SciBar Detector for SciBooNE

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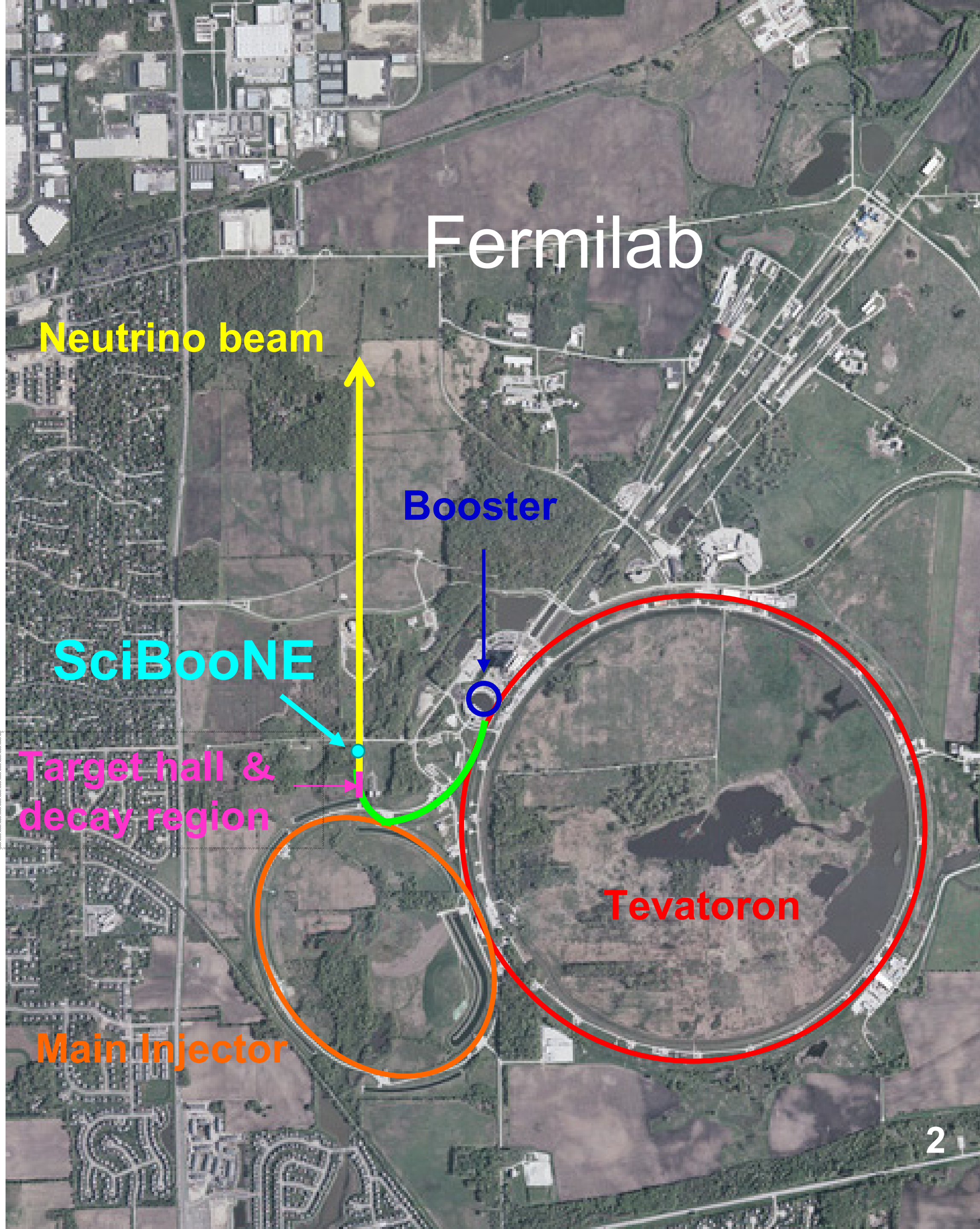
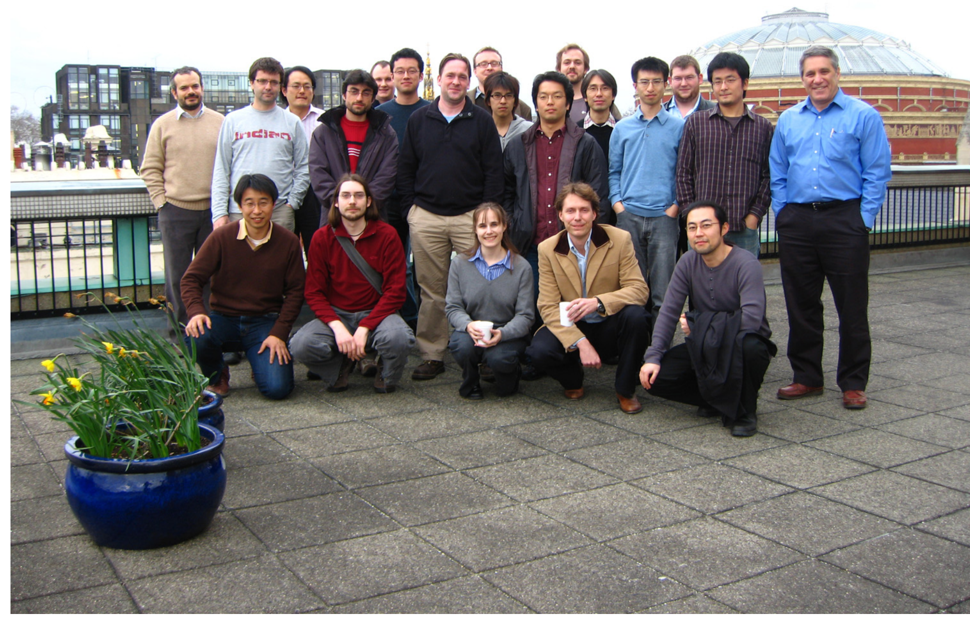


SciBooNE Collaboration

- Universitat Autonoma de Barcelona
- University of Cincinnati
- University of Colorado, Boulder
- Columbia University
- Fermi National Accelerator Laboratory
- High Energy Accelerator Research Organization (KEK)
- Imperial College London
- Indiana University
- Institute for Cosmic Ray Research (ICRR)
- Kyoto University
- Los Alamos National Laboratory
- Louisiana State University
- Purdue University Calumet
- Universita degli Studi di Roma "La Sapienza"
- Saint Mary's University of Minnesota
- Tokyo Institute of Technology
- Unversidad de Valencia

5 countries 17 institutions

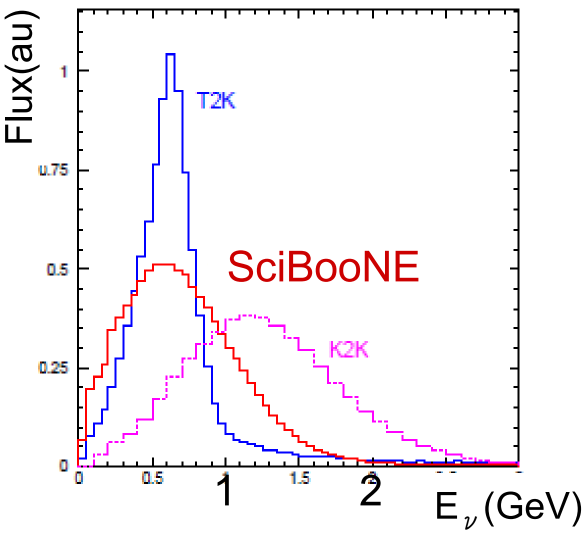
SciBooNE



Spokespeople:

