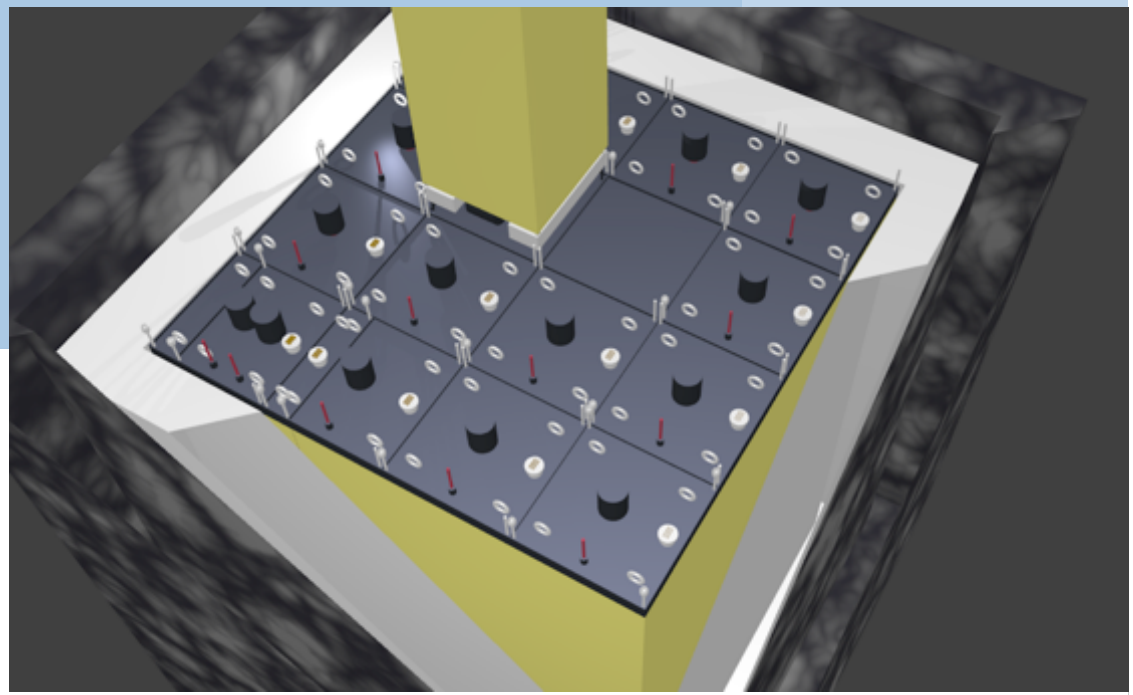
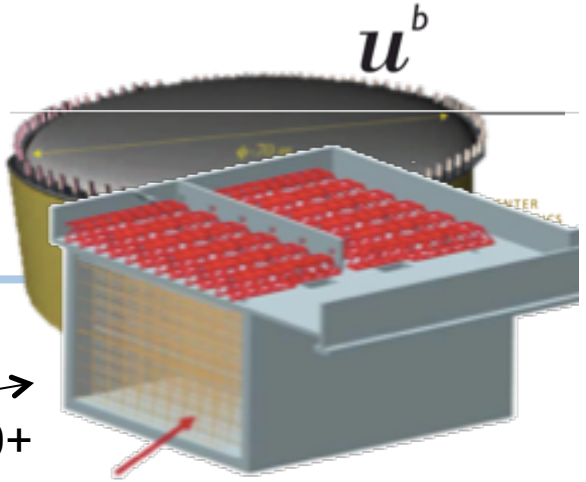
ARGONCUBE

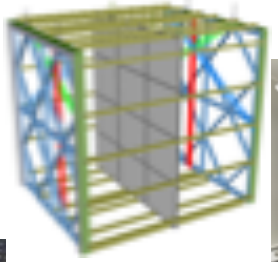
ELBNF
FNAL, Jan 2015

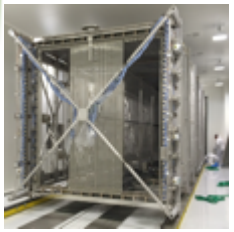


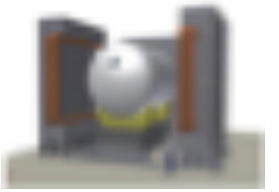
Michele Weber
University of Bern

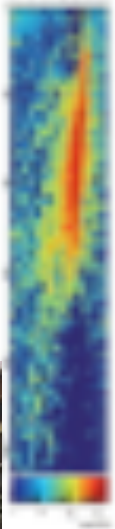


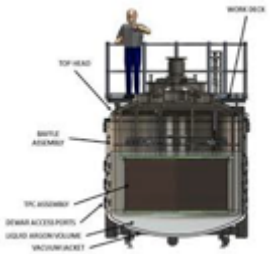
x 100+

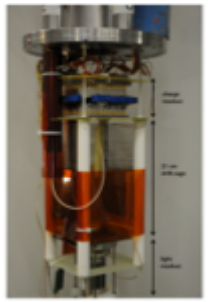


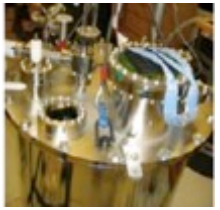


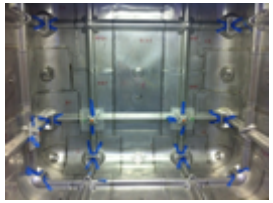












Considerations on an R&D strategy for future LAr TPCs

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- Liquid argon TPCs for the LBNF:
  specific R&D work and the SBN program are the drivers for future technological/methodological choices
- Topical R&D studies need to be performed.
  Achievements: long drift, purity, cold electronics, UV laser calibration, HV generation, discharge prevention…
  good enough ?
- An international effort is growing with different experience/ expertise to perform the next required R&D steps towards a novel LAr TPC implementation: the **ARGONCUBE**
  No-wire charge readout option, novel readout options
  modularity, scalability, robustness

