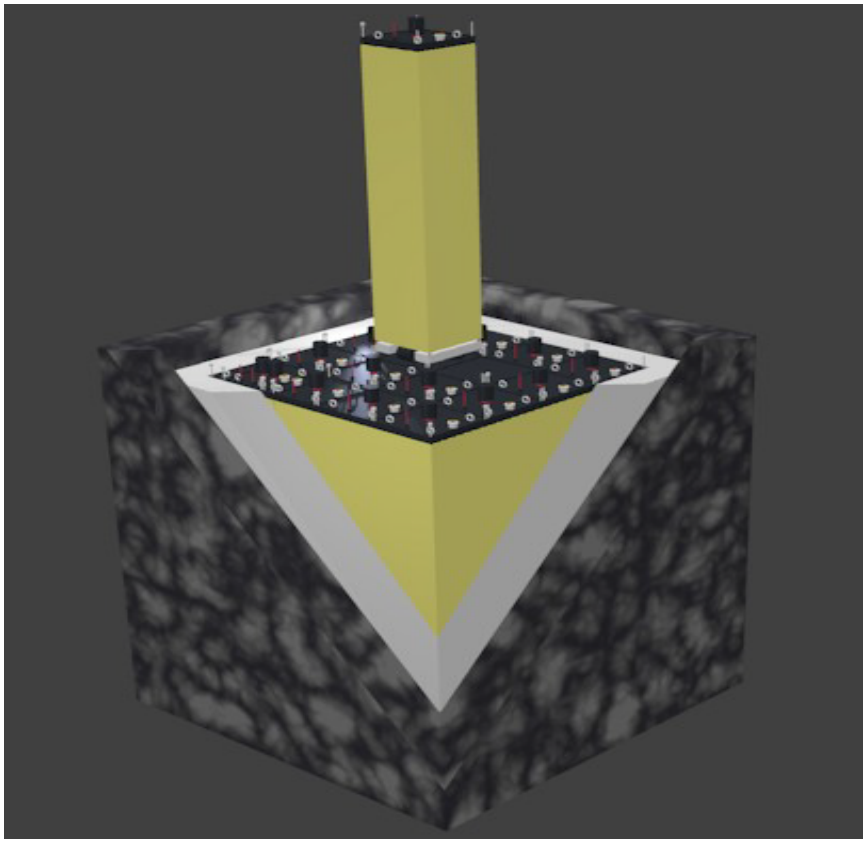
ARGONCUBE – An R&D Initiative of LAr TPC at CERN/Bern

