

## Characterization of a lobster-eye type X-ray telescope

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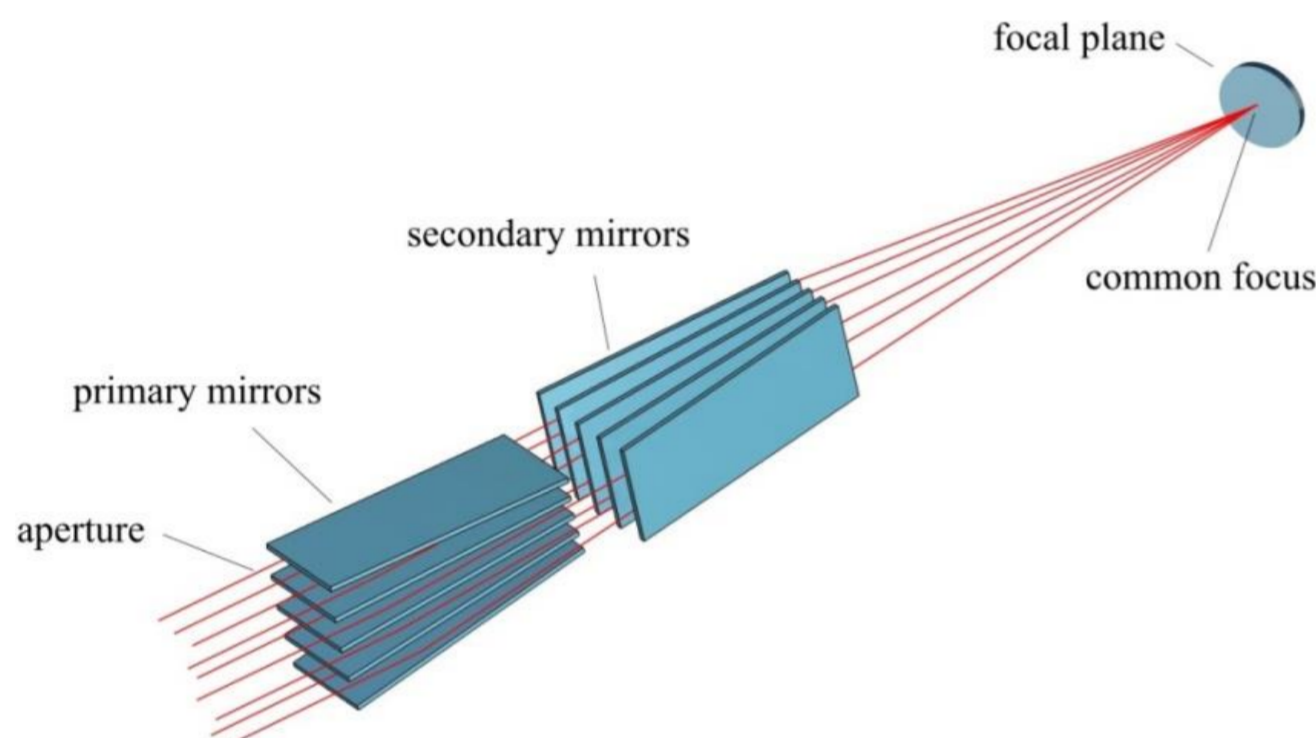
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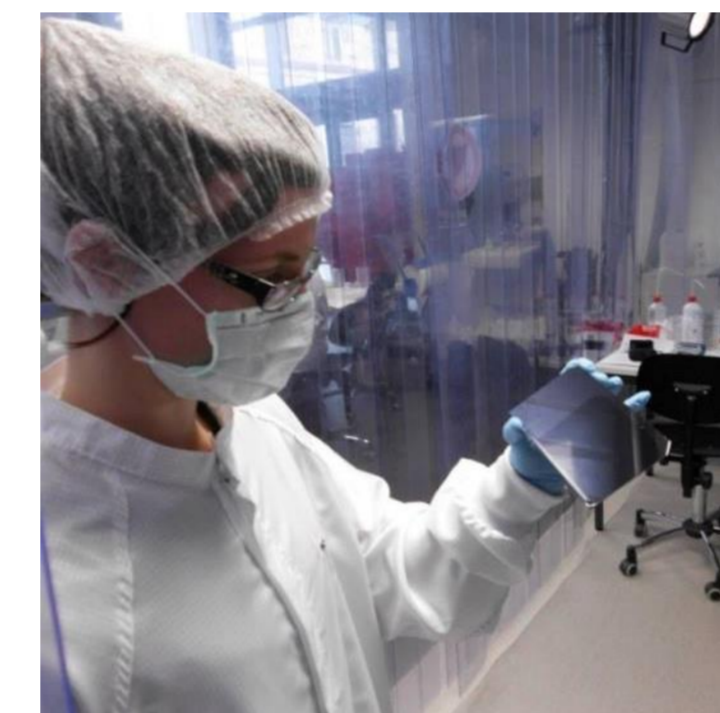
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**Abstract:** Lobster-eye type X-ray telescopes use reflecting plano mirrors under grazing incidence and can observe a large field of view. As part of a Bavarian-Czech cooperation, two telescopes were built, equipped with mirrors coated with gold and iridium. Their X-ray characterization was carried out at the PANTER test facility, which simulates parallel starlight incident on the telescopes. The telescopes have an angular resolution of about 4 arc minutes in X-rays and a focal length of about 2 meters. The used X-ray mirrors reflect and focus visible light as well; their functionality in the optical regime was checked in laboratory tests. Now another test campaign will be carried out to examine the telescope resolution for real objects of the visible night sky and the imaging properties for star constellations.

