Long Baseline Neutrino Experiment

Goals of LBNE

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

- Measure $\sin^2(2\theta_{13})$ to << 0.01
- 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?

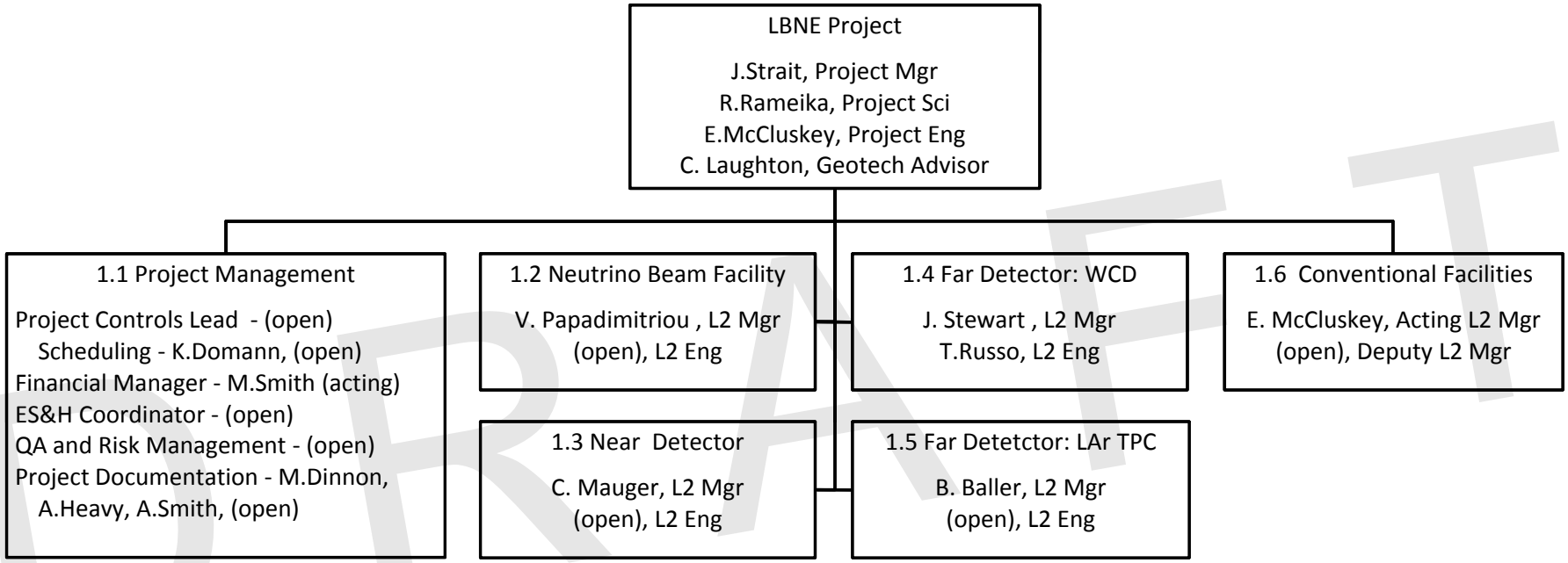
Use the massive detectors necessary for the oscillation physics for:

- Improved limits (or discovery!) of proton decay
- Measurements using astrophysical neutrinos:
  - Neutrinos from a supernova in (or near) our galaxy
  - Relic neutrinos from "all" past supernovas
  - From cosmic ray interactions in the atmosphere
  - Solar neutrinos

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 capable of measuring neutrino beam properties and neutrino cross-sections with sufficient precision that the oscillation physics is limited by far detector statistics.
- A far detector complex of ≥ 200 kT Water Cerenkov equivalent:
- WBS 1.4 – Water Cerenkov far detector (100 kT "modules").
- WBS 1.5 – Liquid Argon TPC far detector (~20 kT "modules").
- WBS 1.6 – Conventional facilities:
  underground and surface facilities at the near and far sites.

