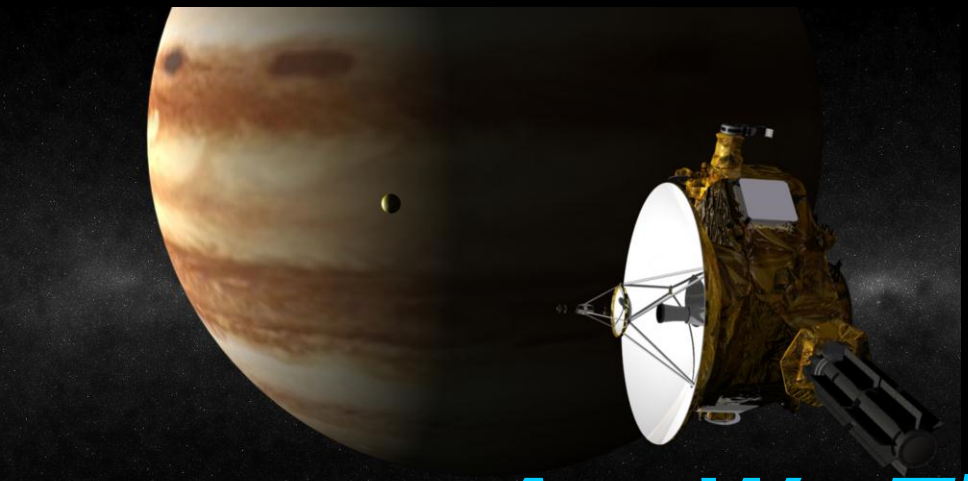
New Horizons to Pluto



Are We There Yet?

(Well, almost…)

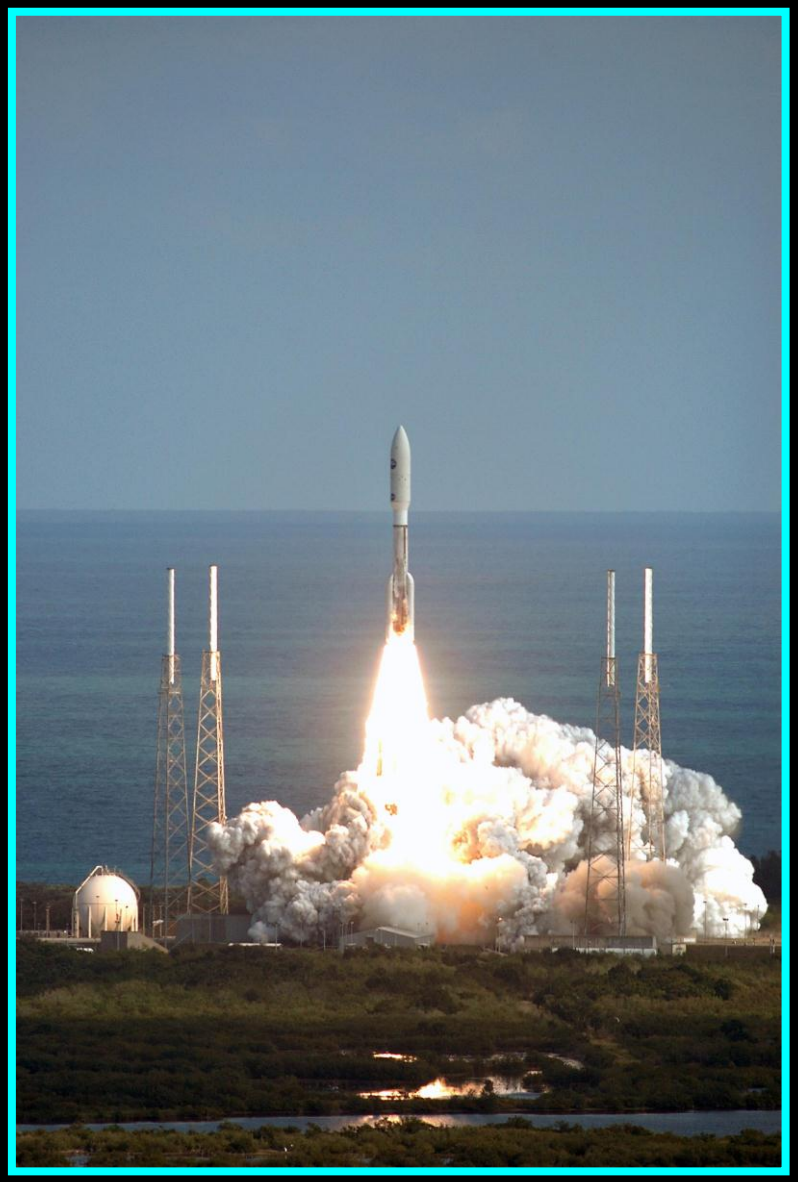
The Challenge of Discovery Educator Workshop

2:45 PM EDT NASA's Digital Learning Network (DLN)

Ralph L. McNutt, Jr., NH Co-Investigator

The Johns Hopkins University Applied Physics Laboratory

Launch 2006 January 19 14:00 EST



- Launched on Atlas V 551
  - Nearly perfect trajectory
  - Fastest Earth departure ever (36,000 mph = 58,000 km/hr)
  - Passed Moon's orbit in 9 hours
  - Pass orbits of:
    - Mars on 4/7/2006
    - Jupiter on 2/28/2007
    - Saturn on 6/8/2008
    - Uranus on 3/18/2011
    - Neptune on 8/24/2014
- Pluto system encounter on 7/14/2015
- Total S/C mass = 478 kg (1054 lb)
  - 77 kg (170 lb) of hydrazine
  - 30 kg (66 lb) of science payload
- 200 W power from RTG at Pluto
- Total Cost ~$710M (FY08)

A milestone … but not the beginning

Pluto at Perihelion – New Horizons at its Beginning

COME TO A **PARTY** TO CELEBRATE

PLUTO's PERIHELION *

1989

EVERY 248 YEARS

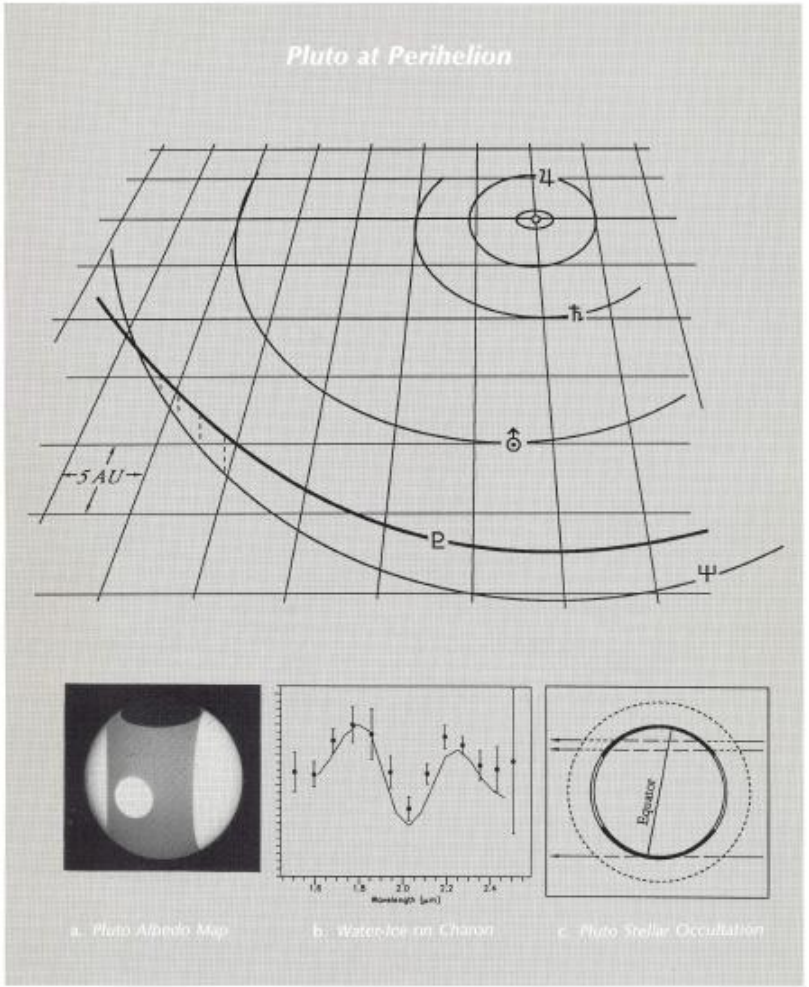
SEPT 5th 5:00 pm

ON THE FIELD BETWEEN LASP & JILA

REFRESHMENTS!

VOLLEYBALL!

* Pluto reaches the point closest to the sun on its 248 year elliptical orbit Monday night.

