

Short Baseline Neutrino Program @ Fermilab (MicroBooNE et al)

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P5 recommendations, based on 5 “physics drivers”



CERN
Platform

SBN

- **Recommendation 12:** In collaboration with international partners, develop a coherent short- and long-baseline neutrino program hosted at Fermilab.
- **Recommendation 15:** Select and perform in the short term a set of small-scale short-baseline experiments that can conclusively address experimental hints of physics beyond the three-neutrino paradigm. Some of these experiments should use liquid argon to advance the technology and build the international community for LBNF at Fermilab.

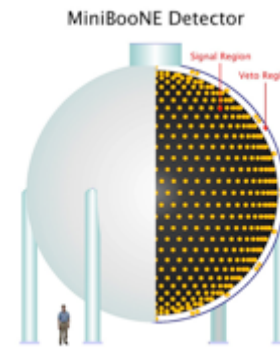
Interesting signals from short baseline experiments (<1km)

Experiment	Type	Channel	Significance
LSND	DAR	$\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ CC	3.8σ
MiniBooNE	SBL accelerator	$\nu_\mu \rightarrow \nu_e$ CC	3.4σ
MiniBooNE	SBL accelerator	$\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ CC	2.8σ
GALLEX/SAGE	Source - e capture	ν_e disappearance	2.8σ
Reactors	Beta-decay	$\bar{\nu}_e$ disappearance	3.0σ

K. N. Abazajian et al. "Light Sterile Neutrinos: A Whitepaper", arXiv:1204.5379 [hep-ph], (2012)

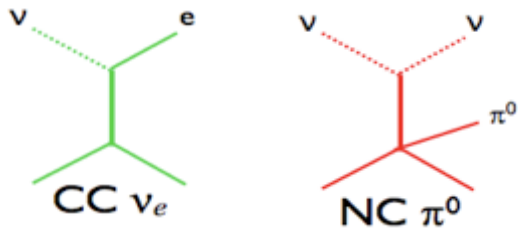
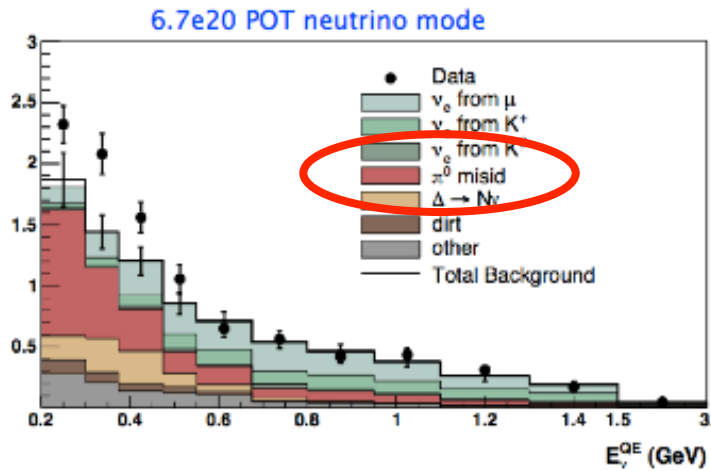
- > Physics case for Short Base-Line experiments
- > No discovery if taken separately,
but together they could be a hint at something new
- > Most common interpretation:
evidence for high mass-squared neutrino oscillations
 - existence of additional, mostly “sterile” neutrino states
with masses at or below a few eV ?

MiniBooNE

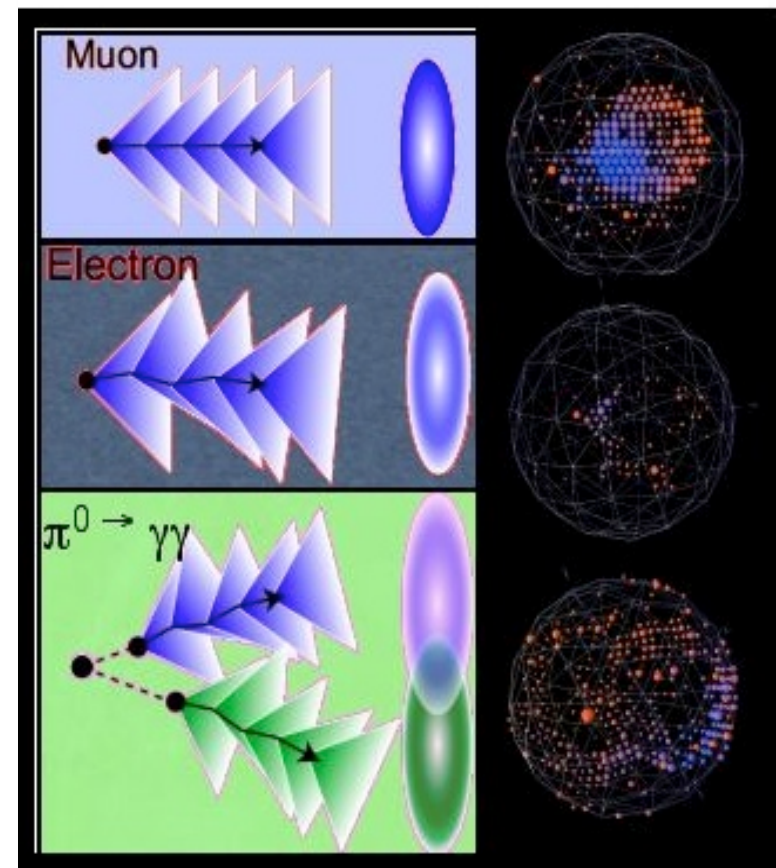


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> A better measurement needs to address this



