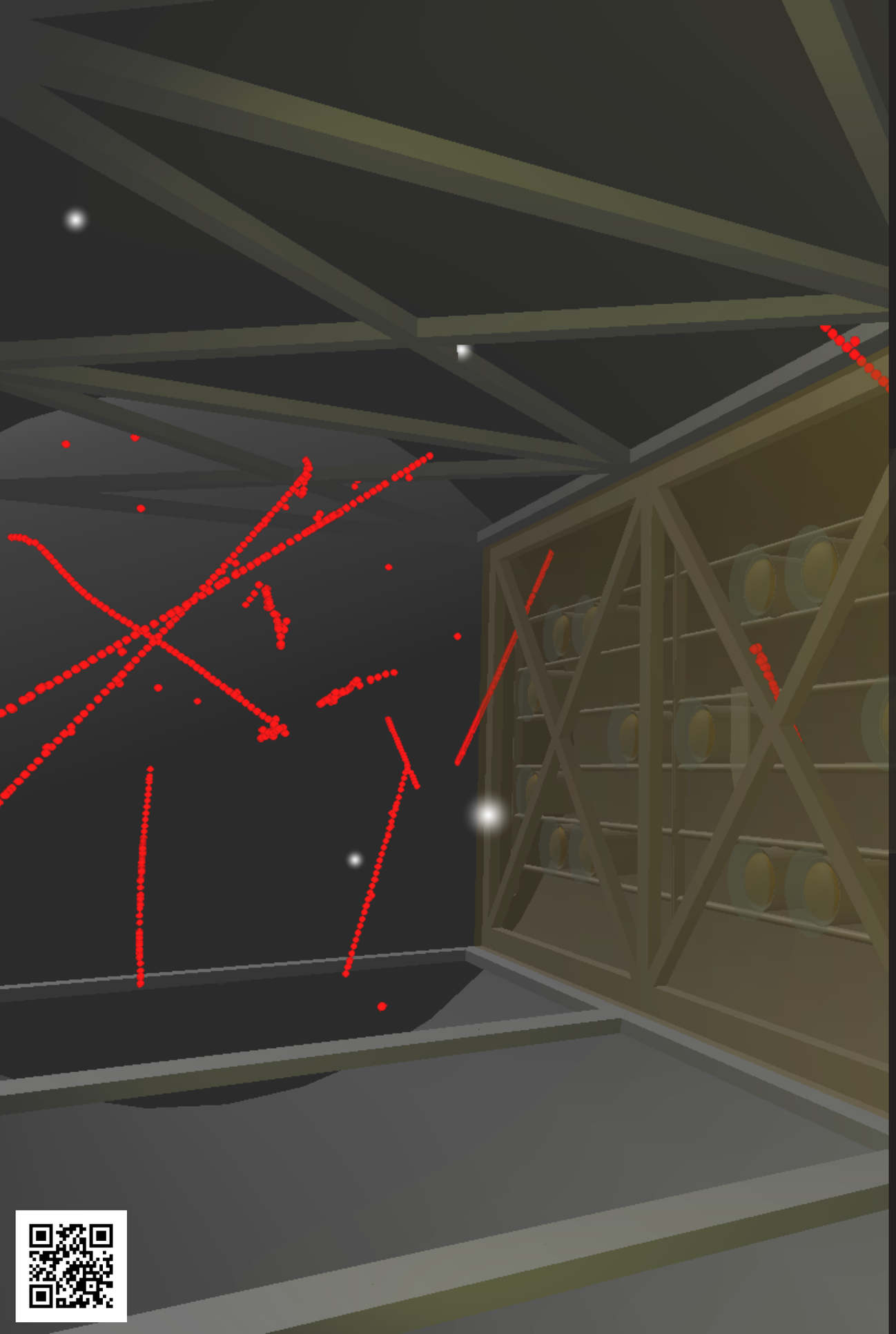


UNIVERSITY OF OXFORD

μBooNE

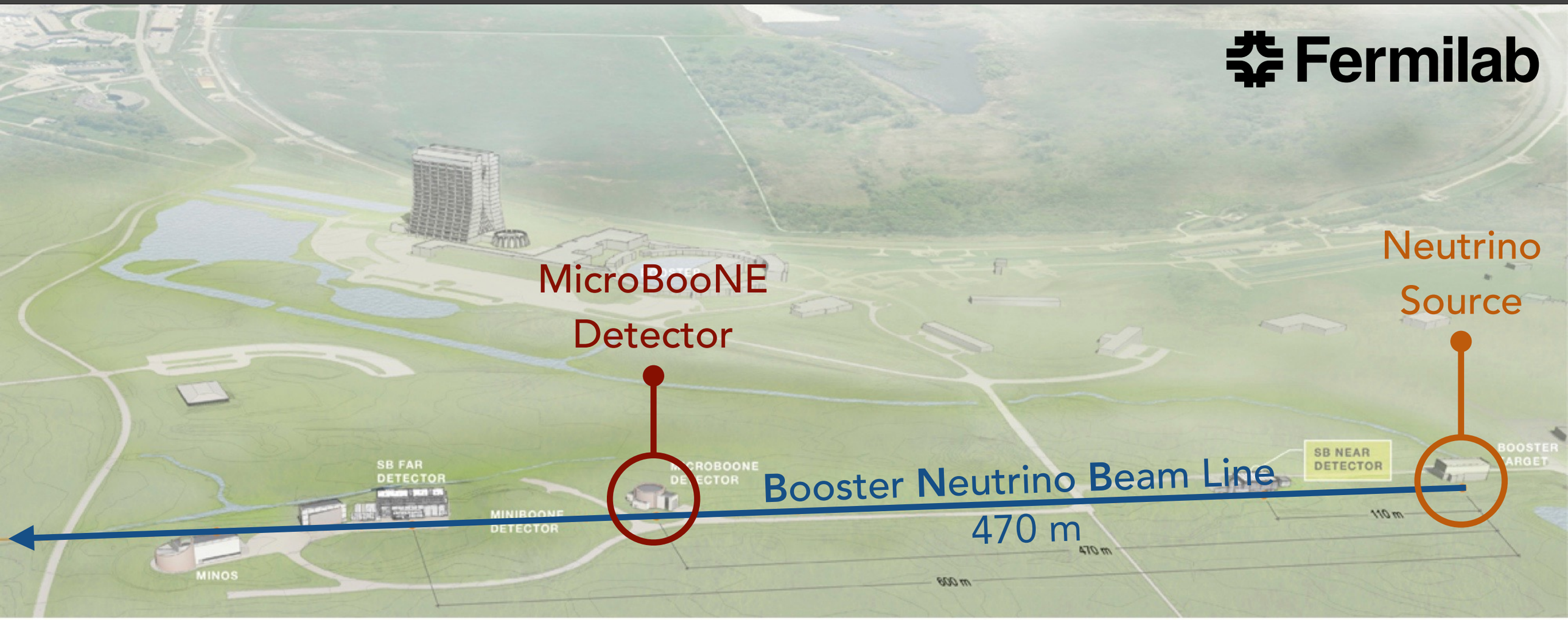
Neutrino interactions in MicroBooNE

Marco Del Tutto

52nd Rencontres de Moriond EW

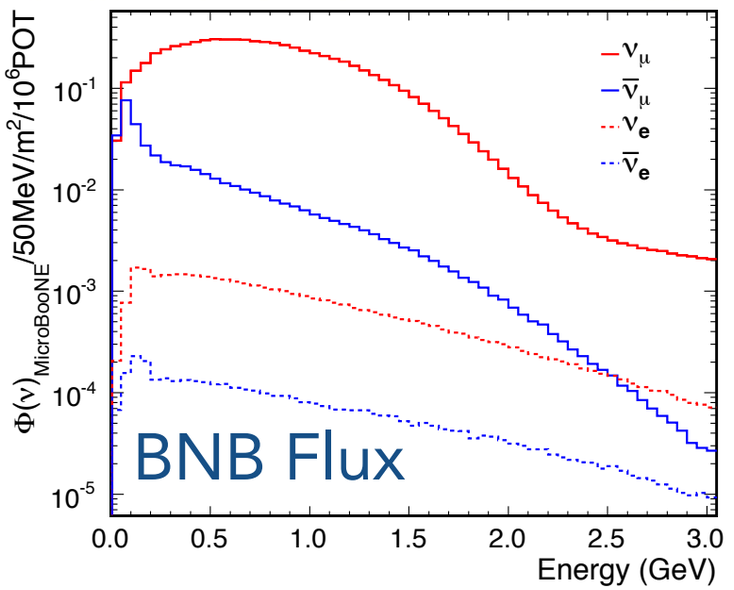
21st March 2017

The MicroBooNE Experiment



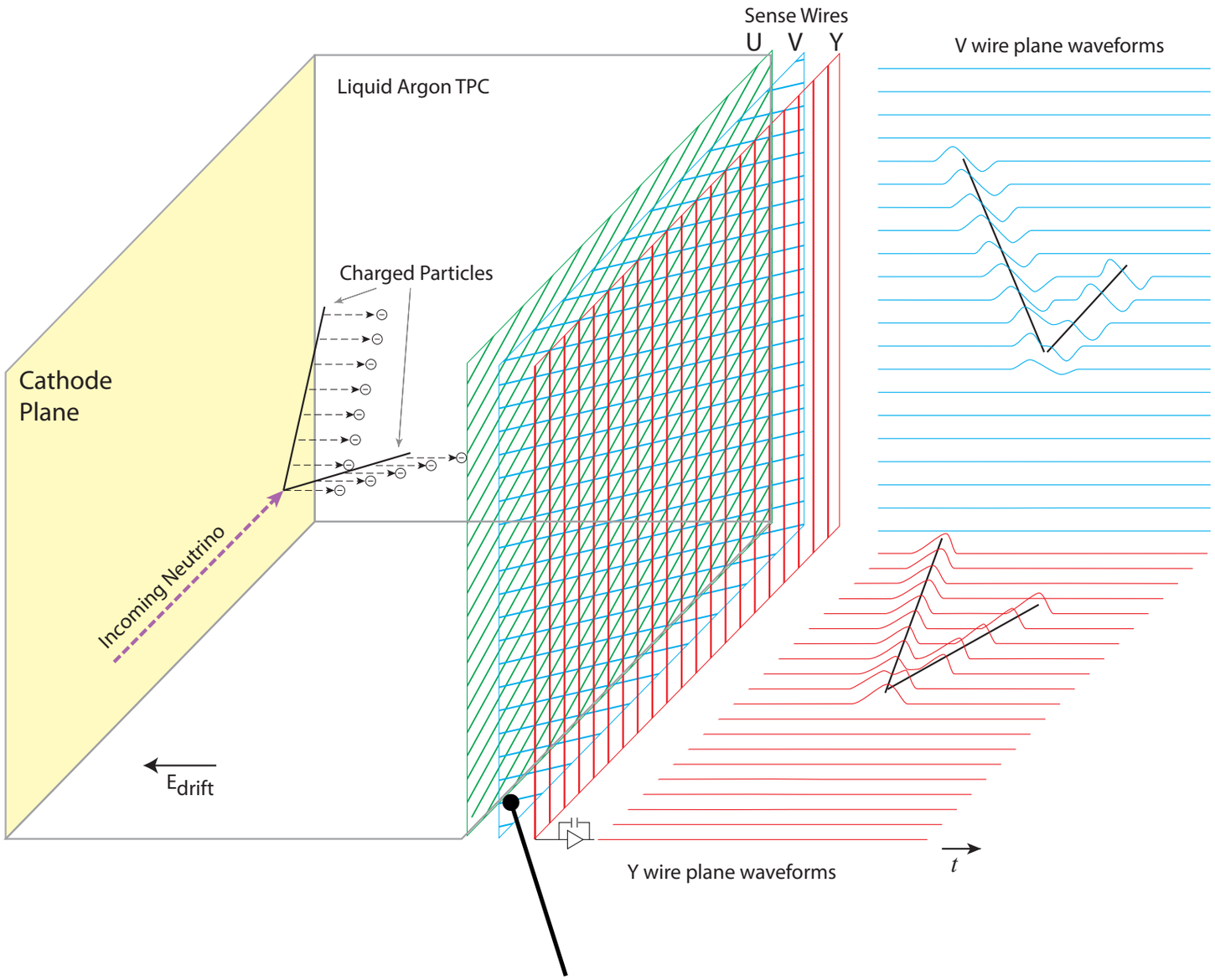
Goals of the **S**hort **B**aseline **N**eutrino program:

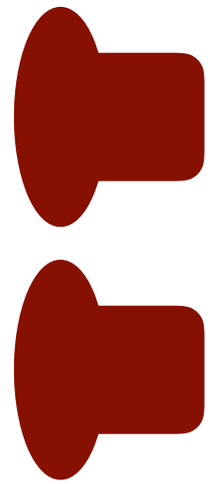
- low-energy excess observed by MiniBooNE
- sterile neutrinos
- cross section measurements