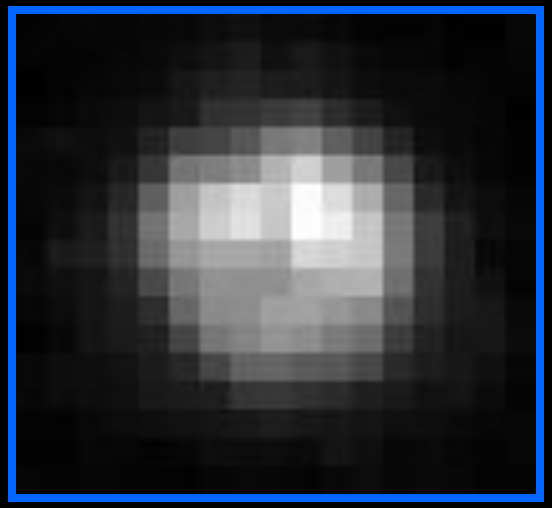


Reprinted From *Geophysical Research Letters*
Volume 16, Number 11, November 1989

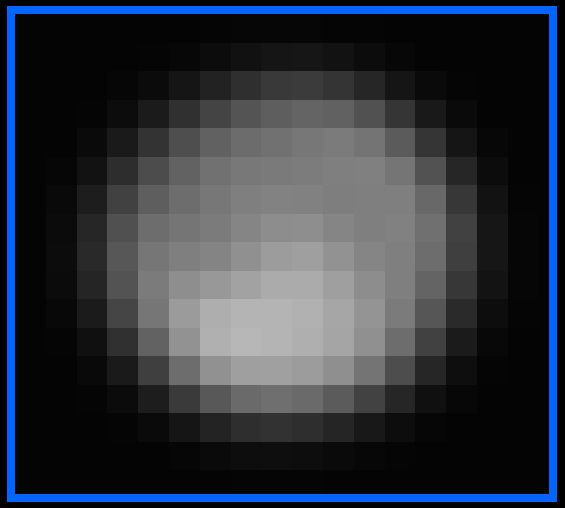
Published by American Geophysical Union

Progress Will Be Limited
Until We Visit

This is the fundamental historical lesson of planetary exploration



Pluto at best Hubble Resolution



Earth's Moon at the Same Resolution

Earth's Moon at 5 km per pixel

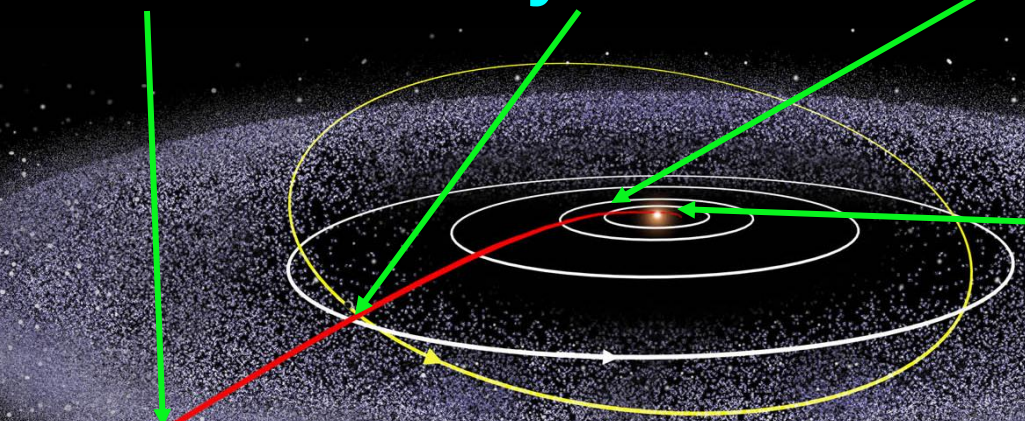
To Pluto and Beyond

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

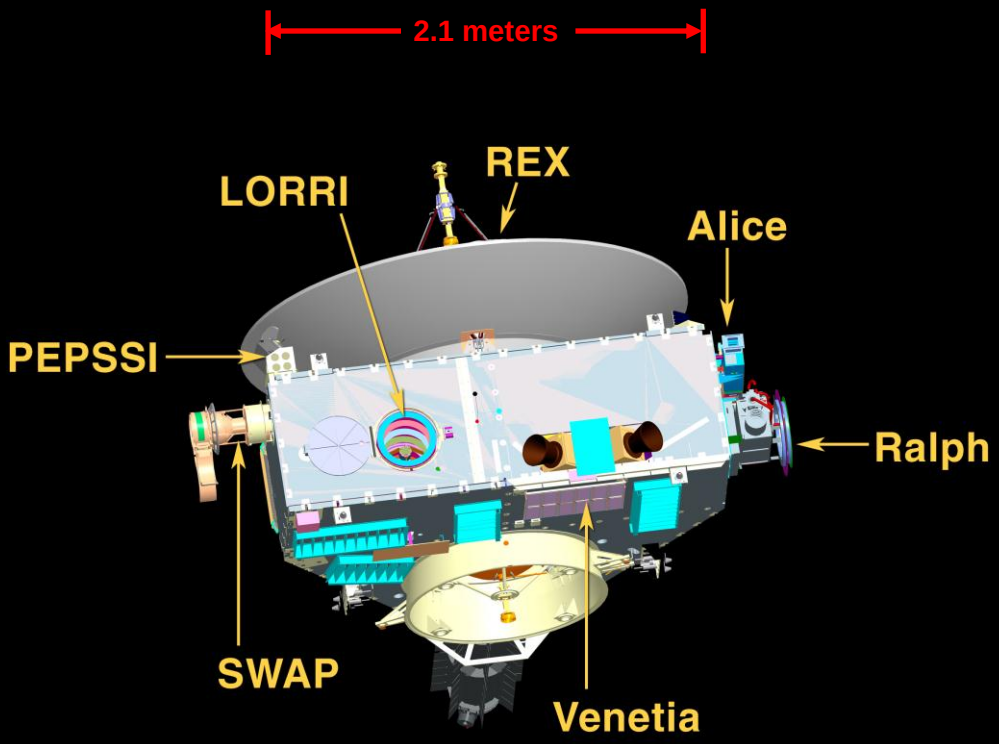
PI: Alan Stern (SwRI)

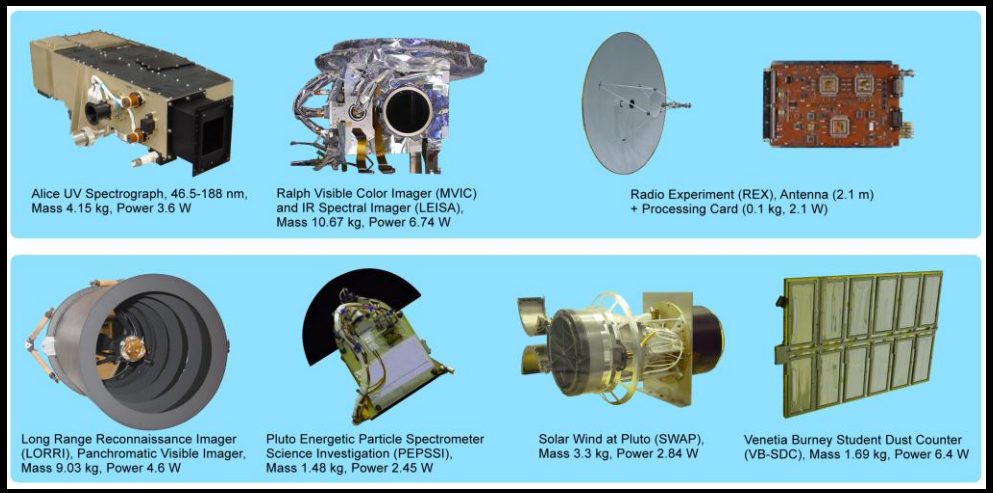
PM: JHU Applied Physics Lab

New Horizons is NASA's first New Frontiers Mission

Radioisotope Thermoelectric Generator Powered with Plutonium-238 Enables Mission

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
Dave Slater
John Spencer
Darrell Strobel
Mike Summers
Len Tyler
Hal Weaver
Leslie Young

