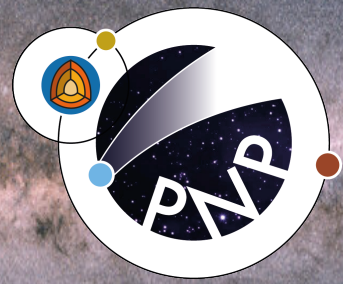
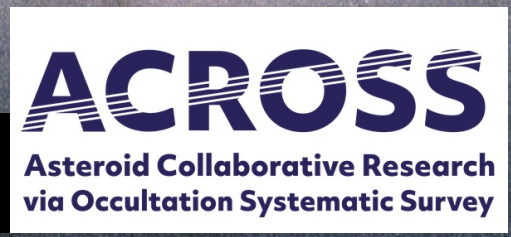
The best 2026 occultation opportunities by Didymos

April 16th (France, Sardinia . . .) & May 4th (Algeria)





Damya Souami and 100+ collaborators of whom many IOTA members across the Globe

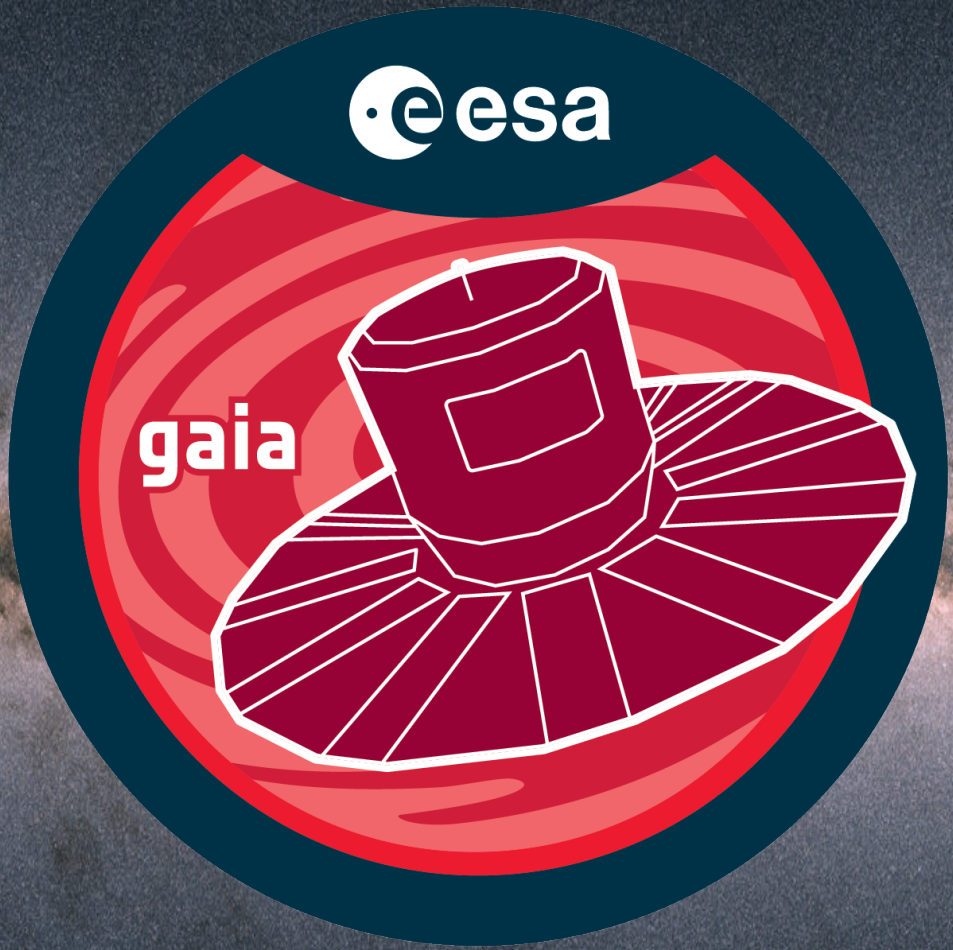
Slides' background, credit: *Gaia* (ESA) mission

Thank you to  members, at large!

OBSERVERS

R. Venable, D. Dunham, D. Herald, D. Gault, F. Marchis, H. Pavlov, N. Carlson, Z. Ioannou, M. Abbas, D. Baba Aissa, N. Al Badi, S. Al Balushi, S. Alfraisi, M. Ali-Dib, S. Almazroui, S. Alonso, O. Al Shammakhy, A, Asai, D. Baratoux, E. Barbotin, A. Benaida, T. Blank, J. Blecic, M. Bogosavljević, G.I. Boudiba, A. Boulkaboul, Z. Bouyahiaoui, G. Brabant, J. Broughton, A. Castillo, A. Cazaux, S. Cikota, K. Cobble, G. Correia, M. Dahmani Della, P. Dalba, D. Darson, J-L. Dauvergne, P. de la Fuente, D. De Nardo, V. de Ory, D. Díaz, J. Delgado, R. Dunford, J. Dunham, S. Els, E. Fernández, J. Flores, K. Getrost, I. Gkolias, R. Gonçalves, F. Garcia, N. Georgakarakos, N. Graciá, A. Gringahcene, J. Hanuš, T. Haymes, J. Jewell, R. Jones, M. Ida, K. Isobe, H Kasebe,B. Keeney, J. Keller, D. Khan, H. Kishimoto, K. Kitazaki, N. Kitazaki, N. Kretlow, V. Krishnamoorthi, G. Langin, R. Lambert, J. Lecachaux, T. Legault, A. Leroy, S. Leseche, B. Lott, R. Nolthenius, P. Maley, N. Manago, J.M. Madiedo, F. Marques, J.B. Marquette, A. Meade, S. More, J. Moore, N. Morales, M. N'Diaye, Y. Nakamura, T. Nagata, R. Nugent, N. Peixinho, S. Renner, A. Román, L. Rousselot, H, Sakashita, A. Salem Belal, M. Sánchez, C. Schnabel, A. Selva, A. Sergeyev, A. Shaji, N. Sioulas, E. Sohail, S. Sposetti, D. Suseelan, S. Sylla, M, Takimoto, A. Toliou, R. Trank, G. Tsirvoulis, M. Vara, V. Nitkin, G. Voyatzis, Hayato Watanabe, A. Wünsche, H. Yamamura, H. Yoshihara, J. Yuan, J. Zuazola, ...

