Status of mPMT mechanical activities

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- Other activities
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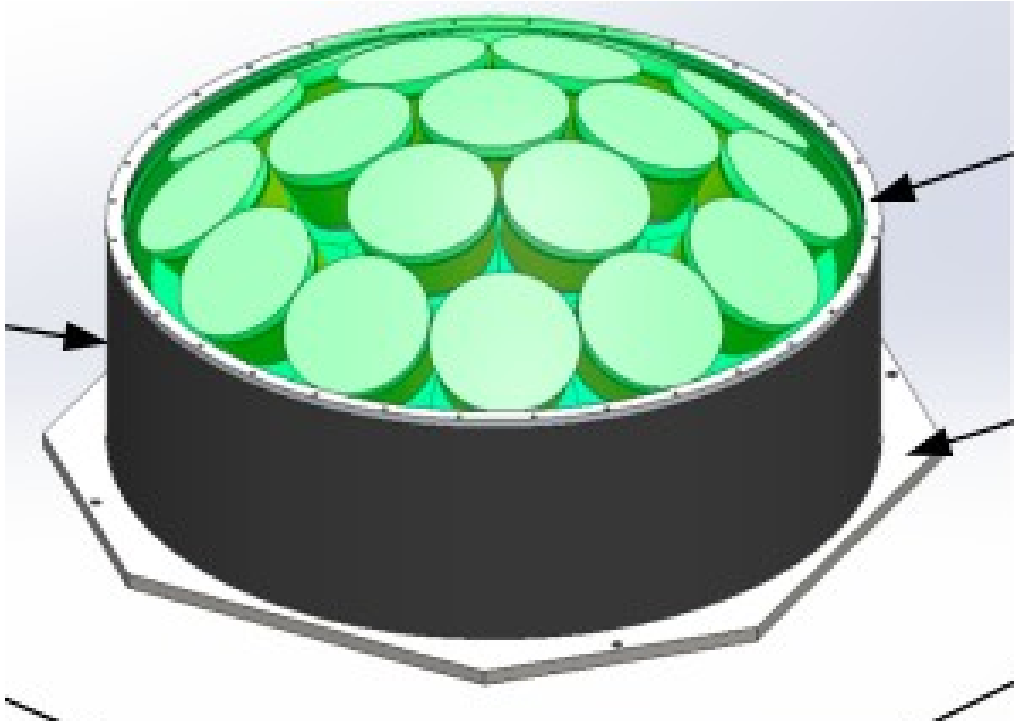
  - mPMT module immersion test
  - mPMT water-tight cable assembly

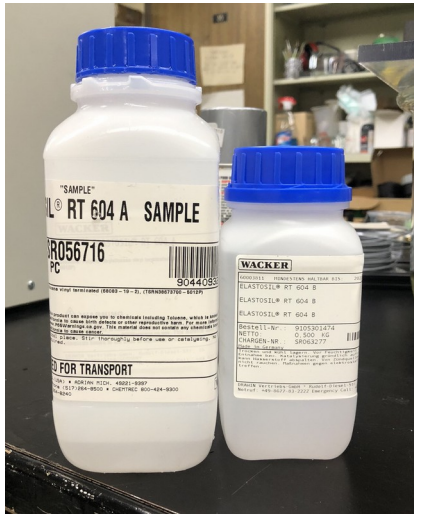


Ex-situ gelling approach (TRIUMF)

- Elastosil gel
  - 612 (A:B = 6:4, non standard ratio)
  - 604 (A:B = 96:4, non standard ratio)
  - 604 (A:B = 9:1, standard ratio)

Primary candidate

Stickiness ↑ Hardness ↓



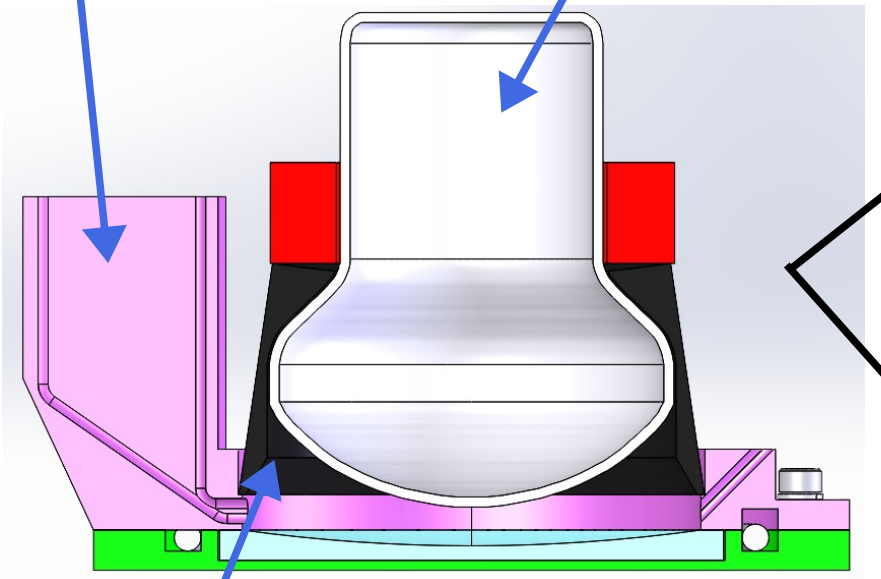
- Carried out several mPMT assembly tests in the last four months

