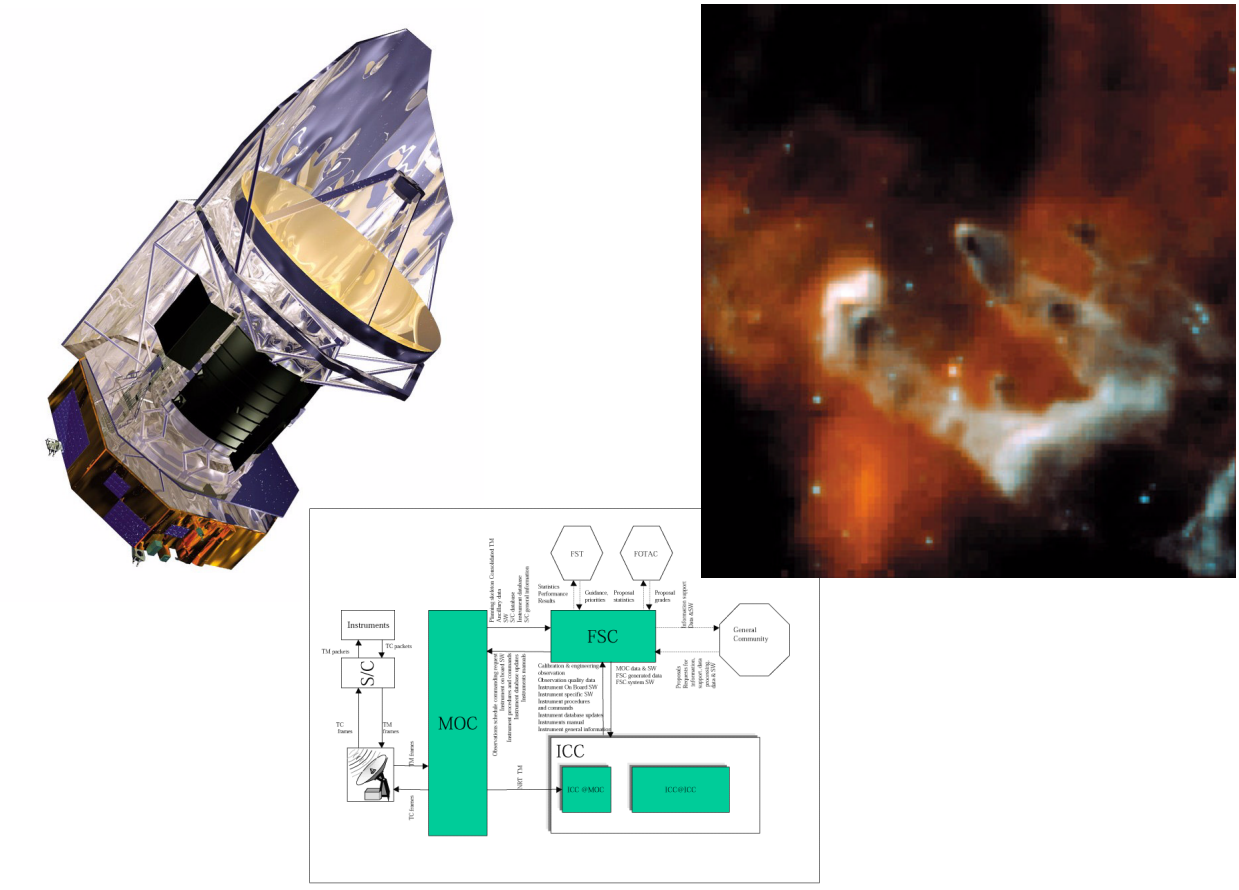
HERSCHEL SPACE OBSERVATORY

HERSCHEL SCIENCE CENTRE
SCIENCE IMPLEMENTATION PLAN



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Document Approval

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Document Status Sheet

Issue	Revision	Date	Reason for change
		Mar 1997	Embryonic SIP, containing initial collection of tasks to be performed. SIRD draft 1 issued 30 Nov 1996.
		22 Jan 1998	As updated after collating inputs from a number of SCI-SA people in preparation for internal review 27 Jan 1998. SIRD drafts 2 / 3 issued on 31 July / 30 Sep 1997.
		7 Apr 1998	As updated after 27 Jan 1998 mtg in preparation for 7 Apr 1998 mtg.
Draft 0.3		2 Dec 1998	First 'real' draft in response to SIRD draft 3. Updated as draft 0.31 on 22 Dec 1998; draft 0.32 on 20 May 1999.
Draft 0.33		21 Mar 2000	Scenario Document work from Jul 1999, draft 0.95 issued on 22 Feb 2000.
Draft 0.4		6 Apr 2000	Draft prepared for internal SCI-SA review on 13 Apr 2000.
Draft 0.5		16 Sep 2001	Draft prepared for internal SCI-SA review on 19 Sep 2001. Incorporates comments from Apr 2000 internal review, and responds to the SIRD 1.1 issued on 18 May 2001. (Scenario Document 1.0 issued on 12 Nov 2000, SIRD 1.0 on 30 Nov 2000.)
Draft 0.8		24 Feb 2002	Draft prepared for internal ESA commenting before submitting the draft HSC SIP for review against the SIRD together with the ICC SIPs. Very slightly updated Draft 0.81 submitted to the review.
Draft 0.9		31 May 2002	Updated version taking both the internal HSC SIP review as well as the HSC+ICC SIPs review comments into account.

Document Change Record

Document Issue/Revision Number: 1.x	
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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Scope of Document

This document is the 'Herschel Space Observatory Science Centre (HSC) Science Implementation Plan' (SIP), the HSC SIP, cf. the document tree presented in Figure 1.1 below. It describes the activities to be undertaken to implement and operate the HSC as part of the overall science ground segment for the Herschel mission, as described in the (then) 'FIRST Science Management Plan' (SMP = [AD1]) as approved by the Science Programme Committee (SPC) in 1997.

The HSC SIP is generated in response to the 'Herschel Science Operations Implementation Requirements Document' (SIRD = [AD3]), which is the document providing the formal requirements for the scientific operations of the Herschel mission**.** The requirements given in the SIRD have been formalised from the narrative description given in the 'Herschel Space Observatory Operations Scenario Document' (the Scenario Document = [AD2]) which elaborated on the ideas presented in the SMP. The HSC SIP has been generated in response to the SIRD version 1.1, issued on 18 May 2001, with (additional) assumptions as given in Section 4.

The full response to the SIRD is contained in four separate SIPs, one being generated by each component of the Herschel science ground segment covering its respective areas of responsibility in the implementation. There is one SIP for each of the three Instrument Control Centres (ICCs, [RD6]), thus the full response to the SIRD consists of a total of four SIPs, including the HSC SIP.

The SIRD, and therefore the HSC SIP, is valid through all funded phases of the Herschel mission. This document covers the entire funded mission life, from the selection of instruments until the end of the post-operational phase (for a mission timeline overview cf. Section 4.3). Note that the final historical archive phase, the 'legacy' of the mission, in this respect is not considered a part of the mission itself and is consequently outside the scope of the present document.

The HSC SIP gives an overview of all tasks to be performed by the HSC, as well as the overall schedule for each task. It does not contain the detailed work package(s) (WPs) of each (sub-)task; these can be found in the 'HSC SIP: Work Packages Descriptions' document [RD11].

The Herschel Common Science System (HCSS) development has a special status. It is carried out under the responsibility of the HSC Development Manager (HSCDT) by the Common (with the ICCs) Software Development Team (CSDT). This work is decribed in detail in the 'Software Project Management Plan' (SPMP = [RD9]), which also contains the WP descriptions for these activities. The 'body' part of the SPMP should be considered an integral part of the HCSS development part of the current document (Section 5.5), and the WP descriptions in the SPMP an integral part of [RD11].

Finally, the costing is outside the scope of the current document. The costing is performed and the resulting CaC is provided in the 'HSC SIP: Costing and CaC' document [RD15].

The custodian of the current document is Göran Pilbratt, SCI-SA.

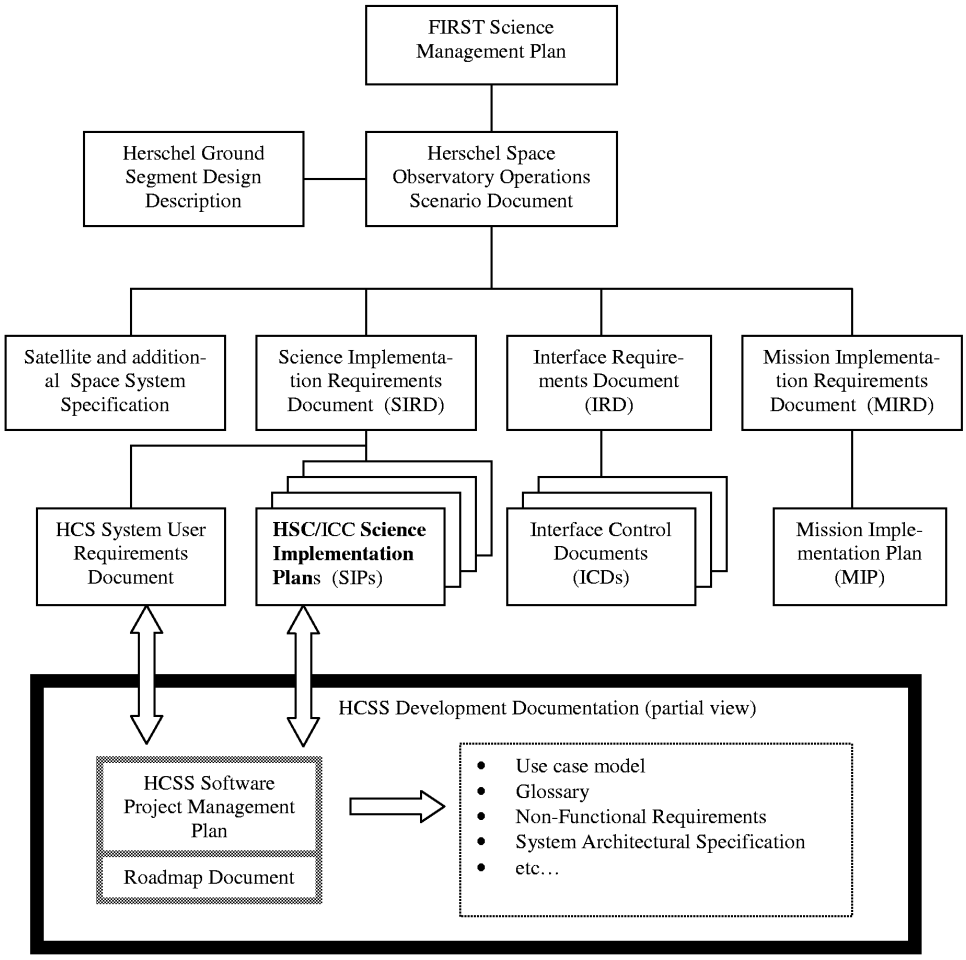


Figure 1.1 *Top level document tree for the Herschel mission. The (FIRST) Science Management Plan (SMP) has been approved by the Science Programme Committee (SPC). The Scenario document is a narrative elaboration of the ideas in the SMP, serving as the source for the formal requirements documents in the third level, including the SIRD. The* ***current document*** *(usually referred to as the* ***HSC SIP****) is the HSC response to the SIRD. The total response to the SIRD includes the HSC SIP as well as the three ICC SIPs.*

1.2 Applicable Documents

AD1: FIRST Science Management Plan (SMP), ESA/SPC(97)22, rev.1 = FIRST/FSC/DOC/0019
AD2: Herschel Space Observatory Operations Scenario Document, FIRST/FSC/DOC/0114

AD3: Herschel Science Operations Implementation Requirements Document (SIRD), SCI-PT-3646
AD4: Herschel Instrument Interface Document, part A
AD5: Herschel Instrument Interface Document, part B
- The HIFI Instrument (HIFI IIDB)
- The PACS Instrument (PACS IIDB)
- The SPIRE Instrument (SPIRE IIDB)

1.3 Reference Documents

RD1: FIRST Science Operations Concept and Ground Segment Document, SCI-PT-3056
RD2: The FIRST Announcement of Opportunity (AO) documentation
RD3: The HIFI Instrument Proposal
RD4: The PACS Instrument Proposal
RD5: The SPIRE Instrument Proposal
RD6: Science Implementation Plans (SIPs) for:
- The HIFI Instrument Control Centre (HIFI SIP)
- The PACS Instrument Control Centre (PACS SIP)
- The SPIRE Instrument Control Centre (SPIRE SIP)

