



GAMMA KNIFE 4335 C
QUALITY ASSURANCE
RADIOPHYSICAL PART

RESULTS
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MEASUREMENT OF GAMMA KNIFE ACCURACY

Accuracy of the Gamma Knife is defined as the distance between the point where the axes of its 201 beams hypothetically intersect and a second point which is symmetrically located relative the "non attenuated" radiation field resulting from these beams. This distance is experimentally determined. The position of the former point, the so called Unit Center Point (UCP) is defined by mechanical means the position of the latter point is found by radiological mean.

A special aluminum tool made with very narrow geometric tolerances is aligned between the trunnions of the 4 mm collimator helmet. When both trunnions are set to 100 the tip of a sharp needle, located in the tool, exactly points towards the UCP, provided the couch is in treatment position. Just prior to exposure a small piece of radiological film also located in the tool is pierced by the tip of the needle. During exposure the film plane coincides with the UCP. Two films are consecutively exposed, one with its surface oriented perpendicularly relative to the symmetry axis of the source distribution. The second film is rotated through 90° with respect to the first film. The films are exposed in the Gamma Knife to be tested and then sent to Elekta Instrument AB in Stockholm Sweden where the films are evaluated.

Optical density profiles are scanned by means of an automatic densitometer in three mutually perpendicular directions. The densitometer has a laser light source, $50\mu\text{m}$ alternatively $100\mu\text{m}$ geometrical resolution and the dynamic of the densitometer can be chosen to be 8 bits or 12 bits. The density profiles thus obtained include also the shift in density caused by the small hole pierced into the films. By measuring the asymmetry of the position of the hole in relation to the density distribution at approximately FWHM, the accuracy of the Gamma Knife is determined, see figures 1-3

The accuracy of Gamma Knife # 4335 was originally determined at the acceptance test procedure and has now been re-measured.



Result

From figures 1 - 3 below the distance (δ) between the radiological center and the needle mark is measured along the three main axes (X, Y and Z). The distance between the radiological center and the mechanical center is then calculated. The measure includes also an experimental error of approximately 0.1 mm.

$$\delta = \sqrt{\Delta_x^2 + \Delta_y^2 + \Delta_z^2}$$

$$\delta = \sqrt{0.095^2 + 0.155^2 + 0.030^2} = 0.18 \text{ mm}$$

The distance, i.e. the accuracy of the Gamma Knife, is well within the specifications (0.5 mm).

