

PDC2025
Stellenbosch, Cape Town, South Africa

□ **Hypothetical Asteroid Threat Exercise**

**Overall Results of the SMPAG Work Package on Mission Scenarios in
Response to the 2025 Planetary Defense Conference Hypothetical Asteroid
Impact Threat Scenario**

Juan L. Cano⁽¹⁾, Brent W. Barbee⁽²⁾, Michael Khan⁽³⁾, Camilla Colombo⁽⁴⁾,
Massimiliano Vasile⁽⁵⁾, Richard Moissl⁽⁶⁾, Detlef Koschny⁽⁷⁾

⁽¹⁾ ESA ESOC / Planetary Defence Office, Robert-Bosch-Straße 5, 64293, Darmstadt, Germany

⁽²⁾ NASA/Goddard Space Flight Center, Code 595, 8800 Greenbelt Road, Greenbelt, MD, 20771,
USA, 301-448-5681

⁽³⁾ ESA ESOC / Mission Analysis Office, Robert-Bosch-Straße 5, 64293, Darmstadt, Germany

⁽⁴⁾ Department of Aerospace Science and Technology, Politecnico di Milano, Via La Masa 34, 2016
Milano, Italy

⁽⁵⁾ Department of Mechanical & Aerospace Engineering, James Weir Building, 75 Montrose Street,
University of Strathclyde, Glasgow, United Kingdom

⁽⁶⁾ ESA ESOC / Planetary Defence Office, Robert-Bosch-Straße 5, 64293, Darmstadt, Germany

⁽⁷⁾ Lunar and Planetary Exploration, TUM, Lise-Meitner-Str. 9, 85521 Ottobrunn, Germany

Keywords: *Planetary Defense, Asteroid Deflection, Mission Analysis, Trajectory Design*

Members of the UN-endorsed Space Mission Planning Advisory Group (SMPAG) are conducting a hypothetical asteroid impact threat exercise in preparation for the 2025 Planetary Defense Conference (PDC2025). The exercise is articulated along two injects played in real time. The first one started on 1st August 2024 and lasted until mid-October with the drafting of a series of recommendations from SMPAG for an international response to the threat represented by simulated asteroid 2024 PDC25. The second inject will be available from December 2024 and simulated in the subsequent weeks, with an updated series of recommendations to be produced by SMPAG in early February.

During the first inject, several work packages were identified and assumed for coordination by different SMPAG members. ESA proposed to coordinate WP01 devoted to the definition of the possible mission scenarios. Those scenarios included reconnaissance options and deflection options.

Main contributors to this joint effort have been the NASA's mission assessment team (including several institutions) [1], ESA's mission analysis team, a team from Politecnico di Milano as part of the Italian Space Agency delegation [2] and a team from University of Strathclyde as part of the UK Space Agency delegation. Discussions were held on a weekly basis (on Fridays), allowing the different teams to present new results at each opportunity. Flyby and rendezvous options were considered for the reconnaissance missions, and impact and rendezvous options were considered for the deflection missions. Different launcher options and deflection options were studied

(including kinetic impactor, nuclear explosive device (NED), and ion beam and laser beam deflection).

A wealth of results was presented and considered along the period by the different teams. The coordination activities involved the discussion of mission goals and assumptions, the joined analysis of mission options, the definition of priorities for the actions to be taken, the approach for the crosschecking of results and the initial proposal of recommendations. These were based on the analysis of the possible mission options available and on the establishment of timelines for mission deployment. The main recommendations included:

1. Start, as soon as possible, the initial design phases (so-called phases A/B) of a fast flyby reconnaissance mission
2. Consider re-tasking already flying spacecraft to perform an early reconnaissance of the target asteroid.
3. Start, as soon as possible, the initial design phases (phases A/B) of a solar electric propulsion rendezvous reconnaissance mission, independently of the implementation of an earlier flyby reconnaissance mission.
4. Start, as soon as possible, the initial design phases (phases A/B) of in-space mitigation missions, based on the following concepts, including the risk assessment on each option: kinetic impactor (deflection and disruption missions) and ion beam deflection.
5. Perform detailed simulations assessing the possibility to disrupt an asteroid by an impulse transfer.

Those recommendations were put in a dedicated SMPAG document. This document can be distributed by UNOOSA to member countries, and by SMPAG delegates in their own decision hierarchy.

Coordination results deriving from the second inject starting in December will be also discussed at the Conference.

Comments: Oral presentation slot preferred.

- [1] B. Barbee, J. Atchison, R. Bull, M. Burkey, W. Caldwell, P. Chodas, J. Dotson, D. Farnocchia, K. Fast, L. Johnson, K. Kumamoto, J. Lyzhoft, D. Mazanek, R. Park, J. Pearl, C. Plesko, I. Santistevan, M. Vavrina, **NASA Analysis of Space Mission Options for the 2025 Planetary Defense Conference Hypothetical Asteroid Impact Threat Scenario**, Abstract Submitted to the Planetary Defense Conference, 2025.
- [2] S. Franzese, E. Basile, E. M., Polli, P. Vasiliki, M. Castronuovo, **Analysis of Asteroid Deflection Mission Options for the 2025 Planetary Defense Conference Hypothetical Asteroid Impact Threat Scenario by the Italian Space Agency delegation at SMPAG**, Abstract Submitted to the Planetary Defense Conference, 2025