Story of the Asteroid Spectral Imager ASPECT

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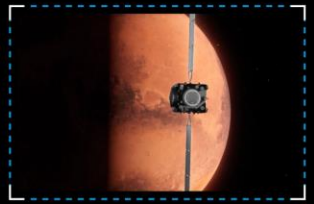
Space Business Forum

Hera mission

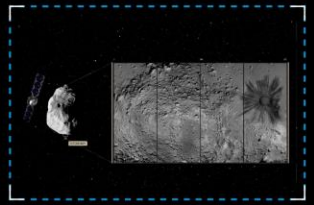
HERA LAUNCH IN OCTOBER 2024



MARS FLYBY

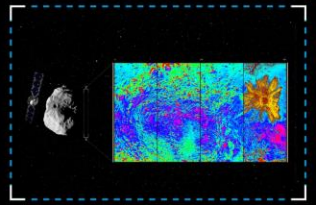
HERA CRUISING TO DIDYMOS

EARLY CHARACTERISATION PHASE
'Measuring dymorphos' mass and dynamics



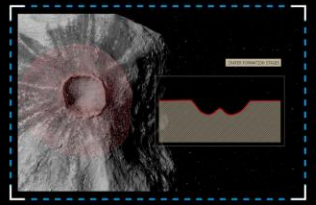
CUBESATS RELEASE

DETAILED CHARACTERISATION PHASE
Measuring Dimorphos
surface and interior properties



