Transverse Ray Aberrations

PRECISION-OPTICAL ENGINEERING

OSE 001

Application Note

When designing optical systems resolution is commonly assessed by means of transverse ray aberration plots. These plots are derived from tracing rays through the optical system and finding out where they arrive at the detector. The plots show variation of ray position at the detector, for a given field angle and beam diameter, over a range of field angles. Diffraction is not taken into account.

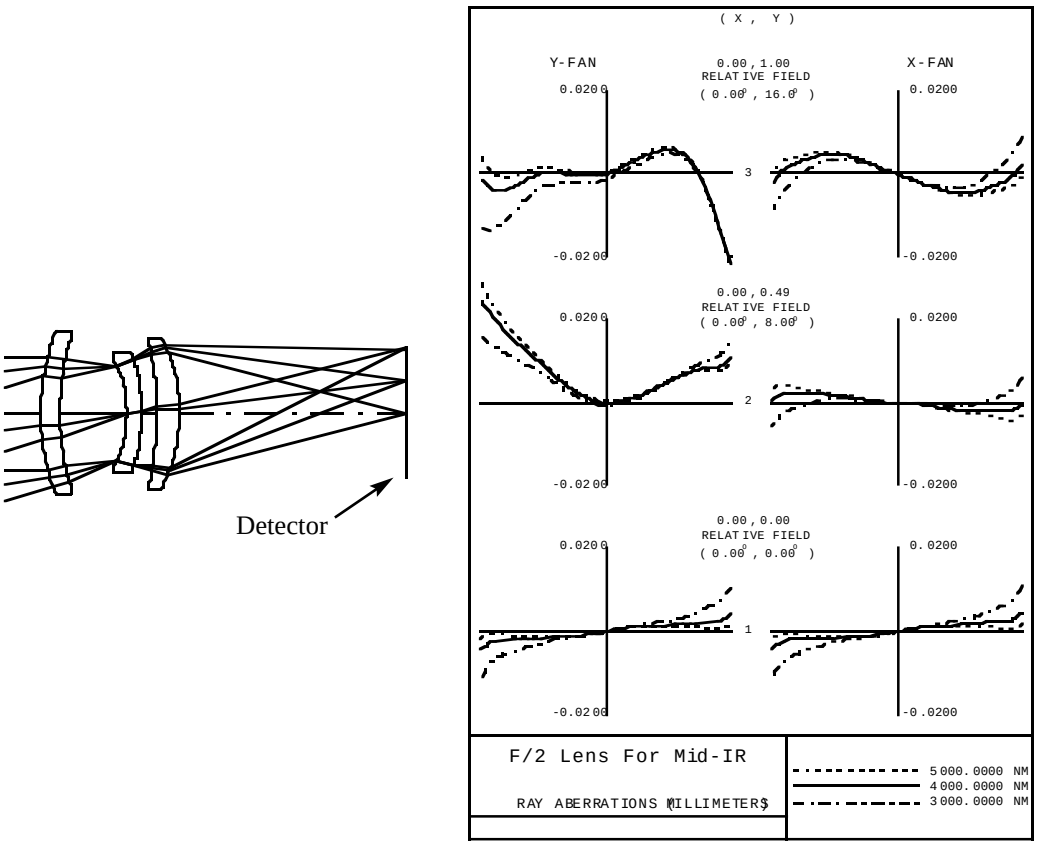

Figure 1: Medium Waveband IR Triplet, Transverse Ray Aberrations

Transverse aberration plots give an idea of image blur at the detector. The vertical axis of each plot gives the magnitude of the blur. Often the scale is set to match the pixel size, so in Figure 1 below the vertical scale of +/- 0.020mm matches a 40mm pixel and it can be seen that the blurring is generally contained within a pixel, which is desirable for good resolution. The horizontal axis represents the beam diameter for any field angle and is effectively normalised so dimensions are not given. Thus the transverse aberration plot shows variation in blur size at the detector for a cross-section of rays across an input beam.

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Transverse Ray Aberrations

It is common optical design practice to consider field angles in a vertical plane and trace a vertical fan of rays and a horizontal fan of rays. This is shown in Figure 2 for a field angle of 16°. For axially symmetrical systems like the one shown here this approach, when applied to a range of field angles, provides sufficient information about geometrical resolution of the optical system.

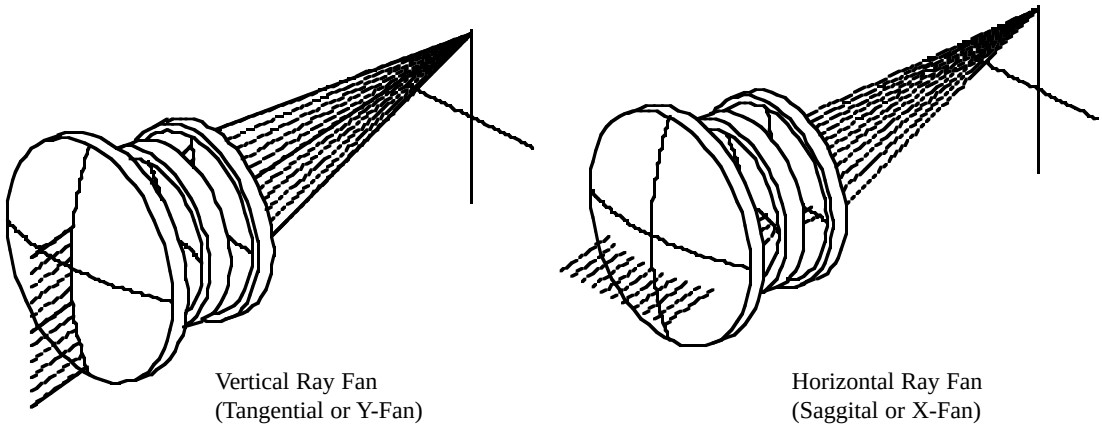

Figure 2: Medium Waveband IR Triplet, Comparison of Ray Fans

The variation in intersection position at the detector is plotted in the transverse ray aberration plot to demonstrate blurring in a radial direction for a Y-fan and blurring at right angles to this for an X-fan. For a more complex system using decentred or tilted optical components it may be necessary to trace additional oblique field angles that lie outside vertical and horizontal planes – an example of this is shown in Figure 3.

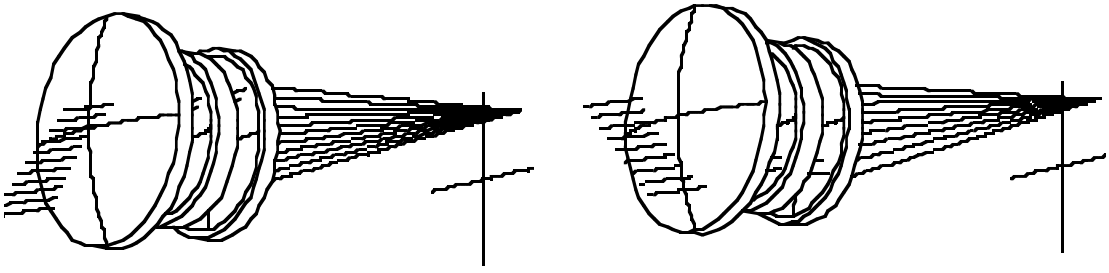

Figure 3: Medium Waveband IR Triplet Showing Oblique Ray Fans

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