



# Hayabusa Sample Investigator's Guidebook

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**A policy document for curation, handling and allocation of  
Hayabusa samples**

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## **Hayabusa Sample Summary**

Hayabusa is a spacecraft built and launched by the Japanese space agency JAXA to rendezvous with and collect samples from asteroid Itokawa and return them to Earth. Hayabusa encountered asteroid Itokawa in November 2005 and made several attempts at collecting samples in touch and go maneuvers. During one of these attempts the spacecraft unexpectedly lost communication with Earth and crash-landed on the asteroid surface, damaging the spacecraft. Despite this setback, JAXA managed to return Hayabusa safely to the Earth on June 13, 2010.

Although the sampling mechanism did not work, thousands of 10 – 100  $\mu\text{m}$  particles were found in one of the sample containers, apparently introduced during the spacecraft impact into the surface of the asteroid. Many of these particles are shown to be asteroidal grains by their chemistry and mineralogy, but they are mixed with contaminant particles from the spacecraft. Thus, instead of returning several grams of sample, Hayabusa has returned less than a milligram of sample. Nevertheless, these are the first direct samples of an asteroid and their geological context is well established from extensive spacecraft surveys of Itokawa by the Hayabusa spacecraft. These samples therefore have great scientific value.

NASA will receive approximately 10% of the returned sample for its support of the mission. This material will be curated at Johnson Space Center and made available for allocation to the international scientific community through sample requests following guidelines outlined within this document.

### ***State of the Hayabusa Samples***

The asteroidal particles were observed as fine particles dispersed on the interior surface of the Hayabusa sample collector. Initial attempts to remove particles individually by micromanipulators were determined to be ineffective. So far, particles have been removed in two ways: gently swabbing a Teflon spatula along the surface of the collector and by simply tapping the collector and collecting particles that fell out. An unknown number of asteroidal particles remain in the collector.

The methods for storing and transporting the particles are still being worked out. In general, it is likely that small particles ( $<25 \mu\text{m}$ ) will simply be set on clean surfaces and transferred to NASA. Such small particles are tightly bound to surfaces by electrostatic force. Larger particles and conductive samples are more challenging to work with because electrostatic forces are much weaker. However, these are valuable samples, so developing methods to safely store, transport, and manipulate these large grains are a high priority and are currently under development.

Investigators should be aware that many of the particles recovered are contaminants, so some asteroidal particles may be contaminated.

### ***Hayabusa Sample Preparation***

The Curatorial Facility at JSC is responsible for the preparation of Hayabusa samples, within the capabilities of the Curatorial operation. Although a few particles may reach several hundred  $\mu\text{m}$ , most available particles will be on the order of 10  $\mu\text{m}$  or smaller. JSC Curation has extensive experience in the handling and preparation of small particles, including interplanetary dust particles (IDPs) and Stardust Mission samples. However, each laboratory/instrument may have unique sample preparation requirements that go beyond the capabilities or experience of the JSC Curation facility. Investigators are strongly encouraged to consult closely with the JSC curatorial staff regarding their sample preparation requirements before submitting a sample request. The Curator

may in turn refer the Investigator to others in the community having expertise in specific areas of sample preparation.

The most common types of samples made available by JSC curation include whole particles, microtome slices, and potted butts prepared from grains by microtomy.

### ***Hayabusa Sample Allocation***

Hayabusa samples received by NASA from JAXA are the property of the United States Government, are irreplaceable, and are therefore made available to Investigators only under a carefully controlled and monitored program.

The Hayabusa sample curator is responsible for the preservation of the Hayabusa sample collection and for providing appropriate samples to Investigators.

The Curator will allocate Hayabusa samples to Investigators on the advice of the Hayabusa Sample Allocation Committee (HSAC) of the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM). Allocation plans will be approved by the Associate Administrator of the Science Mission Directorate or designee.

Requests for Hayabusa samples will be accepted at any time, in accordance with the information posted on the JSC Curation website <http://curator.jsc.nasa.gov>. Requests will be considered at periodic meetings of the HSAC.

### **Hayabusa Sample Requests**

The Hayabusa samples are a unique and valuable collection, yet constitute less than one thousandth the expected mass of the returned sample. Typical samples allocated to Investigators will be on the order of 10  $\mu\text{m}$  in size. Larger particles, reaching up to 100  $\mu\text{m}$  in diameter, are very rare. Preference will be given to Investigators who have demonstrated capability of analyzing small particles and analyses that do not completely consume samples.

