

New Horizons Pluto/KBO Mission

Status Report for SBAG

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New Horizons: To Pluto and Beyond

**The Initial Reconnaissance of The Solar System's
"Third Zone"**

**KBOs
2016-2020**

**Pluto-Charon
July 2015**

**Jupiter System
Feb-March 2007**

**Launch
Jan 2006**

PI: Alan Stern (SwRI)

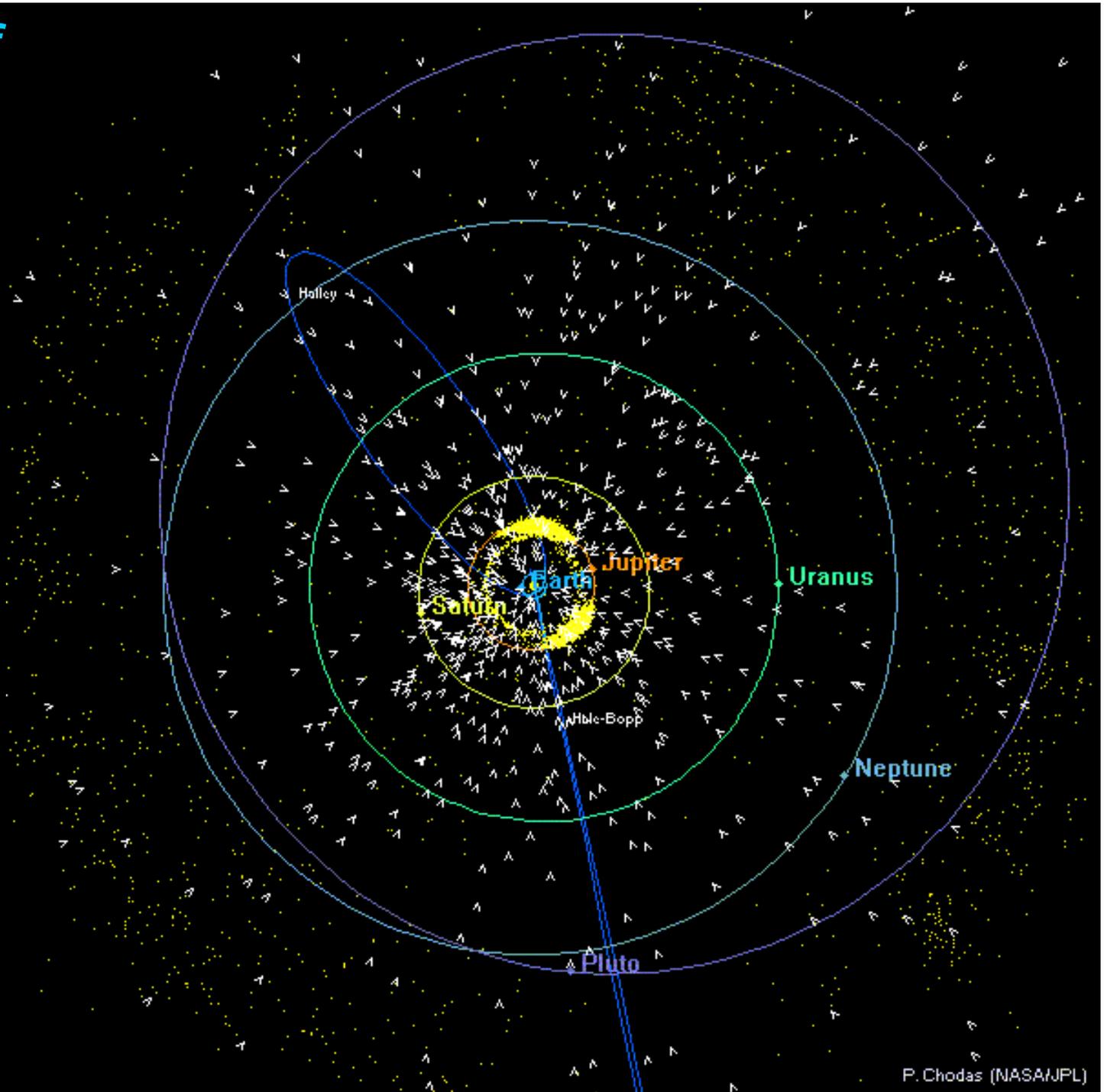
Lead PS: Hal Weaver (JHU/APL)

New Horizons is NASA's first New Frontiers Mission

The Frontier of Planetary Science

Exploring the Pluto system and the Kuiper Belt

New Horizons gives the first close-up view of these newly discovered worlds.