T. Nakaya (Kyoto), M.O. Wascko (Imperial)

Motivation of SciBooNE

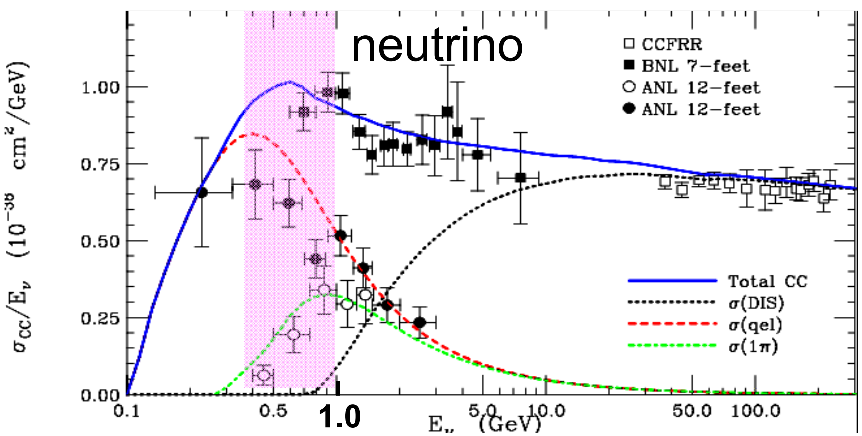


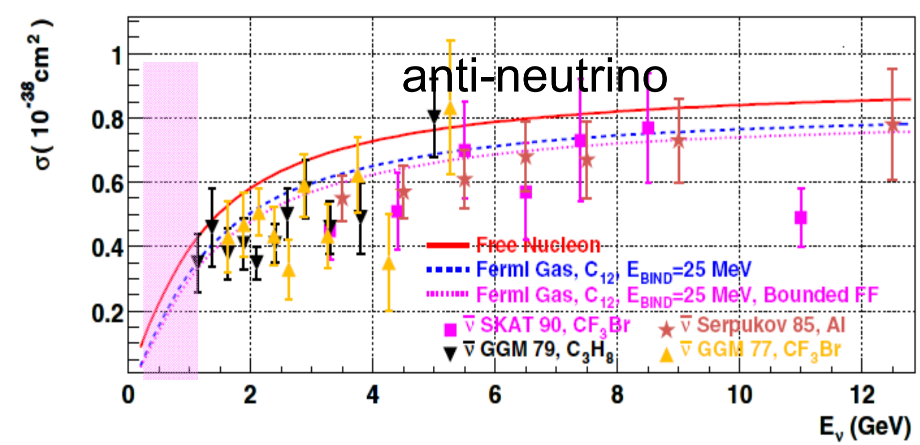
- precise measurment of neutrino-nucleus scattering cross section

- study unexplored physics territory of anti-neutrino

- Precise information is essential for neutrino oscillation measurements.

experimental data

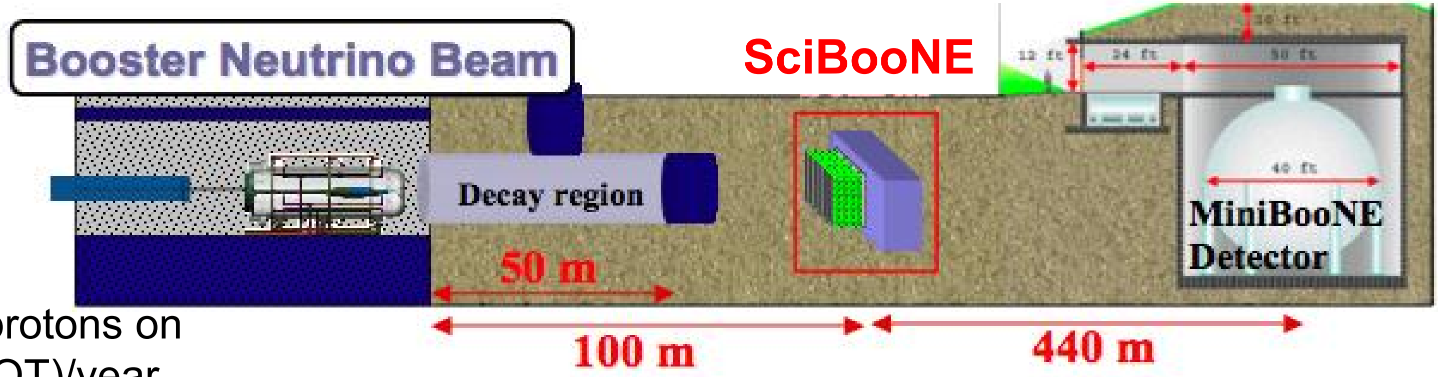




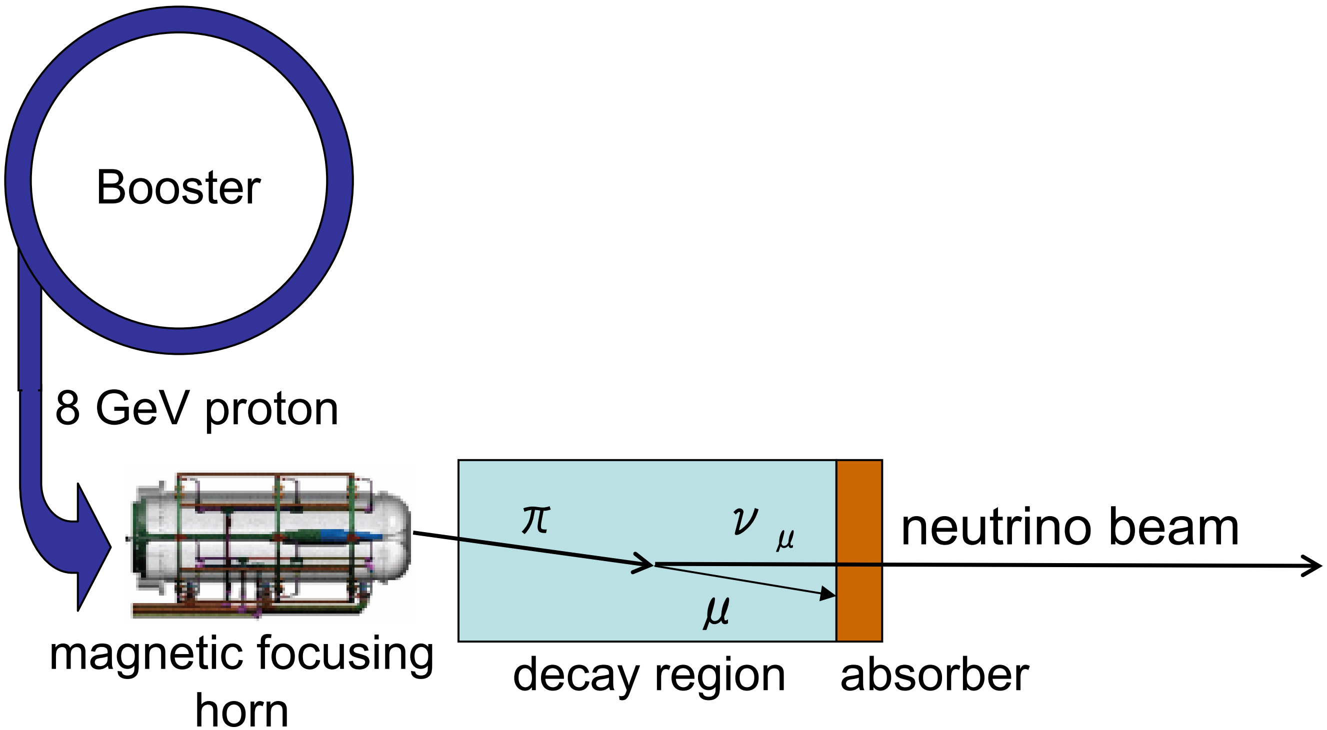
- low statistics in E_ν<1.0 GeV region
- large uncertainties

-no experimental data published in E_ν<1.0 GeV region

Experimental Setup



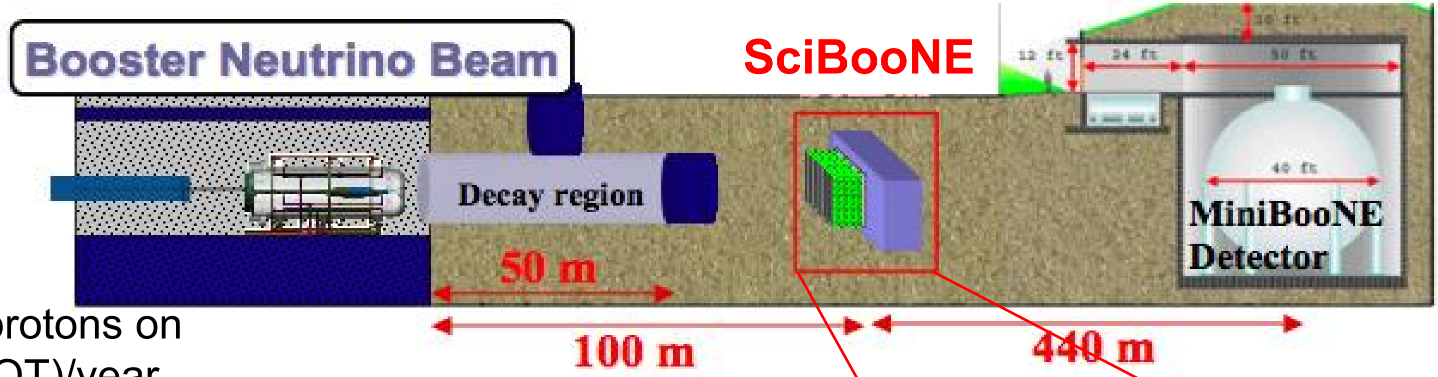
2×10^{20} protons on target (POT)/year



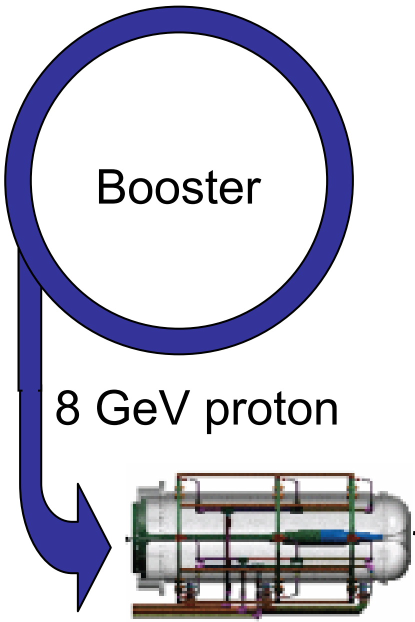
-Protons hit target in horn and produce mesons.

