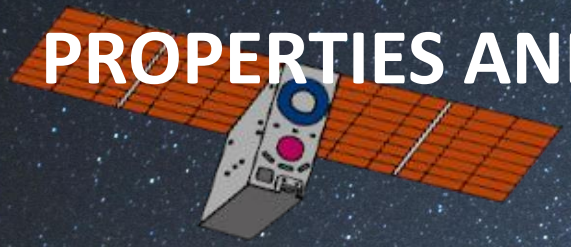
THE COLOR ANALYSIS OF DIMORPHOS PLUME PRODUCED BY DART IMPACT USING LICIACUBE-LUKE DATA: RESULTS ON PHYSICAL PROPERTIES AND COMPOSITION TO BETTER CONSTRAIN PLANETARY DEFENCE EFFICENCY



Poggiali G., Brucato J.R., Caporali S., Deshapriya J.D.P., Hasselmann, P., Ieva S., Bertini I., Dotto E., Ivanovski, S.L., Rossi A., Della Corte, V., Zinzi A., Mazzotta Epifani E., Dall'Ora M., Pajola M., Lucchetti A., Amororso M., Barnouin O., Capannolo, A., Ceresoli, M., Cremonese, G., Fahnestock E.G., Gai, I., Gomez Casajus L., Chabot, N.L., Cheng, A.F., Gramigna E., Impresario G., Lasagni Manghi R., Lavagna, M., Li, J.-Y., Lombardo M., Modenini, D., Palumbo, P., Perna, D., Pirrotta, S., Rivkin, A.S., Sánchez, P., Tortora, P., Trigo-Rodríguez, J.M. Tusberti F., Zannoni, M., Zanotti, G.

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DART and LICIACube

Nov. 24, 2021
SpaceX Falcon 9
Vandenberg Space Force Base, CA

Sept. 26, 2022

- Target the binary asteroid Didymos system
- Impact Dimorphos and change its orbital period
- Measure the period change from Earth

LICIACube
(Light Italian Cubesat for Imaging of Asteroids)
ASI contribution

DART Spacecraft

610 kilograms at launch;
~550 kilograms at impact

15,000 miles per hour
(6.6 kilometers per second)

Dimorphos

177x174x116 meters

11 h 55 min → 11 h 23 min
orbital period

1.206 → 1.169 km
separation between
centers

Didymos

849x851x620 meters
2.26 h rotation period

Earth-Based Observations

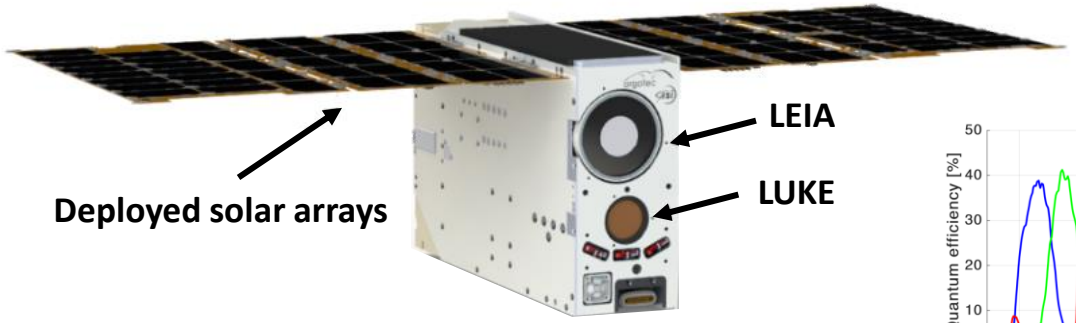
6.8 million miles (0.07 AU) from
Earth at DART impact

LICIACube is carrying a suite of cameras:

LEIA - **L**ICIACube **E**xplorer **I**maging for **A**steroid
A narrow field-of-view (FoV) camera

