UNIVERSITY OF CAMBRIDGE

# ArgonCube2x2: Rack Builds Progress

Karolina Wresilo

2x2 Electronics Integration Meeting 11th May 2022

# Outline

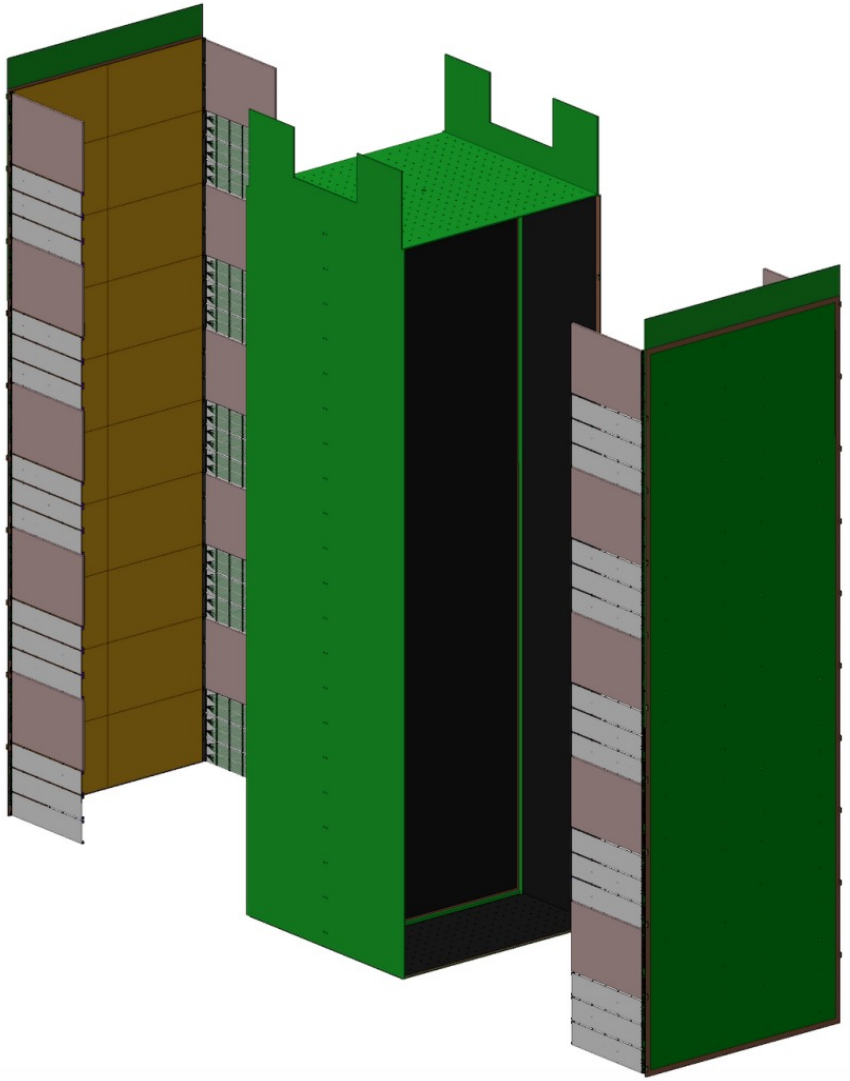
- Introduction
  - ND-LAr ArgonCube
  - ArgonCube 2x2

- Rack builds:
  - The team
  - Safety reviews
  - Subsystems

- Plans and schedule

# ND LAr: ArgonCube

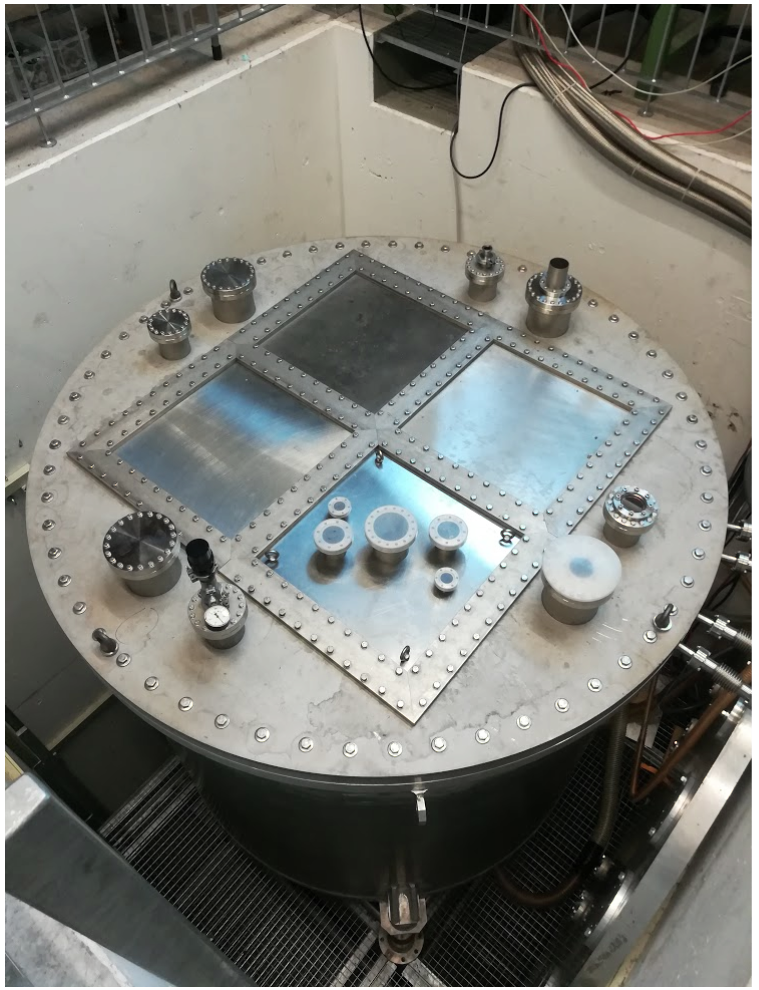
- High-intensity 1.2 MW beam will **deliver 55 neutrino interactions per beam spill** at the DUNE near-detector (ND) site.
- The expected **event pile up** would lead to ambiguous and/or unresolvable final states.
- To combat this a **modular approach** is taken (ArgonCube concept):
  - ND-LAr will consist of 35 optically isolated TPC modules.
  - Each module has a cathode in the middle and two anode read-out planes on either side.



Full sizes modules will be 1.0 x 1.0 x 3.5m

# ArgonCube Prototyping:  2x2 Module

- Prototype consisting of four 0.7 x 0.7 x 1.4m TPC modules, contained within a common cryostat.
- Essential for **confirming the functionality of the modular approach**.

