

# DarkSide-Proto

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June 14, 2018

# Agenda of the session

- 10:30 - Introduction G. Fiorillo
- 10:50 - Materials for Proto R. Santorelli
- 11:00 - PE for Proto E. Scapparone
- coffee-break
- 11:30 - Proto DAQ M. Rescigno/F. Retiere
- 11:50 - Proto Calibration J. Maricic
- 12:00 - Offline for Ds-Proto D. Franco

# ProtoProj Working Group

## Working Group Information

Working group directory (meeting minutes, presentations, documents)

Prototype Project Roadmap document repository

Weekly Meeting on Friday 4PM LNGS time

Zoom Room: 3486504586

<https://fnal.zoom.us/my/giulianafiorillo>

Working group mailing list:

DS-PROTO@LNGS.INFN.IT

Email to me : giuliana@na.infn.it and

Andrew Renshaw: arensaw@Central.UH.EDU

to get your email added

# Prototype Project Roadmap

This document contains the roadmap towards the construction and operation of DS-Proto.

Contributions to this document are expected from:

1. TPC & CRYO for the design and construction of the cryogenic system, 1 ton cryostat and TPC
2. PE for the development of the optical readout system, its FE electronics, the motherboards, power supplies and signal transmission
3. DAQ, Trigger & Slow Control for the respective systems
4. MATERIALS for the screening and radioactive budget evaluation
5. CALIBRATIONS for the calibration setup
6. OFFLINE for the MC simulations, the reconstruction software, the analysis of data
7. INFRASTRUCTURES for the installation in LNGS Hall C

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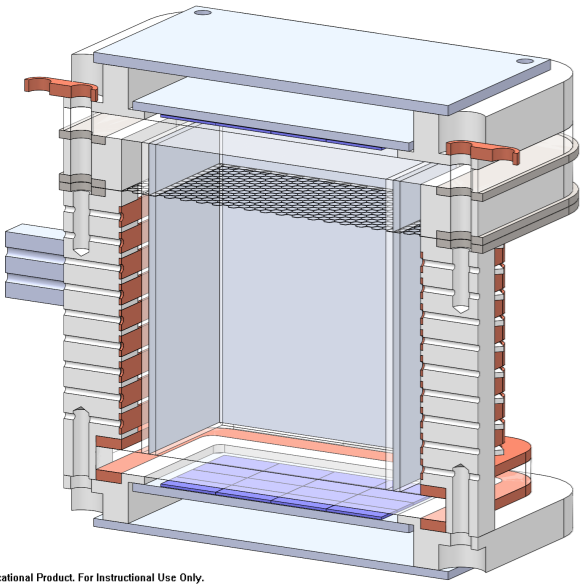
# Scope of the project

- **1-ton TPC prototype of DS-20k detector will allow:**
  1. validation of the design of mechanics and cryogenics of the TPC
  2. integration tests of the custom SIPM-Photosensors and of the full read-out electronics and data acquisition chain
- **Evolutionary prototype**
  - comprising all the elements of the chain, as soon as they are available and “usable”, i.e. interface-able to the rest of the chain even with reduced functionality or based on non-final technology
    - single elements validation and tests made in different laboratories
    - preliminary elements gradually replaced by final ones once available until the full prototype is finalised
- ➔ early identification of **issues related to functionality and performance** that might be revealed only during and after integration
- ➔ develop a better view of the overall project time-line and of the resources needed, both human and financial

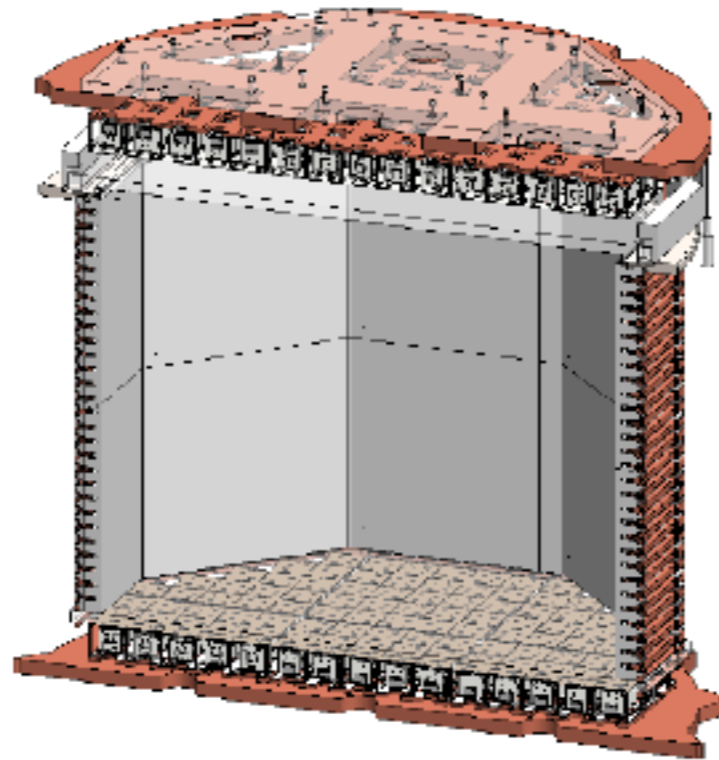
# Phases of the project

- Proto 0:
    - Standalone test of cryogenic system concept;
  - Proto I:
    - Design, construction and assembly at CERN of cryostat and LAr TPC equipped with 50 pre-production PDMs (2 Motherboards);
    - assembly, commissioning, and operation of full read-out and DAQ for 50 PDMs;
  - Proto II:
    - Assembly and commissioning of full system, including 400 first production PDMs;
    - full readout and DAQ operational;
    - evolution towards final configuration.
- ➔ Radiopure Proto to be deployed at LNGS for Low Mass DM searches

