LBNE Project Scope, Cost, Schedule and International Involvement

Jim Strait, Fermilab
LBNE Project Director

P5 Meeting
3 November 2013

Outline

- Scope of LBNE Project
- R&D and prototyping required
- Cost of Construction Project
- Scope of international participation – scenarios for sharing project responsibilities
- Schedule
- Multi-agency issues
- Conclusions

Scope of the LBNE Project

Question 1: "a brief summary of … the explicit scope of the experiment…"

- We have a complete conceptual design and corresponding cost and schedule estimate for:
  - A neutrino beamline
  - A highly-capable near detector system
  - A 34 kt fiducial mass LAr TPC far detector at the 4850 foot depth at SURF

  It was thoroughly reviewed and found to be sound.

- We received CD-1 for a solely DOE-funded initial phase consisting of:
  - A neutrino beamline
  - A system of muon detectors to monitor the beam
  - A 10 kt fiducial mass far detector under minimal overburden

Scope of the LBNE Project

Question 1: "a brief summary of … the explicit scope of the experiment…"

- We are developing international partnerships, with the goal of delivering an initial project consisting of:
  - A neutrino beamline
  - A highly-capable near detector system,
  - A ≥10 kt fiducial mass far detector underground at SURF
  - A cavern for a full 34 kt detector system.
  - The designs of the near and far detectors (and perhaps the beam) will incorporate concepts from new partners.

  DOE/HEP supports this approach.
- The planned project allows for future upgrades:
  - The beamline is designed to upgradeable to ≥2.3 MW proton beam power
  - Future detector module(s) can be installed in the underground cavern.

Fermilab and SURF

*Question 1: "*What makes this experiment unique?*"*

The US is in a unique position to mount this project. We have:

- A high intensity proton accelerator complex at Fermilab
- An world-class underground lab at SURF, strongly supported by the host state of South Dakota
- Optimal source-destination distance for the physics of LBNE

R&D and Prototyping

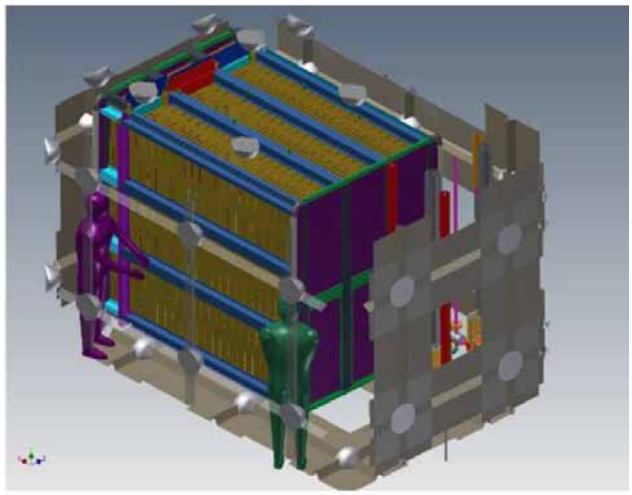
Question 3: "What R&D is still required."

- The basic principles are established for designing and building all elements of LBNE.
- A few elements require R&D to achieve project goals, e.g.:
  - The neutrino production target for the initial 0.7~1 MW operation. (Additional R&D will be required when the beam power is increased to 2.3 MW, but this is not part of the current LBNE project.)
  - Hadron monitors at the end of the decay pipe to handle the higher particle density than in NuMI.
  - A photon detection system for the far detector capable of triggering on non-beam physics with low (<10 MeV) threshold. *Some of this may be done with non-project funds in the US or by other partners.*

R&D and Prototyping

Question 3: "What R&D is still required."

- Substantial prototyping is required for the far detector, due to the large scale-up from the current state of the art:
  - Prototype membrane cryostat now being commissioned
  - Scaled down prototype TPC to be installed in the prototype cryostat
  - Prototype full-scale anode planes
  - Full-scale TPC drift cell(s) operated in LAr, possibly in a test beam. We are exploring with international partners how to develop this capability.
  - Installation mockup
  - Plus electronics, DAQ, etc.



