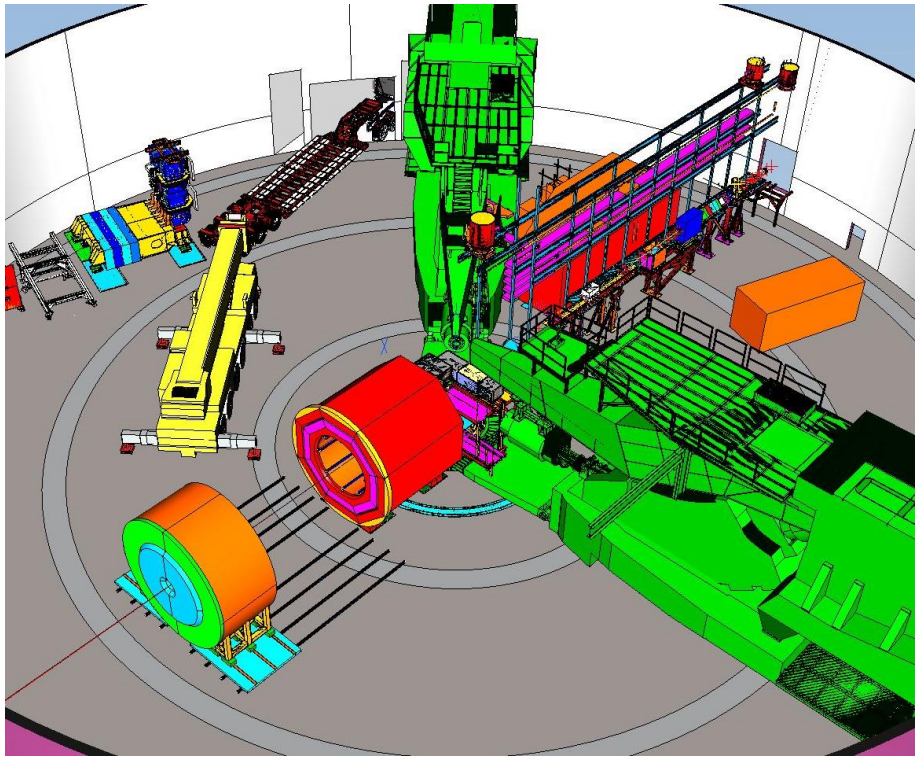
SoLID Collaboration Meeting

Magnet & Infrastructure Support



Whit Seay

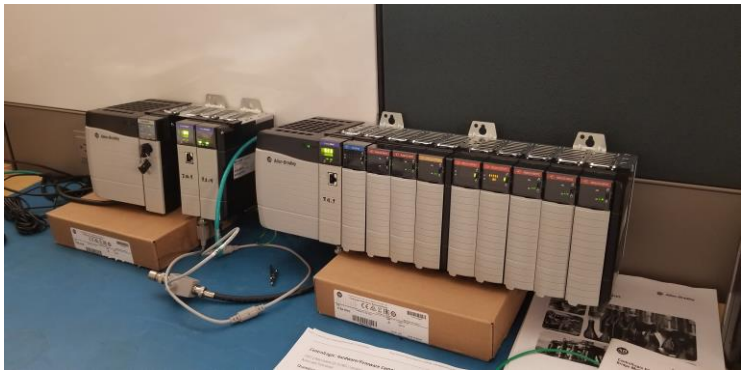
October 8, 2020

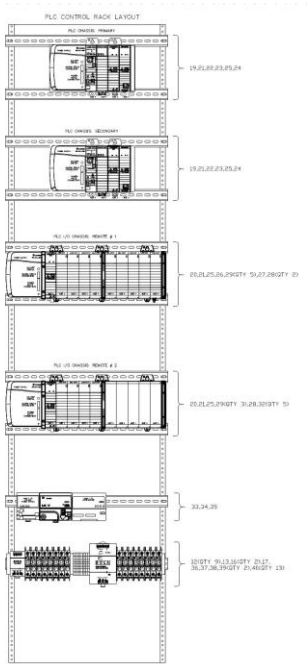
Presentation Outline

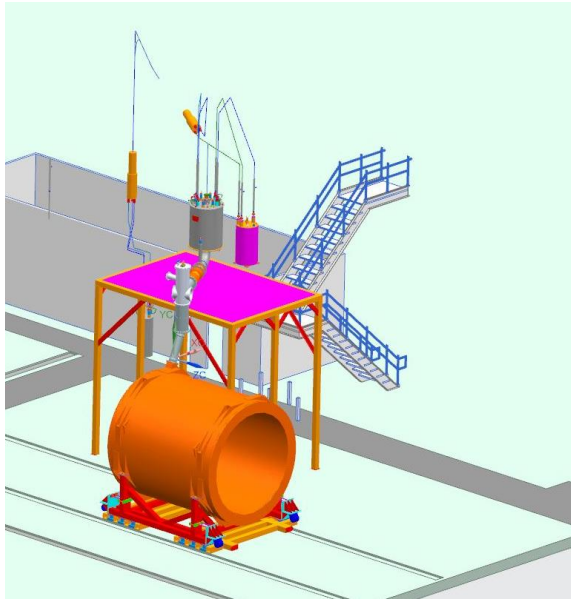
- Latest updates – Cold Test
- Director's Review Talk (preliminary)
  1) Equipment
  2) Infrastructure
  3) Detector Support
  4) Installation
  5) Magnet

Magnet – Cold Test Update

- **Majority of our effort remains focused on the cold test**
- Merged the CLEO refurbishment/static test and cold testing into Phase 1
- **Detector Support Group (DSG) is making steady progress on SoLID control system**
- Hall C has provided engineering and design support for the CCR and interface with the current lead stack (turret). Performed an analysis of the coils in the test lab to identify magnetic field boundaries.
- Designing support and personnel access platforms for CCR, heat exchanger and turret







Merged CLEO Refurbishment and Cold Testing (Phase 1)*

1. New Instrumentation and Control System – FY18
   - Design the system – completed
   - Identify hardware and software requirements – completed
   - Procurement – completed
   - Assemble and test the new I&C – in progress

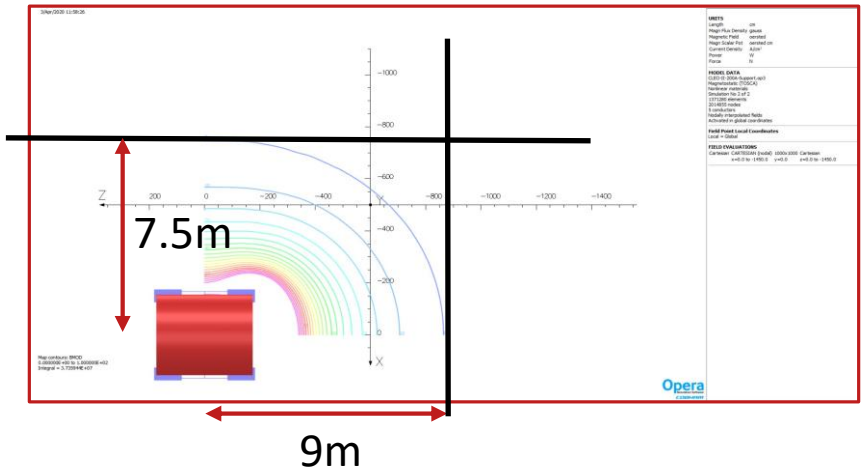
2. New Cryo Control Reservoir – FY 19-20
   - Design to interface w/ CLEO and JLAB ESR system – in progress
   - Procurement: fabrication on-going – in progress
   - Acceptance testing upon arrival-leak & pressure

3. Static Testing of the CLEO Magnet – FY 18-20
   - Check out existing instrumentation in the cryostat – completed
   - HIPOT test the coil – completed

Merged CLEO Refurbishment and Cold Testing (Phase 1)*

4. Test Lab Layout – FY20
   - Run a careful magnetic analysis of coil in test lab* – completed
   - Identify 50 gauss and 5 gauss boundaries* – completed
   - Identify existing transfer lines that can be used in test– completed
   - Lock down final magnet position for test – in progress

