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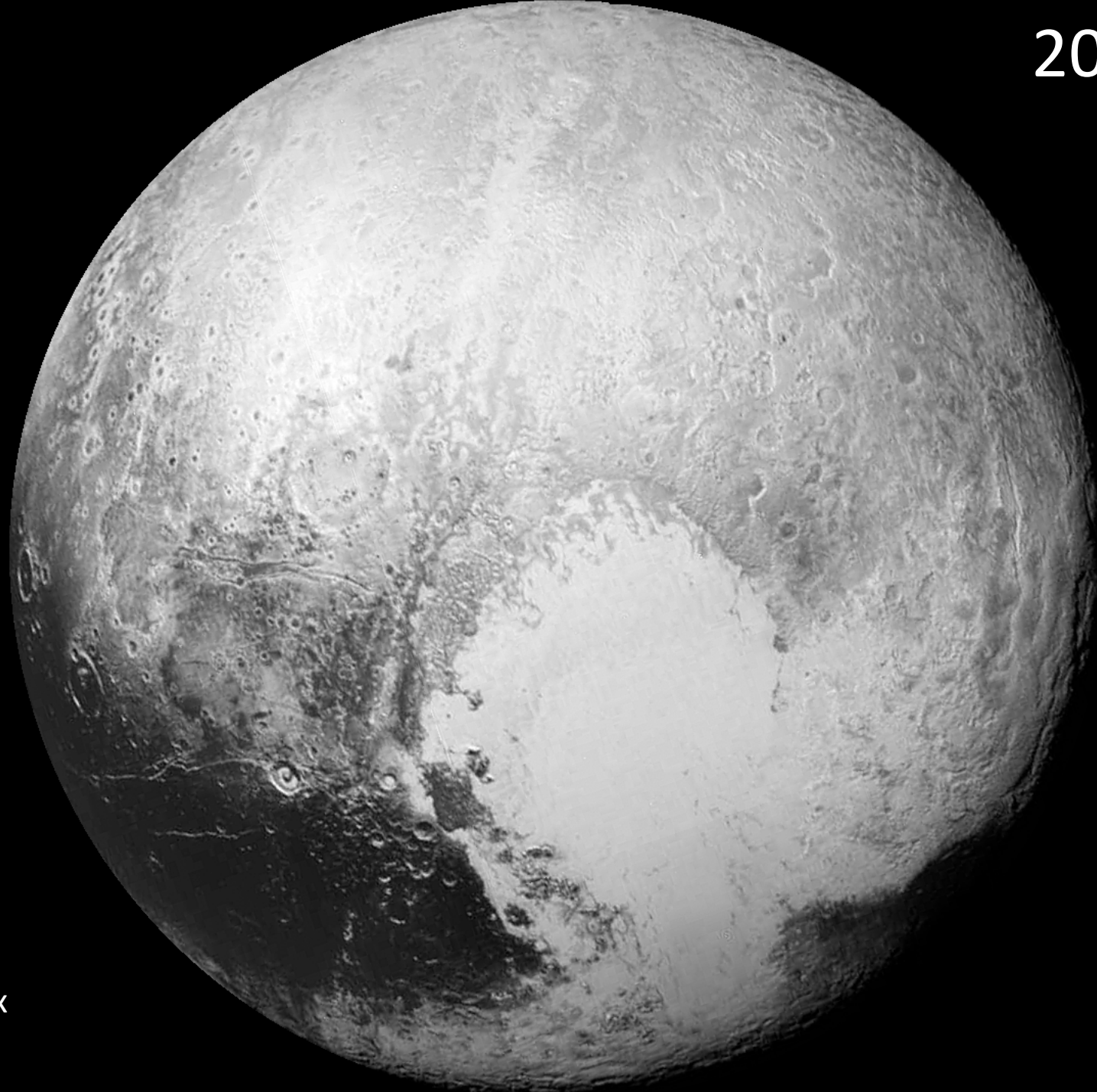


Artist Concept/NASA

1994

200 km/pix

2015



2.2 km/pix

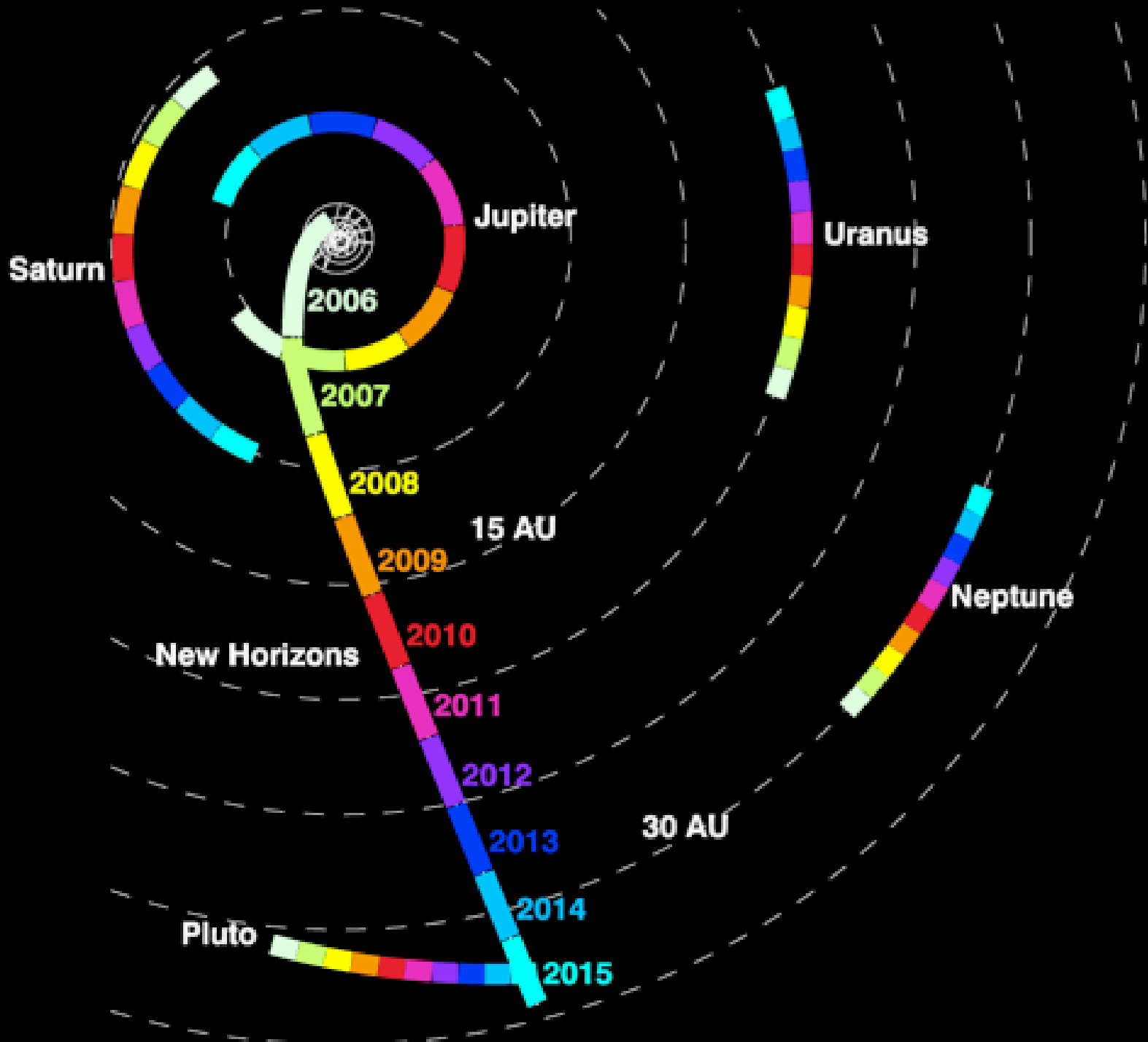
# New Horizons

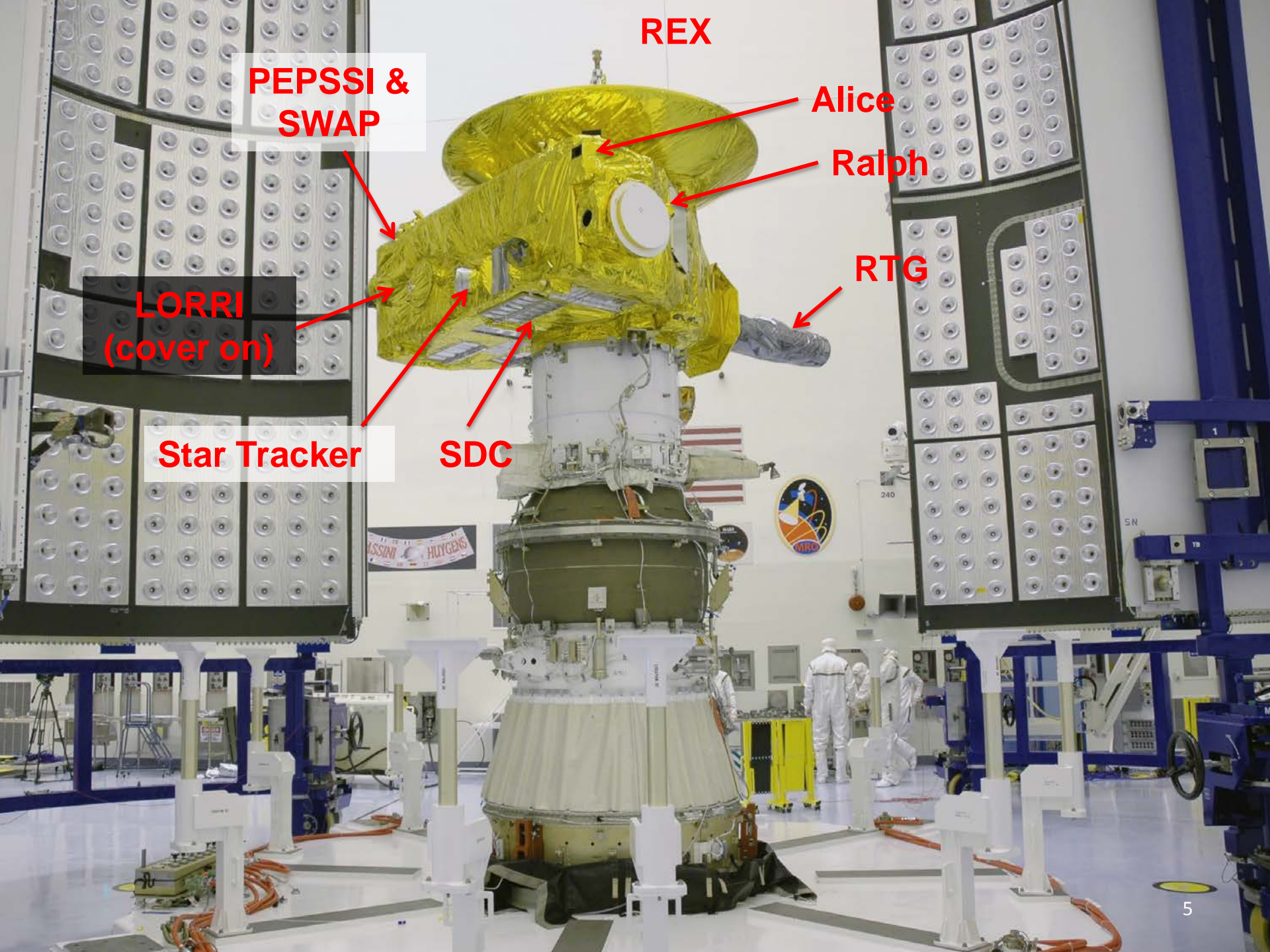
## MISSION OBJECTIVES

### Primary Objectives

- Characterize global geology and morphology of Pluto and Charon
- Map surface composition of Pluto and Charon
- Characterize the neutral atmosphere of Pluto and its escape rate







