

Current NEO-related Activities in Germany

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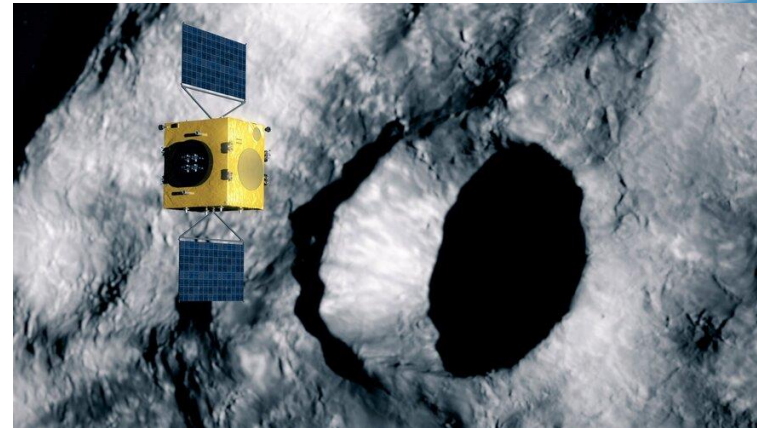
Including input from:

C. Gritzner, M. Noeker,

S. Ulamec (DLR)

R. Srama (Univ. Stuttgart)

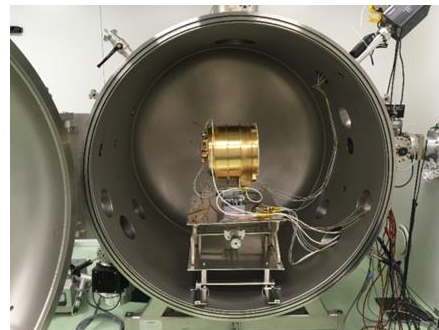
K. Wünnemann (MfN)



Knowledge for Tomorrow

Main NEO-related Missions and Projects with German participation

1. **Hera** – Europe’s reconnaissance mission to Didymos and Dimorphos, following and complementing NASA’s DART impactor. Launched 7th October, 2024.
2. **RAMSES** – Europe’s mission to Apophis.
3. **Modelling tools (MfN)** – for asteroid characterization and impact risk to lunar infrastructure.
4. **Destiny+** – JAXA/DLR mission to 3200 Phaethon.



Hera

- Hera is the European reconnaissance mission to the Didymos system which complements NASA's kinetic-impactor mission, DART, with the aim of returning precise information on the effects of the DART impact.
- Germany is the largest contributor to the Hera mission (37,5 %), mainly via industry but is also well represented in the core investigation team by:
S. Ulamec, DLR (Management Board Member),
J.-B. Vincent, DLR (PI of the Asteroid Framing Cameras, Data Analysis WG Lead),
K. Wünnemann, Museum für Naturkunde, Berlin (Impact Modeling WG Lead).
- OHB System AG, Bremen, is the ESA prime contractor for Hera and is responsible for the design and construction of the spacecraft. The Asteroid Framing Cameras are provided by the German company Jena-Optronik. The Laser Altimeter is provided by the German company Jenoptik.
- Juventas Radar (JuRa) instrument built with major contributions from TU Dresden (D. Plettemeier Co-PI), partially funded by German Space Agency at DLR.
- Launched: Oct. 7th, 2024; arrival: end 2026; duration of operations at the asteroid: at least 6 months. Commissioning phase completed, Mars swing-by and Deimos observations took place in March 2025.



