SciBooNE実験における ニュートリノ反応の精密測定

日本物理学会　第62回年次大会　北海道大学

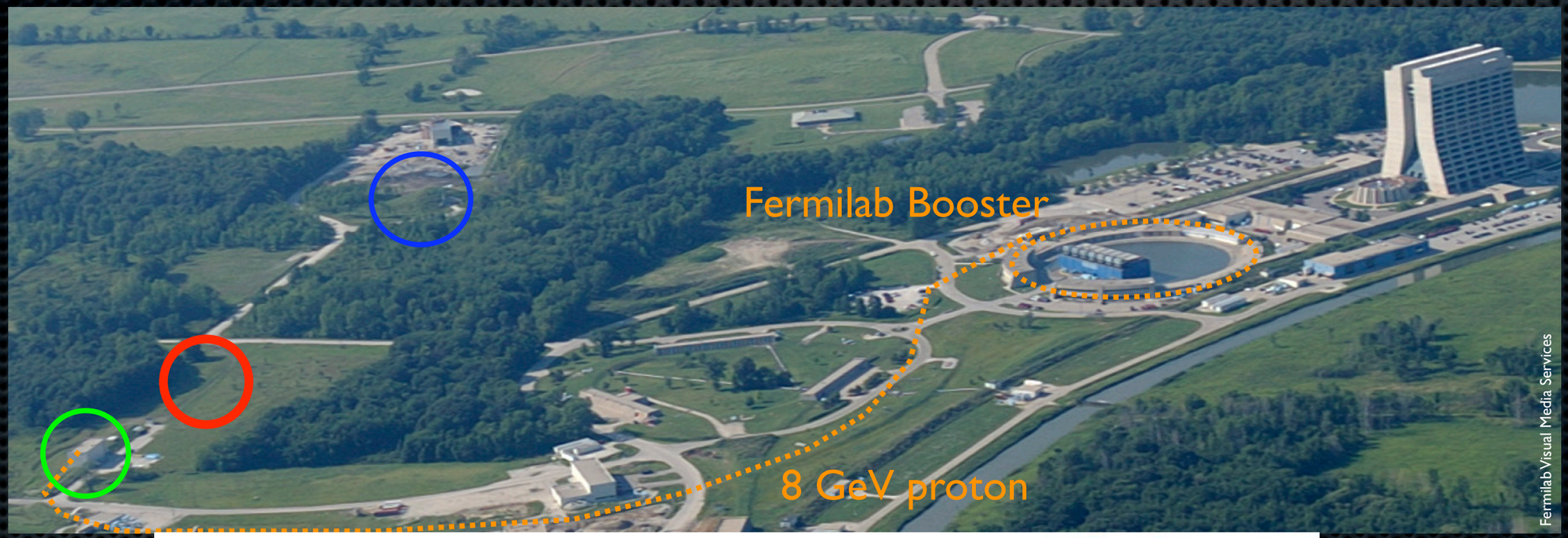
京大理、KEK[A]、東大宇宙線研[B]、東工大理[C]

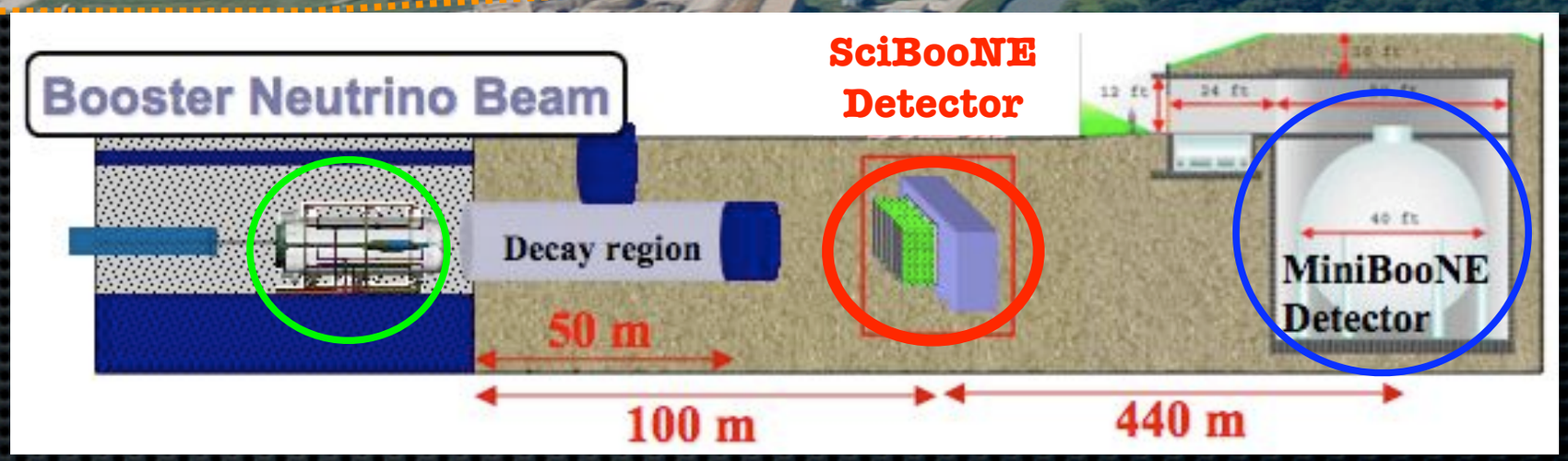
中島康博、中家剛、横山将志、平出克樹、栗本佳典、松岡広大、川向裕之、久保一、五味慎一、大谷将士、村上武[A]、田中真伸[A]、早戸良成[B]、三塚岳[B]、柴田利明[C]、宮地義之[C]、武居秀行[C]