The MicroBooNE Detector

A liquid argon time projection chamber



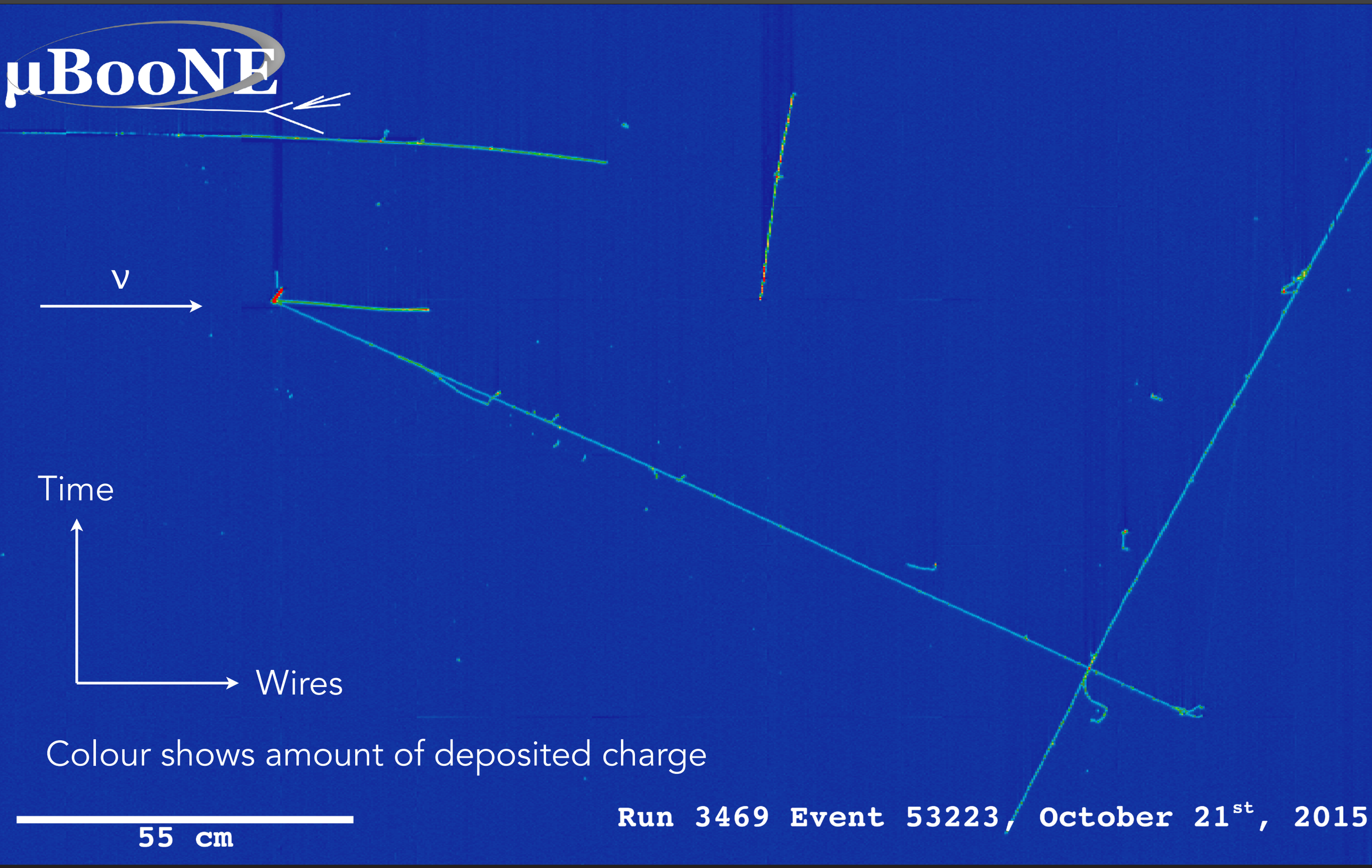


32 8″ Cryogenic PMTs

8192 wires (3 mm pitch)

170 ton LArTPC (total mass)

The MicroBooNE Detector



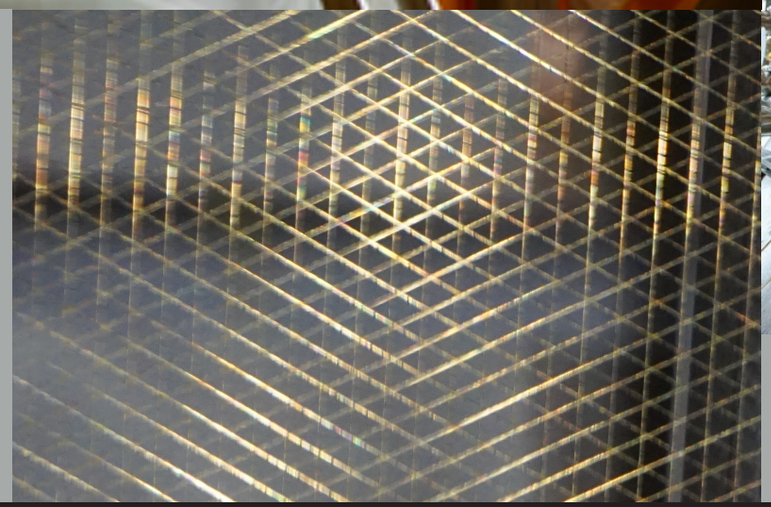
The MicroBooNE Detector

Stainless steel wires

with gold coating

3 wire planes

8192 wires total



MicroBooNE cryostat lowered into the pit

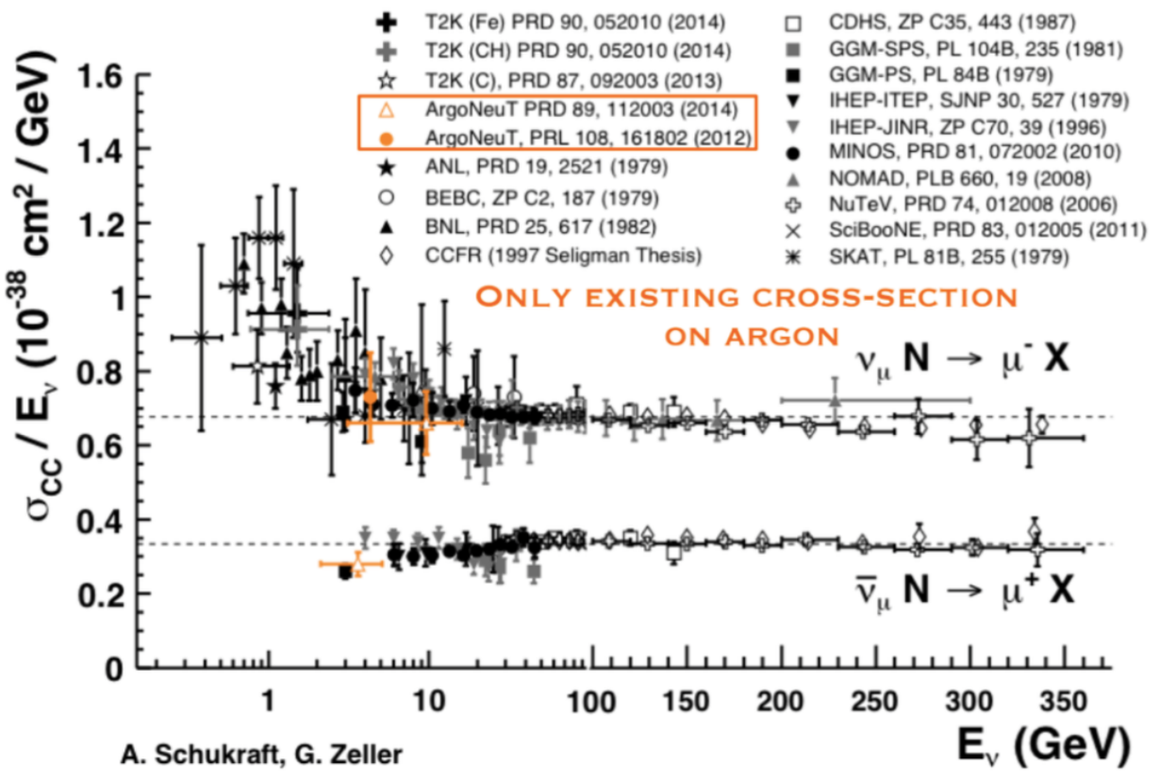
Inside the detector: PMT system

Motivations

- Neutrino oscillation goals require precise measurements of neutrino (and antineutrino) cross sections (e.g. DUNE experiment).

- MicroBooNE can probe different theories of nuclear effects in ν-Ar scattering

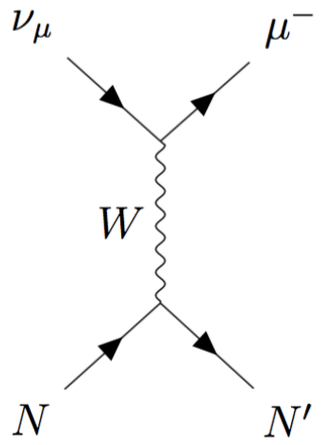
- ν-Ar is important as there are only limited measurements and the future short and long baseline neutrino programs will both use argon for their neutrino detectors

