New Horizons Jupiter encounter

by Philip Corneille

Artist's impression showing New Horizons spacecraft passing by Jupiter in February 2007. After this fly by, the craft will perform an eight year cruise across the expanse of the solar system to reach Pluto in 2015. NASA/Johns Hopkins University APL/SwRI

Just a year after it was dispatched on the first mission to Pluto and the Kuiper Belt Objects, NASA's New Horizons spacecraft swung past Jupiter and continued its voyage toward the outer regions of the solar system. One year down, eight to go on the road to the July 2015 Pluto-Charon encounter.

New Horizons (NH) is the first mission in NASA's New Frontiers programme of medium-class spacecraft exploration projects. It was designed and built by the Applied Physics Laboratory (APL) of the Johns Hopkins University in Maryland, USA, which earlier constructed several other NASA unmanned spacecraft such as Messenger, which is currently en route to its March 2011 encounter with Mercury, the most inner planet of the solar system.

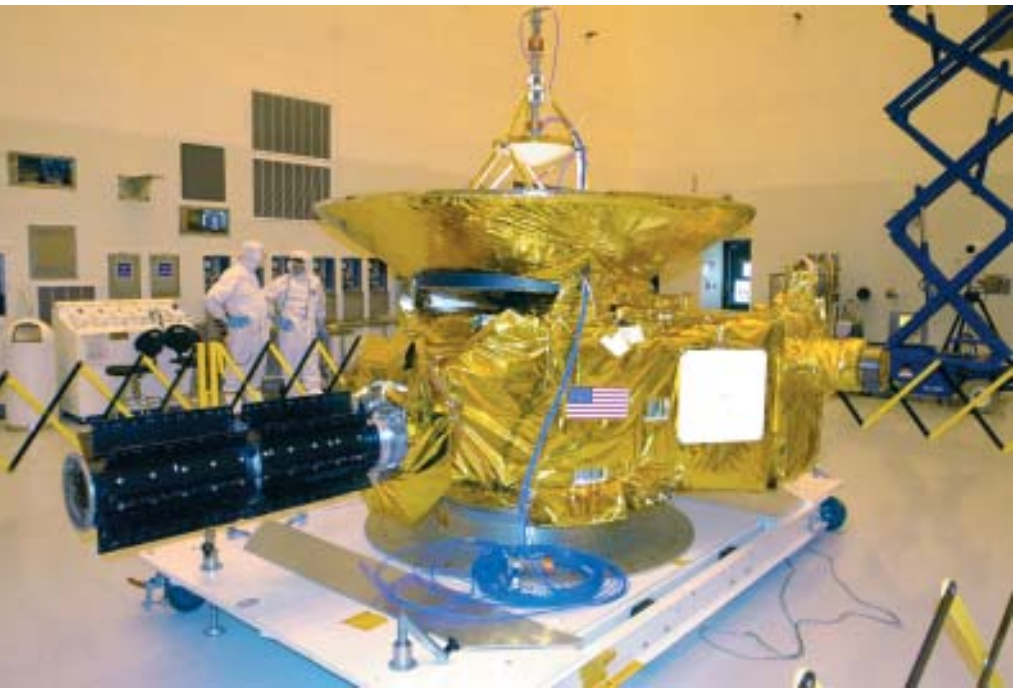
NH is a dual stabilisation mode probe and can operate in three-axis or spin-stabilised attitude control, a common feature for spacecraft on outer planet missions. The 480 kg spacecraft has a triangular 'thermos bottle' shaped space bus in order to maximise safe operating temperatures in deep space.

It is powered by a Radioisotope Thermoelectric Generator (RTG) mounted on an extended boom to minimise effects on the science payload. The RTG converts heat from the radioactive decay of 11 kg Plutonium-238 into electricity and provides continuous power in regions of space where the use of solar energy is not feasible. There are 16 hydrazine-fuelled thrusters to provide for trajectory adjustments and attitude control.

The spacecraft's 2.1 m high-gain antenna

New Horizons in the Payload Hazardous Space Flight Facility being prepared for the January 2006 launch window. The black RTG is the X-axis of the spacecraft.

Ben Cooper/LaunchPhotography.com



dish, attached to the top deck, is linked to advanced electronics and is shaped to receive the faintest radio signals from Earth, a necessity when the mission's targets are five billion kilometres from Earth and round-trip transmission time is nine hours.

