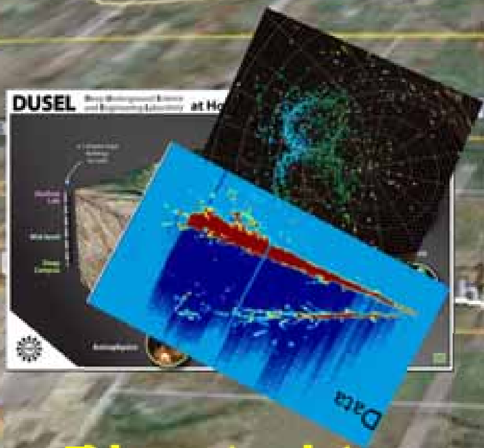
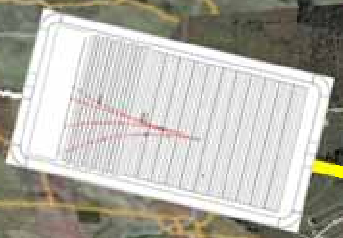
Long Baseline Neutrino Experiment



New Neutrino Beam at Fermilab…

Precision Near Detector on the Fermilab site



…Directed towards a distant detector
200 kton Water Cherenkov Detector
33 kton Liquid Argon TPC Far Detector

…And all the Conventional Facilities required to support the beam and detectors

Jim Strait, LBNE Project Manager

Outline

- Collaboration and Project Organization
- Science Goals and Capabilities
- Conceptual Designs
- Preparation for DOE CD-1
- Far Detector Decision
- Critical Decision Milestone Goals
- Summary

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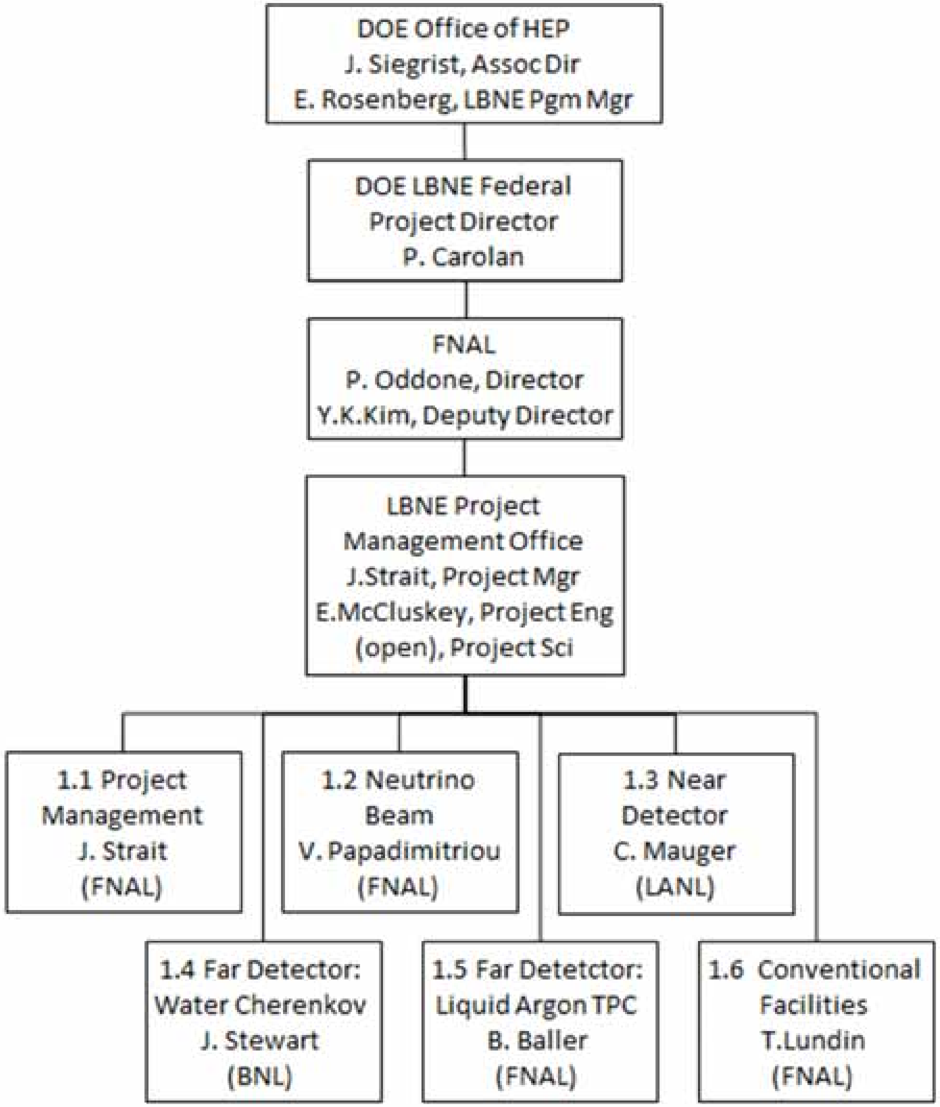
338 individuals
61 institutions
25 US States
5 countries

10 January 2012 (338)

LBNE Project Organization



- Fermilab is the Lead Lab, and is responsible for the Beam and LAr Detector
- BNL is responsible for the Water Cherenkov Detector
- LANL is responsible for the Near Detector
- The Project and Collaboration are well integrated:
  - Collaboration is heavily involved in Project planning.
  - Project leadership are members of the Collaboration Exec Committee.
  - Spokespeople are members of the Project Management Board.

The DOE and the NSF have agreed that DOE will be the "steward" of the LBNE Project, and that NSF will contribute financially to its construction as part of the DUSEL Project.

II. Physics Research Goals of LBNE

Following from the P5 recommendations, the DOE Mission Need Statement, discussions with the funding agencies (DOE Office of High Energy Physics and NSF Physics Division), Fermilab management, and the LBNE Science Collaboration, it is been determined that the priorities for the scientific research to be enabled by the LBNE Project are the following:

1. **The primary objectives** of the LBNE Project are the following experiments:

Understood to be in priority order.

1.1 Search for, and precision measurements of, the parameters that govern $\nu_\mu \rightarrow \nu_e$ oscillations. This include measurement of the third mixing angle θ_{13}, for whose value only an upper bound is currently known, and if θ_{13} is large enough, measurement of the CP violating phase δ and determining of the mass ordering (sign of Δm^2_{32}).

1.2 Precision measurements of θ_{23} and $|\Delta m^2_{32}|$ in the ν_μ disappearance channel.

1.3 Search for proton decay, yielding a significant improvement in current limits on the partial lifetime of the proton (τ/BR) in one or more important candidate decay modes, e.g. $p \rightarrow e^+\pi^\circ$ or $p \rightarrow K^+\nu$.

1.4) Detection and measurement of the neutrino flux from a core collapse supernova within our galaxy, should one occur during the lifetime of LBNE.

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1.4) Detection and measurement of the neutrino flux from a core collapse supernova within our galaxy, should one occur during the lifetime of LBNE.

2. Secondary objectives, which may be enabled by the facility that is designed to achieve the primary objectives include:

2.1 Other accelerator-based neutrino oscillation measurements.

2.2) Measurements of neutrino oscillation phenomena using atmospheric neutrinos.

2.3) Measurement of other astrophysical phenomena using medium energy neutrinos.

3. Additional secondary objectives, the achievement of which may require future upgrades to the facility that is designed to achieve the primary objectives, include:

3.1) Detection and measurement of the diffuse supernova neutrino flux.

3.2) Measurements of neutrino oscillation phenomena and of solar physics using solar neutrinos.

3.3) Measurements of astrophysical and geophysical neutrinos of low energy.

4. Purposes of the Near Detector

4.1) **The primary objective of the near detector** is to make measurements necessary to achieve the primary physics research objectives listed above.

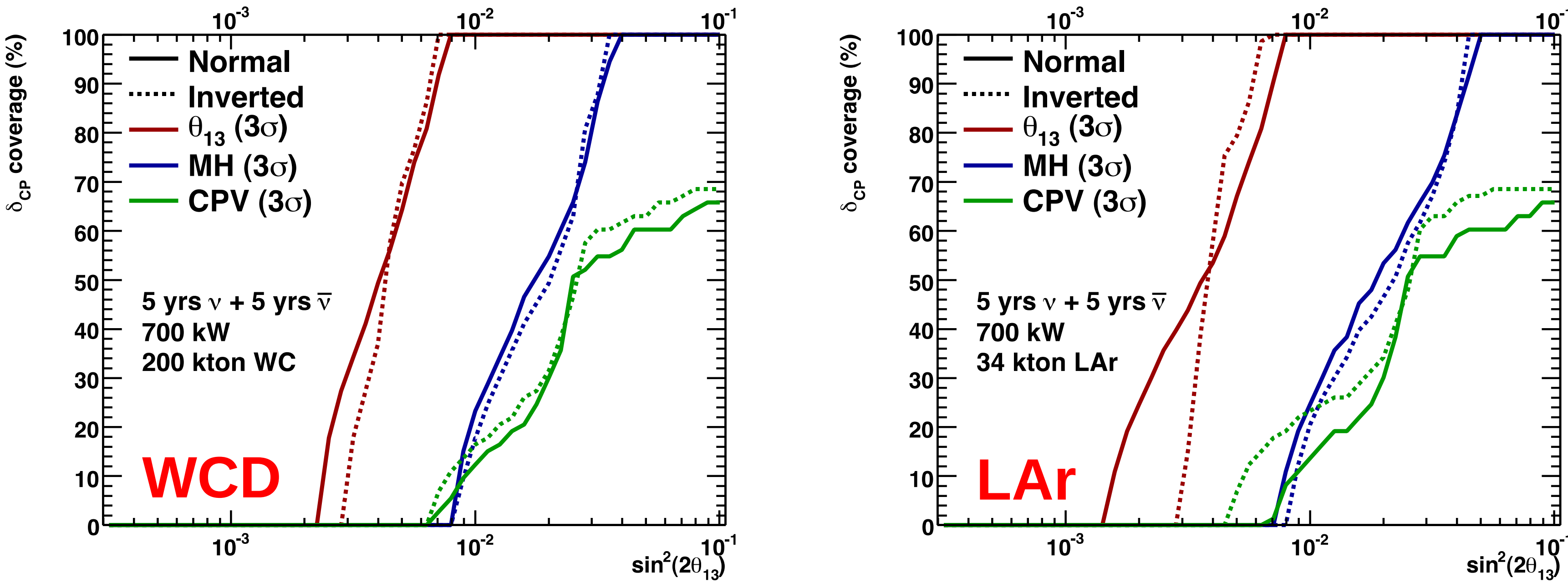
4.2) **Secondary objectives of the near detector** are studies of neutrino interactions, which may be enabled by the facility that is designed to achieve the primary objectives or by future upgrades to the facility and detectors. These include:

- 4.2.1) Studies of the Weak Interaction.
- 4.2.2) Studies of nuclear and nucleon structure.
- 4.2.3) Searches for New Physics.