- Purpose is to see if good contact can be obtained by using wrap and Si spray lubricant, for different mixed gel

Casting gel

Pour mixed gel

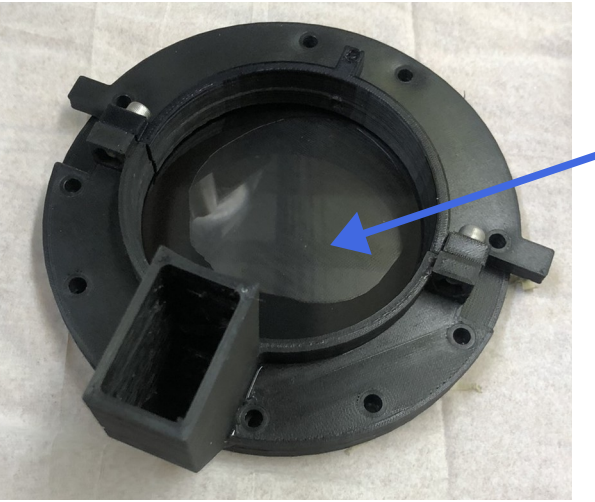
3” PMT



Cup

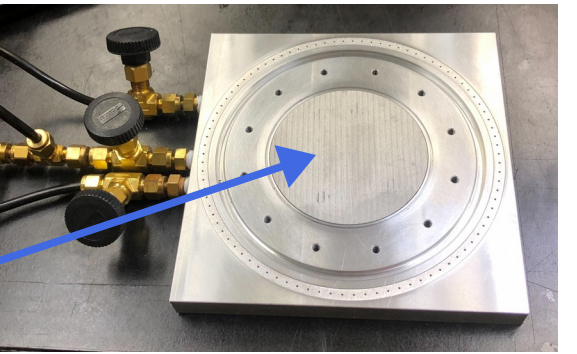
Porous aluminum plate
+ plastic wrap

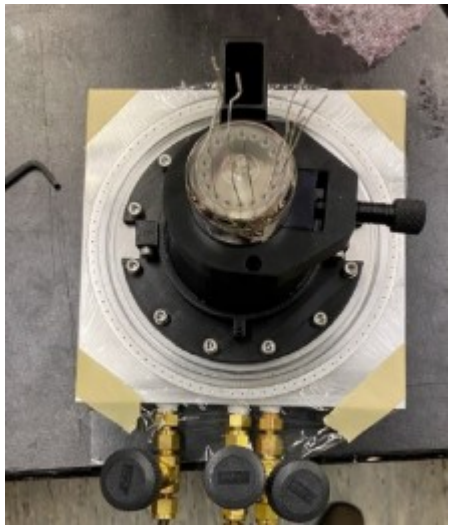
Non plastic wrap jig (604 gel)



