UNIVERSITÄT BERN
AEC ALBERT EINSTEIN CENTER FOR FUNDAMENTAL PHYSICS

ArgonCube
Pixel Readout Status

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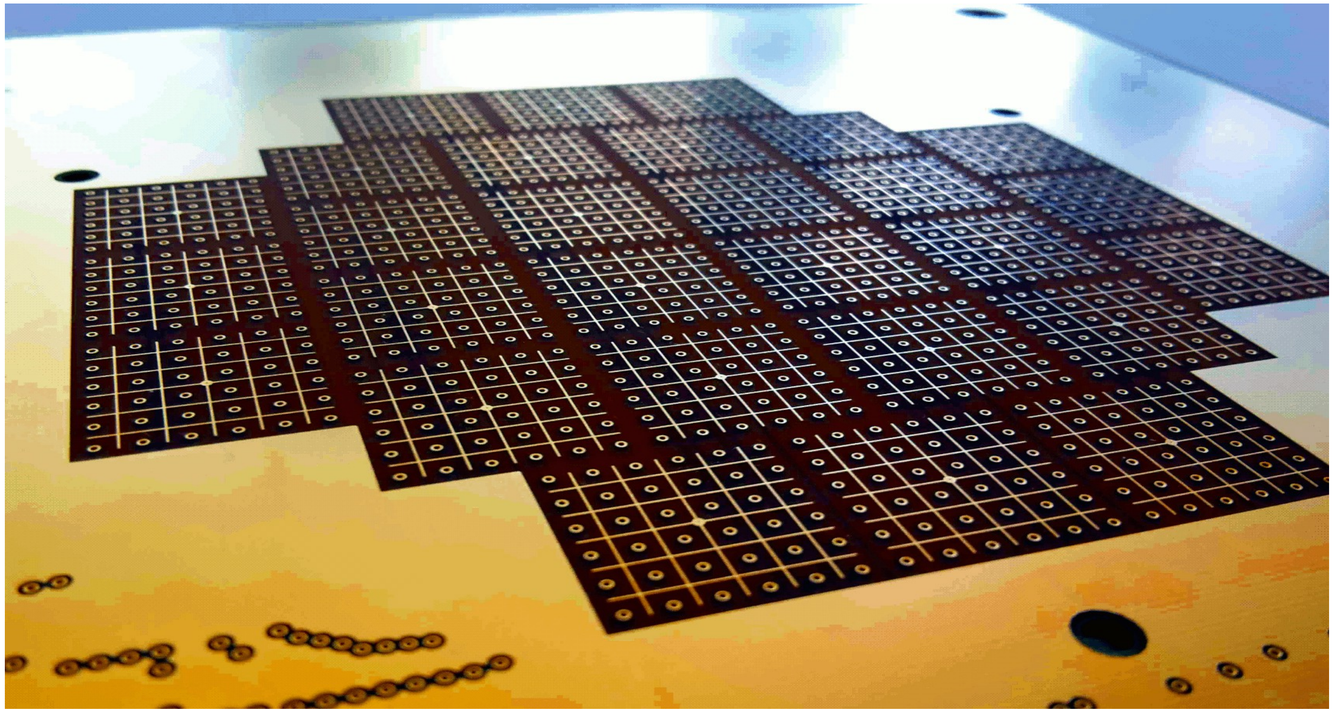
LHEP Bern



LBNL
April 2017

ArgonCube - A Modular LArTPC with Pixel-readout.

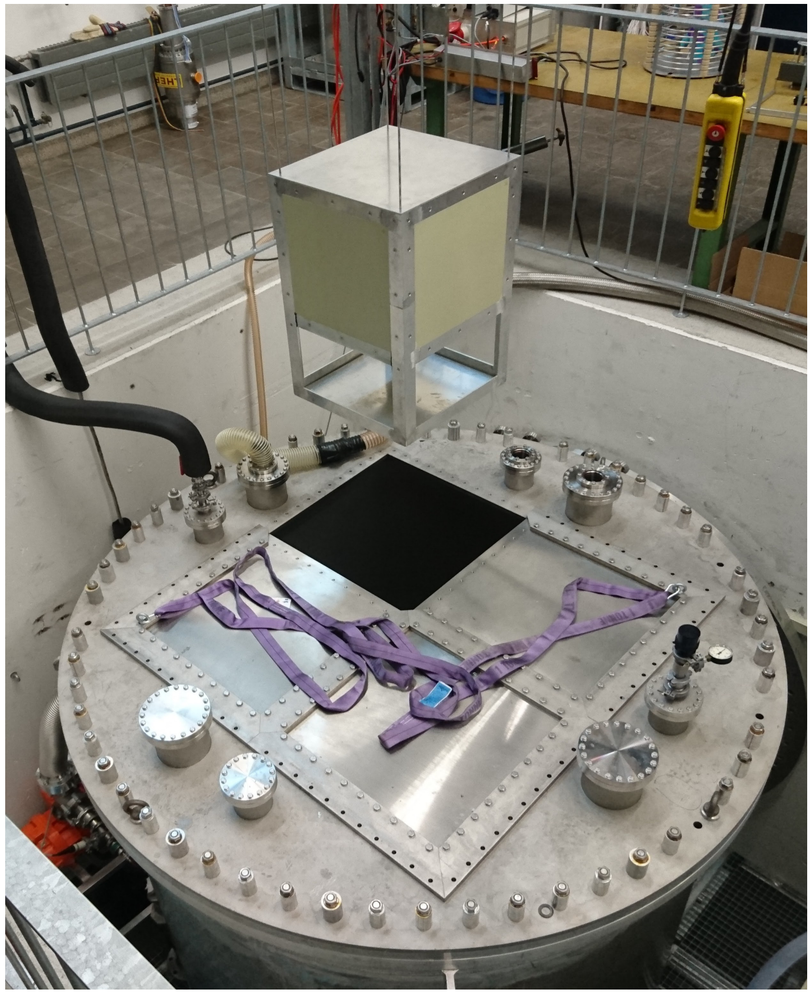
Segment detector volume into a number of self contained TPCs sharing a common cryostat.

