
ArgoNeuT

First ν -Physics Analysis

(not even preliminary)

and an update on MSU/FNAL LAr-electronics

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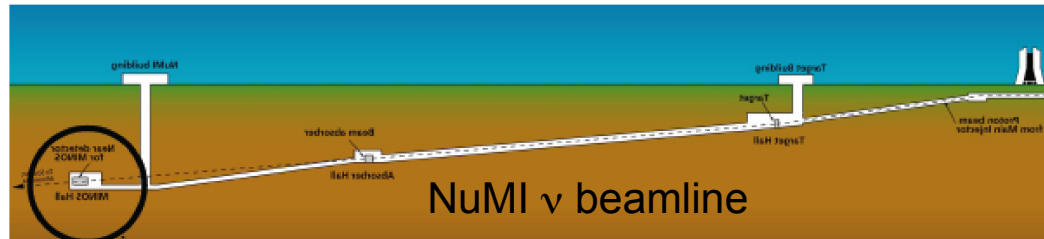
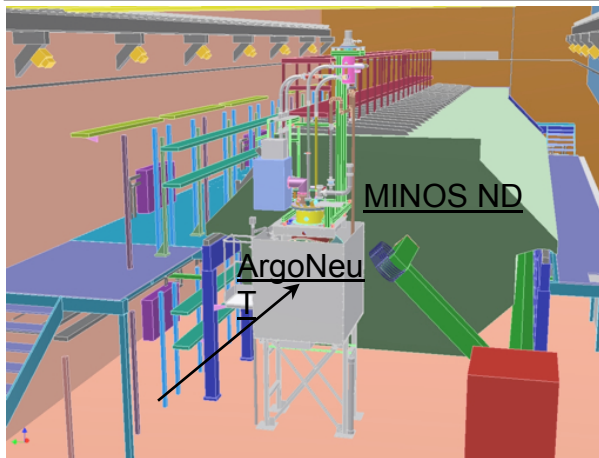
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The University of Texas at Austin

