Antarctic Astronomy

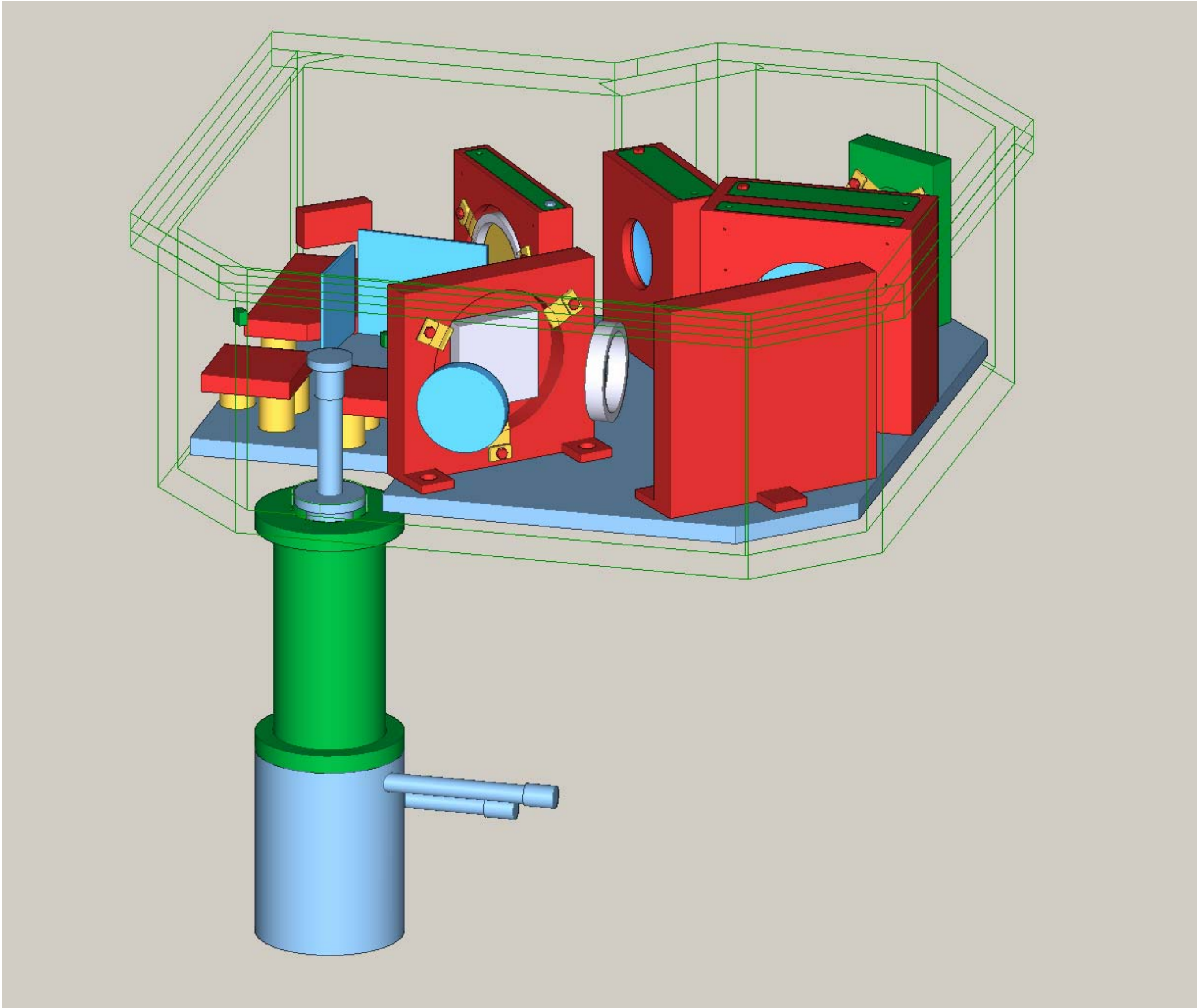
Antarctic Infrared Astronomy

AIR-T-40
40 cm Antarctic Infra-Red Telescope

Overview

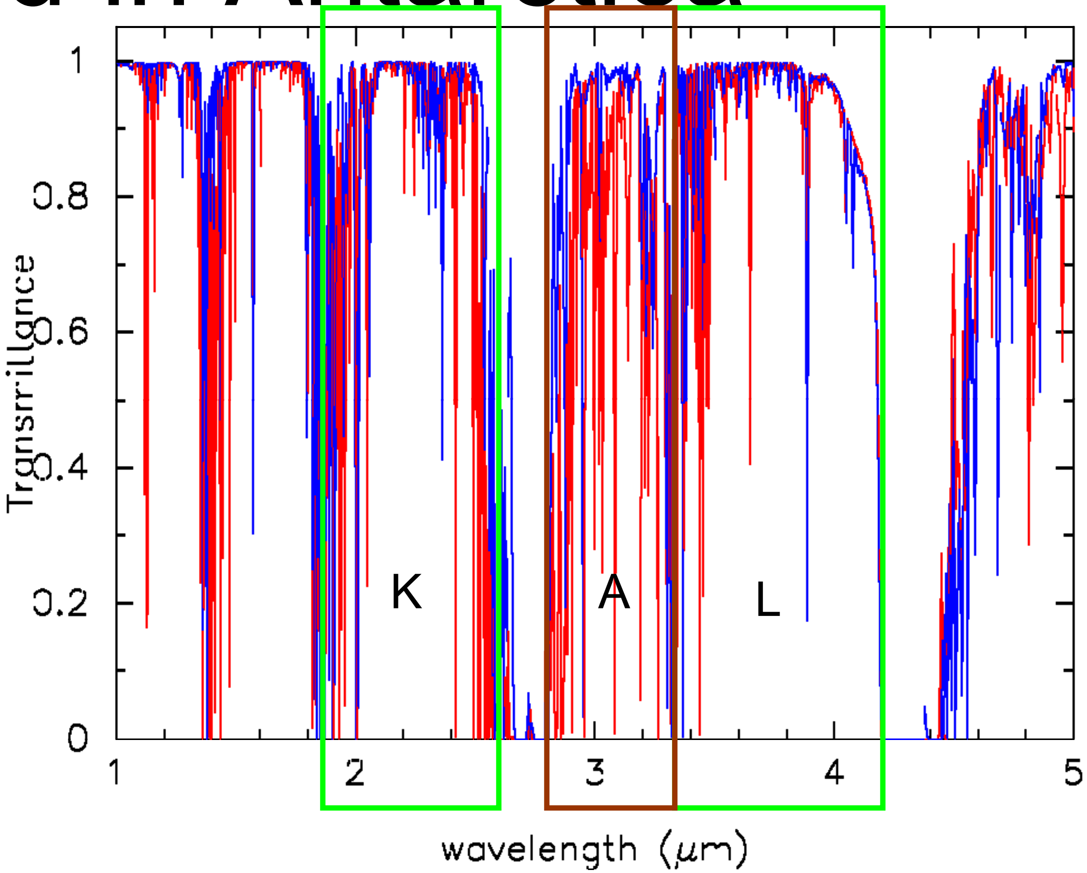
- AIR-C
  - Predicted Performance
- Science Potential for AIR-T-40
  - Space Debris
  - Planets
- Pre-Antarctic observations: Tohoku-Hiroshima-Nagoya Planet Spectra Library (THN-PSL)

