LGC Update

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Temple University

SoLID collaboration Meeting June 8th, 2020

Comments/progress on DR Panel Report

- Recommendations
  - Make a pre-R&D plan, including a notional schedule, that resolves all significant technical questions if implemented. Include static/warm tests of the magnet.
    - Much progress with pre-R&D as applies to LGC and HGC (see later slides and talks).
- General
  - The pre-R&D plan would benefit from consideration of when/where (parasitic) beam tests can be done.
    - Evolving situation with COVID, but plans are in place.
- Staffing
  - The LGC team needs mechanical engineering support to move to the next level of design, e.g. mirror tilt mechanism, access paths for in situ servicing PMTs and electronics etc.
    - Currently, we are transitioning engineering design partially to ANL, design and development should speed up soon.

Comments/progress on DR Panel Report (cont.)

- Technical
  - The project team should put a modest additional effort into re-evaluating alternative approaches. These could include trade-offs such as 1) reducing the cost and complexity of the forward iron return and use of MCPPMTs on the LGC and HGC, ... 7) additional robustness (and physics?) using multi-anode readout of the MAPMTs on the Cherenkov detectors versus summed readout.
    - Testing of MCPPMTs are underway at ANL. Tests were preformed (and are being analyzed) with the small cherenkov prototype. Additional tests will (hopefully) run on the back end of our pre-R&D prototype cherenkov data collection.
    - MAROC testing is a milestone in the pre-R&D test, but limited time/change-over availability due to COVID will make this difficult to achieve at JLab in 2020.
    - Additional simulation should be developed to better quantify the gains with multi-anode readout.

Comments/progress on DR Panel Report (cont.)

- Technical (cont.)
  - The LGC team should consider laminating both sides of carbon fiber with Lexan to make a symmetric structure to avoid warping from differential coefficient of moisture (and thermal) expansion. Materials will have significant water content at assembly (likely 30%) and will dry over time in inert gas atmosphere.
    - Point is taken. Laminating in Lexan may or may not be the best solution for this.
      - Solution could be a carbon-fiber manufacture condition: Vendors may be able to guarantee non-deformity over time.
      - Solution could be a reflective coating condition: Vendor may be able to coat Lexan laminated surfaces.
    - Both cases need to be explored.

Comments/progress on DR Panel Report (cont.)

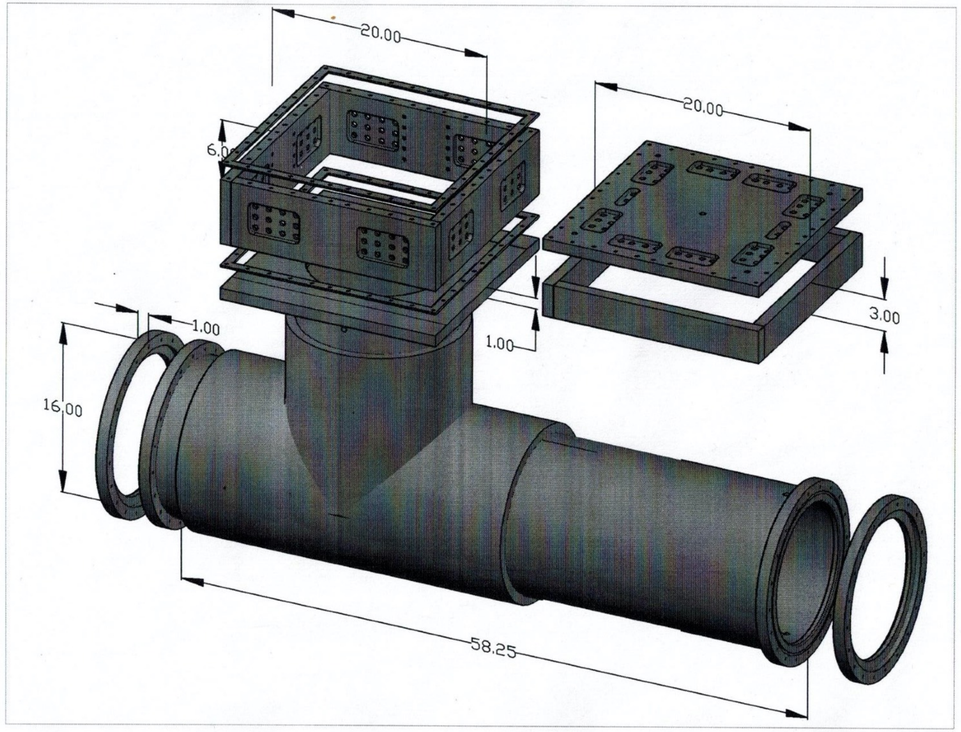
- Schedule:
  - Combined between the LGC and HGC, 700 PMT’s are needed. The team should check production time required at HPK and plan accordingly.
    - Initial conversations with Hamamatsu implied that the 1 year lead window in our budget proposal (requires 50 to 60 per month) may be aggressive. We need to follow up. (Hamamatsu has moved toward increased SiPMT production, which may affect MaPMT production capacity)

Update on Simulation

- The simulation remains in a mostly stable state.
  - Updates included adjusting specific tank dimensions to fit within the re-designed housing geometry due to the extra collar and 10cm downstream move.
  - Three mirror configurations exist to maximize acceptance at low-angle, large-angle, or a compromise.
    - These are not experiment adjustable configurations (mirror shape and size changes), so current plan is to take the compromise setting.
  - Current simulation design has each MaPMT pixel as a separate sensitive detector.
    - This adds some small additional memory load (megabytes), but doesn't seem to impact performance. I am reluctant to change this unless there is major reason to.
- Future improvements:
  - Use information from the pre-R&D test to make realistic FADC signal output.
  - Once tank design is more advanced, add additional materials and possibly migrate to CAD geometry output.

