



# The Herschel Data Processing System: History, Status and latest Developments

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# Outline



- History
- Scope and Methodology of Herschel Data Processing
- Aspects of Herschel Data Processing
- Status and Plans
- Summary



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# History of Herschel Data Processing



# Herschel Data Processing History (1)

- When ESA's Science Programme Committee approved the Science Management Plan in 1997 it was considered sufficient to provide astronomers with raw data and software tools to carry out the data processing, and no 'data products' were to be generated and delivered. The strategy adopted was to offer the means for the individual observer to generate any desired product him/herself.
- This also meant that the Herschel archive was not to be populated (except for with raw data) until in the post-operations phase, severely restricting the usefulness of Herschel data for the wider community during the Herschel mission.

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# Herschel Data Processing History (2)

- **2002: Development of the common Herschel Data Processing framework started to support the data analysis for Instrument Level Tests**
- **At the same time it was realised that expectations of the astronomical community on what to expect from observatories and their data processing systems, data products, and archives have evolved; what was once considered acceptable is no longer considered palatable**
- **2004: Management gave the final go-ahead to continue with the development of the common Herschel Data Processing framework**

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# Herschel Data Processing History (3)

- **2005:** ESA's Science Programme Committee approved additional funding for an "extended Data Processing" development, recognising that Herschel must offer its users, the astronomical community, comprehensive means, beyond observing opportunities, to do science. This permitted to award contracts to the Instrument Control Centres and to hire developers for the Herschel Science Centre to work on software for data products, algorithms, pipeline and observers' framework and support
- **2006:** Recruitment of HSC staff and negotiations with ICCs started
- **2007:** Contracts with ICCs were signed
- – **Summer 2007:** Development focussed to meet instrument experts' needs
- **Summer 2007 – :** Development started to address end-users' needs
- **Summer 2008:** First set of deliveries from ICCs received

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**Scope and  
Methodology of  
Herschel Data  
Processing**

# Management and development methodology (1)



- Herschel Science Centre (ESA), the Instrument Control Centres (HIFI, PACS and SPIRE) and NHSC jointly manage and contribute to the Herschel Data Processing system



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# Management and development methodology (1)



- **Herschel Science Centre (ESA), the Instrument Control Centres (HIFI, PACS and SPIRE) and NHSC jointly manage and contribute to the Herschel Data Processing system**
- **Very distributed development – we work 24/5 (and often 24/7) on Herschel Data processing development**

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# Management and development methodology (2)



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## Development of the Herschel Data Processing System is a significant effort

- HSC, ICCs and NHSC nominally contribute to the Herschel Data Processing framework
  - HIFI 1.0 f.t.e for coding efforts
  - HSC 6.5 f.t.e for coding efforts
  - NHSC 1.5 f.t.e for coding efforts
  - PACS 1.0 f.t.e. for coding efforts
  - SPIRE 1.0 f.t.e. for coding efforts
- Additionally, ICCs provide algorithms to remove instrumental and satellite effects and tools to calibrate data
- Additionally, ESA funds ICCs 3\*10 staff years to provide user friendly functionality (advanced data processing algorithms and interactive tools)



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# Management and development methodology (3)



## Current main responsibilities for Data Processing Framework

- **HIFI**  
documentation framework; spectrum and line list dataset/product; dataflow
- **HSC**  
GUI framework (HIPE, JIDE); pipeline and quality control framework; low level I/O, dataset/product infrastructure; generation of DP-ALL, including installer and updater framework
- **NHSC**  
numerics, tableplotter
- **PACS**  
display; contour plotting, history; image, cube, stack and point source dataset/product; explorer infrastructure and default plug ins; binstruct
- **SPIRE**  
plot; product access layer; access

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# Management and development methodology (4)



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- The Data Processing system is part of Herschel Common Science System, and therefore coded in Java/Jython for platform independence
- Java with scripting/prototyping in Jython gives full Java power to developers and expert users while maintaining user friendliness via GUIs and abbreviated Jython commands
- The general astronomical community that is using the system only occasionally is shielded from the object oriented nature of Java and Jython by the GUI based / data driven data access
- Legacy programs or VO services can be called using VO protocols



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# Management and development methodology (5)




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- All tools for data reduction and analysis, e.g. also the “Instrument Calibration” and “Trend Analysis” systems are part of the general Data Processing system
- The pipeline system that automatically generates the data products is a subset of the Interactive Analysis system
- The system is extensively used by instrument specialists during instrument development and testing
- The Data Processing software will be distributed as source code, and users can write and contribute their own routines



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**(Some) Software  
Aspects of Herschel  
Data Processing**

# Scope of Herschel Data Processing (1)



**Data Processing (DP) = Herschel Interactive Processing Environment (HIPE) + Standard Product Generation (SPG) + Quality Control Processing (QCP) + supporting tools**

- **Integrated, easy to use, license free, well tested and documented Data Processing system available free of charge to the astronomical community**
- **Basic functionality must be available off-line**
- **Tools to remove instrumental and satellite effects from Herschel Data (generation of basic level 1 products)**
- **Capability to further process basic products to a higher level so that scientific analysis can be performed (generation of advanced level 2 products)**
- **Higher level products must be VO compliant**

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# Scope of Herschel Data Processing (2)



**Data Processing (DP) = Herschel Interactive Processing Environment (HIPE) + Standard Product Generation (SPG) + Quality Control Processing (QCP) + supporting tools**