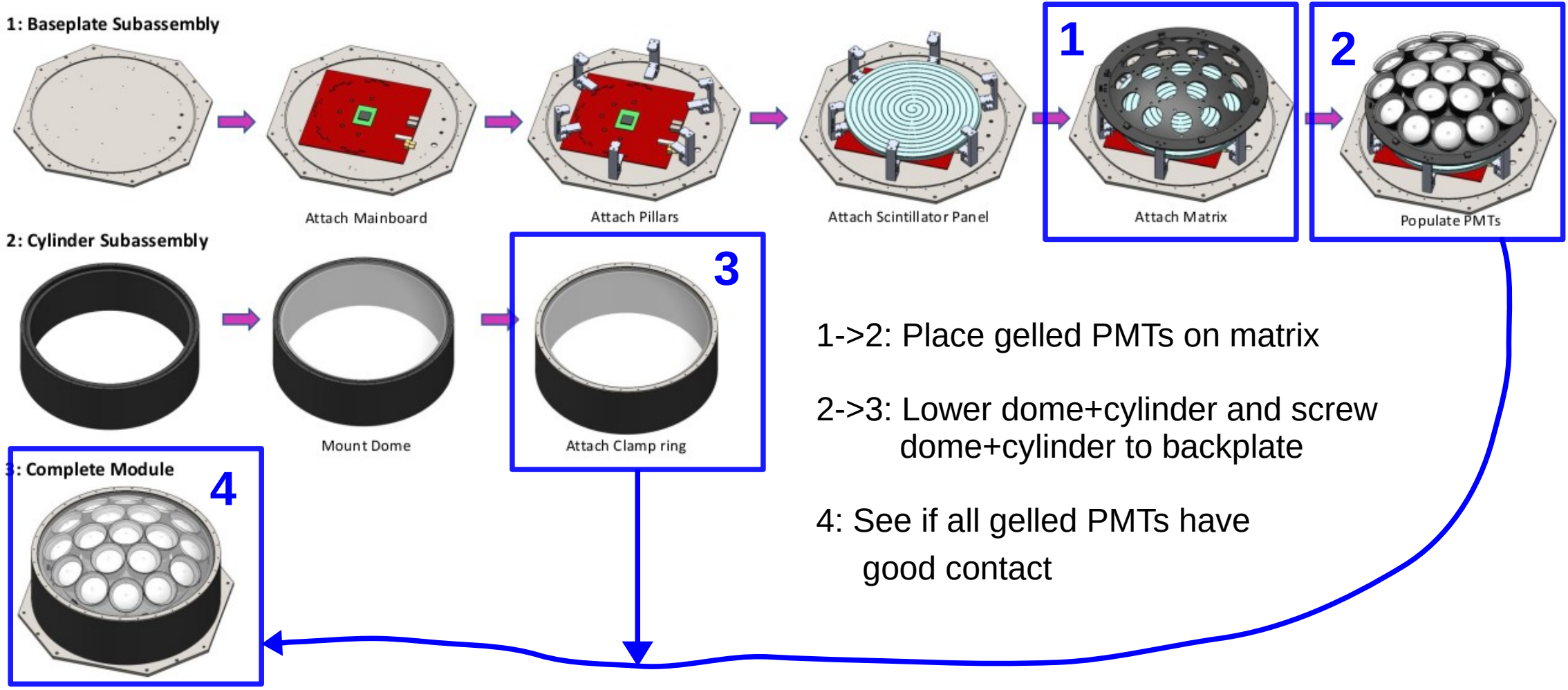
Acrylic plate

Plastic wrap jig (612 gel)

