Dawn Arrives at Main Belt Asteroid (4) Vesta

Launched by a Delta II Heavy rocket on 27 September 2007, the robotic *Dawn* spacecraft was captured into an initial orbit of main belt asteroid (4) Vesta at approximately 5 AM on 16 July 2011 UTC. According to Dr. Marc D. Rayman of JPL, capture occurred at a point about 16,000 km above Vesta's surface when *Dawn* was moving at a speed of 27 m/s with respect to the asteroid. After launch and help from a Mars gravity assist on 18 February 2009, orbit capture by Vesta was made possible by *Dawn*'s solar electric propulsion (SEP) capability. Using 3 thrusters fed by ionized xenon, *Dawn*'s SEP generates total thrust ranging from 19 to 91 mN. With an initial *Dawn* mass of 747.1 kg, maximum SEP thrust yields an acceleration of 0.122 mm/s^2. At that acceleration, it would take 2.55 *days* for *Dawn* to generate a change in velocity of 26.8 m/s (60 mph).

Although *Dawn*'s SEP acceleration is tiny, its rate of propellant consumption is downright miserly. The SEP engines are estimated to be capable of thrusting for 2000 days before expending the 425 kg of xenon loaded at launch. As *Dawn* approached Vesta on 23 June 2011, Dr. Rayman reported 950 days of SEP thrusting had been logged to generate an effective change in velocity of 6.6 km/s. A heliocentric plot of *Dawn*'s rendezvous with Vesta, as viewed from a latitude 45° north of Earth's orbit plane (the ecliptic) appears in Figure 1.