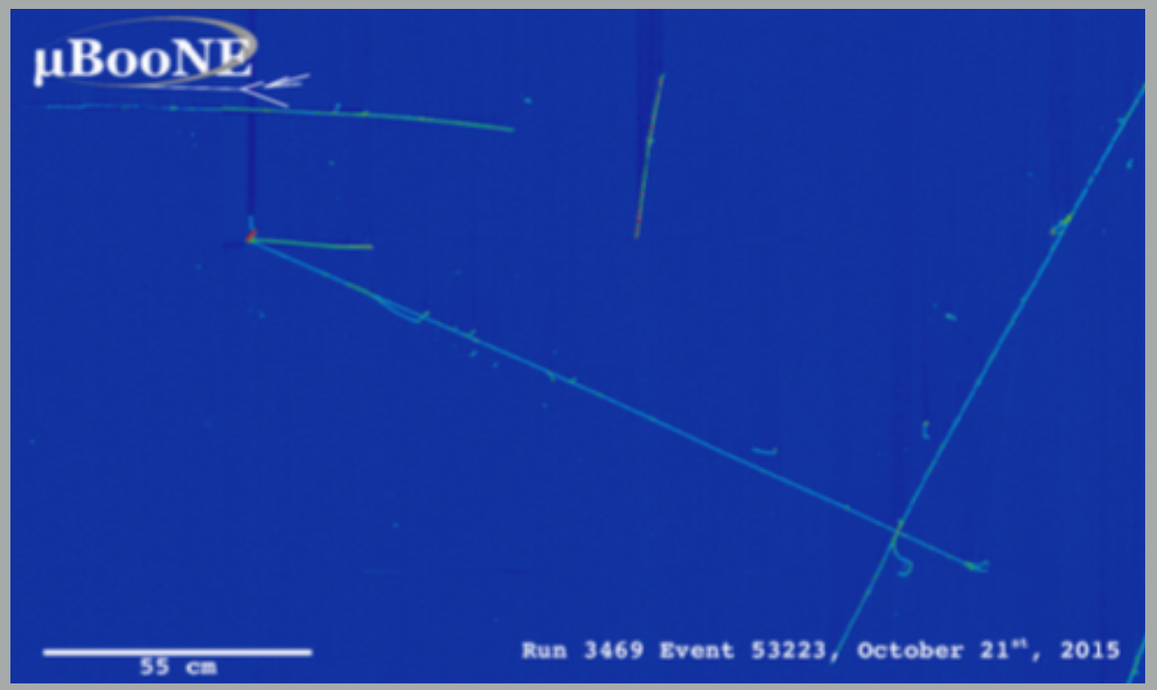


MicroBooNE

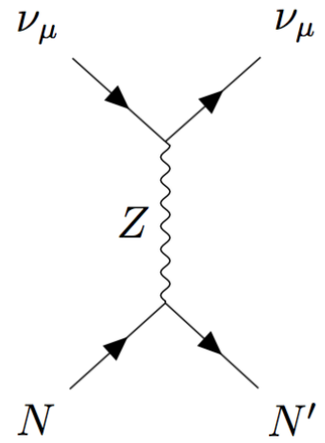
Neutrino Interactions in MicroBooNE

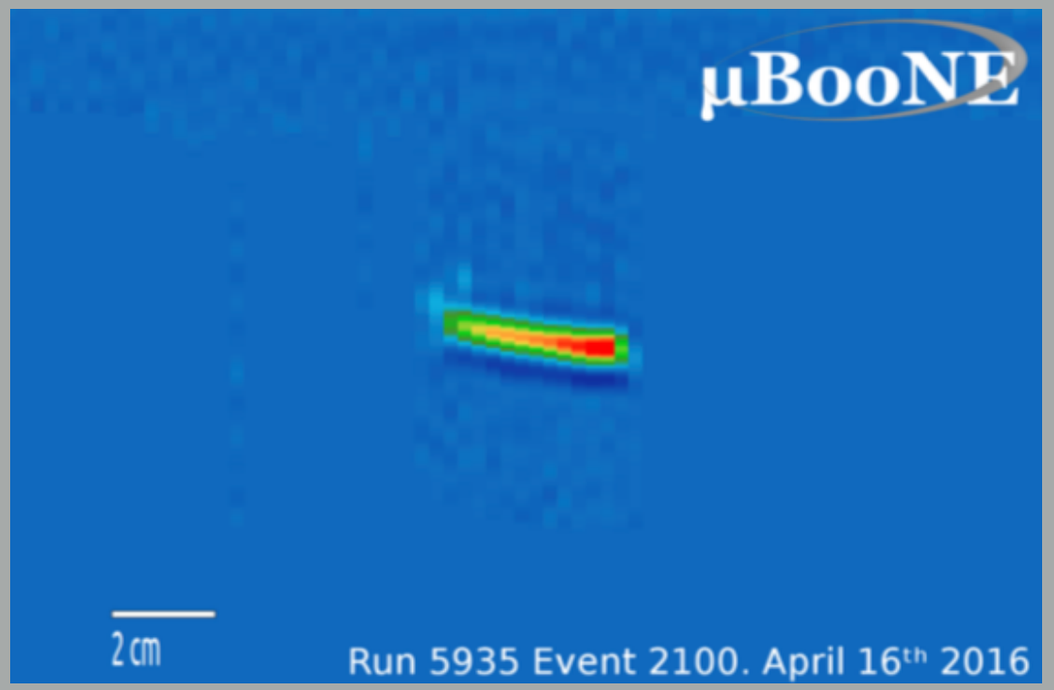
Charged Current Events





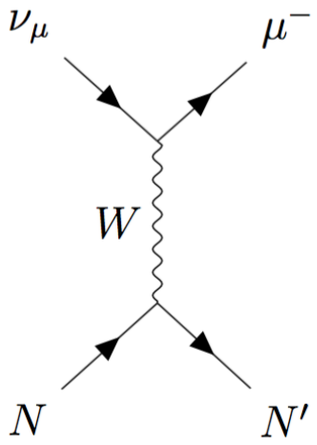
Neutral Current Events

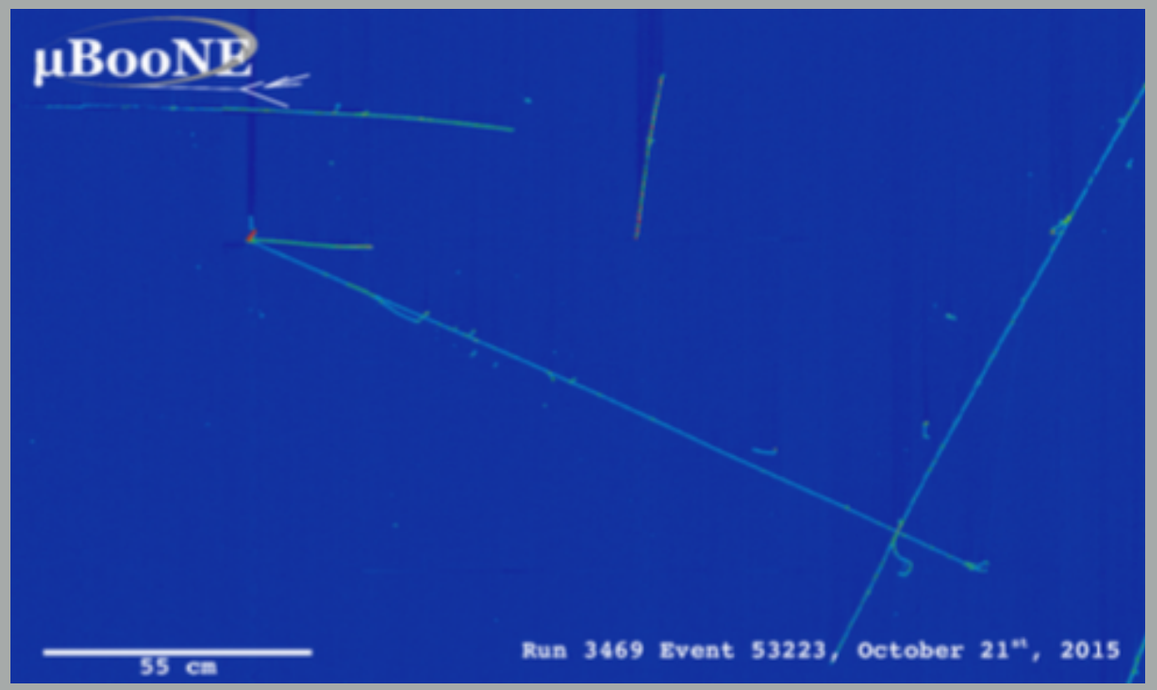




Neutrino Interactions in MicroBooNE

Charged Current Events





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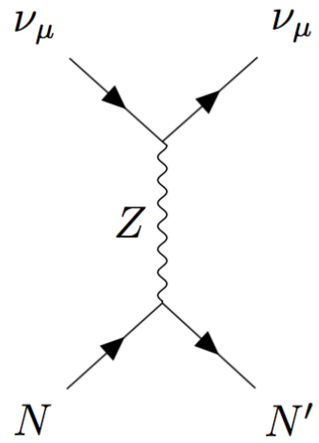
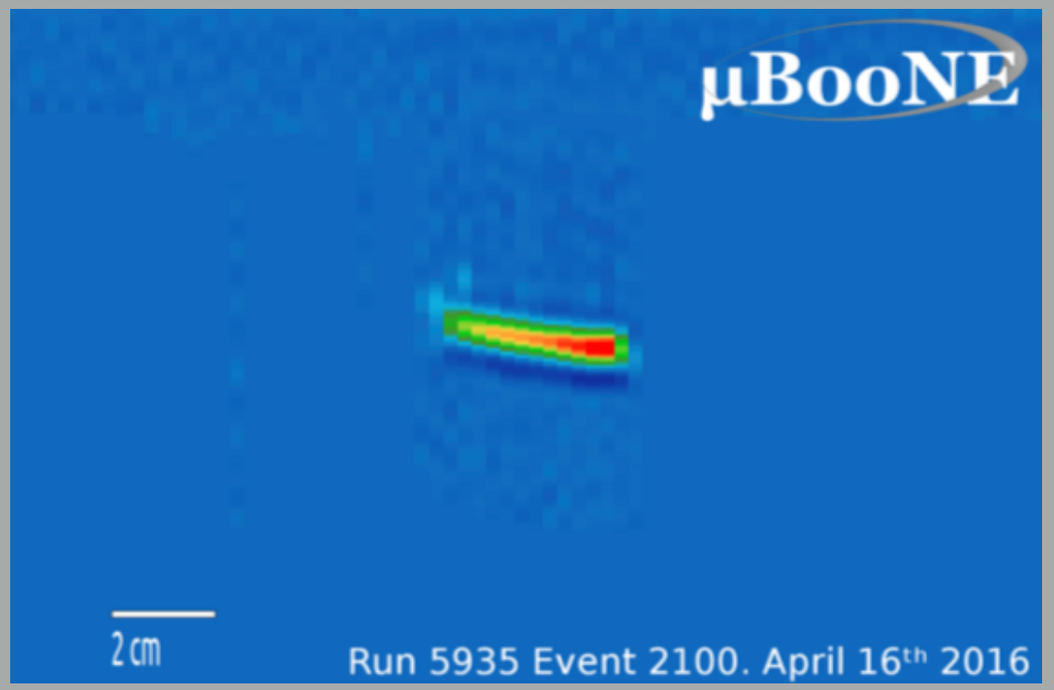
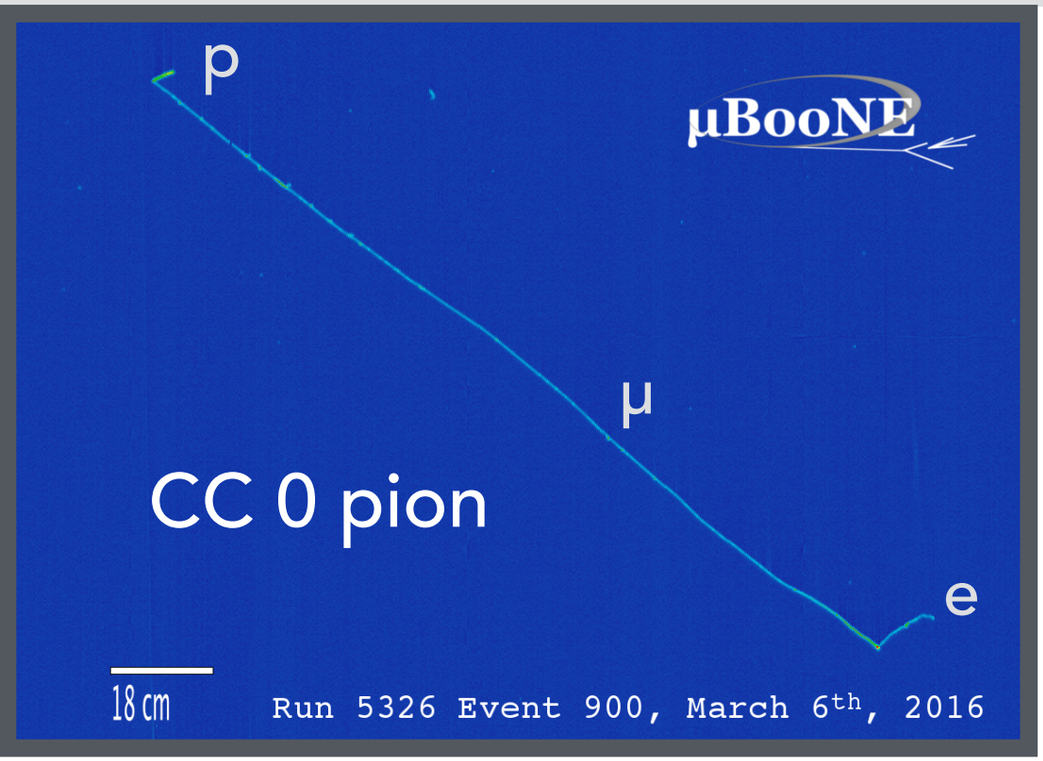




Neutrino Interactions in MicroBooNE

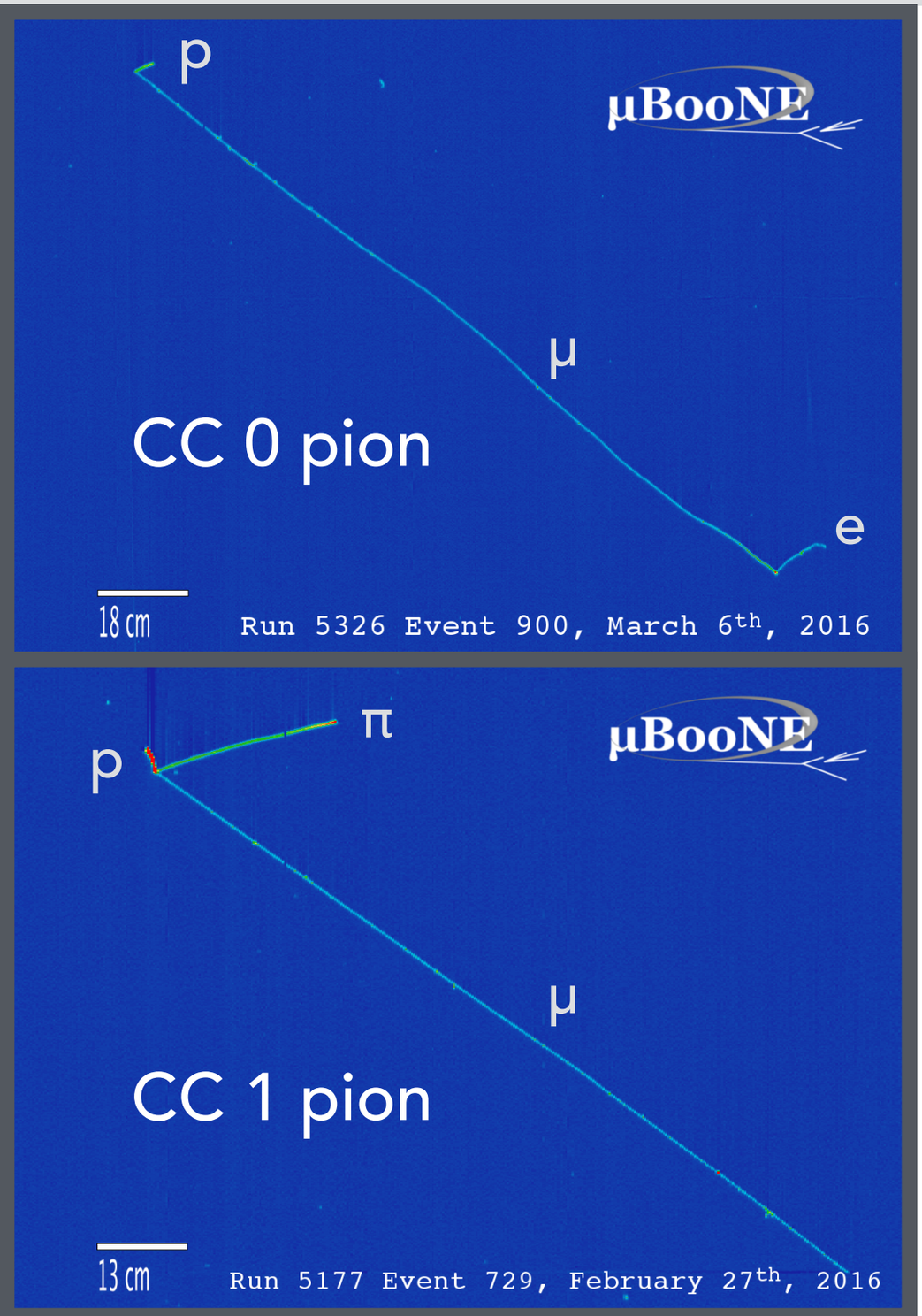
Charged current events



- Collection plane images
- Colour indicates amount of deposited charge
- Neutrino beam coming from the left

