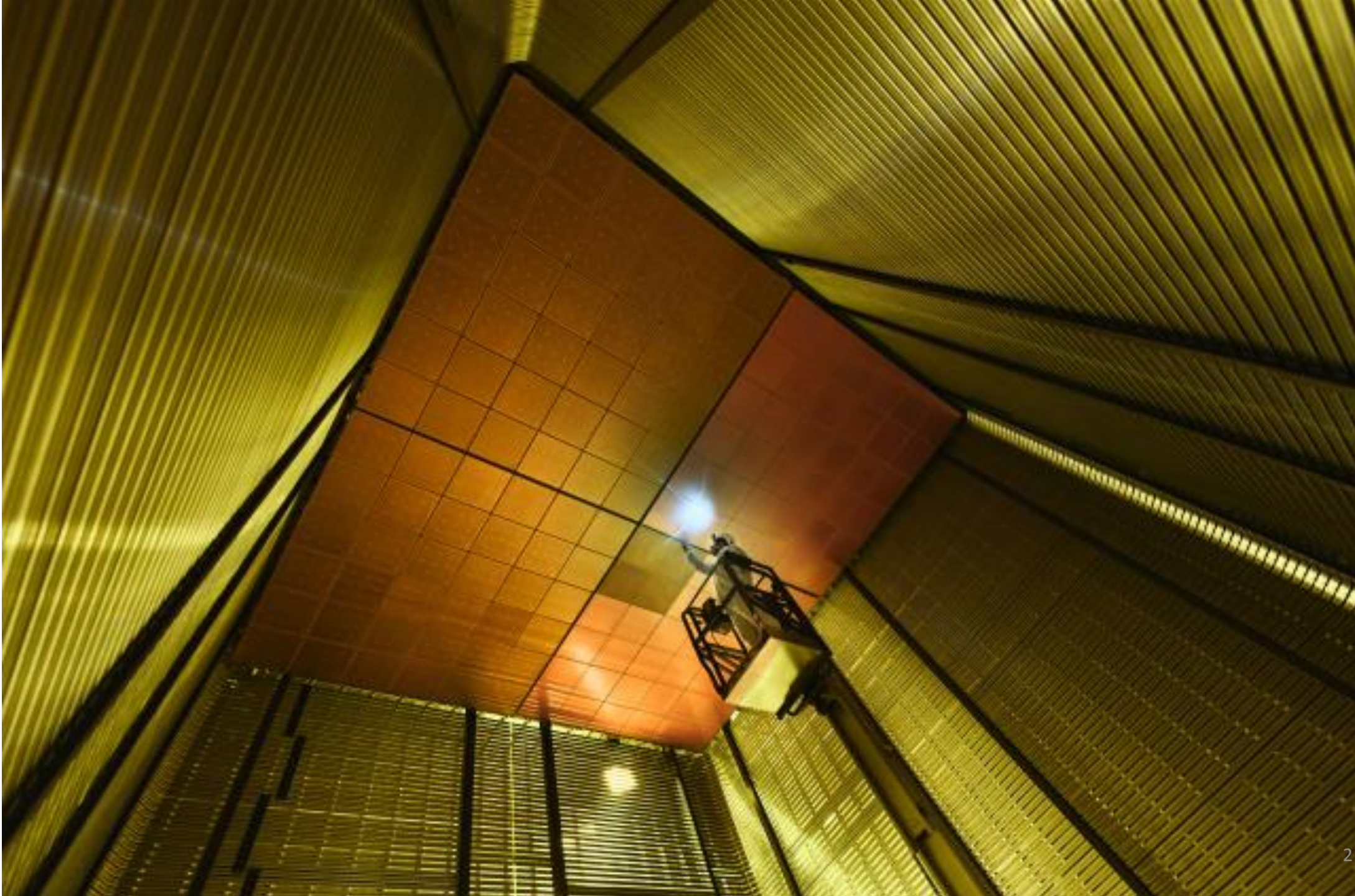