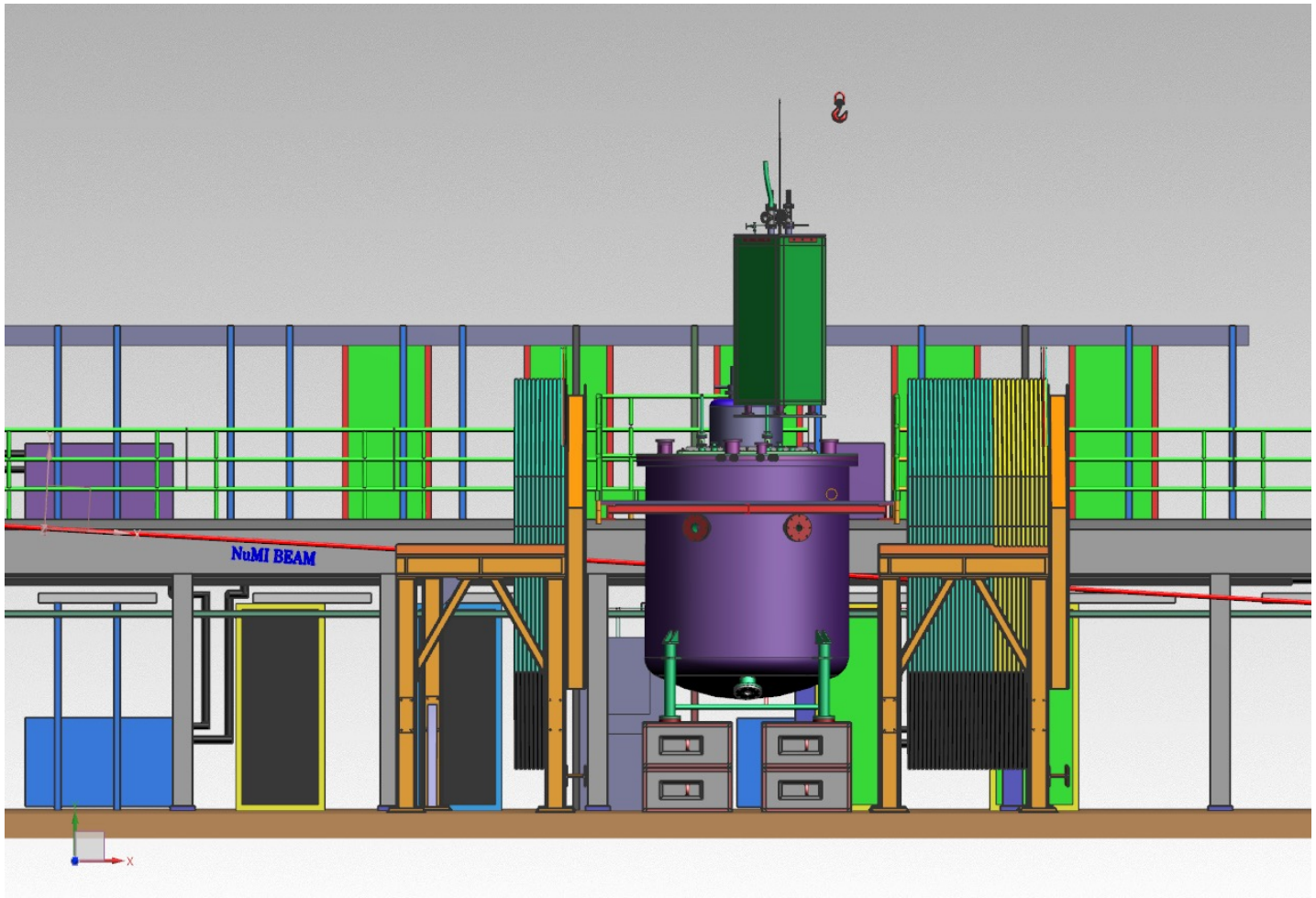


# Detector Layout

- Eventual goal: test beam in the MINOS underground facility.
- Designed based on the space available in the MINOS hall.

NuMI beam

- In the image:
  - Cryostat (purple)
  - TPC module (dark green)
  - **Electronic racks (light green)**




SPARE
DETECTOR POWER
SPARE
DETECTOR POWER
LIGHT ADC
DETECTOR POWER
POWER SUPPLY
DETECTOR POWER
SPARE
DETECTOR POWER
SERVER RACK - 2
QUIET POWER
GAS ANALYZER
EPP POWER
MINERVA READOUT
QUIET POWER
CRYO RACK
EPP POWER
NETWORK
EPP POWER
SERVER RACK - 1
QUIET POWER
X

# Rack Builds: Team

A number of Fermilab staff members:

- Ting Miao (project manager for ArgonCube installation and testing)
- Linda Bagby (…)
- Geoffrey Savage (Neutrino Division Operations Support)
- and support from engineers and technicians

PhD students:

- Jingyuan Shi
- Norman Matrinez
- Alexandra Moor
- Rowan Zaki
- Karolina Wresilo

# Rack Builds: Subsystems

- 4 main subsystems:
  1. Charge read-out
  2. Light read-out
  3. Drift HV
  4. Purity Monitor

- 4 main racks
  1. HV (High-Voltage)/Light VGA (Variable Gain Amplifier) rack: Jingyuan Shi
  2. Light ADC (Analog to Digital Converter) rack: myself
  3. PS (Power Supply) rack: Rowan Zaki and Norman Martinez
  4. PM (Purity Monitor) rack: Alexandra Moor

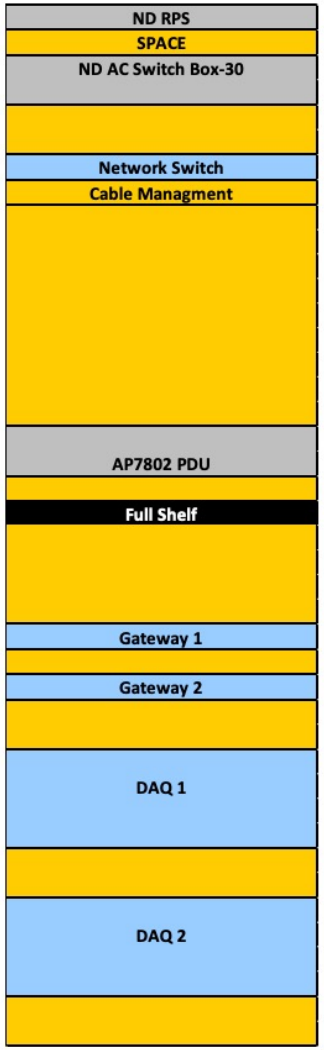
# Rack Builds: Safety Engineering Design Review (SEDR) and Operational Readiness Clearance (ORC)

- Several **non-NRTL (Nationally Recognised Testing Laboratory) equipment is utilised** (custom designs)

- Before powering on:
  - ORC is required due to the use of custom design electrical equipment.
  - SEDR is used to determine whether the custom design follows **Fermilab Engineering Design Standard** based on **National Electrical Code and best engineering practices.**

# Rack Builds: Safety Engineering Design Review (SEDR) and Operational Readiness Clearance (ORC)

- During the rack build design and assembly, we:
  - Follow a system block diagram scheme to ensure **adequate cooling of the equipment and accommodation for cable dressing**.



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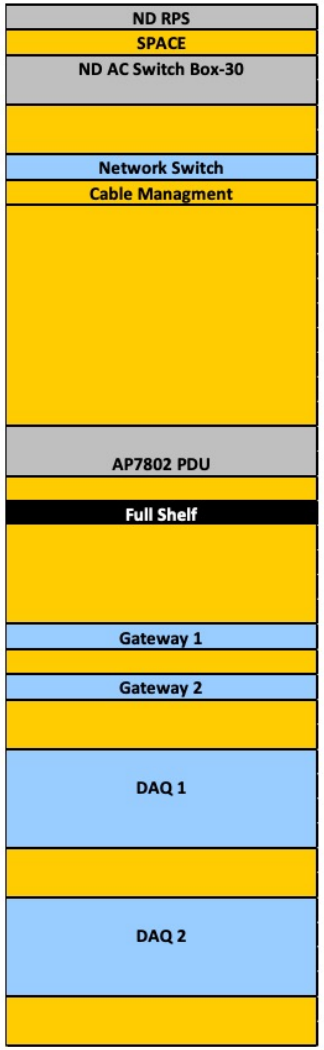


| | | Server Rack | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| # of racks | Location | Rack Name | Rack Components | Network | Voltage (V) | Current (A) | Power (VA) | Space (U) | 120V/15A | 120V/20A | 120V/30A |
| 1 | Under catwalk | Server | ND RPS | | 120 | 1 | 120 | 1 | 1 | | |
| | | | Space | | | | | 1 | | | |
| | | | Switch Box-30 | | | | | 2 | | | 1 |
| | | | Space | | | | | 4 | | | |
| | | | network switch | | 120 | 5 | 600 | 1 | 1 | | |
| | | | cable management | | | | | 1 | | | |
| | | | space | | | | | 6 | | | |
| | | | gateway computer | 2 | 120 | 2 | 240 | 1 | 2 | | |
| | | | space | | | | | 1 | | | |
| | | | gateway computer | 2 | 120 | 2 | 240 | 1 | 2 | | |
| | | | Space | | | | | 2 | | | |
| | | | DAQ computer | 2 | 120 | 3 | 360 | 4 | 1 | | |
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| | | | Space | | | | | 2 | | | |
| | | | **Total** | **8** | | **16** | **1920** | **33** | **8** | **0** | **1** |