Liquid Argon TPC (MicroBooNE)
Ionization in LAr
Charge drift to readout wires

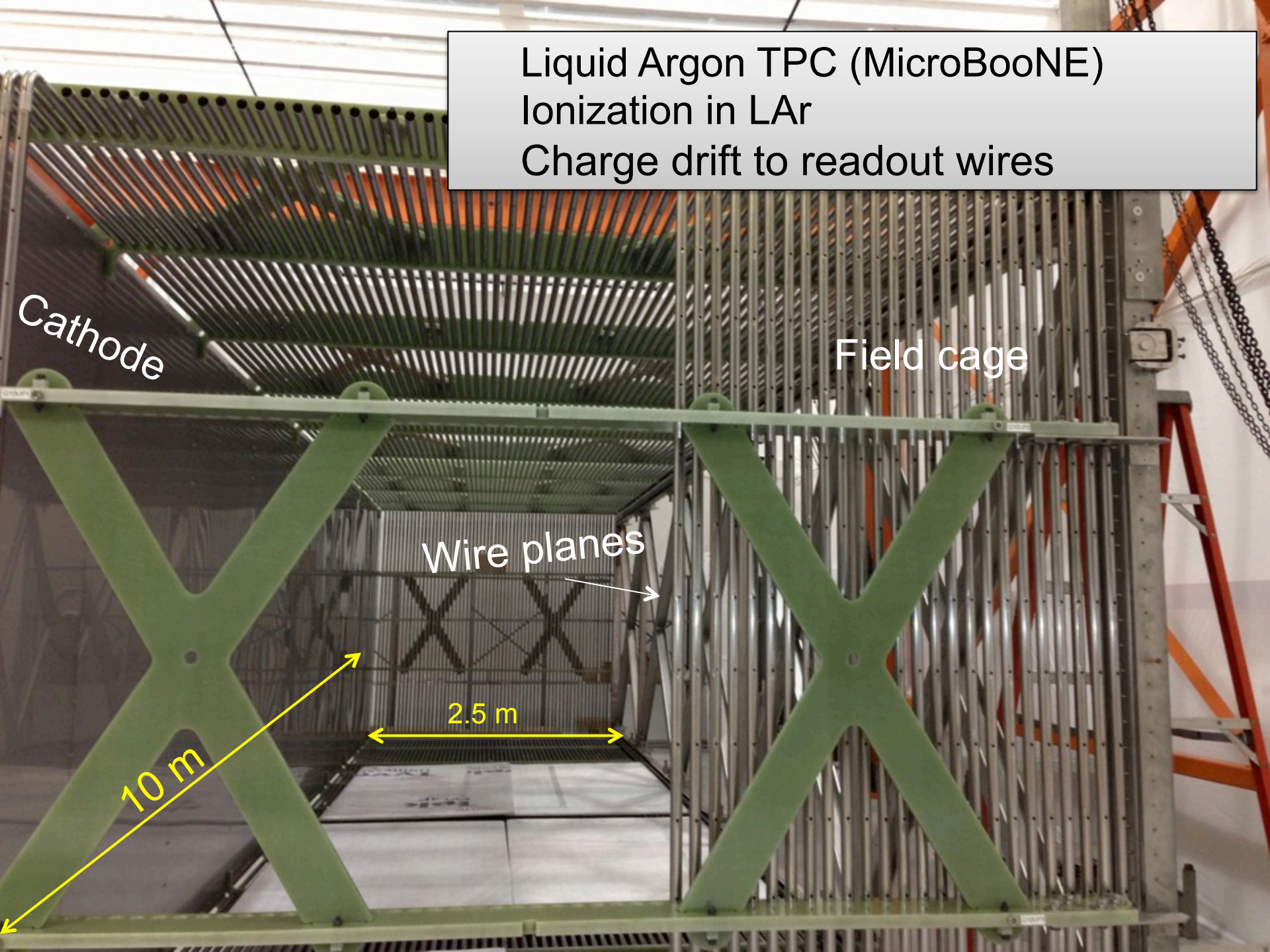
Cathode

Field cage

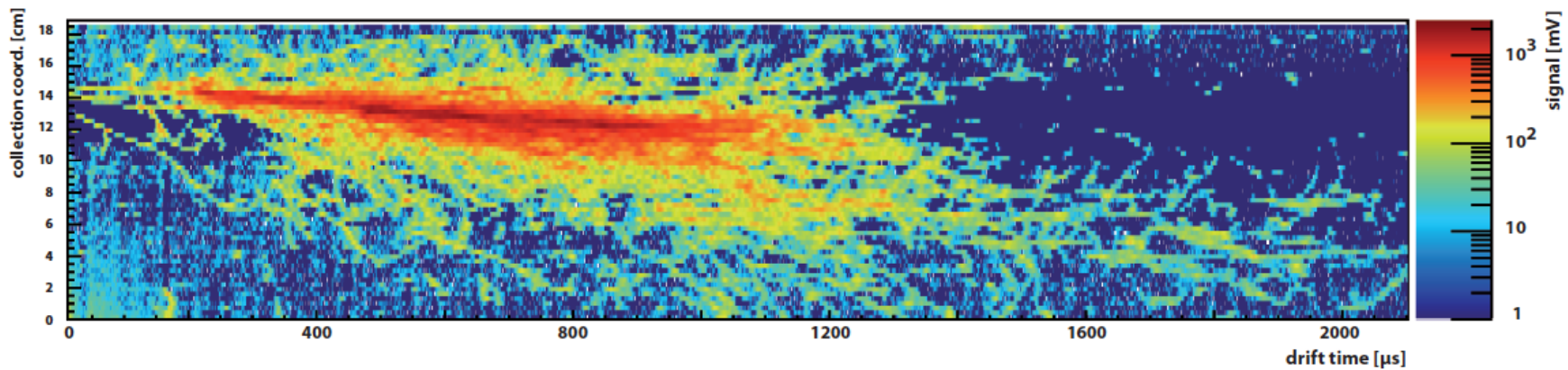
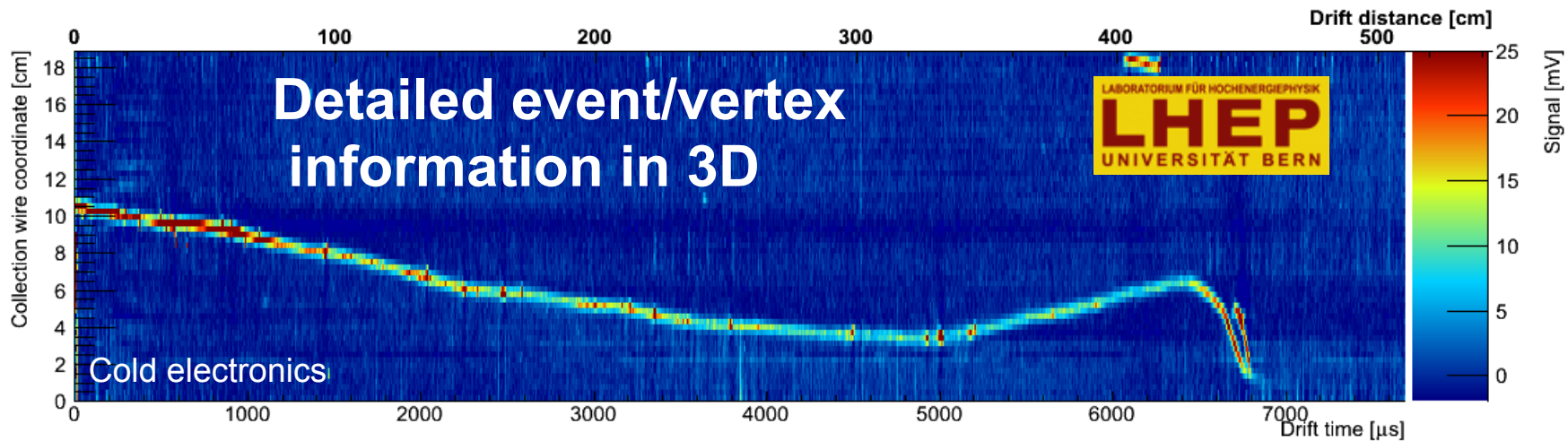
Wire planes

