VIRTIS Rosetta geometry files

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DOCUMENT CHANGE RECORD

Issue	Date	#	Old Paragraph	New Paragraph	Description of the modification	Reason of the modification
Draft 01	25/09/2007	1			First draft for Mars flyby, adapted from V-VEx document	
Draft 02	20/11/2007	2			Finalized for Mars and Earth flybys	
Draft 03	2/11/2008	3			Update after Steins flyby	
	5/11/2008	4			Added detailed pointing information in Appendix A	
	20/01/2010	5			Added Earth and Moon DTM information. Figures updated.	General update after ESB3
Draft 04	17/06/2011	6			Fixed doc reference Added IDL plane # in table	

1- Introduction

This document defines the format and contents of the VIRTIS Rosetta geometry files for both M and H channels during the Steins, Mars, and Earth flybys. These files are distributed to the science team, and are part of the archive delivered to PSA.

1.1 Applicable / Reference Documents

- AD1: EAICD Virtis Rosetta, VIR-INAF-IC-001, Issue 1.0, (10 November 2006)
- AD2 : VIRTIS PDS/IDL software library VVX-LES-SW-2264, Issue 2.7.4 (28/7/2008)
- AD3: Rosetta Payload Boresight Alignment Details. RO-EST-TN-3305. Issue 2, Rev. e (23 Feb 2009).

+ Spice kernels provided by ESA (IK and FK).

- RD1: Seidelman et al., Report of the IAU/IAG working group on cartographic coordinates and rotational elements: 2006. *Celestial Mechanics and Dynamical Astronomy* **98**: 155–180, 2007.
- RD2: Smith, D., G. Neumann, R. E. Arvidson, E. A. Guinness and S. Slavney, "Mars Global Surveyor Laser Altimeter Mission Experiment Gridded Data Record", NASA Planetary Data System, MGS-M-MOLA-5-MEGDR-L3-V1.0, 2003.
- RD3: Hastings, David A., Paula K. Dunbar, Gerald M. Elphingstone, Mark Bootz, Hiroshi Murakami, Hiroshi Maruyama, Hiroshi Masaharu, Peter Holland, John Payne, Nevin A. Bryant, Thomas L. Logan, J.-P. Muller, Gunter Schreier, and John S. MacDonald, 1999. The Global Land One-kilometer Base Elevation (GLOBE) Digital Elevation Model, Version 1.0. NOAA, National Geophysical Data Center (http://www.ngdc.noaa.gov/mgg/topo/globe.html).
- RD4: Zuber, M. T., CLEM1 LUNAR TOPOGRAPHY V1.0, CLEM1-L-LIDAR-5-TOPO-V1.0, NASA Planetary Data System, 1996.
- RD5: Jorda et al., ROS_STEINS_V04.TPC, January 2009 (Steins PCK from Osiris team)
- RD6: Jorda et al., SteinsFinal.dsk, 2009 (Steins DSK from Osiris team)
- RD7: Osiris pointing position relative to other boresights on Rosetta, RO-RIS-MPAE-TN-051, Issue 1.0, Rev. d (18 Jan 2008).

1.2 Acronyms and Abbreviations

EDR: Experimental Data Record
EGSE: Electrical Ground Support Equipment
FPA: Focal Plane Arrays
DTM : Digital Terrain Model
DSK : Digital Shape Kernel
HK: HouseKeeping parameters
IDL: Interactive Data Language
IR: InfraRed
ME: Main Electronic
MSB: Most Significant Byte first
OBT: On-Board Time
PCK : Planetary Constants Kernel
PDS: Planetary Data System
PSA: Planetary Science Archive
RDR: Reduced Data Record
SCET: SpaceCraft Elapsed Time (on-board time measured in s from launch)
SI: Système International d'unités
SPICE : Spacecraft Planet Instrument C-matrix Events

TM: Telemetry
UTC: Universal Time Corrected
VIRTIS: Visible Infra Red Thermal Imaging Spectrometer

2- Detailed specifications

The VIRTIS/Rosetta data archive contains geometrical information together with the data at various processing levels. This includes:

1) General/averaged information contained in the PDS label of data files, pertaining to the overall session.

2) (TBC) - More detailed information stored in a general data catalogue, called GEO_ROS.TAB. This file is a catalogue providing the footprint of the observing sessions. This file was initially required by the PSA for long term archiving, and is intended to facilitate cross-correlation between data sets. Status is TBC.

3) Detailed information on a pixel basis, required to plot the data and analyze them in details. This information is stored in separated geometry files associated to the data files.

The detailed information is stored in separate files, so as to decouple maintenance of the data on one hand, and of the geometry on the other hand. Practically, the geometry files have to be generated several times, as navigation Spice kernels are updated by ESA. This scheme also preserves the possibility to generate and maintain calibrated/derived data files easily.

Consequently, there is one geometry file associated to each data file. This implies that the geometry files are relevant to one focal plane only (separated files for H, M-vis, M-IR). When processing a data file, only the corresponding geometry file needs to be loaded.

Geometry information in the data files labels is computed and implemented in Rome through the SPICE system. Detailed geometry computations are later performed by a specific IDL library developed and maintain in Meudon (GeoRos), relying on the Spice toolkit for IDL (ICY, version N0062). The three types of information are described in the next sections.

