



Searching for the Extended Kuiper Belt Using Subaru Telescope and New Horizons

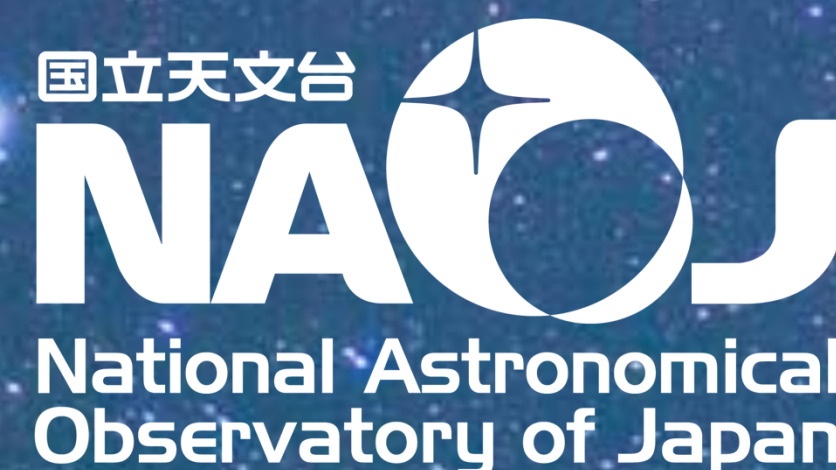
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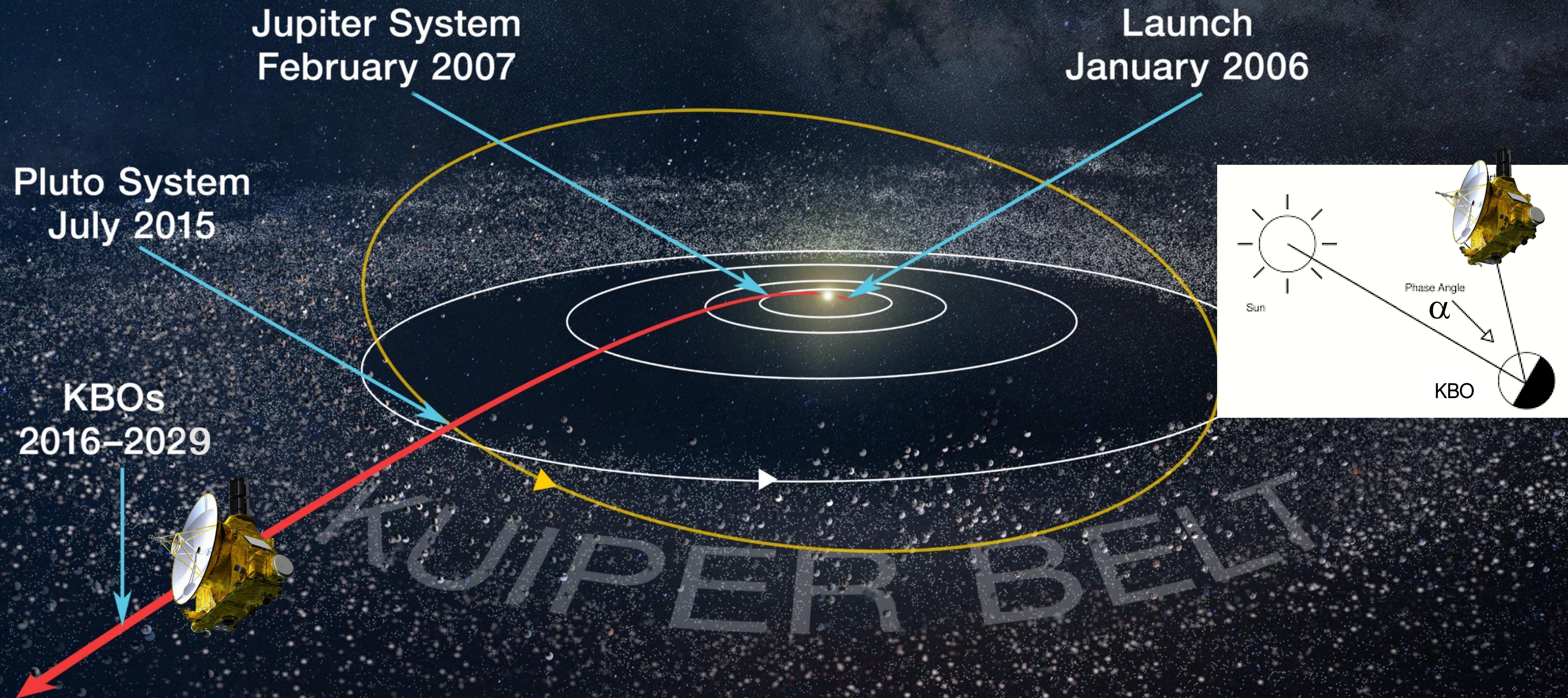