### Principle of the Lobster Eye X-ray telescope



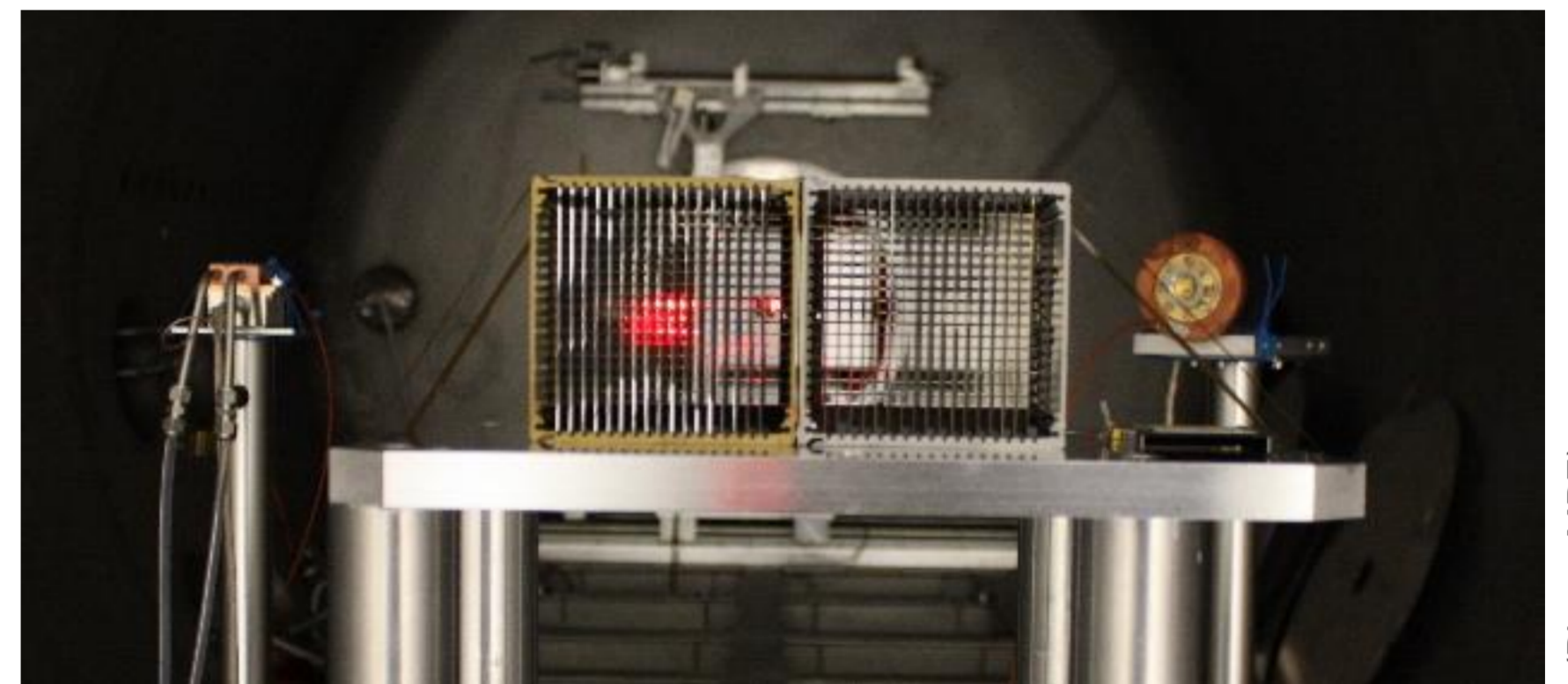
Principle of the Lobster Eye Telescope: The plano mirrors of the vertical and the horizontal modules are focussing the incident rays.



