

# Status of LArIAT

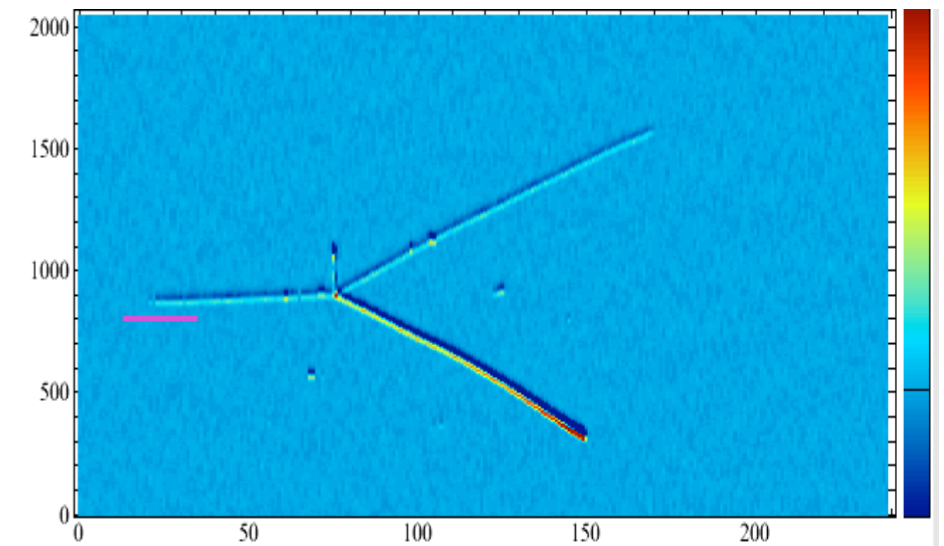
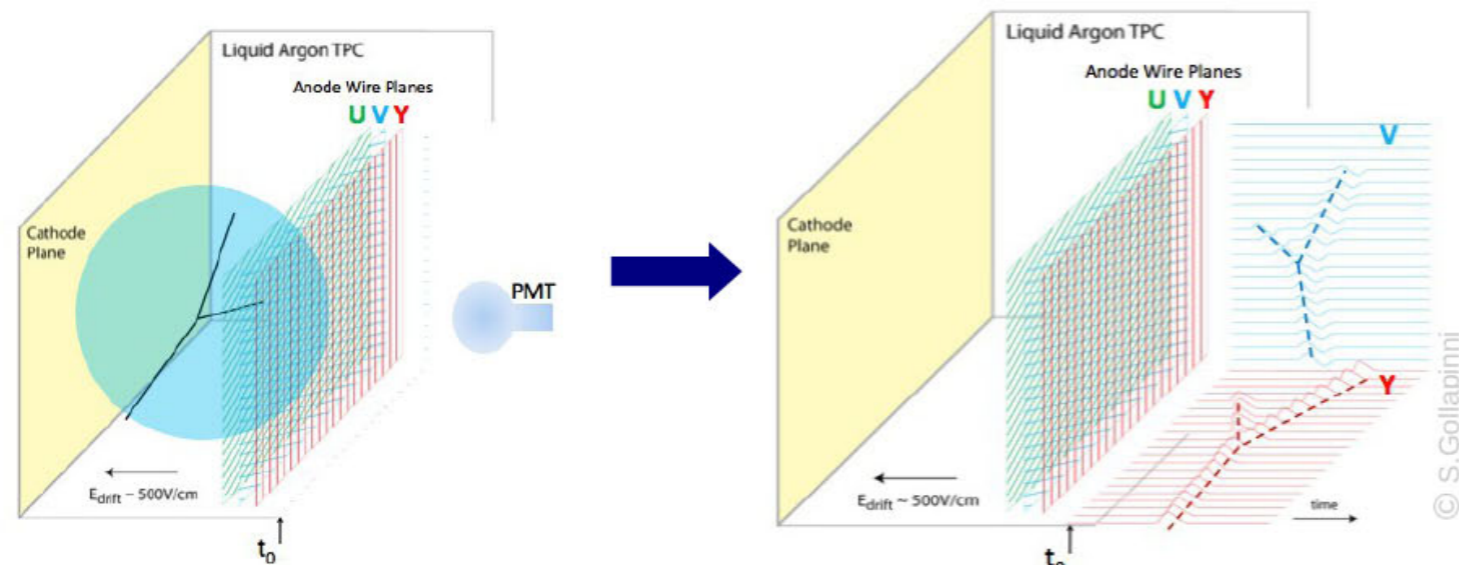
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12/22/2014, Neutrino Frontier Workshop 2014@Fuji  
Eito Iwai, IPNS/KEK

# Introduction

# LArIAT: Liquid Argon TPC In A Testbeam

- Time Projection Chamber
  - 3D reconstruction of charged particle tracks
  - $dE/dx$  along the track
  - calorimetry (total charge, scintillation light)



- To check the physics performance of liquid argon TPC
  - Liquid argon TPC: 175L (active volume)
  - At Fermilab Test Beam Facility
  - PID, energy resolution ...