First of all ...

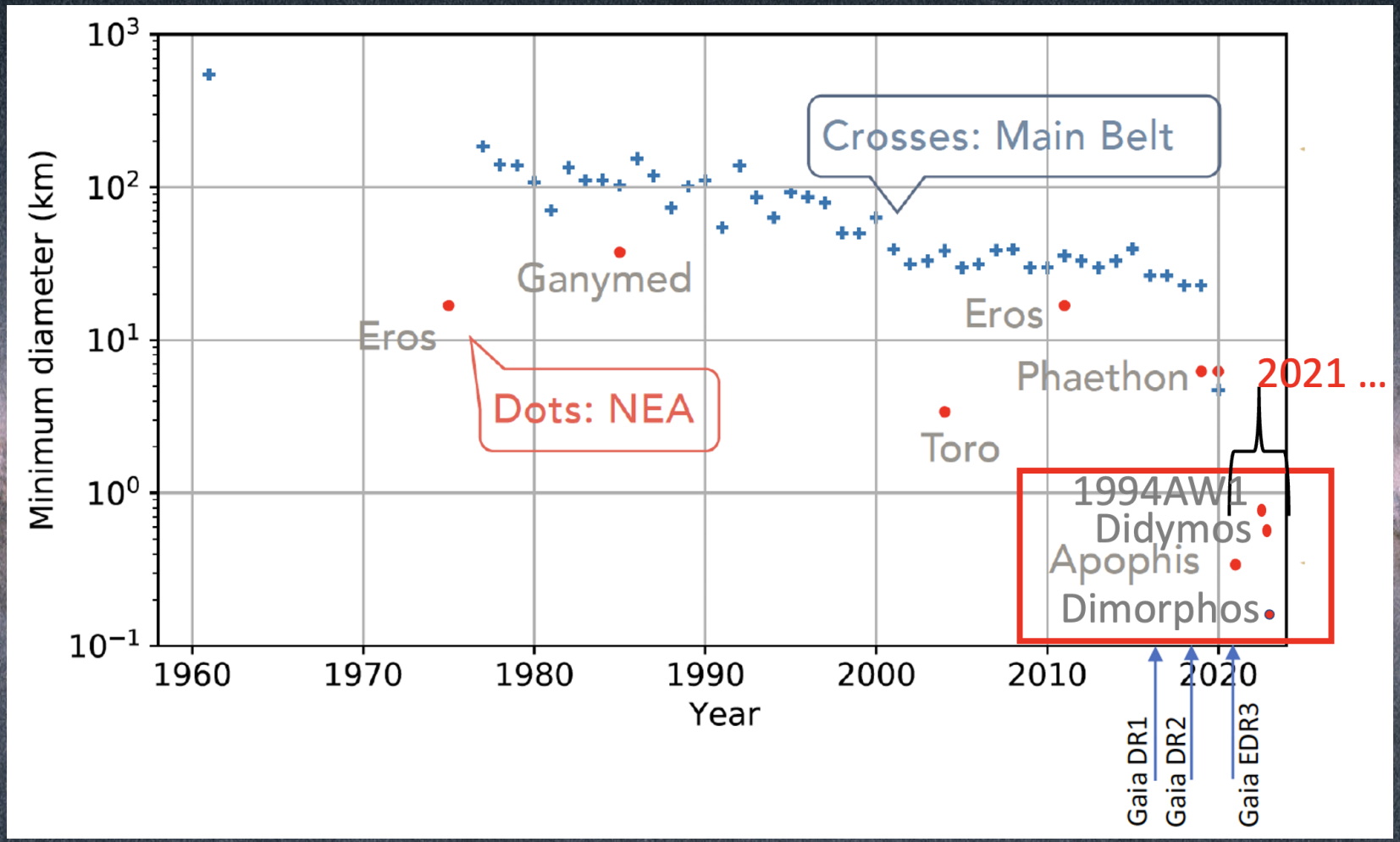


Thank you *Gaia*, for direct and indirect discoveries!

Structure

1. Introduction
2. AIDA - The first planetary Defence programme
3. Past Didymos occultations and lessons learnt!
4. The two 2026 (pre-Hera arrival) events

Introduction



January 1975: 1st occultation by an NEA (Eros)
March 2021: 1st occultation by a sub-km sized object – the NEA Apophis
→ marking the start of a new Era!