E. Church, B. Fleming, R. Guenette, K. Partyka, J. Spitz
Yale University



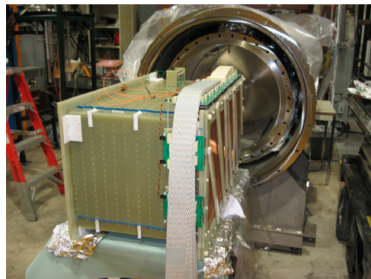
Detector & beamline parameters



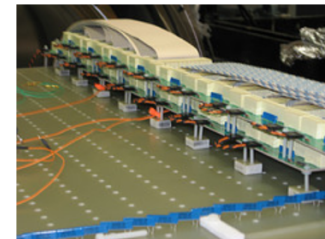
ND hall

- ArgoNeuT just upstream of MINOS Near Detector

TPC Insertion
into cryostat

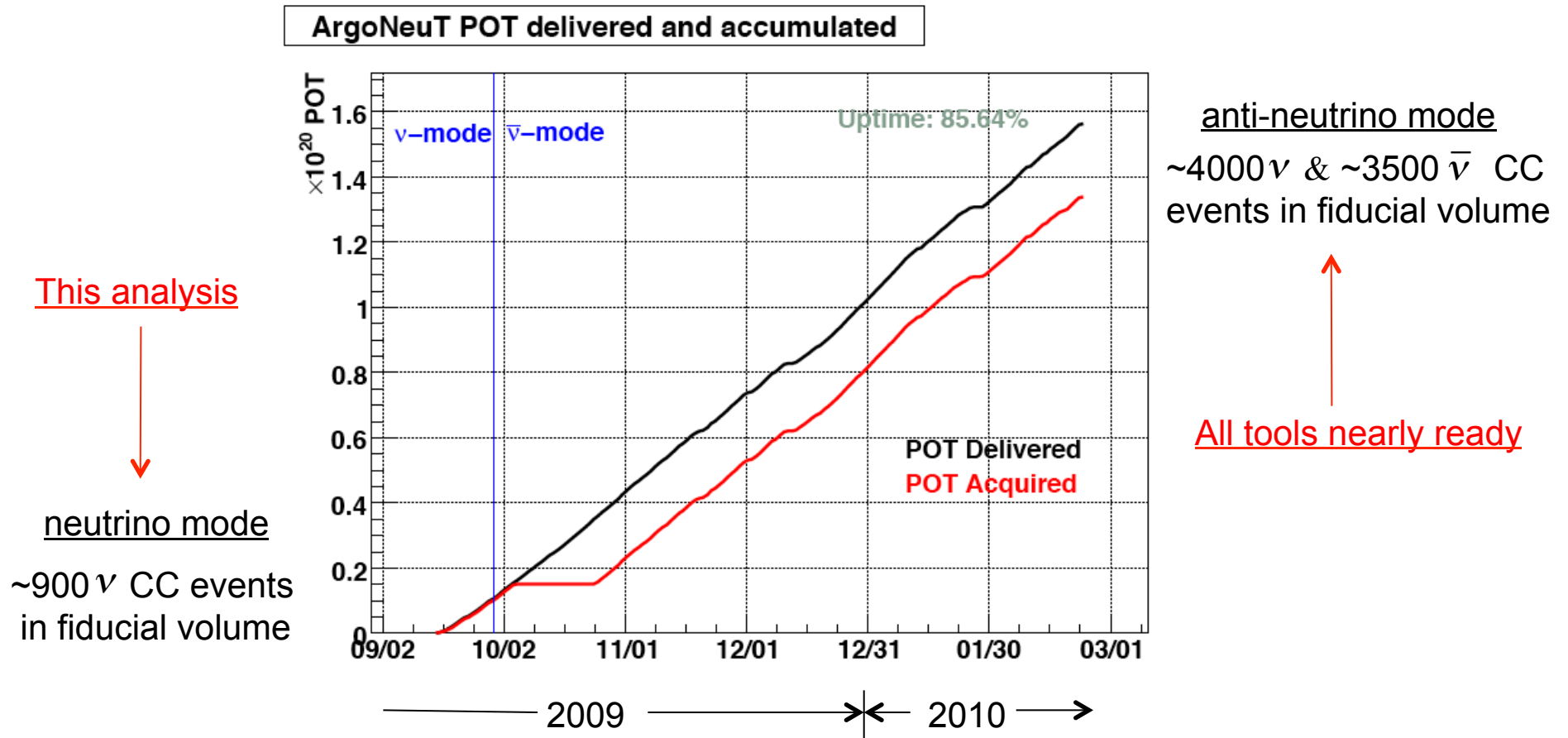


Bias Voltage
Distribution plug-in
Cards w/R&C

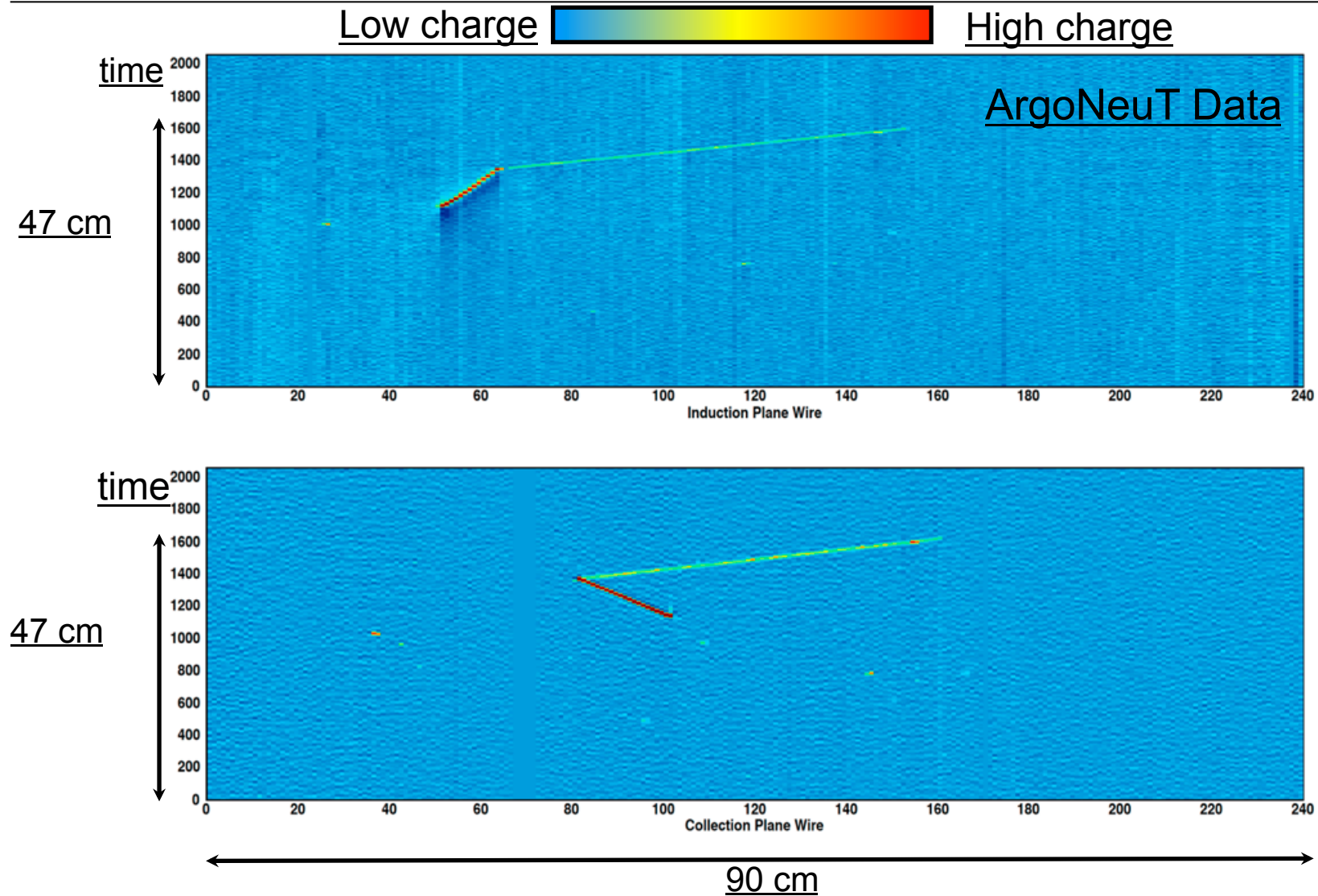


- 1/4-ton TPC, 3 wire planes, **2 readout planes** (wires $\pm 30^\circ$ wrt vertical)
- 4 mm pitch, 4 mm plane separation, 240 wires/plane
- Cryo-cooler driven purification system, $\sim 750 \mu\text{s}$ e^- lifetime (from through muons)
- Bias voltage distribution resistors & decoupling caps **in the LAr**
- Warm dual jFET preamp “narrow gaussian” filter, $3.5 \mu\text{s}$ peaking time