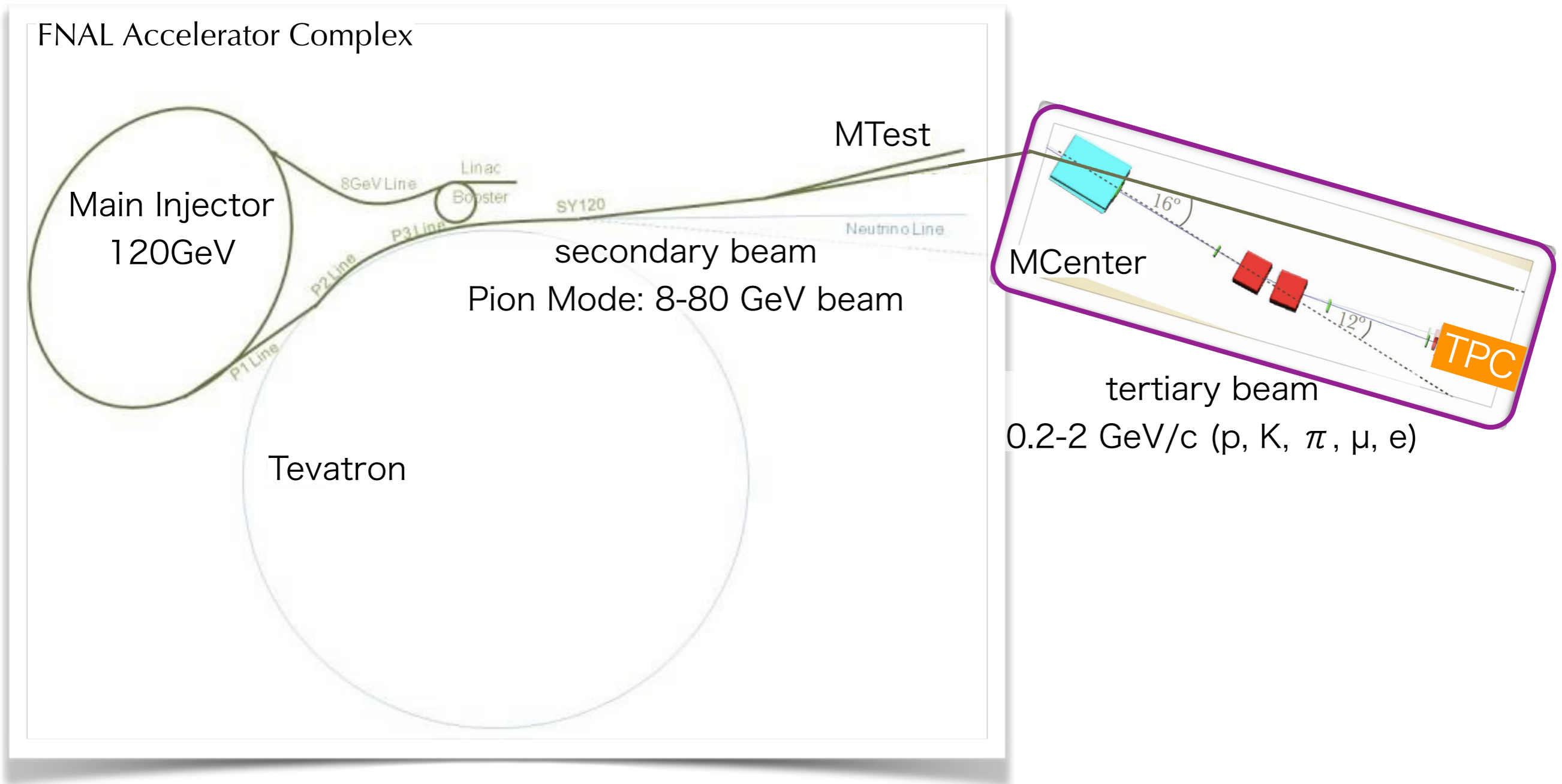
# LArIAT collaboration

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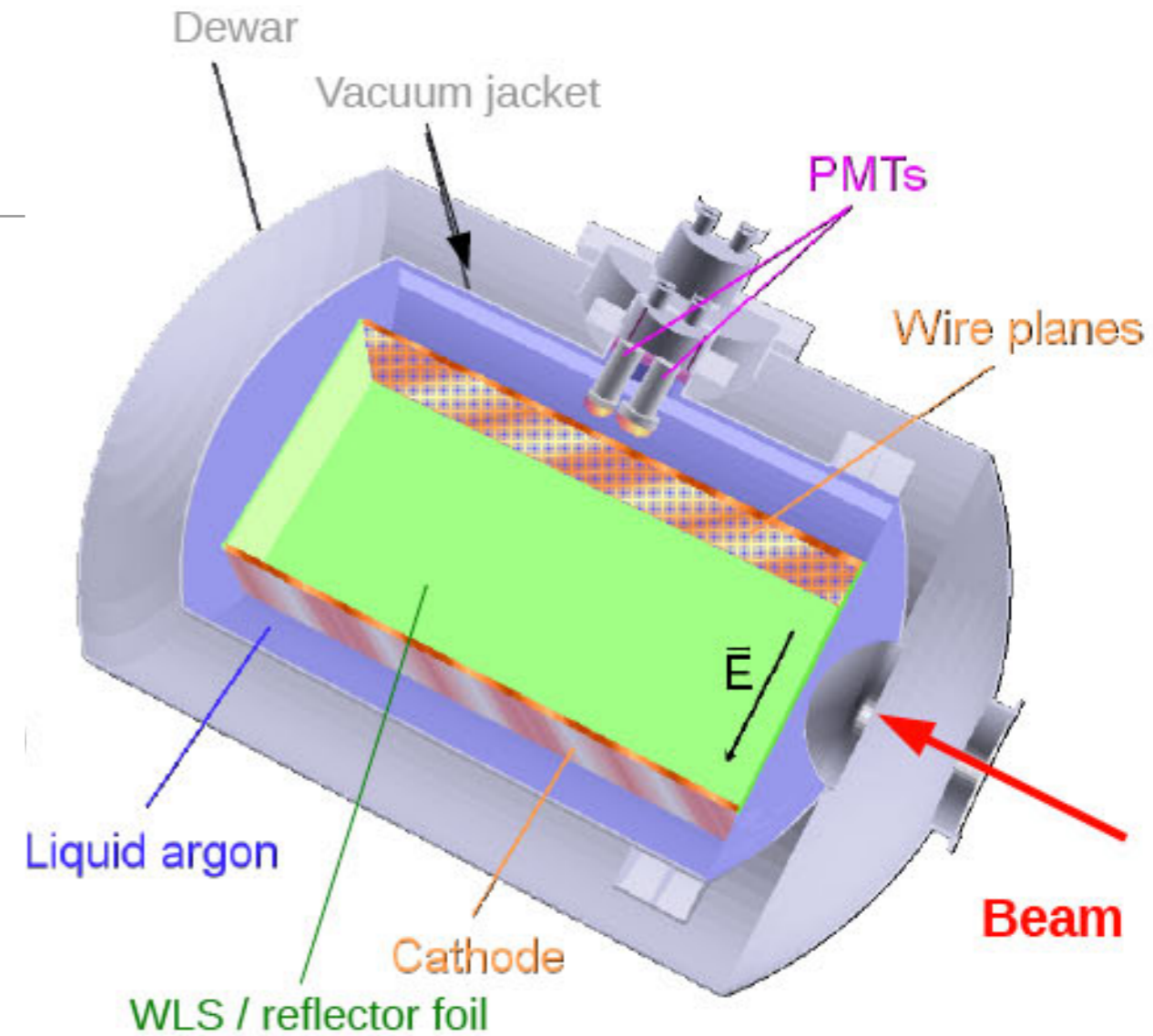
- 20 institutions; US, UK, Japan
- 68 collaborators

# Tertiary beam at FNAL Test Beam Facility



# LArIAT TPC

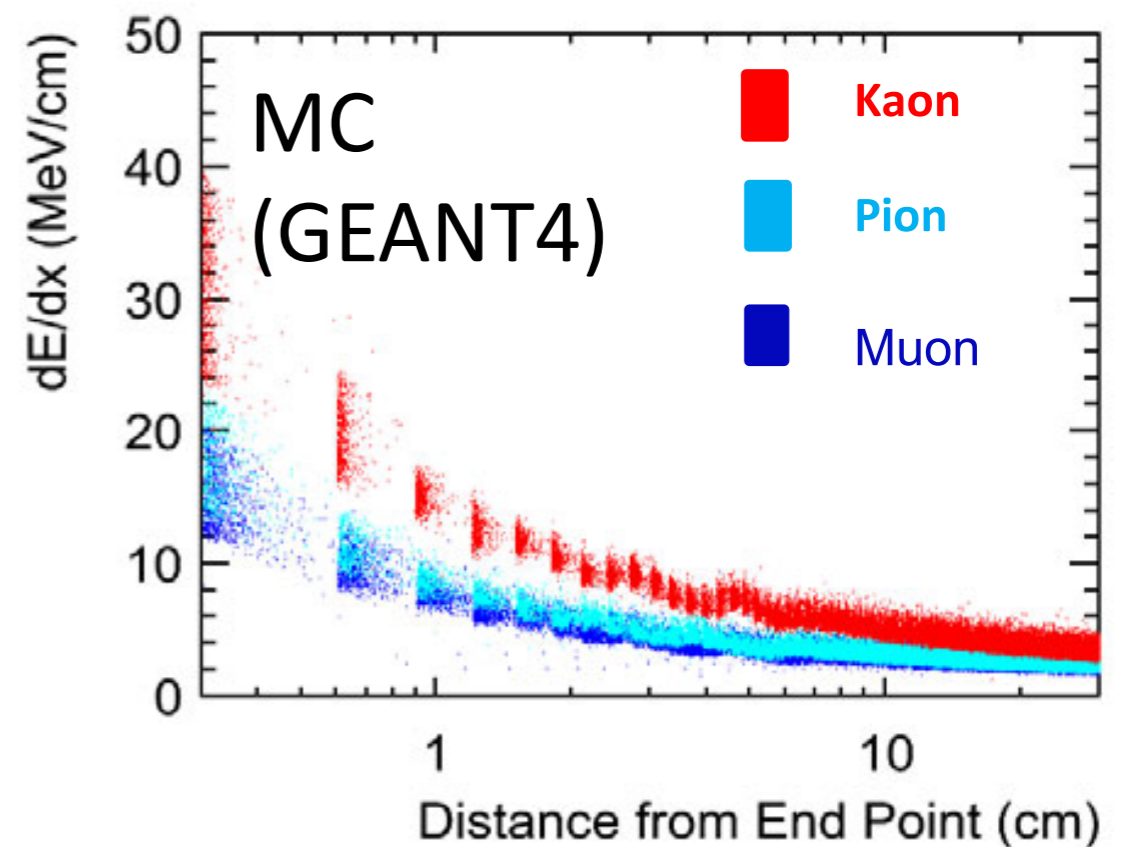
- Refurbished ArgoNeut TPC
  - 550L cryostat (active volume 175L)
  - 90cm x 40cm x 47.5cm(drift)
  - 4mm wire spacing
  - Typical drift field: 500V/cm
    - ~300 $\mu$ s max drift time
  - Scintillation light correction
    - 2PMTs, 2SiPMs and WLS reflector foils
  - Cold readout electronics



# Motivation

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- To check the capability of the LAr TPC detector for neutrino physics
  - PID performance
    - dE/dx
    - Event topology
    - $\pi^0$  vs electron
    - muon charge without magnetic field
  - energy resolution (EM, hadron)
  - hadron interaction
    - Charged pion interaction in LAr
- Going to be the first precise charged particle testbeam with LAr TPC
  - J-PARC T32: 10mm wire spacing, 1D readout, hadron accident ...



