Spatially Resolved UV albedo of PHOBOS with SPICAM on Mars Express

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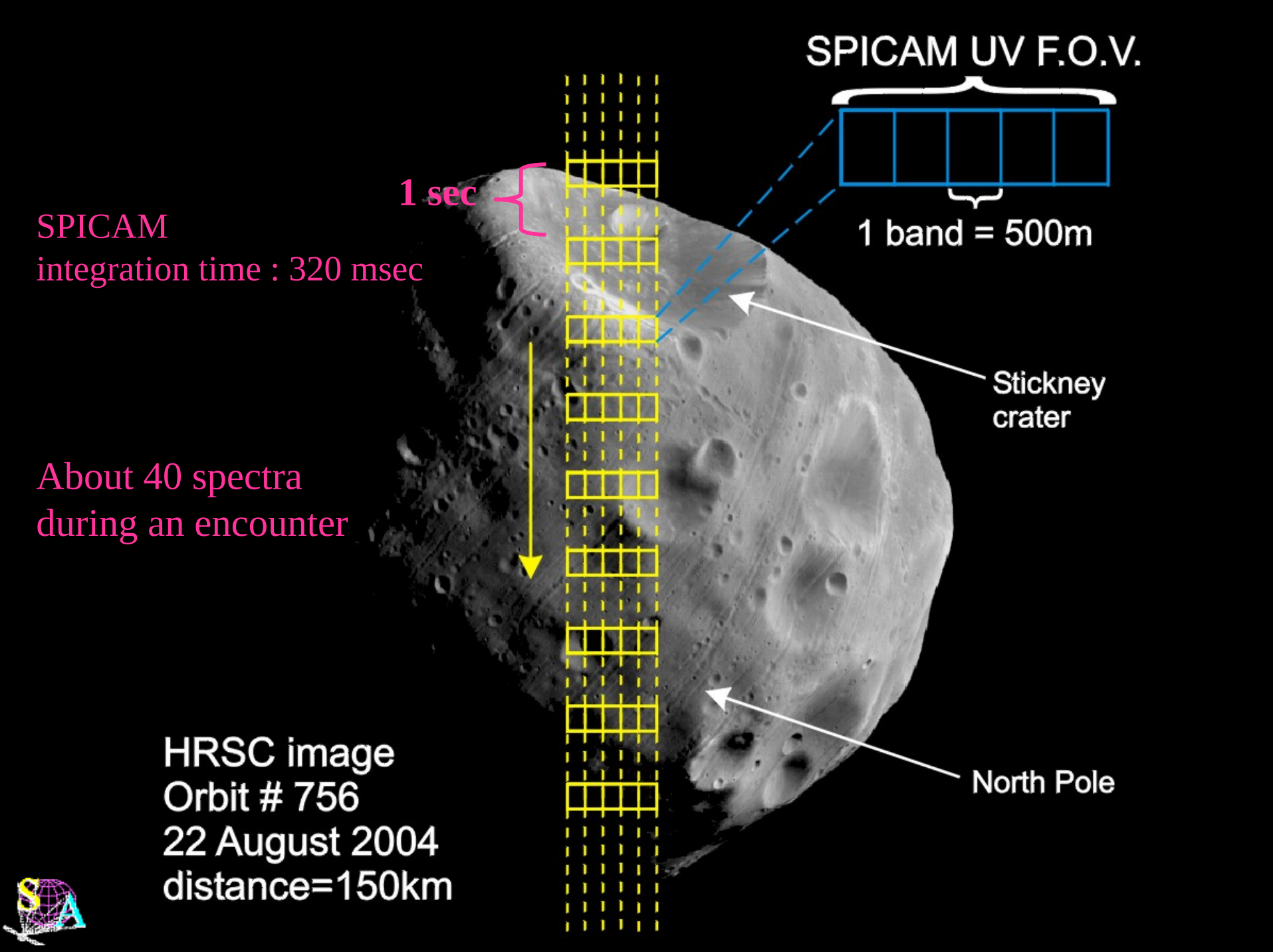
Phobos

- orbital radius : 9378 km (from Mars center)
- diameter : 22.2 km (27 x 27.6 x 18.8 km)
- mass : 1.08 x 10^{16} kg

SPICAM / MEX observations of Phobos

- Analysis of scattered UV solar light between 110 and 310 nm
  - Phobos reflectance (albedo) spectrum
  - Search for spectral / spatial variations of albedo

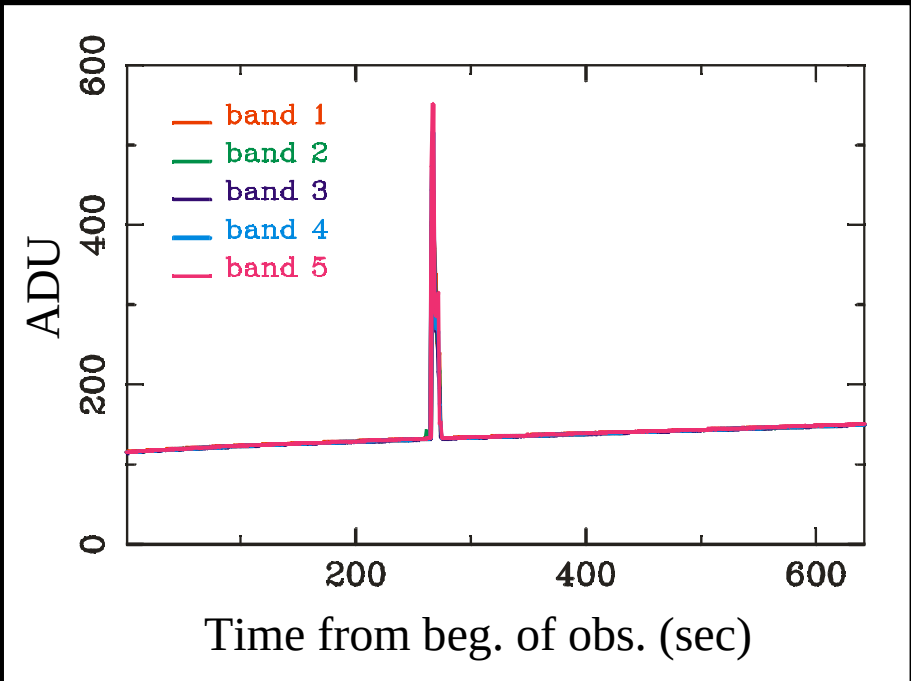

SPICAM UV F.O.V.
1 band = 500m
1 sec
SPICAM
integration time : 320 msec
About 40 spectra
during an encounter
Stickney
crater
North Pole
HRSC image
Orbit # 756
22 August 2004
distance=150km

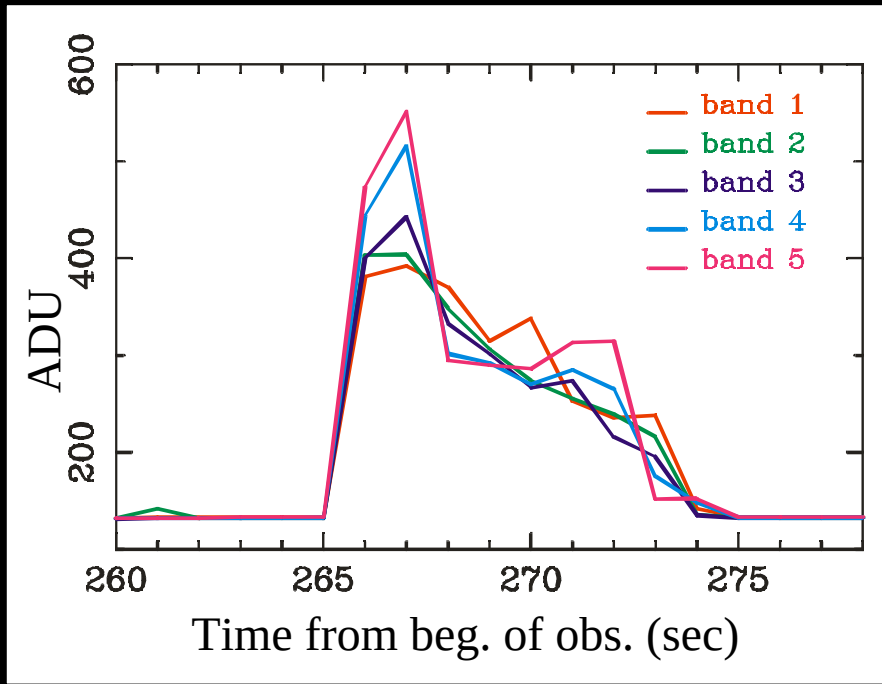
SPICAM / MEX observations of Phobos

Orbit Number	Duration of Phobos obs. (sec)	Distance Phobos-S/C (km)	Phase angle (°)	Band FOV (km)
413	6	1895	42.5	5.8
682	6	1480	64.7	4.6
715	8	1224	40.0	3.8
748	8	1257	22.2	3.9
756	9	162	61.5	0.5
1010	10	9351	132.3	28,7
1064	9	4685	70.4	14.5
1163	8	3840	58	36.5

Photometric time profile : example on orbit 756

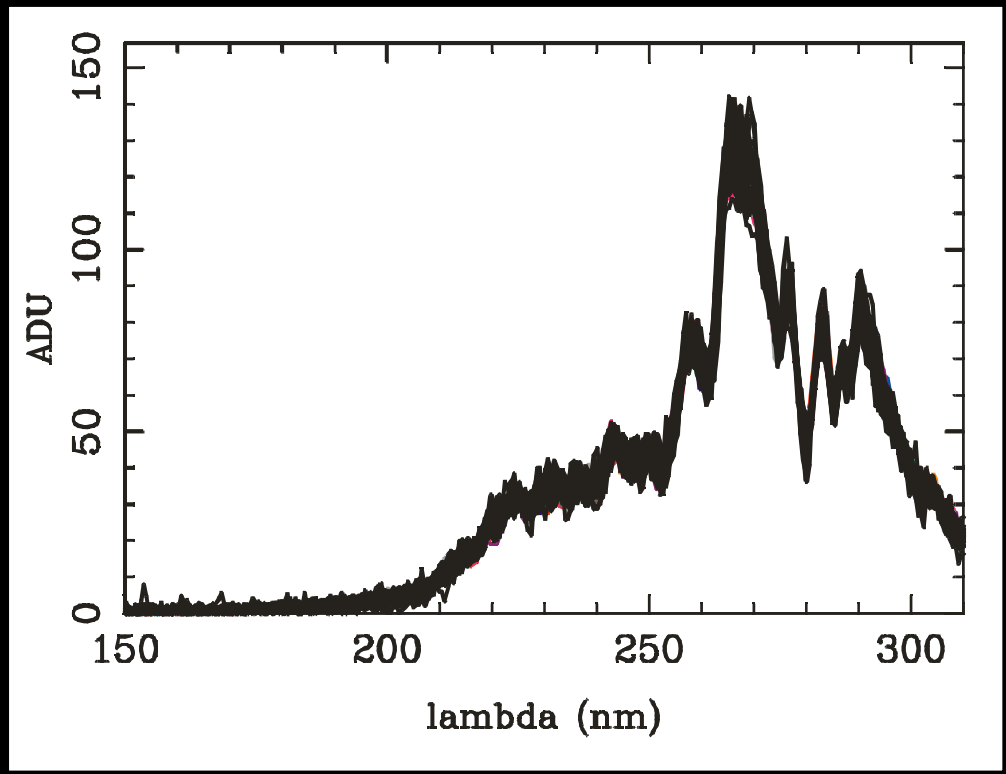
Mean intensity between 150 and 300 nm as a function of time, for each band





Spatial variations ?

