Proto 0 Status Update

GIANFRANCESCO GRAUSO
YURY SUVOROV
RICCARDO DE ASMUNDIS
ANNA BASCO
FRANCESCO DI CAPUA
GIULIANA FIORILLO

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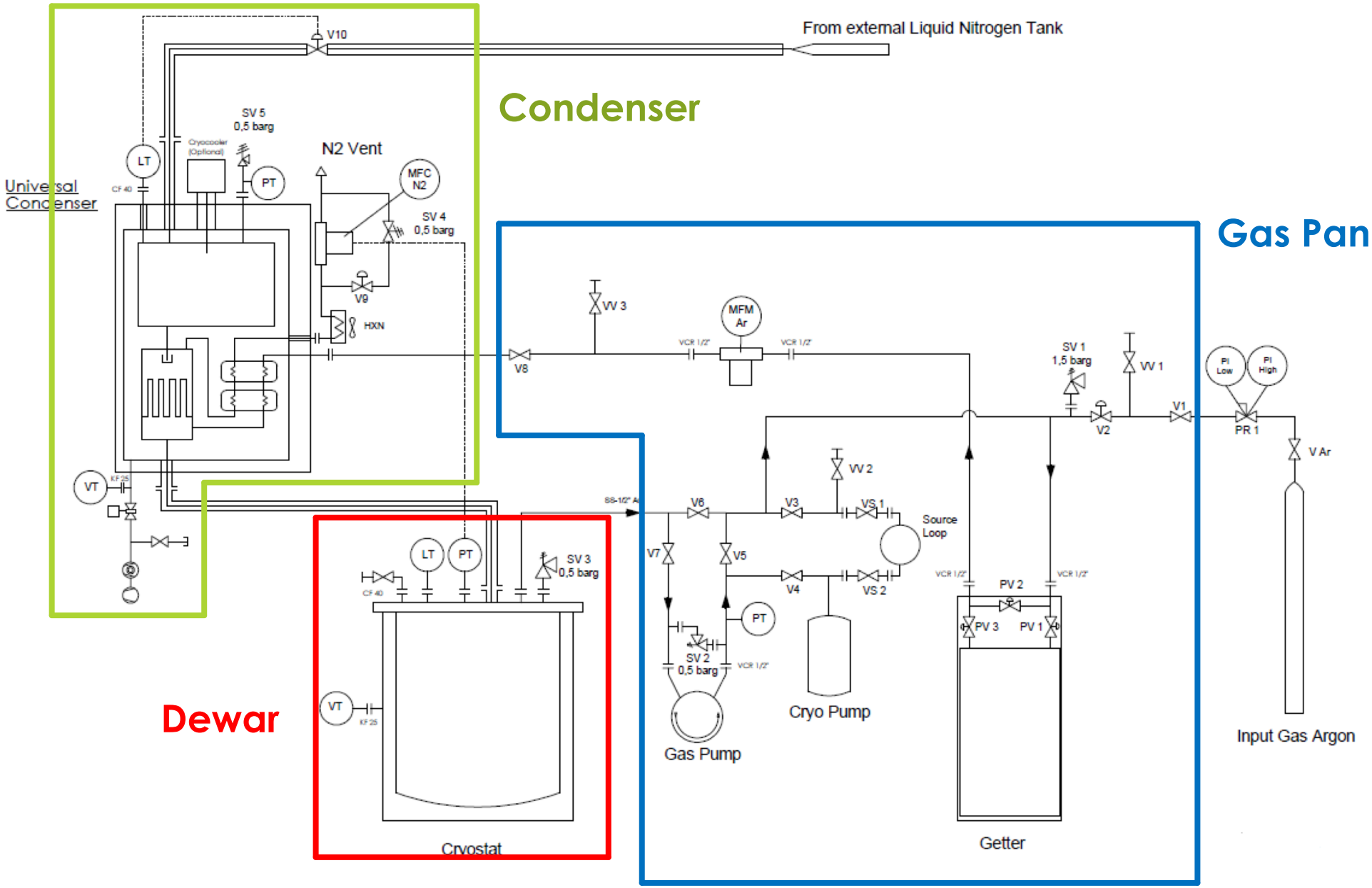
Summary

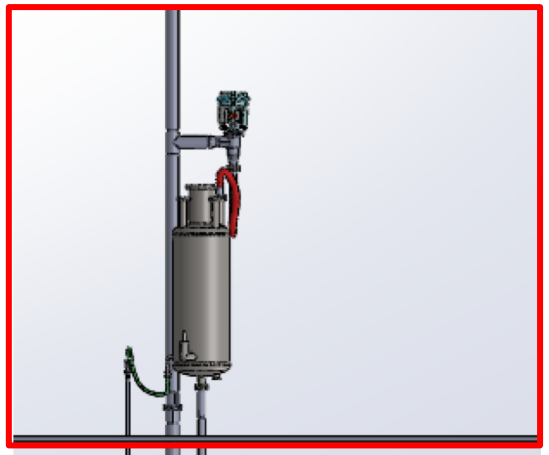
1. SYSTEM OVERVIEW
2. CONDENSER
3. DEWAR + FLANGE
4. GAS PANEL + GETTER
5. SLOW CONTROL
6. CRYO SYST COMMISSIONING
7. ELECTRONICS & DAQ
8. TPC
9. NEXT STEPS

