

Status of ICARUS Calibrations Group Activities

Christian Farnese (University of Padova),
Michael Mooney (Colorado State University)

ICARUS Collaboration Meeting
September 19th, 2018



Group Introduction

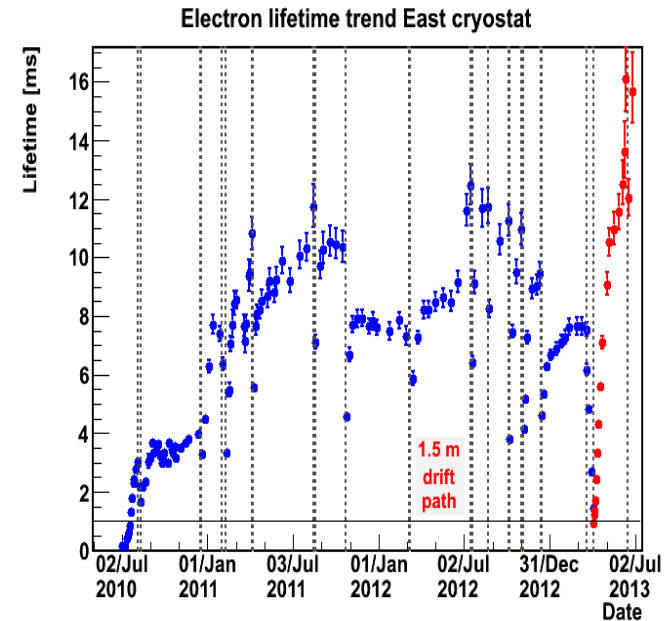
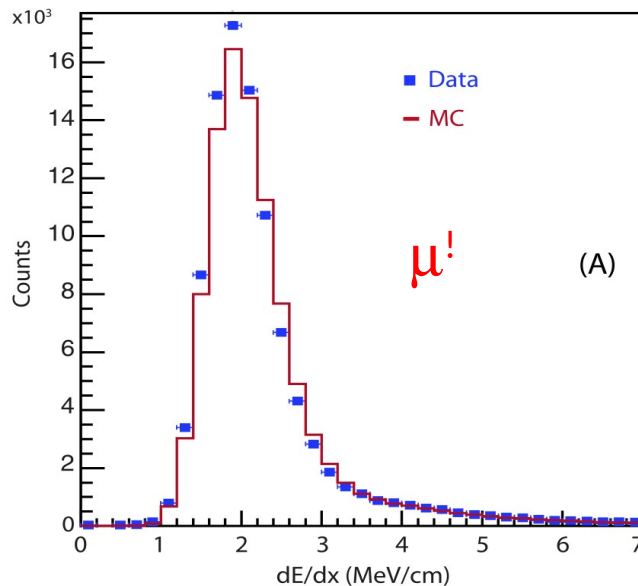


- ◆ ICARUS Calibration Working Group began meeting July 19th - during first meeting, co-conveners identified
- ◆ Four meetings have been held: July 19th, August 1st, August 21st, September 11th
- ◆ Tri-weekly meetings: Tuesdays at noon (FNAL time)
 - Next meeting on **October 2nd**
 - Zoom connection: <https://fnal.zoom.us/j/3288157593>
 - Minutes posted on Doc DB
 - On average 7-8 participants
- ◆ Mailing list: **ICARUS-CALIBRATION@fnal.gov**