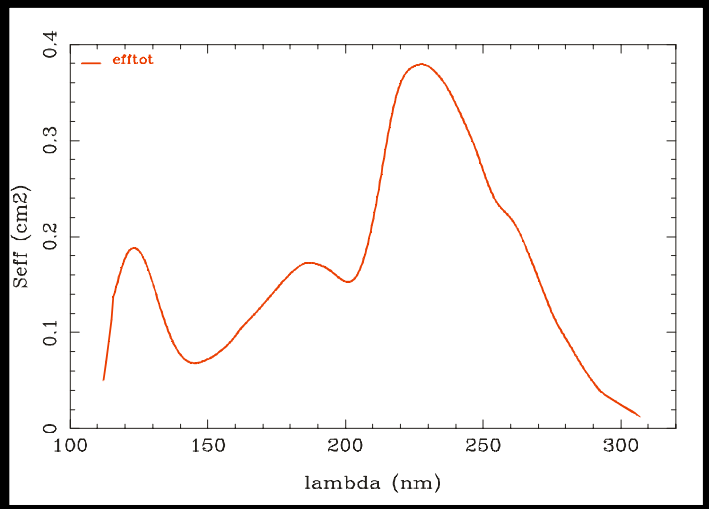
- Orbit 756 (closest encounter, 162 km, FOV = 0.5 x 0.7 km)
- 40 spectra overplotted (normalized to the brightest)



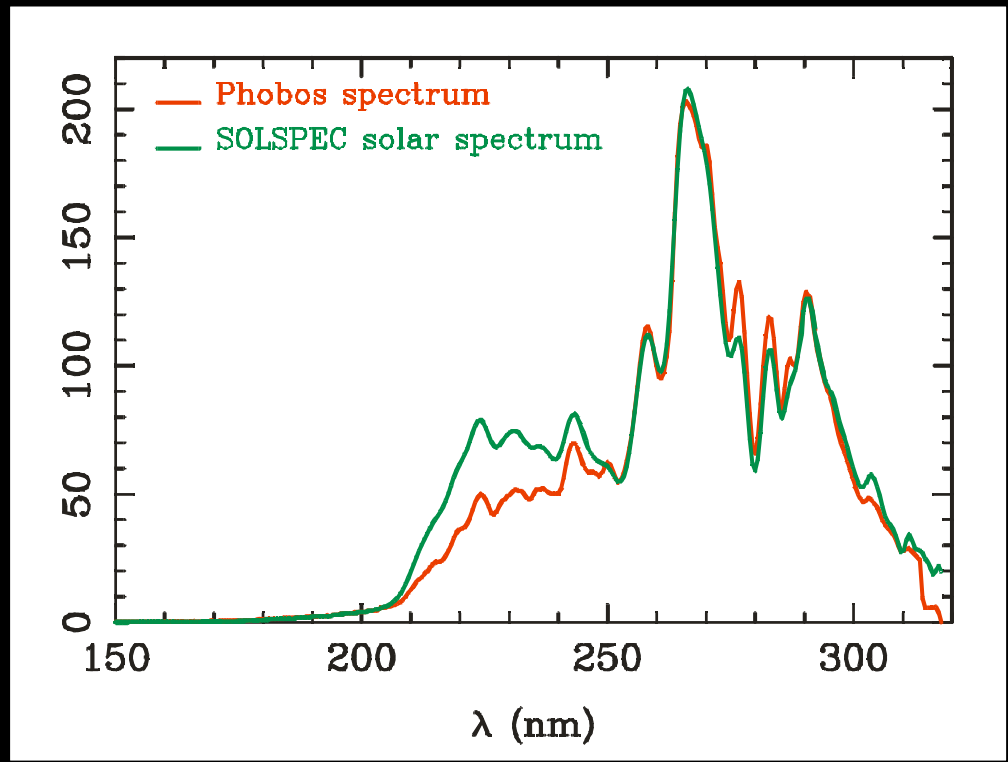
=> no significant spatial variations on Phobos in the UV

Phobos spectrum vs solar spectrum

- Solar spectrum from SOLSPEC (Thuillier et al., 2004) multiplied by SPICAM effective aera
- Computation of the radiance factor I/F

