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Grabbing a sample from a real Near-Earth Asteroid (NEA): A very fast Sample Return Mission opportunity

Martin Hilchenbach(1)**, Thorsten Kleine**(1)**, Jan Thimo Grundmann**(2) **and APOSSUM Team**(2)
(1)*Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany*
(2) *DLR Institute of Space Systems, Robert-Hooke-Str. 7, 28359 Bremen, Germany*

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A mission to NEA (99942) Apophis would provide a unique opportunity to collect and return a regolith sample from a NEA as it passes very close to Earth. ESA is currently investigating the possibility of an orbiter, as part of the RAMSES mission study, to fly close to (99942) Apophis before it makes its closest approach to Earth on Friday, April 13, 2029, with the aim of observing the tidal and magnetospheric effects on the NEA during this close flyby. Later, the asteroid will be well observed by NASA's OSIRIS-APEX mission. At present, none of these missions or mission studies are investigating the possibility of sample return with a very short duration sample return leg, requiring only a tiny additional momentum to return to Earth. We present the results of a concurrent engineering (CE) study on the feasibility of a sample return capsule based on "now-term technology" available from the space industry named APOphiS SUrface saMpler (APOSSUM). The APOSSUM design assumes to be detached, touch and go with semi-autonomous navigation guidance, actively controlled by thrusters while collecting the regolith matter by means of rotating brushes, and by mid-March 2029 be guided towards Earth at a speed offset

of a few tens of meters per second relative to the asteroid. This is orders of magnitude less than the speed required by previous sample return missions due to the very close Earth flyby of (99942) Apophis on April 13, 2029 and the total time needed for return phase is less than a month and the overall mission time is less than a year. The regolith sample contained in the return capsule will arrive on Earth just as the asteroid passes at a safe distance. The spacecraft's entry velocity is about 12.6 km/s, compared to the asteroid's 7.4 km/s flyby, due to Earth's gravitational field. The spacecraft is designed around the entry capsule which, as the sampler, is a mission specific development. The attitude and orbit control systems are based on flight-proven cameras, sensors and propulsion units. The outlined brief sample return mission design scenario is applicable within the design resources to any NEA target asteroid.