**REX**

**PEPSSI &  
SWAP**

**Alice**

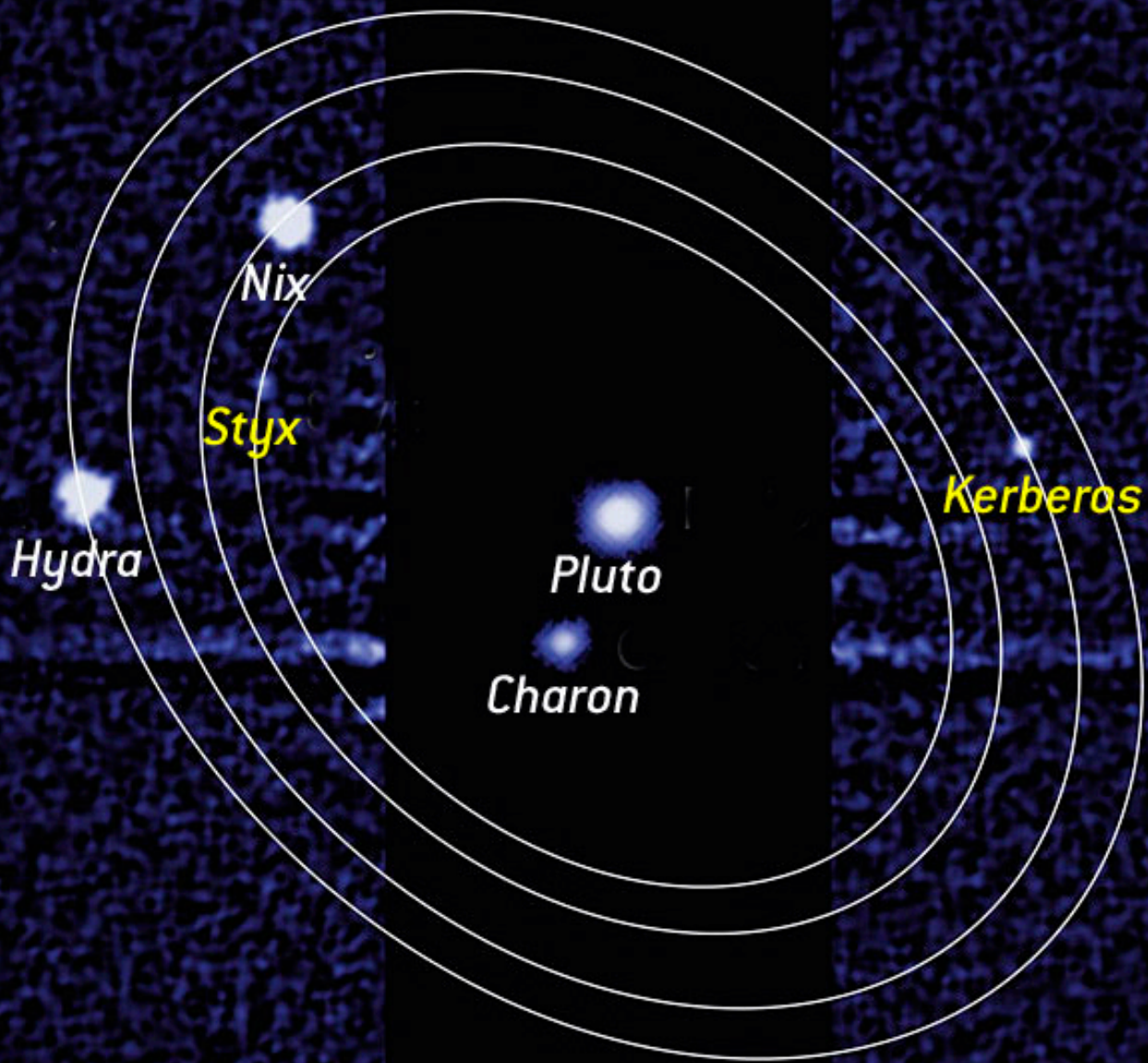
**Ralph**

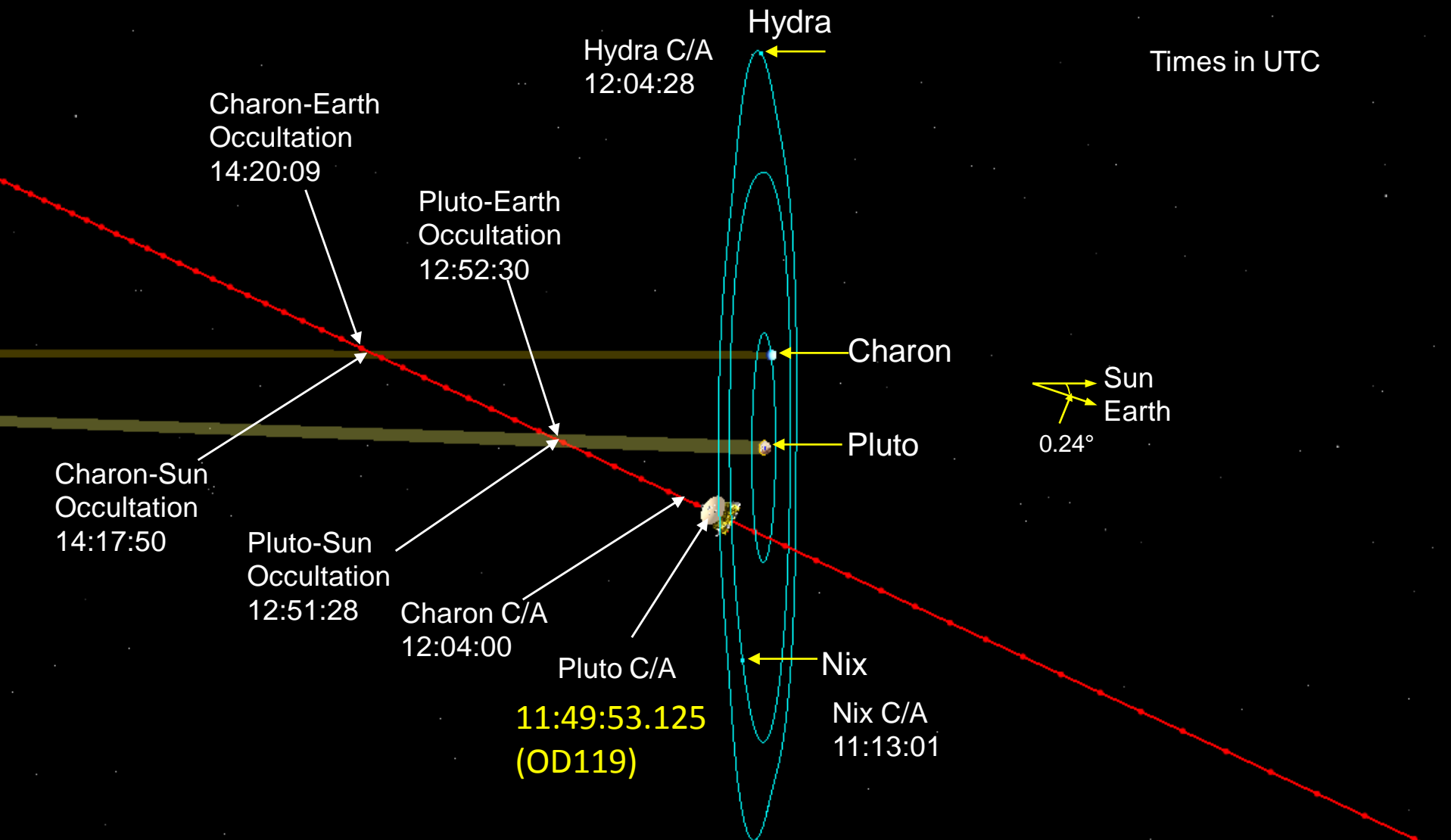
**RTG**

**LORRI  
(cover on)**

**Star Tracker**

**SDC**

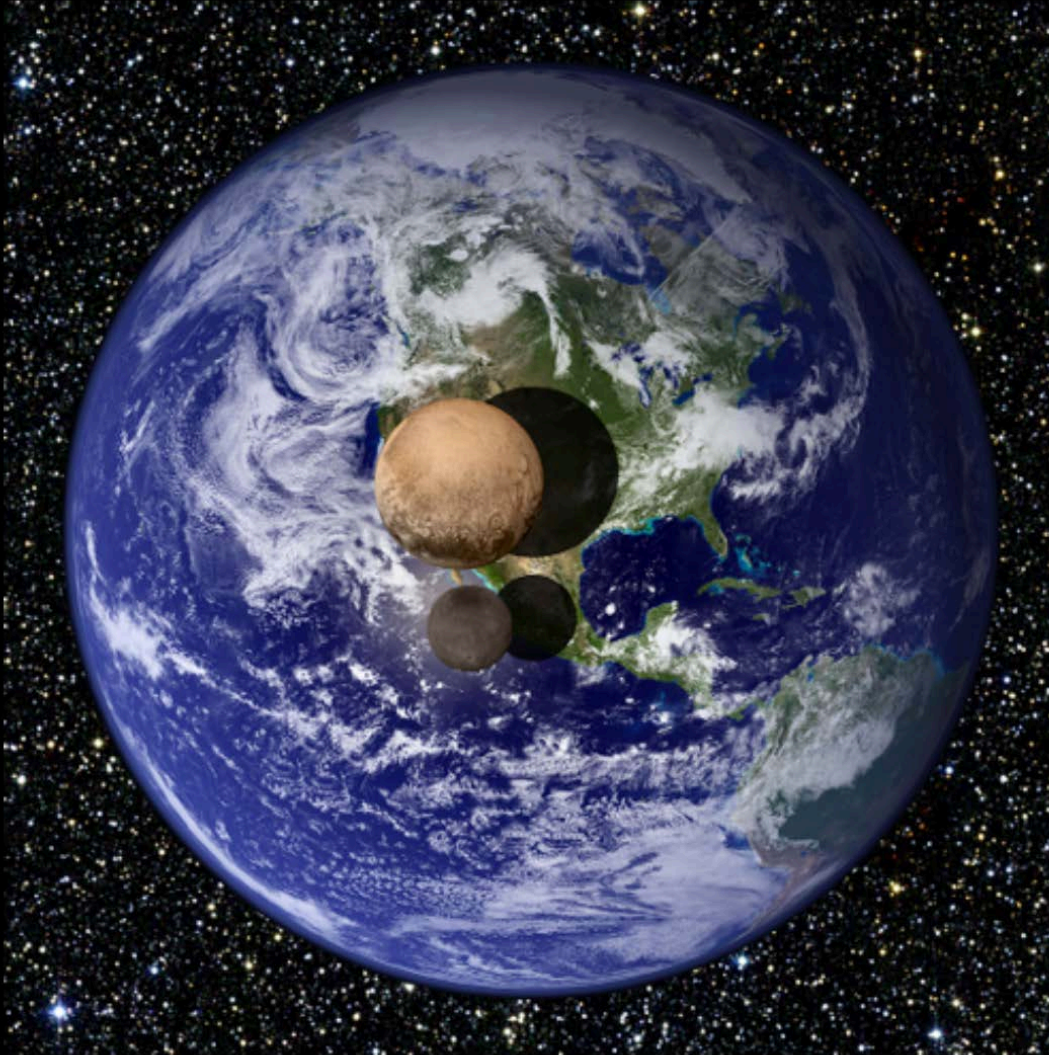






# New Horizons

## RESULTS: Sizes of Pluto & Charon



# New Horizons

## RESULTS: Sizes of Nix & Hydra



'Natural' color



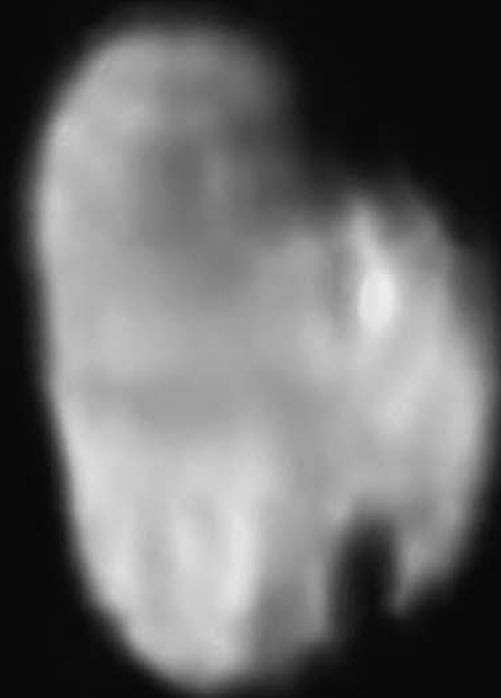
# New Horizons

## RESULTS: Sizes of Nix & Hydra



Enhanced color

MVIC



Black and white

LORRI

# New Horizons

## RESULTS: Charon Polar Spot



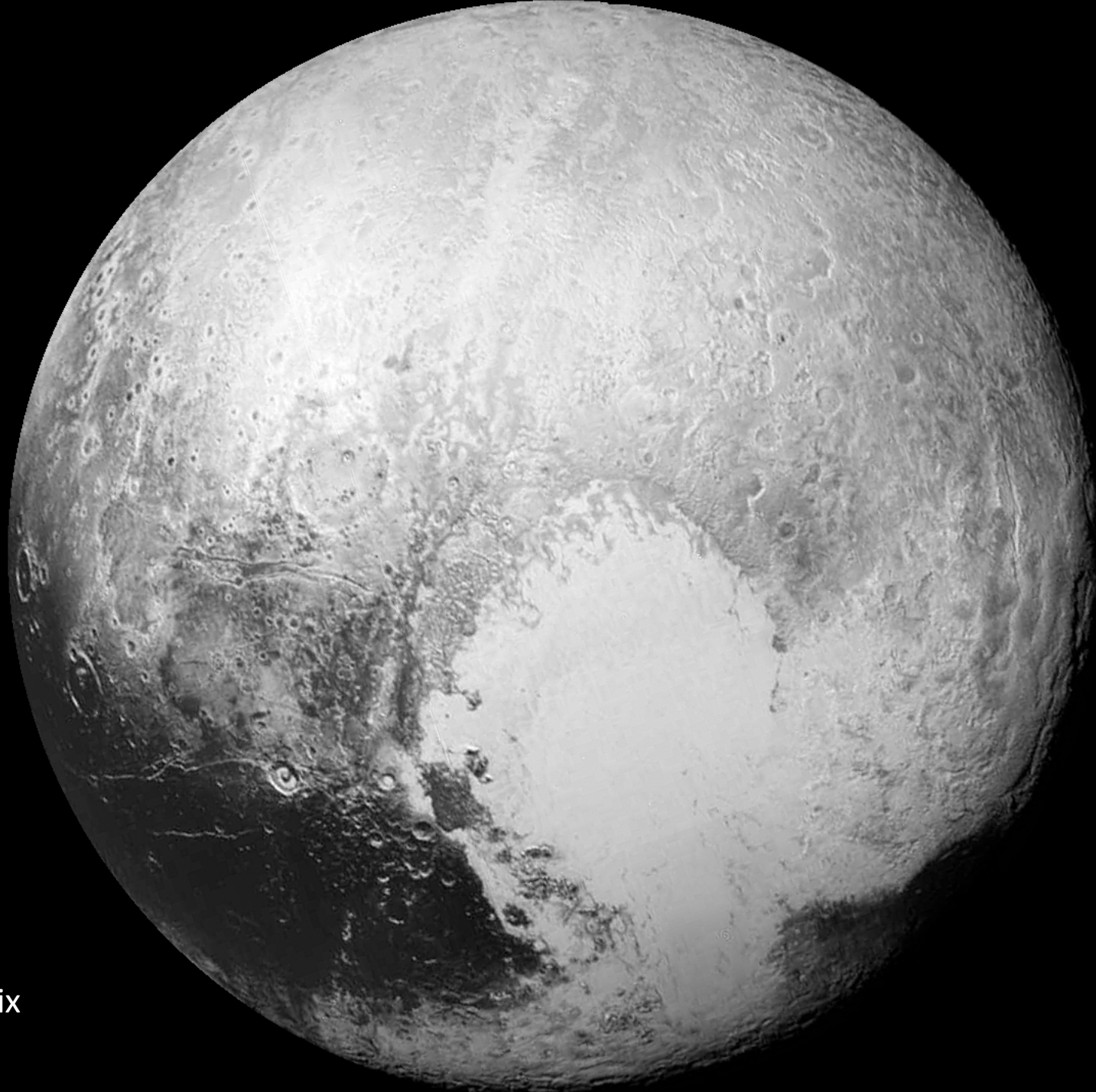
Enhanced color

MVIC



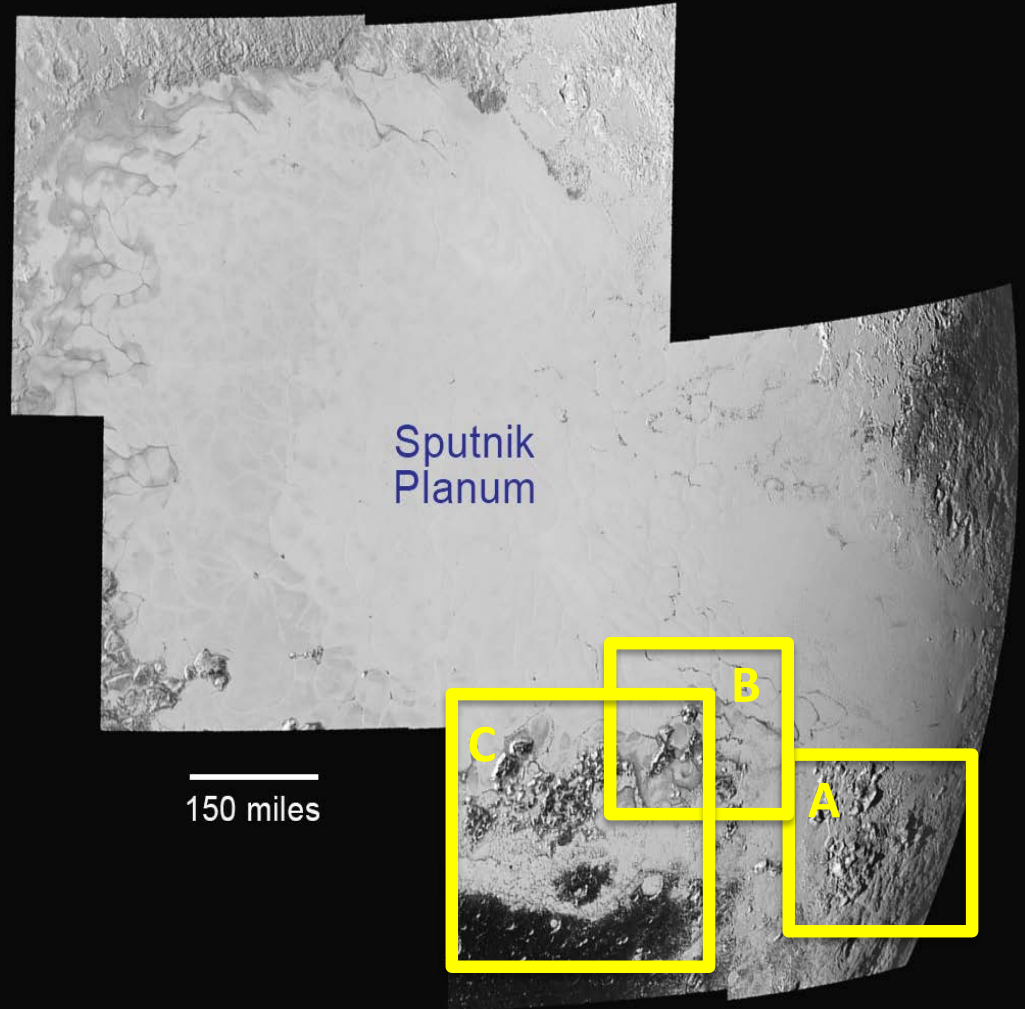
'Natural' color

LORRI