Investigators are strongly encouraged to form consortia in order to maximize the scientific return from each sample. Coordinated analyses are considered to be especially important for studies that will result in damage to or destruction of the samples. The largest particles in the collection and those particles exhibiting unusual or rare properties will be reserved for well qualified consortia.

JSC Curation will perform preliminary examination of a subset of the samples, including obtaining secondary electron images and energy dispersive X-ray spectra. However, owing to limited Curation resources, the samples will not, in general, be extensively characterized prior to allocation. Investigators who receive completely uncharacterized samples should thus be prepared to do pre-analysis characterization of samples allocated to them, and should be prepared for the possibility that allocated samples may not match their expectations. Preference will be given to Investigators who provide commit to reporting pre-analysis characterization to the Curator to support future allocations.

Investigators are also encouraged to make the minimum request that meets the requirements of the proposed measurements. Please ensure that all items called for in Appendix “Checklist for Requestors of Hayabusa Samples for Research” are included in the sample request. Samples lost during shipping (i.e. not found on the sample substrate) may have to be re-requested, at the discretion of the Curator.

Unless explicitly stated otherwise by the Curator, allocated samples must be returned after a period of 1 year. Investigators wishing to extend their sample loan agreement must submit a properly justified request to the Curator. Investigators who have samples beyond the approved return date and who have not requested an extension may be considered delinquent and ineligible for additional sample allocations until their existing samples have been returned.

### ***Sample Analysis Reporting***

All investigators who receive Hayabusa samples are required to report results of their analyses to the Hayabusa Curator within 1 year of sample receipt. This information is critical to future sample analysis planning, and failure to provide this information will result in the loss of future sample allocation eligibility.

### ***Sample Request Submission***

Guidelines and requirements for Hayabusa Allocation requests are described in Appendix A of this document. Sample requests should be submitted electronically in pdf format to the Hayabusa Sample Curator, [michael.e.zolensky@nasa.gov](mailto:michael.e.zolensky@nasa.gov).

### ***Sample Request Review***

Sample requests are reviewed by a subcommittee of CAPTEM, the Hayabusa Sample Allocation Committee (HSAC). In considering allocation requests, HSAC will assess the scientific merit of the proposal, the capability of the proposers, the availability of requested samples, and the realism of the investigation. HSAC will also weigh the overall merit of the request with the required amount of sample and any possible damage that the sample may incur. The subcommittee will consist of approximately five scientists from diverse fields, and will be appointed by the Chair of CAPTEM. The service on HSAC is subject to the procedures established by CAPTEM.

### ***Sample Preparation Priority***

Some types of sample preparation are time-consuming and risky, while others are relatively straightforward. Allocations may not, therefore, be made in the order in which proposals are received. While the HSAC may make recommendations for ordering of sample requests, the decisions for prioritization of sample preparation in order to maximize the number of allocations will be made solely by the Curator. All sample requests supported by the HSAC will be regarded to have equal scientific merit for the purpose of prioritization of allocations.

### ***Alteration of Samples***

Any procedure that is likely to result in a major change in the final state of allocated samples (e.g., subdivision, complete destruction, substantial radiation damage, substantial heating) as compared with that described in the initial sample request must be approved by the HSAC. Such requests should be made in writing to the Hayabusa Sample Curator.

### ***Other Use of Samples***

Samples are provided to Investigators for research purposes only. Requests for samples for display or educational purposes will be considered in the future, but are not currently considered.

## **Hayabusa Sample Security and Accountability**

The Hayabusa samples are the property of the United States government. It is NASA's policy that samples are used only for authorized purposes.

### ***Hayabusa Investigators***

Investigators who wish to analyze Hayabusa samples must become Hayabusa Investigators before receipt of any Hayabusa samples, either from the Curator or from any Investigator. Potential Hayabusa Investigators must make a written commitment to abide by a set of rules, procedures, and restrictions, as outlined below. Investigators make this commitment by signing and returning to the Curator the Hayabusa Sample Loan Agreement. A sample Loan Agreement is shown in Appendix B, and can be downloaded from the web at <http://curator.jsc.nasa.gov/hayabusa/forms/>. The form must be signed and returned by fax or mail to the Hayabusa Curator (Fax: 281-483-5347; Mailing Address: Hayabusa Sample Curator, Mail Code XI2, Johnson Space Center, Houston, TX 77058).

