Design Proposal for a Deep UV-capable Probe Assembly for DSG's Reflectivity Test Station

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This note discusses components required for a reflectivity probe assembly capable of deep UV ($\lambda \approx 200$ nm) reflectivity measurements.

In the Ring Imaging Cherenkov (RICH) detectors of the Electron Ion Collider and the Solenoidal Large Intensity Detector projects, there will be arrays of mirrors which must, per specification, reflect $\geq 90\%$ of UV light with $\lambda \in [180$ nm, 200 nm] and focus that light onto the detectors' electronics array.

Previous tests and investigations [1] showed that for the DSG test station's Thorlabs RP26 probe assembly, the minimum recommended λ is 250 nm. Further, the probe assembly's documentation warns that UV exposure will permanently damage the probe assembly's optical fiber core, reducing light transmission to ~30% in as little as three hours. Hence, a design for a UV-light-capable probe assembly for reflectivity measurements is proposed.

The probe assembly's, Fig.1, test mirror, compact charged-couple device spectrometers, and the UV light source will be coupled to the Thorlabs M112 series multimode solarization-resistant optical fiber patch cables. UV light will go to the test mirror via optical fibers instead of through air, thereby losing intensity—UV light is absorbed by oxygen molecules.

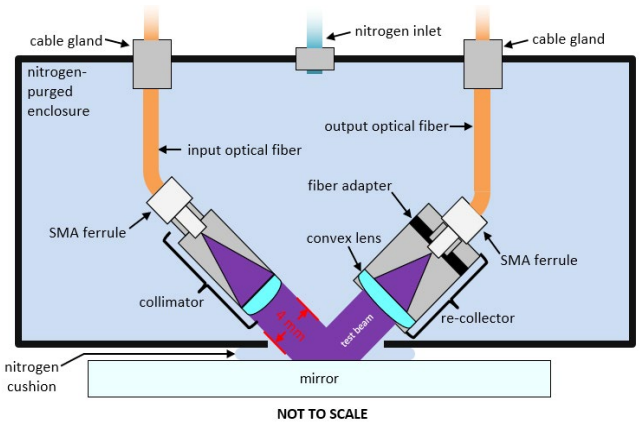

FIG. 1. Diagram of proposed reflectivity probe assembly.

When the UV light exits the optical fiber, it will diverge, forming a cone. The exiting light will be collimated so the rays of the beam are parallel to each other and perpendicular to the exit face of the fiber. For the proposed probe assembly, an Edmunds Optics #88-189 UV/VIS fiber optic collimator will be used to create a 4-mm diameter, collimated UV beam.

The UV light beam will be refocused back to the size of the face of the optical fiber, accomplished by a lens assembly ("re-collector") using a lens tube, an SMA adapter, and to maximize acceptance of the reflected UV light for measurements, a 12.7-mm diameter plano-convex lens with 20.1 mm focal length (Thorlabs LA4647).

For reflectivity testing, the angle of incidence of the UV light beam will be 45°, accomplished by a fixture that will hold the collimator and the re-collector in the required orientations. The fixture will allow repositioning of the collimator and the re-collector so that light passes straight from the collimator to the re-collector, allowing for periodic calibration measurements.

A second, identical probe assembly will measure the test beam's intensity without reflecting it off the mirror, a straight through passage of the UV beam from the collimator to the re-collector, a control-measurement configuration, enabling determination of the components' quality.

To mitigate oxygen-absorption issues, the probe assembly will be enclosed and purged with nitrogen. The enclosure and probe assembly will be set up such that the distance between the components and mirror is ~1 cm. The opening in the enclosure where the UV light beam reflects off the mirror will allow nitrogen to exit the enclosure and form a small cushion of nitrogen between the mirror and probe assembly, Fig. 1.

To conclude, to be able to determine mirror reflectivity of deep UV light, DSG proposes a custom-made probe assembly that uses collimators, plano-convex lenses, solarization-resistant optical fiber patch cables, and a nitrogen-purged probe enclosure.

[1] T. Lemon, et. al., *Evaluating Reflectivity Test Station for UV Measurements*, DSG Note 2023-33, 2023.