-Focused mesons decay into leptons and neutrinos

Experimental Setup



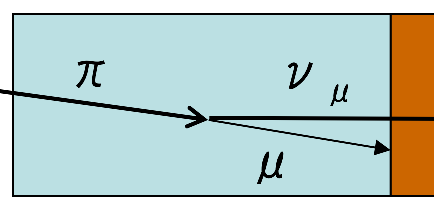
2×10^{20} protons on target (POT)/year



8 GeV proton

magnetic focusing horn

-Protons hit target in horn and produce mesons.



decay region

absorber

-Focused mesons decay into leptons and neutrinos

neutrino beam

EM Calorimeter (EC)

-identify electron

SciBar

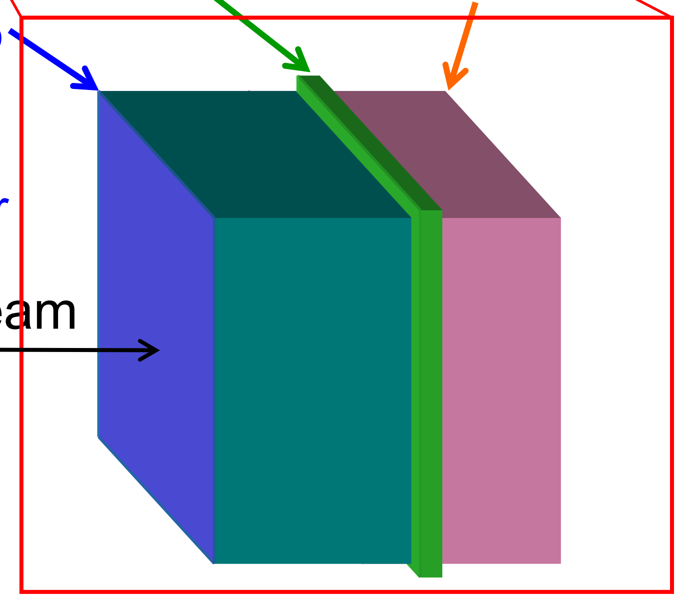
-fully active neutrino target from K2K

-tracking & calorimetric detector

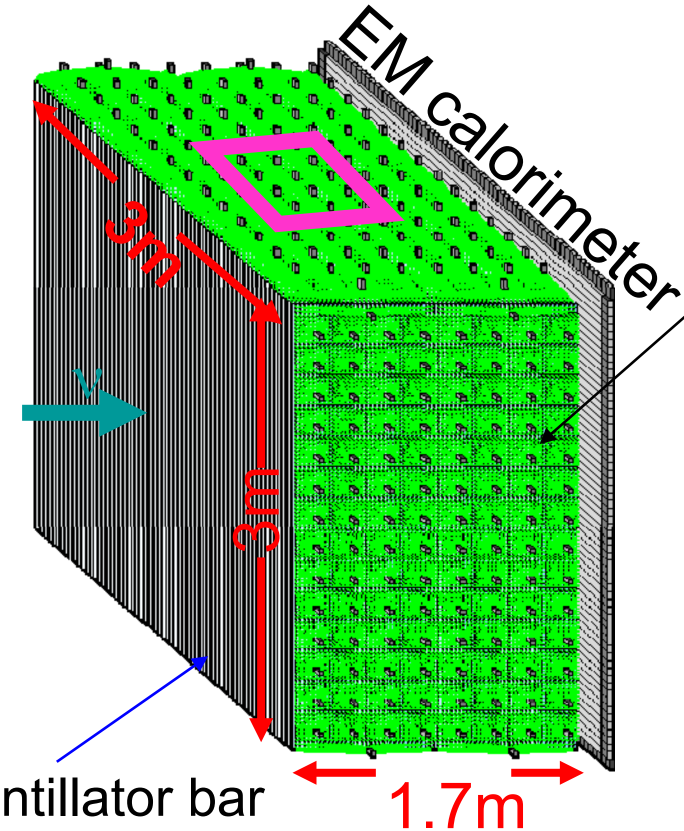
Muon Range Detector (MRD)