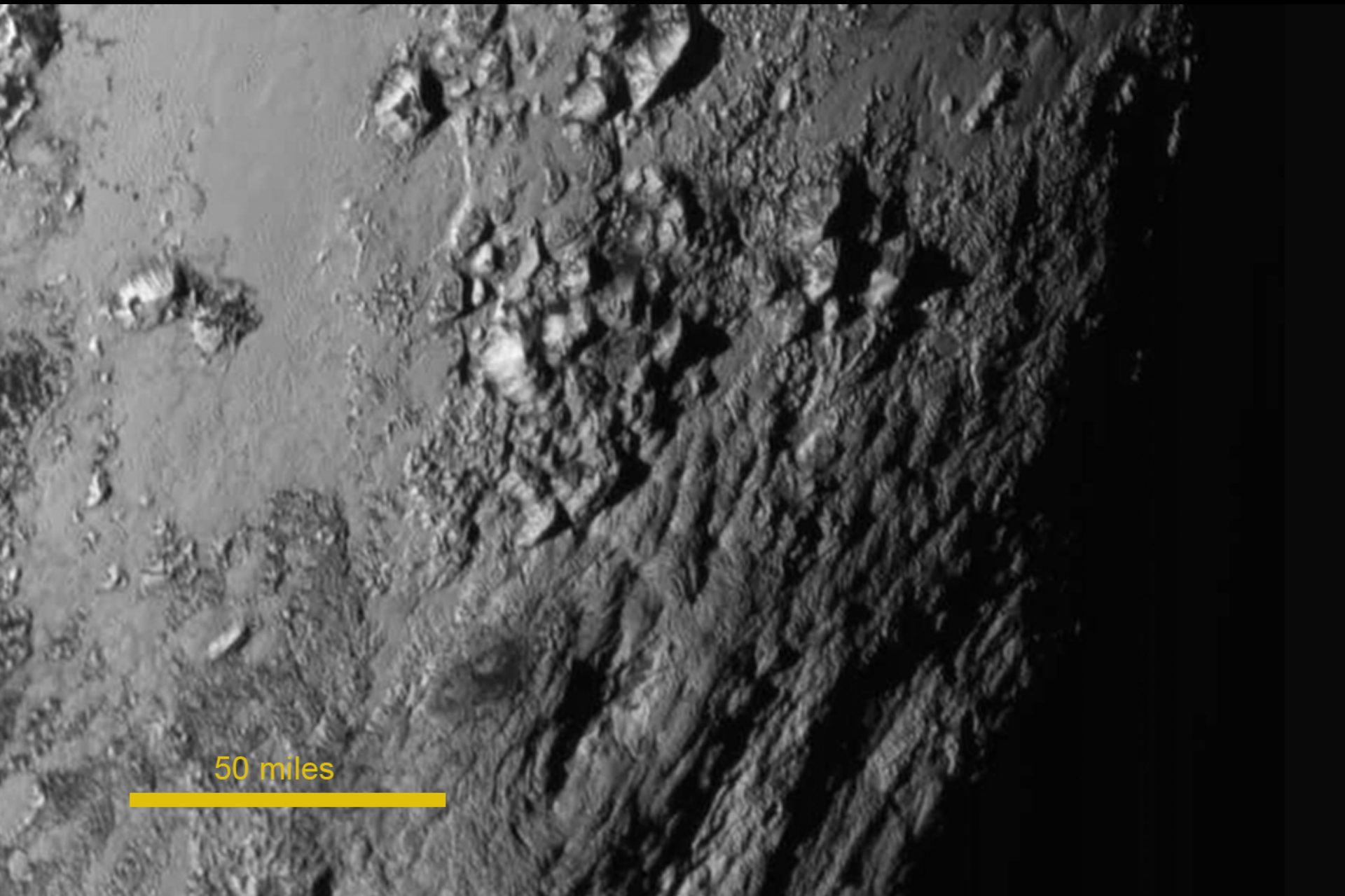


2.2 km/pix

# New Horizons RESULTS: Complex Terrains on Pluto



A



50 miles

**B**



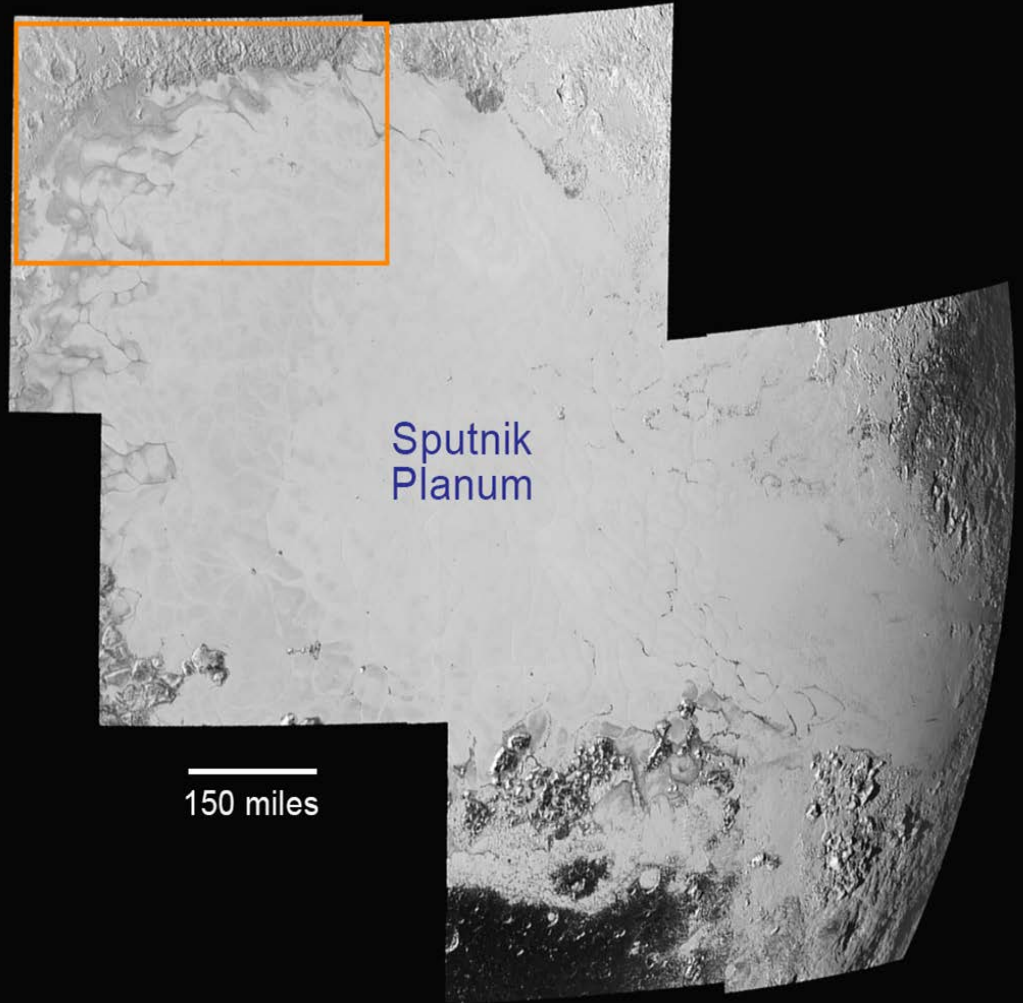


C



20 miles

# New Horizons RESULTS: Glacial Flow on Pluto



Rugged cratered terrain

Nitrogen ice flow

Nitrogen ice flow

Polygonal cells

Sputnik Planum

20 miles

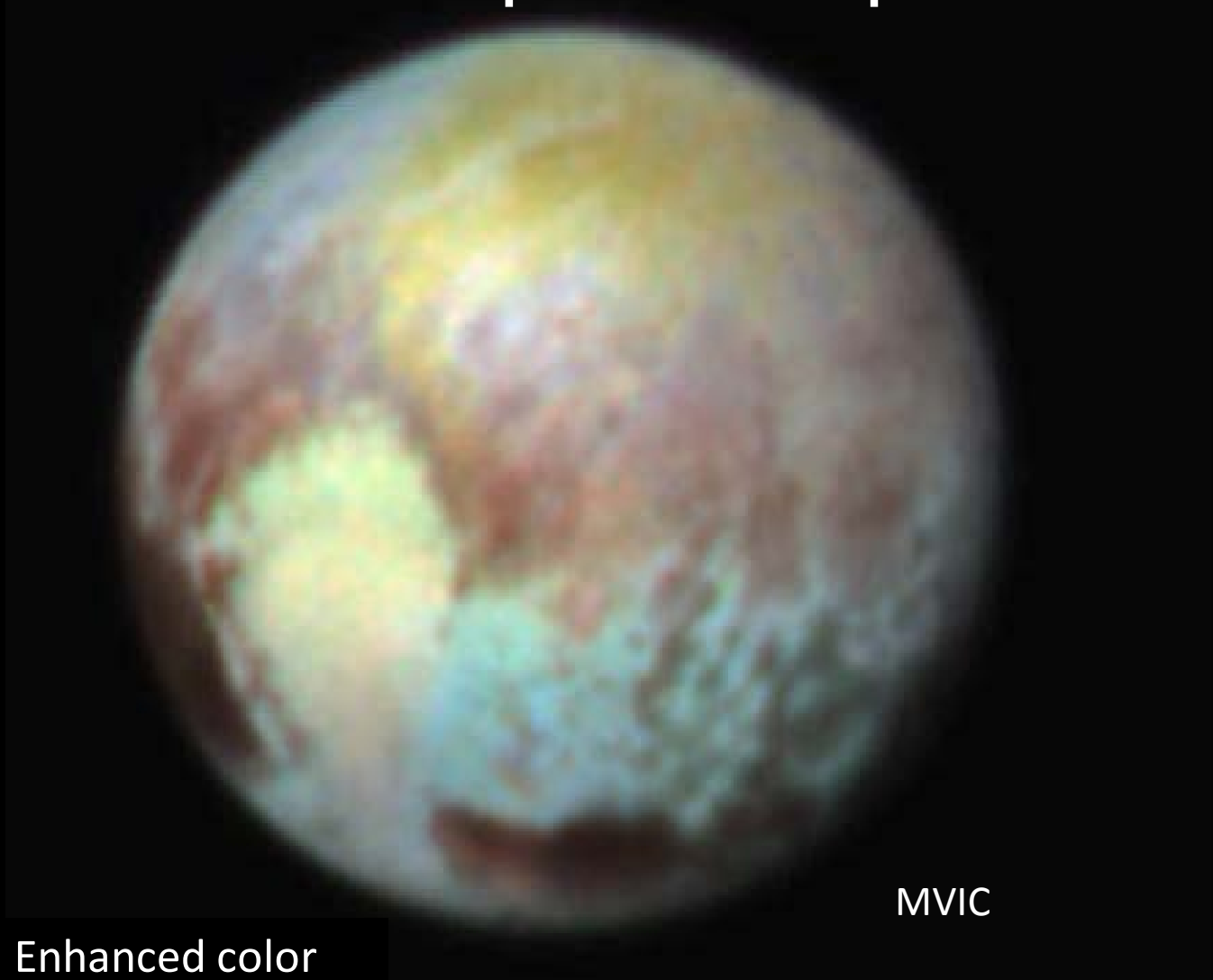
New Horizons

RESULTS: Hazes in Pluto's atmosphere



# New Horizons

## RESULTS: Pluto Complex Composition



# New Horizons

## What's Next? Pluto Flyby Data Downlink



Jet Propulsion Laboratory | California Institute of Technology

DEEP SPACE NETWORK *NOW*

LAST UPDATED: AUG 28 10:49 PM (UTC)