Outline

- Introduction
- SciBooNE Detectors
- SciBooNE Status
  - First data taking (Run I: Jun. 8 - Aug.3, 2007. Anti-neutrino mode.)
- Summary

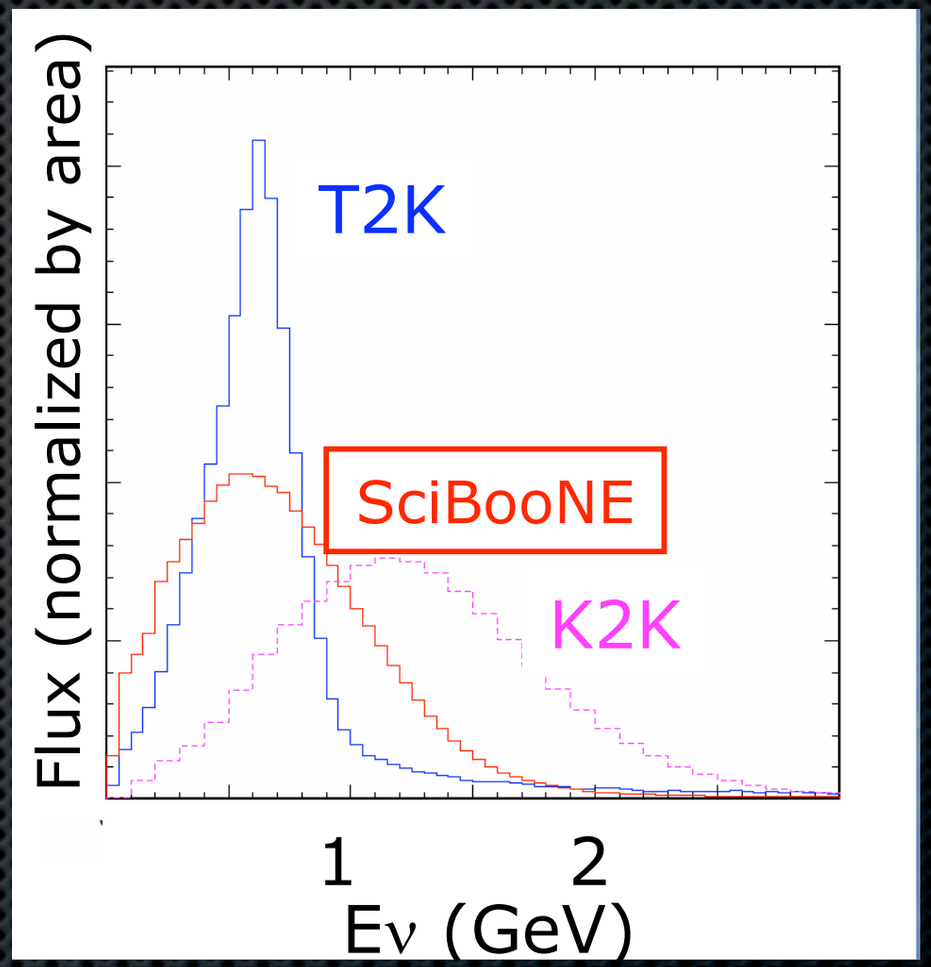
Overview


Fermilab Booster
8 GeV proton
Fermilab Visual Media Services


Booster Neutrino Beam
SciBooNE Detector
Decay region
MiniBooNE Detector
50 m
100 m
440 m

Physics Motivation

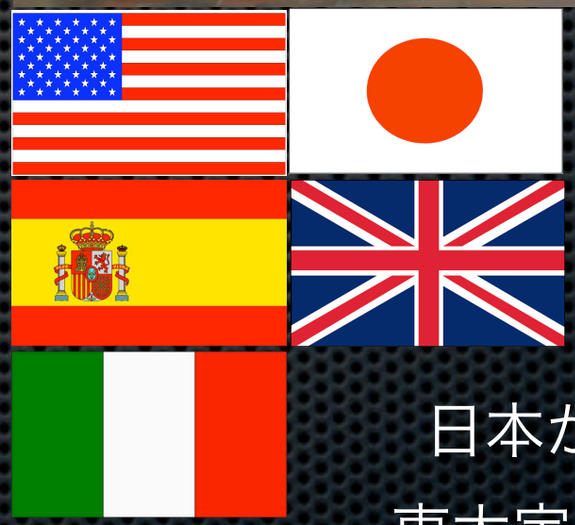
- Precision study of neutrino cross-sections around 1 GeV region.
  - Directly helps T2K
- MiniBooNE near detector.



