



Subject	<i>Technical Review Board (TRB) report:</i> Stray Light Control Shroud for the Output Faraday Isolator (OFI)
From	TRB: Dennis Coyne (chair), Sheila Dwyer, Anamaria Effler, Norna Robertson, Robert Schofield
To:	Design Team: Alena Ananyeva, Stephen Appert, Corey Austin, Calum Torrie, Eddie Sanchez
cc:	aligo_sys@ligo.caltech.edu
Refer to	L1800095-v1
Date	20 Apr 2018

1 Background

The Output Faraday Isolator (OFI) has been found to a significant source of scattered light noise ([G1800717](#) and [FRS issue #10461](#)). The likely scattering paths are diffuse scattering from the OFI to the vacuum chamber walls and back to the OFI:

- 1) Shaking produces DARM noise at vacuum enclosure resonances
- 2) Moving the OFI (with the newly added OSEM actuators) results in strong modulation of scattering noise at the chamber resonances
- 3) The OFI is the greatest source of scattered light visible at the view ports.

In order to mitigate this scattered light noise source, it is proposed to block the light paths from the OFI to the vacuum chamber walls with a “shroud” surrounding the OFI.

In addition to the diffuse scattered light from the OFI, the first and possibly second order ghost beams/reflections from elements of the OFI assembly must also be properly dumped or baffled. Mitigating the effects of these ghost beams are also addressed in this review.

2 TRB review

The TRB (members listed above) met with the design team (also listed above) on 18 April 2018 to review the proposed shroud design ([G1800787-v4](#)). The review team have the following recommendations:

- 1) Shroud on the ISI not the suspended OFI platform: We concur with the design team’s decision to place the shroud components on the ISI table, or the OFI structure, and not on the suspended OFI platform (with the exception of the pre-existing baffles already part of the suspended assembly, [D0900623](#)). The later approach would be difficult to accomplish and would necessitate considerable re-alignment.
- 2) Improved Baffles on the Suspended OFI Platform: Although not indicated in the presentation ([G1800787-v4](#)), it was verbally mentioned in the review that the

baffles/dumps on the suspended OFI platform would be replaced with parts with better stray light performance. Specifically the current parts ([D1001864](#), [D1100247](#), [D1100258](#)) which are oxidized, non-directional, super #8 stainless steel, would be replaced with black nickel coated, non-directional, super #8 stainless steel. We concur that this be part of the improved design.

- 3) Two sets of Shrouds: Two sets of shrouds should be procured for each observatory (H1 and L1). One set intended for rapid procurement and low cost and the second set intended for best performance in mitigating stray light noise. We cannot afford the time to try a low cost solution and then procure a better solution if found to be necessary. Conversely we cannot afford to miss a synergistic, installation window-of-opportunity by delaying for the best solution.
 - a. The first set may be installed first at the observatory(ies), if/as the installation & commissioning schedule allow. Even if only a subset of panels can be procured in time for an opportunistic installation, this first set (or subset) may help to inform, by direct measurement, the efficacy of an OFI shroud in reducing DARM noise. The first set should be comprised of non-directional, super #8, stainless steel panels coated with black nickel.
 - b. The second set may be installed opportunistically, particularly if the first set (if installed) is shown to be inadequate, or the installation may be differed to a future date (even after O3). The second set should be comprised of AR-coated, black glass panels, i.e. our best overall solution from a stray light mitigation perspective.
- 4) Shroud 'Roof': Consider a revised design wherein the angle between the side panels and the roof panels is obtuse (not acute, as is the case in the design as presented). An obtuse angle would insure more than two reflections from the shroud panels before being directed back to the OFI assembly. One way to accomplish this is to implement a Gable Roof.
- 5) Squeezed Beam Aperture: The aperture for the injection of the squeezed beam is currently TBD. It should be an ellipse (since the steering mirror is an ellipse viewed along the squeezed beam path) and the size should not limit the picomotor alignment range for this path, nor should the size require precision alignment (include some radial margin).
- 6) Single Panel on the Squeezed Beam Injection Side: There isn't a need for a low BRDF surface to face the squeezed beam injection direction. A single panel with the low BRDF surface facing toward the OFI is sufficient.
- 7) OFI Input Aperture: Insure that the OFI input aperture diameter is large enough to make precision alignment unnecessary if possible (considering the diameter of the SRM AR baffle aperture and the aperture of the first OFI component).
- 8) Septum Window Ghost Beams: The two ghost beams, one from each of the two AR-coated surfaces of the wedged septum window, are too low in intensity to find in situ (~5ppm AR coating reflectance). Consequently there isn't a need to align/adjust the baffle intended to direct these ghost beams. It should be sufficient to orient the panel to direct the ghost beam reflections to the chamber walls. (Also note that there is a difference in the location of the beams at the

septum window measured at LHO and LLO compared to the Zemax model. The as-measured location should be used to inform the design.)

- 9) Dump for the TFP Ghost Beam: It was recently discovered that a ghost beam from the Thin Film Polarizer (TFP), is directed back toward the squeezed beam injection path and lands on the ZM2 steering mirror bracket. The proposed V-shaped beam dump comprised of black glass, placed near the ZM2 Tip/Tilt mirror assembly is a good solution.

3 Additional Comments

Below are a few minor comments

- 1) The BRDF of the chamber wall, shown in the plot on pg. 2 of [G1800787-v4](#), is surely < 1 .
- 2) When estimating the motion of the suspension structures (as in the plot on pg. 3 of [G1800787-v4](#)) it is best to include ISI rotations as well as translations in a proper transformation. Often the rotations coupled with the height above the effective center of rotation, dominates.
- 3) Consider making the slot for the picomotor cable a keyhole, rather than simply widening the slot.