VIRTIS-VEx geometry files formatting

VVX-LES-SW-2268

Issue 1.2

	NAME	FUNCTION	SIGNATURE	DATE
Prepared by	S. Erard K. Garceran			**28/1/2008**
Checked by	P. Drossart G. Piccioni			
Approved by				
Authorized by				

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DOCUMENT CHANGE RECORD

Issue	Date	#	Old Paragraph	New Paragraph	Description of the modification	Reason of the modification
Draft 02	26/01/2006	1			Added label for VEX-H geometry files	
Draft 03	14/02/2006	2			Modified information in geometric files	Deeper thinking
Draft 0.4	16/03/2006	3			Modified information in geometric files	Finalization after discussions at team meeting
Draft 0.5	20/03/2006	4			Modified information in geometric files	Corrections
0.6	5/05/2006	5				
Draft 0.6b	15/05/2006	6			General Update	Related to actual implementation
0.6c	16/05/2006	7			Correction of UTC encoding	To preserve required accuracy
0.6d	17/05/2006	8			Various corrections	
Draft 0.8	4/06/2006	9			Change cube organization	Space saving in M cubes (~20%) + consistency for H (first planes are common).
		10			Added slit orientation in H cubes	Information was previously not available at the limb
Draft 0.9/0.9b	first distribution	11			Minor updates	Corrections, precisions…
Draft 0.10	25/7/2006	12			Added boresight-Sun angle projections along X and Y axes for both H and M.	For characterization of possible stray light.
		13			Updated Fig. 1	
		14			Geometry files are generated twice (*.PRE and *.GEO)	According to orbital parameters / time correlation generation at ESOC.
		15			Changed offset in surface elevation for limb observations to 100,000 m	Previous value of 20,000 m was not practical.
		16			Modified definition of plane 30 in limb observation	Now in accordance with actual computation (not set to 0)
		17			Included estimated accuracy on pointing direction	From ESOC information, confirmed by SPICAV
		18			Updated labels	
		19			Added Figures 1 and 2	
Draft 0.11	28/8/2006	20			Various	Complete check and corrections to fit actual computation
Draft 0.12	25/10/2006	21			Sun position is now given in the instrument frame (instead of the S/C frame)	Consistency
Draft 0.13	30/10/2006	22			Plane 30 modified for limb observations	Removes duplicate and preserve surface elevation info for limb observations
Draft 0.14	10/11/2006	23			Various corrections in text	Consistency, clarifications
Issue 1	18/6/2007	24			Various corrections in text, figures added	Consistency with final pipeline and updated EGSE
Issue 1.1	11/9/2007	25			Minor corrections	Update after interaction with PSA
Issue 1.2	28/1/2008	26			Overall	Updated after review

1- Introduction

This document defines the format and contents of the VIRTIS VEx geometrical files for both M and H channels. These files are distributed to the science team, and are part of the archive delivered to PSA.

1.1 Applicable / Reference Documents

• AD1 - VIRTIS VEx to Planetary Science Archive Interface Control Document (EAICD). Issue 1.2, 18 July2008.
• AD2 VIRTIS PDS/IDL software library VVX-LES-SW-2264, Issue 2.7.4

• RD1 - Seidelman et al. (2000) Report of the IAU/IAG working group on cartographic coordinates and rotational elements of the planets and satellites. *Celestial Mechanics and Dynamical Astronomy* **82**: 83–110, 2002.
• RD2 - Ford, P.G. and G.H. Pettengill (1992) Venus topography and kilometer-scale slopes. *Journal of Geophysical Research*, **97** 13103.