R&D and Prototyping

Question 3: "What R&D is still required."

- Prototyping for the near detector subsystems
  - Muon detectors (currently being tested in NuMI)
  - Near neutrino detector systems are of relatively conventional design. Prototyping will be done mainly by our international partners.

- Prototyping for beamline elements, including:
  - Proton beamline kickers and corrector magnets
  - Beam position monitors (currently being tested in NuMI)
  - Target system
  - Decay pipe window for helium fill
  - Horn inner conductor for improved designs

Cost Estimates (M$)

Question 3: "what is your current estimate of U.S. construction costs? What contingency are you carrying"

WBS		CD1 Beamline; μ det; 10 kt surface FD, CF	Beamline; Full ND; 10 kt underground FD; CF	Beamline; Full ND; 34 kt underground FD; CF	Contingency
	Total Project Cost	867	1,236	1,541	41%
1.1	Project Mgmt	73	91	100	29%
	top-down conting.	30	62	70	
1.2	Beamline	165	169	169	30%
1.3	Near Detector Sys	23	136	136	29%
1.4	WCD	11	11	11	0%
1.5	Far Detector	253	278	495	44%
1.6	Conventional Fac.	313	489	559	31%

Contingency is *included* in each of the dollar figures above.
Contingency fractions are similar for all three estimates.

DOE has established $867M as the budget for planning the DOE-funded part of LBNE. Scope beyond that cost is to be provided by other partners.

Cost Basis

Question 3: "…and what is the basis of estimate?"

- The estimate with surface FD and no ND is the one presented and approved for CD-1.
- The estimates with underground FD and a full ND are based on those presented and approved by a Fermilab Director's in March 2012, modified by value engineering done during the Reconfiguration process.
- Estimates were developed from the bottom up and are thoroughly documented in >120 BOE documents.
- Contingency is estimated from the bottom up including estimate uncertainty and risk.
- Indirect costs and escalation are included using standard project cost processing tools.

Director's Review of the full-scope LBNE
DOE Review of the reduced-scope CD-1 LBNE