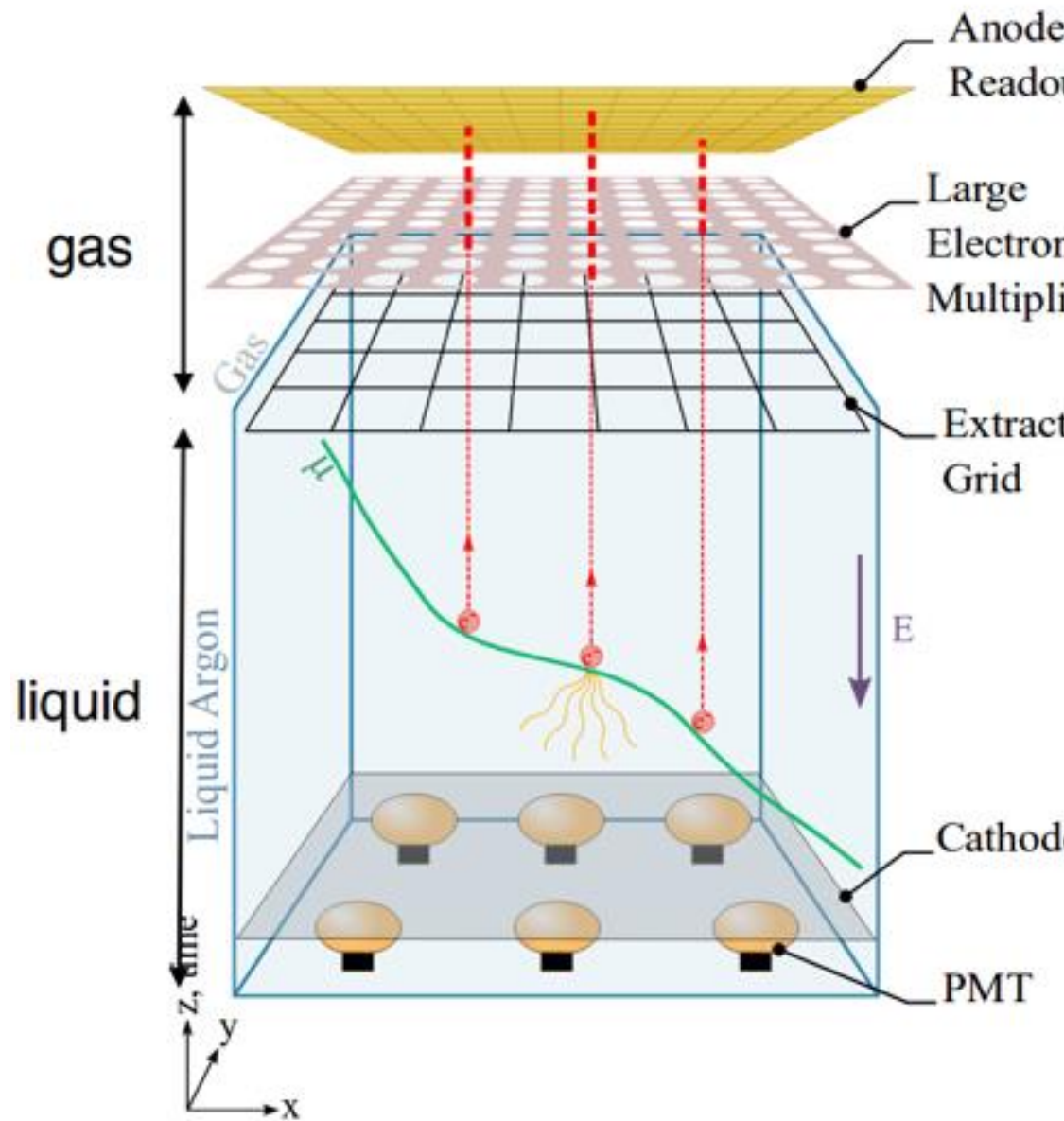