2.1 Data file labels

Data file labels are described in the current versions of the EAICD [AD 1], and derived documents. These geometric quantities are computed with the SPICE system, then are included in the PDS labels of the data files written by the EGSE. This means that the raw data files are written in two steps:

1) Formatting in EGSE, with attached PDS labels. The geometrical keywords have dummy values (such as "NULL").

2) Computation of geometrical quantities with the SPICE system, outside the EGSE. Files generated in the first step are edited and completed with the proper values for the geometric keywords, derived from SPICE analysis. This activity is performed in Rome. It also covers general keywords such as target identification, the values of which are derived from science planning. This information is also stored in the data base in Meudon once for all, so that keyword values may be updated in later stages.

The updated data files are distributed to the science team. The calibrated or derived data files are written from these versions, with complete labels that include values associated to the geometrical keywords.

2.2 Geometric index

TBC (depends on future PSA requirements)— The archive contains two different index files pertaining to the geometry files:

1) A simple index named GEOMINDEX.TAB providing basic catalogue reference to the geometry files contained in the archive; (TBC)

2) A more technical file named GEO_ROS.TAB providing a general description of the footprint for each data file. The contents and structure of these files are defined according to PSA requirements. These files are used for cross-correlation with other data sets and data mining in the PSA. They are computed using the GEOLIB software provided by the PSA, adapted for this particular data set.

2.3 Geometry files contents

The Virtis/Rosetta geometry files for the three focal planes are written by the GEOROS software developed in Meudon. This system makes use of the SPICE kernels distributed by ESA, of Virtis-M CK kernels computed in Rome to handle the scanning mirror angle, and when relevant of target DSK kernels providing a plate model. M CK kernels are generated after observations from TM information, and reflect what has actually been done.

As mentioned above, geometry is computed and stored independently for each FPA. Virtis geometry files contain a cube with structure related to the raw data file, so that there is a direct correspondence between the two:

• Data cube dimensions = (X, Y, Z), where X is the spectral dimension. X and Y depend on instrumental mode, and Z depends on session duration. The sideplane contains the housekeeping parameters.
• Geometric cube dimensions = (N, Y', Z'), where N is the # of geometrical parameters for this FPA/channel. There is no sideplane associated to the cube core.

For M cubes, Z' is equal to the number of spectral frames in the data cube, while Z is equal to the number of spectral frames + dark current frames. The same applies to H cubes in frame (backup) mode. In H nominal mode however, Z' = Z (dark frames are stored independently).
M geometric cubes always have Y' = Y (value depends on binning mode).
H cubes in nominal mode always have Y' = Y = 64.
H cubes in backup mode always have Y' = 1, whereas Y = 256 (each data frame contains a detector image, but is described by 1 single geometric column).
The geometry cubes are stored as long signed integers with MSB encoding. A simple conversion coefficient is used to accommodate the data in this format, so as to preserve accuracy (see below).
The geometry files are handled directly by the VIRTIS IDL library and its front-end routine virtispds [AD 2].

2.3.1 Reference surfaces

For observations of the target bodies, each observed pixel is projected successively at the surface, and the coordinates of the IFOV corners and center are written in the geometry files. During computations, two projection surfaces are used (ellipsoid and Digital Terrain Model when available). Successive Rosetta targets are handled differently, but during the cruise phase only the coordinates projected on the DTM are written in the geometry files. Practically, the differences are almost unnoticeable, except for the asteroids.

<u>Mars 2007 swing-by</u>

The projection surfaces used for Mars observations during the 2007 swing-by (MSB) are :

1) The Mars reference ellipsoid defined in IAU 2006 standard [RD1], This surface is the one described in general SPICE kernels.
2) The Mars DTM measured by MOLA [RD2]. Only the 32 pixels/degree version is used for VIRTIS.

The estimated accuracy on the pointing direction is ~0.02° (TBC).

Earth swing-bys

A similar system is used for the observations of the Earth and the Moon during the 2005, 2007 and 2009 swing-bys (ESB1, ESB2, ESB3). The projection surfaces used are:

1) The Earth and Moon reference ellipsoid defined in the IAU 2006 standard (see [RD1]). Those are provided in general SPICE kernels.
2) The Earth DTM measured by GLOBE [RD3] and the Moon DTM measured by the LIDAR instrument onboard the Clementine spacecraft [RD4]. The resolutions of the Earth and Moon DTM used for the Rosetta swing-bys are respectively 32 pixels/degree and 4 pixels/degree.

Asteroid fly-bys

For the observations of the asteroid Steins during the 2008 fly-by, the projection surfaces used are:

1) The Steins reference ellipsoid updated from OSIRIS observations during the Rosetta fly-by. The corresponding SPICE PCK file is provided by the OSIRIS team and distributed by ESA: ROS_STEINS_V04.TPC [RD5].
2) The Steins 3D plate model derived from OSIRIS observations during the Rosetta fly-by. This model is also provided by the OSIRIS team as a Digital Shape Kernel (DSK) SPICE file: SteinsFinal.dsk [RD6].

According to IAU conventions, the polar axis in this model is oriented along the spin axis of the asteroid. Because Steins has a retrograde rotation, this implies that the north pole actually points in southern hemisphere at the time of the fly-by.

2.3.2 Observations intercepting the surface

The geometry cube planes are listed in Table 1. The description below applies to Mars, but the same system is used for the Earth, Moon, and Steins flybys with the corresponding topographic models (i.e. DTM or DSK).

All computations are performed in the planetocentric system (i.e.: relative to the local vertical) and using eastward longitudes. The geographic frames are those implemented in the SPICE kernels, and defined in the IAU 2006 system [RD1].

