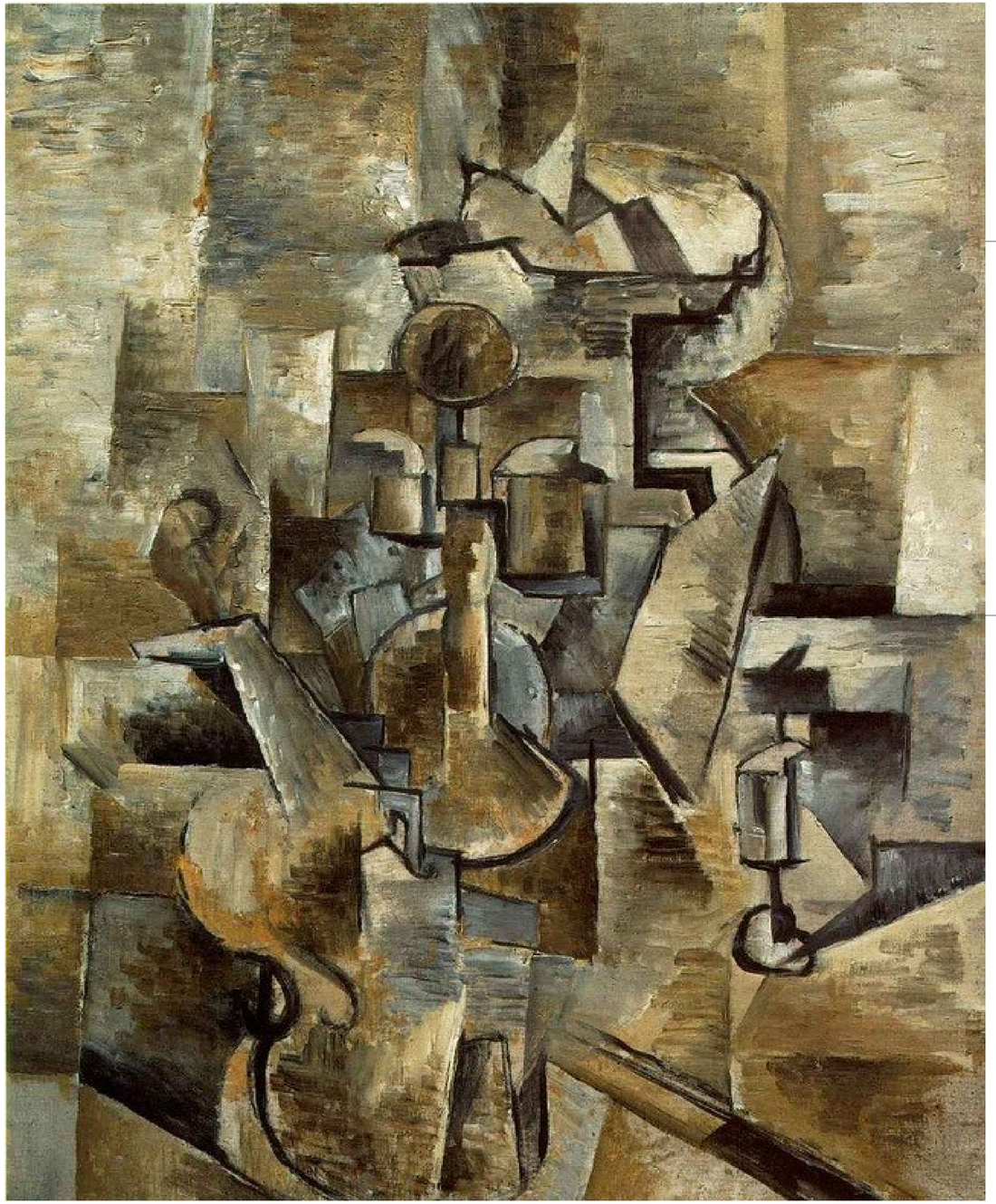


Braque’s Violin and Candle Stick, Paris 1910

ArgonCube

UNIVERSITÄT BERN

AEC ALBERT EINSTEIN CENTER FOR FUNDAMENTAL PHYSICS

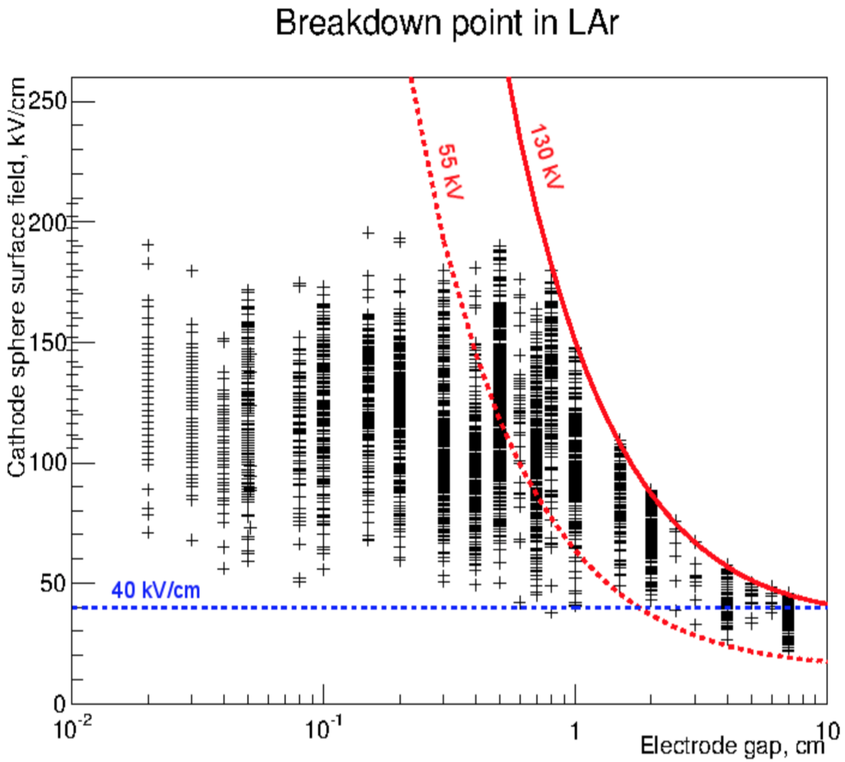
ArgonCube Landscape

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

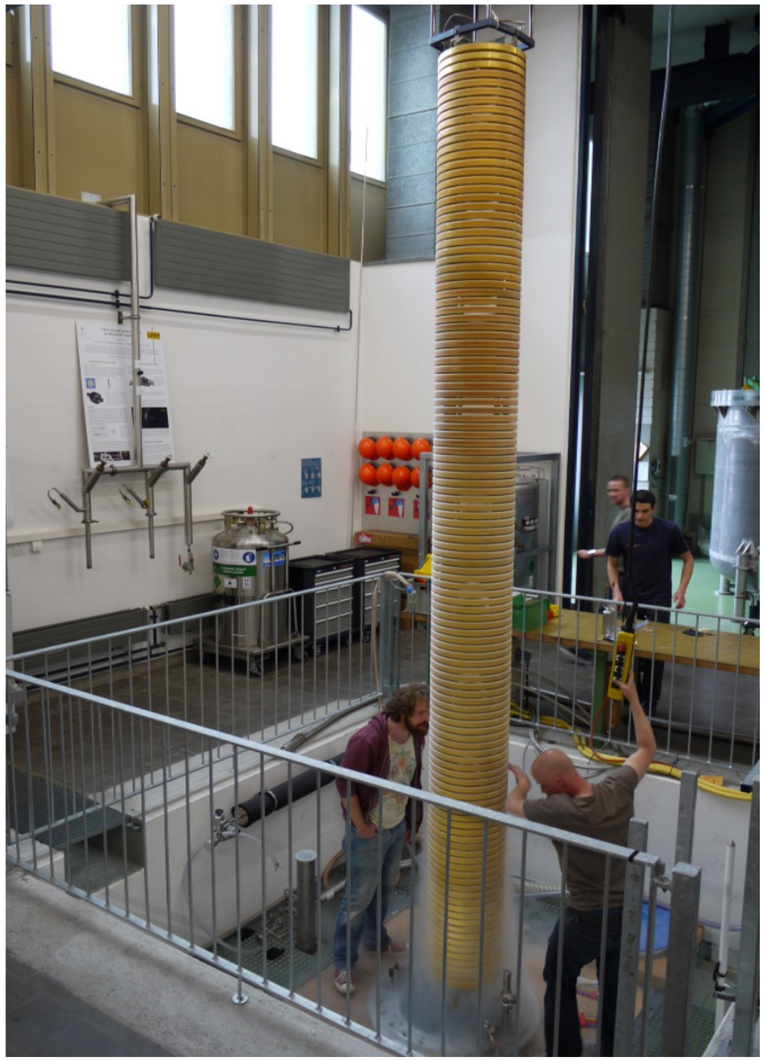
Collaboration meeting
Bern, June 2018
James Sinclair, LHEP

In the Beginning there was ArgonTube

The 5 m TPC was built to investigate the problems involved with large drift distances.