Issued April 23, 2012

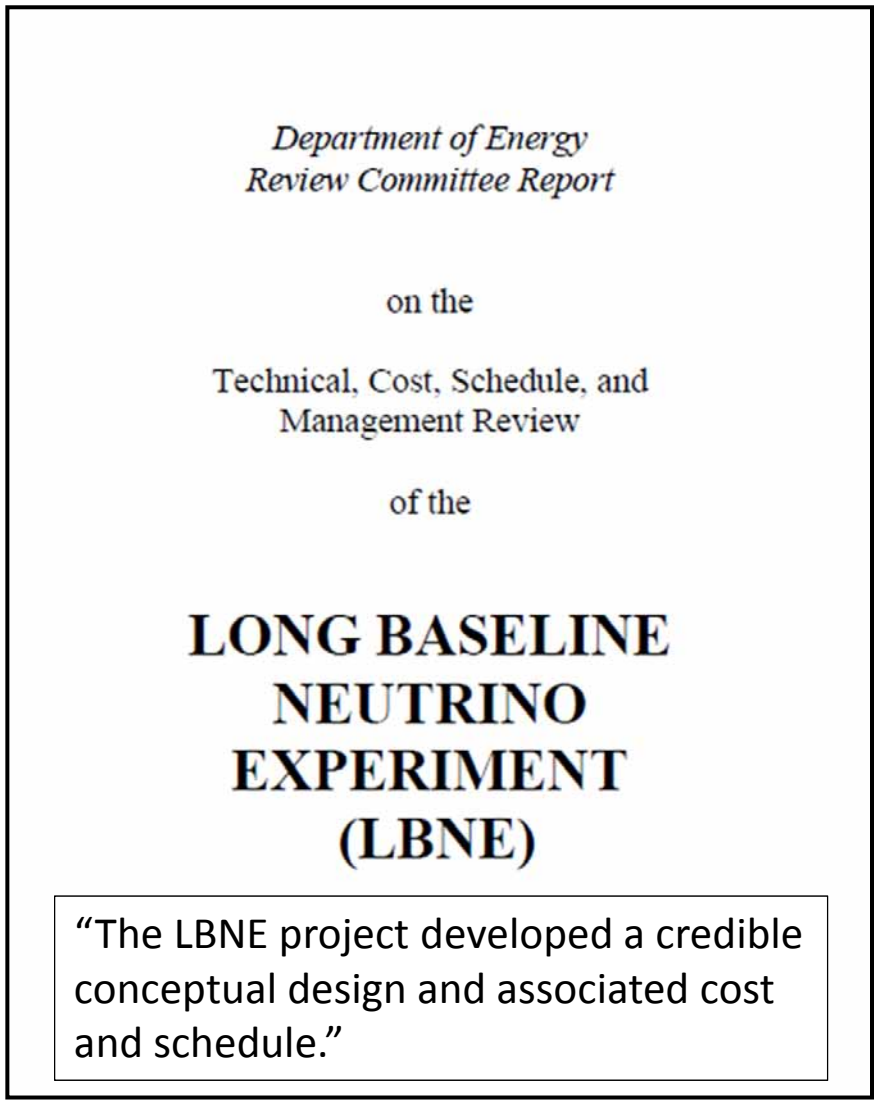
Fermilab

Final Report

Director's Independent Conceptual Design and CD-1 Readiness Review of the LBNE Project

March 26-30, 2012

"The committee finds that the Conceptual Design for the LBNE project is sound…. The committee is confident that the LBNE project can be ready for a CD-1 review …[by] summer of 2012…"



Department of Energy
Review Committee Report

on the

Technical, Cost, Schedule, and Management Review

of the

LONG BASELINE NEUTRINO EXPERIMENT (LBNE)

"The LBNE project developed a credible conceptual design and associated cost and schedule."

Towards a project budget in an international context

*Questions 2/3: "*what scope of international participation is required? *what … [is the] division of scope?*

