RICH Note 8
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Shapes of Sawtooth Radiators

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A. INTRODUCTION

Knowledge of the actual value of the sawtooth angle is of considerable importance for the RICH reconstruction software. Furthermore, it is also important to know the exact shape of the surface. Thus I measured the shapes of teeth profiles on three different radiators: the one used in the test beam, one produced under new manufacturing conditions (called New) except that the final 1/4 micron polishing state had not been done and a third that was complete. It turned out that there was no difference between this third radiator and the one lacking the final polish. For technical reasons the final finished piece will no longer be mentioned. A plot of measurements of the test beam piece is shown in Fig. 1. There are 40,000 points and the vertical precision is good to approximately 50 nm. Such accuracy is certainly overkill, but that was the machine that was available at the Center of Optics Manufacture, University of Rochester.

B. ANALYSIS OF SAWTOOTH ANGLE

After use of the calibration procedure of the machine was made known to the experimenter, the data could be analyzed in a correct manner. Each tooth edge was fit to a linear function. An example is given in Fig. 2.

The angles can be changed slightly by changing the range of fit, but not significantly as will be demonstrated later. Fitting both sides of four teeth on each of the two radiators gave the measurements listed in Table 1.

For both radiators the left side and right side give equivalent values. These then can be averaged to give sawtooth angles of 40.90 ± 0.07 ° for the test beam radiator and 41.585 ± 0.017 ° for the new radiator.

The rms deviations are almost an order of magnitude for the test beam with respect to the new, being on the order of 4 mr and 0.4 mr, respectively. The new radiator will not cause any new increase in Cherenkov angle resolution due to variations in overall tooth angles.

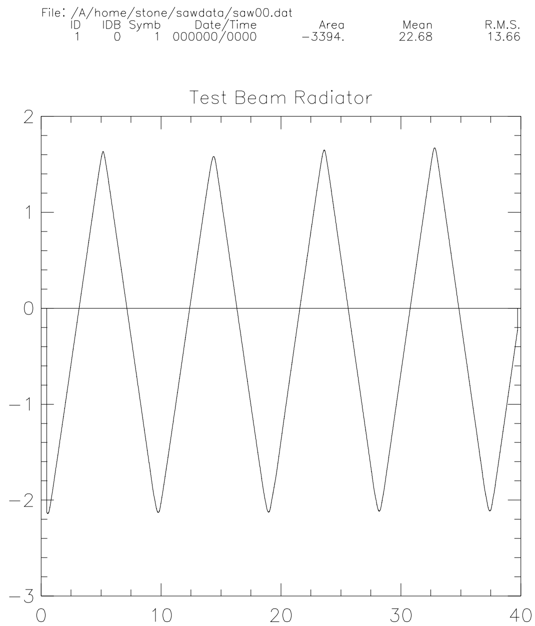

FIGURE 1. The profile of the test beam radiator measurements.

TABLE 1. Angles of the various teeth (degrees)

tooth	Test Beam Radiator		New Radiator	
Face	Left Side	Right Side	Left Side	Right Side
1	40.794	-40.974	41.609	-41.612
2	40.629	-40.820	41.607	-41.507
3	41.088	-41.073	41.635	-41.526
4	41.077	-41.079	41.586	-41.601
avg	40.90±0.11	-40.99±0.06	41.61±0.01	-41.56±0.01
rms (mr)	3.9	2.1	0.4	0.4

The actual tooth shapes do deviate however from strict linearity. Plots of the variation of both with respect to the linear fit are shown in Fig. 3 and Fig. 4 for both radiators. The general features are similar. The non flat portions are caused, on the left side by the roll off in the valleys between the teeth and on the right side by the roll off to the tops of teeth. There is almost 1 mm of surface with "large" variations at the bottom and 0.5 mm at the top. Photons from these parts of the surface will not be at the proper position. T4his effect is somewhat ameliorated by the loss of optical transmission especially in the tooth valleys.

