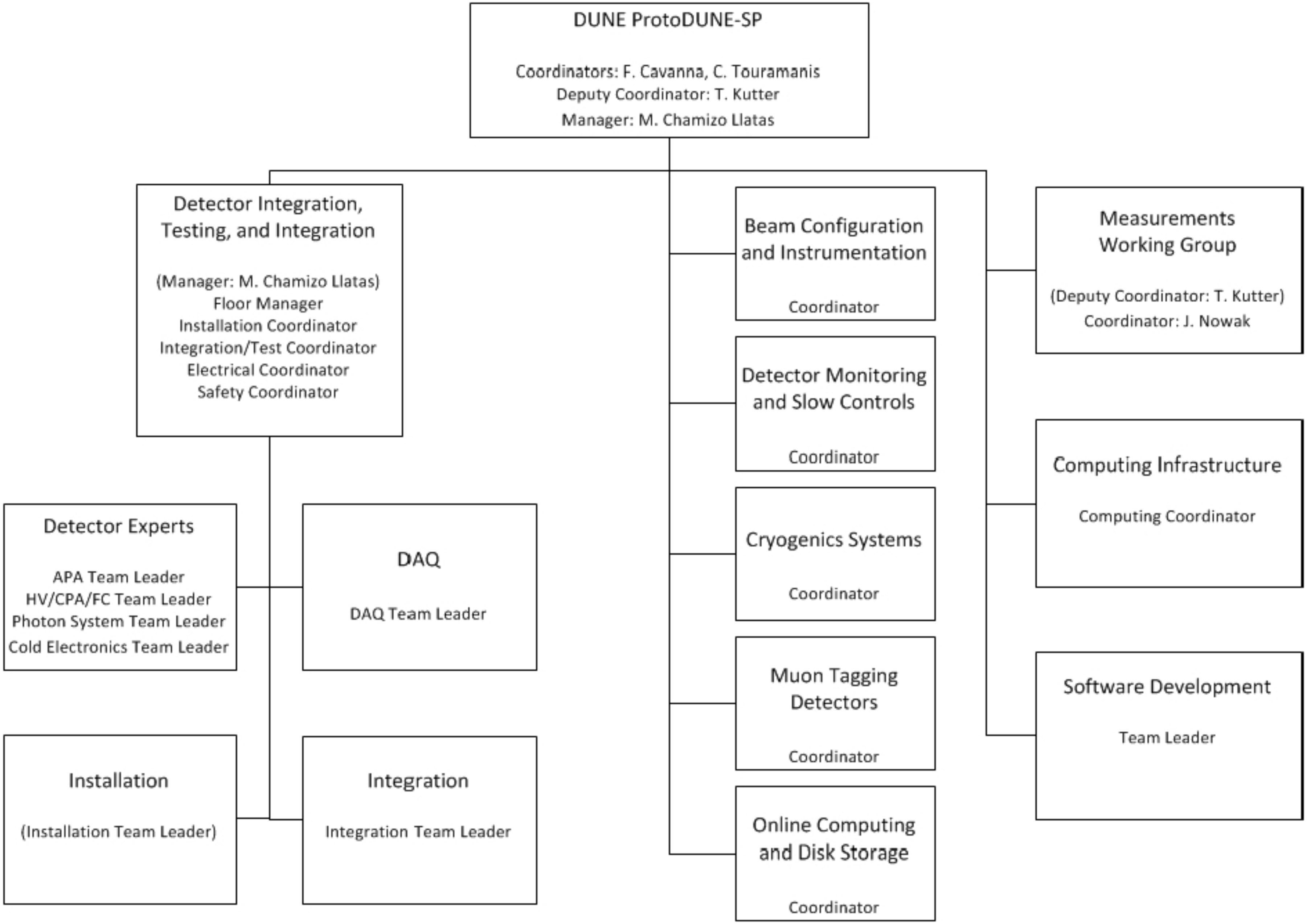
Actions taken for ProtoDUNE-SP

- The ProtoDUNE-SP organization is a completely different structure.
- The Project WBS has a separate ProtoDUNE L2 organization.
  - Two technical coordinators, a project manager and a deputy coordinator form the ProtoDUNE management.
  - The Manager has a team to support her.
  - All work at CERN is planned under ProtoDUNE-SP
  - The ProtoDUNE-SP management and the DUNE management drafted the organization document.

Dune High Level Org. Chart



- The ProtoDUNE organizations are at the same level as the near and far detectors.
- The far detector is responsible for manufacturing the components, testing them, and shipping them to CERN.
- The ProtoDUNE-SP management is responsible for component integration, installation, testing, comissioning, data taking and analysis.