AIR-C: Antarctic Infra-Red Camera



Infra-Red in Antarctica

- K & L Bands as clear as Mouna Kea
- New 2.7—3.3 μm Antarctic Band

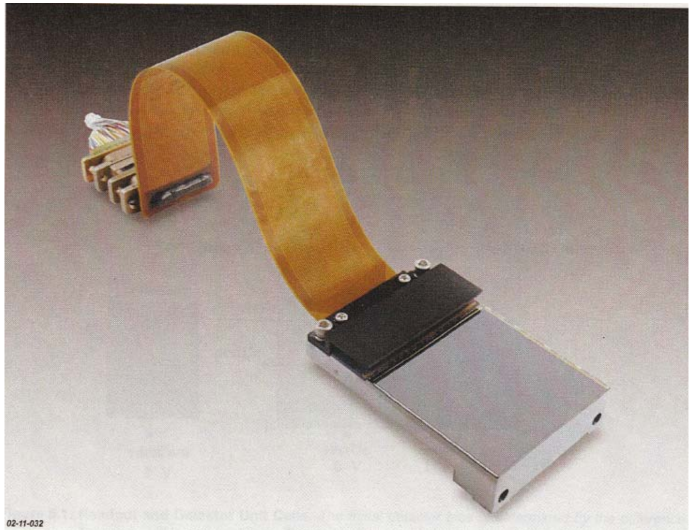


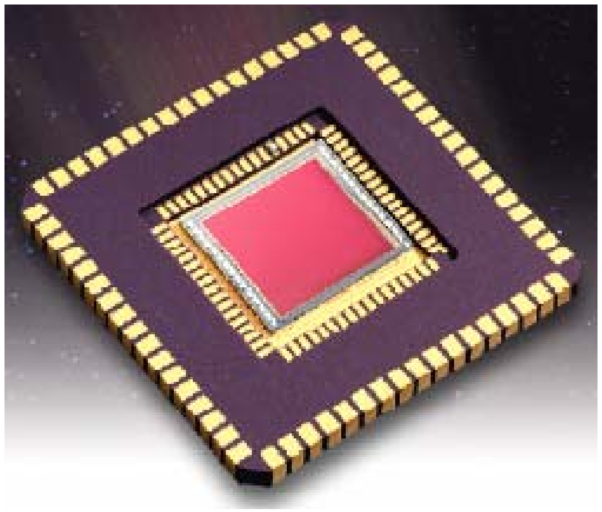
		altitude	temperature	PW
blue	Dome Fuji	3810m	-70℃	0.2mm
red	Mouna Kea	4200m	0℃	1.0mm

Detectors

VIRGO 2K Module	
Parameter	Specification
Pixel Size	20 x20 μm
Array Configuration	2048x2048 or 4,194,304 elements
Detector Type	SWIR HgCdTe (any p-on-n polarity detector)
Wavelength Range	0.9-2.5 μm
Quantum Effecency	>70%
Operating Temperature	80K (nominal)
Dark Current	<1 e-/second

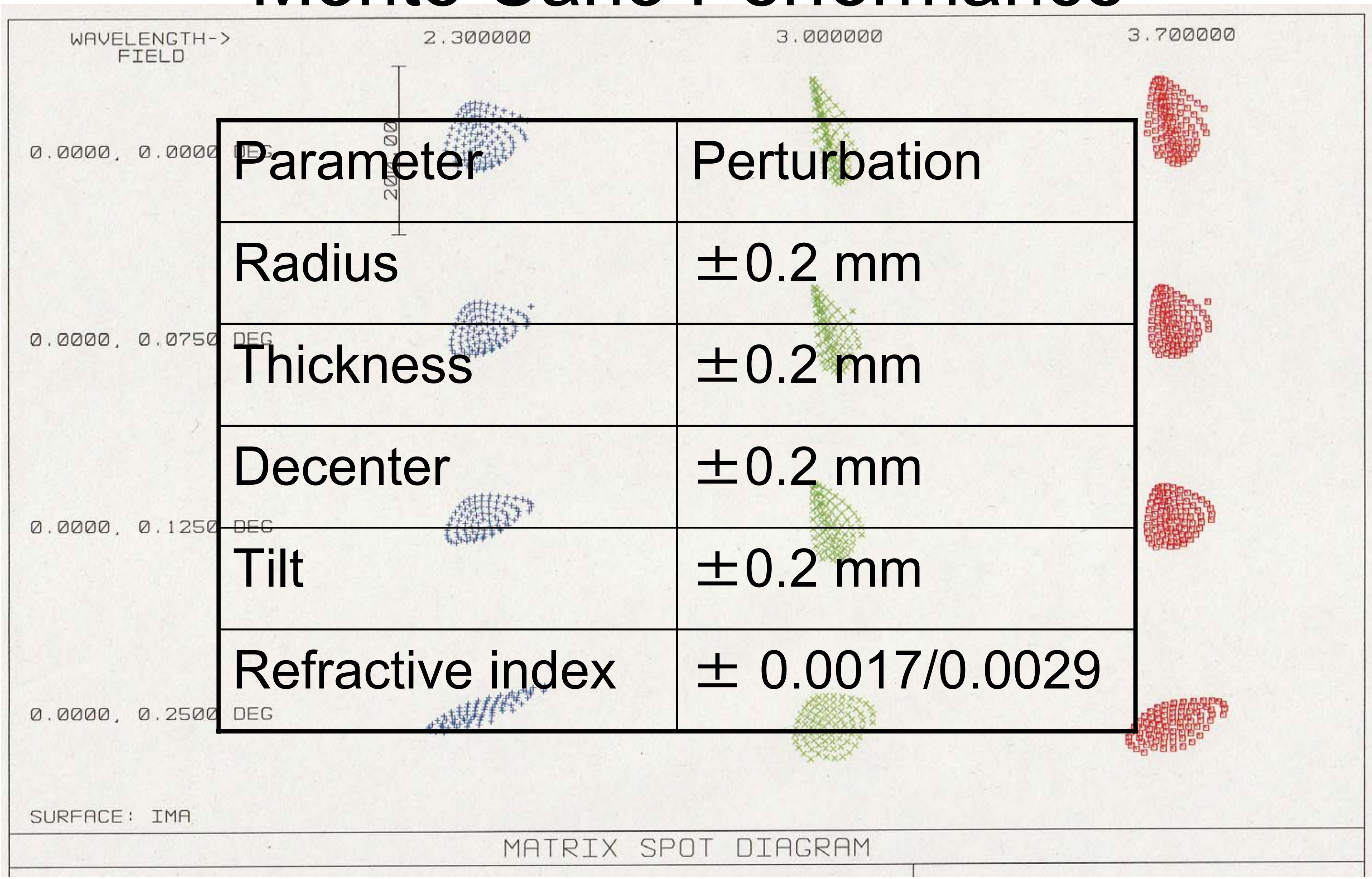
Raytheon 256X256 InSb Detector (x2)	
Parameter	Specification
Pixel Size	30 x30 μm
Array Configuration	256x256 or 65,536 elements
Detector Type	InSb
Wavelength Range	0.6 -5 μm
Quantum Effecency	>80%
Operating Temperature	30K
Dark Current	0.01 e-/second