Neutrino Interactions in MicroBooNE

Charged current events



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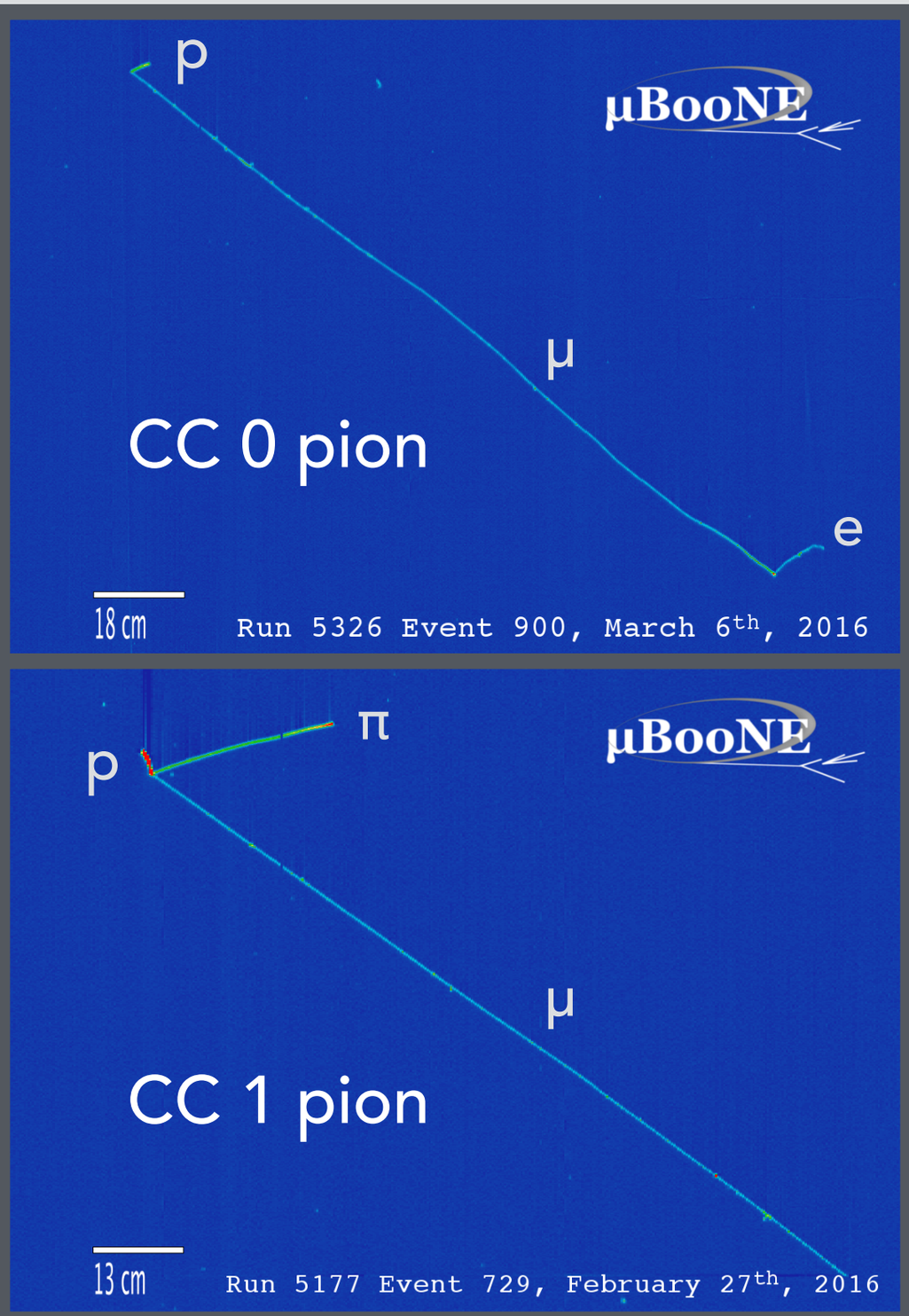
Neutrino Interactions in MicroBooNE

Charged current events



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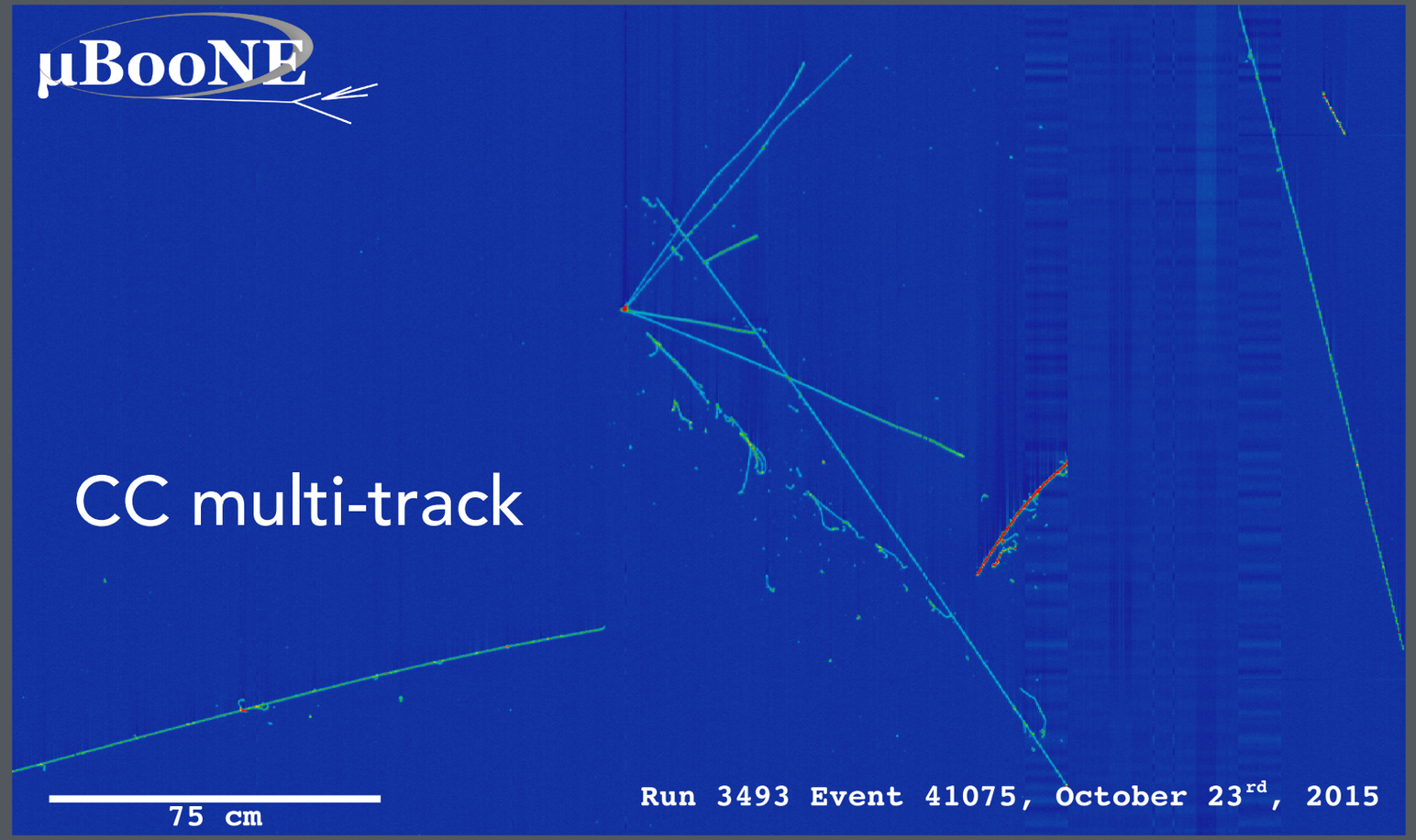
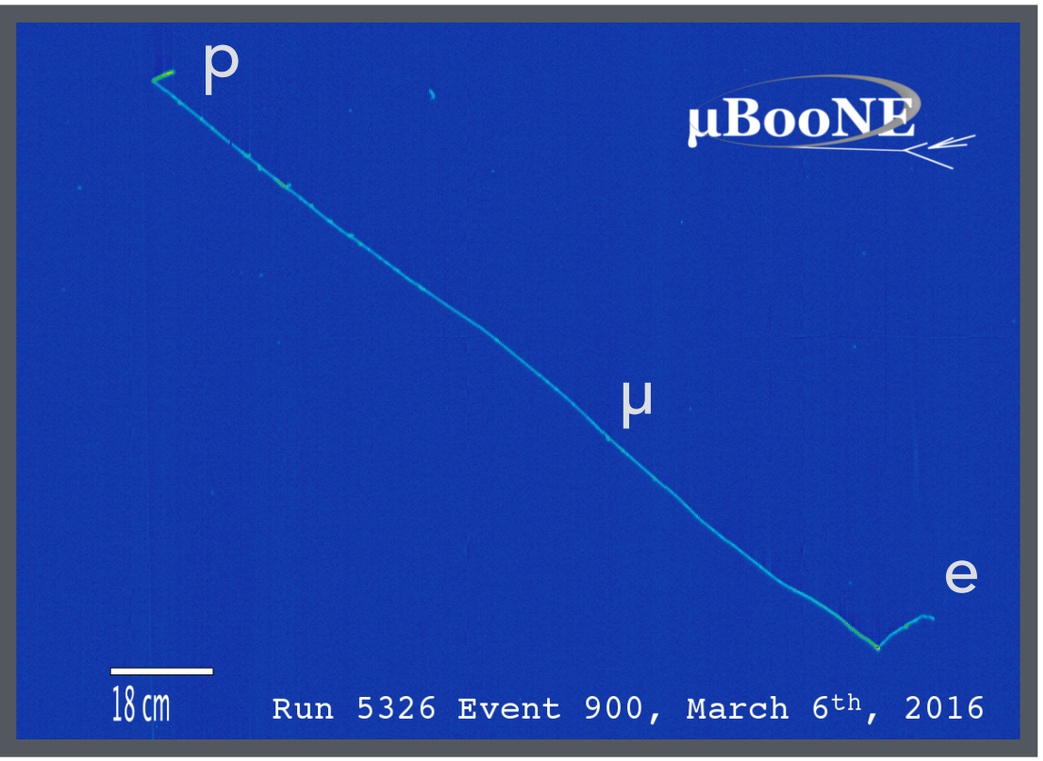