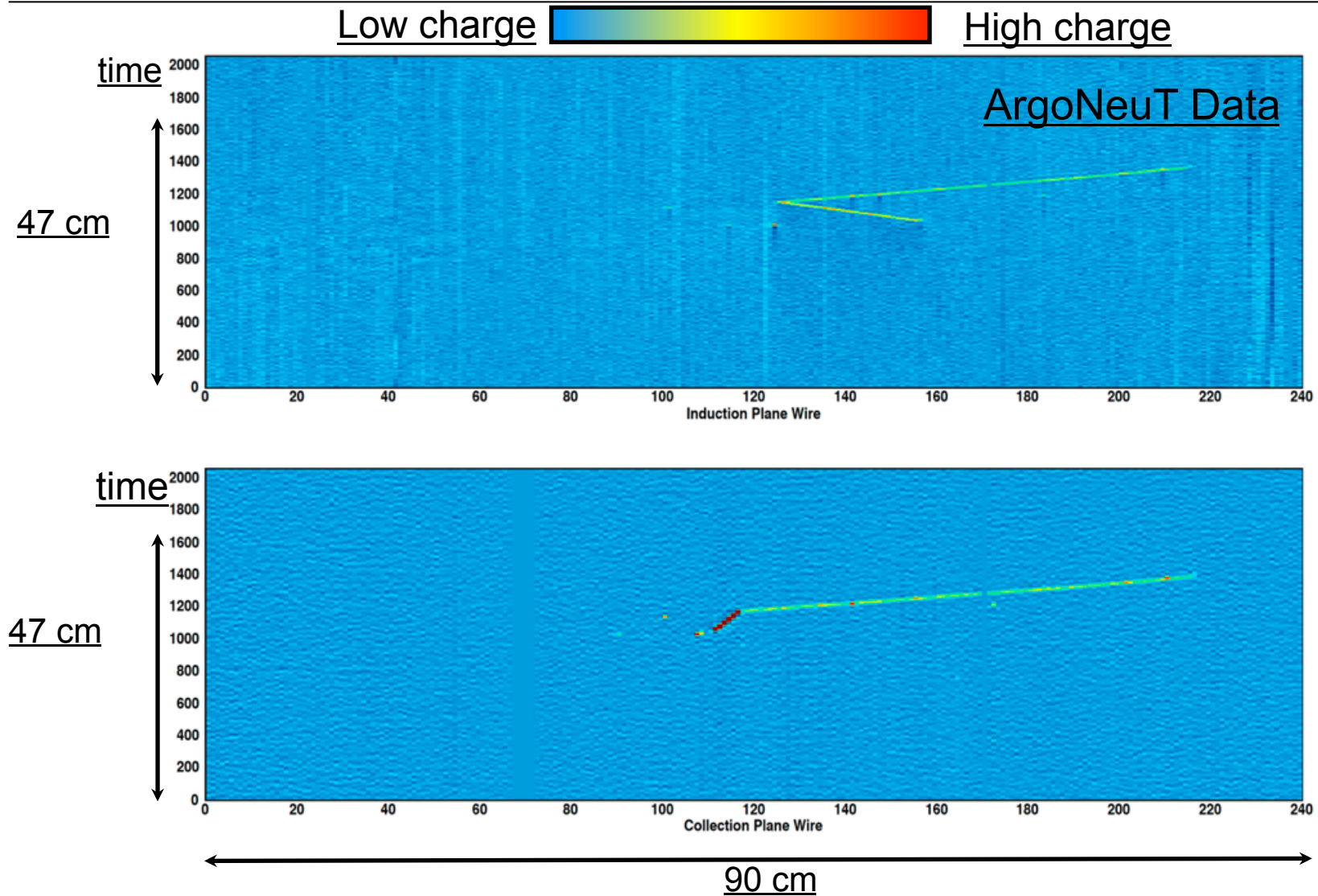
Protons on Target



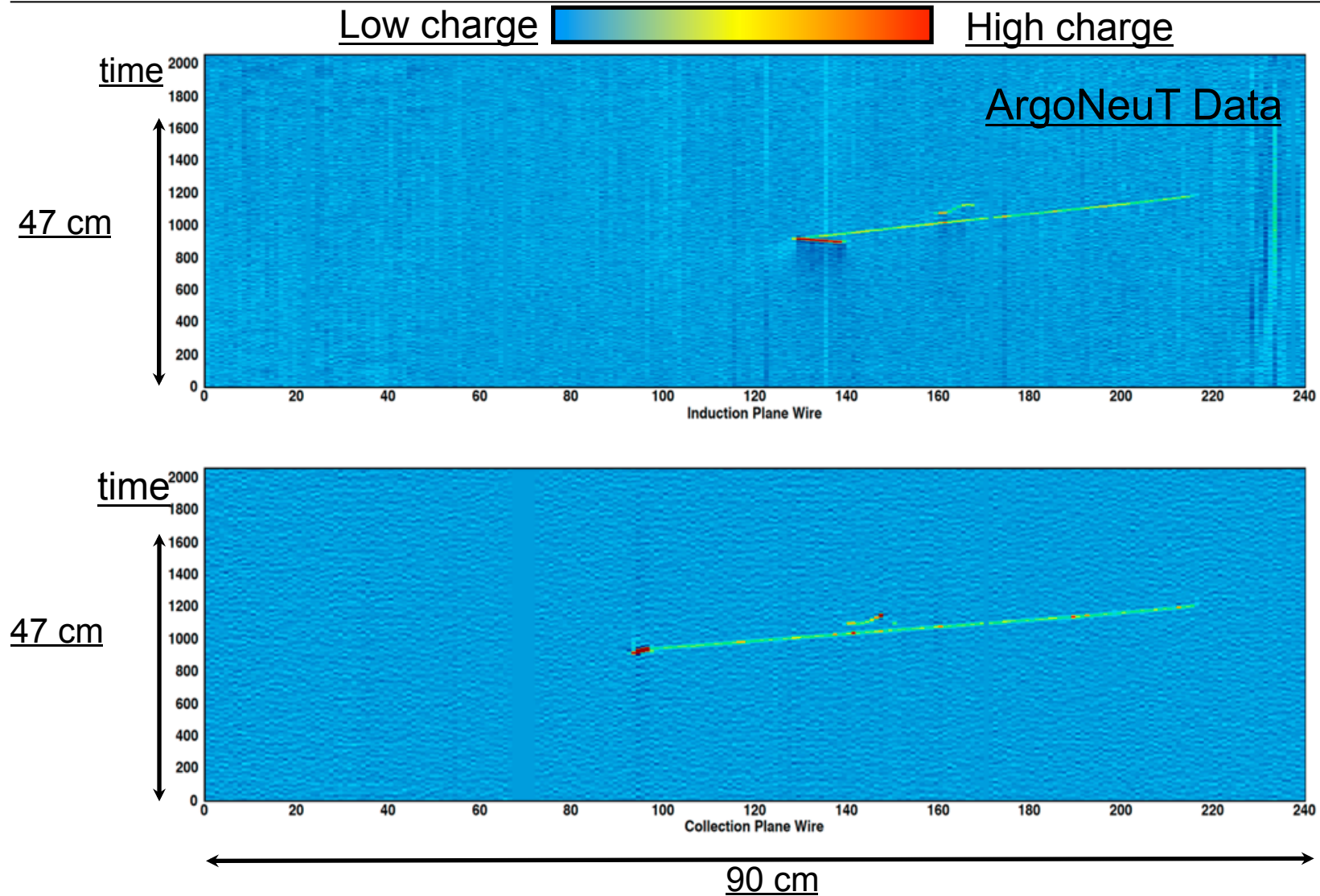
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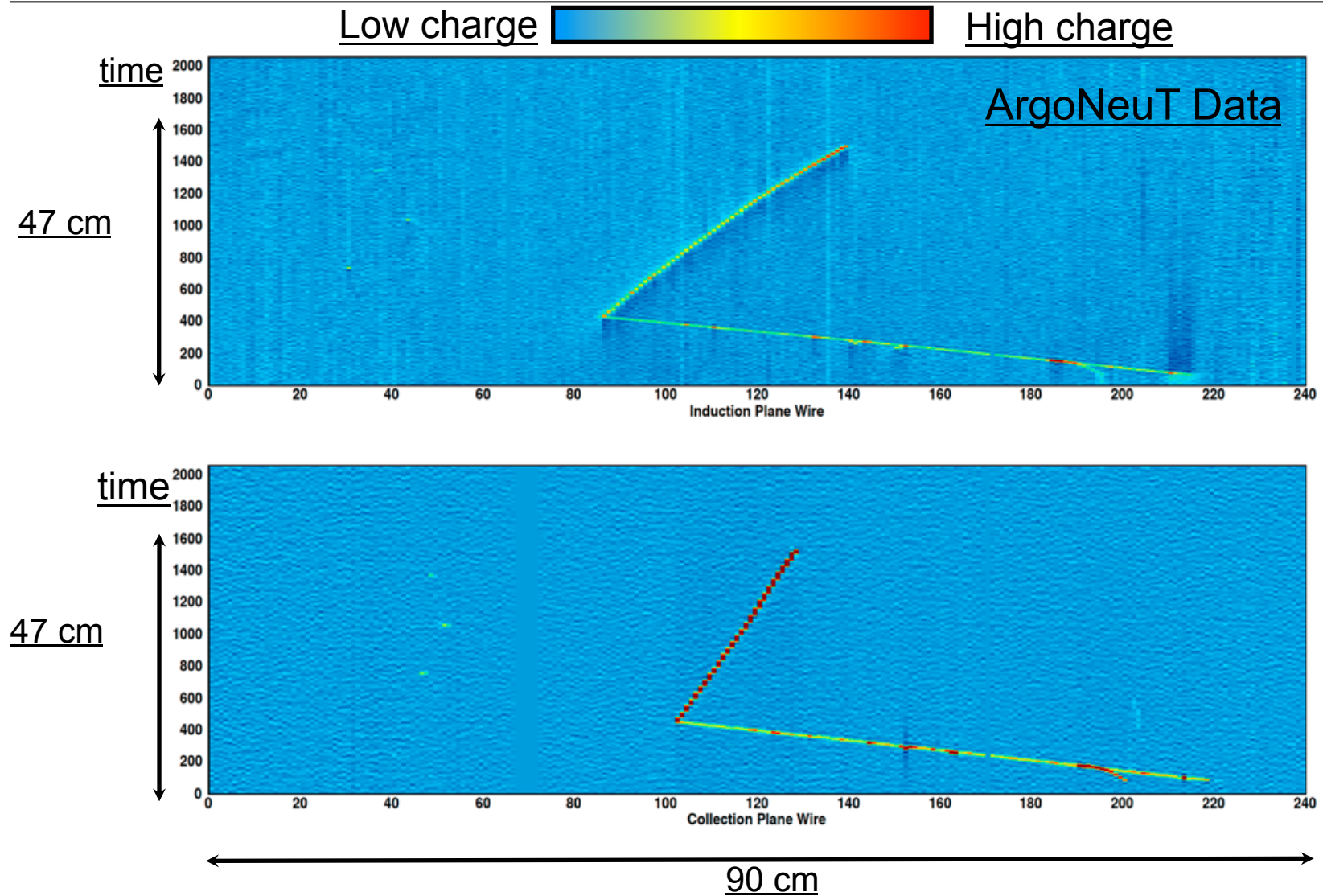
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