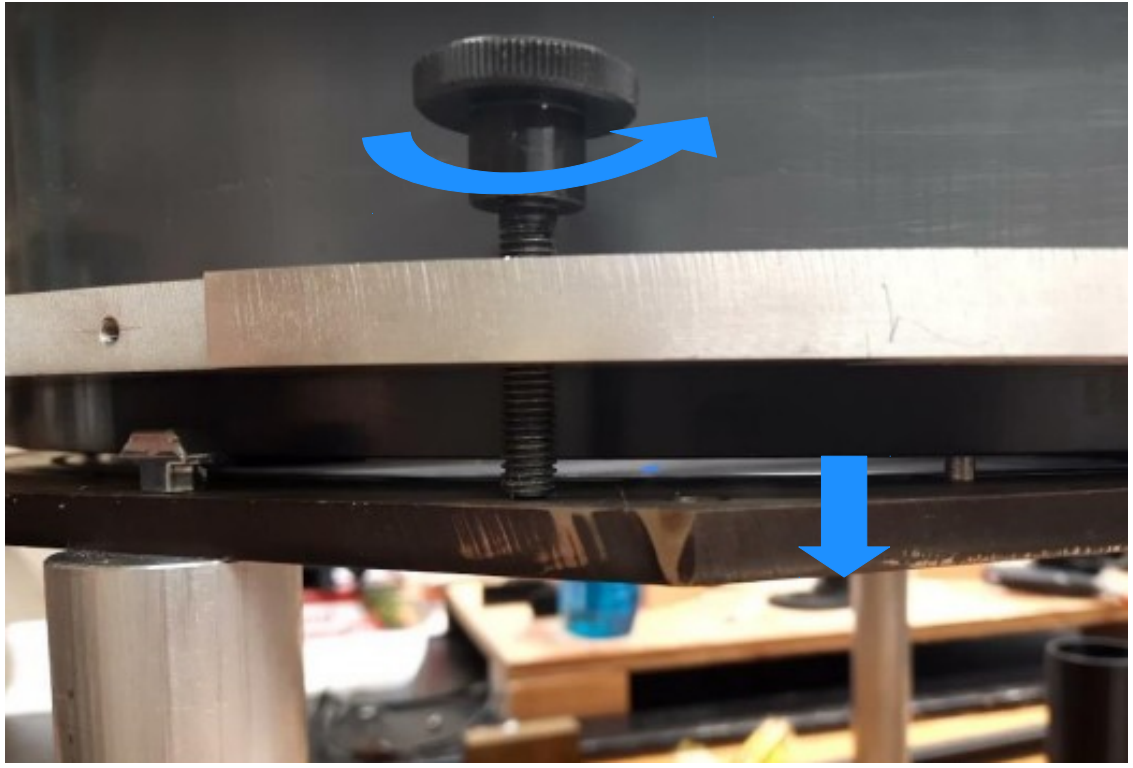




Assembly procedures



Dome+cylinder lowering jig



Assembly tests

Trial #	# PMTs & gel type	Plastic wrap	Si spray lubricant	Result
1	7 PMTs (612, 6:4)	Yes (SR)	No	X
2	7 PMTs (612, 6:4)	Yes (WF)	No	X
3	7 PMTs (612, 6:4)	Yes (WF)	Yes	O
4	7 PMTs (604, 96:4)	No	Yes	O
5	19 PMTs (604, 96:4)	No	Yes	O
6	15 PMTs (604, 96;4) + 4 PMTs (604, 9:1)	No	Yes	O
7	19 PMTs (604, 9:1)	No	Yes	X

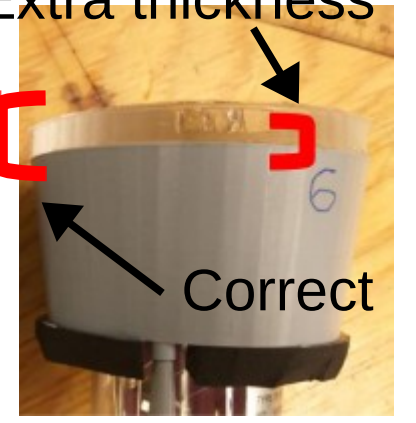
WF: Western Family brand

SR: Saran brand

Si spray lubricant

Identifying problems

- Fixed mis-designed 3D model of gelling jig
  - Not filled with gel completely



- Fixed thickness variation that is probably due to buoyancy occurring after pouring mixed gel

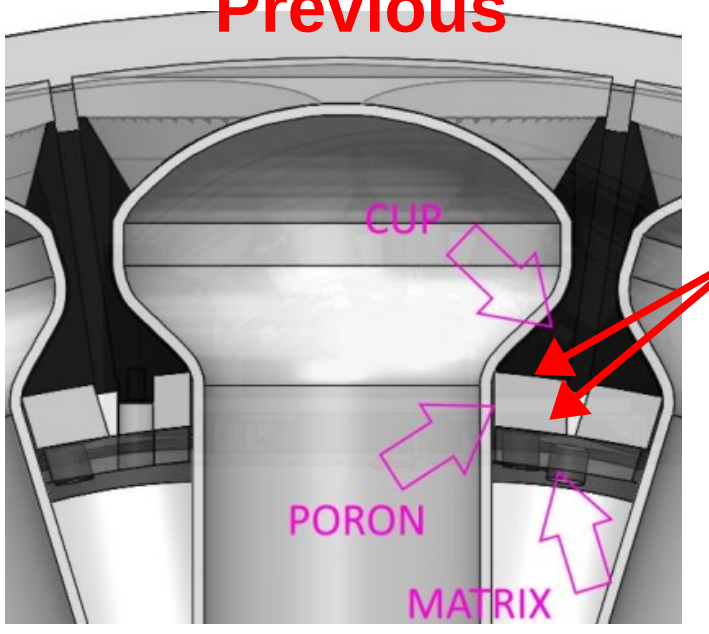
- Measured dimension of each component and compared it with the design
  - Measurements have been incorporated into design (e.g. shape of the dome inner surface)

3D scanner (ROMER INFINITE 2.0)

Design updates

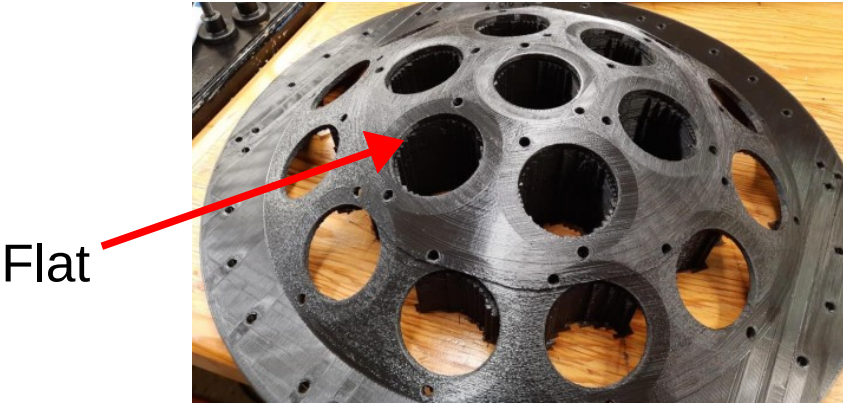
- The tests used flat sheet of porons sandwiched between PMT cup and matrix
  - Surfaces of cup and matrix are not flat
  - They have different diameter
    -> Not uniformly compressed poron