The "New" Solar System

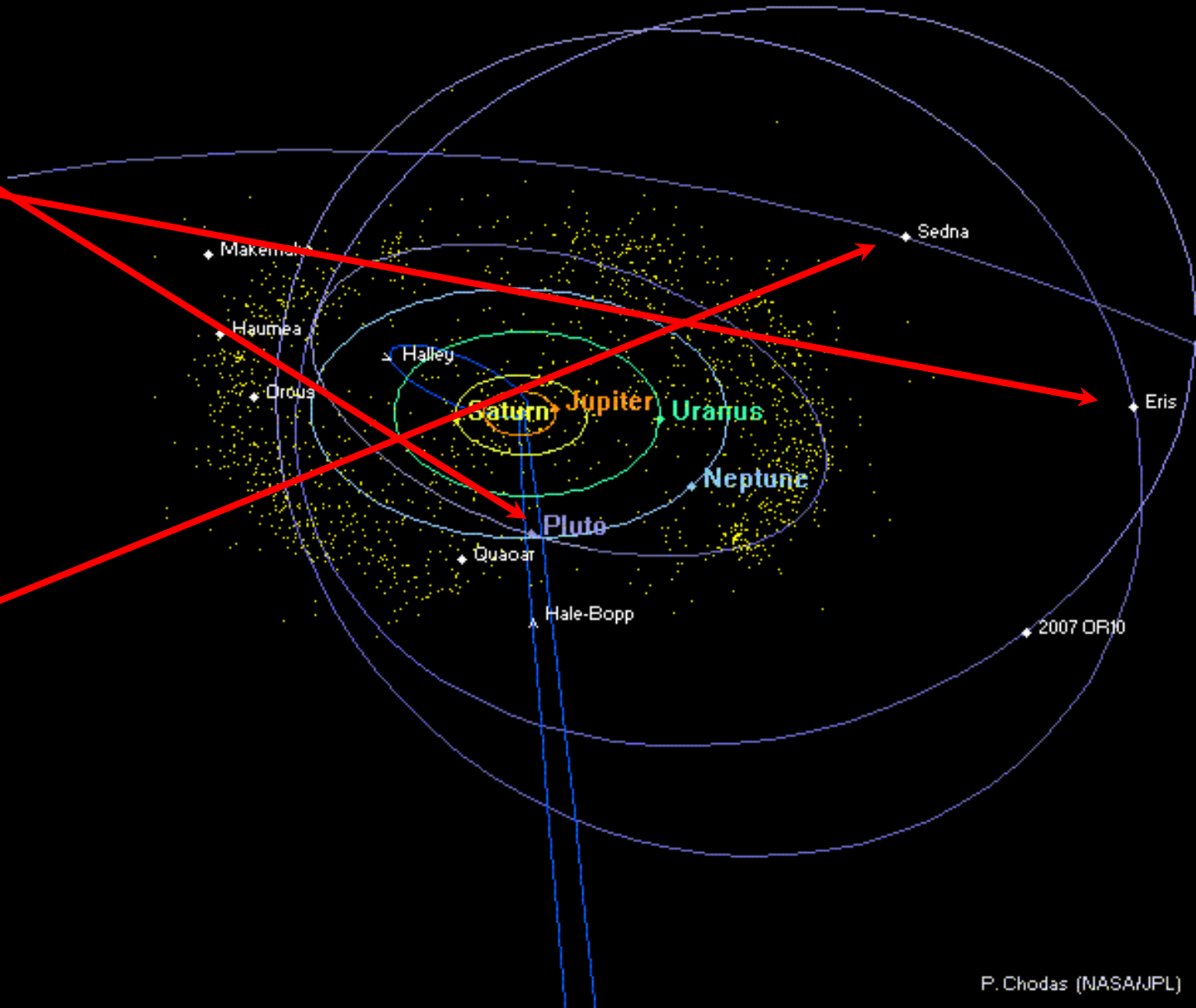
Intriguing Objects

Pluto is just the tip of the iceberg

Discovery of *Eris* prompted discussion of *What is a Planet?*

Ironically, *Eris* now appears to be *smaller* than Pluto

Explaining the orbit of *Sedna* remains beyond our understanding



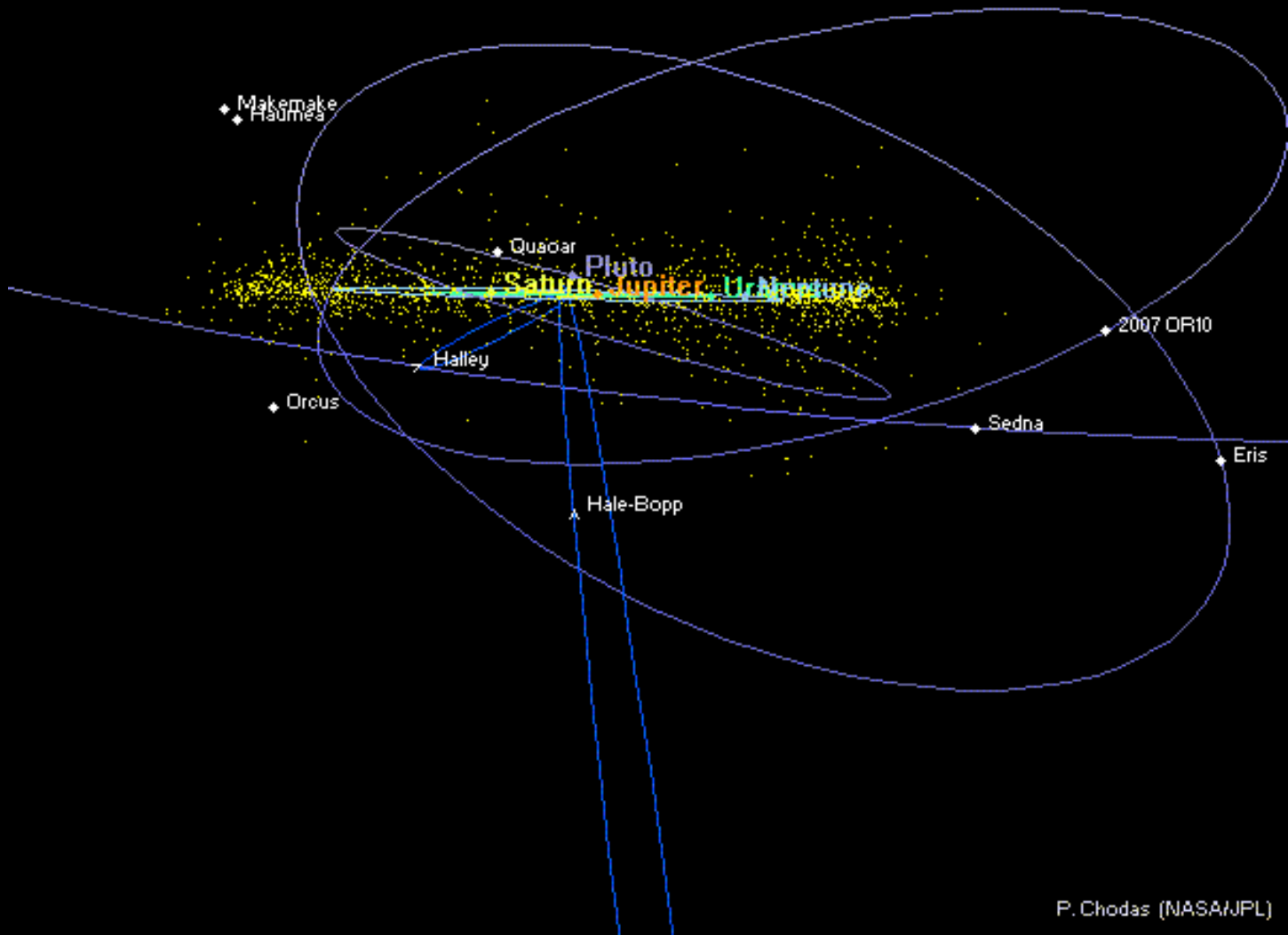
The Outer Solar System

Edgewise View

The cold dark regions of the Outer Solar System have much to teach us about the formation and evolution of Planetary Systems

Apply what we learn in our Solar System to the study of systems around other stars

