

# Planning Small Body Observations with JWST



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SBAG  
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on behalf of 7 billion current Earthlings, ~10,000 future observers, ~ 1000 engineers and technicians, ~ 100 scientists worldwide, 3 space agencies

# Planning your Solar System Observations with the James Webb Space Telescope

- Provide, via the JWST Project members:
  - current instrument specifications and observing modes
  - observatory capabilities (brightness limits, moving targets, tracking, and others)
  - preliminary case studies from JWST SO-DRM

*Goal: fully engage Solar System community  
and provide tools they need to  
begin planning their observations with JWST*

14 October 2012, Reno, Nevada

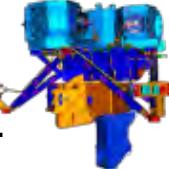
AAS Division for Planetary Sciences Meeting

# JWST Vital Stats

- General Observatory: 5 years required; 10 years goal
- Diameter of primary mirror: 21.3 feet (6.5 meters)
- Number of primary mirror segments: 18
- Sunshield: 5 layer, 69.5 feet by 46.5 feet (21.2 meters by 14.2 meters)
- Orbit: 930,000 miles (1.5 million kilometers) from Earth
- Operating temperature: Below 50 Kelvin ( $-370^{\circ}$  Fahrenheit)
- Four Science Instruments covering 0.6–28.8 microns
  - Filtered Imaging
  - Spectroscopy – Slit, Integral Field, Grism/Prism
  - Coronagraphy – Traditional Lyot + Four Quadrant Phase Masks
  - Aperture Mask Interferometry – Non-Redundant Mask (NRM)



# JWST Instrumentation

Instrument	Science Requirement	Capability
<b>NIRCam</b> Univ.Az/LMATC	 <p>Wide field, deep imaging            • 0.6 μm - 2.3 μm (SW)            • 2.4 μm - 5.0 μm (LW)</p>	Two 2.2' x 2.2' SW Two 2.2' x 2.2' LW Coronagraph Dual filter wheel
<b>NIRSpec</b> ESA/Astrium	 <p>Multi-object spectroscopy            • 0.6 μm - 5.0 μm</p>	9.7 Sq arcmin Ω + IFU + slits 100 selectable targets: MSA R=100, 1000, 3000
<b>MIRI</b> ESA/UKATC/JPL	 <p>Mid-infrared imaging            • 5 μm - 27 μm</p> <p>Mid-infrared spectroscopy            • 4.9 μm - 28.8 μm</p>	1.9' x 1.4' with coronagraph Filter wheel  3.7"x3.7" – 7.1"x7.7" IFU R=3000 - 2250
<b>FGS/NIRISS</b> CSA	 <p>Fine Guidance Sensor            0.8 μm - 5.0 μm</p> <p>Near IR Imaging Slitless Spectrometer,            • 1.6 μm - 4.9 μm</p>	Two 2.3' x 2.3'  2.2' x 2.2' R=150, 700 with coronagraph