LUKE - **L**ICIACube **U**nit **K**ey **E**xplorer
A wide FoV RGB imager

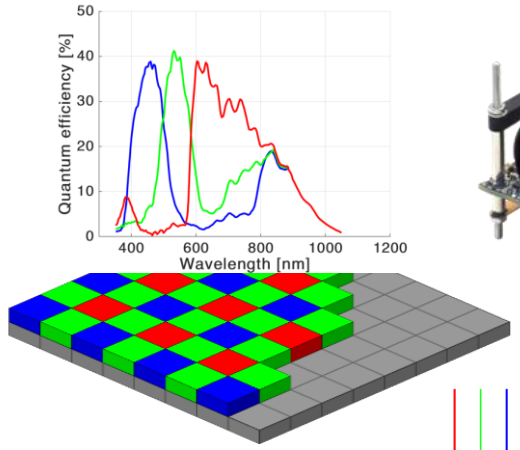
LUKE RGB camera

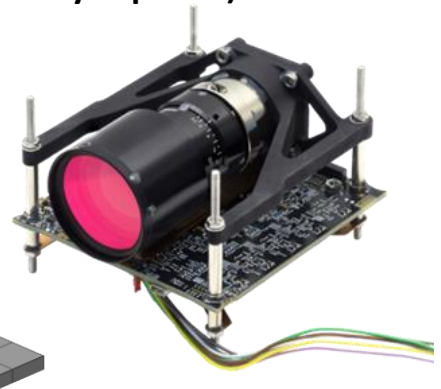


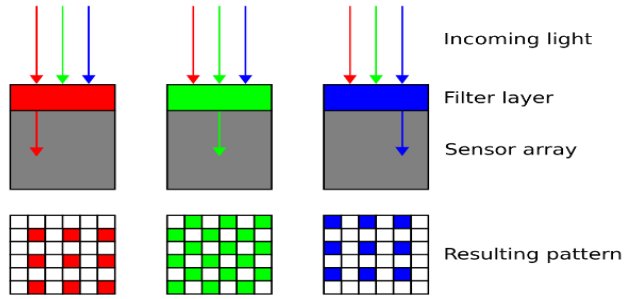
LUKE is a Gecko imager provided by the SCS Space Company.

LUKE is equipped with a front-illuminated CMOS detector (ams CMV2000), the pixel pitch is 5.5 μm, and images are 1088×2048 pixels.

LUKE
(Liciacube Unit Key Explorer)







	Focal length (mm)	FoV (°)	IFoV (µrad/px)	Spat. scale at 55.2km (m/px)
LEIA	222.55	± 2.06	24.71	1.38
LUKE	70.5	±5	78.01	4.31

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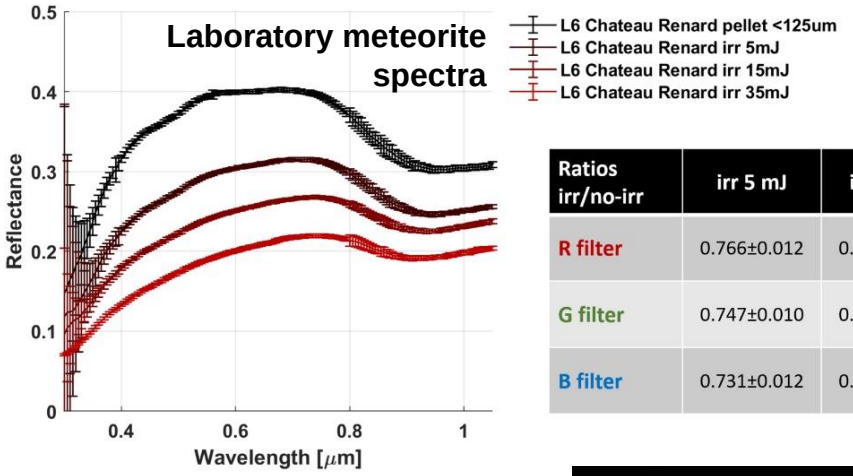
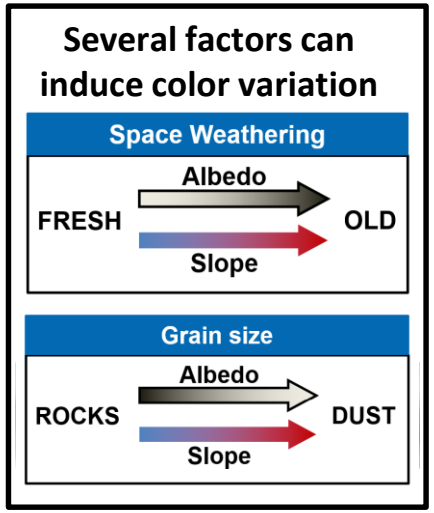
Color data interpretation

Using LUKE color data we can derive composition and effect of alteration process occurred on the surface of Didymos and Dimorphos as well as physical properties of plume