# Evolution

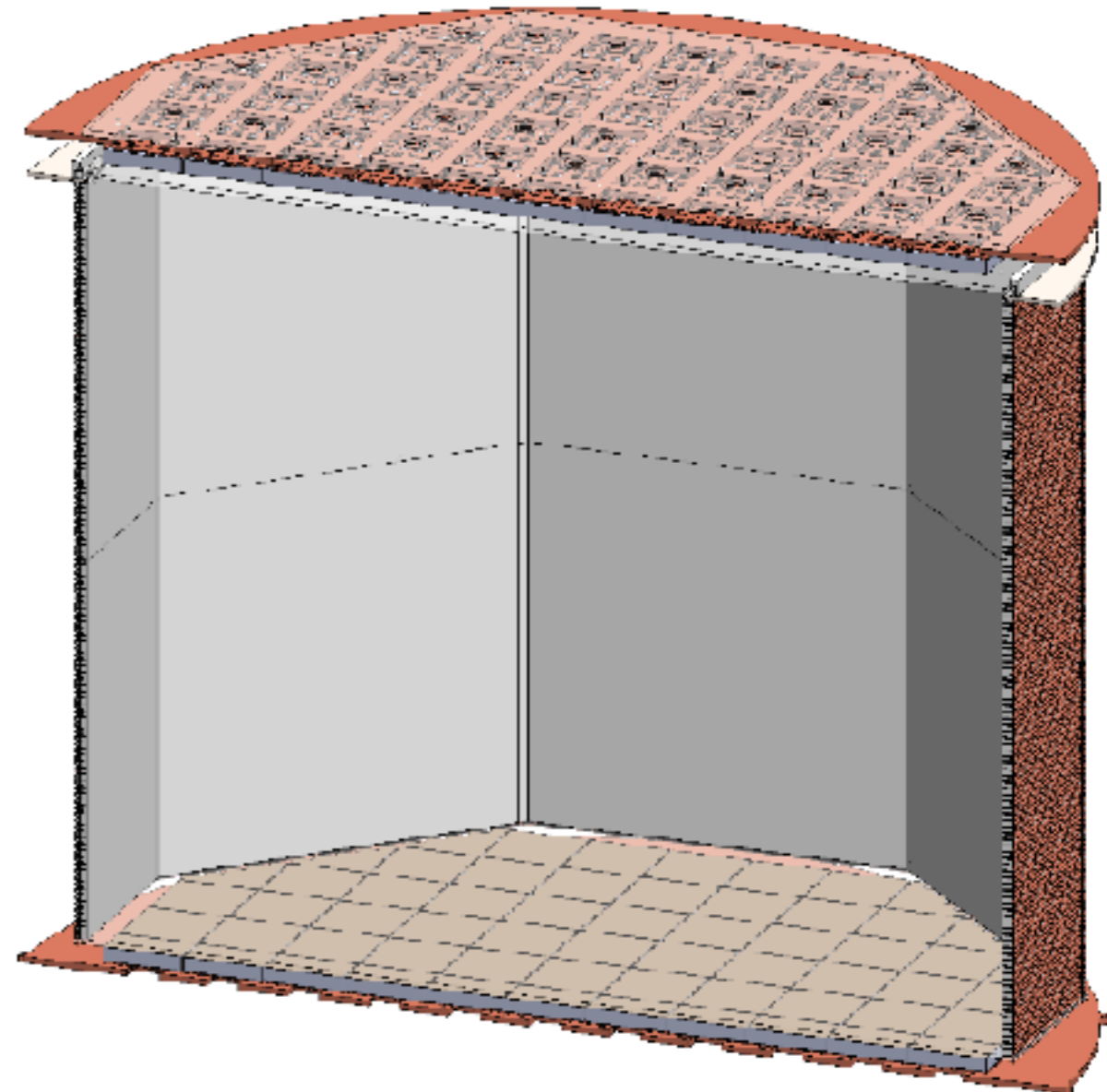


ReD TPC



1-ton prototype

DS-20k

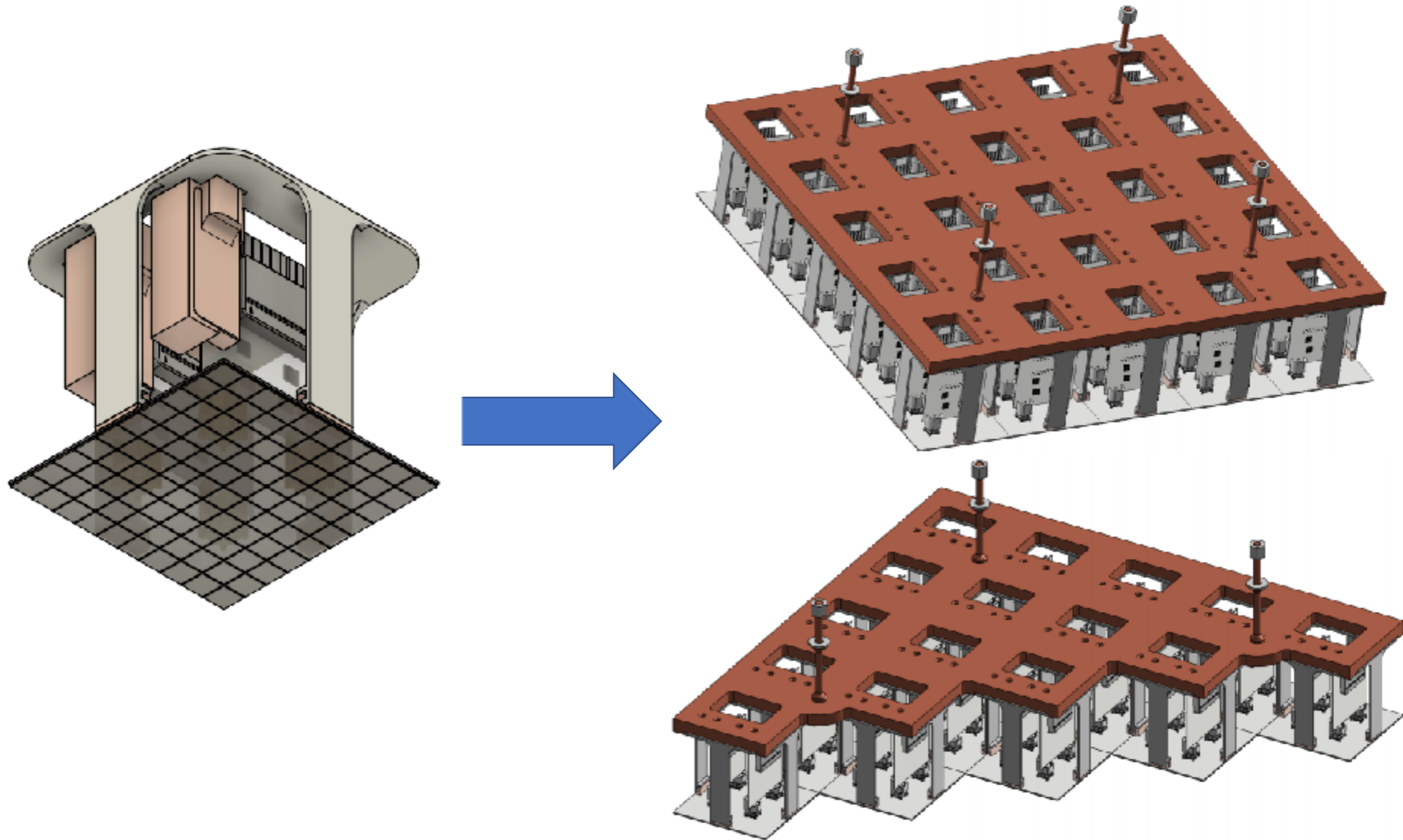


# Timeline to DarkSide-20k

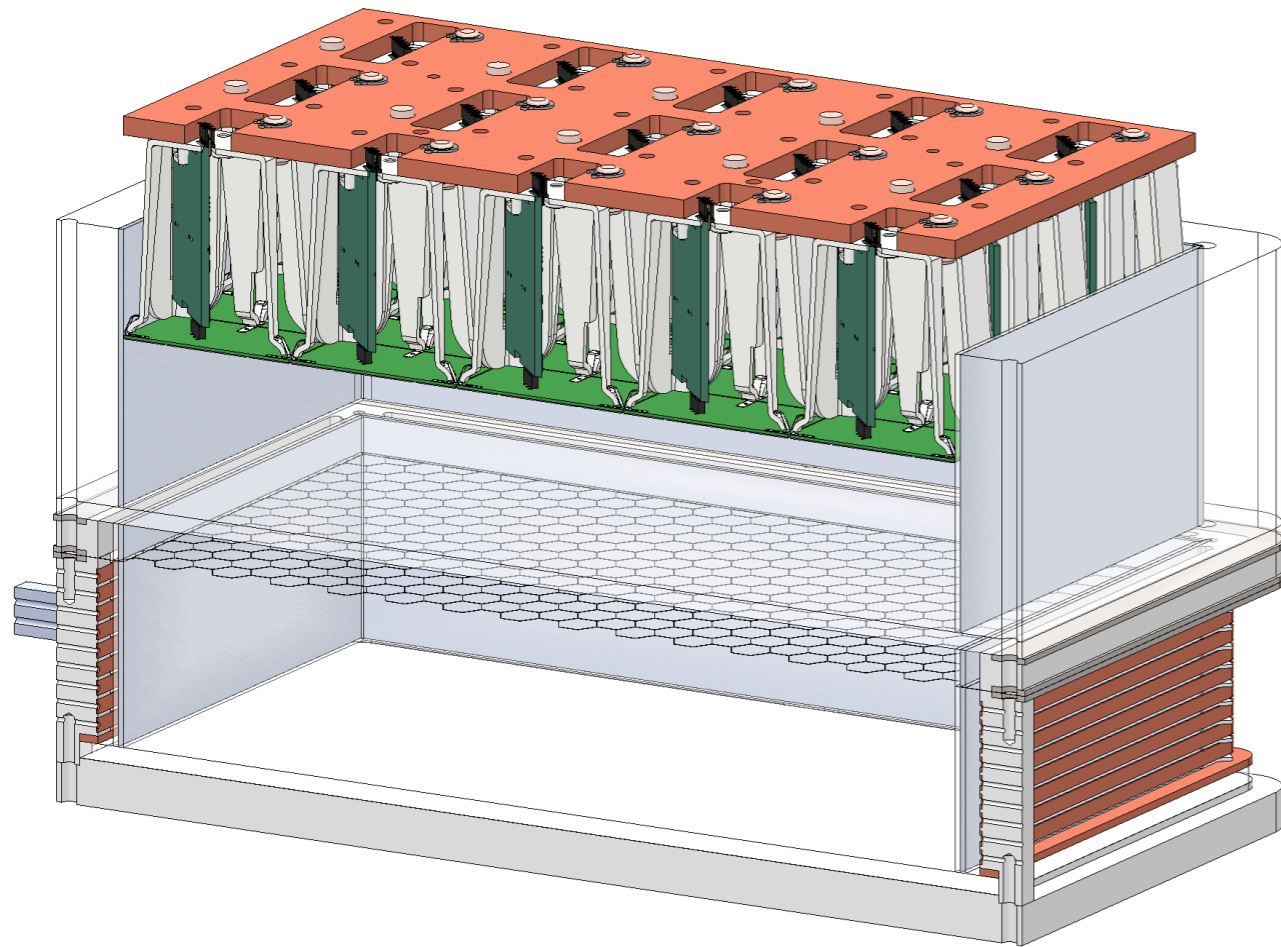
20-	16	17	18	19	20	21	22	23	24	25	26	27
ReD	Yellow	Green	Green	Green	White	White	White	White	White	White	White	White
DS-Proto	Yellow	Yellow	Yellow	Green	Green	Green	Green	White	White	White	White	White
