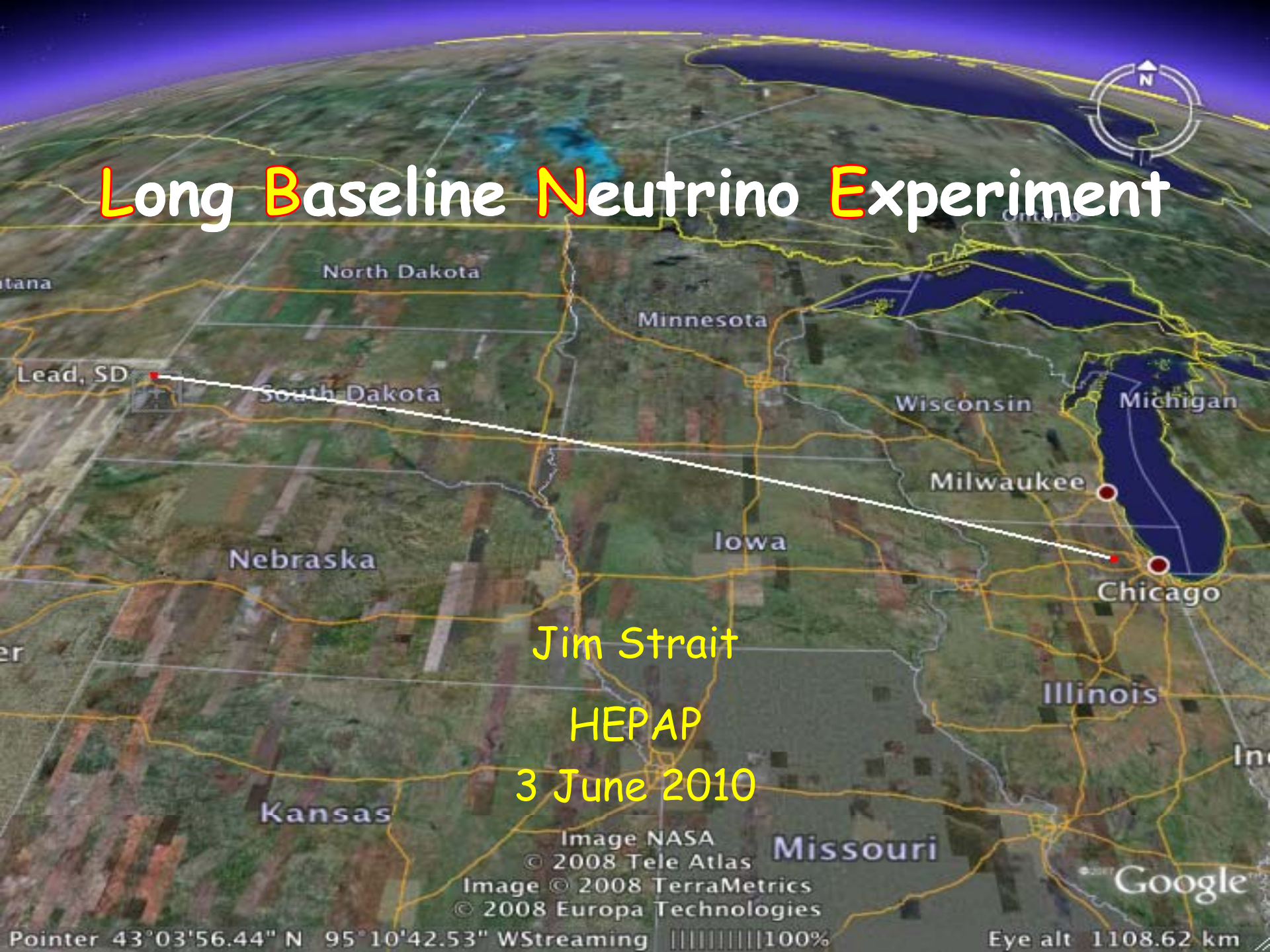
Long Baseline Neutrino Experiment
North Dakota
Minnesota
Lead, SD
South Dakota
Wisconsin
Michigan
Milwaukee
Iowa
Nebraska
Chicago
Jim Strait
HEPAP
3 June 2010
Illinois
Kansas
Missouri
Image NASA
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Google
Pointer 43°03'56.44" N 95°10'42.53" WStreaming 100%
Eye alt 1108.62 km