The coordinates of the four pixel footprint corners and of the pixel central point are computed at the intersection of the line of sight with the DTM. For Mars, the Earth and the Moon observations, at such low resolution the difference with a projection on the areoid is significant only on large volcanoes and bassins/canyons, or at large emergence angles. However the difference is significant in the case of Steins.

Surface elevation is the value from the MGS-MOLA DTM, converted to altitude above the reference ellipsoid. It is provided as the center value ; whenever the pixel center value is missing, a special error code is recorded in the file (the value -20 000 m is used; it is negative and lower than the minimal altitude on Mars).

The other quantities are also computed at the pixel center. The three observing angles (incidence, emergence, phase) are provided in 3 systems: on the DTM (relative to local normal), with respect to the direction of the center of Mars (center of figure), and relative to the ellipsoid normal. The first set of values is related to surface photometry/shadows, the second one to the airmass. The spacecraft slant distance is computed from the surface ellipsoid (not including the topography). Local time on Mars is measured from local midnight. Right ascension and declination of the line of sight are computed for each pixel in all observing modes.

Other instrument-related information is stored in the geometric cubes, including SCET, UTC, and scanning mirror angle for M. SCET are copied directly from the data files, except in the case of H nominal mode where they are reconstructed for each spectrum from acquisition parameters. UTC are the corresponding values recomputed from the SPICE kernels (not using the DDS approximation provided through the EGSE), then translated at mid-exposure (the offset is equal to half the repetition time). UTC is stored on two words, the first one providing the number of day since Jan. 1st, 2000 (starting at 1), the second one providing 10,000 x the number of s on this day, starting at 0h. For H, the slit orientation is provided as the angle between the ellipsoid normal and the longest slit direction (in the plan orthogonal to the line of sight, see Figure 3). For M, the mirror angle is stored as the sine and cosine of this angle (HK parameters are decoded using the adequate transfer function). Whenever these codes are missing in the TM, they are reconstructed using the same algorithm as in the Main Electronics (this may occur for M-IR paquets with no corresponding M-vis paquet). Finally, the Sun direction is provided as the angle from the instrument boresight and its azimuth in the XY plane, counted from the X axis (Figure 4).

For H, all quantities are computed on a pixel basis. For M, those which are common to a complete frame are stored in the same plane; they comprise SCET, UTC, sub-S/C coordinates, mirror angle and Sun-boresight direction in the orthogonal plane (10 words, whereas the minimum plane dimension is 64).

All parameters are stored on 4 bytes as long signed integers. Angles (coordinates, viewing angles, and α/δ) are stored in degrees and multiplied by 10,000. Distances are stored in meters. Sine and cosine of mirror angle are multiplied by 1000. Local time is stored in units of Mars period/24 (local hours) multiplied by 100,000. Parameters based on data or HK which are absent from the TM are replaced by value -2147483648 ('80000000' hexa; this actually occurs mainly for mirror angle parameters).

Geometric information that can be considered constant in the time frame of one subsession is also stored in the label of the geometry files, including sub-solar point coordinates at the surface, solar distance, and solar longitude. Solar longitude is computed as the planetocentric longitude of the Sun (L_s), starting from Mars North hemisphere spring equinox.

Plane #	Plane # (IDL #)	Parameter description	Comment
1-4	0-3	Longitudes of 4 pixel footprint corner points	Geometrical projection on the DTM
5-8	4-7	Latitudes of 4 pixel footprint corner points	Geometrical projection on the DTM
9-10	8-9	Longitude & latitude of pixel footprint center	Geometrical projection on the DTM
11-13	10-12	Incidence, emergence & phase at footprint center, relative to local normal	Angles relative to the DTM
14-15	13-14	Incidence & emergence at footprint center, relative to Mars reference ellipsoid	Not accounting for topography. Incidence angle is equal to solar zenithal angle.
16-17	15-16	Incidence & emergence at footprint center, relative to Mars centre direction	
18	17	Surface elevation (footprint center)	From DTM
19	18	Slant distance (line of sight from spacecraft to surface ellipsoid at pixel center)	Does not include topographic model
20	19	Local time at footprint center	
21-22	20-21	Right ascension and declination of pointing direction.	J2000 reference frame
For M:	For M:		
23	22	One frame-common plane	Provides 10 scalar quantities along the frame spatial dimension. The remainder is set to 0.
		1-2 Original data SCET from TM	The first value stores the SCET first two words (integer part), the second one stores the third SCET word (fractional part)
		3-4 UTC	Encoded UTC recomputed through the SPICE system. The first value contains the number of days since Jan. 1st, 2000, the second

			value contains the time of the day as 10,000 x seconds (starting from 0h)
		5-6 Sub-spacecraft coordinates (longitude/latitude)	
		7-8 Sine and cosine of M mirror angle	Converted into sin/cos values from HK ("electrical" angle in Virtis documentation)
		Sun direction: 9: angle between Sun direction and Virtis Z axis; 10: azimuth of Sun direction in instrument XY plane (counted from 0° at X axis).	
For H:	For H:	9 supplementary planes	
23-24	22-23	Original data SCET from TM	Interpolated for each spectrum in nominal mode. The first plan stores the SCET first two words (integer part), the second one stores the third SCET word (fractional part)
25-26	24-25	UTC	Encoded UTC recomputed through the SPICE system. The first plan contains the number of days since Jan. 1st, 2000, the second plan contains the time of the day as 10,000 x seconds (starting from 0h)
27-28	26-27	Sub-spacecraft coordinates (longitude/latitude)	
29	28	Slit orientation	Relative to the pixel normal at footprint center
30-31	29-30	Sun direction: 40: angle between Sun direction and Virtis Z axis; 41: azimuth of Sun direction in instrument XY plane (counted from 0° at X axis).	

