Reflectivity Testing of the Hall B RICH II Detector's Spherical Mirrors

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September 2, 2022

This note presents the results of reflectivity tests performed on ten spherical mirrors of the Hall B RICH II detector.

The RICH II detector has ten spherical mirrors that reflect Cherenkov light generated in the detector's aerogel radiator. Ideally, the spherical mirrors should reflect at least 90% of light that is incident on their surface. The mirrors' reflectivity is measured using two compact charged-couple device (CCD) spectrometers (CCSs) with a fiber-optic probe.

The reflectivity test station has two Thorlabs CCSs, which are used as the reference and the reflection spectrometers. These CCSs are optimized for a wavelength range of 200–1000 nm and use Czerny-Turner optics to refract light into the CCSs' CCDs (each CCS has a CCD) for spectral analysis.

Light for the tests is generated by a Thorlabs SLS201L tungsten-halogen broadband source, whose power is stabilized to within 0.05% of the operating power. Light is directed to the CCSs and mirror from the SLS201L using a Thorlabs RP26 flexible, fiber-optic probe. Figure 1 shows the setup.

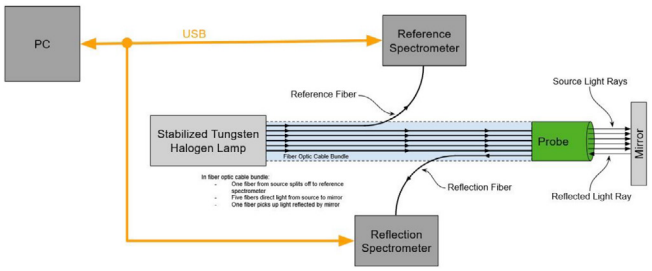

FIG. 1. Diagram of reflectivity test station.

To ensure that the probe is perpendicular to the mirror surface during tests, a three-legged holder was used, Fig. 2. The three-legged probe holder was 3D-printed in one piece and is designed to hold the probe perpendicular to the equilateral triangular surface spanned by the three legs, when the legs have the same height. There may be some angle that the probe is off from the perpendicular due to the fabrication precision of the 3D printer, but it's so close to the perpendicular that angular deviation from the perpendicular is negligible.

Prior to any test, the probe holder's legs were adjusted so the probe was perpendicular to a flat surface. When the holder was placed on to the mirror, the distance between the probe face and mirror surface was adjusted using a screw until the reflected light read by the reflection spectrometer appeared to be at its maximum.

Once the probe was placed on to the mirror, a DSG-developed LabVIEW program triggered the CCSs to take a snapshot of the light intensity of the entire light spectrum for wavelengths from 200–1000 nm, with a resolution of ~0.2 nm. The program took 100 snapshots for each spot tested (4–7 spots) over the surface of a mirror. Additionally, the program calculated the reflectivity of the mirror from the spectrometers' data, averaged all samples acquired, and logged all raw and averaged data from CCSs and all raw and averaged reflectivity for each spot. Table I summarizes reflectivity test results.

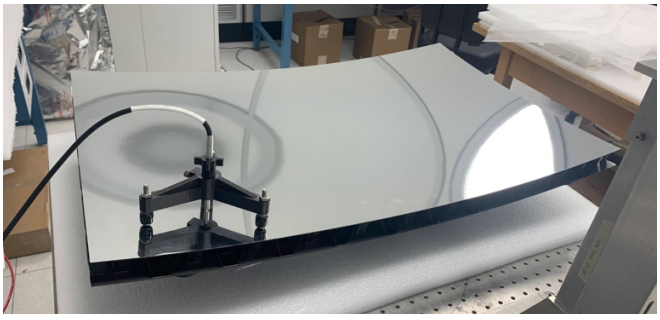

FIG. 2. Spherical mirror 5C with probe holder on its surface.

Mirror	Number of test spots	Overall average reflectivity [%]	Standard deviation [%]
1	6	85.1	1.5
2	5	82.3	1.4
2C	6	83.7	1.4
3	5	82.8	1.4
3C	6	82.3	1.4
4	5	82.8	1.5
4C	7	82.0	1.4
5	5	86.2	1.5
5C	5	82.0	1.4
6	4	81.7	1.4
Average over all mirrors		83.1	0.5

TABLE I. Summary of reflectivity tests.

To conclude, the ten spherical mirrors of the RICH II detector were tested to determine their surface reflectivity. The average reflectivity of the entire array of the spherical mirrors considered as a single large tiled mirror was determined to be 83.1% ± 0.5%.