5. These priorities will be considered in planning the configuration of the facilities constructed by the Project.

- 5.1) Configurations will be chosen which maximize the effectiveness of the facility to achieve the *primary objectives*.
- 5.2) The ability to achieve the *secondary objectives* will be considered in cases in which a modest investment will enable or enhance one or more of them, thereby broadening the LBNE physics program, without significantly compromising the ability to achieve the primary objectives.
- 5.3) The *additional objectives* are expected to require substantial investment, beyond that required to achieve the primary objectives, to be able to be achieved. These will be considered if a modest initial investment, that does not significantly compromise the ability to achieve the primary objectives, can leave open the option of future upgrade(s) that would enable one or more of them.

Performance of LBNE: Long-Baseline $\nu_\mu \rightarrow \nu_e$ Oscillations

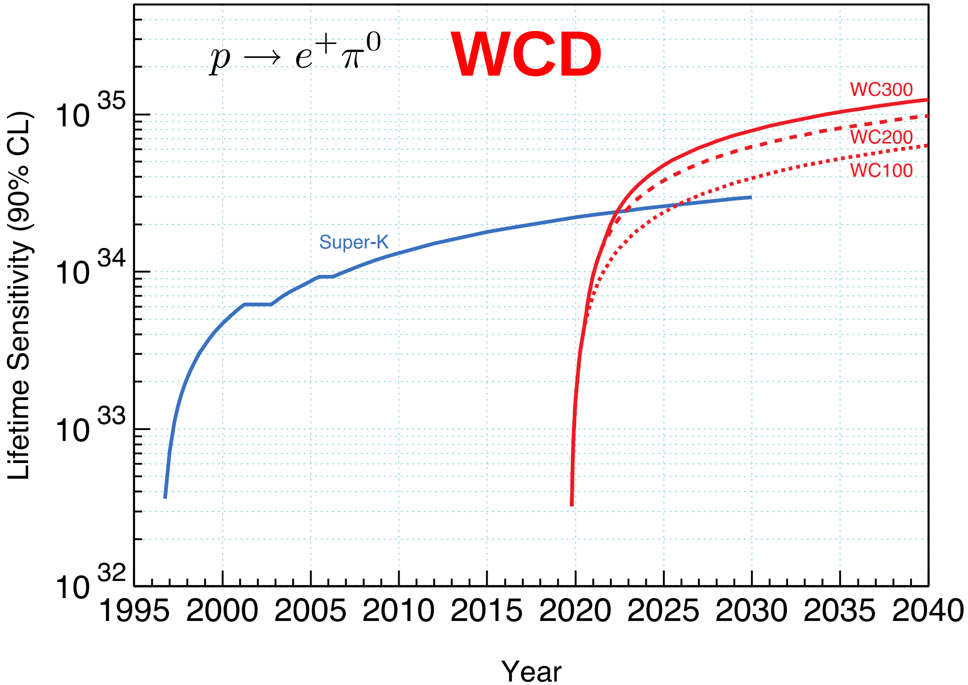


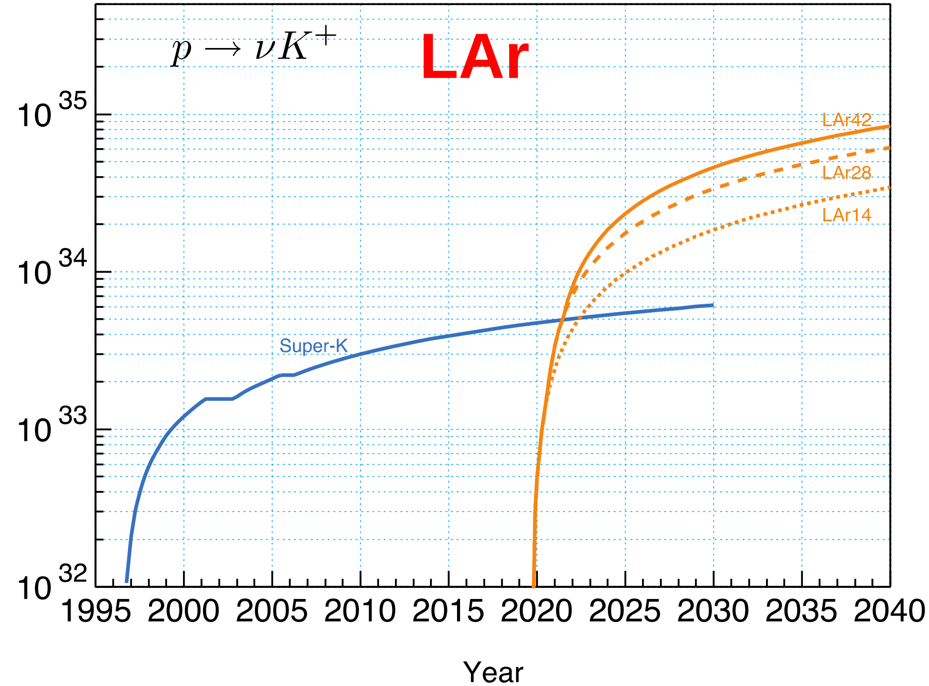
- Sensitivity is mainly limited by statistics => would continue to improve with greater exposure (e.g.higher power beam from Project X)

LBNE Physics Working Group Report, arXiv:1110.6249v1 [hep-ex]

Performance of LBNE:

Proton Decay





LBNE Physics Working Group Report, arXiv:1110.6249v1 [hep-ex]

Current Status and Plans

- LBNE is working towards DOE's Critical Decision 1 (CD-1), and therefore is in the Project Definition phase.
- We are have been exploring a range of designs for all parts of the Project, to find the most cost-effective way to implement the experiment.
- The following slides present a range of configurations for the LBNE beam, near detector and far detector that we have considered in developing reference design that we will present for CD-1.
- We are nearing completion of the process of converging on a single conceptual design for the experiment.

Neutrino Beamline

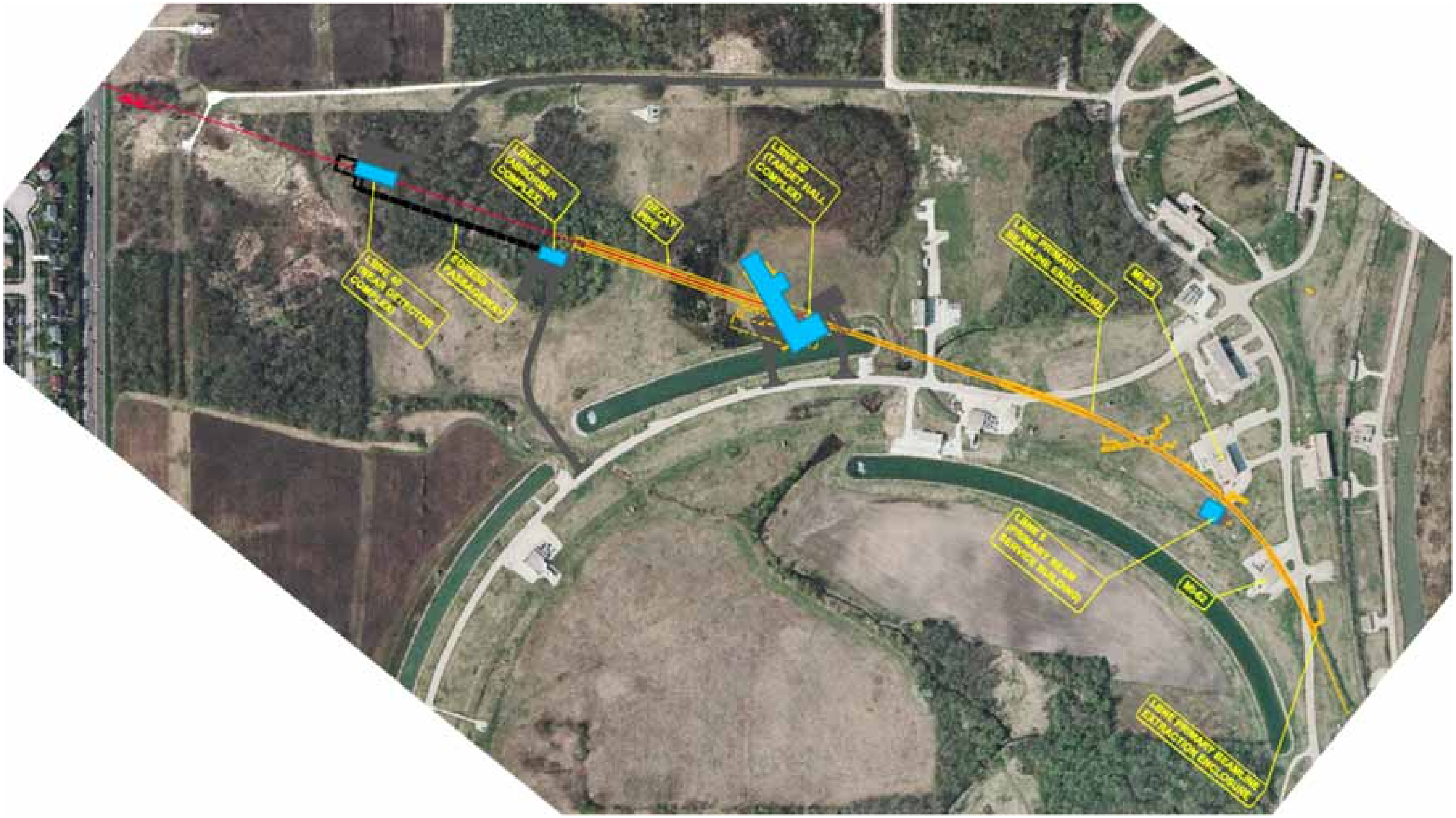
Main Beamline Parameters

- Horn-focused neutrino beam, optimized to cover the first and second oscillation maxima
  => $0.5 < E_\nu < 5$ GeV.
- Driven by Main Injector: $60 \leq E_{beam} \leq 120$ GeV.
- Design for initial operation with E_{beam} = 700 kW; facility designed to enable upgrade to 2.3 MW.
- Decay pipe: 4 m (diameter) x 200~250 m long.

