HIFI Post Operations

F.P. Helmich & R.F. Shipman

ICC/2011-010

Abstract
This document describes the plans and work packages for HIFI ICC during the Post Operations phase of Herschel.

Document: ICC/2011-010
1.0 of 30/09/12
39 pages

Document approval

Prepared by:	Russell Shipman	20 June, 2011
Checked by:		
Authorized by:		

Distribution

ESA:

J. Riedinger	ESTEC
G. Pilbratt	
L. Metcalfe	
A. Marston	

HIFI steering committee

F.P. Helmich	SRON
J. Stutzki	
E. Caux	
T. Phillips	

HIFI project:

P.R. Roelfsema	SRON
ICC Core	

SRON

H. van der Linden
D. Kester

Revision history

Version	Date	Changes	Author
DRAFT 0.1	06/25/11	First version	F.P. Helmich
DRAFT0.16	26/08/11	Updates to focus on activities and deliverables.	RFS
DRAFT0.17	03/10/11	Introduce Motivation section	RFS
DRAFT0.18	29/11/11	High level objectives in line with HSC and other ICCS added	RFS
DRAFT0.2	03/02/12	Added draft work packages	RFS
DRAFT0.21	07/02/12	Updated draft work packages	RFS
DRAFT0.30	08/02/12	Updated work packages	RFS/Helmich
DRAFT0.40	21/02/12	Updated work packages	RFS
DRAFT0.41	22/02/12	Fixed Table of Contents	RFS
DRAFT0.50	16/03/12	Incorporated comments and introduced effort estimates	RFS
DRAFT0.51	10/04/12	Updated based on initial Co-location comments	RFS
DRAFT0.6	13/04/12	WP description refinements with inputs from all leads	RFS
DRAFT0.61	04/05/12	Minor updates	RFS
DRAFT0.7	06/08/12	WP updates	RFS
DRAFT0.8	21/08/12	Incorporated HSC comments	RFS
DRAFT0.9	21/09/12	Added staffing profile	RFS
DRAFT0.91	30/09/12	Updated Effort numbers	RFS
DRAFT0.99	12/10/12	Final version before release 1	RFS
Version 1.0	12/10/12	Release of Version 1.0	RFS
1.01	01/11/12	Minor updates	RFS

Applicable documents

Doc. ref.	Title
ICC-1998-001	HIFI Science Implementation Plan

Reference Documents

Doc. ref.	Title
Herschel-HSC-DOC-1987 Issue 1 rev.0	Herschel Science Centre Post-Operations Plan

Contents

1. Introduction

This document describes the activities to be performed for HIFI in the three years after Helium runs out on the Herschel Space Observatory. It also includes the manpower request to the consortium and a schedule of the activities. This document replaces Chapter 8 of ICC-1998-001 (HIFI Science Implementation Plan)

1. Start and End Dates of HIFI Post Operations

As agreed by the HIFI ICC, the HIFI Post operations period will be for 3 years and will run from 1 April 2013 until 31 March 2016.

2. Assumptions

Notes and assumptions:

- HIFI ICC continues its role in the overall Herschel Ground Segment to maintain HIFI pipeline software and documentation, supply the Herschel user community with in-depth knowledge of the HIFI instrument and support to data processing workshops.
- Herschel products are produced at the HSC. Software and community support is provided to the astronomical community via the HSC.
- HIFI ICC will provide updated software to the HSC which would do the reprocessing.
- After Post-operations, the HIFI team will no longer exist.
- ESA Archive will be the sole long term repository of all information.

The assumptions stated here are fully in accordance with the description of ICCs participation in Herschel Post Operations Phase plan [Reference 1]

2. Motivation

Historically, cryogenic astronomical space missions (e.g., IRAS, ISO, SPITZER) have benefited tremendously by an extended post-operations/post-cryogen (POP) period. Such a period was crucial for the full exploitation of the science of these missions mainly due to the high demand on the various teams during normal operations.

HIFI has acutely felt the effects of unforeseen critical software development, instrument stability, hardware failures and changing manpower. Post operations is not a “nice to have” but rather a “must” for the full exploitation of the scientific potential of HIFI data.

The overall one sentence top-level objectives of the POP towards the Herschel observers and general science community are to:

1. Maintain high quality community support to the ongoing Herschel data exploitation.

2. Create and eventually handover the Herschel legacy for posterity

These tasks will have to be performed in parallel, and most likely with gradually diminishing total resources. In addition, the one sentence top-level objectives include:

3. Derive lessons learned and identify items for possible future re-use.

4. Enable staff to perform their own data exploitation.

It is during the Post-Operations phase when the true legacy the Herschel mission will be ironed out.

3. Post-operations phase plans

In the following section, activities foreseen in Post-operations and the corresponding deliverables are presented. Below is a general list desired activities and is dependent on securing, in part, outside funding. An initial priority has been assigned to each item. The priority is assigned only as a starting point for detailed discussions within the HIFI team and among the Herschel Ground Segment.

1. HIFI Data Products and Pipeline:

The first goal of the Post-operations will be to update the standard processing software with the ideas which occurred during normal operations: in other words to make use of “hindsight”.

The other major focus of Post-operations will be fully documenting HIFI. This includes the instrument's actual behaviour as well proper recipes for addressing instrumental artefacts or non-optimal observations. The goal of this effort is to provide future users with sufficient and proper information to interpret HIFI data.

Efforts to improve HIFI data, data products and documentation will focus on the following areas:

1. Data-mining (Köln: priority I)

- See WP description below.

2. LO investigation (NHSC: priority I)

- See WP description below.

3. Optical SW Model (SRON: priority I)

- See WP description below.

4. Implementation of SW mitigation (SRON: priority I)

- See WP description below.

5. Deconvolution (NHSC: priority I)

- See WP description below

6. Final Determination of HIFI Sideband Ratio (Köln: priority I)

- See WP description below.