AIDA

(Asteroid Impact & Deflection Assessment)

(65 803) Didymos (1996 GT)

- NEA discovered in 1996, by the Spacewatch survey, Kitt Peak
- binary nature → in November 2003 (Pravec et al.,2003)

source:
https://planetpailly.com/2016/05/13/sciency-words-didymoon/

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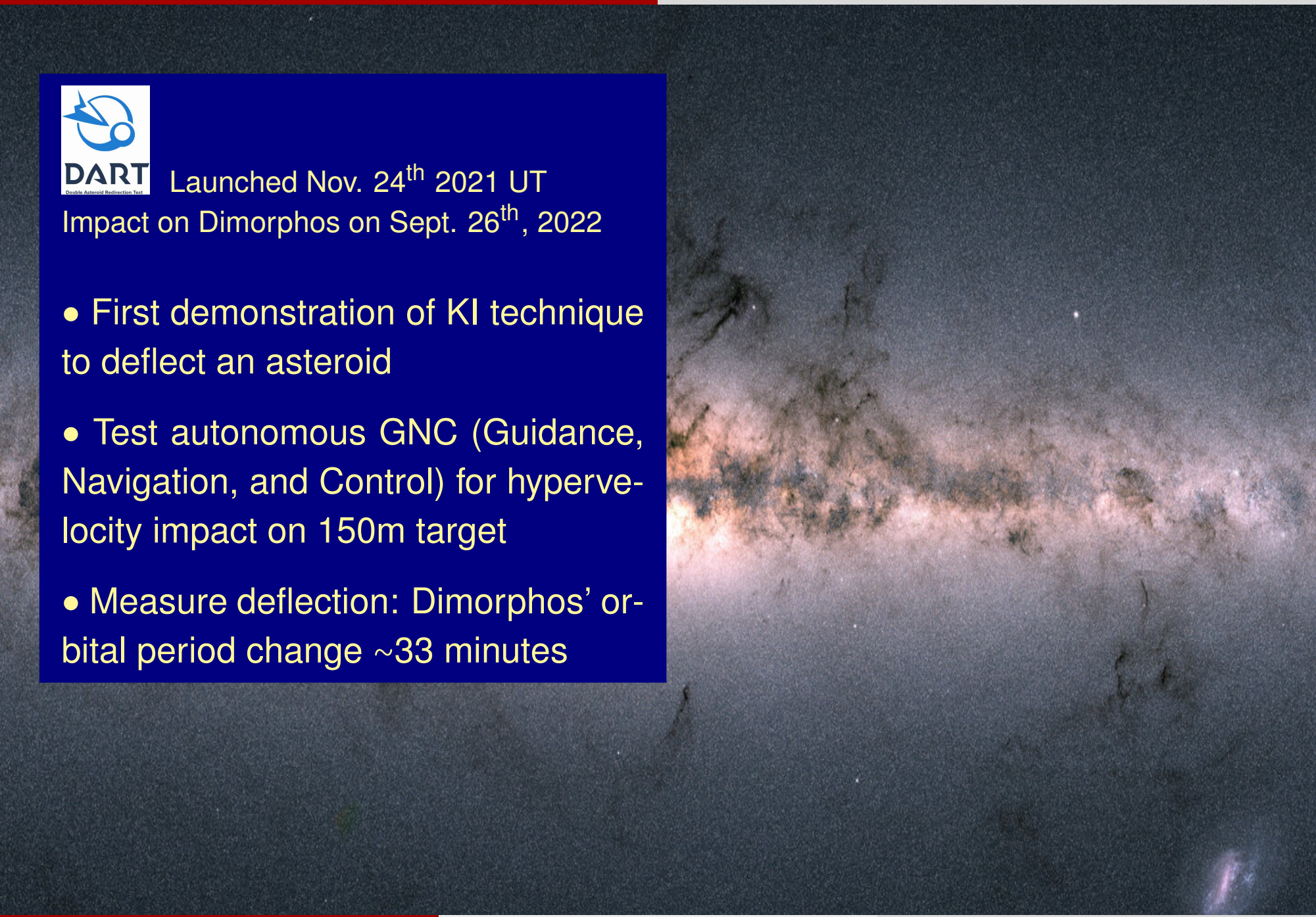
Target of AIDA (Asteroid Impact & Deflection Assessment) programme:

- **DART** - Double Asteroid Redirection Test *(NASA)*
  - kinetic impactor
- **Hera** mission *(ESA)*
  - observer spacecraft



DART Launched Nov. 24th 2021 UT
Impact on Dimorphos on Sept. 26th, 2022

- First demonstration of KI technique to deflect an asteroid
- Test autonomous GNC (Guidance, Navigation, and Control) for hypervelocity impact on 150m target
- Measure deflection: Dimorphos' orbital period change ~33 minutes

