Cold Electronics for LArIAT

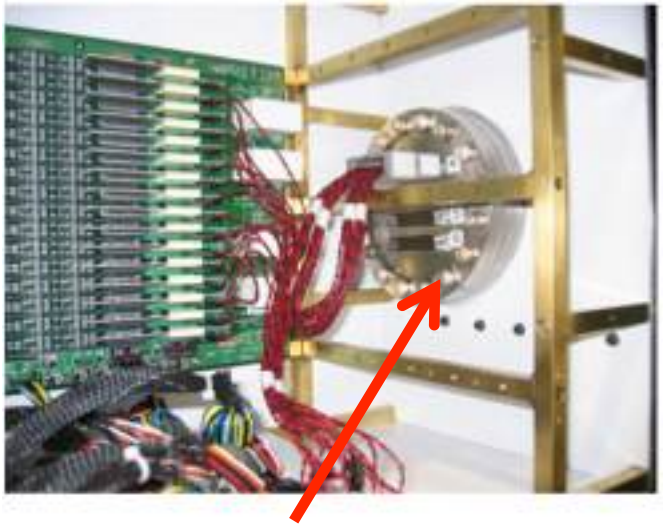
Carl Bromberg
Michigan State University

Outline

LArTPC historical perspective
ArgoNeuT w/warm electronics
R&D on cold electronics
Cold electronics for LArIAT

Bo TPC w/ICARUS style electronics (2005)

Feed through & warm preamp card w/dual-jFET



96 channels in the RF-shield box

ADF2 - 32 ch. Digitizer/FPGA

Signal feed-thru carries Bias-V

$V_{1,2,3}$ = –350V, zero-V , +400 V

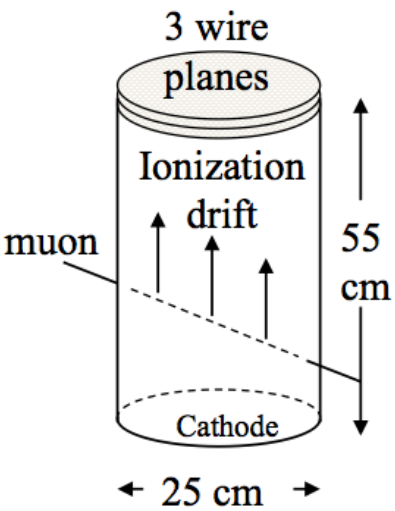
Also, trigger counters & DAQ provided by MSU

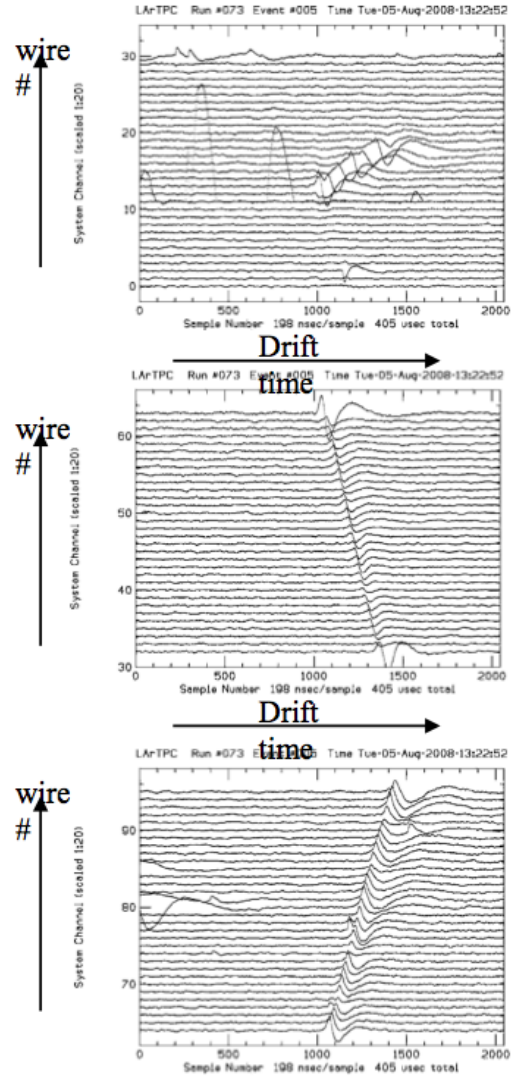
Dan Edmunds (MSU)

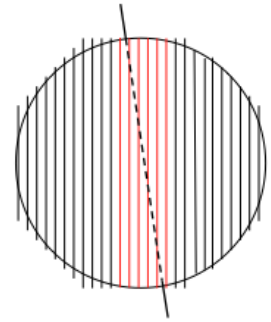
Tracks !

