PHOTOMETRIC FOLLOW-UP OBSERVATIONS OF THE DART IMPACT EFFECTS ON THE DIDYMOS SYSTEM FROM SPAIN. J.M. Trigo-Rodríguez[1,2], I. Pérez-García[3], J.M. Llenas[4], A.J. Castro-Tirado[3,5], E. Fernández-García[3], C.J. Pérez del Pulgar[5], A. J. Reina[5], M. Pajola[6], A. Lucchetti[6] and Eugene G. Fahnestock[7]. [1]Institute of Space Sciences (CSIC), Campus UAB, Carrer Can Magrans s/n, 08193 Cerdanyola del Vallés (Barcelona), Catalonia, Spain. trigo@ice.csic.es [2]Institut d'Estudis Espacials de Catalunya (IEEC), Ed Nexus, Barcelona, Catalonia, Spain, [3]Instituto de Astrofísica de Andalucía (IAA-CSIC), Granada, Spain. [4]Observatori de Pujalt, Pujalt, Barcelona, Catalonia, Spain. [5]Unidad Asociada al CSIC Departamento de Ingeniería de Sistemas y Automática, Universidad de Málaga, Spain. [6]INAF-Astronomical Observatory of Padova, Vic. Osservatorio 5, 35122 Padova, Italy. [7]Jet Propulsion Laboratory, Californian Institute of Technology, Pasadena, CA, USA.

Introduction: The Double Asteroid Redirection Test (DART) mission successfully impacted Dimorphos, satellite of binary asteroid (65803) Didymos, on Sept. 26, 2022. This major achievement in planetary defense consisted in the impact of the 579.4 kg in mass DART spacecraft with Dimorphos at 6.14 km/s to decrease its orbital period, and measure it accurately through ground based telescopes [1-3]. A period change of about 32 min was achieved, but the impact effects produced a cloud of debris and fine dust that surrounded the asteroid system, finally creating a long dust trail [3]. Studying the nature of the debris released by the crater excavation will allow us to increase our knowledge of the physical properties of the materials forming asteroids [4-6]. DART started a new age in planetary defense, and demonstrated our ability to deflect asteroids using a kinetic impactor [7].

Unfortunately the low altitude of Didymos system as seen from Spain constrained the telescopes to be used. We basically needed: 1) observatories with a horizon free of obstacles and 2) telescopes capable to perform observations of targets close to the horizon. Despite of the challenge, and due to the scientific interest, we programmed a post-impact photometric follow-up and a follow-up of the dust trail created after DART's crater excavation on Dimorphos.

Technical procedure: Given that DART collision with Dimorphos occurred while the object was under the horizon, we waited a few hours until the Didymos system could be imaged. Using BOOTES-1B robotic telescope plus a EMCCD we made a photometric sequence to compare Didymos system overall magnitude the night before and after DART's impact using the same instrument. A clear increase in the Didymos system magnitude caused by the debris cloud was noticed as seen in Figure 1.

Observatory (MPC code)	Instrument
Bootes 1-B (Z00)	SC 30.0 f/10
Observatori de Pujalt (M04)	CDK 51 f/6.8

Table 1. Observatories involved in the follow-up.

Results and discussion: Our telescopes performed well in obtaining clear evidence for the increase in the visual magnitude of the Didymos system despite the challenging observing conditions. Few hours after DART's impact with Dimorphos the plume already delivered significant amount of micron-sized dust to the Didymos environment. This is nicely exemplified by Figure 1 in which we show two consecutive images taken the previous night and the night post-impact. On Sep 26.04 Didymos G magnitude was 14.3±0.1, while it increased to 13.1±0.1 magnitude on Sep. 27.04 using an aperture of 8 arcsec. Airmasses during the impact night varied between 5.7 and 3.1. In total 570 images were made, once every 10 seconds from 0h45 until 2h54 UTC.

Consequently, micron-sized dust was efficiently released as consequence of crater excavation [3]. We noticed it indirectly, as it produced a significative +0.8 G magnitude increase in the Didymos photometric signal. It means, as a direct consequence, that solar scattering increased due to the presence of a significant amount of fine-grained dust in the asteroid system surroundings just released in the impact plume [2-6]. The effects that an impact has on the close environment of an asteroid were previously studied in stochastic events like e.g. the experienced in 2010 by (596) Scheila [8].

Conclusions: We performed photometry of the post-impact magnitude of the Didymos system before and after DART's impact. This result makes us think about the nature of the materials released and our ability of producing dust in such type of deflection experiments. In addition, we also studied the evolution of the dust trail. An example is Figure 2 taken from M04 where the dust trail is distinguishable in P.A. ~295º. Even when DART team used the most sophisticated instrumentation to study the dust trail [3], our observations demonstrate that the effects on the asteroid system were also noticeable using medium-sized telescopes, making this type of deflection programs accessible to a wide general audience. This overall increased the outreach impact of the whole DART mission.

