Plans to observe Comet Siding Spring from Mars with CRISM

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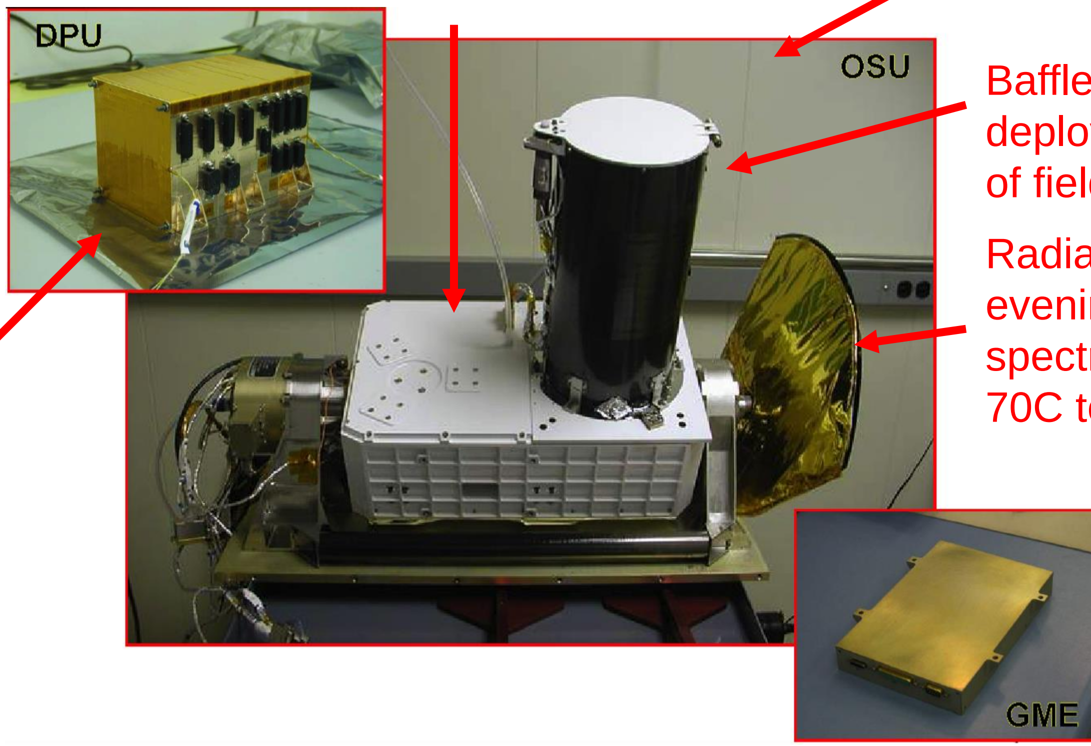
CRISM