-identify muon

-reconstruct momentum

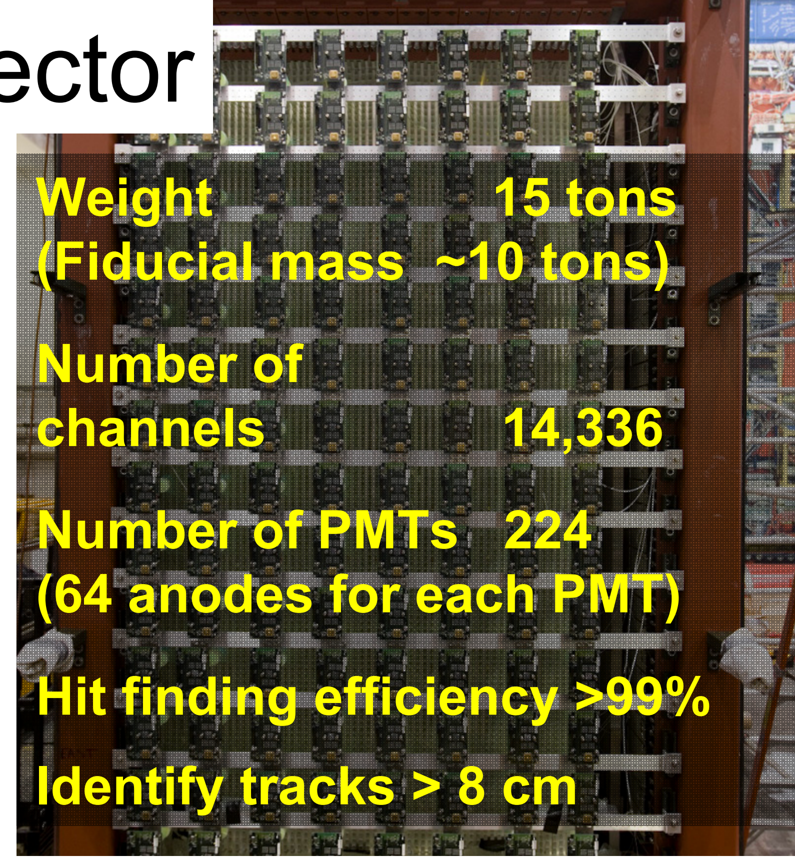


SciBar Detector

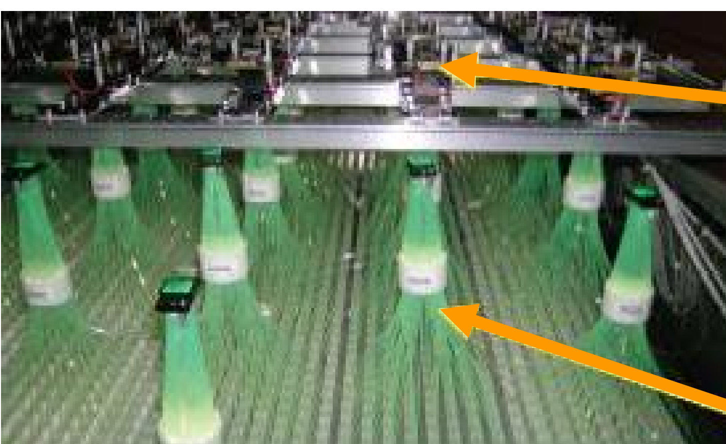


multi-anode PMT & wavelength shifting fiber

scintillator bar

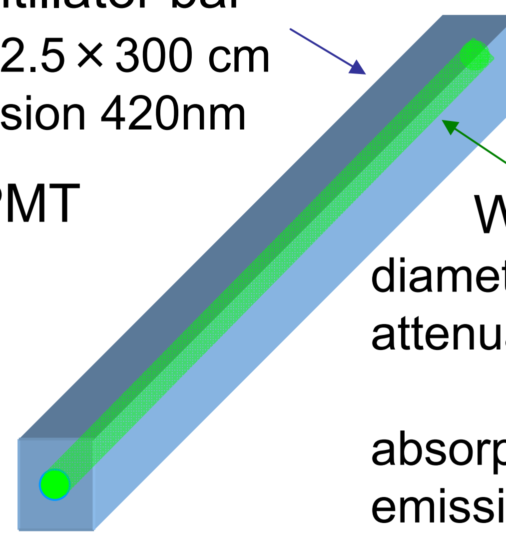


scintillator bar
1.3 × 2.5 × 300 cm
emission 420nm



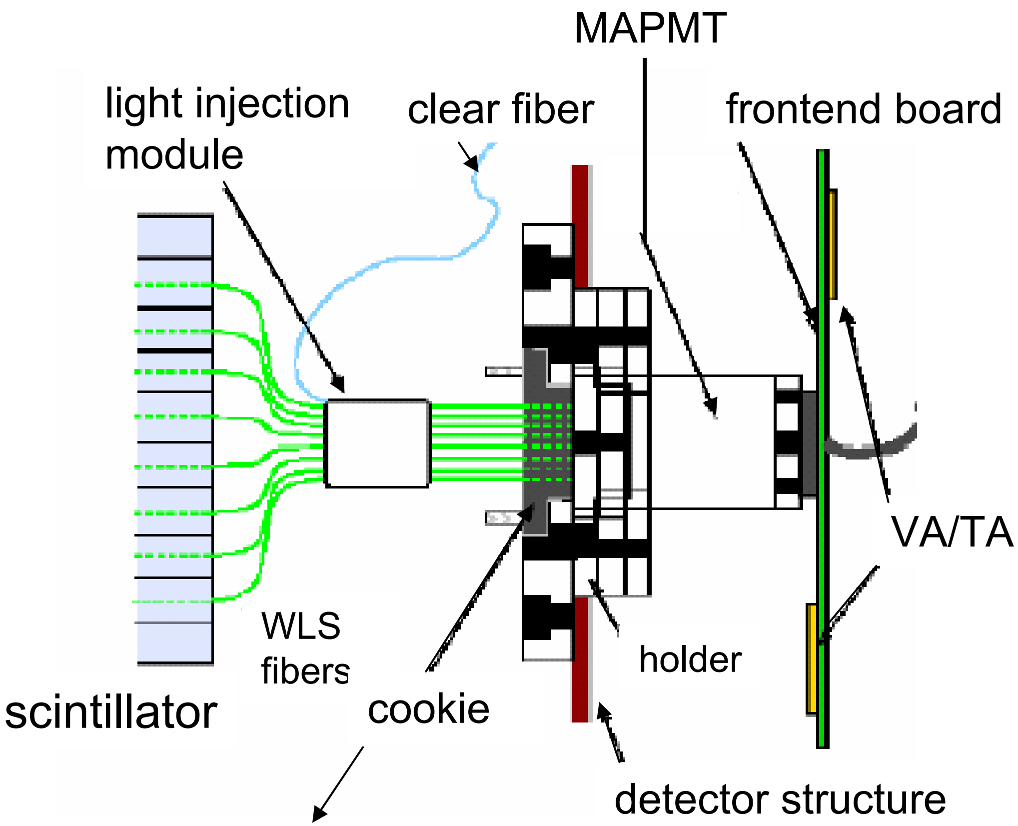
multi-anode PMT

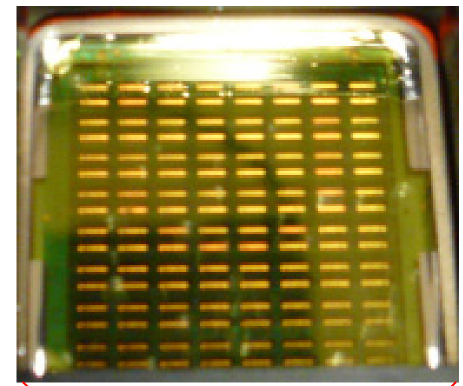
wavelength shifting fiber (WLS fiber)

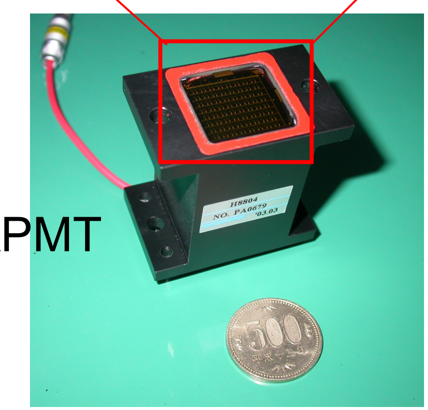


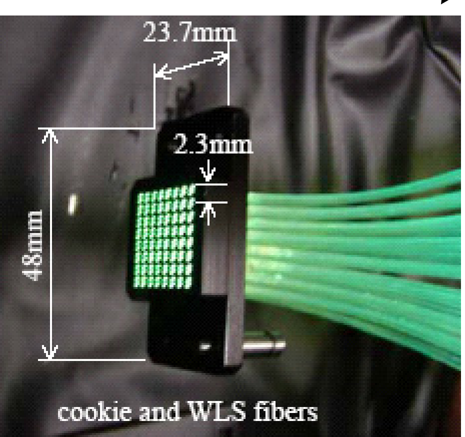
WLS fiber
diameter: 1.5mm
attenuation length: ~3.5m
absorption: 430nm
emission: 476nm

SciBar Readout









VA/TA
- serialize charge from 32 channels of MAPMT
- timing information (32 channels OR)

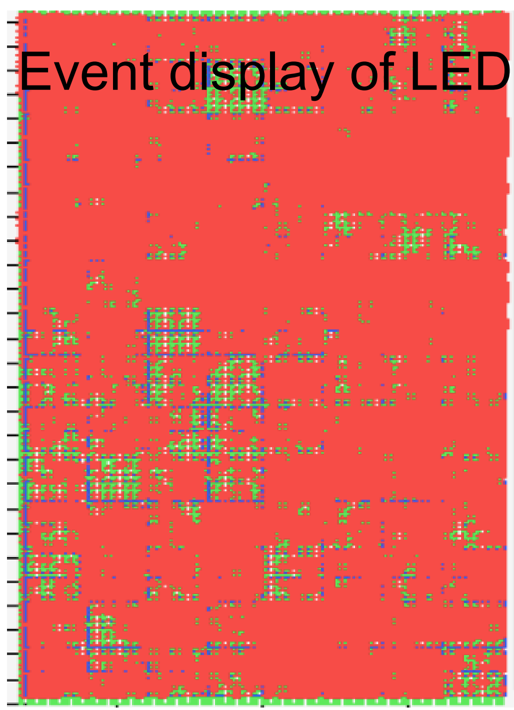
64ch Multi Anode PMT (MAPMT)	
pixel area	2x2 mm^2
typical gain	6x10^5
linearity	~200 p.e.
gain uniformity	20% RMS
crosstalk	~3.5%

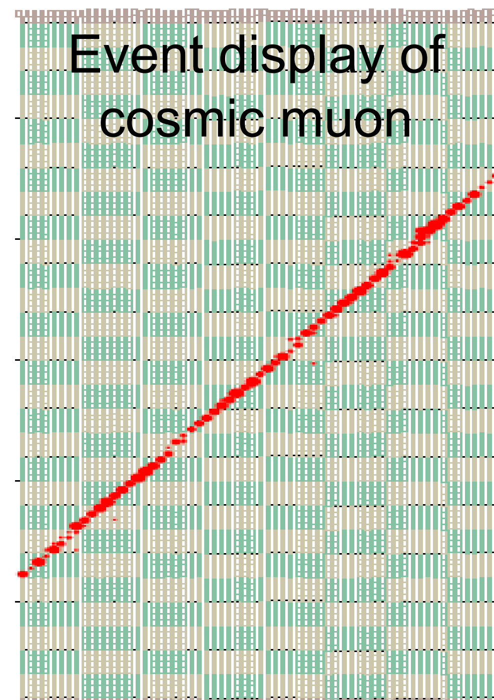
Monitoring of SciBar

-Pedestal, cosmic and gain monitor (LED) trigger are taken between beam spills.