The plot for the new radiator also shows a polynomial fit to the surface. Though the fit isn't perfect it does give a reasonable representation of the global aspects of the surface. Using this fit the derivative of the deviations from the linear fit is calculated and shown inn Fig. 5. This is the angular variation of the surface which will be put in the Monte Carlo to determine the

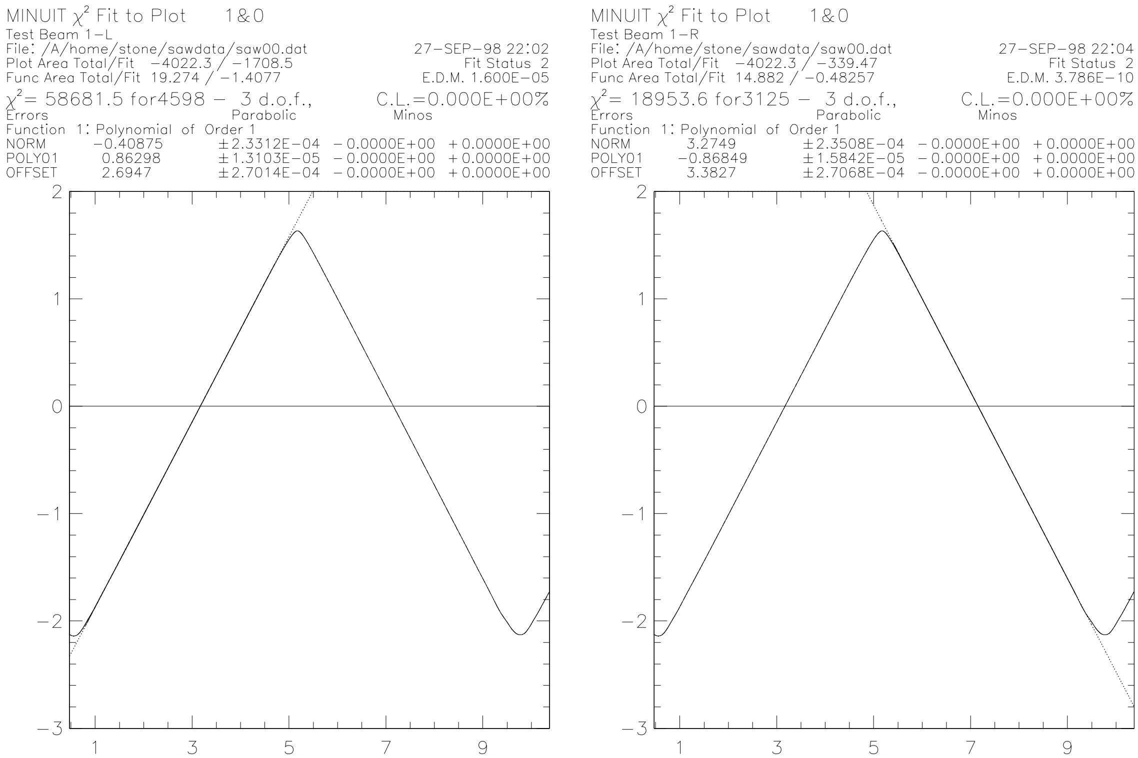

FIGURE 2. Linear fits to the test beam piece.

actual change in Cherenkov angle resolution.

Of course, since we did the test beam, we know sawtooth radiators work, but we do need to measure the surfaces in order to characterize properly the light emission from the radiators.