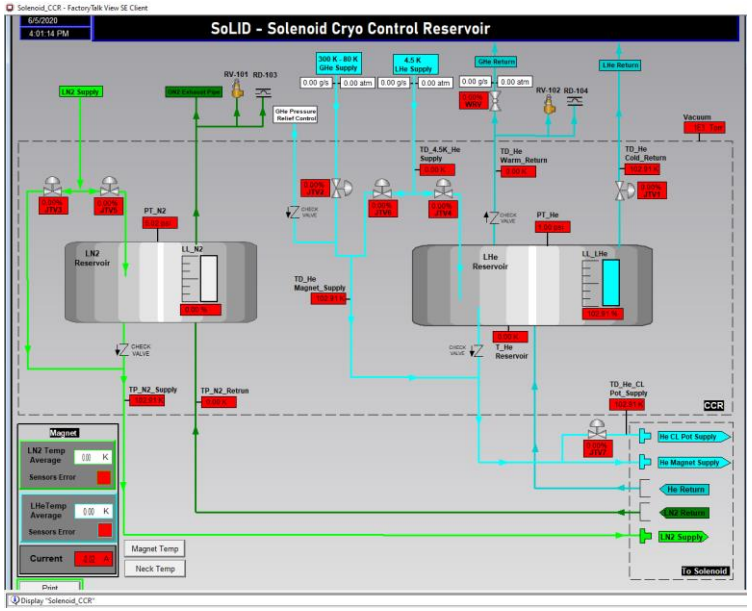
5. Support Structures for Cold Test – FY 20-21
   - Design platform to support CCR/personnel access – on going
   - Design cryo line supports – in progress



*Addresses technical suggestion from Director's Review

Magnet - Cold Test Update - Controls

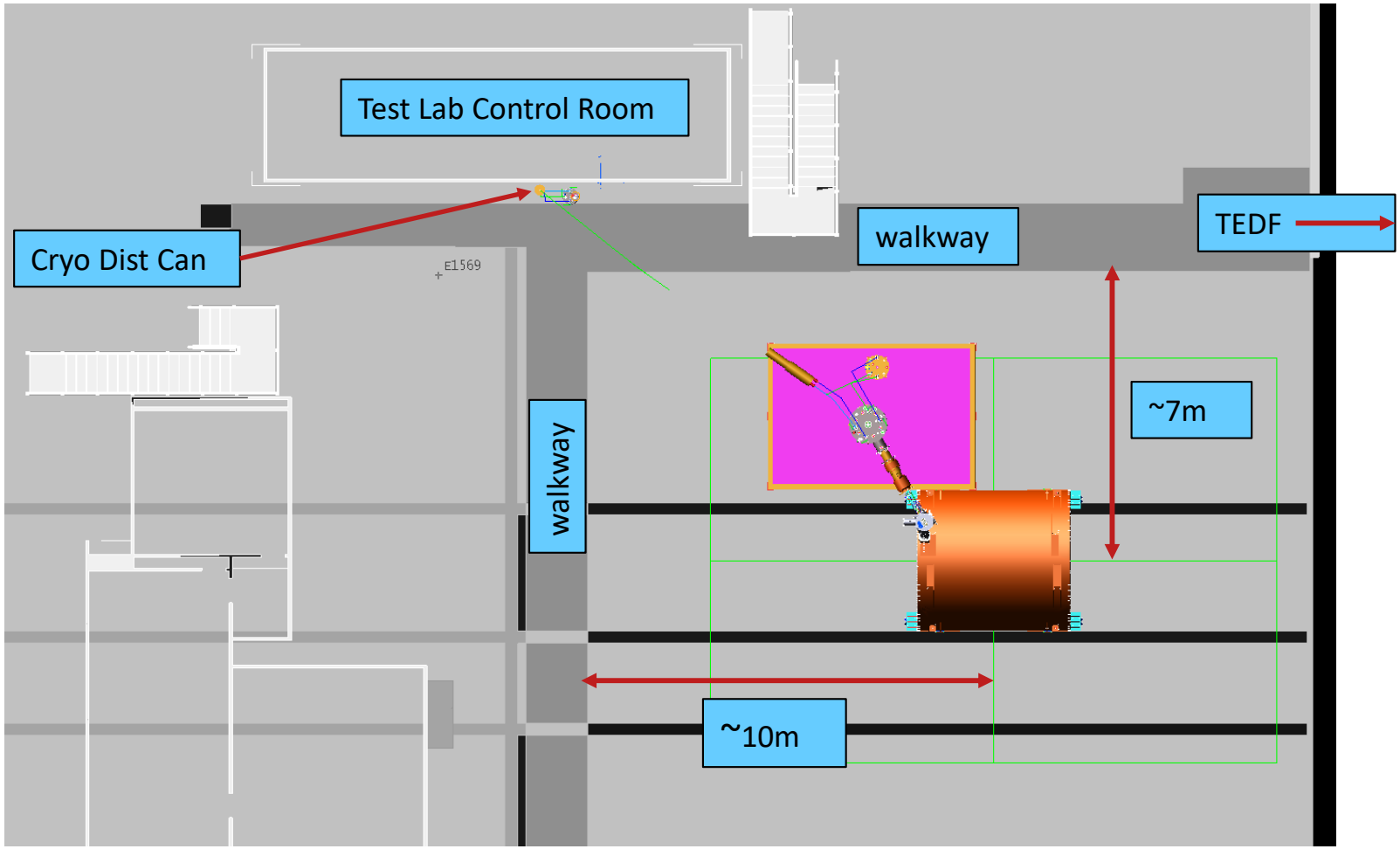
- Detector Support Group (DSG) continues making steady progress
- **PLC code & HMI screen development are progressing well**
- Modifying a Hall C superconducting magnet controls program for use with SoLID
- Interface with cryo group and MCC ongoing (CSS)
- **Motor controller boards for JT valve control developed and in procurement**
- **Implementing the PLC code to control and monitor JT valves for heat exchanger**
- Neck temperatures, radial and axial supports and radial and axial support expert CSS-BOY screens created
- **Latest version of CCR control HMI updated**
- **Electrical drawings are being updated**
- **Start assembly of control system soon**



Jefferson Lab

Cold Test Update – Test Lab Layout

Magnet location in test lab

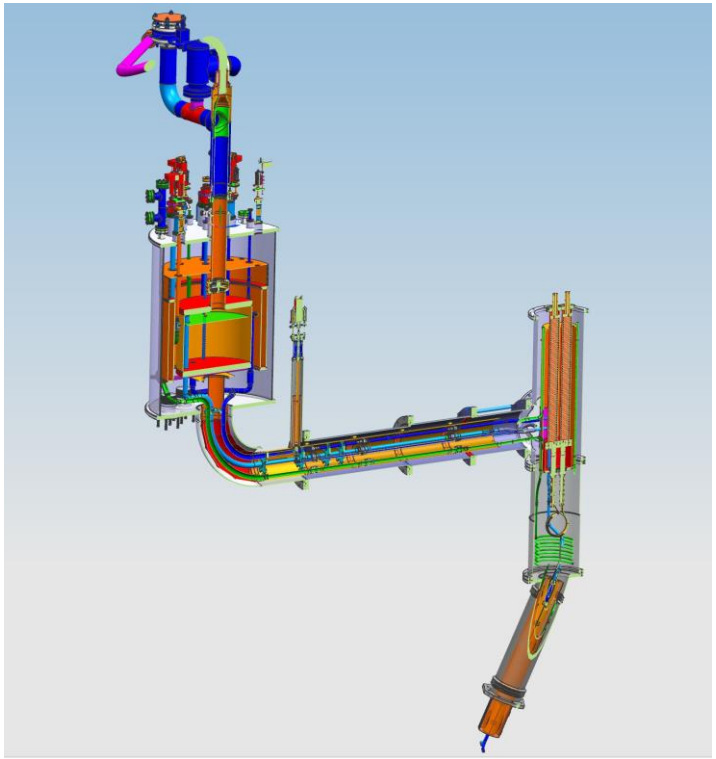


Cold Test Update - Section cut through CCR and Current Lead Pot

Connection between CCR and current lead stack turret updated in Sept 2020

Vacuum jacket and radiation shielding design completed and preliminary drawings ready

Cryo piping updated – may require some revision after turret is separated from dewar

