# Overview of Science Goals

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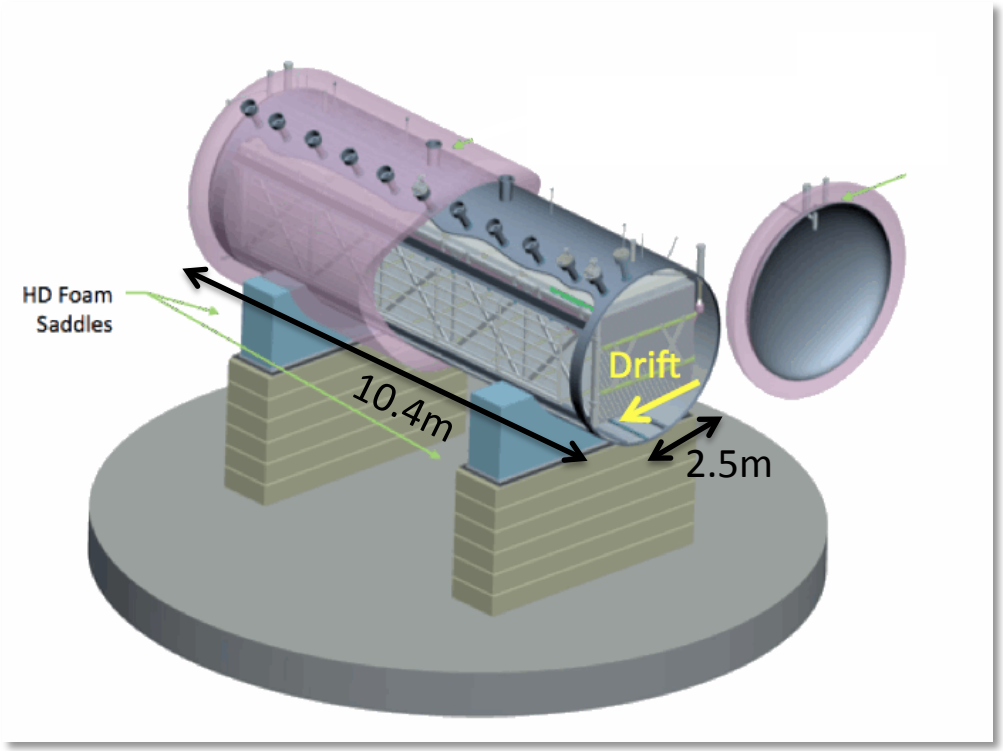
MicroBooNE Operational Readiness Review

November 23, 2015

charge question #6

# MicroBooNE Experiment

- 170 ton LAr TPC in the Booster Neutrino Beam (same beam, approximate location as MiniBooNE)

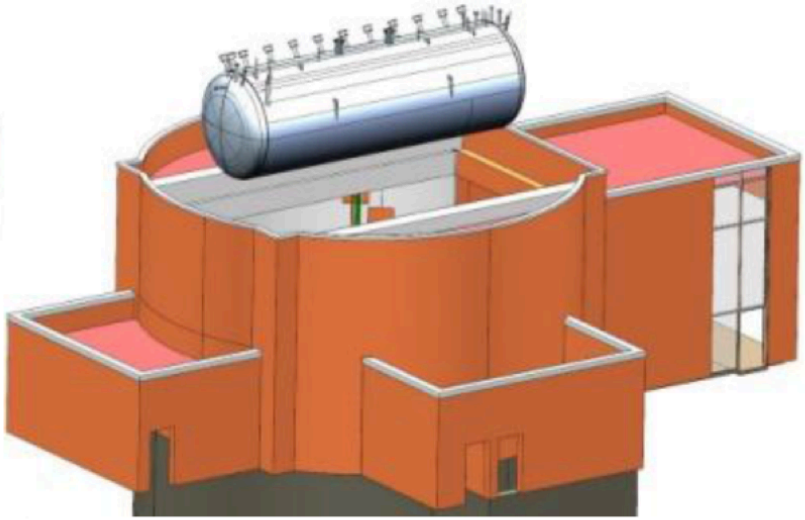



- we kick off the start of the SBN program

- physics goals:
  - *understand the source of the MiniBooNE low energy excess*
  - *make the 1st measurements of low energy neutrino cross sections in argon*

- development goals:
  - *argon fill without evacuation* (*1st demonstrated in LAPD*)
  - *cold front-end electronics*
  - *long drift (2.5m)*
  - *automated reconstruction*
  - *near surface operation*

# Concept to Reality



"drawing"

"reality"

- transition from concept to reality for detector construction & installation is now complete
- now we are doing the same for data taking & physics analyses

# MicroBooNE Milestones

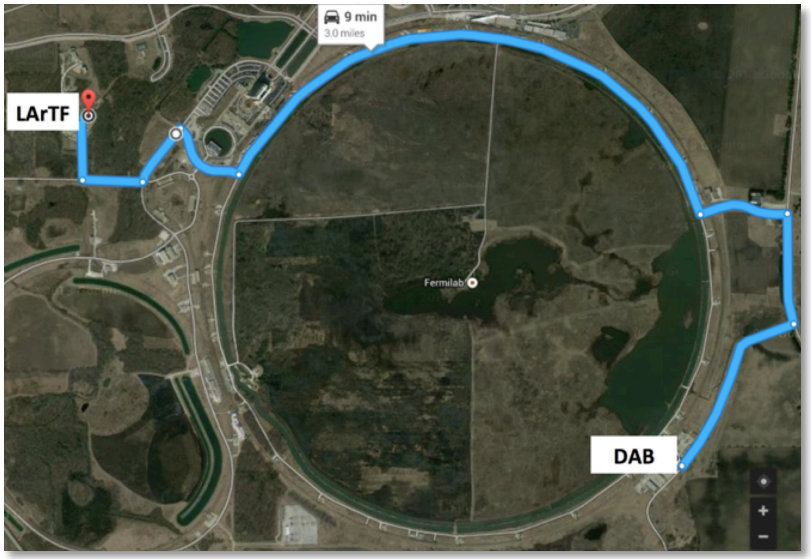
it has taken about 8 years to get to this point …