Staged TPC R&D to date

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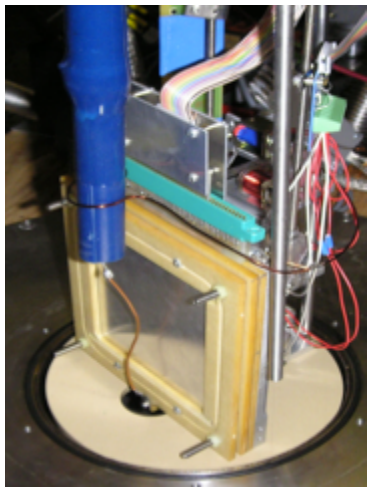
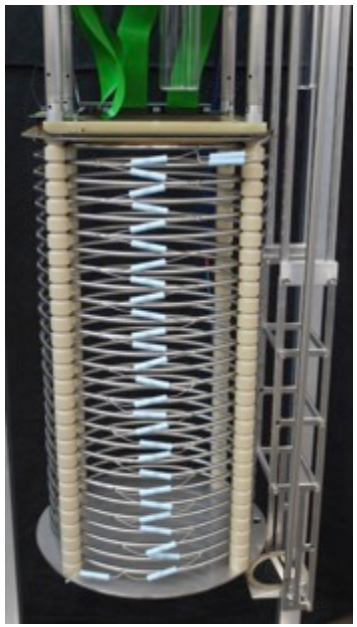




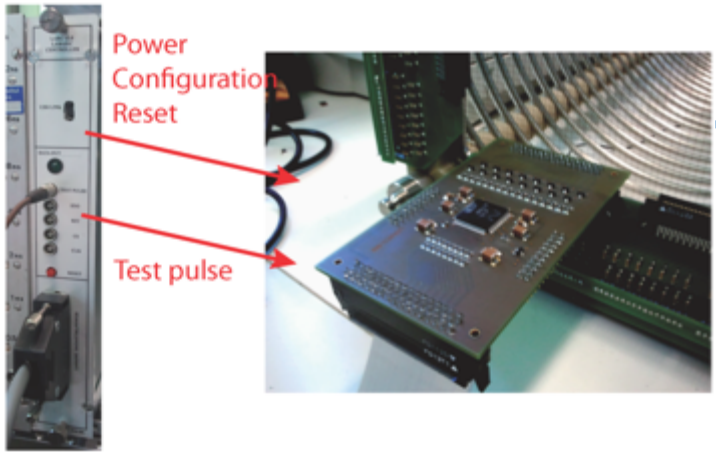

Evolution of detectors with different goals
Some used in several tests as “work horses”

New J. Phys. 12, 113024 (2010)
JINST 4, P07011 (2009)
JINST 5, P10009 (2010)

Longer, higher, purer…!

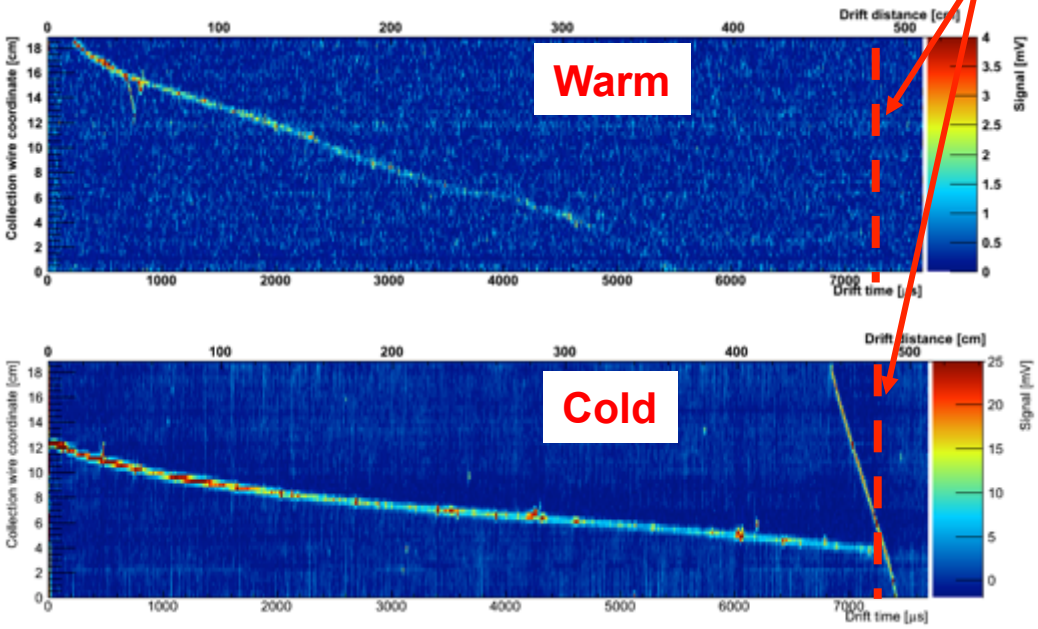
Controller

Frontend
2 LARASIC4 chips, i.e. 32CH
per host PCB.



