CDR Status

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Guiding Principles

- Audience
  - Collaboration, DOE, FNAL @ CD1 (Summer 2009)
- Intent
  - State physics goals → physics requirements → technical requirements
  - Describe the spectrum of detectors that might meet the technical requirements
    - Explain why all were rejected except for the detector we are proposing
  - Describe the detector design, aka the "recommended alternative"
    - Explain why the design is optimum (alternatives, optimization, value eng)
    - Describe risks (technical, vendor, cost, schedule)
    - Describe required steps to ensure detector is built properly (QC, QA)
  - Document how we will ensure the project the satisfies federal regulations, DOE orders & FNAL standards
    - Cost, schedule, technical, ES&H, QA, public interests

The CD1 review will go much smoother if the CDR addresses all of these issues

Recent CDR's

- Minerva – 40 pages (6 CDR, 34 Proj)
  - Similar cost to uB, but…
  - TDR was well advanced when CDR was reviewed
- Nova – 210 pages (180 CDR, 30 Proj)
  - $200M cost
  - Outline shown on the next few slides

Table of Contents

Nova

2.1.1 Table of Scientific Performance Requirements

These NOνA goals translate into the scientific performance requirements summarized in Table 2.1. The requirements are developed in this chapter in the sections indicated in the table.

Design Parameter	Scientific Performance Requirement	Section
Distance off-axis	11.5 to 12.0 km	2.4.1
Distance from Fermilab	As far from Fermilab as practically possible.	2.4.2
Experimental Sensitivity	Figure of merit greater than or equal to 30 (The Figure of Merit is defined as the number of ν_e signal events divided by the square root of the background for 32.5 x 10^{20} protons on the NuMI target at the oscillation values $\sin^2(2\theta_{13}) = 0.1$ and $\Delta m^2_{32} = 0.0025$ eV^2 without regard to matter and atmospheric-solar interference effects.)	2.5.1
Energy resolution for ν_e Charged Current events	Less than 8% at 2 GeV	2.5.2
Energy resolution for Quasi-Elastic ν_μ Charged Current events	Less than 4% at 2 GeV	2.5.2
Far Detector overburden	2 meters of rock with density 2.5 g/cm^3	2.6
Near Detector	At least a 20 ton fiducial volume located about 1 kilometer from the NuMI target with sufficient transverse and longitudinal size for neutrino event containment. At least 62 tons if located at 2.5 km from the NuMI target.	2.7

Table 2.1: Summary of the scientific requirements and the chapter sections in which they are established.

Minerva

The primary detector performance requirements are:

- Target mass:
  - 3-6 tons fiducial volume for analyses using the scintillator as a target
  - > 0.5 tons each of graphite, iron and lead (Pb) nuclear targets
- Tracking:
  - ability to efficiently reconstruct up to three final state tracks from charged minimum ionizing particles (μ, π, K, p)
  - ability to efficiently reconstruct a significant fraction of low momentum ($p<1$ GeV/c) proton tracks in quasi-elastic events
  - ability to efficiently locate track vertices with a resolution of ~1 cm in three dimensions and to identify tracks not originating from the primary vertex to identify strange particle decays
  - ability to measure the starting time of tracks to $\lesssim$ 3 ns resolution
- Calorimetry and track energy measurement
  - ability to identify and reconstruct photon (γ) showers for π^0 identification
  - ability to differentiate e/γ/(μ or π)/K/p by track shape or energy deposited
  - ability to contain energy from e/γ showers in the electromagnetic calorimeters
  - ability to contain energy from deep inelastic scattering events in the hadronic calorimeters
- Ability to determine kinematic parameters with the resolutions shown in Table 6-1

Minerva

	muon momentum resolution	muon angular resolution	Stopping muon momentum resolution	Hadron energy resolution	Neutrino energy resolution
Quasi - elastic scattering	$\lesssim$ 20%	Only limits low Q^2 reach	Benefit if $\lesssim$ 5%	$\leq$ 30%/ E	$\leq$ 15% at low energy
Coherent π production	Mild benefit if $\lesssim$ 12%	**$\leq$ 0.5°**	n/a	**$\leq$ 20%/ E**	n/a
Deeply Inelastic Scattering	**$\leq$ 12%**	Mild benefit if $\lesssim$ 0.5°	n/a	< 12% at high y	n/a

Table 6-1 A summary of kinematic requirements from different reactions. MINERvA proposes to study a wide variety of reactions over a wide kinematic range, and different requirements are set by different reactions. The most stringent kinematic requirements are listed in boldface type. n/a means not applicable.