We are embarking on another revolution in our understanding of the Cosmos



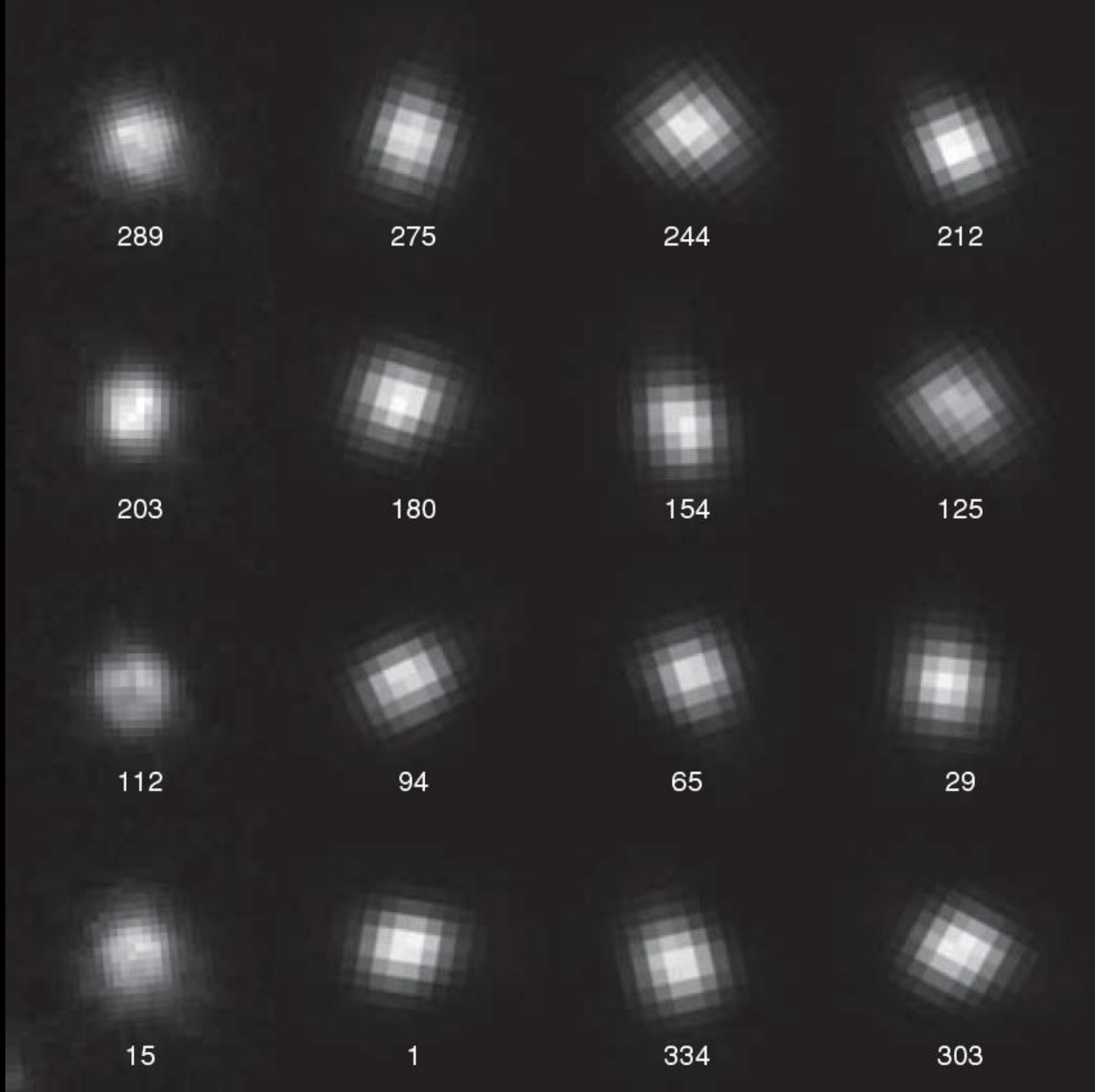
Best Hubble Images of Pluto

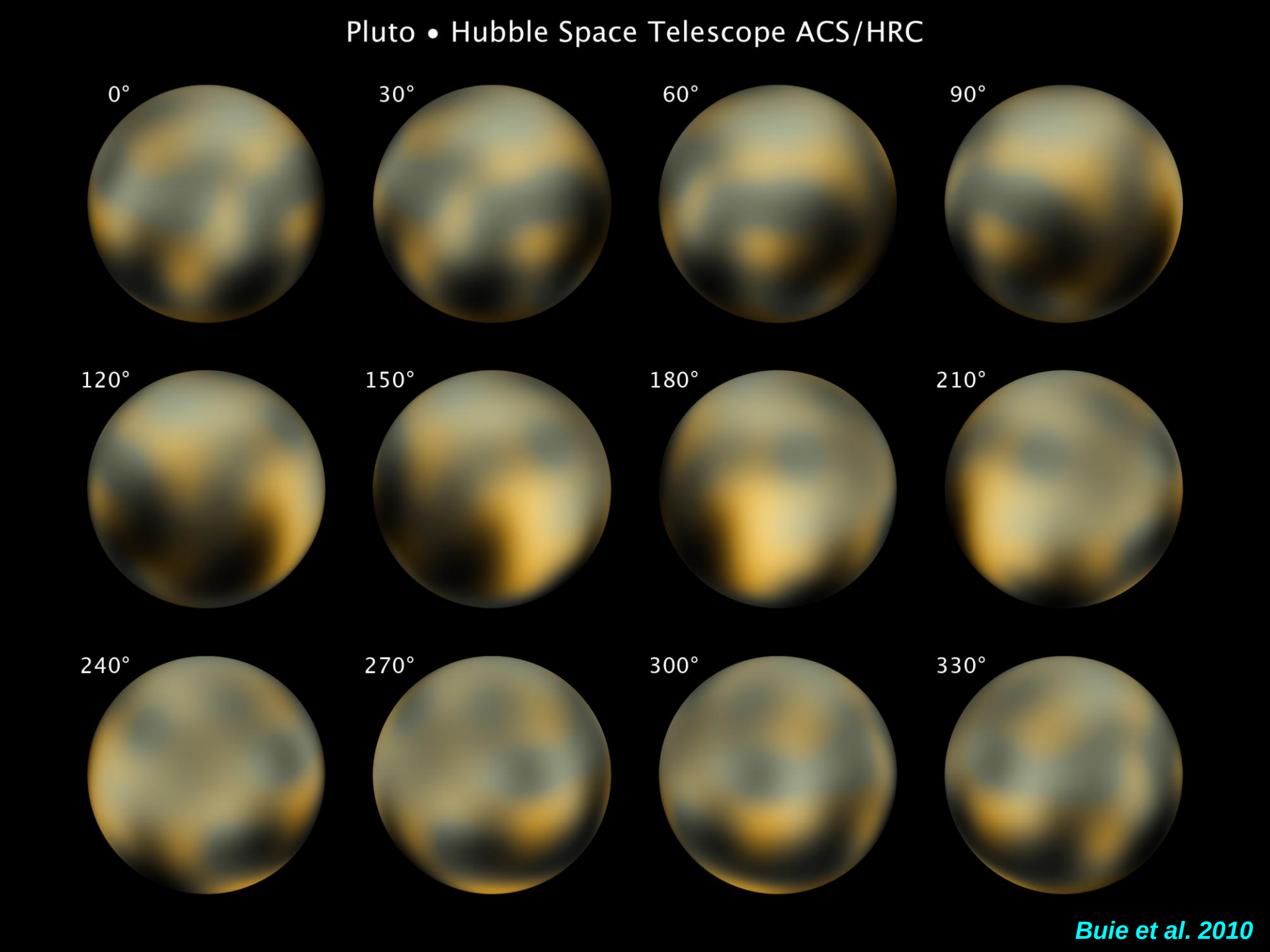
First column shows FOC images taken in 1994

