17/3/2021

VD Top Drift Electronics (TDE) Consortium Meeting

D. Autiero, T. Hasegawa

- An overview of the TDE Consortium Activities was given at the DUNE Collaboration meeting in January (the set of slides is also repeated in the following for reference)

Today:

- T. Coan (SMU) apologizes not to be able to attend this time due a clash with another meeting

- Discussion on the chimneys tests at Orsay IJCLAB, preparation for the mini-chimneys for the cold box tests of VD Top CRP, design activities of VD chimney with 50 cards (Fabien)

- General discussion on the Consortium activities in view of the preparation for the 2021 tests campaign (Dario)

Next:

- Ongoing activity with S. Kettel to prepare the WBS and other documents for the US project, in progress, meeting foreseen with Steve and Raj in the next days → we will have a discussion on this point at the next consortium meeting once the situation is more advanced

- Ongoing activity also to finalize interfaces with CRP consortium, CRP adapter boards → will be discussed next time

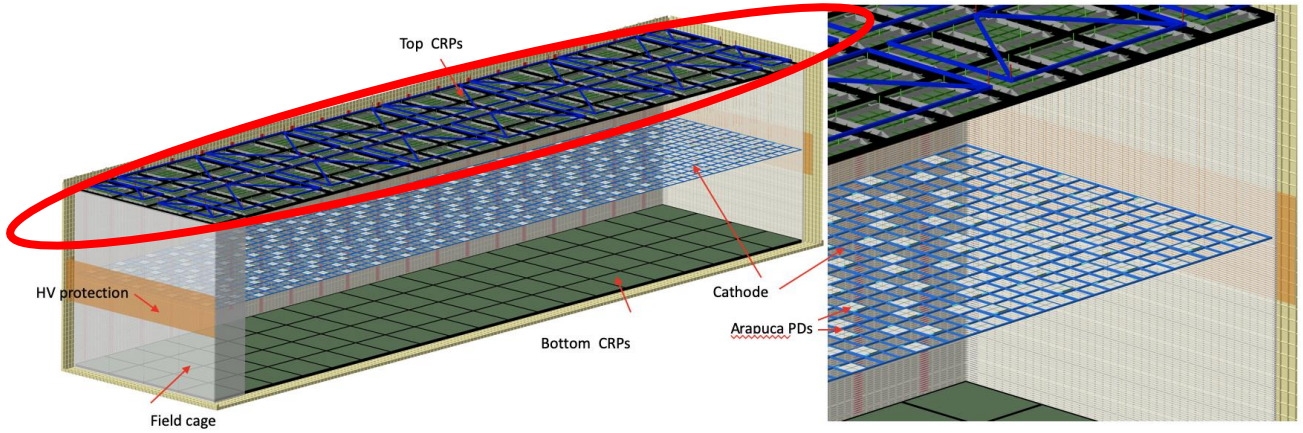
Top Drift Electronics Consortium

D.Autiero (IP2I Lyon), T.Hasegawa (KEK)

DUNE General Meeting

25 Jan 2021

Top Drift Electronics Consortium for the VD Far Detector module



- The Top Drift Electronics (TDE) Consortium will take care of the electronics for the charge readout of the CRPs of the top drift of the Vertical Drift Far Detector module

CL: D. Autiero (IP2I, France) autiero@cern.ch; TL: T. Hasegawa (KEK, Japan) takuya.hasegawa@kek.jp

- The TDE Consortium is an evolution of the former Dual-Phase Electronics Consortium, including institutions from France, Japan and USA.

- The TDE Consortium is open to new member institutions who will be very welcome to join this effort

→ please let us (Dario and Takuya) know if you are interested

- A new mailing list has been created asking for subscriptions in the collaboration

TOP drift electronics concept

- **The vertical drift concept** evolves naturally from the dual-phase design, which has been implemented in ProtoDUNE dual-phase

- **The top drift volume** is particularly similar to a dual-phase detector with the CRPs suspended from the cryostat roof and adjustable superstructures (3x2 CRPs)

- This scheme allows using the **dual-phase electronics** that was designed by the **DP TPC Electronics Consortium** to read strips at high capacitance and **successfully working and validated on the 3x1x1 and NP02 ProtoDUNE-DP detectors.**

- It represents the **reference design in the TDR for the DP far detector module**:
  https://docs.dunescience.org/cgi-bin/private/ShowDocument?docid=20540

- All components produced for protoDUNE-DP (~1/20 of top drift), **good understanding of costs and production**

- In particular, this design **preserves the possibility of accessing at any time the FE electronics**, even the cold electronics (via the signal feedthrough chimneys)

- **Accessibility** to the electronics provides also the **opportunity of profiting from technological evolutions with time**, in particular for the digital components, and of additional costs reductions.

TOP drift electronics concept

- **The top drift CRPs** may be exposed to formation of bubbles or dust contamination on the liquid surface pushed up during the detector filling that could trigger sparking in the anodes.

- Although this risk is extremely low, the **accessibility of the electronics is an additional guarantee (life insurance) of perfect functioning of the detector over a very long lifetime span.**

- These aspects related to the top CRPs position, just above the LAr level, are **absent for the electronics used for the readout of the bottom drift** where CRPs which are lying on the cryostat floor.

- The bottom drift space is more similar to a **SP detector configuration**

- Given the **distance from the roof of the cryostat the only implementable readout scheme for the electronics on the cryostat floor** corresponds to the single phase electronics, designed to operate in similar condition to collect signals at the bottom of the APAs.

TOP drift electronics concept

- Main interfaces:

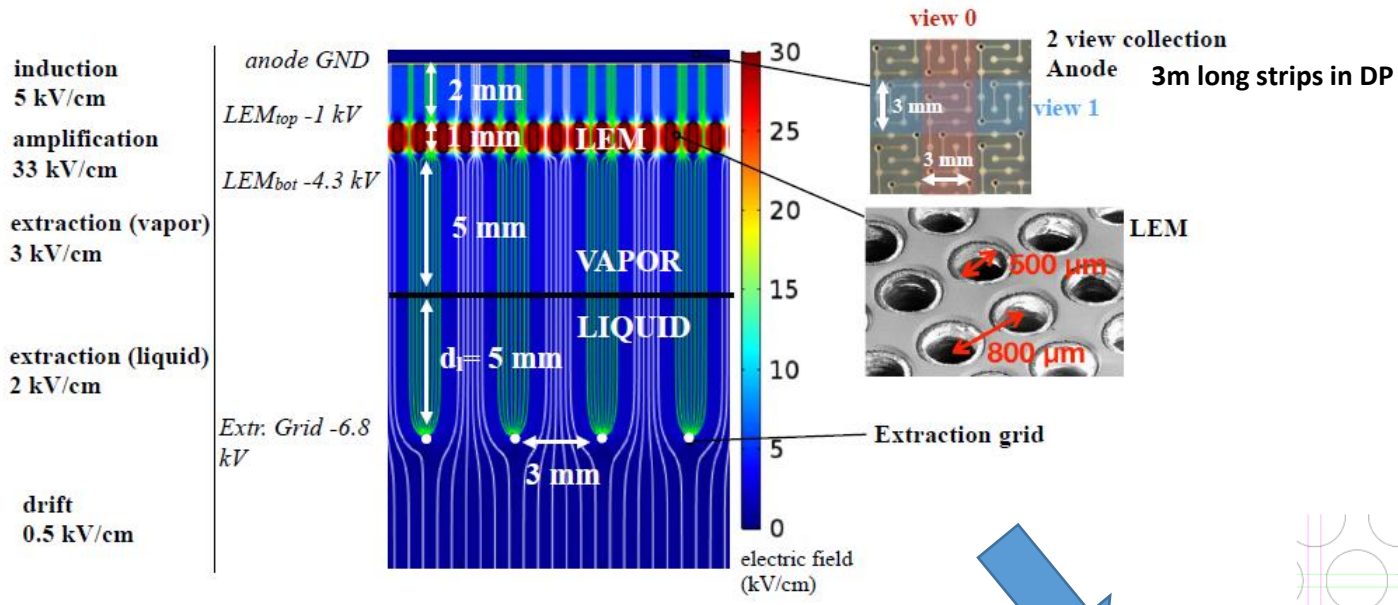
➢ CRPs: similar cabling with flat cables going from top drift CRP anodes to the cold flanges of the chimneys as for DP CRPs (see CRP Consortium talk by Dominique)

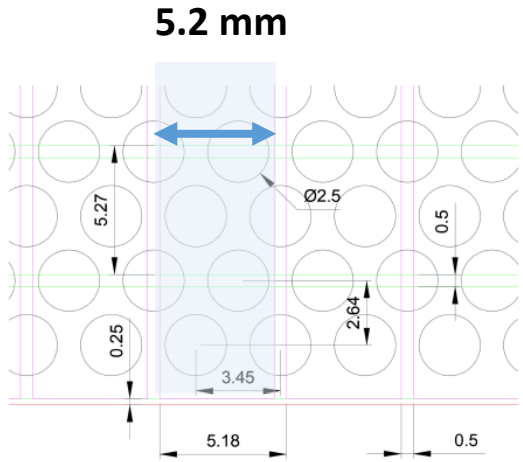
➢ DAQ: already joint SP/DP DAQ foreseen in the TDR, similar for VD with continuous sampling and data streaming from TDE digital FE (AMC cards in uTCA crates) via 40 Gbit/s **optical fibers links**. Common timing, integrated timing distribution system to uTCA crates via White Rabbit. (see DAQ Consortium talk by Alessandro)

➢ Cryostat: chimneys penetration, integrated design developed in collaboration with CERN

➢ Infrastructure/integration: distribution of LV to chimneys, LV generation and filtering system

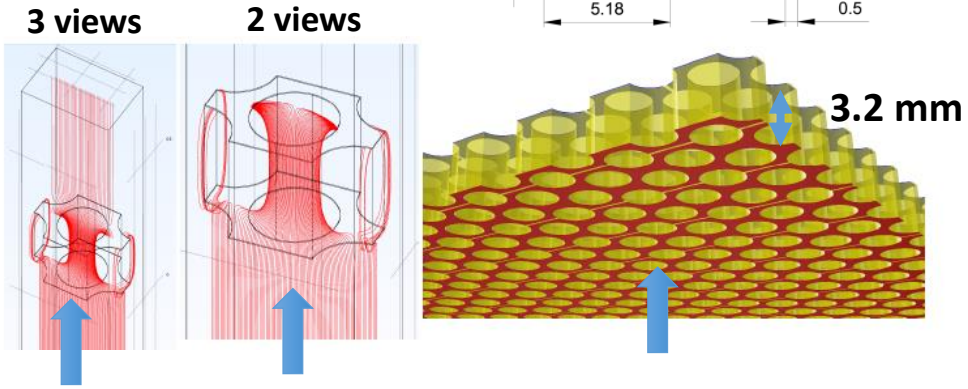
Evolution of CRP charge readout stack: Dual-Phase → Vertical Drift





Vertical drift:

- **Anode PCB (3.2 mm thick) directly immersed in LAr, 2.5 mm holes**
- **Perpendicular strips on the top and bottom faces of the PCB: 5.2 mm pitch, 1.5 or 1.68 m long**
- **Bottom strips induction signals, top strips collection, 1kV across for full transparency**



Vertical Drift vs DP

Signal reduction related to **unitary gain in VD is compensated by a few favorable differences with respect to the DP configuration:**

a) factor 2 is gained by not having to share the charge among two collection views
b) factor 1.7 is given by the strips pitch increase (5.2mm instead of 3.1 mm)
c) factor 1.6 is gained by the absence of the DP extraction/collection efficiencies (0.63)

- **VD overall signal increase factor (x5.3) similar to the DP TDR requirement (gain=6)**

- In addition **DP gain requirement was defined for a more unfavorable** drift length and drift field **configuration present in DP (250V/cm, 12m drift, 5ms lifetime)**

→ requirement relaxed by 4 (equivalent gain 1.5) for 300V/cm, 6.5m drift, 6 ms lifetime
or by 5.2 (equivalent gain ~1) for 500V/cm, 6.5m drift, 6 ms lifetime (~300kV at cathode)

- **Strips capacitance is also lower for VD**: (<100 pF/m) over about 1.5 m length to be compared to 160pF/m over 3m length in case of DP configuration.