Charged Current Interactions

ν_μ CC-Inclusive Analysis



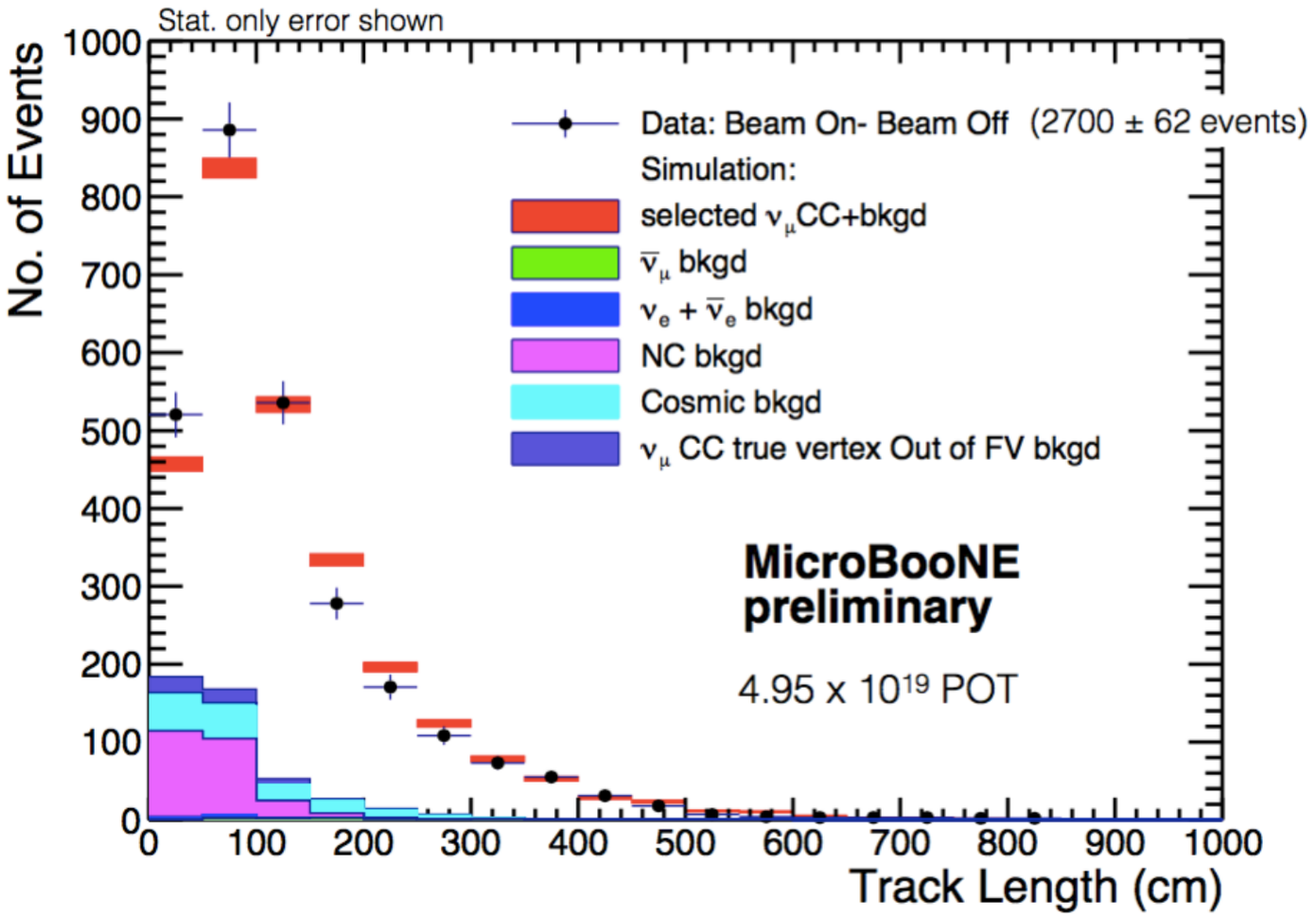
- First channel that will be addressed by the MicroBooNE cross-section program
- Simple: looking for a long muon track
- We have an automated reconstruction and event selection

Motivations

- Interesting physics measurement on argon, provides input for theory
- Will constrain the ν_e rate in MicroBooNE and other backgrounds
- Will provide a sample to study other specific channels (π^0, proton kinematics, …)

Charged Current Interactions

CC-inclusive event distributions



Data

(Beam On – Beam Off)

corresponds to 4.95x10^{19} POT,

about 2700 ν_μ-CC candidate events

MC

Neutrino interaction (GENIE 2.8.6),

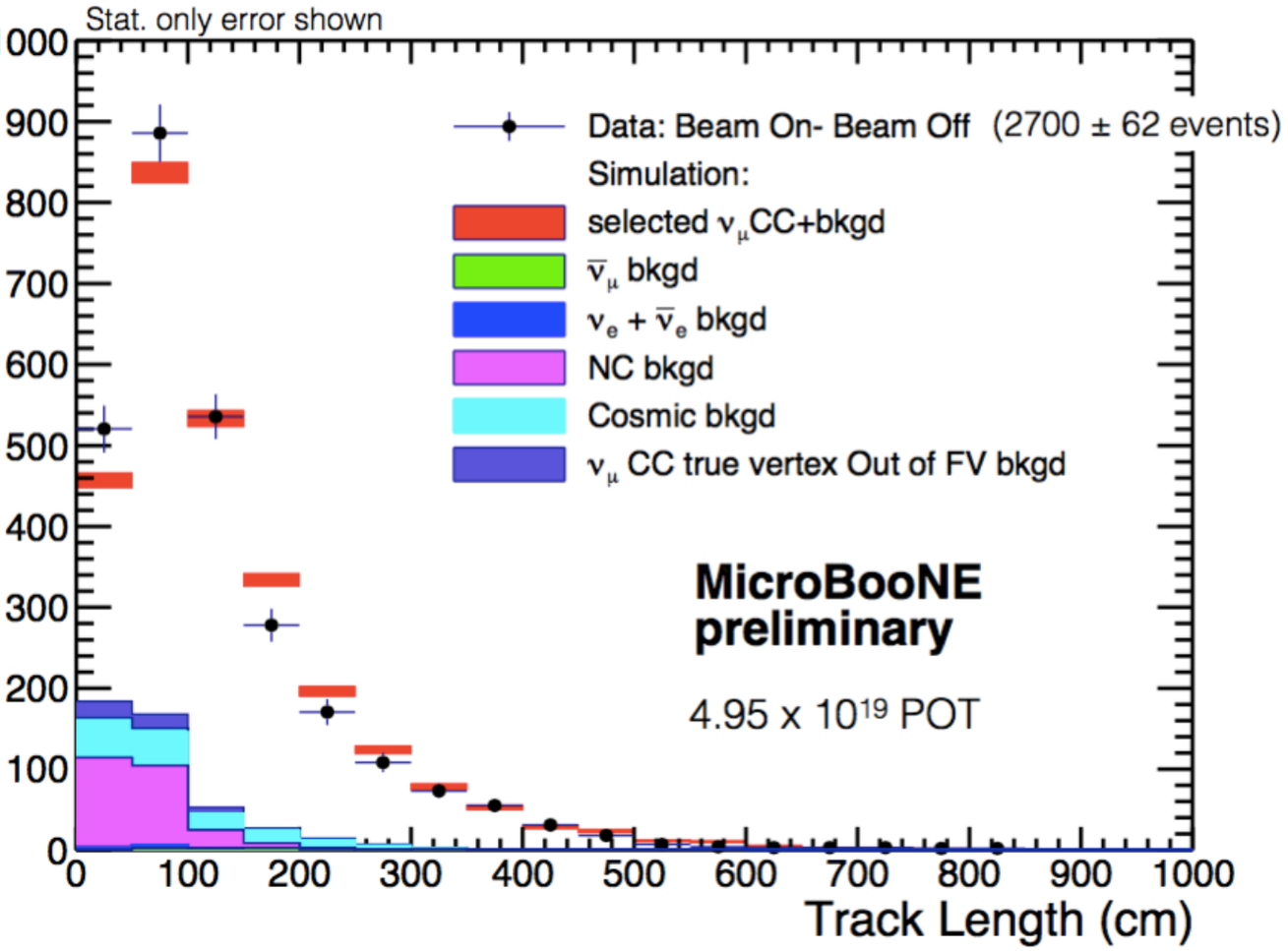
cosmic (CORSIKA v7.4003).

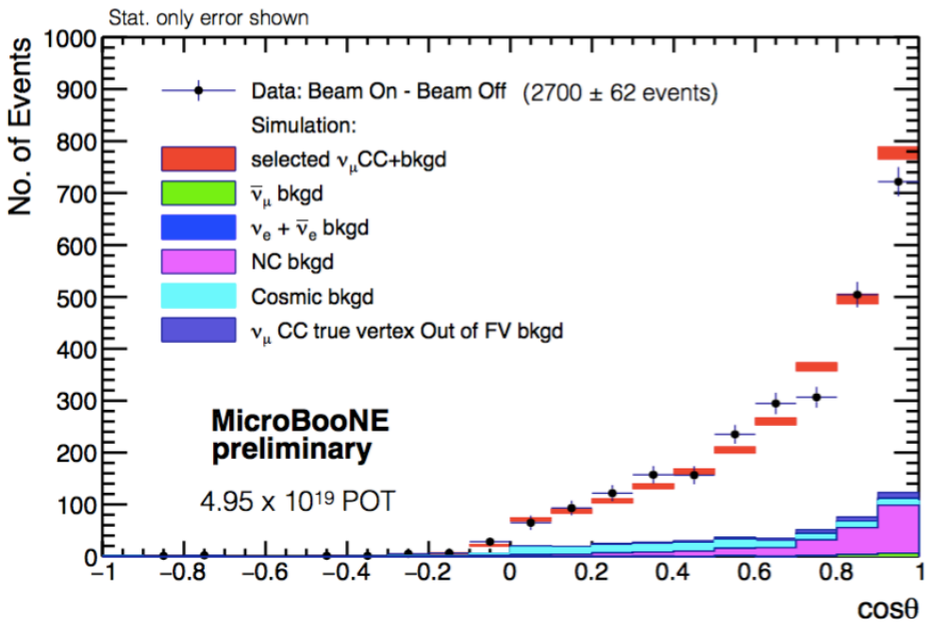
- Simulation scaled to same number of events as data
- Cosmic background subtracted

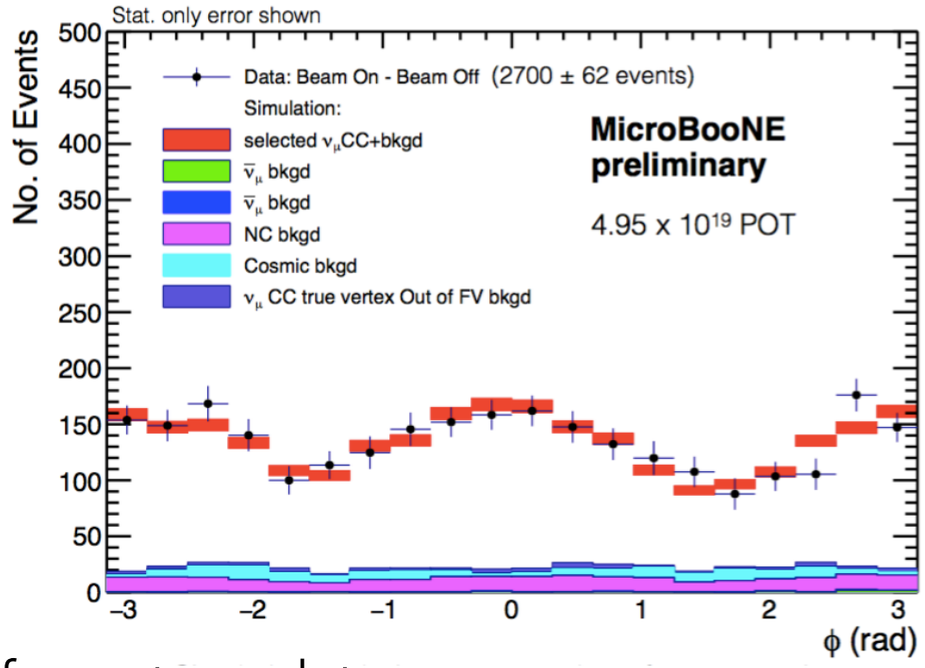
MicroBooNE Public Note 1010: http://www-microboone.fnal.gov/publications/publicnotes

Charged Current Interactions

CC-inclusive event distributions







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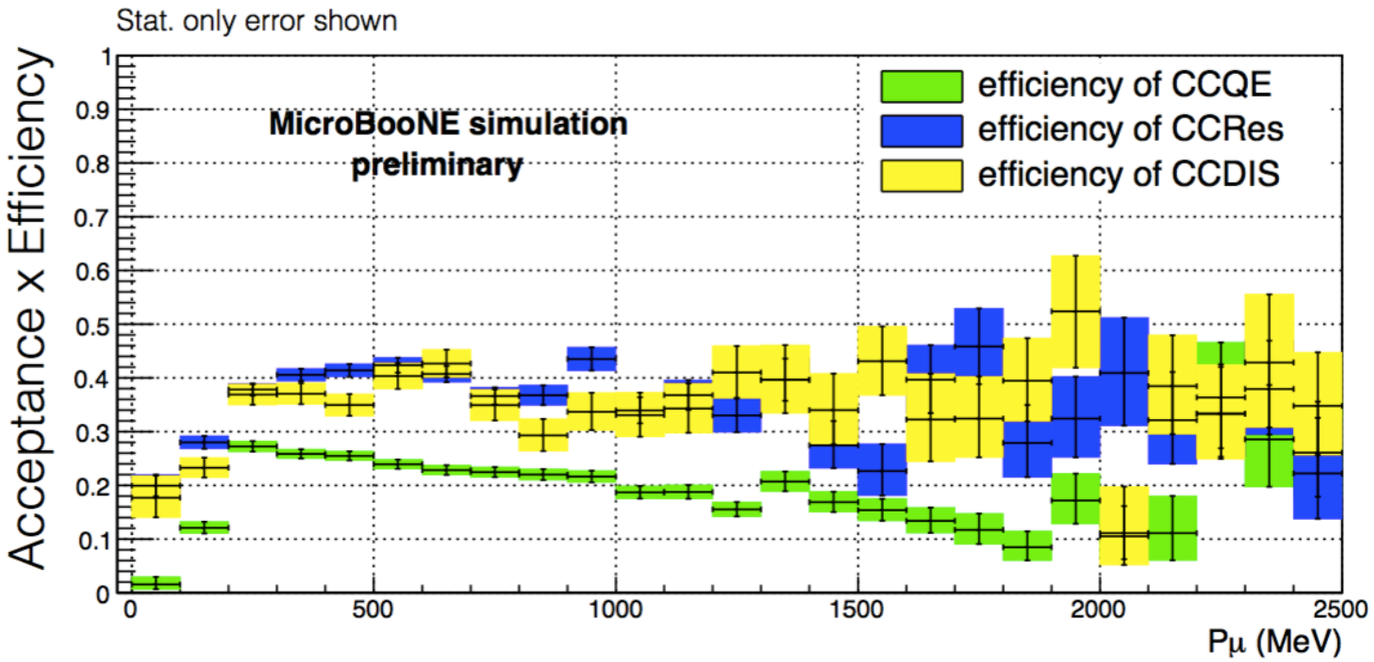
- Cosmic background subtracted