System Overview 1/4

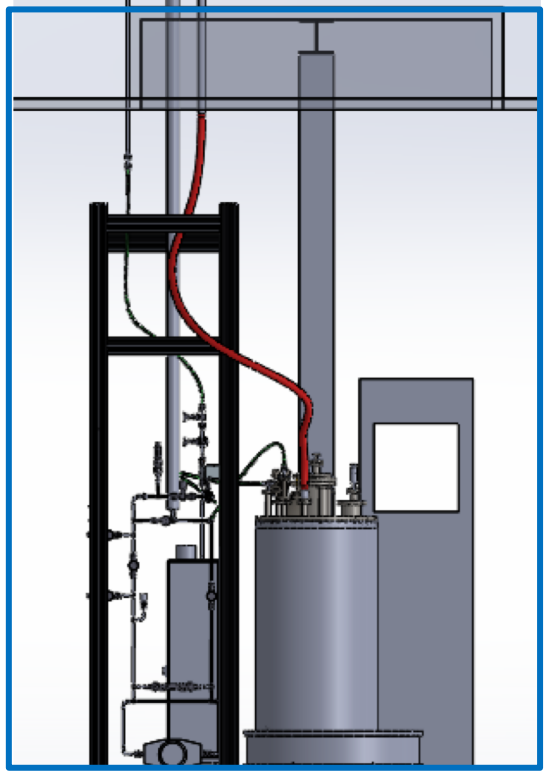


Designed in strong collaboration with Cary Kendziora and Marco Carlini

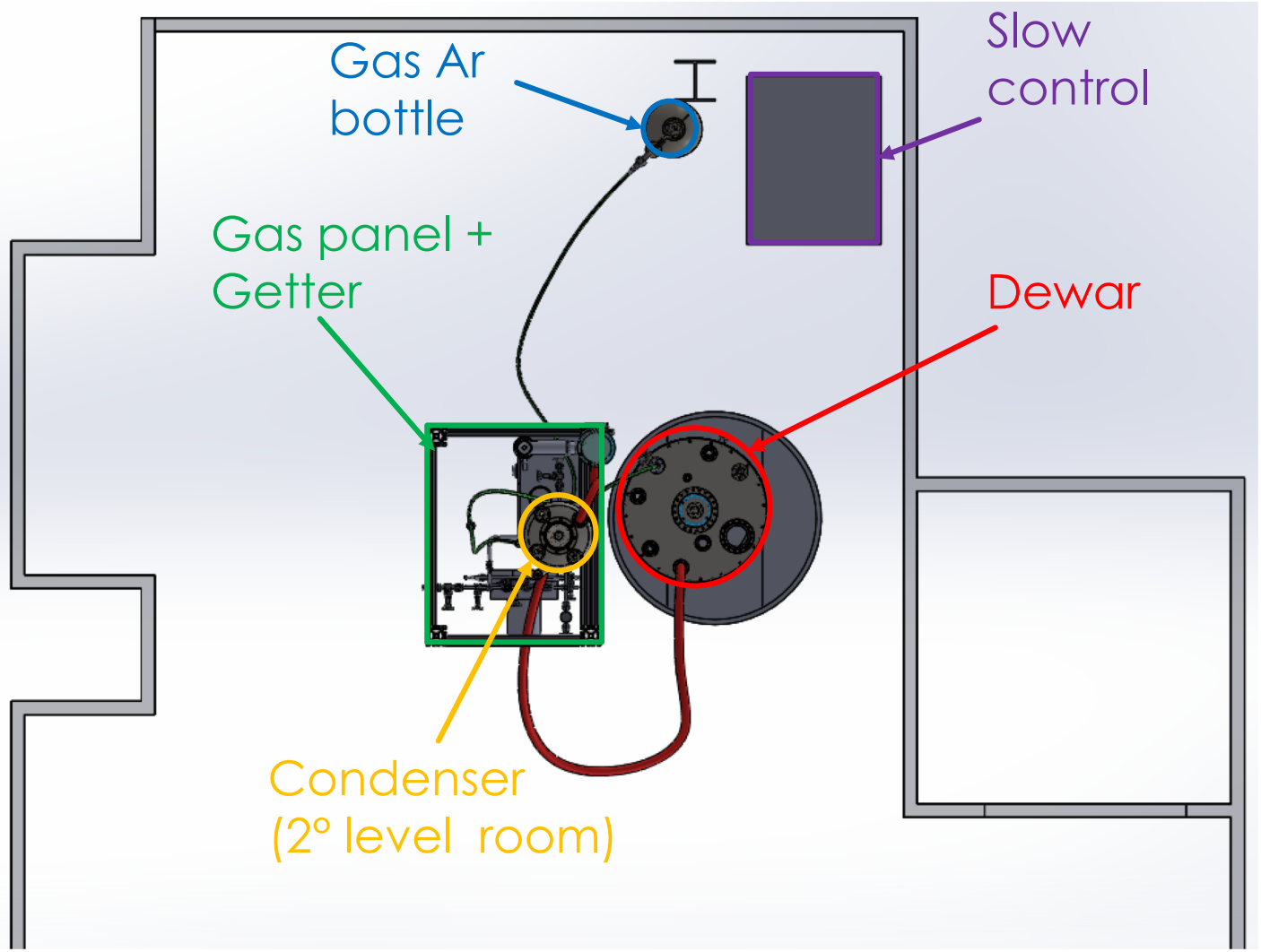
System Overview 3/4



2° level room



clean room



Condenser

Proportional Valve

LN from tank

PT signal for cooling power regulation