DS-20k	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green



# A scalable design: Motherboards



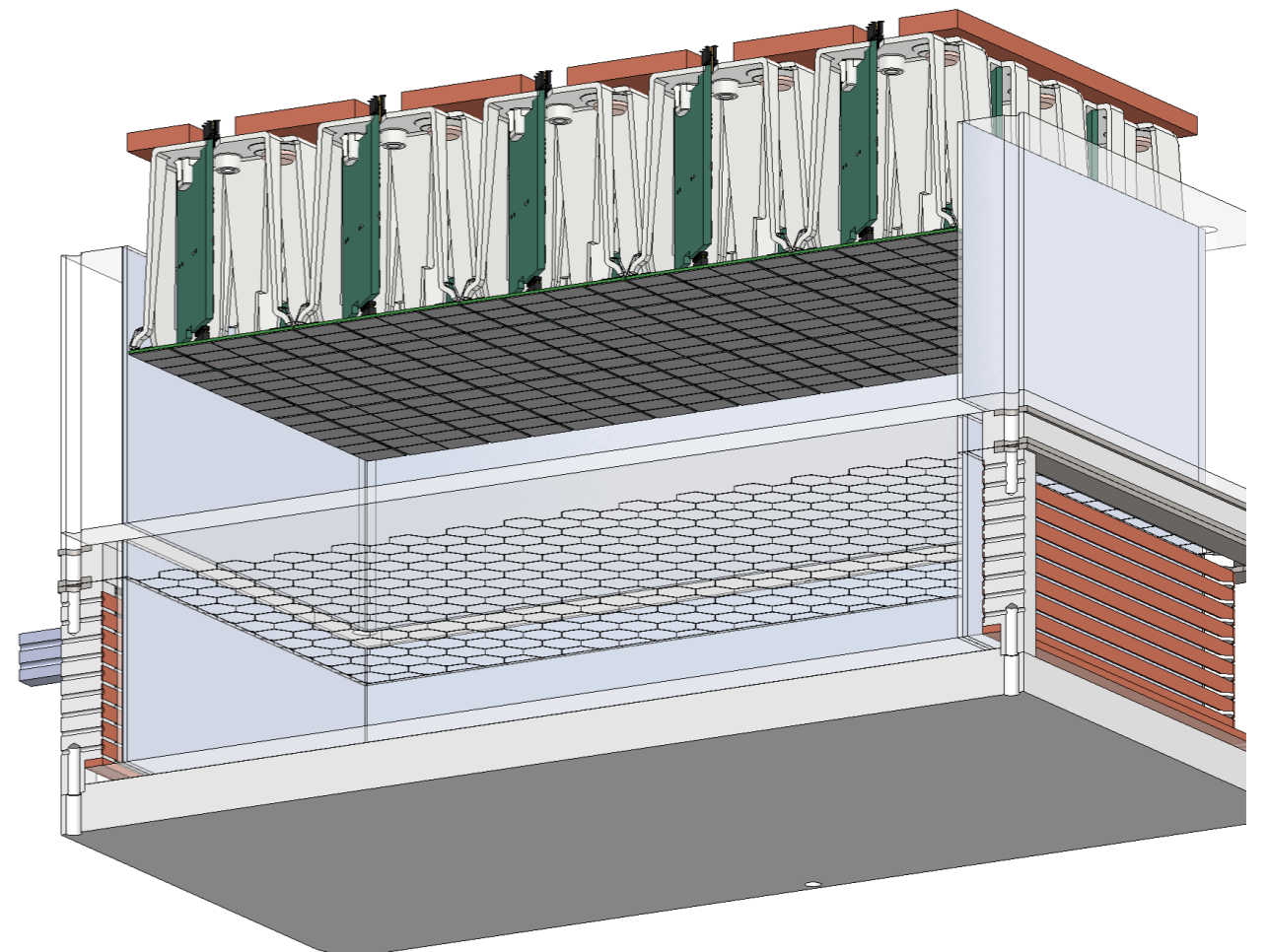
# 2 Motherboards TPC



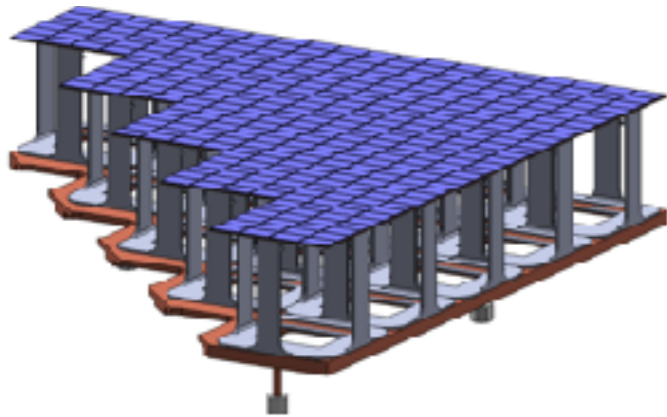
- GOALS:

- electroluminescence field uniformity
- gas pocket thickness uniformity
- S2 signal resolution
- xy position reconstruction