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

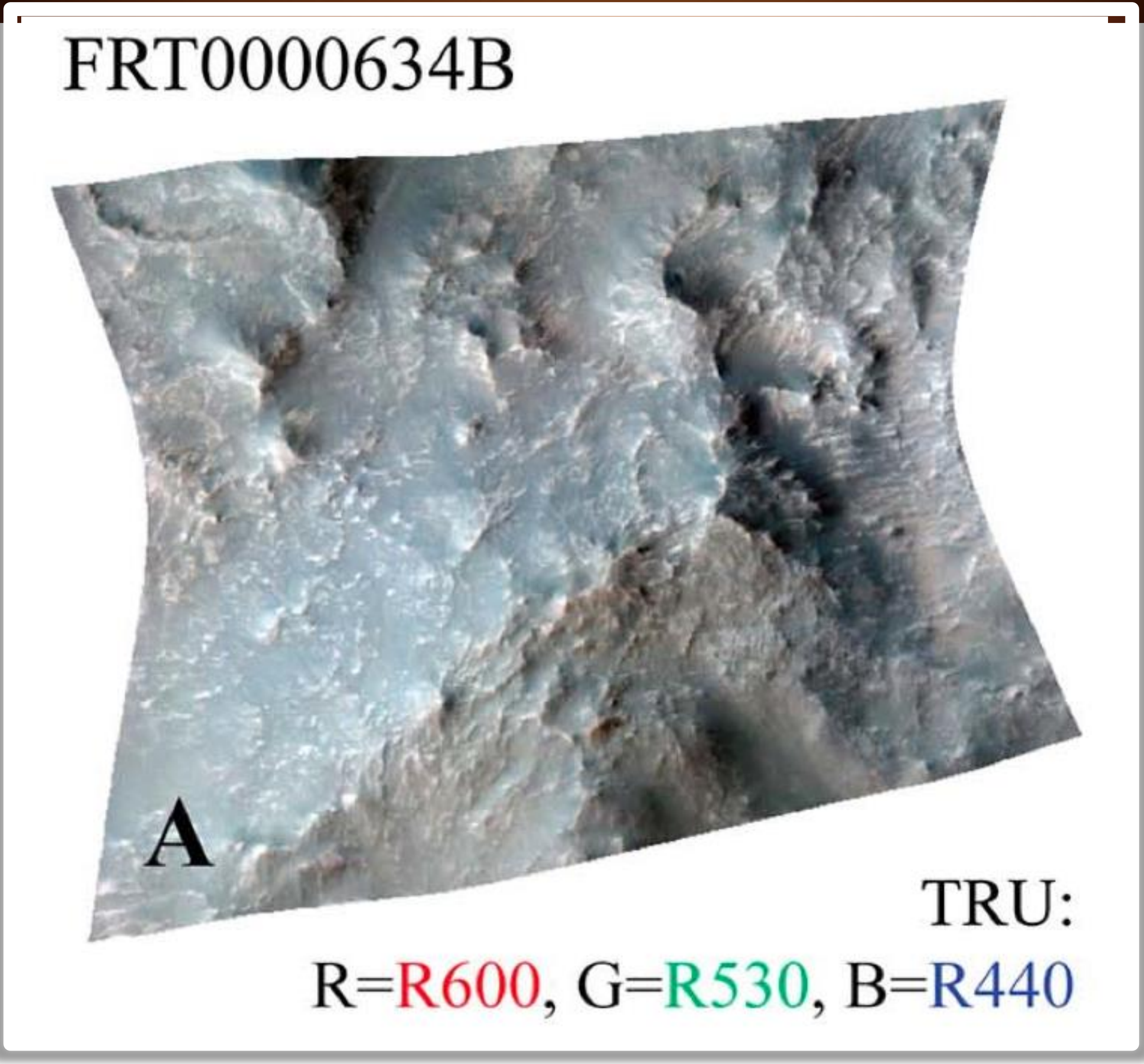
Data Processing Unit controls data acquisition, pixel binning, data editing

