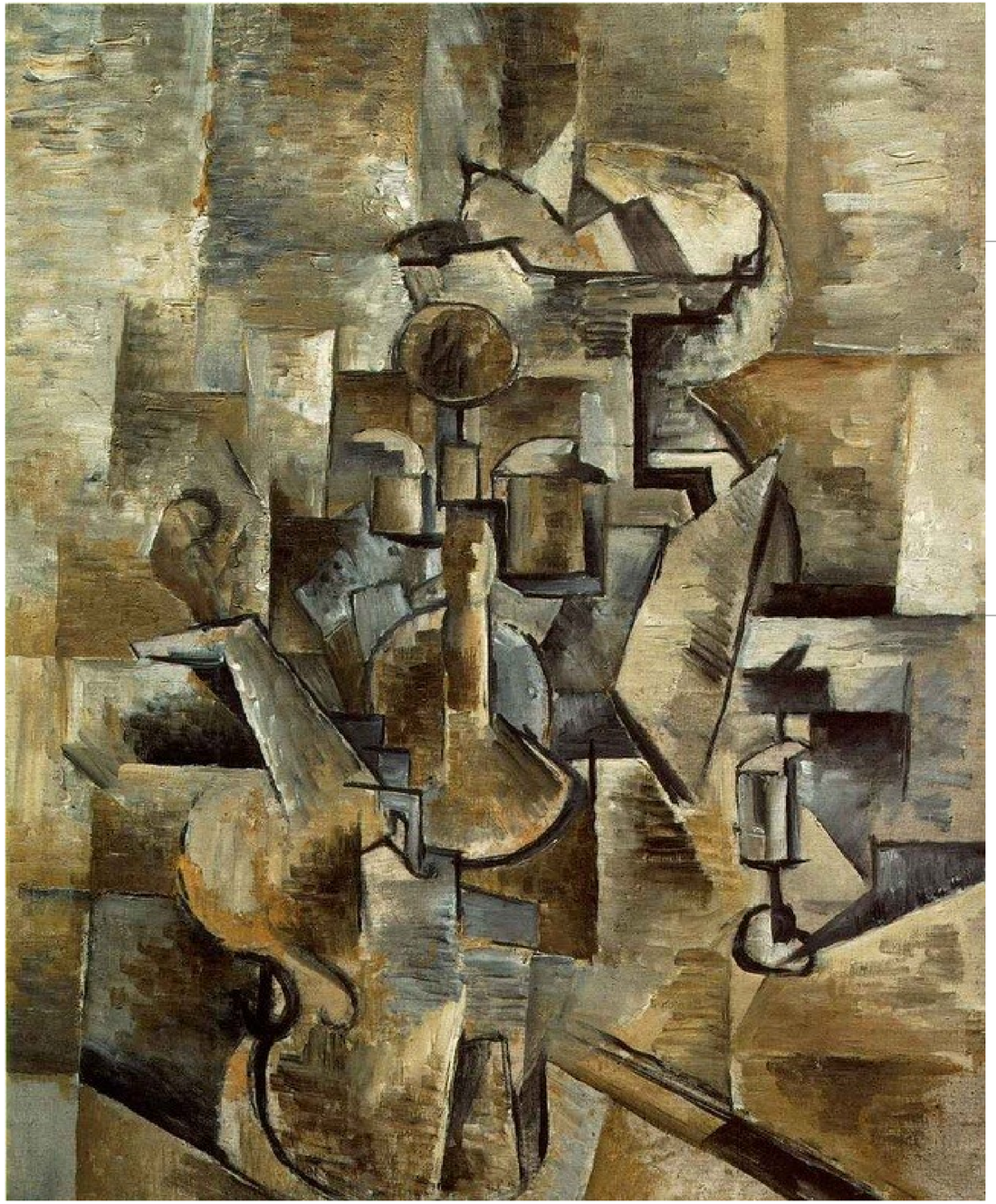


Braque's Violin and Candle Stick, Paris 1910

ArgonCube

UNIVERSITÄT BERN

AEC ALBERT EINSTEIN CENTER FOR FUNDAMENTAL PHYSICS

ArgonCube & DUNE Near Detector

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

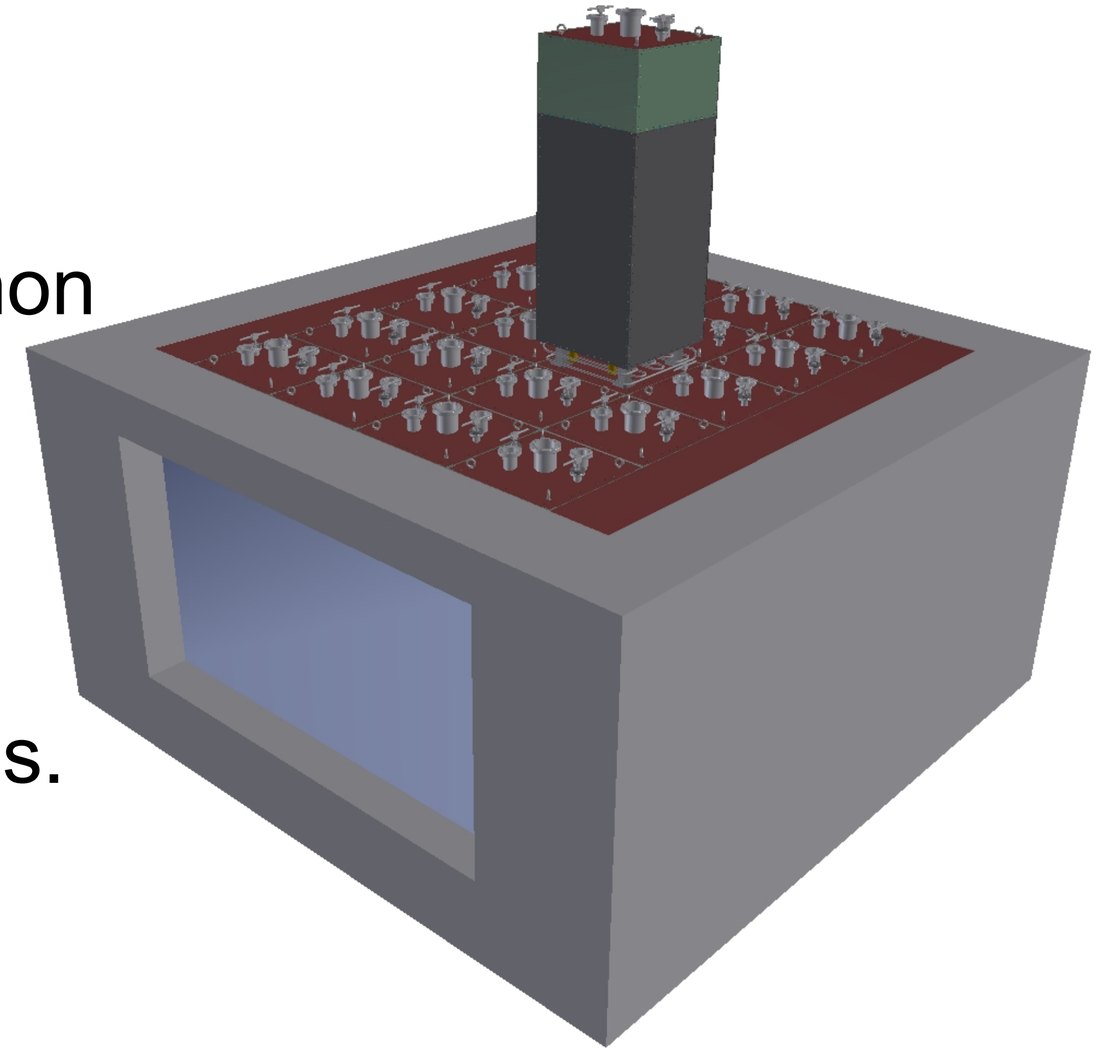
ND Workshop FNAL, March 2018

James Sinclair, LHEP

ArgonCube

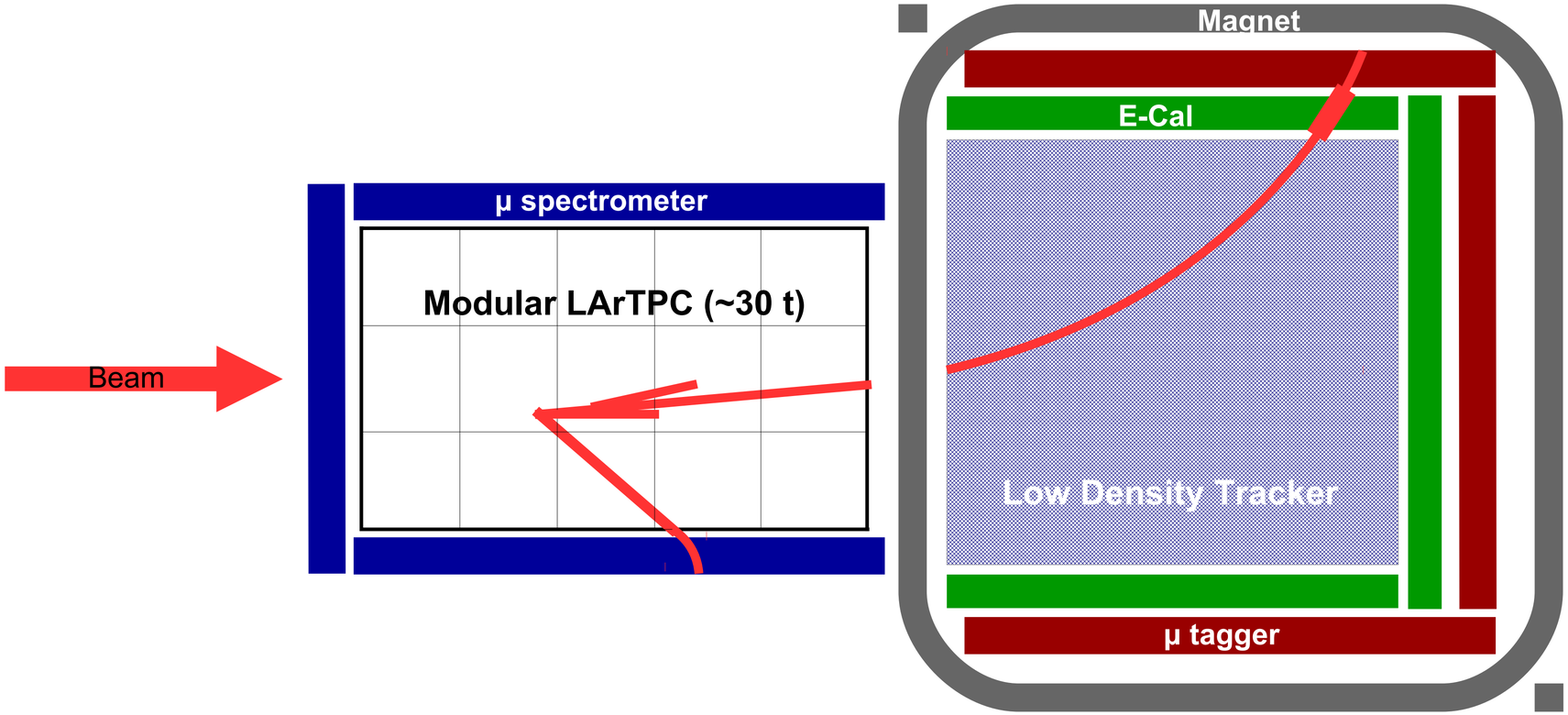
1)
Segmented LArTPC - a number of self-contained TPCs sharing a common cryostat.

2)
Ambiguity free charge readout - pixels.



ArgonCube in the DUNE ND

The current DUNE ND concept is a ‘hybrid’ LArTPC + low density tracker.