### ***Sample Receipt***

A Sample Assignment form will accompany each sample distributed by the Curator. ***The sample documentation form must be signed and returned by mail upon receipt of the samples.*** A blank copy of this form is included in Appendix C.

### ***Sample Transfer between Investigators***

Sample transfers between approved investigators are permitted in the following situations: (1) samples may be transferred between Hayabusa Investigators without permission of the Curator if this has been pre-approved by CAPTEM, i.e. was part of the original approved sample allocation request. In this case, the PI of the original sample request will maintain responsibility for the sample. (2) If PI to whom the sample will be transferred to will perform a new investigation, a new sample request must be submitted to the HSAC. The sample may be transferred only after approval by the Curator. If approved, both the transmitting and receiving Investigators must complete and return transfer forms by e-mail or fax to the Curator. Blank transfer forms may be downloaded from the web at: <http://curator.jsc.nasa.gov/hayabusa/forms/>. After receipt of the transferred sample, care for the sample becomes the responsibility of the receiving Investigator.

### ***Sample Security***

Hayabusa Investigators are responsible for the security of the samples allocated to them, and will be held accountable in the event that samples are lost, stolen or misused. When analyses require facilities outside of the laboratory of the Investigator, the samples should remain under the supervision by the Investigator or the Investigator's research team. The Investigator should prevent unsupervised access to the samples by anyone not on the research team. However, the Investigator should exercise reasonable judgment in the handling and security of these samples in order to maximize the scientific yield of sample analysis.

### ***Sample Storage***

The full requirements for the storage of Hayabusa samples are given in the Hayabusa Sample Loan Agreement, and are summarized here. Samples should be stored in clean and secure conditions, commensurate with the preciousness of these samples. The sample must be stored in

locked safe or a locked laboratory. They should be stored and handled to prevent cross-contamination with terrestrial and other extraterrestrial samples.

### ***Lost Samples***

In the event that a sample cannot be accounted for, the Investigator must report the loss to the Hayabusa Curator immediately, by completing and faxing or mailing a Sample Loss or Consumption form. This form can be downloaded from the web at: <http://curator.jsc.nasa.gov/hayabusa/forms/>.

### ***Sample Accountability***

Each Hayabusa Investigator is required to maintain records of the use of allocated samples. Samples become the Investigator's responsibility when the Investigator accepts delivery of the samples from NASA. That responsibility ends only when the samples have been returned to NASA or transferred to another Hayabusa Investigator in a manner described in this handbook, and all sample material has been accounted for.

A dedicated laboratory notebook should be used to maintain records of the receipt, transmittal, and treatment of samples, including any intentional or accidental damage, contamination or destruction.

Investigators are required to maintain a complete inventory of samples. Investigators are required to complete, sign and return an inventory to the Curator annually. Investigators are reminded that their records and inventory may be audited by the US Government at any time. Such audits have occurred under the Apollo Lunar Sample Program and the Stardust Program.

### ***Destruction During Analysis***

Many types of analysis are destructive to small samples. If, in the course of analysis or handling, samples are destroyed, whether intentionally or unintentionally, a Sample Loss or Consumption form indicating this fact should be completed and returned by fax or mail to the Curator. Blank forms may be downloaded from the web at: <http://curator.jsc.nasa.gov/hayabusa/forms/>. No form is needed in the event of intentional or accidental damage or contamination, but details should be documented in the Investigator's Hayabusa sample notebook.

### ***Division of Samples***

In the event that Investigators subdivide samples, the Curator will assign new identification numbers. The PI shall not preempt the Curator, and assign new numbers independently. The Curator should be contacted for new assignments as soon as possible after the subdivision. Subdivisions should be documented by faxing or mailing a Request for New Sample Numbers form. Blank forms may be downloaded from <http://curator.jsc.nasa.gov/hayabusa/forms/>. The Investigator will then be assigned responsibility for the new subsamples.

### ***Sample Transfer Methods***

These guidelines apply to transfers from the Curator to Hayabusa Investigators, from Hayabusa Investigators to the Curator, and to transfers between Hayabusa Investigators.

Samples can be sent by an overnight package delivery service that allows packages to be tracked online (e.g., FedEx, DHL). Before shipment, the sender and the recipient must agree on a date on

which the recipient or the recipient's designee can receive the allocation. Only persons authorized by the Investigator may receive and open the package. The authorized official shall record the receipt of the samples promptly.

