SciBooNE (E-954)

Ray Stefanski

Fermilab

A detector that will measure ν interaction cross-sections in anticipation of T2K, and in conjunction with MBooNE.

Outline:

a. Properties of the detector;
b. Scientific imperatives;
c. Institutional responsibilities;
d. Project parameters.

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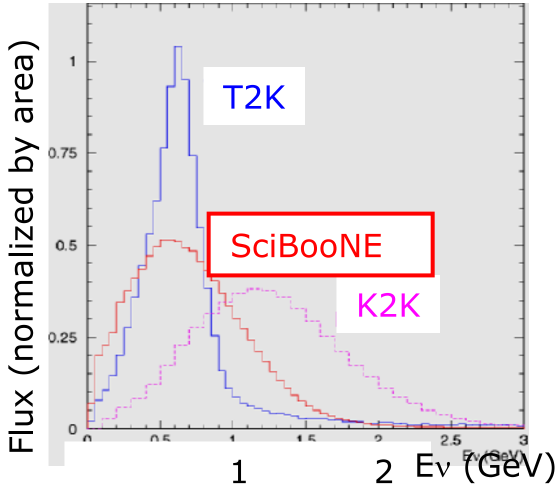
Asia	8
Europe	4
US	6

Some important points associated with SciBooNE:

1. The beam energy is ideally centered around 1 GeV,
2. This project utilizes a pre-existing detector and an operating beamline, which are both well understood and have both demonstrated high quality performance.
3. A measurement of the NC1π^0 cross-section and energy dependence provides an important constraint for T2K misidentification backgrounds. SciBooNE will span an energy range that contains most of the T2K background events. These measurements directly sample the energy region responsible for the bulk of the T2K misidentification background events.
4. The CC1π^+ are also an important source of background that will be constrained by SciBooNE.



$\bar{\nu}_\mu$ Mode 1.5×10^{20} POT	# of ν_μ-bar events (RS)	# of ν_μ events (WS)
CC QE	18,214	7,674
NC elastic	7,410	3,446
CC resonant 1π^-	4,252	0
CC resonant 1π^+	0	4,363
CC coherent 1π^-	2,105	0
CC coherent 1π^+	0	384
NC resonant 1π^0	2,025	1,104
CC multi-π	1,550	2,309
NC resonant 1$\pi^{+/-}$	1,225	738
CC resonant 1π^0	1,097	898
NC coherent 1π^0	1,078	210
NC multi-π	688	823
Total	39,644	21,949

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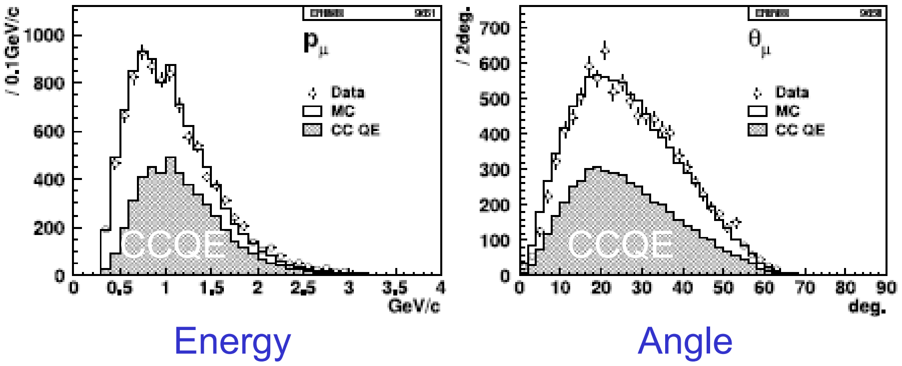
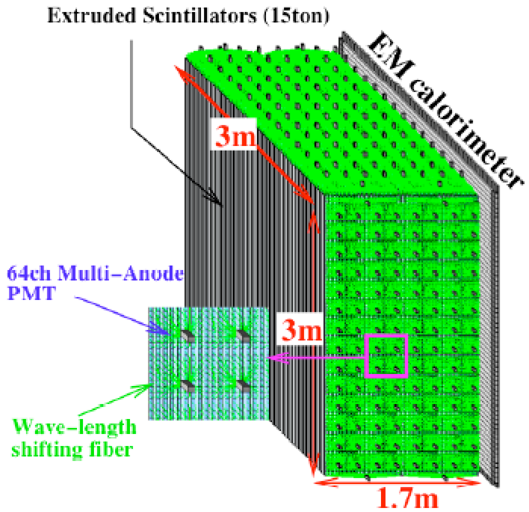
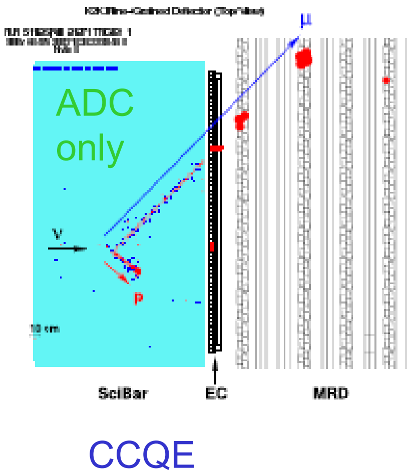
ν_μ Mode 0.5×10^{20} POT	# of ν_μ events
CC QE	32,238
CC resonant 1π^+	14,317
NC elastic	13,976
CC multi-π	4,743
NC resonant 1π^0	3,814
CC resonant 1π^0	3,047
NC resonant 1$\pi^{+/-}$	2,405
NC multi-π	1,650
CC coherent 1π^+	1,466
NC coherent 1π^0	741
Total	78,397