Shorter drift-times - Less stringent purity, less pileup & lower voltage

Light contained - Less optical pileup, accurate trigger & veto

Run constantly – upgrade & repair work without complete detector downtime

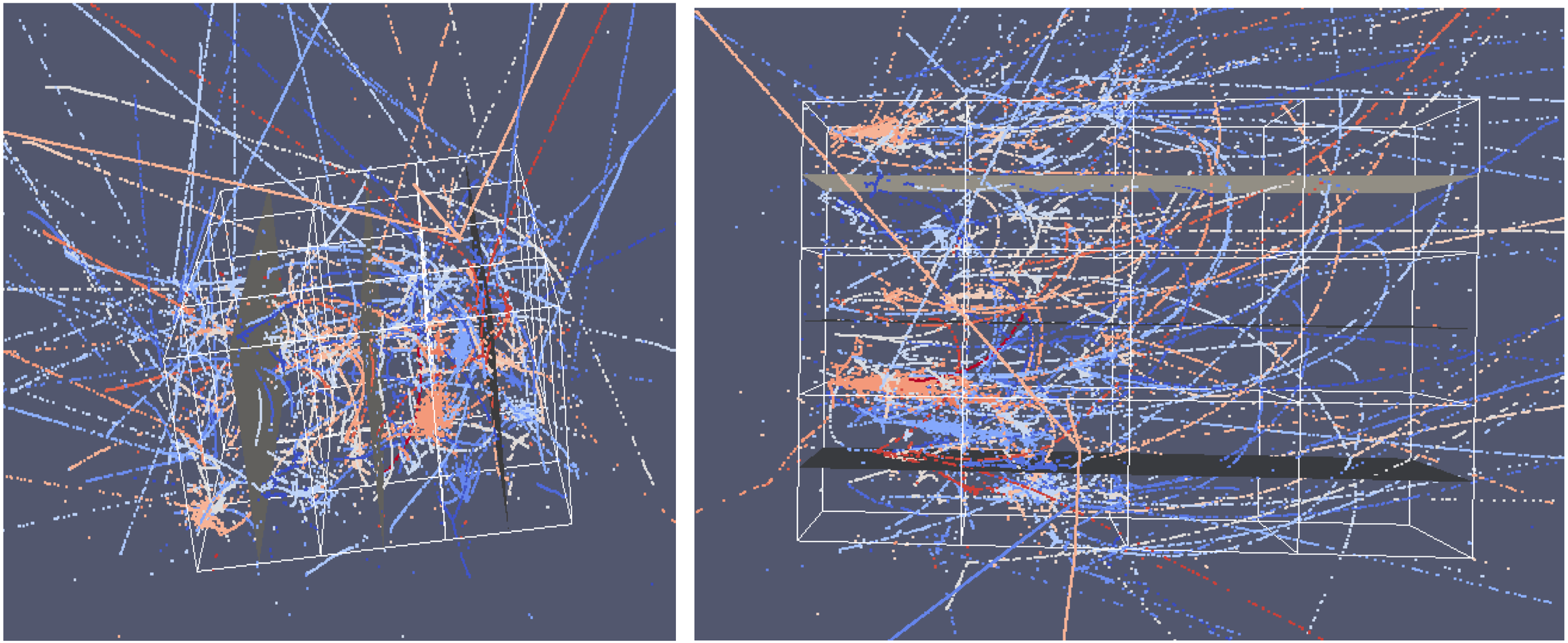
Pixel readout - 3D reconstruction with reduced reconstruction ambiguity, potential for more complex trigger system



ArgonCUBE cryostat and material test Oct 2016

Why Pixels

Pileup can be minimized, but not avoided – LArTPC are not fast. Pixels offer some mitigation.



ParaView event display of single beam spill at 7.5e13 POT with cosmic & rock (colouring by nu).