EVENT # 5

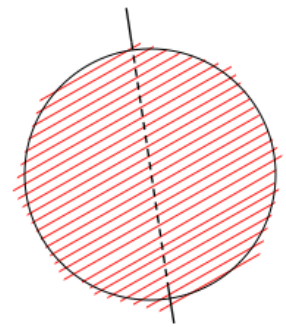
Most triggers look like this:



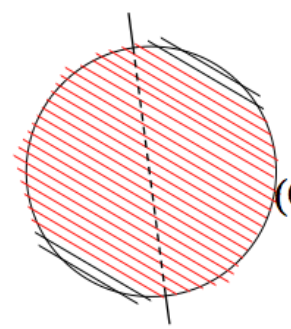




Plane 1 (Induction, 0°)



Plane 2 (Induction, +60°)



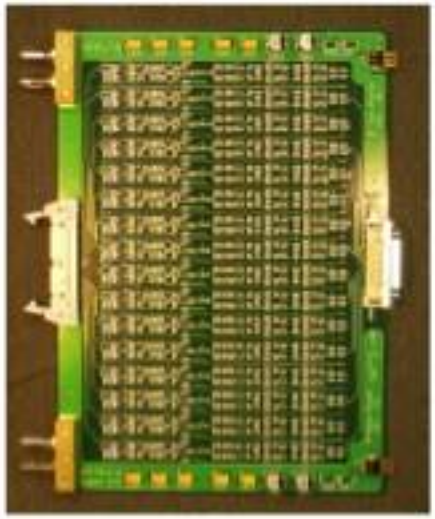
Plane 3 (Collection, –60°)

