NEA OBSERVATIONS WITH THE WORLD'S BIGGEST SCHMIDT TELESCOPE

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Keywords: *NEOCP, Schmidt telescope, synthetic tracking*

Introduction: Since 1960 TLS (IAU code 033) has operated the largest imaging Schmidt telescope with a correction plate of 1.34 m in diameter. Initial asteroid work by Freimut Börngen aimed at discovering main-belt asteroids. In 2010, it was resumed by joining the worldwide NEOCP effort. TLS became a sensor in ESA's NEOCC program in 2019. It is now one of the major European observatories with regard to NEO follow-up. Recently, the first NEA discoveries succeeded.

Observational Infrastructure: The TLS 2-m telescope (Fig. 1) features three optical systems. Switching between Schmidt and Coude is done according to lunar phase. The TAUKAM [1] prime focus camera houses a 6144x6160 e2v CCD, offering a 1.75□° FoV at a 0.775″pixel scale. This is well-matched to the site's median seeing (FWHM 2″.2), allowing imaging of objects with substantial position uncertainties. The camera employs a closed-cycle cooler. While SDSS and narrowband filters exist, NEO imaging is done in white light for better sensitivity. A TM-4 GPS device synchronizes the clocks.

Figure 1: **The telescope in its 20 m dome.**

Observing Pipeline: Targets were previously from NASA Scout and ESA-NEOCC lists but are now chosen from NEOfixer [2]. The telescope tracks the target. Applying deconvolution of stellar trails yields precise astrometry based on GAIA EDR3. The object recognition takes place on the cumulative image while positions are derived from as many frames as possible. They are verified using find_orb [3] with the measured and prior coordinates. Results are reported to MPC immediately after verification. Tasks needing human interaction use DS9 as an interface. Raw images go to ESA-NEOCC and are accessible via the Solar System Object Image Search at CADC.

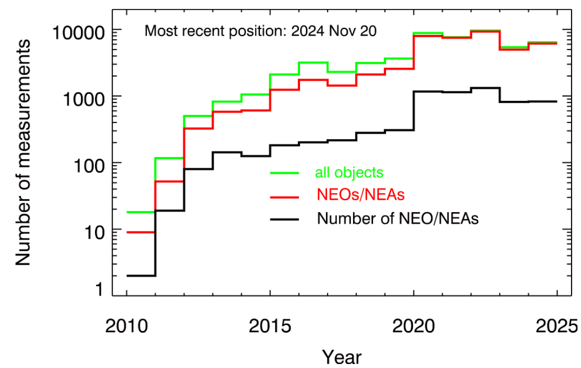

Figure 2: **Annual statistics of submitted positions (green/red) and observed objects (black)**

Results: TLS is committed to the effort to identify and monitor potential hazardous NEOs. The bulk of Schmidt time is devoted to these observations. Thanks to improvements in hard and software, efficiency and accuracy increased over the years. The statistics of the TLS NEO observations are shown in Fig.2. Obviously, TLS became one of the most prolific European observatories with regard to NEO follow-up. During the last years, the trend flattened off, indicating that the observational potential has been fully exploited. Funding for the NEO program is secured until mid-2027.

Synthetic Tracking for NEO Detection: Before mid-2022, efforts focused solely on NEO confirmation. However, TAUKAM is also well suited for detecting them. In fall 2022, several nights were dedicated to this. Data analysis was performed using TYCHO tracker [4] on stacks of 30 images per field. Five candidates were found, two confirmed and designated as 2022SX7 and 2022SK9. A similar 2023 run identified three more NEAs. Thus, NEO discovery became another objective of Schmidt imaging at TLS.

References: [1] B. Stecklum, et al. in *Ground-Based and Airborne Instrumentation for Astronomy VI* vol. 9908 99084U International Society for Optics and Photonics doi.[link]. [2] E. Christensen, et al. (2021) in *7th IAA Planetary Defense Conference* 206. [3] B. Gray (2022) Find_Orb: Orbit determination from observations Astrophysics Source Code Library, record ascl:2202.016. [4] D. Parrott (2020) *JAAVSO* 48(2):262.