1×10^{20} POT for neutrinos
1×10^{20} POT for anti-neutrinos

SciBooNE collaboration

- Universitat Autonoma de Barcelona
- University of Cincinnati
- University of Colorado
- Columbia University
- Fermi National Accelerator Laboratory
- High Energy Accelerator Research Organization (KEK)
- Imperial College London*
- Indiana University
- Institute for Cosmic Ray Research
- Kyoto University*
- Los Alamos National Laboratory
- Louisiana State University
- Purdue University Calumet
- Università degli Studi di Roma and INFN-Roma
- Saint Mary's University of Minnesota
- Tokyo Institute of Technology
- Universidad de Valencia



Spokespeople:
T. Nakaya, Kyoto University
M.O. Wascko, Imperial College

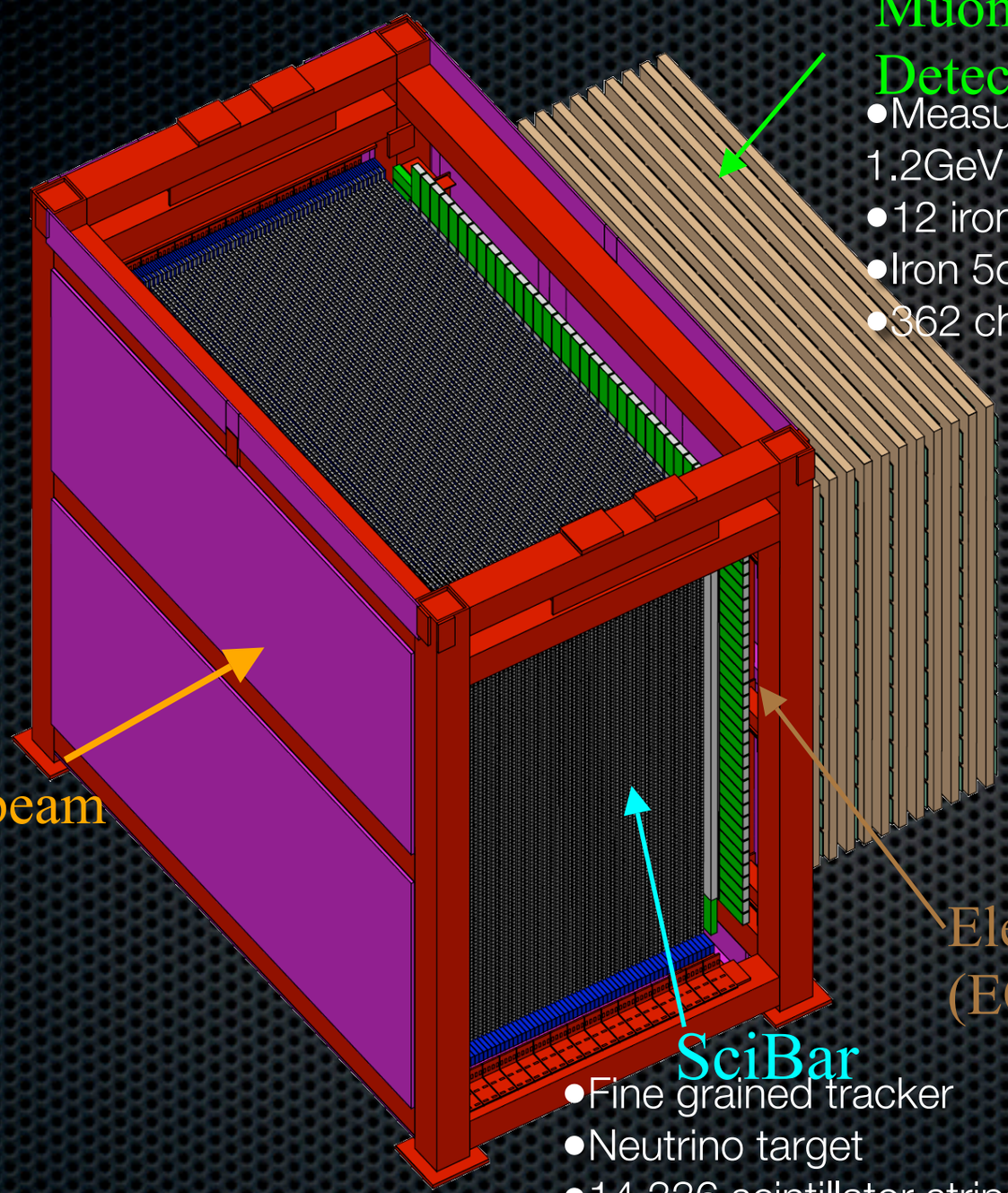
日本からは、京大、KEK、
東大宇宙線研、東工大が参加

SciBooNE Timeline

- 2005, Summer - Collaboration formed
- 2005, Dec - Proposal
- 2006, Jul - Detectors move to FNAL
- 2006, Sep - Groundbreaking
- 2006, Nov - EC Assembly
- 2007, Feb - SciBar Assembly
- 2007, Mar - MRD Assembly
- 2007, Mar - Cosmic Ray Data
- 2007, Apr - Detector Installation
- 2007, May - Commissioning
- 2007, Jun - Anti-Neutrino Data Run