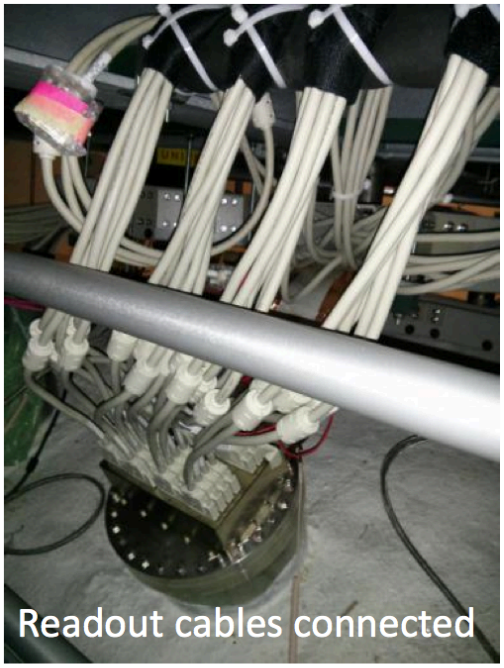
- 2007: proposed to the FNAL PAC
- 2009: CD-0
- 2010: CD-1
- 2011: CD-2/3a
- 2012: CD-3b
- 2014: CD-4
- 2015: detector filled with liquid argon

→ August 6, 2015: saw our first cosmic ray tracks

→ October 15, 2015: first neutrino beam

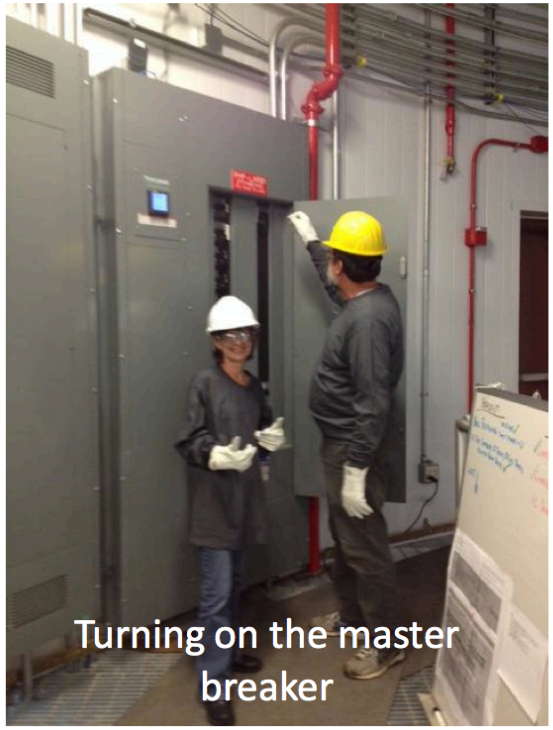
- summer 2014: detector moved across site to LArTF





Readout cables connected


Installing HV Feedthrough

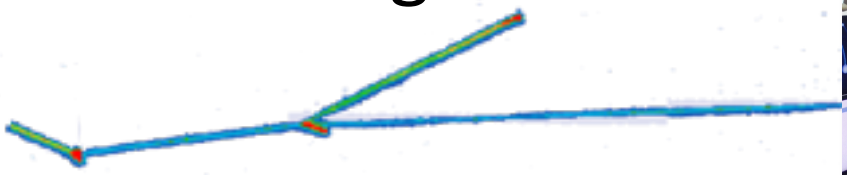

Installed >4 miles of cables


Turning on the master breaker

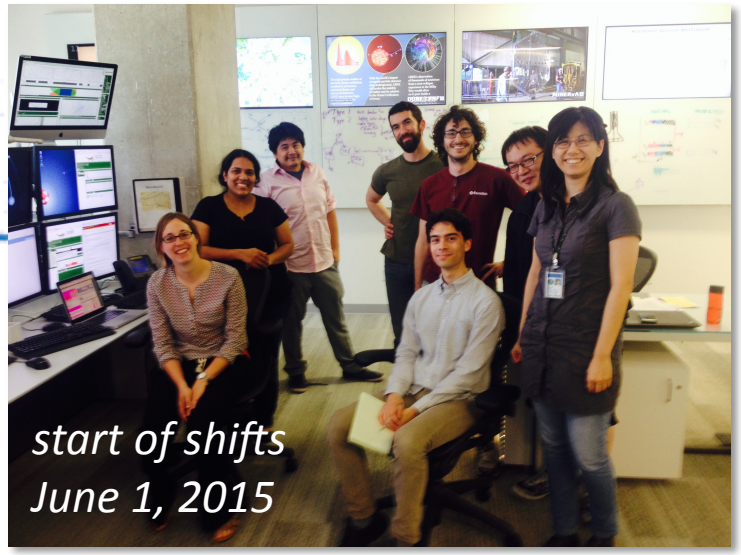
- Fall 2014: detector installation completed & ORCs granted
- CD-4 in **Dec 2014**

It works!

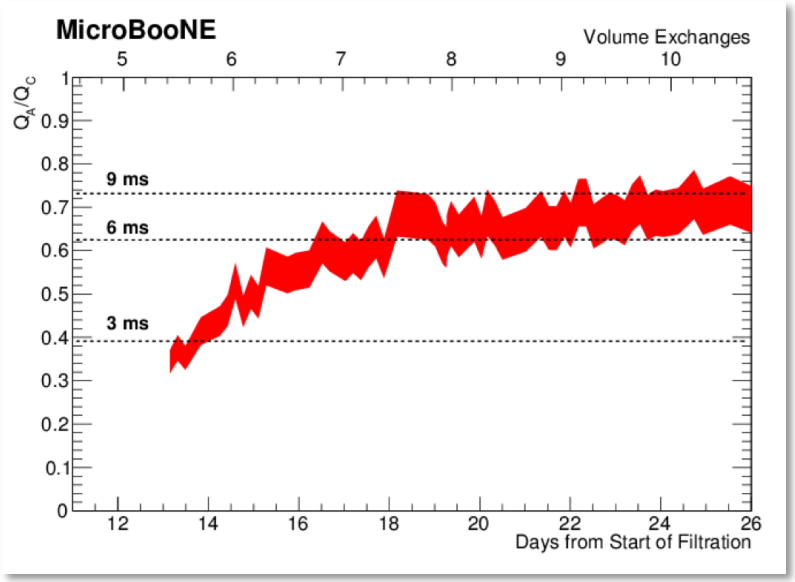
# Commissioning



- Jan-Oct 2015: commissioning
  (see talks by Baller, Asaadi)




