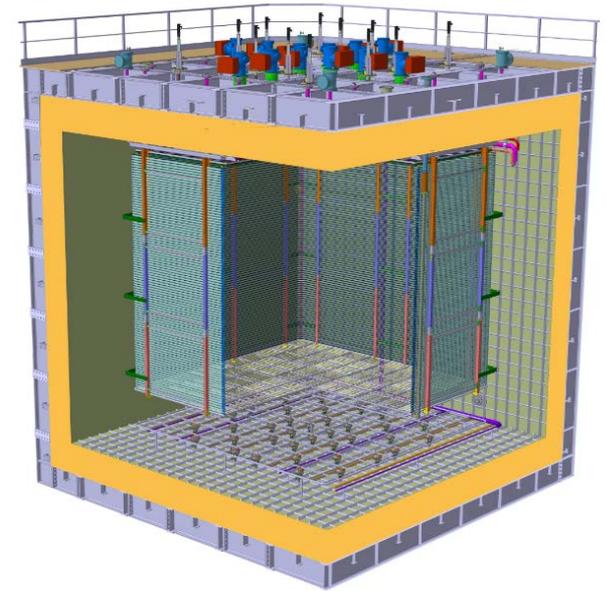


# ProtoDUNE-DP status update

D. Duchesneau

- Cryostat status
- Field cage installation and tests
- NP02 Cold box
- CRP status

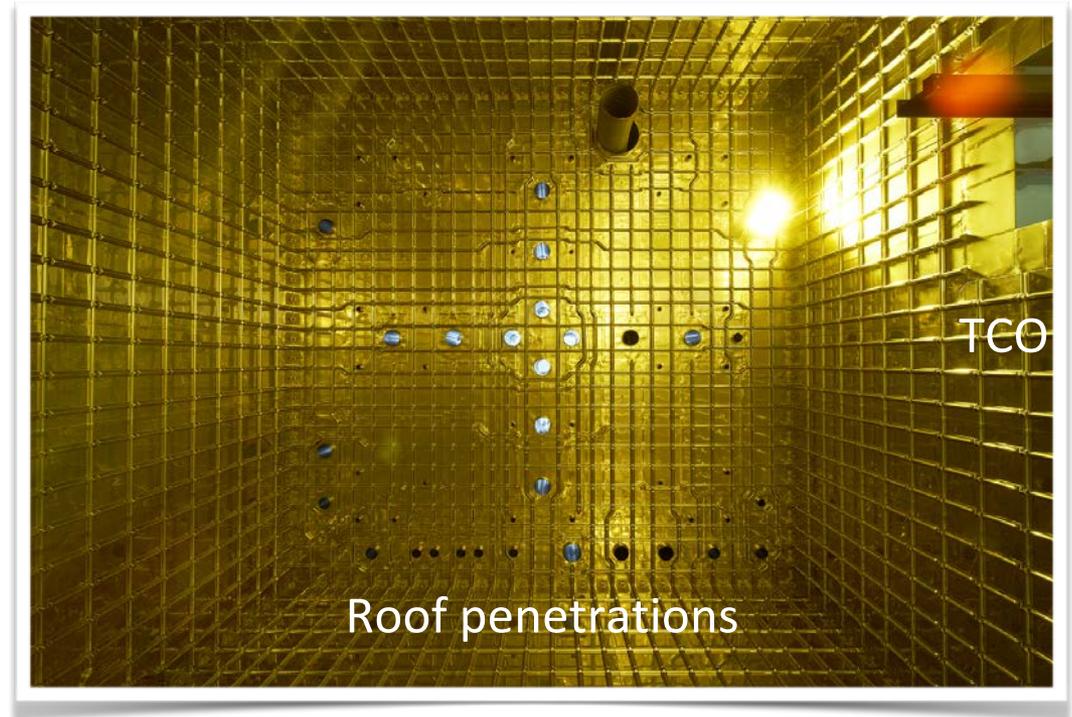
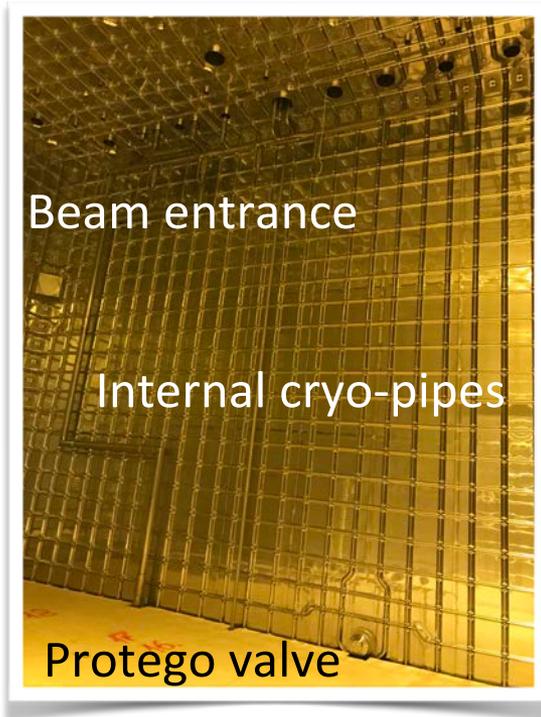