Previous



- Did a new test with new faceted matrix and PMT cups with flat surface
  - Not successful
  - Still trying to identify all the causes

Faceted matrix (new)



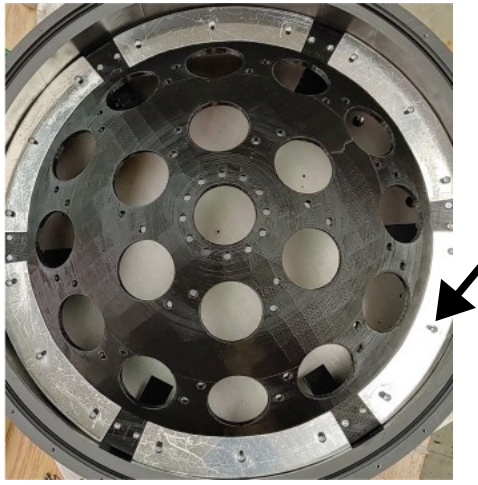
Summary of assembly tests

- 612 gel (A:B=6:4, standard ratio)
  - Achieved good contact with plastic wrap + Si spray lubricant for 7 PMTs
  - Would work for 19 PMTs
  - More complicated assembly procedures than 604 gel
- 604 gel (A:B=96:4, non standard ratio)
  - Achieved good contact with Si spray lubricant for 19 PMTs
  - Relatively fragile -> might cause mechanical strength issue
- 604 gel (A:B=9:1, standard ratio)
  - Not achieved good contact with Si spray lubricant for 19 PMTs
  - Some rooms to improve, but take some time

Same optical property

In-situ gelling approach (Carleton)

- Have been developing in-situ gelling approach
  - Utilize dome, cylinder, matrix being developed for the ex situ approach
  - Necessary design modifications are ongoing

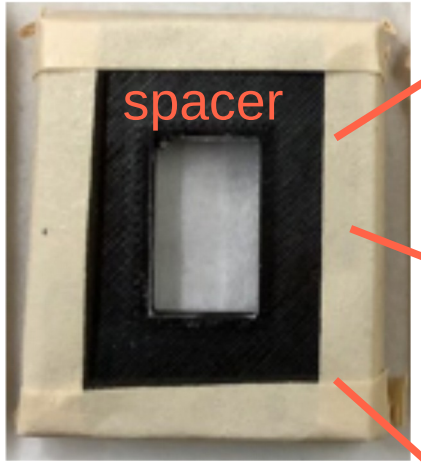


Support arches

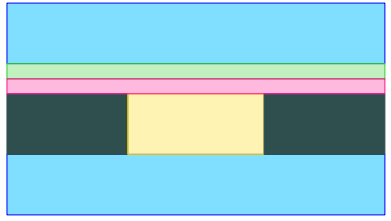
- Procurement issue of gel
  - Can start doing a full in situ gelling with 604 9:1 ratio, once we obtained enough amount of gel
  - Performed a mock-up test of in situ gelling