ArgoNeuT (2006-2010)
First LArTPC neutrino data

480 channels of warm preamp

Bias-V distribution moved onto the TPC

Warm preamp



(MSU) Dan Edmunds

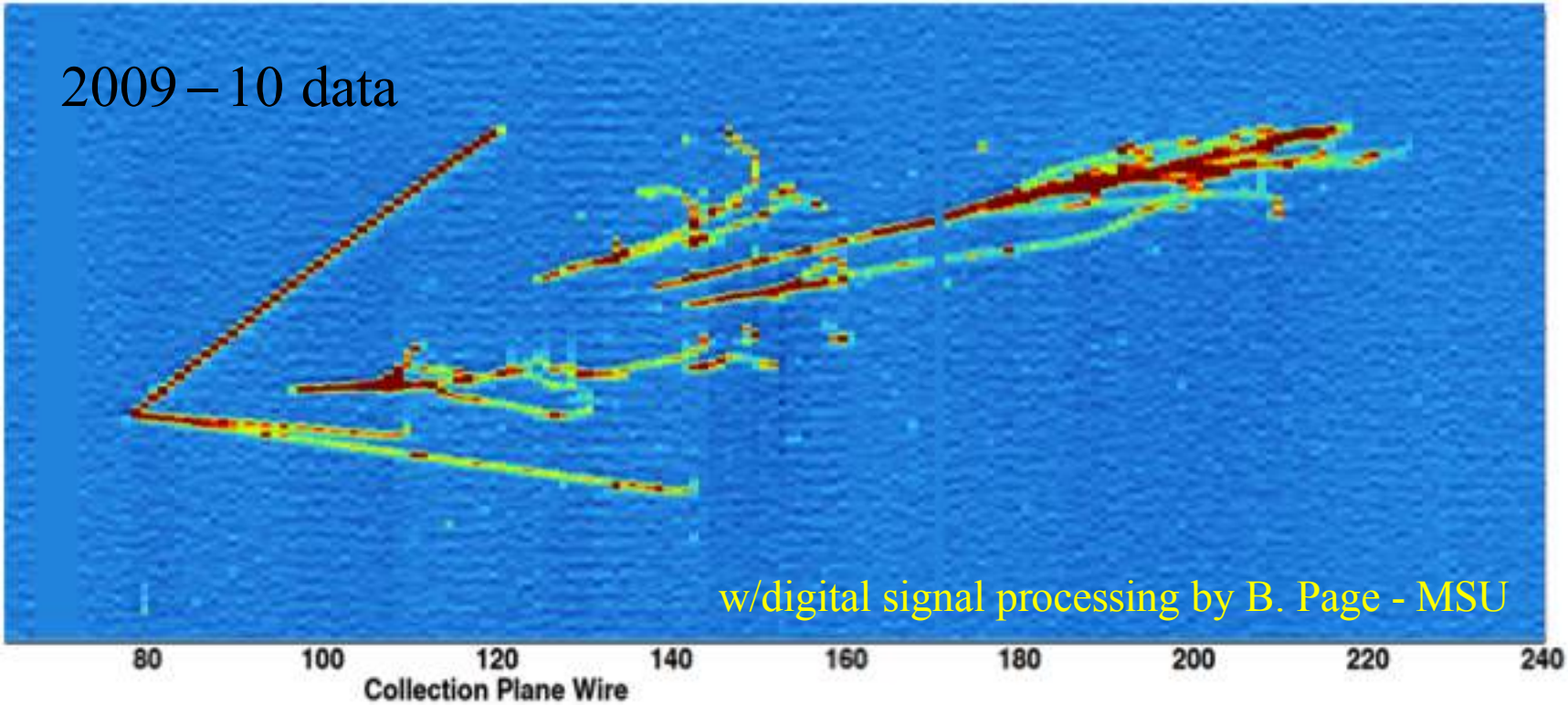
Preamp card file

Also ADF2 digitizer/ DAQ

Uses
Double shielded box
Feed-thru inside box
Forced air cooling

Must disassemble to service.
Completely disassembled
when removed from NuMI

Remarkable!

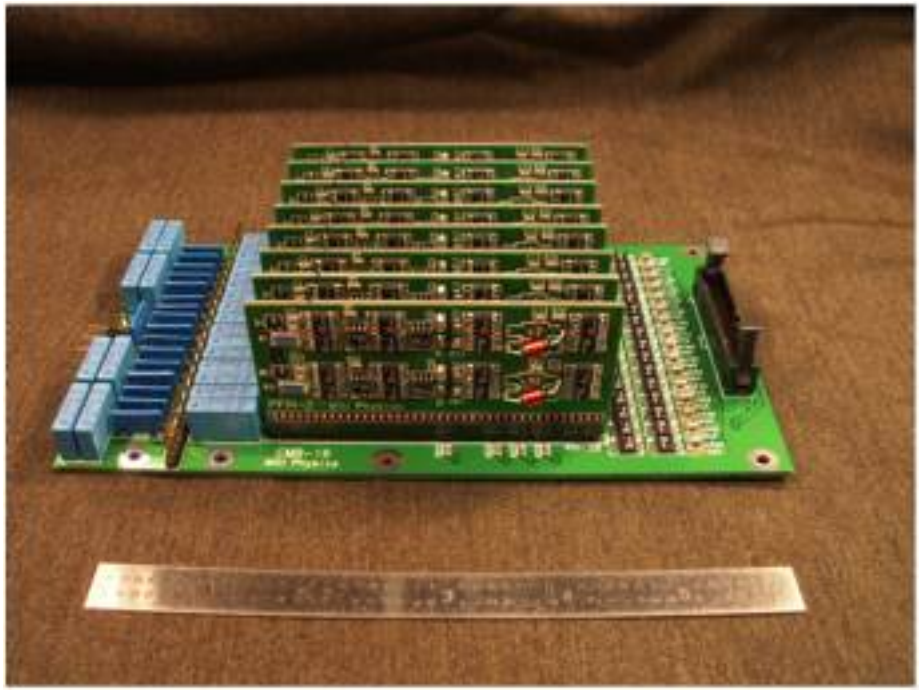


Three papers published - more on the way

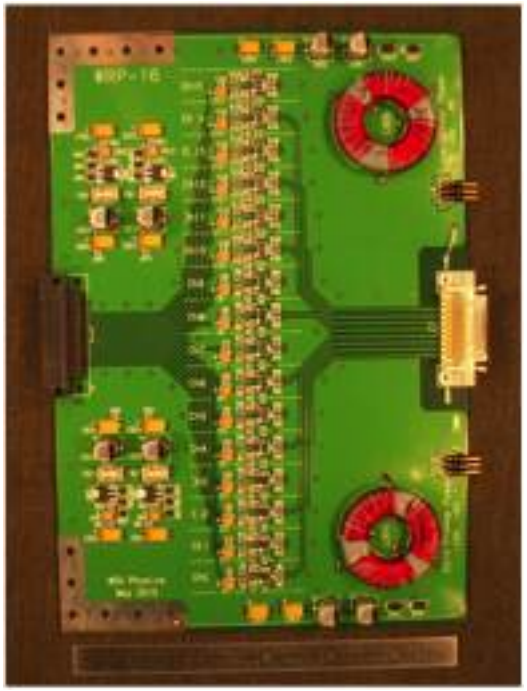
Put preamps in the LAr (2010-2011)

First cold CMOS preamps!