Pixel Charge Readout

Pixelated charge readouts providing live 3D readout

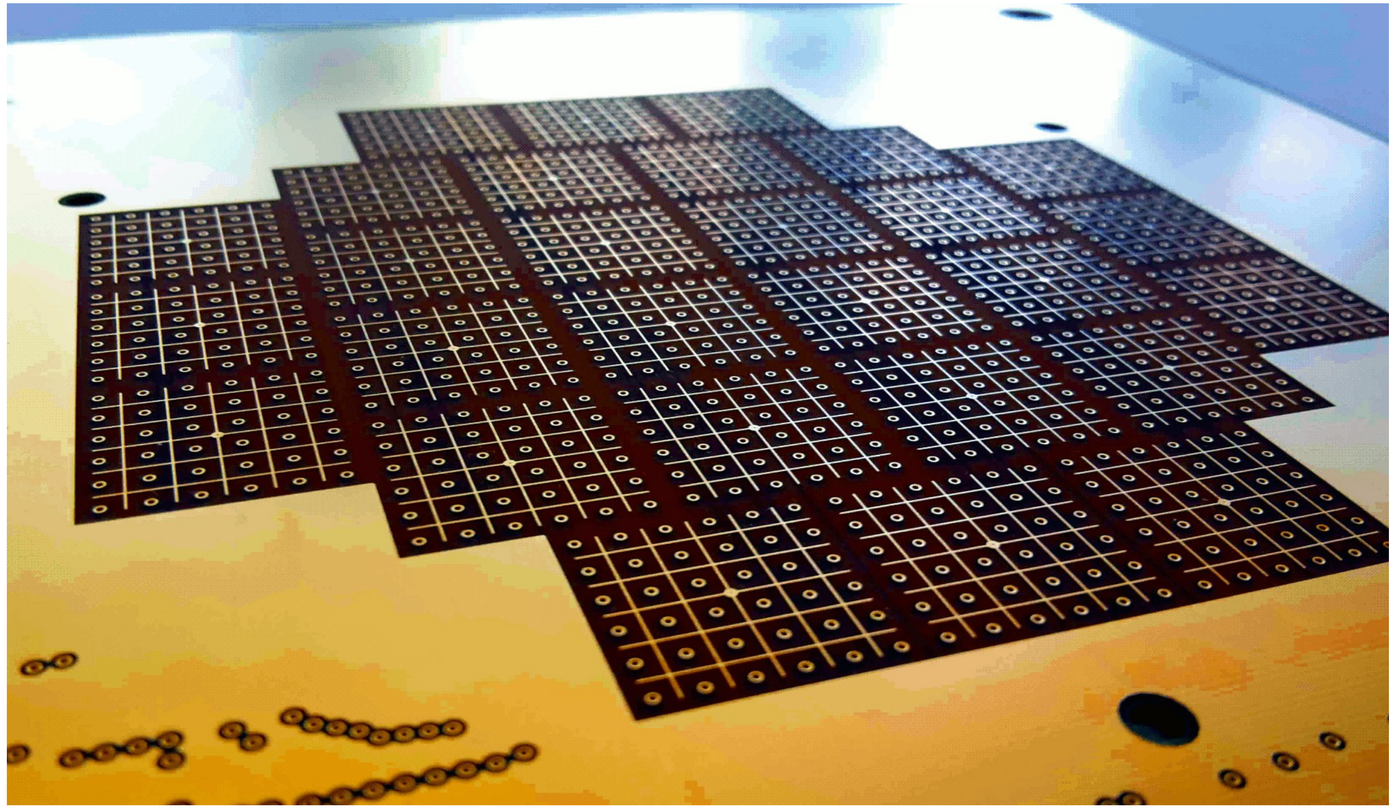
Minimize reconstruction ambiguity

Enabling more advanced triggers

Improving background rejection

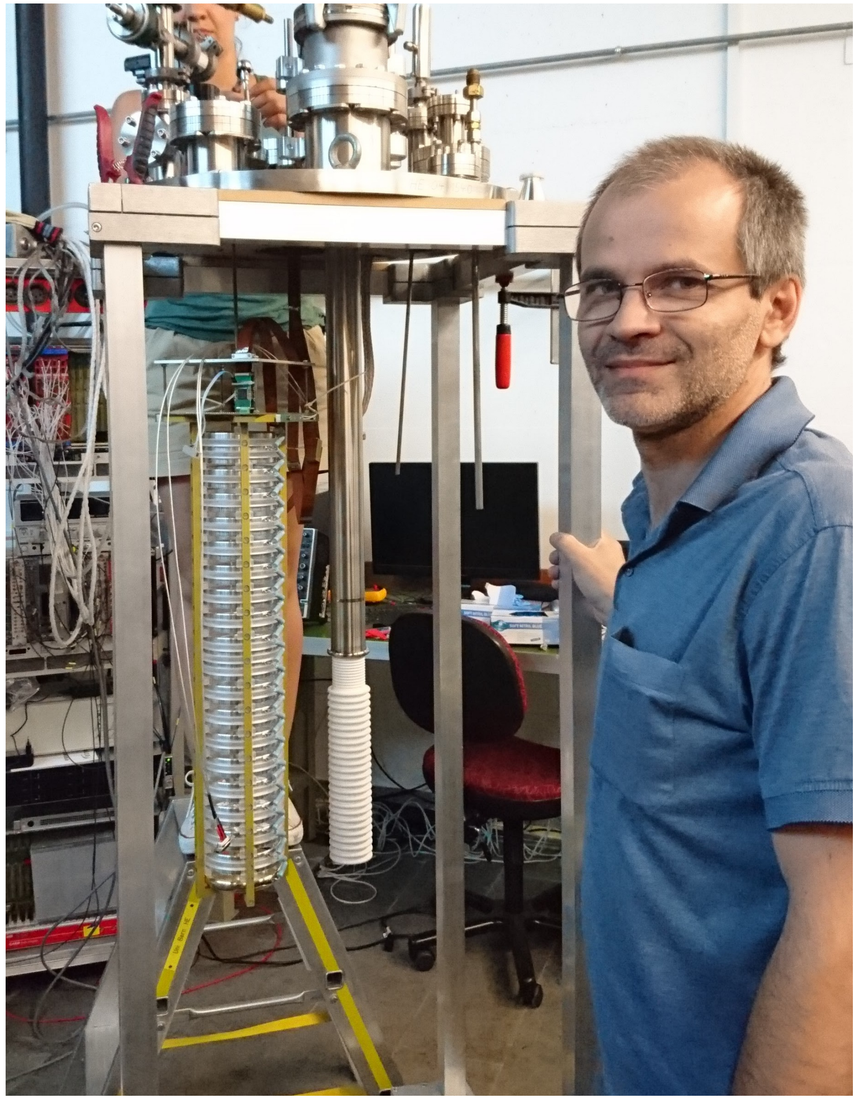
Further reducing event pile-up

Mechanically robust



First ArgonCUBE pixel demonstrator (2.86 mm pitch), Bern 2016

Pixel & Cold SiPM Demonstration TPC



The first pixel readout LAr TPC was successfully demonstrated at Bern in June 2016

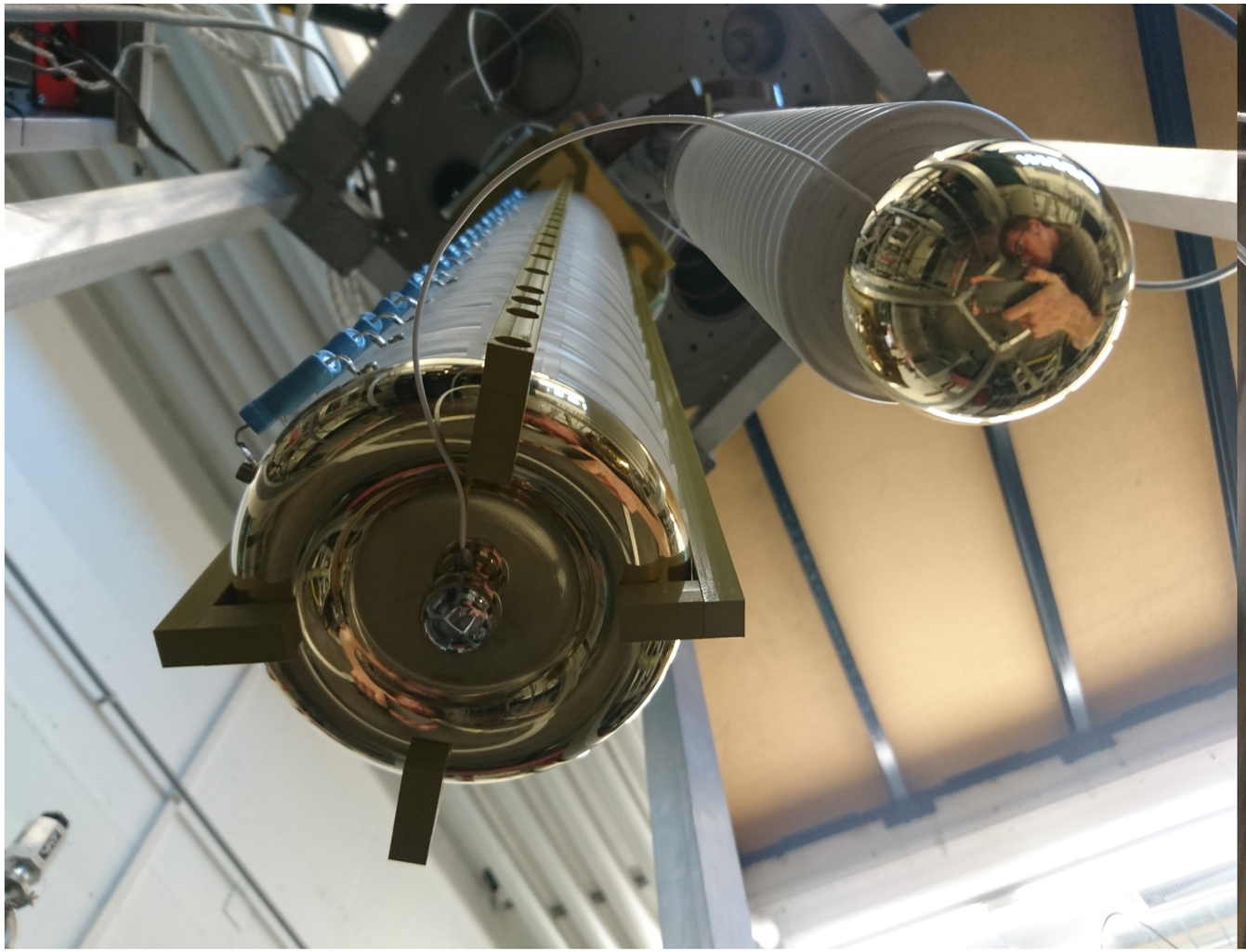
60 cm drift TPC (extendable), 60 kV (1 kV/cm). 2.86 mm pitch.

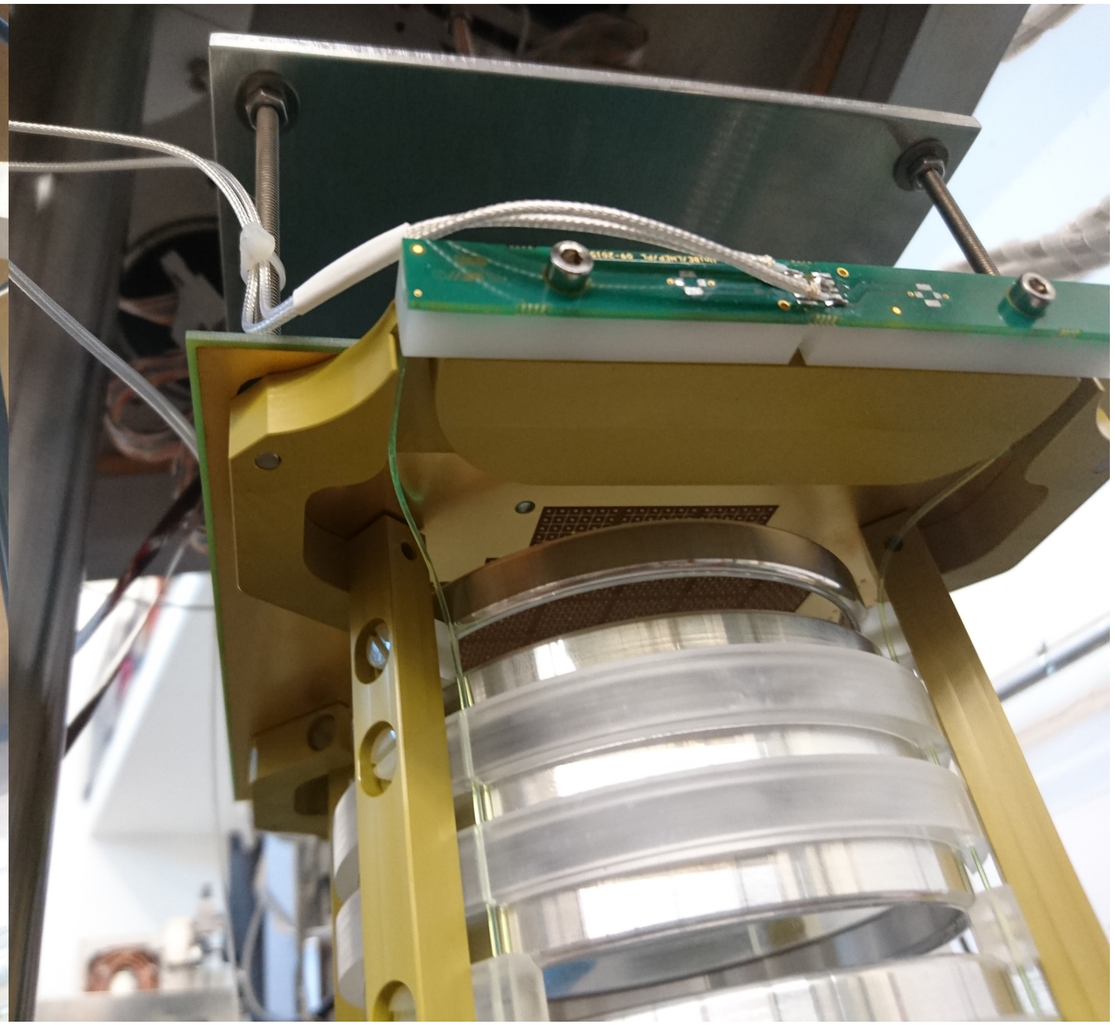
BNL cold preamplifiers and warm commercial ADCs (adapted wire RO from ArgonTUBE)

