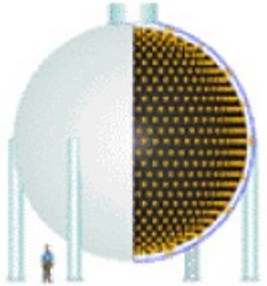
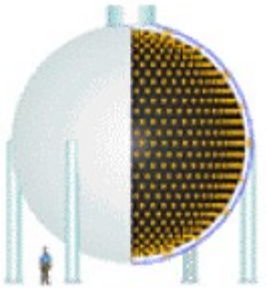


Bari Osmanov

University of Florida

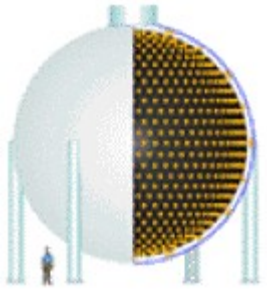
Recent results from MiniBooNE: update on oscillation studies and xsec measurements

Outline



- MiniBooNE experiment
  - Beamline and detector
  - Disappearance analysis overview and results
  - Appearance analysis overview and results
  - Axial anomaly studies
  - Cross-section results
- Conclusions

MiniBooNE experiment



The primary goal of the experiment was to investigate the signal observed in LSND in terms of neutrino oscillations.

The first beam induced neutrino events were detected in 2002 (first anti-neutrino beam delivered in 2006).

Since then MiniBooNE obtained several interesting results both in oscillation and cross-section studies.

Beamline and detector

8 GeV protons from Fermilab booster

Be target and magnetic focusing horn

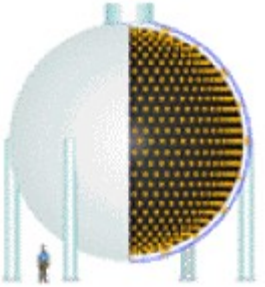
50-m decay pipe

~ 500 m of dirt

Detector

A.A. Aguilar-Arevalo et al., Nucl. Instr. Meth. A599 (2009) 28-46
Phys. Rev. D79, 072002 (2009)

Disappearance analysis



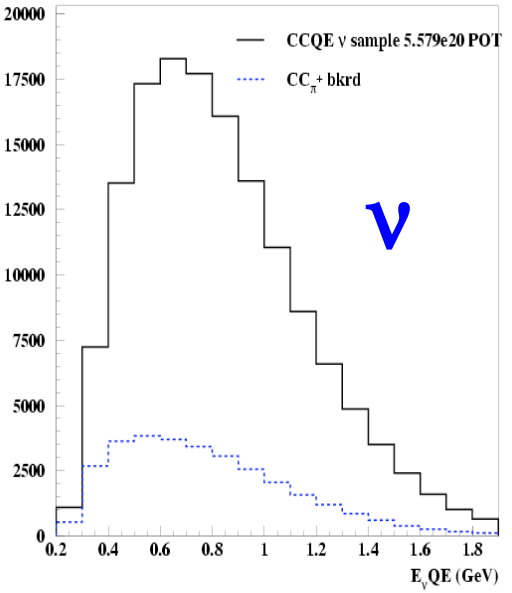
Sample selection:

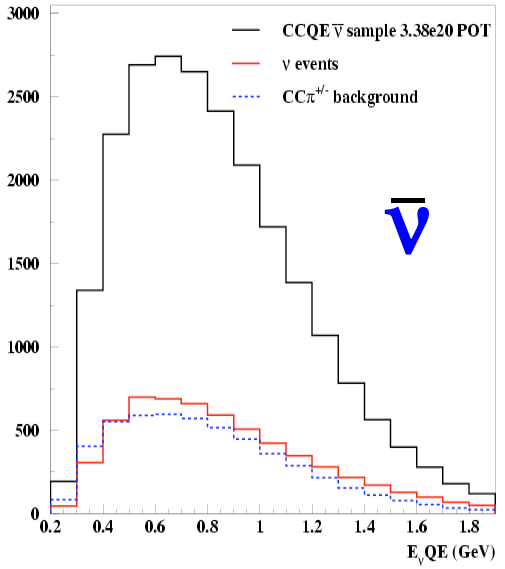
- **two hit clusters separated in time: single muon + decay electron**
- **minimal hits in veto**
- **1st cluster – muon-like track**
- **2nd cluster – below decay electron energy**
- **fiducial volume, beam-coincidence and data-quality cuts**

Appr. 25% ν_μ content in ν_μ sample due to higher π^+ production at the target and higher $\bar{\nu}_\mu$ cross-section

