

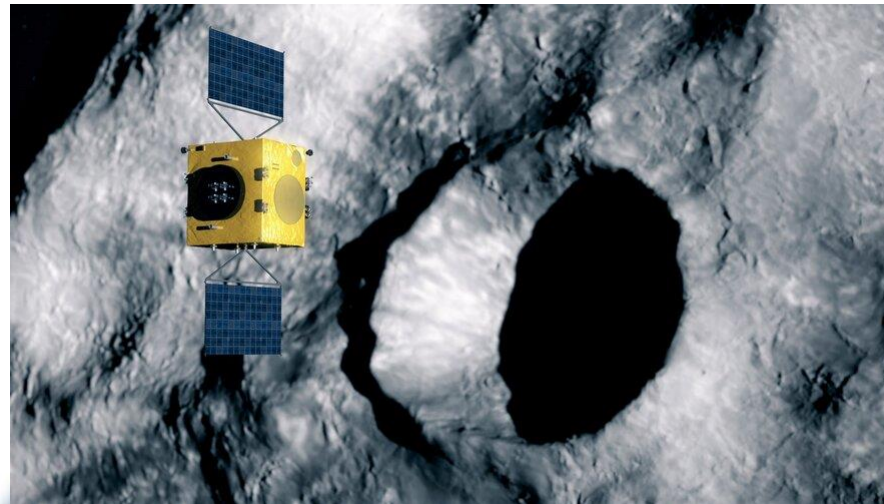
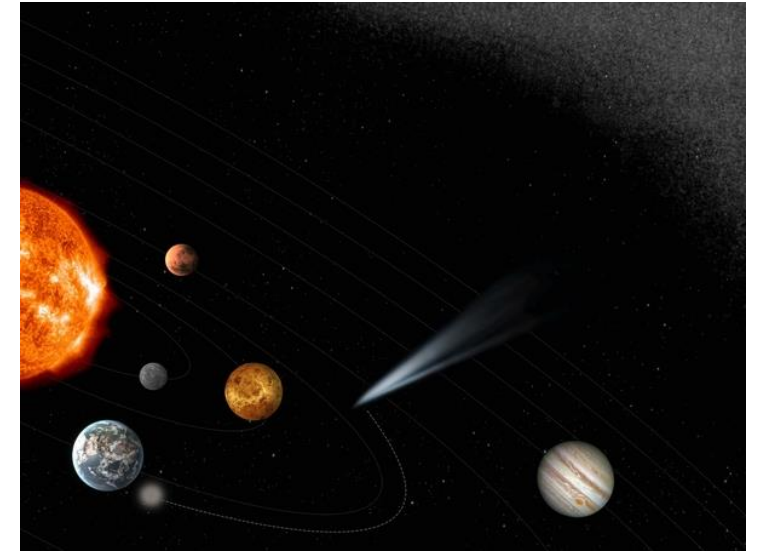
Current NEO-related Activities in Germany

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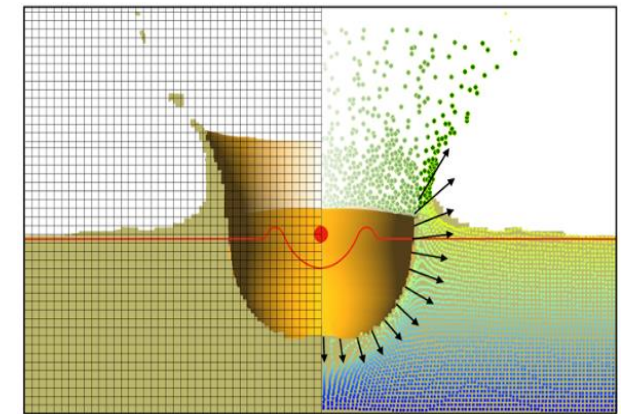
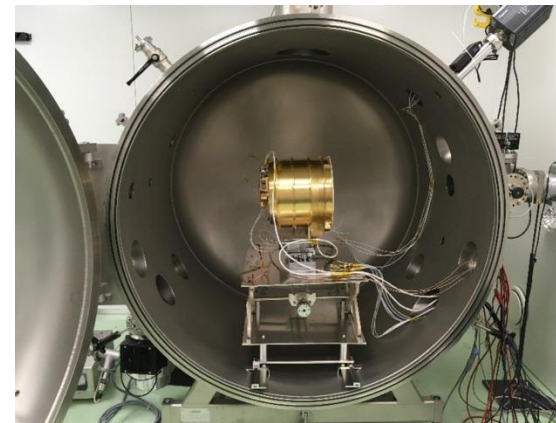
C. Gritzner, M. Noeker,
S. Ulamec, J.-B. Vincent
(DLR)