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Virginia Tech: J. Link

Washington: S. Enomoto, J. Kaspar, N. Tolich, H.K. Tseung

Wisconsin: B. Balantekin, F. Feyzi, K. Heeger, A. Karle, R. Maruyama, C. Wendt

Yale: B. Fleming, M. Soderberg, J. Spitz

54 Institutions, 244 Scientists and Engineers … and growing.

17 May 2010

*co-spokes

Goals of LBNE

Measure ν_μ -> ν_e oscillations with sensitivity >> NOvA and T2K:

- Determine the mass hierarchy:
  Are ν_1 and ν_2 lighter or heavier than ν_3?
- Search for CP violation in the neutrino sector – Why is there matter but almost no anti-matter in the Universe?
- Sensitivity for above down to $\sin^2(2\theta_{13}) \sim 0.01$

Use very massive detector necessary for the oscillation physics for:

- Improved limits (or discovery!) of proton decay
- Measurements using astrophysical neutrinos:
  - Neutrinos from a supernova in (or near) our galaxy
  - Diffuse supernova neutrino flux
  - Atmospheric neutrinos
  - Solar neutrinos
- Further measurements of ν_μ -> ν_μ (disappearance) oscillations
- Geoneutrinos, . . .

LBNE Project Scope

- WBS 1.1 – Project Management.
- WBS 1.2 - New neutrino beam at Fermilab:
  Initial proton beam power = 0.7 MW, but facility to be capable of being upgraded to ≥2 MW.
- WBS 1.3 - Near detector
  To measure un-oscillated beam spectrum and neutrino cross sections needed to make the oscillation measurements.
- A far detector complex of ≥ 200 kT "Water Cerenkov Equivalent":

  WBS 1.4 – Water Cerenkov Detector (WCD) 100 kT "modules
  placed at 4850 feet.

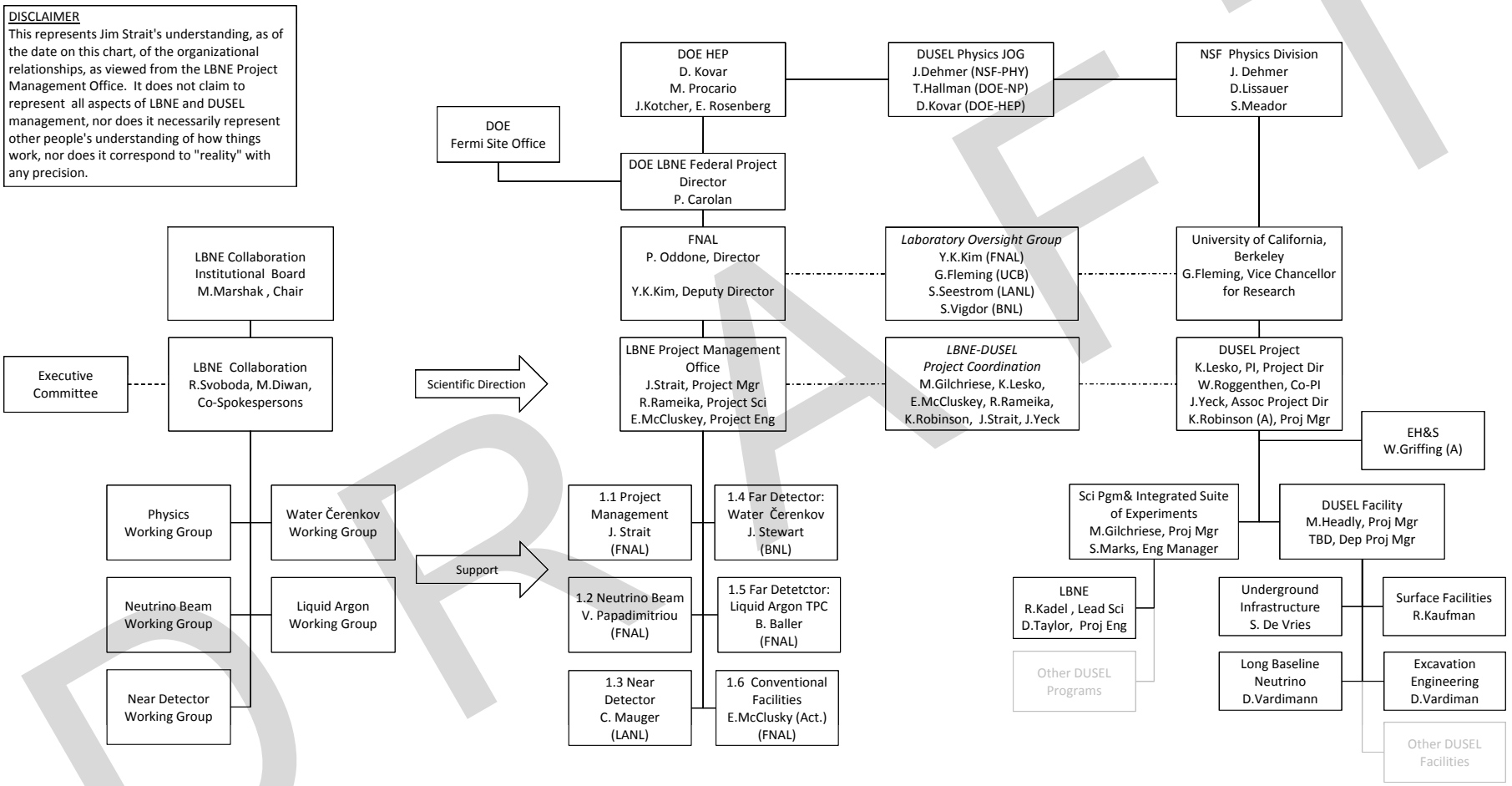
  WBS 1.5 – Liquid Argon TPC Detector (LAr) ~20 kT "modules"
  placed at 300/800 feet or 4850 feet.