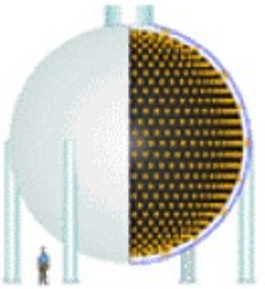
Compare the difference between data and prediction to the error as a function of reconstructed neutrino energy

Where $\chi^2(\Delta m^2, \sin^2 2\theta)$ is larger than χ^2(90% CL) then that oscillation prediction is excluded at 90% CL





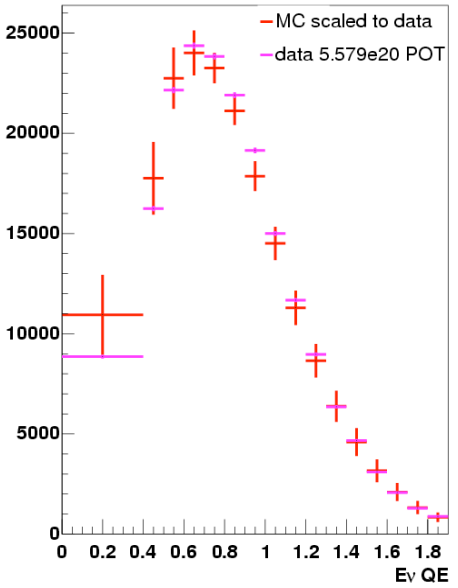
Disappearance results

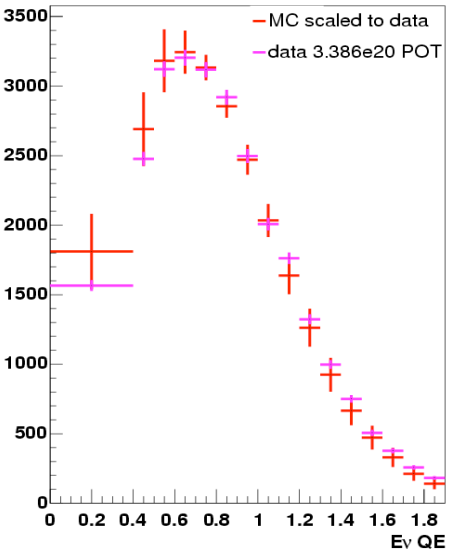


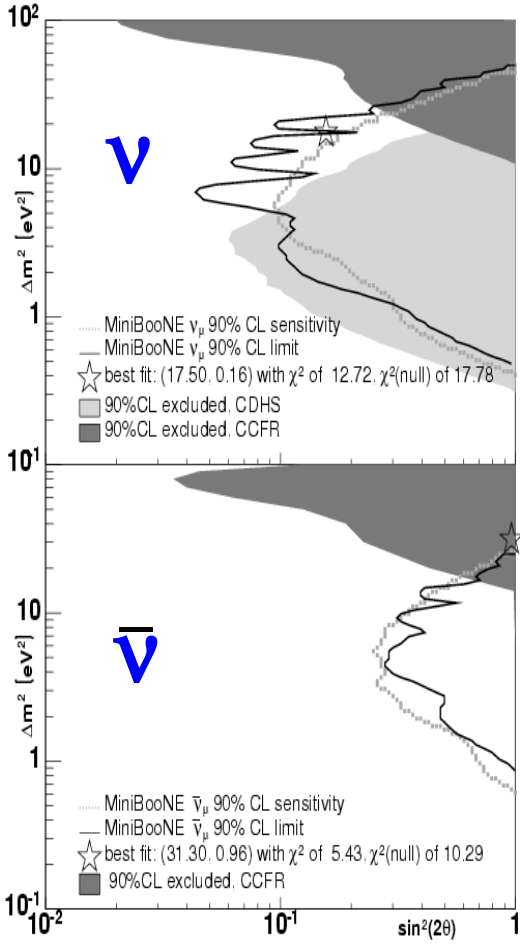
No ν or $\bar{\nu}$ disappearance at 90% CL

First antineutrino disappearance measurement between 0.1-10 eV^2

Work to fold in the data from SciBooNE detector (same flux, xsec)

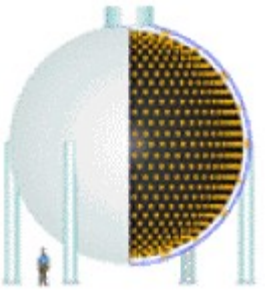






Phys. Rev. Lett. 103, 061802 (2009)

