# Mars Express ASPERA-3 ELS Background Data

## *Software Interface Specification*

for

NASA ROSES PDART Grant 80NSSC24K0797
SwRI® Project 15-28673

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**Document Review**

This document and the archive it describes were submitted to PDS November 2025. A peer review was conducted, and liens were discussed via email March – April 2026. 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 (80NSSC24K0797) and PDS4 Data Production generator have reviewed and approved this document.

Debra Kazden and Joe Mafi, PDS Planetary Plasma Interactions (PPI) Node Representatives, have reviewed and approved this document April 2026.

## Document Change History

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| 1.1 | 04/22/2026 | 5.6, 6.7, Appendix A, Appendix B<br><br>6.5<br><br>Appendix B.10 | Updated to change label file extensions from .xml to .lblx<br><br>Updated section 6.5 to address peer review lien #8 – Put Data Quality Flag information in a table and other minor edits.<br><br>Added XML-formatted .lblx example for CDF |
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# 1 Introduction

## 1.1 Mars Express Electron Spectrometer Overview

The Electron Spectrometer (ELS) instrument is part of the Analyzer of Space Plasmas and Energetic Atoms, 3rd edition (ASPERA-3) experiment on the European Space Agency's (ESA's) Mars Express (MEx) mission. The ELS instrument measures the *in situ* electron plasma in the Mars environment and the solar wind beginning in 2004 until NASA terminated its involvement in the ESA MEx program at the end of 2019. The MEx spacecraft sampled data from an elliptical orbit (250 x 10,000 km) with a quasi-polar inclination of ~86.5°. During its lifetime, the periapsis of the spacecraft increased from 250 km to its present periapsis of 380 km, the inclination drifted to ~87°, and the orbital period lengthened by ~0.5 hours, yielding about three orbits per Earth day. The latitude of pericenter drifts to cover the globe and the orbit plane precesses in longitude providing full global coverage in ~1 Earth year.

Through the first Discovery program Mission of Opportunity (MO), NASA supported Southwest Research Institute (SwRI) to participate in the ASPERA-3 experiment until NASA terminated U.S. involvement in the ASPERA-3 experiment on March 31, 2020. Participation included instrument construction (different instrument components of ASPERA-3 and the entire ELS instrument), archiving of all MEx ASPERA-3 data, and participation in the science investigation. SwRI constructed a flight unit and a flight spare of ASPERA-3 ELS, which were supplied to the PI institution, Swedish Institute of Space Physics (IRF). After the successful launch of the MEx spacecraft in 2003, the MEx ELS flight spare was repurposed (with NASA's permission) for the ESA Venus Express (VEx) mission.

By mutual agreement, science data from the MEx ASPERA-3 experiment were archived by SwRI in the ESA Planetary Science Archive (PSA) and the NASA PDS-PPI node under PDS3 standards. The PDS ELS archive consists of raw and calibrated data from June 2003 through June 2019.

During the science investigation, comparisons between Mars and Venus plasma environments were conducted under the guidance of the NASA Discovery program. To conduct this investigation, knowledge of the ELS instrument's energy-independent background was needed at both Mars and Venus. Although data stored in PDS is scientifically useful and valid, there are times when the background becomes a large fraction of the environment signal, which could lead to incorrect scientific conclusions. Thus, SwRI generated the energy-independent background values for the entire time period for both missions at a time cadence of 5-minute averages to match the Electron Reflectometer flown on the Mars Global Surveyor so that similar comparisons of backgrounds could be made. (Delory *et al.,* 2012 [15])

Science investigations into the solar energetic particle (SEP) event occurring on 27 January 2012 at Mars (Frahm *et al.,* 2013a,b [16], [17]) led to the realization that the 5-minute average background removal was not adequate to capture the onset of the SEP event. Thus, when background values changed quickly, an average of one minute was generated, and ultimately, a 4-second value based on the 4-second spectral accumulation of ELS. Shortly thereafter, SwRI developed a proxy for determining galactic cosmic rays (GCR) based on the ELS background values (Posner *et al.,* 2013 [18]) finding that the 5-minute average background was inadequate even during quiet times and better statistics were needed. This led to a 25-minute average background product. These data products now cover the full-time range for MEx and VEx

operations. Data images for all four cadences of ELS background at Mars and Venus are published on the web. (https://www.aspera-3.org/collaborative-studies/)

### 1.1.1 Description of ELS Instrument and Data Collection

The ASPERA-3 ELS data stored at PSA and PDS include both raw and calibrated forms. The "calibrated" designation means that the data values account for instrument parameters and the value produced has been reconstructed correctly to give an accurate representation of the measurement in geophysical units. Different effects observed in the data are often adjustments to the calibrated values to remove known phenomena and produce a higher-level data product. Such is the case for background effects observed within the ELS. The PSA and PDS calibrated ELS data contain both the environment plasma signal and signals generated internal to the instrument. The ELS documentation has no discussion or description of signals from penetrating radiation, or guidance on how to recover the environmental signal from the ELS data because at the time of data submission, no sources of contamination were identified.

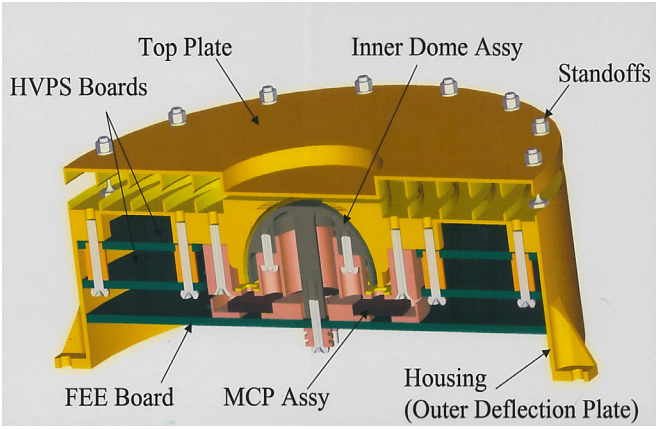



***Figure 1. Cross-section of the MEx ELS instrument showing the internal geometry.*** *Plasma enters through the sides of the housing and travels between the collimator baffles which refine the plasma into a beam. A high voltage power supply (HVPS) generates an electric field between the top plate/outer 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).*

A cross-sectional view of the MEx ELS sensor is shown in **Figure 1**. Normally, plasma enters ELS through an inlet opening in the side of the detector housing from an azimuth of 360°. This azimuth is segmented into 16 sectors, each 22.5° wide (numbered 0-15). The elevation acceptance angle is ±2°. The entering plasma passes through the collimator, 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 using an electric field generated from either of two power supplies covering the low range (LR) energy (0.5 eV to ~150 eV) and the high range (HR) energy (~150 eV to ~20 keV). The selected electrons are then focused onto a microchannel plate (MCP) sensor. The electron signal is multiplied by the MCP, passed to an anode where electrons are collected, amplified by a charge sensitive amplifier, and counted.

