# Current NEO-related Activities in Germany


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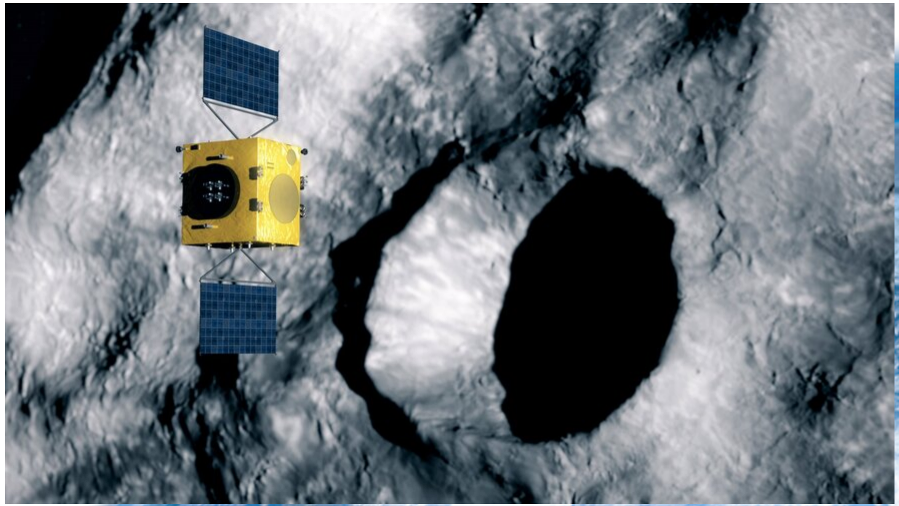

Knowledge for Tomorrow

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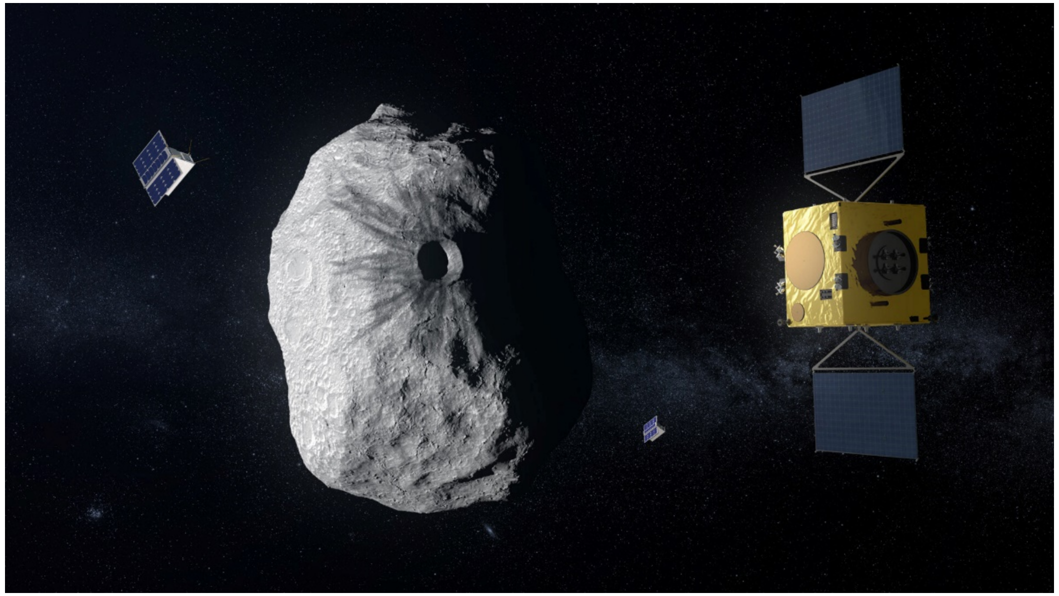
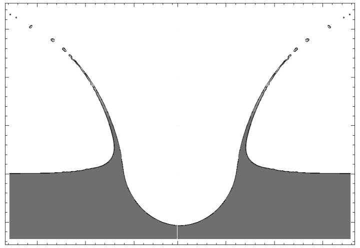
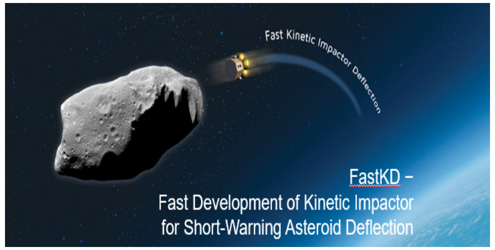
# Current NEO-related Missions and Projects with German participation



1. **Hera** – Europe's reconnaissance mission to Didymos and Dimorphos, planned for launch in 2024, following and complementing NASA's DART impactor.
2. **NEO-MAPP** – EU-funded project (Feb. 2020 – Jan. 2023) with work packages in support of Hera science.
3. **Impact Effects Engineering Tool** – ESA contract (Deimos, MfN)
4. **FastKD** – Fast Kinetic impactor Deflection mission concept.
5. **Destiny+** – JAXA/DLR mission to 3200 Phaethon.