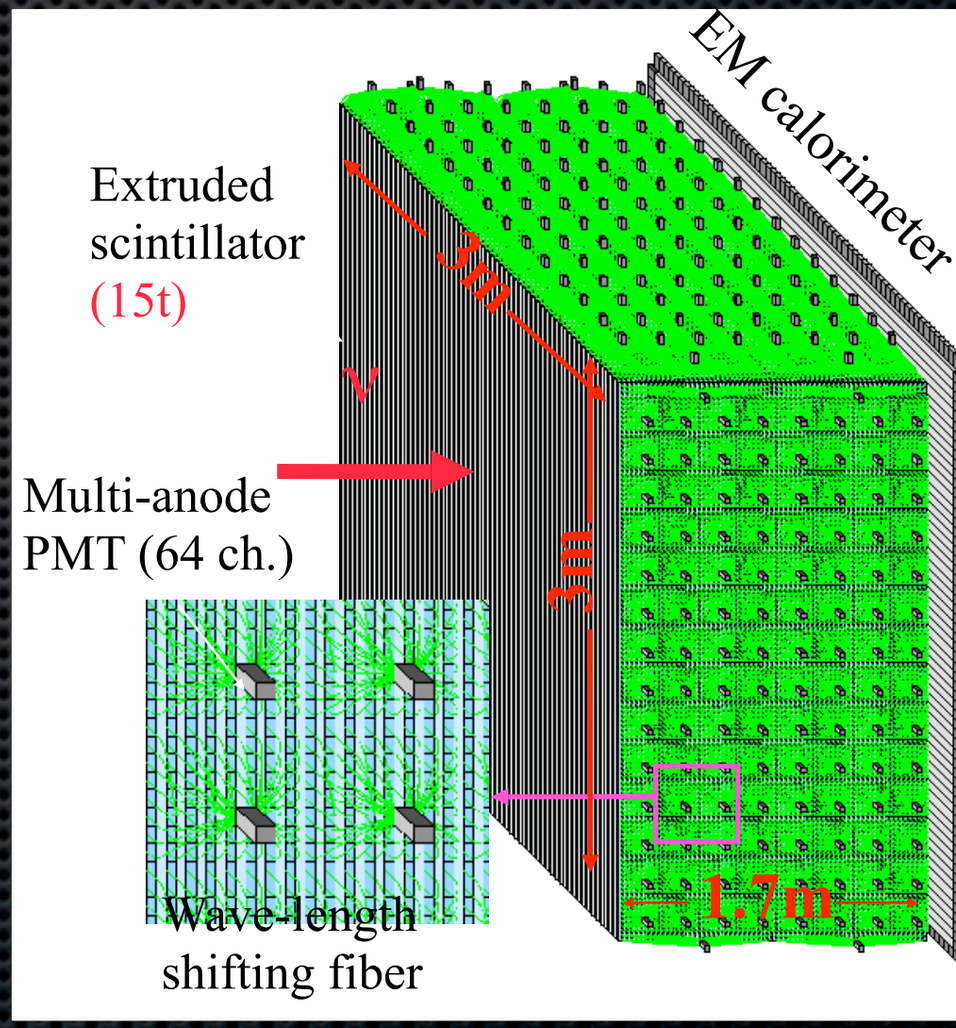
Two years from formation to first data!

SciBooNE detectors



Muon Range Detector (MRD)

- Measure muons up to 1.2GeV
- 12 iron/scintillator planes
- Iron 5cm thick
- 362 channels



Electron Catcher (EC)

