Stellar occultations by sub-km sized Near Earth Asteroids: Apophis & Didymos. D. Souami[1,2,3], J. Desmars[4], P, Tanga[3], K. Tsiganis[5], I. de Pater[2], Y M Hsu[2], J. Ferreira[5], A. Siakas[5], S. Chesley[6], D. Dunham[7], R. Venable[7], J. Irwin[7], H. Watanabe[8], S. Bouquillon[9], D. Herald[10], S. Preston[7], [1]LESIA, Obs, de Paris, CNRS, Meudon, France (damya.souuami@obspm.fr, Fulbright Scholar), [2]Univ. of California, Berkeley, CA, USA, [3]Univ. Côte d'Azur, Obs. de la Côte d'Azur, CNRS/Laboratoire Lagrange, Nice, France [4]IMCCE CNRS UMR 8028, Obs. de Paris, France, [5]Aristotle Univ. of Thessaloniki, Thessaloniki, Greece, [6]JPL, Caltech, Pasadena, CA, USA, [7]International Occultation Timing Association (IOTA), WA, USA, [8]Japan Occultation Information Network, Japan, [9]SYRTE, Obs. de Paris, Univ. PSL, CNRS, Paris, France, [10]Trans-Tasman Occultation Alliance- OTA, New Zealand.

Apophis: We report here on the results of the six Apophis events in 2021/2022 following the March 6th, 2021 encounter with Earth at ~ 43.8 lunar distances. The predictions made use of a "last-minute" refinement of Apophis' orbit using radar measurements (uncertainties of a fraction of *mas* in the radial direction), from Goldstone radio telescopes.

We will report on the size measurement as well as the astrometry of Apophis. In particular we refine our measurement of the Yarkovsky acceleration $A_2=(-2.8992 \pm 0.0161)\times10^{-14}$ AU d^{-2}.

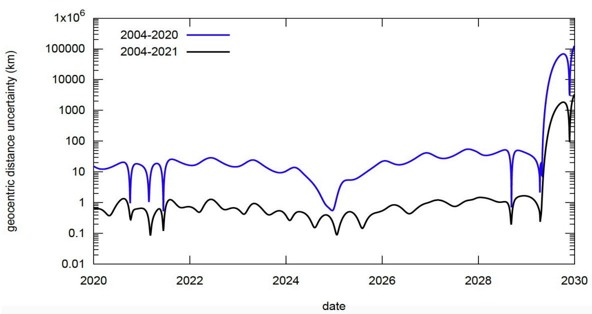

Figure 1 - Evolution of our knowledge of the 1σ uncertainty on Apophis' geocentric distance: using the (2004 - 2020) data and including the modelling of the Yarkovsky acceleration. Blue (upper curve, only optical astrometry and radar).. In black (lower plot): all data is used including the occultation derived astrometry.

Figure 1 shows how the occultation-derived astrometry reduces by an order of magnitude our knowledge of the uncertainty of Apophis' geocentric distance.

Didymos - Dimorphos: Furthermore, we report here on the work done by our group to improve the Didymos system astrometry prior to the DART impact. We reduced the DART Investigation team's data (2015 – 2022) using the GBOT high-accuracy astrometric pipeline [1]. This data was used for the final solution before impact along with historic optical and radar data [2]. This solution combined with DART SmartNAV data led to our four successful occultation campaigns (from Oct. 15th to Oct. 19th, 2022). These first occultations along with radar data (from the DART team), allowed the prediction of 16 additional successful events. More information about other occultation events by NEAs can be found in [3].

We report here on the preliminary results and main lessons learned from the 20 successful Didymos occultation campaigns, four of which led to the detection of both Didymos and Dimorphos.

Figure 2 shows one of the best occultation light-curves (highest signal to noise ratio) by both Didymos and Dimorphos recorded on Jan. 21st, 2023 in France during the occultation of a 9 V mag. star.

The occultation-derived astrometry: For both Apophis and the Didymos system, this new occultation-derived astrometry reduces the uncertainty of the geocentric distance by nearly an order of magnitude. We will mainly report on the Apophis results [4]. For the Didymos system, we will report preliminary details on the effective use of this new astrometry to evaluate the heliocentric orbit post-impact, and therefore the β factor [see 2, 5 for details].

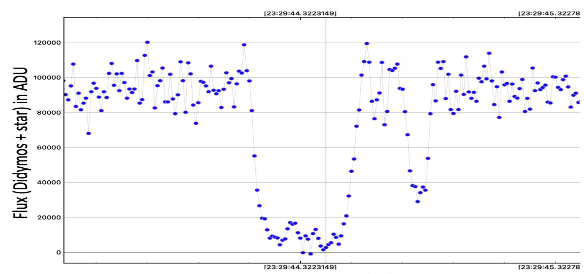

Figure 2 - Jan. 21st, 2023 event in Europe (observer: Lionel Rousselot) - occultation light-curves with one of the highest SNR on both Didymos and Dimorphos. Occulted star in red, reference star in black.

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References: [1] Bouquillon et al. (2014), *SPIE*, 9152, 915203, [2] Chesley et al. (2023) *ACM* submitted. [3] Dunham et al. (2023) *ACM* submitted. [4] Desmars et al. (2023) *ACM* submitted. [5] Makadia et al. (2023) *ACM* submitted.