

Use cases for quantitative CMOS detectors in time domain astronomy

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We are exploring time domain astronomy with commercially available low-noise ORCA-Quest 2 cameras from Hamamatsu™. Aim of our ORCA-TWIN experiment is to achieve synchronized high speed imaging with cameras mounted on two remote 1m-class telescopes at different sites. Commissioning of one OQ2 camera, first on-sky tests and first science observations have been performed in June and September 2025 at Calar Alto Observatory (CAHA) in Spain.

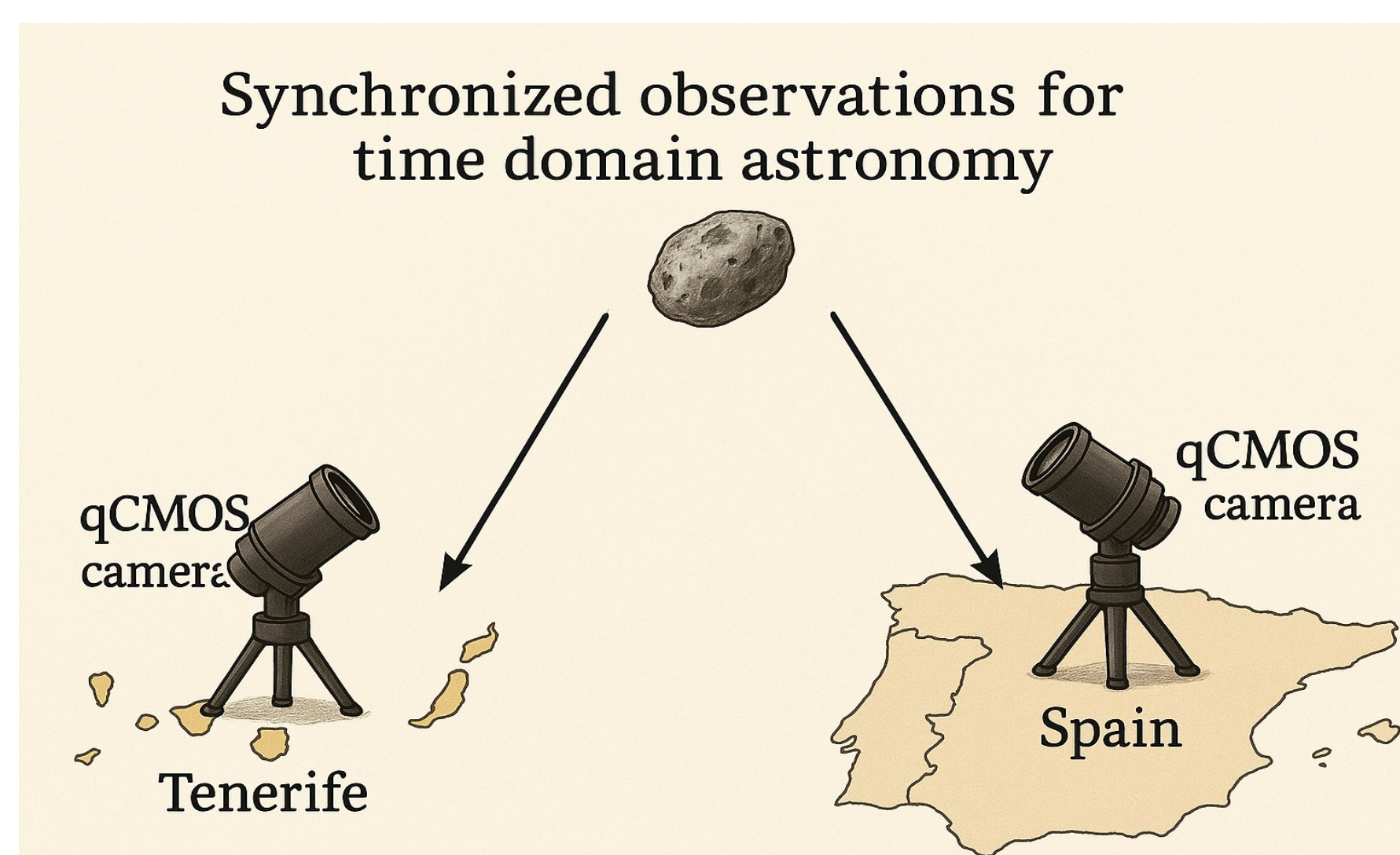
Introduction

Quantitative CMOS (qCMOS) detectors represent a new generation of imaging technology, combining the capability of sub-electron readout noise and high quantum efficiency of EMCCDs with the speed, dynamic range, and stability of modern CMOS sensors.

