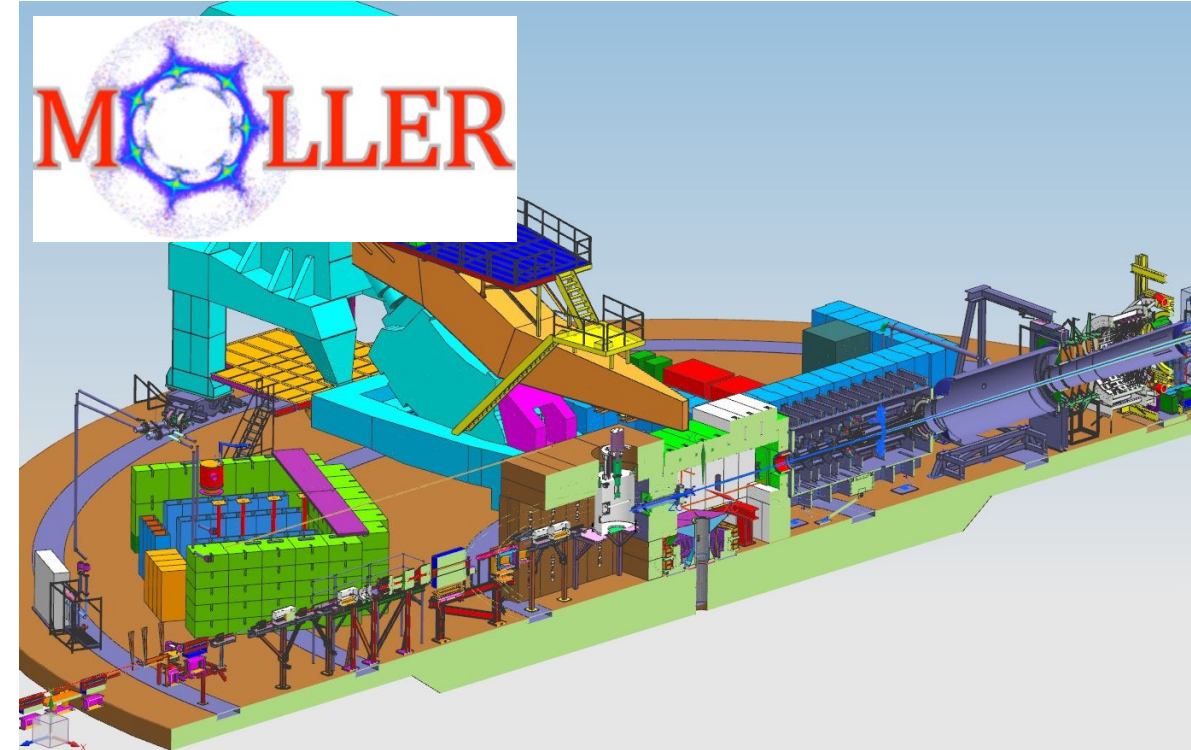


MOLLER CD-2/3 Director's Review

Hall A Infrastructure



Dustin McNulty, Idaho State University

Monday, Aug 14, 2023

Outline

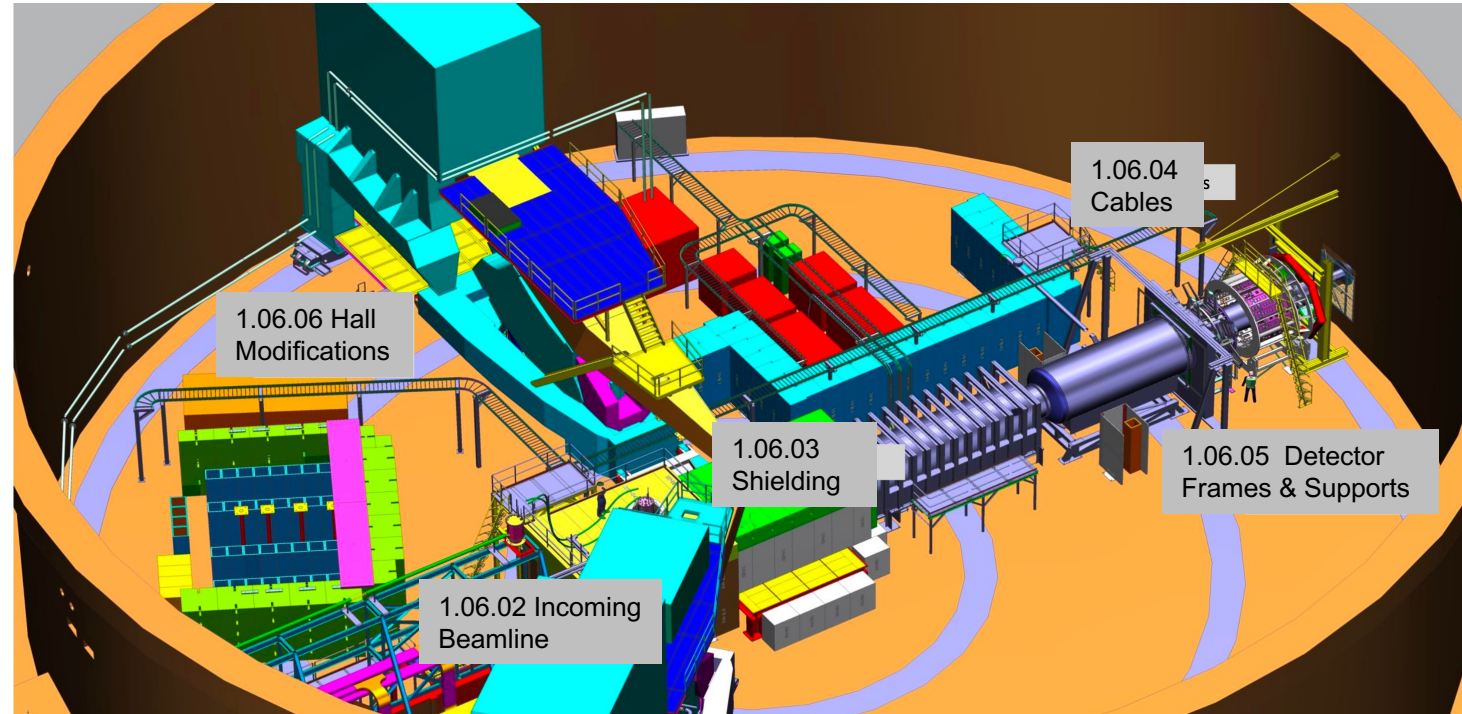
- Subsystem Overview and Status
 - 1.06.02 Incoming Beamline Modifications
 - 1.06.03 Particle Shielding Around Target and Beamline
 - 1.06.04 Cables
 - 1.06.05 Detector Frames and Supports
 - 1.06.06 Hall Modifications
- Summary

- Team Members:
 - L2 Manager, Control Account Manager
 - Ciprian Gal, Jefferson Lab
 - L2 Technical Lead
 - D. McNulty, Idaho State University
 - Technical contributors:
 - Robin Wines, JLab
 - Jay Benesch, JLab
 - Yves Roblin, JLab
 - Zuhair Demiroglu, Stony Brook University
 - Kent Paschke, University of Virginia
 - Chase Dubbe, JLab
 - Ryan Biraben, JLab
 - Dan Spell, JLab

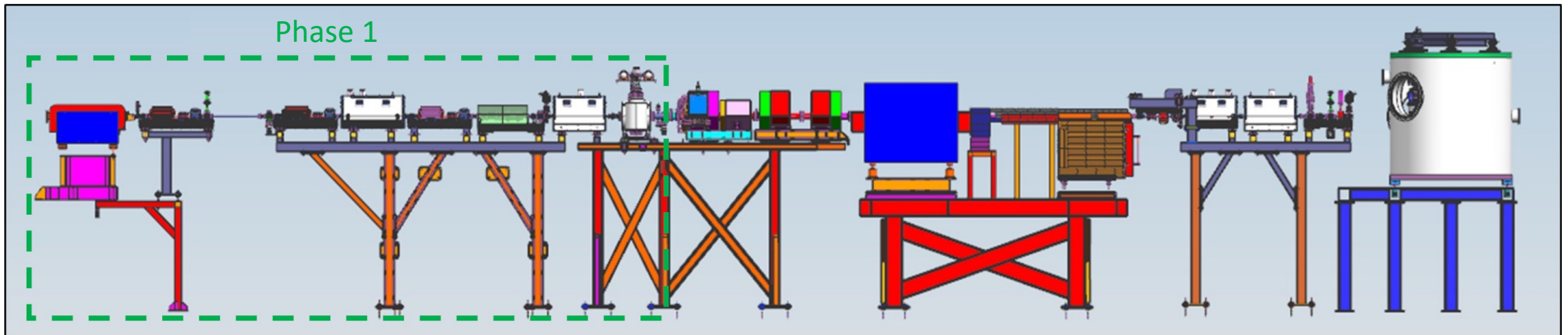
1.06 Overview

WBS 1.06 Includes:

- Incoming beamline mods: diagnostics and beam transport magnets from Hall entrance to target. Target position requires reconfiguration of beam line elements
- Shielding to keep radiation levels within limits:
 - Target region bunker
 - Spectrometer region bunker
 - Detector wall
 - MPS bunker, existing electronics bunker and small GEM electronics bunkers
- Cables, cable routing and electronics power supplies for detector power and readout
- Support of detectors from base to floor mounting including GEMs, Main Detector, and Shower Max
- Access platforms for assembly and maintenance of target, spectrometer and detectors; crane for detector assembly
- Design modifications to Hall A to meet MOLLER assembly requirements:
 - Utility platform removal to allow required target position (4.5 m upstream of pivot)
 - Plan removal of existing spectrometer (HRS) support link and pivot platform to allow for shielding
 - Design connection to utilities for power, LCW and detector gases



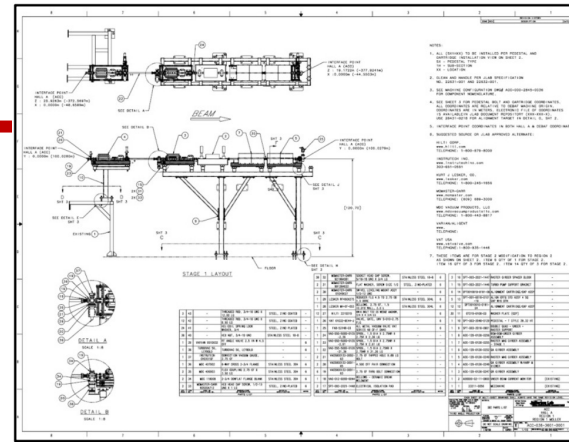
1.06.02 Incoming Beamline Design Modifications



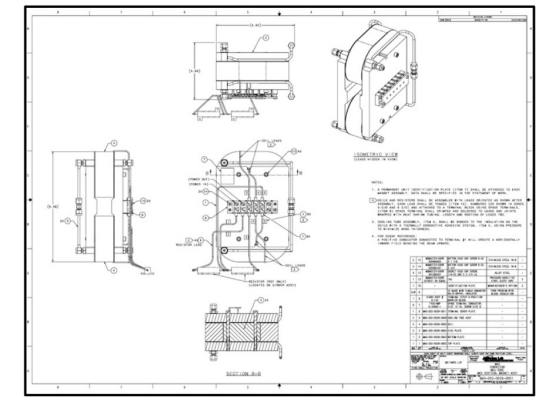
- **Upstream beam line changes are defined.**
 - Reduce beam line length to fit MOLLER target location 4.5 m upstream of the usual target location
 - Improve beam line optics and be able to obtain desired beam profile at MOLLER target position
 - Relocate & electrically isolate current monitors. Relocate cavity BPMs to maximize lever arm within a shorter beam line.
- Prototype assembly Phase 1 was developed to install a portion of the Moller Incoming Beamline ahead of assembly date. This was proposed as a benefit for operations to run the beam with the Moller target in the final location, along with the additional quads and stronger MCG correctors.