SOUTHWEST RESEARCH INSTITUTE

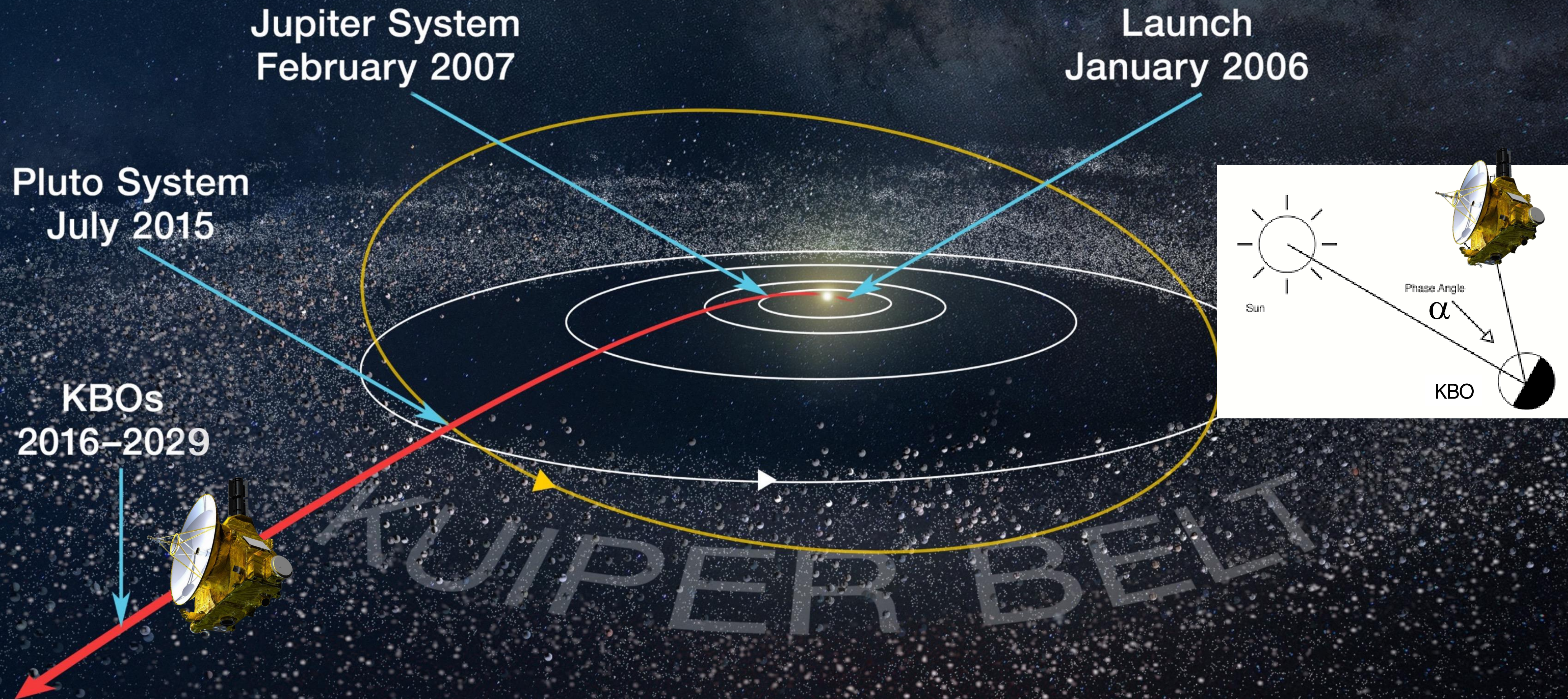


Subaru Users Meeting, NAOJ, Mitaka Campus, 19 June 2026

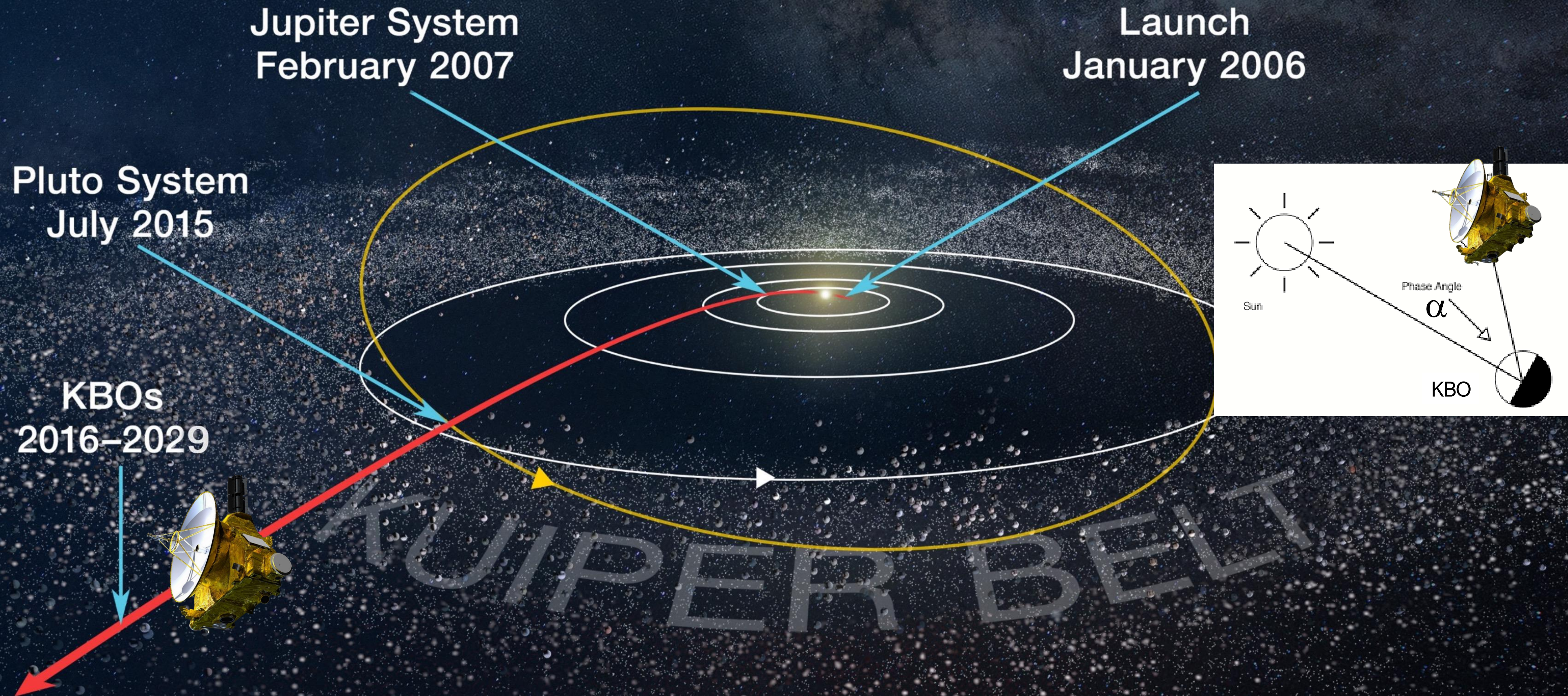
New Horizons' Unique Perspective From its Journey Through the Solar System



It's all about the viewing geometry...



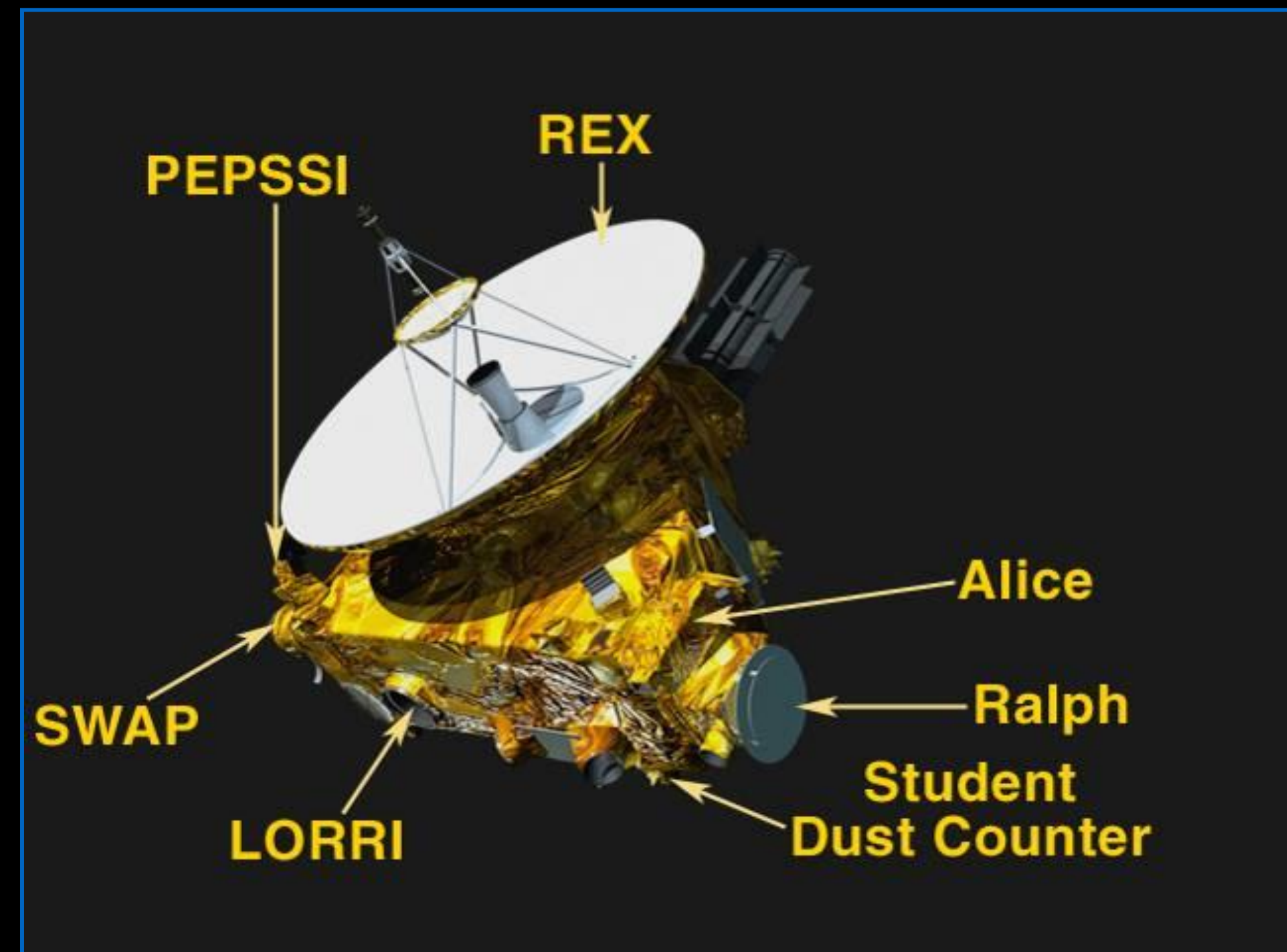
No other spacecraft in flight (or planned) to the Outer Solar System Beyond the Kuiper Belt





Spacecraft Status

- Spacecraft and all instruments are healthy
- Currently outbound at 65 au, 3 au/yr
- Spacecraft exits 11-month hibernation 23 June 2026!
 - Continuous collection of KBO dust and heliospheric particle/plasma data during hibernation
 - No downlink of science data until after hibernation exit
- After hibernation wake up, more extensive science and data downlink begins.
- Next KBO observations may occur in 2027.

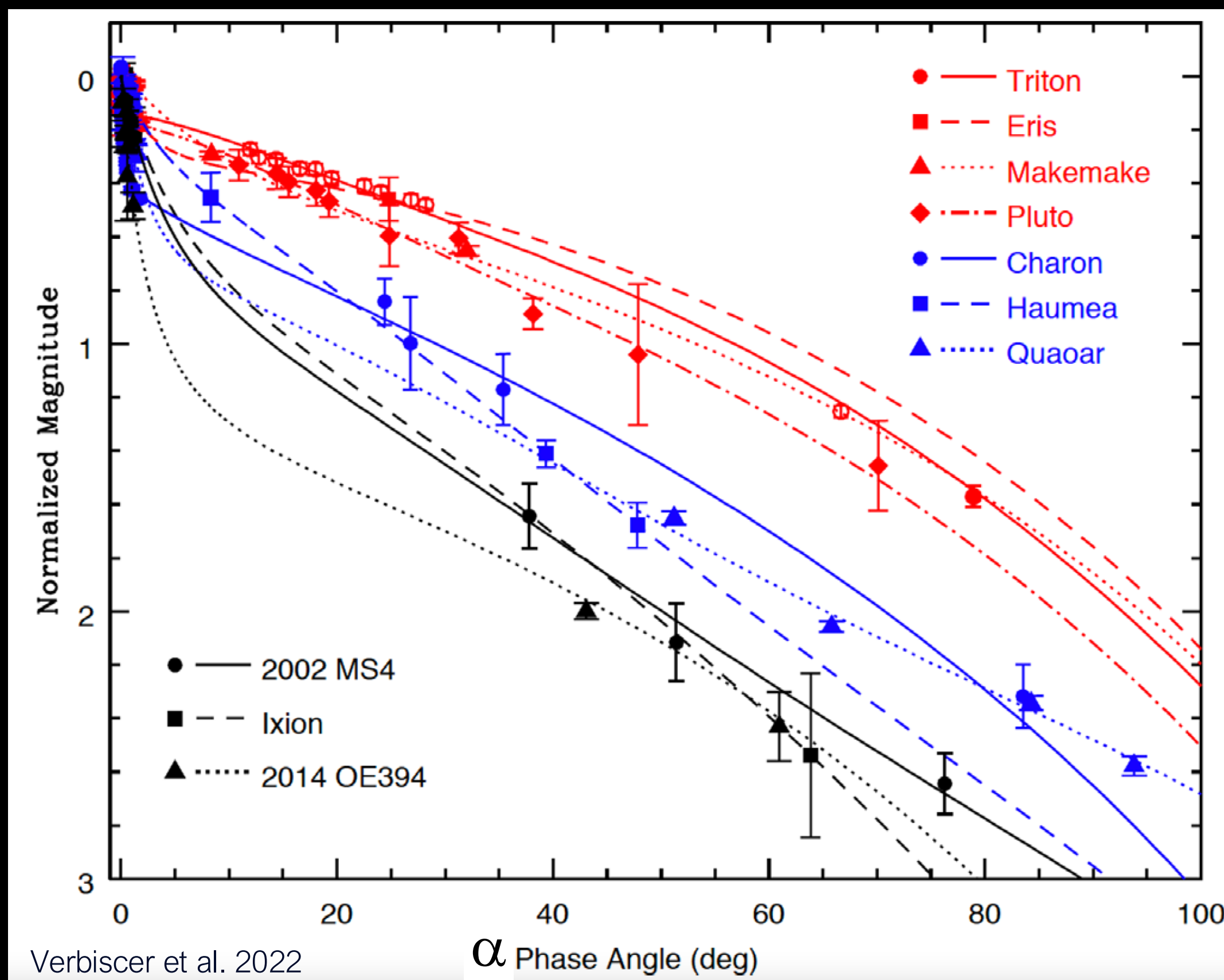


Instruments:

