First Charged-Current Muon-Neutrino Inclusive Cross Section Measurement with the MicroBooNE Detector

Marco Del Tutto[1] and Anne Schukraft[2]
representing the MicroBooNE collaboration

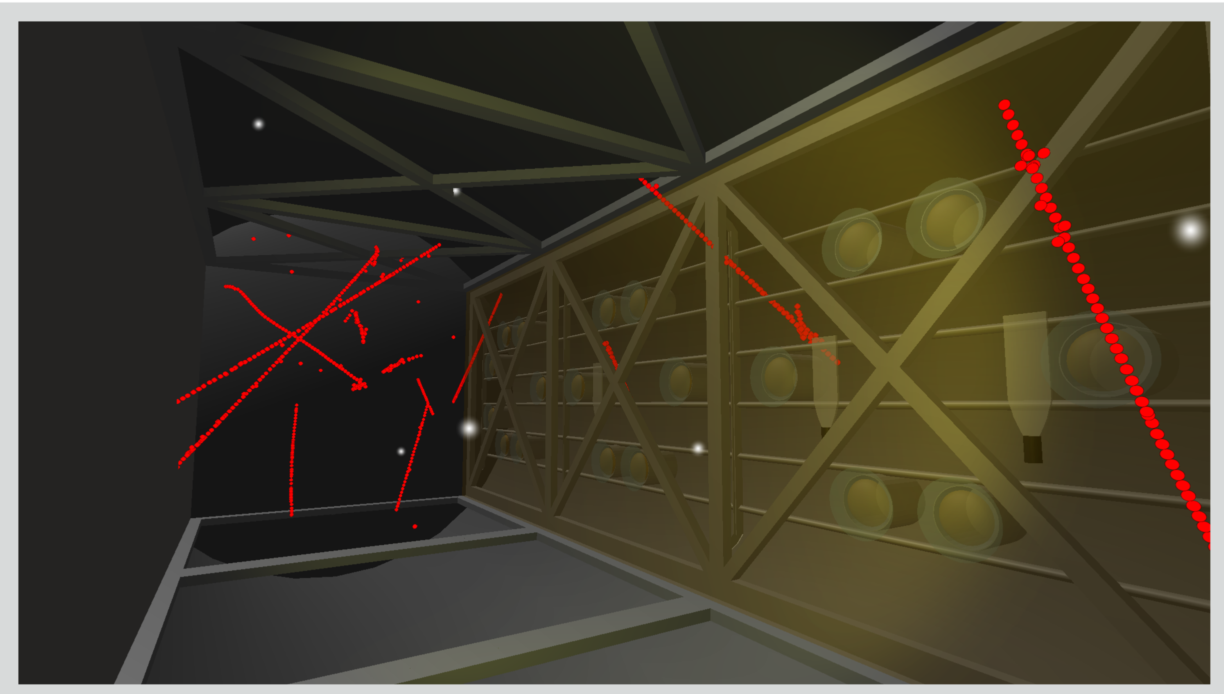
[1]*University of Oxford* *marco.deltutto@physics.ox.ac.uk*
[2]*Fermilab* *aschu@fnal.gov*

INTRODUCTION This poster presents MicroBooNE's first full ν_μ charged-current inclusive measurement using 1.6 x 10^{20} POT of data (6 months of data).

SIGNAL TOPOLOGY The presence of a neutrino-induced muon with or without other accompanying particles.

MOTIVATIONS

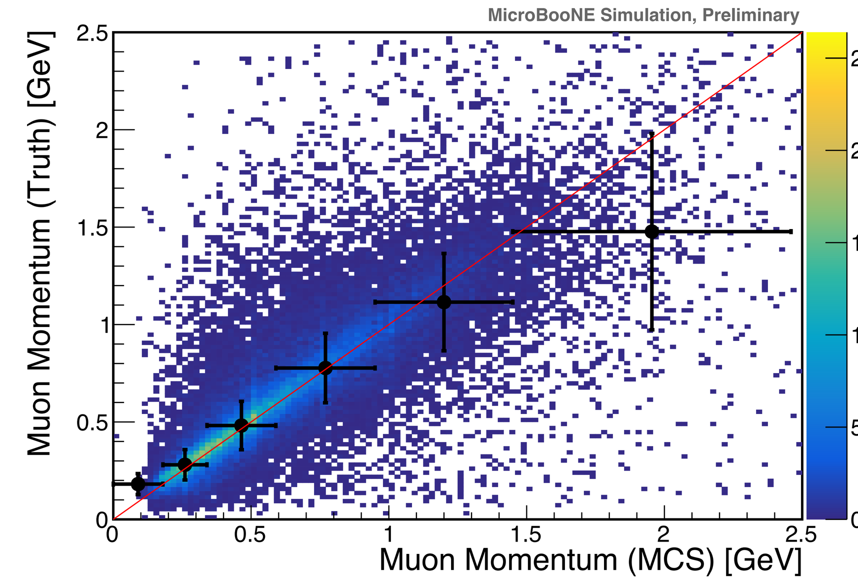
- The clear signal definition allows straight-forward comparisons to theory models and other experiments.
- The heavy target (argon) makes this measurement sensitive to several nuclear effects.
- Important for MicroBooNE reconstruction and tools development: techniques have been developed for cosmic rejection.
- The final sample can be used as a pre-selection for more exclusive channels.



