OMEGA INSTRUMENTAL PROBLEMS

0. To first order, the instrument is working very well !
1. Evolution of the IR detector with time
2. Stability of the L channel
3. Saturation
4. Linearity
5. Registration
6. bad regions for 128 pixel modes
7. Saturation of the dark in the L channel
8. Problems with the visible channel

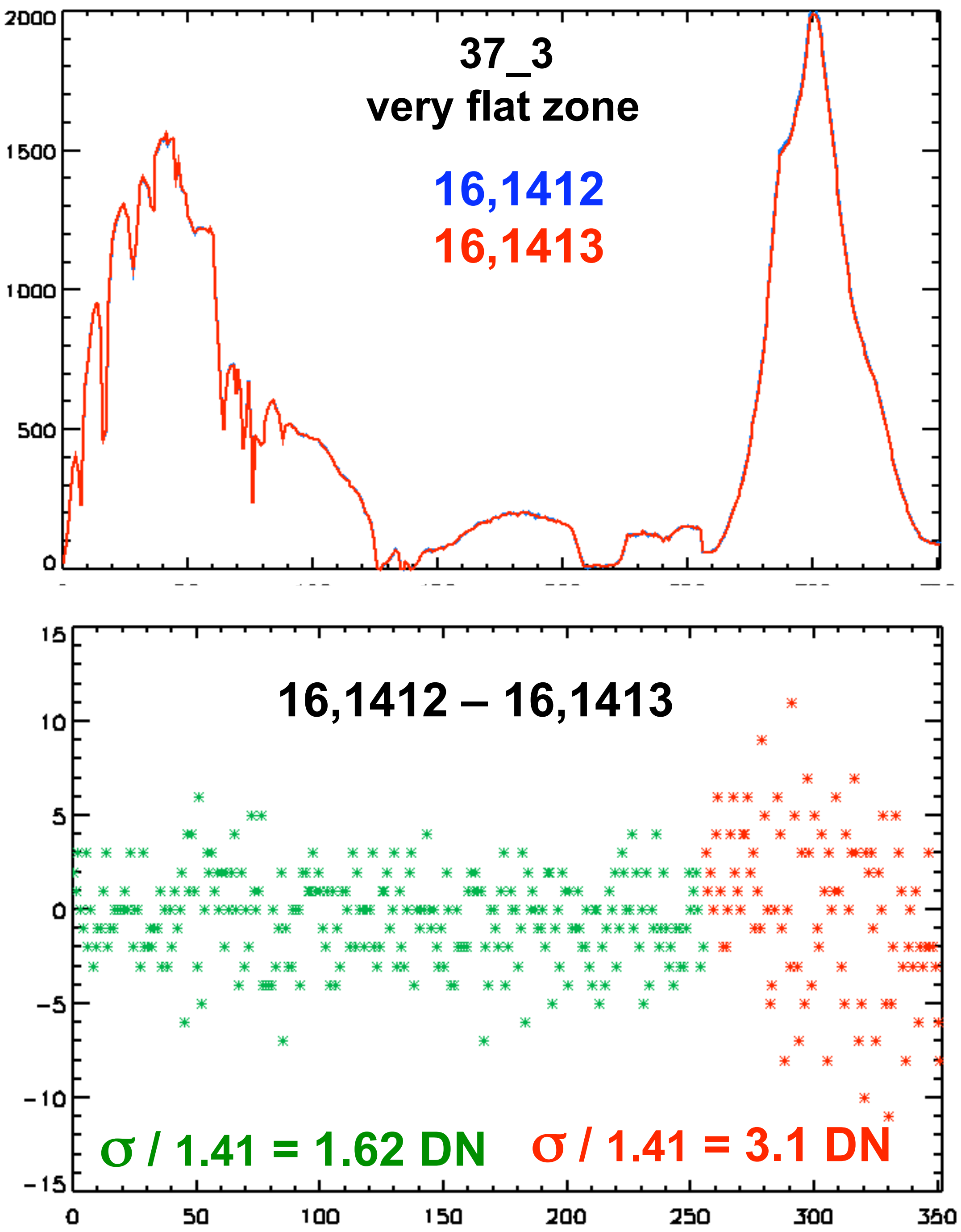
COMPARISON BETWEEN BRIGHT SPECTRA

the signal to noise ratio of OMEGA can exceed 1000 even with the shortest integration time (2.5 msec)

It can be further increased by using the 5 msec int. time (saturation !)

or

when downtrack summing is implemented (128 pixel modes)



OMEGA INSTRUMENTAL PROBLEMS

1. Evolution of the IR detector with time

Can be monitored with the internal calibration lamp
Which has proven very reliable

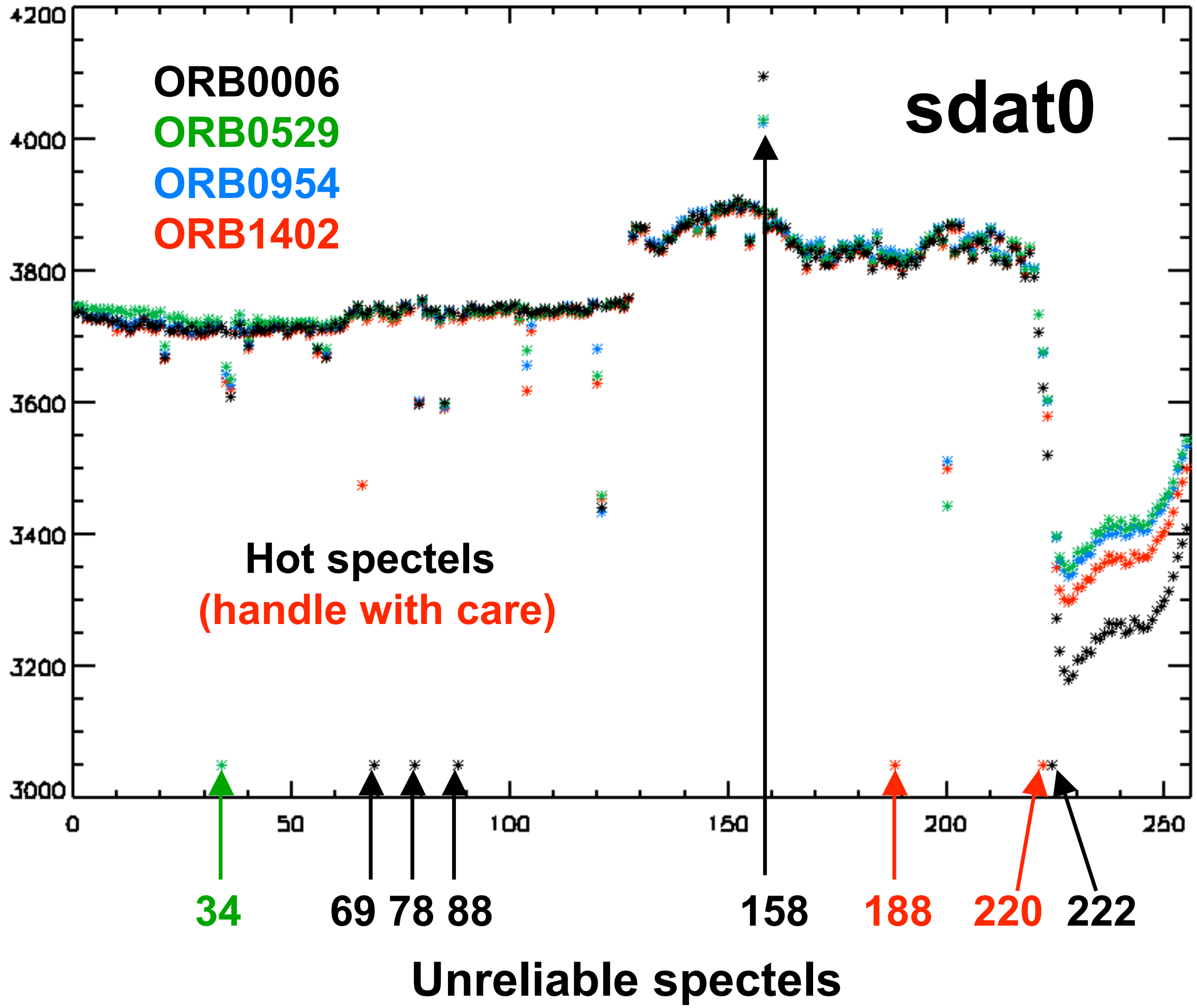
DEAD AND HOT SPECTELS: EVOLUTION WITH TIME

- Hot and dead spectels are not (fully) reliable.
- They increase over time due to detector degradation
- sdat0 must be checked regularly

5 spectels have been dead hot or cold (158) since the beginning

Cosmic ray degradation resulted in the loss of 3 additional spectels:
34 since orbit 0432
188 very recently (1402)

new hot spectels
(lower by < 100 DN)
can still be used
in spectral ratios,
but the photometric function has changed
→ « spikes » in jdat



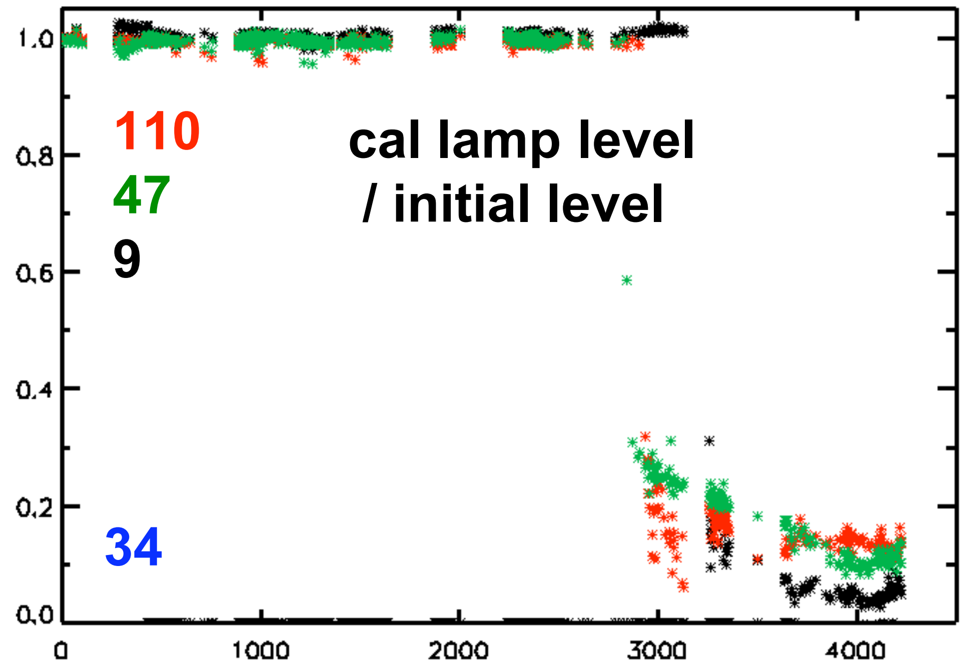
Evolution of spectels with time results from cosmic rays (caught in the act in some cases)