1.2 Acronyms and Abbreviations

EDR: Experimental Data Record
EGSE: Electrical Ground Support Equipment
FPA: Focal Plane Arrays
HK: HouseKeeping parameters
IDL: Interactive Data Language
IR: InfraRed
ISIS: Integrated Software for Imagers and Spectrometers
ME: Main Electronic
MSB: Most Significant Byte first
MTP: Medium Term Plan - basic period for observation planning (~1 month)
OBT: On-Board Time
PDS: Planetary Data System
PSA: Planetary Science Archive
RDR: Reduced Data Record
SCET: SpaceCraft Elapsed Time (on-board time measured in s from launch)
SAP: Science Activity Plan
SI: Système International d'unités
TM: Telemetry
UTC: Universal Time Corrected
VEx: Venus-Express
VIRTIS: Visible Infra Red Thermal Imaging Spectrometer

2- Detailed specifications

The overall pipeline for VEx is described in the EAICD, and is summarized in Fig. 1.

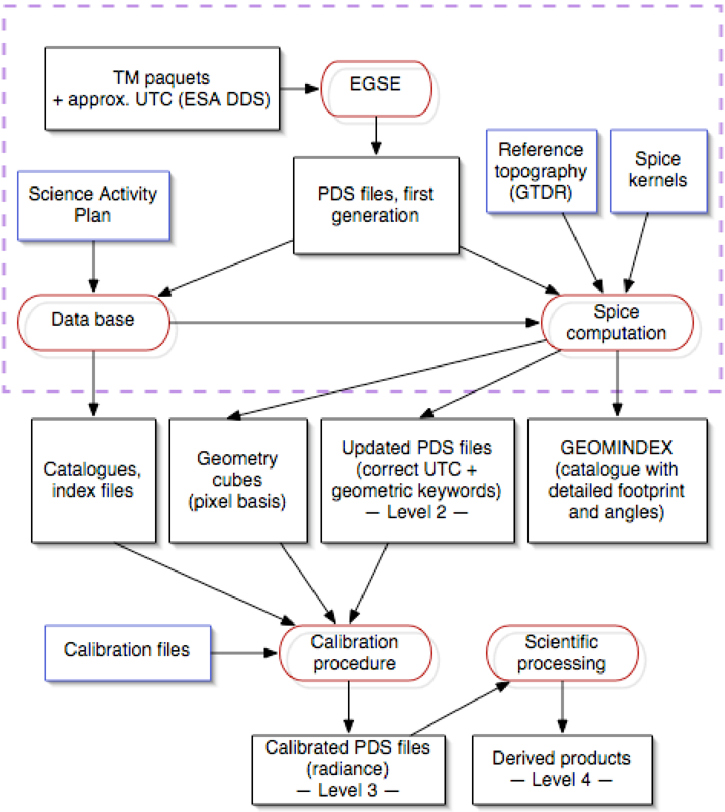

Figure 1: VIRTIS VEx processing pipe-line

The VIRTIS VEx 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) More detailed information stored in a general data catalogue, called GEO_VENUS.TAB. This file is a catalogue providing the footprint of the observing sessions. It is required by the PSA for long term archiving, and is intended to facilitate on-line cross-correlation between data sets.

3) Detailed information on a pixel basis, required to plot the data and analyze them in details. This information is stored in separated geometric 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 geometric 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 geometric file associated to each data file. This implies that the geometric 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.

The geometry computation is in general performed twice for each file: a first time when the raw data file is generated by the EGSE, using predicted orbital parameters; a second time about three weeks later, when the final (reconstructed) orbital parameters and time correlation files become available. The first generation of geometry files have extension “PRE”, whereas the final version have extension “GEO”. The first generation is made available to the team for real time analysis, and is superseded by the final one when available. Only the .GEO files, which are the final versions, are included in the archive.

Geometry computations are performed by a specific IDL library developed and maintained in Meudon (GeoVirtis), relying on the Spice toolkit for IDL (ICY, version N0061). 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 related 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 (see Fig. 1):

1) Formatting in EGSE, with attached PDS labels. The geometrical keywords have dummy values ("NULL"). These files are not distributed outside the PI institutes in Rome and Meudon.