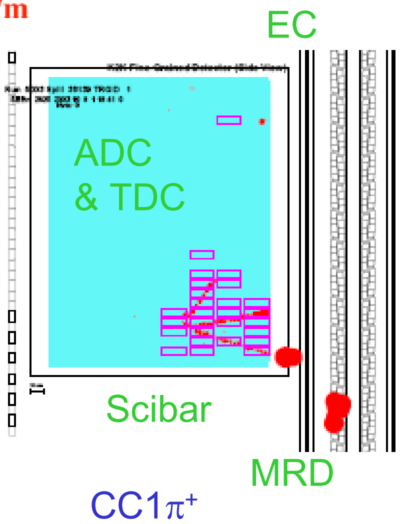
Properties of the detector

Performance compared with MC









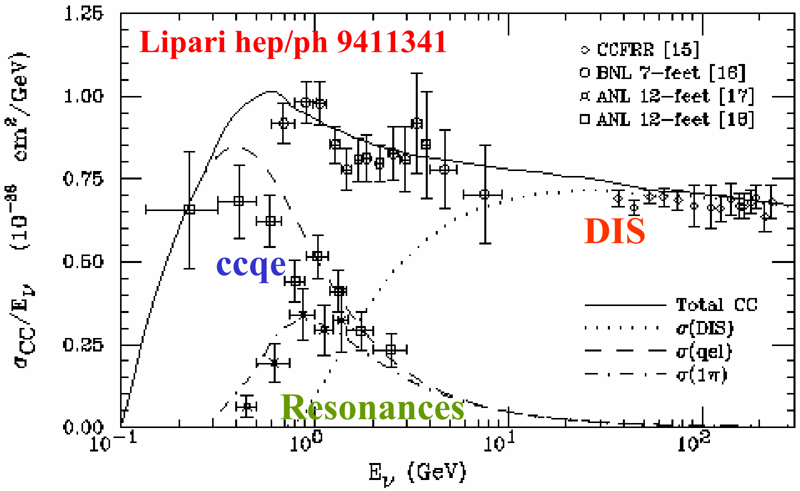
Event displays of typical ν_μ interactions in Scibar at K2K.