# Motivation

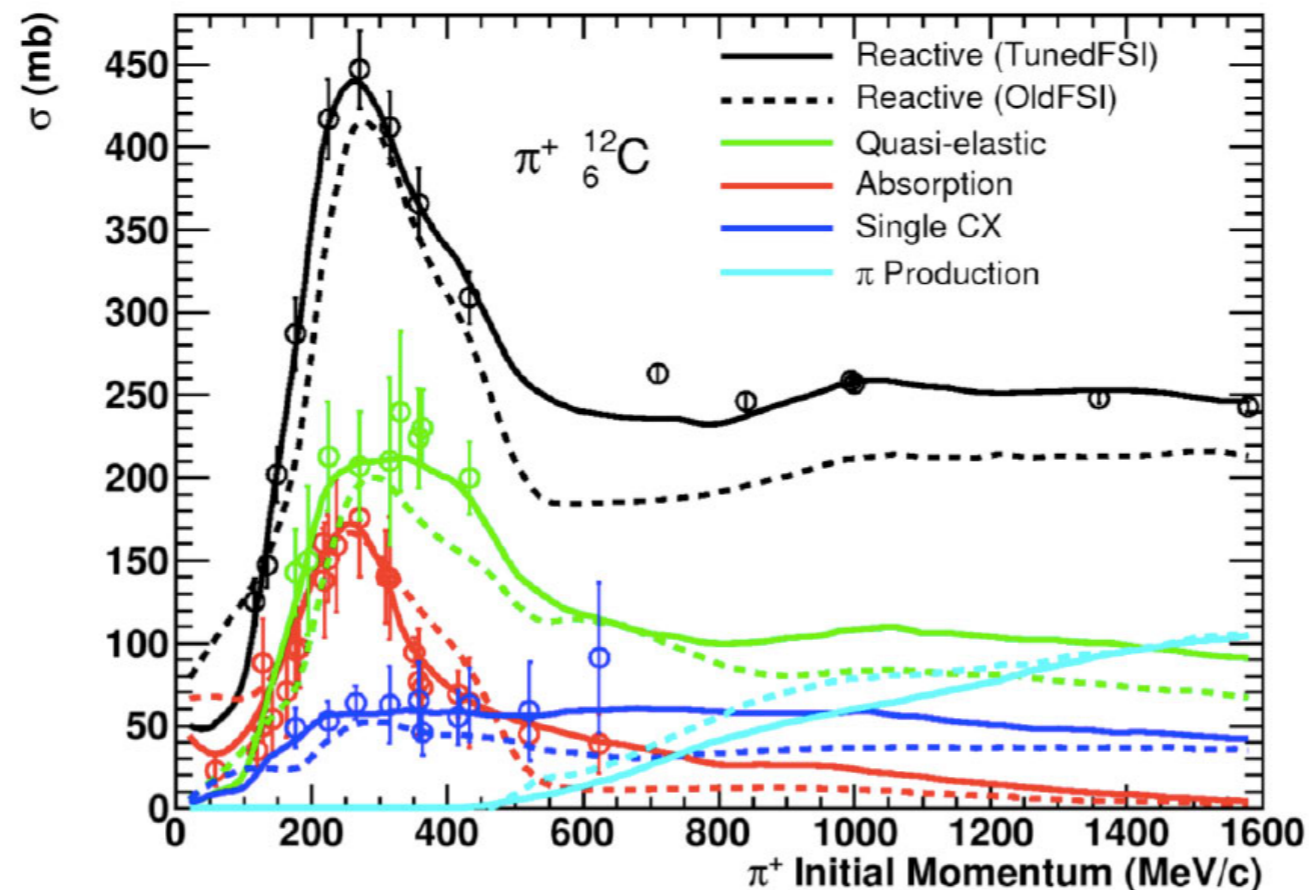
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- Addition to basic performance, such as PID by  $dE/dx$  ...
  - Charged pions in liquid argon below 500 MeV range ( $\Delta$  resonance)
  - Muon charge without magnetic field  
(using magnet with LAr TPC: technically challenging and expensive)
- energy resolution



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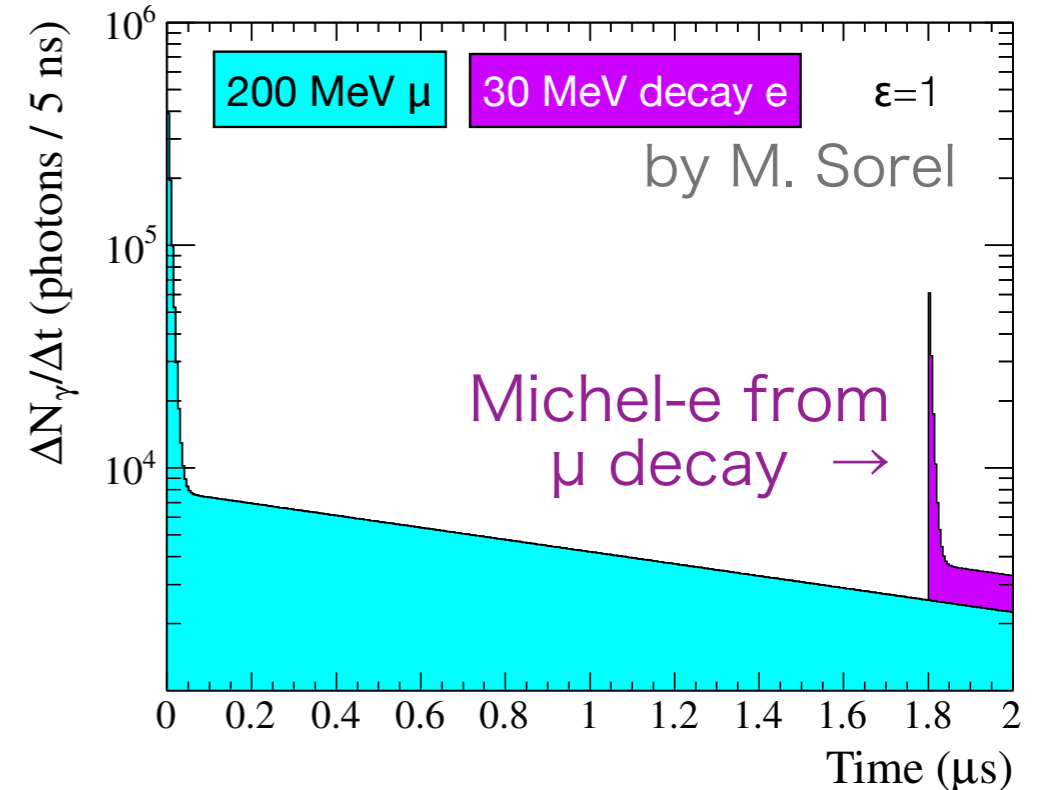
key:  $\pi$  PID

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	decay	capture
$\mu^+$	100%	0%
$\mu^-$	26%	74%

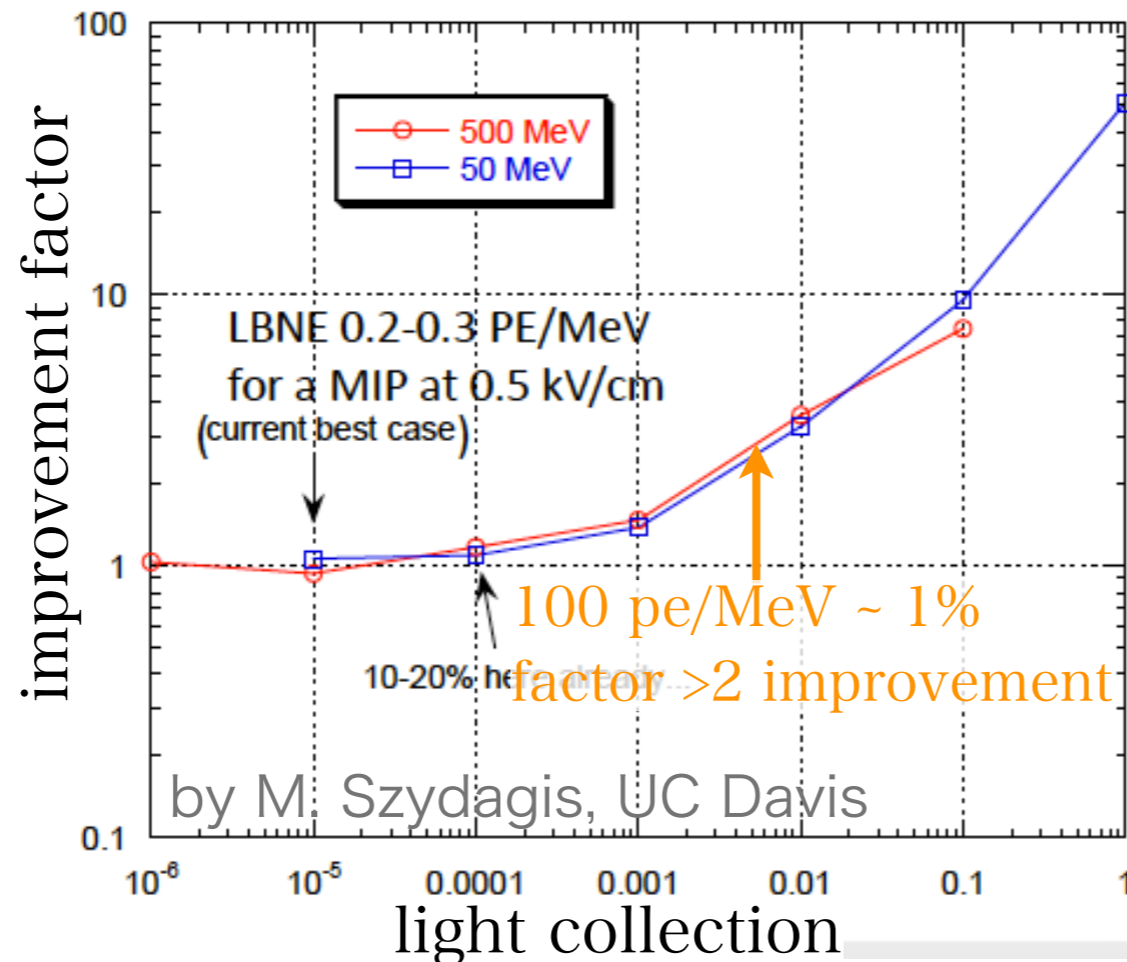
	Isotopes	Isotopic yield per stopped muon, %
$^{40}\text{Ar} + \mu^- \rightarrow ^{40}\text{Cl} + \nu$	$^{40}\text{Cl}$	$7.12 \pm 0.17$
$^{40}\text{Ar} + \mu^- \rightarrow ^{39}\text{Cl} + n + \nu$	$^{39}\text{Cl}$	$48.7 \pm 1.38$
$^{40}\text{Ar} + \mu^- \rightarrow ^{38m}\text{Cl} + 2n + \nu$	$^{38m}\text{Cl}$	$1.6 \pm 0.1$
$^{40}\text{Ar} + \mu^- \rightarrow ^{38}\text{Cl} + 2n + \nu$	$^{38}\text{Cl}$	$15.45 \pm 0.9$
$^{40}\text{Ar} + \mu^- \rightarrow ^{39}\text{S} + p + \nu$	$^{39}\text{S}$	$0.22 \pm 0.10$
$^{40}\text{Ar} + \mu^- \rightarrow ^{38}\text{S} + d + \nu$	$^{38}\text{S}$	$<1.2$