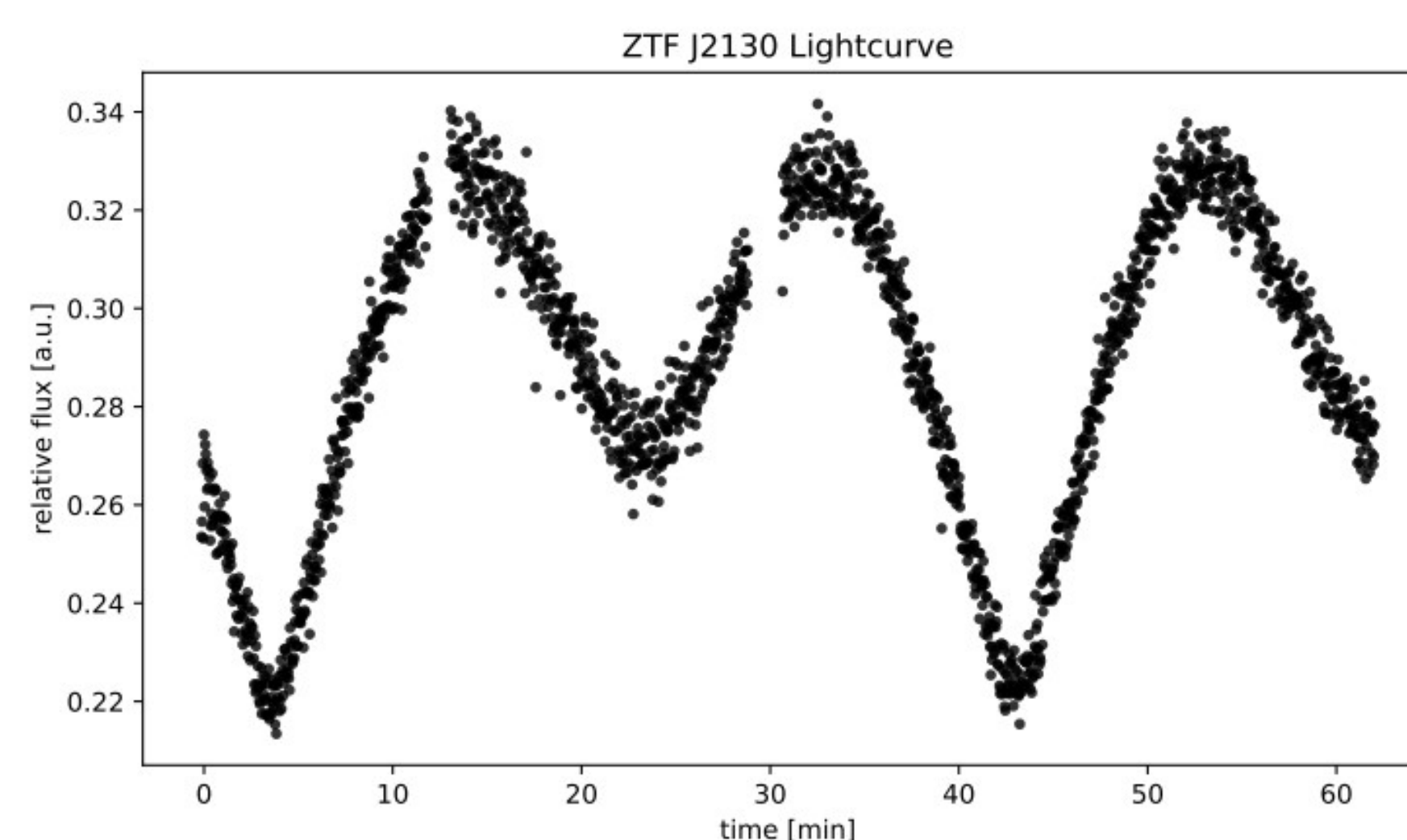
These properties open new opportunities for time-domain astronomy, including fast stellar occultations, transient events, microlensing phenomena, lucky imaging, speckle interferometry, and other high-cadence observations.