MicroBooNE [1] is a Liquid Argon Time Projection Chamber at Fermilab located along the Booster Neutrino Beam Line (E_ν ~ 0.8GeV).

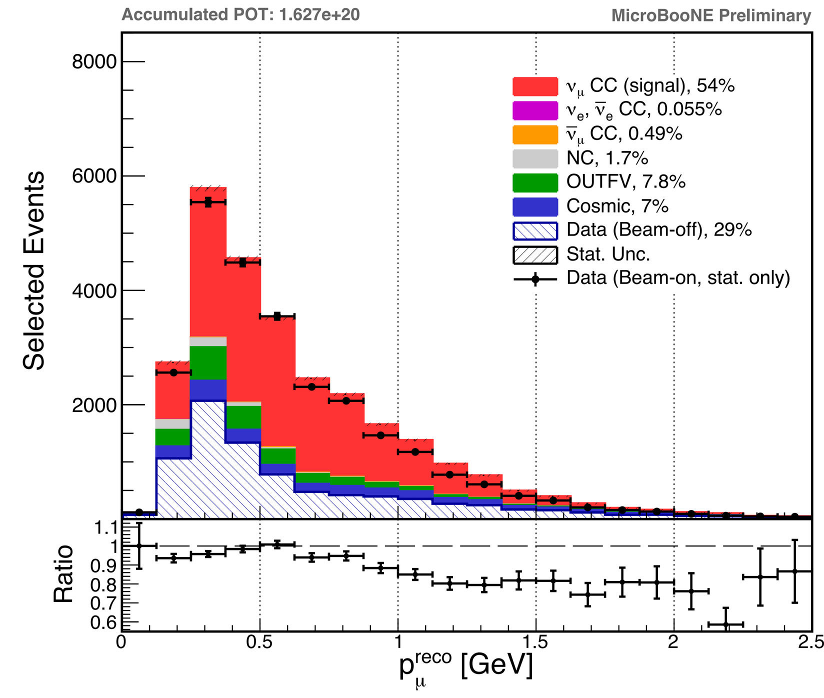
MOMENTUM ESTIMATION

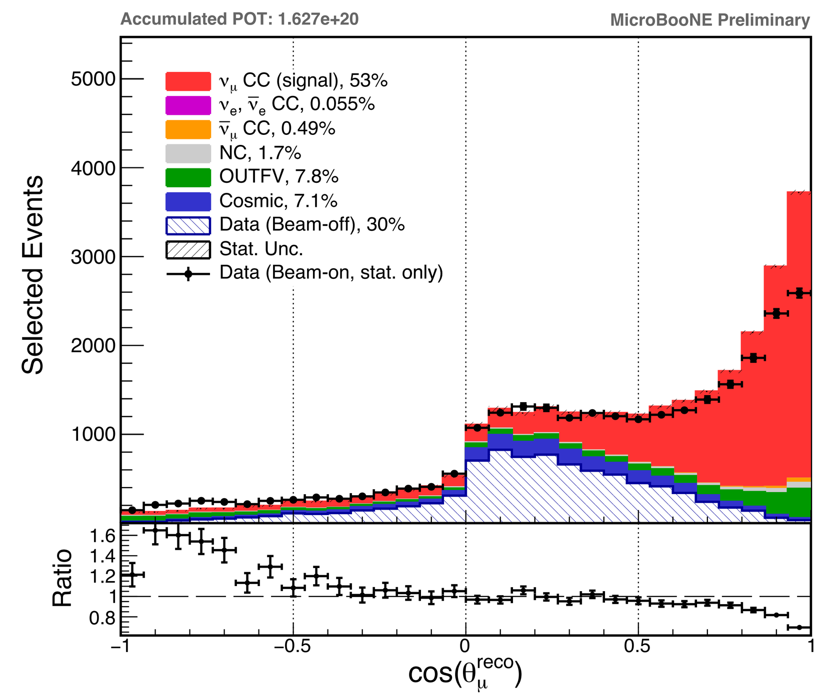
- Multiple Coulomb Scattering (MCS) is used to estimate the particle momentum: the scattering angle along the track trajectory depends on the initial momentum [2].
- Can be applied to both contained and exiting tracks: increases the overall acceptance.

