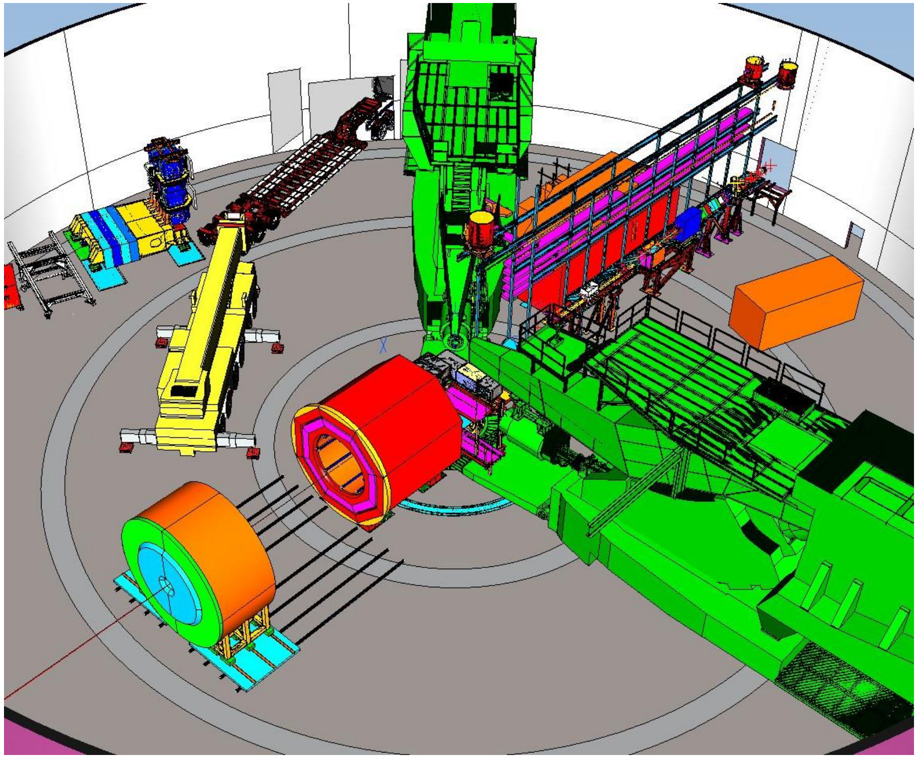
SoLID Collaboration Meeting

Magnet Test & Detector Support



Whit Seay

December 7, 2023

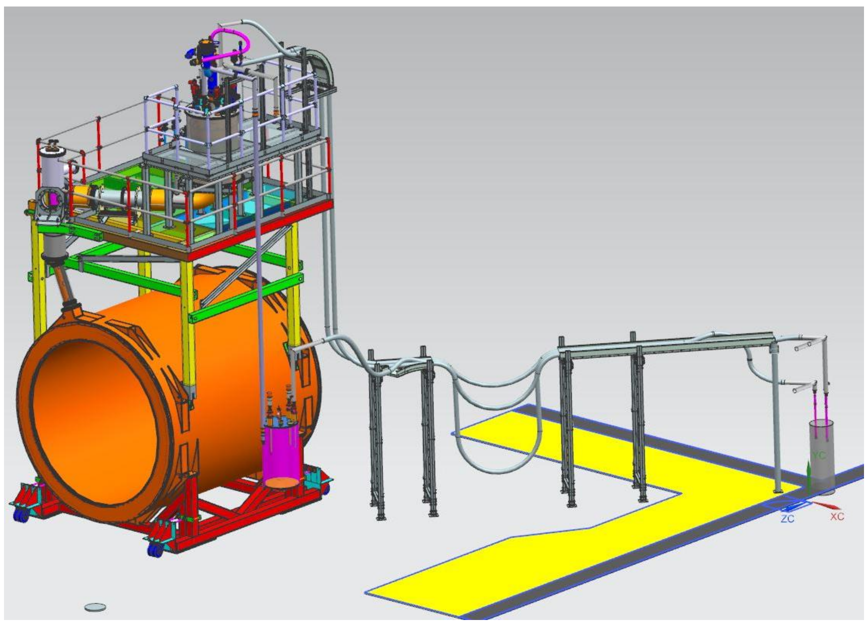
Presentation Outline

Latest updates:

1) Cold test summary
2) Next steps for CLEO II testing
3) Update on engineering and design support for FY23-24

Magnet – Cold Test Update

- **Magnet assembly completed**
- **Cryogenic system assembled and commissioned**
- **Instrumentation and control system commissioned**
- **Energized the coil with 120 A.**
- **Data analysis in progress**



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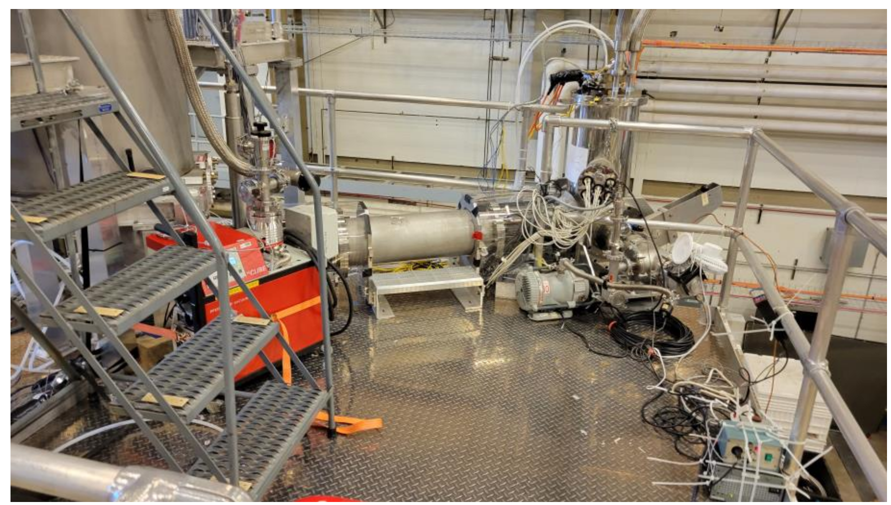
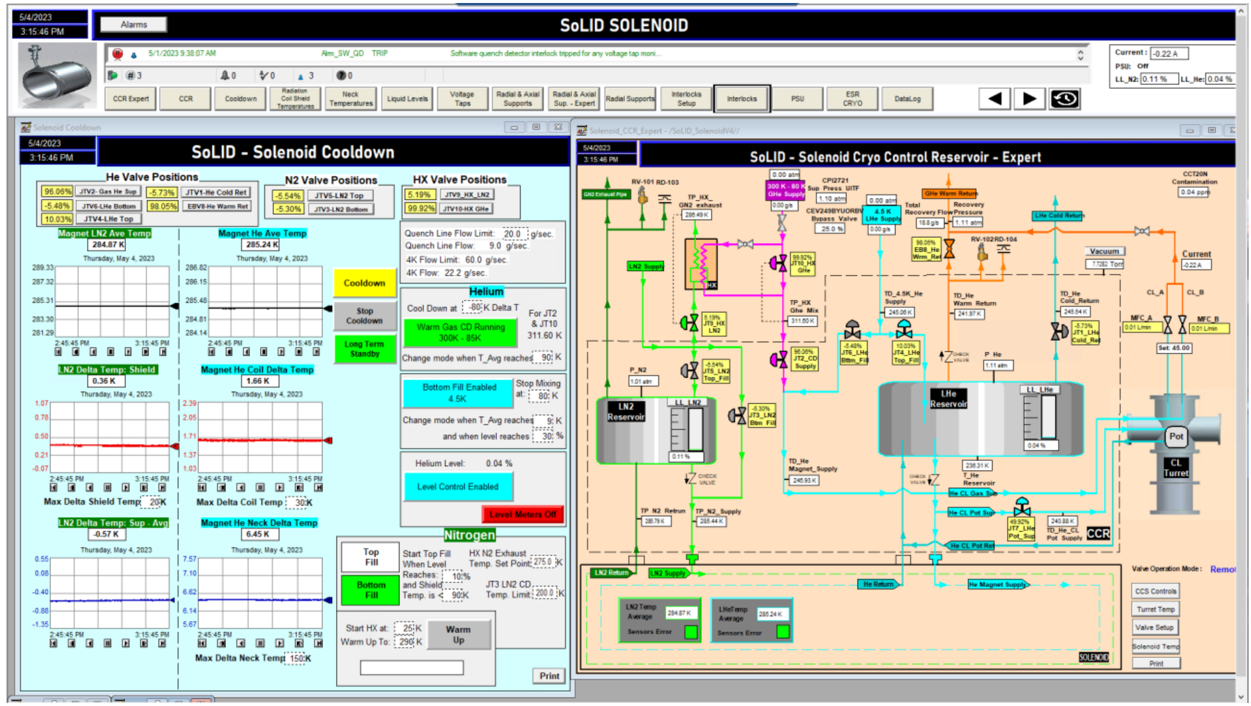
Magnet - Assembly