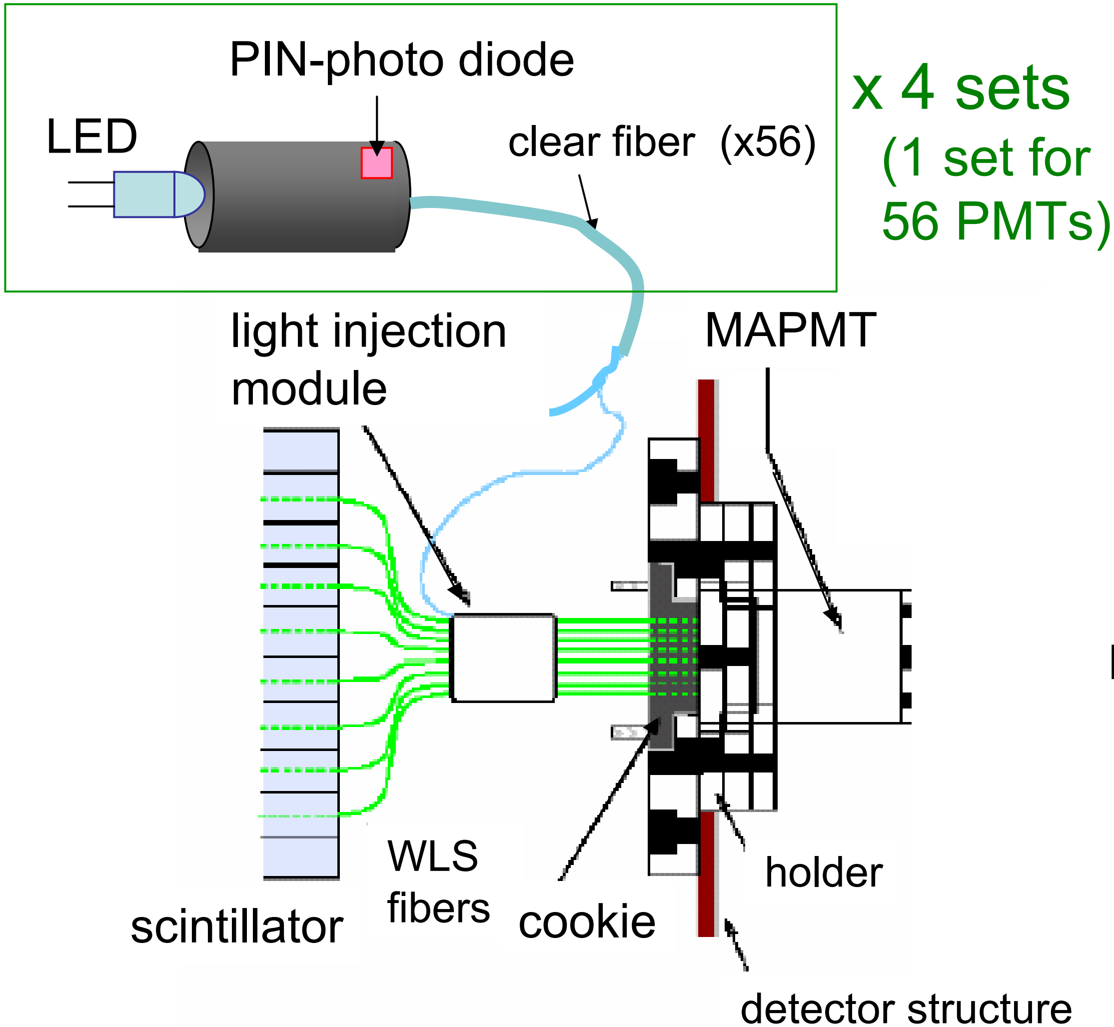
-Pedestal and gain are continuously monitored for every channel (14,336ch in total).

● hit (area proportional to charge)