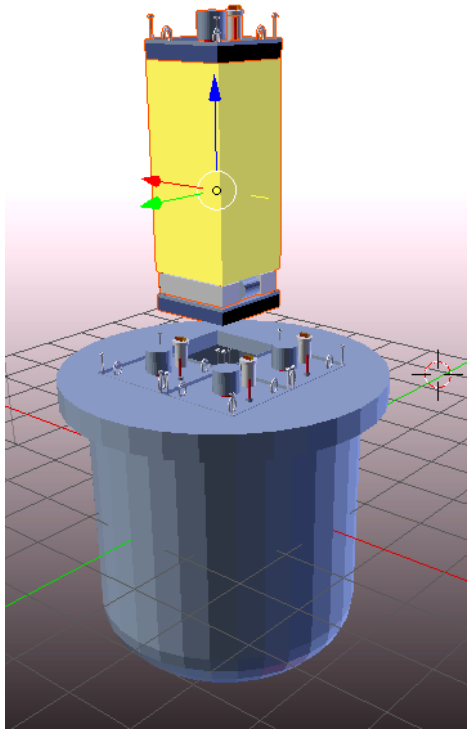
NOVEMBER 19TH, 2014

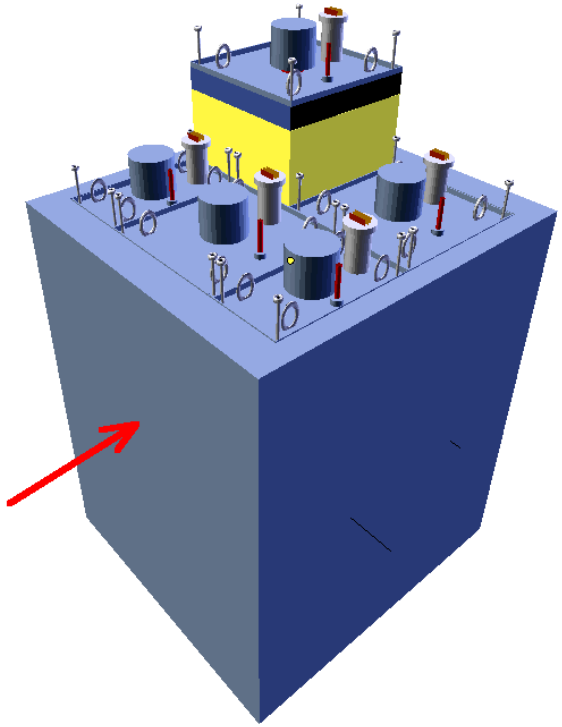
Introduction



- ARGONCUBE – Modular scalable TPC for neutrino observatories
- Design goals
  - 30 kton argon volume, split by ~50 ton modules
  - 29 kton active (97%)
  - Horizontal electron drift
  - Charge amplification by cryogenic electronics
  - Cathode potential ~100 kV
- Motivations
  - Transportable modules
  - Unified modules → high redundancy
  - Step-by-step commissioning
  - Extract module → Repair → Re-insert
  - Scalable and extendable (same tech. for ND and FD)
  - Iterative upgrade with new technologies
  - ***Production facility in different institutes/ countries***