HV was found to be problematic, with breakdowns at ~40 kV/cm.



ArgonTube in Bern

How to Avoid Very High Voltages?

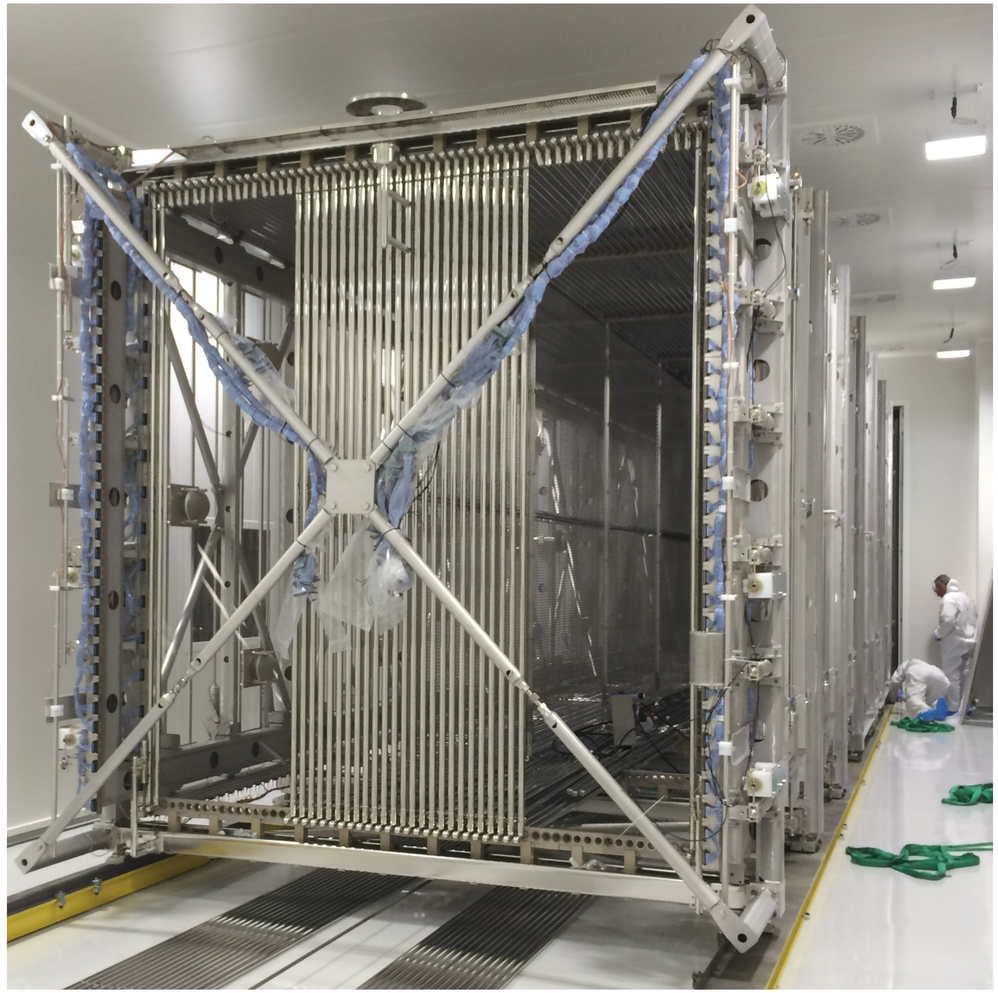
Segment the detector into a number of self-contained TPCs (modules) sharing a common cryostat. Like ICARUS, only more TPCs, and isolated.

Shorter drift distances:

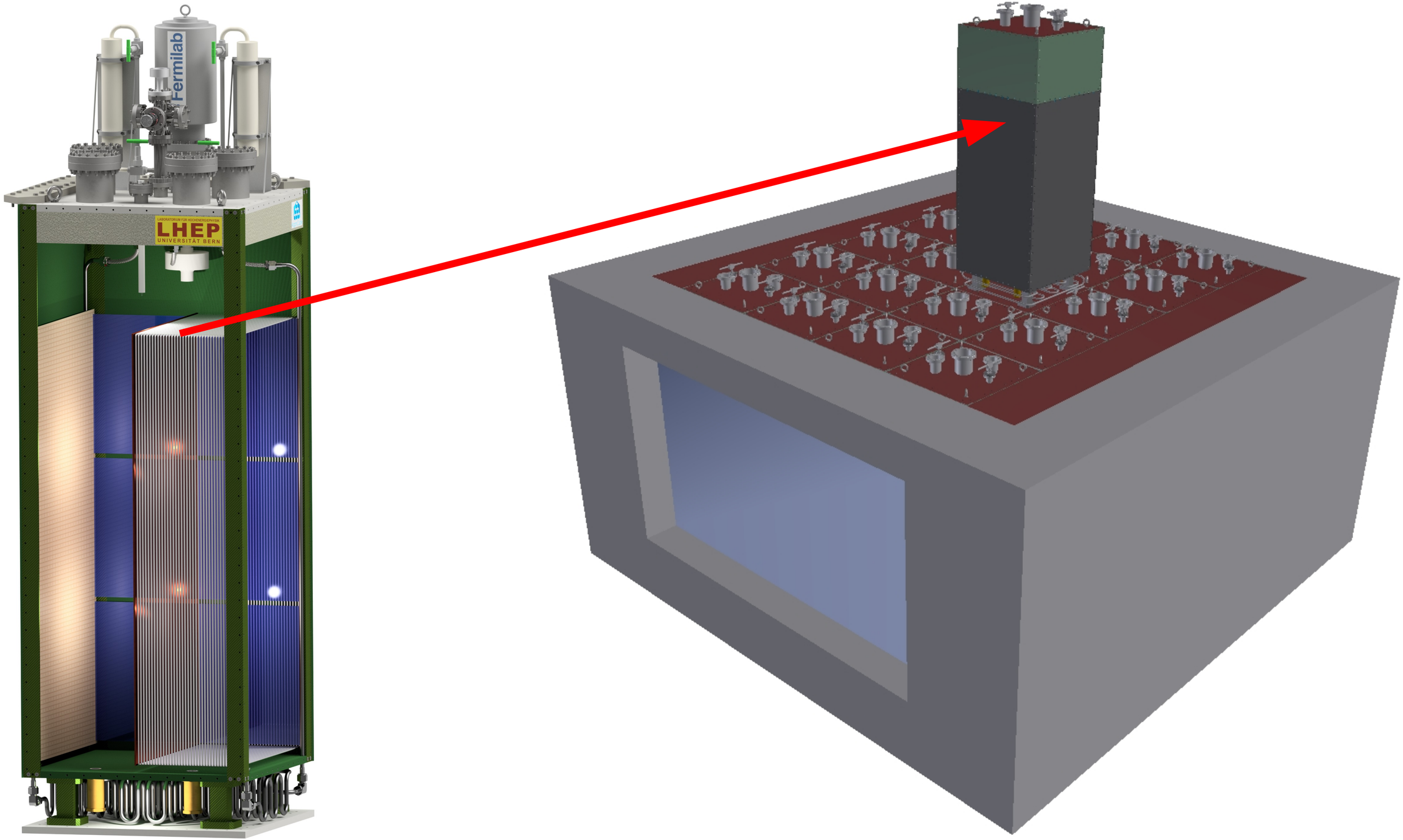
- Reduced cathode voltage for same field
- Reduces stored energy (parallel plate capacitor)
- Less stringent purity requirements
- Shorter readout times = less pileup

Self-contained:

- Isolated from contaminated LAr
- Minimal downtime for upgrade or repair
- Contained scintillation light = fast timing! (See Patrick's talk)



Two TPCs are separated by a central cathode in an ICARUS module



Cut-away illustration of an ArgonCube module, and an array of modules in a common cryostat (N.B. Modules will be sealed.)