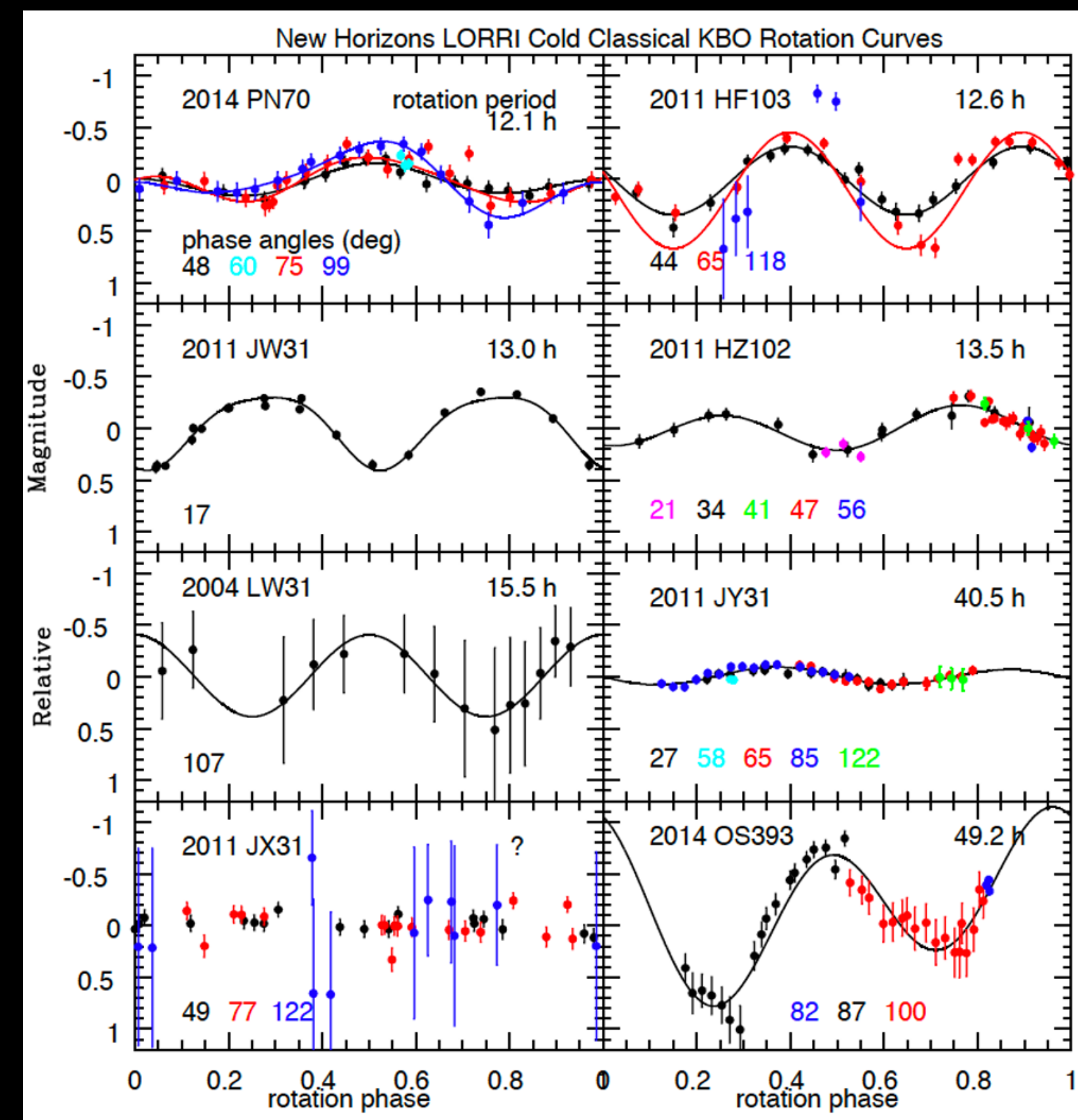
- | | |
|---------------------------------------|--|
| • REX radio science & radiometry | • SWAP plasma spectrometer |
| • RALPH VIS/IR imaging & spectroscopy | • PEPSSI energetic particle spectrometer |
| • ALICE UV imaging spectroscopy | • SDC EPO Student Dust Counter |
| • LORRI High-resolution imager | |



KBOs at High Solar Phase Angles



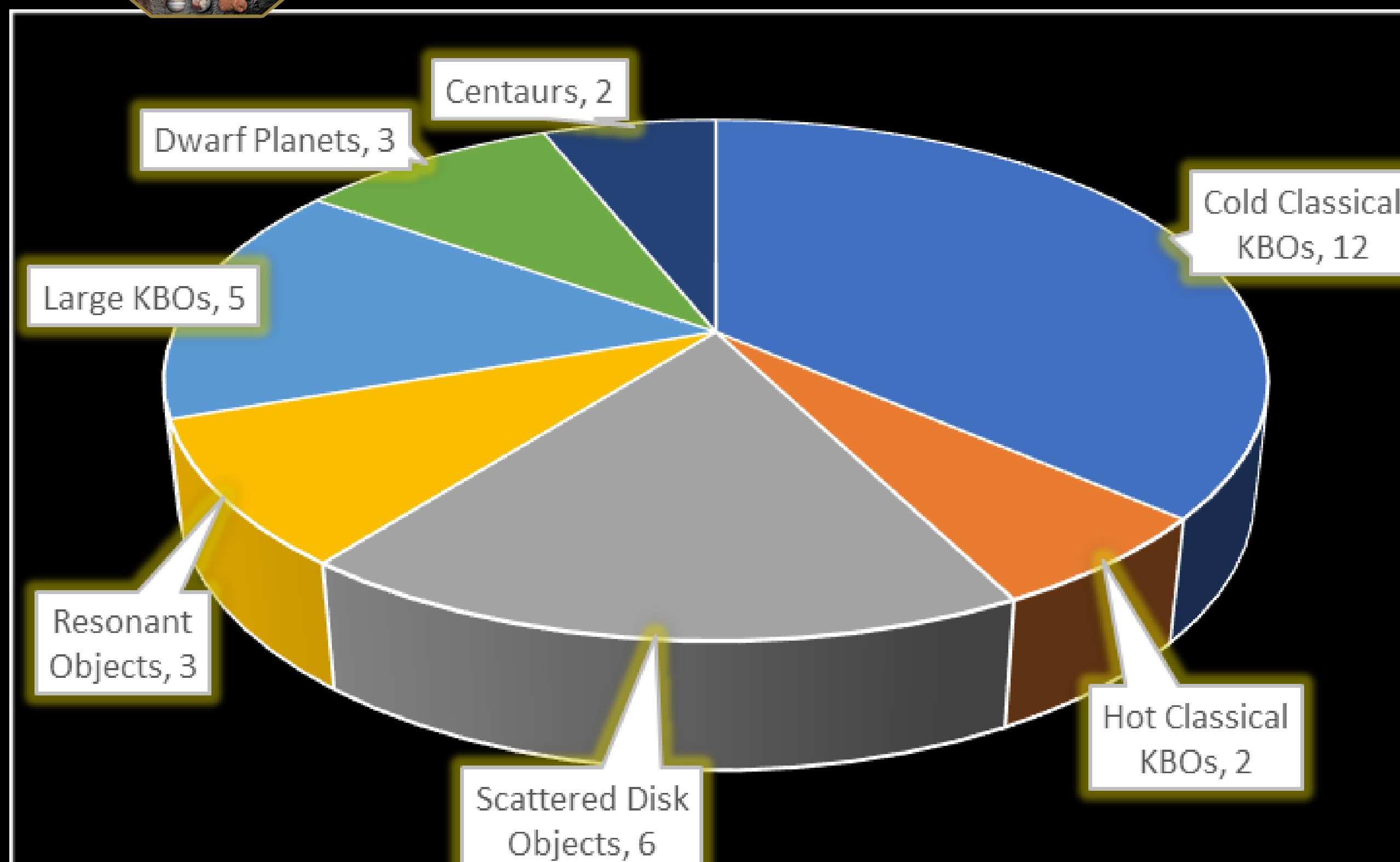
Solar phase curves → surface microtexture



