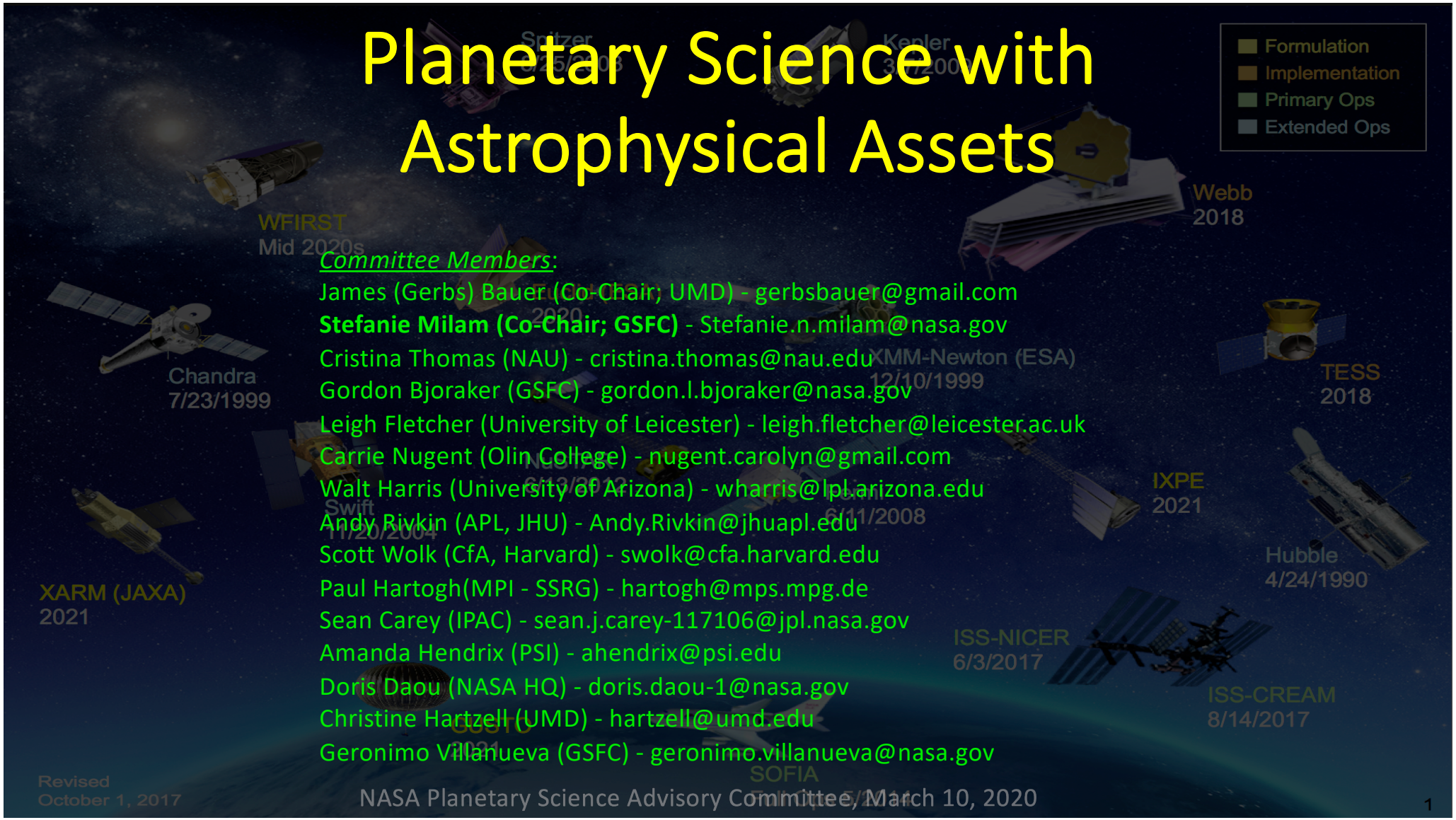
Planetary Science with Astrophysical Assets



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Revised
October 1, 2017

Purpose of the Small Bodies Assessment Group committee

- To compile a uniform set of basic capabilities that maximize the yield of Solar System science with future Astrophysics assets *(white paper for 2020 Astrophysics Decadal Survey)*.