Science cases we are considering and evaluating

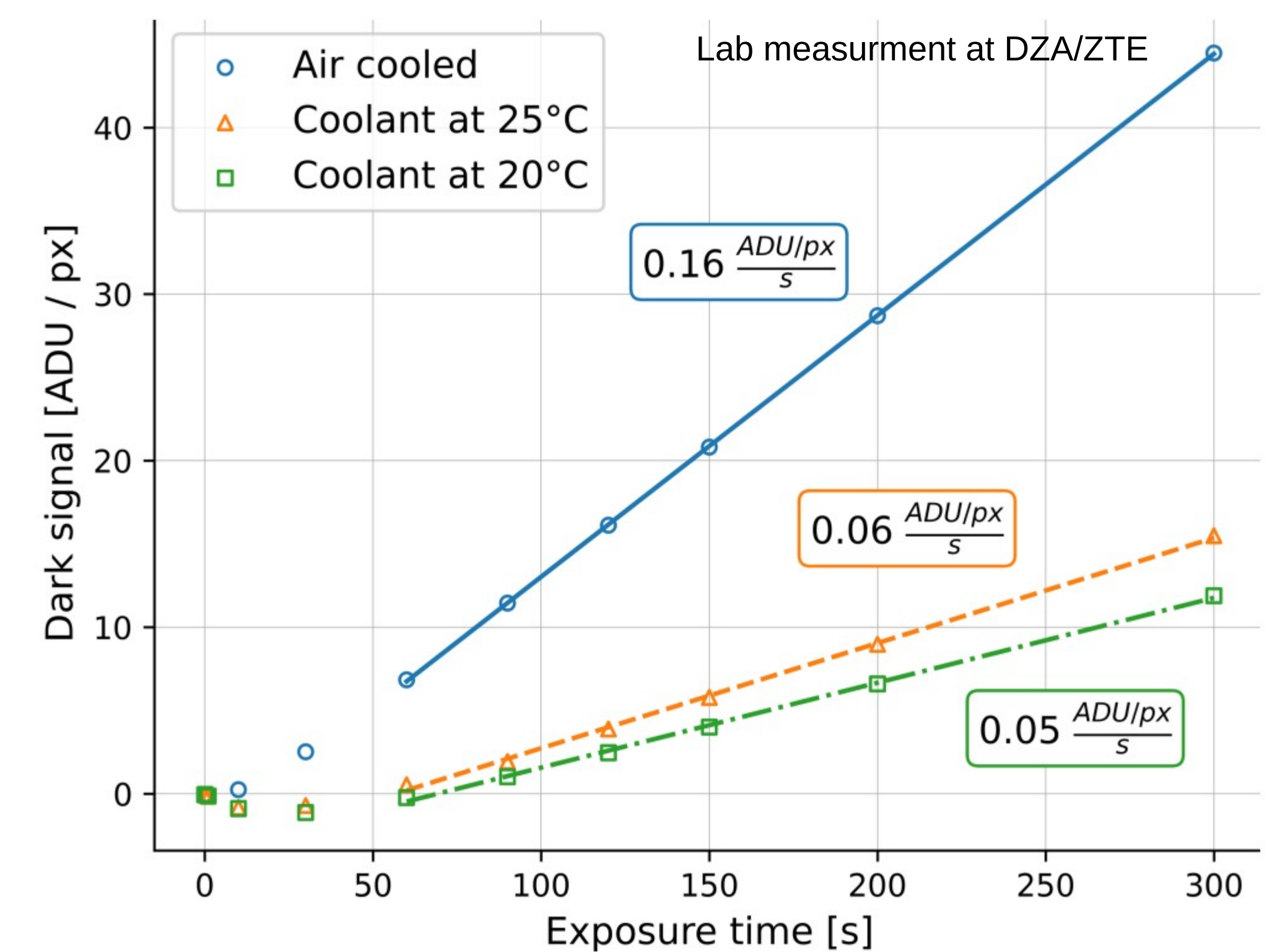
Time-series photometry of short-period binary stars, monitoring stellar flares, resolving close binaries with speckle interferometry, high-contrast Bayesian imaging and adaptive optics, measuring the size and shape of small Solar System bodies (asteroids and TNOs) and their environments (close satellites, rings, etc.), as well as rotational light curves of very fast-rotating asteroids and NEOs and direct distance determinations of fast-moving NEOs via parallaxes.