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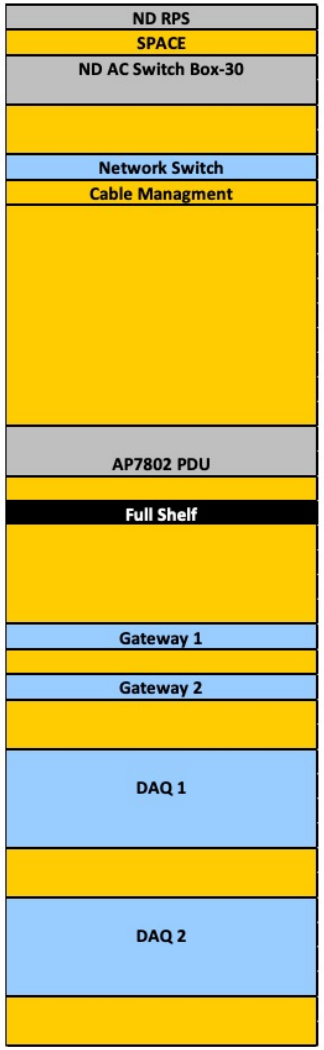
- During the rack build design and assembly, we:
  - Follow a system block diagram scheme to ensure **adequate cooling of the equipment and accommodation for cable dressing**.
  - Construct tables used to determine **AC current requirements.**
  - Collect documentation during the rack build to
    - Generate an **ORC Request** which focuses on AC and DC distributions.
    - Provide resources for collaborators and support staff.

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| | | | Space | | | | | 4 | | | |
| | | | network switch | | 120 | 5 | 600 | 1 | 1 | | |
| | | | cable management | | | | | 1 | | | |
| | | | space | | | | | 6 | | | |
| | | | gateway computer | 2 | 120 | 2 | 240 | 1 | 2 | | |
| | | | space | | | | | 1 | | | |
| | | | gateway computer | 2 | 120 | 2 | 240 | 1 | 2 | | |
| | | | Space | | | | | 2 | | | |
| | | | DAQ computer | 2 | 120 | 3 | 360 | 4 | 1 | | |
| | | | Space | | | | | 2 | | | |
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| | | | Space | | | | | 2 | | | |
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# Rack Builds: Common Features

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    1. RPS (Rack protection system)
        - protects the electronics in the rack by shutting down the powers when there is a smoke (fire) in the rack.

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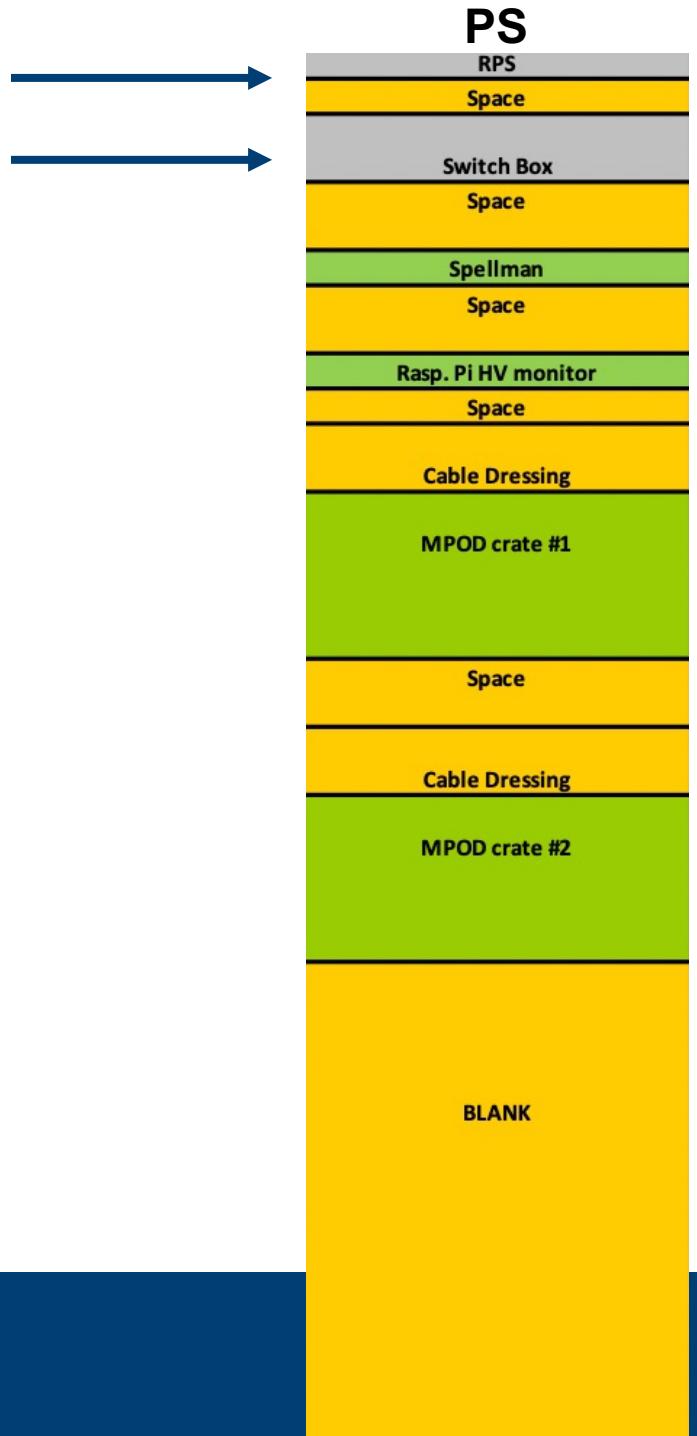
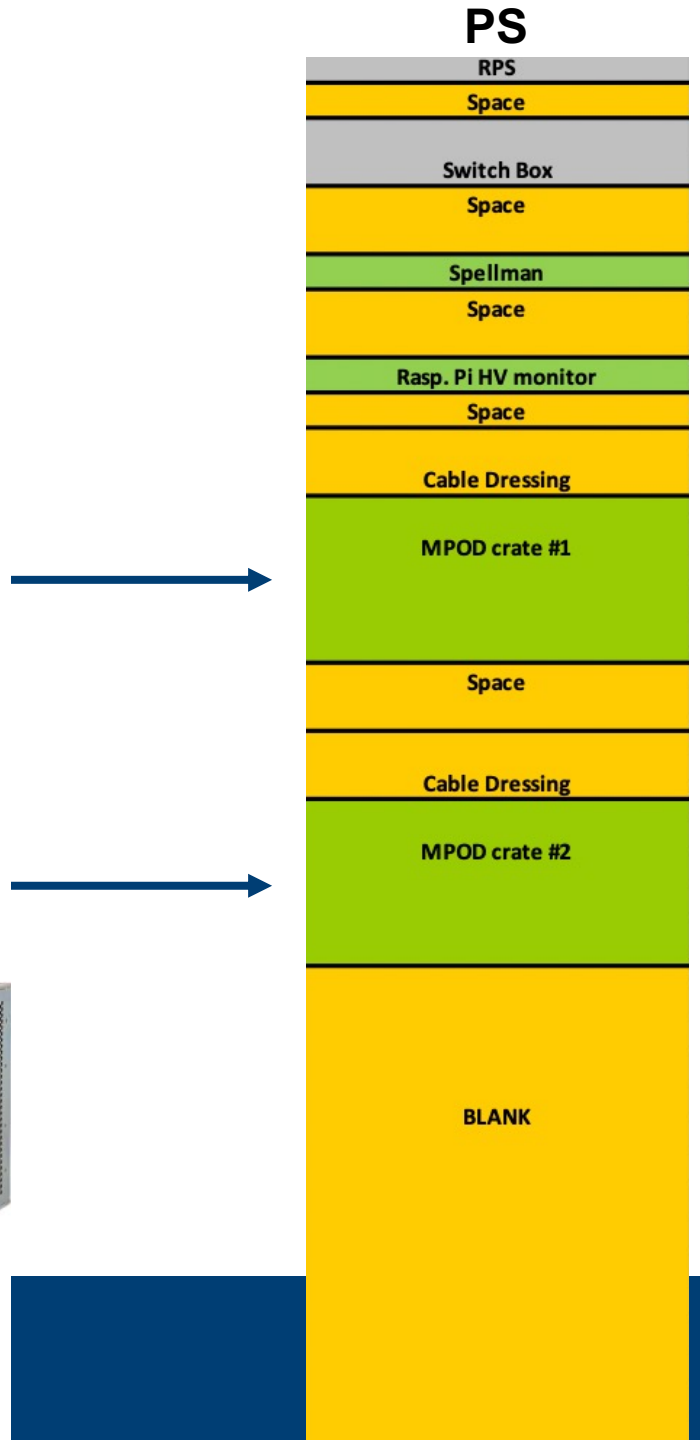
  1. RPS (Rack protection system)
     - protects the electronics in the rack by shutting down the powers when there is a smoke (fire) in the rack.