BNL pre-amps

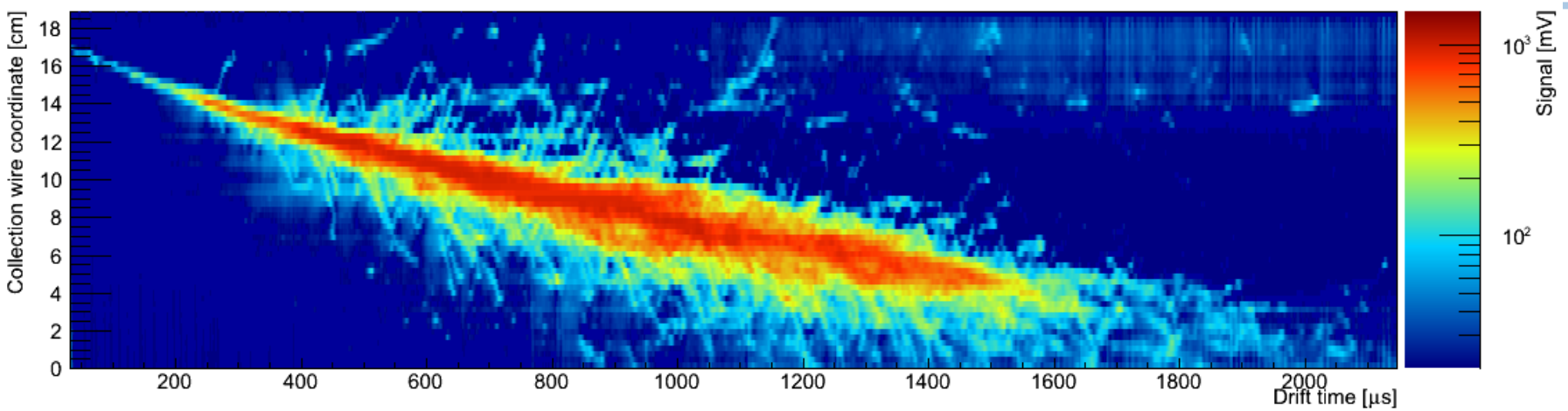
Cathode @ 4.76m

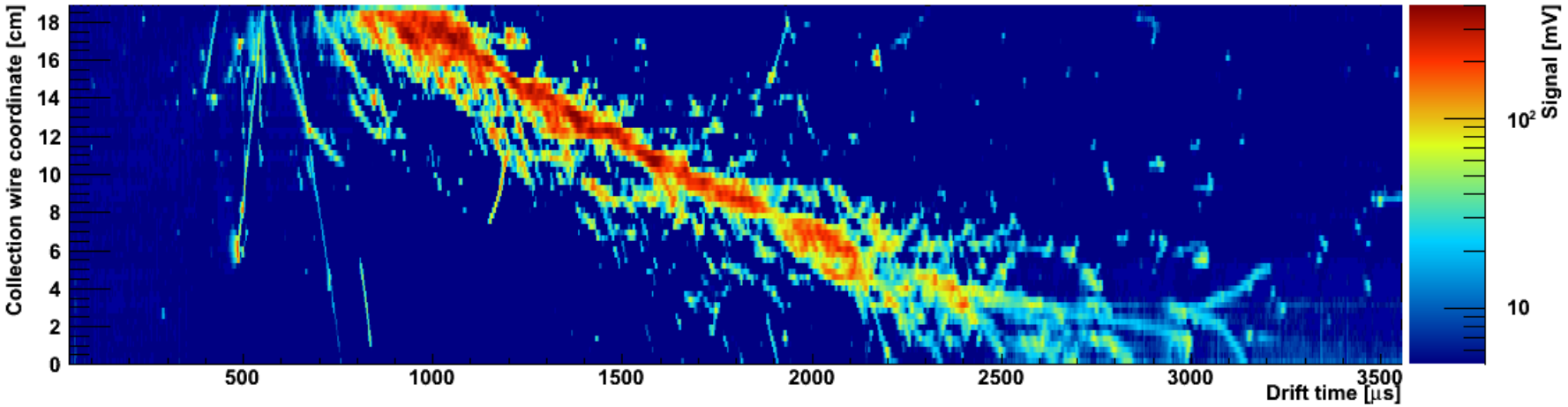


S/N (mip) = 15.7 ± 3.8

JINST 1307 (2013) P07002

Cold electronics

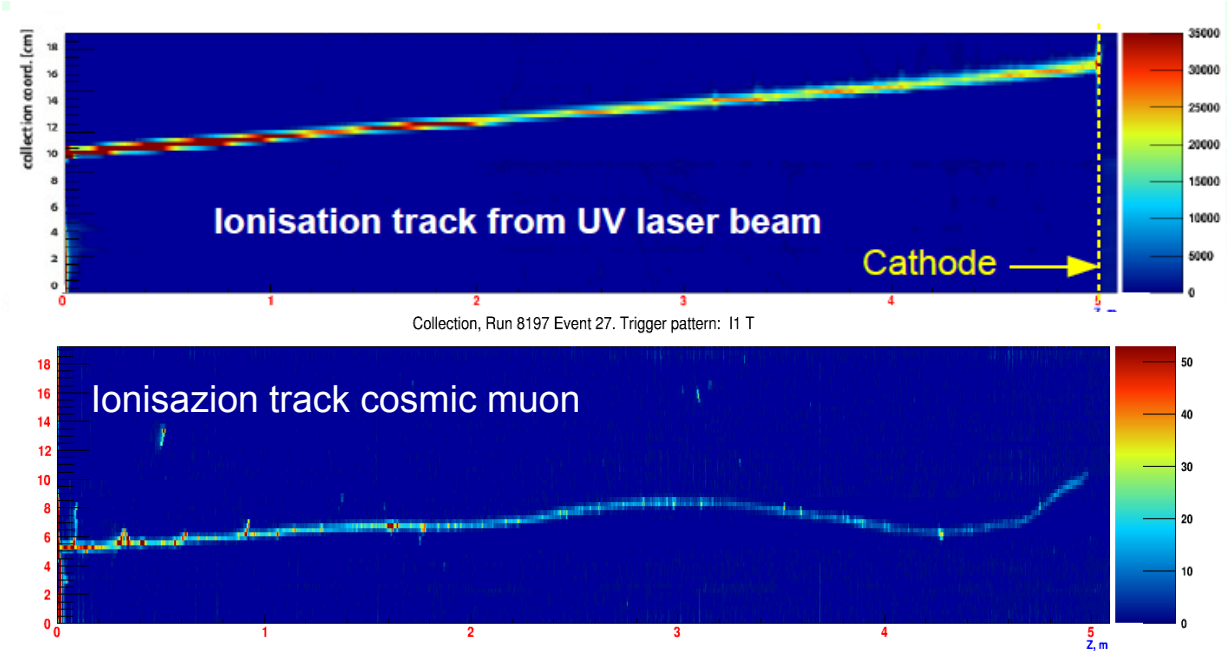


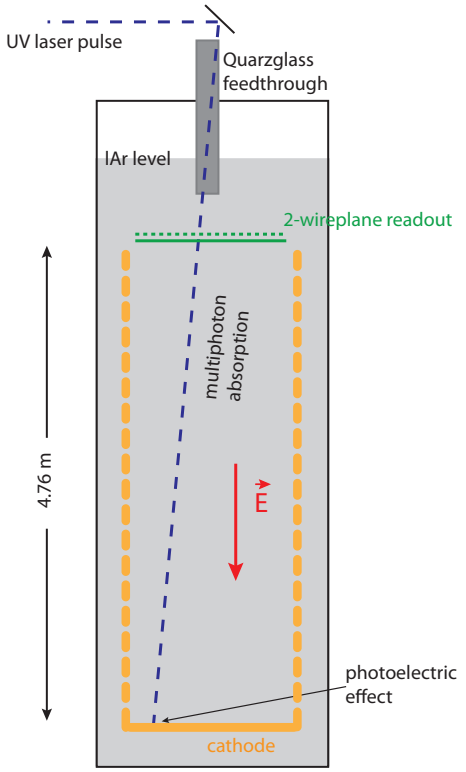


UV laser system

- Straight ionization tracks
- No recombination
- Controlled tracks
- Electric field calibration (distortions, space charge)