Charged Current Interactions

CC-inclusive event selection performances

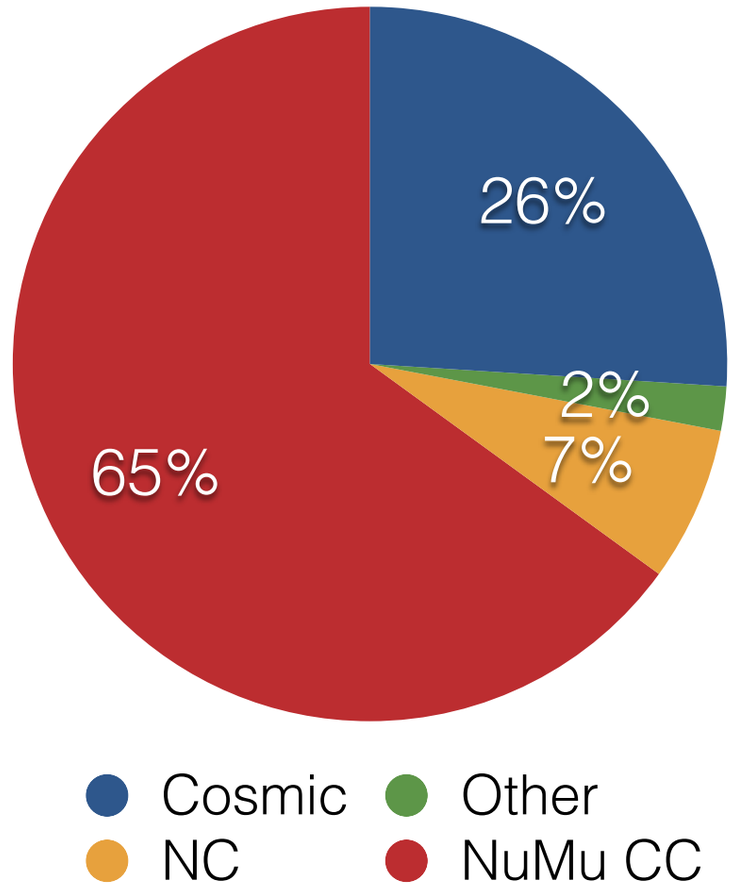
MicroBooNE Public Note 1010: http://www-microboone.fnal.gov/publications/publicnotes

Efficiency



Acceptance x Efficiency: 30%

Purity



Purity: 65%

Conclusions

- ν_μ-CC inclusive measurement to kick off MicroBooNE cross-section program with fully automated ν_μ-CC inclusive event selection
- Area normalised distributions show good data-MC comparison, preliminary results, will improve for summer
- ν_μ-CC inclusive cross-section measurement is underway
- Cross-section studies of many other channels are ongoing

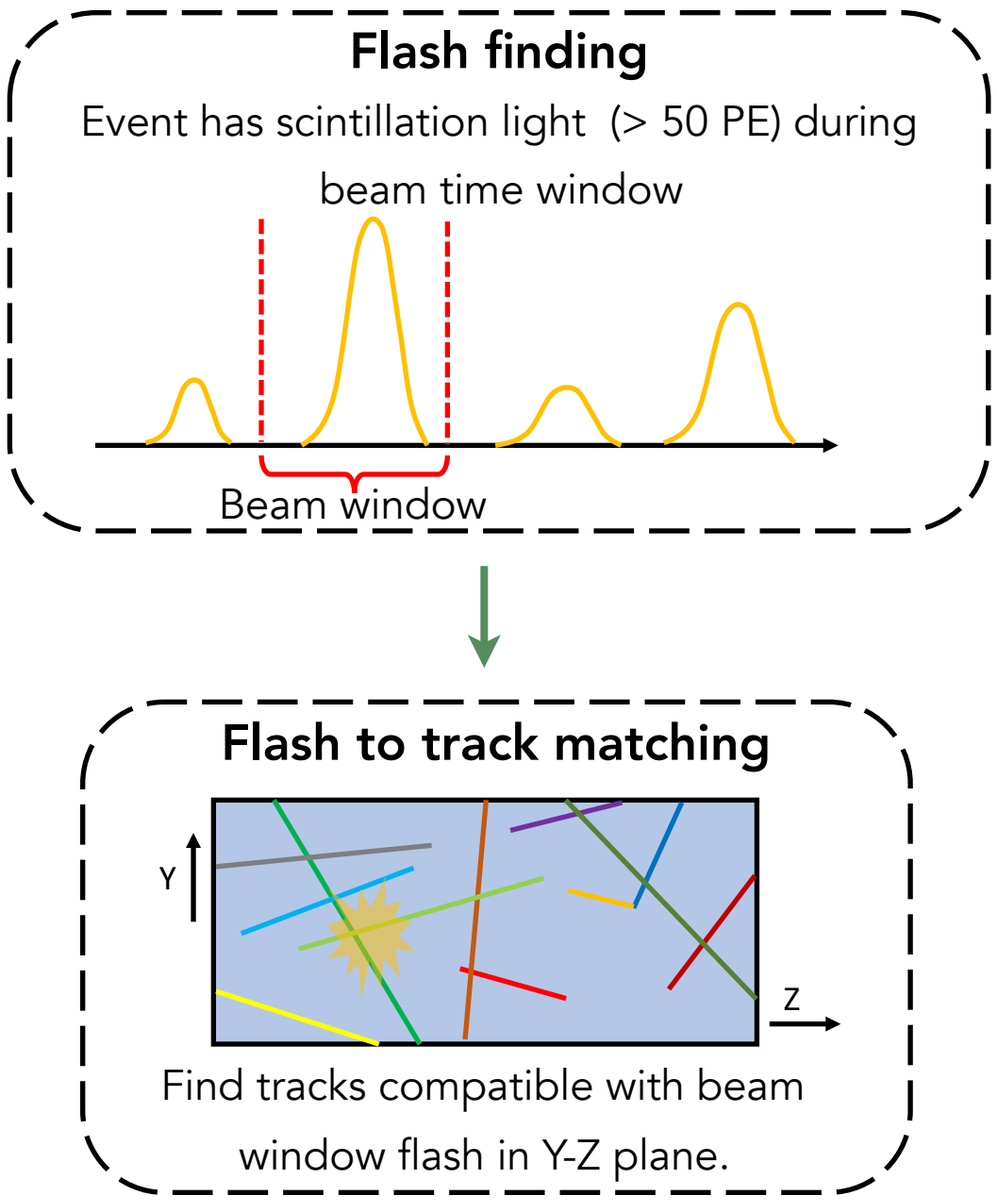
Back up

Ongoing analyses at MicroBooNE

- CC-inclusive differential cross section measurement (this talk)
- Charged Particle Multiplicity
- Proton kinematics (leading proton momentum)
- CCpi0
- NC elastic
- NuMI nue CC

Charged Current Interactions

CC-inclusive event selection



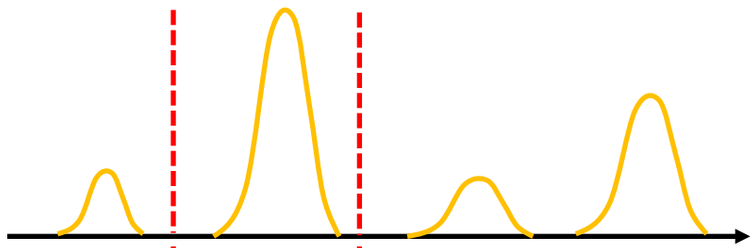
Thanks to A. Schukraft

Charged Current Interactions

CC-inclusive event selection

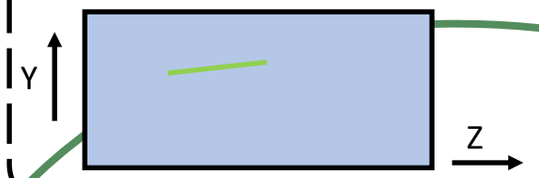
Flash finding

Event has scintillation light (> 50 PE) during beam time window



1 track

Containment

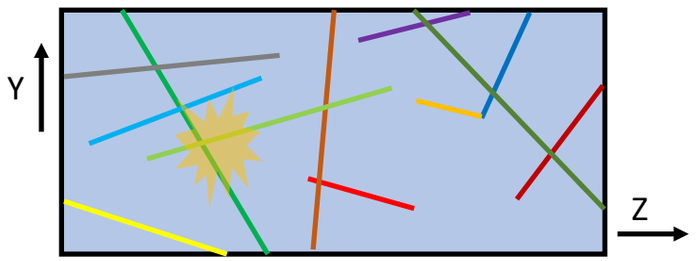


Minimum length

Direction

Bragg peak at higher end

Flash to track matching



Find tracks compatible with beam window flash in Y-Z plane.

Selected

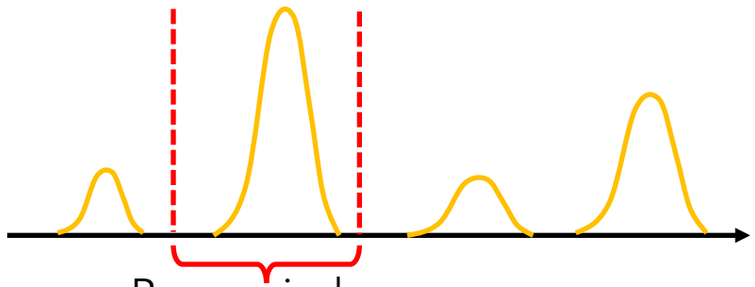
Thanks to A. Schukraft

Charged Current Interactions

CC-inclusive event selection

Flash finding

Event has scintillation light (> 50 PE) during beam time window



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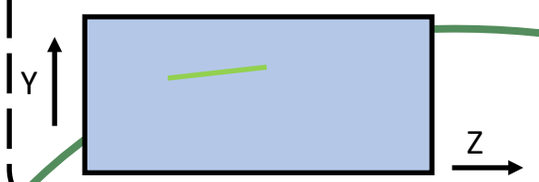


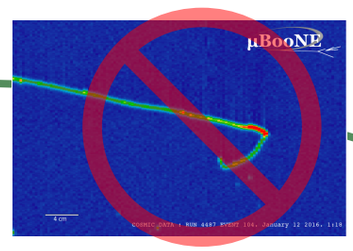
Minimum length

Direction

Bragg peak at higher end

1 track

Michel removal

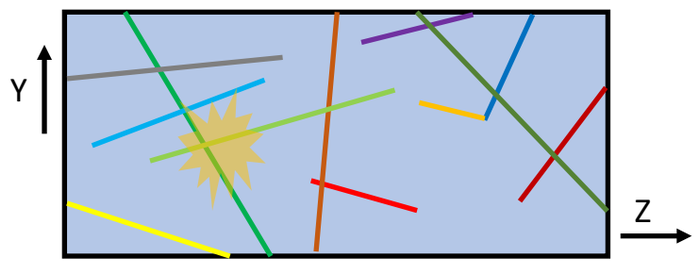


2 tracks

Broken track removal

>2 tracks

Flash to track matching



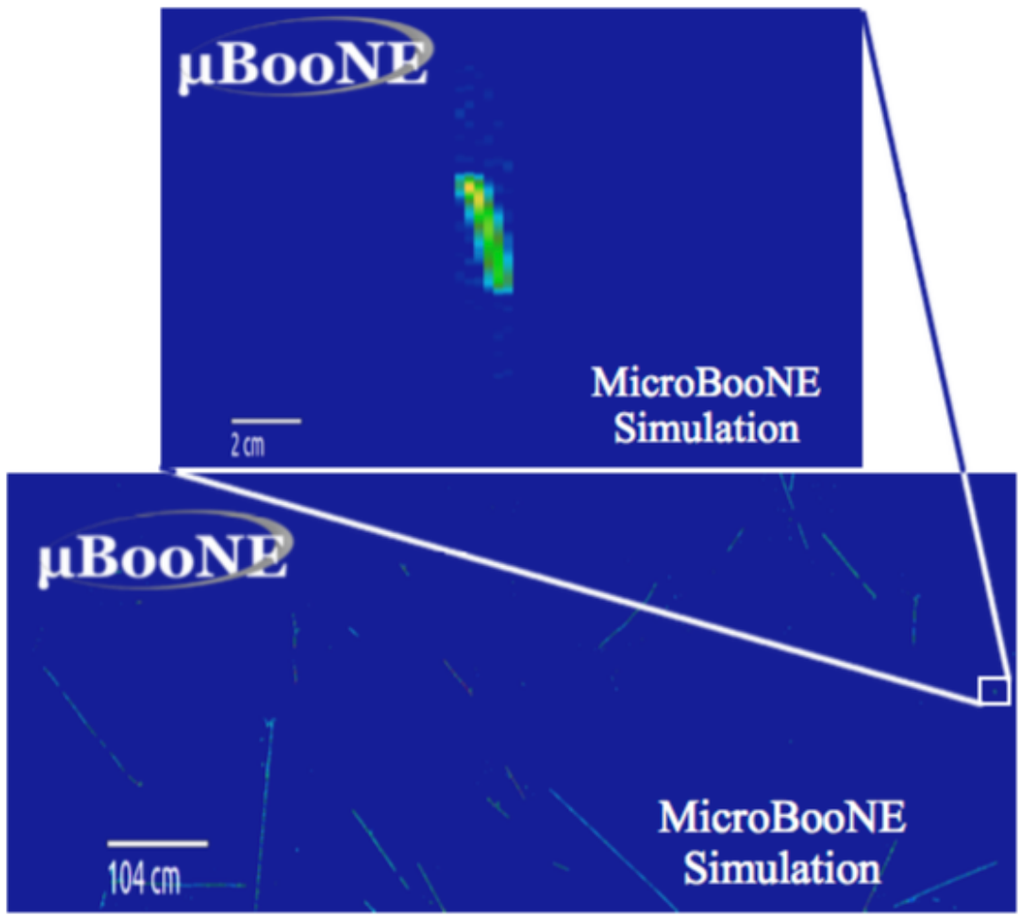
Find tracks compatible with beam window flash in Y-Z plane.

