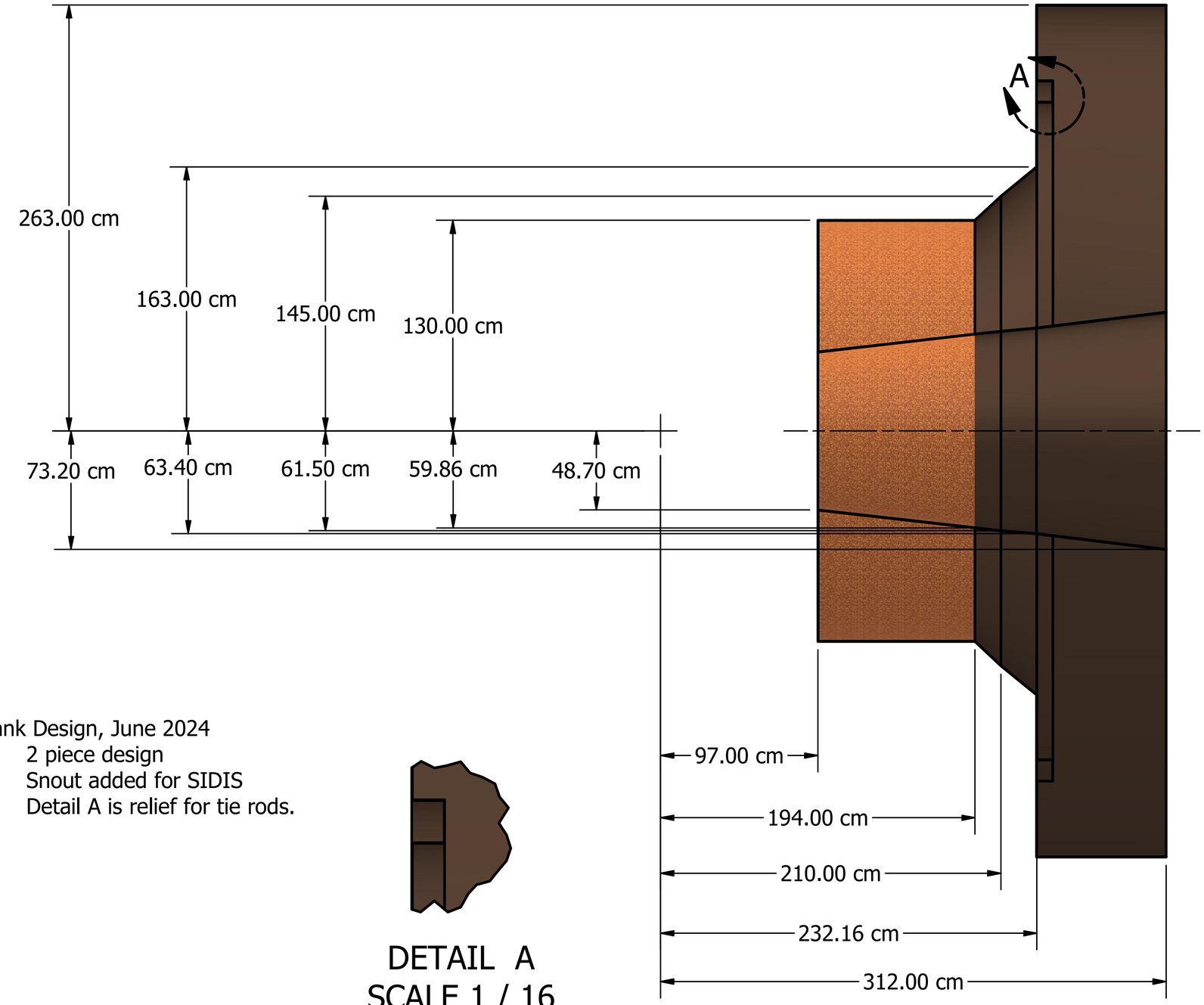
LGC update

SoLID Collaboration Meeting, Jefferson Lab
Jan 8th, 2025
Michael Paolone (NMSU)

Engineering Design

- Recent work at Argonne (Tom O’Connor, Kevin Bailey)
  - Conforms to simulation parameters:
    - 10cm downstream shift
    - 5cm wire bundle clearance.
- Still need some more exact specs for mounting parameters, and wire clearance.

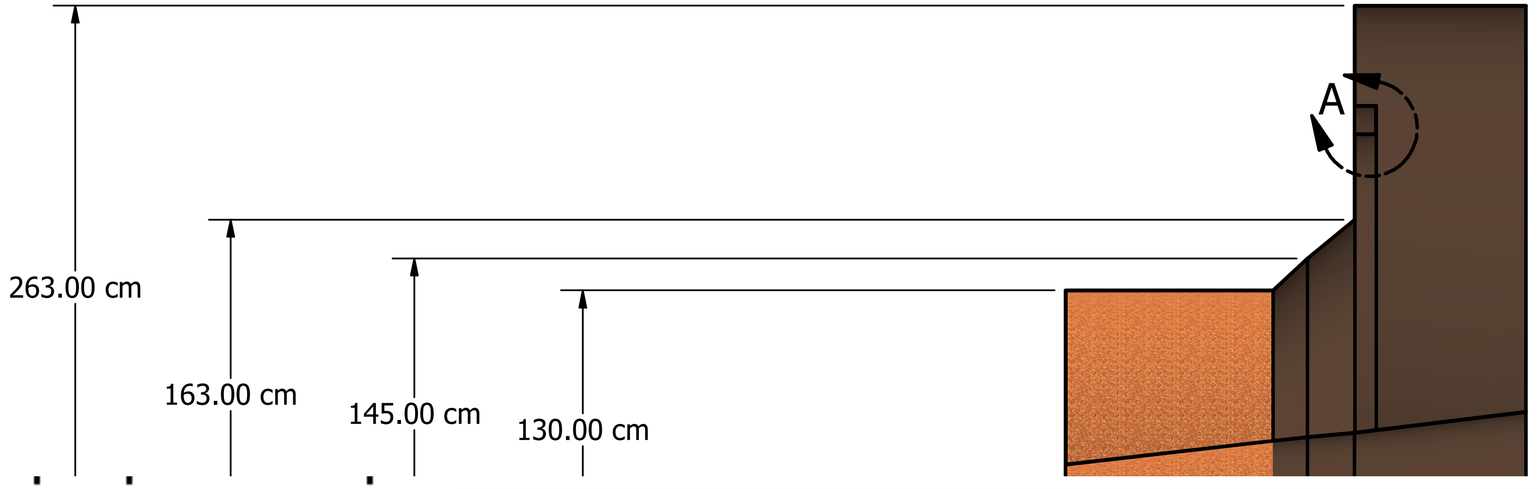


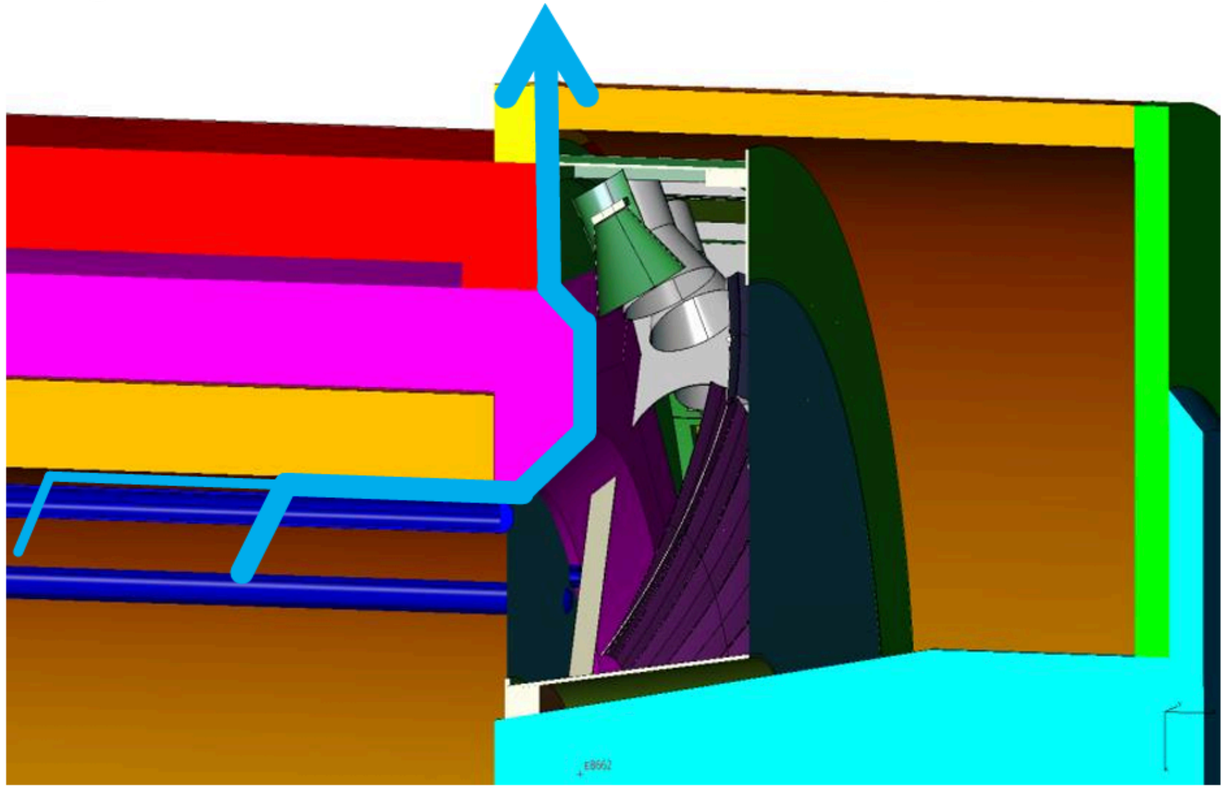
Tank Design, June 2024
- 2 piece design
- Snout added for SIDIS
- Detail A is relief for tie rods.

