

# **DAMIC-M activities at LSM in 2021 and 2022**

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# Outline

- Activities in 2021
  - Cleanroom
  - Our first detector at LSM
- Steps toward the full-scale DAMIC-M detector
- Plan for 2022
- Many thanks to the whole LSM team!

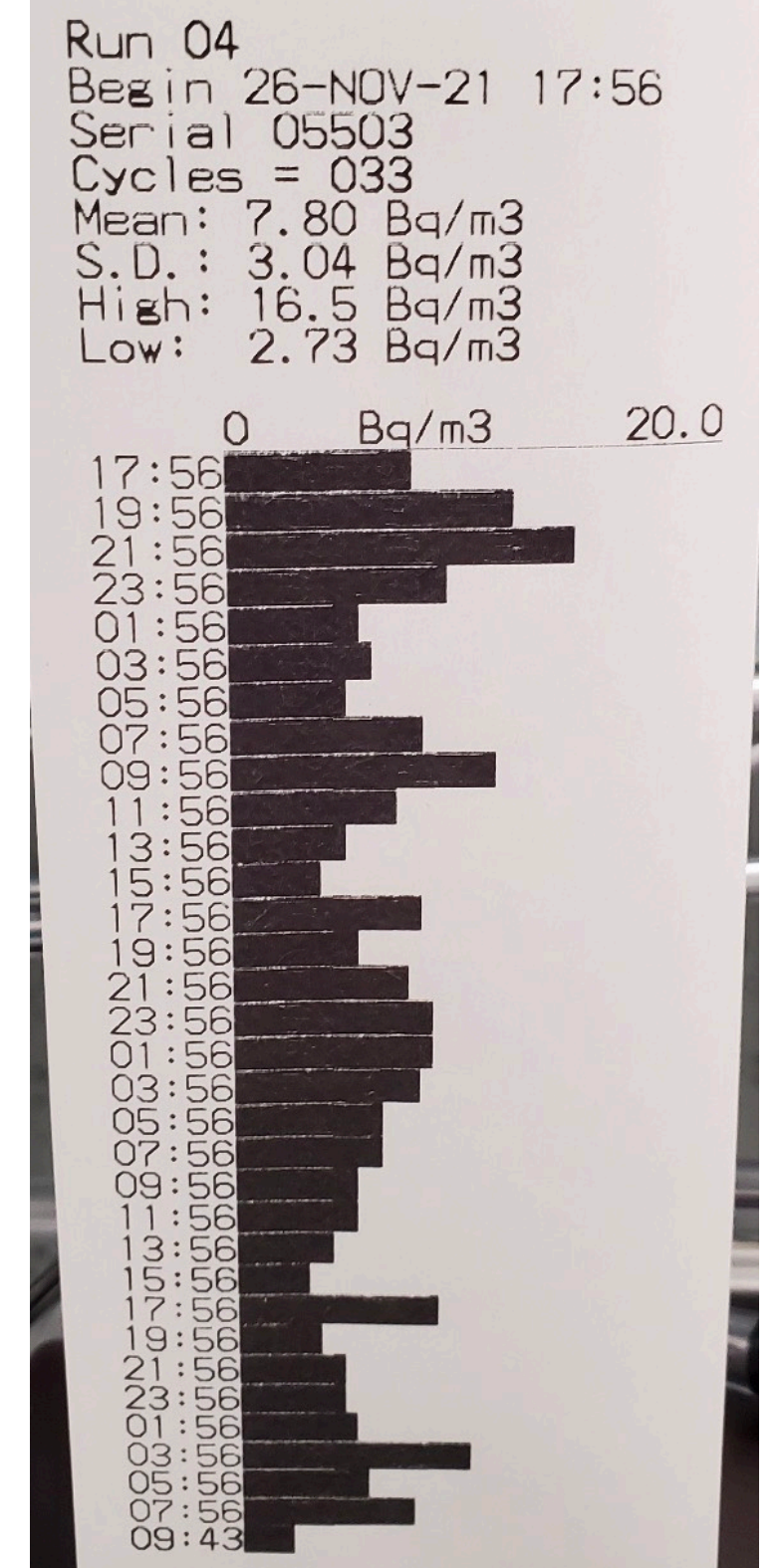


# Cleanroom

- Between SuperNEMO and PARTAGe room.
- Main room is 4.2×4.7 m<sup>2</sup> and ISO 5, gowning room is 4.2×1.4 m<sup>2</sup> and ISO 6.
- Received in Feb and cooling issue addressed in July 2021.
  - Many thanks to Christophe and Thierry for their help.
  - Cleaned by an external company and ourself.
- Radon level measured with DurrIDGE RAD7: (7.8 +/- 3.0) Bq/m<sup>3</sup>.



Sep 15



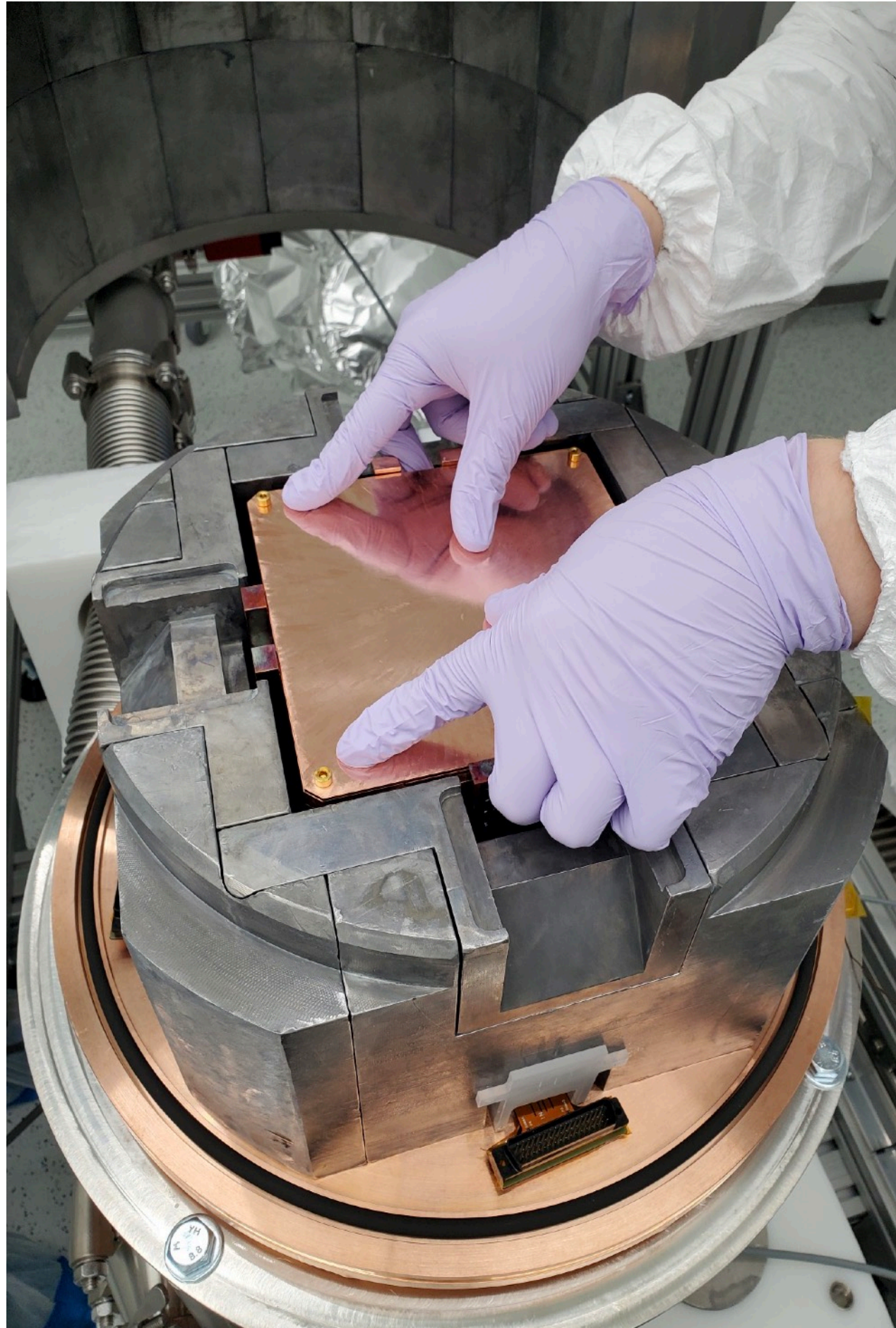
# Cleanroom

- Low Background Chamber (LBC) is there now.