ProtoDUNE-DP accessible cryogenic front-end electronics and uTCA FE system

Full accessibility provided by the dual-phase charge readout at the top of the detector

➢ **Digital electronics at warm on the tank roof:**

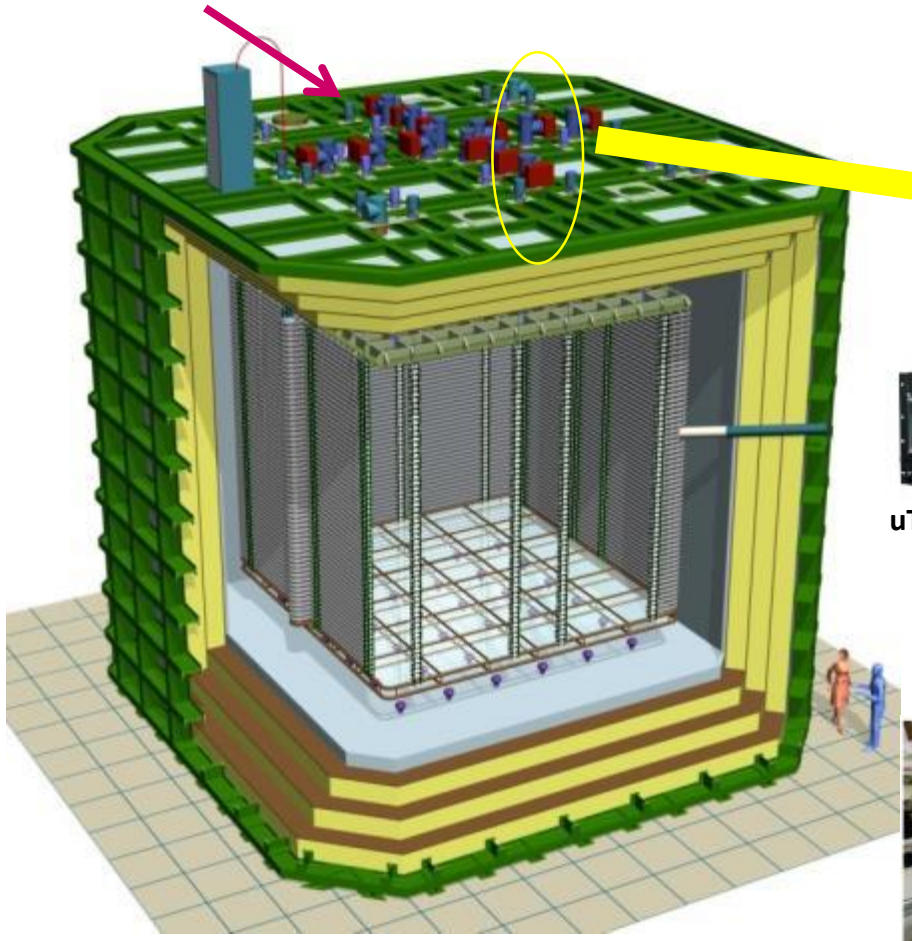
- Architecture based on uTCA standard
- 1 crate/signal chimney, 640 channels/crate

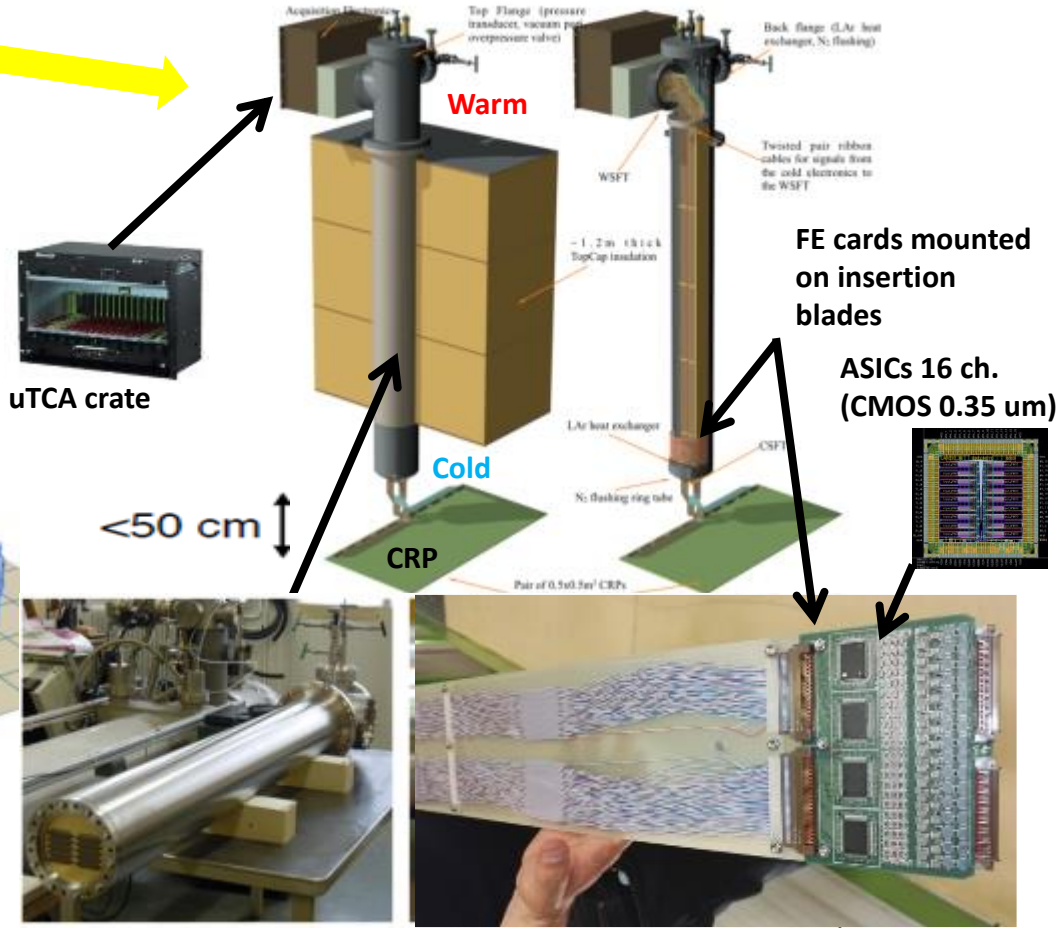
→ 12 uTCA crates, 10 AMC cards/crate, 64 ch/card

➢ **Cryogenic ASIC amplifiers (CMOS 0.35um) 16 ch externally accessible:**

- Operating at 110K at the bottom of the signal chimneys
- Cards fixed to a plug accessible from outside

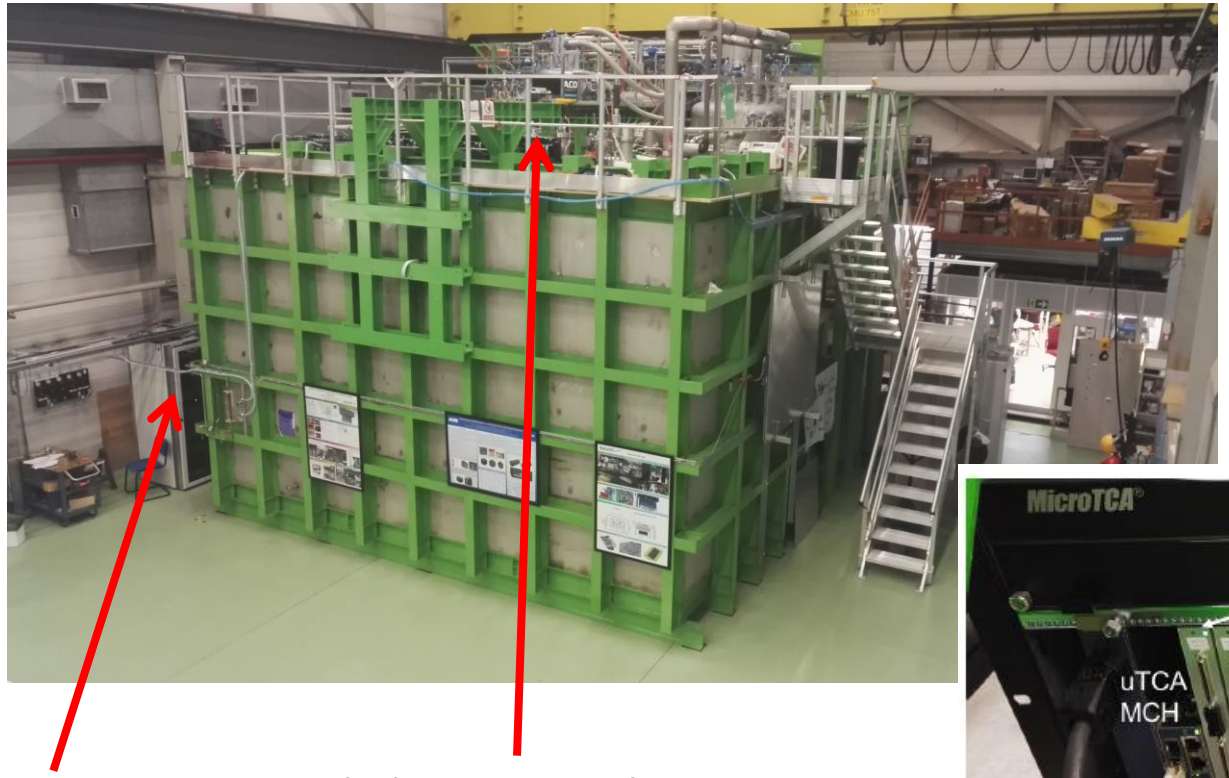
→Short cables capacitance, low noise at low T





Signal chimney

- **R&D on analog and digital charge readout electronics pursued since 2006 aimed at building a large system at low costs**
- **First large scale application in 2016 3x1x1 detector : 4 chimneys/uTCA crates (20 AMCs, 1280 readout channels), smaller chimneys 5 FE cards instead than 10 FE cards for protoDUNE-DP**
- **ProtoDUNE dual-phase: 12 chimneys/uTCA crates (120 AMCs, 7680 readout channels)**

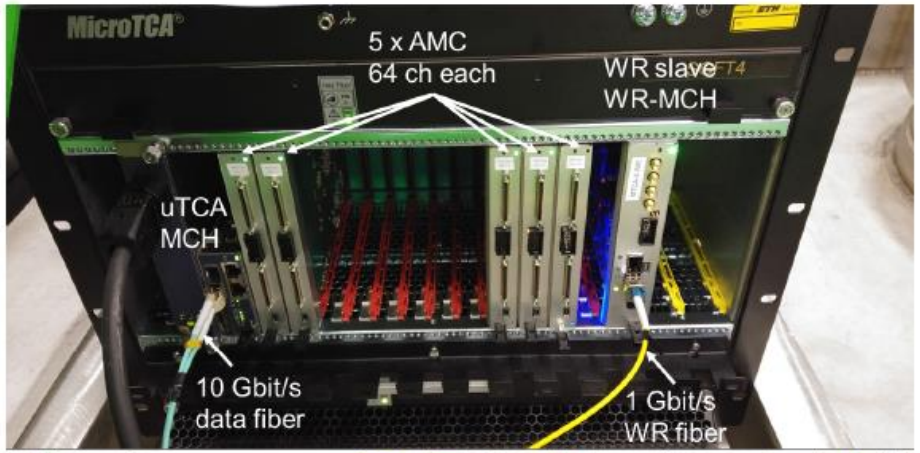


Signal Chimneys and uTCA crates

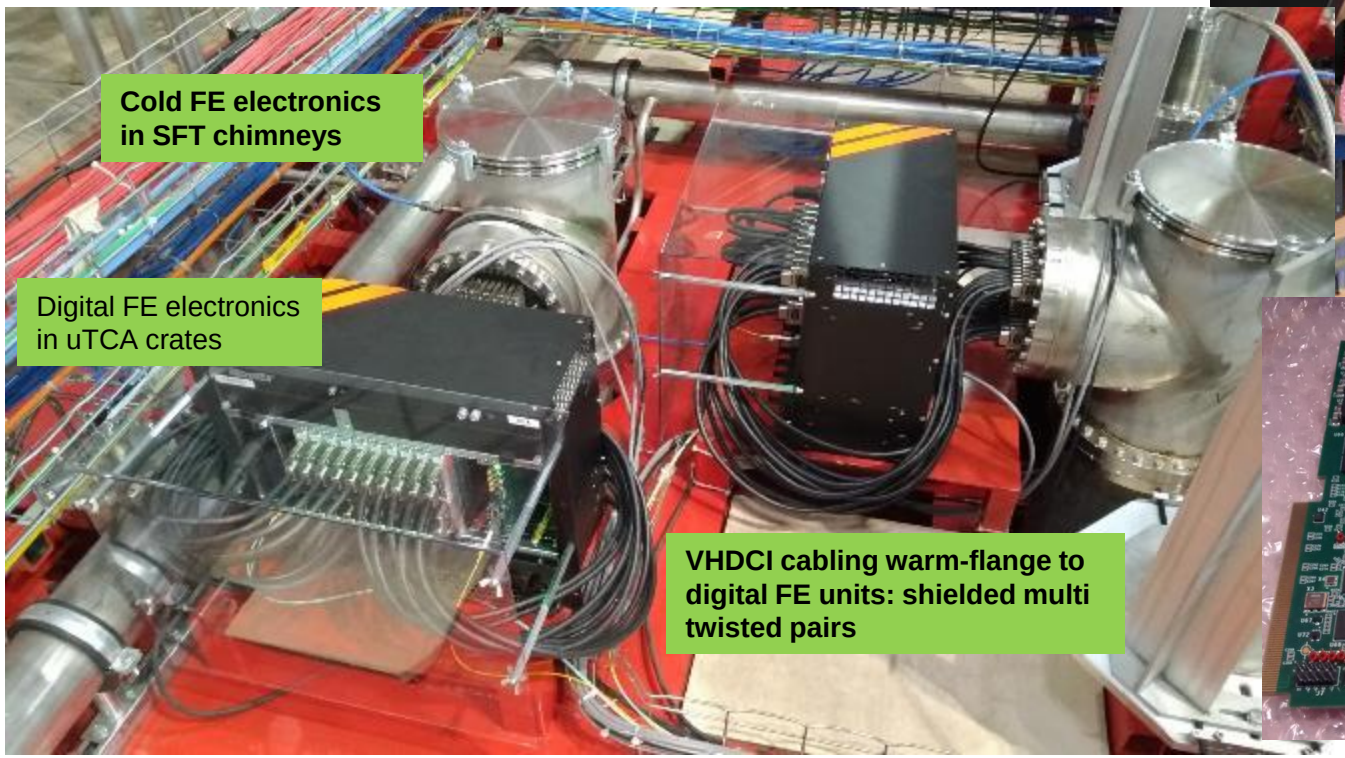
Event builder, network, GPS/White Rabbit GM, WR Trigger PC

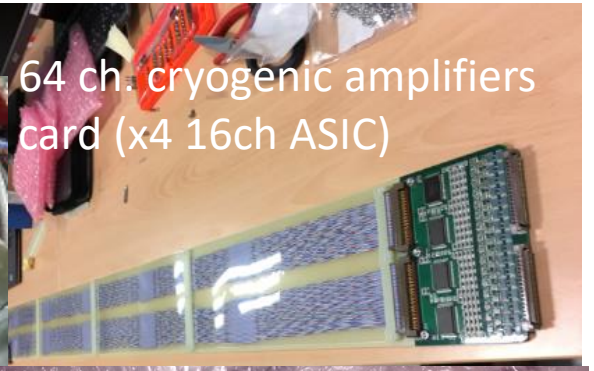
Electronics/DAQ system smoothly operational in the period November 2016-March 2018