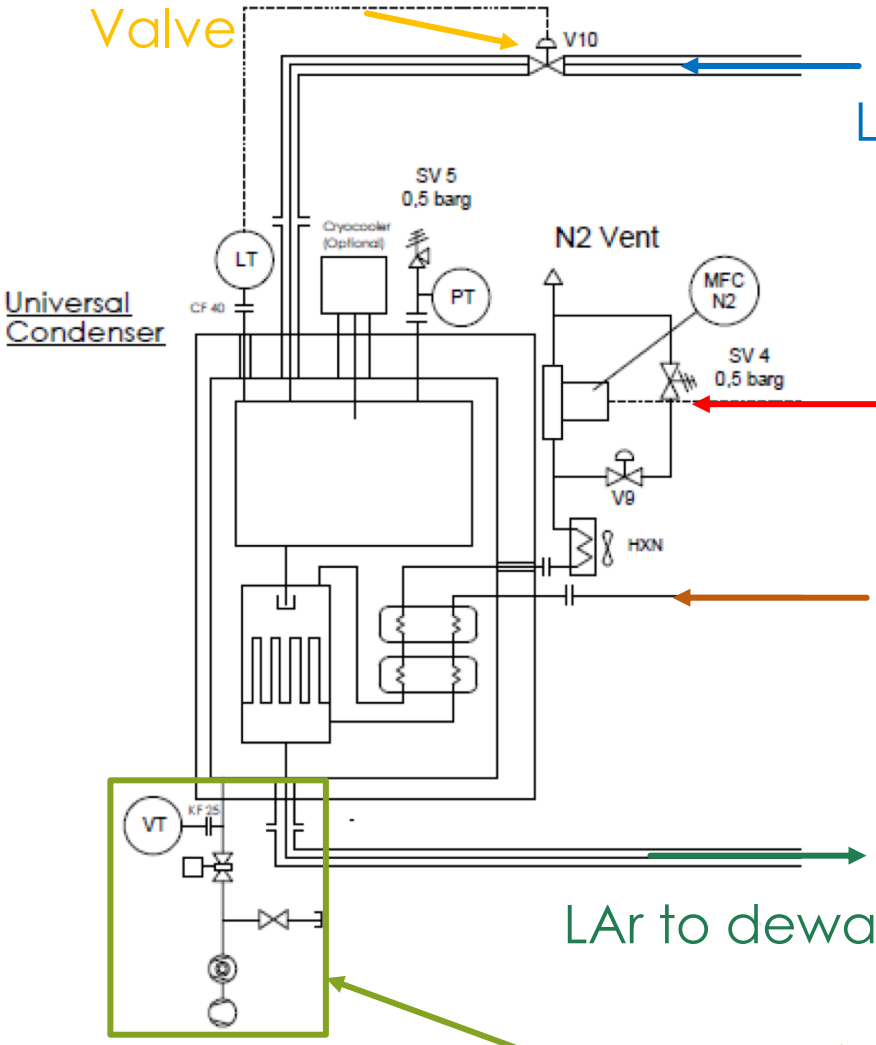
Gas Ar

LAr to dewar

Vacuum jacket pumping station

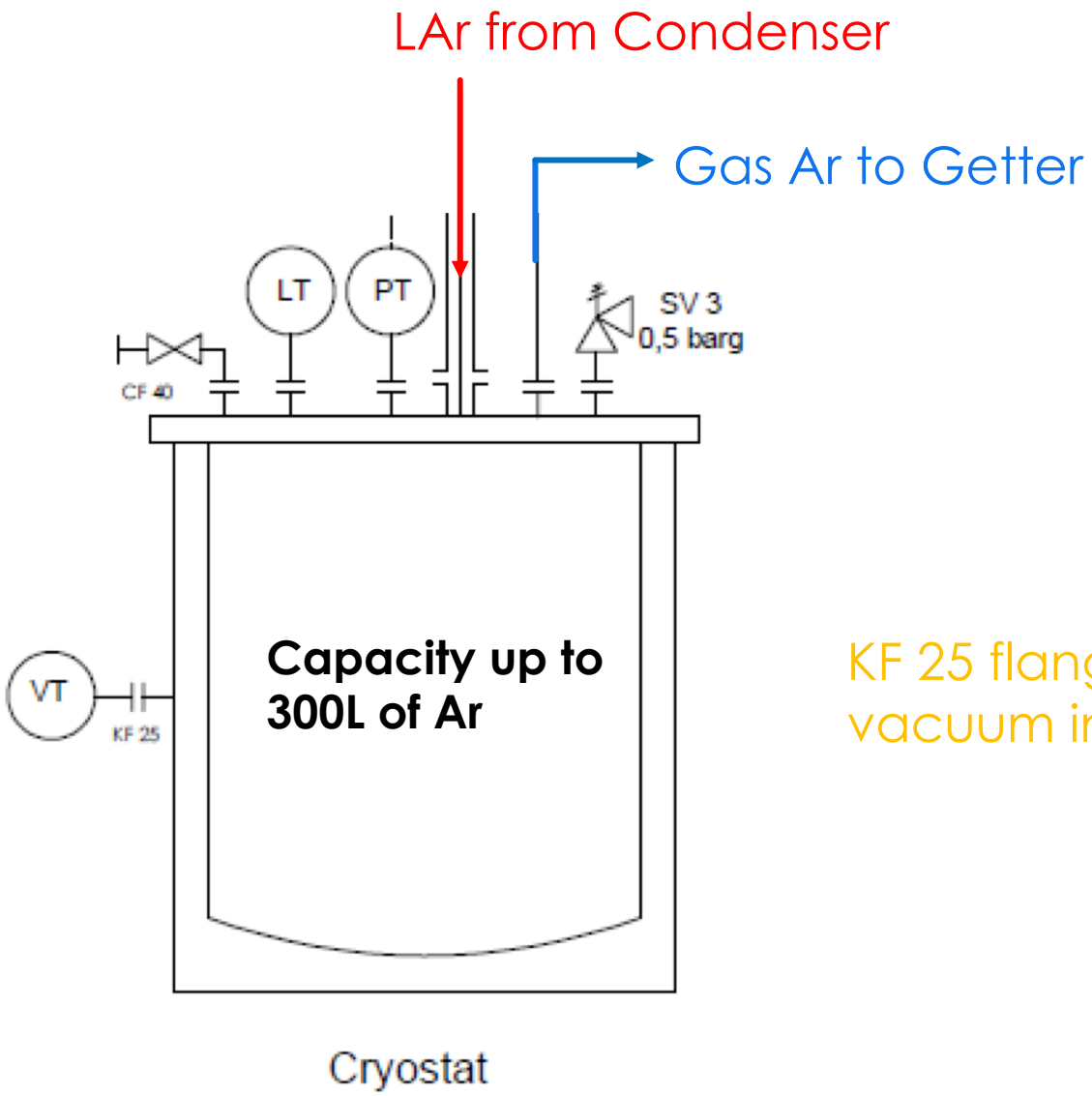
MFC gas nitrogen outlet

Gas nitrogen outlet

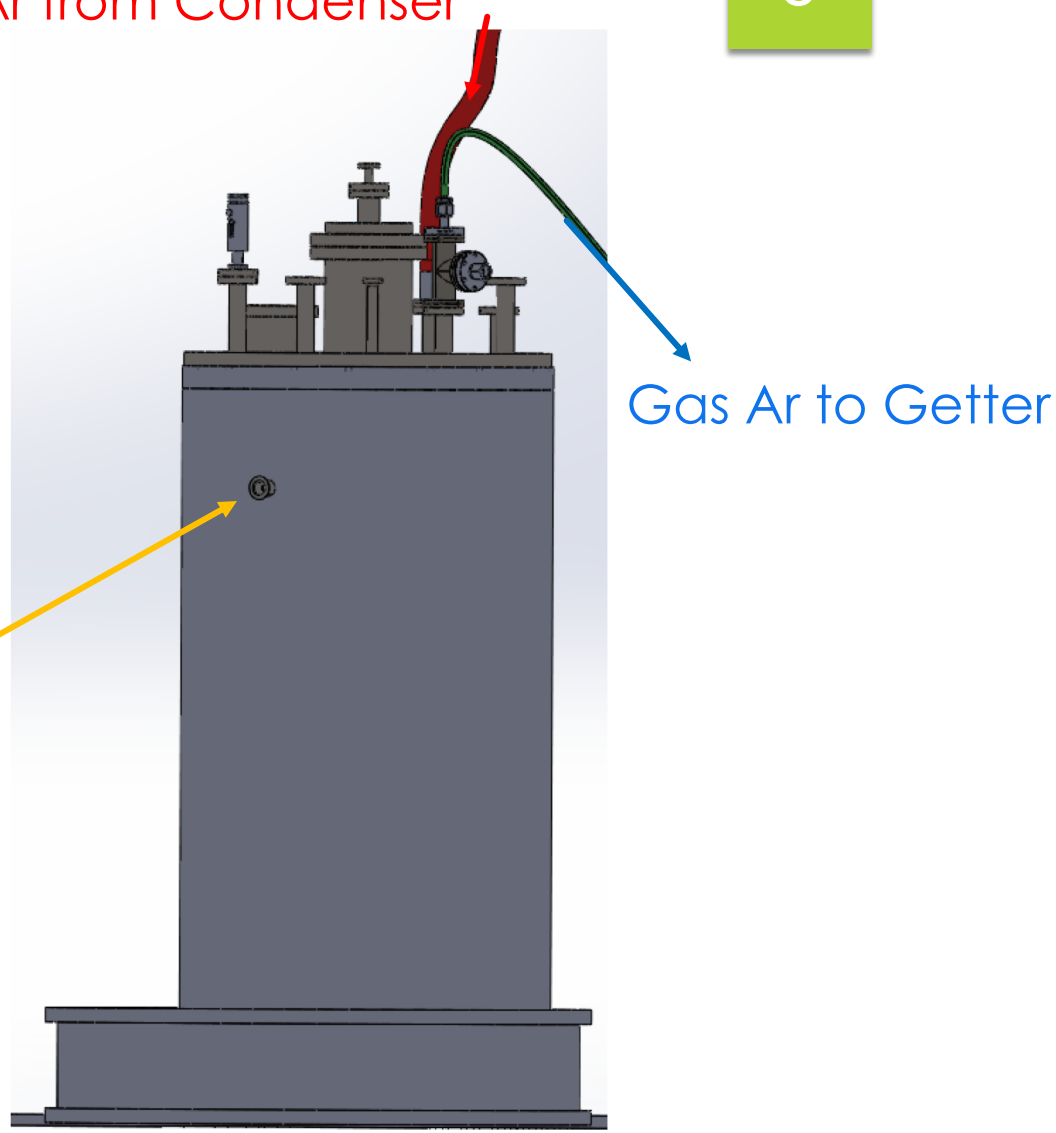


Custom made condenser (universal condenser) designed by Hanguo Wang and Xiang Xiao

