



University of  
**Southern  
Queensland**



Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

# 2024 Didymos Campaign

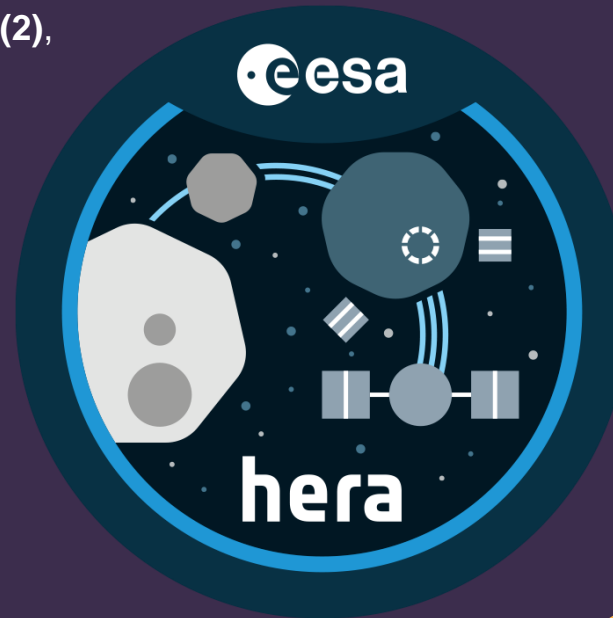
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(2) Centre for Astrophysics, University of Southern Queensland, Queensland, Australia,

# ACROSS

**Asteroid Collaborative Research  
via Occultation Systematic Survey**



# DART

Double Asteroid Redirection Test



# 65803 Didymos (r) and Dimorphos (l)

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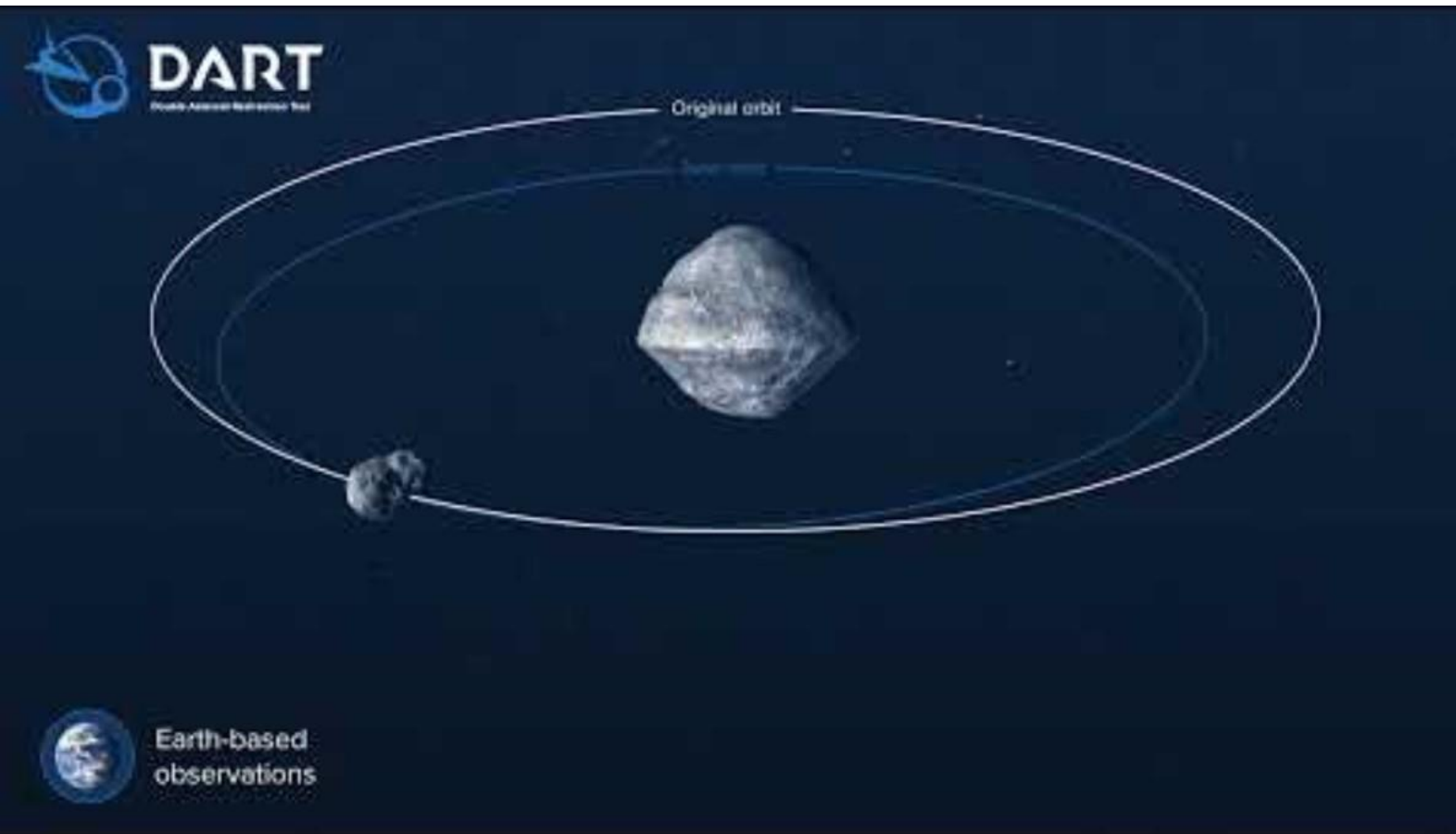
NEA 65803 Didymos (~850m) and  
satellite Dimorphos (~170m)