Showed pixel RO to be possible, but highlighted some issues:

- Noise from various sources.
- Multiplexing ambiguities due to adapting wire RO

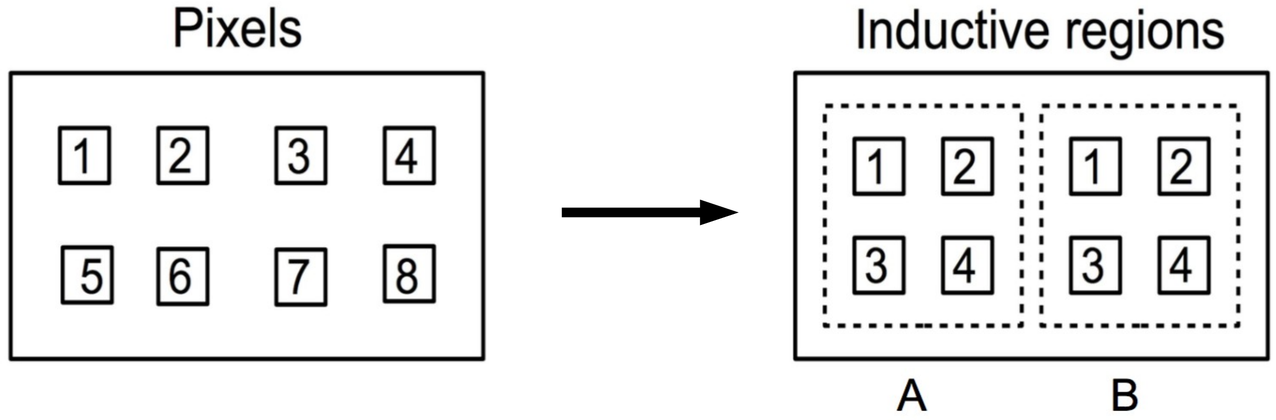
Pixel Demonstration TPC





Pixel Readout – Regions of Interest (ROI)

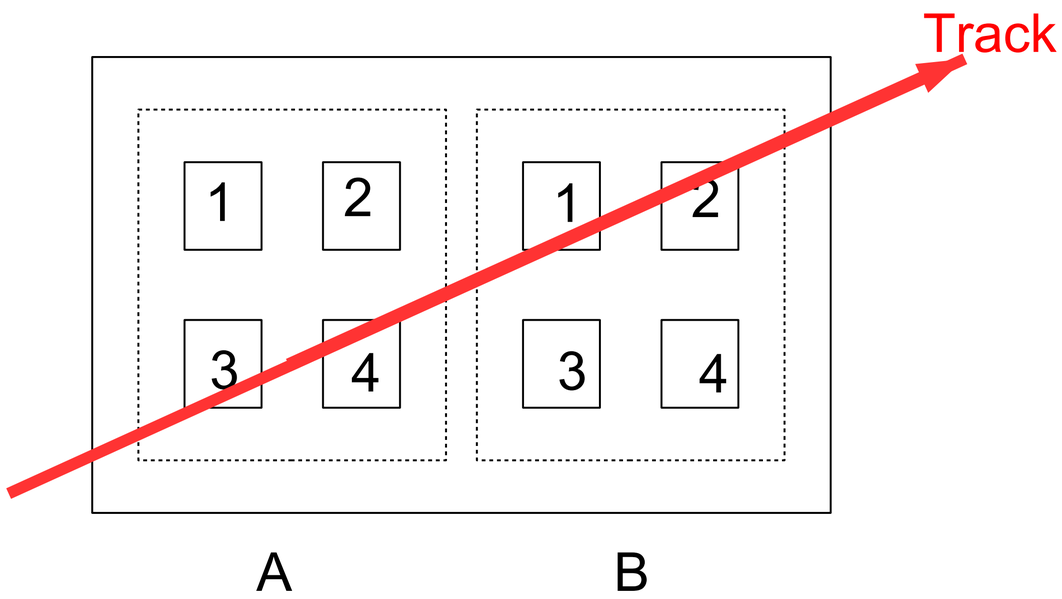
We cannot yet produce our own ASICs, so have to adapting wire readout electronics. Therefore we have to limit channel number.