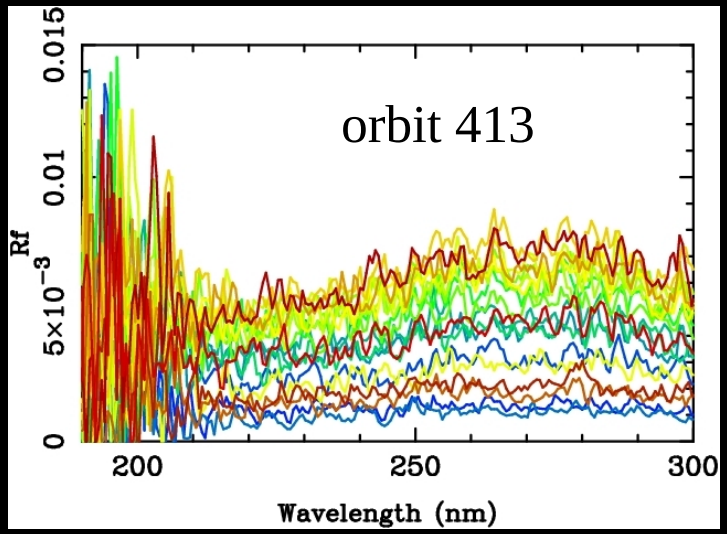


Spicam sensitivity

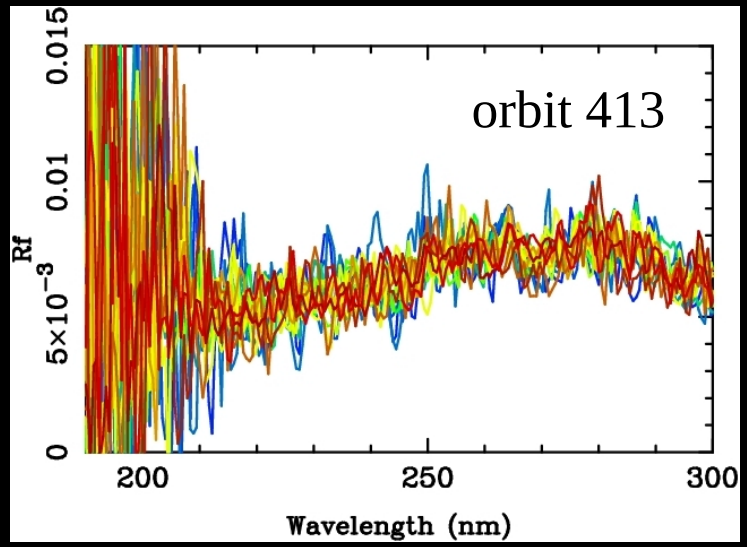


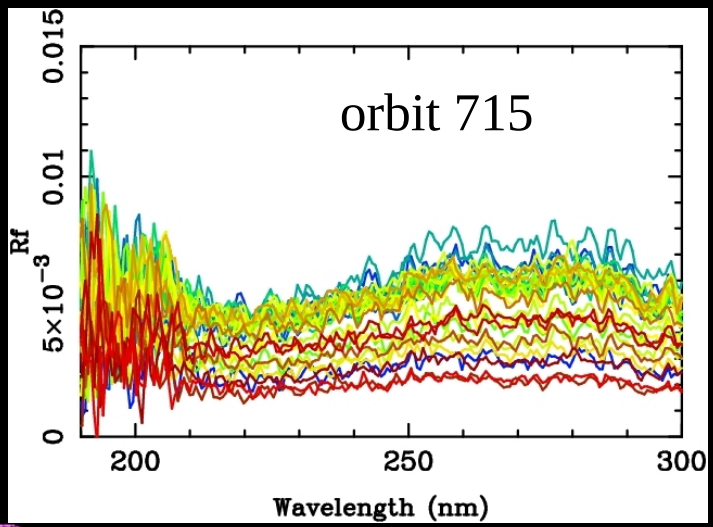
superposed spectra

normalisation to the brightest

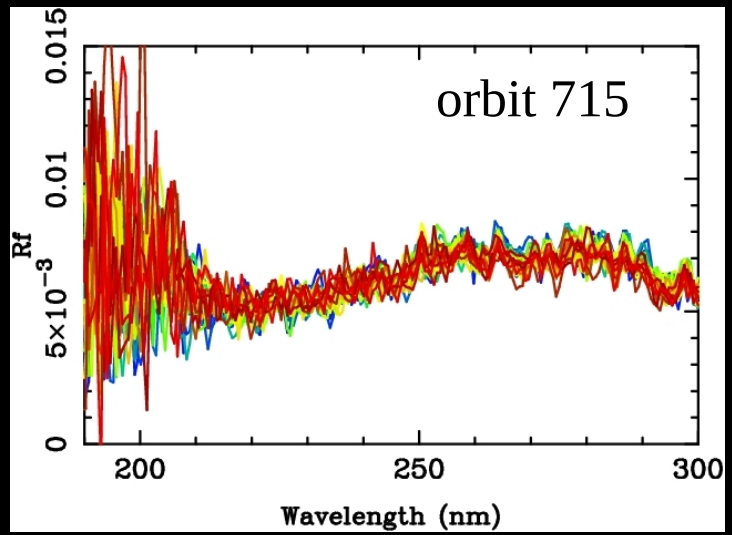


α=42.5°
D=1895 km



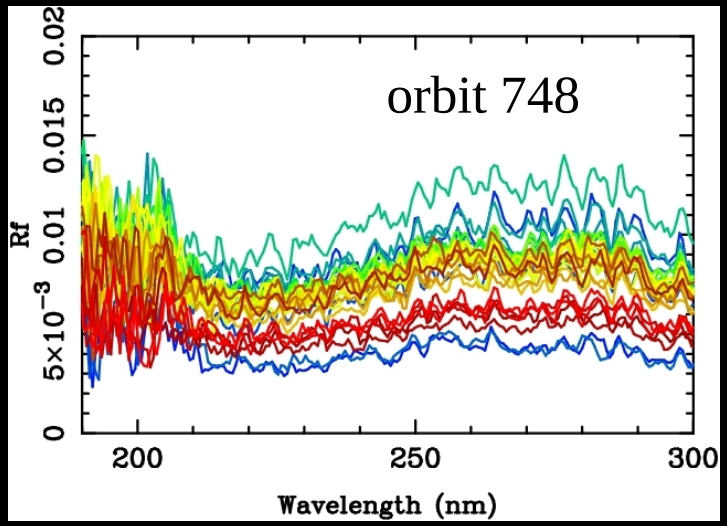


α=40°
D=1224 km

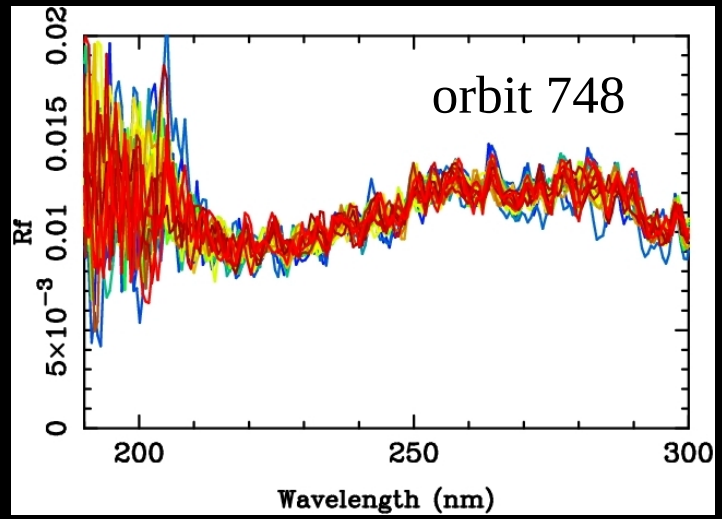


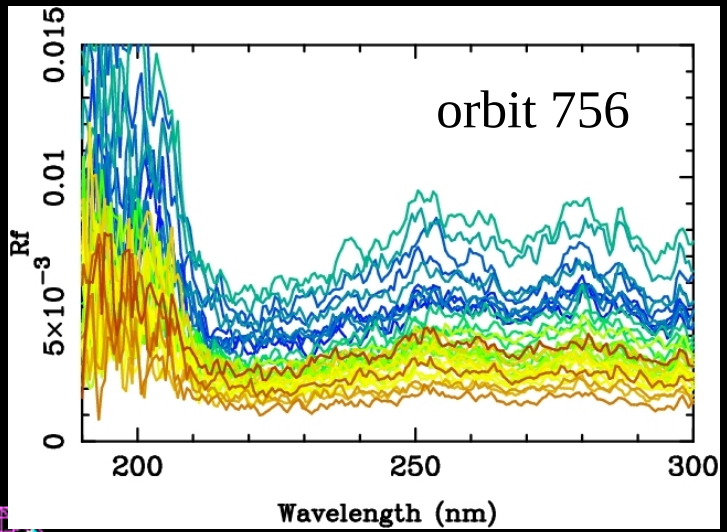
superposed spectra

normalisation to the brightest

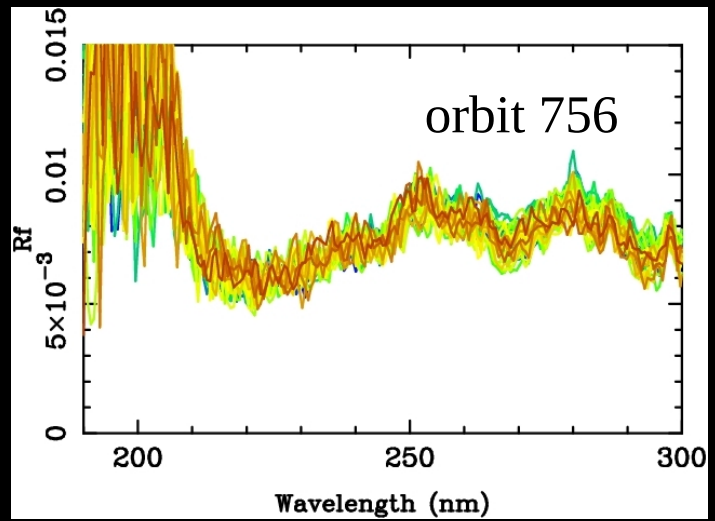


α=22.2°
D=1257 km



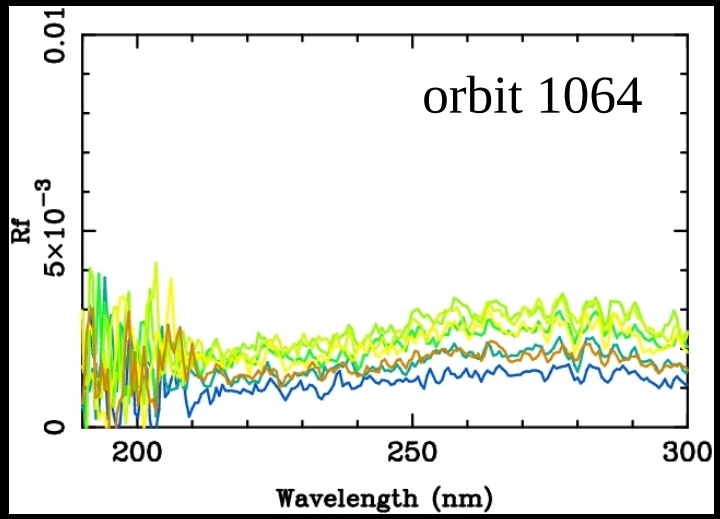


α=61.5°
D=162 km

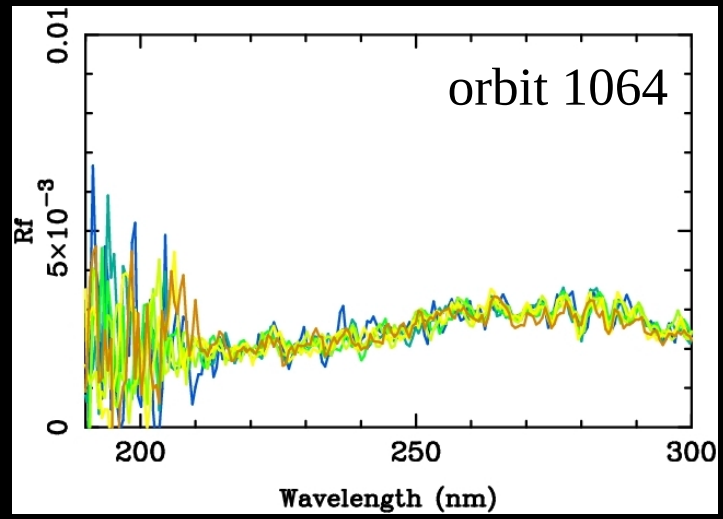


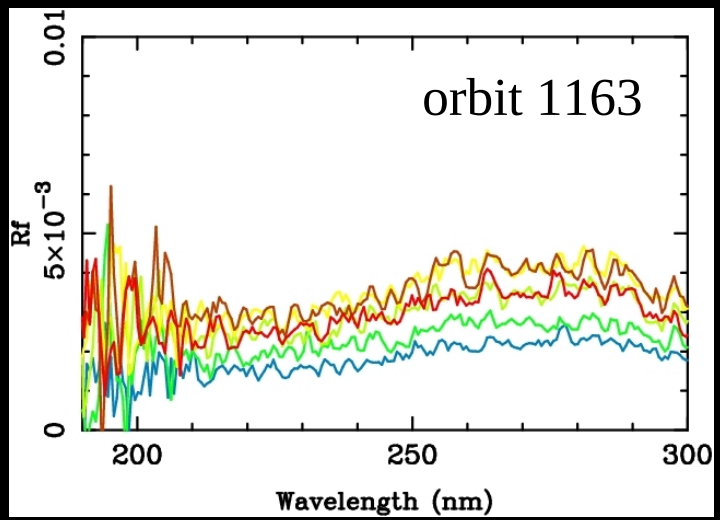
superposed spectra

normalisation to the brightest