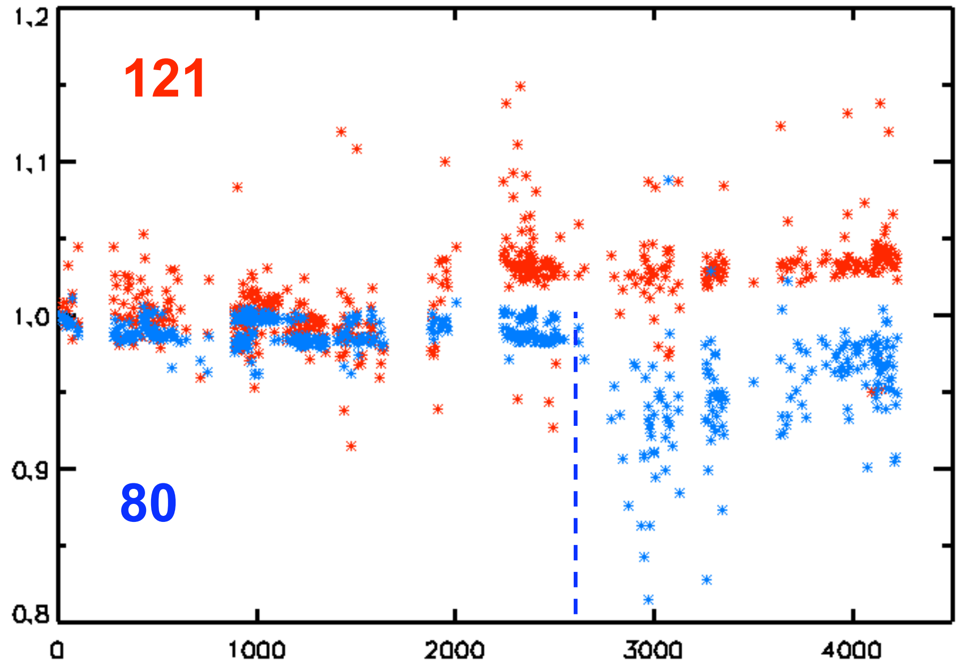
bad spectels:
photometric efficiency suddenly decreases to low values after an observation (MOI: 78, 158, 222)

34: orbit 166 | 72: orbit 2420
133: orbit 2650 | 110: orbit 2772
47: orbit 2830 | 9: orbit 3125
97: orbit 3400 | 116: orbit 3700

Unreliable spectels
The cal lamp level changes by up to 15% from one orbit to the next
« spikes » in the spectrum

Can be initiated by a cosmic ray (spectel 80: after orbit 2610)





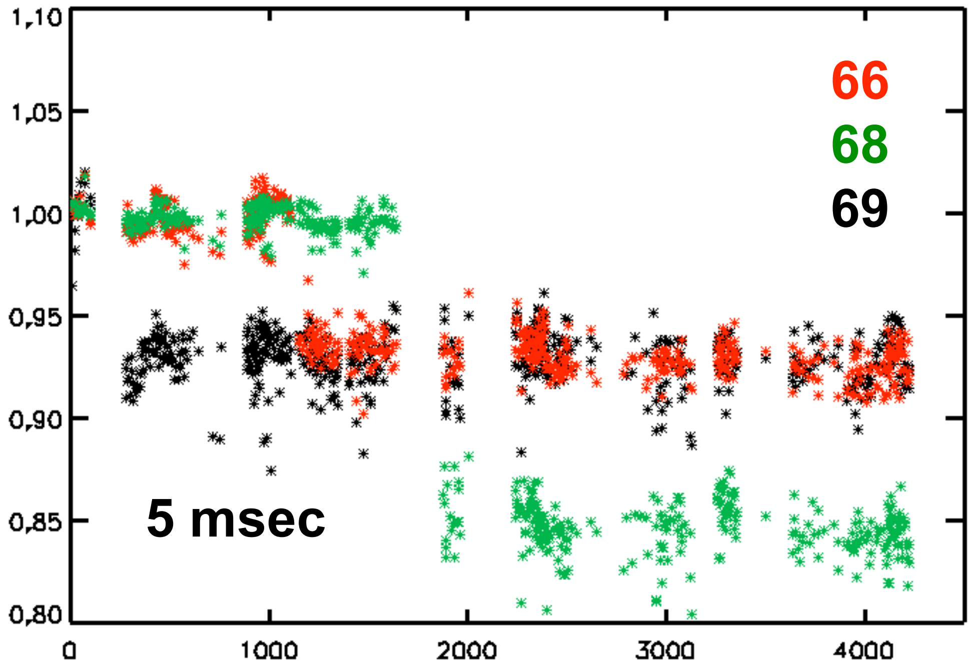
Recoverable spectels:
66, 68, 69

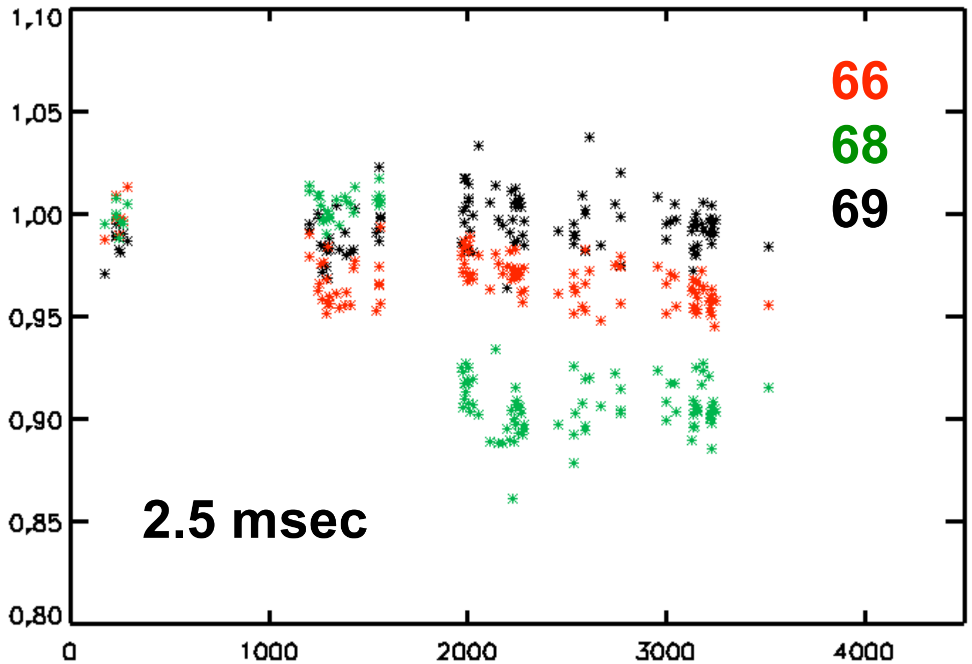
after the damage, the level remains stable

Can be corrected
by using the same ratio as in the cal signal
(different for 2.5 and 5 msec)

impact on linearity

L channel: 155,172





Consequences for the pipeline (SOFT04 and further releases)

- three files are being updated regularly:
  - bound(070201).dat   256 values: orbit numbers of transitions
  - rap(070201)_50.dat   ratios for 5 msec (256 values)
  - rap(070201)_25.dat   ratios for 2.5 msec (256 values)

  - values for bad spectels are set at 0 after the transition
  - values for recoverable spectels are divided by the ratio from the cal levels at the relevant integration time

The « ic » array provides the reliable spectels

plot, wvl(ic), jdat(i, ic, j)

This will become increasingly useful for further releases

OMEGA INSTRUMENTAL PROBLEMS

2. Stability of the L channel

INTERNAL CALIBRATION OBSERVATIONS

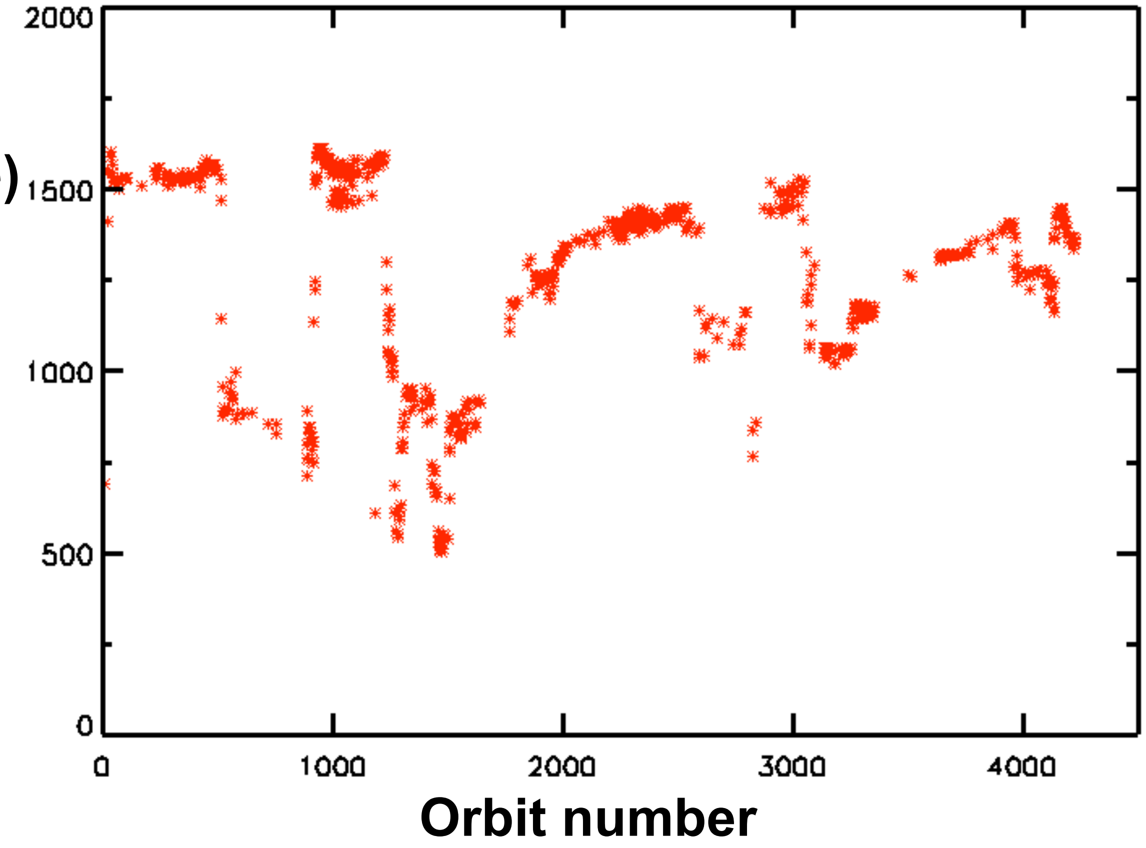
Only available in cubes ORBNNNN_0
Detector temperature sdat1(2,1,0) * 1.e^{-3} must be < - 185° C

Evolution cal level L

(pixel 165, lamp: 4th cycle)
Temp. detector < 83 K

relatively stable since
orbit 3500

the photometric efficiency
is within 6% of that of the
« high » state



Spectral ratios are OK
Absolute values are OK when the cal lamp level is not too far from 1500

