PDS4 Hayabusa AMICA Bundle Overview

(urn:nasa:pds:hay.amica) January 25th, 2022 Kristina Lopez and Carol Neese, PDS Small Bodies Node, Asteroid/Dust Subnode

1. Introduction

Hayabusa was a Japanese space mission to the asteroid 25143 Itokawa. It was launched on May 9th 2003 and returned to Earth on June 13th 2010. The Asteroid Multiband Imaging Camera (AMICA) was a charge-coupled device (CCD) camera with a refractive telescope producing an effective field of view of 5.83 x 5.69 degrees. In the course of the mission, AMICA obtained 1662 images which are included in this data set. For information about the design, performance and calibration of the AMICA camera, see Ishiguro et al. (2010).

In addition to the AMICA instrument the other Hayabusa instruments LIDAR and NIRS have also been archived in PDS, as well as higher level data. See the PDS4 Hayabusa Archive Overview in the Hayabusa Mission Information bundle (urn:nasa:pds:hay.mission) for details.

2. Archive Contents and History

In 2010, the Hayabusa AMICA raw instrument data were archived in PDS in the PDS3 archiving standard. Subsequently, ground observations of ECAS standard stars for the purpose of calibration of AMICA data were also archived.

Data Description	PDS3 Data Set ID	Date archived	PDS node
AMICA raw data	HAY-A-AMICA-3-HAYAMICA-V1.0	2010-03-15	SBN
Groundbased calibration observations for AMICA	EAR-CAL-I1376-3-AMICACAL-V1.0	2012-07-26	SBN

Table 1. PDS3 Hayabusa AMICA datasets included in this bundle

During 2021-2022, the PDS3 Hayabusa AMICA holdings were migrated to the PDS4 archiving standard by the Small Bodies Node, using the On-Line Archiving Facility (OLAF) and the OLAF PDS4 migration tools. The data files are unchanged. This bundle contains both the Hayabusa AMICA ground based calibration data set as well as the Hayabusa AMICA mission images data set, which were previously two separate PDS3 bundles.

Document and metadata changes made during the migration of the bundle include:

• No primary data files were modified.

- The ancillary parameter files in the PDS3 version were found to have significant errors due to shifted columns. These errors were corrected for the PDS4 version.
- The illumination and geometry metadata in the PDS3 data labels had errors which came from the erroneous parameter files. These were corrected for the PDS4 labels.
- The ground-based calibration observations were added to the same bundle with the AMICA instrument data.
- Mission description and spacecraft description documents have been included in the PDS4 Hayabusa Mission bundle and are not included in the AMICA bundle.
- Documentation was in some cases rearranged and updated to meet the needs of the PDS4 bundle.
- A new bundle overview (this document) was created to describe the AMICA bundle, incorporating information from the PDS3 data set catalog files and other documents.

3. Hayabusa AMICA Bundle Contents

The Hayabusa AMICA bundle contains the data and documents pertaining to the AMICA instrument. It has two data collections and a document collection:

The **data_raw** collection contains all the observation images obtained during the course of the mission from the AMICA instrument (See section 4).

The **calibration** collection contains two types of calibration data. The *ecas_ground_cal* directory contains the ground based calibration of stars observed by the Hayabusa AMICA instrument during the cruise phase of the mission. The *preflight* directory contains preflight flat field data. The *filters* directory contains the filter profiles. (See section 5 for details).

The **document** collection contains the AMICA archive overview (this document), instrument description, reference list, observation log, the ground based data description document, and two documents which discuss the alignment of laser altimetry and optical navigation (data alignment_lidar.pdf and alignment_stereo.pdf) (See section 6 for details).

4. The AMICA Raw Data

4.1 Data file types and contents

The AMICA data_raw collection contains the following subdirectories:

data/yyyymmdd - The flight images are FITS files and are grouped into daily directories named with the date the images were obtained. The file naming convention is [T]

[C]_[nnnnnnnnn]_[filter].fit, where [T] is the data type (S for scientific and N for navigation), [C] is the name of the instrument (T for AMICA), [nnnnnnnnn] is the mission elapsed time when the images were generated on the digital signal processing unit, and [filter] is the filter identifier.

parameters - Two files listing illumination and geometry parameters for the AMICA images are included here, one with parameters calculated from the Hayabusa LIDAR data, and one with the same parameters calculated from the Itokawa stereophotoclinometry provided by Bob Gaskell. Both sets of parameters were calculated by Olivier S. Barnouin-Jha. Each file contains parameters for a subset of the images.