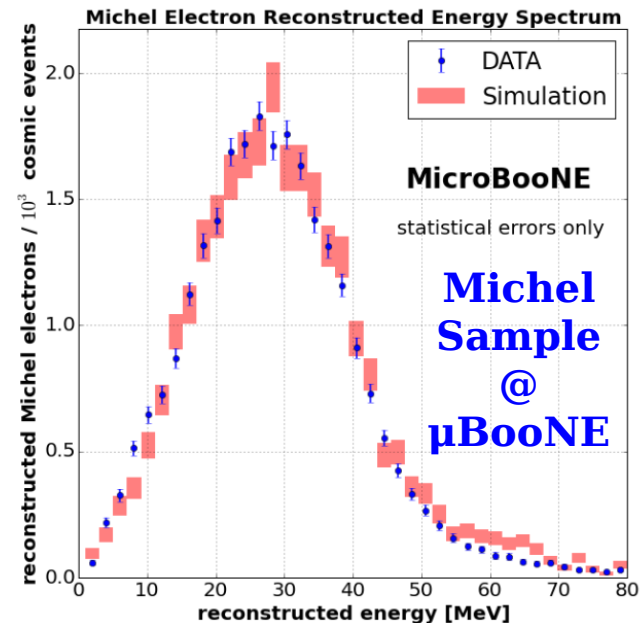
Group Vision

- ◆ Starting to bring together old knowledge and new knowledge regarding LArTPC calibrations
 - ICARUS: long history of experience with LArTPCs
 - MicroBooNE: new methods for near-surface LArTPCs
- ◆ Combining experience will be very helpful to data analysis for near-surface operation of ICARUS
 - Big advantage in getting to quality physics results in a **timely manner**
- ◆ **Dedicated meeting** talking about past experience from each experiment
 - ICARUS: **Doc DB #7786**
 - MicroBooNE: **Doc DB #7822**

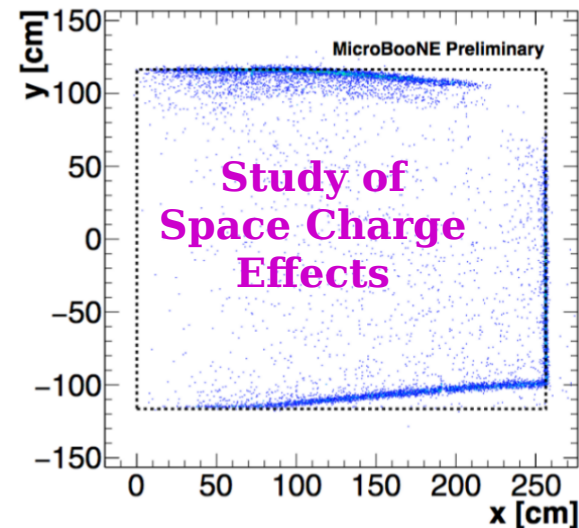
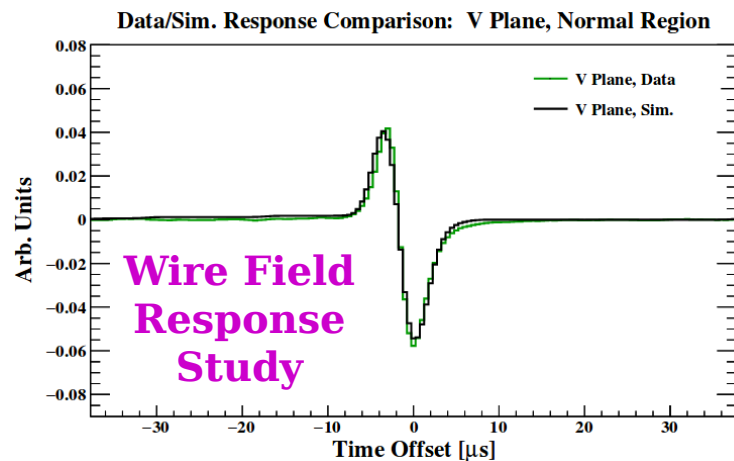
- ◆ ICARUS experience at LNGS is starting point for group activities
 - Equalization of TPC wire signals using test pulses
 - Calibration using reconstructed particles, in particular muon tracks
 - Purity measurements



- ◆ Experience at MicroBooNE with high cosmic rate environment very useful for ICARUS
- ◆ Items studied at MicroBooNE:
 - Noise levels
 - Electronics response
 - Wire field response
 - Electron lifetime
 - Space charge effects
 - dQ/dx uniformity checks
 - Recombination
 - High-level studies
 - e.g. Michel electrons