2) Computation of geometrical quantities with the SPICE system, outside the EGSE. Files from the first step are edited and completed in this step with the proper values for the geometrical keywords.

The calibrated or derived data files are written from these updated raw data files, with complete labels that include values associated to the geometrical keywords. No second step SPICE computation has to be performed when writing the calibrated or derived files.

Some of this information cannot be derived from the SPICE system or the data, but is known from science planning (e.g., target names). Such information is collected in the data base in Meudon, and is included in the labels together with the geometric values. The update of the raw data files is triggered by the geometry software (GEOVIRTIS) as a by-product of geometry computation.

2.2 Geometric index

The archive contains two different index files pertaining to the geometry:

1) The general index of the archive, named INDEX.TAB. It provides basic catalogue reference to all the data files, including some selected geometry keywords;

2) A more technical file named GEO_VENUS.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.

2.3 Geometry files contents

The Virtis-VEx geometric files for the three focal planes are written by the GEOVIRTIS software. This system makes use of the SPICE kernels distributed by ESA, and of Virtis-M CK kernels computed in Rome to handle the scanning mirror angle on the M channel. These latter files 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 geometric files also 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 (the value depends on binning mode).
H geometric cubes in nominal mode always have Y' = Y = 64.
H geometric 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 whenever required to preserve accuracy (see below).
The geometry files are handled directly by the VIRTIS IDL library and its front-end routine virtispds [AD 2].

Each observed pixel is projected on Venus, with coordinates of the IFOV corners and center written in the geometry files. Because most of the signal originates in the atmosphere and not from the surface, the IFOV is projected on Venus along the geometric line of sight with no correction for scattering, refraction, or surface topography. Two projection surfaces are used to allow for simple interpolation of the footprint at various altitudes in the atmosphere:

• The first projection surface is a sphere with 6051.8 km radius. This is the Venus reference surface used in SPICE kernels, derived from the Venus reference ellipsoid defined in the IAU 2000 standard (sphere with radius = 6051.8 ± 1.0 km; see [RD1]).
• The second projection surface is a sphere located 60 km above the reference ellipsoid. This particular altitude is selected to match approximately the upper cloud layer on the day side.

The estimated accuracy on the pointing direction is ~0.02°. However two situations have been reported:
• The pointing direction of Virtis is affected by a small oscillation when the ASPERA mirror is moving during acquisition. This is particularly visible on limb sessions. The amplitude of oscillation is on the order of some pixels. At the time of writing, this translate into a pointing error of the same amplitude on some session acquired in the summer of 2007. In the future, the effect may be measured and compensated in the SPICE kernels.
• The M-IR FOV is not entirely aligned: the spatial direction is slightly bended, with an inflection of about 1 pixel at its center. The M-visible FOV may be deformed similarly. Again, this is mostly sensitive on the limb sessions.

2.3.1 Observations intercepting the surface

The cube planes are described in Table 1.

In general, coordinates of the four pixel footprint corners and of the pixel central point are computed on both reference surfaces. All computations are performed in the planetocentric system (i.e.: relative to the local vertical) and using eastward longitudes. Planetographic coordinates are not provided (they are identical in absolute value because the reference ellipsoid is a sphere). The geographic frame is the one used in the SPICE kernels, and defined in the IAU 2000 system. The three observing angles (incidence, emergence, phase) are also computed on both surfaces. In addition, the spacecraft slant distance is computed from the surface ellipsoid (not including the topography) for each pixel. Right ascension and declination at pixel center are computed for each pixel in all observing modes. Local time at Venus is also provided for each pixel; it is measured from local midnight, and increases with UTC in a given location (although the planet rotation is retrograde).