Pre-R&D efforts

- The pre-R&D Telescopic Cherenkov Device (TCD) was built, installed, and collected data in Hall-C.
  - Almost all construction of the cherenkov was done at Temple between early November 2019 and and mid March 2020. **Major credit to our engineer Ed Kaczanowicz!**
    - Primary tank is built from 14" diameter Schedule 80 PVC (typically made to order). It is not light, and non-trivial to insert and seal segments together.



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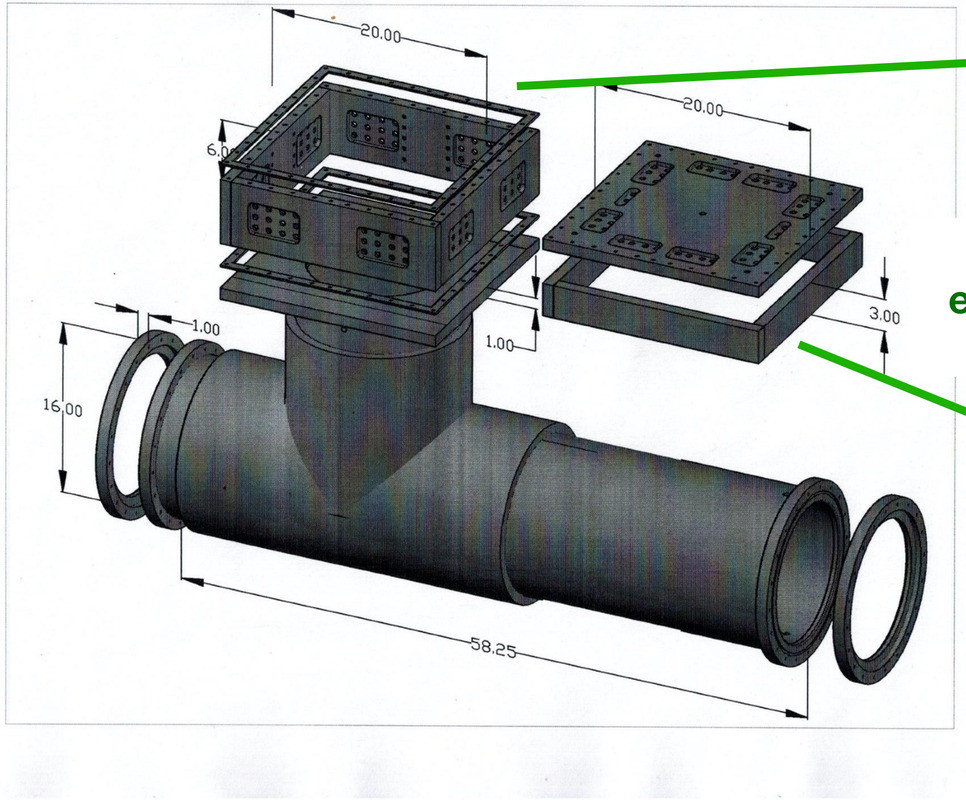
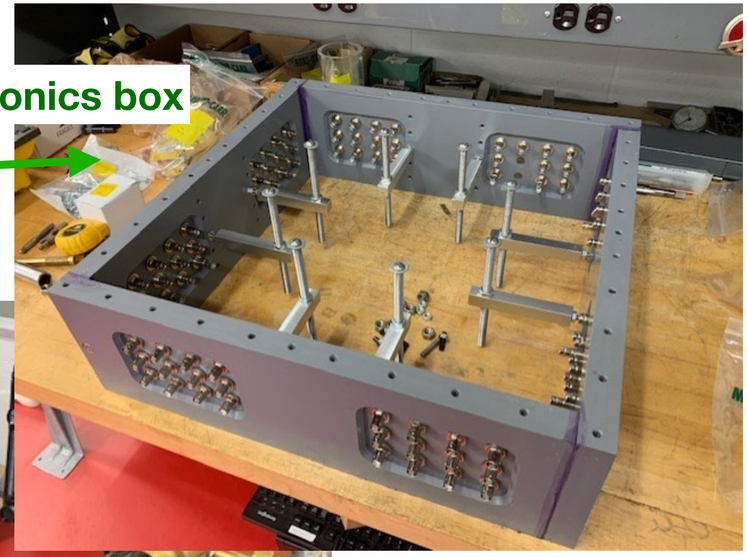