OMEGA INSTRUMENTAL PROBLEMS

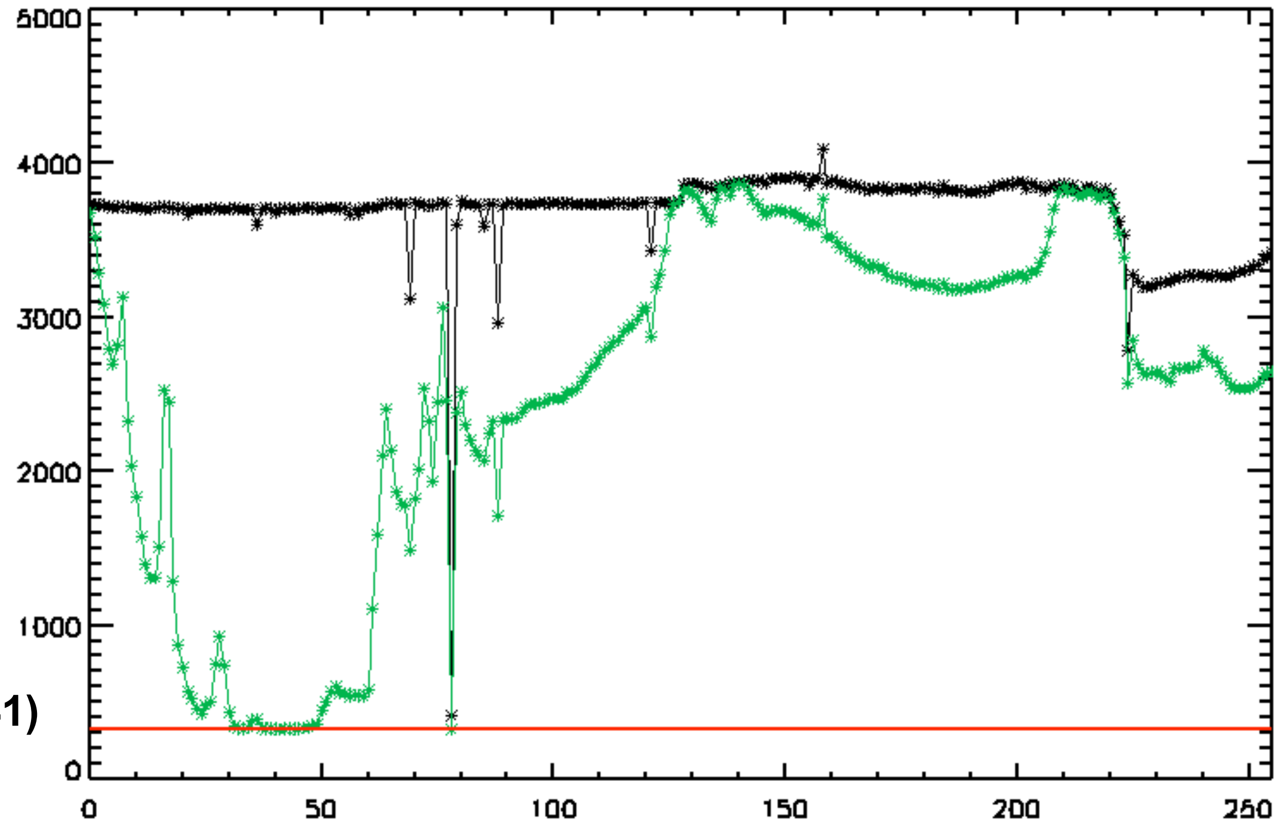
3. Saturation

DARK CURRENT AND SATURATION (IR)

- OMEGA uses a « pre-charge » design
  black: sdat0(0:255,n)
- dead and hot spectels: low pre-charge levels
- photons reduce charge: raw signal (green) is lower than pre-charge

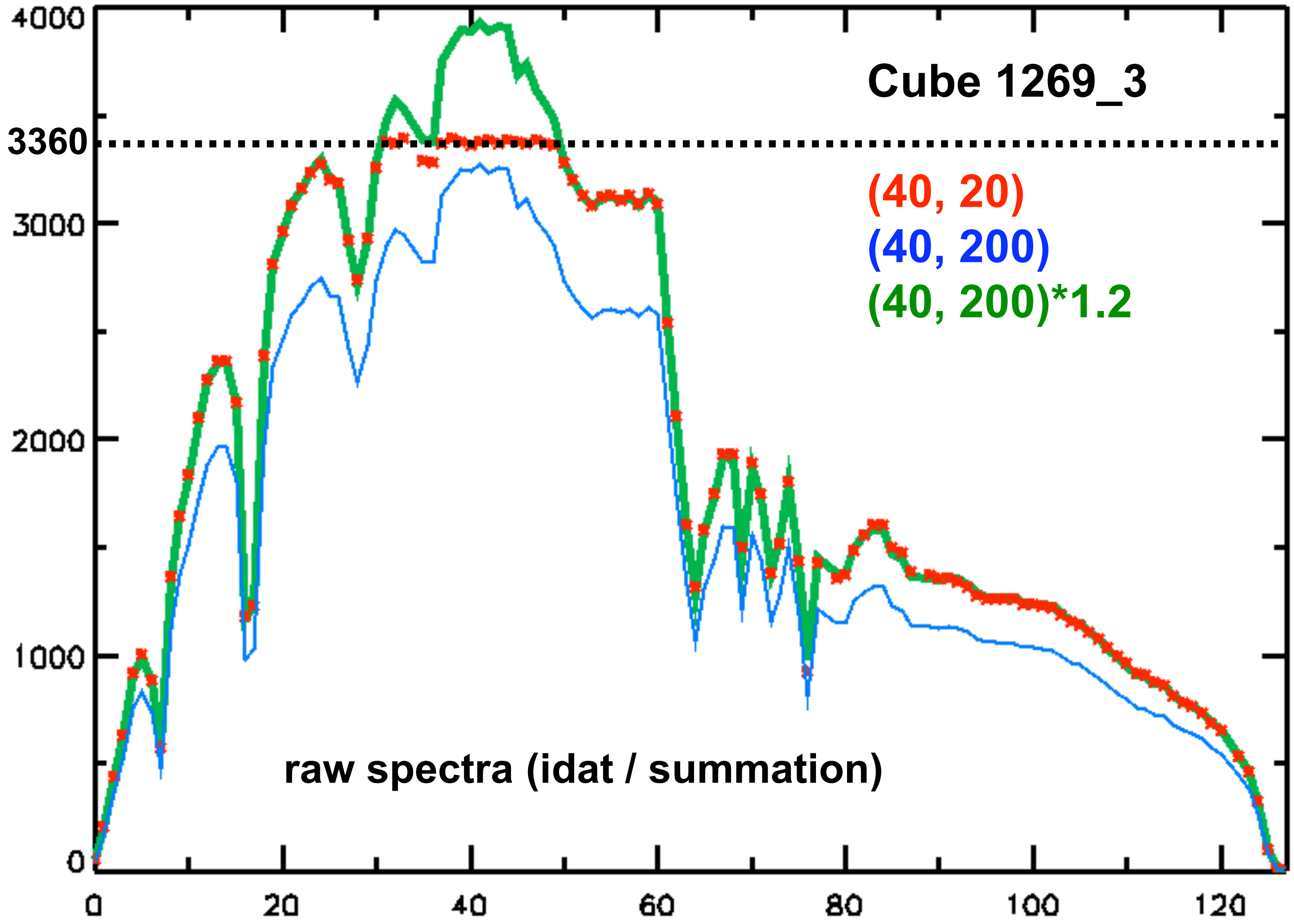
  idat = pre-charge - raw

  saturated level: ~ 327 DN
  (most vulnerable: spectel 41)