10 m

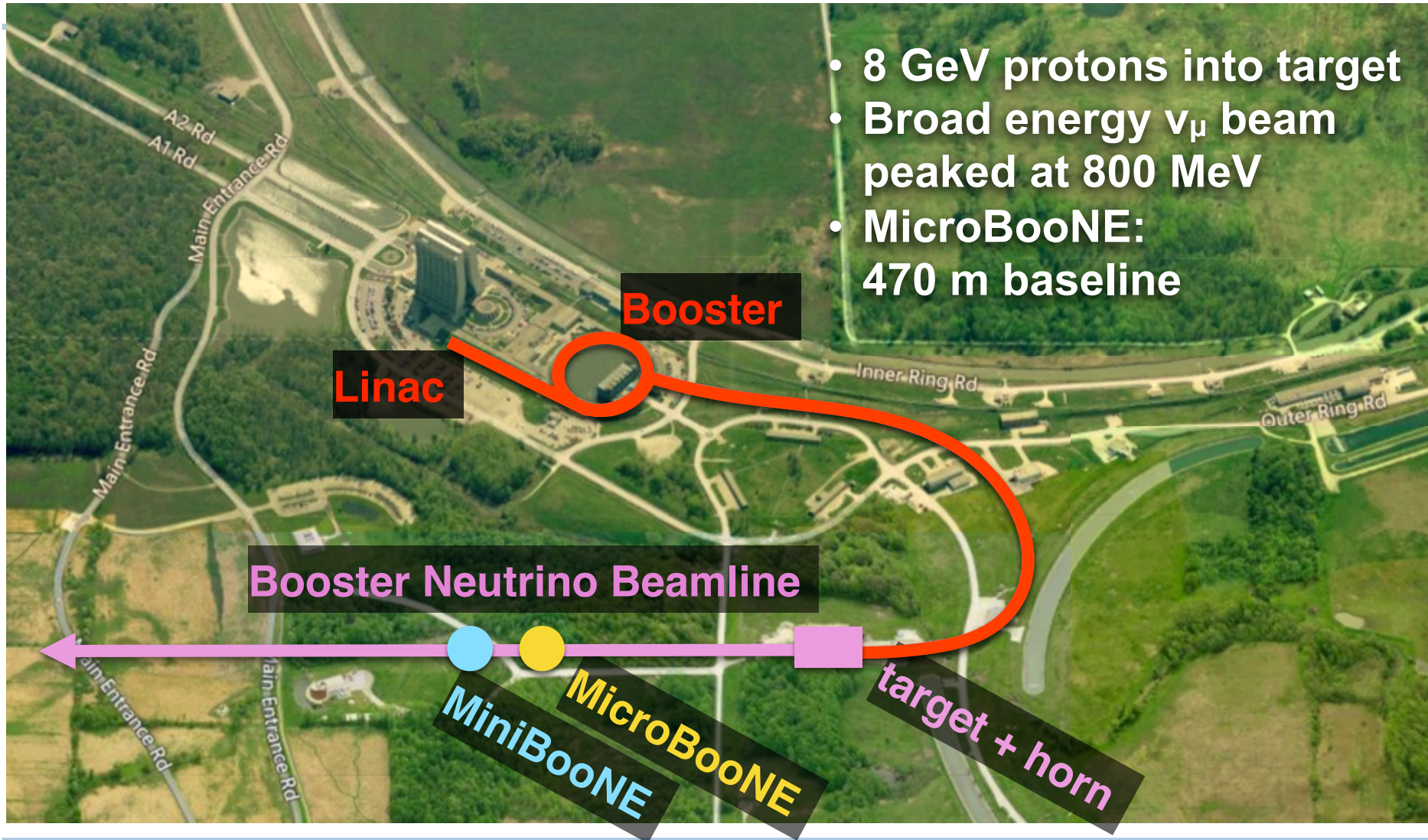
2.5 m

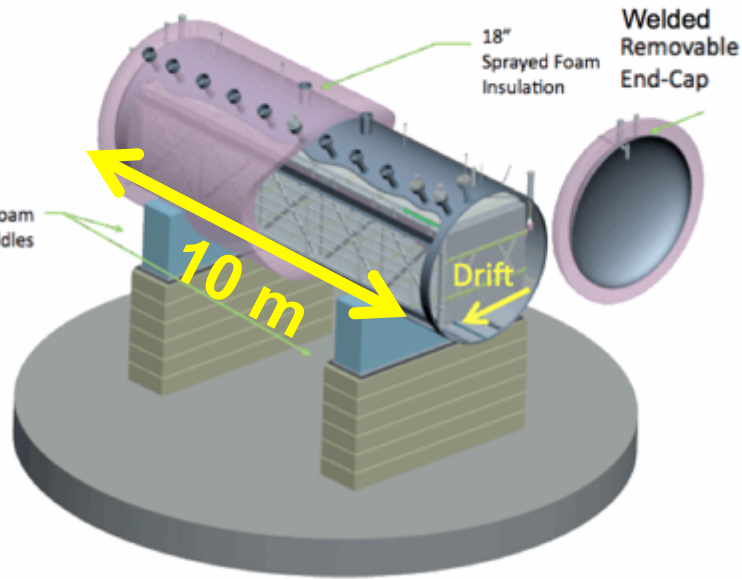


Example events from ARGONTUBE (2006-2015) (actual cosmic rays)

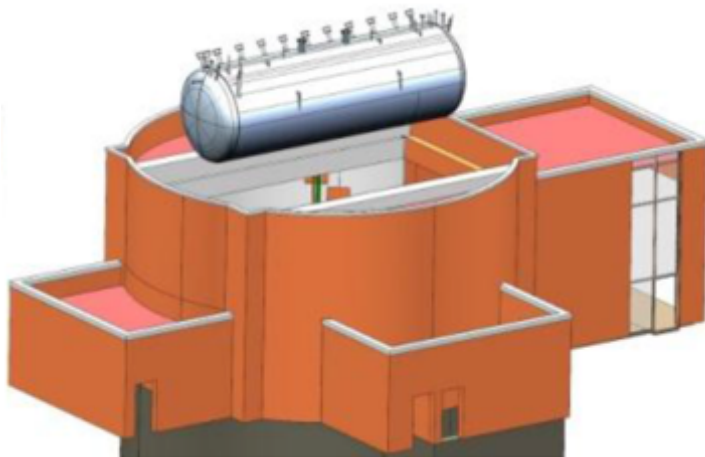


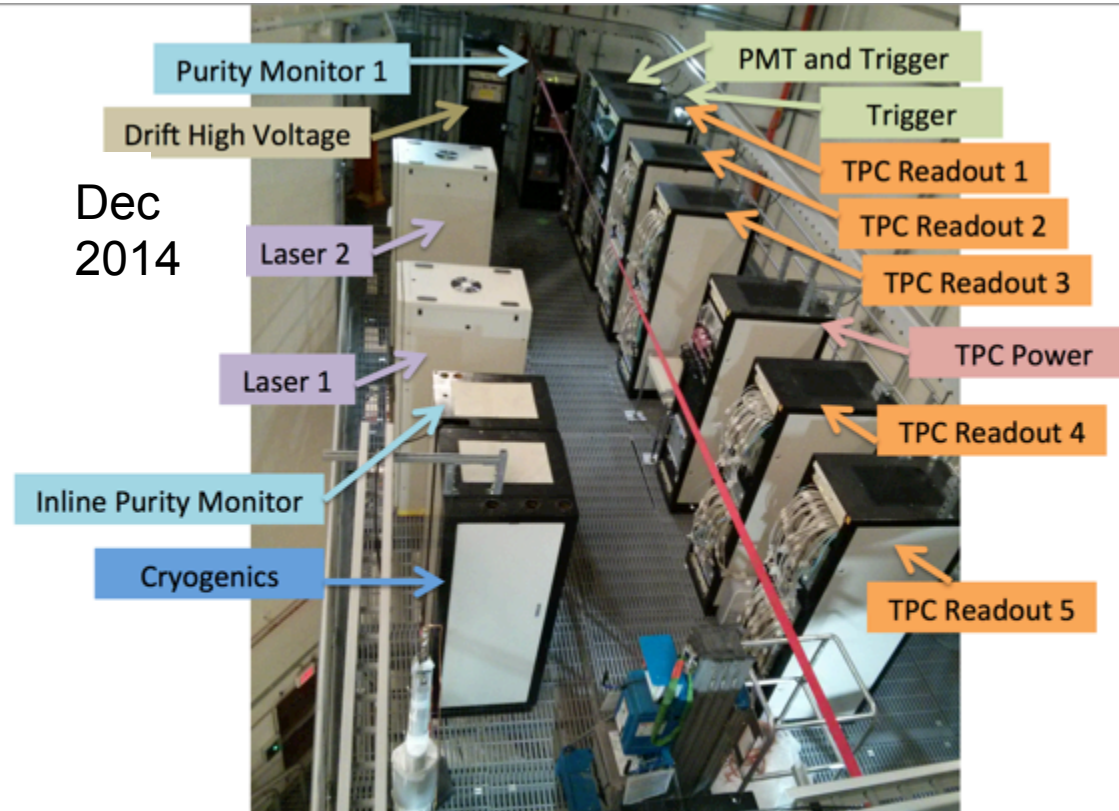
MicroBooNE on the Booster Neutrino Beamline



