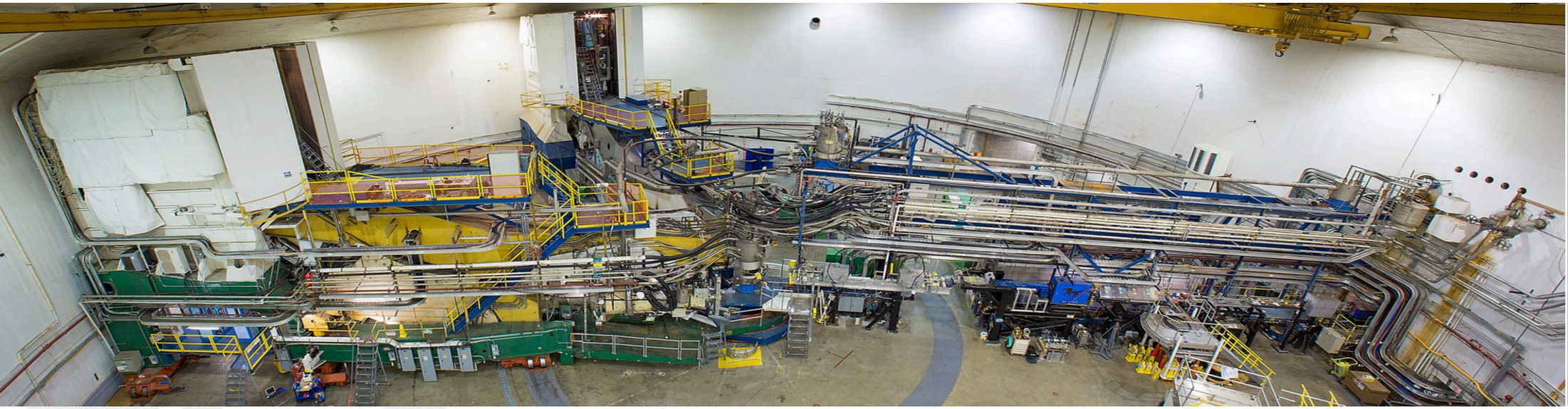
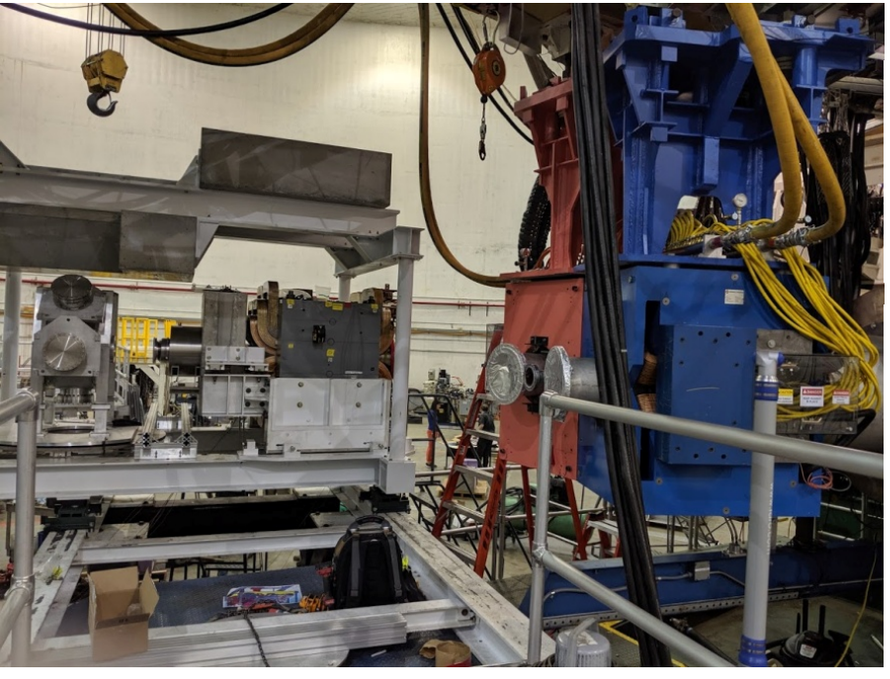
Hall A Update

Super BigBite Spectrometer Collaboration Meeting
July 14, 2020



Thia Keppel

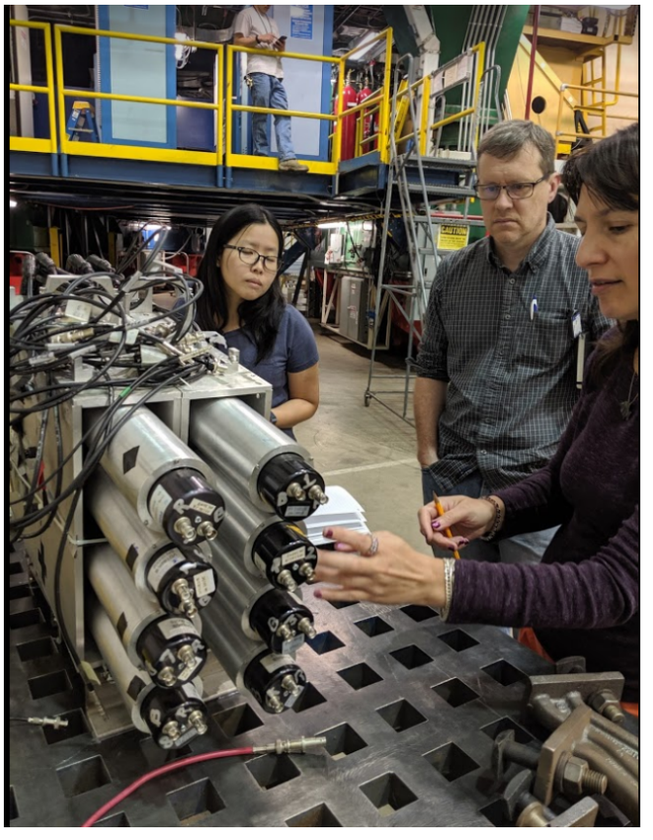


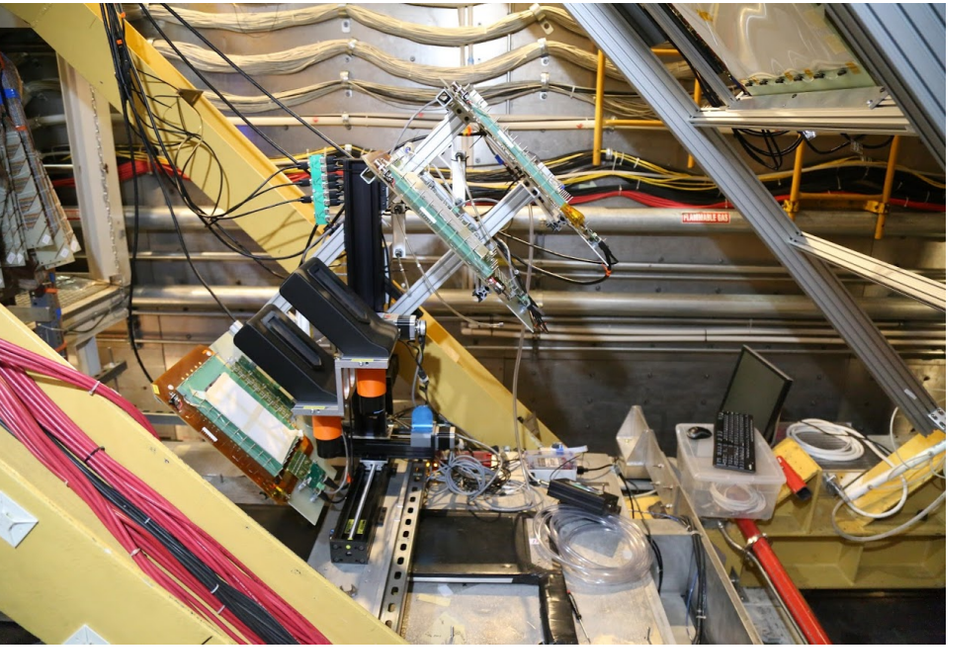
CREX

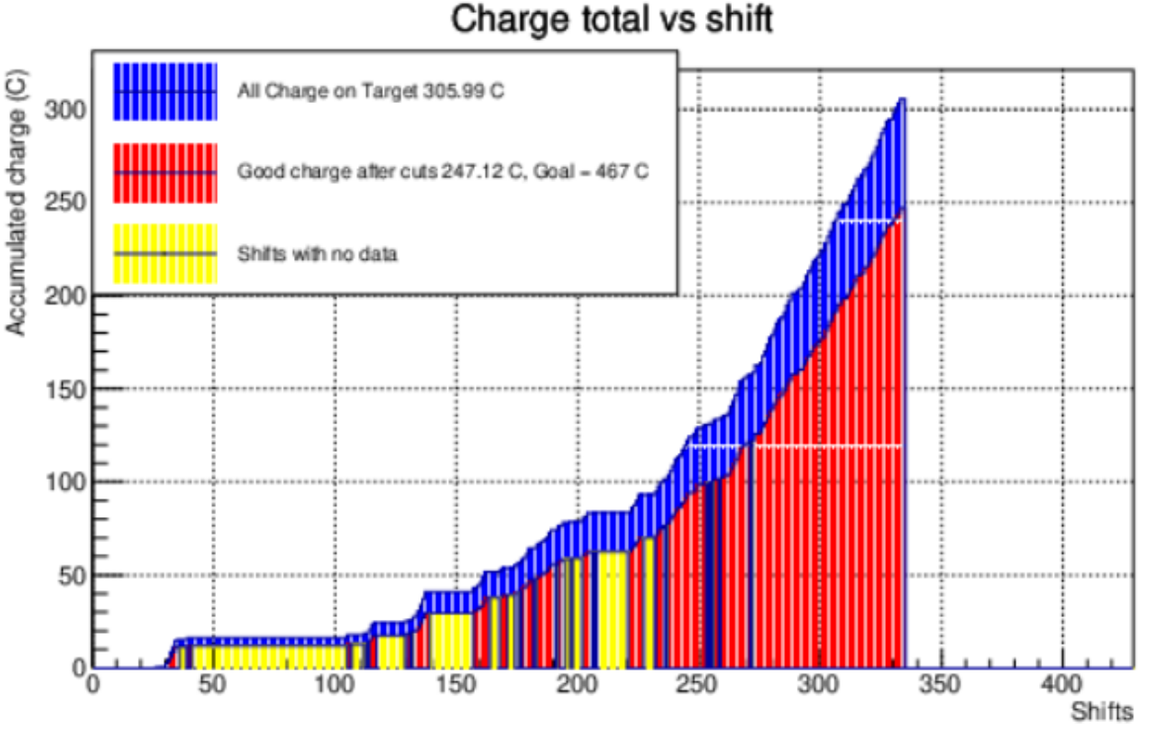
Electroweak asymmetry on ^{48}Ca to measure the weak charge

Getting ready to resume!

