# DataRay Inc. Application Note
# Gaussian Beam Divergence Measurement

## Theory

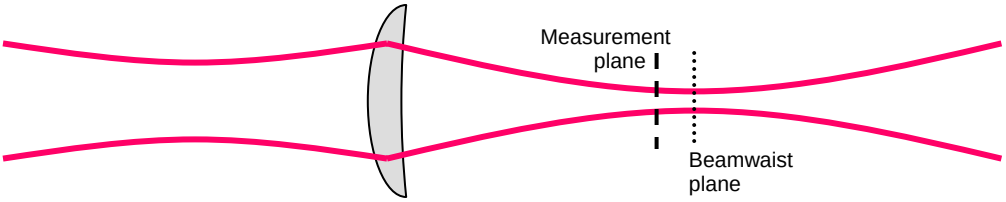
Gaussian beams do not follow the same rules as incoherent beams described by geometric optics. For a Gaussian beam, it may be shown that:

> When a Gaussian beam passes through a lens, the far field divergence of the input beam may be determined by measuring the beam diameter ***at the back focal distance from the lens***.

Note that this is ***not*** the position of the beamwaist formed after the lens.

This is true ***irrespective*** of the distance of the source from the lens.

It obviously assumes that the lens does not introduce additional aberrations, normally achieved by using a long focal length achromat coated for the wavelength(s) of interest.




The far field divergence of the input beam, Θ mrad, is calculated as: **Θ = 2W / F** mrad

Where: **2W** μm is the measured Second moment (4σ) beam diameter in the Measurement plane

**F** mm is the focal length of the lens at the wavelength of interest.

**Modelling**. See the **Gaussian Beam Divergence Measurement** spreadsheet at the website.

## Application

This technique requires an appropriate lens and a beam diameter measurement instrument.

- The instrument may be a WinCamD series camera, or a BeamScope-P7 or Beam'R scanning slit XY profiler.
- The lens must have a known focal length, be coated for the wavelength(s) of interest, and be at least 1.5 times, and preferably 2 times the $1/e^2$ (13.5%) beam diameter at the lens.
- Errors in the lens focal length value or positioning of the instrument with respect to the back focal length will lead to errors in the divergence measurement. The spreadsheet models these errors.
- The beam must be centered on the lens.
- The beam centroid in the measurement plane does reflect the beam pointing.

The lens and instrument may be supplied by DataRay as a prealigned system, or may be mounted on an optical bench or table.

Use the spreadsheet & contact the factory for details and lens suggestions for your beam.

## Accuracy

Typically an accuracy of 0.1 to 0.05 mrad should be achievable. To simply adjust an input beam assembly for best collimation, minimize the value of 2W in the measurement plane. Contact the factory for accuracy and misalignment sensitivity calculations for your beam.