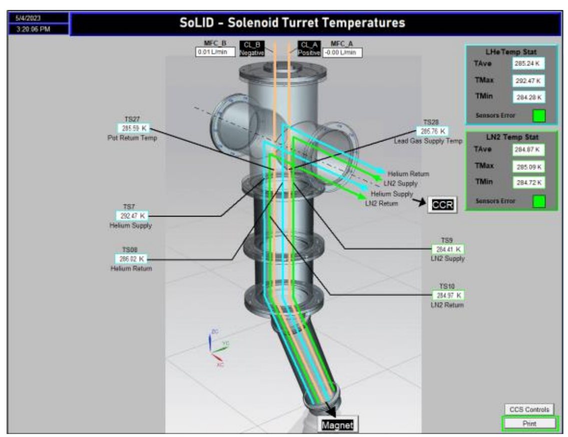
- Assembly completed in mid-December
- Vacuum space closed up and pump down started.
- Helium and nitrogen circuits pressure tested
- U-tubes stung Dec 15th connecting CLEO to the cryo plant (CTF)

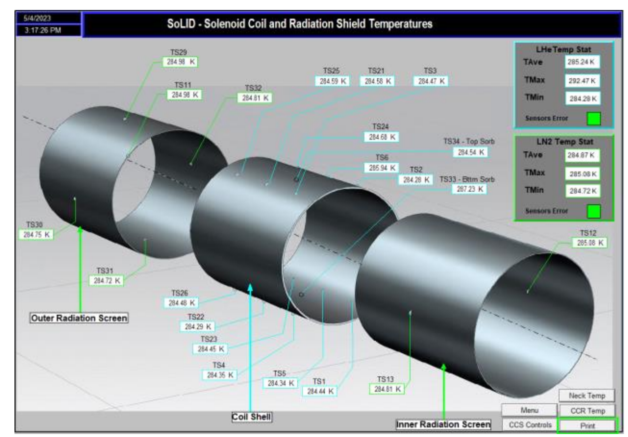


Magnet – Instrumentation and Control System

- I & C system commissioned
- Hot check out of sensors completed after magnet assembly completed
- HMI control panels and PLC code modified further from Hall C setup to better match control parameters set forth by Oxford Instruments
- Troubleshoot wiring and sensor issues as needed
- Connected data channels to JLAB EPICS system allowing communication with CTF control system and data archiving through MYA

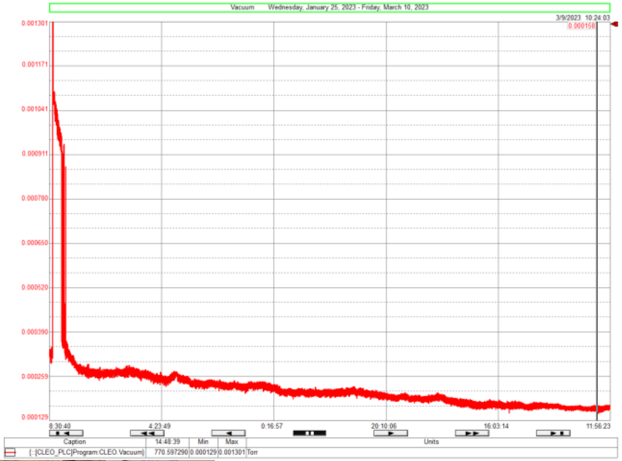






Magnet – Vacuum System

- Started pumping on vacuum space Dec 6th
- Progress was slow – expected since magnet was open to atm for several years and fire extinguisher residue in turret.
- Multiple pump and backfills with GN2 completed
- Leak check completed – potential small leak identified at base of service turret
- Vacuum putty added and showed improvement
- Continued to pump on space through holiday shutdown and CTF maintenance period (Jan 23)
- Turbo pump ran continuously during cool down and testing
- Ultimate vacuum level of 1.8 x 10^{-5} Torr via cryo-pumping at 4.5K



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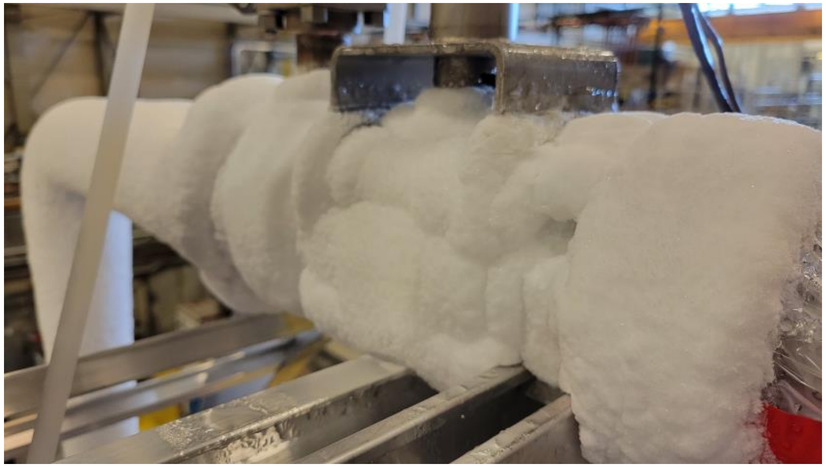
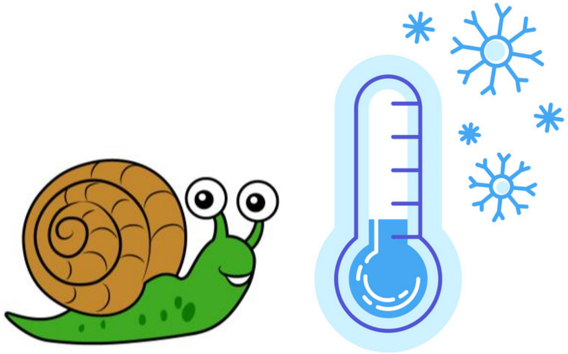
Magnet – Cold Test Cool Down