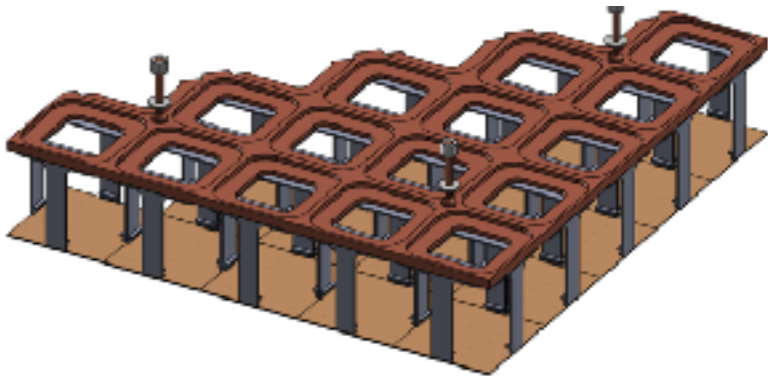
- A TPC to test the basic modular unit
- 25 top + 25 bottom r/o channels
- reduced drift length to avoid pile-up



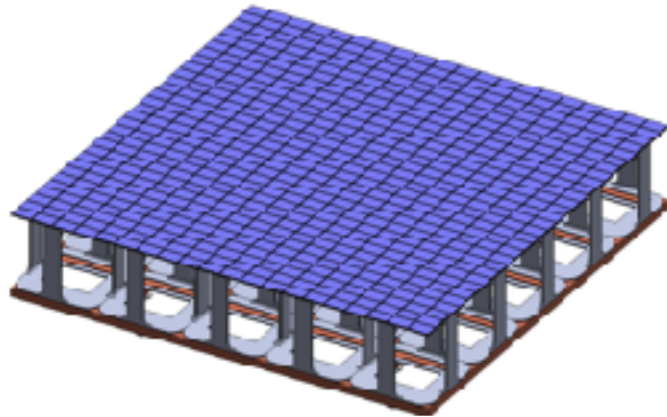
# Triangular Mother Board (TRB)



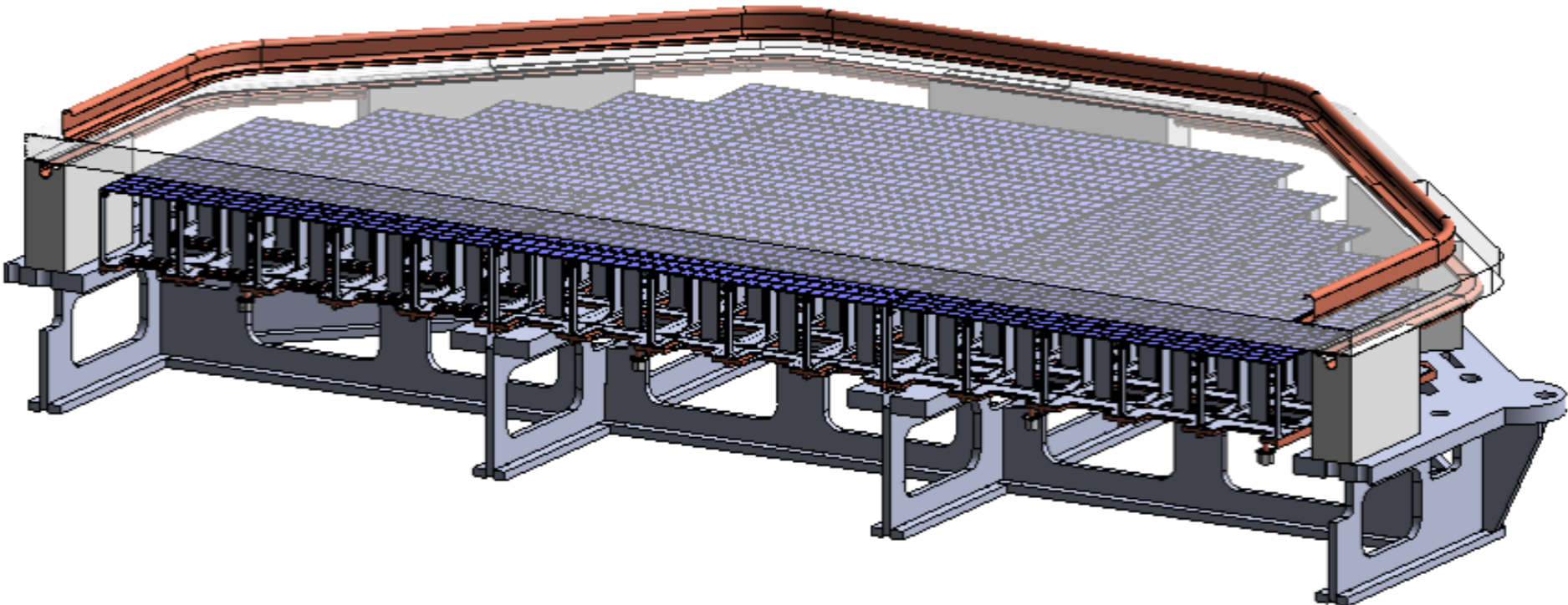
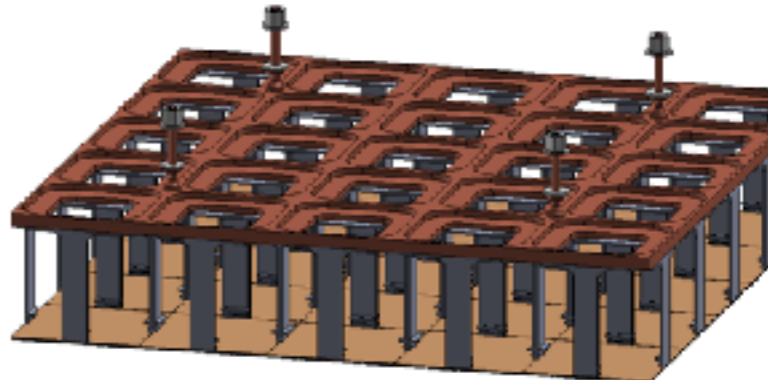
15 PDMs each