Module Requirements

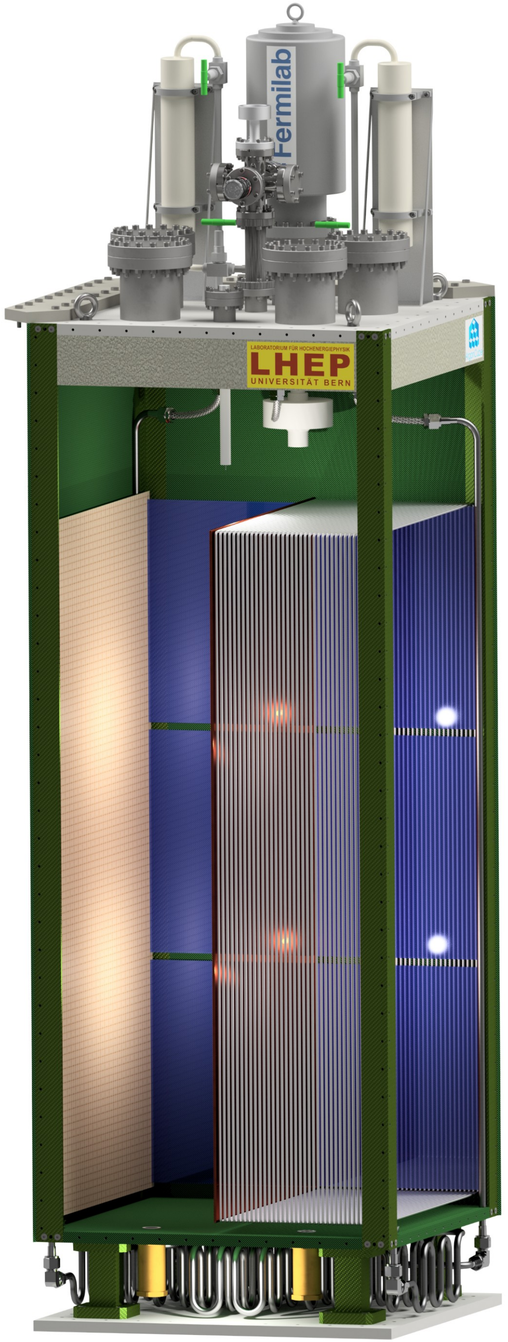
Transparent to tracks:
LAr
- Radiation length = 14.0 cm
- Hadronic interaction length 83.7 cm

G10 structure
- Radiation length = 19.4 cm
- Hadronic interaction length 53.1 cm.

Minimise all material in surrounding active volume.

Light readout:
Compact (thin), dielectric, and large area coverage

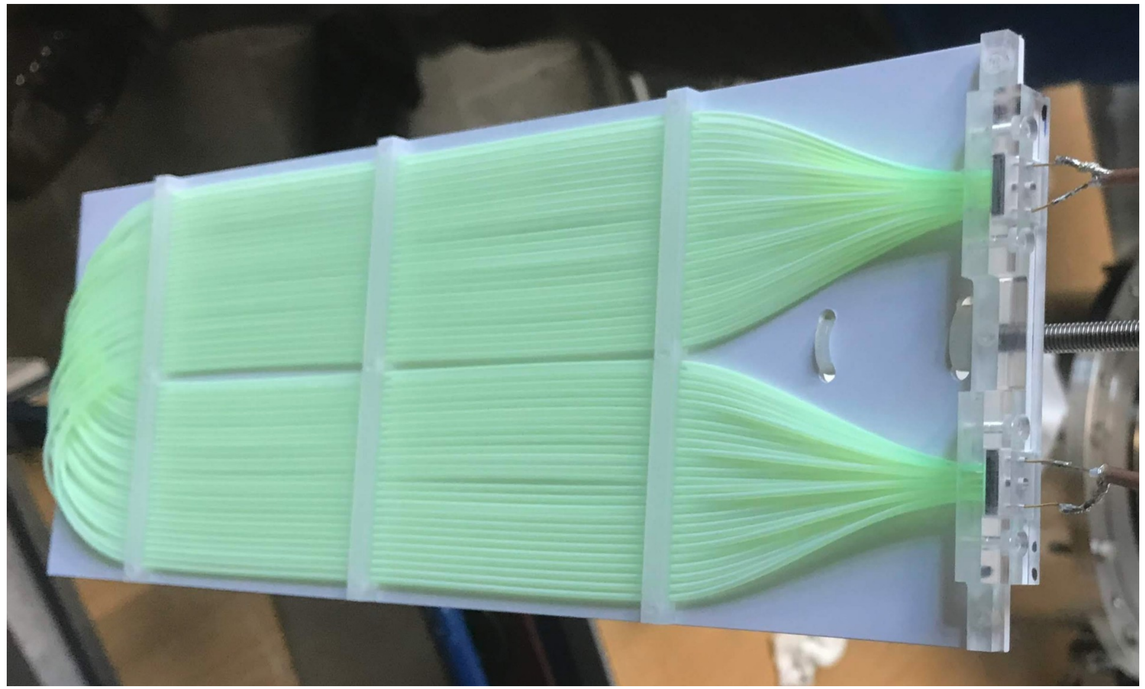
Charge readout:
Compact, mechanically robust, and unambiguous



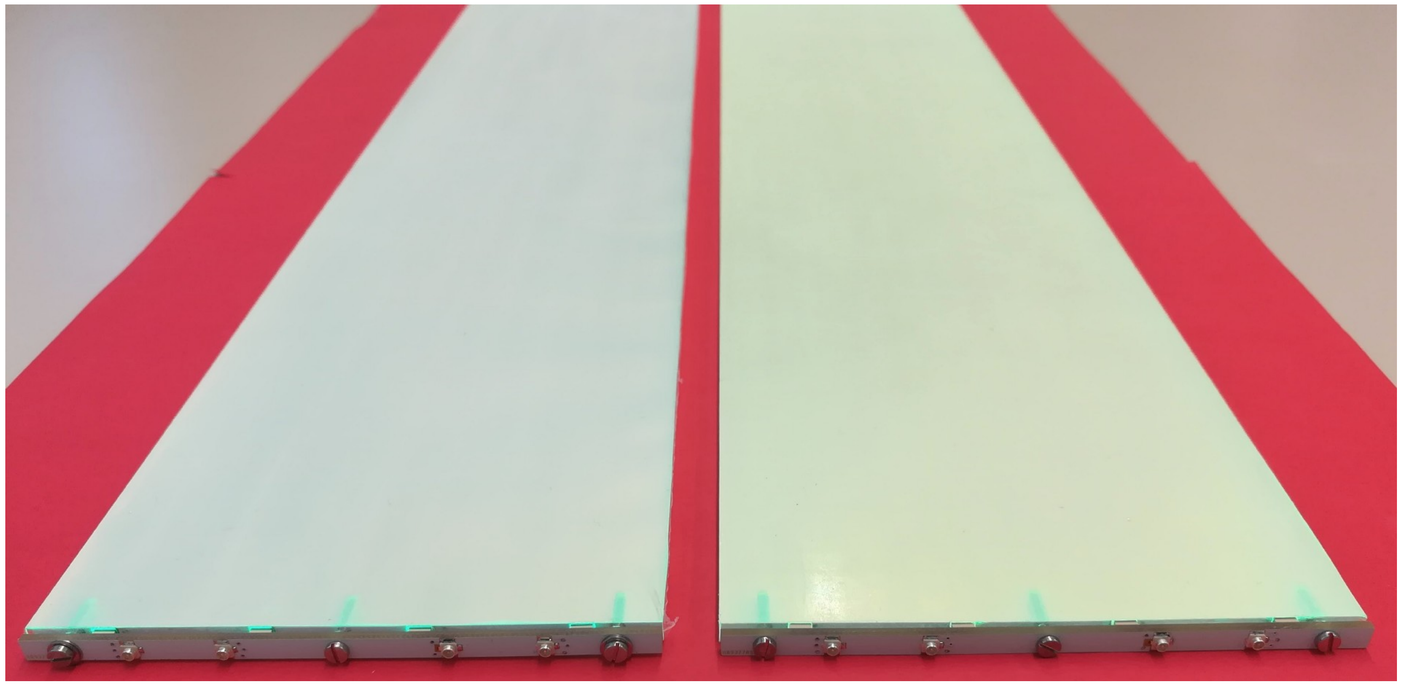
Cut-away illustration of an ArgonCube module

Light Readout

Two complimentary SiPM-based systems currently being developed:



Dubna’s LCM, TPB coated WLS fibres. (See Alexandr’s talk)



Bern’s ArCLight, TPB coated dichroic film on WLS plastic. (See Igor’s talk)

