ECal Status and Plan

SBS Weekly Meeting

Don Jones

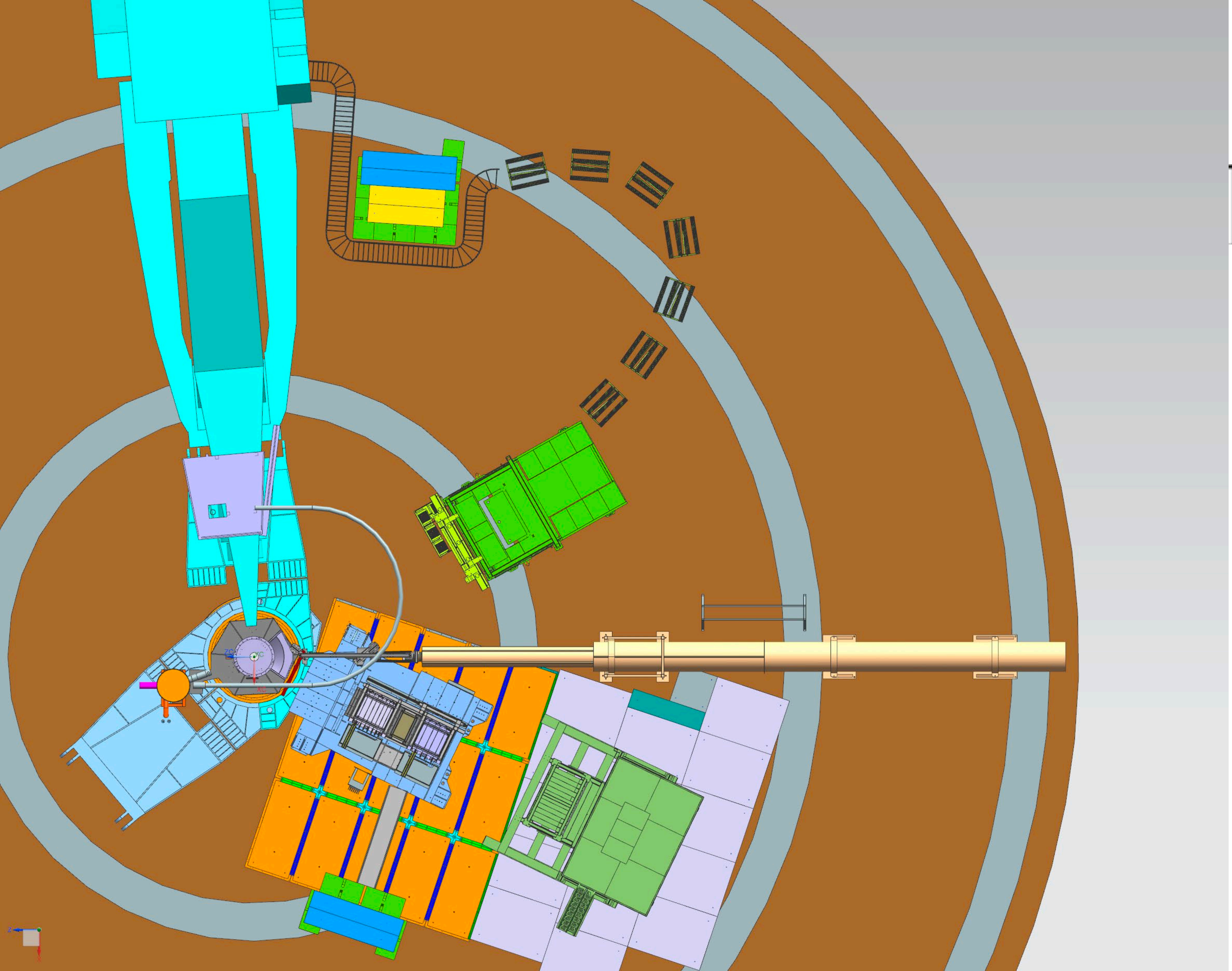
Aug 7, 2024

ECal has 4 positions (3 moves)

GEp 07109 Hydrogen

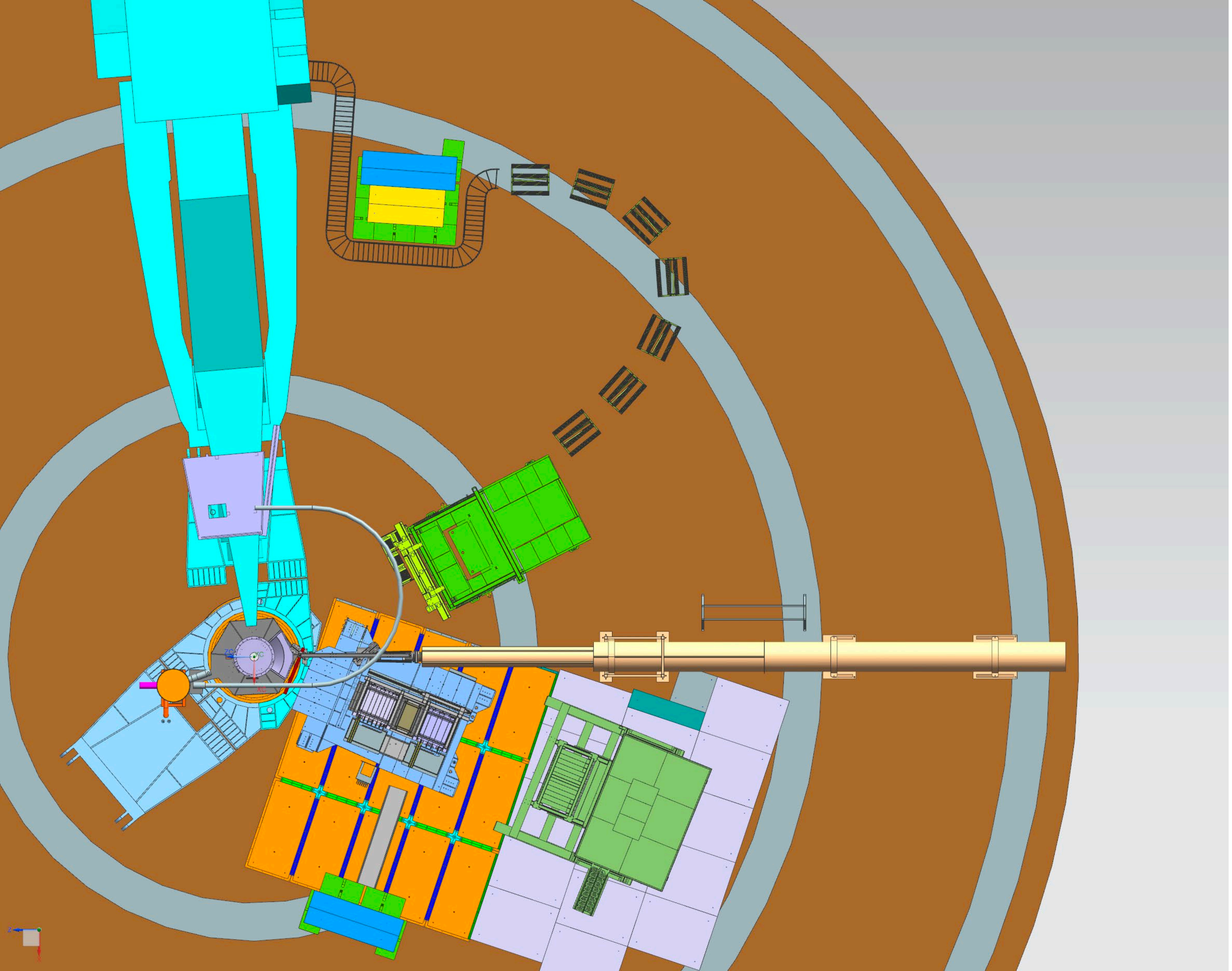
HRS-BR deg. 140.0º

NX ARR.	Energy	Q^2 GeV^2	SBS deg.	SBS m	HCAL deg.	HCAL m	HRSBL deg.	B line	Flr. Layout	ECAL deg.	ECAL m
GEp-1	6.4	5.7	25.7º	1.6	see SBS deg.	10.0	95.0º	1	**B**	29.47º	8.0
GEp-2	8.5	8.1	22.1º	1.6		10.0		1	**B**	27.27º	6.5
GEp-2a	4.4	N/A	28.5º	1.6		10.0		1	**B**	35.0º	5.0
GEp-3	10.6	12.0	16.9º	1.6		10.0		1	**B**	29.25º	4.7