Main alternatives considered:

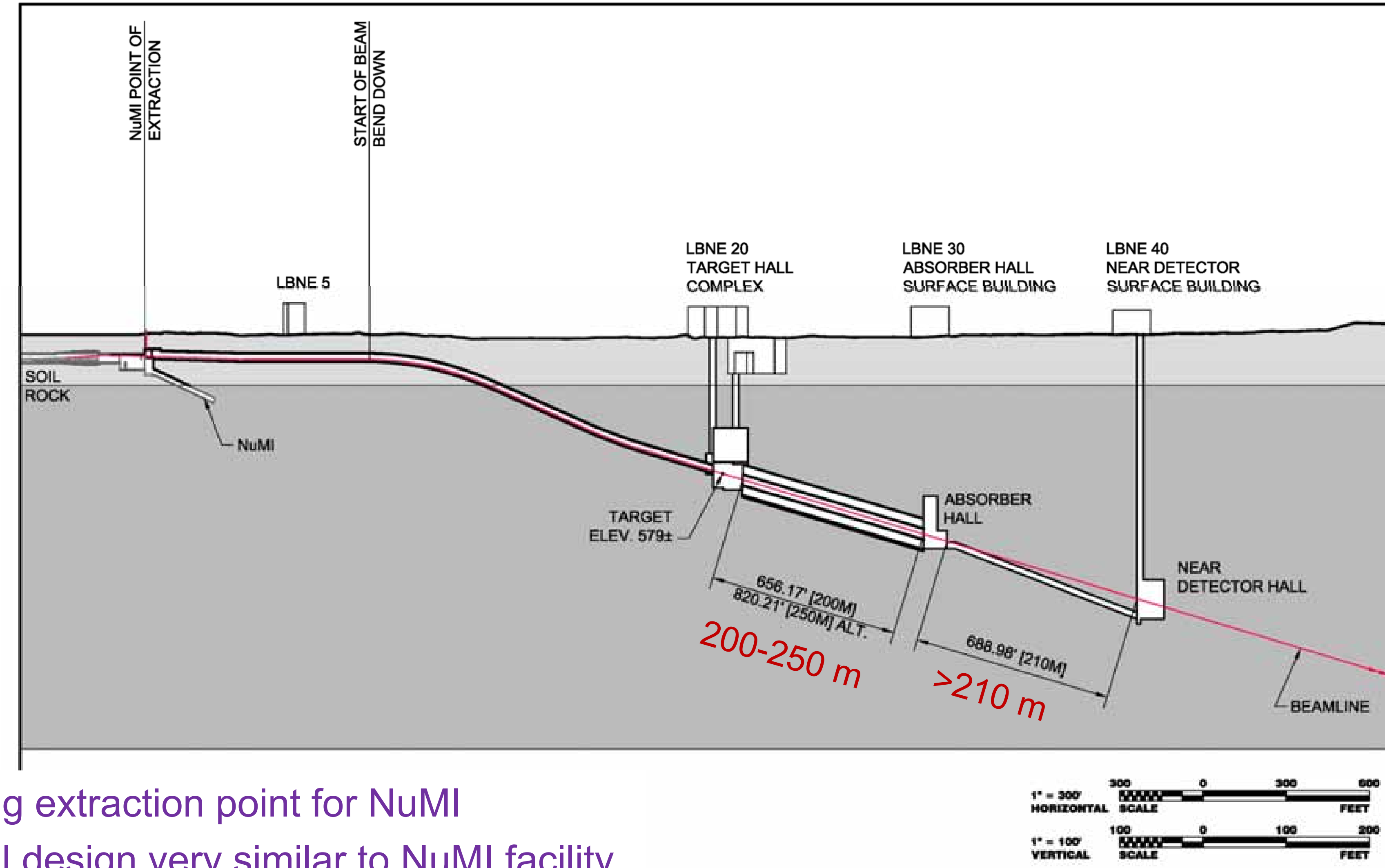
- Proton beam extracted from MI-10 or MI-60.
- Varying depth of the beamline components relative to the rock-soil interface.

Neutrino Beam Alternate Designs: MI-60 Extraction, Deep Beam



Neutrino Beam Alternate Designs: MI-10 Extraction, Shallow Beam

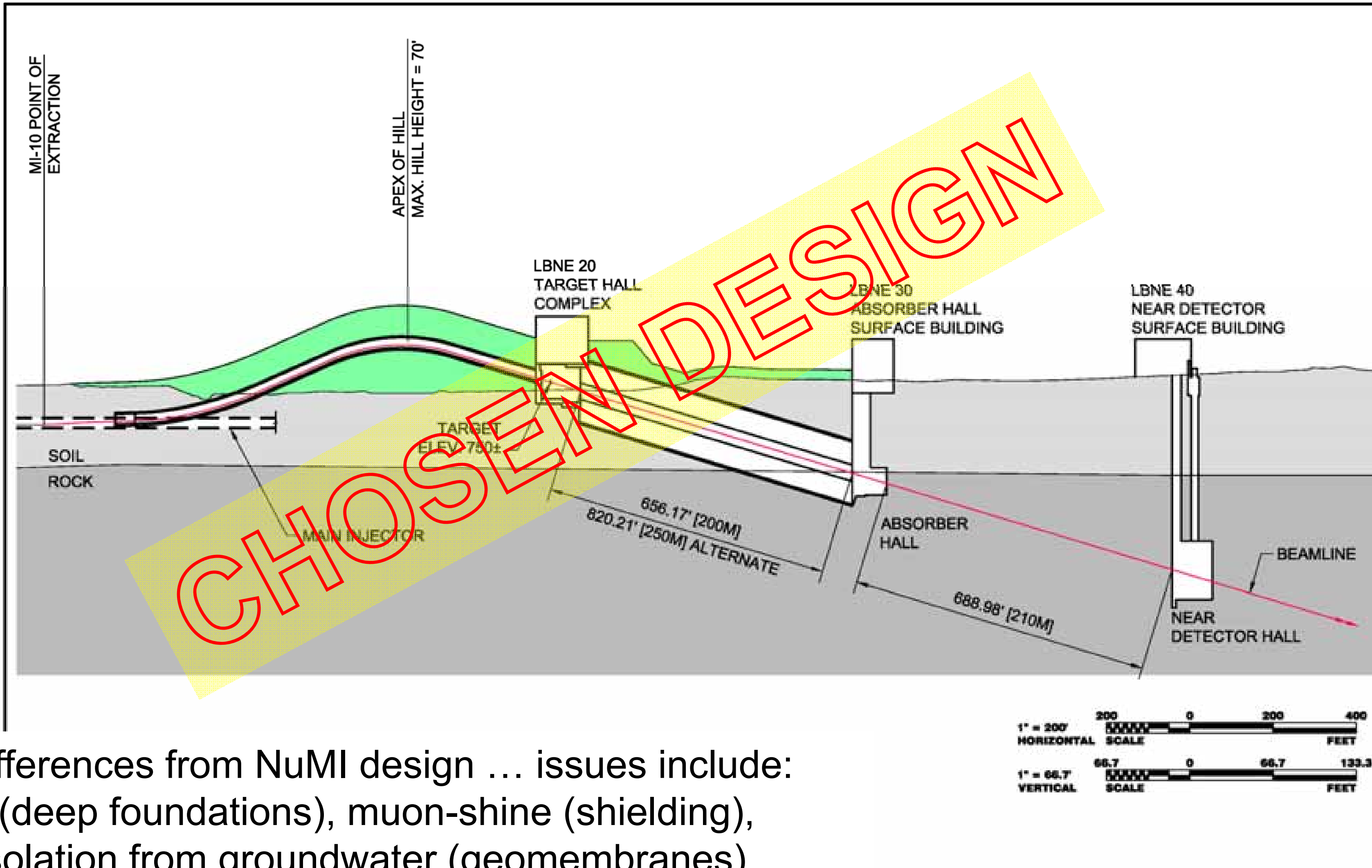
MI-60 Extraction, Deep Beam



Existing extraction point for NuMI

Overall design very similar to NuMI facility.

MI-10 Extraction, Shallow Beam



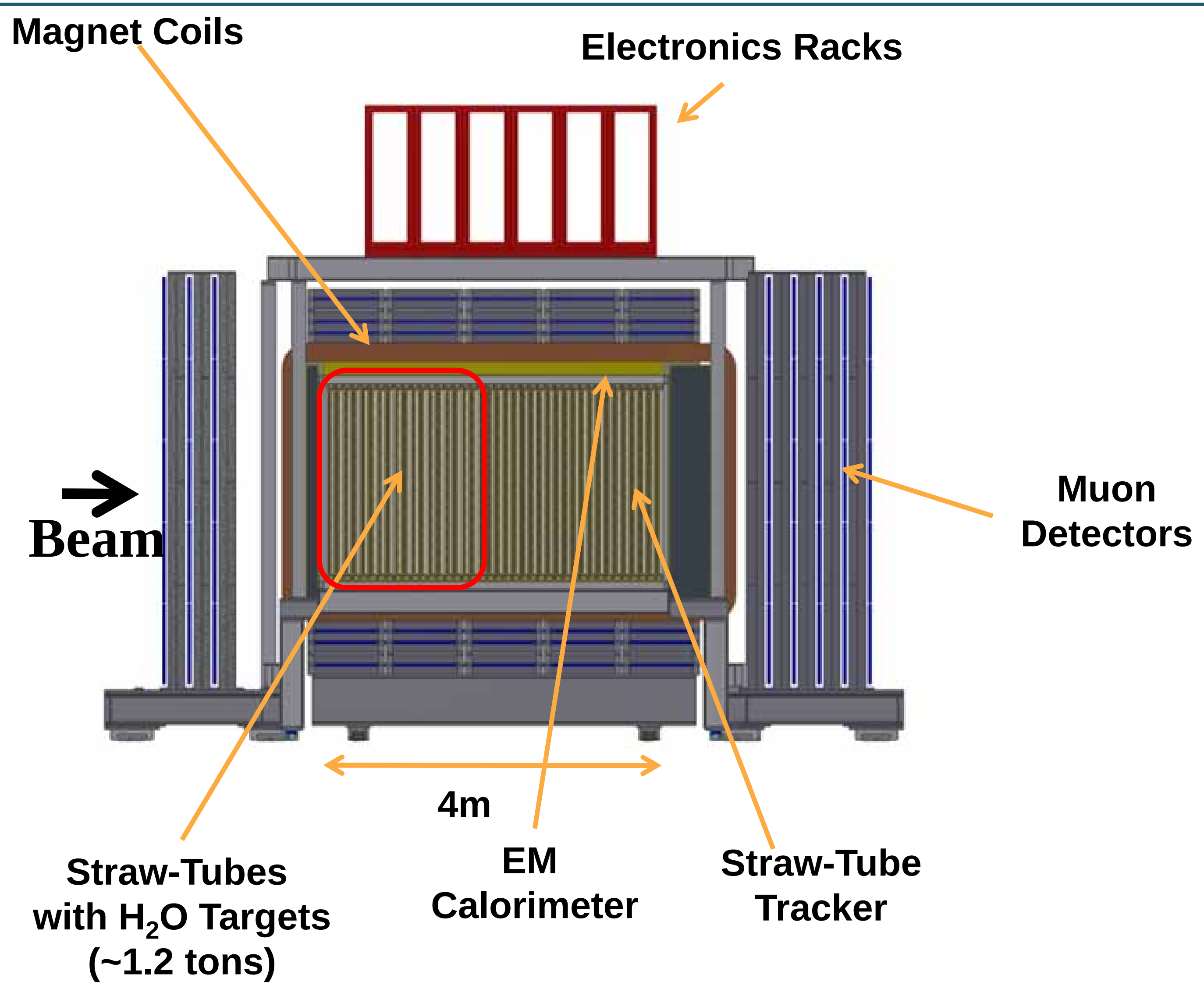
Many differences from NuMI design … issues include: stability (deep foundations), muon-shine (shielding), tritium isolation from groundwater (geomembranes)

