

Design Ideas for pfRICH Laser Monitoring System

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System Design Constraints

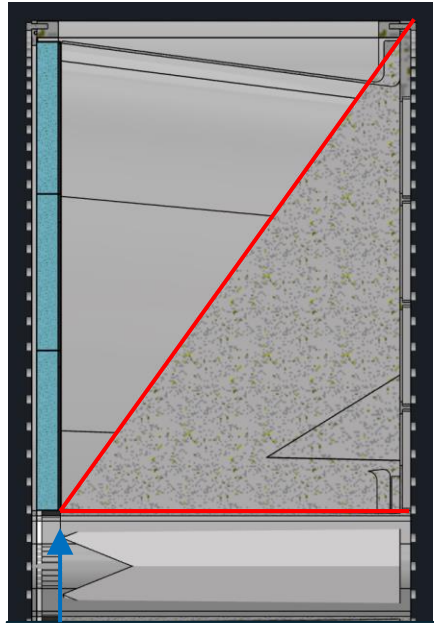
Constraints:

- Every HRPPD pixel must get single photon hits (after N number of pulses, accumulate ~5K single photon events per pixel)
- Prefer good uniformity such that 5K events are uniform across det. acceptance (maybe not critical)
- Must distinguish photon point of origin (ie, which fiber)
 1. HRPPD illumination: how to distinguish overlapping light profiles from fibers?
 2. Mirror illumination: how to distinguish between reflected and direct photons from same fiber?

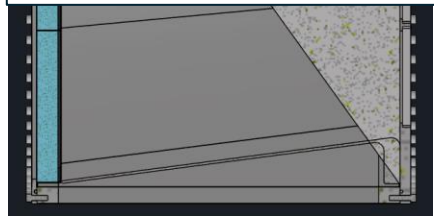
Answers:

1. Timing difference (ie, “fiber delay lines”) take care of light profile overlap for all 12 fibers.
2.
 - a. “HRPPD fibers” will mostly (ie, >95% of the time [goal]) only illuminate the HRPPD with occasional reflections from mirrors
 - b. “Mirror fibers” will mostly (ie, >95% of the time [goal]) only illuminate the mirror with occasional hits from direct photons (multiple reflections can be identified by timing)
 - c. For rays traveling close to parallel to mirror surface, the pathlength difference between a direct ray and a reflected ray become too small to distinguish using timing info. This will result in some efficiency loss in correctly identifying reflected from direct photons. This efficiency loss may be minimized by using a light baffle to help reduce the number of such parallel rays.
 - d. Overall, this shouldn't be a big problem
 - i. For timing, if the pathlength is too small to detect, then the problem isn't noticeable
 - ii. For QE, since the mean amplitude for the reflected and direct rays is not affected much (ie, small counts in pulse height distr.) by parallel rays, this should have a small impact on the QE/reflectivity measurement