1.06.02 Incoming Beamline

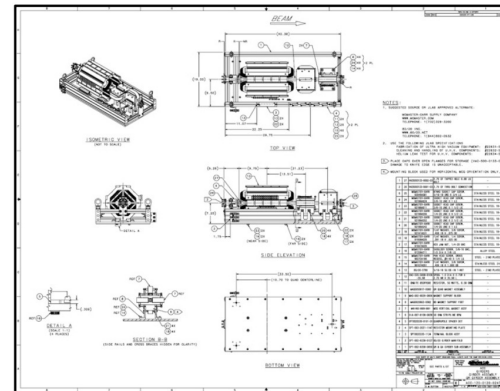
- Incoming Beamline 3D model finalized and all design drawings detailed:
 - ~82 total drawings currently in doc. repository
 - Utilizing existing stand legs for girder platform, without relocation or removal
- Completed design of the new MCG corrector, along with new QQQ diagnostic girder, and new UNSER
- Structural analysis of stands and vacuum analysis of beamline completed
- Current goal is to install majority of Phase 1 as soon as possible to exercise beamline components parasitically
 - All components purchased or in fabrication onsite



Region 1 Assembly Drawing



MCG Assembly Drawing



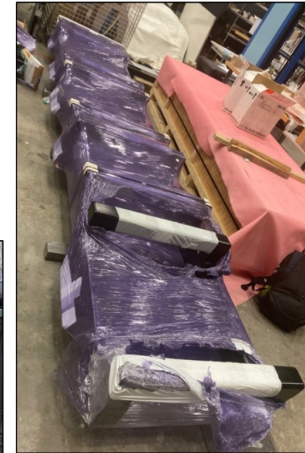
Girder Assembly Drawing



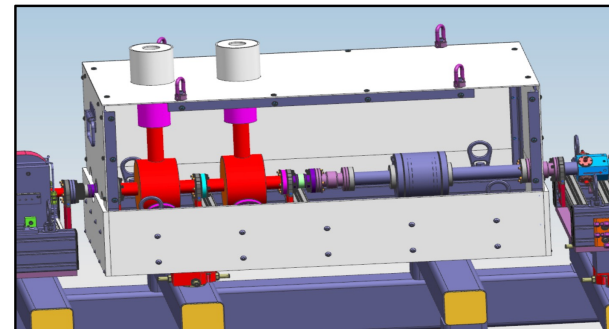
Vacuum spools leak tested



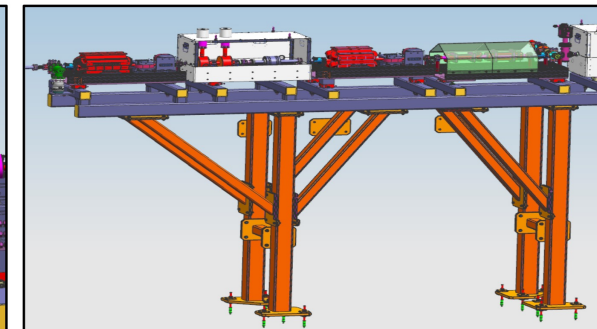
Girder sub-assemblies



Stands in Storage



New Prelim. UNSER Design

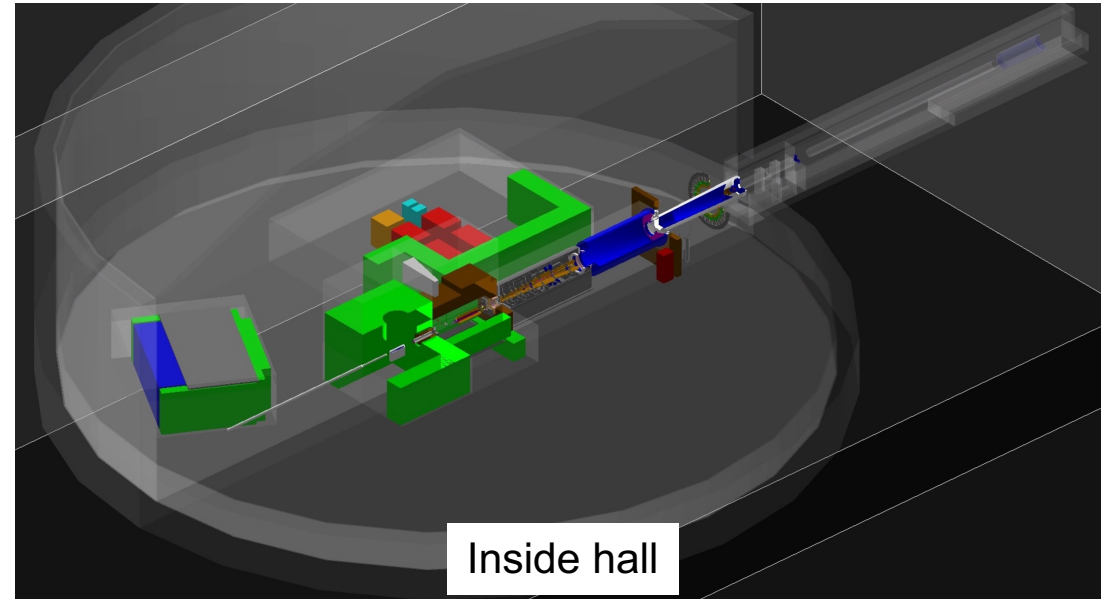
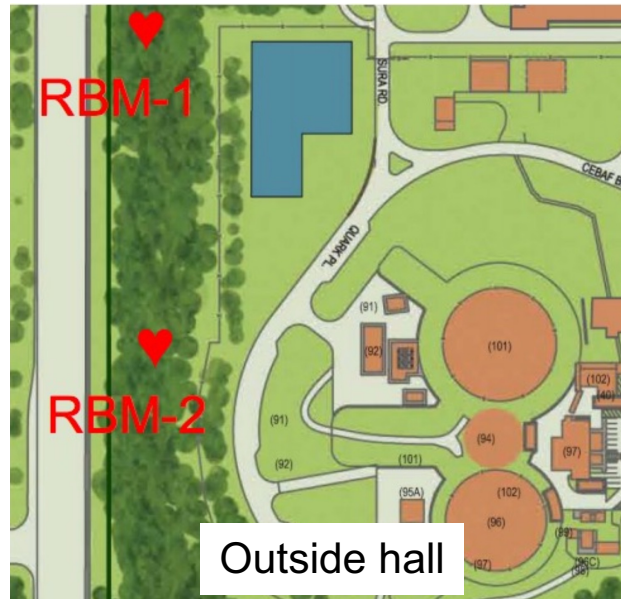


Utilizing Existing Stand Legs

1.06.03 Shielding

- Considerations: personnel and equipment protection, boundary dose estimation, Hall beamline component activation--for efficient access/maintenance
- Additional considerations: minimizing ferrous material in shielding components
- Simulations of longterm electronics damage performed in different areas inside Hall
- These studies have informed decisions on shielding placement/location, type of shielding material and thickness

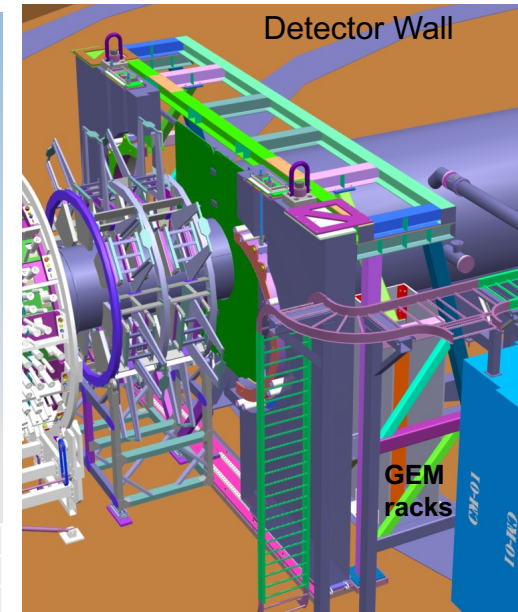
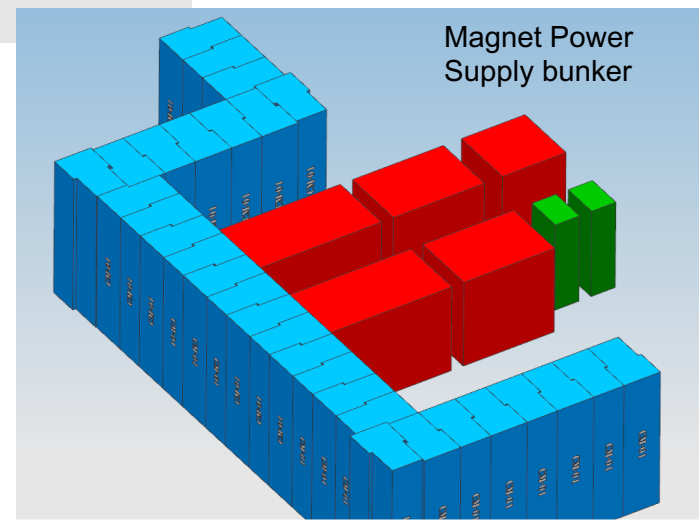
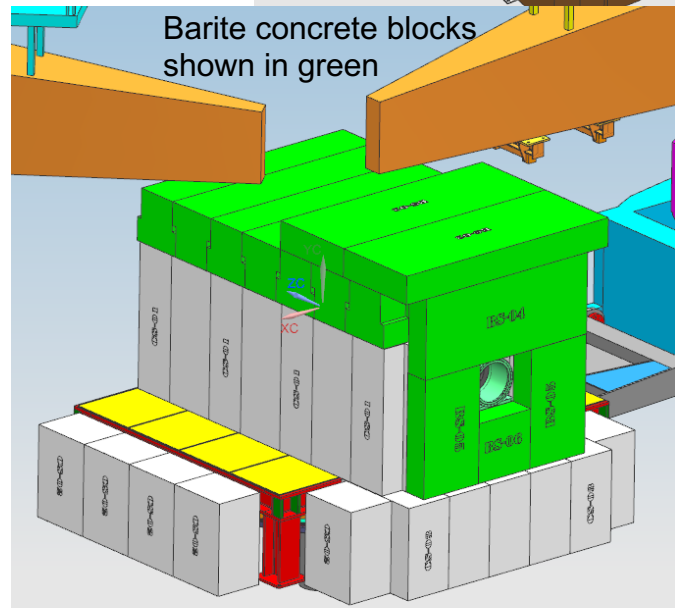
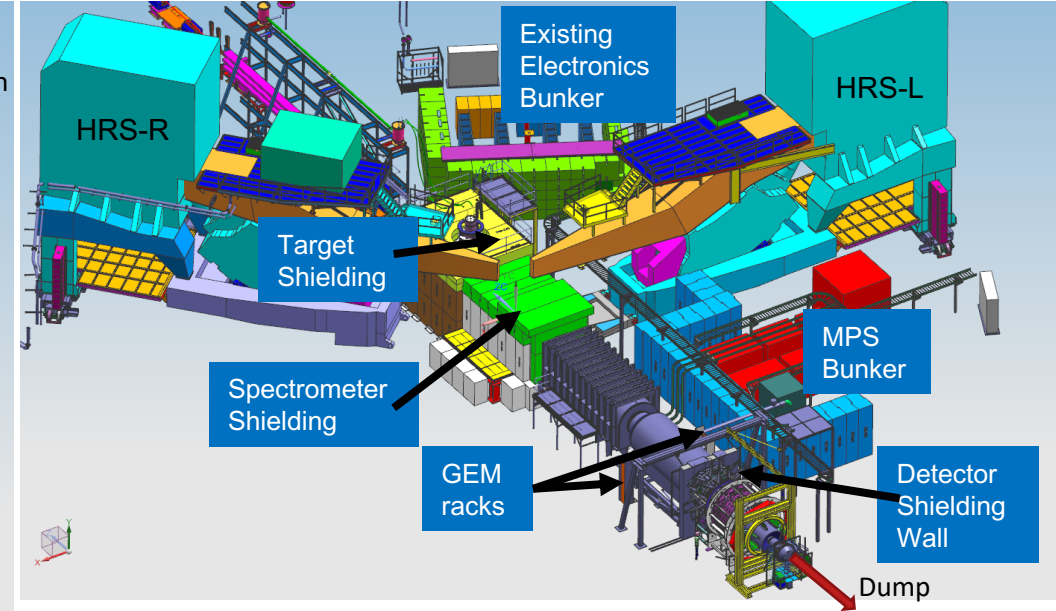
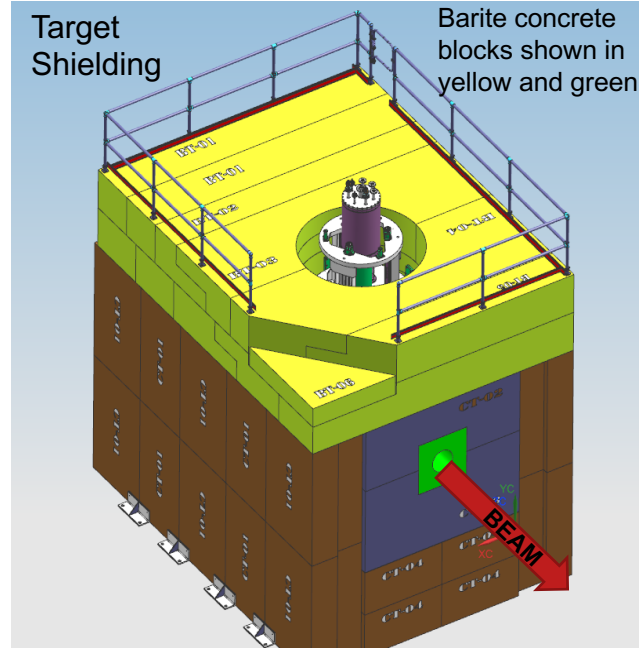
Radiation Levels during MOLLER