MaPMT electronics box



LAPPD electronics box

96 Hermetic feedthroughs

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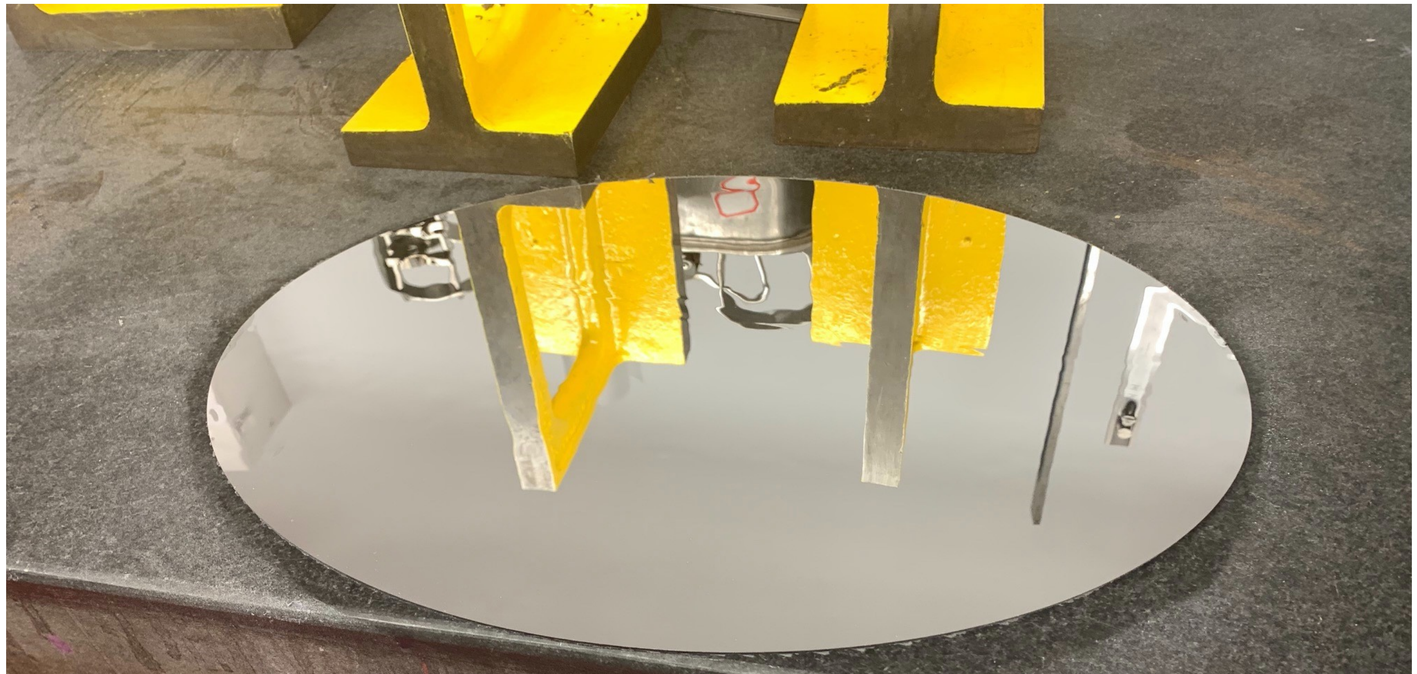
    - First attempts at assembling carbon-fiber blanks with coated Lexan film. Some take aways:
      - 17" by 11" coated lexan ellipses were ordered from ECI.
        - Pieces this large seem to have some manufacture blemishes (small wrinkles from handling). Earlier smaller square pieces had no such defects.
      - Non-trivial to uniformly press the film onto the blank while the adhesive dries.
        - Will be more difficult with curved blanks.



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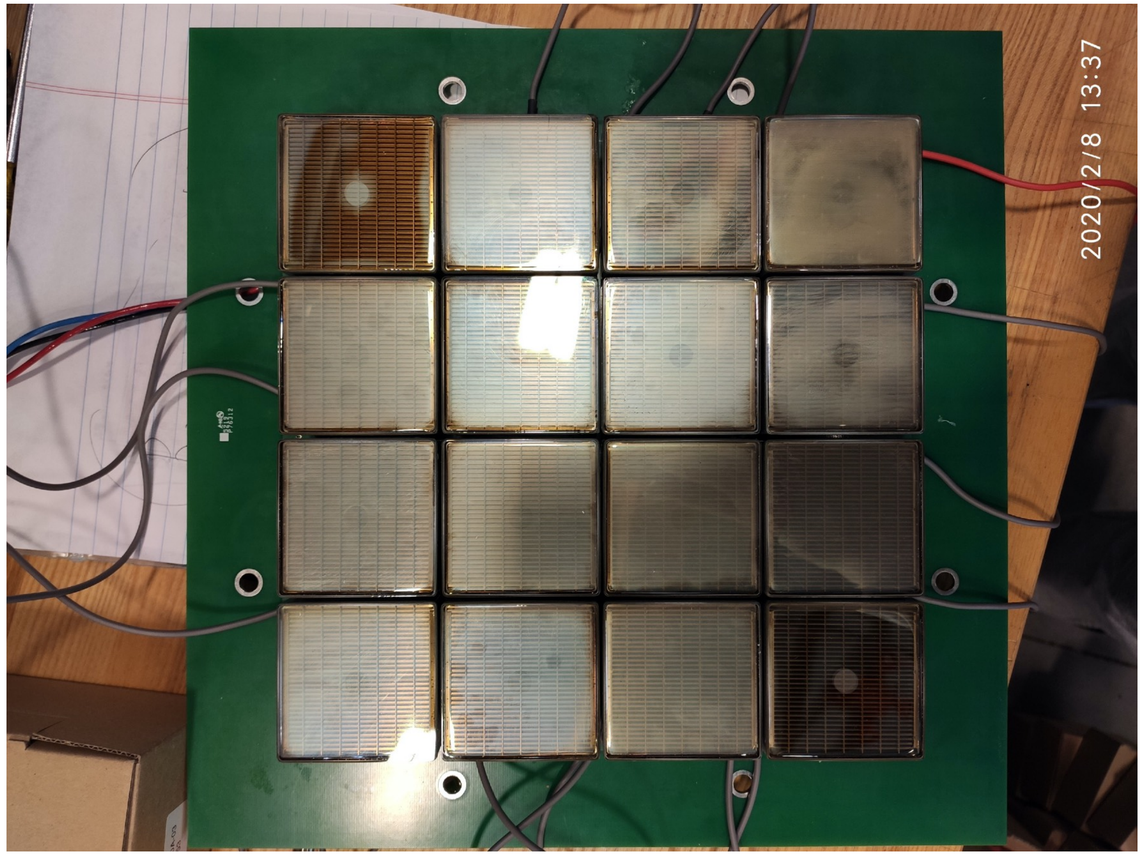
    - 16 MaPMTs were coated with p-Terphenyl and transported to JLab.
      - In transport, 2 MaPMTs lost some of their coating.
        - This is due to the MaPMT face cover. Need to be more careful in transporting of coated MaPMTs.