JINST 4 (2009) P07011
New J. Phys. 12 (2010) 113024

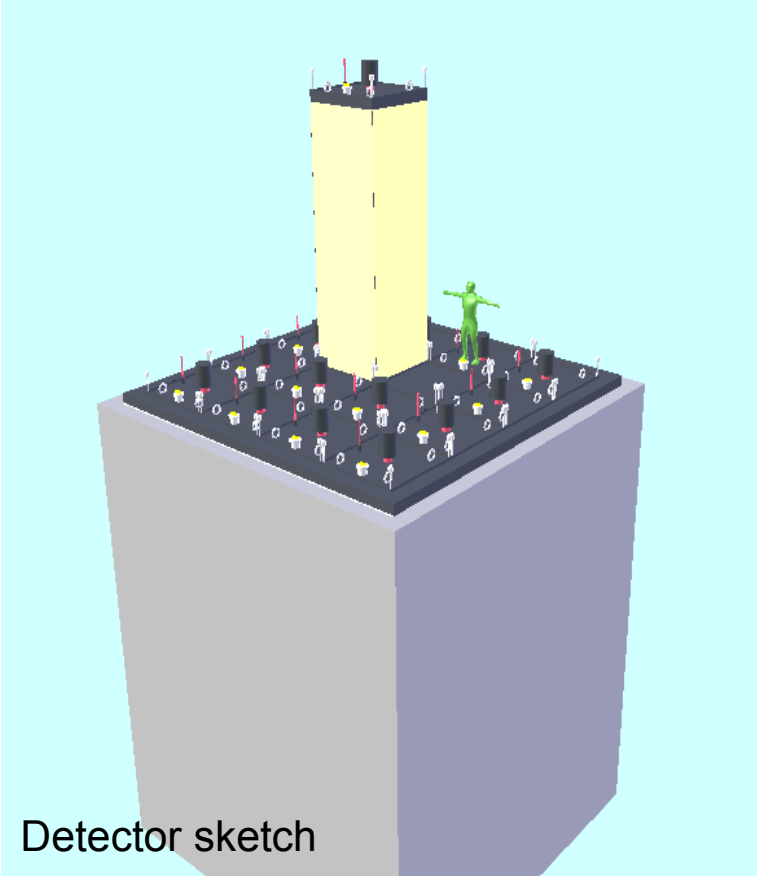




- **Applied to ArgonTUBE, MicroBooNE, LAr1ND**

SO… WHAT IS MISSING ?
ARGONCUBE

ArgonCUBE
a modular LAr test-detector design

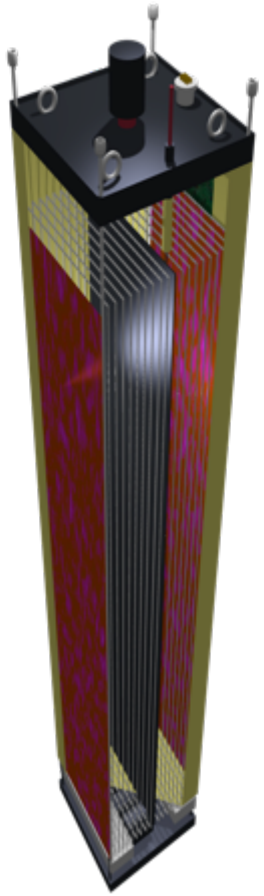

Detector sketch

- Common bath to all independent sub-modules
- Thin walls separated independent modules (2% dead mass)
- Short horizontal drift (~1-2 m), “low” HV
- Single phase readout
  Each module has its own purification and readout systems
- Cold electronics
- Pick up pixels/strips option
- Incremental detector mass