The command and data handling system uses a radiation-hardened Mongoose V processor guided by intricate flight software. For data storage, NH carries two solid-state recorders that can hold 64 gigabits each.

The probe's 30 kg science payload (see also *Spaceflight*, March 2006 page 93) is the most capable suite of instruments ever launched on a first reconnaissance fly by mission to an unexplored planet and consists of seven experiments:

- Ralph, a multispectral imaging camera for obtaining high resolution colour maps of the surfaces of Pluto and its moon Charon
- Alice, an ultraviolet imaging spectrometer that will probe the atmospheric composition of Pluto
- LORRI, a panchromatic high-magnification 21 cm aperture telescope that focuses visible light onto a charge couple device to provide a high-resolution look at the geology of the Kuiper Belt Objects (KBO)
- SWAP, a solar wind analyser
- PEPSSI, an energetic particle and plasma-sensing instrument to study atoms escaping Pluto's atmosphere
- REX, a radio experiment using the occultation technique
- SDC, the Student Dust counter which will count and measure dust particles along NH's entire trajectory, covering regions of interplanetary space never before sampled.

Artist's rendering showing New Horizons speeding away from Jupiter. Near the Sun are Earth, Venus and Mercury. The dim crescent shape at the upper right of the Sun is Callisto, the outermost of Jupiter's four largest moons. Just left of Jupiter is the icy moon Europa.