Table 1: contents of VIRTIS geometric files, for observations intercepting the surface. IDL plane # are counted from 0 (for handling as IDL array elements).

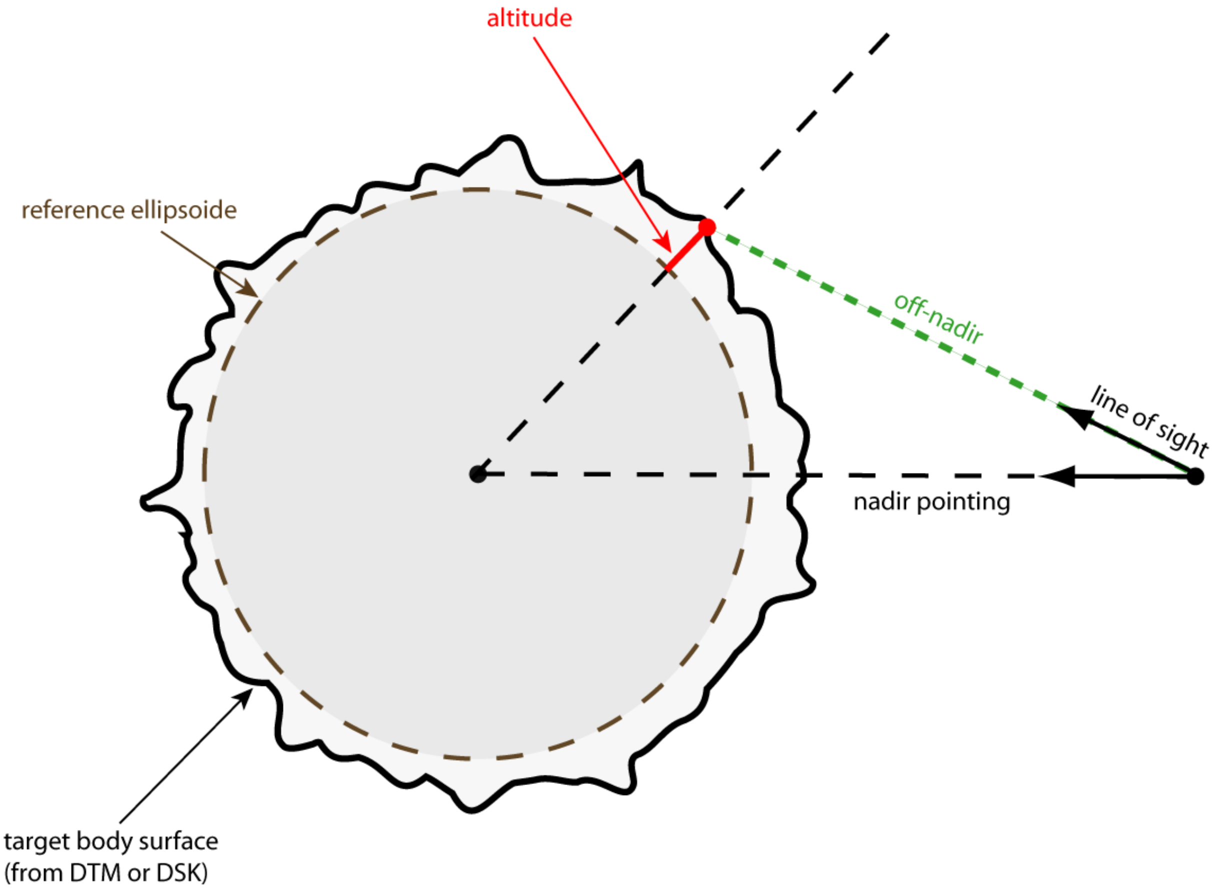

Figure 2: Observations intercepting the surface.

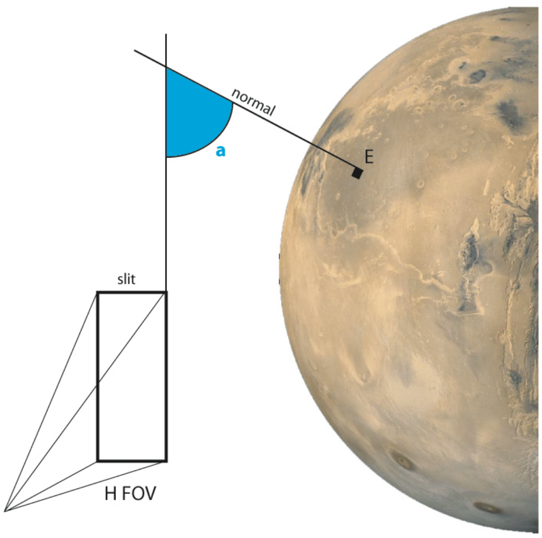

Figure 3: Slit orientation for Virtis-H.

