



Catadioptrical Micro Optics

Miniaturization of Optics for Metrology Systems

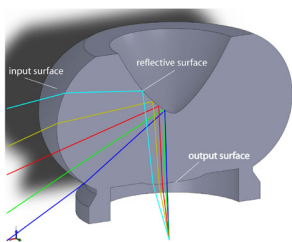
The miniaturization of optical systems comprises several measures to ensure the optical functionality accompanied by a compact design and a cost-effective fabrication technology. A reduction of the number of optical surfaces is achieved by the introduction of aspherical surfaces. A folding of the beam path increases the compactness, for this purpose, reflective surfaces have to be incorporated into the design (catadioptric systems). In planar integrated free-space optics, the complete optical path is integrated into a flat substrate.

Miniaturization in the optical design

- The design targets on cost-effective fabrication technologies with a minimum effort in alignment and packaging (2C injection molding, wafer-level technologies, chip scale packaging). Classical optical fabrication technologies are no longer applicable.
- Software tools for the simulation of complete systems including packaging
- Design with special focus on small system issues: low light, diffraction, image distortion
- Adaptation of sensor performance (pixel field geometries, electron capacity) by virtual electron distributions in the sensor plane simulated by dedicated optical software tools.

Panoramic camera

Conventional catadioptric system designs for panoramic cameras require mirror diameters and optical path lengths of several centimeters. Here, the panoramic view is achieved with a simple lens.

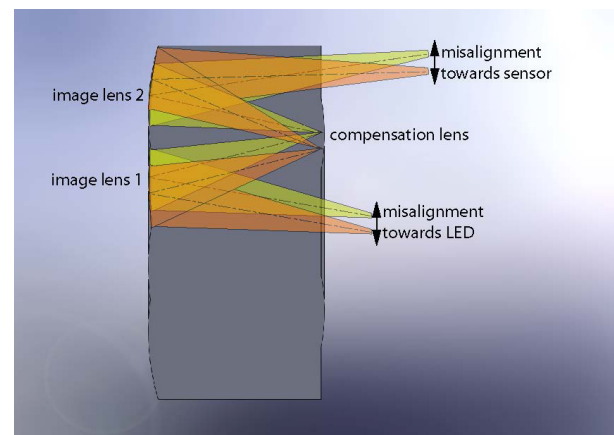


Cross section of the catadioptric lens with rays indicating the different angles of incidence

- Catadioptric component replaces bulky mirror
- Aspherical surfaces for distortion free view (not realizable with fish-eye solutions)
- Compact size (14 mm in height, 11 mm x 11 mm foot print including sensor and sensor package)
- Robust assembly

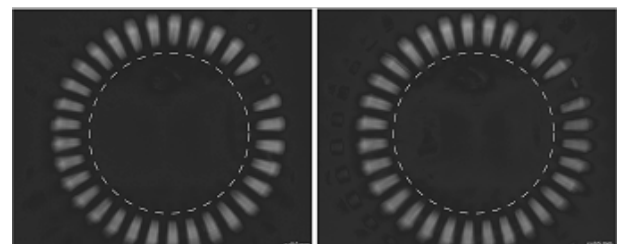
Planar integrated free-space optics for a rotary encoder

Based on planar integrated free-space optics, a self-compensating design to deal with large misalignments of the code disk to the sensor head has been integrated into the code disc (disk diameter is only 5 mm).



Sketch of a planar integrated free-space optics in a code disk to compensate for packaging tolerances

- No further optics for LED or sensor
- Due to the achieved large tolerances (e.g. +/- 0.3 mm in all three directions) a low-cost fabrication/packaging



Images of the optical system output on a high resolution sensor: (left) no lateral displacement of the code disk, (right) lateral displacement of 0.5 mm. The outer image diameter is 5 mm.