Appearance analysis



- Geant4 is used to predict neutrino spectrum at detector location

- NUANCE generator is used to model neutrino interactions in the detector

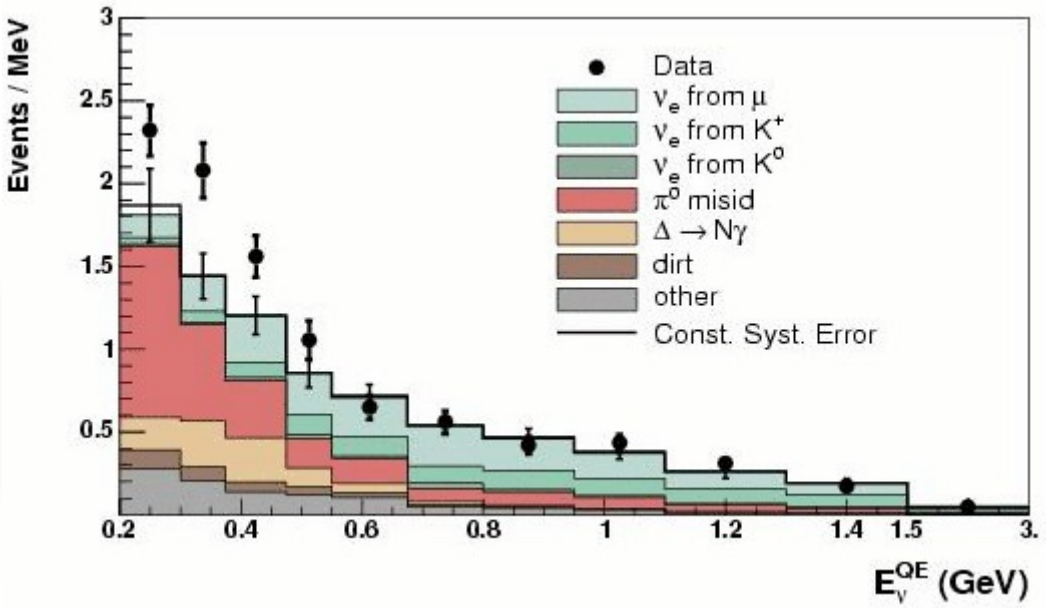
- Geant3 is used to model propagation of final state particles inside the detector

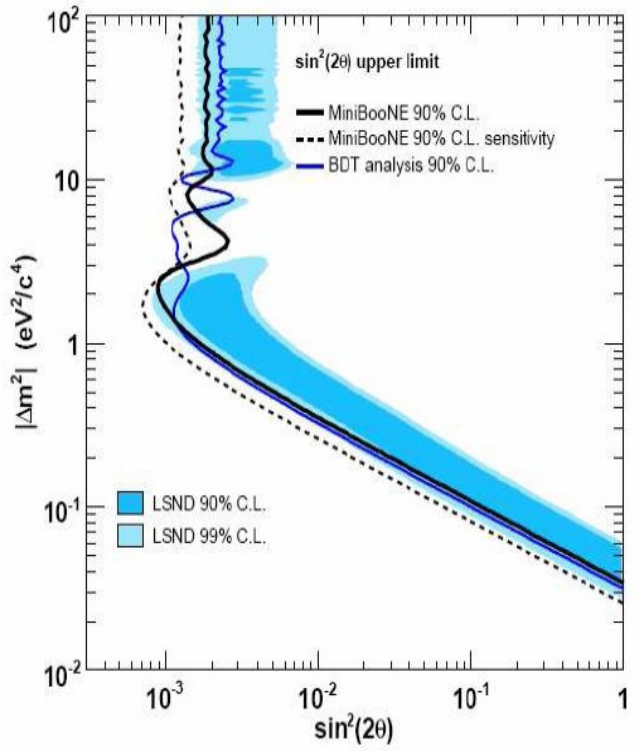
- Track-based likelihood method is used for event reconstruction

- Hit topology and timing are used for particle identification
(separate electrons from π^0,μ)

- Reconstructed energy spectrum is fit for oscillations

Appearance results (neutrino mode)

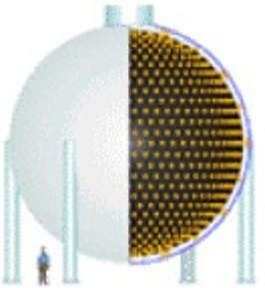




- Analysis based on 6.46E20 POT
- No oscillations at LSND L/E region (> 475 MeV)
- Observed 3σ excess of events in low-energy region (< 475 MeV)

