Testing of the Spherical Mirrors of the Second Hall B Ring Imaging Cherenkov Detector

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The second Hall B Ring Imaging Cherenkov (RICH II) detector is installed in sector 1 of the Cebaf Large Acceptance Spectrometer, upgraded for 12 GeV beam (CLAS 12). This note presents an overview and the results of tests performed on the ten spherical mirrors of the RICH II detector, to determine their minimum spot diameter *d0* and their radius of curvature *z0*.

RICH II has an array of ten spherical mirrors that reflect Cherenkov light generated by particles passing through the detector's aerogel radiator. The figure of merit of the surface quality of the mirrors is their *d0*, which is expected to be ~2 mm. The mirrors are expected to have a *z0* of 2700 ± 27 mm.

For the *d0* test, a mirror stand and a charge-coupled device (CCD) stand were used. The mirror stand held individual mirrors at a fixed height and allowed for adjustment of the mirror around its *x* and *y* axes. The CCD stand was in a three-axis configuration for movement in the *x*, *y*, and *z* directions. The CCD camera and the fiber optic light source were arranged along the *z* axis. The CCD stand's *z* axis was aligned with the mirror stand's center of rotation (intersection of the *x* and *y* axes of rotation and the associated *z* axis). The two stands were placed ~2700 mm apart on two, leveled, optical tables.

After mounting a mirror on the mirror stand, the first step was to center the image of the reflected light source on the CCD camera. Using the rotation adjustments on the mirror stand and by moving the *z* stage of the CCD stand, the image was centered on the CCD camera and made as small as possible. The *z* position of the CCD camera was noted, and then a series of images were taken with the CCD camera at varying *z* positions.

The acquired images of the spots were read into an analysis program and the diameters of the images of the reflected light source were calculated from the CCD counts captured.

The data were fit with a parabola to determine the calculated *d0* and *z0*. Figure 1 is a plot of *d0* as a function of *z*. The red line is a parabolic fit to six points near the minimum. The calculated *d0* is the minimum of this parabolic fit. From the z value of the minimum of the fit, *z0* is calculated. Table I lists the calculated *d0* and *z0* for each spherical mirror.

To conclude, the ten spherical mirrors of RICH II underwent optical tests to determine their surface quality and radius of curvature. The tests used a CCD camera to take images of light from a fiber optic light source reflected off of the mirror at different distances from the mirror. With these images, a calculated *d0* and *z0* were determined. The average *d0* and *z0* are 3.53 ± 0.47 mm and 2721.08 ± 4.15 mm, respectively.

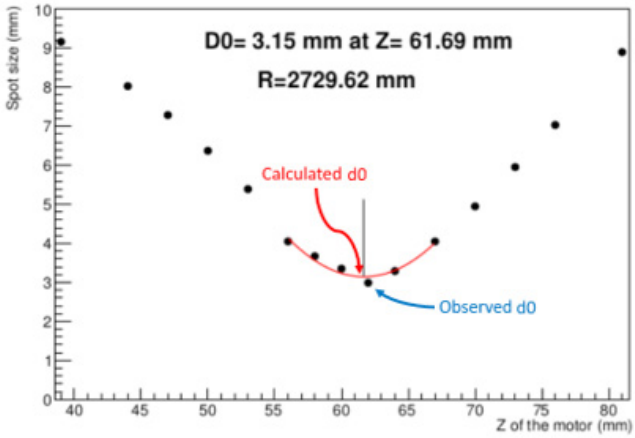

FIG. 1. Plot of *d0* vs *z* for mirror 1.

Mirror	Calculated *d0* [mm]	Calculated *z0* [mm]
1	3.15	2729.62
2	3.40	2723.86
2C	3.60	2718.01
3	3.27	2720.32
3C	2.91	2725.79
4	3.15	2721.38
4C	4.45	2718.48
5	4.16	2717.08
5C	3.55	2717.16
6	3.62	2719.05

Table I. Results of *d0* tests of ten spherical mirrors for RICH II.