

# 1. Introduction

This bundle contains all primary instrument data (raw and calibrated) returned from the NEAR X-ray spectrometer (XRS) and archived in the PDS. Documentation for the instrument, calibration, and data collections are also included.

The NEAR mission operated in the years 1996-2001 with the goal of characterizing the S-type near-Earth asteroid 433 Eros to determine its composition and structure. On the way to Eros, NEAR also made a reconnaissance of the main belt asteroid 253 Mathilde.

The NEAR XRS is part of the X-Ray/Gamma-Ray Spectrometer (XGRS) suite on the NEAR mission; it remotely senses the characteristic X-ray and gamma-ray emissions from the asteroid surface (Star, etal. 2000). The XGRS is designed to have sufficient sensitivity to distinguish between major meteorite types and will either identify the type of meteorite to which Eros is linked or confirm the absence of a relationship. For the NEAR mission, the X-ray detectors were chosen for the sensitivity in the energy regions of scientific interest, while also being consistent with the cost, mass, power and reliability constraints of the mission.

# 2. Archive Contents and History

The NEAR XRS instrument data were originally archived in PDS in the PDS3 archiving standard. In 2012 these data sets were reorganized so that X-ray and Gamma-ray data were in separate volumes. Table 1 shows the resulting PDS3 XRS data sets, which have been included in this bundle.

*Table 1. PDS3 NEAR XRS included in this bundle*

<b>Data Description</b>	<b>PDS3 Data Set ID</b>	<b>Date archived</b>	<b>PDS node</b>
NEAR XRS Cruise Phase 2 data	NEAR-A-XRS-2-EDR-CRUISE2-V1.0	2001-09-01	SBN
NEAR XRS Cruise Phase 3 data	NEAR-A-XRS-2-EDR-CRUISE3-V1.0	2001-09-01	SBN
NEAR XRS Cruise Phase 4 data	NEAR-A-XRS-2-EDR-CRUISE4-V1.0	2001-09-01	SBN
NEAR XRS Earth Phase data	NEAR-A-XRS-2-EDR-EARTH-V1.0	2001-09-01	SBN
NEAR XRS Eros Orbit data	NEAR-A-XRS-2-EDR-EROS/ORBIT-V1.0	2001-09-01	SBN
NEAR XRS Eros Orbit Level 2 data	NEAR-A-XRS-3-EDR-EROS/ORBIT-V1.0	2001-09-28	SBN

During 2022-2025, the PDS3 NEAR XRS holdings were migrated to the PDS4 archiving standard by the Small Bodies Node, using the On-Line Archiving Facility (OLAF). The data files

are unchanged. This bundle contains the raw NEAR XRS Cruise Phase 2, Phase 3, Phase 4, Earth, and Eros Orbit phase data, as well as the NEAR XRS Eros Orbit level 2 and level 3 data.

During the PDS3 to PDS4 migration, it should be noted that the keyword “Data Quality Index (DQI)” was not able to be fully understood by the migration team based on the documentation that was in the PDS3 archive. Although no changes were made to this keyword in the labels, and it was migrated into PDS4 normally. This was something the team felt should be noted to any future data users.

Document and metadata changes made during the migration of the data sets include:

- No primary data files were modified.
- Metadata in the PDS3 labels were migrated to PDS4 labels.
- A new NEAR mission dictionary was created to support PDS3 dataset keywords
- All PDS3 datasets were combined to create one NEAR XRS bundle
- File format definitions documents were corrected to reflect the label contents correctly
- All documentation was moved to a new document collection
- A new bundle overview document (the one you are currently reading) was created
- PDS3 data documentation was restructured as needed to reflect the new PDS4 bundle organization.

### 3. NEAR XRS Bundle Contents

The NEAR XRS bundle contains two data collections and a document collection:

The **data\_raw** collection contains X-Ray Spectrometer (XRS) raw observations data files made during the NEAR mission as well as the NEAR XGRS observation log. The data are separated into subdirectories based upon mission phase, *cruise2*, *cruise3*, *cruise4*, *earth*, and *eros orbit*, and then divided again based upon two different science operating modes: full and summary. The data are presented as FITS binary tables with detached PDS labels. (See section 4).

The **data\_calibrated** collection contains two subdirectories organized by processing level. The XRS Level 2 data products in this archive include daily time series of spectra collected by the instrument along with selected spacecraft engineering and instrument configuration and orbital ephemerides. The data are presented as binary tables with detached PDS labels. The XRS Level 3 data products in this archive include the most optimal XRS sampling of fluorescence of the asteroid surface during selected solar flares. These data include specific time series of spectra collected by the instrument along with selected spacecraft engineering and instrument configuration and orbital ephemerides. The data are presented as ASCII tables with detached PDS labels. (See section 5).

The **browse** collection contains the browse versions of the high-level results of all XRS data collected during the periods that the NEAR spacecraft was below 50 km distance from the surface of the 433 Eros asteroid, which comprise the most optimal sampling conditions for the XRS experiment. The results are in the form of daily image histograms (JPEGs) of spectra collected for the Solar pointing and Unfiltered asteroid pointing detectors as well as an image (JPEG) comprised of 6-orthogonal views of the asteroid surface in asteroid body fixed coordinates. Ancillary data are also included that provide a textual summary of the daily averages of spatial ephemerides and instrument specific information. (See section 6).

Documents in the root of the **document** collection pertain to the whole bundle. There are four subdirectories the *data\_raw\_documents* subdirectory contains all the documentation for the *data\_raw* data collection. The *data\_calibrated\_documents* subdirectory contains all of the documentation pertaining to the *data\_calibrated* data collection. The *instrument* subdirectory contains all documentation pertaining XRS instrument. The *migration\_information* subdirectory contains all the information pertaining to the 2023 PDS3 to PDS4 migration of the NEAR XRS data. (See section 7).

