ROSETTA PDS Data Review

VIRTIS data

Silvia Protopapa

VIRTIS-M

A. Coradini et al., Science 334, 492 (2011)

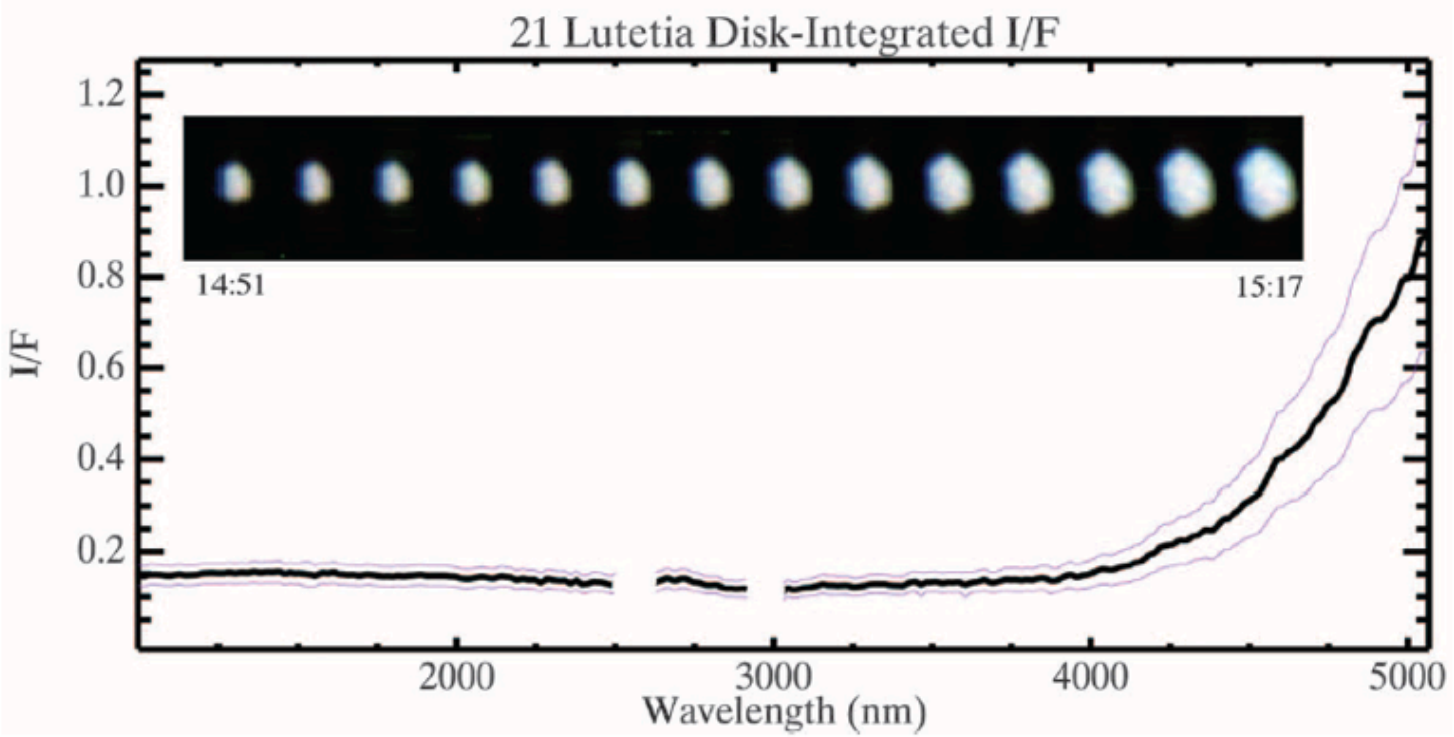


Fig. 1. Mean VIRTIS-M IR channel spectrum acquired during the scan phase. (**Inset**) Sequence of acquisitions taken at a phase angle varying from 7.3° to 4.0° and a wide range of incidence angles from 1.5° to 87.5°. The distance from Lutetia ranged between 47,450 and 25,200 km, giving a spatial resolution increasing from 11.9 to 6.3 km. Each pixel in the image corresponds to a full spectrum. All the spectra were averaged to produce the mean full-disk spectrum shown in black. In purple, we plotted the 1σ spectra, showing a larger dispersion in the thermal emission range (above 3500 nm). Missing regions in the spectrum correspond to areas affected by instrumental artifacts.

VIRTIS-M Data set

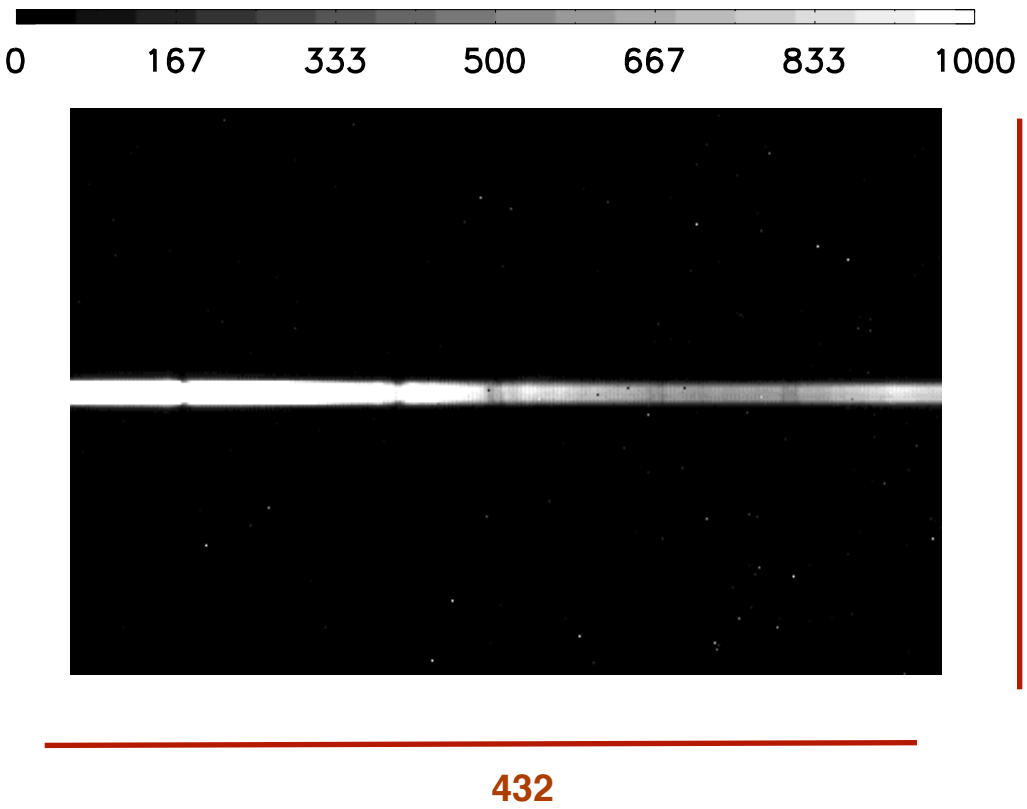
PRODUCT_ID = "I1_00237394252"

TARGET_NAME = "21 LUTETIA"

START_TIME = 2010-07-10T14:51:33.894

STOP_TIME = 2010-07-10T15:17:27.637

CORE_ITEMS = (432, 256, 311)



A raw data cube contains the not calibrated signal in DN; dark currents and thermal background are automatically subtracted from the data by an on-board processing performed by the Main Electronics (ME).