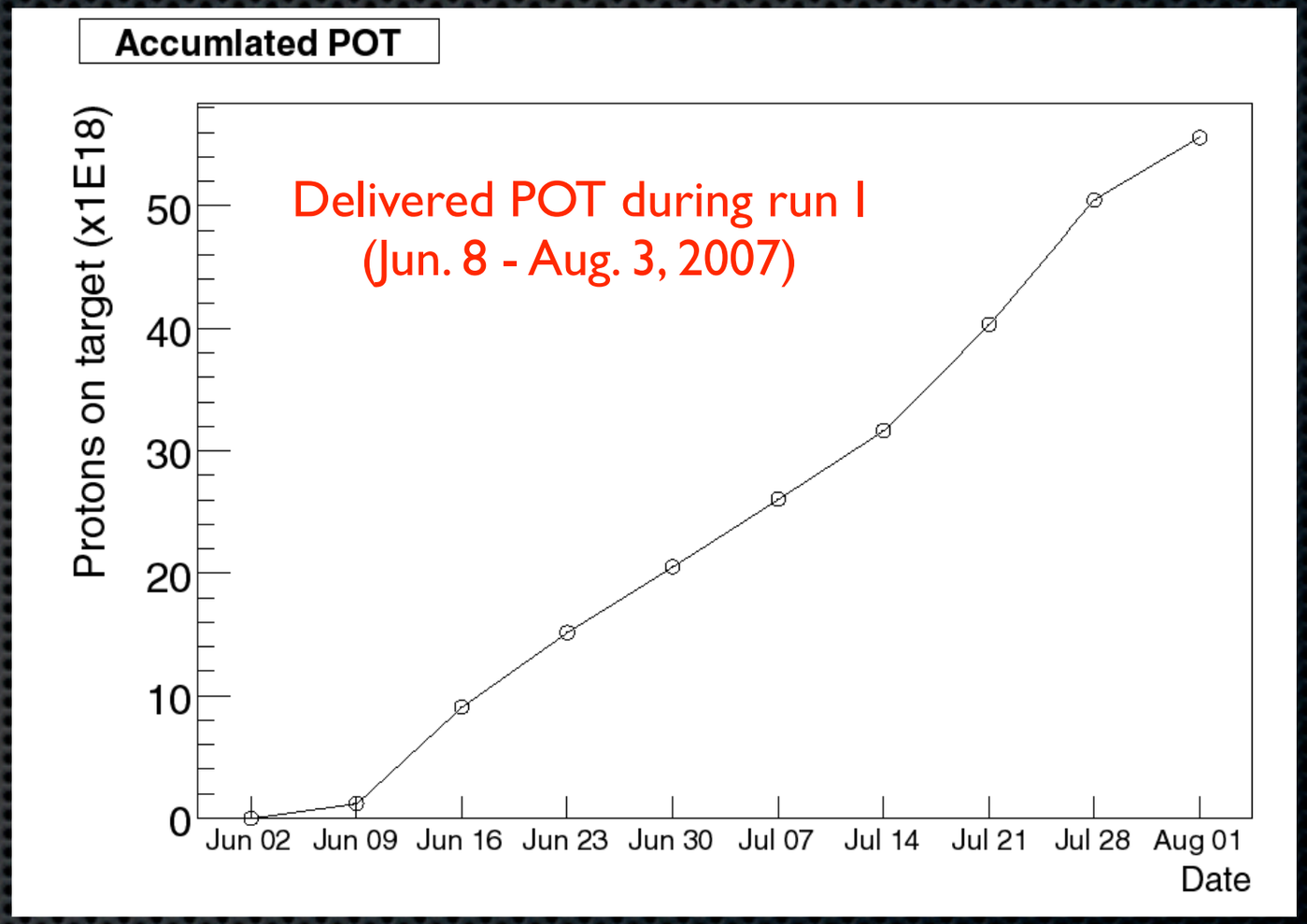
- Spagetty calorimeter from CHORUS
- 1mm fibers in the grooves of lead foils
- 2 planes ($11X_0$)
- Total 256 readout channels.

SciBar

- Fine grained tracker
- Neutrino target
- 14,336 scintillator strips
- Each $2.5 \times 1.3 \times 300 cm^3$
- WLS fiber readout