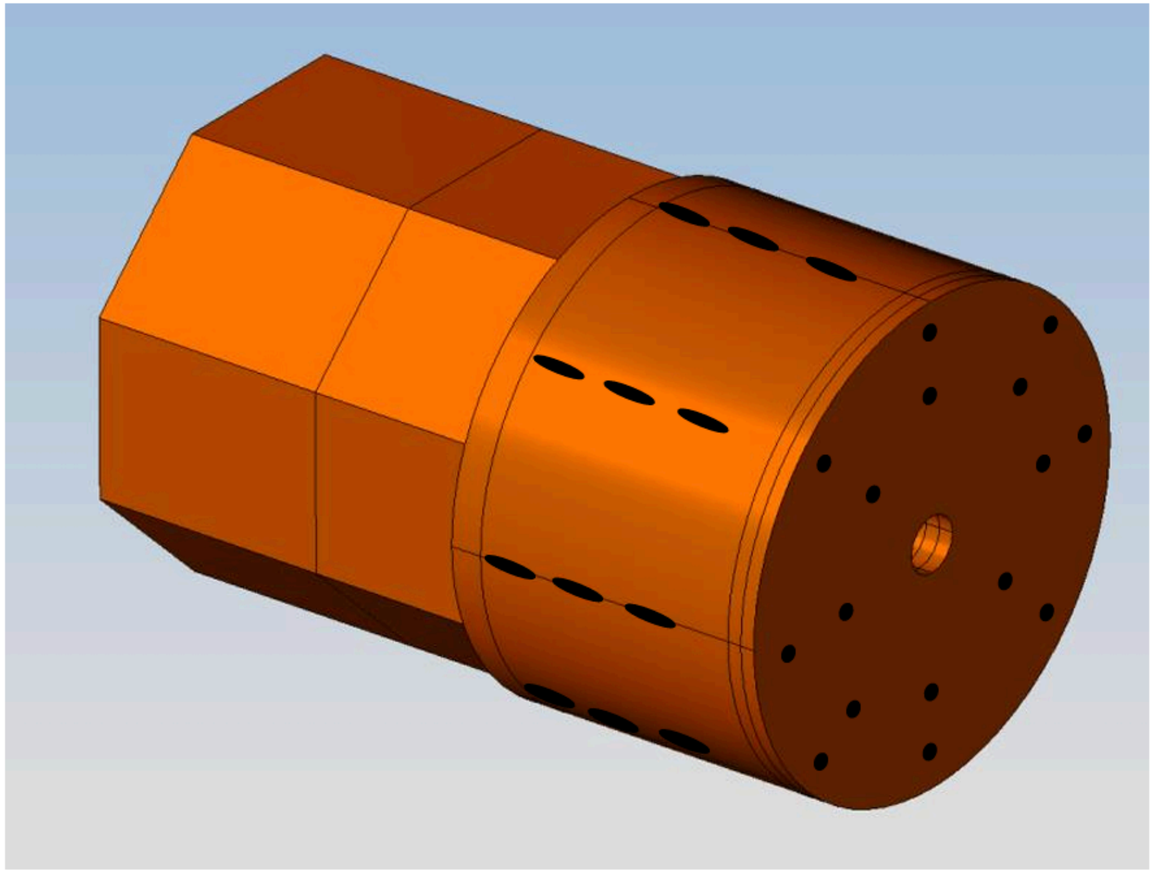
DETAIL A
SCALE 1 / 16

Engineering Design

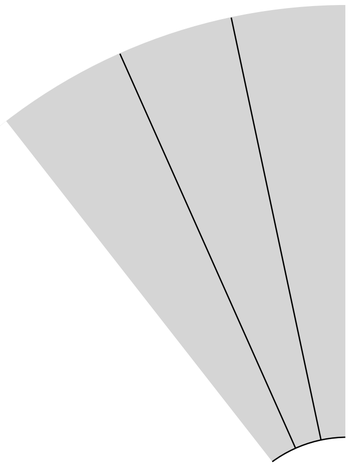
- Recent work at Argonne (Tom O’Connor, Kevin Bailey)
  - Conforms to simulation parameters:



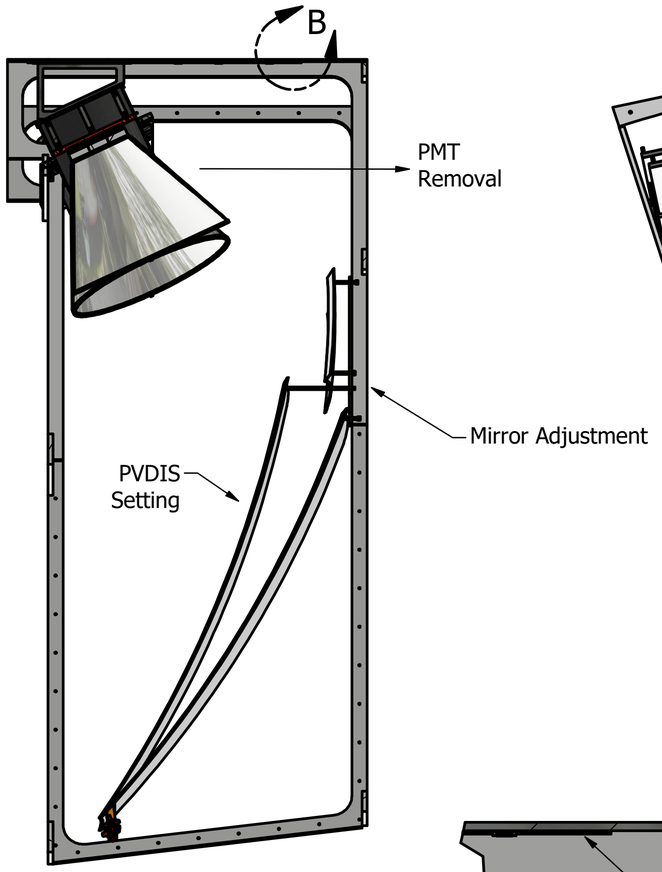




Engineering Design



Protptype Sector
(3 mirrors, no snout)



SECTION A-A
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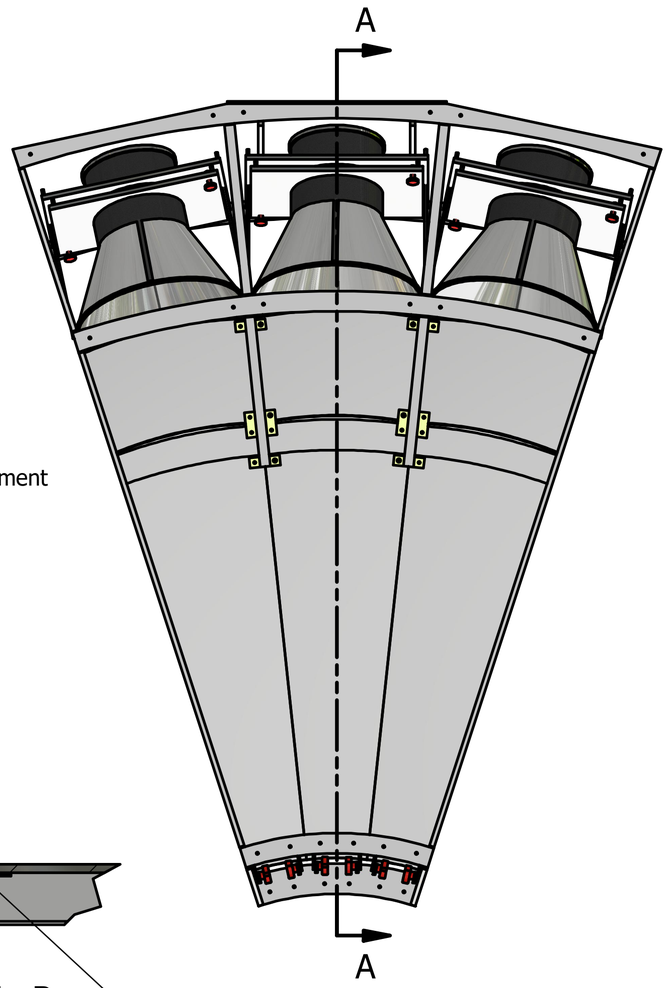
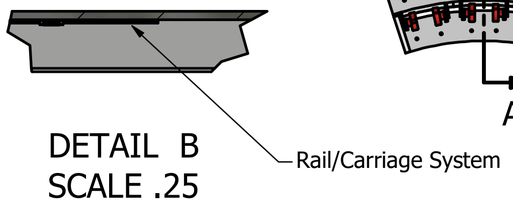
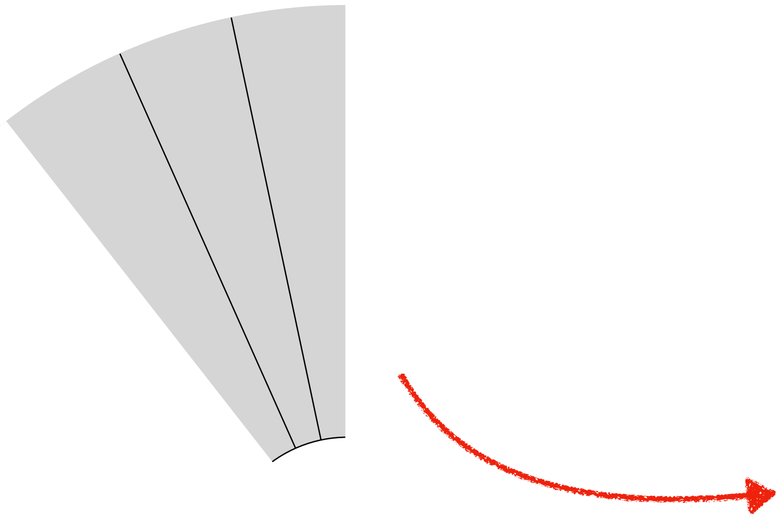
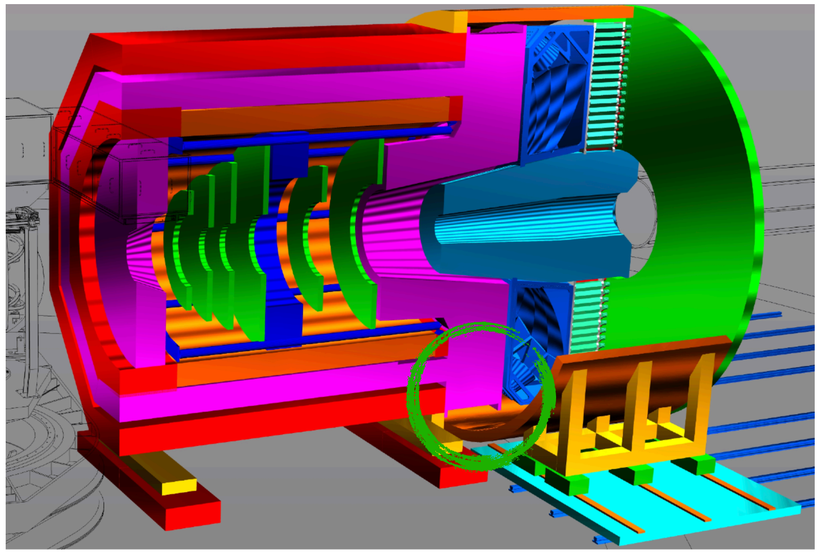