RID ID: 284

RID Classification: Major **Location:** Data Product **Location Details:** **Title:**
qube_name missing

Description:
The qube_name is absent in the data. Below an example:

IDL> result = virtispds('/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/DATA/VIRTIS_M_IR/I1_00230829954.QUB')

IDL> print, result.qube_name
% Tag name QUBE_NAME is undefined for structure .
% Execution halted at: $MAIN$
Recommended Solution: Insert this information in the data structure

VIRTIS-M Absolute Calibration

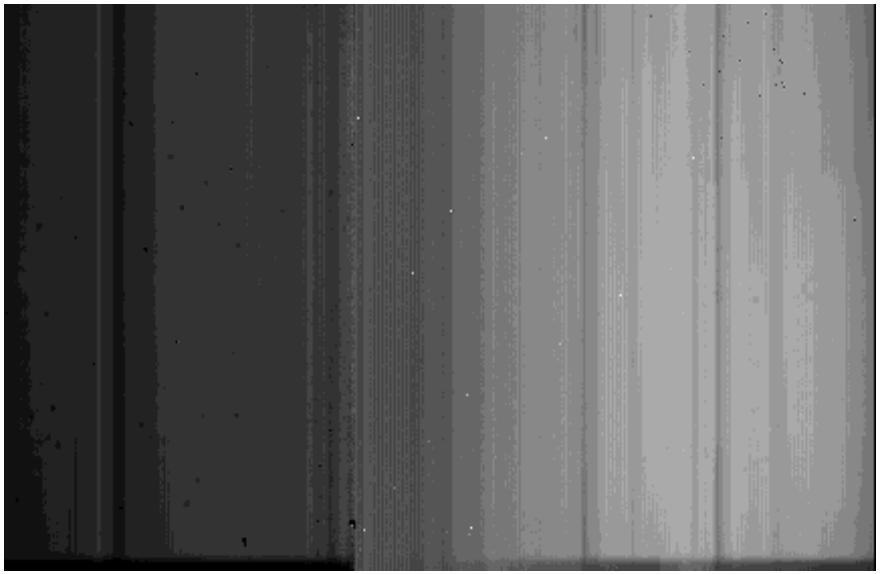
The counts can be converted in physical units of spectral radiance Rad (W m-2 nm-1 sterad-1) by using the following formulas:

$$Rad(\lambda(b),s,l)_{IR} = \frac{DN(\lambda(b),s,l)_{IR}}{t_{IR} \cdot R(\lambda(b),s)_{IR}}$$

integration time in sec

responsivity matrix for IR channel

../RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_IR_RESP_10_V1.DAT



256

432

In the label of the calibration file

DESCRIPTION = "ROSETTA-VIRTIS-M-IR responsivity in (DN*m^2*um*sterad)/(W*s)"

Problems with the units RID to be submitted

VIRTIS-M Absolute Calibration

RID ID: 286 Instrument:VIRTIS Status: Open Created On: 23 Mar 2012 10:22 PM Last Update: 26 Mar 2012 02:31 PM

RID Classification: Major
Location: Data Product
Location Details:
Title:
PROBLEMS READING A CALIBRATION FILE
Description:
I have problems with the cal file CALIB/VIRTIS_M_VIS_RESP_10_V1.LBL. If I read the file using readpds, I get numbers of the order of -7.4866578e+174 and 1.2443965e-231. This does not allow me to calibrate easily and correctly the data. Below an example of what I have done

IDL> ITF_VIS = readpds('/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_VIS_RESP_10_V1.LBL')
IDL> ITF_VIS = ITF_VIS.ARRAY
IDL> print, ITF_VIS

I have problems to read the same file using virtispds. See below

IDL> file = '/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_VIS_RESP_10_V1.LBL'
IDL> test = virtispds(file)

Reading label
/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_VIS_RESP_10_V1.LBL
% Compiled module:V_PDSPAR.
% Compiled module:V_STR2NUM.
%VIRTISPDS: This function handles only plain VIRTIS data files???Try v_readpds

VIRTIS-M Absolute Calibration

RID ID: 286 Instrument:VIRTIS Status: Open Created On: 23 Mar 2012 10:22 PM Last Update: 26 Mar 2012 02:31 PM

I have used therefore v_readpds but I still have problems

```
IDL> test = v_readpds(file)
% Compiled module:V_READPDS.
Reading label
/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/
VIRTIS_M_VIS_RESP_10_V1.LBL
% Compiled module:V_GETPATH.
% Compiled module:V_OBJPDS.
% Compiled module:V_POINTPDS.
% Compiled module:V_ARBINPDS.
%V_ARBINPDS: Now reading array from /Users/silviaprotopapa/Documents/FOLDERS_C
hronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_VI
S_RESP_10_V1.DAT
% Compiled module: REVERSE.
%Array dimensions must be greater than 0.
% Error occurred at:V_ARBINPDS 381
/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/WORK/VIRTI
SPDS/v_arbinpds.pro
%V_READPDS 292
/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/WORK/VIRTI
SPDS/v_readpds.pro
% $MAIN$
% Execution halted at: $MAIN$
```

Recommended Solution: Make sure that all the files can be read using virtispds or v_readpds