4.2 Geometry keywords in the image labels

The parameters given in the parameters collection are also given in keywords in the labels of the individual images. Since the stereophotoclinometry-derived parameters are more accurate than the LIDAR-derived parameters, the stereophotoclinometry-derived parameters are used in the labels for those images which have them. The LIDAR-derived parameters are used only for those images which lack stereophotoclinometry-derived parameters. For some images, it was not possible to calculate the parameters, and the geometry keywords don't appear in their labels.

4.3 Known Data Issues

Image time uncertainty - The UT times listed in the FITS headers are end-of-exposure times and have an uncertainty of +/- 12 seconds due to the periodicity of the control and operation of the analog signal processing unit. This uncertainty applies also to the start and stop times listed in the PDS label, which were derived from the end times and exposure times in the FITS header.

Missing image times - Observation times could not be obtained for three images, 20040106/ST_0670995301_b.fit, 20040601/ST_1076261287_b.fit, and 20040526/ST_1059672071_b.fit. The times in the FITS header and PDS label were determined by interpolating between the times of the images taken immediately before and after.

Dual target images - Four images obtained on August 29th 2005 contain both the asteroid 25143 Itokawa and the star Alpha Leonis. These images are ST_2332479491_v.fit, ST_2332498721_wide.fit, ST_2332786728_wide.fit, and ST_2332825189_v.fit.

5. The AMICA Calibration Data

The AMICA calibration collection contains three directories:

The **preflight** directory contains eight flat field images, one for each of the eight filters. They are FITS images with the file naming convention flat_[filter].fit, where [filter] is the filter identifier. The flats for the ul, b, v, x, zs, and wide filters were obtained using an integrating sphere at NEC Toshiba Space Systems Ltd. at room temperature (around 30 degrees C). The flats for the w and p filters were obtained using a portable integrating sphere. For additional information about the pre-flight and in-flight flats see Ishiguro et al. (2010).

The **filters** directory contains the profiles in transmittance vs. wavelength for the seven narrow-band filters. They have a file naming convention [filter].tab. A filter profile for the wide filter was not supplied by the project.

The **ecas_ground_cal** directory includes calibration observations in the Eight Color Asteroid System of the stars observed by the Hayabusa AMICA camera during the cruise phase of that mission. The observations were made in June 2008 by D.J. Tholen. For more information on this data set please refer to AMICA_Ground_Cal.pdf in the document collection.

6. The Hayabusa AMICA Document Collection

The Document collection contains seven documents.

The document you are reading now, the AMICA_Bundle_Overview.pdf describes the contents of the hay.amica bundle.

The AMICA_Instrument_Description.txt describes the AMICA instrument.

The AMICA_References.txt lists all the references for the Hayabusa AMICA bundle.

The AMICA_Observation_Log provides basic information about the individual AMICA observations, along with some comments on target and purpose. This observation log is provided as downloaded from the JAXA Hayabusa Data Archive website in 2008.

The alignment_stereo.pdf document, by Olivier S. Barnouin and Robert Gaskell, shows how well a combination of laser altimetry and optical navigation acquired by the HAYABUSA spacecraft permits determining the approximate trajectory of the Hayabusa spaceraft relative to the asteroid Itokawa.

The alignment_lidar.pdf document, by Olivier Barnouin-Jha, shows how well altimetry acquired by the Hayabusa spacecraft permits determining the approximate trajectory of the Hayabusa spacecraft relative to Itokawa.

The AMICA_Ground_Cal.pdf document contains the data overview and description of the ground based calibration observations done by the Goodricke-Pigott Observatory on the stars observed by the Hayabusa AMICA camera during the cruise phase of the mission.

7. References

Ishiguro, M., R. Nakamura, D.J. Tholen, N. Hirata, H. Demura, E. Nemoto, A.M. Nakamura, Y. Higuchi, A. Sogame, A. Yamamoto, K. Kitazato, Y. Yokota, T. Kubota, T. Hashimoto, and J. Saito, The Hayabusa Spacecraft Asteroid Multi-Band Imaging Camera: AMICA, Icarus (2010), doi: 10.1016/j.icarus.2009.12.035, 2010.