

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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DOCKING IMPENDER - PRELIMINARY PERFORMANCE RESULTS

**Abstract**

Consortium under ESA Startiger scheme, led by ABM Space Education from Poland is developing the Docking Impender, an innovative orbital docking system, basing on an awarded solution of kinetic energy absorbers. The "Impender" is a name derived from "Impact Defender", but it also describes a system securing an impending contact of two orbital objects, that have only limited maneuvering potential (with no or limited retrorocket use). The first concepts of the kinetic energy absorbers were initially used for prototype car bumpers and they base on dissipation of the impact energy by a special transmission mechanism, eventually accumulating it in a rotor. In case of orbital motion the rotor can also be used for additional stabilization and control of the docked objects. Docking Impender offers several advantages in relation to traditional docking systems: no rebound, higher allowed approach velocities and larger approach angles (larger error margin), recovery of electricity from the rotor for communication or other purposes, additional stabilization by the rotors (acting as gyroscopes), overall decrease of the vehicle mass due to lower retrorocket participation. Furthermore the system has a relatively simple structure and can be modular: separate modules can be used as standalone docking ports or they can be multiplied and placed on a circumference of a hatch. The system is currently tested on a cubesat-compatible models, on an air-bearing table and in thermal-vacuum chambers. This is to provide demonstration of the performance and a basis for rescaling of the system to adapt it to larger satellites or crew vehicles. The system can also be adapted to docking/landing of vehicles on low-gravity celestial bodies, such as asteroids. Theoretical scaling models and simulations suggest that a version of Landing Impender could eliminate such problems as Phileas' triple rebound on the Churyumov-Gerasimenko comet surface or could aid landing of reusable rocket stages. At the moment of abstract submission the Docking Impender ESA Startiger project is pending, and the results will be available in August 2015. There are analyses pending related to non-space market implementation of the concept (for instance in the lifeboat splash-down protection, air-drop crate protection, etc.).