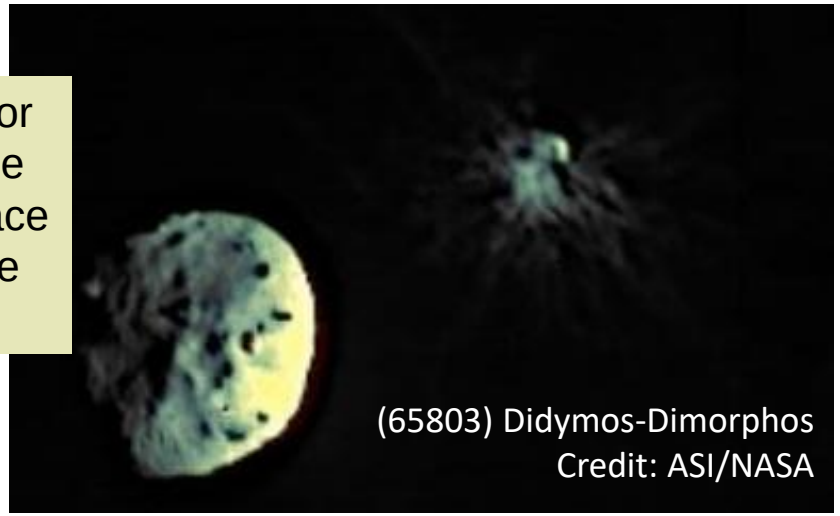


Ratios irr/no-irr	irr 5 mJ	irr 15 mJ	irr 35 mJ
R filter	0.766±0.012	0.636±0.009	0.509±0.009
G filter	0.747±0.010	0.609±0.008	0.480±0.008
B filter	0.731±0.012	0.588±0.009	0.453±0.008

Multiband photometric analysis of LUKE data and laboratory measurements in support of data interpretation will provide new insights on the binary asteroid nature and evolution.



How plume color variation can be linked with surface and subsurface differences?