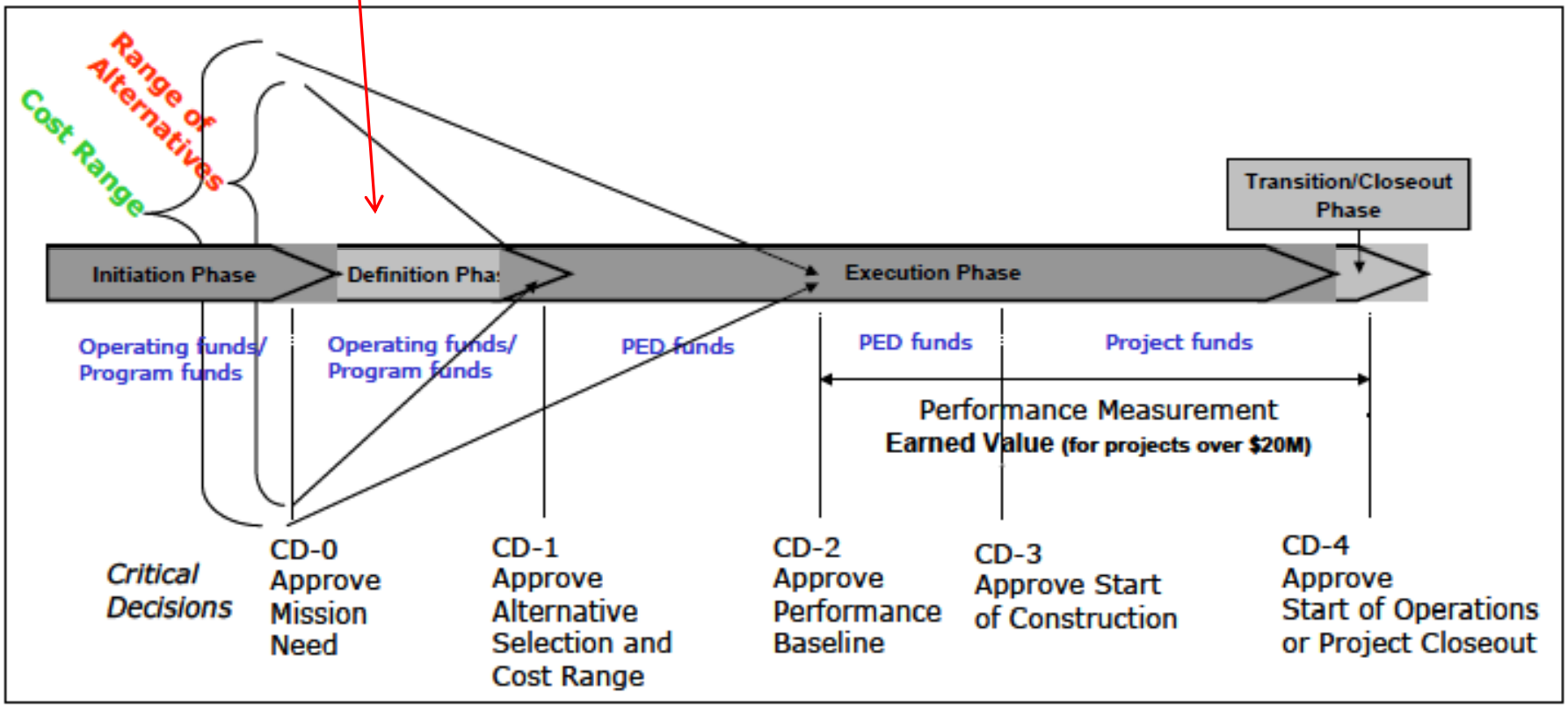
LBNE Project Office
Organization and Staffing



DRAFT

LBNE is at this point

DOE Project Process



LBNE SCHEDULE 8-Jan-10 *March 2011* *Summer 2012* *Fall 2013*

(Draft) Calendar of Events Towards CD-1

- Detailed outline of CDR – 10 May
- Initial draft sub-project Resource Loaded Schedules – 25 June
- Intermediate draft CDR – 25 June
- 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
- CD-1 Directors Design Review – week of 20 September
- CD-1 Directors Cost, Schedule and Management Review – week of 25 October
- Lehman Review (IPR) – first half of December.

Current LBNE Project Efforts

- Working on conceptual design
- Hiring staff
- Creating project office at Fermilab
- Developing management arrangements with collaborating partner labs and universities
- Preparing documentation necessary for CD-1 review (CDR, safety plans, risk assessments, acquisition plans, QA plans, cost and schedule)