- Estimations done with G4 and FLUKA
- Simulation framework benchmarked to PREX-2 and CREX data
- Estimations done with G4
- Shielding is located around components that absorb significant power: target, collimators
- Sensitive components, detectors/electronics also shielded
- See later talk by Ciprian Gal for more details
--SC 2: Topic 5: Shielding Physics Design

1.06.03 Shielding

- Passed all design reviews and starting procurement phase
- Target, spectrometer, MPS, and detector wall shielding designs complete
- GEM hut design complete
- Detector wall support structure redesign is underway



- See later talk by Robin Wines for more details --SC 2: Topic 6: Shielding Engineering

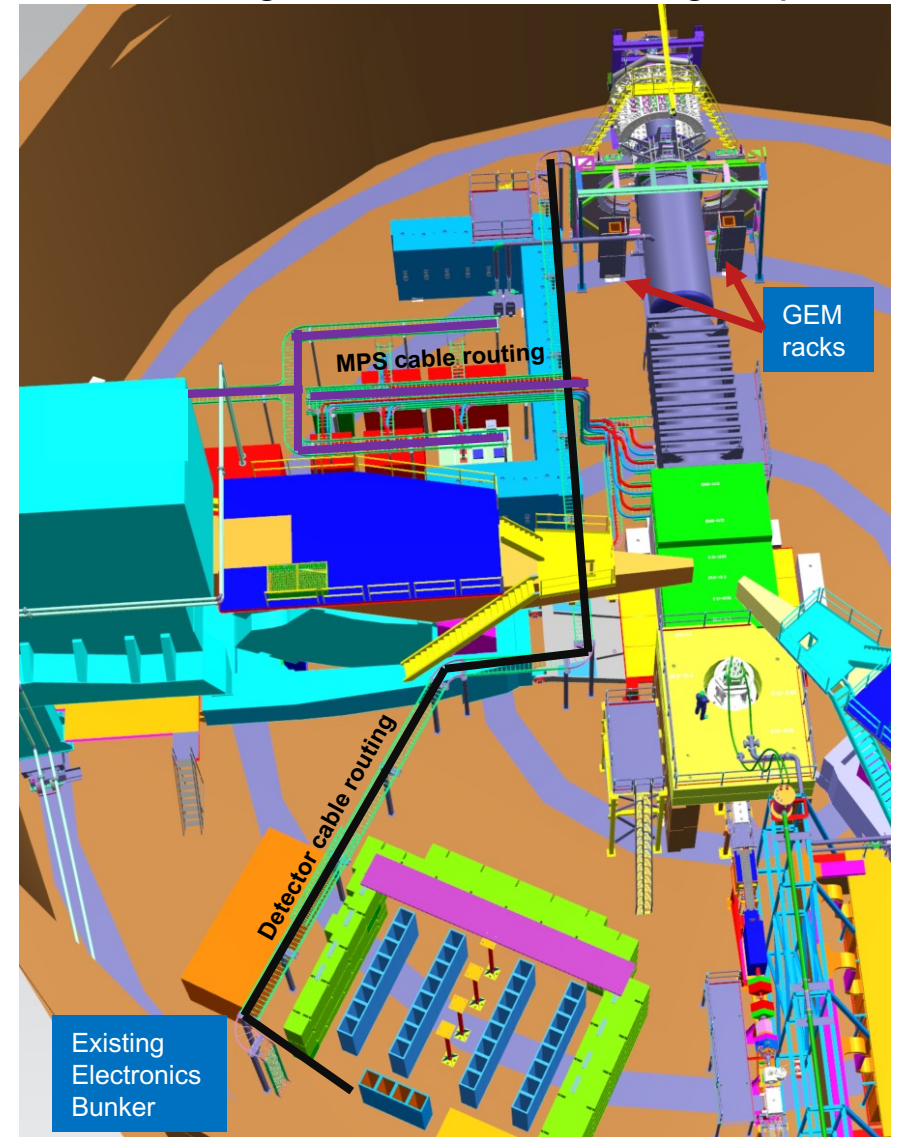
MPS Region Block Data

Name	Material	Quantity	Size (inch)
CM-01	Std Concrete	30	135 60 36

1.06.04 Cables

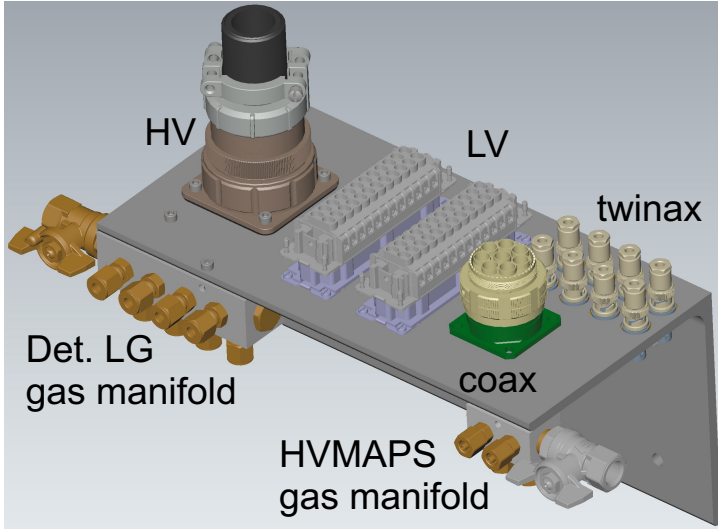
- Cables/connectors defined by collaboration
- Cable and power supply line routing finalized
- MPS cables route between bunker and US and DS torus
- Long detector cable runs are DOE/MIE scope
 - 250 ft planned routing
 - Layout of cable tray routing complete
 - Design of cable strain relief supports in process
- Bundled cable runs (8 cables each) will be used for long cables:
 - HV will use RG-58 or similar
 - Counting mode signals use coax (RG-58)
 - Integrating mode signals use twinax (RG-108)
 - LV power to preamps use twisted pair or RG-58/174
- Detector power supplies funded by CFI/RM and DOE/MIE
- A detailed accounting of all detector cables/connectors required is given in MOLLER docDB #[1050](#)

Cable routing for detectors and magnet power

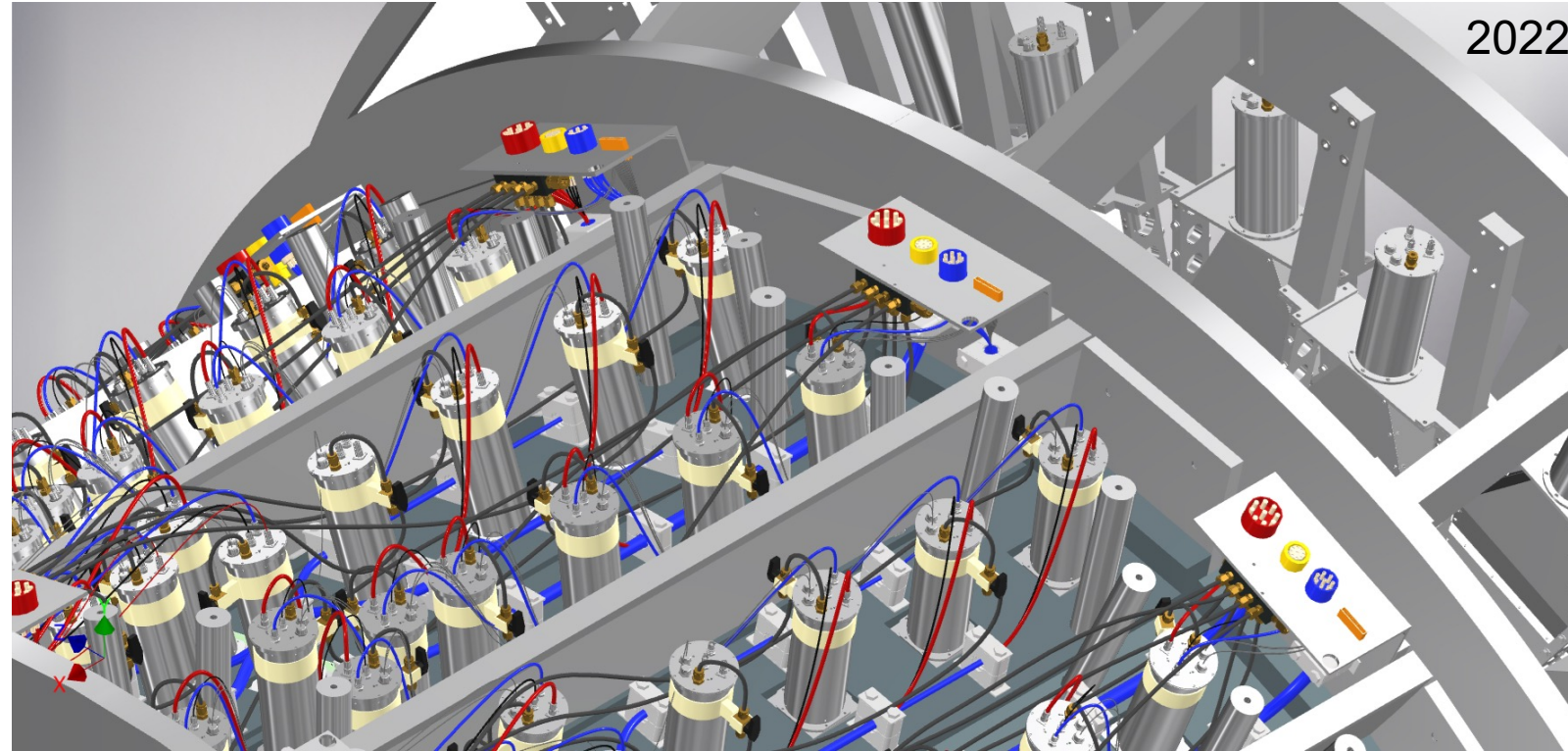


1.06.04 Cables

Main detector patch panel (2023)