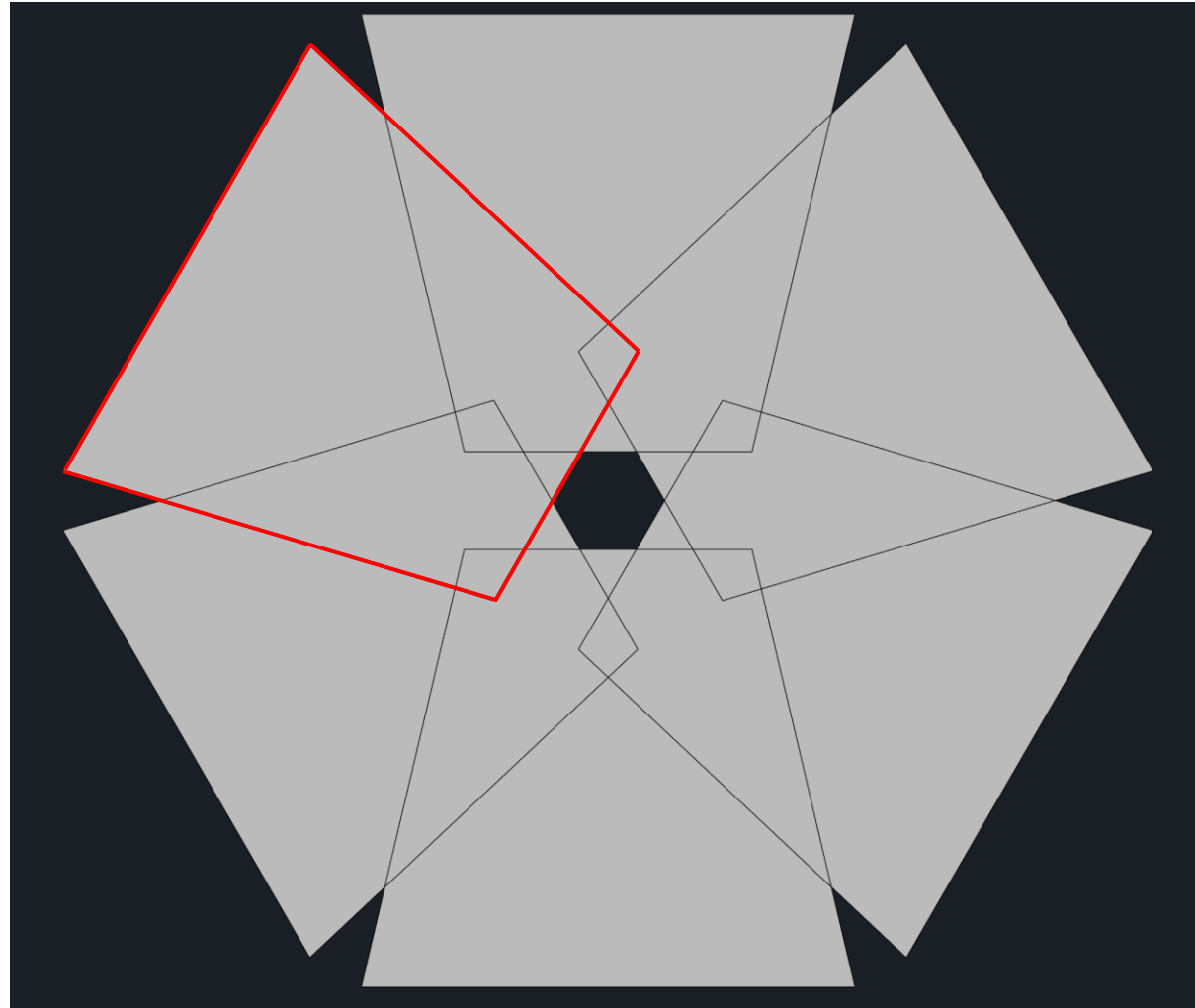
Method of Light Delivery



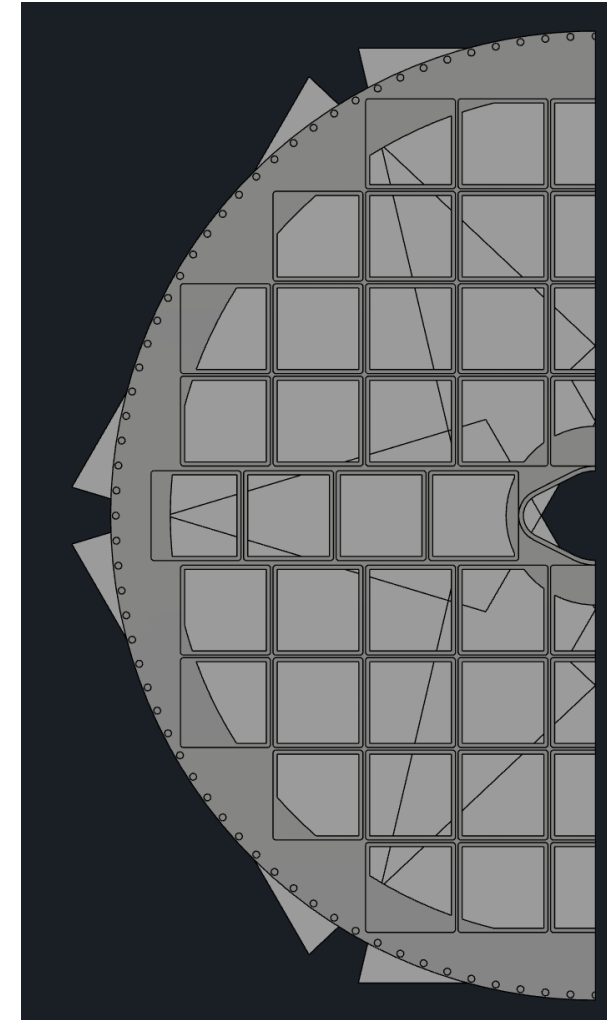
Fiber illuminates HRPPD from gap between inner mirror and aerogel
*Tilt angle of fiber is critical to minimize reflections from mirror; can also use baffle to better shape light profile



