Venus Express ASPERA-4 ELS Background Data

Software Interface Specification

for

NASA ROSES PDART Grant NNX17AL04G
SwRI® Project 15.22926

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Document Review

This document and the archive it describes were submitted to PDS April 2021. A peer review was conducted and a meeting to discuss liens took place on May 21, 2021. All liens were addressed, and this document was resubmitted for acceptance into the PDS archive.

Rudy Frahm, ELS instrument scientist and ELS Background Data creator, and Sandee Jeffers, PI of this NASA Grant (NNX17AL04G) and PDS4 Data Production generator have reviewed and approved this document.

Joe Mafi, PDS Planetary Plasma Interactions (PPI) Node Representative, has reviewed and approved this document July 2021.

Document Change History

Revision	Revision Date	Section(s)	Remarks
1.0	03/01/2021	All	Initial version.
1.1	04/05/2021	6.1, 6.3, B.1, B.2, B.3, B.4, B.5	Minor updates based on PDS-PPI validation.
1.2	06/24/2021	5.6, 4.4.1	Updates to address peer review liens. Lien #18: Section 5.6 – Updated collection names Lien #20: Section 4.4.1 – Added references to ASPERA-4 instrument kernel and Venus Express frames kernel

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1 Introduction

1.1 Venus Express Electron Spectrometer Overview

The Electron Spectrometer (ELS) instrument was part of the Analyzer of Space Plasmas and Energetic Atoms, 4th edition (ASPERA-4) experiment on the European Space Agency's (ESA's) Venus Express (VEx) mission. The ELS instrument measured the *in situ* electron plasma in the Venus environment and the solar wind from April 2006 through 2014. The VEx spacecraft orbited Venus sampling data from a polar orbit with a periapsis, which varied between 250 km and 300 km, and an apoapsis of about 66,000 km. The VEx orbit was polar with pericenter about the north pole of Venus and the apocenter about the south pole of Venus. The VEx orbit precessed, taking 120 days to precess 180° about its semi-major axis.

The VEx mission was constructed from flight spare instrumentation left over from the ESA Mars Express (MEx) mission. In the USA, NASA was a participant in the ESA MEx program. Through the first Discovery Program Mission of Opportunity (MO) and later through the Mars Program, NASA supported Southwest Research Institute (SwRI) to participate in the Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3) experiment in the MEx program. This included instrument construction (different components of the ASPERA-3 contingent as well as the entire ELS instrument), archiving of all MEx ASPERA-3 data in the ESA Planetary Science Archive (PSA) and NASA PDS, and participation in the science investigation of the ASPERA-3 experiment at Mars. SwRI constructed a flight and a flight spare unit of the ASPERA-3 ELS, which were supplied to the PI institution, Swedish Institute of Space Physics (IRF), for the ASPERA-3 experiment on MEx. After the successful launch of the MEx spacecraft in 2003 from Baikonur by a Russian Soyuz rocket, ESA decided to conduct a similar mission to Venus. ESA came to the conclusion that rather than build new instrumentation for the VEx mission, it would modify the left over MEx spare instrumentation for the higher radiation environment expected at Venus. At this time, the ESA member countries all supported the VEx mission; however, NASA opted to only allow the flight spare instrumentation from MEx to be included as part of the VEx mission without support from the USA. Thus, the unused flight spare ELS unit was modified in Europe for the extra radiation shielding needed for the Venus environment and this became the ASPERA-4 ELS unit flown on VEx.

As a consequence of the NASA decision, data from the VEx mission were archived by the Europeans in the European Planetary Science Archive (PSA) without guidance from NASA or SwRI. Data from the VEx mission are now all publicly available. For VEx ELS, the data are archived at the ESA PSA:

https://archives.esac.esa.int/psa/#!Table%20View/Venus%20Express=mission

The PSA ELS data consist of the telemetered ELS science packets in ASCII form, and the calibration factors needed to construct the electron spectrum in geophysical units.

During the science investigation in the USA, comparisons between the Mars and Venus plasma environments were conducted under the guidance of the NASA Discovery program. In order to conduct this investigation, SwRI needed to determine the background which existed within the VEx ELS instrument. These background values were generated for the entire time period of the VEx mission and stored at SwRI (https://www.aspera-3.org/images/11/).

1.1.1 Description of ELS Instrument and Data Collection

The ELS data stored in the public archive are raw data from the ELS spectrometer on the VEx spacecraft. These raw data contain the environmental signal from the Venus plasma and the internal signals generated in the instrument. There is no discussion or description of signals from penetrating radiation, or how to recover the plasma signal from the ELS data. Normally, plasma enters ELS through an inlet opening in the side of the detector in an azimuth of 360°. This azimuth is segmented into 16 22.5°-wide sectors (numbered 0-15).

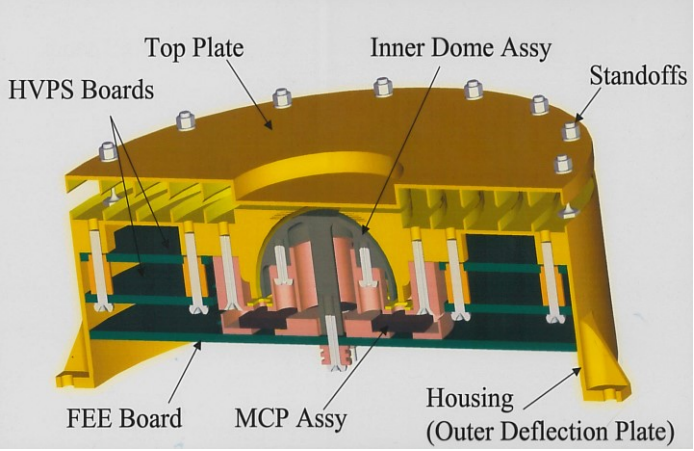

Figure 1. Cross-section of the VEx ELS instrument showing the internal geometry. *Plasma enters through the sides of the housing and travels between the collimator baffles which refine the plasma into a beam. A high voltage power supply (HVPS) generates an electric field between the top plate/outer plate and the inner dome which selects electrons. Energy selection occurs further as the electrons travel between the inner and outer domes, eventually striking the MCP assembly where they are magnified and turned into an electronic signal by the front end electronics (FEE).*

The elevation acceptance angle is ± 2°. The plasma passes through the collimator region, where the plasma from angles beyond the acceptance range is removed. Plasma then enters the top hat region where spherical deflection plates separate out the electron plasma of specific energy. The selected electrons are then focused on to a microchannel plate (MCP) sensor. The electron signal is multiplied by the MCP and passed to an anode. Electrons are collected on the anode, and amplified by a charge sensitive amplifier, and then counted. A cut away view of the VEx ELS sensor is shown in **Figure 1**.

1.1.2 Description of ELS Background Data

The ELS background signal is the portion of the raw data that is internally generated within the instrument and does not reflect the Venus plasma. During its lifetime, the ELS instrument experienced several different types of contamination which altered the electron spectrum from Venus. These signals include external fluxes due to penetrating radiation caused by geophysical events like Solar Energetic Particles (SEPs), cosmic rays that penetrate through the instrument, as well as internal effects due to thermal noise generated within the MCP, outgassing of the MCP, and electronic noise. All these sources are independent of the energy of an incoming electron (energy independent) from the Venus environment; however these sources are time dependent. See the VEX_ASPERA-4_ELS_Description document for a complete and thorough discussion on how to determine the ELS background data.

1.2 Purpose and Scope of this Document

The purpose and goal of this document is to provide the users of the Venus Express Electron Spectrometer (VEx ELS) data with detailed descriptions of the ELS background data products.

These data products are meant to aid in the removal of the ELS background signal for increased science accuracy and improved science quality. This document is intended for those wishing to read and understand the format and content of the VEx ELS PDS data product archive collections. This typically includes scientists, PDS staff, data analysts, and software engineers.

1.3 Applicable Documents

[1] *Planetary Data System Standards Reference*, Vers. 1.12.0, April 1, 2019, JPL D-7669, Part 2

[2] *The PDS4 Data Provider's Handbook: Guide to Archiving Planetary Data Using the PDS4 Standard*, Version 1.12.0, April 1, 2019

[3] *PDS4 Concepts*, Version 1.12.0, April 1, 2019, Data Design Working Group

[4] *PDS4 Data Dictionary Abridged*, Version 1.12.0.0, Generated from Information Model Version 1.12.0.0 on Thu May 02 09:21:18 PDT 2019

[5] *PDS4 Information Model Specification,* Version 1.12.0.0, Thu May 02 09:21:19 PDT 2019

[6] *Venus Express ASPERA-4 ELS Background Data Examples* Document (in this archive's document collection: VEX_ASPERA-4_ELS_Background_Data_Examples.pdf)

[7] *Venus Express ASPERA-4 ELS Background Data* Description Document (in this archive's document collection: VEX_ASPERA-4_ELS_Description.pdf)

1.4 Document Content Overview

The following is an overview of what this document contains:

- Section 2 describes the relationships with other interfaces as they relate to the data generation and archiving of the Venus Express ELS data.
- Section 3 describes the roles and responsibilities of the cognizant personnel in generating, delivering, and archiving of the VEx ELS data.
- Section 4, *Data Product Characteristics and Environment*, provides an overview of the data products in this archive, details the data processing flow and generation of the data products, and describes the standards used in generating the data products.
- Section 5 is describes the archive organization, identifiers, and naming conventions for the bundle, data collections, data products, and document collection.
- Section 6 gives the details of the archive data formats.
- Appendix A has a table of acronyms and abbreviations with their meanings and a list of glossary terms with their definitions.
- Appendix B contains sample PDS product labels for each of data products in this archive.