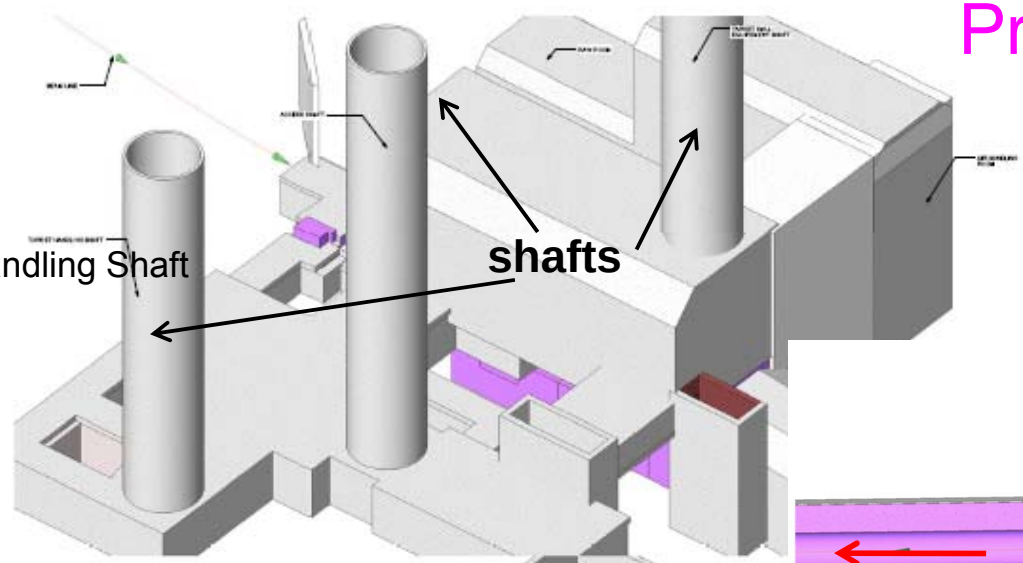
The Neutrino Beam Facility at Fermilab

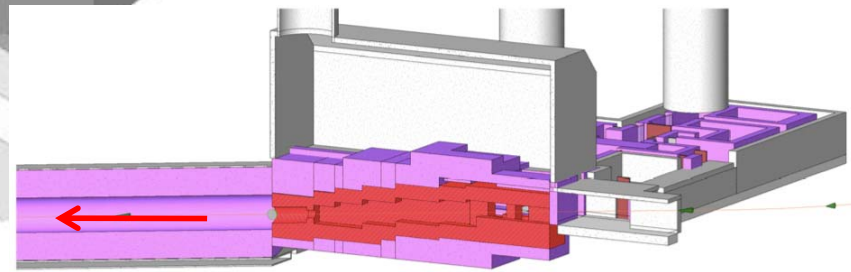
Start with a 700 kW beam, and then take profit of the significantly increased beam power (2.3 MW) available with Project X

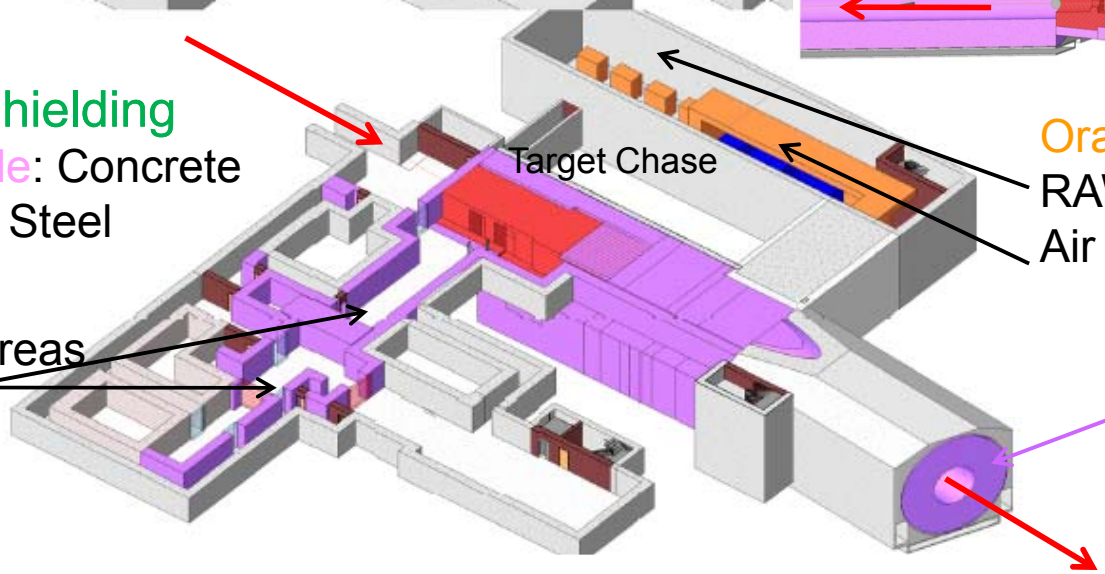
Primary beam energy (protons from the Main Injector) from 60 to 120 GeV