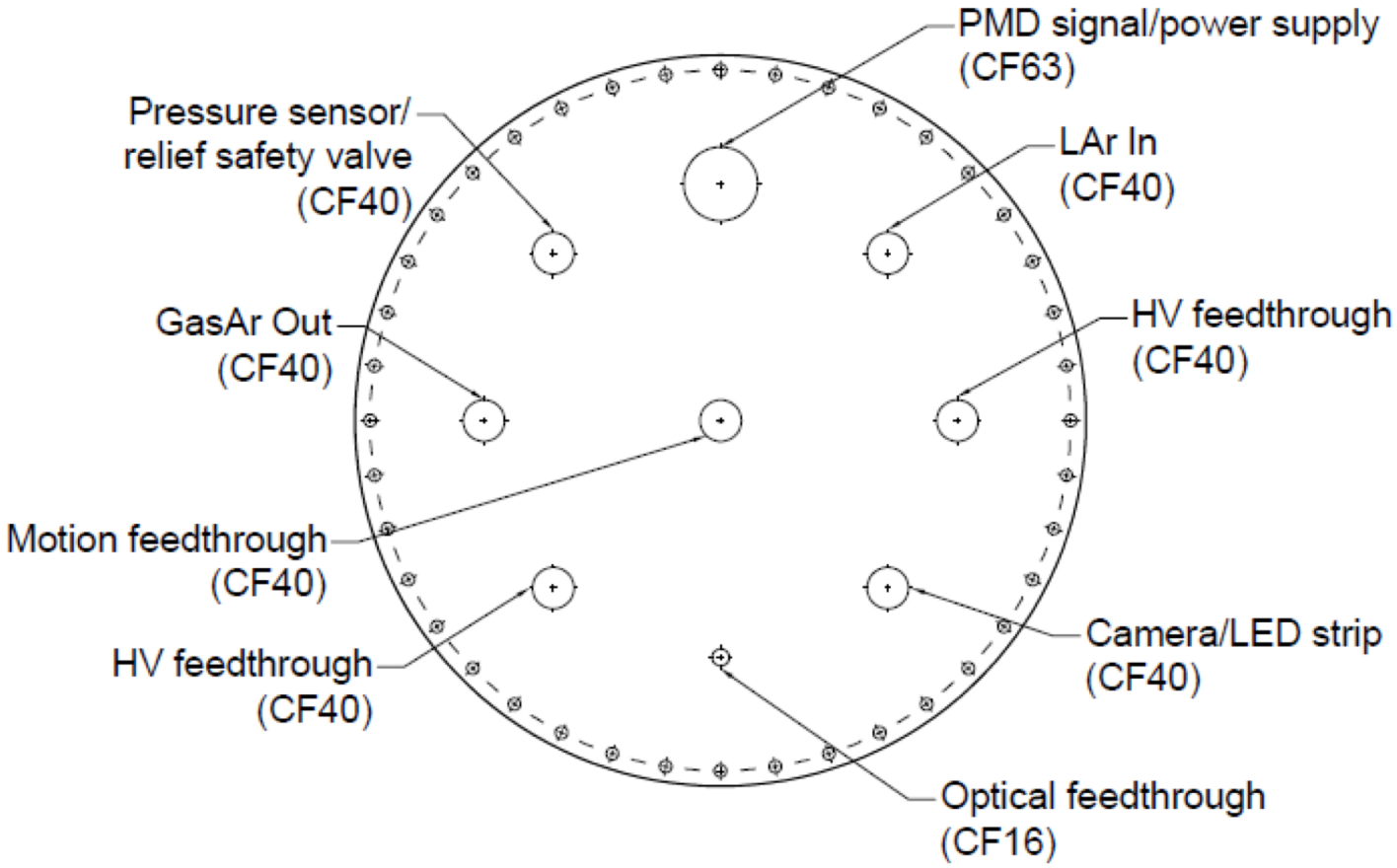
Dewar



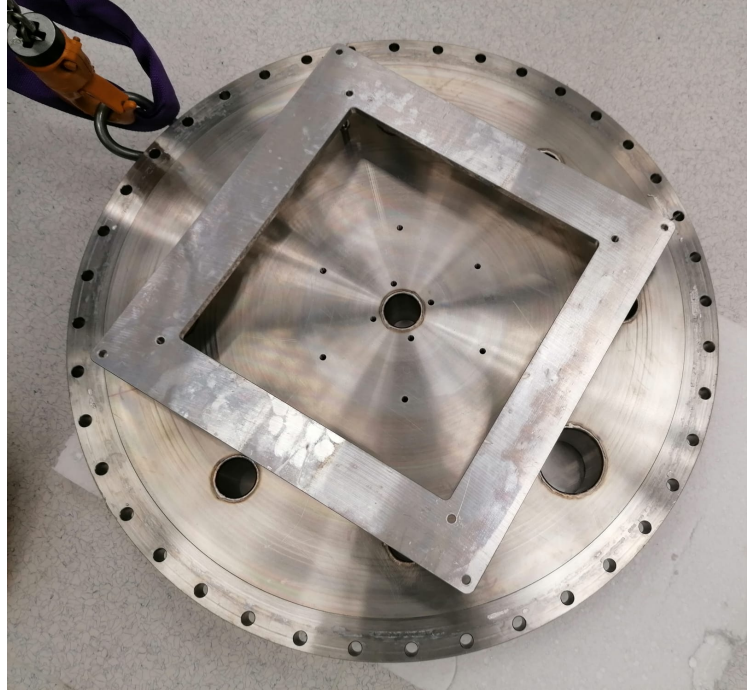
KF 25 flange for vacuum insulation



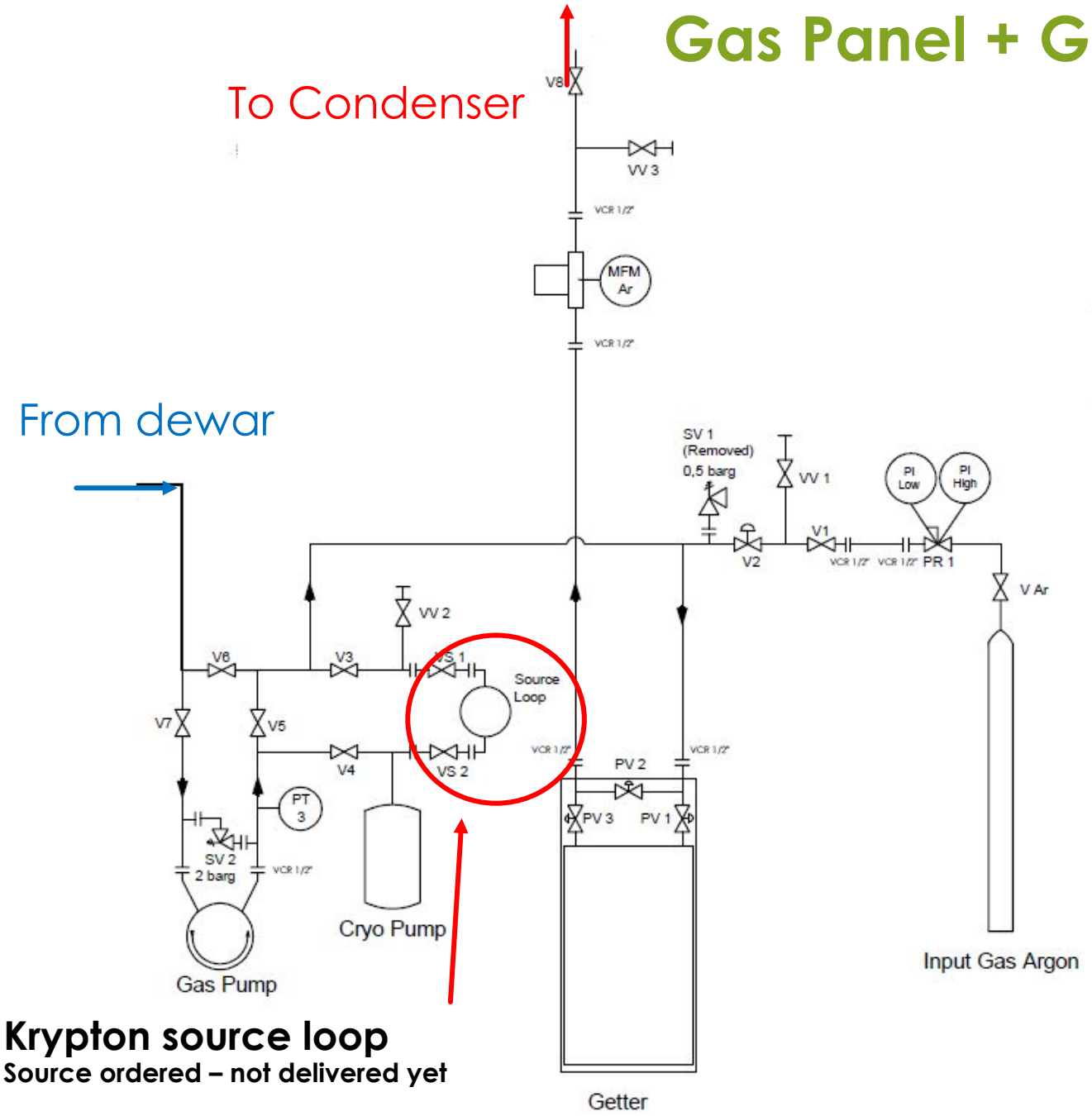
Flange



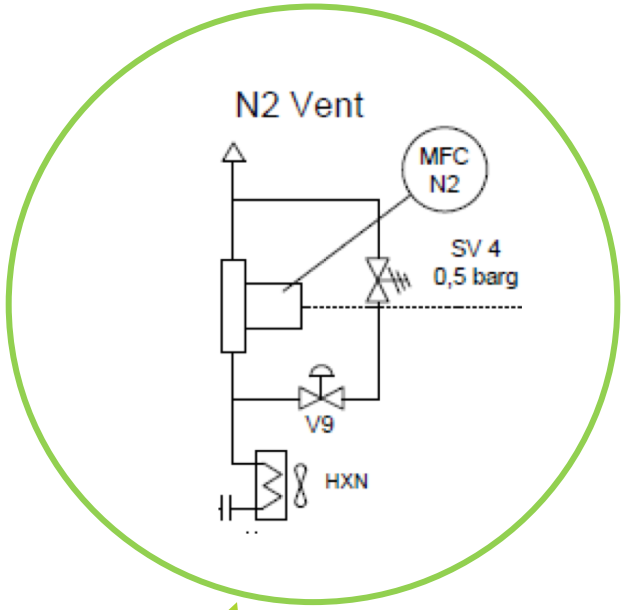