key:  $\mu$  PID, scinti. light

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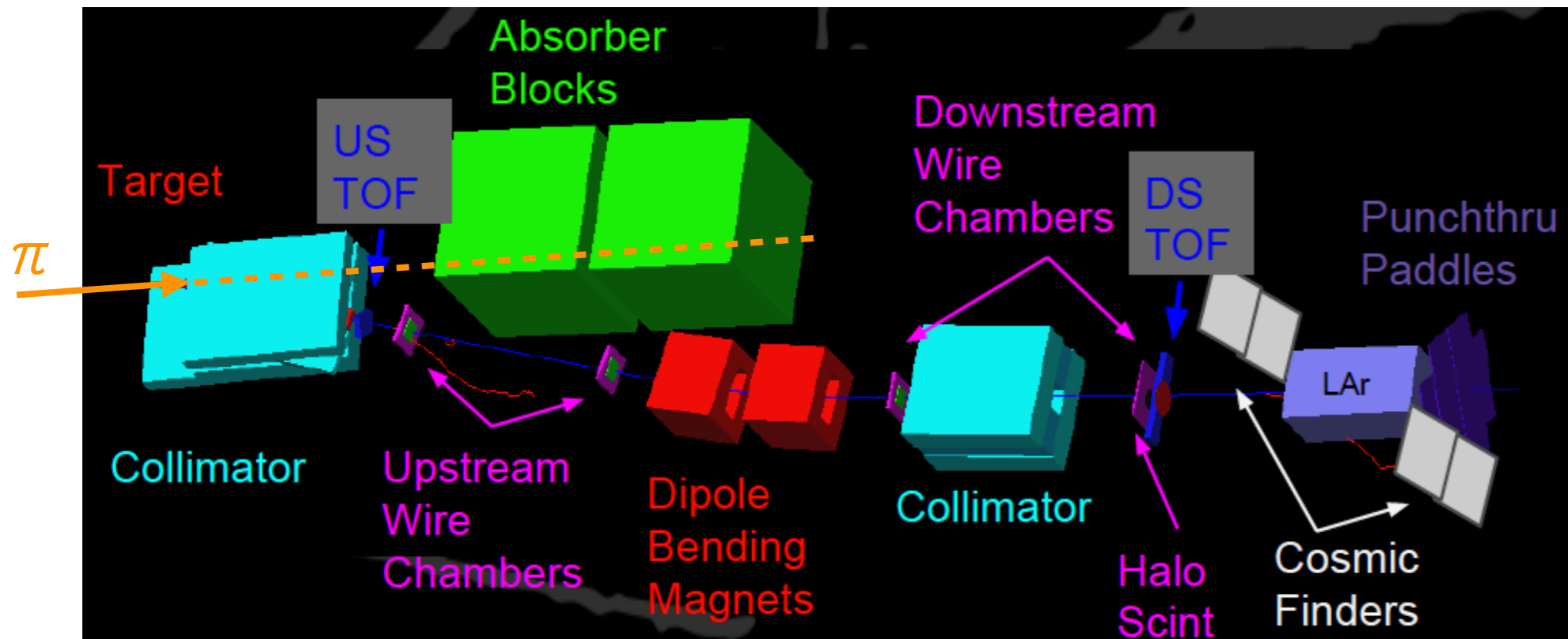
key: scinti. light

# Status

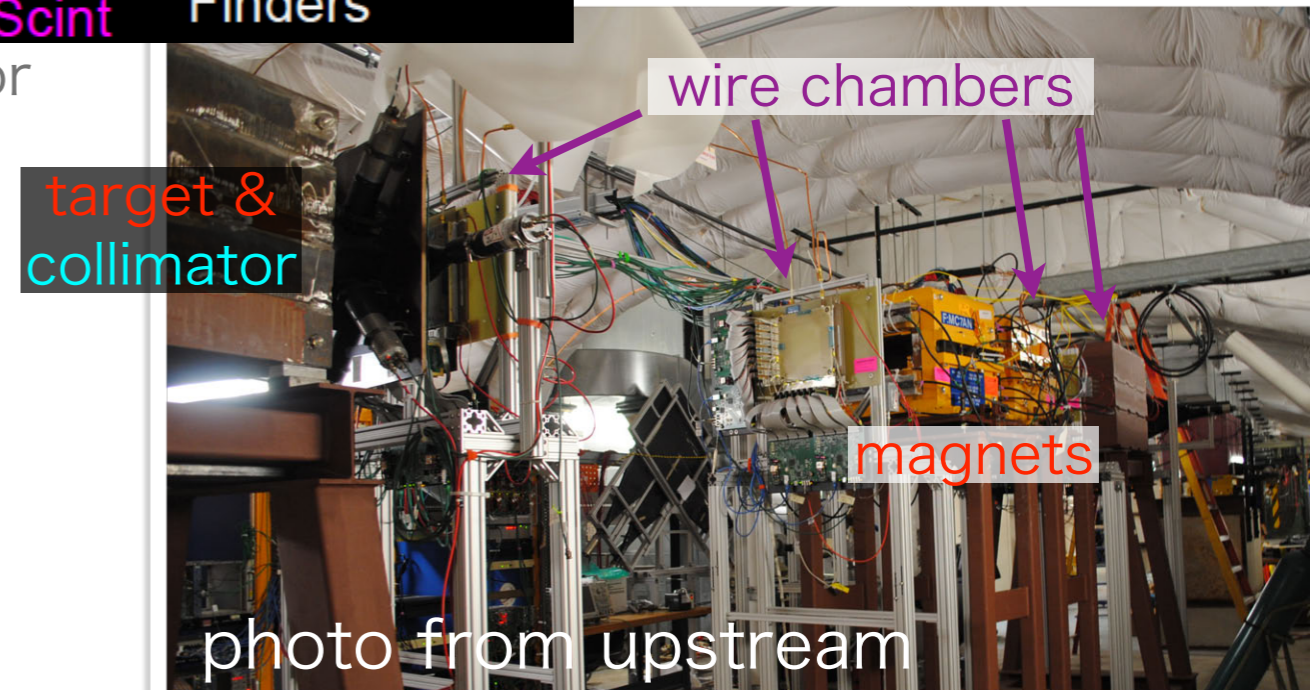
- ◆ Improvements from last year
  - Beam
    - place beam components to MCenter
    - beam commissioning
    - additional Cherenkov counters
  - TPC
    - anode wire planes
    - cold electronics
    - SiPMs
    - ready to go