- Cryo transfer lines stung on Dec 15th in CTF cold box.
- A one day mini cool down was completed on Dec 16th to test cryo and controls systems using 80K N2.
- CTF had a scheduled maintenance down between Dec 21st and Jan 23rd.
- Full cool down started on Jan 24th using heat exchanger with 80K N2 to cool GHe.
- Simultaneous cooled down of the N2 shield started but with no heat exchanger on the N2 circuit made it challenging to moderate temp.
- Dealt with multiple noisy signals or faulty sensors in the C&I system.
- ½" diameter 300K GHe copper supply line from CTF to CLEO and ¼" fitting on regulator in CTF greatly slowed the cooling rate. (1.8K/day)



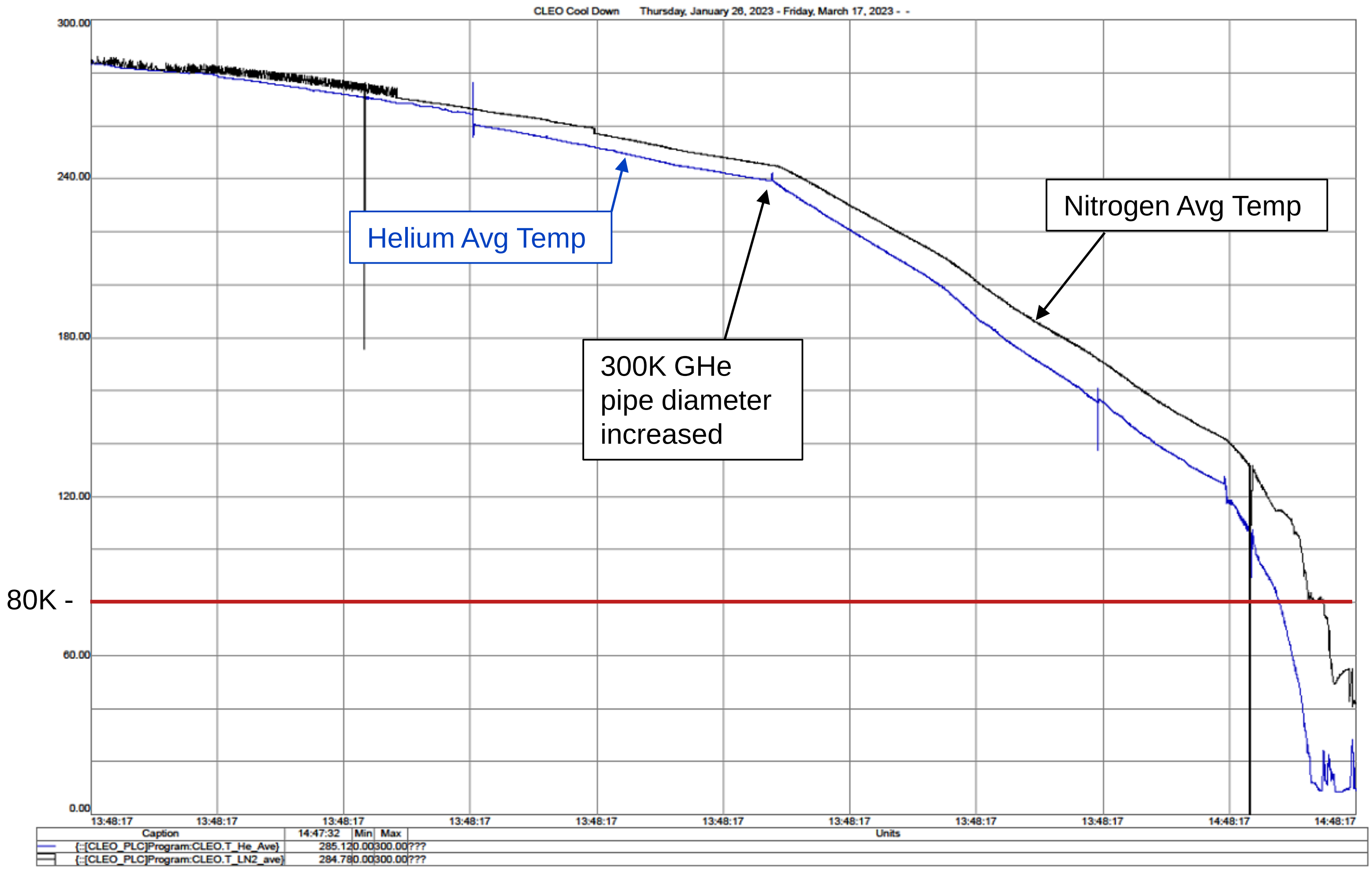
Warm return valve icing up



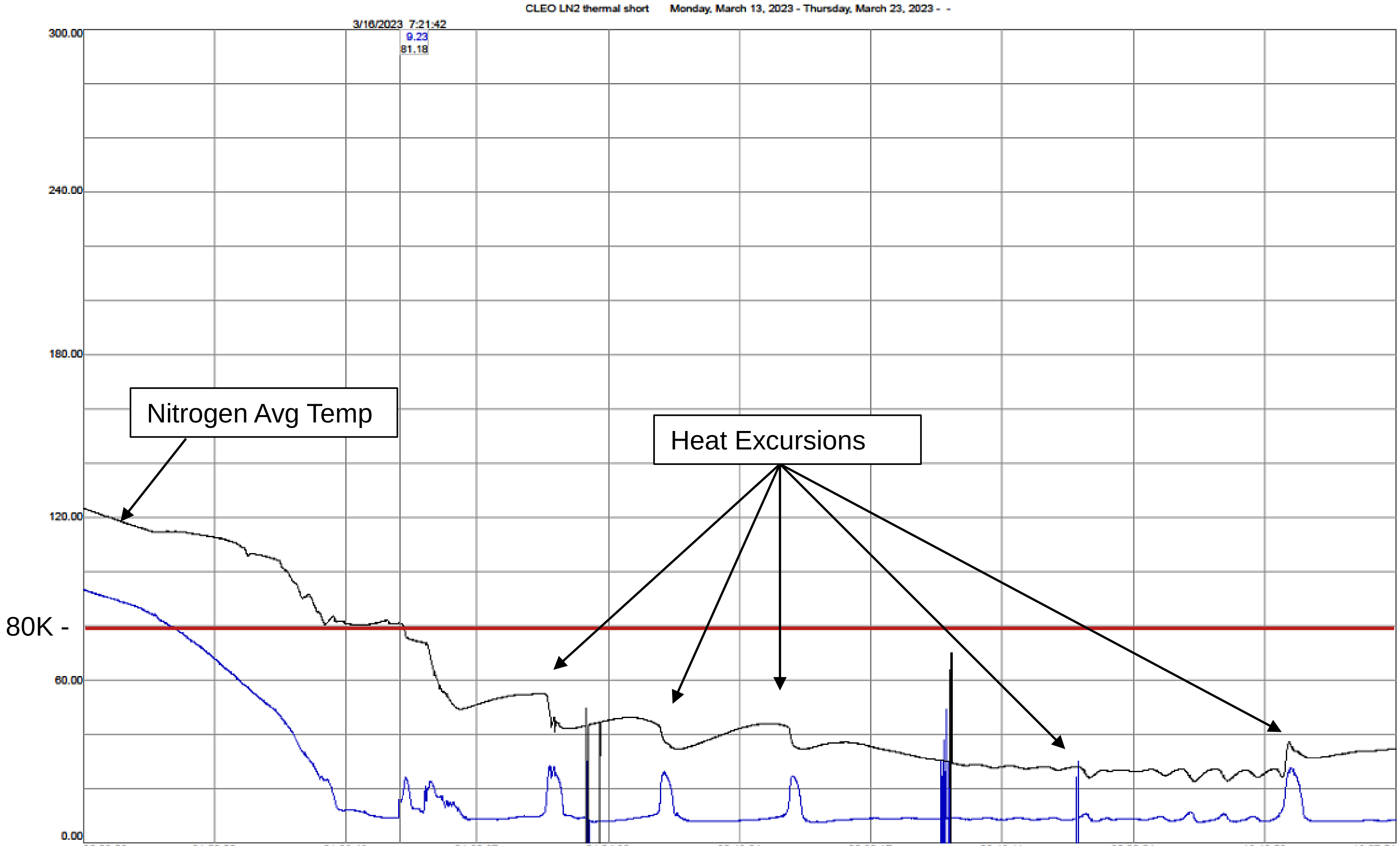
Magnet – Cold Test Cool Down

- CTF upgraded the regulator with ½” fittings and Physics Division installed a 7/8” diameter copper line between CTF and CLEO on Feb 21st.
- Cool down rate increased to 7.2K/day (vs 1.8K/day).
- Cool down from room temperature to 120K took 45 days. (@Cornell 8-10 days)
- The 4K He line was stung in CTF on March 10th.
- After transfer line was cooled, 4K gas was mixed with heat exchanger 300K supply on starting on March 12th.
- Possible thermal short noticed on N2 supply and return temp sensors in the neck on March 12th as they both started reading higher than shield avg temp. Suspected location where the two lines coil around each other in the top of the neck.
- Noisy temp sensors added to the difficulty of maintaining required temp deltas across the coil and N2 shield. (nuisance alarms)