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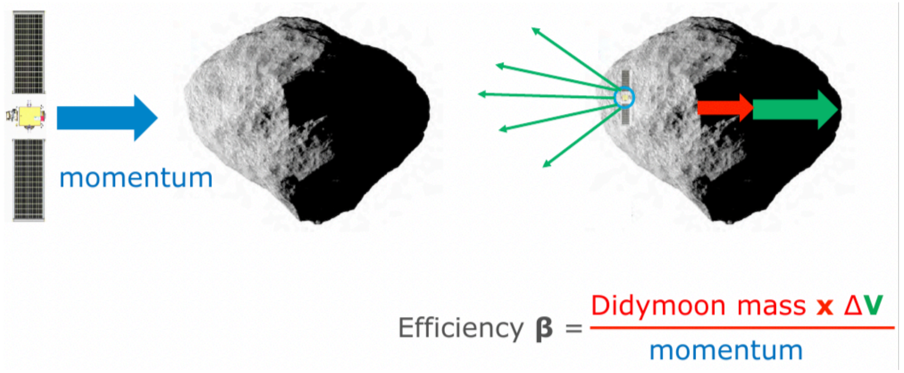
# Hera

- 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 participates primarily via industry but is also well represented in the core investigation team with a Management Board Chair (S. Ulamec, DLR), and two Scientific Working Group Leads (J.-B. Vincent, DLR, for the Data Analysis WG, and K. Wünnemann, Museum für Naturkunde, for the Impact Modeling WG).
- 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 MPS/DLR camera (Dawn's flight spare) has been de-selected in favour of a camera without a filter wheel from the German company Jena-Optronik. J.-B. Vincent (DLR) is the new instrument PI.
- Launch date: 2024; arrival: end 2026; duration of operations: at least 6 months.

# DART/Hera

MfN is represented in the DART and Hera mission working groups on impact simulations:

- Working group leaders:
  - Angela Stickle (DART, Johns Hopkins Applied Physics Laboratory)
  - Martin Jutzi (Hera, Univ. of Bern)
  - Kai Wünnemann (Hera, MfN, Berlin)
- Task: Conduct numerical models and laboratory experiments to predict the outcome of the DART impact experiment.

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# NEO-MAPP ('NEO Modelling and Payloads for Protection')

15 partners; funded Feb. 2020-Jan. 2023

## Tasks with German leadership or significant participation

### 1. Advanced payload synergies (DLR) - focusing on Hera

Develop innovative and synergetic measurement and data-analysis strategies that combine multiple payloads, to ensure optimal data exploitation for NEO missions.

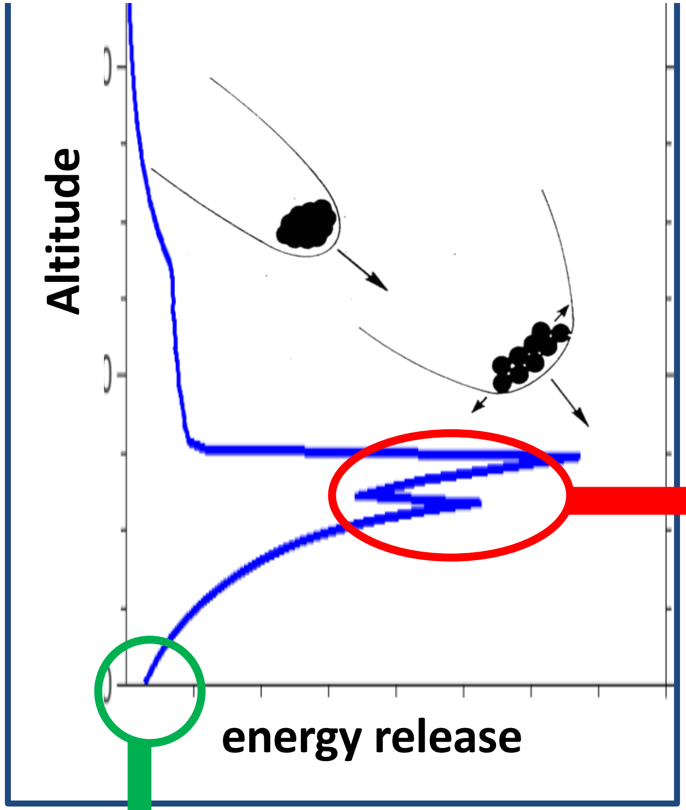
### 2. Simulation of the collision of a kinetic impactor with an asteroid by coupling different numerical approaches (MfN, Berlin)