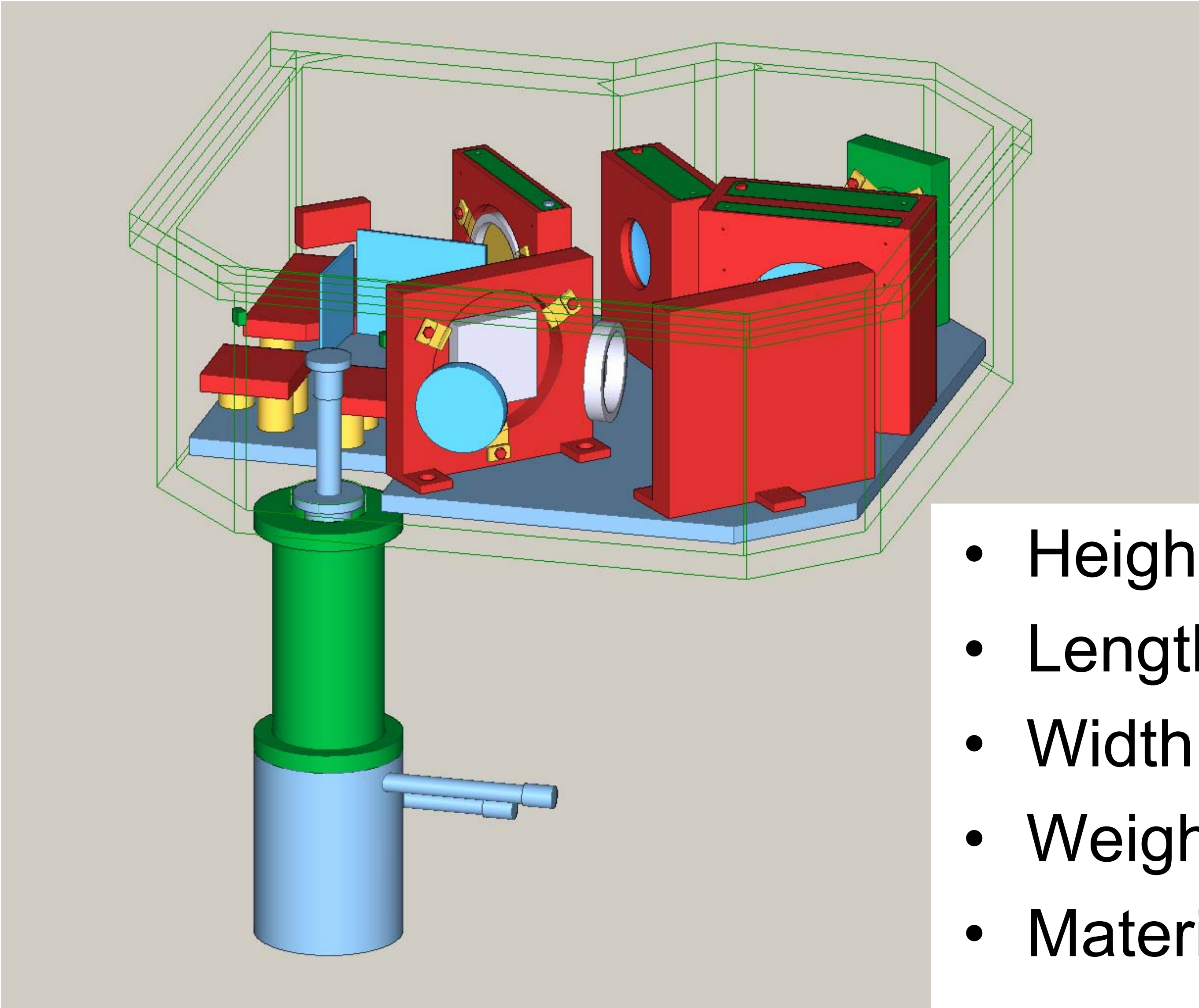
Typical
Monte Carlo Performance

Parameter	Perturbation
Radius	±0.2 mm
Thickness	±0.2 mm
Decenter	±0.2 mm
Tilt	±0.2 mm
Refractive index	± 0.0017/0.0029