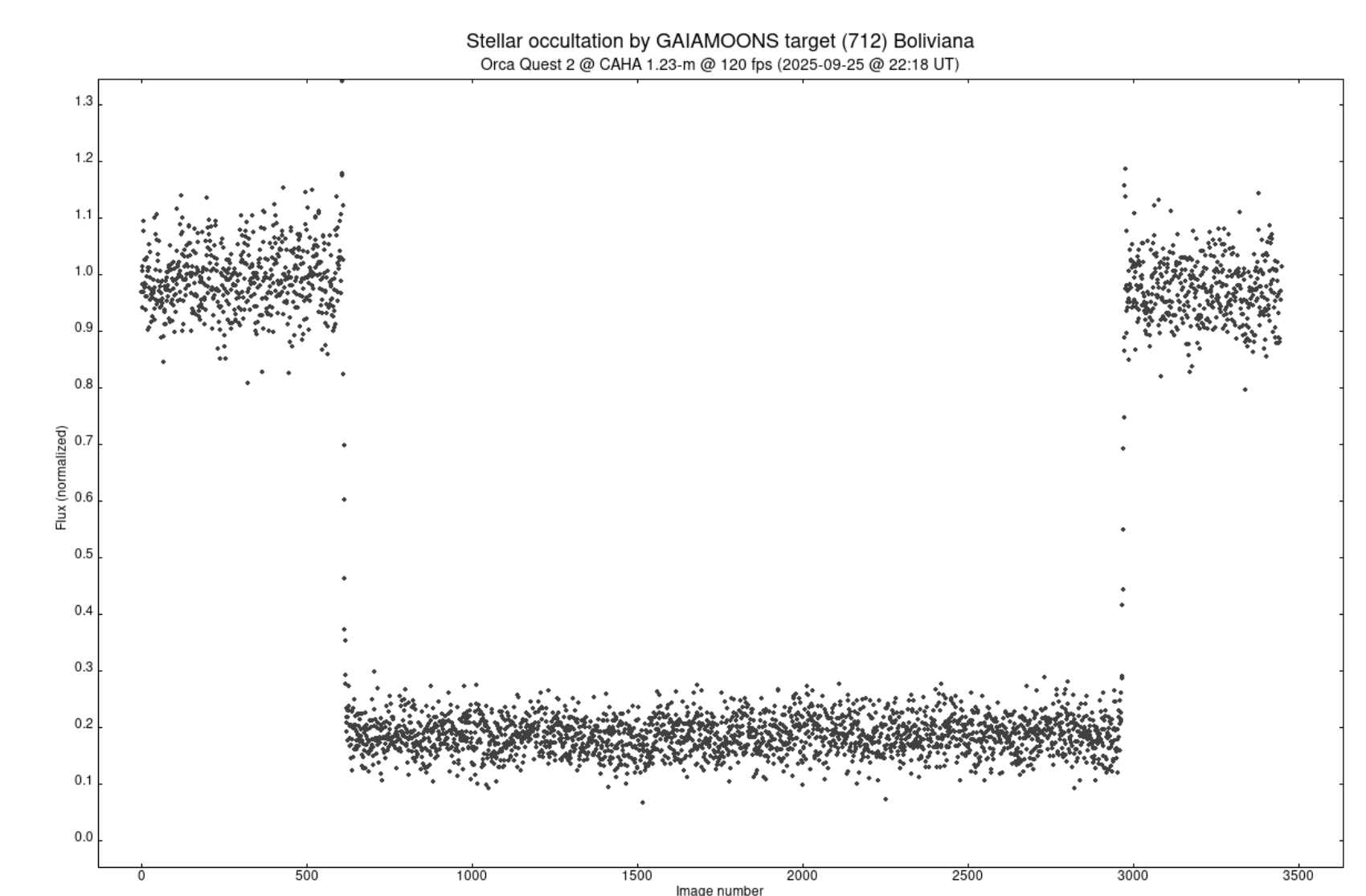
Science case example: using ORCA-TWIN for distance measurements of Near Earth Objects (NEOs) via parallaxes for an improved (Initial) Orbit Determination (IOD).