NP02 protoDUNE-II

LBNC, 5-12-2019





Strategy

- For sure we will need a new generation of CRPs and LEMs
- Should we re-use the existing two and add just 2 new one?
- Or should we construct two new CRPs and LEMs and substitute the existing one in the existing cryostat layout?
- This would open the possibility to test new technologies which have been presented in the recent workshop of opportunity, aiming to define a possible new type of detector (might be the 4th one!) by adding two new CRPs with different technologies. I might also enlarge the interest of the community
- All this must be discussed in the community and point out limitations and possible interferences (for example with beam particles)

Today layout

- 4 times 3x3m² readout units, 2 equipped with DP, 1 equipped with 1m² SP anode + grid
- Field cage all around the cryostat perimeter (DP layout)
- Cathode at 6m down
- Below cathode 36 PMTs

Possible protoDUNE-II layout

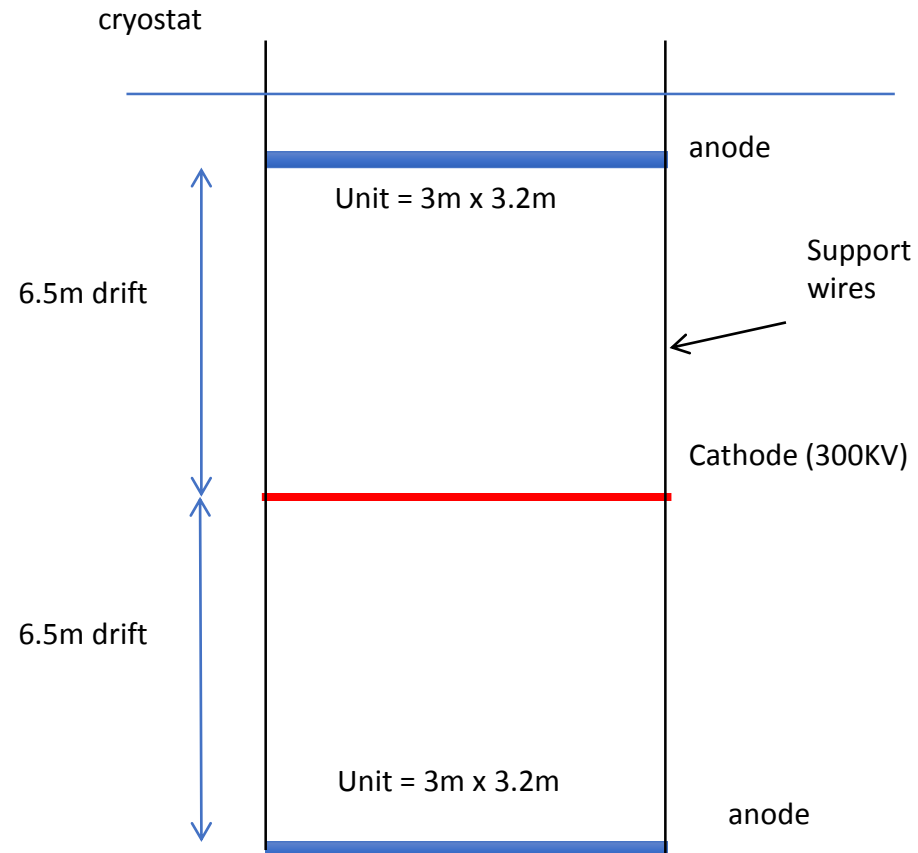
- 4 times 3x3m² readout units:
 - 2 equipped as DP : new grid-LEM-2d anode
 - 1 equipped as SP : readout anode as x-y strips on PCB → see module of opportunity
 - 1 equipped as SP : readout anode as pixels on PCB → see module of opportunity
- Field cage all around the cryostat perimeter (DP layout)
- Cathode at 6m down, 6m e-drift (DP layout)
- Below cathode 36 PMTs or equivalent readout (DP layout)