Rotation phase curves → shapes and poles



33 KBOs & Centaurs Observed So Far (Not including Pluto System or Arrokoth)

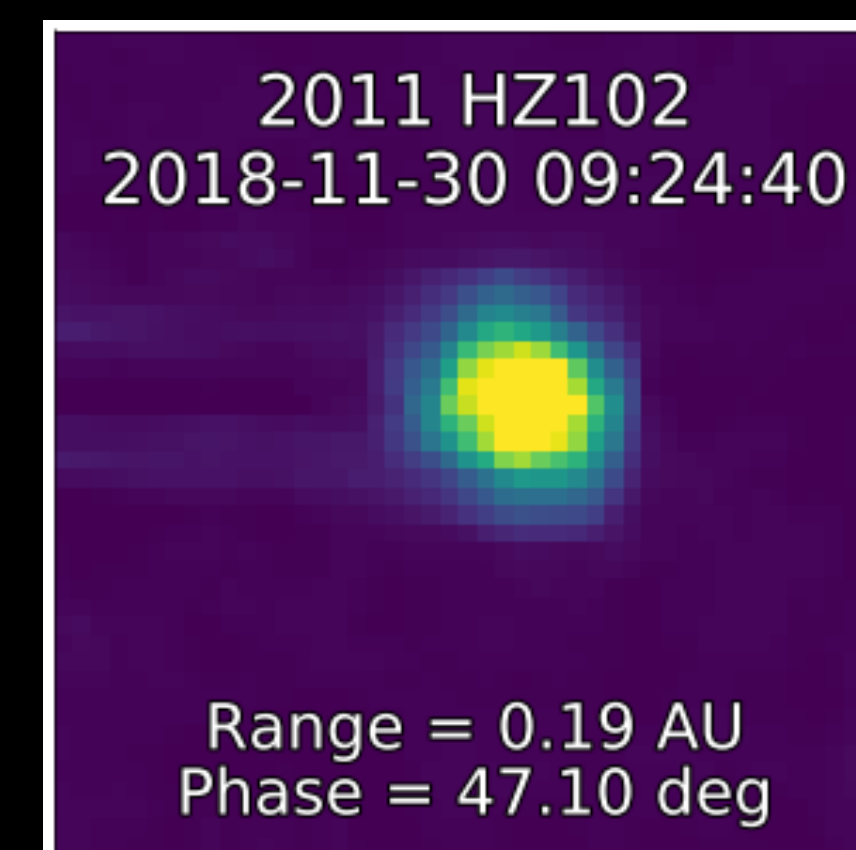
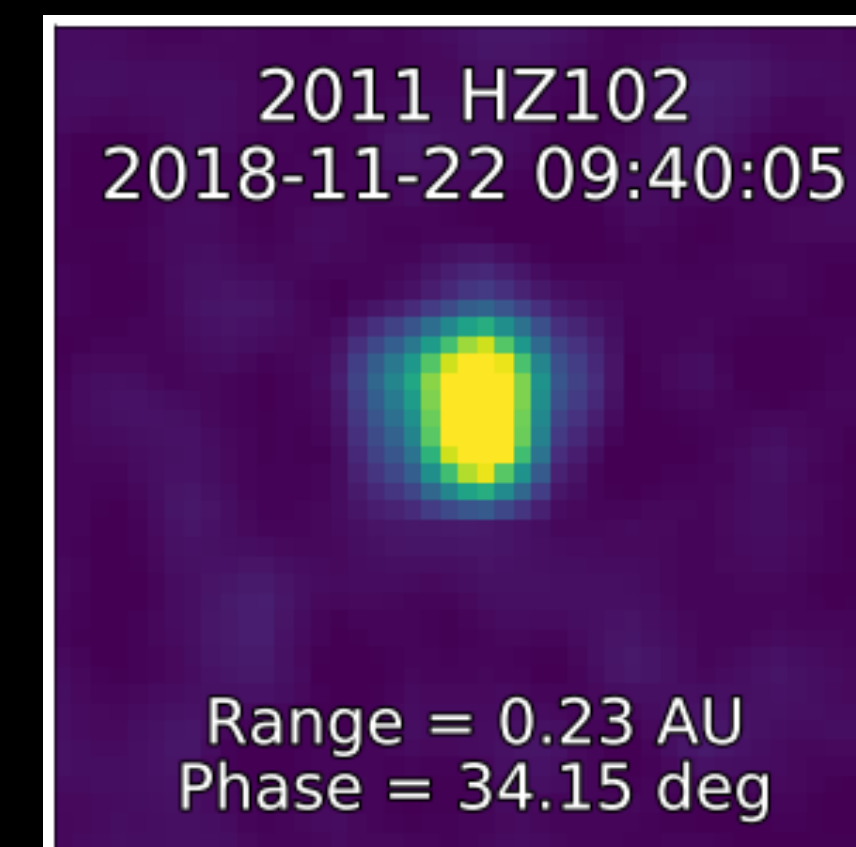


Distances of objects from spacecraft:

Most 0.01 to 2.2 au
Eris at 122 au

Phase Angles:

8-131°



*Image processing
by Simon Porter*

NH has a unique location
and vantage point!



KBOs & Dwarf Planets Observed by New Horizons

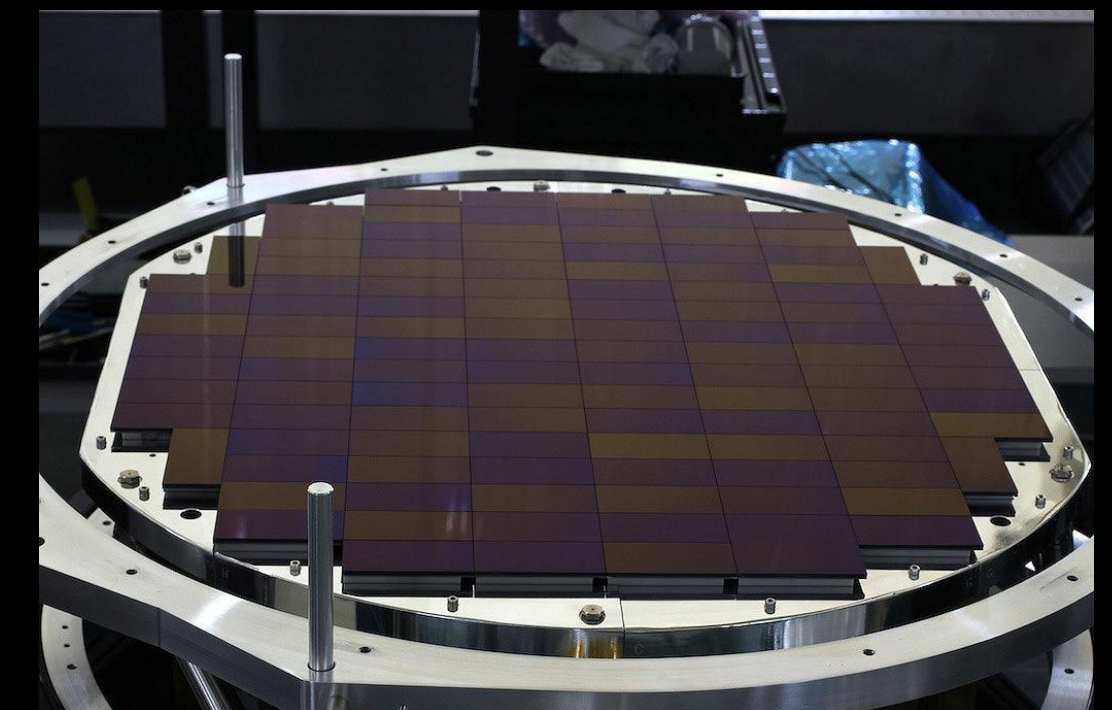
by Dynamical Class (all point source observations)

Cold Classical	Hot Classical	Scattered Disk	Resonant	Large KBO ($H_V < 5$)	Dwarf Planet	Centaur
2004 LW ₃₁	2012 HZ ₈₄	2011 HK ₁₀₃	2012 HE ₈₅	Quaoar	Eris	Chiron
2011 HF ₁₀₃	2011 HJ ₁₀₃	2014 OJ ₃₉₄	2018 MG ₁₃	Ixion	Makemake	2010 JJ ₁₂₄
2011 HZ ₁₀₂		2020 KV ₁₁	2020 KS ₁₁	2014 OE ₃₉₄	Haumea	
2011 JA ₃₂		2020 KP ₁₁	Arawn	2002 KX ₁₄		
2011 JW ₃₁		2020 KH ₄₂		Máni		
2011 JX ₃₁		2020 KT ₁₁				
2011 JY ₃₁						
2014 OS ₃₉₃						
2014 PN ₇₀		KBOs Discovered by Subaru HSC				
2018 MF ₁₃						
2020 KR ₁₁						

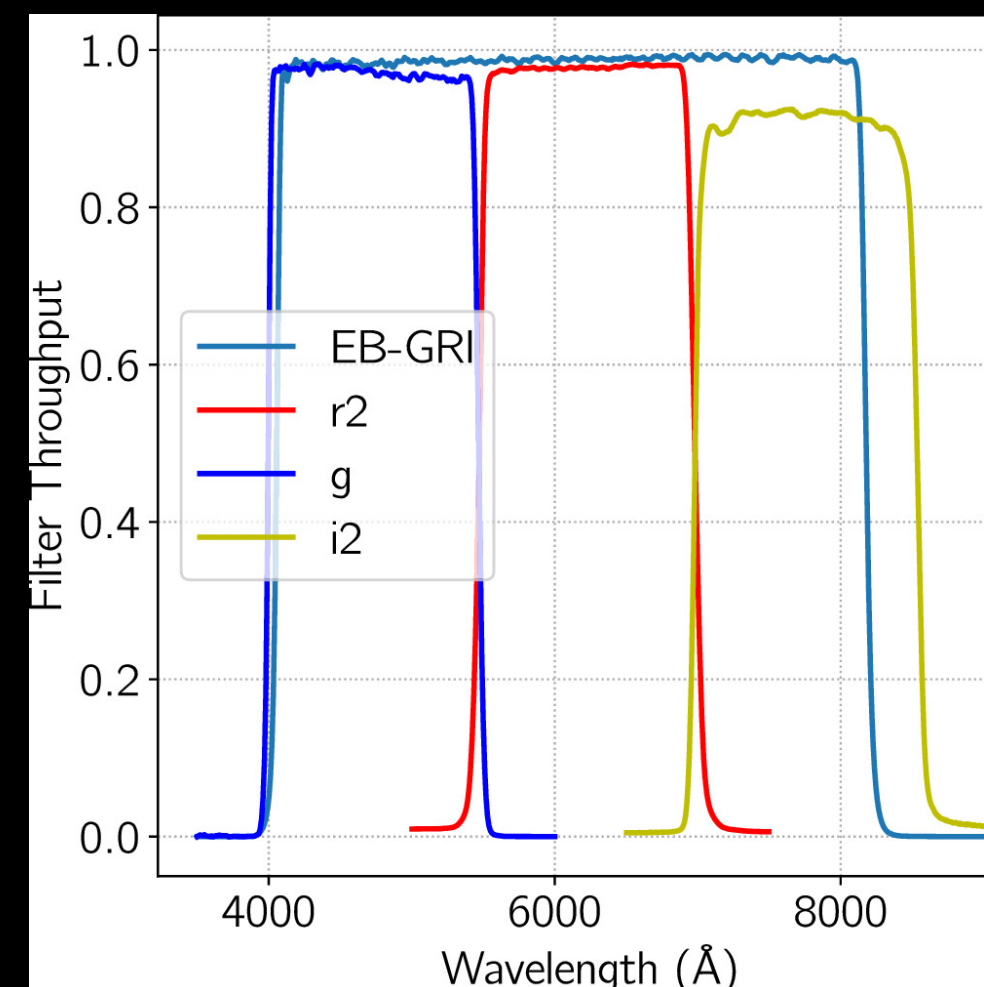


Searching for KBO Targets for New Horizons with Subaru Telescope – Summary

- 2004-2014 observations with Suprime-Cam
- 2020 HSC discovery observations
Japanese collaborators added
- 45 HSC half nights
Magnitude limit (thru 2023) $r \sim 26.5$
- 7 new targets for New Horizons:
5 observed by NH in 2020
1 observed by NH in 2023
1 best observed in 2027
- At least 294 new KBOs (thru 2025)
51 new in 2024, follow up in 2025
239 Fraser et al. (2024) *PSJ*
2 Yoshida et al. (2024) *PASJ*
2 More Added (2025)