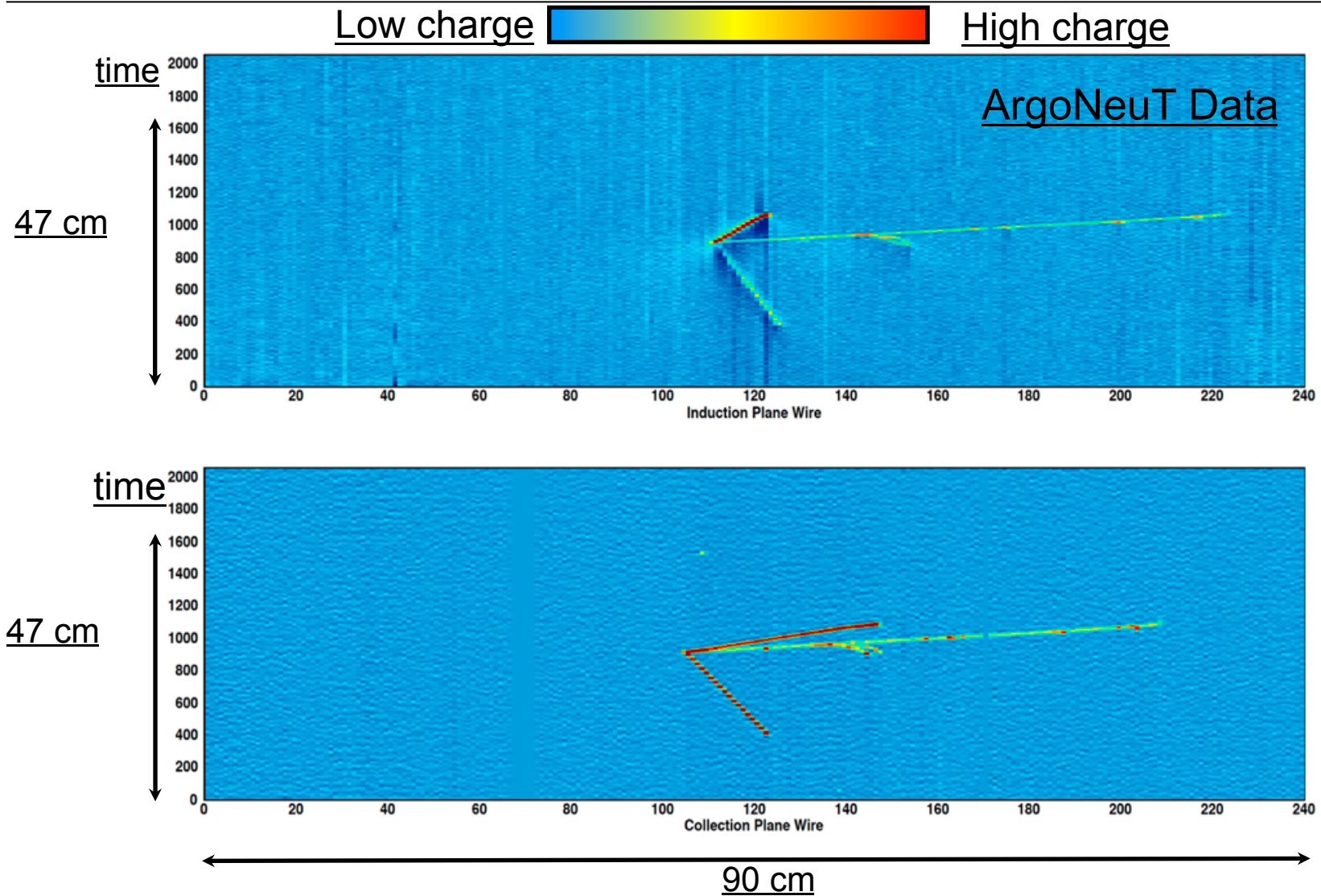
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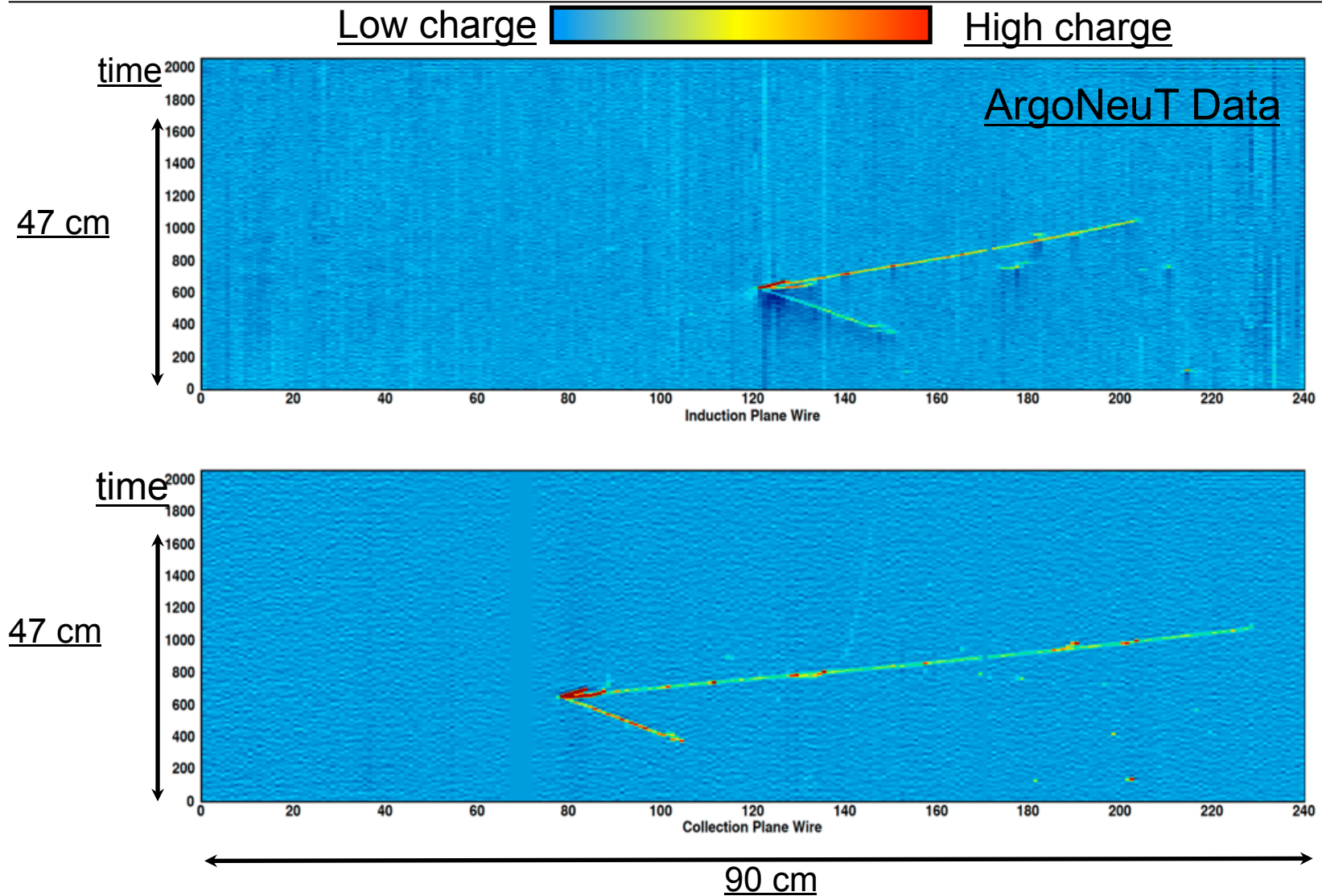
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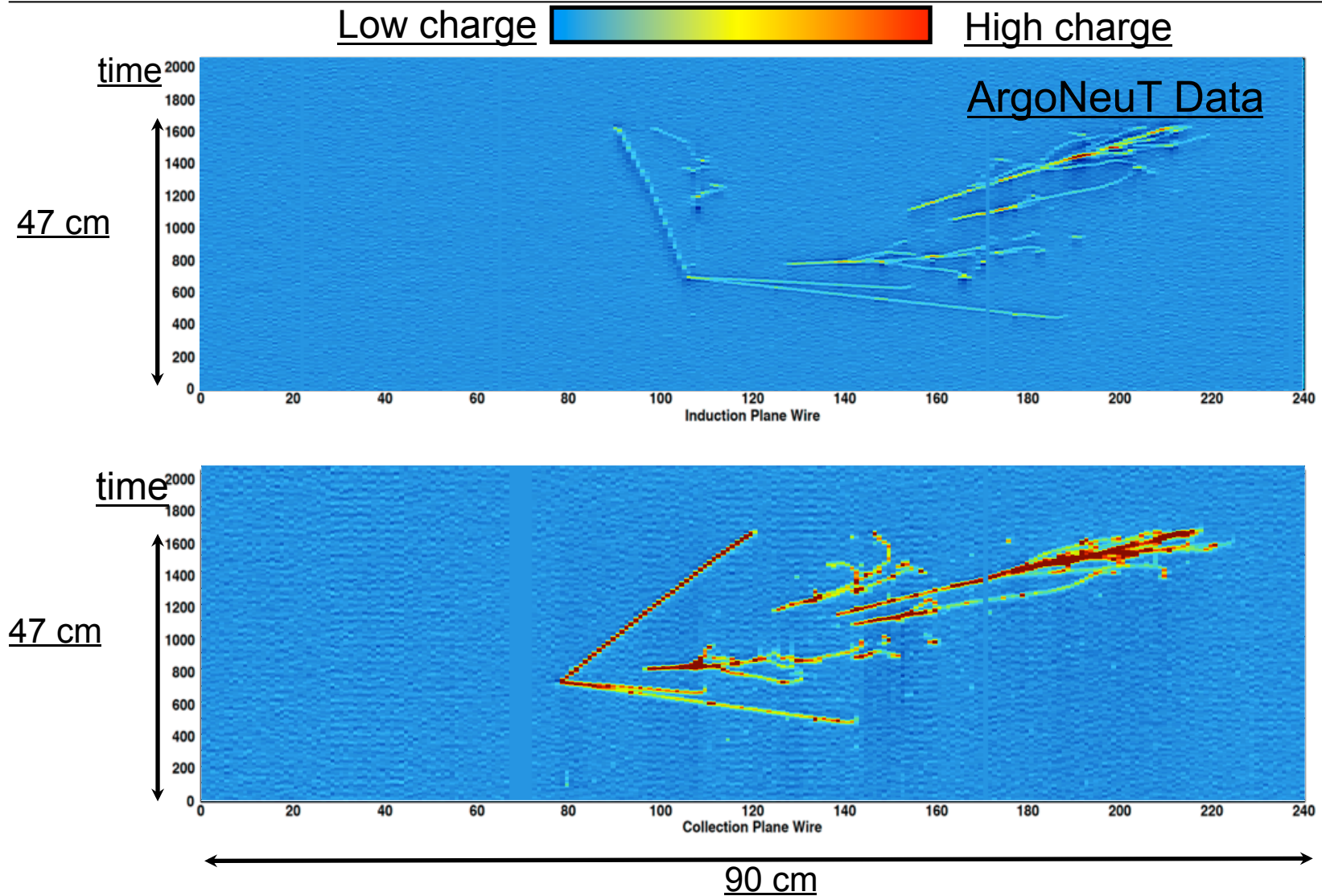
Some events



