PDC2015
Frascati, Roma, Italy

☐ **Planetary Defense – Recent Progress & Plans**
☐ **NEO Discovery**
☐ **NEO Characterization**
☒ **Mitigation Techniques & Missions**
☐ **Impact Effects that Inform Warning, Mitigation & Costs**
☐ **Consequence Management & Education**

IAA-PDC-15-P-78

Performance Assessment of the Nuclear Cycler Concept

Nicolas Thiry [(1)]**, Chiara Tardioli** [(1)]**, and Massimiliano Vasile** [(1)]
[(1)(2)]*University of Strathclyde, 75 Montrose Street, Glasgow, G1 1XQ*

Keywords: *Asteroid Mitigation, Nuclear Interceptor, Incremental Deflection*

ABSTRACT

The nuclear cycler is a variant of the stand-off nuclear blast technique for asteroid deflection. The main idea behind the nuclear cycler is to go from a single shot deflection strategy to an incremental one in which multiple nuclear bombs can be deployed from a vantage point at a distance from the asteroid. The spacecraft carrying the bombs is maintained in formation with the asteroid, exploiting natural dynamics, and periodically drops a bomb probe that detonates at the optimal altitude from the target. It can be demonstrated that this incremental approach provides performance comparable to a single explosion but with a higher degree of controllability and redundancy. As the warning time falls below a single asteroid orbit revolution, the nuclear cycler approaches the single nuclear explosion.

This paper will present an assessment of the performance of the nuclear cycler in different mission scenarios and for different types of asteroids. Although the effectiveness of the nuclear cycler is virtually independent on the distance from the Sun, the schedule used to deploy the bombs has a dependency on the orbit characteristics. More importantly the outcome of the stand-off nuclear blast is dependent on the material the asteroid is made of and the shape.

The model presented in this paper takes into account the shape and composition of the asteroid, A number of these key physical parameters, such as sublimation enthalpy, conductivity, detonation altitude, and material density are affected by a degree of uncertainty that can significantly affect the outcome of a deflection. The paper will present a preliminary uncertainty analysis and a robust deflection strategy that accounts for uncertainty in the key model parameters.

The uncertainty region in the model parameter space is propagated together with the uncertainty in the initial conditions to derive the dispersion of all the possible virtual impactors on the impact plane at the Earth. The control of the deflection action is

then optimised to minimise the collision risk. Since the collision risk depends on the probability distribution of the input uncertainty, the theory of Upper and Lower Previsions is used to account for uncertainty on the probability distribution itself.

****