ASTIGMATISM MITIGATION IN OFF-AXIS TWO MIRROR TELESCOPE

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In ultrashort pulse laser systems, the dispersion free off-axis mirror telescopes are used for manipulating of beams sizes. The tilting of mirrors gives rise to geometrical beam aberrations and the astigmatism arising in off-axis mirror telescopes usually is more pronounced aberration affecting the focal spot size of the beam. The astigmatisms of optical systems lead to formation of two-line foci in vicinity of beam waist and the distance between these two foci can be used for evaluation of amount of beam astigmatism [1]. Strehl ratio is another parameter that is used for characterization of aberrated beams. Strehl ratio includes all aberrations impact on a beam quality (Strehl ratio=1, means no aberrations in a beam; the lower Strehl ratio the bigger aberrations impact and worse beam quality) [2].

It is already has been shown that a two-spherical mirror telescope can be used for the purpose of magnification or reducing of a laser beam with limited distortion that is due to aberrations [3]. The astigmatism in mirror telescope made of convex and concave mirrors can be avoided by choosing proper mirror misalignment angles. For collimated beams:

$$\theta_2=\sqrt{-\frac{f_2}{f_1}\frac{\theta_1}{\left|1-\frac{d}{f_1}\right|}} \quad , \tag{1}$$

here θ_1 – beam incidence angle to mirror telescope; θ_2 – beam incidence angle to second telescope mirror; f_1, f_2 – first and telescope mirrors focal length points; d – distance between mirrors.

In this presentation we are reporting on the results of computer modeling and experimental investigations of astigmatism compensation in simple two spherical mirror telescopes.

Main components of experimental scheme were two mirror telescopes. First mirror telescope was set for low angles, so it had no contribution for astigmatism in a beam, its purpose was to expand beam in a compact way and to control beam collimation. Second mirror telescope was built by using convex and concave mirrors and rotational stages for each telescope mirror that during experiment He-Ne laser beam incidence angle to first and second mirror telescope could be changed.

Experimental results for collimated beam at different incidence angles to mirror telescope, when telescope magnification is 2.5 times, are shown in Fig. 1.

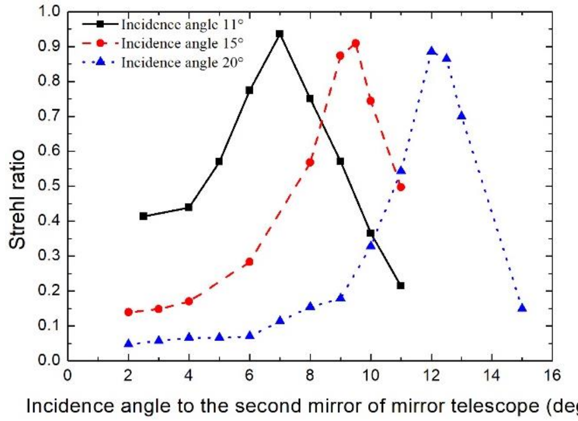

Fig. 1. Beam Strehl ratio dependence on incidence angle to second telescope mirror for different incidence angles to mirror telescope

The results presented in Fig.1 show that there is an incidence angle to second telescope mirror at which astigmatism, created by mirror telescope, is removed/greatly reduced. The astigmatism compensation was observed at particular mirror misalignment angles when increasing beam incidence angle to telescope up to 20 degrees.

Experimental results show that when the telescope magnification was increased to 5 times, the astigmatism, caused by off- axis mirror telescope, can be reduced in same efficiency as for telescope with magnification of 2.5.

In case when incident beam to mirror telescope is non-collimated, mirror telescope caused astigmatism also can be greatly reduced but less efficient compared to collimated beam at same incidence angle to mirror telescope.

The results of computer modeling of light beam propagation through off-axis misaligned mirror telescope qualitatively corresponds to our experimental findings.

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