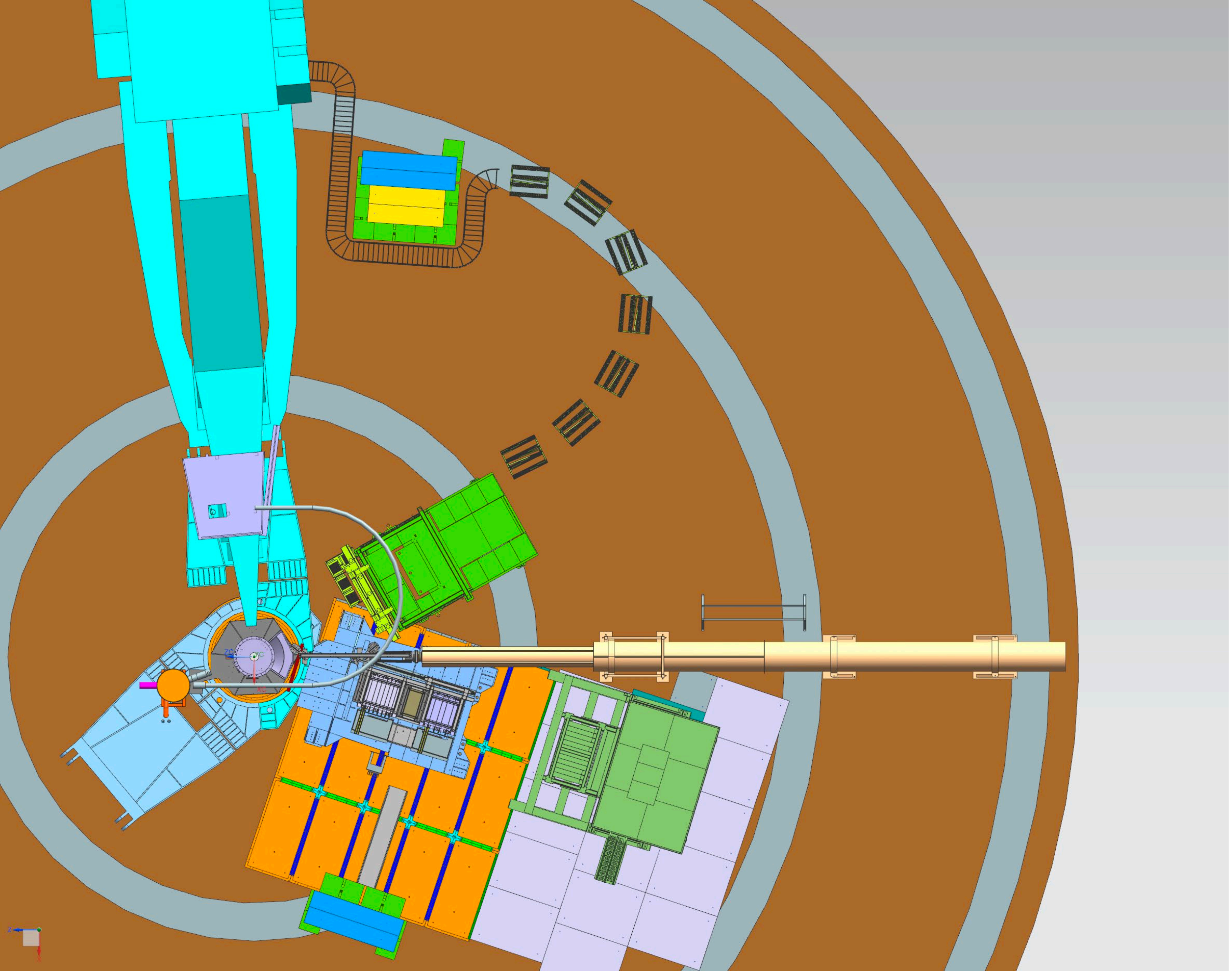
GEP-1

29.47°	8.0 m



GEP-2

27.27°	6.5 m

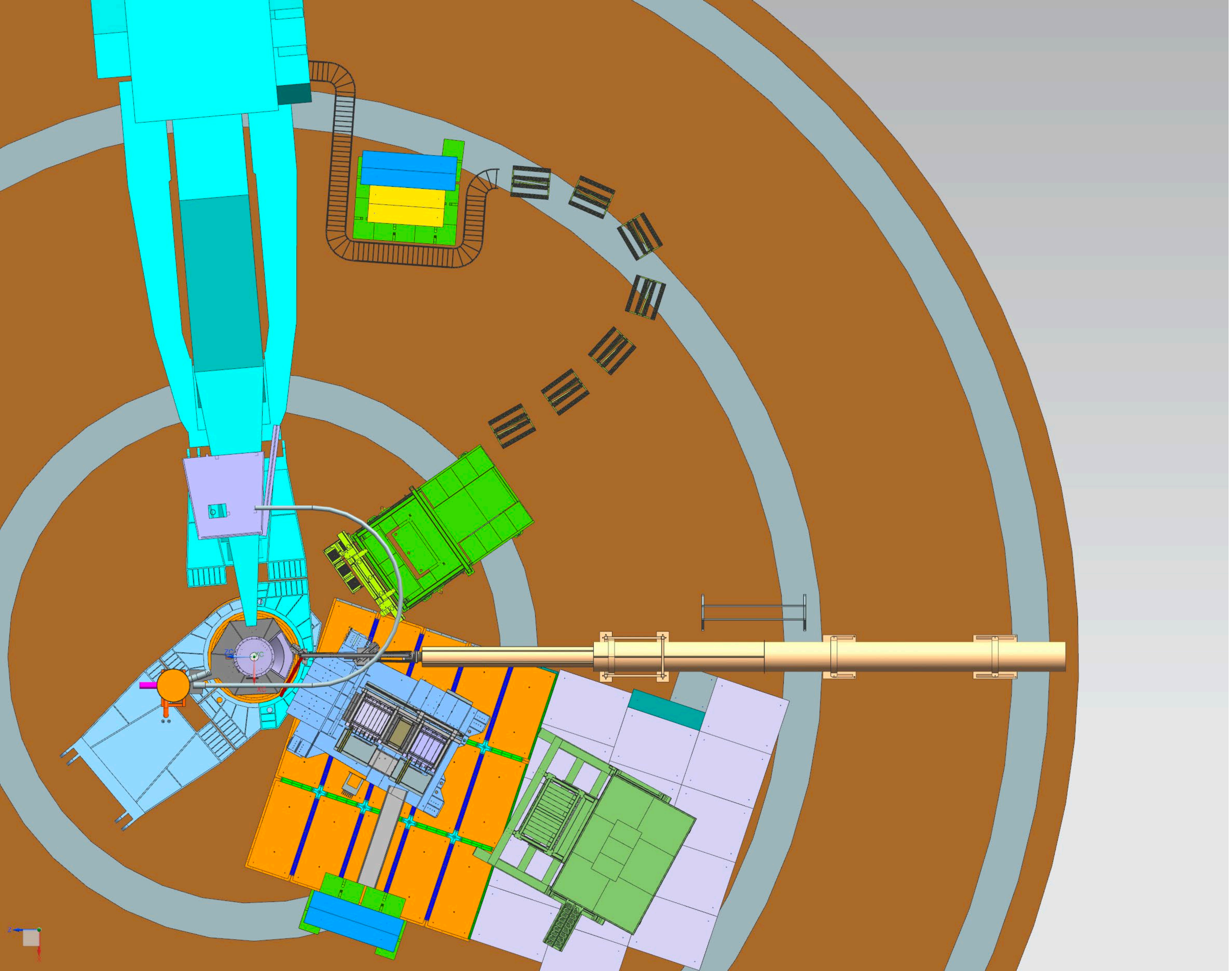


GEP-3

29.25º	4.7 m

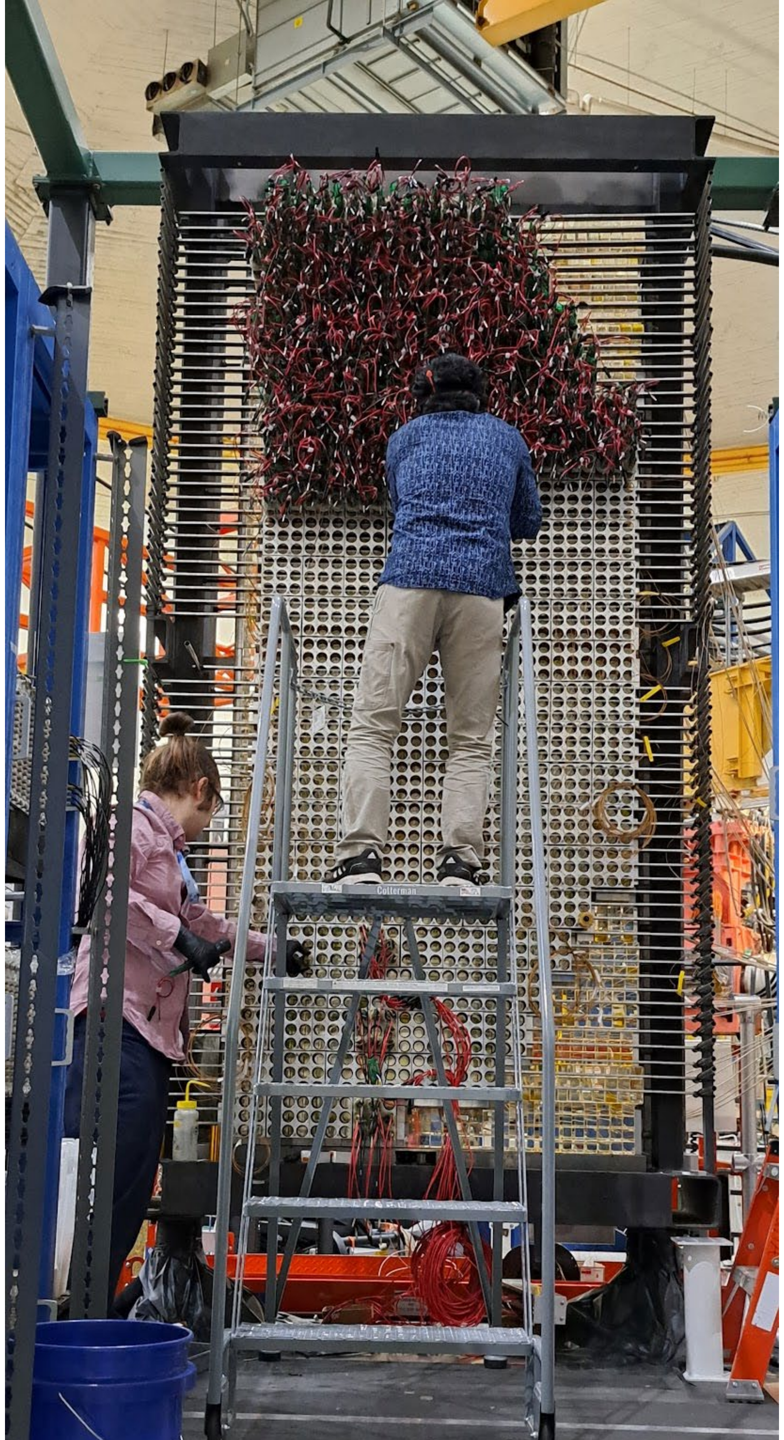
GEP-2a

35.0º	5.0 m



PMT+base preparation and installation

- Not enough old magnetic shields and they were slightly too small in diameter.
- Measurements determined we need thicker shields
- Large effort over past 3 months to purchase and wrap mu-metal into 3-ply-thick shields.
- Completed enough a few days ago.