2 Relationships with Other Interfaces

The interfaces that could have an impact on the ASPERA-4 ELS background data product generation, packaging, distribution, and documentation include:

1. ASPERA-4 IDFS (Instrument Data File Set) Data: These data are produced from telemetry and are used to produce the PDS4-compliant data products with associated labels. If these data are reprocessed for any reason, there could be a direct impact on the generation of the ASPERA-4 ELS background data products and collections.

2. IDFStoPDS4 Software: This software was developed to produce the PDS4-compliant data and label files from the IDFS data. Any changes to this software could impact the generation of the PDS4 data products.
3. PDS collection Tool: This software is used to generate the collection lists (CSV files) and labels. Any changes to this software could impact the generation of the PDS4 collection files.

The probability of these interfaces changing that would impact the ASPERA-4 ELS background data products and collections is very low.

3 Roles and Responsibilities

Southwest Research Institute is responsible for the production and delivery to the PDS-PPI node of documented VEx ELS background data collections using PDS4 standards. In addition, SwRI interfaces with PDS-PPI to ensure PDS4-compliance of the VEx ELS background data archive. It is SwRI's responsibility to resolve any change requests (liens) as a result of the PDS peer review.

The specific SwRI personnel are Ms. Sandee Jeffers (PI of PDART Grant NNX17AL04G), Dr. Rudy Frahm (Co-I), and Ms. Carrie Gonzalez (Software Engineer). Ms. Gonzalez is responsible for the IDFStoPDS4 conversion tool that generates PDS4-compliant files and XML labels. Dr. Frahm is responsible for generating and validating the VEx ELS background data in IDFS format. He is also responsible for providing documentation describing the background data and the procedure on how to use the background data with the VEx ELS science data. Ms. Jeffers is responsible for generating the Software Interface Specification (SIS, this document), PDS4 context files (aspera4-els), infrastructure, and the data collections and archive bundle. She is also responsible for validating the collections and delivery to PDS-PPI. Ms. Jeffers and Dr. Frahm are the SwRI participants of the PDS peer review and are responsible for lien resolution for PDS-PPI approval.

The PDS is the primary organization within NASA responsible for archiving planetary data, and thus the designated point of contact on archive-related issues. PDS-PPI personnel participate in archive planning efforts to ensure that archives are planned, generated, and reviewed using PDS4 standards. PDS standards require that all archive products undergo a peer review (PR) cycle, much in the way a journal article is reviewed. The peer review is a coordinated effort between PDS-PPI and SwRI personnel, and the PDS-PPI assists SwRI with resolving any PR liens. Once SwRI delivers the data, PDS-PPI is responsible for distributing VEx ELS background data to the broad science community.

4 Data Product Characteristics and Environment

4.1 Overview

Throughout the nine-year Venus Express mission (launched in late 2005, arrived at Venus in 2006, and ended late 2014), all the VEx ELS data were automatically processed and stored at SwRI in the Instrument Data File Set (IDFS) format. The VEx ELS data have been and are used for collaborative studies, which necessitated the generation of the background data processed into the IDFS format.

The following sections give an overview of the data products and describe the data processing and standards used in generating the data products.

4.2 Data Product Overview

There are three types of VEx ELS data in this archive: (1) ELS background data, (2) ELS science data, and (3) ELS energy levels. These products are described in the following subsections.

4.2.1 ELS Background Data

The Venus Express ELS background data are derived by calculating 5-minute averages per ELS sector (16 sectors). The background data files contain the background rates and their uncertainty for each ELS sector and for the total anode – 17 background rates (cnts/sec) along with their associated uncertainties (standard deviations in cnts/sec) per 5-minute period.

The following documents, included in the document collection of this archive, provide a detailed description of background generation and use:

VEX_ASPERA-4_ELS_Background_Data_Examples.pdf

VEX_ASPERA-4_ELS_Description.pdf

The ELS background data files are PDS4 ASCII tables and are named as follows:

ELS05BK_**YYYYDDDHHMM**_V**x.y**.TAB

where **YYYY** is the year
DDD is the Day of Year (DOY)
HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

For example, the file ELS05BK_**20130641406**_V**1.0**.TAB is Version 1.0 of the table containing the ELS 5-minute averaged background data beginning year **2013**, day **064**, at time **14:06**.

4.2.2 ELS Science Data

The VEx ELS science data included in this archive are the background corrected number flux, the 1-count threshold data, and the raw counts. The science data are divided into low energy range data and high energy range data. There may be times when only the low energy range data are collected, and thus, only the low range data file(s) are available for that time range.

The *VEX_ASPERA-4_ELS_Description.pdf* document, included in the document collection of this archive, gives a full description and procedure for applying the background data to the raw data and calculating the 1-count threshold values and the background corrected number flux.

The ELS science data are in PDS4-compliant CSV format and are named as follows:

ELS**r**R**<data-type>**_**YYYYDDDHHMM**_V**x.y**.CSV

where **r** = **L** for Low energy range, or r = **H** for High energy range
<**data-type**> is: **BCNF** for **B**ackground **C**orrected **N**umber **F**lux
THR for 1-count **THR**eshold data
CNTS for raw data in Cou**NTS**
YYYY is the year
DDD is the Day of Year (DOY)
HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

4.2.2.1 ELS Background Corrected Number Flux

The Venus Express ELS data, corrected for the 5-minute averaged background, is determined at each energy step for each ELS sector (16 sectors) and written to CSV (Comma Separated Values) files. The background corrected flux data are in scientific units of differential number flux (DNF):

$$\frac{electrons}{cm^2 \cdot s \cdot sr \cdot eV}$$

An example background corrected number flux file is ELS**L**R**BCNF_20130641406**_V**1.0**.CSV, meaning it is Version **1.0** of Comma Separated Values containing the ELS **L**ow energy range **B**ackground **C**orrected **N**umber **F**lux for beginning year **2013**, day **064**, at time **1406**. The file ELS**H**R**BCNF_20130641406**_V**1.0**.CSV is the **H**igh energy range **B**ackground **C**orrected **N**umber **F**lux data for this time period.

4.2.2.2 ELS 1-Count Threshold

The Venus Express ELS 1-count threshold data represent the amount of differential number flux (DNF) when the instrument registers 1 count at each energy step for each ELS sector (16 sectors) and written to CSV (Comma Separated Values) files. The 1-count DNF threshold is necessary to reconstruct the background corrected DNF spectrum

An example 1-count threshold file is ELS**L**R**THR_20130641406**_V**1.0**.CSV, meaning it is Version **1.0** of Comma Separated Values containing the ELS **L**ow energy range 1-count **THR**eshold data for beginning year **2013**, day **064**, at time **1406**. The file ELS**H**R**THR_20130641406**_V**1.0**.CSV is the **H**igh energy range 1-count **THR**eshold data for this time period.

4.2.2.3 ELS Raw

The Venus Express ELS raw data are the measured electron counts at each energy step for each ELS sector (16 sectors) and written to CSV (Comma Separated Values) files.

An example raw data file is ELS**L**R**CNTS_20130641406**_V**1.0**.CSV, meaning it is Version **1.0** of Comma Separated Values containing the ELS **L**ow energy range **C**ou**NTS** for beginning year **2013**, day **064**, at time **1406**. The file ELS**H**R**CNTS_20130641406**_V**1.0**.CSV is the **H**igh energy range raw data for this time period.

4.2.3 ELS Energy Levels

The ELS energy levels (or steps) are needed for science analysis and considered an engineering data product. These are the center energy steps (in electron volts, eV) at which each data value is measured for each ELS sector (16 sectors), and they map directly to the science data. Like the science data files, the energy step data files are divided into low energy range files and high energy range files. There may be times when only the low energy range data are collected, and thus, only the low range data file(s) are available for that time period.

The ELS energy step data are in CSV format and are named as follows:

ELS**r**RSTPS_**YYYYDDDHHMM**_V**x.y**.CSV

where **r** = **L** for Low energy range, or r = **H** for High energy range
YYYY is the year
DDD is the Day of Year (DOY)

HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

An example energy step data file is ELS**LRSTPS_20130641406**_V**1.0**.CSV, meaning it is Version **1.0** of Comma Separated Values containing the ELS **L**ow energy range **STePS** for beginning year **2013**, day **064**, at time **1406**. The file ELS**HRSTPS_20130641406**_V**1.0**.CSV is the **H**igh energy range energy step data for this time period.