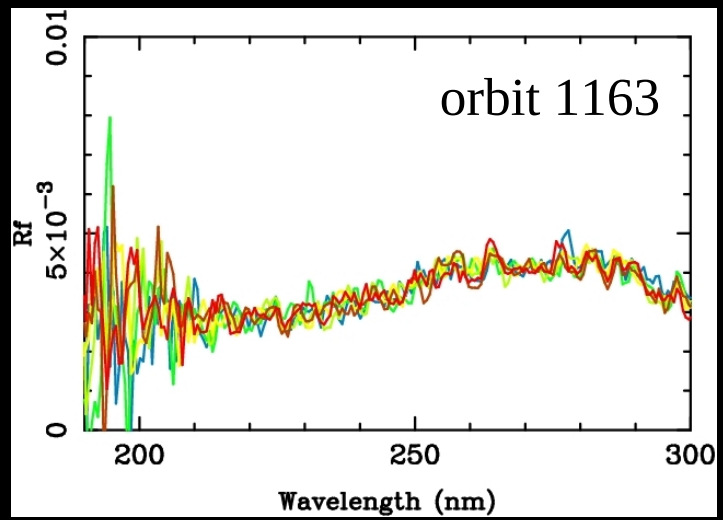


α=70.4°
D=4685 km

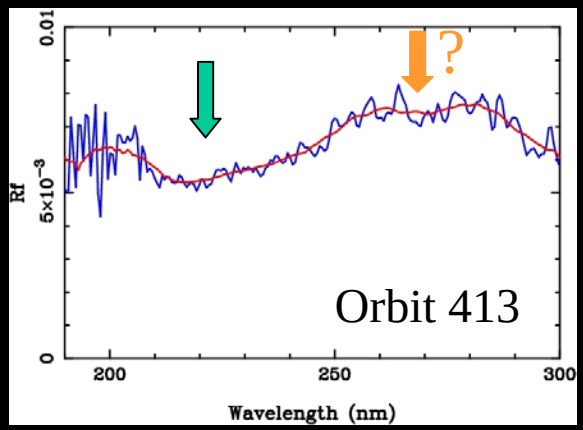


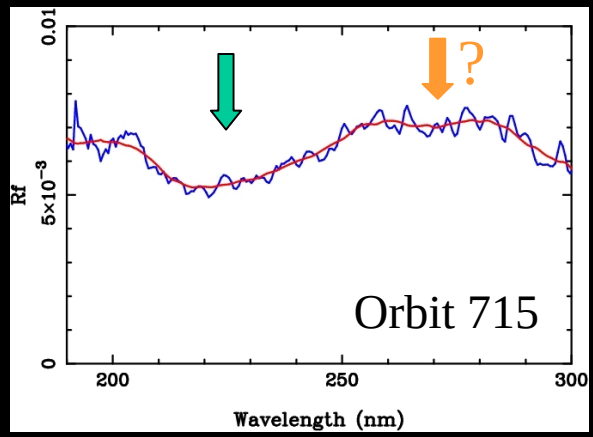


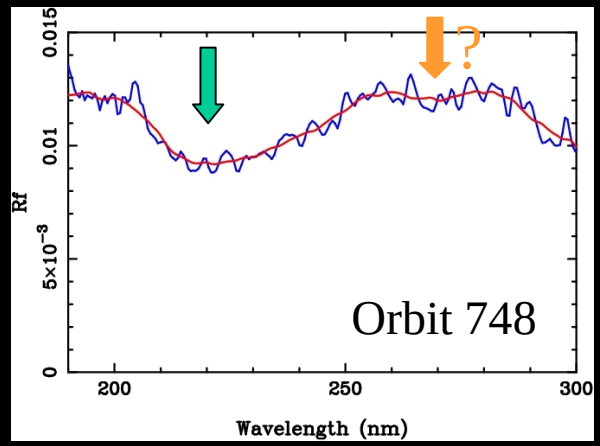
α=57.5°
D=3840 km

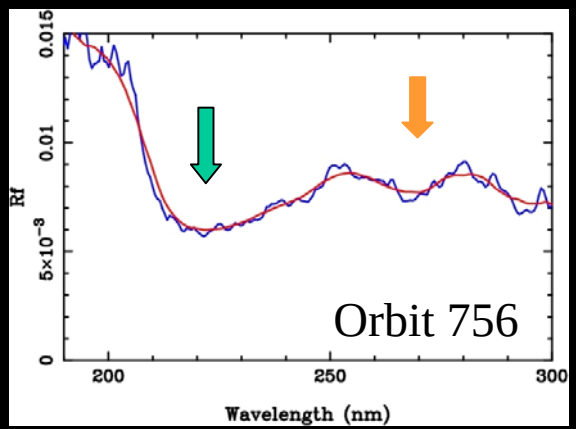


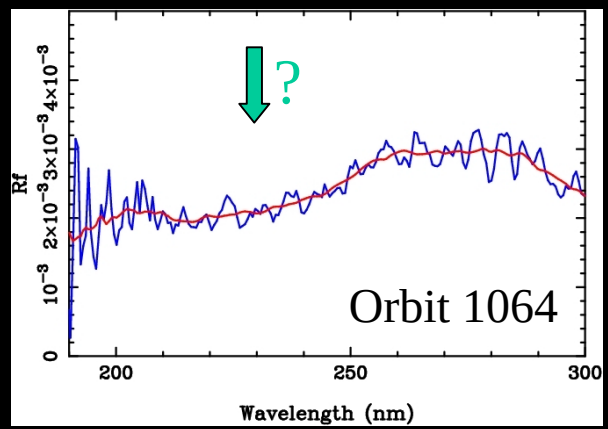
The different Phobos observations with SPICAM

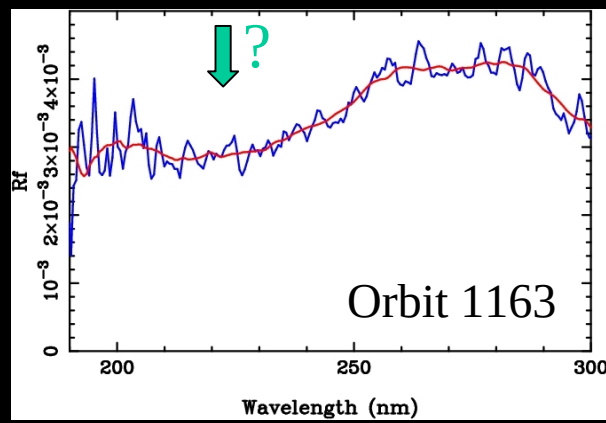




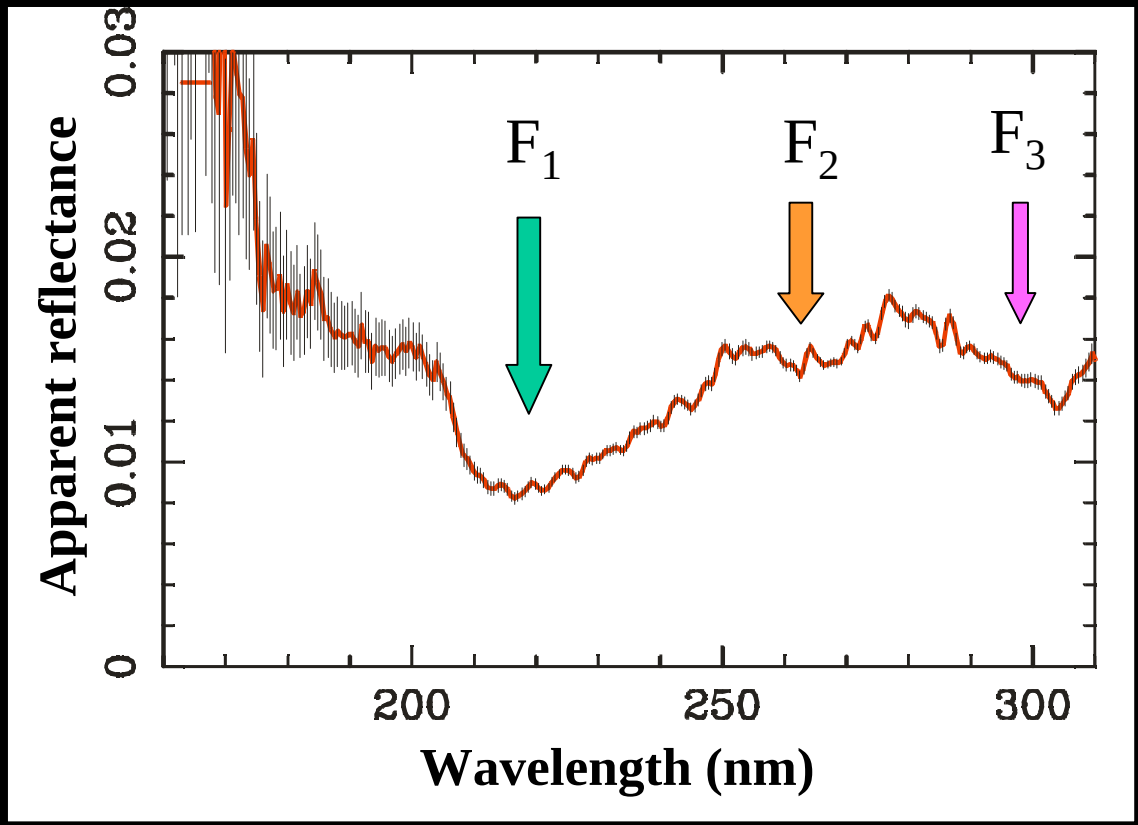








Phobos UV albedo



Average spectrum of Phobos over all observations

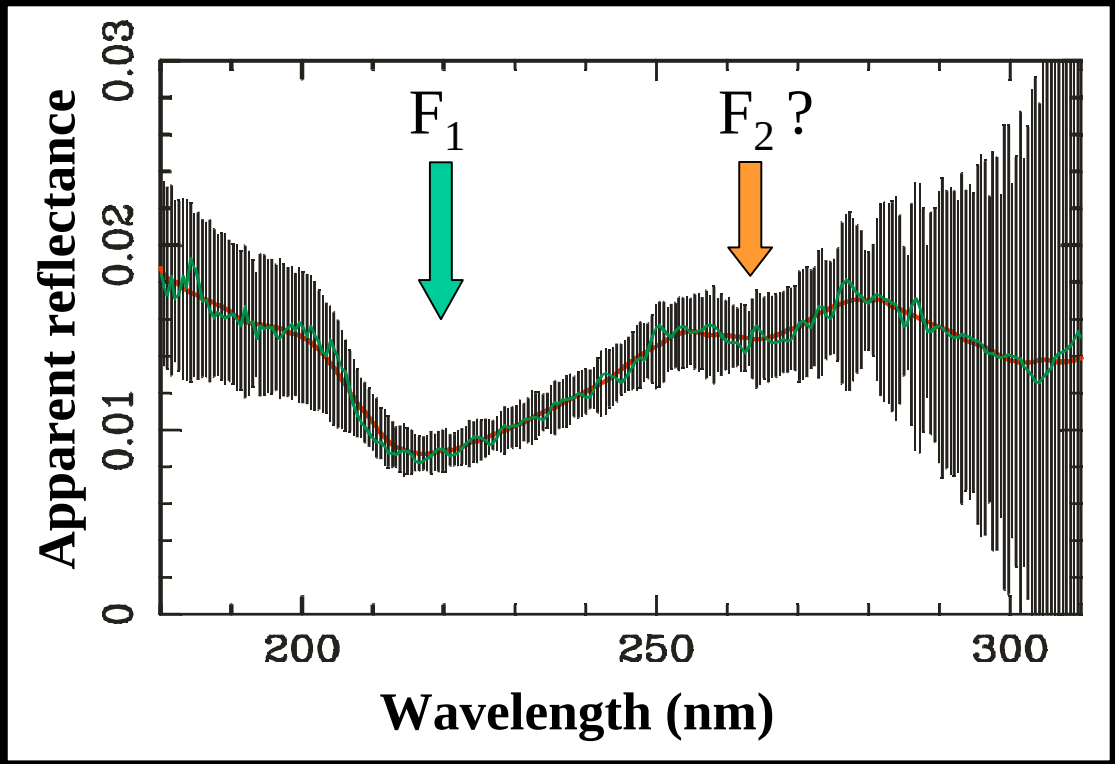
- Calibration on the brightest spectrum observed => a good approch to the geometric albedo
- Several absorption features between 200 and 300 nm