Electronic board for MaPMTs designed by Jack McKisson from the JLab detector group.



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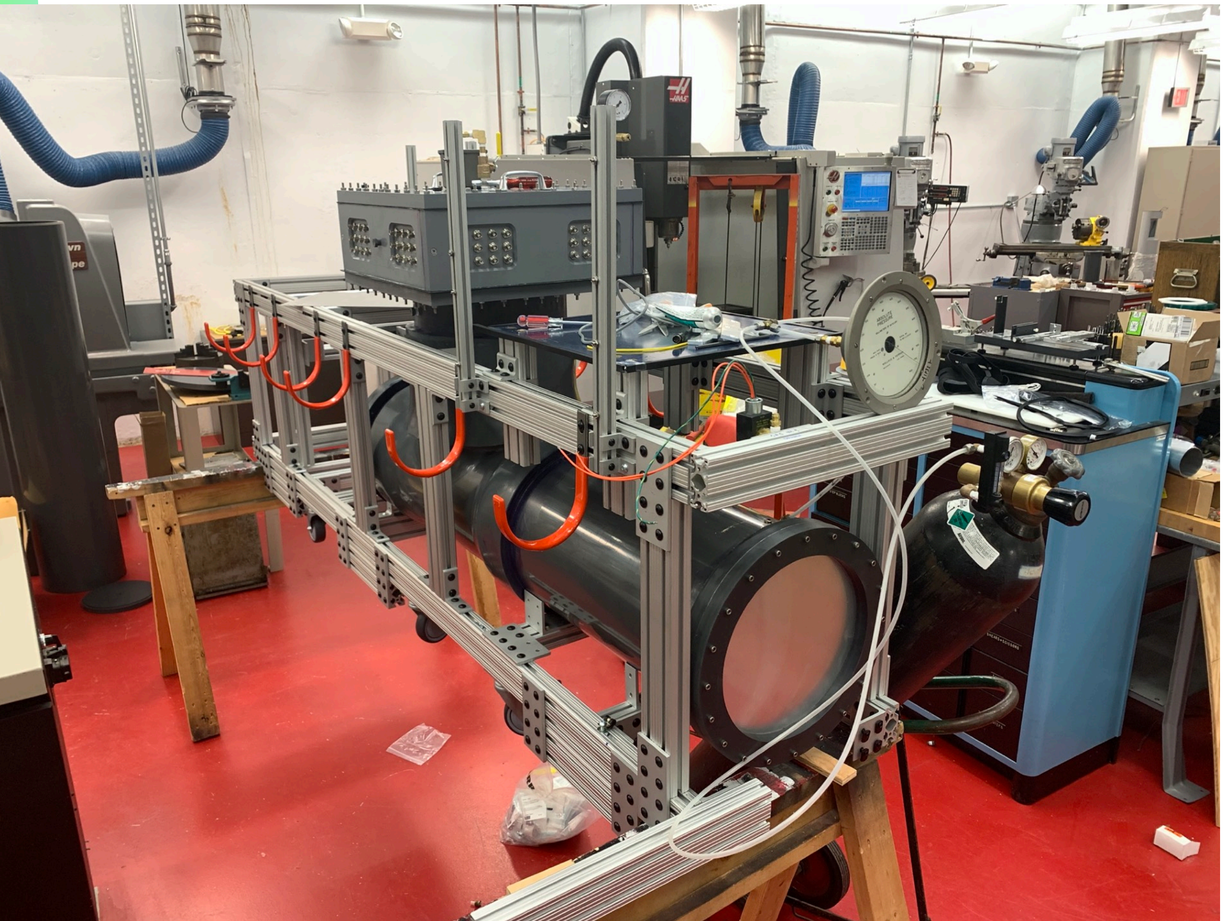
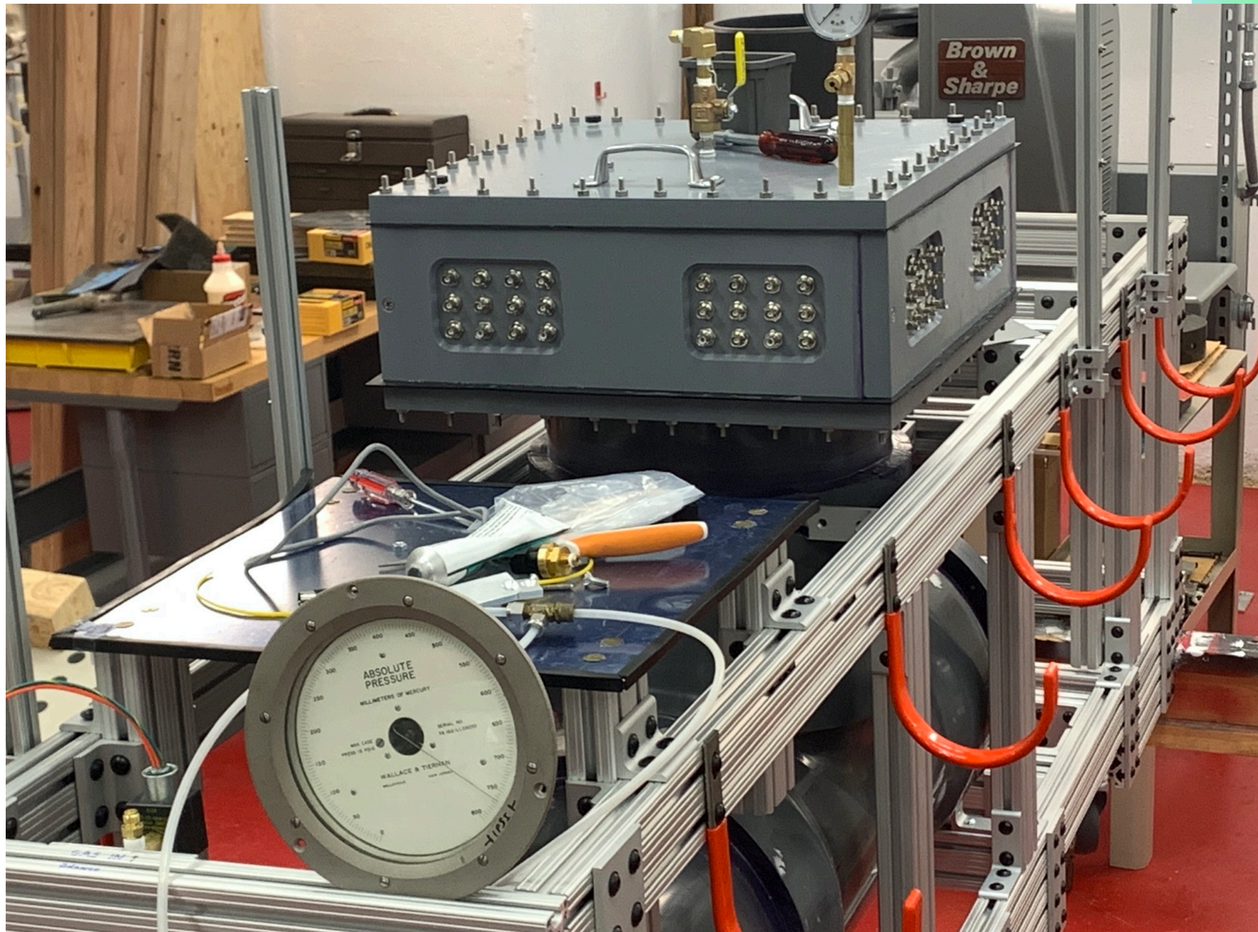
    - A cradle was built from 80/20 to hold tank and supplemental detectors.
    - Assembled tank was gas-tightness tested.