  Choose detector configuration that gives the best science within cost, schedule, and technical risk constraints .

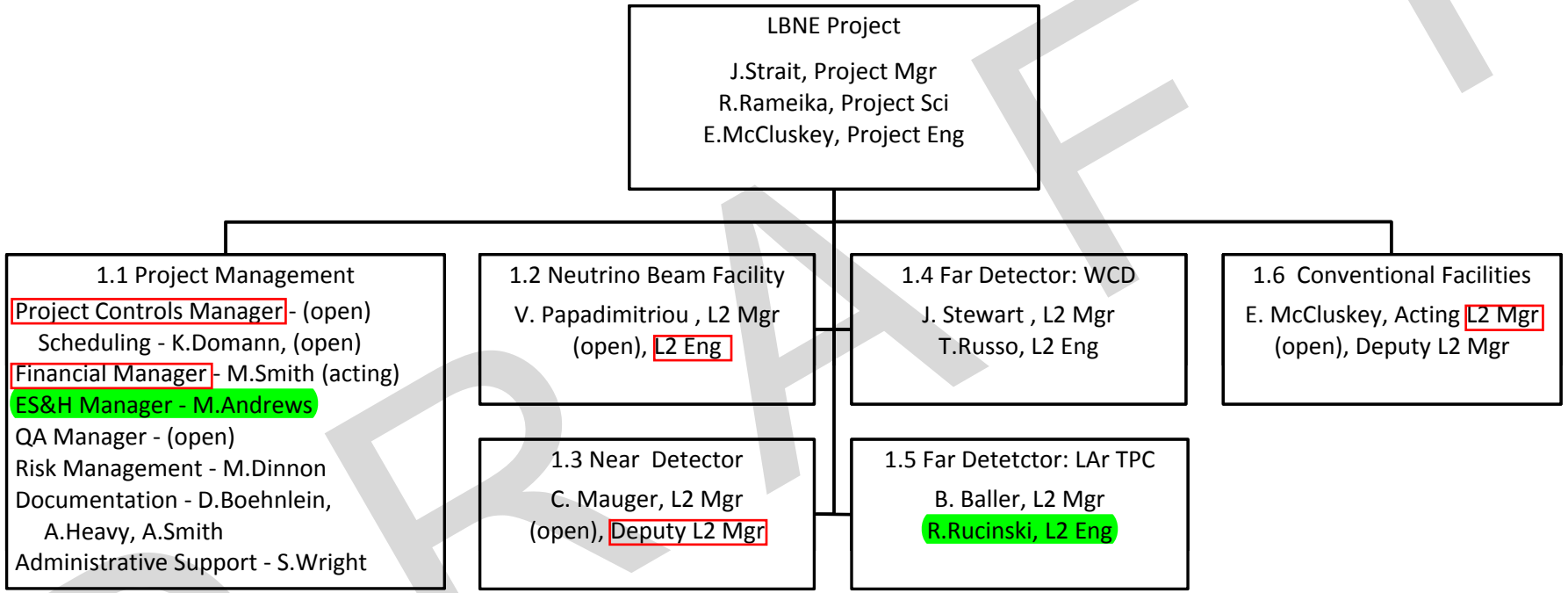
Project Scope

- WBS 1.6 – Conventional facilities:
  underground and surface facilities at the near and far sites.
  - Significant underground and surface civil engineering on the Fermilab site for the beam and near detector.
  - Underground and surface civil engineering for LBNE-specific facilities on/in the DUSEL site.
  - We are working with DUSEL to define:
    - Precise boundaries of responsibility between DUSEL and LBNE.
    - The management of "LBNE's" cavern and surface construction within the overall DUSEL construction project.