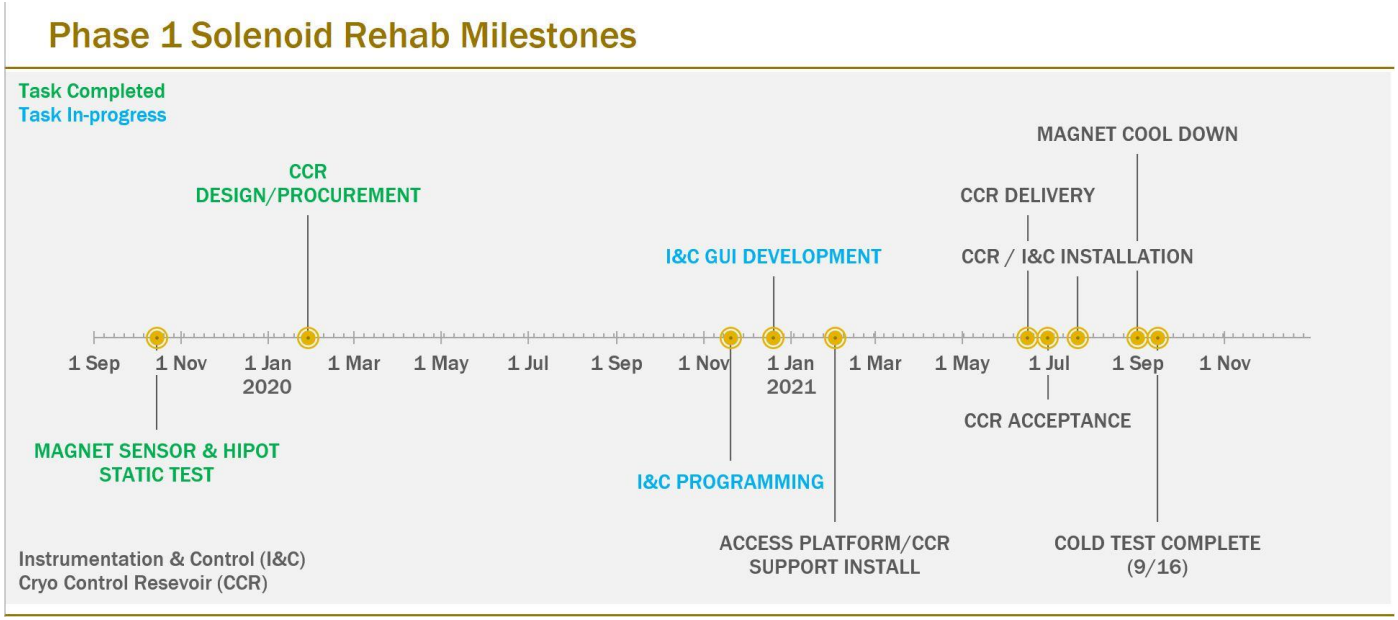


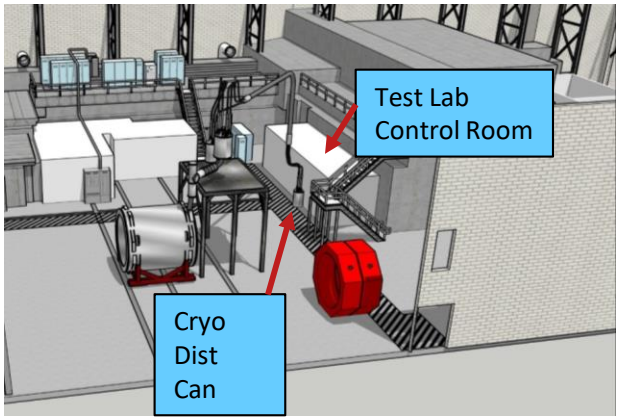
Vendor provided progress on CCR fabrication

In process welding paperwork checked by JLAB QA weld inspector on completed work to ensure compliance with JLAB requirements

Vendor is making good progress on fabrication

Cold Test Update – Cold Test Milestones

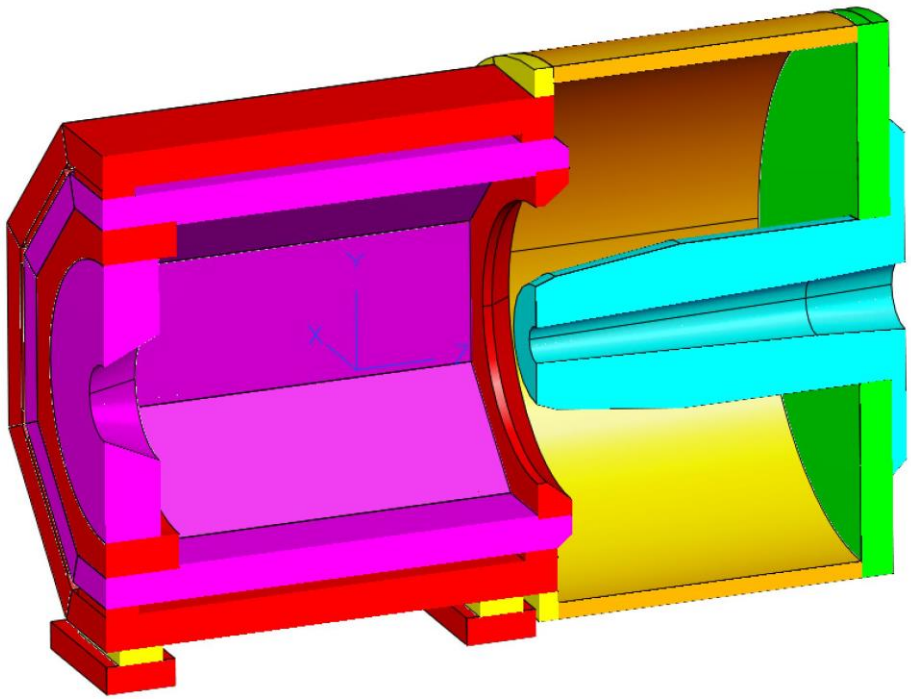




- Solenoid rehab will confirm condition of the magnet
- Provide risk reduction to the project
- Improve magnet cost estimate
- Estimated completion 16 Sept 2021

Magnet – Return Iron Update

- Front endcap conical opening updated to match Jay's study
- Geometry of the endcap nose updated to match Zhiwen's study.
- New CAD will be uploaded to wiki page after the changes are approved.