### 1.1.2 Description of ELS Background Data

The ELS background signal is the portion of the raw data which does not reflect the Mars environmental plasma. During operation, the ELS instrument experienced several different types of contamination that altered the electron spectrum from Mars. These signals include external fluxes due to penetrating radiation caused by geophysical events like SEP events, cosmic rays that penetrate through the instrument, thermal noise generated within the MCP, outgassing of the MCP, and electronic noise. All these sources result in events that trigger the MCP, generating counts

which are **independent of the instantaneous energy band pass (energy independent)**, creating contamination to the measurement of Mars' plasma; however, these sources are **time dependent**. See the MEX_ASPERA-3_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 Mars Express Electron Spectrometer (MEx 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 MEx 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*, Version 1.22.0, March 31, 2024, JPL D-7669, Part 2 *DOI: 10.17189/2ass-x557*

[2] *The PDS4 Data Provider's Handbook: Guide to Archiving Planetary Data Using the PDS4 Standard*, Version 1.22.0, March 31, 2024 *DOI: 10.17189/tcy6-c698*

[3] *PDS4 Concepts*, Version 1.24.0, Marach 31, 2024, Data Design Working Group *DOI: 10.17189/eps2-ee08*

[4] *PDS4 Data Dictionary Abridged*, Version 1.22.0.0, Generated from Information Model Version 1.22.0.0 on Thu Apr 18 10:55:19 EDT 2024

[5] *PDS4 Information Model Specification,* Version 1.22.0.0, Thu Apr 18 10:55:21 EDT 2024

[6] *CDF-A Specification,* Version 1.0, 2015-02-26

[7] *Guide to Archiving CDF Files in PDS4,* Revision 7, July 24, 2018

[8] *ISTP/IACG Guidelines for CDF,* https://spdf.gsfc.nasa.gov/istp_guide/istp_guide.html

[9] *CDF Internal Format Description,* Version 3.9, January 27, 2023, Space Physics Data Facility, NASA / Goddard Space Flight Center

[10] *CDF User's Guide,* Version 3.9.1, September 2, 2023, Space Physics Data Facility, NASA / Goddard Space Flight Center

[11] *Space Physics Archive Search and Extract (SPASE),* http://www.spase-group.org/

[12] *PDF/A Guidelines: Guide to PDF/A document creation, conversion and validation,* Version 1.0, May 17, 2022, PDS – Planetary Data System

[13] *Mars Express ASPERA-3 ELS Background Data Examples* Document (in this archive's document collection: MEX_ASPERA-3_ELS_Background_Data_Examples.pdf)

[14] *Mars Express ASPERA-3 ELS Background Data* Description Document (in this archive's document collection: MEX_ASPERA-3_ELS_Description.pdf)


**Research Publications:**


[15] Delory, G. T., J. G. Luhmann, D. Brain, R. J. Lillis, D. L. Mitchell, R. A. Mewaldt, and T. V. Falkenberg, "Energetic particles detected by the Electron Reflectometer instrument on the Mars Global Surveyor, 1999-2006," *Space Weather*, **10**, S06003, 2012. *DOI: 10.1029/2012SW000781*

[16] Frahm, R. A. J. R. Sharber, J. D. Winningham, H. A. Elliott, T. A. Howard, C. E. DeForest, D. Odstrĉil, E. Kallio, S. McKenna-Lawler, and S. Barabash, "Solar energetic particle arrival at Mars due to the 27 January 2012 solar storm," Solar Wind 13, *AIP Conf. Proc.* **1539**, 394-397, 2013a. *DOI: 10.1063/1.4811068*

[17] Frahm, R. A. J. R. Sharber, J. D. Winningham, H. A. Elliott, T. A. Howard, C. E. DeForest, D. Odstrĉil, E. Kallio, S. McKenna-Lawler, and S. Barabash, "The coronal mass ejection interaction with the induced magnetosphere of Mars due to the 27 January 2012 solar storm," Solar Wind 13, *AIP Conf. Proc.* **1539,** 398-401, 2013b. *DOI: 10.1063/1.4811069*

[18] Posner, A., D. Odstrĉil, P. MacNeice, L. Rastaetter, C. Zeitlin, B. Heber, H. Elliott, R. A. Frahm, J. J. E. Hayes, T. T. von Rosenvinge, E. R. Christian, J. P. Andrews, R. Beaujean, S. Böttcher, D. E. Brinza, M. A. Bullock, S. Burmeister, F. A. Cucinotta, B. Ehresmann, M. Epperly, D. Grinspoon, J. Guo, D. M. Hassler, M.-H. Kim, J. Köhler, O. Kortmann, C. Martin Garcia, R. Müller-Mellin, K. Neal, S. C. R. Rafkin, G. Reitz, L. Seimetz, K. D. Smith, Y. Tyler, E. Weigle, and R. F. Wimmer-Schweingruber, "The Hohmann-Parker effect measured by the Mars Science Laboratory on the transfer from Earth to Mars: Consequences and opportunities," *Planetary and Space Science*, **89**, 127-139, 2103.
*DOI: 10.1016/j.pss.2013.09.013*

### 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 Mars Express ELS data.
- Section 3 describes the roles and responsibilities of the cognizant personnel in generating, delivering, and archiving of the MEx 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 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-3 ELS background data product generation, packaging, distribution, and documentation include:

1. ASPERA-3 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-3 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.
4. CDF Software: This software is used to generate the PDS4-compliant CDF-A files. Any changes to this software could impact the generation of the CDF-A files.

The probability of these interfaces changing that would impact the ASPERA-3 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 MEx ELS background data collections using PDS4 standards. In addition, SwRI interfaces with PDS-PPI to ensure PDS4-compliance of the MEx 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 80NSSC24K0797), 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 MEx 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 MEx ELS science data. Ms. Jeffers is responsible for generating the Software Interface Specification (SIS, this document), the 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 MEx ELS background data to the broad science community.

# 4 Data Product Characteristics and Environment

## 4.1 Overview

Throughout the first sixteen years of the MEx mission, the MEx data were automatically processed and stored at SwRI in the Instrument Data File Set (IDFS) format. The MEx ELS data have been and are used for collaborative studies, which necessitated the generation of the IDFS-formatted background data.

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 four types of MEx ELS data in this archive: (1) ELS background data in ASCII tables, (2) ELS science data in Comma Separated Values (CSV) format, (3) ELS energy levels in CSV format, and (4) ELS science data in PDS4-compliant Common Data Format (CDF-A). These products are described in the following subsections.

### 4.2.1 ELS Background Data

The Mars Express ELS background data are derived by calculating the averages per ELS sector (16 sectors) in four cadences: (1) 4-second (instrument rate), (2) 1-minute averages, (3) 5-minute averages, and (4) 25-minute averages. A fifth background data product is a combined product where the best background average (instrument rate, 1-minute, 5-minute, or 25-minute) to use is determined and stored. The combined background data product is used for the background-corrected science data products. The four time cadence specific background data files contain the background rates and their uncertainties 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 time cadence. The combined background data product contains the background rates (cnts/sec) and associated uncertainties (standard deviations in cnts/sec) for each of the 16 ELS sectors only.

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

*MEX_ASPERA-3_ELS_Background_Data_Examples.pdf*

*MEX_ASPERA-3_ELS_Description.pdf*

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

ELS**BBBB_YYYYDDDHHMM**_V**x.y**.TAB

where **BBBB** is the background data product name:

1. 01BK for 1-minute averaged background
2. 05BK for 5-minute averaged background
3. 25BK for 25-minute averaged background
4. BKGD for background averaged at the instrument rate (4 seconds)
5. MCBK for the combined background data product

**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 ELS**05BK_20120271707**_V**1.0**.TAB is Version 1.0 of the table containing the ELS **5**-minute averaged **B**ac**K**ground data beginning year **2012**, day **027**, at time **17:07**.

### 4.2.2 ELS Science Data

The MEx ELS Comma Separated Values (CSV) science data files 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 files are available.

The *MEX_ASPERA-3_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 **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

Note that the raw data and the background-corrected number flux data are also stored in CDF-A files (Section 4.2.4).

#### 4.2.2.1 ELS Background Corrected Number Flux

The Mars Express ELS data, corrected using the combined background (ELSMCBK), 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**LRBCNF_20120271707**_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 **2012**, day **027**, at time **17:07**. The file ELS**HRBCNF_20120271707**_V**1.0**.CSV is the **H**igh energy range **B**ackground **C**orrected **N**umber **F**lux data for the same time period.

Note that the background-corrected number flux data are also in CDF-A files (Section 4.2.4).

#### 4.2.2.2 ELS 1-Count Threshold

The Mars 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**LRTHR_20120271707**_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 **2012**, day **027**, at time **17:07**. The file ELS**HRTHR_20120271707**_V**1.0**.CSV is the **H**igh energy range 1-count **THR**eshold data for the same time period.

Note that these data are written only to CSV files and are not included in the CDF-A files.