1x CF 63
7X CF 40
1x CF 16



Gas Panel + Getter 1/2

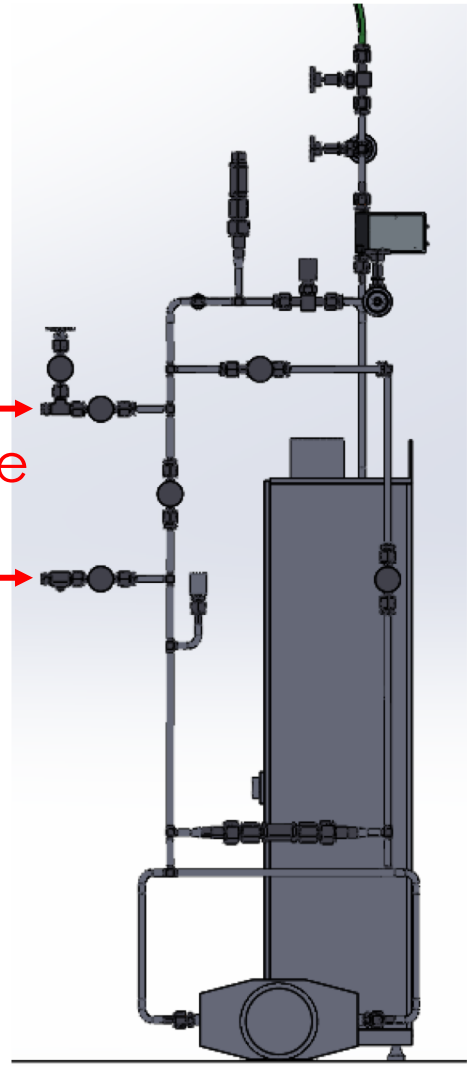


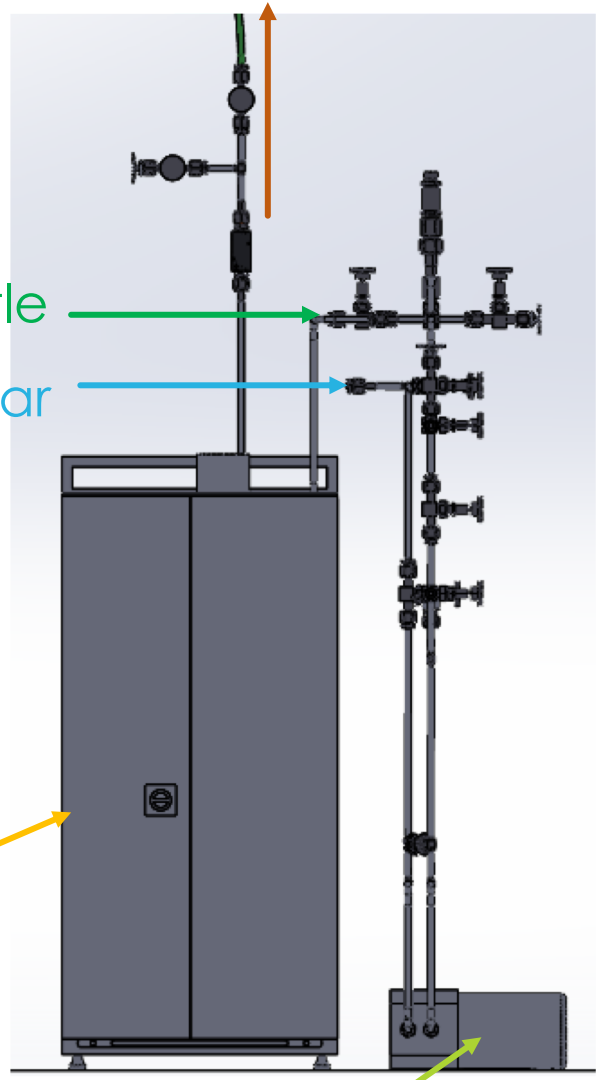
Krypton source loop
Source ordered – not delivered yet