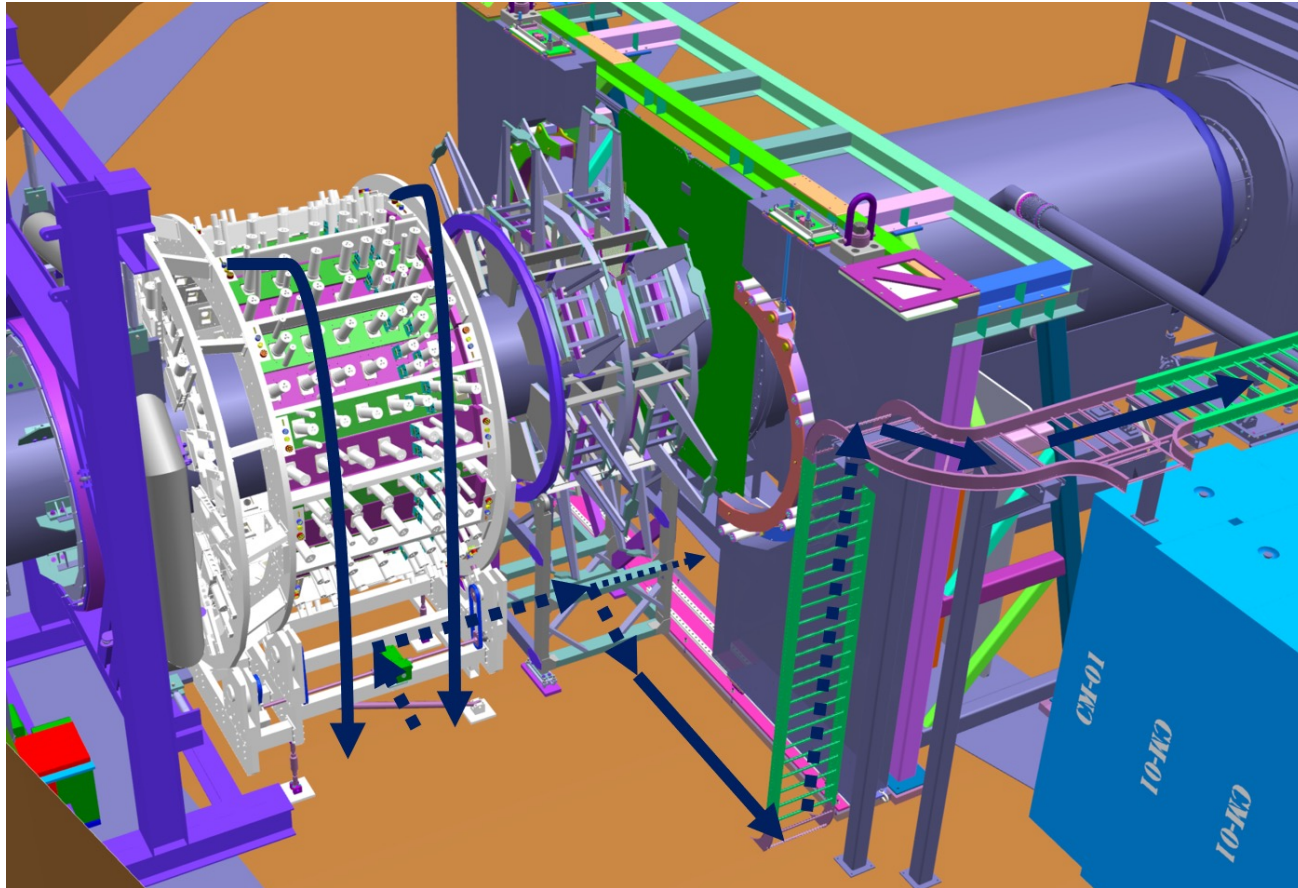


- Connectors:
 - 1 HD GES HV, 8 conductor
 - 2 HD Weidmüller LV, 24 cond.
 - 8 twinax bulkhead feed-throughs
 - 1 HD Amphenol coax, 8 conductor
- Insertion loss/minimum mating cycle specifications from manufacturer are sufficient
- Gas needs are defined for detectors and HVMAPS
- Main detector patch panel prototyping underway



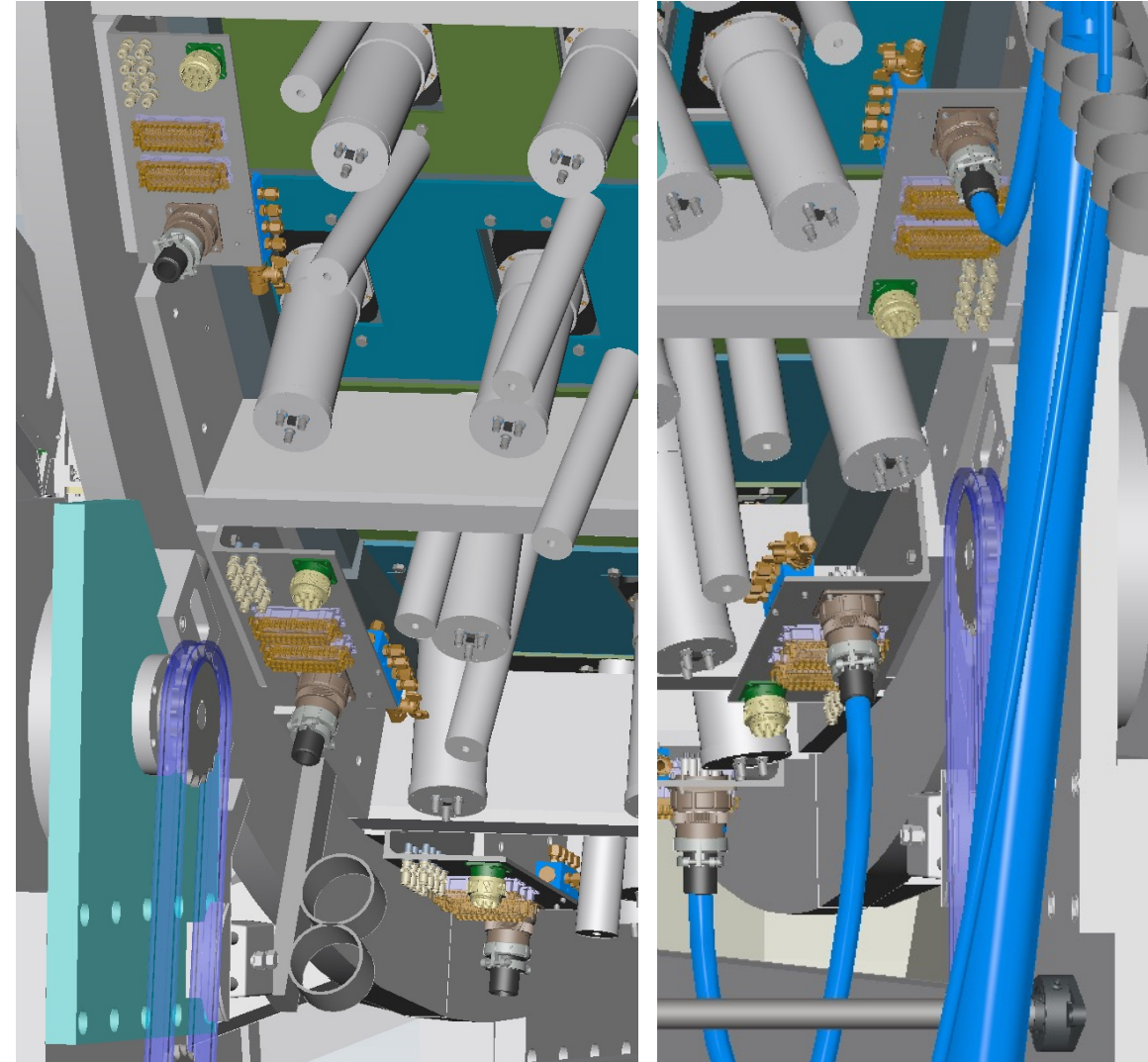
Internal detector cabling harness and gas distribution concept

1.06.04 Cables



- Cables route from detector or patch panel down to floor and then into cable tray to existing electronics bunker.
- GEM signals and HVMAPS power route to GEM racks

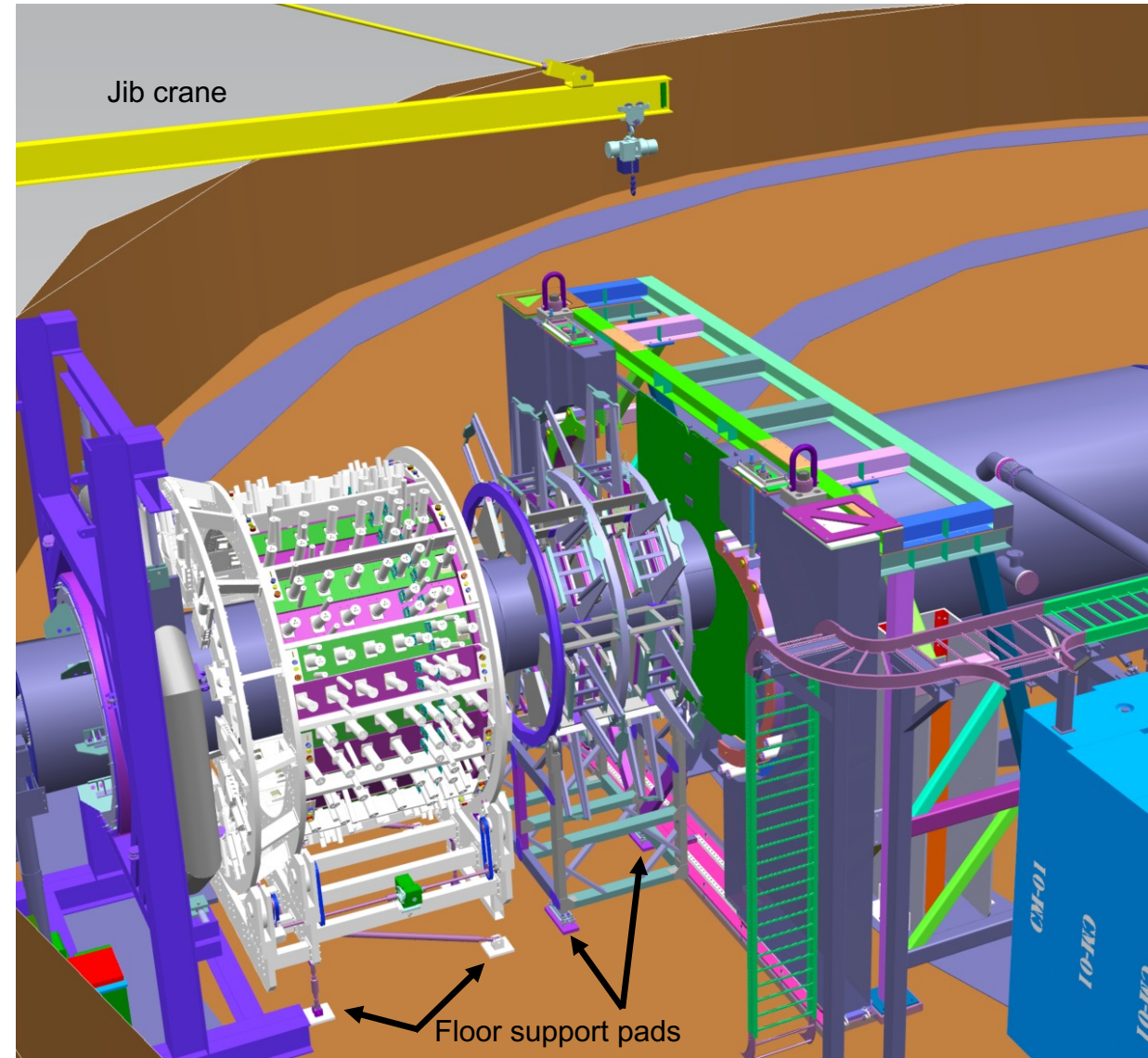
Cable supports/strain relief for main detector patch panels