#### *4.2.2.3 ELS Raw*

The Mars 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**LRCNTS_20120271707**_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 **2012**, day **027**, at time **17:07**. The file ELS**HRCNTS_20120271707**_V**1.0**.CSV is the **H**igh energy range raw data for the same time period.

Note that the raw data are also written to CDF-A files (Section 4.2.4).

### 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.

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_20120271707**_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 **2012**, day **027**, at time **17:07**. The file ELS**HRSTPS_20120271707**_V**1.0**.CSV is the **H**igh energy range energy step data for this time period.

Note that the ELS energy levels are also written to CDF-A files (Section 4.2.4).

### 4.2.4 ELS CDF-A Data

The MEx ELS CDF-A files in this archive include the science data in raw units, uncorrected differential number flux, background-corrected differential number flux, background-corrected differential energy flux, and background-corrected distribution function along with the associated energy levels and a data quality flag for each ELS sector (16 sectors). 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.

Note that the uncorrected differential number flux data, background-corrected differential energy flux, background-corrected distribution function, and quality flags are only provided in the CDF files. The raw data, background-corrected differential number flux, and associated energy levels are also provided in CSV files as described in sections 4.2.2 and 4.2.3.

The CDF-A files are provided so that scientists can easily produce multidimensional analysis presentations that are not possible with the use of flat files without additional data processing. The five units included (raw, uncorrected number flux, background-corrected number flux, background-corrected energy flux, and background-corrected distribution function) are the most useful to a scientist using the CDF data. An example of where the uncorrected number flux and the background corrected number flux are useful can be determined when examining differences between the uncorrected and background corrected fluxes, which will show the profile of a solar energetic particle (SEP) event. The counts are used to generate the Poisson errors in the measurements. If more detailed information is required, the CSV data files can be used.

The *MEX_ASPERA-3_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 using the 1-count threshold values to generate the background-corrected number flux.

The ELS CDF-A files have the following naming convention:

ELS**r**RCDF_**YYYYDDDHHMM**_V**xx**.cdf

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**xx** refers to the file Version number with initial value xx = 01

An example CDF-A file is ELS**L**RCDF_**20120271707**_V**01**.cdf, meaning it is Version **01** of the ELS **L**ow energy range CDF science data for beginning year **2012**, day **027**, at time **17:07**. The file ELS**H**RCDF_**20120271707**_V**01**.cdf is the **H**igh energy range CDF science data for this time.

## 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 MEx 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 |

| PDS4 Level | PDS4 Level Description | CODMAC Level (used in PDS3) | NASA Level |
|---|---|---|---|
| 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 first sixteen years of the MEx mission (from launch June 2003 through June 2019), the MEx data were automatically processed and stored at SwRI in the Instrument Data File Set (IDFS) format. The MEx ELS data have been and are used for collaborative studies, which necessitated the generation of the IDFS-formatted background data. Since the IDFS format is not PDS-compliant, SwRI developed software tools to convert IDFS data to PDS4-compliant forms. These tools were used to batch process the MEx ELS background data into PDS4-compliant tables, CSV files, and CDF-A files.

### 4.3.3 Data Flow

**Figure 2** depicts the steps involved in generating the MEx ELS background data archive. The MEx ELS background data are locally archived in the IDFS format. A software tool was developed to combine the four cadences of background values by going through the ELS background data to determine which background value (4-sec, 1-min, 5-min, or 25-min) is the best to apply to the science data. This resulted in a "combined" IDFS background product that has the correct background value per sector to apply for generation of the background-corrected science data. The SwRI conversion tools extract the ELS background and science data from the SwRI IDFS database and convert them 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 (See Applicable Documents). These components comprise the MEx ELS background data archive collections and bundle.

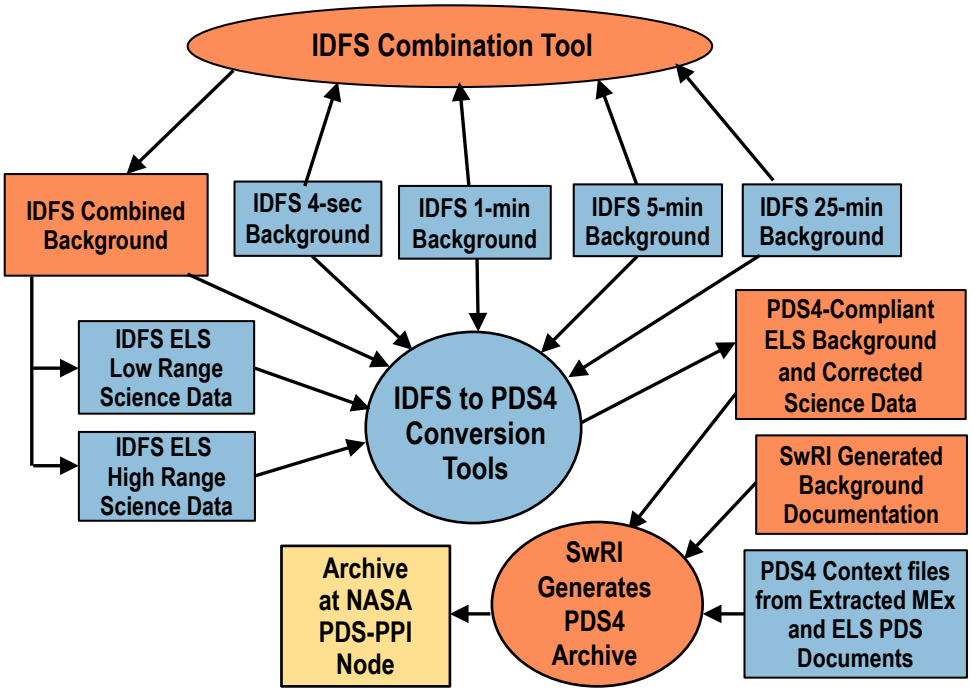



**Figure 2. Archive Generation Flow.**

Shapes: Square boxes – data or documentation; Round – software or process.
Colors: **Blue** – pre-existing items; **Orange** – developed/generated under this grant; **Yellow** – final products (PDS4 archive delivered to PDS-PPI).

## 4.4 Standards Used in Generating Data Products

All the Mars 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 1.22.0, March 31, 2024 [1].

### 4.4.1 Coordinate Systems

The Mars Express ELS measurements are *in situ*, thus the data are in the MEx ELS instrument reference frame as defined in the SPICE (Spacecraft, Planet, Instrument, C-matrix, and Event) instrument kernel, MEX_ASPERA_V09.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 Mars Express SPICE kernels should be used for translating/rotating to other reference frames, which are defined in the frames kernel, MEX_V16.TF. The orientation of the ASPERA-3 scanner is given in the CK kernel, MEX_ASPERA_SAF_030603_91.BC, found on the NAIF (Navigation and Ancillary Information Facility) website:

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

### 4.4.2 Geometric Elements

All geometry information is archived (PDS3) along with the ASPERA-3 ELS data as GEO_MARS.TAB files (with associated GEO_MARS.LBL files) at the ESA PSA and the NASA PDS and can be found in the INDEX subdirectory associated with each data set. Access to the PSA

ASPERA-3 data archive is at: https://archives.esac.esa.int/psa/ftp/MARS-EXPRESS/ASPERA-3/, and access to the PDS ASPERA-3 data archive is at: https://pds-ppi.igpp.ucla.edu/data/.

### 4.4.3 Data Storage Conventions

The Mars 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 as well as in CDF-A files. **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<br>ASCII Tables | 5 GB |
| | ELS Background Corrected Number Flux<br>ASCII CSV files | 800 GB |
| | ELS 1-count Threshold<br>ASCII CSV files | 800 GB |
| data_raw | ELS Counts<br>ASCII CSV files | 430 GB |
| data_eng | ELS energy steps<br>ASCII CSV files | 670 MB |
| data_cdf | ELS science data (raw, number flux, background-corrected number flux, background-corrected energy flux, and background-corrected distribution function) with energy levels<br>CDF-A files | 1.2 TB |

### 4.4.4 Data Validation

The MEx 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

The data in ASCII form 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. The CDF data can be read and analyzed using a variety of publicly available tools.