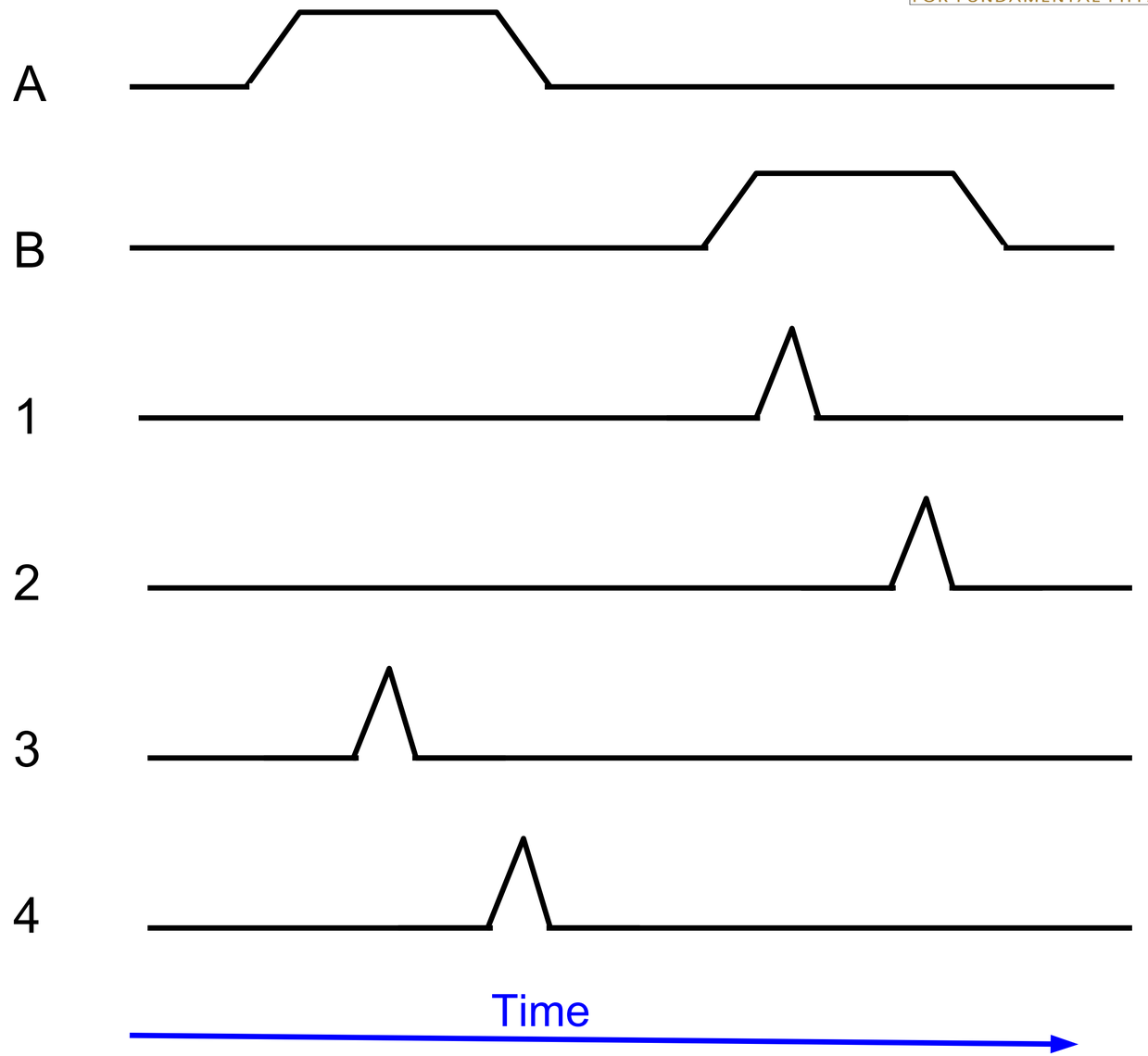


Number of DAQ channels: nROI + nPixel

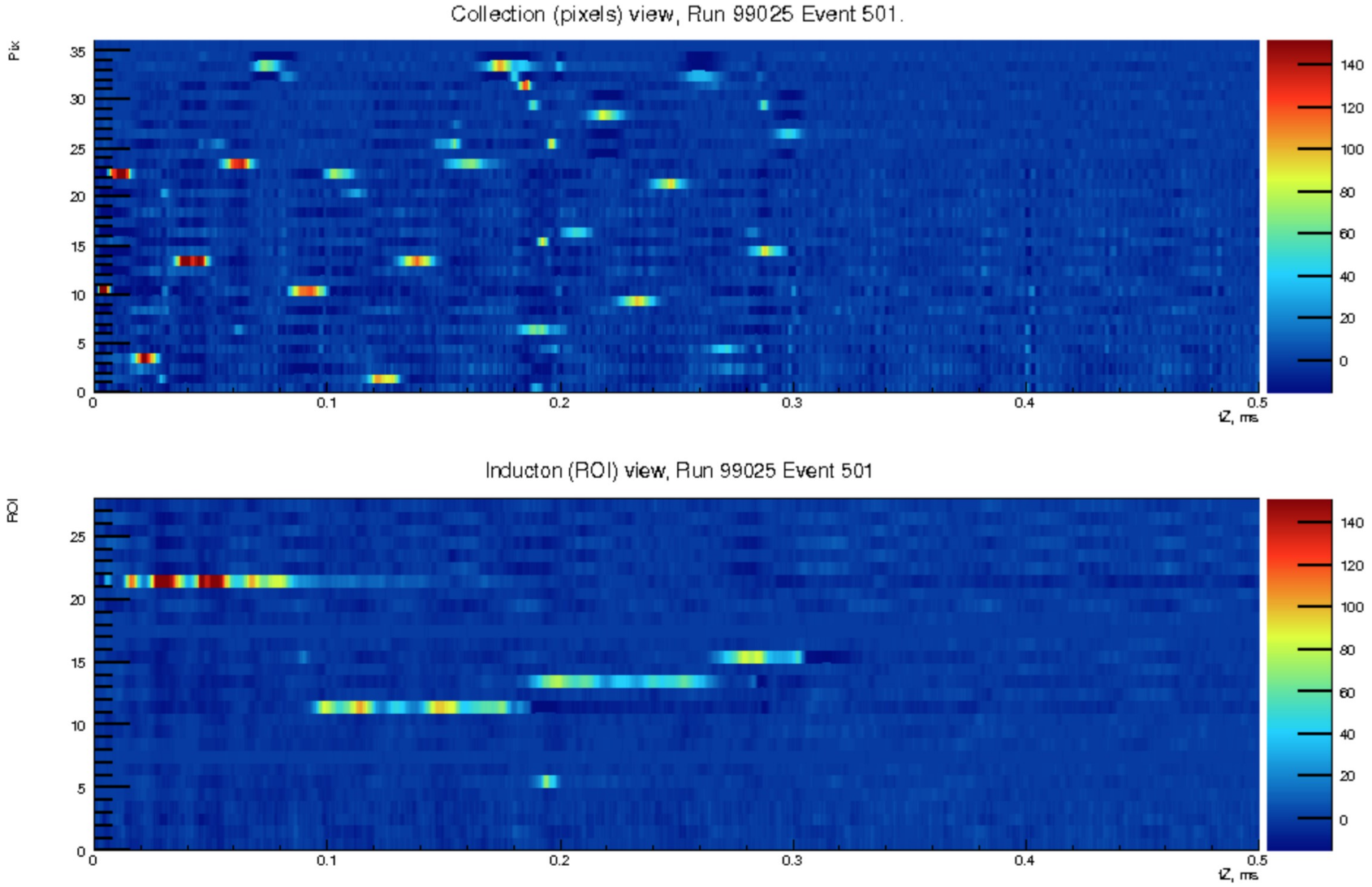
Number of physical pixels: nROI x nPixel