[DSN home](#)

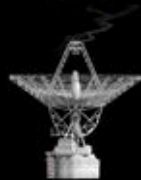


NHPC

DAWN

 MADRID

AUG 29  
12:49 AM




63

65

54

55

 GOLDSTONE

AUG 28  
3:49 PM



14

15

24

25

26

 CANBERRA

AUG 29  
8:49 AM



43

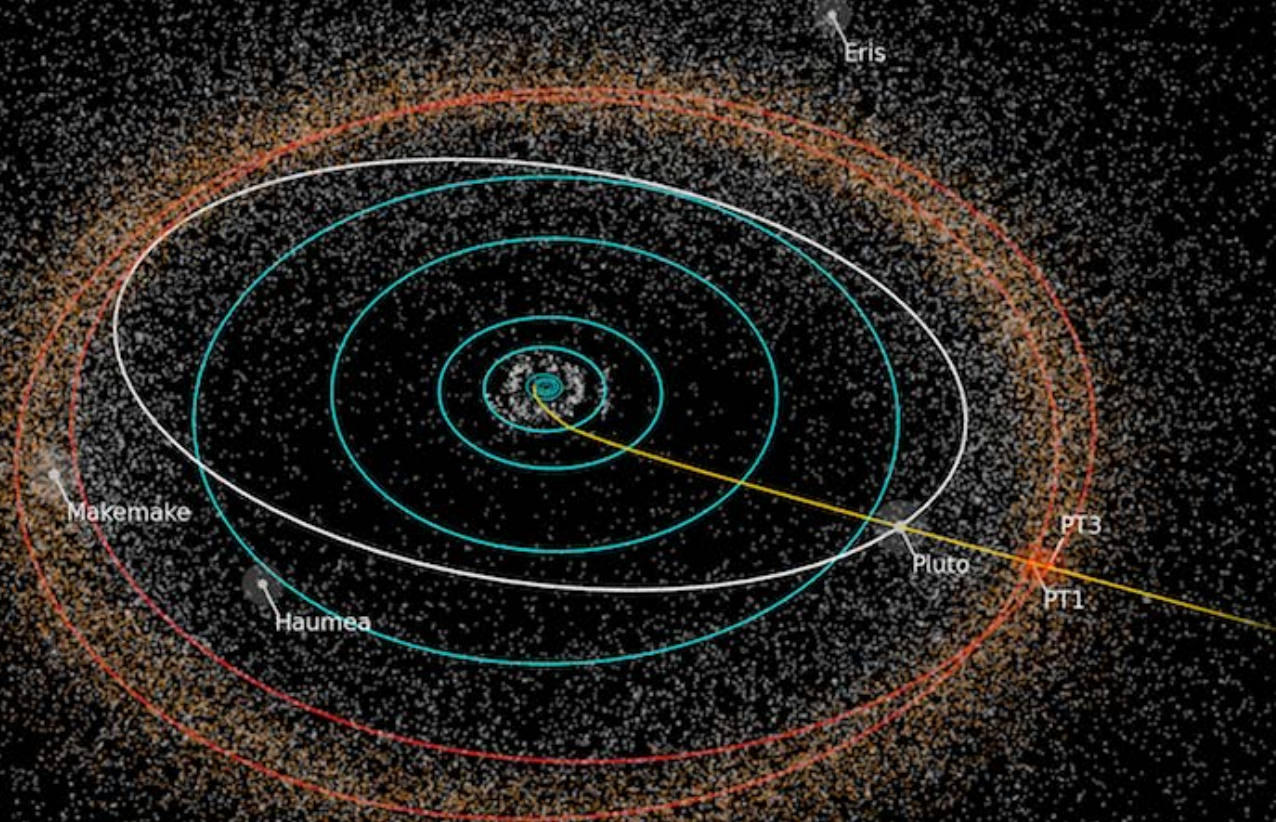
45

34

35

# New Horizons

## What's Next? KBO Extended Mission Proposal



# New Horizons

## KBO Extended Mission

### Science Objectives

- Conduct a close flyby of a primordial KBO planetesimal
- Conduct distant science flyby observations of 10-20 KBOs
- Conduct heliospheric cruise science in the Kuiper Belt; specifically heliospheric plasma, dust and neutral H/He observations
- Potentially conduct astrophysical cruise science

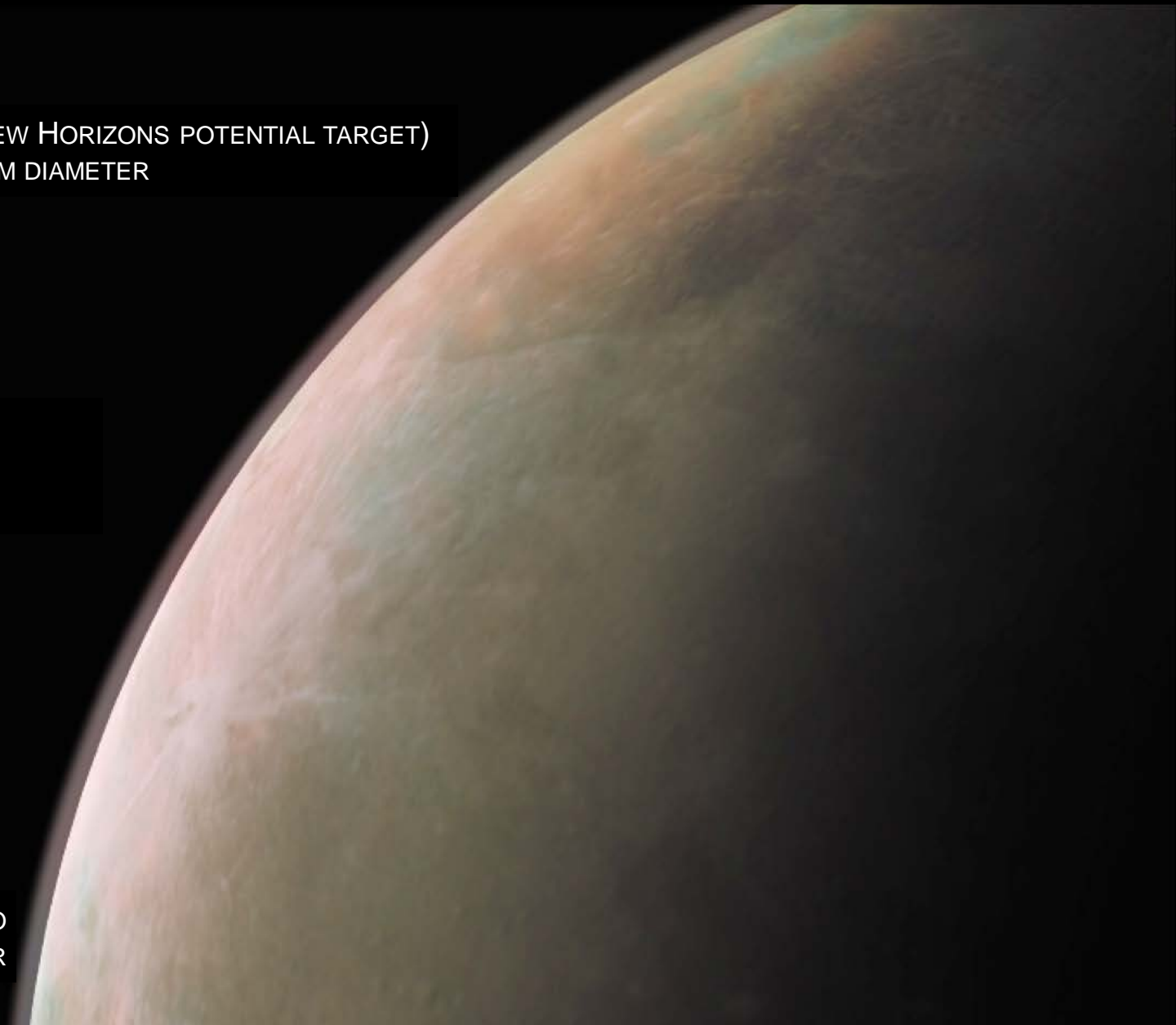




PT1 (NEW HORIZONS POTENTIAL TARGET)  
30-45 KM DIAMETER

COMET C-G  
(ROSETTA TARGET)  
~4 KM DIAMETER

PLUTO  
2374 KM DIAMETER



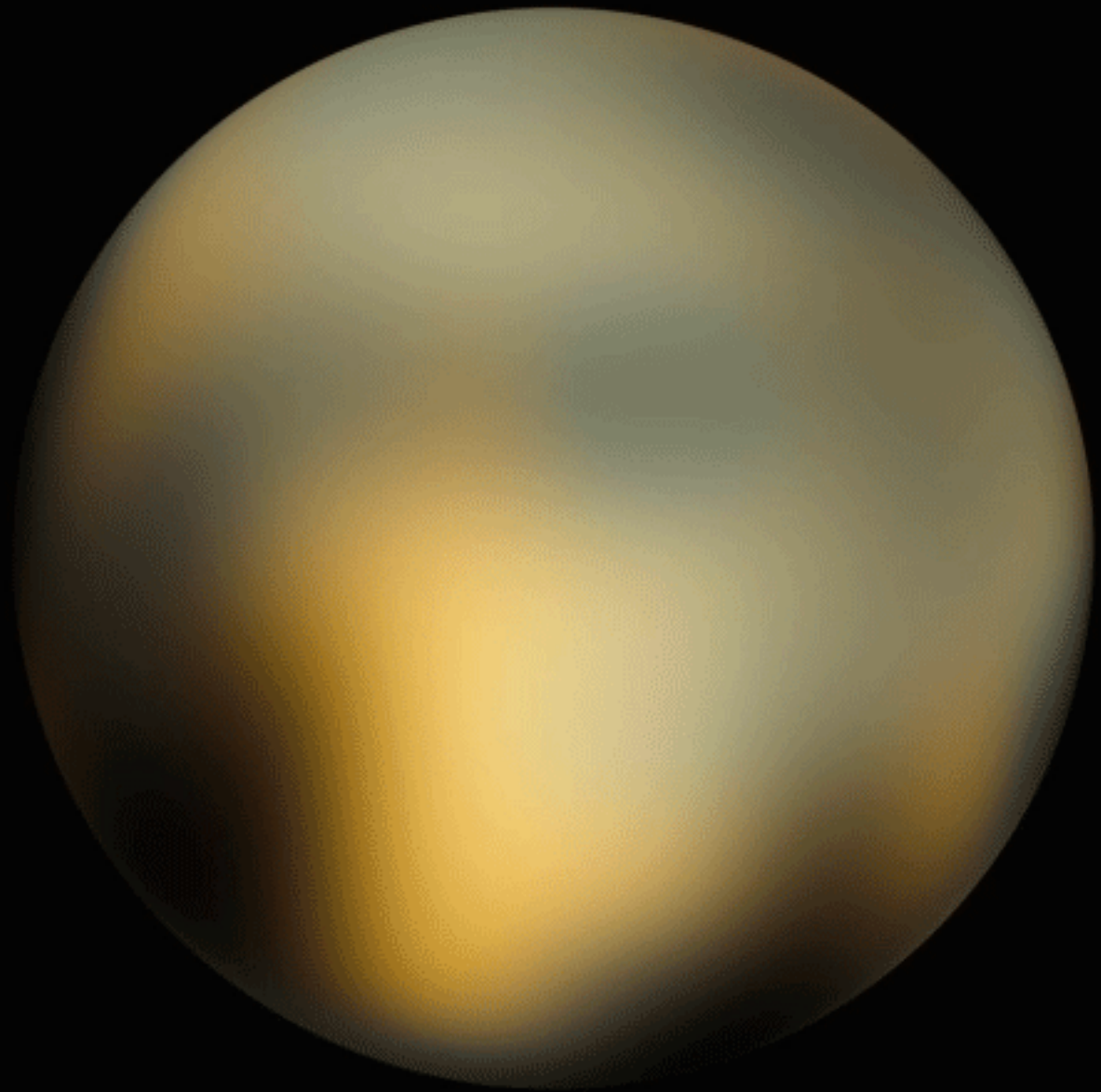
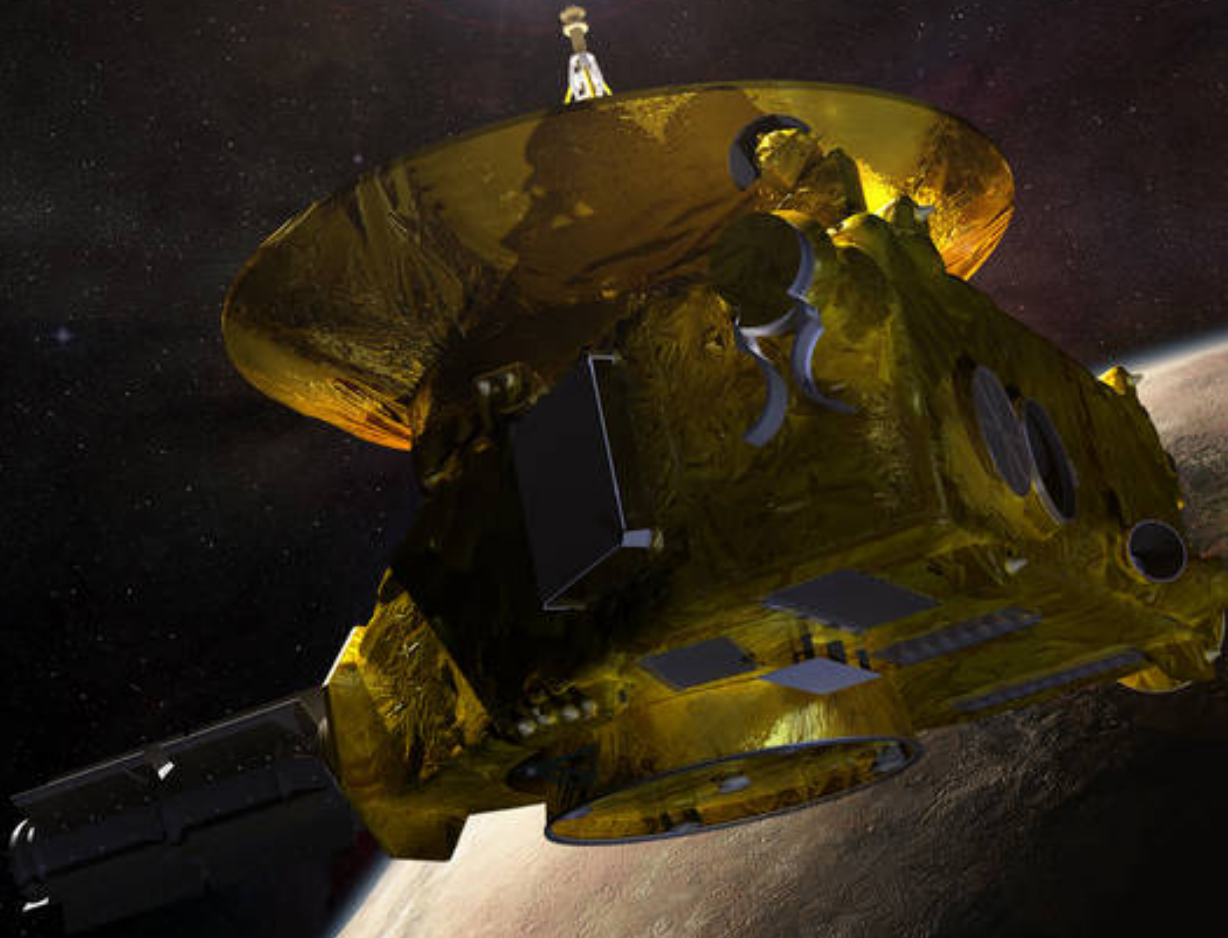