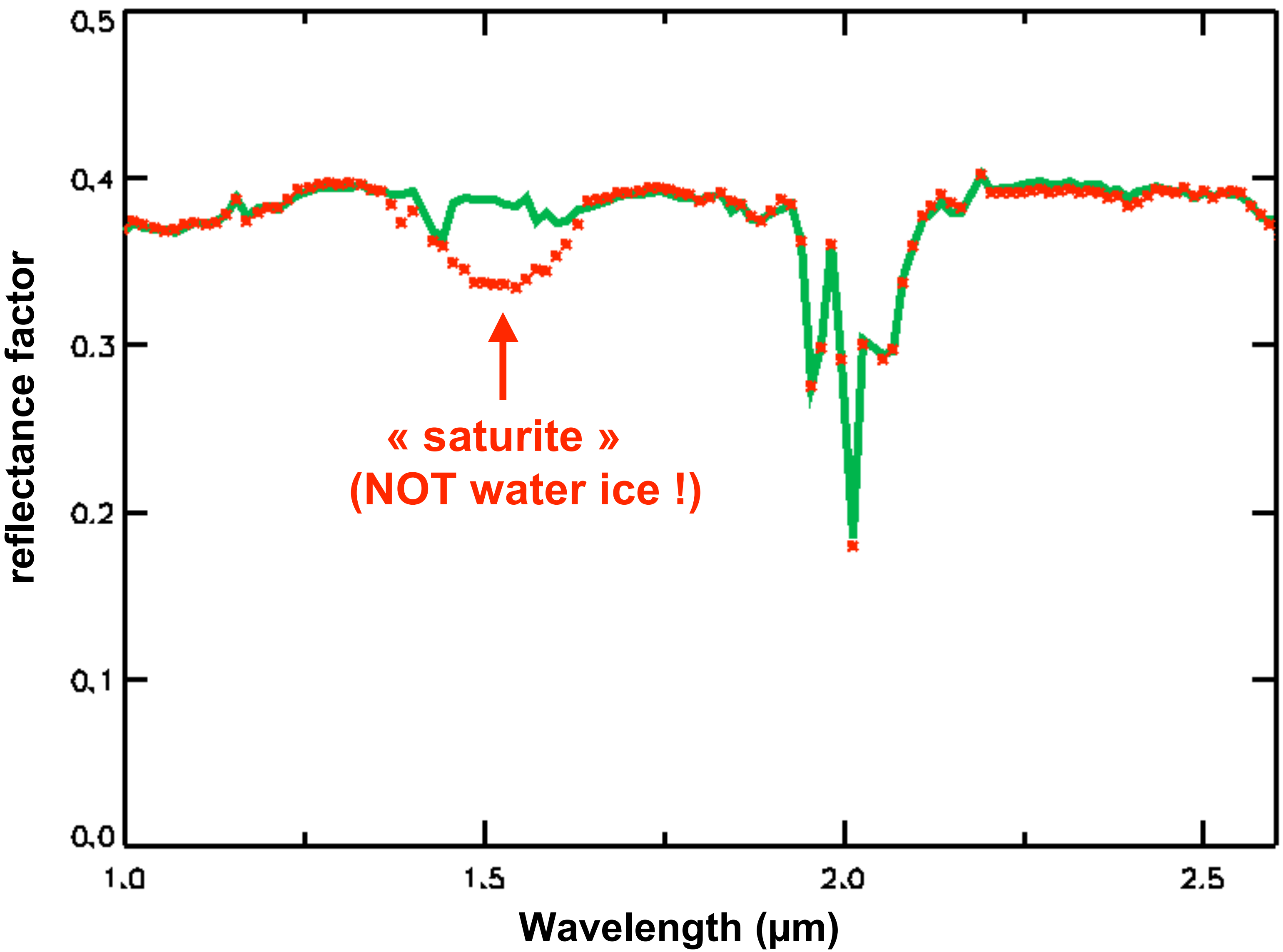


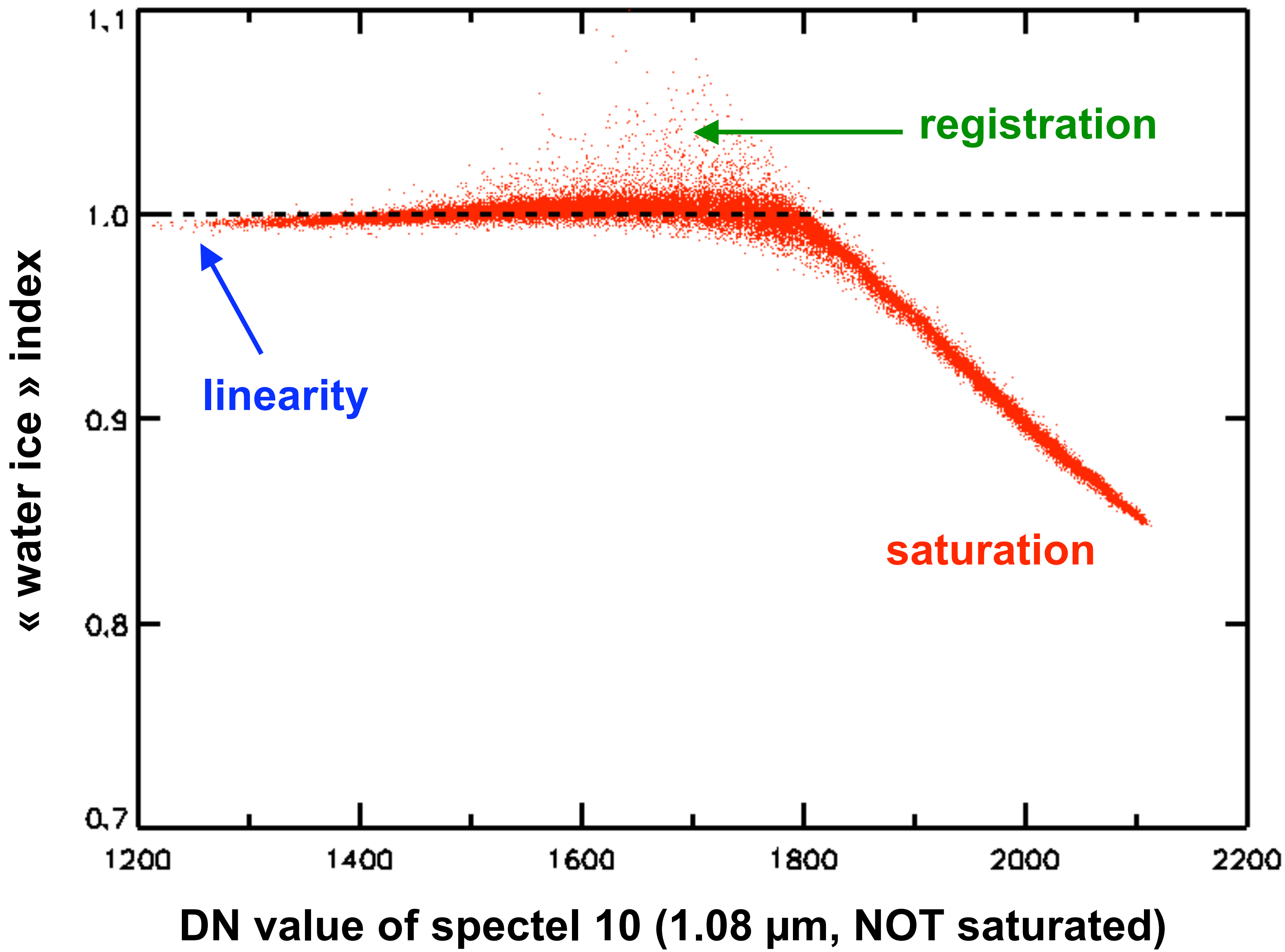
- Saturation reveals itself as a spurious absorption close to 1.5 μm
  this can be checked by plotting sdat0(0:255,n) – idat(i,0:255,n)
  if the raw signal reaches values in the 330 range, the signal is saturated
- there is some hysteresis at near saturation, which impacts the value of the dark current for 16 pixel modes

Example of a saturated spectrum



Example of a saturated spectrum




registration
linearity
saturation
« water ice » index
DN value of spectel 10 (1.08 µm, NOT saturated)
1,1
1,0
0,9
0,8
0,7
1200
1400
1600
1800
2000
2200

OMEGA INSTRUMENTAL PROBLEMS

4. Linearity

LINEARITY ISSUES

Example: band depth at 1.5 µm

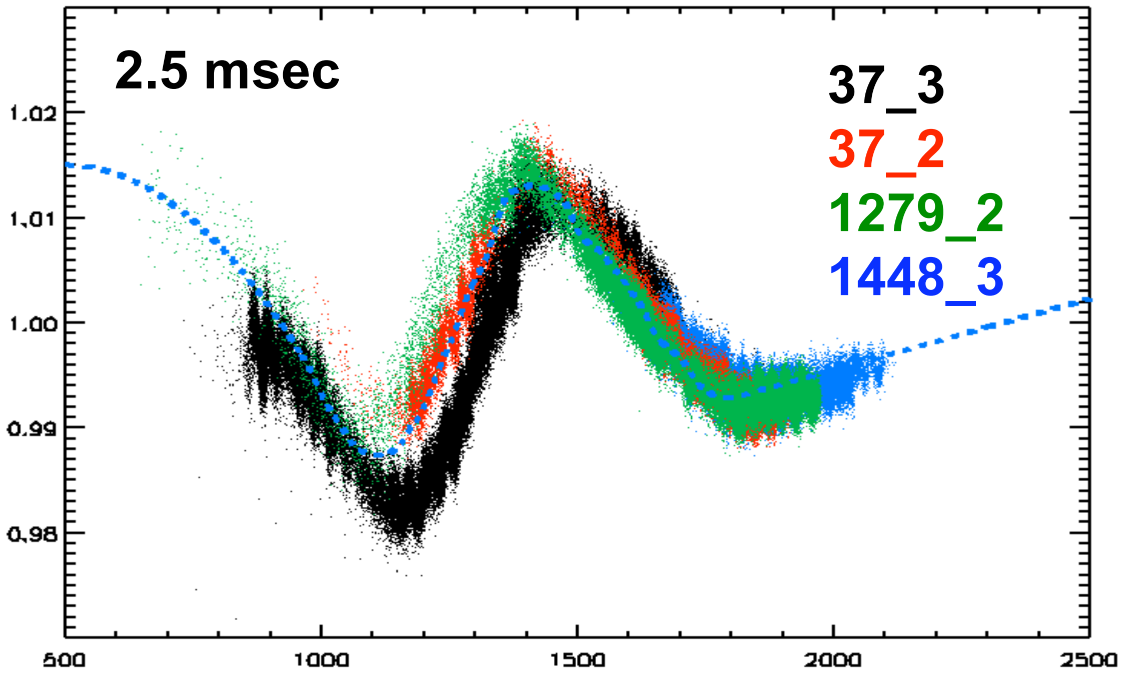
H2O ice, band center close to the maximum of the photometric function

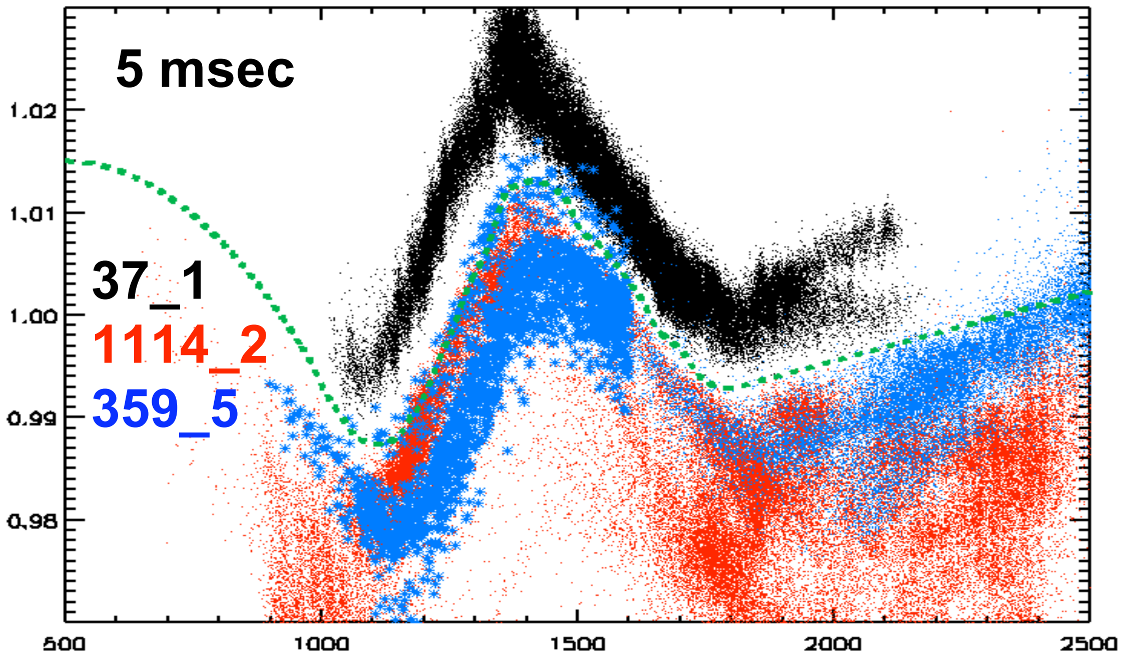
Main danger zone:

Signal between 1000 and 1800 DN (before summation)

Variations by a few % in summer at low latitudes (no ice)