2 equipped as DP : new CRP-grid-LEM-2d anode

- New CRP, more stiff structure, less deformations and improvements of grid support structure as well as upgraded transport box and manipulation system
- New LEMs, following a new optimization R&D (see E. Mazzucato talk)
- Improved electronics protection
- DAQ more in line with SP
- Grounding protection for all cables inside the cryostat volume
- Better components integration (services, cables, grounding, level meters,

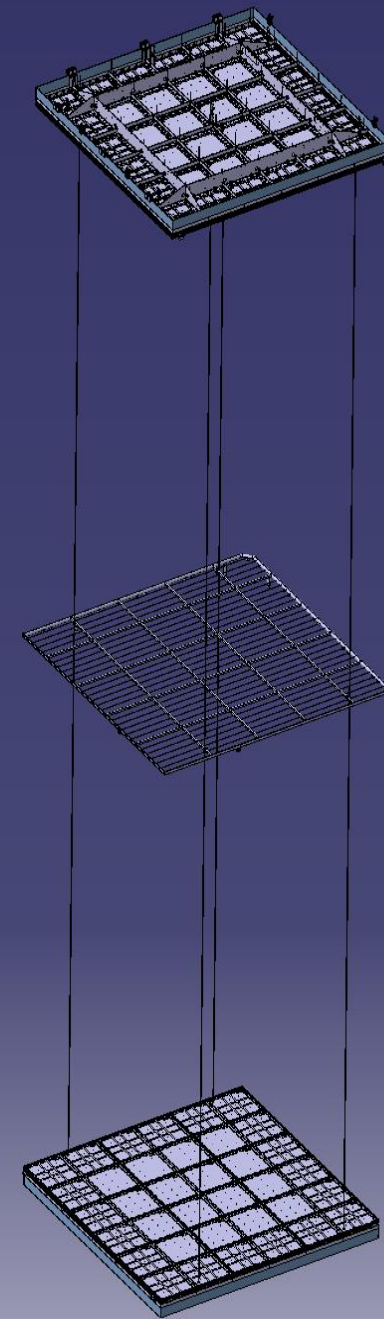
2 equipped as modules of opportunity

- See dedicated workshop (BNL 12-13 November)
- Possibility in DUNE to have 2 vertical drift of 6.5m