Inductive Regions

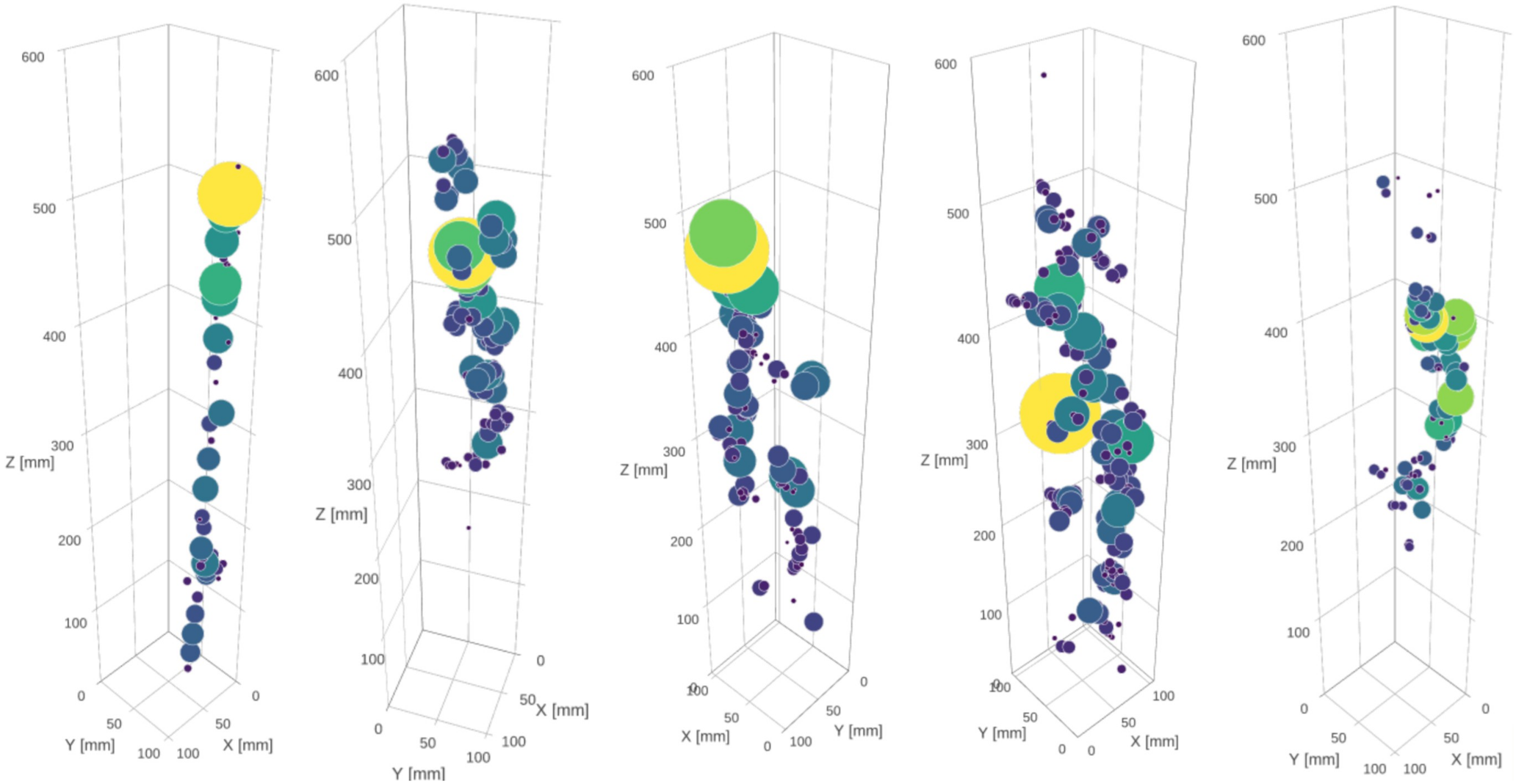




Pixel Readout Results



Phase I Results Event Display



Reconstructed events within LAr using a pixel readout, Bern summer 2016. Cosmic muons and Compton events from ^{60}Co source

Addressing the Noise

Second phase pixel demonstrator successfully completed at Bern in Feb 2017

Noise reduced form 100 mV to 30 mV

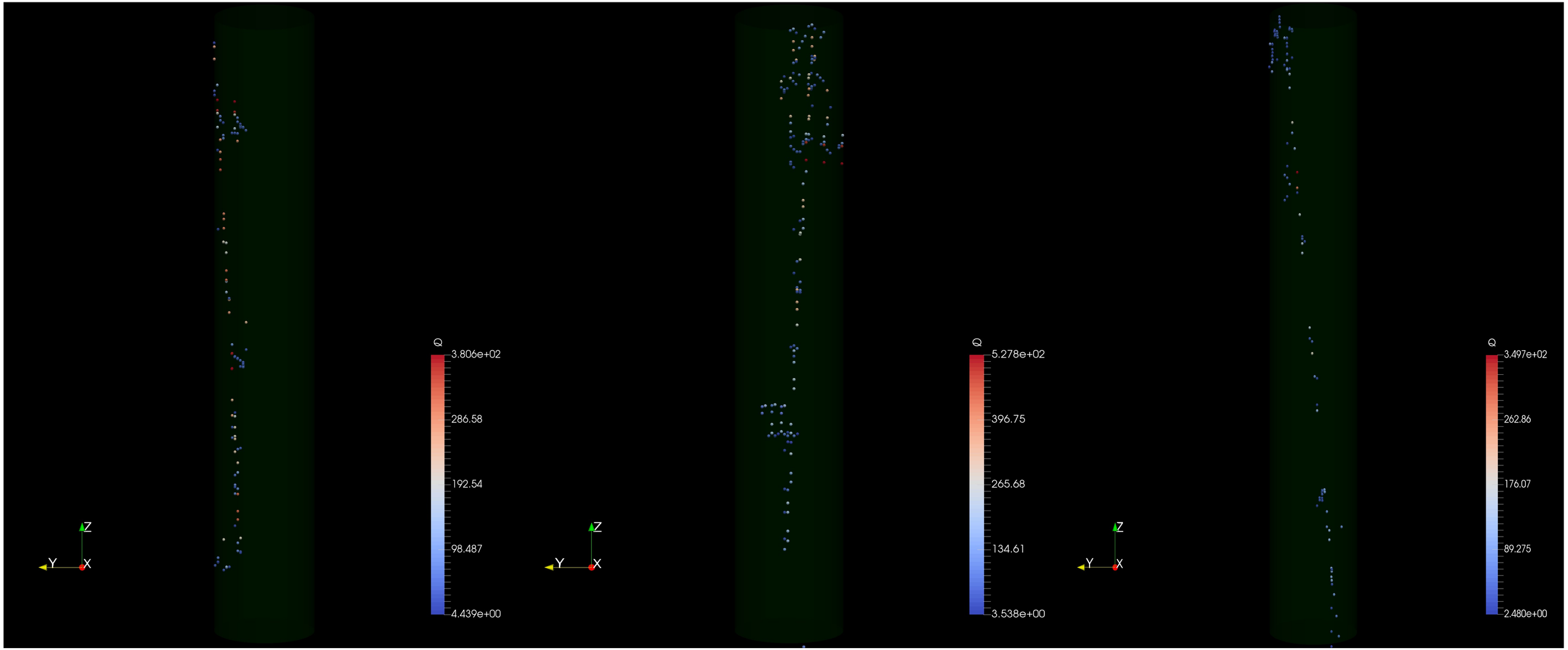
Amplification redesigned, essentially copying LArIAT

Isolating generator installed – clean lab power

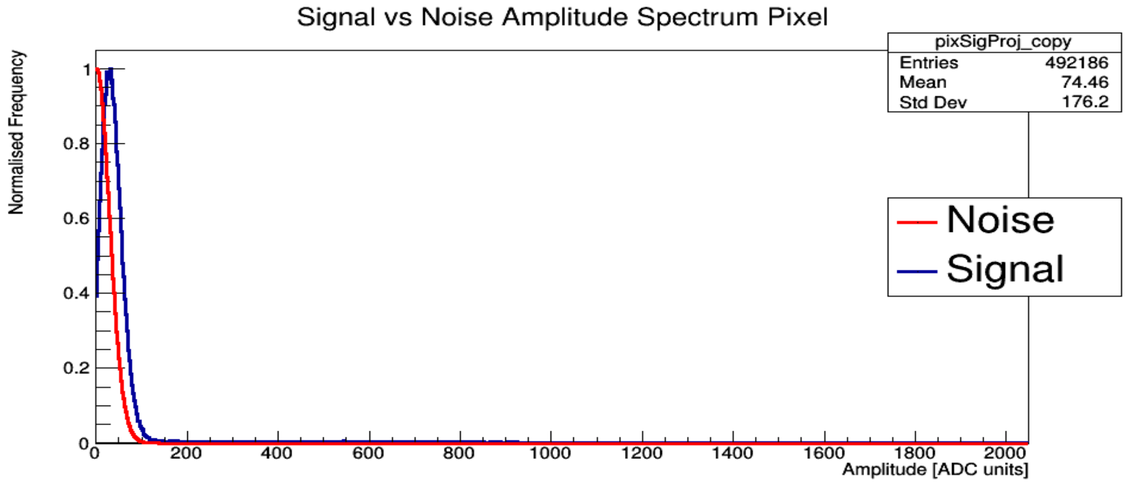
Pixel capacitance reduced from 150 pF to 50 pF with updated PCB (3mm thicker and removed ground planes)