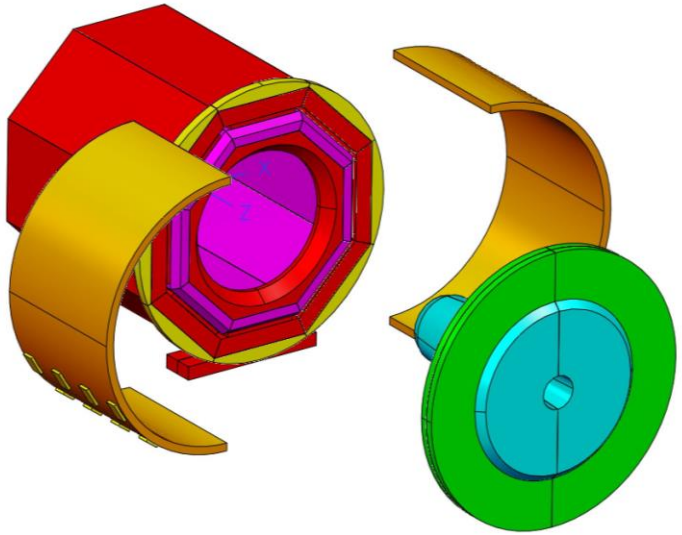


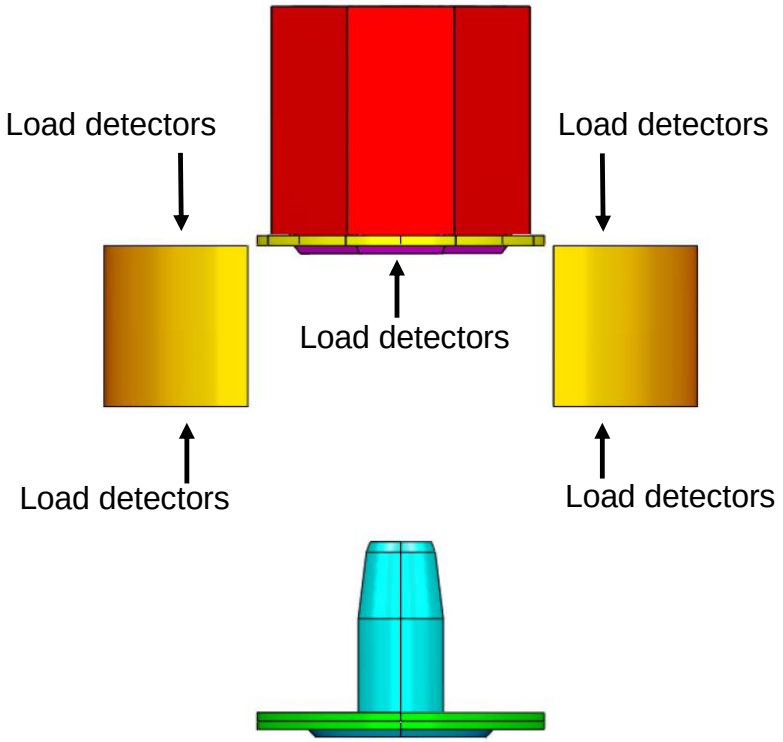
Magnet – Endcap Motion Concept

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





Director's Review

Equipment

Infrastructure

Detector Support

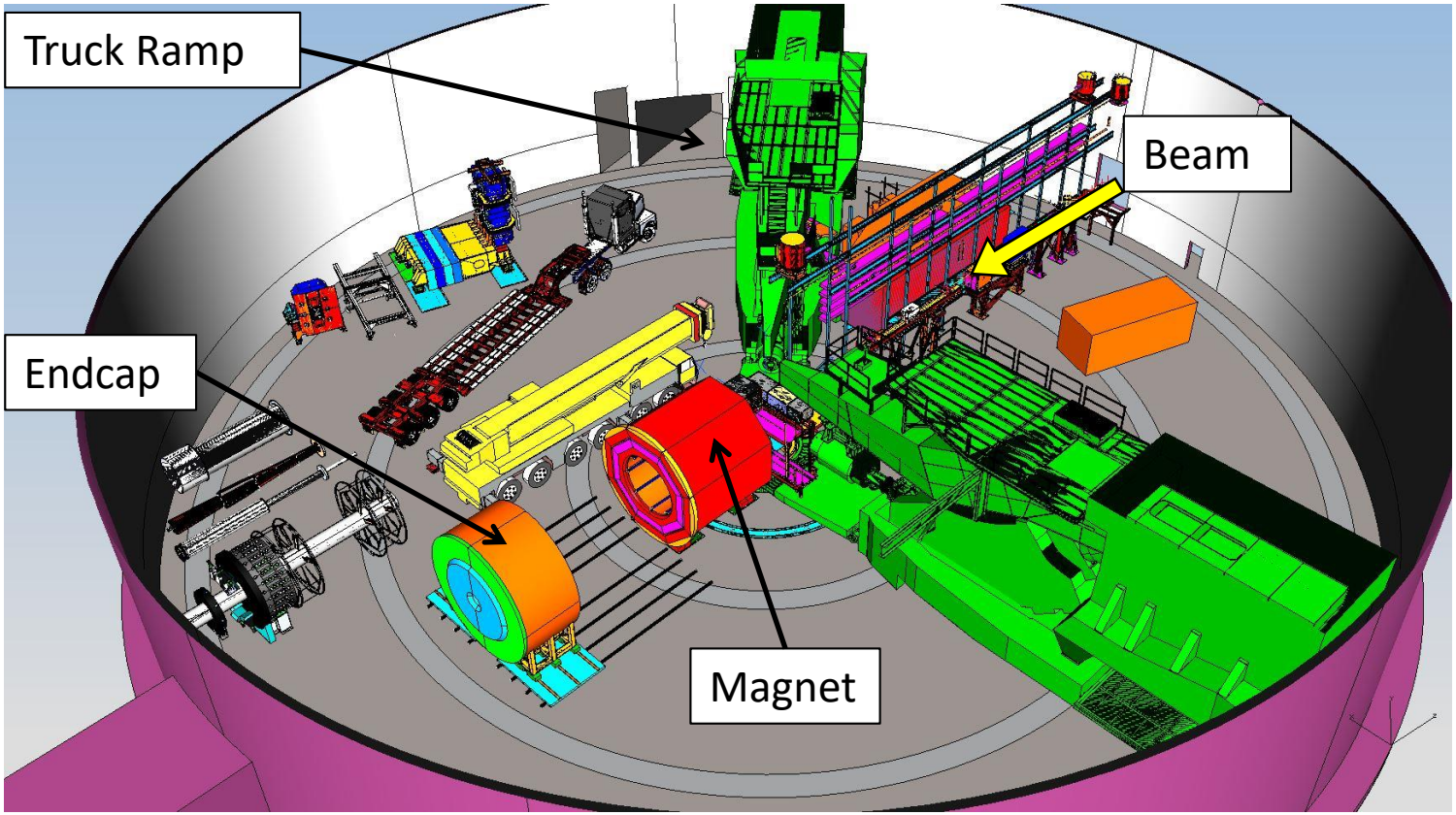
Installation

Magnet

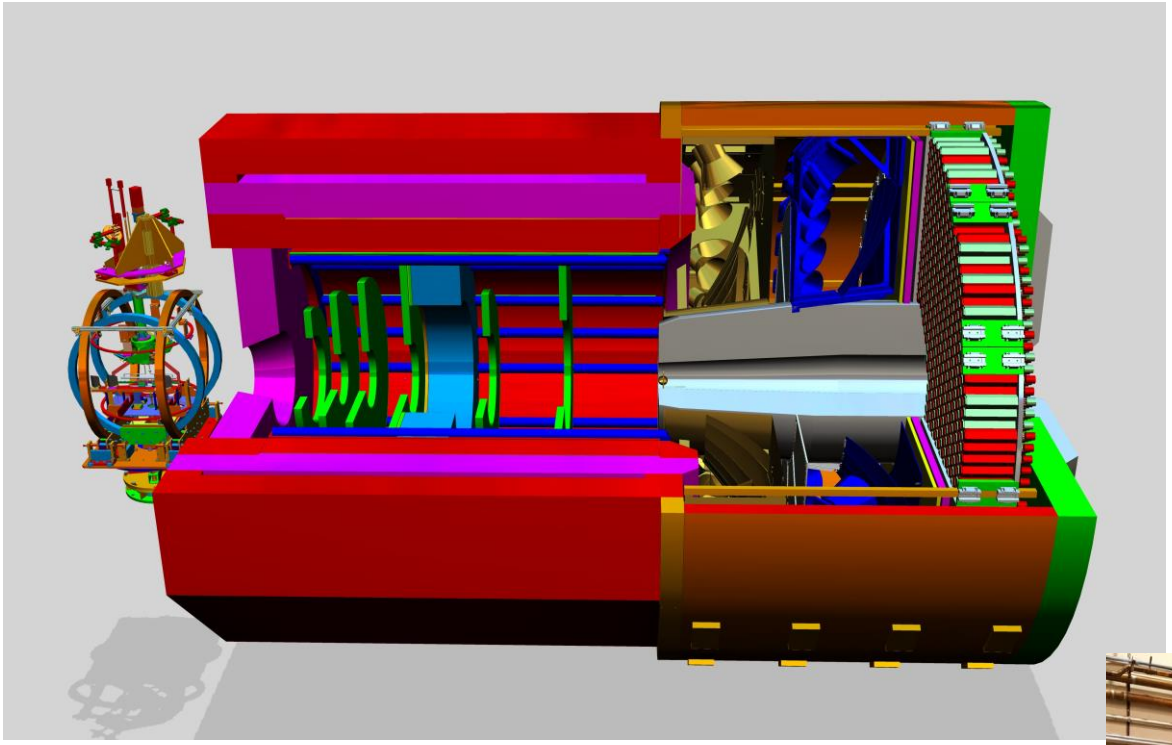
* Goal is to show no show stoppers

Director's Review - Infrastructure

SoLID in Hall A



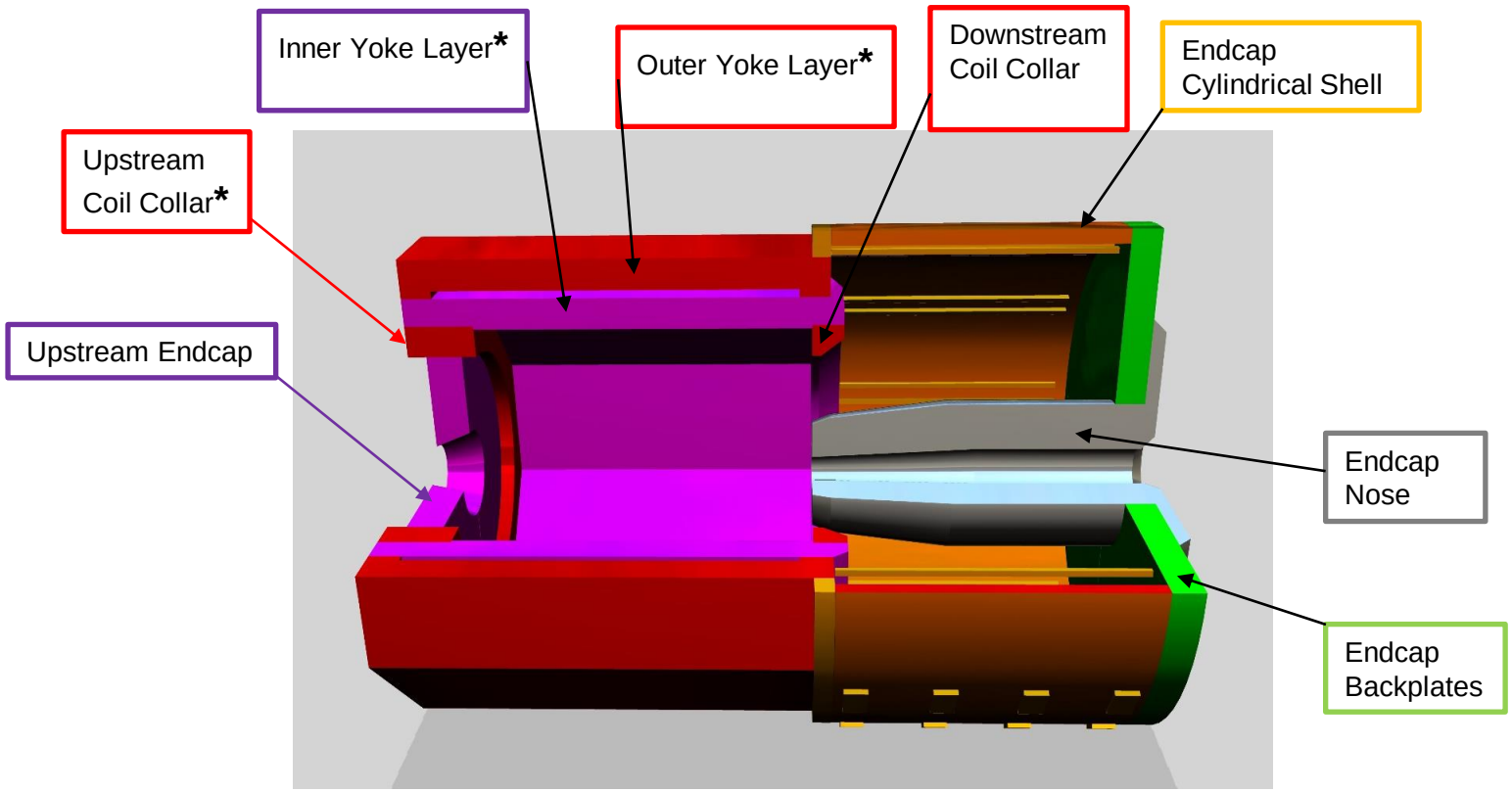
Director's Review - Infrastructure



Return iron, cryostat and detectors cutaway showing internal layout of SoLID

Cryostat on transport frame

Director's Review - Infrastructure



*denotes existing steel

Existing outer and inner layer and downstream coil collar will be shortened to clear acceptance

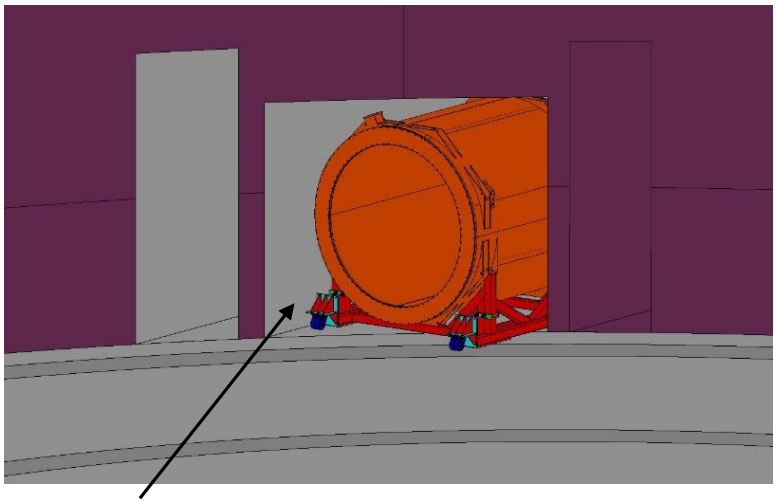
Director's Review - Infrastructure

CLEO-II Cryostat – Hall A Truck Ramp Opening

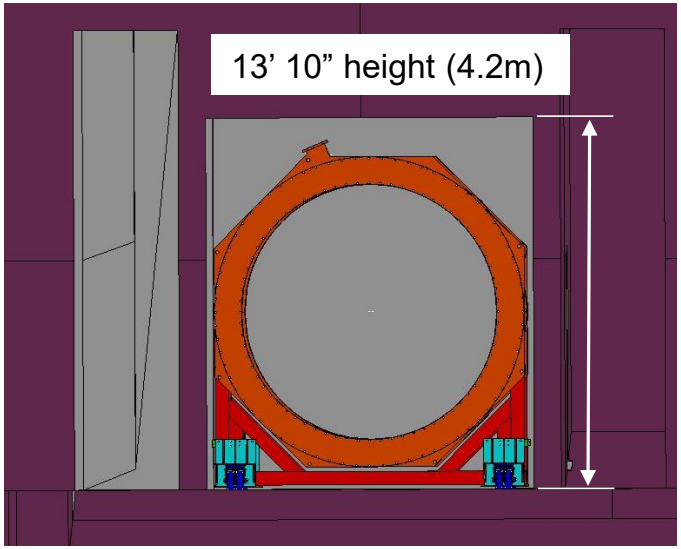
Hall A truck ramp/wall opening
- 13' 10" height
- 12' 0" width

CLEO II Cryostat
- Approx. 13' 2" height