3x1x1 paper on JINST:
https://arxiv.org/abs/1806.03317



ProtoDUNE-DP FE electronics

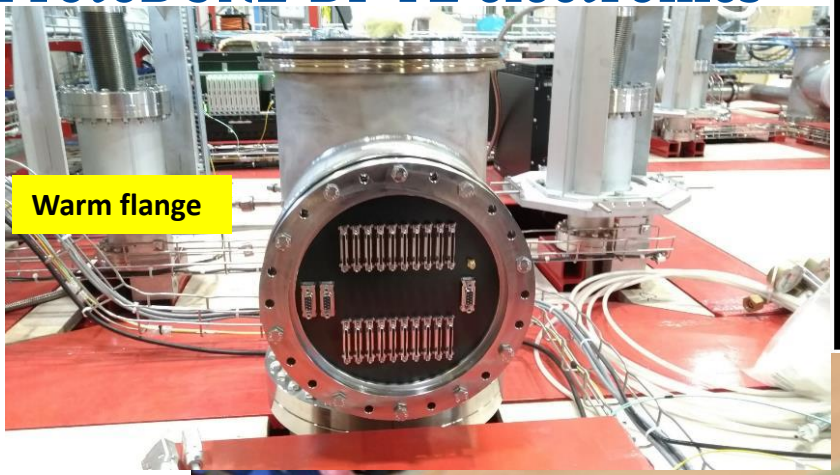


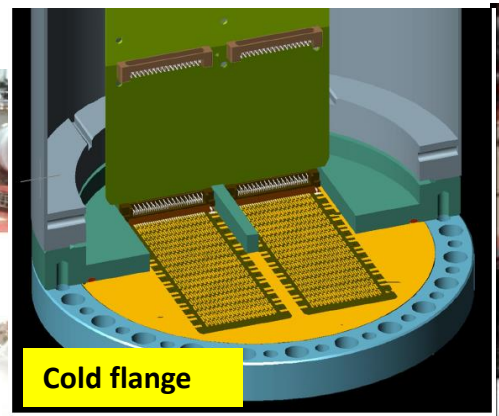


White-Rabbit timing slave node in each uTCA crate →

- 64 channels modularity for both analog and digital FE
- Electronics noise ~600 electrons
- uTCA crates containing 10 (up to 12) FE cards
- 10 Gbit/s (now 40 Gbit/s) connectivity of each uTCA crate
- Reference design for DP far detector module TDR
- Components produced for protoDUNE-DP → 1/20 of a DP FD module

ProtoDUNE-DP FE electronics





- **Signal feed-through chimneys** containing the cryogenic amplifier cards mounted on the extraction blades

- **Cryogenic amplifiers in the signal feedthrough chimneys accessible at any time** without interfering with the functioning of the rest of the detector. Simple intervention, routinely exploited during NP02 operation

  (see also movie at: https://drive.google.com/file/d/16f2ADi4x-CpcNQltQHwR8ZUdAB4VtB1h/view)

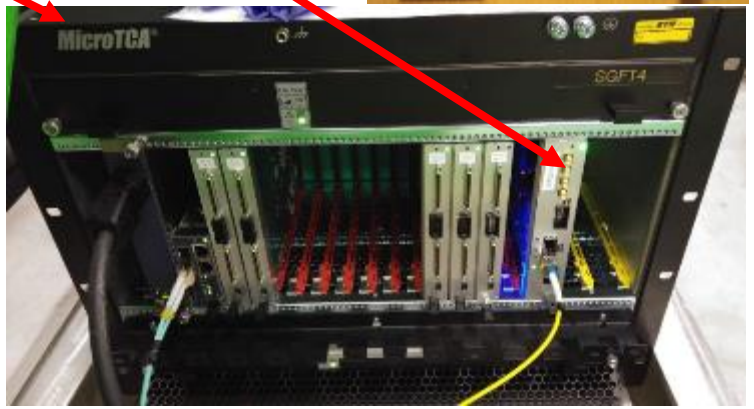
Readout system for a 10 kton dual-phase module (DUNE TDR DP Volume)

Total number of charge readout channels: 153600

- Cryogenic ASICs (16 ch): 9600
- Cryogenic FE cards (64 ch): 2400

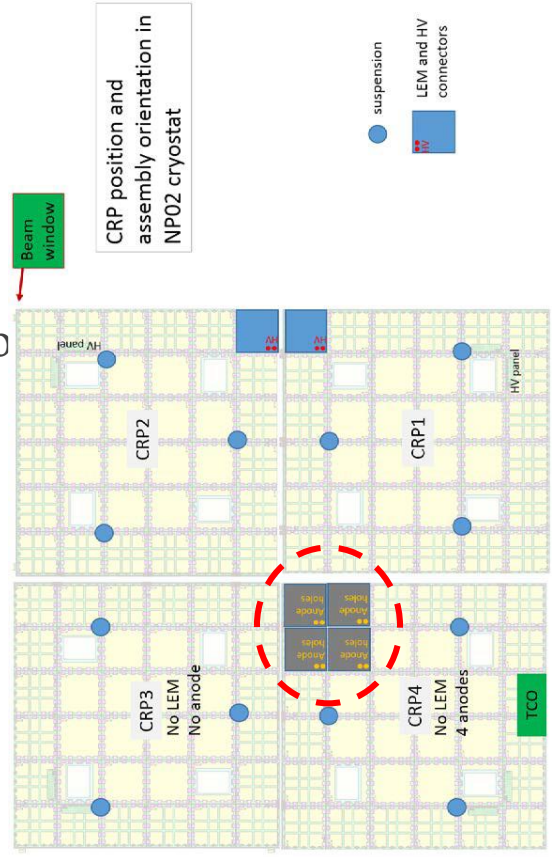
- AMC cards (64 ch): 2400
- uTCA White Rabbit MCH: 240
- uTCA crates (including MCH,PU,FU): 240
- 10 Gbe optical links to backend: 240
- VHDCI cables (32 ch) 4800

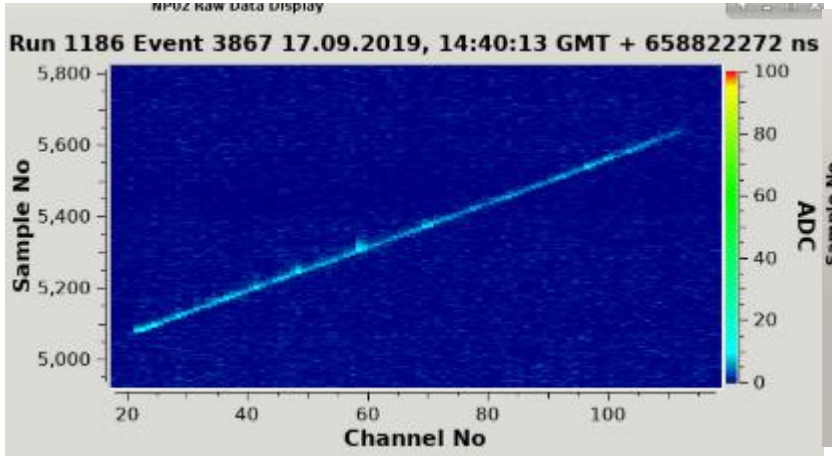
White Rabbit switches (18 ports): 16

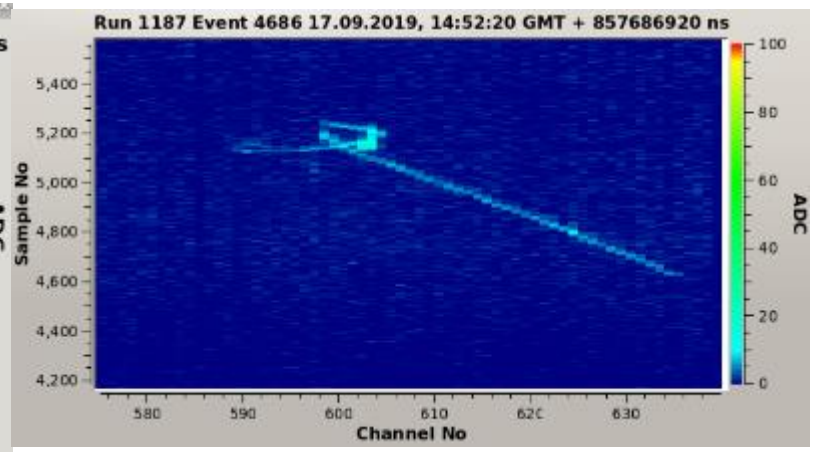


ProtoDUNE-DP: CRP 4 anodes

- CRP 4 in protoDUNE-DP had no LEMs (only extraction grid + anodes)
- Instrumented with 4 anodes connected to the charge readout.
- Readout signal by >~4 lower w.r.t. a VD anode geometry, due to charge sharing and strips pitch, plus low charge yield due to low and dis-uniform drift field ~170V/cm
- dE/dx measurements used as consistency check of the gain assessment of the two CRPs instrumented with LEMs
- NP02 CRPs also operated immersed in LAr at the end of August 2020 run







TOP drift electronics

- The **top drift electronics essentially unchanged with respect to the dual-phase design** documented in the TDR and deployed and validated in 3x1x1 and in ProtoDUNE-DP NP02.

- Foreseen to use for top drift: DP **analog FE cards with the same cryogenic ASICS**, plugged at the bottom of the **signal feedthrough chimneys** and the **digital FE electronics and associated timing distribution system located in the uTCA crates** on the cryostat roof.

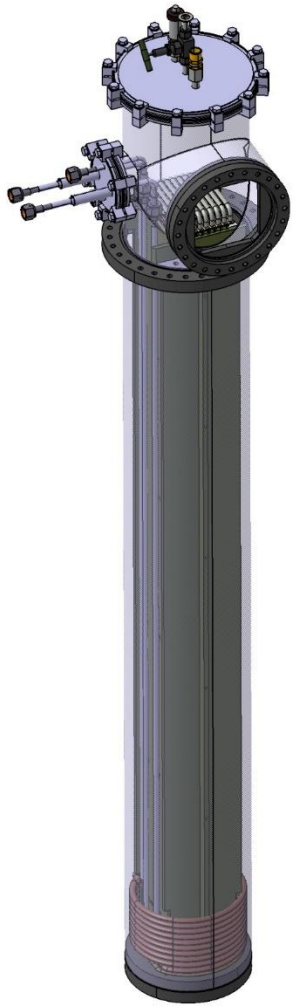
- **Strips length ½ of DP but pitch ~ 2x**

→ similar channels counting as DP module

TABLE I. Top drift charge readout electronics: units counts

Quantity	2-view Configuration	3-view Configuration
1.5m x 1.7m CRU in the top drift	320	320
Anode channels per CRP	2432	3200
Channels per FE card or AMC card	64	64
FE cards or AMC cards per CRP	38	50
Number of SFT	105	105
FE card slots per SFT	50	50
Installed FE cards per SFT	38	50
uTCA crates	320	400
WR-MCH	320	400
40 Gb/s data links	320	400
Anode channels in the top drift	194,560	256,000

- **Minor interface aspects** to be practically worked out:
  - **Signal feedthrough chimneys** which are now larger and containing more cards (see next slide)
  - **Removal of some passive components on the cryogenic Front-End cards** (few resistors and decoupling capacitors) used to bias to ground potential the DP strips These components will be directly on the VD anodes, as part of the anode biasing system.

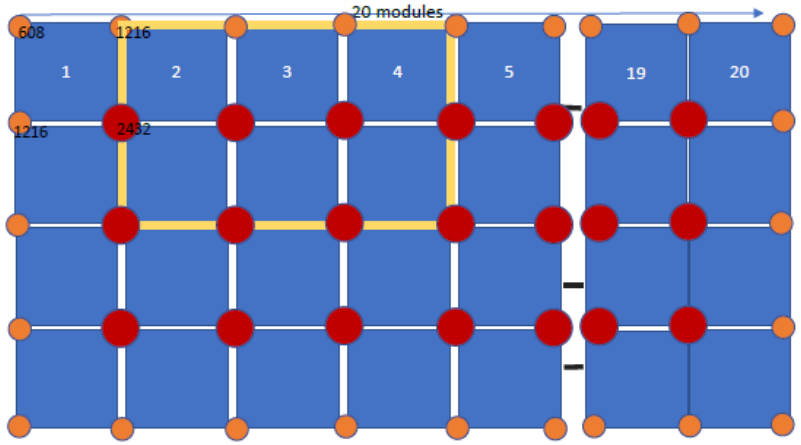


- **Good experience fromSignal feed-through chimneys** for 10 cards implemented in NP02/ProtoDUNE dual-phase
- Within the activities of the DP Electronics consortium the Orsay group further developed that the design in order to optimize it for mass production and making it cheaper
- VD design activities showed the opportunity for a further optimization (still based on the same basic design) by increasing the diameter of the penetration for the pipes and hosting more cards (see next slide)

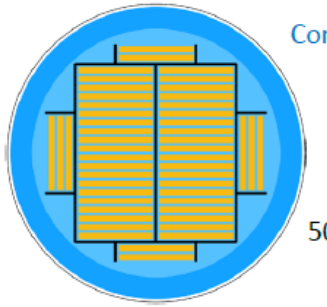
TOP drift electronics: chimneys optimization

Upper Electronic Feedthroughs

Top chimney topology: connexion at each CRP corner



Total 105 feedthroughs
The peripherical one can be of smaller radius!



Connexion similar to DP CRP

50 cards can fit inside!