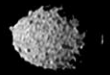
MULTI-POINT INVESTIGATION
OF DIMORPHOS

VERY LOW-ALTITUDE
DETAILED INVESTIGATION

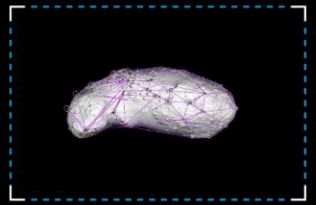


LANDING ON DIDYMOS
MISSION ENDS

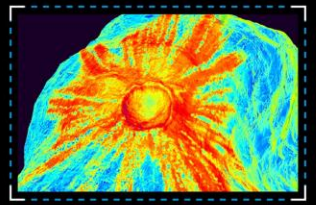
DIDYMOS



DIMORPHOS



AUTONOMOUS PROXIMITY
OPERATIONS DEMONSTRATION



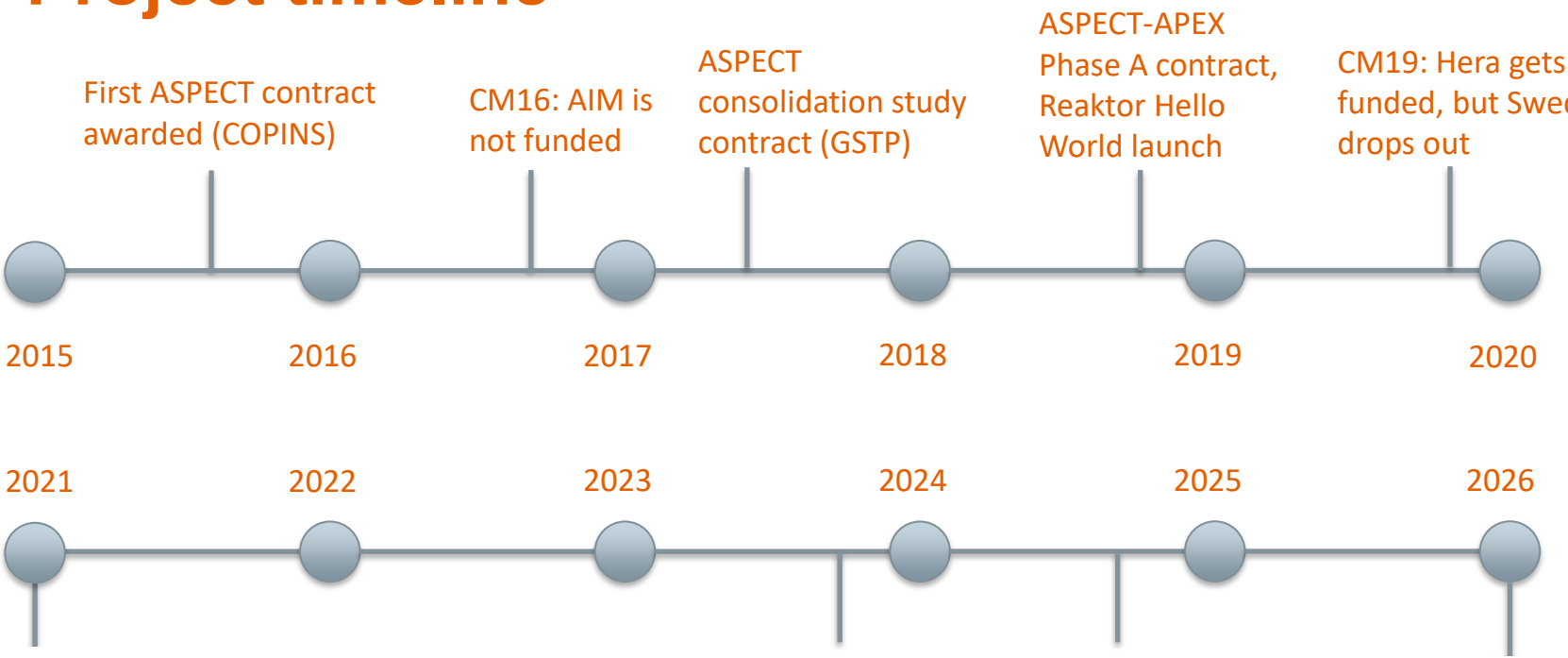
DETAILED CRATER INVESTIGATION

Asteroid Spectral Imager ASPECT

- Main payload of the Milani CubeSat onboard Hera
- ASPECT has three spectral cameras and one spectrometer
- Designed for mineral composition measurements, covering the spectral range 650 - 2500 nm

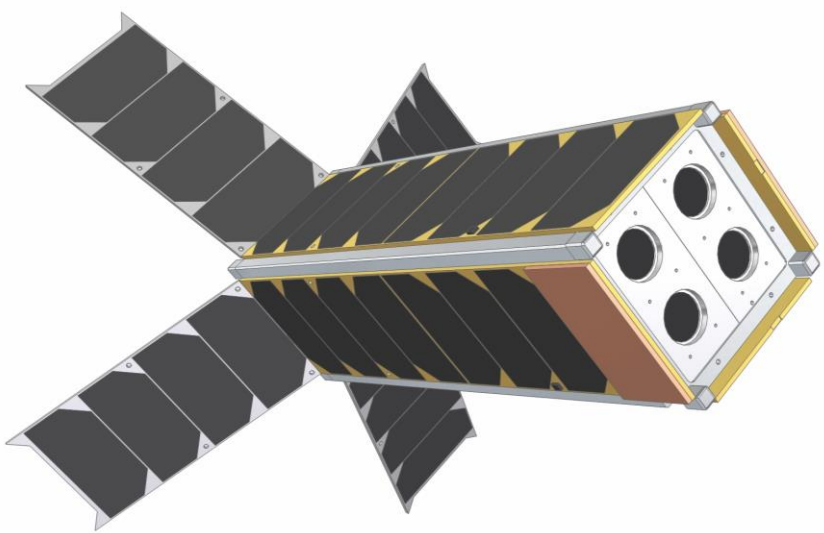
Channel	VIS	NIR1	NIR2	SWIR
Field of View [deg]	10°x10°	6.7°x5.4°	6.7°x5.4°	5.85° circular
Spectral range [nm]	650–900	850–1250	1200–1600	1650–2500
Image size [pixels]	1024x1024	640x512	640x512	1 pixel
Pixel size [µm]	5.5 µm x 5.5 µm	15 µm x 15 µm	15 µm x 15 µm	1 mm
No. spectral bands	Ca. 14	Ca. 14	Ca. 14	Ca. 30
Spectral resolution [nm]	< 20 nm	< 40 nm	< 40 nm	< 40 nm