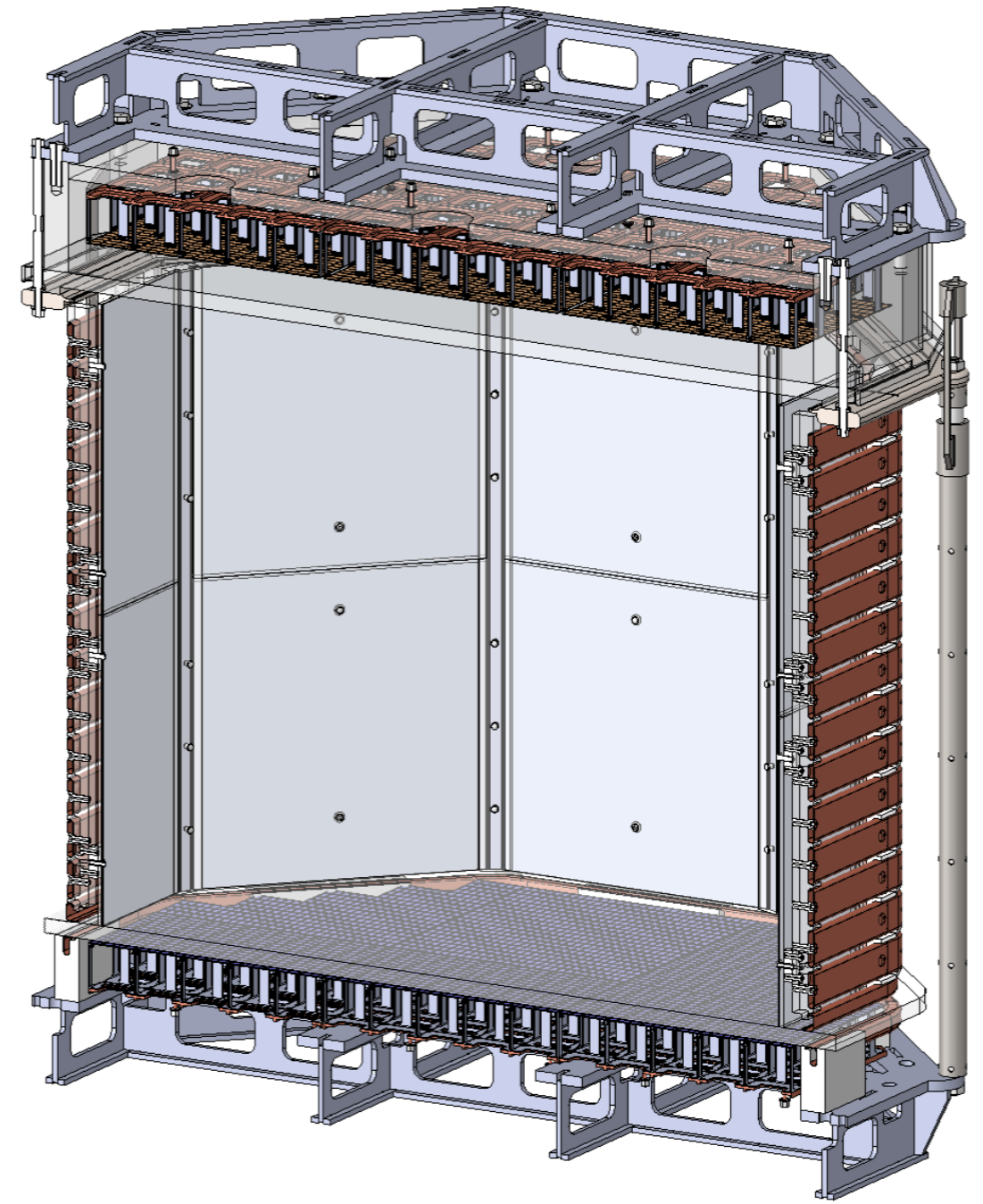
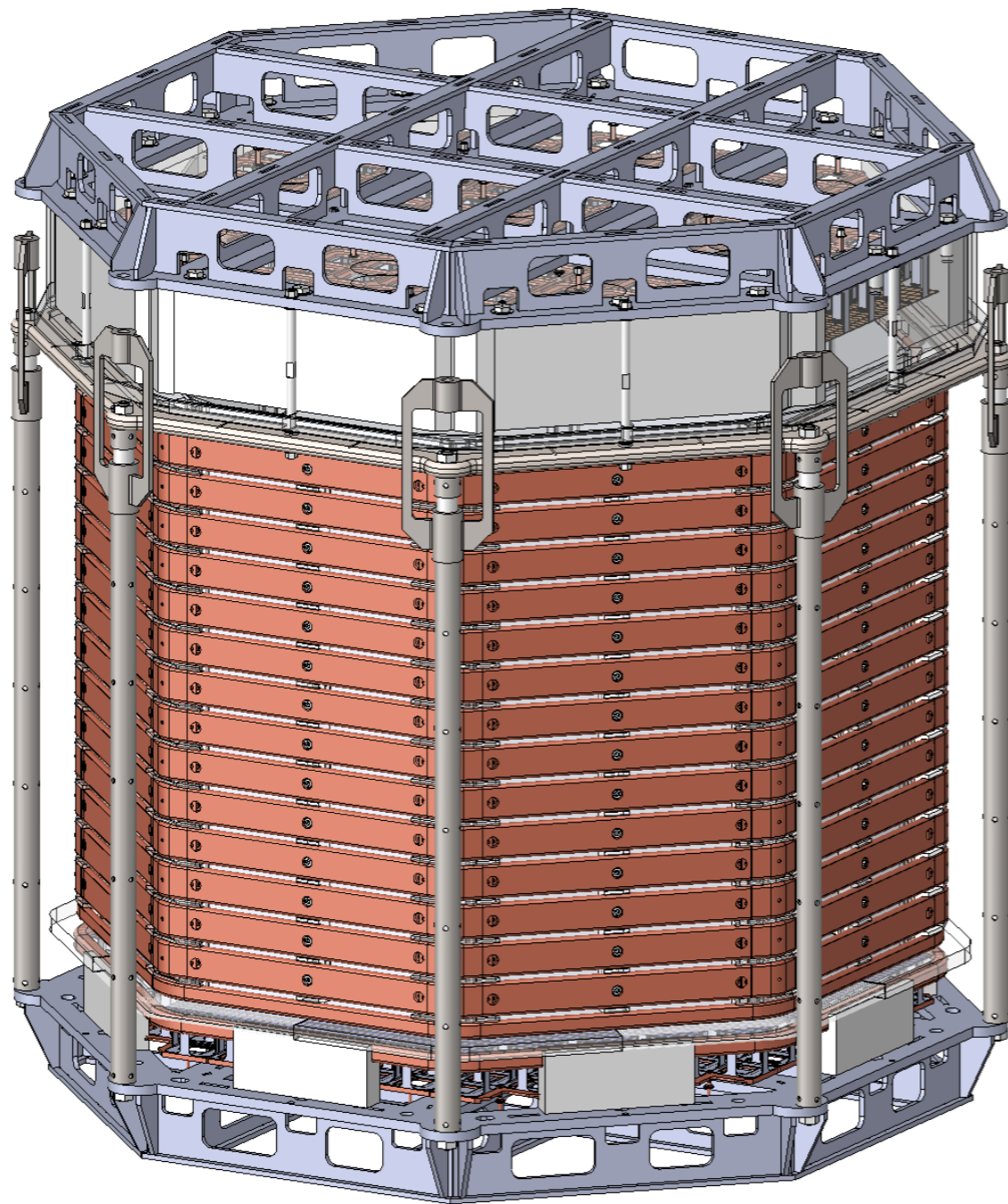