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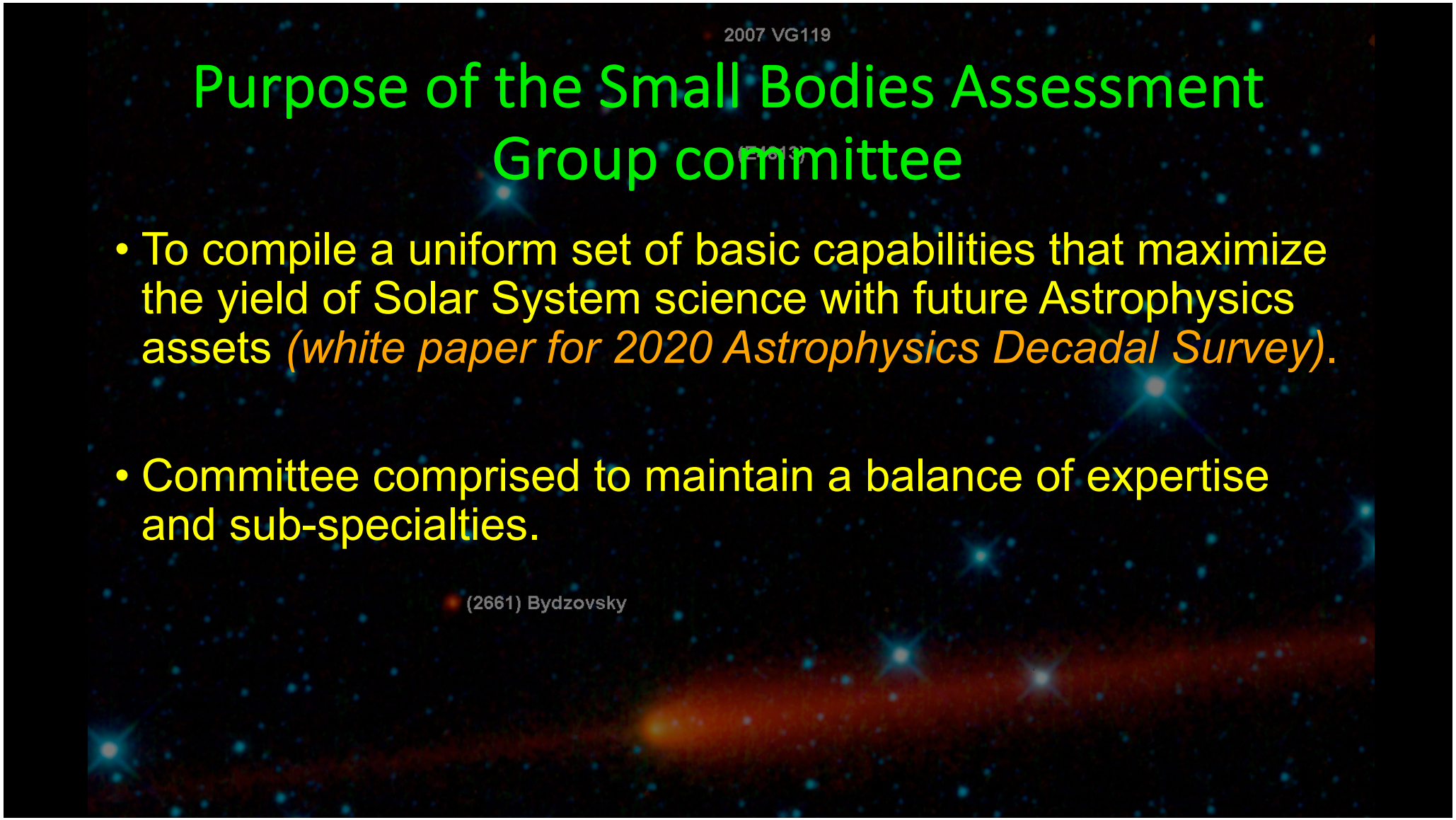

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- Solicited input from the community, including a call for input via a webform.

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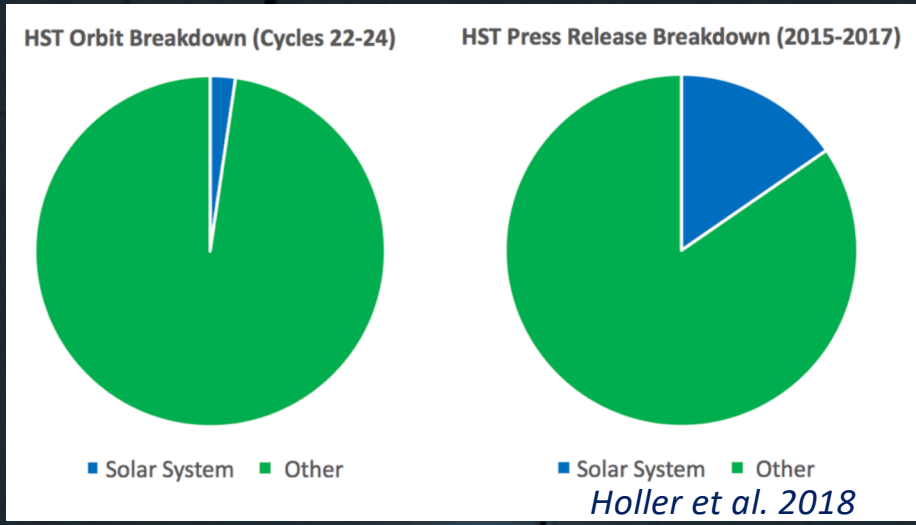
PSAA benefits the missions as well as the Planetary Science community. Some of the astrophysics platforms that have yielded significant contributions to planetary science include:



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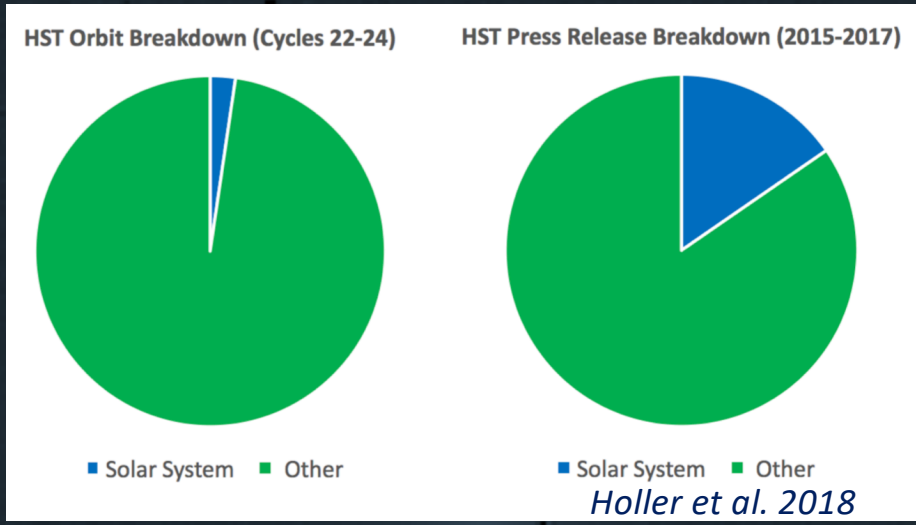