Modular LAr-TPC: high statistics ν-Ar interactions, assessment of LArTPC response.

Low Density Tracker: precision characterization of ν-nucleus interactions, complementary signal vs. BG discrimination. Possibly FGT, scintillator or GArTPC.

Requests from DUNE (To be answered by March ND workshop)

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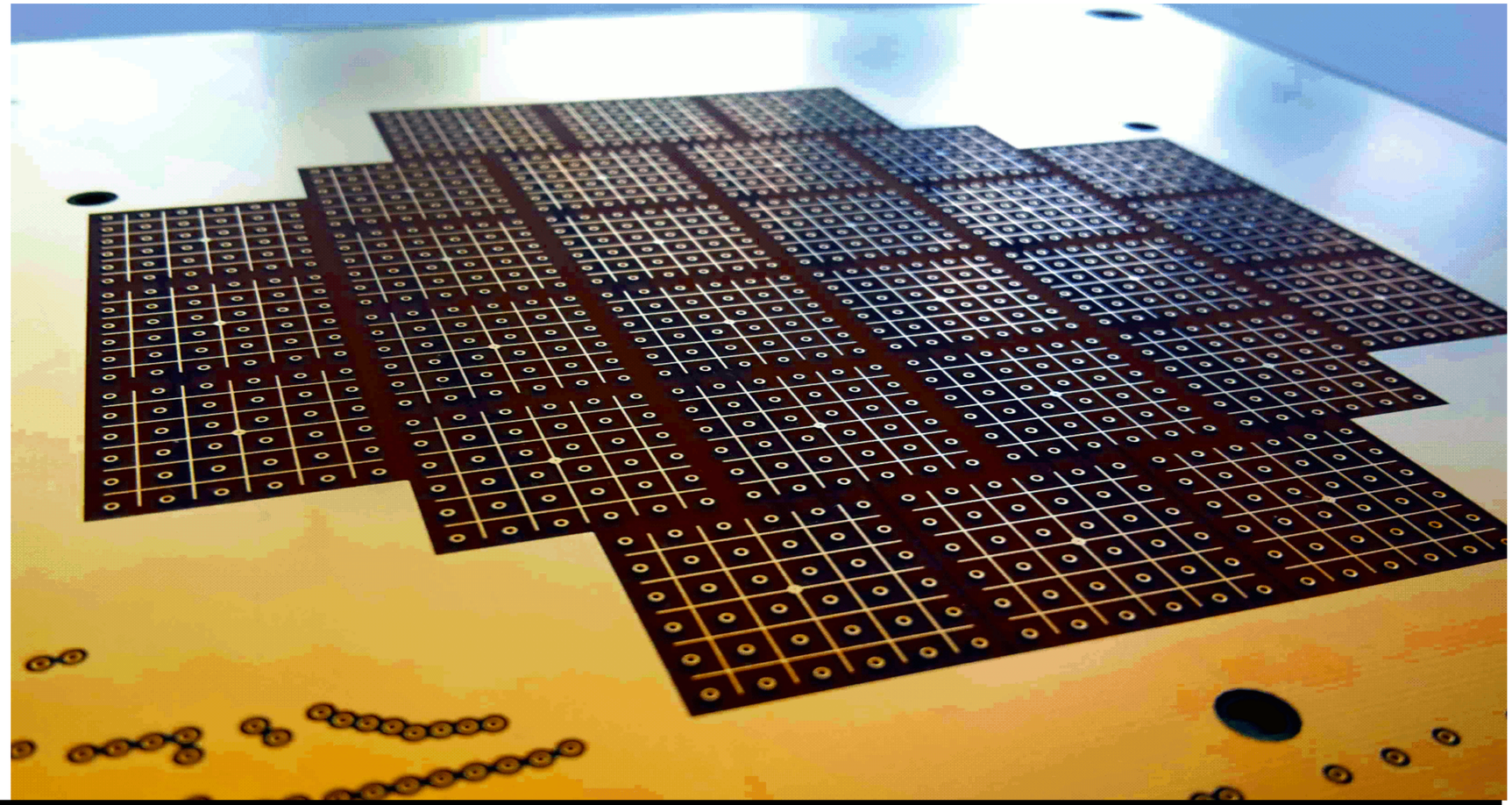
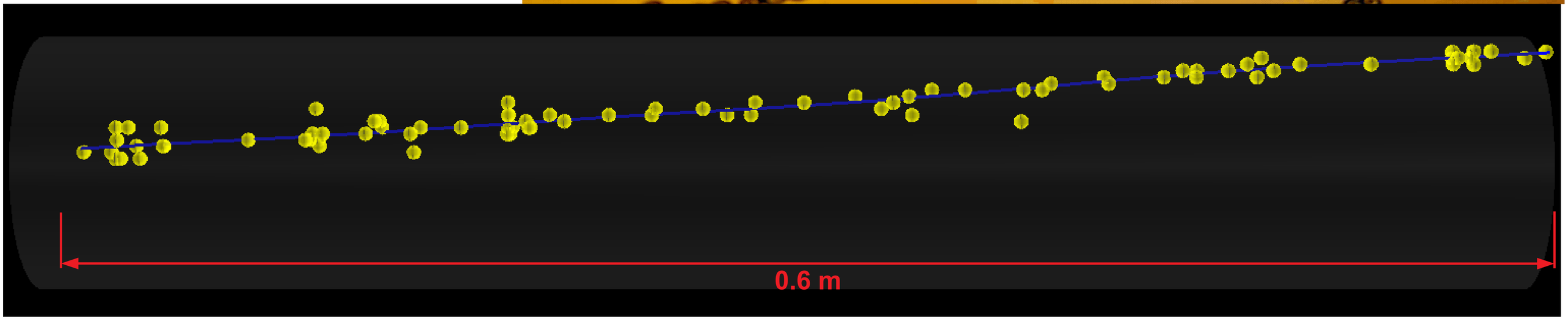
Pixels must be feasible for a LArTPC to handle high rates.

Are Pixels feasible?

2016/17 demonstrator studies in Bern were successful.