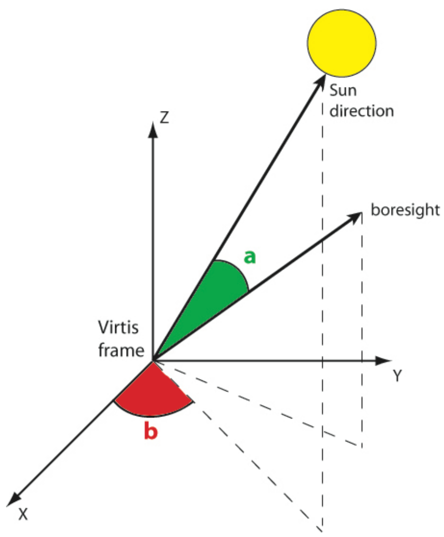

Figure 4: Sun direction in the instrument frame.

2.3.3 Limb observations and other geometries

Whenever the line of sight does not intercept the surface, the above quantities are substituted by specific information (Figure 5):

• During limb observations surface elevation (plane 18) is substituted by the tangent altitude (impact parameter above the surface) with the addition of a large offset (100,000 m). This offset is intended to select or filter limb observations easily. The 100,000 m offset must be subtracted from plane 18 to retrieve the tangent altitude.
• Angles, local time, and slant distance are computed at the intersection with the vector passing through the center of Mars (tangent point).
• The H slit orientation cannot be retrieved from surface coordinates, but is available in plane 29 for H.

The same system is currently used for sub-pixel targets (unresolved observations). In this case, the target is located inside the pixel displaying the shorter distance to the target (which is measured from pixel center).

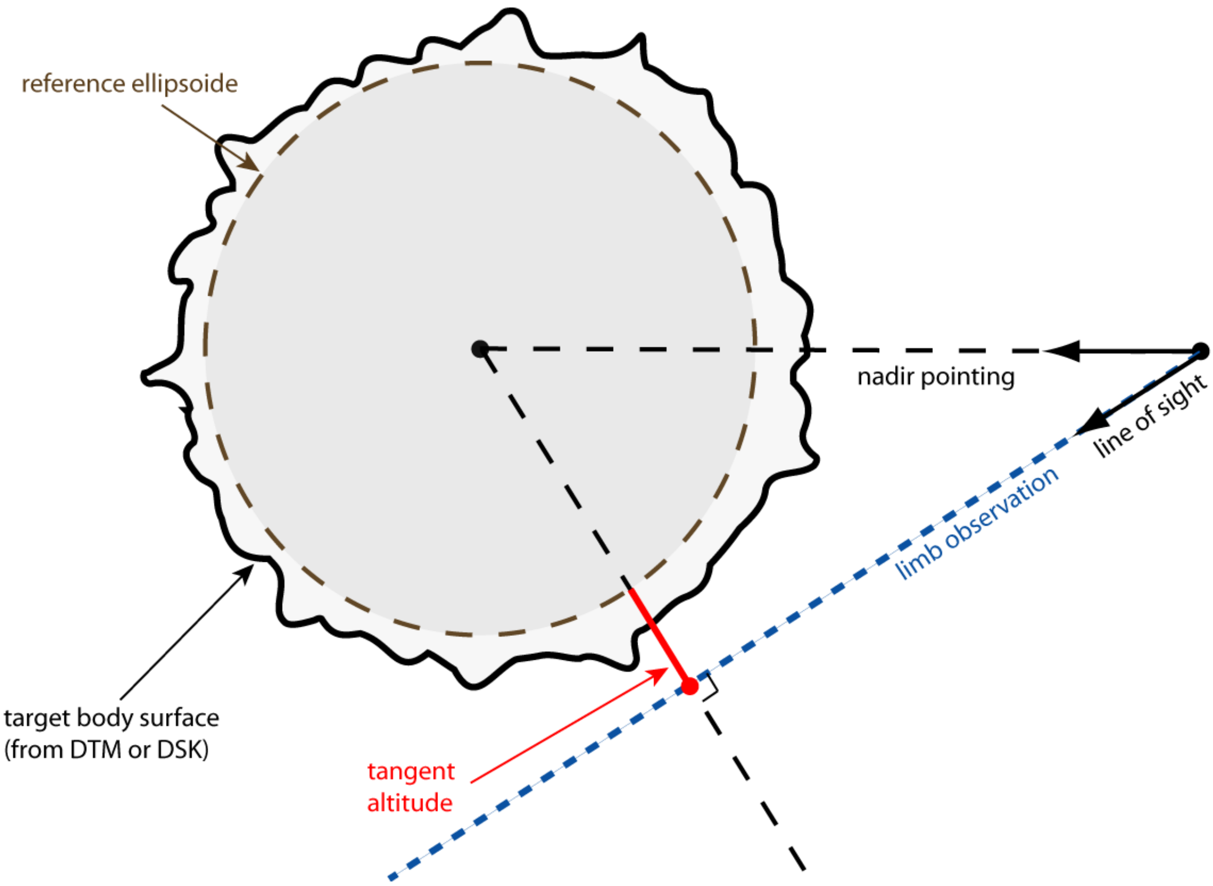

Figure 5: Limb observations.

2.4 Geometry file labels

An example of PDS label for the geometry cubes is given in Table 2 for Virtis-H. This is essentially a shortened version of the raw data files labels. Extra geometric information such as SOLAR_DISTANCE and sub-solar point coordinates is included here (four extra keywords). Other differences are outlined in red.

Solar distance and sub-solar point coordinates are computed at start of acquisition, and are about constant during a session. Slant distance is the average value encountered during observation. The other values are either minimum/maximum values (for coordinates) or start/stop values (for times).

