Plans to observe Comet Siding Spring from Mars with CRISM

Dave Humm, Andy McGovern, Scott Murchie, and the CRISM Team

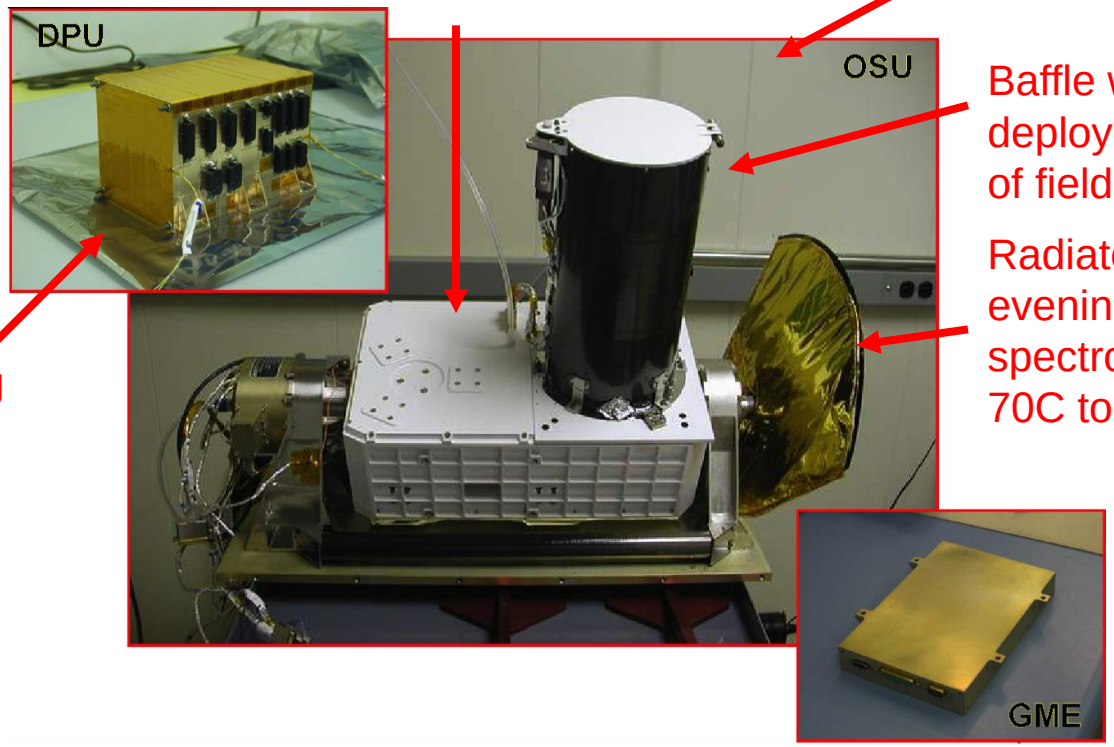
Comet Siding Spring Workshop

9/19/2014

CRISM

3 cryocoolers keep IR detector at 110-125K to control noise

Optical Sensor Unit



Baffle with 1-time deployed cover cuts out of field stray light

Radiator pointing toward evening terminator cools spectrometer optics to -70C to -80C

Data Processing Unit controls data acquisition, pixel binning, data editing

Wavelength range	0.4-3.9 µm
Spectral sampling	6.55 nm/channel
Spatial sampling	60 µrad/pixel
Aperture diameter	100 mm