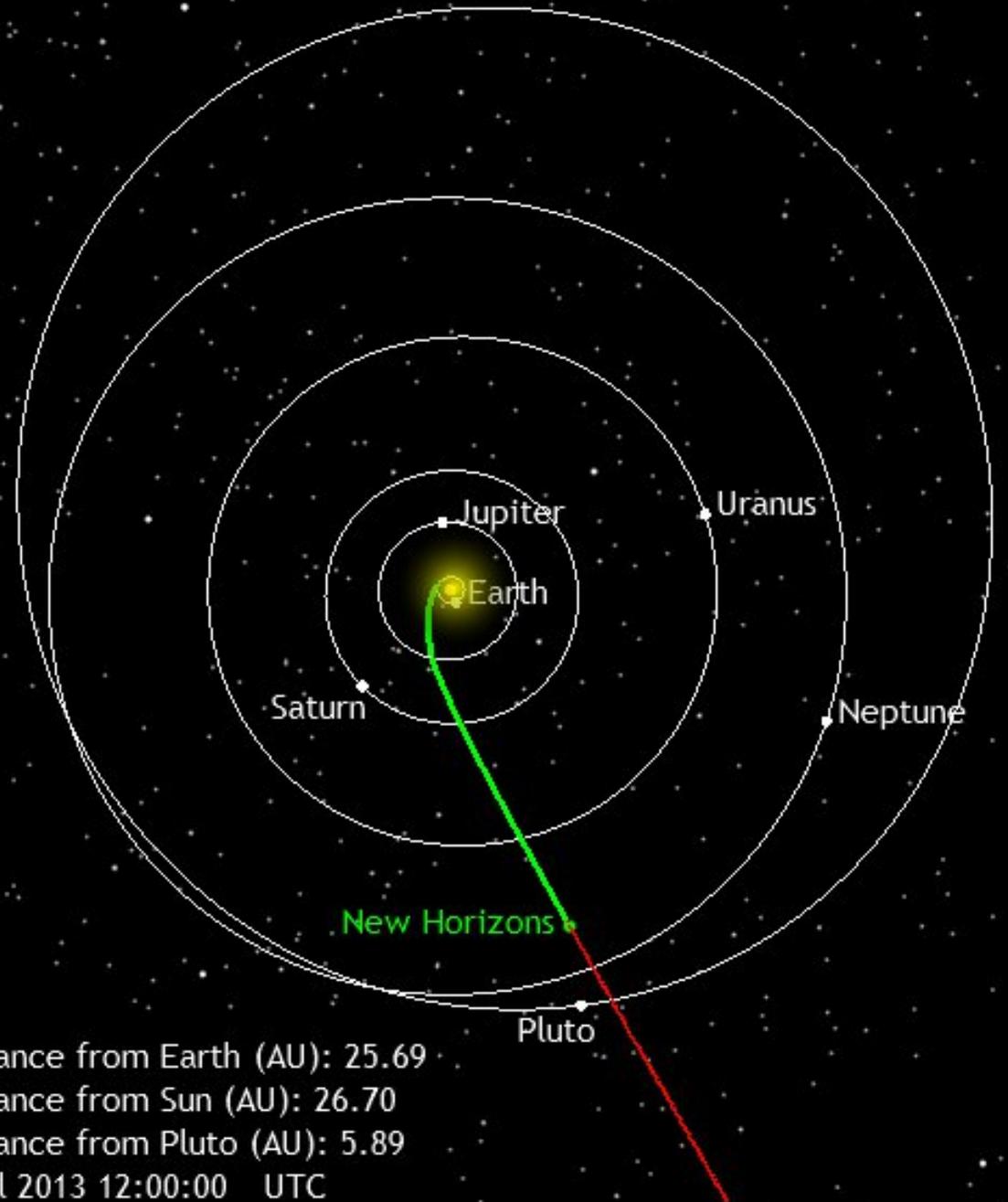
New Horizons Full Trajectory - Overhead View