Target properties determine:

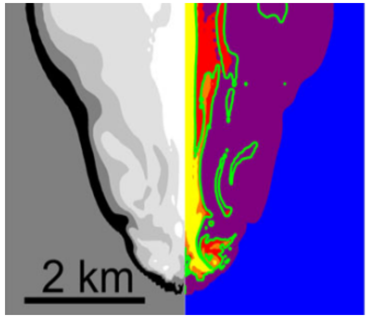
- Efficiency of Momentum transfer
- Crater morphology + morphometry
- Ejecta mass
- Global scale effects
- Impact seismicity

# The Impact Effects Engineering Tool (ESA contract)

**Considered impact scenarios:**
Stones diameter: 20–200 m
Irons diameter: 3 –50 m
Impact velocity: 11-40 km/s
Entry angles: 15 – 90°




- Contractor consortium for software development based on previous contract (The Impact Effects Knowledge-Base) DEIMOS (Lead, industry partner) and MfN
- Fast prediction of atmospheric and ground impact effects
- Combines fast semi-analytical models (parameterized approach) and demanding and computationally expensive computer simulations (database of pre-run simulations)




Small bodies tend to disrupt in the atmosphere
→ Atmospheric blast wave
→ Radiation of heat

Larger bodies and iron objects can reach the ground
→ Formation of craters or crater fields

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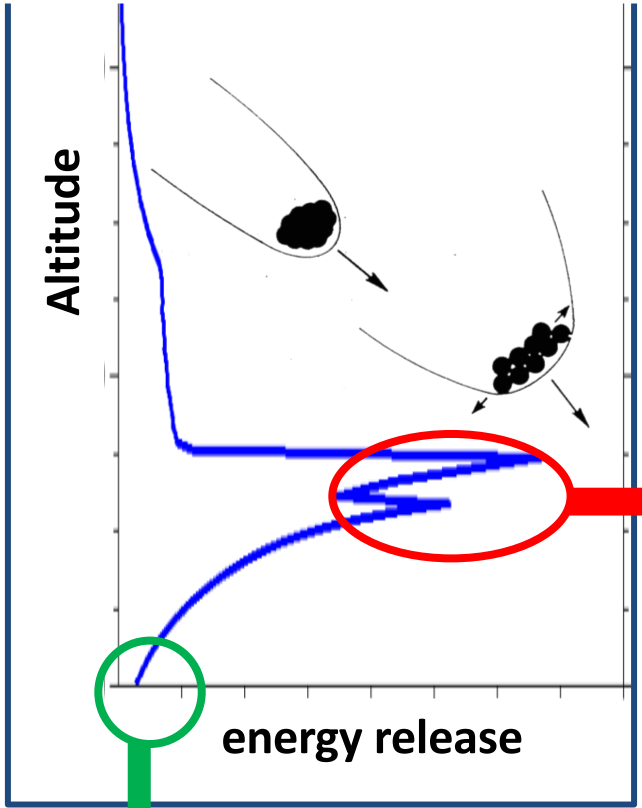
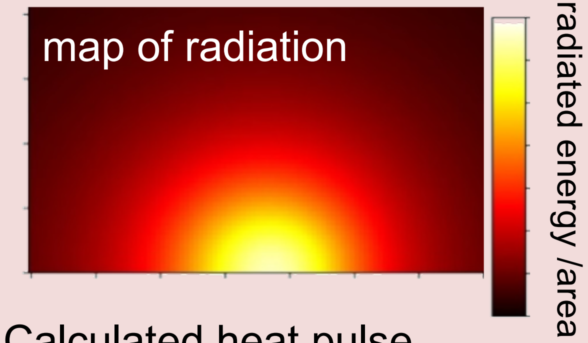



## Radiation: fires, skin burns

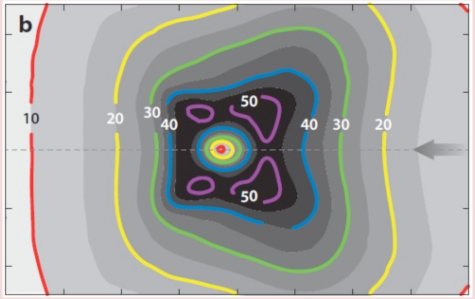

Chelyabinsk bolide.


Forest fires.



Calculated heat pulse.