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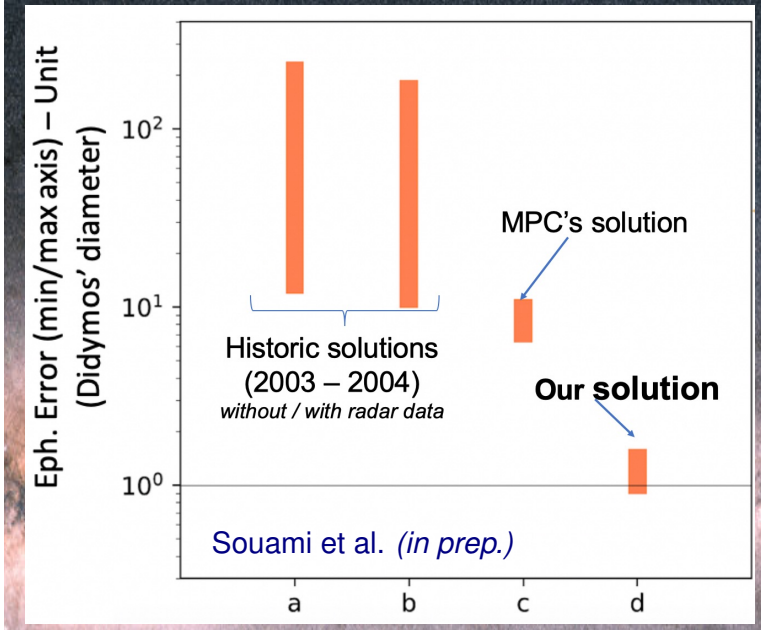
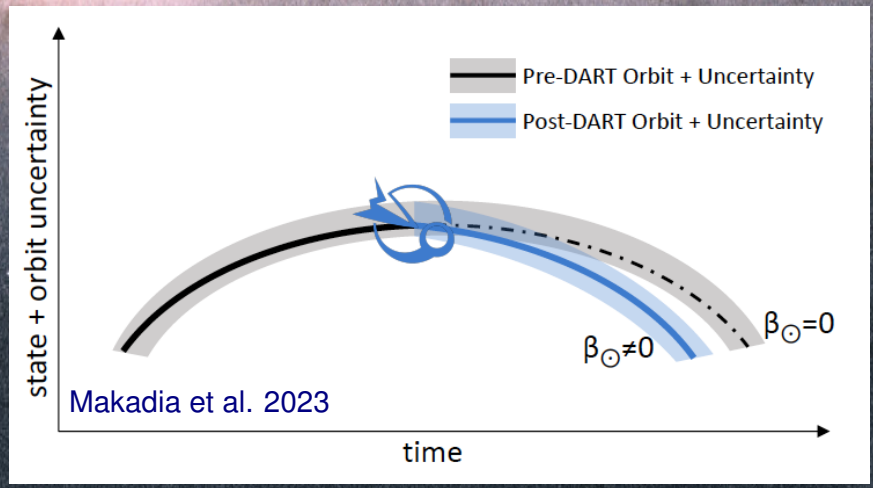
hera To be launched in Oct. 2024
Arrival at the Didymos system in 2026

- First precise measurement of deflection efficiency and Planetary Defence capability
- First binary asteroid and smallest asteroid ever visited
- First detailed measurement of small body cratering physics
- First deep-space CubeSat for very close asteroid inspection