Selected

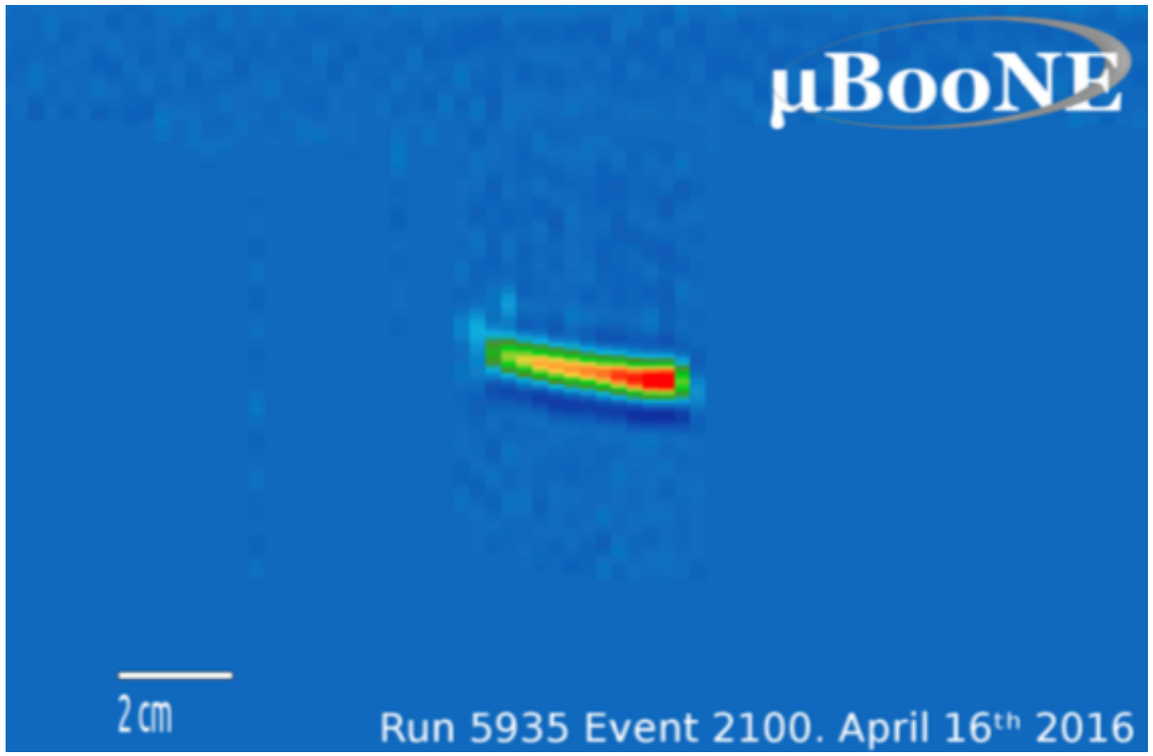
Thanks to A. Schukraft

Neutral Current Interactions

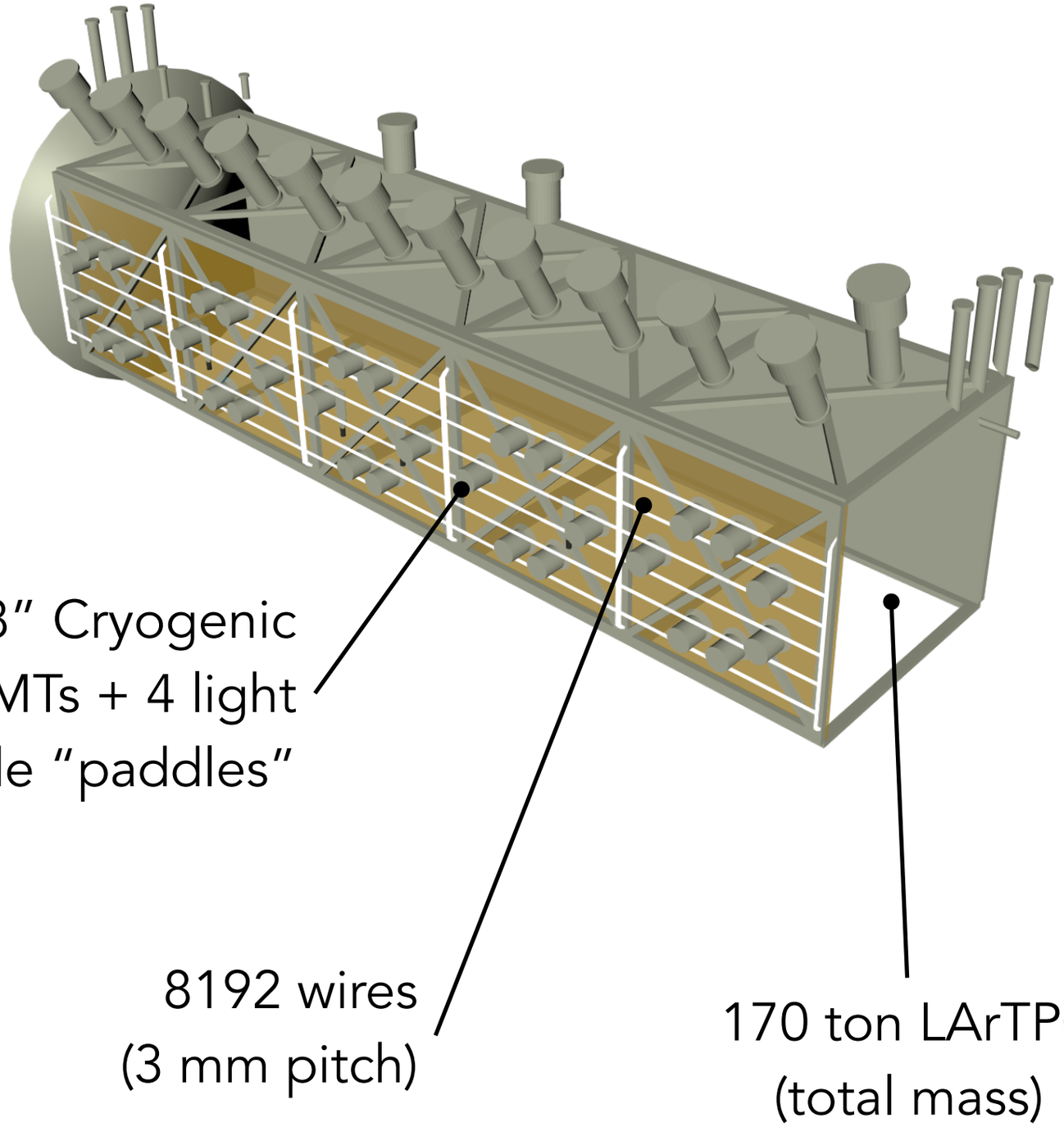
Simulation



Data



The MicroBooNE Detector



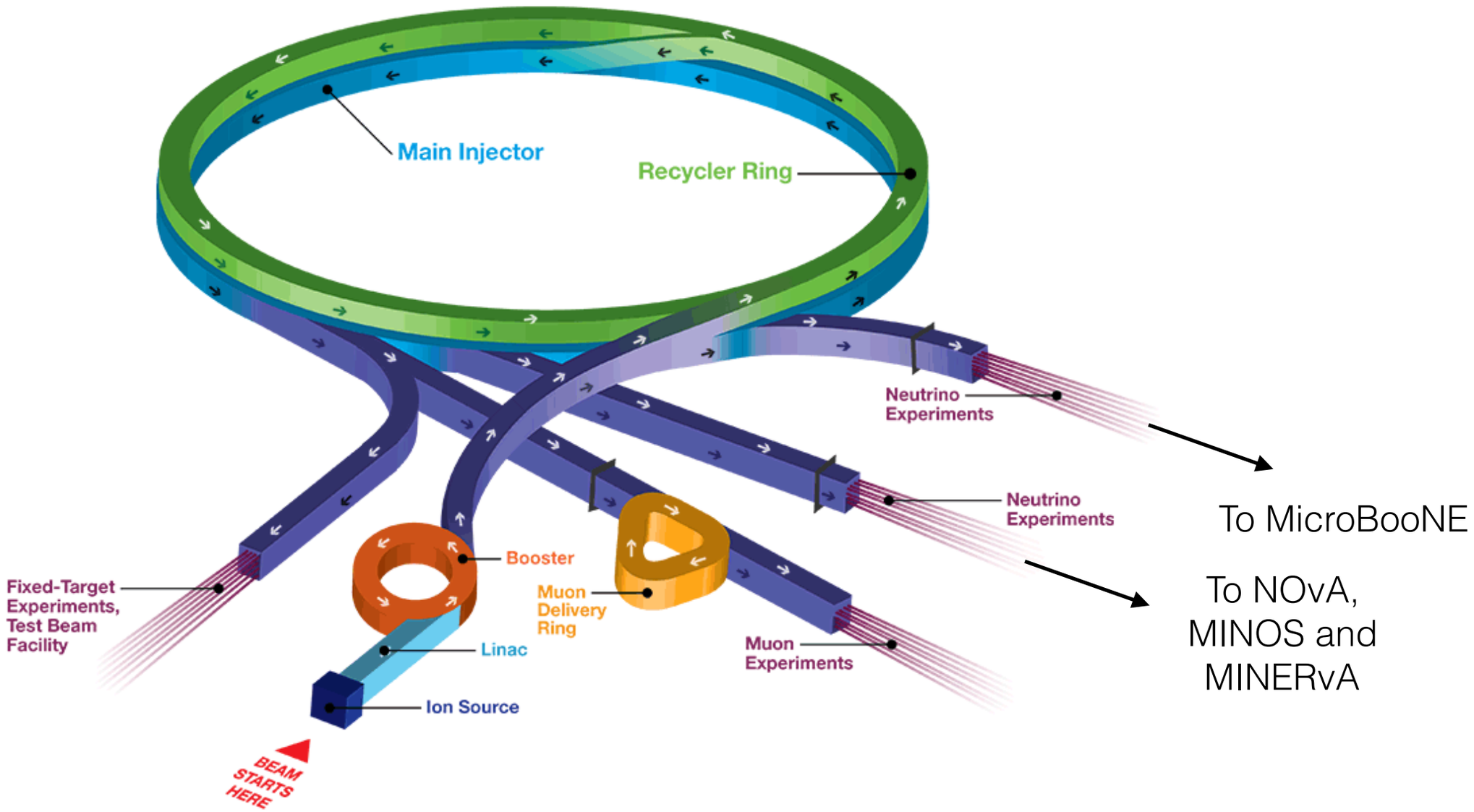
32 8" Cryogenic PMTs + 4 light guide "paddles"

8192 wires (3 mm pitch)

170 ton LArTPC (total mass)

MicroBooNE cryostat lowered into the pit

Inside the detector: PMT system


Fermilab Accelerator Complex
Main Injector
Recycler Ring
Neutrino Experiments
Neutrino Experiments
To MicroBooNE
To NOvA, MINOS and MINERvA
Booster
Muon Delivery Ring
Fixed-Target Experiments, Test Beam Facility
Linac
Muon Experiments
Ion Source
BEAM STARTS HERE

