

# SOIR

## Archive description



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# Overview

- ❑ SOIR measurement modes
- ❑ Treatments between Level 2 and Level 3
- ❑ PSA Level 2
- ❑ PSA Level 3



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# SOIR measurement mode: Description (1)

- ❑ SOIR can send 8 spectra per second to the Earth
- ❑ At most 4 different AOTF frequencies per second
- ❑ → different binning cases

Denomination (Binning configuration)	Number of scanned orders	Number of lines in each bin	Number of binning groups
2 x 16	4	16	2
2 x 12	4	12	2
4 x 4	2	4	4
4 x 3	2	3	4
8 x 4	1	4	8
8 x 3	1	3	8

- ❑ 2 types of command
  - Hopping: same AOTF frequencies are repeated
  - Stepping: AOTF frequency is stepped by regular value



## SOIR measurement mode: Description (2)

- ❑ When SOIR is turned on:
  - Precooling for 600 s
  - Measurement
  
- ❑ Detector integration time
  - Varies between 1 ms and 150 ms
  
- ❑ Accumulations
  - Made to reduce the signal to noise
  - Vary between 1 and 23
  - Each accumulation results of difference between record with AOTF ON and AOTF OFF



# SOIR measurement mode: Types of measurements

- ❑ Different types of measurement are available
- ❑ Occultations:
  - Ingress (hopping) – binning 12 or 16 (I) or binning 3 or 4 (I8)
  - Egress (hopping) – binning 12 or 16 (E) or binning 3 or 4 (E8)
  - Atmospheric fullscan (stepping) – any binning
- ❑ Nadir (N) – hopping
- ❑ Calibration measurements:
  - Miniscan (M) – stepping with small steps – any binning
  - Fullscan (F) – stepping with large steps = 1 order – any binning
  - Other calibrations (C)

Measurement type	Acronym
Ingress	I
Egress	E
Sun fullscan	F
Atmospheric fullscan	A
Miniscan	M
Nadir	N
Other calibration	C



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- ❑ SOIR measurement modes
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## Treatments between Level 2 and Level 3 (1)

### ❑ Detector non-linearity correction

- At low signal, non-linear response of the detector pixels
- References
  - ❖ Nevejans et al., *Compact high-resolution spaceborne echelle grating spectrometer with acousto-optical tunable filter based order sorting for the infrared domain from 2.2 to 4.3  $\mu\text{m}$* , Applied Optics, Vol. 45, No. 21, 20 July 2006
  - ❖ Mahieux et al., *In-flight performance and calibration of SPICAV SOIR onboard Venus Express*, Applied Optics, Vol. 47, No. 13, 1 May 2008

### ❑ Order determination

- $f_{\text{AOTF}} \rightarrow$  wavenumber
- Wavenumber compared to wavenumber centre of each diffraction order
- Minimum value gives the diffraction order