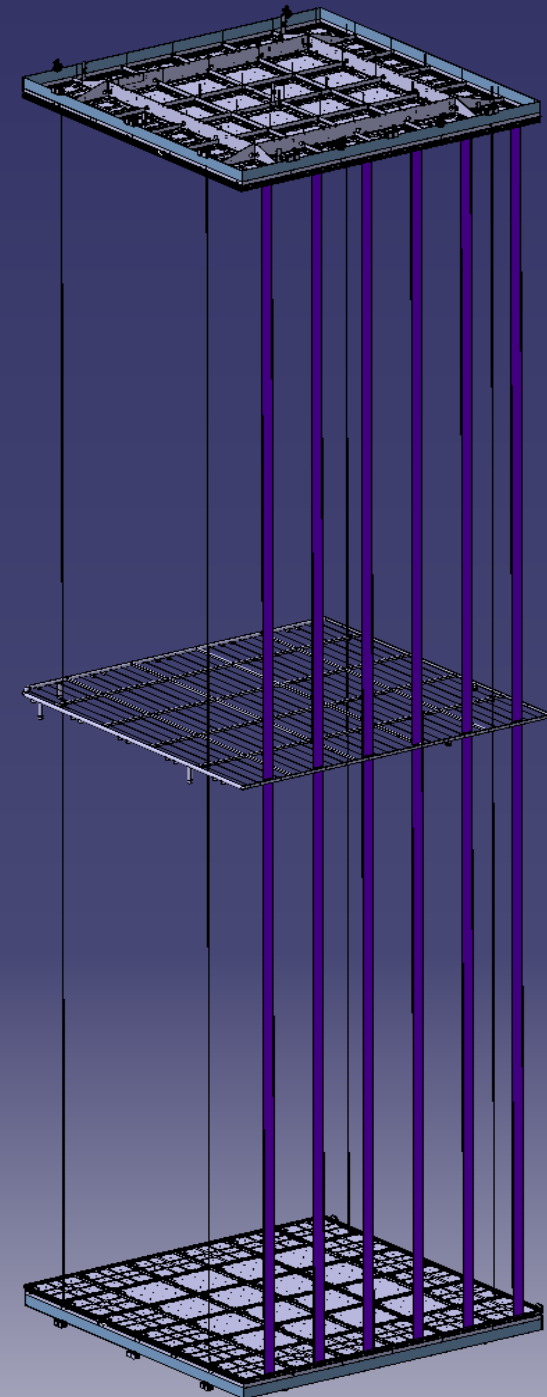
2 x 6.5 m vertical drifts in DUNE

- *Anode Plans*
 - *Several technology can be implemented:*
 - *Projective PCB readout, Pixelated R/O*
 - *Highly modular: exploit the supporting structure developed for the DP detector (~3x3m²)*
- *Cathode Plane*
 - *Similar concept as in DP: resistive bars supported in metallic frame*
 - *Same modularity as Anode planes*
 - *Frame similar to the one developed for the Ground Grid for NP02*
- *Supporting system*
 - *Insulating wires Supports*
 - *Connecting top AP, center CP and bottom AP*
 - *Full structure hanging as in the DP detector*