Dec 20

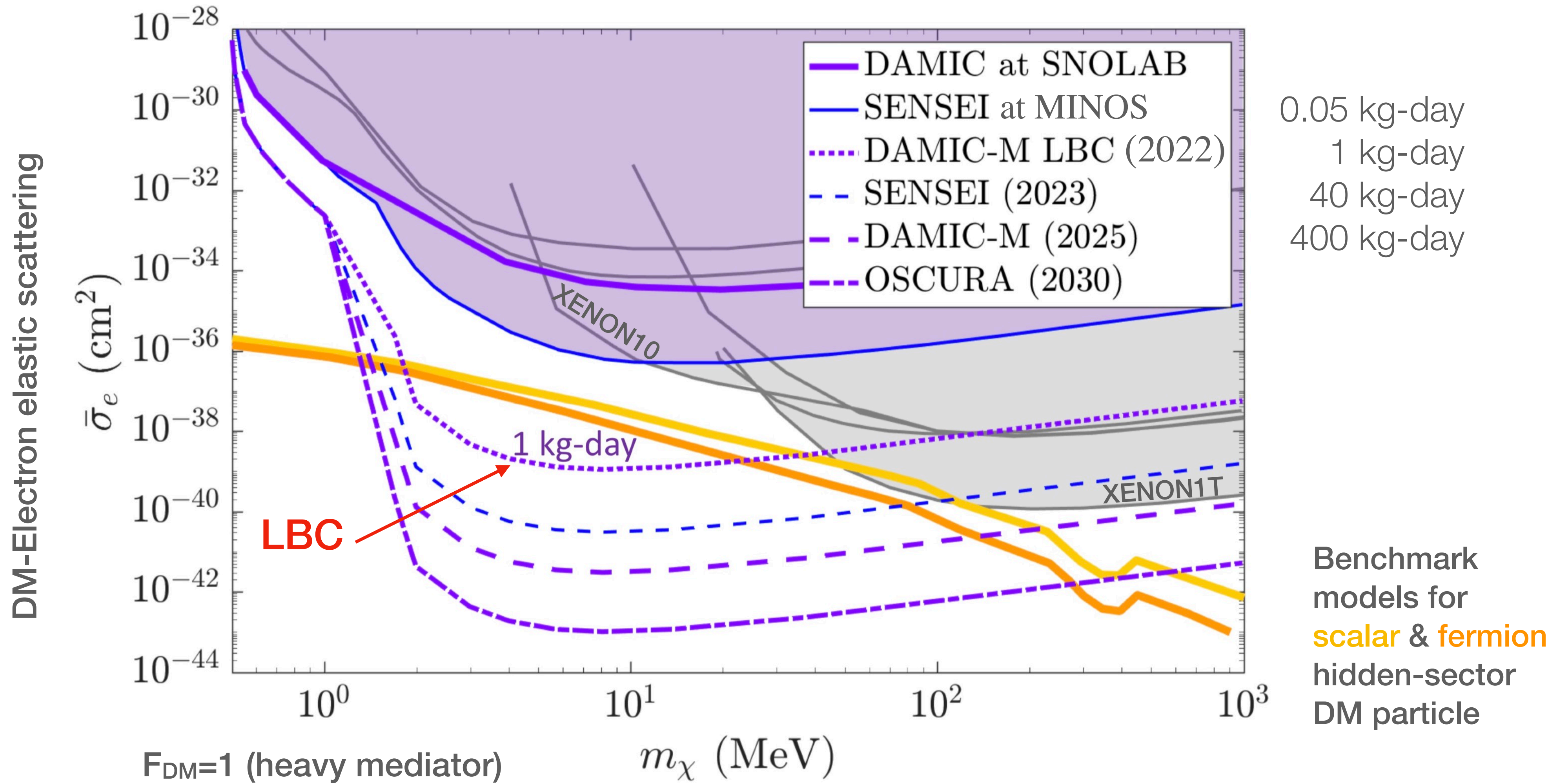
# Low Background Chamber (LBC) Objectives



LBC ~~will be~~ <sup>is</sup> a detector at LSM equipped with two single-electron resolution CCDs. Its objectives are as follows:

1. **The detector built by DAMIC-M Collaboration at LSM.** We have learned a lot about working at LSM and this lesson will help us during the construction of the DAMIC-M detector.
2. **A detector with the background level as low as few d.r.u.** (material, cleaning and assembling procedures, simulations, etc.). This level will be lower than was in the DAMIC@SNOLAB detector. We want to be 10× better with DAMIC-M.
3. **Detailed characterization of selected DAMIC-M CCDs in low-background environment.** Our goal is to measure the dark current,  $^{32}\text{Si}$  rate in the bulk, background in the backside layer, etc.
4. **Science at low energies in silicon target with single-electron resolution CCDs.** We aim to get 1 kg-day exposure. Two CCDs, each with 6k×4k pixels and 8.9 g.

# LBC Science Reach



# LBC Assembly

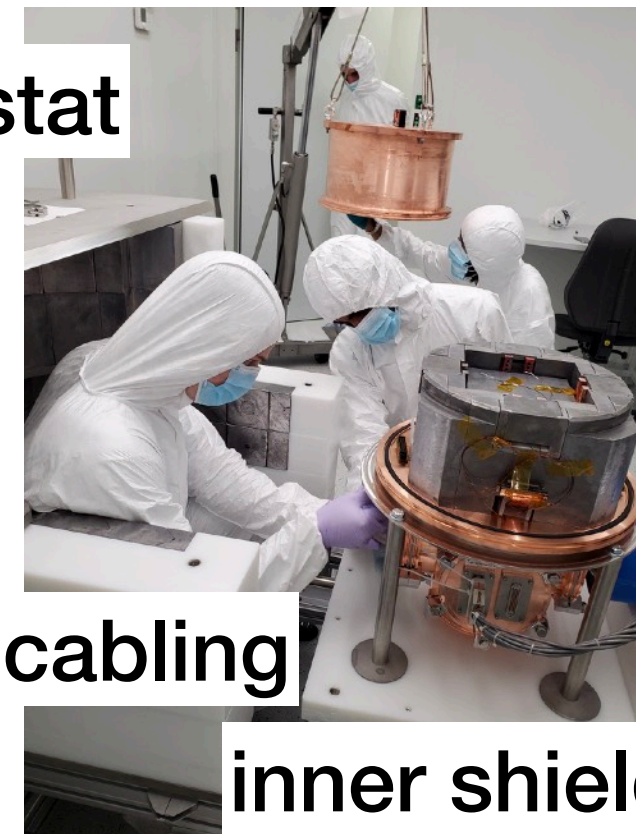
- Took place from October to December 2021.
- Assembly took 11 weeks at LSM (ca. 1200 FTE hours).
- We are grateful for our help provided by LSM and also SuperNEMO and Edelweiss.