DETAIL B
SCALE .25

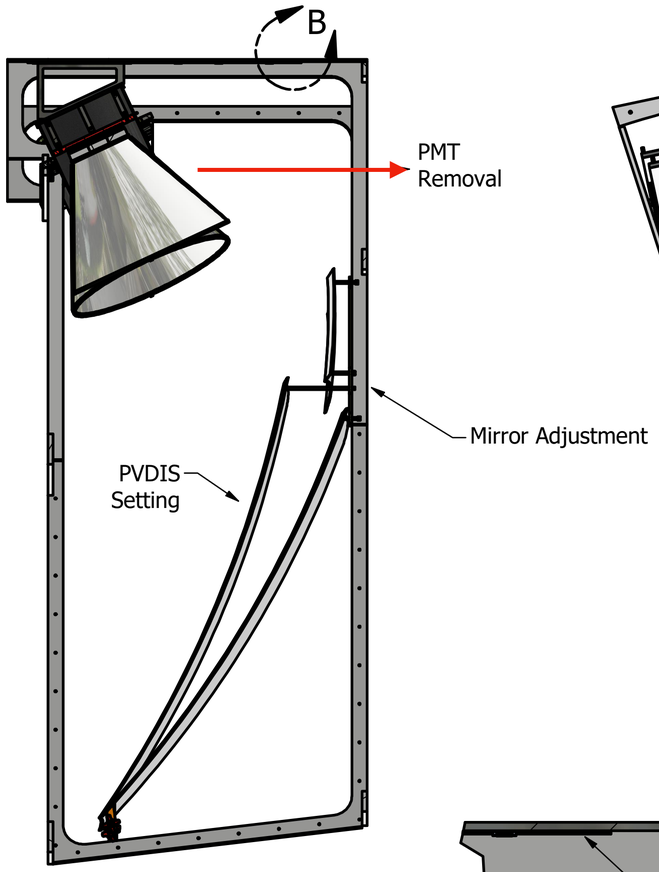
Engineering Design





Protptype Sector
(3 mirrors, no snout)

PMT assembly access from the back (instead of the top)



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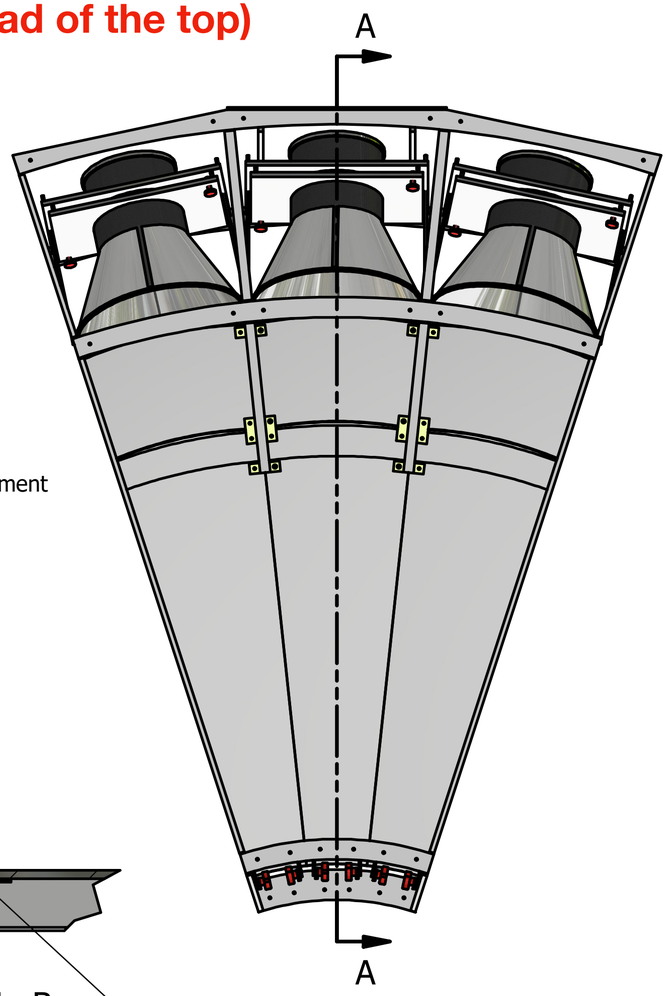

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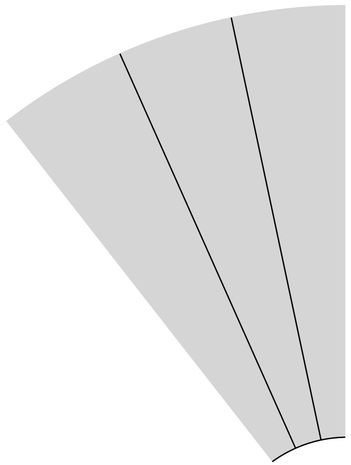
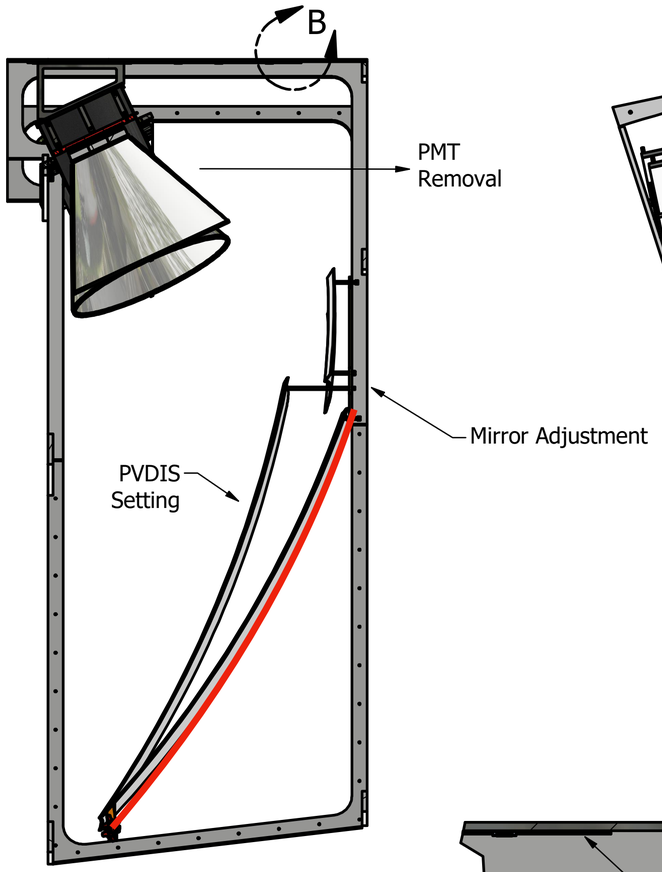


SIDIS Mirror position

Protptype Sector
(3 mirrors, no snout)



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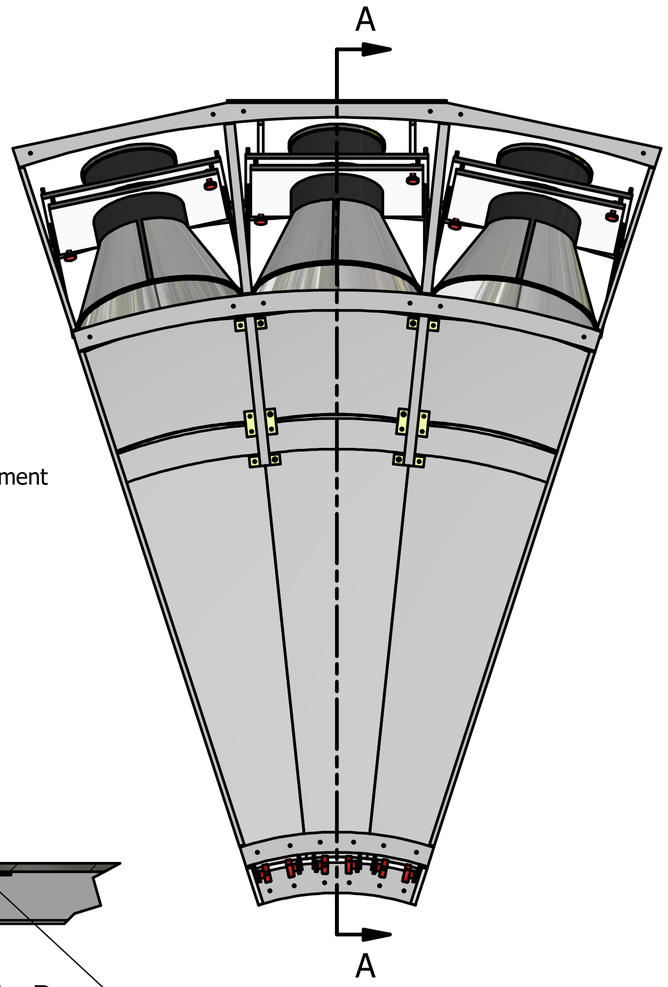
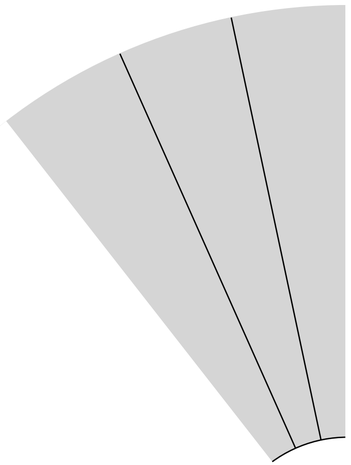