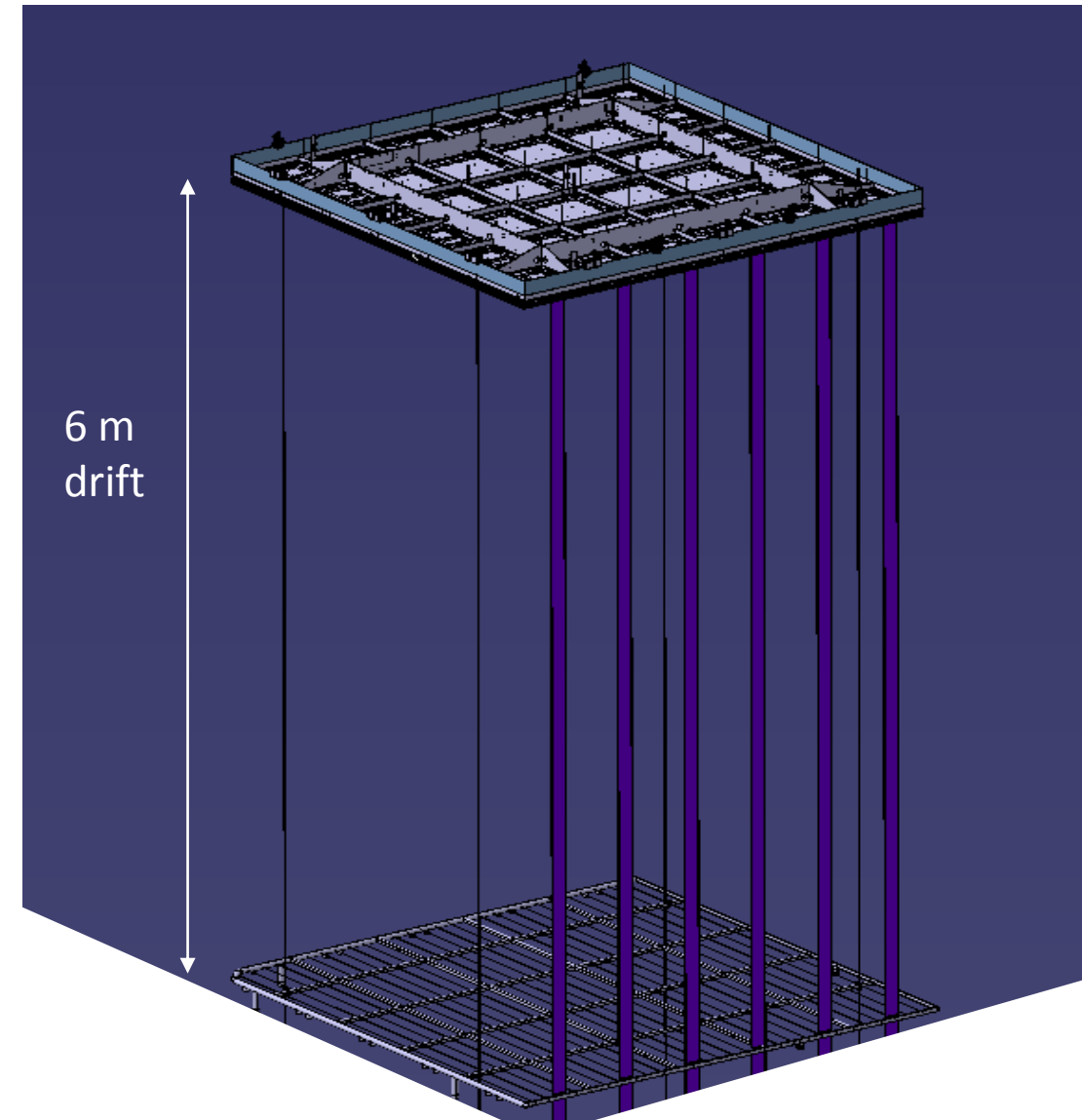
2 x 6.5 m vertical drifts in DUNE

- With “solid” readout planes and cathode in the middle, difficult to embed standard **photon detectors**.
- Possible solutions:
 - Inside the drift volume → need fully insulating thin material to minimize distortions of E-field and dead regions.
 - long Arclight-like PDs
 - PD mounted on the Cathode Assembly → need to solve the biasing issued and the HV signal decoupling
 - X-Arapuca’s
- New possibility to have temperature measurements inside the drift volume, using the supporting wires