## 5 ELS Archive Organization, Identifiers and Naming Conventions

This section describes the basic organization of the Mars 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.

Mars 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 MEx ELS bundle ID is: mex-aspera3-els
  Thus, the bundle LID is: urn:nasa:pds:mex-aspera3-els

  Since all PDS bundle LIDs are constructed this way, the combination of mex-aspera3-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:mex-aspera3-els:<collection ID>
  For example: urn:nasa:pds:mex-aspera3-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:mex-aspera3-els:<collection ID>
  For example: urn:nasa:pds:mex-aspera3-els:data_derived:<product ID>
  urn:nasa:pds:mex-aspera3-els:data_derived:elslrbcnf_20120271707

  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 MEx 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:

ELS**BBBB_YYYYDDDHHMM**_V**x.y**.TAB

where **BBBB** is the background data product name:

1. 01BK for 1-minute averaged background
2. 05BK for 5-minute averaged background
3. 25BK for 25-minute averaged background
4. BKGD for background averaged at the instrument rate (4 seconds)
5. MCBK for the combined background data product

**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

The ELS science data are also in CDF-A format and are named as follows:

ELS**r**RCDF_**YYYYDDDHHMM**_V**xx**.cdf

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**xx** refers to the file Version number xx (e.g., 01)

## 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 the same type. Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization.

This Mars Express ELS archive is organized into one bundle: **urn:nasa:pds:mex-aspera3-els**

## 5.3 Data Collections

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

1. **urn:nasa:pds:mex-aspera3-els:data_derived** – Nine data products
   - Background data (ELS01BK, ELS05BK, ELS25BK, ELSBKGD, and ELSMCBK)
   - Background Corrected Number Flux (ELSHRBCNF and ELSLRBCNF)
   - 1-cnt Threshold (ELSHRTHR and ELSLRTHR)
2. **urn:nasa:pds:mex-aspera3-els:data_raw** – Two data products
   - Counts (ELSHRCNTS and ELSLRCNTS)
3. **urn:nasa:pds:mex-aspera3-els:data_eng** – Two data products
   - Energy Levels (ELSHRSTPS and ELSLRSTPS)
4. **urn:nasa:pds:mex-aspera3-els:data_cdf** – Two data products
   - Science Data in CDF format (ELSHRCDF and ELSLRCDF) – each file contains five units: (1) raw counts, (2) number flux, (3) background-corrected number flux, (4) background-corrected energy flux, and (5) background-corrected distribution function. In addition, the energy levels and a data quality flag are included for each ELS sector (16 sectors).

*Table 3. MEx ELS Data Collections, Products, and Estimated Volumes*

| Collections | Data Products | Estimated Volume |
|---|---|---|
| data_derived | **ELS01BK - 1-minute average background [cnts/sec]**<br>**ELS05BK - 5-minute average background [cnts/sec]**<br>**ELS25BK - 25-minute average background [cnts/sec]**<br>**ELSBKGD - 4-second (ELS rate) background [cnts/sec]**<br>**ELSMCBK - combined average background [cnts/sec]**<br>**ELSHRBCNF - high range corrected diff number flux**<br>**ELSLRBCNF - low range corrected diff number flux**<br>**ELSHRTHR - high range 1-cnt diff number flux thresholds**<br>**ELSLRTHR - low range 1-cnt diff number flux thresholds**<br>**** diff number flux units → [cnts/(cm$^2$·sr·sec·eV)]** | 1.6 TB |
| data_raw | **ELSHRCNTS - high energy range raw counts [cnts]**<br>**ELSLRCNTS - low energy range raw counts [cnts]** | 430 GB |
| data_eng | **ELSHRSTPS - high range center energy steps [eV]**<br>**ELSLRSTPS - low range center energy steps [eV]** | 670 MB |
| data_cdf | **ELSHRCDF - high range CDF science data**<br>**ELSLRCDF - low range CDF science data**<br>**All CDFs have data in raw counts [cnts], uncorrected diff number flux, corrected diff number flux, corrected diff energy flux, & corrected dist. fcn**<br>**** diff number flux units → [cnts/(cm$^2$·sr·sec·eV)]**<br>**** diff energy flux units → [ergs/(cm$^2$·sr·sec·eV)]**<br>**** distribution function units → [s$^3$/(m$^6$·sr)]**<br>**Also, center energy steps with delta width [eV]** | 1.2 TB |

## 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:mex-aspera3-els:data_derived:elslrbcnf_20120271707**

Example LID for an ELS high energy range Common Data Format (CDF) product:

**urn:nasa:pds:mex-aspera3-els:data_cdf:elshrcdf_20120271707**

## 5.5 Document Collection

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

Document Collection LID: **urn:nasa:pds:mex-aspera3-els:document**

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

***Table 4. The Mars Express ASPERA-3 ELS Document Collection***

| Product Logical Identifier (LID)<br>Document Filename** | Description |
|---|---|
| **urn:nasa:pds:mex-aspera3-els:document:sis**<br>MEX_ASPERA-3_ELS_Spec_1.0.pdf | MEx ELS Software Interface Specification (this document): describes the format and content of this archive |
| **urn:nasa:pds:mex-aspera3-els:document:bkexamp**<br>MEX_ASPERA-3_ELS_Background_Data_Examples_1.0.pdf | MEx ELS Background Data Examples: gives general description of background and how it should be used |
| **urn:nasa:pds:mex-aspera3-els:document:bkdesc**<br>MEX_ASPERA-3_ELS_Description_1.0.pdf | MEx 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 Mars Express ELS archive is organized into one bundle with four data collections and a document collection. This section describes the overall directory structure.

```
mex-aspera3-els – top level directory
   bundle_mex-aspera3-els_1.1.lblx
   readme_mex-aspera3-els_1.1.txt
   data_cdf – subdirectory containing the CDF science data collection
      collection_data_cdf_1.0.csv
      collection_data_cdf_1.0.lblx
      ……
         Subdirectories given below

   data_derived – subdirectory containing the derived data collection
      collection_data_derived_1.0.csv
      collection_data_derived_1.0.lblx
      ……
         Subdirectories given below
   data_eng – subdirectory containing the engineering data collection
      collection_data_eng_1.0.csv
      collection_data_eng_1.0.lblx
      ……
         Subdirectories given below
   data_raw – subdirectory containing the raw data collection
      collection_data_raw_1.0.csv
      collection_data_raw_1.0.lblx
      ……
         Subdirectories given below
   document – subdirectory containing the document collection
      collection_document_1.0.csv
      collection_document_1.0.lblx
      MEX_ASPERA-3_ELS_Background_Data_Examples_1.0.pdf
      MEX_ASPERA-3_ELS_Background_Data_Examples_1.0.lblx
      MEX_ASPERA-3_ELS_Description_1.0.pdf
      MEX_ASPERA-3_ELS_Description_1.0.lblx
      MEX_ASPERA-3_ELS_Spec_1.0.pdf
      MEX_ASPERA-3_ELS_Spec_1.0.lblx
```

The subdirectories of each of the data directories are the same and are organized according to mission phase: nominal, ext1, ext2, ext3, ext4, ext5, ext6, and ext7. Under these subdirectories, the data are further divided into years. The directories are structured as follows:

```
data_<type>, where <type> is either cdf, derived, eng, or raw
   nominal
      2003
      2004
      2005
   ext1
      2006
      2007
   ext2
      2007
      2008
      2009
   ext3
      2010
      2011
      2012
   ext4
      2013
      2014
   ext5
      2015
      2016
   ext6
      2017
      2018
   ext7
      2019
```

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

# 6 ELS Archive Data Formats

Data that comprise the MEx 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 MEx ELS background data for the ELS01BK, ELS05BK, ELS25BK, and ELSBKGD data products 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).

