Status of NEO confirmation observations at the Thüringer Landessternwarte

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Summary

In 2010 TLS joined the world-wide effort to confirm whether or not newly detected small solar-system bodies represent NEOs. Since then 3200 positions were submitted to MPC based on measurements with the largest imaging Schmidt telescope (Fig.1). Recent improvements described below increased both the accuracy and efficiency of the observations. The TLS activity is part of the EURONEAR initiative [1].

Fig.1 The world's largest imaging Schmidt telescope staring at the night sky.

Observational improvements

The use of the MIDOPT® BP550 UV+NIR block/visible pass filter doubled the bandwidth compared to R while suppressing atmospheric OH glow at the same time. In addition, tracking the NEO became default which yields a higher SNR. This is particularly advantageous for fast moving objects, e.g. small bodies passing Earth relatively nearby. Both changes reduced the mean position error from 0.75” in 2013 to the current value of 0.4”. Further streamlining of the observing procedure led to an increase of the cadence.

Astrometry from star trails

Transmission changes during the exposure imprint on stellar trails. Thus, object detection algorithms like sextractor [2] segment the trails (even with a deblend threshold of unity). Before establishing the WCS, image deconvolution with a synthetic trail is applied which leads to centrally peaked profiles. Thereby, the proper position is recovered. Fig.2 shows a 1D simulation for the case of a linear transmission change while a real world example is displayed in Fig.3.

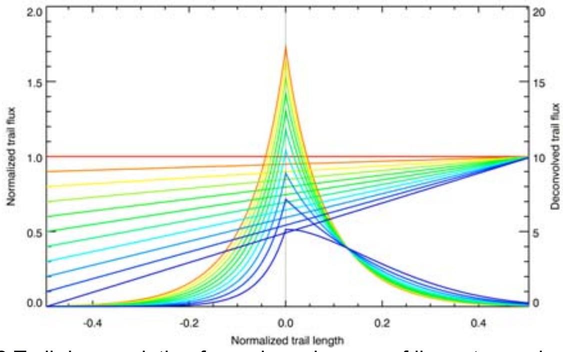

Fig.2 Trail deconvolution for various degrees of linear transmission change during the exposure.

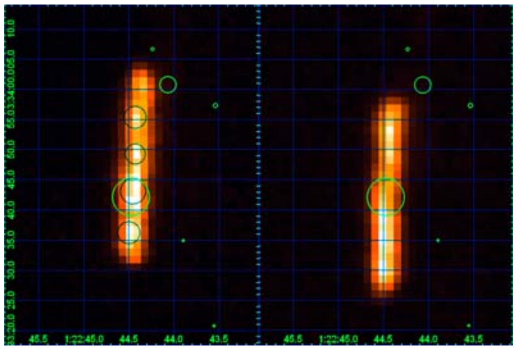

Fig.3 Left – star trail with superimposed sextracted positions (black circles) and initial astrometry. Right – same with position after deconvolution and final astrometry. Green circles mark stars.

Analysis improvements

The NEO identification is based on searching for objects on frame pairs which match the predicted motion. The candidate ranking employs the position likelihood obtained from the MPC uncertainty map. Coincidences with stars and known asteroids are flagged. The object is measured on the stacked frame of highest SNR first. In case of fast NEOs, this position serves as initial guess for single-frame measurements. Find_Orb is used for comparing predicted and derived positions which helps to spot measuring issues.

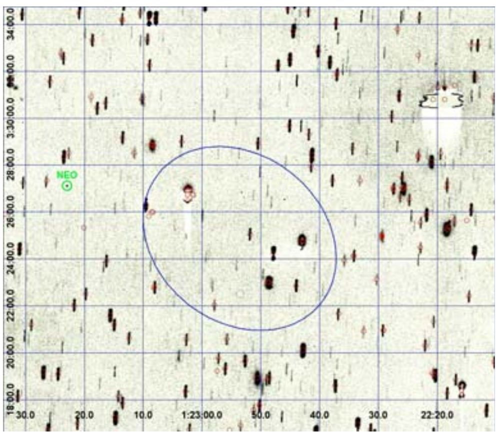

Fig.4 P10ec7e observed in August 2014. The NEO is marked green while the error ellipse is shown in blue.

Outlook

Funding for a new prime focus camera has been granted within the research development initiative of the federal state Thuringia. Negotiations with Spectral Instruments started to purchase a camera equipped with the e2v 6k x 6k CCD231-C6. First light is foreseen in late 2017. This instrument will permit to better exploit the potential of the Tautenburg Schmidt telescope.

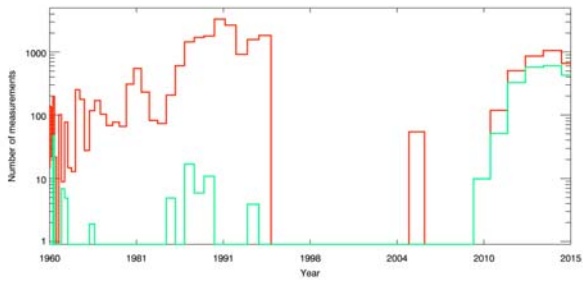

Fig.5 The frequency of TLS minor body positions over time (green – NEOs, red – total)

References

[1] Vaduvescu, O. ea. 2008, P&SS 56, 1913

[2] Bertin, E. & Arnouts, S. 1996, A&AS 117, 393