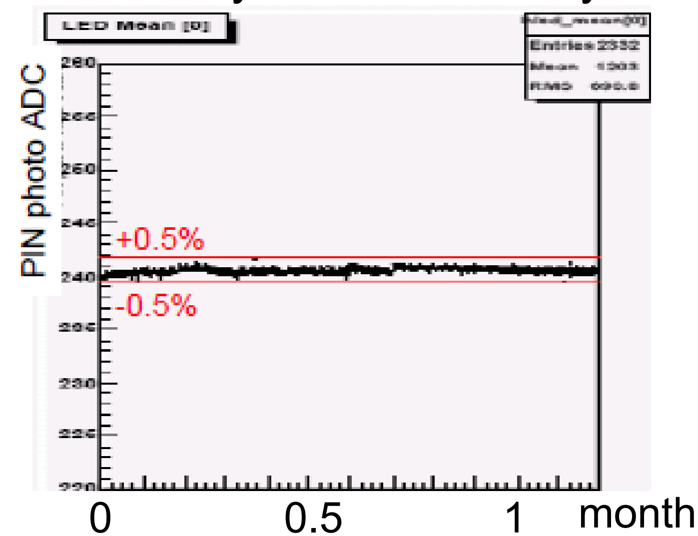




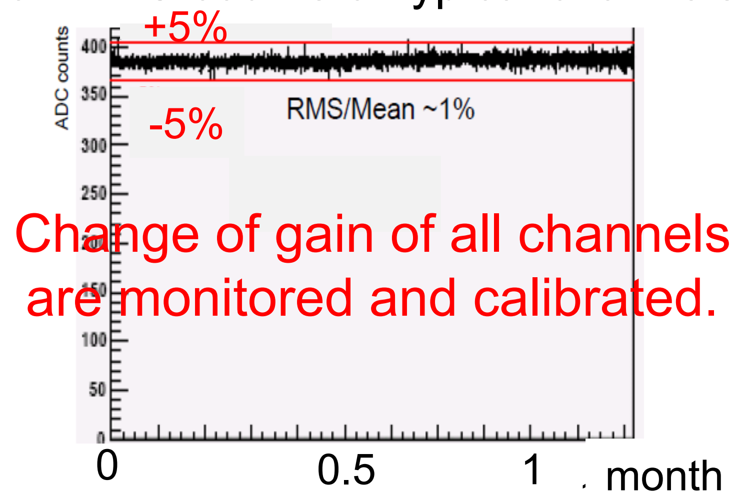
Gain Monitor



stability of LED intensity

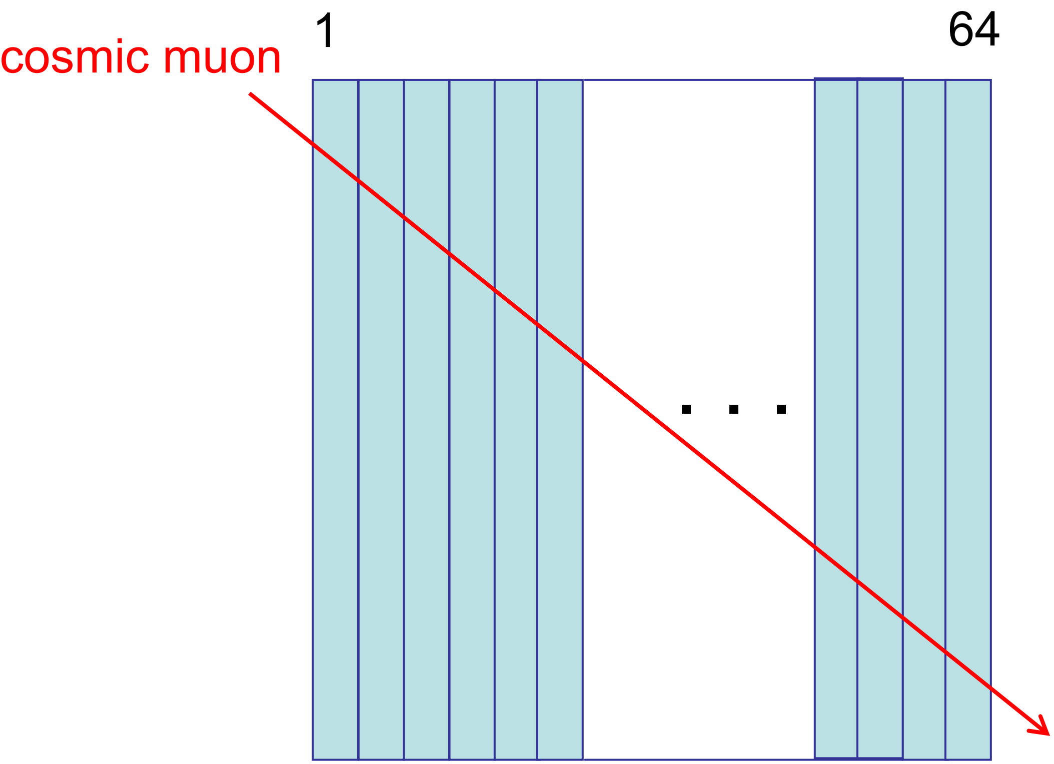


Mean ADC counts of typical channels

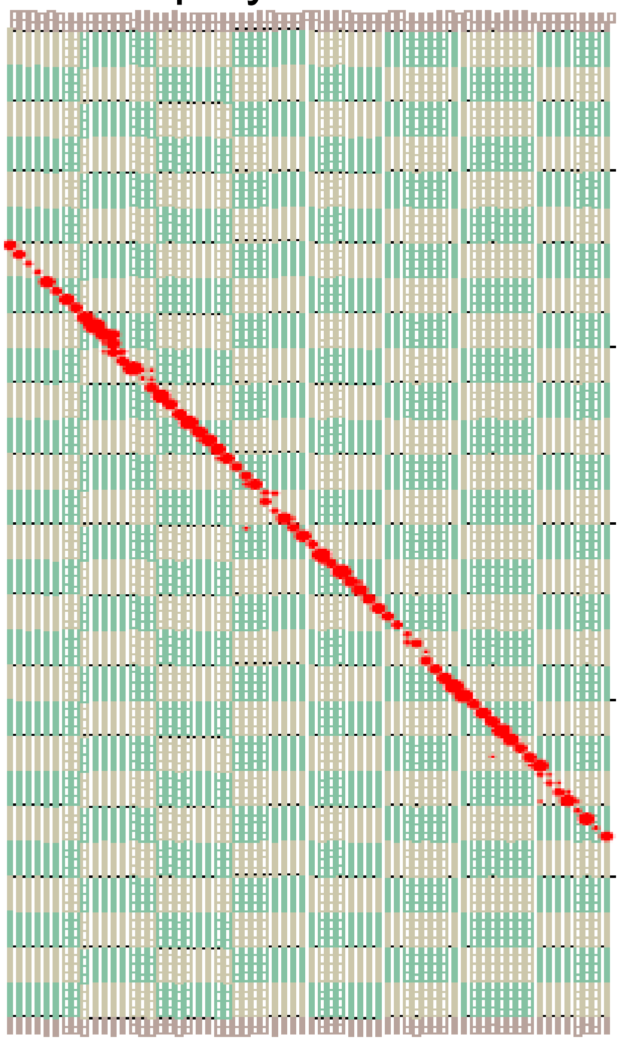


- Gain of MAPMTs are monitored by LED light.
- Light is delivered to all MAPMT by clear fiber.
- Luminosity of LED is monitored by PIN-photo diode

Cosmic Muon



Event display of cosmic muon

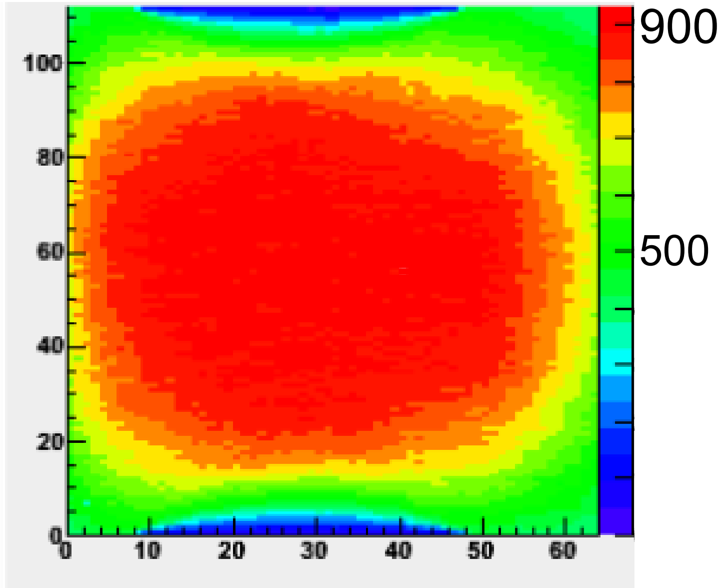


・Light yield is measured using cosmic muon.
・Tracks penetrating all layers are used.