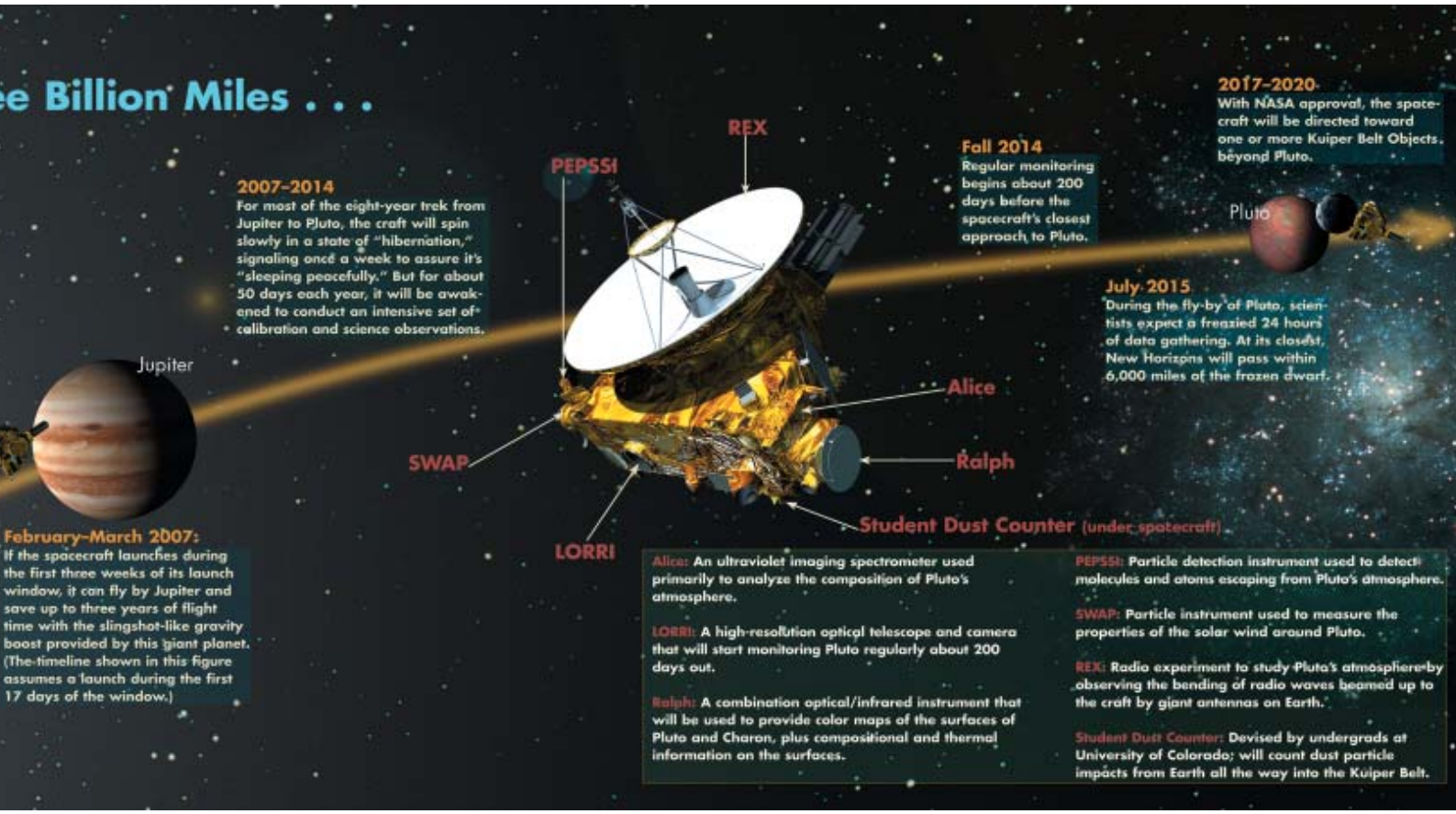
NASA/Johns Hopkins University APL/SwRI

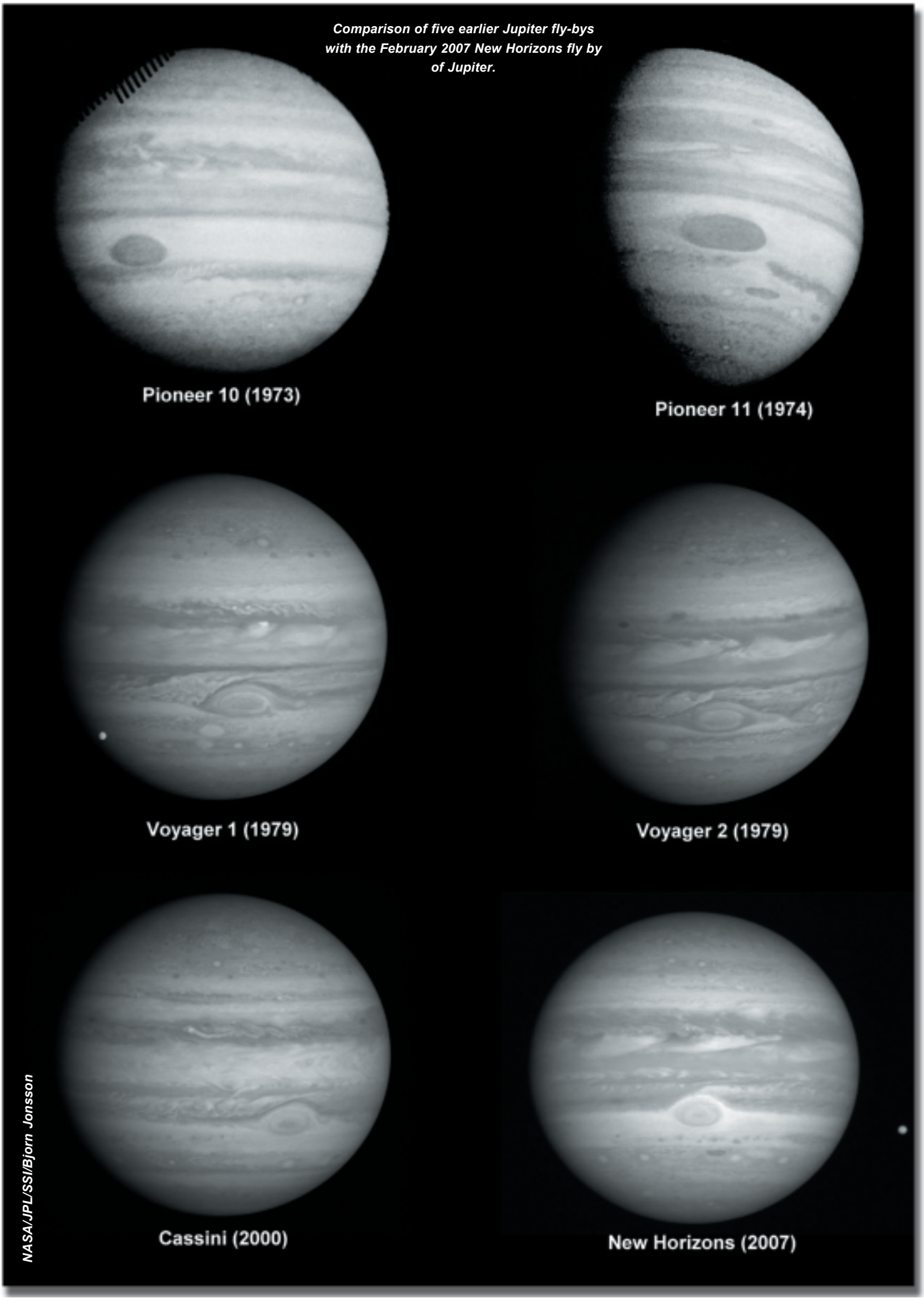
The cost of the 10 year mission, including the Atlas V launch vehicle and operations through the Pluto-Charon encounter, is around $700 million.