Condenser cooling power regulation system

Gas Panel + Getter 2/2

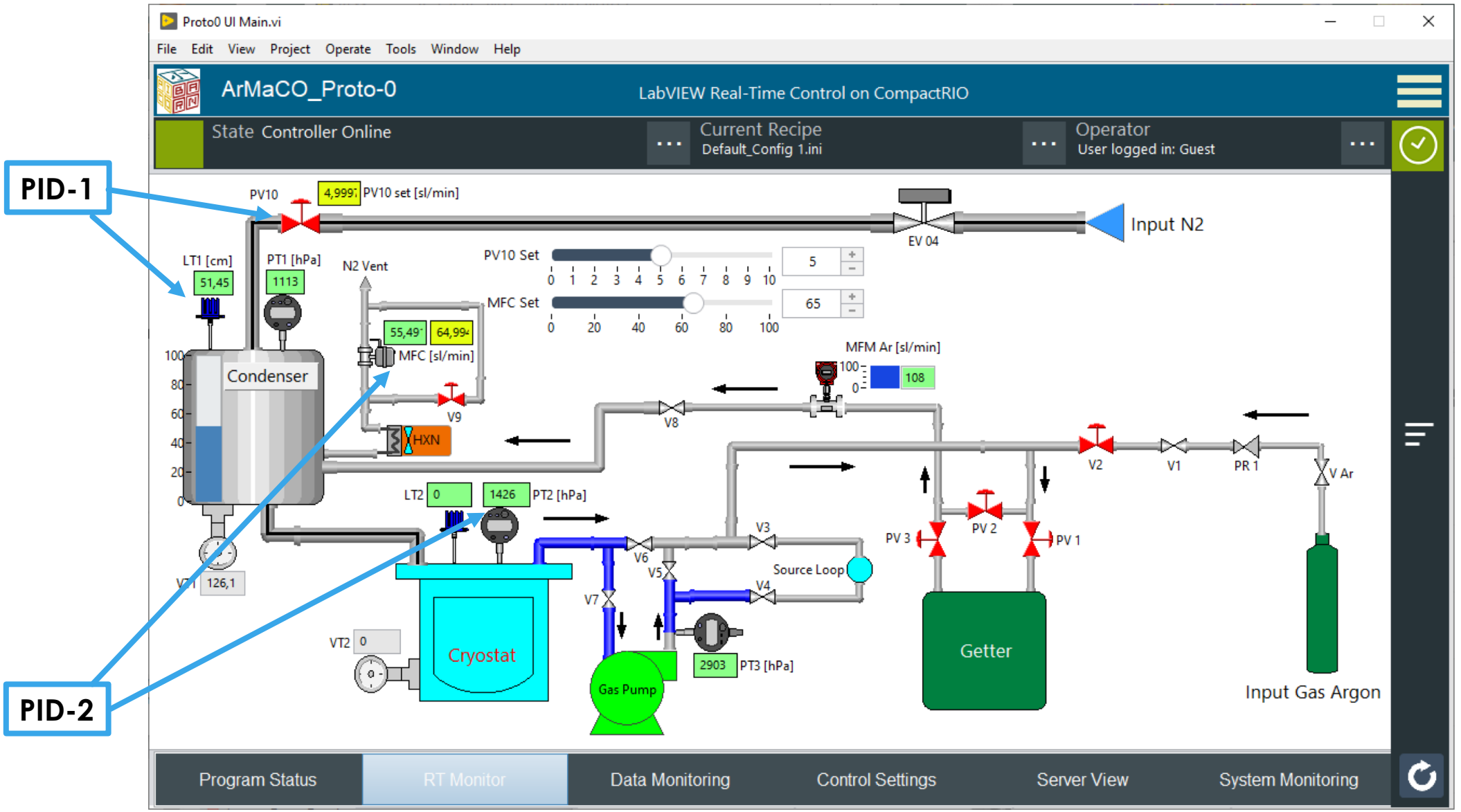




Slow Control 1/3

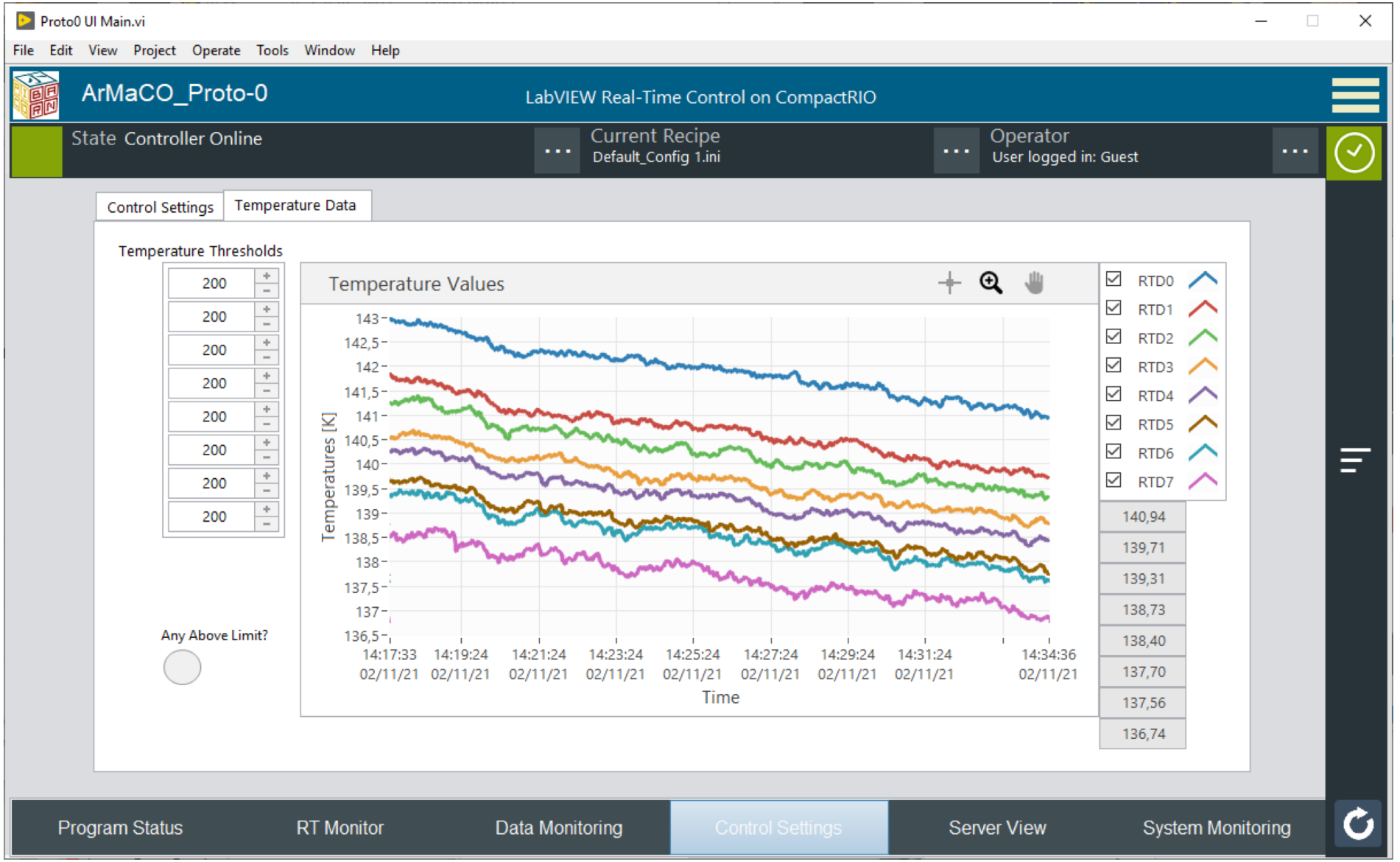
- NI system (cRIO + …)
- Electric valve in the bypass of the tanks (EV04 – P&ID Supply tanks);
- Electric valve of the tank (EV01 – P&ID Supply tanks)
- Argon gas inlet N.C. pneumatic valve, optional(V2 – P&ID Proto 0);
- Condenser's LN_2 supply control valve, PID with level sensor (V10 – P&ID Proto 0);
- N_2 gas outlet N.O. pneumatic valve, bypass of the MFC in the condenser (V9 – P&ID Proto 0);
- MFC - mass flow controller for N_2 gas output line (condenser – P&ID Proto 0);
- MFM - mass flow meter for Ar line (P&ID Proto 0);

Slow Control 2/3



Slow Control 3/3

LAr level monitored by 8 pt100 sensors



Cryogenic System Assembly and Commissioning

- **Sept-Oct 2021:** All parts delivered and installed. Full system assembled and ready for the cryo testing.

- **Oct 2021**: First tests of Ar liquefaction and filling of the large dewar, manual mode, but with a first version of slow control program.