A topographic model is used to provide the average surface elevation of the geometrical footprint at the intercepts of the line of sight with both reference surfaces. The point beneath the intercept with the cloud layer corresponds to the shortest atmospheric path, and is expected to be the main source of photons originating from the surface. The intercept with the ellipsoid roughly corresponds to the intercept with the actual surface; in most situations the difference can be ignored under the thick Venus atmosphere. The two points are identical in nadir pointing (see Fig.2). The topographic model used is the Magellan GTDR (RD2). Surface elevation information is converted to altitude above the reference ellipsoid. The pixel elevation is provided as the average value at the four corners and at center, or as the center value whenever one corner is missing in the GTDR; 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 Venus).

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 attached to the TM data), 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 seconds 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 decoded using the adequate transfer function). 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 Venus 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, starting from Venus North hemisphere spring equinox.

Plane #	Parameter description	Comment
1-4	Longitudes of 4 pixel footprint corner points	Geometrical projection on surface ellipsoid, with no correction for scattering or refraction
5-8	Latitudes of 4 pixel footprint corner points	
9-10	Longitude & latitude of pixel footprint center on surface ellipsoid	
11-13	Incidence, emergence & phase at footprint center, relative to Venus center direction	Angles relative to the reference surface (not accounting for topography). Incidence angle is equal to solar zenithal angle.
14	Surface elevation (footprint corners average)	From topographic model
15	Slant distance (line of sight from spacecraft to surface ellipsoid at pixel center)	Does not include topographic model
16	Local time at footprint center	
17-20	Longitudes of 4 corner points on cloud layer	Geometrical projection on reference cloud layer (60km)
21-24	Latitudes of 4 corner points on cloud layer	
25-26	Longitude & latitude of pixel center on cloud layer	
27-29	Incidence, emergence & phase, relative to local normal of cloud layer	Phase angle is the complement of the scattering angle. Incidence angle is equal to solar zenithal angle.
30	Surface elevation at the vertical of cloud layer intercept	From topographic model
31-32	Right ascension and declination of pointing direction.	J2000 reference frame
For M:		
33	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
	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:	9 supplementary planes	
33-34	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)
35-36	UTC	Encoded UTC recomputed through the SPICE system. See above (33.3-4)
37-38	Sub-spacecraft coordinates (longitude/latitude)	
39	Slit orientation	Relative to the pixel normal at footprint center
40-41	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