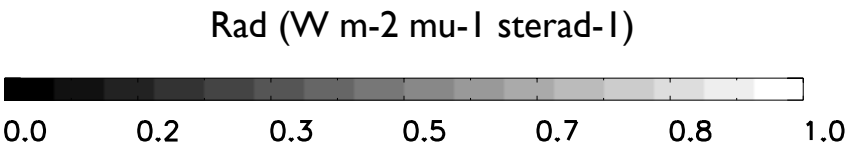
VIRTIS-M Absolute Calibration

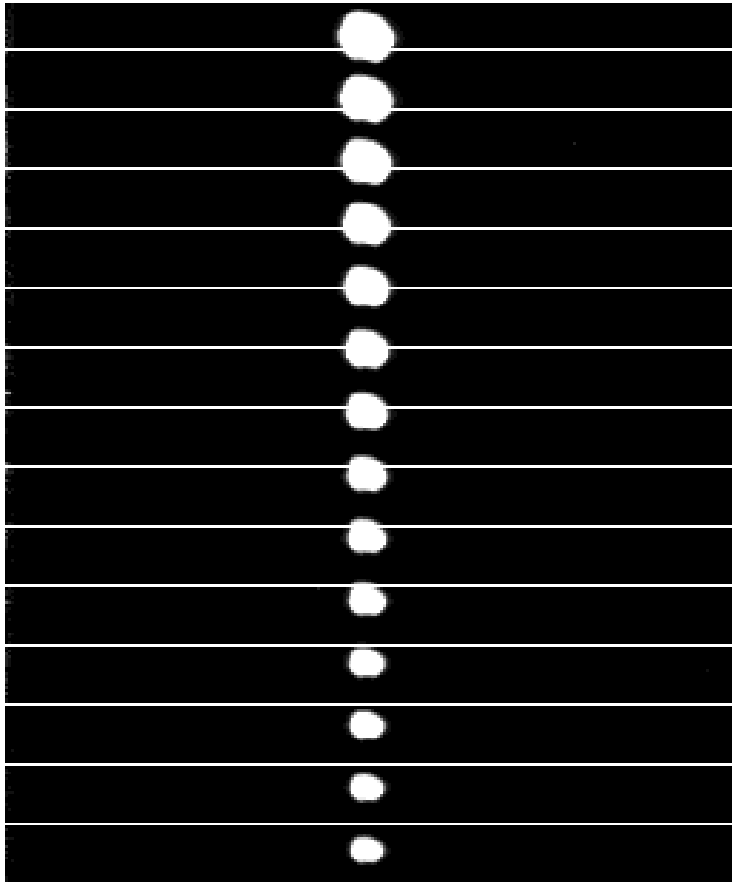
RID ID: 286 Instrument:VIRTIS Status: Open Created On: 23 Mar 2012 10:22 PM Last Update: 26 Mar 2012 02:31 PM

I used the following way to open the file

```
c = dblarr(432, 256)
openr,inf,'/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/
VIRTIS_M_IR_RESP_10_V1.DAT',/get_lun
readu,inf,c
```

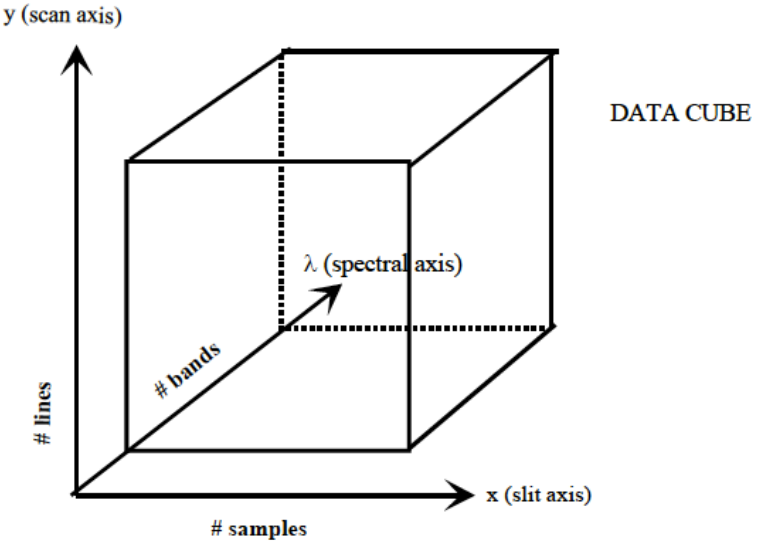
VIRTIS-M Spatial Cube





311

256



VIRTIS_EAICD.pdf, Fig. 4.1

432

VIRTIS-M Dark Frames acquisition

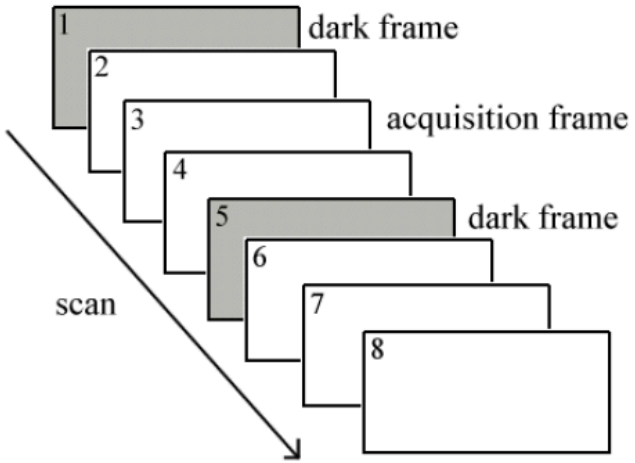
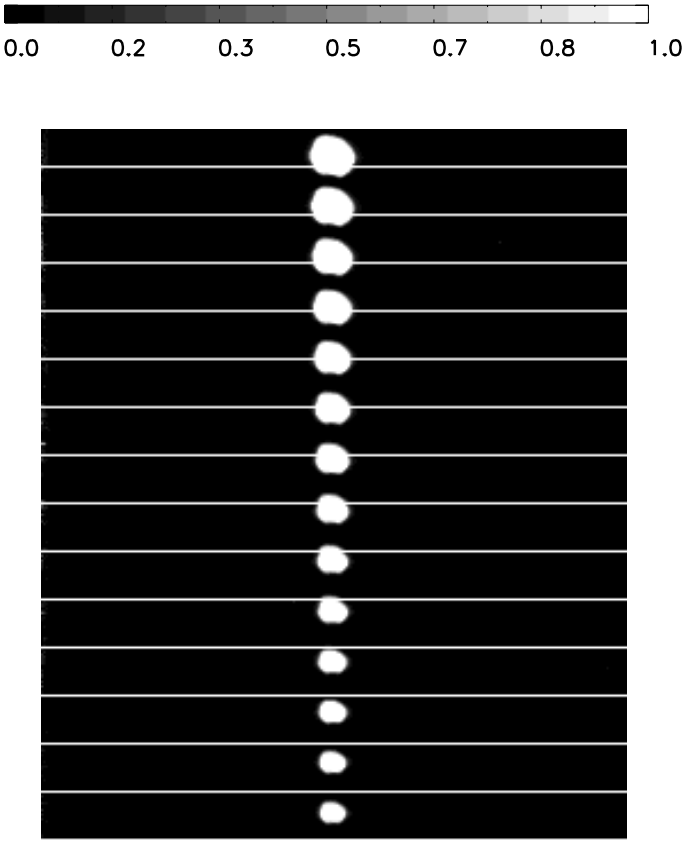


Fig. 4.2 – Structure of dark frames acquisition



DARK_ACQUISITION_RATE = 20

"Dark frames are acquired at intervals given by the DARK_ACQUISITION_RATE parameter and are temporally stored in the QUBE along the scan. During the dark acquisition the scanning mirror is not moved to avoid the lost of a line along the scan. For this reason, in order to extract an image from the cube it's necessary to remove dark current frames. These can be identified thanks to the shutter status value (SHUTT CMD=1 shutter closed, dark current; SHUTT CMD=0 shutter open, acquisition) stored in the HK." (VIRTIS_EAICD.pdf)

VIRTIS-M Dark Frames acquisition

The keyword SHUTT CMD is missing in the HK ← RID not submitted

IDL> file = virtispds('/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/DATA/VIRTIS_M_IR/I1_00237394252.QUB')
..