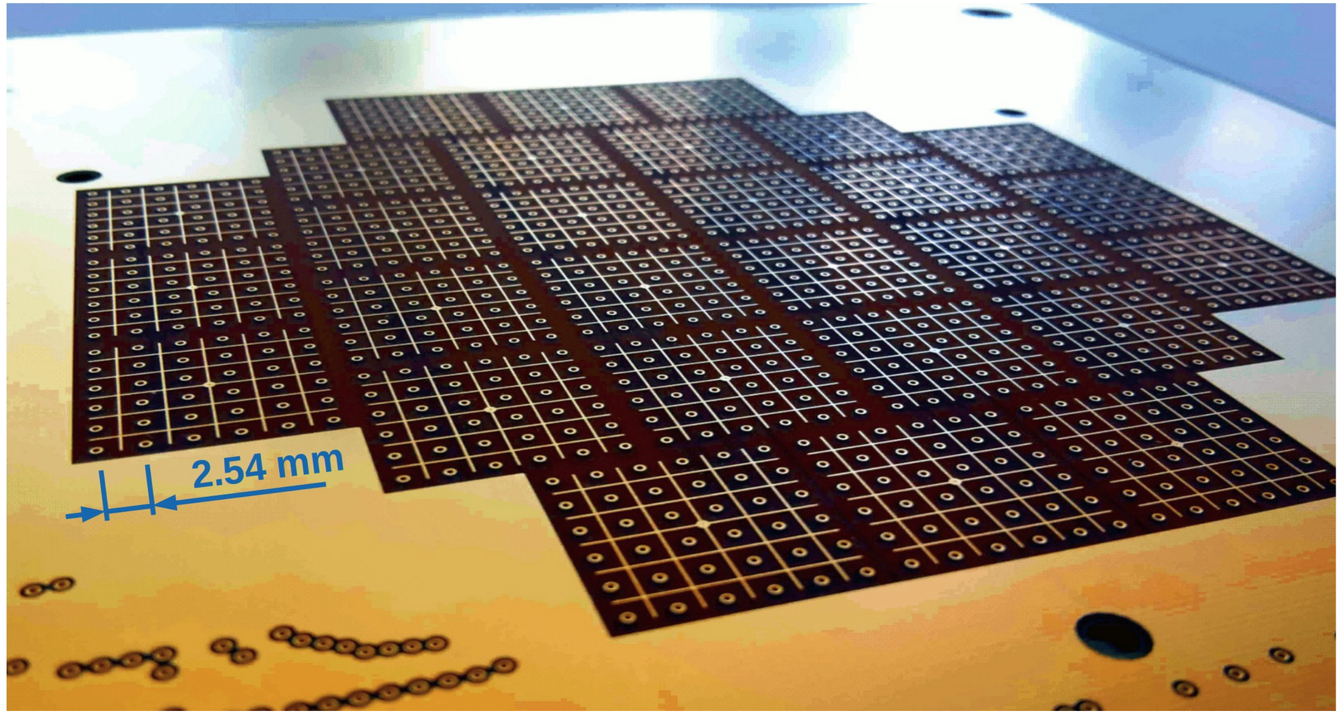
Charge Readout

Pixelated charge readout enables true 3D tracking capabilities of LArTPCs, allowing them to operate in high-multiplicity environments.

The first pixel readout LArTPC was operated in Bern in summer 2016, and spring 2017.

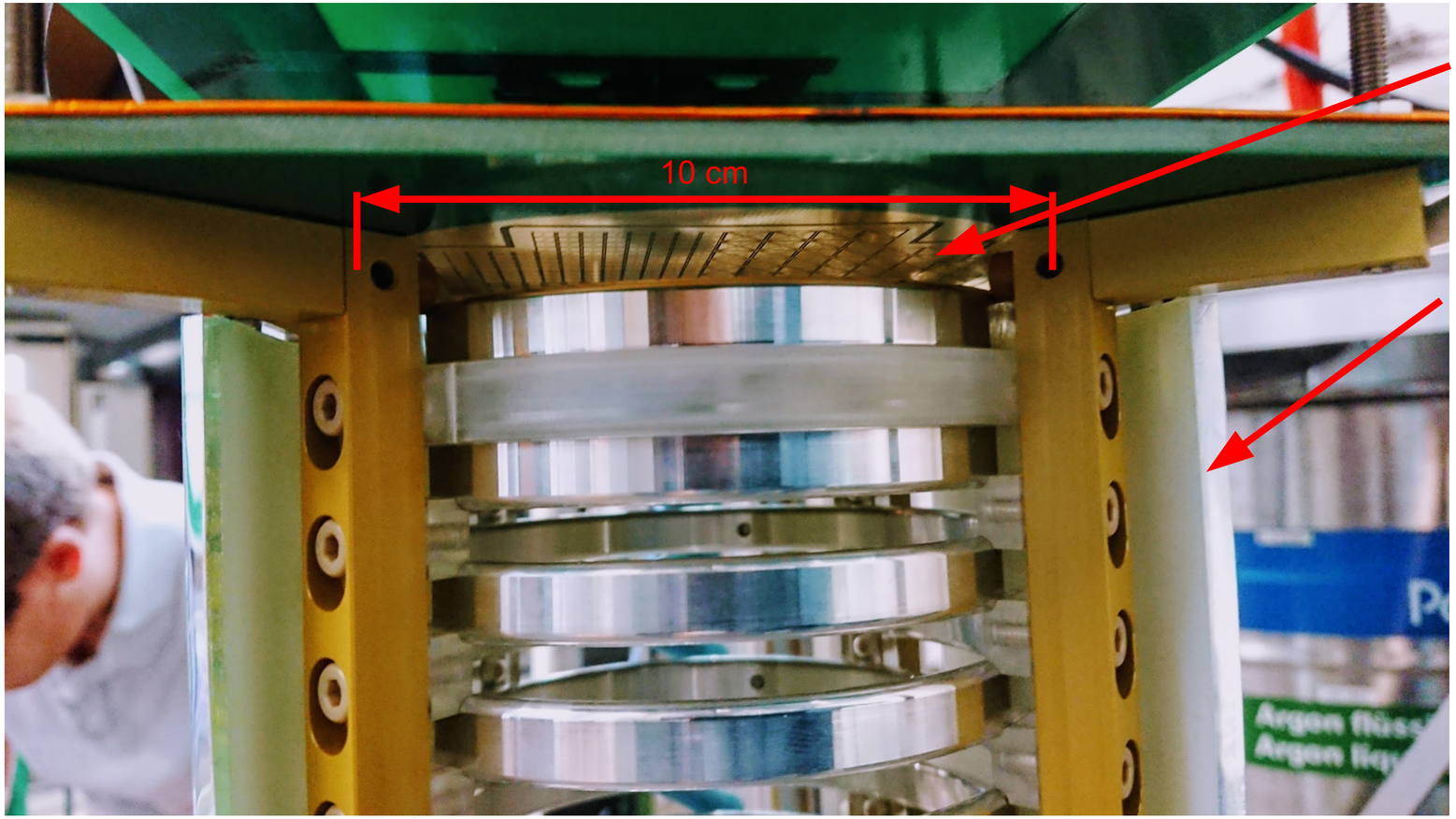
In winter 2017 a pixel plane was installed in LArIAT, PixLAr, and operated in a test beam (See Hunter's talk).

In spring 2018 LBNL's bespoke pixel ASICs, LArPix, enabled native true 3D readout (See Dan's talk).

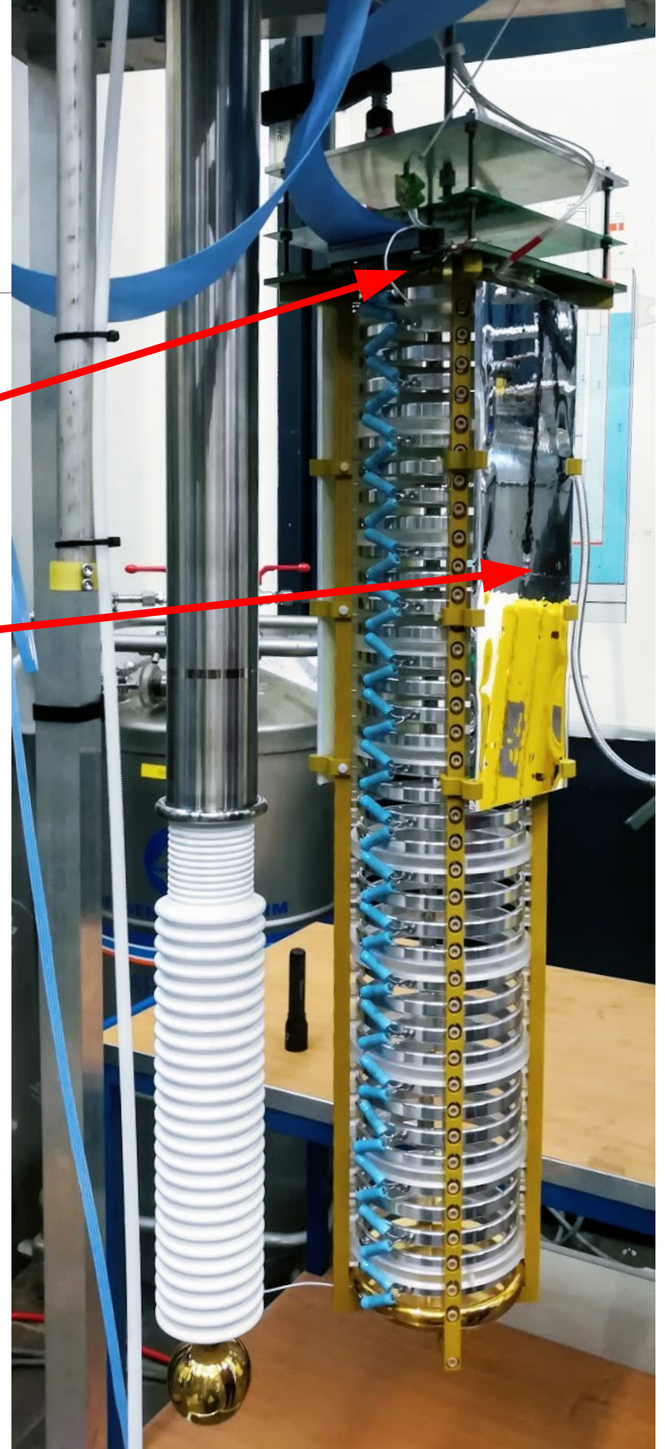


Initial pixel prototype, Bern July 2016

Pixelated Demonstration



Pixelated demonstration TPC in Bern (See Roman’s talk)