- PMT+base testing ongoing
- Still need to solder another 100-200 bases
- Installation of PMT bases going faster than expected. Almost 30% complete!
- Simona taking the lead on this



HV supplies

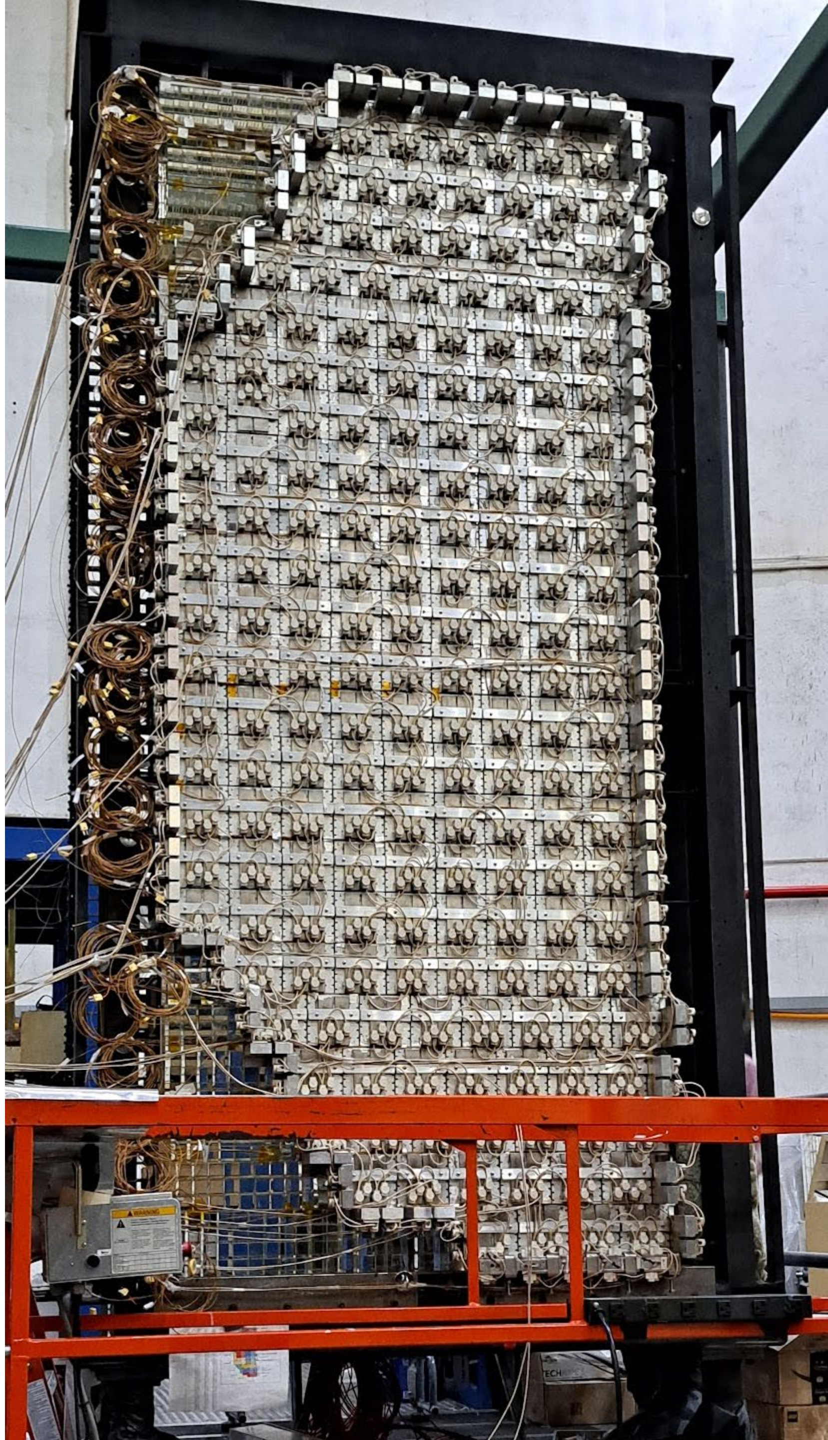
- LeCroy HV supplies all connected
- Debugging of remote control still ongoing but mostly complete.
  - Updated software/OS on RaspPis
  - Located issues with unresponsive HV cards
- Jimmy took the lead with software help from Bob M.