Similar patterns, but significant shifts between orbits

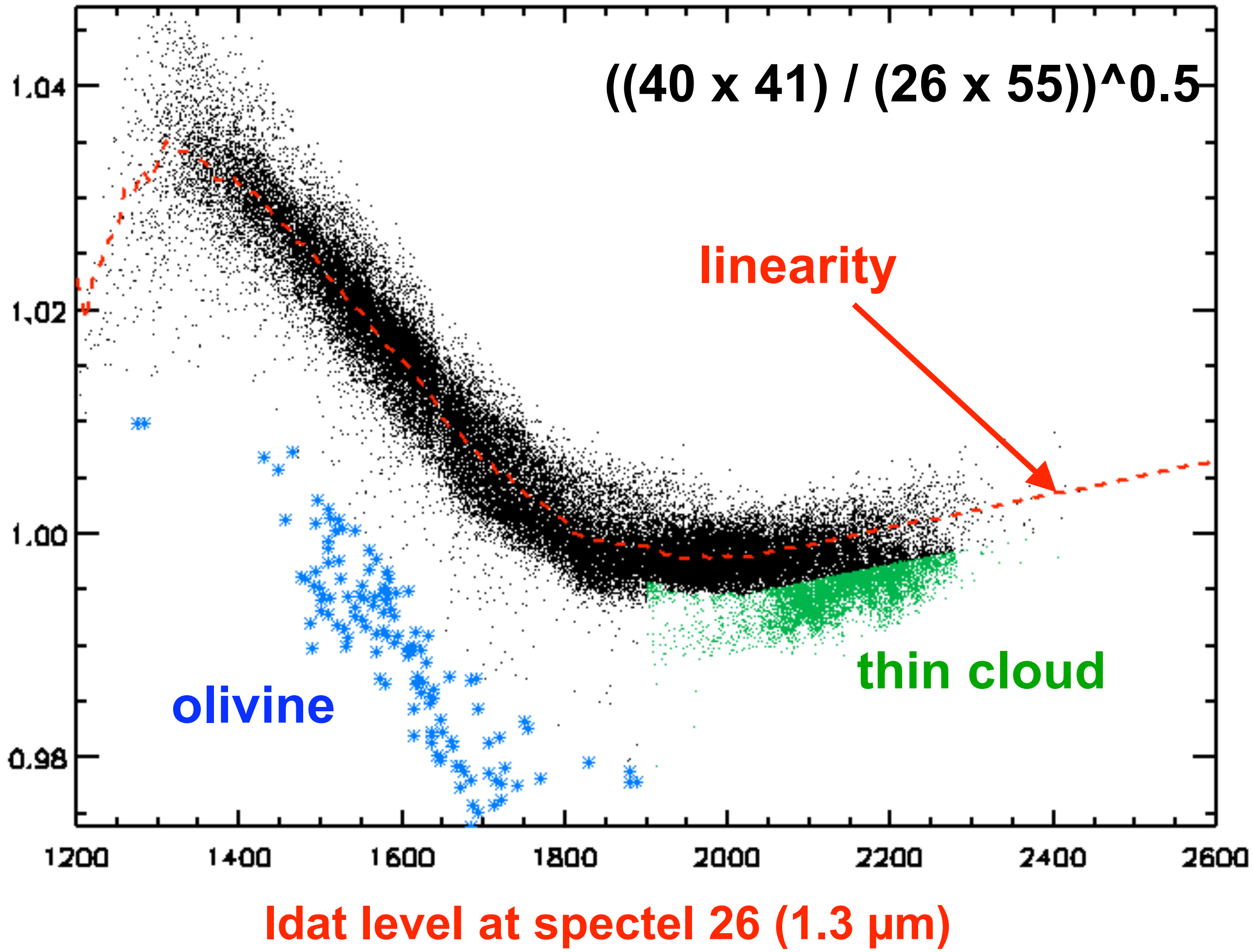




LINEARITY ISSUES AND CONFIDENCE LEVELS

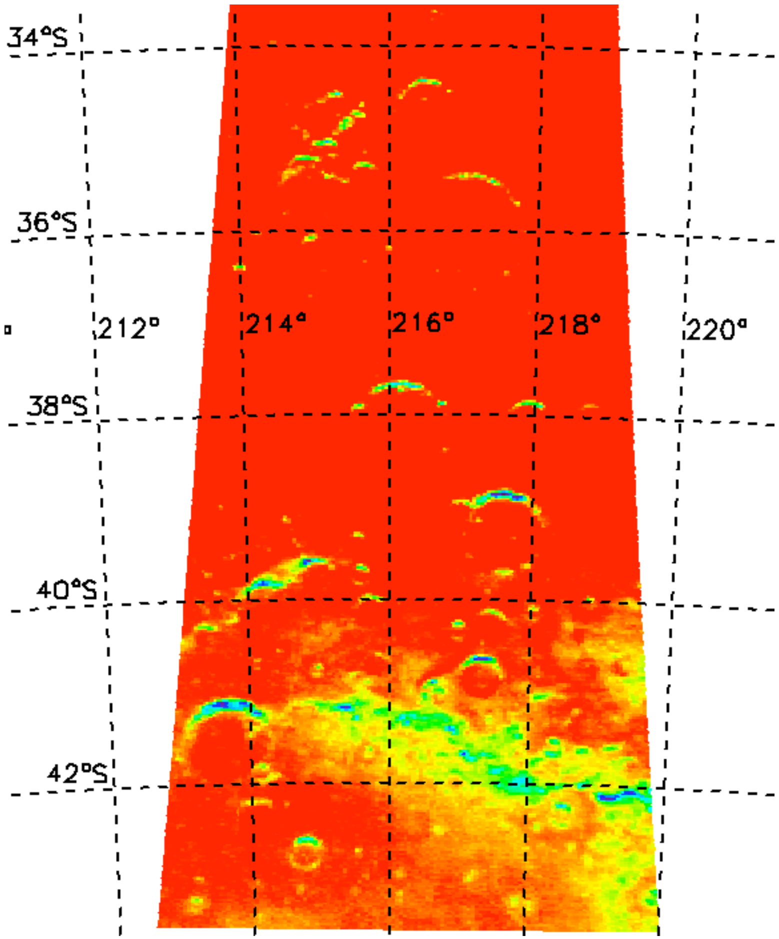
OMEGA, in particular the IR channel can provide S/N > 1000

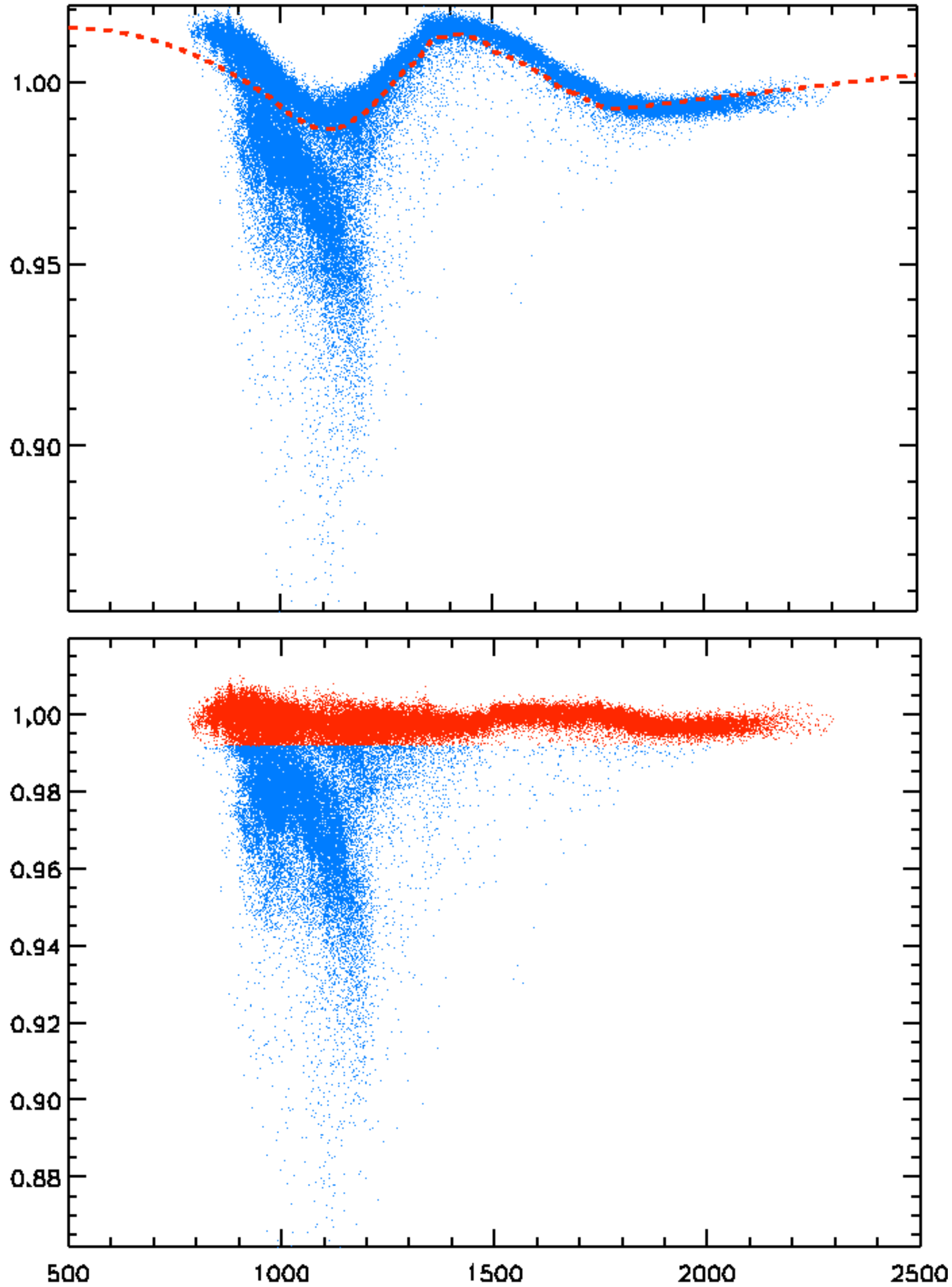
- even minor instrumental effects are prominent
- there is a non linearity at a level of a few % which changes with time
- a given spectral ratio can slightly vary with illumination (idat level) as well as from actual mineralogical variations
- ratios of spectra at similar idat levels can confirm identifications



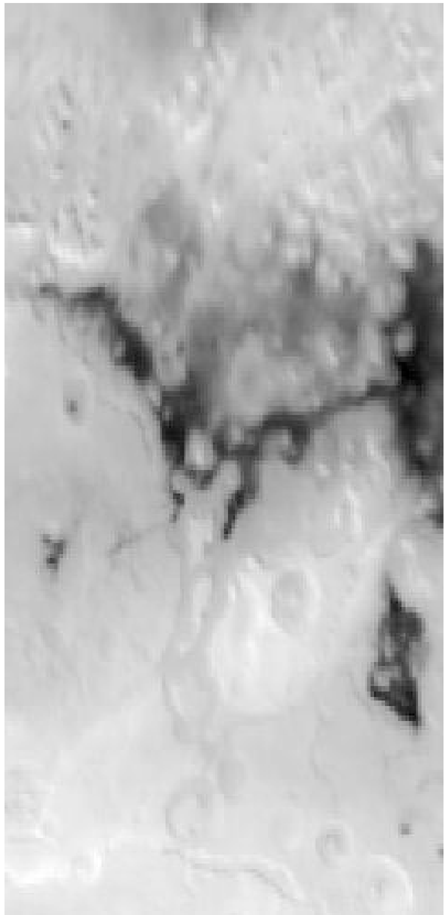
ORBIT 1254_3

H_2O ice patches on South facing slopes

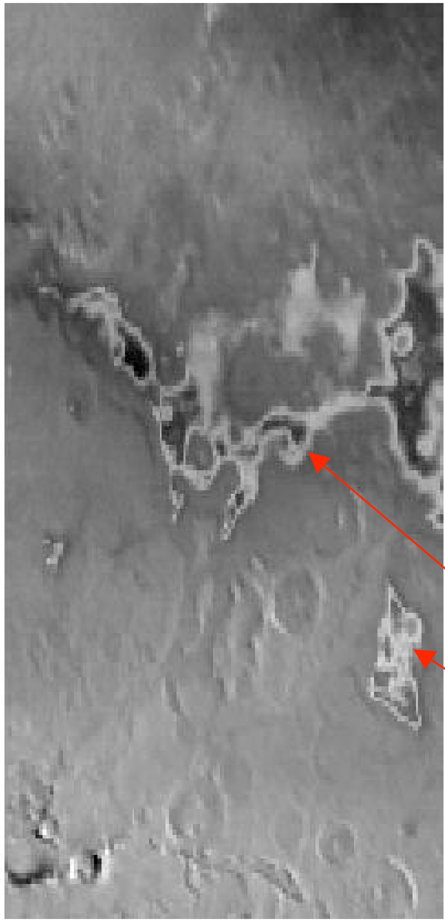




Typical linearity features:
« false deposits » around dark regions
(cube 359_5)

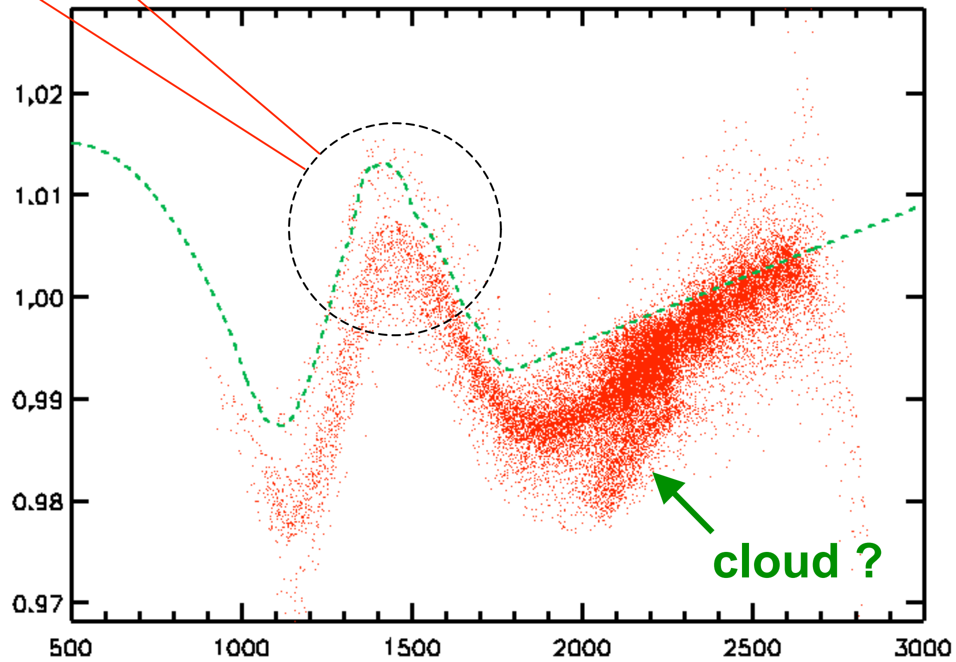


albedo at 1.3 µm
(0.15 to 0.45)