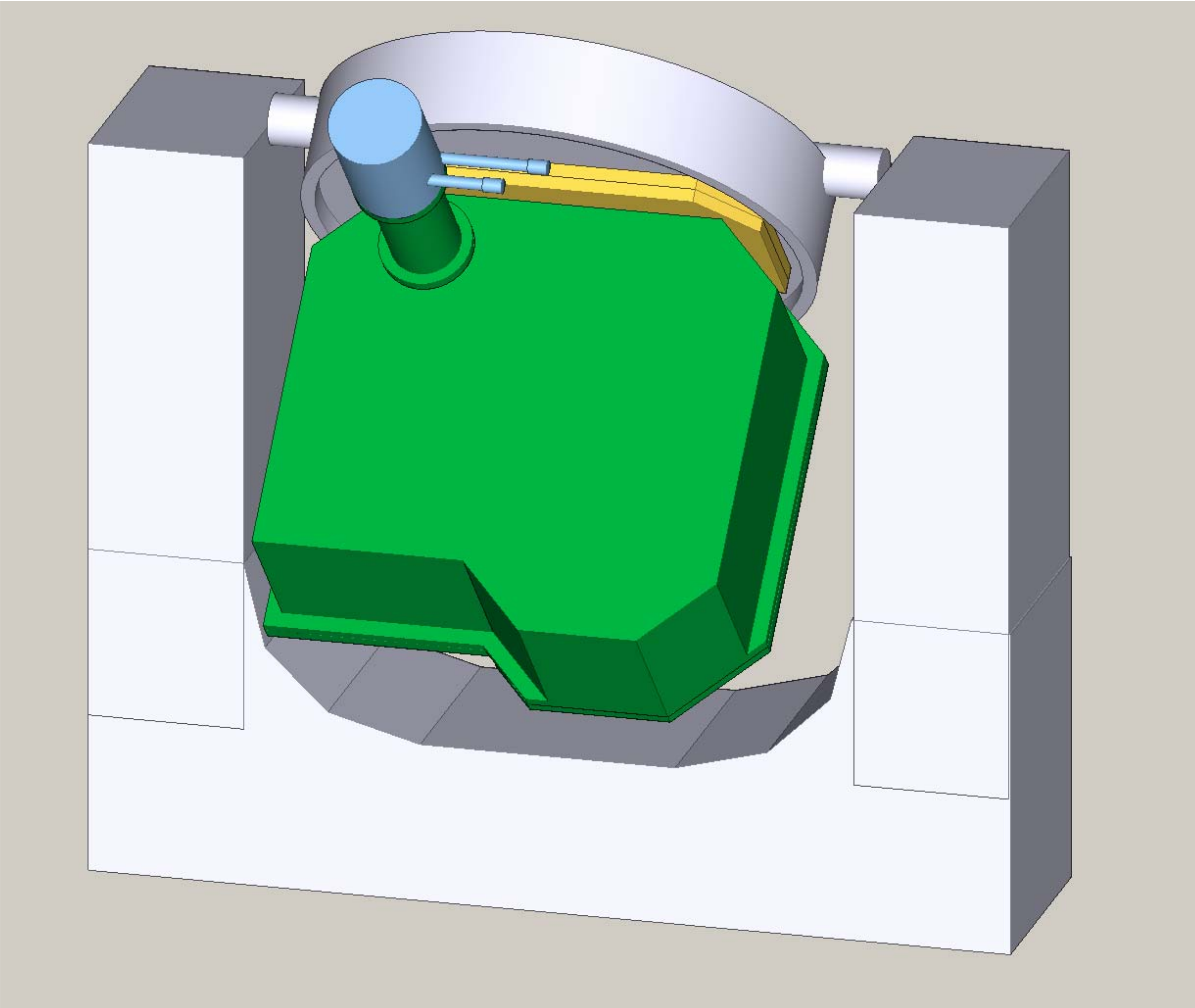


Toleranced Spot Size (70% Encircled Energy)				
	Field of View Angle			
Wavelength	0'	4.5'	7.5'	15'
2.3	29.3	28.9	28.4	32.4
3.0	26.9	26.8	27.4	30.6
3.7	33.7	36.0	39.0	51.0

Cryostat



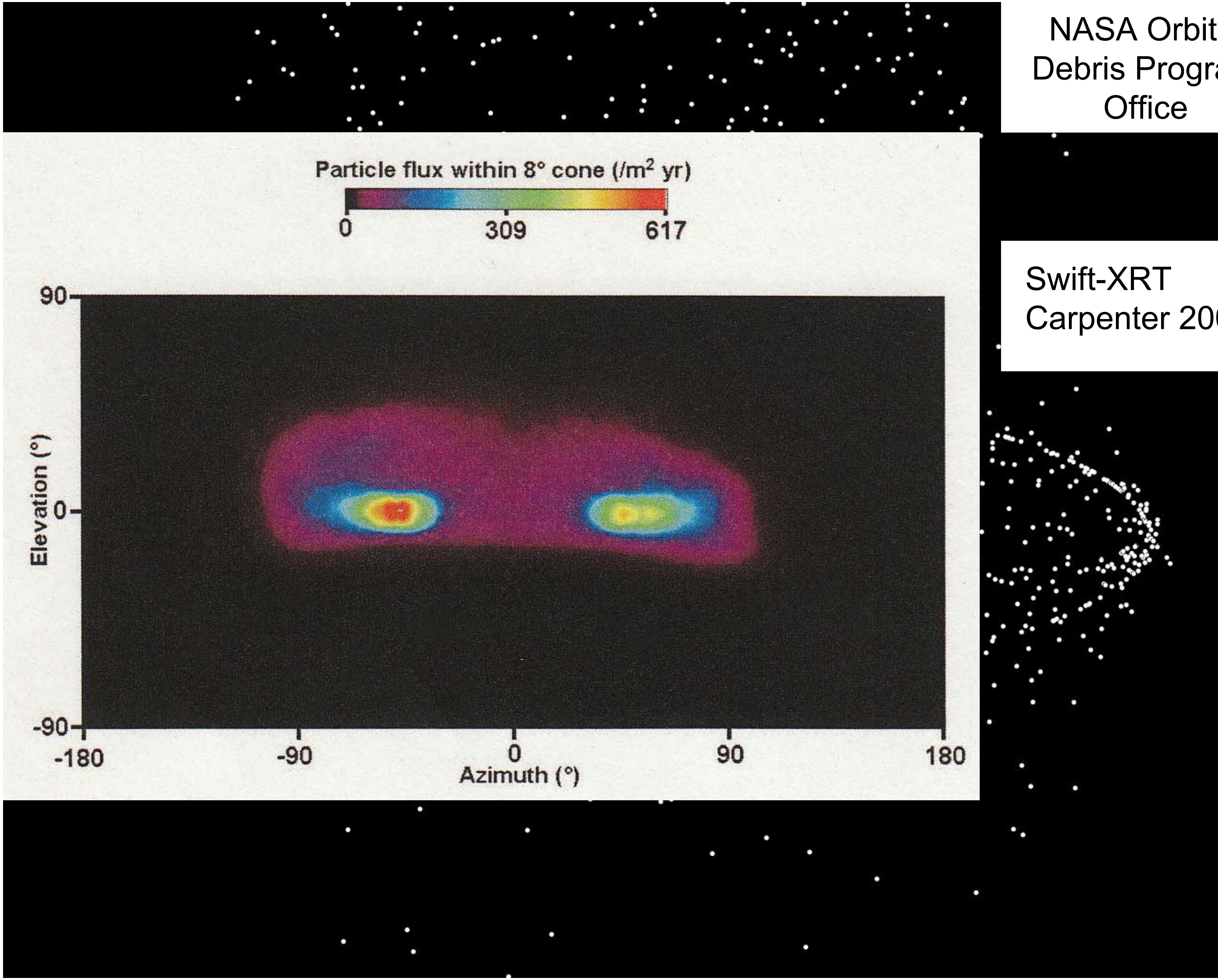
- Height: 160 mm
- Length: 414 mm
- Width: 438 mm
- Weight: <31 kg
- Material: Aluminum