LBNE Collaboration + Project + DUSEL Organizational Relationships



LBNE Project Organization

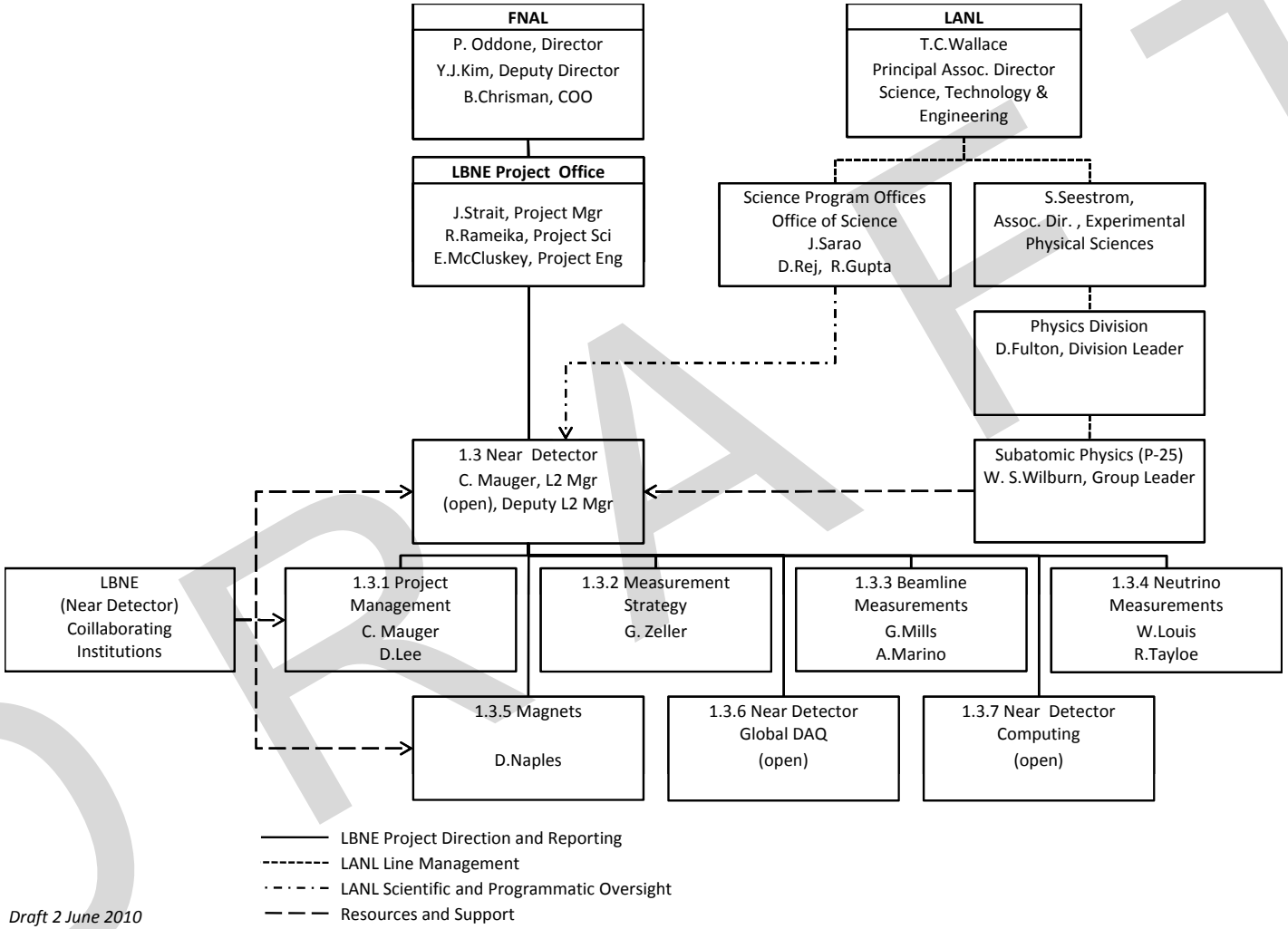


Draft 2 June 2010

Recent Appointments

Active Searches Under Way

LBNE Near Det Sub-Project Organization



Draft 2 June 2010

Funding for the next several years

DOE has given us three potential funding profiles for the coming years:

	"Low"	"Medium"	"High"
FY2009 – ARRA+R&D	$5.0M	$5.0M	$5.0M
FY2010 – ARRA +R&D	$22.2M	$22.2M	$22.2M
FY2011 – R&D+PED	$12.0M	$17.0M	$17.0M
FY2012 – PED	$35.0M	$35.0M	$45.0M
FY2013 – PED	$55.0M	$55.0M	$55.0M

Progress towards baselining the project and beginning construction depends on the actual profile.

LBNE Project Time Line

We are currently early in the project planning phase.

- Received DOE CD-0 (Approve Mission Need) January 2010
- Working towards CD-1 Review (Conceptual design, preliminary cost and schedule range) December 2010
- CD-1 (assuming successful CD-1 review) April 2011
- Schedule for CD-2 (Project baseline)
  depending on funding . . . Winter 2012/3 ~ Summer 2013
- CD-3 (start construction)
  depending on funding . . . 2014 ~ 2015
- Schedule for construction is in the process of being developed
  => guess that project will be complete $\gtrsim$ 2020

LBNE Calendar of Events Towards CD-1

- Detailed outline of CDR — 10 May
- Detailed outline of Preliminary Project Management Plan (PPMP) and DUSEL-LBNE MOU; draft organization and definition of roles and responsibilities — 19 May
- Initial draft sub-project Resource Loaded Schedules (RLS) — 25 June
- Intermediate draft CDR — 25 June
- Intermediate draft of PPMP and DUSEL-LBNE MOU — 9 July
- Readiness check for CD-1 (internal review) — week of 12 July
- Subproject RLS delivered for compilation by PMO — 16 August
- Final draft CDR, ready for final editing — 13 September
- Directors CD-1 Design Review — week of 20 September
- Advanced draft of PMP and DUSEL-LBNE MOU — 1 October
- Directors CD-1 Cost, Schedule and Management Review — week of 25 October
- **DOE CD-1 Review — 7-9 December**

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LBNE Configuration Decisions

LBNE has many configuration choices:

- Not just WCD vs. LAr
- ND configuration
  - o many detector options are on the table
  - o emphasis on flux measurements vs. short-baseline physics
- Trade-offs (relative budgets) among
  - o beam design (e.g. decay pipe dimensions, beam power capability)
  - o ND capability (e.g. "MINERvA" vs. more complex detector)
  - o FD mass (larger or smaller depending on other costs)
- Trade-offs between detector mass and other parameters (e.g. photocathode coverage, or LAr wire spacing)
- What must be built from the beginning vs. left for later upgrades (or contributions from yet-to-be found collaborators)?

Approach to all configuration decisions should be the same:
Build an experimental complex to deliver the best possible science.

LBNE Configuration Decisions

What is required for CD-1?

- CD-1 is *not* a baseline; some options can be left open.
- However, it will make it more straightforward to achieve CD-1 if the number of major alternatives still under consideration is small. ("Keep it simple.")
- On the other hand, we should not close off potentially valuable options until we have enough information to be confident that we are making the right decision.
- Options left open must be covered by the cost range and schedule range presented for CD-1.

LBNE Configuration Decisions

Far Detector Configurations Under Consideration

	WCD @ 4850	LAr @ 4850	LAr @ 300/800
a)	2 x 100 kT		
b)		2 x 20 kT	
c)			2 x 20 kT
d)	1 x 100 kT	1 x 20 kT	
e)	1 x 100 kT		1 x 20 kT

LBNE Configuration Decisions

For the DOE:

- The primary mission is long-baseline neutrino oscillations.
- Proton decay and neutrino astrophysics are important secondary goals, enabled by the large detectors required for the oscillation physics.

For the NSF:

- LBNE represents two of the four physics experiments that "must" be part of the initial experimental program:
  - o Long-baseline neutrino oscillations.
  - o Proton decay.
- Other physics enabled by the large detectors are important secondary goals.

