Updated Mechanical Concepts for nuPRISM

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TRIUMF

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In this document I show my updated Mechanical nuPRISM Concepts, mainly that of the 38-PMT Module. After my 18-December document, there was pressure to change the design to one where the Acrylic domes are Oring-sealed to the Cylinder(s), rather than using glue joints. That would result in four Oring seals. There was also pressure to reduce this number to two.

In this document I present an alternative design that meets both these requirements. This is done by combining the mounting plate and two cylinders into a more complex "Cover", which is discussed. I've modified the internal components, central plate, brackets etc, so that the assembly looks reasonable and practical. I've managed to evolve this new concept so that the Outer half-Module can also be fully populated, if required.

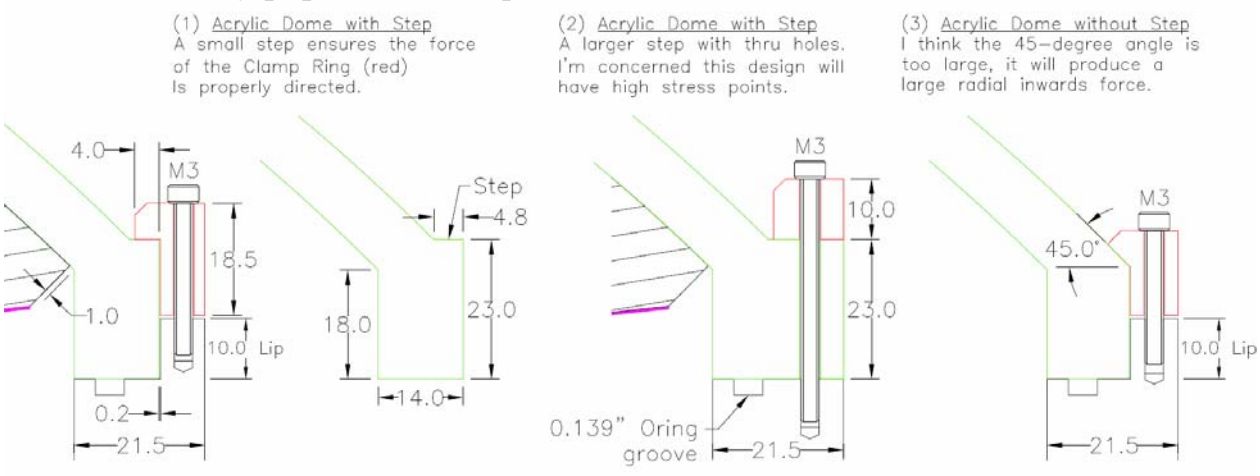
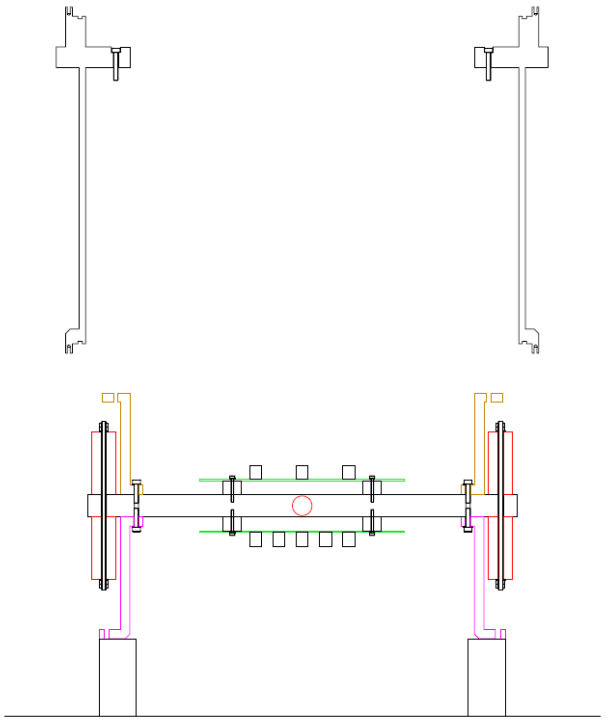
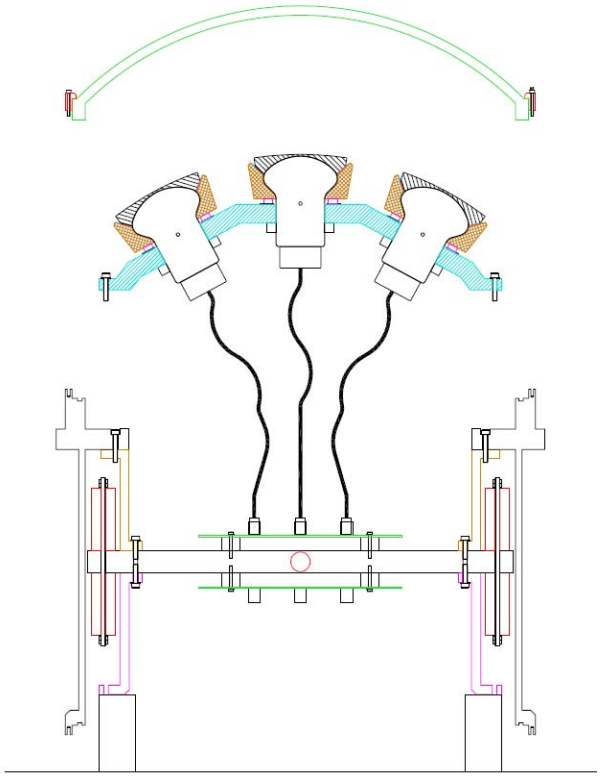