ECal heater system

- Heater system designed to run on <50 VDC.
- 48 heater zones and >200 thermocouples have been installed
- Power connections to the zones are being completed and zone-by-zone testing is underway (heating each zone to 50-60 degC)
- D. Jones taking lead

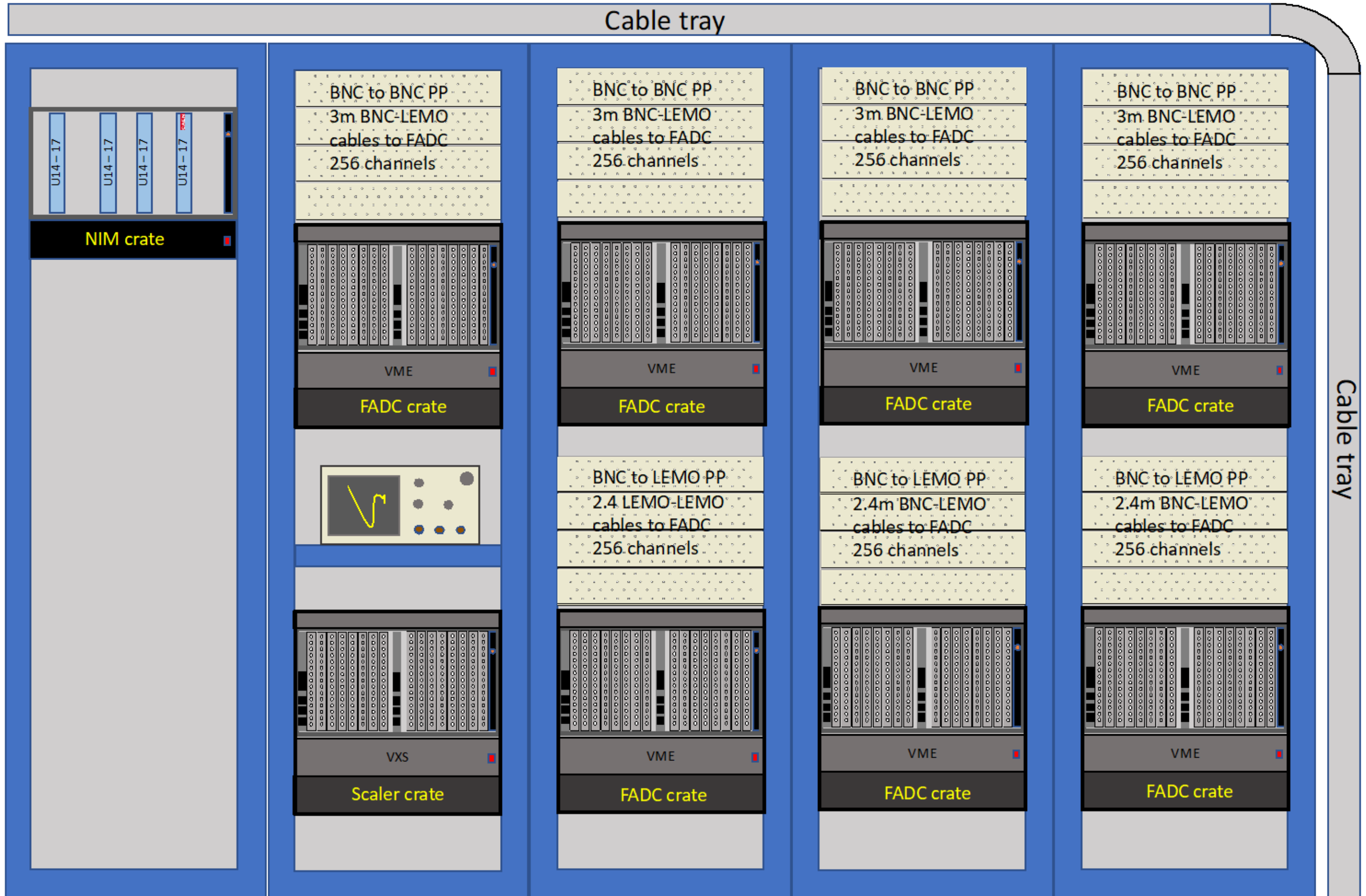

Power supply racks

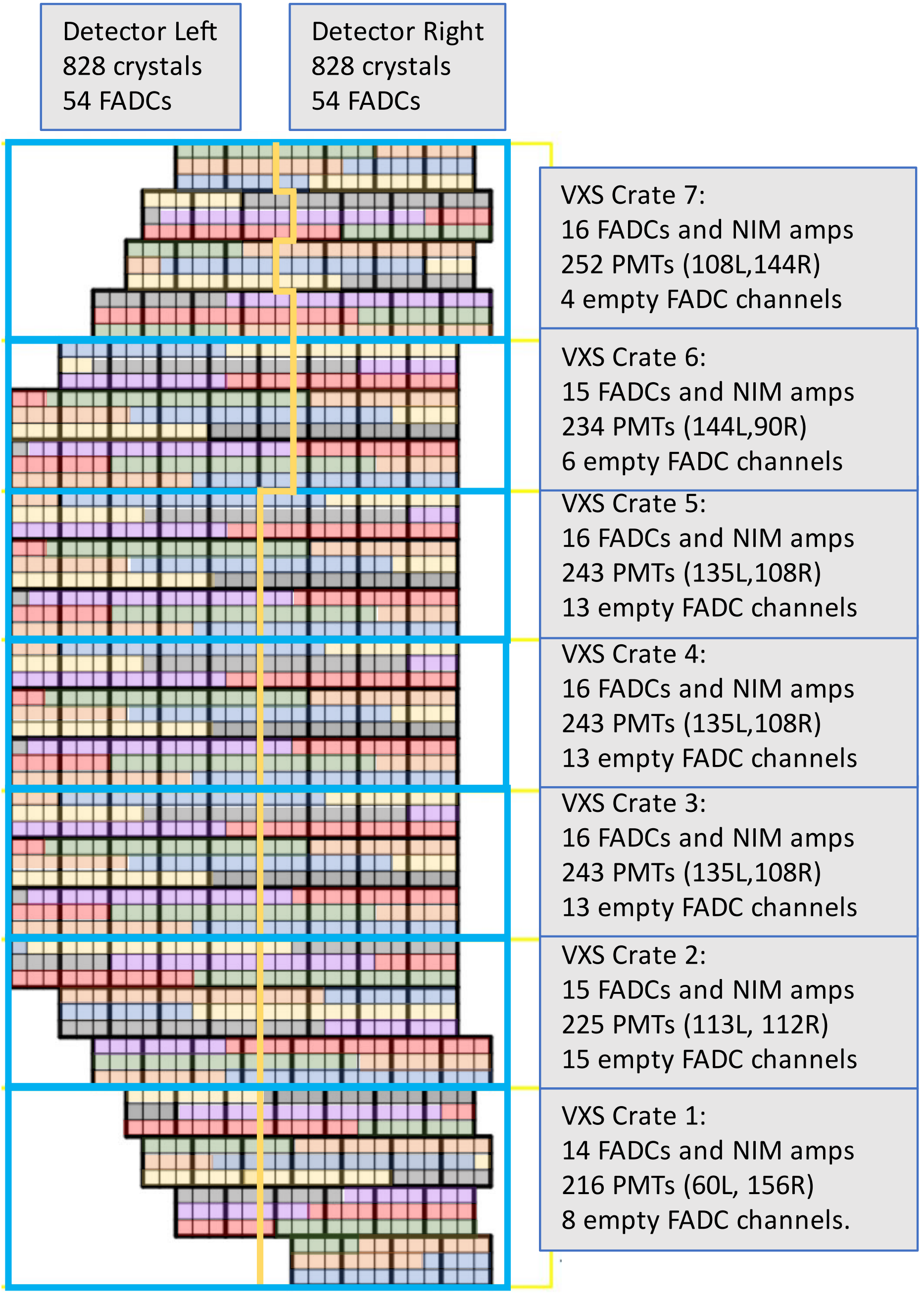
- DSG (Marc McMullen) taking lead on heater controls and monitoring
- Developing a large scale control and monitoring program following the successful prototype model
- Safety and emergency shutoff as well as EPICS updating PVs are all incorporated into the system



FADC-based DAQ

- 1656 channels to 108 FADCs in 7 crates contained in 4 racks





FADC-based DAQ

- Most electronics from GEN removed
- 4 VME crates installed
- Cables and patch panels on hand and mostly labeled
- Jimmy taking the lead with Simona enlisting help from Hall C designers for rack and cable design

Cables and connections

- Signal cables from PMTs to front end modules
- Signal cables front end to DAQ patch panels
- Signal cables from DAQ patch panels to FADCs
- HV cables from PMTs to HV modules on ECal platform
- HV cables (24 ch) from platform modules to DAQ bunker HV modules
- SHV cables from HV modules to HV supplies (already installed)
- Albert S. leading the cable production, testing and labeling effort