The MEx ELS background data for the ELSMCBK data product are also organized in ASCII tables but with a total of 34 columns per row: two for start and stop date/times, 16 for the background data (one for each ELS sector), and 16 for the corresponding uncertainties.

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

*** The anode background and standard deviation are not included for the Combined Background data product, ELSMCBK, since the background values for each sector could come from different time cadences (4-sec., 1-min., 5-min., or 25-min.)**

## 6.2 ELS Background Corrected Number Flux and 1-Count Threshold

The MEx 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<br>YYYY-DOY**T**HH:MM:SS.mmm | | ASCII_String | | | ASCII_Real<br>%12.5e |
| Start Time for MEx ELS-00 data (sector 0) | Stop Time for MEx ELS-00 data (sector 0) | SENSOR referring to primary (science) data | MEx ELS-00 **x**R**<desc>**, **x** = L for Low range and H for High range<br>**<desc>** is "-BK" for BCNF data and "Sensit" for threshold data | $\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$<br>(diff. number flux) | repetitions # of data values, Comma delimited |
| Start Time For MEx ELS-01 data (sector 1) | Stop Time for MEx ELS-01 data (sector 1) | SENSOR referring to primary (science) data | MEx ELS-01 **x**R**<desc>**, **x** = L for Low range and H for High range<br>**<desc>** is "-BK" for BCNF data and "Sensit" for threshold data | $\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$<br>(diff. number flux) | repetitions # of data values, Comma delimited |
| : | : | : | : | : | : |
| Start Time For MEx ELS-15 data (sector 15) | Stop Time for MEx ELS-15 data (sector 15) | SENSOR referring to primary (science) data | MEx ELS-15 **x**R**<desc>**, **x** = L for Low range and H for High range<br>**<desc>** is "-BK" for BCNF data and "Sensit" for threshold data | $\frac{cnts}{cm^2 \cdot sr \cdot s \cdot eV}$<br>(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 MEx 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<br>`YYYY-DOYTHH:MM:SS.mmm` | | ASCII_String | | | ASCII_Real<br>`%8.3f` |
| Start Time for MEx ELS-00 data (sector 0) | Stop Time for MEx ELS-00 data (sector 0) | SENSOR referring to primary (science) data | MEx ELS-00 **x**R<br>**x** = L for Low range and H for High range | c/acc<br>Counts per accumulation period | repetitions # of data values, Comma delimited |
| Start Time For MEx ELS-01 data (sector 1) | Stop Time for MEx ELS-01 data (sector 1) | SENSOR referring to primary (science) data | MEx ELS-01 **x**R<br>**x** = L for Low range and H for High range | c/acc<br>Counts per accumulation period | repetitions # of data values, Comma delimited |
| : | : | : | : | : | : |
| Start Time For MEx ELS-15 data (sector 15) | Stop Time for MEx ELS-15 data (sector 15) | SENSOR referring to primary (science) data | MEx ELS-15 **x**R<br>**x** = L for Low range and H for High range | c/acc<br>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 MEx 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 8** 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<br>YYYY-DOY**T**HH:MM:SS.mmm | | ASCII_String | | | ASCII_Real<br>%10.4e |
| Start Time for MEx ELS-00 data (sector 0) | Stop Time for MEx ELS-00 data (sector 0) | SCAN referring to energy step data | MEx ELS-00 **x**R<br>**x** = L for Low range and H for High range | eV<br>electron volts | repetitions # of data values, Comma delimited |
| Start Time For MEx ELS-01 data (sector 1) | Stop Time for MEx ELS-01 data (sector 1) | SCAN referring to energy step data | MEx ELS-01 **x**R<br>**x** = L for Low range and H for High range | eV<br>electron volts | repetitions # of data values, Comma delimited |
| : | : | : | : | : | : |
| Start Time For MEx ELS-15 data (sector 15) | Stop Time for MEx ELS-15 data (sector 15) | SCAN referring to energy step data | MEx ELS-15 **x**R<br>**x** = L for Low range and H for High range | eV<br>electron volts | repetitions # of data values, Comma delimited |
| Then repeats for the next time range and so on until end of file. | | | | | |

## 6.5 ELS CDF-A Files

The CDF-A files are binary and contain the attributes necessary to describe the data (sensor name, units, energy steps, etc.) along with the counts, uncorrected differential number flux, background-corrected differential number flux, background-corrected differential energy flux, and background-corrected distribution function for each energy step, sector, and time interval. The time intervals are given using the start of data collection and accumulation period. A data quality flag for each ELS sector is also included, and has the following values:

| Data Quality Flag Value | Description | Determination |
|---|---|---|
| 0 | Good Data | Default assumption is that data are good unless determined otherwise |
| 1 | Questionable Data | +30V monitor value out of tolerance |
| 2 | Invalid Data | ±12V or ±5V monitor value out of tolerance or high voltage disabled |
| 3 | Bad Data | +30V monitor value and (±12V or ±5V monitor value) out of tolerance |
| 4 | Unknown State | Time related Main Unit housekeeping packet is not available |

The spacecraft provided ±12V, ±5V, and +30V power lines which were not controlled by the experiment. These voltage lines were measured on the spacecraft and transmitted where they were evaluated to determine instrument performance.

## 6.6 Document Product Formats

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

## 6.7 PDS Labels

There is a PDS4 label for each MEx 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 ".lblx".

For the Mars 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 1.22.0.0 [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 MEx 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) |
| CDF | Common Data Format |
| CDF-A | Archive suitable version of CDF that is considered PDS4 compliant |
| 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 |
| lblx | PDS4 XML-formatted label file extension that is a recognized variation in the PDS4 registry for metadata |
| 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 |

| Acronym or Abbreviation | Meaning |
|---|---|
| PDS3 | NASA Planetary Data System, Version 3 |
| PDS4 | NASA Planetary Data System, Version 4 |
| PI | Principal Investigator |
| PPI | Planetary Data System, Planetary Plasma Interactions Node |
| PR | Peer Review |
| PSA | ESA Planetary Science Archive |
| RDR | Reduced Data Record |
| SIS | Software Interface Specification |
| SPASE | Space Physics Archive Search and Extract |
| 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 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 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. Primarily using a .xml extension, the .lblx extension is a recognized variation in the PDS4 registry for metadata, providing details about data structure, content, and context (such as mission or instrument) to enable data access.

**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 1-min. Averaged Background Data (ELS01BK_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
   <Identification_Area>
    <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_derived:els01bk_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ELS 1-Minute Background Data 2012-01-27 17:07</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
                This product contains ELS 1-minute BacKground (ELS01BK) averages and standard deviations
                for all ELS sectors combined, and for each sector separately.
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2025-07-02</modification_date>
                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
        </Modification_History>
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            <stop_date_time>2012-01-27T19:59:45.992Z</stop_date_time>
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            <processing_level>Derived</processing_level>
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                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
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            </Internal_Reference>
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```

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                <type>Host</type>
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                </Internal_Reference>
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                    <reference_type>is_instrument</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
        </Observing_System>
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            <type>Planet</type>
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                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
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        <Mission_Area>

        </Mission_Area>
        <Discipline_Area>
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                <particle:energy_range_maximum unit="eV">100000.000000</particle:energy_range_maximum>
                <particle:Particle_Parameter>
                    <particle:particle_type>Electrons</particle:particle_type>
                    <particle:particle_measurement_type>Count Rate</particle:particle_measurement_type>
                </particle:Particle_Parameter>
            </particle:Particle_Observation>
        </Discipline_Area>
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    <File_Area_Observational>
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            <creation_date_time>2025-07-02T21:24</creation_date_time>
            <records>161</records>
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        </File>
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            <offset unit="byte">0</offset>
            <records>161</records>
            <description>
                This table contains ELS 1-minute BacKground (ELS01BK) data for all ELS sectors combined,
and background data for each sector separately.
            </description>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
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                <groups>0</groups>
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```

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</Field_Character>
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    <name>Stop Time</name>
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```