Structure	Dimensions	3 m (horizontal), 3 m (vertical), 1.7m (thickness)
	Weight	15 tons
	Number of strips	14,848
	Number of PMTs	224
Scintillator	Material	Polystyrene with PPO(1%) and POPOP(0.03%)
	Size	$2.5 \times 1.3 \times 300$ cm^2
	Coating	0.25 mm (TiO_2)
	Emission wavelength	420 nm (peak)
Fiber	Type	Kuraray Y11(200)MS
	Diameter	1.5 mm
	Refractive index	1.59 (outer)/ 1.50 (middle)/ 1.42 (inner)
	Absorption wavelength	430 nm (peak)
	Emission wavelength	476 nm (peak)
	Attenuation length	350 cm
PMT	Model	Hamamatsu H8804
	Cathode material	Bialkali
	Anode	8×8 (2×2 mm^2/pixel)
	Quantum efficiency	12% for 500 nm photons
	Typical gain	6×10^5 at $\sim$ 800 V
	Response linearity	200 PE at gain of 6×10^5
	Cross talk	4% (adjacent pixel)
DAQ	VA/TA ASIC	IDEAS VA32HDR11 and TA32CG
	Shaping time	1.2 μsec (VA), 80 ns (TA)
	Noise	0.3 PE
	Response linearity	5% at 300 PE
	TDC resolution	0.78 ns
	TDC full range	50 μsec

Scientific imperatives

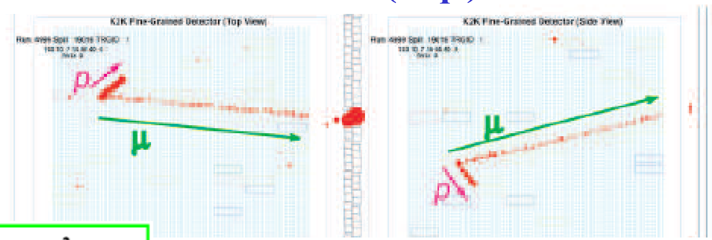
There are three types of neutrino interactions at energies below 4 GeV.

$$\sigma^{CC}_{\nu\bar{\nu}} = \sigma_{CCQE} + \sigma_{1\pi} + \sigma_{DIS}$$



QUASI-ELASTIC INTERACTIONS (ccqe)

ν energy can be reconstructed In CCQE events.



$$E_{\nu}^{rec} = \frac{m_N E_{\mu} - m_{\mu}^2/2}{m_N - E_{\mu} + p_{\mu}\cos\theta_{\mu}}$$

SciBar at K2K

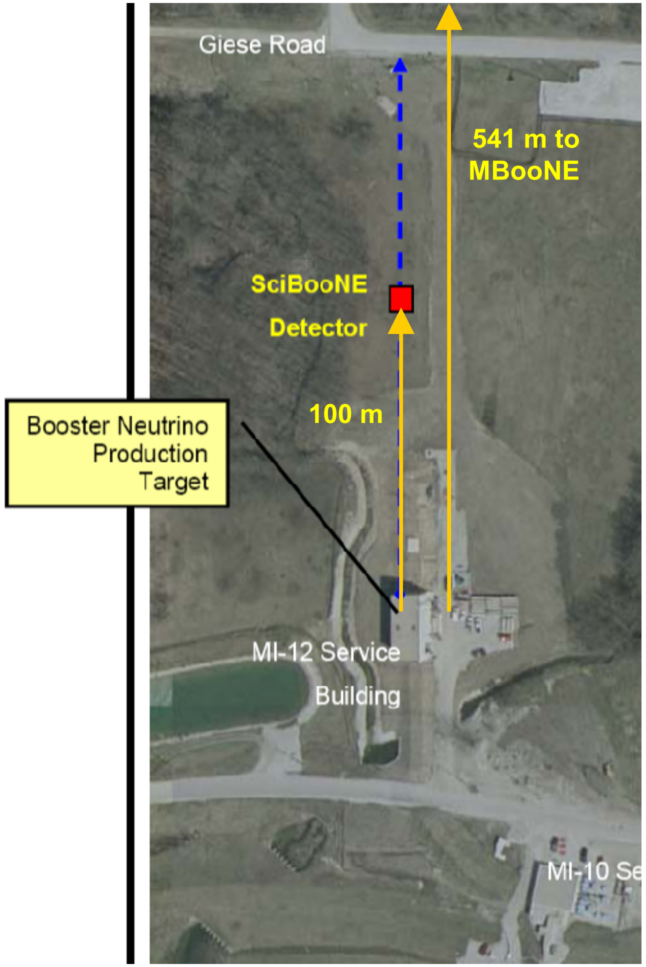
RESONANCES: In 1970, Feynman, Kislinger, and Ravndal published the first attempt to calculate transition rates for ~100 of the then known resonances. In 1980, Rein and Sehgal published a model based on their work. Their model successfully accounts for single pion production mediated by all interfering resonances below 2GeV.