Future Work

- Construction
- Spectroscopy Mode
- Antarctic Observations

Science Potential for AIR-T-40



NASA Orbital Debris Program Office

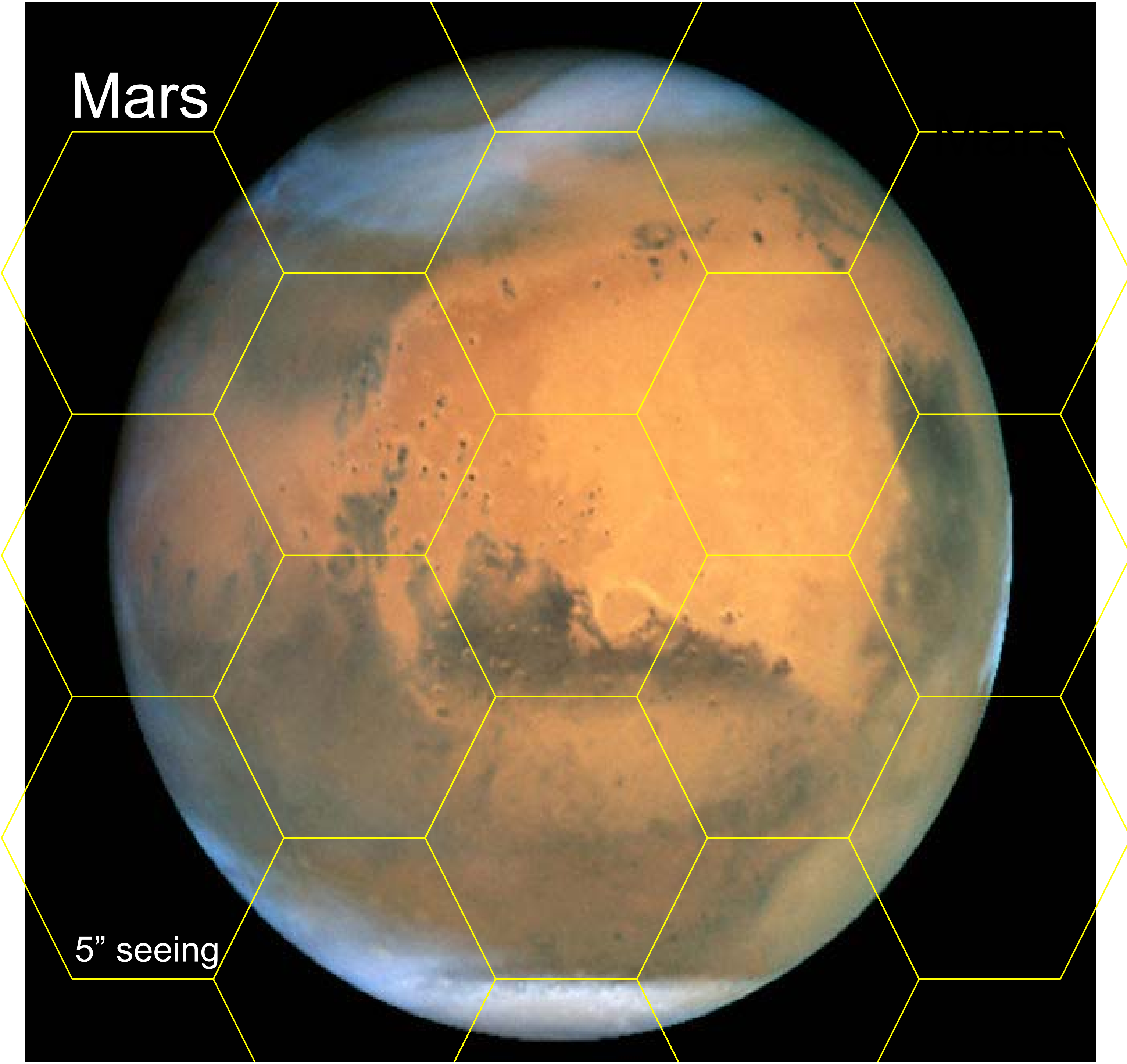
Swift-XRT Carpenter 2008

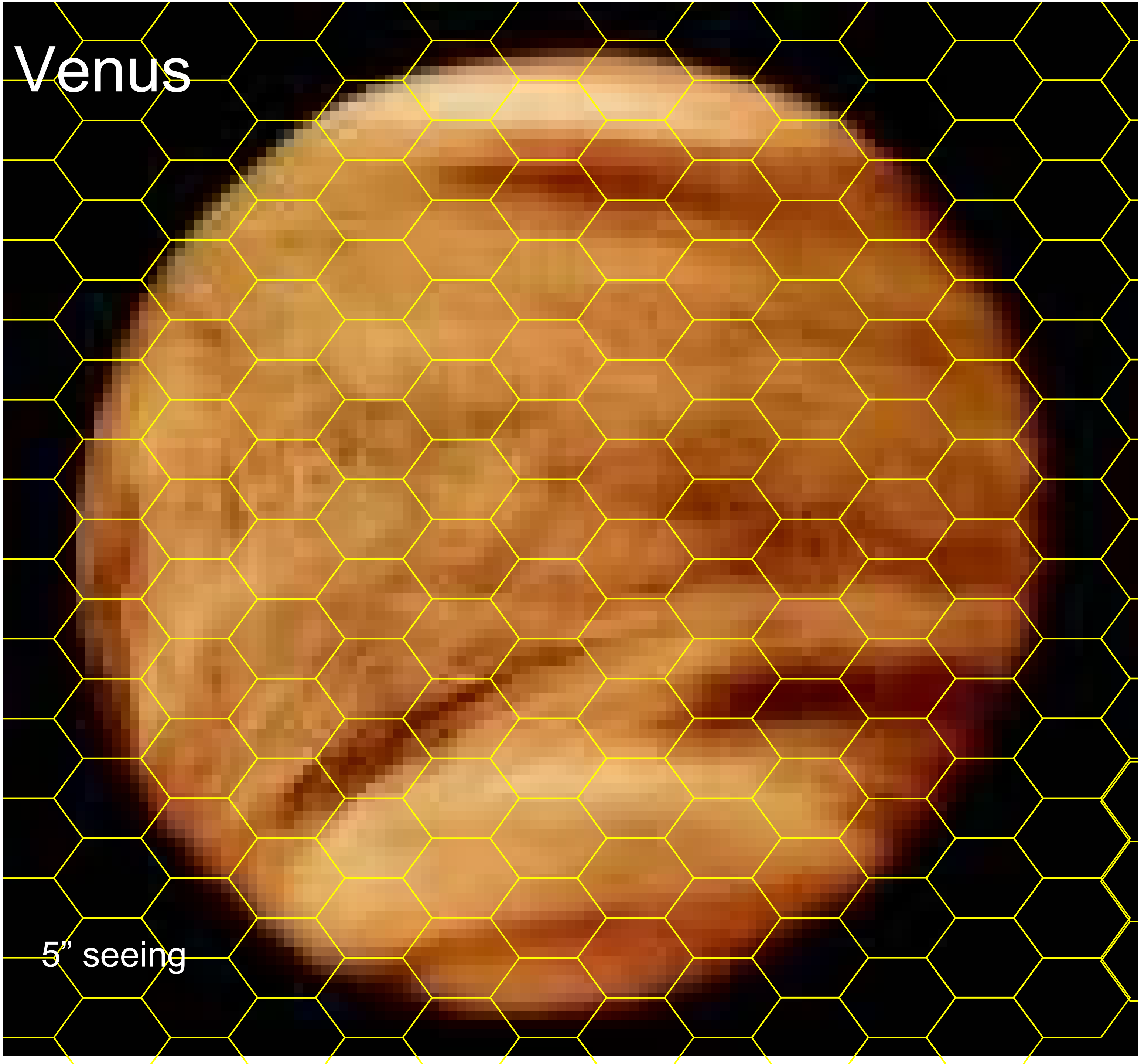
How Much Unknown Debris is there?