Some events



Some events



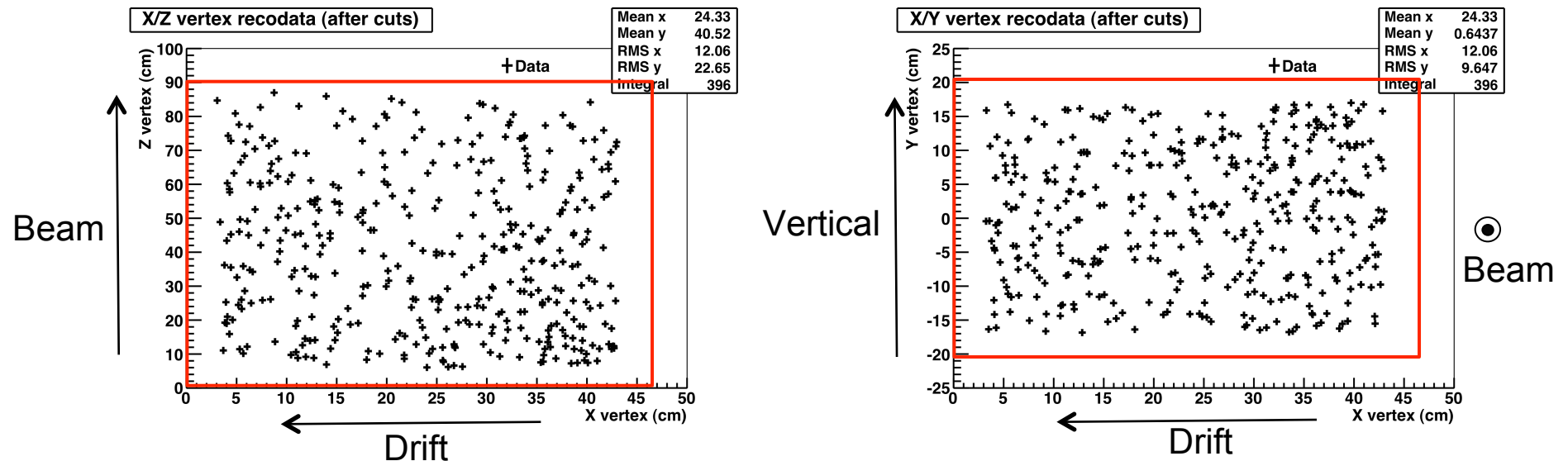
Raw – FFT – Hit/Track/Vertex

- See LArSoft talk (E. Church)
- Unipolar collection plane signals - bipolar induction plane signals
- FFT deconvolution of raw data
 - Chose FFT filter parameters for hit finding & best signal to noise
 - Produces unipolar induction signals with reliable ionization
 - Digitizer's baseline shift restored
- Find hits within signal regions above threshold
- Cluster hits and pass to Hough Transform track finder
- Form vertex in 2D and match to form 3D vertex
- Match tracks to form 3D track trajectories
- Apply Kalman filter to obtain initial and final track parameters
- Project tracks to MINOS near detector and match
 - Match with muon reconstruction in MINOS has unexpectedly low efficiency
 - ArgoNeuT needs to do an independent analysis to understand this
 - Efficiency is included in MC simulation but is still very **PRELIMINARY**

MC simulation of LAr interactions & MINOS

- GENIE (v. 2.6) event generator with NuMI low-energy flux
- Flux for $E > 3.0$ GeV using latest MINOS estimate;
Flux for $E < 3.0$ GeV uses ν -beam MC
- Full reconstruction of events matching muon track to MINOS ND
- Fiducial volume cut (z) essential to remove through-going muons