4.3 Data Processing

4.3.1 Data Processing Levels

Data processing levels in this document refer to PDS4 processing levels.

Table 1 provides a description of the data processing levels along with the equivalent designations used in the PDS3 and NASA systems. The VEx ELS products described in this document include raw and derived data.

Table 1. Data Processing Level Definitions

PDS4 Level	PDS4 Level Description	CODMAC Level (used in PDS3)	NASA Level
Raw	Original data from an experiment. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format. Often called EDRs (Experimental Data Records).	1	0
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status. These and more highly processed products are often called RDRs (Reduced Data Records).	2	1A
Calibrated	Data converted to physical units, which makes values independent of the experiment.	3	1B
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.	4+	2+

4.3.2 Data Product Generation

Throughout the nine-year Venus Express mission (launched in late 2005, arrived at Venus in 2006, and ended late 2014), all VEx ELS data were automatically processed and stored at SwRI in the Instrument Data File Set (IDFS) format. The VEx ELS data have been and are being used for collaborative studies, which necessitated the generation of the background data (also processed into the IDFS format). A software tool, IDFStoPDS, was developed to convert IDFS formatted data to PDS3 form since the IDFS format is not PDS-compliant. This software tool has been updated to be PDS4-compliant and used to batch process all of the VEx ELS background data into PDS4-compliant tables and CSV files.

4.3.3 Data Flow

Figure 2 is a graphical overview of the steps involved in generating the VEx ELS background data archive. The VEx ELS background data are locally archived in the IDFS format, and the SwRI IDFStoPDS4 conversion tool extracts the VEx ELS background data from the SwRI IDFS database and converts it to PDS4-compliant data files with their corresponding XML labels. The PDS4 ELS background documentation describes the ELS background data and how to apply it to the ELS science data archived at PSA (See Applicable Documents). The VEx ASPERA-4 ELS PDS4 context file was generated using similar documentation archived at PSA. These components comprise the VEx ELS background data archive collections and bundle.

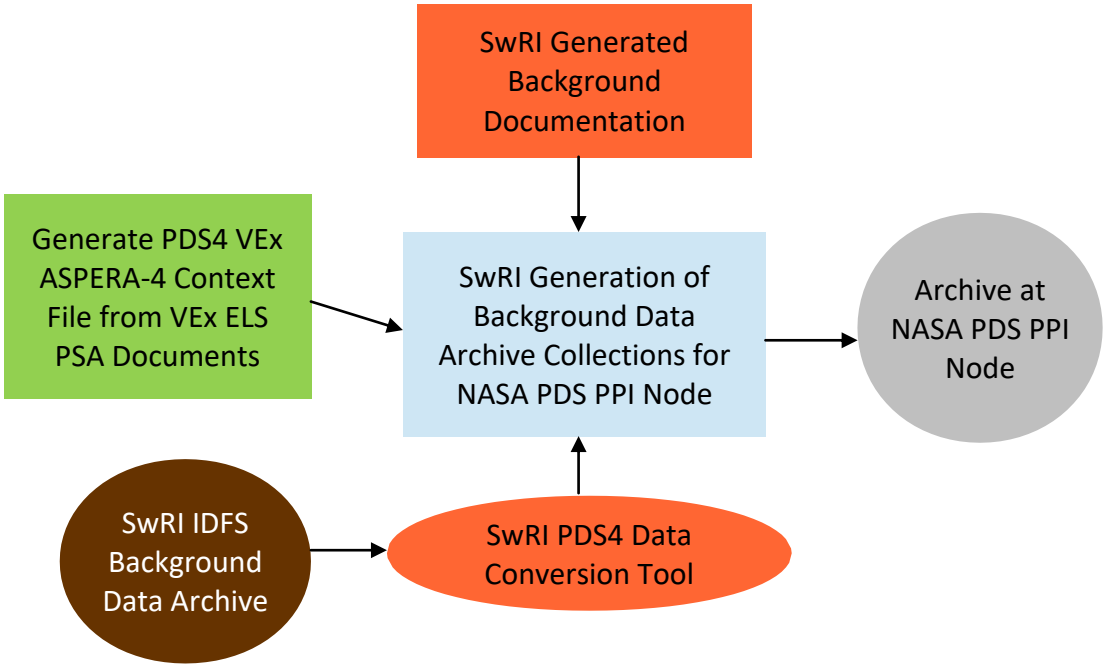

Figure 2. Archive Generation Flow.

4.4 Standards Used in Generating Data Products

All the Venus Express ELS data product files and labels included in this archive comply with the Planetary Data System standards, specifically the PDS4 standard as referenced in the document: *Planetary Data System Standards Reference*, Version 1.12.0, April 1, 2019 [1].

4.4.1 Coordinate Systems

The Venus Express ELS measurements are *in situ*, thus the data are in the VEx ELS instrument reference frame as defined in the SPICE (Spacecraft, Planet, Instrument, C-matrix, and Event) instrument kernel, VEX_ASPERA4_V02.TI. The ELS is mounted on a rotating scanner to give a 360° field of view with a ±2° deviation out of viewing plane (elevation). The 16 ELS sectors are each 22.5°. The Venus Express SPICE kernels should be used for translating/rotating to other reference frames, which are defined in the frames kernel, VEX_V10.TF. The orientation of the ASPERA-4 scanner is given in the CK kernel, VEX_ASPERA_SAF_051109_1.BC, found on the NAIF (Navigation and Ancillary Information Facility) website:

https://naif.jpl.nasa.gov/pub/naif/VEX/kernels/ck/

4.4.2 Geometric Elements

All geometry information is archived along with the ASPERA-4 ELS data at the ESA PSA and can be found in the GEOMTRY subdirectory associated with each data set. FTP access to the PSA ASPERA-4 data archive is at:

ftp://psa.esac.esa.int/pub/mirror/VENUS-EXPRESS/ASPERA4/

4.4.3 Data Storage Conventions

The Venus Express ELS background data are stored in PDS4-compliant ASCII table format. The science data and engineering data are stored in PDS4-compliant ASCII CSV format. **Table 2** shows the estimated data volume for each data collection.

Table 2. Estimated Data Volumes

Data Collection	Data Products	Estimated Volume
data_derived	ELS background data ASCII Tables	850 MB
	ELS Background Corrected Number Flux ASCII CSV files	635 GB
	ELS 1-count Threshold ASCII CSV files	635 GB
data_raw	ELS Counts ASCII CSV files	345 GB
data_eng	ELS energy steps ASCII CSV files	3 GB

4.4.4 Data Validation

The VEx ELS data are validated by Dr. Rudy Frahm for science content and for compliance with PDS4 archive standards. All data and documentation are submitted to a peer review committee for science review according to PDS policy.

4.4.5 Software

All data are in ASCII form so they are readily and easily readable using almost any text editor. In addition, the PDS labels include complete software-readable descriptions of the data file formats for custom-software development if warranted. The CSV files can be read using spreadsheet software (e.g., Microsoft Excel), but users should be aware of row/column limitations of the various software versions.

5 ELS Archive Organization, Identifiers and Naming Conventions

This section describes the basic organization of the Venus Express ELS data archive, and the naming conventions used for the bundle, collections, and data products.

5.1 Logical Identifiers

Every product in PDS is assigned an identifier, which allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. A LIDVID (Logical Identifier plus Version Identifier) includes product version information, and allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. LIDs and VIDs are assigned by the entity generating the labels and are formed according to the conventions described in sections 5.1.1 and 5.1.2 below. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools.

5.1.1 LID Formation

LIDs take the form of a Uniform Resource Name (URN), and are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. The dash, underscore, or period are used as separators within these prescribed components. LIDs are limited in length to 255 characters.

Venus Express ELS LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the PDS base ID:

  urn:nasa:pds:<bundle ID>

  The VEx ELS bundle ID is: vex-aspera4-els
  Thus, the bundle LID is: urn:nasa:pds:vex-aspera4-els

  Since all PDS bundle LIDs are constructed this way, the combination of vex-aspera4-els must be unique across all products archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

  urn:nasa:pds:<bundle ID>:<collection ID>

  urn:nasa:pds:vex-aspera4-els:<collection ID>
  For example: urn:nasa:pds:vex-aspera4-els:data_derived

Collection LIDs are based on the bundle LID, which is unique across PDS, so the only additional condition is that the collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data_raw", "data_derived", etc.) to ensure that multiple collections of the same type within the bundle have unique LIDs.

- Basic product LIDs are formed by appending a product specific ID to the product's parent collection LID:

  urn:nasa:pds:<bundle ID>:<collection ID>:<product ID>

  urn:nasa:pds:vex-aspera4-els:<collection ID>
  For example: urn:nasa:pds:vex-aspera4-els:data_derived:<product ID>
  urn:nasa:pds:vex-aspera4-els:data_derived:elslrbcnf_20130641406

  Since the product LID is based on the collection LID, which is unique across PDS, the only additional condition is that the product ID must be unique across the collection. For VEx ELS data products, the product LID is the same as the data file name without the extension.