RD7: FINDAS Prototype Concept Evaluation Report, FIRST/FSC/REP/0103
RD8: HCSS User Requirements Document, FIRST/FSC/DOC/0115
RD9: HCSS Software Project Management Plan, FIRST/FSC/DOC/0116
RD10: Herschel Ground Segment Interface Requirements Document, FIRST/FSC/DOC/0117
RD11: HSC SIP: Work Packages Descriptions, Herschel/HSC/DOC/0250
RD12: ECSS-M-40 (customised for HSC)
RD13: ECSS-Q-80 (customised for HSC)
RD14: Herschel/Planck Ground Segment Review Plan, SCI-PT-8690
RD15: HSC SIP: Costing and CaC, Herschel/HSC/DOC/0251

1.4 Acronyms

ADD	Architectural Design Document
AGN	Active Galactic Nuclei
AO	Announcement of Opportunity
AOT	Astronomy Observation Templates
AU	Astronomical Unit
CaC	Cost at Completion
CC	Configuration Control
CCB	Configuration Control Board
CMS	Configuration Management Subsystem
COP	Commissioning Operations Plan
CRE	Cryogenic Readout Electronics
CS4	Cornerstone 4 (=Herschel)
CSDT	Common Software Development Team
CST	Community Support Tools
CUS	Common Uplink System

DDD	Detailed Design Document
DMS	Document Management System
DPC	(Planck) Data Processing Centre
EE, E2E	End to End
ESA	European Space Agency
FAR	Flight Acceptance Review
FINDAS	FIRST Integrated Network and Data Archive System
FIRST	Far InfraRed and Submillimetre Telescope (now Herschel)
FRD	Formatted Raw Data
FRR	Flight Readiness Review
HCSS	Herschel Common Science System
HGSAG	Herschel Ground Segment Advisory Group
HOTAC	Herschel Observation Time Allocation Committee
HSC	Herschel Science Centre
HSCDM	HSC Development Manager
HSCOM	HSC Operations Manager
HSCOT	HSC Operations Team
Herschel ST	Herschel Science Team
FTS	Fourier Transform Spectrometer
GFURD	Ground Facility User Requirement Document
GO	General Observer
GS	Ground Segment
GT	Guaranteed Time
GTO	GT Observer
GUI	Graphical User Interface
HEB	Hot Electron Bolometer
HIFI	Heterodyne Instrument for the Far Infrared
ICC	Instrument Control Centre
ICD	Interface Control Document
ICR	Infrastructure Change Request
ICS	Instrument Command Sequences
IDIS	(Planck) Integrated Data and Information System
IID	Instrument Interface Document
INTEGRAL	International Gamma-ray Astrophysics Laboratory
ISCL	Instrument Specific Class Libraries
ISO	Infrared Space Observatory
ITT	Invitation To Tender
LRP	Long-Range Plan
MCR	Model Change Request
MDB	Mission Data Base
MOC	Mission Operations Centre
MPS	Mission Planning Subsystem
OD	Operational Day
ODBMS	Object Data Base Management System
OFD	On the Fly processed Data
OFP	On the Fly Processing
OFR	On the Fly processing Report
OO	Object Oriented
OODBMS	Object Oriented Data Base Management System
OT	Open Time
PACS	Photodetector Array Camera and Spectrometer
PDB	Proposal Data Base

PER	Proposal Evaluation Report
PHS	Proposal Handling Subsystem
PI	Principal Investigator
PLM	Payload Module
PM	Project Manager
POF	Planning Observation File
PPS	Pre-Processing Subsystem
PS	Project Scientist
PSO	Planck Science Office
PST	Project Scientist Team
PV	Performance Verification
PVOP	Performance Verification Operations Plan
QA	Quality Assurance
QAR	Quality Assessment Report
QCP	Quality Control Pipeline
QPD	Quality Processed Data
RID	Review Item Discrepancies
ROP	Routine Operations Plan
SCR	Software Change Request
SIAT	System Integration and Acceptance Testing
SIP	Science Implementation Plan
SIRD	Science Implementation Requirements Document
SIS	Superconductor Insulator Superconductor
SMP	Science Management Plan
SMPS	Scientific Mission Planning Strategy
SPC	(ESA) Science Programme Committee
SPIRE	Spectral and Photometric Imaging REceiver
SPR	Software Problem Reports
SRD	Software Requirements Document
SRSD	Scientific Requirement Scheduling Document
SSD	Software Specification Document
SSD	Space Science Department
SSO	Solar System Objects
SVM	Service Module
SVS	Schedule Visualization Software
SVT	System Validation Test
TA	Technical Assistant
ToO	Target of Opportunity
UML	Unified Modeling Language
URD	User Requirements Document
WBS	Work Breakdown Structure
WP	Work Package
WWW	World Wide Web
XMM	X-ray Multi Mirror (now XMM-Newton)

2 HERSCHEL MISSION OVERVIEW

This descriptive section is only intended to make this document self standing. For a more extensive introduction see the Scenario Document ([AD2]) Sections 3 and 4. In case of contradiction, the Scenario Document takes precedence.

2.1 Introduction

The Herschel Space Observatory is a multi-user 'observatory type' mission targeting the far infrared and sub millimetre part of the spectrum. It will perform photometry and spectroscopy covering approximately the 57-670 μm band.

The key science objectives emphasize current questions connected to the formation of galaxies and stars, however, having unique capabilities in several ways, Herschel will be a facility available to the entire astronomical community. Because Herschel to some extent will be its own pathfinder, the planning and implementation of the overall observing programme as well as the issue of instrument calibration and data processing timeliness have special importance.

Once operational Herschel will offer a minimum of 3 years of routine observations; roughly 2/3 of the available observing time is open to the general astronomical community through a standard competitive proposal procedure.

Herschel is one of the original four 'cornerstone' missions in the European Space Agency (ESA) 'Horizon 2000' long term science plan. The ESA Science Programme Committee (SPC) decided to implement Herschel - then called FIRST - as Cornerstone 4 (CS4) in its November 1993 meeting.

2.2 Science Objectives

Herschel and its instruments have been conceived to provide unique contributions to the studies of the formation and evolution of stars and galaxies. The Herschel wavelength region of the spectrum, 57-670 μm, bridges the gap between what can be observed from current and future ground-based facilities and that of other space missions. Thermal radiation from black-bodies (dust grains) with temperatures between 5 K and 50 K peak, and gases with temperatures between 10 K and a few hundred K emit their brightest molecular and atomic emission lines, in the Herschel wavelength range. These conditions are widespread everywhere from within our own solar system to the most distant reaches of the Universe!

Herschel - being a unique facility in many ways - has the potential of discovering the earliest epoch protogalaxies, revealing the cosmologically evolving AGN-starburst symbiosis, and unravelling the mechanisms

involved in the formation of stars and planetary system bodies. The key science objectives emphasise specifically the formation of stars and galaxies, and the interrelation between the two.

A major strength of Herschel is its photometric mapping capability for performing unbiased surveys related to galaxy and star formation. Redshifted ultraluminous IRAS galaxies (with spectral energy distributions (SEDs) that 'peak' in the 50-100 μm range in their rest frames) as well as class 0 proto-stars and pre-stellar objects peak in the Herschel 'prime' band. Herschel is also well equipped to perform spectroscopic follow-up observations to further characterise particularly interesting individual objects.

Bringing the Herschel capabilities into space for the first time has the important consequence that, at least to a certain degree, it will need to be its own pathfinder. Given this fact and the science objectives of Herschel, it was anticipated already in the SMP ([AD1]) that large 'key projects' in the form of large photometric and spectral 'survey' type programmes would constitute an important part of the overall observing programme. Because only Herschel itself can perform some of the necessary follow-up observations, the key projects must be carried out early in the mission and it must be possible to process the resulting data satisfactorily on the same time scale.

All astronomy missions and observatories - ground, air, and space based - to varying degrees rely on, and complement, each other; in this respect Herschel is not an exception. From past experience, it is also clear that the 'discovery potential' is significant when a new capability is being implemented for the first time. Thus, since a space facility is essential in this wavelength range Herschel will be breaking new ground!

2.3 Science Payload

The Herschel science payload complement will be provided by Principal Investigator (PI) consortia, which have been selected through an Announcement of Opportunity (AO) process. The science payload will consist of the following three instruments: PACS, SPIRE, and HIFI.

The **Photodetector Array Camera and Spectrometer (PACS)** instrument; **PI: A. Poglitsch**, MPE, Garching, Germany, with Co-PI C. Waelkens, KU Leuven, Belgium.

PACS is a camera and medium resolution spectrometer, covering the wavelengths shortward of about 200 μm. It uses two bolometer arrays to provide simultaneous photometric imaging capability in two bands, one of the two 'blue' bands covering 60-90 or 90-130 μm, and the 'red' band covering 130-210 μm. Both bands will have a field of view of 1.75x3.5 arcmin, employing 32x64 and 16x32 pixel arrays respectively. As a spectrometer PACS provides a resolving power R in the range 1500-2000 (velocity resolution in the range 150-200 km/s) with an instantaneous coverage of roughly 1500 km/s and simultaneous imaging of a 50x50 arcsec field of view, resolved into 5x5 pixels, using two Ge:Ga photoconductor arrays covering the same bands as the photometers.

The **Spectral and Photometric Imaging Receiver (SPIRE)** instrument; **PI: M. Griffin**, Cardiff University, Cardiff, United Kingdom with Co-PI L. Vigroux, SAp, Saclay, France.

SPIRE is also a camera and medium resolution spectrometer, it is complementary to PACS covering the wavelengths longward of 200 μm. It uses three bolometer arrays to provide simultaneous photometric imaging capability in three bands centred on 250, 350, and 550 μm over a field of view of 4x8 arcmin, employing 149, 88, and 43 pixel feedhorn bolometer arrays respectively. For spectroscopy SPIRE will use

a fourier-transform spectrometer with two input and two output ports. The two input ports view the sky and a calibration source (which is 'nulling' the telescope background), in the two output ports there are bolometer arrays covering either of 200-300 or 300-670 μm, with a circular 2.6 arcmin FOV and a resolution R of about 1000 at 250 μm.

The **Heterodyne Instrument for the Far Infrared (HIFI)**; **PI: Thijs de Graauw**, SRON, Groningen, The Netherlands, with Co-PIs E. Caux, CESR, Toulouse, France, T. Phillips, Caltech, Pasadena, USA, and J. Stutzki, U Cologne, Germany.

HIFI is a very high resolution spectrometer. It combines the high spectral resolving power capability of the radio heterodyne technique with the low noise detection offered by superconductor physics. It employs five pairs of Superconductor-Insulator-Superconductor (SIS) mixers giving continuous frequency coverage of the 480-1250 GHz band, with two additional higher frequency bands using Hot Electron Bolometer (HEB) mixers targeting the 1410-1910 GHz band. The instantaneous 4 GHz bandwidth is analysed in parallel by a combination of wide -and narrow-band spectrometers which will enable HIFI to perform rapid and complete spectral surveys with resolving powers R ($\lambda/\Delta\lambda$) in the range10^3 to 10^7 (providing velocity resolution in the range 0.03-300 km/s).

2.4 Spacecraft and Mission Implementation

In order to perform sensitive observations in the Herschel wavelength range it is necessary to have a large, low background telescope and cryogenically cooled science instruments. Herschel will employ an Infrared Space Observatory (ISO) derived cryostat to house the focal plane units of its scientific payload complement of three instruments, while its telescope will be accommodated outside the cryostat to maximise size, passively cooled, and optimised for low emissivity.

The Herschel spacecraft is modular in design, three-axis stabilised and points very accurately to specific objects selected for observation (cf. Figure 2.1). The payload module (PLM) consists of the cryostat and the telescope. The Herschel telescope is a 3.5 m diameter Cassegrain system, optimised for low emissivity. It is protected from sun illumination by the sun shield, and will passively cool to an operating temperature in the vicinity of 75 K. The focal plane units of the three scientific instruments are located inside the cryostat. The cryostat is protected in a similar way as the telescope from direct sun illumination via the sun shield.

The service module (SVM) is mounted below the PLM and carries all spacecraft electronics and those instrument units that operate in an ambient temperature environment. The Herschel concept used for payload accommodation and preliminary mission design studies is illustrated on the cover of this document. It measures approximately 9 m in height, 4.5 m in width, and has a launch mass of 3300 kg.

In order to offer the best possible thermal environment for the spacecraft, and the least possible restrictions for the available sky coverage for observations, an operational orbit around the sun–earth/moon system Lagrangian point L2 (located approximately 1.5 million km (0.01 AU) from the earth, in the anti-sun direction) has been selected.