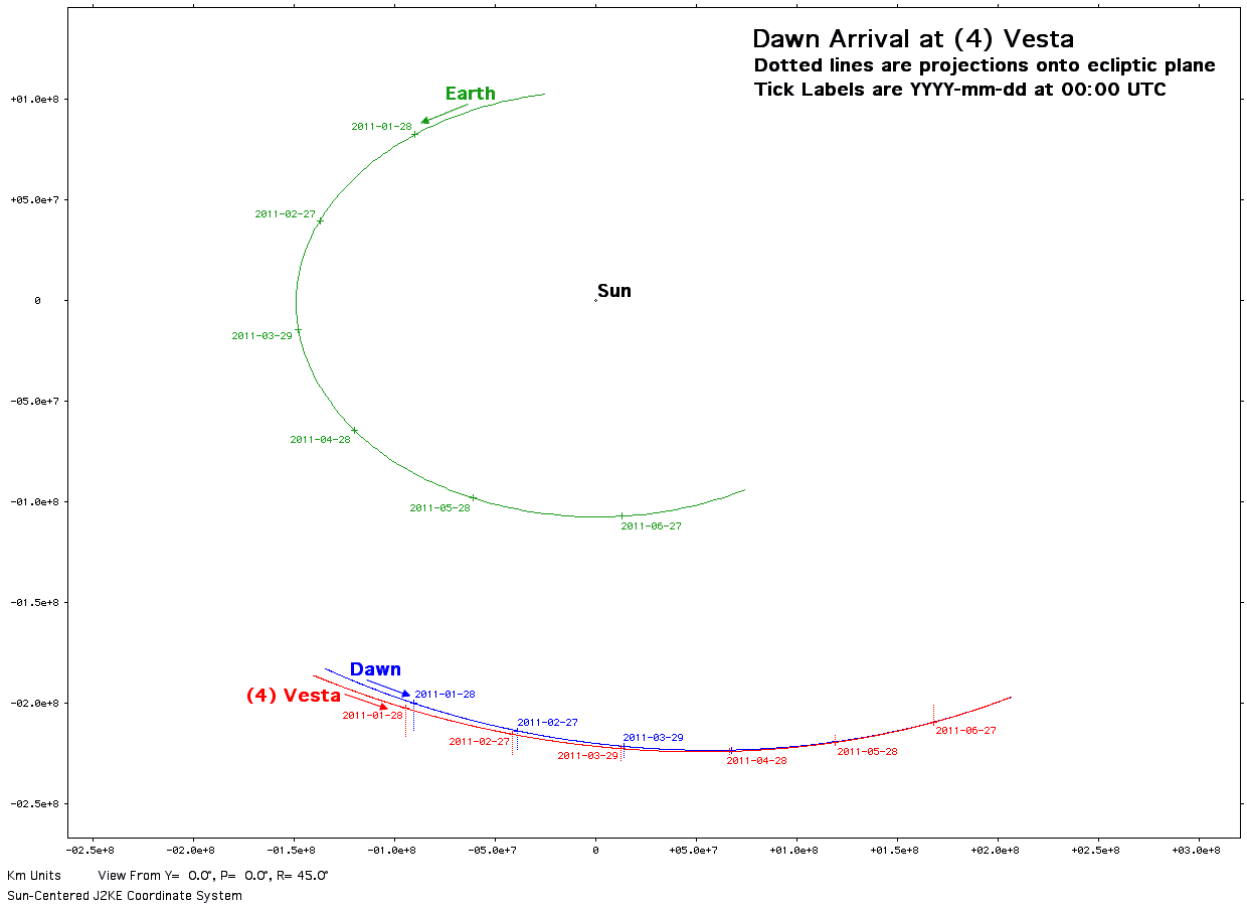

Figure 1. Heliocentric Rendezvous with (4) Vesta by *Dawn*.

On 3 May 2011, *Dawn* commenced its Vesta approach phase. During this interval, SEP thrusting was interrupted at weekly and, in later stages, biweekly intervals to obtain navigation

and scientific imagery of Vesta. By 23 June 2011, Dr. Rayman reported *Dawn*'s Vesta-relative speed had been reduced to 110 m/s. A xenon control circuit electrical anomaly, likely caused by a cosmic ray hit, interrupted SEP thrusting from 27 June until 30 June 2011, when a redundant circuit was activated. During this interval, *Dawn* was able to observe Vesta continually throughout one complete axial rotation of 5.3 hrs. By 4 July 2011, *Dawn*'s Vesta-relative speed had been reduced to 75 m/s.