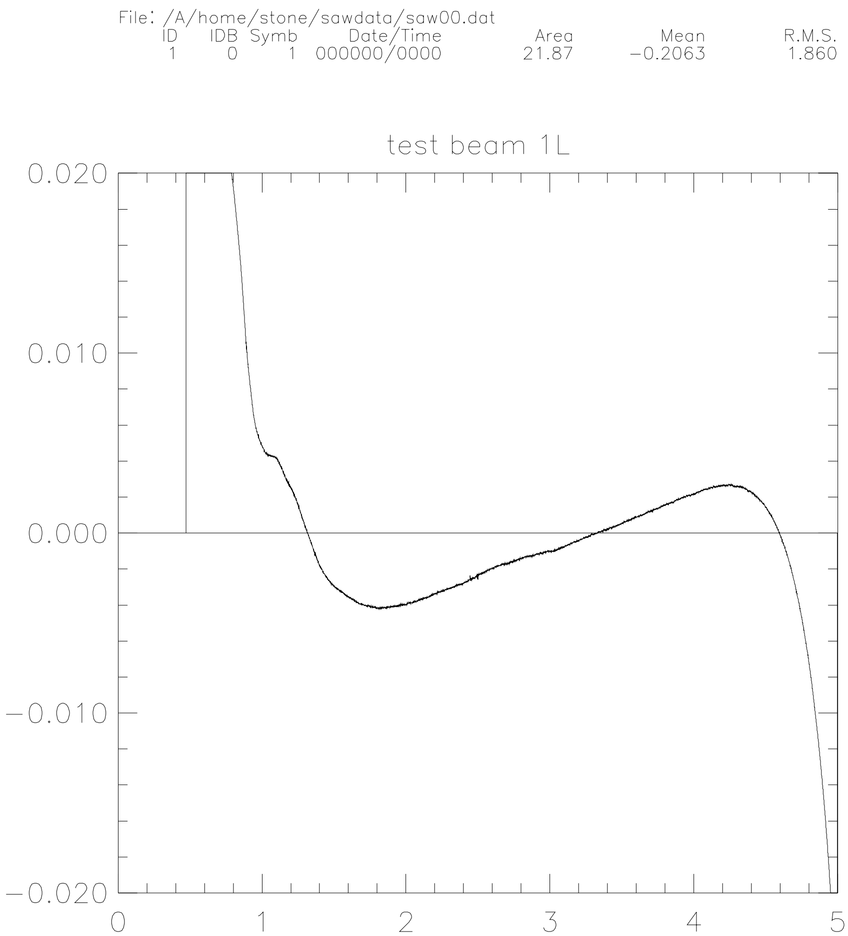

FIGURE 3. The deviations from a linear fit for the test beam radiator. All units are in mm.

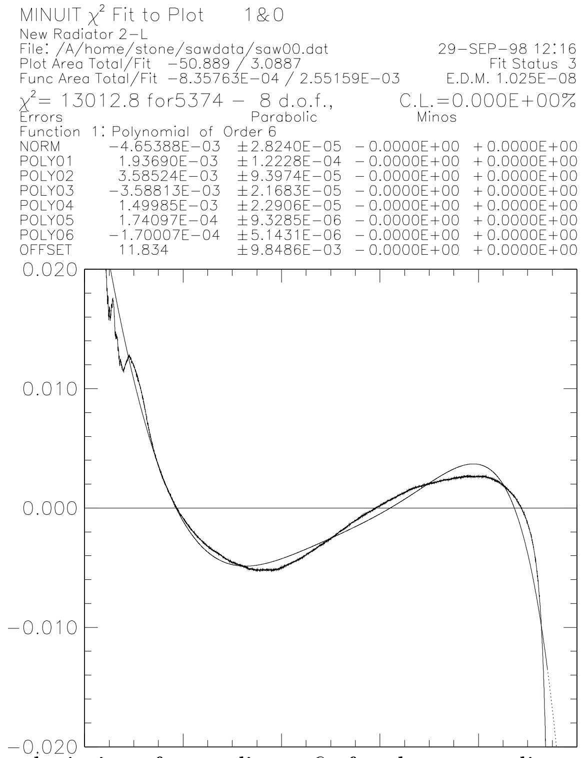

FIGURE 4. The deviations from a linear fit for the new radiator. The polynomial curve is a fit.

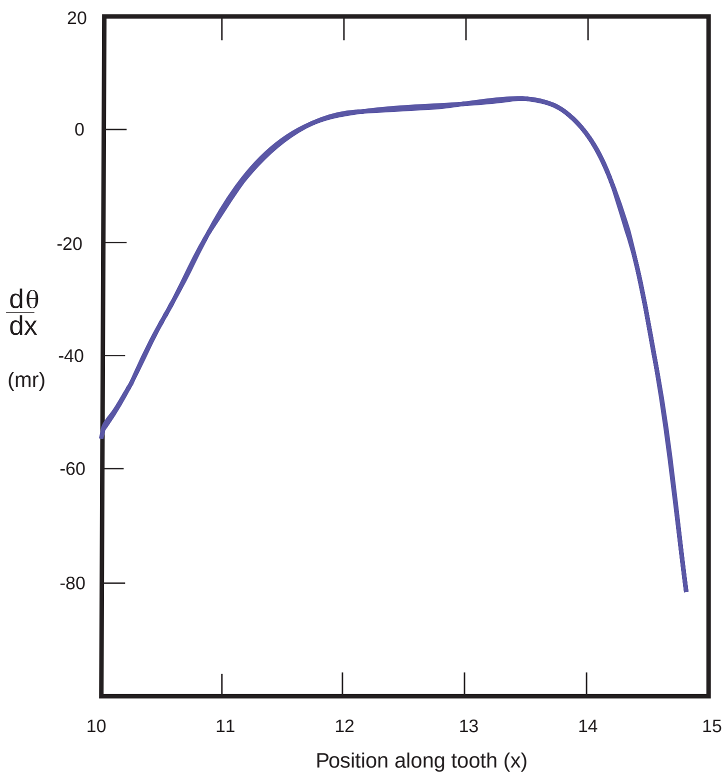

FIGURE 5. The angular deviation of one surface from a linear fit based on the fit shown in Fig. 4.