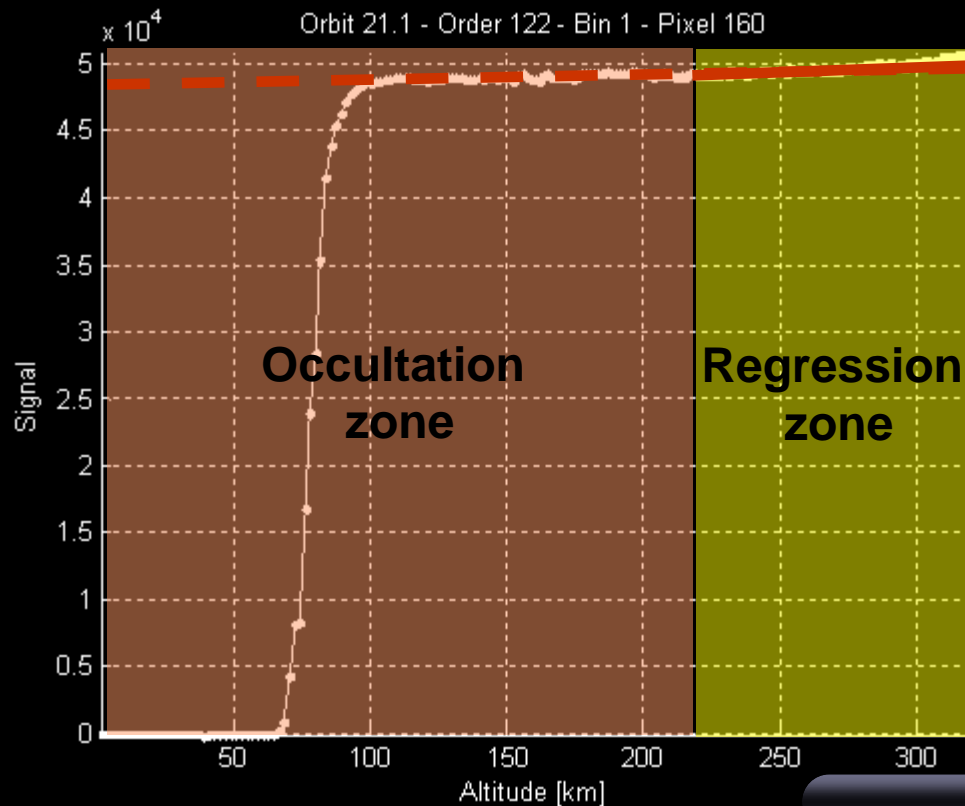




# Treatments between Level 2 and Level 3 (2)

## □ Transmittance calculation

- Regression zone
- Occultation zone
- Definition
  - ❖ Regression zone is at least 40 point above 200 km of altitude (tangent point)
  - ❖ If not, warning is issued in the quality byte (see later)



## Treatments between Level 2 and Level 3 (2)

❑ Pixel to wavenumber calibration

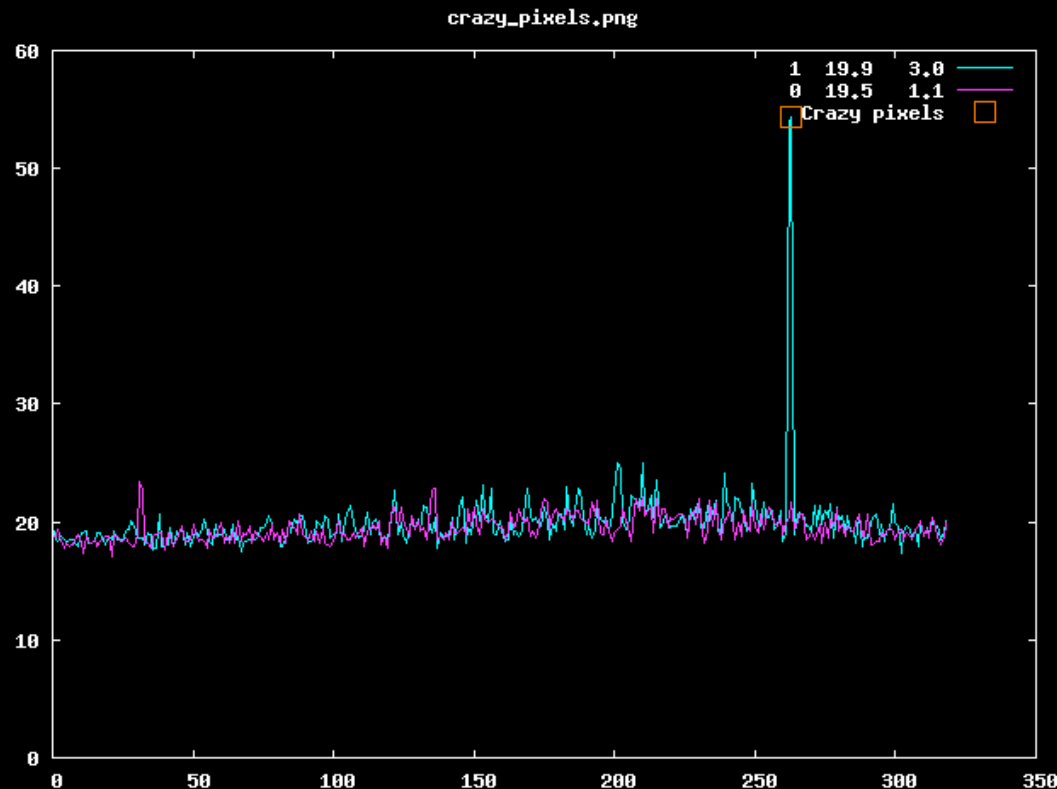
$$p = \left( a \cdot \left( \frac{\tilde{\nu}}{n} \right)^2 + b \cdot \frac{\tilde{\nu}}{n} + c \right)$$

$$\frac{\tilde{\nu}}{n} = \left( a' \cdot p^2 + b' \cdot p + c' \right)$$

❑ “Wrong” signal on pixels

➤ Corrected by averaging by the two side pixels

➤ Example: Orbit 130 (29/08/2006) Order 180 bin 2



## Treatments between Level 2 and Level 3 (3)

### ❑ Generation of the quality byte

Case	Description
0000 0000	No problem, no warning, occultation usable
0001 0000	Error: No telecommand received
0010 0000	Error: Detector temperature problem: too high
0011 0000	Error: Any other kind of error
0000 0001	Warning: Detector saturation
0000 0010	Warning: 40 points above 200 km
0000 0011	Warning: 30 points above 200 km
0000 0100	Warning: 20 points above 200 km
0000 0101	Warning: 20 points above 180 km
0000 0110	Warning: 20 points above 160 km
0000 0111	Warning: 20 points above 140 km
0000 1000	Warning: 20 points above 120 km
0000 1001	Warning: 20 points below 120 km
0000 1010	Warning: Very bad definition of the Sun regression

