

Low Frequency, High Resolution Inverse Synthetic Aperture Radar (ISAR) for Imaging Interior Geology of Asteroids/Comets. M. D. Deshpande, D. Smith, J. Garvin, P. Racette, D. Bradely

The Near-Earth Objects (NEO) Program in the NASA's Science Mission Directorate under the George E. Brown, Jr. Near-Earth Object Survey Act of 2005, has been authorized to detect, track, catalogue, and characterize, all potentially hazardous objects greater than 140 meters in dimension and within 0.05 AU of the Earth's orbit by the end of 2020. One of the important directives under this act is to develop robust technologies to estimate NEO's mass and its orbit, determine whether a NEO presents a potential threat, and provide information to mitigate such a threat. If a scenario of an asteroid on a collision course with the Earth is predicted in advance, one of the approaches suggested to mitigate it is use of explosives to deflect or destroy the approaching asteroid. However, the outcome of such an explosive energy transfer is extremely dependent upon the integrity of asteroid's internal structure as are several of the other possible deflection techniques. Information about the interior of NEOs obtained from the sensors deployed on the Earth and sensors deployed recently onboard the orbiting platform is limited to bulk density properties of these objects. The Science Mission Directorate for its future missions to NEOs and other planets will require low frequency (25~200MHz), high bandwidth or step frequency ISAR radar to image 3-dimensional interiors of NEOs/planets. At present these low frequency, limited bandwidth (<1MHz), and bulky ground based radars are used for studying high-altitude atmospheric discharges, wind profilers, sea surface waves, and underground mapping of buried objects. In this work, we present a low frequency (25~100 MHz) radar operating over a wide frequency band (75 MHz) being developed at NASA Goddard Space Flight Center. Using the frequency hopping technique (pulsed step frequency radar) a wider over all bandwidth is achieved while keeping low instantaneous bandwidth. A wider over all bandwidth allows to obtain very fine down range resolution (2~3 Meters) while keeping less restriction on the digital processing due to very low instantaneous bandwidth. In this presentation the ISAR hardware development at GSFC and its validation with simulated results will be discussed.

The low frequency ISAR radar technology (with larger bandwidth) will improve the scientific return for the near term as well as long term missions sponsored by the NASA's Near-Earth Objects Program. Furthermore, lightweight low frequency ISAR radar will be essential for future missions to the Moon, Mars and others, for planetary geology and geophysics explorations. The Near-Earth Objects, apart from being hazardous, can be objects that could easily be exploited for their raw materials which can be used for building space structures and in generating rocket fuel. The proposed ISAR radar can be used for identifying constituent materials of NEOs and their usefulness.