CMOS 2ch. preamp hybrids for the Bo-TPC



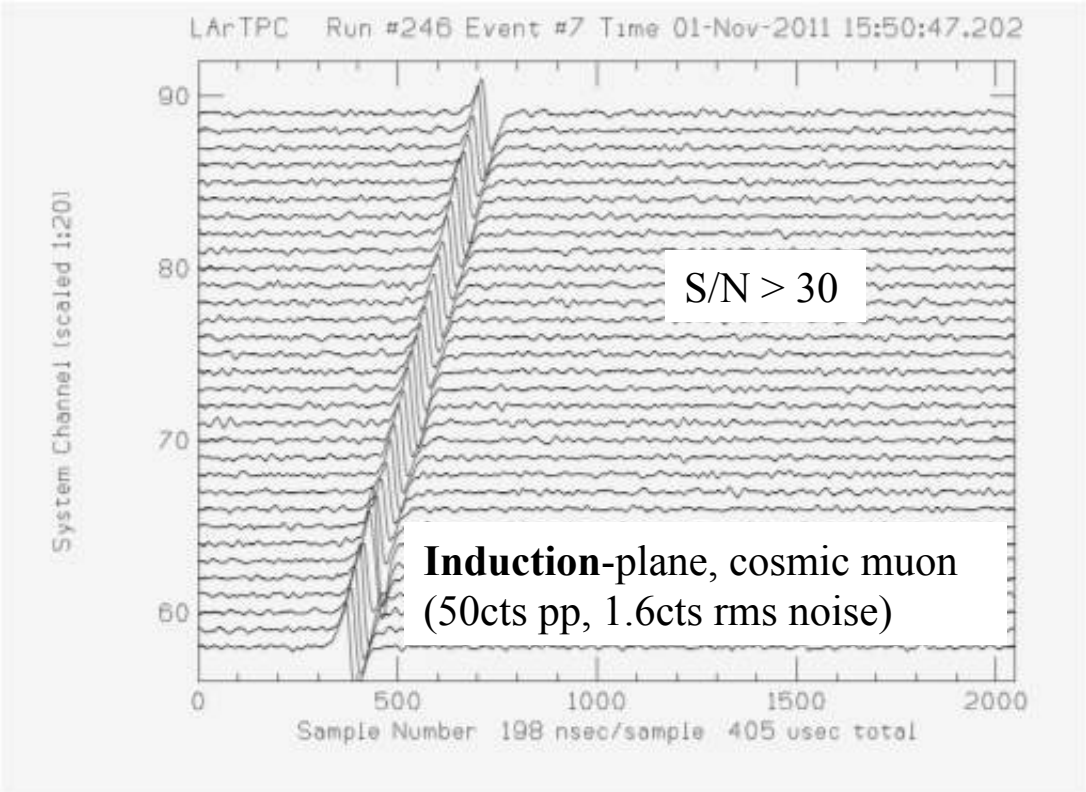
Warm signal receiver with drivers for long cables and supply preamp power



Dan Edmunds - MSU

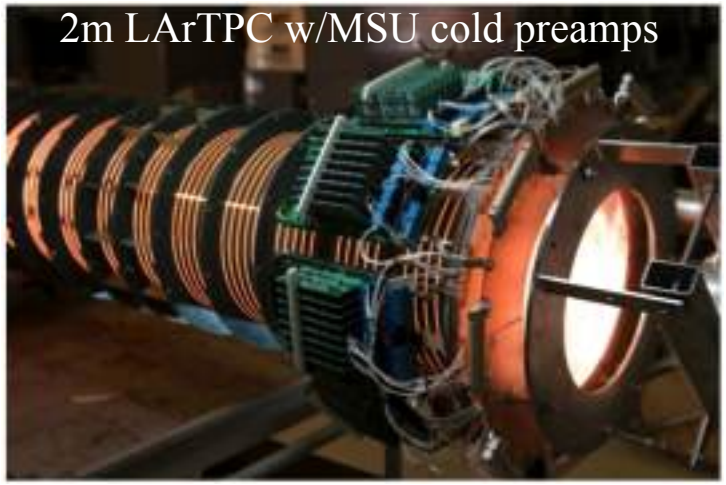
Second cold-electronics run (2011)

Noise was so low in run 1, increased gain x 4 to see it.