Other columns show ACS/PC images taken in 2002-2003

Numbers give sub-Earth longitude

Buie et al. 2010



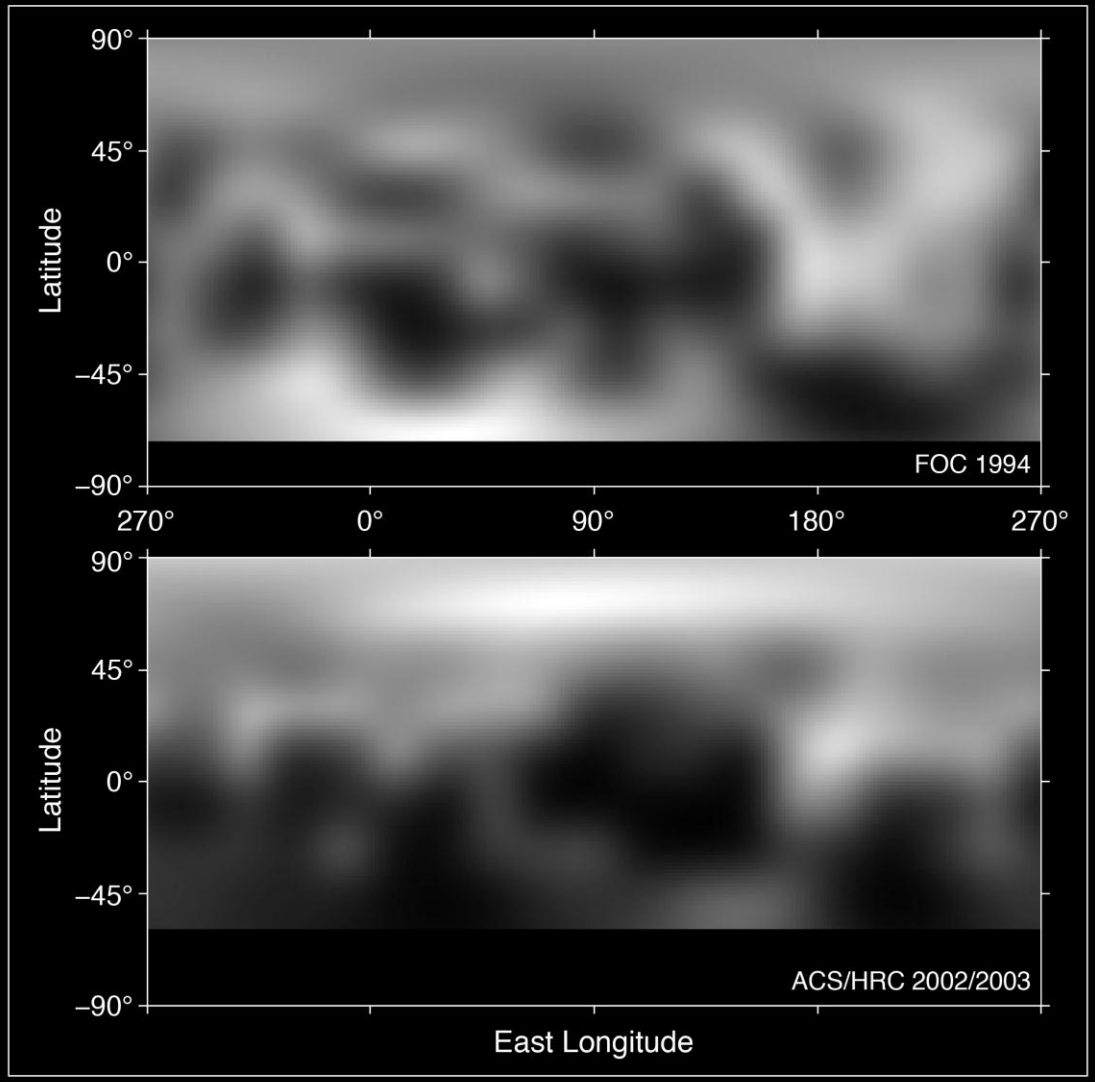

Pluto • Hubble Space Telescope ACS/HRC
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
Buie et al. 2010

Pluto is Changing

Pluto's surface is changing possibly associated with frost migration

Pluto's surface is getting slightly redder and slightly brighter (~10% effects)

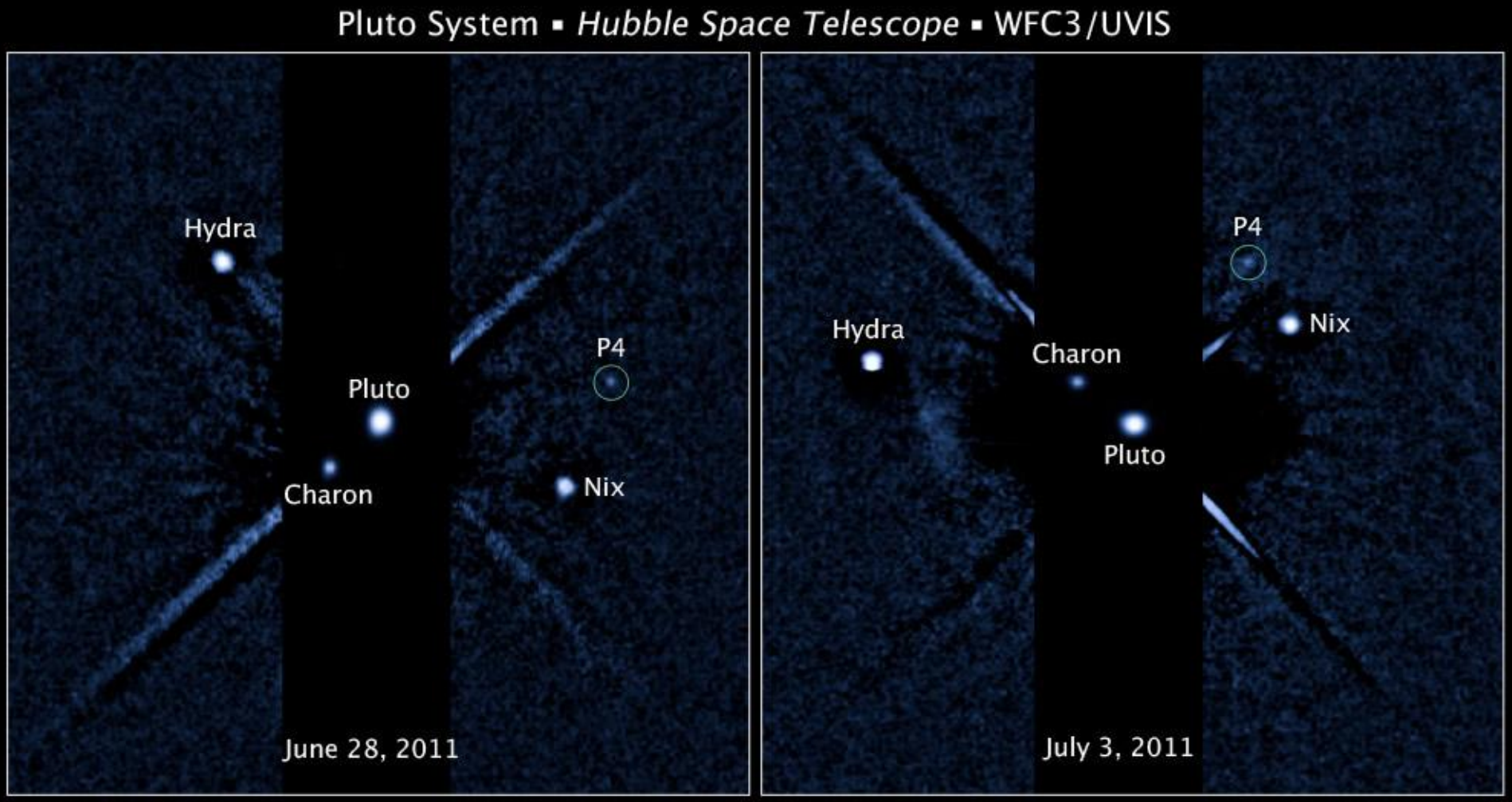
Pluto's atmosphere is getting thicker (by a factor of ~2), at least for now



Comparison Maps of Pluto
Hubble Space Telescope • FOC • ACS/HRC

NASA, ESA, and M. Buie (Southwest Research Institute) STScI-PRC10-06b

Nix and Hydra Discovered in 2005; P4 has followed

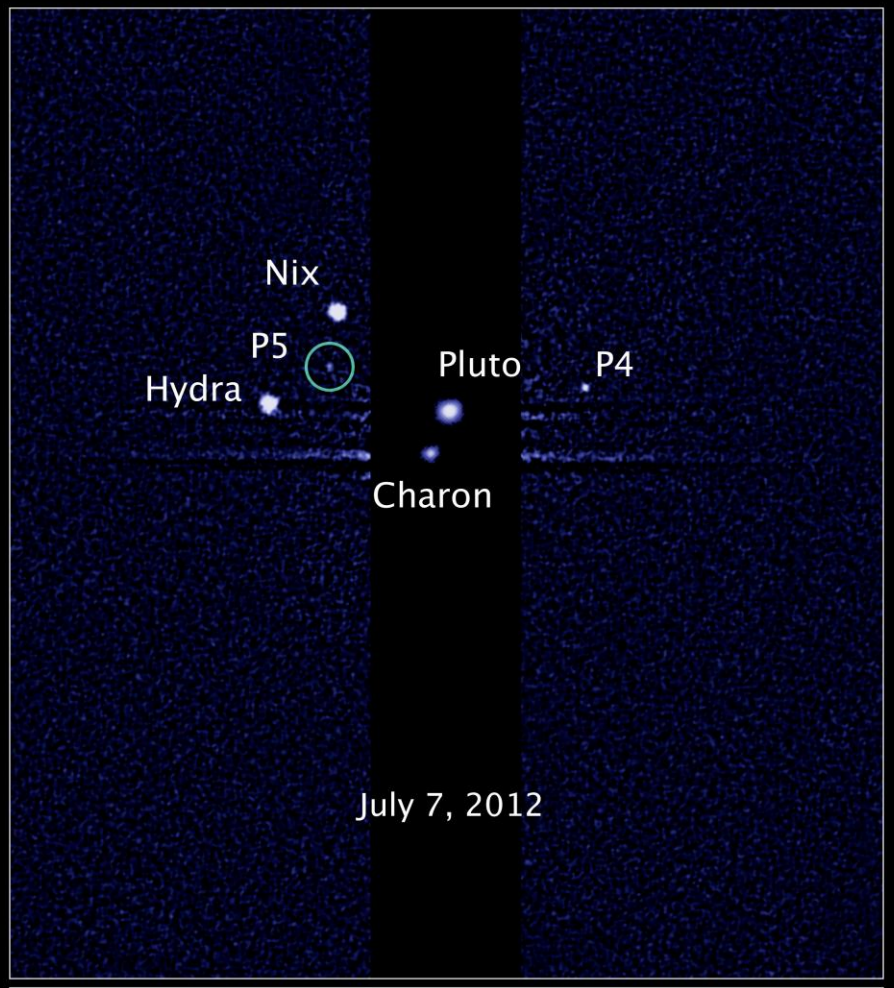


NASA, ESA, and M. Showalter (SETI Institute)