Error

Warning

## Treatments between Level 2 and Level 3 (4)

### □ Quality byte

- Detector temperature too high
  - ❖ Should be at 88 K
  - ❖ Error generated if error more than 10% above 88 K for at least one measurement (97 K)
  - ❖ Example: Orbit 490.1 and 490.3 (MINISCAN)
- Detector saturation
  - ❖ Too many accumulations, signal set to -1
  - ❖ Warning generated
- Sun regression
  - ❖ Condition is 40 points above 220 km
  - ❖ If not, other options are tested, and quality byte tells about it



# Overview

- ❑ SOIR measurement modes
- ❑ Treatments between Level 2 and Level 3
- ❑ **PSA Level 2**
- ❑ PSA Level 3



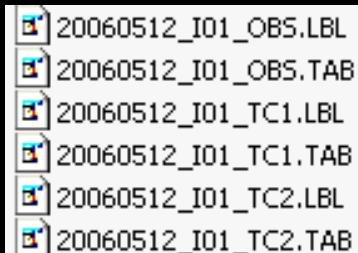
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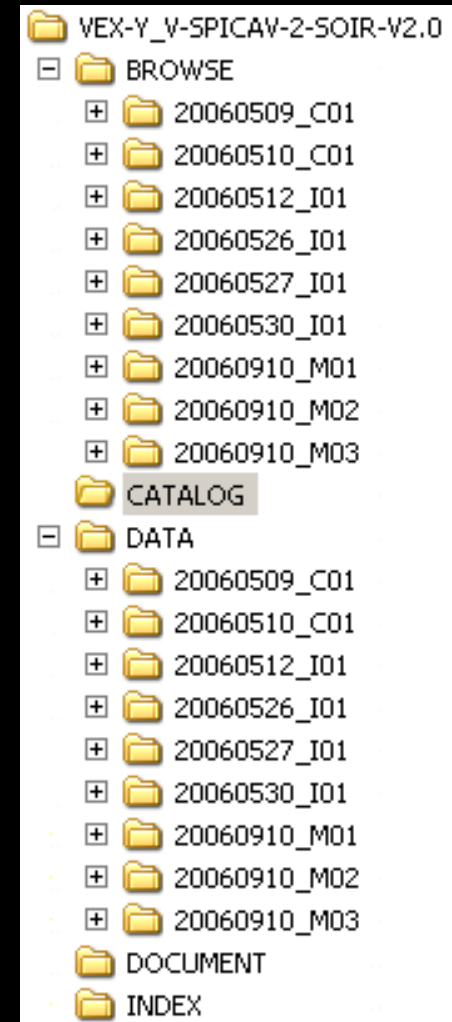
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## PSA Level 2 (1)

- ❑ BROWSE, CATALOG, DATA, DOCUMENT and INDEX directories
- ❑ DATA directory
  - Format YYYYMMDD\_TNN
    - ❖ YYYY: year
    - ❖ MM: month
    - ❖ DD: day
    - ❖ T: type of measurement
    - ❖ NN: measurement number of the day
  - 2 x 3 files in each folder
    - ❖ OBS: measurement values
    - ❖ TC1: telecommand values file 1
    - ❖ TC2: telecommand values file 2



20060512\_I01\_OBS.LBL  
20060512\_I01\_OBS.TAB  
20060512\_I01\_TC1.LBL  
20060512\_I01\_TC1.TAB  
20060512\_I01\_TC2.LBL  
20060512\_I01\_TC2.TAB



## PSA Level 2 (2)

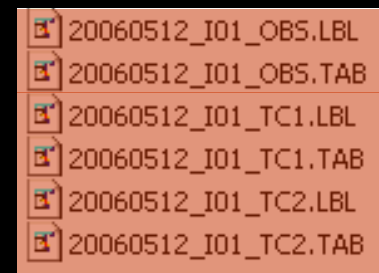
### □ DATA directory

#### ➤ *YYYYMMDD\_TNN\_OBS.TAB* file contains measurement

- ❖ 1 line per second

- ❖ Fields:

- Time
  - One field per scanned order
- Phase
  - Precooling (P) or observation (O)
- Observations
  - 320 values x 8 measurement (bins)
- Housekeeping values
  - 16 fields: temperatures, voltages, etc.