7. Beam properties (SRON: priority I)

- See WP description below.

8. Pipeline Maintenance and Upgrades (Waterloo: priority I)

- See WP description below.

9. Automated line identification (IRAP: priority I)

- See WP description below.

10. Continuum per observation mode (NHSC: priority I)

- See WP description below.

11. Use science data for calibration purposes (SRON: priority II)

- See WP description below.

12. Documentation (Waterloo: priority I)

- See WP description below.

13. Error Computation,Propagation and Consistency (Köln: priority I)

- See WP description below.

14. Alternative calibration schemes (Bordeaux: priority II)

- See WP description below.

15. SEU investigations (Köln: priority II)

- See WP description below.

16. User Support (Waterloo: priority I)

- See WP description below.

2. Science

It is expected that all ICC personnel with an astronomy background participates in HIFI science. At post-operations almost all data is public and can be used for individual science.

At SRON there will also be participation in the KP's WISH, CHESS, WADI and TNO's.

3. HIFI Post Operations Oversight

The HIFI PI Co-PI steering steering committee should continue the general oversight of HIFI in Post operations. In addition, at least two reviews are anticipated, on at the beginning of Post operations and one at the end.

4. Post-operations phase organisation

The organisation of the HIFI team will be similar to present operations. The HIFI consortium is responsible for the allocation of resources for the ICC. The consortium will be lead by the HIFI steering committee. The ICC manager will report to the steering committee. Members of the steering committee will be in close contact with their national funding agencies.

1. Management (SRON P1)

The overall management of the *HIFI* ICC is the responsibility of the ICC manager. The ICC manager reports to the PI directly or via the *HIFI* consortium Project Manager. An appointed deputy can replace the ICC manager when needed.

The ICC manager will establish, distribute and monitor the work packages listed below. The *HIFI* ICC manager also will compile the status reports from the ICC members into general ICC status reports. He will plan and chair ICC progress meetings and monitor progress on action items to be fulfilled by ICC members

The ICC manager represents the *HIFI* ICC in the various bodies governing Herschel ground segment development (e.g. *Herschel Common Science System Management Group* –HCSSMG– and *Herschel Ground Segment Steering Group* –HGSSG) and in *HIFI* project meetings. The deputy should at all times be sufficiently informed about ICC management and planning matters that he/she can represent the ICC at these official meetings

2. ICC organization

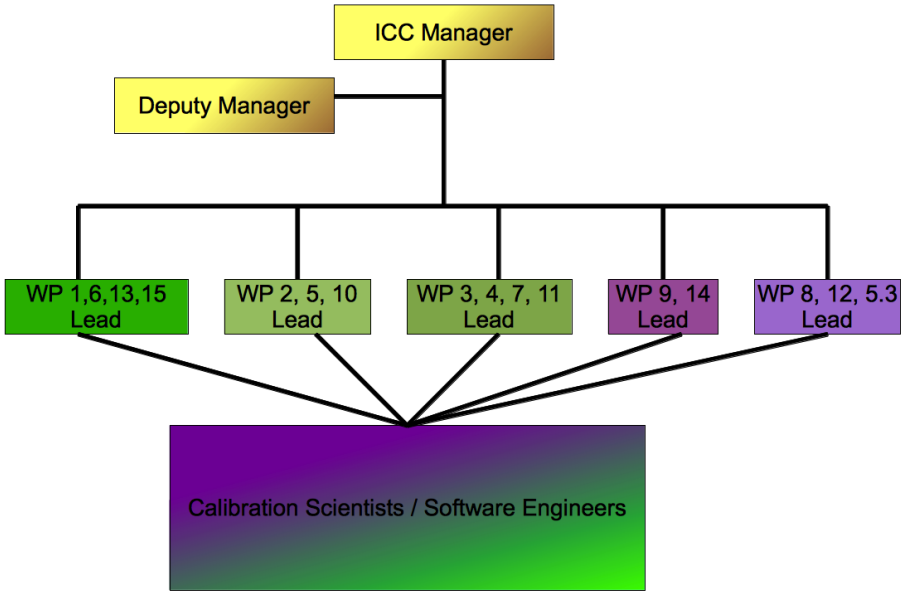
The ICC will be divided into subgroups with specific tasks. Leaders of these subgroups report directly to the ICC manager. There are two main groups in post operations: the calibration scientists and the Software Engineers. The organisational structure of the *HIFI* ICC for operations is shown in Figure 1.

The various activities are broken down into work packages, each work package has a lead. The effort of each work package is distributed among the ICC partners in terms of both calibration scientist and software engineering effort.

- The Calibration Scientists group. This group maintains and improves the calibration of the HIFI instrument. Drawing from calibration and science observations, this group analyses and interprets the resulting data. Also, they maintain the relevant calibration documents and when needed provide the calibration status for use by the HSC. The group also acts as a helpdesk on instrument matters for the rest of the ICC.
- The Software Engineering group. This group is responsible for maintaining and improving all HIFI ground segment software; HIFI Pipeline, CUS, and all its subsidiary systems etc. The HCSS related parts of this work will be done in close collaboration with the other instrument ICCs and the HSC.
- The support group. The support group takes care of all supporting activities; computer system maintenance, secretarial work etc. It also includes the project control within SRON, which checks progress and budgets for the SRON part of the ICC.

Within these groups further subdivisions are created when needed.

Illustration 1: HIFI ICC Organogram



3. Public Relations

Public Relations is generally handled by the principal investigator for HIFI, together with the SRON Media and Communications office and in close collaboration with

ESA through the Herschel project scientist. However, single scientists and institutes are allowed to have their own policy. At SRON web pages will be maintained on HIFI.

4. Communications/meetings

- Bi-weekly meetings will be held by teleconference. These meetings will focus on status of various efforts and help maintain the HIFI ICC as an entity.
- The HIFI ICC will can semi annual co-locations where all parties sit together to review efforts and plan next steps.
- Travel to the high-level Herschel management meetings will be done by the ICC manager, his deputy and by the subgroup leads. Internal management meetings will mainly be by teleconference.
- The ICC manager, his deputy and the PI and the group leaders are expected to participate in high-level reviews, supported by members of the ICC.