Engineering Design



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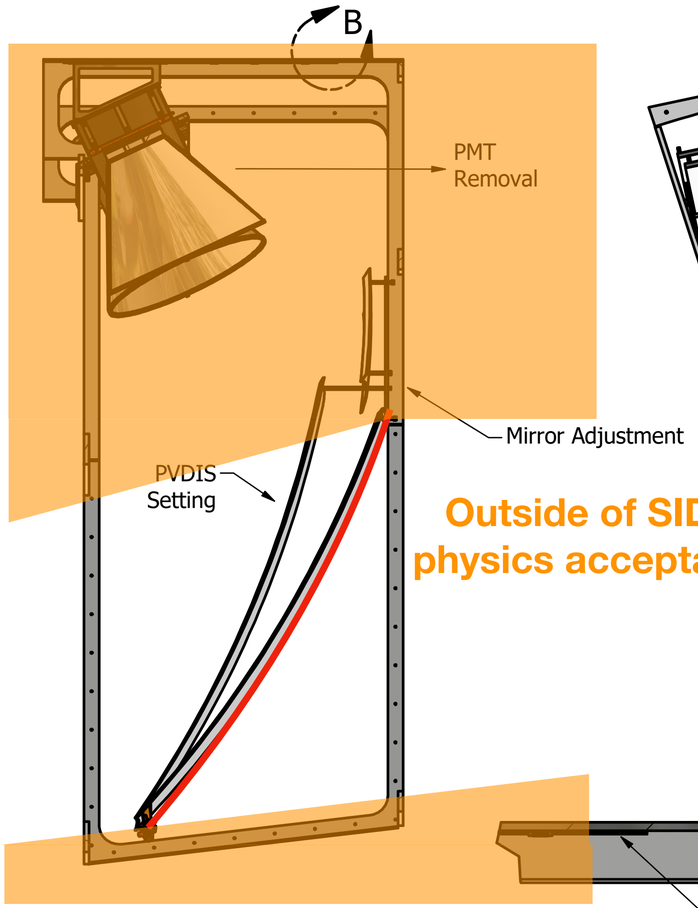

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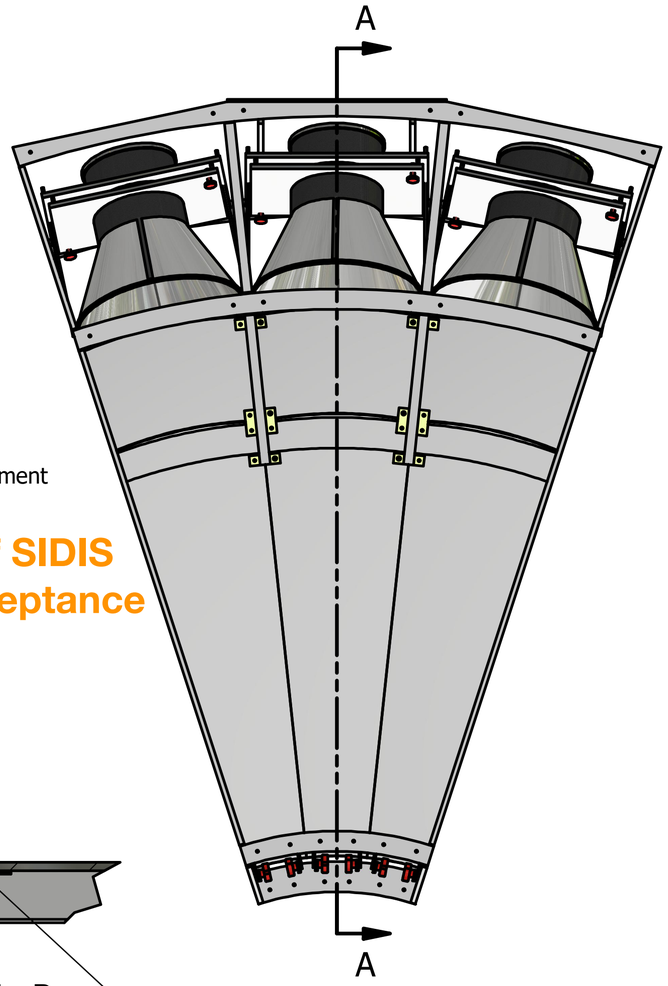
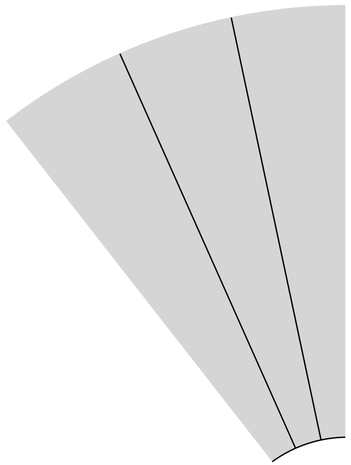
DETAIL B
SCALE .25

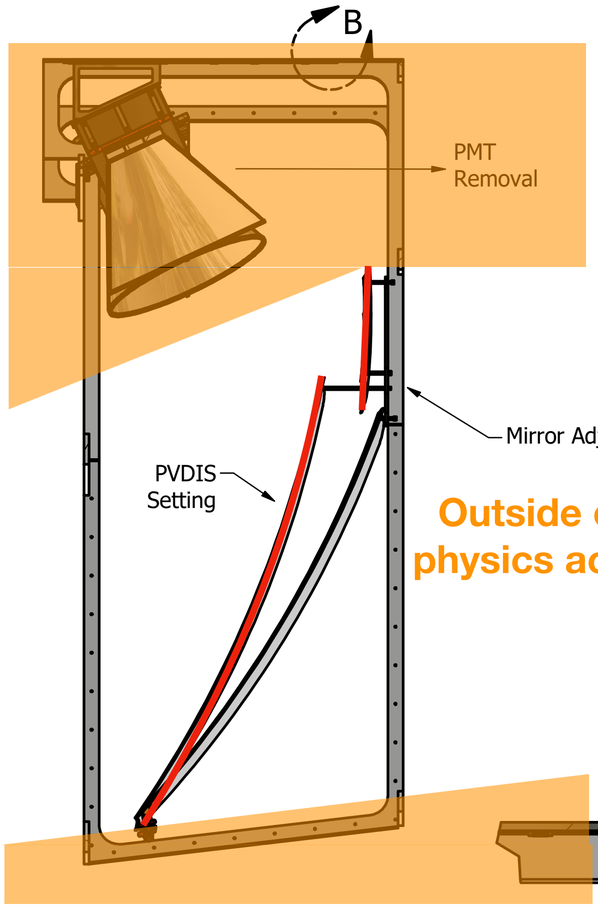


Engineering Design



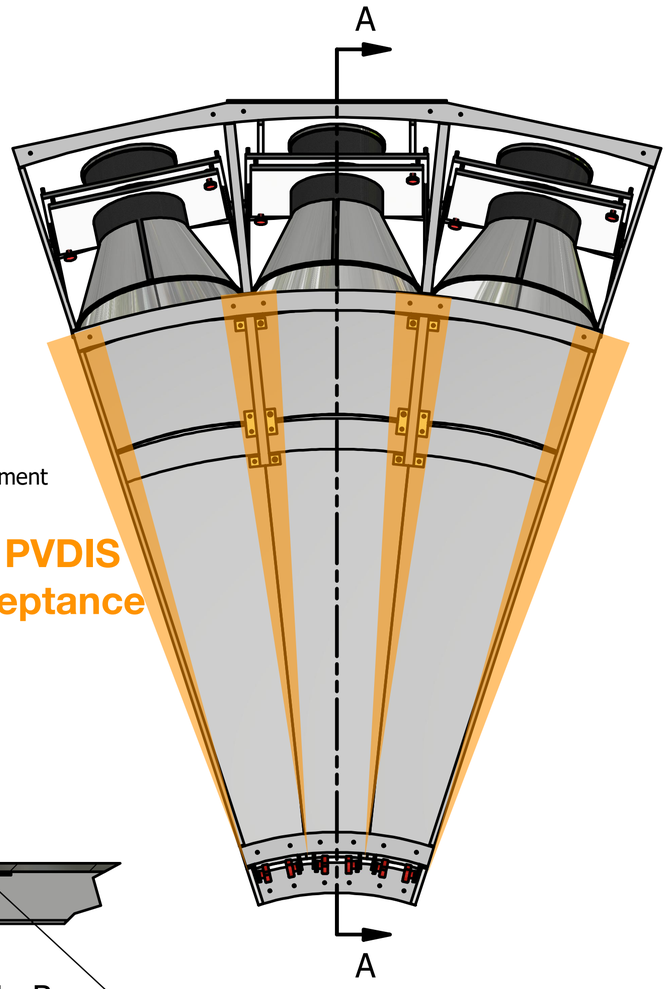
PVDIS Mirror position

Protptype Sector
(3 mirrors, no snout)