*shifts started 4 months before start of ν beam*



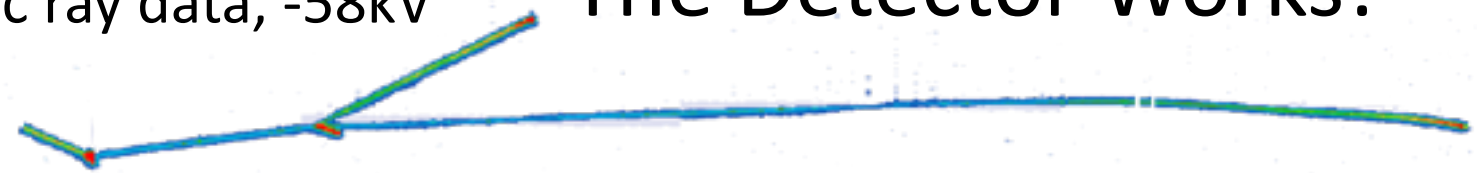

*> x2 better argon purity than design*

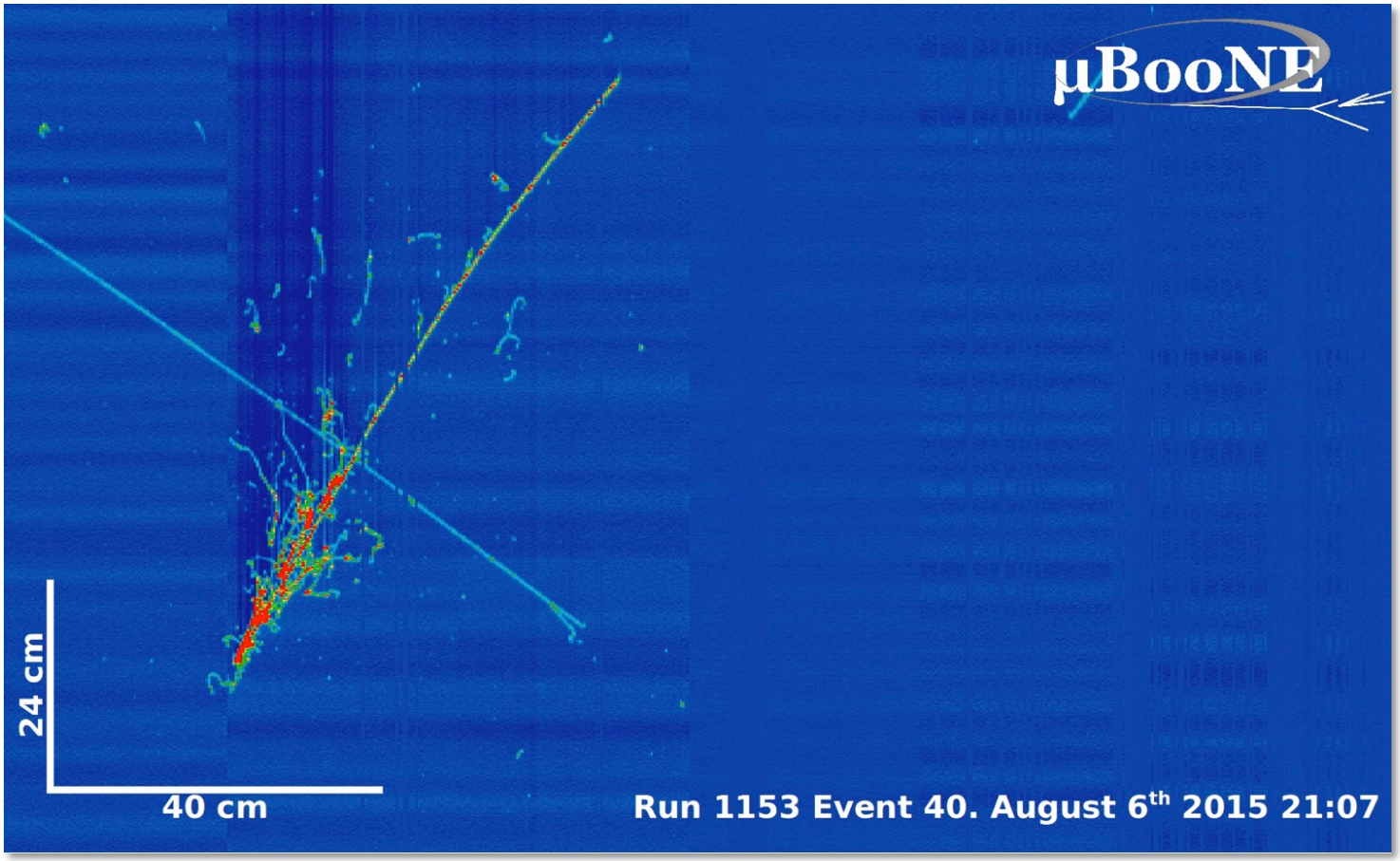

*$O_2$ ($N_2$) x10 (x300) better than spec*

charge question #2

# The Detector Works!

- Aug 6, 2015: 1st tracks cosmic ray data, -58kV

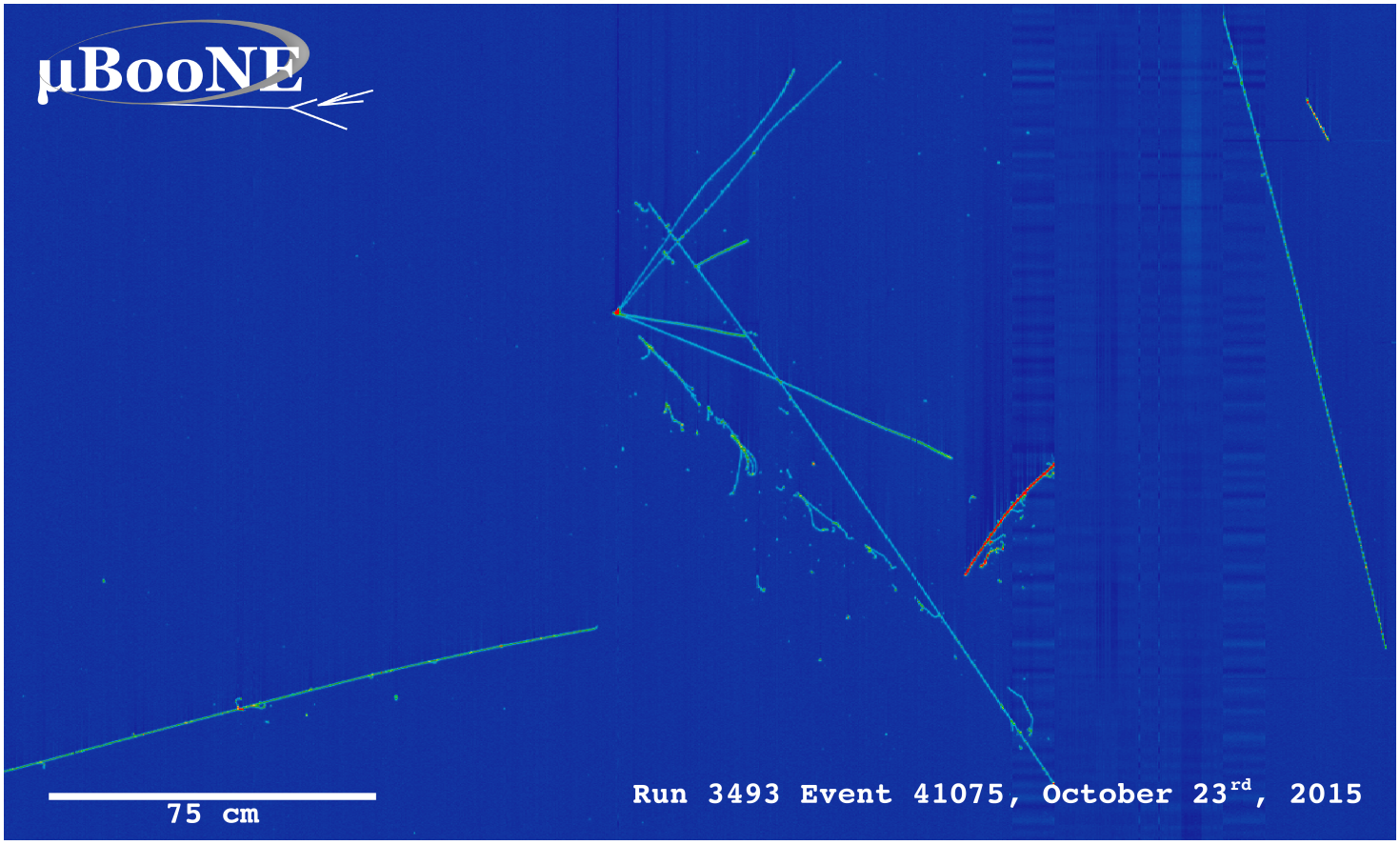




charge question #2