- In 2007 “The International Scientific Optical Network for Space Debris Research” found 288 previously unknown pieces of space debris. (Molotov 2008).
- The loss of the Indium satellite on Jan 12 proves the dangers of space debris and created two new clouds of 100s of pieces of debris.

Science Observations

- Planets exhibit spectral variations in time
  – Rotation
  – 5 day Superrotation of Venus's Atmosphere
  – Seasonal variations of Martian Atmosphere
- Earth's own rotation makes tracking these changes difficult
- From Dome Fuji the planets are visible continuously for months


Mars
5” seeing


Venus
5” seeing

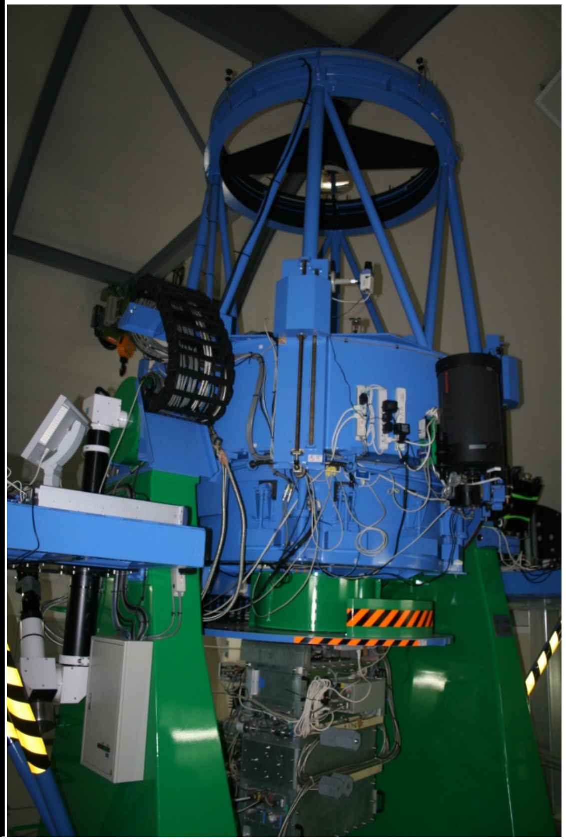
A-Band Spectrography Targets

	Composition Notes	λ	Spectrum Notes	Example Objects
H_2O	Ice	3.5		Saturn's Rings
H_2O	Ice & Frost	3.1	Fresnel Ice Peak	Hyperion
H_2O	Hydrated minerals	3		Ceres?, carbonaceous chondritic meteorites
H_2O	Vapor	3		Earth
H_2O	Ice	3.00		Dione, Iapetus, Mimas, Phoebe, Rhea, Tethys
H_2O	Ice & Frost	2.8-3.2		Dione, Rhea, Ganymede, Callisto, Rings, Ceres?
CH_4		3.31		Earth, Jupiter, Saturn
CO_2		2.98	Weak	Venus

Tohoku-Hiroshima-Nagoya Planet Spectra Library (THN-PSL)

TRISPEC observations @ East-Hiroshima Observatory May 2-13, 2008 NoV 19-27, 2008

Channel Name	Wave length (μ m)	Bands	Detector
OPT	0.45-0.9	B,V,R, I	512x512 SITe CCD
IR1	0.9-1.85	z, J, H	256x256 SBRC InSb
IR2	1.85-2.5	K	256x256 SBRC InSb



Observation Targets

Planets	May	Nov	Satellites	May	Nov
Mercury	11	X	Luna	11	21
Venus	X	20,26	Io	6	26
Earth	11	21	Europa	6	X
Mars	6	X	Ganymede	X	26
Ceres	11	25	Callisto	5	X
Jupiter	6	X	Saturn's Ring	6	19
Saturn	5	19,22	Dione	7	X
Uranus	7,11	20	Rhea	7	25
Neptune	12	20,25,26	Titan	6,7	24
Pluto	11	X			

