FRIEDRICH-SCHILLER-
UNIVERSITÄT
JENA

Group 1 – 18.04.2024

Seminars tutor: Joao Pedro Berti Ligabo

Lecturers: Dr. Yueqian Zhang
Dr. Ziyao Tang

Lens Design I (SS' 24)

Seminar 1

Exercise 1-1: “Stair-mirror-setup” (Homework)

A system with a stair mirror pair, which decenters an incoming collimated ray bundle.

- Beam diameter = 10 mm;
- Beam decentration = 40 mm in the -Y direction;
- Beam wavelength (λ) = 632.8 nm.

After this pair of mirrors, a decentered main objective lens with focal length **f = 200 mm** made of **BK7** is located **25 mm below the optical axis** and focusses the beam.

Questions / Tasks:

a. Setup the system.
b. Generate layout drawings in 3D as well as “Shaded Model”.
c. Check the beam cross section on the second mirror, what is the size of the pattern?
d. Determine the optimal sensor plane location. Check the spot of the focused beam. Discuss the shape of this pattern.

Exercise 1-2: “Symmetrical 4F-system”

A telecentric 4F imaging system with two identical plano-convex lenses:

- Lenses’ material = BK7;
- Lenses’ thickness (d) = 10 mm;
- Approximate lenses’ focal length (f) = 100 mm;
- Object space NA = 0.2;
- Object diameter = 10 mm;
- Beam wavelength (λ) = 546.1 nm.

Questions / Tasks:

a. First, for perfectly symmetrical setup, determine the layout and the spot diagram of the system.

b. Optimize the image location. Why is the spot size improved?

c. If the starting aperture is decreased, the system becomes more and more close to diffraction limited. What is the value of the NA to get a diffraction limited system on axis? Take in mind here, that a re-focusing might be necessary due to the lowered spherical aberrations, which depends on the aperture.

Exercise 1-3: “Apertures, stops and vignetting”

Load the achromat **AAP-125.0-25.4** from the lens catalogue **(CVI Melles Griot, f = 125mm)**. Set the diameter of the **entrance pupil to 20 mm** and the **wavelength to 546.1 nm**. Display the wavefront of the achromat for the **field points 0°, 3° and 5°** with different stops and apertures:

a. With the stop surface at 1st surface of the system;

b. With the stop surface at the front focal plane (for finding the position of the focal plane, use Analysis → Rays and Spots → Cardinal Points);

c. With adjusted entrance pupils using System Data → Fields → Settings → Set Vignetting;

d. Insert a circular central obscuration with 6 mm radius at the 1st surface of the achromat and recalculate the wavefront with and without vignetting factors;

e. Clear all vignetting, then calculate the ray intersection coordinates (REAY) at the last surface for the upper marginal ray and the chief ray of field 5° in the merit function editor. Interpret the result.

FRIEDRICH-SCHILLER-
UNIVERSITÄT
JENA

Thank you for attention!

End of Seminar 1