No air bubbles observed

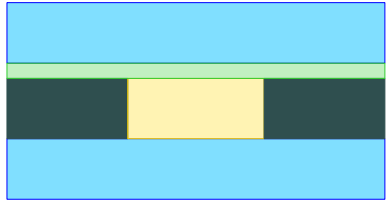
Optical transmission measurements



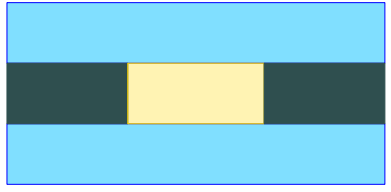
Si spray
+ plastic wrap
+ Gel



Si spray
+ Gel



Gel



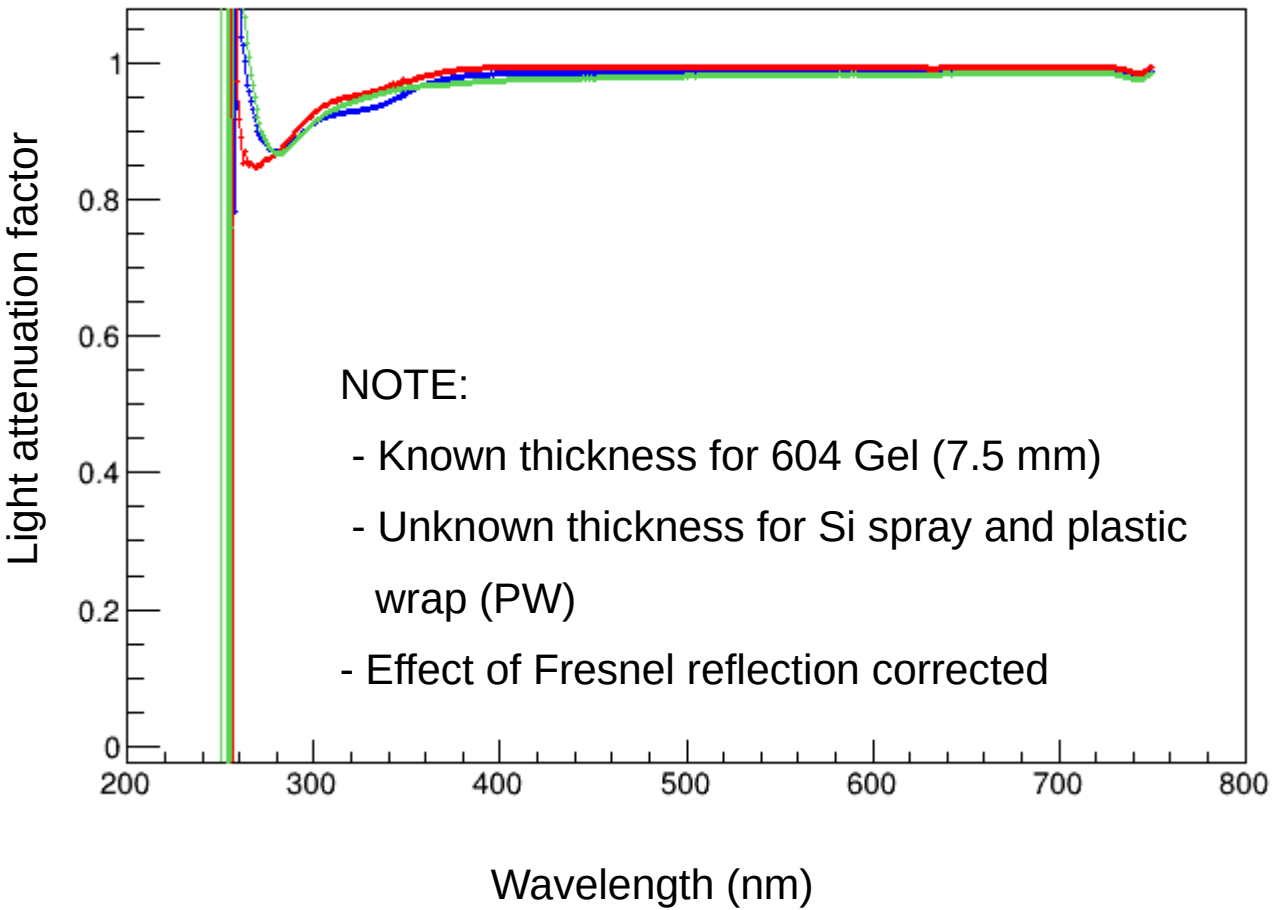
Acrylic

- Acrylic piece: 2.8mm
- Gel: 604 with 96:4 ratio, 7.5mm
- Si spray/Plastic wrap (WF): unknown thickness

Light attenuation factor

d: thickness of a material

L: attenuation length of the material



Y-axis: product of light attenuation

- **604 gel**:

$$\exp(- d_{Gel} / L_{gel})$$

- **Si spray + 604 gel**:

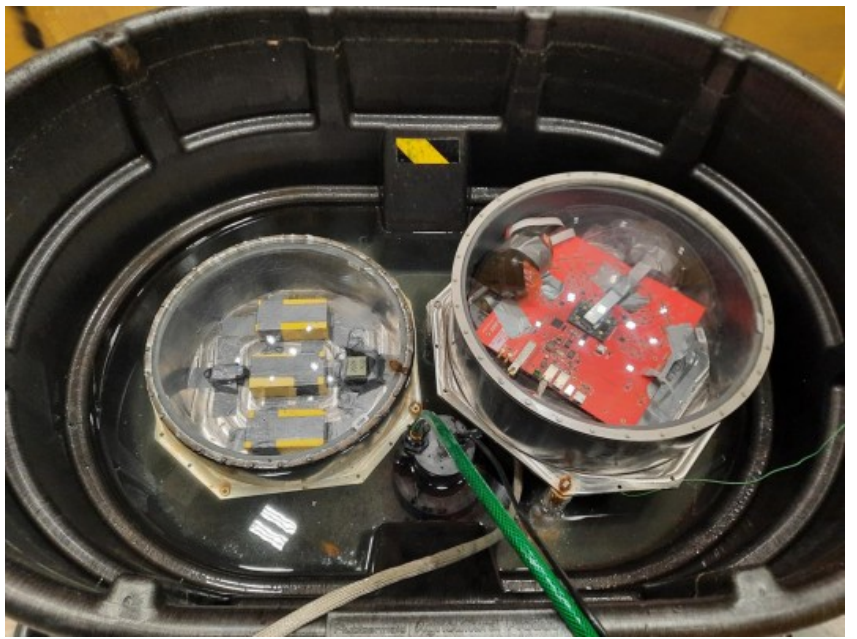
$$\exp(- d_{Gel} / L_{gel}) \times \exp(- d_{Si\ spray} / L_{Si\ spray})$$