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. **Destiny+** – JAXA/DLR mission to 3200 Phaethon.
3. **Hayabusa2 extended mission** – to NEO 1998 KY26 (arrival 2031), after flyby of NEO (98943) Torifune in 2026.
4. **Asteroid Characterization** – ESA contract (MfN, Berlin), Jan 2023 – Dec. 2025. Impact experiments and simulations related to the DART/Hera missions (collaboration with TU Munich).
5. **RAMSES** – Europe’s mission to Apophis.



Hera

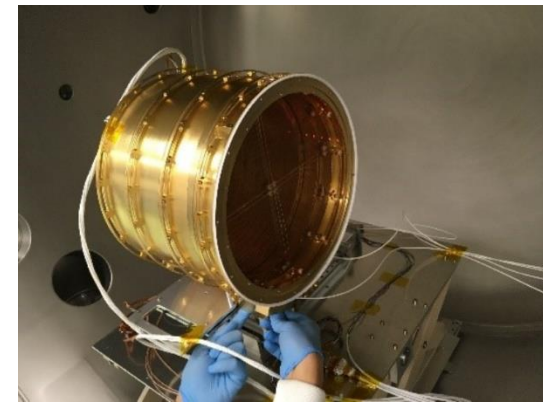
- Hera is the European reconnaissance mission to the Didymos system which complements NASA's kinetic-impactor mission, DART, with the aim of returning precise information on the effects of the DART impact.
- Germany is the largest contributor to the Hera mission (37,5 %), mainly via industry but is also 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).
- The German aerospace company, 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 contributions from TU Dresden.
- 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 scheduled for 12 March 2025



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

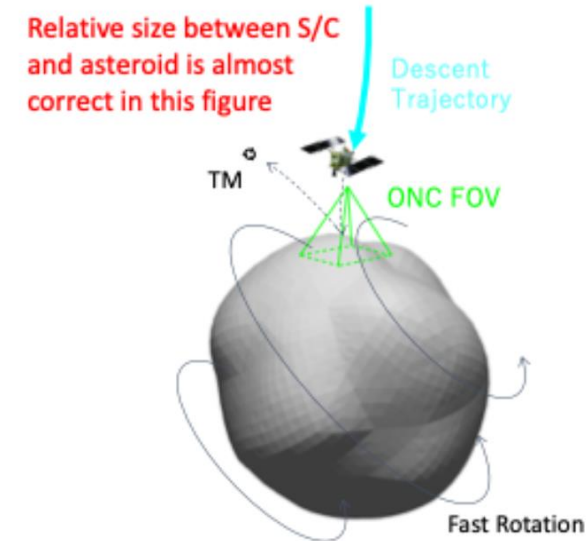
JAXA, Univ. Stuttgart, DLR

- 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), provided by the Univ. of Stuttgart with support from DLR.
- The engineering model of the DESTINY+ Dust Analyzer (DDA) is undergoing tests at a new dust accelerator designed for test and calibration purposes at the Univ. of Stuttgart. DDA is the main instrument of JAXA's interplanetary German-Japanese mission DESTINY+. The flight model is currently being integrated.