More details are given in F. Resnati's presentation at the open session of the 119<sup>th</sup> meeting of SPSC (19/04/18):  
<https://indico.cern.ch/event/720384/>

DUNE collaboration monthly meeting

## NP02 cryostat status

- Cryostat fully installed, cleaned and leak tested
- Internal cryogenics, including all feedthroughs, fully installed and leak tested

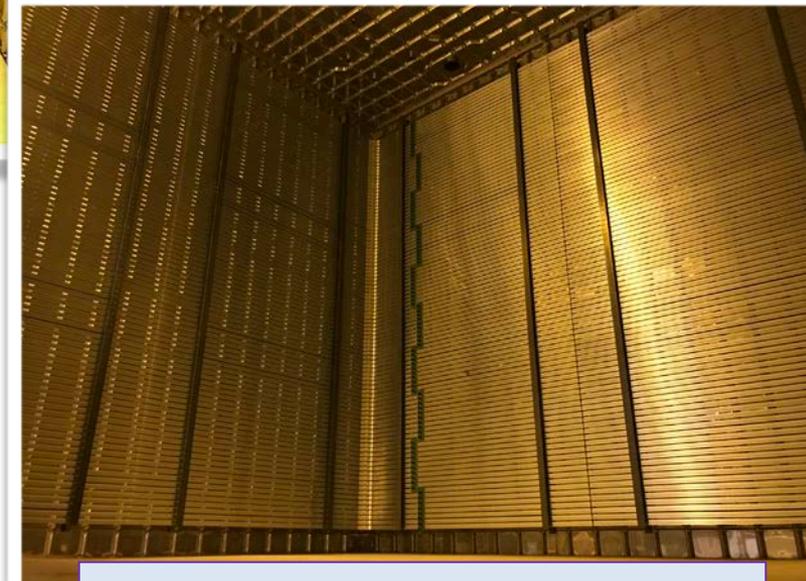
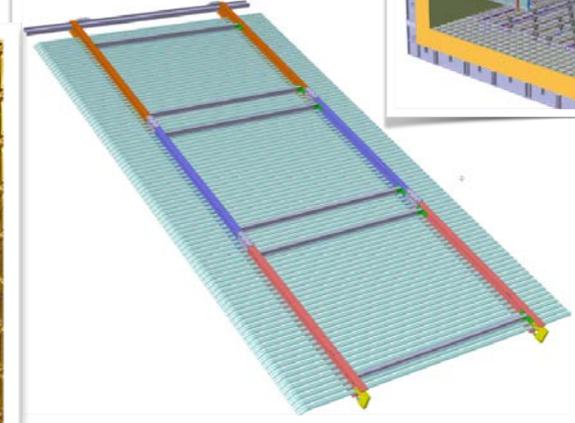
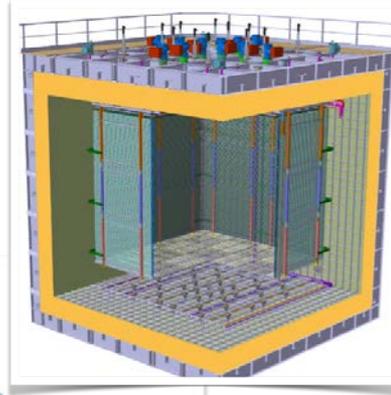