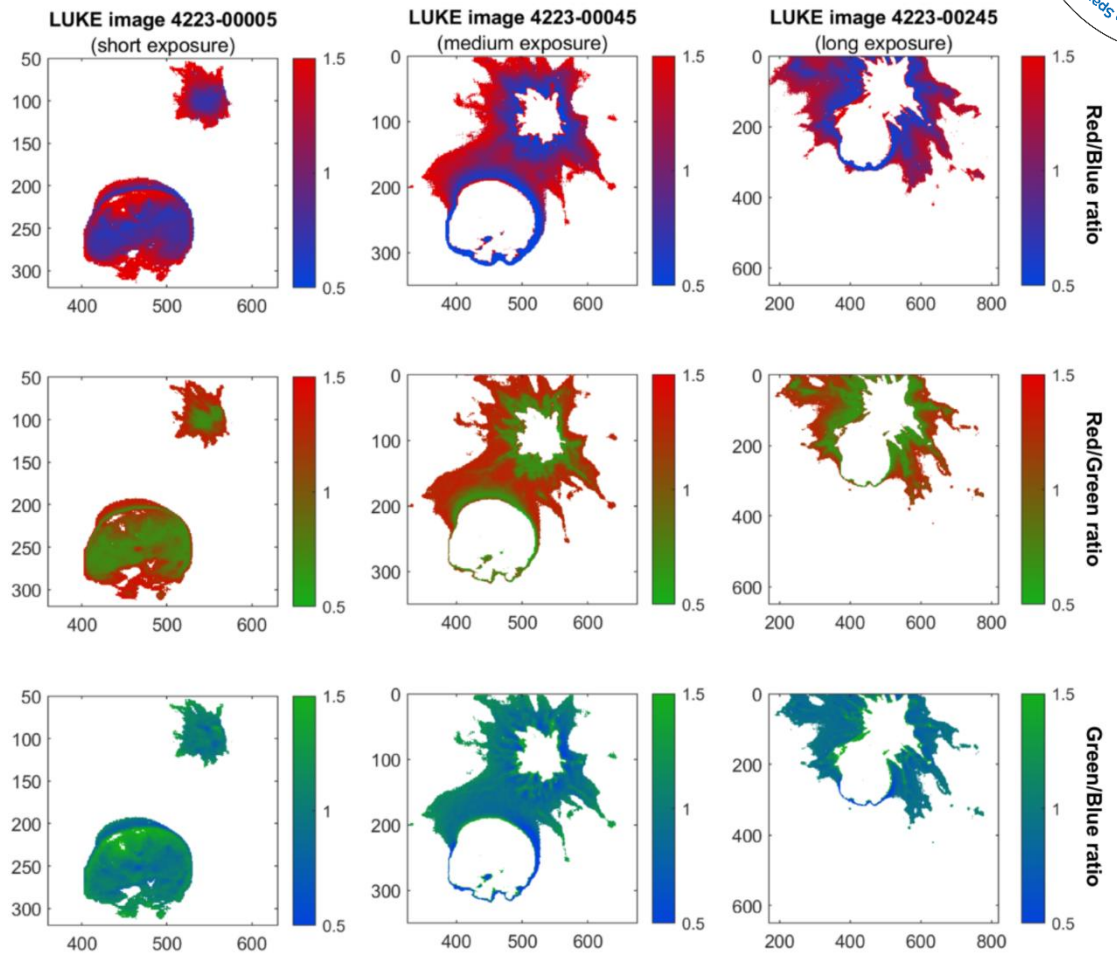


Overview of plume colors

Color analysis can constrain the physical properties of the plume, composition and the degree of alteration from space weathering of Dimorphos.

Ratios of the fluxes observed by the three filter of LUKE were evaluated to look for differences on the surface, in the plume and between Didymos and Dimorphos.

As visible in the figure all the ratios show spatial and intensity differences.



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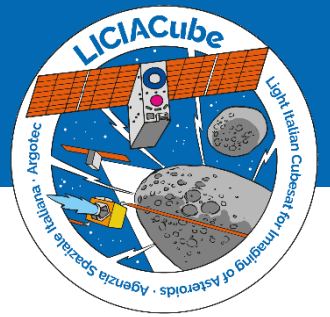
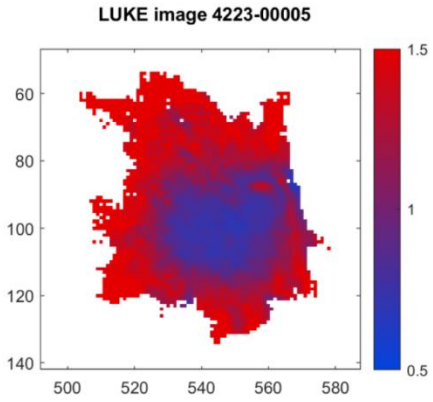
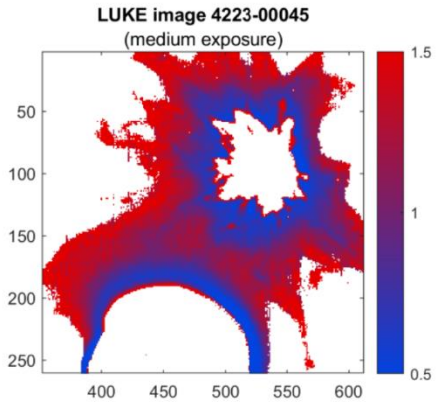
Structure of the plume in RGB



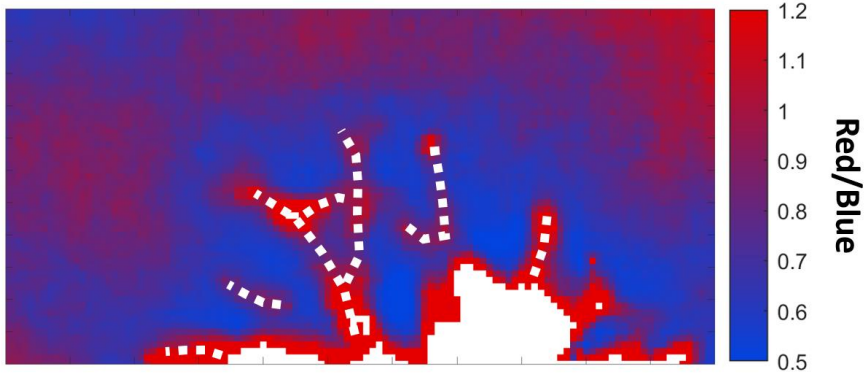
Dotto et al 2023, Nature (submitted)