Herschel will observe autonomously for a nominal period of 21 hours per day, collecting scientific and housekeeping data and storing them in a solid state recorder on board. The 35 m New Norcia antenna will be the single ground station used by Herschel in the routine operational phase. The ground station visibility

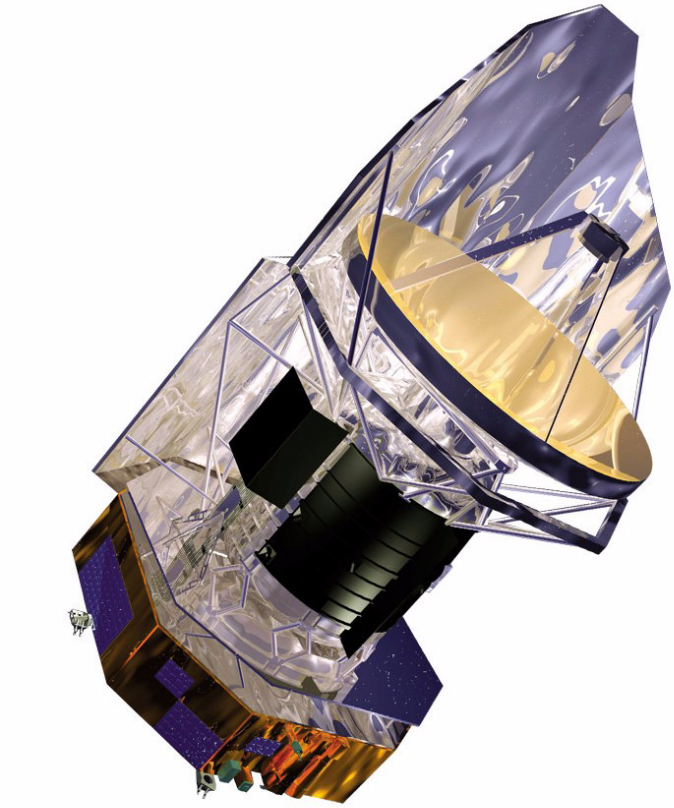


Figure 2.1 *Impression of the Herschel spacecraft performing in orbit operations.*

foreseen that a nominally 3 hour slot will be used for 'real-time' contact (health assessment of spacecraft and instruments, maintenance, etc.), science data downlink (mass memory dump) to the ground station, and uploading of future schedules (time-tagged command sequences). It is foreseen that Herschel will be conducting observations also during the ground contact period, however, subject to sky visibility and other operational constraints.

2.5 Science Operations and Ground Segment Overview

Herschel is a multi-user observatory, open to the general international astronomical community. The science ground segment needs to be appropriately designed to cater for all users, including providing an interface for the community at large to keep abreast with Herschel developments as they happen – especially with regard to its predicted scientific capabilities and schedule for the planned calls for observing proposals – and to provide user support.

The Herschel science operations concept has been designed with the objective to minimise the total overall operations effort (and thus cost) within the constraints given. In order to implement an efficient science ground segment clear and logical divisions of responsibility with clearly defined deliveries and interfaces

must be established; expertise must be utilised efficiently; operability and data reduction must be key drivers for the design, ground test, characterisation, and calibration programs of the instruments; commonality between the various instruments and between the ground and flight operational environments should be enforced; and the design must minimise overheads and needs of dedicated infrastructure.

The above considerations have led to a ‘distributed’ ground segment concept. The ground segment concept is foreseen to comprise six elements:

- the Herschel Science Centre (HSC), provided by ESA,
- three dedicated Instrument Control Centres (ICCs), one for each of the three instruments provided by the respective PI,
- the Mission Operations Centre (MOC), provided by ESA, and
- the associated NASA Herschel Science Center (NHSC), provided by NASA.

The present assumption is that during in-orbit operations the HSC will be located at VILSPA, Villafranca, the MOC at ESOC, Darmstadt or VILSPA, Villafranca (preferred by the HSC but TBD), the PACS ICC at MPE, Garching, the SPIRE ICC at RAL, Didcot, the HIFI ICC at SRON, Groningen, and the NHSC at the (Caltech/JPL) Infrared Processing and Analysis Center (IPAC), Pasadena, CA.

The ground segment elements will be united by computer links into a coherent science ground segment. These computer links are part of the Herschel Common Science System (HCSS), a collection of software and hardware facilities that together act as the common repository for all information, data and software relevant for Herschel operations in the broadest sense. At the same time it provides the backbone for the retrieval and communication of this information for and between all legitimate Herschel users. A vital assumption is that adequate bandwidth between the ground segment elements will be available.

3 HSC AS A GROUND SEGMENT ELEMENT

3.1 Introduction

The tasks of the Herschel Science Centre (HSC), as well as the tasks of the other elements of the Herschel ground segment, are outlined in the (then FIRST) Science Management Plan (SMP = [AD1]), and further elaborated upon in the Herschel Operations Scenario Document (the Scenario Document = [AD2]. The derived formal requirements are listed in the Herschel Science Operations Implementation Requirements Document (SIRD = [AD3]), and the interfaces between the elements will be specified in Interface Control Documents kept under configuration control (cf. the document tree in Section 1.1).

3.2 Herschel Science Centre (HSC) Task Overview

The Herschel Science Centre (HSC) is the interface to the general scientific community for contacting the Herschel observatory.

The HSC will be responsible for all ‘observatory’ aspects of the mission. The HSC shall ensure that the scientific productivity and impact of the Herschel mission is maximised within the given constraints. For this task the HSC will be supported by the Herschel Science Team, and the Herschel Observing Time Allocation Committee (HOTAC).

Specifically, the HSC responsibilities are:

- to perform overall science coordination and scientific mission planning strategy, taking guidance from the Science Team,
- to issue calls for observing time proposals, and the handling of proposals,
- to set up and support the HOTAC for time allocation and proposal rating,
- to provide general community support throughout all mission phases, acting as a single-point input (requests, proposals), output (information, data, software) interface and ‘central helpdesk’,
- to coordinate cross-calibration between Herschel instruments, and between Herschel and other facilities,
- to give support to ESA PR and science communications activities.

In addition, the HSC is responsible for a number of functional tasks, including the responsibility for HSC

software development. In particular, the HSC functional tasks are:

- to perform detailed scientific mission planning,
- to provide quality control information on all observational data,
- HCSS design together with ICCs, development, coordination and maintenance, including the integration of its subsystems according to agreed standards,
- to provide, manage, and maintain the central Herschel data base, and all the HSC software subsystems,
- to populate HCSS with Herschel test, characterisation, science, and operational data,
- to provide the framework and the interfaces with the astronomer for all community interaction, e.g. for information gathering, proposing, data browsing and retrieval/distribution, on-demand data processing, and generation of data and quick-look products,
- to ensure overall ground segment consistency with respect to instrument configuration, including onboard software,
- to perform configuration control and product assurance of all HSC items,
- to provide and maintain the HSC specific infrastructure, including training of staff,
- to lead system engineering tasks and to establish interfaces between all Herschel ground segment elements.

The HSC has major functional interfaces with the Instrument Control Centres (ICCs) and the Mission Operations Centre (MOC); in addition the HSC should provide support to the Planck mission by archiving the final Planck data products. The NASA Herschel Science Center (NHSC) is expected to provide community support to the US users of Herschel.

3.3 Instrument Control Centre (ICC) Task Overview

The ICCs are responsible for the successful operation of their respective instruments, and for providing software and procedures for the processing of the resulting data. The ICCs are responsible for most instrument related operational issues; instrument monitoring and calibration, developing and maintaining instrument specific software and procedures, and supporting operations. Each ICC performs tasks dedicated to their particular instrument. In particular the responsibilities include:

- the monitoring of instrument development, testing, characterisation and calibration,
- status and health monitoring, and maintenance of the instrument,
- the provision of instrument simulators for inclusion into the satellite simulator,
- the provision of instrument “time estimators”,

- the provision of instrument command generation facilities. The ICC generates and verifies commands for tests, calibration and scientific validation purposes,
- the maintenance of the instrument onboard software which has been generated and validated by the instrument teams,
- the generation and maintenance of all instrument specific software,
- input to the procedures needed for operating the instruments, and for performing monitoring and trend analysis,
- the provision of all software required for error correction, calibration, and generally for the scientific processing of the data from the instruments, including interactive analysis tools and scripts ('recipes' with executable command files) allowing the generation of 'standard' data products,
- instrument calibration; all aspects of the instrument specific calibration during all phases of the mission,
- the production of instrument and software user manuals, and inputs for the observer manuals,
- provision of necessary instrument information to the HSC and MOC,
- the definition and scientific validation of AOTs and test modes,
- scientific exploitation. The ICCs play a central role in requiring the instrument consortia to process and scientifically exploit their guaranteed time data, and thereby maximise the scientific return from the mission,
- to support the HSC in areas requiring special instrument expertise, e.g. for quality control of the observations, and community support involving the use of ICC delivered software. In particular, the ICC will review and formally endorse instrument manuals issued in support of the calls for observing proposals, and they will assist the HSC in answering instrument specific queries with complexity beyond available HSC expertise.

There will also be an ICC set-up at the MOC, called the ICC@MOC. It will be used during the commissioning phase and potentially for the remainder of the mission during instrument emergencies. It will allow for TM monitoring and commanding (via MOC) of the instruments.

The responsibility for the design, implementation, and operation of the ICCs rests with the corresponding PIs.

3.4 Mission Operations Centre (MOC) Task Overview

The Mission operations Centre (MOC) is responsible for all 'real-time' operations of the satellite i.e. the spacecraft as well as the science instrument complement. Herschel will perform science operations during the whole OD. Ground station contact will be carried out during 2-4 hours, which entails repointing the spacecraft telemetry antenna towards the earth and transmitting the data stored during the observations.

The responsibilities of the MOC include:

- Generating all commands to be uplinked to the satellite based on input from the HSC, the ICCs and its own subsystems,
- receiving, recording for safekeeping, consolidation of the telemetry data and making these data (together with the auxiliary data) available to the rest of the Ground Segment,
- making near real-time telemetry available to the ICC@MOC; providing the ICCs with necessary space, etc. for setting up the ICC@MOC,
- ensuring the health and safety of the satellite and all its subsystems, including that of the science instrument complement,
- maintaining the instrument and spacecraft data bases shared by the MOC, ICCs, and HSC, and of the SCOS-2000 system used by the MOC and ICCs.

The responsibility for the design, implementation, and operation of the MOC rests with ESA/ESOC.

3.5 Planck Mission Tasks

The Planck mission is a PI mission, it does not offer 'open' (general community) time. Consequently the full responsibilities both for mission planning ('uplink'), and data processing including scientific product generation ('downlink'), rest entirely with the PI consortia. The two Planck PIs have each established a Data Processing Centre (DPC) for this purpose, with an infrastructure called the Integrated Data and Information System (IDIS). However, there is no equivalent to the HSC in the Planck science ground segment. It is foreseen that the Planck science data and final data products will be stored into the HCSS for community-wide access.

Thus, it is envisaged to use the HCSS to carry out the following tasks:

- the storage of the Planck data and final data products,
- the provision of the access tools necessary to allow the astronomical community access to Planck data and final data products,

Implementation of these tasks will be addressed in the relevant HCSS user requirements, specifications, and design documents.

The Planck related work is assumed to be performed at the post-operational phase and the effort has been isolated in one dedicated work package. The basic principle is that the bulk of the effort of the above tasks is carried out under auspices of the Planck Science Office (PSO), the HSC task is limited to supporting and interfacing to the PSO staff. The **HSC plays no further role in the Planck mission**.

4 HSC IMPLEMENTATION ASSUMPTIONS

4.1 General Assumptions

The HSC SIP has been written in response to the SIRD (cf. Section 1.1). In addition to the outline given above concerning the overview, tasks, structure, and interfaces of the HSC, the following specific assumptions/changes and comments have been made:

- Herschel is a fully-open observatory (like ISO), implying of order a few thousand individual observers (ranging from novice to expert) performing tens of thousands of astronomical observations which must be adequately supported.
- Herschel instruments and operations will be of similar complexity as those of ISO but distributed approach brings in more complexity.
- The Common Uplink System (CUS) is part of HSCC with infrastructure under the HSC responsibility and population of modes under the responsibility of the ICCs.
- The end users, that is the HSC (representing also the general community) and ICC staff, shall be closely involved in the definition of user requirements and acceptance testing of all HCSS software.
- The scientific staff of the HSC must (be given the opportunity to) go through all the phases of using Herschel as general users by proposing, observing and reducing their own data as part of the guaranteed time for the HSC.
- Herschel will perform scientific operations (commencing with the PV phase) while still 'in transit' enroute to L2 without any special additional requirements on the HSC.
- The HSC will issue all Calls for Observing Proposals. Proposals will be submitted in two stages.
- Scientific mission planning is performed by the HSC.
- No backup schedules are required to be produced by the Mission Planning system.
- Quality information will be derived systematically at the HSC for each observation.
- No special manning arrangements shall be made for 'Targets-of-Opportunity' (ToOs).

- It is envisaged that Planck shares or makes use of some Herschel ground segment resources and facilities as described in Section 3.5.