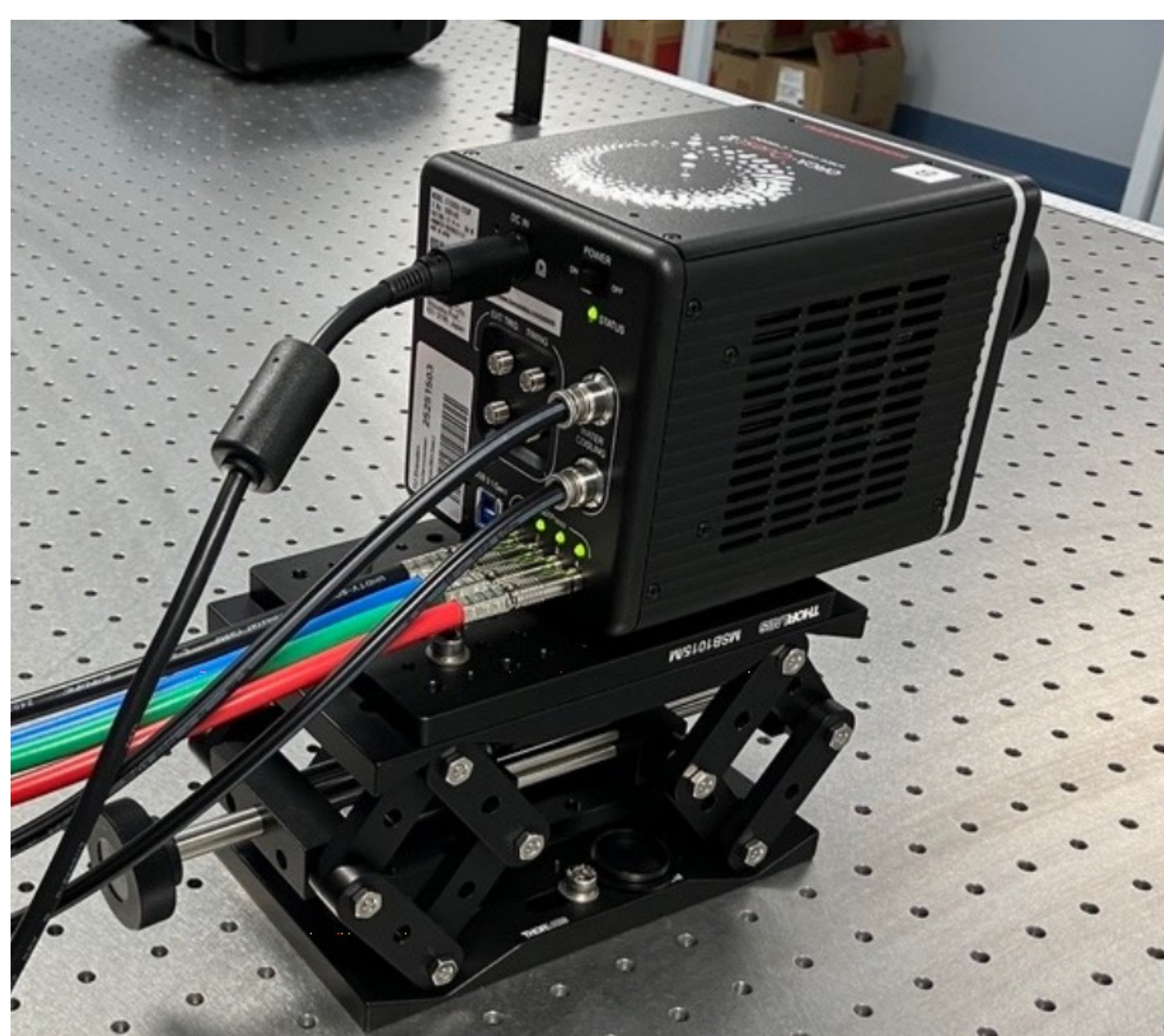
Time series photometry of ultracompact binary ZTF J2130, obtained on 2025-09-24/25. 2-sec exposures, 4x4 binning, OQ2 cam @ CAHA 1.23-m telescope. The orbital period decreases over time due to the emission of gravitational waves.