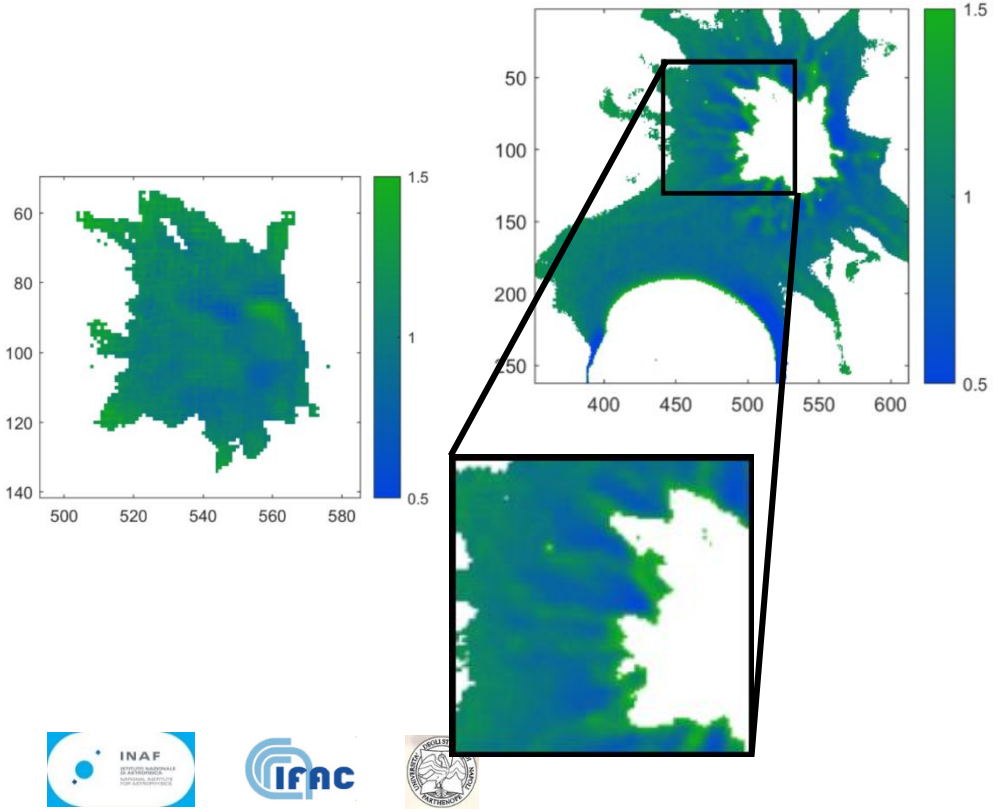




In the red/blue ratio a strong dichotomy is visible between the inner and the outer part of the plume while in the green/blue ratio the dichotomy is less visible.

On the other side the streams are evident in any ratio (R/B and G/B) with differences in extension.