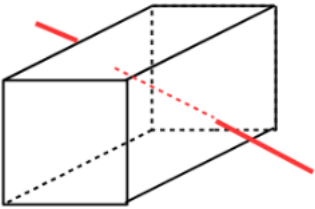


- ◆ Priorities for calibrations activities:
 - Update ICARUS calibrations chain to include cosmics-based calibrations (a la MicroBooNE)
 - Begin defining/developing physics samples for calibrations (e.g. Michel electrons from cosmic muons)
 - Establish good communication with other working groups
- ◆ Regarding last item, have defined liaisons to other groups to ensure robust communication chain:
 - TPC Electronics - Mike Mooney
 - PMTs - Gianluca Petrillo
 - CRT - Biswaranjan Behera
 - Reconstruction/Simulations - Christian Farnese
 - DAQ and Online Monitoring - Christian Farnese

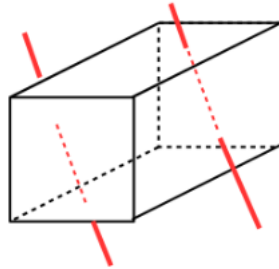


- ◆ In updating ICARUS calibrations chain for cosmics-based calibrations, MicroBooNE experience very helpful - see **Doc DB #7822** for more info
- ◆ Relevant calibrations include wire field response, electron lifetime, recombination, space charge effects, and studies of reconstruction performance (e.g. charge clustering)

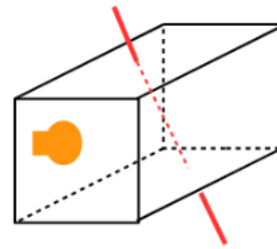
Anode-Cathode crossing
low-stats / low-coverage



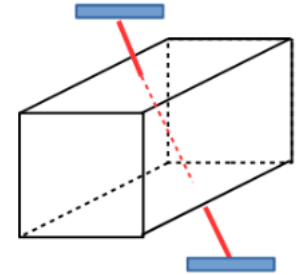
Anode **or** Cathode piercing
low coverage @ center



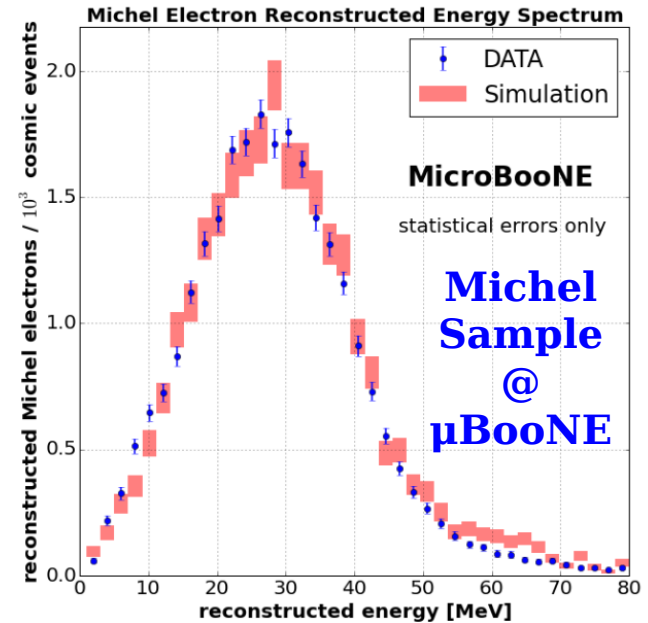
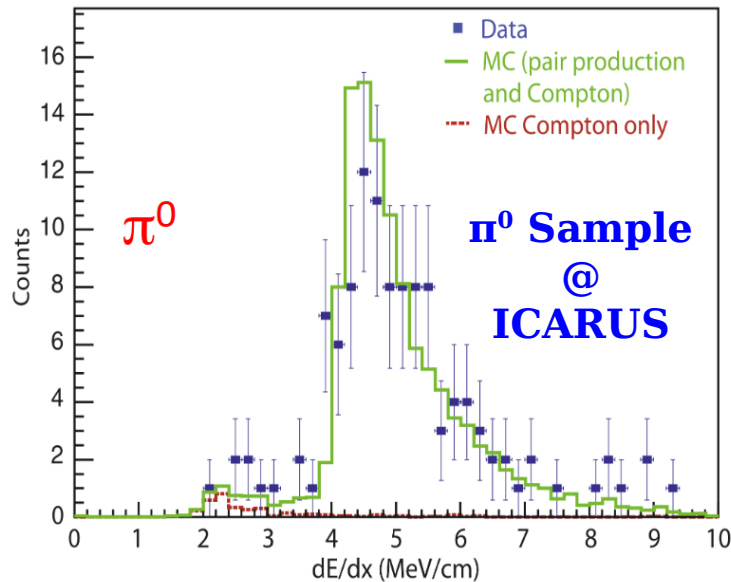
Flash-Matching
More complex reconstruction