- Work planning – in Hall, shift crews,….
- Spectrometer magnets
- Target (re-installation)
- Polarimeter fixes

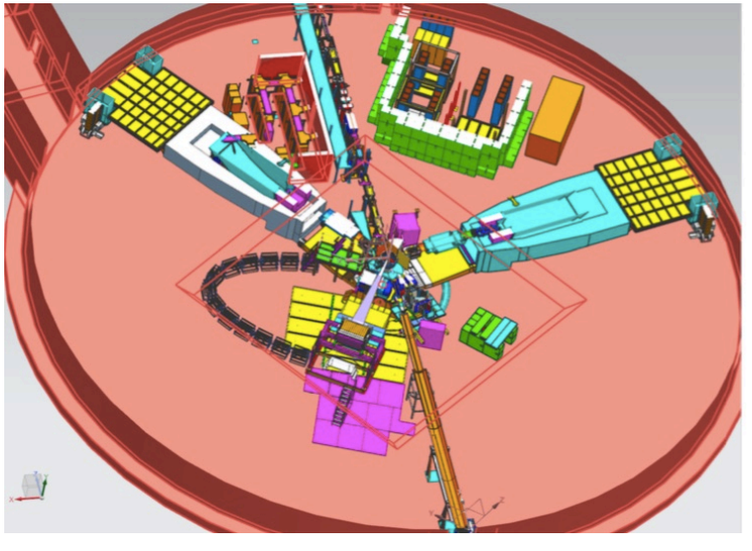






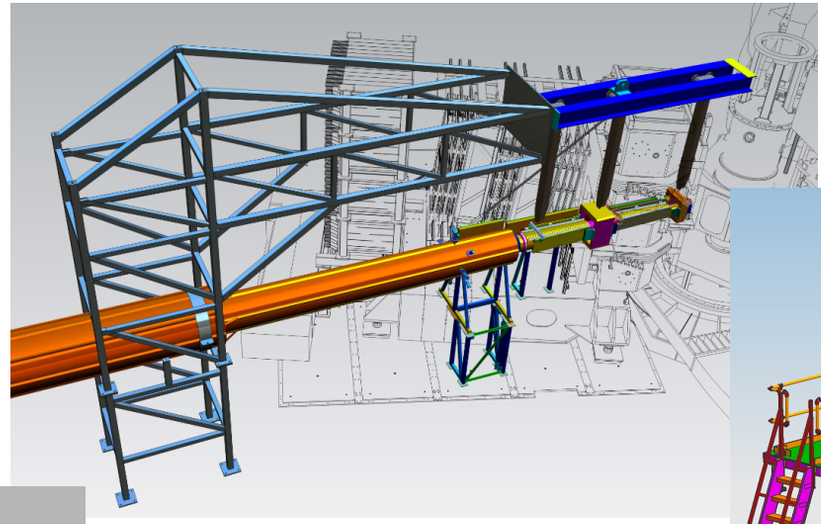
Planning for SAD 2020 (i.e. SBS installation!)

- Remove PREX2/CREX Equipment
- Upgrade LCW System *(parts ordered, documentation in process)*
- Assemble SBS Equipment
  - Install SBS Magnet & Detector Systems
  - Install Big Bite Magnet & Detector Systems
  - Install Target Chamber, Exit Beamline, and Tower Assembly
  - Install Electronics Bunkers
  - Equipment Commissioning and Testing



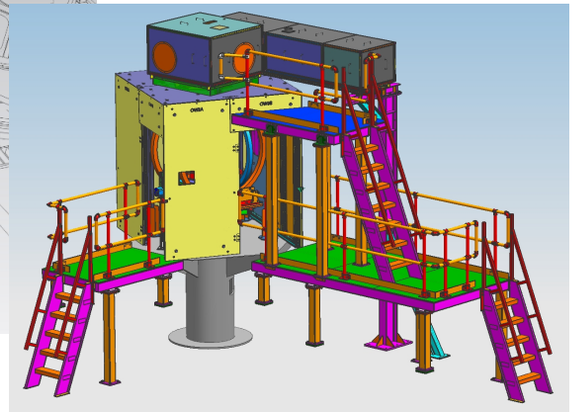
- Decommission HRS-R
  - Warmup Cryogenic system.
  - Rotate HRS-R pass rollup door
  - Cool down and cleanup HRS-L cryogenic system
- Facilities Work List
  - Hall power upgrade *(contract in place for upgrade to 2MVA)*
  - Move small AHU, replace main (overhead) AHU
  - Move various electrical connections along the wall
  - *Changeout overhead lights*
  - Repair ground water leak near Compton

Continued Hall Emphasis: SUPER BIG Efforts for SUPER BIGBITE SPECTROMETER Installation

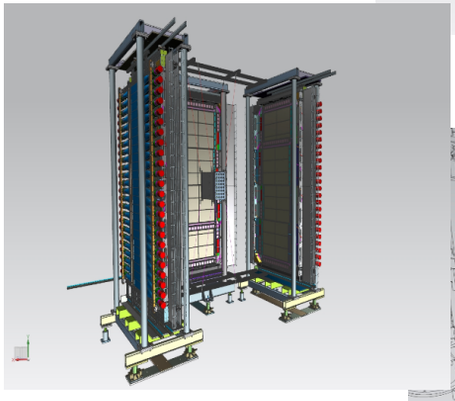


Shielded beamline

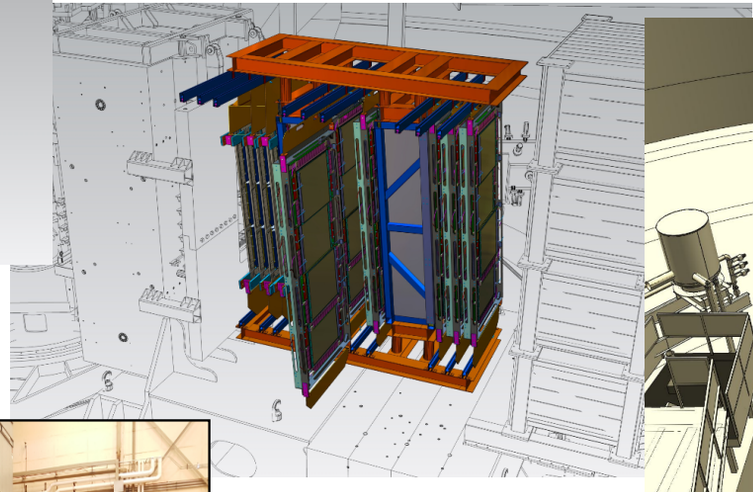
Polarized
3He Target

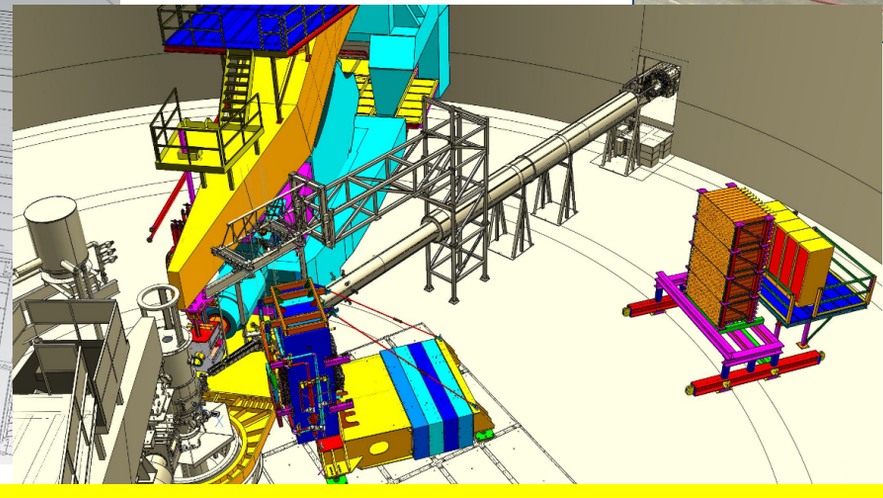


Dipole magnet



Gen-RP
detectors





GEM
detectors

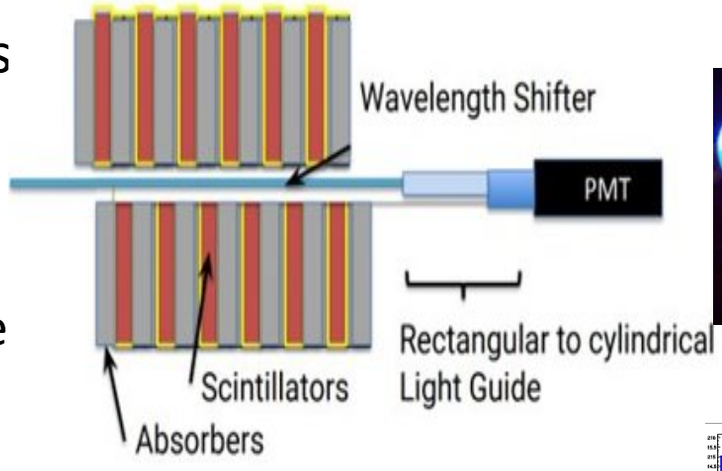
Counterweight
support

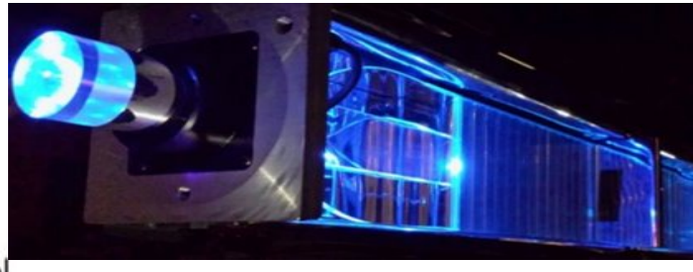
- Layout of equipment for **14 different configurations**
- Installation planning - assuming COVID restrictions!
- Preparation for multiple experiments utilizing SBS (Gen-RP, GMn, GEn, GEp, SIDIS, TDIS……..)