Pipe internal diameter : 48 cm

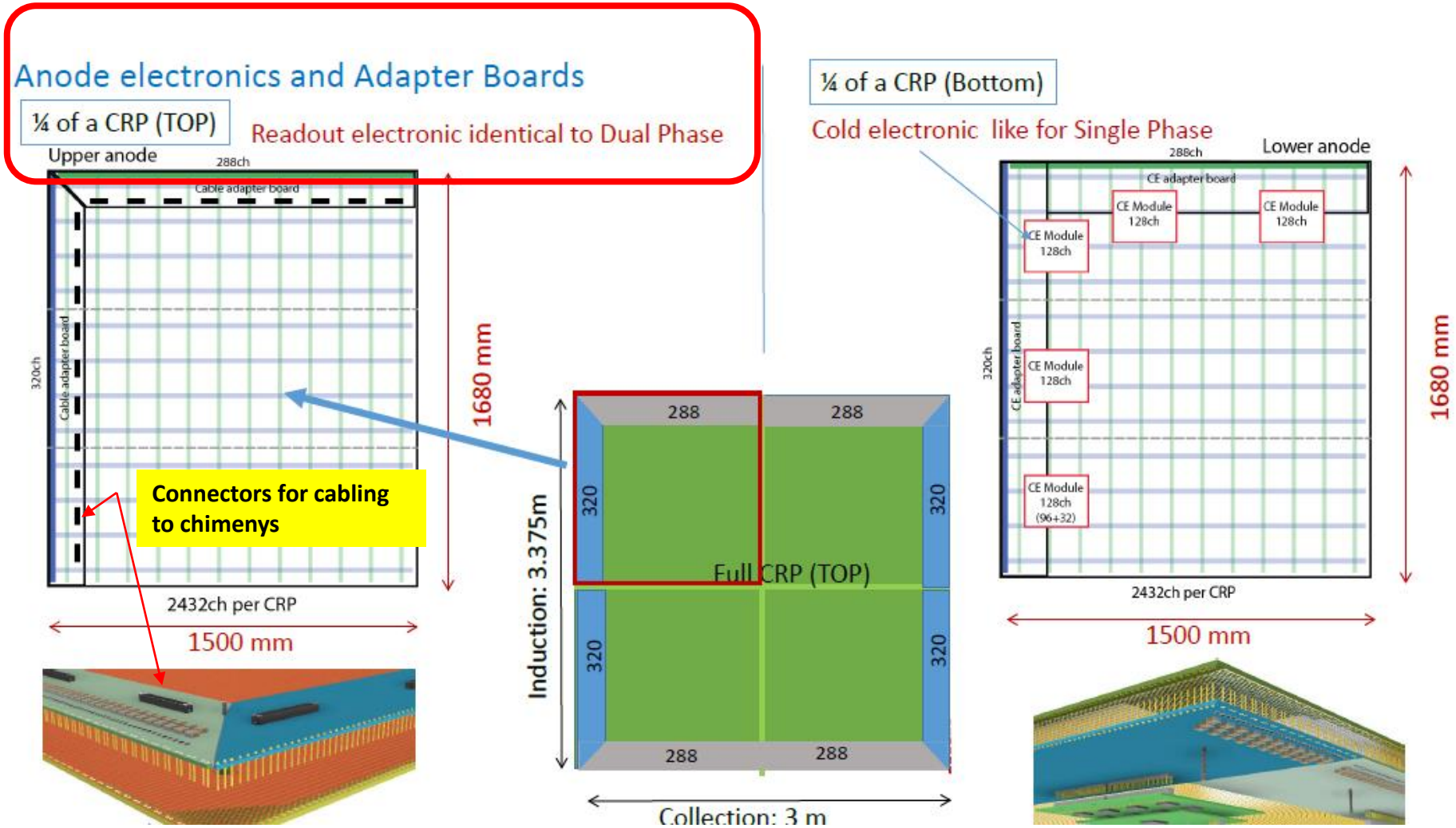
- Experience with the cryostat design has shown that **larger penetrations** are possible and desirable.

- Signal feedthrough chimneys **optimized by keeping the same design as in NP02** but by exploiting larger cryostat penetrations, each one capable of **containing up to 50 cards and serving 4 quarters** of different CRPs.

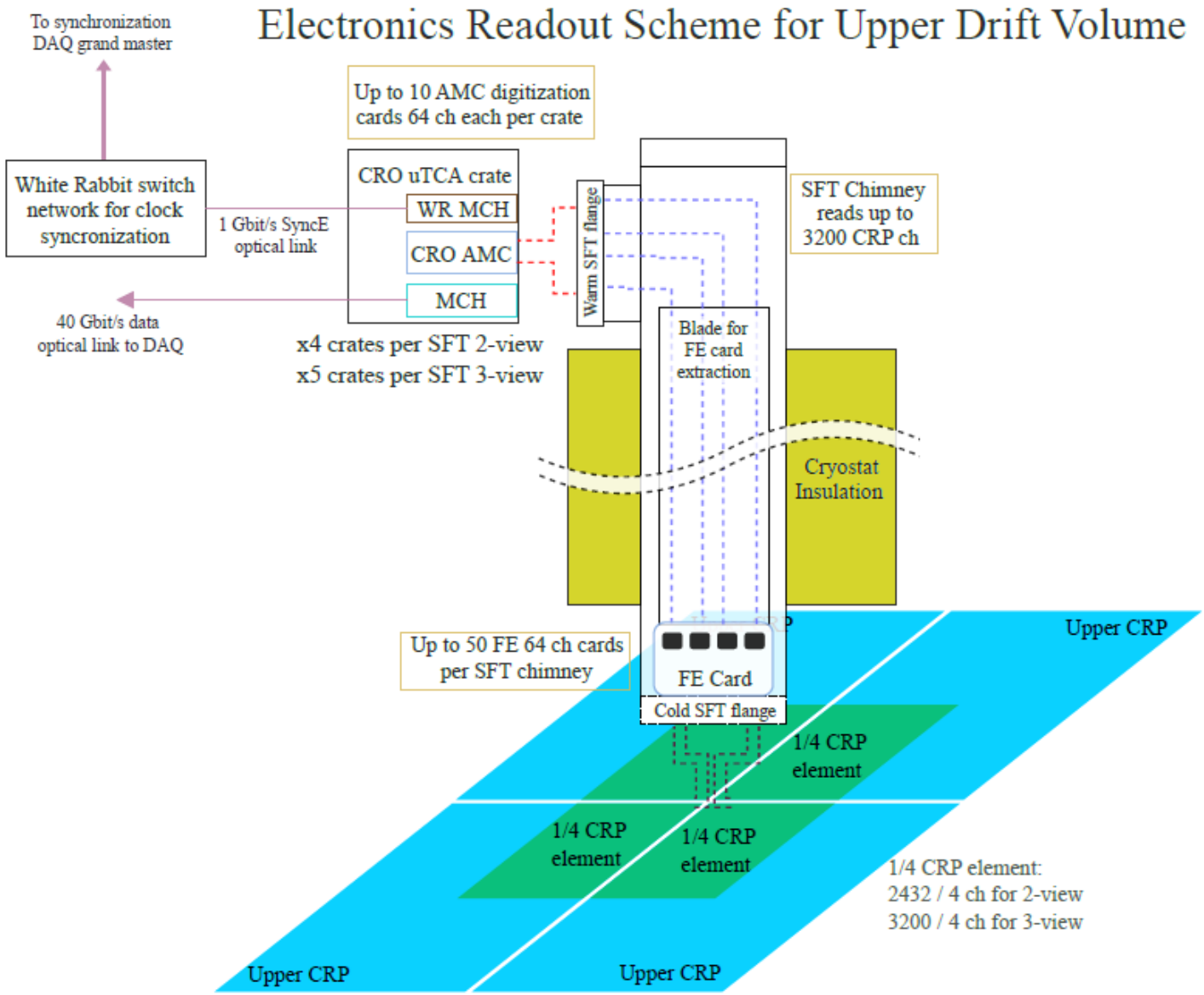
- **105 chimneys accommodating also the possibility for 3 views readout**

- **Cables from the CRPs to the feedthroughs may be slightly longer** with respect to what was done for the DP in between 1.5 and 2m instead of 1.5m for NP02.

TOP drift readout: anodes layout and connections for cabling

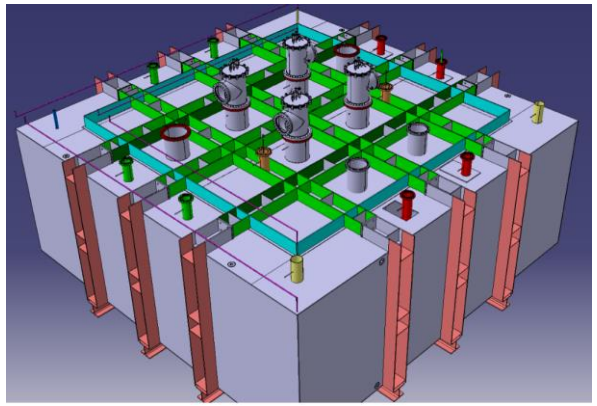


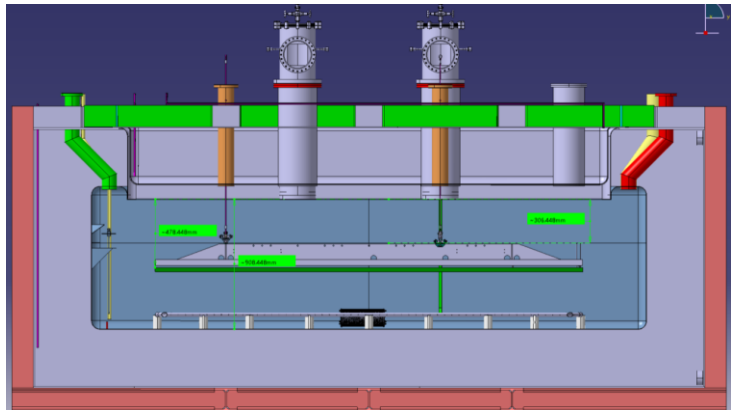
TOP drift readout: general layout



TDE Consortium 2021 test activities:

- Intensive activity foreseen to support and perform the top drift CRPs cold box tests (up to 50 FE cards) (see also VD proposal document)





- Given the layout of the cold box shorter versions of the 10 cards chimneys will be used

Cold box test:

- Cold box to be refurbished and installed at EHN1 by April 2021
- Cryogenics commissioning of the empty cold box in May 2021
- Receive all the detector components at CERN by June 2021
- Integrate the detector components in the NP02 clean room in July 2021
- Insert the VD module in the cold box in August 2021
- Operate the VD TPC in the cold box from September to November 2021 (up to 3 tests are feasible)
- December 2021 present the results to the CD2 IPR

List of TDE components (max quantities):

- Chimneys: 5
- Warm + Cold Flanges PCBs : 5+5
- Blades: 50
- FE Cards: 50
- uTCA digitization cards: 50
- uTCA crates: 5
- White Rabbit slave cards: 5
- Low voltage power supply + distribution system
- Cabling

TDE Consortium longer term activities:

- Completion of tests activities in 2021 at CERN
- Module 0, NP02 activities 2022-2023
- Entering in the mass production aspects (**production expected in ~2024**) for this very large system (industrialization, further costs reduction, production management, tests QA/QC, installation, commissioning). We have the experience from ~1/20 but **this is a large effort and help is very welcome !**

1) **Finalization of the AMC design for large scale production (replacement of a few obsolete components, removal of some components not used, further costs reductions) → in progress**
2) **Finalization of cryogenic FE cards (maybe slightly reshaped is size for new chimneys also profiting of the removal of some components)**
3) **Definition of all grounding aspects for the large scale system for FD and industrialization of the LV distribution system**
4) **Preparation for large scale production of warm/cold flanges**
5) **Finalization of test system for analog electronics ASIC**
6) **Firmware finalization**
7) **DAQ/timing interfaces finalization**
8) **Cabling finalization**

Finalization/Preparation for massive production

9) **ASICs production and tests**
10) **Cryogenic FE cards production and tests**
11) **Chimneys production and tests**
12) **AMC digitization cards production and tests**
13) **Timing system components production and tests**
14) **uTCA system infrastructure production and tests**
15) **LV distribution system production and tests**

Production

16) **Definition of installation and commissioning procedures and all practical integration aspects**
17) **Installation and commissioning**

Installation/Commissioning

Summary

- The top drift electronics for the vertical drift capitalizes on the dual-phase electronics design documented in the TDR and successfully deployed in NP02. The main elements can be used with little modifications

- It preserves interesting features such as the complete external accessibility of the electronics (including the cryogenic amplifiers) guaranteeing risks minimization and perfect functioning over a very long lifetime span as well as the possibility of profiting of technological/economical evolutions

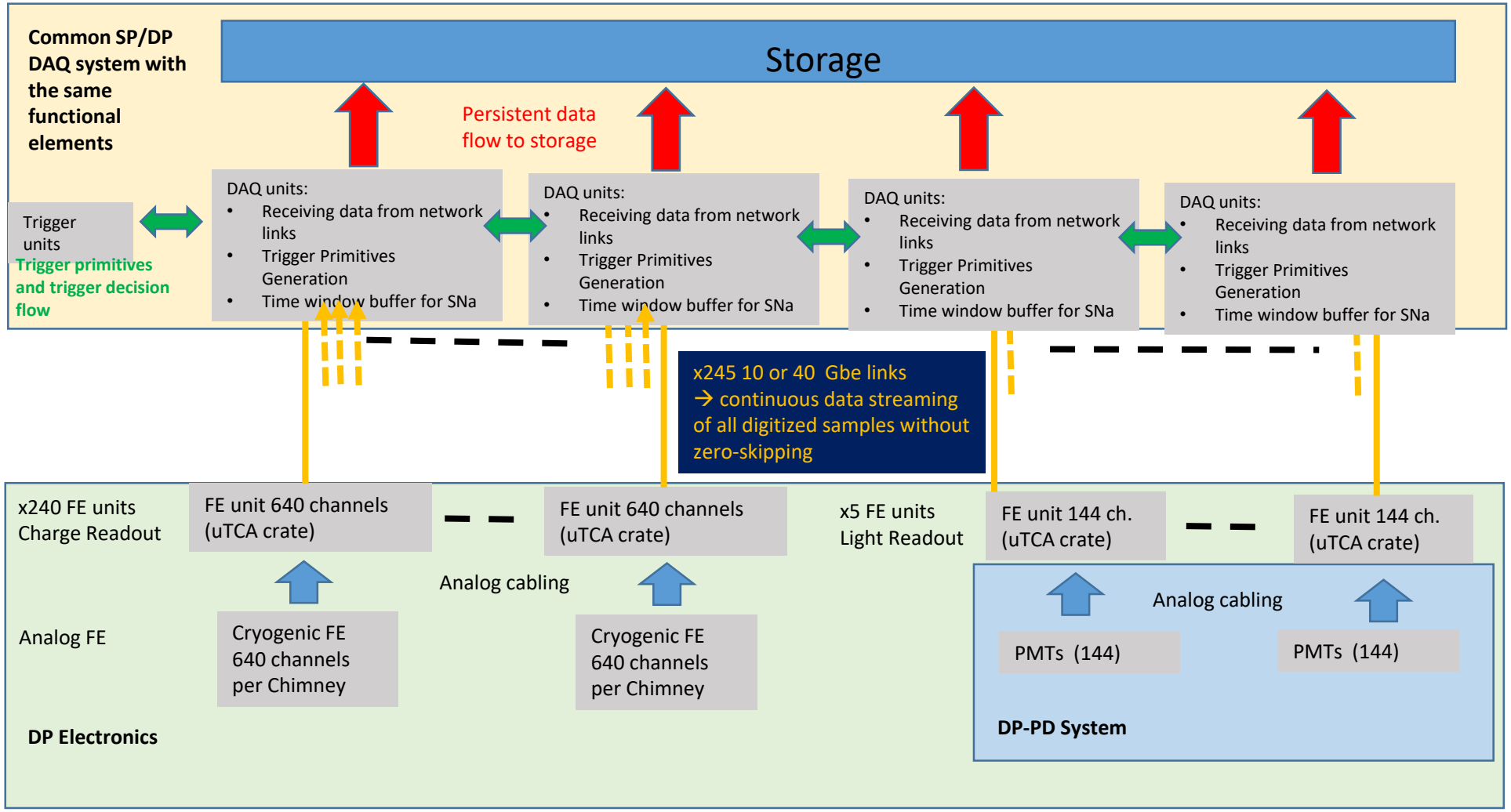
- Chimneys layout optimized by exploiting larger cryostat penetrations