  2. Switch Box
     - provides controlled and safe way to supply AC power to electronics inside the rack.



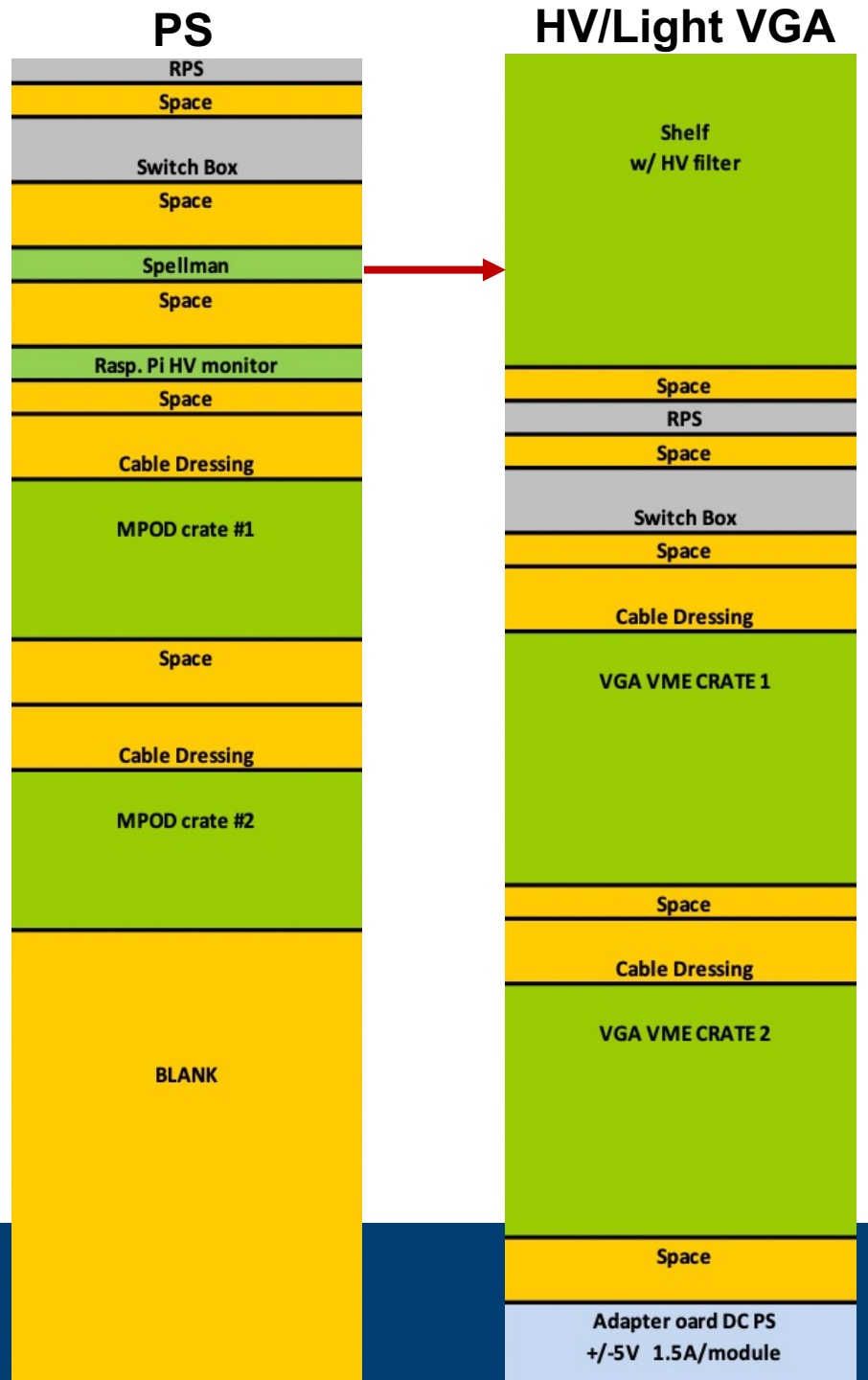
# Rack Builds Subsystems: Charge Readout (Rowan and Norman)

- The TPC has a pixelated anode with pixels instrumented by ASICs.
- 2 PACMAN per TPC mounted on top of the feed through to provide data **input/output.**
- Currently, the charge readout system QA/QC for module-0 performed using bench top power supply :
  - the setup will be **replaced with MPOD MPV modules** in the DC PS rack.



# Rack Builds Subsystems – Drift HV (Jingyuan)

- **Spellman PS** used for powering the high-voltage system.
- The **HV filter** connected to the cathode through the feedthrough on top of the cryostat.