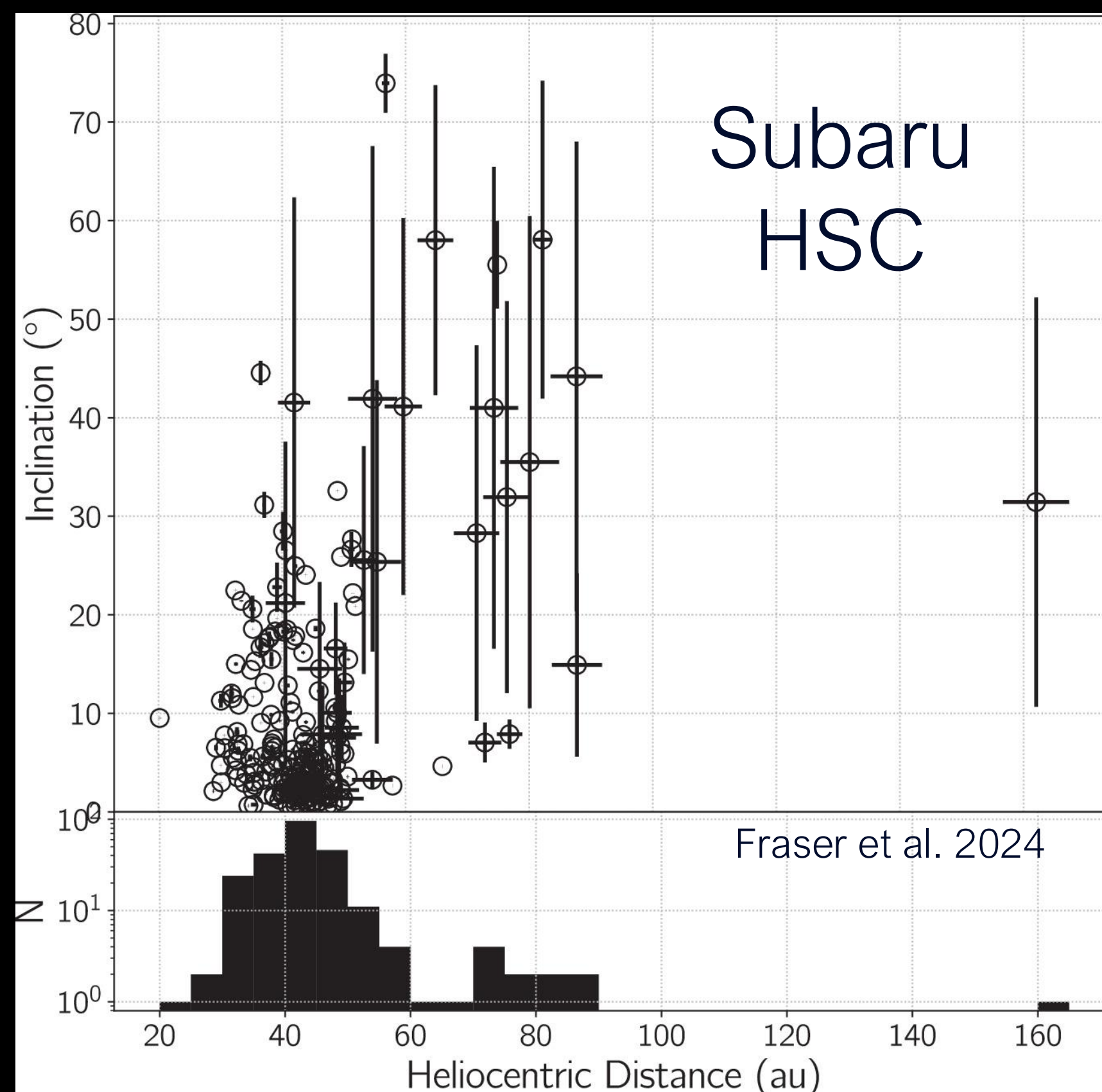
HSC 116 CCDs



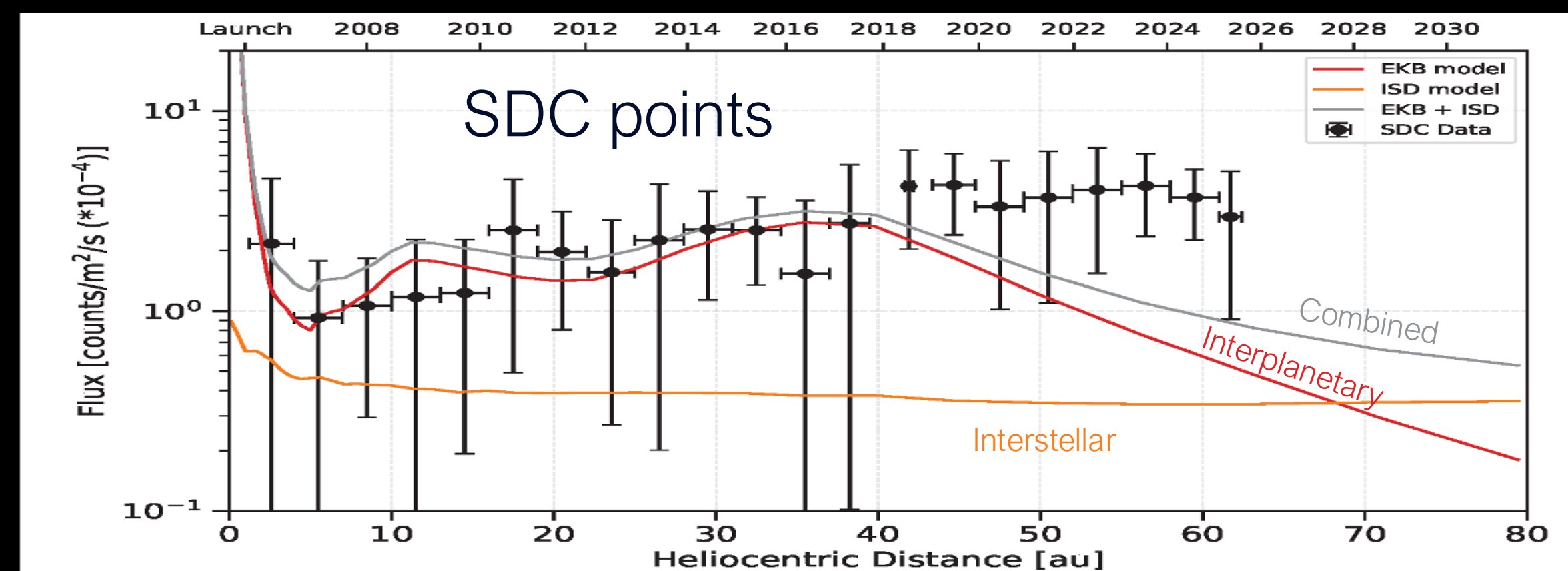
Extreme wide-Band
EB-*gri* filter
(since 2023)
Provided by New Horizons Project



Searching for KBO Targets for New Horizons with Subaru Telescope – Results



Evidence for an extended Kuiper Belt?
Potential for a major discovery!



New Horizons Student Dust Counter (SDC) detects
small (<10 μ m) particles generated by collisions

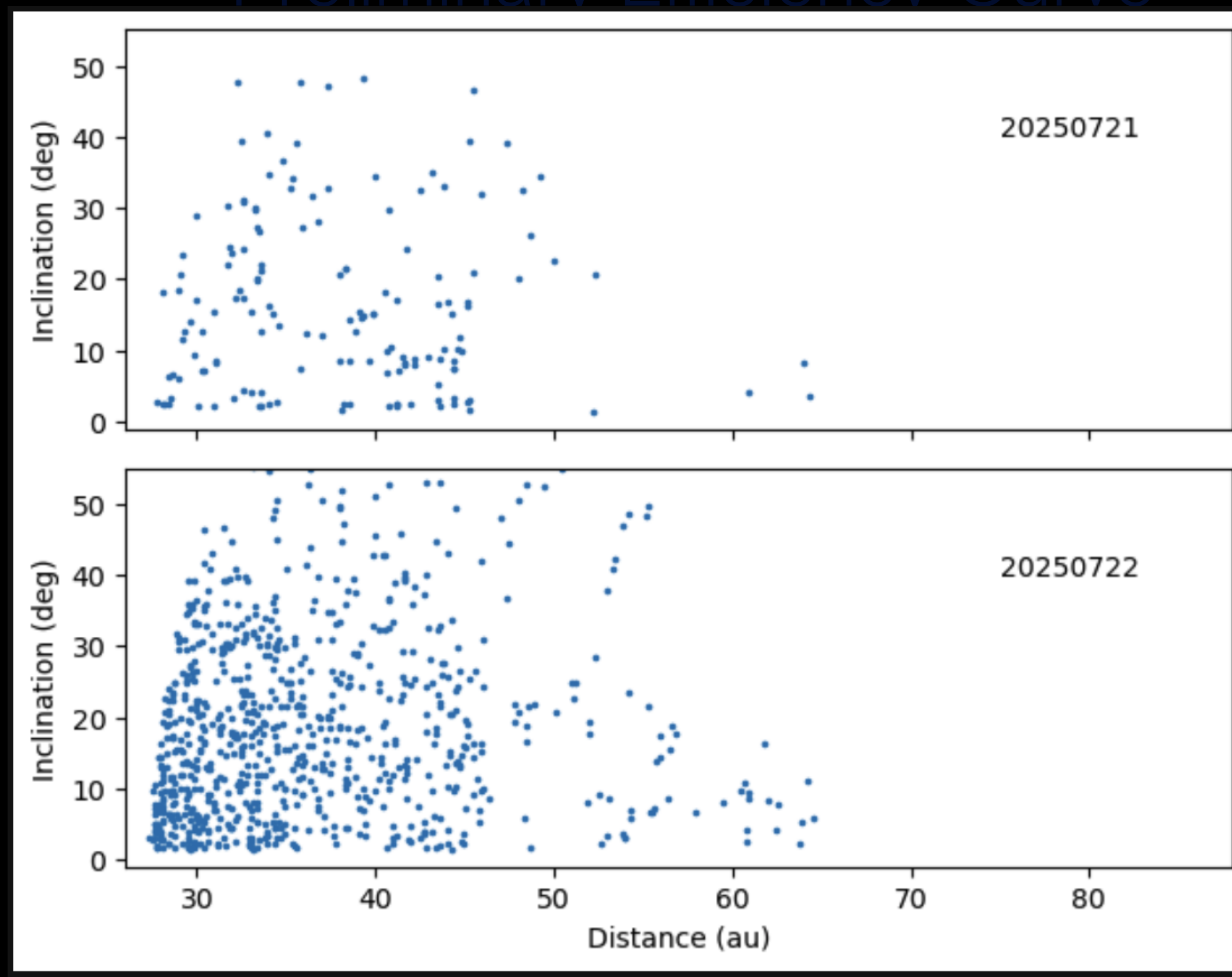
294 new KBOs, including 11 with $R > 70$ au (5x more than OSSOS++ model predicts)