## 4. The data\_raw Collection

The **data\_raw** collection contains X-Ray Spectrometer (XRS) raw observations which are separated into five subdirectories, each subdirectory contains data from one mission phase. Within each mission phase subdirectory (**cruise2, cruise3, cruise4, earth, eros\_orbit**) the data is organized into two categories based upon the instrument sensor.

All data in this collection is in FITS binary table format. The individual observations are combined into a single file per day for each sensor. The collection also contains in its main directory the observation log.

The X-Ray Full (**XRF**) data contains all observations taken while the instrument was in X-ray Full mode

The X-Ray SUMM (**XRS**) data contains all observations taken while the instrument was in X-ray Summary mode

The NEAR XGRS observation log is contained in **xgrs\_obslog.csv**. Documentation for the observation log can be found in the document collection in the *data\_raw\_documents/observation\_log* subdirectory.

## 5. The data\_calibrated Collection

The **data\_calibrated** collection contains the calibrated XRS data products which are separated into two subdirectories by processing level.

The **level 2** subdirectory contains daily time series of spectra collected by the instrument along with selected spacecraft engineering and instrument configuration and orbital ephemerides. The file name scheme is *iyyyymmdd.dat*, where *i* is the instrument (*x=xrs*) and *yyyymmdd* is the date of observation.

The **level 3** subdirectory contains the most optimal XRS sampling of fluorescence of the asteroid surface during selected solar flares. These data include specific time series of spectra collected by the instrument along with selected spacecraft engineering and instrument configuration and orbital ephemerides. The file name scheme is *iyyyymmdd.dat*, where *i* is the instrument (*x=xrs*) and *yyyymmdd* is the date of observation.

## 6. The browse Collection

The **browse** collection was created to be an easy way to browse the calibration results of all XRS data collected during the periods that the NEAR spacecraft was below 50 km distance from the surface of the 433 Eros asteroid.

The browse files are organized into directories by processing level. The **level 2** and **level 3** subdirectories each contain four different browse product subdirectories and a **browse\_info.txt** document that describes each subdirectory. The **cov\_map** subdirectory holds the daily coverage maps (.jpgs) of the surface of all data collected that day. The **d\_html** subdirectory contains the daily HTML reference files. The **daily\_summary** subdirectory contains the text file that was generated alongside each coverage map. These documents hold the summary information about the spatial ephemerides convolved in each coverage map. The **hist** subdirectory contains two types of images. The *solar histograms* contain the time-sequenced daily solar activity from the solar pointing detector. The *unfiltered histograms* contain the time-sequenced daily results from the unfiltered asteroid pointing detector.

## 7. The document Collection

The document collection contains documentation in the root directory as well as four subdirectories.

### Root Directory

The **xrs\_bundle\_overview.pdf** which is the document you are reading now.

The **references.txt** document contains references for published papers referred to in the XRS bundle.

The **acronyms.txt** document contains all of the acronyms used in the NEAR XRS instrument bundle.

The **errata.txt** document describes the errata in the NEAR GRS and XRS data bundles.

### The instrument documents

The **goldsten\_1998.pdf** published document provides an overview of the The NEAR X-Ray/ Gamma-Ray Spectrometer.

The **instrument\_description.txt** document is the NEAR XRS instrument information catalog file.

### The data\_raw documents

The **data\_raw\_collection\_description.txt** document describes the XRS data raw collection and its contents.

The **xrs\_definitions.txt** and the **xrf\_definitions.txt** documents contain the keyword definitions for each of the instrument mode data products.

The **fits\_standard\_1999.pdf** document provides all the information on the FITS data standard that was used during the NEAR XGRS PDS3 dataset archiving.

The **observation\_log** subdirectory contains documentation used to describe the GRS observation log contents. The observation log itself can be found in the *data\_raw* collection.

The **obs\_log\_info.txt** document provides an overview of the Near Earth Asteroid Rendezvous Gamma-Ray Level 2 Observation Log archive. These documents describe the systems that were used to command and control the spacecraft during times when XGRS was controlling attitude, as well as commands that were used to configure the instrumentation during the orbital encounter.

The **xgrs\_command\_description.txt** document describes the Observation Log macro names and configuration parameters.

The **xgrs\_instrument\_users\_guide.txt** document describes the commanding and CAS generation for instrument and commanding of spacecraft. Lists formats and other higher-level issues for team members to build instrument control macros.

The **xgrs\_users\_guide\_fig1-3.pdf** document contains the three figure images accompanying the XGRS Instrument User Guide Document

### **The data calibrated documents**

The **data\_calibrated\_collection\_description.txt** document describes the contents of the calibrated data collection.

The **xrs\_reqs\_7\_2.pdf** document elaborates the formats and derivations of all of the parameters required for XRS Level-2 analysis

### **The migration information documents**

The **migration\_report.txt** describes the findings made during the NEAR GRS and XRS PDS3 to PDS4 migration.

The **migration\_column\_information.pdf** contains the table created for reference during migration that displays the PDS4 label values for the GRS raw data in comparison to the PDS3 archived FITS headers, labels, and documentation. Due to the data format similarities this document is also relevant to the PDS3 to PDS4 XRS migration.

## **8. References**

Starr R. *et al.* (2000) Instrument calibrations and data analysis procedures for the NEAR x-ray spectrometer. *Icarus* **147**, 498–519.