Phobos UV albedo : total error

- We take into account systematic errors

  3% on the SOLSPEC solar spectrum

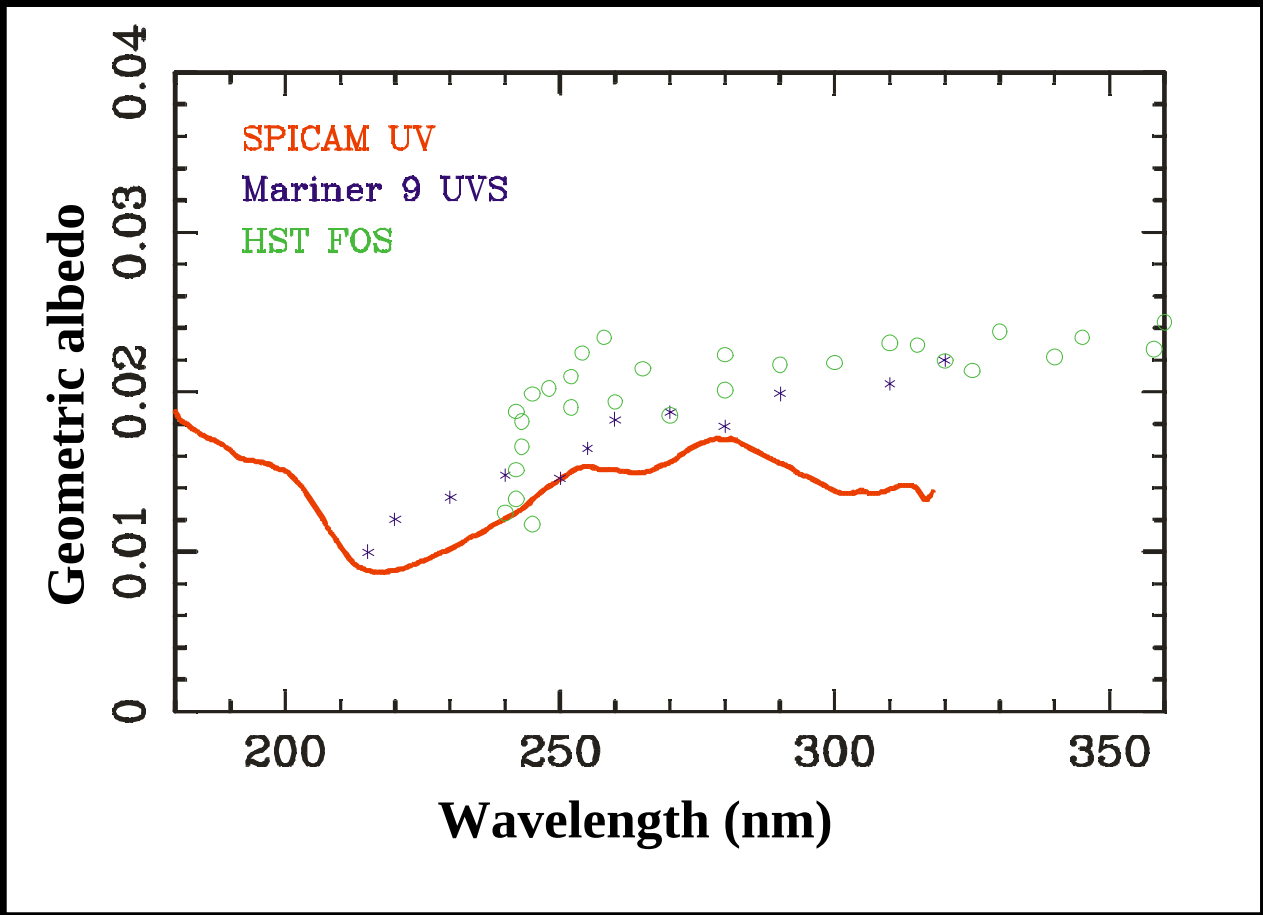
  10% over the SPICAM sensitivity



- Above 280 nm, absorption not real
- Absoption feature at 270 nm : possible but not certain
- The absorption feature F1 at 220 nm seems to be real !

Comparison with previous measurements

- Mariner 9 data (1971-1972) *(Pang et al. 1978)*
- HST data *(Cantor et al. 1999)*



Origin of Phobos surface material

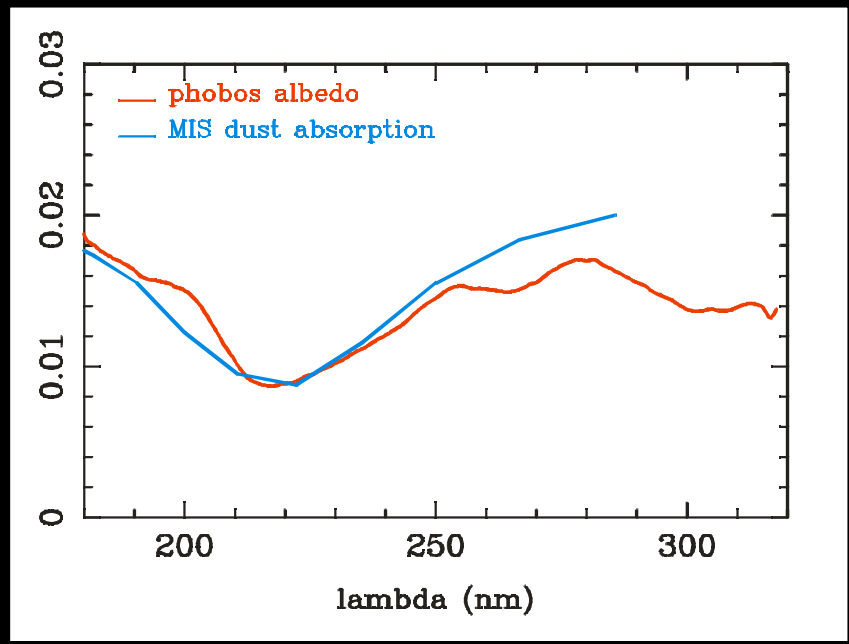
- Mars (?)
- Phobos bulk
- Interplanetary dust
  - Asteroid source
  - Cometary source
- Interstellar dust (minor)

Speculation about the origin of Phobos UV absorption at 220 nm

- Not compatible with UV silicate signature (around 260 nm) (Hapke, 2004)

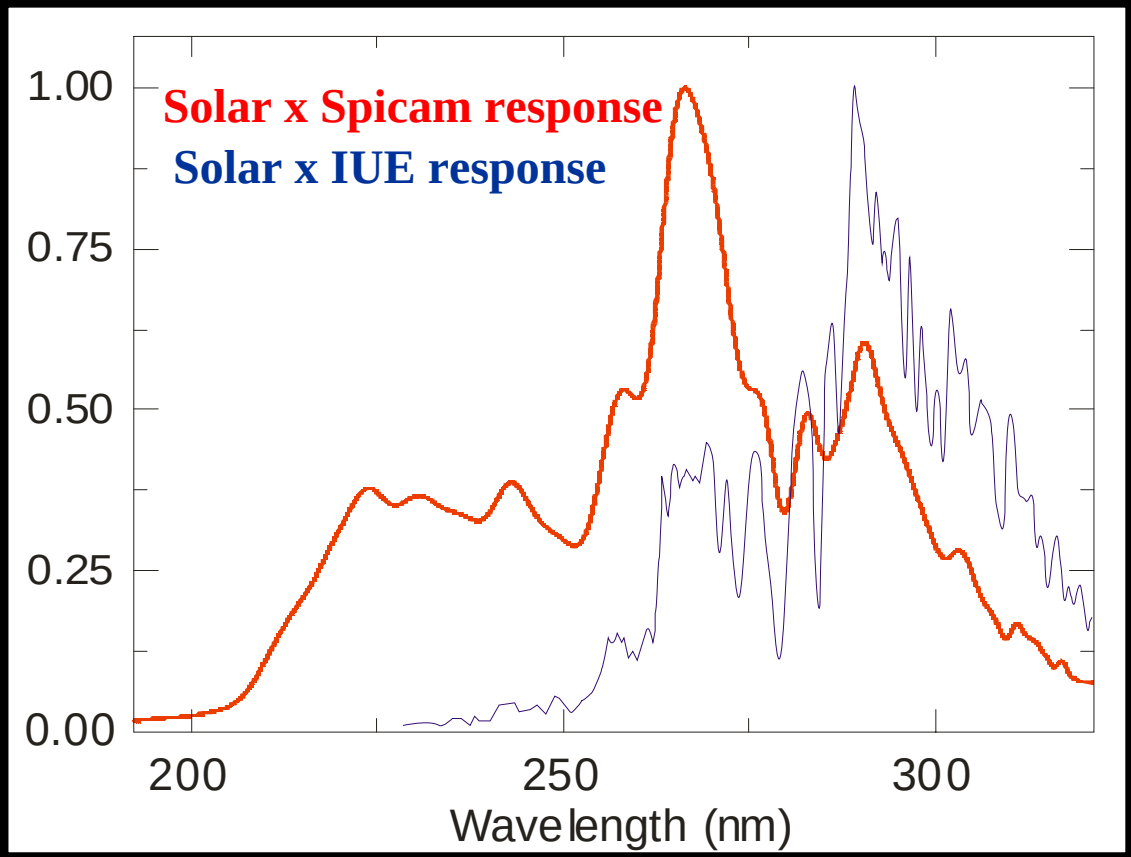
- Phobos absorption similar to the extinction feature observed in the Interstellar Medium at 217.5 nm