5. Other Post-operation phase activities.

In order to fulfil the goals listed above, it is anticipated that many of the current ICC activities will continue.

1. Support functions

Support functions include secretarial and project control support, which are of a general nature. Important in the context of post-operations is the ICT support

Computer support includes the maintenance of the TM and AUX databases, which will be needed for preparation of reprocessing exercises, i.e. preparing an updated pipeline. It includes the maintenance of the parallel set-up in which OBSW can be tested and TM can be generated on demand (TBC - the HRS is going back to Toulouse). It also includes the maintenance of the general infrastructure in the various nodes like NHSC and Köln.

Training – this is both internal training (parallel setup (TBC whether we keep it running), training to maintain the whole GS software; HIPE for ICC members new to HIFI) and external training (teaching people to do HIFI analysis in the partner countries. Data processing workshops and/or specific topical tutorials provided via WebEx or something equivalent and which are open for the entire astronomical community will be coordinated with the HSC.

2. Software maintenance

This will remain an activity. The goal however will be to improve the software documentation at a very detailed level, such that it can still be supported by independent groups after post-operations. PA/QA will play a significant role here.

3. Product and Quality Assurance (Waterloo: Priority I)

PA/QA becomes an even more important activity during the post-operations phase. The data products, software and documentation produced must stand on their own when in the future experts are no longer available.

Quality control and Quality Control Pipeline will have to be coordinated with the HSC to which depth the quality reports of the final archive products should have.

It is anticipated that there will be at least one last preprocessing campaign. The ICC would play a necessary test and validation role in these campaigns. Also, processing and analysis algorithms will be updated and provided to the general astronomical community. Testing, supported by the HIFI ICC, will be necessary for each release.

See WP description below.

6. Resources

1. Participants

A number of participants in the post operations can be identified. HSC at ESAC, HIFI ICC at SRON, NHSC at IPAC, University of Köln , Univ. of Waterloo, Laboratoire d'Astrophysique de Bordeaux (LAB), IRAP, Arcetri, Chalmers, FHNW.

For the post operations phase, we expect at least two reviews

2. Travel

The HIFI ICC will continue to be a widely distributed effort spanning over 6 distinct locations. It is therefore vital to continue the semi annual co-location periods which bring the entire ICC together for no less than one week at one location.

Travel will be needed during this period for the calibration scientists involved in the issues listed above to meet with each other and for management for reviews of the Post-operations phase.

Travel is foreseen to HSC at ESAC and ESTEC for several persons, to ESTEC for the management and to the nodes Köln, Toulouse and NHSC.

Travel is anticipated two times / year to Groningen (or another HIFI institute) for co-locations and coordination meetings. Travel will be needed to ESAC 2-3 times /year.

3. Manpower (Activity, Location, Who)

The total effort is estimated largely from the work packages listed in section Detailed Work Packages. In total the work described here covers an estimated 392 man months of calibration scientist effort, 106 man months of software engineering effort and 6 man months of support. The HIFI ICC organisations which have expressed interest in participation in HIFI post operations are indicated below.

- HIFI data investigations (calibration scientists CS), SRON, Univ. of Waterloo, Univ. of Köln, NHSC, IRAP, LAB, LESIA, MPS , Chalmers, ESAC.
- Pipeline and software (software engineers SE), SRON, Arcetri, Univ. of Waterloo, IRAP, NHSC.

- Database maintenance and support, SRON, Univ. of Waterloo,
- Project Management, SRON
- Reviews, HSC, Post ops management.
- Project support, SRON.

The anticipated support per country partner is identified in the tables below:

Calibration Scientists:

	CS Year 1	CS Year 2	CS Year3
Netherlands	3.42	2.92	2
Germany	2.25	2.25	2
France	1.67	1.67	1.5
Canada	1	1	1
NHSC	2.33	2.17	1.92
Italy	0	0	0
Sweden	0.29	0.29	0.29
HSC	0.63	0.63	0.63
	11.58	10.92	9.33

Software Engineers:

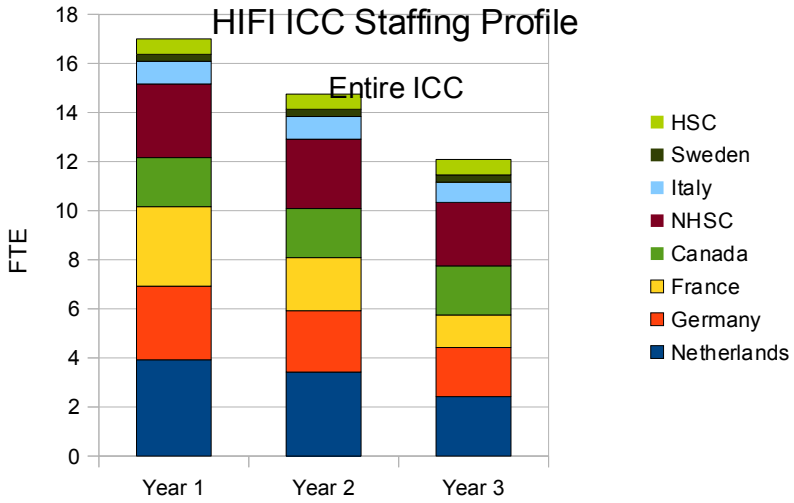
	SE Year 1	SE Year 2	SE Year3
Netherlands	0.5	0.5	0.5
Germany	0	0	0
France	0.67	0.58	0.5
Canada	1	1	1
NHSC	1.17	1.17	0.67
Italy	0.92	0.92	0.83
Sweden	0	0	0
HSC	0	0	0
	4.25	4.17	3.5

4. Schedule

A detailed schedule is being developed with the HSC and other ICCs. It is anticipated that each work package will have to review the progress with respect to the overall schedule and updated as needed. The schedule presented in this document is roughly what is anticipated each year, starting in April 2013.