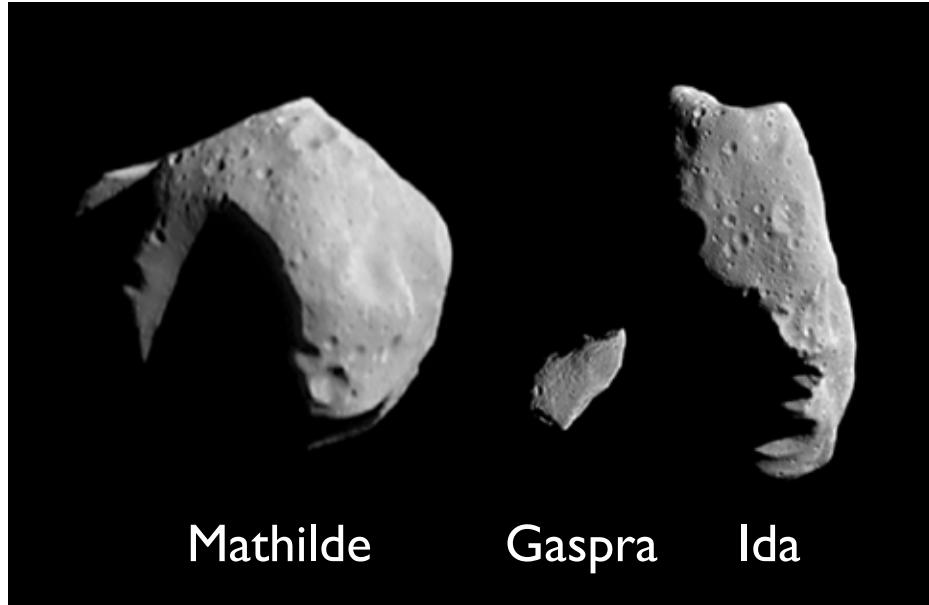
# JWST Imaging Modes

Mode	Instrument	Wavelength (microns)	Pixel Scale (arcsec)	Full-Array* Field of View
Imaging	NIRCam*	0.6 – 2.3	0.032	2.2 x 2.2'
	NIRCam*	2.4 – 5.0	0.065	2.2 x 2.2'
	NIRISS	0.9 – 5.0	0.065	2.2 x 2.2'
	MIRI*	5.0 – 28	0.11	1.23 x 1.88'
Aperture Mask Interferometry	NIRISS	3.8 – 4.8	0.065	-----
Coronography	NIRCam	0.6 – 2.3	0.032	20 x 20"
	NIRCam	2.4 – 5.0	0.065	20 x 20"
	MIRI	10.65	0.11	24 x 24"
	MIRI	11.4	0.11	24 x 24"
	MIRI	15.5	0.11	24 x 24"
	MIRI	23	0.11	30 x 30"

# JWST Spectroscopy Modes

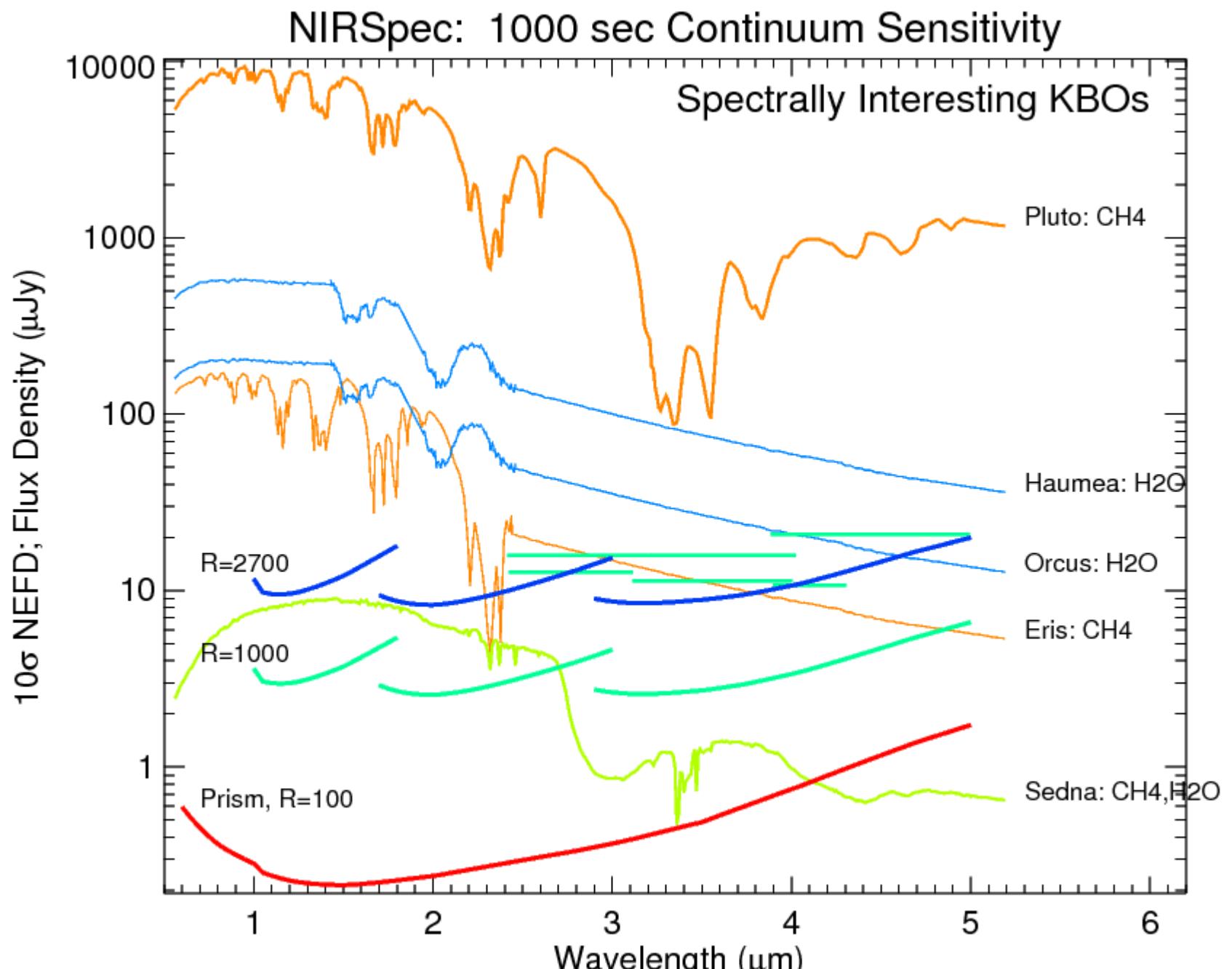
<b>Mode</b>	<b>Instrument</b>	<b>Wavelength (microns)</b>	<b>Resolving Power (<math>\lambda/\Delta\lambda</math>)</b>	<b>Field of View</b>
Slitless Spectroscopy	NIRISS	1.0 – 2.5	150	2.2' x 2.2'
	NIRISS	0.6 – 2.5	700	single object
	NIRCam	2.4 – 5.0	2000	2.2' x 2.2'
Multi-Object Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.4' x 3.4' with 250k 0.2 x 0.5" microshutters
Single Slit Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	slit widths 0.4" x 3.8" 0.2" x 3.3" 1.6" x 1.6"
	MIRI	5.0 – ~14.0	~100 at 7.5 microns	0.6" x 5.5" slit
	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.0" x 3.0"
Integral Field Spectroscopy	MIRI	5.0 – 7.7	3500	3.0" x 3.9"
	MIRI	7.7 – 11.9	2800	3.5" x 4.4"
	MIRI	11.9 – 18.3	2700	5.2" x 6.2"
	MIRI	18.3 – 28.8	2200	6.7" x 7.7"