Dimorphos target of the DART  
mission and follow up LICIACUBE  
and HERA

# DART Mission

Hit satellite Dimorphos  
26<sup>th</sup> September, 2022

- Aim to discover effect of impactor on an asteroid.
- Followed by
- Original orbit time 11 hours and 55 minutes
- Impact reduced by ~33 minutes
- Followed by LICIACube



# Hera mission

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ESA mission

Launching in October 2024

Arrive December 2026

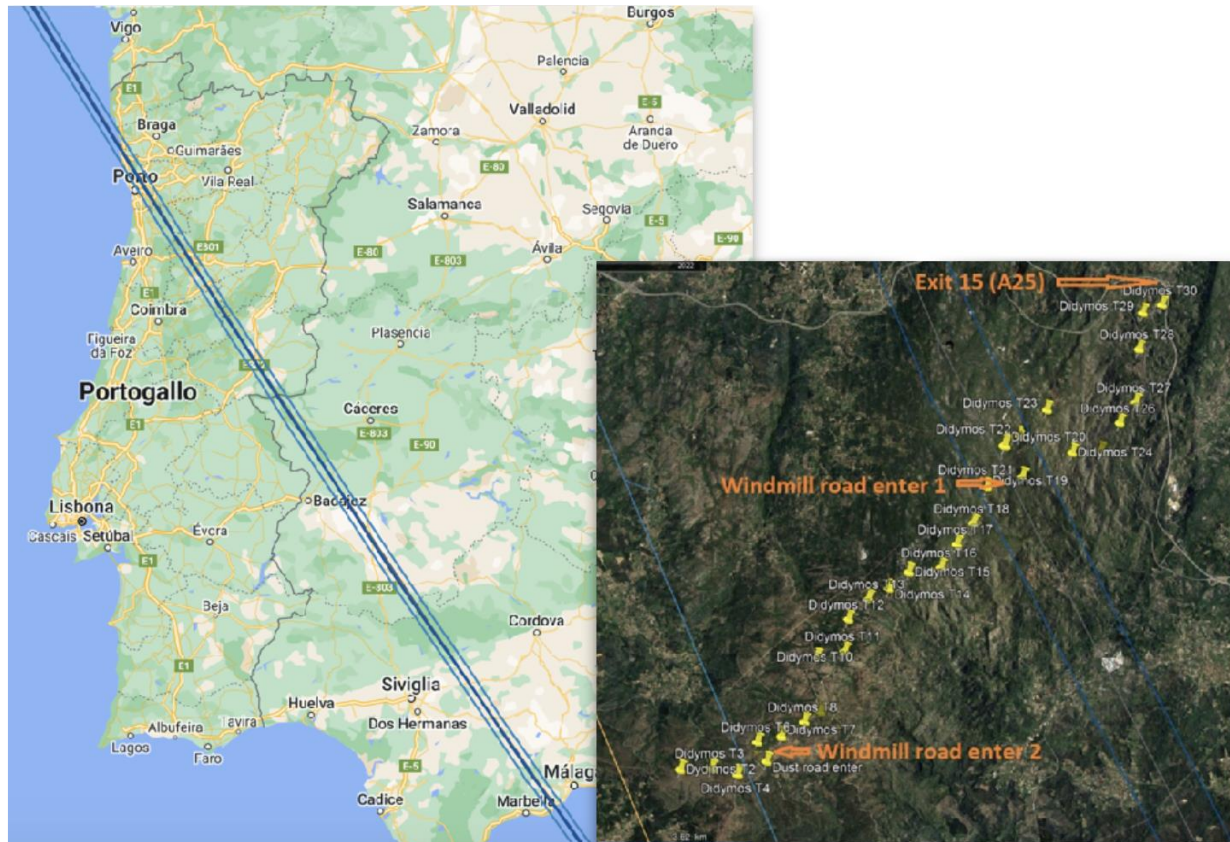
Evaluate the impact of DART

- Deploy two CubeSats
- Cameras on board to document the results of the impact



# ACROSS Campaign

Porto Spain,  
Largest ACROSS ( funded) campaign – Aug. 25th, 2022  
Deployment: Algeria, Spain, Portugal w. 3, 7, & 21 stations.



- Before impact  
Observations' period June. 15<sup>th</sup>, 2022 - Sept. 25<sup>th</sup>, 2022  
Stars' G. mag. 7.0 to 11.0 mag.  
Max. expected durations 0.01 s to 0.13 s  
Outcome 5 attempts: 3 bad weather, 2 unsuccessful
- After impact:  
Observations' period Oct. 15<sup>th</sup>, 2022 - Mar. 22<sup>nd</sup>, 2023  
Successful outcomes 20 for Didymos, 4 of which with Dimorphos  
Stars' G. mag. 9.0 to 13.5 mag.  
Max. expected durations 0.15 s to 0.39 s