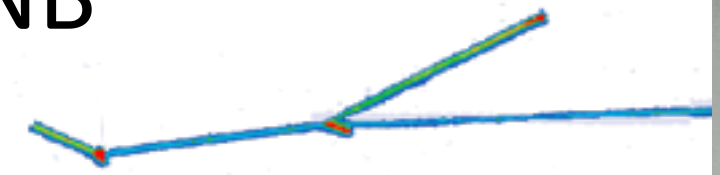
# The Detector Works!

- Oct 15, 2015: 1st neutrinos
  BNB data, -70kV




(Matt Toup's talk)

# BNB



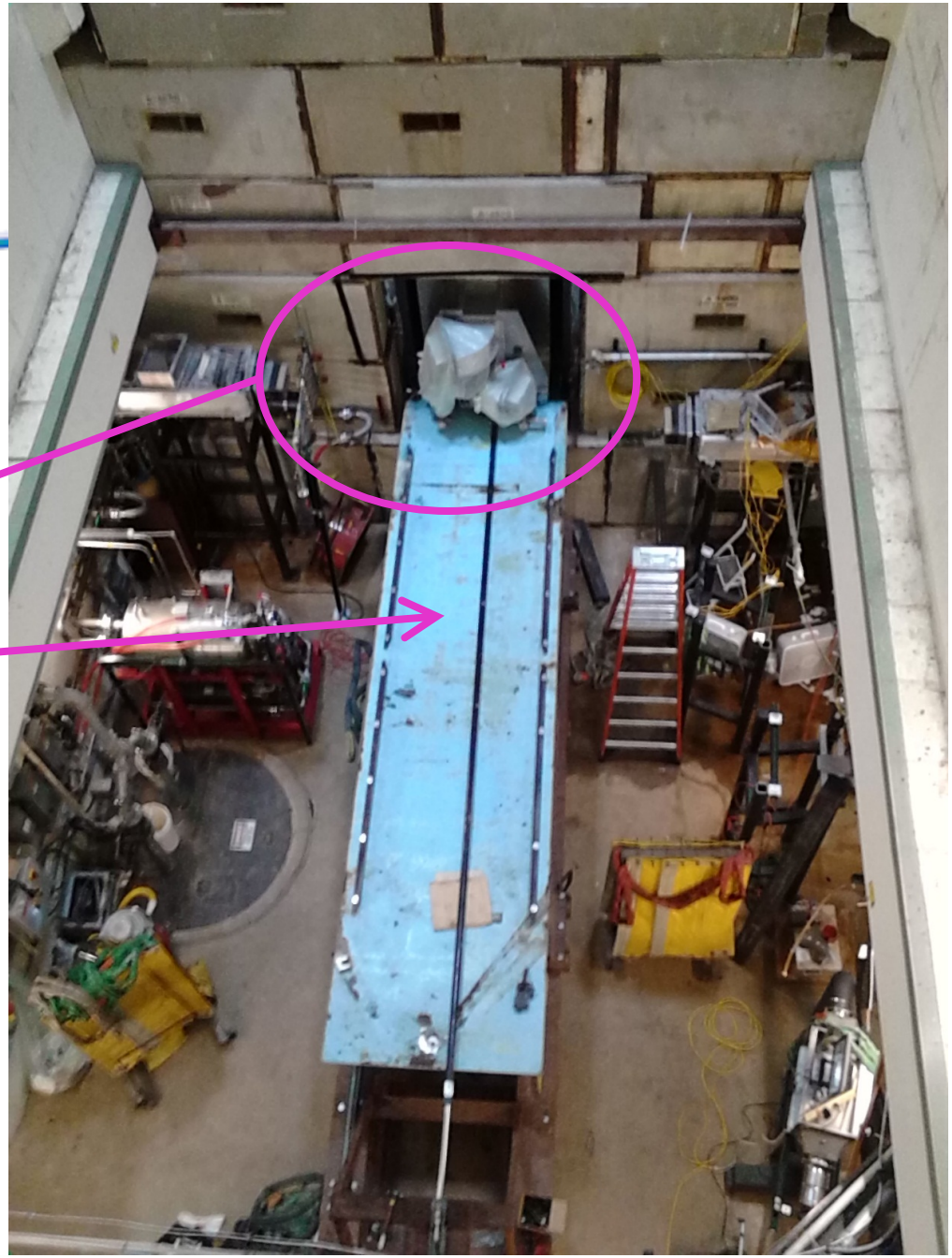
- we replaced the horn before the shutdown (horn #3 is in)

*horn in target pile*

- horn #2 had been in service since Oct 2004, pulsed >400M times *(world record)* water heads became clogged in Nov 2014