# Tertiary beam at FNAL Test Beam Facility

- MCenter is reclaimed, and the beam line is prepared for LArIAT



by J. St. John (Cincinnati, LArIAT run coordinator)

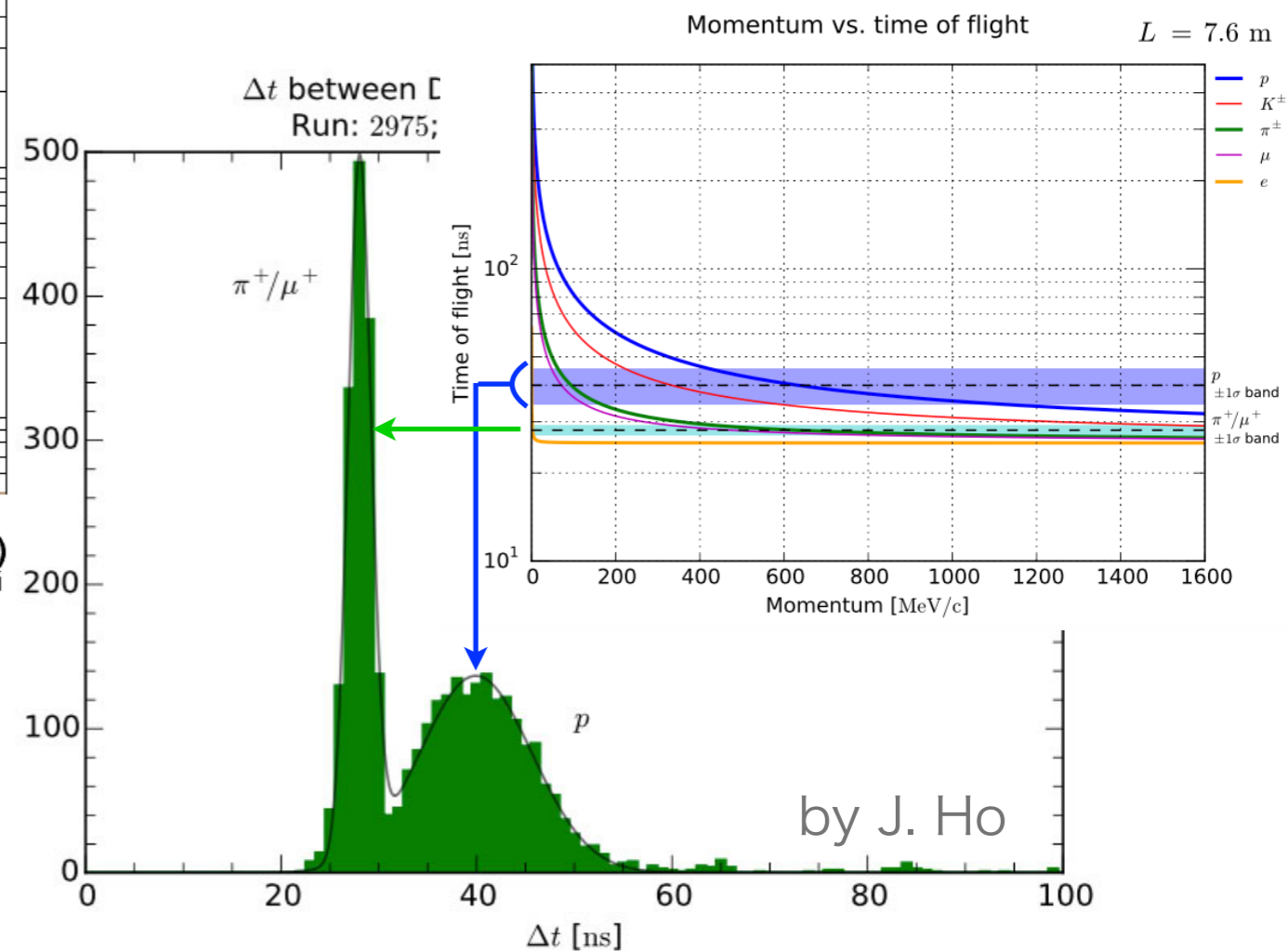
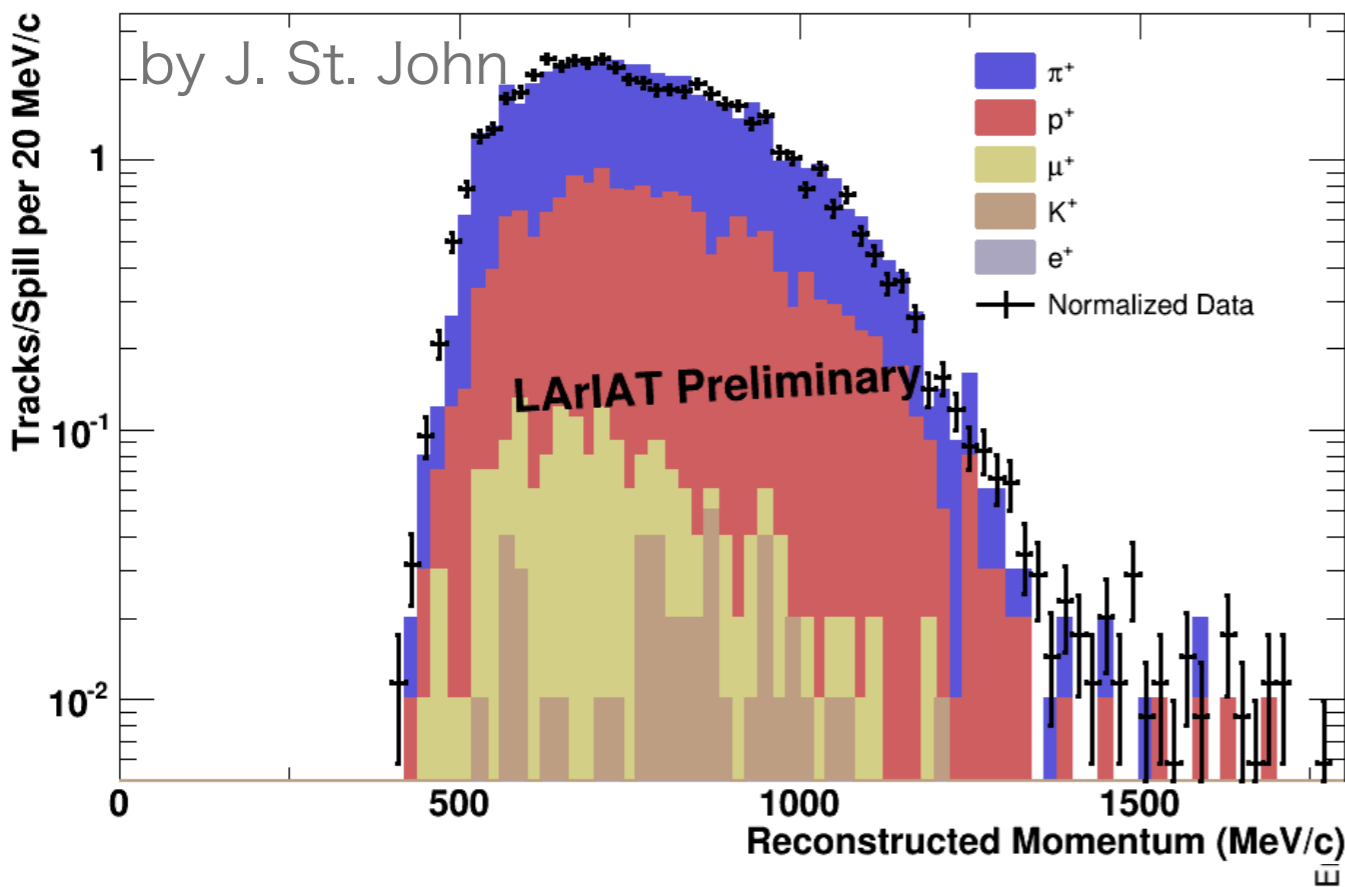


wire chambers で測るよ

# Tertiary beam at FNAL Test Beam Facility

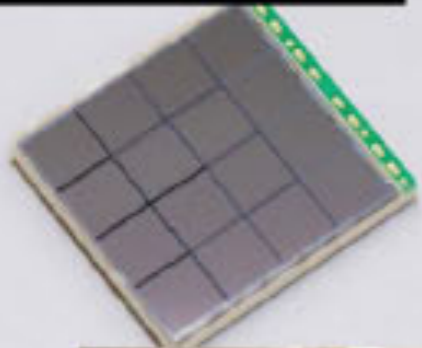
- beam commissioning finished (in this summer)

