# Characterizing Space Debris Objects using Simultaneous Multi-Color Optical Array

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## ABSTRACT

Optical characterization of resident space objects (RSOs) in low-Earth (200-1,800 km) and medium-Earth (1,800-35,000 km) orbits is challenging due to their small size and fast rate of motion. RSO characterization is important for differentiating between debris and active satellites. To overcome these challenges, we have constructed a multi-aperture array on an alt-alt telescope mount controlled by Sidereal Technologies software capable of tracking RSOs at various altitudes. The primary aperture is 200 mm with an F/1.9 focal ratio. The detector field of view is 2.4 x 1.8 degrees with a pixel scale of 1.8 arc-seconds/pixel. Each RSO has unique spectral characteristics primarily indicative of the material it is made of, however it is also dependent on object attitude, rotation rate, and solar phase angle. These parameters, coupled with the relatively fast motion of objects in LEO and MEO make spectral characterization quite challenging. As such, simultaneous multi-color photometry is the best way to characterize unresolved RSOs, offering multiple independent channels of data that can be used to identify their unique spectral signatures and estimate attitude/attitude rates. The high framerate supported by the CMOS sensors chosen will allow us to accurately quantify the rotation rates of even fast rotating (tumbling) objects. This will serve as one of the primary metrics used in characterizing an RSO as a debris object since operational multi-axis stabilized RSOs typically have a very low (if any) rotation rate. Complimentary to this effort we are creating a spectral inventory of common materials found in spacecraft so that we may build a spectral database to compare against. With this database, we hope to identify diagnostic absorption bands of common space materials to help aid in our selection of appropriate filters for our optical array telescope and ultimately characterize the RSOs in question. We hope to produce reliable metrics that can be used to identify the type of RSO and its material characteristics without the aid of resolved imagery.