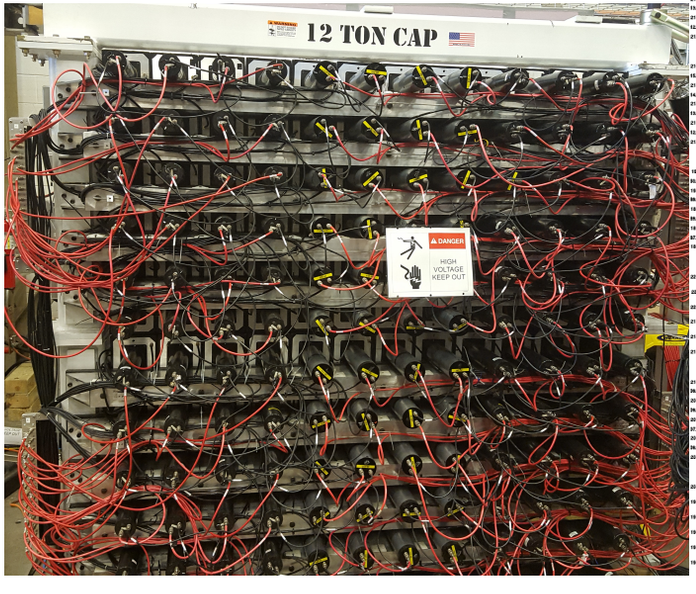
Jefferson Lab

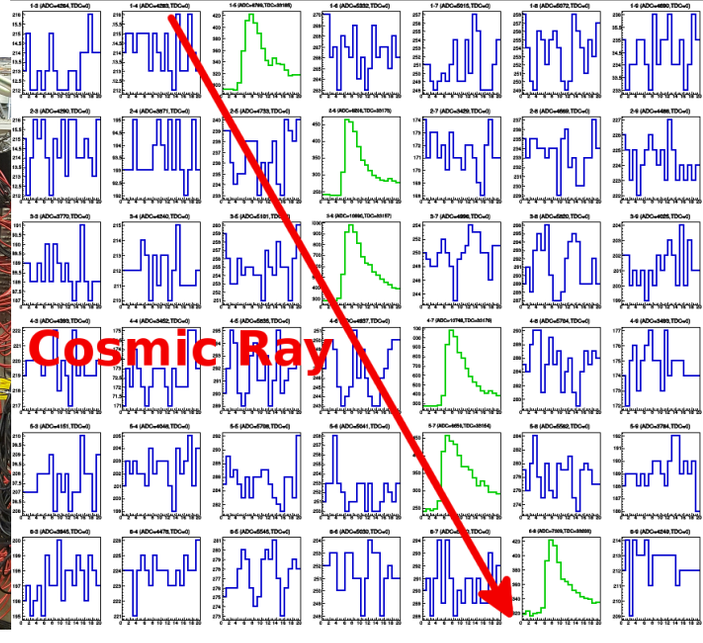
Hadron Calorimeter (JLab, CMU, INFN Catania)

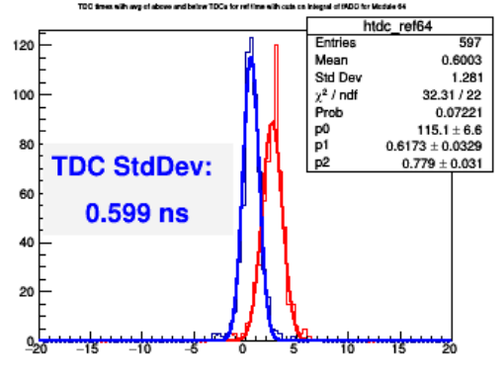
- Detects multiple GeV protons and neutrons.
  - 40 iron layers (absorbers) create particle showers.
  - 40 scintillator layers sample energy.
- 288 modules over 4 subassemblies.
  - Fully assembled and cabled.
  - Data acquisition system operational.
- Cosmic ray tests underway.
- Approaching 0.5 ns timing resolution goal

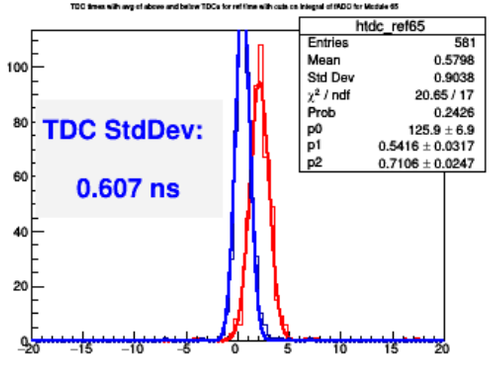


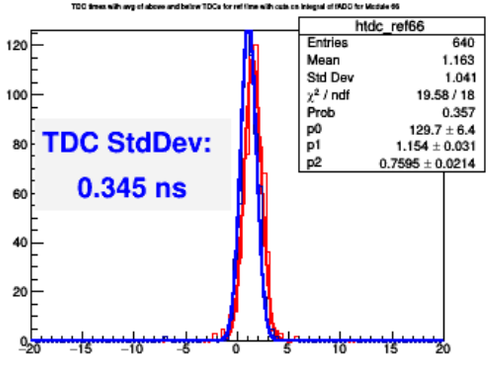


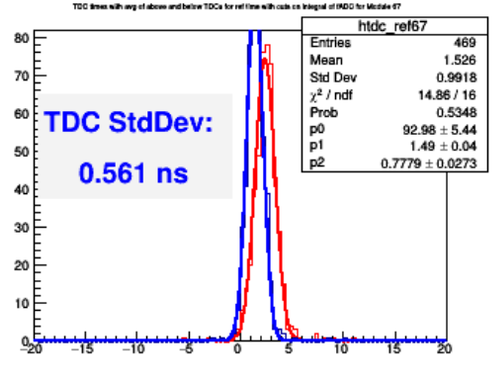










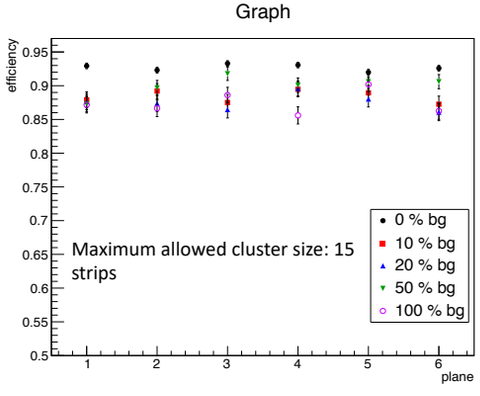


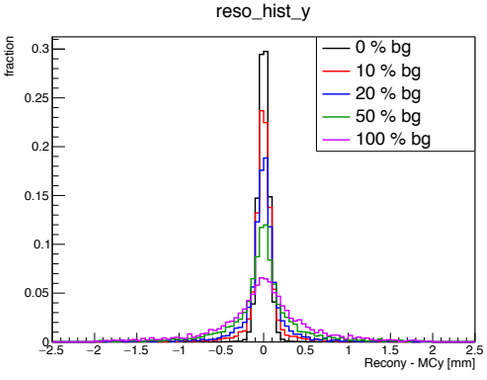
SBS GEM-based tracking (UVA, INFN Rome, HU, Uconn, JLab)

- Assembly of five ***50x60cm²*** modules into one chamber
- Five chambers assembled. Schedule to complete remaining six chambers is six months
- A testing "factory" with large scale DAQ setup
- Have engaged Physics Division Detector and Imaging group for general GEM development and support (also CLAS12, SoLID, TDIS,..)

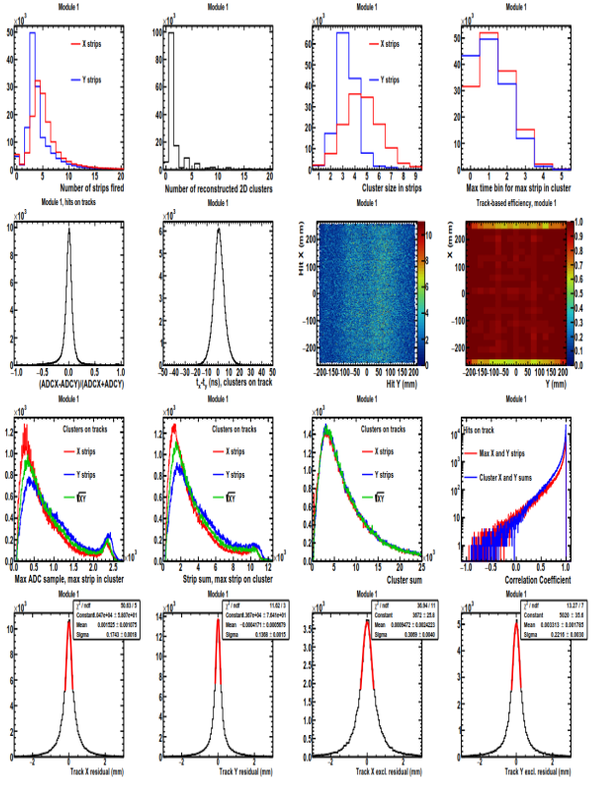
GEM efficiency and resolution

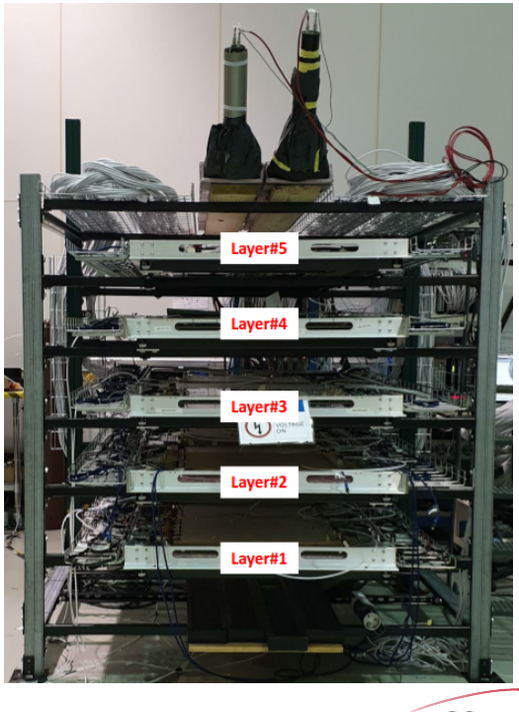
- GEM efficiency and resolution with the current algorithm
- GEM is counted as efficient if there is a reconstructed hit within +/- 5 strips (2mm) around the MC hit
- GEM resolution: the difference between the MC hit and its closest reconstructed hit within the +/- 5 strips range