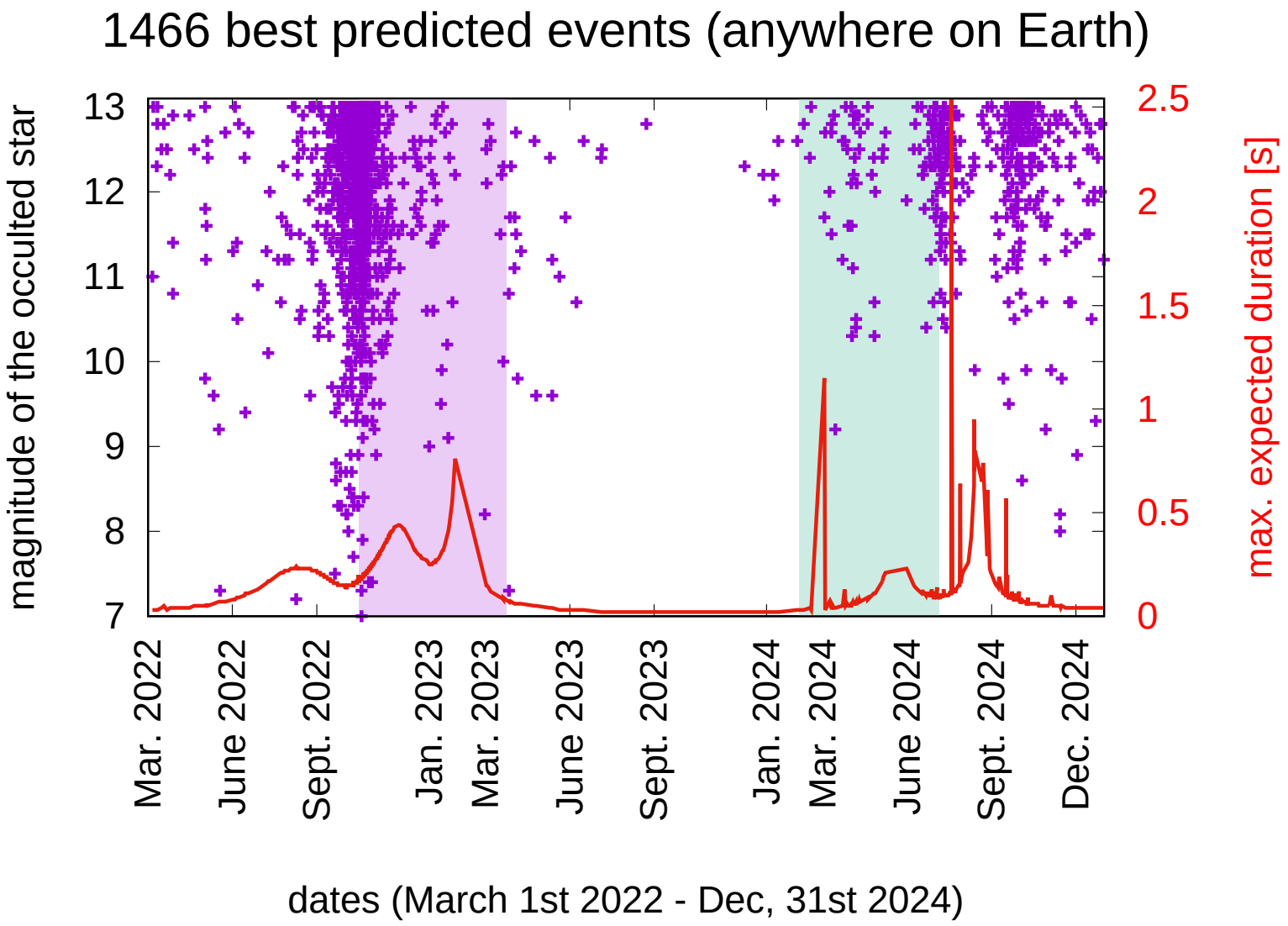
(65 803) Didymos-Dimorphos

source:
https://planetpailly.com/2016/05/13/sciency-words-didymoon/





Didymos occultation events

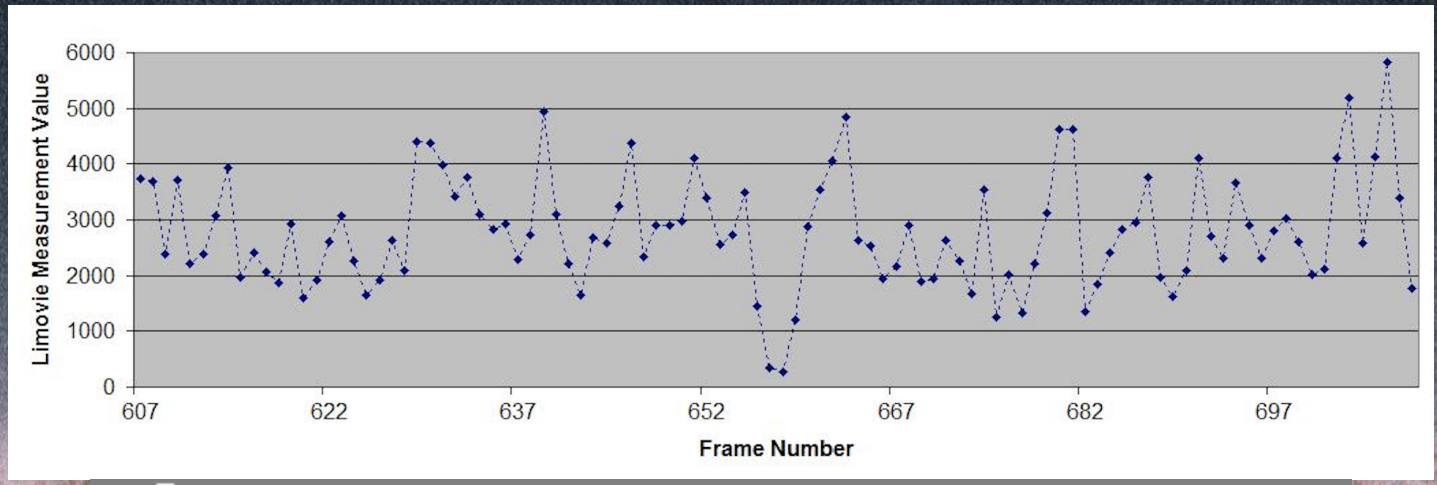


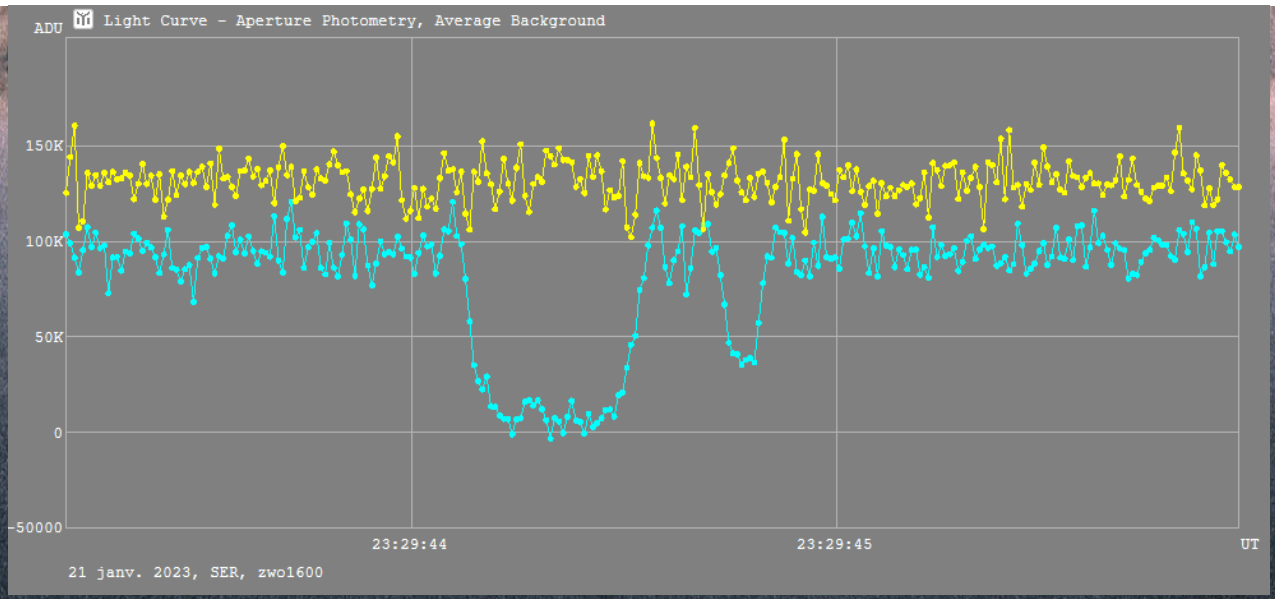
Season 1 – Didymos Occultation circumstances