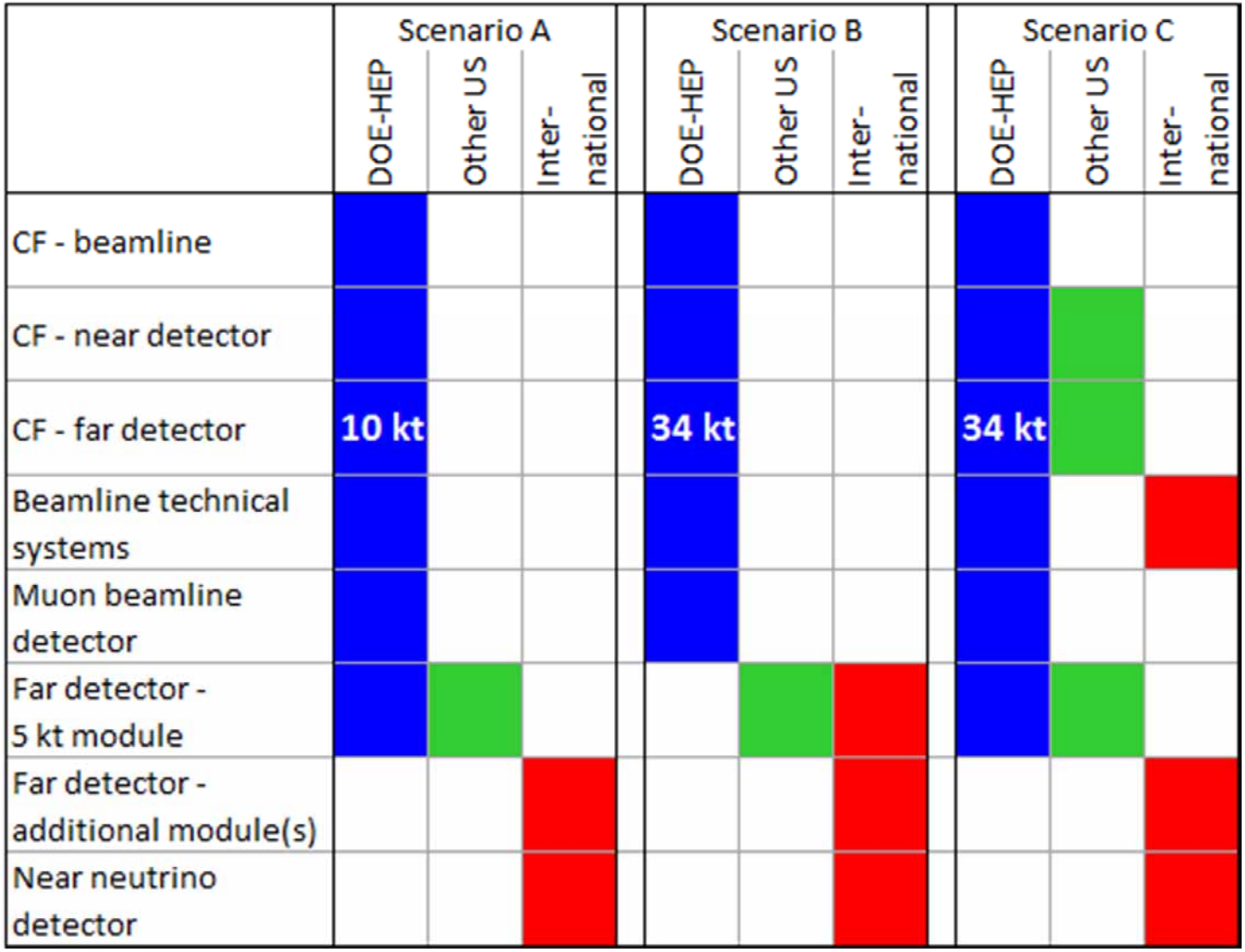
Based on the substantial interest by many groups in many countries to participate in and contribute to the construction of LBNE, we can start to sketch what a possible internationalized LBNE might look like.

To develop a plan, we make a number of general assumptions:

- Conventional facilities will be funded by mainly or entirely by the DOE. Illinois and South Dakota have already invested in Fermilab and SURF, and may in the future contribute to the conventional facilities construction for LBNE.
- Construction of the beamline systems will be funded mainly by the DOE, but there could be in-kind contributions from other partners.
- Contributions from non-US partners will be in-kind and will concentrate on the construction of the detectors, both near and far.
- Funding from other domestic funding source(s) would concentrate on the detectors, and in particular contribute to enabling scientific research beyond what the DOE-funded CD-1 configuration could provide.

Scenarios for and International LBNE

Questions 2/3: "what scope of international participation is required? *what … [is the] division of scope?*



Scenario A

*Questions 2/3: "*what scope of international participation is required? *what … [is the] division of scope?*

DOE/HEP funding ($867M) would provide:

- All conventional facilities for the beamline, near detector, and for a 10 kt fiducial mass far detector at a depth of 4850 feet.
- All of the beamline technical systems.
- Muon detectors to monitor the neutrino beam.
- Partial funding for a 5 kt fiducial mass far detector module.
- Modest partial funding for the near detector.

If other domestic funding source(s) would provide:

- The remaining funding for a 5 kt fiducial mass far detector module.
- Modest partial funding for the near detector.

And if other countries would provide:

- A second 5 kt fiducial mass far detector module.
- A high-performance near neutrino detector system.

Scenario B

*Questions 2/3: "*what scope of international participation is required? *what … [is the] division of scope?*

DOE/HEP funding ($867M) would provide:

- All conventional facilities for the beamline, near detector, and for a 34 kt fiducial mass far detector at a depth of 4850 feet.
- All of the beamline technical systems.
- Muon detectors to monitor the neutrino beam.