- **Gen 2022**: Liquefaction test with a smaller dewar and with updated version of slow control program. Definition of PID controller parameters for the automatization of the condenser LN filling and of the pressure control in the dewar.

Proto-0 Commissioning Setup

Small dewar to simplify and speed up the test (~20 L).

Input Gas Ar (5.0), 10 m3 bottle.

- Controlled filling of the LN vessel of the condenser. Stability of LN level through PID control, tuning of the parmeters.
- Filling of the dewar (speed, stability, with and without gas pump).
- Pressure control through the PID control of the N2 MFC, tuning of the parameters.
- Measurement of max filling rate and max recirculation rate.

From Naples CM November 2019

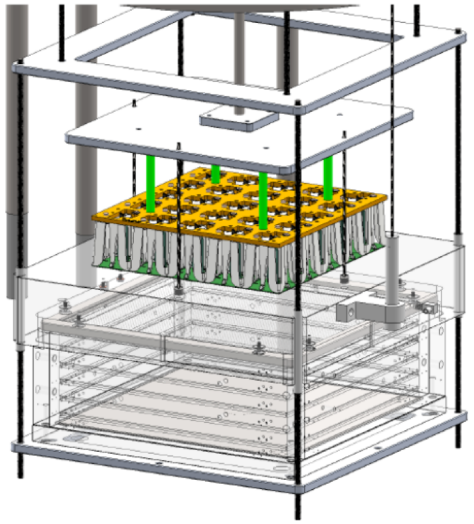
Proto-0

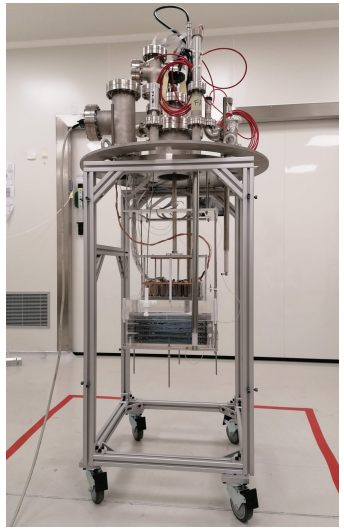
Y. Wang

- Integrated R&D TPC for DS-Proto and DS-20k
  - Conductive polymer, to replace ITO and copper field cage rings (CERN)
  - Kapton resistor chain, as the link of the field cage ring (UC Davis)

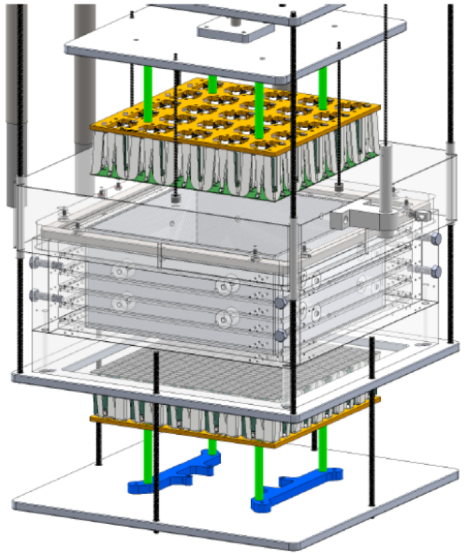
- **Proto-0 v1:**
  - Optimization of
    - S2 Generation
    - Gas pocket height
    - XY resolution
  - Test of 1 MB readout (25 pre-production PDMs)
    - ➡ Validation of MB1 & MB2 Prototypes
    - ➡ Preparation of full readout and DAQ for 50 channels