Phys. Rev. Lett. 102, 101802 (2009)

Low-energy excess



Anomaly Mediated Neutrino-Photon Interactions
Harvey, Hill, & Hill, arXiv:0905.029

CP-Violation 3+2 Model
Maltoni & Schwetz, arXiv:0705.0107; T. Goldman, G. J. Stephenson Jr., B. H. J. McKellar, Phys. Rev. D75 (2007) 091301

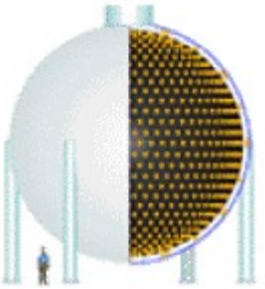
Lorentz Violation
Katori, Kostelecky, & Tayloe, Phys. Rev. D74 (2006) 105009

CPT Violation 3+1 Model
Barger, Marfatia, & Whisnant, Phys. Lett. B576 (2003) 303

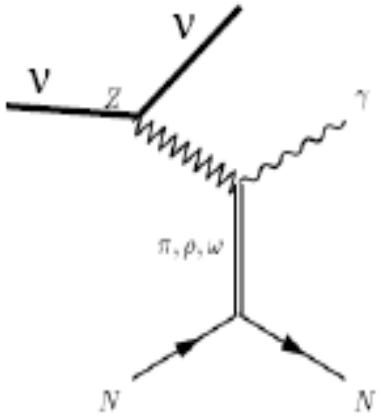
VSBL Electron Neutrino Disappearance
Giunti and Laveder arXiv:0902.1992

New Gauge Boson with Sterile Neutrinos
Ann E. Nelson & Jonathan Walsh, arXiv:0711.1363

Axial anomaly



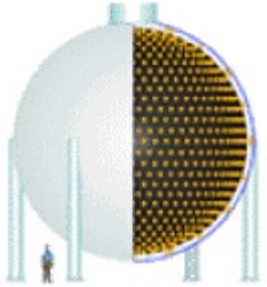
$\nu N \rightarrow \nu N\gamma$ and $\bar{\nu} N \rightarrow \bar{\nu} N\gamma$