- Top drift readout layout compatible with both 2/3 views anode readout (+31% channels with 3 views)

- Full scale integration test with VD top drift CRP foreseen in 2021 with cold-box program

- The Top Drift Electronics consortium, evolving from the former DP electronics consortium, is now established in DUNE. New institutions joining this effort are very welcome

DUNE TDR: DAQ back-end interface for 10 kton DP module (joint SP/DP DAQ back-end system)



17/3/2021

D.A.

TDE Consortium activities in support of the VD tests campaign

Test activities were already described in the proposal document:
https://edms.cern.ch/file/2429382/1/VERTICAL_SINGLE_PHASE_LARTPC_Draft_1_no_linenumbers.pdf

and presented to the reviews (LBNC, Director's review, IPR) in December/January

Two aspects supported by the VD Top Electronics Consortium happening in parallel in 2021:

-Test of Top CRP in cold box with associated electronics → New

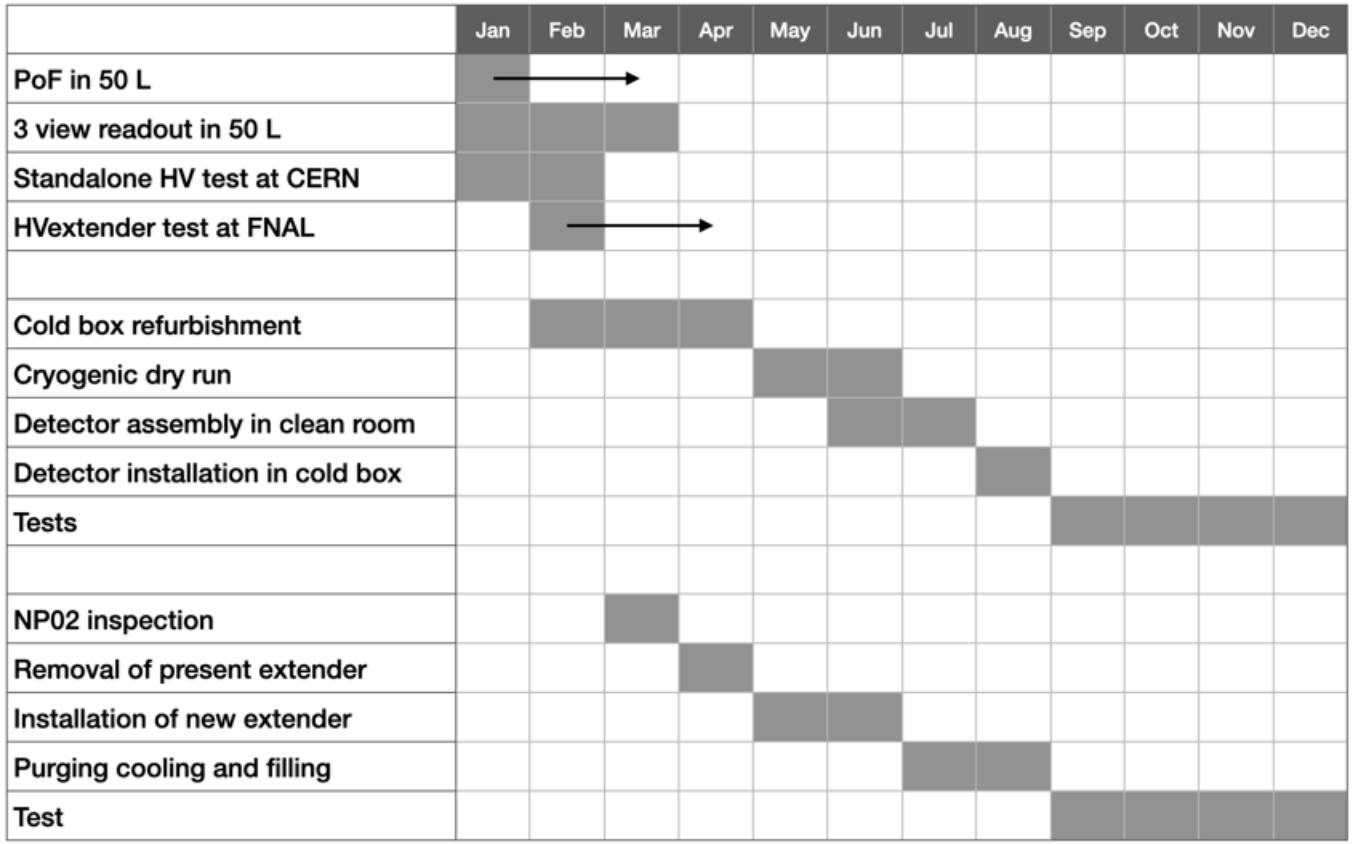
-Support to protoDUNE-DP electronics for the HV extender tests (this implies also keeping electronics alive, spares and maintenance)

From Director Review December 2020

Cold Box CRP tests

HV test in NP02

Overall schedule

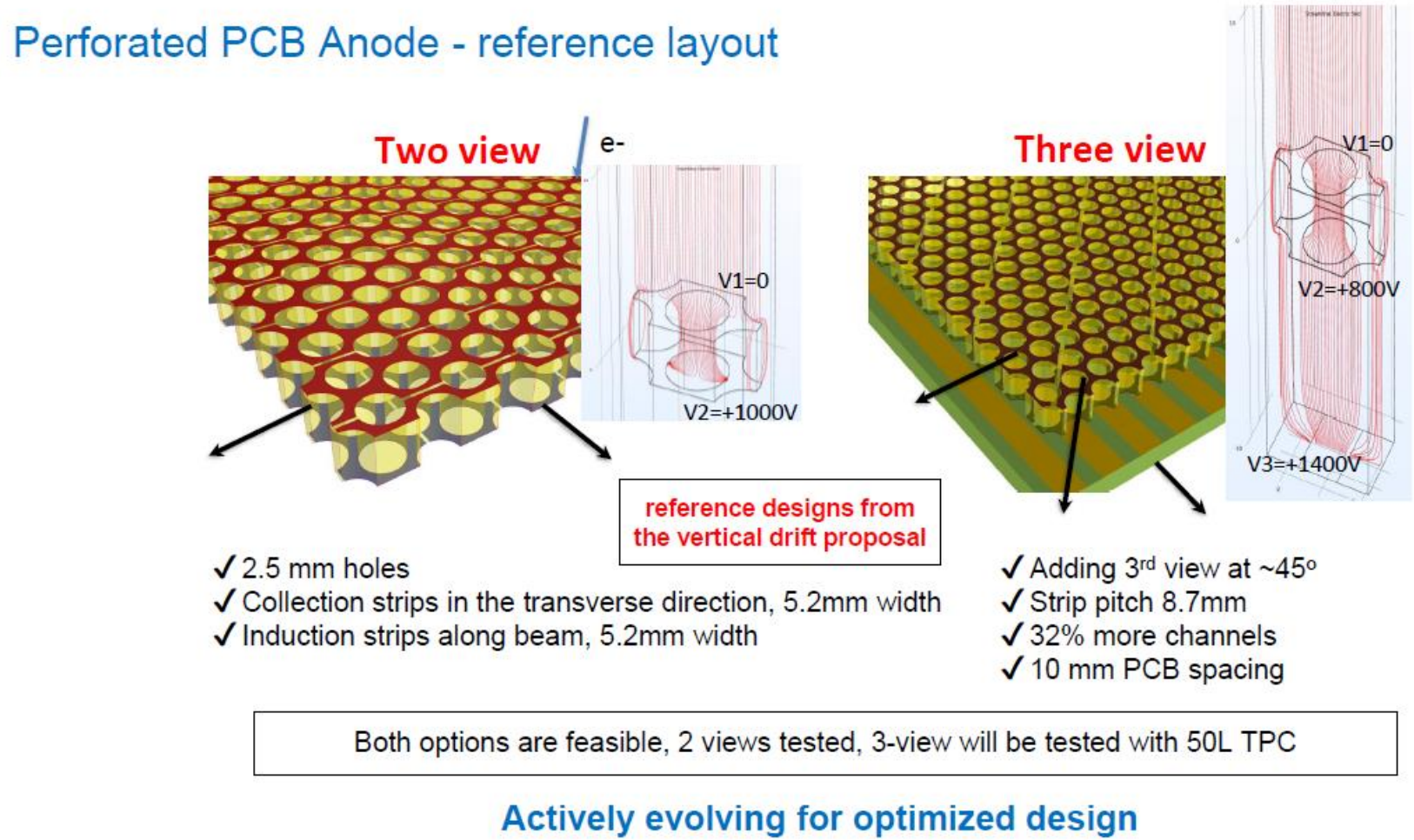


Milestone Timeline

- Cold box to be refurbished and installed at EHN1 in April 2021
- Cryogenics commissioning of the empty cold box in May 2021
- Receive all the detector components at CERN by June 2021
- Integrate the detector components in July 2021
- Insert the module in the cold box in August 2021
- Operate the TPC prototype in the cold box from September to November 2021 (up to 3 tests are feasible)
- December 2021 present the results to the CD2 IPR

VD proposal document:
https://edms.cern.ch/file/2429382/1/VERTICAL_SINGLE_PHASE_LARTPC_Draft_1_no_linenumbers.pdf

→Original plans to perform cold-box tests of both 2views and 3 views configurations at different times, first the 2 views baseline



From Director Review December 2020

(5) On the 2-view versus 3-view decision:
a) When is the decision point for what will be tested in the cold box in 2021?
b) When will the final decision be made, and on what basis

March 2021 when

- The various 50L tests (see question 3) are successful – this is critical
- The anode vendors have been contacted and we know their possibilities and schedule
- The detailed mechanical structure of the CRP is understood

To add a 3 view in the first cold box test we will need a convincing success of the 50L tests and an absolute requirement from the Collaboration.

The final decision will be made while planning for Module-0 in 2022.

Answer to Director's review 12/12/20
Slide 14

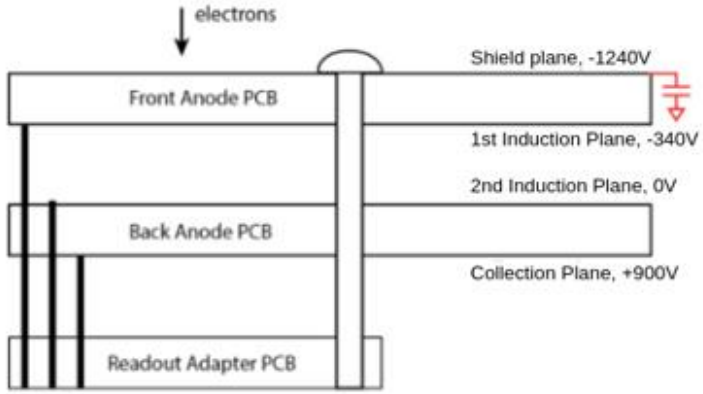
Cold-box designed since the beginning in order to be compatible with both configurations
2views need 38 FE cards, 4 chimneys
3views, need 50 FE cards, 5 chimneys

Today reference + protection layer
+ 3th induction layer

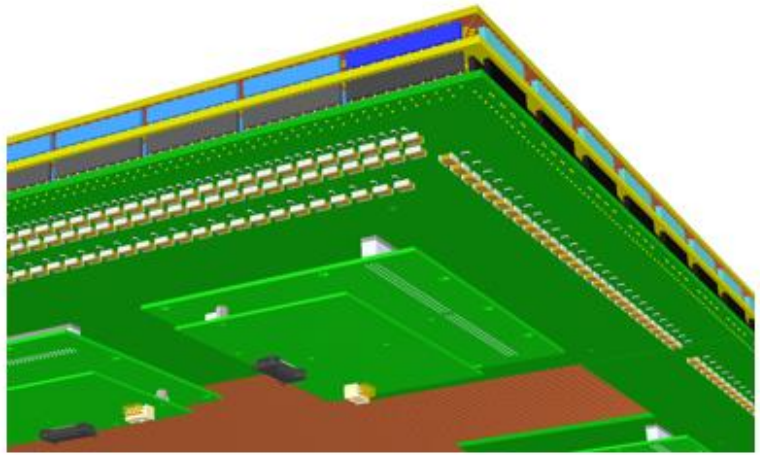
After the introduction of the shield layer in February 2021

→ reference configuration including a 3 view test embedding the two views PCB plus the inclined view on the other side of the shield layer