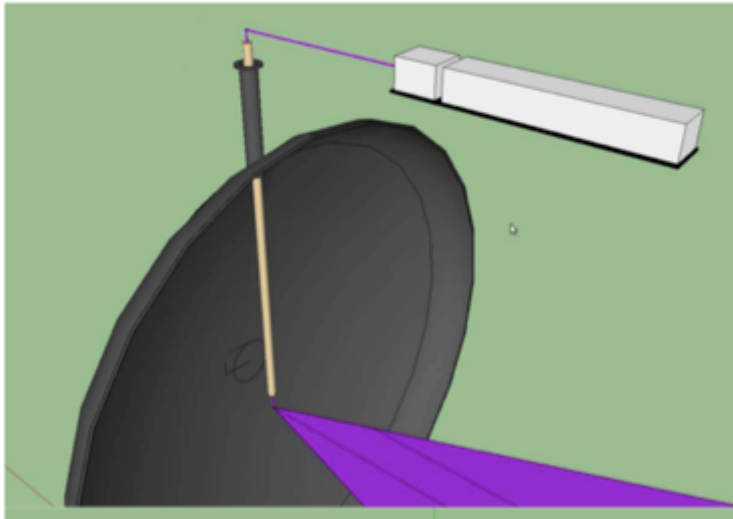


MicroBooNE:
170 tons LAr (89t active)