If other domestic funding source(s) would provide:

- A 5 kt fiducial mass far detector module, solely or with other countries.
- Modest partial funding for the near detector.

And if other countries would provide:

- Additional far detector module(s), ≥ 5 kt.
- A high-performance near neutrino detector system.

Scenario C

*Questions 2/3: "*what scope of international participation is required? *what … [is the] division of scope?*

DOE/HEP funding ($867M) would provide:

- Much of the conventional facilities for the beamline, near detector, and for a 34 kt fiducial mass far detector at a depth of 4850 feet.
- Some, but not all of the beamline technical systems.
- Muon detectors to monitor the neutrino beam.
- Partial funding for a 5 kt fiducial mass far detector module.
- Modest partial funding for the near detector.

If other domestic funding source(s) would provide:

- The remaining funding for a 5 kt fiducial mass far detector module.
- Modest partial funding for the near detector.

And if state funding would provide:

- Contribution to conventional facilities at Fermilab and/or SURF

And if other countries provide:

- Additional far detector module(s), ≥ 5 kt.
- A high-performance near neutrino detector system.
- Some beamline technical system(s).

Comments on LBNE as a Multinational Project

*Question 3: "*If this is a multi-agency project, what are the envisioned roles?*"*

- Collaboration and project organizations will need to evolve as international partners become part of LBNE
- Very early discussions within the collaboration and between members of the collaboration and NSF regarding a possible NSF role.
- An international governance structure will be necessary. First discussions with DOE have occurred concerning formal relations with external partners.
- We are looking at structures from other international experiments, e.g. ATLAS, CMS, BaBar, to learn what we can from them.
- The Collaboration has formed an International Advisory Committee to advise us on these topics.

Comments on LBNE as a Multinational Project

*Question 3: "*If this is a multi-agency project, what are the envisioned roles?*"*

- National funding agencies who are making a significant investment in LBNE will almost certainly want a voice in how the project is managed.
- A forum will be necessary in which issues and problems whose resolution affects more than one country or funding agency can be discussed and resolved.
- Agreements regarding the scope of deliverables from each country, that document the understandings under which the work on LBNE will be done, will almost certainly be a set of individual country-to-country agreements rather than a grand multinational agreement.

Possible International Management Structure

*Question 3: "*If this is a multi-agency project, what are the envisioned roles?*"*

A "standard" solution would be to form an International Finance Committee:

- Chaired by the US DOE representative as lead funding agency from the host country.
- Representatives from each funding agency or country
- Develops and the overall division of responsibilities according to national budgetary commitments.
- Monitors progress and allows future adjustment of national responsibilities to ensure overall success.

The "day-to-day" project management structure would incorporate international partners, according to their responsibilities.