Figure 1 This shows; (1) The proposed Oring face-seal for the Acrylic Dome (green). The dome has a small 4.8mm step so the force from the Aluminum clamp ring (red) is properly directed. (2) shows a design with a larger step and thru holes. I'm concerned this design would have high stress points at the screws. (3) For a Dome without a step, half the force from the clamp ring would be directed inwards. I don't like this and it may not work properly.

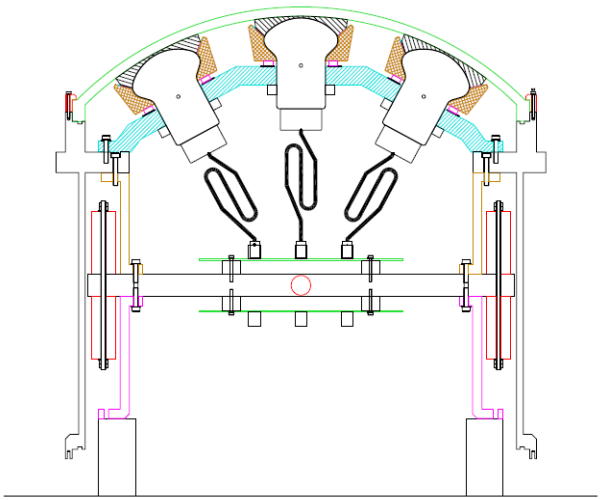
The Dome edge cannot be much wider, because the similar inside end of the Modules need to pass through the holes in the nuPRISM support structures. At present the clearance is only 2mm. The holes could be a little larger, up to dR~4mm if really required. FEA of this Dome profile is clearly needed to determine if the stresses are acceptable. We also need confirmation that the required step is not a problem. The inside transition from arc to vertical is also important. Figures 2 and 3 show the Module assembly steps. Figure 4 shows three Section-views and associated Top-views of the Module, to make it's the features clearer.



(1) Assemble Internal Componets – Central Plate, RO Electronics, Ballast, two types of Support Brackets. Mount on Temporay stand. Install Cover. Connect Cover output Cables to the RO Electronics.