5. Staffing Profile for Post operations.

In this section, a broad overview of the effort over the three years is presented. These estimates are based on stated commitments from consortium partners. The plot below includes both Calibration Scientist and Software Engineer commitments.



7. Detailed Work Packages

In this section, the various work package titles are listed again with more details concerning the activities and and estimate of the resources needed to accomplish the work package. CS = Calibration Scientist, SE= Software Engineer, mm=man month, P1 = priority 1, P2 = priority 2.

WP #	Title	Start	End	Resources
3. 1. 1.	**Data-mining (P1)**	M1	M24	Lead Köln
1. Create large cross correlation matrix of housekeeping parameters describing the conditions for the instrument operation including normal housekeeping, spacecraft activities, observational history, and space weather conditions, and instrument performance parameters, like spurious signals, impedance changes, gain and standing wave stability. 2. Identify major correlations and probable causes for different performance parameters and irregularities. Assign further investigation of identified relations and particular data sets with deviations/anomalies to other working groups (LO, SBR, standing waves, continuum stability, ...). 3. Investigate details of impact on science data. Create correction tables in the calibration tree and the corresponding correction algorithms based on the phenomenological correlation between the				

WP #	Title	Start	End	Resources
	different housekeeping data. 4. Perform data quality analysis: Investigate quality of the HIFI data (calibrated products), problems, including searching of data anomalies and data produced during SEU events. Check Quality report, and messages/warnings vs. associated Quality Flags in the quality reports. 5. Report/Communicate QF problems: report inconsistencies found to HIFI ICC team for resolution and implementation. Grade the data. Improve data characterisation. Collect QF reports. Coordinate QF issues between TA and ICC teams, telecons.			
Participants: Köln, IRAP 7mm, SRON 17mm, UW 9mm, NHSC 3mm, HSC 3mm, Arcetri 2mm				
Precondition	Unlimited access to science and housekeeping data from instrument			Total effort: 60 mm CS Y1: 15mm Köln Y2: 9mm Köln Y3: 2mm Köln
Deliverables	• Description document of anomalies and uncorrectable problems as a function of operating conditions • Tables of correction functions for calibration tree with fitted dependence on different housekeeping parameters • Sets of correlations and identified data frames for further investigation in other working groups			

WP #	Title	Start	End	Resources
3. 1. 2.	**LO Investigation (P1)**	M1	M24	Lead NHSC
1. Find/assess the spurs and spurious responses given the entire database of HIFI observations. 2. Correlation with spacecraft/instrument parameters 3. Update calibration tree 4. HRS has dedicated Los, need to investigate if they produce HRS specific spurs and spurious responses				
Participants: NHSC, IRAP 3mm, HSC 3mm				
Precondition				Total: 24mm 1mm (SE) Y1 6mm NHSC Y2 6mm NHSC Y3 5mm NHSC
Deliverables	Document detailing findings Updated Calibration			

WP #	Title	Start	End	Resources
3. 1. 3.	**Optical SW Model (P1)**	M1		Lead: SRON
1. Create a model of HIFI standing waves based on first principles. 2. Validation of model with HIFI data				24 mm CS 12 mm CS
Participants: SRON, JPL 6mm				
Precondition				Total: 36 mm CS Y1 12mm SRON Y2 13mm SRON Y3 5mm SRON
Deliverable	SW Model Publication SW algorithm Validation of Model (publication)			

WP #	Title	Start	End	Resources
3. 1. 4.	**Implementation SW mitigation**	M1	M36	Lead SRON
1. Creation of a zoo of possible standing waves (SW) occurring in the different HIFI bands. 2. Correlation of SW with spacecraft/instrument parameters. 3. Heuristic modelling. 4. Implementation of the deliverable model of WP 3.1.3. 5. Update HIFI calibration tree to address SW. 6. Maintenance and improvements of current SW mitigation efforts available in interactive tools.				2 mm CS 22 mm CS 6 mm SE 3 mm SE. 1 mm SE. 4 mm SE.
Participants: SRON, Köln 6mm, LAB 3mm, NHSC 6mm, Arcetri 3mm				
Precondition:	Optical SW Model (SRON: priority I) Provides sufficient guidance for optical SW. Other issues are needed regardless of outcome.			Total: 24 mm CS 14 mm SE Y1 4mm SRON Y2 3mm SRON Y3 3mm SRON
Deliverable:	Feed into data processing if possible via improved data processing or calibration→ Update pipeline and quality products. Astronomer tools for SW mitigation.			

WP #	Title	Start	End	Resources
3. 1. 5.	**Deconvolution (P1)**	M1		Lead: NHSC
1. Improve automated cleaning abilities which are needed to obtain the best possible deconvolution result. (e.g., de-fringing, spur identification/removal, etc.) 2. Clean/deconvolve HRS data when present in Spectral Scans for direct comparison with WBS single sideband result. Help from the HRS team to assess the comparison/validation of HRS deconvolved spectra vs WBS ones. 3. Update Deconvolution software for mitigation of electrical SW, if possible. 4. If available, update deconvolution software taking into account optical standing wave model.				6 mm SE / 6 mm CS 12 mm CS 3 mm SE 3 mm SE
Participants: NHSC, Köln 6mm, IRAP 3mm				
Precondition:				Total: 18 mm CS 12 mm SE Y1 9mm NHSC Y2 9mm NHSC Y3 7mm NHSC
Deliverable:	Updated HIFI pipeline			

