

**Orbit Operations at 433 Eros:  
Navigation for the NEAR Shoemaker Mission**

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NASA's Near Earth Asteroid Rendezvous Mission began its record-setting exploration of the asteroid 433 Eros by inserting the spacecraft into orbit about Eros on February 14, 2000. This is the first spacecraft from any country to orbit an asteroid. The mission has overcome a failed insertion burn attempt on December 20, 1998, an event that would have ended most planetary missions, to return to the same target and successfully begin its science mapping a little more than a year later. Shortly after the successful insertion into orbit, the mission was renamed NEAR Shoemaker (NEAR) in memory of the late astronomer and geologist Eugene Shoemaker.

NEAR will gather science data at Eros until February 14, 2001, which is the nominal end of mission. The NEAR mission is managed by the Johns Hopkins University, Applied Physics Laboratory in Laurel, Maryland. Since the initial mission concept in 1992, the design and implementation of the NEAR navigation system have been the responsibility of the Jet Propulsion Laboratory, California Institute of Technology. This presentation will show some of the unique features of navigation and mission design related to orbiting an asteroid and to designing a robust navigation system for the NEAR spacecraft. The problem of navigating a spacecraft about an asteroid is made difficult by the relative uncertainty in the asteroid physical properties which perturb the orbit: i.e., the mass, gravity field, and spin state. To help solve this problem, the navigation system for NEAR uses traditional DSN radio metric Doppler and range tracking, along with new technologies of optical landmark tracking and laser ranging to the asteroid surface. The experiences to date for each of these data types in the navigation solutions will be presented. Plans for the remainder of the NEAR mission will be presented, which include low orbits (down to 35 km radius circular orbits), and close flybys that may pass within 1 km of the surface. In addition, at the end of mission, NASA has approved a controlled descent and hovering phase that will culminate with the spacecraft impacting the surface. The maneuver planning for this final phase will also be presented.