A summary of the Far Detector parameters is given in Table 3.2 and more details of the structure and assembly are in Chapter 16.

Total mass	25,398 metric tons (includes epoxy and fiber)
Mass of rigid PVC extrusions	6,854 metric tons
Mass of liquid scintillator	18,463 metric tons
Liquid scintillator	Mineral oil base with 5% pseudocumene as the scintillant, PPO and bis-MSB waveshifters added.
Active mass fraction	73%
Active height × width	15.7 m × 15.7 m
Active length	111 m
Number of layers	1674 (864 vertical, 810 horizontal) 54 blocks of 31 planes each
Radiation length per layer	~ 0.15
Mass of epoxy between layers	~ 67 tons
Extrusions per layer	12
Extrusion outer wall thickness	3 mm in horizontal cells, 4.5 mm in vertical cells
Extrusion inner web thickness	2 mm in horizontal cells, 3 mm in vertical cells
Extrusion width	1.3 m
Extrusion length	15.7 m
Maximum pressure in vertical cells	19.2 psi
Cells per extrusion	32
Cell interior width × depth, horizontal cells vertical cells	 3.87 cm × 6.00 cm 3.76 cm x 5.70 cm
Total number of cells	642,816
Total number of extrusions	20,088
Wavelength-shifting fiber	0.8 mm diameter double clad fiber with K27 waveshifting dye
Total WLS fiber length	21,624 km
Total WLS fiber mass	13.8 tons
Photodetector	Avalanche Photodiode

Table 3.2: Summary of Far Detector parameters.

Standard format for each sub-system chapter

MicroBooNE Current Outline @ Level 2

Proposal → Bruce

Bonnie

Bruce

Bruce

Brian?

Bonnie

Hucheng? & Leslie?

Cat

Bruce

Suggested Section Editors

Drafting
Conceptual Design Sub-Sections

4.3.Active Detectors

- **4.3.1. Introduction** ← Short description of the technical scope
- **4.3.2. The Recommended Design** ← Add Level 4 headings as necessary (e.g. 4.3.2.1 TPC, 4.3.2.2 Photo Detectors)
- **4.3.3. Alternatives Considered** ← e.g. Use fibers instead of PMT's
- **4.3.4. Optimization** ← e.g. Why 3 mm wire space? Cost/benefit
- **4.3.5. Quality Control & Quality Assurance** ← e.g. control wire spacing uniformity
- **4.3.6. Risks** ← labor cost risk? Single vendor for PMT's
- **4.3.7. ES&H** ← Wire winding repetitive motion injuries?
- **4.3.8. Value Management** ← Wire winding: automatic, semi-automatic, manual

Word Smithing Suggestions

- Use proposal text as a starting point
- If you are unsure of a number or date, use “XX” as a placeholder
- Highlight statements that are currently not supportable (but should be at CD1) in red font and/or use “(?)”
  - Example p7: “Communications and utility connections will be made to existing systems that were installed for MiniBooNE. No upgrades to existing systems are required (?) for MicroBooNE.”
- If you add a sub-section, be sure to use a heading style that matches the outline level
  - Use “Heading Style 4” for 4.3.2.1

Plan

- Each section editor should get a copy of the CDR (DocDB #340) and modify their section (4.1 – 4.6)
- Members of the system group should draft text and submit it to the section editor
- The section manager should
  - Ensure their section is coherent
  - Submit the entire CDR document to Bruce Baller by 8AM April 10
- All sections will be merged into CDR v2 and presented at the next collaboration meeting
  - I can't guarantee that late submittals will be included in v2
- Next Round
  - Internal reviewer (TBA) comments to section editors
    - Comments from everyone in the collaboration are welcome
  - Section editor updates to Bruce by May 18th
  - Present v3 at the May 22 collaboration meeting