Photo by NASA/ESA/M. Buie (SwRI)/STScI/JHU-APL/SwRI

# BACKUP Materials



Artist Concept/NASA

# New Horizons

## MISSION OBJECTIVES

### Secondary Objectives

- Characterize the time variability of Pluto's surface & atmosphere
- Image Pluto and Charon in stereo
- Map the terminators of Pluto and Charon with high resolution
- Map composition of selected areas of Pluto & Charon at high res.
- Characterize Pluto's ionosphere and solar wind interaction
- Search for neutral species ( $H, H_2, HCN, C_xH_y$ ) and other hydrocarbons and nitriles in Pluto's upper atmosphere
- Search for an atmosphere around Charon
- Determine bolometric Bond albedos for Pluto and Charon
- Map the surface temperatures of Pluto and Charon
- Map composition of dark surfaces on Pluto
- Do "far side" imaging of Pluto & Charon
- Do "far side" color and composition maps of Pluto & Charon
- Obtain high resolution imaging of Nix and Hydra
- Map composition of Nix and Hydra
- Determine shapes of Nix and Hydra

# New Horizons

## MISSION OBJECTIVES

### Tertiary Objectives

- Characterize the energetic particle environment of Pluto & Charon
- Refine bulk parameters (radii, masses, densities) & orbits of Pluto & Charon
- Search for magnetic fields of Pluto and Charon
- Search for additional satellites and rings
- Assess surface microphysics of Pluto and Charon
- Measure the surface temperature of Nix and Hydra
- Measure the phase curve of Nix and Hydra
- Image Nix and Hydra in stereo

# New Horizons

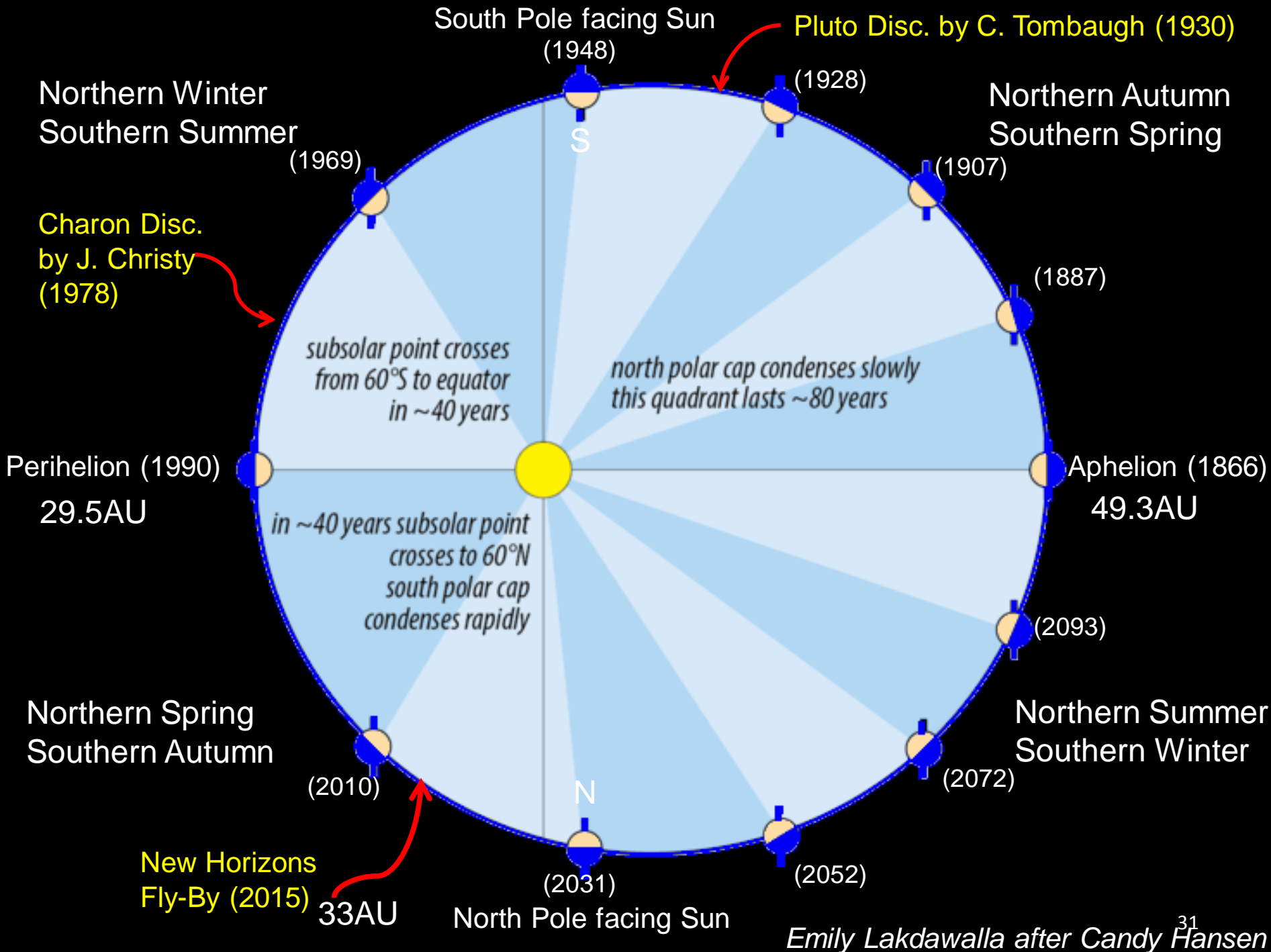
## Payload Instruments

Alice	UV Spectrometer	<ul style="list-style-type: none"> <li>➤ 46.5-188.0 nm, 0.3 nm resolution</li> <li>➤ FOV 4° x 0.1° "slot" and 2° x 2° "box", 5 mrad/pixel</li> <li>➤ Airglow &amp; occultation capabilities</li> </ul>
Ralph/ MVIC	Multispectral Visible Imaging Camera (Pan/Color Imager)	<ul style="list-style-type: none"> <li>➤ Panchromatic (350-850 nm) &amp; 4-color (Blue, Red, CH<sub>4</sub>, Near-IR)</li> <li>➤ FOV 5.7° x 0.15° or 5.7° x scan length, 20 microrad resolution</li> </ul>
Ralph/ LEISA	Linear Etalon Imaging Spectral Array (IR Imaging spectrometer)	<ul style="list-style-type: none"> <li>➤ 1.25-2.50 micron at R=240 and 2.10-2.25 micron at R = 550</li> <li>➤ FOV 0.9° x 0.9° (scanned), 62 microrad/pixel</li> </ul>
LORRI	LONg-Range Reconnaissance Imager (High-Resolution Imager)	<ul style="list-style-type: none"> <li>➤ Panchromatic (350-850 nm)</li> <li>➤ FOV 0.29° x 0.29° , 5 microrad/pixel</li> </ul>
REX	Radio Experiment (Uplink, Radiometry)	<ul style="list-style-type: none"> <li>➤ Part of telecommunications systems, with 2.1 m antenna</li> <li>➤ X-band (7.182 GHz uplink, 8.438 GHz downlink)</li> </ul>
SWAP	Solar Wind at Pluto (Solar Wind Detector)	<ul style="list-style-type: none"> <li>➤ 0.25-7.5 keV. RPA: 0.5V (&lt;1.5 keV), ESA: DE/E=0.4 (&gt;1.4 keV)</li> <li>➤ FOV 200° x 10°</li> </ul>
PEPSSI	Pluto Energetic Particle Spectrometer Science Investigation (Particle Detector)	<ul style="list-style-type: none"> <li>➤ e<sup>-</sup>: 25-500 KeV, Protons: 40-500 KeV, CNO: 150-1000 KeV</li> <li>➤ FOV 160° x 12° , 25° x 12° resolution</li> </ul>
SDC	In Situ Dust Counter	<ul style="list-style-type: none"> <li>➤ 0.10 m<sup>2</sup> active area,</li> <li>➤ Threshold Mass ~10<sup>-12</sup> gram (~1 micron)</li> </ul>

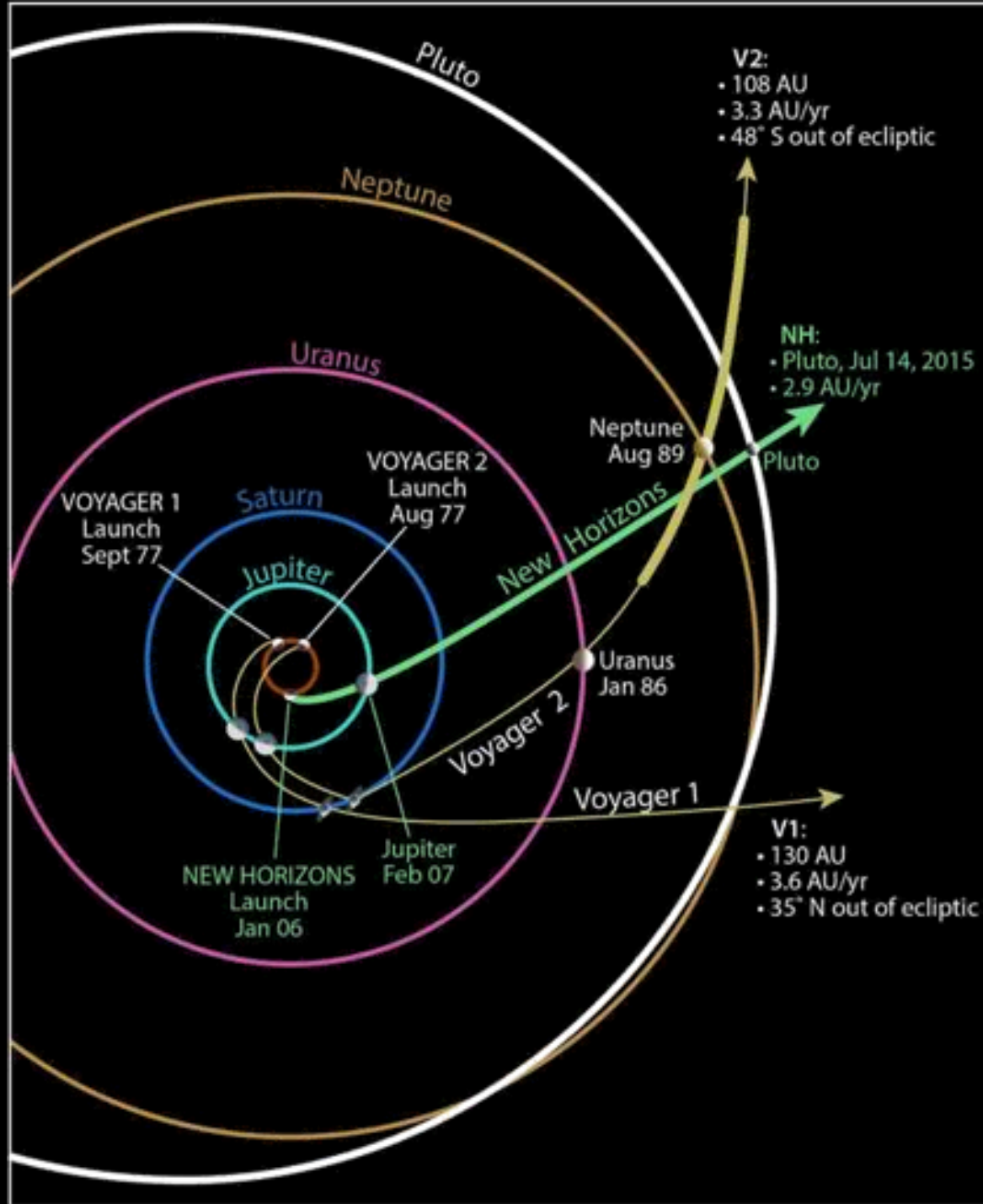
# New Horizons

## Fly-by Best Resolutions

	Panchromatic Imaging (LORRI)	Vis-NIR Color (MVIC)	Infrared Composition Spectral Cube (LEISA)
Pluto	0.5 km/pixel hemispheric 70 m/pixel regional	0.6 km/pixel	6.0 km/pixel hemispheric 2.7 km/pixel local
Charon	0.6 km/pixel hemispheric 150 m/pixel regional	1.4 km/pixel	8.4 km/pixel hemispheric 4.7 km/pixel local
Nix	0.5 km/pixel 300 m/pixel possible	2.0 km/pixel	3.6 km/pixel
Hydra	1.1 km/pixel	4.6 km/pixel	14.6 km/pixel
Kerberos	2 km/pixel	13 km/pixel	124 km/pixel