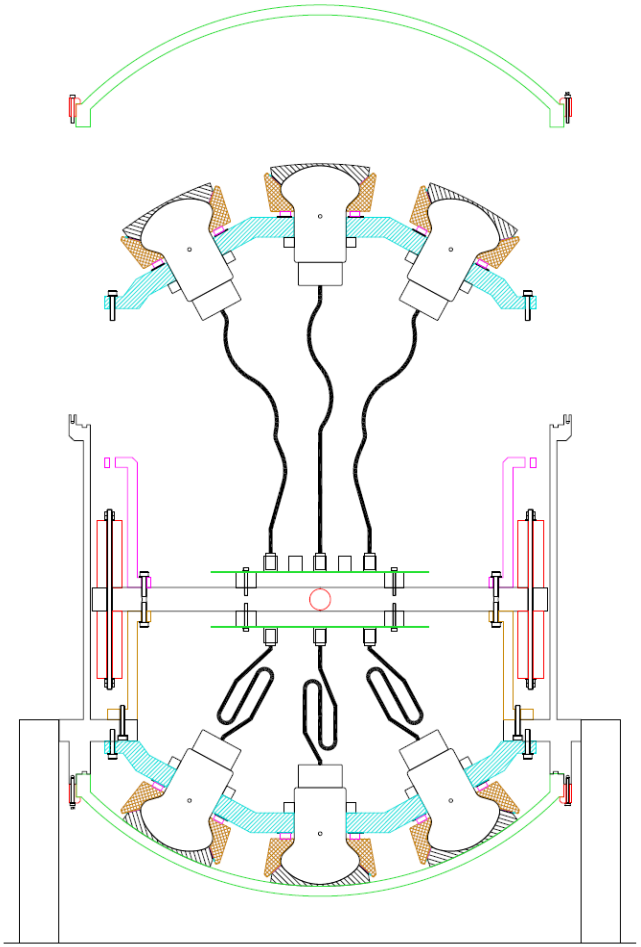


(2) Position Printed 19–PMT Suport (with PMTs) ~150mm above assembly, reach in and plug PMT cables into Internal Electronics.

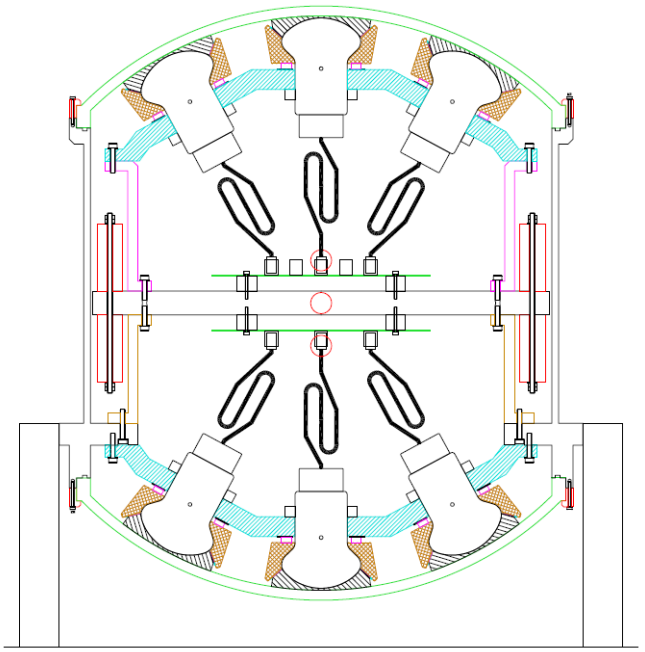


(3) Install Support+PMTs for half–module. Install first Acrylic dome. Half–Module assembly now complete.