- The Historical Archive Phase is outside the scope of the HSC SIP as described in Section 1.1, while the preparations for the historical archive are included.

The baseline for all functions during the routine phase is 5 days per week during one (~8 hour) shift, i.e. normal working hours. Nevertheless, HCSS is nominally expected to be available at all times. It is foreseen that during the mission phases preceding the routine phase, HSC will have to be manned every day, for extended hours.

To be able to properly support the scientific community the HSC needs staff with hands-on experience of the Herschel instruments and their associated software. Recruited well in advance of the start of in-orbit operations, these staff will spend extensive colocation periods with the instruments/ICCs in the development phase. This is necessary in order to build up the needed instrument expertise, particularly with regard to user handbooks (observer and data/software user manuals), instrument calibration, and data reduction and processing, for enabling them to discharge their community support functions effectively. As a goal the HSC shall have instrument expertise sufficient to deal with 95% (TBC) of the community requests for assistance.

All astronomers in HSC should to spend 30% of their nominal working time doing independent research in astronomy, putting themselves in the position of the members of the community they support. This has been taken explicitly into account when calculating efforts, all astronomers have been counted as 0.3 FTEs in research work package and 0.7 FTEs in total in other work packages.

4.2 Costing Assumptions

The costing performed for the HSC is based on the following assumptions:

- The basic salary assumption for all man-years is grade A3/4, expatriate, married with 1 child, ESTEC level salary during development phase, VILSPA level salary for operational staff after move to Spain for operations and post-operations.

- The cost estimate generated from the SIP includes co-location of HSC manpower (calibration scientist) to ICCs for extended periods to gain instrument expertise needed during operations. No other extended co-location of HSC manpower to MOC or ICCs are expected, nor does it include any provision of manpower to ICCs.

- The SIRD defines many important development and operational tasks to be carried out by parties external to the HSC, in particular by the ICCs. Because of the strong interdependency of the activities of the ICCs and the HSC, it is clear that any failure of the external parties to discharge their respective responsibilities in a timely fashion will have an adverse impact on the HSC. Such a situation will require either a descoping of the science mission, or an increase of the HSC CaC, or a combination of the two.

- The cost estimate does not include any communications costs (networks) between the HSC and the MOC, the ICCs, the NHSC, or any other place or individual.

4.3 Mission Phases and Milestones

The following time lines have been used as working assumptions in this document. They are taken from the Scenario Document ([AD2]) and correspond to actual dates in the past, or to current planning. Only the 'mission level' reviews and a selection of the most important dates vis-à-vis the instrument and spacecraft hardware as well as the calls for observing time are listed.

In addition to the mission level reviews there is a set of reviews for each of the instruments, the satellite system, and the ground segment, as well as separate reviews for components of the ground segment, as described in the 'Herschel/Planck Ground Segment Review Plan ([RD14]).

4.3.1 Development Phase

Release of Announcement of Opportunity (AO)	October 1997
Scientific payload complement selection	May 1998
Scientific payload complement approval	February 1999
Release of Invitation To Tender (ITT)	September 2000
Start of Phase B	April 2001
Mission level Preliminary Design Review (M-PDR)	September 2002
Start of Phase C/D	Q3 2002
Instrument Avionics Model deliveries	October 2003
Instrument Cryogenic Model deliveries	October 2003
Mission level Critical Design Review (M-CDR)	December 2003
Call for 'Key Project' observation time proposals (L-36 months)	February 2004
Instrument Proto-Flight Model deliveries	Jan 2005
Call for Guaranteed Time observation time proposals (L-24 months)	February 2005
Call 1 for Open Time observation time proposals (L-12 months)	February 2006
Mission level Flight Acceptance Review (M-FAR)	Q3 2006
Mission level Flight Readiness Review (M-FRR)	January 2007
Launch	L = 15 February 2007

4.3.2 Post Launch Time Line

The assumed schedule (the unit of time is month) post-launch. Note that the dates given for the additional calls for open observation time are TBD, although explicitly listed here. Note also that the expected time to reach the vicinity of L2 is approximately 4 months.

Launch	L = 15 February 2007
Commissioning phase (1 month)	L => L+ 1
Performance verification phase (2 months)	L+ 1 => L+ 3
Science demonstration (1 month)	L+ 3 => L+ 4
Mission level In-Orbit Commissioning Review	June 2007
Herschel routine observations (minimum 36 months)	L+ 4 => L+ >40 = Boil-off = B
Call 2 for Open Time observation time proposals	L + 12
Call 3 for Open Time observation time proposals	L + 24
Run-down phase (3 months)	B => B+ 3
Mission consolidation phase (6 months)	B+3 => B+ 9

Active archive phase (48 months) B+9 => B+57
Archive consolidation phase (6 months) B+57 => B+63 = **End** of Herschel mission
Historical archive phase (indefinite) B+63 (= **beyond the end** of Herschel mission) => undef

4.3.3 HSC Phases

The activities of the HSC have been broken down into 3 main phases:

- HSC development and preparations for the operational phase, up to the launch of Herschel. The HSC activities performed during this phase are addressed in Section 5.
- Herschel orbital operations, including commissioning phase, performance validation (PV) phase and routine operations. The HSC activities performed during this phase are addressed in Section 6.
- Post-operations leading to the provision of the historical archive. The HSC activities performed during this phase are addressed in Section 7.

The HSC development is phased in line with the milestones listed in Appendix E and associated reviews as defined in [RD14].

To facilitate transfer of knowledge and procedures, as well as for reducing conversion efforts, it is very desirable to have the same (or at least a similar) environment through all Herschel mission phases from early development to post operations. It is thus desirable that the HCSS is available (in some form) in all these phases to provide a smooth transition starting from Instrument Level Tests (ILTs) all through post operations.

In the ILT phase the ICCs will start performing the first characterisations of their instruments. The initial deliverable version of the HCSS, the HCSS v0.1, will be used to support these tests.

In the subsequent Integrated System Test (IST) phase the integrated satellite system will be tested. In this test phase a special test set-up shall be created to command the satellite and its subsystems (i.e. also the instruments) in a fashion closely resembling the final operational environment. In this phase the HCSS should function like the backbone system it will be in the post launch phases. The IST set-up should subsequently smoothly adapt into the operations environment as sketched in the previous sections.

Finally, in Post Operations the main task of the HCSS will be to provide the user community a stable access point into the Herschel legacy archive. The user community should not be adversely affected by any potential updates to the HCSS when going from operations to post operations.

4.4 HSC Teams and Transfer to VILSPA

The people working in the HSC will need to be an appropriate mix of several skills and backgrounds, most notably astronomers and software engineers. They will belong to different ‘teams’, and the internal organisation and management will be slightly different in the three phases described above (Section 4.3.3) as detailed in the appropriate sections following this one (Sections 5, 6, 7). An overview of the team sizes and build-up and wind-down periods is shown graphically in Appendix H.

The scientific tasks in HSC will be performed by the astronomers in the Project Scientist Team (PST). The team will be built up during the development phase at ESTEC, and transferred to VILSPA prior to the launch.

The HSC Development Team (HSCDT) is built up during the development phase at ESTEC with the main task of, together with the ICCs, providing a working HCSS for the HSC and ICCs to perform their tasks. In addition to PST the HCSS will be used at HSC by the Operations Team (HSCOT), which will be built up some time before the launch (mainly) in VILSPA.

Prior to launch the HSCOT will 'acceptance test' the HCSS as provided by the HSCDT. Following acceptance, the will be an overlap period when the HSCDT is available for user support as well as HCSS bug fixing and general improvements. There is thus a period of about one year around the launch when there is a peak in staff (see Appendix H) caused by the described overlap period between dismantling the HSCDT and the building up the HSCOT. This has been planned so as to ensure that the most critical period around the launch (final testing and PV phases) has sufficient staffing for all required tasks.

For the post-operations the team sizes will be reduced with the majority of the required manpower coming from the PST. There will be no division of staff into main teams as during development and operations phases. Nevertheless there will be team structure according to the tasks planned for the post-operational phase.

In both ESTEC and VILSPA it is foreseen that some fraction of the HSC complement will come from individuals not 'belonging' the HSC but who will be part of the ESTEC or VILSPA general infrastructures and allocated (and 'charged') to the HSC for some part of their time. This is especially (but not only) true for tasks where 'fractions' of people are needed; examples could be controllers, secretaries, and computer infrastructure personnel.

The actual moving between ESTEC and VILSPA is minimised by the strategy to build up and keep the HSCDT in ESTEC, providing support in VILSPA during the overlap period mentioned above, and by building up the HSCOT (mainly) in VILSPA from the very start so that they never move. What need to move is the PST and (a part of) the operational hardware, and the HCSS needs to be (re-)installed, (re-)configured, (re-)tested, and accepted in VILSPA. Since computer hardware has a limited lifetime it is planned, to the extent practical, to phase the acquisition of new hardware together with the time of the move to VILSPA in order also to minimise also the actual moving of hardware.

5 HSC DEVELOPMENT PHASE ACTIVITIES

HSC Development phase activities extend from the definition of the overall operations concept to the readiness before launch of the S/W, data bases and procedures that will be the basis for a successful Herschel operations phase. In the following, the development phase tasks are described in the frame of the main areas that conform the HSC development, that is: (i) Management; (ii) Support to HSC; (iii) Research and Scientific Support Activities; (iv) Definition of HSC; (v) HSCC Development; and (vi) HSC Operations Preparations.

5.1 Management

The Herschel Science Management Plan (SMP) charges the Project Scientist (PS) with the responsibility to manage the science programme, to safeguard the scientific interests, and to maximise the scientific return of the Herschel Space Observatory throughout all mission phases. The PS has overall responsibility for the HSC, but belongs to the ESA RSSD Astrophysics Missions Division and is not formally part of the HSC complement, except for missions which are conducted in relation to Herschel. Therefore the PS tasks, reporting and responsibilities are not detailed any further in this document.

The development phase main tasks can be divided between three teams. In addition there are support tasks (e.g. project control) which will be shared between the teams. The Project Scientist Team belongs to RSSD Astrophysics Missions Division and is responsible of the scientific tasks during development phase and preparations for the scientific tasks during operations. The team reports to the Project Scientist. The Development Team belongs to RSSD Science Operations and Data Systems Division and is responsible of the the delivery of HSSC (S/W and H/W) in the location for operations (VILSPA). The Development Team reports to the Development Manager. The Operations Team belongs to RSSD Science Operations and Data Systems Division and is responsible of preparations for non-scientific operational tasks and of tests and simulations of operations during development phase. The Operations Team reports to the HSC Operations Manager.

5.1.1 HSC Development Management

An HSC Development Manager (HSCDM) will be required to oversee and control the development activities.

5.1.2 HSC Science Operations Management

An HSC Science Operations Manager (HSCOM) will be required for the operations preparation.

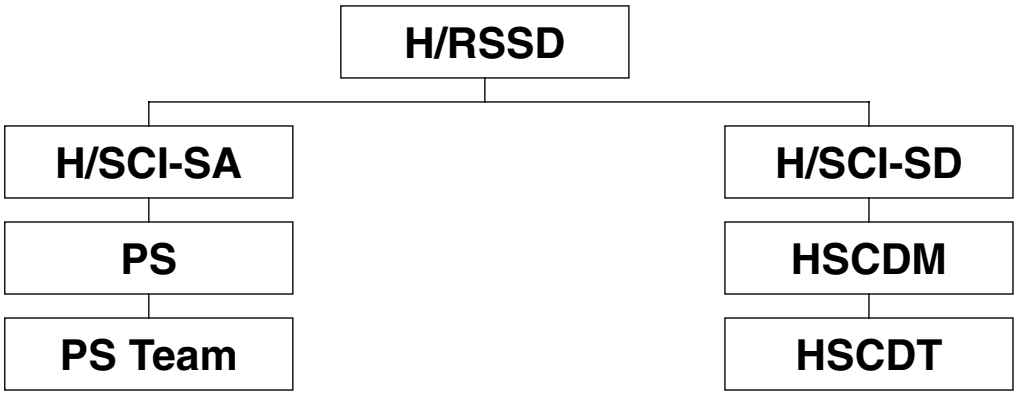


Figure 5.1 *HSC internal organisation during the development phase. The PS reports to H/SCI-SA while the HSCDM reports to H/SCI-SD in order to ensure a 'division' between the 'customer' and the 'supplier', notwithstanding the close collaboration between the two. The HSCDT is now a part of the CSDT with the HSCDM coordinating the entire team. The HSC 'Exec' consists of the PS and the HSCDM.*

5.1.3 HSC Team Management

The HSC will be structured in a number of teams, each one being responsible for a certain HSC area (e.g. HSC scientific support, integration and test team, mission planning). It is assumed that there will be a team leader for each group, who will spend a fraction of his/her nominal working time undertaking management tasks in addition to his/her technical or scientific tasks. The community support plan will be written by the team leader for community support.