Design and drawings under development

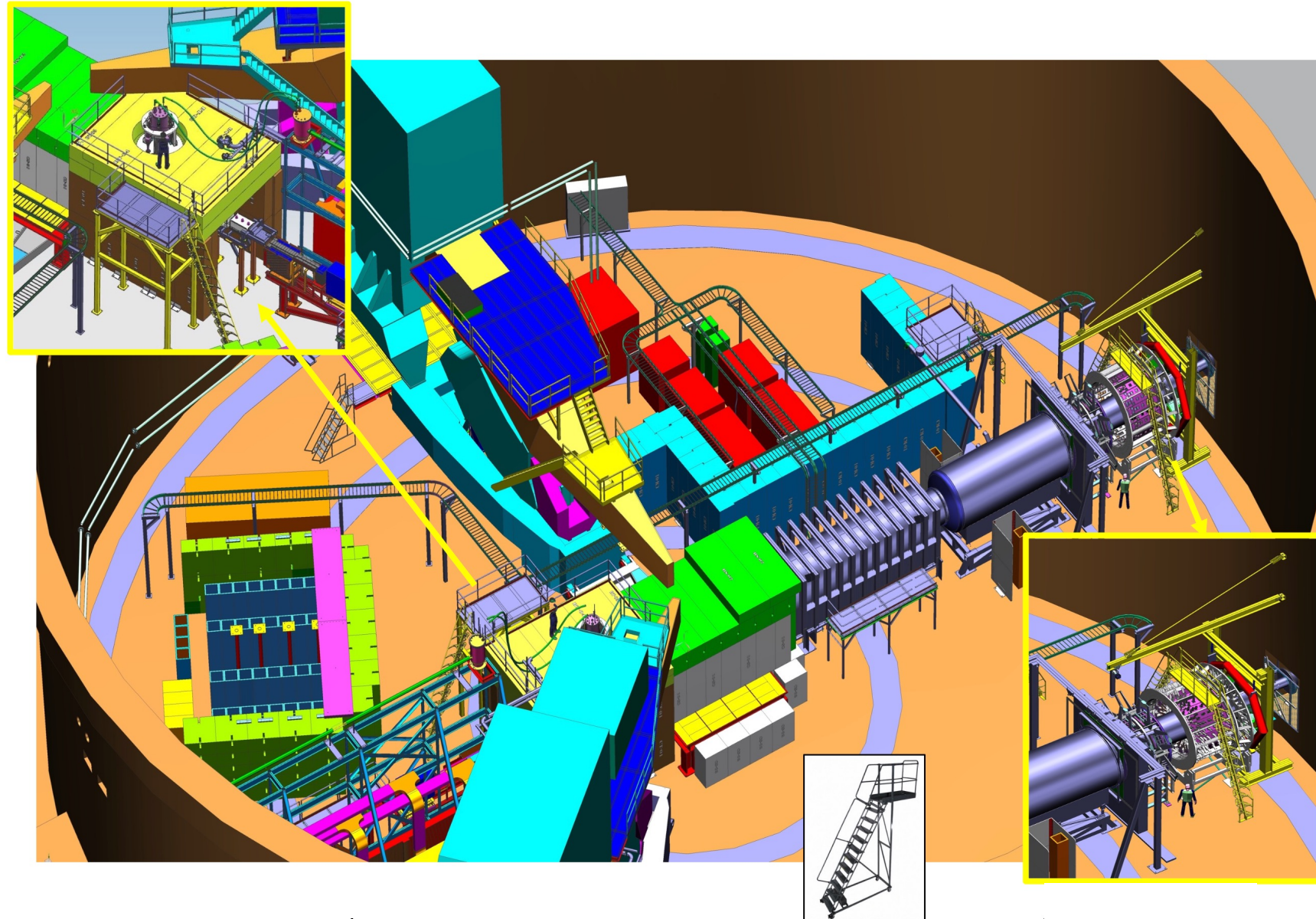
1.06.05 Detector Frames and Supports

- Main Detector and Shower Max Detector support concept developed by collaboration and contract engineer Larry Bartoszek
 - (See later talk by Larry for more details
--SC 2: Topic 4: Detector Mechanics)
- Detectors mounted on rotating ring with cradle support
- Structure utilizes 6 strut support to pads mounted to Hall floor
- Similar concept developed by collaboration for GEM rotator support (uses alignment cartridge pads)
 - (See later talk by David Armstrong for more details
--SC 2: Topic 1: Tracking Detectors)
- LAMs supported in detector shield wall
- Pion detector supported in Pb Donut
- SAMs built into beampipe penetrations
- Floor elevation survey conducted to define the floor mounting specification for detectors
- Vendor cost estimates have been updated



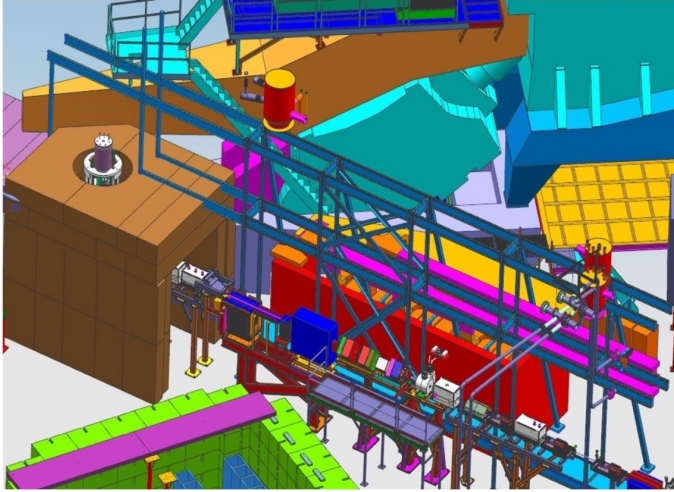
1.06.06 Access Platforms

- Hall overhead crane (which is now repaired) does not reach to the Hall wall
- Plan to mount Jib crane in detector region for detector assembly
- Jib crane defined as commercially available wall mount 2-ton crane, 20' span
- Target and detectors require access platforms. Plan to utilize OSHA standard commercially available rollup stairs/platforms
- Will use rollup stairs for access around spectrometer magnets
- Access platforms defined. Main detector access platform design in process.

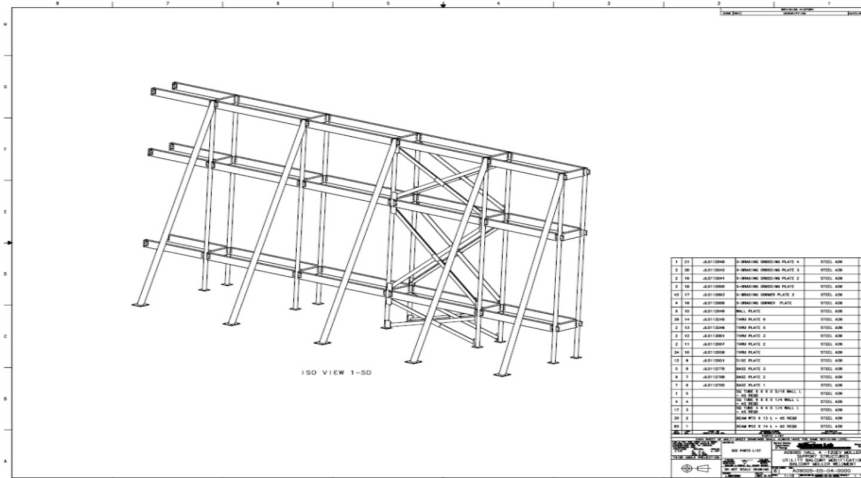


1.06.06 Hall Modifications

Existing Utility Platform

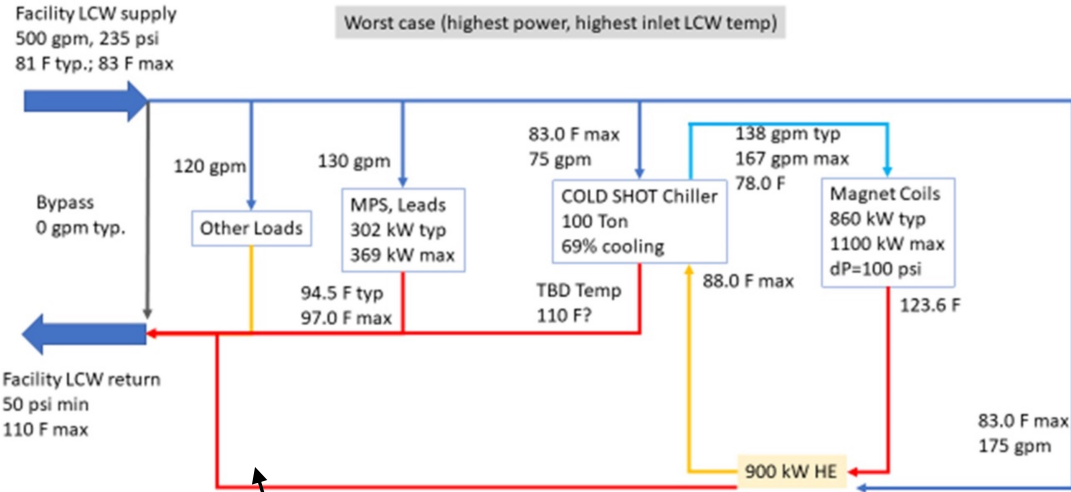


Utility Platform as needed for Moller



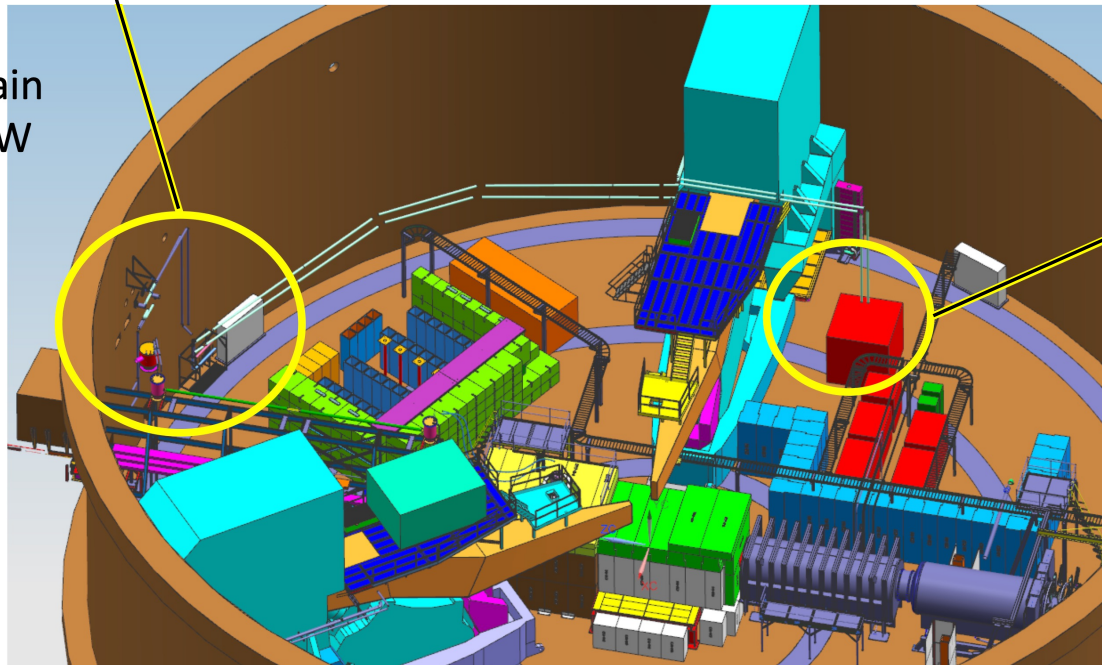
- Approximately 30' of blue utility platform needs to be removed, including utilities on structure
- Design has been analyzed and modification drawing is complete
- Removal and relocation of utilities to be done in-house, labor included in assembly plan