(Photo: s TH Aschaffenburg)

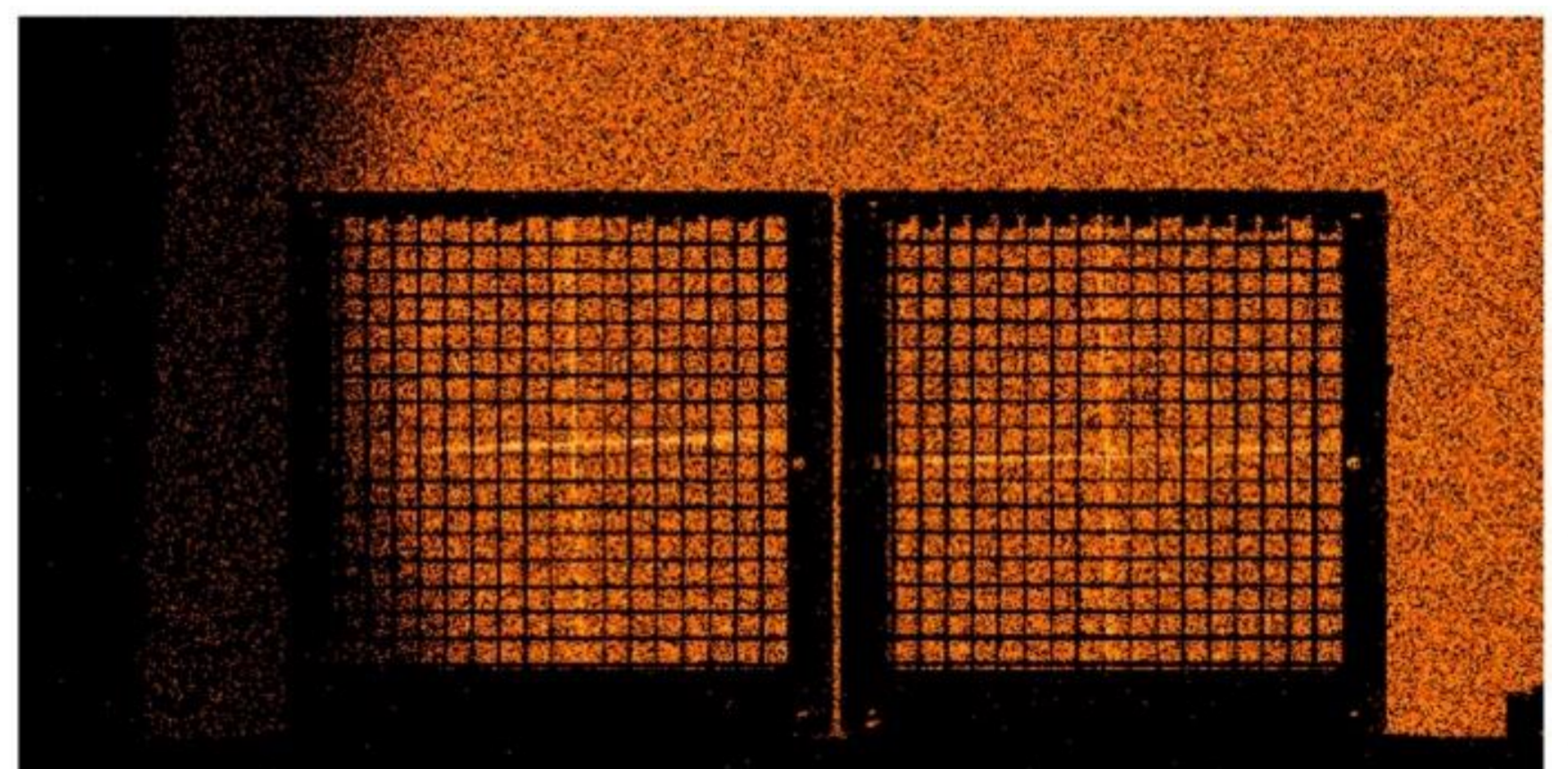
Each X-ray mirror is using a flat silicon wafer substrate which is coated with a highly reflective Cr-Ir-Cr layer system