Figure 2 Three steps of Assembly of half–Module

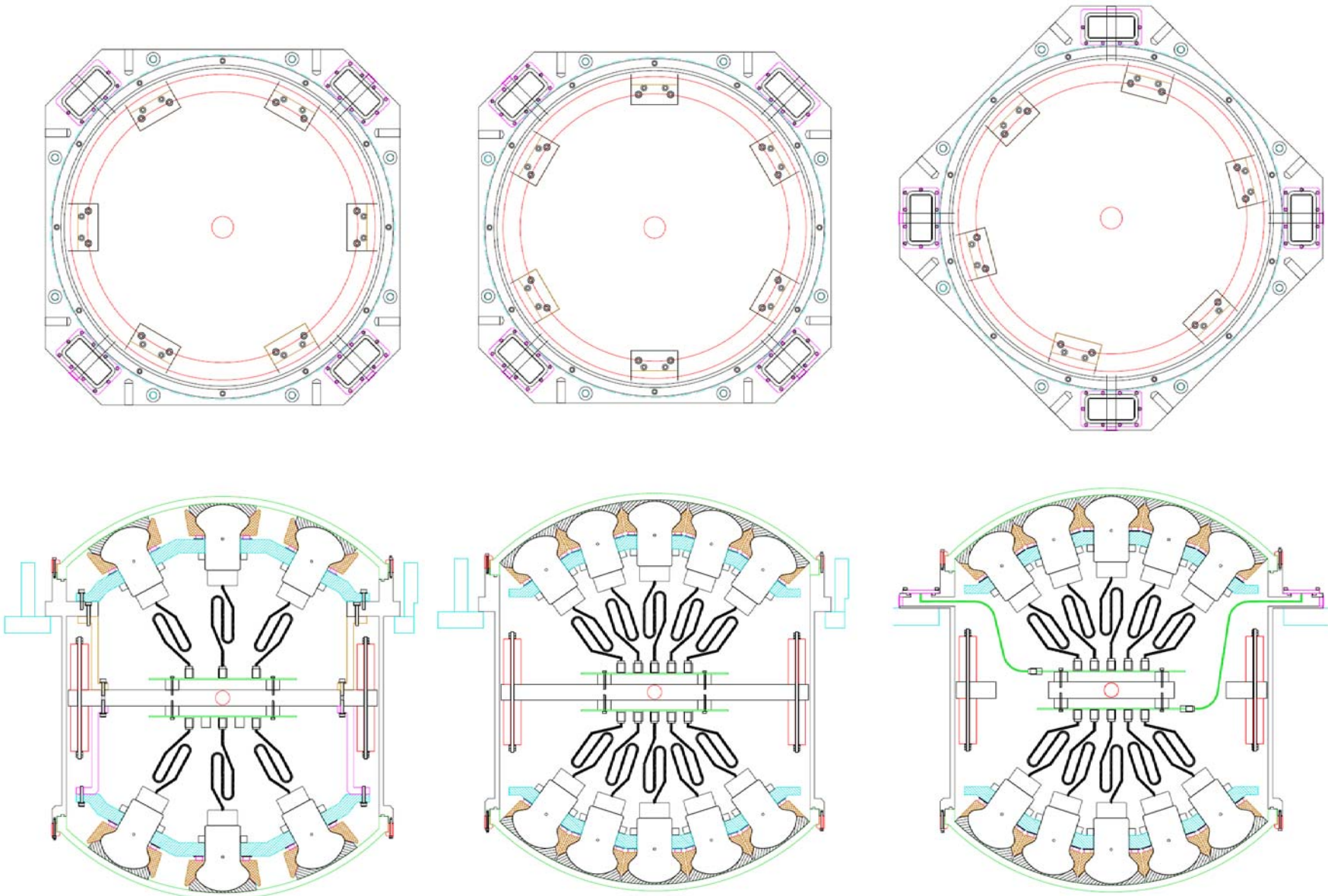


(4) Rotate assembly 180 degrees and mount on a second Tempory stand. Position Printed 19–PMT Suport (with PMTs) ~150mm above assembly, reach in and plug PMT cables into Internal Electronics.



(5) Install Support+PMTs for half–module. Install first Acrylic dome. Module assembly now complete.

Figure 3 Two steps to complete Module Assembly



(6) Top View (top) and Section View (bottom) thru the support brackets, This shows the support brackets holding the nuPRISM Inward-Facing PMTs, and the brackets. The support bracets connecting the central plate to the six cover 'tabs' also provide the conduction cooling of the electrincs to the water.

(7) Top View (top) and Section View (bottom) at 90-degrees to (6). It shows the 5-PMTs of a fully set of 19 PMTs.

(8) Top View (top) and Section View (bottom) thru the Signal Output cables thru the Cover and to the RO Electronics. There are four such services 'ports' at the 'corners' of the External Mounting Plate part of the Cover.