Epoch (UT)	max. expected duration / mag. ↘	across path 1σ uncer. ($d_{Didymos}$)	Didymos' V. mag. / geocentric Δ (AU)	Stars' G mag.
*2022-10-15	0.15 s / 5.1 mag.	0.441	15.1 / 0.0796	10.34
2022-10-18	0.16 s / 3.0 mag.	0.354	15.3 / 0.0838	12.22
2022-10-18	0.16 s / 4.4 mag.	0.359	15.3 / 0.0849	11.20
*2022-10-19	0.17 s / 3.5 mag.	0.477	15.3 / 0.0859	12.14
2022-10-19	0.17 s / 3.2 mag.	0.478	15.6 / 0.0866	12.43
2022-10-21	0.18 s / 3.6 mag.	0.497	15.7 / 0.0897	11.82
2022-10-26	0.2 s / 4.3 mag.	0.496	15.6 / 0.099	11.32
2022-10-27	0.2 s / 4.0 mag.	0.521	15.7 / 0.1013	11.95
2022-10-27	0.2 s / 4.4 mag.	0.512	16.0 / 0.1021	11.59
2022-11-04	0.25 s / 3.3 mag.	0.073	16.2 / 0.1188	12.90
*2022-11-12	0.3 s / 4.8 mag.	0.104	16.3 / 0.1353	11.51
2022-11-14	0.32 s / 6.2 mag.	0.103	16.3 / 0.1395	10.15
2022-11-15	0.33 s / 4.7 mag.	0.322	16.4 / 0.1415	11.63
2022-12-17	0.29 s / 2.9 mag.	0.211	16.5 / 0.2136	**13.54**
2022-12-19	0.28 s/ 4.7 mag.	0.214	16.4 / 0.2186	11.73
2022-12-23	0.26 s/ 4.5 mag.	0.222	16.4 / 0.2312	11.97
2022-12-29	0.24 s/ 6.0 mag.	0.205	16.4 / 0.2523	10.56
2023-01-18	0.3 s/ 4.12 mag.	0.199	17.2 / 0.3565	13.04
*2023-01-21	0.36 s/ 8.5 mag.	0.206	17.4 / 0.3816	9.07

Some of the challenges encountered

2022/10/15 – USA – first +ve chord (Obs: Roger Venable), 10.34 mag., 0.15 s.





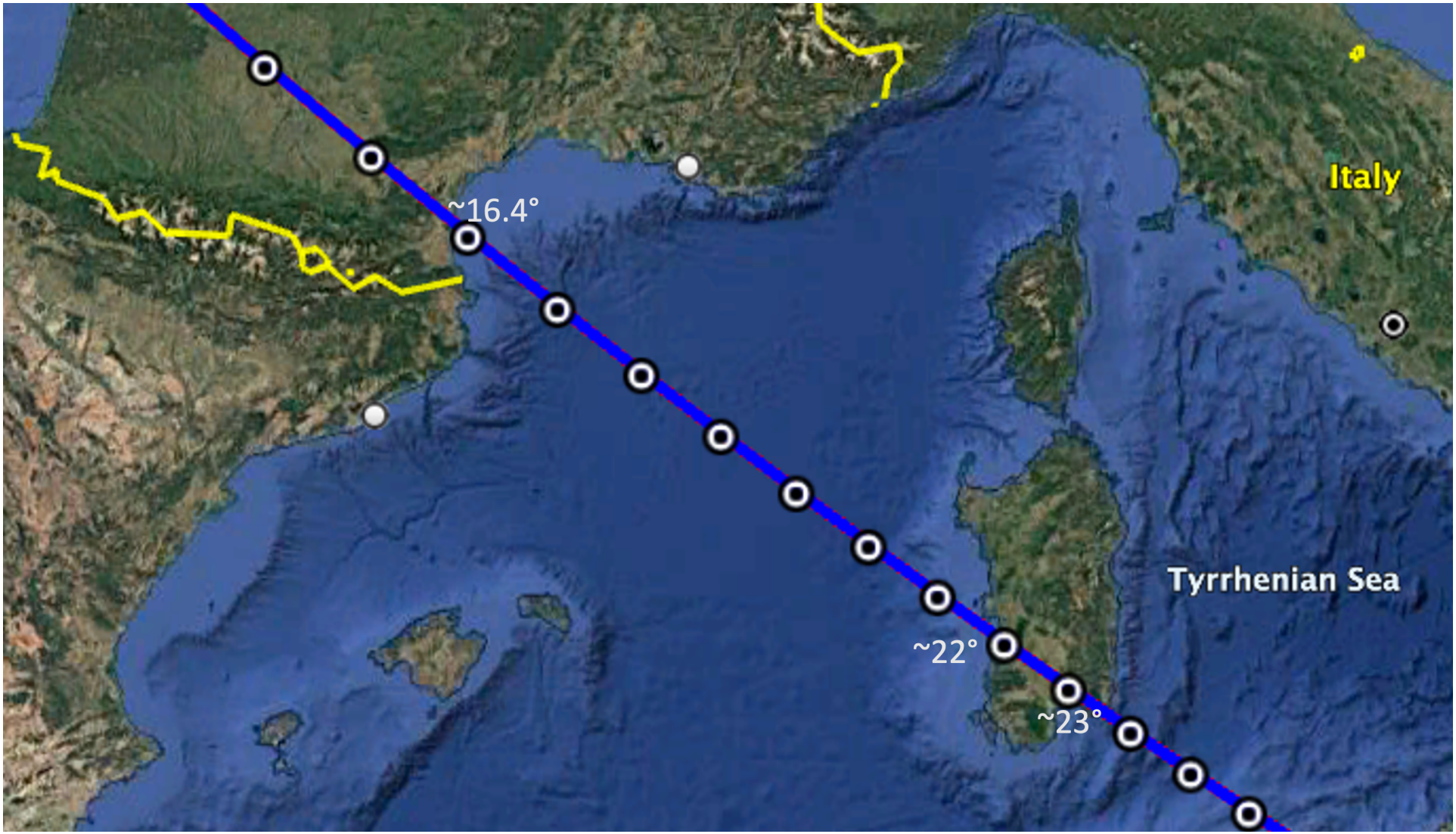
2023/01/21 – France (Obs: Lionel Rousselot), 9.07 mag., 0.36 s.