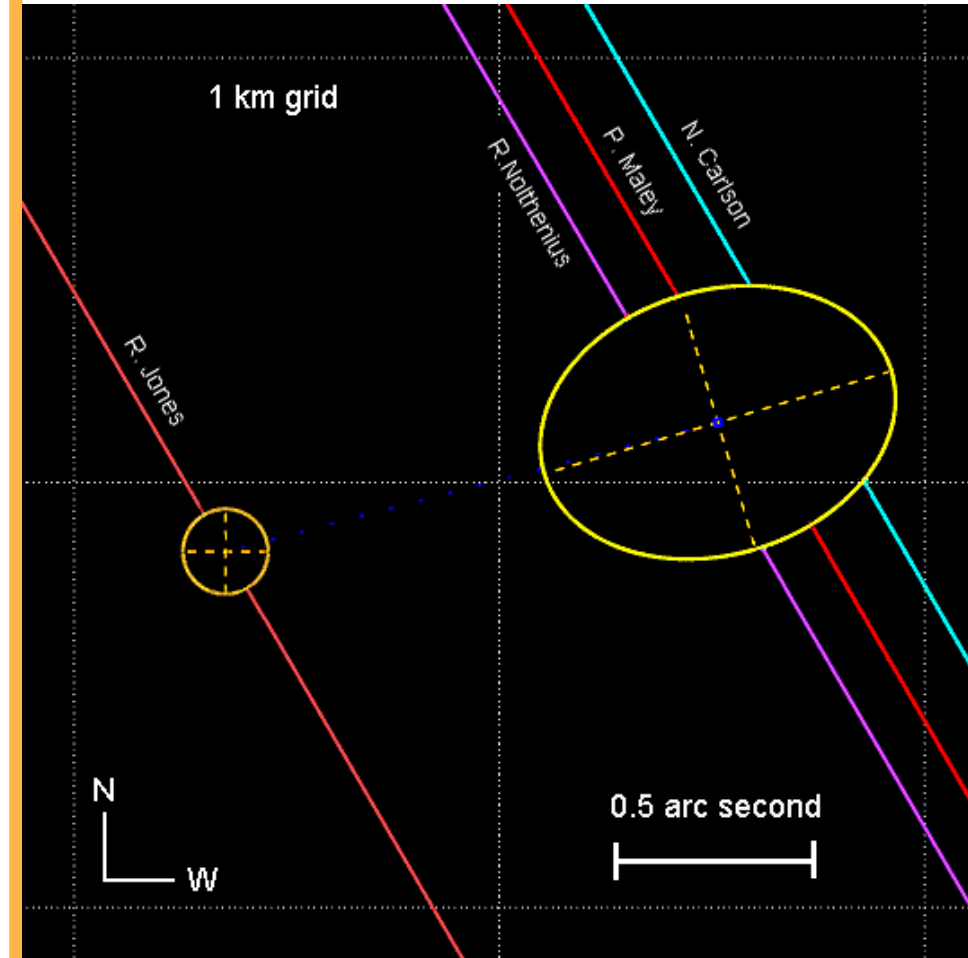
# ACROSS Campaign

## Challenges

- The dispersion of the initial orbital solution
- The very short durations, mostly between 0.07 s and 0.21 s
- Very few events involving bright stars <12
- The ability to deploy enough mobile stations equipped with fast cameras ...
- non-homogeneous distribution of observers across the globe!
