



## Ultra-precise optics for a star sensor

Bi-aspheric mirrors improve attitude & orbit control of satellites in space

### Project details:

Jena-Optronik is developing under contract of European Space Agency (ESA) the new star sensor ASTRO® XP for autonomous attitude and orbit control of satellites and probes. Besides autonomous position determination, size, weight and temperature resistance are the most important challenges of such modern sensors. With a measurement accuracy of 0.1 arc sec, the ASTRO® XP is ten times more accurate than other existing star sensors. The innovative ASTRO® XP star sensor is extremely light-weight due to its optical design based on aspheric mirrors. It consists of an electrical unit and an optical head (see Fig. 1). asphericon manufactured the two complex mirror optics and a spacer for the first development models of the optical head. The ASTRO® XP star sensor is foreseen to be used on scientific missions of ESA in the late 2020s.

### Project realization:

The purely reflecting mirrors with diameters of 77 and 140 mm are bi-aspheric and have a ring-shaped input aperture (see Fig. 2). This innovative and award winning (“Thüringer Innovationspreis 2020”) optical design by Jena-Optronik allows a compact construction and avoids the need for additional optics. The latter has a positive effect on size as well as on the weight of the sensor. To enable missions in space, the mirrors with a PV of < 150 nm have an outstanding surface quality. For suitable handling of temperature fluctuations of up to 60°C, the aspheres were made of fused silica, in perfect material match with the overall imaging system parts. This exclusive material selection ensures that the optical components do not suffer from any thermal-mechanical stress. To be able to process and measure several disjunctive optical surfaces on one component surface, the process strategy and measurement technology were precisely coordinated and further developed. A spacer completes the optical system. This 140 mm wide, fused silica ring has a flatness of less than one micrometer and holds the optical system in position.

### Optical head



Fig. 1 Mechanical design of the optical head  
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### Specifications of the mirrors



Fig. 2 Manufactured mirror optics and spacer  
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**Main parameters**  
Focal length:  
175 mm  
Field of view:  
 $\pm 2.25^\circ$   
Outer diameter:  
< 164 mm  
Thickness:  
~ 80 mm  
Effective entrance  
aperture:  
 $\varnothing 88 \text{ mm (} f\# = 2.0 \text{)}$

*Disclaimer: The contract was carried out under a programme of and funded by the European Space Agency.  
The view expressed herein can in no way be taken to reflect the official opinion of the European Space Agency.*