Near Detector Complex

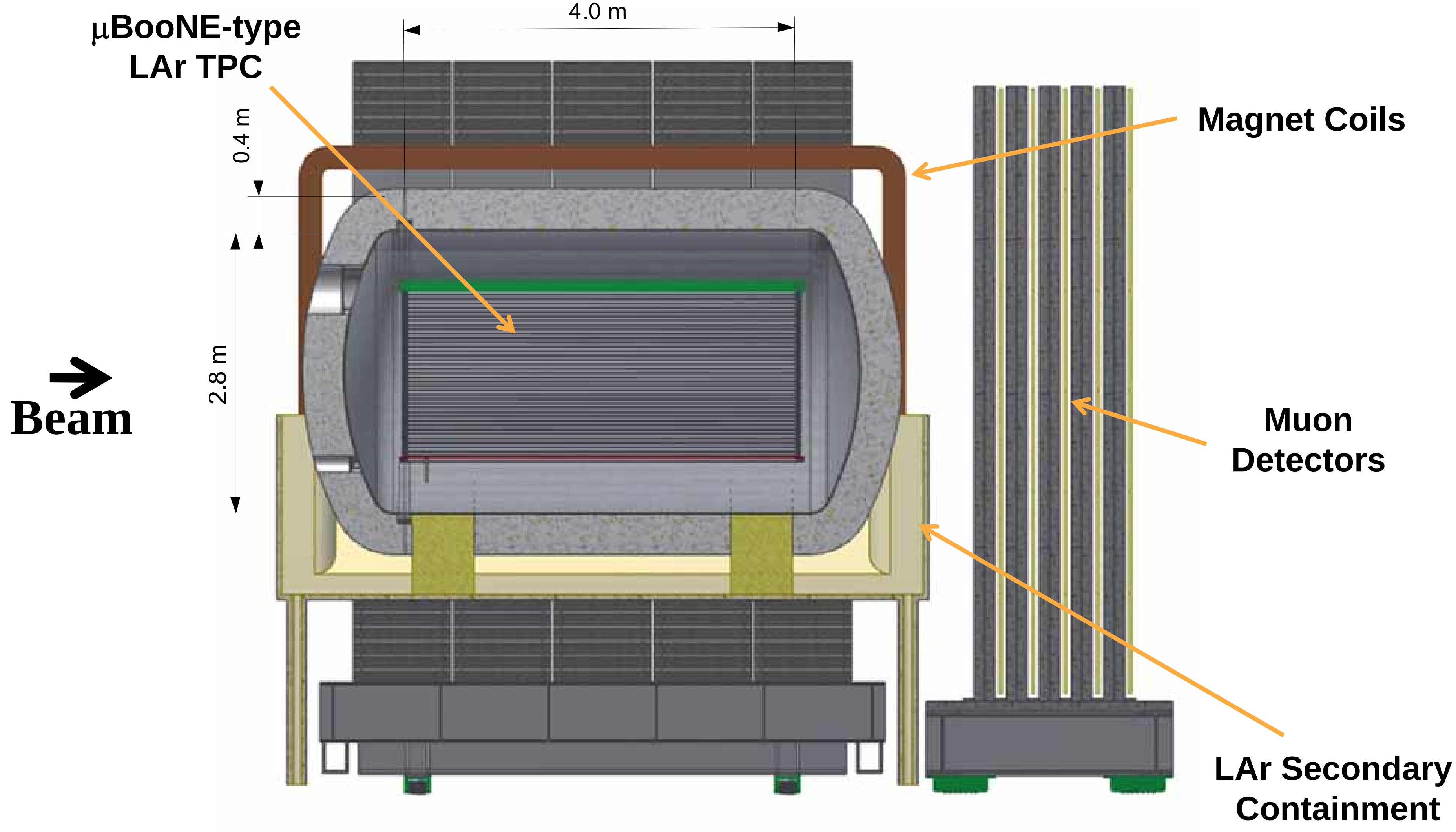
- Measure the (un-oscillated) neutrino flux
  => Neutrino detector system
  Two designs are being developed, corresponding to water or LAr far detectors:
  - Magnetized straw-tube tracker with embedded water targets.
  - Magnetized liquid-argon TPC

- Measure the muon flux downstream of the absorber as another check on the neutrino flux, and to provide pulse-by-pulse monitoring of the beamline.
  => Muon detector system
  - Design is independent of far detector choice.

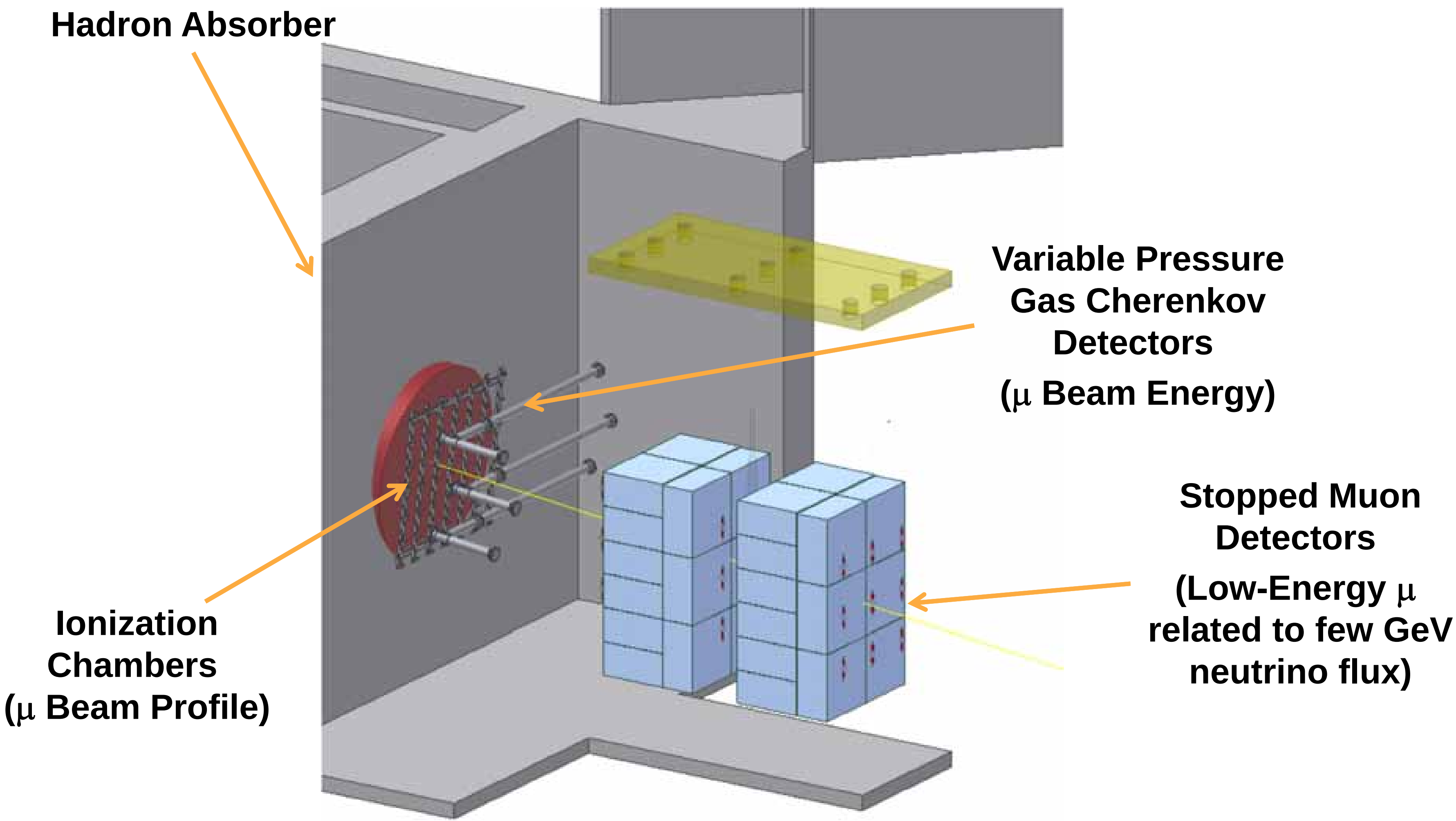
Near Detector Alternate Designs: Fine Grained Tracker