WP #	Title	Start	End	Resources
3. 1. 6.	SBR (P1)	M1		Lead: Köln
1. Unify all available information on sideband ratios from gas-cell lab measurements, astronomical mini-spectral scans and separate-sideband observations, and normal science spectral scans 2. Separate the effects of non-unity sideband ratios from standing wave contributions and LO impurities, Separate slopes in sideband ratios from slopes in standing waves 3. Verify derived sideband ratios in the deconvolution of science spectral scans using adapted parameters 4. Define metrics for assessing the quality of the assumed SBR. 5. Perform additional gas cell measurements in the laboratory for CH3OH to understand the pre-flight tests used to calibrate the sideband ratio and develop a resulting recalibration of the line intensities. 6. Develop model to characterize sources with non-constant continuum contribution and separate line and continuum in spectral scans 7. Create validated entries for final calibration tree				Year 1: 4 mm CS Year 2: 8 mm CS Year 3: 4 mm CS 2 mm SE 12 CS
Participants: Köln, LAB 6mm, SRON 1 mm, UW 2mm, HSC 3mm				
Preconditions				Total: 28 mm CS 2 mm SE Y1 3mm Köln Y2 5mm Köln Y3 5mm Köln
Deliverables:	Calibration Tree update. Publication of HIFI SBR per band			

WP #	Title	Start	End	Resources
3. 1. 7.	Beam Properties (P1)	M1		Lead: SRON

Task 1) Analysis of the HIFI beams

Context: HIFI has 14 mixers (7 frequency bands in 2 polarizations), each of which has a frequency-dependent antenna pattern (beam). Precise knowledge of the beam is a prerequisite for optimal interpretation and calibration of HIFI data, especially in the case of extended sources. Beam-characterization measurements were taken both before and after launch. Analysis has started, but has yet to be finalized.

10 mm CS
1 mm SE

1. Create maps of all runs performed on the large planets. In particular, the dedicated Mars observations should be used, but maps of Jupiter in the water bands do exist as well.
2. Use Instrument Level Test data of the mixer beam measurements to propagate through the HIFI/Herschel optical model.
3. Create models of Mars' brightness at sufficient spatial resolution and at the appropriate frequencies for convolution with the propagated mixer beams.
4. Create synthesized observations by convolving the Mars model with propagated beams.
5. Derive optimized antenna patterns for all mixers and assess the differences with a Gaussian beam model.
6. Update main-beam efficiencies
7. Derive encircled-energy fraction diagrams / fractional coupling to extended sources for each mixer / polarization
8. Determine and validate frequency dependence of beam pattern within each mixer band

Task 2) Application of HSC pointing improvements to HIFI data

Context: Pointing uncertainty is a major source of uncertainty for HIFI. More than half-way into the mission, the Herschel Science Centre has optimized the pointing reconstruction from star-tracker data. Application of the new pointing knowledge to existing HIFI data is mandatory.

18 mm CS
6 mm/year

1. Assess impact on HIFI data by checking those areas that are known to be most critically affected. Maps of, e.g., the Orion Bar will be used to track other possible pointing effects. PACS, with its narrower beam and its array of detectors, can trace and correct for pointing errors more readily than HIFI. Close interaction with the PACS team is necessary and PACS documentation needs to be studied.

WP #	Title	Start	End	Resources
For pointed observations in the higher-frequency bands, pointing uncertainties may dominate the flux-calibration uncertainty and H/V imbalance (due to the small misalignment between the two polarizations). Task 3) Assess impacts of improvements on planetary modelling Context: While models of the emission of Mars, Uranus, and Neptune are used in the flux calibration of Herschel's focal-plane instruments, Herschel observations of these planets feed back into the planetary models. Specifically, the usage of better HIFI antenna patterns promises to tighten the parameter range employed in planetary modelling. An improved understanding of PACS and SPIRE data will have a similar effect. 1. Describe the loop between calibrating the Herschel instruments and planetary modelling in a report or scientific paper (or both).				year 1 12 mm CS 1 mm SE year 2 3 mm CS
Participants: SRON, LESIA 6mm, NHSC 20mm				
Preconditions:	Improved pointing product for entire Herschel mission from HSC Preconditions (task 1): * ILT beam-measurement data (available) * In-flight beam-characterization data (available / delivered for observation) Preconditions(task 2): * Updated Herschel pointing product throughout the mission * Detailed beam model defined in Task 1 (required for part of this analysis)			Total: 33 mm CS 2 mm SE Y1 4mm SRON Y2 3mm SRON Y3 2mm SRON
Deliverables:	Task1: 1. Maps/cubes of all dedicated Mars observations. Maps/cubes of other planet science data useful for beam characterization. 2. Maps/cubes of the propagated ILT data at much denser sampling (to facilitate reliable interpolation) 3. Maps/cubes of the propagated ILT data, down-sampled to the resolution of Mars			

WP #	Title	Start	End	Resources
	observations 4. Mars models for the epochs observed 5. Antenna pattern cubes to be stored in HSA: one per mixer/polarization along with frequency dependence 6. Tabulation of main parameters and assessment of the accuracy of these parameters 7. Technical report and/or scientific publication describing the beam models, how they were measured, and the impact on extended-source flux calibration 8. Update HIFI calibration tree and HIFI pipeline as needed Task2: 9. Report on the impact of the pointing improvement 10. Re-assessment of uncertainties in flux calibration and H/V imbalance (combining new pointing product and new HIFI beam model) 11. Report on the findings on the Orion Bar and other science map data. 12. Report on effects found by PACS and assessment of the possible impact on HIFI data Task 3: 13. Publication of impact on planetary models 14. HIFI beam patterns in calibration tree 15. Tools to use (via improved pointing)/visualize beams			