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

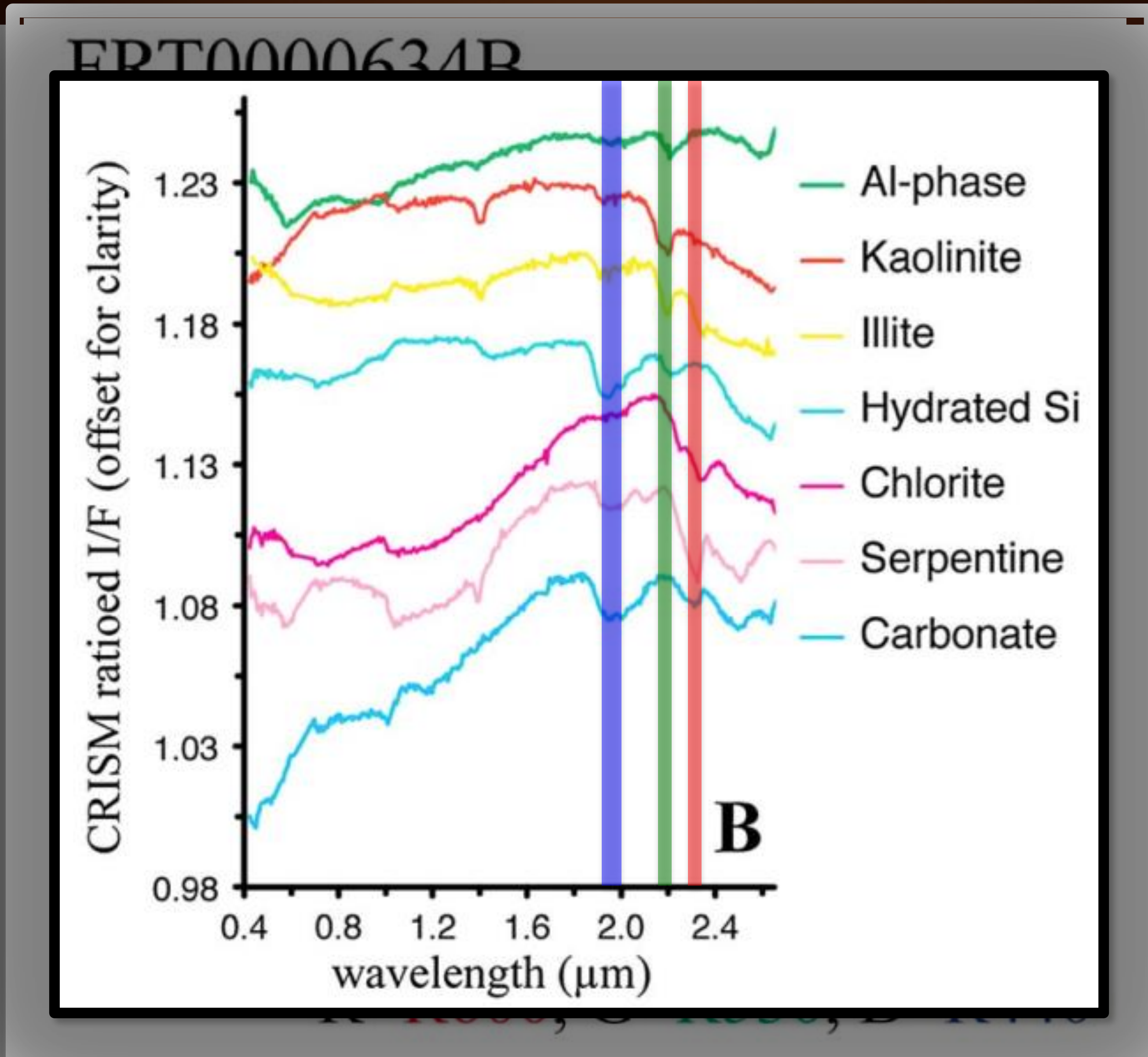
Imaging Spectrometer

- 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
- Standard example from Mars on next four slides