Cable Routing

- Most cable
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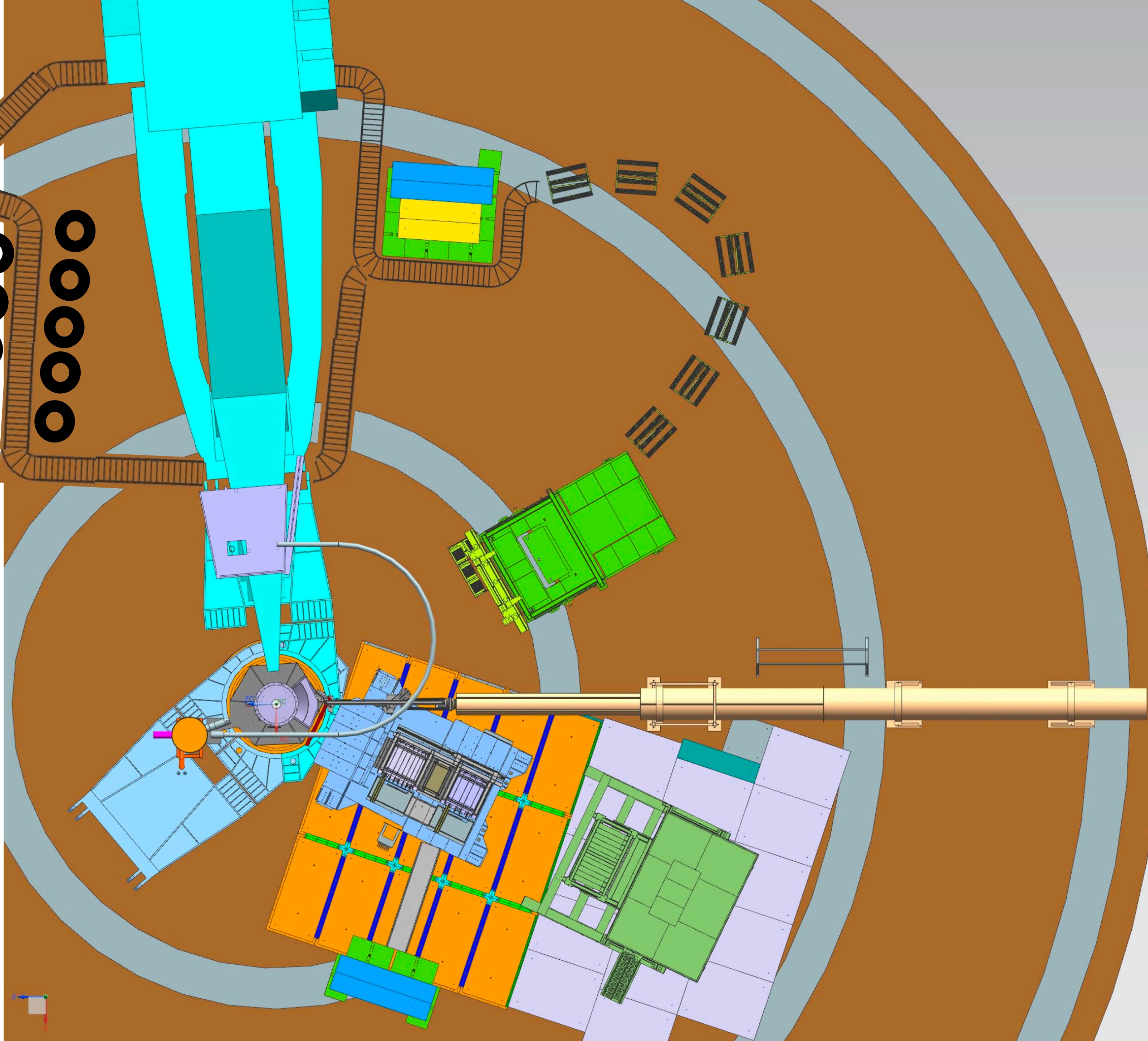
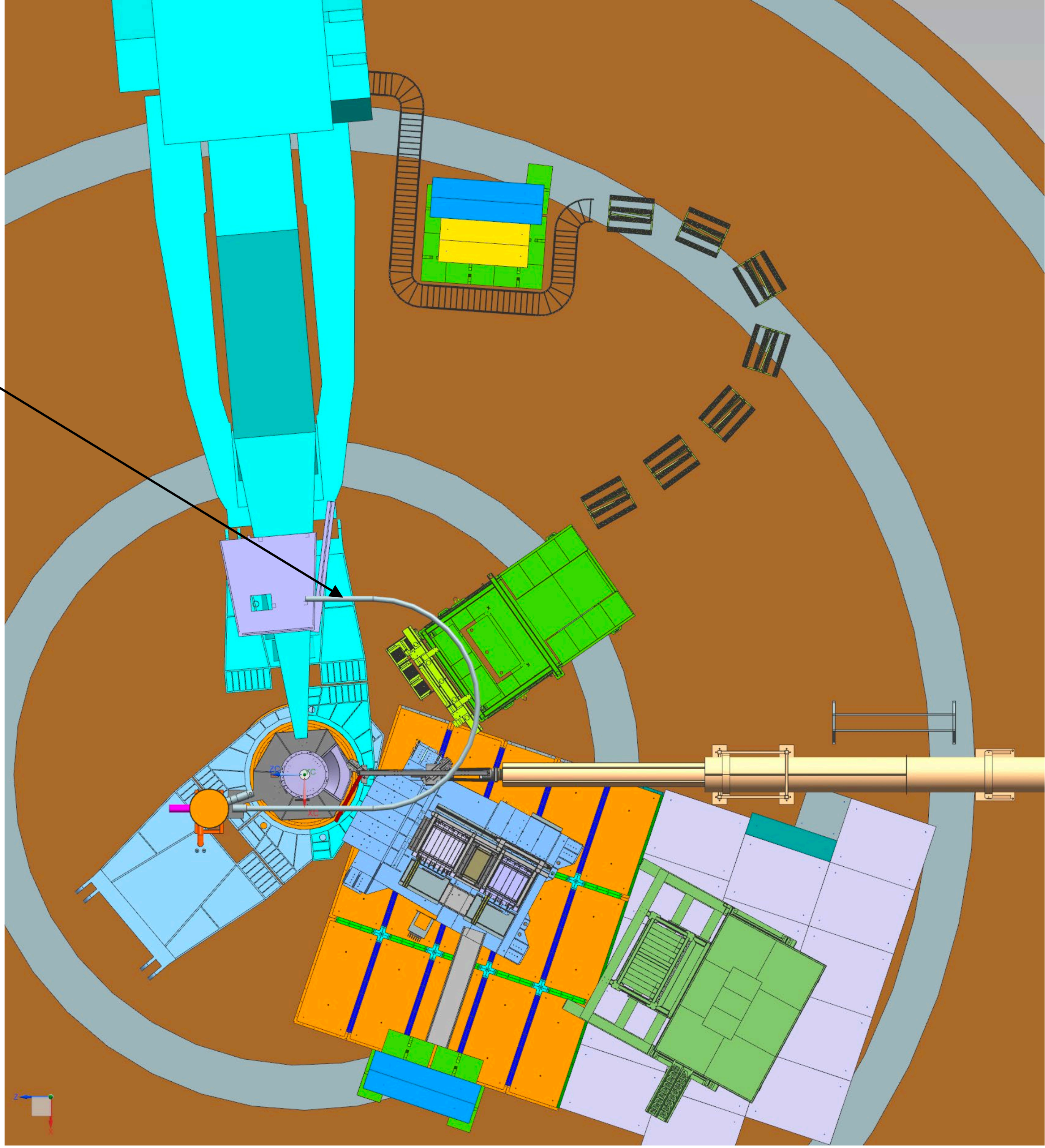
  going und
  walkthrou

- To accommodate storage of the extra length (15m-40m per cable) I am considering adding a second path under the HRS



New plan for CDET

- Due to overhead cryogenics line, CDET cannot be moved to closest position by crane.
- New plan is to directly attach it to the ECal platform so that it moves with it
- Requires new engineering, design and modification which is causing further schedule slip