Searching for KBO Targets for New Horizons with Subaru Telescope in 2025

- 3 half nights in 2025
- Analysis ongoing - shift and stack using Rubin/LSST pipeline with ML
- Magnitude limit $r \sim 27$

Preliminary Efficiency Curve

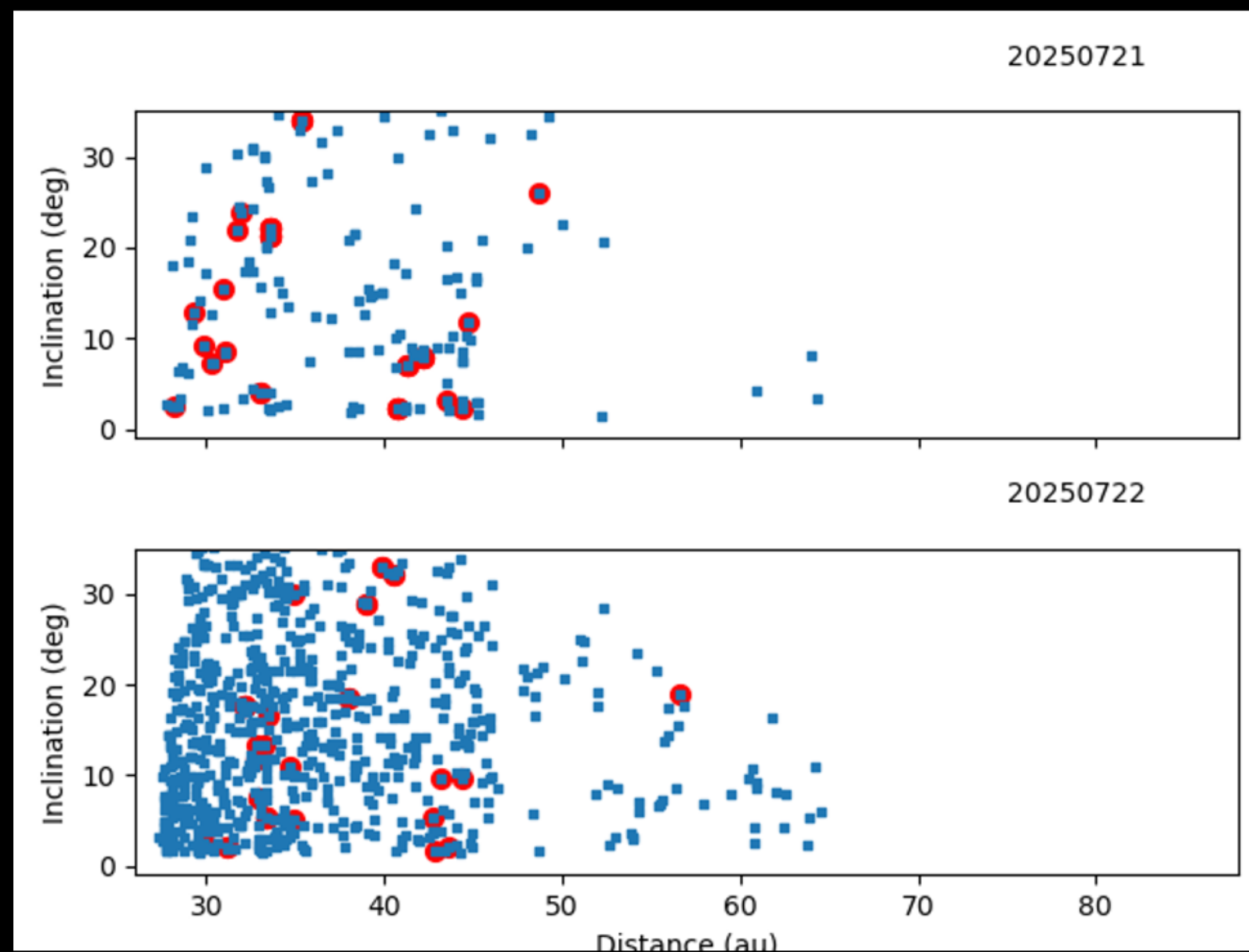


JJ Kavelaars



Searching for KBO Targets for New Horizons with Subaru Telescope in 2025

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- Red dots are linked KBOs on 2 nights