RGB image of a CRISM scene



Mineral features are at longer λs



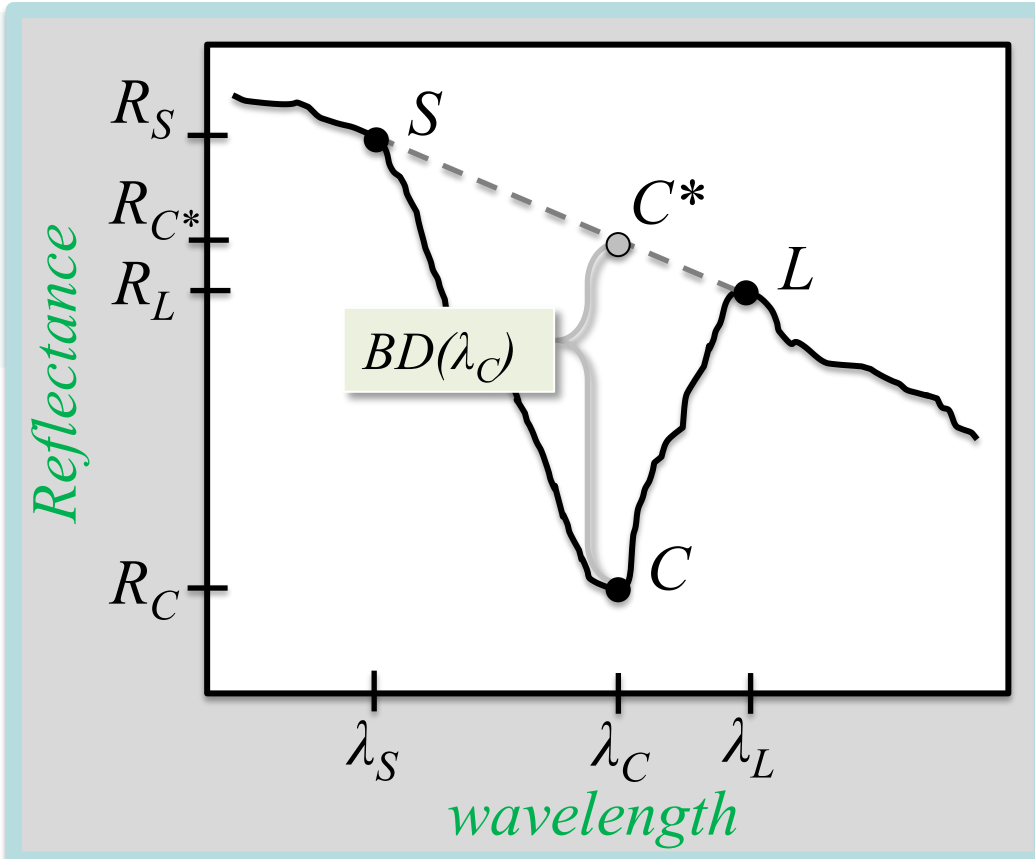
CRISM summary parameter example: band depth