Light profiles from 6 fibers for direct illumination

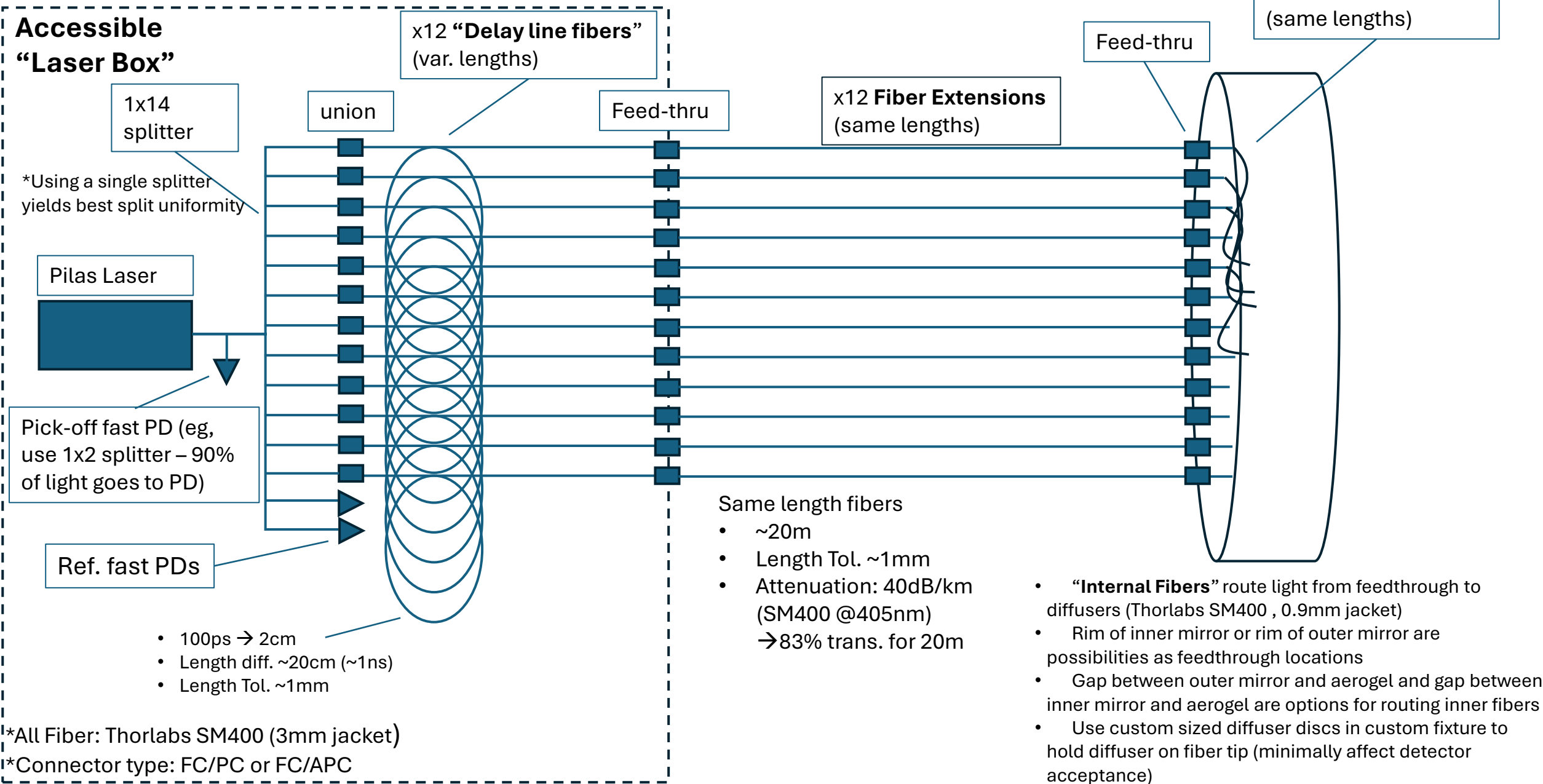


HRPPD coverage



6 fibers for direct HRPPD illumination + 6 fibers for the mirror illumination should suffice to illuminate all HRPPD pixels