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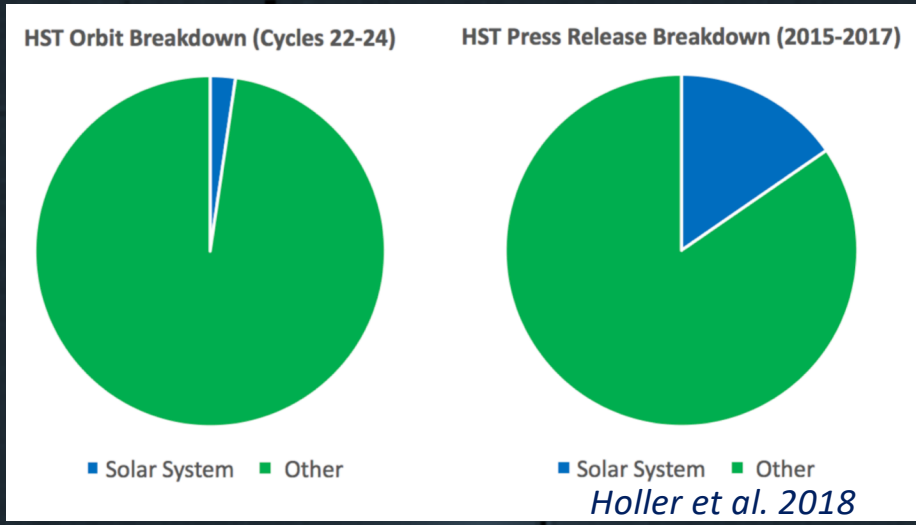

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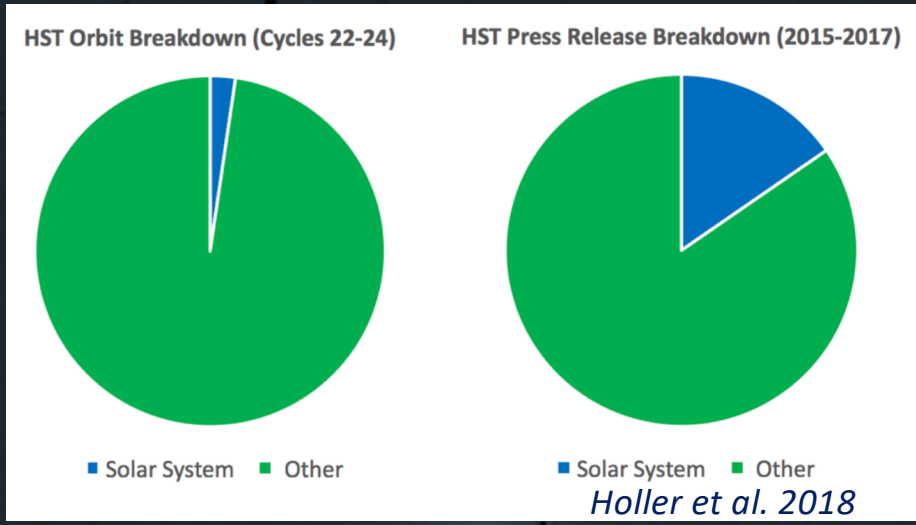

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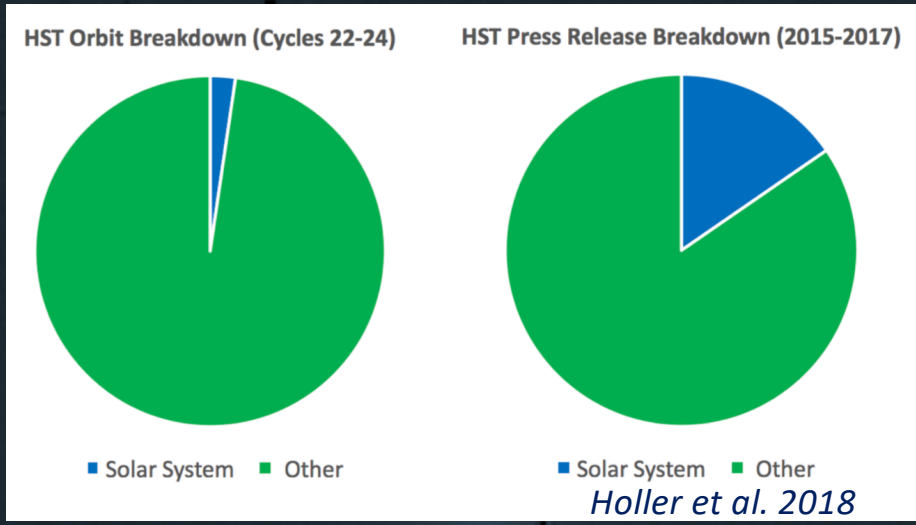

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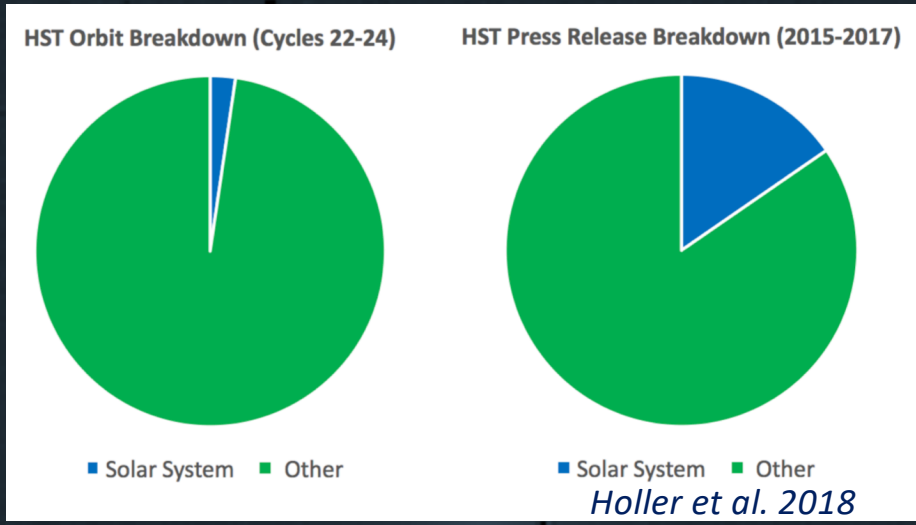

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- *Pan-STARRS: One of the most prolific discoverers of small bodies in operation.*

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PSAA Topical Investigations

- Scientific Investigations:
  - Identify the most compelling subjects of study.
  - Identify the key capabilities that are unique to AA platforms for the highest-priority subjects.
  - Identify the range of Platform and Payload Criteria that are required to span the populations.