6 m vertical drifts in protoDUNE-II

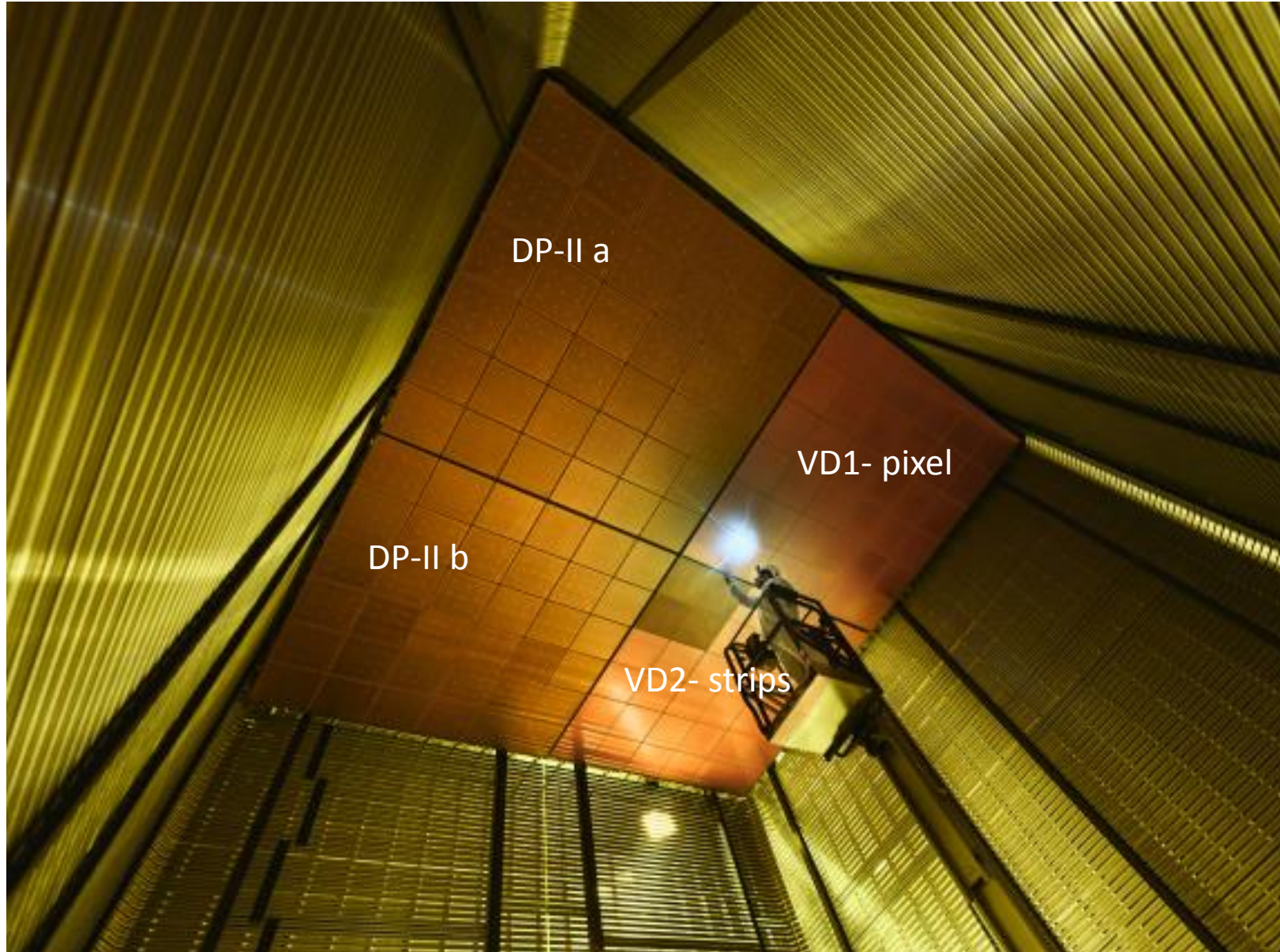
- *2 different solution for anodes and readout electronics (Single Phase)*
- Photon detectors inside the drift volume
- Temperature measurements inside the drift volume



Additional improvements in protoDUNE-II

- *New HV system, with different feedthrough, extender or resistive cable, resistive cathode*
- Some correction to the layout of the field cage to avoid bubbles formation (?)
- Better integration of all elements
- More robust filtering system, with possibility to exchange filters
- New beam plug for beam events

ProtoDUNE-II NP02 possible schedule



- *Sept 2020 start emptying and warming up*
- January 2021 open cryostat
- March 2021 remove 4 CRPS
- March to October 2021 reinstall the new detectors + improvements
- December 2021 start flushing and cooling down
- Ready for commissioning with beam in March 2022

ProtoDUNE-II DP future R&D requirements

- HV at 600KV R&D on power supply and connection (see Francesco talk)
- Assess the potential/problem related to 12m drift
 - Purity requirements
 - Purity uniformity, argon circulation
 - Photon detectors related problems and requirements

Do we need a 12m demonstrator?