**New Horizons Now
(overhead view
for July 2013)**

**Crossed Uranus orbit
2011-March-18**

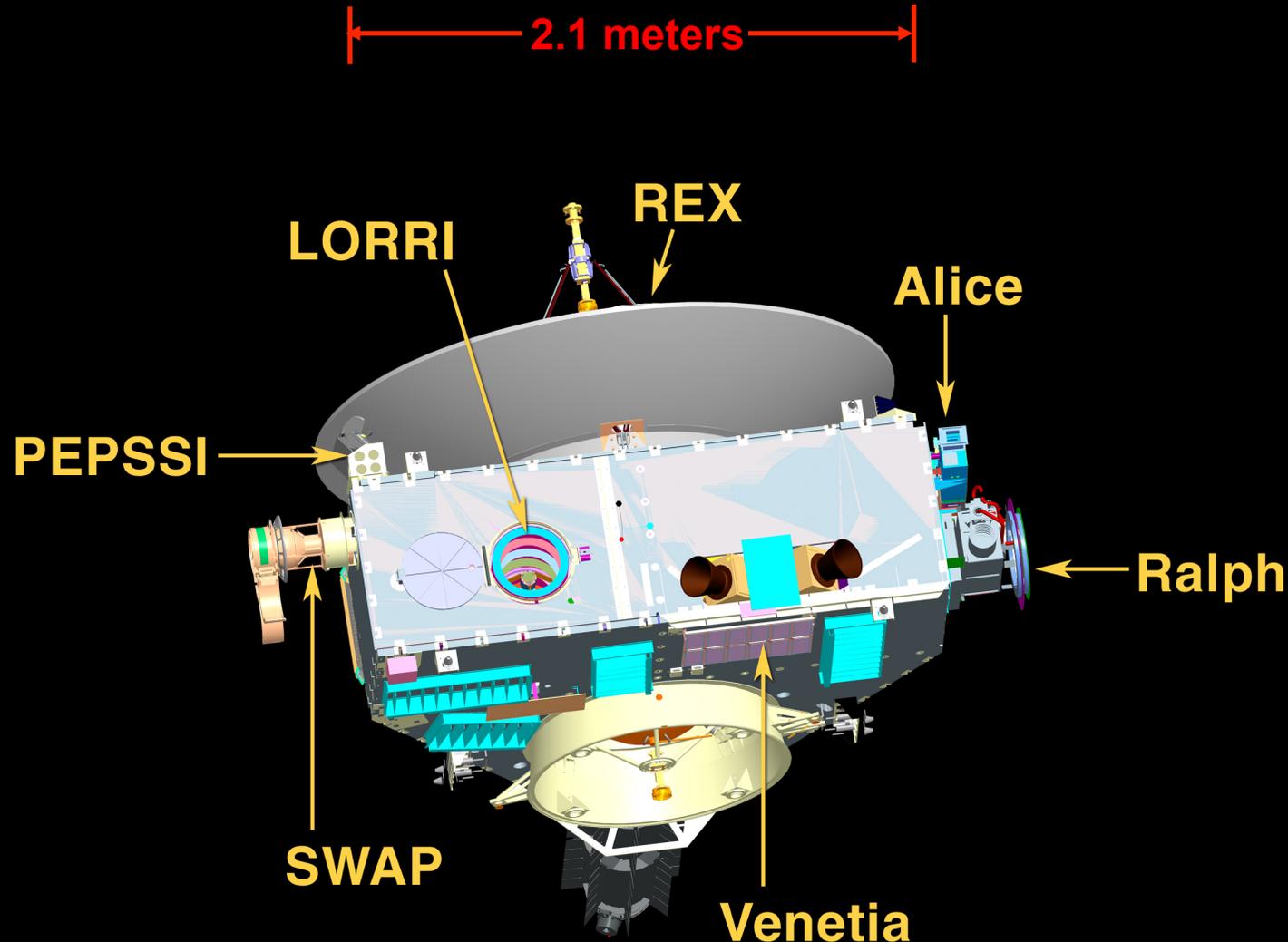
**Cross Neptune orbit
2014-August-25
(25 years after Voyager 2)**

**Pluto Closest Approach
2015-July-14**



Distance from Earth (AU): 25.69
Distance from Sun (AU): 26.70
Distance from Pluto (AU): 5.89
5 Jul 2013 12:00:00 UTC

NH Spacecraft & Instruments



Science Team:

PI: Alan Stern
Fran Bagenal
Rick Binzel
Bonnie Buratti
Andy Cheng
Dale Cruikshank
Randy Gladstone
Will Grundy
Dave Hinson
Mihaly Horanyi
Don Jennings
Ivan Linscott
Jeff Moore
Dave McComas
Bill McKinnon
Ralph McNutt
Scott Murchie
Cathy Olkin
Carolyn Porco
Harold Reitsema
Dennis Reuter
John Spencer
Darrell Strobel
Mike Summers
Len Tyler
Hal Weaver
Leslie Young

**All instruments performing nominally*

Pluto System Science Goals

Specified by NASA or Added by New Horizons

Group 1 Objectives: REQUIRED

Specified by NASA	Added and ranked by New Horizons Science Team
Characterize the global geology and morphology of Pluto and Charon	None
Map surface composition of Pluto and Charon	
Characterize the neutral atmosphere of Pluto and its escape rate	

Group 2 Objectives: STRONGLY DESIRED

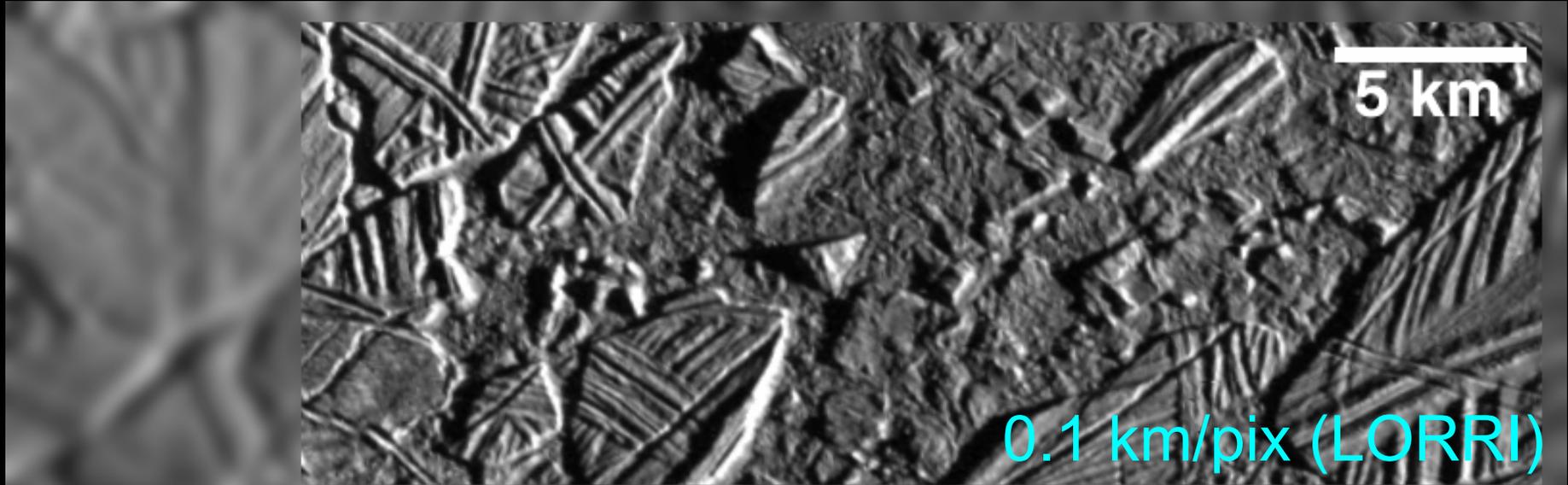
Specified by NASA	Added and ranked by New Horizons Science Team
Characterize the time variability of Pluto's surface and atmosphere	Composition of dark surfaces on Pluto
Image Pluto and Charon in Stereo	"Far-side" imaging of Pluto and Charon
Map the terminators of Pluto and Charon with high resolution	"Far-side" color and composition of Pluto and Charon
Characterize Pluto's ionosphere and solar wind interaction	High resolution imaging of Nix and Hydra
Search for neutral species including H, H ₂ , HCN, and C _x H _y , and other hydrocarbons and nitriles in Pluto's upper atmosphere	Composition of Nix and Hydra
Search for an atmosphere around Charon	Shapes of Nix and Hydra
Determine bolometric Bond albedos for Pluto and Charon	
Map the surface temperatures of Pluto and Charon	