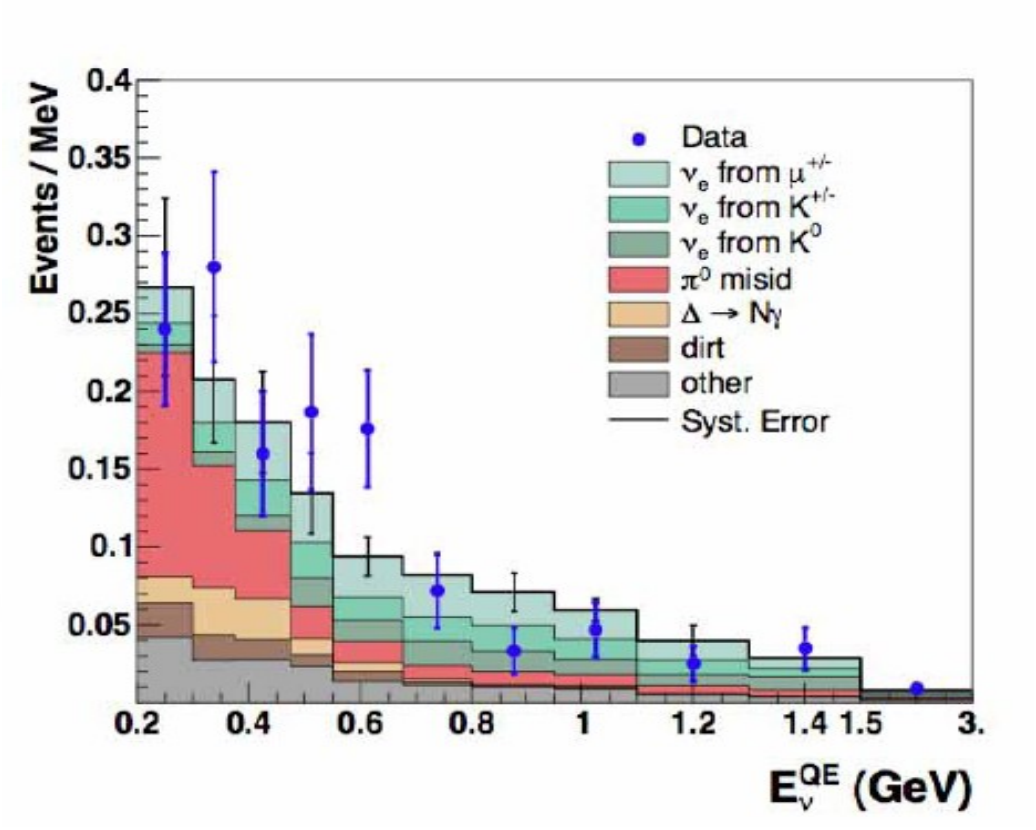


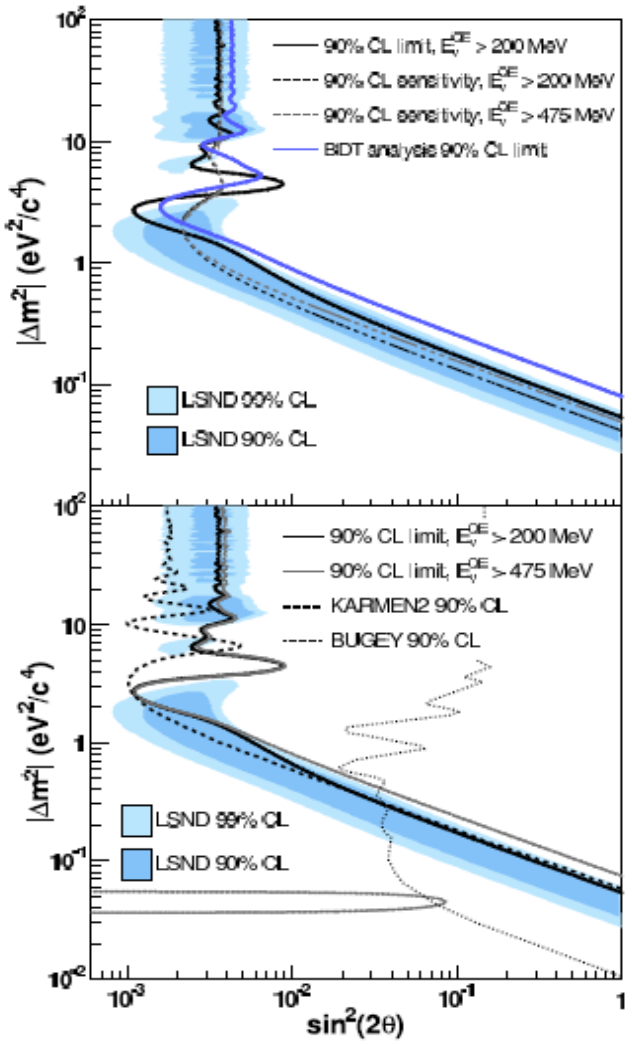
- Anomaly-mediated photon production
- Photon can be mis-identified as electron in MiniBooNE detector
- Studies are undergoing

arXiv:0905.029

Appearance results (anti-neutrino mode)



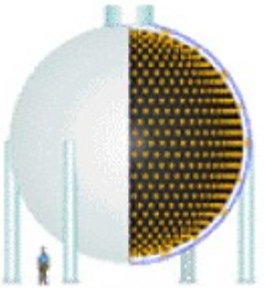




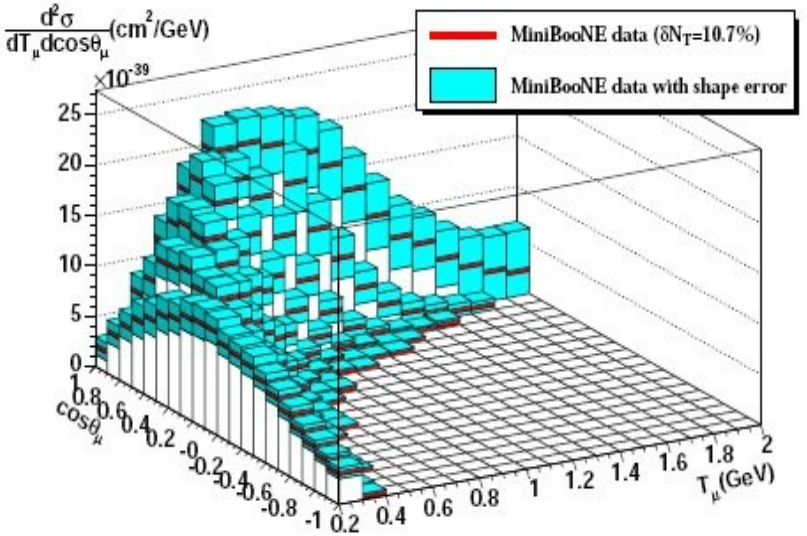
- Analysis based on 3.386E20 POT
- No low energy excess
- Currently work on combined $\nu - \bar{\nu}$ analysis
- More data will provide additional information