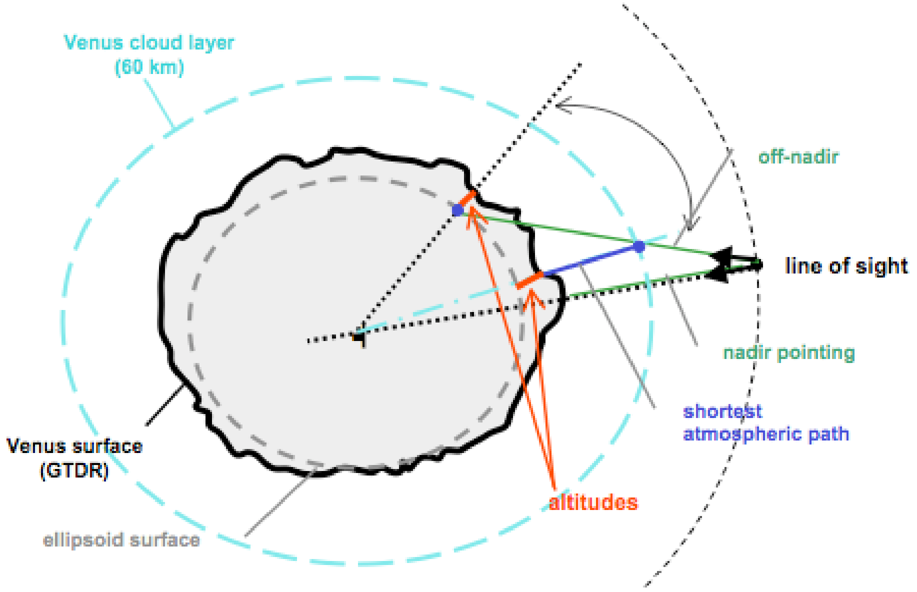

Figure 2: Observations intercepting the surface

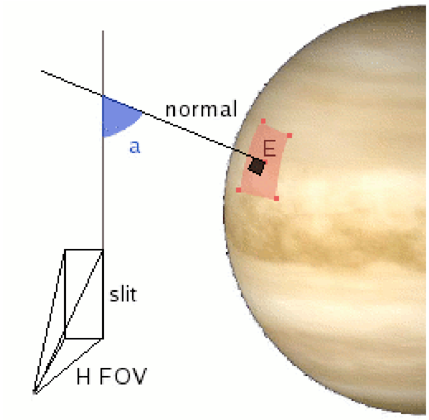

Figure 3: Slit orientation for Virtis-H

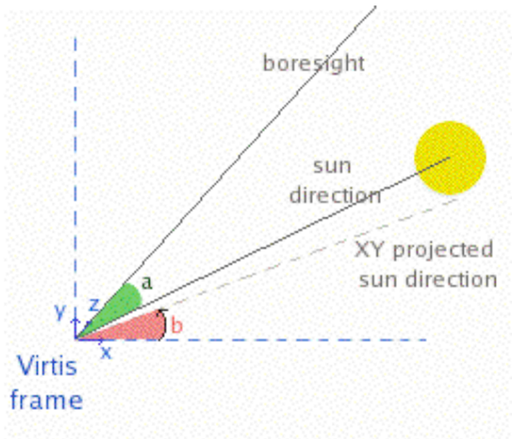

Figure 4: Sun direction in the instrument frame

2.3.2 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 at the ellipsoid intercept (plane 14) 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 inside a file. The 100,000 m offset must be subtracted from plane 14 to retrieve the tangent altitude.
• Surface elevation at the cloud layer intercept (plane 30) is maintained whenever possible. If the line of sight does not intercept the cloud layer, this plane provides the surface elevation at the vertical of the tangent point. A

surface elevation is therefore always available in the geometry cubes, although not necessarily below the tangent point.
• Angles, local time, and slant distance are computed at the intersection with the local vertical (tangent point).
• The H slit orientation cannot be retrieved from surface coordinates, but is available in plane 39 (computed at the tangent point).

In some occasions, the target is a planet different from Venus (Mercury, Earth…). In such cases, the geometry is computed similarly with respect to the target using its ellipsoid shape, and no second reference surface. Planes 17-30 are therefore not used. Such targets are subpixel when observed from the Venus orbit, but a resolved observation of the Earth and the Moon was performed during cruise.

If the target is not a planet (e.g., stars, comets…) it is not expected to produce any geometry files. Whenever such observations are performed in inertial mode, the bore sight direction is available in the file labels.