32 GeV  $\pi^+$  on Target, +100 A Magnet Current



# Scintillation light collecting system

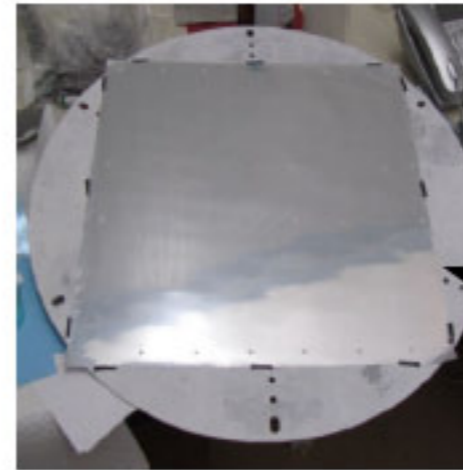
Hamamatsu SiPM



Cryogenic PMTs

Cryostat side port

## WLS reflector foils

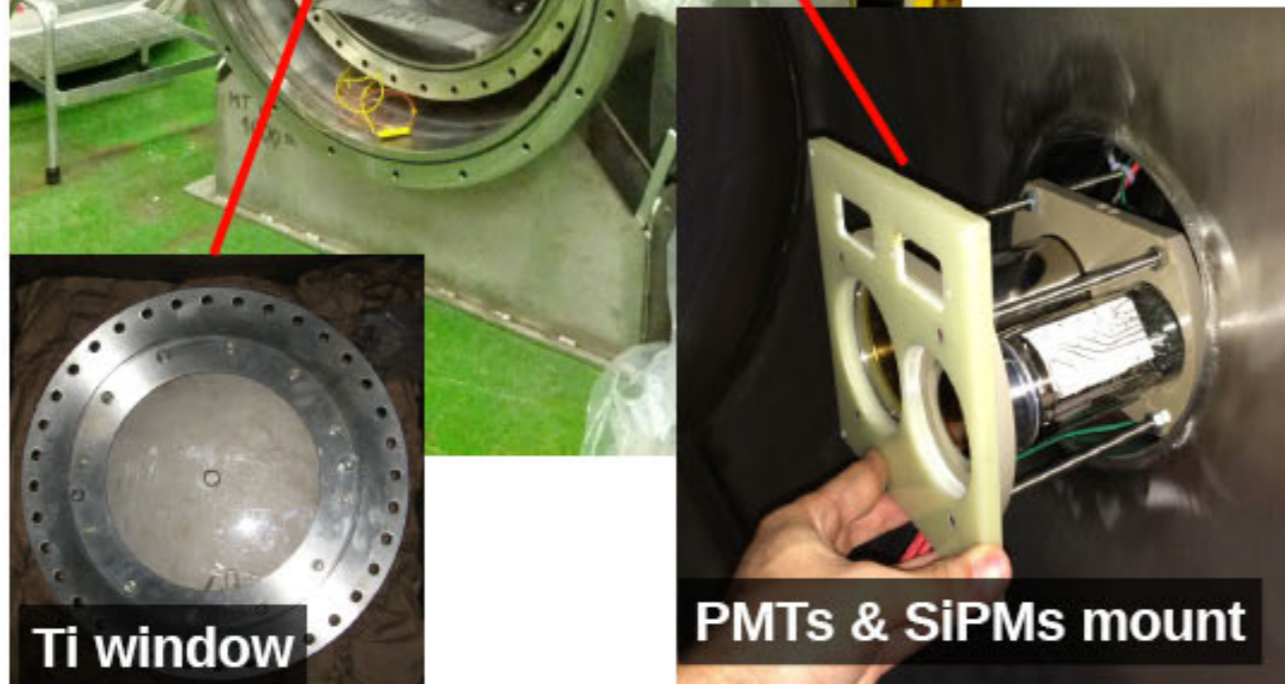
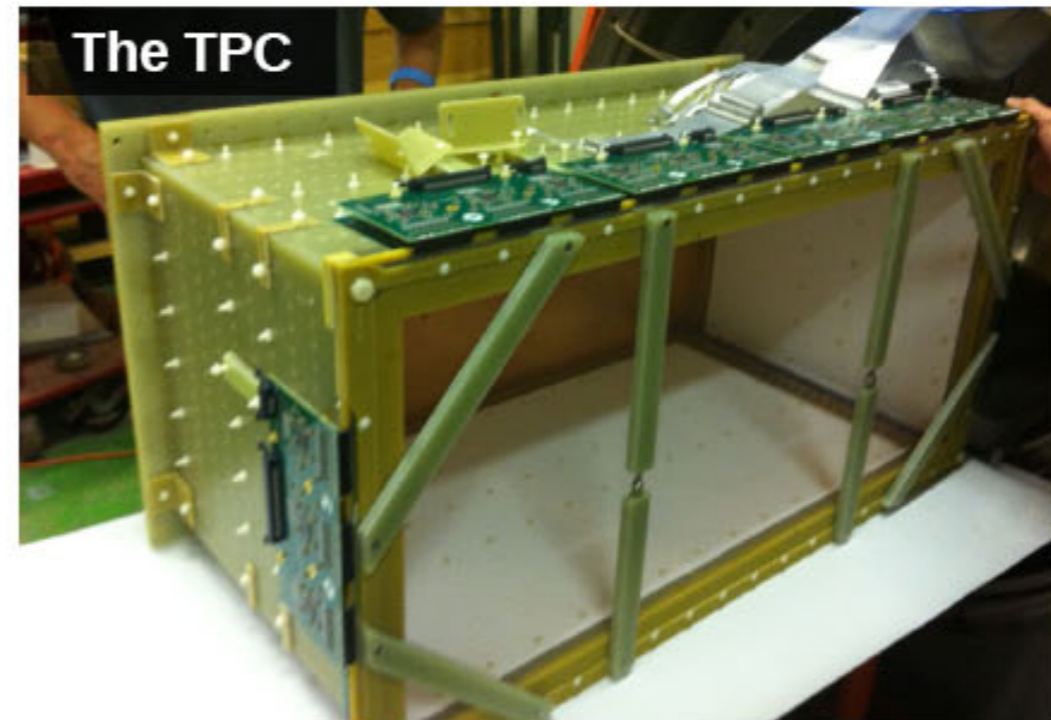
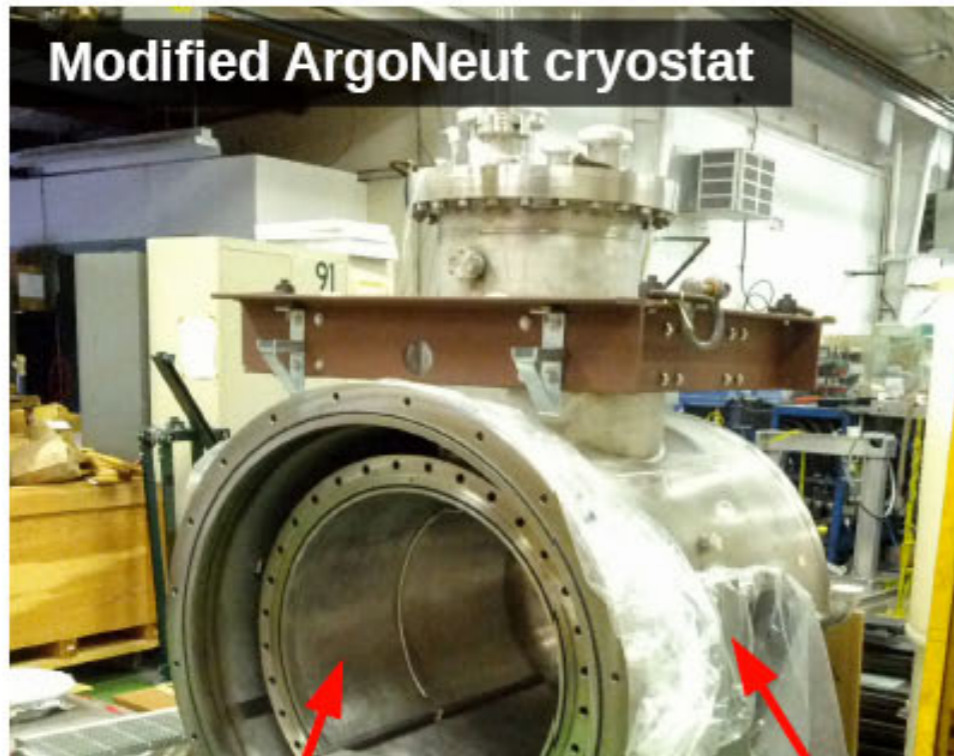


