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# Summary Statement by B612 Foundation regarding its contract with JPL to conduct a detailed performance analysis of a transponder equipped Gravity Tractor spacecraft[1]

A successful NEO deflection campaign will involve several key functional elements, including the ability to, in situ, precisely determine the orbit of a threatening NEO prior to and post deflection, and to precisely adjust the NEO's orbit to assure its successful passage between return keyholes at the time of its closest approach to Earth. B612's contract with JPL called on it to quantify these two critical capabilities. The analysis verified the viability of the transponder-Gravity Tractor (t-GT) spacecraft to perform these critical deflection functions. A full report of this work is now available on the B612 website at http://www.b612foundation.org/press/press.html, #18.

In summary a 140 meter diameter equivalent, Hayabusa-shaped NEO, with a rotation period of 6 hours was approached by the t-GT spacecraft with the initial task of determining a precise orbit for the NEO. Effective convergence in the orbit determination was reached after approximately 8 days of tracking and resulted in about a 5 meter (one sigma) error ellipse projected forward 18 years in time. A second orbit determination was performed following a simulated kinetic impact deflection during which the t-GT functioned as a stand-off observer. The post-deflection orbit determination converged to the pre-deflection precision level of accuracy in only one day of tracking.

The solar powered, 1150kg. t-GT spacecraft towing performance evaluation was performed in a 200 day simulated operation in which the t-GT was stationed 155 meters forward of the NEO center of mass along its velocity vector. A very simple control law was employed to maintain the spacecraft within a "box" centered on this nominal location. No control problems or unusual excursions were experienced during the months of towing which produced the desired velocity change of ~0.07cm/sec. During towing a NEO acceleration of 0.22 microns/sec/day was achieved at a fuel expenditure of approximately 0.05 kg/day.

The study confirms that a t-GT spacecraft can determine the orbit of an asteroid accurately enough to assess whether or not it is on an impact course with Earth, even if that course must pass through a relatively small keyhole first. Furthermore, towing operations by such a spacecraft will work with a simple and robust spacecraft design. Finally, the GT towing capability is adequate to assure that an asteroid does not pass through a return keyhole[2] whether such threat arises naturally (e.g. Apophis in 2029) or as the result of a preceding primary deflection impulse.

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[1] *Near-Earth Object (NEO) analysis of Transponder tracking and Gravity Tractor Performance*, September 1, 2008, D.K. Yeomans, S. Bhaskaran, S.B. Broschart, S.R. Chesley, P.W. Chodas, M.A. Jones, and T.H. Sweetser

[2] Each such instance will be unique and detailed analysis will be required to determine both mission requirements and GT capability