Simulation



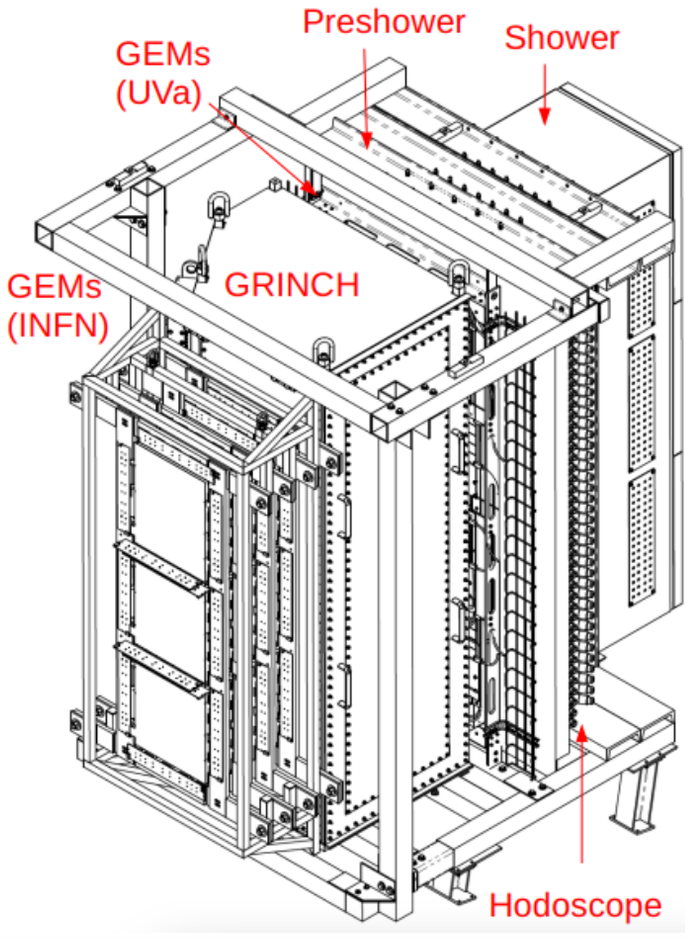


Cosmic ray test stand

Hall A SBS, MOLLER, SoLID Experiments

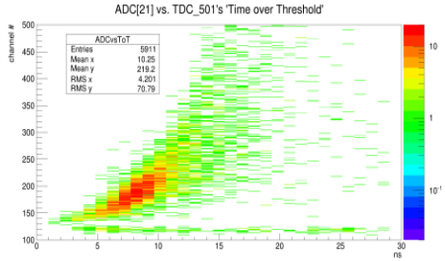
Jefferson Lab

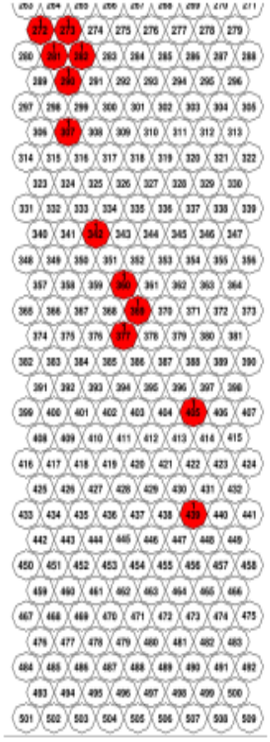
BigBite Detector Package



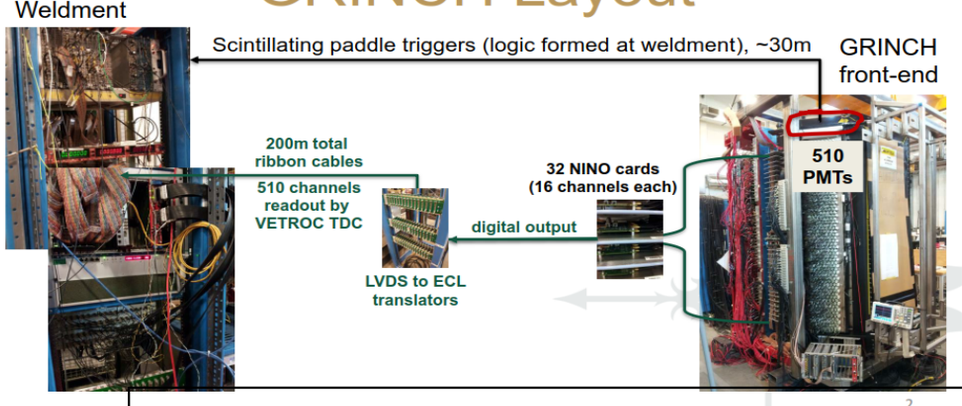
Gas Cherenkov (W&M, JMU, NCA&T)

- 510 PMT are being calibrated using cosmic data by comparing ADC to TDC Time-over-Threshold.





GRINCH Layout



Hodoscope (Glasgow U, JLab)

- Counter holding method was improved.
- Rigidity of individual counters is improving.
- Front-end electronics was installed
- DAQ is under commissioning

Preshower & Shower (JLab, Uconn, Yerevan)

- Cosmic testing done to measure each block's gain versus HV
- Lower performing blocks were replaced in the Shower.
- Preshower blocks were replaced with radiation hard from HERMES
- Magnetic shielding on shower and preshower upgraded to meet field conditions during GMn experiment.

GEM chambers (UVa, INFN/Sanita)

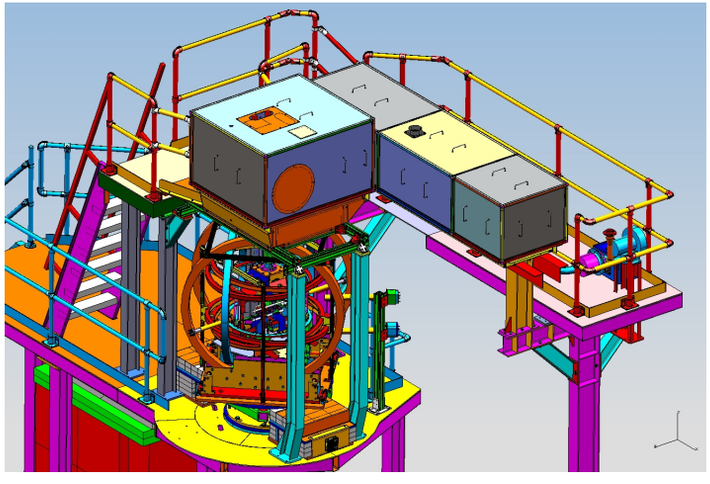
- Rear chamber was test installed
- Front holding frame was optimized for operation
- Two extra chambers with UV strip orientation are under construction

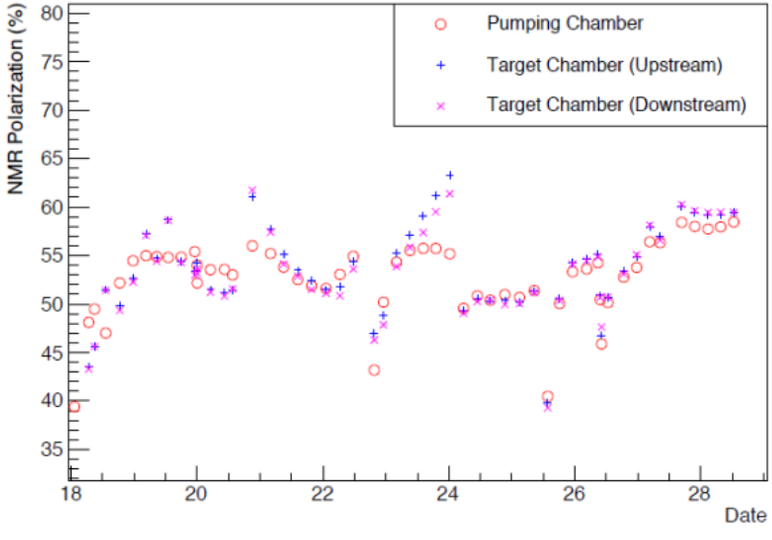
12-GEV PHYSICS SUPPORT: POLARIZED 3HE

Polarized ^{3}He for A1n/d2n experiment in Hall C

- ✓ 30 μA on 40 cm, ~10 atm ^{3}He gas
- L ~ 2.2x10^{36} cm^{-2}s^{-1} – x2 previous highest L
- ✓ In-beam polarization ~ 55%
- Polarimetry precision ~ 3%

Main challenge was to resume cell production

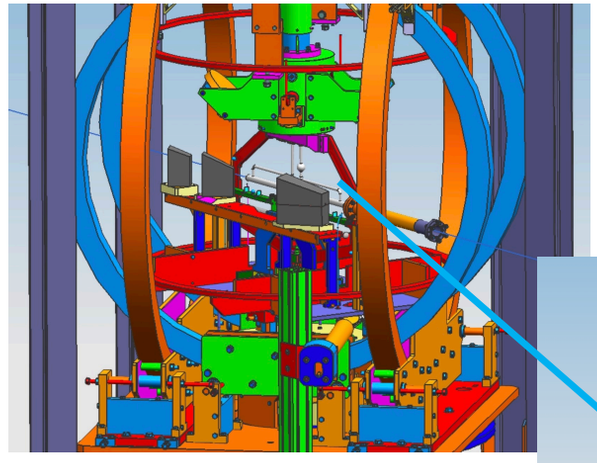


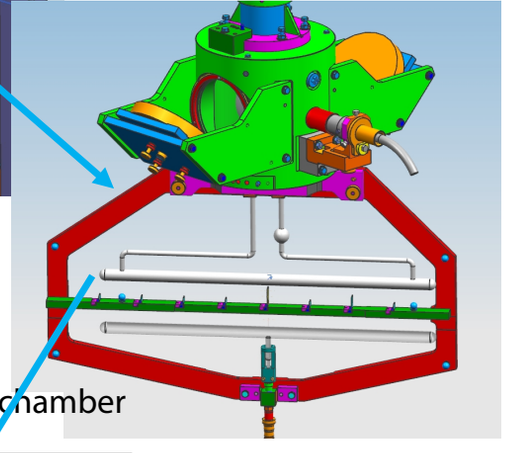


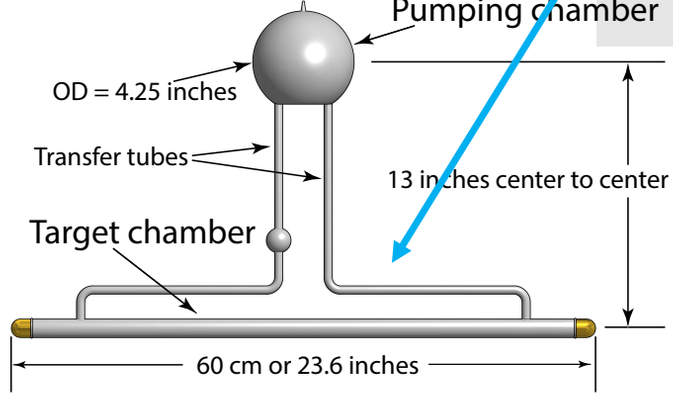
Polarized ^{3}He for GEn experiment in Hall A

- 60 μA on 60 cm, ~10 atm ^{3}He gas
- L ~ 6.6x10^{36} cm^{-2}s^{-1} – x3 higher L again
- In-beam polarization ~ 55-60%
- Polarimetry precision ~ 3%

