Ray tracing exercise 1

Optics, spring 2018

Assignment: CD pickup for profilometry

The goal of the assignment is to design optics for a CD pickup to be used in profilometry. Write a short report (1-2 A4s) on the results from the assignment and return it to the assistant before the course exam.

Tasks:

1. Read about CD-pickup in the referred Applied Optics paper [1]. What is the working principle of CD-pickup?
2. Design the pickup (Fig. 1) in MacroSim
3. Use approximately f = 3 mm objective lens and acquire the focus-error-curve (Fig. 2)
   a. What is the sensitivity of the focus error measurement (slope of the linear part of the curve in intensity / µm)? What is the working distance (distance between lens and cd surface)?
4. The depth of focus (length of linear part of the focus-error-curve) of the pickup is limited to approximately 6 µm in Fig. 2. Try to increase the depth of focus to 1 mm.
   a. What kind of lens did you use?
   b. Calculate the focus-error curve again. Did the sensitivity change? What is the working distance?

Some helpful tips

- Use refractive index of correct wavelength λ = 780 nm in the optical elements.
- Good way to simulate a laser diode is to use a GeomRayField with an angular deviation of approx. 10°.
- Either use an existing lens (e.g. Thorlabs) with given lens parameters or use the lens-makers-equation to design one.
- An aspheric lens is likely to give better results.
- Use proper materials for the elements (glass or plastic).
- You may ignore the diffraction grating and the tracking beams in this exercise.
- Use a perfect mirror as a CD surface.
- MacroSim outputs detector data in .txt or .mat formats. Use e.g. Matlab to extract the focus-error-curve from detector data.
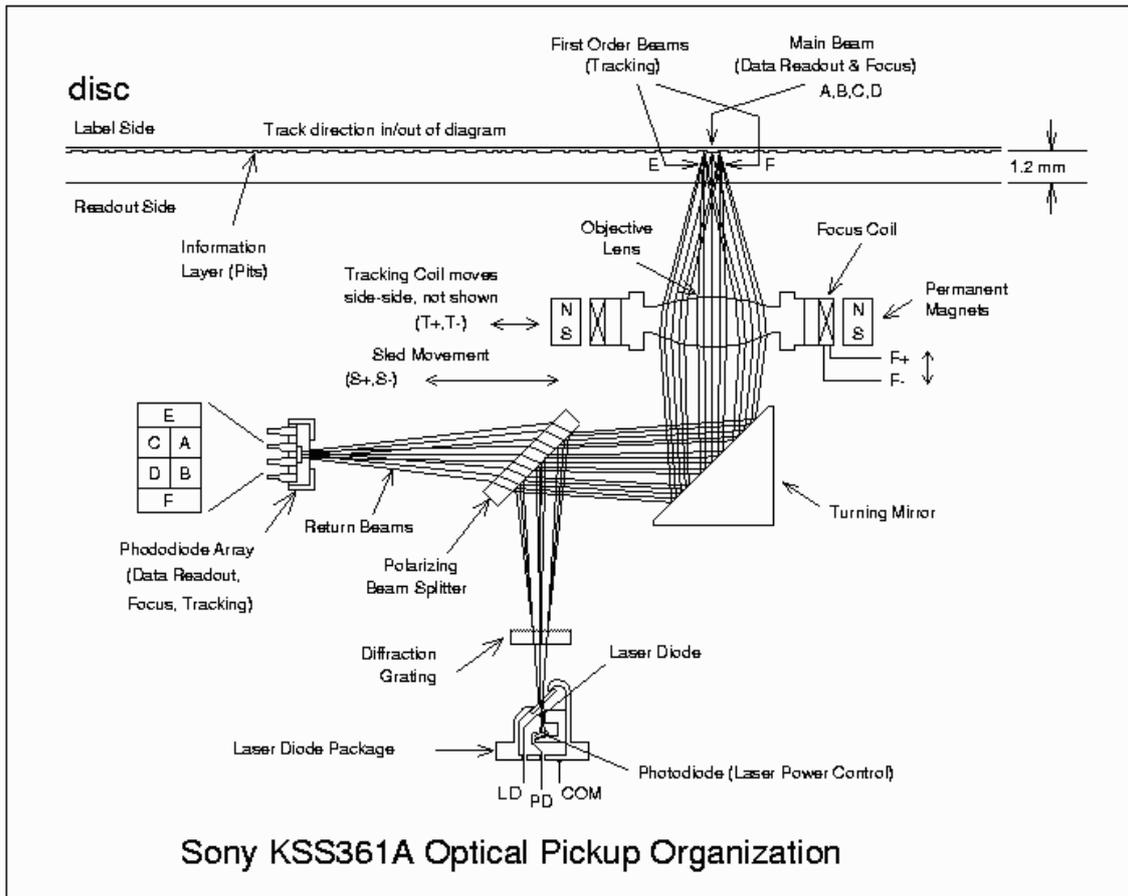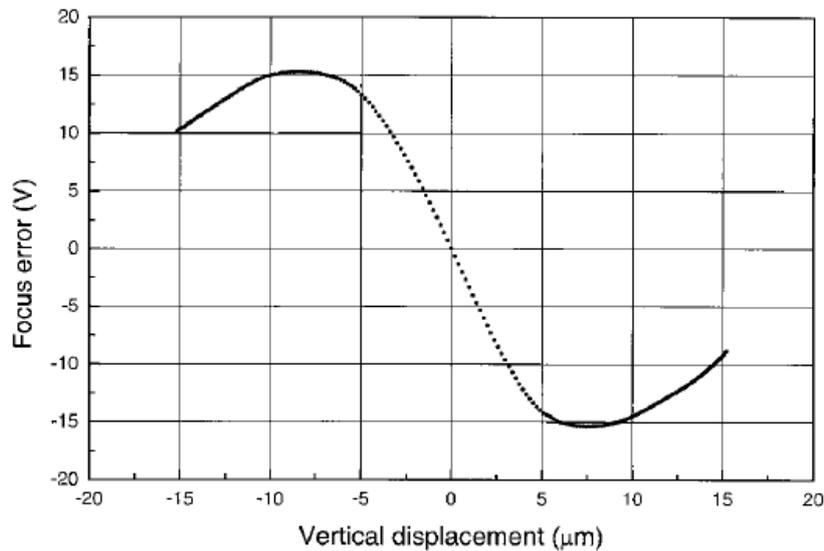
Figure 1 – A simple pickup design.

Figure 2 – Characteristic focus-error curve of a pickup [1].

References

[1] A. Bartoli et al. "Fast one-dimensional profilometer with a compact disc pickup", Applied Optics, Vol. 40(7), pp. 1044-1048 (2001).