Group 3 Objectives: DESIRED

Specified by NASA	Added and ranked by New Horizons Science Team
Characterize the energetic particle environment of Pluto and Charon	Surface microphysics of Pluto and Charon
Refine bulk parameters (radii, masses, densities) and orbits of Pluto & Charon	Measure the surface temperatures of Nix and Hydra
Search for magnetic fields of Pluto and Charon	Measure the phase curve of Nix and Hydra
Search for additional satellites and rings	Image Nix and Hydra in stereo
	Education/Public Outreach

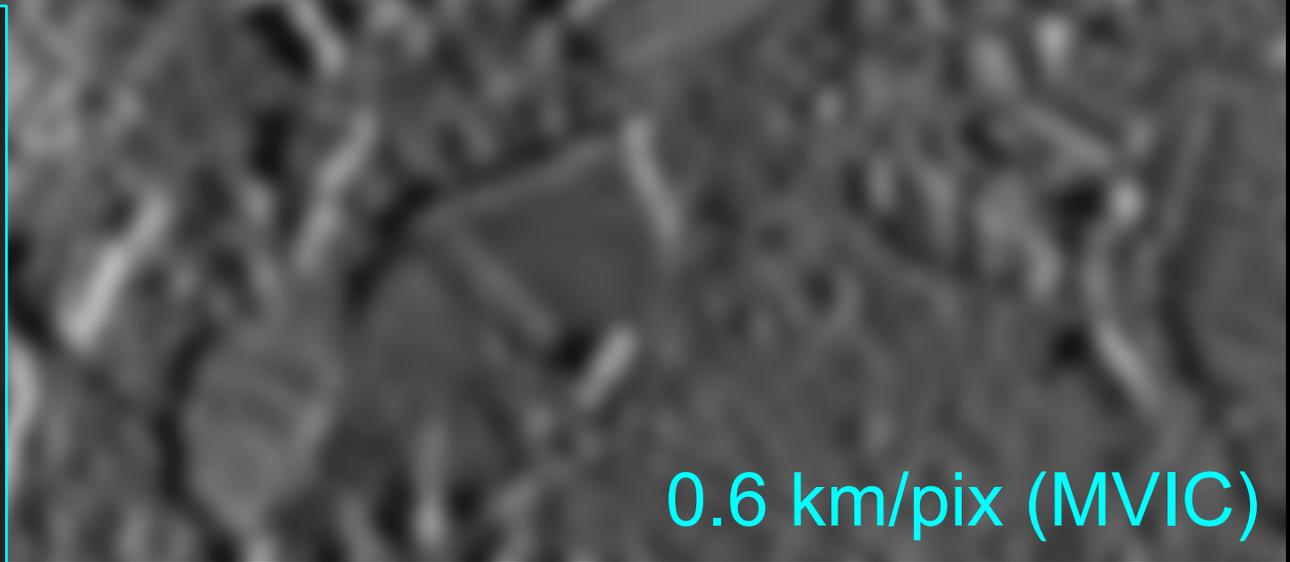
New Horizons Resolution on Pluto

(Simulations of MVIC context imaging vs LORRI high-resolution "noodles")



The Best We Can Do Now

HST/ACS-PC: 540 km/pix



New Horizons Science Status

- New Horizons remains on track to deliver the goods
 - The science objectives specified by NASA and the Planetary Community should be achieved, or *exceeded*
 - Nix, Hydra, Kerberos (P4), and Styx (P5) added (new discoveries)
 - More data collected than originally anticipated (~7x larger)
 - Only exception is direct measurement of Pluto's magnetic field, which was a Group 3 objective
 - Robust timeline with built-in redundancy to ensure success
- Rehearsal of most intense 22 hr flyby segment successfully conducted in May 2012 (“stress test”)
- Flight rehearsal of entire P-7 to P+2 “Core Sequence” in July 2013
 - *Executing this week (July 5-14)!*
- Conducting intensive search for KBOs that are targetable by New Horizons during an Extended Mission phase still to be proposed
 - Using large ground based telescopes with Hubble follow-up