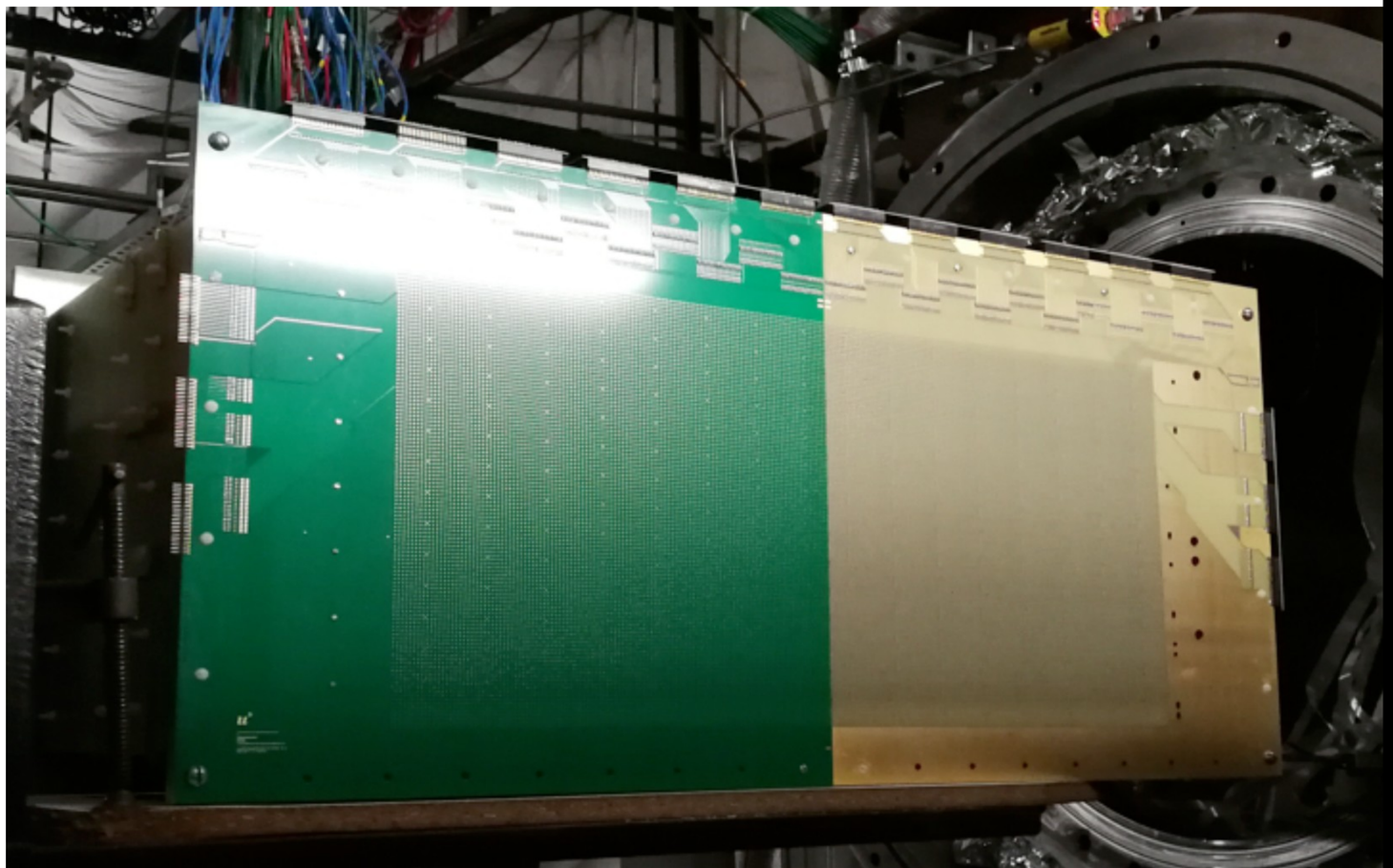
(arXiv:1801.08884)

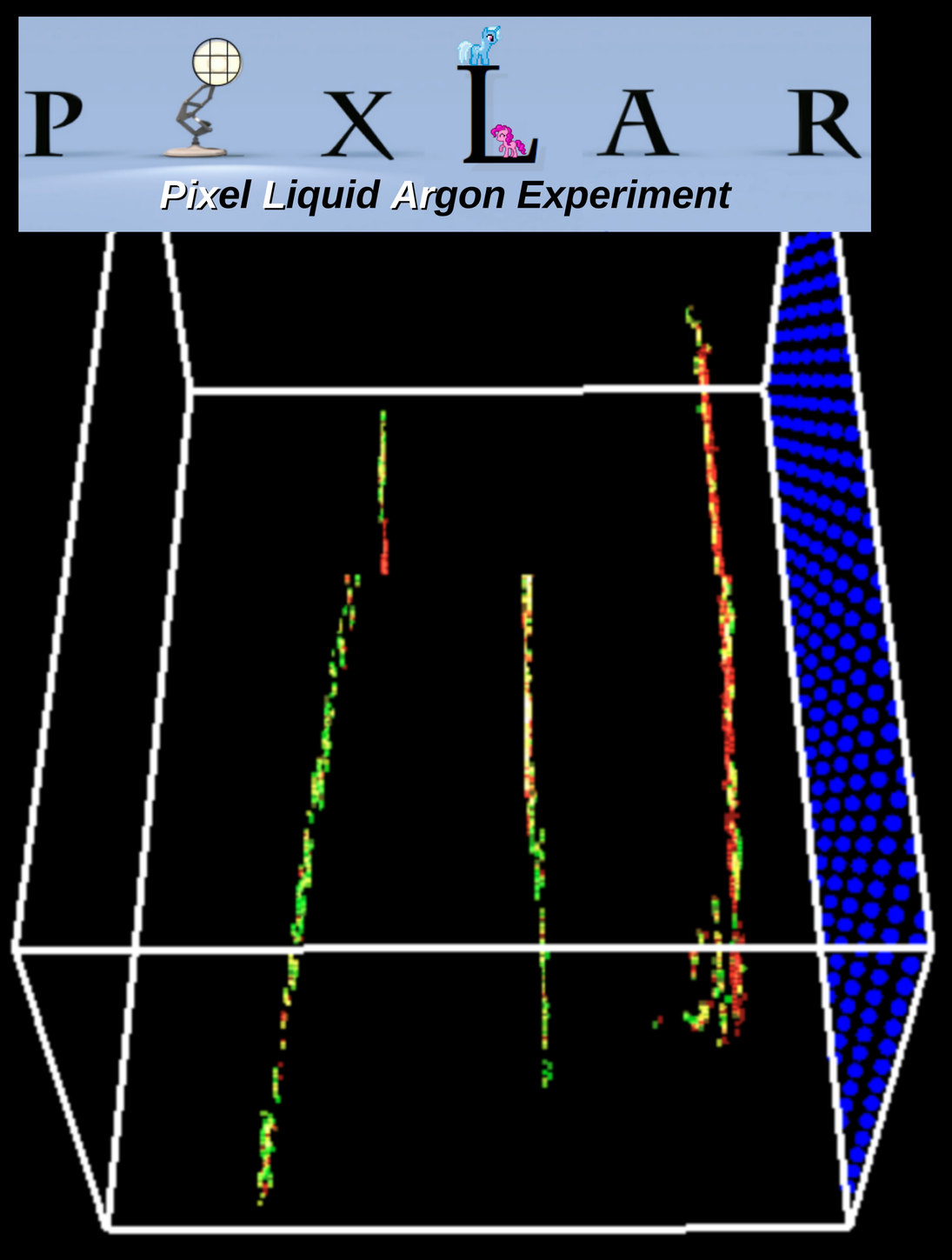




2017/18 Pixel test beam studies (PixLAr) at FNAL were also successful.