Main challenge: glass/metal end window of cell



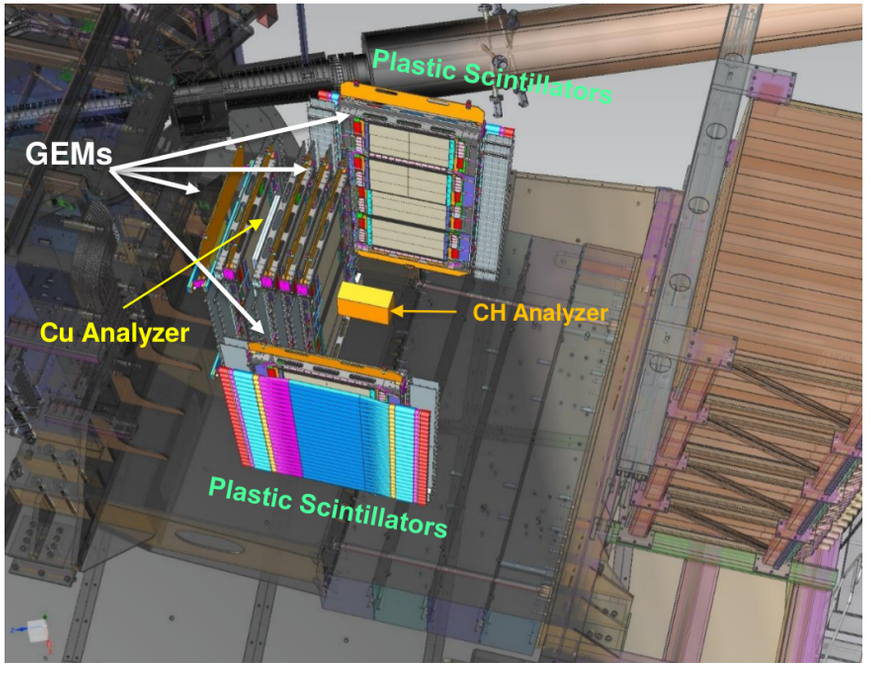




Jefferson Lab

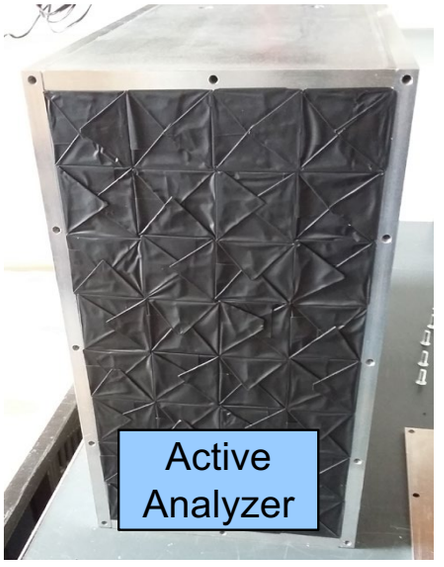
Readying Additional Hardware for G_e^n-RP / E12-17-004

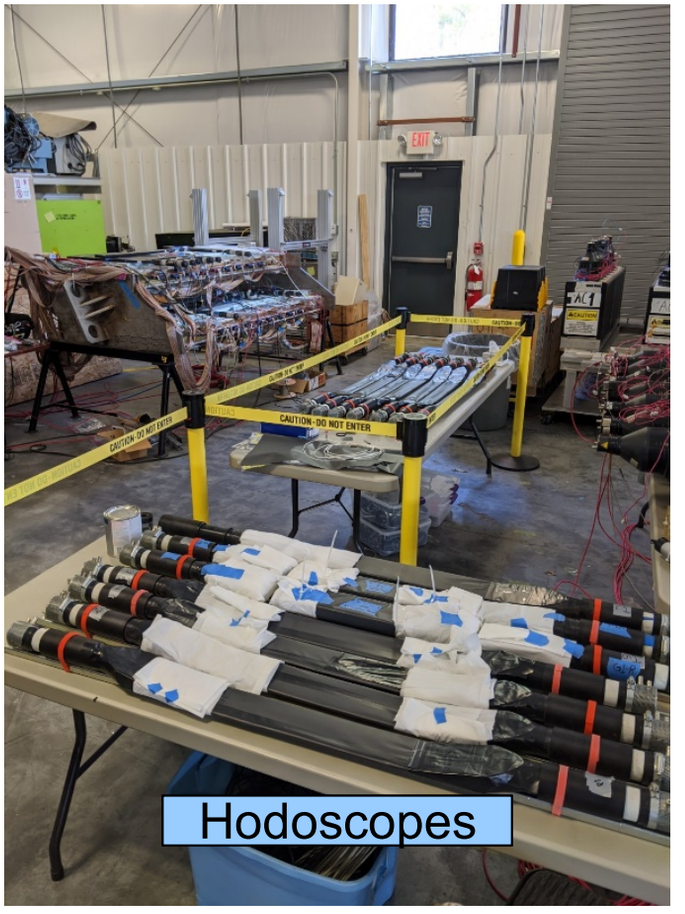
- Active Analyzer (RP)
  - → segmented plastic scint. array
  - → np recoil vertex identification
- Recoil proton detectors (RP)
  - → 2 packages total:
    - » One on SBS Left
    - » One on SBS Right
  - → Each package contains
    - » 1x Hodoscope array
      - – timing, coarse location
    - » 2x UVa GEM planes
      - – proton tracking
- Inline GEMs (R + ChEx)
  - → 2x INFN + 6x UVa GEMs
  - → charged particle veto
  - → large angle proton tracking (RP)
- Steel Analyzer (ChEx)



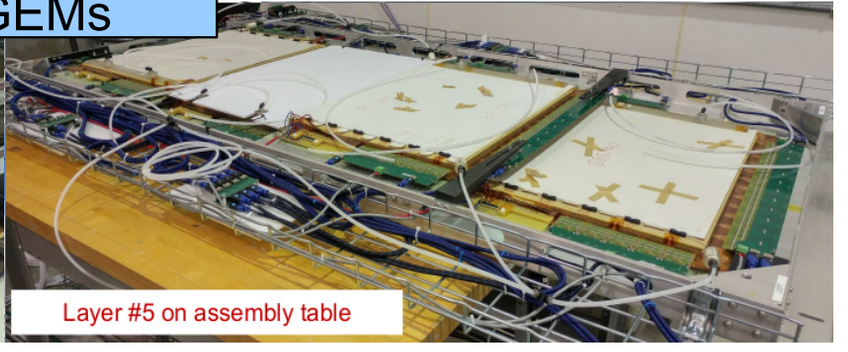
G_E^n-RP Status

- ERR
  - → Some ongoing questions from the ERR Committee regarding GEM status need resolution
    - Significant benefit to entire SBS program – accelerates GEM schedule
  - → **October 15 deadline allows for scheduling**
- E&D work continues
- Adds substantially to installation





GEMs



PREX2/CREX as (one) GEM testing ground

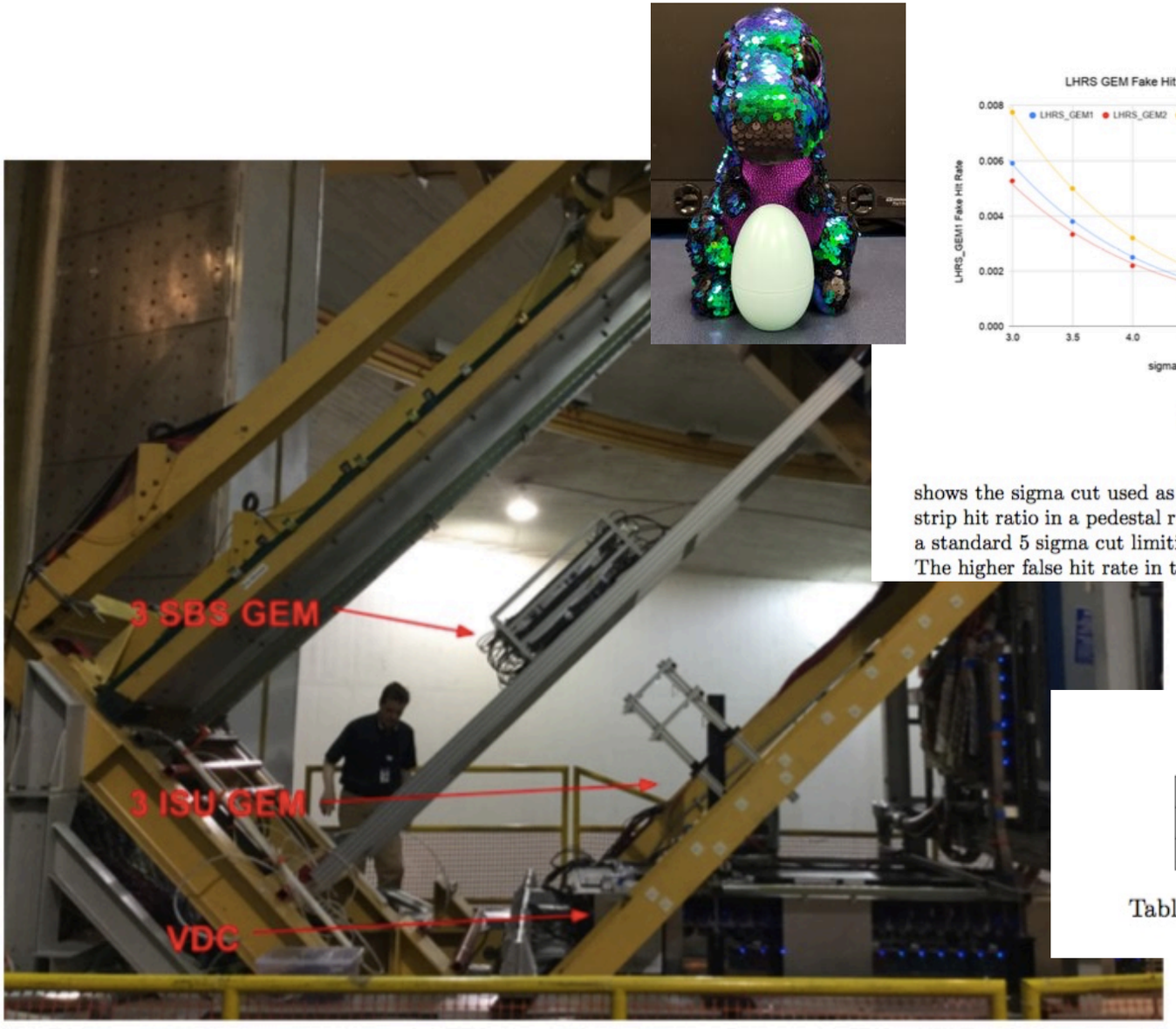


Figure 16: PRex Experiment GEM detectors Layout

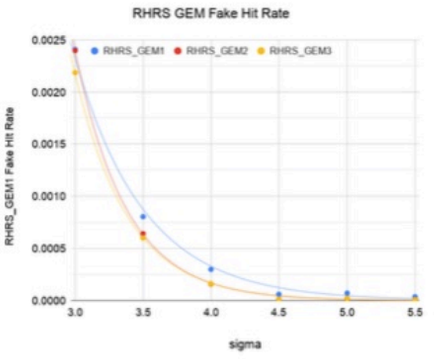


Figure 19: PRex GEM Fake Hit Rate

shows the sigma cut used as a threshold to identify the effective signals. The Y-axis is the false single strip hit ratio in a pedestal run. As expected the increasing threshold reduces the false hit probability; a standard 5 sigma cut limiting the false hit possibility to $1*10^{-4}$ for RHRS and $1.5*10^{-3}$ for LHRS. The higher false hit rate in the LHRS is due to the higher LHRS pedestal noise levels shown in fig 17.