Project timeline



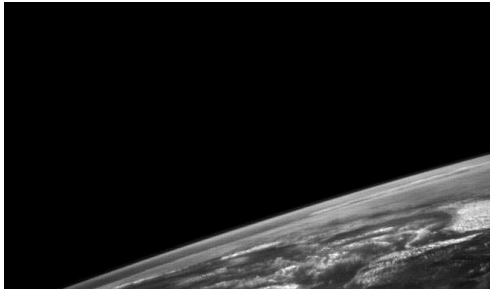
Original ASPECT

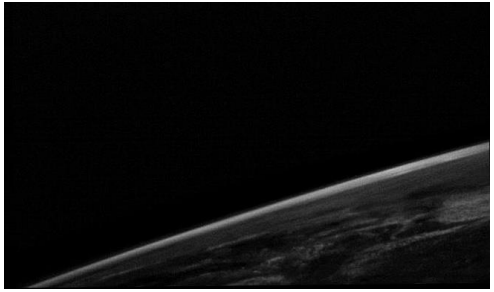
- Fully Finnish mission
  - Proposal by VTT, Aalto University and University of Helsinki
- Would have utilized a 3U CubeSat based on Aalto-1 and Aalto-2 heritage

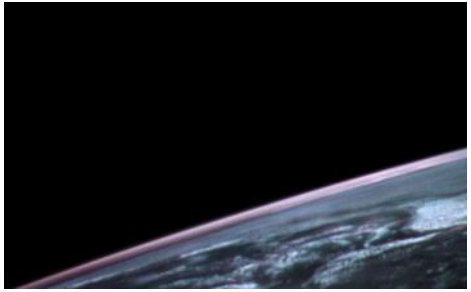


Original ASPECT

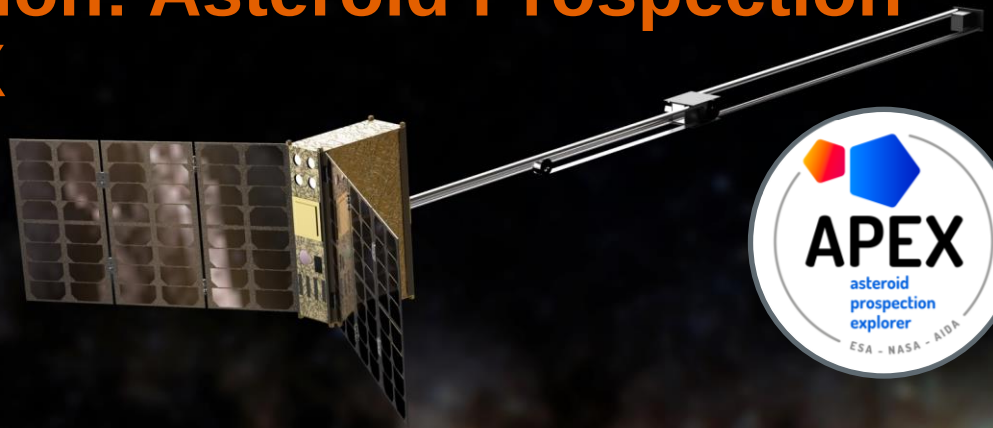
- Successful pre-cursor mission was launched with Kuva Space (Reaktor Space Lab) in 2018
  - First infrared spectral imager in a nanosatellite
  - Demonstrated the ASPECT NIR channel