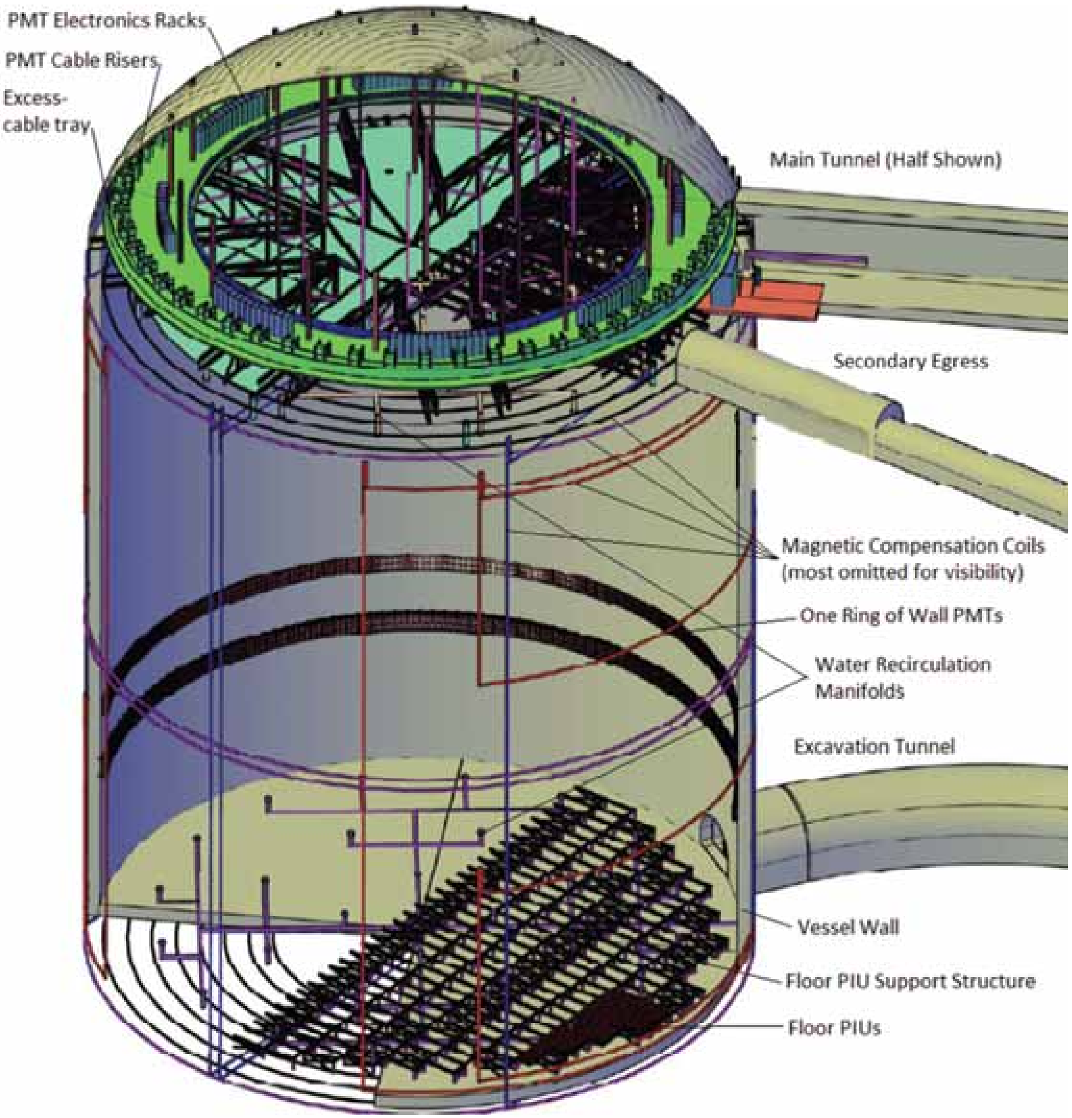
Near Detector Alternate Designs: Liquid Argon TPC



Muon Beam Monitoring System



Water Cherenkov Far Detector

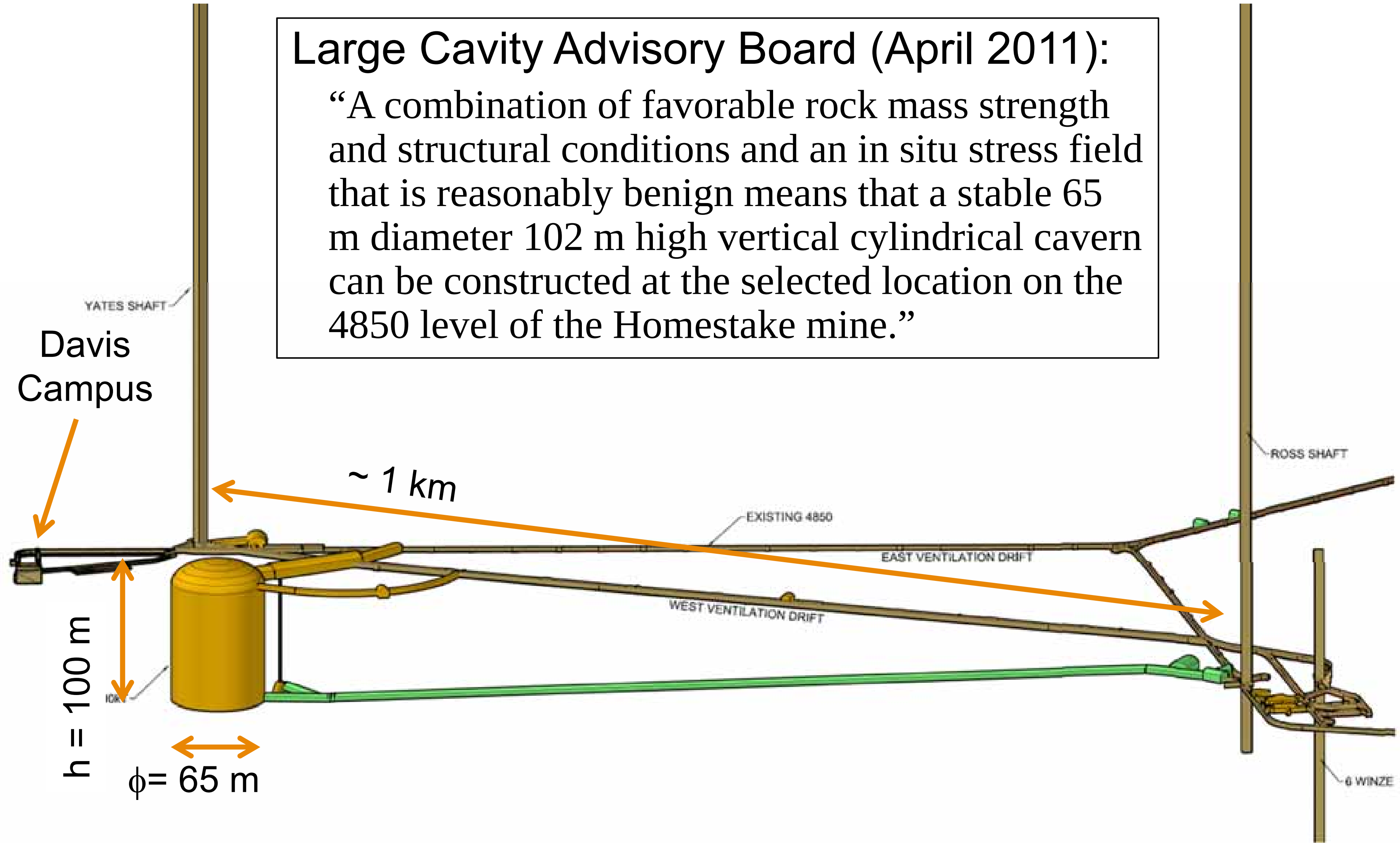


- Large Cavern at 4850 ft.depth
- Water Vessel
- Ultra-pure water system
- PMT + light collectors to give photon detection efficiency equivalent to SuperK II
- 200 kt fiducial mass (9 x SuperK)
- Detector active volume: 63 m dia.x 77 m high.

WCD Cavern at 4850 Level (LBNE-Only Configuration)

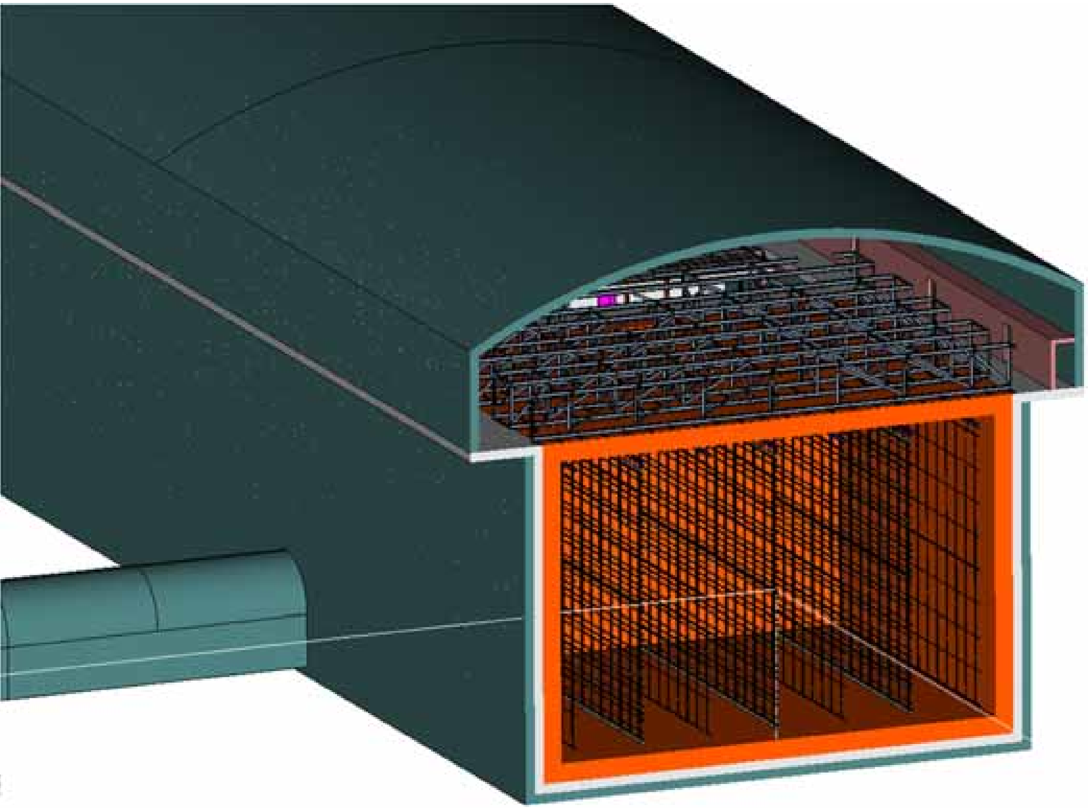
Large Cavity Advisory Board (April 2011):

"A combination of favorable rock mass strength and structural conditions and an in situ stress field that is reasonably benign means that a stable 65 m diameter 102 m high vertical cylindrical cavern can be constructed at the selected location on the 4850 level of the Homestake mine."