Jupiter encounter

NH was launched atop a Lockheed Martin Atlas V launch vehicle carrying a Boeing STAR-48B solid-propellant rocket third stage on 19 January 2006 - the 'fastest' spacecraft in terms of launch energy.

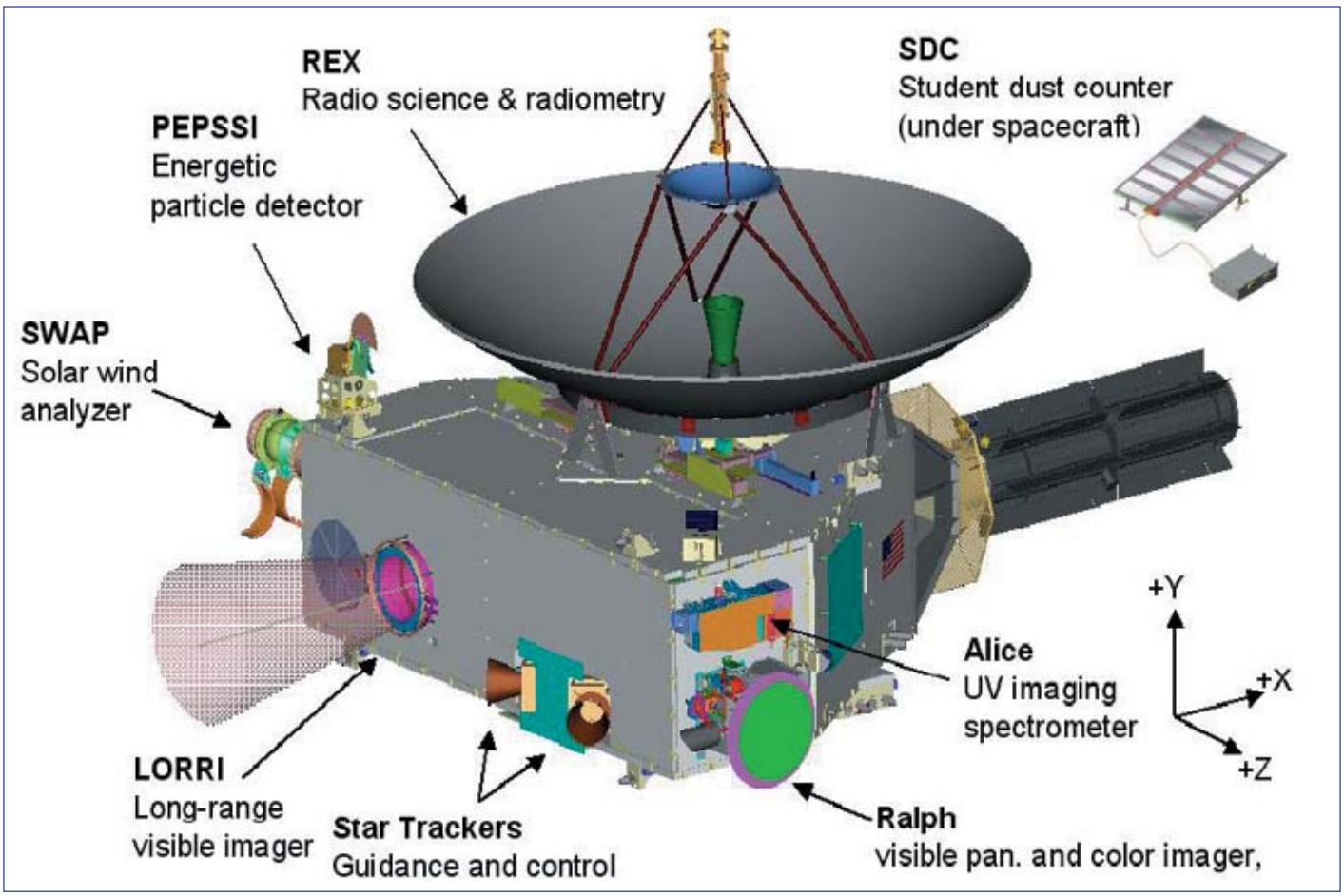
The Boeing kick-motor boosted the probe





Comparison of five earlier Jupiter fly-bys with the February 2007 New Horizons fly by of Jupiter.

NASA/JPL/SSI/Bjorn Jonsson



onto a high speed cruise, passing the Moon after nine hours and then on to its first rendezvous, with Jupiter the largest planet of the solar system.

Between May and August 2006, the spacecraft passed the asteroid belt, a concentration of small rocky celestial bodies in the space between the orbits of Mars and Jupiter.

By September 2006, the Long Range Reconnaissance Imager (LORRI) spotted the very first glimpse of Pluto during an optical navigation test, demonstrating that NH can find distant targets, a critical capability the team will use to navigate toward Pluto and later to one or more KBOs.

By January 2007, the Jupiter encounter was underway as the spacecraft began collecting data on the Jovian system, starting with black-and-white images of the giant planet and an infrared look at the icy moon Callisto.

Scientists compared the images with older photos of Jupiter taken during the six previous spacecraft encounters - Pioneer 10 (December 1973), Pioneer 11 (December 1974), Voyager 1 (March 1979), Voyager 2 (July 1979), Galileo (December 1995) and Cassini-Huygens (November 2000). The planet's equatorial region appeared far clearer and less turbulent than expected.

The New Horizons mission team used the flyby to put the probe's systems and seven science instruments through the paces with more than 700 observations of Jupiter and its four largest moons.

Planned observations included scans of Jupiter's stormy atmosphere, a detailed survey of its ring system and a detailed study of the Jovian moons.

Callirrhoe (S/1999 J 1), one of the small outer satellites, proved an important target as its brightness was comparable to the KBO targets NH will encounter by 2020.

By early February, the spacecraft was flying inside Jupiter's satellite system, which occurred as NH passed inside the outer part of the orbit of S/2003 J2, the moon that ranges farthest from the giant planet.

The spacecraft performed flawlessly and used 20 percent less fuel in conducting observations than planned. On 10 February 2007, NH's LORRI took its best full-disk portrait of Jupiter, just before the giant planet filled the camera's field of view.

Closest approach to the solar system's largest planet came on 28 February, when the spacecraft zoomed within 2.3 million km (1.4 million miles) of the gas giant to use Jupiter's gravity to speed toward its ultimate destination, Pluto.

The NH mission operations team at the Johns Hopkins APL in Maryland, works closely with the science operations team, based at Southwest Research Institute (SwRI) in Colorado, to plan, test and send the observation commands to the spacecraft, which runs the sequences from memory in its onboard computers.

Data are stored on the spacecraft's recorders and sent back to Earth through NASA's Deep Space Network antennas, after which the newest images are made available on the NH web site (http://pluto.jhuapl.edu/index.php).

NH's observations of Jupiter and its moons are planned to last until June 2007. Thereafter, the spacecraft will make the first-ever trip down the long "tail" of Jupiter's magnetic field, which extends tens of millions of miles beyond the planet.

If all goes well New Horizons will continue its historic mission to the outer edges of the solar system, a region too far to observe from Earth in any detail (even the Hubble Space Telescope can only provide blurry images of Pluto). The July 2015 fly by of the Pluto-Charon system will certainly provide invaluable insights into the origin of this enigmatic part of the outer solar system, exciting both the scientific community and the general public alike.

Acknowledgement

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