RAMSES (Rapid Asteroid Mission for Space Safety, ESA)

- Asteroid 99942 Apophis (D ~340m) will have a very close encounter with Earth (32000 km from the surface) on 13 April 2029.
- RAMSES is ESA's Apophis rendezvous mission. S/C design, team, payload almost identical to Hera. Instruments provided by Germany:
 - Cameras and Laser Altimeter (Hera spares/heritage)
 - RAMSES Plasma Spectrometer (RPS) by MPS (JUICE spare) on main S/C
 - Magnetometer on lander cubesat (TU Braunschweig).S. Ulamec and J-B. Vincent are on the Mission Management Board.
- Final funding secured by ESA Ministerial decision in November 2025. The launch has to be in April 2028 to arrive at Apophis in February 2029, two months before the close approach.
- There are plans for NASA's OSIRIS-APEX to go to Apophis, but will only reach it several weeks after the Earth encounter.



ESA-Funded Planetary Defence Activities at Museum für Naturkunde Berlin

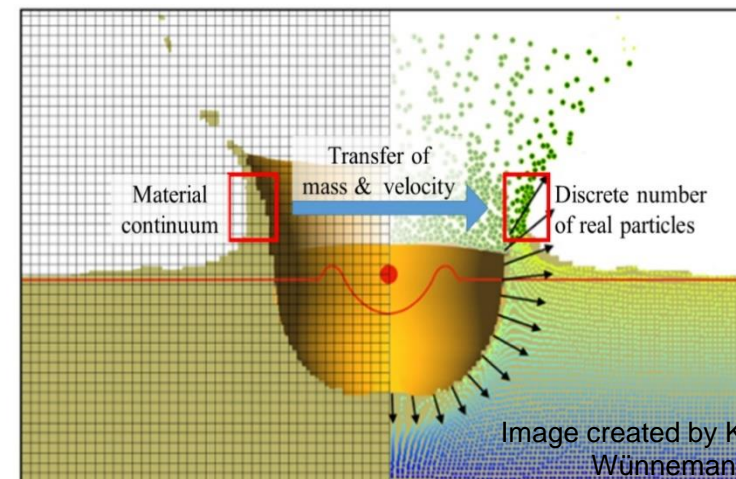


- **Asteroid characterisation:** project to develop impact modelling capacities for typical asteroidal low-strength and low-gravity environments. The tools are designed primarily for DART/Hera but can be applied generally to modelling impacts on various asteroids.

Kai Wünnemann, project lead
Robert Luther, project engineer

- **Impact Risk for lunar Infrastructure:** study of the impact risk by primary impacts and by secondary effects from ejecta of nearby impacts.

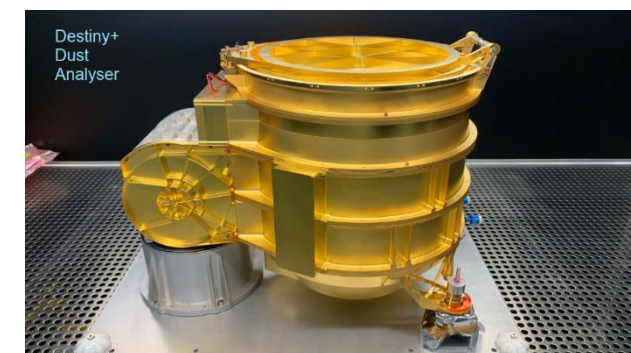
Robert Luther, project lead
Tiantian Liu, project engineer



DESTINY+ (=Demonstration and Experiment of Space Technology for INterplanetary voYage)