Cosmic-Ray Tagger
In development

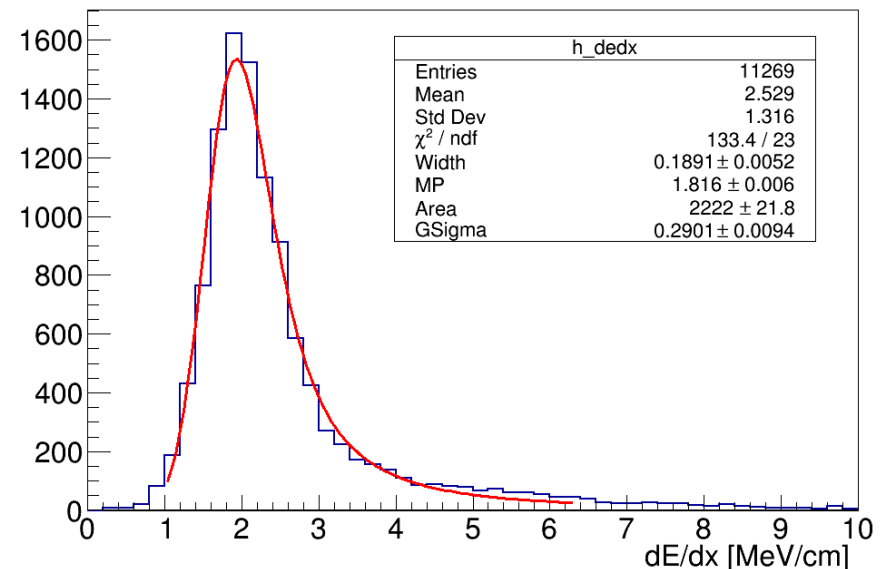


- ◆ Toward calibrations with cosmics, must know position of cosmic track in drift direction
 - Equivalently: must know t_0 (time cosmic ray enters TPC)
- ◆ Hannah Rogers (CSU postdoc) currently porting tools for t_0 -tagging from MicroBooNE/ProtoDUNE
 - Anode-piercing track tagging from MicroBooNE
 - Cathode-crossing track tagging from ProtoDUNE-SP