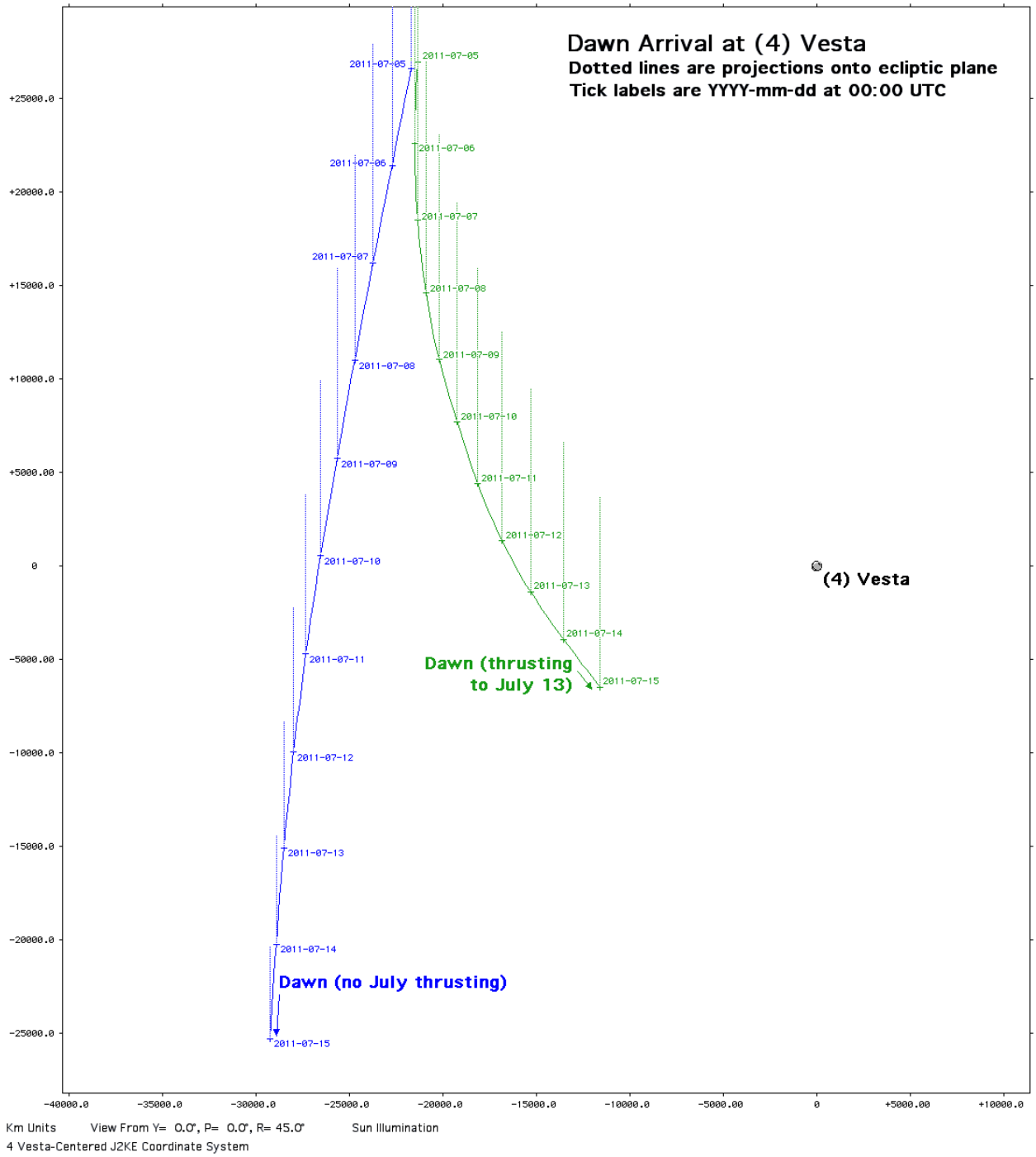

Figure 2. *Dawn* Trajectories Relative To (4) Vesta Assuming Early Thrust Termination.

The effect of *Dawn* thrusting from 30 June until 13 July 2011 is evident in Figure 2. During this interval, the only pause in thrusting was from 9 to 10 July, when additional Vesta imagery was acquired and a search for companions orbiting Vesta was conducted. No such companions have been reported, but analysis of this imagery was ongoing as of 18 July. Perspective in Figure 2 is identical to that in Figure 1. Two trajectories are plotted relative to Vesta. The blue trajectory assumes no thrusting in July, and the green trajectory assumes nominal thrusting until July 13. With respect to Vesta, the green trajectory's eccentricity reduces from 16 to 1.9. Both trajectories perform a Vesta flyby, but very little additional thrusting is necessary to achieve Vesta orbit capture on the green trajectory after July 13. Vesta's 530 km diameter is shown to scale in Figure 2 with its north pole of rotation rendered to an accuracy of several degrees. The shaded area of Vesta is its night side.

Figure 3's perspective and scale are identical to Figure 2's. The single Figure 3 trajectory reflects nominal *Dawn* thrusting through Vesta orbit capture and into 23 July 2011 as posted by JPL on 18 July. Subsequent thrusting will further reduce *Dawn*'s altitude above Vesta to 2700 km. Scientific observations of Vesta are expected to commence from this altitude in mid-August 2011.

Dr. Rayman's "*Dawn* Journal" commentary, together with other mission status, can be accessed from URL http://dawn.jpl.nasa.gov/. Trajectory data for *Dawn* are available from JPL's *Horizons* online solar system data and ephemeris computation service at http://ssd.jpl.nasa.gov/?horizons.