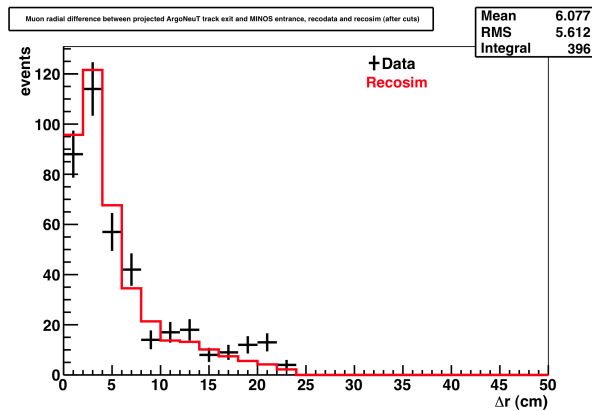
Interaction vertex



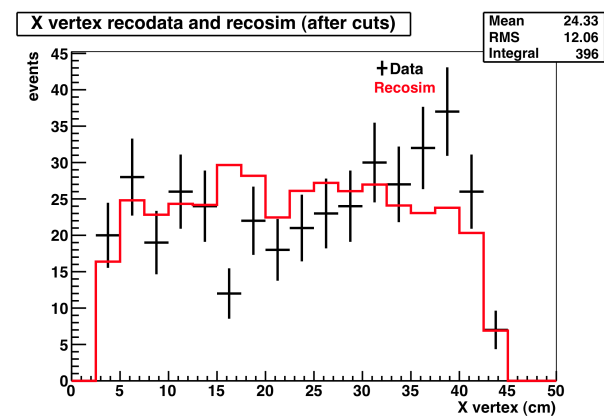
Geometrical aspects of data and MC

Data in black, MC in red

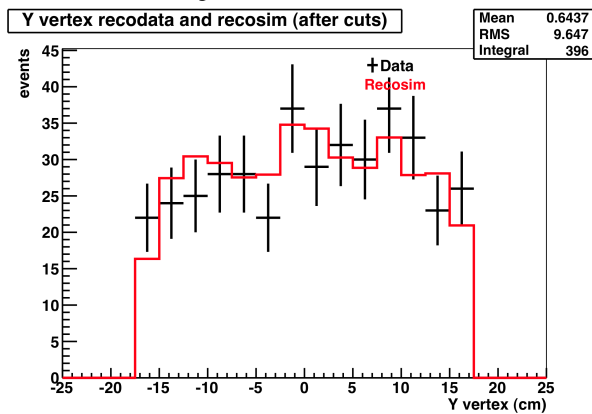
MINOS match in Δr



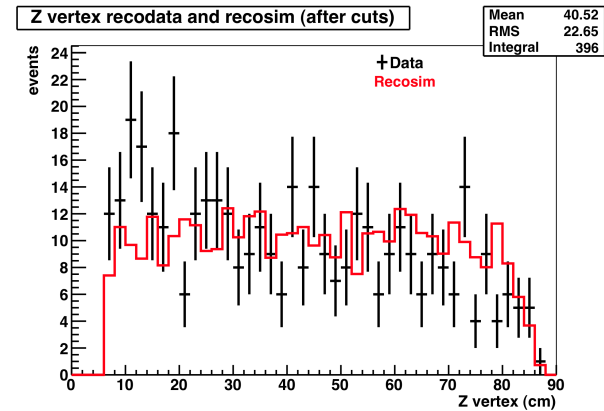
x-vertex



y-vertex



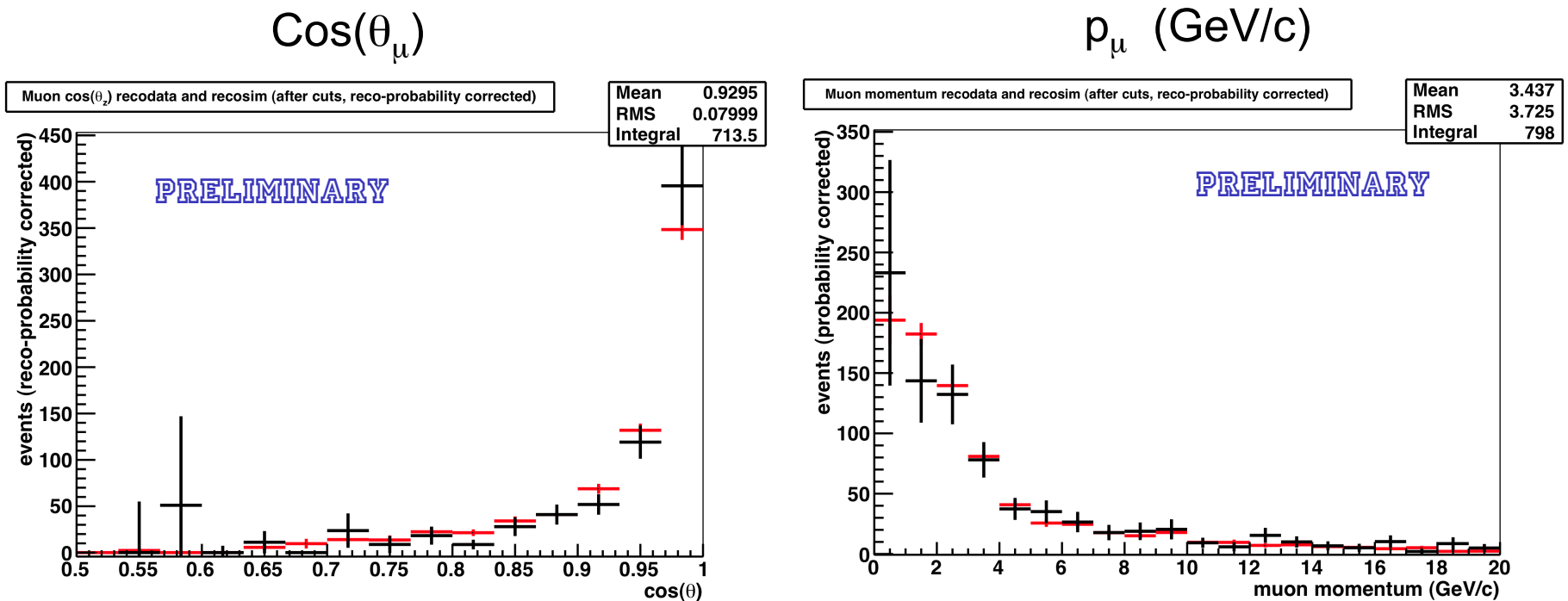
z-vertex



Comparison of ν CC-event yields and MC simulation

- Weighted event yields are flux integrated and normalized
- Independent scan is consistent but results below are based on *automatic LAr event reconstruction*
- Low-energy CC-parameters: muon angle and momentum

Data in black, MC in red




Program for the next year

- Finalize and publish CC neutrino cross sections
- Measure CCQE cross section and investigate nuclear FSI
- Measure π^0 production and backgrounds to electron-neutrino interactions
- Measure electron-neutrino content of the NuMI beam
- All of the above for (reverse horn polarity) neutrino and *anti-neutrino* interactions (w/~10 times greater statistics).