5.1.2 VID Formation

Product version IDs consist of major and minor components separated by a "." (x.y). Both components of the Version Identifier (VID) are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented. The *Planetary Data System Standards Reference* [1] specifies rules for incrementing major and minor components.

5.1.3 File Naming Conventions

The ELS background data files are PDS4 ASCII tables and are named as follows:

ELS05BK_**YYYYDDDHHMM**_V**x.y**.TAB

where **YYYY** is the year
DDD is the Day of Year (DOY)
HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

The ELS science data are in PDS4-compliant CSV format and are named as follows:

ELS**r**R**<data-type>**_**YYYYDDDHHMM**_V**x.y**.CSV

where **r** = **L** for Low energy range, or r = **H** for High energy range
<**data-type**> is: **BCNF** for **B**ackground **C**orrected **N**umber **F**lux
THR for 1-count **THR**eshold data
CNTS for raw data in **C**ou**NTS**
YYYY is the year
DDD is the Day of Year (DOY)
HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

The ELS energy step data are in CSV format and are named as follows:

ELS**r**RSTPS_**YYYYDDDHHMM**_V**x.y**.CSV

where **r** = **L** for Low energy range, or r = **H** for High energy range
YYYY is the year
DDD is the Day of Year (DOY)
HH is the hour of the day
MM is the minute of the hour
V**x.y** refers to the file Version number x.y

5.2 Bundles

The highest level of organization for a PDS4 archive is the bundle. A bundle is a set of one or more related collections which may be of different types. A collection is a set of one or more related basic products which are all of the same type. Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization.

This Venus Express ELS archive is organized into one bundle: **urn:nasa:pds:vex-aspera4-els**

5.3 Data Collections

Collections consist of basic products all of the same type. The Venus Express ELS bundle contains the data collections listed in **Table 3**. There are three ELS data collection LIDs:

1. **urn:nasa:pds:vex-aspera4-els:data_derived** – Five data products
   - Background data (ELS05BK)
   - Background Corrected Number Flux (ELSHRBCNF and ELSLRBCNF)
   - 1-cnt Threshold (ELSHRTHR and ELSLRTHR)
2. **urn:nasa:pds:vex-aspera4-els:data_raw** – Two data products
   - Counts (ELSHRCNTS and ELSLRCNTS)
3. **urn:nasa:pds:vex-aspera4-els:data_eng** – Two data products
   - Energy Levels (ELSHRSTPS and ELSLRSTPS)

Table 3. VEx ELS Data Collections, Products, and Estimated Volumes

Collections	Data Products	Estimated Volume
data_derived	**ELS05BK - 5 minute average background [cnts/sec]** **ELSHRBCNF - high range corrected diff number flux** **ELSLRBCNF - low range corrected diff number flux** **ELSHRTHR - high range 1-cnt diff number flux thresholds** **ELSLRTHR - low range 1-cnt diff number flux thresholds** **** diff number flux units → [cnts/(cm^2·sr·sec·eV)]**	1.3 TB
data_raw	**ELSHRCNTS - high energy range raw counts [cnts]** **ELSLRCNTS – low energy range raw counts [cnts]**	345 GB
data_eng	**ELSHRSTPS - high range center energy steps [eV]** **ELSLRSTPS – low range center energy steps [eV]**	3 GB

5.4 Products

A PDS product consists of one or more digital objects and an accompanying PDS label file. PDS labels provide identification and description information for labeled objects. The PDS label includes a Logical Identifier (LID) by which any PDS labeled product is uniquely identified throughout all PDS archives. PDS4 labels are XML-formatted ASCII files.

The LID for a product in all the collections consists of the collection LID concatenated with the file name, without the extension.

Example LID for an ELS low energy range background corrected number flux product:

urn:nasa:pds:vex-aspera4-els:data_derived:elslrbcnf_20130641406

5.5 Document Collection

Documents are also considered products by PDS and have LIDs, VIDs and PDS4 labels similar to the data products. The VEx ELS bundle includes a Document Collection, which consists of documents relevant to this archive.

Document Collection LID: **urn:nasa:pds:vex-aspera4-els:document**

Table 4 contains a list of the documents included in this collection along with a brief description of each.

Table 4. The Venus Express ASPERA-4 ELS Document Collection

Product Logical Identifier (LID) Document Filename**	Description
urn:nasa:pds:vex-aspera4-els:document:sis VEX_ASPERA-4_ELS_Spec_1.0.pdf	VEx ELS Software Interface Specification (this document): describes the format and content of this archive
urn:nasa:pds:vex-aspera4-els:document:bkexamp VEX_ASPERA-4_ELS_Background_Data_Examples_1.0.pdf	VEx ELS Background Data Examples: gives general description of background and how it should be used
urn:nasa:pds:vex-aspera4-els:document:bkdesc VEX_ASPERA-4_ELS_Description_1.0.pdf	VEx ELS Background Description: gives how background is calculated along with how to use and apply to generate background corrected differential number flux

***All documents are in PDF/A format.*

5.6 Archive Organization and Directory Structure

The Venus Express ELS archive is organized into one bundle with three data collections and a document collection. This section describes the overall directory structure.

```
vex-aspera4-els – top level directory
   bundle_vex-aspera4-els_1.1.xml
   readme_vex-aspera4-els_1.0.txt
   data_derived – subdirectory containing the derived data collection
      collection_data_derived_1.0.csv
      collection_data_derived_1.0.xml
      ……
         Subdirectories given below
   data_eng – subdirectory containing the engineering data collection
      collection_data_eng_1.0.csv
      collection_data_eng_1.0.xml
      ……
         Subdirectories given below
   data_raw – subdirectory containing the raw data collection
      collection_data_raw_1.0.csv
      collection_data_raw_1.0.xml
      ……
         Subdirectories given below
   document – subdirectory containing the document collection
      collection_document_1.0.csv
      collection_document_1.0.xml
      VEX_ASPERA-4_ELS_Background_Data_Examples_1.0.pdf
      VEX_ASPERA-4_ELS_Background_Data_Examples_1.0.xml
      VEX_ASPERA-4_ELS_Description_1.1.pdf
      VEX_ASPERA-4_ELS_Description_1.1.xml
      VEX_ASPERA-4_ELS_Spec_1.2.pdf
      VEX_ASPERA-4_ELS_Spec_1.2.xml
```

The subdirectories of each of the data directories are the same and are based on the data directory structure of the Venus Express ASPERA-4 ELS archive at the PSA. Each has a subdirectory for each mission phase: nominal, ext1, ext2, ext3, and ext4. Under these subdirectories, the data are further divided into time periods and have subdirectories formulated: `YYYYMMDD_YYYYMMDD` indicating the beginning year, month, and day through the ending year, month and day. The directories are structured as follows:

`data_<type>`, where `<type>` is either `derived`, `eng`, or `raw`

- `nominal`
  - `20051109_20060831`
  - `20060901_20061130`
  - `20061201_20070228`
  - `20070301_20070531`
  - `20070601_20070831`
  - `20070901_20071002`
- `ext1`
  - `20071003_20071231`
  - `20080101_20080331`
  - `20080401_20080630`
  - `20080701_20080930`
  - `20081001_20081231`
  - `20090101_20090331`
  - `20090401_20090531`
- `ext2`
  - `20090601_20090831`
  - `20090901_20091130`
  - `20091201_20100228`
  - `20100301_20100531`
  - `20100601_20100831`
- `ext3`
  - `20100901_20101130`
  - `20101201_20110228`
  - `20110301_20110531`
  - `20110601_20110831`
  - `20110901_20111130`
  - `20111201_20120229`
  - `20120301_20120531`
  - `20120601_20120831`
  - `20120901_20121231`
- `ext4`
  - `20130101_20130228`
  - `20130301_20130531`
  - `20130601_20130831`
  - `20130901_20131130`
  - `20131201_20140228`
  - `20140301_20140531`
  - `20140601_20141127`

The data files (ASCII tables and CSV) along with their associated labels (XML) for each data collection are located in their respective subdirectories.

6 ELS Archive Data Formats

Data that comprise the VEx ELS archive are formatted in accordance with PDS4 specifications (see the *Planetary Data System Standards Reference* [1], *PDS4 Data Provider's Handbook* [2], and *PDS4 Data Dictionary* [4]). This section provides details on the formats used for each of the products included in the archive.

6.1 ELS Background Data

The VEx ELS background data are organized in ASCII tables with a total of 36 columns per row: two for start and stop date/times, 17 for the 5-minute averaged background for the anode (all sectors together) and for each ELS sector (16 sectors,) and 17 for the uncertainties (standard deviations) that correspond to each background value. **Table 5** describes the 36 fields (columns).

