

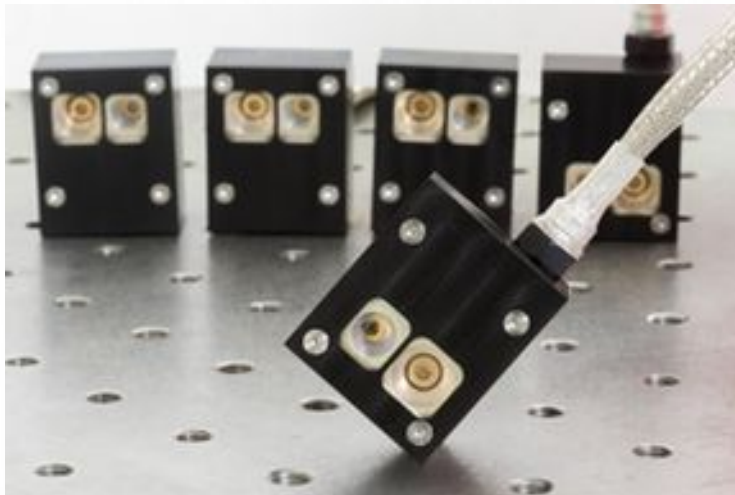


A multi-purpose, multi-spectral,
miniaturized payload for Hera, based on
the HyperScout-2 platform

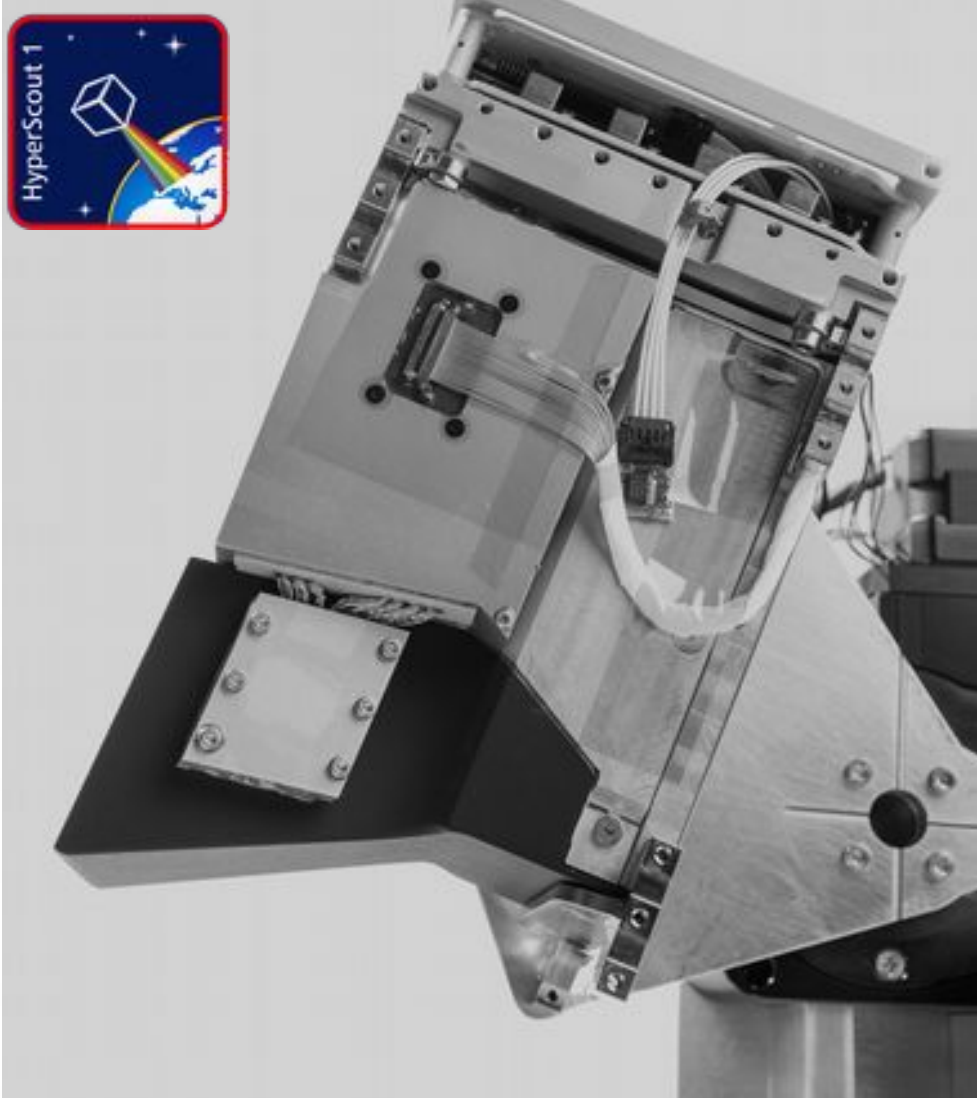
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Introduction

- ▶ cosine Remote Sensing Business Unit is active in the development of small size space optical instruments
- ▶ Wide experience in the context of missions to asteroids
 - Optical proximity sensors on board of the Mascot lander of Hayabusa2
 - TIRI Thermal Imager for AIM
- ▶ HyperScout - First miniaturized hyperspectral imager with on-board processing capabilities
- ▶ HyperScout-2 as technological platform for Hera mission