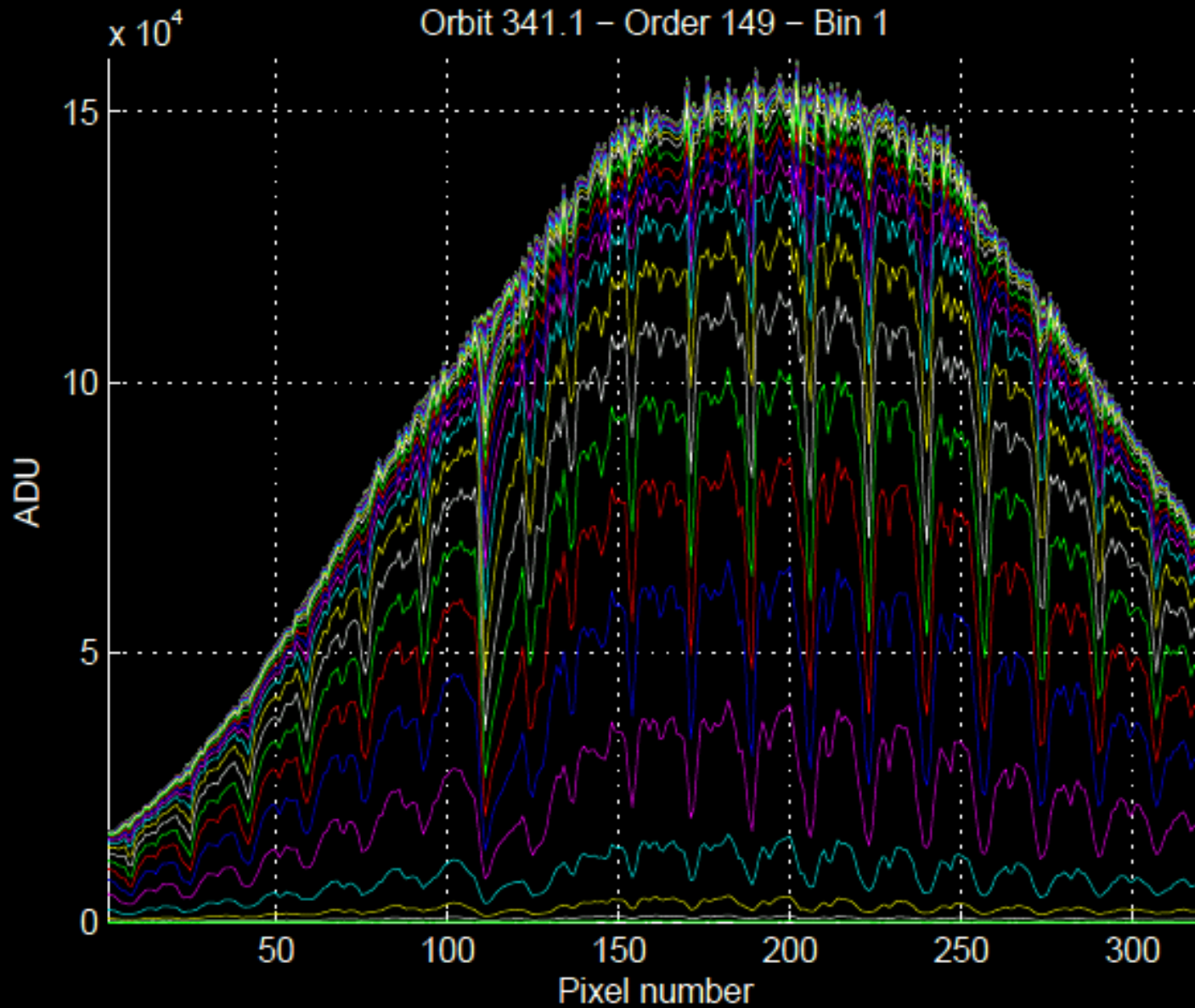


#### ➤ *YYYYMMDD\_TNN\_TC1.TAB* & *YYYYMMDD\_TNN\_TC2.TAB*

- ❖ TC1 for telecommand of precooling
- ❖ TC2 for telecommand of observation phase



