# Image on the beam diagnostics camera during focusing

Users are often surprised by the pattern of fringes seen by the focus diagnostics camera. The video below shows the behavior of back-reflection of a well aligned polarized laser beam from the upper surface of a clean, empty coverslip. (Glass-air interface; inverted microscope with UPlanSApo 60x, NA = 1.2, water immersion objective.)

This is indeed normal, it is the result of using polarized light and interplay of various interference and diffraction effects.

Perfect alignment is reached when the lobes are more or less symmetric, that means they have roughly the same intensity in each quadrant. To reach this, you have to precisely position the beam to enter at the center of the objective entrance pupil, and the beam must be of course aligned with the optical axis of the objective. (Note that parallel beam displacement, not just tilting, is necessary to achieve that.)

Adding a drop of water on top of the coverslip reduces the back-scattering intensity by an order of magnitude or so, but the basic shape remains the same. Even if one removes everything extra from the beam path, these fringes remain there, they are universal. Note that all those images above are slightly defocused.

Such images are used for daily and fundamental alignment of the MicroTime 200. A detailed procedure is described in the user manual of MicroTime 200. Although MicroTime is extremely robust, we suggest to spend 5-10 minutes every day for verifying the quality of the alignment by inspecting the back-reflection pattern. Have a look how this is used also by watching the tutorial How to exchange the main dichroic of the MicroTime 200.

The paper by B. Richards and E. Wolf: Electromagnetic diffraction in optical systems, II. Structure of the image field in an aplanatic system shows such 4 lobed patterns for polarized light.

Similar figures can be found in this classic textbook.



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