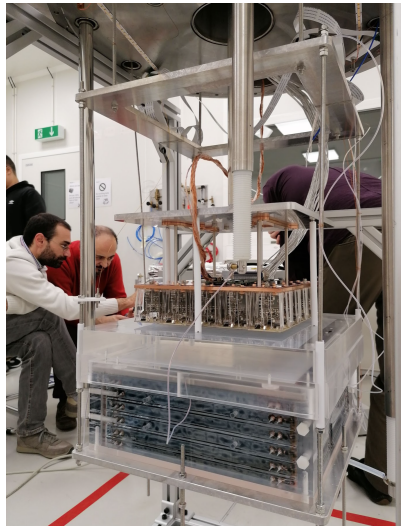
Note: no reflectors!
Low LY for S2 studies





- **Proto-0 v2:**
  - TPC equipped with 50 pre-production PDMs (2 Motherboards)
    - ➡ Fully functional TPC demonstrator
    - ➡ Cherenkov event study
  - Assembly, commissioning and operation of full read-out and DAQ for 50 PDMs
    - ➡ Perform all the needed tests on the pre-production MB
    - ➡ Validation of DAQ board Prototype #1
    - ➡ Development and validation of SW reconstruction algorithms
    - ➡ Training of Proto team on both TPC and cryogenics operation towards the runs of Proto-1 and DS20k





Proto-0 TPC status

Designed by Yi Wang, constructed and assembled by the CERN team (Yi, Alex, Xiang, Hanguo, Tom + …).

Oct-Nov 2019: Proto-0 TPC assembled and then tested in LAr coupled with MB2.

Oct. 2020: MB2 dismounted from CERN and brought to Pisa.

Apr-May 2021: TPC dissembled, packed, shipped to Naples together with its electronics and all hardware.

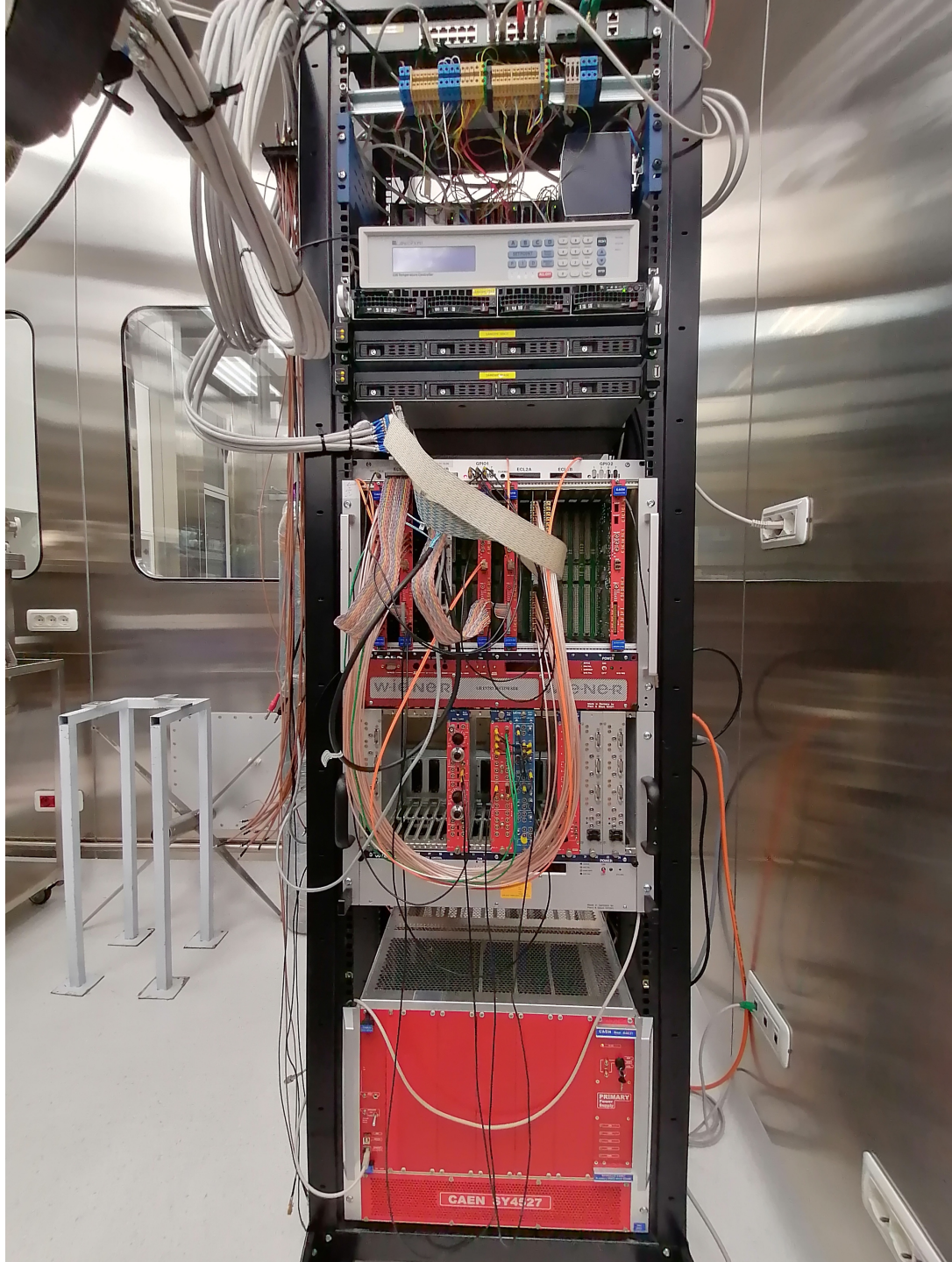
Feb 2022: re-assembly and integration @ Naples

Configuration to be decided:

- 1 or 2 PDUs (presently available MB2 and MB3)
- w/o reflectors
- TPB/PEN
- ext/int gamma source

Electroics & cabling, DAQ, computing system

- **Electronics & cabling**
  - MB3 test setup (setup1) already uses Proto-0 components delivered from CERN: LV/HV filter box, adapter box with steering module driver, steering module, differential to single-ended converter board, etc.
  - Replaced blue “ALICE” cables with custom-built DB-50 to Amphenol CAT 6a cables
- **DAQ**
  - Equipped with 4 x CAEN V1725B digitizers (250 MS/s, 14-bit, 16 channels)
- **Computing**
  - darkside-daq: main DAQ machine with ROOT online server for online and offline analysis
  - darkside-ui: gateway for user analysis
  - darkside-stor: DAQ storage server



Next steps

- **Q1 22**
  - Preparation of detector, commissioning of cryogenic and recirculation purification systems;
- **Q2 22**
  - First phase of Proto-0 detector runs in the new system with the V1725 based DAQ aiming at studying both S1 and S2 signals;
  - Offline studies of the first acquired data with the aim of validating the current DSP algorithms on real data;
  - Prepare Vx2740 custom firmware suitable to be deployed for the TPC readout (hit finding/zero suppression, window resizing to accommodate longer signals from S2);
- **Q3 22**
  - Second phase of Proto-0 aimed at comparing readout of V1725 based and Vx2740 systems;
  - Offline study of S2 data rate reduction strategies and FEP, TSP initial algorithms;
- **Q4 22**
  - Possible implementation in firmware and preparation of a DAQ slice possibly including online data processing in FEP and TSP nodes;
  - Third phase of Proto-0 runs and tests.