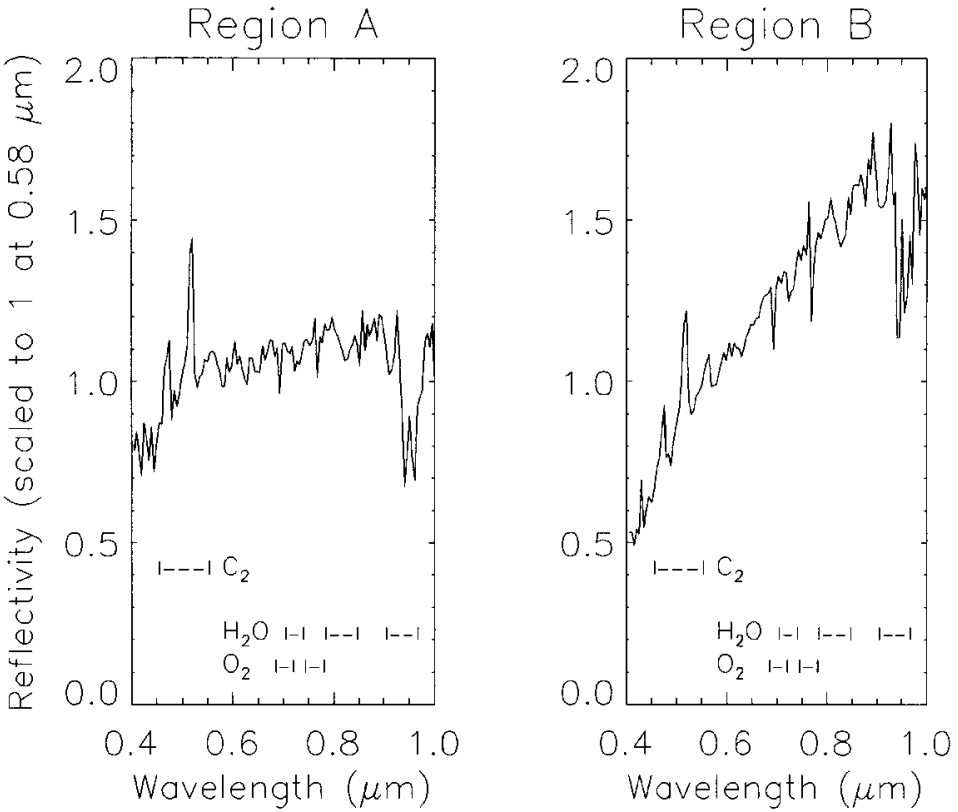
Imaging Spectrometer

- CRISM entrance slit is 2 degrees long
- CRISM always scans to get 2-dimensional images
- If CRISM sees a spectral feature
  - CRISM can make an image in just that spectral feature
  - Can also select an image region and sum pixels for full spectrum with better SNR
- Cometary coma
  - Can make an image in any visible emission line
  - Can make an image in reflection at any wavelength
  - If a feature such as a jet is dim, can sum over area of jet and generate spectrum of jet with better SNR

VNIR coma spectra 0.4-1.0 µm

- For estimated brightest pixel or summed pixels
- Good potential CRISM full resolution spectra
- Possible species in emission or absorption
  - C2 0.52, 0.78 microns
  - C3 0.40 microns
  - H2O 0.72, 0.82, 0.94 microns
  - CN 0.39, 0.79 microns
  - NH2 0.57 microns
  - O2 0.69, 0.760 microns
- IR 1.0-3.9 µm 2-3 orders of magnitude lower SNR