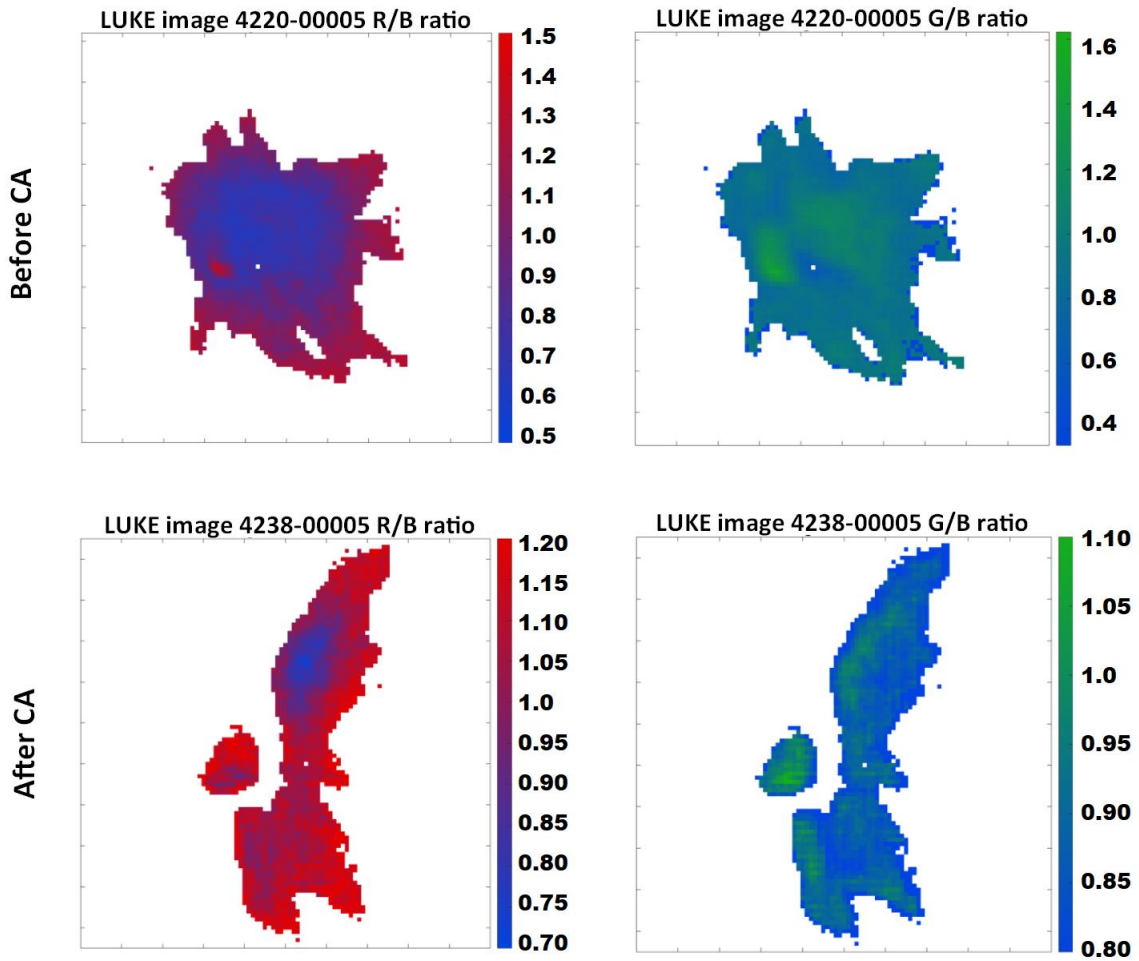




Dotto et al 2023, Nature (submitted)

Agenzia Spaziale Italiana · argotec · Politecnico di Milano Aerospace Science and Technology Department · Alma Mater Studiorum Università di Bologna · INAF · IFAC

Colours interpretations



Also images after the CA seems to confirm this dichotomy of red and blue colors.

Color variation could be due to presence of micrometer dust grain (Lara et al 2007) and reddening in the outer part of the plume was already observed in comets due to silicate fragmentation (Bertini et al. 2009) or presence of more altered material.

Less altered material from space weathering is show a bluer slope as found by laboratory experiments (Marchi et al 2005)

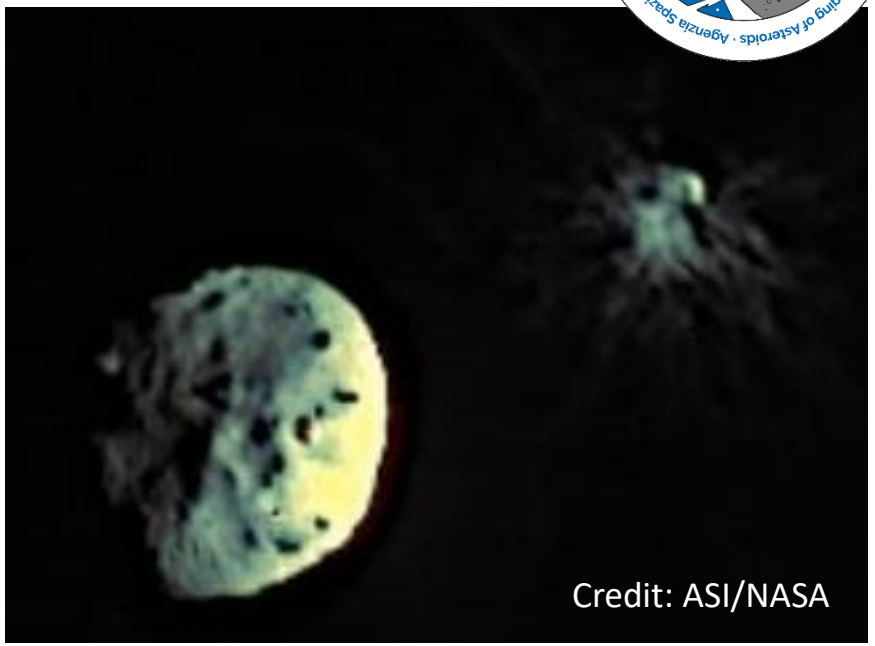
Conclusions

- Potential formation scenarios and evolutionary pathways are linked with differences in surface colors but no strong color variation between Didymos and Dimorphos is observed in LUKE.

- The plume ejected from Dimorphos shows a dichotomy between the inner and outer region confidently linked with the variation in grain size but with a possible contribution from less space altered material from the subsurface of Dimorphos.

- Analysis are still ongoing: LUKE acquired more than 200 images starting from 29 seconds after the impact up to more than 300 seconds after the impact.

- Obtain physical and mineralogical properties from RGB color can improve our knowledge on NEO asteroid and help in the implementation of efficient planetary defense techniques



For question and comments:

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