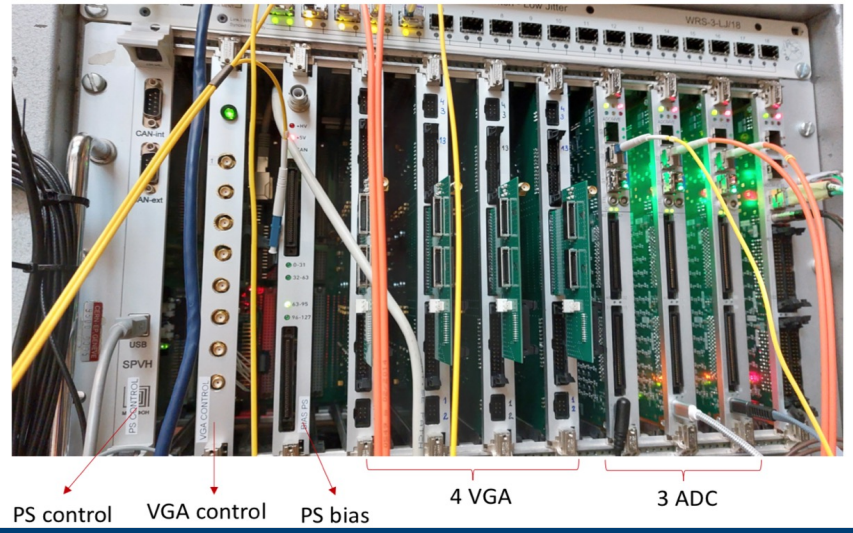



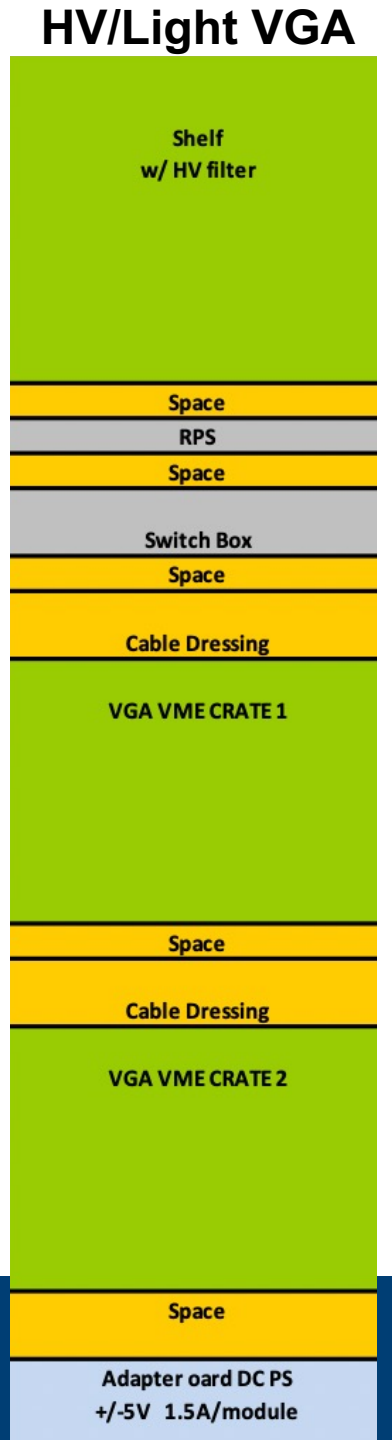
# Rack Builds Subsystems – Light Readout (myself)

- The location of this rack (lower hall) will reduce the required length of the cables and therefore **minimise the noise.**

- Adapter board at the bottom distributes the signal from feedthrough to VME crates via micro-coaxial cables.

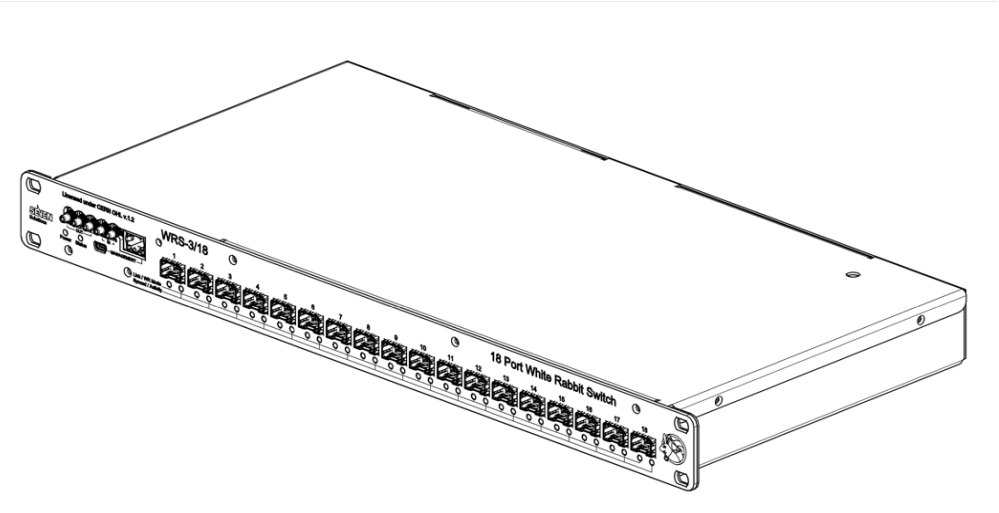
- The signal is sent to the VME crates. These contain:
  - Contain PCB modules with VGAs (x8)
  - DAC PS (x2)
  - Control unit (x1)

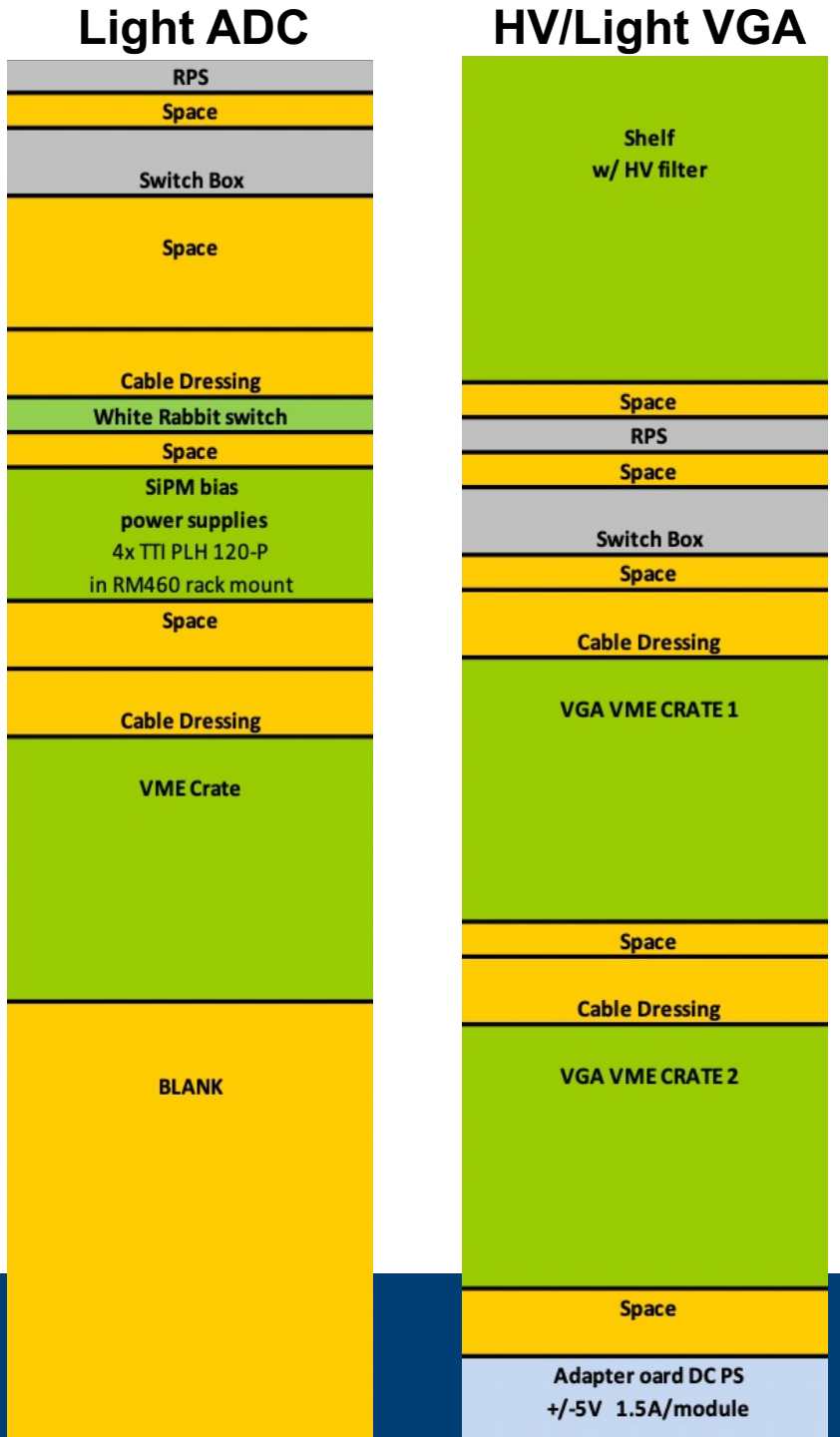


# Rack Builds Subsystems – Light Readout (myself)

- White rabbit switch which will eventually be used for beam clock.