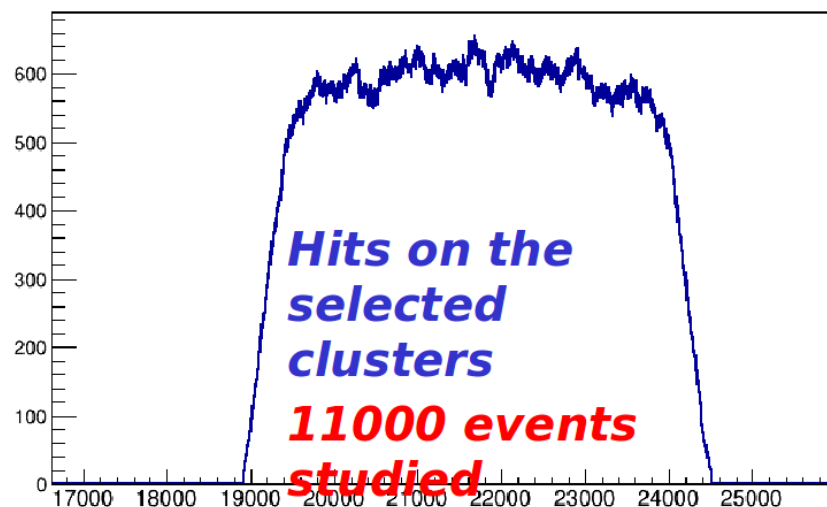
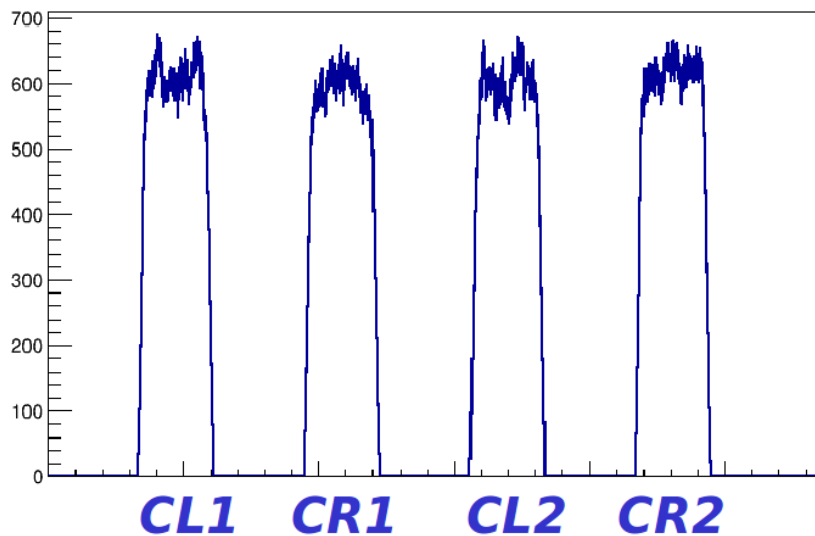


- ◆ Next goal: design selection for physics samples relevant for detector calibration
 - Examples include stopping muons, Michel electrons, neutral pions, cosmogenic showers for NuMI physics, etc.
 - Ultimately automate creation of samples in nominal processing of data in order to expedite calibration chain

- ◆ With t_0 -tagged cosmic tracks and other physics samples in hand, can perform dedicated calibrations
- ◆ One example: ensure uniformity of TPC channel gain across entire TPC
 - Result is set of calibration constants to convert hit area to deposited energy
- ◆ Required steps:
 - Obtain t_0 -tagged cosmic track sample
 - Adjust for LAr purity
 - Extract most probable value (MPV) from hit charge distribution



- ◆ First studies of TPC wire calibration with track hits has been performed
 - Purpose: get a sense of required statistics
 - 2D clusters from 11k cosmic events - old CORSIKA MC
 - Roughly 600 entries/channel
- ◆ For $\sim 1\%$ uncertainty, need sample of $\sim 200\text{k}$ tracks