support structure



cryostat



cabling

inner shielding



cooling and vacuum system



CCDs

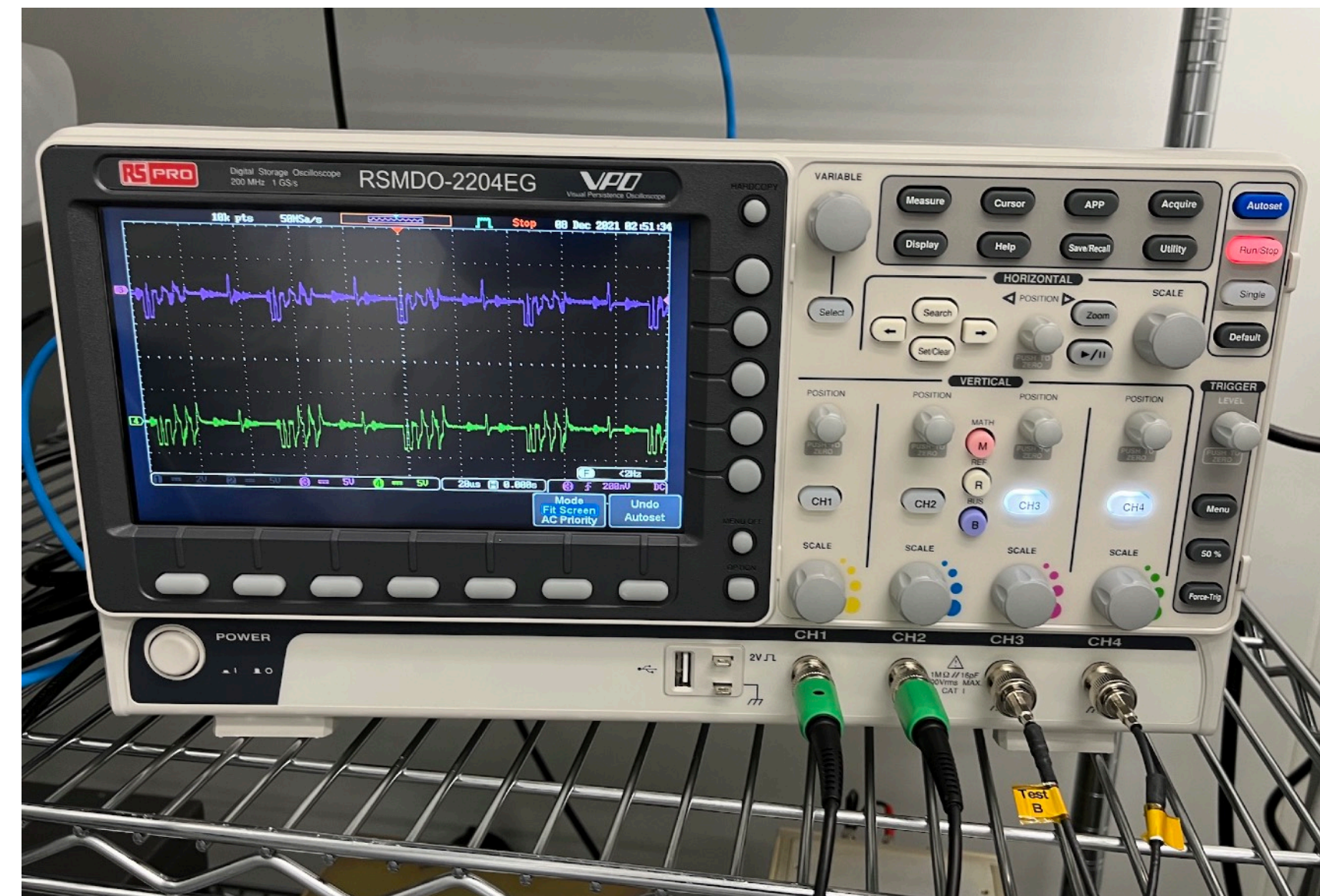