Liquid Argon electronics – MSU/FNAL collaboration

LAr TPC Electronics Test Stand

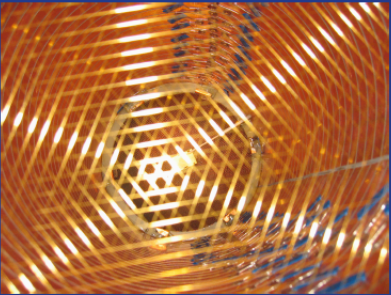


MSU
Electronics
& DAQ

1st LAr TPC with U.S.
electronics readout

50 cm vertical drift TPC
HV 20 - 30 kV
3 planes of wires at 120⁰

FNAL TPC
HV Feedthrough
Argon

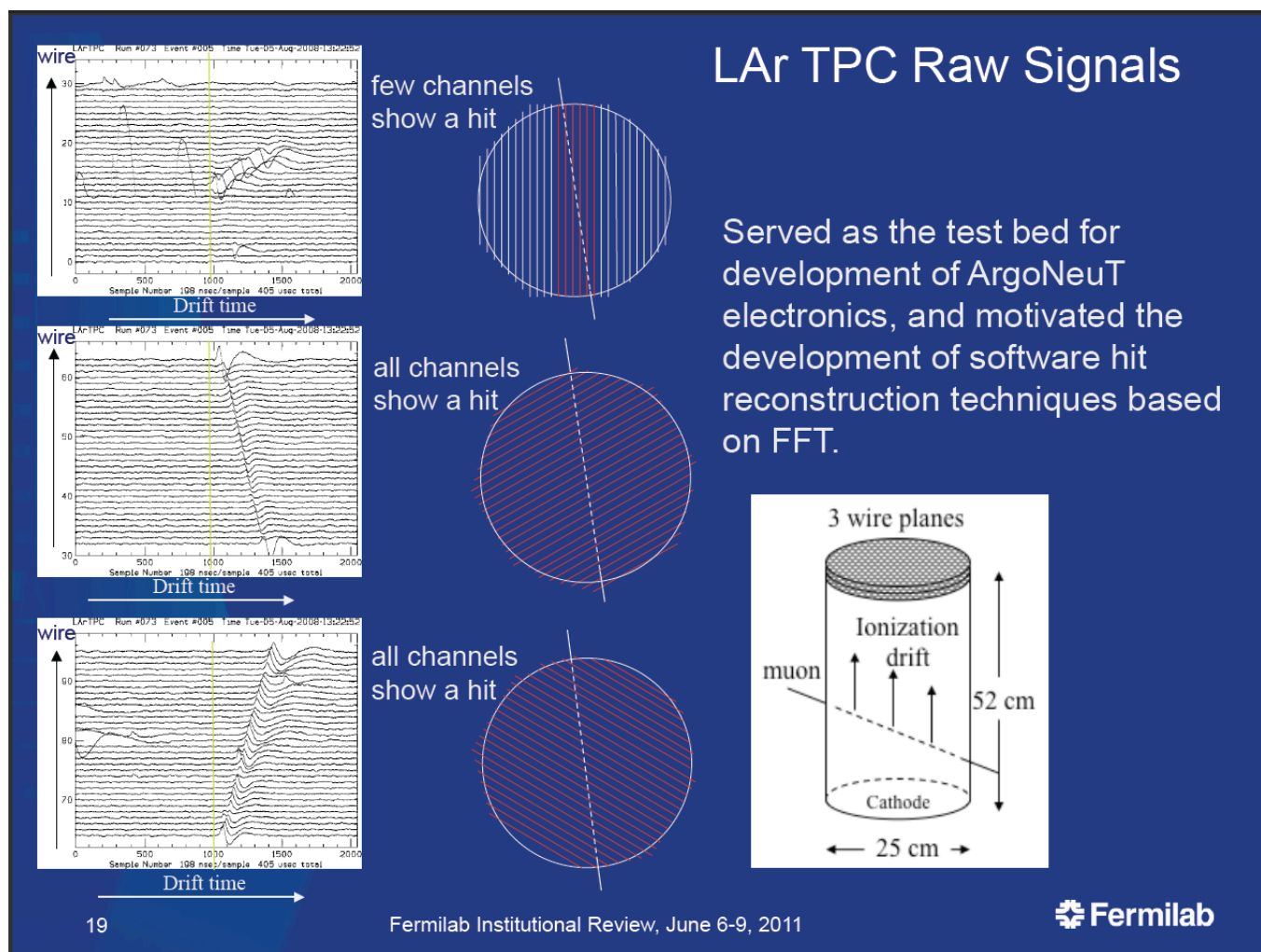


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Fermilab Institutional Review, June 6-9, 2011

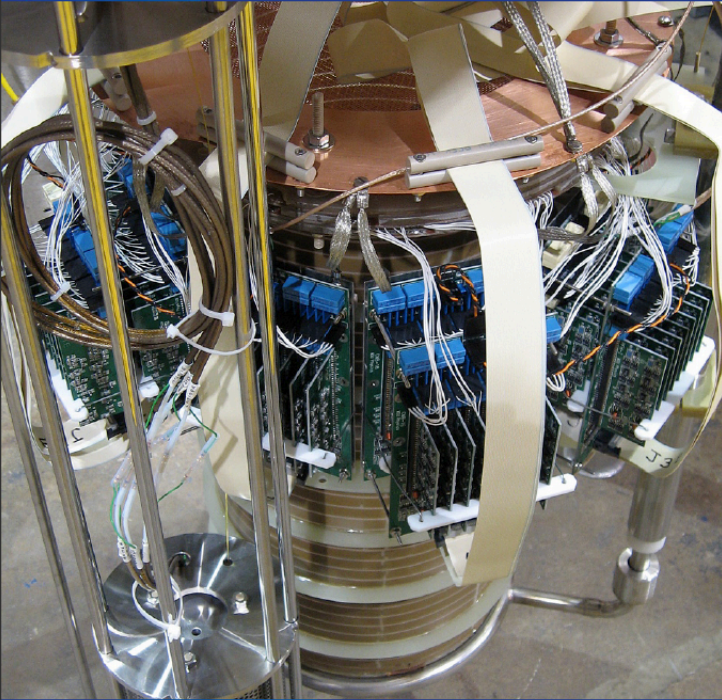
Fermilab

96-channels of warm dual-jFET preamp



144-channels of cold MOSFET preamp

1st in-liquid CMOS electronics on a LArTPC
Built at Michigan State University




CMOS based design.

- Available technology.
- Operates well at 90K.
- Can be converted into ASIC.
- Capacitors and Inductors require careful selection.
- Connectors and cabling need careful testing.
- Ground connections need robust mechanics.