Schedule

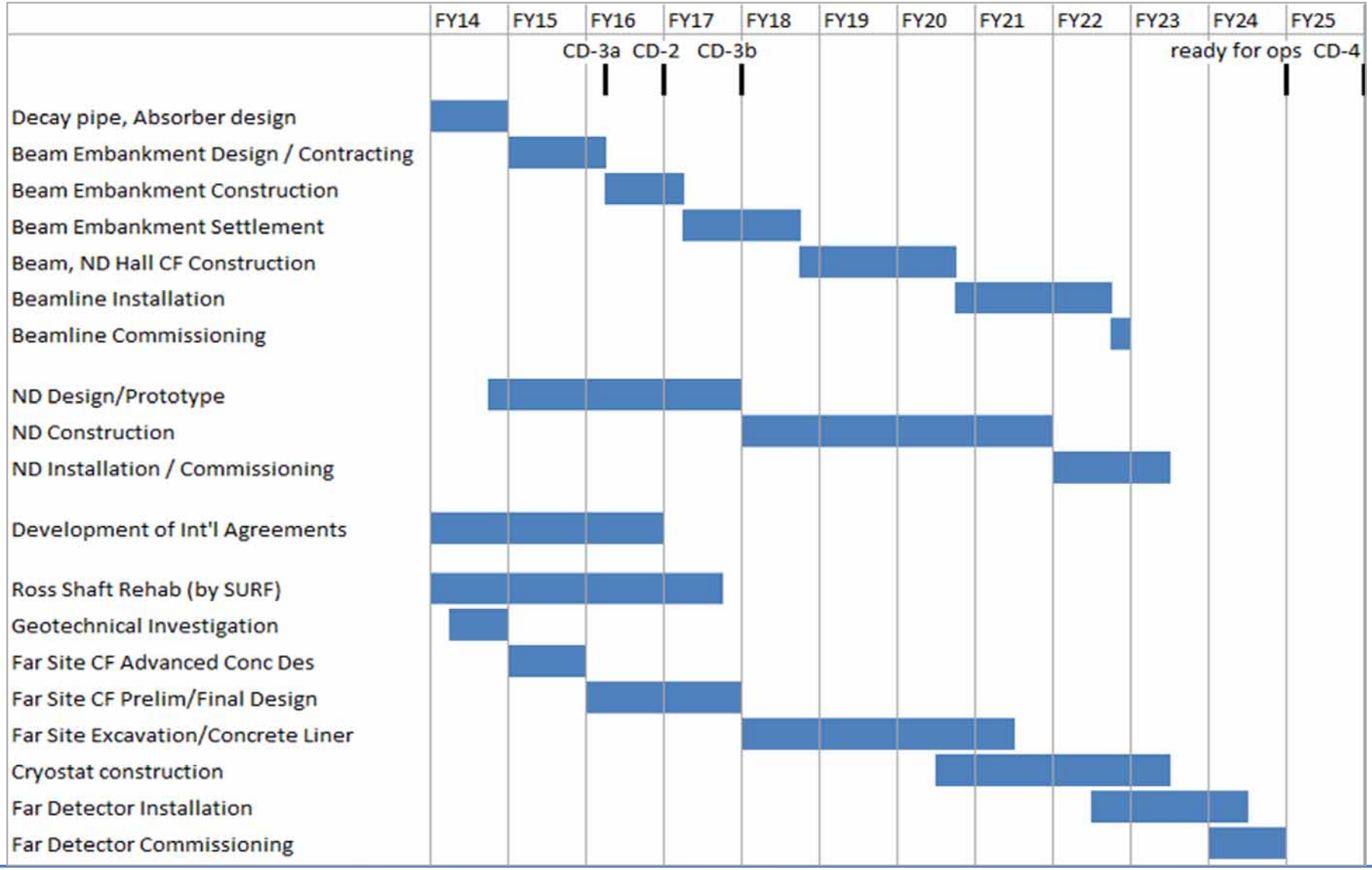
Question 1: "a brief summary of … a notional timeline…"

- We have fully developed schedules for
  - the CD-1 scope (surface 10 kt FD, no ND) and
  - the full-scope LBNE (underground 34 kt FD, full ND)

  assumed to be fully funded by DOE.
- Detailed schedules involving non-DOE partners cannot be made yet; however, an estimate can be made using information from the two well developed schedules and the following assumptions:
  - International agreements sufficient to baseline the DOE-funded project can be put in place in ~ 3 years
  - The DOE-funded project will proceed according to a funding profile similar to the current guidance from DOE/HEP
  - We have freedom to proceed with parts of the project that are ready to go (e.g. the beamline) without waiting for others that may take longer (e.g. the far detector)
- Goal to complete LBNE construction and start operation no later than 2025 (consistent with CD-4 milestone in CD-1 plan)