1.5 µm band strength
(0.965 to 1.025)

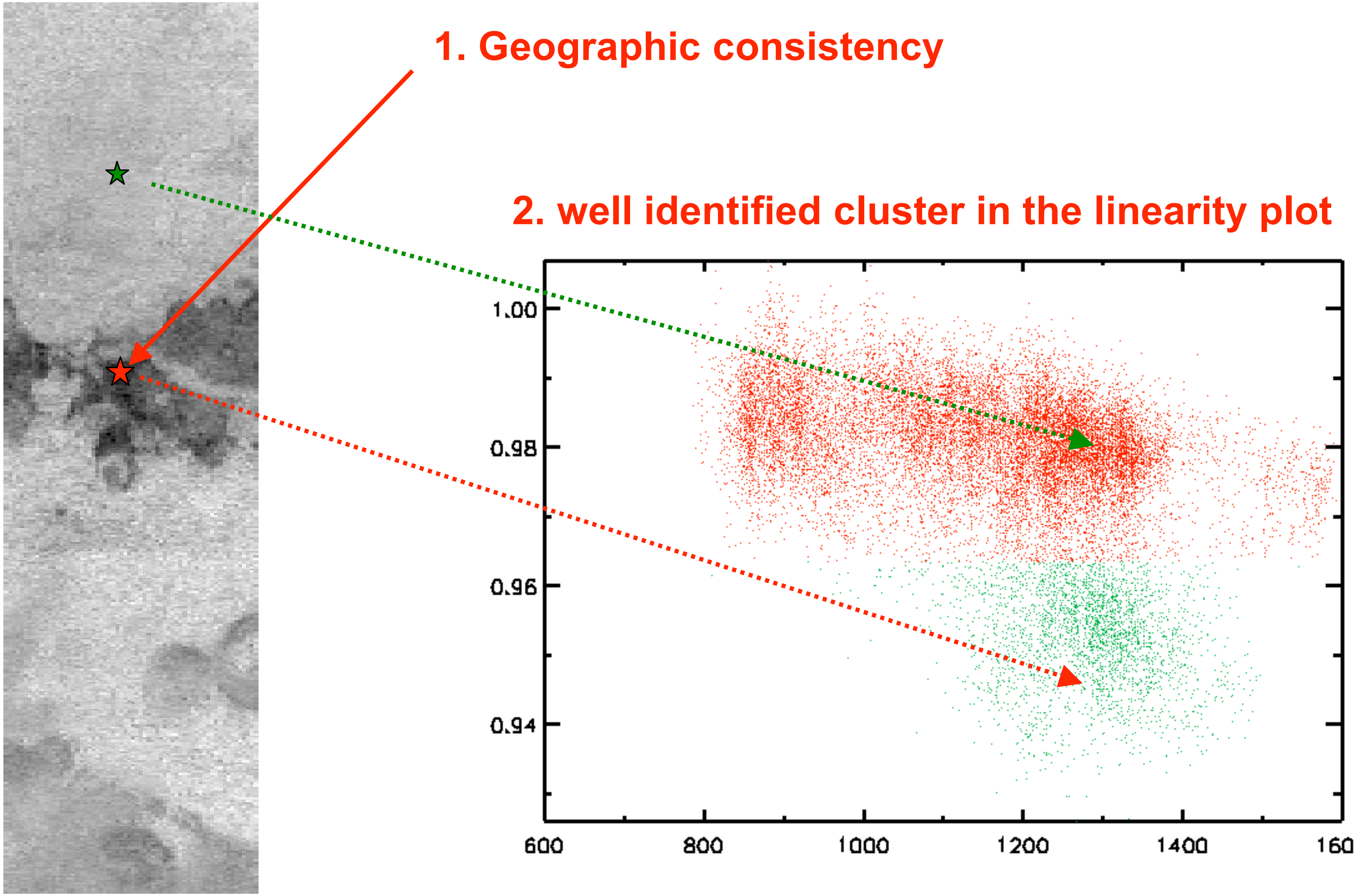
1.5 µm band strength



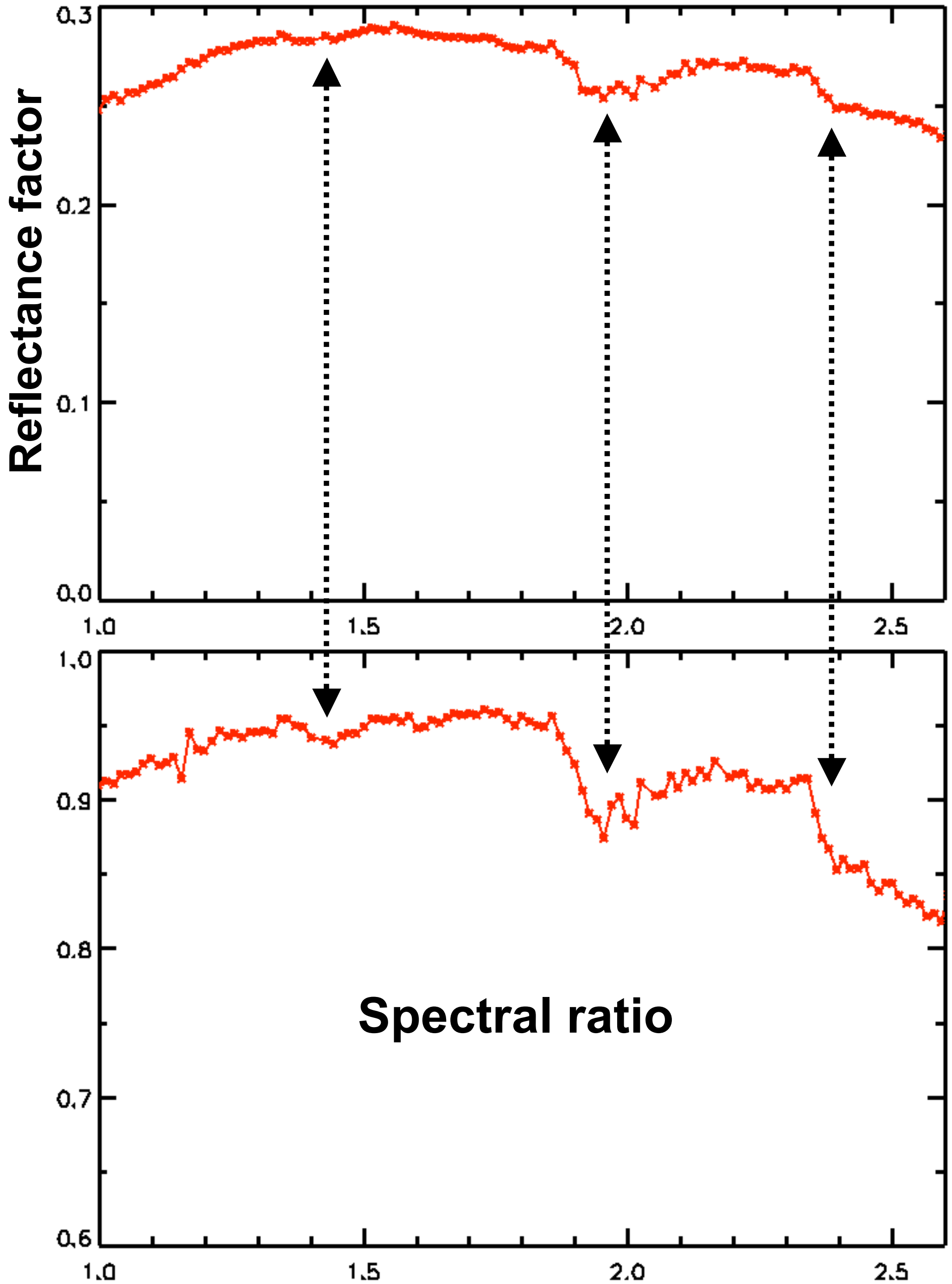
Idat(*,26,*) / summation

THE THREE LITMUS TESTS FOR A RELIABLE DETECTION

example : 1.92 µm hydration feature of sulfates, oxides and clays



3. Similarity of the spectral features between the I/F spectrum and a spectral ratio to a reference region



Opportunity landing site:

4. Ground truth !

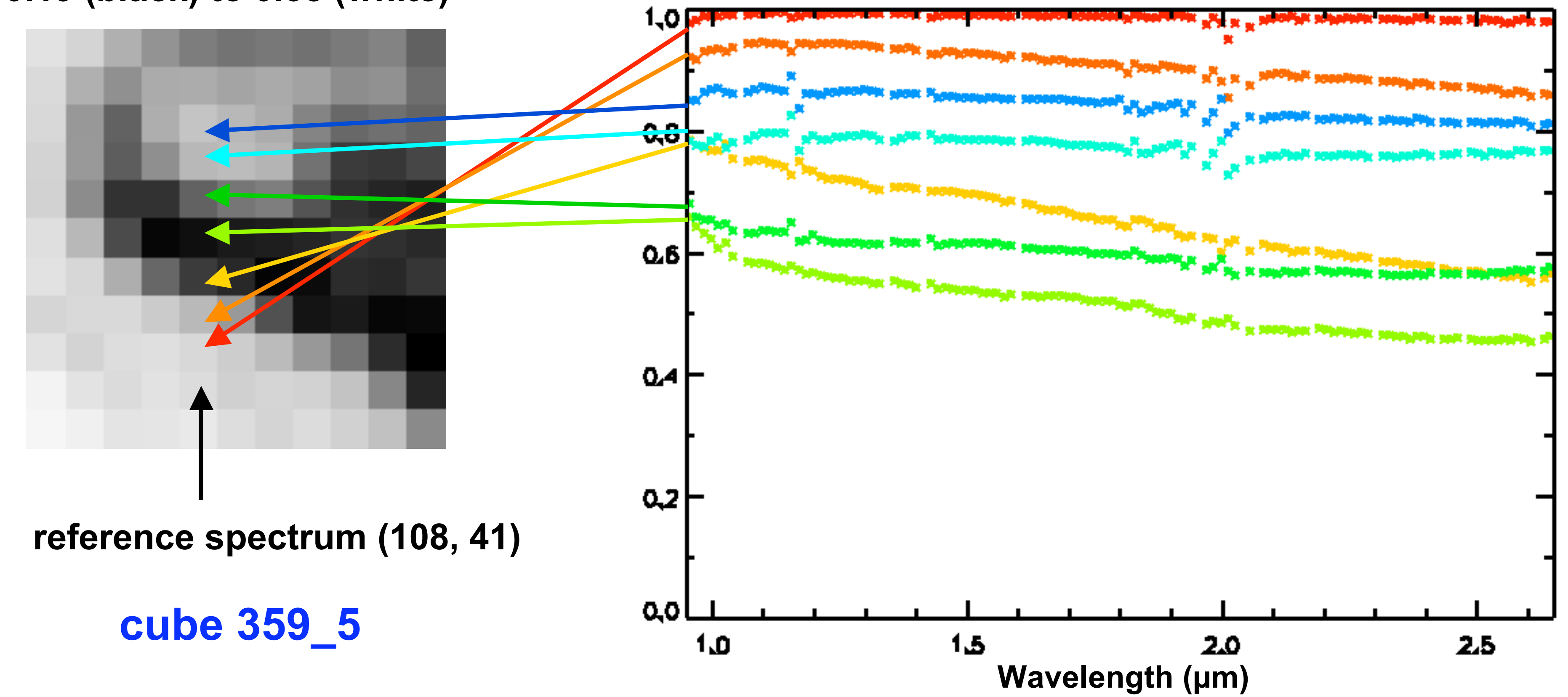
OMEGA INSTRUMENTAL PROBLEMS

5. Registration

REGISTRATION PROBLEMS

The looking direction of each spectral element can be slightly different this can impact spectra when strong contrasts are present,