5.2 Support Functions

5.2.1 Project Control

Project control support will be required through all phases. It will include preparing and maintaining the overall HSC schedule, the subsystems schedules and milestones. Project control will also provide the PS with assistance in budget control and cost control.

5.2.2 Secretarial Support

Secretarial support (dependant on overall numbers in the team) will be required.

5.2.3 Computer Administration

System management for all computer hardware and software in the HSC is required. They will be responsible for the maintenance and upgrade of all HSC H/W. This task covers the routine back-ups, installation of new operating systems, first diagnostics of failure, liaising with H/W supplier, installation of new devices, preventive maintenance, assistance to users, liaising with computer support for all network related

activities, ensuring that communication within the Ground Segment and between HSC and the outside world is satisfactory. In addition to the work package described here, they will also be assigned specific tasks for operations preparations as the ones mentioned in Section 5.6.3.3.

It is assumed that the maintenance of the overall HSC internal network and communications to the external world will be provided by third parties (e.g. computer support and MOC respectively). H/W Maintenance together with Computer Support will make sure that all the availability and performance criteria outlined in the SIRD are met, especially with regard to the HCSS- (+ network links) and HCSS database hardware. Unacceptable long unavailability or bad-performance because of software sub-systems or database configuration is managed by HSC Software Maintenance.

5.3 Research and Scientific Support Activities

The essence of the HSC support work is **provision of expertise**. Vis-à-vis the community, this is expertise in Herschel and its instruments. Vis-à-vis the rest of the project (ESA project team, the instrument teams and ICCs, and the rest of the HSC), this is expertise in knowing the community and its requirements. Clearly, in both directions, there has to be filtering of requirements/expectations etc; to be accepted, this can only be done from a position of knowledge. Thus, without adequate experienced manpower, the support part of the HSC cannot discharge its mandate.

5.3.1 Scientific Research

All astronomers in HSC should spend 30% of their nominal working time doing scientific research linked, but not necessarily restricted to ‘Herschel science’. The astronomers in HSC must have a detailed and current understanding of the facilities an observatory is expected to provide to scientists. This knowledge can only be achieved by doing actively research. For their ‘Herschel science’ the HSC astronomers must use the same tools made available for the community. This way the astronomers gain the most relevant information in view of understanding what kind of support is most urgently needed by the astronomical community in large.

5.3.2 Calibration and Cross-calibration Coordination

The HSC ensures that the proper coordination is carried out in relation with calibration activities and is responsible for the cross-calibration of the instruments. For these purposes it collaborates in the definition of the instrument calibration requirements, the in-orbit instrument calibration plans, and PV phase plans. The HSC sets up and leads the Herschel Calibration working group, in which the calibration activities are followed up and coordinated among the different instruments, and the necessary ground-based programs for calibration are established. The HSC will organize working groups with representatives of the ICCs that will focus on specific calibration topics, as is done currently on ISO, and will prepare the in-orbit calibration plan.

5.3.3 Instrument Characterisation

In order to ensure an optimal support to the community, the astronomers in the HSC must have an in-depth knowledge of the instruments, the observational data and their calibration. They monitor the instrument design and characterisation in order to assess the fulfilment of the mission scientific requirements and

instrument performance requirements. They are involved in the main instrument tests and in the generation of the instrument tests reports. This implies that the HSC instrument specialists will have to spend significant time at the ICC's. It should be assumed that, on average, each instrument specialist should spend 3 months per year at his/her instrument's centre of gravity. Clearly, during certain periods, e.g. instrument calibration campaigns, the co-location should be intensified. While located at the PI Centre (or ICC), the ESA instrument specialist should fall under PI/ICC responsibility, but should carry out a programme of work agreed in advance between the PS and the PI/ICC manager.

5.3.4 Scientific Satellite Characterisation

The HSC will coordinate with the ICCs, the Project team and the MOC those activities concerning satellite-instrument interactions that influence the scientific performance and the calibration of the instruments, and which have an impact on the HCSS end-to-end processing of the scientific data. In particular these include:

- Spacecraft subsystems-instruments, instrument-instrument physical interactions (e.g. in relation with temperatures), discovered during instrument and system tests.

- Satellite pointing analysis for general targets and solar system objects. This activity involves the definition and control of the end-to-end pointing sequence in the HCSS, that is, from the input by the astronomer of the source coordinates, through the satellite pointing requests in the planning files, to the final pointing products that will be derived from the MOC files, and that will contain the actual pointing to be used in the observations data reduction. An important task will be the verification of the instrument pointing requirements implementation in all operational and data reduction processes.

- Predictions and analysis of radiation effects on the science data, during quiet periods and in relation with solar particle events, taking into account the influence of the satellite shielding. For this purpose simulations, models and the results from ground radiation tests will be used. This task also includes the preparation for the usage of the on-board radiation monitor data during operations.

5.3.5 Community Support

This topic covers all HSC support to the Herschel astronomical user community. This includes provision of general information regarding Herschel, its instruments, policies, etc. In particular it includes the support to Key programmes and Open time proposers, which consists of:

- Prepare and issue ‘Calls for Proposals’, including documentation such as policy documents, and observer’s manuals for instruments and satellite. Prior to distribution, the instrument observer’s manuals will be reviewed by the respective ICCs, and formally endorsed by the PI.

- Support the proposers during proposal submission processes, that is, for each call and both phases. The support will be provided through email, telephone, and maintenance of web pages with information and FAQs. During the proposal submission phase 2, personal assistance to proposers on-site at the HSC will probably be organised. In this task the HSC will be supported by the ICCs when instrument expertise beyond inhouse HSC expertise is required.

- Receive and process proposal inputs.

- Perform some checking/analysis of proposals.

- Inform proposers, management and general community of the review process results.

The Helpdesk will be the front-end of the community support effort, acting as the main human interface between the astronomical community and the mission. The community should see the helpdesk as a single point of contact for queries and a single point of replies to questions independently of the complexity of getting the answer compiled at the helpdesk side. The turn around time and accuracy of information provided will, to a large extent, determine the impression the astronomical community will have of the project, its staff and the capability of ESA to run observatory type missions.

Helpdesk will use the so-called helpdesk system, which will consist of a collection of software tools to support helpdesk activities. In particular the helpdesk system should be able to track the questions and answers so that the status of each query can always be known. It should provide access to the question/ answer database (including the interface to the astronomer), and support the generation of Web pages including FAQs. In addition it should provide the possibility to make statistics on helpdesk usage. Generation and maintenance of mailing lists are also expected from the helpdesk system.

All necessary Herschel related information is assumed reside within the HCSS, thus this part of the HSC task reduces to specifying, implementing, testing, using, maintaining, the necessary tools to make the appropriate queries to the database. Typical queries would include a proposal tracking tool, and a more-specific mission constraint tool (than that used for HOTAC). This will allow HSC and the observers to get full visibility into the status of their programmes, including scheduling status and constraints.

The real service provided to the community is **expertise** in Herschel and its instruments and this manpower drives the costs. Without this expertise, the HSC **cannot** carry out its charge to support users, e.g. issuing Calls for Proposals, answering helpdesk questions, etc. nor can it ‘shield’ the ICCs from

5.3.6 HOTAC Support

This topic covers all HSC support to HOTAC. In addition to the provision of general information regarding Herschel, its instruments, policies, etc., two main tasks are envisaged:

- Providing HOTAC with the necessary proposal data base information as required, by operating the HOTAC support tools. HOTAC support tools allow to perform specialised queries on the data base and to generate reports on paper of the query result. Tools specific to HOTAC support include: assessing impacts of mission constraints (e.g. visibility), flagging duplicated pointings, statistical analysis of proposals, supporting peer review of proposals including storing of results, providing HOTAC members with on-line report submission, etc.

- Performing the technical feasibility assessments for the accepted proposals.

5.3.7 Coordination of the Guaranteed Time and Key Programmes

The HSC will act as a contact point for the scientific and technical coordination of the Guaranteed Time and Key Programmes. It will support their definition, and will issue the corresponding documentation and process the proposal inputs. Moreover, the HSC will support all review/approval processes and will inform

of the results to the interested parties. The HSC will be responsible to inform the general community of the resulting Guaranteed Time and Key Programmes.

The astronomers in the team will have a personal scientific involvement in these programmes, both through the submission of their own proposals and through participation in others.

Concerning the Key Programmes, no dedicated staffing has been incorporated to support e.g. the data processing of these programmes. On the assumption that the overall Herschel observing programme is structured so that in the early part of the mission - approx first year of the routine phase - the vast majority of the observing time is spent on Key and Guaranteed progtrammes, then it is foreseen that demand for 'normal' community support would be low enough to potentially enable HSC astronomer staff to dedicate themselves to 'Key Programme' community support.

5.3.8 Information, Public Relations and Communications

HSC has the responsibility to provide a 'single-point' of contact for the astronomical community for all issues regarding Herschel observatory, and to provide both general information as well as more specific information regarding the status of the mission.

HSC is responsible for the communication of the Herschel science opportunities and results directly to the general astronomical community, and to support the ESA Science Communication service in its role of providing information to the 'general public', and the ESA Scientific Projects Department in its role of providing information to industry.

It is also recognised that e.g. the instrument consortia, or individual institutes in these consortia, have 'communications' obligations and/or desires on their own in connection with Herschel. The HSC will on best effort basis support/coordinate such activites with those of its own.

Examples of the above include:

- the preparation of WWW pages,
- the preparation of the Herschel Newsletter.
- the organisation of workshops on specific Herschel topics and edition of the Proceedings.
- collaborating in the organisation of special Herschel sessions in scientific conferences (e.g., EAS, IAU).
- the organisation (and/or supporting, cf. below) of press conferences.
- support to ESA communications events,
- support to press releases preparation,
- support in writing/polishing of Herschel materials to be distributed directly by ESA (e.g. brochures, posters, slide sets, PR CD-ROMs, etc.).

The Internet, and in this role particularly the WWW, is foreseen to be the main medium for the provision of Herschel information. HSC will provide information both for the astronomical community and (in collaboration with the Science Communication service) the general public containing the description of the mission and its status in a clear and direct way, where appropriate making use of multimedia capabilities.

Links to the WWW pages of the instrument teams, and other relevant mission and sites will also be included. For the astronomical community, it will contain lists (and links, if possible) to Herschel publications in astronomical journals, and information on Herschel conferences and workshops. For non astronomers there should be material tailored for different groups such as for instance the general public, the interested layman, and schools.

5.4 Definition of HSC

5.4.1 Pre-Development Consolidation

Pre-development consolidation is necessary to prepare the HSC development schedule at the highest level. It is intended to establish/consolidate the initial assumptions for the Herschel instrument operations, interactions with the ICCs, the MOC, and with the wide astronomical user community, as well as the 'general public' including the media.

This is a continuation and expansion of the preparatory work that has taken place in defining the present Herschel science operations concept. It needs to be completed before significant progress can be made in scheduling HSC development activities at any detailed level. It includes the definition, together with Project, ICCs and MOC of the Herschel operational scenarios for all operational phases.

This work includes (re-)assessing – keeping potential commonality advantages with past and current ESA mission science ground segments for possible guidance and/or 'reuse' at any appropriate level, such as concept, items and/or data model, OO-analysis and design, possible implementation of some classes, automatic document generation tools, and software maintenance configuration control tools and WWW publishing, in order to lower HCSS development effort compared to the current estimates.

The output of this WP will be the system concept and will lead to a confirmation/update of assumptions made in, not only the HSC SIP, but also in the SIRD and the instrument consortia provided SIPs.

5.4.2 HCSS User's Requirements Identification

As a result of the activities described in the previous subsection and taking as inputs the Scenario Document ([AD2]) and the Herschel SIRD ([AD3]), the high-level user's requirements on the Herschel Common Science System (HCSS) will be defined and compiled in the HCSS User Requirements Document (URD) ([RD8]). The HCSS URD will contain user requirements identified both by the HSC and the ICCs and will cover all mission phases.

The user's representatives in the HSC and ICCs will be responsible to ensure that the user's requirements are properly taken into account when the 'use cases' for the HCSS subsystems (derived from the HCSS URD [RD8]) are defined by the CSDT. For this purpose the user's representatives will follow up the activities of the different groups (i.e. HST, ICCs, GSAC, HSC) across the Ground Segment. It is assumed that

the main users of the system are the astronomical community (represented by the Project Scientist and the HST), the HSC and the ICCs.

5.4.3 Detailed User Requirements

The HSC shall be the main responsible for the definition of the user requirements for the operational scientific software of the ground segment in which there are interfaces to the astronomer. These interfaces are mainly related to proposal handling, the quality assessment of the science data, the generation of the associated 'data products' (QCP, on-demand processing), and the science data query and retrieval from the HCSS archive. The specification of these requirements will be performed in collaboration with the ICCs. High level user requirements will be specified in the HCSS URD (task described in section 5.4.2), while lower-level user requirements will be described in other documents (e.g. scenario notes and use cases).