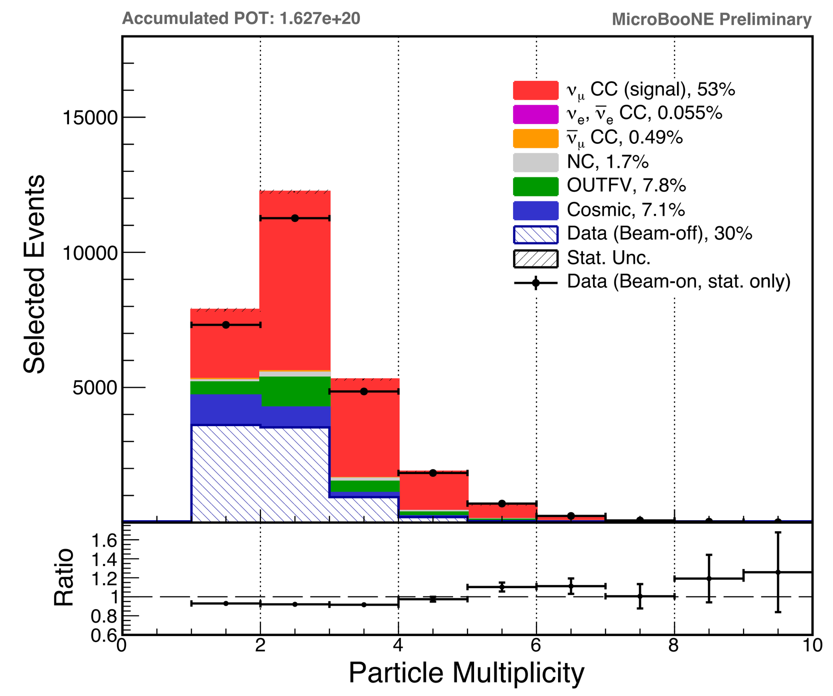


EVENT SELECTION

- Light must be detected in time with the beam spill (flash).
- A PMT-by-PMT matching is run between the flash and all reconstructed TPC interactions in order to select the best one (if any).
- Quality cuts ensure the event is well reconstructed.
- The candidate muon track must have a dQ/dx profile compatible with a minimum ionising muon.
- The reconstructed vertex has to be in the fiducial volume.







TOTAL CROSS SECTION

The total CC cross section on argon has been measured:

$$\sigma = \frac{N - B}{\epsilon \cdot N_{target} \cdot \Phi_{\nu_\mu}}$$

$$\sigma = 0.756 \pm 0.011\,(\text{stat}) \pm 0.186\,(\text{syst}) \times 10^{-38}\,\text{cm}^2$$

The GENIE MC predicted cross section is:

$$\sigma_{\text{MC}} = 0.867 \pm 0.004\,(\text{stat.}) \times 10^{-38}\,\text{cm}^2$$

N, B	Selected and background events
ε	Efficiency (smeared to reco. for differential)
N_{target}	Number of target nucleons
Φ	Muon-neutrino flux
Δ_i	Bin width of bin i (differential only)

This poster presented the first ν_μ charged-current inclusive measurement from MicroBooNE with full treatment of systematic uncertainties.

DIFFERENTIAL CROSS SECTION

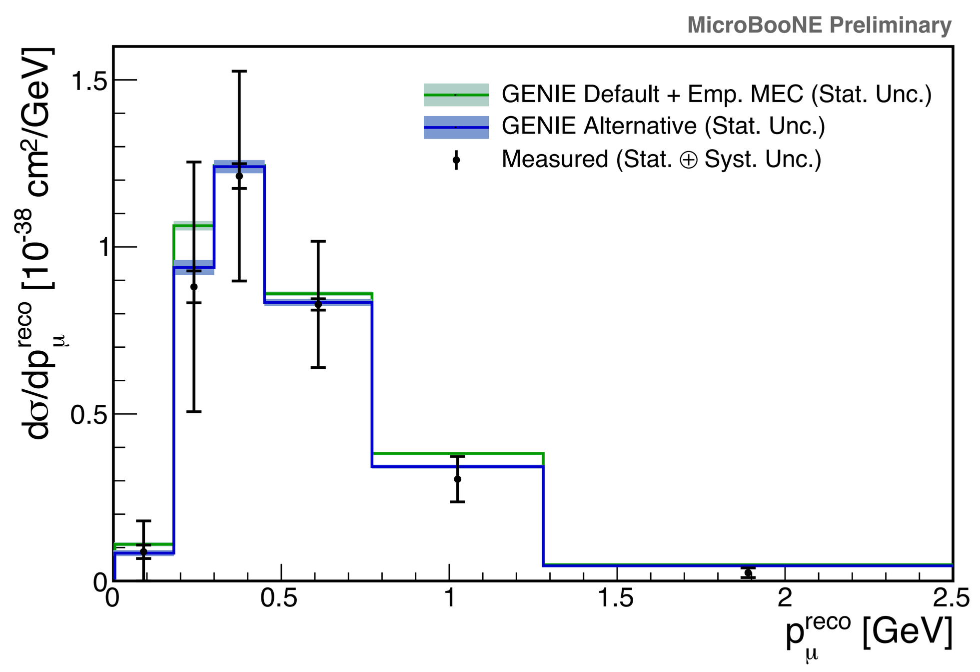
The differential cross section is measured as a function of reconstructed kinematics. Detector effects have not been deconvolved.

