NEOShield – Progress Towards an International NEO Mitigation Program

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and the NEOShield Consortium
• November 2010: Submitted in response to the European Commission’s FP7-Space-2011 call for research proposals. Category: “Prevention of impacts from near-Earth objects (NEOs) on our planet”

• March 2011: After assessment, NEOShield topped the list of 6 proposals submitted in the category.

• November 2011: Negotiations with the European Commission were successfully concluded with the signing by the EC of the NEOShield Grant Agreement.

• January 2012: Kick off meeting

• June 2015: End of funding period. Duration: 3.5 years.

• Funds provided by the European Commission = 4.0 million euro.

• Total volume of NEOShield funding = 5.8 million euro.
The NEOShield Project

Brief description (1/2)

PRIMARY AIM: investigate in detail the three most promising mitigation techniques: kinetic impactor [O], gravity tractor [O], blast deflection [P].

Main themes/tasks of the project:

1. Science

• Physical properties of NEOs: Analyze properties from the point of view of mitigation requirements; what are the most likely properties of the first object to trigger space-borne mitigation action? [P]

• Mitigation precursor reconnaissance: Determine requirements, strategy, instrumentation, for ground-based facilities and space missions. [O]

• Lab. experiments on impacts - into asteroid surface analogue materials; validation of impact modeling at small scales.

• Numerical simulations: Impact and momentum transfer modeling scaled to realistic NEO sizes. [O]
Main themes/tasks of the project (continued):

2. Mitigation demonstration missions
   • **Suitable mission targets:** Identify and characterize suitable target NEOs for mitigation demo missions. [P]
   • **Space mission design:** Provide detailed designs of technically and financially realistic missions to demonstrate the effectiveness of mitigation techniques. Investigate mission funding and implementation options.

3. Global response campaign roadmap
   • **Impact threat response strategy:** Develop a decision-making tool [P] to aid in response planning. Develop a global response roadmap in collaboration with partners such as the UN, space agencies, etc.
The NEOShield Consortium

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<thead>
<tr>
<th>Participant organisation</th>
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Mitigation Demonstration Missions

- Modeling and computer simulations can give us some confidence, but there’s no substitute for proving we can move an asteroid by actually doing it.

- NEOShield funding does not stretch to launching a space mission but we aim to provide detailed designs of feasible mitigation demonstration missions, at least of the kinetic impactor and/or gravity tractor methods.

- Together with colleagues at ESA (SSA programme), the UN (COPUOS, Action Team 14 on NEOs), NASA, the European Commission, etc. we are working to establish a long-term program, including mitigation demo missions.
Mitigation Demonstration Mission Ideas

1. ESA’s Don Quijote Study

Two-spacecraft impactor mission:
*Sancho* (rendezvous)
*Hidalgo* (impactor)

Target size ~ 500 m

Objectives:

- **Pre-impact** *(Sancho 7 months at target):* Measure size, shape, bulk density, mass distribution.

- **Impact of Hidalgo:** Info. on regolith properties, internal structure.

- **Post-impact** *(Sancho 3-4 months at target):* Measure $\Delta v$, observe impact effects.
Mitigation Demo-Mission Ideas

2. AIDA/ DART

- currently at the feasibility study phase

1 or 2 spacecraft impactor mission:

*DART* (300kg impactor)  NASA  
*AIM* (rendezvous)  ESA

**Target:** 150 m moon of the binary NEO Didymos (mass of the moon ~9 million tonnes)  
**Impact time:** 2022 during close Earth approach.

*AIDA (= AIM + DART)* would do a full characterization of the kinetic impact and of the asteroid and moon.

*DART without AIM* would use ground-based observations to measure the 0.5-1% expected change in orbital period of the moon about the primary object. This would be a very basic demonstration of asteroid deflection at a low cost.
Future work relevant to impact mitigation should include:

- **Characterization of the NEO population:** the population of small NEOs (D = 50 – 300 m; some 200,000 objects) remains largely unexplored. We need to determine sizes, albedos, spin, mineralogy, shapes, densities, structures, porosities, frequency of binaries, frequency of rubble piles, etc.

- **Technology development relevant to:**
  - maneuvering close to small asteroids with very weak gravity fields.
  - accurate guidance, navigation and control systems.
  - sample collection, in-situ analysis, sample return to Earth.

- **Novel techniques for NEO mitigation:** The first hazardous NEO to trigger a space-borne mitigation action will probably be in the size range 50 m – 200 m. Techniques to deal with very small asteroids should be investigated.
NEOShield Presentations at the PDC

Watch out for:

Oral:

• Numerical Study of the Asteroid Deflection Efficiency of the Kinetic Impactor Approach in the NEOShield Project, Jutzi, Michel, Benz
• Performance and Derived Requirements of a Gravity Tractor Serving as a Precursor to a Kinetic Impactor Within the NEOShield Study Framework, Bellerose

Poster:

• NEO Threat Mitigation Software Tools within the NEOShield Project, Cano, Bellei, Martín
• NEOShield: The Physical Properties of the Most Frequent Impactors, Drube, Harris, Barucci, Fulchignoni, Perna
• Requirements for Mitigation Precursor Reconnaissance – a Study from the NEOShield Project, Perna, Barucci, Bancelin, Birlan, Eggl, Fornasier, Fulchignoni, Hestroffer, Thuillot, Harris
• Assessments of Blast Deflection of Asteroids, Meshcheryakov, Lipnitsky
• Choosing NEO Mission Targets: Current knowledge and Future Earth-Based Observation Opportunities, Fitzsimmons, Harris, Eggl, Perna
If implemented, SRCs will be multi-annual funding frameworks for the whole duration of H2020.

**SRC FOR: SPACE SITUATIONAL AWARENESS – NEOs**

*(one of 7 topics on the current short-list)*

“This SRC would deal with the detection, characterization, mitigation and exploitation of NEOs. The focus could be the development of a concept that will follow the entire development line from detection of the NEO, through the analysis of the object to the design of a mitigation strategy. The possible sub-areas of the SRC could be:

1. To establish an operating worldwide network for follow-up observations of NEOs.
2. Provision of a mitigation technology capable of averting a collision within broad parameters (for example, kinetic impactor, ion-beam shepherd or gravity tractor).
3. Development of technologies for asteroid resource exploitation.”
NEO Strategic Research Cluster in Horizon 2020?

- The European Space Sciences Committee (ESSC) of the European Science Foundation (ESF) is coordinating a consultation targeted specifically to the European scientific community; the objective of this initiative is to provide a consolidated input into the EC Strategic Research Clusters identification effort.

- This is the second step in the space sciences community consultation for the Strategic Research Clusters in H2020 Space.

- The European Space Sciences Community is invited, through an on-line questionnaire to review, profile and elaborate on the proposed topics. The link to the questionnaire can be found here:

  http://www.research.net/s/ESSC_consultation_phase2

  N.B. The questionnaire will be online until 29 April 2013.