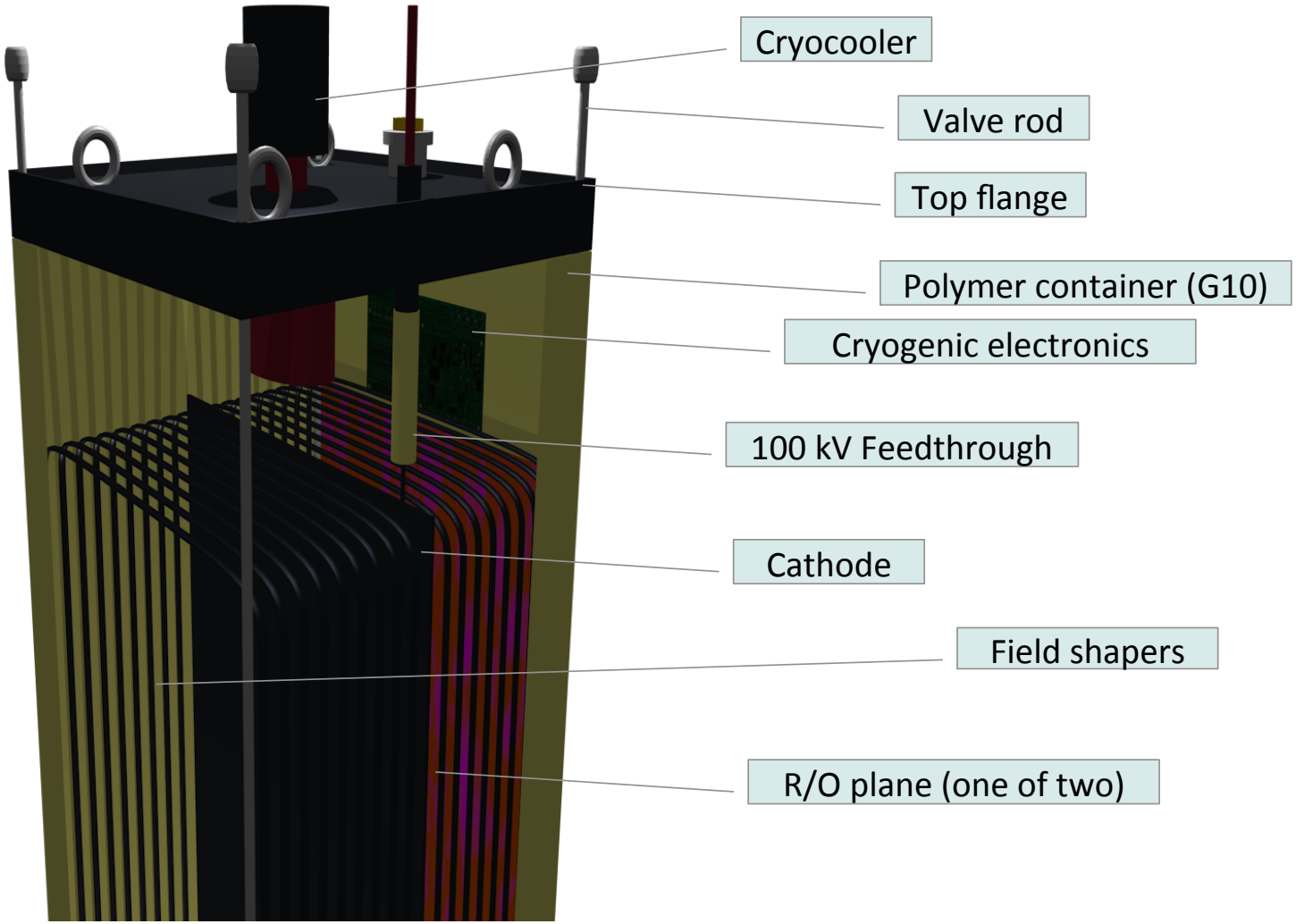
Advantages

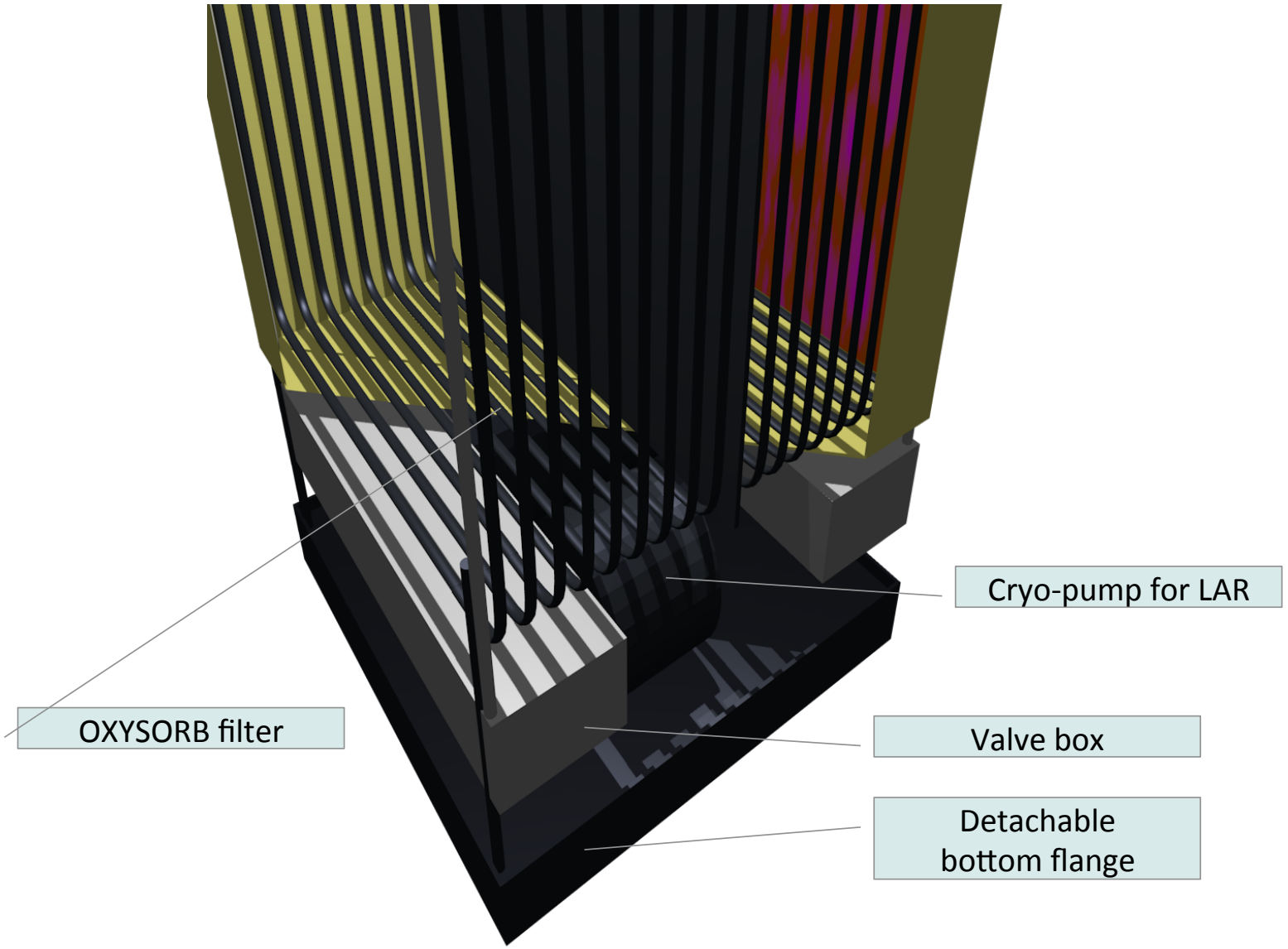
Robust, scalable, modula, cheap

- "Short" drift distance, tuned to the achievable HV and purity (1ms drift time)
- Low space charge, low stored charge & energy compared to monolithic approaches
- Scalable with currently known and proven technology
- If pixel/strip readout viable
  → simpler mechanics and reconstruction
- Extractable modules for staged installation and maintenance/repairs
- Upgrades to the technology are possible (besides repairs)
- Modular structure allows for shared, "democratic" construction load/cost. In principle also different module implementations are possible