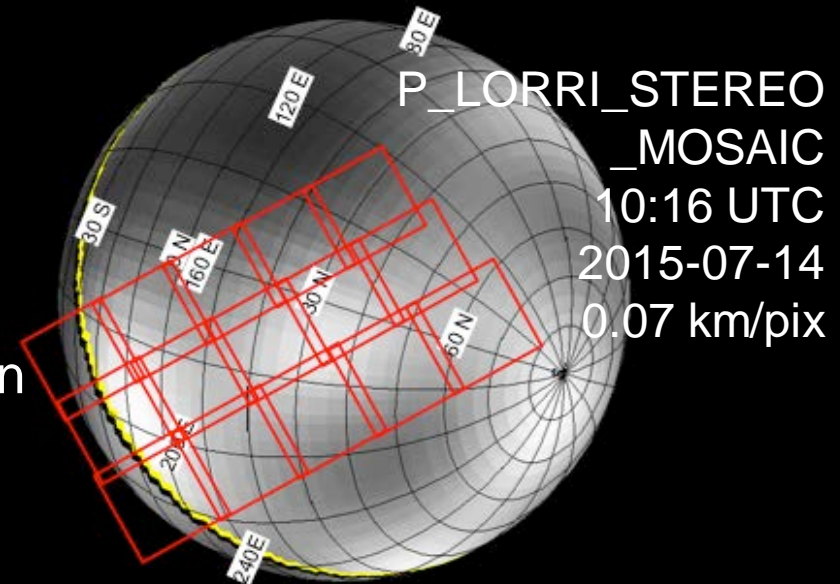
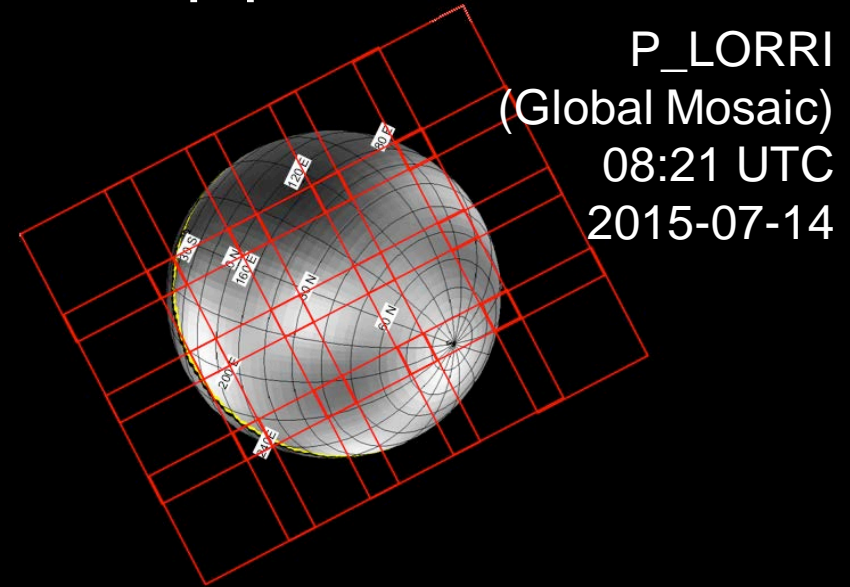






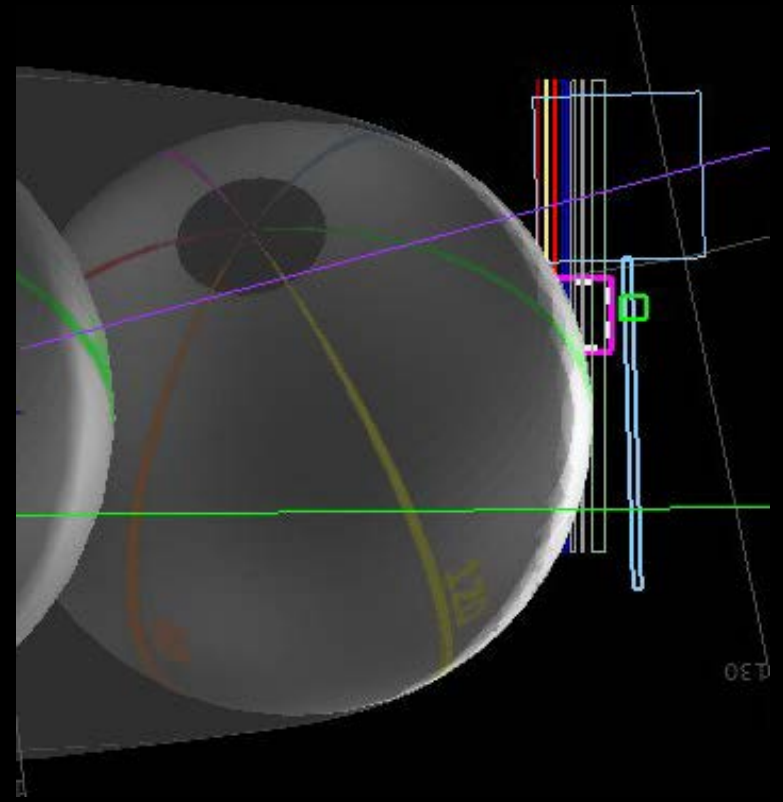
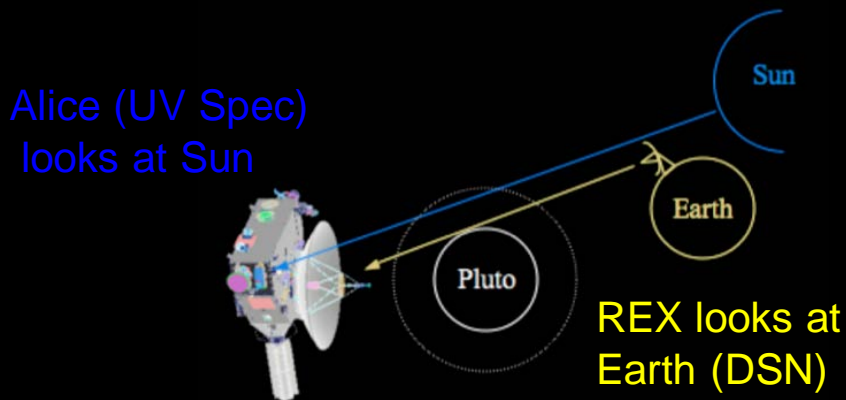
# Milestones Upon Approach

- July 11<sup>th</sup>, P-3 days:
  - Map Pluto's "far-side" at 40 km resolution
- July 13<sup>th</sup>, P-1 day:
  - Best image sent down before C/A (Rec'd 11pm Eastern)
- July 14<sup>th</sup>, P-20 hrs out (1 million km away)
  - Perhaps see first pick-up ion signatures
- July 14<sup>th</sup>, P-12 hours:
  - Pluto fills the LORRI camera frame
- July 14<sup>th</sup>, P-2.5 hours
  - Global maps of surface composition
- July 15<sup>th</sup>, P-40 minutes
  - Best global images

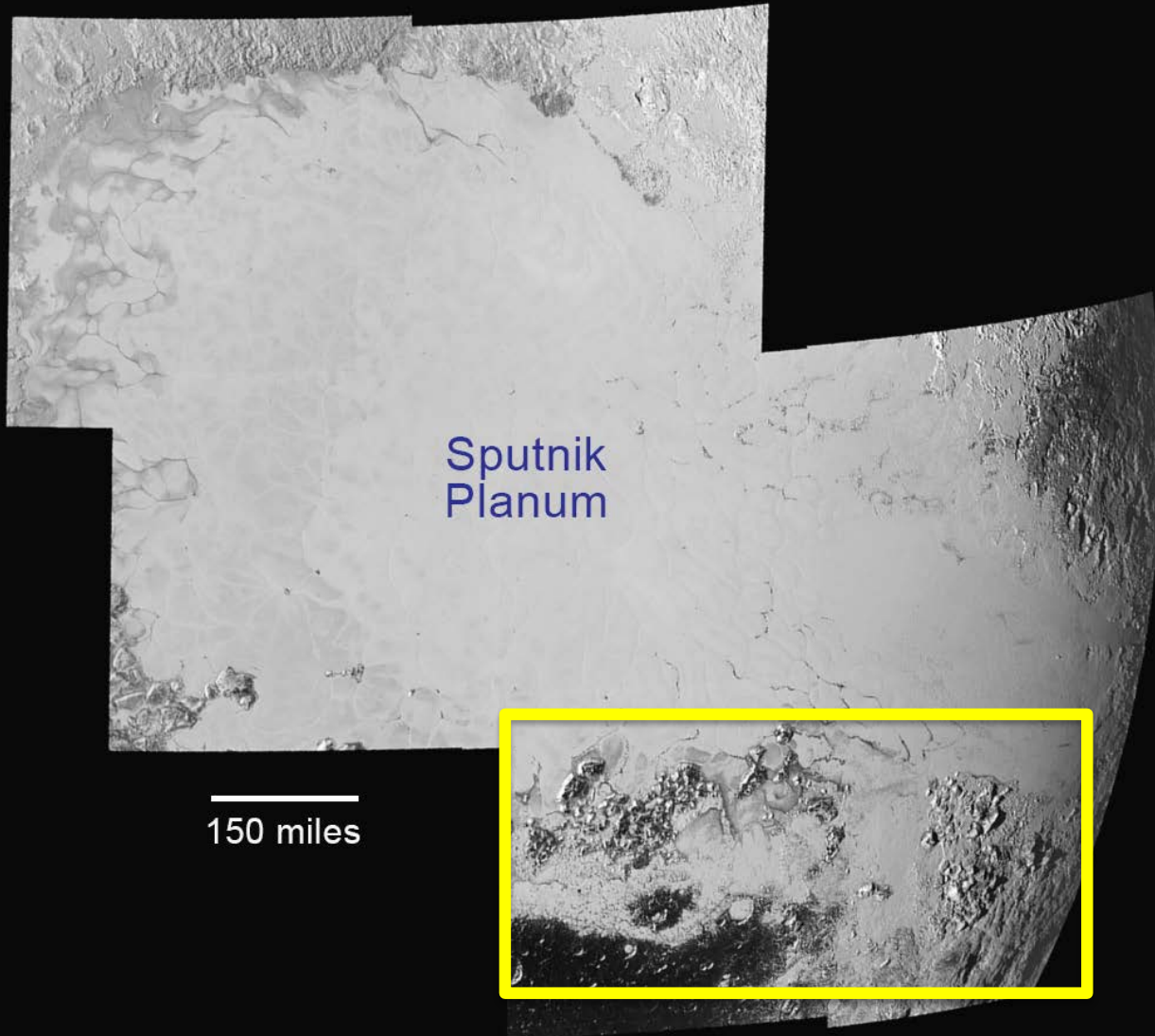


# Milestones on Departure

- P+1 hr after closest approach:
  - Solar Occultation Pluto - Density, extent, composition of Pluto's atmosphere
- P+2.5 hr after closest approach:
  - Solar Occultation Charon - Look for an atmosphere at Charon
- 165° solar illumination
  - 40 km wide illuminated on Pluto
  - Look for Hazes, Plumes, Rings
  - Pluto's winter pole in Charon-shine