# Square Mother Board (SQB)



25 PDMs each

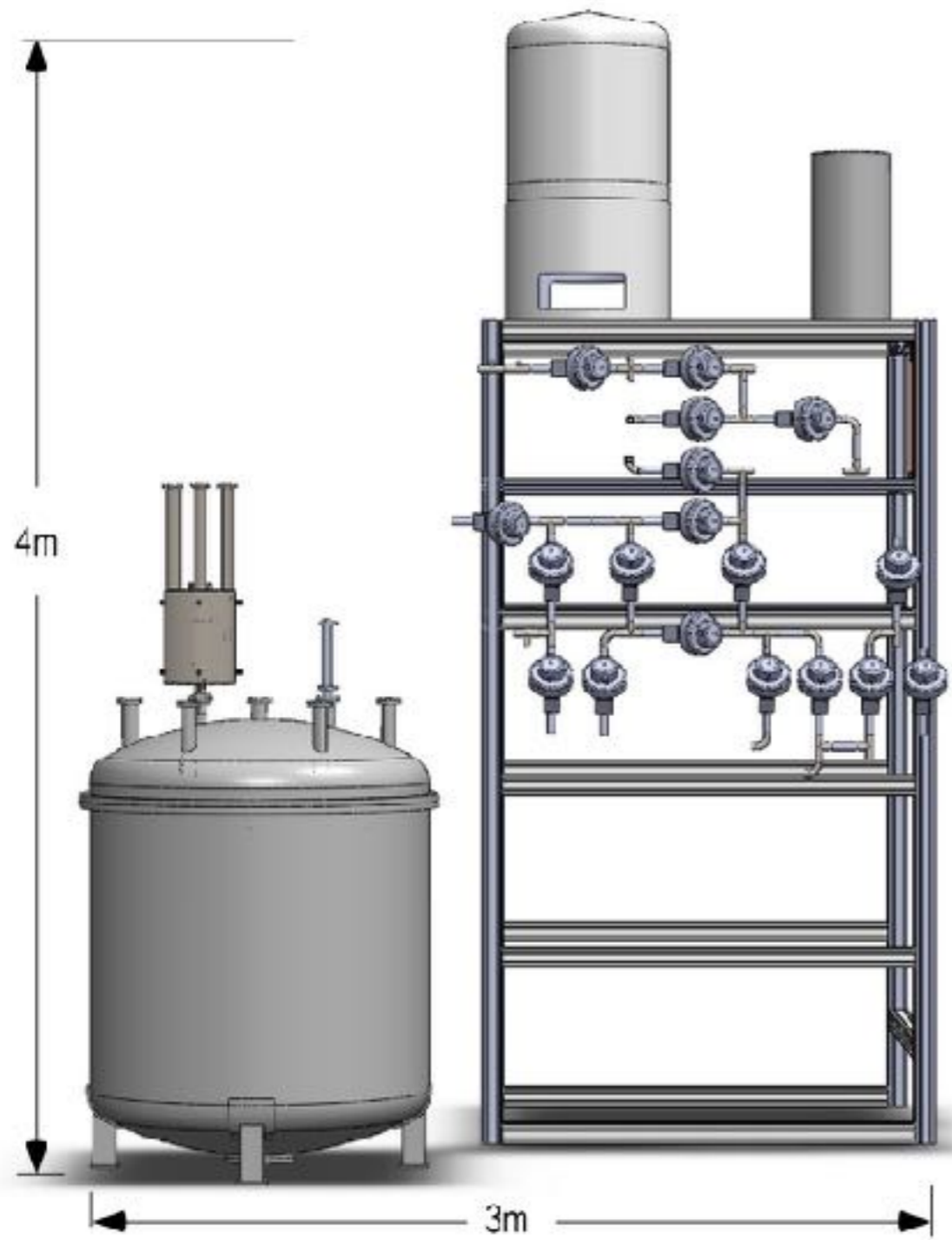




# 1 ton prototype TPC

# Cryostat

*Delivered to test site + integrated - Q3 2018*



## Tests before TPC installation

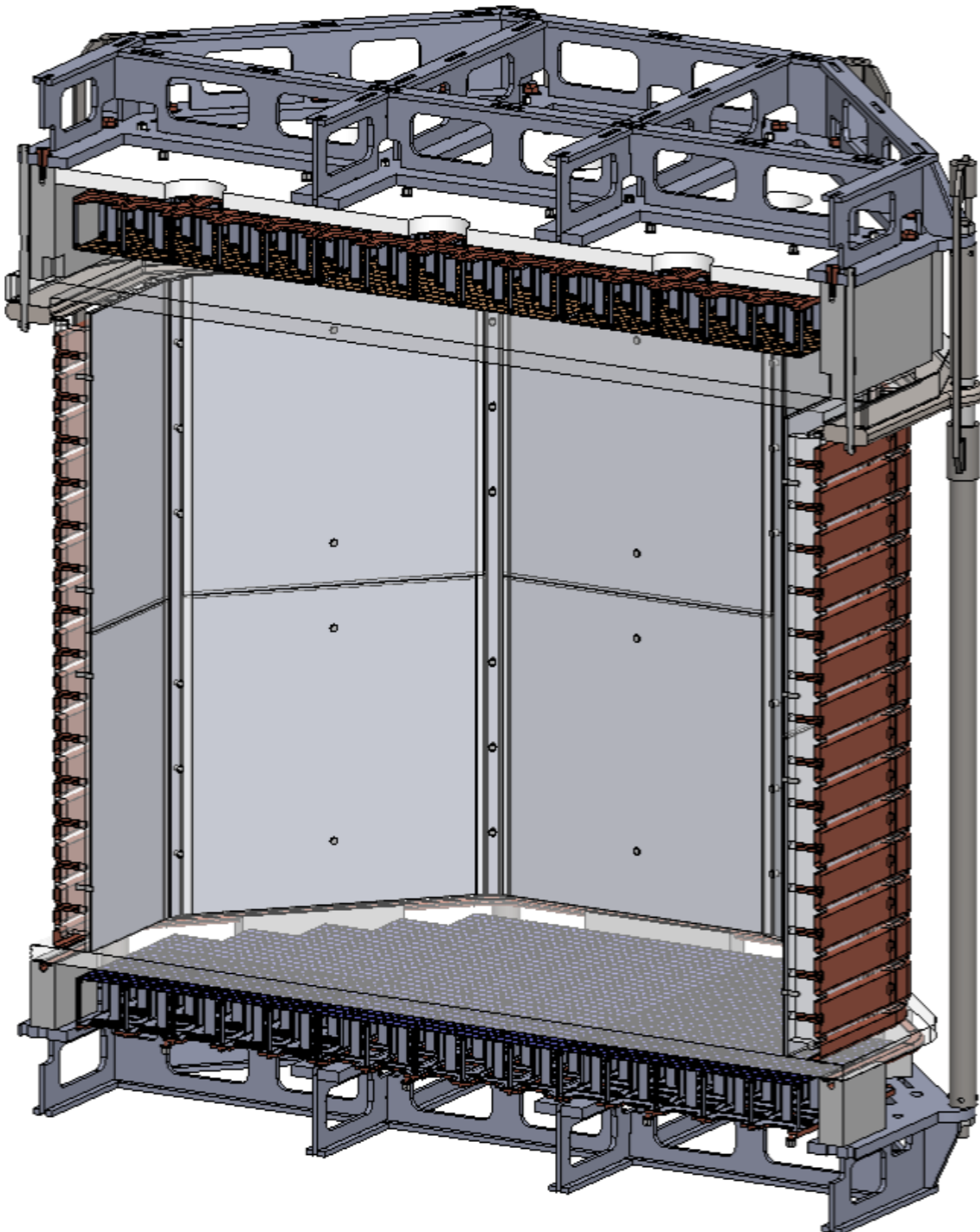
- New upgraded argon condenser
- Heat exchanger
- Heat recovery system
- Functionality and stability of controls
- System safety during power failure
- 500 std L/min gas pump & flow rate

# TPC

*Assembled at site and mechanically tested - Q3 2018*

*Partial coverage of photosensors - Q3 2018*

*Full coverage - Q2 2019 (?)*



## TPC mechanics validation

- structural elements
- field cage
- reflector cage
- transparent cathode & anode
- wire extraction grid