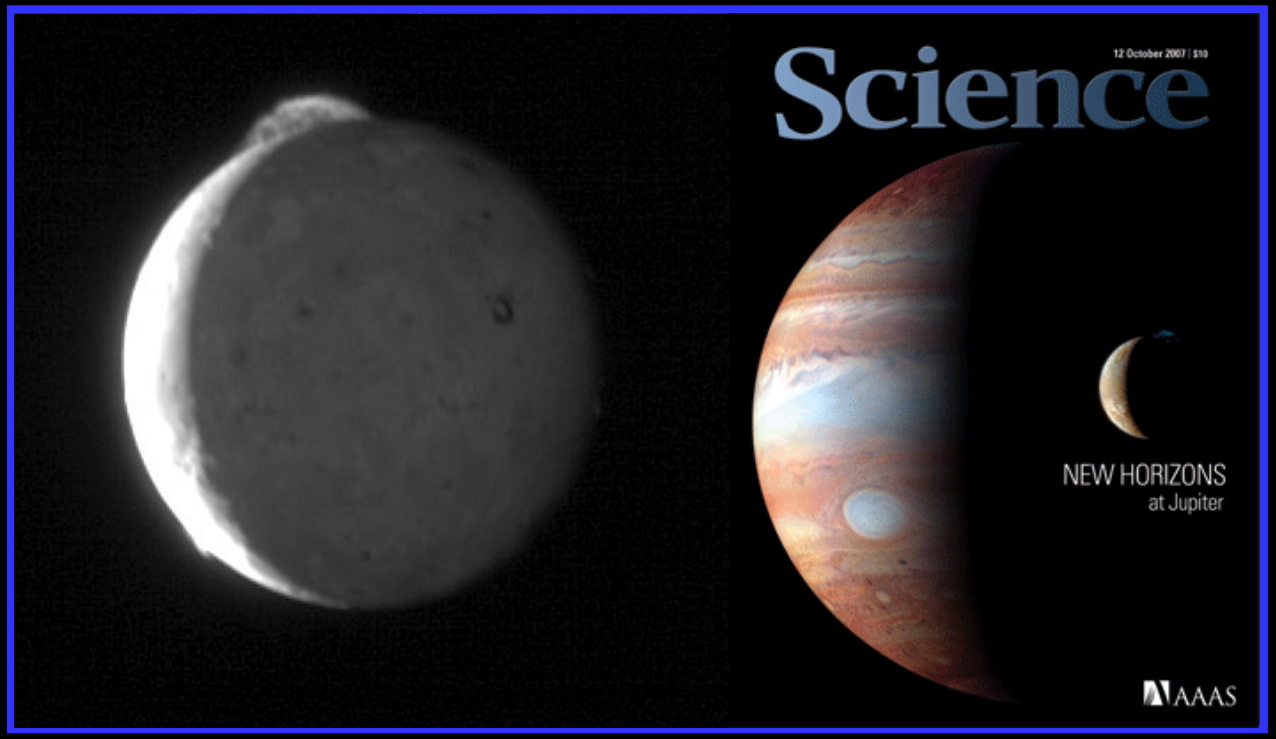
STScI-PRC11-23

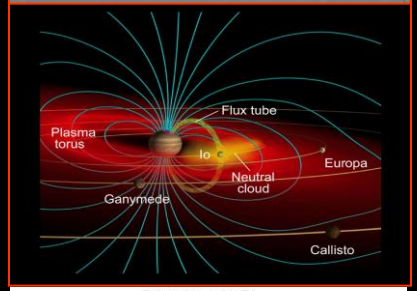
And then P5!

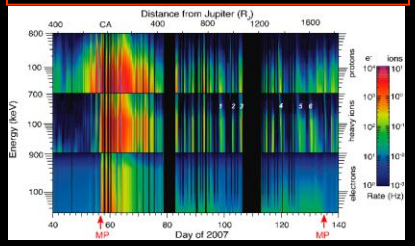
JULY 11, 2012: A team of astronomers using NASA's Hubble Space Telescope is reporting the discovery of another moon orbiting the icy dwarf planet Pluto. The moon is estimated to be irregular in shape and 6 to 15 miles across. It is in a 58,000-mile-diameter circular orbit around Pluto that is assumed to be co-planar with the other satellites in the system. Provisionally designated S/2012 (134340) 1, the latest moon was detected in nine separate sets of images taken by Hubble's Wide Field Camera 3 on June 26, 27, and 29, 2012 and July 7 and 9, 2012. This discovery increases the number of known moons orbiting Pluto to five.



A tug from Jupiter and new science along the way – 28 Feb 2007







Jovian meteorology, satellite geology and composition, Auroral phenomena, and magnetospheric physics.