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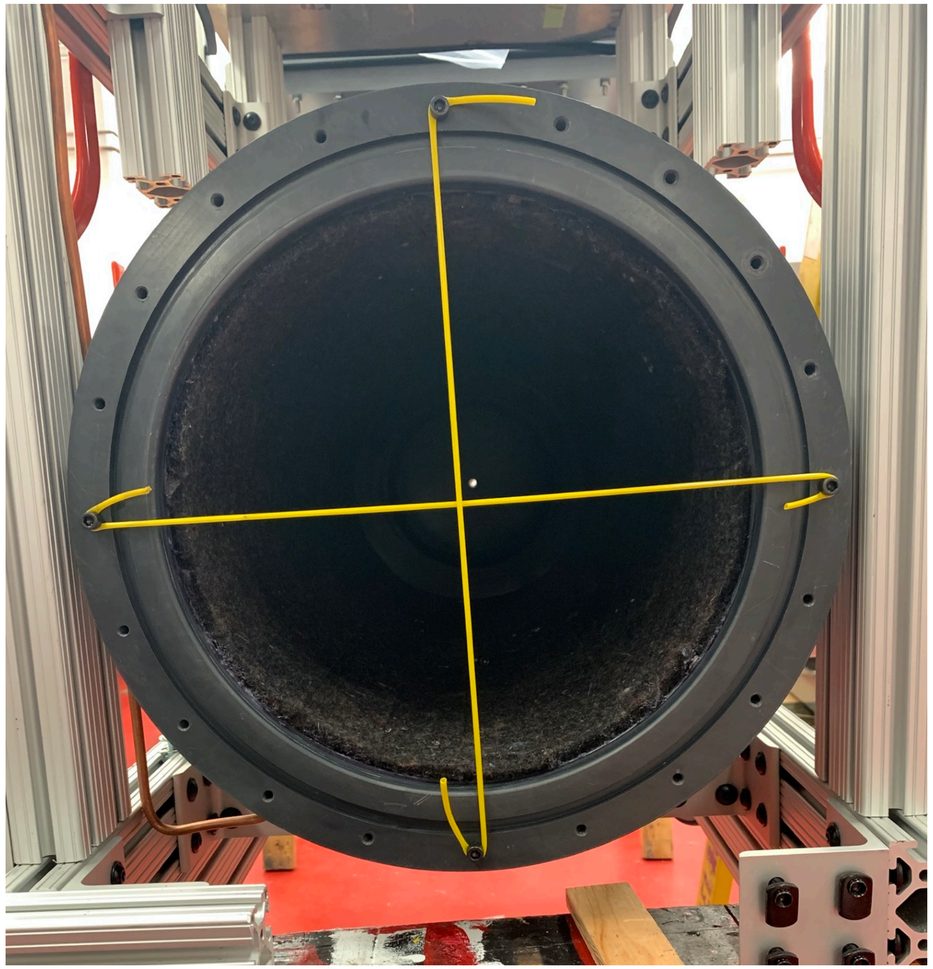
    - Cross-hair style aiming system to align mirror.