- Accounting for topography in the prediction and deployment

## So far:

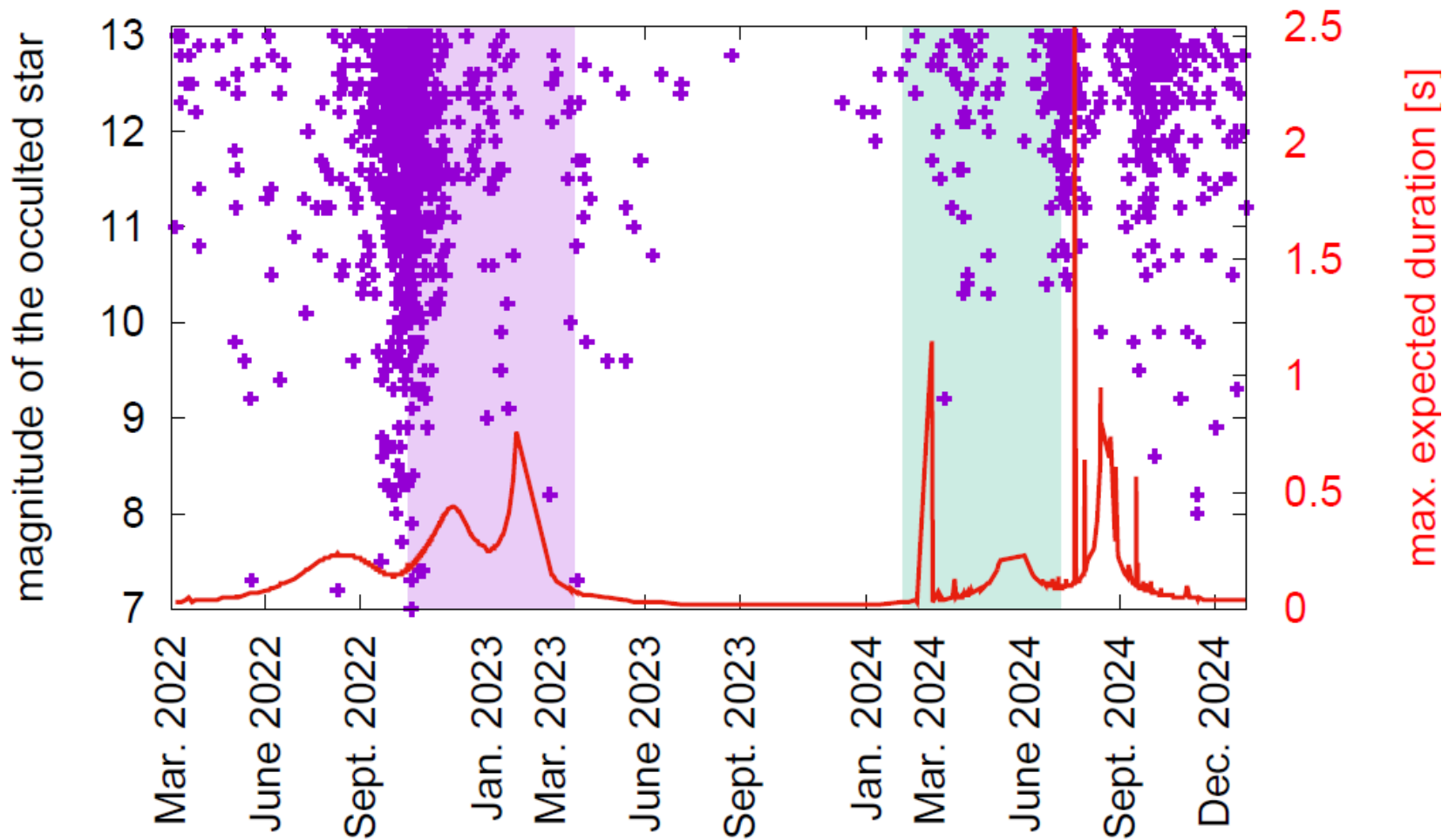
- an amazing ProAm adventure
- 20 successful occultations by Didymos
- dramatically reduced the orbital uncertainties
- improving the accuracy of the heliocentric momentum enhancement parameter  $\beta_{\odot}$  (Makadia, et al. 2024, PSJ)