Four extra keywords are present in the Virtis-M geometry files. They are all related to the scanning mode, and are identical to those present in the data file labels.

Keyword	SSE	Type	Possible values / range	Description
PDS_VERSION_ID	SC	ID	PDS3	Version of PDS standard used, constant
LABEL_REVISION_NOTE	SC	CHAR	"SE-MTC, 21/09/2007"	ID of label version
(blank line)				
/* File format and length */				
PRODUCT_ID	SC	CHAR	"xxx.GEO"	Current file name with extension
ORIGINAL_PRODUCT_ID	SC	CHAR	"xxx.QUB"	Original data file name with extension (ie: PI72P331.QUB)
RECORD_TYPE	SC	ID	FIXED_LENGTH	File formatting info
RECORD_BYTES	SC	INT	512	Record length in bytes, constant
FILE_RECORDS	SC	INT	nn1	Total file length / RECORD_BYTES (closest integer greater than or equal to this value)
LABEL_RECORDS	SC	INT	8	Smallest integer large enough to accommodate the label up to the END keyword (ie., label length in byte ≤ LABEL_RECORDS * 512)
FILE_STATE	SC	ID	CLEAN	Flag for incomplete files, constant
(blank line)				
/* Pointers to data objects */				
^QUBE	SC	PT	nn2	LABEL_RECORDS + 1
(blank line)				
/* Producer information */				
PRODUCER_ID	SC	ID	ROSETTA_VIRTIS_TEAM	(constant)
PRODUCER_FULL_NAME	SC	CHAR	"CORADINI"	(constant)
PRODUCER_INSTITUTION_NAME	SC	CHAR	"OBSERVATOIRE DE PARIS-LESIA"	(constant)
PRODUCT_CREATION_TIME	SC	TIME	yyyy-mm-ddThh:mm:ss.fff	Time when the PDS file is written
TELEMETRY_SOURCE_ID	SC	CHAR	"VIRTIS_EGSE<n>"	EGSE ID (<n> is the version number of EGSE itself)
SOFTWARE_VERSION_ID	SET	CHAR	{ "VirtisROS SW v.3.61", "EGSE_SOFT_<n>", "PDS_CONVERTER_<p>", "GEOROS_<q>", "V_GEOLABEL_4"}	Versions ID of software used to process this file, including on-board software and conversion routines. <n>, <p> and <q> are the version numbers of EGSE and GEOROS software. V_geolabel is

				the software writing the files
(blank line)				
/* Data description parameters */				
DATA_SET_NAME	SC	CHAR	"xxx"	(Same as raw data)
DATA_SET_ID	SC	CHAR	"xxx "	(Same as raw data)
RELEASE_ID	SC	INT	0001	Delivery # to PSA, related to observation date
REVISION_ID	SC	INT	0000	Version # for this release, may be incremented
PRODUCT_TYPE	SC	ID	EDR	(constant)
PROCESSING_LEVEL_ID	SC	INT	2	As in DATA_SET_ID
STANDARD_DATA_PRODUCT_ID	SC	CHAR	"VIRTIS GEOMETRY"	Identifies data versus geometry
MISSION NAME	SC	CHAR	"INTERNATIONAL ROSETTA MISSION"	(constant)
MISSION_ID	SC	ID	ROSETTA	(constant)
INSTRUMENT_HOST_NAME	SC	ID	"ROSETTA-ORBITER"	(constant)
INSTRUMENT_HOST_ID	SC	ID	RO	(constant)
MISSION_PHASE_NAME	SC	CHAR	"xxx"	String, as defined by PSA
PI_PDS_USER_ID	SC	CHAR	"CORADINI"	(constant)
INSTRUMENT_NAME	SC	CHAR	"VISIBLE AND INFRARED THERMAL IMAGING SPECTROMETER"	(constant)
INSTRUMENT_ID	SC	ID	"VIRTIS"	(constant)
INSTRUMENT_TYPE	SC	CHAR	"IMAGING SPECTROMETER"	(constant)
^INSTRUMENT_DESC	SC	PT	"VIRTIS_EAICD.TXT"	(constant)
ROSETTA:CHANNEL_ID	SC	ID	"VIRTIS_H"	(constant)
DATA_QUALITY_ID	SC	INT	0 1 "NULL"	0 if TM *data* paquets are missing when writing PDS data 1 otherwise "NULL" is no diagnostic (may be used to store other error codes)
DATA_QUALITY_DESC	SC	CHAR	"0:INCOMPLETE ; 1:COMPLETE"	(constant)
(blank line)				
/* Science operations information */				
TARGET_TYPE	SC	CHAR	"PLANET" "CALIBRATION" "SKY" "ASTEROID"	As defined by PSA
TARGET_NAME	SC	CHAR	"EARTH" "MARS" "CALIBRATION" "SKY" "2867 STEINS" "61 LUTETIA"	As defined by PSA
START_TIME	SC	TIME	yyyy-mm-ddThh:mm:ss.fff	UTC of first acquisition
STOP_TIME	SC	TIME	yyyy-mm-ddThh:mm:ss.fff	UTC of last acquisition
SPACECRAFT_CLOCK_START_COUNT	SC	CHAR	"n/ssssssssss.fffff"	Formatted, from TM packet data field header. n is increased after each resynchronization of the S/C clock, starting from 1
SPACECRAFT_CLOCK_STOP_COUNT	SC	CHAR	"n/ssssssssss.fffff"	Formatted, from TM packet data field header. n is increased after each resynchronization of the S/C clock, starting from 1
ORBIT_NUMBER	SC	INT	"N/A"	Reserved, unused during cruise