- Technical Investigations:
  - Identify the gaps in instrumentation and spacecraft architecture.
  - Investigate the trade spaces of the technical desirables.
  - Weigh implementation costs against the range of capabilities.

X-RAY & OPTICAL

Dunn et al. 2017

Examples of Capabilities and Science Drivers

- Compelling Topics:
  - Drivers of MBC activity.
  - Distribution and Composition of Oort Cloud Objects.
  - Giant Planet Aurorae.
  - Comet D/H ratios.
  - Planet IX
  - Tracing Solar System Evolution through asteroid composition

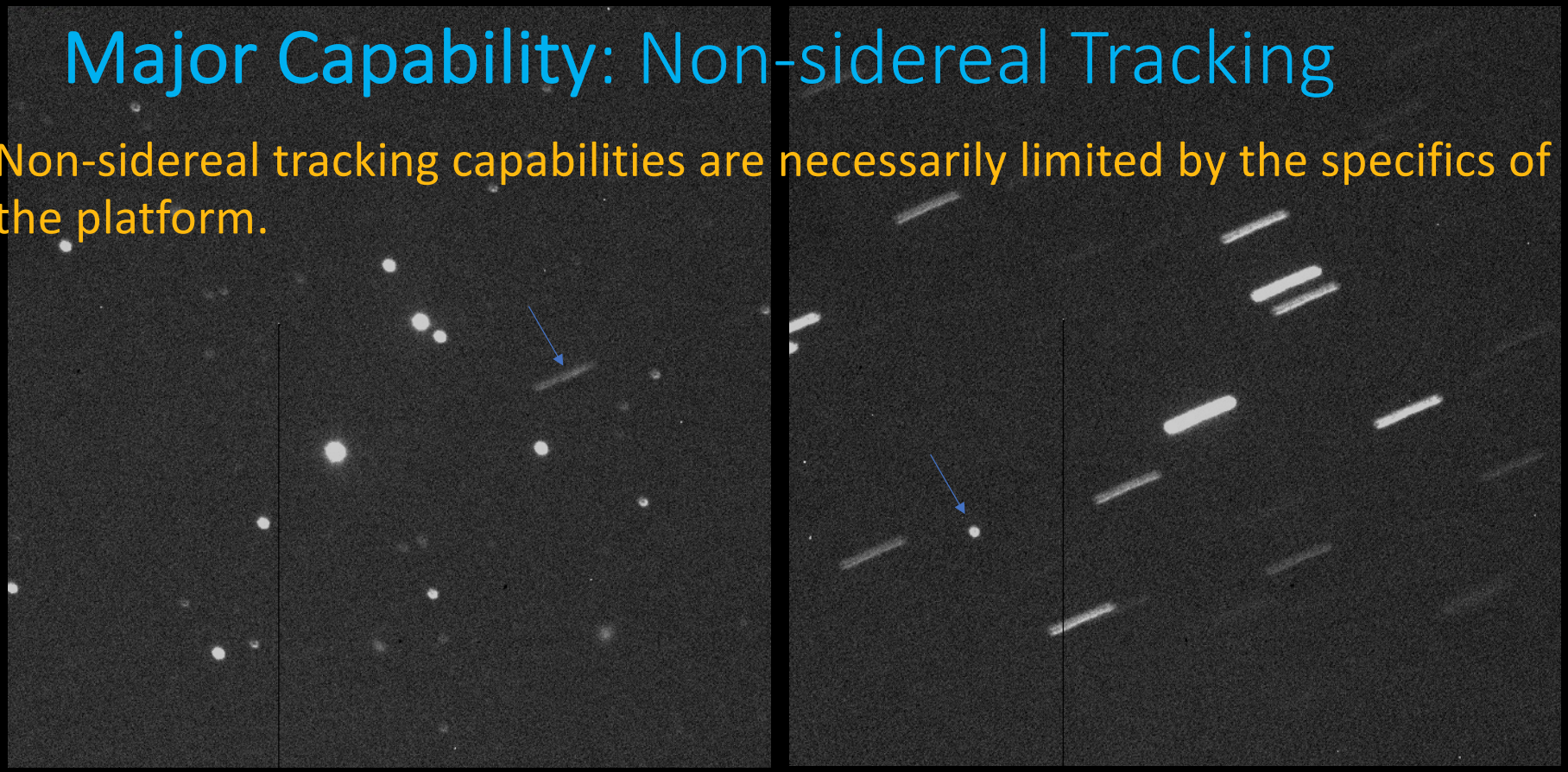
- Key Capabilities:
  - Non-sidereal Tracking/Guiding.
  - Large Area FOV.
  - High Spatial or High Spectral Resolution.
  - High sensitivity and collection area.
  - Rapid read-out/sampling.
  - Multiple visit cadence.

NORTH POLE

SOUTH POLE

Major Capability: Non-sidereal Tracking

- Non-sidereal tracking capabilities are necessarily limited by the specifics of the platform.