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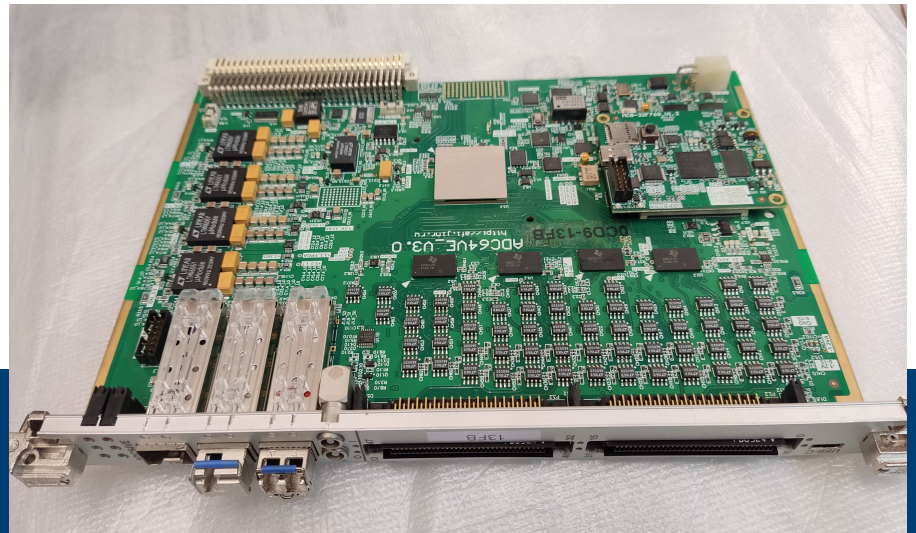
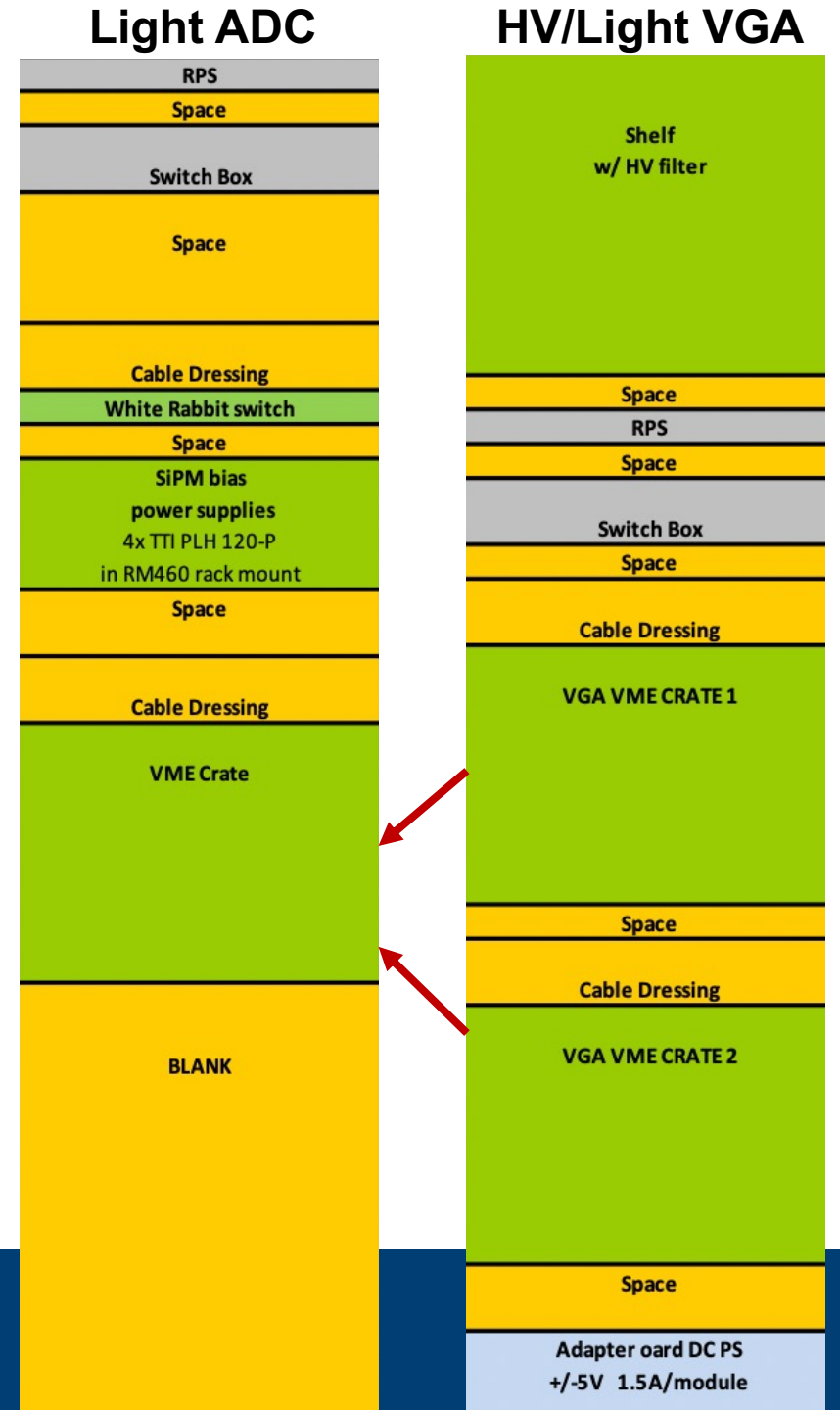
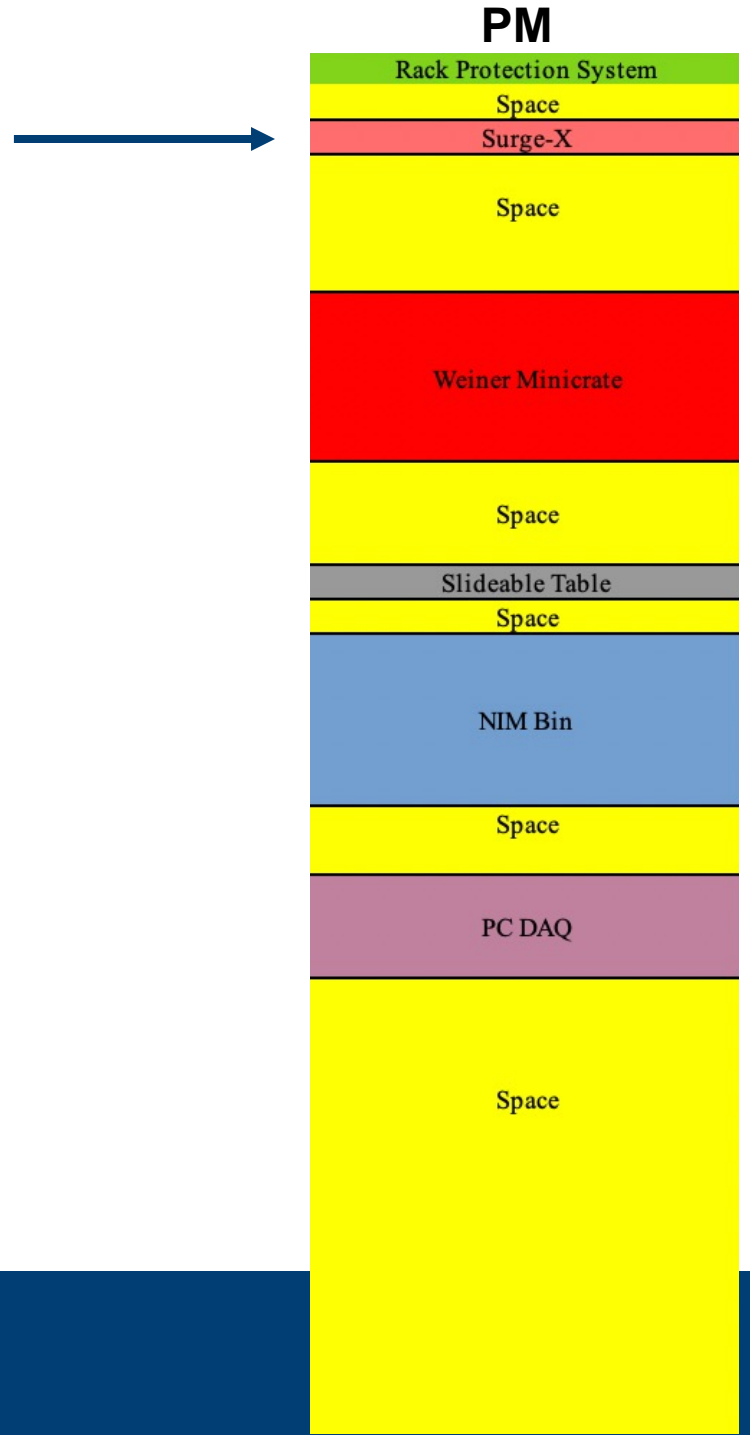
- VGA VME crates (right) connected to VME crate in the Light ADC rack (left). This contains:
  - ADC modules (x8)
  - Trigger unit (x1)