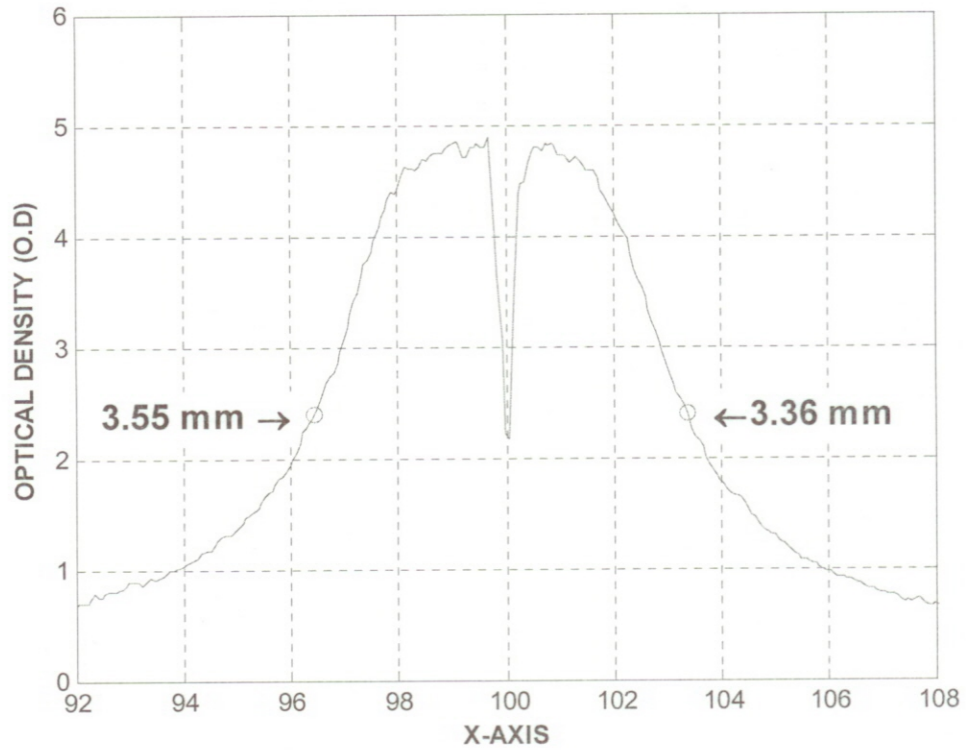


Figure 1. Determination of δx

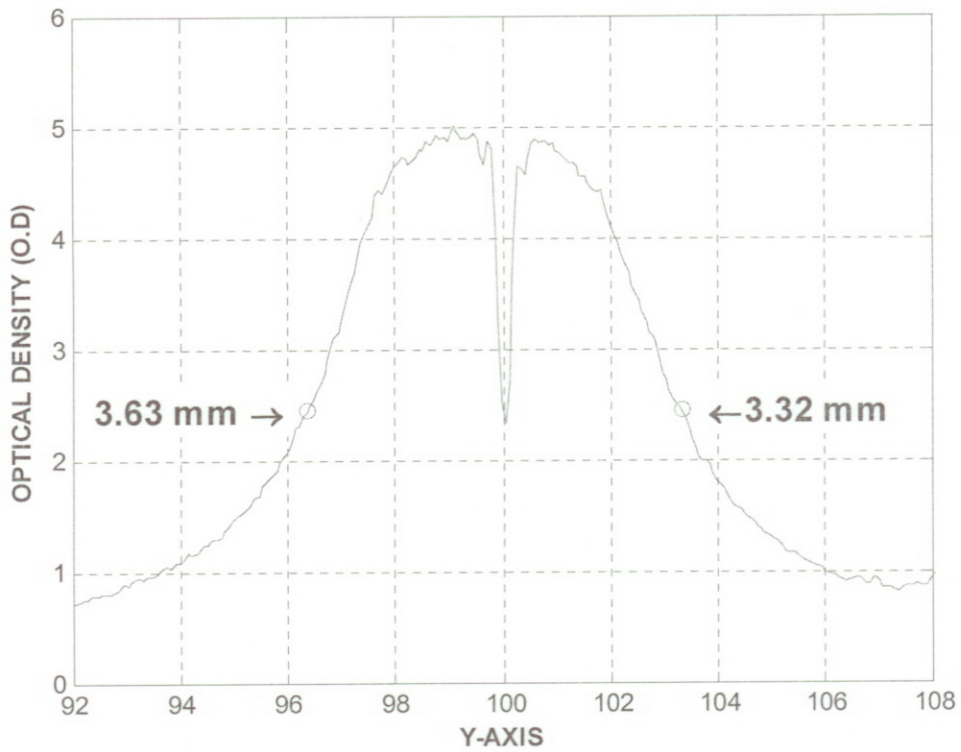


Figure 2. Determination of δY

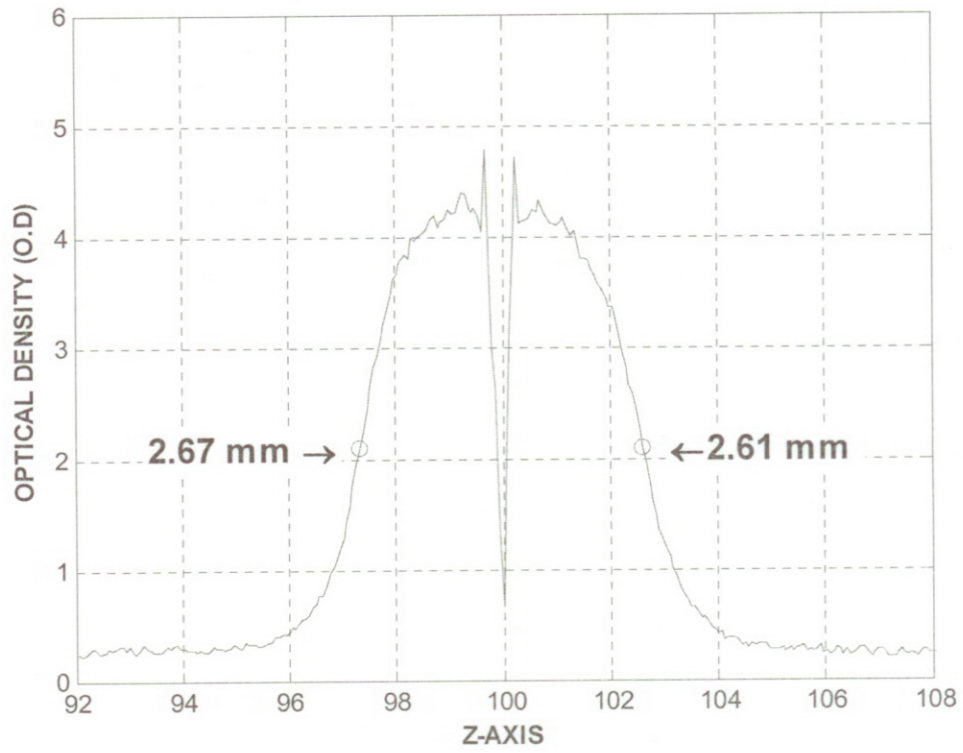


Figure 3. Determination of δZ