SECTION A-A
SCALE .075

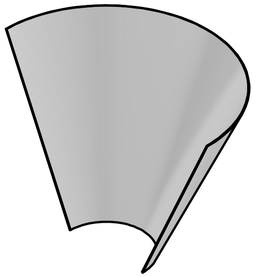
Outside of PVDIS
physics acceptance

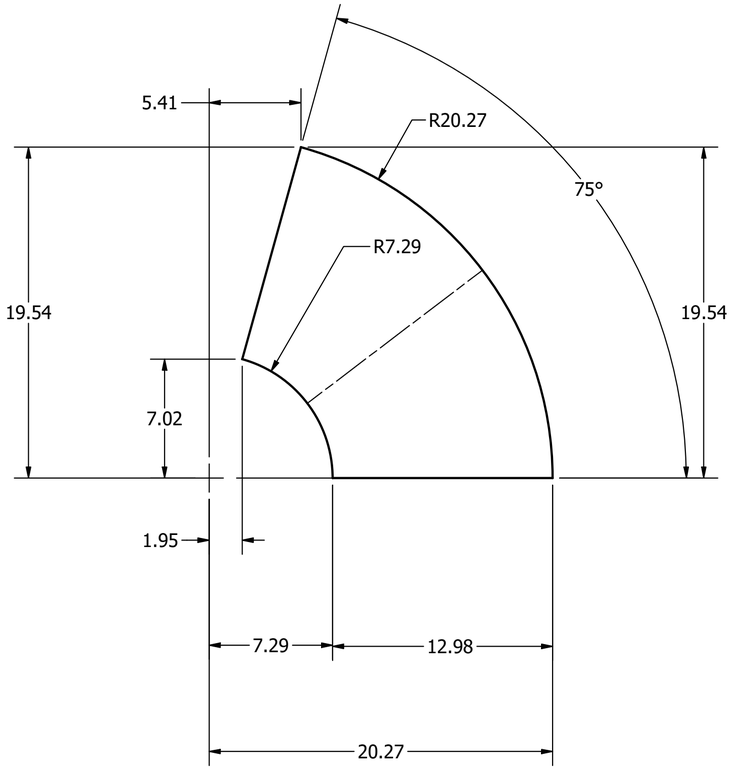


DETAIL B
SCALE .25

Engineering Design

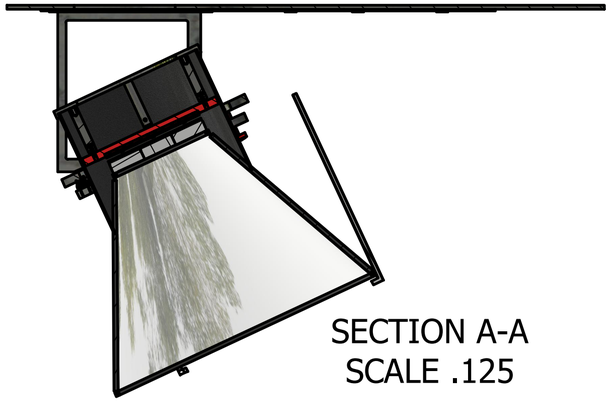
- Reflective cones:
  - Straight cones could be two “rolled” polycarbonate sections, with some additional shape support.



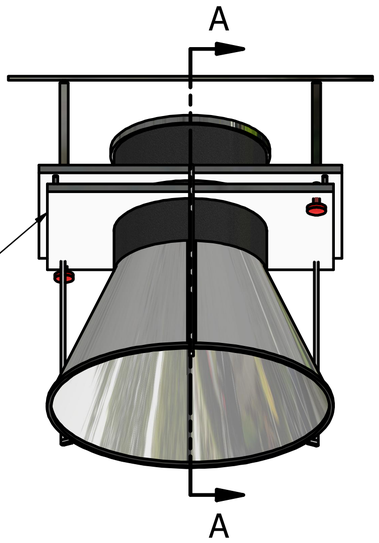


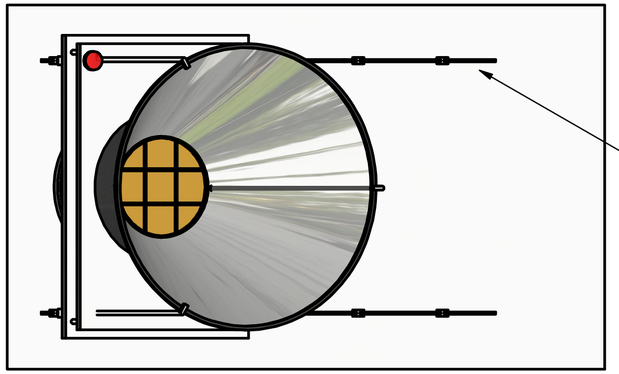
2-Piece Cone

Polycarbonate, $\frac{3}{64}$" thick
Sheet Metal?



SECTION A-A
SCALE .125

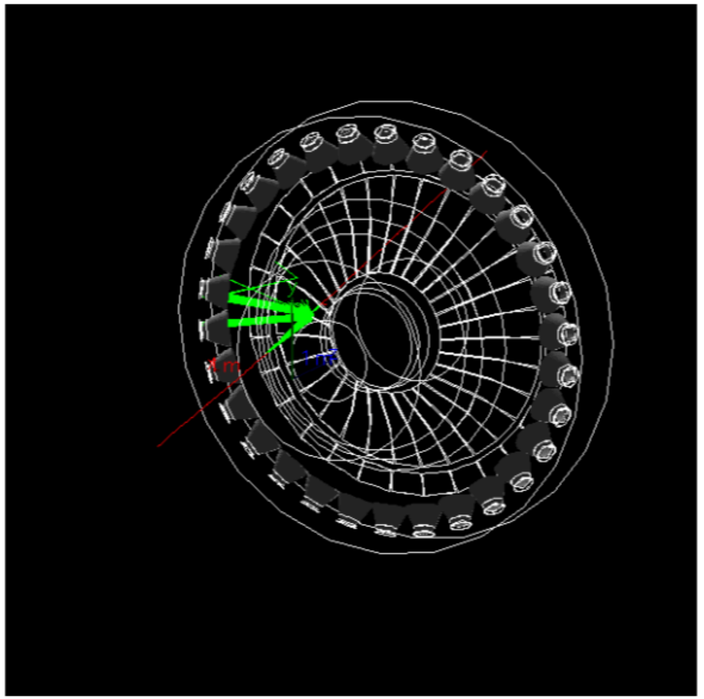


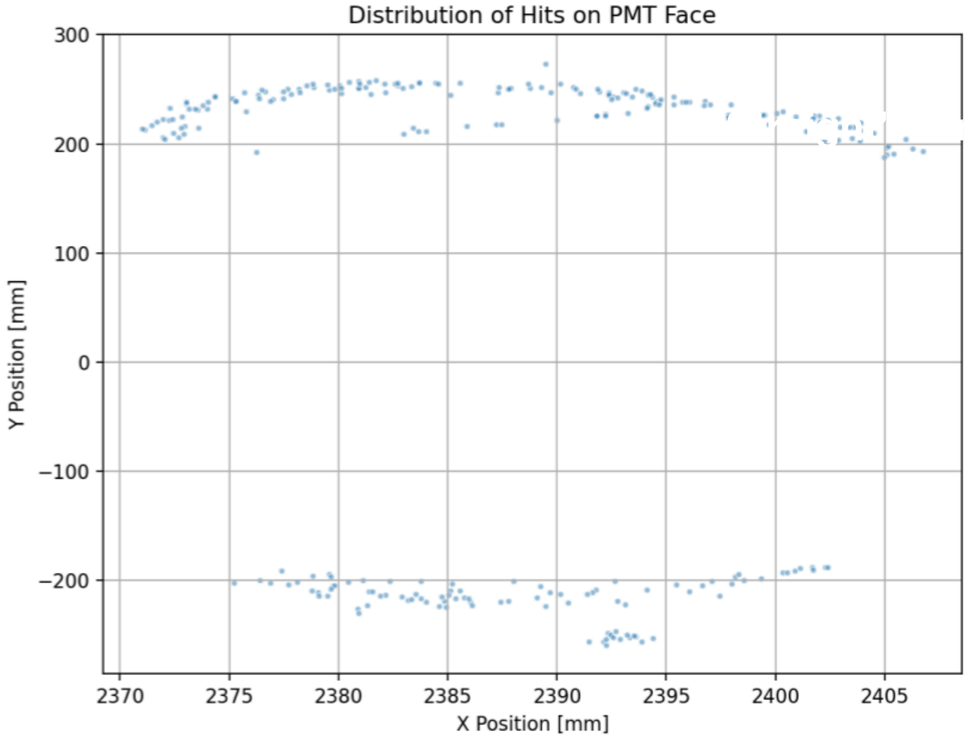


Mounted PMT
longitudinal adjustment with rails
tip/tilt adjustment plate
no transverse adjustment

Simulation update

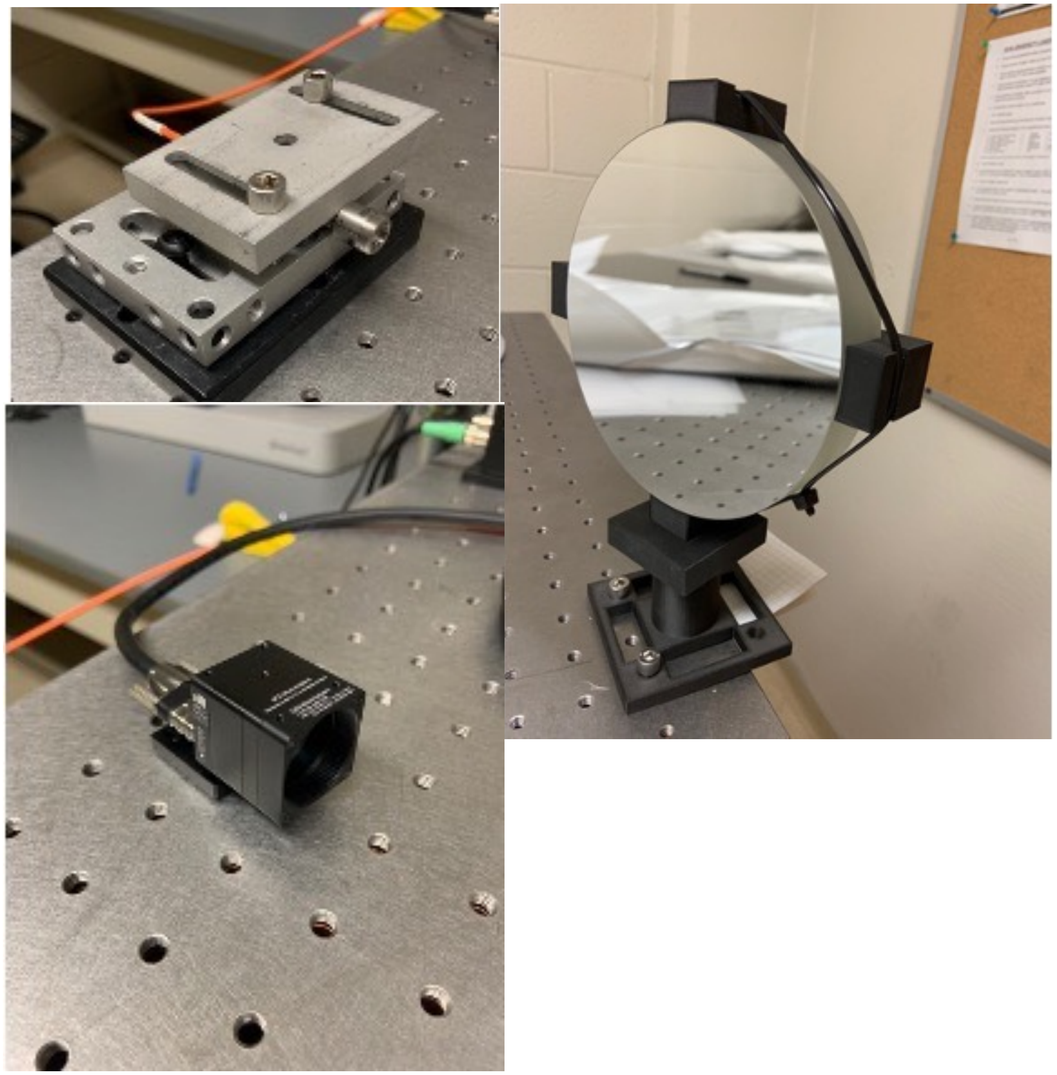
- Work is ongoing to update and validate DD4HEP cross-checked against GEMC.
  - Churamani Paudel is leading this effort.
    - Most recent progress was to verify the Cherenkov “cone” on the PMT face for a single event.
      - Next steps are to build the digitization at the PMT face and start to implement trigger conditions.
    - On temporary pause while we prepare for ALERT.