WIYN 0.91m Tracking test

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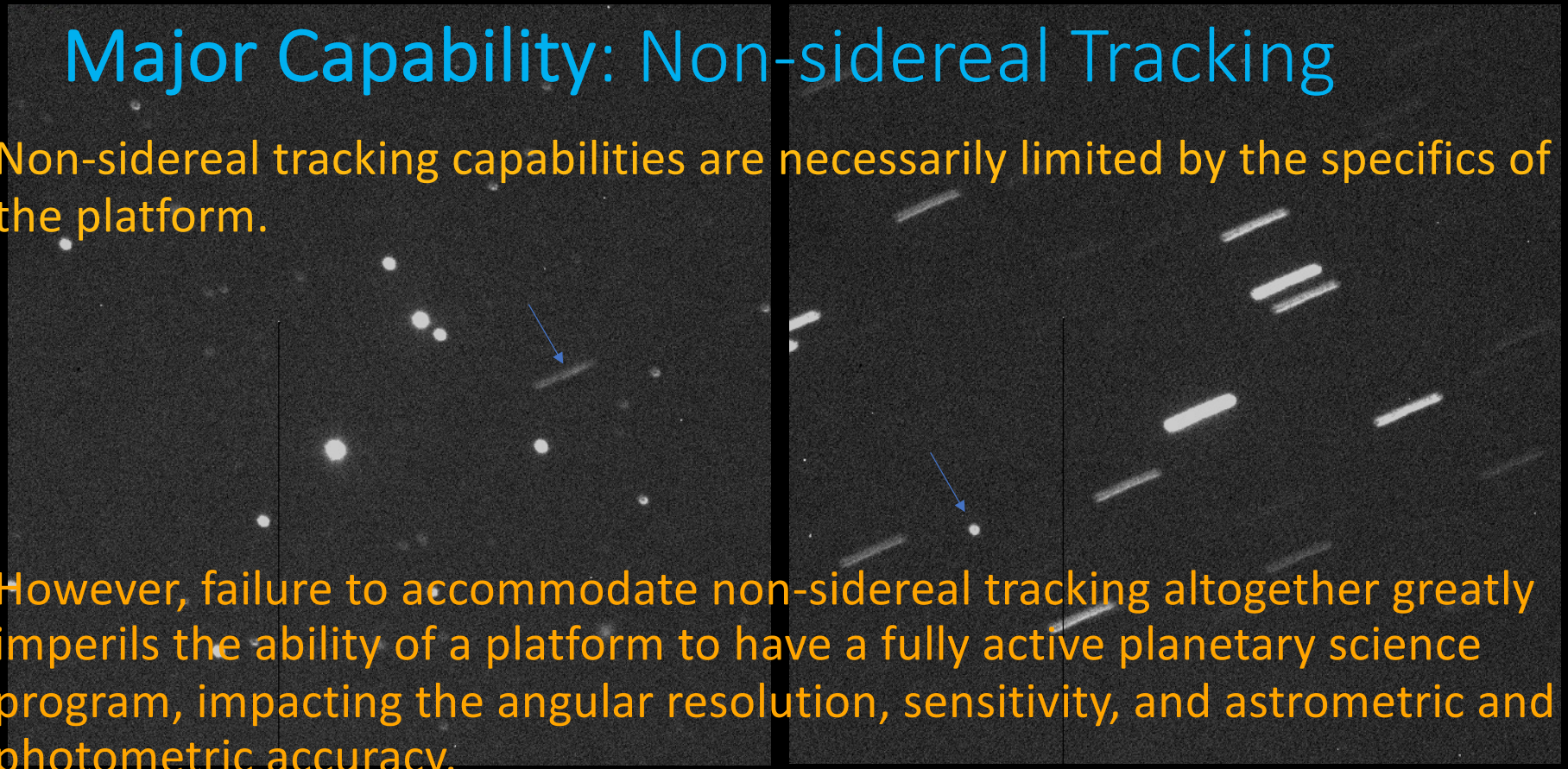

- However, failure to accommodate non-sidereal tracking altogether greatly imperils the ability of a platform to have a fully active planetary science program, impacting the angular resolution, sensitivity, and astrometric and photometric accuracy.

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- Observations of most major categories of objects can make use of large dynamic range coupled with increased sensitivities.

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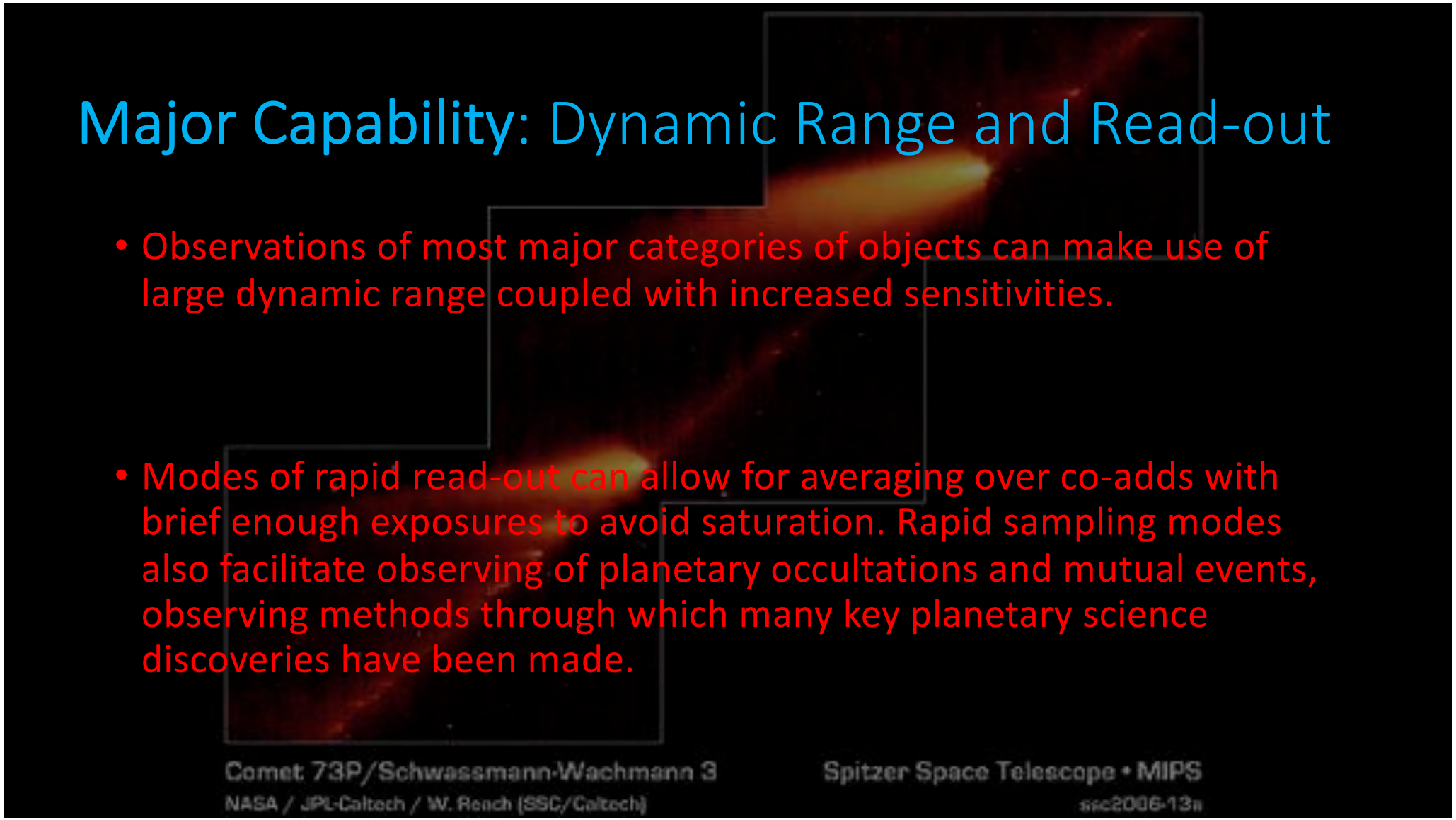