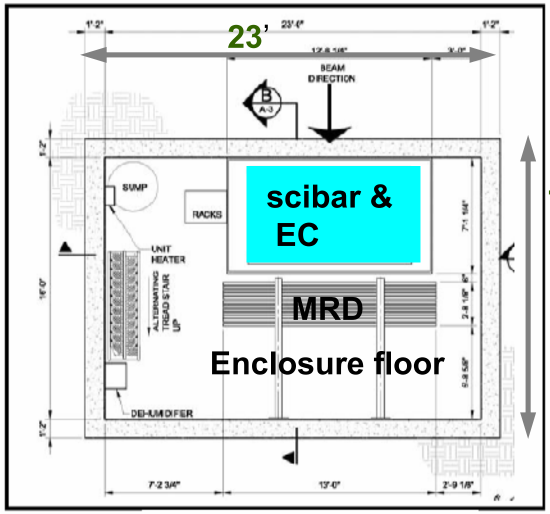
Deep Inelastic Scattering (DIS)

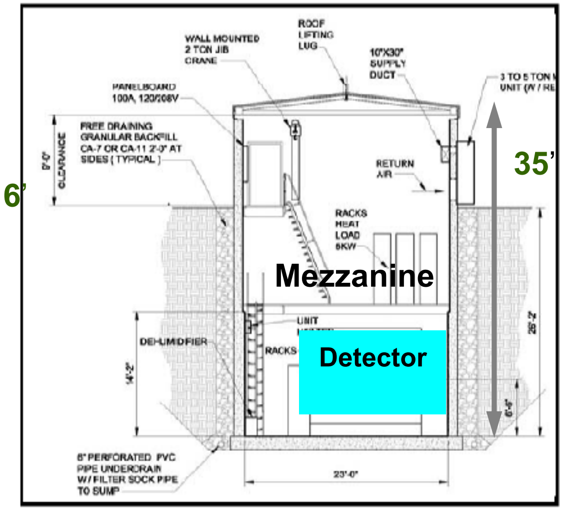
"Modeling Deep Inelastic Cross Sections In the Few GeV Region" by A.Bodek and U. K. Yang "good modeling of neutrino cross-sections at low energies is needed to resolve the atmospheric $\nu_\mu \rightarrow \nu_\tau$ issue, and even more important for future oscillation experiments." Measurement of θ_{13} and further understanding of the LSND effect will require precise Knowledge of neutrino interactions in complex nuclei.

It cannot be overemphasized that future oscillation experiments will require a precise understanding of neutrino cross-sections. The atmospheric and solar oscillation experiments had the benefit of working with mixing matrix parameters ($\sin^2(2\theta)$) nearly equal to 1. θ_{13} and LSND are small effects, and require much more careful analysis of backgrounds and systematic effects. Current models are not sufficiently constrained by data.