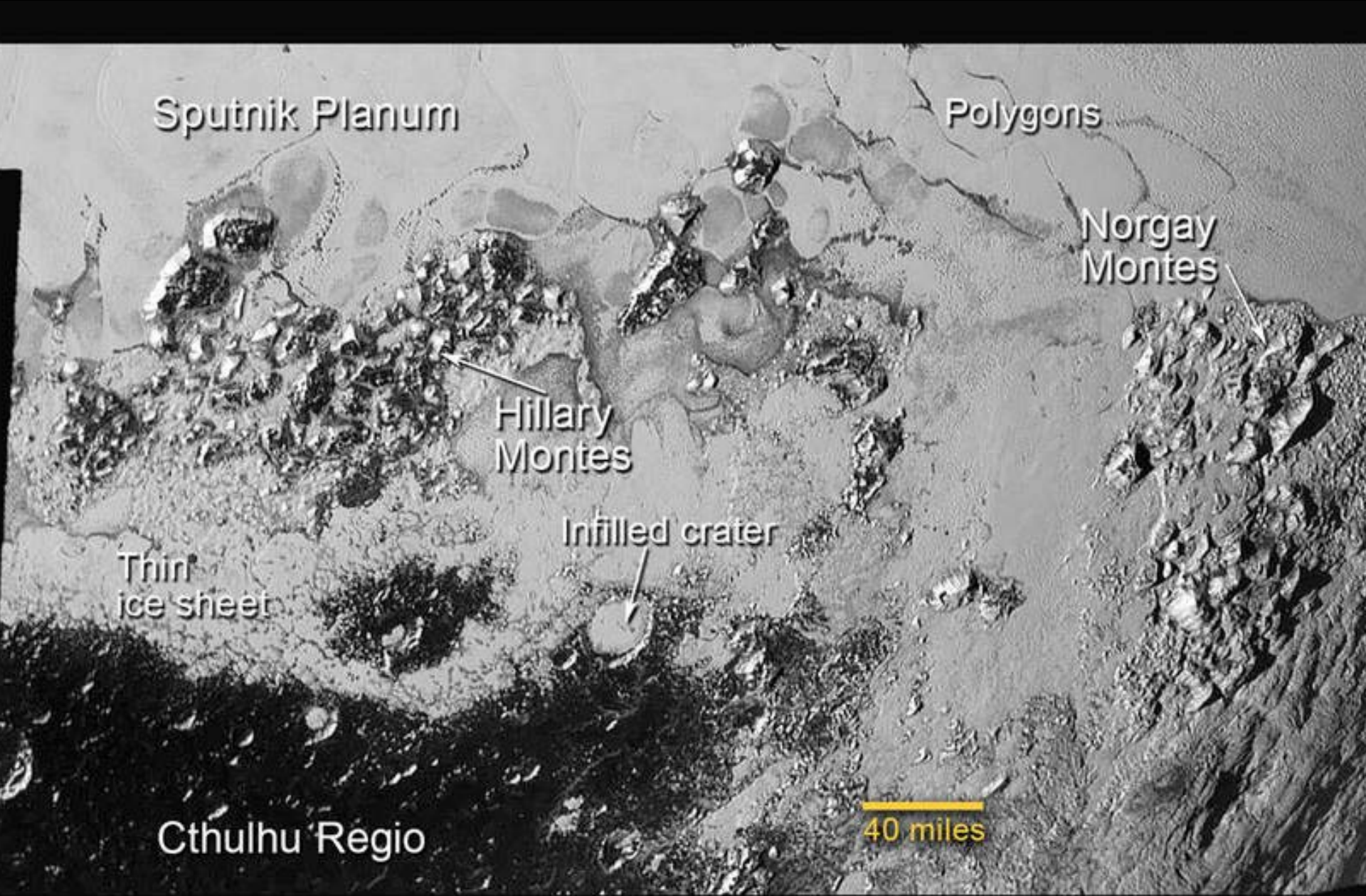


New Horizons best planned haze  
152° phase, 0.4 and 0.1 km/pix  
(MVIC/PAN & LORRI)