Calculating band depth **"summary parameter":**

$$R_{C*} = aR_S + bR_L$$

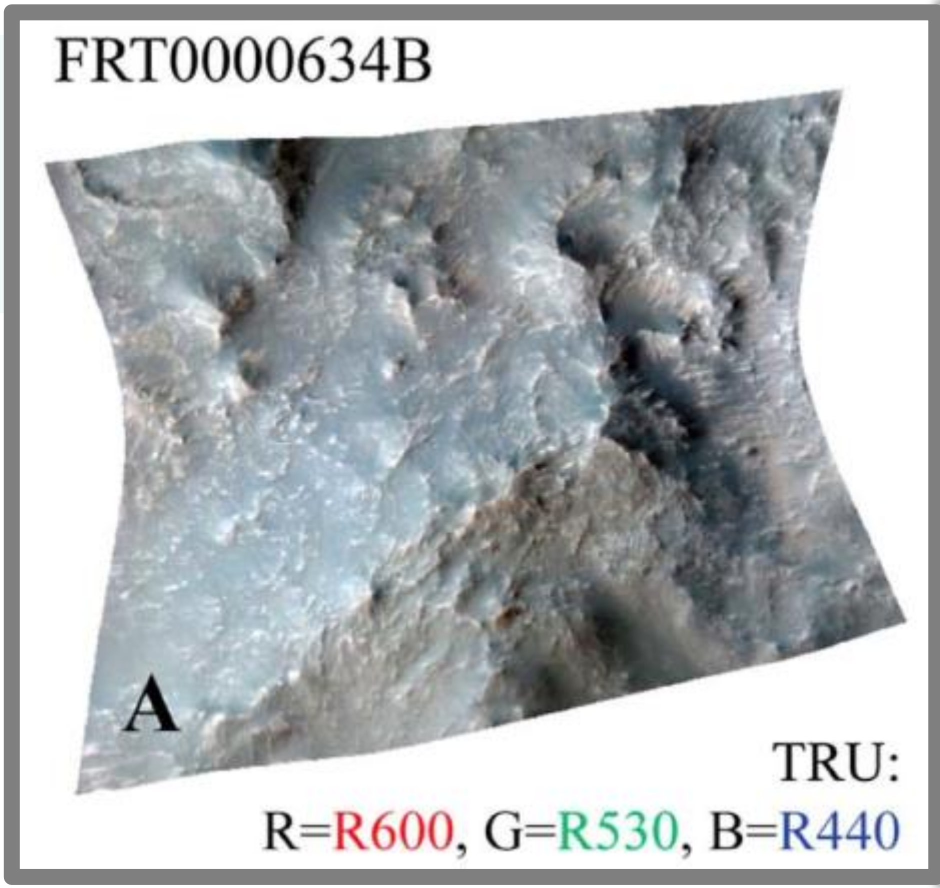
$$a = 1 - b$$

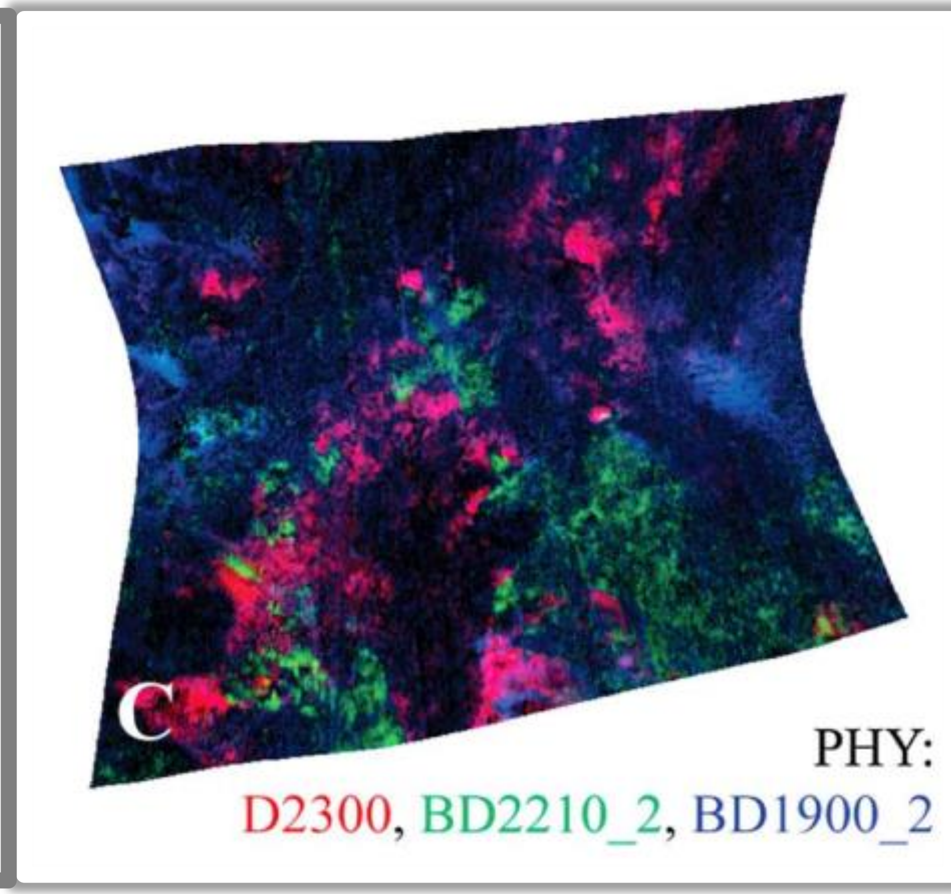
$$b = \frac{\lambda_C - \lambda_S}{\lambda_L - \lambda_S}$$