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## B.2 *ELS 5-min. Averaged Background Data (ELS05BK_20120271707_V1.0.lblx)*

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    </Special_Constants>
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    <field_number>35</field_number>
    <field_location unit="byte">381</field_location>
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    <field_length unit="byte">10</field_length>
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    </Special_Constants>
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                    </Special_Constants>
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</Product_Observational>
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## B.3 *ELS 25-min. Averaged Background Data (ELS25BK_20120271707_V1.0.lblx)*

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<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
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    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
   <Identification_Area>
    <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_derived:els25bk_20120271707</logical_identifier>
        <version_id>1.0</version_id>
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        <information_model_version>1.22.0.0</information_model_version>
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        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
                This product contains ELS 25-minute BacKground (ELS25BK) averages and standard deviations
                for all ELS sectors combined, and for each sector separately.
            </description>
        </Citation_Information>
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                <version_id>1.0</version_id>
                <description>Initial version</description>
            </Modification_Detail>
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        </Time_Coordinates>
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            <processing_level>Derived</processing_level>
            <Science_Facets>
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                <facet2>Energetic</facet2>
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```
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                <type>Host</type>
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                    <reference_type>is_instrument_host</reference_type>
                </Internal_Reference>
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                <type>Instrument</type>
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        </Mission_Area>
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                <particle:Particle_Parameter>
                    <particle:particle_type>Electrons</particle:particle_type>
                    <particle:particle_measurement_type>Count Rate</particle:particle_measurement_type>
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    </Observation_Area>
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            <records>7</records>
            <md5_checksum>986f608e9f8a368f2eb407b6e0a1440c</md5_checksum>
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            <offset unit="byte">0</offset>
            <records>7</records>
            <description>
                This table contains ELS 25-minute BacKground (ELS25BK) data for all ELS sectors combined,
and background data for each sector separately.
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        <field_length unit="byte">21</field_length>
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    <name>MEx ELS-04 Background Std Dev</name>
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    <field_location unit="byte">359</field_location>
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    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
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    <name>MEx ELS-13 Background Std Dev</name>
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    <field_location unit="byte">370</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
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    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
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    <name>MEx ELS-14 Background Std Dev</name>
    <field_number>35</field_number>
    <field_location unit="byte">381</field_location>
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                <Field_Character>
                    <name>MEx ELS-15 Background Std Dev</name>
                    <field_number>36</field_number>
                    <field_location unit="byte">392</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">10</field_length>
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                    <Special_Constants>
                       <invalid_constant>3.4000e+38</invalid_constant>
                    </Special_Constants>
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    </File_Area_Observational>
</Product_Observational>
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## B.4 *ELS Instrument Rate (4-sec.) Background Data (ELSBKGD_20120271707_V1.0.lblx)*

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<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
   <Identification_Area>
    <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_derived:elsbkgd_20120271707</logical_identifier>
        <version_id>1.0</version_id>
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        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
                This product contains ELS BacKGrounD (ELSBKGD) averages and standard deviations at the
                sensor rate for all ELS sectors combined, and for each sector separately.
            </description>
        </Citation_Information>
        <Modification_History>
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## B.5 *ELS Combined Background Data (ELSMCBK_20120271707_V1.0.lblx)*

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            <description>
                This table contains the ELS Combined BacKground (ELSMCBK) data at the sensor rate
for each ELS sector.
            </description>
            <record_delimiter>Carriage-Return Line-Feed</record_delimiter>
            <Record_Character>
                <fields>34</fields>
                <groups>0</groups>
                <record_length unit="byte">381</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>MEx ELS-00</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>counts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>  -9.9999</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>MEx ELS-01</name>
                    <field_number>4</field_number>
                    <field_location unit="byte">55</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">9</field_length>
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                    <Special_Constants>
                       <invalid_constant>  -9.9999</invalid_constant>
                    </Special_Constants>
                </Field_Character>
                <Field_Character>
                    <name>MEx ELS-02</name>
                    <field_number>5</field_number>
                    <field_location unit="byte">65</field_location>
                    <data_type>ASCII_Real</data_type>
                    <field_length unit="byte">9</field_length>
                    <unit>counts/sec</unit>
                    <Special_Constants>
                       <invalid_constant>  -9.9999</invalid_constant>
```

```
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-03</name>
    <field_number>6</field_number>
    <field_location unit="byte">75</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
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    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
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    <name>MEx ELS-04</name>
    <field_number>7</field_number>
    <field_location unit="byte">85</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
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       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-05</name>
    <field_number>8</field_number>
    <field_location unit="byte">95</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
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    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-06</name>
    <field_number>9</field_number>
    <field_location unit="byte">105</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-07</name>
    <field_number>10</field_number>
    <field_location unit="byte">115</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
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       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-08</name>
    <field_number>11</field_number>
    <field_location unit="byte">125</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
```

```
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
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</Field_Character>
<Field_Character>
    <name>MEx ELS-09</name>
    <field_number>12</field_number>
    <field_location unit="byte">135</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-10</name>
    <field_number>13</field_number>
    <field_location unit="byte">145</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-11</name>
    <field_number>14</field_number>
    <field_location unit="byte">155</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-12</name>
    <field_number>15</field_number>
    <field_location unit="byte">165</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
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    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-13</name>
    <field_number>16</field_number>
    <field_location unit="byte">175</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-14</name>
    <field_number>17</field_number>
```

```
    <field_location unit="byte">185</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-15</name>
    <field_number>18</field_number>
    <field_location unit="byte">195</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">9</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>  -9.9999</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-00 BKGD Std Dev</name>
    <field_number>19</field_number>
    <field_location unit="byte">205</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-01 BKGD Std Dev</name>
    <field_number>20</field_number>
    <field_location unit="byte">216</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-02 BKGD Std Dev</name>
    <field_number>21</field_number>
    <field_location unit="byte">227</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-03 BKGD Std Dev</name>
    <field_number>22</field_number>
    <field_location unit="byte">238</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
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```
<Field_Character>
    <name>MEx ELS-04 BKGD Std Dev</name>
    <field_number>23</field_number>
    <field_location unit="byte">249</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-05 BKGD Std Dev</name>
    <field_number>24</field_number>
    <field_location unit="byte">260</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-06 BKGD Std Dev</name>
    <field_number>25</field_number>
    <field_location unit="byte">271</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-07 BKGD Std Dev</name>
    <field_number>26</field_number>
    <field_location unit="byte">282</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-08 BKGD Std Dev</name>
    <field_number>27</field_number>
    <field_location unit="byte">293</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
       <invalid_constant>3.4000e+38</invalid_constant>
    </Special_Constants>
</Field_Character>
<Field_Character>
    <name>MEx ELS-09 BKGD Std Dev</name>
    <field_number>28</field_number>
    <field_location unit="byte">304</field_location>
    <data_type>ASCII_Real</data_type>
    <field_length unit="byte">10</field_length>
    <unit>counts/sec</unit>
    <Special_Constants>
```

```
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-10 BKGD Std Dev</name>
        <field_number>29</field_number>
        <field_location unit="byte">315</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>counts/sec</unit>
        <Special_Constants>
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-11 BKGD Std Dev</name>
        <field_number>30</field_number>
        <field_location unit="byte">326</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>counts/sec</unit>
        <Special_Constants>
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-12 BKGD Std Dev</name>
        <field_number>31</field_number>
        <field_location unit="byte">337</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>counts/sec</unit>
        <Special_Constants>
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-13 BKGD Std Dev</name>
        <field_number>32</field_number>
        <field_location unit="byte">348</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>counts/sec</unit>
        <Special_Constants>
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-14 BKGD Std Dev</name>
        <field_number>33</field_number>
        <field_location unit="byte">359</field_location>
        <data_type>ASCII_Real</data_type>
        <field_length unit="byte">10</field_length>
        <unit>counts/sec</unit>
        <Special_Constants>
            <invalid_constant>3.4000e+38</invalid_constant>
        </Special_Constants>
    </Field_Character>
    <Field_Character>
        <name>MEx ELS-15 BKGD Std Dev</name>
        <field_number>34</field_number>
        <field_location unit="byte">370</field_location>
        <data_type>ASCII_Real</data_type>
```