1.06.06 Hall Modifications (Utilities)

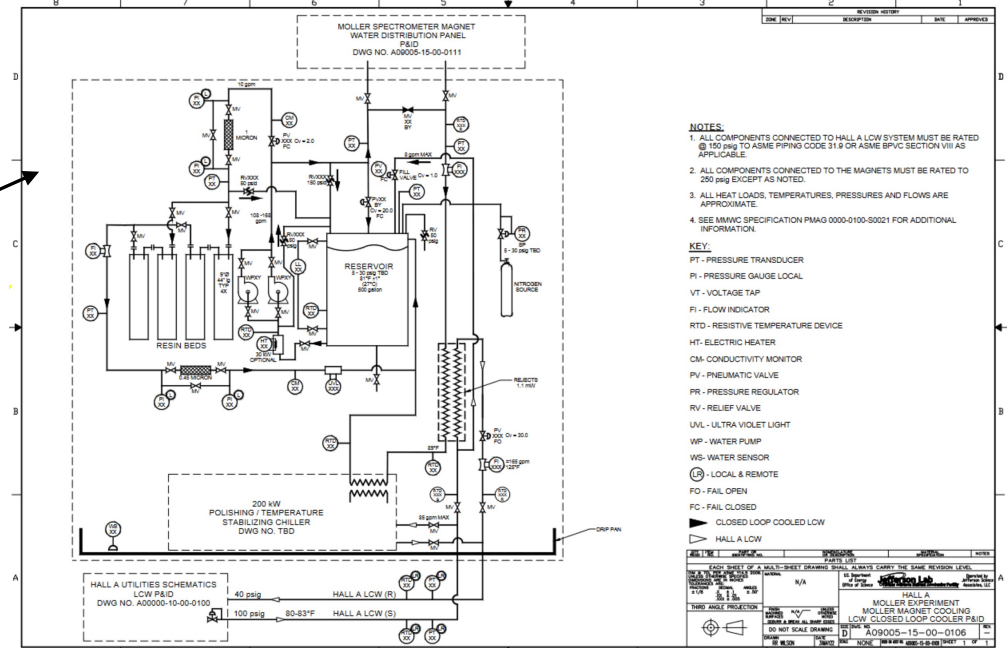


- LCW design modifications and layout required for MOLLER are in process and to be completed by Sep 2023
- Magnet closed loop cooling system defined in Specification and P&ID drawing
- Power routing to power supplies defined and cost estimate updated
- Detector and GEM gas systems to utilize existing Hall A gas systems

Main LCW



Hall A Infrastructure

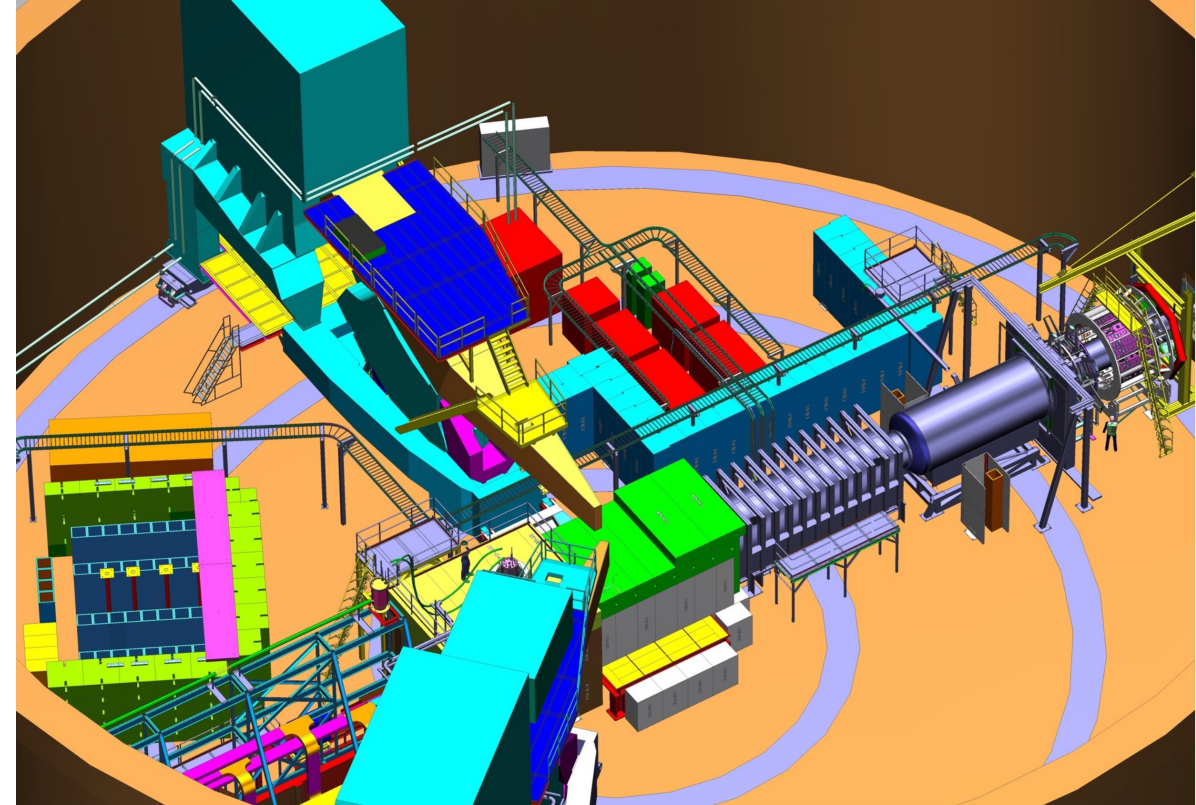


MOLLER Magnet LCW

Infrastructure Summary

Dustin McNulty
mcnulty@jlab.org

- Beamline elements defined and procurements started
- Cables and cable routing defined. Main detector patch panel prototyping started
- Cable tray layout and supports completed; connector strain relief design in process
- Detector support designs nearly completed. Mounting to Hall A floor defined.
- Access platforms defined. Main detector access platform design in process.
- Hall Modifications are defined
- Utilities defined. LCW modification layouts in process. Detector and GEM gas systems defined and will use existing systems.

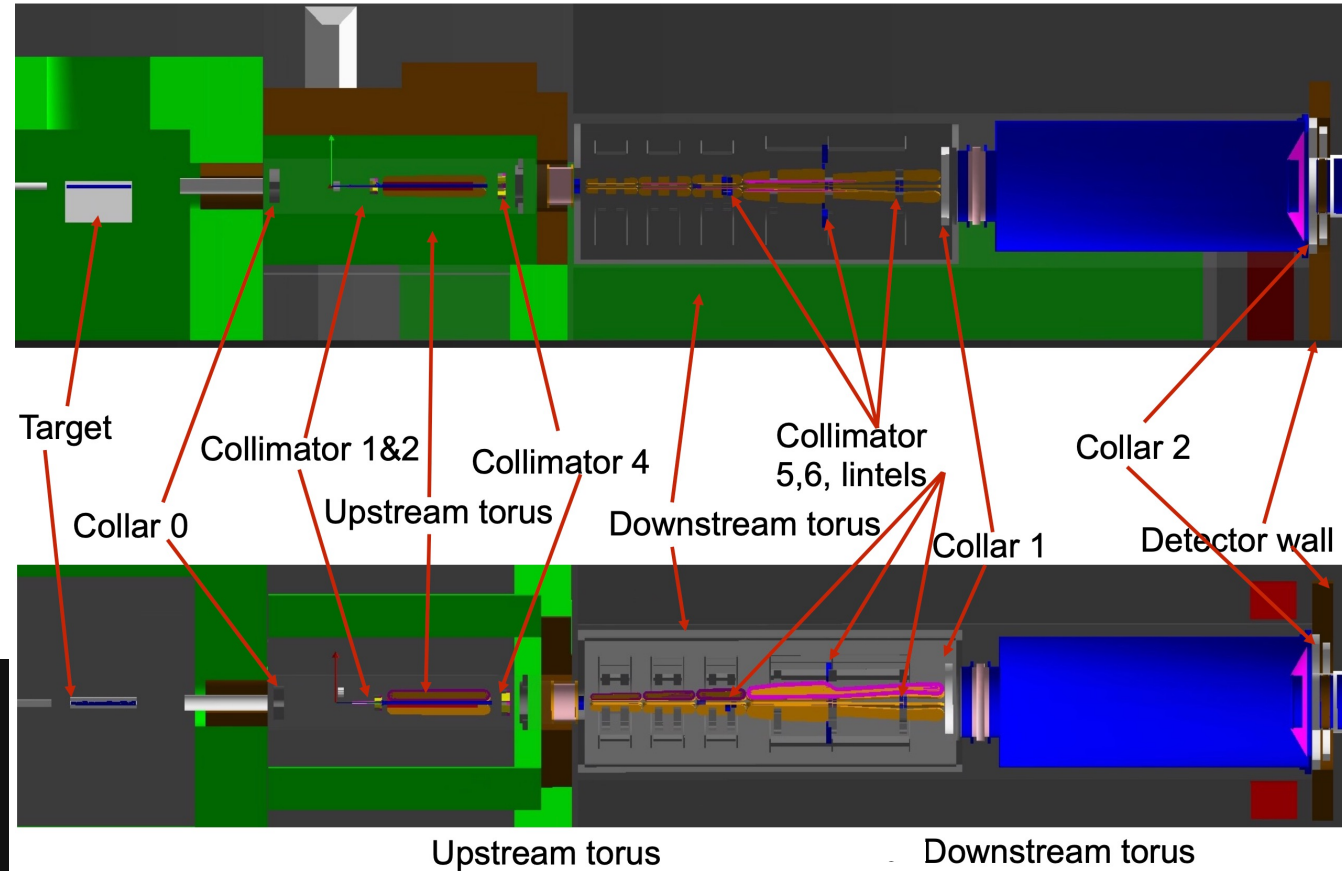


Appendix Slides

1.06.03 Shielding

- Shielding is located around components that absorb significant power:
 - Target
 - Collimators (Spectrometer)
- Sensitive components, detectors/electronics also shielded
 - Existing and MPS Bunkers
 - Detector wall and Pb trays