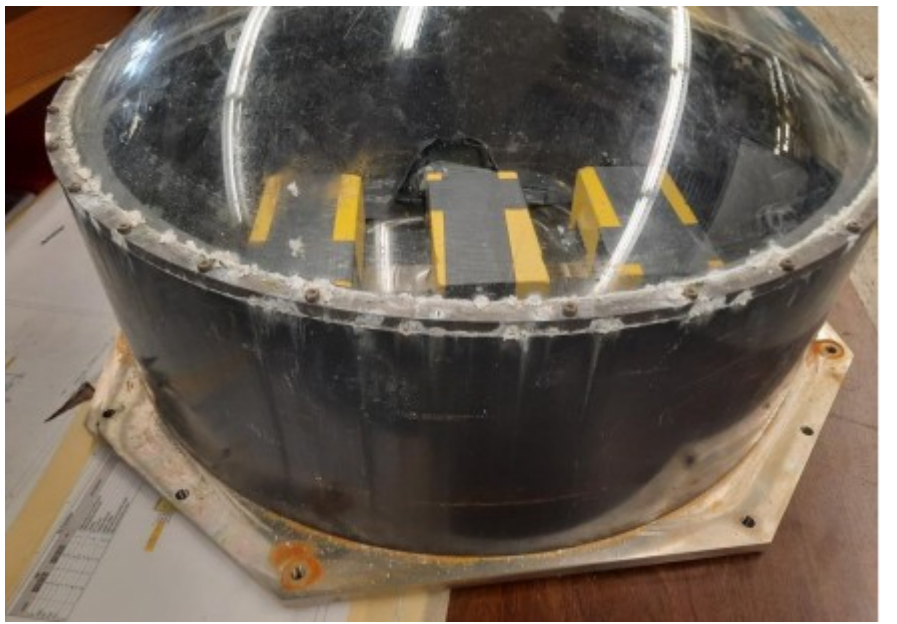
- **Si spray + plastic wrap + 604 gel**:

$$\exp(- d_{Gel} / L_{gel}) \times \exp(- d_{Si\ spray} / L_{Si\ spray}) \times \exp(-d_{PW} / L_{PW})$$

Immersion test (1/2)

- Performed mPMT module immersion test for nine months at TRIUMF
- No water leak found