System Layout



Fiber Optics

Possible splitters

- 1x2 up 1x16 possible (custom)
- Have quote for 1x16 (SM400 fiber, 405nm) \$~3600, 6 wks
- If using two lasers, we simply replace 1x12 with two 1x6
- The fewer the splitters used, the better the split ratio uniformity



[405 nm Single Mode Fused Fiber Optic Couplers / Taps \(thorlabs.com\)](https://www.thorlabs.com)

Possible feedthrough

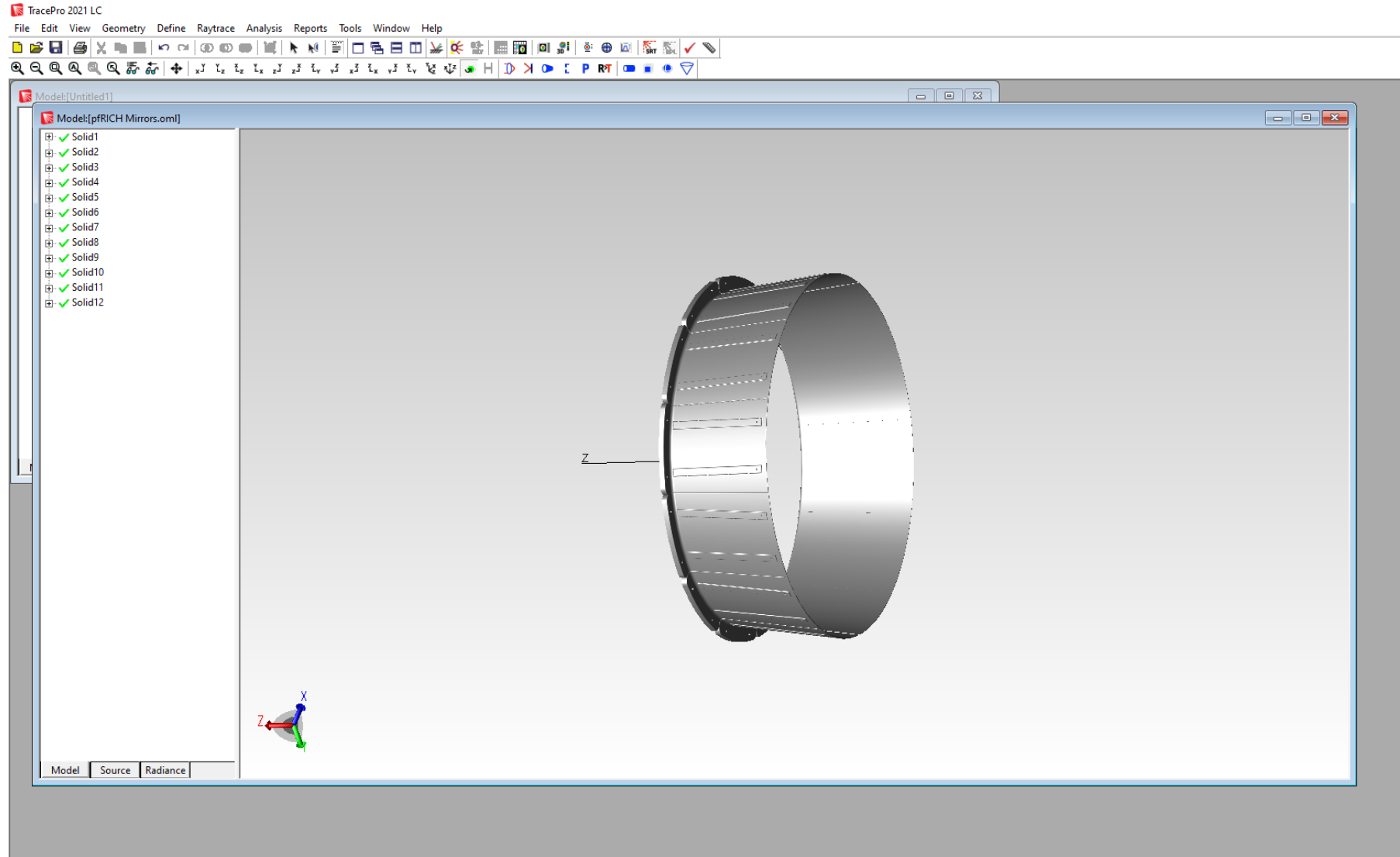
- Small size
- Cheap ~\$60 apiece
- Can be made to have reasonable gas seal
- Can pot an array of them in a G10 flange, which can then be glued into the honeycomb structure of the vessel