- On March 16th, as the N2 shield reached 80K, an apparent thermal short developed between the N2 and LHe circuits. N2 temps decreased below LN2 saturation temps @ 1.1 atm and continued to drop into the low 20K range.
- Temperature fluctuations in one circuit corresponded to changes in the other circuit.
- These fluctuations continued for the remainder of the cold test.
- CLEO switched to cold return on March 16th.
- Heat excursions continued occasionally requiring switching to warm return to recover He liquid levels.
- Warm up was started on March 28th.

Magnet – Cool Down Temperatures



Magnet – Cool Down Temperatures



Caption	14:52:01	Min	Max	Units
{::[CLEO_PLC]Program:CLEO.T_He_Ave}	285.11	0.00	300.00	???
{::[CLEO_PLC]Program:CLEO.T_LN2_ave}	284.78	0.00	300.00	???

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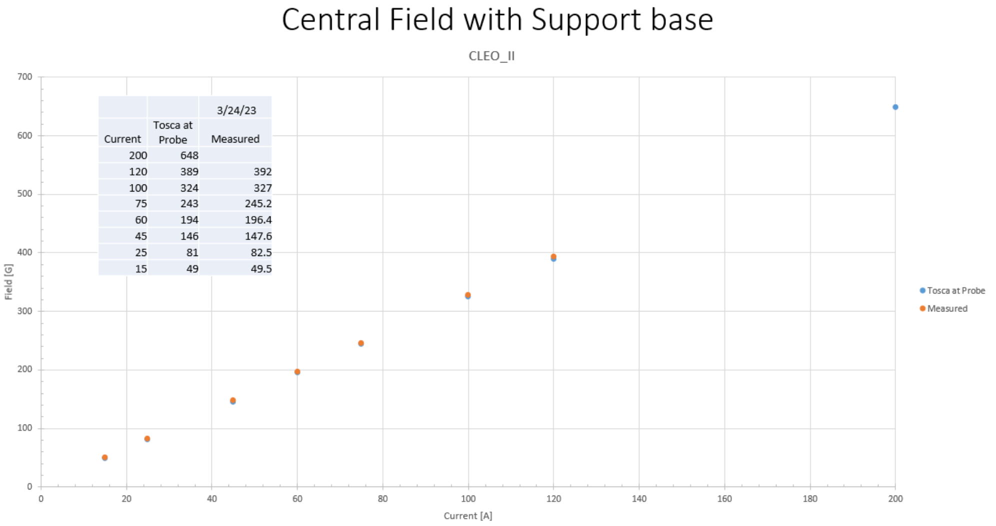
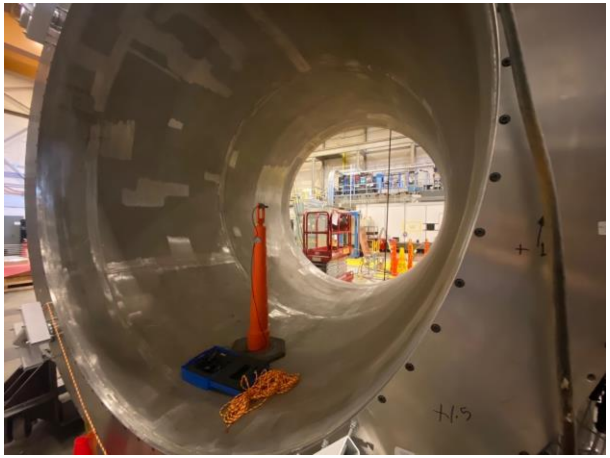
Magnet – Low Current Test – Preliminary Data

- A low current test was conducted on March 21st up to 75A. Test was cut short due to another heat excursion.
- March 21st test indicated connectors for voltage taps wired incorrectly – corrected on March 24th.
- A 2nd low current test was conducted on March 24th while LHe temps were stable. The current for this tests was ramped up to 120A and was held for 30 mins.
- PSU output voltage was approx 1.15V during ramp up at 0.5A/s.
- No increase in coil voltages observed during ramp up or while at 120A for 30 mins.
- Coil believed to be superconducting with flat lined nature of temp curves during test.
- 5 Gauss boundary was monitored with the help of ES&H to ensure the field remained within limits at the established boundaries.
- A 3 axis Hall probe was installed in the bore of the magnet for each of the tests.