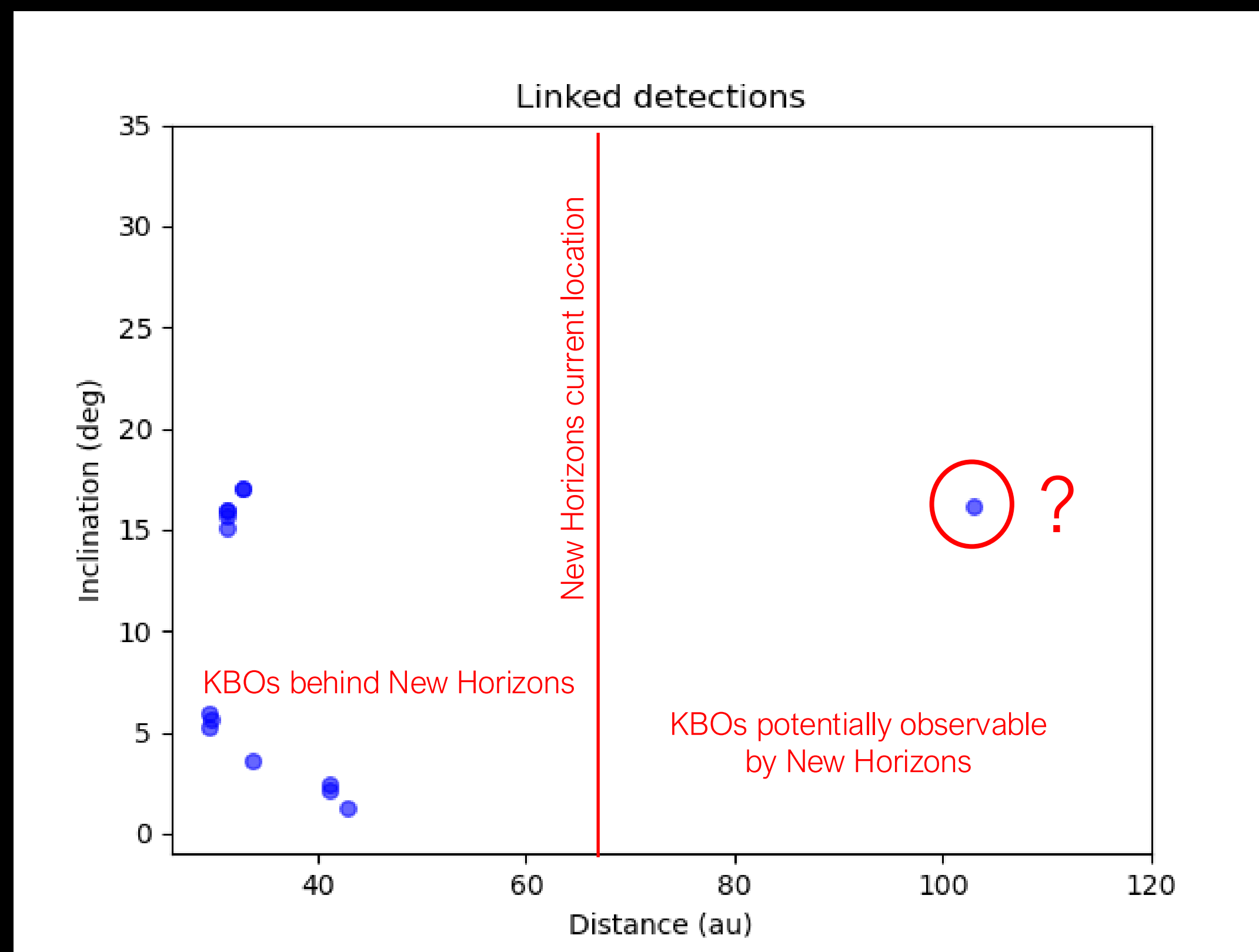


JJ Kavelaars



Searching for KBO Targets for New Horizons with Subaru Telescope in 2025

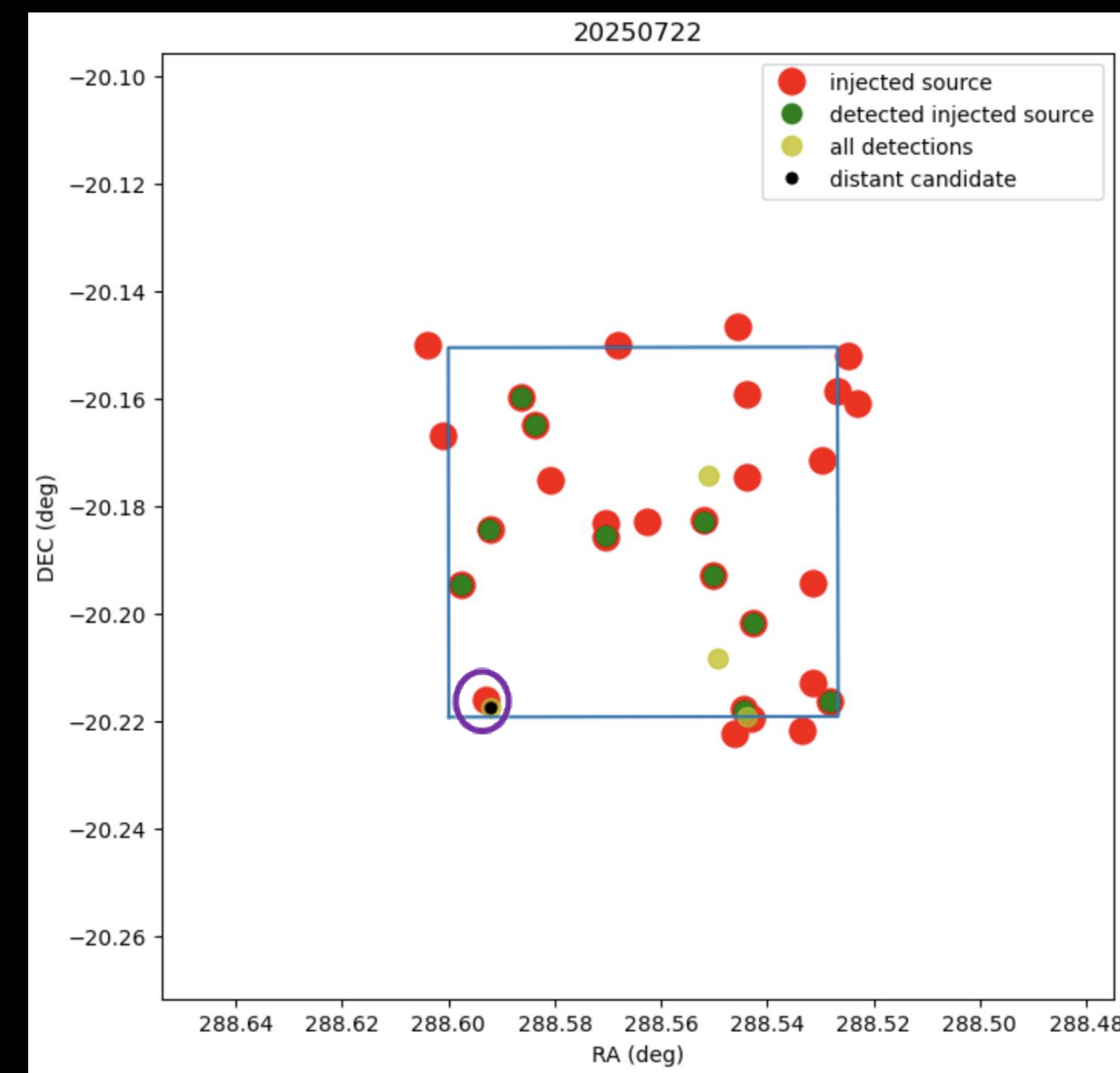
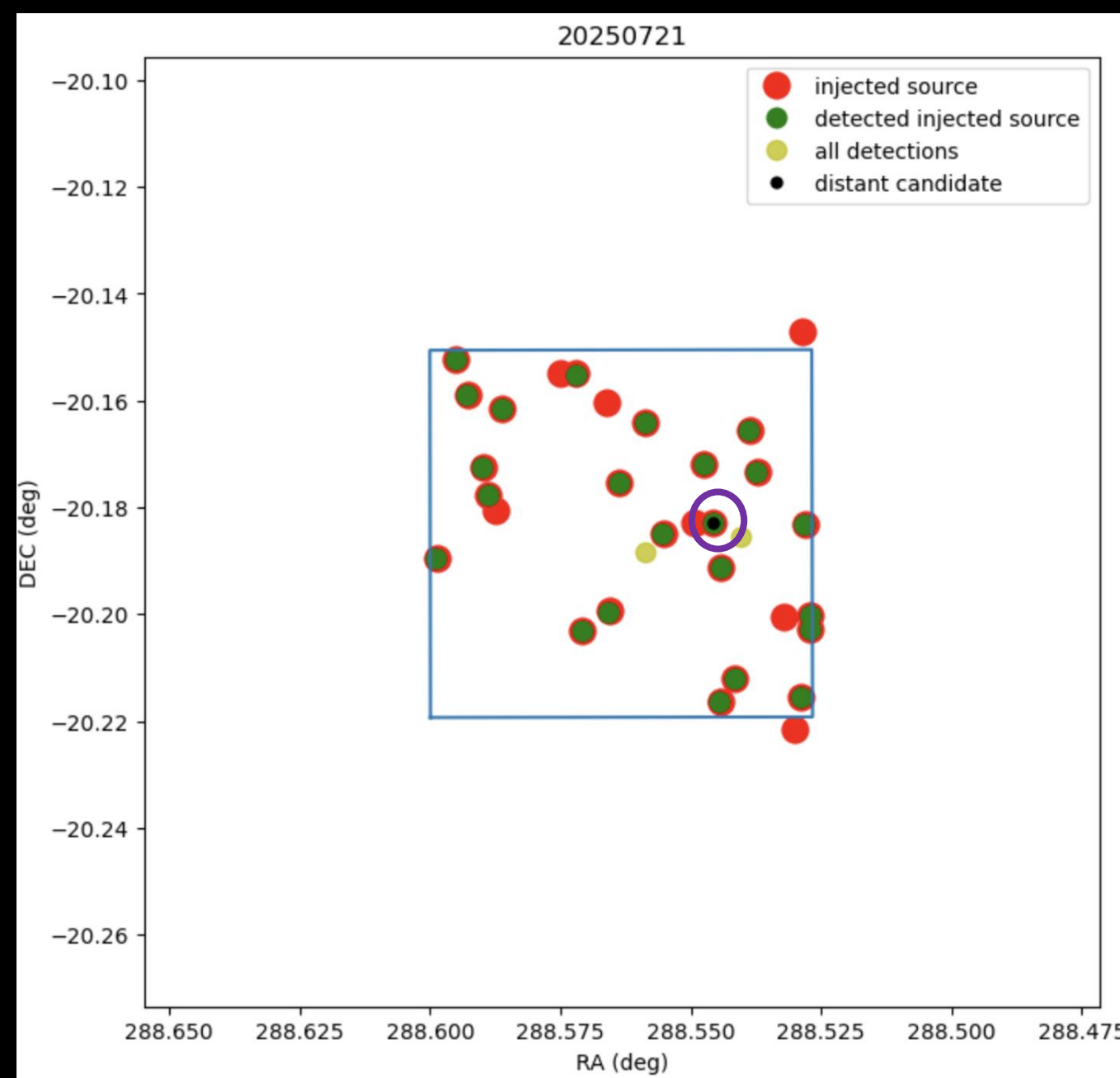
- 3 half nights in 2025
- Analysis ongoing
- Magnitude limit $r \sim 27$
- Red dots are linked KBOs on 2 nights
- One KBO > 100 au?





Searching for KBO Targets for New Horizons with Subaru Telescope in 2025

- 3 half nights in 2025
- Analysis ongoing
- Magnitude limit $r \sim 27$
- Red dots are linked KBOs on 2 nights
- False Positive!
- No KBO > 100 au
- Keep looking!



JJ Kavelaars

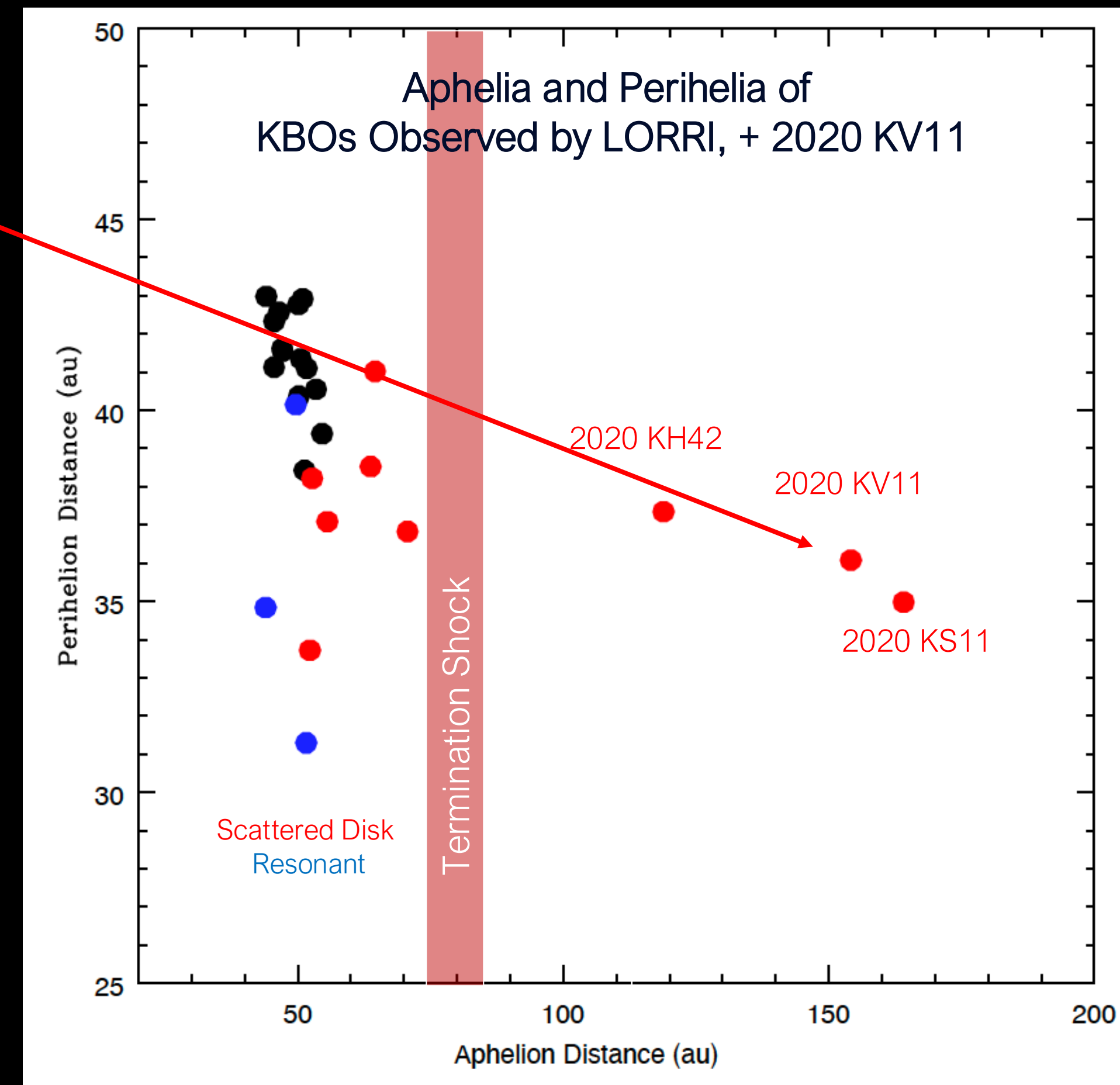


KBO 2020 KV11

2020 KV11 is a large Scattered Disk Object

- discovered by Subaru Search in 2020
- aphelion distance 154 au, beyond heliopause
- $H = 7.3$, ~ 210 km for $p_V = 0.05$ (similar to plutino Arawn)