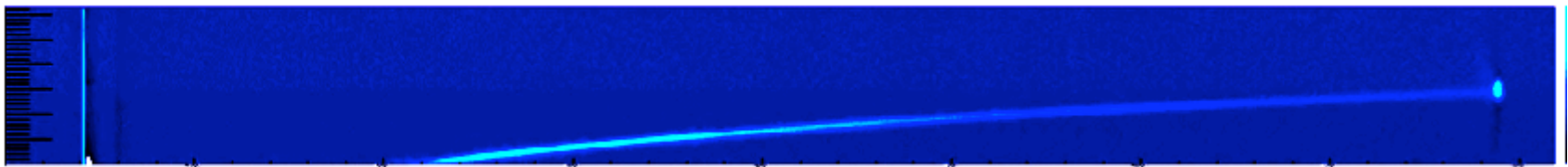




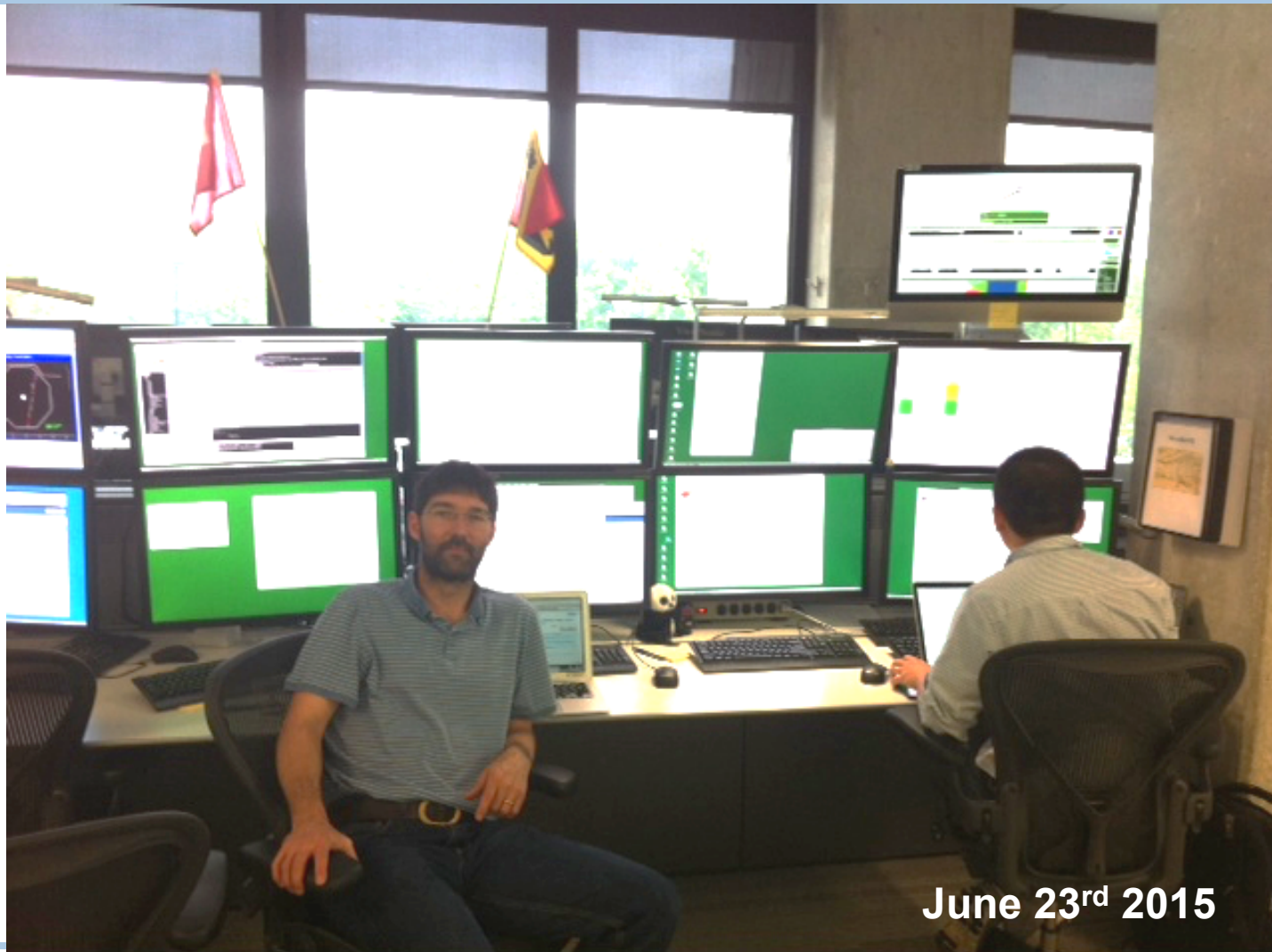
UV laser calibration system



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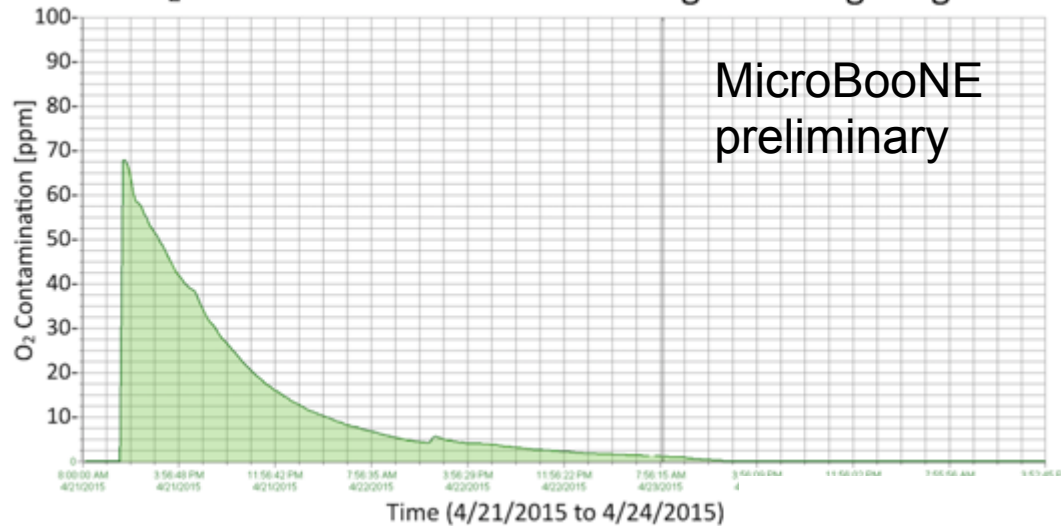
24/7 shifts



June 23rd 2015

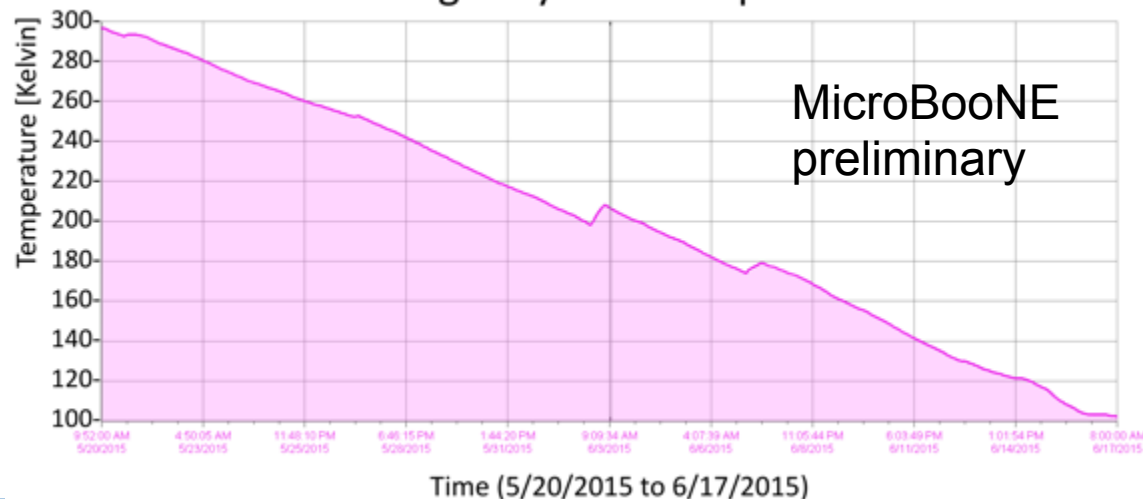
Purging and cooling

O₂ Contamination of Gaseous Argon During Purge



Average Cryostat Temperature

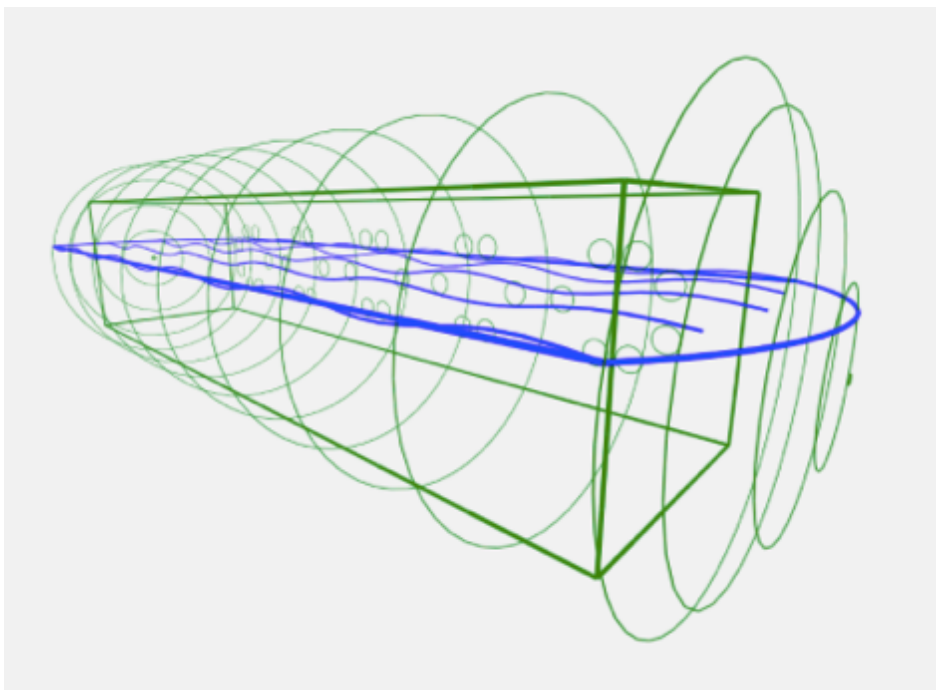
May 2015



Filling !



Top temp: 107.6K Bottom temp: 89.0K
227.8 cm / 22027 gal / 83.38 m³ / 89.7 in of ℓAr
as of 2015-06-30 02:09:44.124319