## PhotoDetector Modules

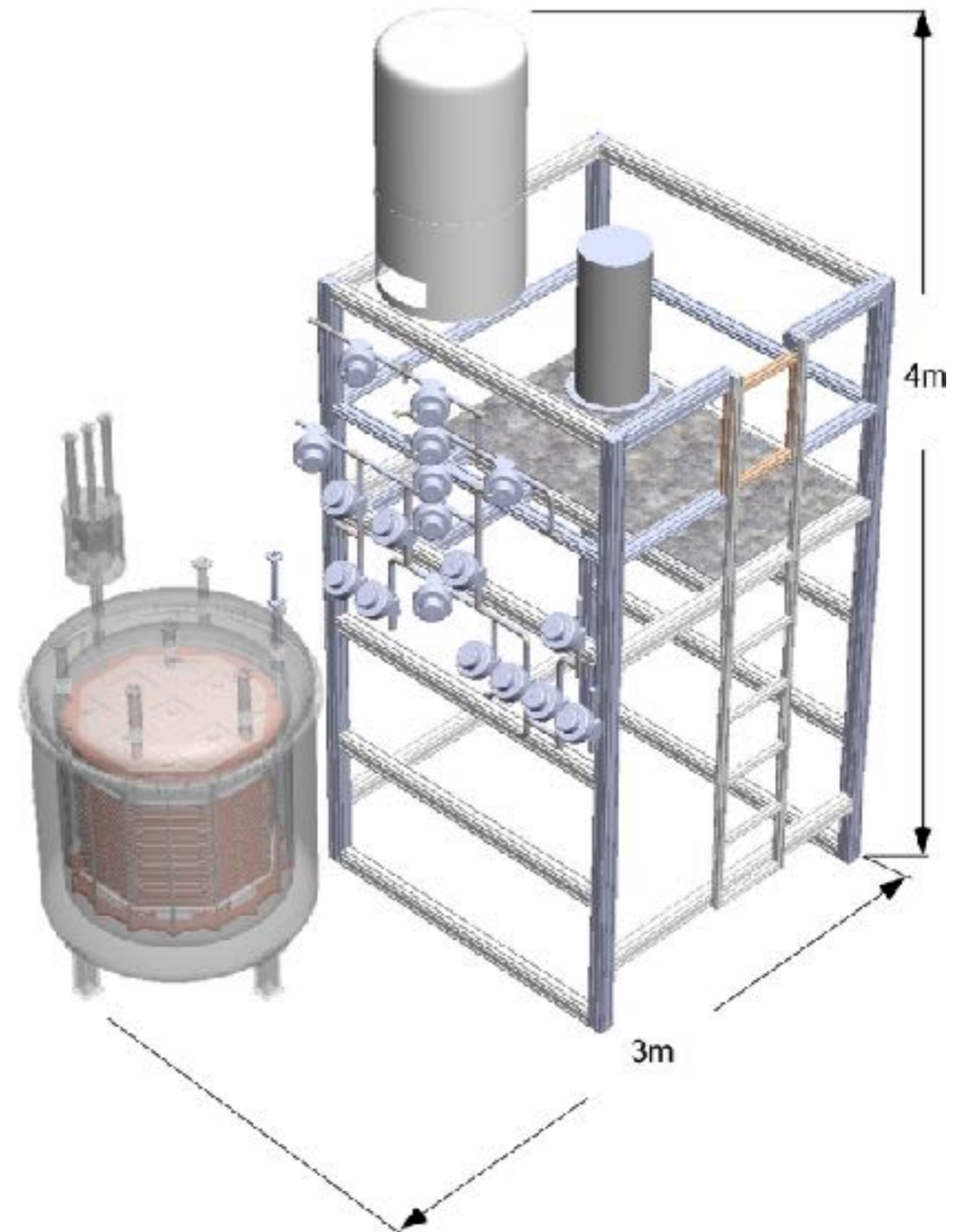
- Initially (Q3 2018), 50 pre-production PDMs (2 Motherboards).
- Later (Q2 2019), total number of PDMs for DS-Proto, i.e. 370 (8% of DS-20k)

**All built utilizing, on a scaled down dimension, same design and construction techniques foreseen for DS-20k**

# Prototype system

*Integration + validation + operation - Q4 2018 / Q4 2019*

- **Partial coverage commissioning and operation (Q4 2018/ Q1 2019)**  
2 motherboards + preliminary readout
- **Full system integration and validation (Q2/Q3 2019)**  
18 motherboards from DS-20k pre-production, full electronics chain and DAQ final components
- **Evaluate performance of key parameters (Q4 2019)**  
zero-suppression, trigger algorithms, online DSP

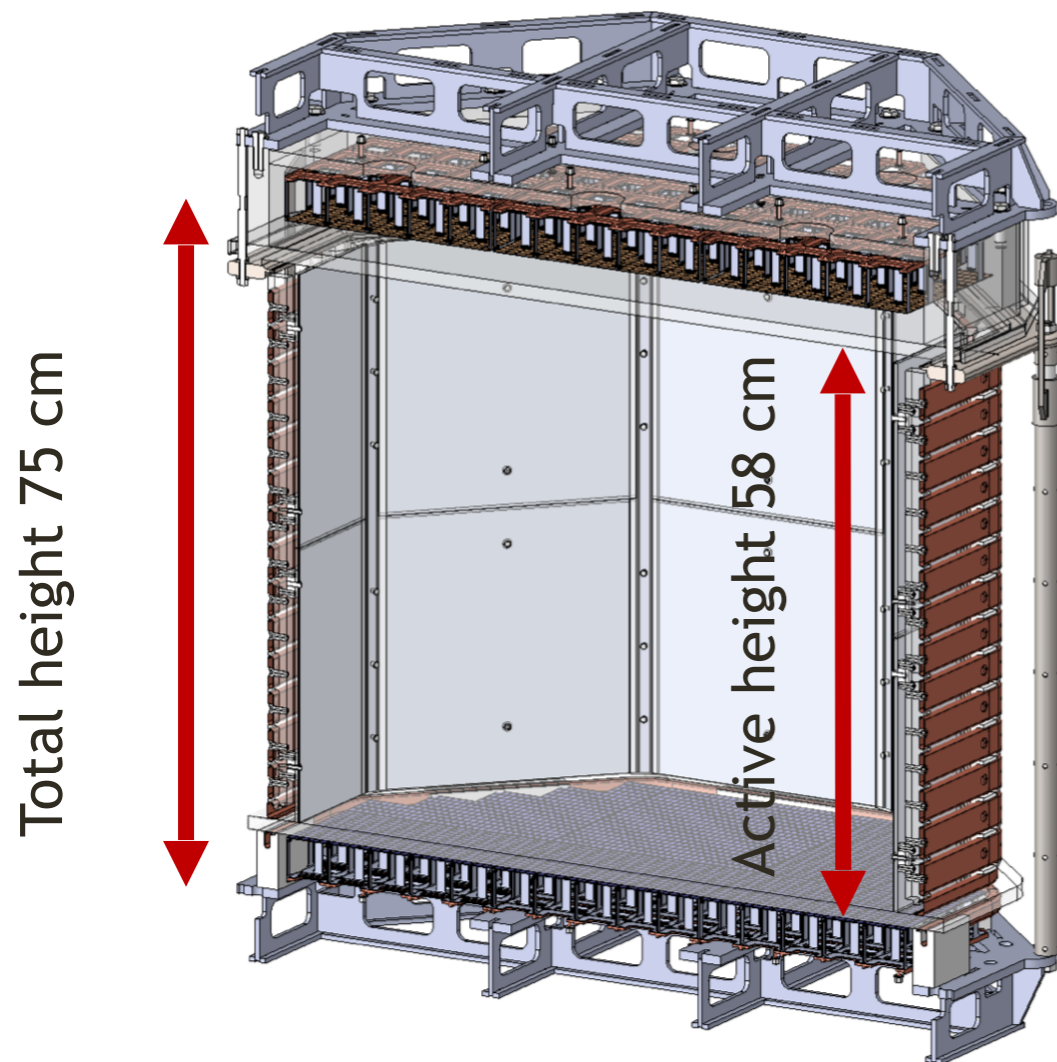


# DarkSide-Proto Project Timeline (updated)

	2018				2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Cryostat Construction and Delivery	█											
Cryogenic System Assembly and Test	█	█										
PDM Prototype Production	█	█	█									
TPC Assembly and Mechanical Test			█									
PDMs in TPC (Part. Coverage)				█								
Comm. and Operation (Part. Coverage)				█	█							
Full System Integration and Validation					█	█	█	█				
Full System Operation								█	█	█		