Next step: closing of the TCO once the detector is completed

# Field cage installation in the cryostat

## Field cage:

- 8 vertical modules of 6.3 m x 3 m
- Each module consisting of 3 sub modules
- Aluminium profiles held by horizontal FRP I-beams



FC entirely mounted on April 4th

Profiles connected mechanically and electrically to form rings  
Two series of resistive divider define the potential on each ring



## Electrical test of the Field cage

- Voltage applied in the middle of the FC
- Ground on top and on bottom of the FC

April 16th 2018



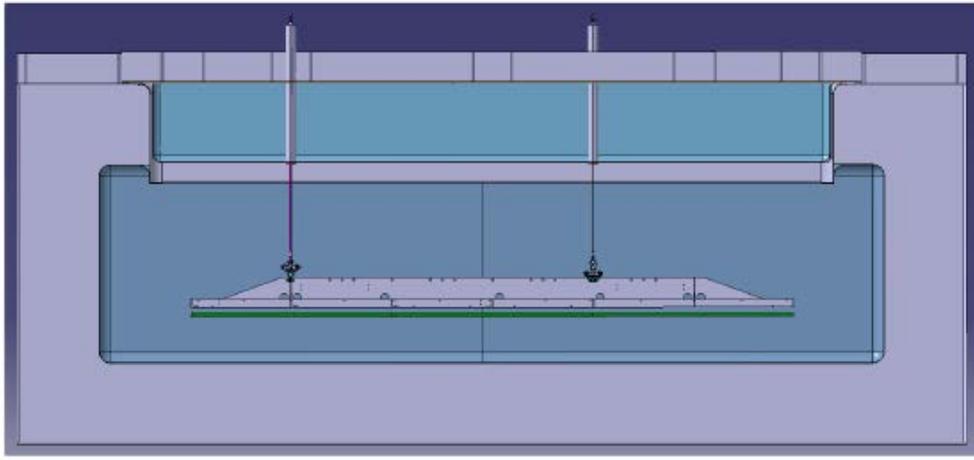
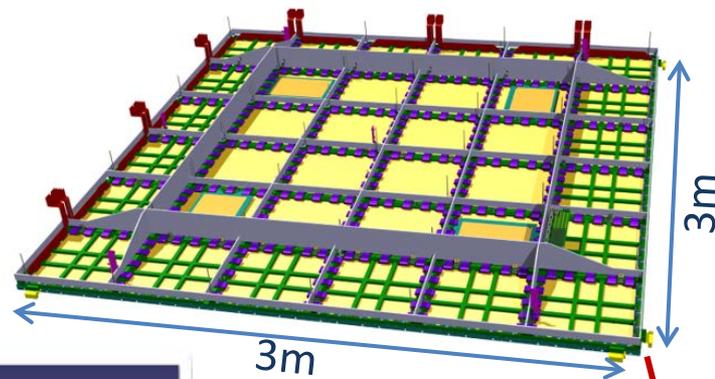
- Maximum voltage: -150 kV
- Run several hours => no discharge
- Current is linear

Work going on to compare with expectations

# ProtoDUNE-DP Cold Box

Cold box to test each CRP:

Project started in December 2017

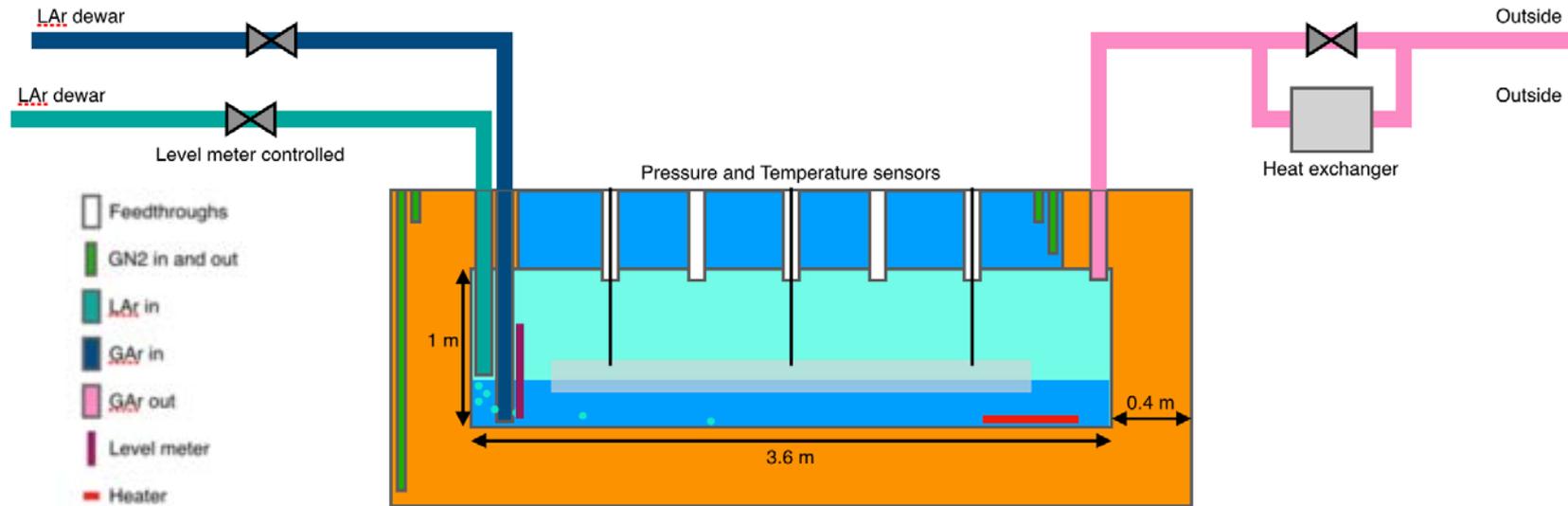


## Goals:

Electrical and mechanical tests of each final CRP in nominal thermodynamic conditions:

- Characterisation of the operation voltage of each LEM
- Characterisation of the operation voltage of the extraction grid
- Test the planarity of the CRP itself
- Test the tensioning of the extraction grid wires
- Test the HV contacts and connections (LEM & grid)

# ProtoDUNE-DP Cold Box



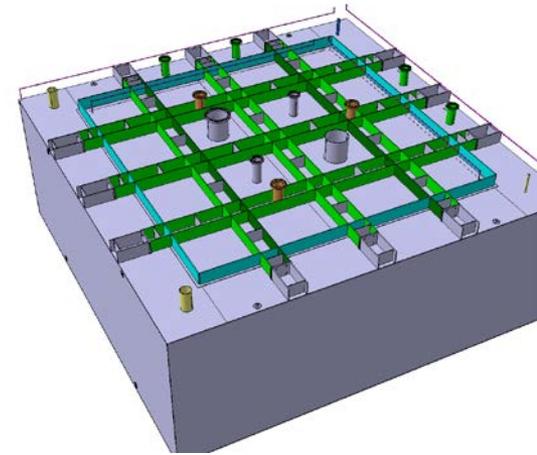
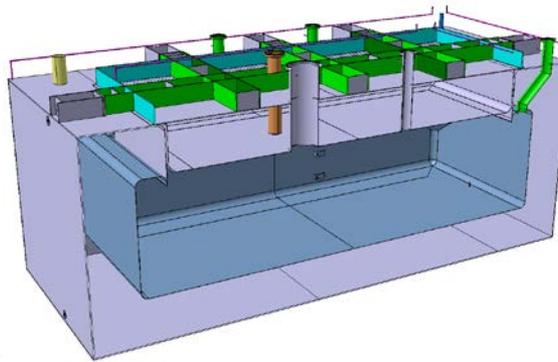
## Requirements:

- LAr surface: flat in order to allow the LEM to be in the vapour phase and the grid in liquid (2 mm, very stringent...)
- Pressure: not stabilised close to the atmospheric, monitored
- Vapour temperature: not controlled, monitored
- Purity: of the order of 100 ppm ( $O_2$ ) measured from the boil-off
- CRP planarity adjustable (at least before filling)

# ProtoDUNE-DP Cold Box

Dimensions:

- external 470 cm x 470 cm x 210 cm
- internal 389 cm x 389 cm x 99 cm
- insulation thickness 40 cm
- roof opening 333 cm x 333 cm
- roof size 360 cm x 360 cm



Already available:  
- safety measures ODH  
- cryogenic equipment

First cold test with LAr foreseen  
in coming weeks.