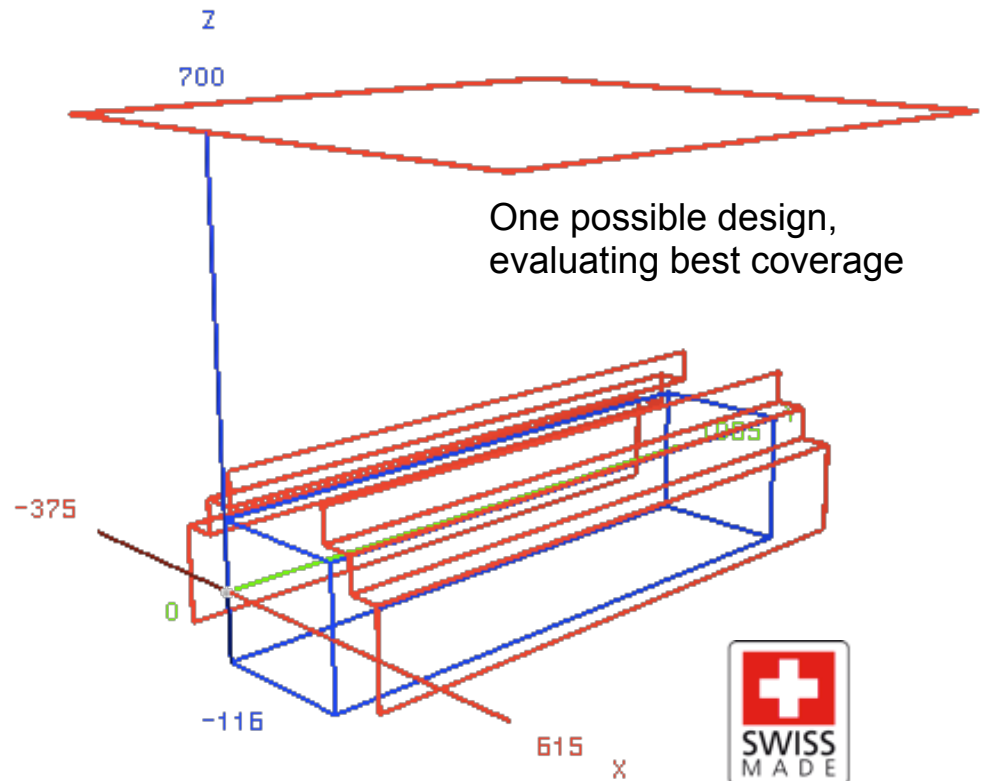
68% full

83.4 m³
= 117 t

<http://argo-microboone.fnal.gov/FillLevel/>

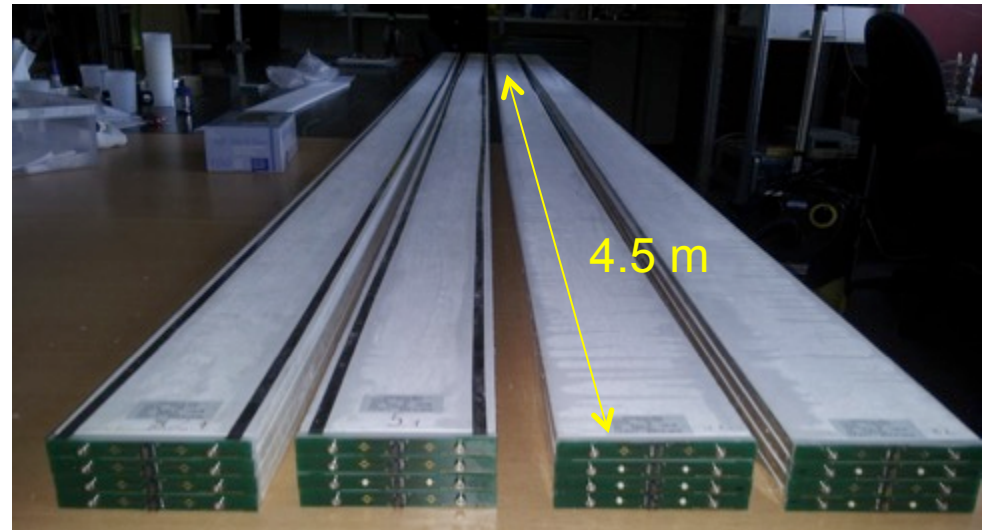
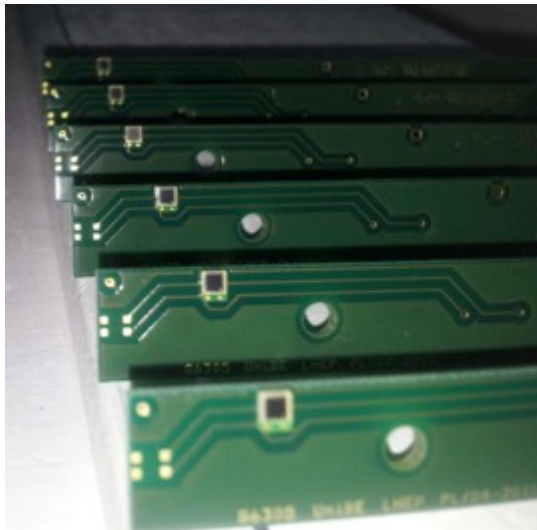
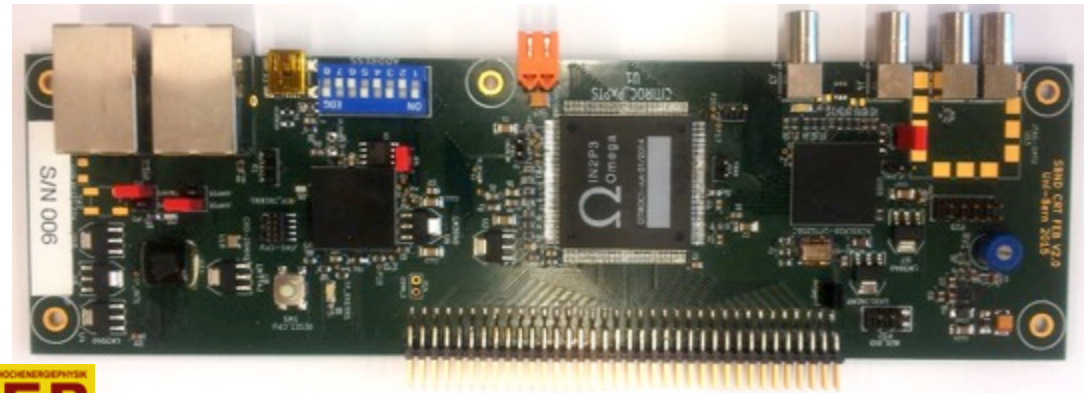
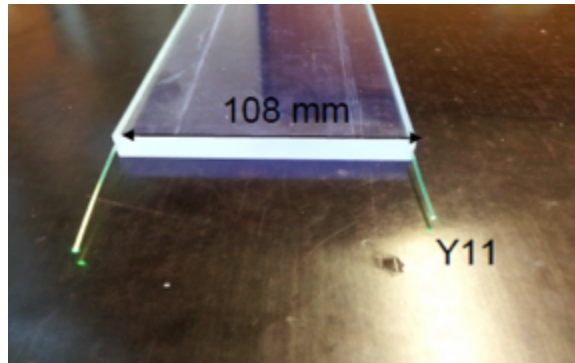
External muon tagger

- > Upgrade to MicroBooNE: add a tagger system for cosmic rays
- > Challenging retro-fit due to space constraints



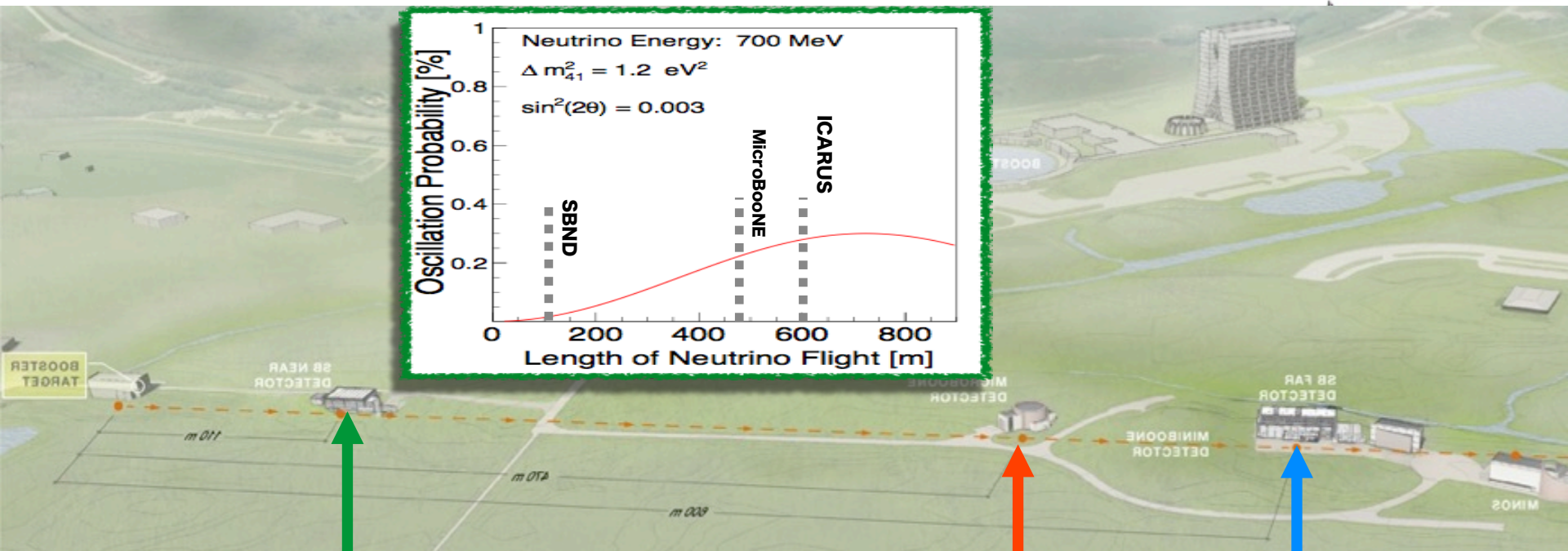
- > Issue:
 - Operation at surface
 - the detector is active during the drift time and $t_{\text{drift}} = 1000 \times t_{\text{spill}}$