Lessons learnt & Gear Requirements

- Mobile stations
- Telescope's aperture
- Frame acquisition rate
- Timing requirements (GPS timing accuracy is by-far the most reliable)
  - cameras with integrated GPS antennas is by far the best option
  - time-boxes (external GPS antenna)
  - NTP synchronisation of your computer clock
  - alternative solution: use of a chronoflash.

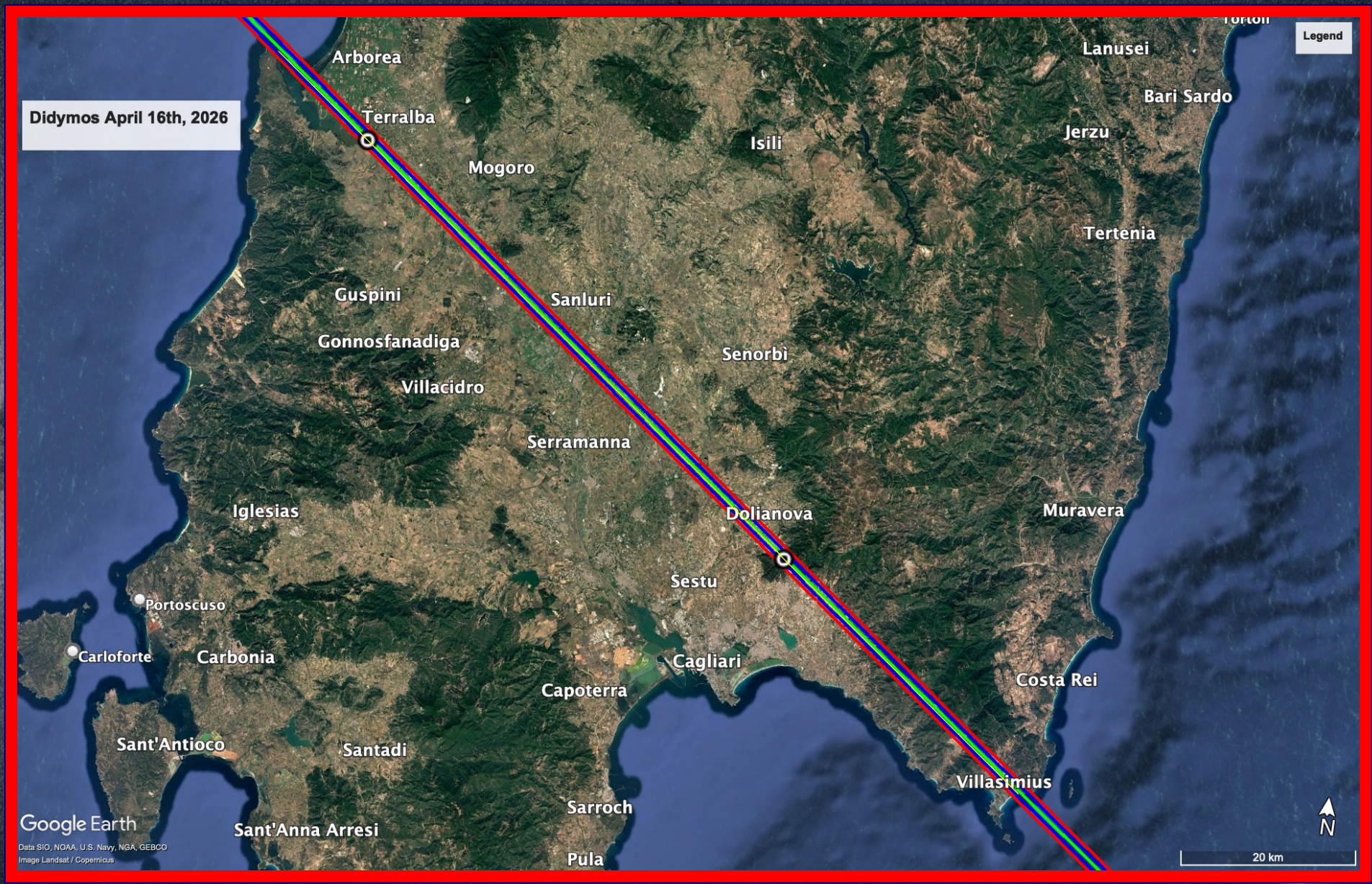
PRACTICE, PRACTICE, PRACTICE, AND MORE PRACTICE