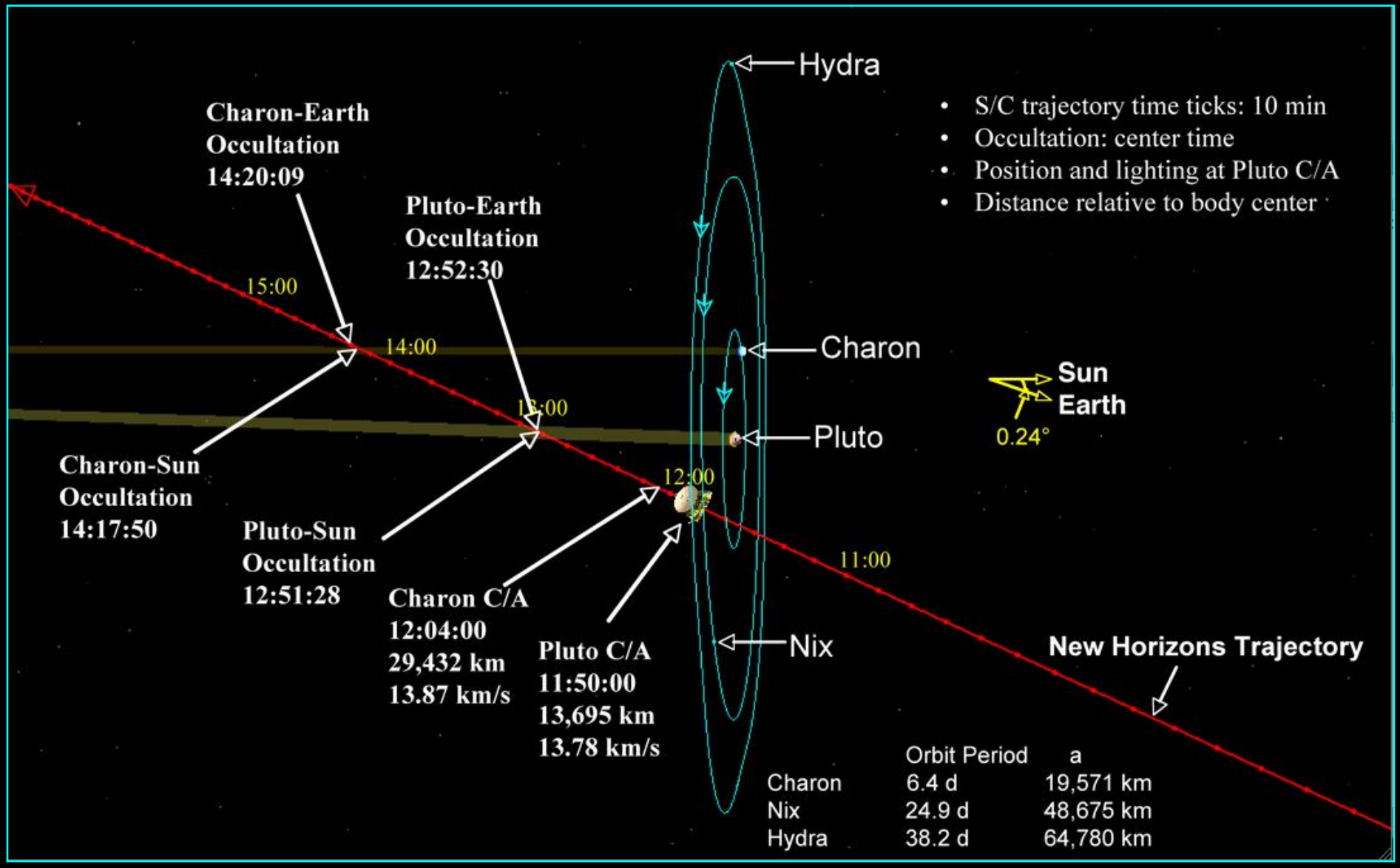
RLM 16

Pluto Closest Encounter Operations Begin in 2015

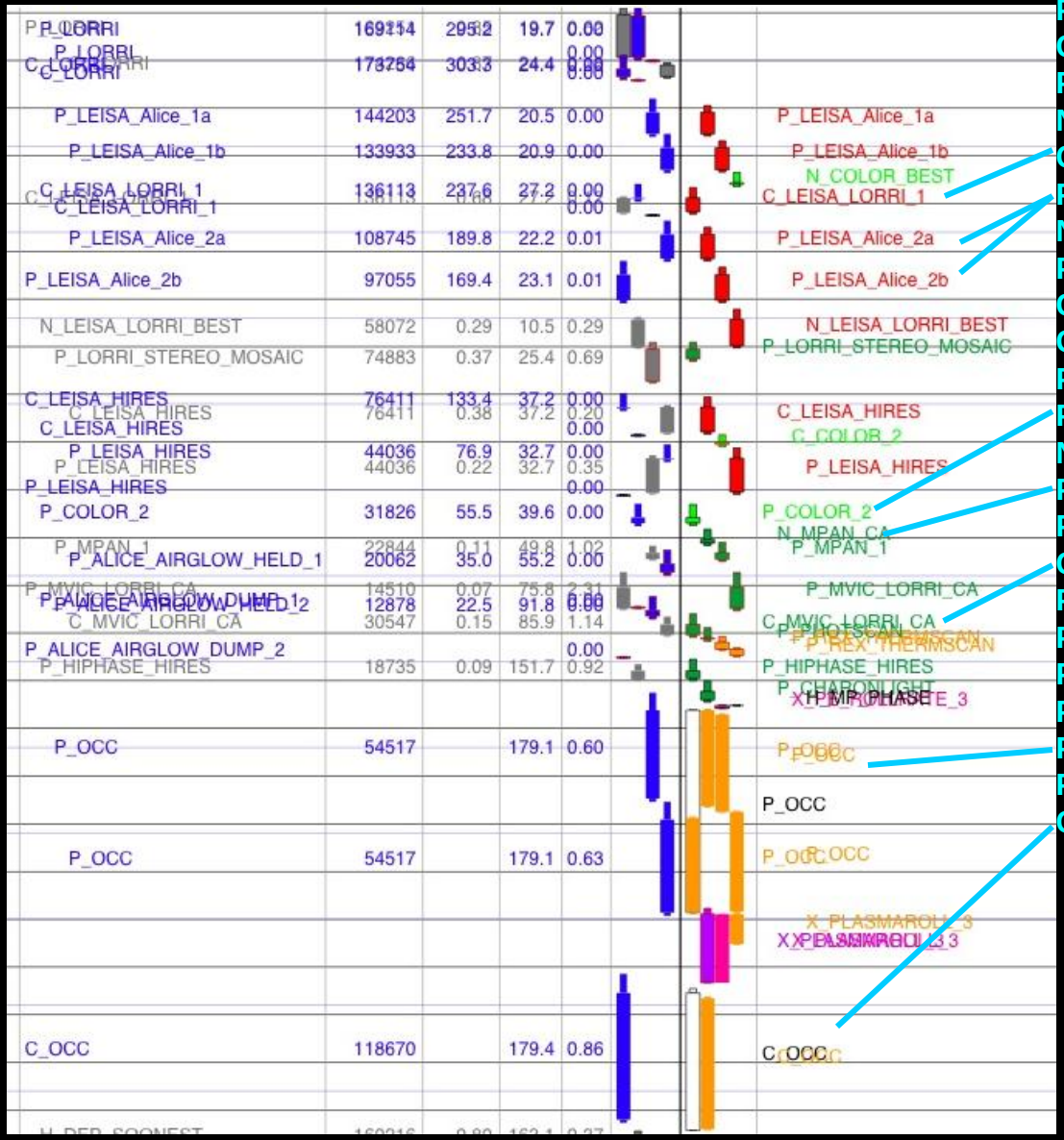
- 12 April 2015 – operations Start
- Closest approach now scheduled for
  - 14 July 2015
  - 11:49:59 UTC

Instruments are "go"
LORRI looking back at Jupiter in June 2010 – at 16.3 AU out

New Horizons Pluto Encounter



Timeline near Closest Approach

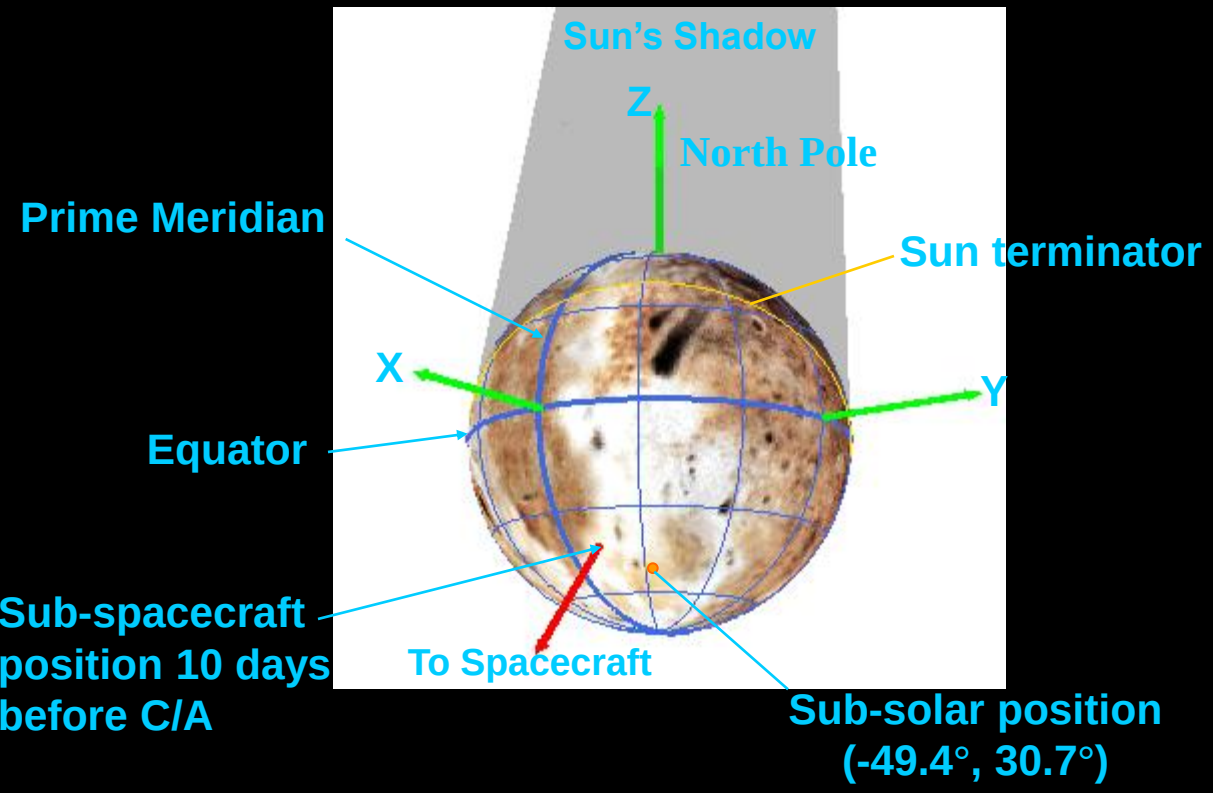


Pluto global pan maps at 0.9 km/pix
Charon global pan maps at 0.9 km/pix
Pluto global IR at 9 km/pix
Nix global color maps at 2 km/pix
Charon global IR at 9 km/pix (+ pan at 0.6 km/pix)
Pluto global IR at 6 km/pix
Nix IR at 4 km/pix & pan at 0.3 km/pix
Pluto pan images at 0.4 km/pix
Charon IR at 5 km/pix (+ pan at 0.4 km/pix)
Charon global color at 1.4 km/pix
Pluto IR at 3 km/pix
Pluto global color at 0.7 km/pix
Nix pan at 0.5 km/pix
Pluto global pan at 0.5 km/pix, strip at 0.12 km/pix
Pluto pan at 0.3 km/pix, strip at 0.08 km/pix
Charon global pan at 0.6 km/pix, strip at 0.16 km/pix
Pluto (smeared) at 110 deg phase
Pluto radiometry at 230 km/pix
Pluto at 0.34 km/pix, 146 deg phase
Pluto in reflected Charonlight, 0.44 km/pix
Pluto solar and earth occultation
Plasma roll
Charon solar and earth occultation