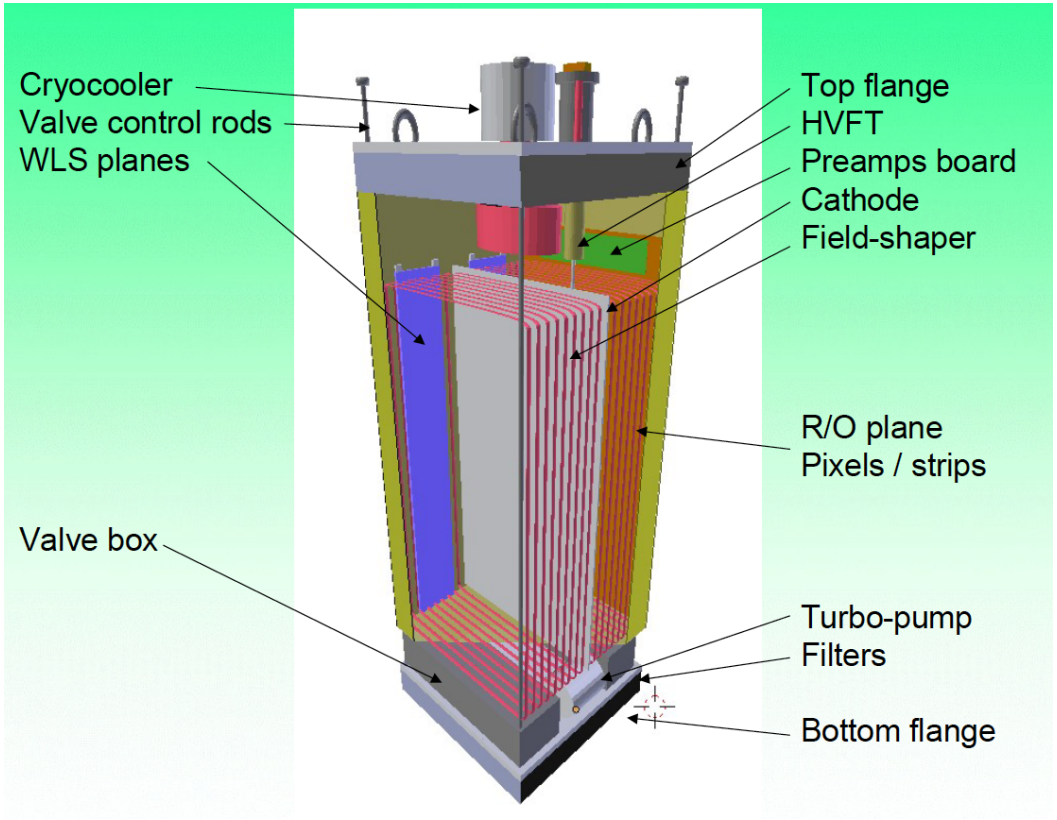
Multiple Phases Prototype

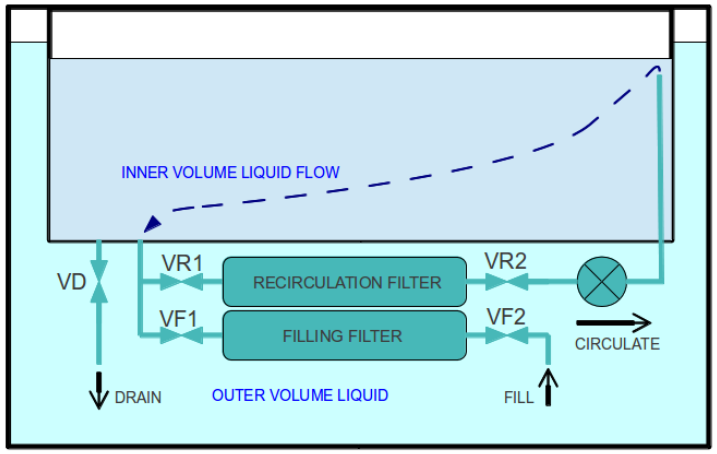




- Phase 1 prototype
  - 4 modules
  - 67 x 67 cm, 1.8 m high
  - Argon volume ~ 0.6 m^3 per module
  - Argon mass ~ 820 kg per module
  - Fiducial mass ~ 750 kg per module
- Phase 2 prototype
  - Cryostat 5 x 5 x 5 m^3
  - 5 modules
  - 2 x 2 m (1 x 2 m), 5 m high
- ***BNL is already involved in by contribution of cryostat*** ☺