Cosmogenic tagger



Extension to three detectors

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SBND
112t Active Mass

MicroBooNE
89t Active Mass

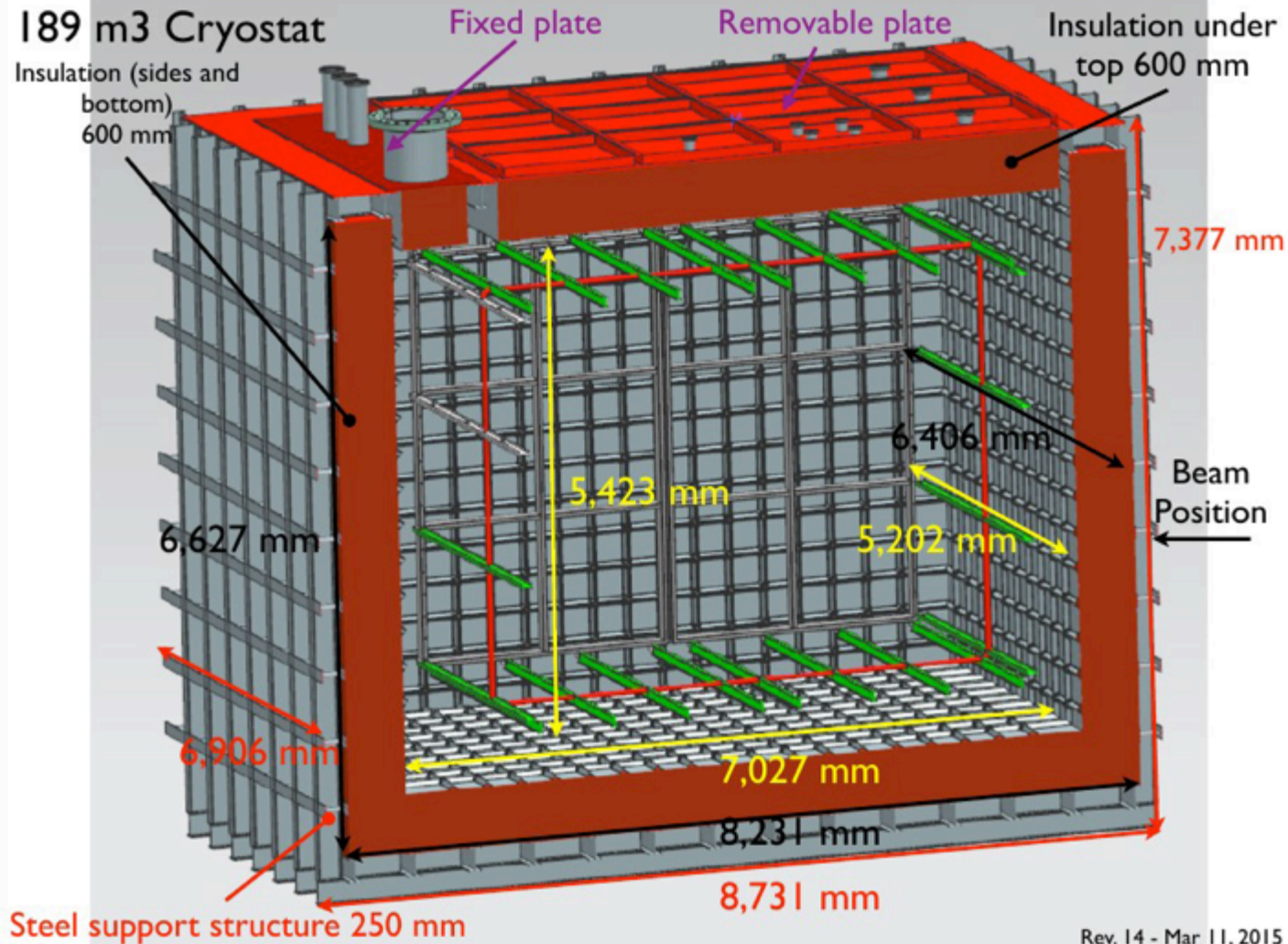
ICARUS T600
476t Active Mass

Protons

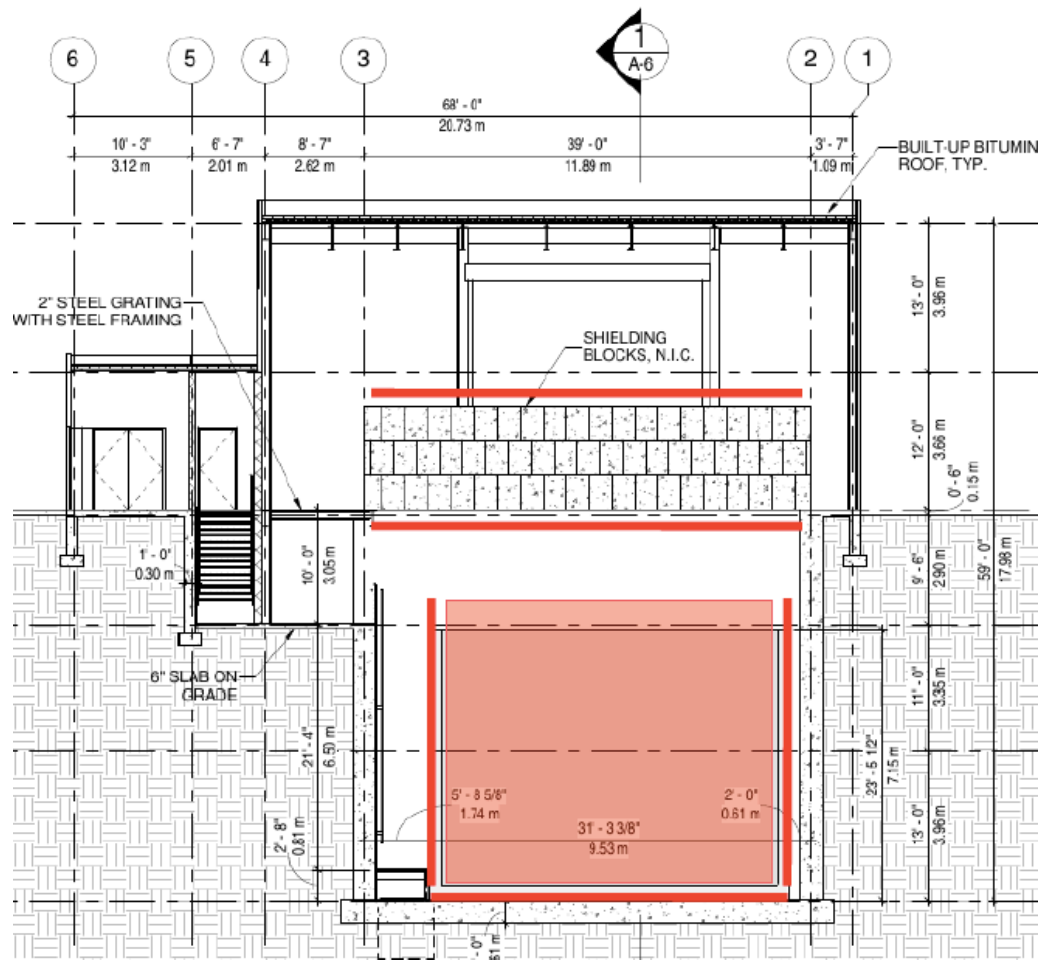


ν_μ $\nu_e?$

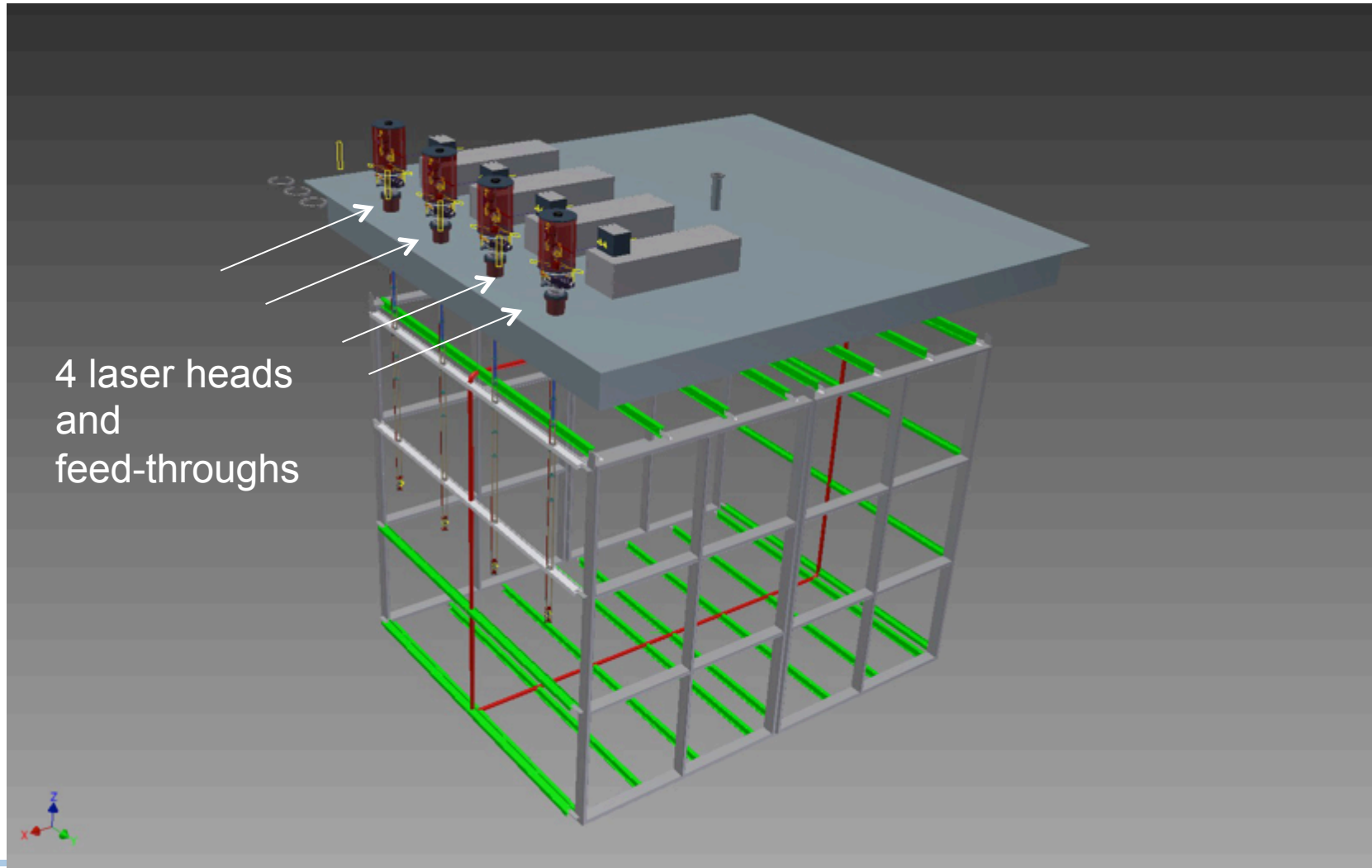
SBND (SNB near detector)



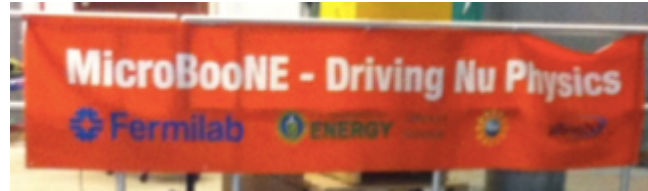
Muon tagger SBND



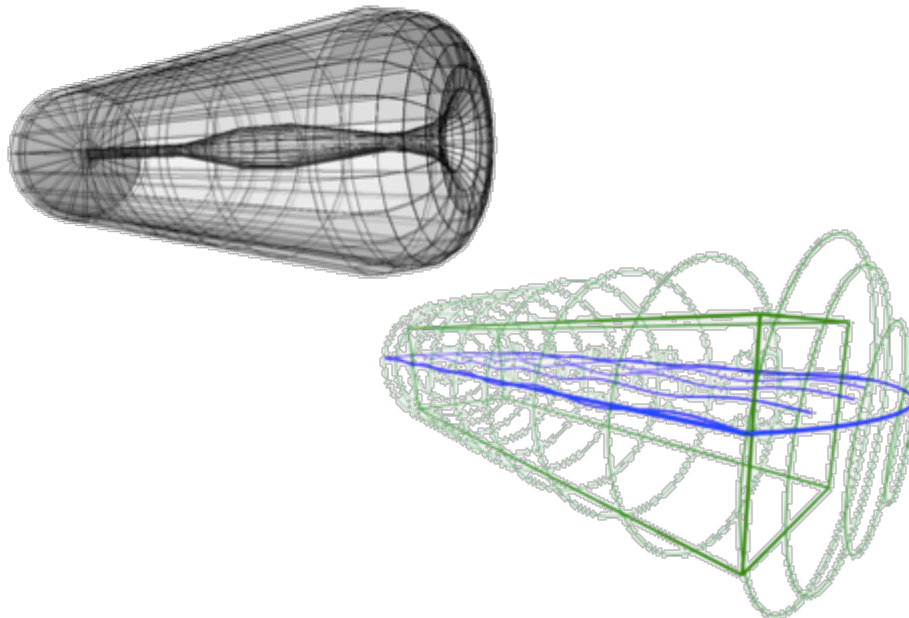
Laser system



Summary



- > Physics motivated short baseline neutrino program
- > Strong Swiss contributions
- > MicroBooNE being commissioned, first data 2015
- > Extension to a three-detector setup, operation in 2018



A Proposal for a Three Detector
Short-Baseline Neutrino Oscillation Program
in the Fermilab Booster Neutrino Beam



“The Committee recommends Stage 1
approval for the SBN program...”

~Fermilab Physics Advisory Committee, January 2015