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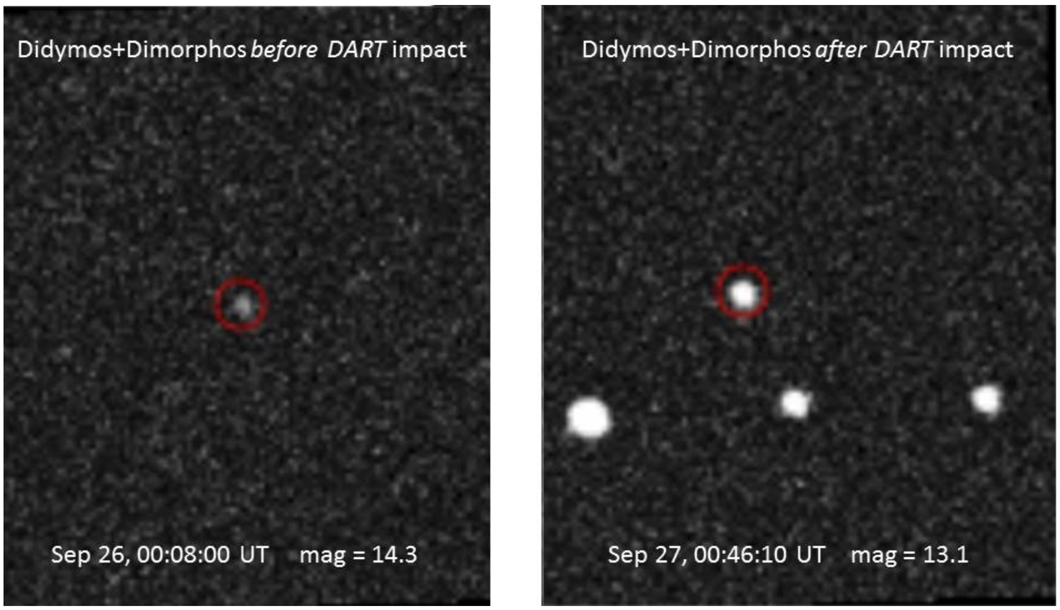

Figure 1. 65803 Didymos on Sep 26 and 27 from Z00. Red circle shows its location, and the magnitude increase is evident

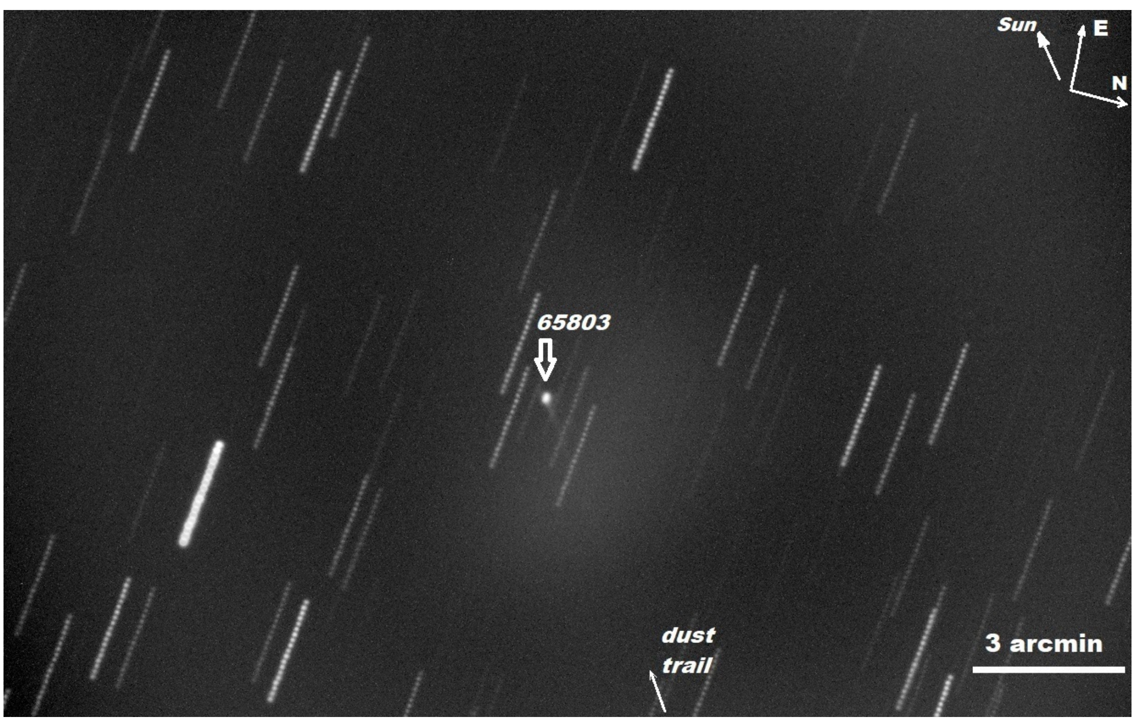

Figure 2. Image stack of 25 images of 60 s of exposure of (65803) Didymos system taken from M04 on Oct. 4th, 2022 from 3h02 to 3h50 UTC. The dust trail is clearly noticeable in the original and extended about 6 arcmin.