Measurements of the Orbital Debris Environment

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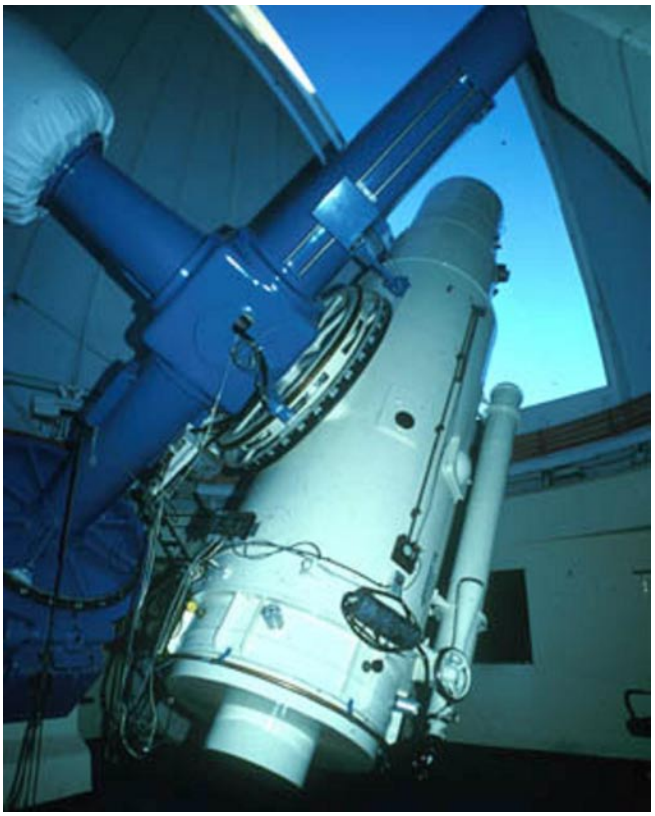
Orbital debris is a concern for all present and future space-faring nations. The U.S. Space Command tracks orbiting objects larger than about 10 cm in diameter. Objects much smaller still can damage operational spacecraft because of the high relative velocities between orbiting objects (average collision velocity = 10 km/s). The Orbital Debris Program Office measures the debris environment in a statistical sense for objects smaller than 10 cm that cannot be tracked.

NASA has used the Haystack Observatory, including both the Haystack radar and Haystack Auxiliary Radar (HAX), since 1990 to sample the debris environment at low Earth orbit altitudes. The Haystack radar is a high-power, X-band (3-cm-wavelength) radar with very high sensitivity. It is capable of detecting debris as small as 0.5-cm diameter at an altitude of 500 km. HAX can detect 2-cm-diameter debris at 500 km but has a larger field of view. Rather than tracking individual objects, these radars are used in a non-tracking, or "staring," mode that allows debris to pass through the radar field of view. The rate at which objects are detected can then be related to the density or flux of particles in orbit. NASA collects 600 hours of data from each of the two radars each year.

Aerial view of the Haystack Observatory.

From 1995 to 2001, Johnson Space Center operated a 0.3-m telescope located in Cloudcroft, N.M., to conduct searches for high-altitude debris in the region of geostationary orbit. Within the next several years, NASA plans to deploy a 1-m telescope in



The University of Michigan 0.6/0.9 Schmidt telescope located at the Cerro Tololo Inter-American Observatory in Chile.

the Pacific region to conduct similar research. In the interim, a cooperative program with the University of Michigan provides measurements of this important and highly populated orbital regime.

NASA is collaborating with the University of Michigan in operating its 0.6/0.9-m classical Schmidt telescope located at the Cerro Tololo Inter-American Observatory in La Serena, Chile. The facility is capable of detecting a 10-cm object at geosynchronous orbit (GEO), assuming an albedo of 0.2. More than 340 hours of data were collected in fiscal year 2003.

NASA and the Air Force Maui Optical and Supercomputing site are cooperating to place a wide field of view, meter-aperture telescope on Kwajalein Atoll for space debris research. The telescope system, designated the Meter-Class Autonomous Telescope (MCAT), will be deployed as part of the High Accuracy Network Orbit Determination System and will use the Oceanit, Inc., K-Star design.

The telescope will operate in two different modes. During twilight hours, it will sample low-inclination orbits in a "track before detect" mode. In the middle of the night, it will perform a more standard GEO search. Kwajalein Atoll was chosen as the location for MCAT because its:

- Low-latitude location is necessary for sampling low-inclination orbits.
- Location allows it to measure a part of the GEO belt not covered by other optical sensors.
- Has a technically skilled workforce that can help maintain the telescope.