** Structure <18df808>, 6 tags, length=69047128, data length=69047124, refs=1:
   LABEL   STRING   Array[159]
   QUBE_DIM   LONG   Array[3]
   QUBE   INT   Array[432, 256, 311]
   SUF_NAME   STRING   Array[82]
   SUF_DIM   LONG   Array[3]
   SUFFIX   UINT   Array[82, 5, 311]

IDL> print, file.SUF_NAME
Data SCET-1 Data SCET-2 Data SCET-3 Acquisition ID # of subslices + 1st serial #
Data Type SPARE ME_default HK SCET-1 ME_default HK SCET-2 ME_default HK SCET-3
V_MODE ME_PWR_STAT ME_PS_TEMP ME_DPU_TEMP ME_DHSU_VOLT ME_DHSU_CURR EEPROM_VOLT
IF_ELECTR_VOLT SPARE M_ME_general HK SCET-1 M_ME_general HK SCET-2
M_ME_general HK SCET-3 M_ECA_STAT M_COOL_STAT M_COOL_TIP_TEMP M_COOL_MOT_VOLT
M_COOL_MOT_CURR M_CCE_SEC_VOLT SPARE MVIS_HK_report SCET-1 MVIS_HK_report SCET-2
MVIS_HK_report SCET-3 M_CCD_VDR_HK M_CCD_VDD_HK M_+5_VOLT M_+12_VOLT M_-12_VOLT
M_+20_VOLT M_+21_VOLT M_CCD_LAMP_VOLT M_CCD_TEMP_OFFSET M_CCD_TEMP
M_CCD_TEMP_RES M_RADIATOR_TEMP M_LEDGE_TEMP OM_BASE_TEMP H_COOLER_TEMP
M_COOLER_TEMP M_CCD_WIN_X1 M_CCD_WIN_Y1 M_CCD_WIN_X2 M_CCD_WIN_Y2 M_CCD_DELAY
M_CCD_EXPO M_MIRROR_SIN_HK M_MIRROR_COS_HK M_VIS_FLAG_ST SPARE
MIR_HK_report SCET-1 MIR_HK_report SCET-2 MIR_HK_report SCET-3 M_IR_VDETCOM_HK
M_IR_VDETADJ_HK M_IR_VPOS M_IR_VDP M_IR_TEMP_OFFSET M_IR_TEMP M_IR_TEMP_RES
M_SHUTTER_TEMP M_GRATING_TEMP M_SPECT_TEMP M_TELE_TEMP M_SU_MOTOR_TEMP
M_IR_LAMP_VOLT M_SU_MOTOR_CURR M_IR_WIN_Y1 M_IR_WIN_Y2 M_IR_DELAY M_IR_EXPO
M_IR_LAMP_SHUTTER M_IR_FLAG_ST SPARE

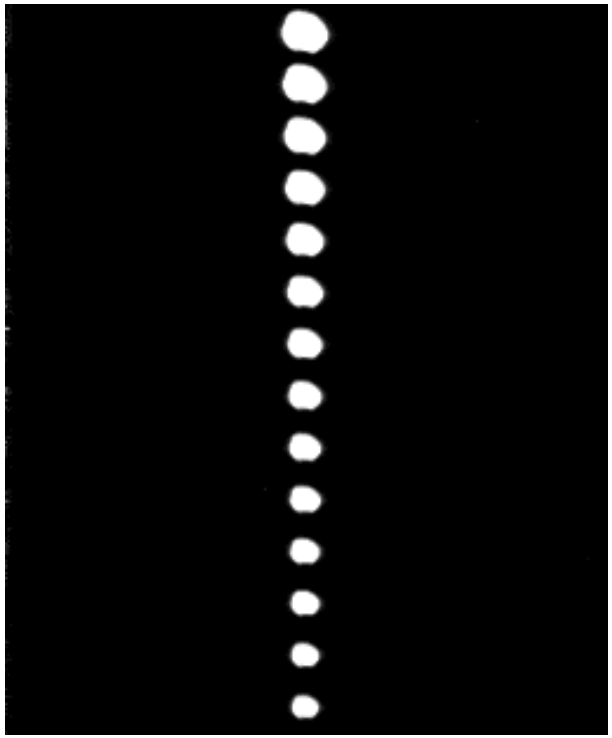
VIRTIS-M Dark Frames acquisition

Dark frames can be selected from raw data cubes with (beware of parenthesis!):
idark = where((result.suffix(5,0,*) and '2000'X) NE 0)

from VIRTIS_PDS_IDL_SW_MANUAL.pdf

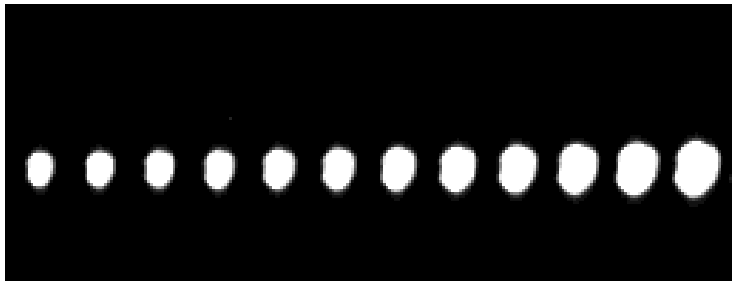
```
IDL> idark = where((file.suffix(5,0,*) and '2000'X) NE 0)
IDL> print, idark
       0       21       42       63       84      105
     126      147      168      189      210      231
     252      273      294
```

IT WORKS!



VIRTIS-M Spatial Cube

A. Coradini et al., Science 334, 492 (2011)



No right orientation

I could not find anywhere an explanation of how to create a spatial cube such in a way to have the right orientation of the target

RID to be submitted

VIRTIS-M Wavelength Calibration

VIRTIS_M_HIGHRES_SPECAL_10_V1.TAB = 432 row ASCII table containing the wavelengths of the VIRTIS-M-VIS and -M-IR channels in High Resolution Mode.