```
                    <field_length unit="byte">10</field_length>
                    <unit>counts/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.6 *ELS Low Range Background Corrected Number Flux (ELSLRBCNF_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
 <Identification_Area>
  <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_derived:elslrbcnf_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ELS Low Energy Range Background Corrected Number Flux 2012-01-27 17:07</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
                This product contains ELS Low energy Range Background Corrected Number Flux (ELSLRBCNF)
for each ELS sector.
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2025-07-02</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>2012-01-27T17:07:19.036Z</start_date_time>
            <stop_date_time>2012-01-27T19:59:45.964Z</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>Mars_Express</name>
            <type>Mission</type>
```

```
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:investigation:mission.mars_express</lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
        </Investigation_Area>
        <Observing_System>
            <Observing_System_Component>
                <name>MEX</name>
                <type>Host</type>
                <Internal_Reference>
                    <lid_reference>urn:esa:psa:context:instrument_host:spacecraft.mex</lid_reference>
                    <reference_type>is_instrument_host</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
            <Observing_System_Component>
                <name>ASPERA-3</name>
                <type>Instrument</type>
                <Internal_Reference>
                    <lid_reference>urn:esa:psa:context:instrument:mex.aspera-3</lid_reference>
                    <reference_type>is_instrument</reference_type>
                </Internal_Reference>
            </Observing_System_Component>
        </Observing_System>
        <Target_Identification>
            <name>Mars</name>
            <type>Planet</type>
            <Internal_Reference>
                <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
                <reference_type>data_to_target</reference_type>
            </Internal_Reference>
        </Target_Identification>
        <Mission_Area>   </Mission_Area>
        <Discipline_Area>
            <particle:Particle_Observation>
                <particle:energy_range_minimum unit="eV">0.100000</particle:energy_range_minimum>
                <particle:energy_range_maximum unit="eV">200.000000</particle:energy_range_maximum>
                <particle:Particle_Parameter>
                    <particle:particle_type>Electrons</particle:particle_type>
                    <particle:particle_measurement_type>Flux</particle:particle_measurement_type>
                </particle:Particle_Parameter>
            </particle:Particle_Observation>
        </Discipline_Area>
    </Observation_Area>
    <File_Area_Observational>
        <File>
            <file_name>ELSLRBCNF_20120271707_V1.0.CSV</file_name>
            <creation_date_time>2025-07-02T21:58</creation_date_time>
            <records>36064</records>
            <md5_checksum>93381a18ea5795ec36b95dc6fb7bb63f</md5_checksum>
            <comment>
                This table contains ELS Low energy Range Background Corrected Number Flux (ELSLRBCNF)
for each sector.
            </comment>
        </File>
        <Table_Delimited>
            <offset unit="byte">0</offset>
            <parsing_standard_id>PDS DSV 1</parsing_standard_id>
            <records>36064</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.7 *ELS High Range 1-Count Threshold (ELSHRTHR_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
  <Identification_Area>
   <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_derived:elshrthr_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ELS High Energy Range 1-count Threshold 2012-01-27 17:07</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
               This product contains ELS High energy Range 1-count THReshold (ELSHRTHR) for each ELS sector.
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2025-07-02</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>2012-01-27T17:07:17.161Z</start_date_time>
            <stop_date_time>2012-01-27T19:59:43.870Z</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>Mars_Express</name>
            <type>Mission</type>
            <Internal_Reference>
              <lid_reference>urn:esa:psa:context:investigation:mission.mars_express</lid_reference>
```

```
            <reference_type>data_to_investigation</reference_type>
        </Internal_Reference>
    </Investigation_Area>
    <Observing_System>
        <Observing_System_Component>
            <name>MEX</name>
            <type>Host</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:instrument_host:spacecraft.mex</lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>ASPERA-3</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:instrument:mex.aspera-3</lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>   </Mission_Area>
    <Discipline_Area>
        <particle:Particle_Observation>
            <particle:energy_range_minimum unit="eV">0.100000</particle:energy_range_minimum>
            <particle:energy_range_maximum unit="eV">100000.000000</particle:energy_range_maximum>
            <particle:Particle_Parameter>
                <particle:particle_type>Electrons</particle:particle_type>
                <particle:particle_measurement_type>Flux</particle:particle_measurement_type>
            </particle:Particle_Parameter>
        </particle:Particle_Observation>
    </Discipline_Area>
</Observation_Area>
<File_Area_Observational>
    <File>
        <file_name>ELSHRTHR_20120271707_V1.0.CSV</file_name>
        <creation_date_time>2025-07-02T21:43</creation_date_time>
        <records>36064</records>
        <md5_checksum>6645f2ed7215c774aa6101b02b8d53d3</md5_checksum>
        <comment>
            This table contains ELS High energy Range 1-count THReshold (ELSHRTHR) for each sector.
        </comment>
    </File>
    <Table_Delimited>
        <offset unit="byte">0</offset>
        <parsing_standard_id>PDS DSV 1</parsing_standard_id>
        <records>36064</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.8 *ELS Low Range Raw (ELSLRCNTS_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
    <Identification_Area>
     <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_raw:elslrcnts_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ELS Low Energy Range Counts 2012-01-27 17:07</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</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>2025-07-02</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>2012-01-27T17:07:19.036Z</start_date_time>
            <stop_date_time>2012-01-27T19:59:45.964Z</stop_date_time>
        </Time_Coordinates>
        <Primary_Result_Summary>
            <purpose>Science</purpose>
            <processing_level>Raw</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
        <Investigation_Area>
            <name>Mars_Express</name>
            <type>Mission</type>
            <Internal_Reference>
              <lid_reference>urn:esa:psa:context:investigation:mission.mars_express</lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
        </Investigation_Area>
```

```
    <Observing_System>
        <Observing_System_Component>
            <name>MEX</name>
            <type>Host</type>
            <Internal_Reference>
              <lid_reference>urn:esa:psa:context:instrument_host:spacecraft.mex</lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>ASPERA-3</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:instrument:mex.aspera-3</lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>   </Mission_Area>
    <Discipline_Area>
        <particle:Particle_Observation>
            <particle:energy_range_minimum unit="eV">0.100000</particle:energy_range_minimum>
            <particle:energy_range_maximum unit="eV">200.000000</particle:energy_range_maximum>
            <particle:Particle_Parameter>
                <particle:particle_type>Electrons</particle:particle_type>
                <particle:particle_measurement_type>Counts</particle:particle_measurement_type>
            </particle:Particle_Parameter>
        </particle:Particle_Observation>
    </Discipline_Area>
</Observation_Area>
<File_Area_Observational>
    <File>
        <file_name>ELSLRCNTS_20120271707_V1.0.CSV</file_name>
        <creation_date_time>2025-07-02T20:46</creation_date_time>
        <records>36064</records>
        <md5_checksum>038e78a18fefb71a37cab7333e4006a3</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>36064</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>%9.3f</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.9 *ELS High Range Energy Levels (ELSHRSTPS_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
    <Identification_Area>
      <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_eng:elshrstps_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ELS High Energy Range Center Energies 2012-01-27 17:07</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
            This product contains ELS High energy Range center energy STePS (ELSHRSTPS) for each ELS sector.
            </description>
        </Citation_Information>
        <Modification_History>
            <Modification_Detail>
                <modification_date>2025-07-02</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>2012-01-27T17:07:17.161Z</start_date_time>
            <stop_date_time>2012-01-27T19:59:43.870Z</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>Mars_Express</name>
            <type>Mission</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:investigation:mission.mars_express</lid_reference>
                <reference_type>data_to_investigation</reference_type>
            </Internal_Reference>
        </Investigation_Area>
        <Observing_System>
            <Observing_System_Component>
                <name>MEX</name>
```