# Science Operations Design Reference Mission (SODRM)



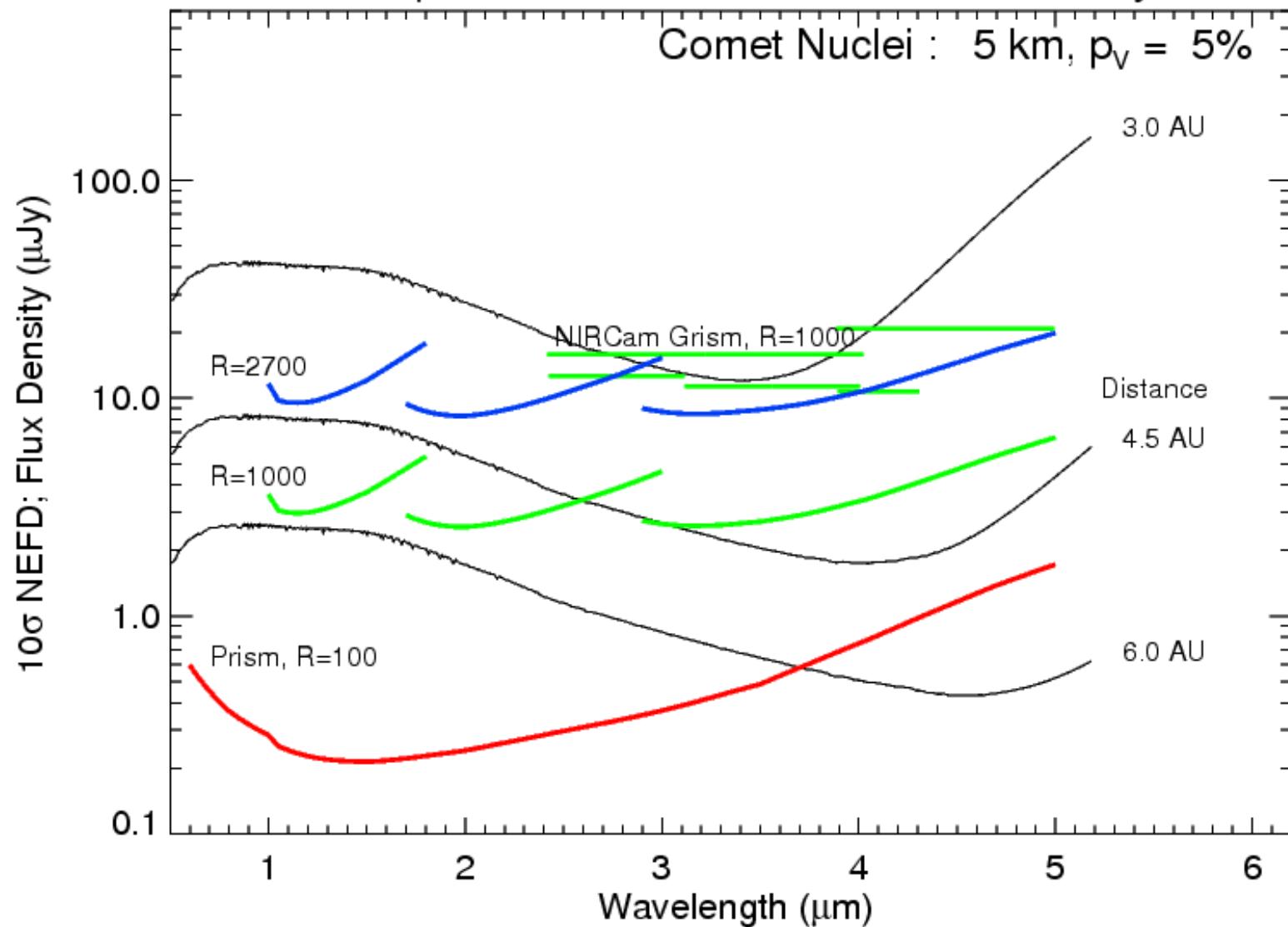
112 programs → 1.78 years total  
*Wall-Clock* time  
→ 70 science, 42 calibration

1. Asteroids – NIRSpec & MIRI slit spectroscopy
2. Bright Comets – NIRSpec & MIRI IFU, NIRCam imaging
3. Ice Giants – NIRSpec & MIRI IFU, NIRCam, MIRI Imaging
4. Icy Dwarf Planets – NIRSpec spectroscopy, MIRI 25 $\mu$ m imaging
5. KBOs – NIRSpec slit spectroscopy, NIRCam & MIRI imaging
6. Mars – NIRSpec & MIRI IFU spectroscopy
7. Outer Planet Satellites – NIRSpec & MIRI slit spectroscopy
8. Periodic Comets – NIRSpec & MIRI slit spectroscopy