*platform for sliding horn into the target pile*

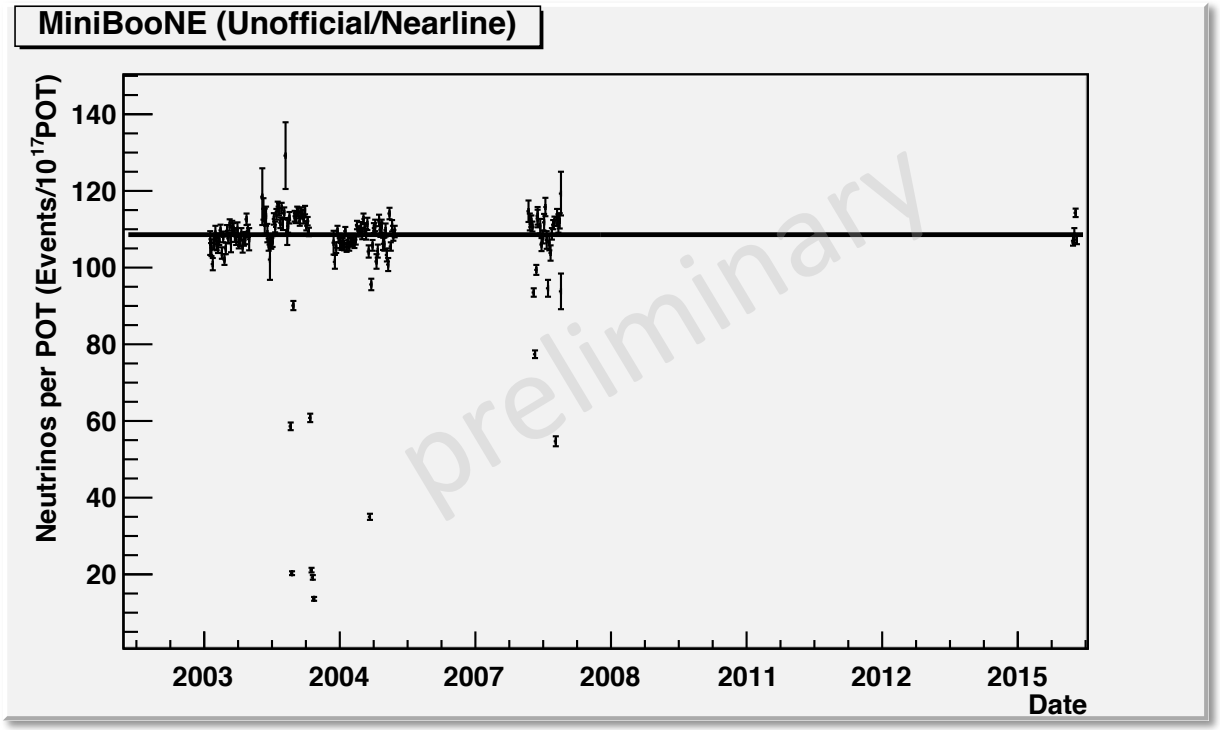
- work started on new BNB interlocks that will allow us to run when NuMI is down



charge question #2

# Neutrino Rate Check

MiniBooNE data:




- will also produce a spectral comparison ($E_\nu$)

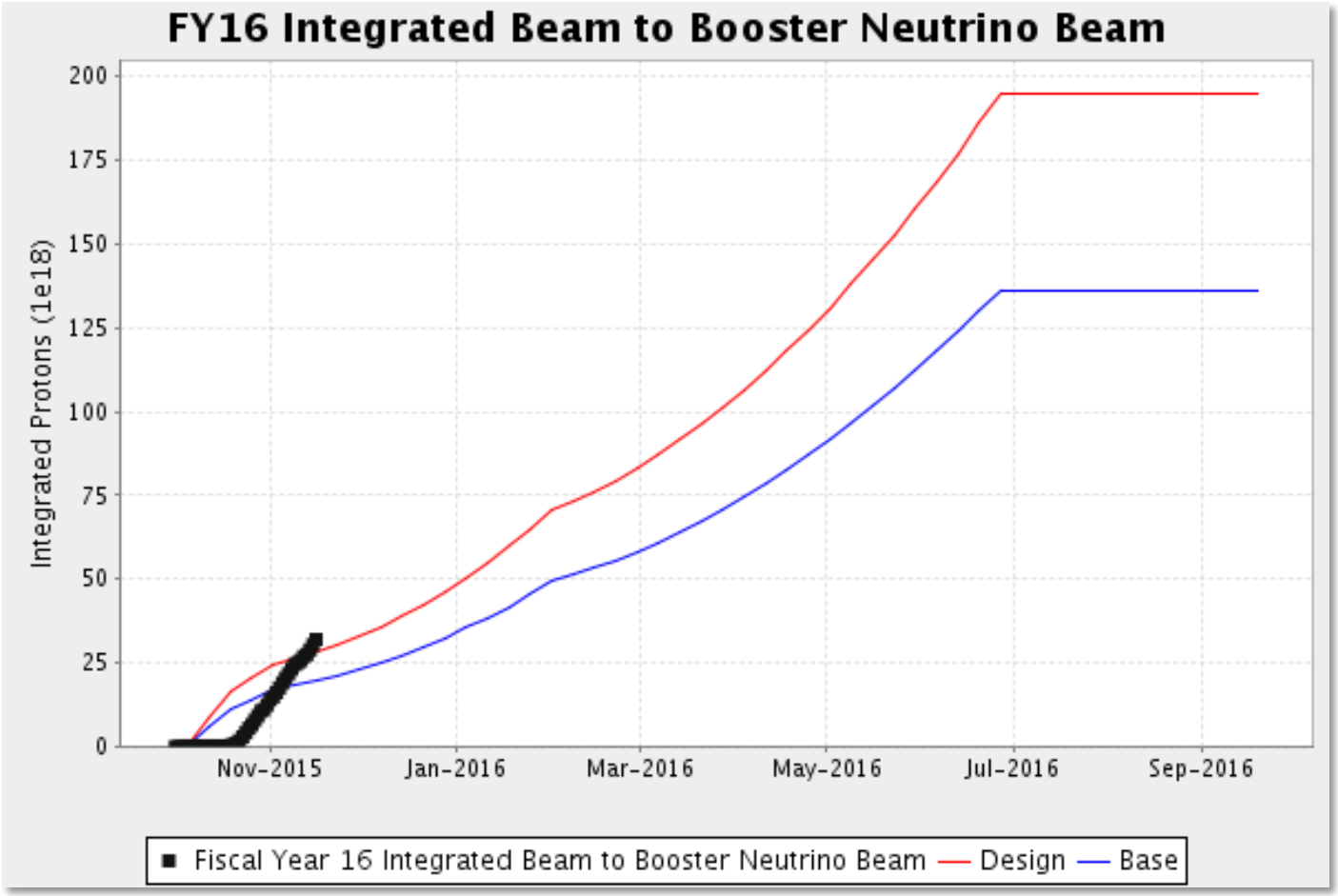
- we have not run the BNB in neutrino mode since 2007
- we turned the MiniBooNE detector back on in September
- we are running MiniBooNE as a verification that the beam is the same as it was before, but with the new horn (MOU with MB)