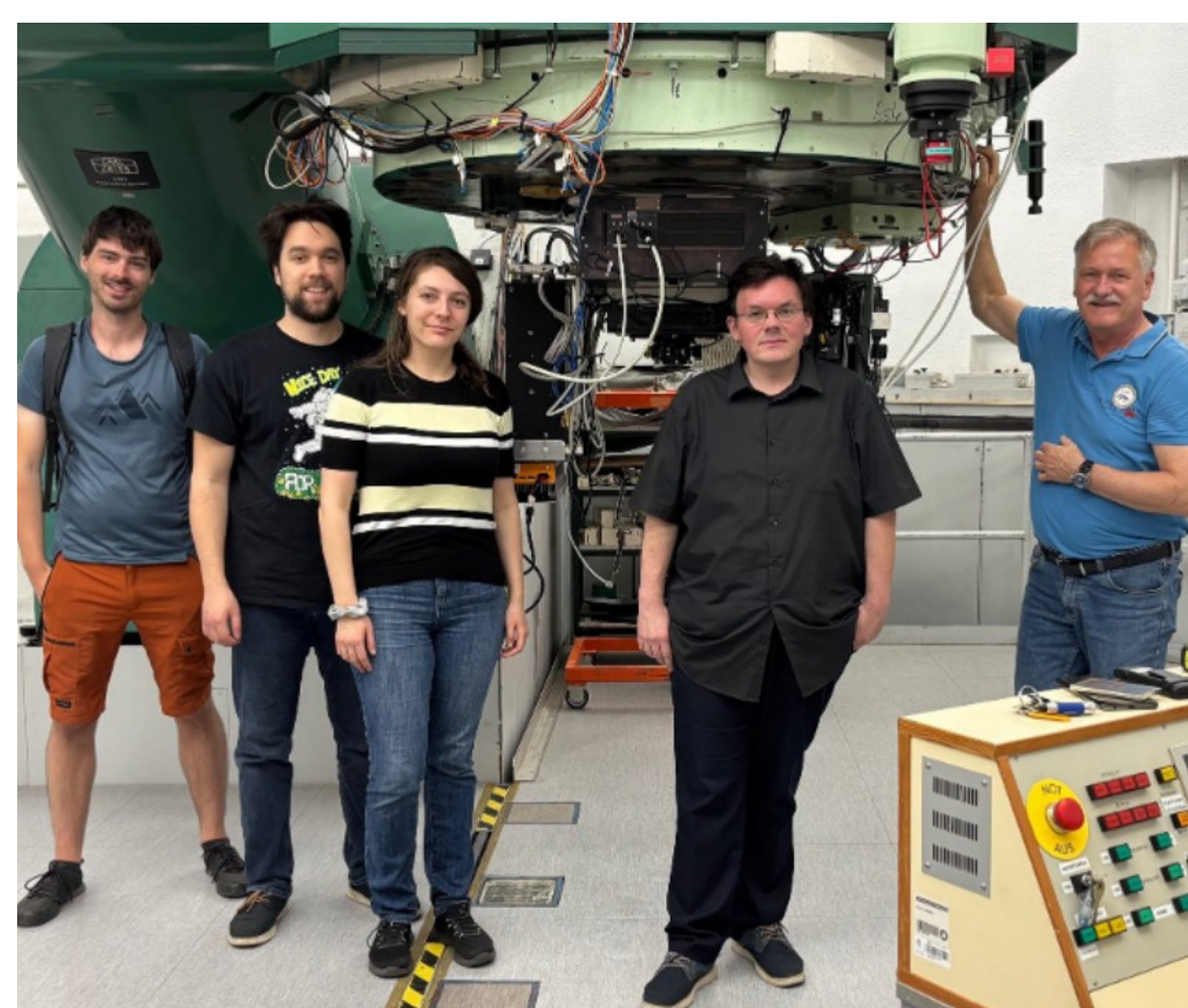
- Low dark current
- Low readout noise 0.3 e- RMS @ 25 fps
- QE ~ 50/85/30 % @ 300/460/900 nm



High cadence (120 fps) recording of a stellar occultation by asteroid (712) Boliviana, a GaiaMoons project suspected binary with OQ2 cam @ CAHA 1.23-m telescope on 2025-09-25. The plot represents just a small window of the complete recording. No secondary event due to a moon was detected within 20 sec before and after the primary body occultation.