### X-ray characterization at the PANTER test facility



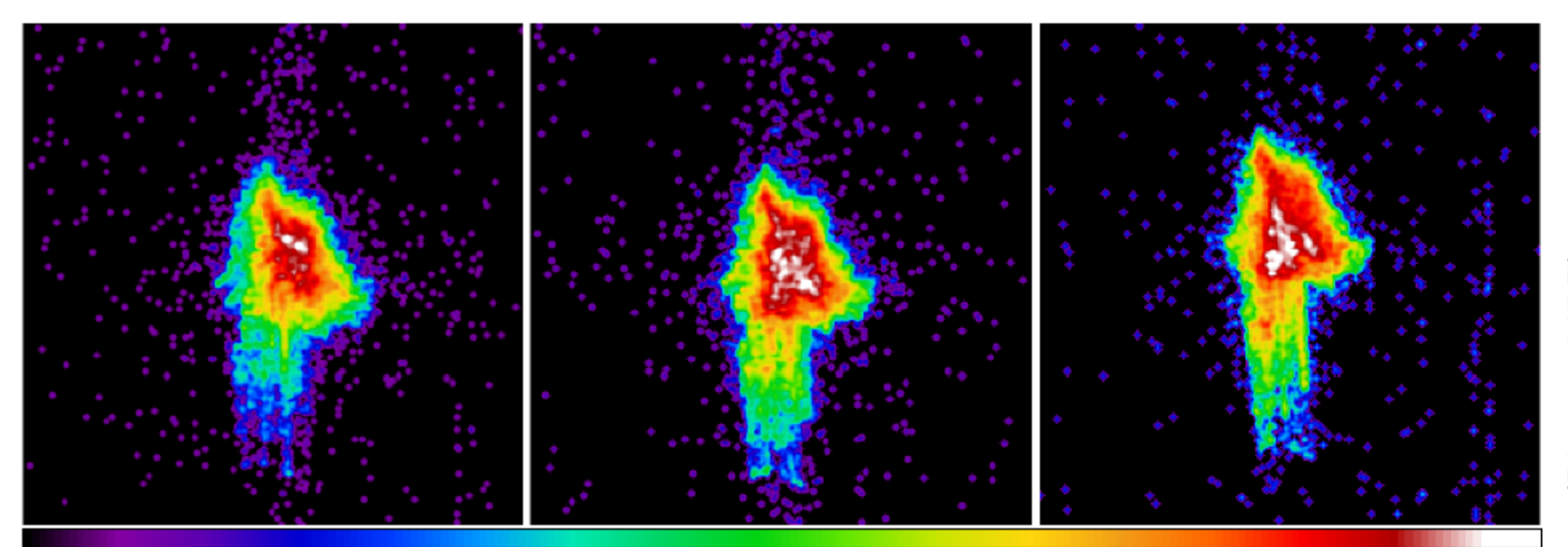
(Photo: MPE)

The two HORUS telescopes, installed next to each other in the vacuum test chamber of the PANTER test facility, are waiting for the "First Light Event".