The value of the shipment must be recorded on the shipping form as "zero". To preclude inadvertent opening by mailroom employees, place inside the box a prominent message "MAIL ROOM EMPLOYEES: THIS PACKAGE CONTAINS MATERIALS TO BE OPENED ONLY IN A CLEAN ENVIRONMENT". Samples should be sealed in at least two layers of packaging so that exterior packaging can be removed prior to clean environment entry.

Samples may also be carried by hand from and to JSC. If samples are hand-carried by air, an accompanying letter from NASA should be carried with the samples indicating the scientific value of the samples and cautioning airport security personnel against opening or touching the samples. The samples should not be put in checked luggage.

## Appendix A: Sample Request Guidelines

Requests for research samples from the NASA Hayabusa sample collection are carefully reviewed by the Hayabusa Sample Allocation Committee (HSAC), a subcommittee of the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM). Sample requests are considered independently of the status of research proposals that have been submitted or funded for the analysis of Hayabusa samples. Therefore, each Hayabusa sample request must be as informative and well justified as possible.

The sample request consists of a letter or e-mail from the Principal Investigator (PI) who will be responsible for the loan of any Hayabusa samples. The request letter will contain the following:

1. A clear description of the **scientific goals** and objectives of the proposed work and how the new analyses or tests will improve upon or complement previous work.
2. A clear description of the **measurements to be made**. For example, specify whether 'probe' analyses are electron-, ion-, proton-, or other microbeam method. Identify which Co-I and facility will perform each analysis. The request must demonstrate that the proposed measurements can be made with the requisite sensitivity and accuracy to achieve the scientific objectives, ideally by previous analyses of similarly prepared samples or analogs.
3. **For new investigators or new techniques**, the following should be provided:
  - a. PI/Co-I team's previous relevant experience and publications on Hayabusa samples or a closely related subject.
  - b. Demonstrate the feasibility of the analysis (sensitivity, precision, and accuracy) by similar measurements of appropriate analog samples
4. Explanation of **time constraints** (such as schedules for instrument time).
5. **Sample requirements**
  - a. Composition and size of sample necessary for the proposed investigation. If samples matching these requirements are not available, the request may be denied.
  - b. Form of samples: microtomed sections, individual grains, potted butts. Special sample preparation procedures may be requested, but may not be possible owing to time or resource constraints.
  - c. Mounting requirements (type of TEM grid or substrate). Special sample substrates and special sample containers must be provided by the requestor.
  - d. Specific sample numbers (if known). Samples may be given unofficial designations by individual PIs that differ from the official designations assigned by the Hayabusa Sample Curator. The Curator must be able to unambiguously identify the sample.
  - e. Specify whether returned (previously studied) Hayabusa samples are acceptable.
6. List of **Hayabusa samples already in the possession of the PI**.

Please refer any questions about Hayabusa sample requests as follows:

Michael Zolensky (Michael.e.zolensky@nasa.gov)  
Hayabusa Sample Curator, Mail Code XI2  
NASA Lyndon B. Johnson Space Center 2101 NASA Parkway Houston, TX 77058-3696

## Appendix B: Hayabusa Sample Loan Agreement

The Johnson Space Center of the National Aeronautics and Space Administration, a Federal Agency, hereinafter referred to as JSC, desires to enter into a Loan Agreement and to make certain material available to «**institution**», hereinafter referred to as the INSTITUTION. The INSTITUTION proposes to use said material to undertake, at its own direction, scientific investigations proposed to the Hayabusa Allocation Subcommittee of the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM).

The use of the material by the INSTITUTION will permit beneficial contact between representatives of JSC and the INSTITUTION to provide opportunities for discovery and dissemination of information concerning the Hayabusa samples, promote maximum utilization of material by JSC and provide opportunities for dissemination of information concerning the activities of the National Aeronautics and Space Administration.