Applying TPB to the reflective foil that will line the inside of the LArIAT TPC



# TPC and cryostat

- ready to start data taking

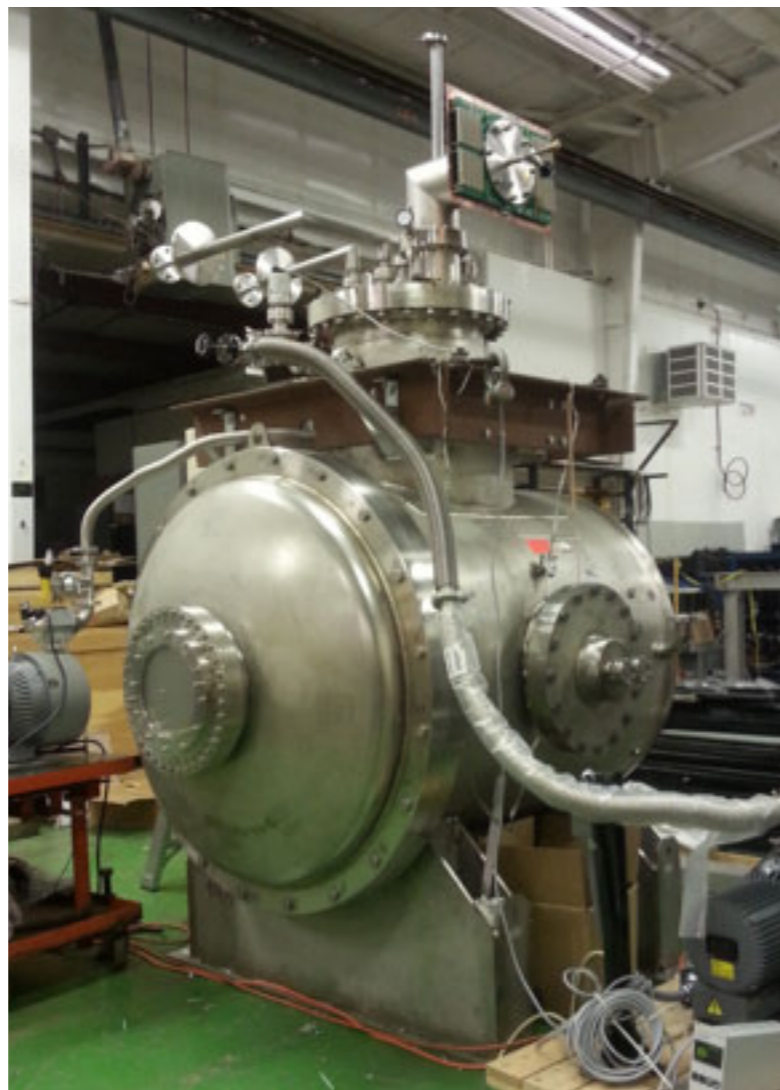




# TPC and cryostat

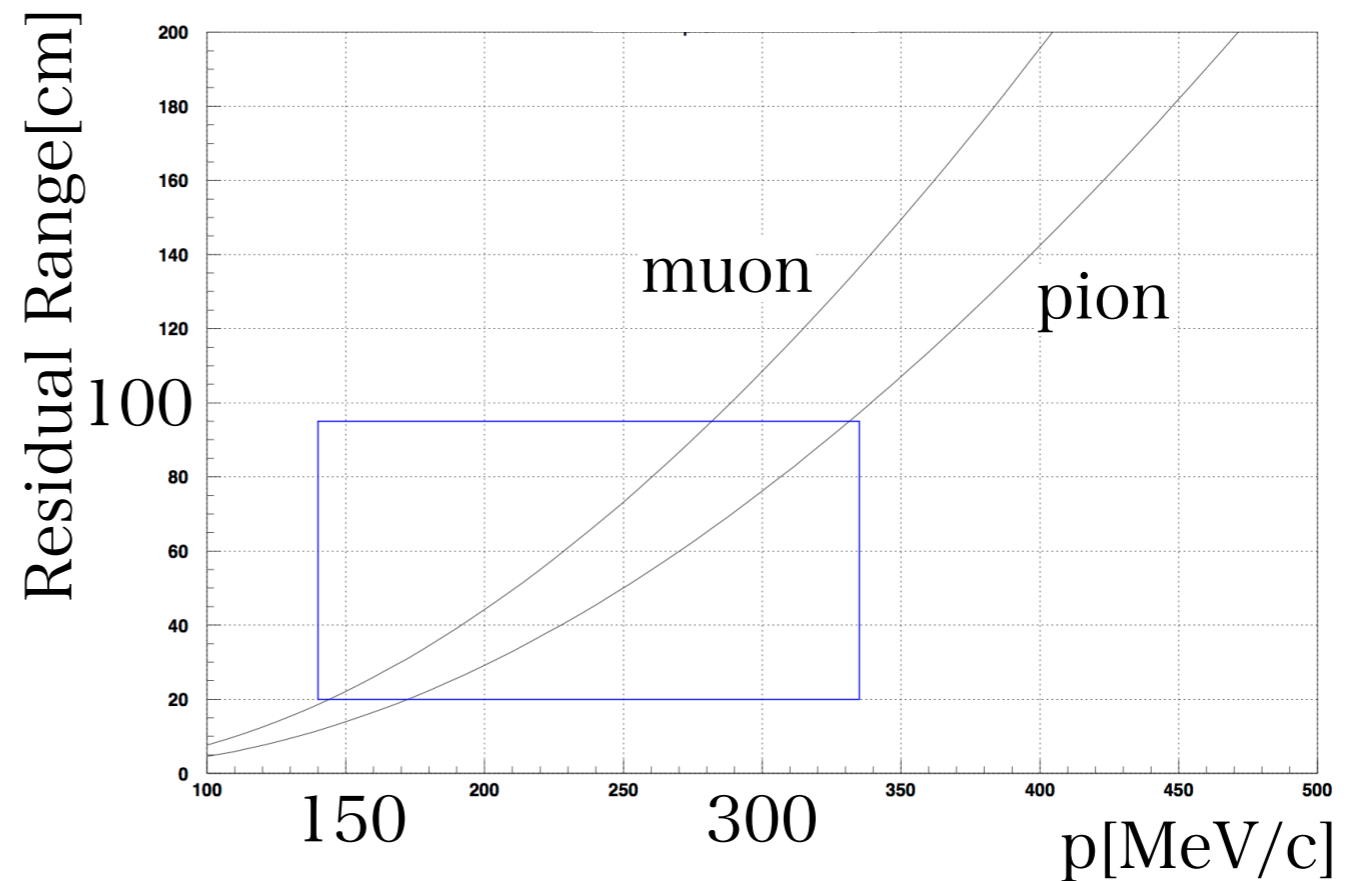
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- ready to start taking data