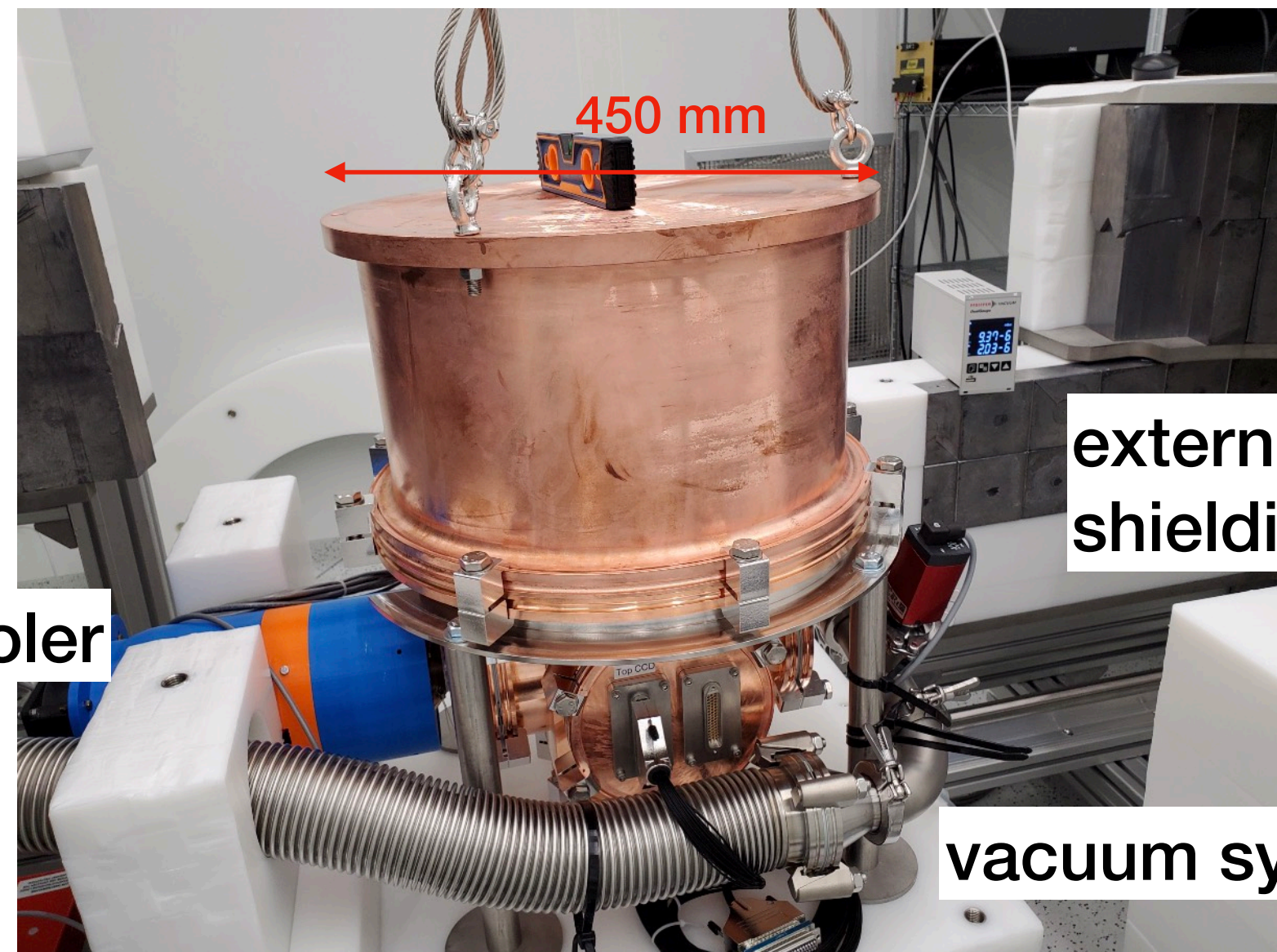
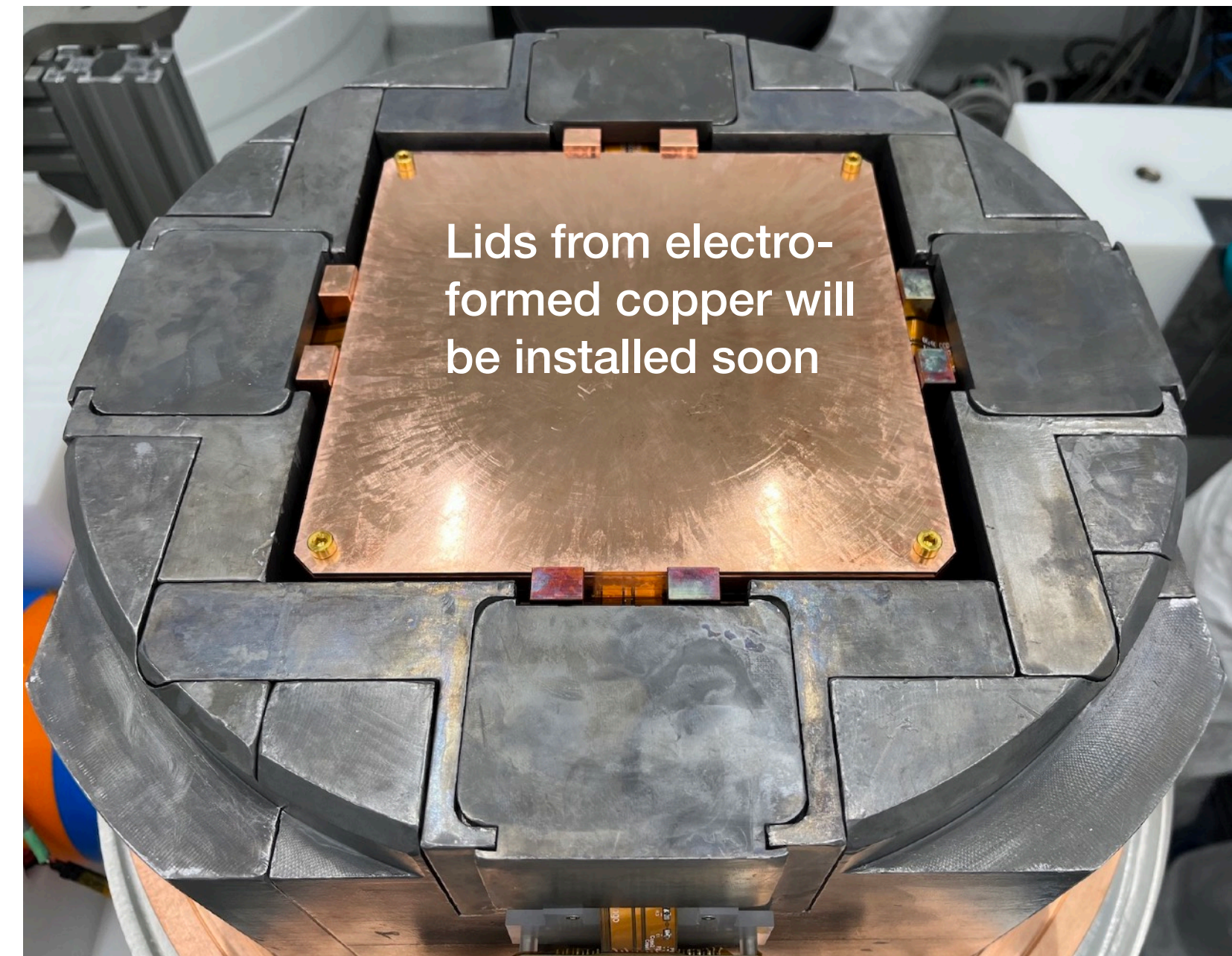
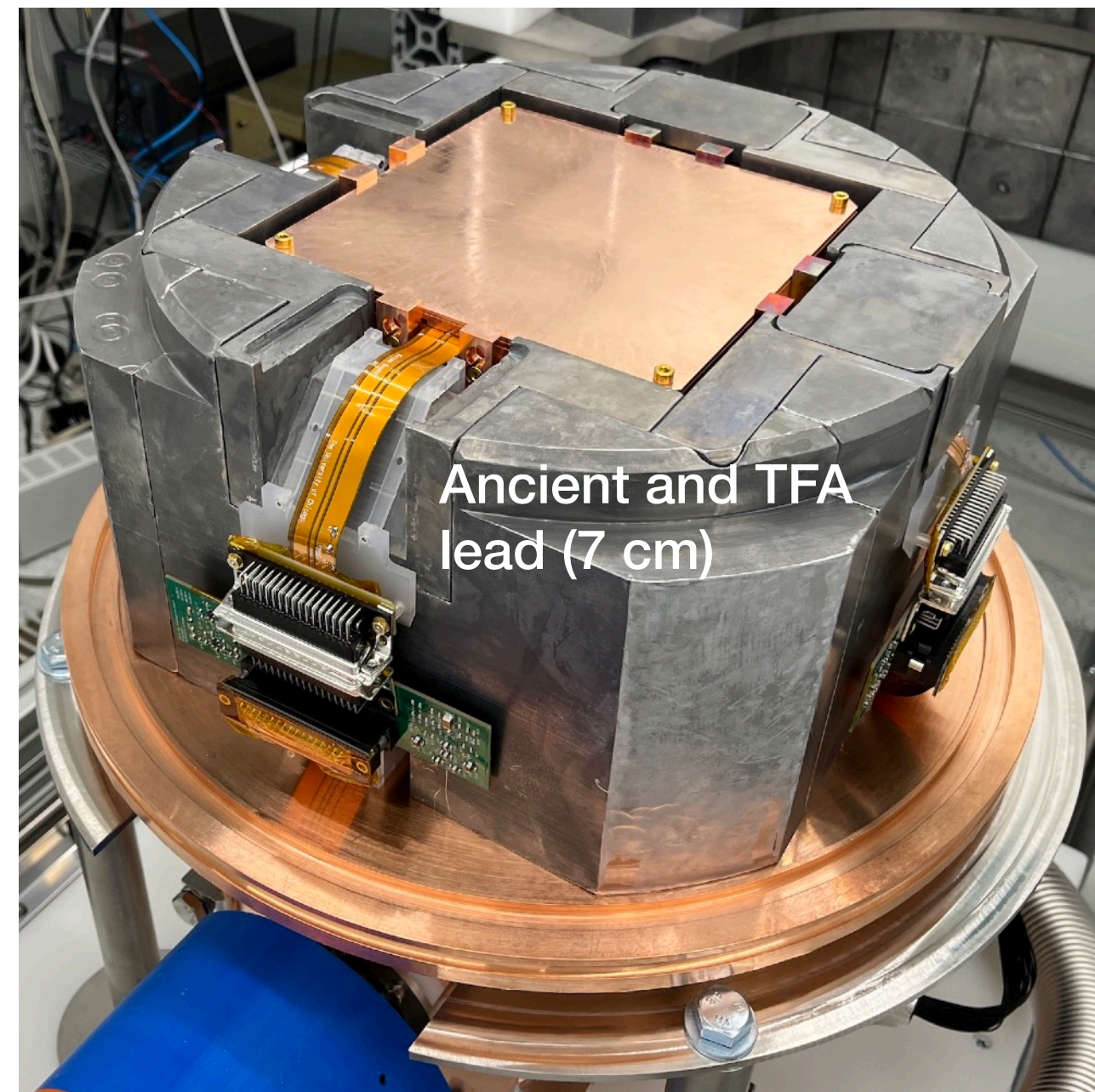
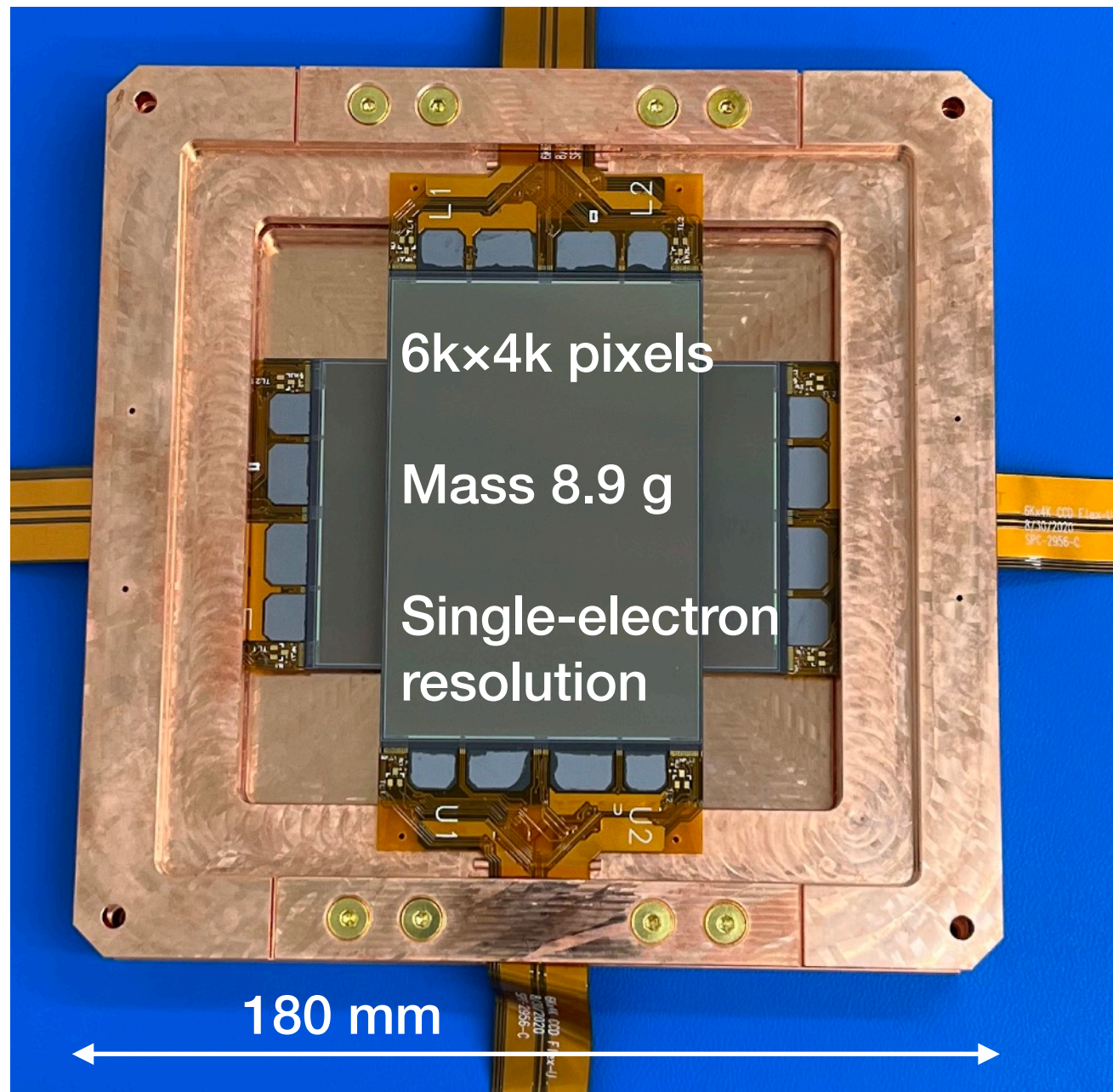