Hayabusa2 extended mission

- Flyby of NEO (98943) Torifune (D ~ 0.5 km) in July 2026.
- Arrival at 1998 KY26 (D ~ 0.3 km) in 2031.
- DLR membership in Science Team.



NEO 1998 KY26 and Hayabusa2

D ~ 30 m, rotation period ~ 10 min.



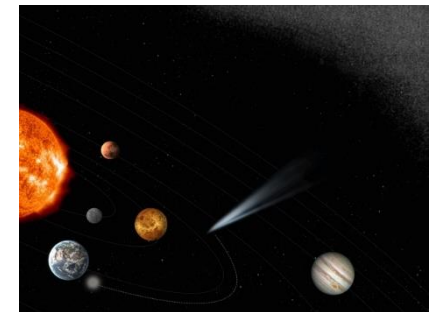
RAMSES

- Asteroid 99942 Apophis (D ~340m) will have a very close encounter (32000 km from the surface) with Earth on 13 April 2029.
- NASA's OSIRIS-APEX is going to Apophis, but will only reach it several weeks after the Earth encounter.
- ESA is planning the Rapid Asteroid Mission for Space Safety to address this challenge.
- S/C design, team, payload almost identical to Hera. Cameras and Laser Altimeter provided by Germany (Hera spares). S. Ulamec and J-B. Vincent are on the Mission Management Board.
- September 2024: ESA signed a 63 M€ contract with OHB-Italia to start building the RAMSES spacecraft.
- Final funding for mission pending Ministerial decision in November 2025.



Other Activities and Projects with German Involvement Relevant to Planetary Defence

- German Space Situational Awareness Centre
- Contributions to JAXA Mars Moons eXploration (MMX) Mission
- Comet Interceptor
- Psyche
- Lucy
- APOSSUM
- NEAlight



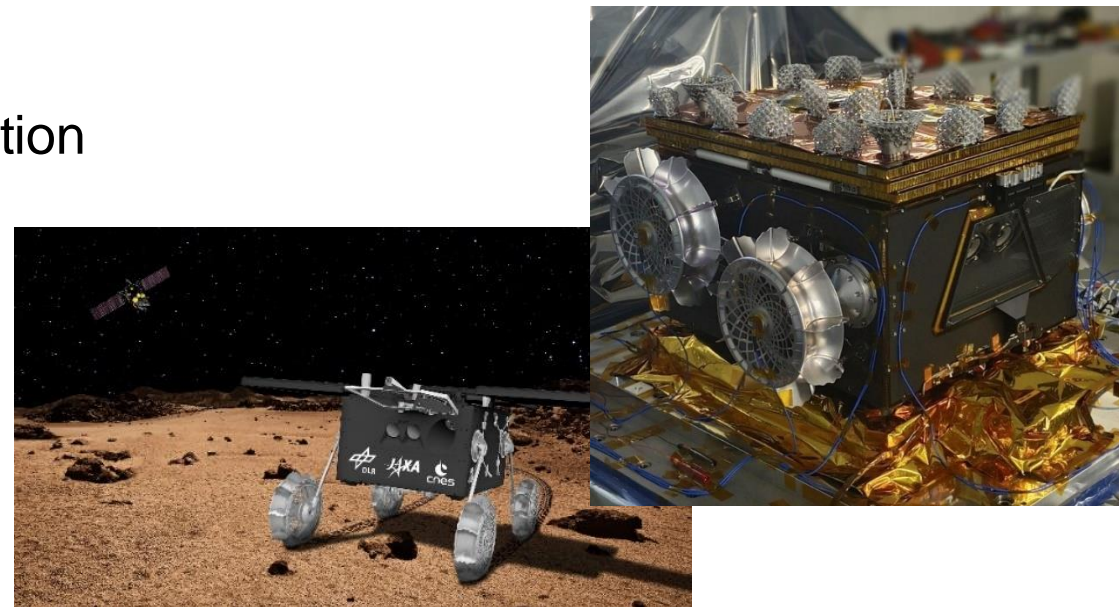
German Space Situational Awareness Centre ("Weltraumlagezentrum")