Draft concepts



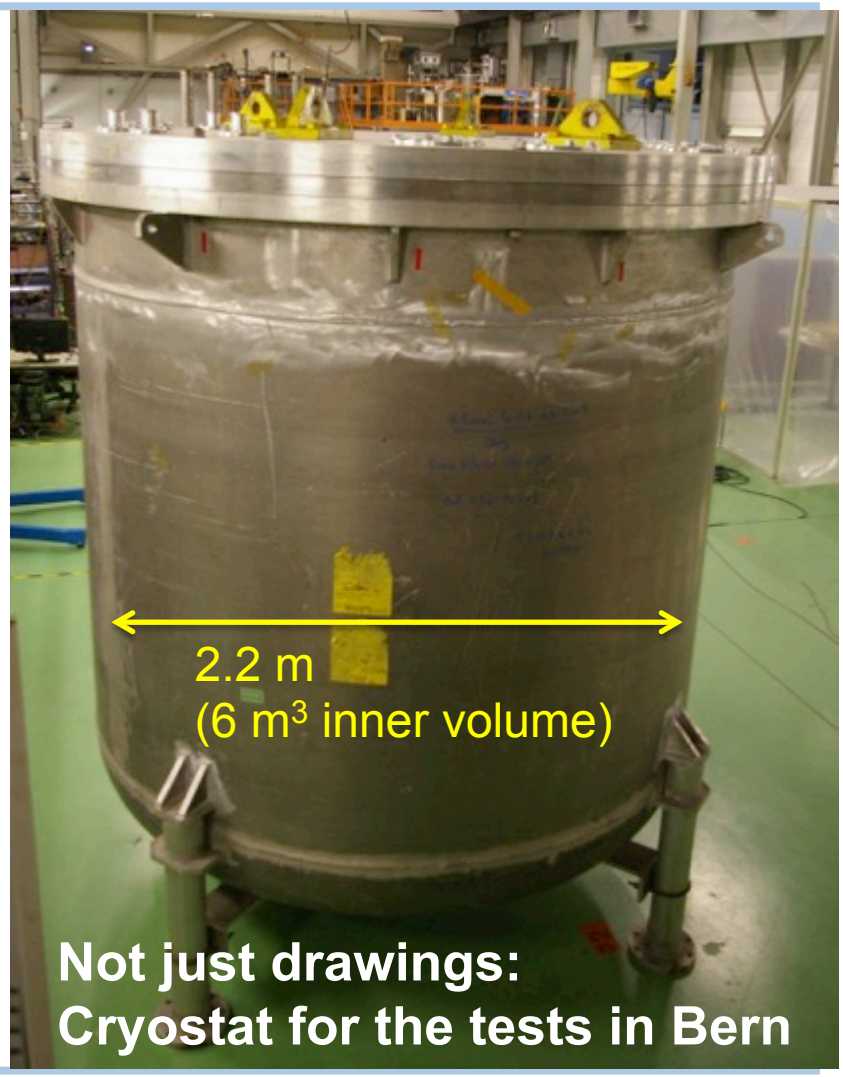

Cryo-pump for LAR
OXYSORB filter
Valve box
Detachable bottom flange

ARGONCUBE R&D phases

0) Research done to date
1) Test in Bern: 4 small-module setup for R&D studies on readout, electronics, mechanics, cryogenics, modularity, etc.
   Charged beam beam test in the North Area is an option
2) Larger scale (5 modules) setup for CENF at CERN