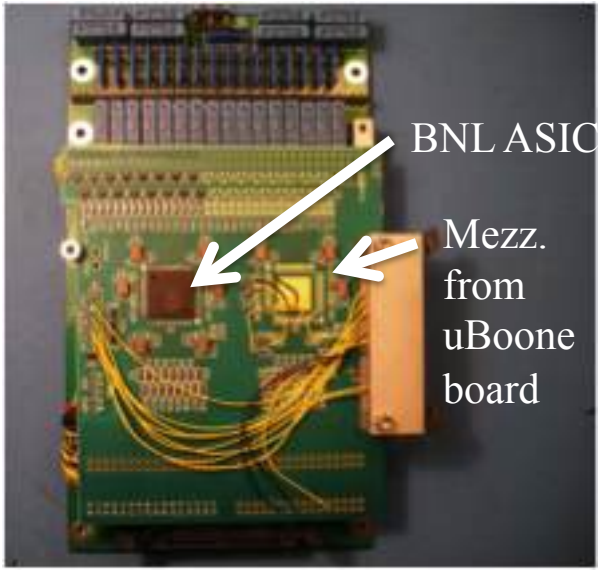
2012 selection of LArTPC technology for LBNE !

2011-2013 Liquid Argon Purity Demonstrator long-Bo TPC

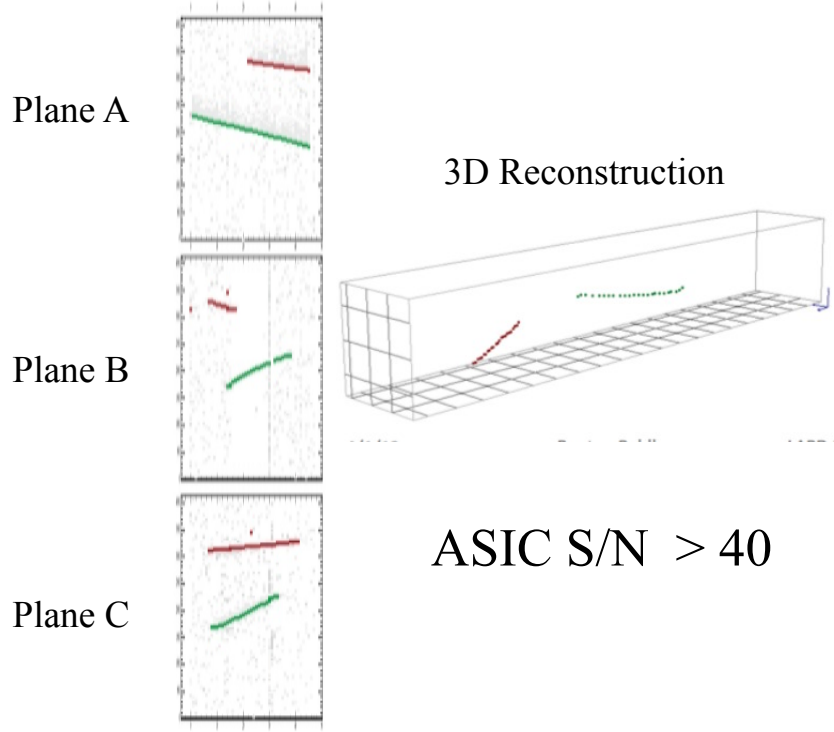


Modified one MSU 16-channel card to use a BNL ASIC. Installed on the central induction plane

Dean Shooltz - MSU



Long-Bo Tracks



ASIC S/N > 40

Cold electronics for LArIAT

ArgoNeuT was an R&D project designed over 6 years ago, superceded by 2 generations of cold electronics with significantly better S/N.

Cryostat provides hermetic shielding of cold preamps from external coherent noise. No need for RF shielding box.

Reassembly of old warm preamp shielding box not anticipated. Extensive testing required, and replacement parts difficult or impossible to obtain.

Internal cables/connectors must be replaced to remove water contamination issues.

Cold Electronics Components, Tasks, Personnel

- Components
  - TPC mounted preamp motherboards (30) and cables to feed-thru
  - Preferred use of 30 BNL ASIC chips - Excess MicroBoone production
  - Warm receiver/power for preamps and driving long twisted-pair cables
  - ADF2 digitizers w/firmware modifications
- MSU Tasks
  - Preamp motherboard design – integrated with new TPC wire planes
  - Selection of internal cables, connectors, and design of routing
  - Component purchasing and QA prior to assembly
  - Assembly and testing of premaps, warm receivers, and cables
  - Installation of premaps, cables, warm receivers, twisted-pair cables
  - Fimware modifications to ADF2 digitizers for improved readout speed
  - Warm checkout of system followed by cold commissioning
- Personnel
  - Carl Bromberg, PI
  - Dan Edmunds, EE (MSU staff member)
  - Dean Shooltz (Ph.D) contract engineer