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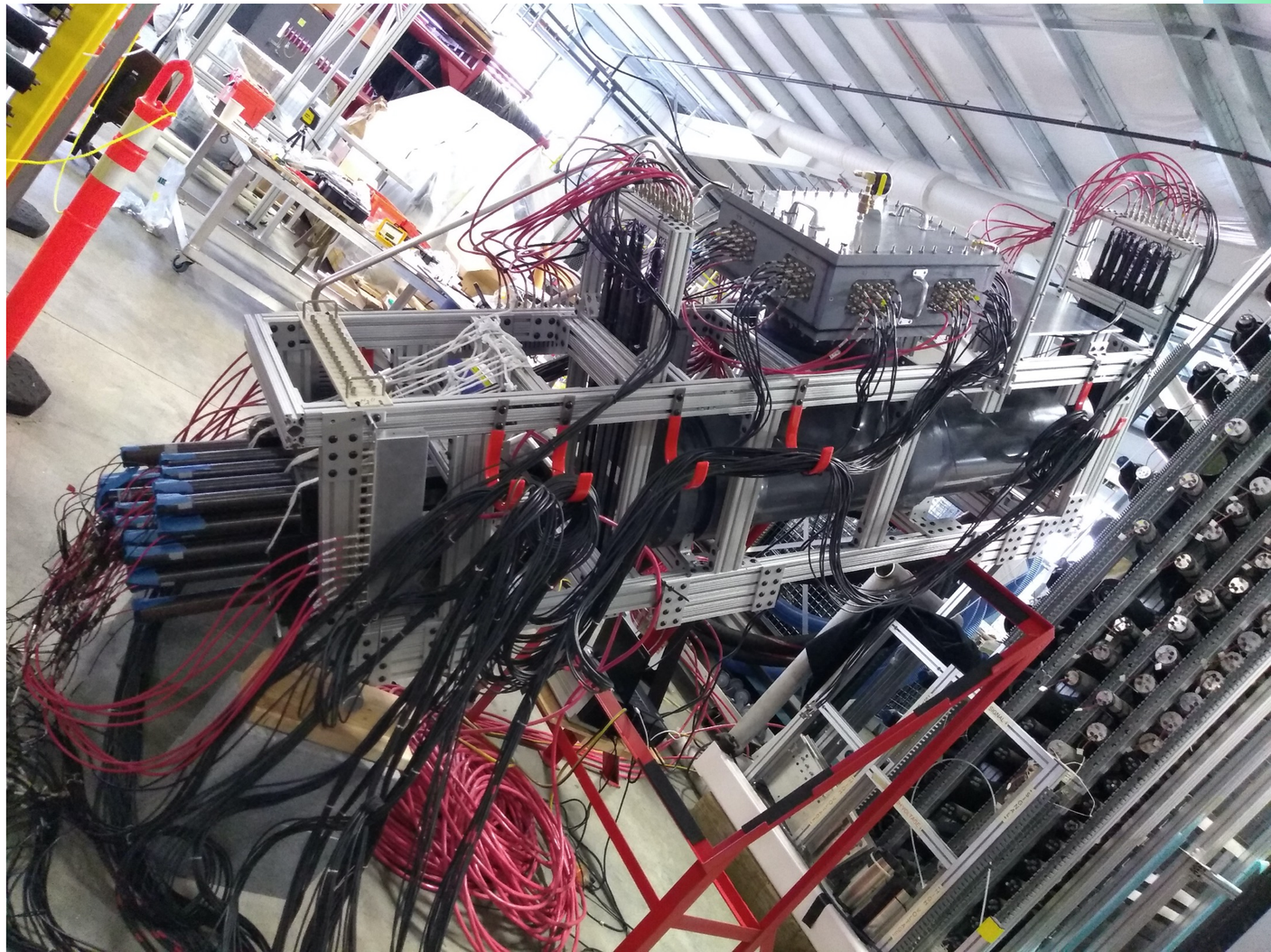
  - Tank was delivered to the ESB at JLab.
  - Tank was assembled and mirror aligned for final testing by Ed.
  - MaPMTs were connected to electronics board and tested by Zhiwen.
  - Simona, Mark, and Alex completed set up and running of cosmics, including:
    - HV gain matching all PMTs
    - Setting up the scintillator planes and calorimeter blocks.
    - Finalizing the digital pressure system.
    - Setting up the DAQ and all of the cabling.

