ASTEROID IMPACT AND DEFLECTION ASSESSMENT (AIDA) MISSION: THE DOUBLE ASTEROID REDIRECTION TEST (DART)

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The Asteroid Impact and Deflection Assessment (AIDA) Mission: Introduction

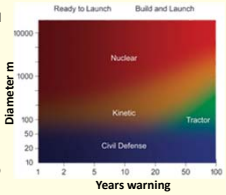
The AIDA mission will provide the first demonstration and test of the effectiveness of kinetic impactors for planetary defense. AIDA is a joint project between NASA and ESA. The NASA-led mission element is the Double Asteroid Redirect Test (DART) which is a kinetic impactor, a ~300-kg spacecraft designed to impact the moon of the binary system 65803 Didymos. The deflection of the moon will be measured by the ESA-led Asteroid Impact Mission (AIM) (which will characterize the moon) as well as by ground-based optical and radar observations.

AIDA is the first mission to demonstrate asteroid deflection by a kinetic impactor and to study a binary asteroid and its internal structure, physical properties, and origin. It will demonstrate interplanetary optical communication and deep-space inter-satellite links with CubeSats and a lander in deep space (done by AIM).

Spacecraft kinetic impact to change the course of an asteroid

AIDA: Critical Test of Asteroid Mitigation by Kinetic Impact

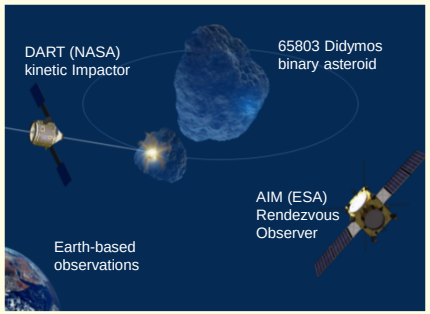
- **The asteroid threat is international**. Initially following the discovery of a hazardous asteroid, its impact location is uncertain, spanning borders and continents. Eventually the predicted impact is pinpointed to one nation, but even then its effects will be regional or even global. Prevention, preparation, and recovery must be coordinated internationally to benefit from worldwide resources and expertise.
- **Techniques for deflecting a hazardous asteroid require demonstration and validation prior to implementation against a real threat**. Kinetic deflection (crashing a massive rocket into an asteroid to move it off course) is the most mature and capable method of deflecting most asteroids, except for rare objects with short warning time or very large size.



Kinetic impactor technique assessed as most mature and capable of sufficient deflection except for very short warning or large size

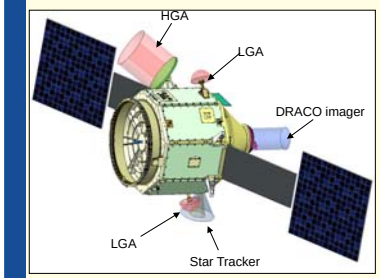
- Sophisticated models exist for simulating kinetic deflection, but **the predicted amount of deflection depends on physical properties that have never been measured on any asteroid**, and that AIDA is designed to measure.
- **The scale of a kinetic deflection event is much larger than can be accessed in laboratory experiments**, and occurs in a microgravity geology, so Earth-based experiments are helpful but insufficient.
- Until kinetic deflection models are benchmarked on an actual asteroid, their predictions will have unknown uncertainties, and the possibility of unexpected behavior that is overlooked or unresolved by the models.
- AIDA will characterize the physical properties and internal structure of the target asteroid prior to the kinetic impact, providing ground truth for making quantitative predictions of deflection.
- AIDA will provide an end-to-end test of the integrated technology required to carry out an asteroid deflection mission.

DART + AIM = AIDA



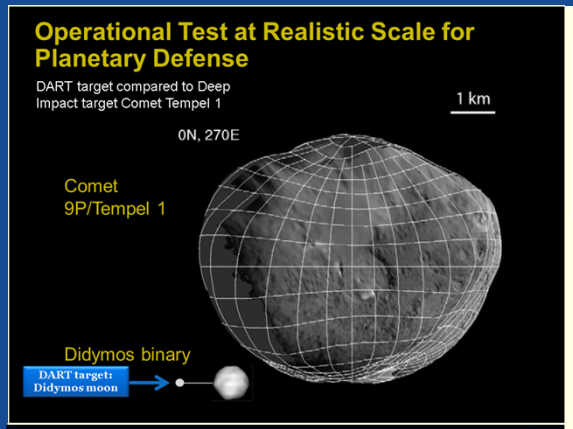
(left) Schematic of the AIDA mission concept. Although DART and AIM are independent missions, together they will provide the first measurements of a planetary-scale impact experiment with known impact conditions on a well-characterized target body.

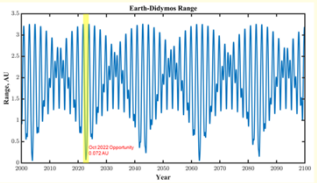
DART: Double Asteroid Redirection Test



The DART payload is one instrument, a high resolution imager derived from New Horizons LORRI

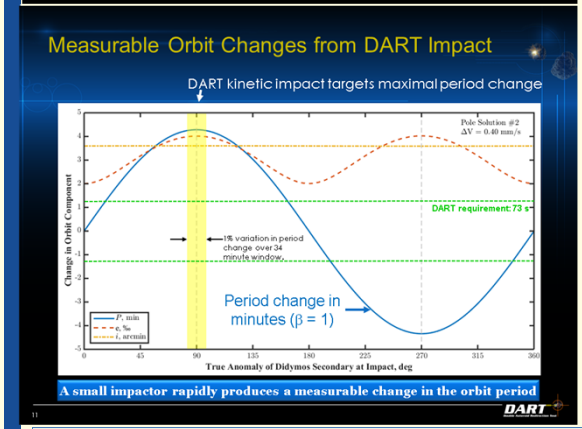
- NASA's DART mission is currently a Phase-A study. DART is a strategic technology demonstration that will launch in 2020 and impact the secondary of the Didymos binary system in 2022. DART will be a full-scale demonstration of asteroid deflection by kinetic impact
- DART will develop our understanding of impact effects at large scales, infer asteroid properties, and study long-term dynamics of impact ejecta
- DART will use ground-based observations to measure the binary period change from kinetic impact with an accuracy of 10%
- DART will return high-resolution images of the target prior to impact to determine the impact site and its geologic context





Didymos the only binary asteroid with Earth approaches close enough for ground-based measurement of the deflection magnitude and accessibility for AIM rendezvous at reasonable Δv.

The next intercept opportunity as favorable as 2022 at Didymos is after 2040



- **DART impact during excellent apparition: Didymos at V ~ 14-15, very well placed for Chile, observable from other observatories**
- **Didymos primary and secondary are separated by up to 0.02 arcsec when 0.08 AU from Earth**
  - **Marginally resolvable with ALMA (sub-mm), Magellan adaptive optics**
- **Post-impact brightening and ejecta stream as extended object ("coma") may be observable from Earth**
- **Debris cloud analogous to YORP-driven Main Belt Comets?**

AIDA Investigation Working Groups		
WG 1	**Modeling and Simulation of Impact Outcomes**	Angela Stickle, Paul Miller, Steven Schwartz
WG 2	**Remote Sensing Observations**	Andy Rivkin, Petr Pravec
WG 3	**Dynamical and Physical Properties of Didymos**	Derek Richardson, Kleomenis Tsiganis, Adriano Campo-Bagatin
WG 4	**Science Proximity Operations**	Stephan Ulamec, Olivier Barnouin