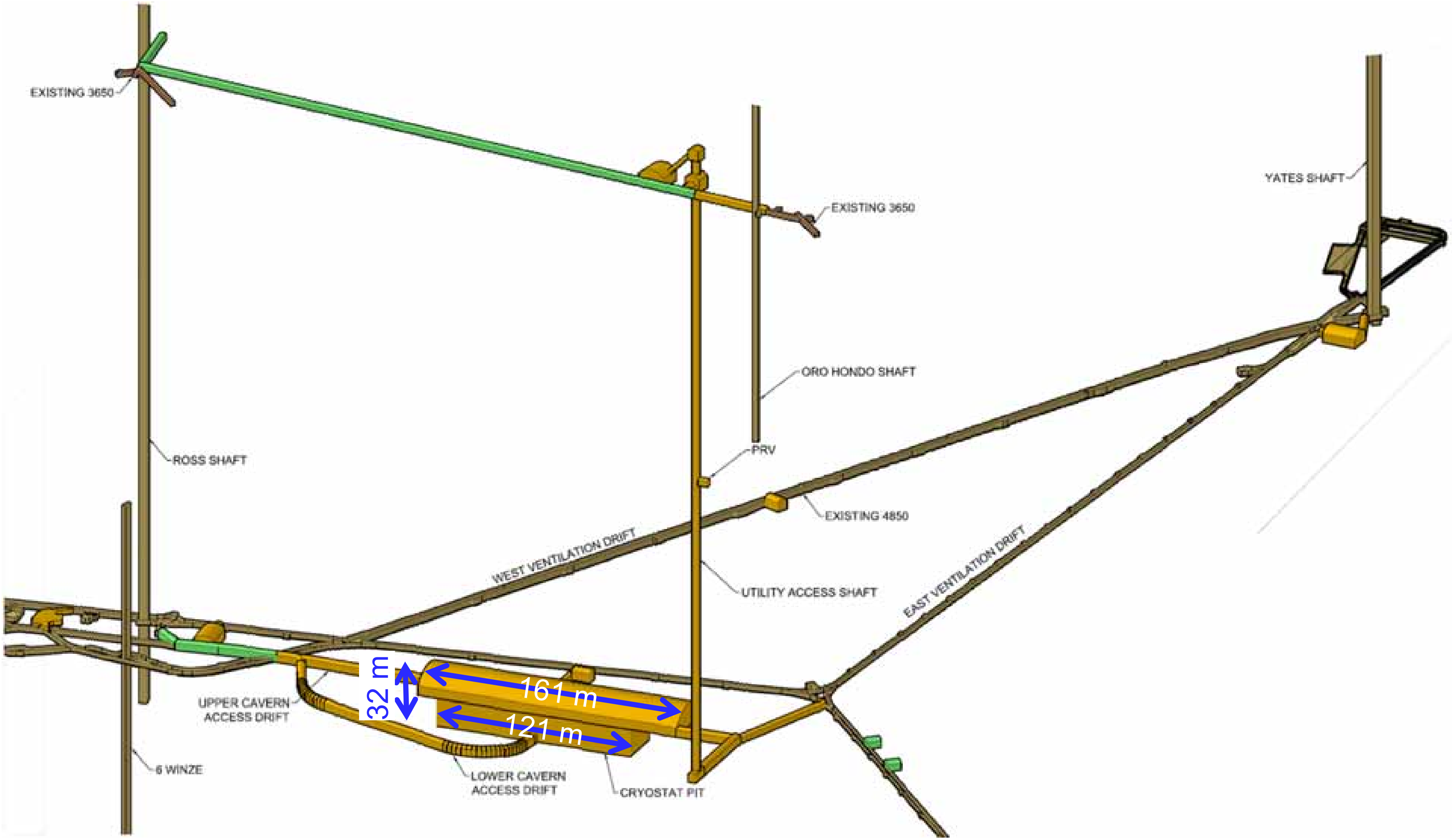
LAr TPC Detector

- Two detectors, end-to-end in a common cavern at the 4850 foot level.
- Active volume of each detector: 22.4 x 14 x 45.6 m^3 (w x h x l)
- Total fiducial mass = 33 kt.

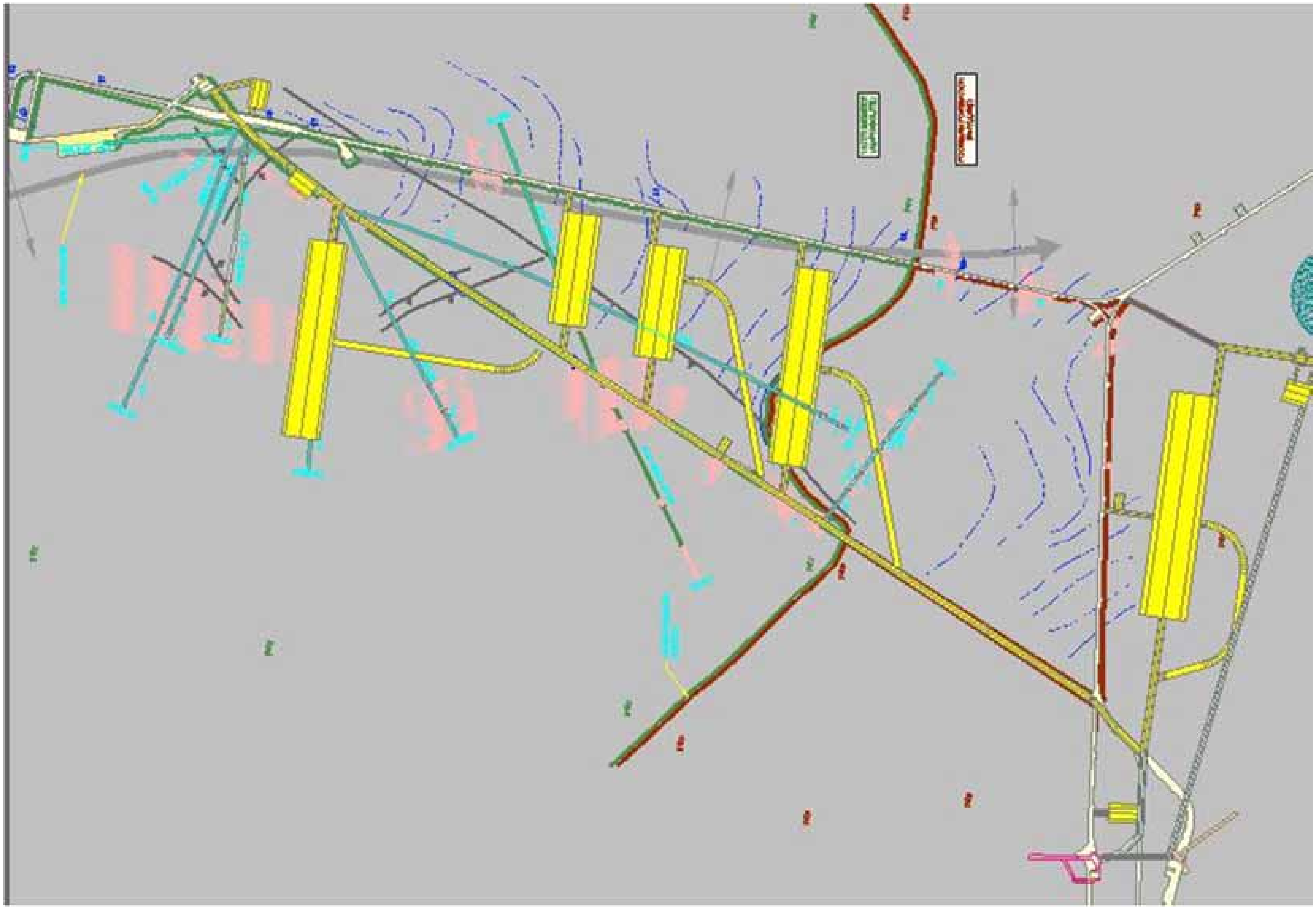


- TPC design:
  - o 3.7 m drift length
  - o 5 mm wire spacing
  - o three stereo views
- Photon detection system integrated into TPC anode plane assemblies.

LAr Cavern at 4850 foot Level



Alternate LAr Cavern Locations



Preparation for DOE CD-1

	Event	Location	Date
	2010 Milestones		
☑	Near Site Risk Analysis Workshop	Fermilab	19-20 October 2011
☑	Near Site Internal Conceptual Design Review	Fermilab	1-3 November 2011
☑	Science Capabilities Review	Fermilab	3-5 November 2011
☑	WCD, LAr, Beamline, Near Detector, Project Risk Mitigation Workshop	Fermilab	16-17 November 2011
☑	Conventional Facilities Risk Mitigation Workshop	Fermilab	21 November 2011
☑	Intensity Frontier Workshop	Rockville, MD	30 Nov.-02 Dec. 2011
☑	Far Site Internal Conceptual Design, Cost, Schedule and Risk Review	Fermilab	6-9 December 2011
☑	Executive Committee Retreat	Lake Geneva, WI	12-14 December 2011
☑	LBNE Collaboration meeting	Argonne National Laboratory	15-17 December 2011
☑	Configuration selection		December 2011
☐	Near Site Internal Cost, Schedule and Risk Review	Fermilab	24-25 January 2012
☐	Director's CD-1 Design, Cost, Schedule and Management Review	Fermilab	**26-30 March 2012**
☐	DOE CD-1 Review		June 2012

Far Detector Technology Decision Process

- Two detector technologies have been under consideration for the LBNE far detector complex: WCD and LAr TPC
- Both are able to achieve the primary physics goals; however their capabilities are not identical, due to:
  - Very different particle detection methods.
  - Nuclear physics: ^{40}Ar vs. ^{16}O + 2 free protons.
- The strengths and limitations/risks are rather different between the two.
  - WCD is well developed technology, but requires very large detectors.
  - LAr provides much more information per event, but is newer technology requiring more development.
- Decision based on:
  - Technical feasibility and risk.
  - Cost … within boundary conditions that are not precisely known yet.
  - Physics capability, according to the prioritized physics goals.

Far Detector Decision Process

- Decision process was established jointly by the Project, the Collaboration, and Fermilab management and "blessed" by DOE.
- Main elements:
  1) Establish and validate the facts:
     - External review of science cases
     - External review of conceptual designs
     - External reviews of the cost estimates
  2) Collaboration Executive Committee, augmented by additional advisors, provides formal advice to the Project Manager
  3) Concurrence of Fermilab Director, Laboratory Oversight Group, DOE/OHEP required.