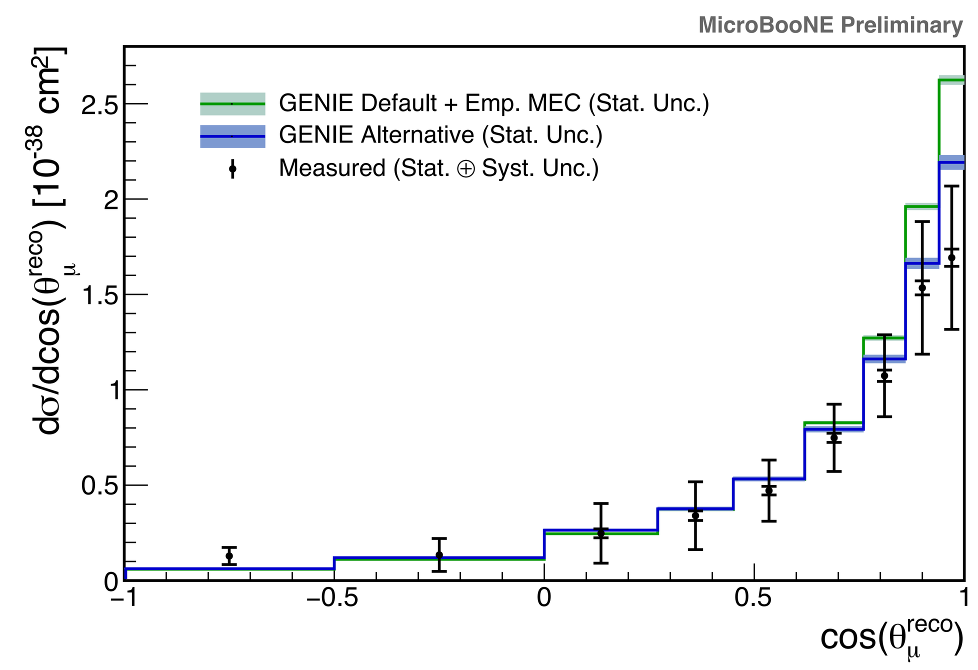
$$\left(\frac{d\sigma}{dp_\mu}\right)_i = \frac{N_i - B_i}{\tilde{\epsilon}_i \cdot N_{target} \cdot \Phi_{\nu_\mu} \cdot (\Delta p_\mu)_i}$$

$$\left(\frac{d\sigma}{d\cos\theta_\mu}\right)_i = \frac{N_i - B_i}{\tilde{\epsilon}_i \cdot N_{target} \cdot \Phi_{\nu_\mu} \cdot (\Delta \cos\theta_\mu)_i}$$

The cross section is compared with two sets of models [3

Model Element	GENIE Default + Emp. MEC	GENIE Alternative
Nuclear Model	Bodek-Ritchie Fermi Gas [4]	Local Fermi Gas [5,6]
Quasi-elastic	Llewellyn-Smith [7]	Nieves [5,6]
MEC	Empirical [8]	Nieves [5,6]
Resonant	Rein-Seghal [9]	Berger-Seghal [10]
Coherent	Rein-Seghal [9]	Berger-Seghal [10]
FSI	hA [3]	hA2014 [3]





SYSTEMATIC UNCERTAINTIES

Preliminary systematic uncertainties that affect the total cross section measurement. Detector systematics show a conservative estimate.

Error Source	Method	Relative Unc.
Beam Flux	multisim variations	11.9%
Cross Section	multisim variations	3.6%
Detector Response	unisim variations	18.8%
POT Counting	Toroids resolution	2%
Cosmics (out-of-time)	MC + Data Overlay	6.9%
Cosmics (in-time)	Off-beam statistics	1.1%
Beam Timing Jitter	On- minus off-beam flashes	4%