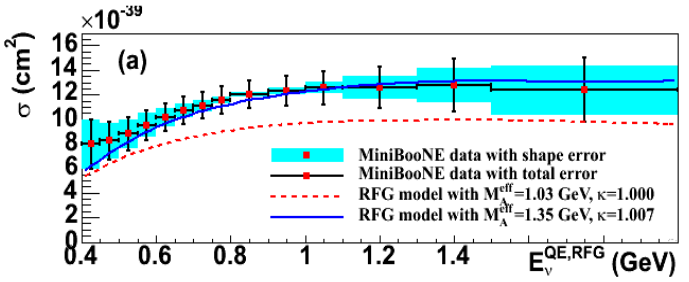
Phys. Rev. Lett. 103, 111801 (2009)

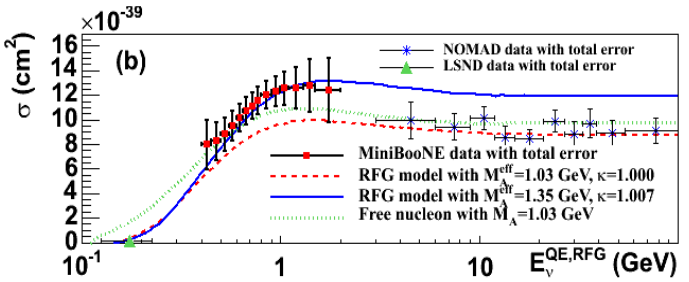
Cross-section results



- ν_μ CC QE
  - Based on 150K event sample
  - First measurement of double-differential xsec on carbon
- Extracted axial mass from a "shape-only" fit of the Q^2 QE distribution: $M_A = 1.35 \pm 0.17$ GeV

