

CACT

Class 13

**Scanning Lenses:
F-THETA LENS**

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A scanning (F-theta) lens supplies an image in accordance with the so-called F-theta conditions:

$$(y' = f \times \theta)$$

and, therefore, has a specially corrected distortion.

Applications:

F-theta lenses are used in:

- engraving and labeling systems,
- phototypesetting,
- image transfer and material processing,
- to read or write texts or image components with a laser beam.

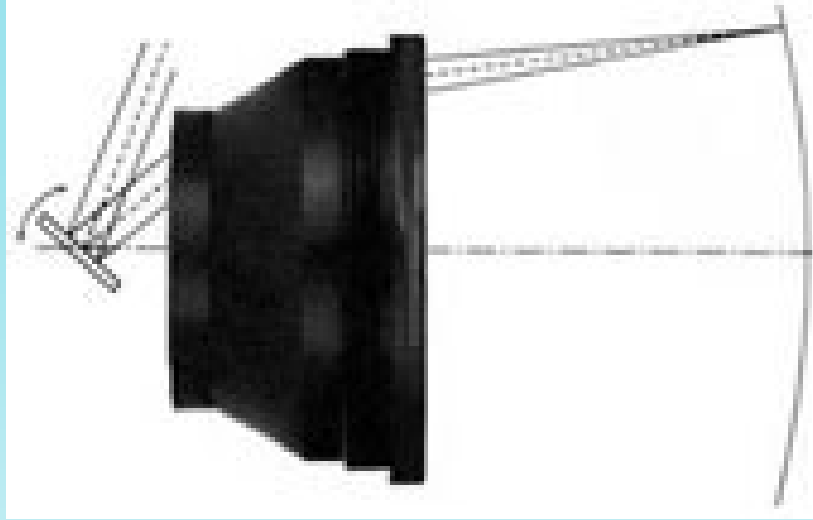


Figure 1: If a laser beam focused by an ordinary lens is deflected in the beam path behind the lens, the scanning path produced takes the form of a circular arc.

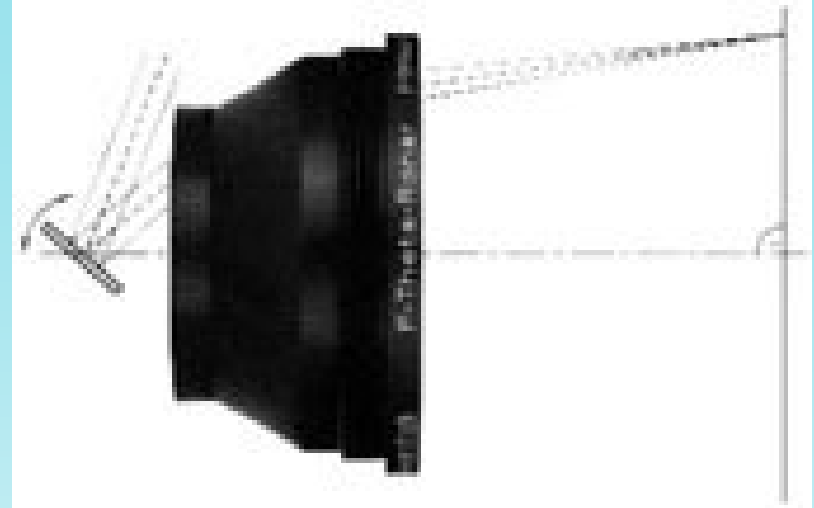


Figure 2: If the deflection of the laser beam occurs in the beam path in front of the lens, the scanning path lies in a plane perpendicular to the optical axis of the lens. If the image height y' is to be proportional to the scanning angle θ , then $y' = f \times \theta$ instead of $y' = f \times \tan \theta$.

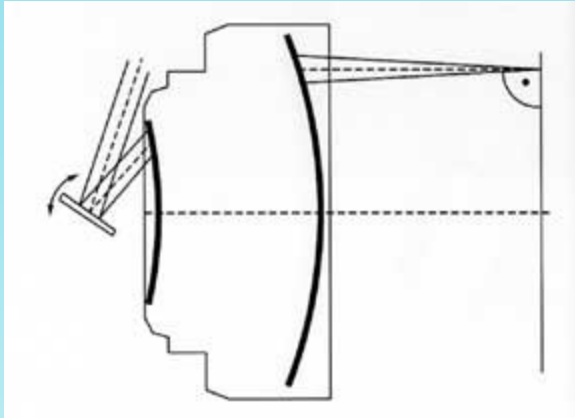


Figure 5: A telecentric F-theta lens differs from a normal F-theta lens in that the axis of the focused laser beam bundle is perpendicular to the scanning plane throughout

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A special case: telecentric F-theta lenses

If a non-flat surface is scanned, and the beam hits the surface at an angle, there will be a deviation in the position compared to the projection of the respective point in the scanning plane. The extent of the deviation will be in proportion to the distance from the ideal scanning plane. This will result in a discrepancy of scale. This error is avoidable through use of a "telecentric" F-theta lens, which is distinguished from normal F-theta lenses in that the axis of the focused beam is perpendicular to the scanning path ([Figure 5](#)).

Telecentric F-theta lenses require very large lens diameters for long scanning paths (lens diameter approx. $2y' + \text{entrance beam diameter}$).

The technical property that distinguishes telecentric lenses is that the **chief ray**, that is the rays through the center of the entrance or exit pupil, are all parallel to the optical axis, on one or both sides of the lens, no matter what part of the image space or object space they go through.