charge question #3

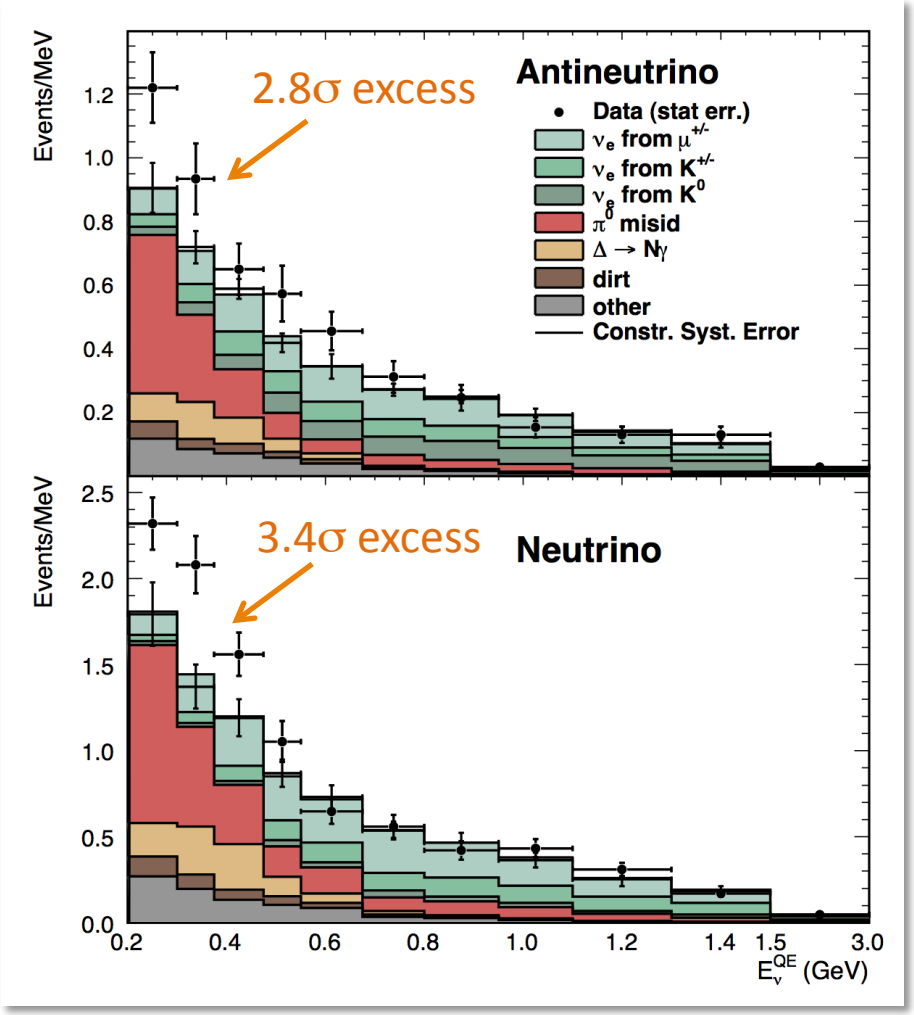
# Run Plan

(Mike Mooney's talk)

- expect to collect between ~1-2x$10^{20}$ POT before the 2016 summer shutdown
- we have been running at 5Hz and have collected ~0.4x$10^{20}$ POT since Oct 15th



# Goal #1




- <u>understand the source of the MiniBooNE low energy excess</u>
- MiniBooNE published its final $\nu_\mu \rightarrow \nu_e$ results in 2013
- MB observed an excess of low energy events in both modes


- source of the excess is still unknown

→ **MicroBooNE!**

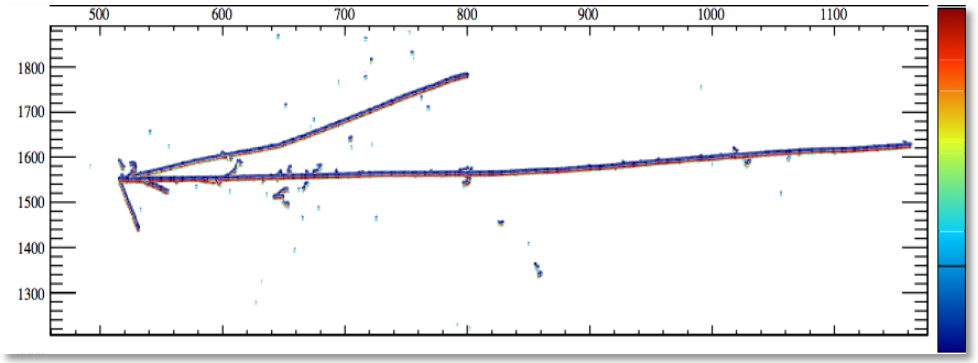
*(this analysis requires the full 6.6x10$^{20}$ POT)*

(Matt Toup's talk)

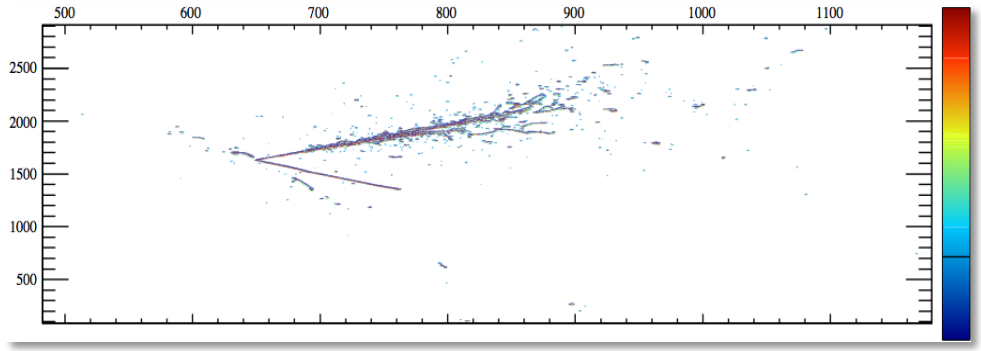
 *Aguilar-Arevalo, PRL 110, 161801 (2013)* 