WP #	Title	Start	End	Resources
3. 1. 8.	Maintenance (P1)	M1		Lead: U of Waterloo:
1. Maintenance/upgrades of Versant databases at all nodes. 2. Continue support of propagating calibration 3. Maintain ICC analysis software 4. Maintenance of relational databases 5. Support HIFI software 1. code reviews 2. JIRA/SONAR administration and review of tickets 3. CIB/CVS administration 4. HIFI CCBs 6. Support of HIFI responsible HCSS modules 1. code reviews 2. JIRA/SONAR …. 3. CIB/CVS 4. CCBs 7. New / updated pipeline and tool development 8. Warnings: in common framework for the 3 instruments, stablish HIFI warning/alarms messages in the quality report. 9. HIFI bulk reprocessing 10. Uplink system maintenance (JBOSS, testing old CUS, etc.) 11. Clean up decommission downlink systems				7 mm SE 1 mm SE 3 mm SE 6mm SE 6 mm SE 12 mm SE 3 mm SE 2 mm SE 1 mm SE 1 mm SE
Participation: UW, IRAP 1mm, SRON 2mm, NHSC 6mm, Arcetri 15mm				
Precondition				Total: 42 mm SE Y1 7mm UW Y2 7mm UW Y3 7mm UW
Deliverable	Maintained and updated HIFI pipeline			

WP #	Title	Start	End	Resources
3. 1. 9.	Line Identification (P1)	M1		Lead: IRAP
1. Investigation of automatic finder of lines in HIFI USB and LSB in non-Spectral Scan modes. Final identification is left to astronomer. 2. For SpectralScans, an automated line finder would make use of existing templates from e.g., Orion KL and IRC10216. 3. Documenting possibilities 4. Prototyping of pipeline line finder and eventual porting to pipeline module. 5. Implementation of interface to line database through the VirtualDB and CASSISS module.				3 mm CS 6 mm SE 3 mm CS 3 mm SE 3 mm CS 2 mm SE
Participation: IRAP				
Preconditions	This work package makes use of existing line databases (CMDS, JPL). It is assumed that those independent efforts remain supported.			Total: 9 mm CS 11 mm SE Y1 9mm IRAP Y2 9mm IRAP Y3 9mm IRAP
Deliverables	Document describing process of how to make use of lines list possibly in HIFI data (capabilities and caveats). Updated pipeline processing if appropriate, improved Standard Products and Quality information.			

WP #	Title	Start	End	Resources
3. 1. 10.	Continuum (P1)	M1		Lead: NHSC
1. Characterize and separate baseline drift from source continuum (special attention to HEB bands). 2. Investigate quality of continua present in HIFI data per OBS mode. 3. Assess how accurately the continuum can be determined even for modes not making us of continuum stabilisation. 4. Develop models to separate continuum and line calibration from each other in light of standing waves and sideband-ratio. 5. Analysis of brightness temperatures of planetary continuum radiation over the applicable HIFI spectra range and comparison with continuum models. Investigations whether calibrations or models have to be improved. 6. Development of a baseline removal algorithm for planetary observations				12 mm CS 12 mm CS 12 mm CS 12 mm CS 6 mm SE 3 mm CS 3 mm CS
Participation: NHSC, IRAP 6mm, Köln 9mm, SRON 9mm, UW 10mm				
Precondition				Total: 54 mm CS 6 mm SE Y1 4mm NHSC Y2 4mm NHSC Y3 3mm NHSC
Deliverable	Deliverables: Interactive software tool to provide highest probability source continuum and documentation of tool. Software to calibrate continua and lines separately, Report and quality product associated with observation.			

WP #	Title	Start	End	Resources
3. 1. 11.	Science → Calibration (P2)	M1		Lead: SRON
1. Create database of OFF and REF spectra 2. Create database of load measurements. 3. Assess whether/how a general database can be used on other science data 4. Building of prototype pipeline modules for OFF/REF matching				2 mm CS 1 mm SE 2 mm CS 3 mm SE
Participation: SRON				
Precondition				Total: 4 mm CS 3 mm SE Y1 0mm Y2 0mm Y3 0mm
Deliverable	Update of standard pipeline and quality pipeline, OFF/REF database			

WP #	Title	Start	End	Resources
3. 1. 12.	Documentation (P1)	M1		Lead: U of Waterloo

Instrument:

1. *The HIFI Observers Manual should be updated to reflect knowledge of instrument characteristics gained during post operations activities.* — 1 mm CS
    - Examples include updated spur tables, sideband gain coefficients, beam characteristics.
2. *The HIFI Instrument and Calibration Web Page should continue to be updated*. — 2 mm CS
    - Updates should occur every HIPE release and whenever updated information about calibration and instrumental effects are available. As the release cycle slows down the web page may become the most up to date source on calibration issues for users.
3. *The Instrument Known Issues page should continue to be updated.* — 2 mm CS
    - Characterisation of known issues in HIFI data will will continue during post operations and this information should be kept updated on the Known Issues web page.
4. *The HIFI Data Reduction Guide (DRG) should continue to be updated.* — 1 mm SE, 4 mm CS
    - The calibration available in each version of the calibration tree should be documented.

Pipeline:

1. *The Pipeline Specification Document should be updated to contain a description of all steps performed by the final version of the pipeline.* This includes:
    - purpose of the task
    - description of the task, including
    - assumptions made
    - mathematics/algorithms used
    - inputs and outputs of each step
    - the result of the task including changes to metadata, dataset columns, flags, calibration

WP #	Title	Start	End	Resources
products, errors and warnings ◦ Same description for alternative (non-default) pipeline steps up to level 2 ◦ Flow diagrams for each pipeline				1 mm SE
2. *Pipeline tasks should all have a complete and clear User Reference Manual (URM) entry.* ◦ It should include a description, a python script example, the task API summary and details and a history.				1 mm CS
3. *The summary of pipeline steps in the HIFI DRG should continue to be updated*				3 mm CS
Processing: 1. *The description of how to run the pipeline in the HIFI DRG should continue to be updated for developments to the pipeline.* It should describe how to: ◦ run the pipeline interactively with default settings ◦ run the pipeline interactively with a different calibration version ◦ customise pipeline algorithms ◦ how to include non-pipeline tasks in the pipeline. ◦ solve issues in data using alternative pipeline tasks or algorithms and describe any techniques for improving data by modifying the pipeline found during post operations.				5 mm CS
Tools: 1. *The descriptions of HIFI-specific processing tools and how to use them should be updated in the HIFI DRG.* Each tool developed by the HIFI ICC should be documented to describe: ◦ a summary of the purpose of the tool ◦ any mathematics or assumptions used by the tool ◦ how to use the tool ◦ suggested parameters for typical data issues or known special cases ◦ how to pass data from one tool to another. ◦ Each tool should have a complete and clear URM				1 mm SE 3 mm CS