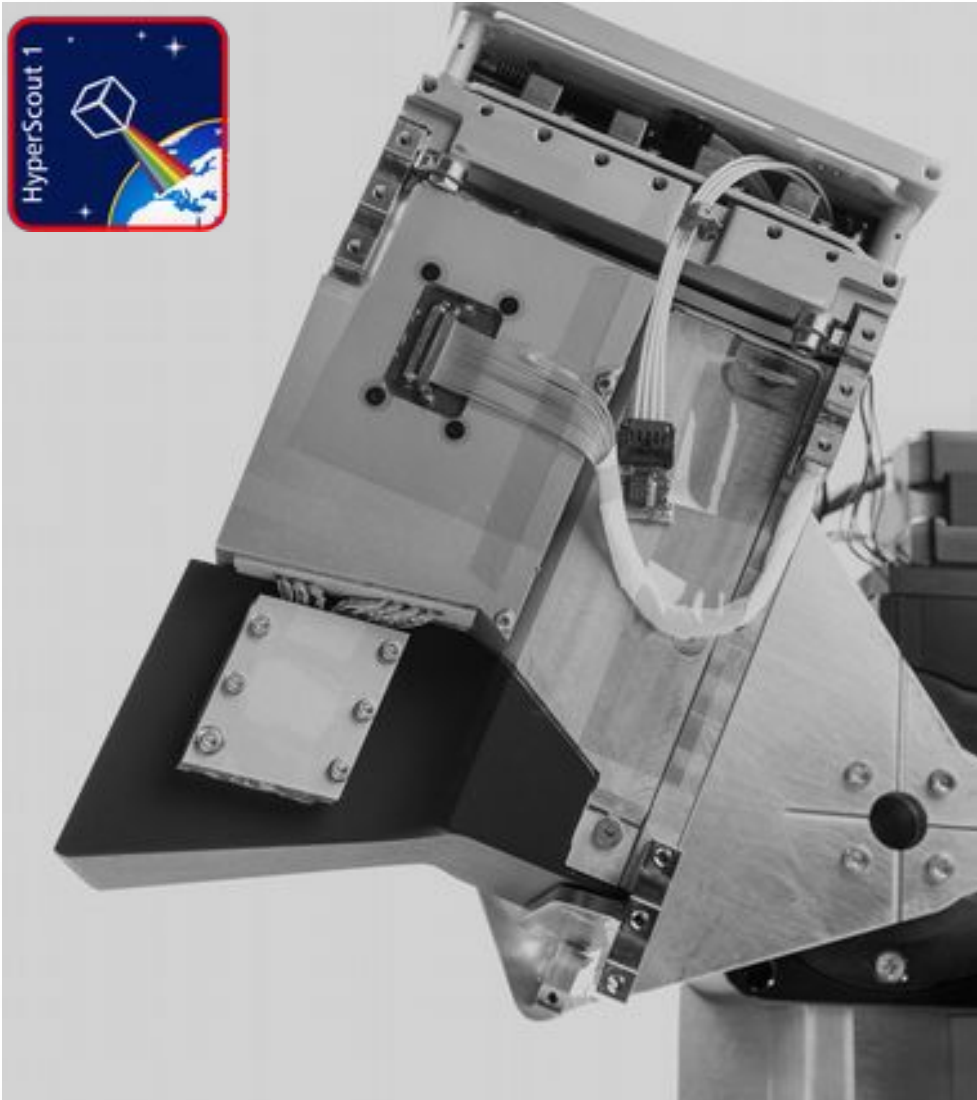


HyperScout®



- ▶ HyperScout-1 is the first ever 1.3 kg full-fledged hyperspectral camera.
 - provides full performance at a fraction of weight
- ▶ large field of view
 - high revisits with a few units deployed
- ▶ full processing chain
 - application parameter retrieved in orbit
- ▶ commercially available
 - Opens the door for commercial hyperspectral remote sensing on any size of satellite from nanosat on up

HyperScout®

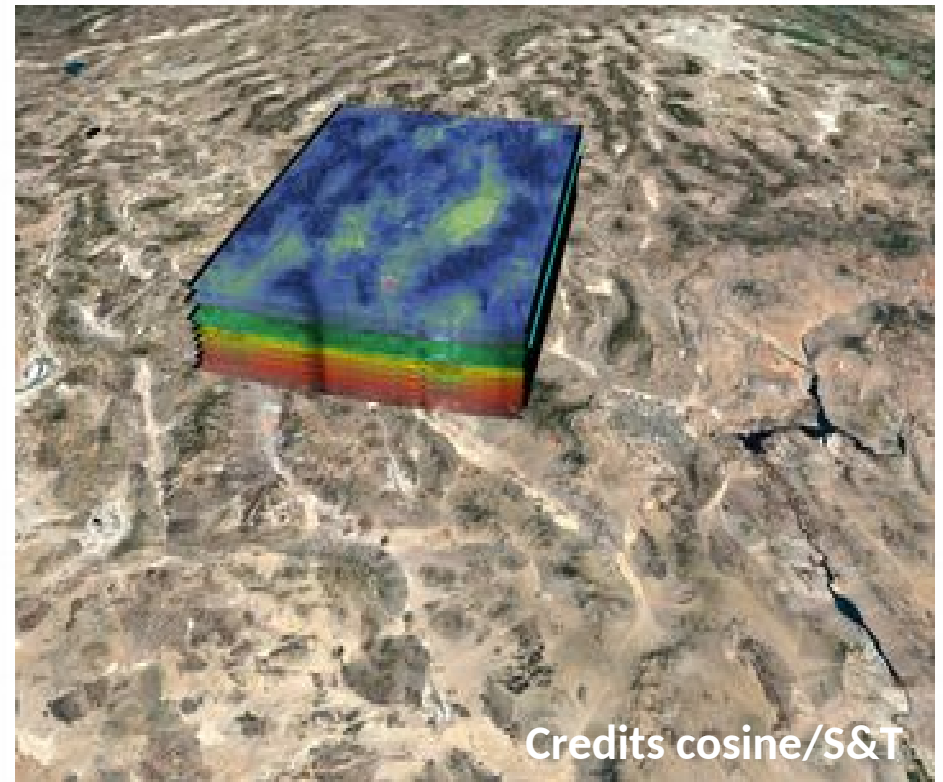


- ▶ hyperspectral for early warning
 - vegetation condition
 - crop water requirement
 - fire Hazard monitoring
 - flooding areas delineation
 - change detection of land cover and land usage