# PSA Level 2 (3)



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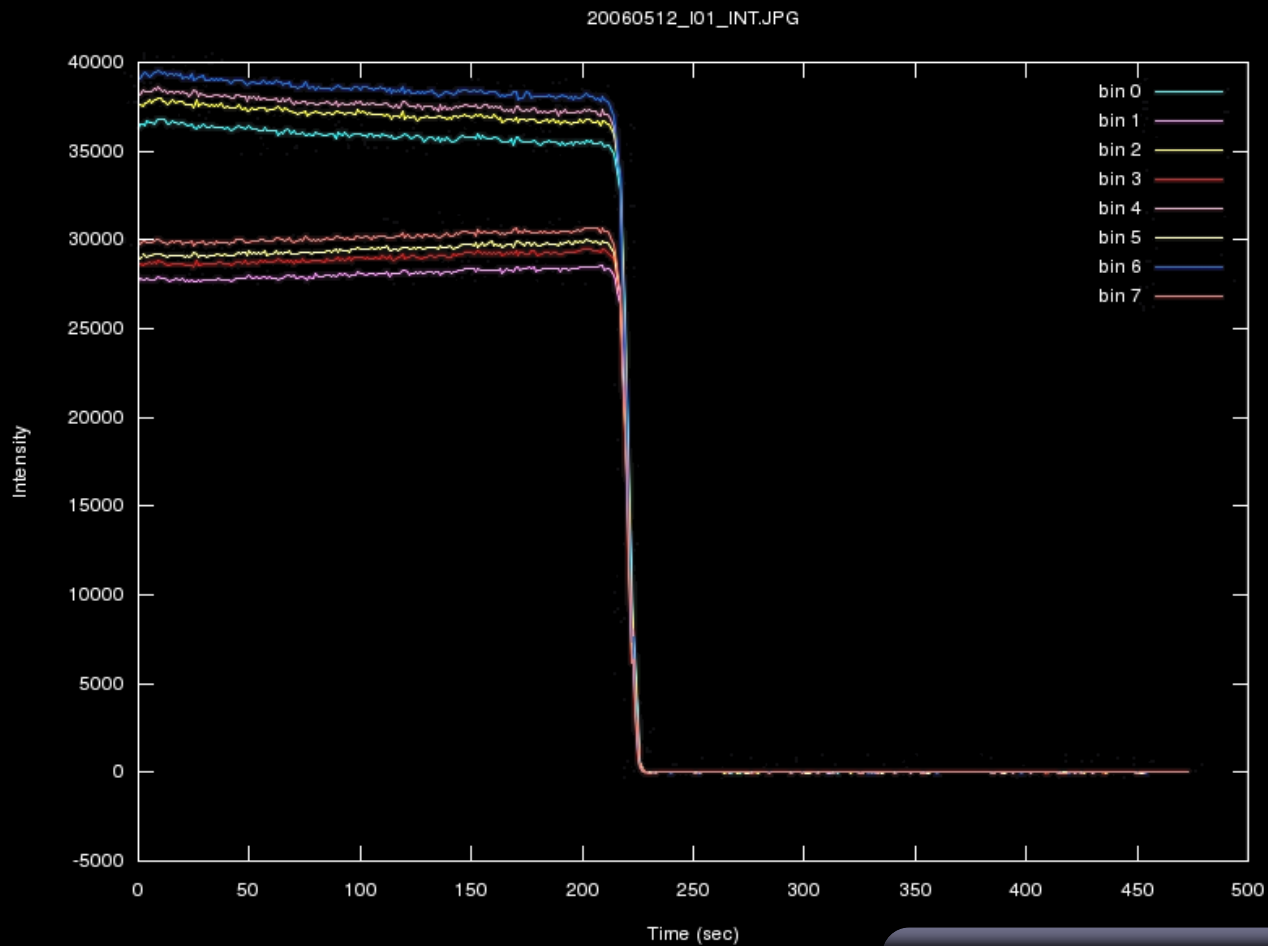
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## PSA Level 2 (4)

### ❑ BROWSE directory

- Each folder contains a JPG file
- Sum of all the 320 pixels in each bin as a function of time



## PSA Level 2 (5)

- ❑ CATALOG directory
  - Edited by ESA
  
- ❑ DOCUMENT directory
  - EAICD
    - ❖ SOIR archive global manual
  - FLIGHT\_USER\_MANUAL
    - ❖ Edited by ESA
  - INSTRUMENT CALIB PAPER
    - ❖ Publication *In-Flight performance and calibration of SPICAV SOIR on board Venus Express*, A. Mahieux et al., Applied Optics
  - INSTRUMENT\_DESC
    - ❖ SOIR short description
  - INSTRUMENT\_PAPER
    - ❖ Publication *Compact high-resolution space-borne echelle grating spectrometer with AOTF based order sorting for the infrared domain from 2.2 to 4.3 micrometer*, D. Nevejans et al., Applied Optics
  - OBSERVATION\_TYPE\_DESC
    - ❖ Edited by ESA