# Goal #2

- make the first measurements of low energy ν interactions on argon (DUNE 2nd oscillation maximum)




*(simulated ν events in MicroBooNE)*



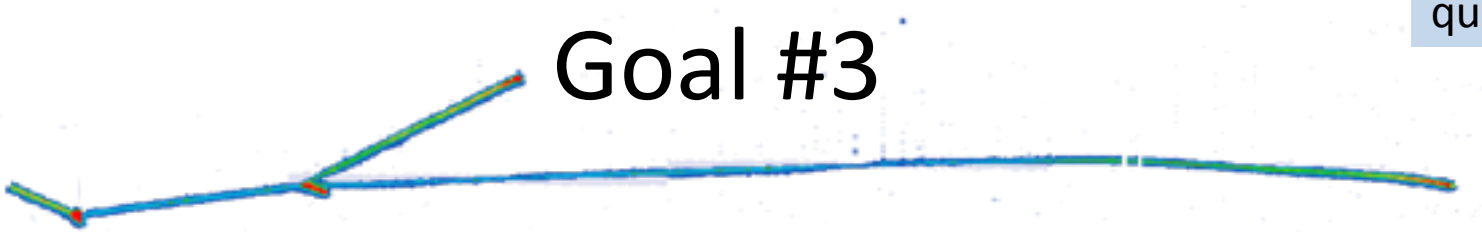

- MicroBooNE will build off what we have already learned from MiniBooNE *(same beam)* and ArgoNeuT *(same technology)*
- these analyses will benefit from well-known BNB flux

  *Aguilar-Arevalo et al., PRD 79, 072002 (2009)*
- will collect an ArgoNeuT-sized event sample in 1st few months

(Matt Toup's talk)

charge question #6

# Goal #3



- advance the LAr TPC technology

**Related Publications by MicroBooNE Collaborators:**

- B. Carls *et al.*, "Design and Operation of a Setup with a Camera and Adjustable Mirror to Inspect the Sense Wire Planes of the TPC Inside the MicroBooNE Cryostat", JINST 10, T08006 (2015)
- J. Conrad *et al.*, "The Photomultiplier Tube Calibration System of the MicroBooNE Experiment", JINST 10, T06001 (2015)
- L.F. Bagby *et al.*, "Breakdown Voltage of Metal Oxide Resistors in Liquid Argon", JINST 9, T11004 (2014)
- R. Acciarri *et al.*, "Liquid Argon Dielectric Breakdown Studies with the MicroBooNE Purification System", JINST 9, P11001 (2014)
- A. Ereditato *et al.*, "First Working Prototype of a Steerable UV Laser System for LAr TPC Calibrations", JINST 9, T11007 (2014)
- J. Asaadi *et al.*, "Testing of High Voltage Surge Protection Devices for Use in Liquid Argon TPC Detectors", JINST 9, P09002 (2014)
- M. Auger *et al.*, "A Method to Suppress Dielectric Breakdowns in Liquid Argon Ionization Detectors for Cathode to Ground Distances of Several Millimeters", JINST 9, P07023 (2014)
- A. Blatter *et al.*, "Experimental Study of Electric Breakdown in Liquid Argon at Centimeter Scale", JINST 9, P04006 (2014)
- T. Briese *et al.*, "Testing of Cryogenic Photomultiplier Tubes for the MicroBooNE Experiment", JINST 8, T07005 (2013)
- B.J.P. Jones *et al.*, "Photodegradation Mechanisms of Tetraphenyl Butadiene Coatings for Liquid Argon Detectors", JINST 8 P01013 (2013)
- B.J.P. Jones *et al.*, "A Measurement of the Absorption of Liquid Argon Scintillation Light by Dissolved Nitrogen at the Part-Per-Million Level", JINST 8 P07011 (2013)
- C.S. Chiu *et al.*, "Environmental Effects on TPB Wavelength-Shifting Coatings", JINST 7, P07007 (2012)
- A. Ereditato *et al.*, "Design and Operation of ARGONTUBE: a 5m Long Drift Liquid Argon TPC", JINST 8, P07002 (2013)

- argon purification without evacuation (beyond LAPD)
- cold front-end electronics
- long drift distance (2.5m)
- automated reconstruction
- near-surface operation (SBN)
- we are learning a lot as we go and we are transmitting this

*(13 papers produced during the construction of MicroBooNE)*

(Jonathan Asaadi's talk)

# We Are Well On Our Way

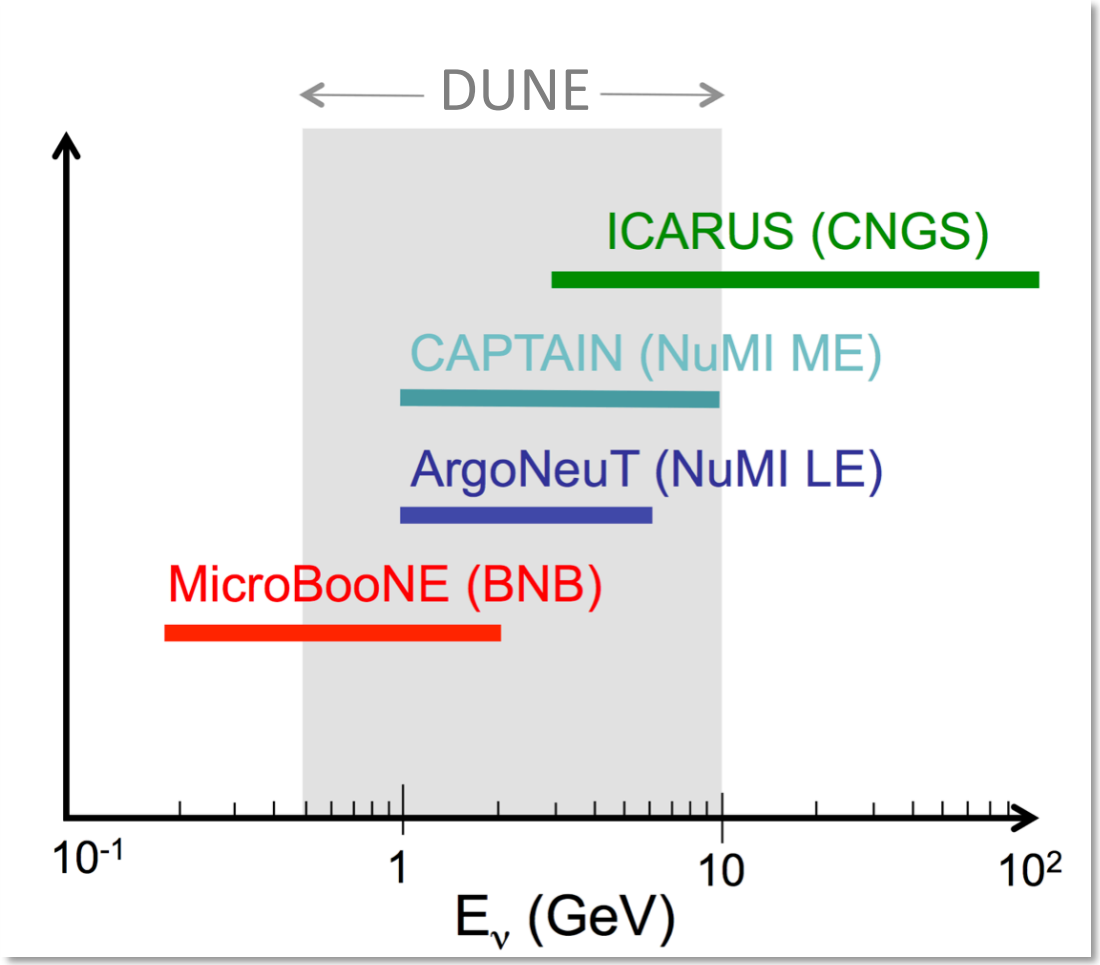
- MicroBooNE assembly, installation, and commissioning is complete; experiment has been operating since June 1, 2015
  - *this has been unchartered territory for most of us*
  - *$\mu$B is the largest LAr TPC we have built and operated in the U.S.*
- we have successfully identified our first neutrinos!
- our focus right now is on:
  - *continuing to ensure smooth operations (Mooney, Ketchum)*
  - *commissioning our PMT trigger (Wongjirad, Greenlee)*
  - *understanding the detector (Asaadi)*
  - *working towards first physics results (Toups)*
- expect to collect ~1-2x$10^{20}$ POT by the 2016 summer shutdown