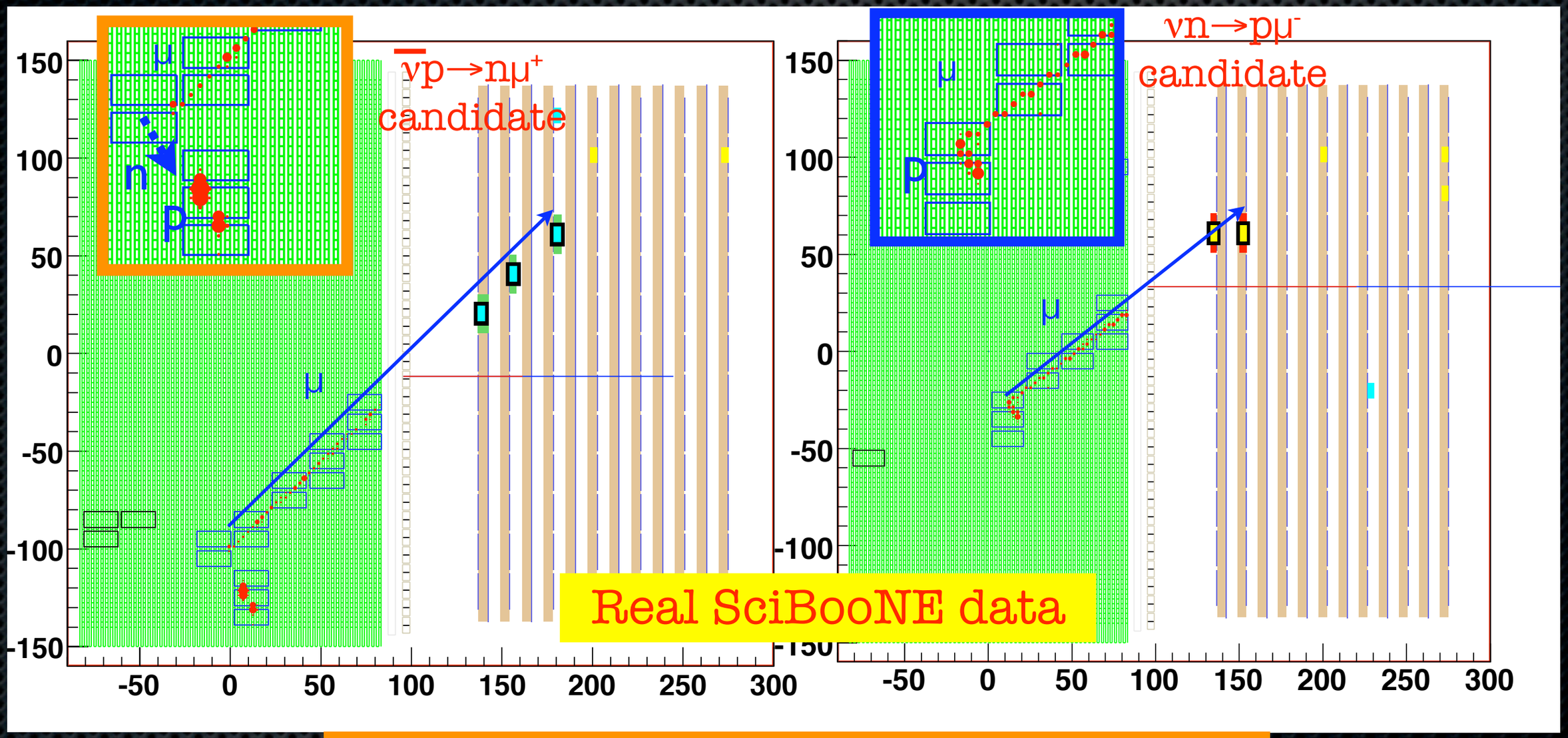
First data run

- Run I: Jun. 8 - Aug. 3, 2007.
- Anti-neutrino mode.
- Delivered 5.45×10^{19} POT.
- Detector live time fraction: ~95%.



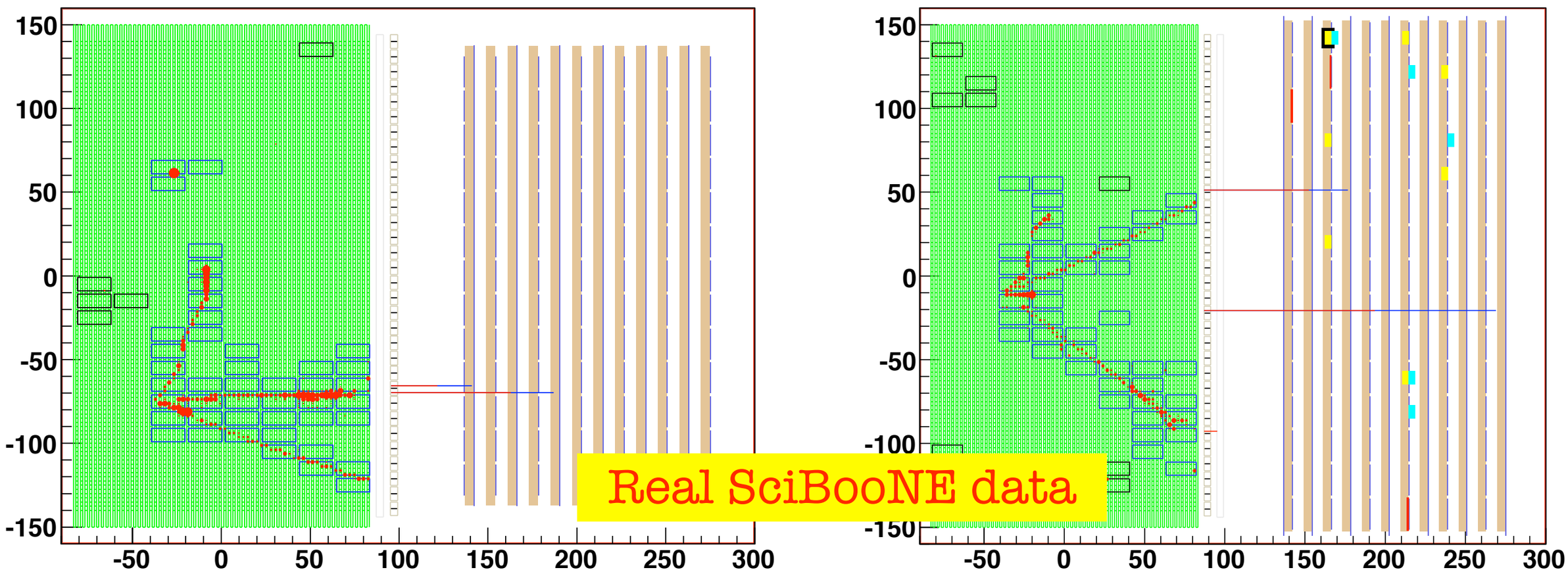
Half of projected for anti-neutrino mode!

