

Roadmap of Relevant Research for Planetary Defense v. 2.0

SMPAG working plan activity 5

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The tasks:

1. Monitor relevant activities of space agencies and other organizations.
2. Identify technological and scientific activities relevant to space missions for planetary defense (e.g. for in-situ reconnaissance, deflection demonstration and emergency deflection missions) requiring emphasis in future work; such activities may include mission-related observational projects, e.g. for NEO physical characterization, and laboratory experiments and modeling/analysis work.
3. Develop/update an international strategy for future missions and mission-related research and development work in support of planetary defense.
4. Analyze and report on the effectiveness of international collaboration and funding of mitigation activities.




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Changes since last version

- Updated the information and improved the text
- Removed section on
 - ARM
 - Sentinel
 - “Rapid Response to the next TC3” consortium
- Added illustrations
- Added more references
- Added sections on
 - NEODys
 - Laser ablation
 - Asteroid mining
 - Research group in Asteroid Redirection/Utilization at Luleå University of Technology, Sweden
 - Asteroid observation using VLBI networks
 - Asia-Pacific Asteroid Observation Network
 - Appendix B: Summary of mitigation methods for asteroids and comets



Summary and conclusions 1/3

Despite significant progress over the past decade or so much more needs to be accomplished before the international community can feel adequately protected from a potentially catastrophic asteroid impact. We have identified the following areas as requiring continued or increased effort at the present time:

- The development and execution of technically and financially realistic **test missions** to enable deflection concepts to be tried out on real asteroids.
- Remotely-sensed **physical characterization of small NEOs** (radar, infrared, visible, etc. observations; analysis of archival data). Asteroid observing strategies and campaigns need to be coordinated internationally to make the most efficient use of available telescope time. A dedicated space based thermal-infrared telescope would be a very valuable asset for simultaneous NEO discovery and characterization.
- The development of a **rapid-response network** for physical characterization of asteroids during the discovery apparition.



Summary and conclusions 2/3

- The development and **execution of space missions** for surface material sample return and/or in-situ characterization of asteroids.
- **Laboratory tests** for a range of asteroid analog materials to better understand impact effects on asteroids.
- **Computer modeling** with more complex and realistic conditions to understand impact effects on asteroids.
- The development of plans for a **rapid-reconnaissance space mission** to be launched promptly in case of a real impact threat, to gather information on the physical properties of the asteroid and its orbit.
- The development of **new deflection techniques for small NEOs**.
- The development of **reliable codes for Earth impact consequences assessment** taking account of the full range of expected effects.
- The development of **software tools for emergency deflection campaign planning** to inform decision making.
- Exploration of synergies between the fields of NEO deflection and **asteroid mining**.



Summary and conclusions 3/3

- Funding for the tasks described in this document has increased significantly in recent years but is concentrated in the US and Europe, and in the case of Europe it is largely dependent on short-term funding with no guarantee of continuity.
- The lack of continuity is a major problem in a field in which many projects are necessarily long-term (e.g. the development and execution of a space mission can take a decade or more), and specialized personnel with vital expertise are lost as soon as funding runs out.
- *The impact-hazard problem is a permanent problem that requires permanent research and development work.*