New Horizons 2

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New Horizons is the inaugural mission in NASA's New Frontiers program—a series of mid-sized planetary exploration projects. This mission was competitively selected in 2001 after a peer review competition between industry-university teams. The mission is on track toward a planned launch in January 2006—just over 6 months hence.

The primary objective of New Horizons (NH) is to make the first reconnaissance of the solar system's farthest planet, Pluto, its comparably sized satellite Charon. If an extended mission is approved, New Horizons may be able to also flyby a Kuiper Belt Object (KBOs) farther from the Sun. The exploration of the Kuiper Belt and Pluto-Charon was ranked as the highest new start priority for planetary exploration by the National Research Council's recently completed (2002) Decadal Survey for Planetary Science. In accomplishing its goals, the mission is expected to reveal fundamental new insights into the nature of the outer solar system, the formation history of the planets, the workings of binary worlds, and the ancient repository of water and organic building blocks called the Kuiper Belt.

Beyond its scientific ambitions, New Horizons is also breaking ground in lowering the cost of exploration of the outer solar system—for it is being built and launched for what are literally dimes on the dollar compared to deep outer solar system missions like Voyager, Galileo, and Cassini.

The New Horizons spacecraft carries a suite of seven advanced, miniaturized instruments to obtain detailed imagery, mapping spectroscopy, thermal mapping, gravitational data, and in situ plasma composition, density, and energy sampling of the exotic, icy Pluto-Charon binary and a modest-sized (~50 km diameter) KBO. The mission also carries a sensitive dust counter.

The concept of flying a second New Horizons mission was born in mid-2002. Over the past two years, this has been studied by the mission team, debated in the scientific community, and discussed in the space press. The objectives of New Horizons 2 are straightforward:

- Provide backup to the key Decadal Survey science (i.e., Kuiper Belt exploration) of New Horizons 1;
- Broaden and deepen the science that can be accomplished by NH 1 to provide a target of opportunity flyby of Uranus at equinox and flyby reconnaissance of multiple KBOs.
- And do so at significantly less cost than New Horizons 1.

The first objective of New Horizons 2 is to provide important backup to the high priority KBO science that NASA has stated is only a goal and not a requirement for NH 1.

We are acutely aware that our tiny, relatively low cost spacecraft must travel over 9 years to cover the mind-boggling 5 billion kilometers between Earth and Pluto-Charon, and even farther to reach KBOs. This journey is both farther and longer than any spacecraft ever has had to undertake to reach its primary target, and the risks inherent in sending a lone spacecraft on such a long journey have long been known.

NASA has protected against such risks in the past by building and flying a second spacecraft to ensure that a high priority mission has the best possible change to accomplish its objectives. A two spacecraft strategy saved NASA's first flyby missions to Mars and Venus, and NASA's first Mars orbiter mission too. The damaging impact of the Genesis mission onto the Utah desert last year reiterated to many the need for backup spacecraft on high profile and high-priority space exploration missions.

Sometimes when NASA flew two spacecraft on long and distant journeys, both spacecraft reached their targets successfully, as did both Voyagers, both Vikings, and this year's stunning MER Mars rovers. In each of those cases, a dramatic one-two punch was achieved for both exploration and science. Thus, if New Horizons 1 and 2 both succeed, then NASA and the United States will have achieved a far greater science return at a lower average cost per mission and mission target than one spacecraft alone could accomplish.

The most exciting candidate trajectory we have identified so far for New Horizons 2 takes it to the Kuiper Belt via a fast trajectory that involves both Jupiter *and* Uranus flybys on the way. This exciting trajectory initiates its KBO flybys with a mammoth (400-to-500 km sized) Kuiper Belt binary called 1999 TC36. "TC36" is almost 10 times bigger than any KBO NH 1 can possibly reach after Pluto-Charon; even TC36's satellite is more than twice as large as any KBOs NH 1 can target! After TC36, NH 2 would go on to explore one or two additional, smaller KBOs.

This trajectory would flyby a total of three or four KBOs, far more than the zero to one KBOs that can be reconnoitered by New Horizons 1 in its still-to-be approved extended mission. Thus New Horizons 2 can accomplish what New Horizons 1 cannot: i.e., to satisfy the key recommendation of the Planetary Decadal Survey with regard to Kuiper Belt exploration—to sample the diversity of bodies in the Belt (e.g., big and small, with and without satellites, etc.).

New Horizons 2's Uranus 2014 flyby will be a stunning exploration accomplishment its own right. Beyond bringing far more sophisticated remote sensing instruments and a dust detector to the Uranian system than Voyager did, New Horizons 2 can accomplish a flyby to reconnoiter the Uranus system near equinox, a geometry that allows all of the Uranian system to be explored—something Voyager's solstice arrival geometry of 1986 was denied. The Uranian equinox opportunity that NH 2 can achieve in 2014 will not reoccur

until almost 2050! It is no exaggeration to say that the timing of the NH 2 Uranus-KBO exploration combination is literally once in a lifetime.

We note that exploration of the Kuiper Belt ranks as a top priority of the Decadal Survey, and that NH 2 provides a key opportunity to achieve that goal.[1] While Flagship missions are crucial to the advancement of planetary science, no such mission can be sold, designed, built, and flown to its target before the 2020s. However, NH 2 can be constructed and flown in time to produce science in the 2010-2020 decade. As such, NH 2 provides an important near term opportunity for advancing outer solar system science while a flagship mission is being built and flown.

Preliminary studies have shown that a second New Horizons mission can be built and launched for significantly less than New Horizons 1—approximately $450-$500M—but only if the second craft is identical to the first, and only if it can be built on the heels of the first, which requires a new start in FY06 or FY07. Otherwise, mundane but real issues including electronic parts availability, launch vehicle evolution, and inflation will defeat the anticipated savings. Time is also of the essence for reaching Uranus by JGA, as the Jupiter Gravity Assist window to Uranus closes in mid-2009.

In order to maximize the scientific participation in NH2, the New Horizons science team has voted to keep the spacecraft and instrument payload fixed, but to have the flight mission science team re-competed for NH2.

More information on both New Horizons and New Horizons 2 can be found at http://www.boulder.swri.edu/pkb

[1] The NH2 concept was not invented for consideration during the Decadal process, thus it does not appear therein.