RID ID:
287
RID Classification:
Major
Location:
Data Product
Location Details:

Title:
MISSING LABEL IN A CALIBRATION FILE
Description:
The calibration file VIRTIS_M_HRES_SPECAL_10_V1.LBL does not have a label. See below

dpix = virtispds('/VVEx/CALIBRATION/DEADPIXELMAP.LBL')
TABLE data
The output structure is such that:
result.label: label of the PDS file
result.column_names: a string array providing the names of the table columns
result.table: a 2D array containing the table

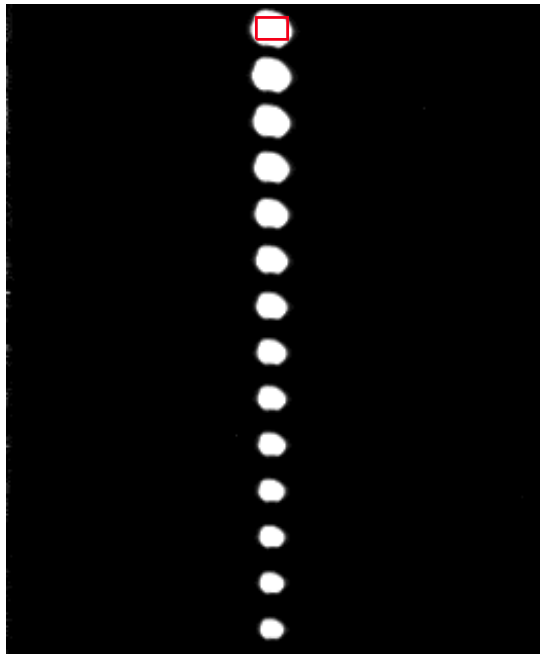
from VIRTIS_PDS_IDL_SW_MANUAL.pdf

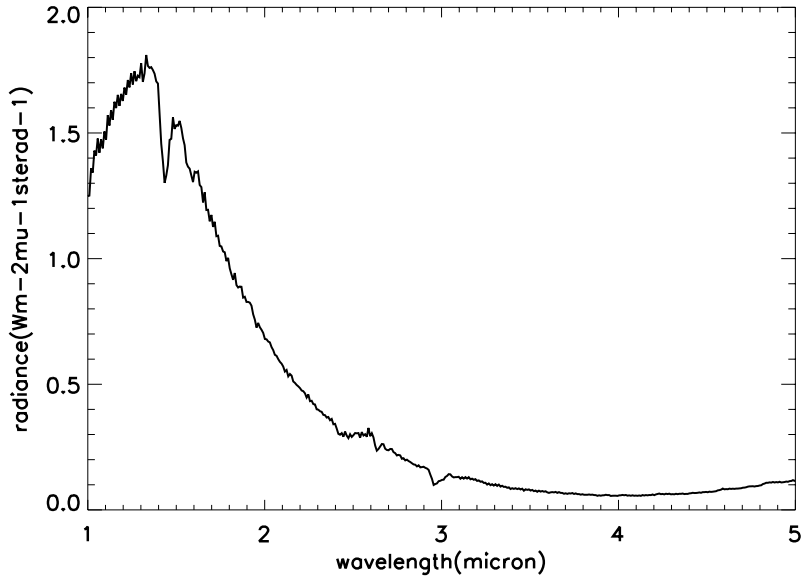
IDL> file = '/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_HRES_SPECAL_10_V1.LBL'
IDL> dpix = v_readpds(file)
Reading label
/Users/silviaprotopapa/Documents/FOLDERS_ChronoSync/Lutetia_PDS/RO-A-VIRTIS-2-AST2-V1.0/CALIB/VIRTIS_M_HRES_SPECAL_10_V1.LBL
% V_ATABPDS: Now reading table with 2 Columns and 432 Rows
** Structure , 2 tags, length=8640, data length=8640, refs=1:
COLUMN1 FLOAT Array[432]
COLUMN2 STRING Array[432]
IDL> print, dpix.label
% Tag name LABEL is undefined for structure .
% Execution halted at: $MAIN$

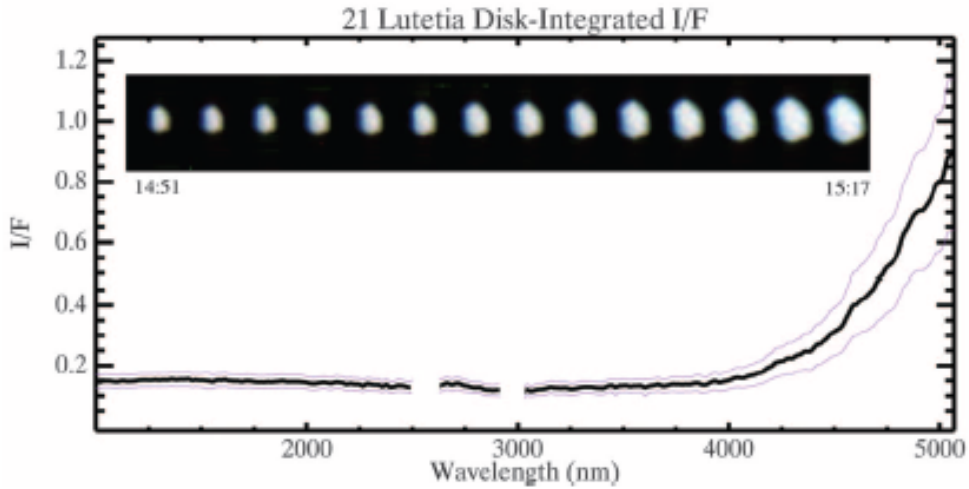
RID ID: 288

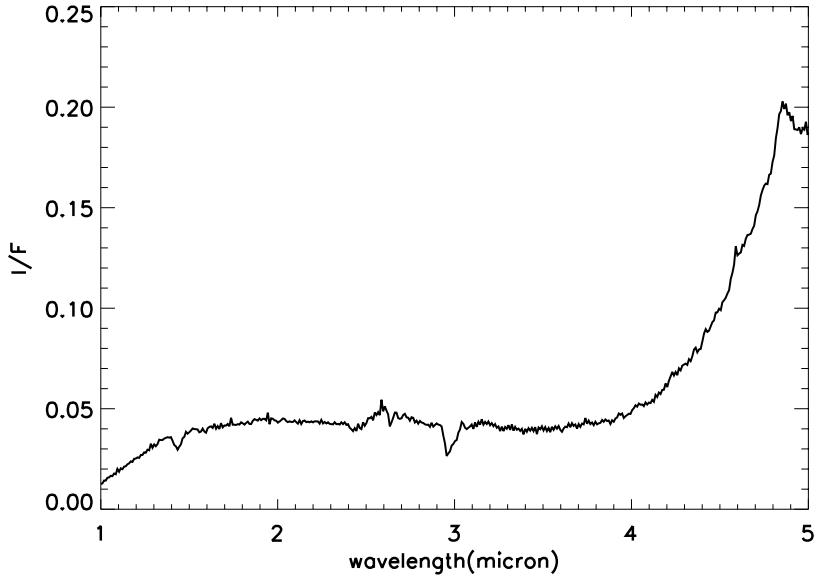
VIRTIS-M I/F


0.0
0.2
0.3
0.5
0.7
0.8
1.0




radiance(Wm−2mu−1sterad−1)
wavelength(micron)


21 Lutetia Disk-Integrated I/F
14:51
15:17
I/F
Wavelength (nm)


I/F
wavelength(micron)

