

Technical Tip: The Focal Length Divergence Measurement Method

The Focal Length Divergence measurement method is based upon the beam width of a focused beam's spot size and the focal length of the focusing optic.

The Focal Length Divergence method provides a means for finding the far-field beam divergence at any point in the beam propagation path. As shown below, the calculation performed by the [BeamGage](#)® software is quite simple; however the optical setup must be done with great care.

The user, to suit his particular application, must provide the optic. The focusing optic must be large enough to accommodate the input beam without introducing diffraction effects. Either a refracting or reflecting focusing optic can be used, but in either case the camera's detector must be placed at the exact focal length of the optical element.

The Divergence result is based on the focused spot size as described in the equation below:

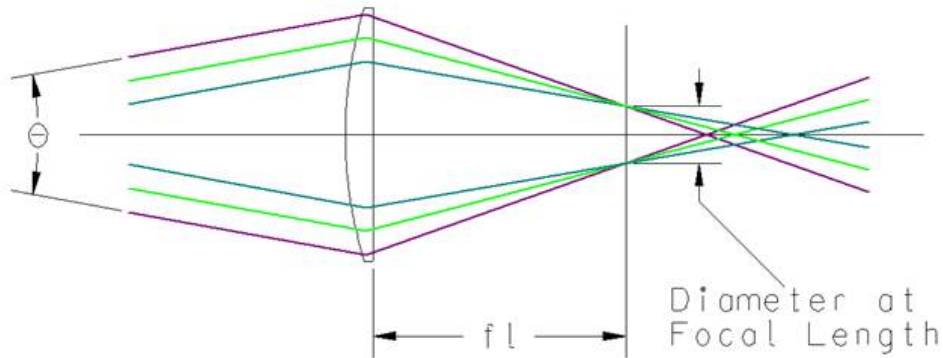
$$divergence = \tan^{-1}\left(\frac{W_f}{f}\right)$$

Where: W_f = The width of the focused spot at distance f from the optic
 f = The focal length of the imaging optic at the wavelength of the laser, which is entered into the BeamGage software

There are some important points regarding the Focal Length Divergence method that can be better understood by the graphic below. In the graphic you will notice a few characteristics, given a single focal length lens.

1. The spot size diameter is measured at the focal length, not the focus.
2. The divergence result is the before lens divergence, not the after lens divergence.

3. For any beam that is diverging at the lens, it will focus after the focal length; for any beam that is collimated at the lens, it will focus at the focal length of the lens; and for any beam that is converging at the lens, it will focus prior to the focal length.
4. Any divergent beam that is the same spot size at the focal length (not the focus), the divergence is equal as seen by the parallel rays before the lens. All three beams are diverging equally, and have the same spot size at the focal length lens. Due to this effect, this method is capable of calculating the divergence of any beam by only measuring the spot size at the focal length.



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