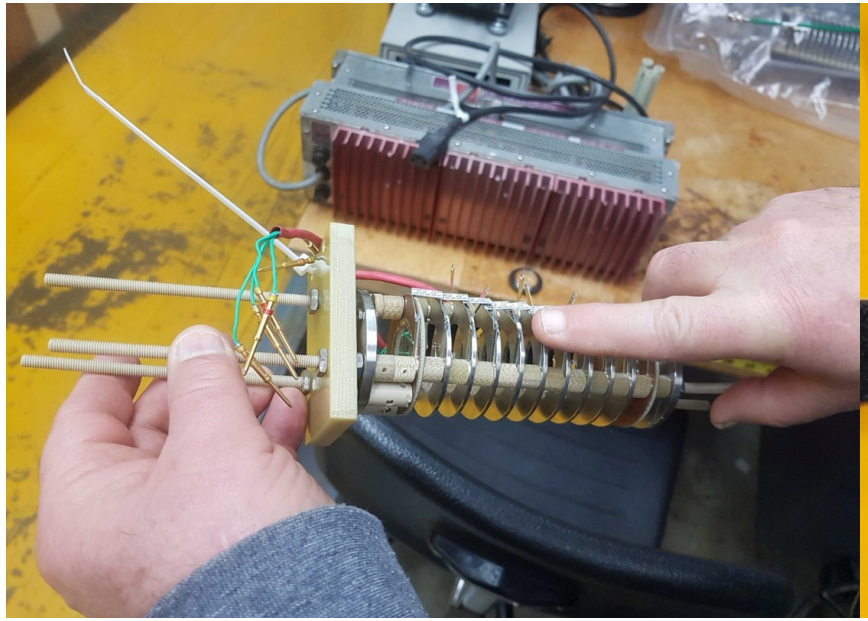
# Rack Builds Subsystems – Purity Monitor

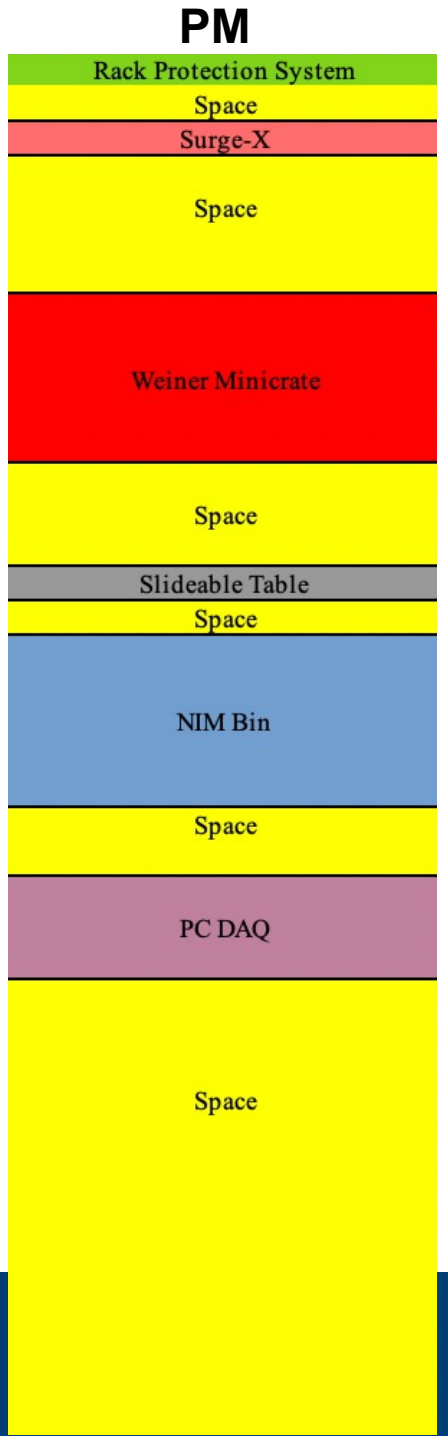
- Surge-X provides power and serves as a switch box for the rack.



# Rack Builds Subsystems – Purity Monitor

- Surge-X provides power and serves as a switch box for the rack.
- Purity monitor situated inside the TPC. Connects to the adapter modules inside the NIM Bin (modified such that is has its own PS).





