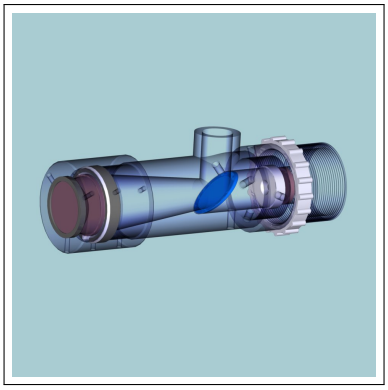
Custom Optics

Refractive, Reflective and Diffractive Optics

Introduction



Eureca Messtechnik GmbH offers the development and production of customized optical systems.

Customized optical systems are the method of choice when special requirements have to be met. This may concern optical parameters such as resolution, or mechanical properties. Aspects of cost-effectiveness are important, as well. Eureca supports the development of customized optical systems for imaging and non-imaging applications. Often, the development of customized optics is part of more complex projects which may include other customized components.

Reasons for the Customized Development of Optical Systems

Some of the typical reasons for custom optical design are listed below. In many cases, there are requirements regarding more than one of the mentioned points. The most general reason for custom developments is that there is no off-the-shelf product available which meets all important requirements.

- special first-order optical properties or optical performance required
- applications in difficult environments (e.g. mechanical shocks)
- special requirements regarding size, weight or materials
- reliability and long-term availability of components
- projects with critical price targets
- high production volumes

Categories of Optical Systems

Optical systems for imaging applications may be classified into the following main categories. First estimations of the effort of a customized design can be derived from that. For certain combinations of parameters there may be a large number of standard lenses on the market so that a customized design will not always be necessary. Other combinations (although physically realizable) might not be available at all, so that a customized solution is mandatory.

- refractive, reflective or diffractive setups
- endocentric, telecentric or pericentric properties of perspective
- visual, ultraviolet or infrared spectral range
- monochromatic, low or high spectral bandwidth
- high, medium or low aperture or resolution, respectively
- small, medium or large field of view

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Project Steps from Specifications to Production

When the development of a customized optical system is considered, the first step usually is the determination of precise and verifiable specifications, e.g. regarding optical performance or mechanical properties. In this step of development, numerical simulations based upon exemplary data provided by the customer can help determine which specifications are required. At this point, Eureca's strong competences in image simulation are particularly important. Once general specifications are found, the best ways of development and production are discussed.

Our detailed knowledge of physics and optical system design makes sure that precise and cost-effective ways of development are chosen. The experience of Eureca regarding the different manufacturing processes for optical systems also ensures that all steps from first evaluations to final production are interrelated at its best. Chosing reliable partners for prototyping and production is our competence, as well.

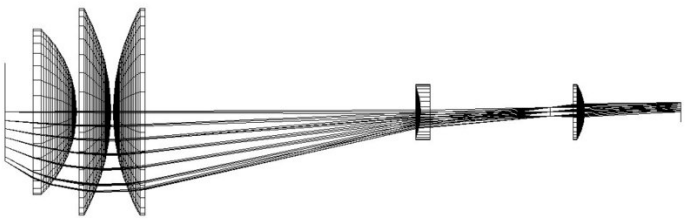
Concept Studies of Refractive Optical Systems made of Standard Components

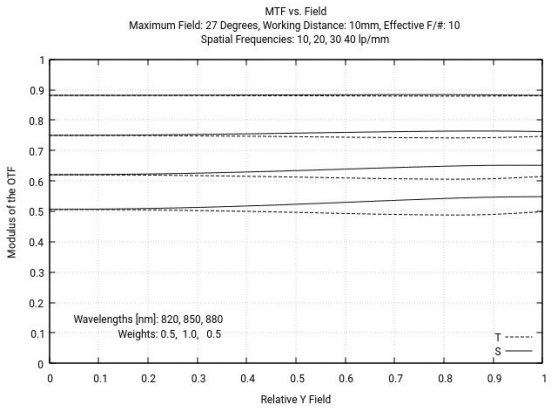
In this section it is shown at the example of two concept studies that optical standard components can have advantages regarding time and cost if customized optics are developed. Moreover, it will be demonstrated how even very special requirements can be realized by restriction to standard lenses.

Pericentric (Hypercentric) Lens

Lens for imaging front and side views of an object at the same time. Maximum object side angle of incidence measured with respect to the optical axis is $27°$, largest sensor format is $3/4''$. Working distances up to 20 mm can be used. Diameter of object field is 40 mm at 10 mm working distance. The graphics for MTF vs. Field refers to an effective $F/\#$ of 10.

The availability of pericentric lenses on the market is very limited, so a customized solution ideally fitting to the customer's needs may be useful or mandatory depending on the application. Such lenses are typically employed for the inspection of electronic components on pcbs, where a simultaneous acquisition of front and side views is most important regarding an efficient workflow. Pericentric lenses feature a special optical construction, generally comparable to eyepieces, with the entrance pupil being located before the lens. Such a construction can also be utilized as a borescope with long working distance.





Apochromatic Lens 3.5/32 mm for UV-VIS-NIR

Lens of 32 mm focal length and $F/3.5$ made of silica and calcium fluoride (CaF_2), chromatically corrected from 250 nm to 750 nm. This lens is optimized for a working distance of 200 mm and sensor formats up to $1/1.8''$. The graphics for MTF vs. Field refers to $F/3.5$.

The availability of such lenses on the market is extremely limited, so a customized solution ideally suited for the application will be mandatory in most cases. Lenses of this kind are mainly employed in the ultraviolet spectral range, or in cases where a broad spectral range of illumination is used, respectively. Depending on the actual requirements, similar systems can also be employed to reduce cromatic aberrations in the ultraviolet range at narrow spectral bandwidths. Enhancing the applicability in the NIR range is also possible. For the short wavelengths, the substrates allow for applications from near to far ultraviolet (down to about 180 nm). Calcium fluoride is a substrate often used for the correction of optical systems since it has special properties such as low index of refraction, low dispersion and anomalous partial dispersion.