NEA observations with the World's Biggest Schmidt Telescope

Introduction

Since 1960 TLS (IAU code 033) has been operating the largest imaging Schmidt telescope with a correction plate of 1.34 m in diameter. Initial asteroid work, done until 1996 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 the ESA 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

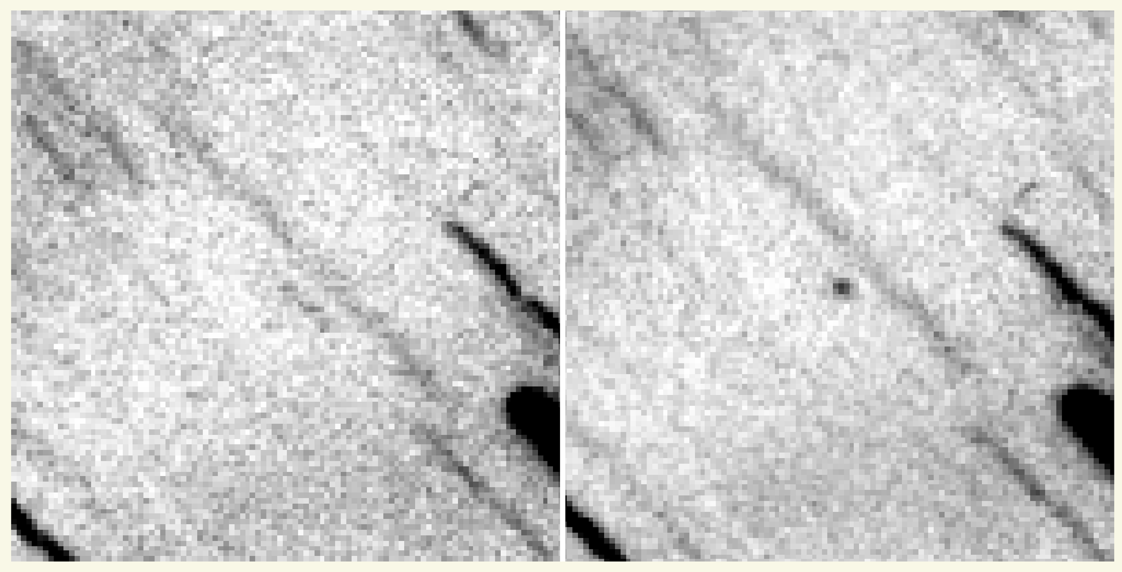
The TLS 2-m telescope (Fig. 1) features three optical systems. Switching is done mainly between Schmidt and Coude according to lunar phase. The TAUKAM[1] prime focus camera houses a 6144×6160 e2v CCD, offering a $1.75\,\square^\circ$ FoV at a $0''.775$ pixel scale. This is well-matched to the site's median seeing (FWHM $2''.2$), while the large field allows catching objects with substantial position uncertainties. The camera employs a closed-cycle cooler. SDSS and narrowband filters are available; however, NEO imaging is performed in white light for better sensitivity. A TM-4 GPS device synchronizes the clocks.

Fig. 1: The telescope in its 20 m dome.

Observing pipeline

Targets were previously drawn from NASA Scout and ESA-NEOCC lists but are chosen from NEOfixer[2] since mid-2024. The telescope tracks the target to minimize the influence of the sky noise. Stellar trail deconvolution yields centrally peaked profiles which enable precise astrometry tied to GAIA EDR3. The object identification is done on the stacked image, while positions are derived from as many frames as possible. They are checked using find_orb[3] against prior measurements. The results are reported to MPC immediately after verification. Tasks that require 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 as well.
In case the actual motion differs too much from predicted one, individual images do not superimpose when stacking. Then, tweaking the velocity in a reasonable range helps to reveal the object. An example of this recently implemented "linear synthetic tracking" is shown in Fig. 2.

Fig. 2: Left: Stacked image. Right: Superposition with properly tweaked velocity.



Results

TLS is committed to the effort to identify and monitor potential hazardous NEOs. The bulk of Schmidt time is devoted to this objective. The statistics of the TLS NEO observations are shown in Fig. 3. By improving hard- and software, efficiency and accuracy increased over the years. Thus, TLS became one of the most prolific European observatories with regard to NEO follow-up. Recently, this trend flattened off, indicating that the observational potential has been almost exploited by now. One of the current highlights is the observation of 2024 BX1 one hour before its impact. Funding for the NEO program is provided until mid-2027 by the ESA contract 4000134667/21/D/MRP.