$\bar{\nu}$ and ν CCQE events



Anti-neutrino and neutrino interactions are clearly distinguished

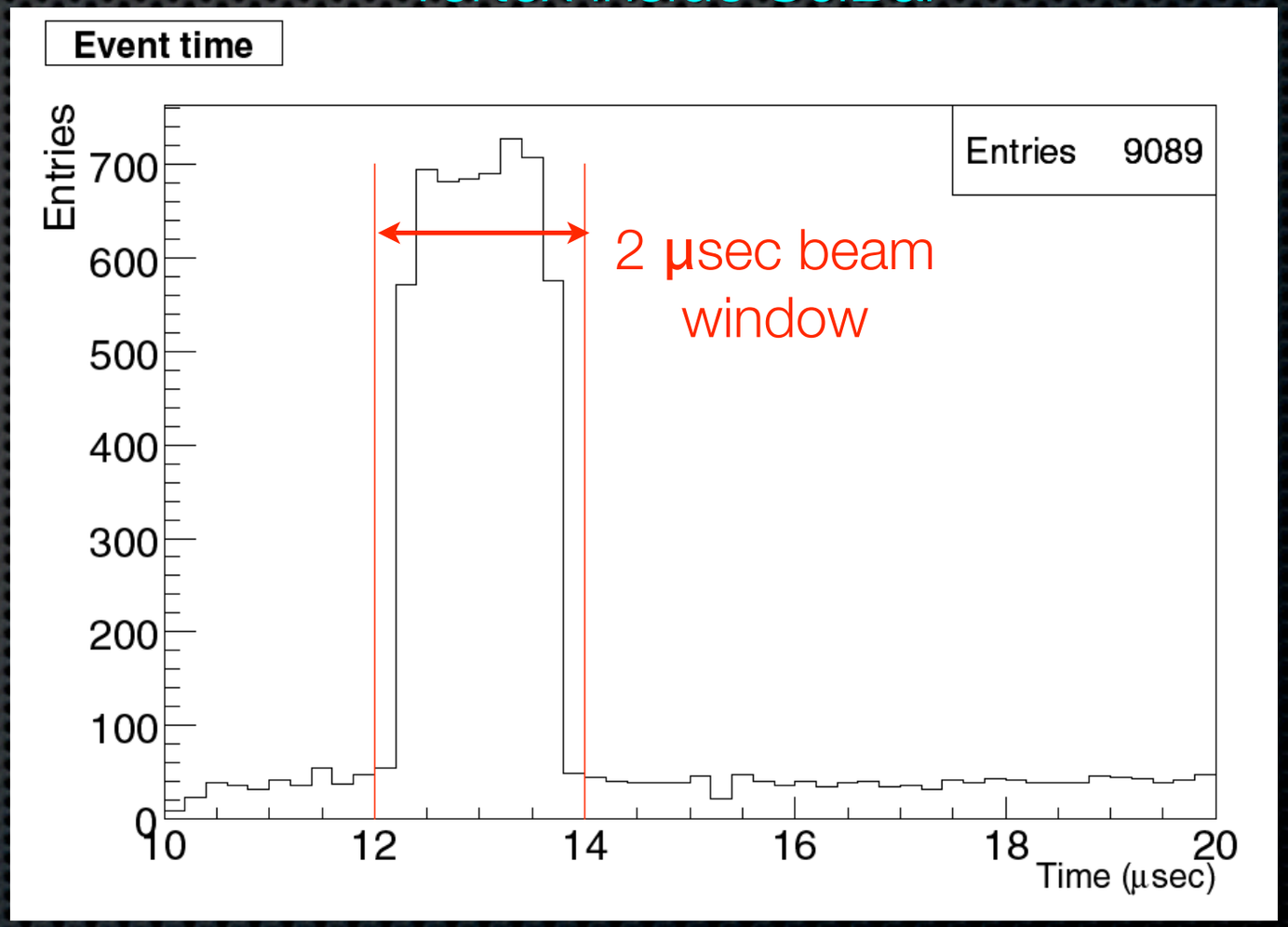
Multi-track event



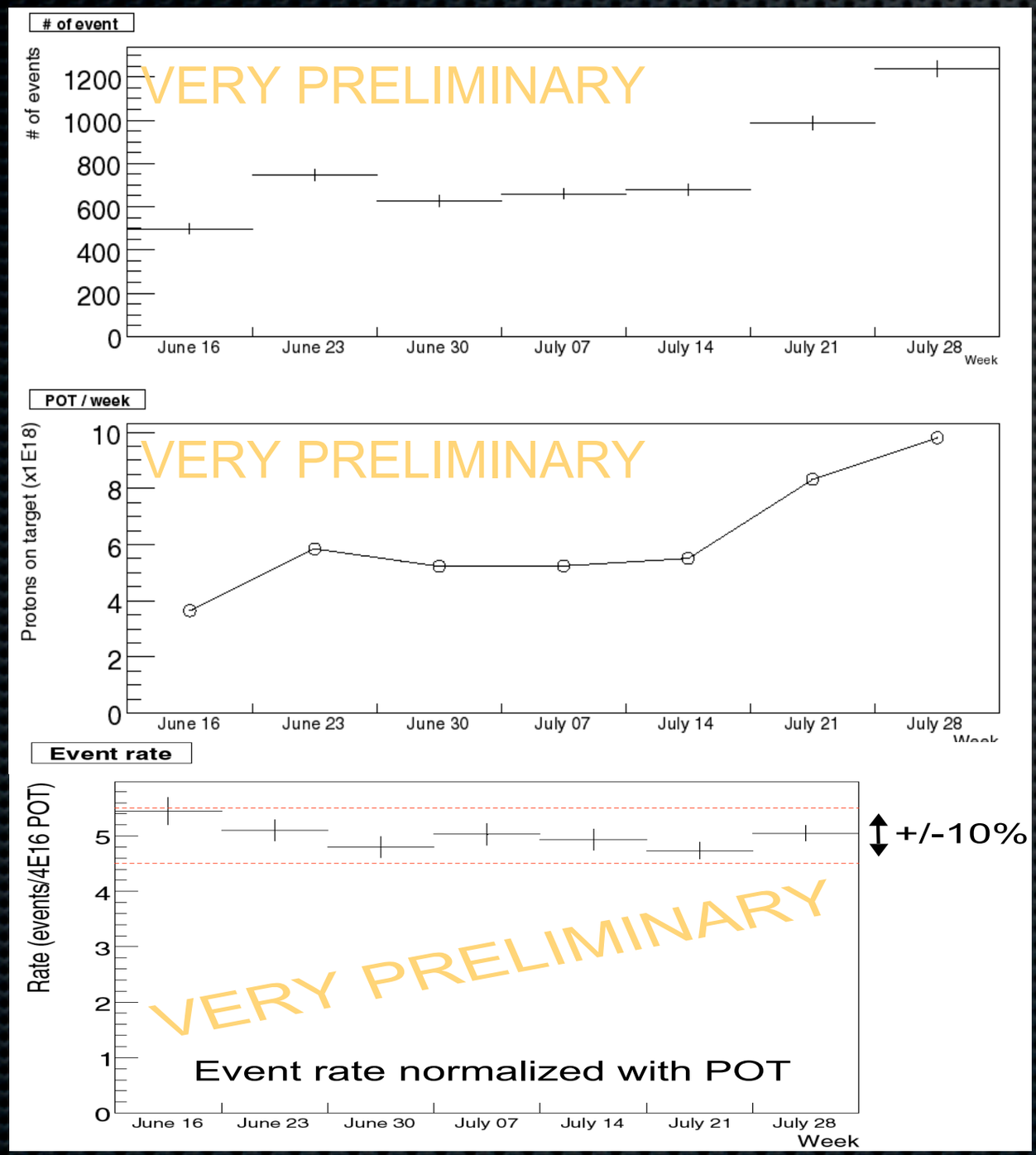
Event Timing

- Select CC-like events vertex inside SciBar
  - Require a hit in the most downstream layer.
  - Track penetrating more than 4 layers.
  - Vertex inside the FV of SciBar. (FV mass: 10.6 tons)
  - Within 2 μsec beam window.
- Note: This selection is just stability checks (not for physics)

Event timing of CC candidate vertex inside SciBar



Stability



- CC event candidates vertex inside SciBar: ~5000 events.
  - FV mass: ~10.6 tons.
  - Period: June 12 - July 28. (~4×10^{19} POT)
- Event rate normalized with POT stable within ±10%.

Note:
CC event efficiency: ~45%
CC event purity: ~94%
$\nu/\bar{\nu}$ fraction: ν ~63%, $\bar{\nu}$ ~36%
(estimated by MC)

Summary

- SciBooNE: Precise study of neutrino and anti-neutrino interactions around 1 GeV.
- Project 2 x 10^{20} POT.
- SciBooNE detector is working well and has successfully collected anti-neutrino data. (0.5x10^{20} POT)
- Next:
  - From October 2007: Neutrino mode (1.0x10^{20} POT)
  - From March 2008: Anti-neutrino mode (0.5x10^{20} POT)