WP #	Title	Start	End	Resources
entry 2. *Descriptions of general data processing tools developed by the HIFI ICC should documented in the Herschel Data Analysis Guide*, in the same way that HIFI specific tools are documented in the HIFI DRG.				1 mm CS
Flags, error and warning messages:				6 mm CS
1. *Document budget of all quality flags, including thresholds/limits, and impact of the data. Provide support to the HSC for the quality control procedure based on that.* 2. *The descriptions of quality flags and data flags in the HIFI DRG should be maintained with updates to the pipeline.* ○ All automatically generated flags should be fully described, identifying where in the pipeline and under what conditions they can be raised. ○ The likely impact on the quality of science data should be described. ○ A page maintained on the Herschel twiki should contain the same information and what actions TAs should take in the event that such flags are raised during bulk re-processing.				1 mm CS 5 mm CS
Cookbooks: 1. *Cookbooks should exist for each observing mode. They should:* ○ summarise how observations are carried out in that mode ○ describe where in the Observation Context to find calibration products or level 1 data that are particularly helpful for identifying data issues for that observing mode ○ describe the typical data reduction workflow for that observing mode ○ describe how to improve typical data issues for that observing mode 2. *Cookbooks should exist for more involved data processing steps. For example, a step-by-step guide for dealing with typical standing waves*				1 mm CS
Participation: UW, Köln 6mm, SRON 5 mm, IRAP 3mm , NHSC 7mm, Sweden 3mm, HSC 3mm				

WP #	Title	Start	End	Resources
Precondition				Total: 35mm CS 3mm SE Y1 3mm UW Y2 2mm UW Y3 4mm UW
Deliverable	Deliverables: HIFI Observers Manual HIFI Instrument and Calibration web page HIFI Known Data Issues web page HIFI Pipeline Specification Documentation HIFI Data Reduction Guide HIFI User Reference Manual HIFI Expert Reference Manual HIFI Cookbooks Tabulation of Quality flags for HSC TA use			

<table>
<tr><th>WP #</th><th>Title</th><th>Start</th><th>End</th><th>Resources</th></tr>
<tr><td>3. 1. 13.</td><td>Error Computation/ Propagation/ Consistency (P1)</td><td>M1</td><td></td><td>Lead Köln (17mm)
IRAP (6 mm)
LESIA (6 mm)
SRON</td></tr>
<tr><td colspan="4">Quantify sources of uncertainties at every stage of processing. Estimate of propagation of uncertainties through the pipeline modules.
Update of calibration tree to contain uncertainties, propagation of errors through pipeline.
Update of error budget as function of frequency.
Consequences on science data: Investigate and evaluate the consequences on science data and action to follow for the astronomer. Improve usefulness of QFs for astronomers.
Perform consistency checks:
standard monitoring sources
science observations vs. calibration measurements
cross calibration vs. PACS/SPIRE
cross calibration vs. SOFIA and ground-based observatories</td><td>Year 1:
6 mm CS

Year 2:
12mm CS

3 mm SE
3 mm CS
Year 3:
12mm CS

3 mm SE</td></tr>
<tr><td colspan="4">Participation: Köln, IRAP 4mm, LESIA 4mm, SRON 6mm, UW 4mm, NHSC 4mm, HSC 6mm, Arcetri 2mm</td><td></td></tr>
<tr><td>Precondition</td><td colspan="3">Unlimited access to PACS/SPIRE science and calibration data
Input from other work groups (SBR, standing waves, ...) for instrument model</td><td>Total:
33 mm CS
6 mm SE
Y1 2mm Köln
Y2 7mm Köln
Y3 8mm Köln</td></tr>
<tr><td>Deliverable</td><td colspan="3">Update of calibration tree with errors
Update of pipeline modules for systematic error propagation
Final calibration budget</td><td></td></tr>
</table>

WP #	Title	Start	End	Resources
3. 1. 14.	Alternative Calibration Schemes (P2)	M1		Lead: LAB
1. For the FSW and Load Chop observing modes (both for pointed and mapping modes), it is highly recommended to have a reference spectra measured at a reference position. In the double difference method, those spectra are then smoothed to reduce the extra noise from that reference measurement (the reference spectra is indeed observed with a shorter integration time, and as a consequence has a higher noise for the same spectral resolution). 2. In 2010-2011 we investigated what is the optimal smoothing that could be applied to the reference spectra in order to improve the S/N in the final observation for the user. First conclusions and improvements have been obtained for Load chop and FSW pointed observations, but no clear picture appeared for OTF maps. We hence plan to investigate that in more details alternative calibration schemes for FSW observations. 3. A first study in 2010 comparing different possible calibration schemes has been conducted, but on a limited number of observations. The same investigation must be done on a larger sample of observations to draw conclusions. Moreover, new calibration schemes will be tested.				7 mm CS
Participation: LAB, Köln 2mm				
Precondition				Total: 7 mm CS Y1 2mm LAB Y2 2mm LAB Y3 2mm LAB
Deliverable	1. new schemes for smoothing width for end 2012 2. new schemes for FSW for end 2013 3. version 2 of new schemes end 2014. 4. documentation			