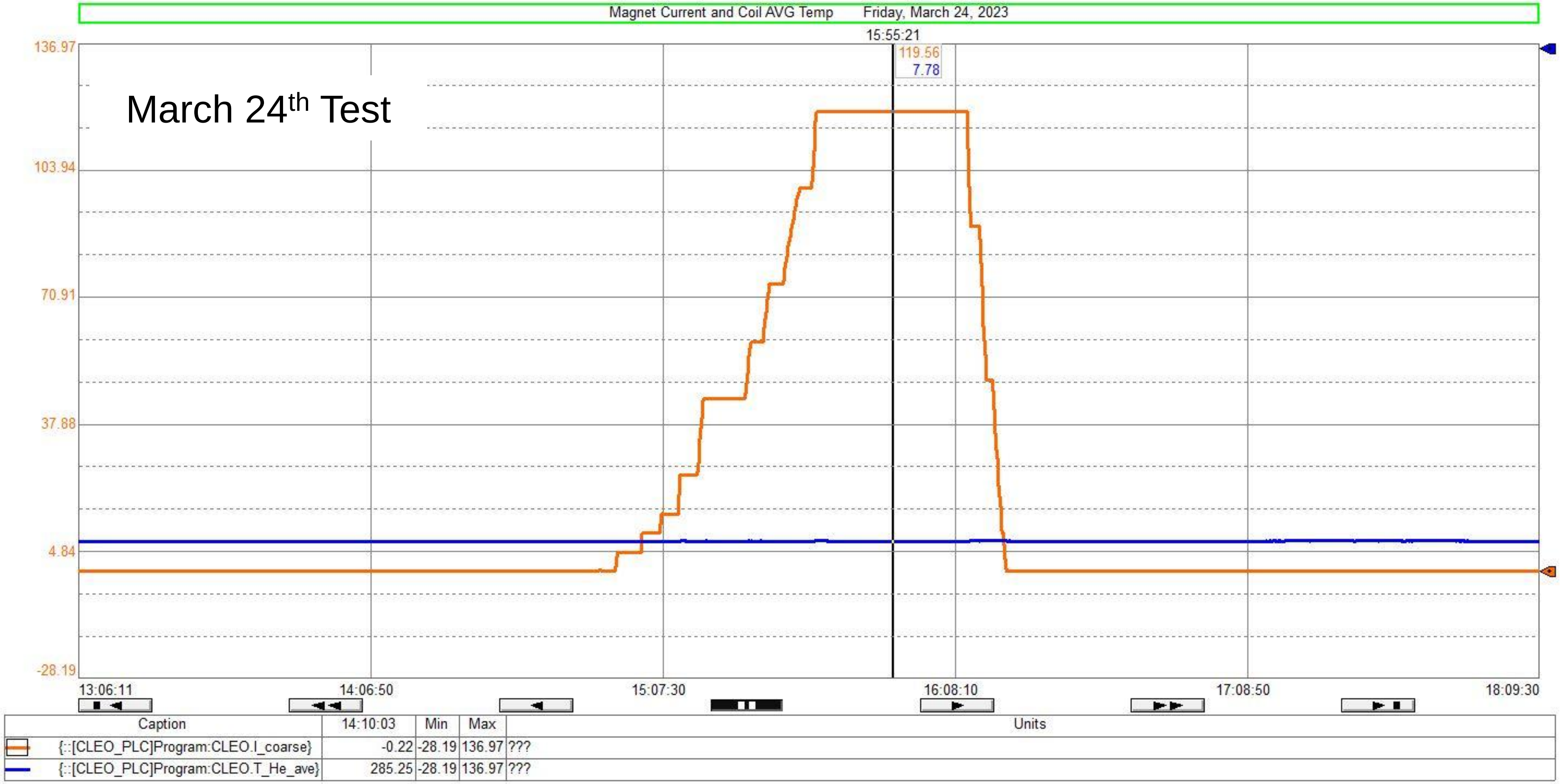


		3/24/23
Current	Tosca at Probe	Measured
200	648	
120	389	392
100	324	327
75	243	245.2
60	194	196.4
45	146	147.6
25	81	82.5
15	49	49.5



Magnet – Low Current Test – Preliminary Data

Coil average temperature remained constant during low current test.
Test current of 120A.
Coil average temp read 7.8K – RhFe sensors likely need low end offset adjustment.



Magnet – Low Current Test – Summary

- Low current test data in this presentation is considered preliminary.
- Data analysis continues on test data and temperature excursions.
- Focus on understanding likely thermal short and cause.
- Considering options for further investigation of thermal short and repair of vacuum leak.
- Test draft report created – work on it continues as quickly as time allows.
- Test report will be distributed to collaboration upon completion.
- Instrumentation and control system is functional but needs some improvement.
- Cryo system is able to cool the magnet. A secondary heat exchanger for N2 shield circuit advisable.
- Implement "Lessons Learned" (too many to list here).

Magnet – Low Current Test – Next Steps

- Finalize data analysis and present conclusions to division and collaboration.
- Verification of JT valve seats and bullets required to investigate leak by on some valves and calculate flow rates.
- Considering options for further investigation of thermal short and repair of vacuum leak.
- Options include removing transfer lines and pressure testing He and N2 circuits to verify leak tightness after cold test.
- Fix vacuum leak in service turret and search for any additional leaks on cryostat.
- Develop plan based on the above options with labor and cost requirements to present to physics management for approval.
- Make improvement to instrumentation and controls.
- Provide a report of any new findings from follow up testing
- Provide cost/labor estimations and planning input for full current test in the future.

Magnet – Engineering and Design Support

-Slide from May 2023 presentation

At the last collaboration meeting mentioned Physics Division had allocated personnel to support SoLID starting near the end of Summer (Sept - Dec)

Designer - 100% for 3 to 4 months

Engineer – 50% for up to 6 months

After consulting with SoLID Collaboration work will focus on the following priorities:

1. Produce SoLID cad model matching latest magnet design from Jay Benesch.
2. Coordinate with the LGC group to update tank design, specifically focused on how the LGC interfaces mechanically with the greater SoLID assembly and accounting for all expected necessary attachments and cabling from the LGC and other components/detectors that require space in the vicinity of the LGC detector.
3. Coordinate with EC group to have a conceptual design to mount EC shower, pre-shower and SPD for both forward and large angles.
4. Coordinate with HGC, baffle, GEM and MRPC groups to have a conceptual design to mount them.

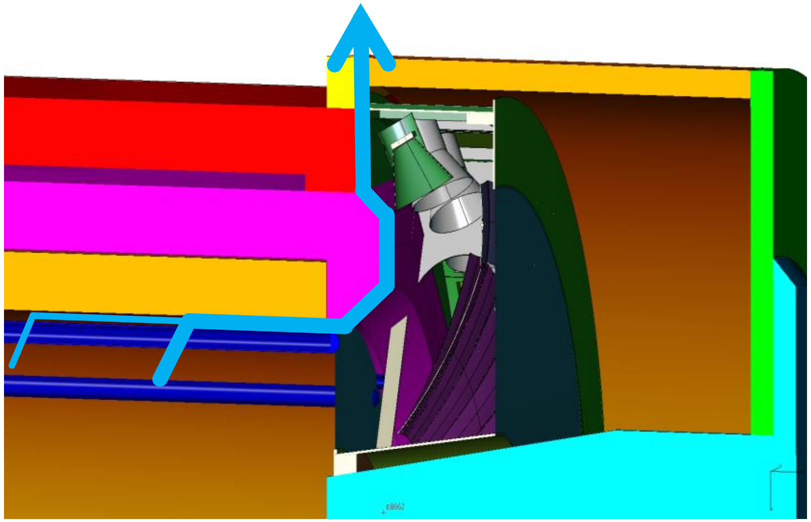
Magnet – Engineering and Design Support

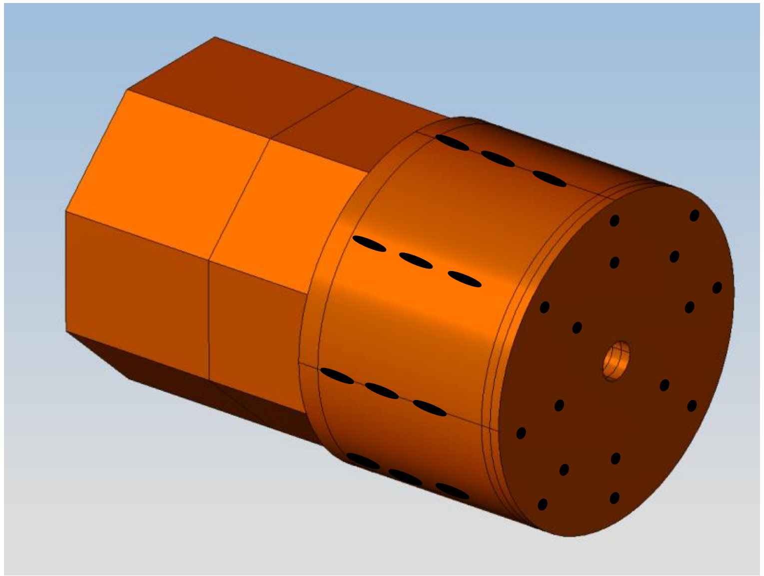
Priority:

1. Produce SoLID cad model matching latest magnet design from Jay Benesch.

- ✓ Match geometry of magnet steel
- ✓ Add details of axial and radial support mechanisms
- ✓ Add some of the required details to assemble magnet. Mounting hardware, etc
- Further the design concept for detector support rails inside magnet and endcap
- Develop details for cable routing – access holes in steel, etc

Design work listed above will help prepare for priorities 2 thru 4.





Magnet – Engineering and Design Support

Hall A Eng/Des group lost one of our designers at the end of October.

Designer - ~50% from Sept to Dec

Engineer – <25% from Sept to Dec

The design effort on priority #1 produced the following:

1. Cleaned up the existing NX CAD model. A lot of "mock-up" out of date geometries removed. This brought the structure of the CAD model more in line with our group's standards.

2. Create detailed model of the existing return steel with all cutouts and threaded holes.

3. Create the cuts to match the latest return steel geometry. Add conceptual mounting holes for new return steel (endcap) interface to look for interferences with existing holes.

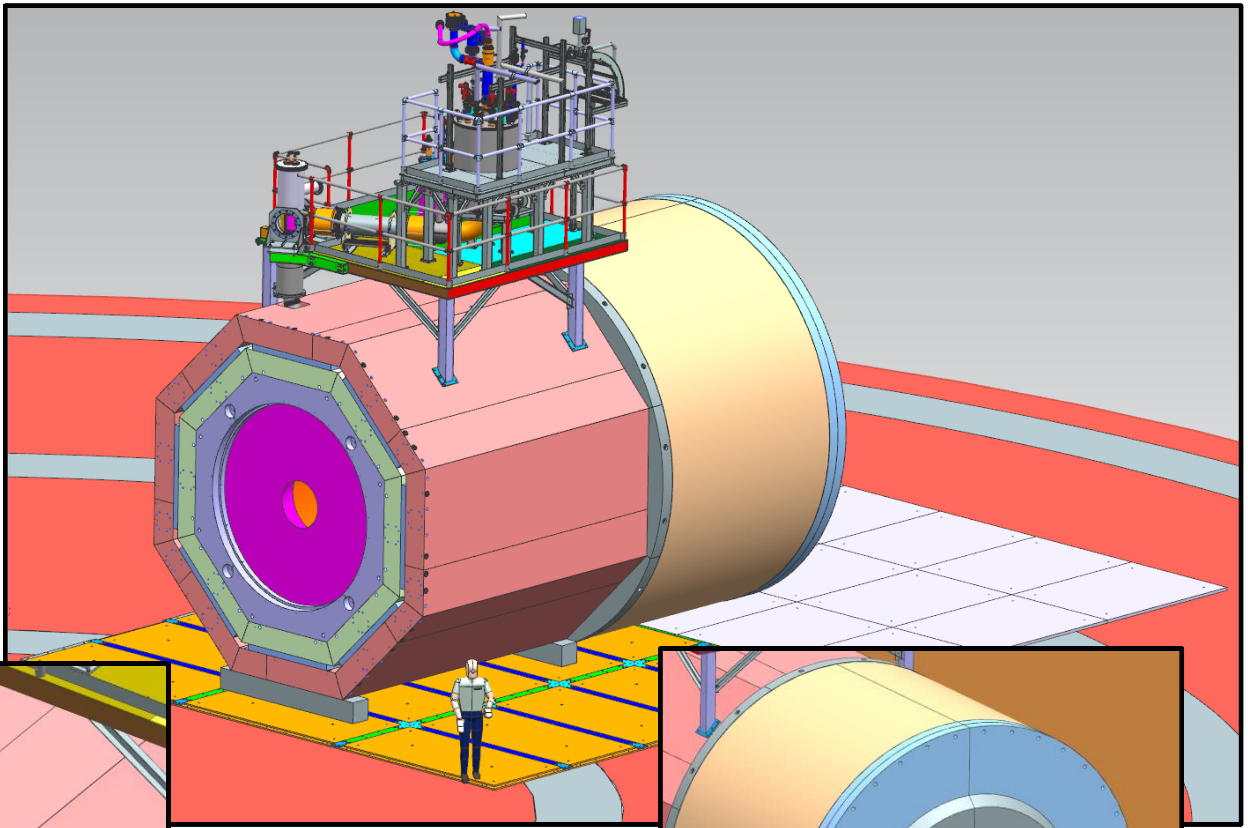
4. Add cryogenic platform on top of magnet

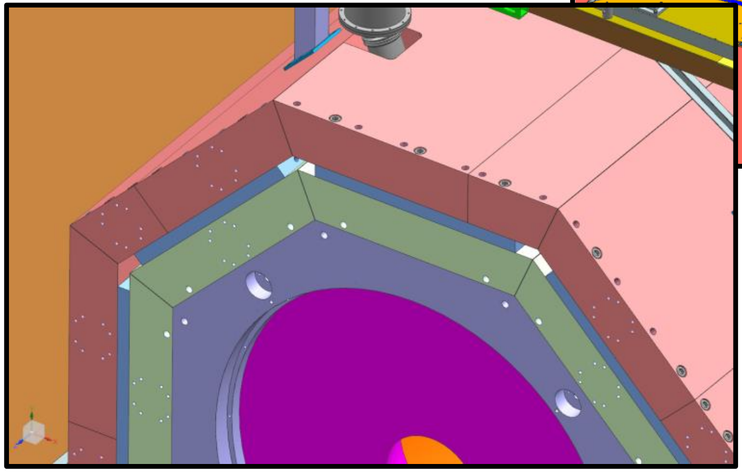
Magnet – Engineering and Design Support

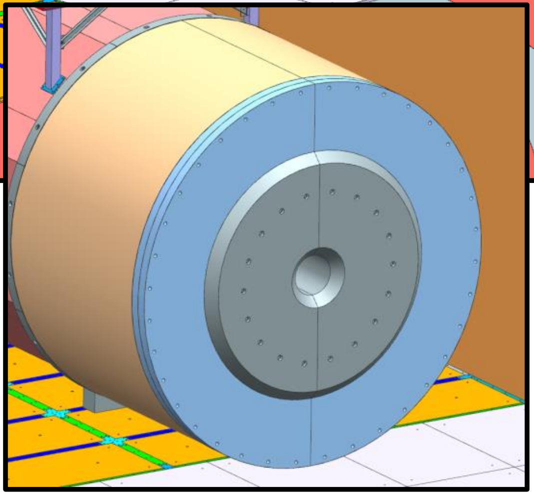
All known existing holes in the steel have been modeled.