electronics



DAQ and slow control system, ...

# CCDs in the LBC cryostat





# LBC Status

- The detector works very well (vacuum, cooling, slow control, CCDs, etc.),
- The detector has been fully operated remotely since the mid December,

Refresh time: 3m [Plots](#) [MPlot](#) [Scatter](#) [Sys Log](#) [Runs](#) [Users](#) [Alarms](#) [Config](#) [Control](#) [LogBook](#) [Cams](#) You are logged in as smida from 127.0.0.1.

Select All  Cryocooler:  Legacy:  PDU:  PowerSupply:  Pressure:  Temperature:  UPS:  Deselect All

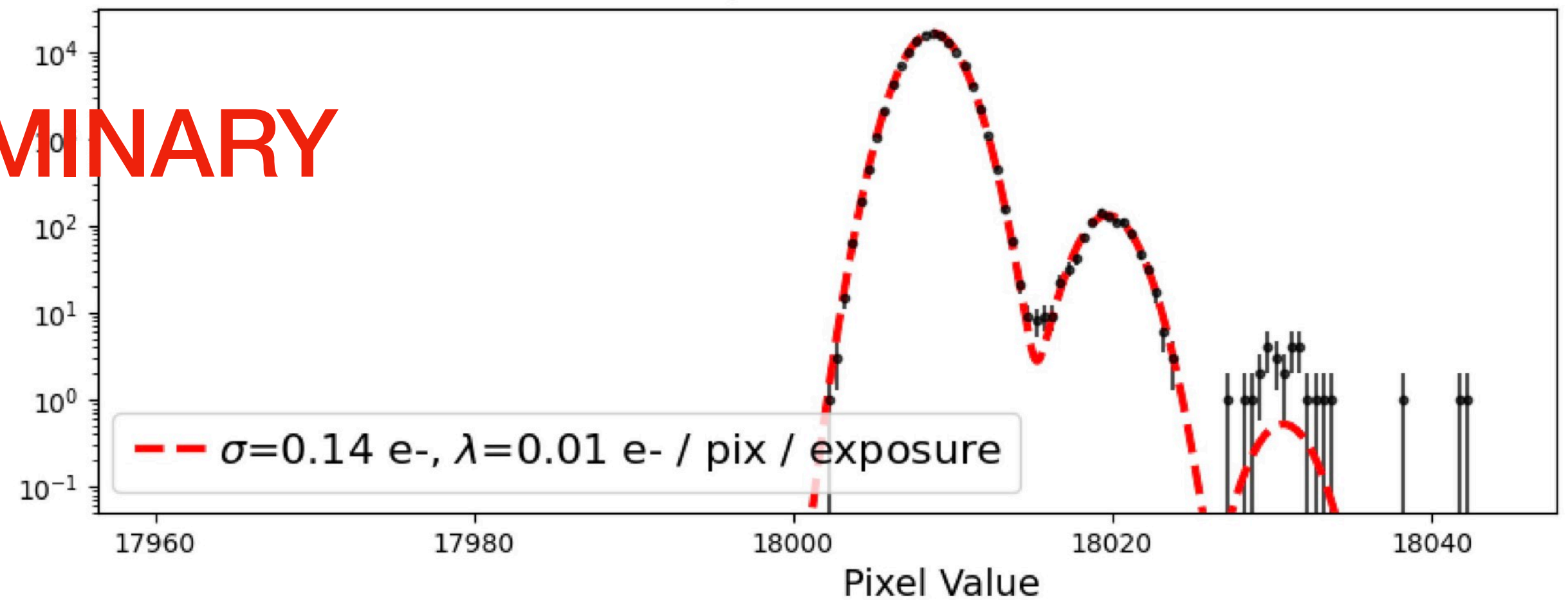
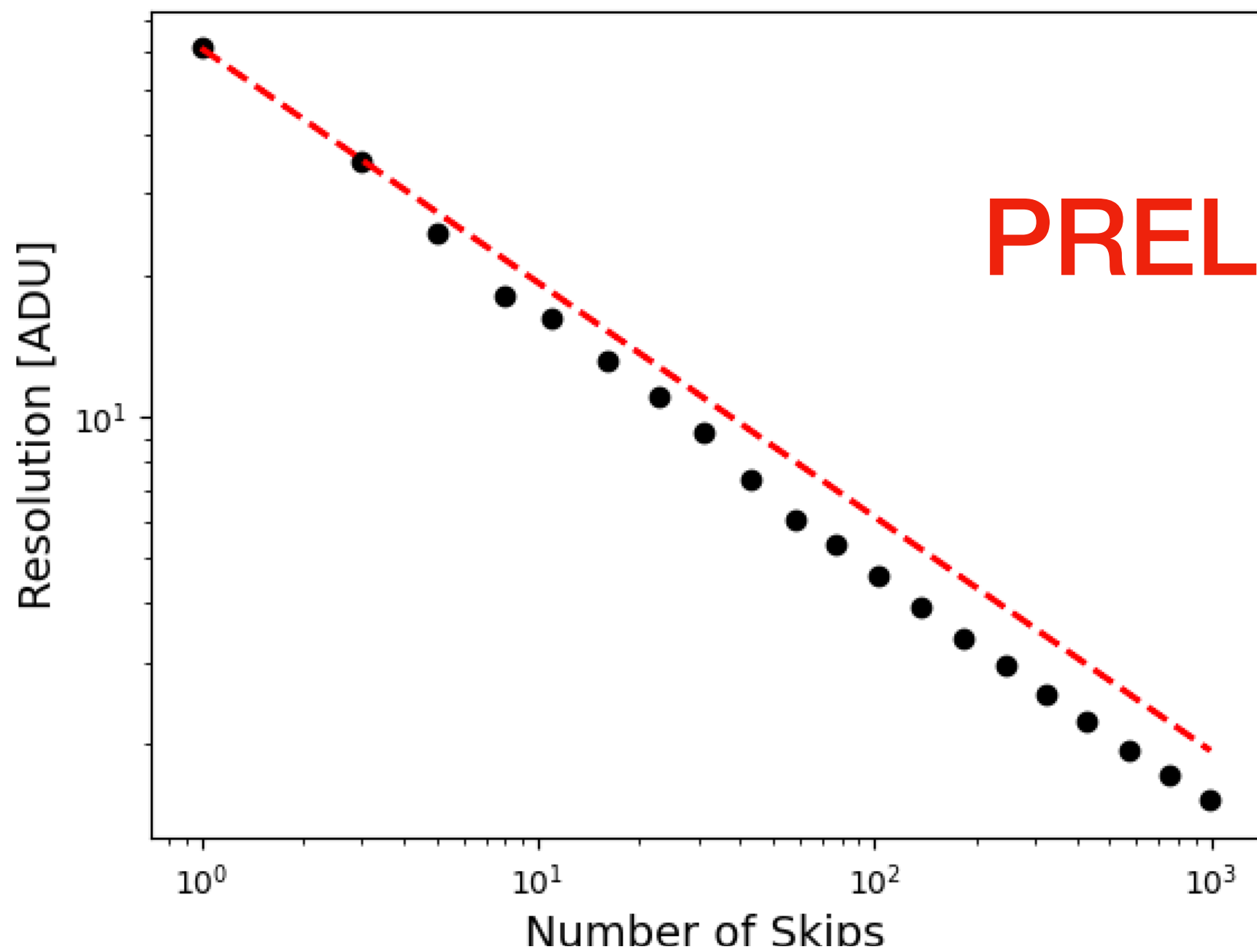
Last db update: Jan 10, 2022 @ 22:14:54. Sensors values in yellow are more than 10 minutes old.