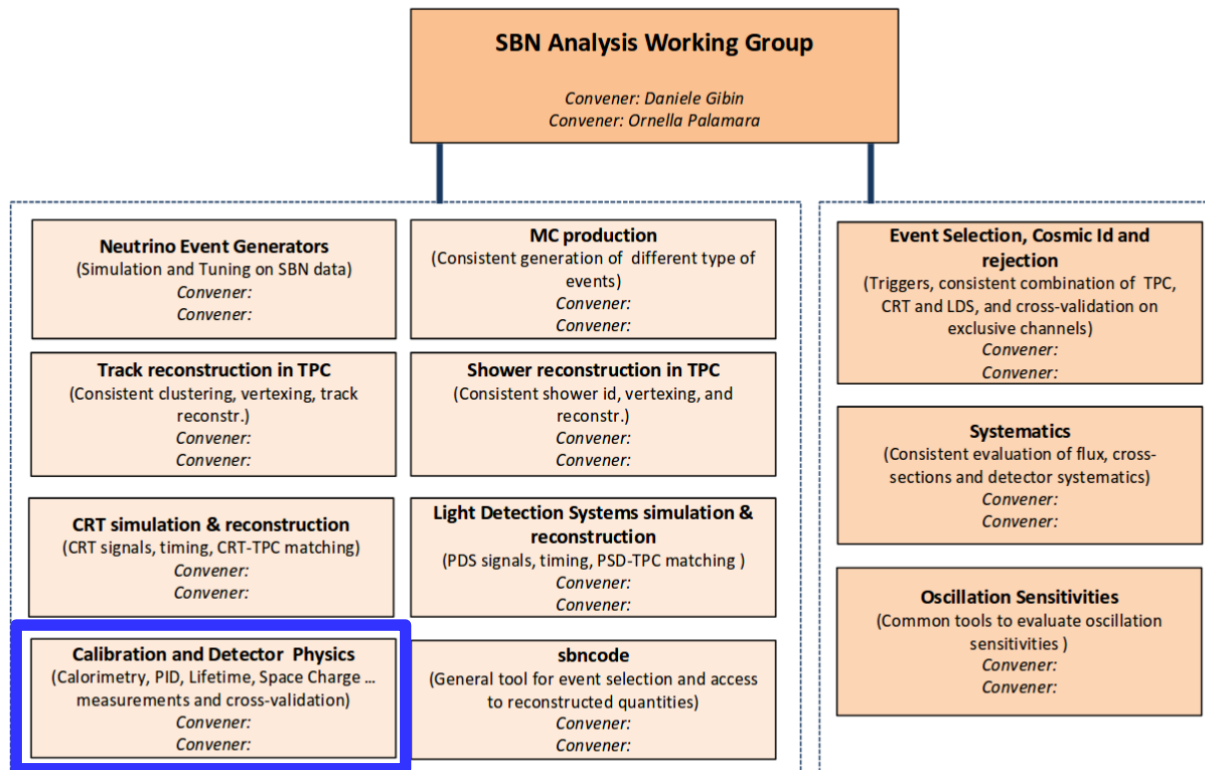




Meetings w/ Other Groups



- ◆ Calibration Group beginning to meet with other working groups to understand interfaces
 - In addition to liaison maintaining chain of communication
- ◆ Have already met with PMT group - discussion:
 - Relevant calibrations:
 - Make timing and gain of PMTs uniform across subsystem
 - Ensure light yield well known across cryostat
 - Monitoring of calibration during data-taking
 - PMT gain calib. hardware: laser w/ known light amount
 - Calibration Group action item: ensure PMT group is kept in the loop regarding procurement of physics samples (such as stopping muons)
- ◆ Goal: meet with other groups in next two months



- ◆ In discussion: combined SBN working groups, including calibration group (TPC focus)
 - One possibility is to expand scope of current ICARUS calibration group - has been proposed, being discussed

- ◆ ICARUS Calibration Working Group has begun meeting regularly
 - Tri-weekly meetings on Tuesdays at noon (FNAL time)
 - Next meeting on October 2nd
- ◆ First priorities:
 - Continue to meet with other working groups
 - Establish t_0 -tagged track sample and other physics samples for use in dedicated calibrations
 - Carry out first studies of dedicated calibrations – see Christian’s talk on purity measurement studies
- ◆ Please give us feedback (now is a good time!) – are there specific requests from other working groups? Concerns? Suggestions?