Component	Power @65uA, 1.25m Tgt
Target	3100 W
Collar 0	275 W
Collimator 1	3700 W
Collimator 2	950 W
Collimator 4	60 W
Coll 5,6, Lintel	<55 W



Boundary dose estimation

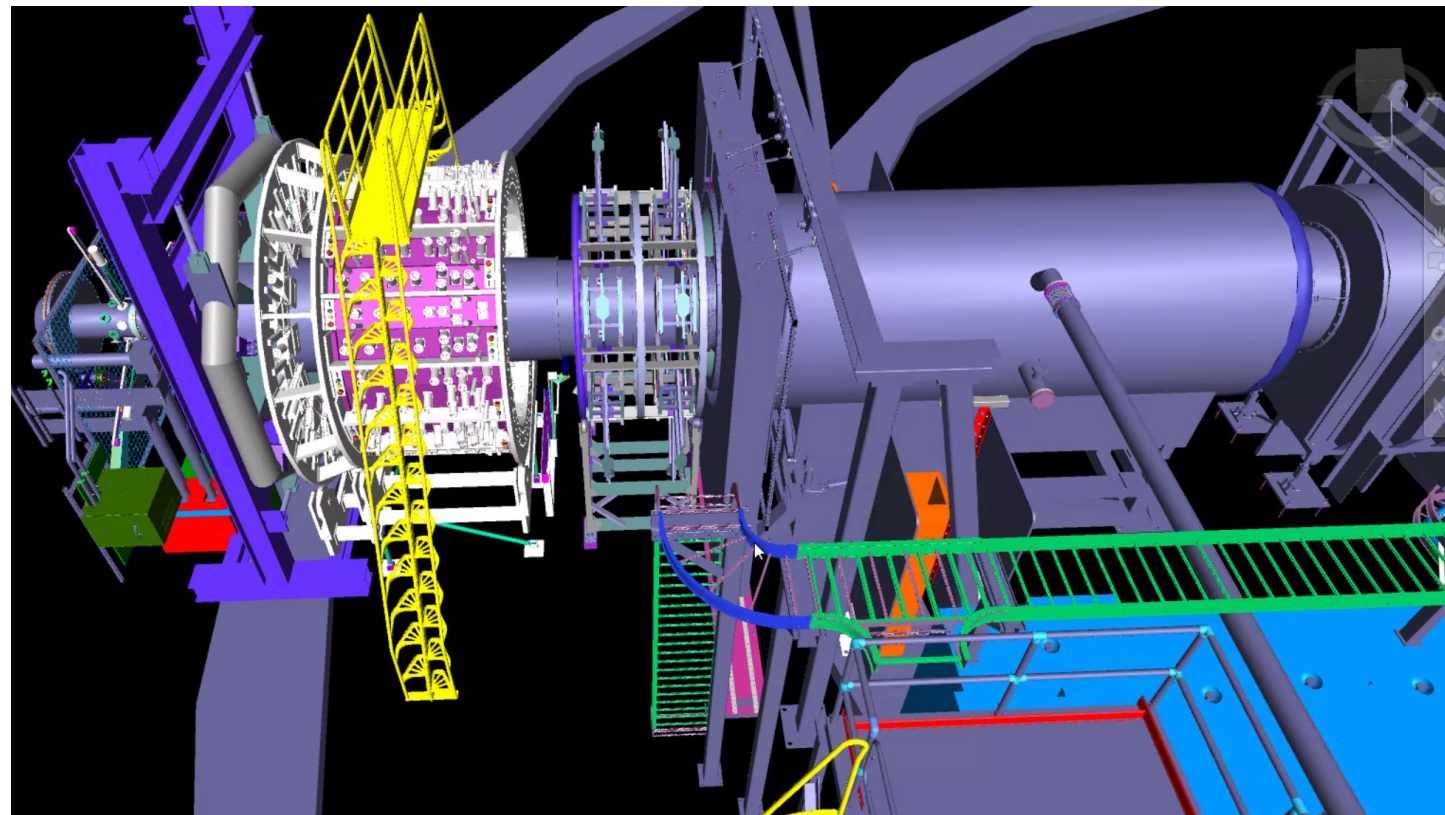


- See later talk by Ciprian Gal for more details
--SC 2: Topic 5: Shielding Physics Design

Sim. framework benchmarked to PREX-2 and CREX data

1.06.04 Cables (Channel Accounting)

- Both integrate- and event-mode:
(needs HV, twinax, coax, and base LV)
 - Main Detectors: 224
(8 per segment, 28 segments)
 - Auxiliary Detectors: 112
LAMs (7x2), US scanner (2), beam halo monitors (2x14), Shower-max (28), Pion detector (28), DS scanners (4), and SAMs (8)
- HVMaps Detectors: 84 (3 arrays per Main detector Segment (power, fiber RO))
- Event-mode only:
(needs HV, coax, fiber RO, and power)
 - GEM Detectors: 28 (7 GEMs per wheel, all 4 wheels (HV and fiber RO))
 - Trigger Scintillators: 14 (7 paddles per wheel for 2 wheels (HV and coax signal))



- ❖ All these cables except HVMaps' power route from detector to the SBS bunker
- ❖ GEM fiber interconnects between GEM electronics racks and SBS bunker electronics

Detailed presentation in docDB # [1050](#)

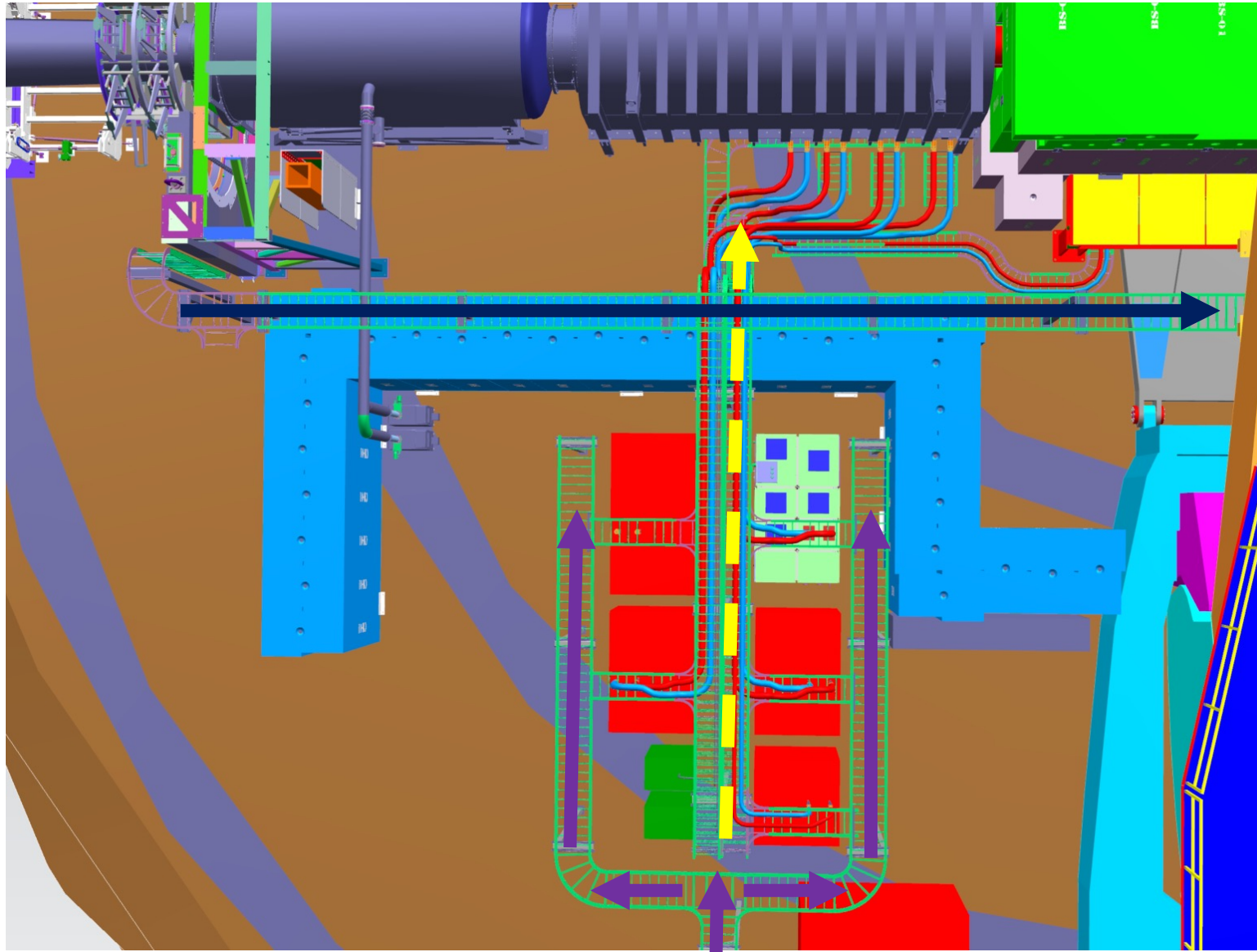
1.06.04 Cables

- All signal and power cables (both counting and integrating) have been defined in concert with the collaboration and will be purchased by this CA
 - The HVMAPS detector system is the exception (CFI scope)
- The main detector signal cables will have a patch panel next to the detector where we can transition to ~250ft long cables to the SBS bunker
- Additionally, ~1/3 of the power supplies (112 auxiliary detector channels) have been identified and we will purchase similar systems as for the main detectors
- We are going to purchase a set of connectors to assemble a prototype patch panel together with long cables
 - Will increase confidence in design and allow for detector segment readout tests

All Detectors		70% packing fraction: 30 bundles			
Bundle No.	purpose	group area (sq.in)	group diam (in)	group width (in)	
		70%	70%	70%	
Main detectors					
1	PMT HV	19.90	5.03	24.19	
2	PMT twinax	19.90	5.03	24.19	
3	PMT Coax	12.74	4.03	19.35	
4	pmt base power	2.25	1.69	8.13	
5	HVmaps fiber RO	1.87	1.54	7.41	
6	Hvmaps power	19.10	4.93	23.70	
7	Hvmaps pow sigs	3.18	2.01	9.67	in feet
Groups 1 - 5 sum		56.65	17.33	83.26	6.94
Groups 6 - 7 sum		22.29	6.95	33.37	2.78 Not included in cable tray sum
Aux detectors					
8	PMT HV	9.95	3.56	12.09	
9	PMT twinax	9.95	3.56	12.09	
10	PMT Coax	6.37	2.85	9.67	
11	pmt base power	1.12	1.20	4.06	in feet
Groups 8 - 11 sum		27.39	11.16	37.92	3.16
GEM detectors					
12	PMT HV	3.98	2.25	4.84	
13	PMT Coax	0.85	1.04	1.29	
14	GEM fiber RO	1.45	1.36	3.77	in feet
Groups 12 - 14 sum		6.28	4.65	9.90	0.82
Total sum in cable tray		90.32	33.15	131.08	10.92