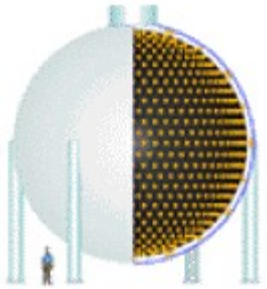




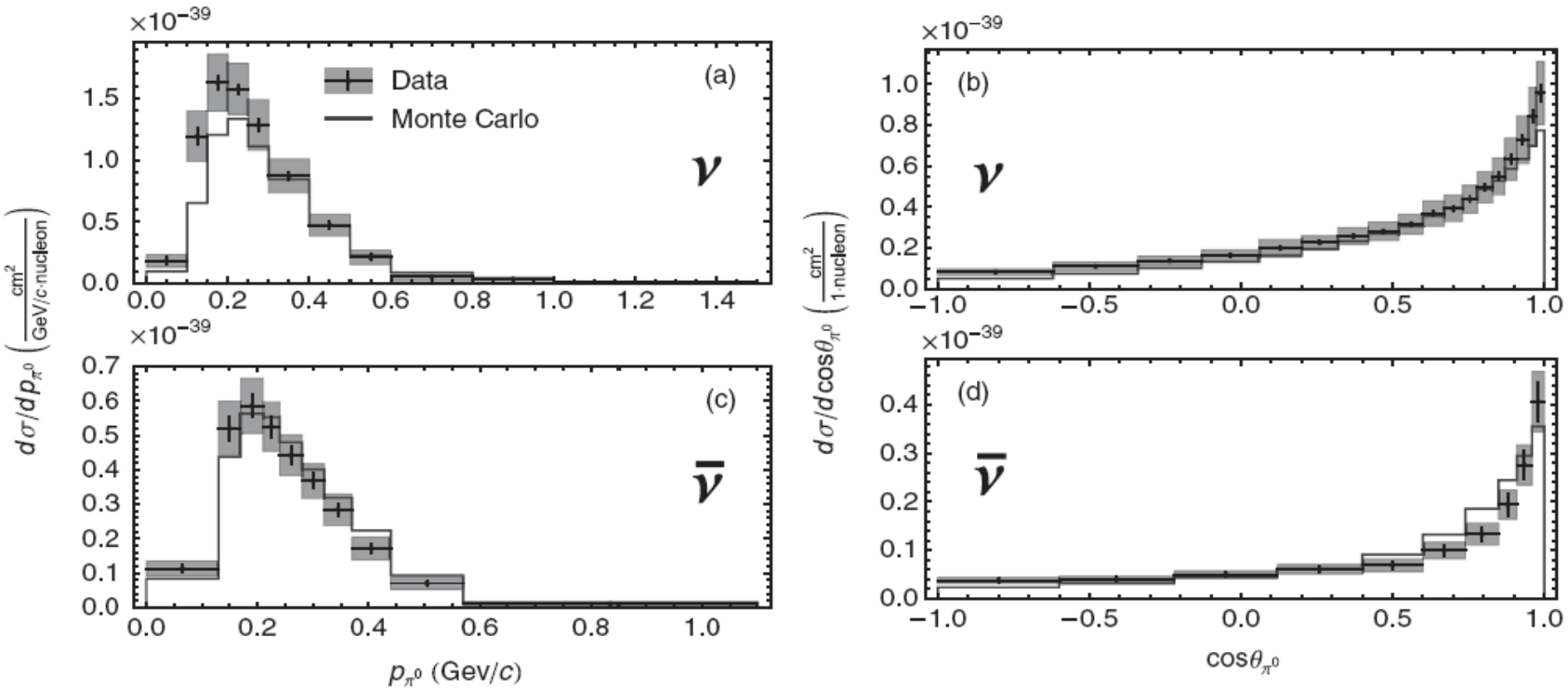


arXiv:1002.2680

Cross-section results

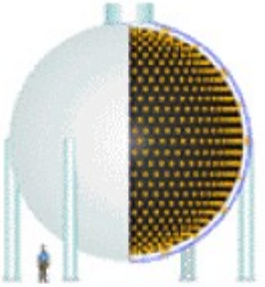


- First differential xsec measurement of NC $1\pi^0$ production
- Based on 21K (ν) and 2.8K ($\bar{\nu}$) event samples
- Kinematics of this process are important for background studies in appearance experiments

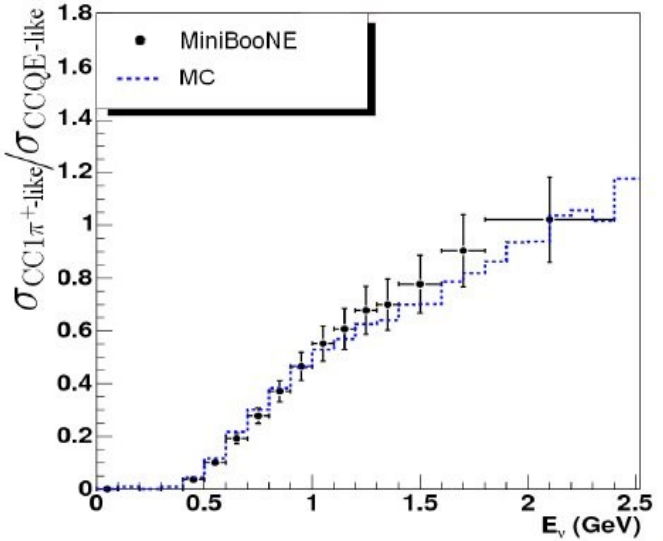


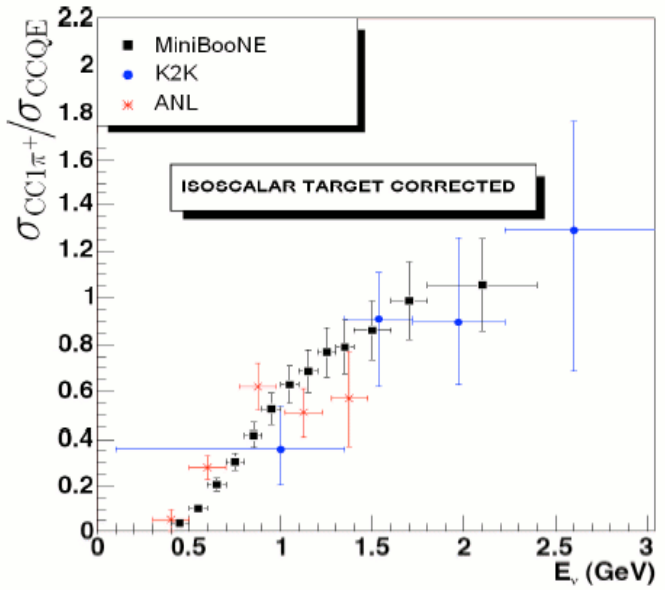
Phys.Rev.D 81, 013005 (2010)