CryoTelGT target temperature in T control mode (Temp_Target) <b>200.000</b> (K)	Power output of AVC controller of CryoTelGT (Power_Output_AVC) <b>140.000</b> (W)
Reject temperature of CryoTelGT (Reject_Temp) <b>39.330</b> (C)	Temperature of CryoTelGT cold head (Temp_Cooler) <b>87.470</b> (units)
Pressure of LBC cryostat (Pressure_Gauge_1) <b>7.290e-6</b> (mbar)	Pressure of LBC pump hose (Pressure_Gauge_2) <b>6.780e-7</b> (mbar)
Rotation Speed of Pump (Rotation_speed) <b>9.003e+4</b> (rpm)	Heater power output percentage (sensor) (Heater_100W) <b>10.300</b> (%)
Ramprate of 100W Heater (Ramprate_100W) <b>1.000</b> (K/min)	Setpoint of 100W Heater (sensor) (Setpoint_100W) <b>115.000</b> (K)
Temperature sensor A (Temp_A) <b>115.000</b> (K)	Temperature sensor B (Temp_B) <b>114.971</b> (K)
Temperature sensor C (Temp_C) <b>117.081</b> (K)	Temperature sensor D (Temp_D) <b>293.710</b> (K)

Number of values to average: 1 Show raw sensor names with descriptions:

# LBC Status

- The detector works very well (vacuum, cooling, slow control, CCDs, etc.),
- The detector has been fully operated remotely since the mid December,
- We are still in a commissioning phase
  - Both 6k×4k-pixel CCDs are working. We have reached noise below 5 e<sup>-</sup> rms.
  - The resolution is 0.14 e<sup>-</sup> with 1000-skip readout (i.e. non-destructive, repetitive measurement of the pixel charge).
  - We are reducing the dark current to reach our target value < 10<sup>-3</sup> e<sup>-</sup>/pix/day = 10<sup>-21</sup> e<sup>-</sup>/cm<sup>2</sup>.



# LBC Plan for 2022

Work activities requiring our presence at LSM

To start our first science run:

1. Set up the readout system for the second CCD and the CompactRIO controller in February,
2. Temporary installation of the external shielding in February/March,

Both activities will 3 FTE for 3 weeks.

Improvements of LBC:

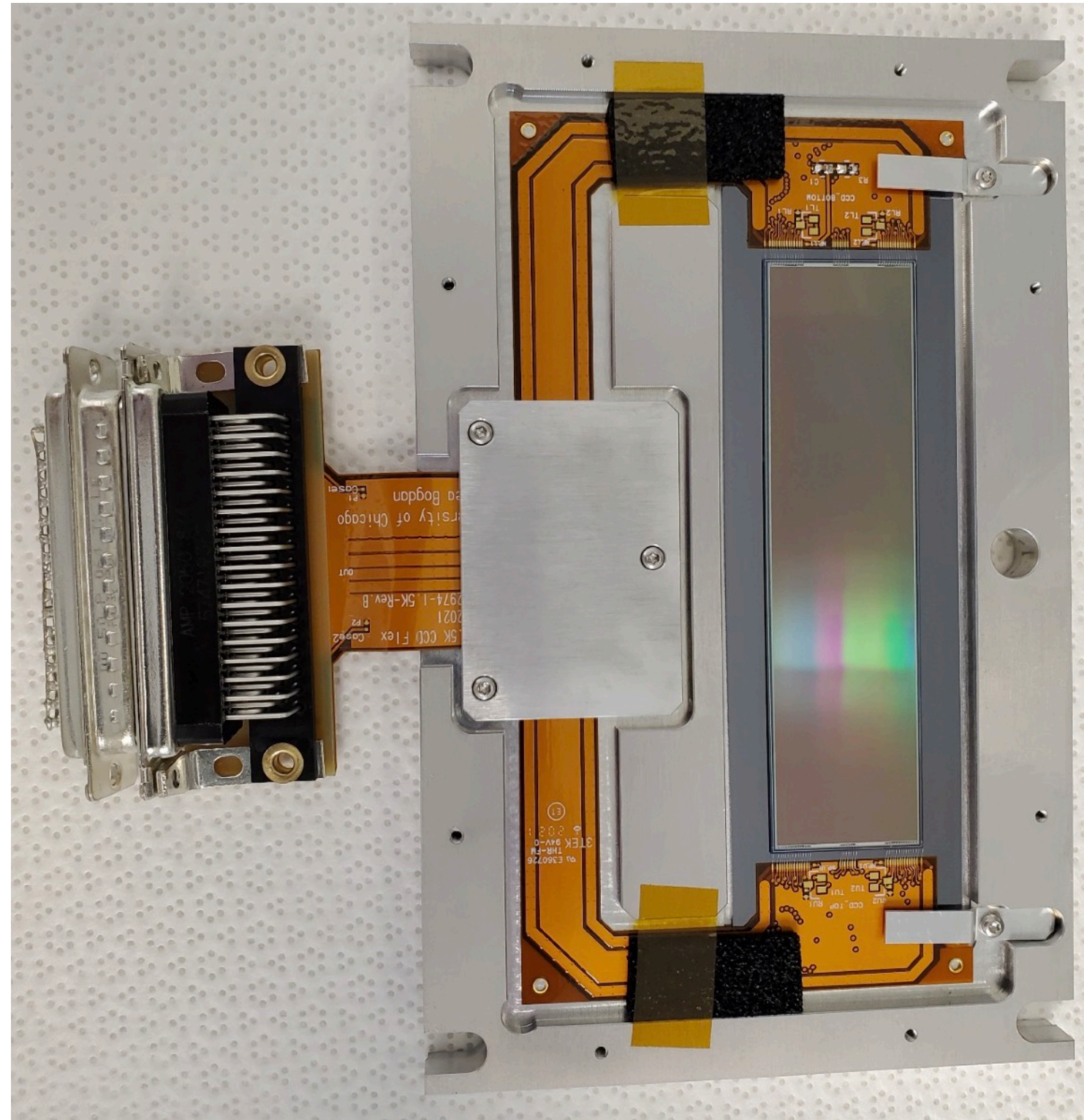
3. Modify the support structure and external shielding in March/April,
4. Install electro-formed copper parts from Canfranc in April.

Both activities will require 3 FTE for 4 weeks.

With these improvements, we plan to take science data remotely for months. Our presence will be only for monitoring and trouble shooting.