The HSC will also be the main responsible for the identification of the user requirements for the HOTAC support tools and the Community Support tools. In addition, the HSC must be involved in the user requirement definitions of operational software in which a maximum scientific return must be achieved (e.g. the Mission Planning Subsystem).

User requirements identification will be an iterative process during software development. Use cases, which are the basis of the software implementation, will be specified by the CSDT, and reviewed in detail by the user's representatives in the HSC and ICCs. In this way it is expected that a good understanding and completeness of the user requirements will be achieved.

5.4.4 Tests and User Trials

The HSC astronomers will test and devote extensive periods of user trials to all those software packages with interfaces to the general astronomer. Since the success of these tools depends on their acceptability to the user, the HSC astronomers must monitor their development and be deeply involved in the testing and feedback loops. As the tools are used, problems will be found and desired improvements specified. Thus, the HSC astronomers will need to be involved in raising SPRs and SCRs (from internal experience as well as acting as advocate and filter for the community).

As required, HSC astronomers will participate in other major testing and integration activities, as end-to-end test and operations simulations.

5.4.5 Acceptance Testing

This task covers the acceptance testing of the HSC subsystems. These activities are assumed to be carried out by a test team within HSC. The team needs to be independent from the software development team. The peak of these activities are after the HSC subsystem development completion and before and during overall ground segment test activities.

Acceptance testing of each HCSS version, starting with v0.3, is a prime task for the test team. They will be responsible for the definition of the acceptance test plans based on existing User Requirements/Use Cases, for the definition and preparations of test data, for the execution of the acceptance tests and for the preparation of test reports and conclusions. For this task it is expected that the test team will be supported by the HSC software development team, the user's representatives, and the QA function.

5.5 HCSS Development

The methodology and top level schedule for the development of the HCSS are provided in the HCSS Software Project Management Plan (SPMP = [RD9]). Also, the detailed schedule and the Work Packages for each development phase will be provided with updates to this SPMP. The essential input to the start of the development are:

- Herschel Space Observatory Operations Scenario Document ([AD2])
- HCSS URD ([RD8])
- HCSS SPMP ([RD9])
- Herschel Ground Segment Interface Requirements Document ([RD10])

In summary, the HCSS will be developed incrementally using an object-oriented approach. As was agreed at the HSC Development kick-off meeting (cf. Herschel/HSC/MOM/0106), six system releases will be made at approximately yearly intervals starting in spring 2002 and ending with the first operational version 1.0 in December 2006. The development will be use-case driven and the emphasis will be on establishing and maintaining an integrated HCSS from v0.1 onward.

Conceptually, the HCSS will consist of the following subsystems:

- A Proposal Submission and Handling subsystem, including proposal generation support tools for astronomers,
- Tools for use by the Project Scientist Team in their support of the astronomical community and the Herschel Observing Time Allocation Committee,
- A Scientific Mission Planning (scheduling) subsystem,
- An Archiving subsystem for the permanent storage of all relevant Herschel data, software and documentation, together with the necessary infrastructure for submission, querying and retrieval of these data by authorized parties,
- A Configuration and Version control system for all data, software, and documentation produced during Herschel development, testing, and in-orbit operations,
- A Quality Control Pipeline subsystem, which allows a scientific user of the archived data to obtain information on the completeness of a given data set and whether or not a scripted standard processing of the data has generated any formal errors. Note that in the context of QCP and a joint HSCDT/ICCs development of the HCSS, the HSCDT contribution is mostly in the area of system architecture, infrastructure, user interfaces and scripts that assemble Interactive Analysis tools to be run in a batch-like process; while the tools themselves are provided by the ICCs.
- An Interactive Analysis subsystem, which is a natural extension of the QCP processing, as it will allow the user to configure individual Interactive Analysis tools in terms of the parameters they use and the sequence in which they are run rather than using the fixed QCP settings and sequences.

Development of all these subsystems requires extensive cooperation with and contributions from the other centres participating in the Herschel Ground Segment development, in particular

- Detailed definition of all interfaces between the MOC, HSC and ICCs,
- Detailed definition and descriptions of instrument modes (AOTs) and their parameters by the PI teams/ ICCs,
- Instrument observing time estimators from the PI teams/ICCs,
- Instrument command generators from the ICCs,
- Instrument simulators from the ICCs,
- Scientific data reduction software from the ICCs,
- Software, data and algorithms from ESA/ESOC, in particular from Flight Dynamics.

The HCSS development will be compliant with the schedule and milestones listed in Section 4.3.

5.5.1 HSC System Engineering

A system engineering function is required throughout all phases of HSC development and a full time System Engineer was put in place in October 1999. This function is particularly relevant to the ‘commonality’ desired throughout the Herschel Ground Segment elements and the coherence of the overall Ground Segment during the different phases of definition and implementation. The Herschel Ground Segment System Engineering Group (HGSSE), chaired by the HSC System Engineer and consisting of system engineers from all contributing Ground Segment centres (Project, MOC, three ICCs, HSC), has taken up work in October 1999.

The tasks covered by the HSC System Engineer include:

- organising and chairing of HGSSE meetings.
- defining, maintaining and documenting together with the HGSSE the interfaces requirement between the different elements of the Herschel Ground segment in the different mission phases.
- defining, maintaining and documenting together with the HGSSE the top level system design of the Herschel Ground segment in the different mission phases.
- contributing together with the HGSSE to the definition and implementation of the HGS system level tests.
- monitoring of system level tests
- acting as the interface of the HSC with the ICCs, MOC and Project on technical matters;

- ensuring consistency of the system reviewing all relevant documentation;
- coordinating the analysis of Herschel GS change requests originating from any member of the GS (ICCs, MOC, HSC), and the implementation of approved changes;
- assisting in diagnosing problems that affect science operations and coordination of the implementation and validation of a solution across the GS (HSC, ICCs, MOC).

5.5.2 Software Development

Software developers are responsible for the definition of the HSC System architecture at the detailed level, the definition and subsequent refinement of use cases and the resulting domain/class models, and the development of all subsystems (Section 5.5) and their verification at subsystem level.

5.5.3 Software Maintenence

Software developers are also responsible for the maintenence of the HSC System software, at system level as well as the maintenence of all subsystems (Section 5.5) and their verification at subsystem level after each update.

5.5.4 Support Functions

The following tasks are identified as support tasks within the development team as HSC responsibility in building HCSS:

- **Database Engineering**: Is required as soon as any significant amount of persistent, operationally relevant data is accumulated. Such data is expected to be injected into the HCSS from some stage of instrument level testing onward (end 2001) and when the first operational use is made of the Proposal Submission System for entering Guaranteed Time and Key Programme proposals (Q1 2004). The responsibilities of this role include proper partitioning of the archive (operational, test, scratch, etc. areas), the migration of data between these partitions, ensuring that each of these partitions is maintained in a state of integrity at all times, supporting schema evolution and providing support to the installation of the DBMS at different sites.
- **System Testing**: Has overall responsibility for the formal testing and validation of the system. He produces test plans/scenarios for all tests above unit level, ensures that the required test environment and data are available (including a mock-up of or data from systems external to the HCSS that may be required in this testing), produces test reports, feeds test results back to the developers and provides test support to the ICCs.
- **Products Engineering**: Is responsible for the coordination of interactive analysis development in the ICC consortia and the definition/generation of Quality Control Pipeline software at the HSC. Because the HSC is a major user of interactive analysis software (also on behalf of the astronomical community), it is foreseen to start this coordination as soon as substantial thought is given by the instrument teams to their interactive analysis software; this is considered necessary to prevent divergent interactive analysis software approaches by different instruments which could ultimately prevent the HSC from providing adequate support in producing scientific results from Herschel data.

- **Software Configuration Control**: Is responsible for setting up an appropriate configuration control system on top of a commercial version control system, for identifying all configurable items of the system, for producing all formal releases of the HCSS, proper tagging of all modules that constitute a formal system release, and for maintaining the system in a state such that any previous version can be regenerated on demand.

- **Quality Assurance**: Is responsible for tailoring the applicable standards for HCSS development from the ECSS standards, for overseeing that these standards are adhered to by the development team, and for providing appropriate input to the development team that allows objective measurement and tracking of development progress.

- **User Support**: Is responsible for providing support to HCSS users that are not part of the CSDT, most notably the PST. This support is provided through demonstrations and hands-on training that enables the PST to exercise and provide early feedback on the implementation of HCSS functionality and its "look and feel". This role is also responsible for the final preparation and harmonisation of HCSS User Manuals.

5.6 HSC Operations Preparations

This section covers those activities in the HSC that are directly related to the preparation of the daily operations of the Herschel satellite. It also includes the actual operation of the Proposal Handling System as a response to the calls for proposals.

5.6.1 Operation of the Proposal Handling Subsystem

All proposals, whether key, guaranteed, or open programs, are stored in HCSS. The proposals database is maintained and operated upon using the Proposal Handling Subsystem (PHS). The operation of the PHS will support phase-1 of each call for proposals. The submitted proposals will be extracted from HCSS and distributed to HOTAC for evaluation. After the selection process has been completed, the astronomers will enter the details of their approved proposals in PHS during proposal submission phase-2. This process will be supported by the PHS operators, who will check the entered observations, assign the corresponding flags for their schedule by the Mission Planning Subsystem and establish the observations database under the supervision of the HSC astronomers. The pre-launch observations data base contains all science observations to be carried out during the first year of operations, and shall be ready and operational not later than 9 months before launch i.e. on time for End-to-end test #1. This will serve the dual purpose of (1) user testing the PHS and MPS and their interaction with the observations database, and (2) training the HSC team. Furthermore, the pre-launch mission data base will be extensively used and validated during the end-to-end test and simulations.

It is assumed that the PHS operators will be technical assistants, and their peak working periods will take place after the calls for proposals (key programmes and open time), for the entry of the Guaranteed Time programme, for the supply of test data for end to end tests and simulations and the entry of Commissioning Phase/PV observations.

5.6.2 Scientific Mission Planning Preparations

5.6.2.1 Scientific Mission Planning Strategy and Supervision

The HSC will be responsible for the definition, taking guidance from the HST, of a scientific mission strategy to optimise the scientific return of the mission. In particular, the HSC shall define a clear set of scientific requirements, guidelines and instructions that will be compiled in the Scientific Requirement Scheduling Document, to be ready 6 months before launch. This includes the coordination and support to the definition of the Herschel key programs and the priority definition of guaranteed and open time observations.

5.6.2.2 Generation of the Long Term Scientific Mission Plan

In reply to the HSC SRSD, the HSC mission planners shall operate the Mission Planning Subsystem (MPS) to prepare and optimise a Long Term Plan for the initial first year of the routine phase. The Long Term Plan serves as basis to analyse the impact of schedule constraints and future strategies for mission planning. This task includes the fine-tuning and tailoring of the Mission Planning system to the scientific needs expressed in the SRSD. A first draft of this plan shall be ready by L-3 months at which point it will be reviewed by the HSC astronomers and, if required, iterated until Launch.

5.6.3 HSC Operations Implementation

5.6.3.1 Operational Interfaces

The HSC shall be responsible of the preparation of the Operational Interface Control Documents with the ICCs and MOC. The HSC participates in the definition of the interfaces between ICCs and MOC.

Therefore the following Operational ICDs will be prepared by the HSC:

- HSC to ICCs
- HSC to MOC
- HSC Facilities Operations Handbook

The above are preliminary lists of required interface documents. They may be increased according to additional needs identified in the course of the system development.

The HSC astronomers will review and approve the science operational interfaces and ground segment procedures prepared by the ICCs, HSC and MOC. The objective is to ensure that the instrument in-flight operations procedures respect the scientific objectives and provide a means for enabling maximum scientific return within the given constraints.

5.6.3.2 Preparation of the HSC Routine Phase Operations Plan and Procedures

The HSC shall prepare an HSC Routine Operations Plan (HSC-ROP) describing all operational tasks to be carried out by HSC staff during the Herschel routine operational phase. The HSC-ROP shall describe the resources required, the management of the HSC including its internal organisation in various operational units, the internal interfaces as well as the interfaces of the HSC with third parties (ICC, MOC, observers).

The HSC shall expand the HSC-ROP into a set of HSC routine operations procedures describing in detail how, when and by whom all HSC activities are to be carried out. The draft procedures shall be ready not later than L-9 m and will be used as input for the HSC training and will be validated and detailed during the GS simulations. They will nevertheless be updated continuously up to three months after completion of the PV phase.