Target Hall Isometric Views

Preparing for ~2 MW







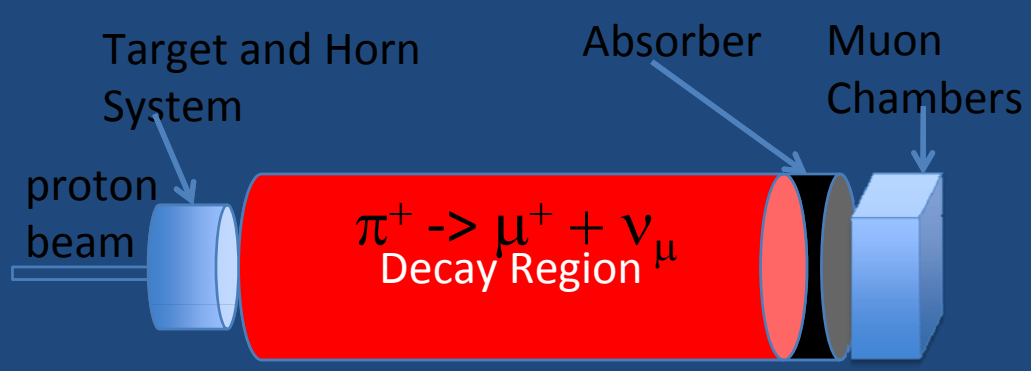
Shielding
Purple: Concrete
Red: Steel

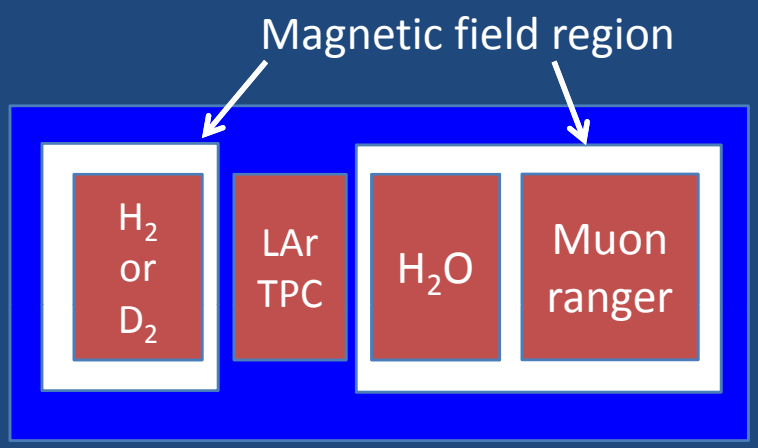
Orange:
RAW Room
Air Handling Room

Work areas

Decay pipe: 2m radius
Decay pipe + minimum concrete shielding: 5.3m radius

Near Detector Complex



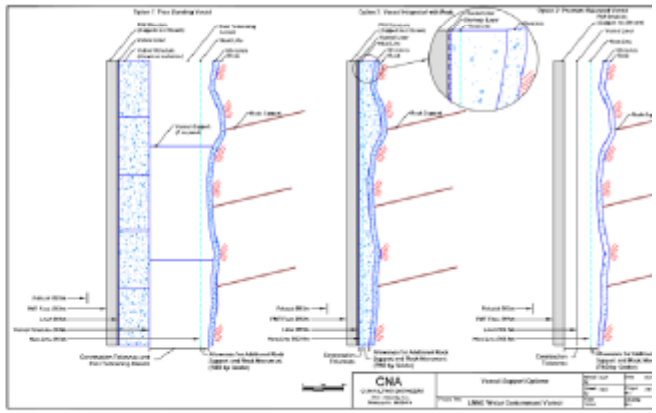


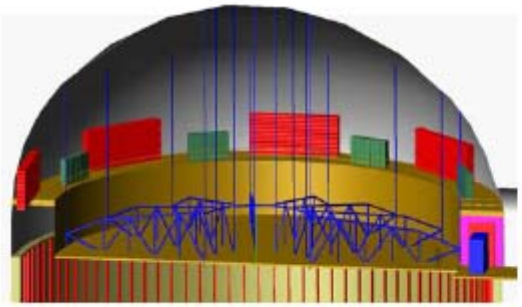
Scope of Work

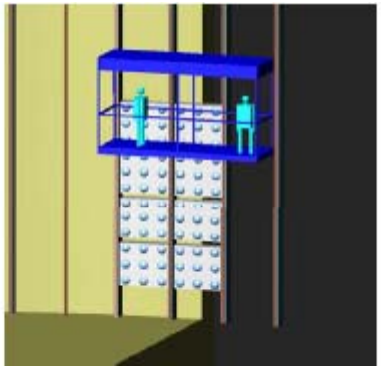
- Design a system of detectors and measurements to maximize the sensitivity of LBNE
  - Post-target hadron flux – extract neutrino flux
    - in-situ
    - external (eg MIPP, HARP, SHINE)
  - Post-absorber muon flux – neutrino flux information, spill-by-spill beam stability
  - Neutrino Hall
    - flux
    - interactions on same nuclear targets as far detector

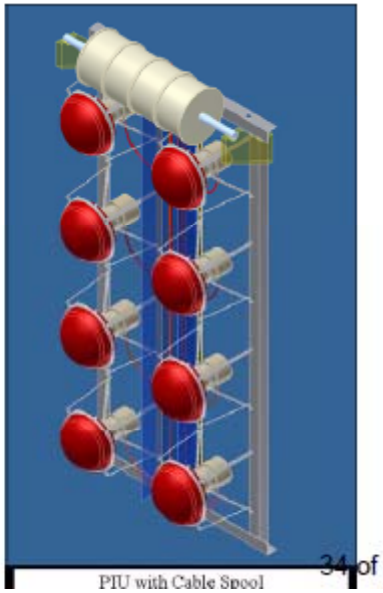
Water Cherenkov Detector

- Vessel: Consortium of A&E companies evaluating vessel options
  - Select primary option March 9-10
  - 4 months to develop design, cost, and schedule for CD-1
- Deck: Three concepts being developed
  - Select primary option in April
  - Need time after vessel option select
- PMT mounting
  - Numerous options
  - Select best and alternate in April
  - Depends on deck decision