- **Systematic pipeline processing, quality control and distribution of all generated data**
- **Pipelines are scripted HIPE tasks that are executed on the ESAC grid**
  - **User can choose most suitable pipeline and adjust parameters for on-demand reprocessing**
  - **Pipelines can also be run interactively at users' computer**
- **Tools for support of operations (calibration, trend analysis, instrument monitoring)**
- **Tools to enable astronomers to perform Herschel specific science**
- **Export to FITS for ingesting in other Data Processing systems**

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# Scope of Herschel Data Processing (3)



**Data Processing (DP) = Herschel Interactive Processing Environment (HIPE) + Standard Product Generation (SPG) + Quality Control Processing (QCP) + supporting tools**

- **HIPE is connected to the Herschel Science Archive, and data can be retrieved directly into an Interactive Analysis Session**
- **The Product Access Layer (PAL) provides an implementation-independent interface for astronomers, calibration scientists and developers alike to read, query, write and save Products to persistent storage locations**
- **HIPE provides access to VO-aware tools that can be used in combination with Herschel data**

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**Latest  
Developments,  
Plans (and some  
words of caution)**

# Words of caution first ...



- **As expected for a pre-launch version, the system contains some quirks. Old hands will be used to these, while they are rather confusing to new users. Your feedback on such issue is most welcome!**
- **While very advanced in view of the project life cycle, the Herschel Data Processing system is in beta state, and will remain so until we have seen first light**
- **Following in-flight experience the Data Processing system might undergo major revision. Be prepared to change your programs and scripts during the first year(s) of the mission**
- **Only limited manpower is available. Usually we have an oversubscription factor of three for wishes to be implemented**
- **We are depending on third party libraries like Java, Jython or Macrovision. Therefore we are not in complete control of the timescale for implementation of new features, or the resolution of problems**

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# Achievements in Version 0.6.7 (Framework)



- Implementation of history
- HSA pool can now deal with directory structure from archive tar files
- HIPE includes line-by-line execution mode; products can be saved through the pop-up menu
- Plots can be saved as PDF files
- Reduction in memory footprint needed by installer
- Images have now North up by default
- Change of pointing product following SOVT-2 experience
- Tasks have tooltips texts
- Updates to documentation

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# Achievements in Version 0.6.7 (HIFI)



- Front-end for pipeline interactions in HIPE generally updated to allow for working from an observation context to provide
  - selection of spectrometer backend
  - selection of level of processing to be done
- more quality information (products) now produced
- Updates following experience of end-to-end tests, acceptance tests, SOVT-1 and 2
- Updates to documentation

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# Achievements in Version 0.6.7 (PACS)



- 7 new pipeline tasks for chop/nod branch
- prototype for wavelength switching branch
- logical observing block selection is complete
- Updates following experience of end-to-end tests, acceptance tests, SOVT-1 and 2
- Updates to documentation

# Achievements in Version 0.6.7 (SPIRE)



- added the PCAL reduction pipeline
- almost all actual pipeline Tasks are now available as HIPE tasks
- Implementation of the quality control flags
- Updates following experience of end-to-end tests, acceptance tests, SOVT-1 and 2
- Updates to documentation

# Achievements since December Workshop (general and framework for Version 1.0)



- Execution of SOVT-2, and SIMS-1 and -2 campaigns
- Roll-out of new build system
- Vista support; system currently undergoes acceptance testing
- Rollout of user friendly property system framework
- Improvements of definition of high-level products quality control products, quality control flags and reports
- Implementation of on-demand processing and bulk reprocessing modes; access to ESAC grid nodes
- Improvements of instrument pipelines and calibration
- Improvements of advanced pipeline algorithms and interactive tools
- Updates to documentation

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# Currently ongoing major activities



- Preparation for SIMS-3 and commissioning/performance verification phase
- Finalisation of system clean-up, including reduction of memory requirements to install the system
- Finalisation of sliced datasets
- Finalisation of user friendly property system
- Refinement of definition of quality control products, quality control flags and reports
- Refinement of instrument pipelines and calibration
- Development of advanced pipeline algorithms and interactive tools
- Increasing the user friendliness
- Updates to documentation

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# Plans



- **April 2009: Delivery of post-workshop HCSS 0.6.7**
- **April 2009: Launch of Herschel**
- **Launch + ~6+ months: HIPE V2.0 will be made available. Future versions will be provided in regular intervals**
- **Launch + ~7 months: Planning scope and schedule of extended data processing efforts for following two years**
- **Launch + ~8+ months: Workshops in ESAC and NHSC to brief community about updated pipelines and any calibration/data reduction issues after in-flight experience**

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A dense field of galaxies in various colors and orientations against a black background. The galaxies are scattered across the frame, with some appearing as bright, distinct shapes and others as faint, diffuse clouds. The colors range from bright yellow and orange to deep blue and purple, suggesting a variety of stellar populations and redshifts. The overall appearance is that of a rich, multi-colored galaxy cluster or a deep-field survey of the universe.

# Summary

**(some questions first)**

# Questions



- Would you like to receive Version 1.0, 1.1 and 1.2 of HIPE?
- What level of details do you expect to see in the release notes?
- What is the status of your plans to contribute to HIPE?

Please put your answers into the feedback questionnaire

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# Summary



- **Herschel Data Processing system supported data analysis by the Instrument Teams for Instrument Level Tests**
- **Herschel Data Processing system supported the first and second System Operational Verification Test**
- **Herschel Data Processing system supported the first and second simulation campaign and is ready to support the third**
- **For a mission ~ 1 month before launch, the Herschel Data Processing system is in a well advanced state, containing an impressive suite of functionality and documentation**

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