5.6.3.3 Provision of HSC Infrastructure, H/W and Network

The HSC shall draft an HSC Ground Facility User Requirement Document (GFURD) detailing all the infrastructure (building, rooms, furniture, etc.) required for the HSC to discharge its operational duties. It is assumed that the actual infrastructure will be provided by a third party (e.g. site service) but the HSC will nevertheless be responsible to monitor that the implementation fits its GFURD requirements.

The HSC shall draft an HSC H/W plan detailing all H/W equipment and network connection for the HSC to discharge its operational duties. The final plan shall be ready not later than L-24 m.

The HSC shall procure, install configure and test all H/W equipment listed in the H/W plan. It is assumed that the network and connections will be installed by a third party (e.g. Computer Support). All H/W shall be in place and operational not later than L-12 m, i.e. well on time for the first EE tests.

5.6.4 Preparation for and Participation in the SVT and EE Tests

The HSC test team will be responsible, together with MOC and ICCs, for the definition, preparation and execution of the SVT and EE-tests where all GS H/W, S/W, and procedures shall be tested end-to-end with the S/C. This includes preparing test plans, test data (Observations database, planning files...) and procedures to be applied during these tests. They shall participate in the de-briefings and write the necessary test reports and raise SPRs as well as non conformance reports as appropriate. Support from the CSDT and ICCs for these activities is expected.

5.6.5 Preparation for and Participation in the GS Simulations

The HSC shall give input to the overall Ground Segment simulations plan and participate actively to the simulations under the supervision of the Herschel project. The HSC shall also generate all necessary HSC specific test data required for the simulations. The simulations will cover all aspects of the mission, in particular critical parts of the commissioning and PV phases (see above) as well as a significant number of routine phase ODs. As a result of these simulations, HSC procedures may have to be amended and staff retrained.

5.6.6 Preparation for the Commissioning Phase

Based on requirements and input from the ICCs and the Herschel project, the HSC shall prepare a HSC Commissioning Operations Plan (HSC-COP). This plan shall be incorporated into the Herschel commissioning plan generated under the responsibility of the Herschel project. The plan will describe the tasks, responsibilities and schedule of all operations to be carried out during the commissioning phase. The HSC-COP must be ready not later than L-9 months and put under configuration control.

Based on the commissioning phase HSC operations plan, the HSC operations team shall generate all the

special ground segment procedures and timelines applicable during the commissioning phase. The team will also set-up any special hardware configuration or software that may be required during this phase. All GS procedure timelines, H/W and S/W shall be ready by L-3 months and serve as input to the simulations.

As part of the GS simulations, the most critical commissioning phase ODs will be simulated. This point is covered elsewhere under training and simulations.

Special requirements on the HCSS to support Commissioning and Performance Verification phases are not anticipated.

5.6.7 Preparation for Performance Verification (PV) Phase

Based on requirements and input from the ICCs, the HSC shall prepare a detailed HSC Performance Verification (PV) Operations Plan (HSC-PVOP) describing the tasks, responsibilities and schedule of all operations to be carried out during the PV phase. This plan shall be ready not later than L-6 months and put under configuration control.

The HSC shall operate the PHS to populate the observations database with all validated observations and measurements to be carried out during the satellite commissioning phase (TBC) and the Performance Verification (PV) phase. All commissioning/PV phase observations must be delivered to the HSC not later than 6 months before launch.

Based on the PVOP and PV observations in the HCSS, the HSC mission planners shall generate and optimise a detailed time-line (POF) for all observations and measurements to be carried out during the PV phase. The work shall carried out from L-6 months up to the start of the PV phase.

Based on the PVOP, the HSC engineering team shall generate all the special ground segment procedures applicable during the PV phase. All GS procedures shall be ready by L-3 months and serve as input to the HSC simulations.

From the PV planning generated by the mission planners, the HSC ‘real-time’ team and engineering team shall run the mission planning S/W and validate a sizable (50%) fraction of all PV ODs through the HSC stand-alone simulator (satellite plus MOC selected functionality). This activity shall be carried out in the time frame L-6 months to the start of the PV phase. The simulations shall be witnessed by instruments specialists from the ICCs; the simulated T/M will be archived in the HCSS archive for examination and endorsement by ICC instrument specialists. As a result of this activity, the PV observations database and plannings may have to be updated.

As part of the GS simulations, a sub-set of critical PV plannings will be used as input. The PV HSC GS procedures will be exercised as well. This is covered elsewhere under training and simulations.

5.6.8 Training of HSC Staff

The HSC shall generate a suitable training plan for operators, detailing training courses and training material for all HSC operations staff. The plan shall be ready not later than L-9 months.

HSC staff shall undertake a targeted training course as well as specialized ‘hands-on’ training sessions in

their area of duty. The first phase of the training shall be completed prior to the simulations. The second phase will extend from the simulations up to launch.

6 HSC OPERATIONAL PHASE ACTIVITIES

HSC Operational phase activities are a direct follow-up to development phase activities extending till the end of mission and including preparations to the post-operational activities. In the following the operational phase tasks are described in the main areas of activity: (i) Management; (ii) Support to HSC; (iii) Research and Scientific Support Activities; (iv) HCS operations activities; and (v) HCSS maintenance.

6.1 Management

The Herschel Science Management Plan (SMP) charges the Project Scientist (PS) with the responsibility to manage the science programme, to safeguard the scientific interests, and to maximise the scientific return of the Herschel Space Observatory throughout all mission phases. The PS has overall responsibility for the HSC, but belongs to the ESA RSSD Science Operations and Data Systems Division and is not formally part of the HSC complement, except for missions which are conducted in relation to Herschel. Therefore the PS tasks, reporting and responsibilities are not detailed any further in this document.

The HSC will be structured in a number of teams, each one being responsible for a certain HSC area (e.g. the HSCOM identified during the development phase will lead a team responsible of functional tasks). It is assumed that there will be a leader for each group, who will undertake management tasks in addition to his/her technical or scientific tasks. A team leader will spend a fraction of his/her nominal working time on management.

6.2 Support Functions

6.2.1 Project Control

Project control support will be required through all phases. It will include preparing and maintaining the overall HSC schedule, the subsystems schedules and milestones. Project control will also provide the PS with assistance in budget control and cost control.

6.2.2 Secretarial Support

Secretarial support (dependant on overall numbers in the team) will be required through all phases.

6.2.3 Computer Administration

System management for all computer hardware and software in the HSC is required throughout all phases.

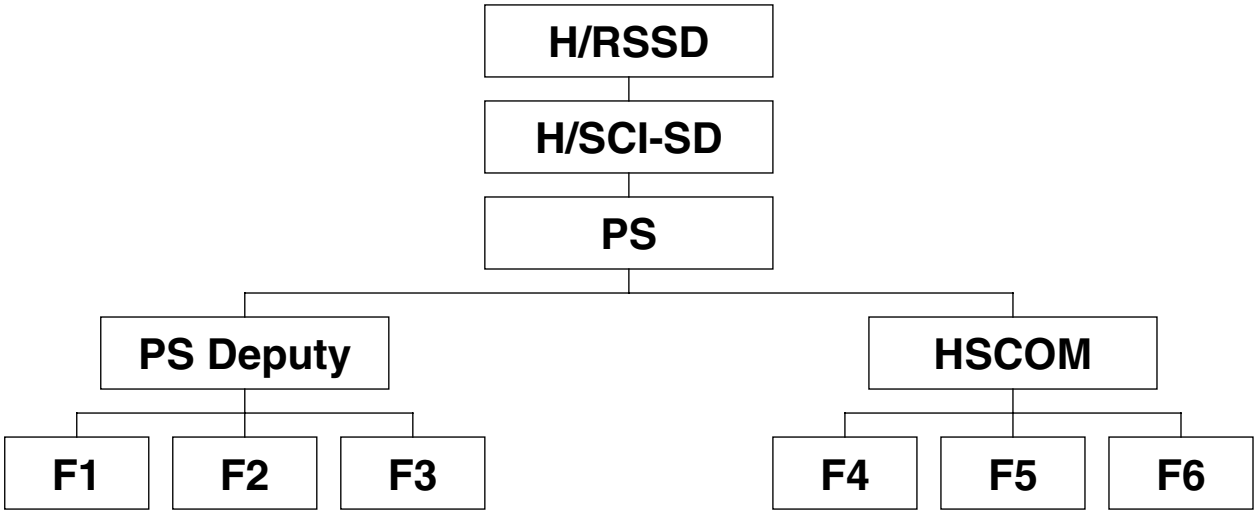


Figure 6.1 *HSC internal organisation during the in-orbit operational phase. The PS reports to H/SCI-SD, the 'scientific' tasks are lead by the PS Deputy, and the 'operational' tasks are lead by the HSCOM. The exact number and nature of the 'functional groups' (labelled Fi) are yet to be defined; examples of such groups are e.g. mission planning and hardware maintenenace. The HSC 'Exec' consists of the PS, PS Deputy, and HSCOM.*

They will be responsible for the maintenance and upgrade of all HSC H/W. This task covers the routine back-ups, installation of new operating systems, first diagnostics of failure, liaising with H/W supplier, installation of new devices, preventive maintenance, assistance to users, liaising with computer support for all network related activities, ensuring that communication within the Ground Segment and between HSC and the outside world is satisfactory.

It is assumed that the maintenance of the overall HSC internal network and communications to the external world will be provided by third parties (e.g. computer support and MOC respectively). H/W Maintenance together with Computer Support will make sure that all the availability and performance criteria outlined in the SIRD are met, especially with regard to the HCSS- (+ network links) and HCSS database hardware. Unacceptable long unavailability or bad-performance because of software sub-systems or database configuration is managed by HSC Software Maintenance.

6.3 Research and Scientific Support Activities

The scientific support activities are a continuation of tasks started in the development phase as described in Section 5.3.

6.3.1 Scientific Research

All astronomers in HSC must spend 30% of their nominal working time doing scientific research linked, but not necessarily restricted, to 'Herschel science'. This is necessary both for being able to perform their

community support functions, it is the only appropriate 'training' for the job, and for motivation and morale, the astronomers in the HSC must be an integral part of the overall Herschel astronomical (user) community.

The astronomers in HSC must have a detailed and current understanding of the facilities Herschel will provide to its users. This knowledge can only be achieved by actively doing research, as demonstrated by the ISO mission. The involvement of ISO team members in most of the major coordinated scientific programmes of the ISO mission, which began well before launch, ensured that their research work provided a profound understanding of the ISO system and the ISO data. The resulting understanding of the needs of the user community, and the capacity to fulfill those needs, cannot be achieved to a comparable degree through any other approach.

For their 'Herschel science' the HSC astronomers must use the same tools made available for the community. This way the astronomers gain the most relevant information in view of understanding what kind of support is most urgently needed by the astronomical community in large. This interaction between the engineering responsibilities of the HSC astronomers and the insight consequent upon their scientific motivation and personal engagement in the science of the mission will be an an indispensible driver towards its success.

6.3.2 Calibration and Cross-calibration Coordination

The HSC is responsible for the coordination of the cross-calibration activities as specified in the Cross-Calibration Plan. Cross-calibration will be done between the Herschel instruments, between Herschel and other far-infrared missions and through comparison with models (asteroids, planets…). The HSC will organize and coordinate cross-calibration working groups with representatives of the ICCs that will focus on cross-calibrations issues considered most relevant during operations. It is therefore expected that the ICCs will collaborate in cross-calibration activities and will provide manpower to the working groups when required. Their tasks will cover the identification of common problematic areas and the definition of common approaches for implementation, with the additional purpose of saving resources.

6.3.3 Instrument Characterisation

The instrument specialist astronomers in the HSC (cf. Section 5.3.3) will provide their expertise to HSC in community support and operational aspects. In order to maintain their expertise, they need to continue the tasks of instrument characterisation also during the operations. In order to perform these tasks visits to PI institutes are envisaged, but now with a rate of 6 one week stays per year.

6.3.4 Scientific Satellite Characterisation

The tasks described in Section 5.3.4 will continue during operations with the aim to understand all interactions between instruments and satellite with scientific impact. These include physical interaction between subsystems or instruments and (other) instruments, pointing and radiation impacts.

6.3.5 Community Support

During the execution of the observing programme, the support of the HSC to the observers will consist of:

- Assistance to maximise the output from their programmes, including tune-ups of their proposals. A particular objective in this respect is to attempt identifying programmes with poorly performing observations or inappropriate parameter settings, and work with the observer to correct and rescue their future observations.

- Monitor uplink changes and inform the users of the impacts on their programmes.

- Monitor the overall execution status of programmes and adjust them.

- Monitor and resolve duplicate pointings.

- Address data rights issues.

- Assist the observers with the data reduction of their observations. Due to the high sophistication of the Herschel instruments and the expected complexity of the data reduction, it is considered essential for the success of the mission that proper support is provided to the astronomer. This support will be required from the beginning of the operations, and will consist of a helpdesk service by email, telephone, and WWW pages with FAQs, customer satisfaction feedback, and mission performance indicators. Special effort will be made in organizing data reduction assistance on-site at the HSC for those astronomers that will require it.