- 11' 6" width

The cryostat will fit through the wall opening.



Bottom of the truck ramp entering Hall A



Moving the cryostat into the Test Lab with a door height of 13' 6"

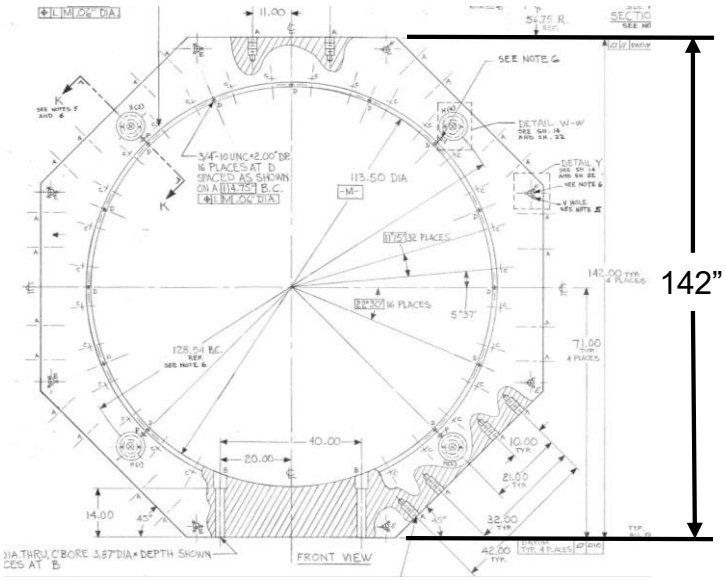
Director's Review - Infrastructure

CLEO-II Coil Collar – Hall A Truck Ramp Opening

Hall A truck ramp/wall opening
- 13' 10" height
- 12' 0" width

CLEO II Coil Collar
- 11' 10" width

The coil collar will fit through the wall opening.



Unloading the coil collar in the Test Lab from a flatbed truck. Shipped in horizontal position

Director's Review - Infrastructure

Detector Endcap – Hall A Truck Ramp Opening

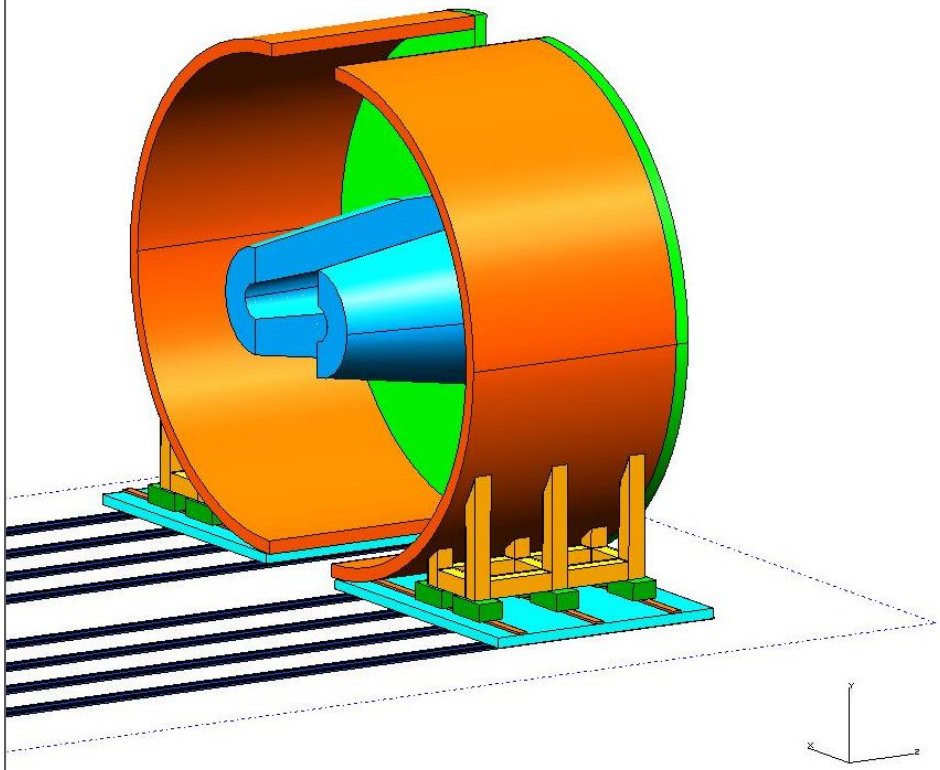
Hall A truck ramp/wall opening
- 13' 10" height
- 12' 0" width

Detector Endcap Half Cylinder (orange)
- 9' 5" outer radius
- 10' 6" length

Detector Endcap Half Circular Plates (green)
- 9' 5" outer radius
- 18' 10" length

Detector Endcap Nose Half (blue)
- 2' 9" outer radius
- 12' 9" length

The endcap pieces will fit through the wall opening.