# DAMIC-M Preparation

Packaging and Testing pre-production CCDs, format 6kx1.5k pixels



Pre-production CCD package

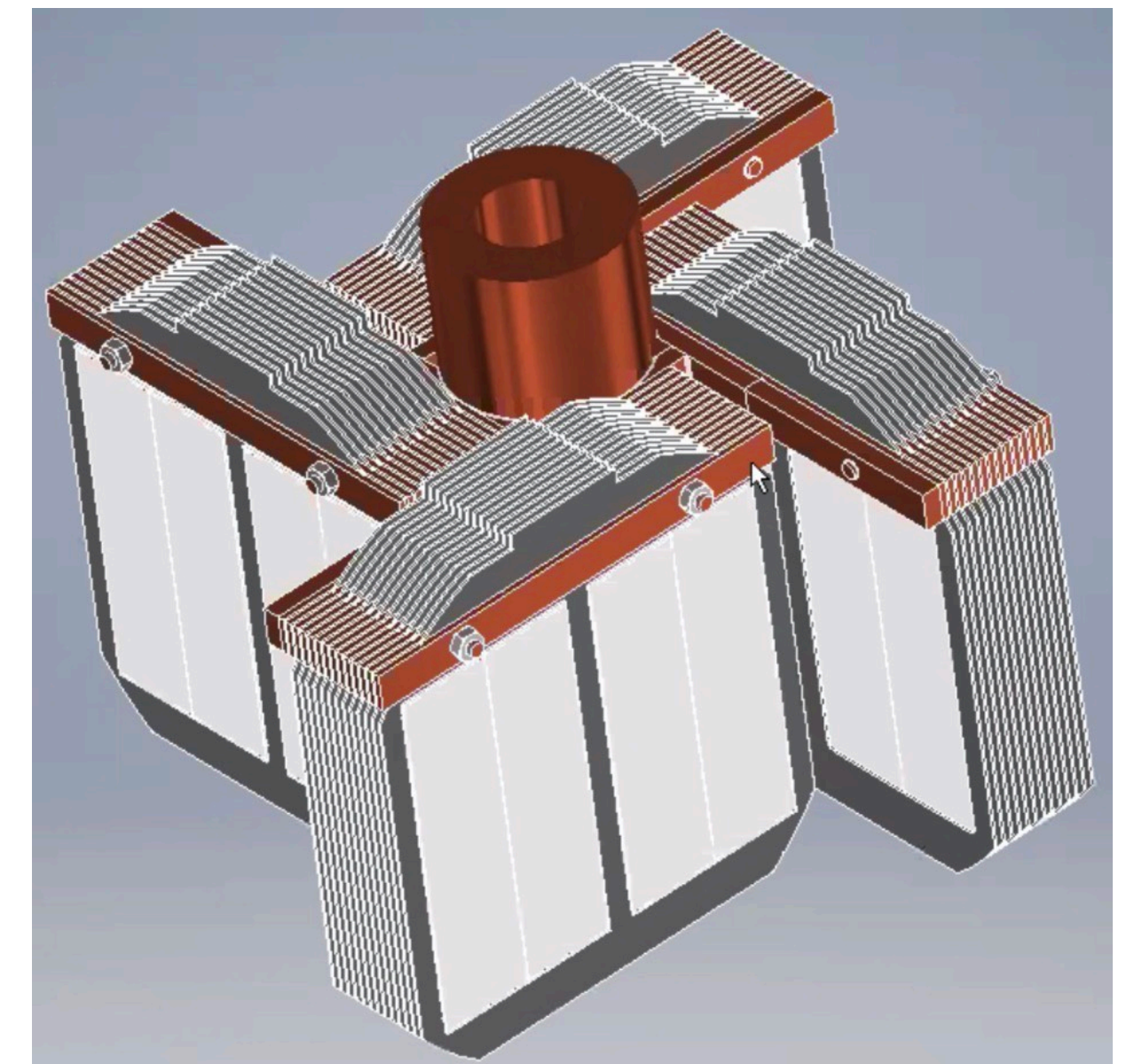
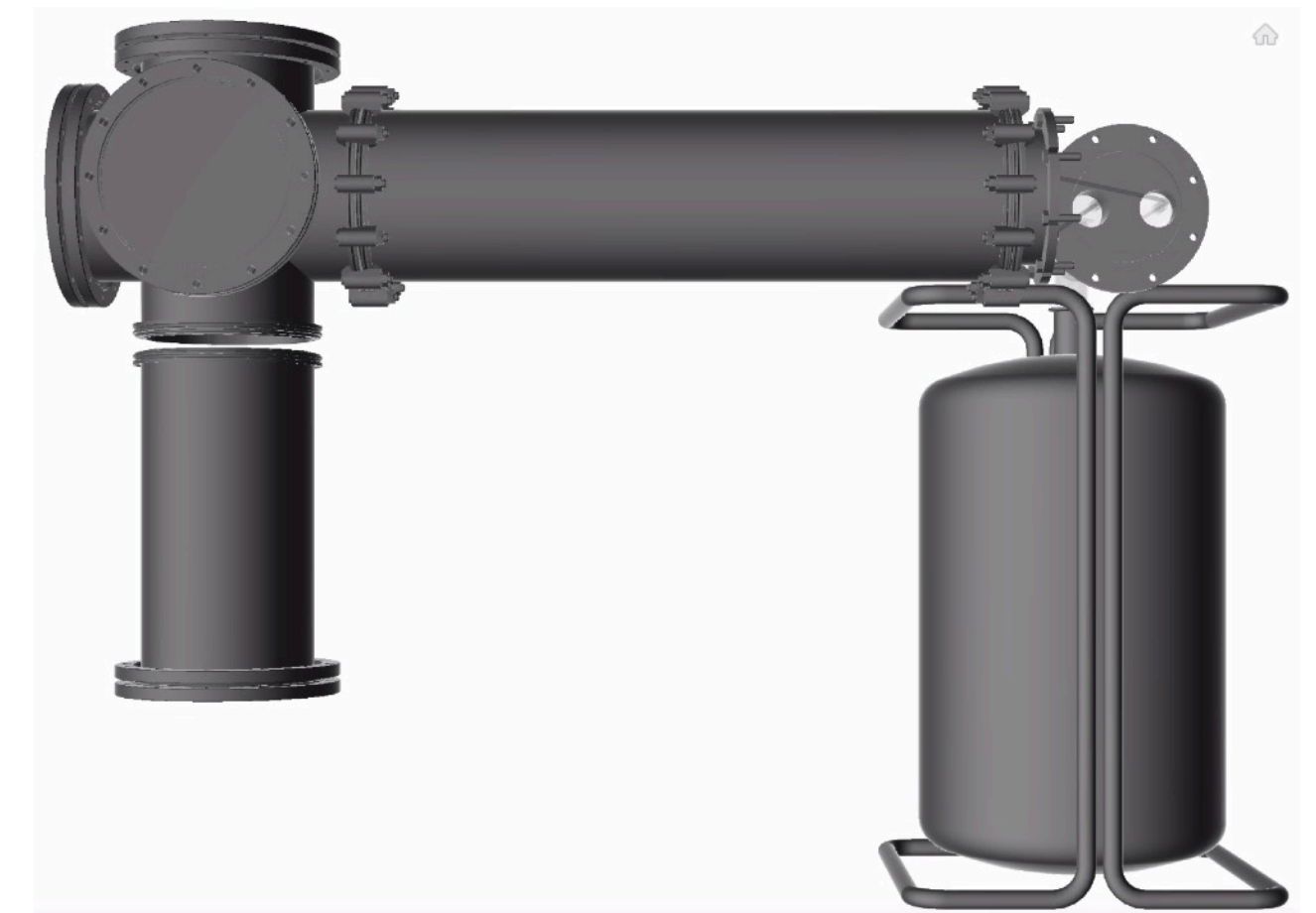
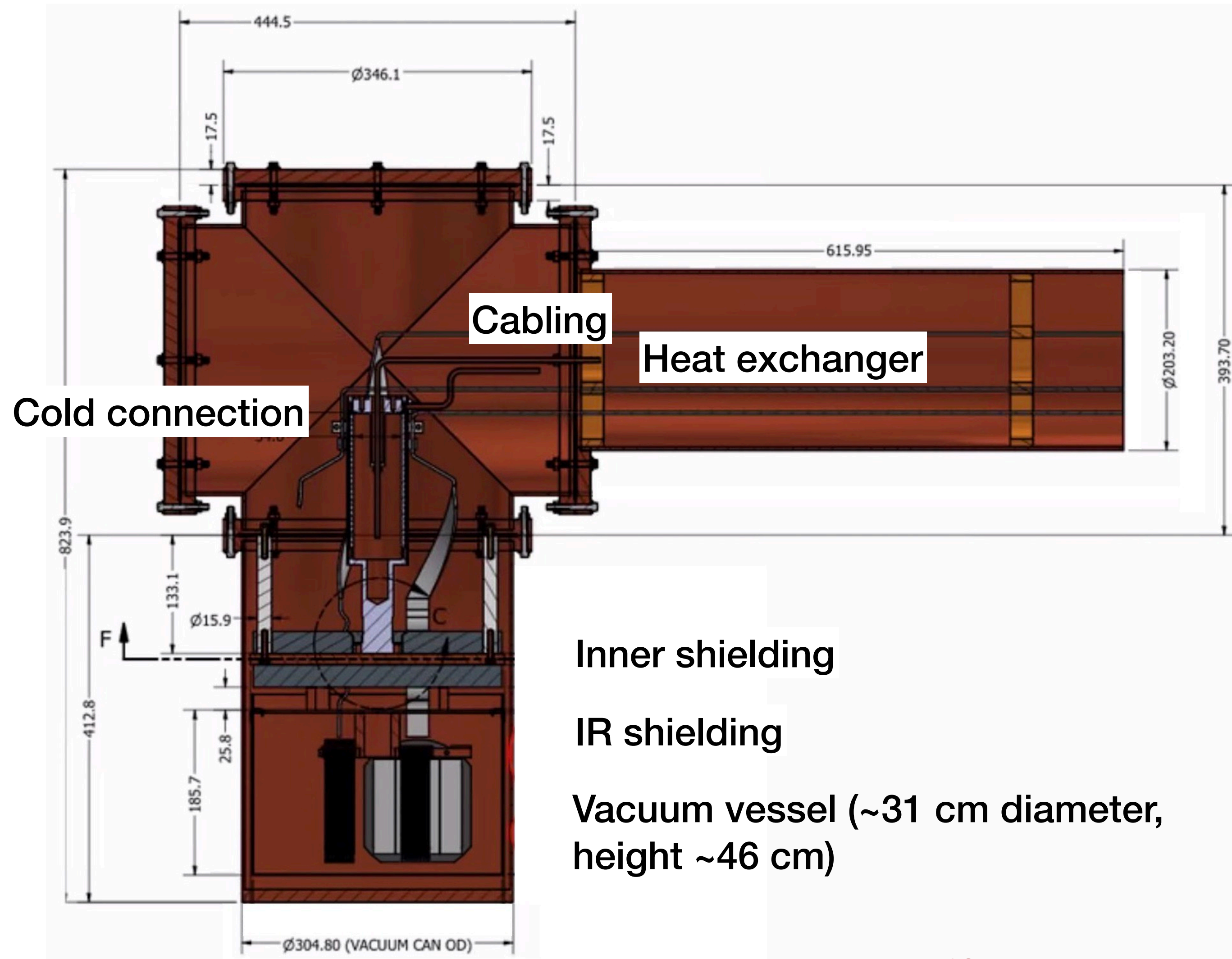
We are getting ready for the CCD production