VIRTIS-H

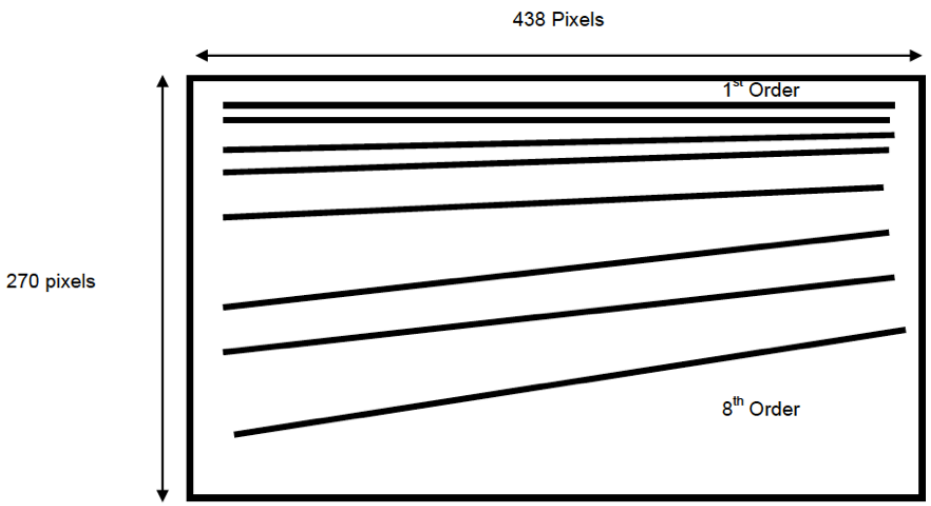


Figure 2.3 Spectral orders distributed over the IR FPA area. Only 15% of the matrix contains scientific data.

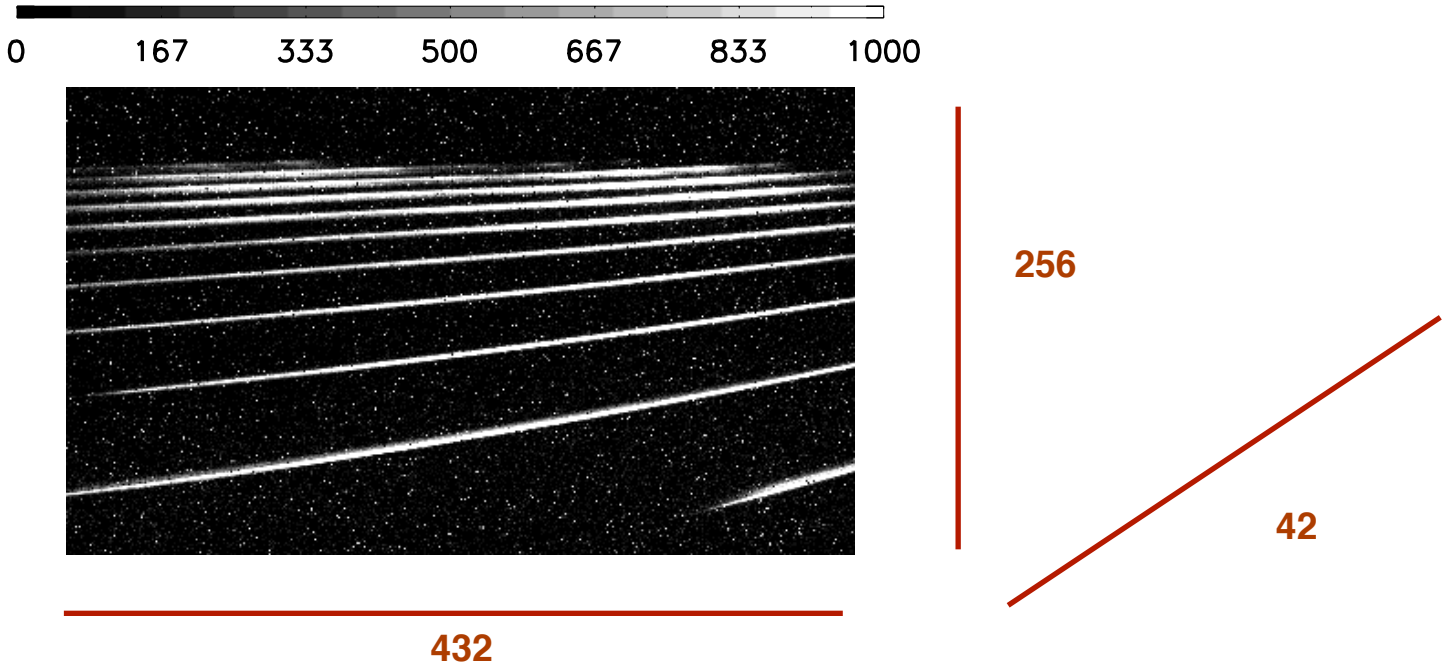
PRODUCT_ID = "H1_00237390320"

TARGET_NAME = "21 LUTETIA"

START_TIME = 2010-07-10T13:46:01.632

STOP_TIME = 2010-07-10T13:49:58.122

CORE_ITEMS = (432, 256, 42)