Figure 2

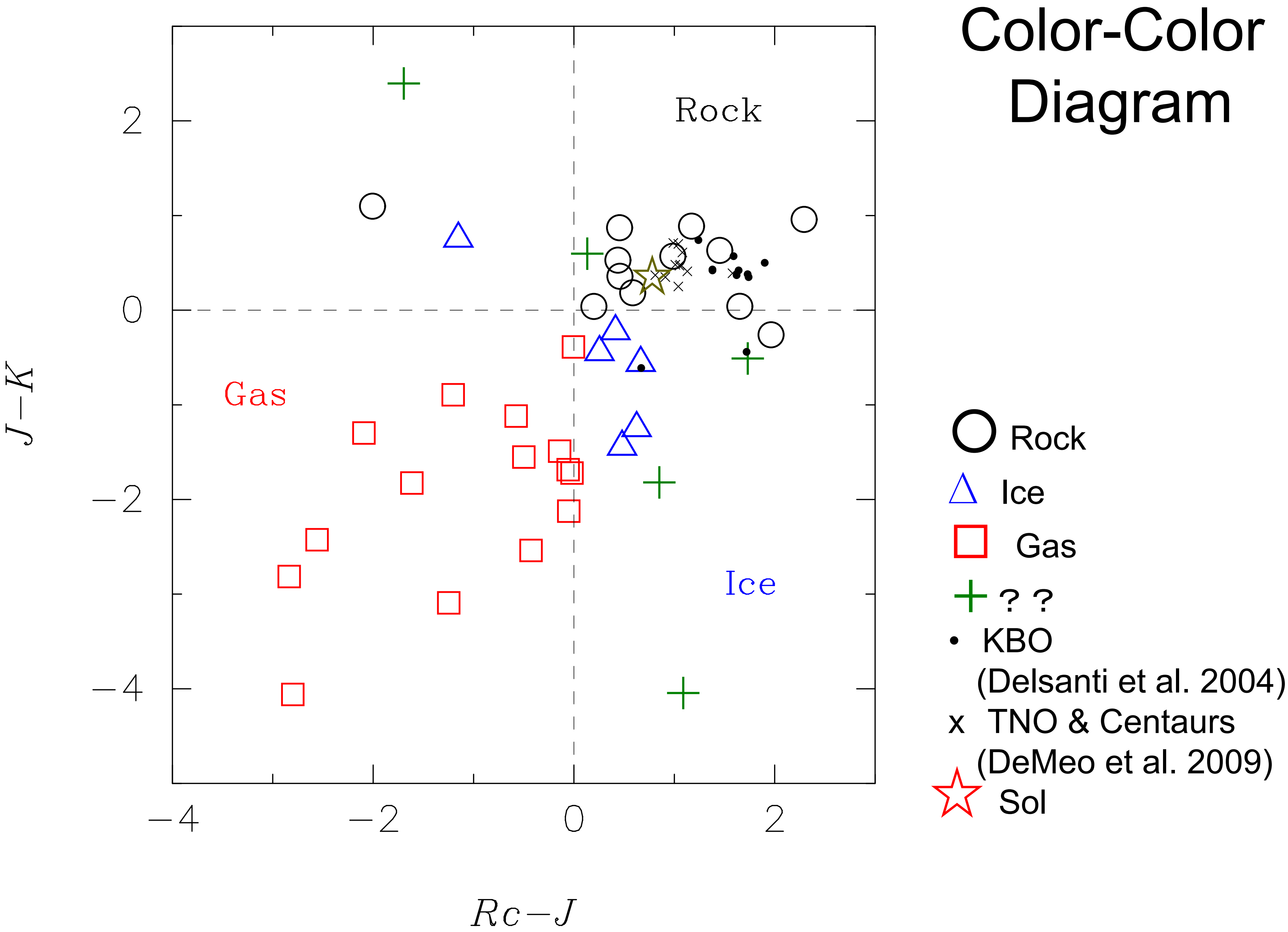
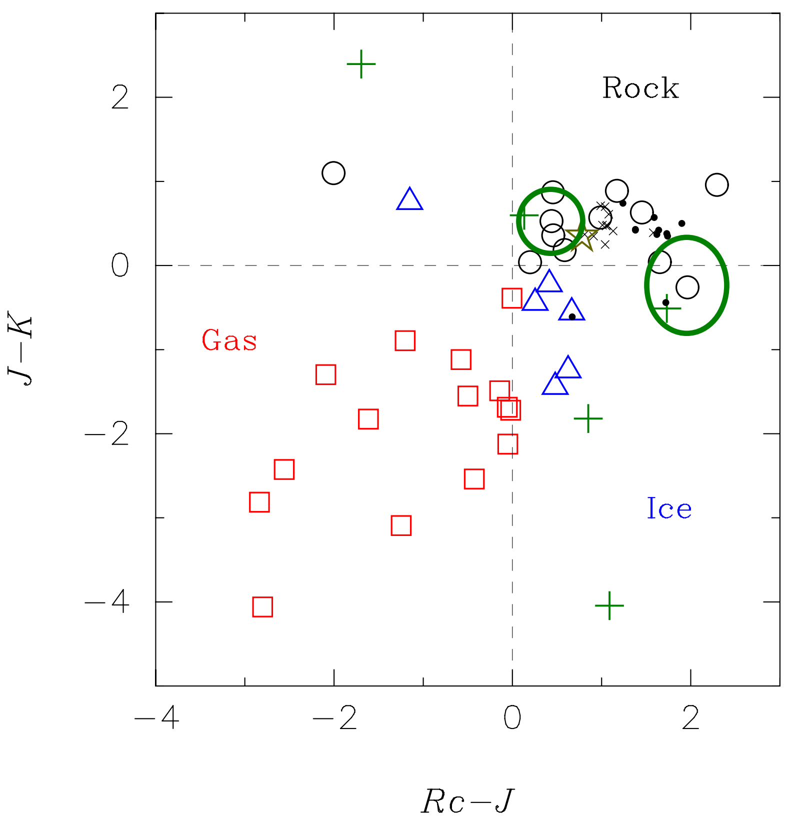
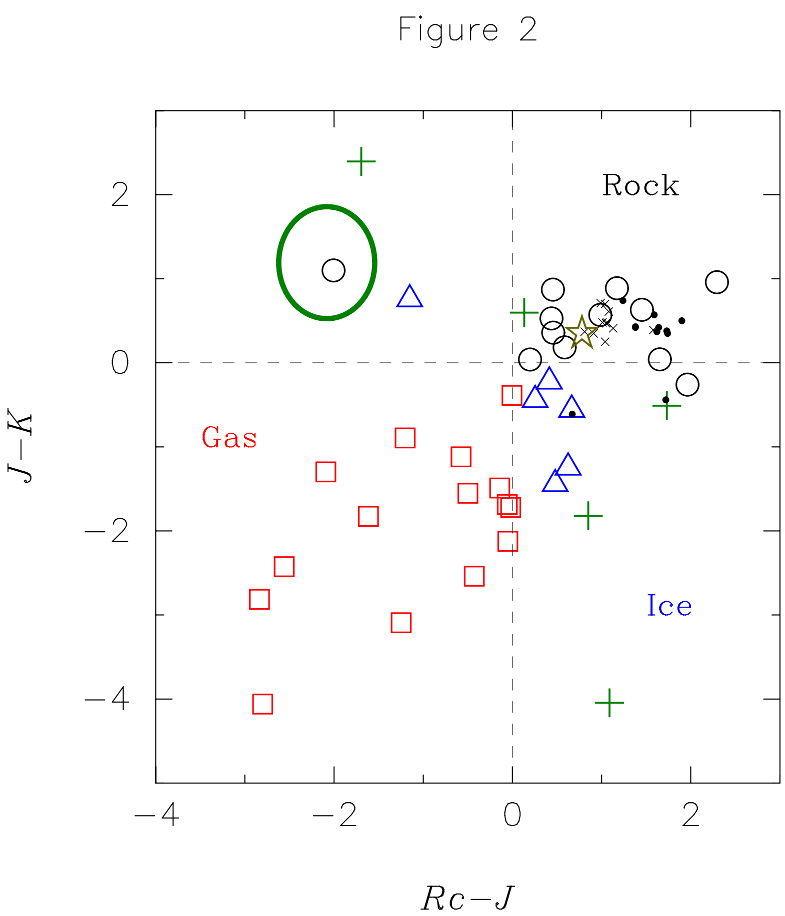