OBSERVATION_TYPE	SC	CHAR	"xxx"	Reserved for future use?
SC_SUN_POSITION_VECTOR	VEC	REAL	(x,x,x)	Provides sun direction
SC_TARGET_POSITION_VECTOR	VEC	REAL	(x,x,x)	Provides target direction
SC_TARGET_VELOCITY_VECTOR	VEC	REAL	(x,x,x)	
COORDINATE_SYSTEM_ID	SC	PT	"NULL"	J2000
COORDINATE_SYSTEM_NAME	SC	PT	"PLANETOCENTRIC"	Constant
DECLINATION	SC	REAL	0.0	
RIGHT_ASCENSION	SC	REAL	0.0	
MAXIMUM_LATITUDE	SC	REAL	000.000	In decimal degrees
MINIMUM_LATITUDE	SC	REAL	000.000	In decimal degrees
EASTERNMOST_LONGITUDE	SC	REAL	000.000	In decimal degrees, Eastward longitudes
WESTERNMOST_LONGITUDE	SC	REAL	000.000	In decimal degrees, Eastward longitudes
SPACECRAFT_ALTITUDE	SC	REAL	0000.000	Average value in km
PHASE_ANGLE	SC	REAL	0000.000	In decimal degrees
SUB_SPACECRAFT_LATITUDE	SC	REAL	0000.000	In decimal degrees
SUB_SPACECRAFT_LONGITUDE	SC	REAL	0000.000	In decimal degrees, eastward
SLANT_DISTANCE	SC	REAL	0000.000	Average value in km
SOLAR_DISTANCE	SC	REAL	0000.000	Sun-target distance in km
SOLAR_LONGITUDE	SC	REAL	0000.000	Ls, counted from vernal equinox, in decimal degrees
SUB_SOLAR_LONGITUDE	SC	REAL	0000.000	Longitude of sub-solar point, in decimal degrees
SUB_SOLAR_LATITUDE	SC	REAL	0000.000	Latitude of sub-solar point, in decimal degrees
(blank line)				
/* Instrument status */				(constant)
INSTRUMENT_MODE_ID	SC	INT	1 H_Off 2 H_Cool_Down 3 H_Idle 4 H_Annealing 5 H_PEM_On 6 H_Test 7 H_Calibration 8 H_Nominal_Simulation 9 H_Science_Maximum_Data_Rate 10 H_Science_Nominal_Data_Rate 11 H_Science_Minimum_Data_Rate 12 (deleted) 13 H_Science_Backup 14 H_User_Defined 15 (deleted) 16 (deleted) 17 (deleted) 18 H_Spectral_Calibration_Simulation 19 H_Degraded 63 H_ME_Test	H channel functioning mode
^INSTRUMENT_MODE_DESC	SC	CHAR	"VIRTIS_EAICD.TXT"	(constant)
(blank line)				
/* Pointer to navigation data files*/				
SPICE_FILE_NAME	SET	CHAR	{"xxx", ...,"xxx"} or "NULL"	List of Spice files used in

				computation
(blank line)				
/* Cube keywords */				
OBJECT	SC	ID	QUBE	(constant)
AXES	SC	INT	3	(constant)
AXIS_NAME	EN	ID	(BAND,SAMPLE,LINE)	(constant, provides data structure)
CORE_ITEMS	EN	INT	(x,y,z)	Cube dimensions: y, z same as data cube. x constant (# of geometrical values stored = 41 for H or 33 for M)
CORE_ITEM_BYTES	SC	INT	4	(constant)
CORE_ITEM_TYPE	SC	ID	MSB_INTEGER	(constant)
CORE_BASE	SC	REAL	0.0	(constant)
CORE_MULTIPLIER	SC	REAL	1.0	(constant)
CORE_VALID_MINIMUM	SC	INT	-2147483648	(constant)
CORE_NULL	SC	INT	-2147483648	(constant) '80000000' hexa
CORE_LOW_REPR_SATURATION	SC	INT	-2147483648	(constant)
CORE_LOW_INSTR_SATURATION	SC	INT	-2147483648	(constant)
CORE_HIGH_REPR_SATURATION	SC	INT	2147483647	(constant)
CORE_HIGH_INSTR_SATURATION	SC	INT	2147483647	(constant)
CORE_NAME	SC	ID	"GEOMETRIC PARAMETERS"	(constant)
CORE_UNIT	SC	ID	"UNK"	(constant) Depends on parameter
CORE_DESC	SC	CHAR	"Parameters are defined in EAICD"	(constant)
(blank line)				
SUFFIX_BYTES	SC	INT	4	(constant)
SUFFIX_ITEMS	EN	INT	(0, 0 ,0)	No suffix present
END_OBJECT	SC	ID	QUBE	(constant)
(blank line)				
END	SC	ID		

Table 2: Label for Virtis-H on Rosetta. Extra or modified lines relative to the raw data labels are outlined in red (several lines present in the data labels are also canceled).

Appendix-A FOV definitions

The data provided here are copied from the latest Spice kernels provided by ESA, and partly come from documents AD3 and RD7. Virtis offsets in Table 3 have been derived from analysis of Mars fly-by data and star pointing during PC6.

Both Virtis channels have their slit in the Y direction.