- Nature of ISM absorbing material ?
  possible organic material :
  PAH *(Duley and Lazarev, ApJ 2004)*
  from laboratory measurements
  $C_{24}H_{x,}$, x<3



Compared UV sensitivity of SPICAM/MEX and IUE

- IUE : UV albedo of 45 asteroids, λ > 240nm (Roettger and Buratti, 1994)
- high-sensitivity of SPICAM between 200 and 300 nm



Conclusions : PHOBOS UV SPECTRUM

- Obtained over a larger UV spectral range than before
- Spatially resolved

- No strong spatial variations on Phobos

- Significant absorption feature around 220 nm, similar to the interstellar extinction feature.
- Could be caused by the presence on Phobos of organic material (either from Phobos or from an external source)

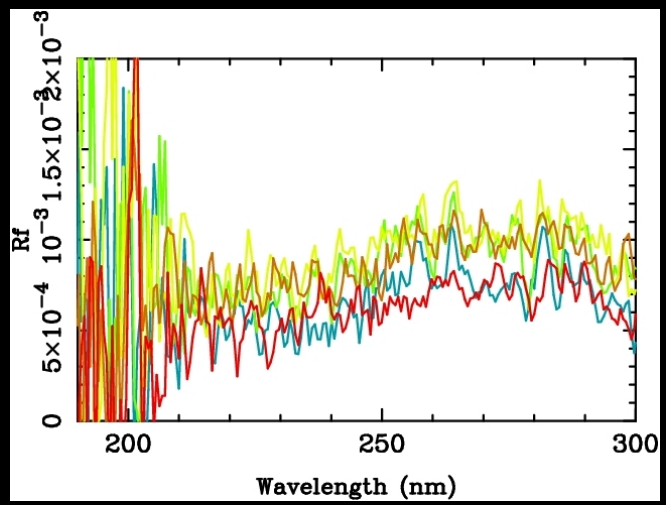
SPICAM / MEX observations of Deimos

Deimos

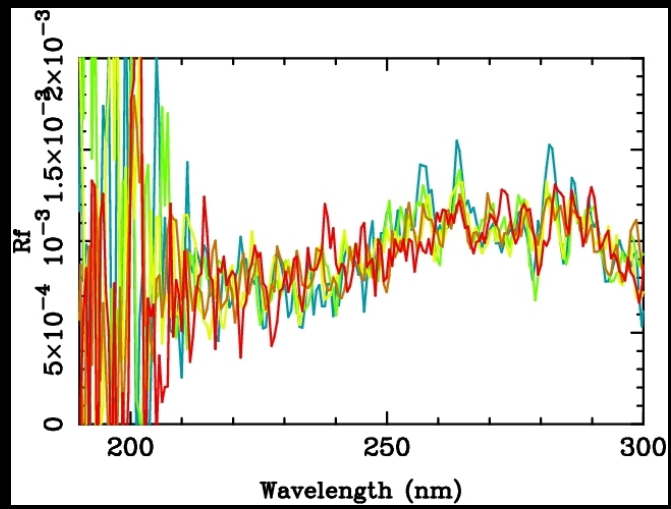
- orbital radius : 23 459 km (from Mars center)
- diameter : 12.6 km
- mass : 1.8 x 10^{15} kg

Orbit Number	Duration of Phobos obs. (sec)	Distance Phobos-S/C (km)	Phase angle (°)	Band FOV (km)
756	9	162	61.5	0.5
1222	9	11 852	45.6	36.5

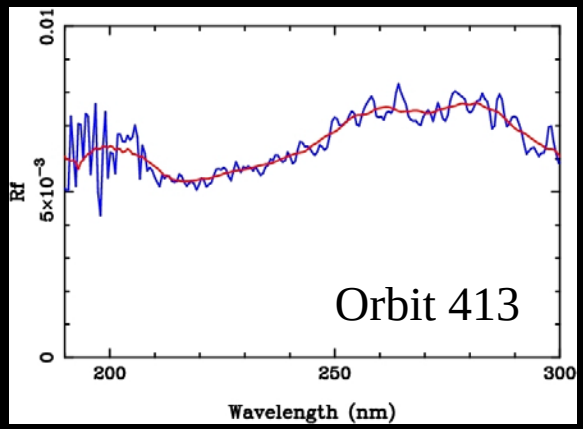
superposed spectra

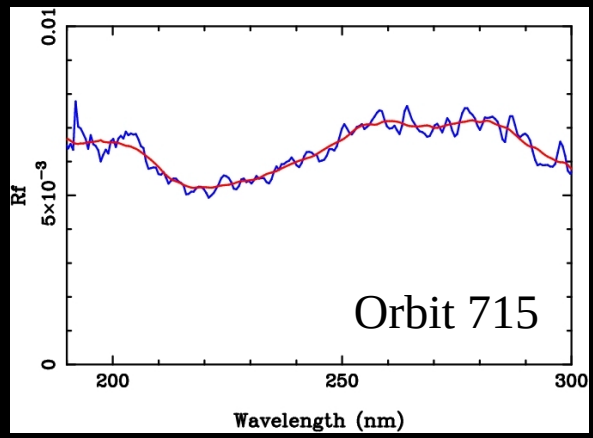


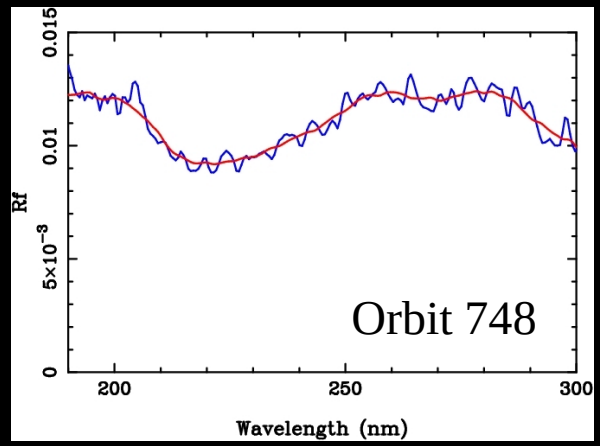
normalisation to the brightest

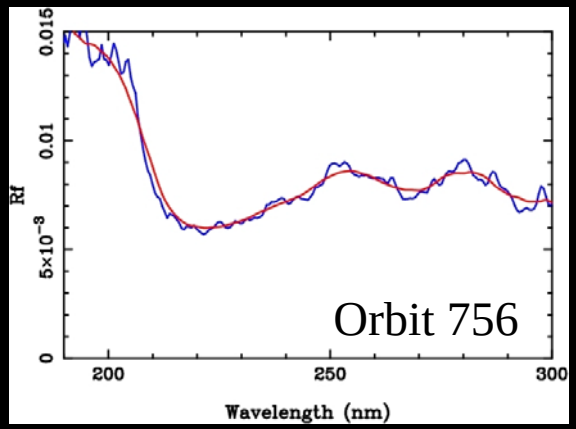


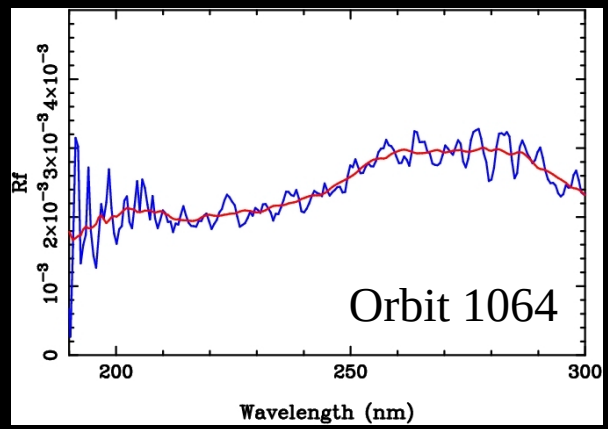
Comparison Deimos spectrum vs Phobos spectrum