Albedo map at 1.3 µm: 0.19 (black) to 0.38 (white)



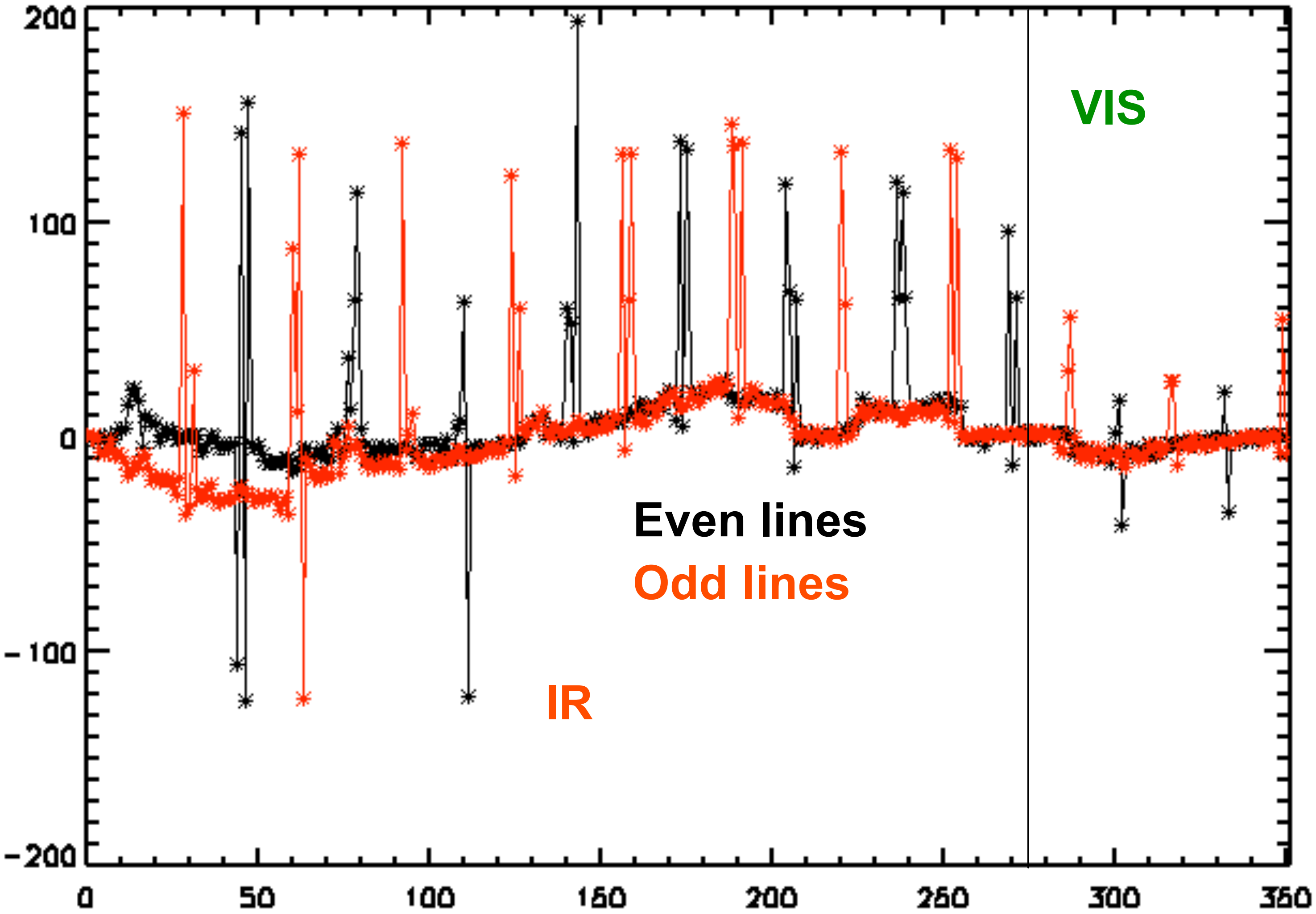
Registration effects are negligible for regions homogeneous over > 3 pixels

The contribution of aerosol scattering is larger in relative terms when the albedo is low. It depends on the season, local storms…

OMEGA INSTRUMENTAL PROBLEMS

6. Corrupted region in 128 pixel scans

SPURIOUS VALUES FOR PIXELS 80-95 (128 pixel modes) FOR SOME WAVELENGTHS SINCE ORBIT 0513



Difference between pixel 80 and pixel 79

Corrupted regions in 128 pixel scans

- 80 – 95 from orbit 513 to orbit 2130
- 65 – 127 after orbit 2130

perturbations are not at the same wavelengths for odd lines and even lines

a comprehensive spectrum can be recovered at a lower resolution

This is reliable only at > 5 % (major absorptions : ices)

first level advice is not to use these parts of the 128 pixel cubes

the OMEGA team decided a few months ago not to implement the 128 pixel mode

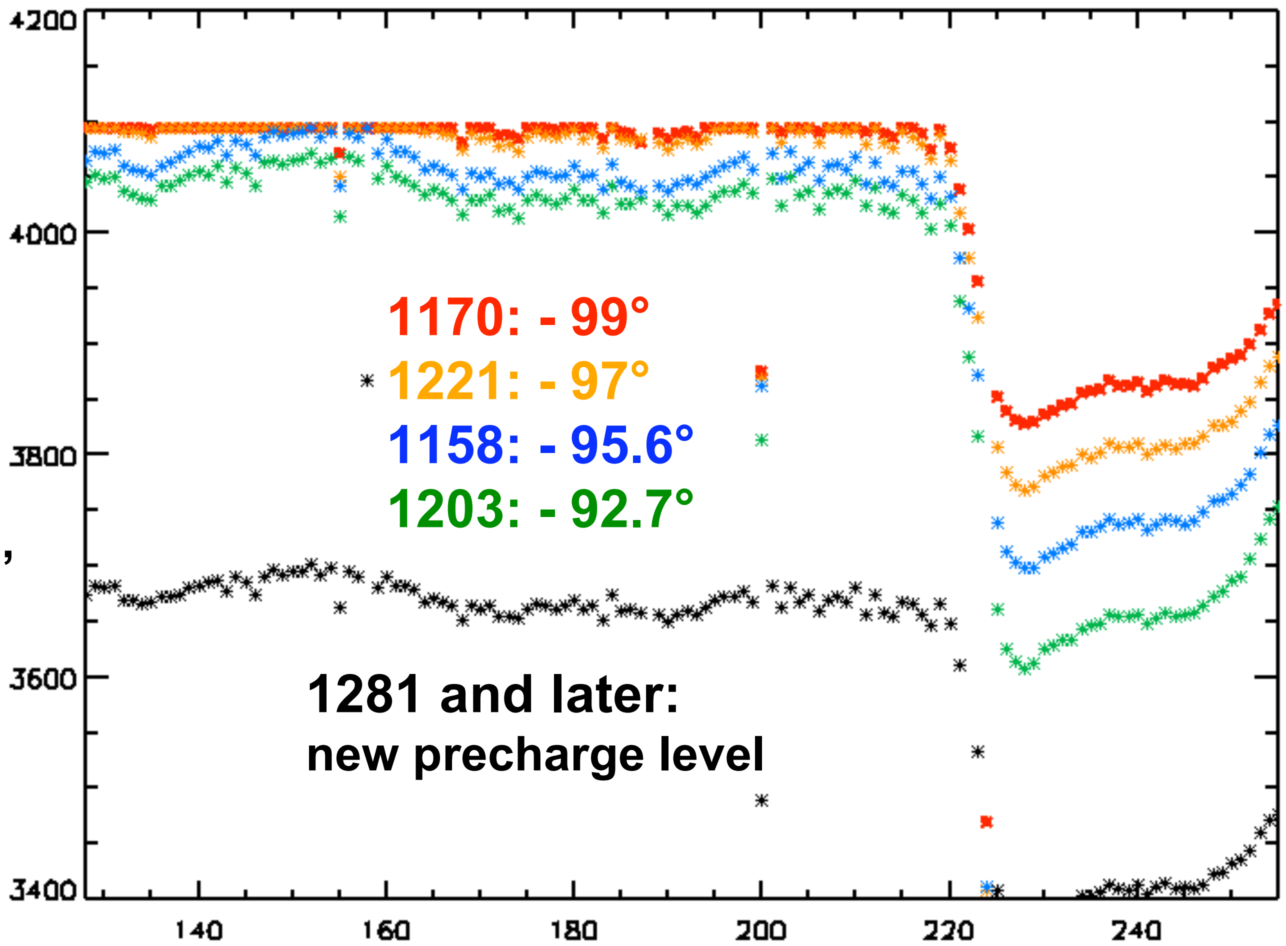
OMEGA INSTRUMENTAL PROBLEMS

7. Saturation of the dark in the L channel

Small range of orbits from 1140 to 1279
the problem was identified and corrected
by adjusting the precharge

SATURATION OF THE BACKGROUND LEVEL ON THE L CHANNEL

- high fluxes from orbit 1150 (low incidence reduced Rs)
- switch to 2.5 msec int. time (IR) near the subsolar point
- eclipse season begins, reduced flux from the spectrometer: the « shutter closed » signal gets close to digital saturation (12 bits: 4095)

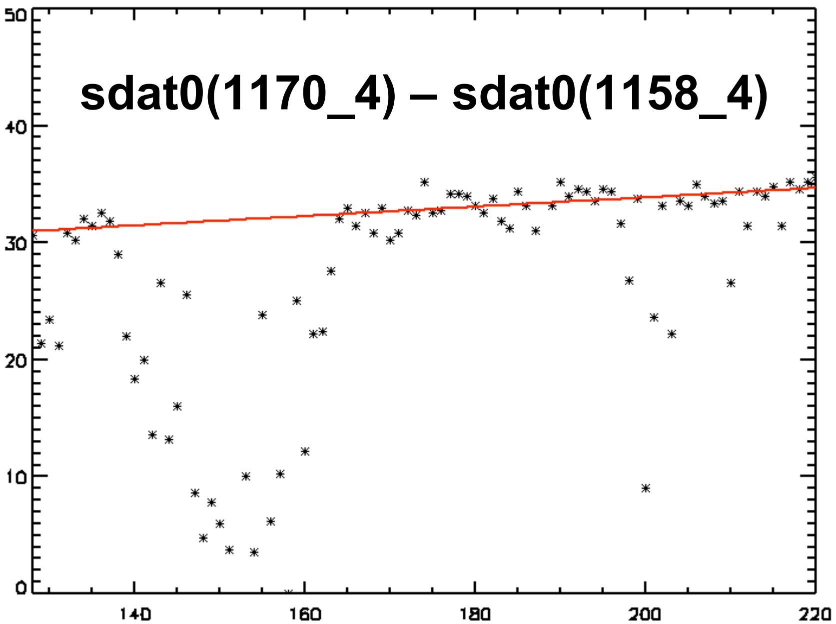


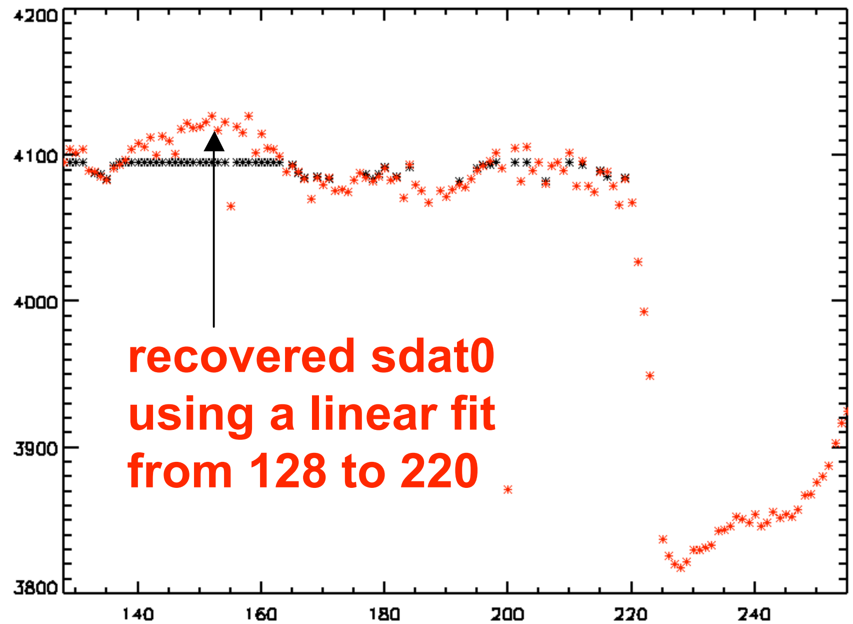
Part of the L channel can be impacted when IR exposure = 2.5 msec