Director's Review - Infrastructure

Detector Sections – Hall A Truck Ramp Opening

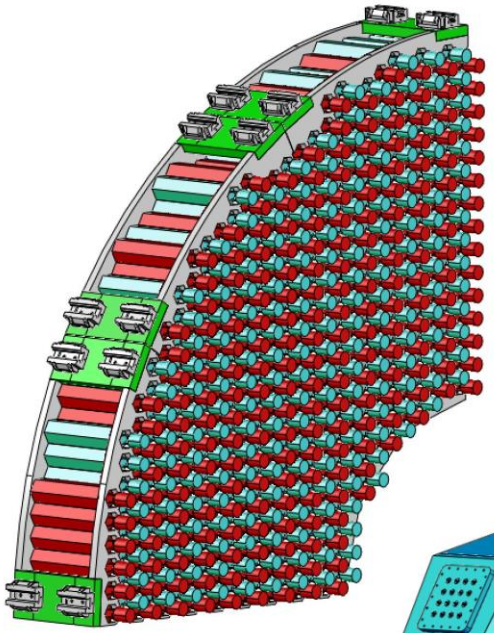
Hall A truck ramp/wall opening
- 13' 10" height
- 12' 0" width

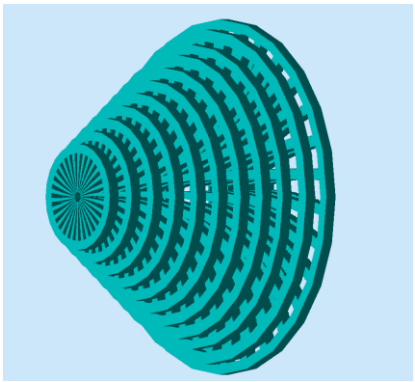
Detector groups provided clearance requirements for entry through Hall A truck ramp door openings.

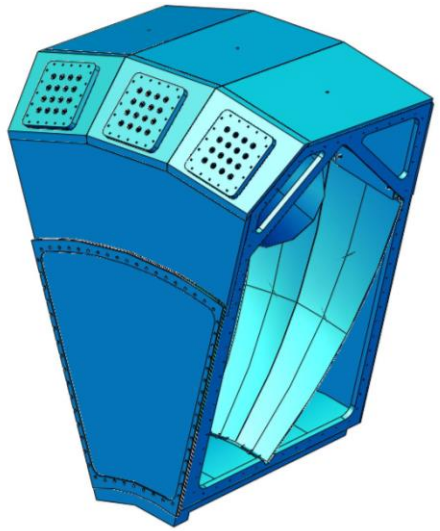
The detectors will be constructed in sections small enough to fit down the truck ramp and assembled into units once delivered into the hall.

Inner bore of the magnet is 9' 6"

Detectors and baffle layers that will be installed inside the magnet bore will fit through truck ramp door as assembled units.

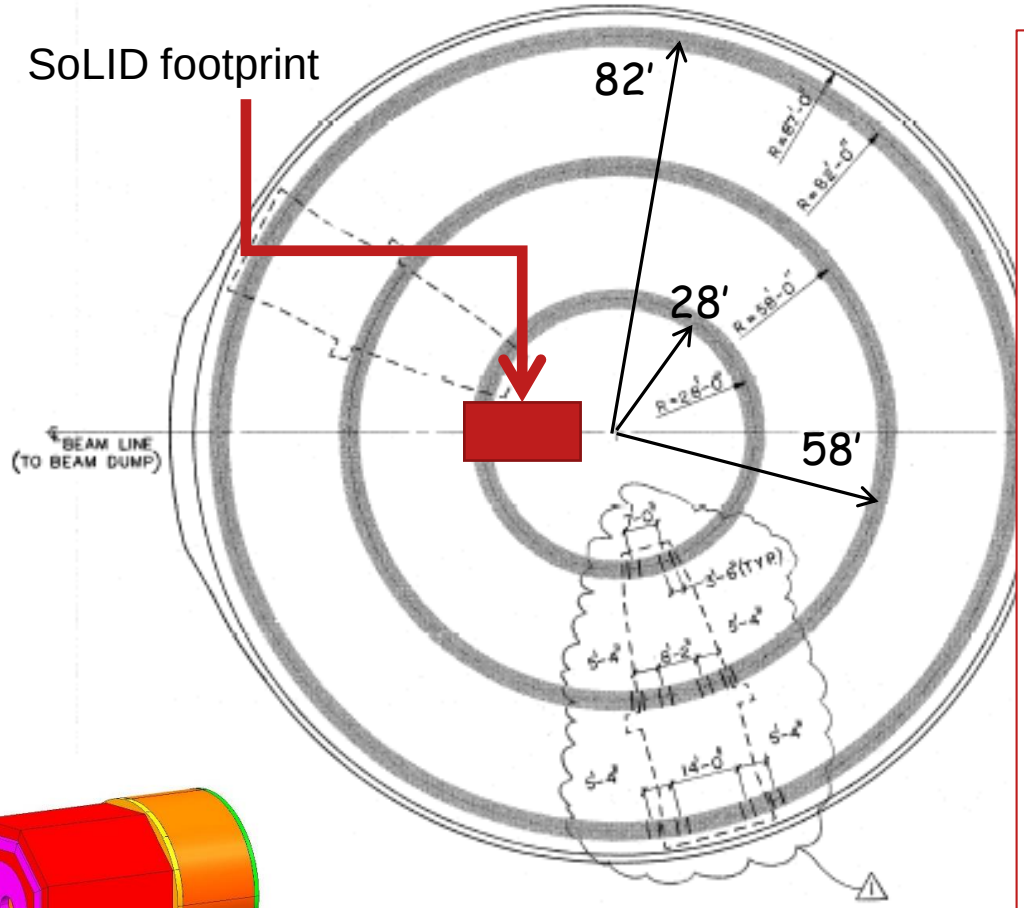


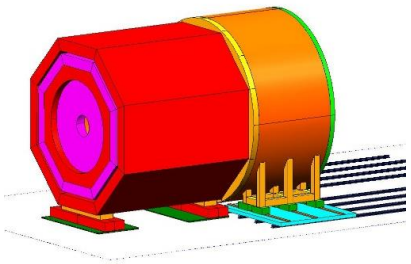




Director's Review - Infrastructure

SoLID Floor Loading in Hall A





- SoLID magnet and endcap overall footprint is 332" long by 138" wide. The current magnet and endcap support concept distributes the load across an approximate area of 95 ft^2.
- Weight of the CLEO-II magnet, endcap and detectors is approximately 1000 tons. SoLID floor loading is approx. 126 tons per 12 ft^2 area. The floor in the installation region is designed for 250 tons for a 12 ft^2 area.
- Floor loading information provided by JLAB facilities engineering.

Director's Review - Infrastructure - Electrical and Cryogenic Requirements

- The projected **electrical power load** for the magnet is less than 1 MVA. A planned upgrade to the Hall A substation is scheduled prior to the running of SoLID and would bring the capacity up to 2 MVA.

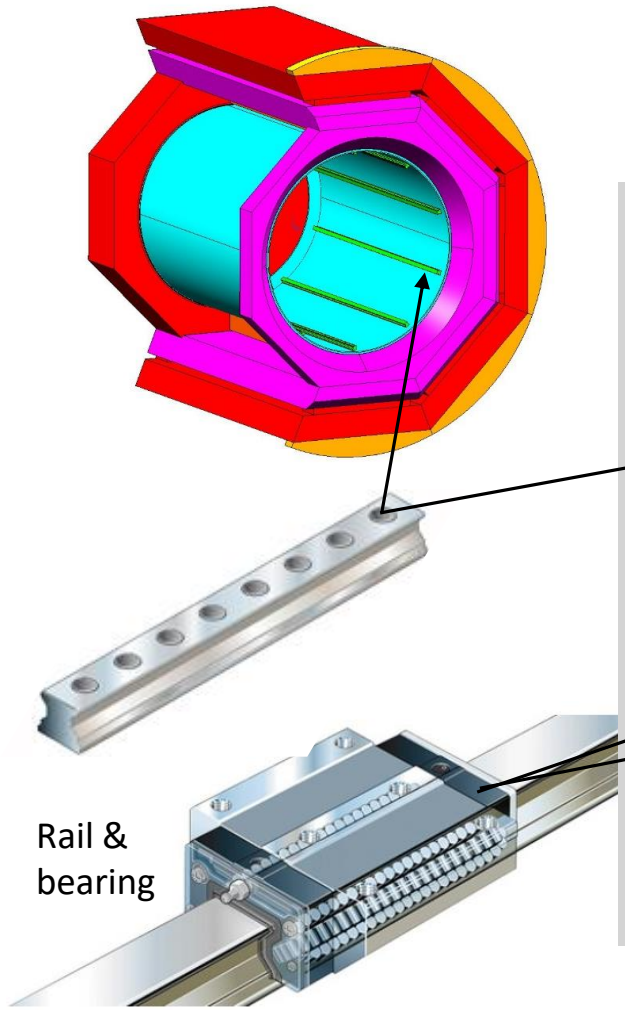
- The CLEO-II magnet was designed to have a low **cryogenic heat load** with passive cooling. Oxford estimated heat load is 8.3 watts and 14 l/hr. The existing cryogenic system will be used to provide liquid helium to the CCR. The HRS spectrometers will be offline during the SoLID run. The heat load is within the capacity of the current system in Hall A. The magnet requires two weeks to cool down while maintaining a 25º delta T.