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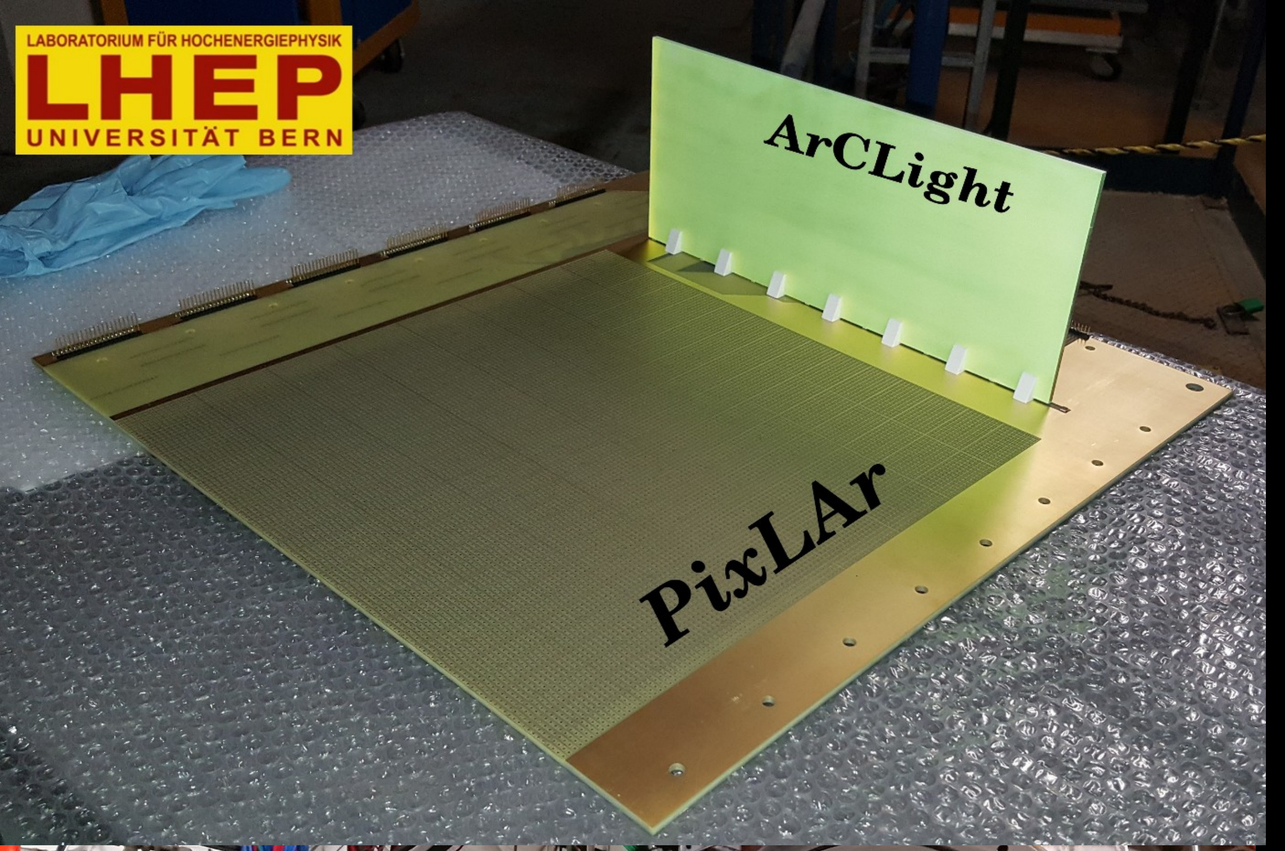
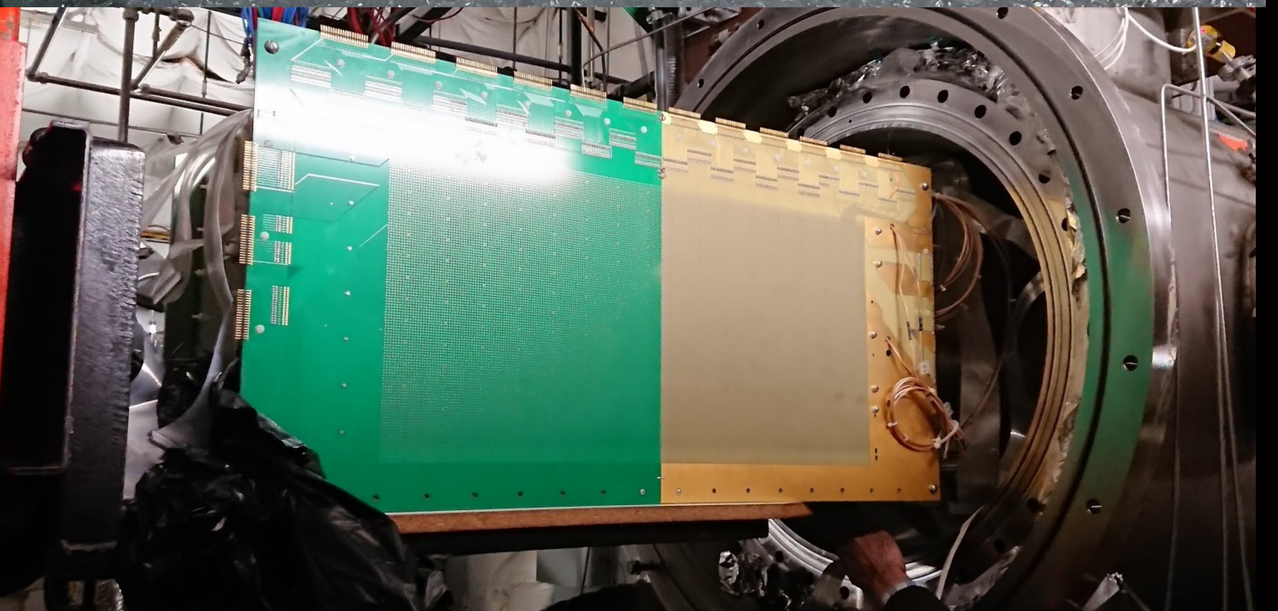
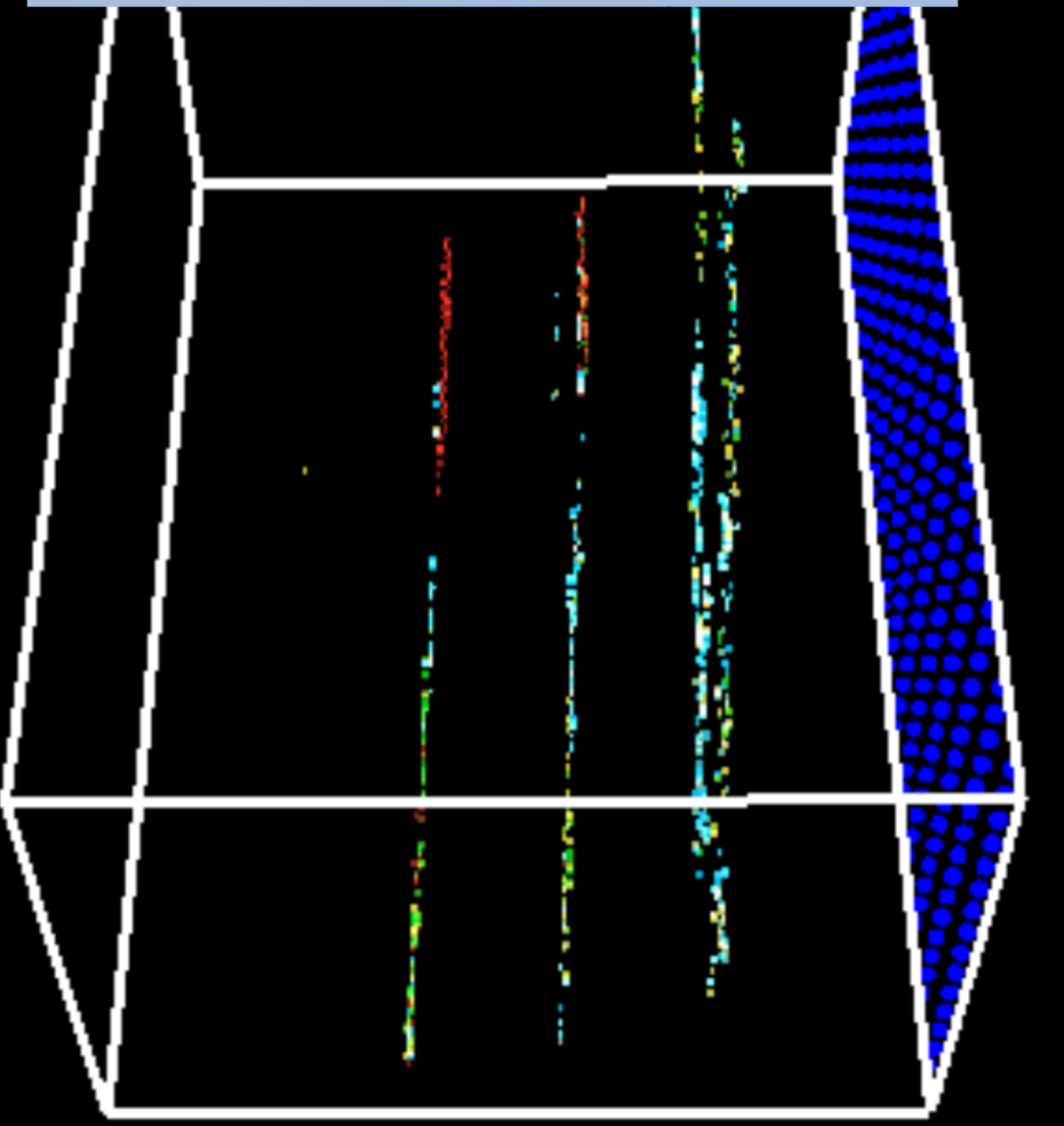
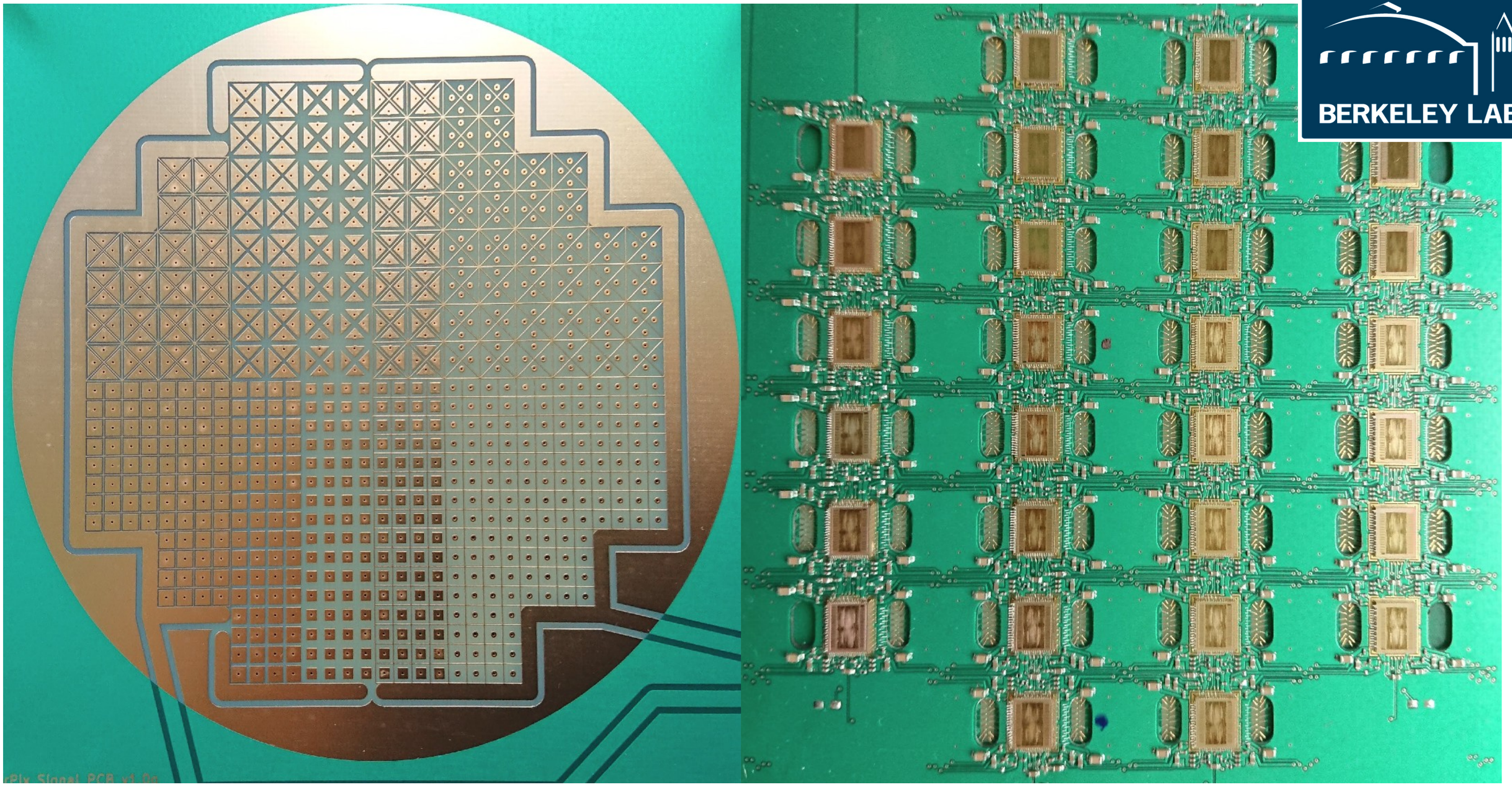