WP #	Title	Start	End	Resources
3. 1. 15.	SEU Investigation (P2)	M1		Lead: Köln
1. Statistics of HIFI SEUs in different subunits 2. Identify data anomalies from "glitches", develop mitigation routines 3. Search for showers in WBS: ◦ individual pixels ◦ readout lines ◦ identify other false signals ◦ develop routines for systematic identification close to noise level 4. Correlate with space weather 5. Lab tests for impact of different high-energy particles on CCDs (flight spare at synchrotron) 6. Identification of critical energy for different subsystems/events				Year 1 1 mm CS Year 2 3 mm CS Year 3: 2 mm CS 2 mm SE
Participation: Köln, Arcetri 2mm				
Precondition	Input from data mining group on anomalies Input from LO group on impurities			Total: 5 mm CS 2 mm SE Y1 1mm Köln Y2 2mm Köln Y3 2mm Köln
Deliverable	Glitch correction routine in pipeline Report			

WP #	Title	Start	End	Resources
3. 1. 16.	User Support	M1		Lead: UW Participants: SRON NHSC
1. Support planning, preparing and execution of workshops and webinars. 2. Investigating Helpdesk tickets and answering direct user questions				12 mm CS
Participanten: UW, SRON 4mm, NHSC				
Precondition	HSC arranges for Seminars and Webinars HSC maintains an astronomer Helpdesk. HIFI has access to tickets			12 mm CS Y1 2mm UW Y2 2mm UW Y3 2mm UW
Deliverables	1. HIFI participation at seminars and webinars			

WP #	Title	Start	End	Resources
4. 1.	**Management (P1)**	M1	M36	Lead: SRON
1. Prepare bi-weekly meetings agenda/minutes 2. Prepare organize co-locations 3. Prepare and maintain Post-operations plans 4. Review status of WP in monthly (or bi monthly) meetings with WP leads. 5. Prepare and maintain a documentation repository 6. Organize ICC post operations web pages including a wikki 7. Prepare and Maintain ICC post operations schedule				6 mm CS
Participation: SRON				
Precondition				Total 6 mm CS Y1 2mm SRON Y2 2mm SRON Y3 2mm SRON
Deliverable	Plans, Reports			

WP #	Title	Start	End	Participants and Resources
5. 3.	Product Verification (P1)	M1	M36	Lead: U. of Waterloo
1. Verification that HIFI data products produced by the HIFI pipeline available in the HSA have not regressed since the previously released HIPE version 2. Verification that HIFI data products in the HSA are scientifically valid 3. Verification that the data processing tools used for HIFI data produce valid results ○ The above three bullet points will be met by following procedure already established for Astronomer Acceptance Testing and Product Validation 4. Updates of tests used in product validation for modifications to the pipeline and data processing tools 5. Improvements to tasks used to automate aspects of product validation 6. Upkeep of wiki test and report pages				10 mm CS 1 mm CS 1 mm SE 1 mm CS
Participation: UW, SRON 5mm, NHSC 3mm, Sweden 1.5mm, HSC 1.5 mm				
Precondition				12 mm CS 1 mm SE Y1 1mm UW Y2 1mm UW Y3 2mm UW
Deliverable	Test reports for each HIPE release			

8. Effort in Time By Work Package

Below are two tables. The first is the estimated Calibration Scientist effort per work package. The second table is the estimated Software Engineering Effort per work package. The numbers in red are short falls.

Calibration Scientists

WP	Title	Total Estimated	Year 1	Year 2	Year 3	Total Comited CS to WP	Needed or surplus
@3.1.1	Data-mining	60	27	17	7	51	-9
@3.1.2	LO Investigation	24	8	8	7	23	-1
@3.1.3	Optical SW Model	36	14	15	7	36	0
@3.1.4	Implementation SW mitigation	24	10	8	7	25	1
@3.1.5	Deconvolution	18	6	6	6	18	0
@3.1.6	SBR	28	6	8	8	22	-6
@3.1.7	Beam Properties	33	12	11	10	33	0
@3.1.8	Maintenance	0	0	0	0	0	0
@3.1.9	Line Indetification	9	3	3	3	9	0
@3.1.10	Continuum	54	18	18	16	52	-2
@3.1.11	Science →calibration	4	0	0	0	0	-4
@3.1.12	Documentation	35	12	11	11	34	-1
@3.1.13	Error Computation	33	9	13	13	35	2
@3.1.14	Altrnative Calibration Schemes	7	4	2	2	8	1
@3.1.15	SEU Investigation	5	1	2	2	5	0
@3.1.16	User Support	12	3	3	4	10	-2
@4.1	Management	6	2	2	2	6	0
@5.3	Product Verification	12	4	4	7	15	3
Staff Months		400	139	131	112	382	
FTEs		33.33	11.58	10.92	9.33	31.83	

Software Engineers:

WP	Title	Total Estimated	Year 1	Year 2	Year 3	Total Comited SE to WP	Needed or surplus
@3.1.1	Data-mining	4	2	2	0	4	0
@3.1.2	LO Investigation	1	3	2	0	5	4
@3.1.3	Optical SW Model	0	0	0	0	0	0
@3.1.4	Implementation SW mitigation	14	3	6	8	17	3
@3.1.5	Deconvolution	12	6	6	4	16	4
@3.1.6	SBR	2	2	1	0	3	1
@3.1.7	Beam Properties	2	0	1	1	2	0
@3.1.8	Maintenance	42	17	16	12	45	3
@3.1.9	Line Indetification	11	6	6	6	18	7
@3.1.10	Continuum	6	3	3	2	8	2
@3.1.11	Science →calibration	3	2	0	1	3	0
@3.1.12	Documentation	3	2	1	2	5	2
@3.1.13	Error Computation	6	4	5	3	12	6
@3.1.14	Altrnative Calibration Schemes	0	0	0	0	0	0
@3.1.15	SEU Investigation	2	0	0	2	2	0
@3.1.16	User Support	0	0	0	0	0	0
@4.1	Management	0	0	0	0	0	0
@5.3	Product Verification	1	1	1	1	3	2
Staff Months		109	51	50	42	143	
FTEs			4.25	4.17	3.5	11.92	