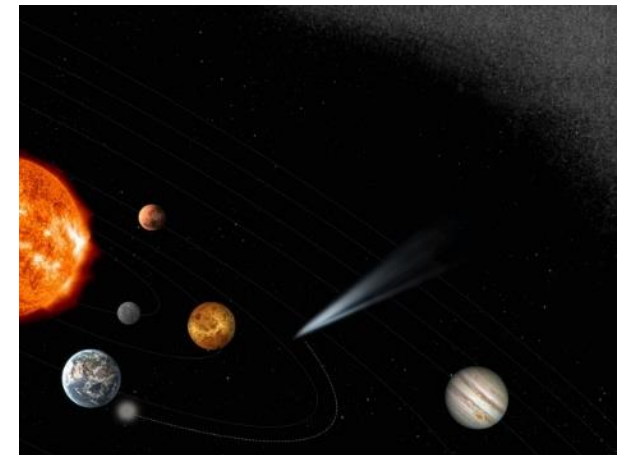
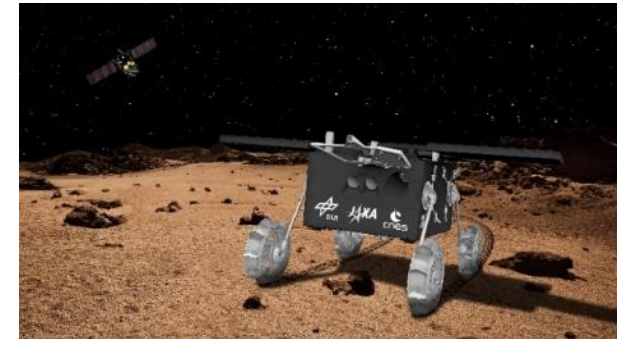
JAXA, Univ. Stuttgart, DLR

- DESTINY+, selected by the Japanese space agency JAXA/ISAS, will fly by the active asteroid (3200) Phaethon in ~ 2030 and observe dust using a dust analyzer. It will map Phaethon's surface to understand the mechanisms of dust ejection. The spacecraft will pass as close as 500 km to the surface of Phaethon at a speed of 36 km/s. It will also observe interplanetary and interstellar dust.
- The scientific payload consists of a telescopic camera, a multi-band camera, and the DESTINY+ Dust Analyzer (DDA). The DDA is provided by Germany (Univ. of Stuttgart), funded by the German Space Agency at DLR.
- The DDA has passed qualification tests (Shaker, Shock, TV, EMC) and is scheduled to be launched from Japan in Spring 2028, together with ESA's Ramesses mission.



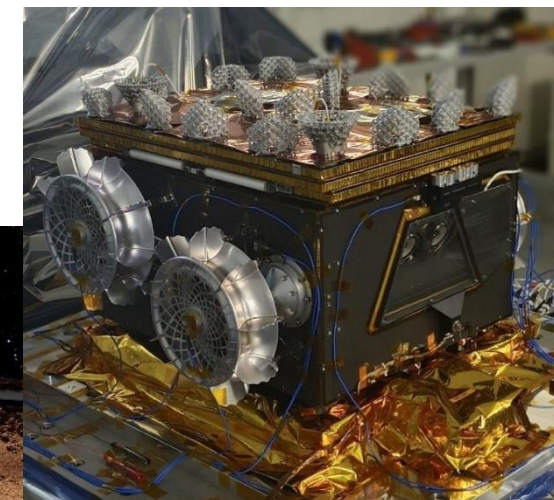
Other Activities and Projects with German Involvement Relevant to Planetary Defence

- Contributions to JAXA Mars Moons eXploration (MMX) Mission
- Comet Interceptor
- Psyche
- Lucy
- Hayabusa2 extended mission – to NEO 1998 KY26 (arrival 2031), after flyby of NEO (98943) Torifune in 2026.
- PRIAMOS
- NEAlight, +...



Contributions to JAXA Mars Moons eXploration (MMX) Mission

- JAXA Mission to investigate the Martian moons, Phobos and Deimos, including sample return from Phobos. Launch currently scheduled for October 2026.
- Germany (DLR) is involved in the MMX Science Board including participation in the science teams on “Early Solar System Evolution”, “Surface Science and Geology” and “Origins of Phobos and Deimos”.
- Provision of CNES-DLR Rover IDEFIX as contribution to the MMX Mission:
 - Rover System with 4 Scientific instruments.
Rover PI’s: S. Ulamec (DLR) and P. Michel (CNRS)
 - Raman Spectrometer, RAX (DLR, with contributions from INTA and JAXA).
 - Radiometer (miniRAD) (DLR).