It therefore is agreed as follows:

1. The samples (hereinafter referred to as the PROPERTY) made subject to this agreement will be assigned to [INSTITUTION] on Hayabusa Sample Assignment Forms signed by the JSC Hayabusa Curator and the Investigator of [INSTITUTION NAME].
2. The PROPERTY is the property of the United States Government, is considered irreplaceable, and is therefore made available to users only under a carefully controlled and monitored program. It is therefore essential that rigorous security and accountability procedures be followed by all persons who have access to the PROPERTY. The Investigator will be responsible for the receipt, use (including security during use), accountability, and return of the PROPERTY at the end of the designated time. The INSTITUTION will agree to strictly adhere to the following procedures for the security of the PROPERTY:
  - a. Only persons authorized by the Investigator may receive and open the package. The authorized official shall record all of the PROPERTY promptly upon receipt, and it shall be so identified so long as it remains in the custody, possession, or control of the INSTITUTION.
  - b. Verification of sample transfers by electronic media shall be from persons authorized by the Investigator using institutional computer accounts secured with password protection under the exclusive control of the authorized person.
  - c. During use the PROPERTY must be under the control of the Investigator. At the end of each use of the PROPERTY, an inventory shall be made to insure the accountability of the PROPERTY. Such inventories shall be maintained as a permanent record and shall be made accessible to NASA at all reasonable times.
  - d. When not in use, the PROPERTY must be locked in a safe or secure storage cabinet equipped with a combination padlock, or, if a controlled environment is required, in a locked laboratory.
  - e. Combination to the storage safe or cabinet will be under the exclusive control of authorized officials.

- f. Report immediately the loss or damage of the PROPERTY to the Hayabusa Curator, Johnson Space Center, Houston, Texas 77058, telephone (281) 483-5128, michael.e.zolensky@nasa.gov.
  - g. Transfer of samples among collaborators is allowed if each collaborator has submitted a signed Hayabusa Sample User Agreement to the Hayabusa Curator. Upon receipt of the sample, the receiving collaborator becomes responsible for the sample. The Hayabusa Curator should be notified of samples transferred to collaborators.
  - h. The PROPERTY shall be either hand-carried by the INSTITUTION's authorized official or mailed via FedEx or equivalent responsible, real-time tracking courier. The JSC reserves the right at the INSTITUTION's expense, to direct the mode of transportation for the PROPERTY. Shipping of samples among collaborators shall be carefully tracked and consists of 3 steps: 1) verify recipient is available to receive package on arrival date, 2) recipient immediately acknowledges receipt, and 3) sender inquires about package receipt if recipient does not respond by day after expected arrival.
3. NOTWITHSTANDING any other provision of this agreement, the INSTITUTION shall not be liable for loss of or damage to the PROPERTY, or for the expenses incidental to such loss or damage, except that the INSTITUTION shall be responsible for any such loss or damage (including expenses incidental thereto):
  - a. which results from willful misconduct or lack of good faith on the part of the INSTITUTION's directors or officers, or on the part of any of its managers, superintendents or any other equivalent representatives, who have supervision or direction of all or substantially all of the INSTITUTION's business; or
  - b. which results from a failure on the part of the INSTITUTION due to the willful misconduct or lack of good faith on the part of any of its directors, officers, or other representatives mentioned in (a) above (i) to maintain and administer, in accordance with the provisions of this agreement, the program for delivery, protection, and preservation of Government property, or (ii) to take all reasonable steps to comply with any written directions from JSC with respect to the delivery, protection, and preservation of Government property. HOWEVER, loss or damage to the PROPERTY caused by failure to follow proper safeguarding standards as set forth in this agreement will be considered in selecting participants in future agreements.
4. Title to the PROPERTY shall remain with NASA and shall not be affected by the incorporation, attachment, or mixture thereof to or with property not owned by NASA.
5. To the extent permitted under the law of the State of «state», the INSTITUTION shall be liable for all claims, demands, actions, costs, and charges made, asserted, or incurred by reason of any injury to any person or property, or loss of life or property, suffered or sustained during the period of the use and enjoyment when the injury, loss of life, or property damage is caused by any act or omission of any agent or employee of the INSTITUTION.

6. This agreement shall become effective upon the date of the last signature hereto and will remain in effect for four years.

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**Signature of Investigator**      **Date**

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**Signature of Curator**      **Date**

## Appendix C: Hayabusa Sample Documentation Form

Date:

CO:

Event:                   \_\_Transmittal   \_\_Receipt   \_\_Loss or Destruction   \_\_Subdivision

JSC Tracking Number:	Hayabusa Sample Description
Transfer from:  _____	Processor:
Date:	
Transfer to:	Receipt signature:

PLEASE RETURN THIS FORM TO:

HAYABUSA SAMPLE CURATOR  
MAIL CODE XI2  
NASA JOHNSON SPACE CENTER  
2101 NASA PARKWAY  
HOUSTON, TX 77058