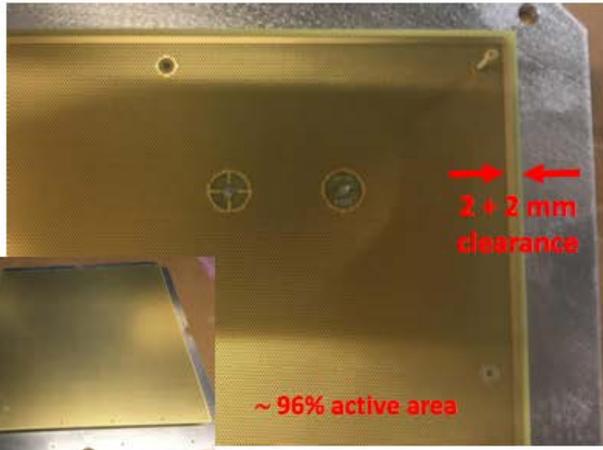
Built at EHN1 installed on  
March 14<sup>th</sup> at 182/2-001

Bld 182  
Mid April 2018



New design with larger guard rings has been developed in order to improve HV characteristics => production started in Dec 2017

**CFR-34 - 311 prototype**



**CFR-35 – NP02**



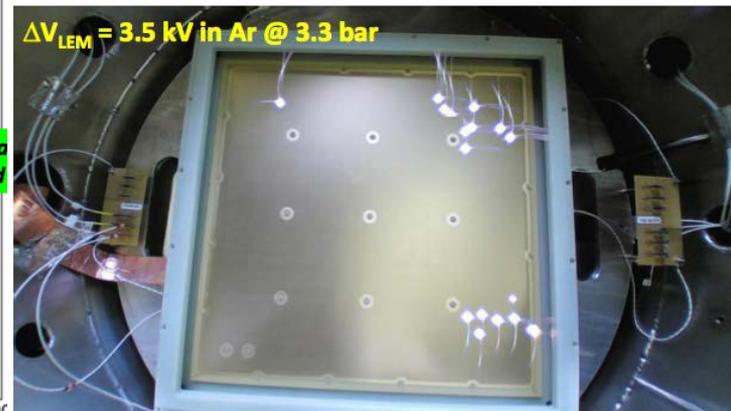
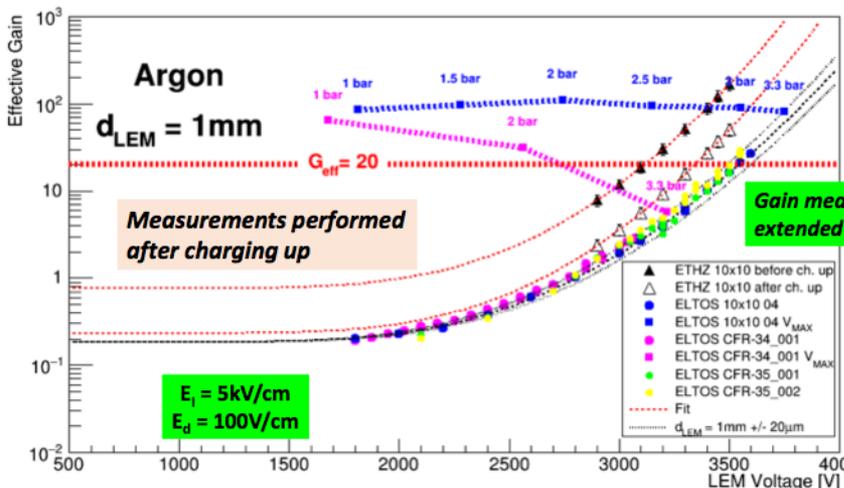
CFR35 offers a safe design with an improved stability and reaches the required HV up to 3.5 kV

**CFR-34**  $\Delta V_{LEM} = 3.3-3.5$  kV in Ar @ 3.3 bar

*Before charging-up* ~ 20 sparks/h ( > 45% of sparks near edges or corners)

**LEM CFR-35 Test in Ar @ 3.3 bar**

**Sparks Rates for LEM CFR-35**



*Before charging up*

@ 3.5kV :

- G > 100 in DLAr
- No trip for > 40h
- Spark rate : ~3/h

@ 3.1kV :

- G ~ 20 in DLAr
- No trip for > 64h
- Sparks : 0

# CRP status: LEM

- LEM production for 2 CRPs restarted in Dec. 2017 with new design.
- 28/36 LEMs for CRP1 validated so far. Expect CRP1 completed in 2-3 weeks.