```
            <type>Host</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:instrument_host:spacecraft.mex</lid_reference>
                <reference_type>is_instrument_host</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
        <Observing_System_Component>
            <name>ASPERA-3</name>
            <type>Instrument</type>
            <Internal_Reference>
                <lid_reference>urn:esa:psa:context:instrument:mex.aspera-3</lid_reference>
                <reference_type>is_instrument</reference_type>
            </Internal_Reference>
        </Observing_System_Component>
    </Observing_System>
    <Target_Identification>
        <name>Mars</name>
        <type>Planet</type>
        <Internal_Reference>
            <lid_reference>urn:nasa:pds:context:target:planet.mars</lid_reference>
            <reference_type>data_to_target</reference_type>
        </Internal_Reference>
    </Target_Identification>
    <Mission_Area>  </Mission_Area>
    <Discipline_Area>
        <particle:Particle_Observation>
            <particle:energy_range_minimum unit="eV">0.100000</particle:energy_range_minimum>
            <particle:energy_range_maximum unit="eV">100000.000000</particle:energy_range_maximum>
            <particle:Particle_Parameter>
                <particle:particle_type>Electrons</particle:particle_type>
                <particle:particle_measurement_type>Counts</particle:particle_measurement_type>
            </particle:Particle_Parameter>
        </particle:Particle_Observation>
    </Discipline_Area>
</Observation_Area>
<File_Area_Observational>
    <File>
        <file_name>ELSHRSTPS_20120271707_V1.0.CSV</file_name>
        <creation_date_time>2025-07-02T20:54</creation_date_time>
        <records>16</records>
        <md5_checksum>0afb73c907ec64d7cfd489ab3fcb2fc6</md5_checksum>
        <comment>
            This table contains ELS High energy Range center energy STePS (ELSHRSTPS) for each 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>
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                        <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>
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## B.10 *ELS Low Range CDF (ELSLRCDF_20120271707_V1.0.lblx)*

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1M00.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.sch"
schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:particle="http://pds.nasa.gov/pds4/particle/v2"
    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_1M00.xsd
                        http://pds.nasa.gov/pds4/particle/v2
                        https://pds.nasa.gov/pds4/particle/v2/PDS4_PARTICLE_1N00_2020.xsd">
    <Identification_Area>
       <logical_identifier>urn:nasa:pds:mex-aspera3-els:data_cdf:elslrcdf_20120271707</logical_identifier>
        <version_id>1.0</version_id>
        <title>MEX ASPERA-3 ELS Low Energy Range: 2012-01-27T17:07 - 2012-01-27T19:59</title>
        <information_model_version>1.22.0.0</information_model_version>
        <product_class>Product_Observational</product_class>
        <Citation_Information>
            <publication_year>2025</publication_year>
            <description>
                This data product contains Mars Express ASPERA3 low energy
                range electron differential flux and raw counts covering the time period
                2012-01-27T17:07:19.036317000 to 2012-01-27T19:59:43.870564000.
            </description>
        </Citation_Information>
        <Modification_History>
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            <processing_level>Raw</processing_level>
            <processing_level>Derived</processing_level>
            <Science_Facets>
                <discipline_name>Particles</discipline_name>
                <facet1>Electrons</facet1>
                <facet2>Energetic</facet2>
            </Science_Facets>
        </Primary_Result_Summary>
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            <type>Mission</type>
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                <lid_reference>urn:esa:psa:context:investigation:mission.mars_express</lid_reference>
                <reference_type>data_to_investigation</reference_type>
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            <Observing_System_Component>
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                <type>Host</type>
```

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        <type>Planet</type>
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            <msn:mission_phase_name>ME Phase 24</msn:mission_phase_name>
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        <particle:Particle_Observation>
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**Multidimensional Data for raw counts snipped…. showing only uncorrected and corrected diff. number flux**

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**Multidimensional Data for corrected diff. energy flux and corrected distribution function snipped…**

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each of sectors (anodes) 0-15.
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            <unit>eV</unit>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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            <valid_minimum>0.1</valid_minimum>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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            Energy scan values for the data returned for Sensor 2.
        </description>
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            <unit>eV</unit>
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        <Axis_Array>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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            <valid_minimum>0.1</valid_minimum>
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        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
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        </description>
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        <Element_Array>
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            <unit>eV</unit>
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        <Axis_Array>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>eV</unit>
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        <Axis_Array>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>eV</unit>
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        <Axis_Array>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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    </description>
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        <unit>eV</unit>
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        <elements>67</elements>
        <sequence_number>1</sequence_number>
    </Axis_Array>
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        <valid_minimum>0.1</valid_minimum>
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        Energy scan values for the data returned for Sensor 7.
    </description>
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        <unit>eV</unit>
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    <Axis_Array>
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        <elements>67</elements>
        <sequence_number>1</sequence_number>
    </Axis_Array>
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        <invalid_constant>-3.4E38</invalid_constant>
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        <valid_minimum>0.1</valid_minimum>
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    <axis_index_order>Last Index Fastest</axis_index_order>
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    </description>
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```

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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <elements>67</elements>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        <description>
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        </description>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
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            <valid_maximum>200.0</valid_maximum>
            <valid_minimum>0.1</valid_minimum>
        </Special_Constants>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>eV</unit>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
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            <valid_minimum>0.1</valid_minimum>
        </Special_Constants>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>eV</unit>
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            <elements>67</elements>
            <sequence_number>1</sequence_number>
        </Axis_Array>
        <Special_Constants>
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    <axis_index_order>Last Index Fastest</axis_index_order>
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    </description>
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        <unit>eV</unit>
    </Element_Array>
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        <elements>67</elements>
        <sequence_number>1</sequence_number>
    </Axis_Array>
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        <valid_maximum>200.0</valid_maximum>
        <valid_minimum>0.1</valid_minimum>
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    <axes>1</axes>
    <axis_index_order>Last Index Fastest</axis_index_order>
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    </description>
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        <unit>eV</unit>
    </Element_Array>
    <Axis_Array>
        <axis_name>Energy</axis_name>
        <elements>67</elements>
        <sequence_number>1</sequence_number>
    </Axis_Array>
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        <invalid_constant>-3.4E38</invalid_constant>
        <valid_maximum>200.0</valid_maximum>
        <valid_minimum>0.1</valid_minimum>
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</Array>
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**Array description for raw counts snipped…. showing only uncorrected and corrected diff. number flux**

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    <axis_index_order>Last Index Fastest</axis_index_order>
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        ELS low range differential number flux for Anode 0.
    </description>
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```

```
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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            <axis_name>Time</axis_name>
            <elements>2254</elements>
            <sequence_number>1</sequence_number>
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            <axis_name>Energy</axis_name>
            <elements>67</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
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        </Special_Constants>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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            <elements>2254</elements>
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            <elements>67</elements>
            <sequence_number>2</sequence_number>
        </Axis_Array>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
        </Element_Array>
        <Axis_Array>
            <axis_name>Time</axis_name>
```

```
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            <sequence_number>1</sequence_number>
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            <elements>67</elements>
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        </Axis_Array>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
        </Element_Array>
        <Axis_Array>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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```

```
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
        </Element_Array>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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            <elements>2254</elements>
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            <elements>67</elements>
            <sequence_number>2</sequence_number>
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        <Special_Constants>
            <invalid_constant>-1.0E31</invalid_constant>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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        <Axis_Array>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
        <description>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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        <Axis_Array>
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            <elements>2254</elements>
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        </Axis_Array>
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            <elements>67</elements>
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            <valid_maximum>3.0E38</valid_maximum>
            <valid_minimum>-3.0E38</valid_minimum>
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        <axis_index_order>Last Index Fastest</axis_index_order>
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        </description>
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            <unit>Counts/(cm**2*sr*s*eV)</unit>
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        <axes>2</axes>
        <axis_index_order>Last Index Fastest</axis_index_order>
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**Array descriptions for corrected diff. energy flux and corrected distribution function snipped…**

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