# A physics-case for DS-Proto



Test bed for DS-20k technology to be installed at CERN in 2019

370 SiPM tile photo-sensors

Low background SS cryostat

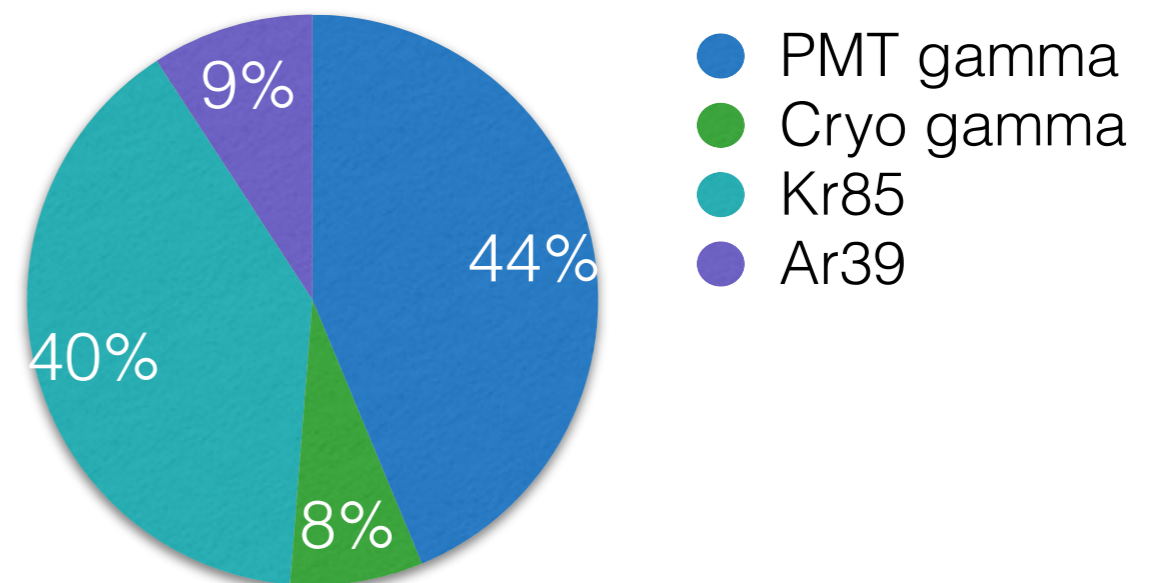
Possible installation in LNGS in ~2020

Run in 2020-21

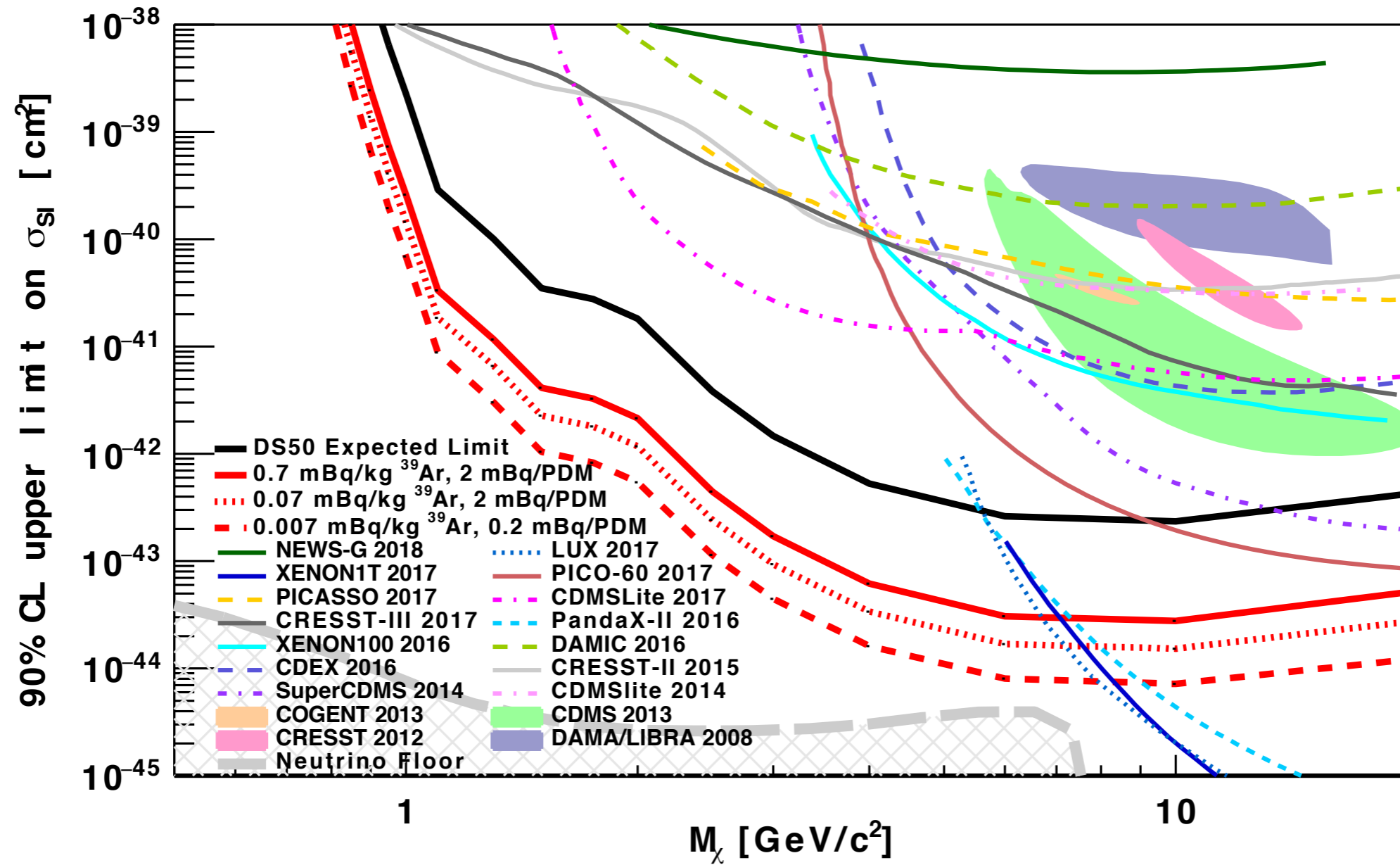
S2-only analysis background limited in DS50

Potential breakthrough:

- Urania/Aria program
- Use of SiPM
- Larger mass in DS-Proto



# Future Darkside Low-Mass Searches



# Summary of Project Status involved WGs

1. TPC & CRYO for the design and construction of the cryogenic system, 1-ton cryostat and TPC
  - Development and construction of the cryosystem is rapidly proceeding towards a stand-alone test
  - SS cryostat under construction. Delivery expected by Q3 2018 at CERN
  - Material procurement and construction of the TPC scheduled for Q3 2018
  - ITO and TPB deposition still not assigned to a specific group
2. PE: Prototype PDM production (for 2MB) scheduled for Q3 2018
3. DAQ, Trigger & Slow Control. Plan to use commercial digitiser. First prototype of dedicated board appearing in Fall 2018
4. MAT for the materials screening and radioactivity budget evaluation
  - Work just started
5. CALIB for the calibration setup
  - Work not started yet. Installation on the detector scheduled for Q1 2019
6. OFFL for the MC simulations, the reconstruction software, the analysis of data
  - Prototype geometry available in g4ds since 2017
  - Detailed studies started, targeted to design the experiment and estimate expected performances in the underground run
7. INFRASTRUCTURES for the underground site and infrastructures preparation

# Next steps

- Cryosystem + Cryostat installation at CERN
- TPC construction and assembly with 2 MB
- Proto DAQ, trigger, slow control
- Offline: simulation studies oriented to experiment design + reconstruction software
- Materials for 1-ton Proto
- Plan for remaining 16 MB construction and integration
- Plan for calibration setup
- Full system integration + ancillary systems (shield, muon hodoscope, ...?)