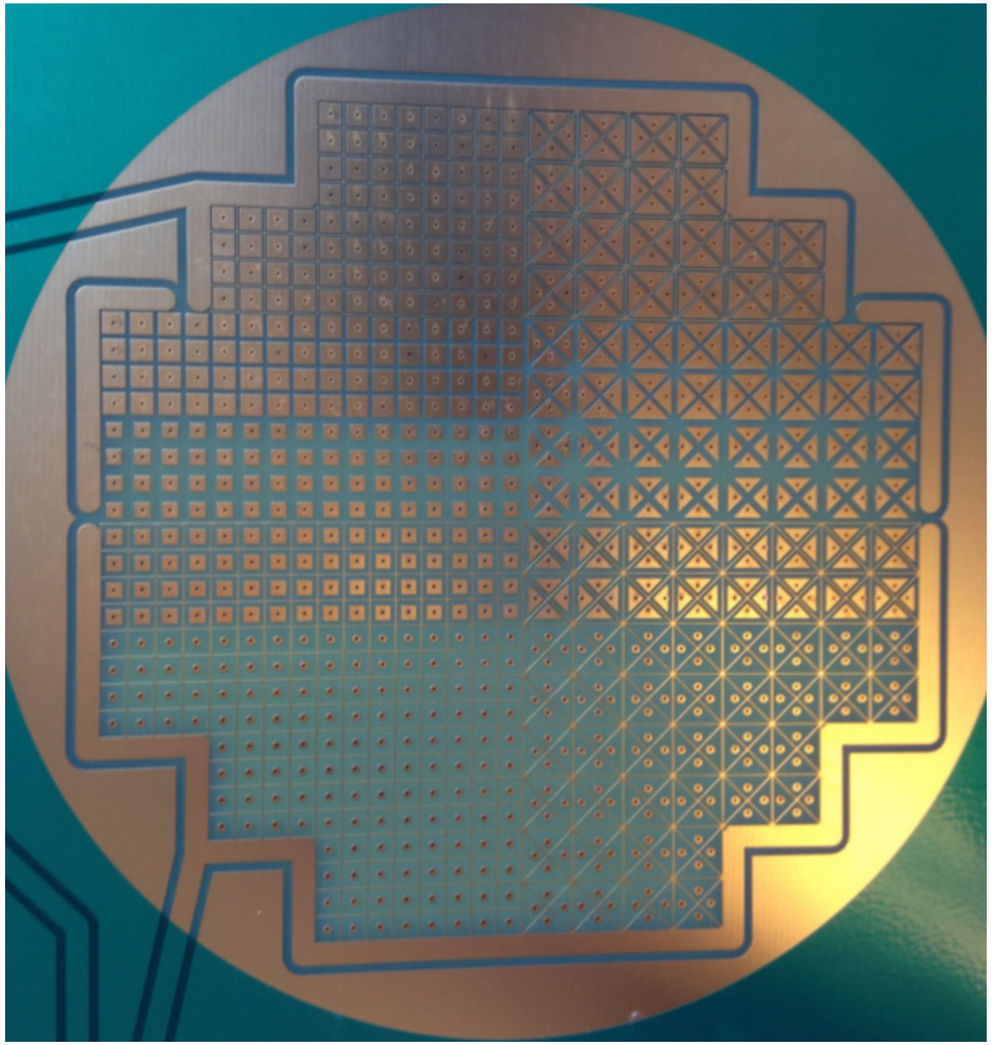
(See Jonathan’s talk)

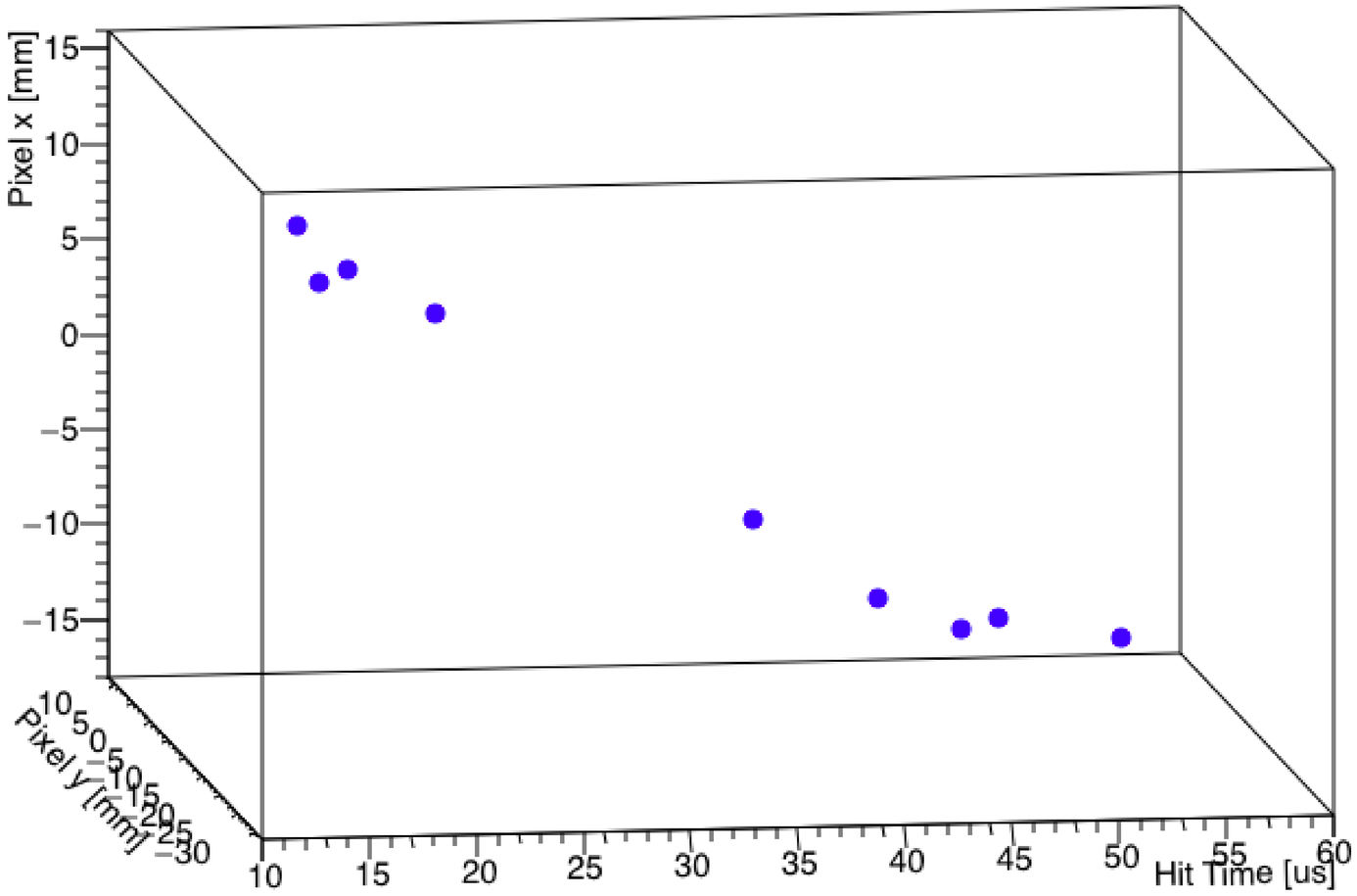




Initial bespoke pixel ASIC (LArPix) tests at LBNL have been successful.

(See Dan's talk)





...pixels are feasible!

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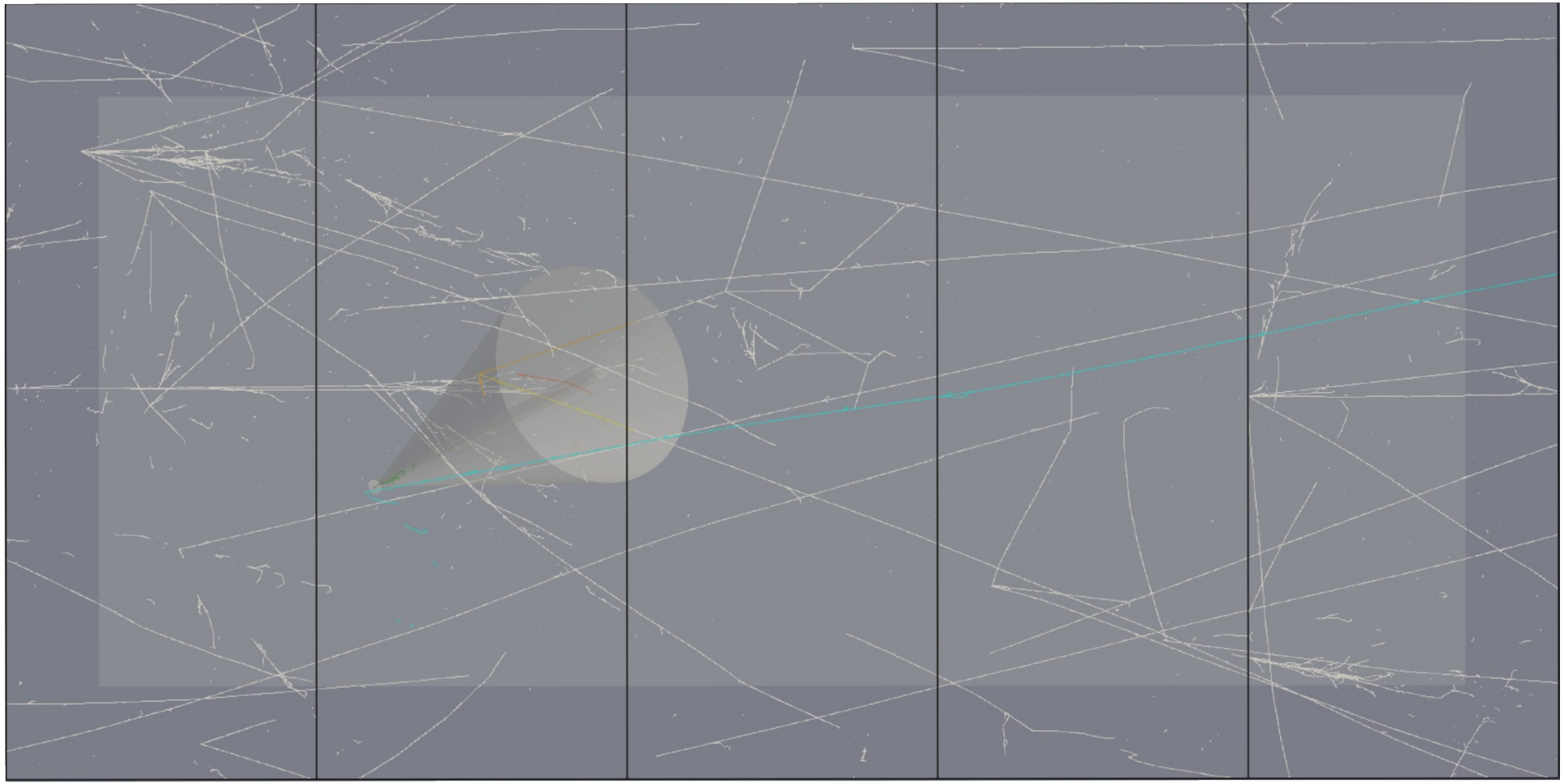
Can ArgonCube Handle the High Rate?