Far Detector Technology Decision
General Principles

Far Detector Technology Decision General Principles:

LBNE-doc-4099

Purpose

We need to select a specific far detector configuration in a manner that is open, objective and timely. The decision should be based on facts concerning the scientific capabilities, risks, and cost and schedule to implement each of the two candidate detector types. An objective process is needed to establish those facts, so that, to the greatest extent possible, all of the stakeholders agree that the information used for the decision is valid. Although the final decision is formally made by the Project Manager (as the contracted agent for the DOE through FNAL), the goal is to reach a decision by consensus among all of the stakeholders.

within budget guidelines, in a manner that meets the mission need, and on a schedule that is both

Assumptions

1) The far detector will be sited in the Homestake facility in Lead, SD.
2) The decision will be between all-WCD and all-LAr. A staged implementation of both technologies is not considered to be an option within the LBNE Project as currently defined.
3) The decision process involves the LBNE Project, the LBNE Collaboration, Fermilab and the other participating National Laboratories, and the Department of Energy.
4) The decision will be based on maximizing the scientific capabilities of LBNE within a fixed (yet to be specified) cost, which is estimated to be not too far over $1B.
5) The beam and near detector configurations do not affect the choice of far detector type.

If external events invalidate one or more of these assumptions, the procedure will be adjusted to the new boundary conditions.

Procedures for Far Detector Decision

Procedures for LBNE Far Detector Configuration Decision

28 July 2011

Milind Diwan*, Jim Strait†, Bob Svoboda*
*LBNE Science Collaboration Co-Spokesperson
†LBNE Project Manager

Approved by the LBNE Executive Committee, 28 July 2011

Objective

The objective is to make a selection of the far detector configuration in an open, objective and timely manner. The decision will be based on facts concerning the scientific capabilities, risks, and cost and schedule for each of the two candidate detector types. A process will be followed to establish those facts, so that, to the greatest extent possible, all of the stakeholders agree that the information used for the decision is valid. The process is a joint effort of the LBNE Science Collaboration and the LBNE Project. Although the final decision is formally made by the Project Manager (as the contracted agent for the DOE through FNAL), the goal is to reach a decision by consensus among all of the stakeholders. This document outlines the specific steps that will lead to the decision.

A description of the stakeholders and the assumptions under which this document was prepared are given in DocDB #4099 "Far Detector Technology Decision General Principles". This document defines the procedures that will be used to implement those principles.

Criteria:

1) The two candidate far detector types will be evaluated against their capabilities to achieve the scientific objectives documented in "Key Assumptions: Physics Research Goals of the LBNE Project," LBNE-doc-3056. The greatest weight will be given to the primary objectives, which are understood to be listed in priority order.

   The scientific cases will be developed by the LBNE Collaboration.

2) Cost estimates will be developed for each of the two detector types, including both the detectors and conventional facilities, based on conceptual designs which are capable of achieving the primary scientific objectives. The costs include design, development, prototyping, construction, and commissioning, as well as contingency to cover both cost uncertainties and technical risks. Costs will be developed initially for configurations that have equivalent capabilities for the primary scientific objectives. The cost estimates will be used to allow detector parameters to be scaled to allow comparison of their scientific capabilities under the constraint of a common cost. This common cost will be set based on our best understanding at the time of the allowed total project cost for LBNE.

3) The schedule will be used as a criterion only if there is a significant difference between the projected completion date of one detector type versus the other, and the scientific and cost criteria do not result in a clear conclusion.

   The conceptual designs and cost and schedule estimates will be developed by the LBNE Project.

Procedure

1) Case studies documenting the scientific capabilities of each far detector type will be developed by the LBNE Science Collaboration and will be reviewed by an external, independent committee. The committee will not be asked to recommend the choice; rather it will be asked to evaluate the physics case presented for each detector.

2) The conceptual designs of the two detectors will be developed by the LBNE Project and will be reviewed by external, independent committees, to ensure that the designs are technically sound from an engineering standpoint and are capable of making the measurements that support the physics cases reviewed above. Technical risks associated with each detector will be included in these reviews.

3) The cost and schedule estimates for the two detectors will be developed by the LBNE Project and will be reviewed by external, independent committees, to ensure that they are complete and on a sound basis. The adequacy of contingency to cover both cost uncertainties and technical risks will be reviewed.

4) The LBNE Collaboration Executive Committee (EC), potentially augmented by additional advisors (e.g. relevant scientific or technical experts or representatives of other stakeholders) develop recommendations concerning the far detector choice. One or more meetings of the EC will be required to develop the recommendations.

   The additional advisors, if any, will be nominated by the Co-Spokespeople, following consultation with the Project Manager, Fermilab Management, and the DOE. Their appointment will be subject to approval by the EC. These advisors will present information as needed and take part in discussions but will not vote on the final recommendation.

   An *ad hoc* subcommittee of LBNE collaborators, proposed by the Co-Spokespeople and approved by at least two-thirds or more vote of the EC, will draft written recommendations that reflect the consensus of the EC, which will then be brought back to the EC for approval.

5) The Project Manager will make the formal decision, based on the advice received from the LBNE Collaboration EC, and subject to the concurrence of the Fermilab Director, the LBNE Laboratory Oversight Group, and the DOE Office of High Energy Physics.

The several review committees will be constituted and charges as follows:

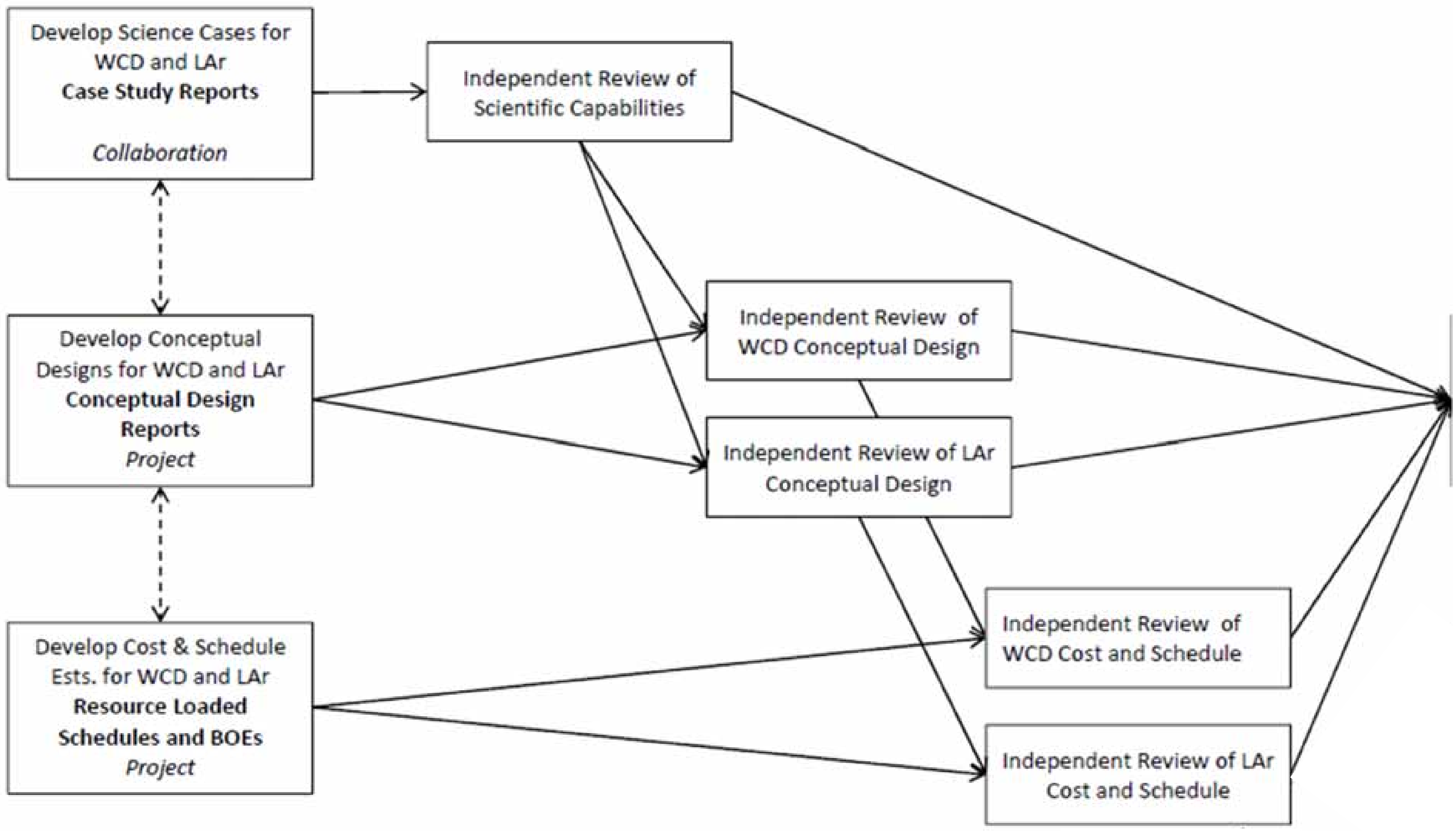
1) The Independent Review of Scientific Capabilities will be constituted and charged by the Spokespersons with advice from the EC.

2) The Independent Reviews of the CDR's will be charged and constituted by the Project Manager.

3) The Independent Reviews of Cost and Schedule will be charged and constituted by the Project Manager.

Target date for the completion of the decision process is by the end of CY11. This target date will be revisited as circumstances dictate.

Procedures for Far Detector Decision



Procedures for Far Detector Decision

Science Capabilities Review

Report of the LBNE Scientific Capability Review Committee

Dec. 14th, 2011

1 Introduction

This document reports the views of the LBNE Scientific Capability Review Committee after its consideration of the goals, potential capabilities, and risks of the two proposed technologies for the far detector for the LBNE experiment. The committee was convened by the collaboration to give advice on a realistic estimate of relative scientific capability of each technology, and where we felt the key risks lay. The committee consisted of:

Prof. Paul Grannis, SUNY Stony Brook

Dr. Dan Green, Fermi National Accelerator Laboratory

Prof. Koichiro Nishikawa, Institute of Particle and Nuclear Studies, KEK

Prof. Hamish Robertson, University of Washington

Prof. Bernard Sadoulet, University of California Berkeley

Prof. Dave Wark (Chair), Rutherford Appleton Laboratory/Imperial College London

considerations of technical, cost and schedule risks, but only where those are directly tied to the scientific capabilities. While we were only charged with considering the goals of LBNE itself, the scale of the facilities for this effort and its critical impact on the future Fermilab programme make it impossible to ignore the importance to the future US and world HEP programme. The Committee came to the unanimous opinion which is given below.