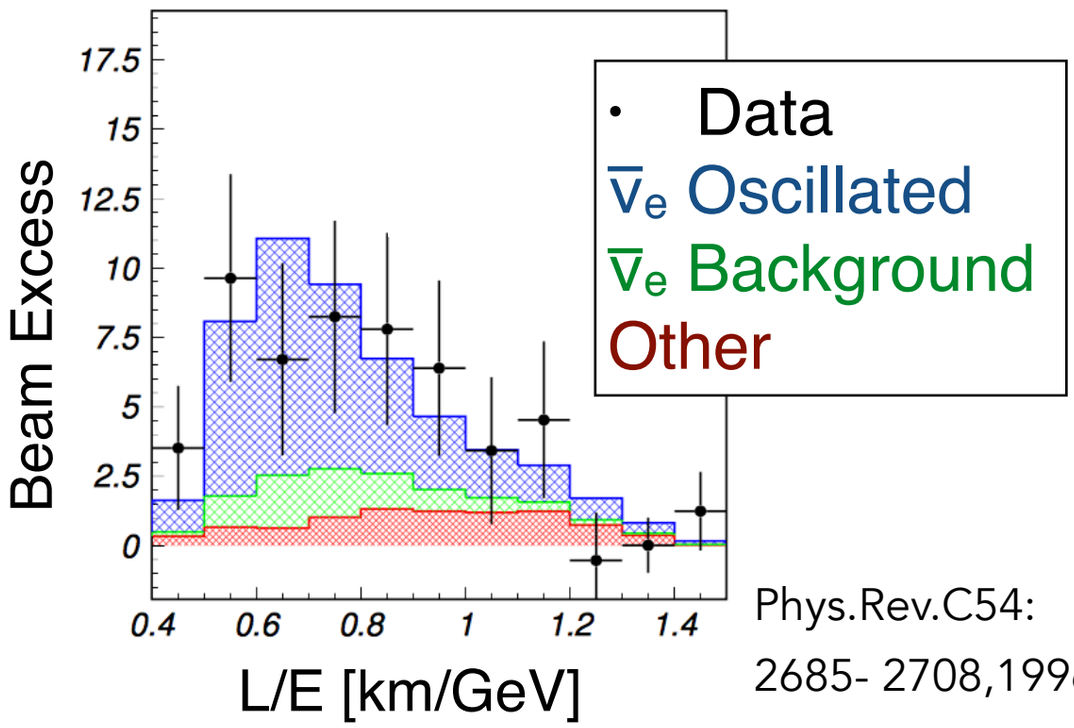
Motivations for MicroBooNE

LSND

Muon anti-neutrino beam

Excess of electron anti-neutrino events

Could be explained by oscillations
L/E ~ 1 km/GeV



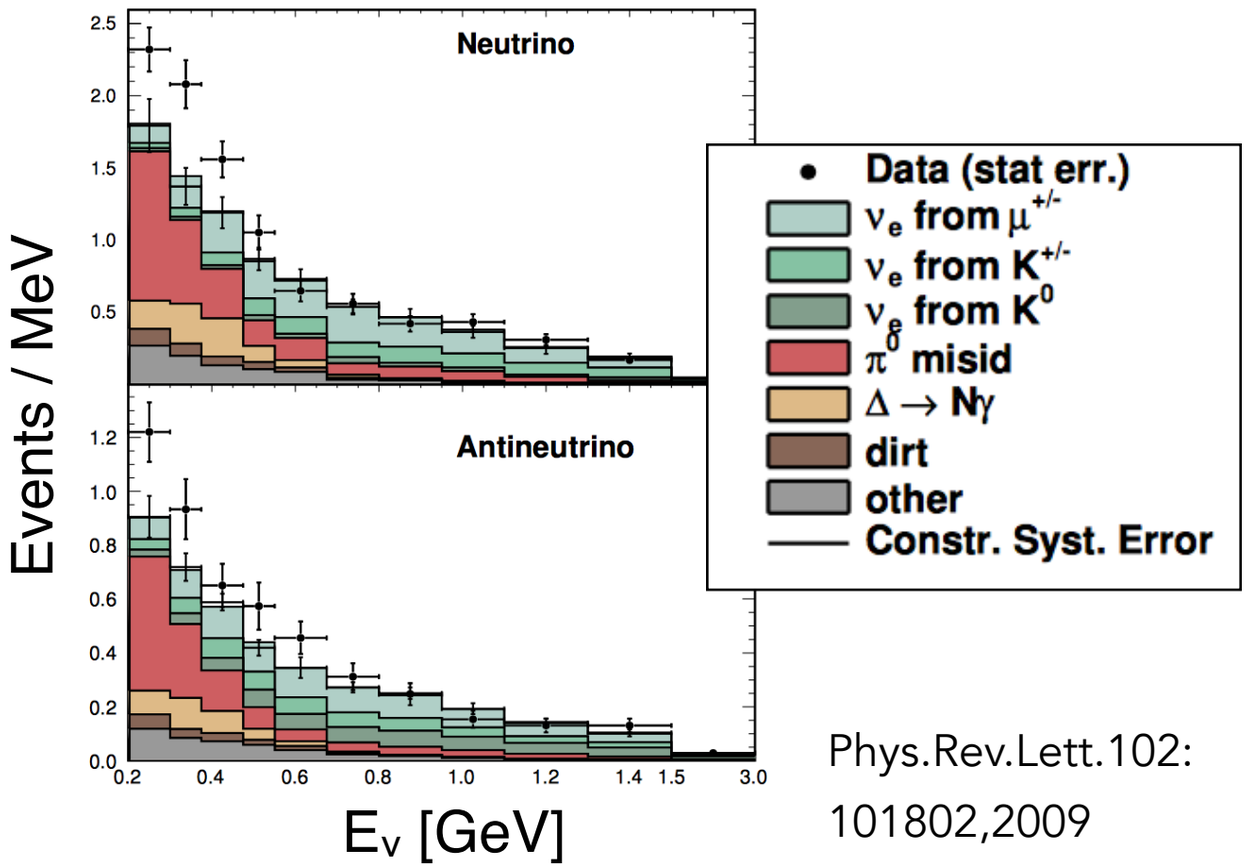
Phys.Rev.C54: 2685- 2708,1996

MiniBooNE

Designed to study the LSND anomaly

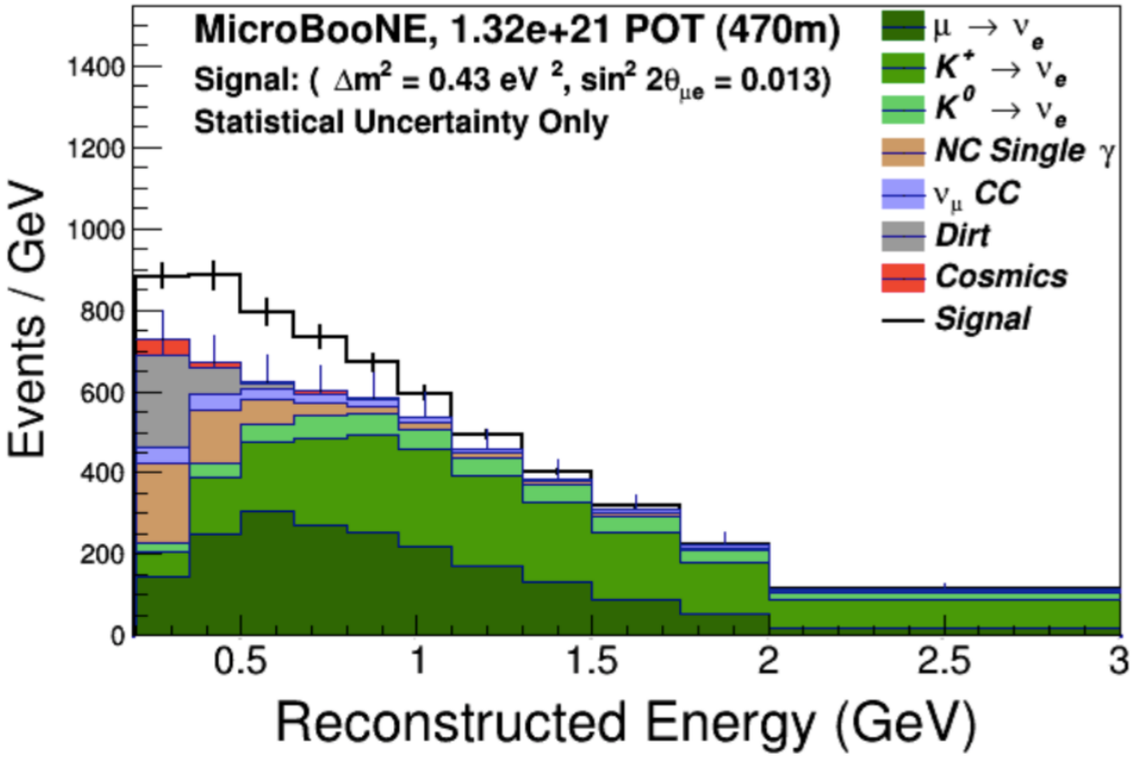
Different baseline and energy but same L/E

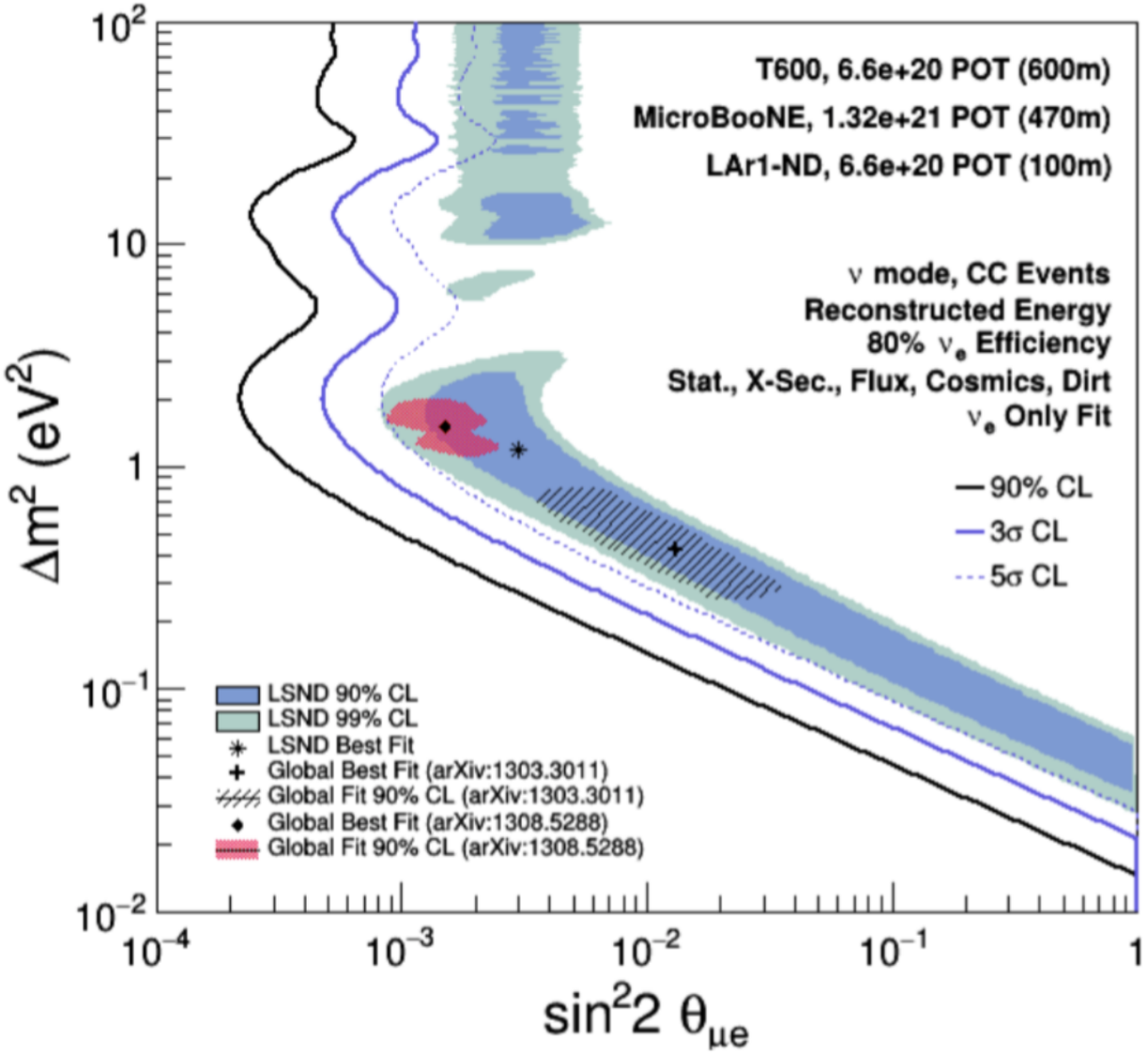
Found excess in both neutrino and anti-neutrino data



Phys.Rev.Lett.102: 101802,2009

SBN - Neutrino oscillation





"A Proposal for a Three Detector Short-Baseline Neutrino Oscillation Program in the Fermilab Booster Neutrino Beam", arXiv:1503.01520v1