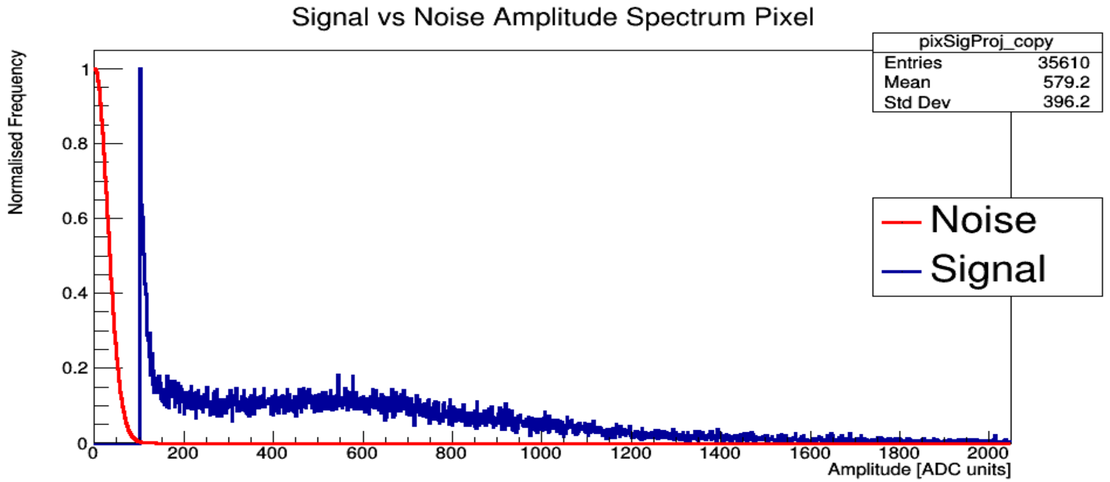
Multiplexing ambiguities remain

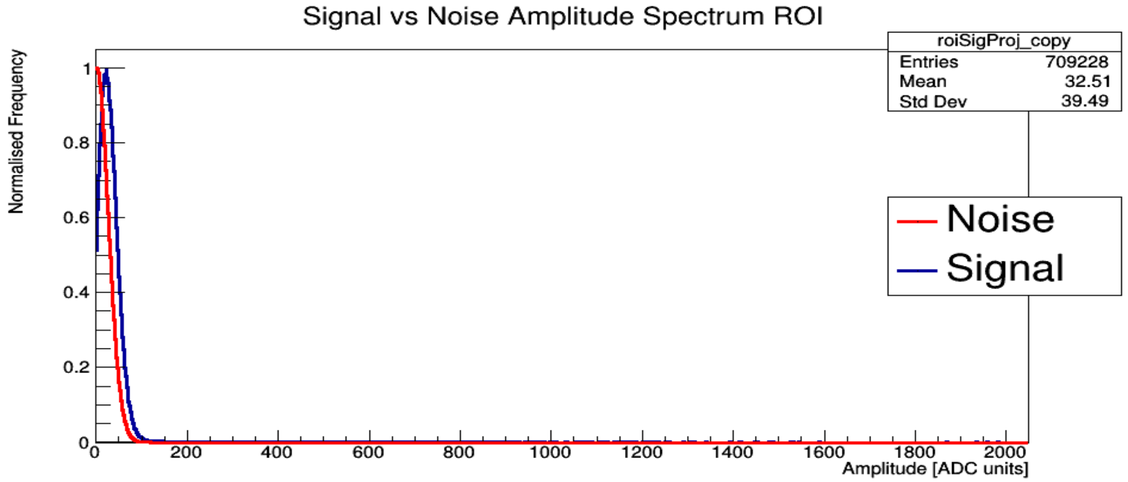
Phase II Results – Event Display

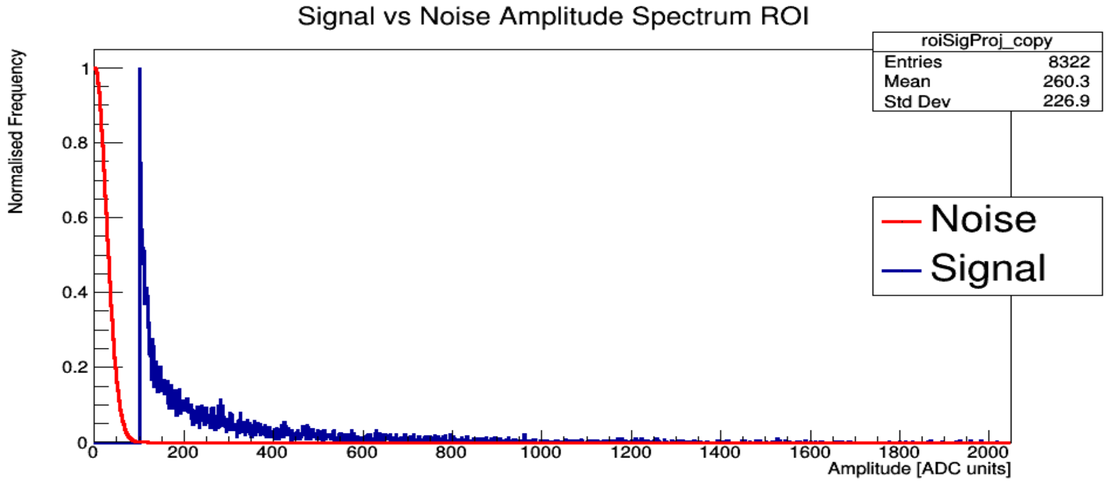


Phase II Results - Signal and Noise Distribution





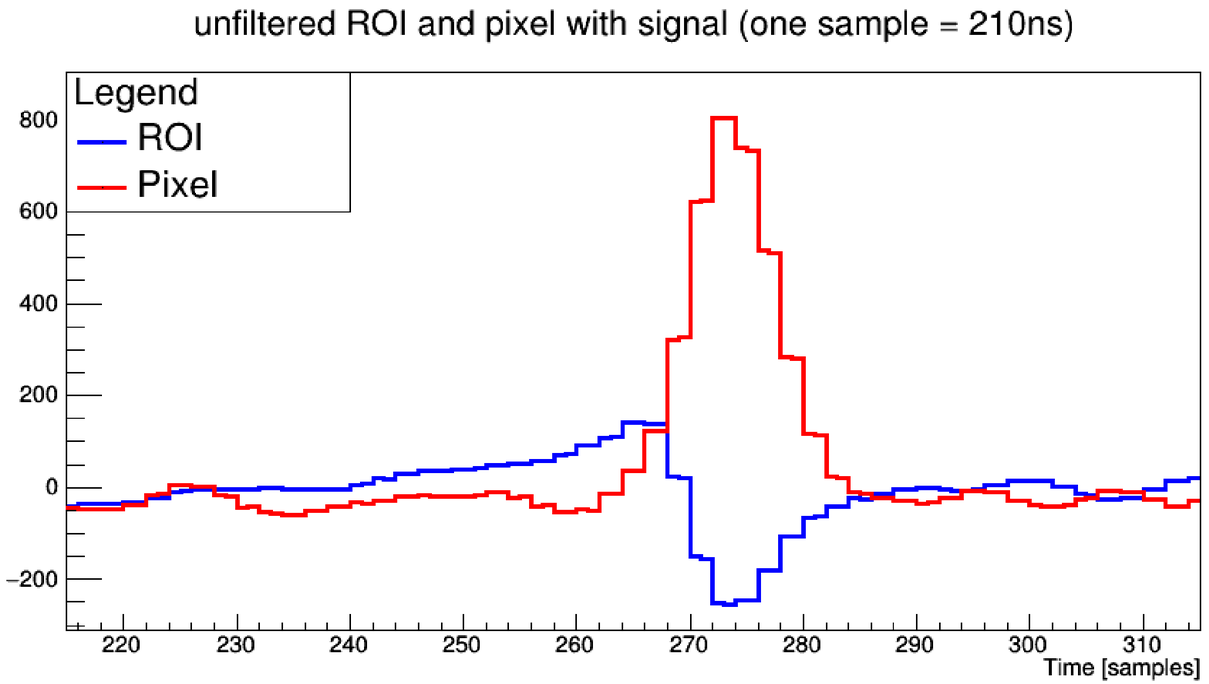


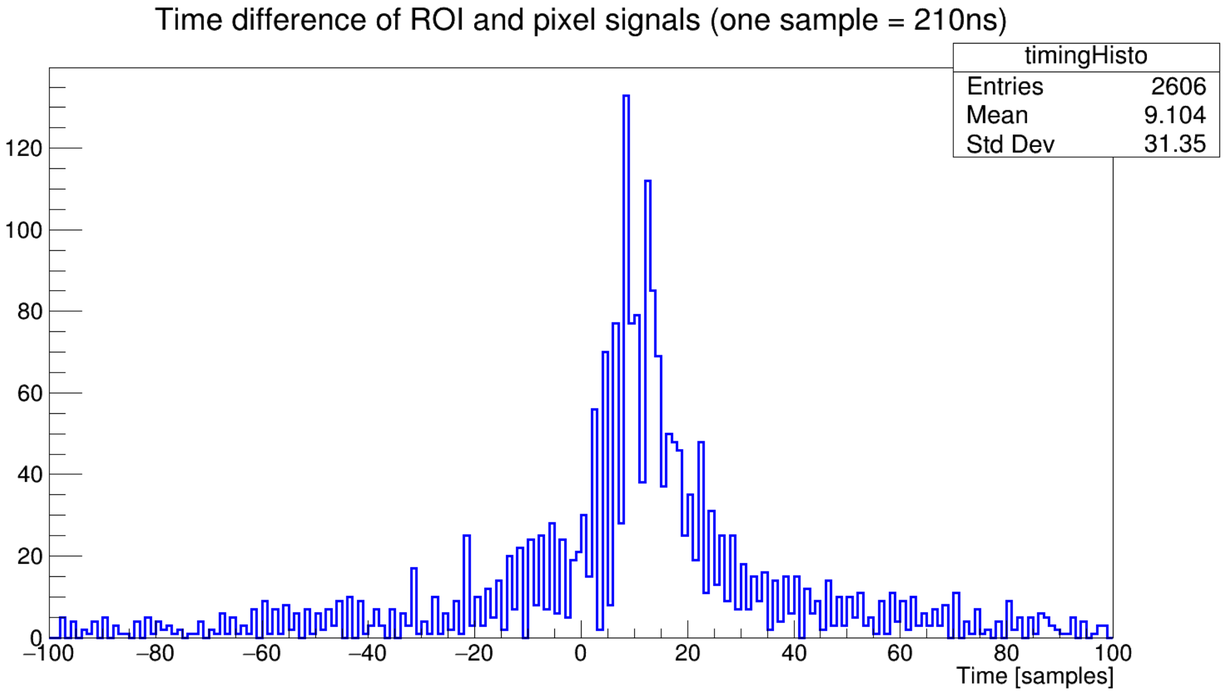


Cutting on 100 ADC counts

Phase II Results – Time Distribution