## PSA Level 2 (6)

- ❑ DOCUMENT directory
  - SOIR\_CALIBRATION\_DESC
    - ❖ SOIR archive CALIB directory description
  - SOIR\_CALIBRATION\_SOFTWARE
    - ❖ Code to reach PSA level 2
  - SOIR\_DATA\_QUALITY\_DESC
    - ❖ Describes the data quality byte
  - SOIR\_DATA\_DESC
    - ❖ Describes the SOIR data in the archive
  - TMTC
    - ❖ Telecommand parameters and formats for SOIR
  - VEX\_MISSION\_CALENDAR
    - ❖ Edited by ESA, gives the VEX calendar
  - VEX\_ORIENTATION\_DESC
    - ❖ Edited by ESA, describes the VEX orientation frame
  - VEX\_POINTING\_MODE
    - ❖ Edited by ESA, describes the VEX pointing modes



## PSA Level 2 (7)

### ❑ DOCUMENT directory

#### ➤ VEX\_POINTING\_MODE

❖ Edited by ESA, describes the VEX pointing modes

#### ➤ VEX\_RSSD\_LI\_009

❖ Edited by ESA, VEX subphases index table

#### ➤ VEX\_SCIENCE\_CASE\_ID\_DESC

❖ Edited by ESA, description of the science done during a VEX observation

### ❑ INDEX directory

➤ Edited by ESA



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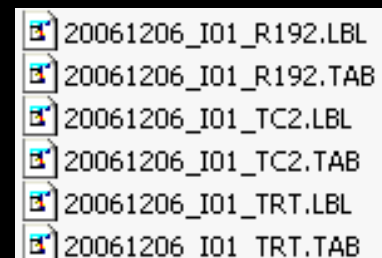
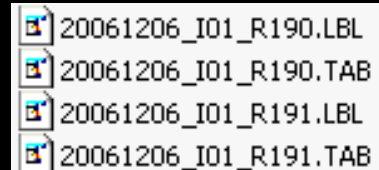
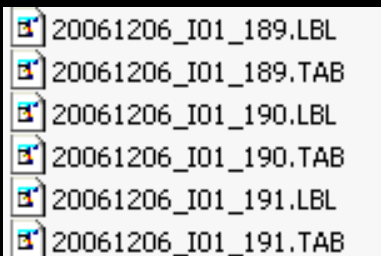
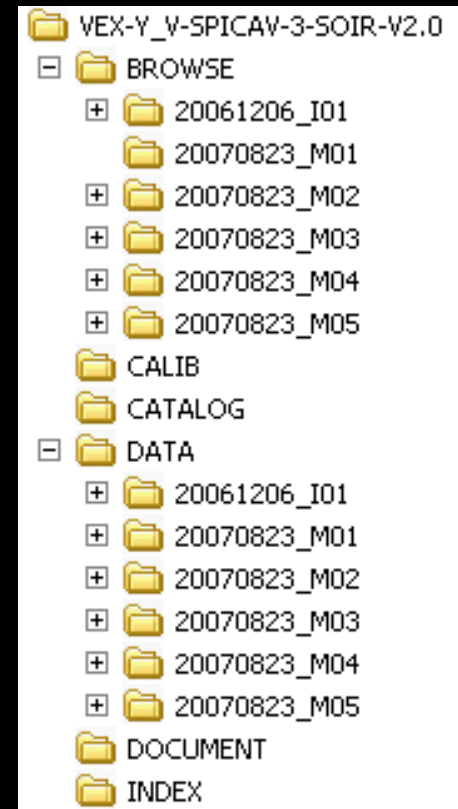
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# PSA level 3 (1)

- ❑ BROWSE, CALIB, CATALOG, DATA, DOCUMENT and INDEX directories
- ❑ DATA directory
  - Format YYYYMMDD\_TNN(\_OOO)
    - ❖ YYYY: year
    - ❖ MM: month
    - ❖ DD: day
    - ❖ T: type of measurement
    - ❖ NN: measurement number of the day
    - ❖ OOO: diffraction order
  - 2 x 10 files in each folder
    - ❖ OOO: measurement values for order OOO
    - ❖ ROOO: regression coefficients of order OOO
    - ❖ TC1: telecommand values file 1
    - ❖ TC2: telecommand values file 2
    - ❖ TRT: treatment file