DUNE ProtoDUNE-SP
Coordinators: F. Cavanna, C. Touramanis
Deputy Coordinator: T. Kutter
Manager: M. Chamizo Llatas
Detector Integration, Testing, and Integration
(Manager: M. Chamizo Llatas)
Floor Manager
Installation Coordinator
Integration/Test Coordinator
Electrical Coordinator
Safety Coordinator
Detector Experts
APA Team Leader
HV/CPA/FC Team Leader
Photon System Team Leader
Cold Electronics Team Leader
DAQ
DAQ Team Leader
Installation
(Installation Team Leader)
Integration
Integration Team Leader
Beam Configuration and Instrumentation
Coordinator
Detector Monitoring and Slow Controls
Coordinator
Cryogenics Systems
Coordinator
Muon Tagging Detectors
Coordinator
Online Computing and Disk Storage
Coordinator
Measurements Working Group
(Deputy Coordinator: T. Kutter)
Coordinator: J. Nowak
Computing Infrastructure
Computing Coordinator
Software Development
Team Leader

Actions taken for ProtoDUNE-SP

- The ProtoDUNE-SP management estimated the manpower needed from each detector component at CERN.
  - Detector managers and conveners are developing proposal for how to meet the local CERN needs.
    - Proposals will be presented to the technical board.
  - A proposal is submitted to DOE for travel funds to enable long term stay at CERN for technical experts.
  - ProtoDUNE-SP management is negotiating with each detector component to identify a key person to be present at CERN for each component.
  - Target manpower is roughly a factor of five more than what was available for the 35t Phase II test.

ProtoDUNE SP at CERN:

DEEP UNDERGROUND NEUTRINO EXPERIMENT

Organizational Structure: the ProtoDUNE team at CERN

DUNE Personnel at CERN for protoDUNE-SP Integration/Installation/Commissioing/Data Taking

	2017												2018											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Managers																								
protoDUNE-SP manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Floor Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
Installation coordinator (Jack)			1	1	1	1	1	1	1	1	1	1												
Integration/Test Coordinator					1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Computing Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Electrical Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Safety Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Detector Experts																								
TPC				2	2	4	4	4	4	4	4	4	2	2	2	2	2	1	1	1	1	1	1	0
TPC HV												2	2	2	2	2	2	2	2	2	2	2	2	0
PD				1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Electronics (cold and warm)	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
DAQ	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
Trigger				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DQM	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Beam Detectors					1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Cosmic Muon Tracker*					2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0
Calibration*					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Computing expert	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Slow Control Monitoring	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cryogenics	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
General Assistants																								
Technitians	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1
Run Coordinators (3)																	3	3	3	3	3	3	3	3
Total	21	21	22	26	34	36	36	36	36	36	36	38	32	32	32	32	34	32	31	31	31	31	31	19

Operations Funds request submitted to DoE to support ProtoDune US team at CERN in 2017-18

	2017	2018	Total
Total personnel at CERN	378	368	746

(person-months)

~50% from US

C-K Jung, Mar. 16

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Agenda:35t Phase 2 Detector Testing and Assembly Review

Detailed Agenda

✓	Start Time (CT)	Link	Speaker
	09:30	Committee Closed Session	
	09:40	The 35t test Phase II Goals and Milestones	Alan Hahn
	10:00	35t Detector Design Overview	Bo Yu
	10:25	Structural Support & Cooldown	Dan Wenman
	10:45	Break	
	11:05	APA Design	Lee Greenler
	11:35	Photon Detector Paddle/Sensor/Readout Design	Denver Whittington
	11:55	Photon Detector Mechanical Design	Dave Warner
	12:15	Lunch (reviewer working lunch)	
	13:15	CPA Design	Bill Sands
	13:35	Field Cage Design	Bo Yu
	13:55	TPC Installation and Integration	Jack Fowler
✓	14:25	Cold Electronics	Hucheng Chen
	14:45	DAQ	Giles Barr (remote)
	15:00	Tour of PSL	
	15:30	Committee Closed Session (with Coffee)	
	18:00	Closeout	
	18:20	Adjourn	
	19:30	Dinner	

Reviewers :

Jeff Dolph, Rick Ford, Elaine McCluskey, Jim Stewart, and Rick Tesarek

Agenda: 35t Phase 2 Detector Installation Readiness Review

Detailed Agenda - 8/25

✓	Start Time (CT)	Description	Speaker
	09:00	Welcome, Charge, Agenda	Jim Stewart
	09:15	The 35t Phase II Goals and Risk Mitigation for FD	Alan Hahn
	09:35	Overview of 35t Phase 2 Detector	Bo Yu
	10:05	Schedule Overview and Status	Russ Rucinski
	10:25	**Coffee Break**	
	10:45	Installation Plan, Infrastructure, Staging and Storing	Joe Howell
	11:25	Status of TPC Trial Assembly	Dan Wenman
	11:55	**Lunch** (reviewer working lunch)	
	12:55	TPC Installation Into Cryostat	Jack Fowler
	13:25	ORC Preparation Status	Linda Bagby
	13:45	Interlocks	Linda Bagby
	13:55	Grounding	Terri Shaw
	14:15	Cryogenic Modifications Phase 1 to Phase 2	Terry Tope
	14:30	Component Testing & System Checkout	Matt Graham/Giles Barr/Alan Hahn
	15:10	Commissioning and Operation Plan	Michelle Stancari
	15:30	Any Other Business	
	15:55	Committee Closed Session (with Coffee)	
	17:25	Closeout	
	17:45	Adjourn	

Reviewers:

Jeff Dolph, Rick Ford, Cat James , Elaine McCluskey, Jim Stewart, Rick Tesarek