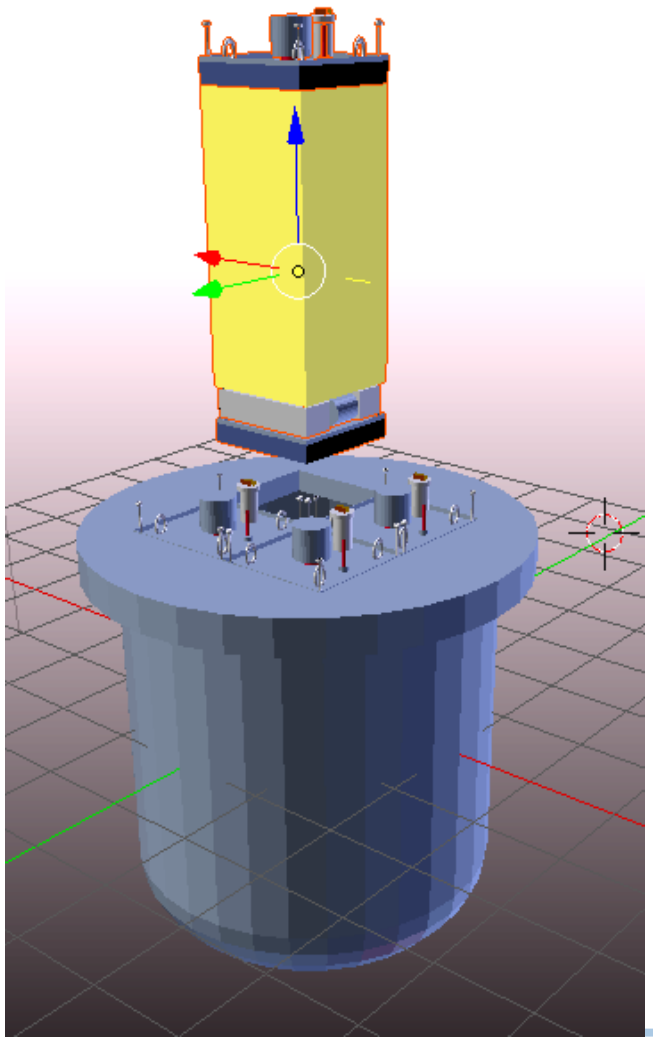
Modularity demonstration

R&D ! New electronics, pixel, any-other-great-idea, …



Not just drawings:
Cryostat for the tests in Bern

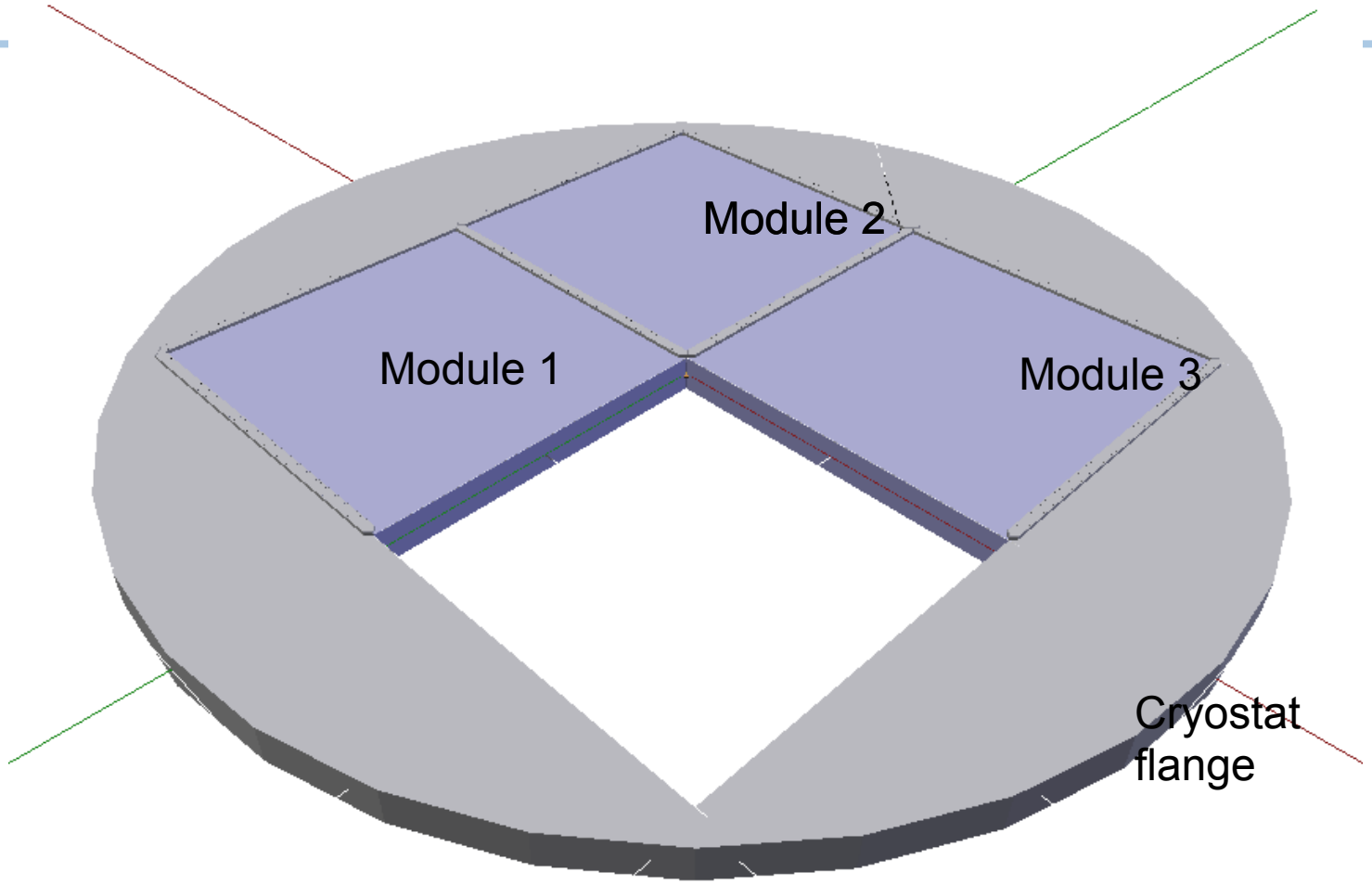
Phase 1



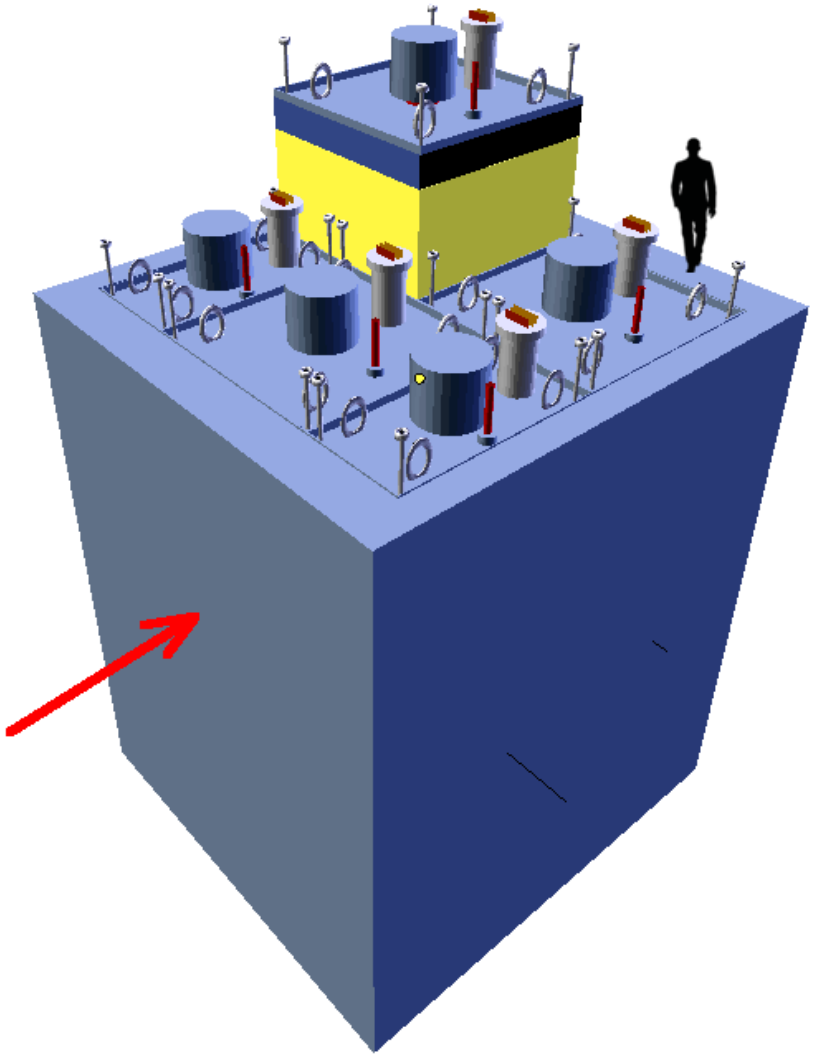
4 modules (at the time in the cryostat)

67x67 cm^2, 1.8 m high
Argon volume ~ 0.6 m^3 per module
Argon mass ~ 820 kg per module
Fiducial mass ~ 750 kg per module

Double-side drift
Max drift length: 33 cm
Field cage : copper-in-G10
Scintillation: WLS bars + MPPCs
Cryogenic preamps: LARASIC4
MicroBooNE signal feed through
ARGONTUBE HV feed through