$$BD(\lambda_C) = 1 - \frac{R_C}{R_{C*}} = 1 - \frac{R_C}{aR_S - bR_L}$$

False color image of 3 summary parameters



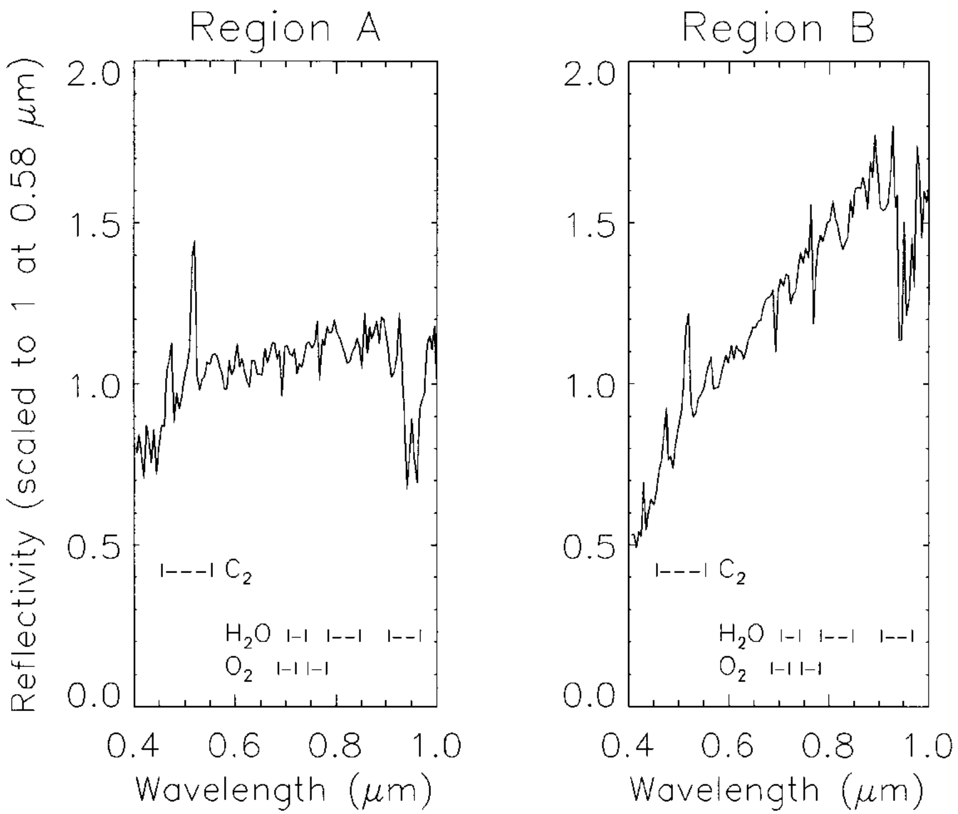


Summary parameters highlight distribution/diversity.

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 sees nucleus and coma

- CRISM pixel 8 km at 130,000 km closest approach
- CRISM sees nucleus
  - Beware of brightness models, but…
  - Scale IRAS-Araki-Alcock (~7 km nucleus diameter)
    - For distance and solar distance gives absolute magnitude of Siding Spring nucleus V~2.5
    - For 0.6-6.0 km diameter nucleus, V~7.8-2.8
    - CRISM gives good VNIR full-resolution spectrum for V<4
  - Detectable, maybe good SNR, probably hard to separate spectrum of nucleus from inner coma
- CRISM sees coma
  - Models give coma brightness V~2.5 in brightest CRISM pixel

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 8x35 milliradians (~1120x4900 km)
- Closest approach +-1 orbits (~300000 km)
  - 2 images each FOV 7x35 milliradians (~2100x10500 km)
  - 1 image each FOV 4x35 milliradians (~1200x10500 km)
- Closest approach +-2 orbits (~700000 km)
  - 2 images each FOV 4x35 milliradians (~2800x24500 km)
- Over +-60 hours from closest approach
  - Some number of images with FOV 4x35 milliradians

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

Backup slides

IR coma spectra 1.0-3.9 µm

- IR *much* higher background, a big effect for low signals
- At 1.0-2.7 microns
  - ~2 orders of magnitude poorer SNR than VNIR for dim signal (need Hmag < -2 for good full-resolution IR spectra)
  - H_2O 1.1, 1.38, 1.87, 2.7 microns
  - CO_2 2.0 microns
  - CO 2.3 microns
  - OCS 2.44 microns
- At 2.8-3.9 microns
  - another order of magnitude less SNR
  - H_2O ice 3.1 microns
  - CH-X 3.2-3.4 microns
  - CH_3OH 3.4 microns
  - H_2CO 3.6 microns
- No CO_2 at 4.3 microns or CO at 4.7 microns