Figure 4 Three sections views thru Module

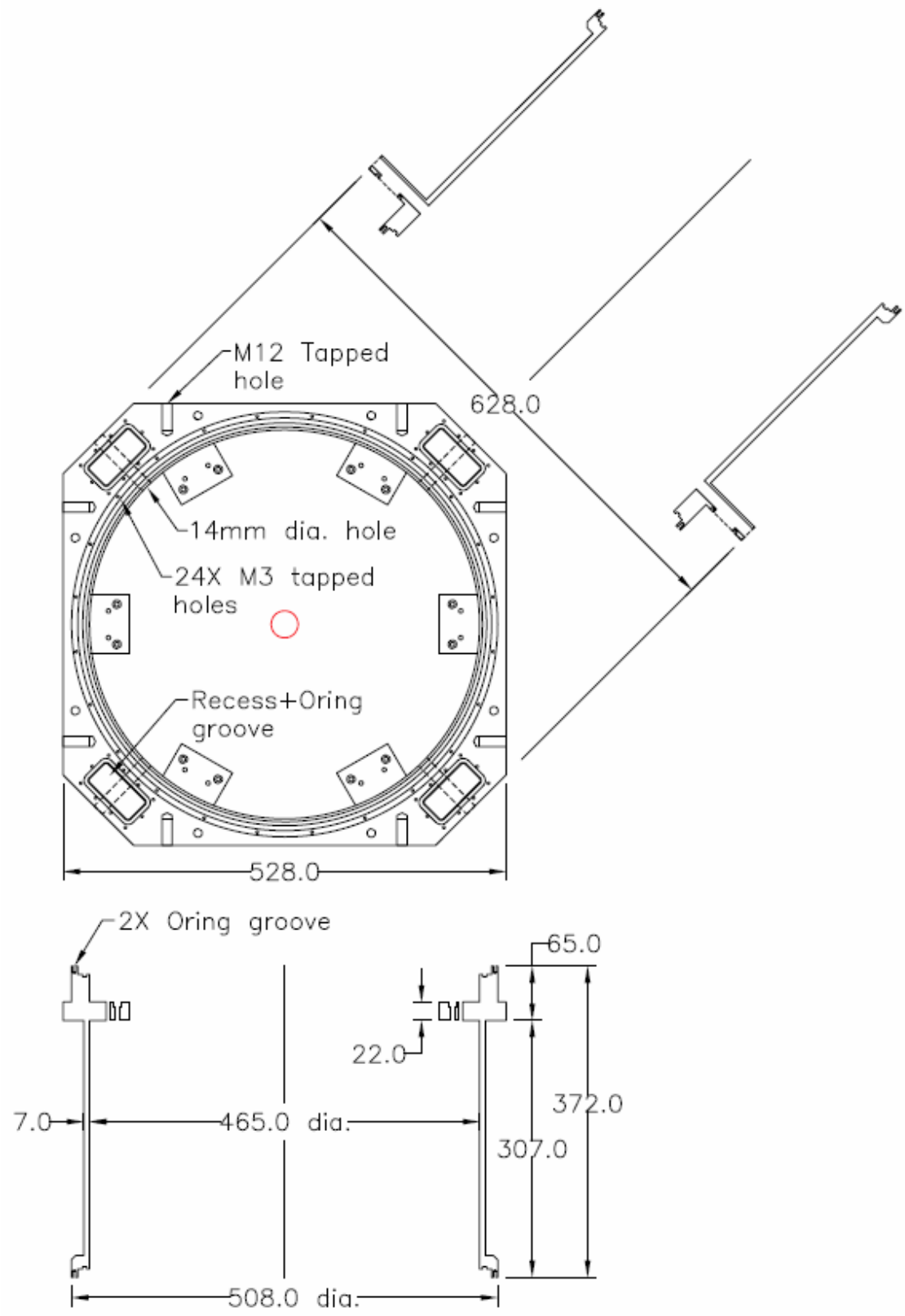


Figure 5 This shows the complex Cover required to eliminate two Orings.