PIXLAR

Pixel Liquid Argon Experiment





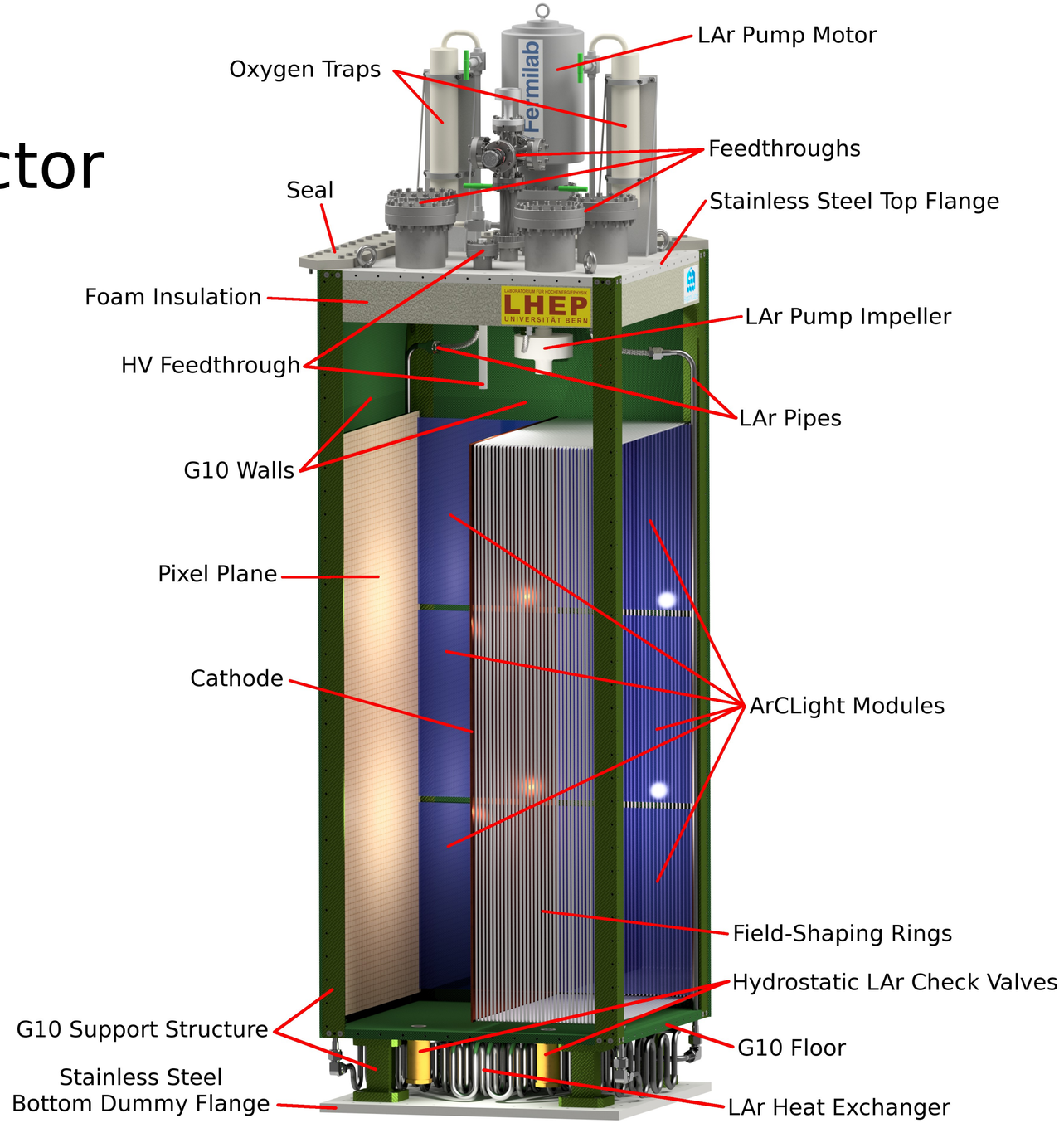
LArPix equipped pixel plane operated in Bern in April 2018