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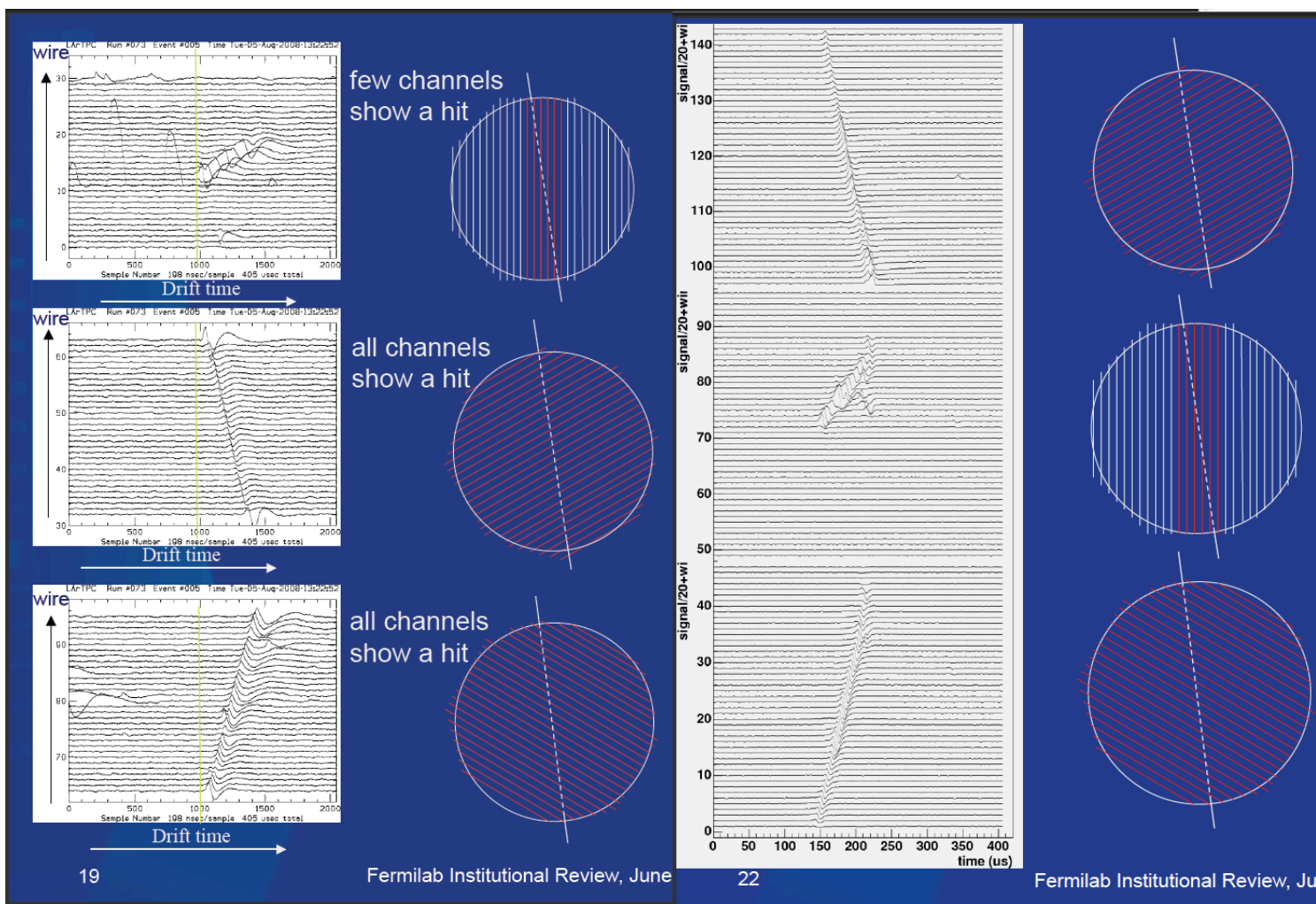
Fermilab Institutional Review, June 6-9, 2011

 Fermilab

Qualitative comparison of signal to noise

96 channels warm

144 channels cold



Observations

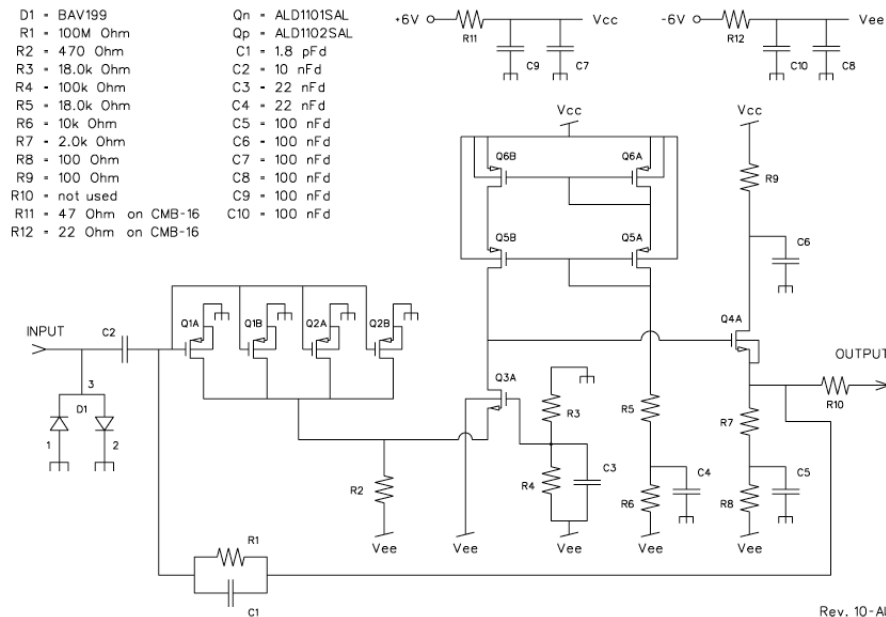
- MOSFET electronics mounted on a TPC at 90K exhibits a signal (muon tracks) to noise perhaps *twice* that of warm electronics (more quantitative values soon)
- Initially pumped-down, but just evaporation purging of the gas around the signal output and HV cables. With periodic top-off, operation is continuous over weeks.
- No contamination effects ($< 10\%$ signal loss) over a 50 cm drift (electron lifetime > 3 ms)
- FNAL/MSU TPC is a viable testbed for cold electronics development. First application is a system test of the (BNL) ASIC preamp for MicroBoone (see talk by V. Radeka).
- Future: tests of a mixed-signal ASIC for a long-baseline experiment.

GLA2011

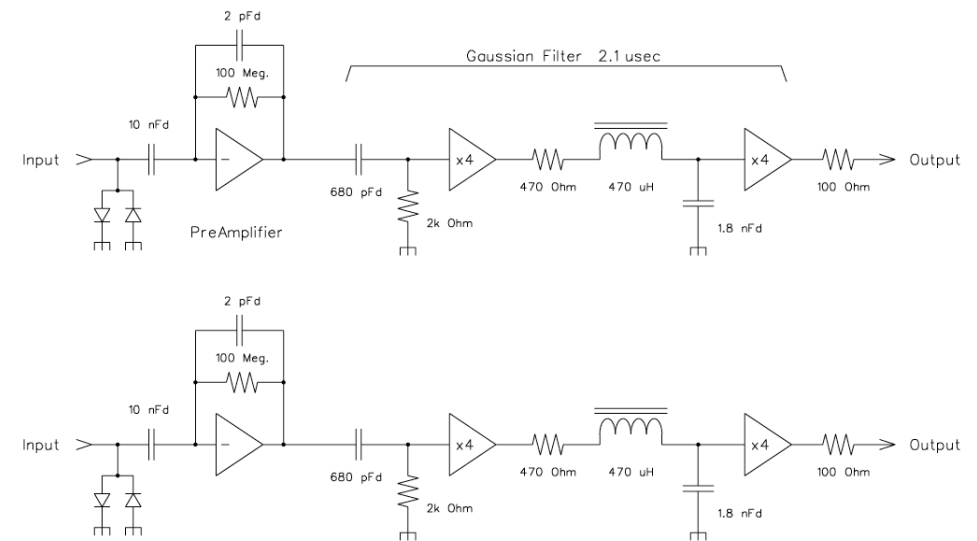
- Thanks to the organizers of the GLA series for the opportunity to present our work, and
- Many thanks for the hospitality shown by the people of Jyväskylä

Backup Slides

Cold MOSFET Preamplifier



PreAmp-Filter 2 Channel



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