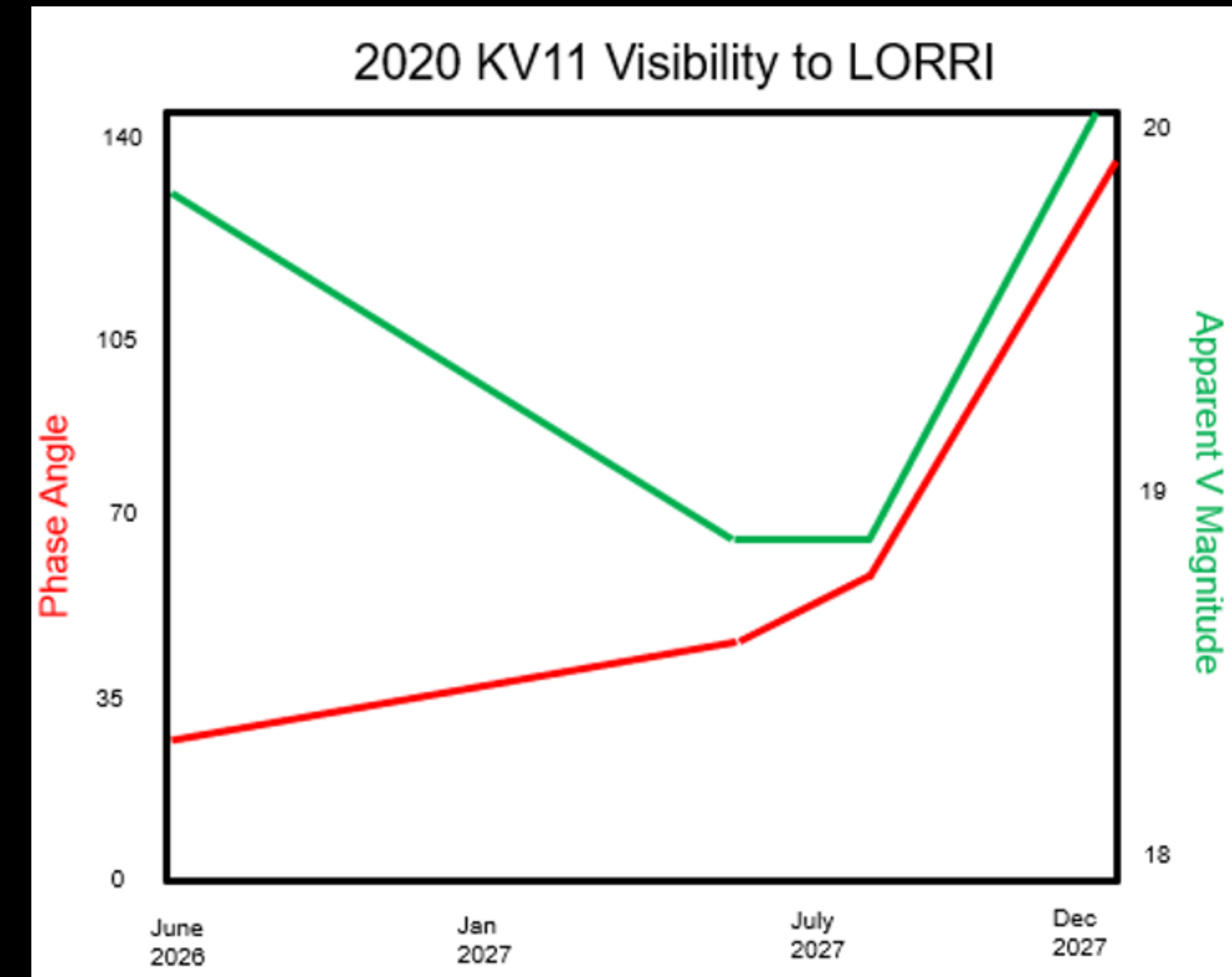
Only 2020 KS11, observed previously by NH, has a larger aphelion distance.





KBO 2020 KV11 Visibility to LORRI

- 2020 KV11 is visible ($V < 20$) to NH LORRI from hibernation exit (June 2026) until December 2027:
- $V = 19.8$, $\alpha = 23^\circ$ (June 2026)
- $V = 20.1$, $\alpha = 134^\circ$ (December 2027)
- Appears brightest to NH/LORRI from June 10-August 6 2027:
 $V = 18.9$
 $\alpha = 44^\circ$ to 57°
- Closest to NH on November 19, 2027, $V=19.6$, $\alpha = 111^\circ$

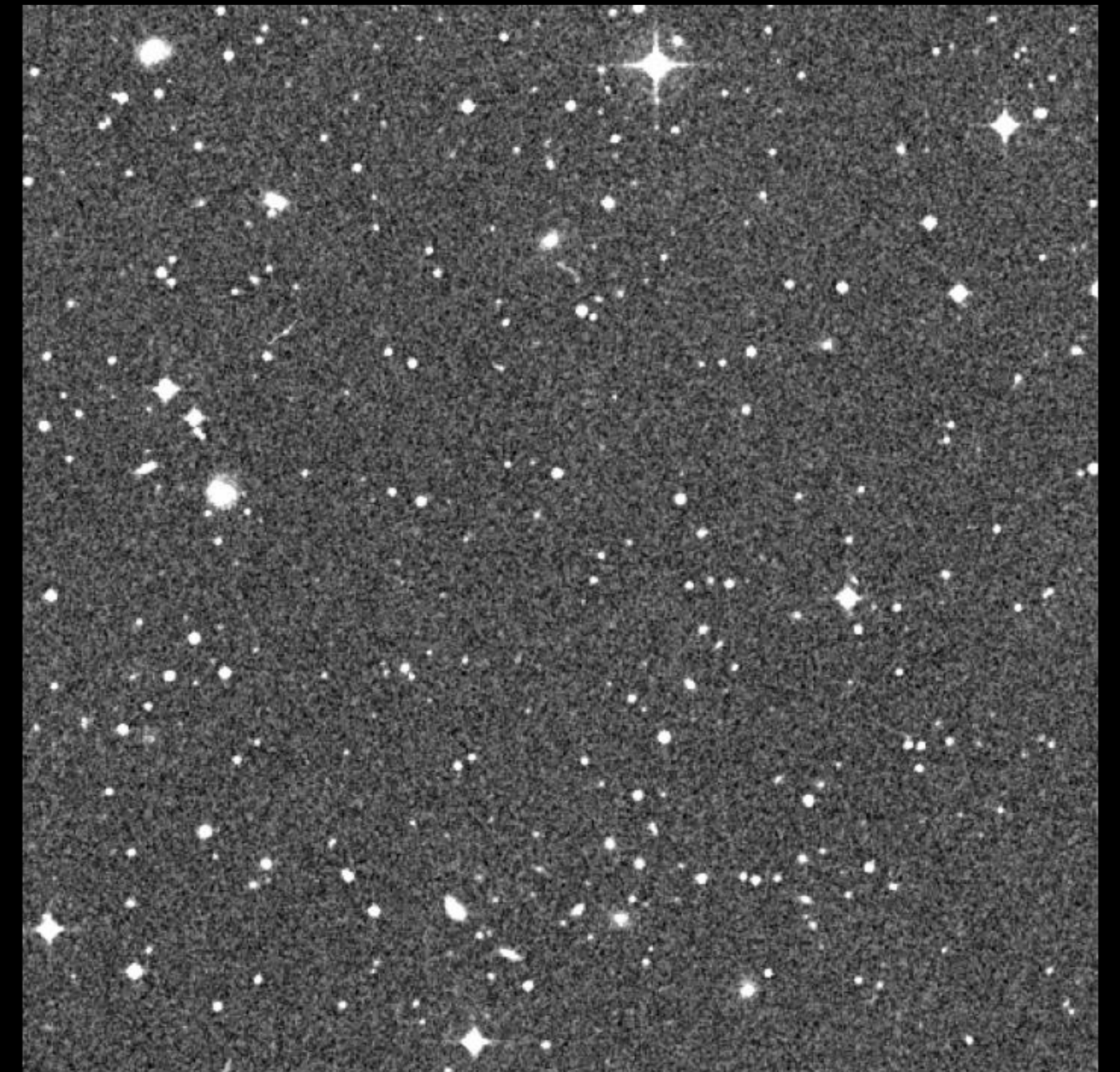




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 - Goals: Measure rotation curve, construct solar phase curve
 - Compare properties to other KBOs closer to Sun

LORRI FoV 2020 KV11 July 2027





Searching for KBO Targets for New Horizons: Looking Ahead

- Complete 2024-25 Data Analysis
report discoveries (at least 51) to MPC
still more objects $R > 70$ au than expected?
potential for a major discovery!
- Subaru/HSC Proposals going forward (S27A →
led by Japanese collaborators (Ito, Yoshida, et al.)
- Pending proposals to use Rubin, Roman Telescopes
reach magnitudes $r \sim 27.5$, $r \sim 30.5$ (>5000 new KBOs)
- Observe new KBOs with New Horizons
can accommodate close flyby for at least a decade
 - power available until ~2050
 - limited remaining fuel for ΔV , flyby activities