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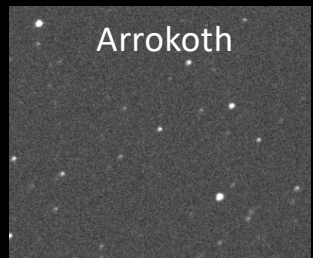
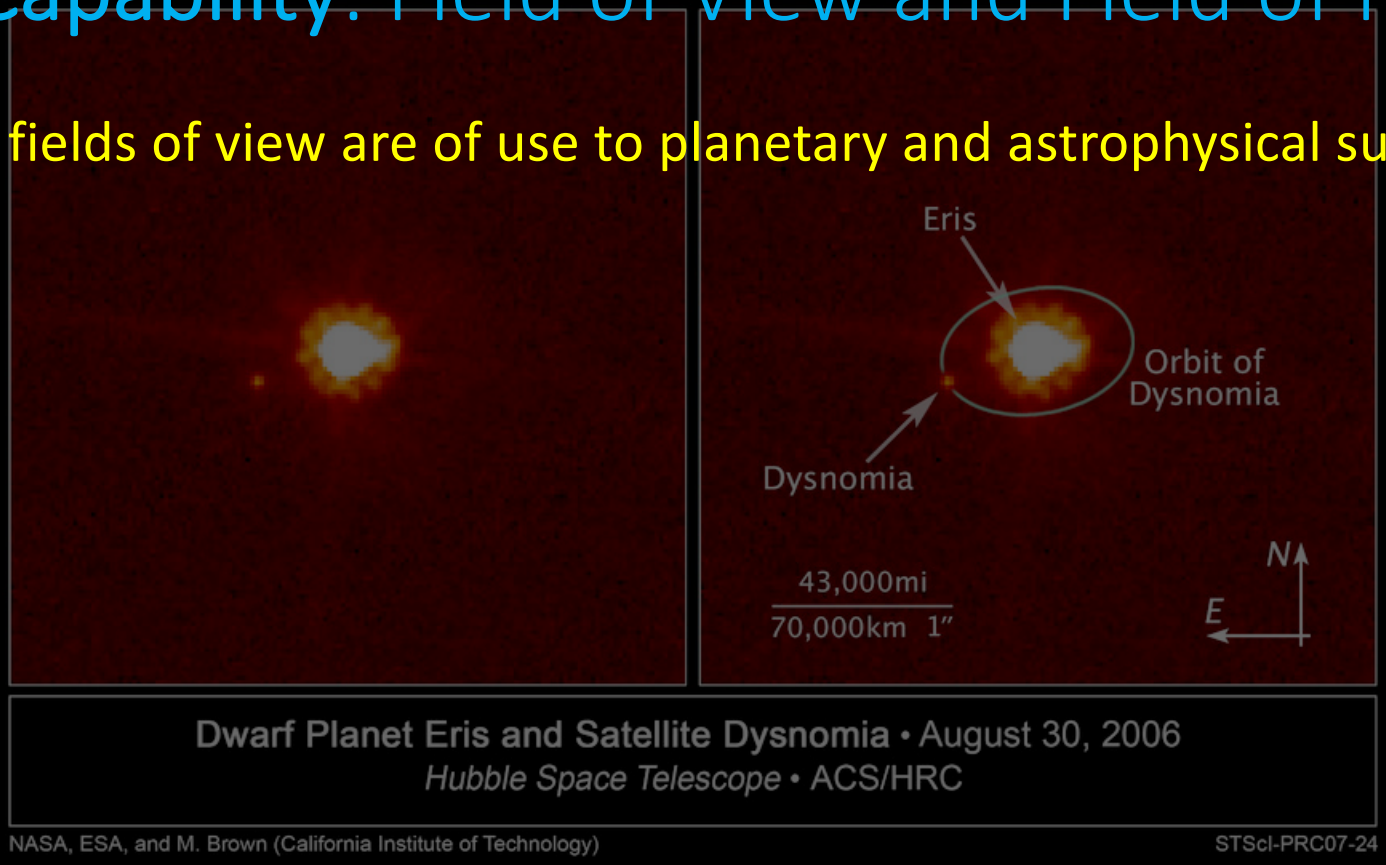


Comet 73P/Schwassmann-Wachmann 3
NASA / JPL-Caltech / W. Reach (SSC/Caltech)
Spitzer Space Telescope • MIPS
ssc2006-13a

Major Capability: Field of View and Field of Regard

- Large fields of view are of use to planetary and astrophysical surveys alike.