For Virtis-M (both visible and IR imaging channels):
• IFOV (pixel size) is ~ 0.000250x0.000250 rad = 0.0143x0.0143°
• FOV is elongated in the Y direction by 256 pixels: 0.064 rad = 3.67°
The FOV corresponds to the detector line which is acquired at each time step.

For Virtis-H (high resolution point spectrometer channel):
• IFOV (pixel size) is ~ 0.000583x0.000583 rad = 0.0334x0.0334°
• FOV is elongated in the Y direction by 3 pixels: 0.001749 rad = 0.1002°
The FOV corresponds to the 3-pixel wide area on which the signal has to be integrated; in nominal mode, this integration is performed on-board by the ME.

FOV centers are slightly offset from the spacecraft bore sight. The exact positions are given in terms of offset in document AD3 (but are given in terms of rotations around the axes in the Spice kernels). The figures are provided in Table 3, and are used in Fig. 6 to overplot the various instruments' FOV.
Table 4 provides a tentative estimate of the location of Virtis boresight in the Osiris images (as stated in RD7).

	X	Y
M-offsets	dx = -0.075°	dy = -0.02167°
M- rotations	Rx = -0.02167°	Ry = 0.075°
H-offsets	dx = -0. 0936°	dy = 0.0027°
H-rotations	Rx = 0. 0027°	Ry = 0.0936°

Table 3: Virtis FOV centers relative to spacecraft boresight

	X/Y NAC pixels	X/Y WAC pixels
M boresight	992 / 980	1043/ 946
H boresight	1013/ 963	1039/ 943

Table 4: Virtis FOV centers projection on Osiris frames

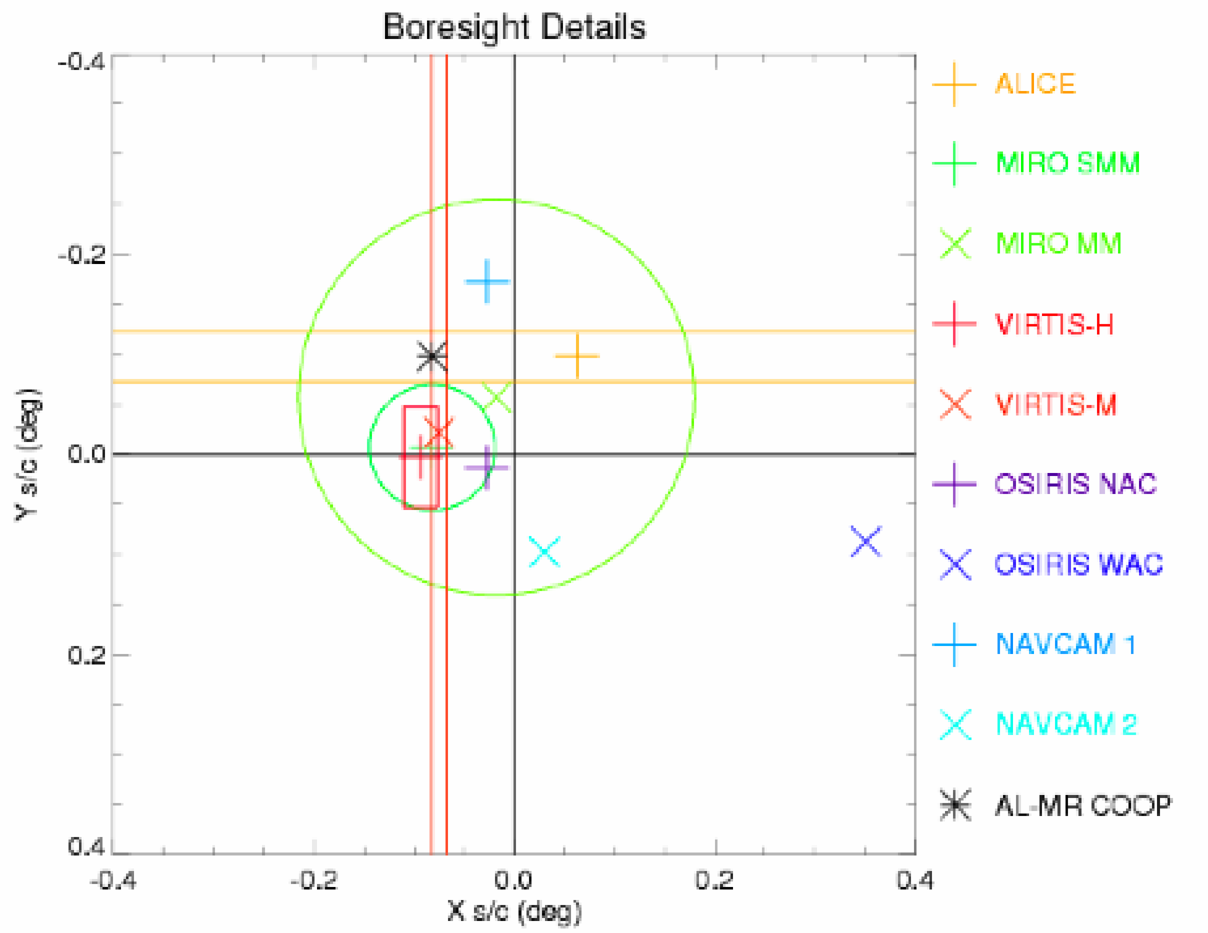

Figure 6: Details of Rosetta instruments' FOV in the spacecraft X/Y frame. Zs/c points into the page (figure from AD3)