Mirror Fabrication Update

- Carbon Fiber blank segments have been received from Allred Inc:
  - 1/2 size Mirror-1 and Mirror-2 segments:
    - Comparison of infill: Depends on the material and orientation of fibers between layers.
    - Total thickness comes in at 1/2 of expected material budget!
  - **Tests of Radius of curvature:**
    - Using minimum spot-size calibrated versus known spherical mirror: about 1-3% deviation from design spec, depending on infill, all systematically large. Also slight aberration between “vertical” and “horizontal” focal length (~ 1%).
      - Relaxing after forming? Moisture drying? Maybe compensated with slightly larger mandrel.
  - Tests of mechanical deformation:
    - Laser deflection set-up:
      - Very small deflections at moderate force



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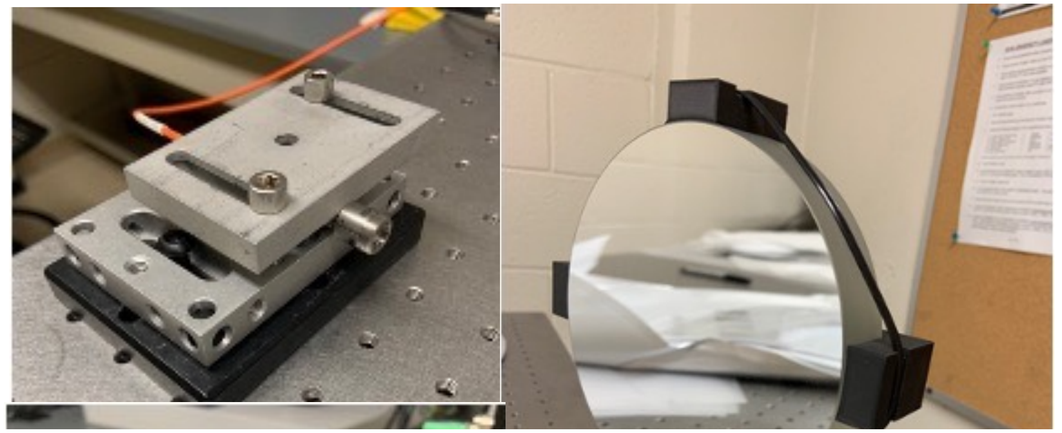

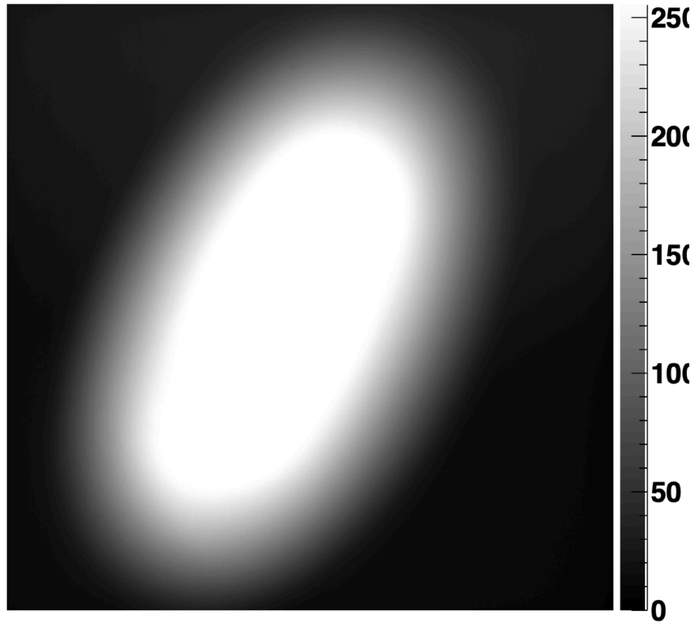

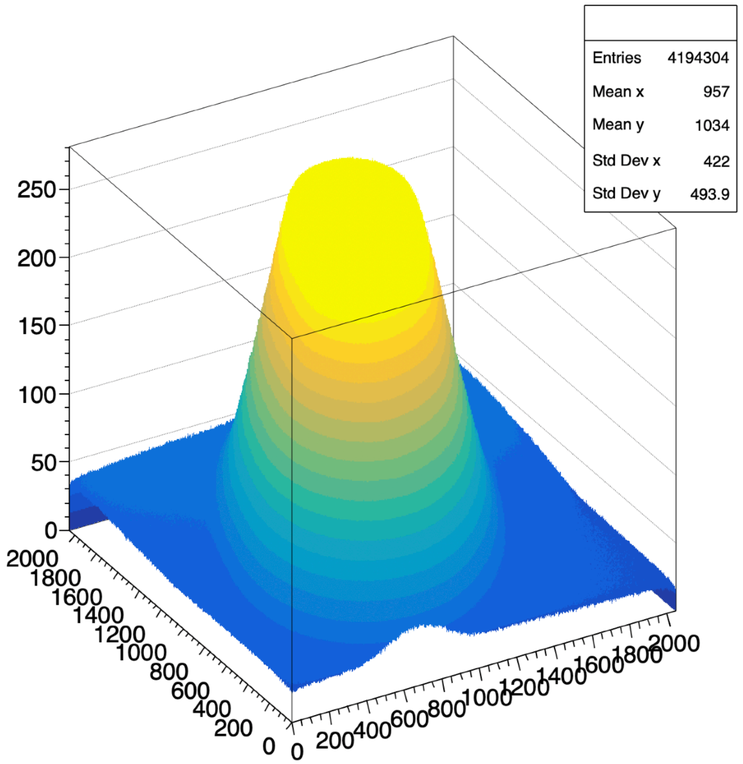

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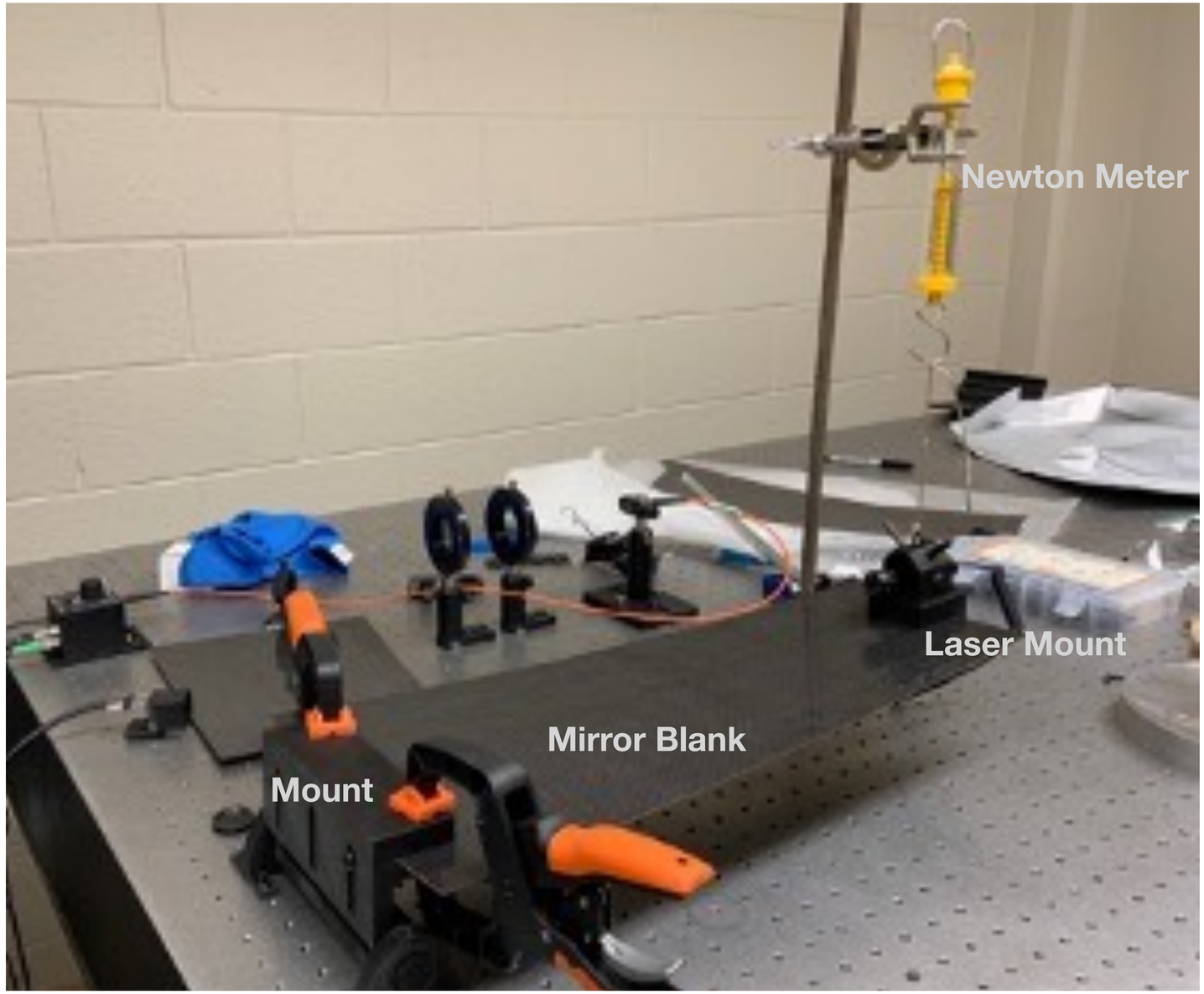