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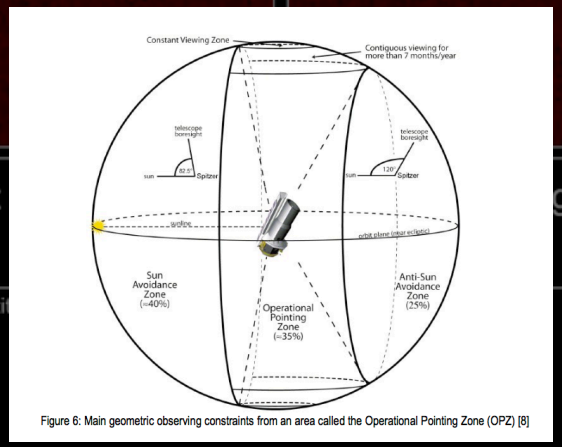

Figure 6: Main geometric observing constraints from an area called the Operational Pointing Zone (OPZ) [8]

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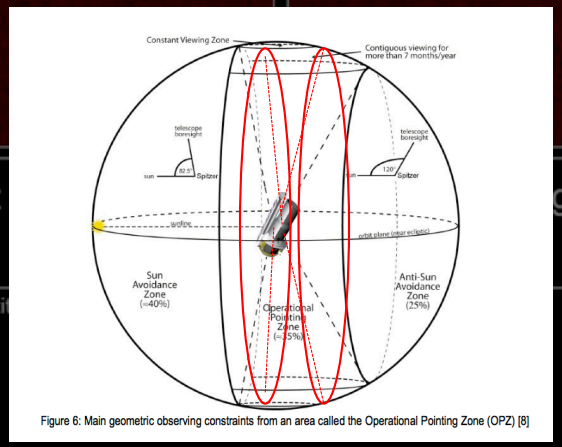

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Comet-like Asteroid P/2010 A2 • January 29, 2010 *Hubble Space Telescope* • WFC3/UVIS

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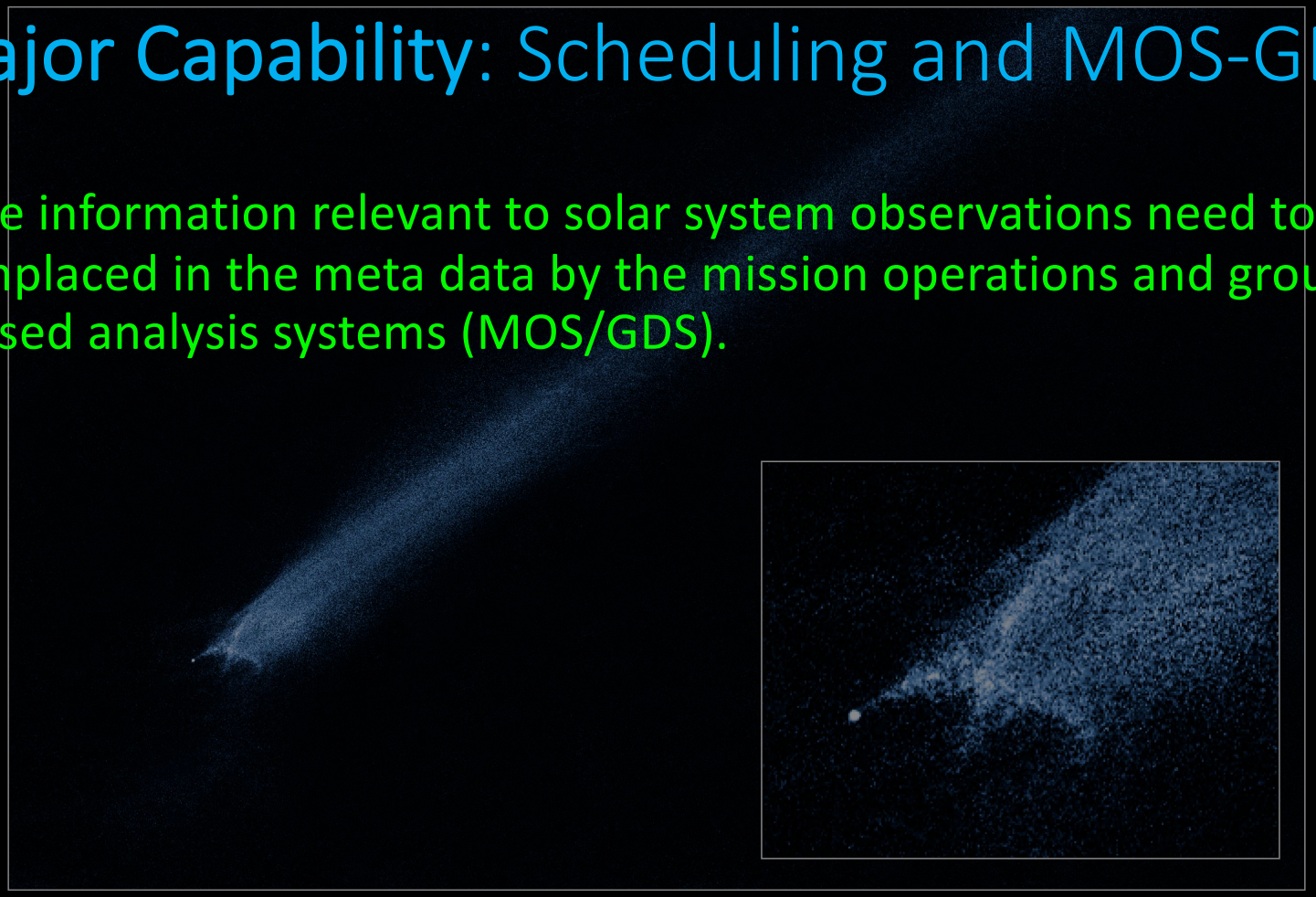