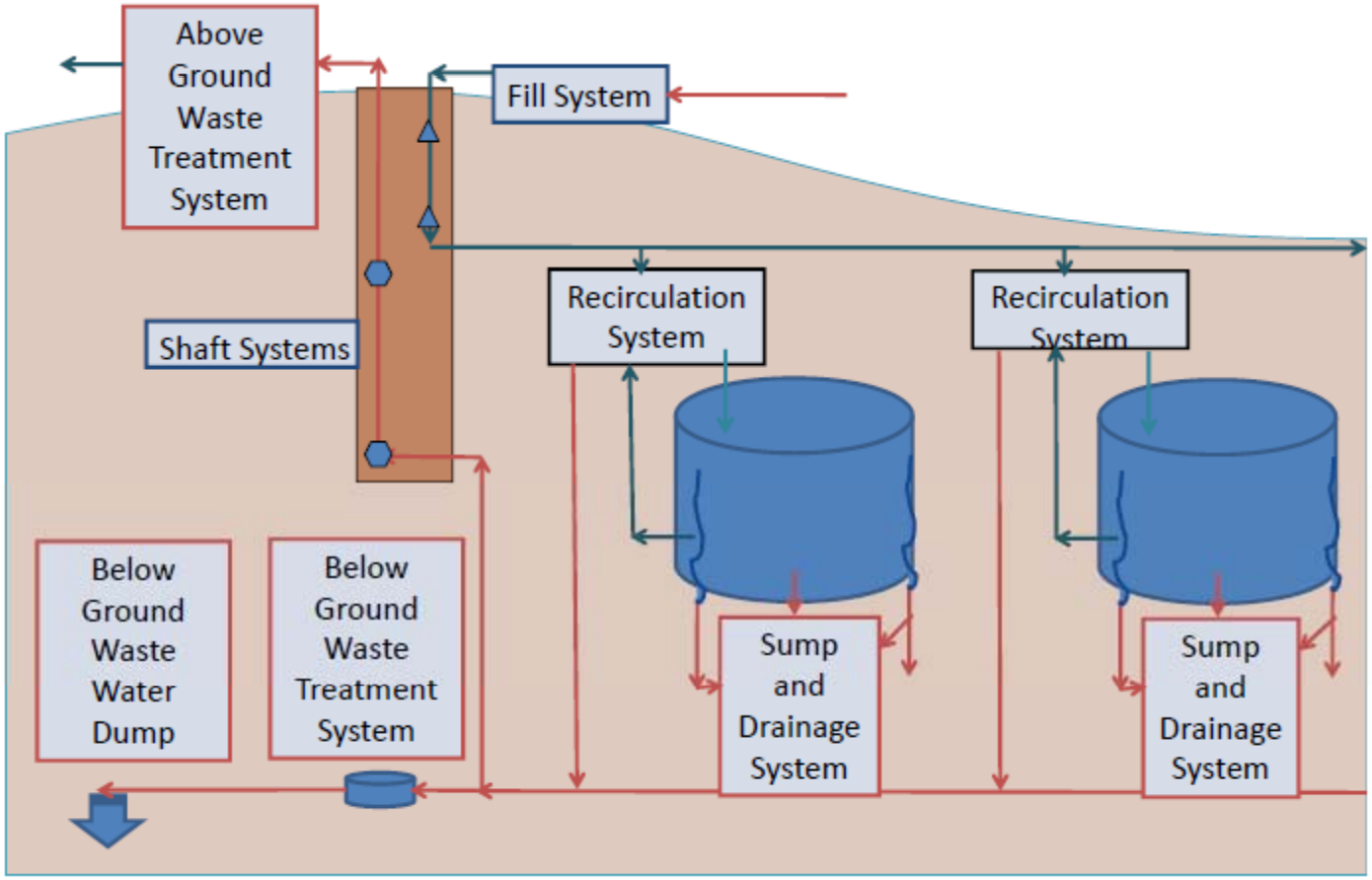






Water Cherenkov Detector

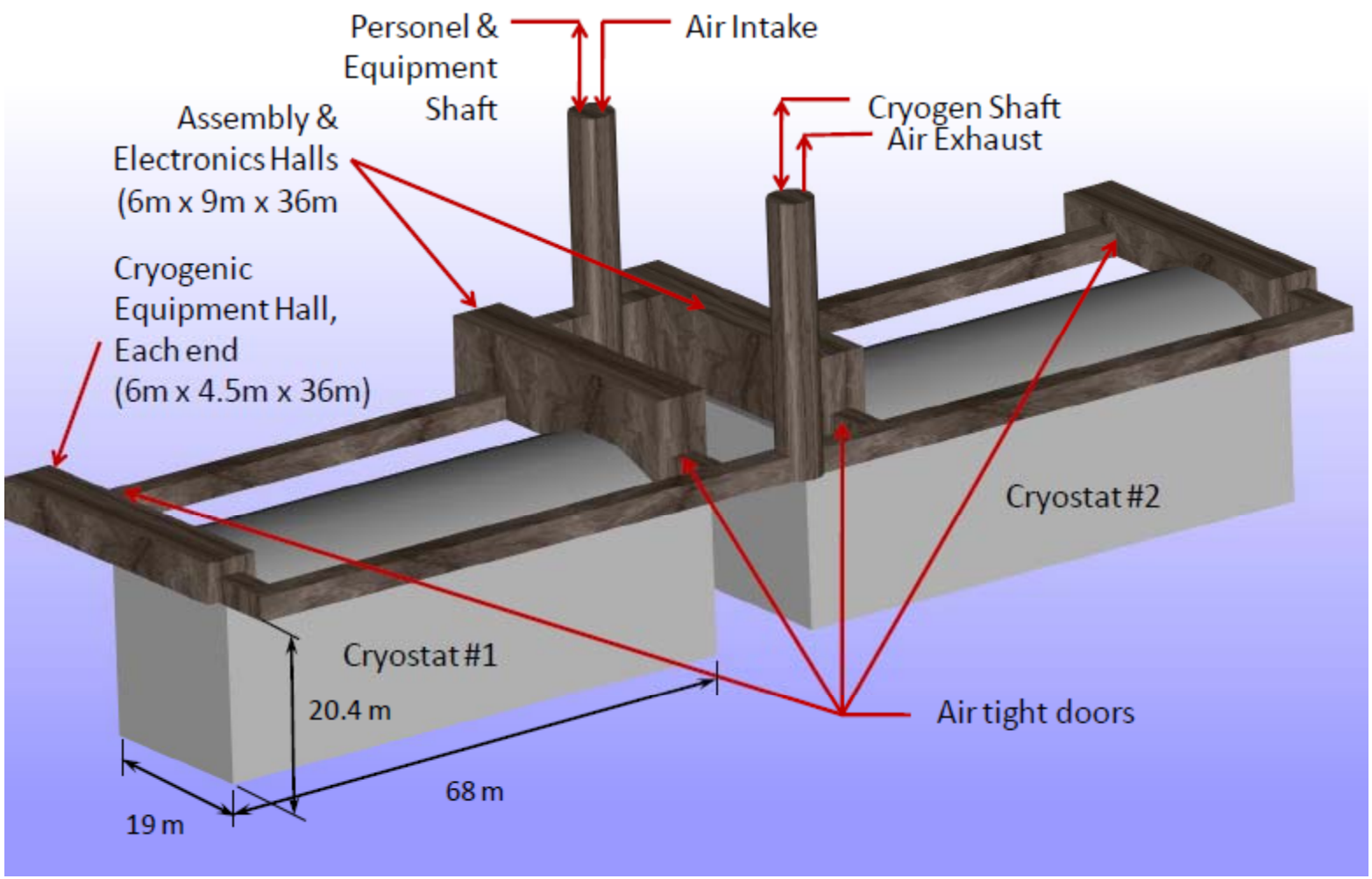
Figure 1: WCD Water Treatment Plant



Liquid Argon Detector

Reference Design 3a

Cryostat Overview

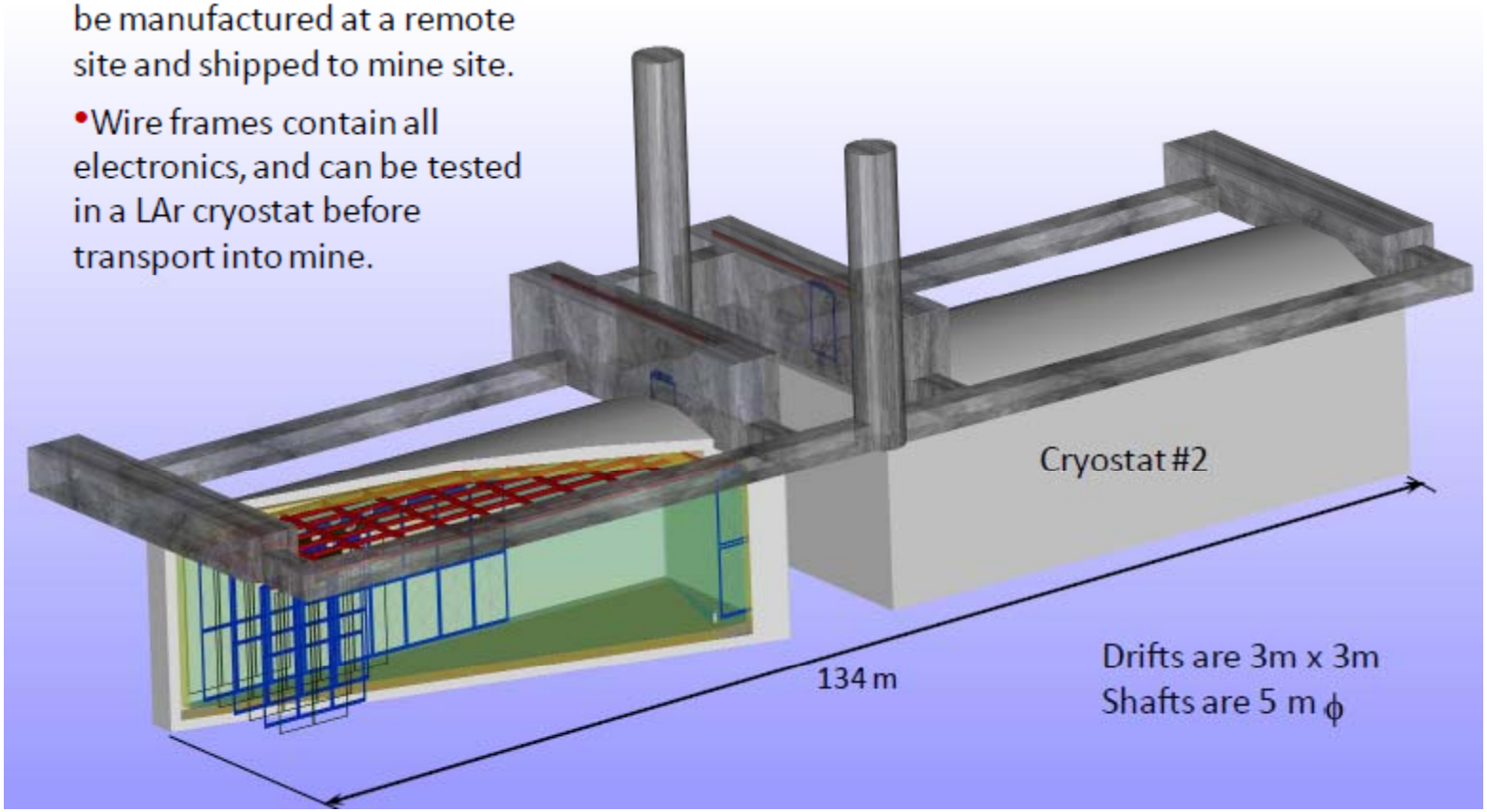


Liquid Argon Detector