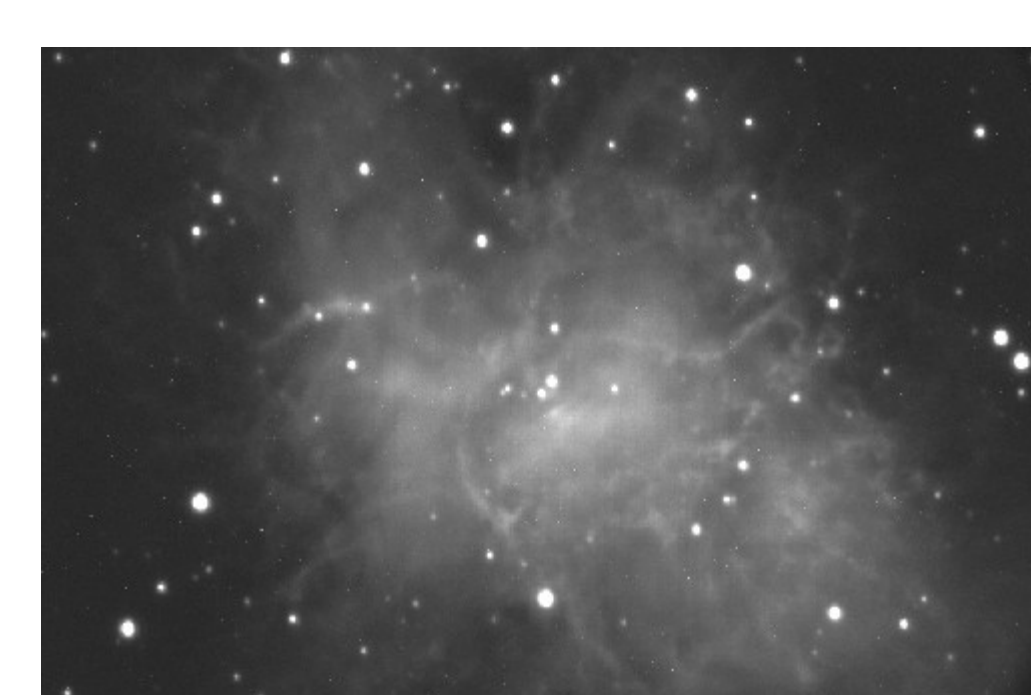


ORCA Quest 2 camera characterization at the DZA detector lab.

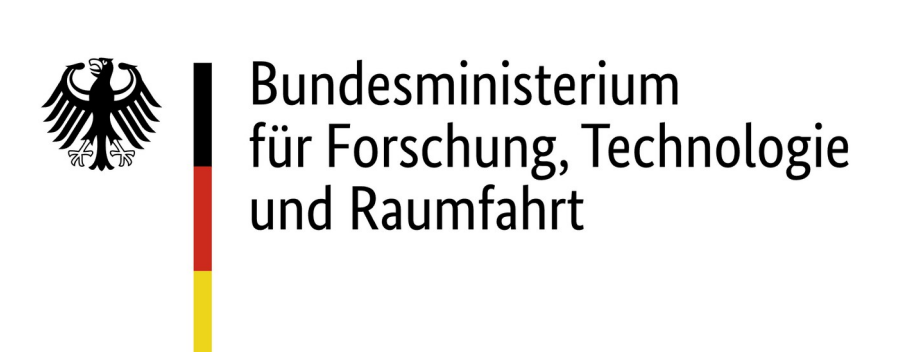
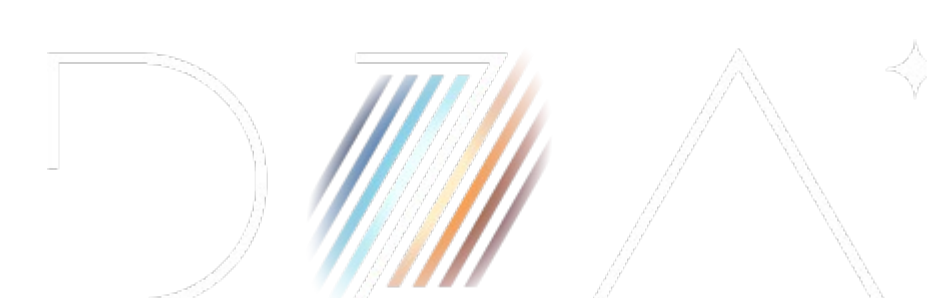


Top: Start of commissioning at the Calar Alto 1.23-m telescope in Spain in June 2025

Right: Further commissioning work and observations (dark run) in September 2025



M1 (crab nebula). Unprocessed raw image, OQ2 @ CAHA 1.23-m



Collaborations:

AIP, CAHA, Hamburg Univ., IAA, and more