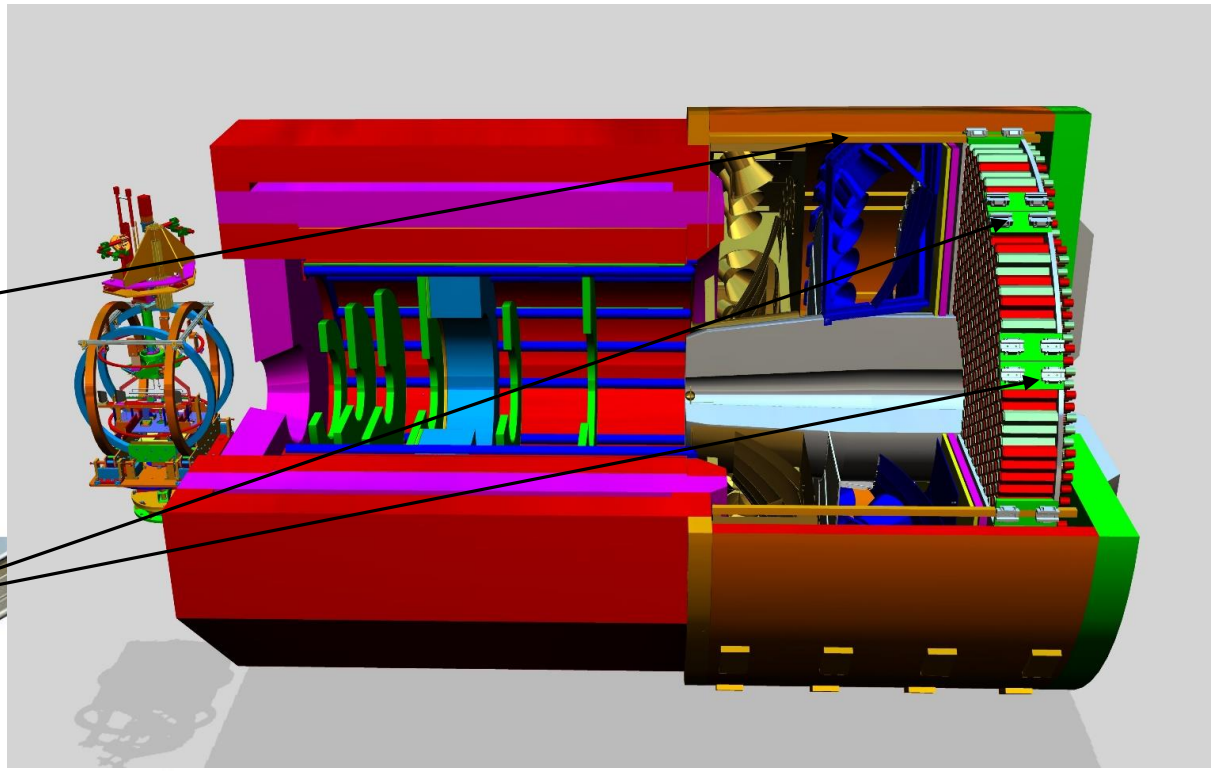
Parameter	**Design Value**
Coil Electrical	
Operating current	3300 A
Coil inductance	4.6 H
Stored energy	25 MJ
Cryogenics	
Coil operating temperature	4.3 - 4.6 K
Coil working pressure	1.1 - 1.2 bar
Refrigeration load	8.3 watts and 14 l/hr

Director's Review - Infrastructure – 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.

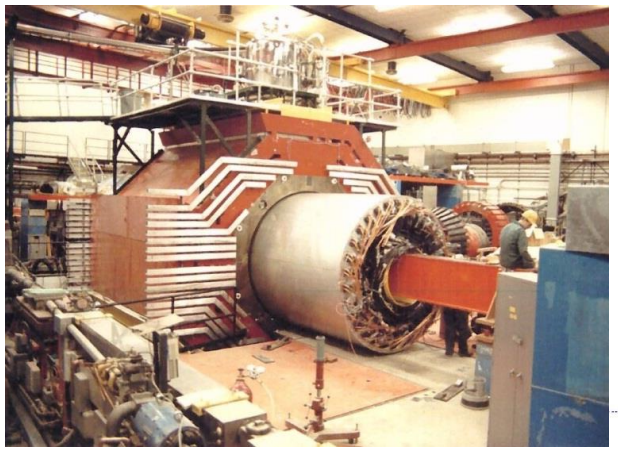


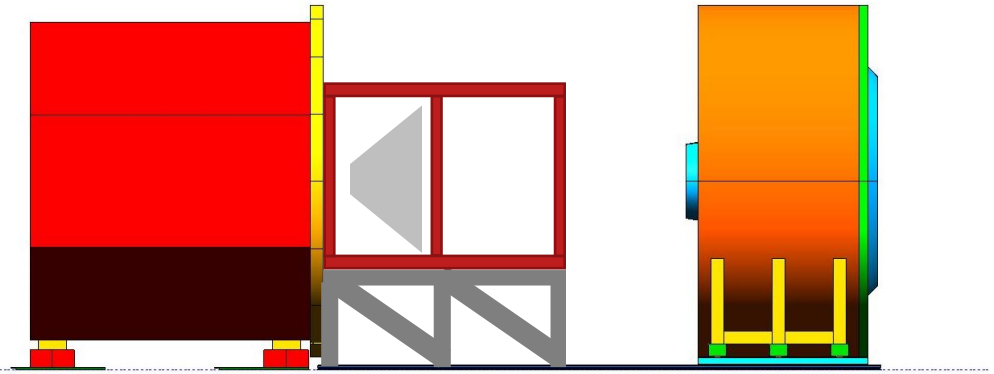


Director's Review - Infrastructure – Detector Support Structure

Large Angle Detector and Baffle Installation

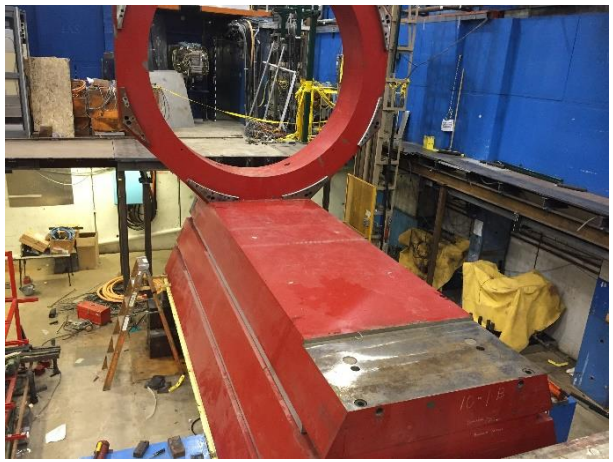
- The magnet will be located adjacent to the existing Hall A center pivot/target mount area and will have limited access to the front of the magnet.
- The insertion of the large angle detector packages that will reside internal to the cryostat will be accomplished from the downstream side of the magnet using a supporting framework to roll the packages in and out.
- An installation mechanism is needed to load the large angle detector packages and baffle system into the internal support structure
- This mechanism will likely be mounted to the longitudinal track system used for the endcap movement and can utilize the tracks for rolling the detectors and baffles into the cryostat and transferring the load to the internal frame.
- Similar method used for **endcap detectors** requiring a larger installation frame to transfer detectors to rail system.