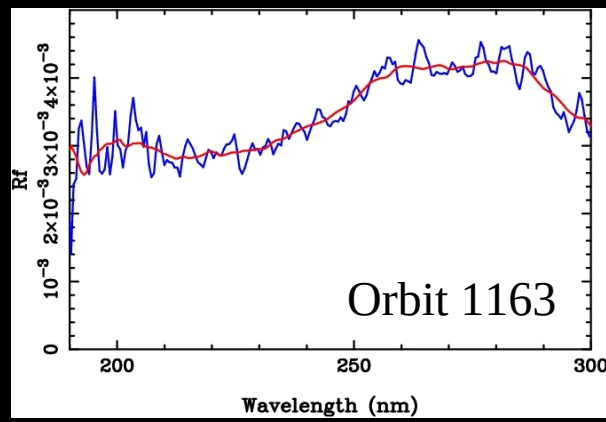


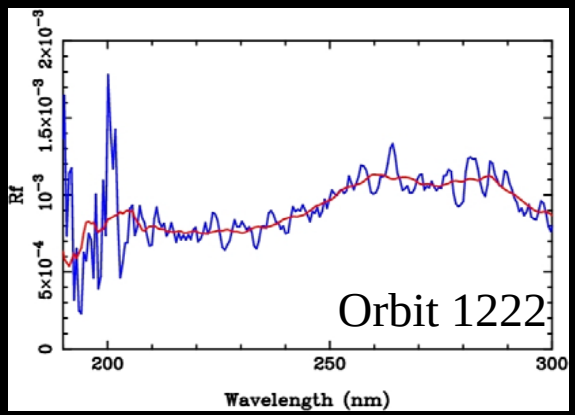










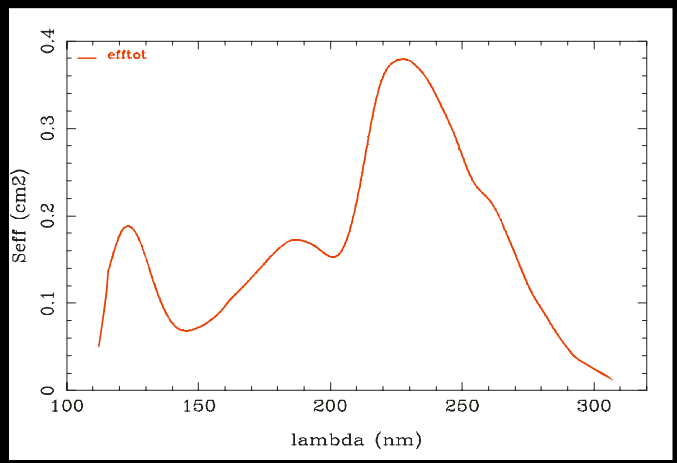


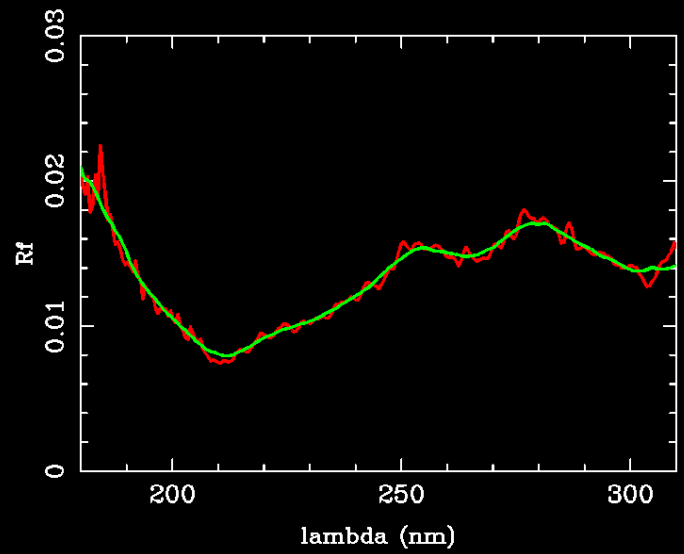
Same absorption on Deimos ???

Need of a closer encounter…

Influence of the efficient surface curve over the albedo

- If the « hole » in the efficient surface at 220 nm wasn't real ?

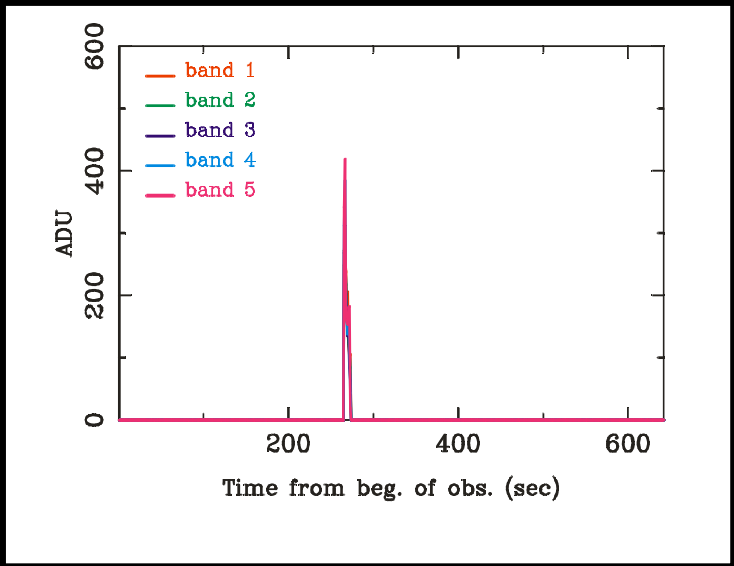


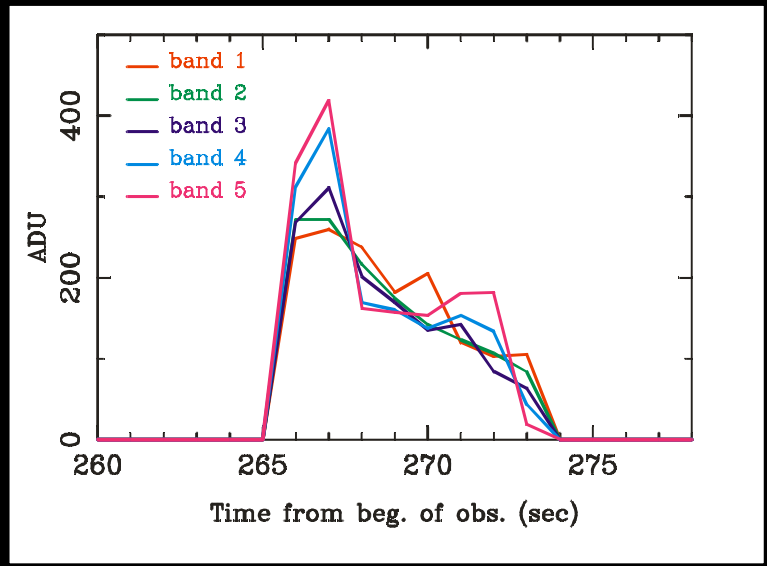


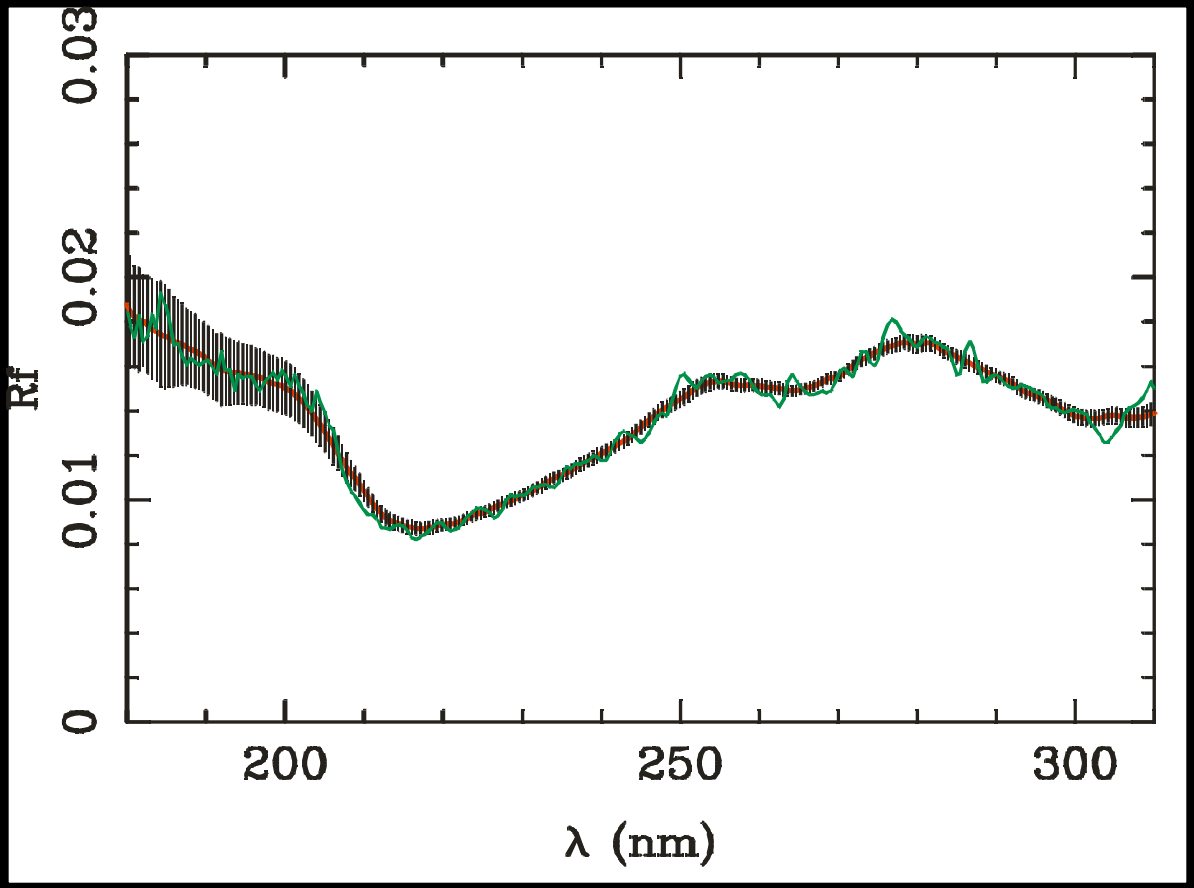
- The absorption band at 210 nm is always here !

Light curves : example on orbit 756

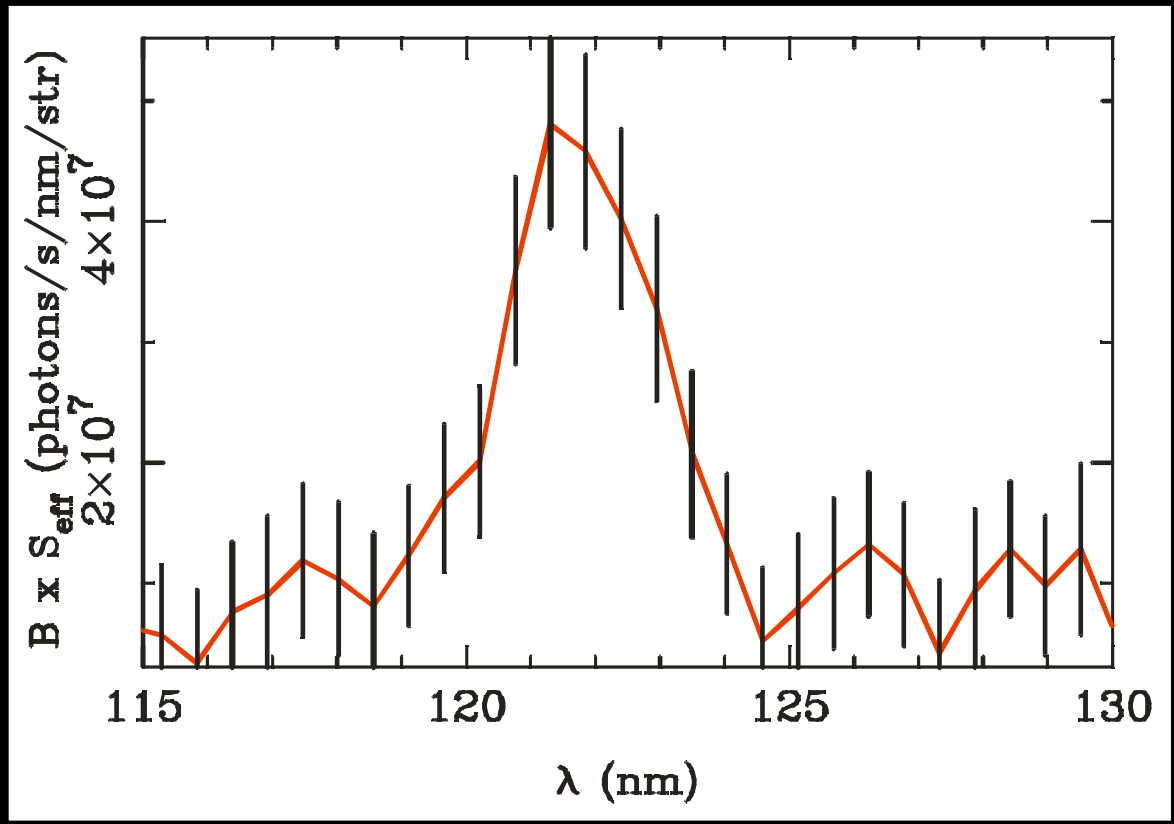
- Mean intensity between 150 and 300 nm as a function of time, for each band