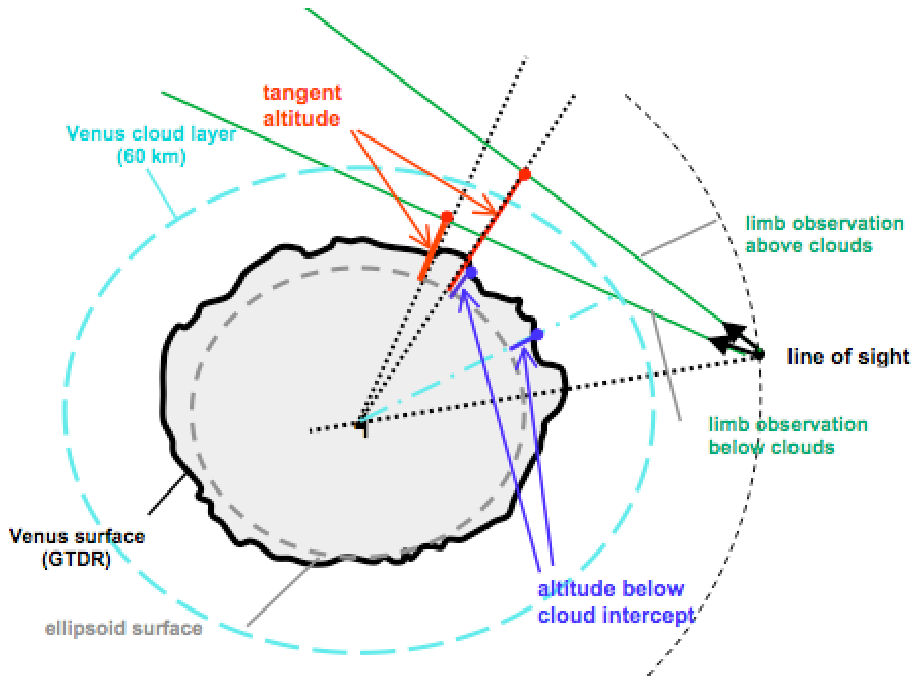

Figure 5: Limb observations at Venus

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, 07/06/2007"	ID of label version
(blank line)				
/* File format and length */				
PRODUCT_ID	SC	CHAR	"xxx.GEO"	Current file name with extension
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	7	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	VEX_VIRTIS_TEAM	(constant)
PRODUCER_FULL_NAME	SC	CHAR	"DROSSART-PICCIONI"	(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	{ "VirtisVEX SW v.2.50", "EGSE_SOFT_<n>", "PDS_CONVERTER_<p>", "GEOVIRTIS_<q>", "V_GEOLABEL_2"}	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 GEOVIRTIS software
(blank line)				
/* Data description parameters */				
DATA_SET_NAME	SC	CHAR	"VENUS EXPRESS VENUS VIRTIS 2/3 V1.0"	(Same as raw data)
DATA_SET_ID	SC	CHAR	"VEX-V-VIRTIS-2/3-V1.0 "	(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	"VENUS EXPRESS"	(constant)
MISSION_ID	SC	ID	VEX	(constant)
INSTRUMENT_HOST_NAME	SC	ID	VENUS_EXPRESS	(constant)

INSTRUMENT_HOST_ID	SC	ID	VEX	(constant)
MISSION_PHASE_NAME	SC	CHAR	"xxx"	String, as defined by PSA
PI_PDS_USER_ID	SC	CHAR	"DROSSART-PICCIONI"	(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)
VEX: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"	As defined by PSA
TARGET_NAME	SC	CHAR	"EARTH" "VENUS" "CALIBRATION" "SKY"	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	xxxx	Follows ESA convention, see EAICD
VEX:SCIENCE_CASE_ID	SC	INT	1 to 8	Science case, encoded. From VEX science case definition document (VEX-RSSD-TN-001)
OBSERVATION_TYPE	SC	CHAR	"xxx"	From VEX document VEX-RSSD-LI-004
SPACECRAFT_ORIENTATION	VEC	REAL	(0.0,-1.0,0.0) or (0.0,1.0,0.0)	Provides scanning orientation (descending or ascending branch of orbit)
^SPACECRAFT_ORIENTATION_DESC	SC	PT	"VEX_ORIENTATION_DESC.TXT"	(constant) Pointer to description file
SPACECRAFT_POINTING_MODE	SC	CHAR	"NADIR" "INERTIAL" "LIMB" "EARTH_POINTING" "STAR_OCCULTATION" "SUN" "SPECULAR" "ALONGTRACK" "ACROSSTRACK" "SPOT"	ID of pointing mode Values as provided by PSA

			...	
^SPACECRAFT_POINTING_MODE_DESC	SC	PT	"VEX_POINTING_MODE_DESC.TXT"	Pointer to description file, 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
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	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 VEx. Extra or modified lines relative to the raw data labels are outlined in red (several lines present in the data labels are also canceled).