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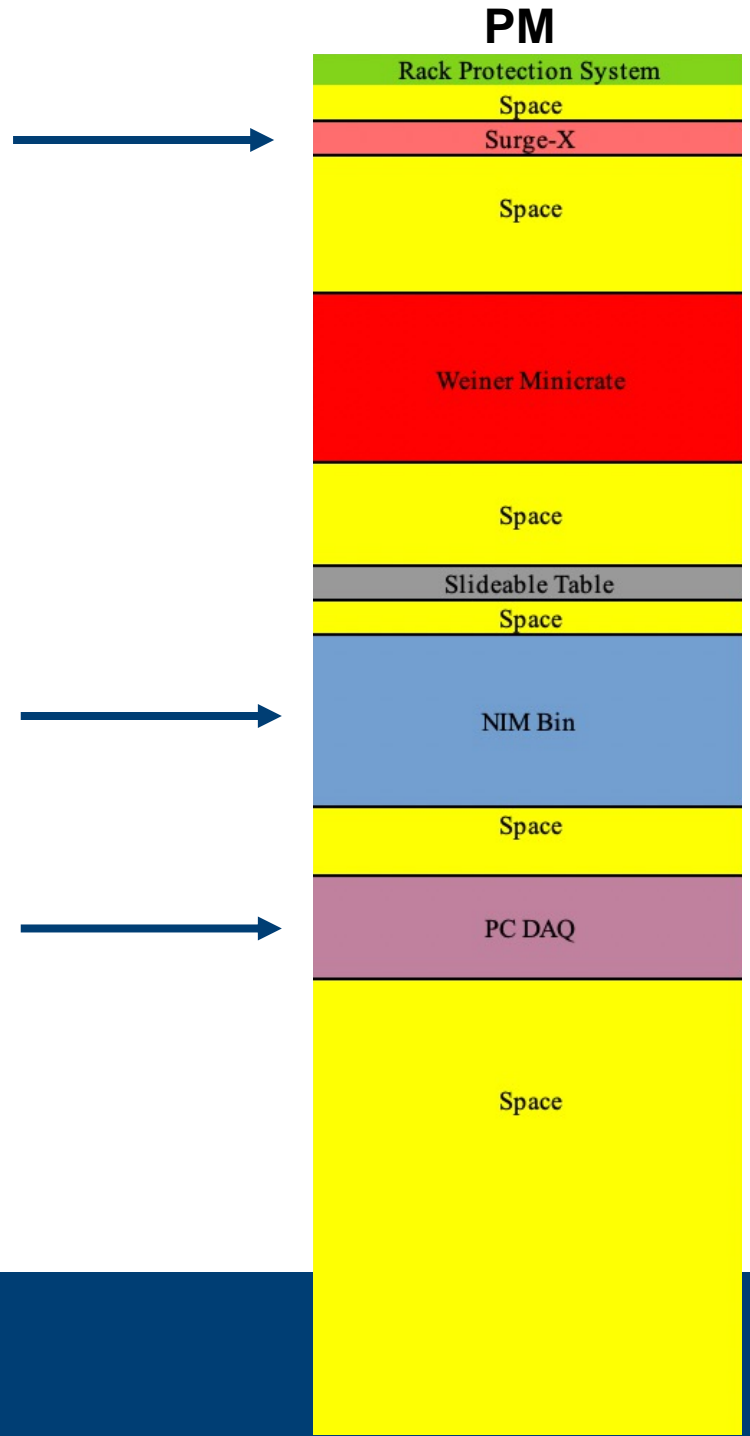

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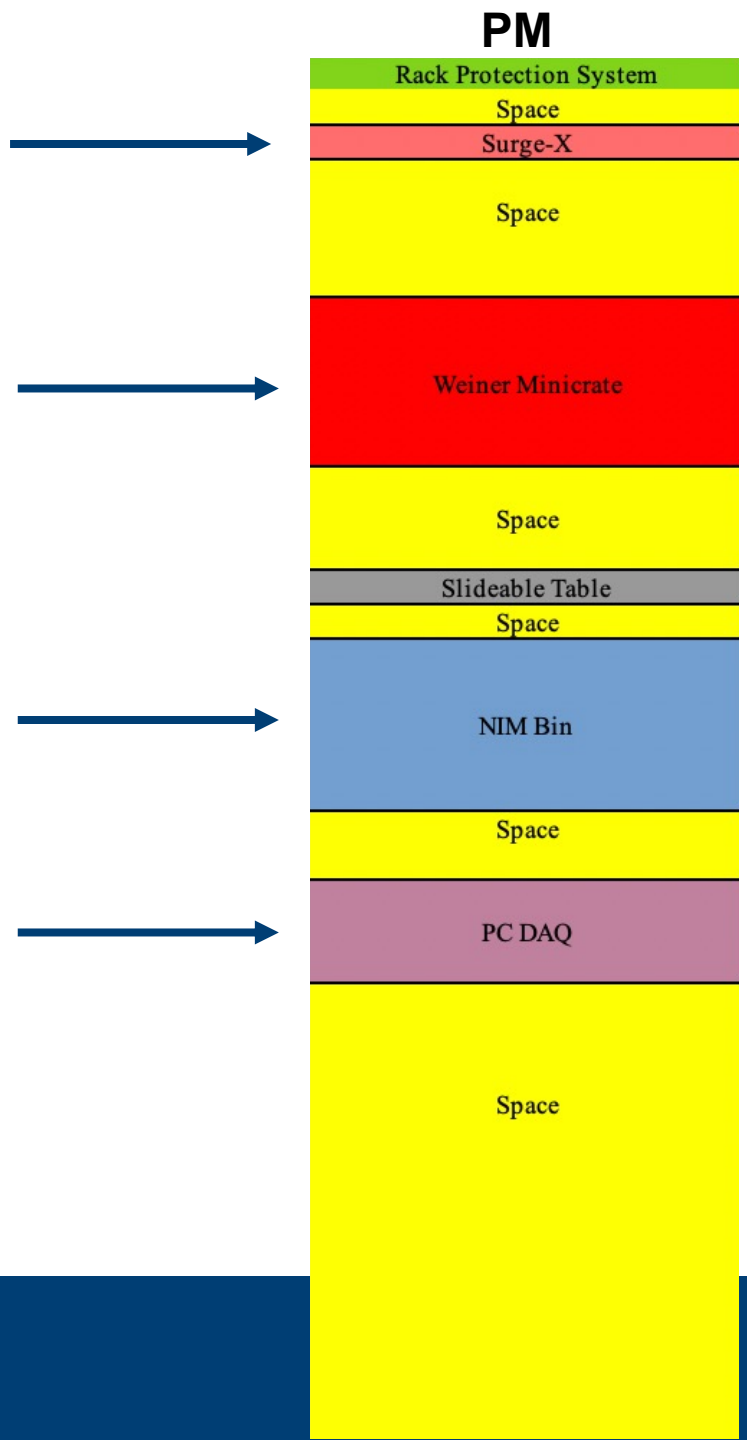
- Purity monitor situated inside the cryostat. Connects to the adapter modules inside the NIM Bin (modified such that is has its own PS).
- NIM Bin communicates with a bench top computer for DAQ.
- Wiener Minicrate containing:
  - Control modules.
  - HV module.

# Plans and Schedule

**May 2022**

Module-1 and VME light-readout electronics

**July 2022**

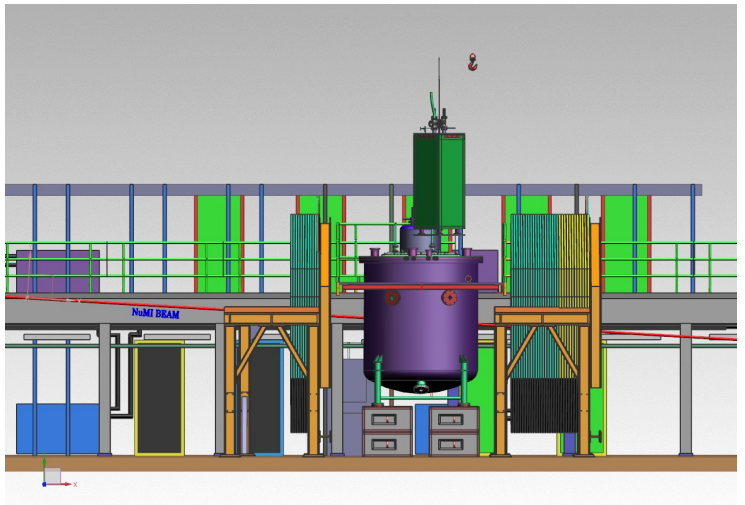
Module-2

**September 2022**

Module-3

**October/November 2022**

Transfer to MINOS underground




**QA/QC tests to be performed as the modules arrive (warm tests).**

# Summary

- The long-term goal of the ArgonCube 2x2 module is to confirm the **functionality of the modular approach in beam environment.**
- Rack build designs are finalised. **The assembly of them has begun.**
- **QA/QC of the subsystems** will be performed module by module (warm tests).
- All modules set to arrive by the end of September with relocation to the underground facility later this year.