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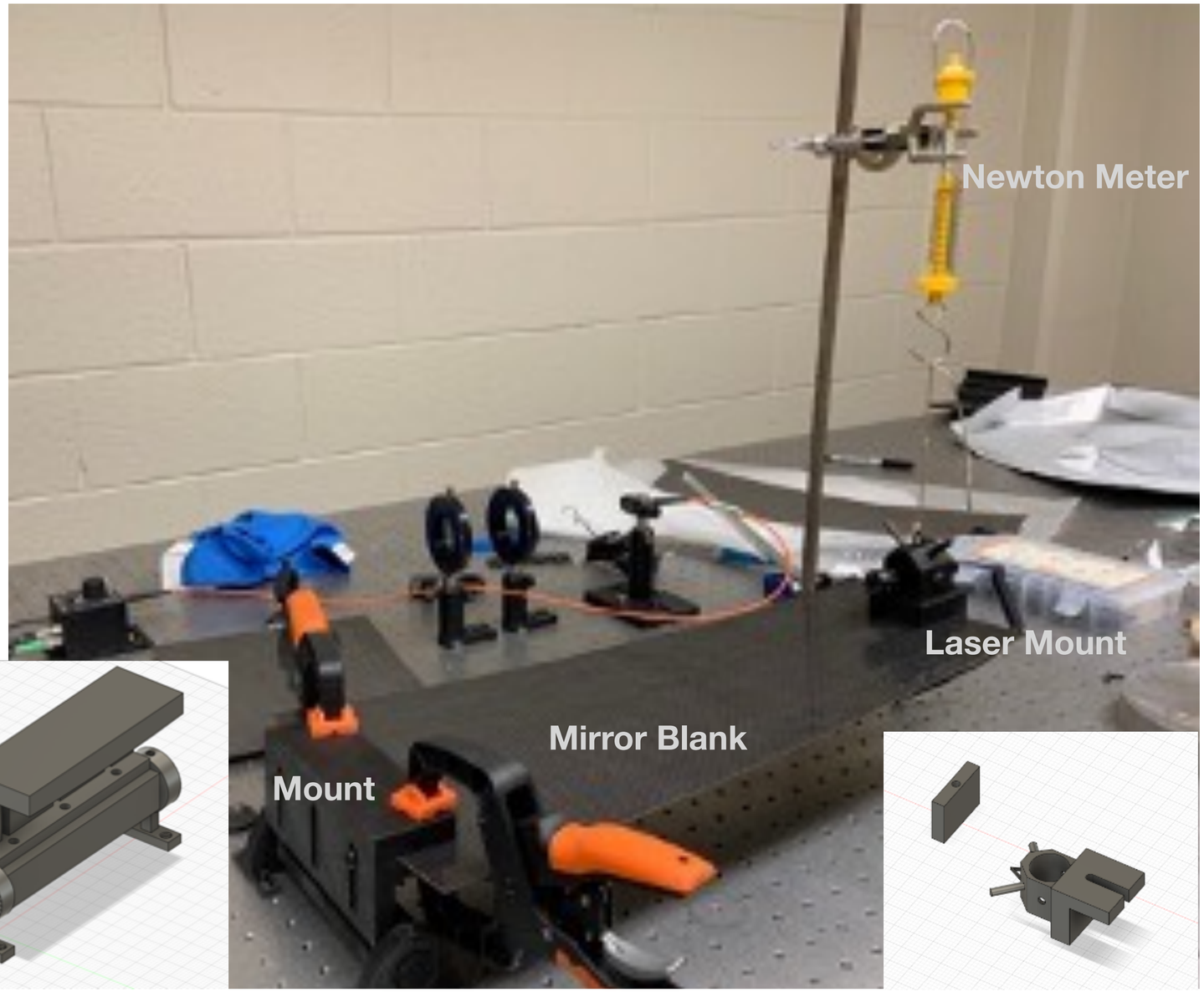
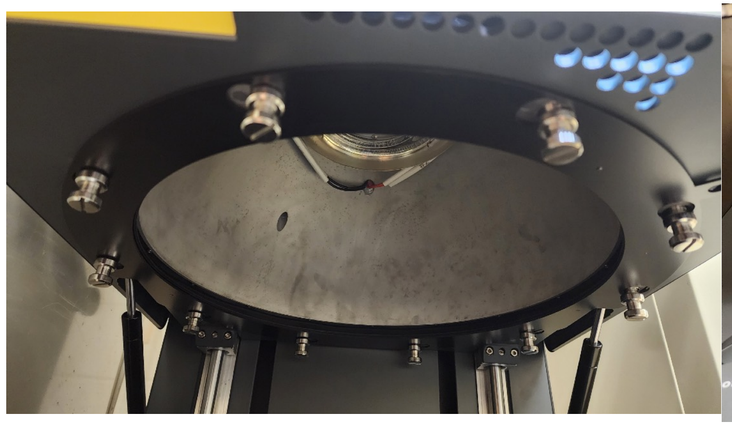


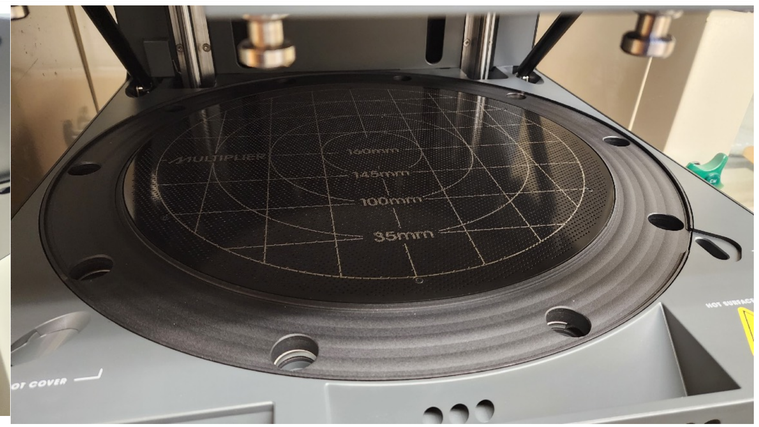
Mirror Fabrication Update

- Plastic Film materials test
  - A number of different films are under investigation as alternatives to Lexan.
    - Lexan (PC)
      - PROS: We know we can coat it, good reflective properties
      - CONS: High forming temperature. Deformation during thermal relaxation. Does not laser cut well.
    - Acrylic (PMMA)
      - PROS: Good optical qualities (HTCC mirror), rigid form after forming. Good shape stability.
      - CONS: Lower melting temperature than Lexan (though better than others)
    - PETG
      - PROS: Excellent forming qualities. Great shape stability.
      - CONS: Low melting temperature.
    - Acetate
      - PROS: Excellent optic qualities. (traditionally used as motion picture film)
      - CONS: low shape stability, lowest of the melting temperatures.

Mirror Fabrication Update

- Forming and forming procedure:
  - MAYKU Multiplier:
    - Max pressure: 60 psi
    - Max Temp: 440F/220C
    - Forming area: 15”/38cm D