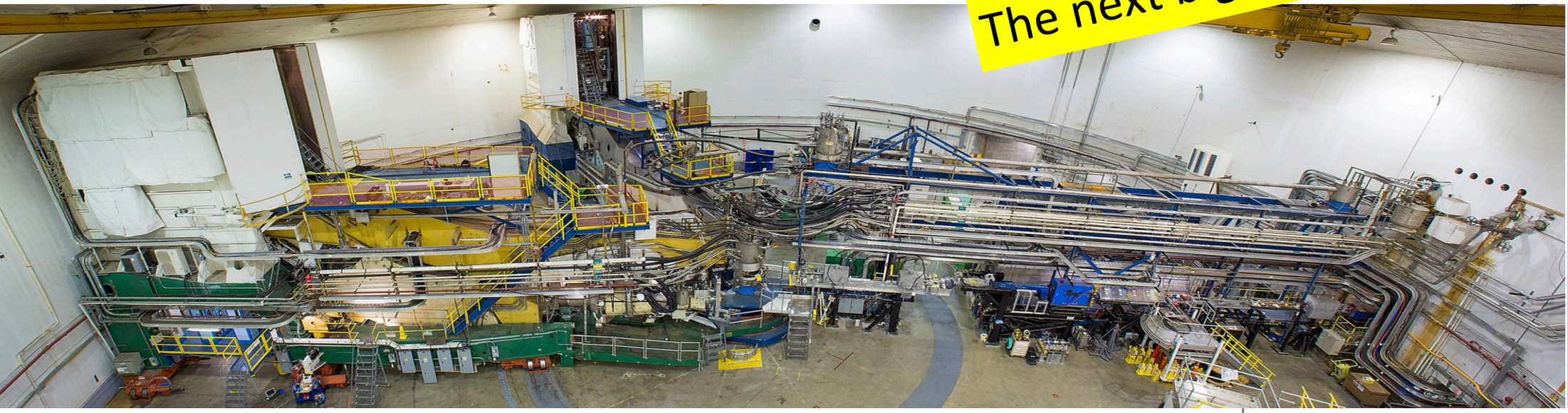
Figure 18: GEM Efficiency Map

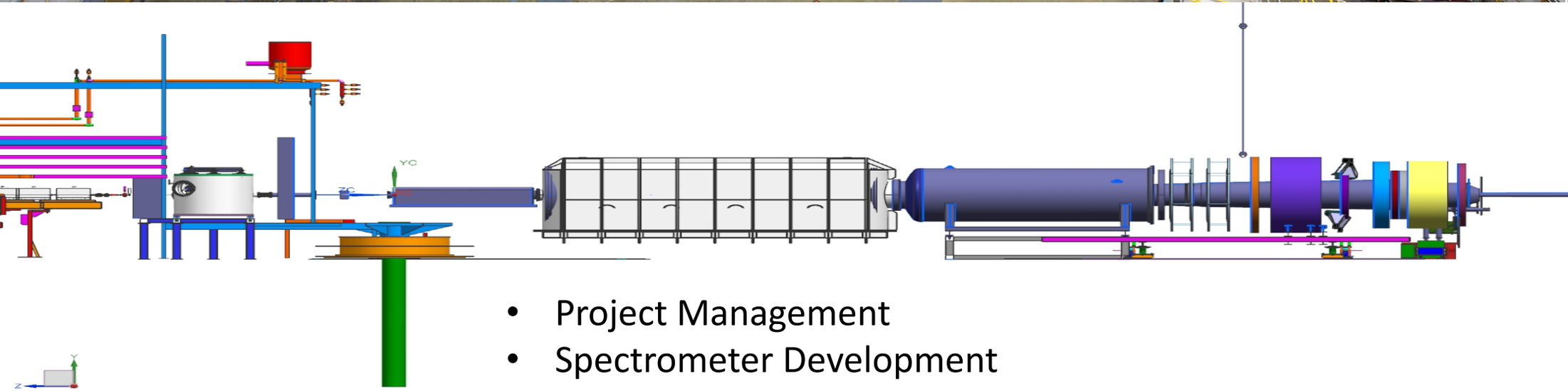
HRS	LHRS			RHRS		
Module	1	2	3	1	2	3
Efficiency	88%	76%	92%	88%	93%	94%

Table 2: PRex GEM Detector hits near (projected) VDC track

MOLLER

The next big E&D push

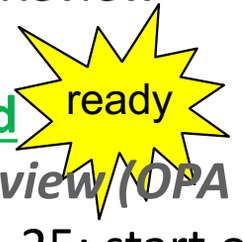




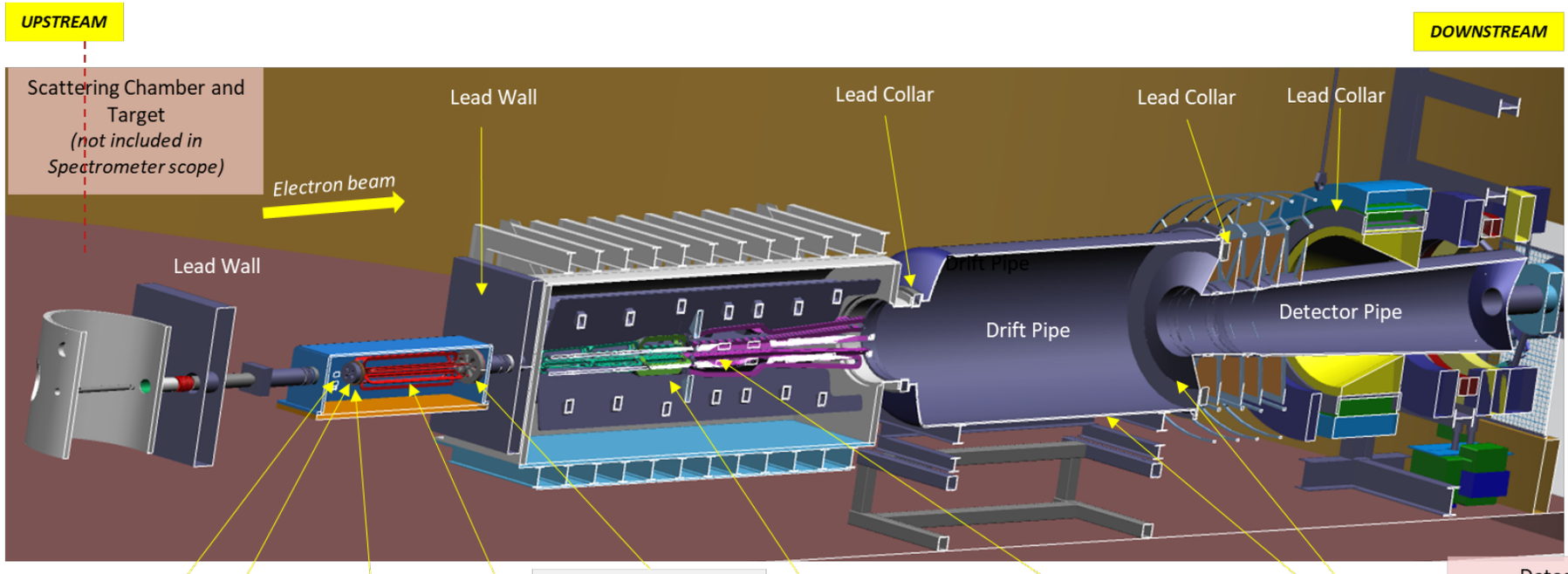
- Project Management
- Spectrometer Development (Physics Division Magnet Group)
- Detector and Integration (Hall A)

MOLLER Timeline

- 2009: Approved by PAC
- 2010: Assigned A rating and awarded full beam time request of 344 PAC days
- 2014: DOE Science Review, Strong Endorsement
- December 2016: Director's Technical Cost and Schedule Review
- ***CD-0 achieved on Dec. 21, 2016*** *with caveat that project is "paused"*
- 2015-2018: Work continues on physics design and simulation of apparatus
- ***2019: Project restarted*** and OPC funding provided for preconceptual design and planning
  - Ongoing Computational Fluid Dynamics calculations for 4 kW LH_2 target
  - Spectrometer magnet – hybrid vs segmented coil design
  - Evaluated vacuum vs inert gas in spectrometer – decision to use vacuum
  - Optimized quartz detector geometry and acceptance
  - Ongoing conceptual design for support structures and shielding requirement evaluations
- April 2019: Director's Technical Cost and Schedule Review
- November 2019: Cost Review
- December 2019: Conceptual Design Review
- January 2020: Director's Technical Cost and Schedule Review
- May 2020: New Project Manager Jim Fast starts
- **August 18-21 2020: CD-1 Director's Review scheduled**
- ***September 22-24 2020: CD-1 Independent Project Review (OPA review) scheduled***
- Design and prototyping in FY21-22; construction FY23-25; start of operations late FY25



Spectrometer Design (JLab, Manitoba)



1.03.05 Blockers #6 and #7
(for calibration and background checks) – not shown in this image

1.03.05 Collimator #1
(Primary beam intercepting collimator)

1.03.05 Collimator #2
(Primary acceptance defining collimator)

1.03.05 Collimator #4
(Secondary acceptance defining collimator)

1.03.03 Upstream Torus
(Pre-bending of particles)

1.03.02 Downstream Torus
(Focusing and separation of particles)

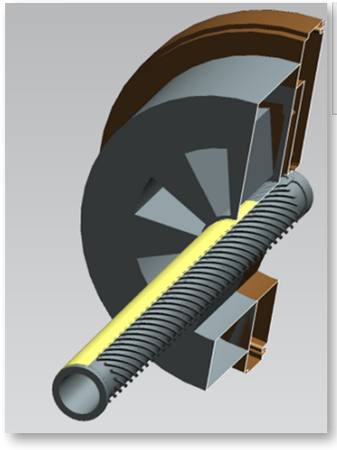
1.03.05 Collimator #5
(Photon blocking collimator)

Detectors
(not included in Spectrometer scope)