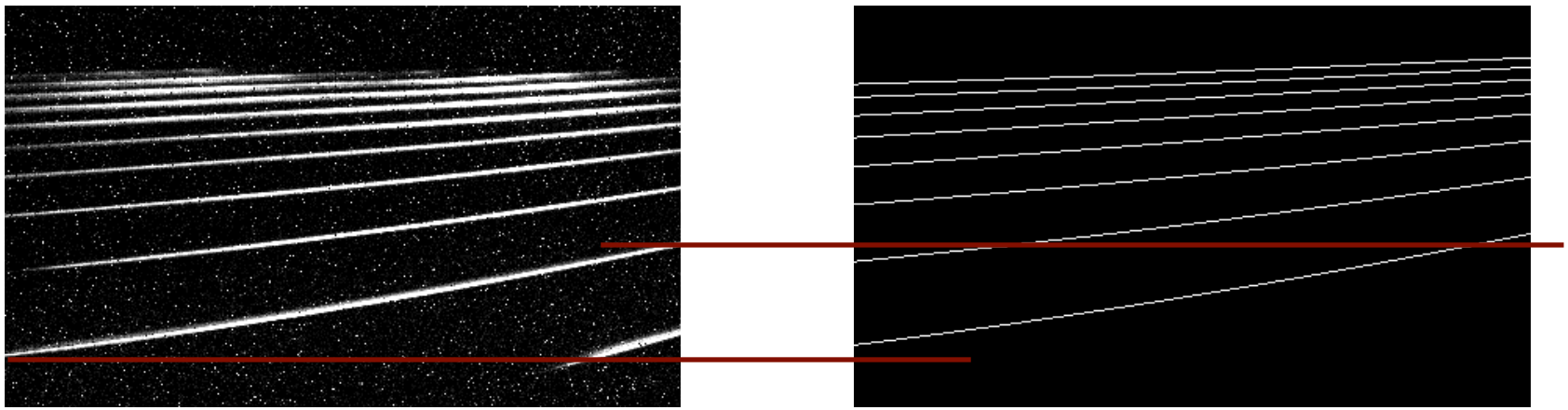
VIRTIS-H

The calibration of VIRTIS-H spectra is performed on line at the VIRTIS-H Meudon center.
In H nominal mode, spectral orders are extracted on board from the detector image by summing the intensity of pixels illuminated through the slit. For each spectral order the central y coordinate corresponding to a given x coordinate is computed using a second order polynomial in x. The coefficients of these polynomials are stored in the data file labels (label keyword VIR_H_PIXEL_MAP_COEF). The 5 pixels centered in y on this pixel are then summed:

```
canal = findgen(432)     ; index vector (0, 1,… 431)
for i = 0, 7 do begin
  Ycoord[i,*] =  coef[i,0]+ coef[i,1] * canal + coef[i,2] * canal^2
  for x = 0, 431 do $
    sum[i,x] = total(image[x, Ycoord(i,x+0.5)-2: Ycoord(i,x+0.5)+2])
endfor
```

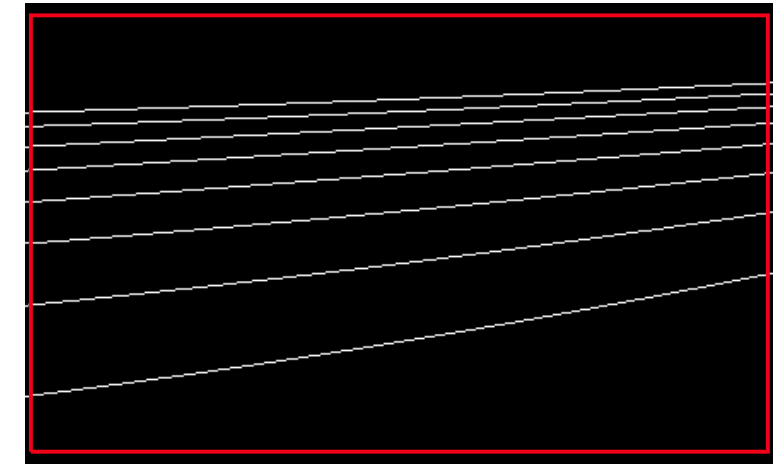
from the document VIRTIS_EAICD.pdf

MISMATCH!



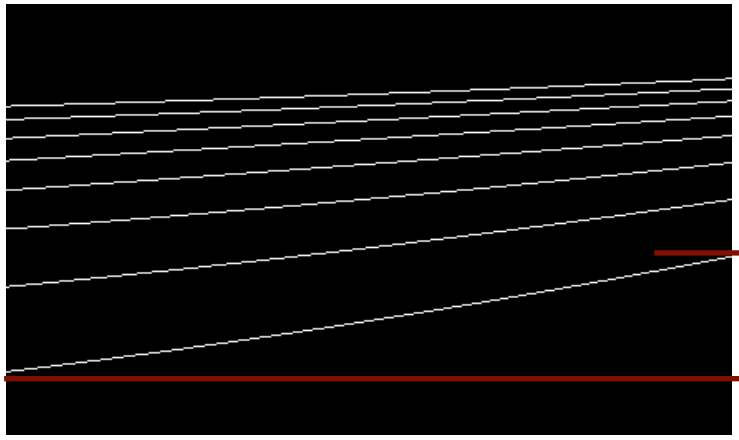
VIRTIS-H

The coefficients stored in the keyword VIR_H_PIXEL_MAP_COEF refer to the full detector system (438,270)

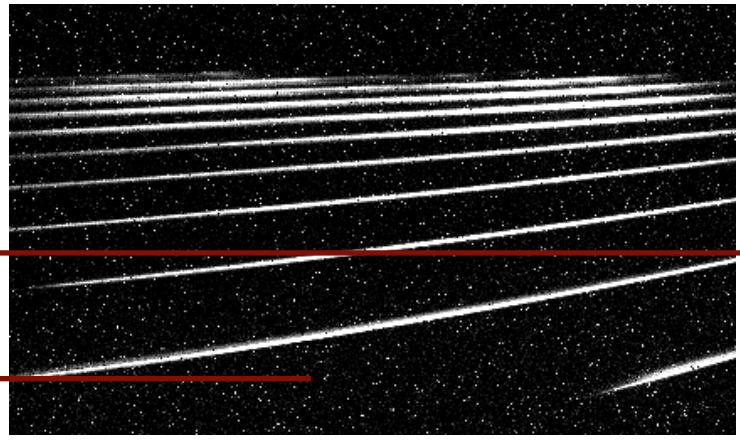


270

438



256



432

Problems in the documentation

The calibration of VIRTIS-H spectra is performed on line at the VIRTIS-H Meudon center.
In H nominal mode, spectral orders are extracted on board from the detector image by summing the intensity of pixels illuminated through the slit. For each spectral order the central y coordinate corresponding to a given x coordinate is computed using a second order polynomial in x. The coefficients of these polynomials are stored in the data file labels (label keyword VIR_H_PIXEL_MAP_COEF). The 5 pixels centered in y on this pixel are then summed:

```
canal = findgen(432)     ; index vector (0, 1,… 431)
for i = 0, 7 do begin
  Ycoord[i,*] =  coef[i,0]+ coef[i,1] * canal + coef[i,2] * canal^2
  for x = 0, 431 do $
    sum[i,x] = total(image[x, Ycoord(i,x+0.5)-2: Ycoord(i,x+0.5)+2])
endfor
```

Dead pixels, as identified from the file *DEADPIXELMAP.DAT*, are not included in the sum. The same procedure is applied on ground to extract spectra from data transferred in "backup" mode (when complete detector images are transferred).

from the document VIRTIS_EAICD.pdf

- In the document VIRTIS_EAICD.pdf is written that in the CALIB directory the file
  DEADPIXELMAP.DAT = pixels not included in the summing of the intensity of pixels illuminated through the slit.
  can be found.
  I did not find this calib file in the folder

