

# **Herschel Data Products and Tools Contributor's Guide**

**Herschel Science Centre**

**HERSCHEL-HSC-DOC-1405  
4 December 2009**

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by Herschel Science Centre

Published issue 1.0, 4 December 2009

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# Chapter 1. Introduction

## 1.1. Objectives and purpose

This purpose of this document is to inform the Herschel Space Observatory users of the possibilities, procedures and rules to provide user reduced data products, catalogues and data reduction software tools to the Herschel Science Centre, with the aim to make them available to the general astronomical community.

The Herschel Science Centre provides, through the [Herschel Science Archive \(HSA\)](#), level-0 to level-2 products that are generated systematically with the Standard Product Generation software (SPG) (see the [HSC Data Products pages](#) for an overview). Interactive data reduction by Herschel observers, especially after level-1, will definitely increase the scientific quality of level-2 products, through the improvement of algorithms, detailed analysis and the tuning of methods to the particularities of the observational data. The final scientific products of the observational programmes, like maps or catalogues, will be produced by Herschel observers and will undoubtedly constitute a major element of the Legacy of the mission. By making these products available through the Herschel Science Centre, observers will facilitate their access to the astronomical community at large and will make them easily retrievable by multi archive environments like the Virtual Observatory.

In addition to products, data reduction software tools developed by the observers are welcome as valuable contributions to the observatory and its users, since they are regarded as a source of processing knowledge and expertise that will clearly have a positive impact on the mission scientific outcome.

## 1.2. Contributors

### 1.2.1. Key Programmes Observers

Observers who have been awarded observation time through a Key Programme Announcement of Opportunity followed in their proposals the guidelines specified in the [Policies and Procedures](#) document for the KP AO. In particular, this document states:

*"Consortia proposing for Herschel observing time on the occasion of this AO need to demonstrate ability and commitment to perform data reduction and make products (at a 'publishable' level of quality) and related tools publicly available through the HSC at the end of the proprietary period.*

*Besides fulfilling their scientific goals, Key Programme consortia must provide data products which will:*

- i. *allow for early science exploitation by the community, based on the data products themselves;*
- ii. *provide the community with information usable as the basis of follow-up proposals for Herschel observing time during the mission.*

*The Key Programme consortia are also required to share the methods employed to generate the data products provided to the HSC. It is possible that these methods could be incorporated into or adapted for use in the standard HSC data processing software for public release."*

Consequently, in order to enable follow up observations to be proposed by the astronomical community, each KP consortium included in their proposal a description of the data products and methods that they planned to provide at the end of the proprietary period. The approval of the proposal by HOTAC and the allocation of observing time implicitly assume the fulfilment by the KP consortia of the committed deliveries.

Note that, unless otherwise stipulated in their respective proposal, KP observers are not required to share their software code. However, the Herschel Science Centre welcomes its delivery following the instructions given in this document.

## 1.2.2. Regular Programme Observers

Observers who have been awarded observation time through a Regular Programme Announcement of Opportunity are encouraged to contribute, on voluntary basis, with highly processed data products and software tools to the Observatory, and to make use of the HSC facilities to widespread their results to the astronomical community. Contributed products shall be supported by the corresponding paper in a refereed publication. Deliveries should follow the guidelines and procedures specified in this document.

## 1.3. Proprietary period

### 1.3.1. Key Programmes

The specification of the Proprietary period for the Herschel observations is given in the Herschel Space Observatory Science Management Plan and reflected in the KP AO Policies and Procedures document. That is:

*"All observations made in the first year of the routine phase will have proprietary times of 12 months, while for all observations made later, the proprietary time will be 6 months, with a simple 'bridging scheme' so that no observation will become public before observations that were executed earlier become public as well. The proprietary time applies to each observation individually, counted from the day when the data are made available to the initial data owner. However, a scheme will be put in place whereby the Herschel Project Scientist and the HOTAC Chair in consultation can grant additional proprietary time to certain large programmes, in order to prevent the release of improperly or inhomogeneously calibrated or processed data. Note that data resulting from routine calibration observations will generally enter the public domain immediately after they are processed unless duplicating a science observation."*

Following these conditions, the Principal Investigator of each proposal will receive timely notification from the HSC/NHSC when the Key Programme data products and methods need to be made available to the community.

### 1.3.2. Regular Programmes

The proprietary period for regular programmes is specified in the Herschel Space Observatory Science Management Plan, and will be reflected in the corresponding AO documentation when issued.