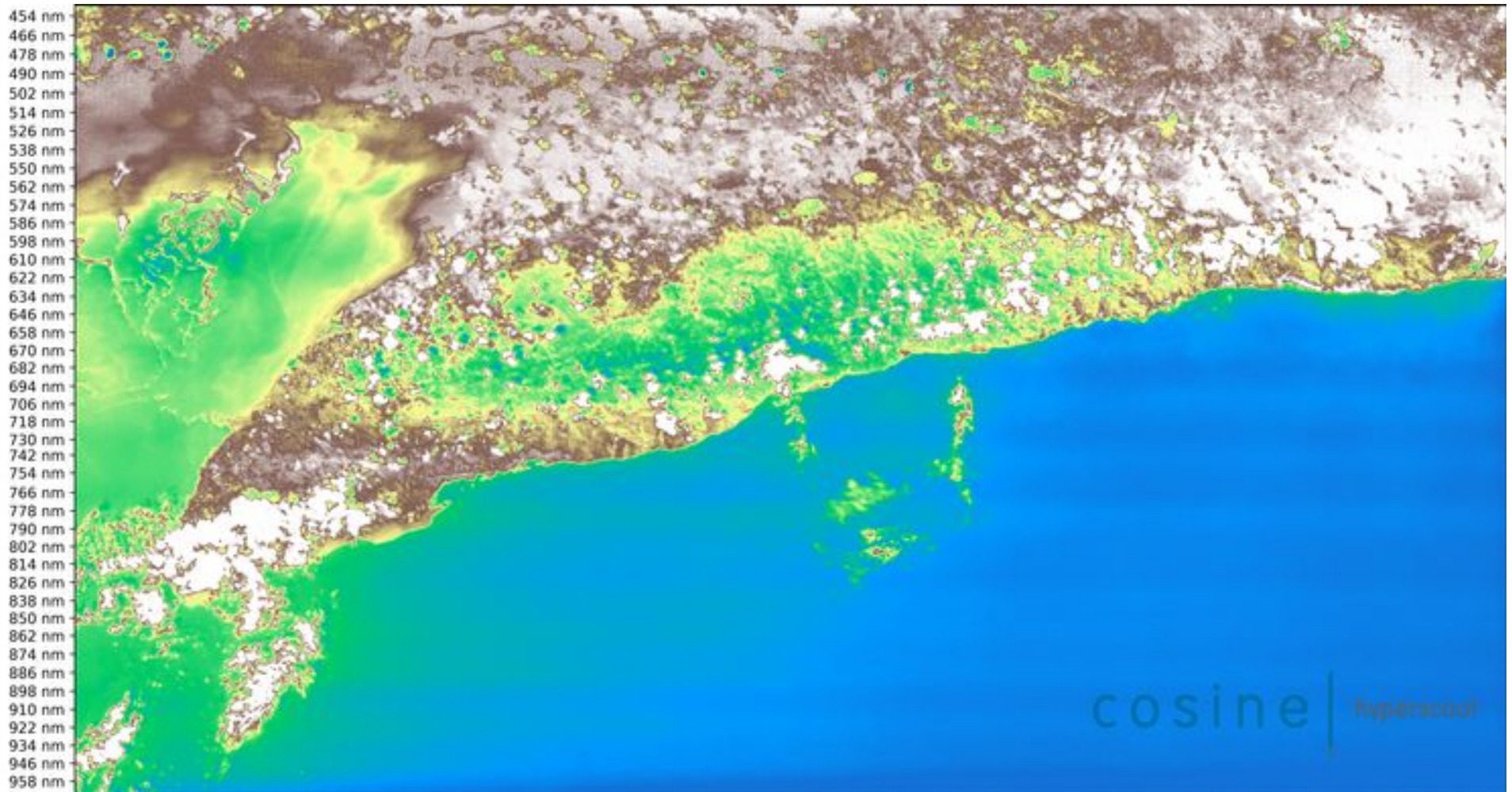
- ▶ modus operandi
 - target regions for selected applications
 - on-board data processing for data reduction by scene

HyperScout® | first in the world producing ARD in orbit

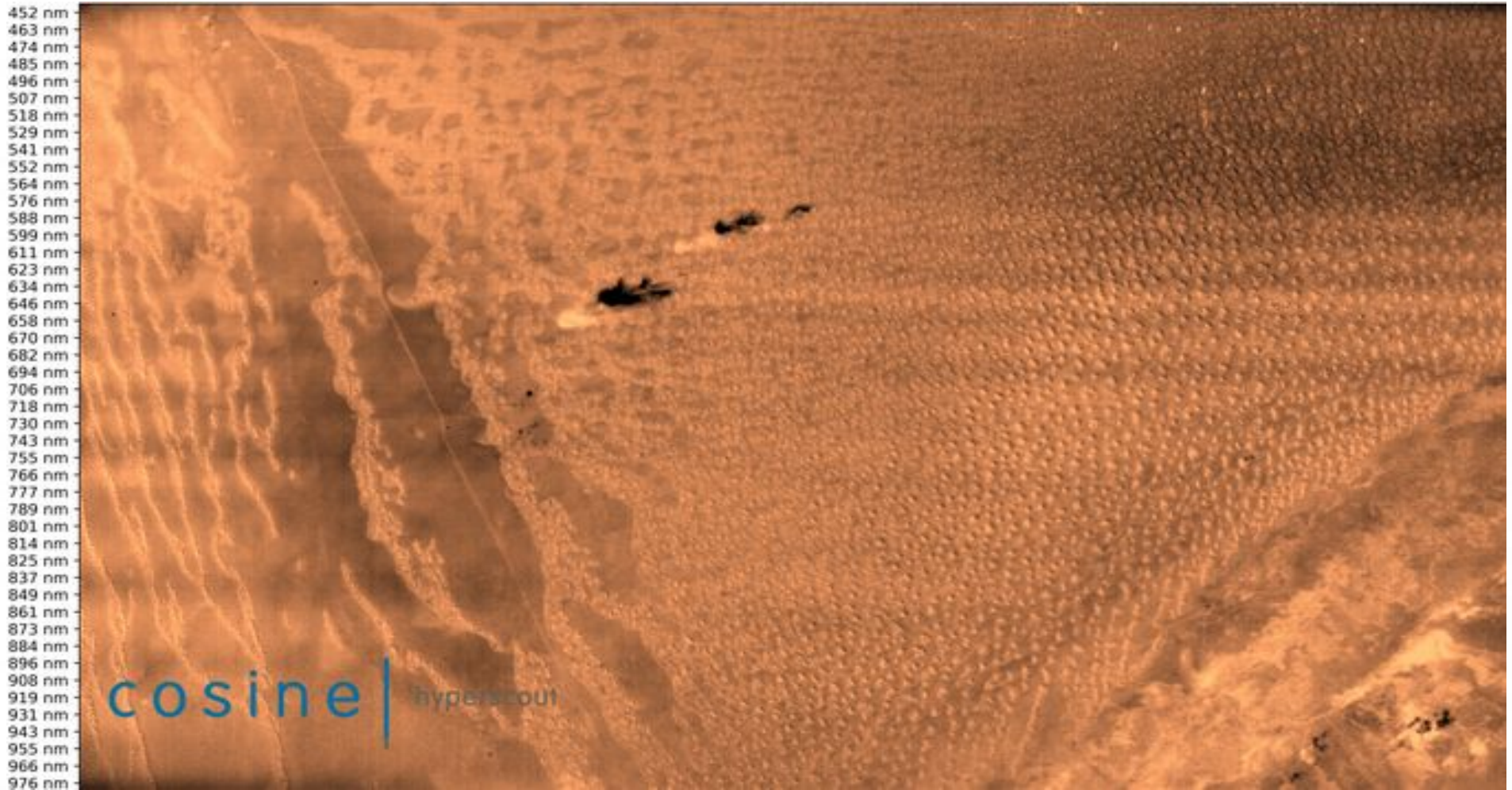
- ▶ The HyperScout 1 camera produced the so-called Analysis Ready Data (ARD) for the first time on board
 - ARD available onboard for customized third party applications
- ▶ The hypercube has been produced in-orbit. Orthorectified, georeferenced and radiometrically corrected spectral band images. With this information available, it is possible to analyze the spectra on board