Comet Interceptor

- The Comet Interceptor (CI) will be the first mission to visit a long-period comet just starting its journey into the inner Solar System. Comprising 3 spacecraft (A & B2 from ESA, B1 from JAXA), CI will wait at L2 for a suitable target, then move off to intercept it as it approaches the Earth's orbit. The three spacecraft will perform simultaneous observations from multiple points around the object.
- The Multilateral Agreement of participating agencies, including German Space Agency at DLR, was approved by ESA in 2022 and entered into force on 30 May 2023. It shall remain in force until at least 8 years after launch of the mission.
- The prime contractor is OHB Italia, a subsidiary of the German OHB company. OHB Germany and Sweden are sub-contractors. Launch is scheduled for 2029.
- DLR is providing the focal plane array electronics for the CoCa camera and will contribute s/w to the MANIAC mass spectrometer (probe A). TU Braunschweig provides a magnetometer (probe B2), funded by the German Space Agency at DLR.



Psyche

- NASA mission to main-belt asteroid Psyche. Launched 13. Oct. 2023. Arrives Aug. 2029.
- German involvement - Freie Universität Berlin (F. Postberg) and DLR Institute of Space Research, Berlin: data analysis, production of digital terrain models. Activities funded by the German Space Agency at DLR.

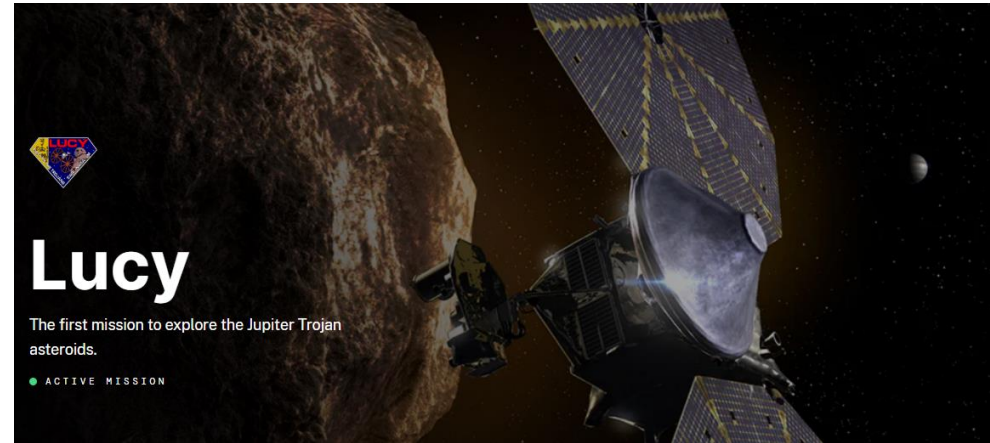


Credit: NASA/JPL-Caltech



Lucy

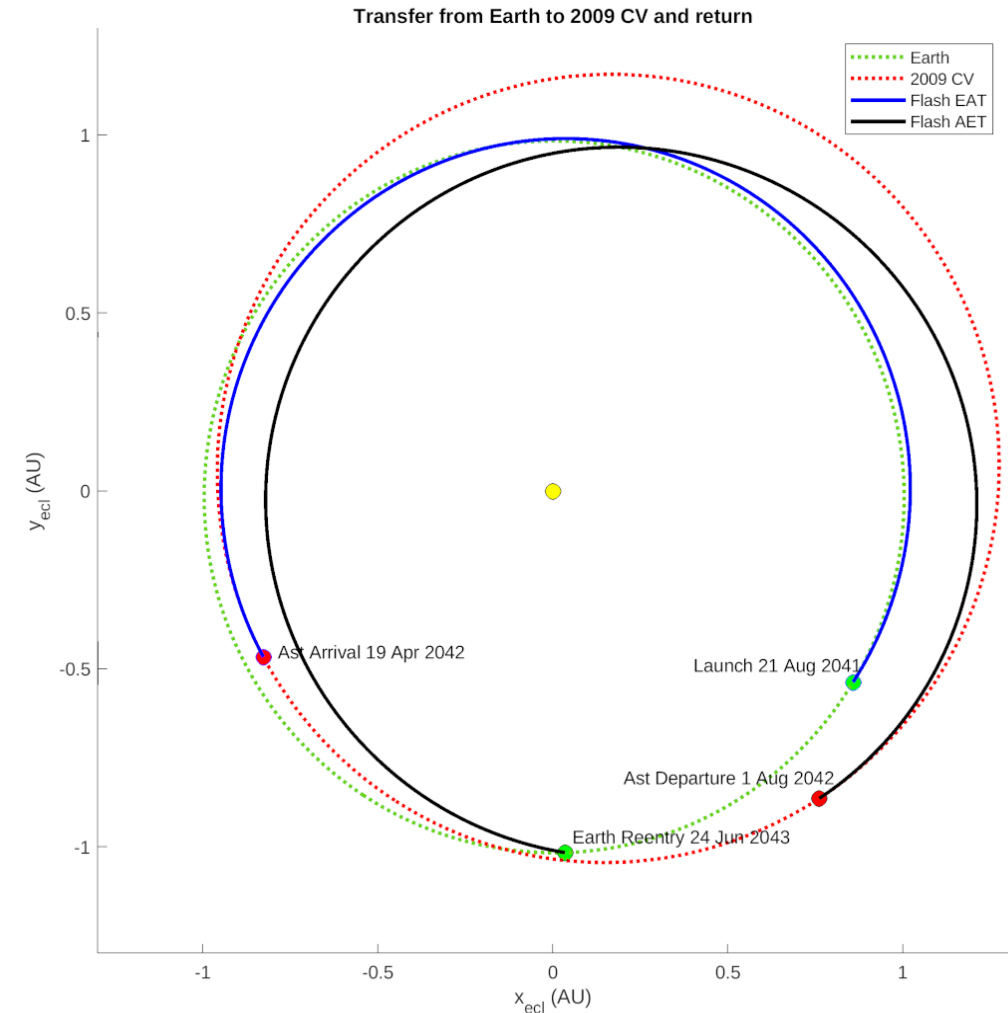