Towards an ArgonCube Detector

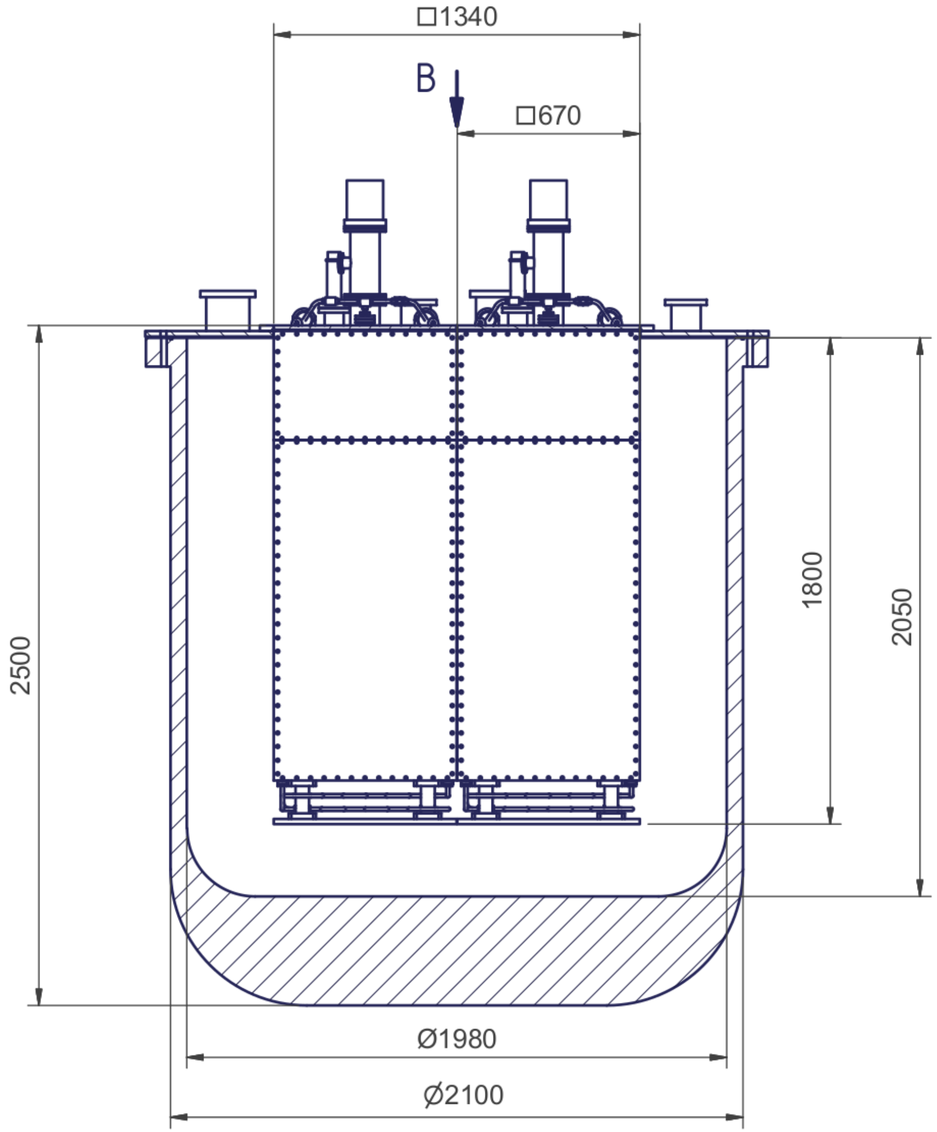
All technologies required to produce an instrumented ArgonCube module have now been demonstrated.

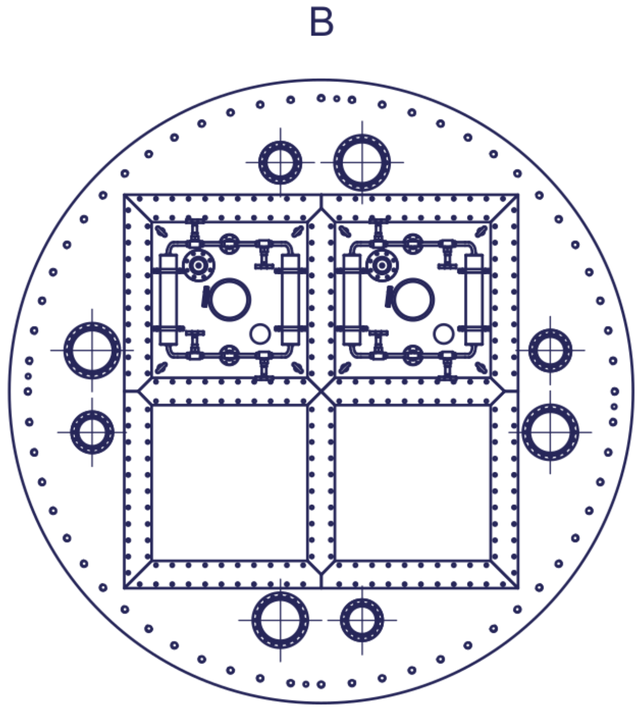
Work is now under way to scale up the various technologies, and source suppliers for the 2x2 module demonstrator.
(See Francesco’s talk)

Physics studies within the DUNE Near Detector working group are being used to optimise the design for deployment in the DUNE ND. (See Chris’s talk)



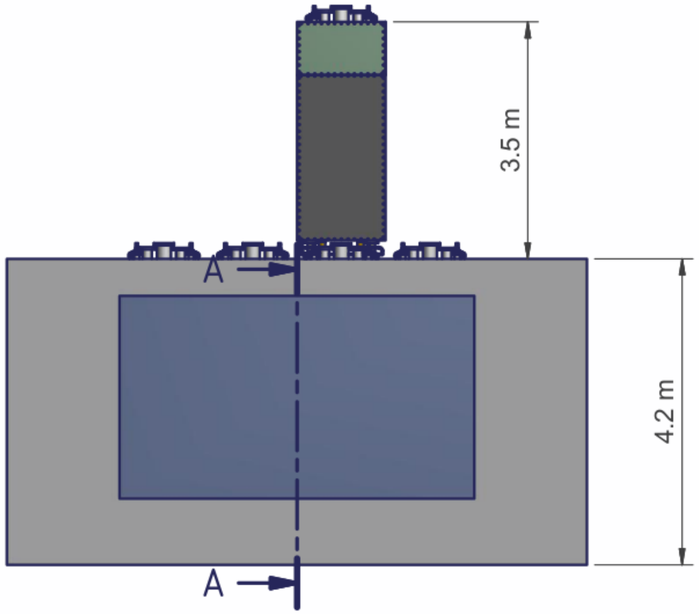
Cut-away illustration of an ArgonCube module

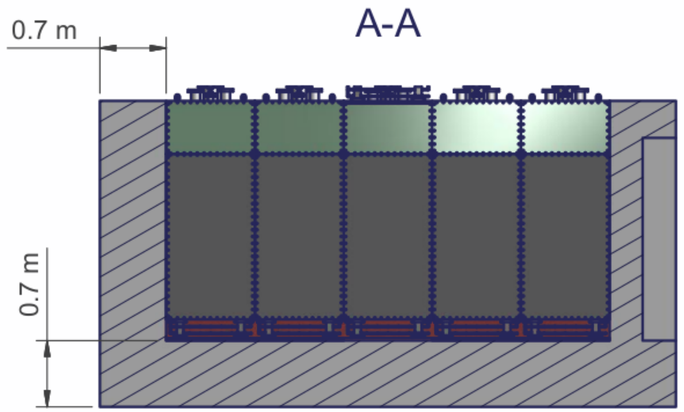


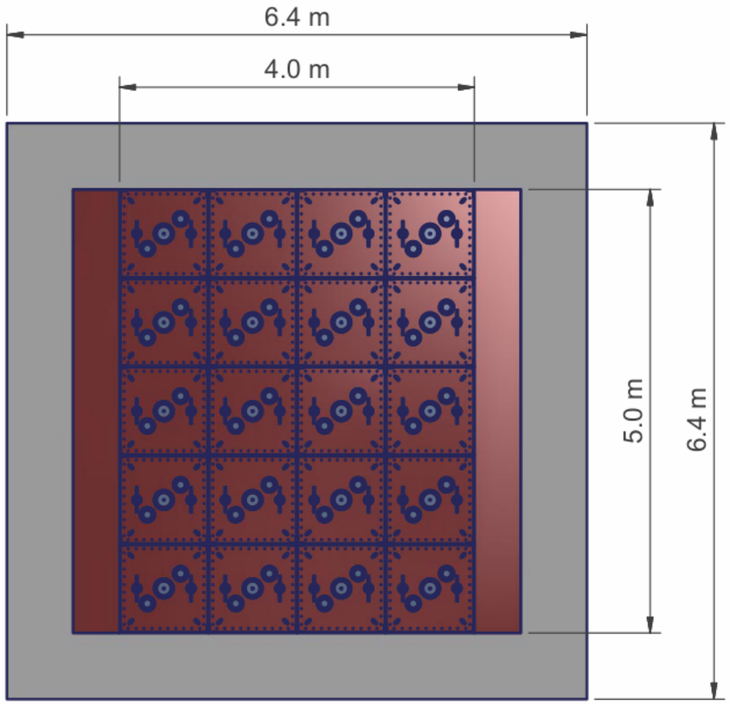


The 2x2 prototype, due to be deployed in beam at FNAL in 2019.
(See Callum's talk)