Hale-Bopp, Belucci 1999

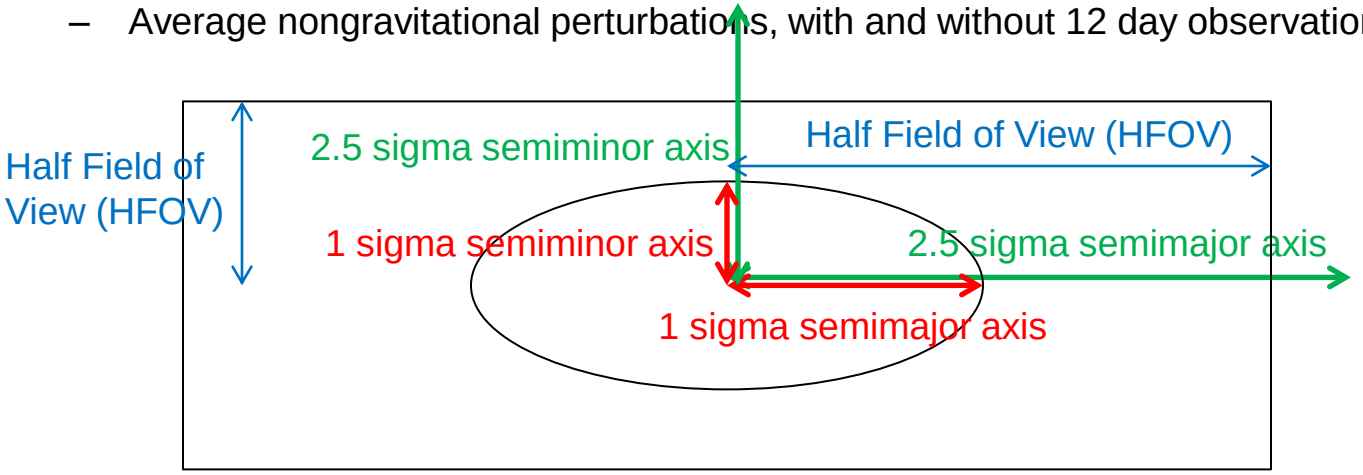


CRISM observing plan

- Test observation of star finished August 6
  - Pointing and commanding successful
  - SNR approximately as expected
- MRO orbit with closest approach to comet (~140000 km)
  - 2 images FOV 10x35 milliradians (~1400x4900 km)
  - 1 image FOV 10.5x35 milliradians (~1500x4900 km)
- Closest approach +-1 orbits (~300000 km)
  - 2 images each FOV 7x35 milliradians (~2100x10500 km)
  - 1 image each FOV 6.5x35 milliradians (~1900x10500 km)
- Closest approach +-2 orbits (~700000 km)
  - 2 images each FOV 6.5x35 milliradians (~4500x24500 km)
- Over +-60 hours from closest approach
  - 18 images with FOV 6.5x35 milliradians

Comet ephemeris uncertainty

- For observations near closest approach, there is a late pointing update
  - All Earth observations and HiRISE observation 12 days before closest approach
  - Use estimated uncertainties from “unc_sep17pptx”, D. Farnocchia
  - “conservative astrometric treatment” (generous allowance for Earth-based uncertainties)
  - “A1 between 0 and 2x10-8 (3σ)” most likely range of nongrav perturbations
  - HiRISE precision 1 microradian
- Two dimensional Gaussian probability function
  - 39% of cases fall within 1 sigma ellipse
  - 86% of cases fall within 2 sigma ellipse
  - 96% of cases fall within 2.5 sigma ellipse
  - Davide gives semimajor and semiminor axes, so compare with HFOV of images
- Compare 2.5 sigma downtrack and crosstrack with HFOV for cases
  - Average nongravitational perturbations, with and without 12 day observation



Comet ephemeris uncertainty versus CRISM and HiRISE HFOV

	HFOV or 2.5σ estimated comet ephemeris uncertainty (milliradians)			
	Without 12-day observation		With 12-day observation	
	downtrack	crosstrack	downtrack	crosstrack
CRISM HFOV CA orbit	5	18	5	18
HiRISE HFOV CA orbit	4	4	4	4
Grav only unc				
Avg nongrav unc	6.5	6.3	4.2	2.1
Extreme nongrav unc				
CRISM CA-1 orbit	3.5	18	3.5	18
HiRISE CA-1 orbit	2	3	2	3
Grav only unc				
Avg nongrav unc	2.9	3.3	1	0.8
Extreme nongrav unc				
CRISM CA+1 orbit	3.5	18	3.5	18
HiRISE CA+1 orbit	2	3	2	3
Grav only unc				
Avg nongrav unc	1.7	2.9	0.6	0.8
Extreme nongrav unc				

Summary

- CRISM wavelengths include potential coma species
  - C2, C3, H2O, CN, NH2, O2 at 0.4-1.0 micron, good SNR
  - Can image in any spectral feature with sufficient SNR
- CRISM can image nucleus and inner coma
  - CRISM pixel 8 km so nucleus may be a significant fraction
  - Opportunity for good VNIR spectrum of nucleus
  - Sum pixels to get VNIR spectrum of inner coma features
- CRISM baseline plan
  - Star test of pointing and commanding successful
  - 9 images in 3 orbits close up for nucleus and inner coma
  - More distant images for context
- Estimated comet ephemeris uncertainties
  - Confident of imaging comet in FOV using the advance HiRISE image to update the ephemeris