=> Neutrino oscillations and proton decay should be most strongly considered in choosing the configuration for "the best possible science."

LBNE Configuration Decisions

Inputs to the decision:

1) Determine and compare the sensitivity for each physics topic for each configuration.

2) Simulations or other studies to determine (or improve determination of) detection efficiency and background rejection for each detector technology and for each relevant physics process, and the uncertainties in these quantities.

3) Conduct complete risk analysis (technical, cost and schedule) for each detector technology and far-detector depth.

4) Estimate the cost of each configuration, including:
   - Contingency required by risks
   - Required R&D
   - Specific impact of (far) detector choice on beam requirements

LBNE Configuration Decisions

(More) inputs to the decision:

5) Estimate schedule for each configuration, including:
   - Common assumptions about DUSEL schedule
   - Time for required R&D
   - Commissioning time
   - Uncertainties due to identified risks.

6) For far detectors, normalize detector mass in each configuration to common cost (including contingency).

7) Estimate physics reach = f(t) for each configuration.

8) . . .

LBNE Configuration Decisions

(More) inputs to the decision:

5) Estimate schedule for each configuration, including:
   - Common assumptions about DUSEL schedule
   - Time for required R&D
   - Commissioning time
   - Uncertainties due to identified risks.

6) For far detectors, normalize detector mass in each configuration to common cost (including contingency).

7) Estimate physics reach = f(t) for each configuration.

8) . . . *Hope that the answer becomes obvious . . . .*

LBNE Configuration Decisions

(More) inputs to the decision:

5) Estimate schedule for each configuration, including:
   - Common assumptions about DUSEL schedule
   - Time for required R&D
   - Commissioning time
   - Uncertainties due to identified risks.

6) For far detectors, normalize detector mass in each configuration to common cost (including contingency).

7) Estimate physics reach = f(t) for each configuration.

8) Need a mechanism to:
   - Evaluate the "input data"
   - Weigh the relative importance of the inputs
   - Come to a consensus concerning the configuration of experimental complex.

LBNE Configuration Decisions

Formally, the decision is the responsibility of the LBNE Project, which is the organization that is responsible to the funding agencies, and through them the taxpayers, for how their money is spent.

Strong input from the collaboration is required,
since the Project is building the experiment for the collaboration to do the science.

Plan: Constitute the Collaboration Executive Committee as an advisory committee* charged to make recommendations:

- Charge to include a set of issues to be addressed (see previous list "Inputs to the decision"), not just a request for a recommendation about the configuration.
- Produce a single consensus report – no "majority" or "dissenting" reports.
- "Too early to decide" is a possible outcome for some choices.

*Could invite a few external advisors, e.g. from DUSEL(?)

DUSEL - LBNE Partnership

- LBNE represents two of the four "pillars" of the initial physics program of DUSEL: long-baseline neutrino oscillations and proton decay.
- DUSEL will provide a cost-effective facility, at near-ideal distance and depth, for LBNE, thereby permitting larger and more sensitive detectors to be built.

=> It is in the interest of both Projects to work closely together
. . . ***And we are!***

Examples of "early" cooperation:

- Weekly meetings between DUSEL and LBNE management.
  Weekly meetings between DUSEL and LBNE engineers.
- Participation by Golder in LBNE WCD vessel design meetings.
- MOU to allow LBNE to work through DUSEL with DUSEL's contractors for LBNE-specific engineering studies.
- Participation by LBNE in monthly DUSEL "integration week" meetings

LBNE – DUSEL Partnership

The "rules of engagement" will be codified in a DUSEL-LBNE MOU, which we are actively working on drafting.

Issues currently being actively (and productively) worked include:

- Defining boundaries between DUSEL and LBNE Project responsibilities.
- Organizations and procedures to manage the civil construction of LBNE facilities within DUSEL.
- Our view of how NSF and DOE funding can be managed to support LBNE civil construction at DUSEL, LBNE detector construction, and LBNE beam and civil construction at Fermilab.
- Need to understand how to "normalize" the DUSEL vs. LBNE project development schedules:
  DUSEL is working towards "Preliminary" design, while
  LBNE is working towards "Conceptual" design.

Summary

- The LBNE Project is making good progress towards a CD-1 Review, currently scheduled for this coming December.
- A strong project team is functioning well – active searches are under way to fill out the remaining key openings.
- Making decisions about experimental configurations will be an important (and interesting!) process.
- DUSEL and LBNE Projects are developing a good partnership.