Scibar – Location in the BNB





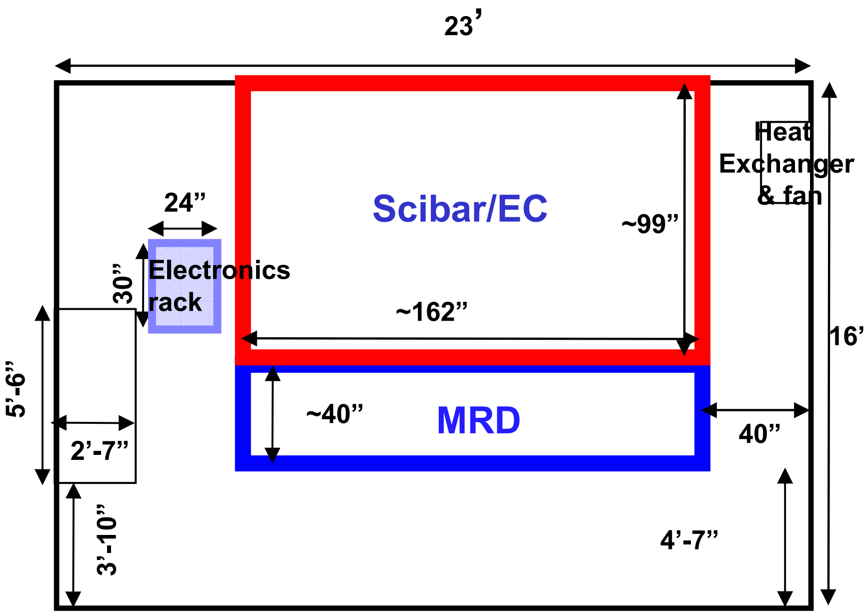


The civil design has passed the 90% review stage. Documents are being prepared in support of the request for plant funds, including a Conceptual Design Report, and Project Execution Plan.

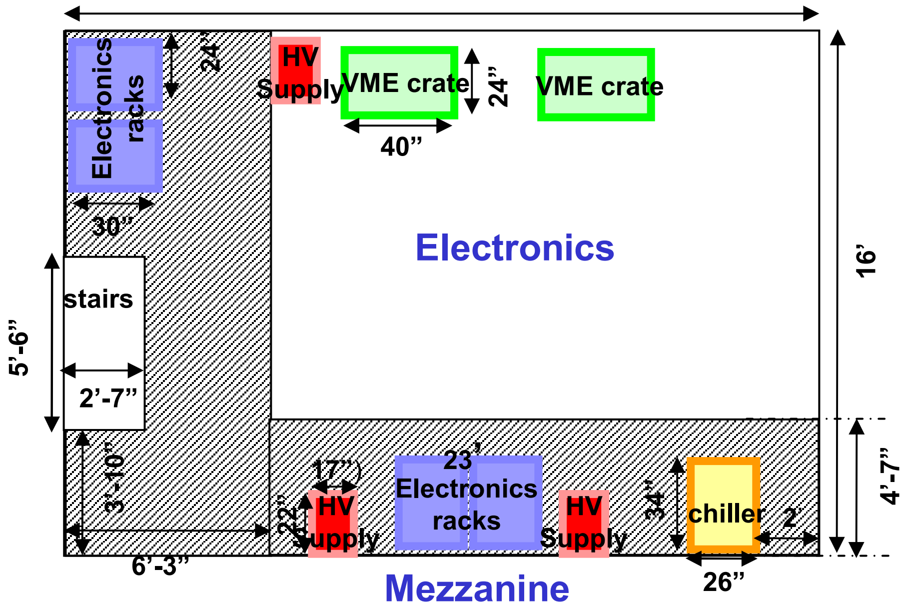
The enclosure design was closely coordinated between the civil engineers, representatives of the experiment, and PPD mechanical engineers.

Safety constraints were reviewed by the FESS, PPD and AD safety groups, as well as the Lab ES&H section.