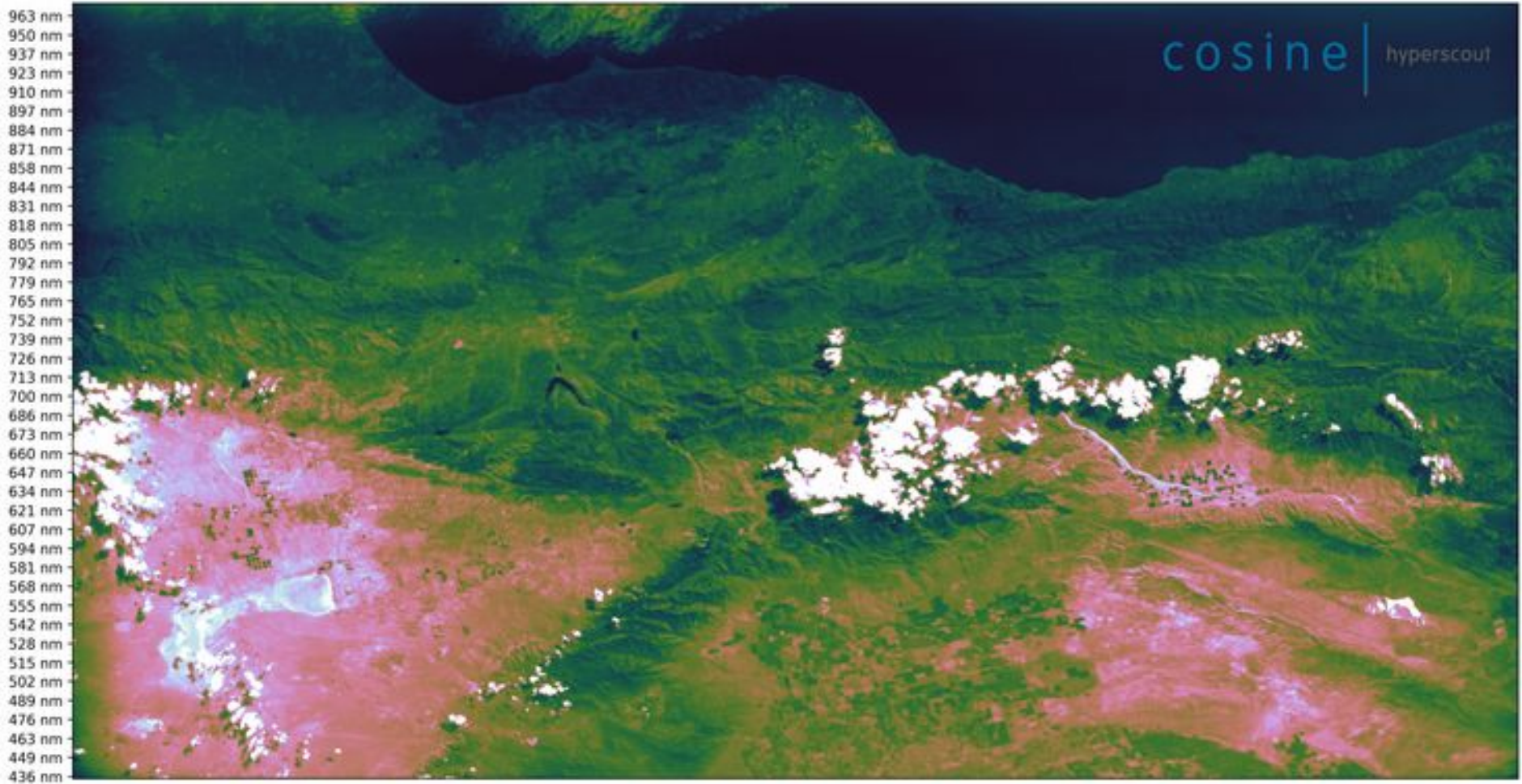
HyperScout® | Hyperspectral Cuba



HyperScout® | Hyperspectral Libya

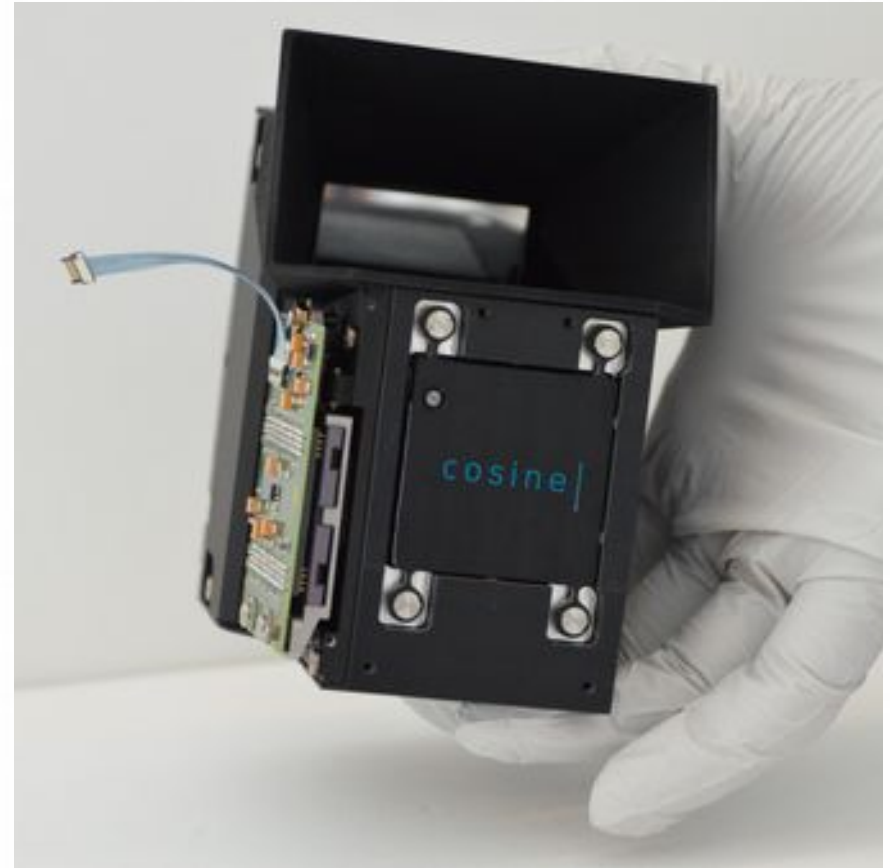


HyperScout® | Hyperspectral California



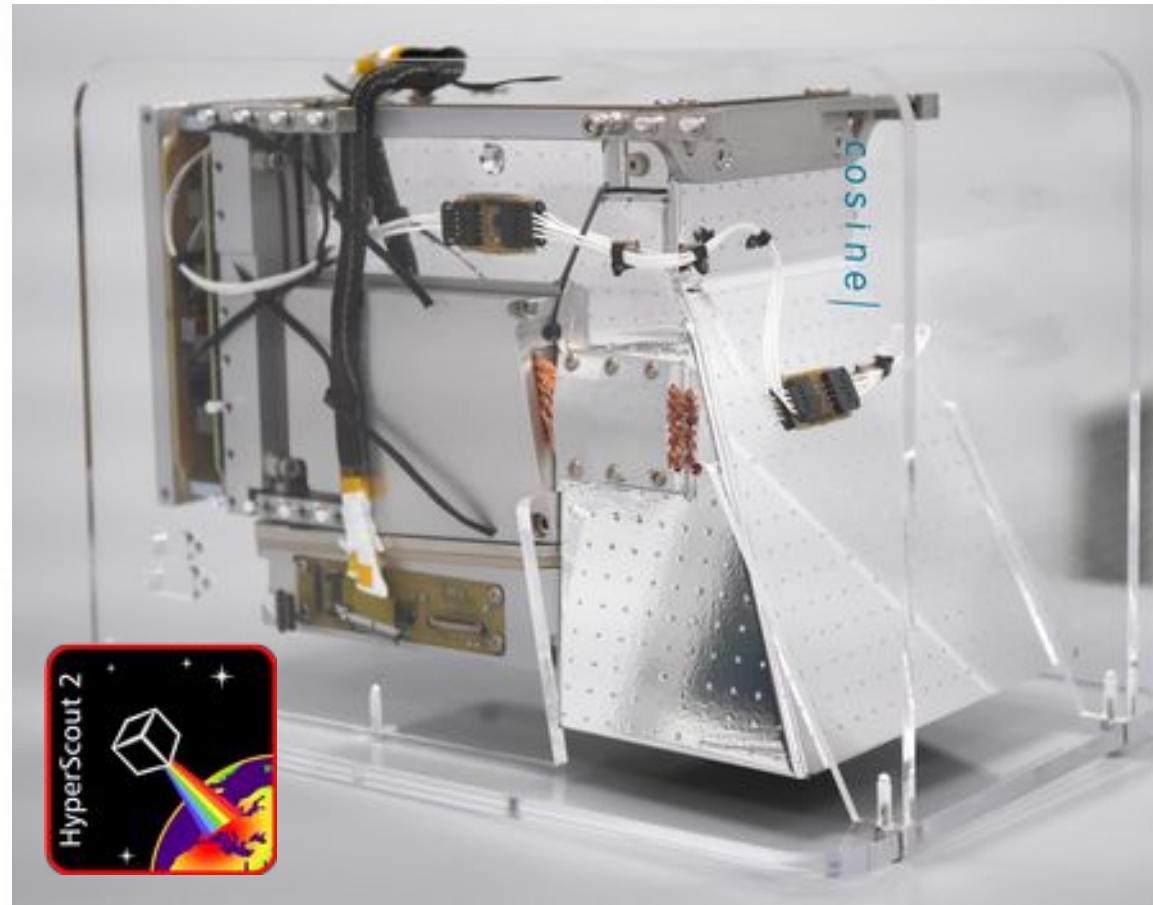
HyperScout®

- ▶ HyperScout® is a fully reflective telescope, designed to offer the possibility of adding or replacing spectral channels with only minor modifications
 - TIR – Detector selected and laboratory tested (NavIR™ for AIM)
 - SWIR – Laboratory tested
 - UV – Detector and operating modes selected
 - Combinations of two of the aforementioned channels is possible
 - An evolution of the instrument optics to obtain a VNIR spectrometer has been conceived