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# Chapter 2. Data products contribution

## 2.1. Types of data products

Herschel data products are classified based on their processing level (from raw data to highly processed) and their contents. For an overview see the [HSC Data Products pages](#) and for a more detailed description please refer to the Products Definition Document. Generally, it is expected that contributed products will be advanced processed data of the following type:

- Highly processed level-2 products
- Level-3 products, per AOR or combination of AORs (e.g., large maps, spectral surveys)
- Catalogues (e.g., astronomical sources catalogues, spectral line lists)
- Ancillary data (e.g., model SEDs, reference spectral line lists)

## 2.2. How to make products available at the HSC

### 2.2.1. Product delivery

Highly processed data products can be made available to the HSC by:

1. Providing the URL(s) of the Web site where the products are located (e.g., Key Programme site). The URL will be included in the Herschel Science Centre public Web pages, and will be associated with the corresponding proposal and observations in the HSA.
2. Providing the URL(s) of the Astronomy Web sites where the products are accessible (e.g., CDS for catalogues). The URL will be included in the KP section of the Herschel Science Centre public Web pages, and will be associated with the corresponding proposal and observations in the HSA.
3. Submitting the data files for ingestion in the Herschel Science Archive as "Highly Processed Data Products", so that they are integrated in the HSA facilities and become part of the Virtual Observatory. For users who choose this option, the HSA provides:
  - Integration of the delivered highly processed data products in the HSA, through links to the stored observations, so that they are retrievable as a result of archive queries.
  - Querying, access and retrieval of catalogues through dedicated specific GUIs.
  - Access and retrieval of documentation associated with the delivered products or catalogues.
  - Access and retrieval of ancillary data associated with the delivered products or catalogues (e.g., models).
  - Links to publications in the NASA ADS

**Note**

The infrastructure for ingestion, query and retrieval of Highly Processed Data Products in the HSA is not expected to be available until 2011.

These product delivery options are not exclusive and more than one may be selected. Starting 2011 we recommend to embrace option 3 and make highly processed data products available through the HSA.

## 2.2.2. Accompanying product information

Contributed products must be accompanied by the following information:

1. Proposal Identification (as provided by HSpot and in the product metadata keyword "proposal")
2. List of products contained in the delivery
3. For delivery options 1 and 2, URL of the Web pages where the products are located
4. Refereed paper(s) reference (this is only required for products to be ingested in the HSA)
5. Each product shall be identified as follows:
  - a. Name of the product
  - b. Description of the product contents
  - c. Description of the product format
  - d. Observation identifiers ("obsid" values) of the observations that have been used to create the product
6. For KP associated products, a brief description of the algorithms, methods and processing steps involved in the creation of the product (please see section 2.3).

## 2.2.3. Methods used in product generation

Methods used in the generation of the scientific products shall be described indicating:

1. If SPG products have been used, the SPG version and the maximum SPG level from which the interactive/user analysis has started (see [HSC Data Products pages](#)) Example: SPG v1.0, level-1.
2. A detailed description of the data reduction steps carried out on top of the standard product to generate the final product.
  - For data reduced in the Herschel Interactive Processing Environment (HIPE), the HIPE version number must be provided, and a description of the user input for each step.
  - For steps that do not involve official HIPE routines, observers should provide a detailed description of the algorithms used. As stated in the [KP Policies and Procedures](#) document, the HSC may decide to include or implement these methods in the standard HSC data processing software for public release.

## 2.2.4. Contacting the Herschel Science Centre

Observatory users should contact the Herschel Science Centre Helpdesk (<http://herschel.esac.esa.int/esupport/>) to notify of the availability of products, methods, and of the delivery option selected. In response, the HSC Helpdesk will provide detailed instructions on how to proceed.

## 2.3. Format of products submitted to the HSA

The format of products that are submitted to the Herschel Science Centre for ingestion in the Herschel Science Archive should conform to the following specifications:

1. Products shall be provided as FITS files. The structure and keyword definition shall conform to the FITS standard as defined by the NOST v2.0 standard.
2. The product metadata must contain, at least, the compulsory keywords listed in Table 2.1.

**Table 2.1. Contributed products compulsory metadata**

FITS keyword	Type	Description	Herschel DP keyword name	Notes
DATE	String	Date of product creation	creationDate	
CREATOR	String	The name of the software that created the product	creator	
DESC	String	Full name of product	description	
OBSERVER	String	Name of observer	observer	As given in SPG products
PROPOSAL	String	Proposal name	proposal	As given in SPG products
TYPE	String	Product type identification	type	It should be equal to "User Contribution"
OBSID	Long integer	Observation identification	obsid	Mandatory metadata only for products associated with an individual observation

To ensure consistency with HIPE and to maximise commonality, we encourage observers to deliver their products following the standard Herschel product definitions. In particular, we advise to implement:

- Metadata keywords as listed in Appendix A of the Herschel Products Definitions Document.
- Images following the structure of the SimpleImage Product (see section 2.4.4 of the Herschel Products Definitions Document)
- Image cubes following the structure of the SimpleCube Product (see section 2.4.4 of the Herschel Products Definitions Document)
- Spectral cubes following the structure of the SpectralSimpleCube Product (see section 2.4.4 of the Herschel Products Definitions Document)
- Spectra following the structure of the Spectrum1d or Spectrum2d datasets as appropriate (see section 2.4.3 of the Herschel Products Definitions Document)
- Spectral line list catalogues following the definition as given in section 6.3.1 of the Herschel Products Definitions Document (Part I)
- Source list catalogues following the definition as given in section 6.3.2 of the Herschel Products Definitions Document (Part I)

#### Caution

Users need to be aware that, as a result of the Performance Verification and Science Demonstration phases activities, these basic product definitions may undergo modifications to further optimise the representation and handling of Herschel data. Afterwards it is expected that the definitions will remain stable.