Color-Color
Diagram
Rock
Gas
Ice
2
0
−2
−4
J−K
−4
−2
0
2
Rc−J
Rock
Ice
Gas
? ?
KBO
(Delsanti et al. 2004)
x TNO & Centaurs
(DeMeo et al. 2009)
Sol

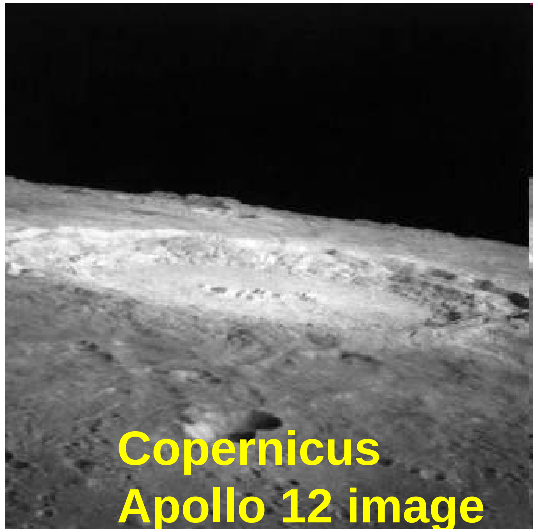
Figure 2



CERES

- In May Ceres was observed low in the Western sky just after dusk.
- In November observing conditions were better, spectrum cleaner, correctly identified as rock planet.

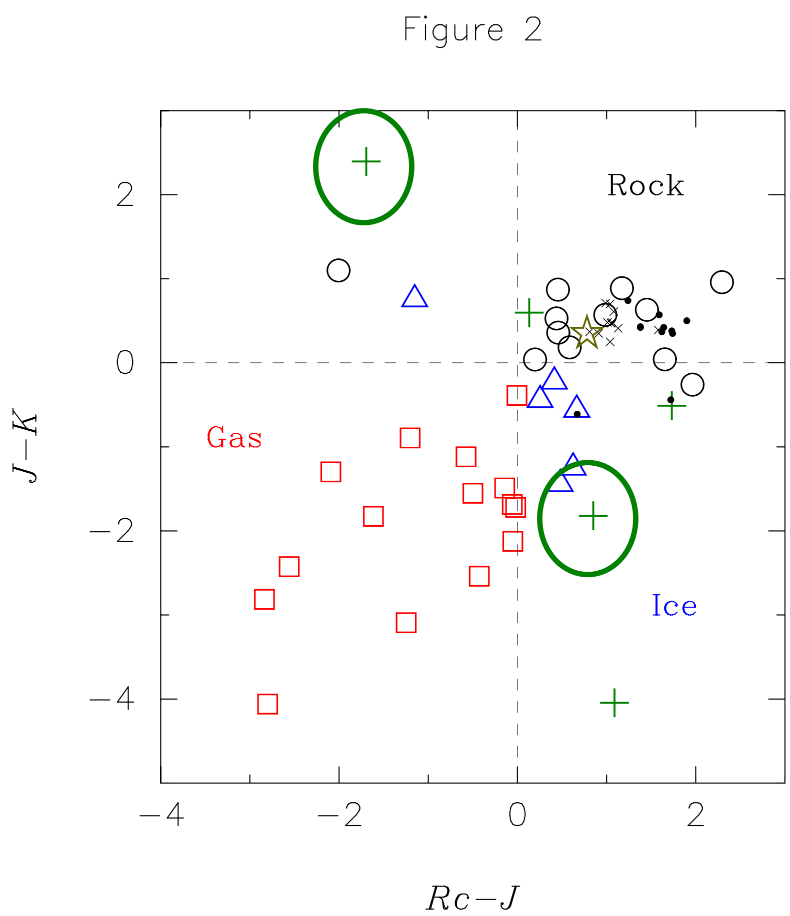




Luna (crater)

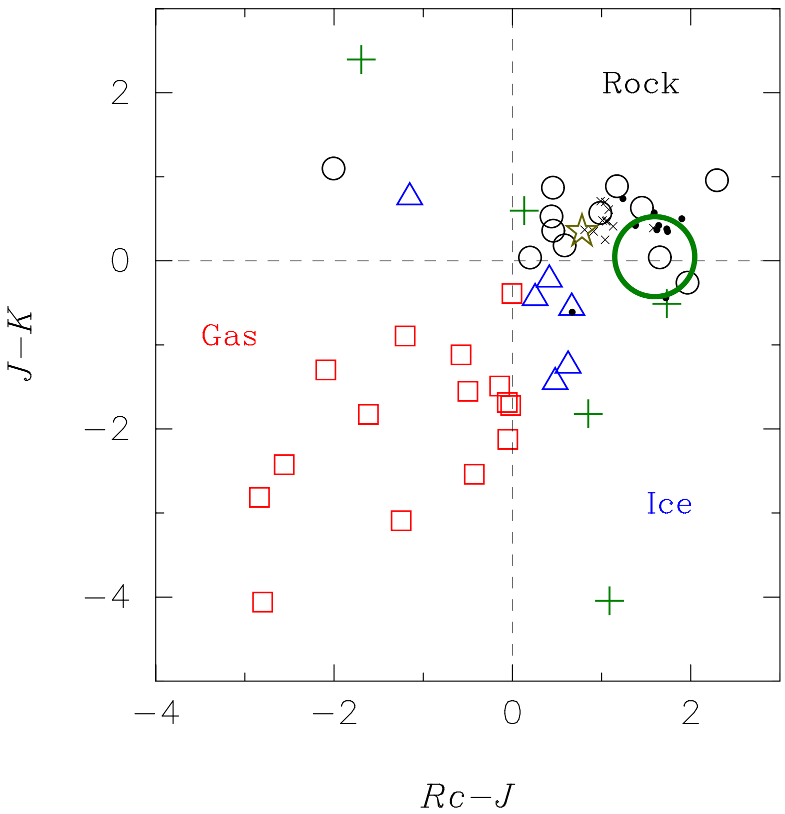
- Lunar craters contain bright, young material.
- Space weathering, particularly sediment accumulation will ‘redden’ the spectra.
- As the crater weathers it will move right on the diagram.

Venus



- Venus surface not visible.
- Distinguishing from ice planets requires distinguishing CO2 absorption lines (1.4, 1.6, 2.0 μm) from ice absorption lines (1.55, 1.65, 2.0 μm)
- Possible 4th class: Rayleigh planets

Figure 2



Galileo probe image

Ganymede

- Ganymede's surface is primarily ice, but we classify it as a Rock Planet.
- Ganymede has a large rocky core, evidence for volcanoes.
- Surface is dirty ice contaminated with dark (Fe rich?) material not found on other ice moons.
- Surface particles direct result of rock core?