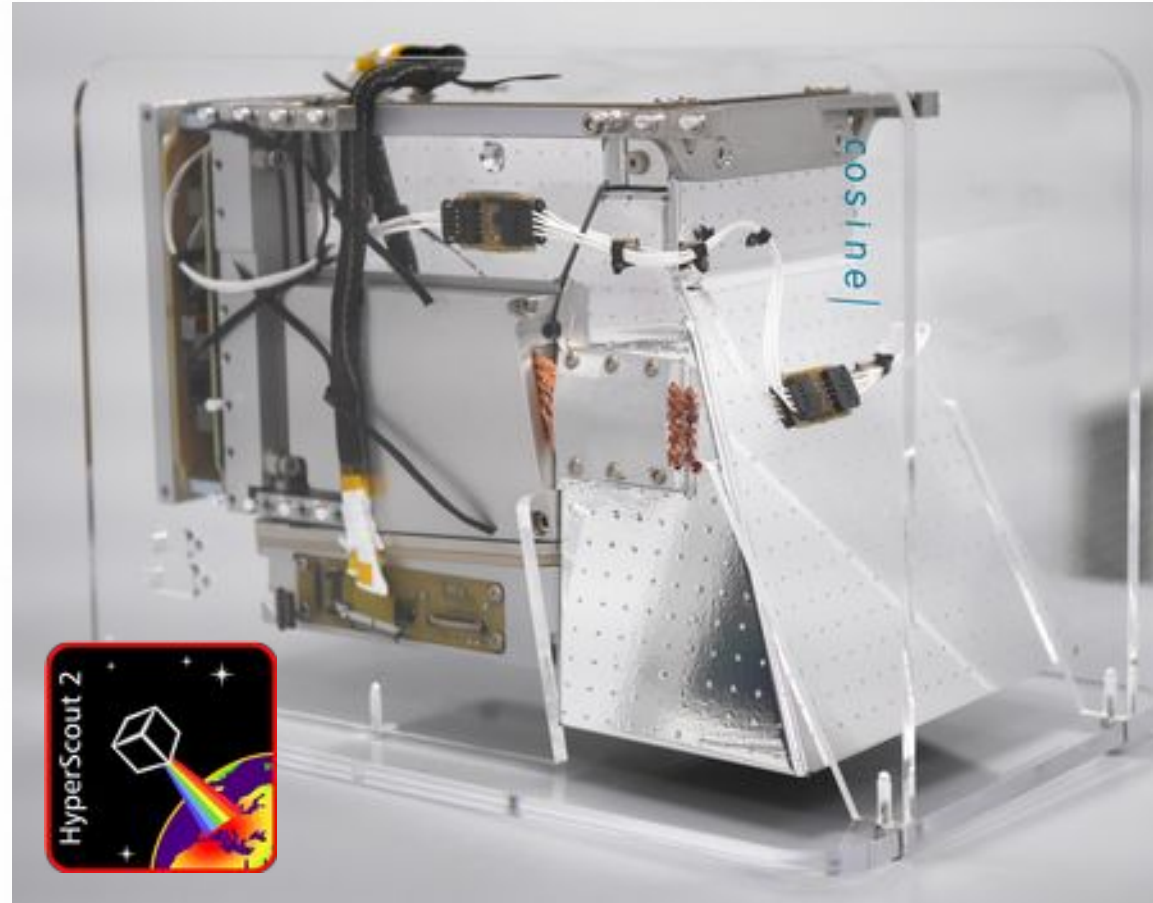
HyperScout-2

- ▶ Evolution of HyperScout
 - Enhanced functionalities
 - Increased performance
- ▶ Dual channel miniaturized payload
 - Hyperspectral VNIR
 - Multispectral TIR
- ▶ Launch in Q3 2019 within FSSCat mission
 - Federated Satellite System Catalonia
 - Satellites in formation flight