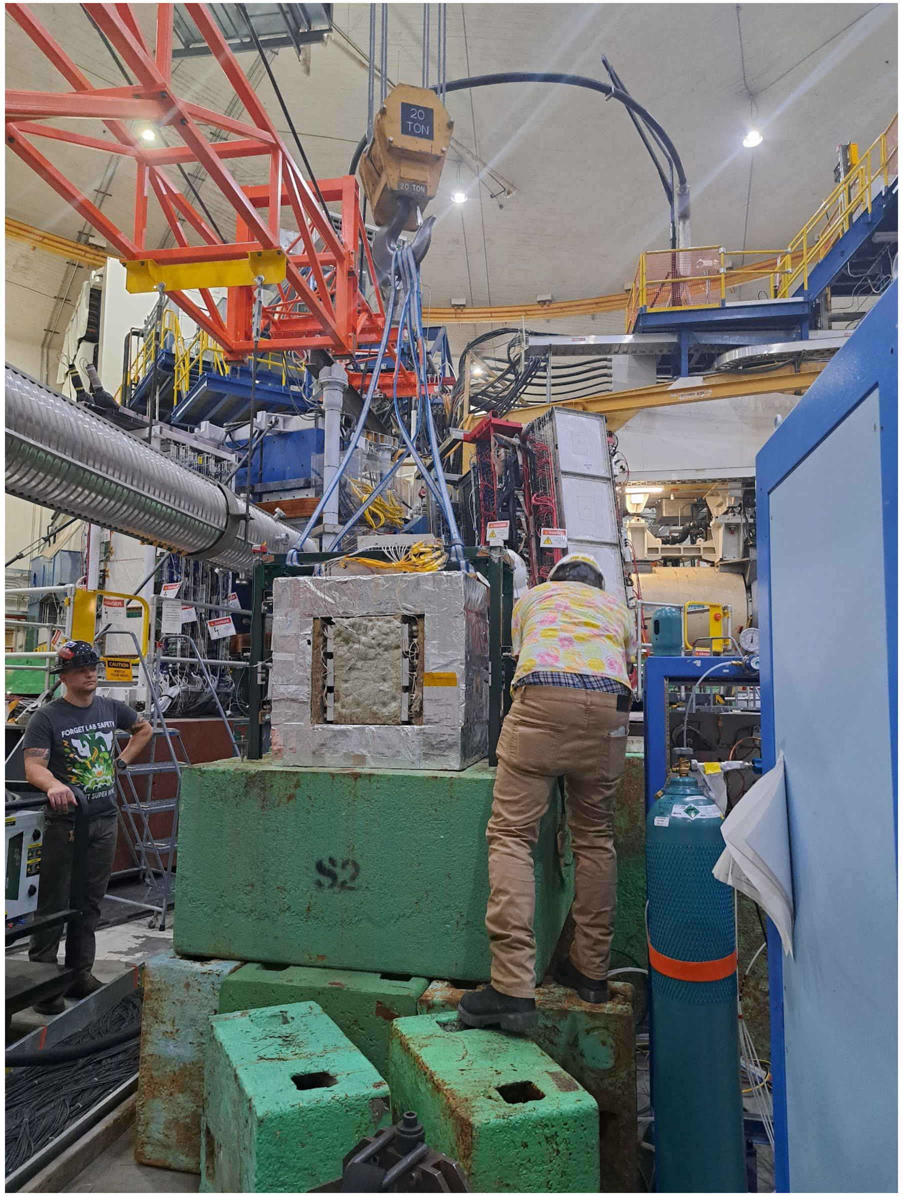


Schedule

- With the safety pause, our schedule is delayed
- We were planning for an initial 50% cosmic test in early September
- What has to happen first?
  - ECal moved into GEP-1 position, insulated walls installed, heater system installation complete, small bunker built, cable tray system installed, cooling system installed, at least 50% PMTs+patch panels installed with cables to front end signal cables to DAQ run, DAQ installed and cosmic trigger set up.
- Realistically that is not likely to happen now until late October at the earliest
- We would like the full detector installed and ready for testing by sometime in December

Prototype heated detector in Hall

- ERR committee requested we demonstrate the heater system on the prototype operating under beam conditions.
- During Sept 2023 we installed it in the Hall on top of the GEM bunker near the left downstream beamline
- We ran it smoothly for months during GEN and GEN-RP again demonstrating the ability to reach the desired temperatures of 220 ℃ on the front and 170-180 ℃ on the rear.
- During 2023 the rear was open to air. In 2024, the rear was enclosed and active cooling added.
- Near the end of GEN-RP, a connector failed causing sparking and partial melting of a power box leading to power failure in a single zone. This was a faulty connector and not a failure of the design which safely withstood the energy of the event.



Adding active cooling

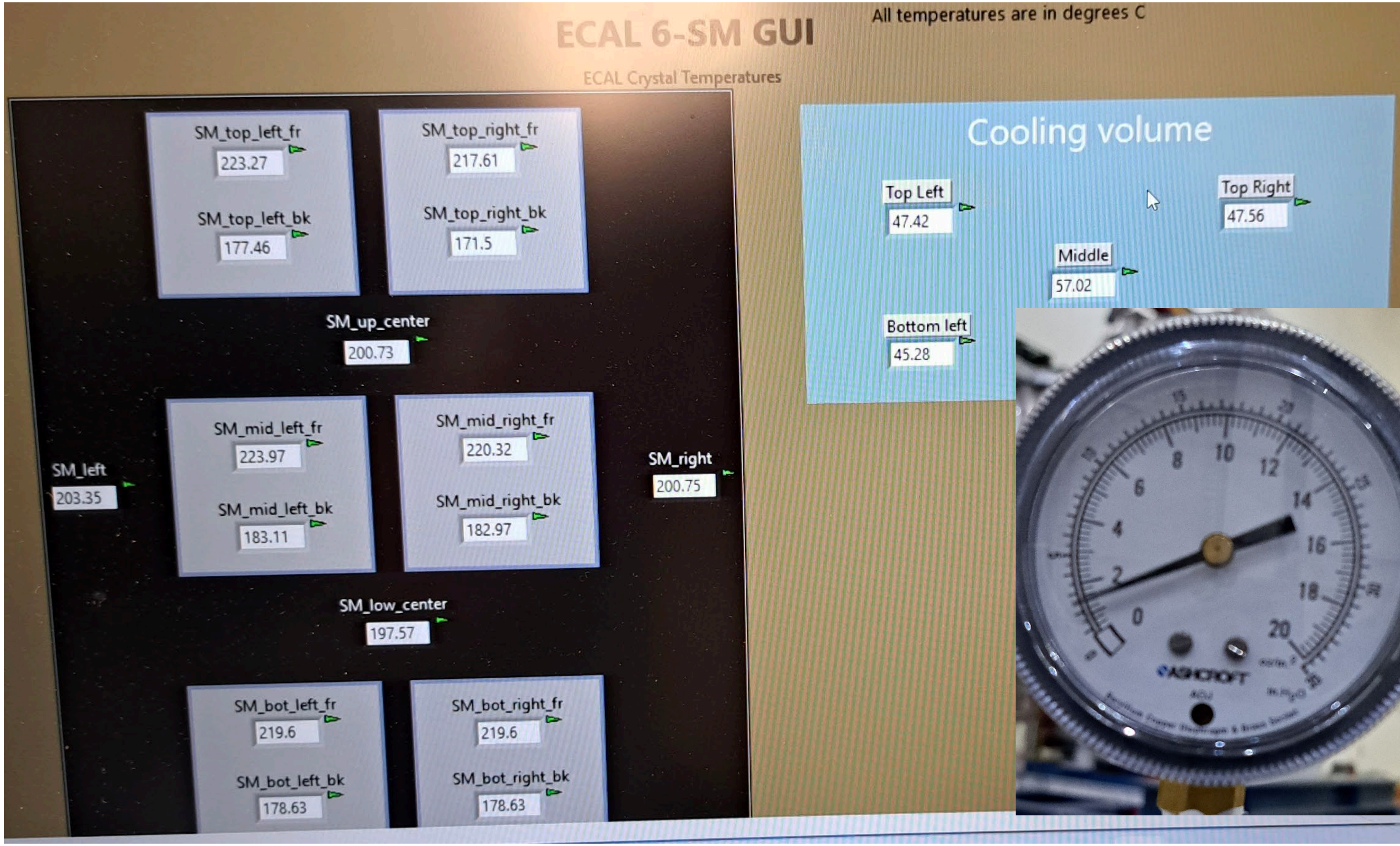
- Installed manifold and conduits with air jets for each light guide similar to system for full scale
- Installed a rear aluminum enclosure and an air pump on the system

Active cooling

- Pump is single speed so pressure in cooling system adjusted with release valve
- Started system with valve fully open which gives a reading of 1.5 oz/in^2 or 2” of H_2O
- There is a 2.25” diameter outlet hole in the top of the plenum to allow air to escape to minimize airflow to the front of the heated enclosure