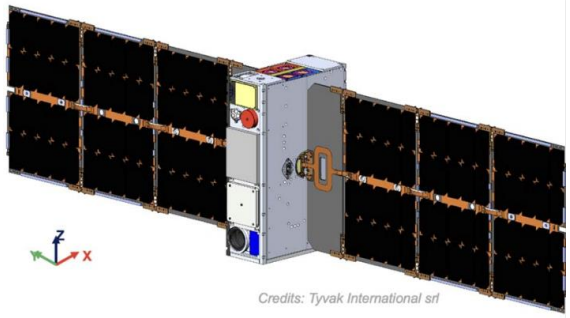
Second evolution: Asteroid Prospection Explorer APEX



- APEX was the combination of the Finnish and Swedish proposals for COPINS
  - Finnish-Swedish-Czech consortium
  - Included an Ion Analyzer and a magnetometer
- Cancelled because of the Swedish withdrawal

Realized project: Milani

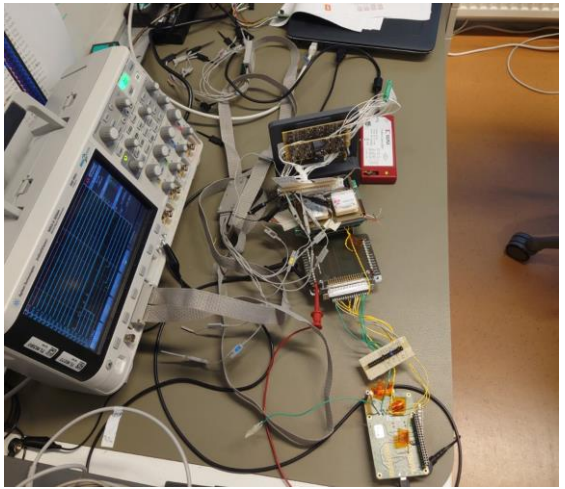
- Flight model project was finally funded by Italy, Finland and Czech Republic
- Tyvak International provided the CubeSat, Huld Czech Republic made most of the software and VTT, Kuva Space and University of Helsinki developed the payload
- Project kicked off in late 2020



Credits: Tyvak International srl

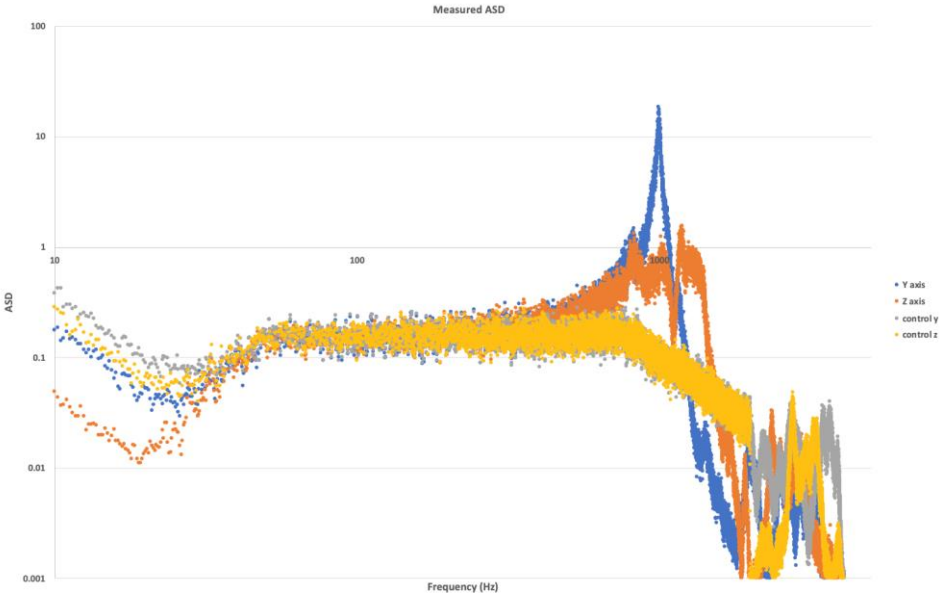
ASPECT development

- While the payload preliminary design had been completed, challenges in component availability and findings in the detailed design resulted in practically complete re-design
- Mission had a fixed launch date so extensions or delays were not possible
- Lack of development hardware was a huge problem