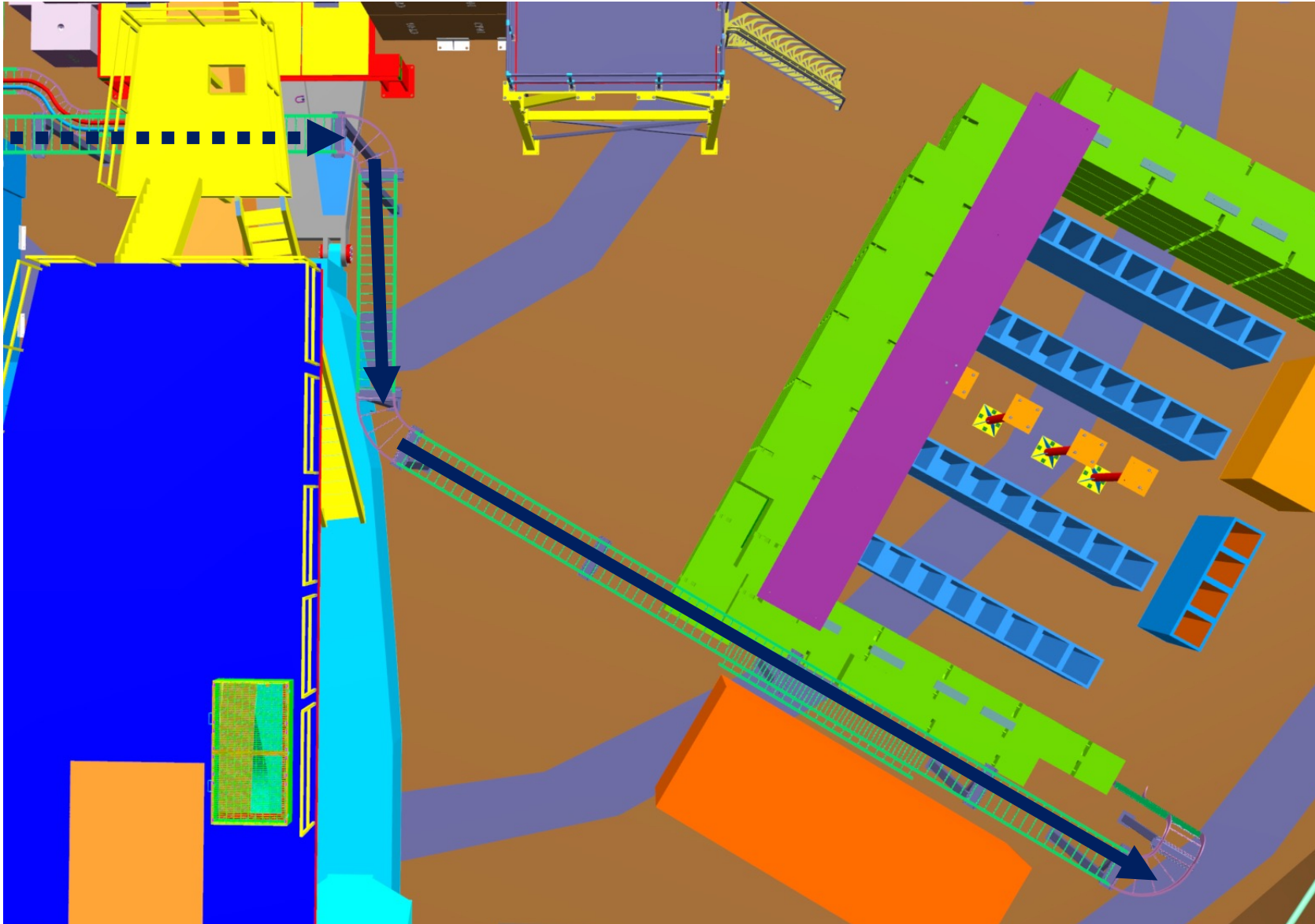


1.06.04 Cables (Cable paths)



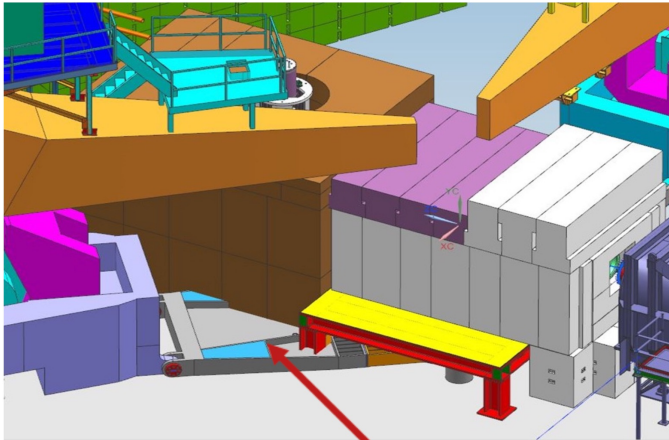
- Detector cables (black) will travel over the MPS bunker and pass over the MPS cables trays
- The MPS are supplied (purple) from the distribution panel at the hall edge
- The power cables and instrumentation readout (yellow) for the magnets will go over the MPS bunker wall and fan out to the different magnets

1.06.04 Cables (Cable paths)



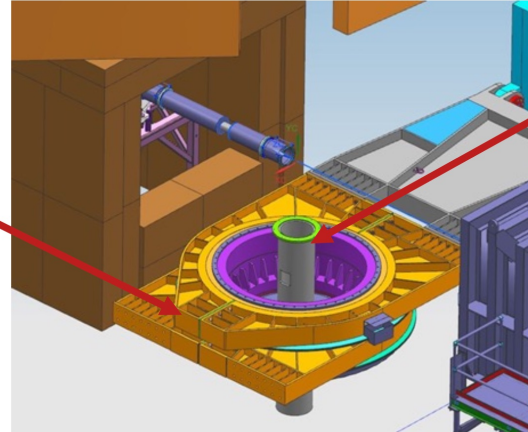
- The detector cables are routed to the SBS bunker where racks are going to be available for the readout and power supplies

1.06.06 Hall Modifications (HRS pivot removal planning)



Existing HRS-R link to pivot bearing is not designed to carry additional vertical loading. Link interferences with target support, shielding and shielding support

Solution- HRS-R remains stationary. Plan to remove HRS-R link and rotate bearing connection to remove interferences.



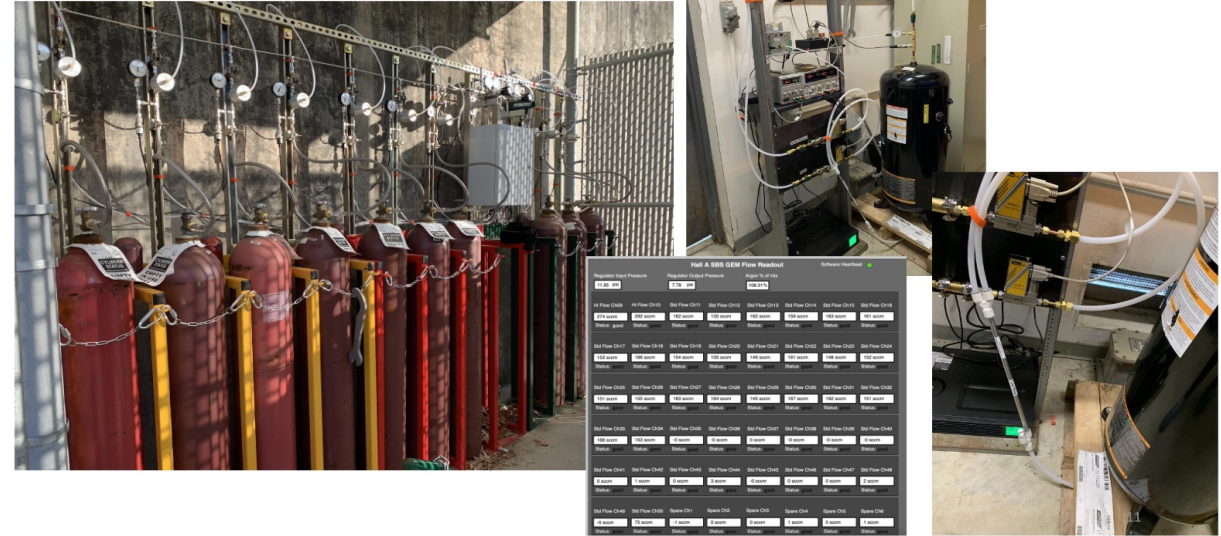
Existing pivot platform interferes with spectrometer shielding region, plan to remove.

- Local rigging contractor provided estimate to complete
- Documentation of link analysis and Statement of Work completed

1.06.06 Hall modifications (gas systems)

- The gas system for MOLLER will reuse as much of the existing equipment as possible
- For the GEMs the SBS experiment already has a gas system that has been used for much larger area GEMs
 - We will reuse the basis setup and redo the piping in the hall leading to the detectors
- The main detectors will use the existing Hall A gas system
 - Calculations were done that showed the current compressor provides enough flow to purge the air in all the detector lightguides

GEM gas system already used in SBS

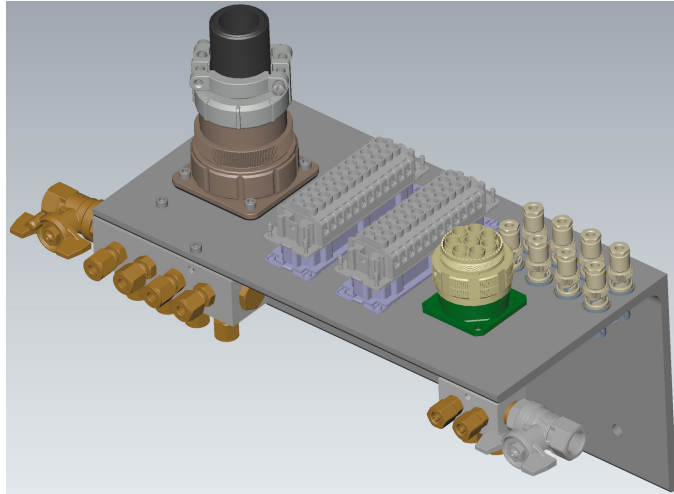


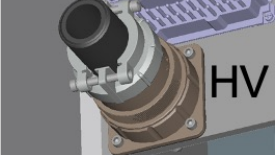


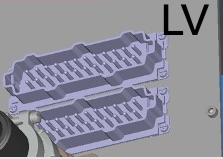
Infrastructure ES&H and QA

- All components governed by JLab ES&H manual requirements and JLab QA program
- Shielding specification and fabrication defined by structural concrete building codes: ACI318-11, ACI 117, ACI 301-10 and SF-2.0
- Shielding materials require material certifications
- Structures fabricated and inspected according to JLab Welding Specifications
- LCW and gas systems designed according to ASME Pressure System codes
- Access platforms and shielding access require JLab fall protection and elevated work regulations
- Utilizing commercially available platforms and ladders fabricated to OSHA standards
- Cables, connections and cable supports defined by JLab Electrical Hazard Program
- ODH and flammable gas hazards minimized in design of shielding areas
- Confined space hazards minimized in design of shielding areas

Minimum mating cycle specs for main detector patch panel connectors

Main detector patch panel



Connector purpose	Connector description	Manufacturer Specs: Insertion Loss/min. mating cycles
PMT high voltage (HV) 	GES High Voltage Inc. --Panel mount receptacle 8pin, 2.7mm female contacts Ag-plated --Cable mount plug, male contacts	"High quality contacts for up to 100 tsd. mating cycles"
Integrate mode signal 	8 standard, individual twinax female-to-female feed throughs with male cable connectors on each end (Twin-BNC, bayonet)	Amphenol website says their standard Twin-BNC connectors have 500 minimum mating cycles
Event mode signal 	Amphenol --Panel mount receptacle 8pin, RG58 female contacts Au-plated --Cable mount plug, male contacts	"1500 connector and contact couplings minimum" --Mil-approved plating process
PMT base power (LV) 	Weidmüller: HDC HE 24 --panel mount 24 pin receptacle --cable mount 24 socket plug	"Plugging cycles, silver \geq 500"