## Characterisation

CEA/Irfu

LEM Survey



Soldering HV pins + glueing MACOR insulation

Ultrasonic bath

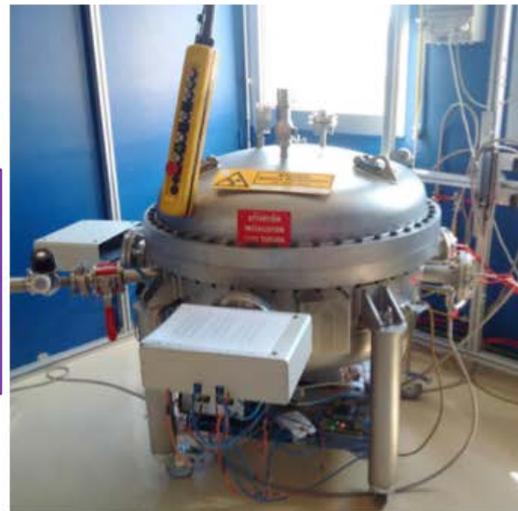


Cleaning + drying + polymerization

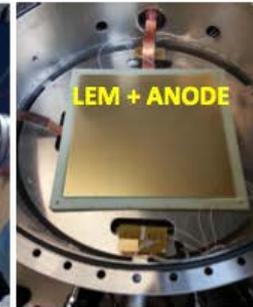


## HV Tests in a High Pressure Chamber

LEM production for CRP2 started. Should be completed by end of June



Stack of 6 LEMs



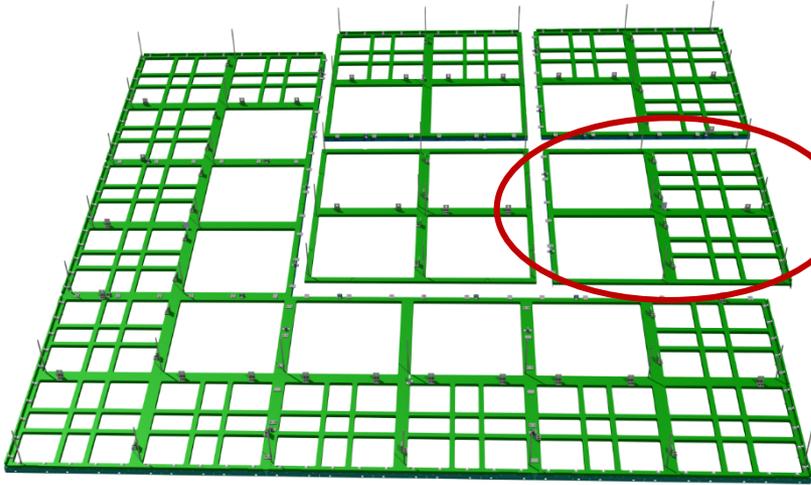
- Gain amplification inside the LEM depends on gas density  $\rho$  or  $P/T$  :