2022/11/12 – USA

Third detection of both components

## 1466 best predicted events (anywhere on Earth)



dates (March 1st 2022 - Dec, 31st 2024)

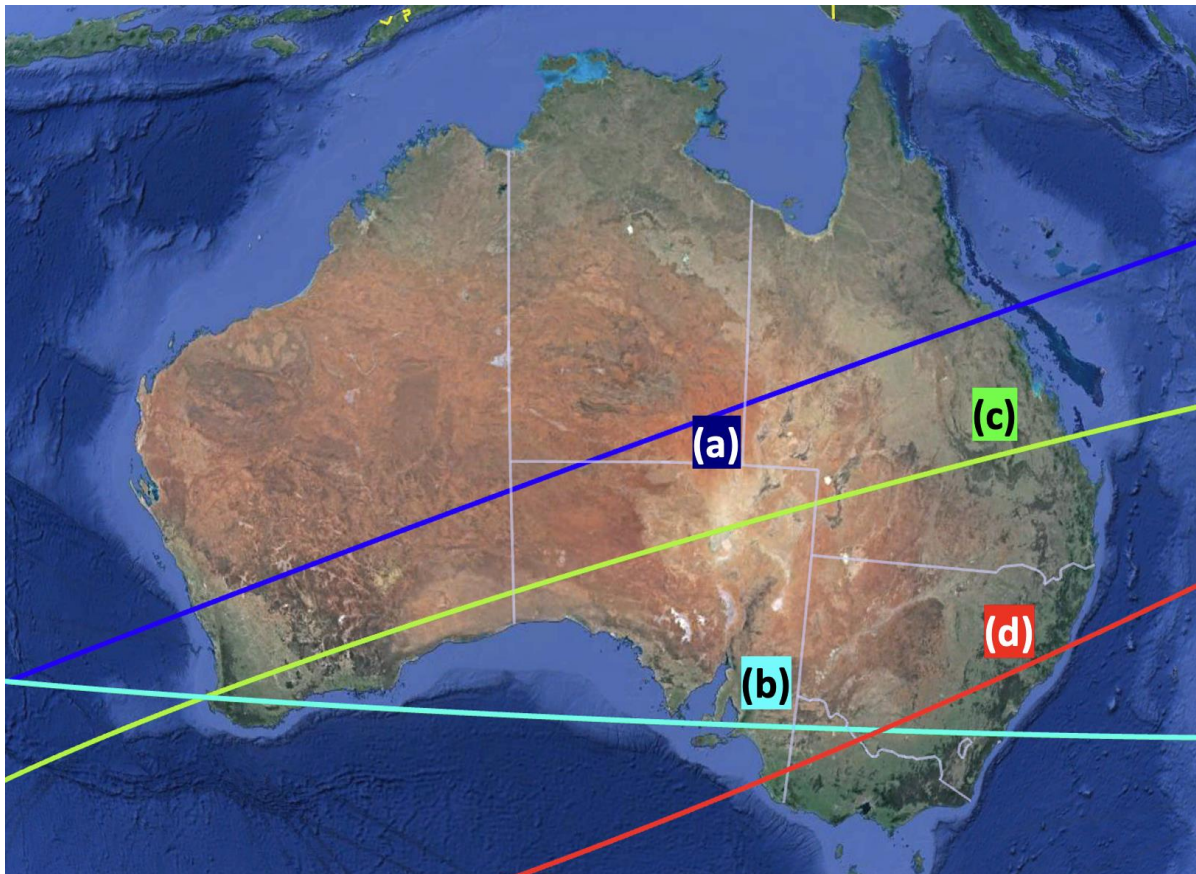
# 2024 Campaign

## Objectives

- keeping the high-accuracy astrometry to support Hera
- (both heliocentric orbit and mutual orbit)
- better determination of  $\beta_{\odot}$ ,
- refining the 3D shape model.