## 2.4. Redelivery of products

As time advances in the mission, our knowledge of the satellite and instrument behaviour will increase, and this will be reflected in improvements of the data processing software and calibration. Products



generated automatically by the HSC with the SPG will be continuously reprocessed to reflect the most up to date knowledge. However, automatic updates cannot be applied to user contributed products, which will be frozen at the time of their delivery to the HSC. The impact will be more significant in user contributed products that have been provided earlier in the mission, as will be the case for some KP deliveries. For the benefit of the mission's legacy, the HSC welcomes that observers include in their plans the re-processing with upgraded versions of data reduction software and calibration of their contributed products, and their re-delivery to the HSC at a late stage in the mission.

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# Chapter 3. Tools Contribution

Observers may share their scripts and tools, implemented in Jython or Java, with other observatory users. This can be done in two ways:

1. By delivery of the tools/routines to the Herschel Science Centre so that other users can download them from the HSC web pages. For more information please refer to the guidelines provided in the following sections and to the *HIPE contributor's guide* (in preparation).
2. By providing the URL where the tools can be retrieved from.

Submitted tools must be accompanied by documentation that describes their purpose and algorithms, and how to install and use them.

## 3.1. Jython scripts

Contributing single Jython scripts, or collections of related scripts, is the simplest way to share code with the community. Such scripts are intended to be run from the *Editor* view of HIPE, much like routines from the IDL Astronomy User's Library are run from the IDL environment.

## 3.2. Jython or Java plugins

With *plugin* we denote any external component that can be integrated into HIPE. This can be a *task* (a special type of function, usually for data processing), a *view* (a window within HIPE, such as the *Editor* view) or a *perspective* (a set of windows within HIPE).

Such plugins should be contributed as JAR (Java ARchive) files. Users would install the plugins manually by listing the corresponding JAR files in the CLASSPATH environment variable (a list of places where Java looks for code). This would allow HIPE to "pick up" the plugins.

At the moment there is no mechanism to install, update or uninstall user-contributed plugins from HIPE. If interest in external plugins is sufficiently strong, it may be worth to invest effort into developing some sort of integrated plugin mechanism.

As already mentioned, *tasks* are a type of plugin especially suited to contributing data processing routines. A task, which can be written in Jython or Java, follows a predefined common template to specify input and output parameters and check for their consistency. Additionally, HIPE automatically provides a default parameter dialogue window and an association with selectable products. Contributed routines implemented as tasks will be visible in HIPE within the *Task* view.

A detailed description of how to develop Jython-based tasks is given in chapter 4 of the *Scripting and Data Mining* guide (for HIPE versions prior to 2.0 the same is found in chapter 8 of the *Advanced User's Manual*).

## 3.3. Delivery

Observers who intend to share their tools with the community should inform the HSC/NHSC Helpdesk accordingly. In this initial phase, HIPE contributed tools will be made available through a Web repository.

The delivery should include documentation containing:

- Name of author or authors, affiliation, email
- Associated Herschel proposal identifier
- List of HIPE versions with which the module is compatible

- Purpose of the module(s)
- Description of the algorithms
- Short user's manual
- Observation identifiers of the data for which the modules have been developed, if applicable
- Description of the Highly Processed Data Products derived with the modules, if applicable

## **3.4. Maintenance**

The responsibility to maintain and update the contributed tools lays on the contributors. The Herschel Science Centre will provide no support for problems with these tools, or for problems arising in HIPE because of these tools. Users will download and install the tools at their own risk. This disclaimer will be clearly stated on any download page provided by the Herschel Science Centre.

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# Appendix A. Acronyms

AO	Announcement of Opportunity
AOR	Astronomical Observation Request
CVS	Concurrent Version System
DP	Data Processing
GUI	Graphical User Interface
HIPE	Herschel Interactive Processing Environment
HOTAC	Herschel Observing Time Allocation Committee
HSA	Herschel Science Archive
HSC	Herschel Science Centre
KP	Key Programmes
NHSC	NASA Herschel Science Center
PI	Principal Investigator
SED	Spectral Energy Distribution
VO	Virtual Observatory