$$G^{eff} = Ce^{\alpha d} \quad \text{with} \quad \alpha = Ape^{-Bp/E}$$

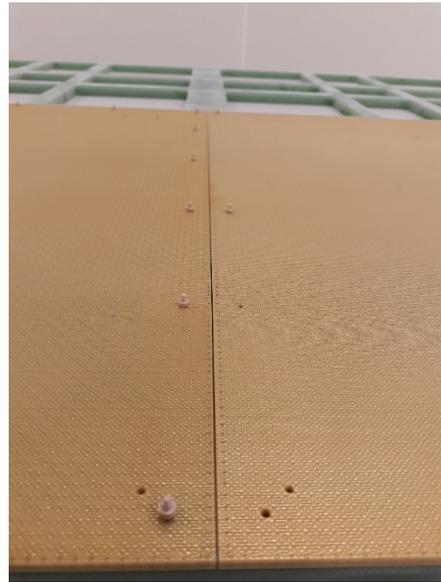
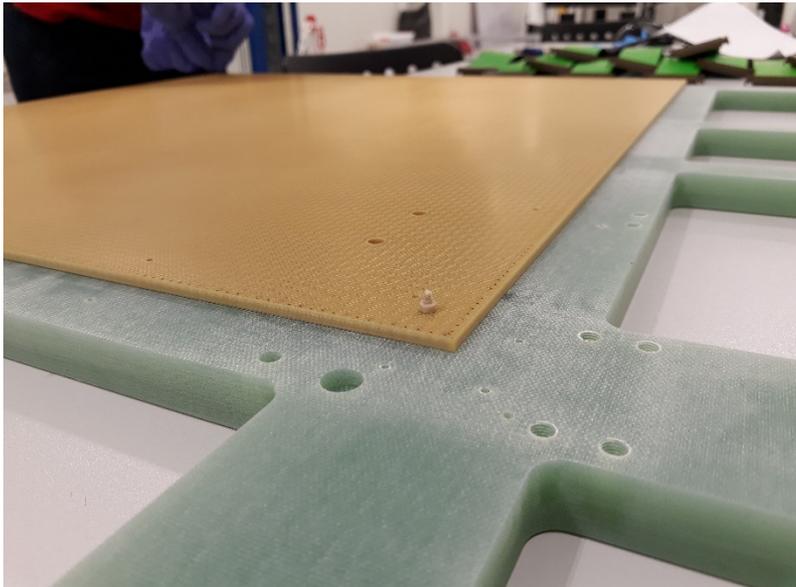
- GAr @ 87°K and ~1 bar  $\leftrightarrow$  T = 20°C and P = ~3.3bar.

# CRP status: G10 frame and Anodes

40 anodes for first CRP produced and received at CERN



Assembly test of 2 anodes on a G10 subframe for mechanical control



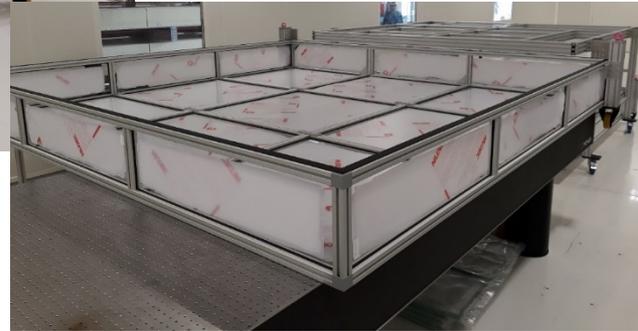
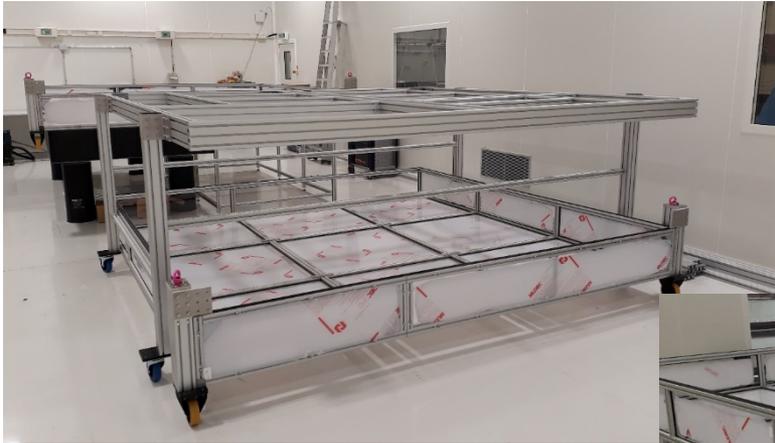
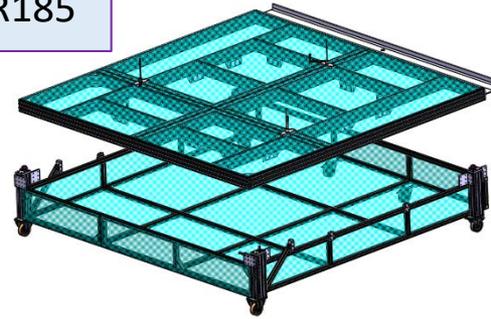
Strip continuity test done for 31 anodes