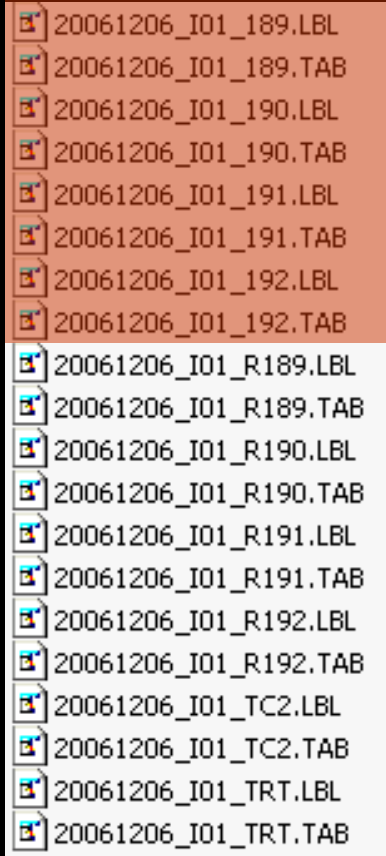


## PSA level 3 (2)

### □ DATA directory

#### ➤ *YYYYMMDD\_TNN\_OOO.TAB* file contains measurement

- ❖ One file per scanned order
- ❖ If same order scanned twice file format becomes:
  - *YYYYMMDD\_TNN\_OOOP.TAB*
  - With *P* a letter
- ❖ 1 line per second
- ❖ Fields:
  - Time
  - Wavenumber of bin 1 in  $\text{cm}^{-1}$ 
    - 320 values
  - Wavenumber of bin 2 in  $\text{cm}^{-1}$ 
    - 320 values
  - Transmittance of bin 1
    - 320 values
  - Transmittance of bin 2
    - 320 values
  - Housekeeping values
    - 16 fields: temperatures, voltages, etc.



20061206\_I01\_189.LBL  
20061206\_I01\_189.TAB  
20061206\_I01\_190.LBL  
20061206\_I01\_190.TAB  
20061206\_I01\_191.LBL  
20061206\_I01\_191.TAB  
20061206\_I01\_192.LBL  
20061206\_I01\_192.TAB  
20061206\_I01\_R189.LBL  
20061206\_I01\_R189.TAB  
20061206\_I01\_R190.LBL  
20061206\_I01\_R190.TAB  
20061206\_I01\_R191.LBL  
20061206\_I01\_R191.TAB  
20061206\_I01\_R192.LBL  
20061206\_I01\_R192.TAB  
20061206\_I01\_TC2.LBL  
20061206\_I01\_TC2.TAB  
20061206\_I01\_TRT.LBL  
20061206\_I01\_TRT.TAB



## PSA level 3 (3)

### □ DATA directory

- *YYYYMMDD\_TNN\_ROOO.TAB* file contains regression coefficients for each pixel
  - ❖ Fields:
    - Bin
    - Constant coefficient value
      - 320 values
    - Linear coefficient value
      - 320 values
- *YYYYMMDD\_TNN\_TC2.TAB* file contains telecommand of observation phase
- *YYYYMMDD\_TNN\_TRT.TAB* file gives the description of the treatment applied to the data

20061206_I01_189.LBL
20061206_I01_189.TAB
20061206_I01_190.LBL
20061206_I01_190.TAB
20061206_I01_191.LBL
20061206_I01_191.TAB
20061206_I01_192.LBL
20061206_I01_192.TAB
20061206_I01_R189.LBL
20061206_I01_R189.TAB
20061206_I01_R190.LBL
20061206_I01_R190.TAB
20061206_I01_R191.LBL
20061206_I01_R191.TAB
20061206_I01_R192.LBL
20061206_I01_R192.TAB
20061206_I01_TC2.LBL
20061206_I01_TC2.TAB
20061206_I01_TRT.LBL
20061206_I01_TRT.TAB





# PSA Level 3 (4)

## ❑ CALIB directory

### ➤ AOTF frequency to wavenumber (tuning curve)

#### ❖ Fields:

- Type (pix → wn or wn → pix)
- Binning
- Bin
- Relation (2<sup>nd</sup> order)

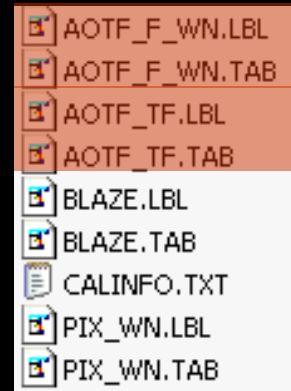
❖ → One for Nominal period and each Extension

### ➤ AOTF transfer function

#### ❖ Fields

- Order
- Wavenumber (from -100 to 100 cm<sup>-1</sup>, steps 0.1 cm<sup>-1</sup>, 2001 values)
- Values of TF bin 1 (2001 values)
- Values of TF bin 2 (2001 values)

❖ Only for bins 1 and 2 of binning 12



# PSA Level 3 (5)

## ❑ CALIB directory

### ➤ Blaze function

#### ❖ Fields

- Order
- Wavenumber (from -100 to 100  $\text{cm}^{-1}$ , steps 0.1  $\text{cm}^{-1}$ , 2001 values)
- Values of TF bins 1 or 2 (2001 values)