SciBooNE – Location in the Enclosure



Enclosure Floor



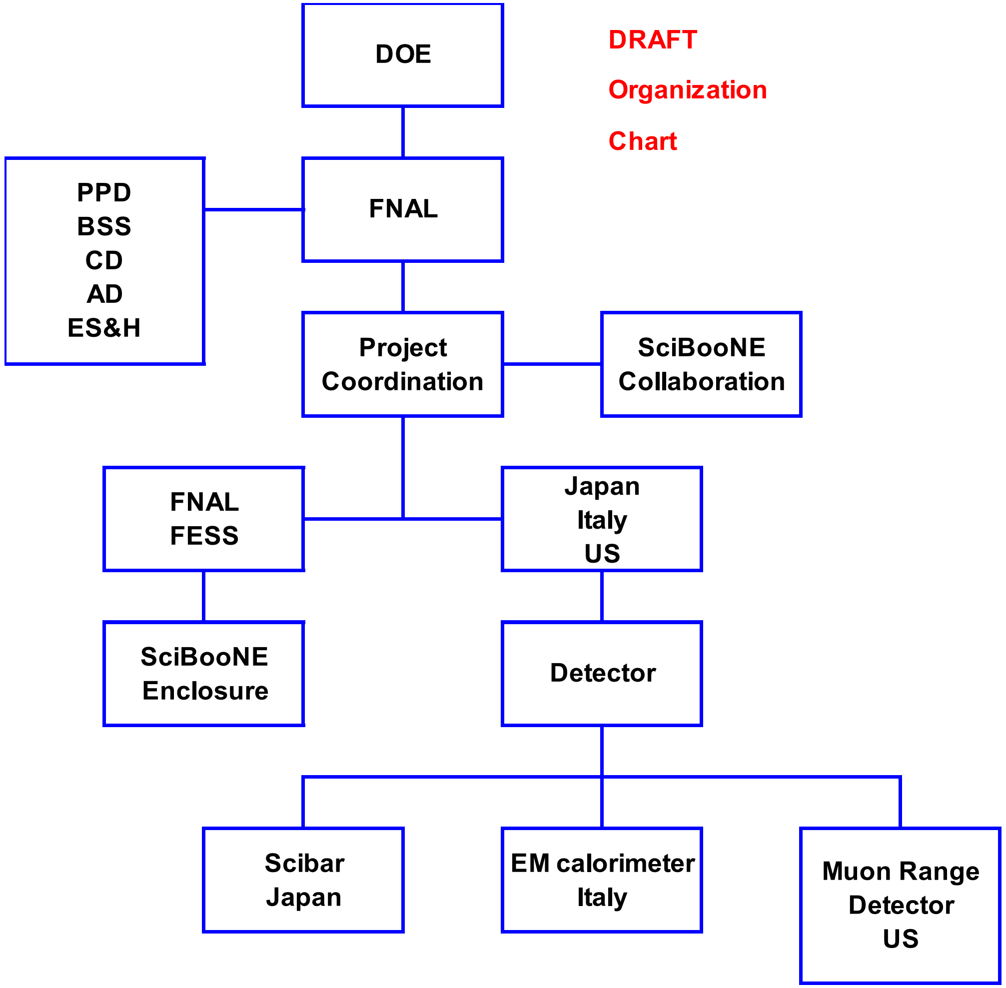
Mezzanine

- The concept is to maximize utility with minimal space.
- Scibar and the EC are loaded into the enclosure as a unit.
- The MRD is built in situ.
- Scibar and the EC will be rebuilt at the B0 Assembly Building.
- The detectors will be mounted on a truck mobile platform.
- A rented mobile crane will lower the platforms into the enclosure.
- The platform load is ~15T.

Institutional responsibilities

Project parameters

Stage I approval given on Dec. 14, 2005



SciBooNE Enclosure:
Civil Costs $689,000
Duration < 9 months.
Start (anticipated) Summer 2006

SciBooNE Detector
Duration < 9 months.
Start (anticipated) May 2006

Costs		
SB & EC shipping	$78K	Japan
MRD	$91k	FNAL
SB & EC frames	$98K	Japan
Installation	$60K	Japan
Total	$327K	
Japan	$236K	
FNAL	$91K	

SciBooNE Computing
Working with CD on the details of data routing from the detector. Plan to make use of existing facilities: Such as Enstore, and the Computing Farms.

Conclusions:

- The science is imperative. It needs to be done.
  - BNB is ideal for T2K, and MiniBooNE.
  - Future oscillation experiments will require a precise understanding of ν cross-sections
- The detectors are available, waiting for shipment & assembly.
  - Funds are provided within the US-Japan agreement.
  - Communication with Fermi-DOE have begun
- The organizational structure and methodology are nearly understood.
  - Several PPD review meetings have been held.
  - An Draft MOU exists between Fermilab and SciBooNE
  - Safety issues have been resolved with PPD and AD safety groups

- **The details are falling into place, and we're ready to go!**