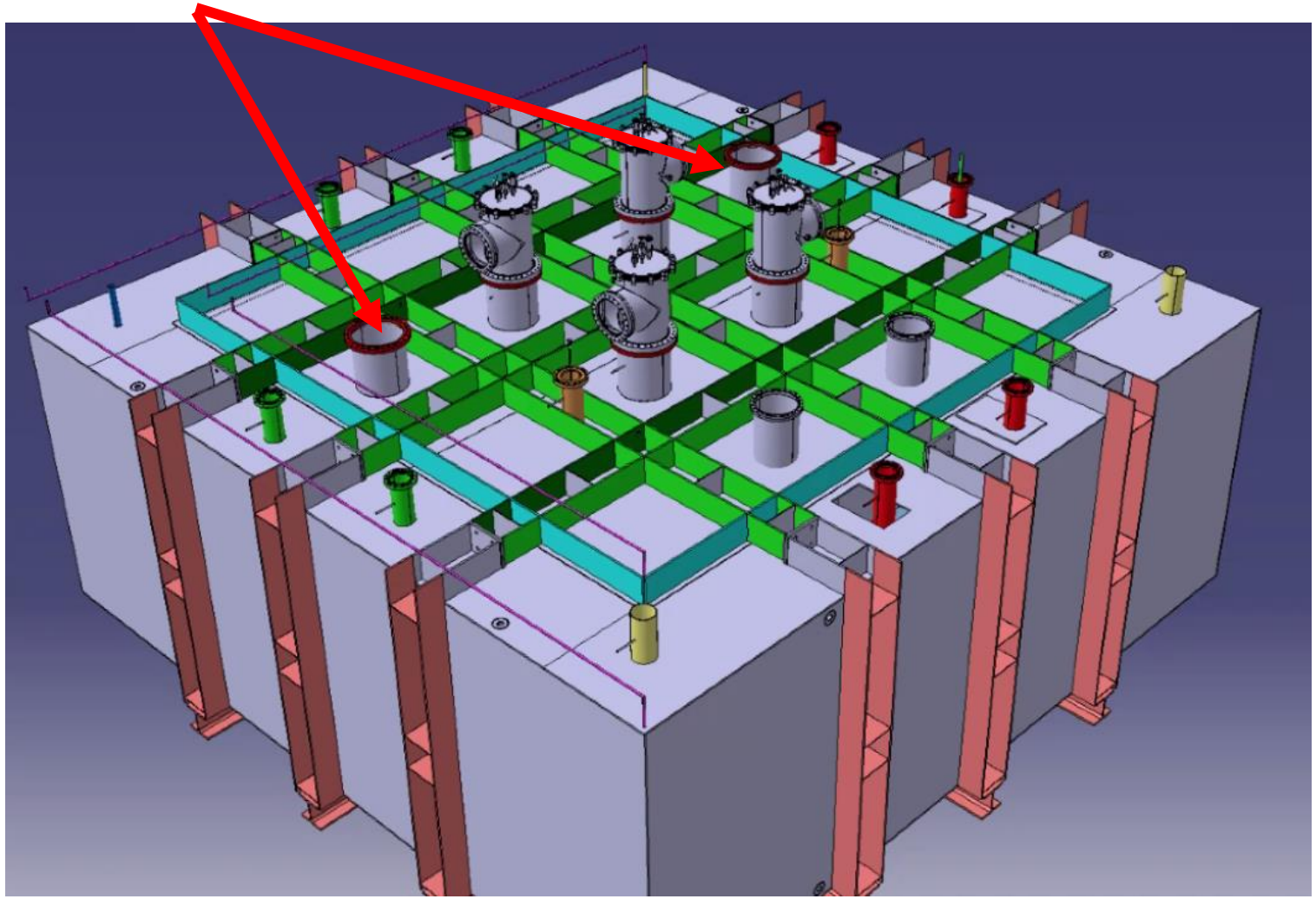
→ Combination in a single test of the 2views and the 3 views tests



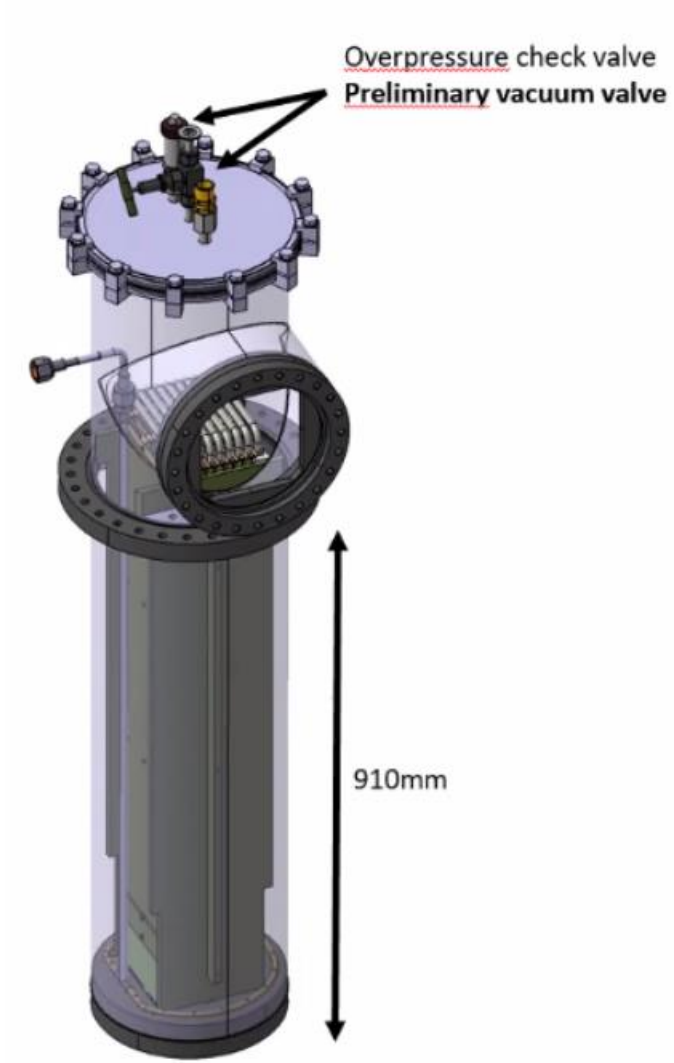
3- view setup with a shield plane:
minimal dead space (connectors),
no criticalities on HV bias
VERY similar concept as for the wires of HD-APA configuration

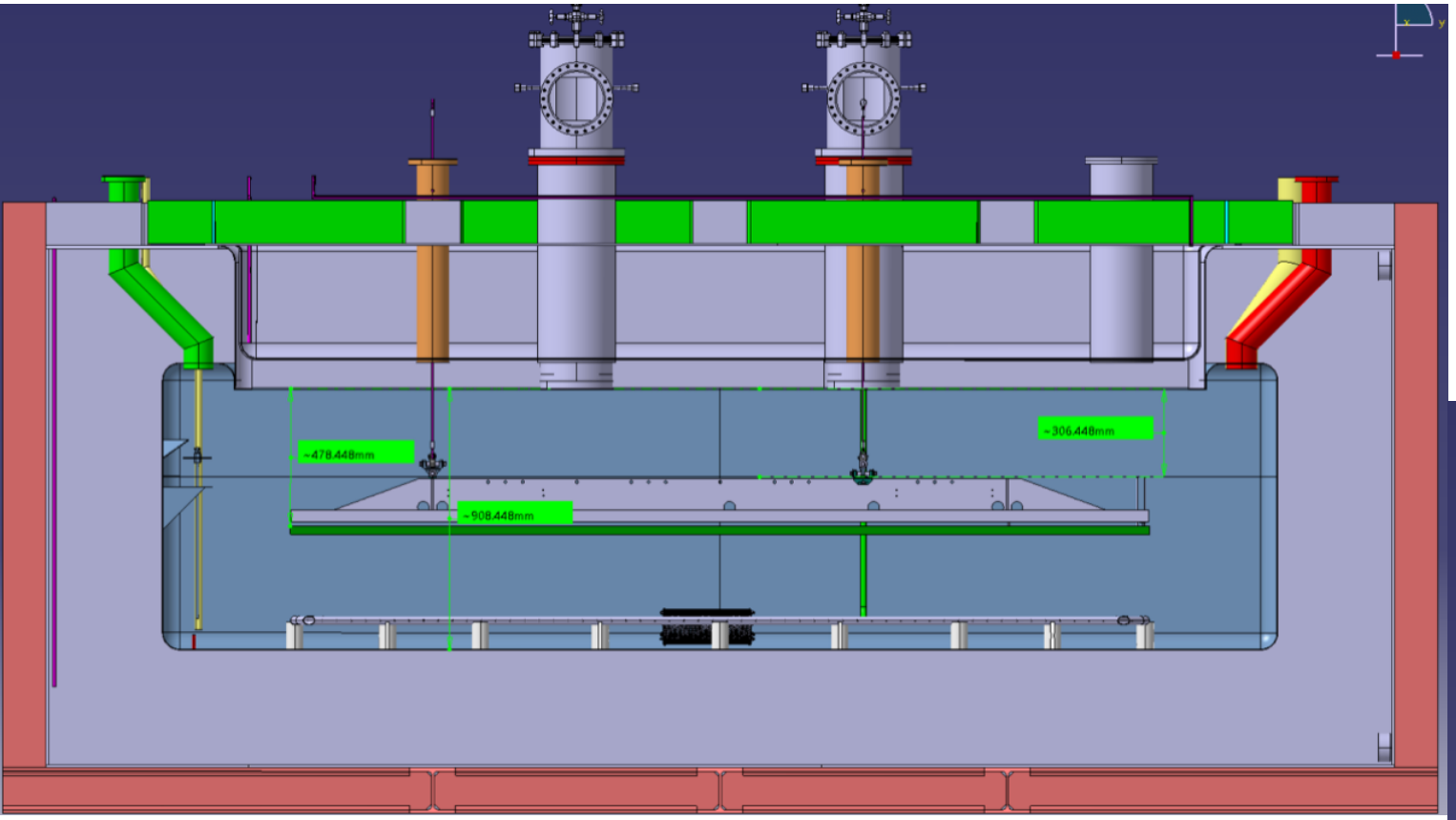


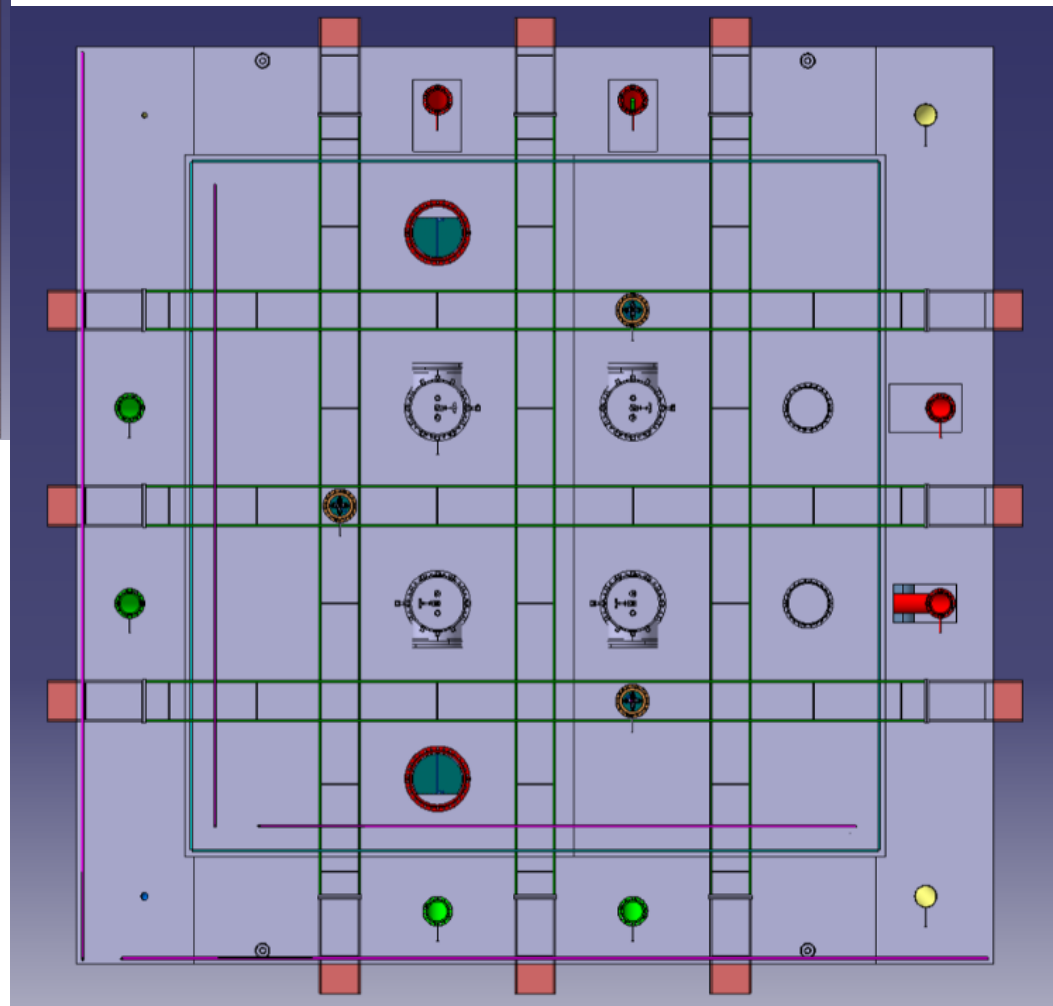
Penetrations for 6 chimenys
5th chimney



Mini-chimneys of same size but shorter lenght (910 mm) than in ProtoDUNE-DP
(in preparation at IJCLAB, see presentation by Fabien)




~478.448mm
~306.448mm
~908.448mm



Working assumptions for the VD Top Electronics Consortium, based on proposal document and material presented and discussed at the reviews in Dec 2020:

- Time scale for tests indicated in proposal in view of **CD2 by the end of 2021**