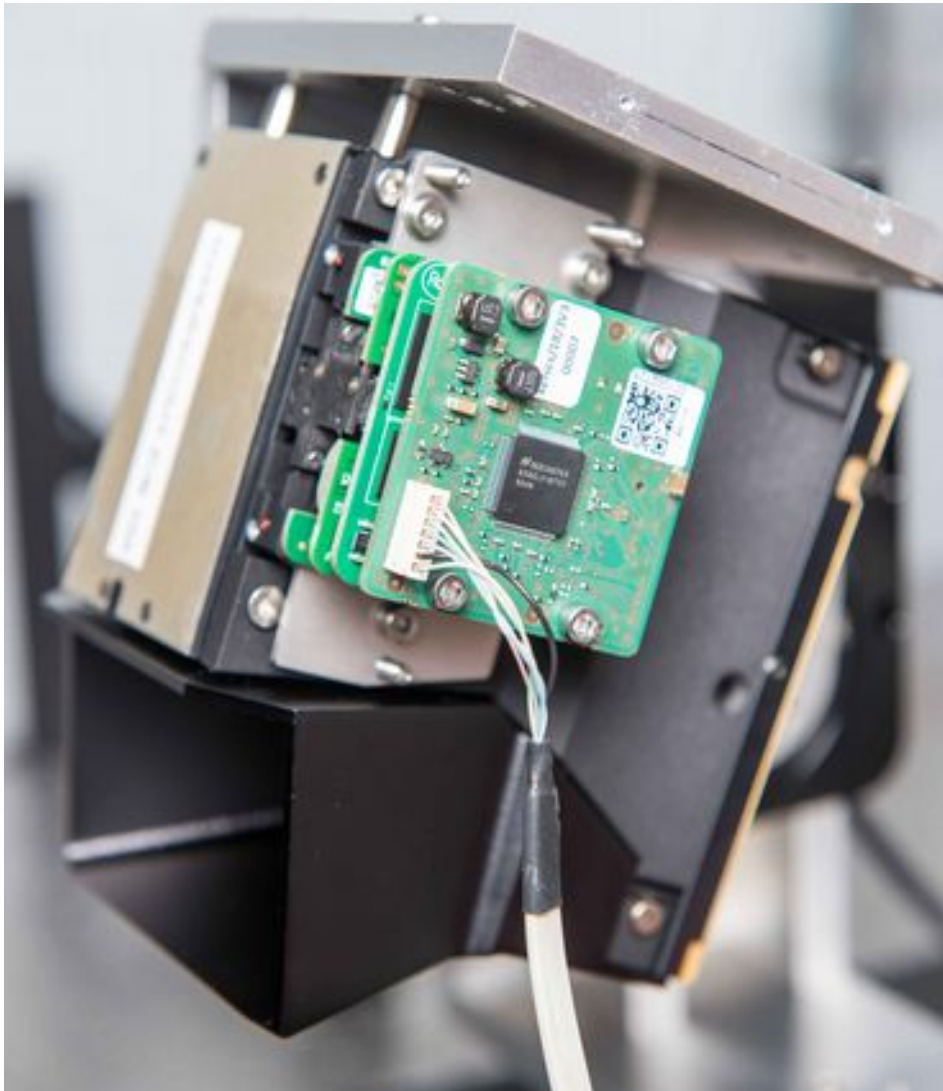


HyperScout-2

- ▶ expanding to Thermal InfraRed
- ▶ larger swath up to 300 km
- ▶ increasing platform compatibility
- ▶ validating data products within Copernicus
- ▶ bringing Artificial Accelerator in flight



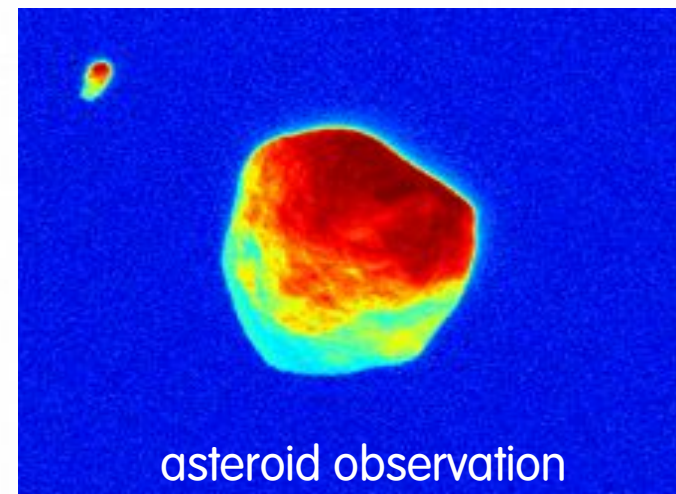
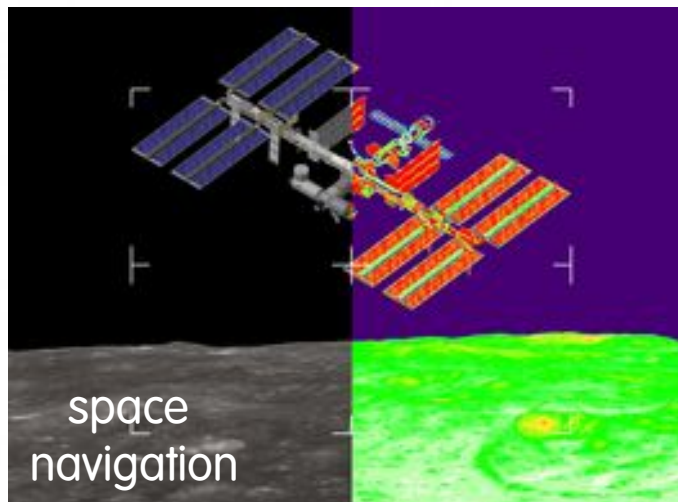
HyperScout-2 | Thermal IR channel



- ▶ A single-band engineering model has been tested in laboratory environment
- ▶ Radiometric performance fully enable the operation as TIR navigation camera for deep space operation
 - NETD lower than 1 K at room temperature.
 - NETD lower than 10 K at 150 K
 - Large dynamic range: temperature range from 150 K to 670 K

HyperScout-2 applications

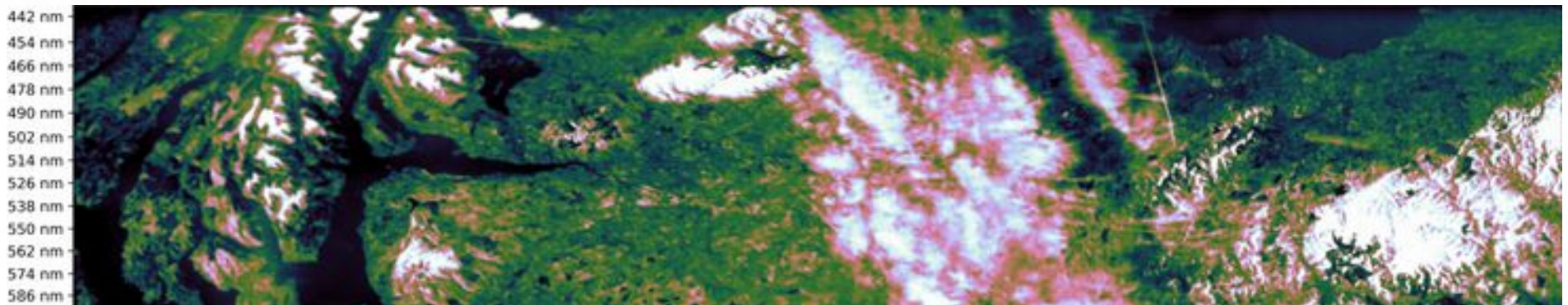
- ▶ Flooding warning
- ▶ Change detection
- ▶ Urban heat islands
- ▶ Oil spill
- ▶ Volcano and fire monitoring
- ▶ Fire hazard
- ▶ Water quality
- ▶ Evapotranspiration



HyperScout-2 | contribution to Hera

- ▶ Miniaturized Visible Near infrared hyperspectral instrument
 - VNIR spectroscopy
 - High spectral resolution
 - Good noise performance
 - Possibility of extension to other spectral ranges of interest (SWIR)