Full G10 frames batches delivery expected for the end of April

# CRP construction preparation status:

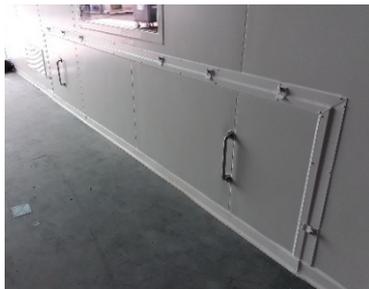
# Activities in Clean room185

2 transport boxes are being assembled in CR185



Load test of boxes end of April for safety requirements

Tooling for CRP extraction grid production ready



Special opening has been done on the side of the room to ease the CRP transport in and out

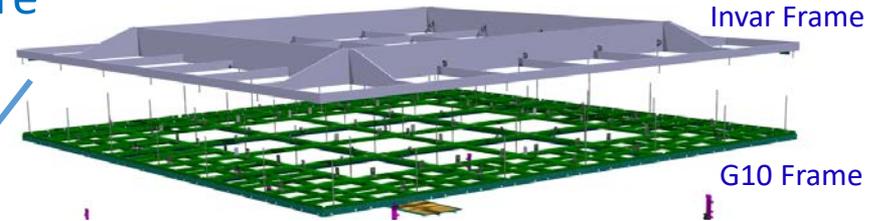
# CRP construction preparation status:

## CRP Invar frames and mechanical structure

February 2018



Invar structure being soldered at the SDMS company



4 CRP Invar frames + 1 mock-up for load test delivered last month at CERN.

March 8th 2018



# ProtoDUNE-DP plan

The ProtoDUNE-DP collaboration is committed to demonstrate the Dual Phase concept at the kton scale in a time-scale useful for the DUNE Technical Design Report, as recommended by SPSC in January.

Goal: build ProtoDUNE-DP detector with 2 active CRPs and 2 non instrumented CRP frames but with ground plates to guarantee the closure of the field lines.

## Schedule:

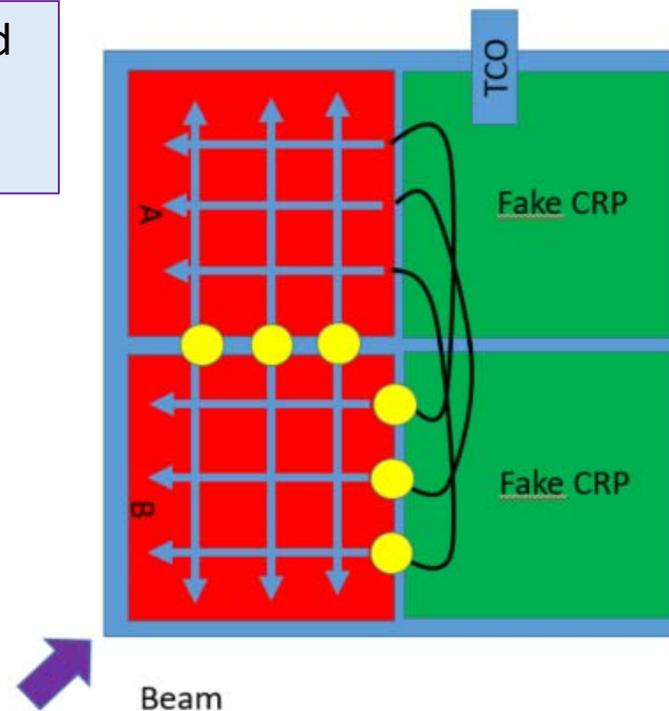
### CRP 1:

- Start of assembly in CR 185: end of April
- End of assembly in CR 185: end of May
- Cold test: June (1 month)
- Installation in EHN1: July

### CRP 2:

- Start of assembly in CR 185: beginning of June
- End of assembly in CR 185: beginning of July
- Cold test: July (1 month)
- Installation in EHN1: August

**CRPs 3&4:** Fake (not instrumented with LEMs and anodes) to be prepared after July



## ProtoDUNE-DP

- Field cage assembly completed and first HV test performed
  - A cold box has been built to allow full CRP to be tested at cold
  - New LEM design improving the HV stability are produced
  - Assembly of the first CRP will start in a few weeks
  - Production of several critical detector components ongoing:
    - Cathode
    - Signal feedthroughs
    - CRP instrumentation feedthroughs
  - Electronics and light readout systems are in advanced status
- => Goal to complete and install the detector by October