Pos.	Anz.	Nummer	Gegenstand	Material	Bemerkungen
			A3 Datum Name		
			Gez. 6/8/2018 rohaenni		
			Freig.		
			Gewicht:		
			LABORATORIUM FÜR HOCHENERGIEPHYSIK LHEP UNIVERSITÄT BERN	ArCube_Phase1_2	Ausgabe / Blatt Nr. 1 von 1 / Massstab
Aus-gabe	Änderung	Datum Name	Zusammenst. Nr.:	Ersatz für:	Ersetzt durch:





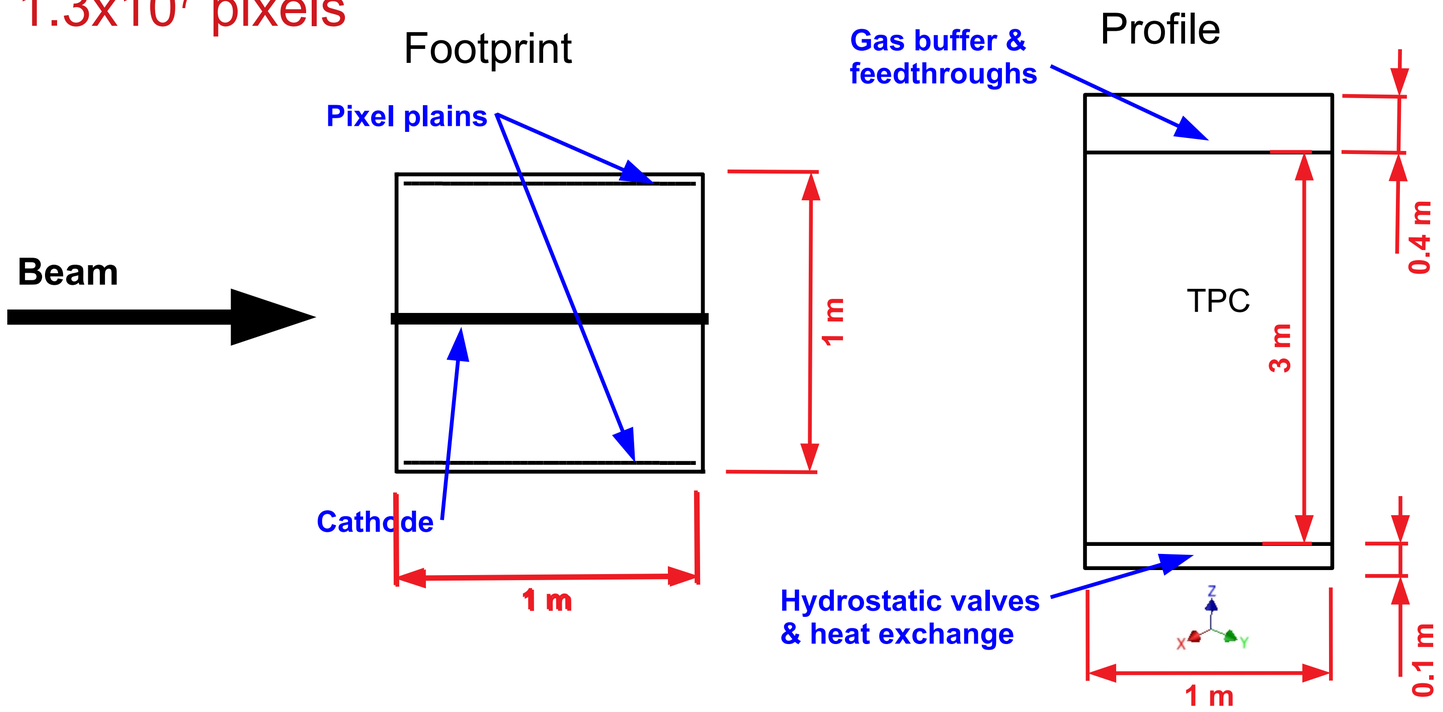


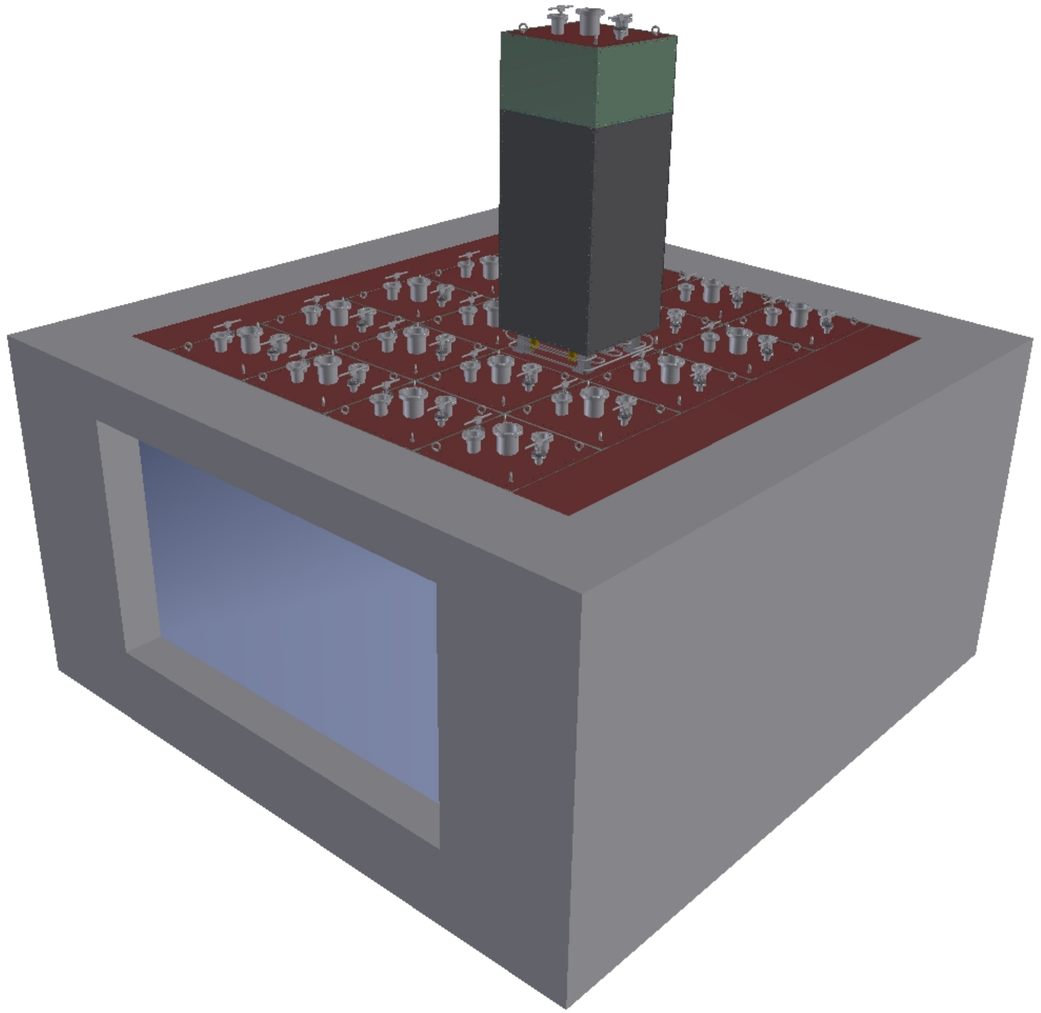
The 4x5 geometry optimised for the DUNE ND. (See Chris' talk)

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:

DUNE Near 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





FNAL low-density cryostat, with beam window

Recommendations of the DUNE ND Working Group

“The ND CD group recommends that DUNE should have a LArTPC that is optically segmented, with a short drift and 2D pixelized readout, like the concept under study by the ArgonCube collaboration.” March 2018