**All systems and instruments are GO.*

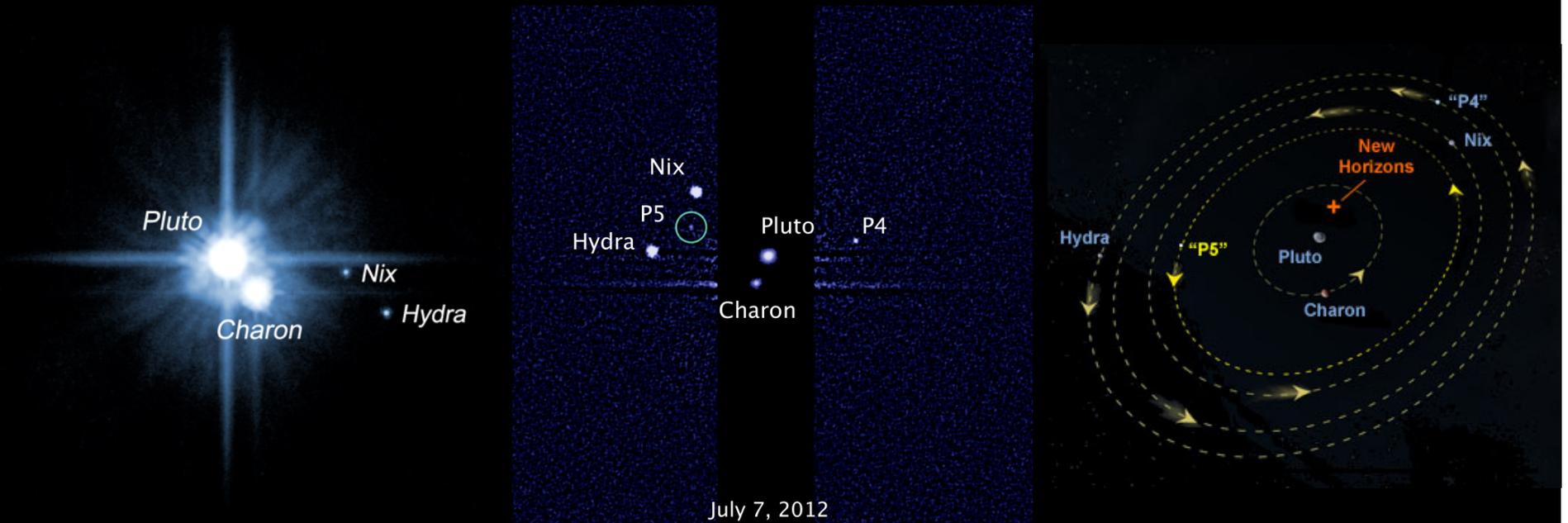
More New Satellites: *Good and Bad*

Recently Announced Names: P4 = Kerberos, P5 = Styx

Hubble: May 2005

Hubble: July 2012

Pluto + 5 Moons



Six for the price of one, but with strings attached.

Where there are small satellites, there will be debris. A collision between mm-sized particles and the NH spacecraft moving at ~ 14 km/s could result in a loss of mission, *but we think NH is safe on current trajectory.*

Concerns

- Loss of mission (LOM) by high velocity (~14 km/s) impact of Pluto system dust on the NH spacecraft
 - *Largely mitigated: Estimated probability of LOM is < 0.3% (95% confidence); two backup encounters planned in case LOM probability increases significantly.*
 - See next two slides
- Pluto heliocentric ephemeris error
 - Pluto observed for < 1/3 of its orbit
 - Recent analysis shows systematic error in ephemeris derived from visible light astrometry
 - Reanalysis of Lowell historical plates should help
 - Unlike previous planetary flybys, Pluto is too small to enable use of spacecraft trajectory perturbations
 - *Use ALMA to measure Pluto's position relative to quasars*
 - Completely independent of visible light measurements and could cut Pluto ephemeris error in half.