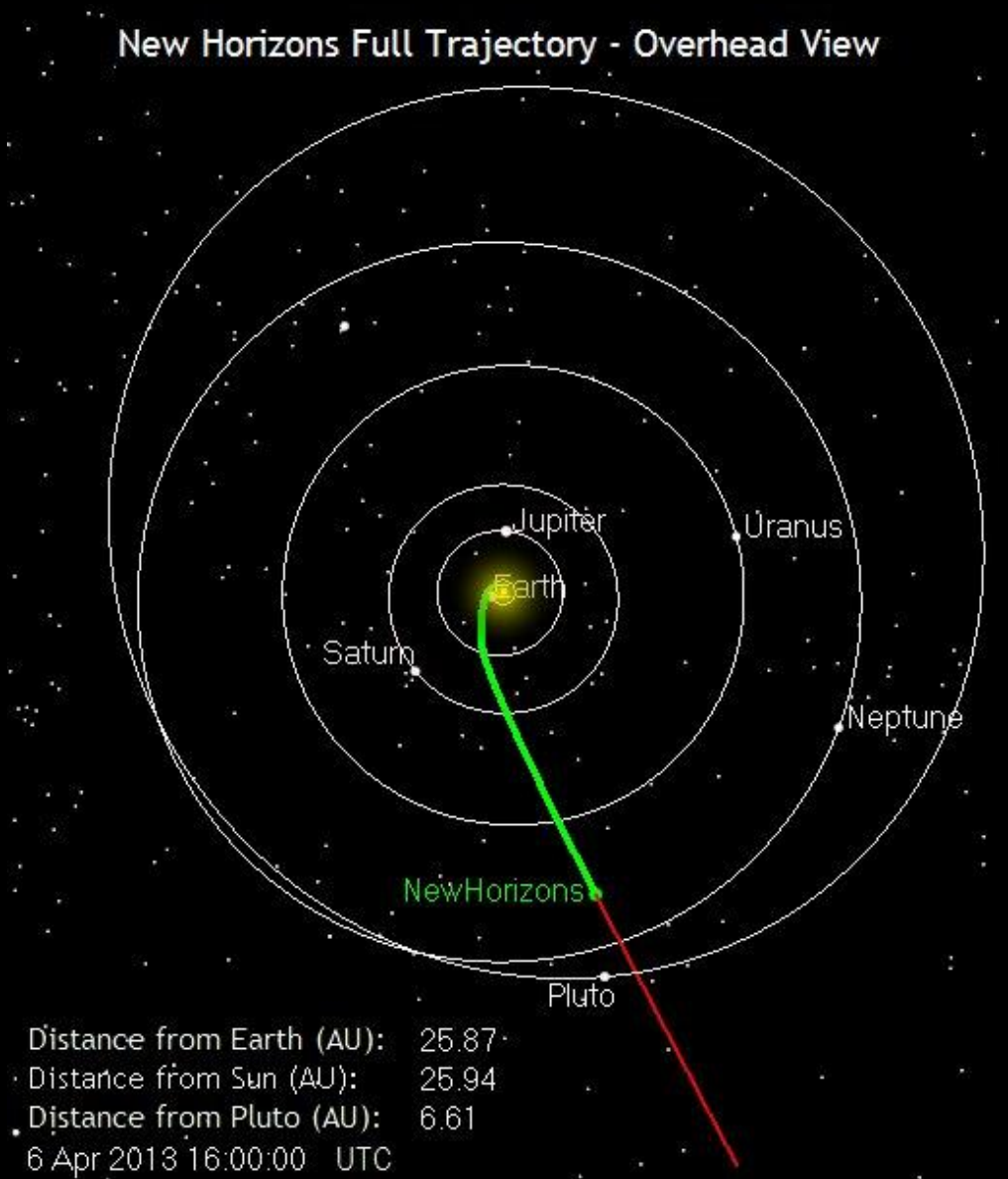
- Timeline addresses all group 1 (required) and 2 (strongly desired) goals, and all but one group 3 (desired) goal.
- All group 1, and most of group 2 and 3 are addressed redundantly
- P-7 days to P+2 days has already been sequenced and reviewed by the science team

Pluto at Approach 2015

- Sunlit in southern hemisphere & dark in northern cap
- *New Horizons* approaches Pluto from southern hemisphere
- Solar phase angle at approach is 15°
- Pluto makes one rotation every 6.4 Earth days



New Horizons – 6 April 2013 (Today)



25.87 AU is 3.58 light hours from Earth

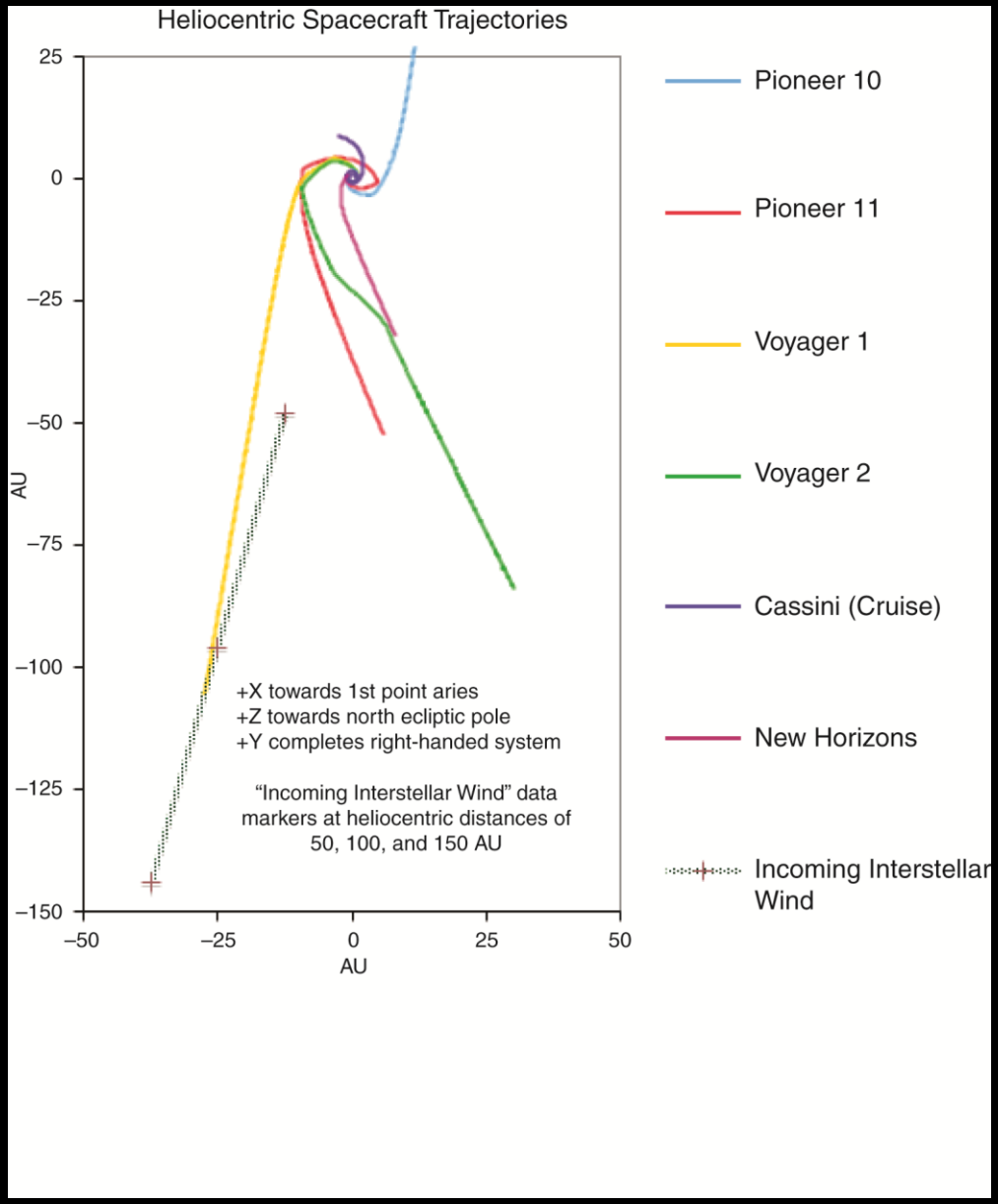
Mission elapsed time: 2633 days 23 hours

Time to Pluto closest approach: 828 days 18 hours

Follow the mission: http://pluto.jhuapl.edu

What Next?

Another KBO encounter – and then out of the solar system!

Power is “good to go” until ~July 2032 to ~84 AU at least

Joining the heliosphere fleet of Pioneer 10 and 11 and Voyager 1 and 2 to the stars…