#### ❖ Same for every binning

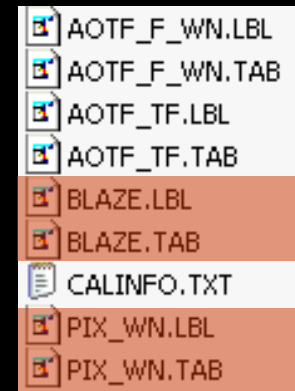
### ➤ Pixel to wavenumber relation

#### ❖ Fields:

- Type (pix  $\rightarrow$  wn or wn  $\rightarrow$  pix)
- Binning
- Bin
- Relation (2<sup>nd</sup> order)

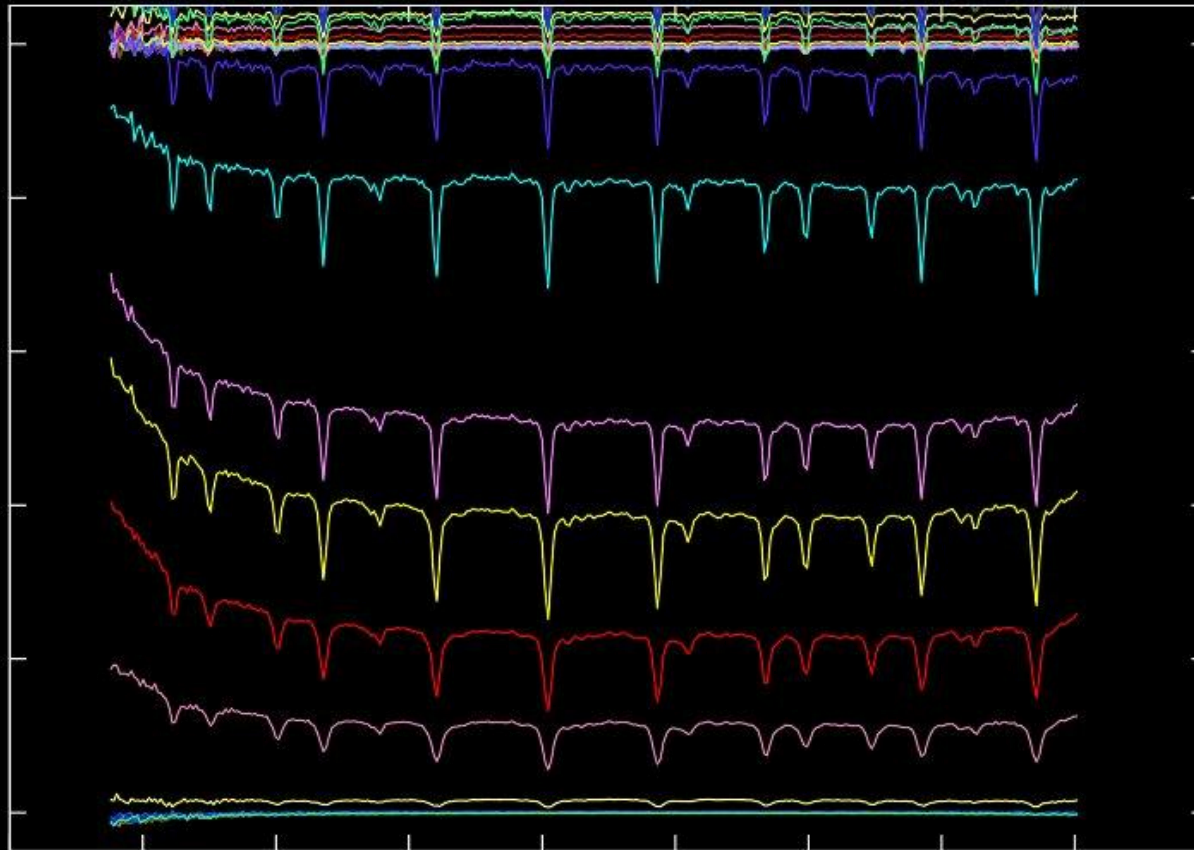
#### ❖ $\rightarrow$ Same for Nominal period and each Extension

#### ❖ Only for bins 1 and 2 of binning 12



## PSA Level 3 (6)

- ❑ BROWSE directory
  - Each folder contains JPG files
  - Overview of the transmittance spectra



## PSA Level 3 (7)

- ❑ CATALOG directory
  - Edited by ESA
  
- ❑ DOCUMENT directory
  - Same as level 2 DOCUMENT directory
  
- ❑ INDEX directory
  - Edited by ESA



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**Thank you for your attention**



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