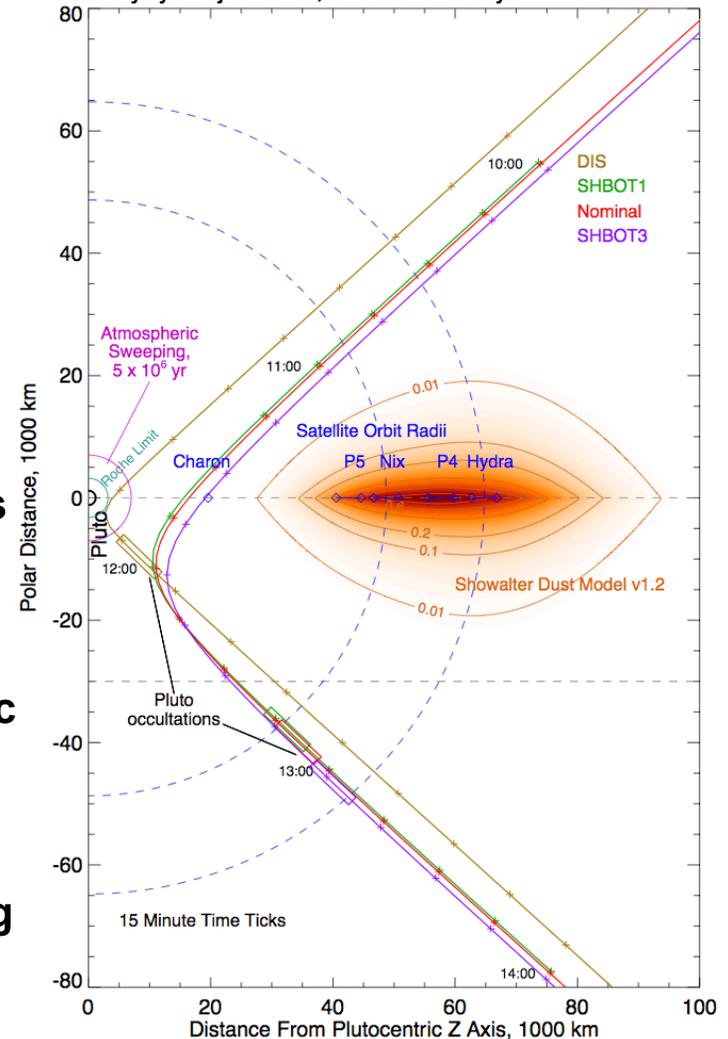


Mitigating the Impact Risk



- NH Project spent 1.5 yr investigating impact hazard
 - Hubble search for satellites & debris
 - Fire projectiles at NH hardware, in combination with modeling, to determine susceptibility of spacecraft (*S/C more durable than we thought*)
 - Dynamical modeling to identify safe/dangerous regions in the Pluto system (see figure to right)
- Put NH trajectory in *Charon Instability Strip*
 - Charon clears debris from its neighborhood, creating a “donut hole” in dust cloud
- Or put NH trajectory through upper portion of Pluto’s atmosphere, which also clears debris
- Three NH *timelines* are now on the table:
 1. Previously planned trajectory (*Baseline*) with s/c attitudes to optimize Pluto science
 2. Generic Inner Safe Haven By Other Trajectory (GIS): Similar trajectory as *Baseline* but with Antenna-To-Ram (ATR) near ring plane crossing
 3. Deep Inner SHBOT (DIS): Fly through Pluto’s atmosphere *and* use ATR

Pluto Flyby Trajectories, Plutocentric Cylindrical Coordinates



***Loss of Mission probability $\leq 0.3\%$ for Baseline, so that’s what we expect to fly in 2015.**

In preparation for the flyby of the Pluto system, the New Horizons project team will hold a scientific conference at The Johns Hopkins Applied Physics Laboratory in Laurel, Maryland on 22-26 July 2013.

This conference will allow the mission science team and members of the planetary science community to:

--Integrate the broad range of existing datasets and perspectives about this system and its context in the Kuiper Belt.

--Discuss and begin to prepare ground-based and other observing proposals to provide additional context alongside the New Horizons encounter.

--And introduce potential new mission collaborators and those interested in participating in Pluto system data analysis programs to the details of the scientific investigations planned during the 6-month long New Horizons encounter.

--Prepare for DAP proposals in ROSES-15.

Registration remains open!
View Program and Register at:
<http://plutoscience.jhuapl.edu>

NEW Shedding Light on Frontier Worlds **HORIZONS**

**The Pluto System on the Eve of
Exploration by New Horizons:
Perspectives and Predictions**

**A Scientific Conference
July 22–26, 2013**



Co-Sponsored by:

**The Johns Hopkins University Applied Physics Laboratory
and**

The Southwest Research Institute

To be held at the Applied Physics Laboratory, Laurel, MD

Local Organizing Chair: Hal Weaver, New Horizons Project Scientist

Program Committee Chair: Alan Stern, New Horizons Principal Investigator