(Photo: MPE)

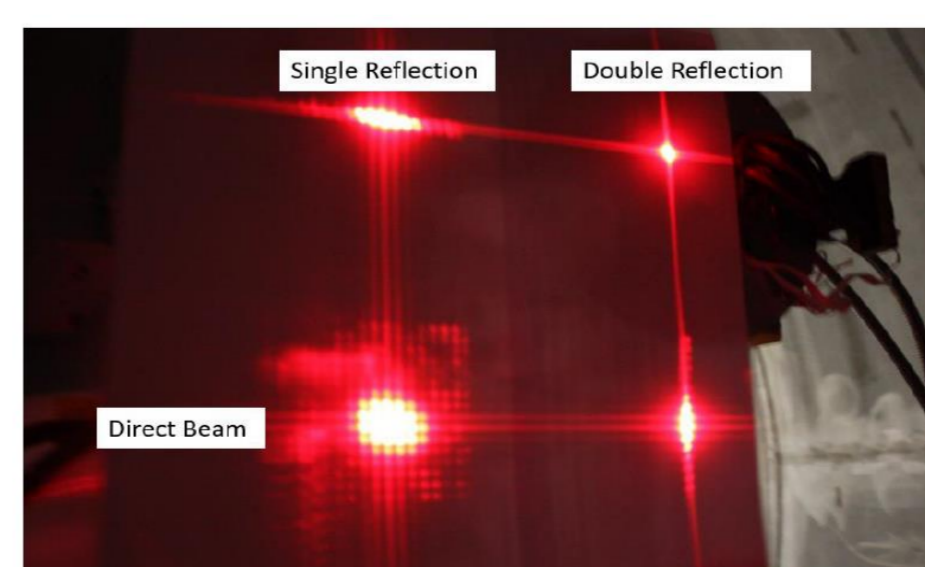
The shadow of the two HORUS telescopes in X-ray illumination.



(Photos: MPE)

The double reflection spots of the iridium coated telescope using a low energy X-ray continuum band. From left to right: Measurements at 1°, 1.6° and 2.2°.

### Alignment tests with visible light in the laboratory



(Photos: MPE)

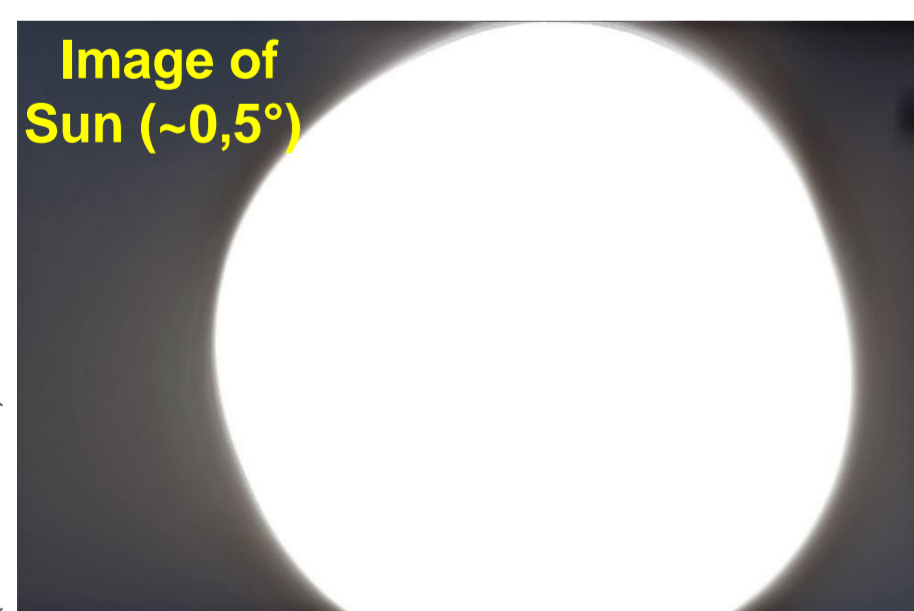
Left: Focal plane image during laser alignment showing the location of the direct beam through the optic, two single reflection on the top and to the right side of the image, and the double reflection focus on the top right corner. Here the telescope optic was rotated by 2.3° in pitch and yaw. Right: Focus image of a green LED.