Table 5. ELS Background Table Fields for each Row of Data (Columns)

Field Name	Data Type/Format	Units	Description
Start Time	ASCII_Date_Time_DOY YYYY-DOY**T**HH:MM:SS.mmm	UTC	Start date/time of the data
Stop Time	ASCII_Date_Time_DOY YYYY-DOY**T**HH:MM:SS.mmm	UTC	Stop date/time of the data
VEx ELS Anode Background	ASCII_Real xxxx.yyyy	count rate (cnts/sec)	Background for all sectors combined (anode)
VEx ELS-nn Background	ASCII_Real xxx.yyyy	count rate (cnts/sec)	Background for sector nn nn = 00 to 15 16 fields (columns)
VEx ELS Anode Background Std Dev	ASCII_Real x.xxxx**e±**yy	count rate (cnts/sec)	Background standard deviation for all sectors combined (anode)
VEx ELS-nn Background Std Dev	ASCII_Real x.xxxx**e±**yy	count rate (cnts/sec)	Background standard deviation for sector nn nn = 00 to 15 16 fields (columns)

6.2 ELS Background Corrected Number Flux and 1-Count Threshold

The VEx ELS background corrected number flux (ELSHRBCNF and ELSLRBCNF) and 1-count threshold (ELSHRTHR and ELSLRTHR) data are stored in ASCII CSV files, and they have the same format. Each row (data file record) of the CSV files has six fields. The sixth field, VALUES, has a number of repetitions corresponding to the number of energy steps for that file (or data product). The number of repetitions (or energy levels) is in the range 0 < repetitions ≤ 128. There are 16 rows for the same time period (start and stop times), each row representing one of the 16 ELS sectors (numbered 0 – 15). The columns in **Table 6** give the field names and the rows describe the contents of the fields for the ELS background corrected number flux and the 1- count threshold CSV files.

Table 6. ELS Number Flux and 1-Count Threshold Data CSV File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA NAME	DATA UNIT	VALUES
ASCII_Date_Time_DOY YYYY-DOY**T**HH:MM:SS.mmm		ASCII_String			ASCII_Real %12.5e
Start Time for VEx ELS-00 data (sector 0)	Stop Time for VEx ELS-00 data (sector 0)	SENSOR referring to primary (science) data	VEx ELS-00 **x**R**<desc>**, **x** = L for Low range and H for High range **<desc>** is "-BK" for BCNF data and "Sensit" for threshold data	$\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$ (diff. number flux)	repetitions # of data values, Comma delimited
Start Time For VEx ELS-01 data (sector 1)	Stop Time for VEx ELS-01 data (sector 1)	SENSOR referring to primary (science) data	VEx ELS-01 **x**R**<desc>**, **x** = L for Low range and H for High range **<desc>** is "-BK" for BCNF data and "Sensit" for threshold data	$\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$ (diff. number flux)	repetitions # of data values, Comma delimited
:	:	:	:	:	:
Start Time For VEx ELS-15 data (sector 15)	Stop Time for VEx ELS-15 data (sector 15)	SENSOR referring to primary (science) data	VEx ELS-15 **x**R**<desc>**, **x** = L for Low range and H for High range **<desc>** is "-BK" for BCNF data and "Sensit" for threshold data	$\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$ (diff. number flux)	repetitions # of data values, Comma delimited
Then repeats for the next time range and so on until end of file.					

6.3 ELS Raw

The VEx ELS raw data (ELSHRCNTS and ELSLRCNTS) are also stored in ASCII CSV files like the background corrected number flux (ELSHRBCNF and ELSLRBCNF) and 1-count threshold (ELSHRTHR and ELSLRTHR) files. Each row (data file record) of the CSV files has six fields. The sixth field, VALUES, has a number of repetitions corresponding to the number of energy steps for that file (or data product). The number of repetitions (or energy levels) is in the range 0 < repetitions ≤ 128. There are 16 rows for the same time range (start and stop times), each row representing one of the 16 ELS sectors (numbered 0 – 15). The columns in **Table 7**give the field names and the rows describe the contents of the fields for the ELS raw data files.

Table 7. ELS Raw Data CSV File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA NAME	DATA UNIT	VALUES
ASCII_Date_Time_DOY YYYY-DOY**T**HH:MM:SS.mmm		ASCII_String			ASCII_Real %8.3f
Start Time for VEx ELS-00 data (sector 0)	Stop Time for VEx ELS-00 data (sector 0)	SENSOR referring to primary (science) data	VEx ELS-00 **x**R **x** = L for Low range and H for High range	c/acc Counts per accumulation period	repetitions # of data values, Comma delimited
Start Time For VEx ELS-01 data (sector 1)	Stop Time for VEx ELS-01 data (sector 1)	SENSOR referring to primary (science) data	VEx ELS-01 **x**R **x** = L for Low range and H for High range	c/acc Counts per accumulation period	repetitions # of data values, Comma delimited
:	:	:	:	:	:
Start Time For VEx ELS-15 data (sector 15)	Stop Time for VEx ELS-15 data (sector 15)	SENSOR referring to primary (science) data	VEx ELS-15 **x**R **x** = L for Low range and H for High range	c/acc Counts per accumulation period	repetitions # of data values, Comma delimited
Then repeats for the next time range and so on until end of file.					

6.4 ELS Energy Levels

The VEx ELS energy levels are stored in ASCII CSV files. These contain the center energies that correspond to the science data. Each row (data file record) of the CSV files has six fields. The VALUES field has a number of repetitions corresponding to the number of energy steps for that file (or data product). The number of repetitions (or energy levels) has range 0 < repetitions ≤ 128. There are 16 rows for the same time range (start and stop times), each row representing one of the 16 ELS sectors (numbered 0 – 15). The columns in **Table 7** give the field names and the rows describe the contents of the fields for the ELS energy steps files.

Table 8. ELS Energy Step Data CSV File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA NAME	DATA UNIT	VALUES
ASCII_Date_Time_DOY YYYY-DOY**T**HH:MM:SS.mmm		ASCII_String			ASCII_Real %10.4e
Start Time for VEx ELS-00 data (sector 0)	Stop Time for VEx ELS-00 data (sector 0)	SCAN referring to energy step data	VEx ELS-00 **x**R **x** = L for Low range and H for High range	eV electron volts	repetitions # of data values, Comma delimited
Start Time For VEx ELS-01 data (sector 1)	Stop Time for VEx ELS-01 data (sector 1)	SCAN referring to energy step data	VEx ELS-01 **x**R **x** = L for Low range and H for High range	eV electron volts	repetitions # of data values, Comma delimited
:	:	:	:	:	:
Start Time For VEx ELS-15 data (sector 15)	Stop Time for VEx ELS-15 data (sector 15)	SCAN referring to energy step data	VEx ELS-15 **x**R **x** = L for Low range and H for High range	eV electron volts	repetitions # of data values, Comma delimited
Then repeats for the next time range and so on until end of file.					

6.5 Document Product Formats

All documents in the VEx ELS archive are provided in Adobe Acrobat PDF/A.

6.6 PDS Labels

There is a PDS4 label for each VEx ELS product. PDS4 labels are ASCII text files written in the eXtensible Markup Language (XML). All product labels are detached from the files they describe (except the Product_Bundle label). There is one label for every product. A PDS4 label file usually has the same name as the data product it describes, but always with the extension ".xml".

For the Venus Express ELS archive, the structure and content of the PDS labels conform to the PDS master schema and schematron based upon the *PDS4 Information Model Specification,* Version 1.12.0.0 [5]. By use of an XML editor the schema and schematron may be used to validate the structure and content of the product labels.

See Appendix B for examples of PDS labels for the VEx ELS data products.

Appendix A – Acronyms, Abbreviations, and Glossary

A.1 *Acronyms and Abbreviations*

Table 9. Acronyms and Abbreviations.

Acronym or Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms (3rd Version)
ASPERA-4	Analyzer of Space Plasma and Energetic Atoms (4th Version)
CK	C-matrix Kernel (NAIF orientation data)
Co-I	Co-Investigator
CODMAC	Committee on Data Management and Computation (of NRC)
CSV	Comma Separated Values (PDS Spreadsheet Object ASCII format)
DOY	Day Of Year (Julian date, 3 digits)
EDR	Experiment Data Record
ELS	Electron Spectrometer (of the ASPERA-3 instrument package)
ESA	European Space Agency
FTP	File Transfer Protocol
GB	Gigabyte(s)
IDFS	Instrument Data File Set or Instrument Description File Set
IRF	Swedish Institute of Space Physics (Kiruna, Sweden)
JPL	Jet Propulsion Laboratory
LID	Logical Identifier
LIDVID	Versioned Logical Identifier
MB	Megabyte(s)
MEx	Mars Express
NAIF	Navigation Ancillary Information Facility
NASA	National Aeronautics and Space Administration
PDF	Portable Document Format
PDS	NASA Planetary Data System
PDS4	NASA Planetary Data System, Version 4
PI	Principal Investigator
PPI	Planetary Data System, Planetary Plasma Interactions Node

Acronym or Abbreviation	Meaning
PR	Peer Review
PSA	ESA Planetary Science Archive
RDR	Reduced Data Record
SIS	Software Interface Specification
SPICE	Spacecraft, Planet, Instrument, C-matrix, Events files and software
SwRI®	Southwest Research Institute®
TB	Terabyte(s)
URN	Uniform Resource Name
UTC	Universal Time Coordinated
VEx	Venus Express

A.2 *Glossary*

Many of these definitions are from Appendix A of the *PDS4 Concepts* Document [3], pds.nasa.gov/pds4/doc/concepts. See this document for more information.