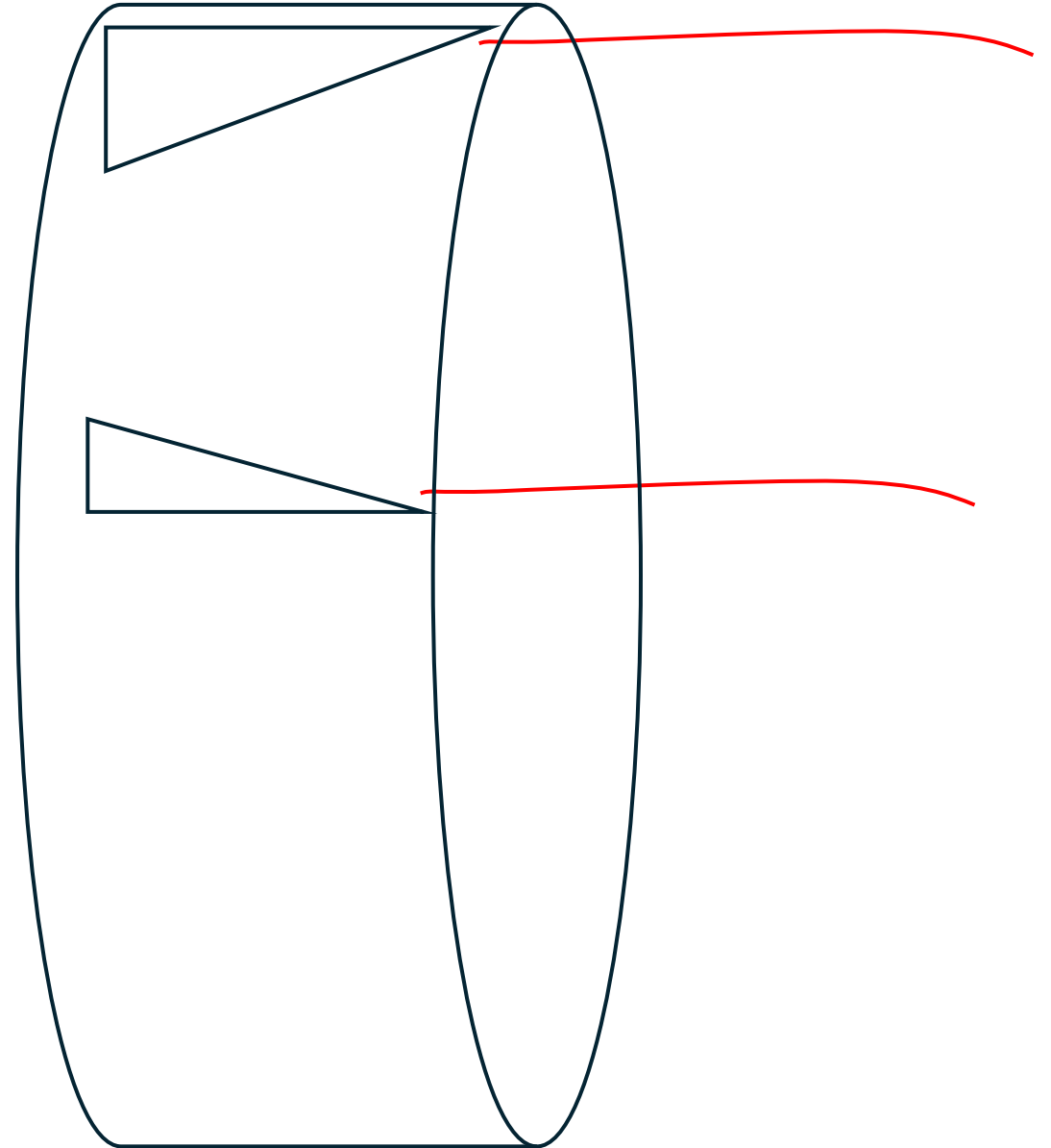
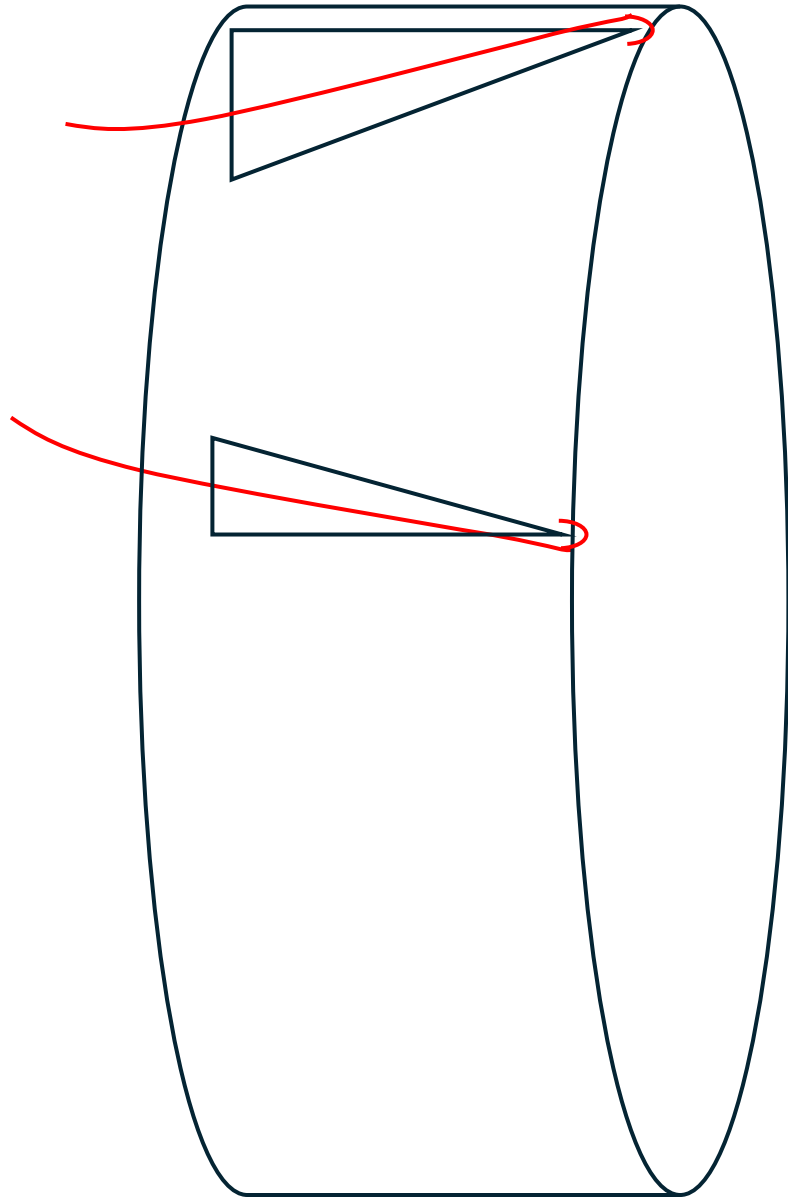
[Thorlabs - ADAFCPM3 FC/PC to FC/PC or FC/APC to FC/APC Mating Sleeve, Narrow Precision Key \(2.0 mm\), D-Hole](#)

Ray Tracing Sims

Can use Trace Pro to simulate light profiles on sense plane for both reflected and direct rays



Possible paths for internal fibers



Dan is working on a design for these options...