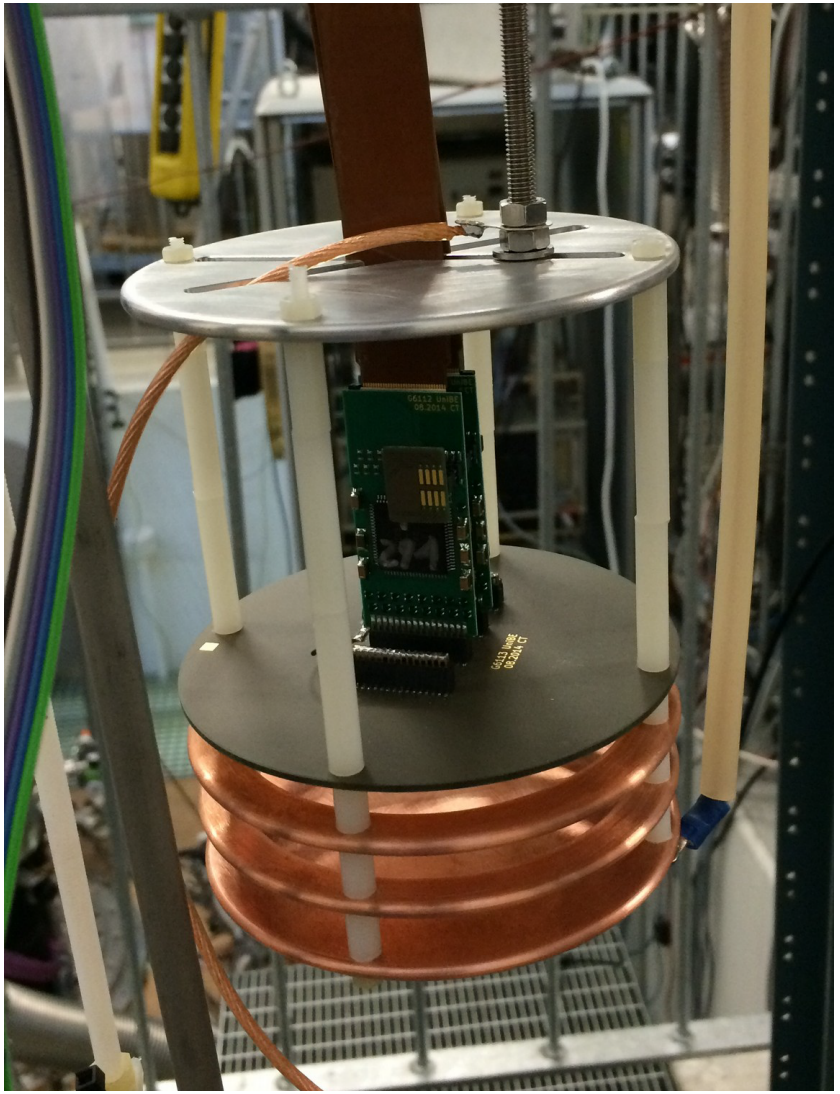
ARGONCUBE Module Design



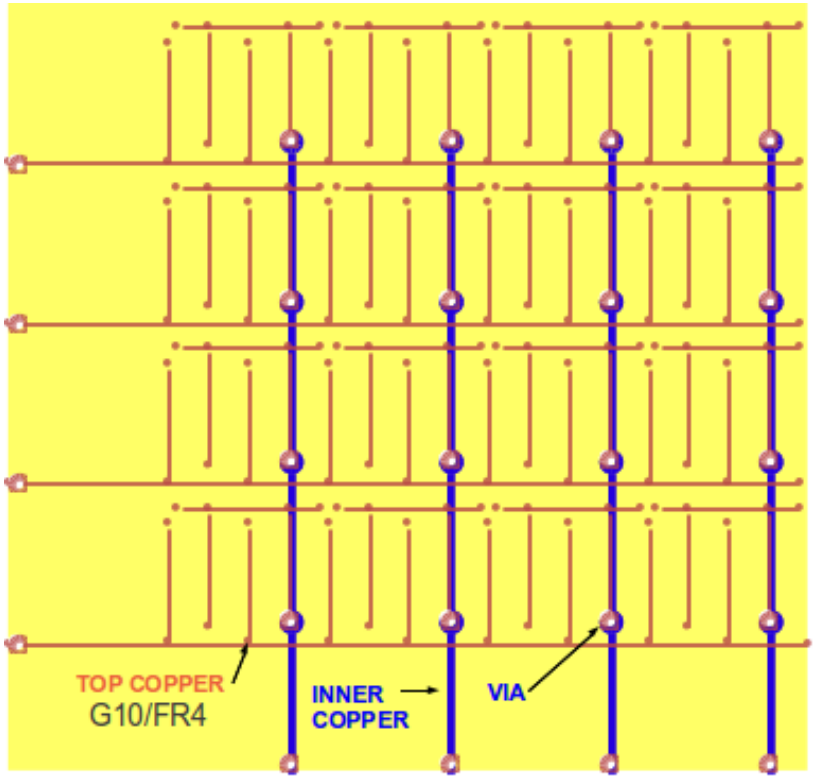


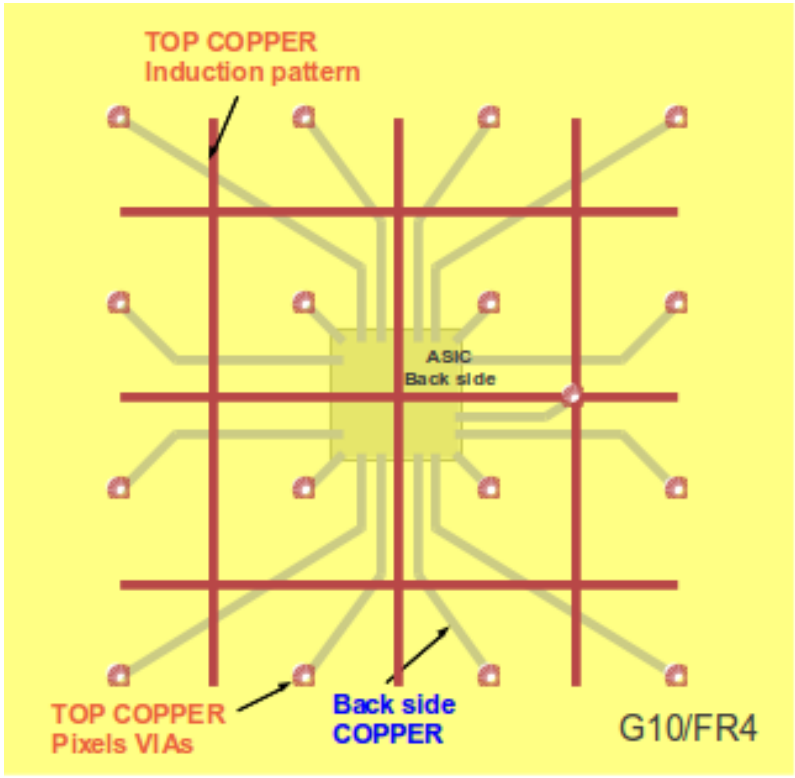
- Module insertion/extraction
  - Top flange seal removed
  - Top flange unfixed from neighbors
  - Module lifted until bottom matches top
  - Fix "bottom" flange to neighbors
  - Detach support rods
  - Seal the flange
  - Remove the module

R&D on Pixel Charge Readout



R&D on Pixel Charge Readout





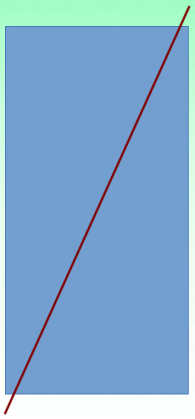
- Strip readout: ambiguity? → simulation inputs
- Pad readout: power consumption? → electrode and readout studies

R&D on Pixel Charge Readout

LARASIC4 : 6 mW/ch
Induction channel (always active) 6 mW
Collection channel together with smart-token and ADC : 200 mW/ch (when active)

Assume 1 induction channel per 64 collection channels is always active

For worst scenario, diagonal track:



Total readout window (drift) 1 ms

R/O time slice 1us

Wakeup time 5 us

power per ind channel, mW	6	6	6	6
power per full channel,mW	200	200	200	200
APA height, m	5	5	5	5
APA width, m	2	2	2	2
Drift time, ms	1	1	1	1
Time slice, us	1	1	1	1
Drift length, m	1	1	1	1
Argon mass, t	14	14	14	14
pixel size, mm		3	4	5
pixels/roi side	8			
pixels/roi	64	64	64	64
roi side, mm		24	32	40
Nroi/width		83	62	50