1.03.07 Beam Pipes and Window

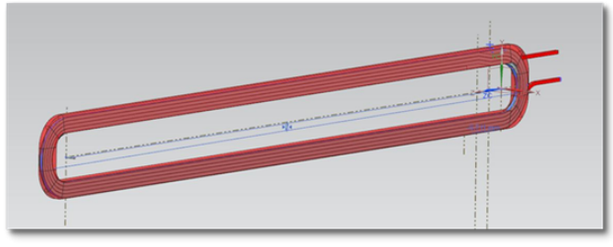
Not shown here:
- **1.03.04 Field measurement system**
- **1.03.06 Water chiller**
- **1.03.08 Shielding supports**

[Note: There is no Collimator #3]



A. Combined Collimator #1 & #2

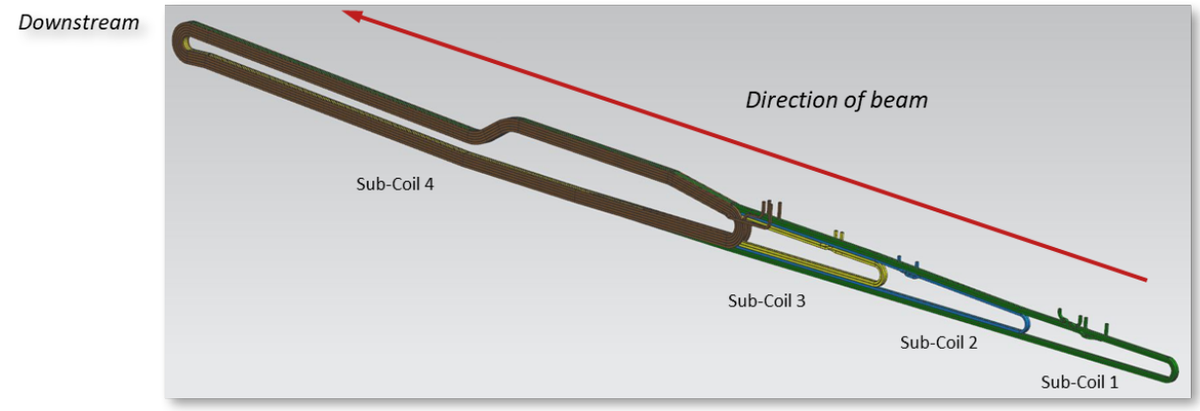
B. Upstream coil – 7 off – simple pancake

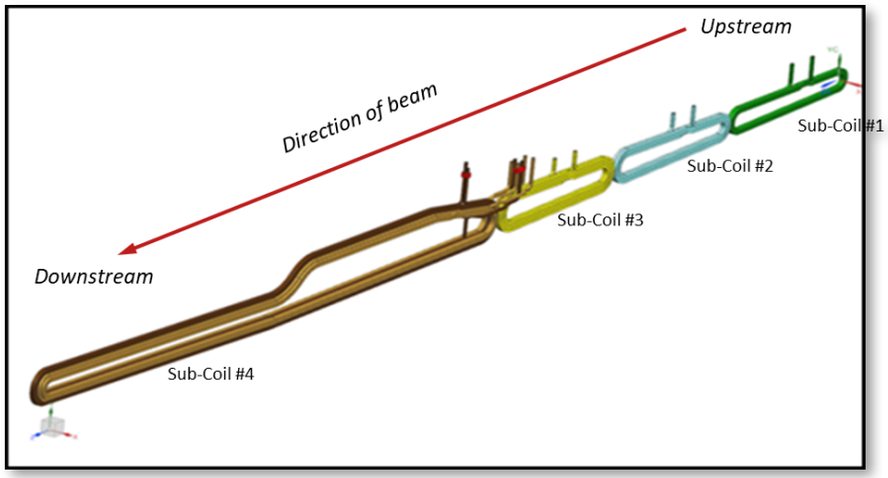


Jefferson Lab

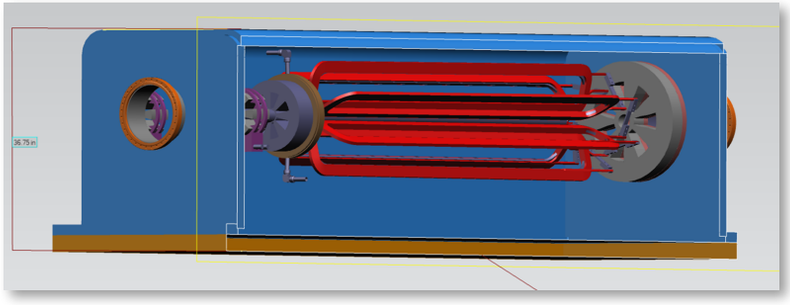
Spectrometer Design (JLab, Manitoba)

C. Downstream coils – 7 off (2 possible designs)

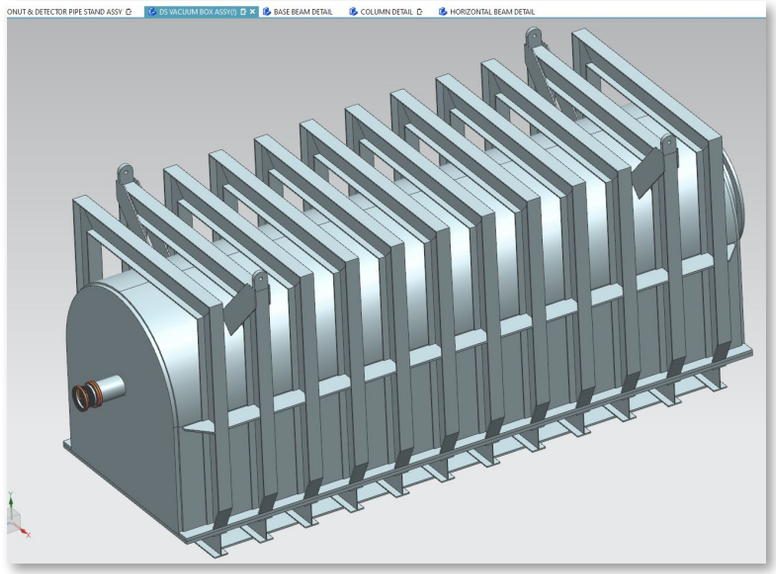




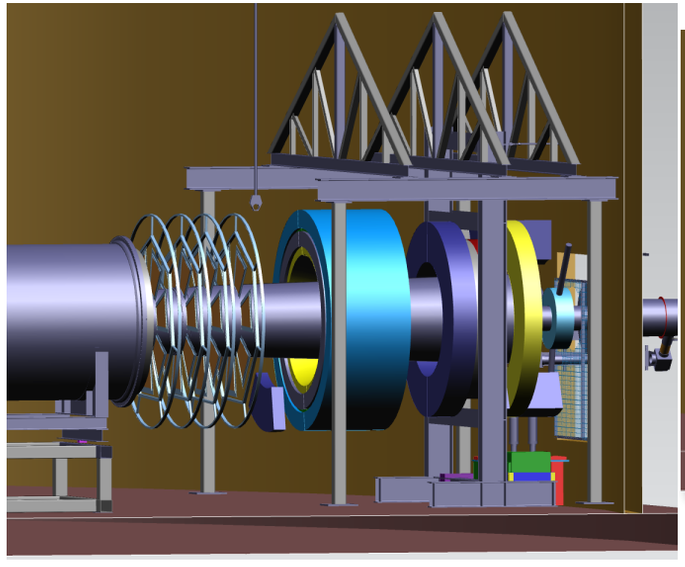
D. Upstream magnet vacuum enclosure

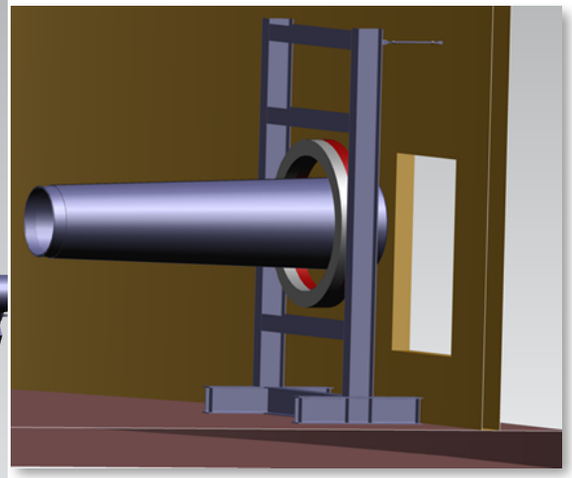


E. Downstream magnet vacuum enclosure



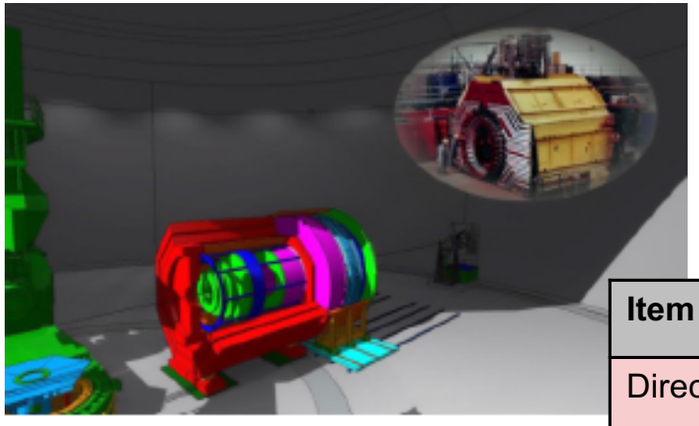
F. Detector Frames





Jefferson Lab

SoLID Timeline Overview
Proposed QCD & Fundamental Symmetries MIE



Unique Capability:

- ✓High luminosity (10^{37-39})
- ✓ Large acceptance detector with full ϕ coverage

