NEOShield – Progress Towards an International NEO Mitigation Program

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NEOShield

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)

[O] = Oral presentation[P] = Poster

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]







The NEOShield Project Brief description (2/2)

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

Participant organisation	Leading personnel	Country
German Aerospace Center (DLR), Berlin Coordinating partner	A. W. Harris	Germany
Observatoire de Paris (LESIA and IMCCE)	LESIA: M. A. Barucci, M. Fulchignoni IMCCE: D. Hestroffer, W. Thuillot	France
Centre National de la Recherche Scientifique (Observatoire de la Côte d'Azur)	P. Michel	France
Open University	S. F. Green	UK
Fraunhofer – Ernst-Mach-Institut	F. Schäfer, M. Rudolph	Germany
Queen's University Belfast	A. Fitzsimmons	UK
Astrium (supervisory interface for technical work packages)	N. Saks, U. Johann M. Chapuy, E. Kervendal S. Eckersley	Germany France UK
Deimos Space	J. L. Cano	Spain
Carl Sagan Center, SETI Institute	D. Morrison	USA
TsNIIMash (Roscosmos)	S. Meshcheryakov	Russia
University of Surrey	V. Lappas	UK





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 Δv, 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

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:

 To establish an operating worldwide network for follow-up observations of NEOs.
Provision of a mitigation technology capable of averting a collision within broad parameters (for example, kinetic impactor, ion-beam shepherd or gravity tractor).
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.

