NEAR EARTH ASTEROID RENDEZVOUS: FIRST LAUNCH OF THE DISCOVERY PROGRAM Andrew F. Cheng; *Johns Hopkins Applied Physics Laboratory, Laurel, Maryland*

Abstract. The Near Earth Asteroid Rendezvous (**NEAR**) mission will be the first launch of NASA's Discovery Program, and it will be the first mission to orbit a small body. NEAR will make the first comprehensive scientific measurements of an asteroid's surface composition, geology, physical properties, and internal structure. The development cost for NEAR, like that for other missions in the Discovery Program, is capped at FY92$ 150 million, and the development time must be less than 36 months. NEAR will launch in February 1996 and arrive at the unusually large and important near-Earth asteroid 433 Eros in January 1999. The spacecraft will orbit Eros for about one year, and the minimum orbit radius will be about 35 km from the center of the asteroid. I will present an overview of the NEAR mission, spacecraft, and instruments, focusing on how a small satellite design approach can be used to achieve first rate science return from a low cost, quick turnaround planetary mission.

Scientific Objectives. The NEAR mission will rendezvous with and orbit the Mars-crossing asteroid 433 Eros, which is one of the largest and best-studied of the near-Earth asteroids. Eros made a close approach to Earth in 1975 and was the subject of a international ground-based observing campaign. It is an S-type asteroid, it has a regolith, its rotation period is 5.27 hours, and its approximate diameters are 40x14x14 km. The visible to near infrared spectrum of Eros places it within the subclass of S-asteroids whose spectra may be consistent with an undifferentiated mineralogy. Comparison of Eros with the S-type asteroids Gaspra and Ida studied by Galileo should lead to important insights into the diverse natures and origins of S-asteroids.

The scientific goals of the NEAR mission are to measure:

- Bulk properties - size, shape, mass, density, gravity field, and spin state
- Surface properties - elemental and mineralogical composition, geology, morphology, and texture
- Internal properties - search for heterogeneity and magnetic field

The following are examples of science questions that the NEAR data are expected to address.

What are the characteristic morphology and texture of the surface and how do they compare with those on larger bodies?
What is the elemental and mineralogical composition of the asteroid?
Is there evidence of compositional or structural heterogeneity?
Is the asteroid a solid fragment of a larger parent body, or a rubble pile?
Were precursor body(ies) primitive or differentiated?
Is there evidence for past or present cometary activity?
Is the asteroid related to a meteorite type or types?
Is there an intrinsic magnetic field? What is it like?
Are there any moons, and how might they compare with Eros?

Spacecraft. The NEAR spacecraft is a solar-powered, three-axis stabilized spacecraft that will be launched on a Delta II-7925 rocket. The launch mass, including propellant, is 805 kg maximum. The spacecraft is simple and highly redundant; it has fixed solar panels, a fixed 1.5 m high gain antenna, and fixed, body-mounted instruments. NEAR will use X-band telemetry to the NASA Deep Space Network, with the data rates at Eros selectable in the range 2.9 to 8.8 kbps using a 34 m HEF dish. A solid state recorder is accommodated with a memory capacity of 1 Gb. Attitude determination uses a star camera, an inertial measurement unit, and sun sensors; attitude control can use reaction wheels or small thrusters. Attitude control is to 1.7 mr, line-of-sight pointing stability is within 50 μr over 1 second, and post-processing attitude knowledge is to 50μr.

Instruments. NEAR will accomodate 60 kg of instruments and provide them with 70 W. The instruments are: a multispectral imager (MSI), a near infrared spectrometer (NIS), an x-ray/gamma ray spectrometer (XGRS), a magnetometer (MAG), and a laser rangefinder (NLR).

NEAR EARTH ASTEROID RENDEZVOUS: A. F. Cheng

A radio science investigation (RS) will be performed using the spacecraft coherent X-band transponder. MSI is a CCD camera with an 8-position filter wheel. NIS will cover the range 0.8 to 2.6 μ and includes a scan mirror. XGRS includes gas proportional counter X-ray detectors, solar monitors, and a shielded scintillator γ-ray detector. MAG is a three-axis fluxgate magnetometer mounted on the high gain antenna feed. NLR uses a solid state Nd:YAG laser. These are all facility instruments.

Mission Design. The NEAR spacecraft will be launched into a two year, Earth return trajectory. After an Earth swingby in January 1998, it will rendezvous with Eros in January 1999. Initially, NEAR will execute a slow flyby of Eros, with a flyby speed of 5 m/s and a closest approach distance of 500 km. This will enable initial shape and spin state determinations plus low phase angle reflectance spectroscopy. Subsequently, NEAR is injected into a high altitude orbit, nominally at 1000 km radius, and the orbit is gradually lowered to 35 km. During the low altitude rendezvous phase, the orbit plane normal will be maintained near the Earth line-of-sight. The orbit plane is not far from the terminator plane, and observations will be taken at large phase angle.

Mission Operations. The NEAR Mission Operations Center and the Science Data Center will be at the Johns Hopkins Applied Physics Laboratory. Spacecraft autonomy has been designed to simplify and lower the cost of mission operations. The Science Data Center will maintain the entire NEAR data set on-line, and data from all instruments will be accessible by every member of the NEAR Science Team. Data, including images, will be released over the INTERNET as soon as they are validated.

Status. The NEAR Project Science Team was selected by NASA in September, 1994. The Project passed its Critical Design Review in November, 1994. The NEAR Project is within budget and on schedule.