Major credit to Simona and the Hall-C staff!



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- The pre-R&D Telescopic Cherenkov Device (TCD) was built, installed, and collected data in Hall-C.
  - More information about the installation and analysis will be discussed by Simona and Chao after this talk.
  - We were able to achieve the first two milestones promised to DOE.
    - Construction and delivery.
    - Collection of low rate data at large angle using the MaPMT electronics.

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- Moving forward:
  - With COVID-19 and the lab shutdown, schedules have changed and our parasitic opportunities have also changed.
  - The plan from here out:
    - **MUST:** Install the device at small angle, collect high rate data on the MaPMTS, and remove the device from the low angle setting (interferes with future d2n spectrometer settings).
    - **SHOULD/LIKE:** Set-up again at large angle, Collect low rate data for:
      - LAPPD electronics
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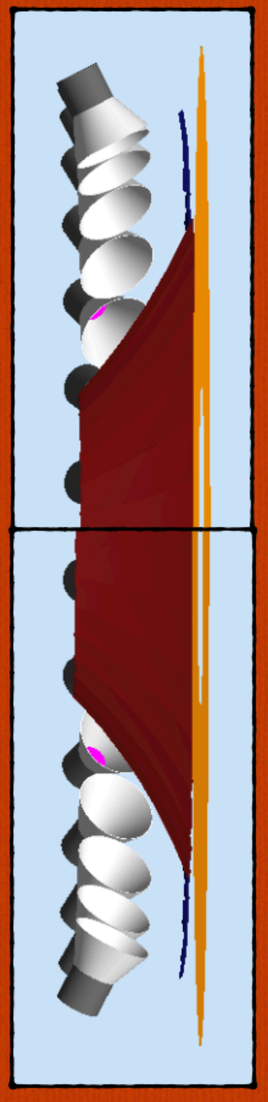
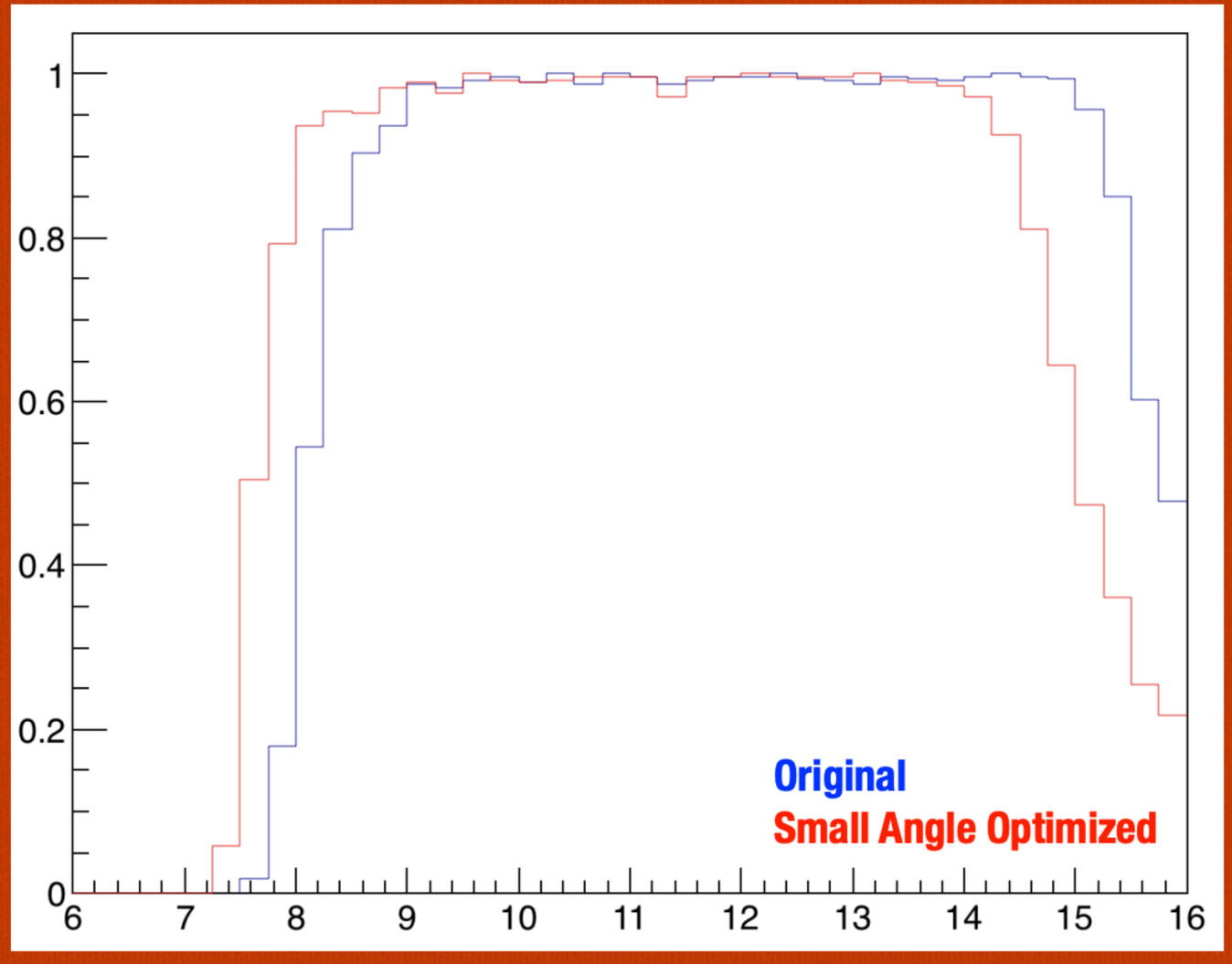
- DOE review:
  - The first quarterly report was submitted to DOE.
    - Thank you to everyone who contributed!!!
  - A DOE will review will happen soon, no exact charge has been provided for the review.