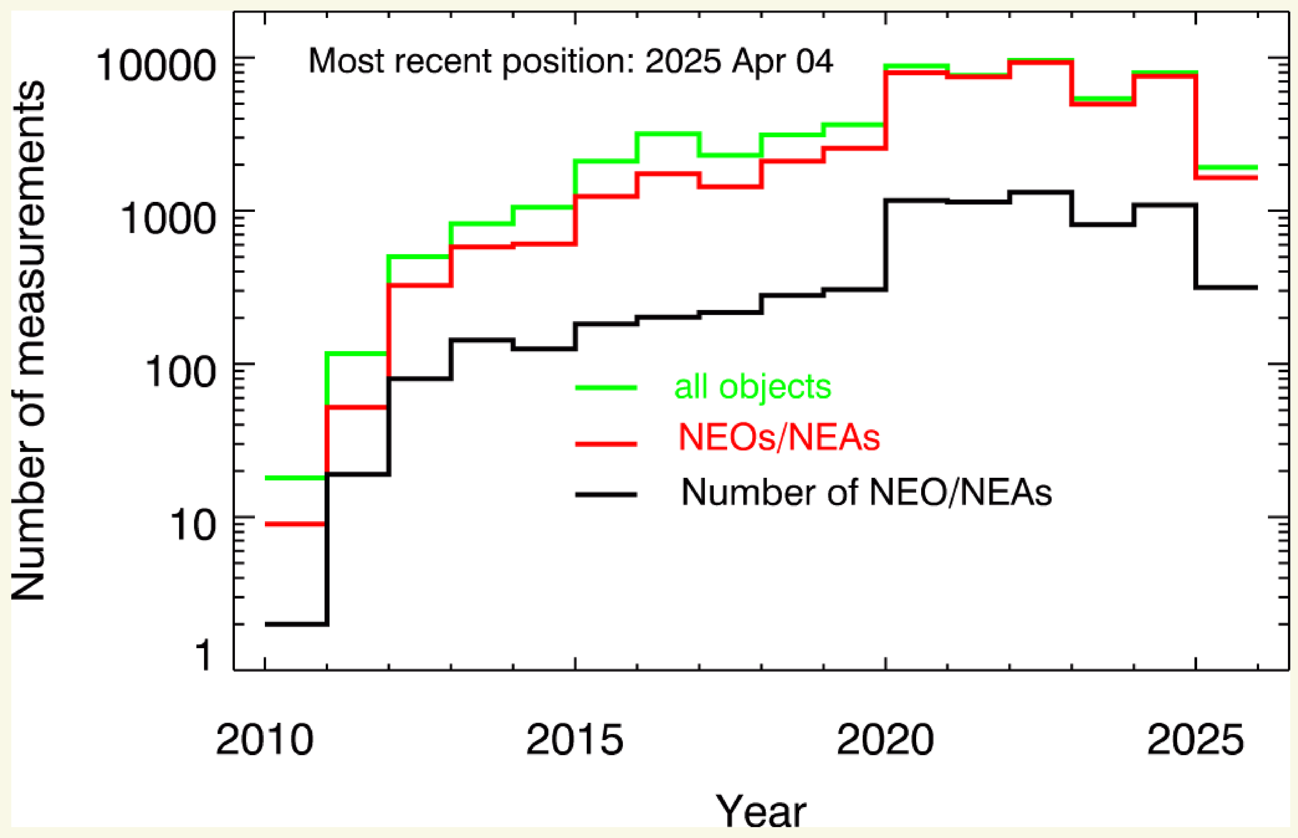


Fig. 3: Statistics of submitted positions (green/red) and observed objects (black)

Synthetic Tracking for NEO Detection

Before mid-2022, efforts focused solely on confirming NEOs. However, TAUKAM is also well suited for detecting them. In fall 2022, several nights were dedicated to this task. Data analysis is performed using the 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. TLS is presently engaged in the NEODetect Beta Program[5] (ESA 4000144612/24/D/BL), aimed at enhancing NEO detection using artificial intelligence.

References

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