Sputnik  
Planum

150 miles



Sputnik Planum

Polygons

Norgay Montes

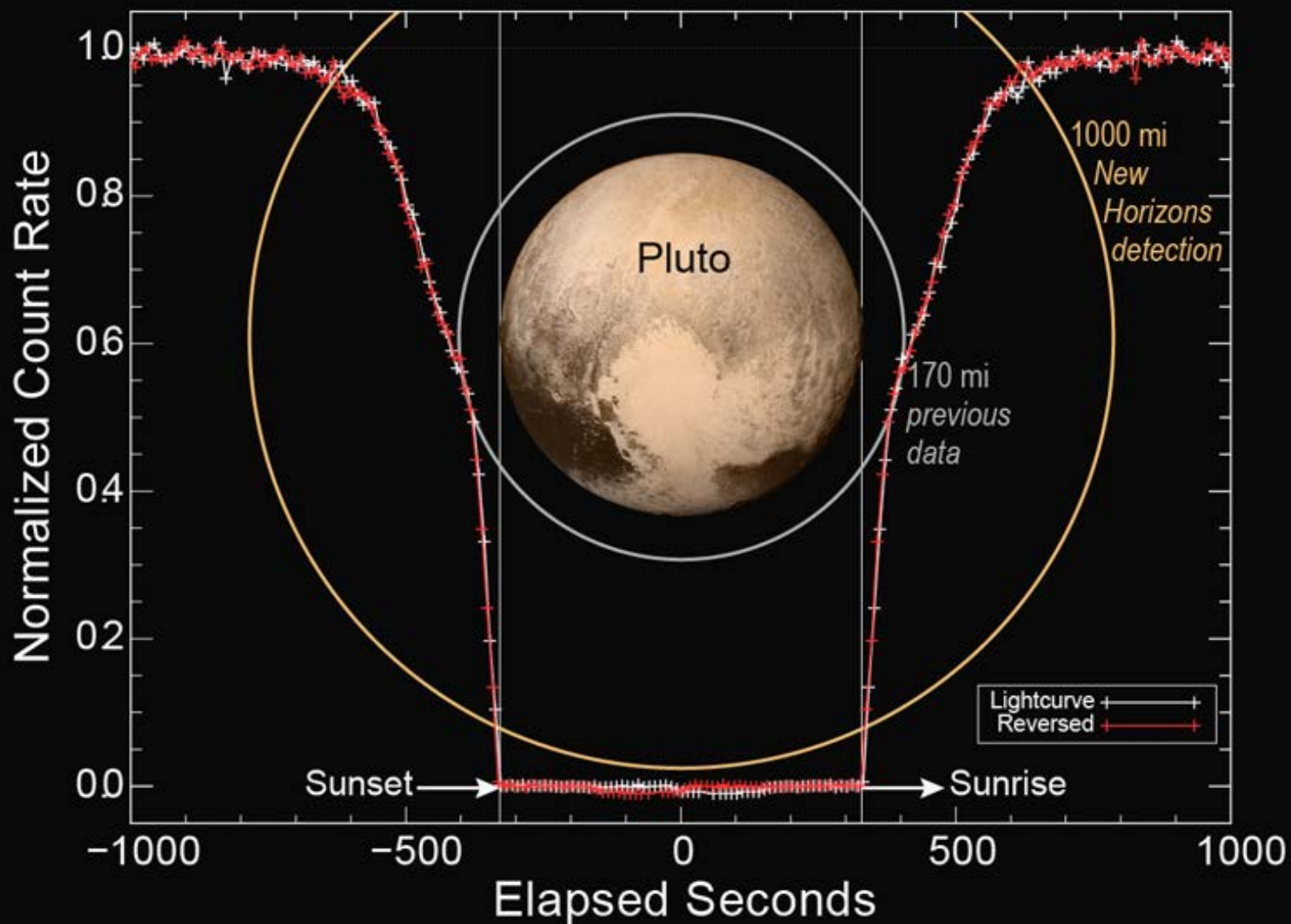
Hillary Montes

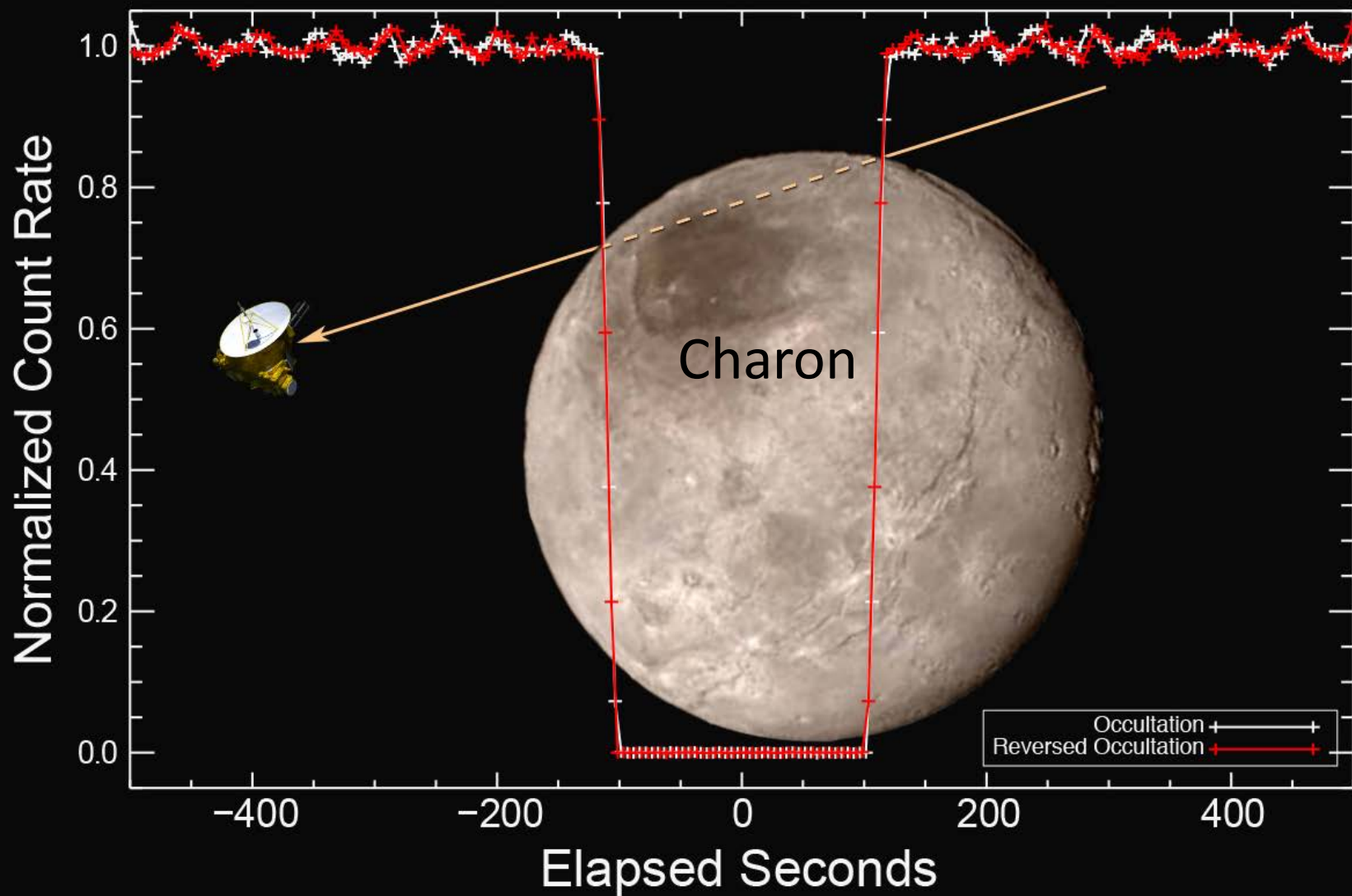
Infilled crater

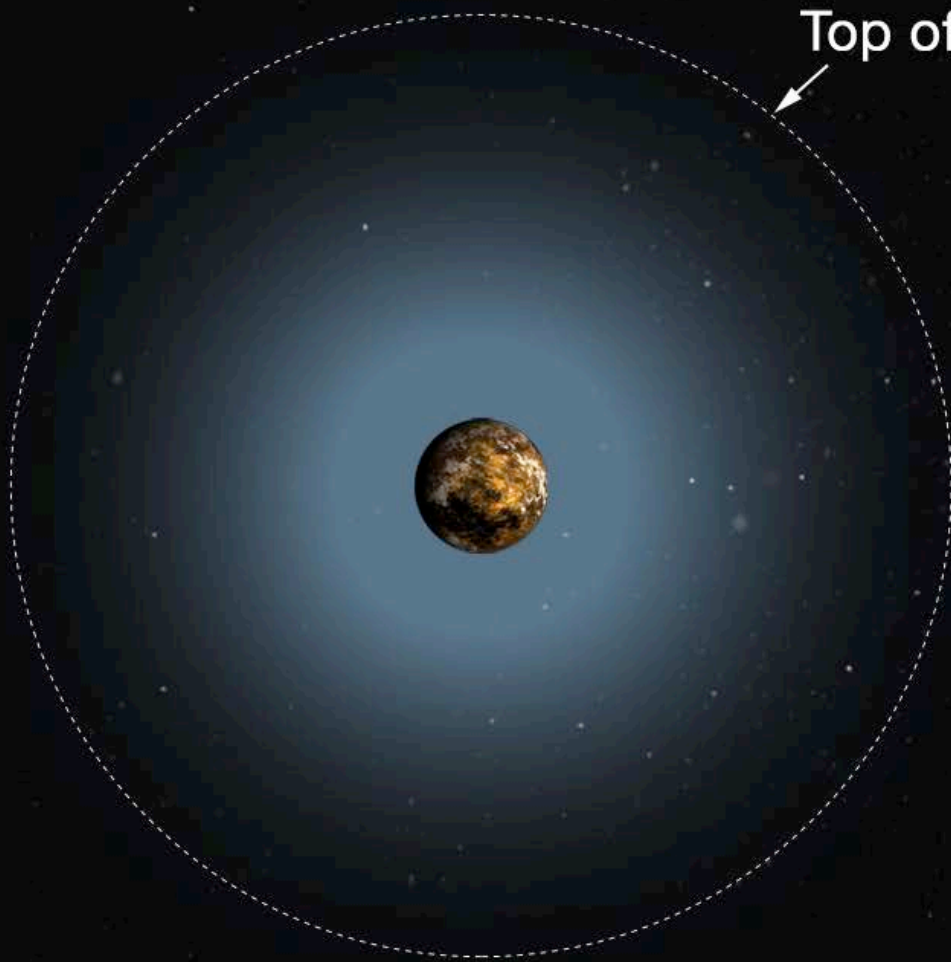
Thin ice sheet

Cthulhu Regio

40 miles







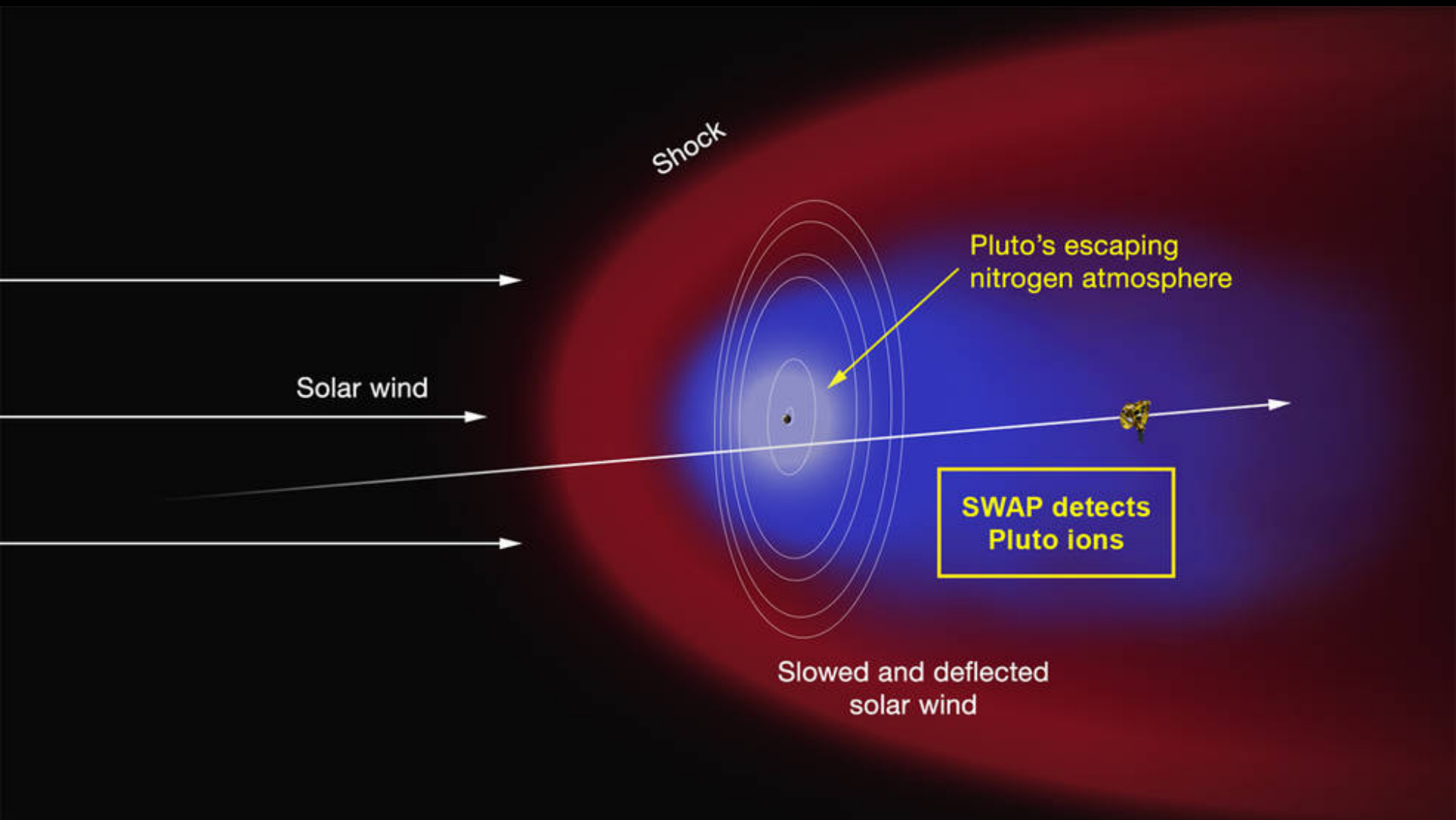
**Pluto**

Top of atmosphere



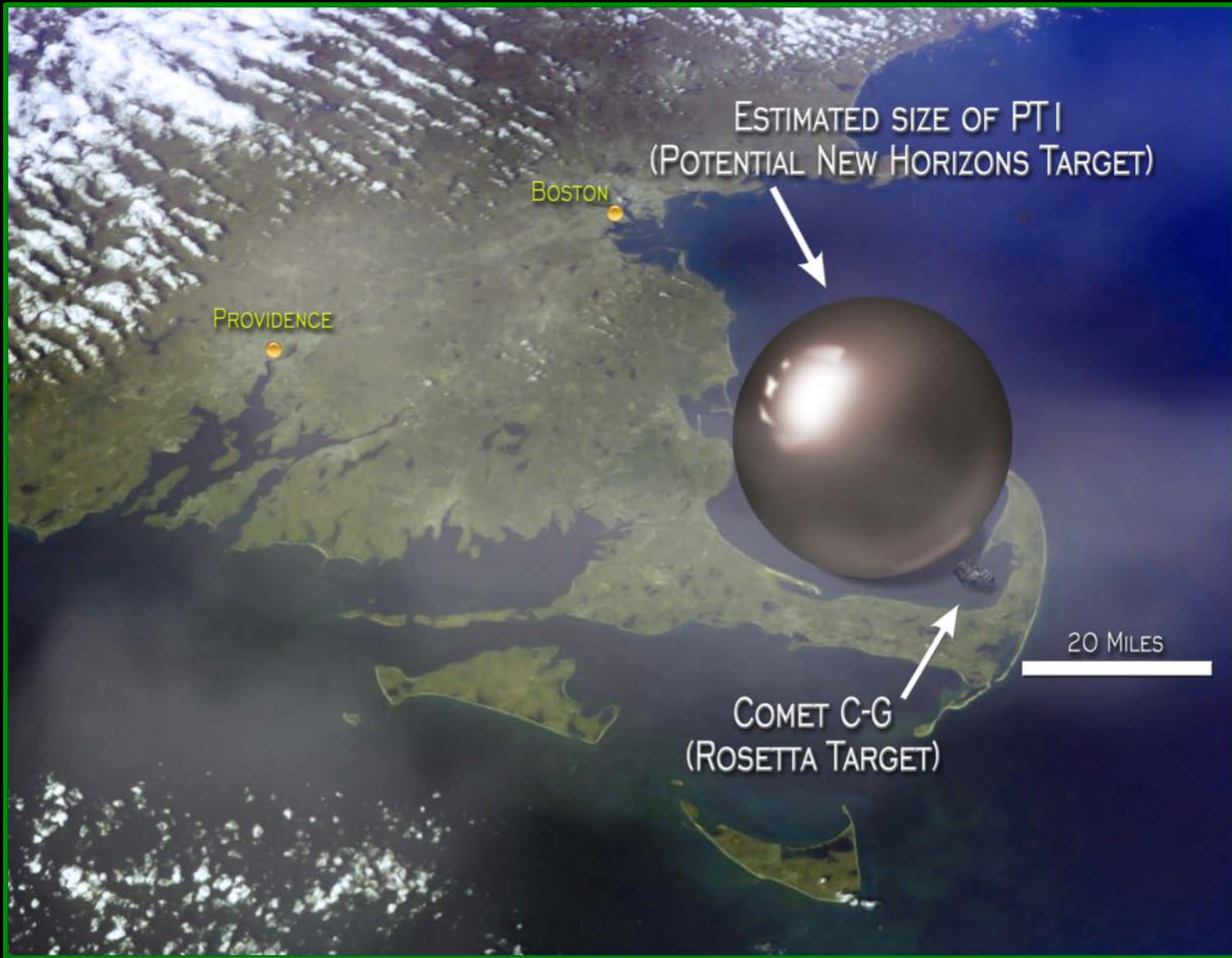
**Earth**





# New Horizons KBO Flyby Targets

	<b>PT1</b>	<b>PT3</b>
<b>MPC Designator</b>	2014 MU69	2014 PN70
<b>Diameter (p=0.04, smaller if higher albedo)</b>	<b>45 km</b>	<b>55 km</b>
<b>Orbital Semi-major Axis</b>	44.2 AU	44.3 AU
<b>Orbital Eccentricity</b>	0.036	0.068
<b>Orbital Inclination</b>	1.9 deg	2.8 deg
<b>Cold Classical</b>	<b>Yes (96.5%)</b>	Yes (95.4%)
<b><math>\Delta V</math> to Target</b>	<b>56.5 m/s</b>	116.9 m/s
<b>Encounter Date</b>	<b>2018 Dec 31</b>	2019 March 18
<b>Encounter During Solar Conjunction</b>	No	No
<b>Encounter OpNav Field</b>	Go	Go
<b>Encounter OpNav Acquisition</b>	Meets Requirement	Meets Requirement



ESTIMATED SIZE OF PT I  
(POTENTIAL NEW HORIZONS TARGET)

BOSTON

PROVIDENCE

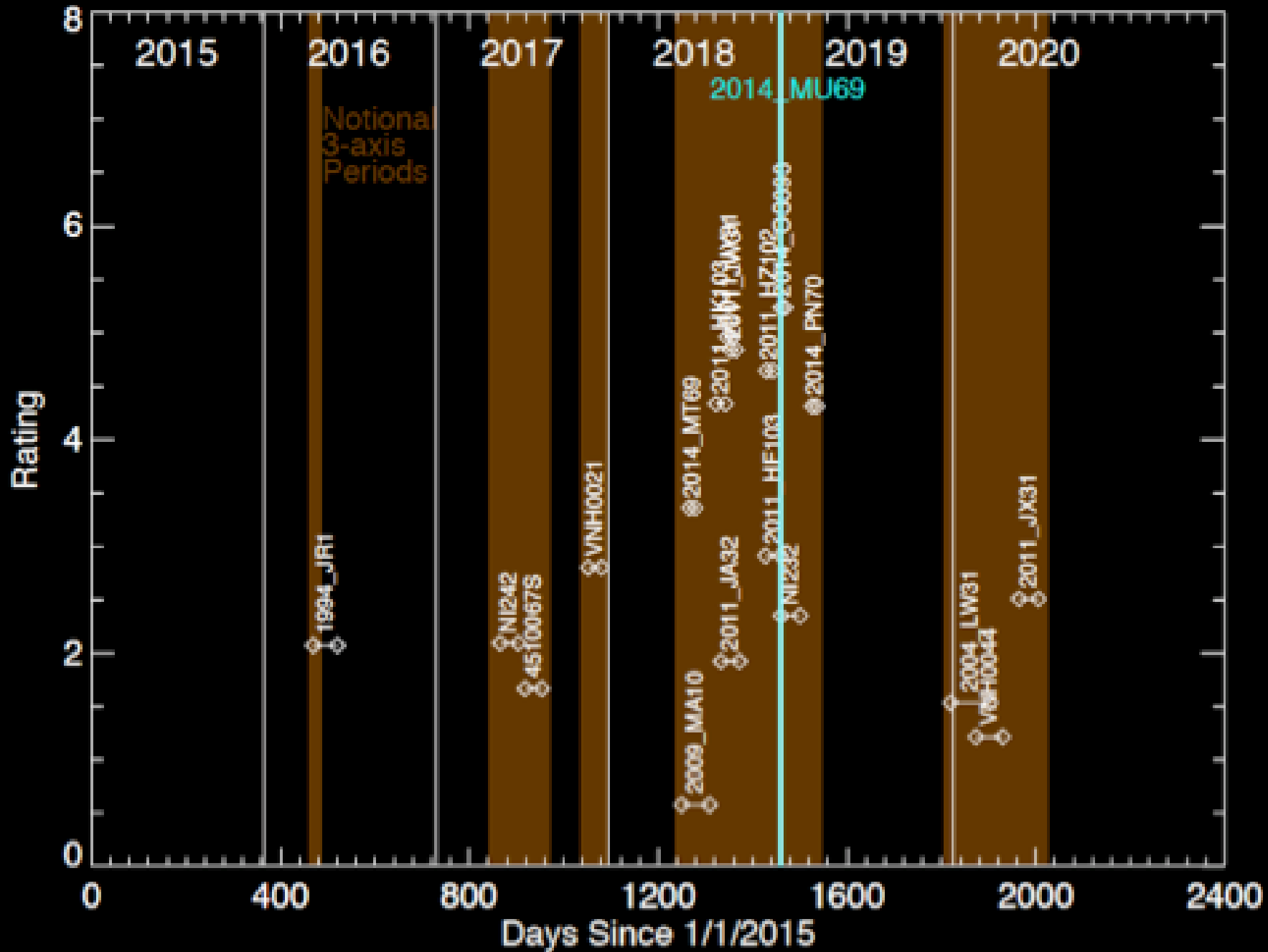
20 MILES

COMET C-G  
(ROSETTA TARGET)

# New Horizons

## KBO Distant-Flyby Targets

Most Official Name	H_R	Date of Max. Brightness	Dist (AU)	Phase angle (deg)	Mag from S/C	Too faint LORRI 1x1
<b>1994_JR1</b>	<b>7.7</b>	<b>4/14/16 2:13</b>	<b>0.68</b>	<b>62</b>	<b>16.8</b>	*
NI242	9.7	5/13/17 14:05	0.51	56	18.3	*
VNH0021	9.5	11/18/17 2:32	0.39	48	17.3	*
2011_JY31	8.4	9/7/18 12:30	0.17	51	14.5	
2014_MT69	11.3	6/18/18 14:31	0.17	62	17.5	*
2011_JW31	8.7	9/14/18 6:51	0.18	46	14.8	
2011_HF103	8.1	11/28/18 6:34	0.41	61	16.5	*
2011_JA32	9.4	8/26/18 7:01	0.56	48	18.1	*
2011_HZ102	9.0	12/1/18 9:42	0.19	48	15.3	
NI232	9.2	12/29/18 10:11	0.52	47	17.4	*
2014_OS393	9.8	12/30/18 20:54	0.12	45	15.1	
<b>2014_MU69</b>	<b>10.6</b>	<b>12/30/18 6:50</b>	<b>0.00</b>		<b>3.2</b>	
2011_HK103	8.0	8/15/18 5:49	0.30	47	15.4	
2014_PN70	10.0	3/6/19 16:47	0.14	61	16.1	*
2013_LU35	9.5	6/17/19 1:45	0.45		18.1	*
VNH0044	8.9	2/18/20 11:45	0.72	52	18.4	*
2004_LW31	6.9	12/25/19 11:53	1.14	48	17.4	*
2011_JX31	7.8	5/18/20 15:13	0.52	61	17.0	*



# New Horizons

## KBO Distant-Flyby Targets

Name	a (AU)	e	i (deg)	Date of Enc.	Range at Enc. (AU)	LORRI Resolution (km)
2011 HZ102	43.2	0.008	2.4	2018/12/16-2018/12/16	0.15 - 0.16	111-119
2011 JY31	44	0.057	2.6	2018/09/17-2018/09/17	0.16 - 0.16	118
2011 JW31	45.6	0.094	1.9	2018/09/27-2018/09/27	0.19 - 0.19	141
2011 HJ103	49.6	0.322	5.4	2017/02/24-2018/01/10	0.19 - 0.43	141-319
2013 LU35	43.8	0.024	3	2019/02/04-2019/10/12	0.30 - 0.38	222-282

In addition to having a close-encounter flyby to one KBO target (**10,000-20,000 km**), New Horizons will image others with resolution better than Hubble to get phase curves and do searches for satellites.

*From Benecchi et al 2014*