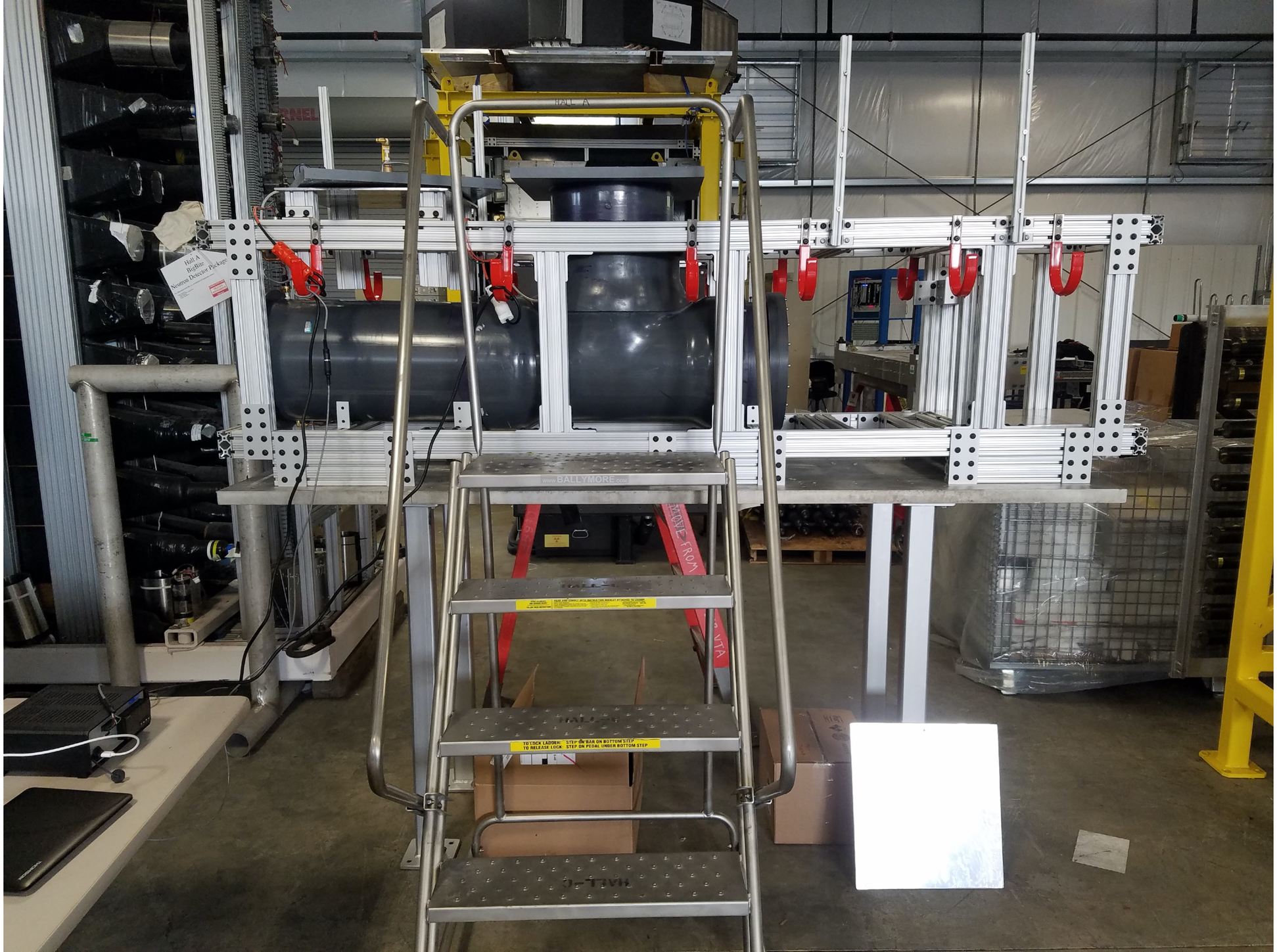
Backups

Small Angle Optimized:
8.5 deg optimized
R = 273.9 cm
L = 116.7 cm

Original Mirror:
11.3 deg optimized
R = 361.5 cm
L = 118.3 cm



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