### Set-up for night-sky measurement campaign at MPE in Garching



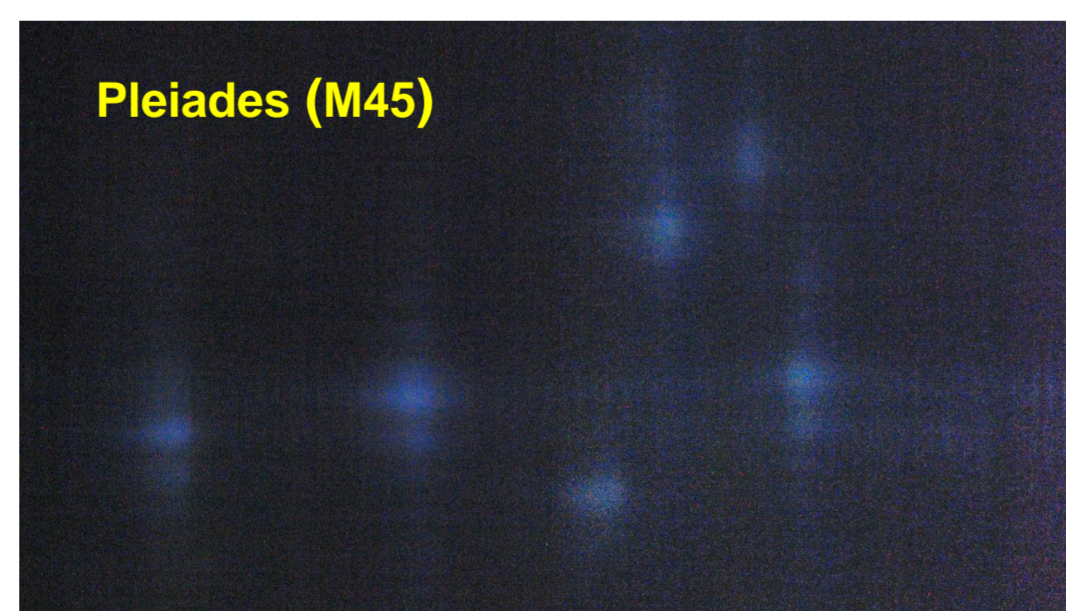
(Photos: TH Aschaffenburg)

### Visible images of astronomical objects: Sun and stars



(Photo: MPE)

Visible image of Sun as seen by the X-ray telescope.



(Photo: CVUT Prag)

Star constellation, observed with another Lobster Eye X-ray telescope at the Czech BART telescope.

### References:

- [1] T. Döhning et al.: „Development of iridium coated X-ray mirrors for astronomical applications”, Proc. SPIE 10399,103991C (2017)
- [2] T. Döhning and R. Hudec: “JEUMICO and TRILAMICO: Dimensions of successful Bavarian-Czech cooperation”, Contrib. Astron. Obs. Skalnaté Pleso 48, 430 – 436 (2018)
- [3] T. Döhning et al.: “Characterisation of X-ray mirrors based on chromium-iridium tri-layer coatings”, Proc. SPIE 11776, 1177607 (2021)
- [4] V. Stehlikova et al.: “Lobster eye type X-ray telescope with chromium-iridium coated tri-layer mirrors”, Proc. SPIE 11776, 1177605 (2021)