Plausible Schedule for International LBNE

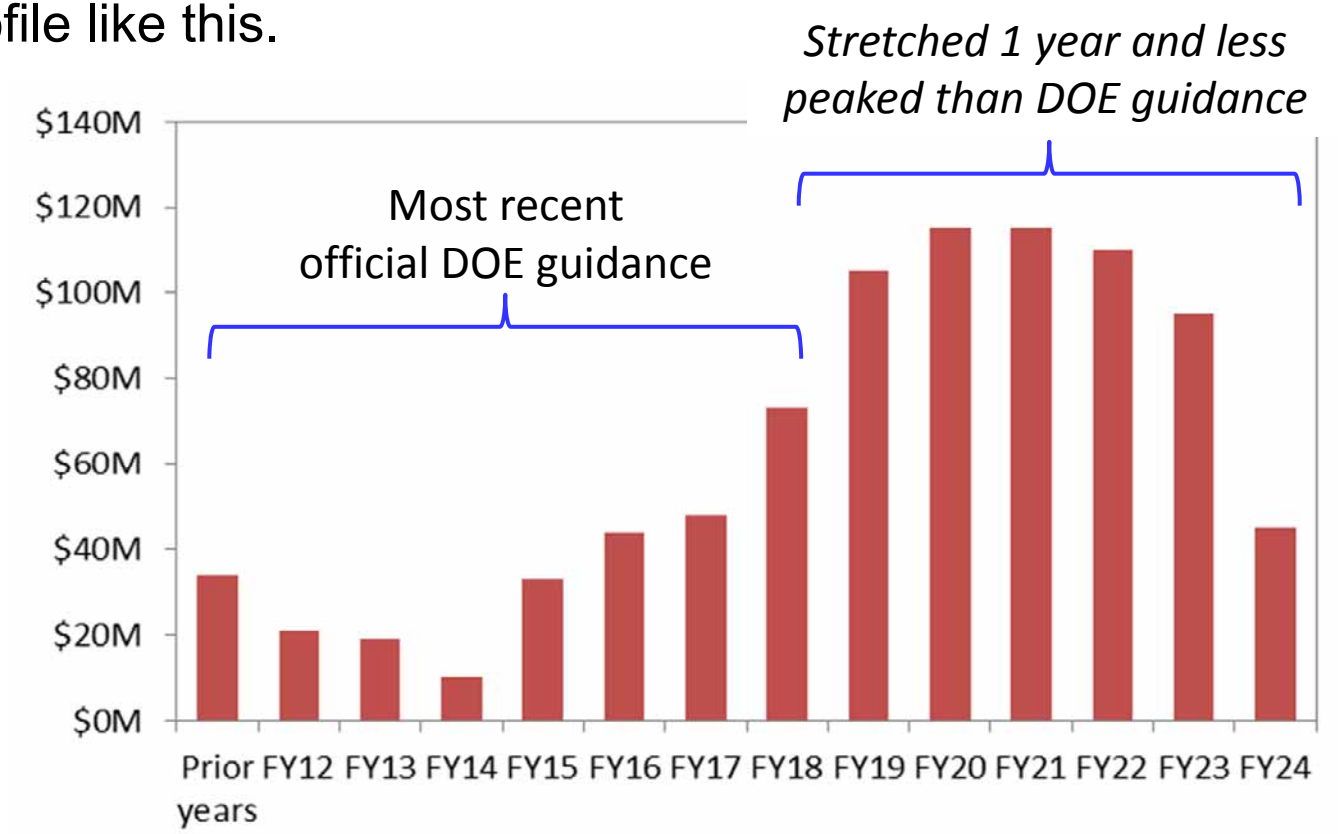
Question 1: "a brief summary of … a notional timeline…"



Plausible DOE Funding Profile

*Question 3: "i*ncluding notional technically-driven and realistic cost profiles*"*

- The schedule on the previous slide is consistent with a DOE funding profile like this.



- Funding for work by other partners is assumed to come when it is needed to support this schedule.

Conclusions

Question 5: "anything else you would like to communicate to P5?"

- The science case for LBNE is compelling.
- LBNE has the support of the US HEP community as demonstrated at the Snowmass meeting this summer
- There is growing international interest in participating in and contributing to the construction of LBNE
- We have well developed project plans and are working to integrate these with international partners, with whom we can work to achieve the full goals of LBNE
- We seek P5's endorsement to proceed vigorously with this important program.