April 16th, 2026 UT (night of Wednesday to Thursday)

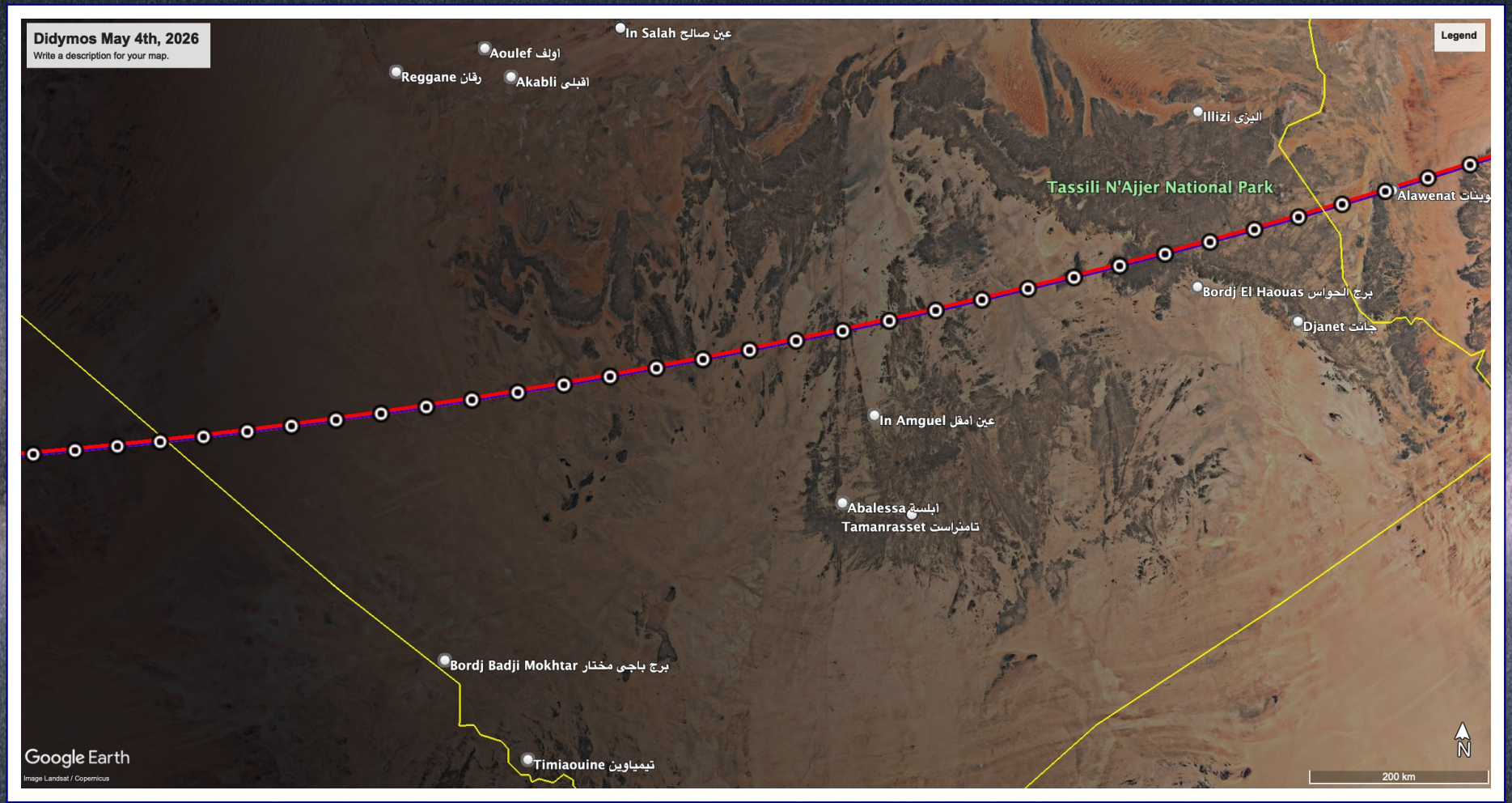


Star: 13.6 G mag., max. expected duration 0.35 s

Zoom onto Sardinia ...



May 4th, 2026 UT (night of Sunday 3rd to Wednesday)



Contrast for the SOLE purpose of better viewing the path (middle of the Sahara).

Star: 12 G mag., max. expected duration 0.19 s

Proposed plan of action

- Planning and logistics
  - recruiting observers
  - identifying additional equipment
  - identifying (for Sardinia) shipping equipment and strategies.

Last opportunities before Hera arrives @ Didymos.

Incentives / objectives

- keeping the high-accuracy astrometry to support Hera
  (both heliocentric orbit and mutual orbit)
- better determination of $\beta_\odot$,
- continue to push further the limits.

Thank you! Dziękuję !

ACROSS Campaigns

ACROSS FOR CITIZEN SCIENTISTS

Largest ACROSS (esa funded) campaign – Aug. 25th, 2022

Deployment: Algeria, Spain, Portugal w. 3, 7, & 21 stations, resp.

Porto team – North of Porto at *Vila Nova de Gaia*

Largest ACROSS (esa funded) campaign – Aug. 25th, 2022

Deployment around Porto