ASPECT development: test failures

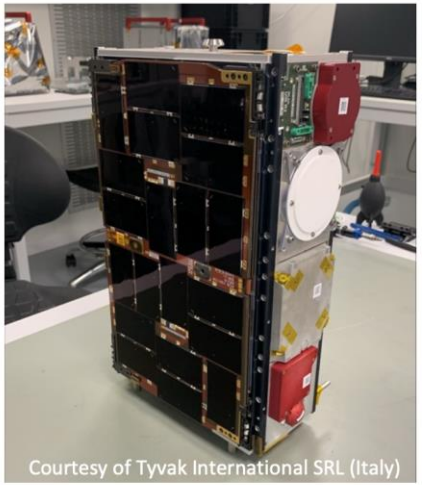
- Two major failures occurred in the qualification: Vibration failure and image readout failure in TVAC
- Vibration failure was caused by unforeseen vibration amplification at ca 1000 Hz
- Image readout malfunction was originally missed because everything worked at the extreme temperatures
- Both issues were resolved in the end



Successful delivery

- ASPECT was delivered in time for Milani integration
- The integration went smoothly and everything worked nominally in the end
- Final calibrations were performed with the integrated satellite in ESTEC few months before the launch
- Successful launch was achieved against all odds on October 7th

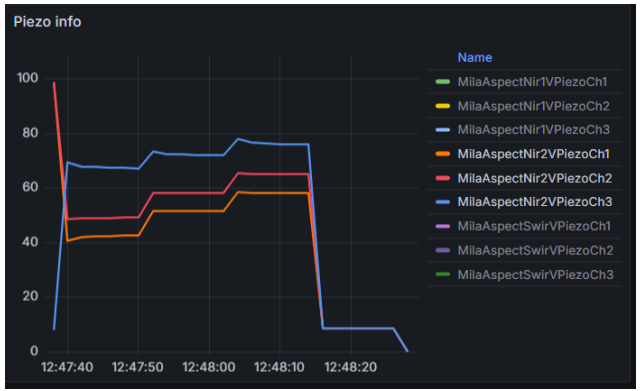
Team selfies with VIS and NIR

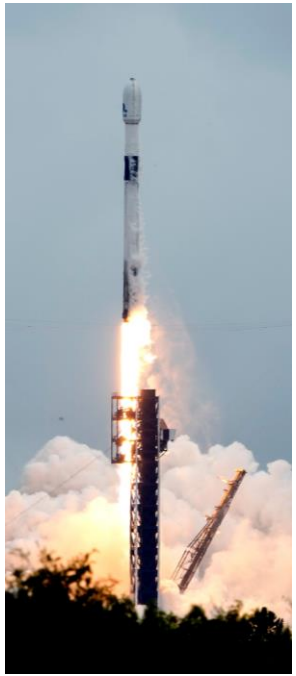


Integrated MILANI

Nominal operations in space

- First health checks in flight indicate fully functional payload
- Dark image acquisition test scheduled for this week
- Arrival to Didymos is scheduled in late 2026





Project summary

- Like in many space missions, the work has been divided to several projects / contracts
- While the overall instrument concept did not change very much, the ever-changing environment made it impossible to freeze the actual design
- Together with Covid-19 pandemic, this resulted in quite challenging project execution

Discussion

- Disrupted funding is a problem. If the project had started with the full funding already in 2016, the development probably would have been much smoother
- Final confidence in the design can only be achieved with fully integrated hardware
  - “It fits in the cad”
  - “It works on paper”
  - ”the EM works”
- All in all we succeeded in the end, which has led to new activities and prospects
  - Comet Interceptor and Ramses