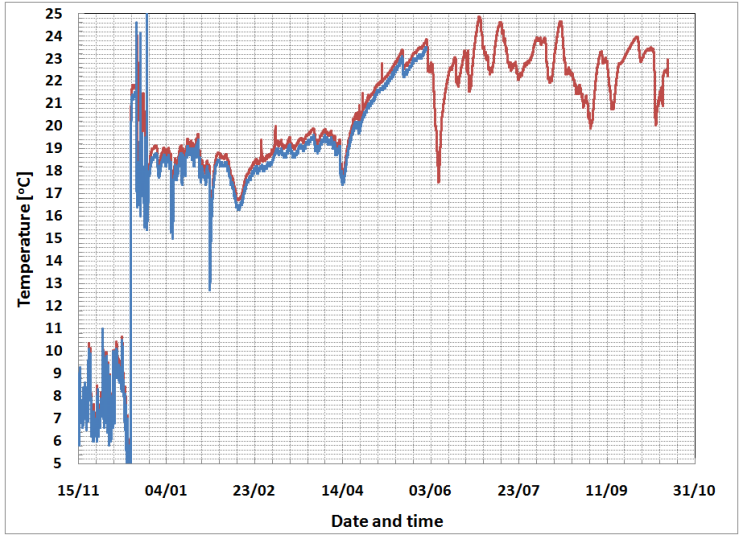




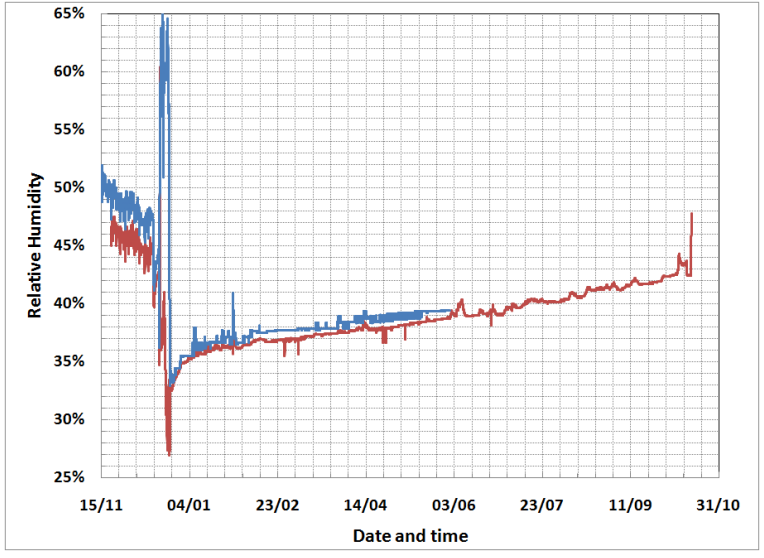
Immersion test (2/2)

- Had two humidity sensors inside module
  - Both temperature and relative humidity increase over time
- Clear increase of water mass, though the behaviour has not understood yet
  - Consistent with other measurement done at Carleton

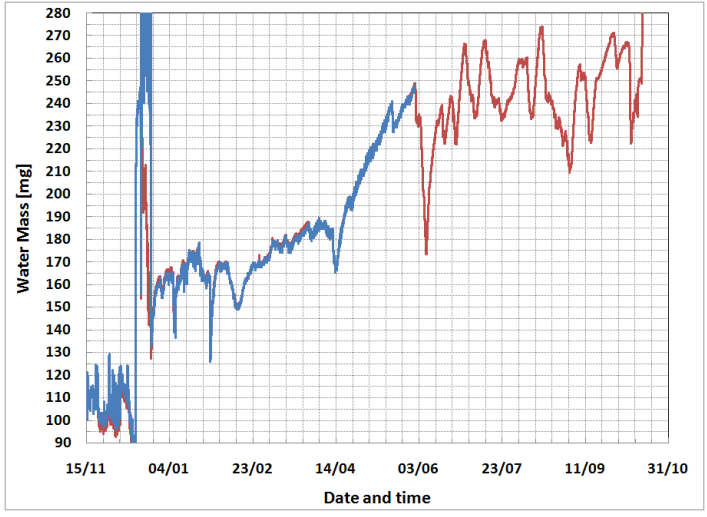
Temperature



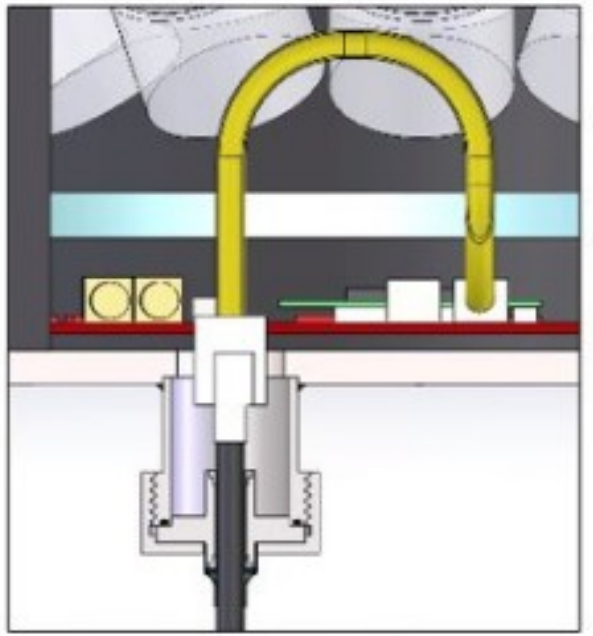
Relative humidity

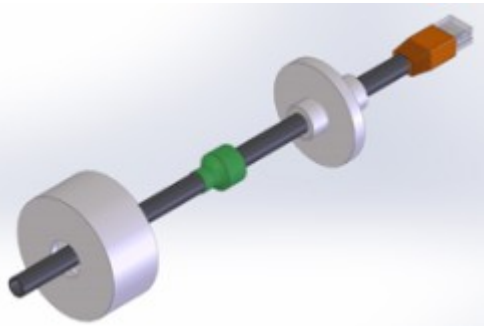


Water mass (mg)



Water-tight cable assembly


During Operation



- Performed initial assembly of water-tight cable + outer flange
  - Waterproof cable from ICRR + RJ45 connector
  - Using silicone sealant + heat shrink (messy assembly procedures)
  - Plan to test full feed-through in a water

Summary

- Both ex-situ and in-situ gelling approaches are being developed
- Observed no clear degradation in optical transmission due to plastic wrap or Si spry lubricant
- Performed mPMT module immersion test for nine months and found no water leak
- Performed initial assembly of water-tight cable
- Other works are ongoing
  - mPMT test stand development
  - mPMT module pressure test
  - accelerated aging studies on gel