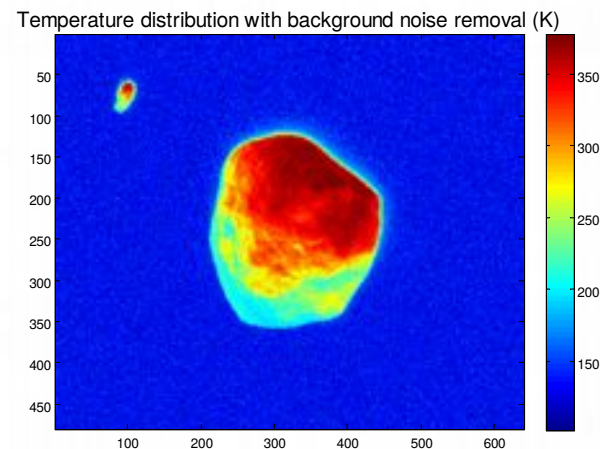
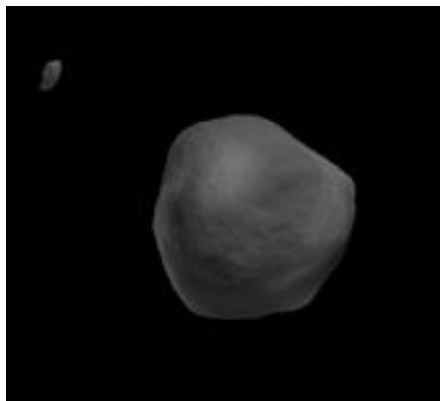
- ▶ Support to Hera spacecraft navigation
 - Large field of view greatly advantageous
 - Possibility of executing navigation algorithms on board
 - Studies predict excellent quality of space navigation based on HyperScout imagery in multiple scenarios
 - Baseline for other space exploration projects



HyperScout-2 | contribution to Hera

- ▶ Thermal InfraRed multi-spectral channel
 - Scientific operation
 - Spectral bands tailored to the asteroid scenario
 - Thermodynamical parameters can be determined with a limited number of bands
 - Evolution of the brightness temperature may allow a coarse determination of the shape of surface rocks

- ▶ TIR imagery can be used to support navigation
 - Independent of the illumination condition
 - Broad range of accepted asteroid temperatures
 - Results of the simulations in the AIM context reveal performance comparable to visual navigation for both centroiding and feature tracking
 - Possibility of data fusion



HyperScout-2 | contribution to Hera

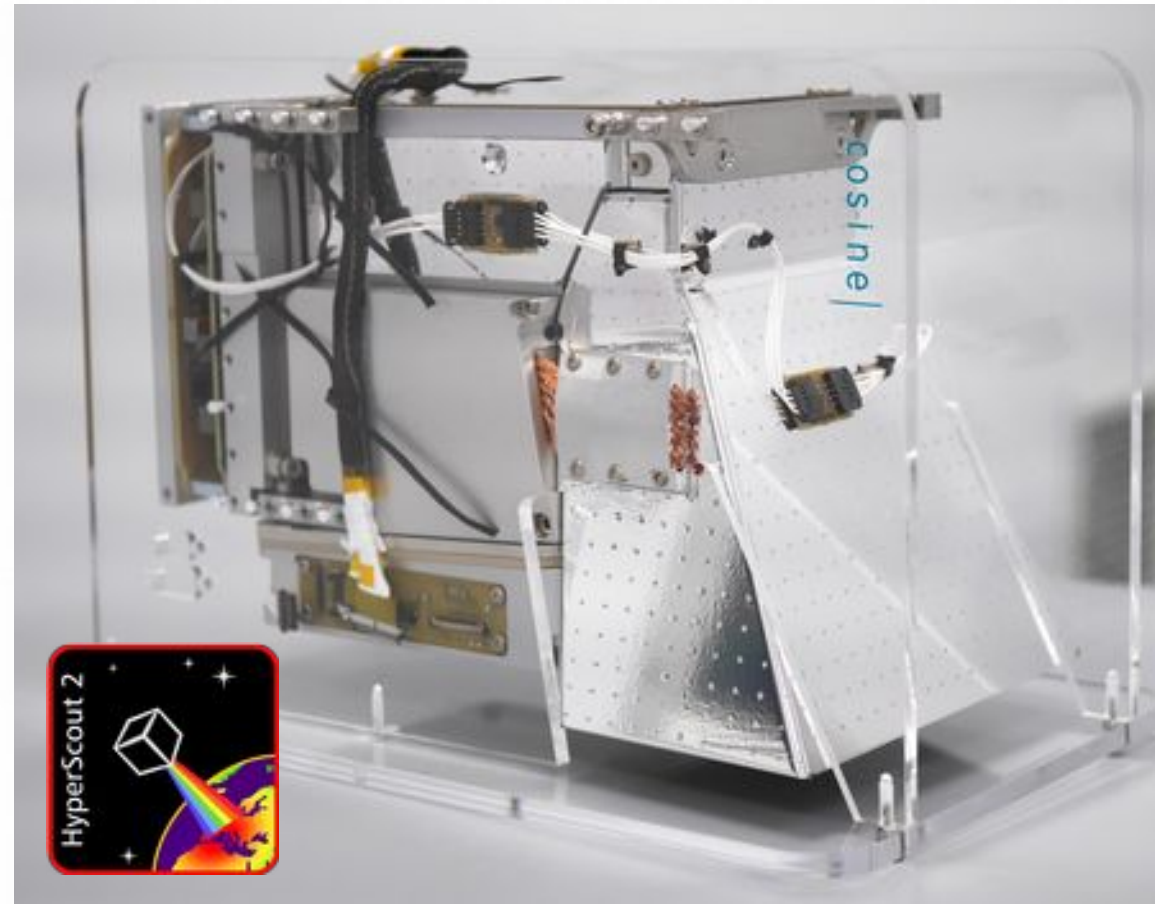
- ▶ HyperScout-2 will be operational in space in late 2019
- ▶ In – orbit experiments can be performed within the FSSCat mission
 - Satellites flying in formation
 - In flight navigation experiments to de-risk Hera mission can be carried out
- ▶ In - orbit testing Testing of Artificial intelligence algorithms
 - AI algorithms relevant to Hera operation may be tested using representative hardware



Conclusion

- ▶ HyperScout-2
 - High TRL
 - High performance
 - Low engineering budgets

- ▶ Valuable platform for the Hera mission
 - Enabling scientific applications in VNIR and TIR
 - Enabling multi-spectral space navigation
 - Possibility of IOV experiments for concept validation and mission de-risking
 - On board generation of data products
 - Possibility of machine learning and artificial intelligence applications



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