- **Procurement of parts by June 2021.**

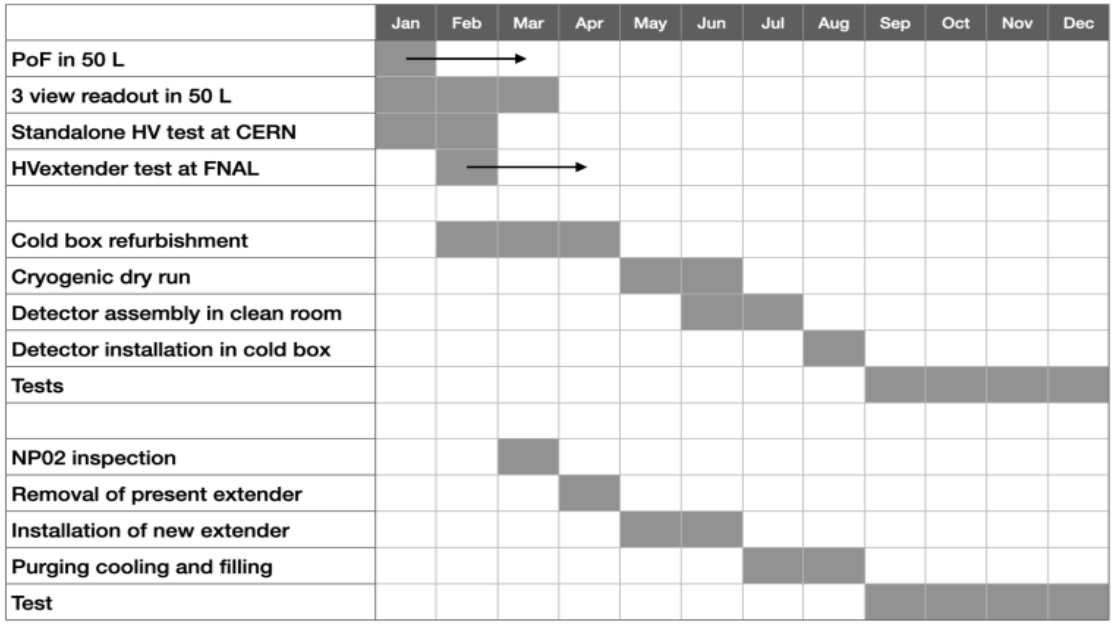
- Baseline 2 views design + 3 views option as in the proposal document,

- February 2021: due to implementation of shield layer → **tests of 2 and 3 views layouts of proposal document combined in a single test. → Efforts continued in the direction of preparing a full Top-drift CRP cold box test with this 3 views single test configuration**

- Given the initial uncertainty pending on when a 3 view test was happening (see QA DR) since the end of 2020 **components produced/procured for the max quantity needed for 3 views for a full top-drift CRP cold box test:**

  - 5 chimneys + flanges
  - Full Top CRP frame
  - 50 FE cards
  - 50 AMC digitization cards
  - 5 uTCA crates
  - 5 WR timing end nodes
  - Full LV distribution system
  - Associated cabling etc ...

Overall schedule in 2021



Milestone Timeline

- Cold box to be refurbished and installed at EHN1 in April 2021
- Cryogenics commissioning of the empty cold box in May 2021
- Receive all the detector components at CERN by June 2021
- Integrate the detector components in July 2021
- Insert the module in the cold box in August 2021
- Operate the TPC prototype in the cold box from September to November 2021 (up to 3 tests are feasible)
- December 2021 present the results to the CD2 IPR

New schedule CERN prepared for the LBNC of March 2021

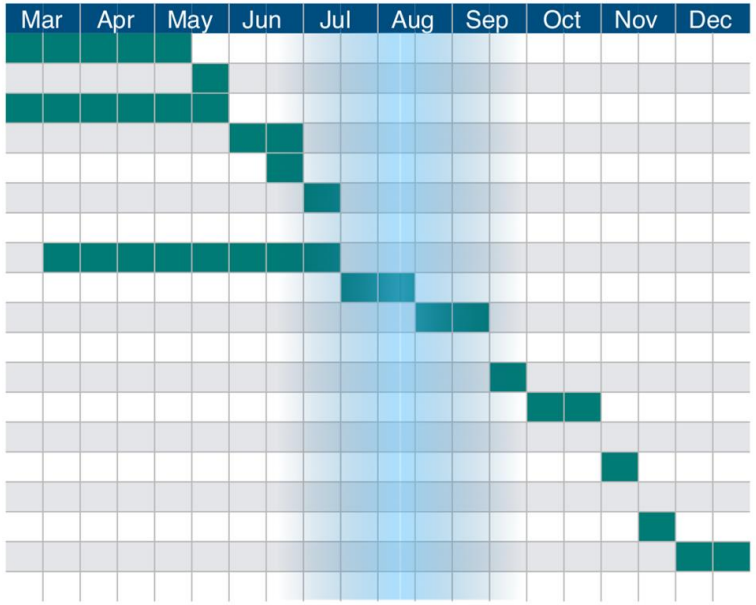
Cold box modification
Cold box installation
Procurement of cryogenics components
Installation of cryo components
Availability of instrumentation
Cold box dry run

Anode procurement
CRP assembly
Buffer

CRP integration in the cold box
Shortest cryogenic run

Open, dismount and debug

CRP integration in the cold box
Shortest cryogenic run



Situation with the VD Top Electronics components:

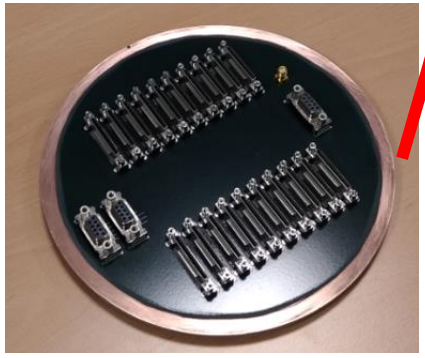
→ **Goal : having all components tested by June and moved to CERN**

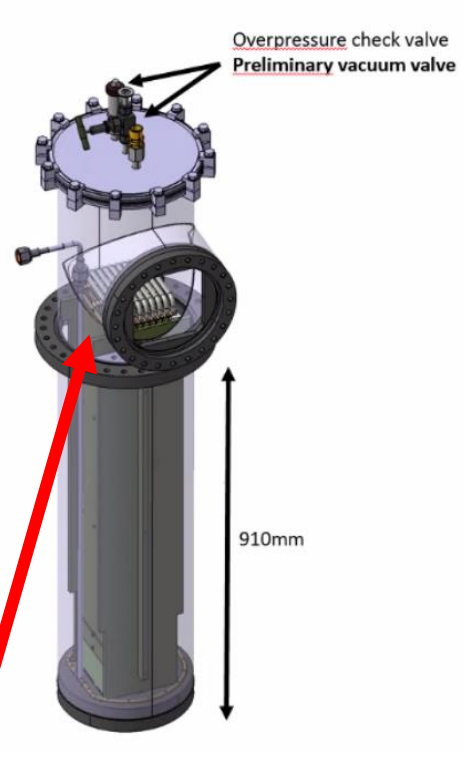
- Search for KEL connectors retrieval at CERN and Lyon (thanks to Takuya, Franco, Dominique Filippo for their contribution to the effort). Large part of existing material retrieved. Some additional material coming from KEK and ordered from KEL

- Chimneys (see talk by Fabien), 5 mini-chimneys in progress of ordering

- Chimney cold flanges: 5+1 new ones ordered

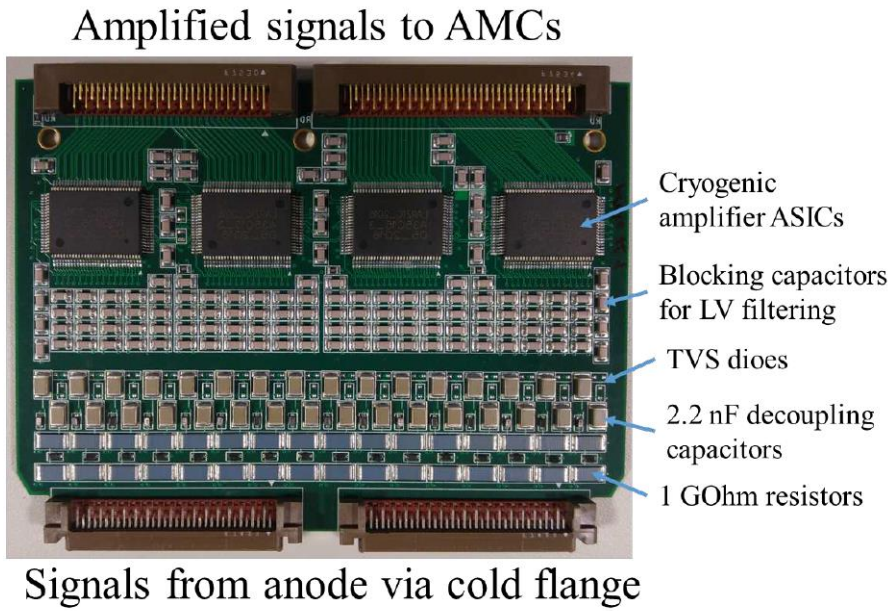
- Chimney warm flanges; 5+2 new ones ordered





- Cryogenic FE cards (50+20) ordered with HV

decoupling and biasing components not mounted (transferred to anode adaptor boards)



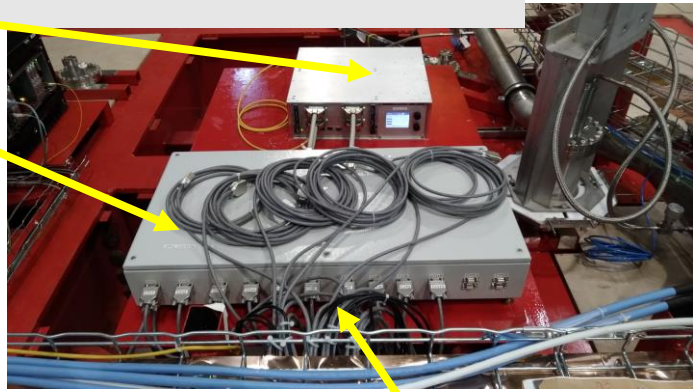
- AMC digitization boards, existing ones being modified with a ADC reference voltage set to GND in order to deal with the dynamics of the bipolar signals

- Low voltage distribution system, cloning of the system of NP02 serving 12 chimneys with procurement of a new Power Supply (Wiener MPOD Micro-2 LX 800 W + 2 modules MPV 4008I (done) and construction of a new filtering and distribution box (in progress) → see next page

Low voltage generation and distribution system

Low voltage power supply: Wiener MPOD Micro-2 LX 800 W with 2 modules MPV 4008I (remote control by network)

LV filtering and distribution box (5 voltages distributed per chimney + sense system)



Power supply:
generates VCC,VDD,V18,VREF,VTIN

4 shielded cables
MPV Sub-D 37, 30 cm,
for high currents

30 cm

Low voltage filtering and distribution box

Cabling to 12 chimneys

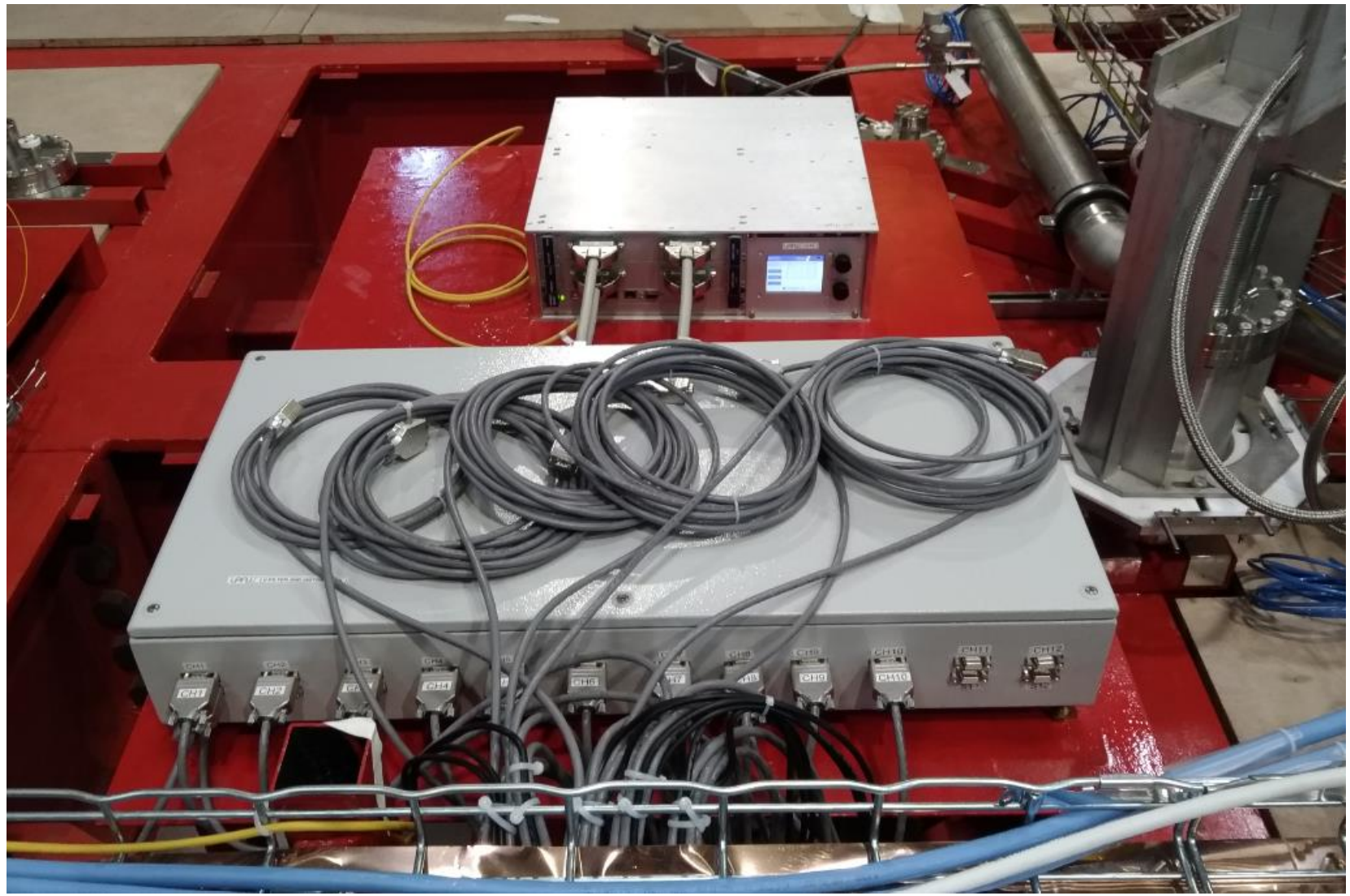
10 m

Multi-wire shielded cables connecting the 5 voltages, GND + sense to a FE units (Chimneys 1-6) (Chimneys 7-12)