Archive – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. It may be capitalized when referring to all of PDS holdings – the PDS Archive.

Basic Product – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

Bundle Product – A list of related collections. For example, a bundle could list a collection of raw data obtained by an experiment during its mission lifetime, a collection of the calibration products associated with the experiment, and a collection of all documentation relevant to the first two collections.

Class – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

Collection Product – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

Data Object – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

Description Object – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a 'description object' is a digital object – a string of bits with a predefined structure.

Digital Object – An object that consists of electronically stored (digital) data.

Identifier – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

Label – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

Logical Identifier (**LID**) – An identifier which identifies the set of all versions of a product.

Versioned Logical Identifier (LIDVID) – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

Manifest - A list of contents.

Metadata – Data about data – for example, a 'description object' contains information (metadata) about an 'object.'

Object – A single instance of a class defined in the PDS Information Model.

PDS Information Model – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

Product – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to find specific bit strings within digital objects), PDS4 defines 'products' to be the smallest granular unit of addressable data within its complete holdings.

Tagged Object – An entity categorized by the PDS Information Model, and described by a PDS label.

Registry – A data base that provides services for sharing content and metadata.

Repository – A place, room, or container where something is deposited or stored (often for safety).

XML – eXtensible Markup Language.

XML schema – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

Appendix B – ELS PDS4 Sample Label Files

B.1 *ELS Background Data (ELS05BK_20130641406_V1.0.xml)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                        https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd">
    <Identification_Area>
        <logical_identifier>
         urn:nasa:pds:vex-aspera4-els:data_derived:els05bk_20130641406
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>VEX ELS 5-Minute Background Data 2013-03-05 14:06</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2020</publication_year>
            <description>
                This product contains ELS 5-minute BacKground (ELS05BK)
                averages and standard deviations for all ELS anodes combined,
                and for each anode (or sector) separately.
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2020-01-06</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2013-03-05T14:06:53.556Z</start_date_time>
            <stop_date_time>2013-03-05T15:59:55.021Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Venus_Express</name>
            <type>Mission</type>
            <Internal_Reference>
                <lid_reference>
                  urn:esa:psa:context:investigation:mission.venus_express
```

```
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <Observing_System_Component>
            <name>VEX</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                 urn:esa:psa:context:instrument_host:spacecraft.vex
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>ASPERA4-ELS</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                  urn:esa:psa:context:instrument:vex.aspera4-els
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Venus</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>
             urn:nasa:pds:context:target:planet.venus
            </lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>

    </Mission_Area>
</Observation_Area>
<File_Area_Observational>
    <File>
        <file_name>ELS05BK_20130641406_V1.0.TAB</file_name>
        <creation_date_time>2020-01-06T17:52</creation_date_time>
        <records>23</records>
        <md5_checksum>b63ff5a2b34b53b94f4eba4e6b78f69e</md5_checksum>
    </File>
    <Table_Character>
        <name>ELS 5-Minute Background Data</name>
        <offset unit="byte">0</offset>
        <records>23</records>
        <description>
            This table contains ELS 5-minute BacKground (ELS05BK) data
            for all ELS anodes combined, and background data for each
            anode (or sector) separately.
        </description>
        <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
```

```
<Record_Character>
    <fields>36</fields>
    <groups>0</groups>
    <record_length unit="byte">386</record_length>
    <Field_Character>
        <name>Start Time</name>
        <field_number>1</field_number>
        <field_location unit="byte">1</field_location>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <field_length unit="byte">21</field_length>
    </Field_Character>
    <Field_Character>
        <name>Stop Time</name>
        <field_number>2</field_number>
        <field_location unit="byte">23</field_location>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <field_length unit="byte">21</field_length>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS Anode Background</name>
        <field_number>3</field_number>
        <field_location unit="byte">45</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">9</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>  -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-00 Background</name>
        <field_number>4</field_number>
        <field_location unit="byte">55</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>-9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-01 Background</name>
        <field_number>5</field_number>
        <field_location unit="byte">64</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>-9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
   <Field_Character>
        <name>VEx ELS-02 Background</name>
        <field_number>6</field_number>
        <field_location unit="byte">73</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
```

```
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-03 Background</name>
        <field_number>7</field_number>
        <field_location unit="byte">82</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-04 Background</name>
        <field_number>8</field_number>
        <field_location unit="byte">91</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
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        <Special_Constants>
           <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
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    <Field_Character>
        <name>VEx ELS-05 Background</name>
        <field_number>9</field_number>
        <field_location unit="byte">100</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-06 Background</name>
        <field_number>10</field_number>
        <field_location unit="byte">109</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-07 Background</name>
        <field_number>11</field_number>
        <field_location unit="byte">118</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
```

```
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-08 Background</name>
        <field_number>12</field_number>
        <field_location unit="byte">127</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-09 Background</name>
        <field_number>13</field_number>
        <field_location unit="byte">136</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
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        <name>VEx ELS-10 Background</name>
        <field_number>14</field_number>
        <field_location unit="byte">145</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-11 Background</name>
        <field_number>15</field_number>
        <field_location unit="byte">154</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-12 Background</name>
        <field_number>16</field_number>
        <field_location unit="byte">163</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">8</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
            <invalid_constant> -9.9999</invalid_constant>
        </Special_Constants>
```

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<Field_Character>
    <name>VEx ELS-13 Background</name>
    <field_number>17</field_number>
    <field_location unit="byte">172</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <unit>cnts/sec</unit>
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       <invalid_constant> -9.9999</invalid_constant>
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    <name>VEx ELS-14 Background</name>
    <field_number>18</field_number>
    <field_location unit="byte">181</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <unit>cnts/sec</unit>
    <Special_Constants>
       <invalid_constant> -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>VEx ELS-15 Background</name>
    <field_number>19</field_number>
    <field_location unit="byte">190</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">8</field_length>
    <unit>cnts/sec</unit>
    <Special_Constants>
       <invalid_constant> -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>VEx ELS Anode Background Std Dev</name>
    <field_number>20</field_number>
    <field_location unit="byte">199</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>cnts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>VEx ELS-00 Background Std Dev</name>
    <field_number>21</field_number>
    <field_location unit="byte">210</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>cnts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
```

```
        <name>VEx ELS-01 Background Std Dev</name>
        <field_number>22</field_number>
        <field_location unit="byte">221</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-02 Background Std Dev</name>
        <field_number>23</field_number>
        <field_location unit="byte">232</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-03 Background Std Dev</name>
        <field_number>24</field_number>
        <field_location unit="byte">243</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-04 Background Std Dev</name>
        <field_number>25</field_number>
        <field_location unit="byte">254</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-05 Background Std Dev</name>
        <field_number>26</field_number>
        <field_location unit="byte">265</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-06 Background Std Dev</name>
        <field_number>27</field_number>
```

```
        <field_location unit="byte">276</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-07 Background Std Dev</name>
        <field_number>28</field_number>
        <field_location unit="byte">287</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-08 Background Std Dev</name>
        <field_number>29</field_number>
        <field_location unit="byte">298</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-09 Background Std Dev</name>
        <field_number>30</field_number>
        <field_location unit="byte">309</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-10 Background Std Dev</name>
        <field_number>31</field_number>
        <field_location unit="byte">320</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>cnts/sec</unit>
        <Special_Constants>
           <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>VEx ELS-11 Background Std Dev</name>
        <field_number>32</field_number>
        <field_location unit="byte">331</field_location>
        <data_type>ASCII_Real</data_type>
```

```
                    <field_length unit="byte">10</field_length>
                    <unit>cnts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>VEx ELS-12 Background Std Dev</name>
                    <field_number>33</field_number>
                    <field_location unit="byte">342</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">10</field_length>
                    <unit>cnts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>VEx ELS-13 Background Std Dev</name>
                    <field_number>34</field_number>
                    <field_location unit="byte">353</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">10</field_length>
                    <unit>cnts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>VEx ELS-14 Background Std Dev</name>
                    <field_number>35</field_number>
                    <field_location unit="byte">364</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">10</field_length>
                    <unit>cnts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>VEx ELS-15 Background Std Dev</name>
                    <field_number>36</field_number>
                    <field_location unit="byte">375</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">10</field_length>
                    <unit>cnts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
                </Field_Character>
            </Record_Character>
        </Table_Character>
    </File_Area_Observational>
</Product_Observational>
```

B.2 *ELS Low Range Background Corrected Number Flux (ELSLRBCNF_20130641406_V1.0.xml)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                        https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd">
    <Identification_Area>
        <logical_identifier>
         urn:nasa:pds:vex-aspera4-els:data_derived:elslrbcnf_20130641406
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>
               VEX ELS Low Energy Range Background Corrected Number Flux
               2013-03-05 14:06
        </title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2020</publication_year>
            <description>
                The product contains ELS Low energy Range Background Corrected
                Number Flux (ELSLRBCNF) for each ELS anode (sector).
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2020-01-06</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2013-03-05T14:06:55.430Z</start_date_time>
            <stop_date_time>2013-03-05T15:59:54.992Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Venus_Express</name>
            <type>Mission</type>
            <Internal_Reference>
               <lid_reference>
                urn:esa:psa:context:investigation:mission.venus_express
```