- Established on July 1, 2009, it became part of the new German Armed Forces Space Command on July 13, 2021. The Centre is commanded by a civilian/military dual leadership (DLR/Bundeswehr) and is situated near the town of Uedem, near the German-Dutch border.
- It is tasked with protecting German space-based civilian and military systems. Its brief includes publishing forecasts of the entry of objects into the Earth's atmosphere and the potential for damage (includes asteroids in addition to space debris - the Centre operates in collaboration with ESA).
- The Centre would likely play an important role in providing information and advice to federal and state governments in Germany in the event of a persistent and significant impact hazard.



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 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 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 (co-rider with ESA's ARIEL mission).
- 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).



Psyche

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

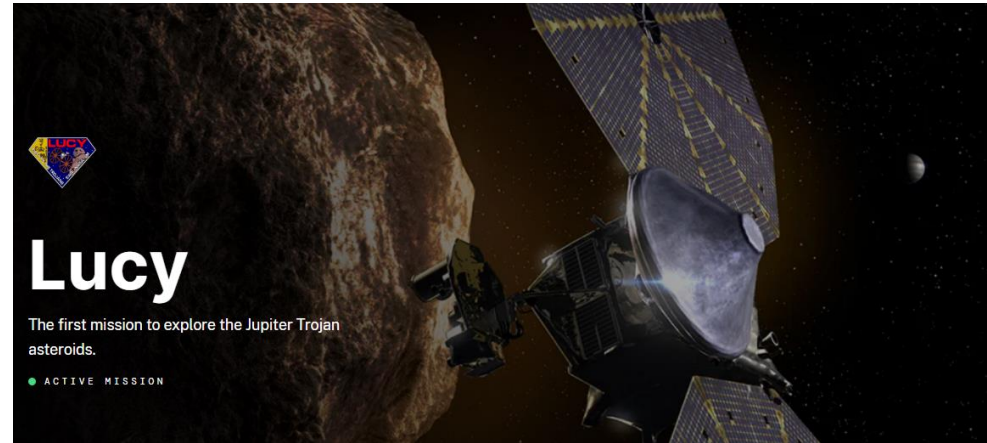


Credit: NASA/JPL-Caltech



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.
- Flyby of MBA (52246) Donaldjohanson (D ~ 4 km) 20th April, 2025.

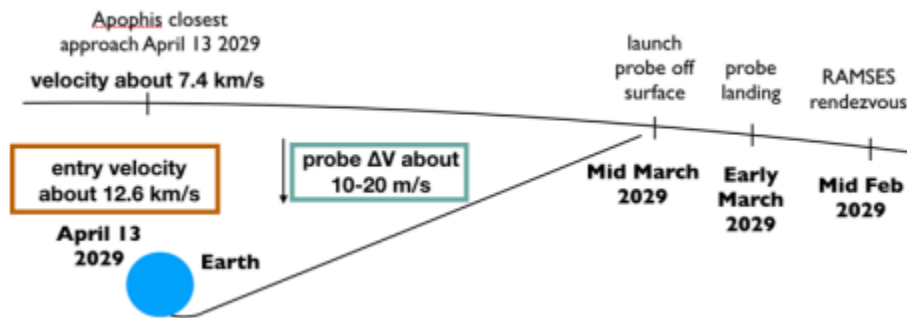


Credit: NASA/Goddard/SwRI/Johns Hopkins APL



APOSSUM

- Proposal for an Apophis Sample Return Mission as part of RAMSES. Return flight very cheap by hitchhiking on Apophis back to Earth.
- Two concurrent engineering studies conducted at DLR Bremen, funded by Max Planck Institute for Solar System Research. Sampler development study at University of Münster funded by the German Space Agency at DLR.



Credit: Max Planck Institute for Solar System Research

NEAlight

- Preliminary mission study for investigations of Apophis using small satellites (Uni. Würzburg).
- Study funded by the German Space Agency at DLR, but no mission funding allocated to date.