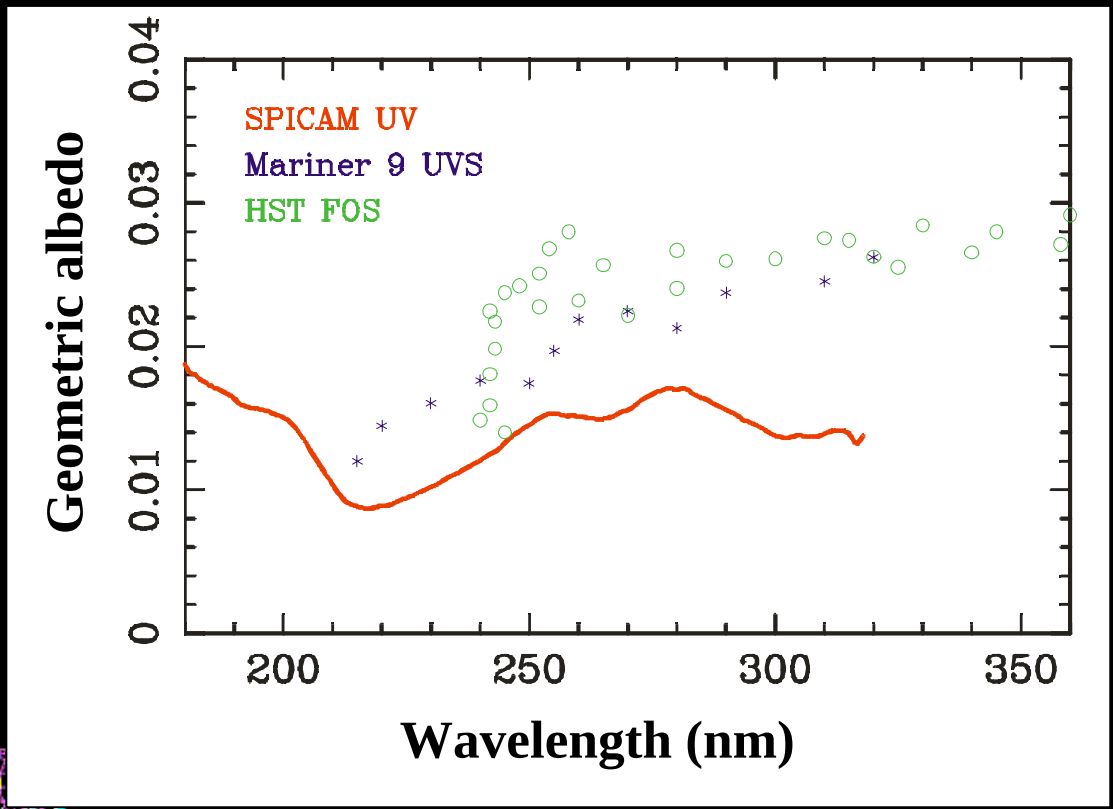

0.03
0.02
0.01
0
Rf
200
250
300
λ (nm)

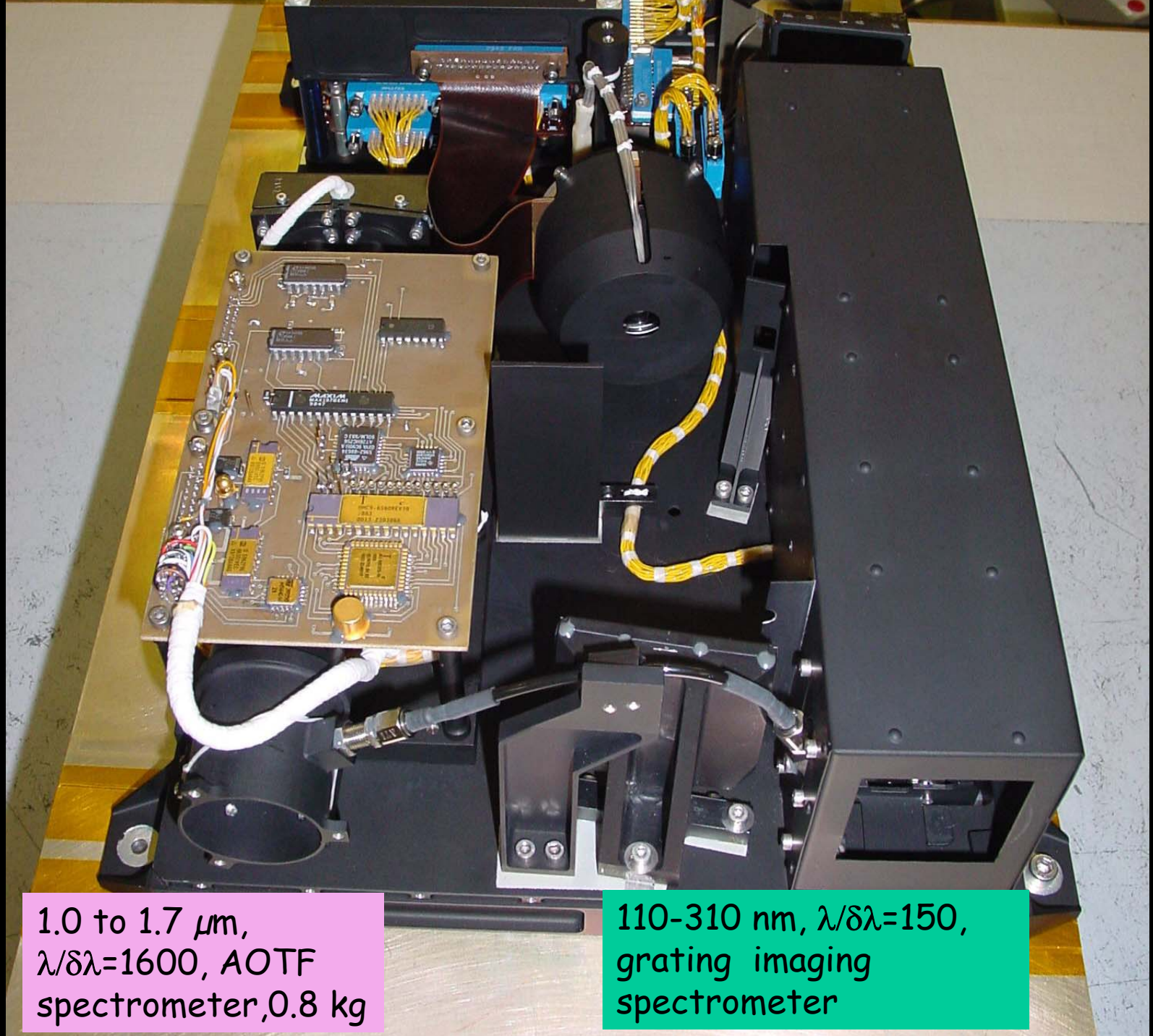
Lyman α



Comparison with previous measurements

- Mariner 9 data (1971-1972) *(Pang et al. 1978)*
- HST data *(Cantor et al. 1999)*



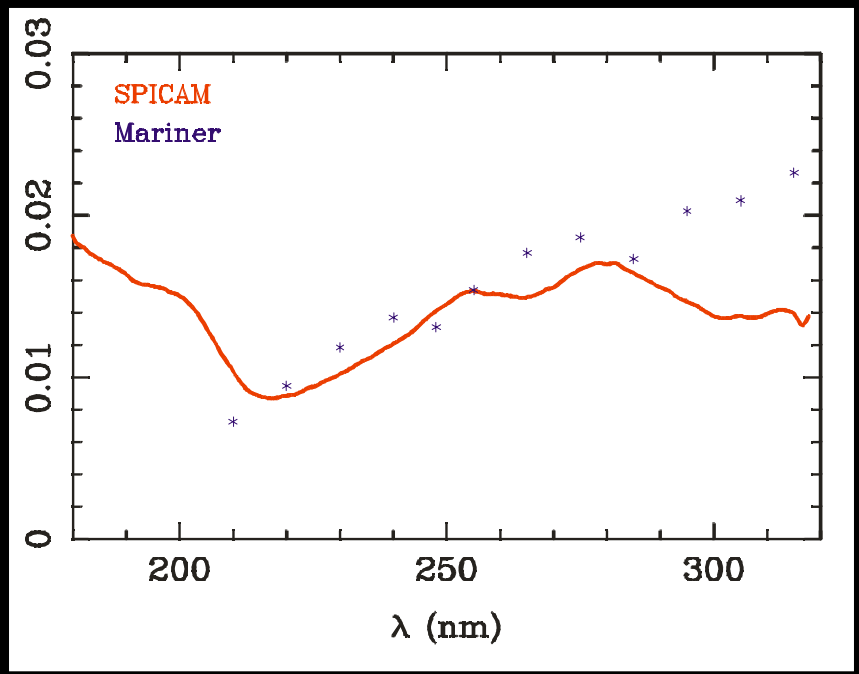


1.0 to 1.7 μm, λ/δλ=1600, AOTF spectrometer,0.8 kg

110-310 nm, λ/δλ=150, grating imaging spectrometer

Comparison with previous measurements

- Mariner 9 data (1971-1972)



Origine of this absorption ?

- Duley : MIS absorption feature at 2175 nm
- Possible PAH or silicates
- model