Science Capabilities Review

5 Conclusions and Recommendations.

The material presented in the previous sections is intended to be mostly factual. In this section we offer, as requested, our best scientific judgement of the relative merits of the two technologies.

- The proponents of both technologies have produced an impressive body of technical development and wide-ranging and sophisticated simulation and analysis work to support their proposed detectors.
- *In light of the presented materials the committee unanimously agrees that both technologies represent significant scientific opportunities, that either detector could be built at an acceptable level of risk, and that current knowledge supports the view that either is likely to deliver its expected performance, and that either detector would make world-leading measurements relevant to all of the major science goals.*

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sample from the large contamination of neutrino events (or, to a lesser extent, to do the converse). This requires a magnetized near detector, and it would be important to be able to make these measurements with the same target material in the near and far detectors. Therefore the potential to build a magnetized LAr detector at the near site seems a significant advantage for the LAr option.

- Given existing limits from Super Kamiokande, the best opportunity for a significant discovery in proton decay is in the p -> Kν channel, and in this channel the LAr detector has the clear advantage. The committee notes that the impact of continued SK data taking, and the desire for complementarity in p decay final states reinforces this conclusion.
- The greater size of the WC detector gives it a clear advantage for some of the other physics, in particular, for the SN burst measurement, although the LAr could see a striking signature of the hierarchy and give important information on collective phenomena in the neutrino sphere. If Super Kamiokande continues to run, the complementary information provided by a LAr detector in the event of a galactic SN would be valuable.
- The LBNE experiment will be the leading experiment at the Intensity Frontier. As such, very good "buy in" from the US high energy community is essential. Although it obviously did not conduct a survey of the field, the committee felt that the LAr, as a new technology on this

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Science Capabilities Review

scale, could create more opportunities to excite and thus recruit new young physicists in the project.

- The committee noted the value of enhanced infrastructure at the 4850 level at Homestake to a variety of other high-priority physics topics such as the search for Dark Matter and for neutrinoless double-beta decay. The committee felt that this added value to the overall US programme should not be discounted in the decision to put either detector at a deep site.
- The committee unanimously agrees that, that on the question of scientific capabilities, that the prospect for the LAr detector to refine our understanding of neutrino oscillations, and to be sensitive to unexpected new physics, exceeds that from the WC detector.

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Conceptual Design, Cost and Schedule Review

LBNE Far Site Internal Conceptual Design, Cost, Schedule and Risk Review

6-9 December 2011

Scope | Charge | Subcommittees | Supporting Design Documents | Project Planning Documents | Closeout Report

Scope

Assess the status and adequacy of the conceptual design for LBNE Water Cherenkov Detector (WCD), Liquid Argon Detector (LAr), and the associated Conventional Facilities (CF) at the Far Site (Sanford Lab). This review is to identify areas of weakness, and to recommend actions necessary to bring these elements to the level required for a successful DOE CD-1 review, currently planned for spring 2012. In addition, this review will assess the cost and schedule status of each subproject.

This review will cover only these three subprojects of the overall LBNE Project. (The conceptual design, cost, and schedule for Beamline, Near Detector and their associated Conventional Facilities at Fermilab are covered in separate reviews.) For this review, the four subcommittees will each be responsible for the technical aspects of the subprojects of WCD, LAr, and CF, plus cost/schedule. Each technical subcommittee should respond to the charge questions independently.

See a Brief Introduction to LBNE

Note that LBNE is still carrying three far detector options, a 200kt water Cherenkov detector at 4850L, a 33kt liquid argon detector at 800L, and a 33kt liquid argon detector at 4850L. The decision regarding which detector configuration will be used for LBNE will be made shortly after this review.

Committee Membership:

Overall committee chair – Peter Limon

Liquid Argon Detector – subcommittee chair: Howard Gordon

Cryostat and Cryogenics: Johan Bremer (CERN), Joel Fuerst (ANL)
TPC, Electronics, DAQ, Computing, Photon Detectors, Veto: Gary Drake (ANL), Peter Limon (consultant), Howard Gordon (BNL), Francesco Pietropaolo (Padova)

Water Cherenkov Detector – subcommittee chair: Bob Tschirhart

Water Containment and Water Systems: Fraser Duncan (SNOLab), Jim Mills (BNL)
PMTs, Electronics, DAQ, Computing – Bob Tschirhart (Fermilab), Gene Beier (UPenn), Sten Hansen (Fermilab), Bill Christie (BNL)

Conventional Facilities at Far Site - subcommittee chair: Marty Fallier

Surface: Jeff Sims (ANL), Marty Fallier (BNL),
Underground Infrastructure: Mark Laurenti (consultant), David Taylor (Sanford)
Underground Excavation: David Jurich (Hatch Mott McDonald), Randall Essex (Hatch Mott McDonald)

Cost/Schedule - subcommittee chair: Bill Edwards

Detectors: Bill Edwards (LBNL), Bill Freeman (Fermilab)
CF: Sherese Humphrey (ANL), Dave Leeb (Fermilab)

Conceptual Design, Cost and Schedule Review

Fermilab

Committee Report

LBNE Far Site Review

December 6-9, 2011

LBNE Far Site Review- Absolutely Final Report Issued Jabuary 6, 2012

0.0 Executive Summary

The focus of this Internal Review was the LBNE Far Site detectors, conventional facilities and cost & schedule. Technical, cost, schedule, project management and risk aspects were assessed to determine the current state of the project and to evaluate the project's preparedness for a DOE Lehman CD-1 Review presently scheduled for early Spring 2012.

The LBNE teams have made significant progress in the state of three reference designs, one of which will be chosen soon as a vehicle to permit progress toward a design for CD-1. It is important to note that this reference design is not a baseline design. The team is to be congratulated and thanked for their excellent work.

The primary conclusions of the review committee is that the present state of understanding of the design, R&D, performance and cost & schedule for the LBNE far-site detectors and conventional facilities are capable of executing the primary science mission, that LBNE will be ready for a DOE CD-1 review in a few months, and that there is no reason not to expect success. We further believe that the technology decision can be made now and that having a single detector model will facilitate moving forward to CD-1 and beyond.

It seemed to the Committee that the organizational and management requirements such as a CDR for the reference design, resource-loaded schedules and cost estimates can be in a state that is appropriate for a CD-1 review in a few months, although there are incomplete parts and some inconsistencies at the present time. Resource-loaded technically-driven schedules exist or are actively being ported to appropriate platforms; in some cases the connections between tasks have not been made. The cost estimates exist in sufficient detail for a CD-1 review, and many have been peer reviewed and iterated.

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LBNE Executive Committee

- Bruce Baller
- Ed Blucher
- Milind Diwan
- Bonnie Fleming
- Maury Goodman
- Richard Kadel
- Ed Kearns
- Josh Klein
- Bill Louis
- Tracy Lundin
- Elaine McCluskey
- Bob McKeown
- Marvin Marshak
- Christopher Mauger
- Vaia Papadimitriou
- Gina Rameika
- Kate Scholberg
- Hank Sobel
- Jim Stewart
- Jim Strait
- Greg Sullivan
- Bob Svoboda
- Bob Wilson

+ Advisers: F.Cavanna (ArgoNeut, μBooNE, ex-ICARUS), M.Gilchriese (SURF), S.Kettell (LBNE/WCD), J.Urheim (LBNE/LAr)

The LBNE Collaboration has had a multi-year process of considering the technology choice for the experiment. Recently there has been a series of reviews addressing this choice including the Science Capabilities Review, Far Site Review, Risks Workshop findings, and the most recent cost estimates from the Project. The LBNE Collaboration EC met to discuss these reviews and findings.

The recommendation below was based on consideration of the following factors:

1. The Science Program
2. Depth related issues
3. Performance Validity and Prototyping Program
4. Scope for Improvements/Future possibilities
5. Cost and Schedule
6. Near Detector Issues
7. Scientific Community and International Context

The executive committee spent two full days reviewing the two technologies and the most recent cost estimates, and discussing the points made by the review panels.

Conclusions and Recommendations:

- There was very strong support for both technologies. The committee feels that both technologies are viable and complementary in many aspects.
- There was a very strong preference for siting the experiment at the 4850L depth.
- Given the current state of knowledge and considering the factors listed above, the committee favored the Water Cerenkov option.

After preference decision was made, this statement was passed unanimously by the LBNE Executive Committee, Dec 14 2011

The Executive Committee also wished to strongly express their view that getting the science done should outweigh consideration of far detector technology in the final decision making-process.

As per the Procedures for LBNE Far Detector Configuration Decision (LBNE-doc-4099)

The Project Manager will make the formal decision, based on the advice received from the LBNE collaboration EC, and subject to the concurrence of the Fermilab Director, the LBNE Laboratory Oversight Group, and the DOE Office of High Energy Physics.

The Executive Committee reaffirms its commitment to the Scientific Goals of LBNE and will endorse the ultimate technology decision.

Passed unanimously by the LBNE Executive Committee, Dec 14 2011

The Far Detector Decision

Based on input from:

1) The Scientific Capabilities Review Committee, which was unanimous in its conclusion "that the prospect for the LAr detector to refine our understanding of neutrino oscillations … exceeds that from the WC detector."
2) The CDR Review Committee, which concluded that both "the LBNE far-site detectors and conventional facilities are capable of executing the primary science mission."
3) The LBNE Executive Committee, which "favored the Water Cerenkov option."

I concluded that LBNE should proceed a liquid argon TPC detector at the 4850L depth at the Sanford Underground Laboratory at Homestake.

We are now awaiting concurrence of the DOE Office of High Energy Physics.

Schedule Overview – Critical Decision Goals

CD-0 (Mission Need)	January 2010	(Actual)
CD-1 (Alternative Selection)	July 2012	(Goal)
CD-2 (Baseline)	June 2014	(Goal)
CD-3a (Long-lead Procurement)	June 2014	(Goal)
CD-3 (Construction Start)	December 2015	(Goal)
CD-4 (Project Complete)	2022	(Goal)

Summary

- LBNE is an important next step in neutrino physics.
  It will be the only experiment capable of fully untangling the physics governed by θ_{13}, for $\sin^2 2\theta_{13} \gtrsim 0.01$.
- It will enable a broad physics program including:
  - other precision neutrino oscillation measurements
  - search for proton decay
  - measurements of neutrinos form a core-collapse supernova
  - studies utilizing atmospheric neutrinos.
- It can anchor a facility for underground science, enabling other experiments in fundamental physics.
- We have nearly completed our process for fixing the configuration of the experiment.
- Assuming positive decisions from DOE regarding Homestake, we plan to achieve CD-1 in FY2012.