FE unit 1 | FE unit 2 | FE unit 3 | FE unit 4 | FE unit 1 | FE unit 2 | FE unit 3 | FE unit 4 | FE unit 1 | FE unit 2 | FE unit 3 | FE unit 4

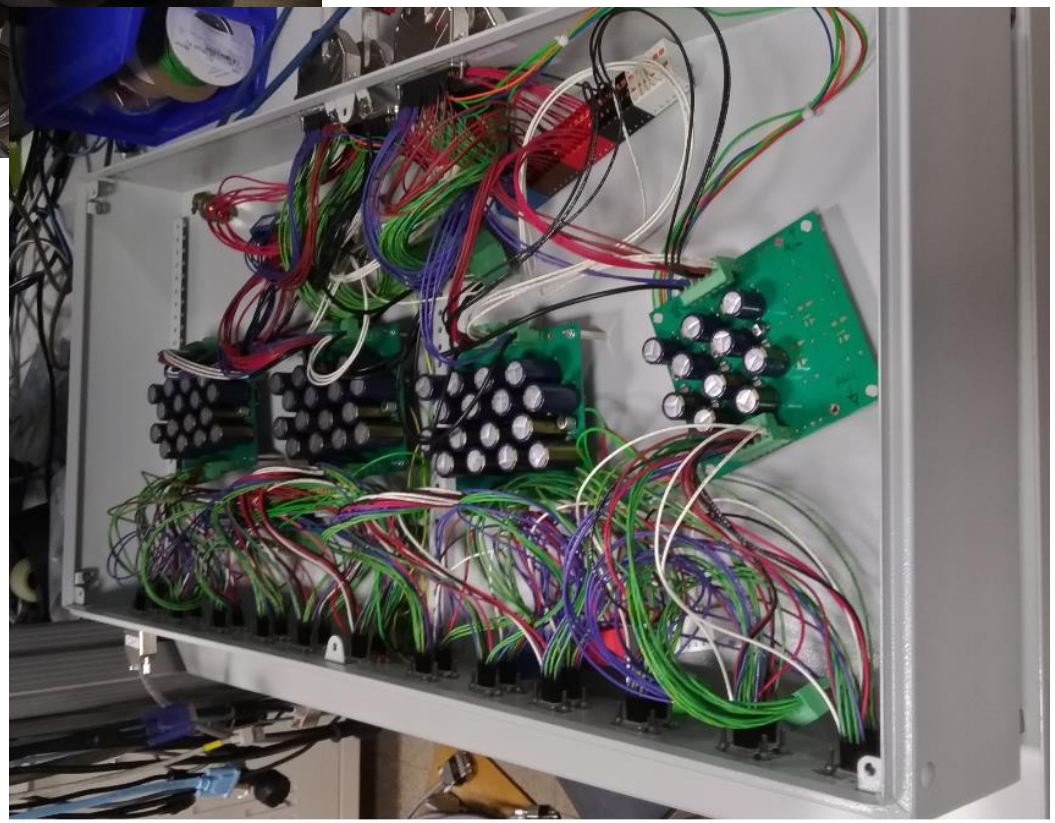
Front-End Units (chimneys warm flanges) VHDCI cabling to uTCA

Chimneys+ LV distribution system + cabling to uTCA and uTCA infrastructure
→ successful system for noise prevention
→ low intrinsic noise level of the electronics/DAQ system ~600 electrons


CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH10
CH11
CH12

Filtering Boards

Each board serving a group of 3 chimneys



- x5 new uTCA crates: ordered

- VHDCI cabling: purchased and received

- X5 new White Rabbit timing end-nodes: new PCB produced, WRLEN cards purchased

→ Assembly and dedicated firmware flashing to be done

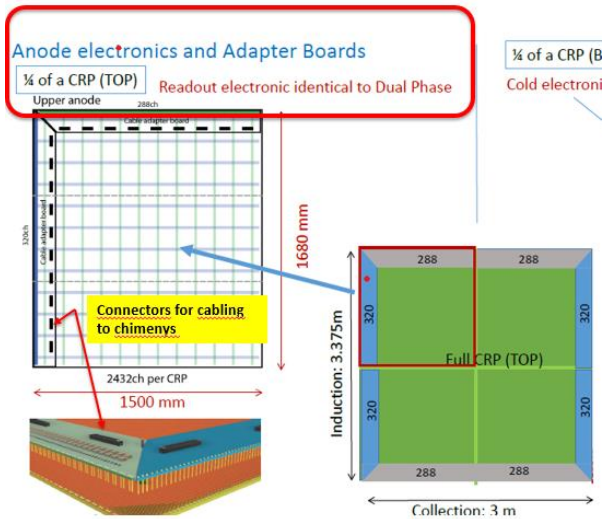
- Cabling and integration at EHN1, materials to be ordered (fibers etc …)

Interfaces:

➢ Grounding:

- The Top electronics is self shielded and takes the ground reference from the cryostat of the cold box via the chimneys. This is a sensitive system issue involving all penetrations of the cold-box (see next slide)

→ dedicated discussion organized with Filippo. Layout in progress



➢ CRP interfaces (defined with CRP consortium)

- Anode adaptor boards including decoupling/biasing components and KEL connectors (design being finalized)

- CRP Cabling

➢ DAQ/Timing

- Foreseen x5 fiber links to White Rabbit System of NP02 and x5 optical data links from uTCA crates to the NP02 counting room, easy integration in the existing NP02 system

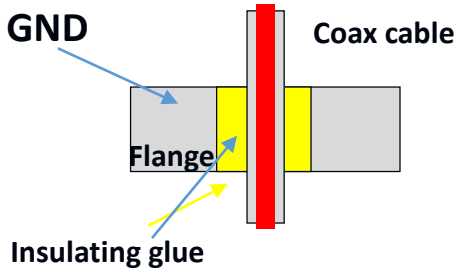
- Possible also a duplication for dedicated small tests with a local system → White Rabbit components and small DAQ system can be duplicated locally and the hardware has been procured for that

General grounding aspects (valid for all flanges)

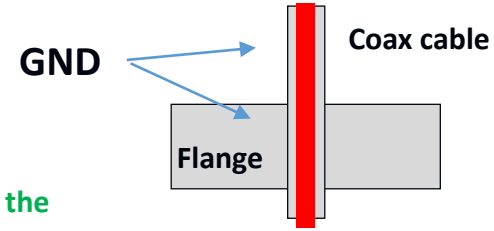
Basic prescriptions:

1) **Grounding of all equipments referred to cryostat**, decoupling, isolation transformer
2) Connections topology of cabling on cryostat roof to avoid ground loops
3) **Use for all connections shielded cables correctly grounded at the cryostat flanges**

→ The cryostat is a Faraday cage shielding the anode strips but if the shields of the cables are not well connected to the cryostat ground at the level of the flanges these cables will act as antennas and bring external noise inside the cryostat



NOT OK: Coax cable shield disconnected from flange GND



OK: Coax cable shield grounded to cryostat at the feedthrough flange via feedthrough connector

It is foreseen, before bringing the material to CERN:

a) to apply the same QA/QC and calibration procedure which was applied in 2018 to all the FE cards and the AMC cards produced for protoDUNE-DP with the test setup described in the dual-phase TDR

b) uTCA crates and timing end-nodes crates will also be qualified with the QA/QC procedures used in 2018

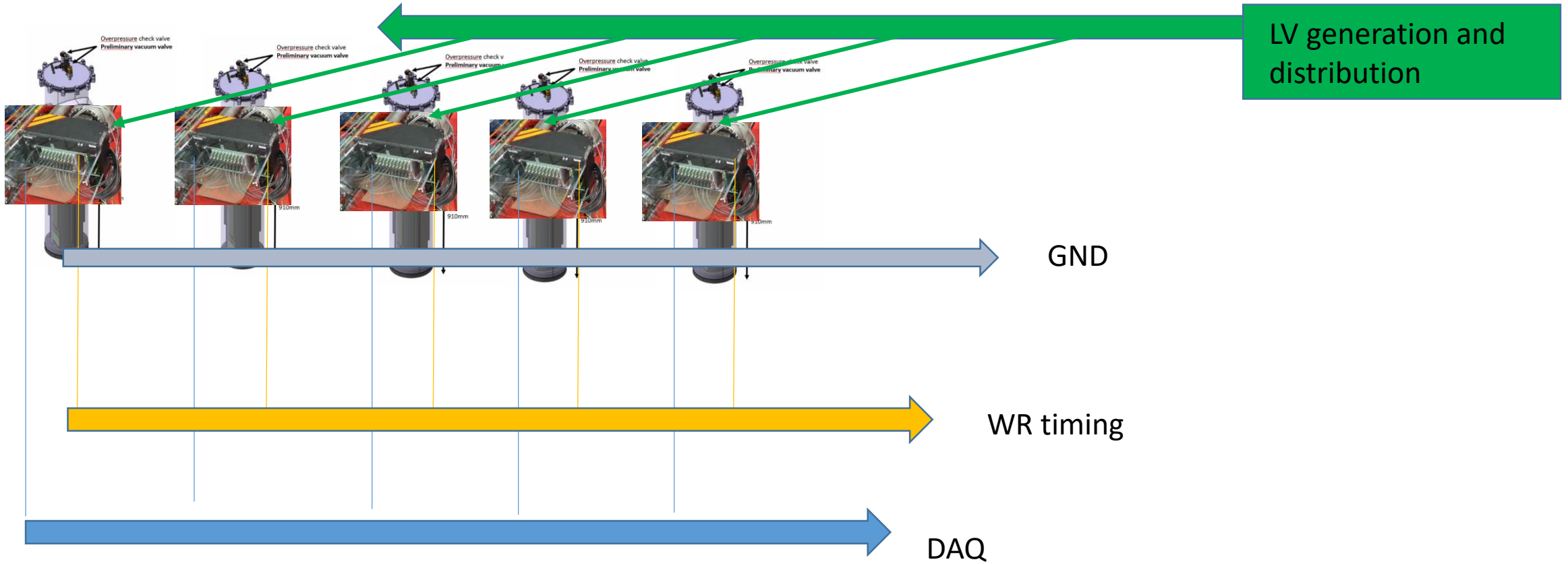
c) Cold and warm flanges will be also tested for continuity of all channels

d) The clone LV distribution system will be qualified with similar QA/QC tests as in 2018

Once at CERN, integration test layout lasting until final cabling in the cold box (September according to last schedule).
Can be performed in proximity of the cold box or in a nearby place at EHN1 depending on availability of space and safety interferences)

- Chimneys put on some temporary stands with a common ground reference.
- All blades and FE cards inserted in chimneys which are connected to the LV distribution system and cabled to the uTCA crates connected to the timing system and DAQ

→ Tests of the full system at warm and noise measurements, possible signal injections from bottom of cold flanges

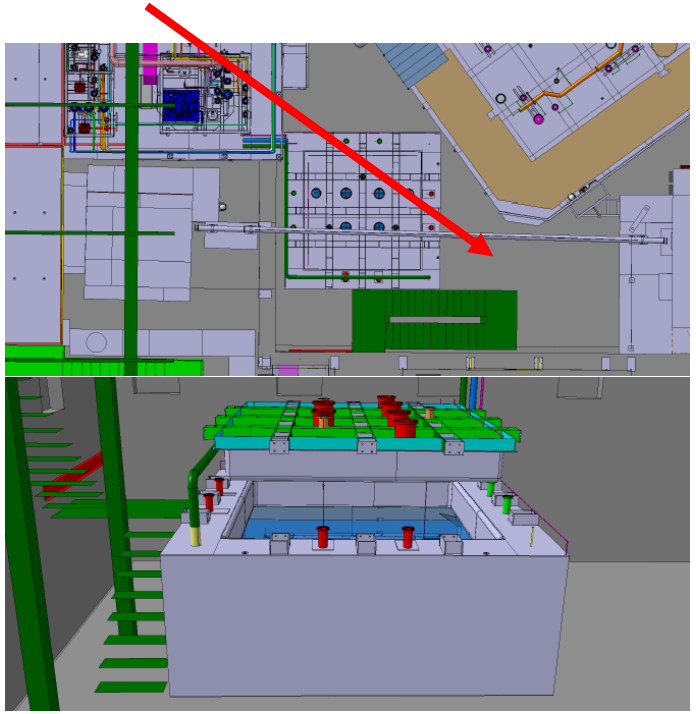


Top drift electronics

- Components at CERN: June

- June-September Integration and full commissioning test in NP02 as parallel system at the side of the cold-box (? Or in a nearby place) :

Chimneys filled with blades, cabled to uTCA crates + LV distribution → take noise data



- When cold box integration starts (beginning of September): un-cabling of chimneys from crates + plugging of chimneys in cold-box cover 2 day

- When cold-box cover closed: Installation of uTCA crates on cold-box roof and re-cabling 1 day

Conclusions:

We are in a very intensive phase in view of the tests campaign in 2021 with:

a) Procurement and tests of additional material until June
b) Integration and preliminary tests June-August
c) Commissioning and operation + NP02 support September →

The test campaign will start with first tests in 2021 and then extend to 2022 in order to prepare for the module 0 campaign in 2023

All these activities affect the Top Electronics Consortium and need support in parallel to the activities to progress on the VD Far Detector module preparation and the reviews