Nroi/height		208	156	125
Nroi/plane		17264	9672	6250
Max active roi (diag. Track)		223	167	134
Wakeup time, in time slices	5	5	5	5
<P> per plane, W		117	68	46
<P> per ton of LAr W/ton		8.36	4.86	3.29
Npix per plane		1104896	619008	400000
ADC bits	16	16	16	16
pixel in roi address, bits	6	6	6	6
Time slice number, bits	10	10	10	10
Data, KB per drift (1 track)		446	334	268
Data flow MB/s (1tr/frame)		435	326	261

(C2*C16*C6/C5/1000*C11+C1*C15)

pixels ind.

- Trigger based pad readout
  - Use induction channel signal as trigger
  - Signals from collection pads will be turned on based on trigger, then sampled, buffered, digitized, multiplexed and sent out
  - Power consumption and power distribution will need to be studied carefully
  - For surface experiment, beam trigger can be used to control the readout

Summary

- Interesting idea for modular LAr TPC design, with very challenging requirements for pad readout
- Early stage of development with LoI in preparation, a good opportunity for R&D studies
  - Sense electrode design
  - Strip/pad readout design
  - Light readout design
- Staged program with test beam at CERN
  - Start from wire electrode, to strip electrode and finally pad electrode, to exercise different readout schemes
  - Simulation studies with help of postdoc/students (Bern, Yale)