# Additional detectors - Cherenkov counters

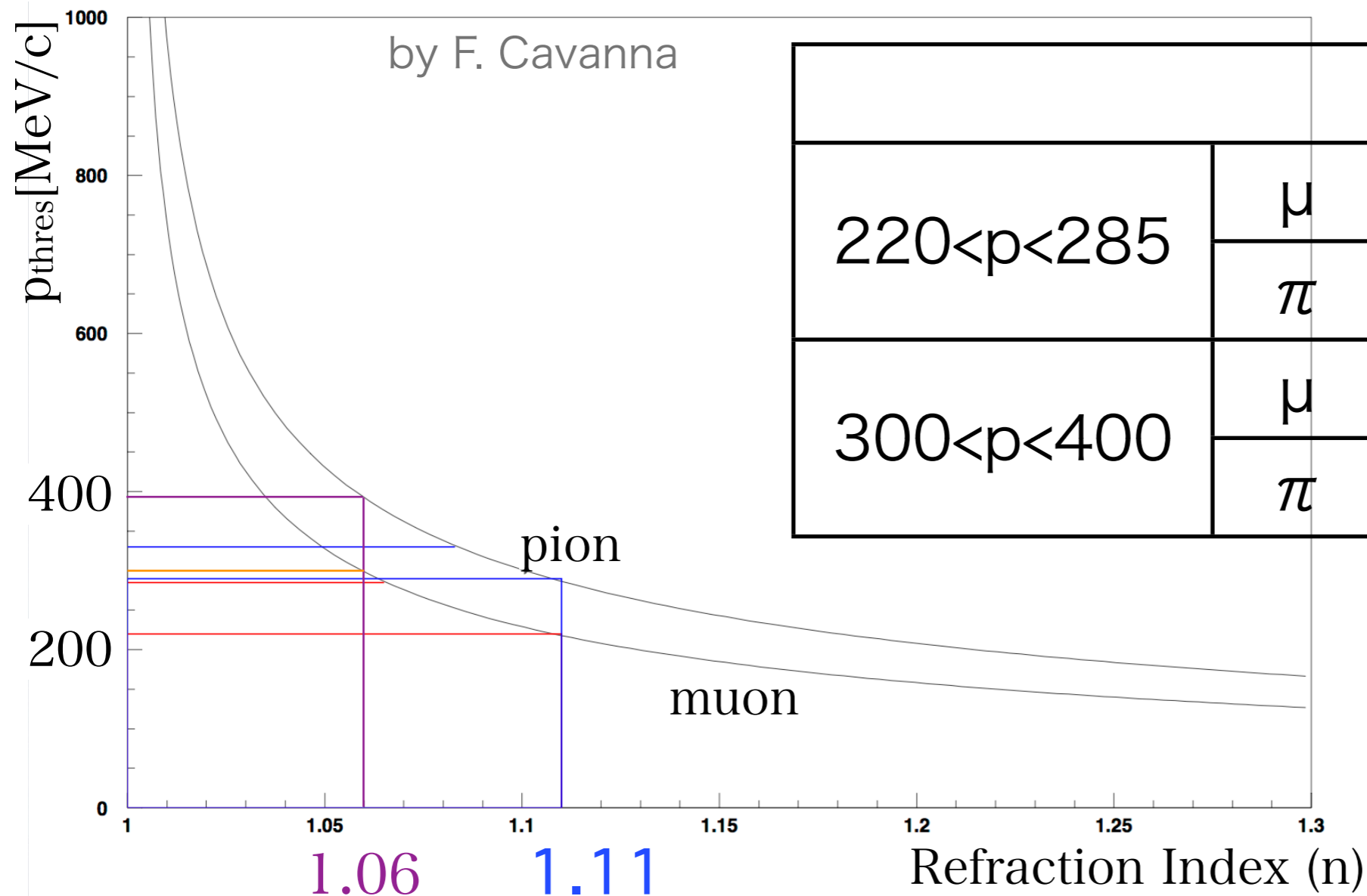
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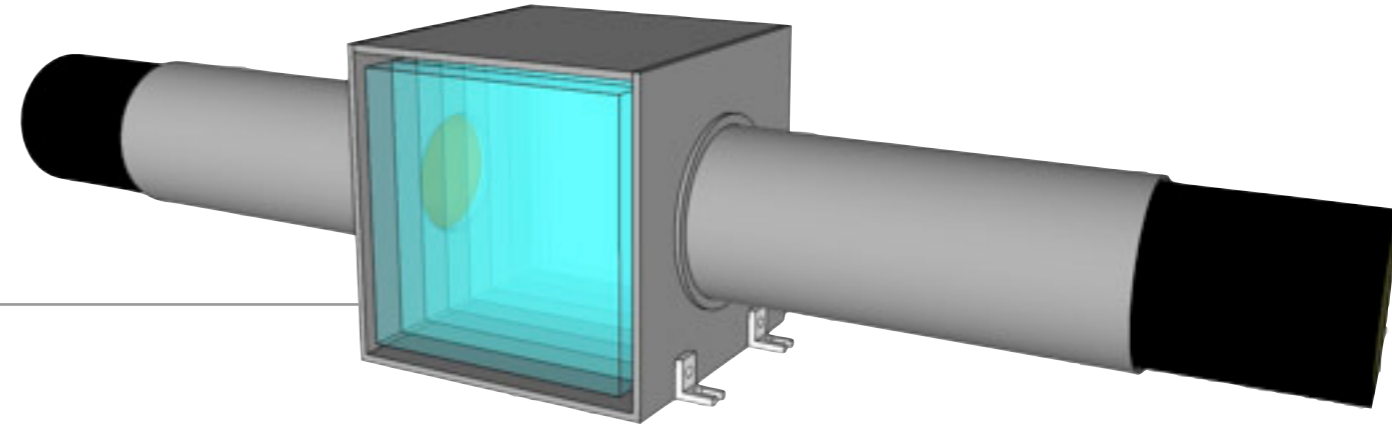
- $\mu/\pi$  separation: stopping particles in the TPC  
(for punch-through particles: muon range stack)
  - $\mu$  :  $p < 285$  MeV/c
  - $\pi$  :  $p < 330$  MeV/c

# Additional detectors - Cherenkov counters

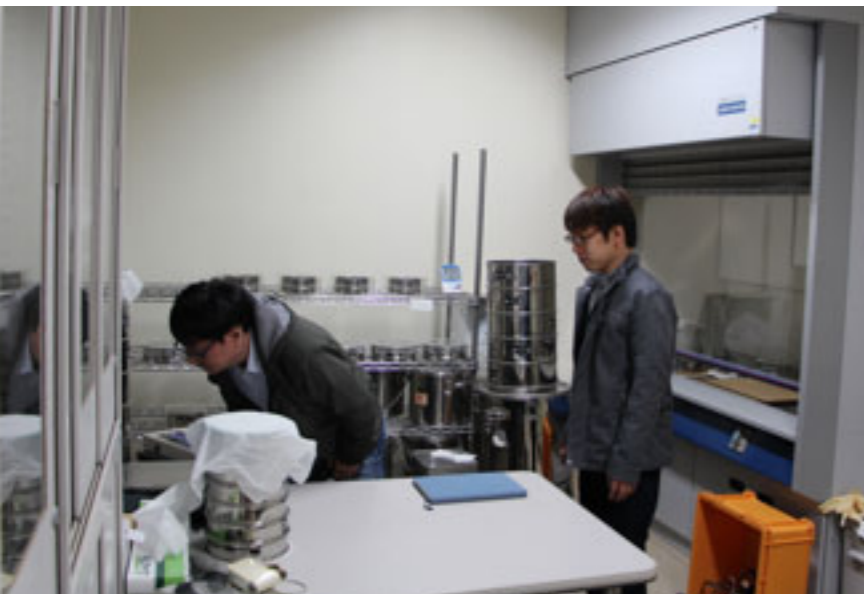
- By combining two aerogel Cherenkov counters ( $n=1.11, 1.06$ ),  $\mu/\pi$  can be identified for  $p < 400 \text{ MeV}/c$



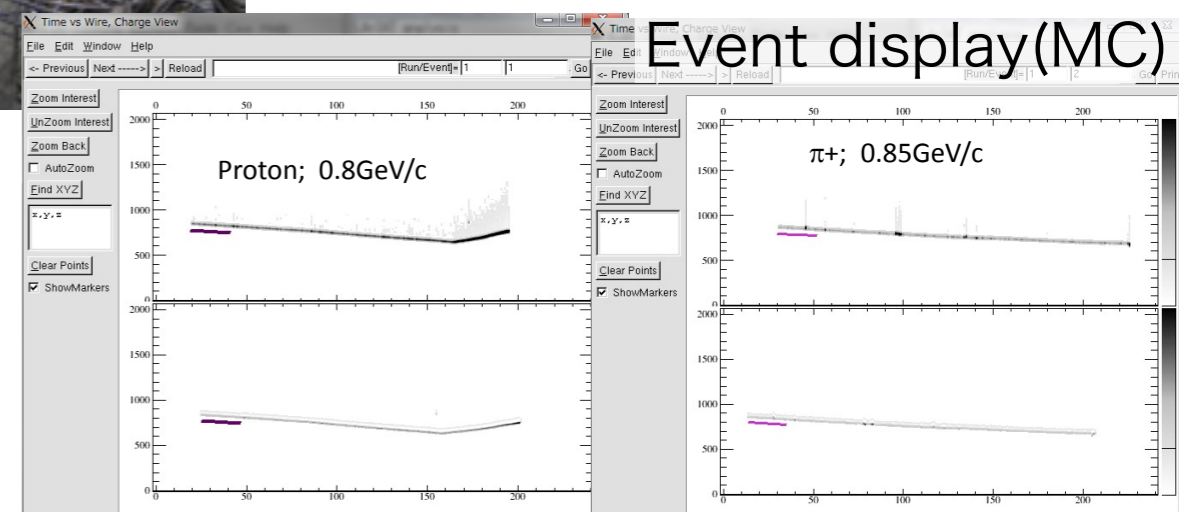
# Recent contributions



- $n=1.11$  aerogel Cherenkov counter
  - We(KEK) take charge of the Cherenkov counter
  - The aerogel tiles are now in production by M. Tabata (Chiba univ.)
  - will be installed and tested at Fermilab within this fiscal year
- If necessary, we plan to add a Lucite detector to enhance kaon PID capability



- In addition to PID projects, we contribute to MC production



# Summary

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- LArIAT is going to be the first precise charged particle testbeam with LAr TPC
  - basic performance and other various physics outputs
- Status and improvements from last year
  - The beam commissioning was finished at Fermilab MCenter
  - TPC and cryostat is ready to start taking data in the next month
  - Additional features
    - Scintillation light collection system
    - PID by Cherenkov counters