# Backup Slides

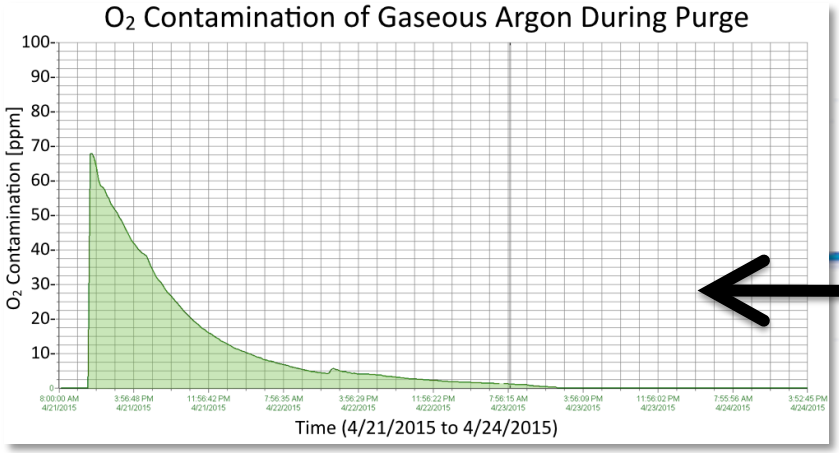
# Energy Ranges

- MicroBooNE (and SBND) will extend our coverage to lower neutrino energies

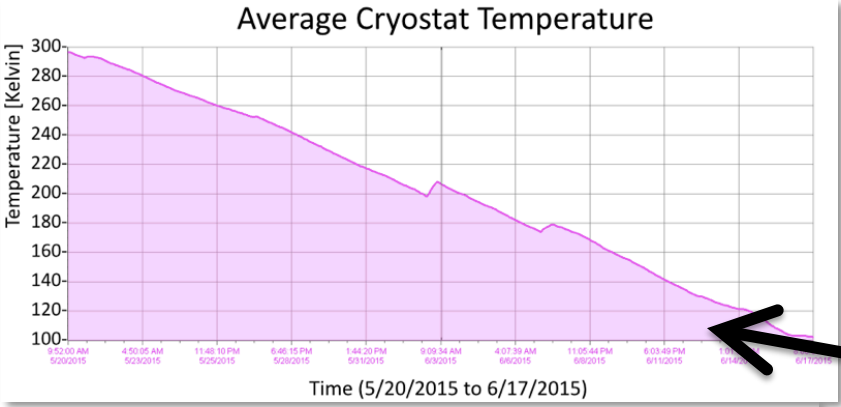
- this is an important energy region where MiniBooNE (& others) have revealed the presence of completely neglected nuclear effects



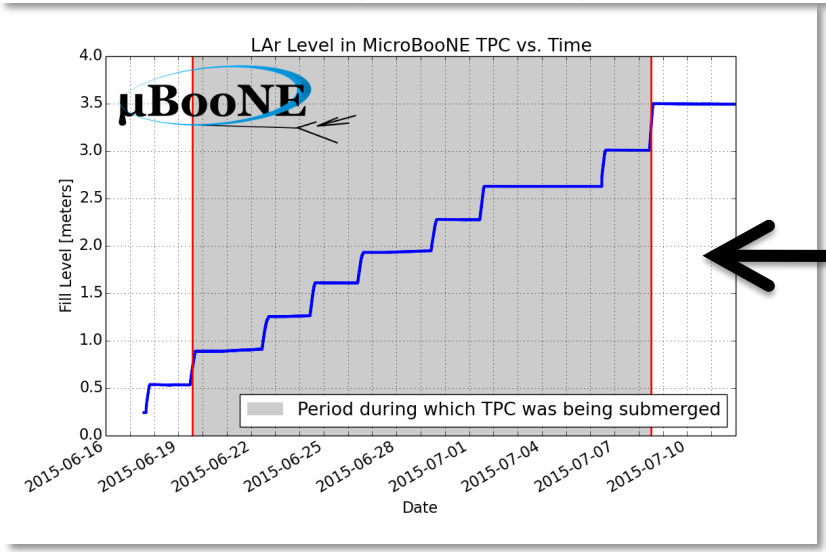
# Successful Purge, Cooldown, and Fill




- step 1: purge with gaseous argon
  - *- $O_2$ contamination reduced by 2 orders of magnitude in 10 volume exchanges*
  - *- first demonstration of this technique in a fully instrumented physics experiment*
  - *→ vessel evacuation not necessary*




- step 2: cool to LAr temperatures
  - *- slowly cooled down from 300 → 100 K over the course of 28 days*




- step 3: fill with liquid argon
  - *- it took 9 tanker trucks to fill the vessel*
  - *- detector is now filled with 34,000 gallons (170 tons) of high purity LAr*