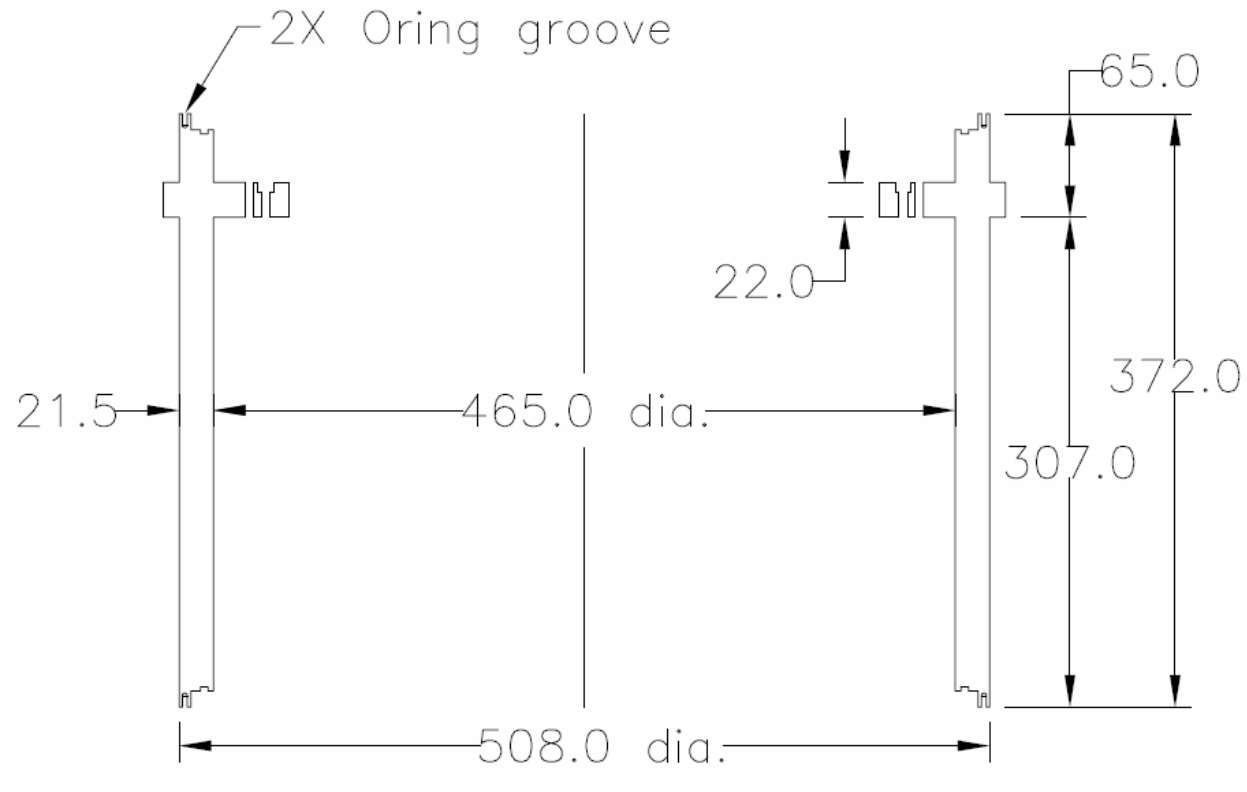


Figure 6 This shows the same Cover with straight cylindrical wall.

Complex Cover

Figure 5 shows the complex new Cover design required to eliminate. Basically it's a 528x528mm rectangular plate (with cutoff corners), 22mm thick, with short 43mm high cylindrical section on the Outer surface and a much longer (307mm) cylindrical section on the Inner surface. Figure 6 This shows the same Cover with straight cylindrical wall 22.5mm thick, rather than recessed to 7.0mm. This sounds like unnecessary extra weight (~17 kg), but in fact it just reduces the ~38 kg Ballast by ~10.7 kg, a 28% reduction. The greater wall thickness could also be important if this part is made from cast Aluminum, which is typically not as strong.

I'm not sure how this part could/should be made:

1) One way would be to machine the Plate and Outer cylindrical from a 65mm thick piece of Aluminum. The 307mm long Inner cylinder could be fabricated (not sure how) separately, then the two parts welded together.
2) Perhaps a better way would cast the part in Aluminum, then machine the critical surfaces, Oring grooves, reference surfaces.

Poron ‘Spring’

As discussed in my 18-Dec document, using a spring to push the PMT+Puck sub-assemblies against the Acrylic Domes should reduce the reliance on tight part and position tolerances.

Poron is a simple and option for the spring, it is readily available in a range of thicknesses and strengths. But since it is a closed-cell rubber, its use would probably mean we couldn’t use vacuum or partial pressure. With the clamp ring and twenty-four M3 screws holding compressing the Dome against the Oring of the Cover, I don’t see a need to retain the ‘vacuum option’. If dropped, it eliminates the need for pumping facilities, valves, gauges/sensors etc.

If the group wishes to retain the ‘vacuum option’, we’d need to have custom metal strings made, probably of phosphor-bronze, or perhaps custom multi-wave spring-washers.

My Conclusions

I think the alternative 1-PMT sub-assembly design has definite advantages:

(1) It reduces the tolerances requirements on; Puck, 19-PMT support, PMT positioning.
(2) The 19-PMT printed support is much simpler.
(3) The new 1-PMT printed support easy to make and much easier to QC.
(4) It allows much of the assembly and QC to be at a lower level, i.e. PMT level rather than Module level.

The more difficult Cover will certainly be a challenge to make, but it does eliminate two of the four Oring seals. This alternative design presented here looks reasonable and the assembly steps appear fine. In spite of my earlier doubts, I’ve evolved the design so that both halves of the Module can be populated with 19 PMTs if required. This means the Outer half can be partially populated in any way that simulation and cost indicate is best.

I don’t see a significant advantage to using reduced pressure in the Module to hold the Domes and compress their Orings. I prefer using the indicated clamp rings. It’s certainly better during the assembly process, since each half-Module s sealed in turn. I there’s no clamp rings, the Outer Dome (first installed) would need to temporarily held in place (upside down), while the Inner Module half is

assembled. Also, as mentioned previously, using negative pressure precludes using Poron discs as simple cheap reliable springs.