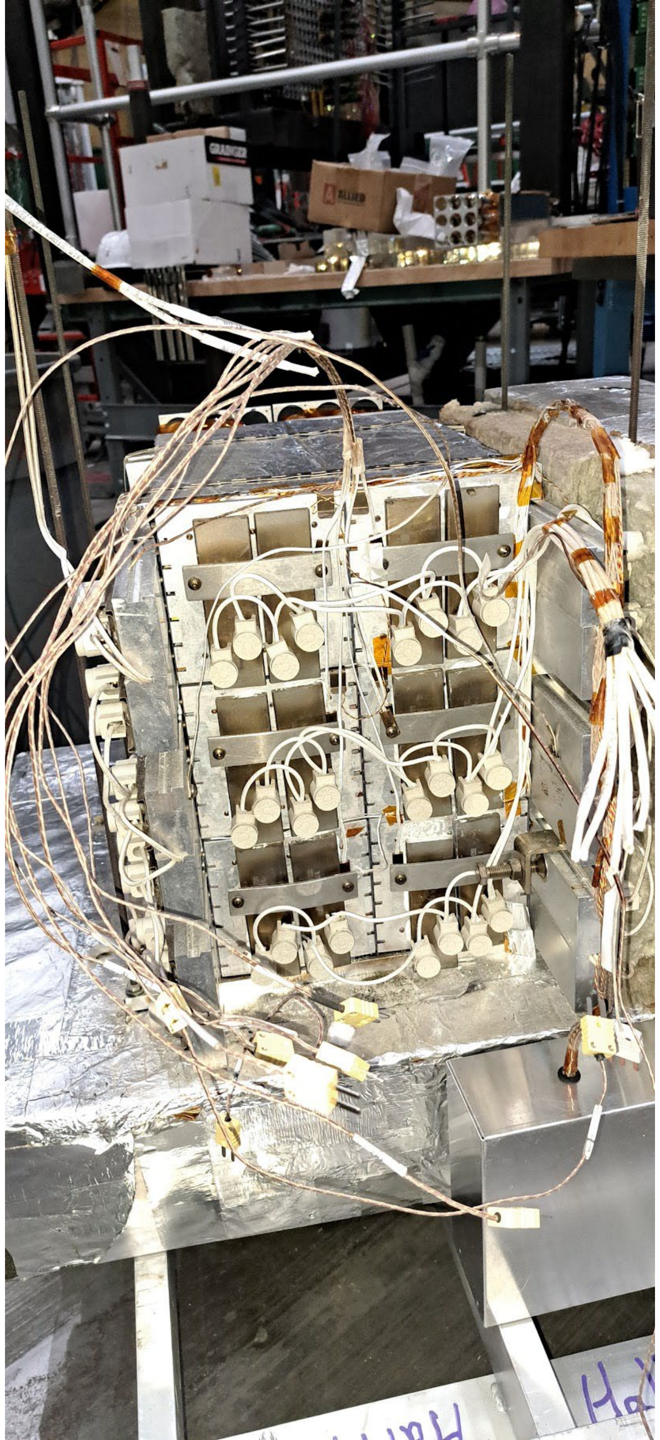
Lowest pressure setting 2”H_2O

- Since full scale pump cooling only 6 supermodules, we started with the lowest possible pressure with the vent valve wide open
- Temperatures on crystals are exactly what we want: around 220℃ on the front and 180℃ on the back
- Light guide temperatures are a little high at 46°C
- One light guide is much hotter at 57℃
- Ran the system at several pressures from 2- 17”of water and found
  - Cannot reach desired temperature profile above ~10” of water without exceeding temperature limit (300 °C) on the front aluminum plate
  - Adding air flow pressure had a large effect on the power requirement, but had much smaller effect upon the light guide temperatures.
  - Increasing pressure from 2 to 10 only decreased light guide temp by ~3 °C
- The largest effect on light guide temperatures is air flow from the front hot side. The better we seal the front, the more control we will have over the temperature of the light guides which were sufficiently cooled just by being left open to air.