To reduce the power consumption, is it possible to 'wake' on induction signal?





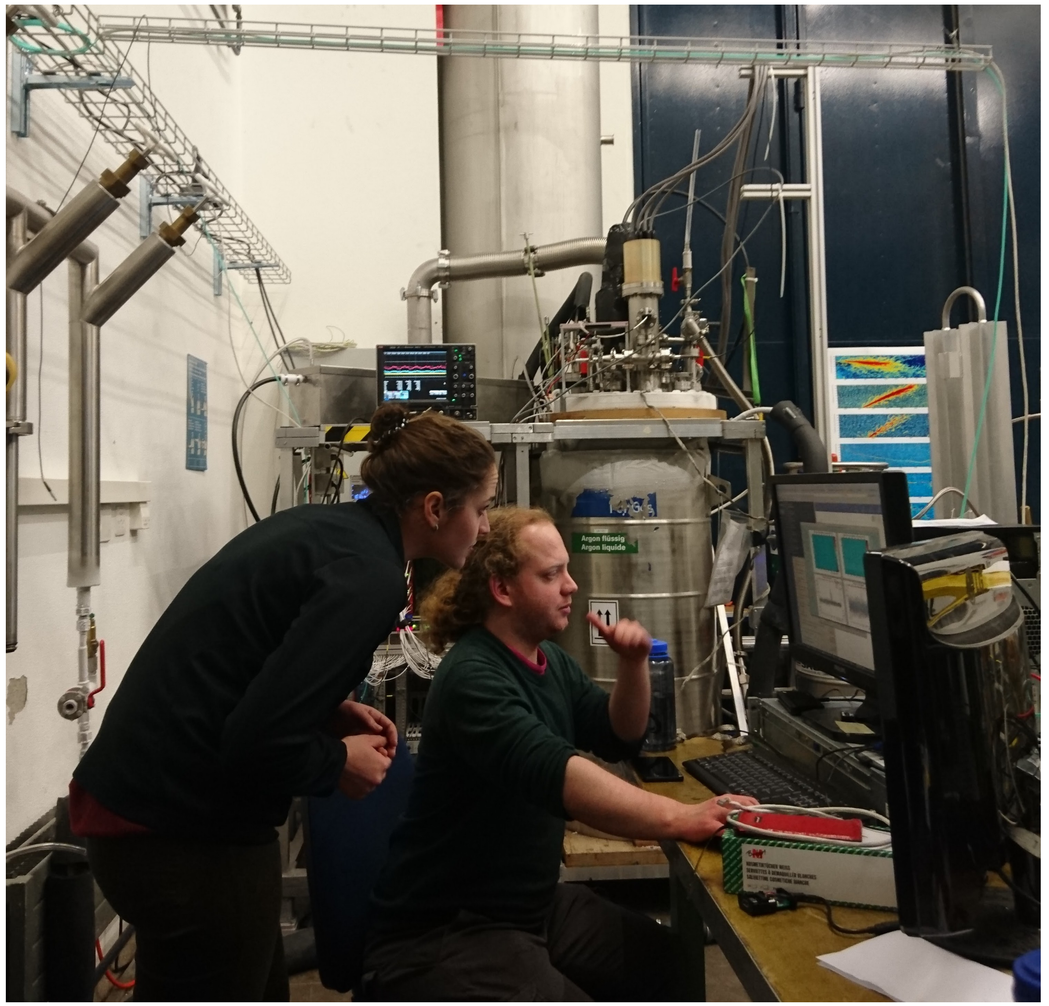
Status & Outlook

First TPC deployment in ArgonCUBE & cryogenic infrastructure test. Summer 2017

Pixel scalability study & test beam (LarIAT). Fall 2017/spring 2018

Initial bespoke pixel ASIC tests fall 2017

Fully instrumented ArgonCUBE module deployment. Fall 2018



Francesca & Damian operating the Bern pixel test stand