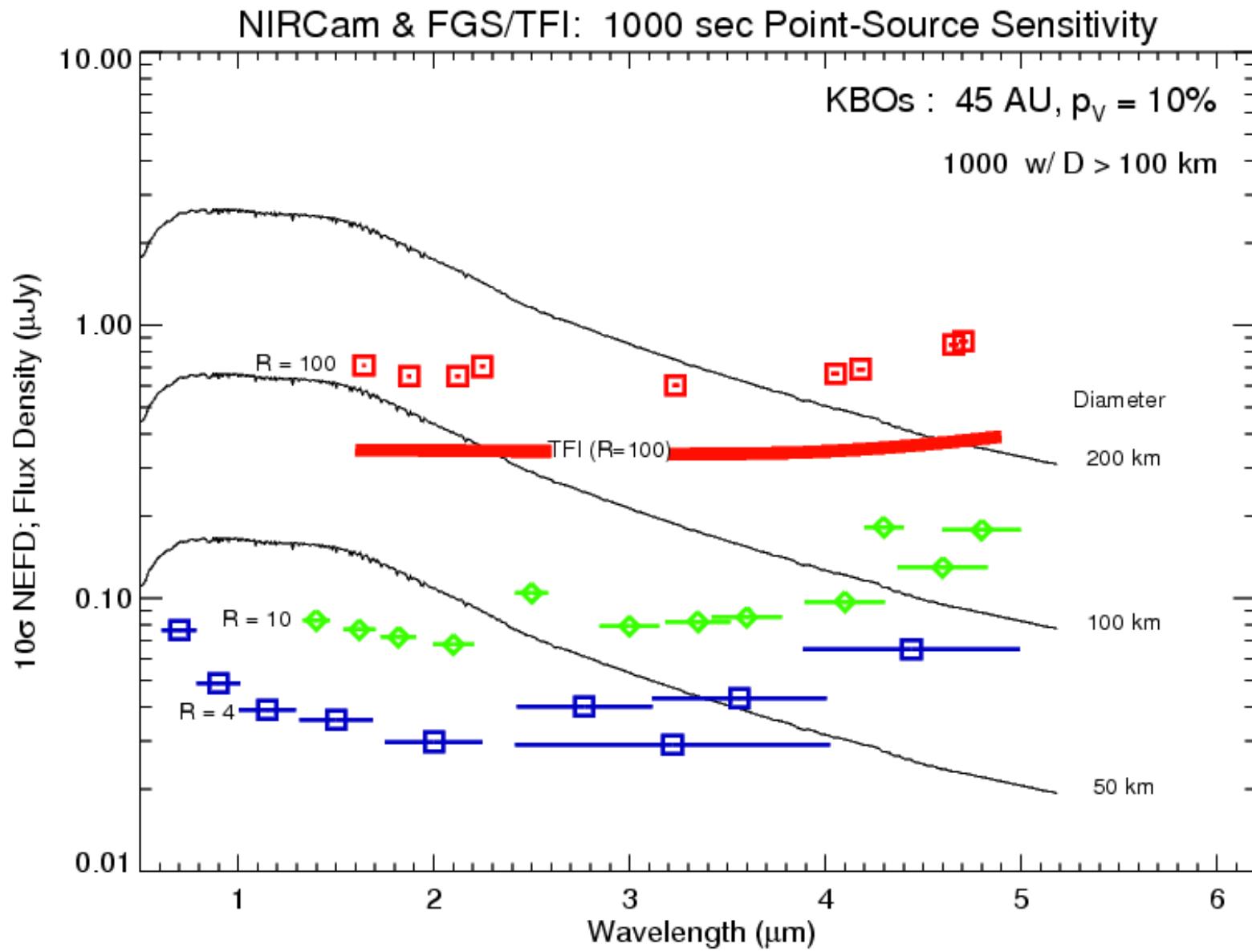


# Near-IR Comet Spectra

NIRSpec: 1000 sec Continuum Sensitivity

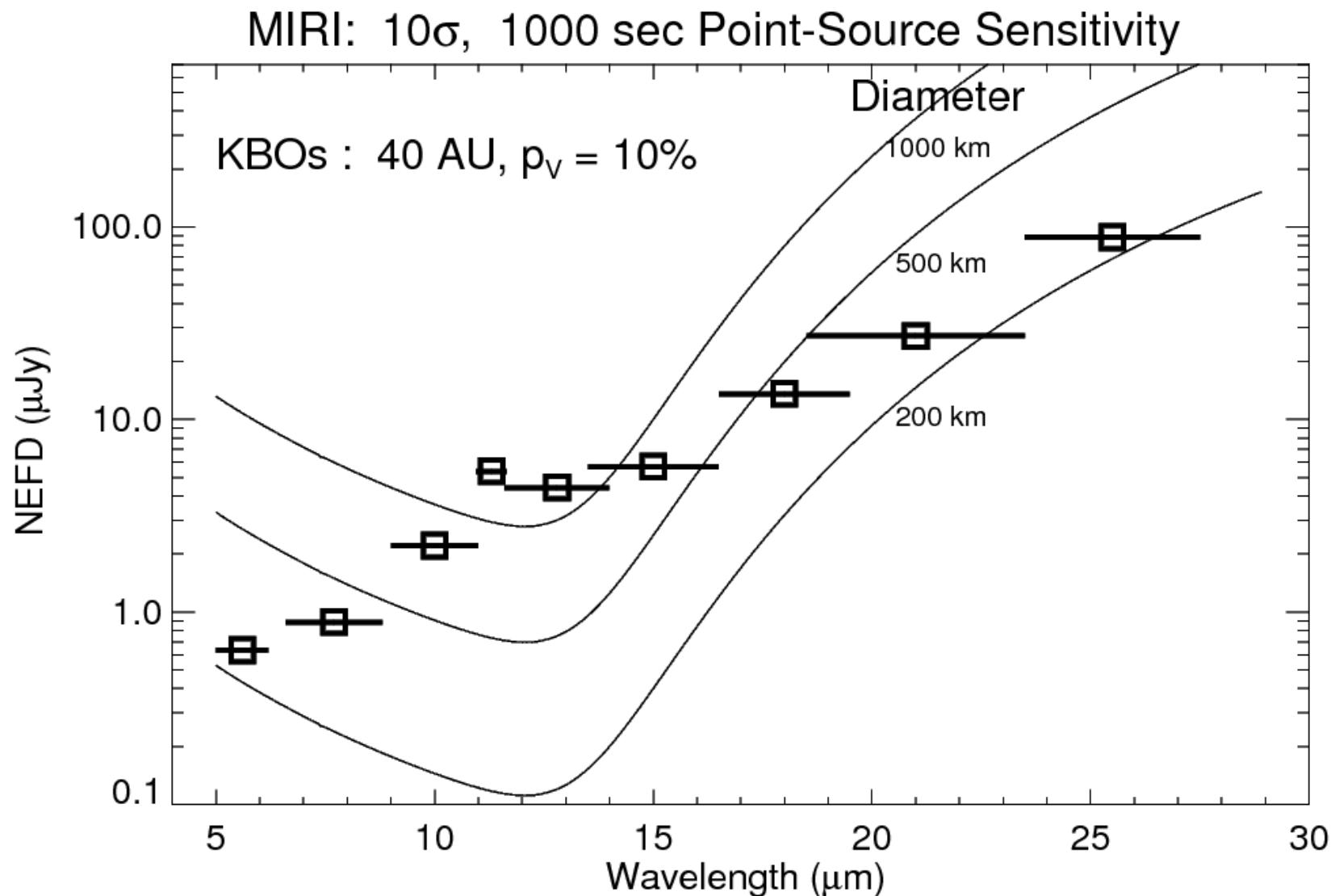


# NIRCam: 1 – 5 micron Colors of Small TNOs



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# MIRI Photometry: TNOs

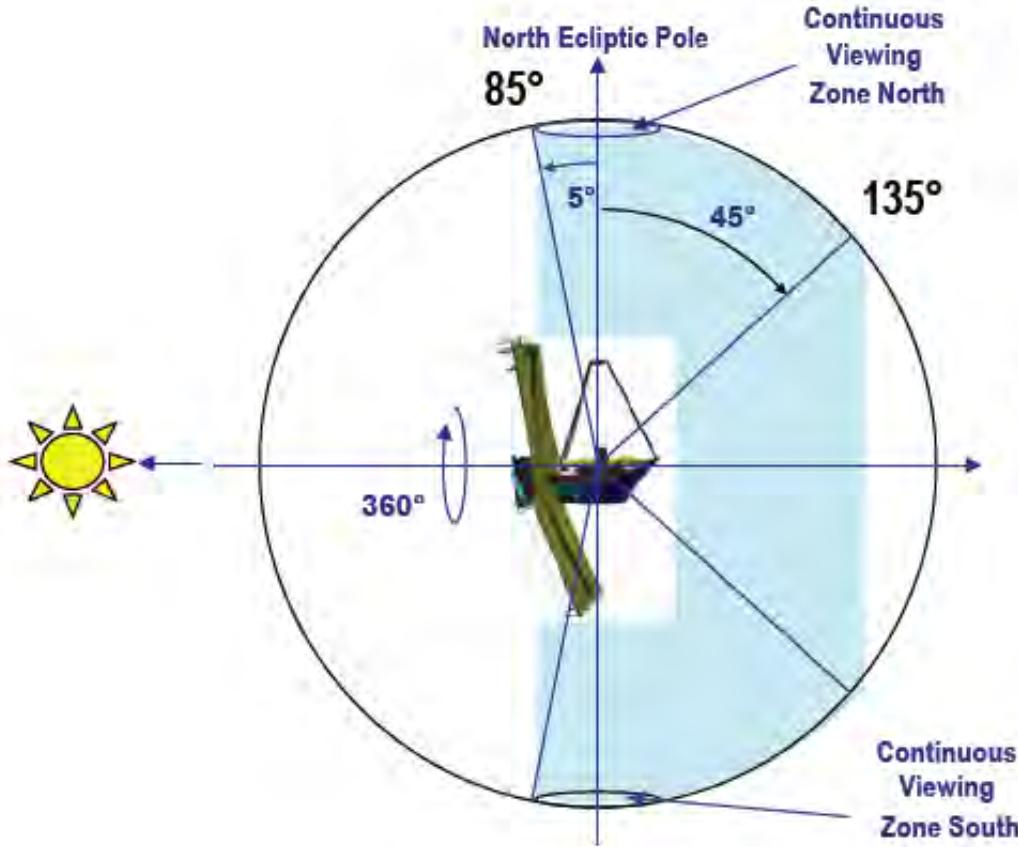


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# JWST solar system capabilities

- HST (or better) angular resolution at longer wavelengths
  - diffraction limited 6.5 telescope at 2  $\mu\text{m}$
- Zodi background limited imaging sensitivity for  $\lambda < 12 \mu\text{m}$ 
  - faint objects like KBO's, asteroids, satellites of Pluto, planetary rings
- Full coverage from 0.6 to 28  $\mu\text{m}$  with imaging *and* spectroscopy,  $R = \lambda/\Delta\lambda = 3000$  (chemistry and physics)
- Follows ephemeris up to at least 0.03 arcsec/sec for moving targets
  - Nonlinear tracking (JPL/HORIZONS)
- Subarray readout modes for bright objects
- Can observe all planets and satellites except Mercury, Venus, Earth, and Moon (from 85 to 135 deg from Sun)

# Field of Regard



- Observatory thermal design defines the allowed Solar orientations
  - Solar elongation 85° to 135° (like Spitzer)
  - Roll  $\pm 5^\circ$  about line of sight