## Circumstances

- mostly observable from the southern hemisphere!
- a handful of events in Europe and North America (most at low elevations),
- non-homogeneous distribution of observers!

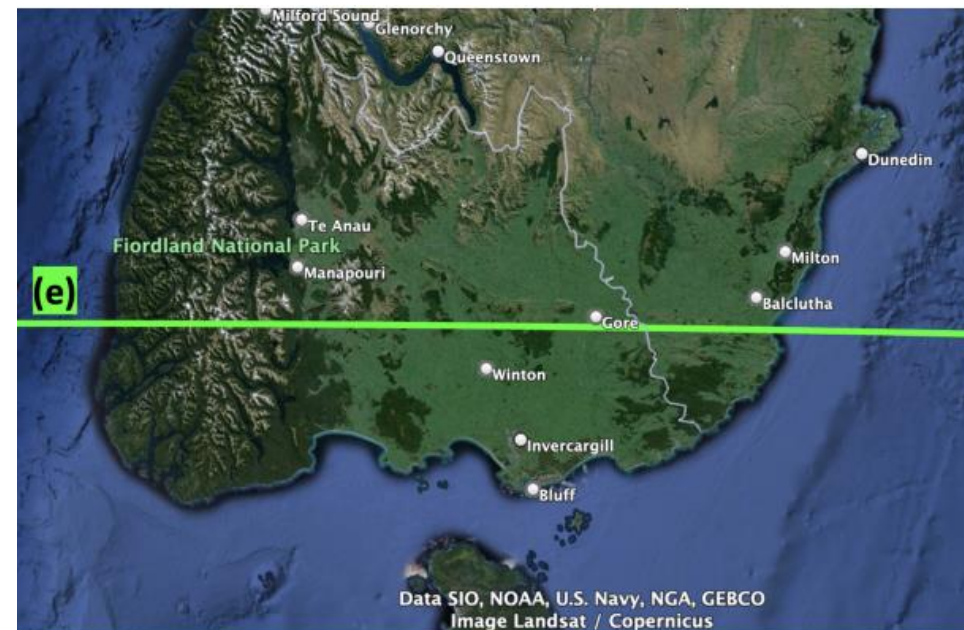
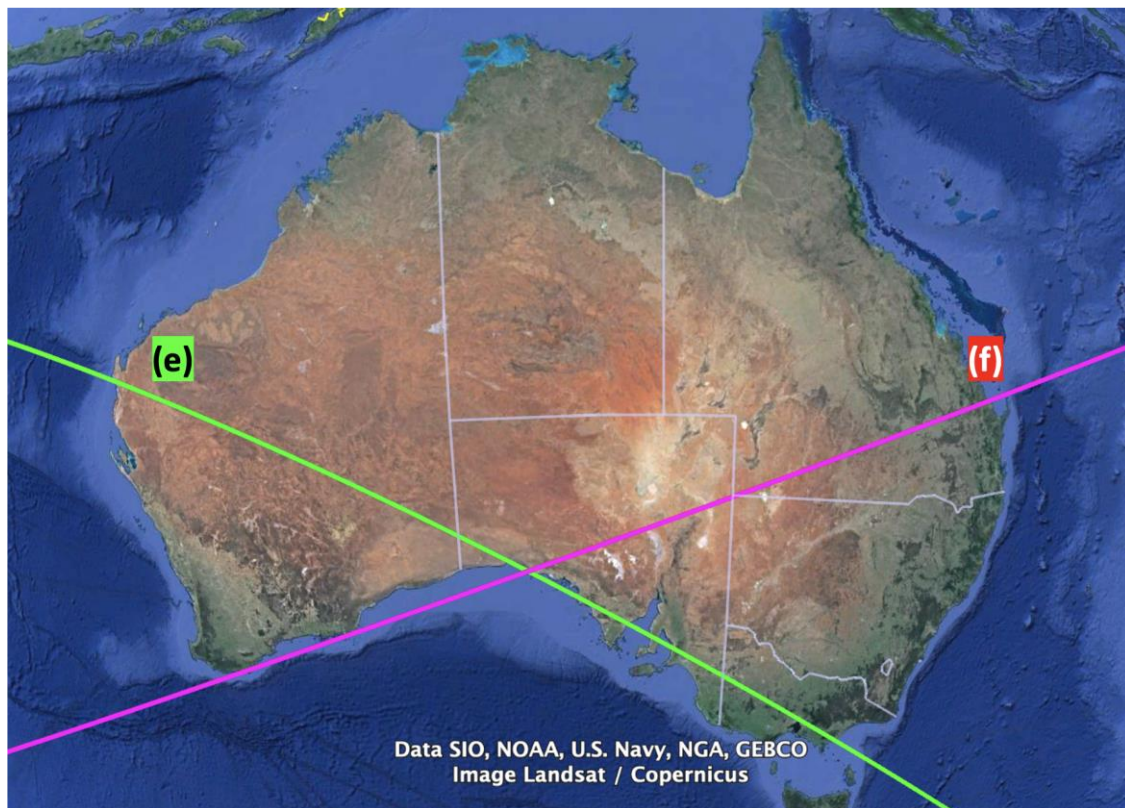