Mounting hole concept established on the endcap.

Added service turret and CCR components along with access platform on top of the magnet.

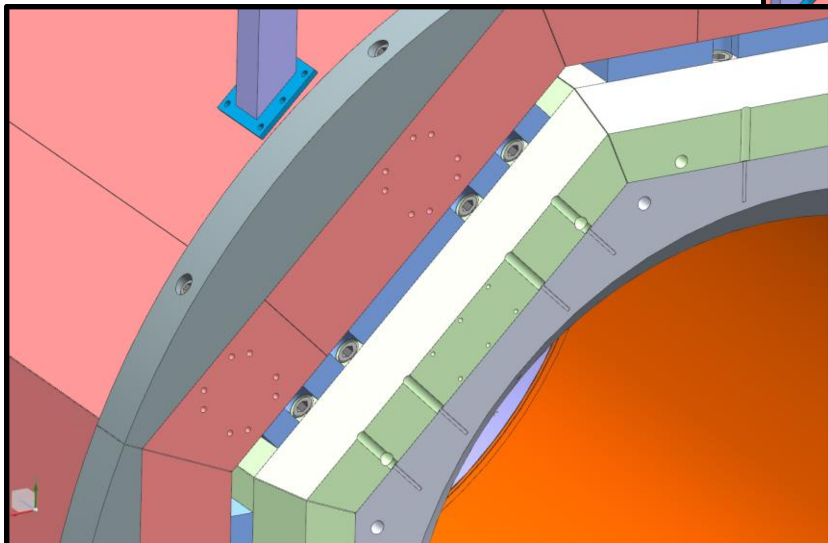


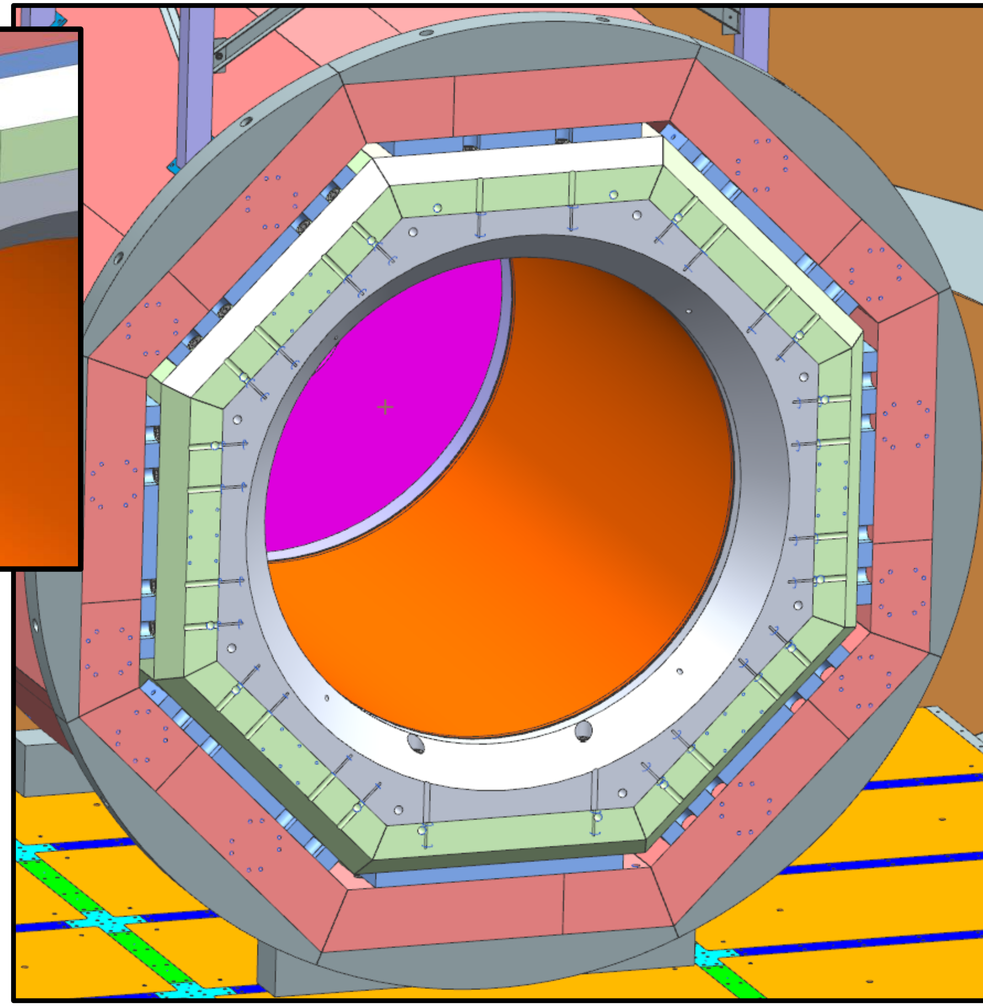




Magnet – Engineering and Design Support

Downstream end of the magnet – endcap removed



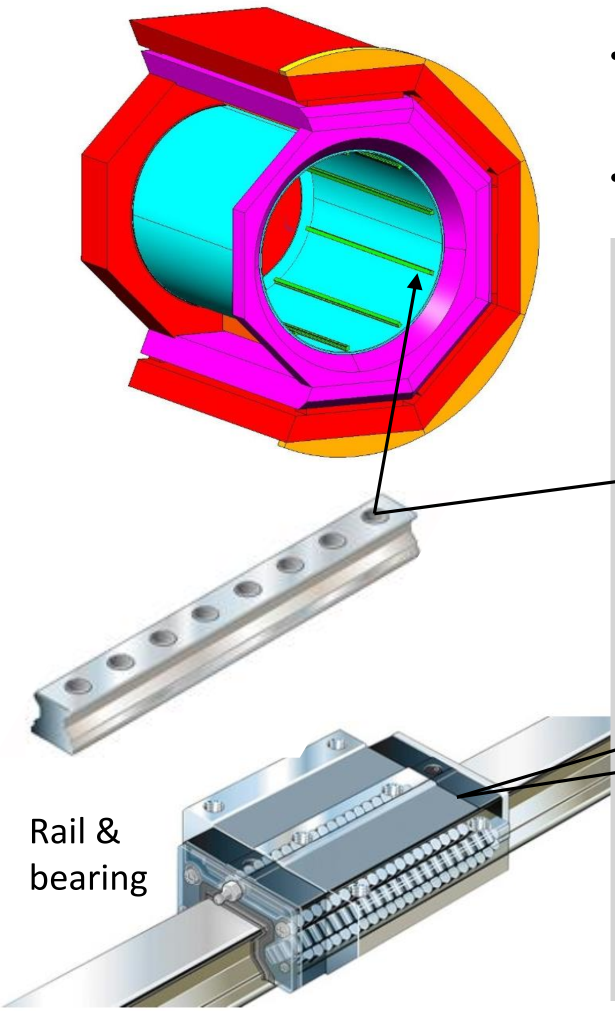


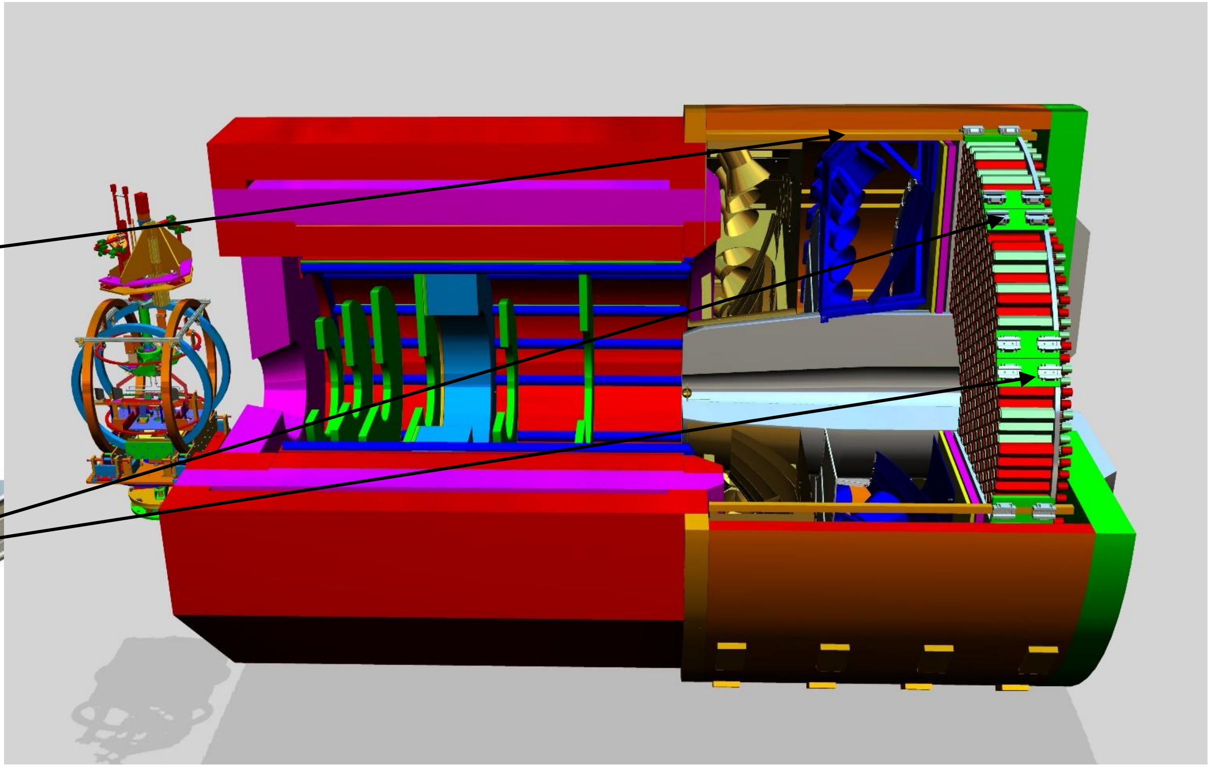
Shortening the CLEO II steel on the downstream end by the specified amount causes the cut to go directly through the existing bolt holes for mount the first layer of steel to the DS octagonal ring. New holes were established for SoLID configuration.

Radial support adjusters (pucks) are not visible but have been created to better define the space where the LGC resides.

Magnet – Detector Support Structure