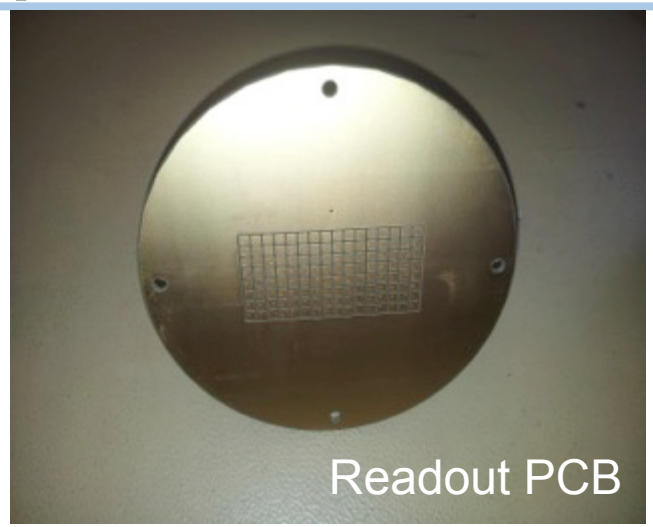

Module 2
Module 1
Module 3
Cryostat flange

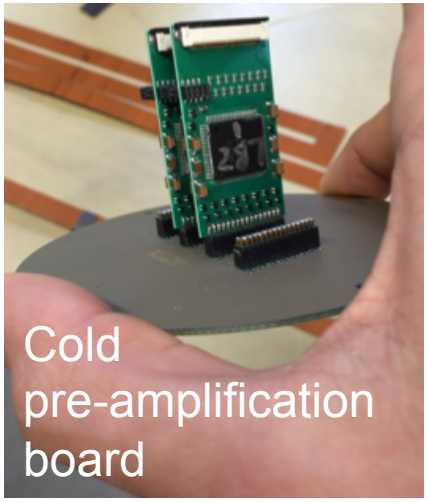
Phase 2

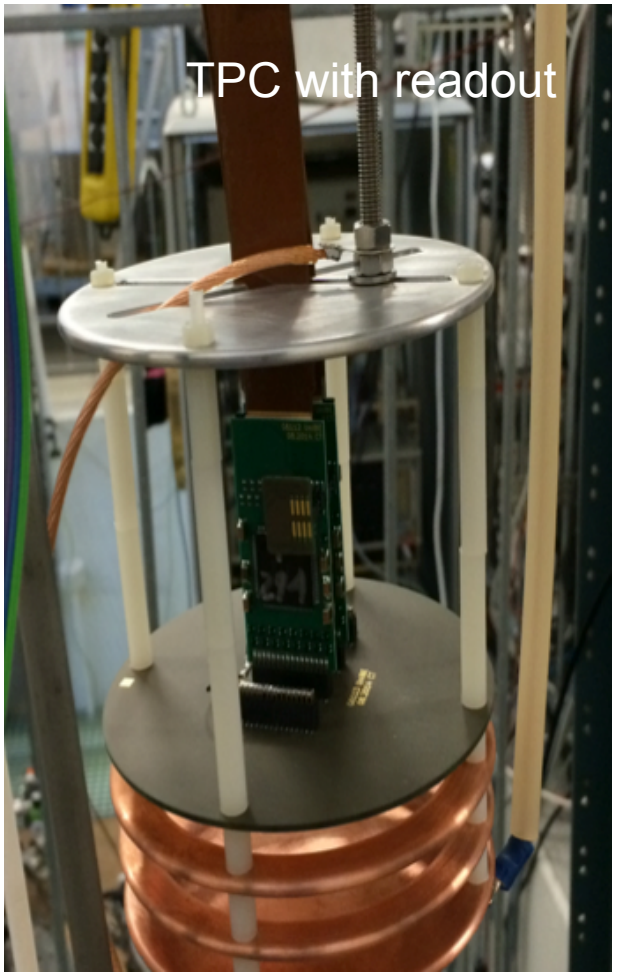


- Cryostat 5x5x5 m^3
- In the CENF charged particle beams
- 5 modules. Present design:
  - Three with 2x2 m2 5m height
  - Two with 1x2 m2 5m height
- Share the cryostat with other groups?

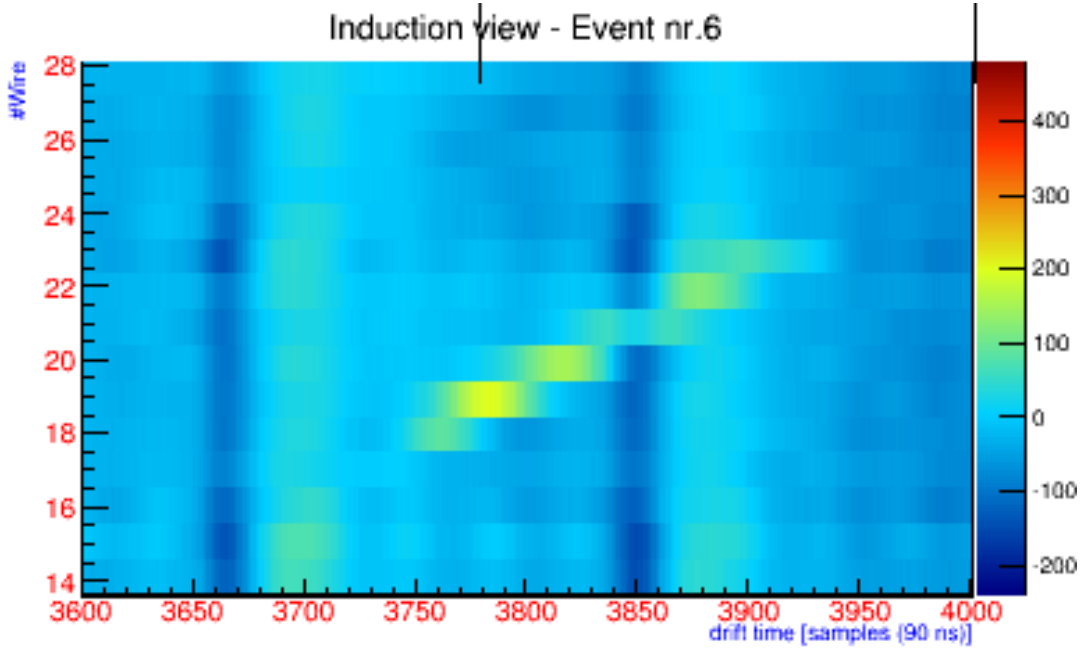
Example of R&D in progress: pixelized readout







Cosmic muon detection by pixel readout



How does this fit into ELBNF ?

Takes all the achievements done so far and brings them to a scalable, flexible, distributed, robust, realizable detector