A Kinetic Impactor Technology Demonstration Option for the BASiX Mission. S. R. Chesley1, D. J. Scheeres2, P. A. Abell3, E. Asphaug4, and D. S. Lauretta5.  

**Introduction:** We propose to fly a kinetic impactor demonstration in concert with the proposed BASiX Discovery mission. BASiX is a mission proposal to visit binary asteroid (175706) 1996 FG3 and perform repeatable geophysics experiments in order to reveal the geotechnical properties of a rubble pile asteroid and understand the dynamical evolution of a binary asteroid system. A key mission objective for BASiX is the delivery of small high-explosive BlastPods to the asteroid’s surface that would be used to probe the mechanical properties of the surface and subsurface materials.

The proposed kinetic impactor spacecraft would launch with the BASiX mission as a secondary payload. The BASiX Impactor would separate immediately after launch and continue on its own trajectory to an impact with the secondary body of 1996 FG3, arriving after BASiX has completed its baseline mission at the asteroid. The concept is similar to the ISIS mission concept that proposed to use the OSIRIS-REx spacecraft to observe an impact at that mission’s asteroid target (101955) Bennu [1].

**An ambitious TDO:** The BASiX Impactor is to be proposed as a Technology Demonstration Option (TDO) as a part of the BASiX Discovery proposal. The 2014 Discovery Announcement of Opportunity (AO) states that TDOs must be clearly separable from the primary mission in the event that the TDO is not selected or the development does not conclude successfully. The BASiX Impactor concept certainly fulfills this requirement because the two spacecraft are built and delivered to the launch pad separately. And even late in development the impactor can be eliminated or replaced with a mass simulator. After the post-launch separation, BASiX carries out its entire primary mission without reference to the impending arrival of the kinetic impactor.

The Discovery AO also indicates that TDOs should demonstrate relevant technologies that may enhance the host mission’s science or that of future missions. The BASiX Impactor TDO would demonstrate two key technological abilities, namely precision terminal guidance and asteroid deflection techniques. While the technology for a hypervelocity impact with targeting accuracy ~50 m is available, it has yet to be demonstrated in an interplanetary environment. And measuring an asteroid’s change in velocity in response to such an impact would dramatically improve confidence in our technical ability to perform a real-world asteroid deflection.

**Schedule:** The BASiX Impactor TDO would launch with BASiX in Dec. 2020. BASiX arrives at 1996 FG3 in May 2024 and conducts its prime mission, including Science Enhancement Activities for nine months, concluding in Feb. 2025. The impactor arrives in June 2025 with an arrival mass of 600 kg and an impact velocity of 16 km/s. This translates to 78 GJ of kinetic energy (19 t TNT equivalent).

**Objectives:** The BASiX Impactor would significantly extend the science returns of the BASiX mission by anchoring two points on the energy curve. A BlastPod explosion would release an energy of 20 MJ, enough to create a crater up to several meters in diameter, while the BASiX Impactor would release 4000× more energy and would create a 10× larger crater. The experiment would be a direct and immediate test of the knowledge gained from the primary mission. The prime mission is focused on the primary body, and the Impactor would extend the knowledge to the secondary with a much deeper look into the interior.

The impact would also induce seismic waves that travel through the body and reflect off boundaries. This would induce lower energy disturbances far from the impact site, providing a seismic experiment that may loft material, cause landslides and topple boulders across the body. The comparison of pre- and post-impact imagery would provide strong constraints on the local and global stability of rubble pile asteroid surfaces.

The impact would also induce a change in velocity of the target asteroid of roughly 0.12 mm/s. This effect would be readily detectable as a change in the binary system mutual orbit, and thus would reveal the amount of momentum enhancement derived from escaping ejecta, a key question for planetary defense applications.

**Conclusion:** The BASiX Impactor TDO would lead to significant science enhancement and provide the first-ever asteroid deflection demonstration. By utilizing an already-present observer spacecraft it would leverage significant NASA investments for a dramatic gain in our understanding of how asteroids respond to kinetic impactor deflections.