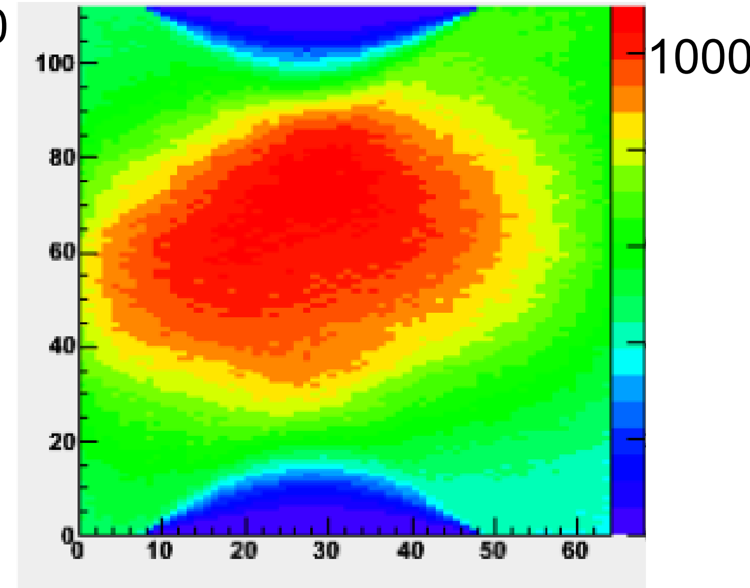
Cosmic Muon

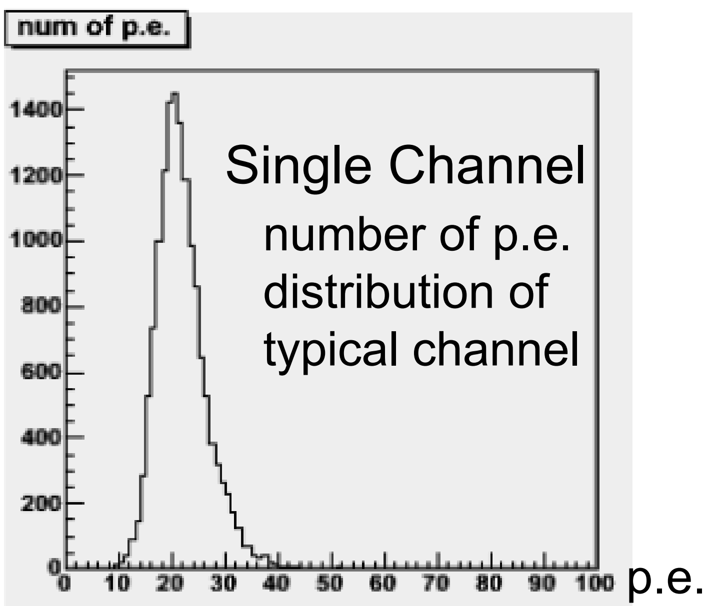
number of hit
per channel
for 1 week

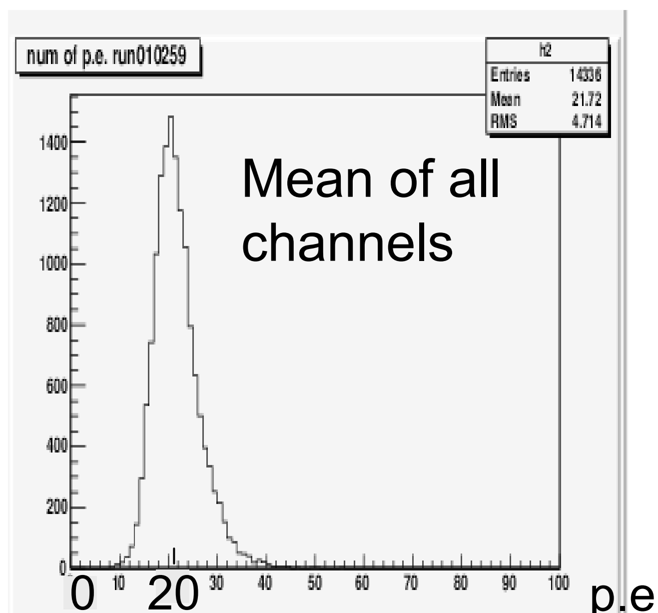
top view



side view





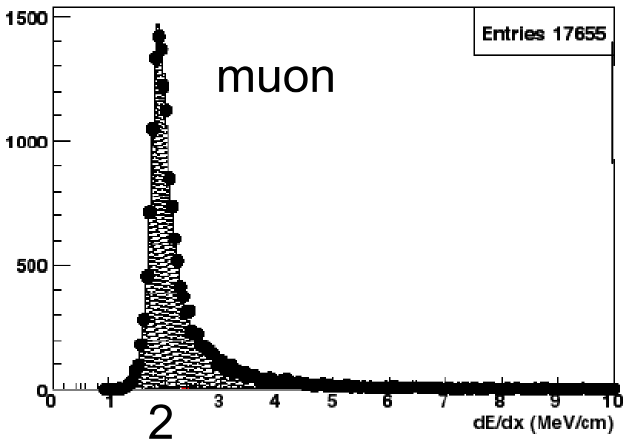


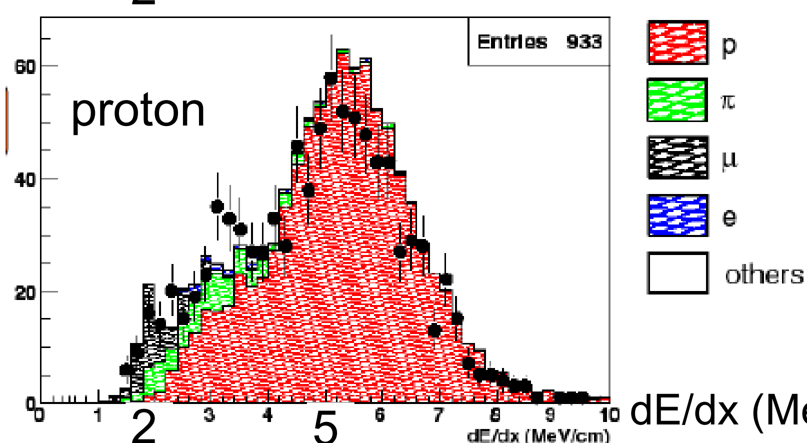
light yield (MIP)
~20 p.e. / 1.3cm

Neutrino Events (1)

Tracks penetrating MRD are identified as muon.

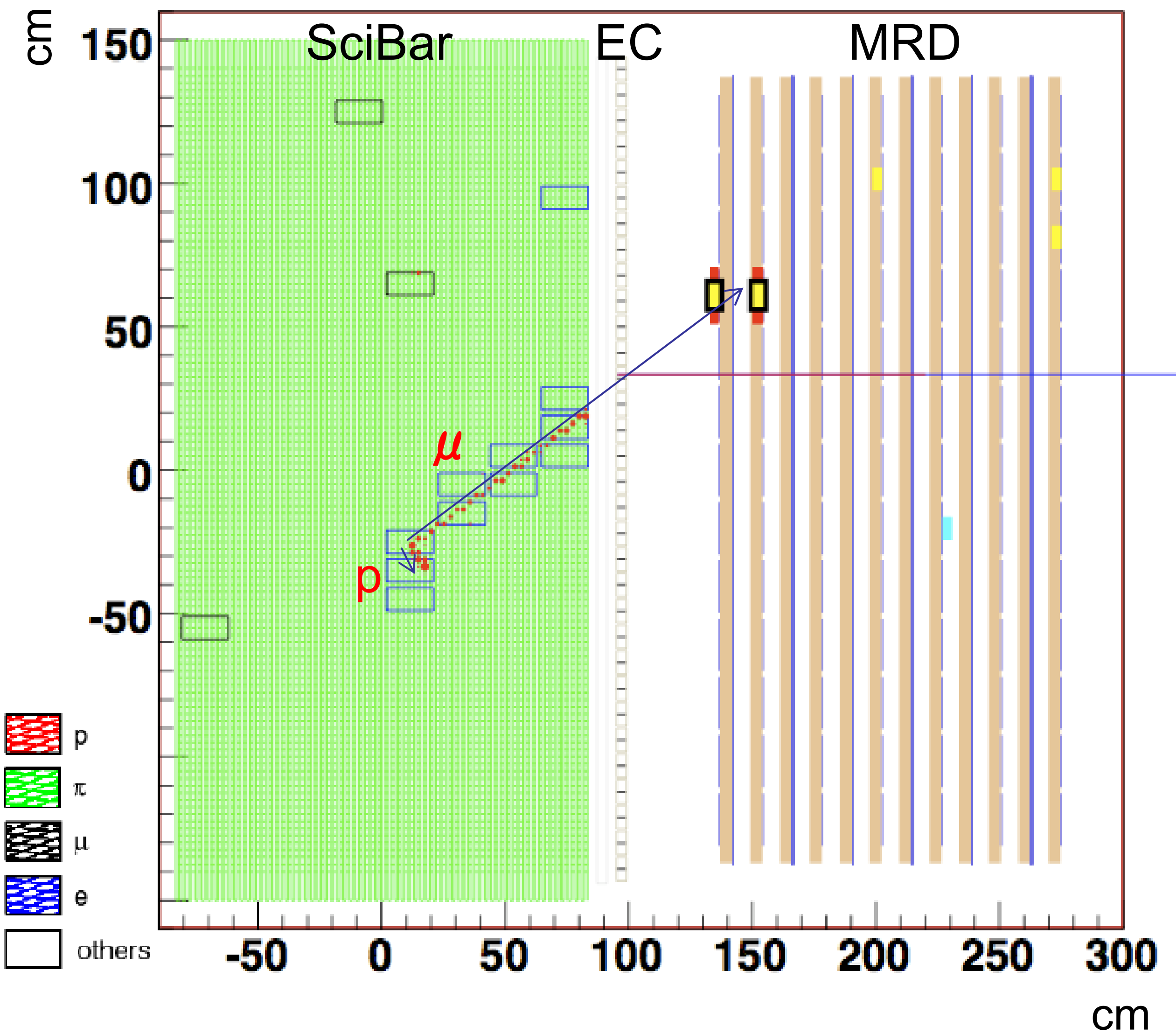
Protons separated from other MIPs using dE/dx information with efficiency ~90%





dE/dx (MeV/cm)

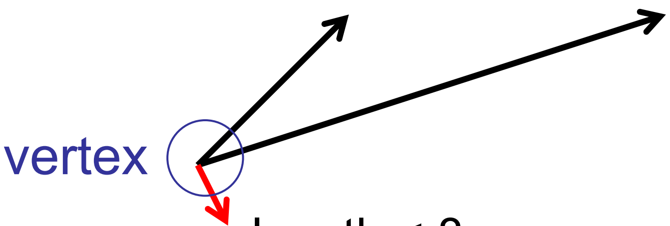
CCQE candidate (ν n → p μ^-)



Neutrino Events (2)

CC-1π production candidates

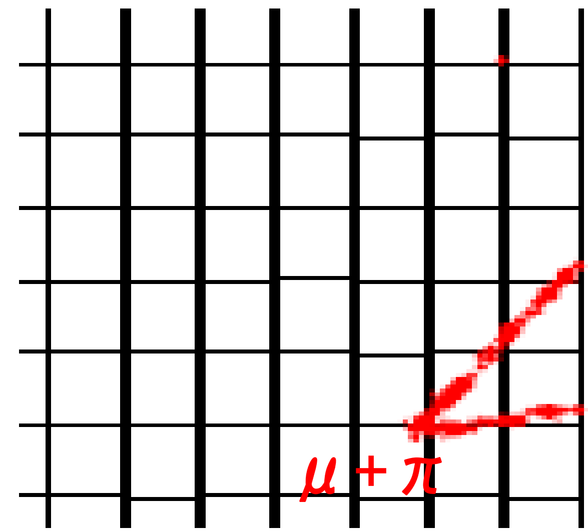
If there is a track that is not long enough to be reconstructed….



$\nu A \rightarrow \mu A' \pi$

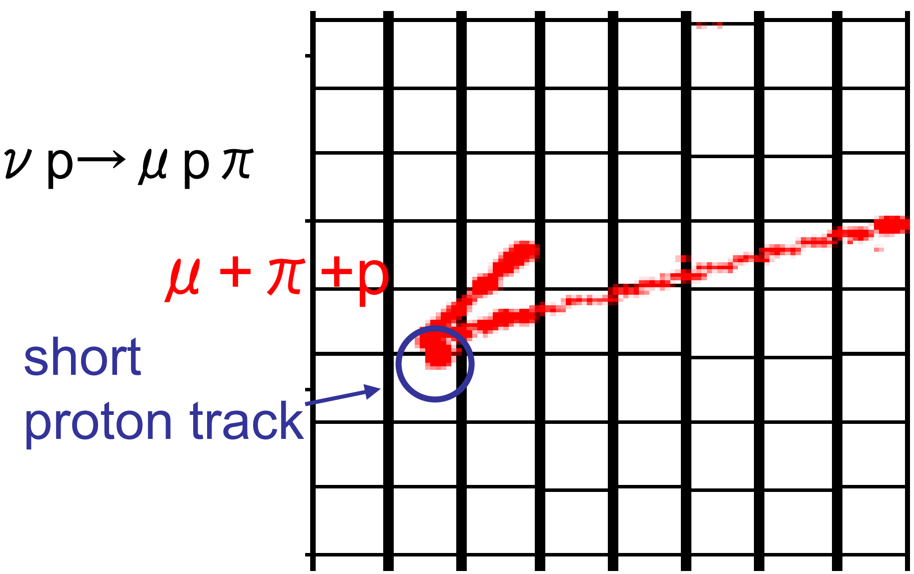
or

$\nu n \rightarrow \mu n \pi$



Existence of short track is detected by looking at large energy deposit at vertex.