```
            </lid_reference>
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <Observing_System_Component>
            <name>VEX</name>
            <type>Spacecraft</type>
            <Internal_Reference>
                <lid_reference>
                 urn:esa:psa:context:instrument_host:spacecraft.vex
                </lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>ASPERA4-ELS</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>
                 urn:esa:psa:context:instrument:vex.aspera4-els
                </lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Venus</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>
             urn:nasa:pds:context:target:planet.venus
            </lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>

    </Mission_Area>
</Observation_Area>
<File_Area_Observational>
    <File>
        <file_name>ELSLRBCNF_20130641406_V1.0.CSV</file_name>
        <creation_date_time>2020-01-06T18:58</creation_date_time>
        <records>23632</records>
        <md5_checksum>3d5b08e1c03c6a154bd92b74fa641948</md5_checksum>
        <comment>
            This table contains ELS Low energy Range Background Corrected
            Number Flux (ELSLRBCNF) for each anode (sector).
        </comment>
    </File>
    <Table_Delimited>
        <offset unit="byte">0</offset>
        <parsing_standard_id>PDS DSV 1</parsing_standard_id>
        <records>23632</records>
        <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
        <field_delimiter>Comma</field_delimiter>
```

```
<Record_Delimited>
    <fields>5</fields>
    <groups>1</groups>
    <Field_Delimited>
        <name>START TIME</name>
        <field_number>1</field_number>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <maximum_field_length unit="byte">21</maximum_field_length>
        <description>The START TIME field specifies the start time
                     of the data sample(s) being returned in the
                     current row.  The Start Time and Stop Time
                     fields define the time range covered by the
                     data in the current row.
                      Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>STOP TIME</name>
        <field_number>2</field_number>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <maximum_field_length unit="byte">21</maximum_field_length>
        <description>The STOP TIME field specifies the stop time of
                     the data sample(s) being returned in the
                     current row.  The Start Time and Stop Time
                     fields define the time range covered by the
                     data in the current row.
                     Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA TYPE NAME</name>
        <field_number>3</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">14</maximum_field_length>
        <field_format>%-14s</field_format>
        <description>The DATA TYPE NAME field identifies the type of
                     the data sample(s) being returned in the
                     current row.  Valid entries include:
                          SENSOR          - primary data
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA NAME</name>
        <field_number>4</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">50</maximum_field_length>
        <field_format>%-50s</field_format>
        <description>The DATA NAME field identifies the name of the
                     primary data associated with the data values
                     being returned in the current row
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA UNIT</name>
        <field_number>5</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">50</maximum_field_length>
```

```
                    <field_format>%-50s</field_format>
                    <description>The DATA UNIT field identifies the units that
                                the data values are expressed in for the
                                current row
                    </description>
                </Field_Delimited>
                <Group_Field_Delimited>
                    <repetitions>67</repetitions>
                    <fields>1</fields>
                    <groups>0</groups>
                    <Field_Delimited>
                        <name>VALUES</name>
                        <field_number>6</field_number>
                        <data_type>ASCII_Real</data_type>
                        <field_format>%12.5e</field_format>
                        <description>This field contains the data values for
                                    the data parameter being returned in the
                                    current row.
                                    This column is repeated 67 times, one
                                    value per sweep step.
                        </description>
                    </Field_Delimited>
                </Group_Field_Delimited>
            </Record_Delimited>
        </Table_Delimited>
    </File_Area_Observational>
</Product_Observational>
```

B.3 *ELS High Range 1-Count Threshold (ELSHRTHR_20130641406_V1.0.xml)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                        https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd">
    <Identification_Area>
        <logical_identifier>
         urn:nasa:pds:vex-aspera4-els:data_derived:elshrthr_20130641406
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>VEX ELS High Energy Range 1-count Threshold 2013-03-05 14:06
        </title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2020</publication_year>
            <description>
                The product contains ELS High energy Range 1-count THReshold
                (ELSHRTHR) for each ELS anode (sector).
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2020-01-06</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2013-03-05T14:06:53.555Z</start_date_time>
            <stop_date_time>2013-03-05T15:59:52.898Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Venus_Express</name>
            <type>Mission</type>
            <Internal_Reference>
                <lid_reference>
                 urn:esa:psa:context:investigation:mission.venus_express
                </lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
```

```
        </Investigation_Area>
        <Observing_System>
            <Observing_System_Component>
                <name>VEX</name>
                <type>Spacecraft</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument_host:spacecraft.vex
                    </lid_reference>
                    <reference_type>is_instrument_host</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
            <Observing_System_Component>
                <name>ASPERA4-ELS</name>
                <type>Instrument</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument:vex.aspera4-els
                    </lid_reference>
                    <reference_type>is_instrument</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
        </Observing_System>
        <Target_Identification>
            <name>Venus</name>
            <type>Planet</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:target:planet.venus
                </lid_reference>
                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
        </Target_Identification>
        <Mission_Area>

        </Mission_Area>
    </Observation_Area>
    <File_Area_Observational>
        <File>
            <file_name>ELSHRTHR_20130641406_V1.0.CSV</file_name>
            <creation_date_time>2020-01-06T18:08</creation_date_time>
            <records>23632</records>
            <md5_checksum>16c0a86d483cd72c028f82725c858de2</md5_checksum>
            <comment>
                 This table contains ELS High energy Range 1-count THReshold
                 (ELSHRTHR) for each anode (sector).
            </comment>
        </File>
        <Table_Delimited>
            <offset unit="byte">0</offset>
            <parsing_standard_id>PDS DSV 1</parsing_standard_id>
            <records>23632</records>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
            <field_delimiter>Comma</field_delimiter>
            <Record_Delimited>
                <fields>5</fields>
                <groups>1</groups>
```

```
<Field_Delimited>
    <name>START TIME</name>
    <field_number>1</field_number>
    <data_type>ASCII_Date_Time_DOY</data_type>
    <maximum_field_length unit="byte">21</maximum_field_length>
   <description>The START TIME field specifies the start time of
                the data sample(s) being returned in the
                current row.  The Start Time and Stop Time
                fields define the time range covered by the
                data in the current row.
                Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>STOP TIME</name>
    <field_number>2</field_number>
    <data_type>ASCII_Date_Time_DOY</data_type>
    <maximum_field_length unit="byte">21</maximum_field_length>
    <description>The STOP TIME field specifies the stop time of
                the data sample(s) being returned in the
                current row.  The Start Time and Stop Time
                fields define the time range covered by the
                data in the current row.
                Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA TYPE NAME</name>
    <field_number>3</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">14</maximum_field_length>
    <field_format>%-14s</field_format>
   <description>The DATA TYPE NAME field identifies the type of
                the data sample(s) being returned in the
                current row.  Valid entries include:
                      SENSOR          - primary data
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA NAME</name>
    <field_number>4</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">50</maximum_field_length>
    <field_format>%-50s</field_format>
   <description>The DATA NAME field identifies the name of the
                primary data associated with the data values
                being returned in the current row
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA UNIT</name>
    <field_number>5</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">50</maximum_field_length>
    <field_format>%-50s</field_format>
```

```
                    <description>The DATA UNIT field identifies the units
                                 that the data values are expressed in for
                                 the current row
                    </description>
                </Field_Delimited>
                <Group_Field_Delimited>
                    <repetitions>60</repetitions>
                    <fields>1</fields>
                    <groups>0</groups>
                    <Field_Delimited>
                        <name>VALUES</name>
                        <field_number>6</field_number>
                        <data_type>ASCII_Real</data_type>
                        <field_format>%11.5e</field_format>
                        <description>This field contains the data values for
                                     the data parameter being returned in the
                                     current row.
                                     This column is repeated 60 times, one
                                     value per sweep step.
                        </description>
                    </Field_Delimited>
                </Group_Field_Delimited>
            </Record_Delimited>
        </Table_Delimited>
    </File_Area_Observational>
</Product_Observational>
```

B.4 *ELS Low Range Raw (ELSLRCNTS_20130641406_V1.0.xml)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                        https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd">
    <Identification_Area>
        <logical_identifier>
         urn:nasa:pds:vex-aspera4-els:data_raw:elslrcnts_20130641406
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>VEX ELS Low Energy Range Counts 2013-03-05 14:06</title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2020</publication_year>
            <description>
                The product contains ELS Low energy Range CouNTS (ELSLRCNTS)
                for each ELS anode (sector).
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2020-01-06</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2013-03-05T14:06:55.430Z</start_date_time>
            <stop_date_time>2013-03-05T15:59:54.992Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Venus_Express</name>
            <type>Mission</type>
            <Internal_Reference>
                <lid_reference>
                  urn:esa:psa:context:investigation:mission.venus_express
                </lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
        </Investigation_Area>
```