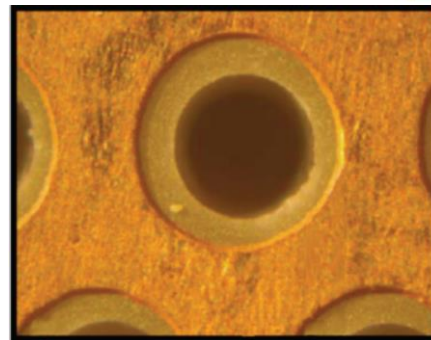
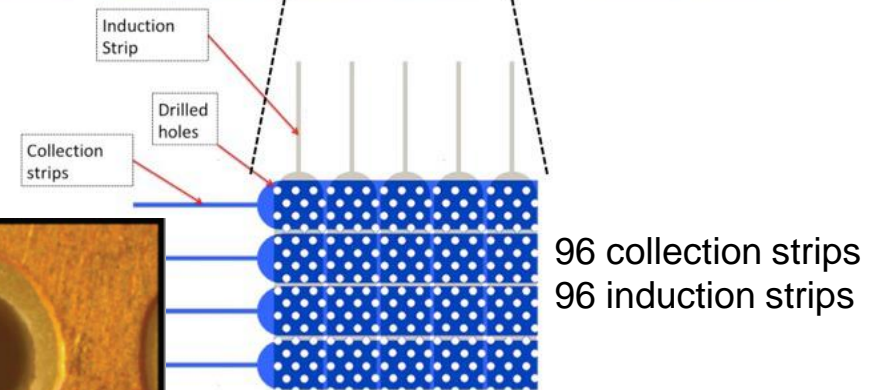
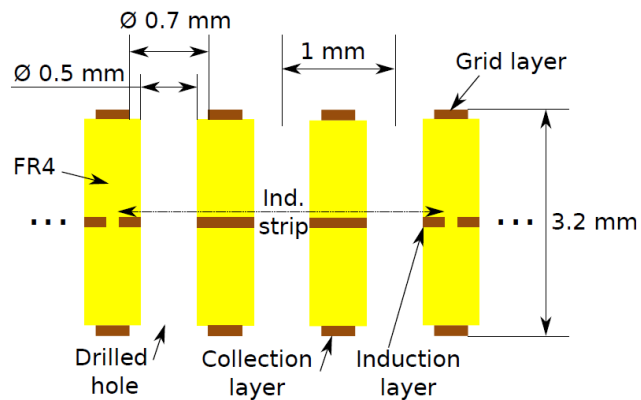
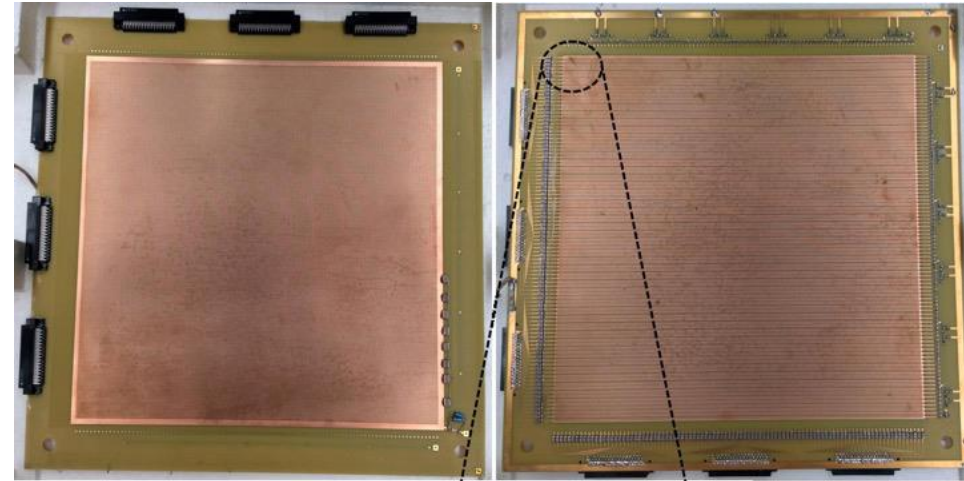
- Our proposal is to workout such a plan after the end in August 2020 of base NP02 program
- We are also working towards a strengthening of the DP community

Back up slides

The Perforated MultiLayer PCB

Several prototypes have been realized at CERN for signal test and optimization purposes:

- 1 Screen plane (not read-out)
- 1 induction plane
- 1 collection plane
- 3mm pitch of the read-out strips
- Holes to surface ratio: 30 - 50 %
- Hole positioning not critical (many holes per strip)
- Hole rim also not critical due to operation in LAr and absence of amplification



ICARUS LNGS version of the warm front end electronics through 2m long cables