Dawn Arrives at Main Belt Asteroid (4) Vesta

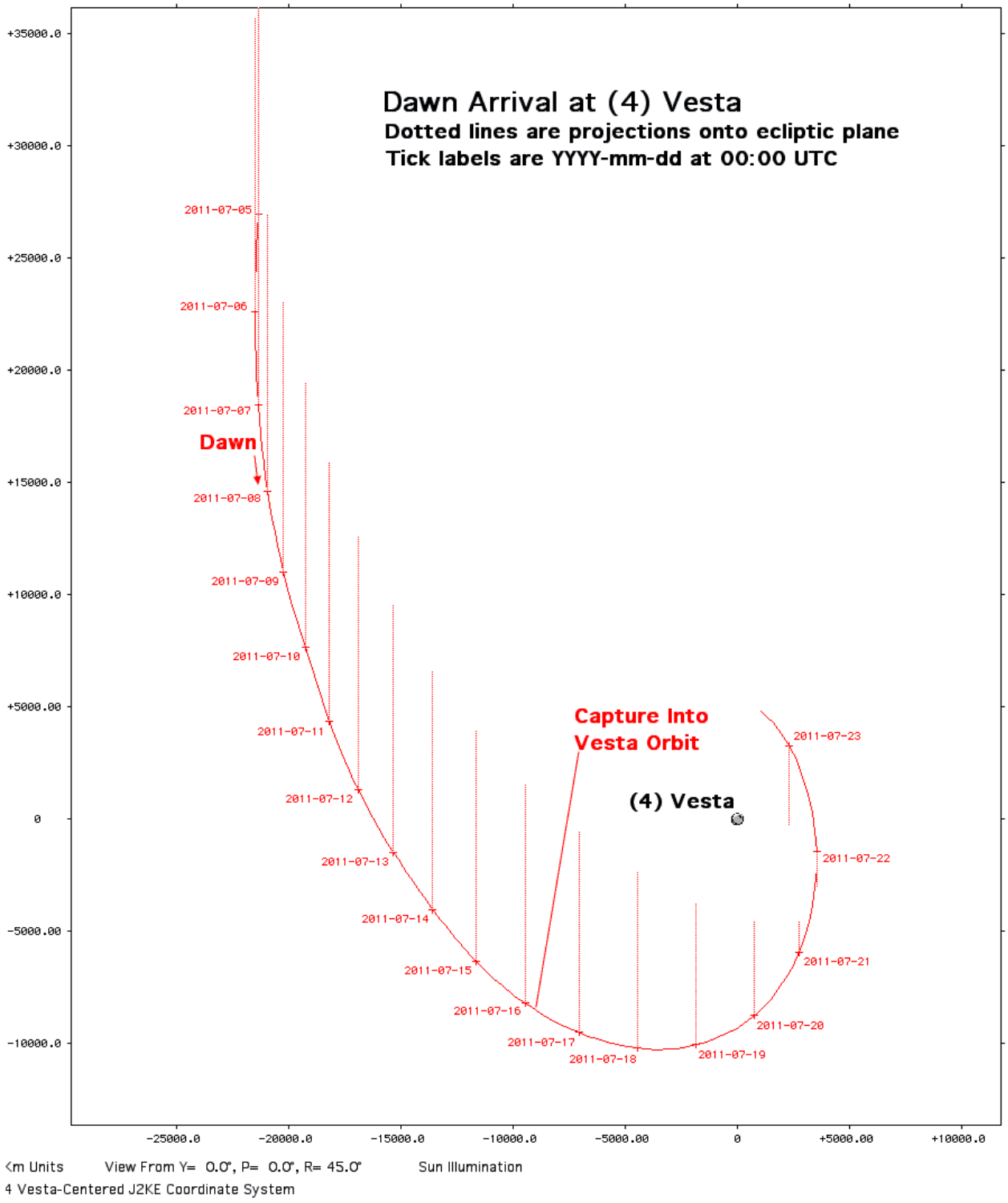

Figure 3. *Dawn* Trajectory Relative To (4) Vesta With Thrusting Through Orbit Capture.