- German contribution to the NASA Lucy mission to explore the Trojan asteroids: groundbased observations and data analysis (DLR Institute of Planetary Research, Berlin and University of Cologne) are funded by the German Space Agency at DLR.
- Lucy flew by the main-belt asteroid (152830) Dinkinesh (D ~ 0.8 km) in November 2023, discovering contact binary satellite Selam.
- Lucy flew by the main-belt asteroid (52246) Donaldjohanson (D ~ 4 km) in April, 2025.



Credit: NASA/Goddard/SwRI/Johns Hopkins APL

APOSSUM → PRIAMOS

- (PRImordial Asteroid Mission to understand the Origin of the Solar system) is a proposal for a sample return mission to a D-type asteroid.
- Proposers: MPI for Solar System Research; DLR. The proposal was prepared for the ESA M8 mission call (Medium-Class mission).
- The NEA 2099 CV is a primary candidate target due to its reachability within a two-year mission timeframe.
- Time at target: ~ 3 months. Recovery: It is planned that the return capsule (APOSSUM) will land in Australia at the end of the mission.



Other Missions Proposed or Under Study

- **NEAlight**: investigations of Apophis using small satellites (Uni. Würzburg). Study funding by German Space Agency at DLR extended until April 2026.
- **CALICO+**: A mission to land in Occator Crater on Ceres to sample the surface (ESA M8).
- **PEANUTS**: Probing Evolution of Asteroids aNd Uncovering Traces and Sources, a mission to explore a D-, E-, or Q-type asteroid (ESA Mini-F call).

(ESA M8- and F-mission selections scheduled for 2030)