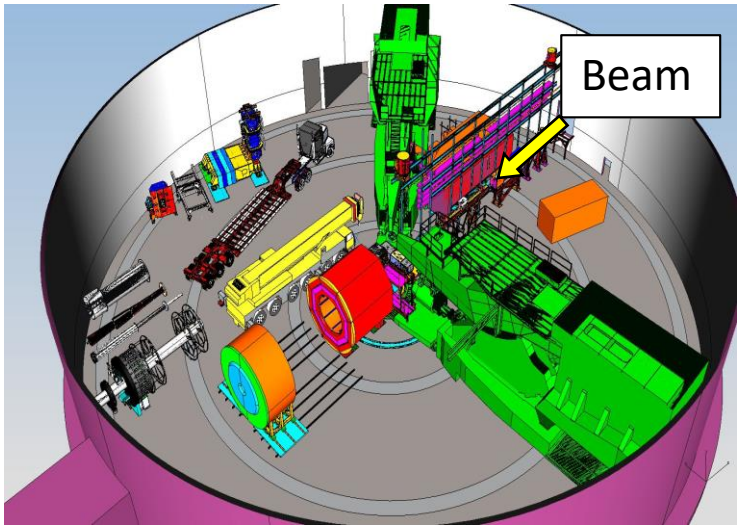
Director's Review - Infrastructure and Support Structure





Assembly and installation plan

- Assembly of magnet, detectors and infrastructure.
- Integrate subsystem assembly and installation with hall infrastructure and magnet planning.
- JLAB personnel participated in the disassembly of the CLEO II magnet to gain experience for magnet reassembly planning.
- Studied the hall layout in CAD to ensure the logistics of moving massive pieces of equipment with flatbed trucks and mobile cranes was feasible.

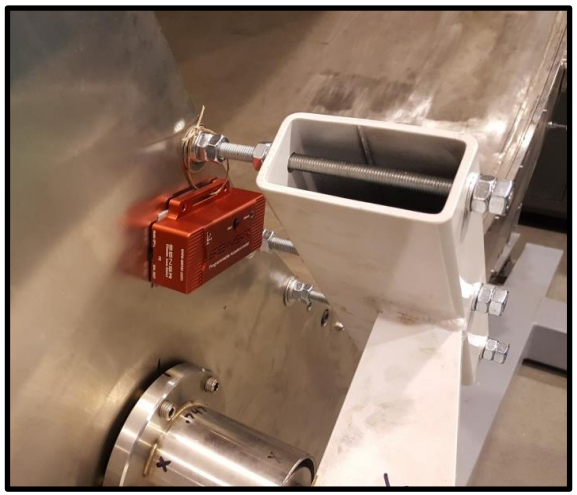


Director's Review - Magnet – Risk Reduction

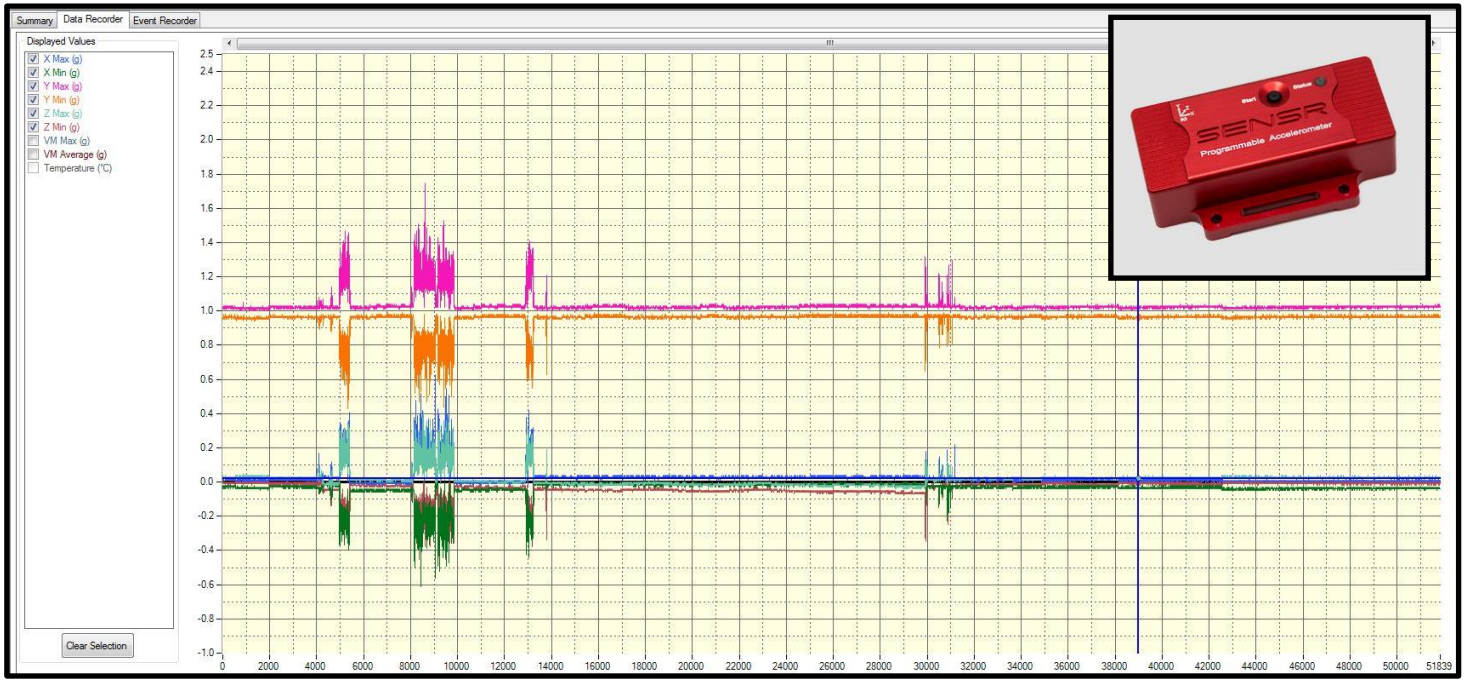
Evaluate the health of the magnet in order to quantify risk to the project

- Operational History: Cryostat had remained sealed while at Cornell, 4 noted quenches with no change in functionality, only modification in cryogen controls and new power supply.
- The magnet has been moved from Cornell to JLAB. JLAB personnel participated in the disassembly and shipping of the magnet.
- The cryostat is stored in the climate controlled Test Lab.
- Static testing conducted after delivery to JLAB showed no issues. Tests include hipot test of coils and electrical check out of instrumentation inside the magnet.
- Low current cold tests are scheduled in the JLAB Test Lab during summer 2021. These tests will further confirm the condition of the magnet after transport to JLAB and permit test, troubleshooting and commissioning of the new I&C and cryo interface (CCR).

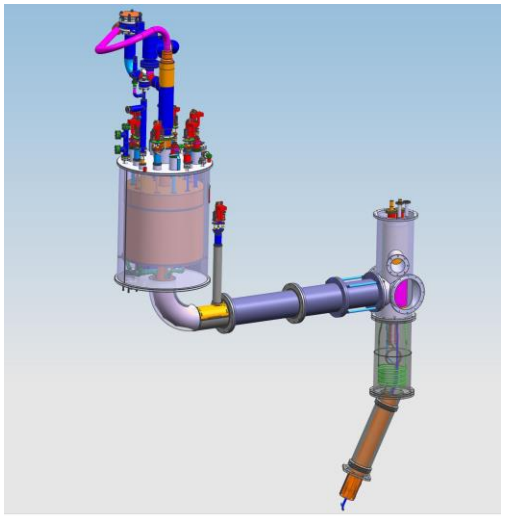
Director's Review - Magnet - Load Monitoring Cornell to JLAB

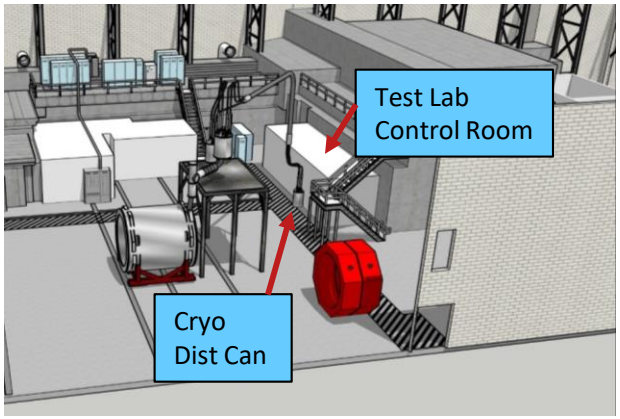


- Two accelerometers mounted to end plate to measure loads during transit
- Programmable 3 axis MEMS
- Setup to record a data point every 20 sec. (reporting interval)
- Records highest acceleration measured during reporting time interval
- Samples @ 100Hz per axis
- Max acceleration of 0.8 g (Vertical direction)
- Most loads under 0.5 g
- Also reports vector magnitude MAX and AVG $r = \sqrt{x^2 + y^2 + z^2}$
- The Oxford Operating Manual states the magnet was designed to withstand a 3g load.



Director's Review – Magnet - Cold Test





- Solenoid rehab will confirm condition of the magnet
- Provide risk reduction to the project
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- Estimated completion 16 Sept 2021

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Questions/Comments?