Cross-section results



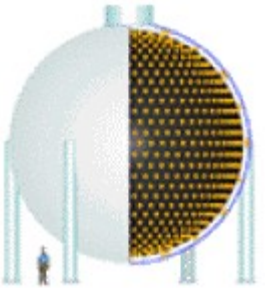
- CC π^+ to QE xsec ratio measurement
  - Based on 46K sample
- Observed (top) and FSI corrected (bottom) ratios



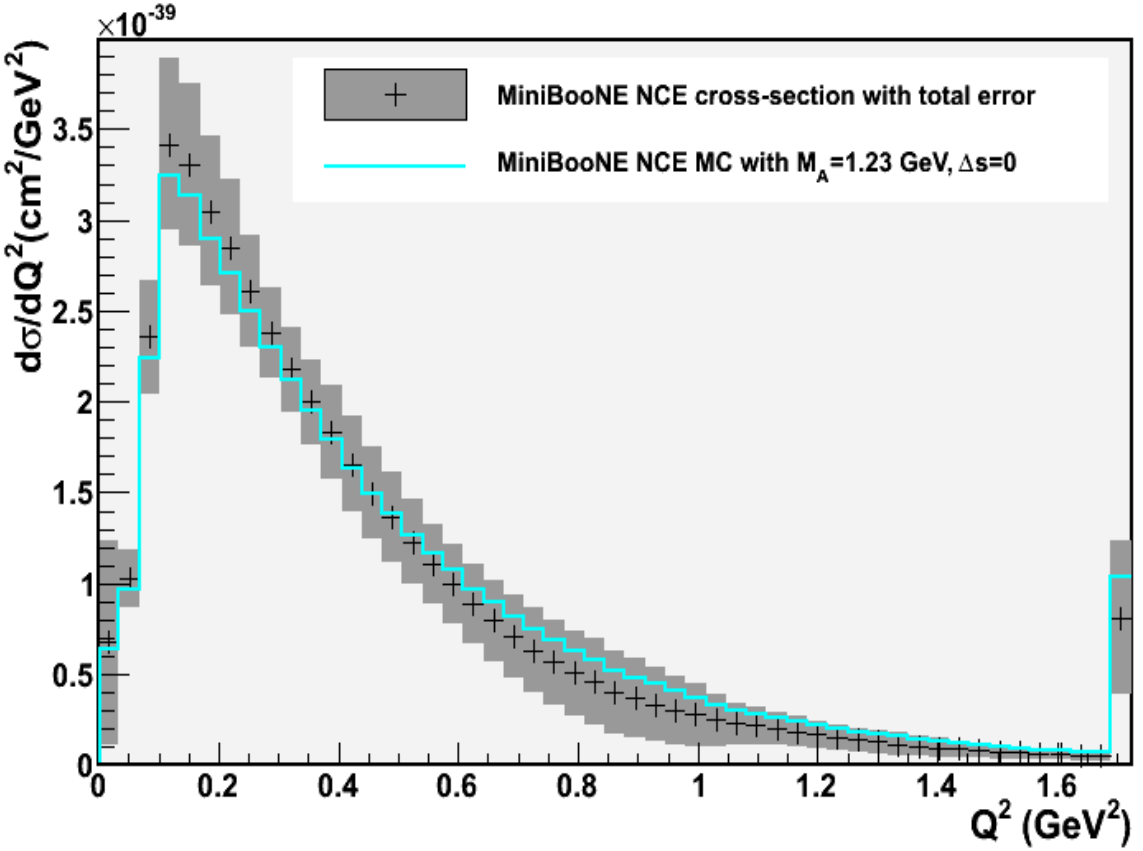


Phys. Rev. Lett. 103, 081801 (2009)

Cross-section results

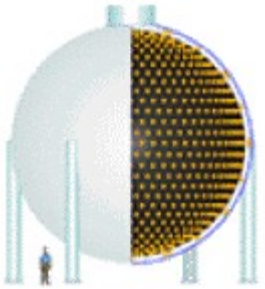


- NC elastic xsec
- Based on 94.5K NC elastic candidates
- First measurement in $Q^2 < 0.4$ GeV^2



arXiv:0909.4617

Conclusions and future plans



- Collect more anti-neutrino data (approved for a new 5E20 POT - currently running) for updated anti-neutrino and joint neutrino-anti-neutrino analyses

- Integration of SciBooNE data (near detector)

- Further studies of low-energy excess (MicroBooNE)