NASA, ESA, and D. Jewitt (UCLA) STScI-PRC10-07

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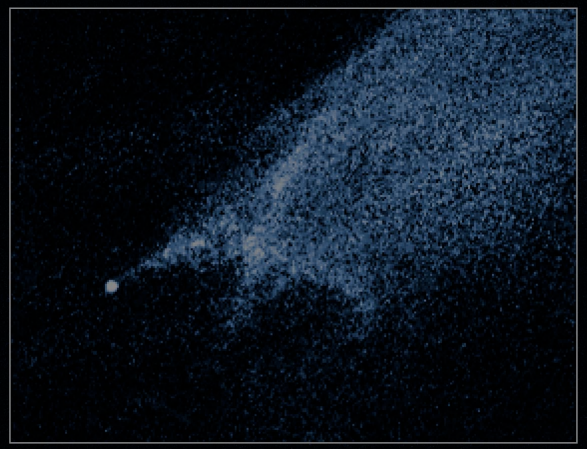

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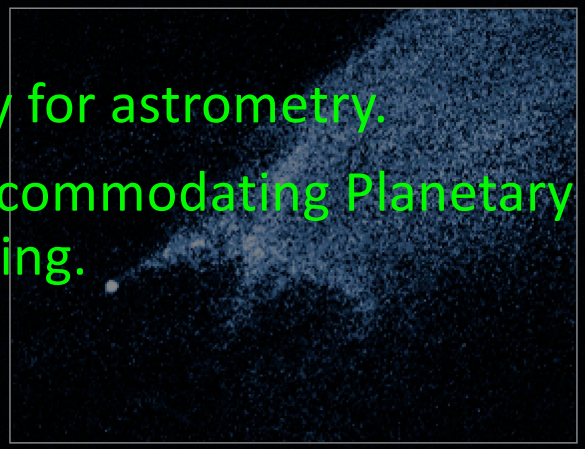
- Minimize scheduling penalties for accommodating Planetary Observations and Non-Sidereal tracking.



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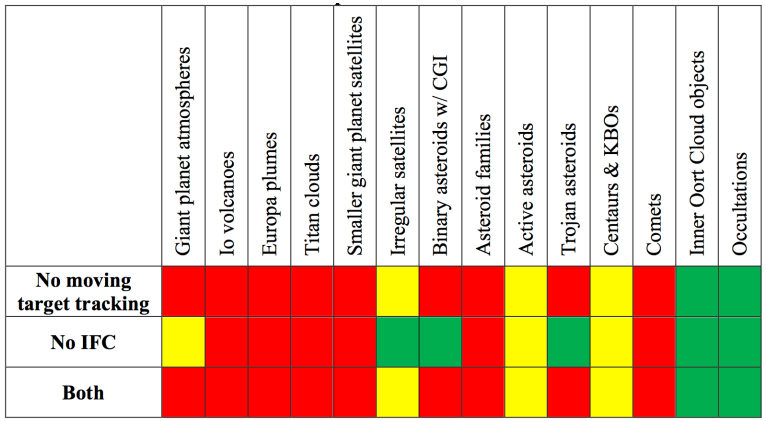
Enhanced Capabilities and Benefits

Capability/Priority	Small Bodies	Giant &Terrestrial Planets
Non-sidereal Tracking (1)	• Allows the full benefits of the observing platform to be used for planetary bodies.	
FOV/FOR (2)	• Large FOV allows simultaneous imaging of cometary coma, tails, and trails • Expanded FOR allows access of small bodies through more of their orbits.	• A small FOV can impact the ability to monitor the planet's full disk, or conduct simultaneous satellite observations. • A limited FOR impacts the ability to study a given planet in the time-domain.
Scheduling, MOS-GDS (3)	• Flexibility in scheduling without special penalties for planetary targets allows more complete exploration of the time-domain. • Complete meta-data and well calibrated individual frames facilitates small body discoveries and characterization of temporal behavior.	
Imaging, Dynamic Range and Readout (4)	• Larger dynamical range allows for comprehensive comet imaging. • Planetary occultation observations are facilitated by rapid read-out capabilities.	• Limited dynamic range impacts imaging and spectroscopy of atmospheres, aurorae, and satellite volcanism.
Spectroscopy (5)	• Flexibility for marginal alterations of wavelength coverage to include key spectral features can greatly impact planetary spectroscopy across categories.	
Survey cadence (6)	• For surveys, appropriate cadence considerations tailored to the planetary bodies of highest interest are critical to the survey success.	

e.g. Impact on proposed modifications on Pl. Sci. Cases for WFIRST



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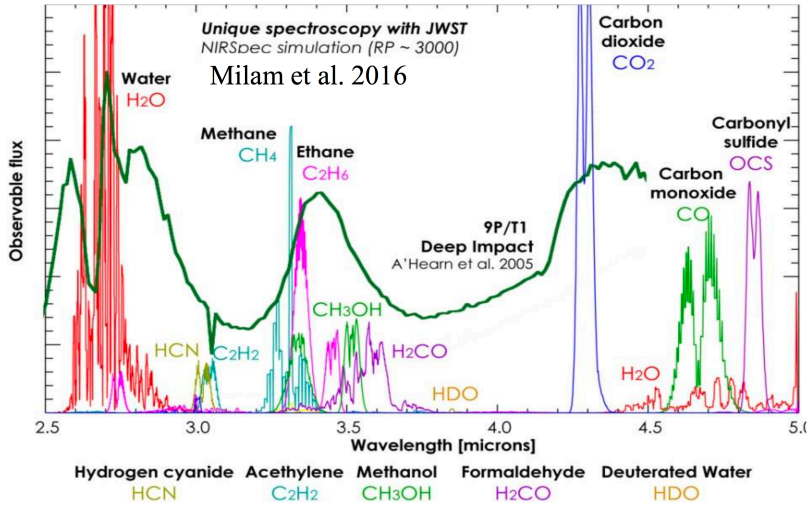

Conclusions

- PS-enabling capabilities should be considered early in the design.
- Planetary Science capabilities must be weighed in the balance of the overall platform capacities.
- Small alterations should be considered with other science goals for their impact on the Planetary Science usage cases, such as:
  - Flexibility for marginal alterations of wavelength.
  - For surveys, appropriate cadence considerations for surveys.

White Paper - https://arxiv.org/abs/2002.05838