- Provide a universal mounting system that is utilized by each detector group.
- Use the same concept for internal magnet and endcap locations.
- Conceptual design uses off the shelf rails and bearings. Bearings will be integrated into individual detector design.
- Engineering analysis on-going to specify components for detector mouting.



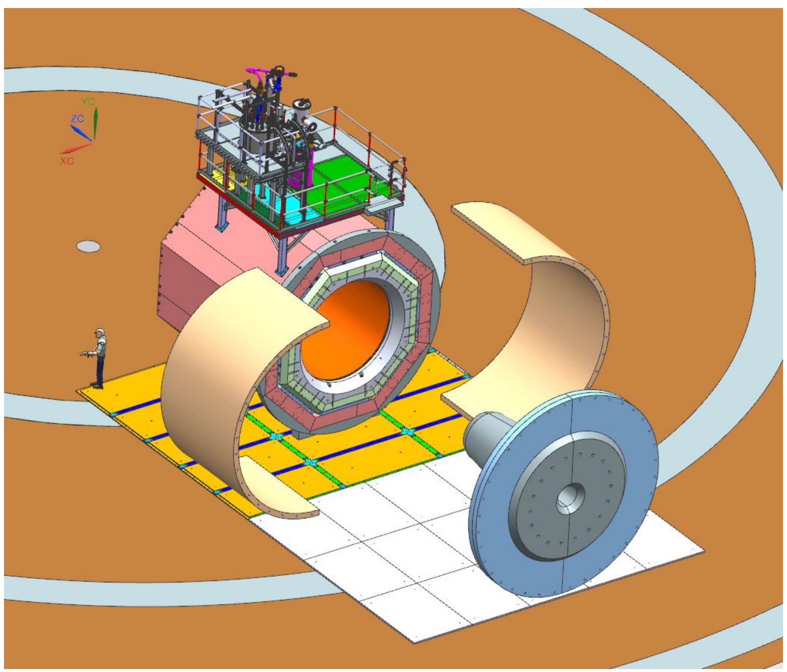


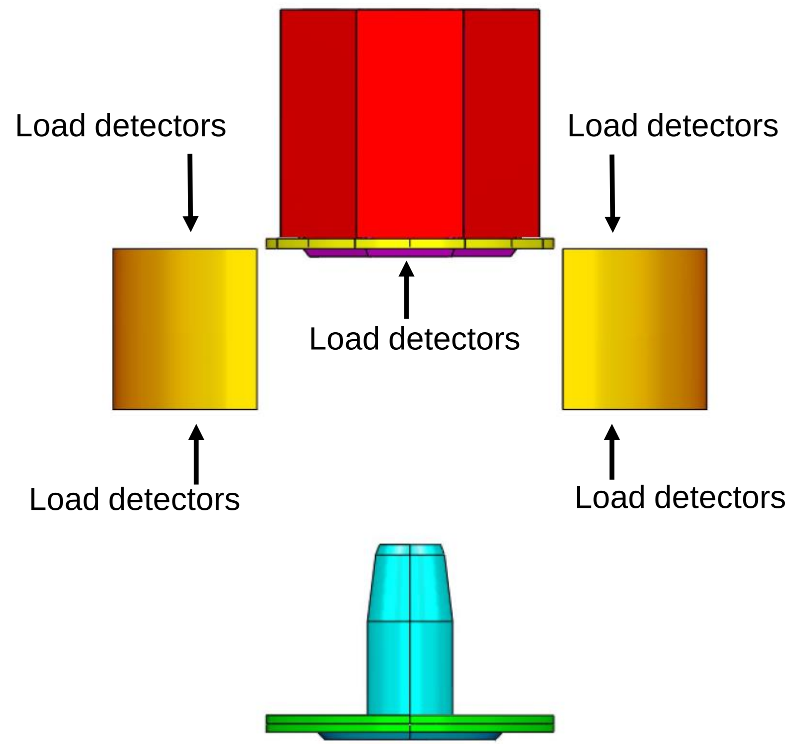
Magnet – Endcap Motion Concept

- Decouples the nose and backplates from the half cylinders

- Provides additional access points for installing and servicing detectors

- Simplifies motion system and tracks mounted to the floor





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Questions/Comments?

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Extra Slides