Fraunhofer IOF

Fraunhofer Institute for Applied Optics and Precision Engineering IOF

Optical components for Earth observation instruments

Components for space spectrometers with exeptional accuracy

We design, manufacture, and integrate highly precise slit assemblies for spectrometer applications with mechanical accuracy of the slits down to the sub-micron range in absolute width and length, and a slit planarity less than 5 µm.

SLITA – slit assembly for the FLEX mission

The "Fluorescence Imaging Spectrometer" (FLORIS) will be the heart of ESA's "Fluorescence Explorer Mission" (FLEX). For the spectrometer, the IOF developed and manufactured a double-slit assembly with exceptional accuracy as well as two high-precision mirrors in cooperation with OHB. The requirements were at the limits of what is technically feasible. Each slit must be manufactured with an exact width of $85(^{+1}_{-1})$ µm over a length of 44.15 mm. Both slits are mounted highly parallel to each other and have a slit planarity of less than 10 µm. Special requirements also applied to the mirrors, which are intended to guide the light onto the detector inside the spectrometer: These had to have a roughness requirement of 0.3 nm rms (root mean square).

Design and analysis

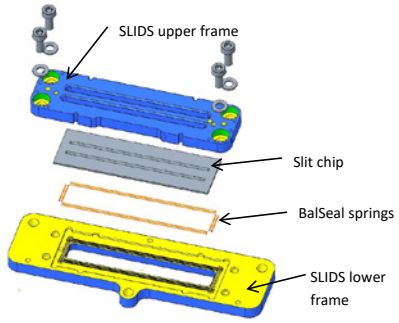
- Two mechanical parts – upper and lower frame
- Slit will be clamped and fixed by mechanical springs
- Planarity of mechanical parts defines the slit planarity
- Additional fixation by dot of adhesive to prevent thermal induced position deviations of slit up to end of life
- The maximum of the corresponding out-of-plane deformation of the slits chip amounts to 5.7 µm while a maximum out of plane deformation of 3.5 µm occurs at the slit edges

Manufacturing and integration

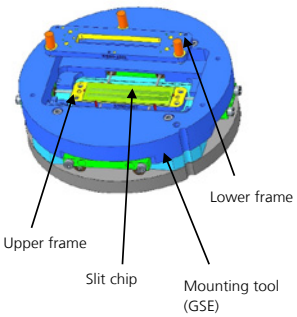
- Slit structure was fabricated by a lithographic exposure processes in combination with a silicon wet-etching processes
- Special tools have been developed for mounting and positioning of upper and lower frame and slit chip
- The integration and positioning concept use mechanical references of GSE for slit chip alignment
- The final position was measured by contact-less optical coordinate measurement

Testing

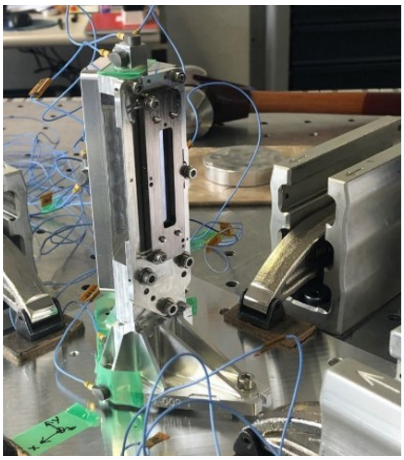
- Thermal-vacuum cycle test with 25 cycles and a temperature range from –25 °C to +65 °C
- Shock test was performed along x-, y- and z-axis. Per each axis three shocks were applied.
- Vibration tests were performed along x-, y- and z-axis. Per each axis the sine and random vibration loads were applied.



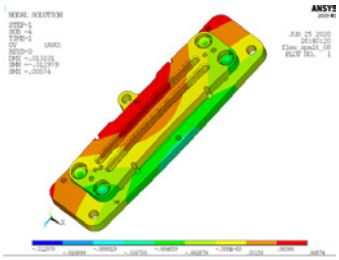
Design of double slit device (SLIDS)



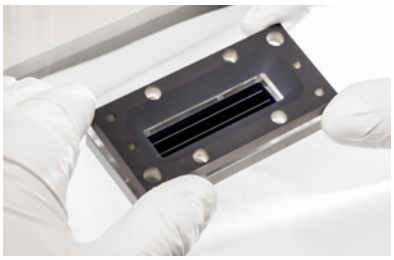
CAD image of assembly tool



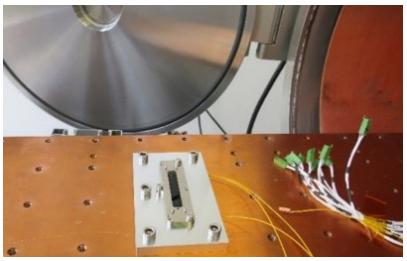
SLIDS during shock test (z-axis)



Out-of-plane deformation of the upper and lower frame



Black coating GSE for slit chip



SLIDS on thermal adapter of thermal vacuum chamber

Top:
Researchers at Fraunhofer IOF check the bidirectional positioning accuracy of slit chip with respect to the mechanical interfaces during the assembly process

Cover:
SLITA – slit assembly for the "Fluorescence Imaging Spectrometer" (FLORIS)
The FLEX Slit Assembly was developed with financial and technical support from the European Space Agency (ESA) in the frame of the Earth Explorer – Fluorescence Explorer (FLEX) mission.

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for more
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