RID to be submitted

VIRTIS-H

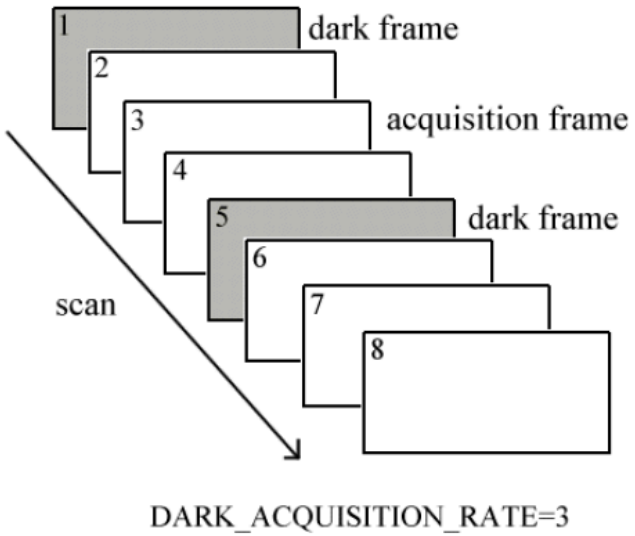
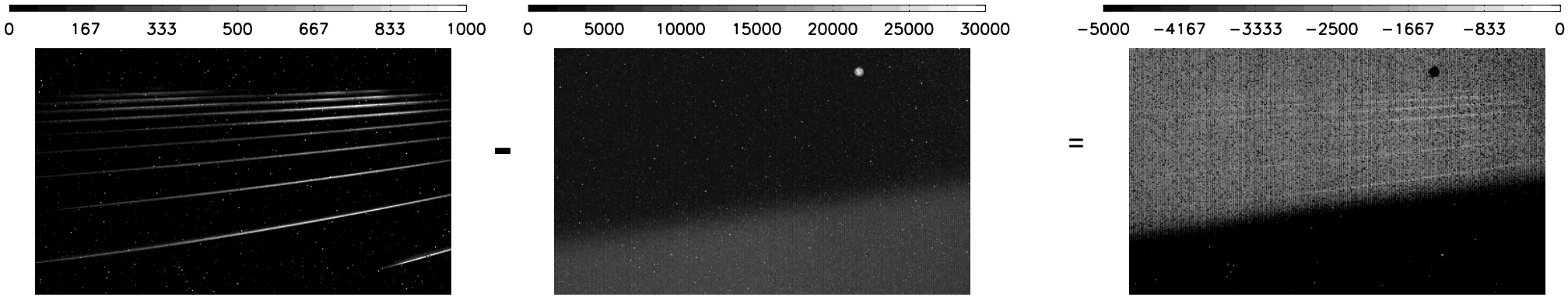


Fig. 4.2 – Structure of dark frames acquisition

A first order radiometric calibration is used during this mission phase. It consists in subtracting the last dark current acquired before the data, and in dividing the result by the flat-field and by the integration time. Non linearity is neglected for the time being.
During observations, dark currents alternate with data acquisitions.
In backup mode, dark currents consist in detector images interleaved in the data file. They are identified through element 5 in the sideplane (starting from 0):
idark = where((qube.suffix(5,0,*) and '2000'X) NE 0)

IDL> print, idark
0 9 18 27 36



I guess that the data are already dark subtracted

VIRTIS-H

The flat-field for this mission phase is available in spectrum format (i.e., extracted from the detector image in the same way as the data) in the file *VIRTIS_H_TRANSFERT_FCT_V1.TAB*. V1 refers to the current version of the file. The correction consists in dividing the data (after dark removal) by the flat-field and by the exposure time in seconds (as provided in the labels through the FRAME_PARAMETER keyword). This results in data calibrated in radiance, with unit µW/m2/sr/µm.

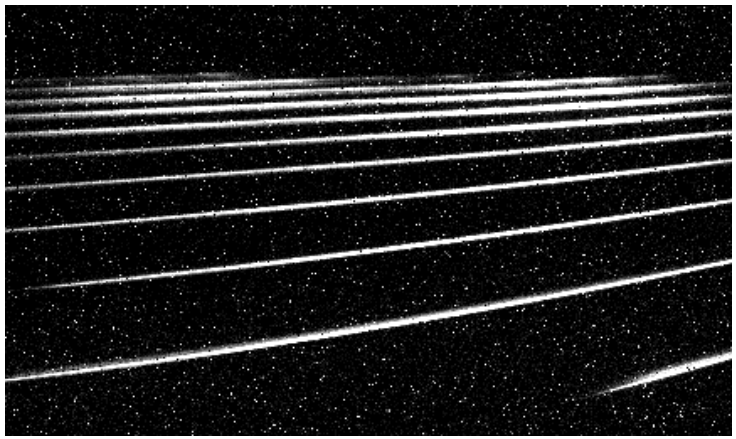
DESCRIPTION = "This file contains the tranfer function for Virtis H channels. Each column corresponds to one VIRTIS H spectral order."

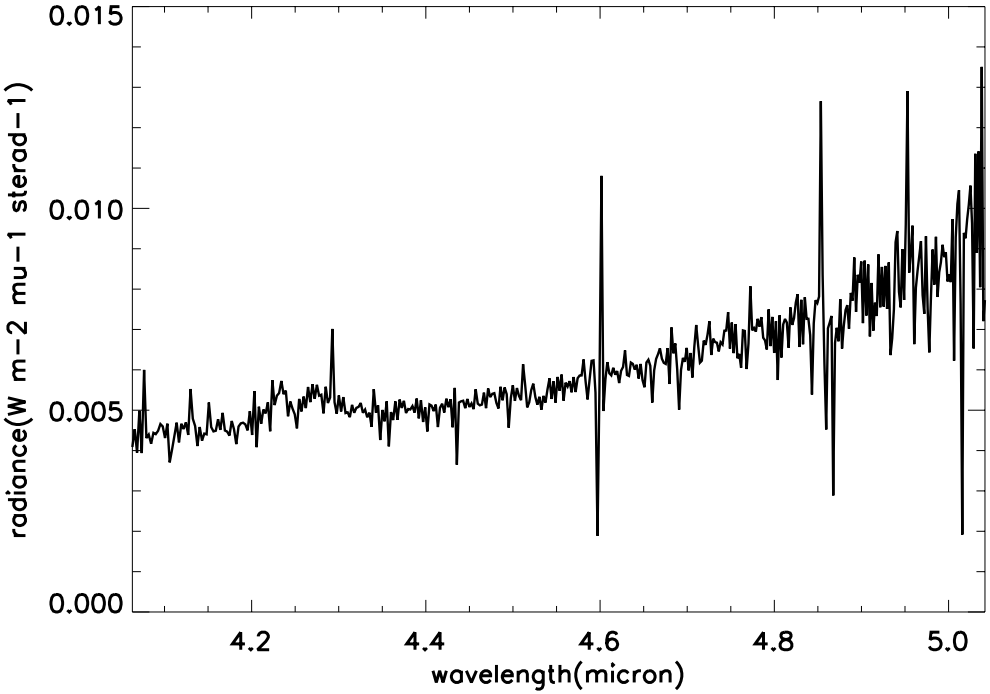
In the label are missing the units

The wavelengths in µm are derived using a second order polynomial for each spectral order. The coefficients of the polynomials are stored in the file *VIRTIS_H_SPECTRAL_COEF_V1.TAB*

In the label are missing the units

VIRTIS-H




0.015
0.010
0.005
0.000
radiance(W m−2 mu−1 sterad−1)
4.2
4.4
4.6
4.8
5.0
wavelength(micron)