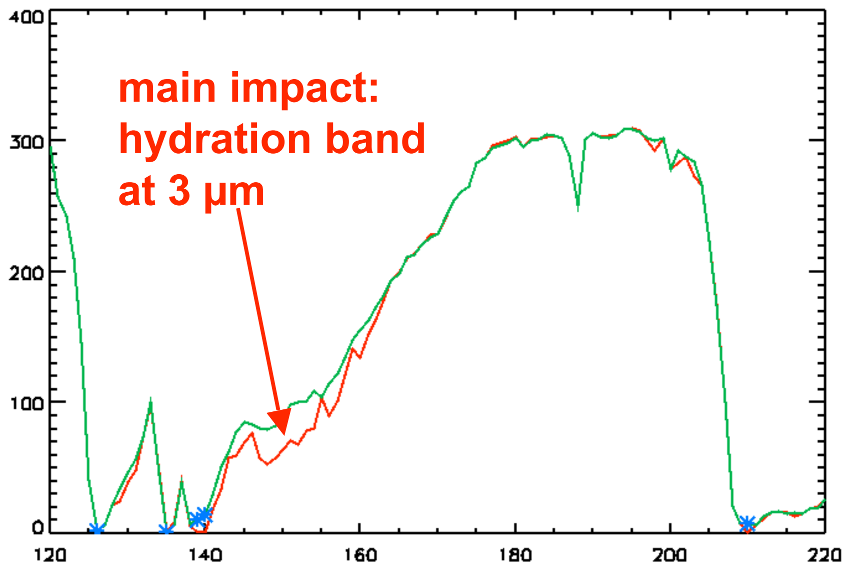
Signature: flat sdat0 (background level) from 128 to 220

Danger zone: orbits 1150 to 1279

RECOVERY PROCEDURE USING SDAT0 FROM 1158_4





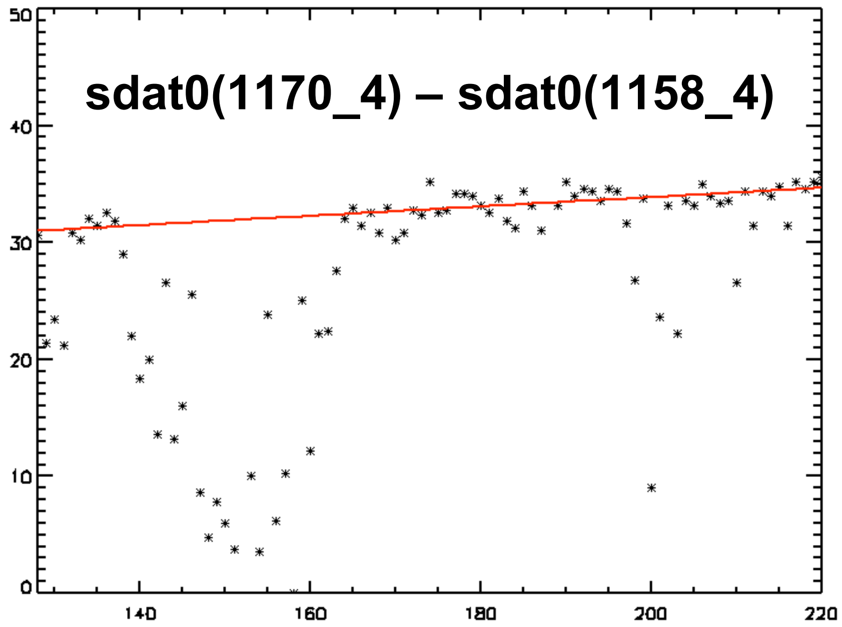


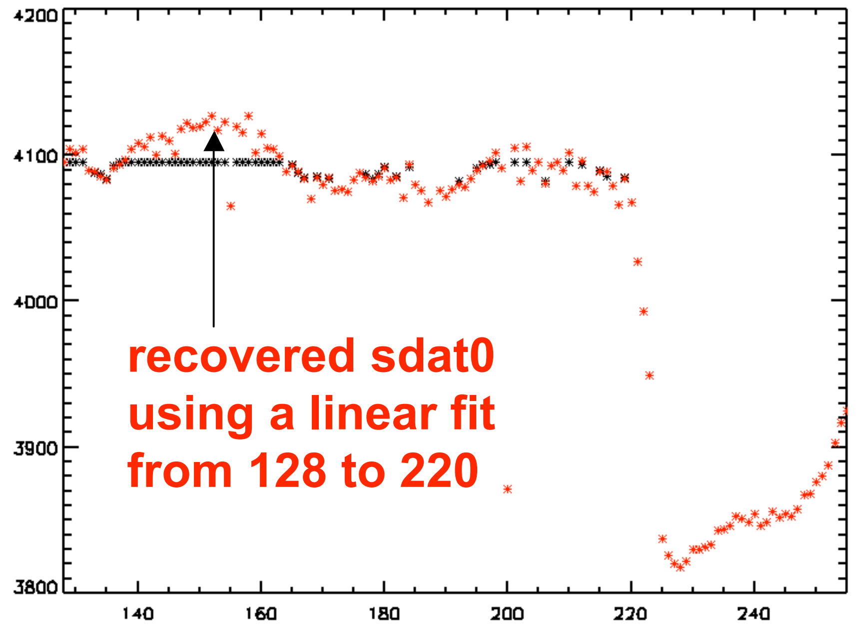
red: raw spectrum idat(8,*,4850)

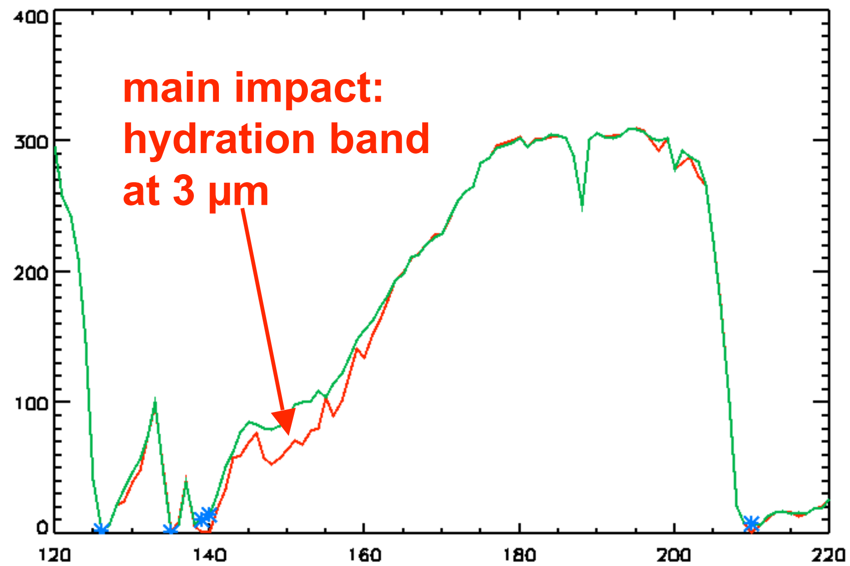
green: recovered idat(8,*,4850)
(idat – sdat0 + sdat0_recovered)

Blue stars: sdat0-idat at 4095
(no possible recovery)

RECOVERY PROCEDURE USING SDAT0 FROM 1158_4







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(idat – sdat0 + sdat0_recovered)

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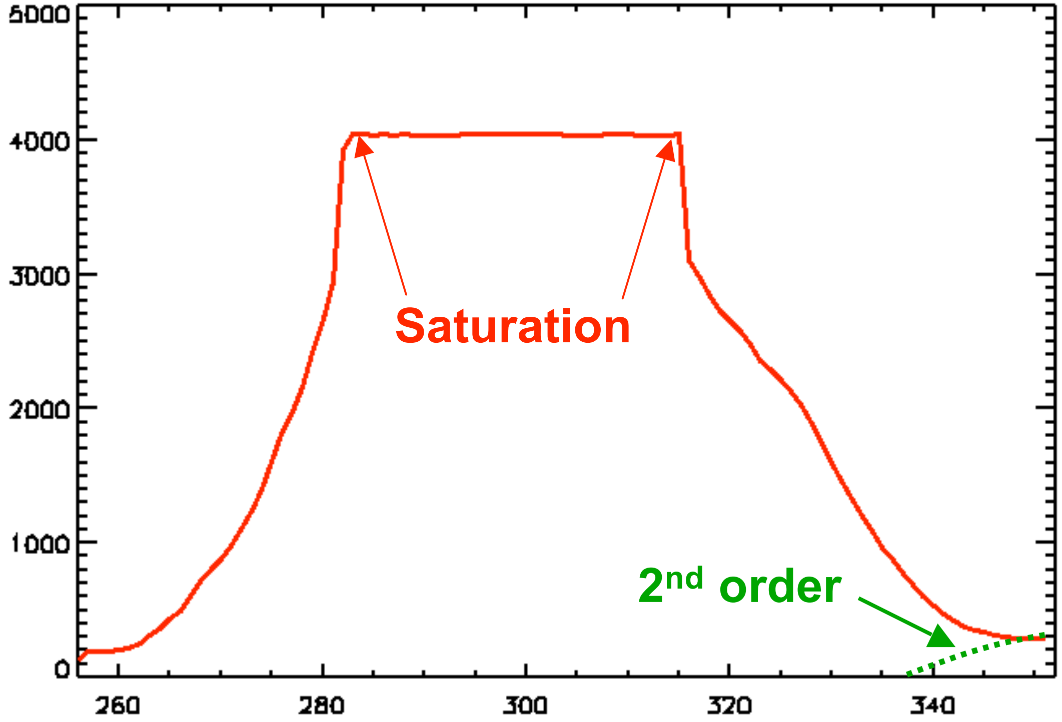
(no possible recovery)

OMEGA INSTRUMENTAL PROBLEMS

8. Problems with the visible channel

VISIBLE CHANNEL: FLAT FIELD, 2nd ORDER, SATURATION

- a flat field must be applied as there are 128 rows of 96 spectels
- The visible channel reaches physical saturation (4040 DN) close to digital saturation (4095 DN)
- idat can be larger for modes with 128 pixels (summation by 2 in the VIS channel + possible summation of 2 or 4 successive scans : « summation » parameter)
- The PSF is large (~ 4 pixels) in the cross-track direction
- Offset by ~ 4 pixels and 4 lines relative to the C channel (IR)



A second order contribution is observed beyond spectel 335 (0.95 µm)

« readomega » takes care of the VIS flat-field, second order and summation