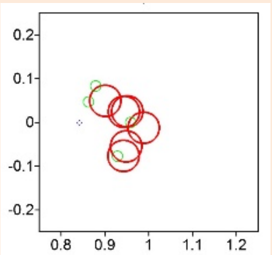
## Atmospheric shock waves: pressure pulse and winds

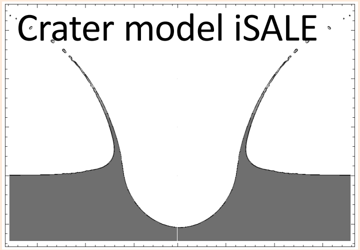



Tunguska event:
calculated winds and observed damage.

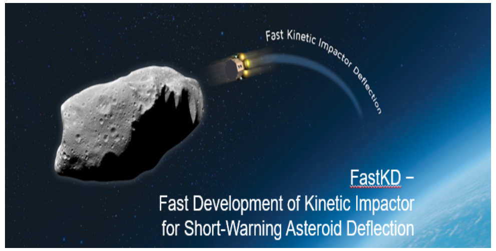

Chelyabinsk:
Broken glasses.

## Cratering event: strewn fields, single crater, ejecta



# Fast Kinetic Impactor Deflection Mission Concept (FastKD)




## Airbus DS, Germany

- With ESA funding, the Airbus Defence and Space operation in Germany ~~is assessing~~ has assessed the feasibility of modifying a commercial spacecraft platform in order to perform asteroid kinetic deflection in the shortest possible time.
- The tight schedule would be maintained by taking a commercially available (e.g. telecommunications) satellite and adapting it for the kinetic deflection attempt (actual build/adaptation time: 2-3 months; launch readiness: within 6 months from threat discovery).
- The results have ~~just~~ been presented to ESA and ~~will be~~ published ~~after evaluation~~.

7th IAA Planetary Defense Conference – PDC 2021
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**HIJACKING A SATELLITE FOR SHORT-WARNING ASTEROID DEFLECTION – FastKD MISSION, DESIGN AND IMPLEMENTATION**

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### 1 Scenario and objectives

The work published in this paper has been elaborated within an activity performed under a program of, and funded by, the European Space Agency. The scenario addressed within this study activity assumes the discovery of an asteroid whose orbit propagation reveals a high probability of Earth impact within a very short warning time of approximately 1-3 years. In such a scenario, one (or multiple) kinetic asteroid deflection missions are identified as a viable mitigation method, but because of the short warning time a significant consequence is an extremely constrained mission preparation time with a "to Launch" requirement of 6 months or less. This results in a build or system adaptation timeframe of 2-3 months.

The activity consequently assesses the feasibility of modifying a commercial spacecraft platform in order to perform asteroid kinetic deflection in the shortest possible time. Moreover, the necessary prerequisites to enable the challenging "build and launch of a Kinetic Impactor (KI) deflection system extremely fast".

The selected approach is outlined by "hijacking" an existing commercial platform with minimal adaptations and the addition of a pre-developed Kinetic Deflection (KD) module, providing in particular GNC impact capabilities, in order to convert it to an asteroid deflection mission.

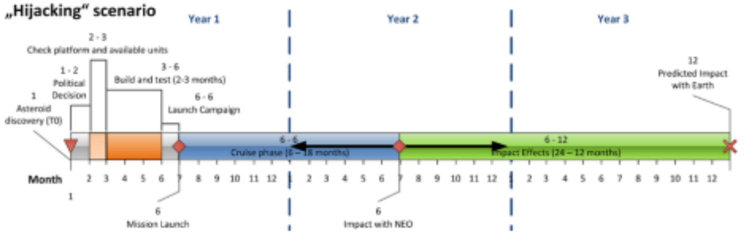


**Figure 1: Tentative timeline for the chosen "hijacking" scenario where predicted Earth impact is extremely time constrained (~1-3 years) allowing only minimal build and adaptation time.**

# Destiny+

## JAXA, DLR

- Mission selected by the Japanese space agency JAXA/ISAS for launch in 2023/2024 to fly by the active asteroid (3200) Phaethon in early 2028.

- The scientific payload consists of:
  - Telescopic Camera for Phaethon
  - Multi-band Camera for Phaethon and the
  - Destiny+ Dust Analyzer (DDA), Univ. of Stuttgart with support from DLR.


- The mission is described as a technology demonstrator to further improve operations of low cost solar electric propulsion in deep space and to demonstrate innovative light-weight solar array panel technology.

- It will observe dust from comet/asteroid 3200 Phaethon, parent of the Geminid meteor shower, using the dust analyzer and map its surface to understand the mechanisms of dust ejection. The spacecraft will pass as close as 500 km to the surface of Phaethon.

# Thank you! Any questions, comments?