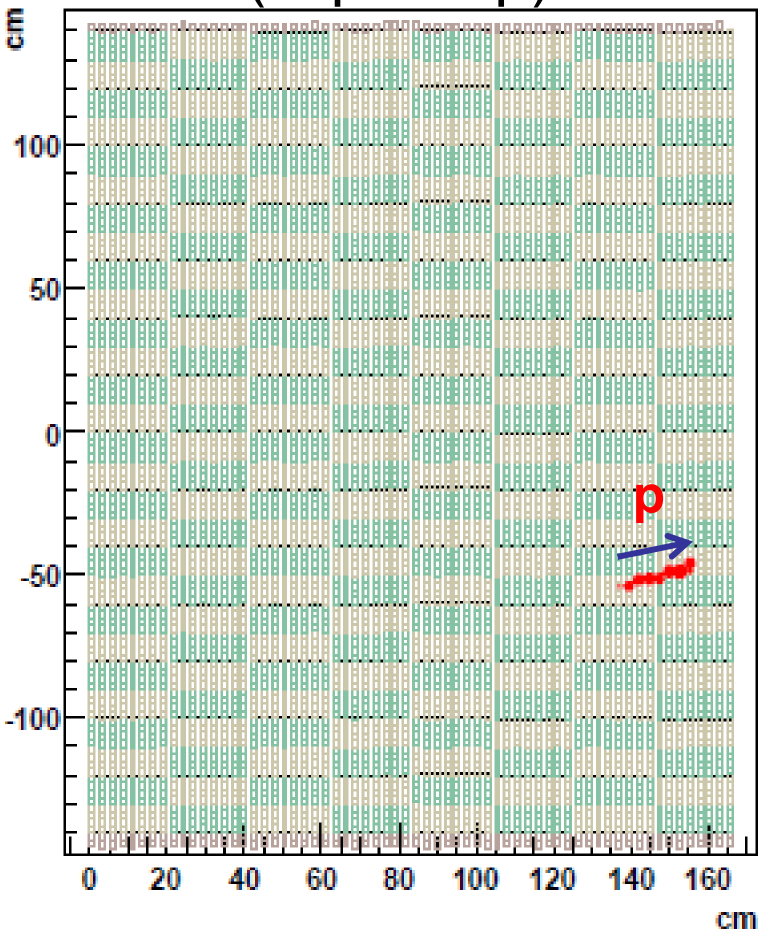
$\nu p \rightarrow \mu p \pi$



$\nu p \rightarrow \mu p \pi$ can be separated from CC-coherent π and $\nu n \rightarrow \mu n \pi$.

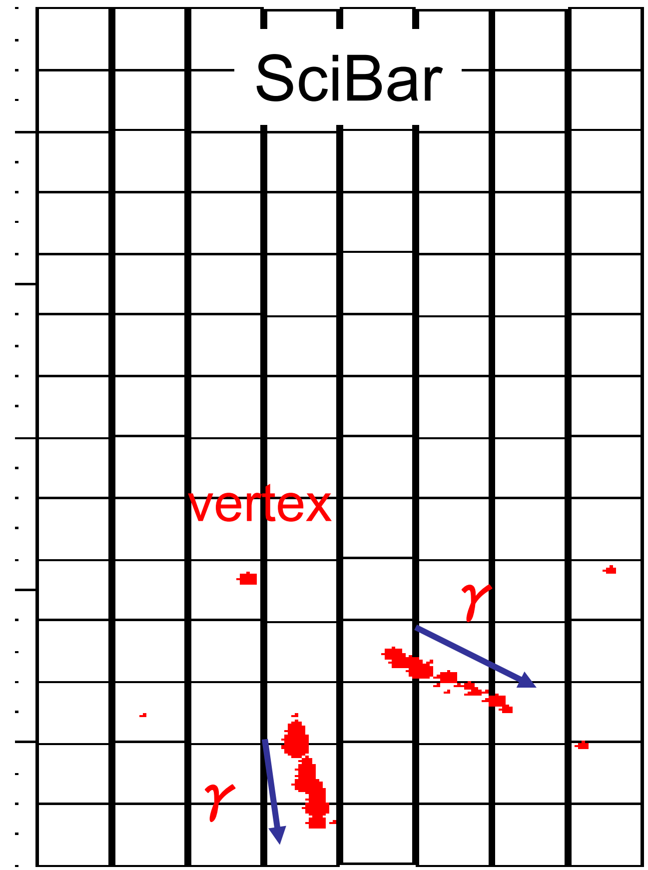
Neutrino Events (3)

NC elastic candidate
(ν p→ ν p)



Single track with large dE/dx

Neutral Current (NC) π^0 candidate ($\nu N \rightarrow \nu N \pi^0$)

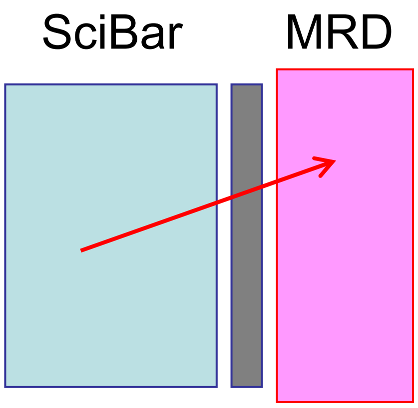


No muon track.
EM shower from $\pi^0 \rightarrow 2\gamma$ decay can be seen.

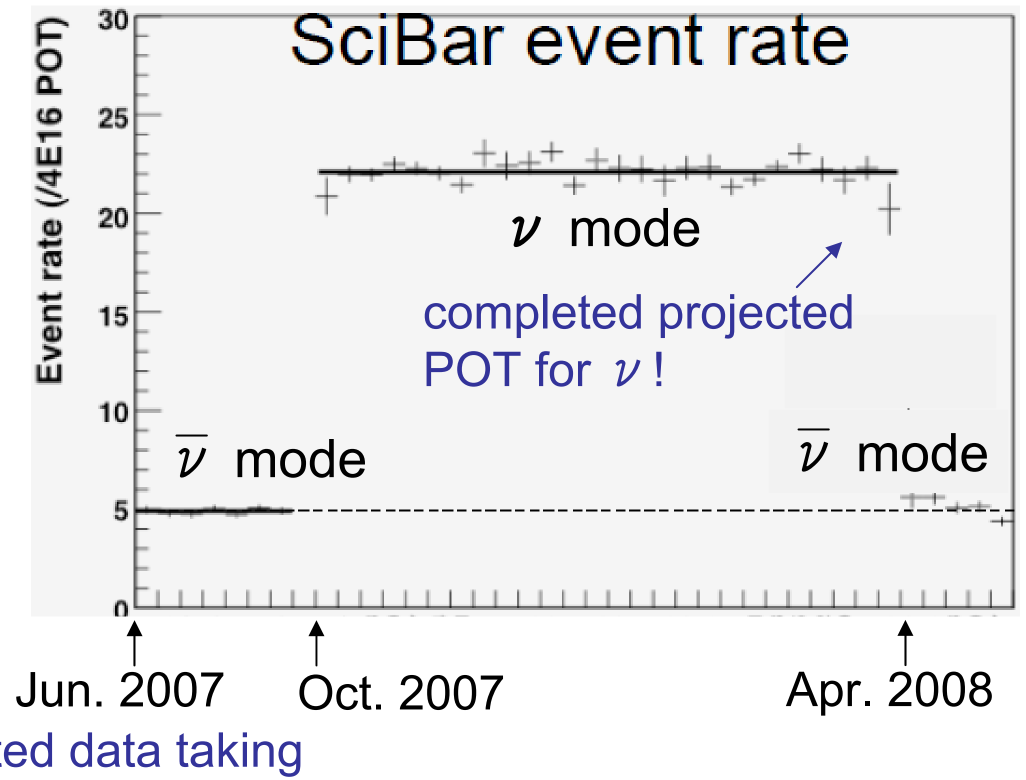
Analyses of these interactions are on going!

SciBar Event Rate

number of Charged Current (CC)
event candidate normalized by POT



track starting
inside SciBar



SciBar is collecting ν and $\bar{\nu}$ data stably!

Summary

- SciBooNE is an experiment for the measurement of neutrino-nucleus scattering cross section at Fermilab.

- The SciBar is a fully-active, finely segmented tracking and calorimetric detector.

- Calibration of the SciBar is done with gain monitor and cosmic muon.

- The SciBar has great capability to identify several ν ($\bar{\nu}$) interactions.

Gain

typical gain: 6×10^5