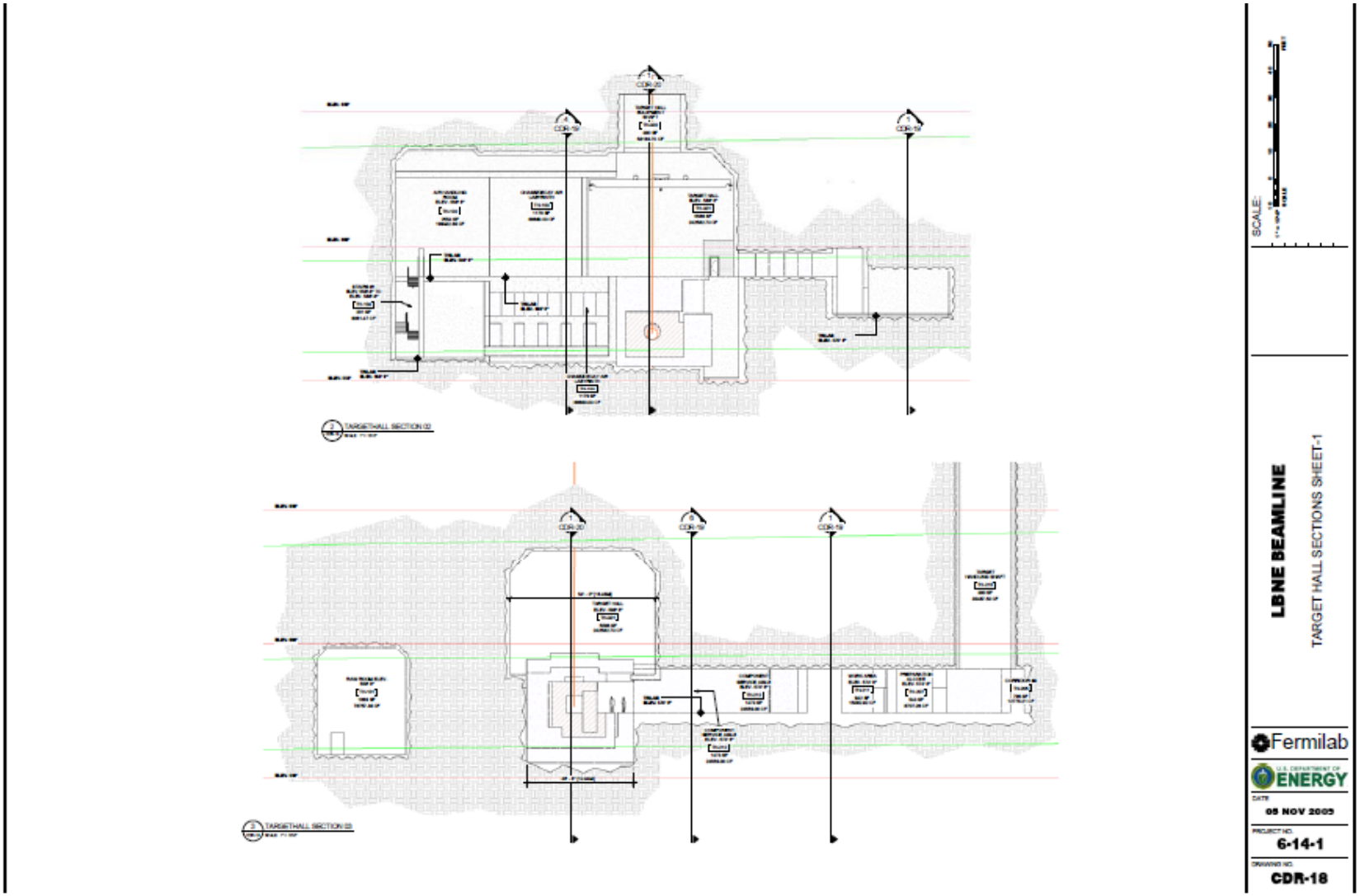
Reference Design 3a

Cryostat #1 cut open to show assembly; drifts and shafts are transparent

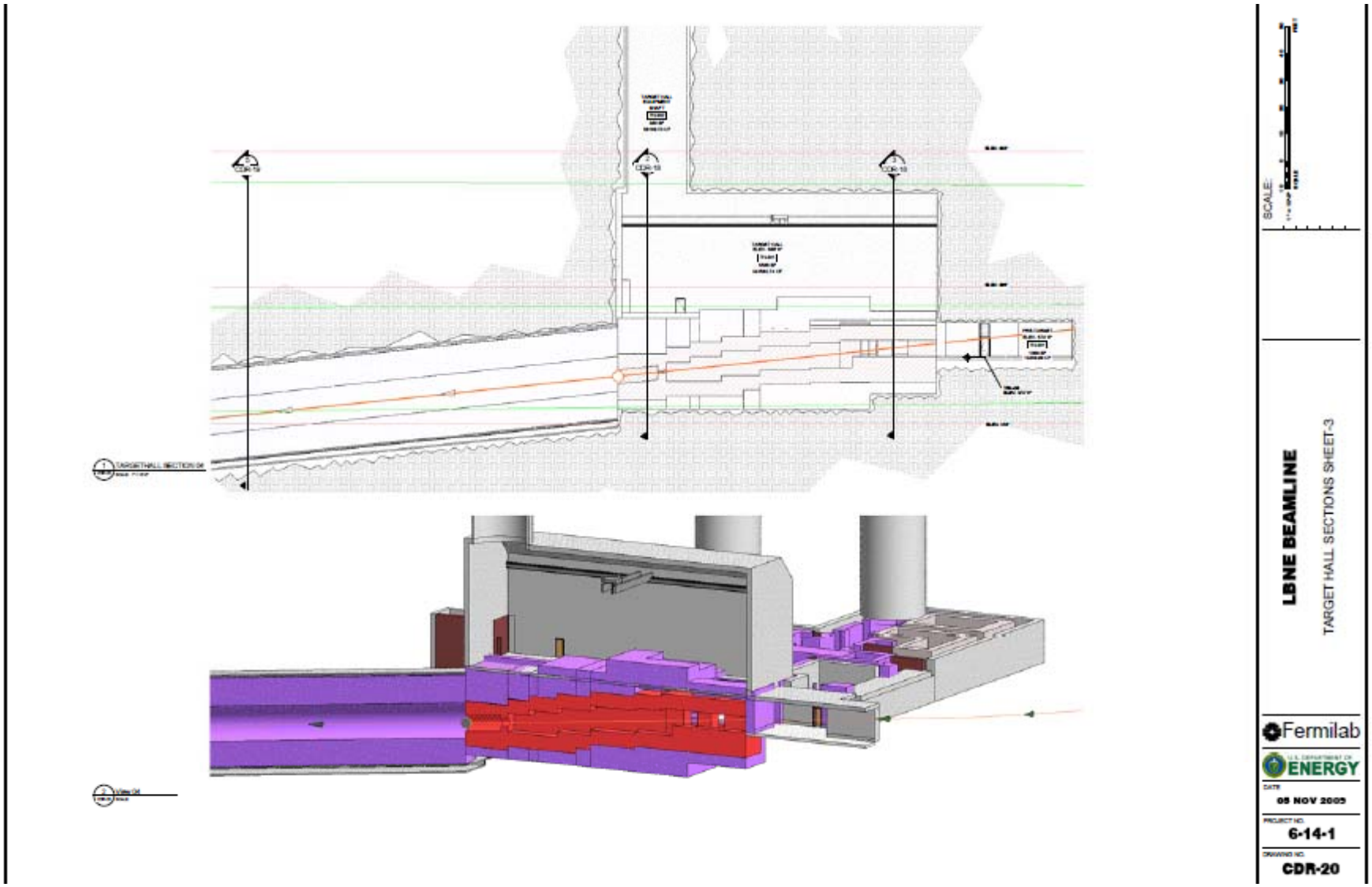
- Cathode and wire frames can be manufactured at a remote site and shipped to mine site.
- Wire frames contain all electronics, and can be tested in a LAr cryostat before transport into mine.



Conventional Facilities at FNAL



Conventional Facilities at FNAL



Conventional Facilities at Far Site

- Must present scope, cost and schedule for WC and LAr facilities in our CDR, cost/schedule for CD-1
- DUSEL information for WC
- Developing information with Jacobs Associates for LAr
- Towards the time of baselining the LBNE Project, will make detector configuration decision to meet mission need of 200 kT WC equivalent detector
  - 2 WC detectors
  - 2 LAr detectors
  - One of each