Argon_Box simulation of single 2 MW beam spill in (old) 3x5 ArgonCube geometry.
At 0.2 events/t/spill occupancy is < 1%, assuming 3 mm pitch.

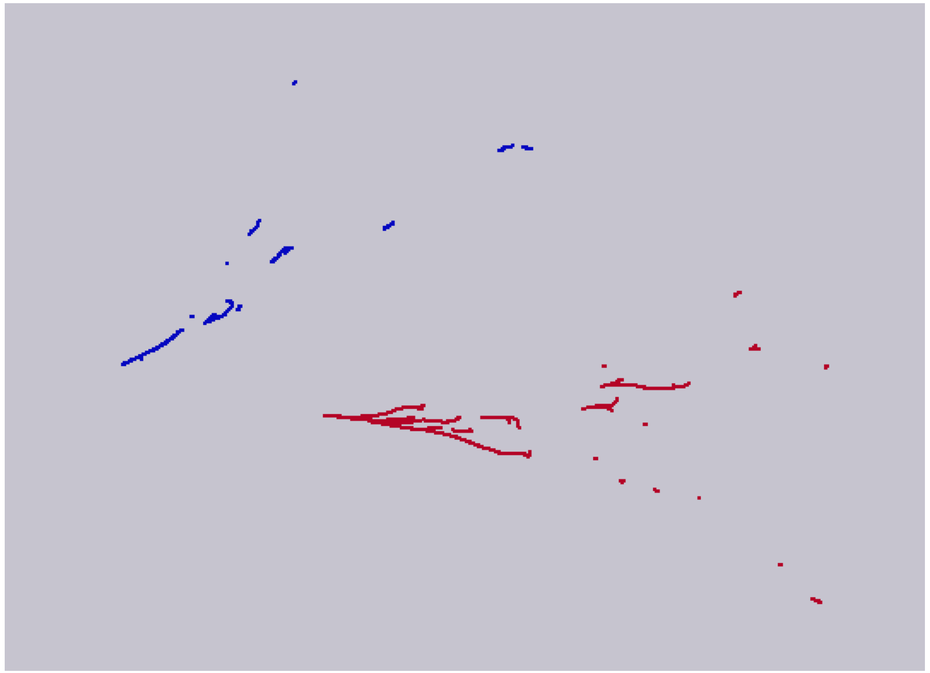
π^0 Reconstruction; a Metric of Handling the High Rate

LArTPC should be good at resolving π^0, but it is not easy with a wire readout.

Assuming a pixel readout, π^0s can be distinguished to a high precision by reconstructing particles within a 3D cone.

Damian showed:
Piled-up (misidentified) deposits have a mean error of 2 % to 3 %.
For > 50 % of the neutrino events containing π^0s this error is < 0.1 %.

(see Chris' talk)



$\pi\pi^0$ decay in LAr, simulated in Argon_Box

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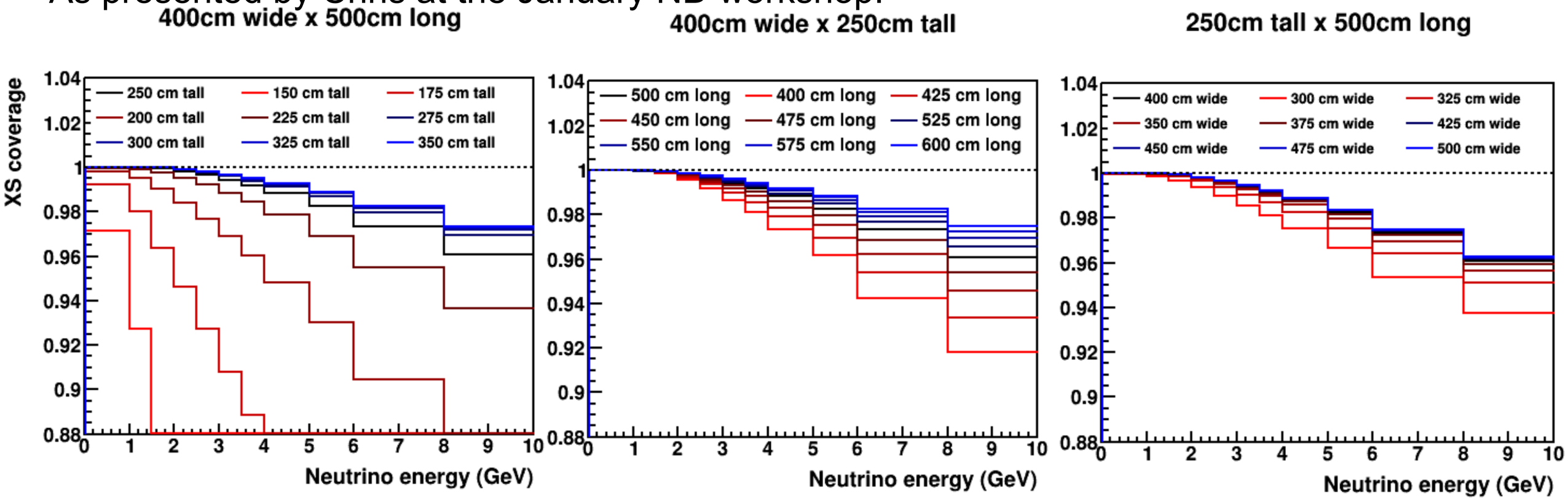
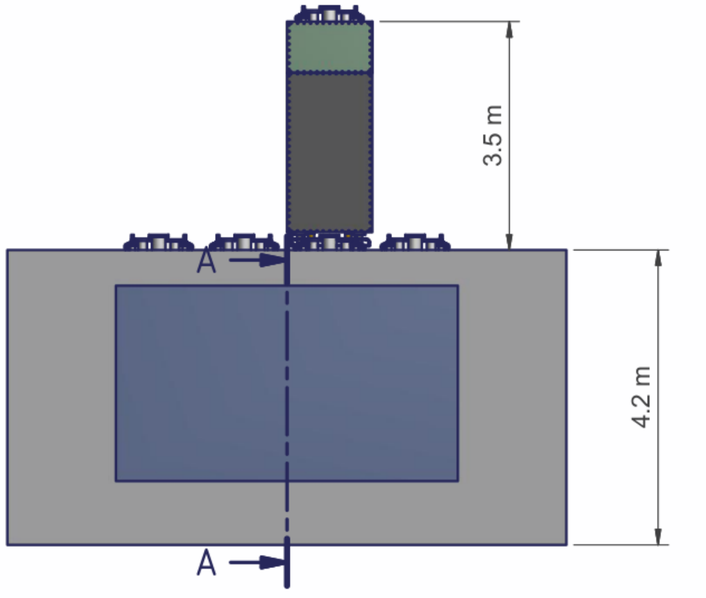
Optimal Dimensions Hadron Containment

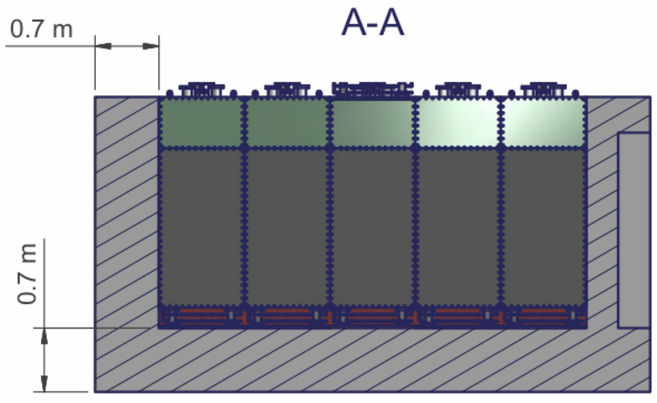
As presented by Chris at the January ND workshop:

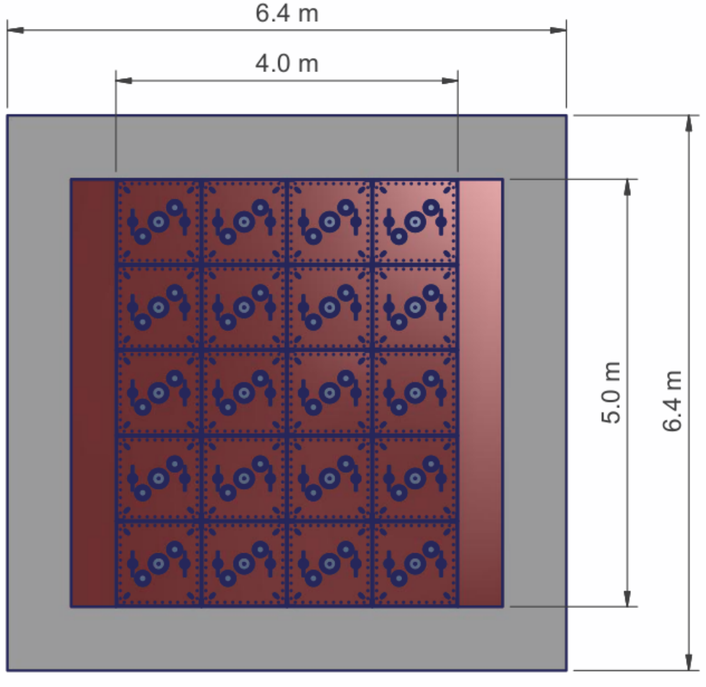


Reasonable efficiency across a wide range of kinematics
No phase space with zero acceptance
>95% hadron containment (non-neutrals)

3 m tall x 5 m long x 4 m wide



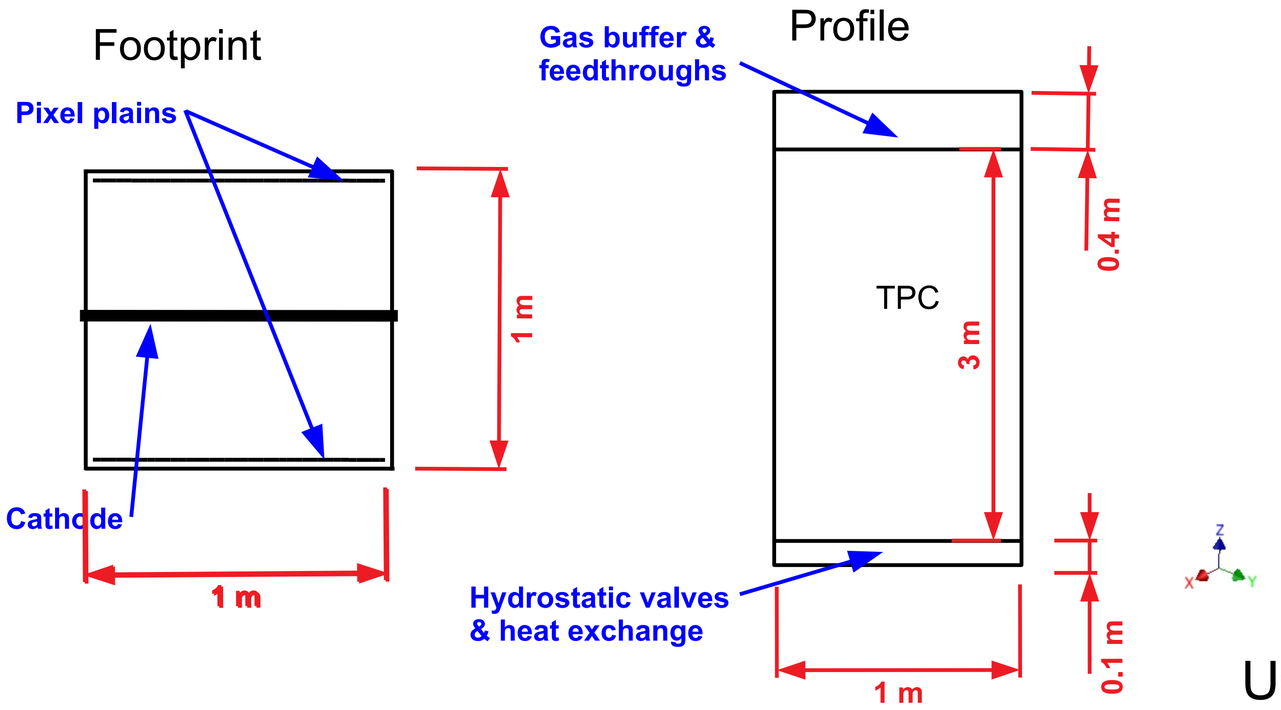


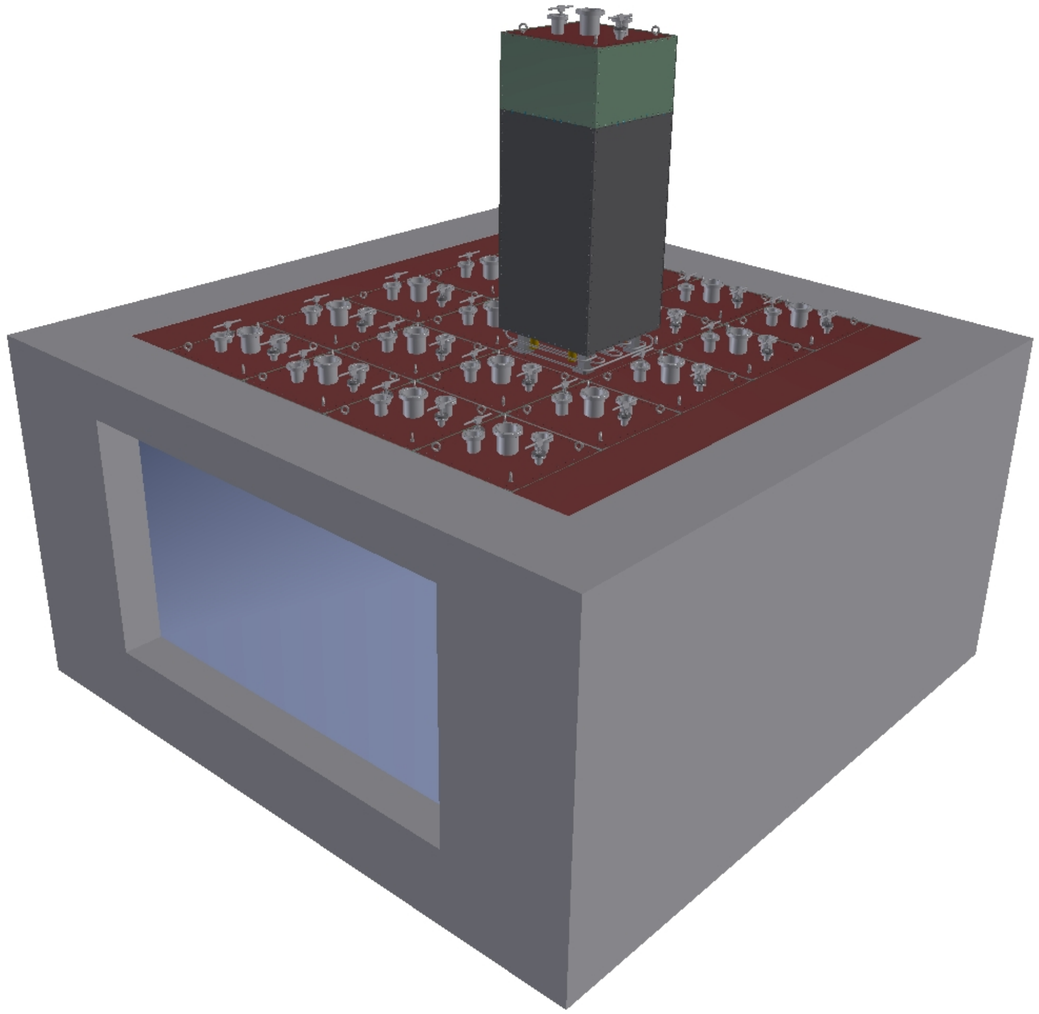


Pos.	Anz.	Nummer		Gegenstand		Material	Bemerkungen
				A3	Datum	Name	
				Gez.	3/14/2018	rohaenni	
				Freig.			
				Gewicht:			
				LABORATORIUM FÜR HOCHENERGIEPHYSIK LHEP UNIVERSITÄT BERN		Assembly_ND	Ausgabe / Blatt Nr. 1 von 1 / Massstab
Aus-gabe	Änderung	Datum	Name	Zusammenst. Nr.:		Ersatz für:	Ersetzt durch:

Detector Dimensions

4 x 5 modules (longest in beam)
Each module: 1 m x 1 m x 3.5 m (50 cm drift, 50 kV)
Active volume: ~ 5 m x 4 m x 3 m ~ 80 t active, 25 t FV
At 3 mm pixel pitch:
3.3×10^5 pixels per plane
1.3×10^7 pixels





Using the FNAL cryostat described in DocDB 6652

Requests from DUNE (To be answered by March ND workshop)

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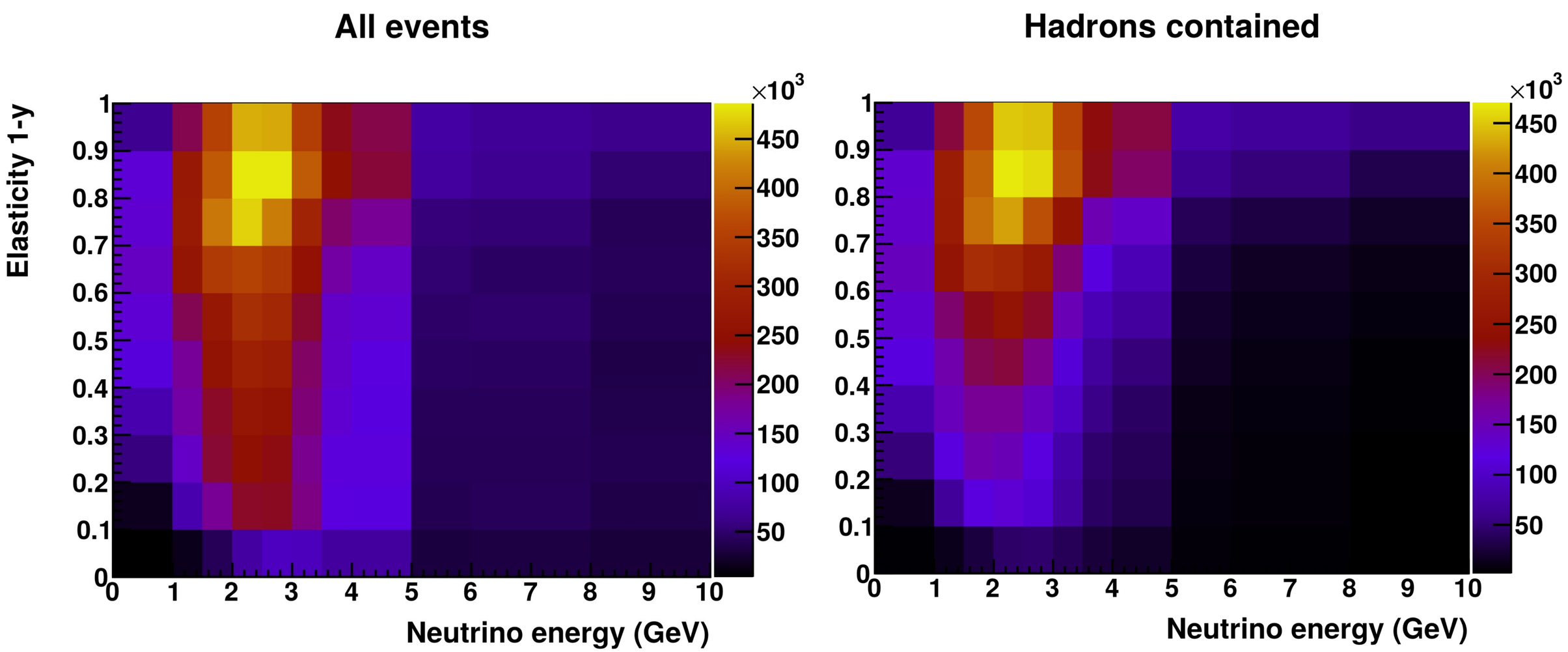
Statistics in the 25 tonne FV per Year



Rates are per bin. 37M total events per year in 25 t FV, FHC at 1.07 MW.

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Hardware Tasks

Field cage:

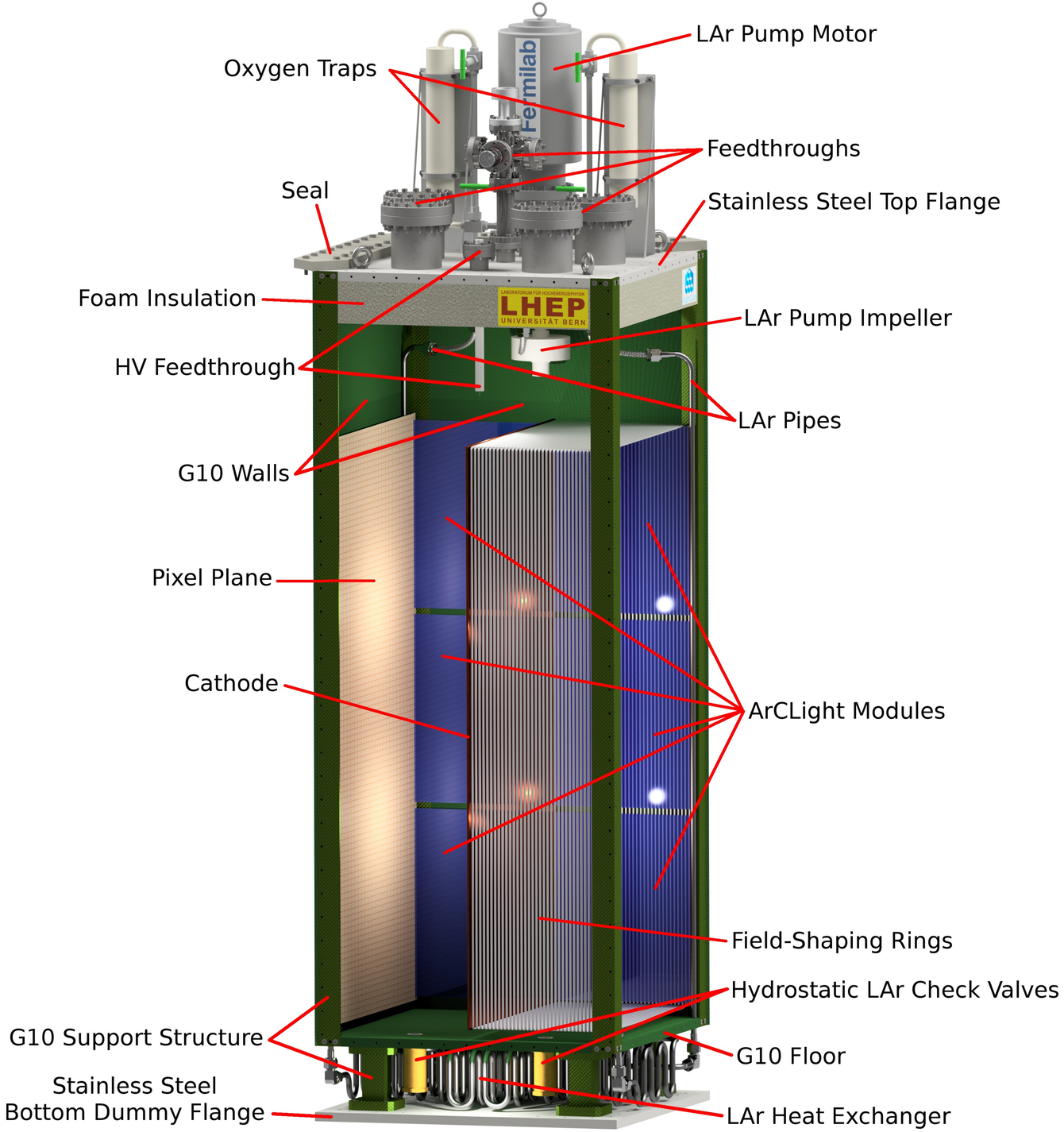
Resistive plane or PCB
Combined with ArCLight

Unambiguious pixel readout:

Production and RO of large area

Cryosystem

Infrastructure & slow control
Filter design
B-field tolerence



Hardware Status and Outlook

April:

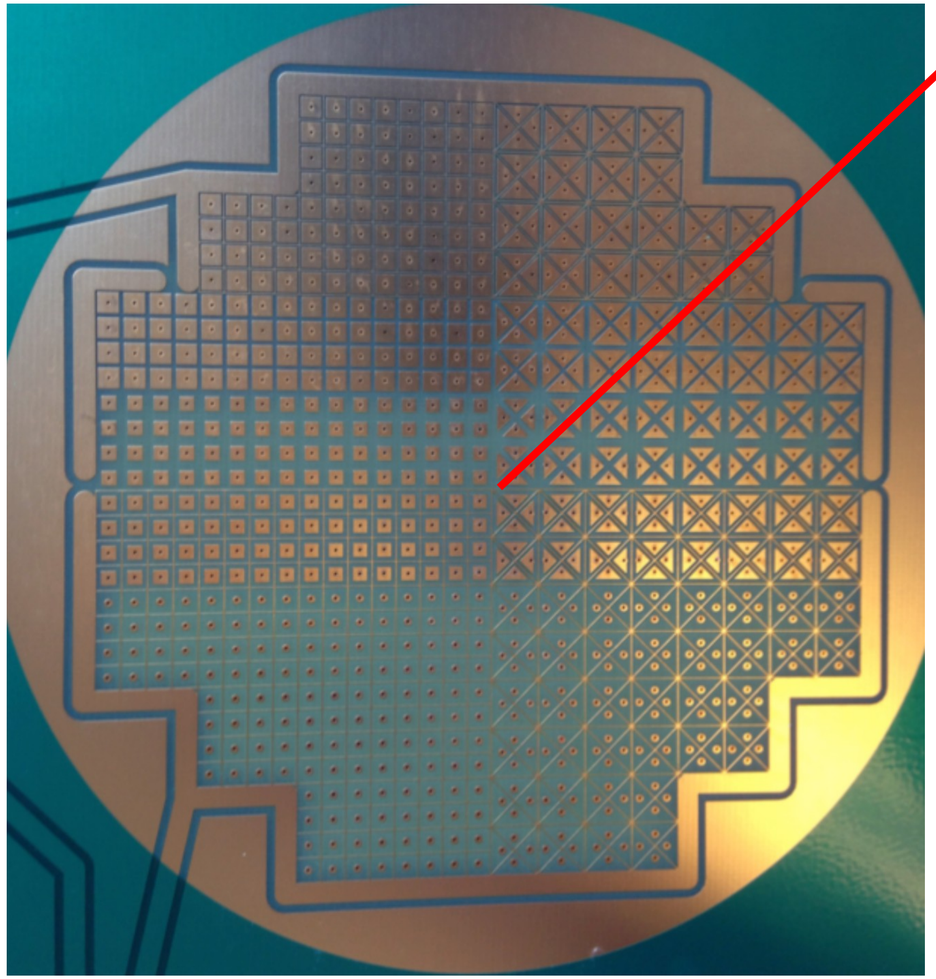
LArPix into the Bern 60 cm Pixel demonstrator TPC.

Implement track reconstriction on PixLAr data.

Optimize ArCLight production techniques.(arXiv:1711.11409)

Prototype resistive plane field cage.

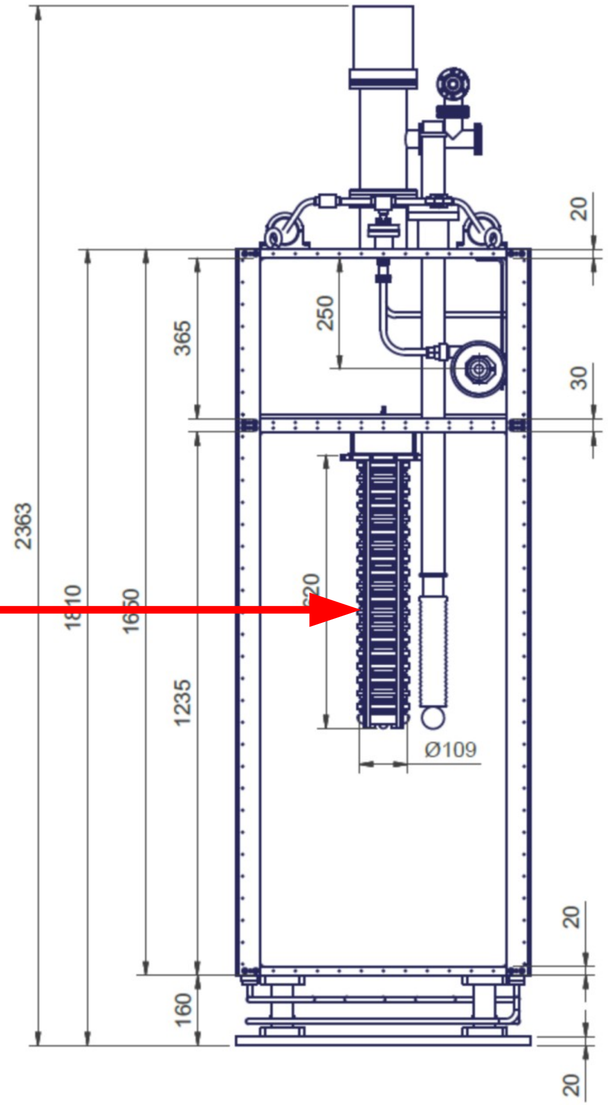
Optimize cryo components.



Hardware Status and Outlook

March:

Instrument and deploy purity module in 2x2 cryostat

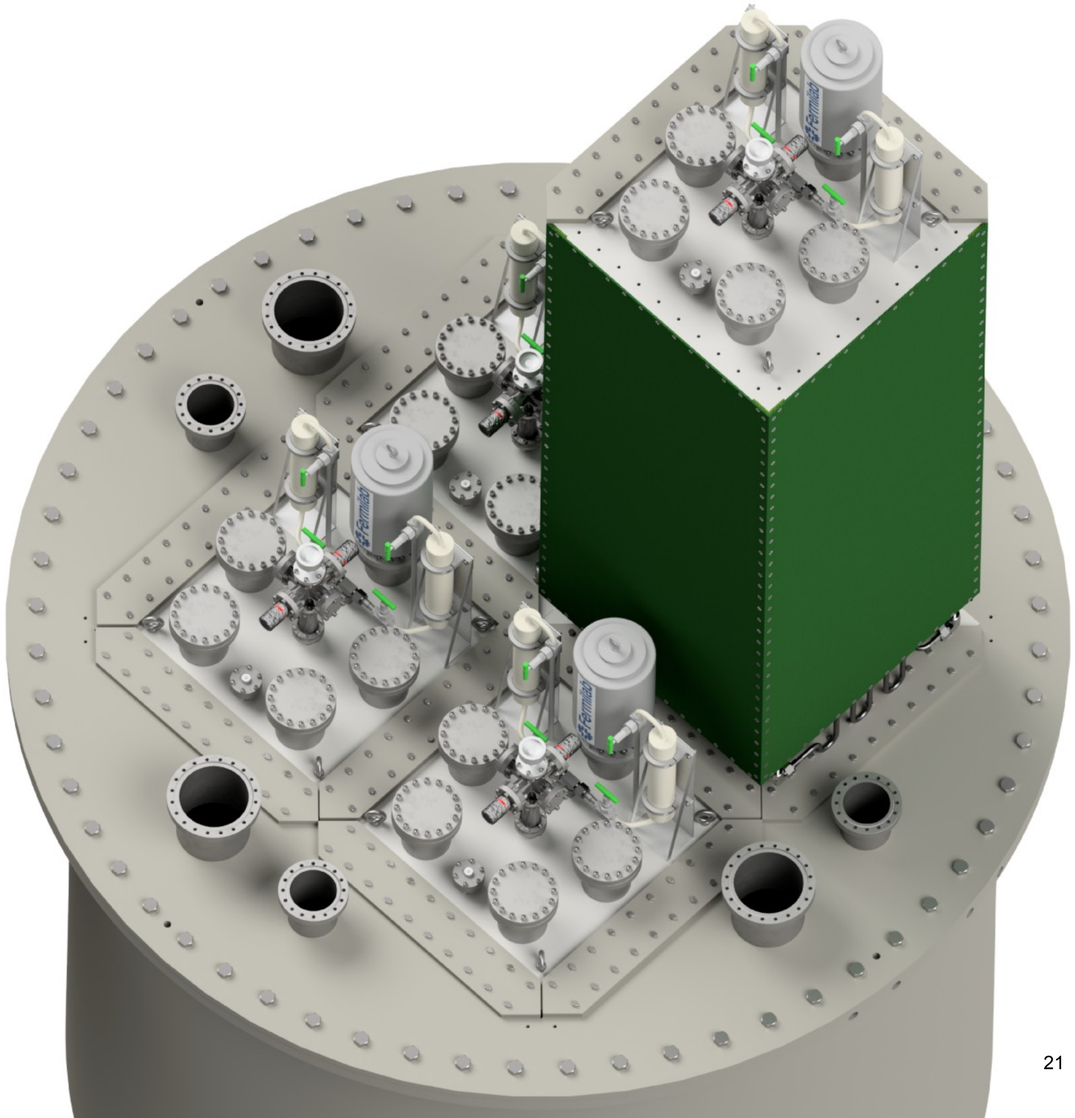


Hardware Status and Outlook

Summer 2018:

Construct the first ArgonCube module with central cathode and large area pixel readout.

With a mid to long term plan of moving the 2x2 into neutrino beam at FNAL



Summary

The working group has answered the collaboration's questions, and in doing so shown a LArTPC is feasible for the DUNE ND.

Simulations and R&D are progressing considerably given the resources. However, to increase effort we need more people and more funding. For which, a strong statement of intent from DUNE is required.