Mirror Fabrication Update

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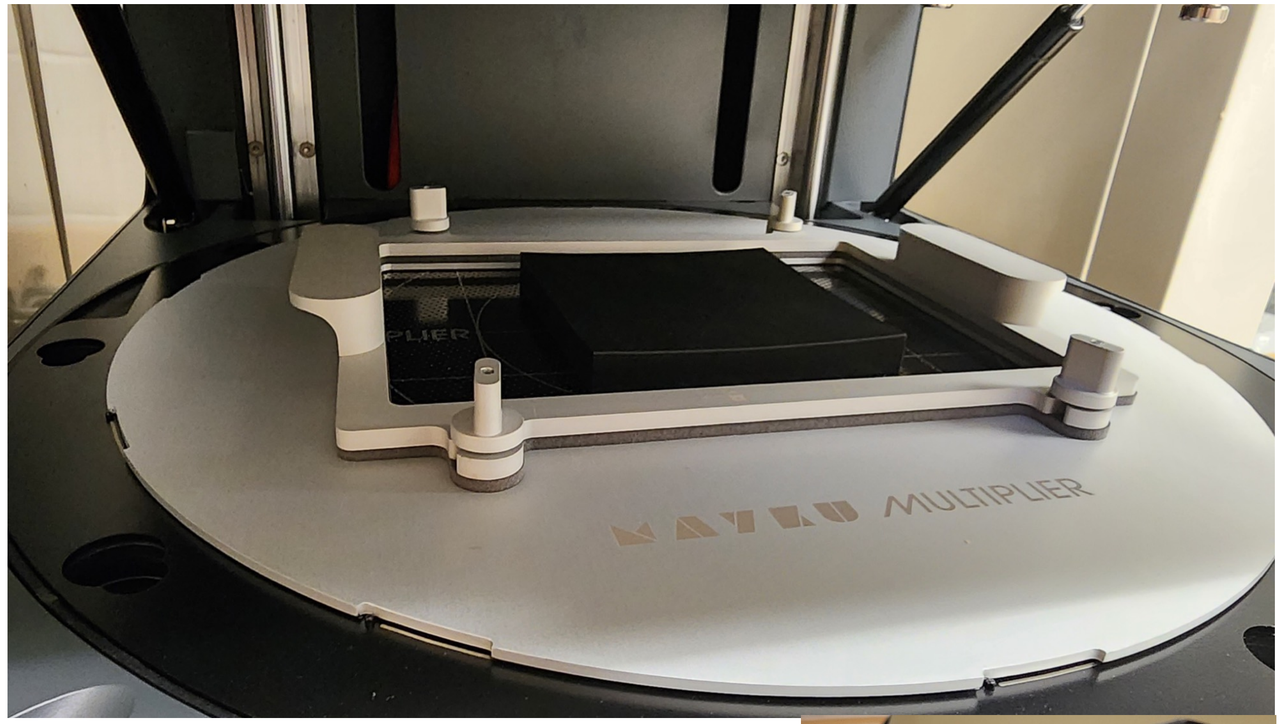
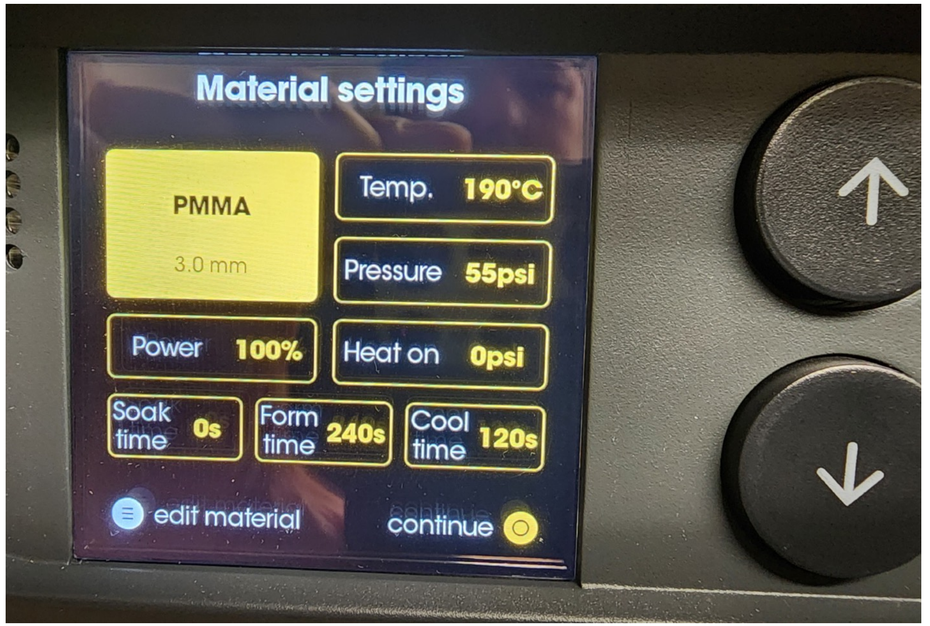
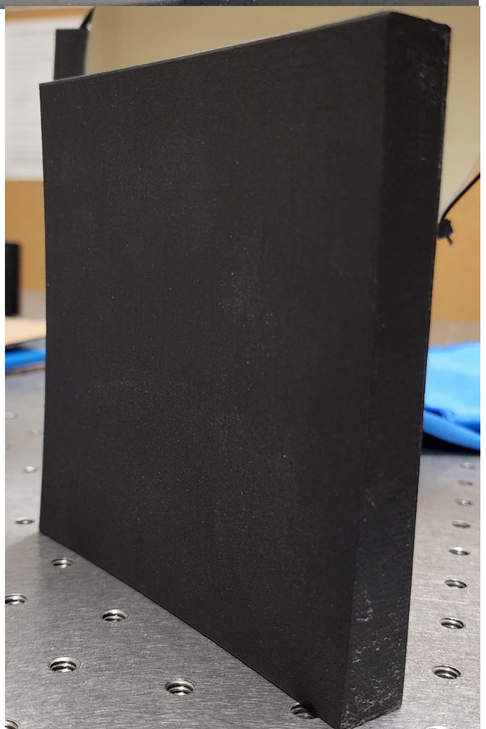
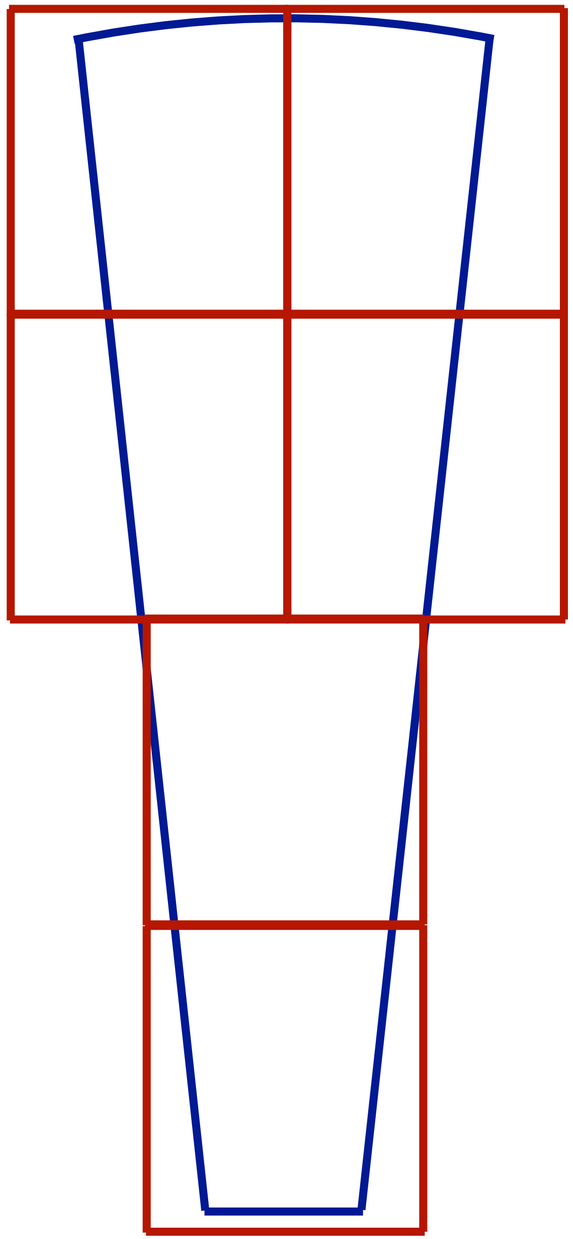
  - MAYKU Multiplier:
    - Max pressure: 60 psi
    - Max Temp: 440F/220C
    - Forming area: 15”/38cm D
  - Material adjustable settings:
    - Temp / pressure
    - Power: heat ramp time
    - Soak time: time spent on mold at temperature before pressure.
    - Form time: time spent at form temp and pressure.
    - Cool time: Time spent at pressure while cooling.



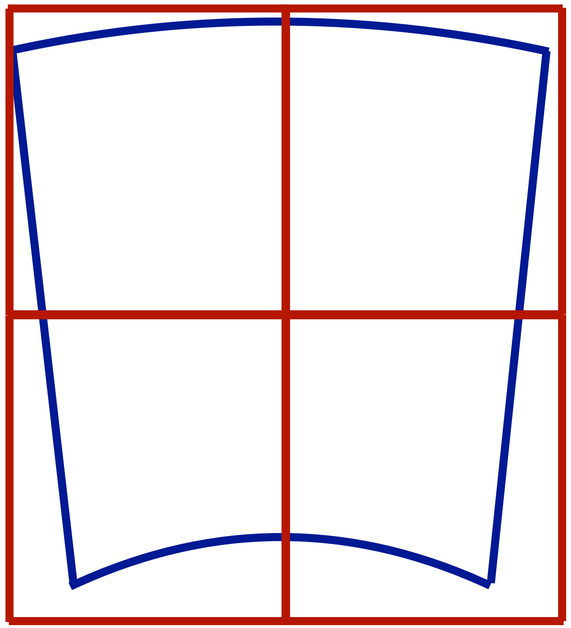




Mayku Multiplier surface segmentation

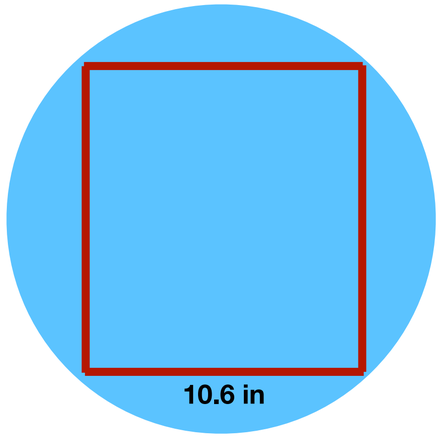


LGC Mirror 1



LGC Mirror2

Mayku form area

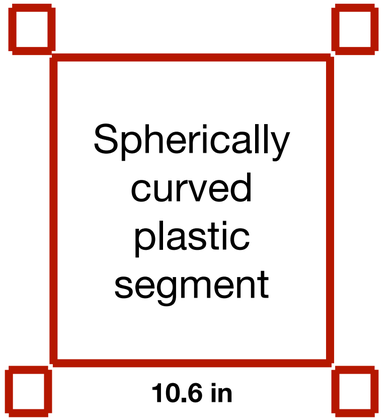


Mirror Assembly

- Mirror assembly procedure:
  - Form plastic to spherical shape
  - Cut plastic to required size
    - Options for cutting:
      - Precision laser cutting (not expensive, but only works on certain materials)
      - By hand shape tracing and cutting.
  - Aluminize plastic pieces.
  - Attach to carbon fiber mirror blank
    - Options for attaching:
      - Large area chemical adhesive / gluing
      - Small area spot gluing
      - Small area adhesive film “spot attaching”
      - Pinning

Reflectivity testing

Inside aluminum coating chamber



2 in x 2 in
Flat sample

- Difficulties in spot testing spherical mirror coated segments:
  - Larger sized mirrors can be difficult to mount in measuring apparatus.
  - Non-flat mirrors are difficult to measure.
  - Everything get more difficult in the UV

Stuff to do

- Mirror assembly:
  - Finish material forming study and test coating (at SBU or ECI)
  - Produce full half-mirror (blank + formed plastic + coated)
  - Finalize/formalize spot testing procedure
- Simulation
  - Bring DD4HEP into agreement with GEMC
  - Apply as realistic as possible mirror properties (considering fabrication procedure) to test efficiencies.
    - Tolerances on radius of curvature:
      - Most likely deformations are bi-lateral: study systematics of an asymmetric deformation.