Vacuum chamber with four CCDs

# DAMIC-M Preparation

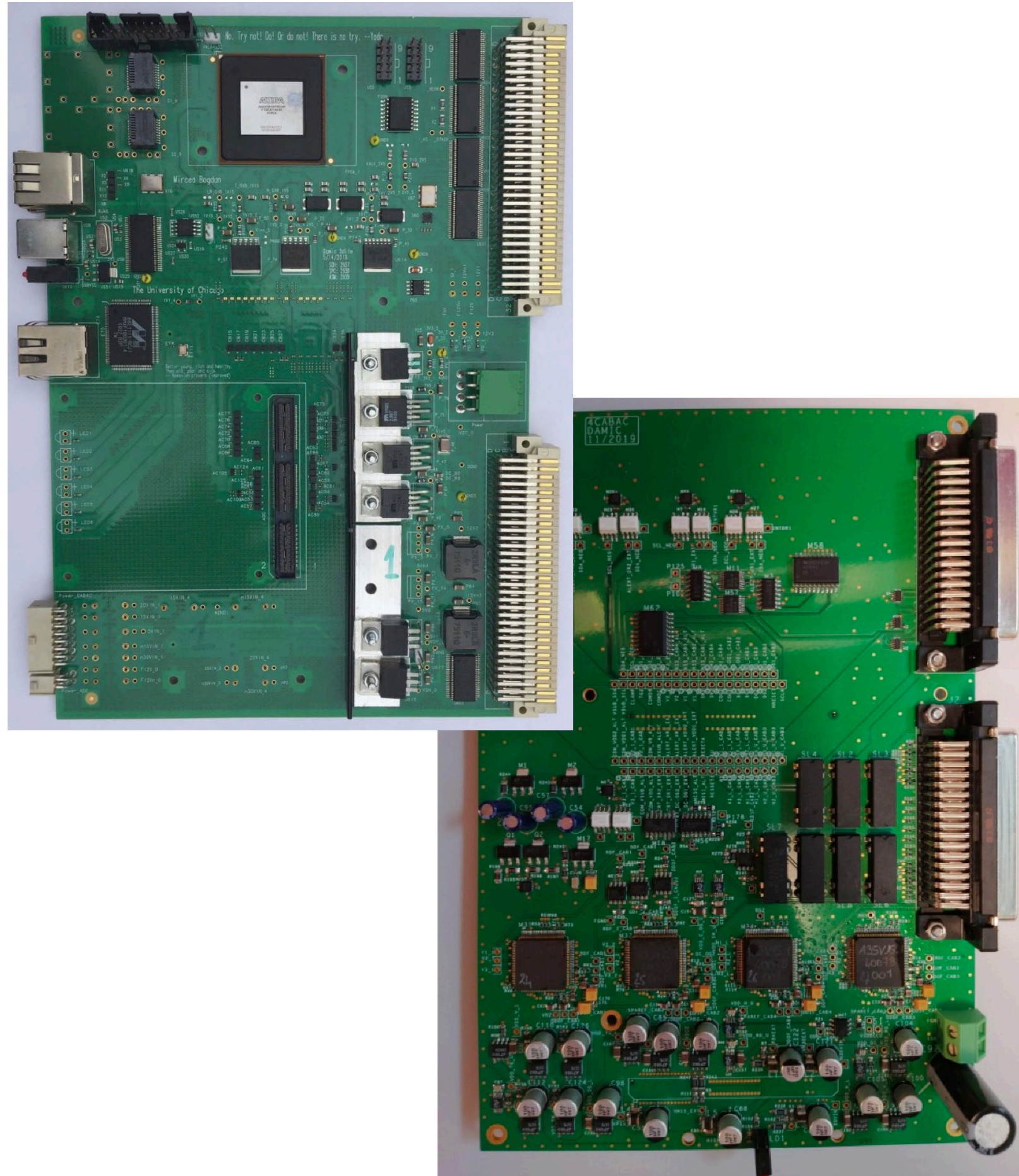
Moving forward with the Detector design



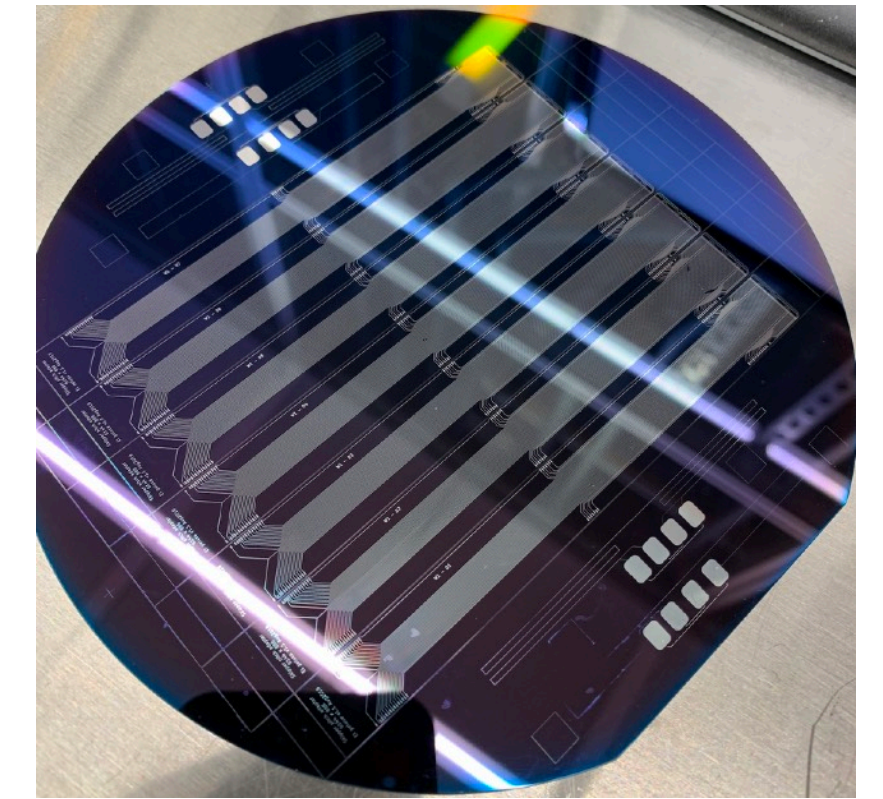
Array with 208 CCDs

# DAMIC-M Preparation

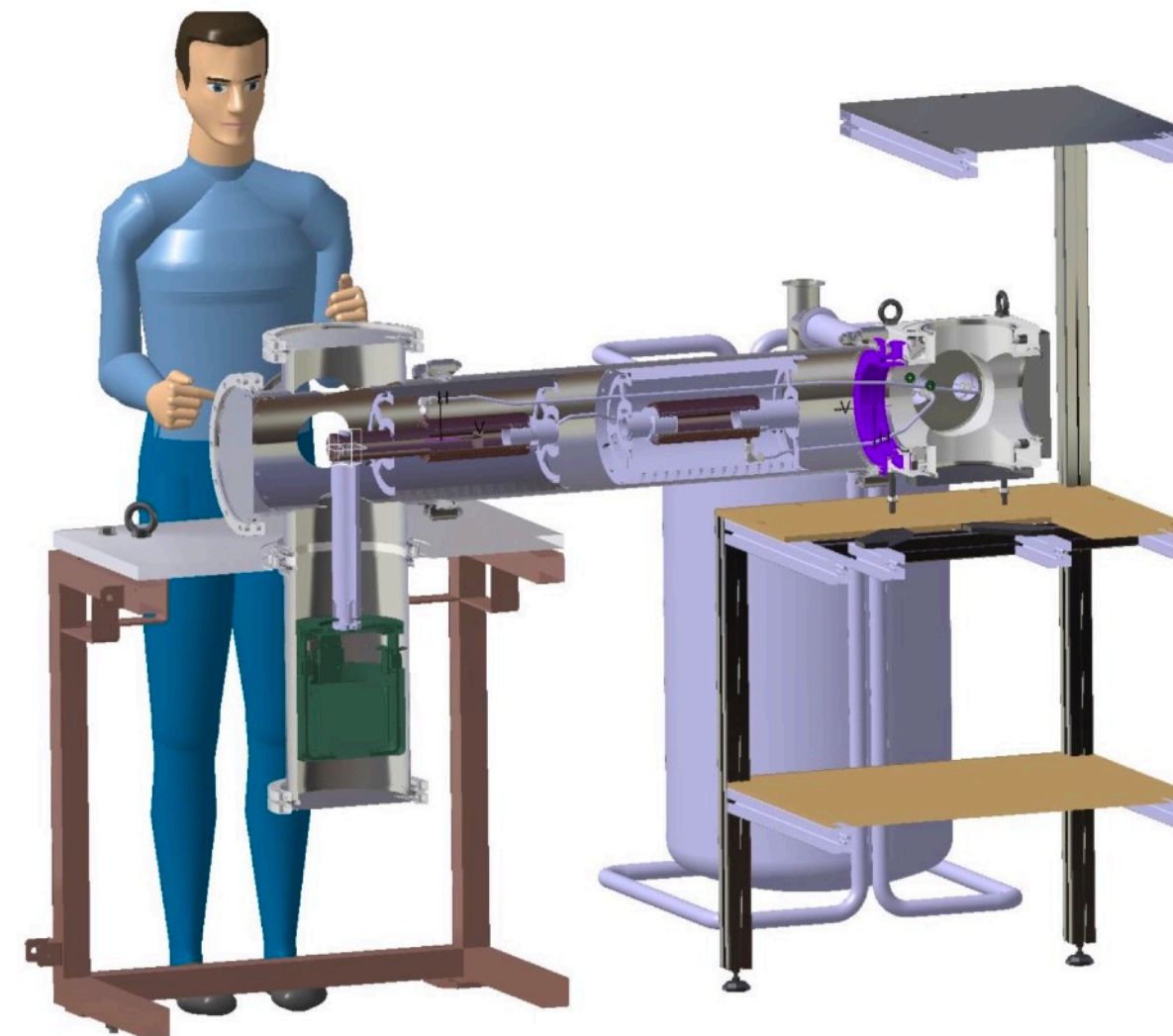
Electronics under development



Silicon pitch adapter CCD mock-up

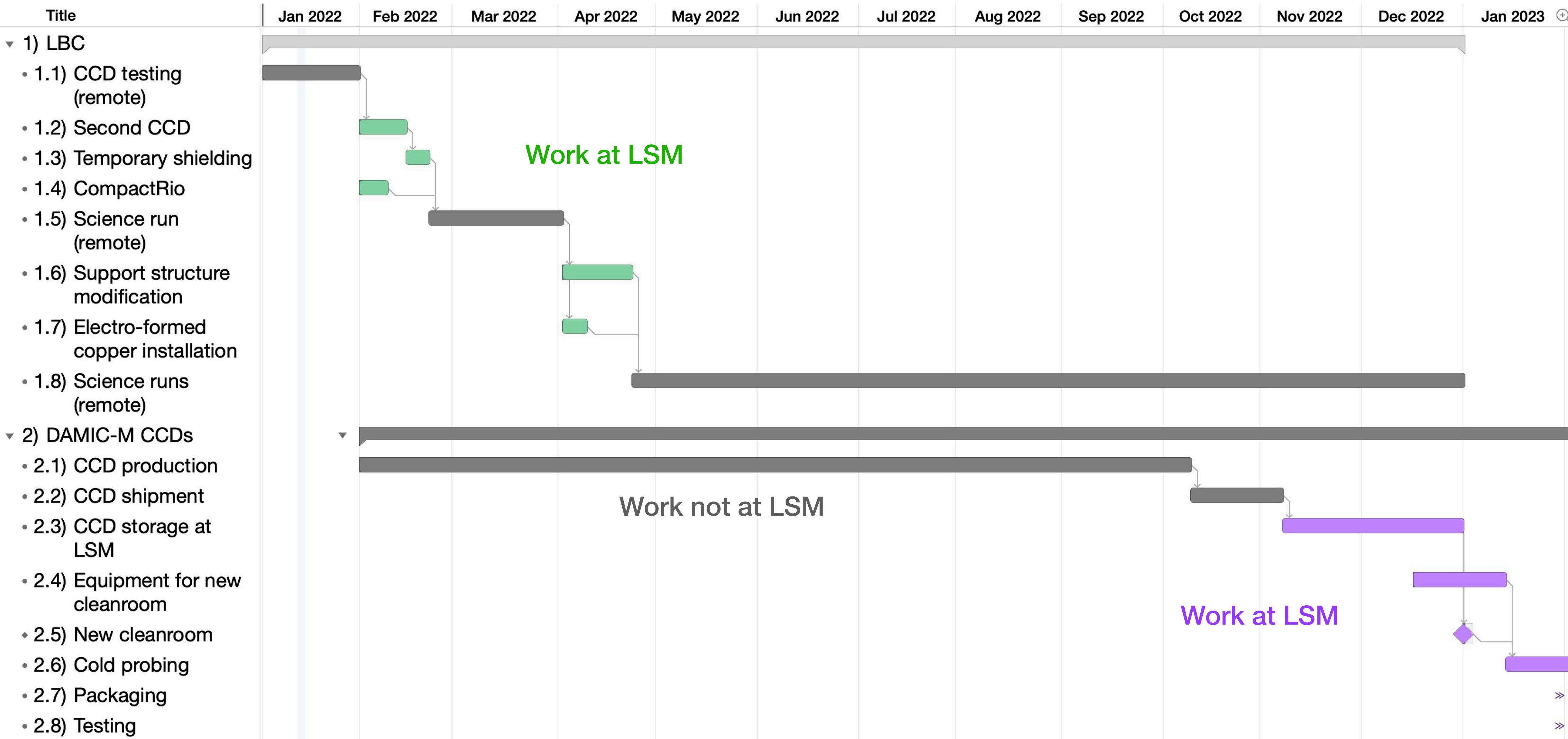


Heat exchanger mock-up



Heat exchanger will require ca. 1 kg/h of liquid N<sub>2</sub> at LSM

# Schedule for 2022



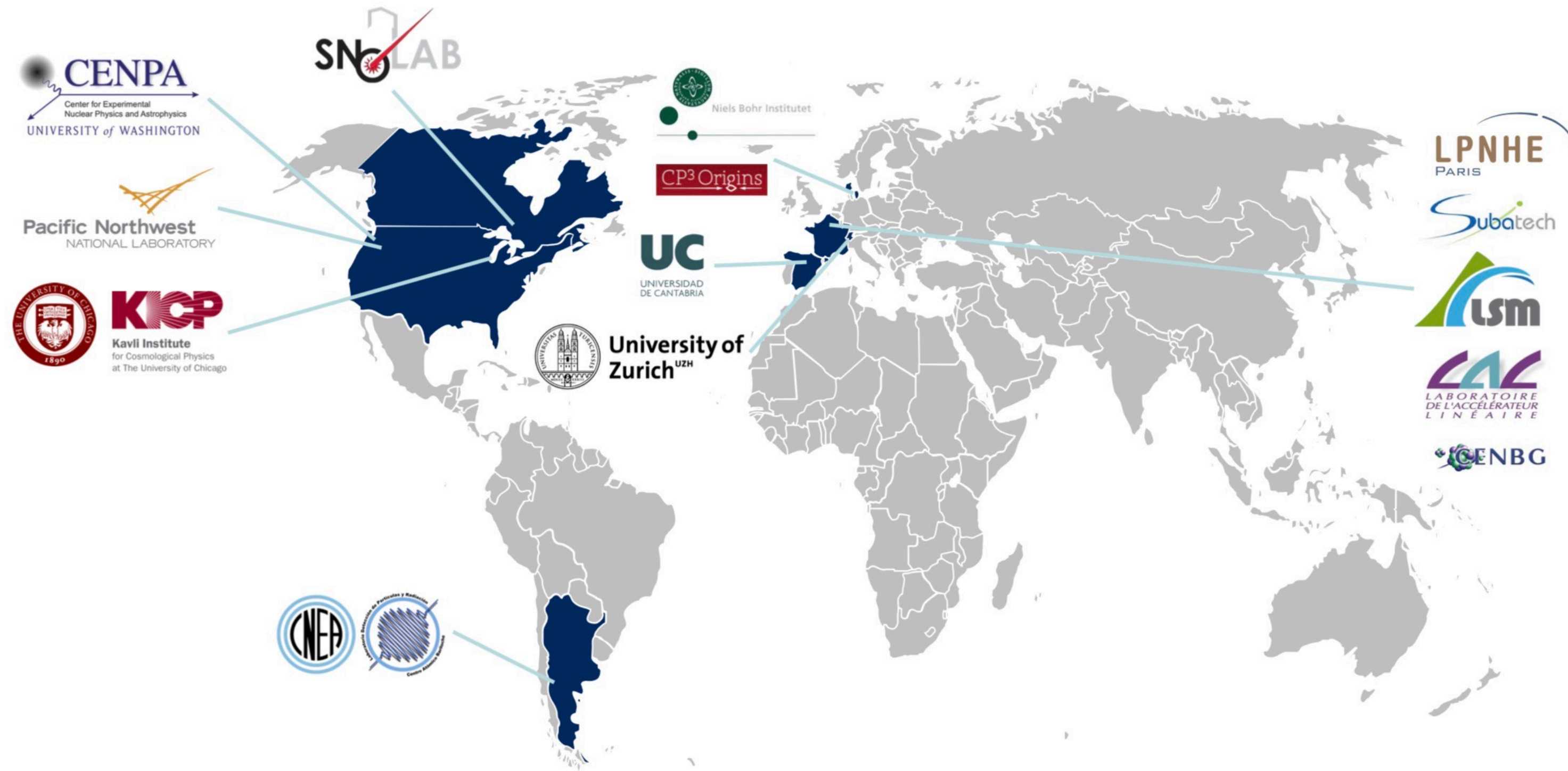
# Questions

1. Does our schedule fit the LSM plan?
2. What is the construction schedule of the new BINGO cleanroom?
3. Can we get nitrogen gas or radon-free air for a cabinet with CCDs?
4. Is it feasible to have ~1 kg/h of liquid nitrogen for the cooling of the full-scale DAMIC-M detector?



# DAMIC-M Collaboration

## DAMIC-M Collaboration



The National Science Foundation



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