Science Review – proposed late 2020

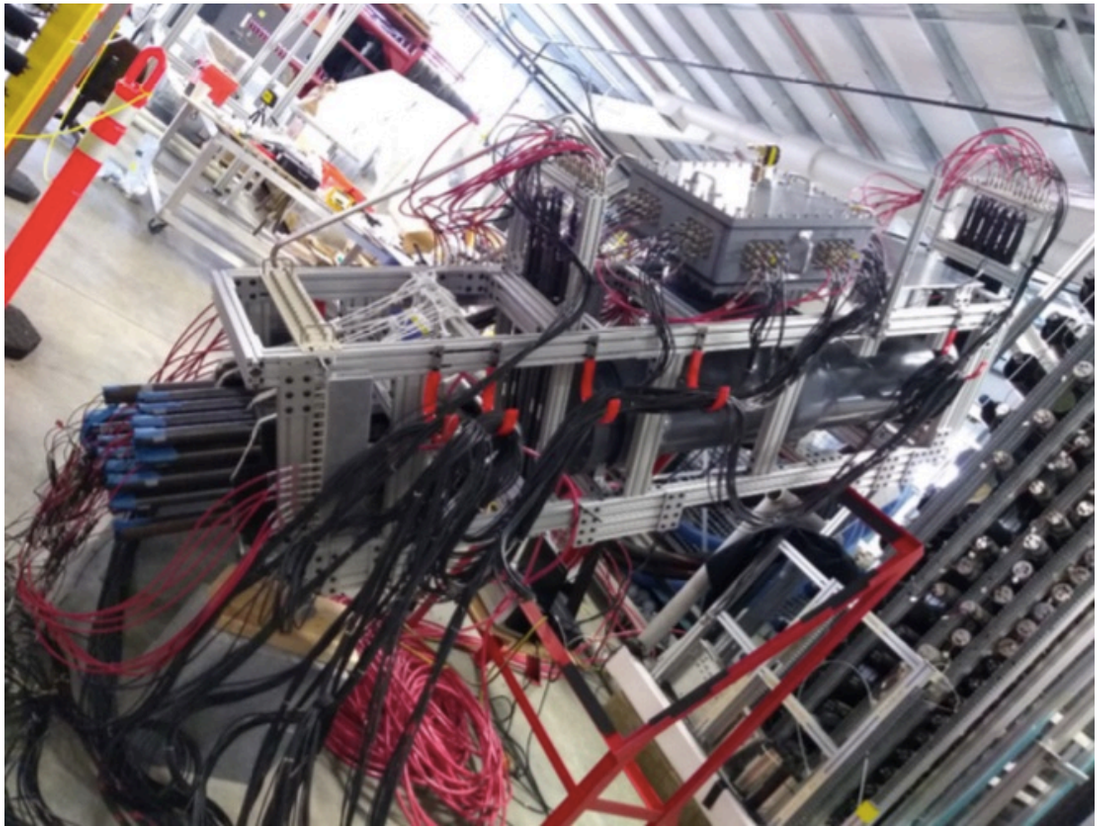
CD0 – proposed 2Q FY21

CD1 – proposed 1Q FY22

Item	Date
Director's Review	February 2015
SoLID User Meeting with DOE/NP	November 2015
Director's Review	February 2016
Follow-Up to Director's Review	Late 2017
SoLID User and JLab Management Meeting with DOE/NP	Mid 2018
Pre-R&D Plan Submission - Updated Cost, Scheduled and Assessed Technical Risks	Summer 2019
Director's Review	September 2019
Follow-Up to Director's Review	End of 2019
SoLID MIE Submission to DOE	**February 2020**

SoLID PreR&D – *retiring the few risks*

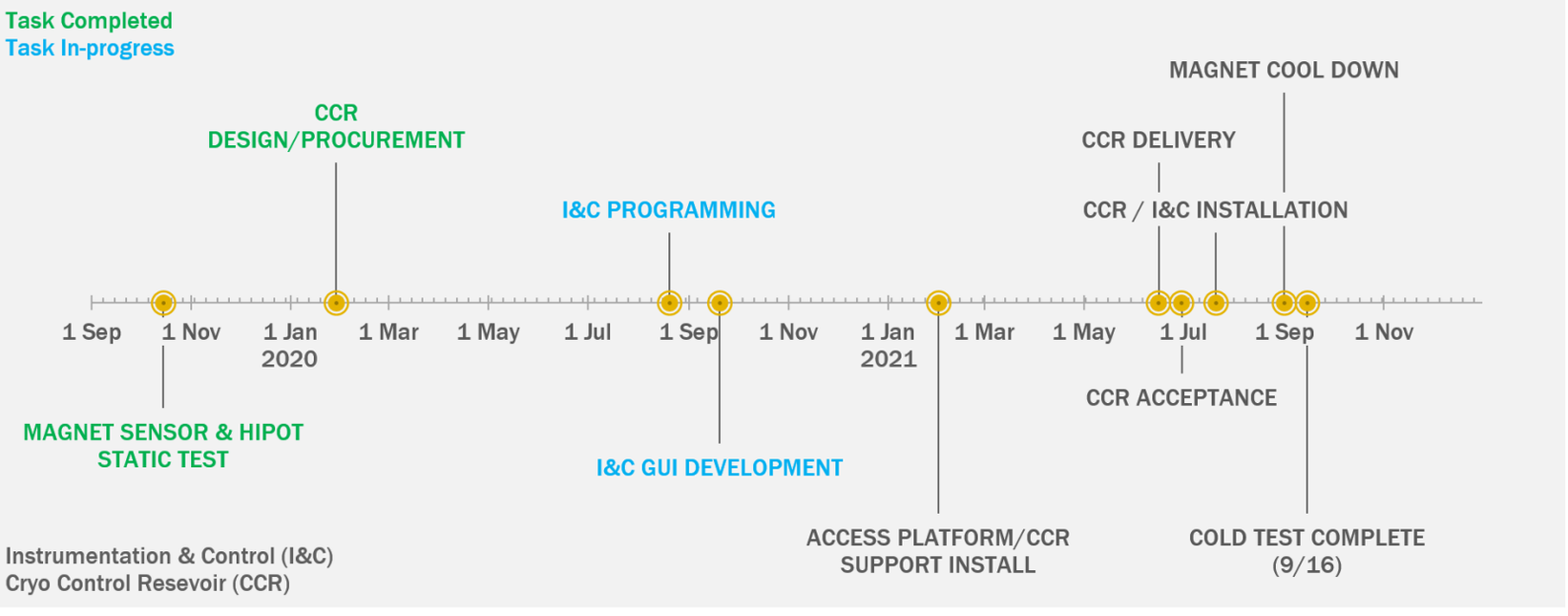
- Funding started this year (thank you!)
- DAQ: GEM readout and DAQ testing for high rates
- Cherenkov test for high rates/high background
  - test data acquired during A1n/d2n in Hall C
- CLEOII magnet static tests
- *Met 1st quarter milestones*



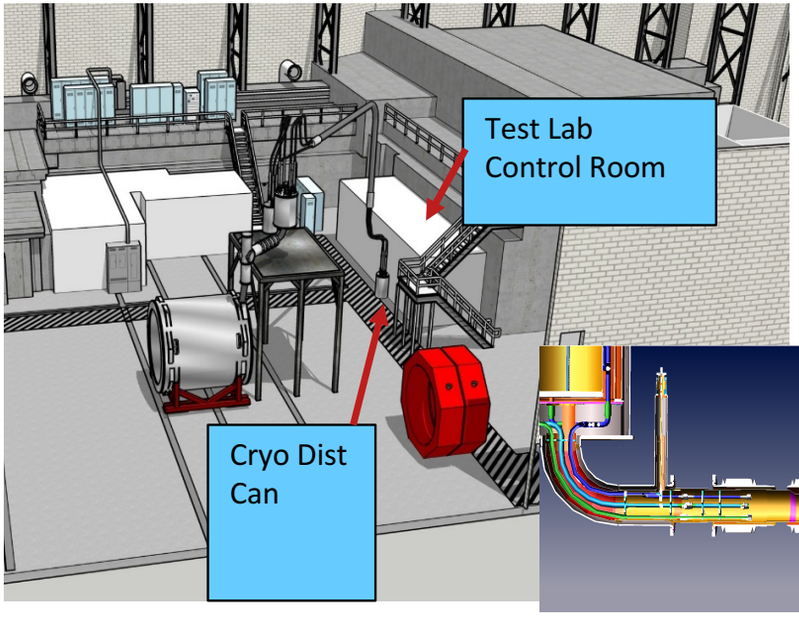
Low rate configuration (~300 kHz rate on maPMTs) at ~ 105 deg, 17 feet away from the target

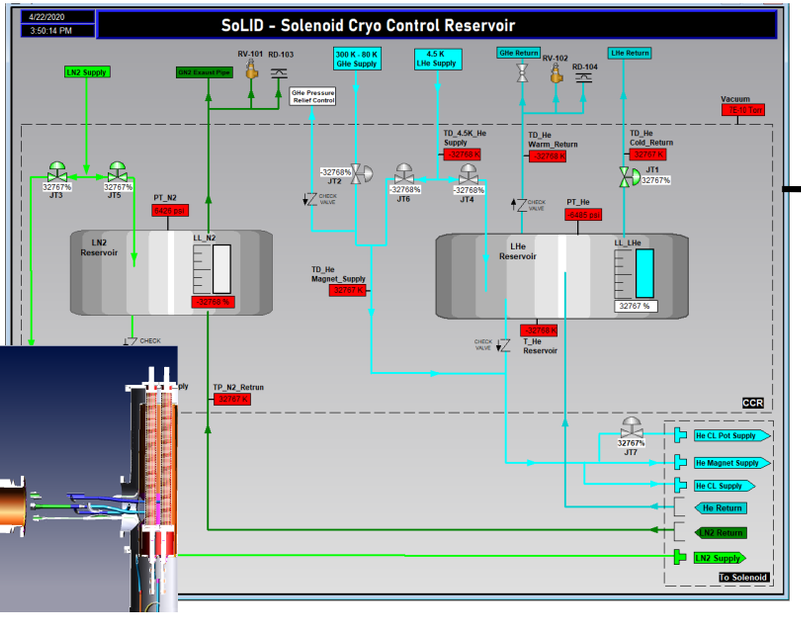
CLEOII Solenoid Rehab – Static and Cold Test

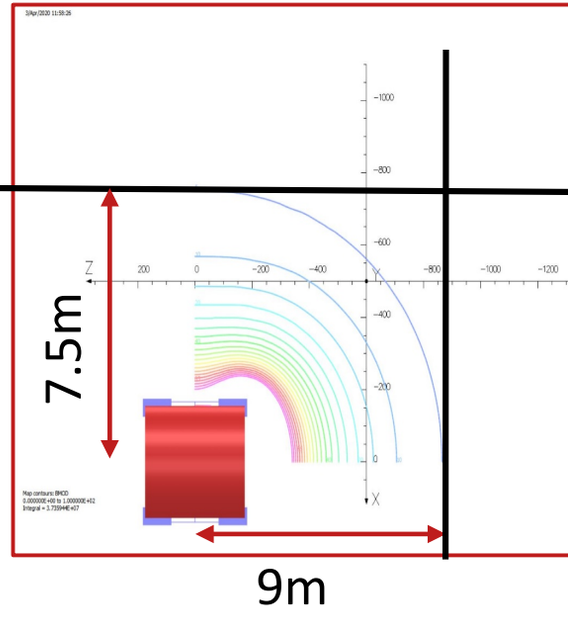
Phase 1 Solenoid Rehab Milestones



- Solenoid rehab will confirm magnet condition
- Provide project risk reduction
- Refine magnet planning
- Estimated completion Sept 2021







And….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Thanks!