# Best events

Epoch (UT)	Stars' G mag.	max. duration	max. drop	geographic region	interactive sky chart (lab.)
2024-05-31 T15:22	11.8	0.21 s	6.43	<u>QLD</u> , NT, SA, WA	(a)
2024-08-10 T09:37	11.0	0.40 s	5.87	<u>NSW</u> , <u>VIC</u> , SA	(b)
2024-08-13 T13:02	6.7	0.74 s	9.47	<u>QLD</u> , SA, WA	(c)
2024-08-26 T13:38	11.4	0.29 s	6.03	<u>NSW</u> , <u>VIC</u> , SA	(d)



# Good events



Epoch (UT)	Stars' G mag.	max. duration	max. drop	geographic region	interactive sky chart (lab.)
2024-05-05 T15:25	10.9	0.17 s	8.62	<u>(VIC, SA, WA)</u> , & <u>(NZ)</u>	<u>(e)</u>
2024-06-05 T16:26	12.0	0.16 s	6.35	<u>QLD</u> , SA	<u>(f)</u>



# The challenge

Epoch (UT)	Stars' G mag.	max. duration	max. drop	geographic region	interactive sky chart (lab.)
2024-07-12	10.4	0.09 s	7.47	<u>QLD</u> , NT, WA	(g)

# Gear requirements

- You will need mobile telescopes, if you are off the path by 500m, and you are not mobile ...
- Timing requirements: GPS timing accuracy is by-far the most reliable, as the timing uncertainty cannot be larger than (or equivalent the exposure) time.
  - → The 1a solution: use of cameras with integrated GPS antennas is by far the best option.
  - → The 1b solution: time-boxes if you can (external GPS antenna, practice, practice, practice),
  - → The second best is NTP synchronisation of your computer clock,
  - → an alternative solution to be explored depending in your equipment is the use of a chronoflash.
- Telescope's aperture: for the brightest events, small aperture scopes can be used
- Frame acquisition rate: depending on the event, we would suggest at least 33Hz, however tests must be made



Observers' registration form  
(for coordination purposes)



# Plan of action

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- Planning and logistics
  - recruiting observers
  - identifying additional equipment
  - possibly shipping equipment document for observers
- Campaigns' coordination to maximise the return
  - Local coordinators working closely with the ACROSS team
  - always check the latest prediction
  - chords will be assigned
- **May 5th and 31st, and June 5th events are crucial to prepare for August**
- The last good opportunities to support Hera before it reaches Didymos
- Another great opportunity for the Australian community to support yet another space mission



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Observers' registration form  
(for coordination purposes)



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# Questions?

**Each observer, each institution is considered as a collaborator and is therefore a co-author to the scientific paper.**

In return, we ask that you communicate your results to us and not post them on social media.