- JWST can observe the whole sky every year while remaining continuously in the shadow of its sunshield.
  - Field of Regard is an annulus covering 35% of the sky
  - The whole sky is covered each year with small continuous viewing zones at the Ecliptic poles



## James Webb Space Telescope Solar System

- ▶ JWST Overview
- Community Advice
- ▼ Science
  - JWST Science
  - Goals
  - Data Simulation Resources
  - SODRM
  - White Papers
  - Science Planning Timeline
- ▶ Optical Telescope Element
- ▶ Instruments
- ▶ Operations
- Software Tools
- Document Archive
- Glossary
- Meetings
- JWST Community Input Wiki

### Planning your Solar System Observations with JWST

The JWST team participated in the Division for Planetary Sciences Annual Meeting in Reno on October 14-19th, 2012. In addition to our booth presence, we organized a special workshop titled "Planning your Solar System Observations with JWST". This workshop took place from 9 am to noon on Sunday October 14th, and was attended by 50 DPS members. We discussed topics such as moving target capabilities, bright observing modes, imaging and spectroscopic sensitivities for Solar System objects, and much more. Lots of new ideas emerged at the workshop and we have noted these down and will begin evaluating after the DPS meeting. The seven presentations that were given at the meeting are all linked below.



**Division for Planetary Sciences**  
of the  
**American Astronomical Society**

1. Opening Remarks and Schedule [¶](#)
2. Proposing for HST time [¶](#)
3. JWST Observatory, Instrument Modes, and Specs [¶](#)
4. JWST Brightness Limits [¶](#)
5. Operations Concepts for Moving Target Observations with JWST [¶](#)
6. Solar System Science in the JWST Science Operations Design Reference Mission [¶](#)
7. Summary, Closing Thoughts, and Next Steps [¶](#)

The three JWST Solar System flyers that were presented at the meeting are also available here, as well as the FAQ sheet. [¶](#)

1. JWST Observations in the Solar System [¶](#)
2. JWST Observations of Dwarf Planets [¶](#)
3. NIRSpec and MIRI Observations of Asteroids [¶](#)

More information about the [AAS Division for Planetary Sciences Annual Meeting](#) [¶](#)

# 44<sup>th</sup> Lunar and Planetary Science Conference

March 18-22, 2013  
The Woodlands, Texas

- Peripheral Meeting Request
  - Sunday, March 17 (afternoon)
  - Same format as DPS
  - Targeted Invite List

# Extra Slides

# SODRM 2012 by Category



# NIRSpec: and Smaller TNOs too...