```
        <Observing_System>
            <Observing_System_Component>
                <name>VEX</name>
                <type>Spacecraft</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument_host:spacecraft.vex
                    </lid_reference>
                    <reference_type>is_instrument_host</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
            <Observing_System_Component>
                <name>ASPERA4-ELS</name>
                <type>Instrument</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument:vex.aspera4-els
                    </lid_reference>
                    <reference_type>is_instrument</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
        </Observing_System>
        <Target_Identification>
            <name>Venus</name>
            <type>Planet</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:target:planet.venus
                </lid_reference>
                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
        </Target_Identification>
        <Mission_Area>

        </Mission_Area>
    </Observation_Area>
    <File_Area_Observational>
        <File>
            <file_name>ELSLRCNTS_20130641406_V1.0.CSV</file_name>
            <creation_date_time>2020-01-06T19:33</creation_date_time>
            <records>23632</records>
            <md5_checksum>5cb191de362ae7f57f8ddb63e2a59823</md5_checksum>
            <comment>
                This table contains ELS Low energy Range CouNTS (ELSLRCNTS)
                 for each anode (sector).
            </comment>
        </File>
        <Table_Delimited>
            <offset unit="byte">0</offset>
            <parsing_standard_id>PDS DSV 1</parsing_standard_id>
            <records>23632</records>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
            <field_delimiter>Comma</field_delimiter>
            <Record_Delimited>
                <fields>5</fields>
                <groups>1</groups>
                <Field_Delimited>
```

```
        <name>START TIME</name>
        <field_number>1</field_number>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <maximum_field_length unit="byte">21</maximum_field_length>
        <description>The START TIME field specifies the start time
                     of the data sample(s) being returned in the
                     current row.  The Start Time and Stop Time
                     fields define the time range covered by the
                     data in the current row.
                     Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>STOP TIME</name>
        <field_number>2</field_number>
        <data_type>ASCII_Date_Time_DOY</data_type>
        <maximum_field_length unit="byte">21</maximum_field_length>
       <description>The STOP TIME field specifies the stop time of
                     the data sample(s) being returned in the
                     current row.  The Start Time and Stop Time
                     fields define the time range covered by the
                     data in the current row.
                     Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA TYPE NAME</name>
        <field_number>3</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">14</maximum_field_length>
        <field_format>%-14s</field_format>
       <description>The DATA TYPE NAME field identifies the type of
                     the data sample(s) being returned in the
                     current row.  Valid entries include:
                           SENSOR          - primary data
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA NAME</name>
        <field_number>4</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">50</maximum_field_length>
        <field_format>%-50s</field_format>
        <description>The DATA NAME field identifies the name of the
                     primary data associated with the data values
                     being returned in the current row
        </description>
    </Field_Delimited>
    <Field_Delimited>
        <name>DATA UNIT</name>
        <field_number>5</field_number>
        <data_type>ASCII_String</data_type>
        <maximum_field_length unit="byte">50</maximum_field_length>
        <field_format>%-50s</field_format>
       <description>The DATA UNIT field identifies the units that
                     the data values are expressed in for the
                     current row
```

```
                    </description>
                </Field_Delimited>
                <Group_Field_Delimited>
                    <repetitions>67</repetitions>
                    <fields>1</fields>
                    <groups>0</groups>
                    <Field_Delimited>
                        <name>VALUES</name>
                        <field_number>6</field_number>
                        <data_type>ASCII_Real</data_type>
                        <field_format>%7.3f</field_format>
                        <description>This field contains the data values for
                                     the data parameter being returned in the
                                     current row.
                                     This column is repeated 67 times, one
                                     value per sweep step.
                        </description>
                    </Field_Delimited>
                </Group_Field_Delimited>
            </Record_Delimited>
        </Table_Delimited>
    </File_Area_Observational>
</Product_Observational>
```

B.5 *ELS High Range Energy Levels (ELSHRSTPS_20130641406_V1.0.xml)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://pds.nasa.gov/pds4/pds/v1
                        https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1B00.xsd">
    <Identification_Area>
        <logical_identifier>
         urn:nasa:pds:vex-aspera4-els:data_eng:elshrstps_20130641406
        </logical_identifier>
        <version_id>1.0</version_id>
        <title>VEX ELS High Energy Range Center Energies 2013-03-05 14:06
        </title>
        <information_model_version>1.11.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2020</publication_year>
            <description>
                The product contains ELS High energy Range center energy
                STePS (ELSHRSTPS) for each ELS anode (sector).
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2020-01-06</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
    </Identification_Area>
    <Observation_Area>
        <Time_Coordinates>
            <start_date_time>2013-03-05T14:06:53.555Z</start_date_time>
            <stop_date_time>2013-03-05T15:59:52.898Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Venus_Express</name>
            <type>Mission</type>
            <Internal_Reference>
                <lid_reference>
                  urn:esa:psa:context:investigation:mission.venus_express
                </lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
```

```
        </Investigation_Area>
        <Observing_System>
            <Observing_System_Component>
                <name>VEX</name>
                <type>Spacecraft</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument_host:spacecraft.vex
                    </lid_reference>
                    <reference_type>is_instrument_host</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
            <Observing_System_Component>
                <name>ASPERA4-ELS</name>
                <type>Instrument</type>
                <Internal_Reference>
                    <lid_reference>
                     urn:esa:psa:context:instrument:vex.aspera4-els
                    </lid_reference>
                    <reference_type>is_instrument</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
        </Observing_System>
        <Target_Identification>
            <name>Venus</name>
            <type>Planet</type>
            <Internal_Reference>
                <lid_reference>
                  urn:nasa:pds:context:target:planet.venus
                </lid_reference>
                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
        </Target_Identification>
        <Mission_Area>

        </Mission_Area>
    </Observation_Area>
    <File_Area_Observational>
        <File>
            <file_name>ELSHRSTPS_20130641406_V1.0.CSV</file_name>
            <creation_date_time>2020-01-06T20:09</creation_date_time>
            <records>16</records>
            <md5_checksum>781d5ec3409ae3fc4696338432aa92f9</md5_checksum>
            <comment>
                 This table contains ELS High energy Range center energy STePS
                 (ELSHRSTPS) for each anode (sector).
            </comment>
        </File>
        <Table_Delimited>
            <offset unit="byte">0</offset>
            <parsing_standard_id>PDS DSV 1</parsing_standard_id>
            <records>16</records>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
            <field_delimiter>Comma</field_delimiter>
            <Record_Delimited>
                <fields>5</fields>
                <groups>1</groups>
```

```
<Field_Delimited>
    <name>START TIME</name>
    <field_number>1</field_number>
    <data_type>ASCII_Date_Time_DOY</data_type>
    <maximum_field_length unit="byte">21</maximum_field_length>
   <description>The START TIME field specifies the start time of
                the data sample(s) being returned in the
                current row.  The Start Time and Stop Time
                fields define the time range covered by the
                data in the current row.
                Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>STOP TIME</name>
    <field_number>2</field_number>
    <data_type>ASCII_Date_Time_DOY</data_type>
    <maximum_field_length unit="byte">21</maximum_field_length>
   <description>The STOP TIME field specifies the stop time of
                the data sample(s) being returned in the
                current row.  The Start Time and Stop Time
                fields define the time range covered by the
                data in the current row.
                Format is YYYY-DDDTHH:MM:SS.mmm, in UTC
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA TYPE NAME</name>
    <field_number>3</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">14</maximum_field_length>
    <field_format>%-14s</field_format>
    <description>The DATA TYPE NAME field identifies the type of
                 the data sample(s) being returned in the
                 current row.  Valid entries include:
                      SCAN   - center sweep step data associated
                               with the primary data
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA NAME</name>
    <field_number>4</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">50</maximum_field_length>
    <field_format>%-50s</field_format>
    <description>The DATA NAME field identifies the name of the
                primary data associated with the data values
                being returned in the current row
    </description>
</Field_Delimited>
<Field_Delimited>
    <name>DATA UNIT</name>
    <field_number>5</field_number>
    <data_type>ASCII_String</data_type>
    <maximum_field_length unit="byte">50</maximum_field_length>
    <field_format>%-50s</field_format>
```

```
                    <description>The DATA UNIT field identifies the units that
                                 the data values are expressed in for the
                                 current row
                    </description>
                </Field_Delimited>
                <Group_Field_Delimited>
                    <repetitions>60</repetitions>
                    <fields>1</fields>
                    <groups>0</groups>
                    <Field_Delimited>
                        <name>VALUES</name>
                        <field_number>6</field_number>
                        <data_type>ASCII_Real</data_type>
                        <field_format>%10.4e</field_format>
                        <description>This field contains the data values for
                                     the data parameter being returned in the
                                     current row.
                                     This column is repeated 60 times, one
                                     value per sweep step.
                        </description>
                    </Field_Delimited>
                </Group_Field_Delimited>
            </Record_Delimited>
        </Table_Delimited>
    </File_Area_Observational>
</Product_Observational>
```