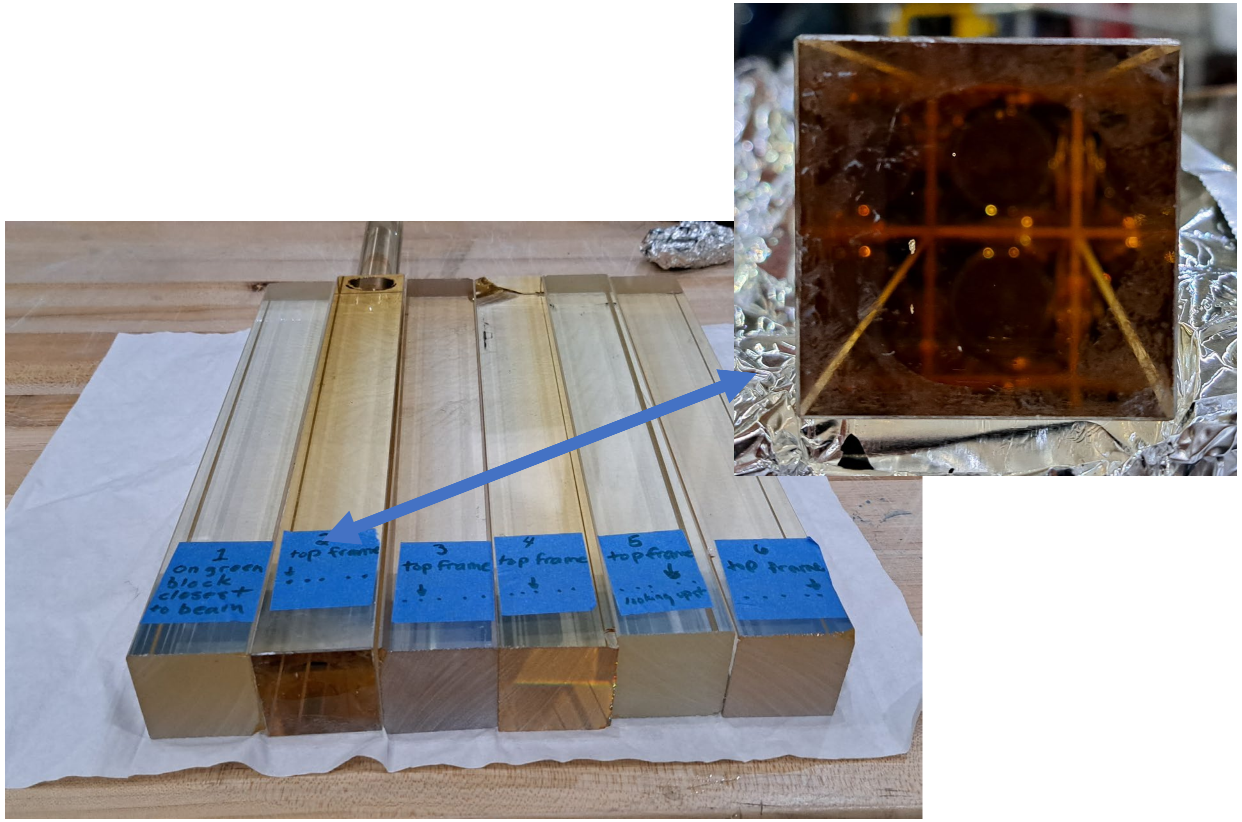
Post-mortem

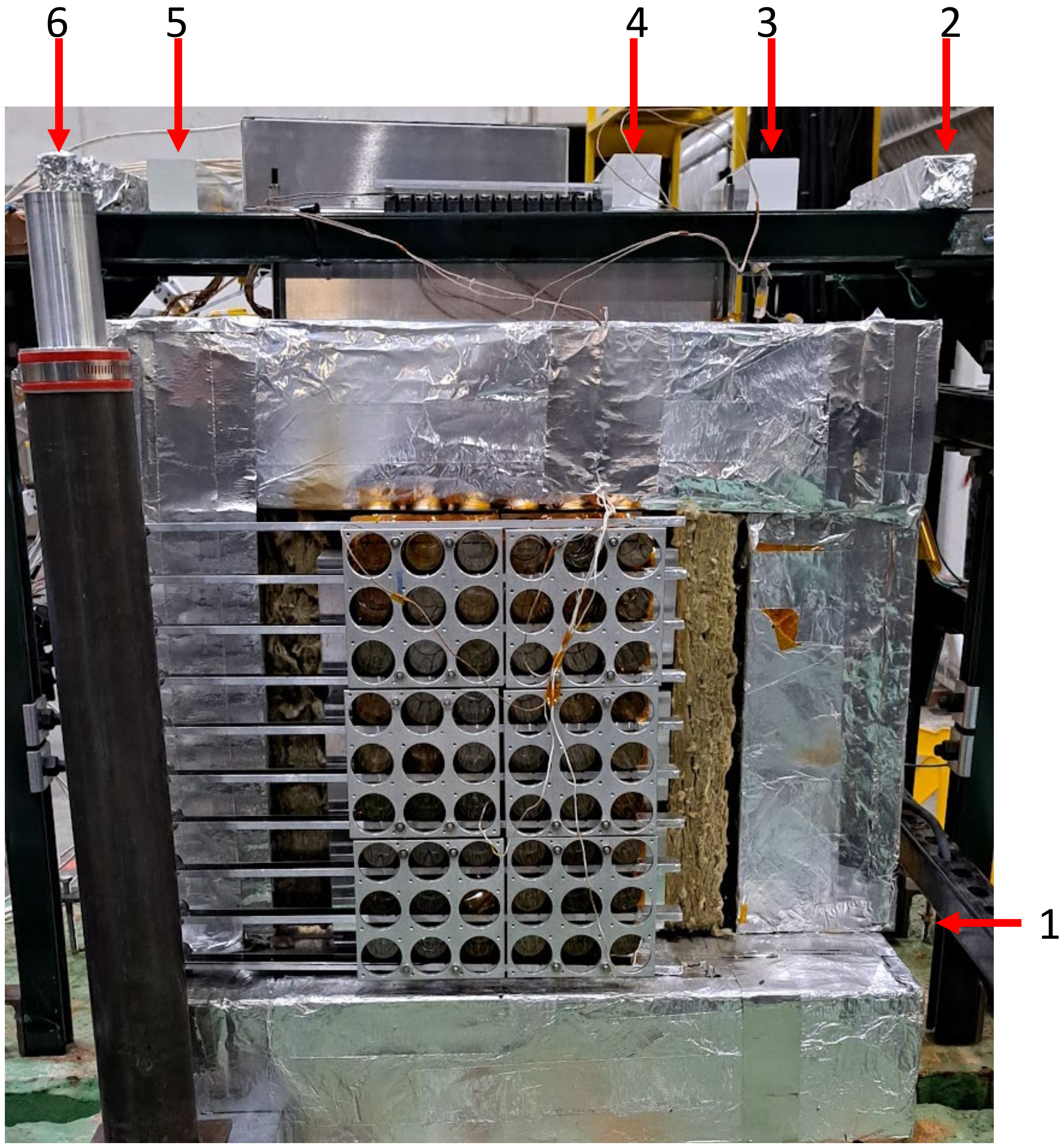
- After the run was complete we disassembled the detector and examined the components
- The heater system components looked healthy



Post mortem cont..

- We also placed 6 unheated spectator crystals around the detector
- Ones closest to beamline showed darkening



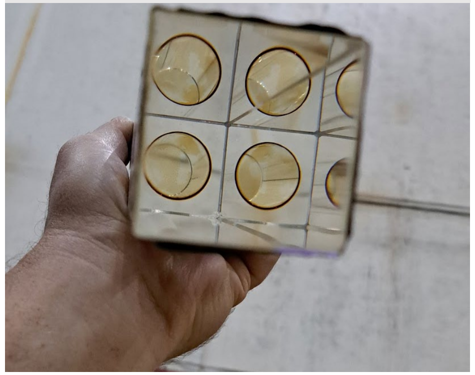


Post mortem cont..

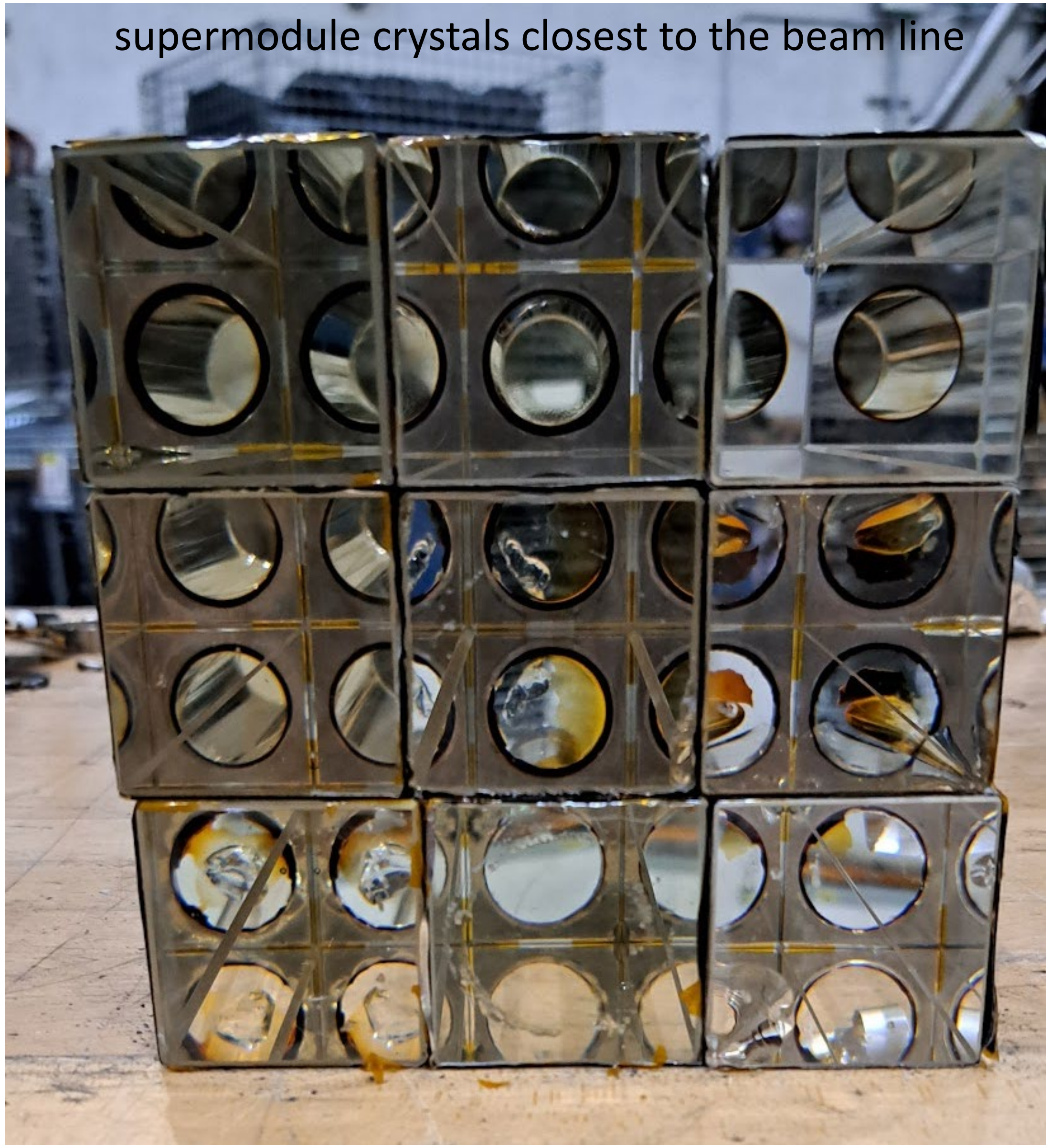
- Heated crystals still clear. Shown on the right is the supermodule crystals closest to the beam line which would have seen the most radiation
- However, a number of glue joints between the crystal and light guide had darkened significantly throughout the detector
- Those that retained strong and full adhesion were usually almost clear, but those that had become loose were quite dark
- Note: this darkening is not the result of radiation but of heat and oxidation. This is obvious when you see clear glue across the face of well-coupled light guides and a dark ring of glue at the edge. Also, darkening was independent of distance from the beam and dependent completely on quality of adhesion

light guides that came loose showing glue discoloration

Single crystal with good light guide adhesion shows glue rim discoloration



supermodule crystals closest to the beam line



Conclusions from darkened adhesive

1. Glue is darkened by exposure to heat and air. We know this because
   - The glue on the well-fastened light guides is still relatively clear across the face of the light guide but dark at the edges.
   - Light guides whose adhesion failed have a variation of darkness of glue showing that ones who failed early are darkest having the longest exposure time
   - The 1656 Light guides on ECal that have not been been exposed to heat do not show signs of darkening.
2. We have to limit the exposure of light guides to heat. We will empirically find the lowest temperatures at which sufficient annealing is achieved.
3. If a light guide is obviously loose or the glue is deteriorating, it is preferrable to scrape the glue off and simply push it back against the crystal without adhesive rather than have darkened glue.
4. We will avoid keeping the detector hot for extended periods without beam

Questions?