- Organization of specific workshops to improve dissemination of satellite, instrument and data reduction knowledge to the general astronomical community.

- Maintain an overview of the data-processing software and user test all versions.

- Provide data reduction documentation (Data User's manuals).

- Collaborate with the ICCs in ensuring a proper provision of software (IA packages), user's manuals and data reduction recipes to the community.

For additional Open Time call(s) for proposals, the HSC will provide the astronomers with the necessary documentation and support for proposal submission, as described for the 1st call in Section 5.3.5. Also follow-up of the coordination of guaranteed time and key programmes, and other tasks as described in Section 5.3.7, is foreseen here.

All S/W packages and tools provided to the astronomical community will be routinely checked and monitored by the HSC. The HSC will issue the corresponding SPRs in case of malfunctioning and will specify new user requirements to be implemented in order to improve the service to the astronomical community. It is essential that the HSC continuously identifies the needs and requirements from the astronomical community on the Herschel ground segment.

6.3.6 HOTAC and its Support

Some degree of updating of the HOTAC support tools will be needed as a result of experience gained, both with HOTAC and with spacecraft and instruments in orbit. The HSC will specify new user requirements if necessary.

For additional Open Time call(s) for proposals, the effort for the required HOTAC support will be the same as specified in Section 5.3.6.

6.3.7 Scientific Mission Planning Strategy

The HSC ensures that the observation planning follows the defined Scientific Requirements Scheduling Document (SRSD), including (together with the HST and supported by HOTAC) assessing the relevance of the scientific mission planning strategy vis-à-vis demonstrated performance and obtained scientific results and the initiation of any necessary updating of the (SRSD).

The Project Scientist will approve the schedules for each revolution and the HSC will check routinely the observation history log and will follow up the execution of the survey programs. During the mission the Project Scientist will declare and approve the Target of Opportunity (ToO) observations and recommend their scheduling. HSC will coordinate the scheduling of fixed time observations, including Solar System Objects (SSOs), and will block or enable observations in the mission database when required to accomplish maximum science return within laid out concept of key programmes, guaranteed and open time observations.

It must be emphasized that the scheduling of SSOs is especially complex. The special characteristics of these objects regarding pointing/tracking, visibility, coordinates determination, the fact that in some cases new ephemeridies must be calculated for new sources (e.g. comets) and the usually complicated scheduling requests from the observers (related to, e.g., the SSO orbit elongation, rotation, phases) requires a significant effort during the operational phase.

The Project Scientist will request to the mission planners the production of Long Term plans in order to analyse the impact of schedule constraints and analyse future strategies for mission planning.

6.3.8 Information, Public Relations and Communications

HSC is a single-point interface for the astronomical community, the press and the general public to contact the Herschel observatory and to obtain both general information as well as more specific information regarding the status and scientific achievements of the mission.

HSC is responsible for the communication of the Herschel science opportunities and results directly to the general astronomical community, and to support the ESA Science Communication service in its role of providing information to the ‘general public’.

This task includes:

- the preparation of Web pages, which will provide information both for the astronomical community and (in collaboration with the Science Communication service) the general public. They will contain the description of the mission, its status, achievements and main discoveries in a clear and direct way, where appropriate making use of multimedia capabilities. It will also include links to the Web pages of the instrument teams, and other relevant mission and sites. For the astronomical community, it will contain lists (and links, if possible) to Herschel publications in astronomical journals, and information on Herschel conferences and workshops. For non astronomers there should be material tailored for different groups such as for instance the general public, the interested layman, and schools.

- the preparation of the Herschel Newsletter.
- the organisation of workshops on specific Herschel topics and edition of the Proceedings.
- collaborating in the organisation of special Herschel sessions in scientific conferences (e.g., EAS, IAU).
- the organisation (and/or supporting, cf. below) of press conferences.
- (supporting) the preparation of material and, possibly, commissioned articles for amateur astronomer magazines (e.g., Sky and Telescope, Astronomy, Ciel et Espace, Sterne & Weltraum, etc.).
- (supporting) the preparation of material and, possibly, commissioned articles for monthly and weekly magazines (e.g. National Geographic, GEO, Time, Newsweek, Stern, Spiegel, Focus, etc.)

HSC will provide support to the ESA Science Communications service by working in close collaboration with the Herschel Science Writer, who will be responsible for the preparation of ESA press releases and ESA information notes related to Herschel. The specific HSC Public Relations tasks are:

- support to ESA communications events,
- support to press releases preparation (e.g. information notes each about 1-2 pages long or picture releases with captions) at a frequency of 1 every 2-6 weeks,
- support in writing/polishing of Herschel materials to be distributed directly by ESA (e.g. brochures, posters, slide sets, PR CD-ROMs, etc.).

6.4 HSC Operations Activities

6.4.1 Operate the Proposal Handling Subsystem (PHS)

The HSC manages the proposals submitted by the astronomical community and uses the PHS to generate the corresponding data that will be used to produce the observation schedules. PHS operations will be carried out by Technical Assistants and will have peak activity in relation with the proposal entry for the guaranteed time and open time programs (at least two calls for proposals are envisaged). In addition, PHS will also be continuously operated during the mission for the update and tuning of proposals and for the discretionary time proposal entries. The HSC is responsible for the management of the proposal database. Moreover, the HSC will assess the impact on the observations database of any modification of the uplink system requested during the mission.

6.4.2 Support to Commissioning and PV Phases

Members of HSC will support the Commissioning and Performance Verification Phases and, if needed, join MOC for the duration of these phases. In this case the logistics and office accommodation will be provided by the MOC.

It is not foreseen to recruit special manpower during Commissioning and PV Phases, but development team members could be 'kept on' for a limited period.

6.4.3 Operate the Mission Planning Subsystem (MPS)

The HSC will require a small dedicated team of Mission Planners whose responsibility will be to produce scientific observation schedules by filling the MOC provided planning skeleton with observations from the observation database. In particular the mission planners tasks are:

- update the observations database throughout the mission, as required, in order to flag executed observations, block/unblock observations, re-schedule (failed) observations, etc.
- update the observations database throughout the mission to take into account changes in mission parameters and/or spacecraft and/or instrument anomalies,
- update the observations database to accommodate fixed time and concatenated observations,
- generate schedules,
- manage the observation history log,
- to check availability of data quality flag from HSC and/or ICC,
- liaise with the MOC and ICC as required,
- to generate Long Term plans of possible observations scenarios on request. The Long Term plans will be based on the database of approved and as yet unscheduled observations and scheduling preferences provided by the Project Scientist.

6.4.4 Ingestion of Data into HCSS

The TM, auxiliary data, and other MOC data sets, will be retrieved on a daily basis from the MOC by the HSC operators, and ingested into HCSS. This should be an automatic process triggered by an operator, who will only take action in case of problems by following pre-defined contingency procedures.

6.4.5 Operate the 'Quality Control Processing' (QCP)

All observational data will be run systematically through the QCP for quality control purposes.This will allow HSC to assess and record the quality of the observations in the terms defined in section 6.4.6, and to assign the corresponding quality flag.

The QCP data processing subsystem will be run in addition to routine operations:

- for complete on-demand scientific processing (remotely by the Observer)
- for execution of processing of key-programmes

- for execution of processing of special modes, such as serendipity (SMODE) and parallel mode (PMODE)

- for testing purposes by the HSC-Maintenance Group and the ICCs

Operator activity should be limited to monitoring the automatic processes, triggering possible Maintenance intervention in the case of problems.

Operators would initiate the processing for key-programmes for a given Operational Day.

6.4.6 Perform Data Quality Assessment

The quality processing subsystem will be run systematically for every observation:

- for the generation of a detailed complete 'quality of data'-assessment report, which will include the QCP report, MOC operational logs, the TM event packets, and RTA logs. The quality flag assigned to each observation reflects: (i) whether the observations has been executed nominally; (ii) whether all data generated are available in the archive; (iii) whether QCP has completed without error messages having been generated, and (iv) whether the corresponding quick-look product is available.

- it is anticipated that about 10% of observations need expert analysis to complete the 'quality of data'-assessment report. This will be done by the instrument experts at HSC who are expected to need to resort to expertise at ICC only in rare (goal << 5% of the observations) pathological cases.

- to generate lists/views with summaries of quality assessment in order to obtain various quality statistics by those interested in such statistics to generate lists of failed observations or observations with problems, establish/visualise their relation to SPRs and pass the necessary information to Mission Planners for re-scheduling. It is expected that the final assessment of the causes of the problem, the declaration of failed observation and the flagging for re-scheduling will generally require human intervention (HSC operators and/or instrument experts and/or community support astronomers and/or the Project Scientist).

6.4.7 Post-Operations Preparations

The HSC ensures that all data (science data, calibration data, auxiliary data, etc.), processing tools and documentation are properly collected and archived both for the operational activities and in preparation for the Post-operations phase. The HSC is responsible to secure the transfer of knowledge between the different groups (MOC, HSC and ICCs), and to prepare with them the required documentation for the transition to Post-operations.

6.5 HCSS Maintenance

6.5.1 HSC System Engineering

A system engineering function is foreseen as a direct continuation of tasks outlined in Section 5.5.1.

6.5.2 Software Maintenance

During Herschel in-orbit operations, the HCSS will need a small team for software maintenance, which is to be understood in a wider sense than just 'fixing bugs'. The entire development approach, which extends into the maintenance phase, is driven by the realization that developing a rigid system, that does not allow for a certain amount of controlled changes or evolution of user requirements, will not satisfy user expectations nor lead to a mission which is as successful as externally imposed boundary conditions would allow (e.g. instrument performance, cost constraints, etc.); as a result, 'maintenance' explicitly includes a controlled expansion or modification of the system through changes requested by HSC based on findings resulting from actual Herschel operations.

The amount of changes and the speed with which such changes can be implemented post-launch directly depends on the number of people and the expertise resident in this maintenance team and thus on the cost investment one is prepared to make. In a mission that is under so severe budget pressure as Herschel/ Planck, one possible approach is to define the total amount to be invested into post-launch software maintenance/enhancement and then use a profile for this expenditure (e.g. one-third of the effort to be spent in the first year post-launch, two-thirds for the remainder until the legacy archive has been established) in the hope that this profile closely resembles that of the number and severity of "features" detected in spacecraft, instrument operational behaviour, Ground Segment behaviour and instrument produced data sets, which need to be corrected as a function of time.

However, it is also clear that there is a minimum critical mass for this maintenance team which, if it cannot be accommodated in the budget, will make it almost impossible to expand or adjust system functionality on any reasonable time scale. This minimum mass depends on assumptions which are made pre-launch concerning the frequency and severity of anomalies in spacecraft, instruments and Ground Segment after launch and on the amount of exposure the HSC System has had during development to realistic data (quality of simulators) in realistic scenarios (quality of use cases). Depending on these assumptions, the minimum critical mass is estimated to be 8 fte's during the first year after the launch with a gradual reduction to 4 fte's at the end of the mission.

7 HSC POST-OPERATIONAL PHASE ACTIVITIES

Due to the design of the Herschel operations and ground segment, the post-operations phase should follow the routine phase smoothly. Indeed, many activities 'normally' associated with this phase will already have been on-going as part of the routine day-to-day activities in the preceding phase. Specific to this phase is that all these activities will have to be concluded, and finally 'wrapped up' for posterity in the historical archive which will constitute the ultimate legacy of Herschel.

7.1 Management

The HSC will be responsible for the overall management of the Post-operational phase. Particularly, the HSC will define with the ICCs the technical interfaces and the post-operational phase schedule, with the purpose to ensure maximum scientific output and a proper legacy of the Herschel mission.

The Herschel Science Management Plan (SMP) charges the Project Scientist (PS) with the responsibility to manage the science programme, to safeguard the scientific interests, and to maximise the scientific return of the Herschel Space Observatory throughout all mission phases. The PS has overall responsibility for the HSC, but belongs to the ESA RSSD Science Operations and Data Systems Division and is not formally part of the HSC complement, except for missions which are conducted in relation to Herschel. Therefore the PS tasks, reporting and responsibilities are not detailed any further in this document.

The HSC will be structured in a number of teams, each one being responsible for a certain HSC area (e.g. HSC scientific support). It is assumed that there will be a leader for each group, who will undertake management tasks in addition to his/her technical or scientific tasks. A team leader will spend a fraction of his/her nominal working time on management.

7.2 Support Functions

7.2.1 Project Control

Project control support will be required through all phases. It will include preparing and maintaining the overall HSC schedule, the subsystems schedules and milestones. Project control will also provide the PS with assistance in budget control and cost control.

7.2.2 Secretarial Support

Secretarial support (dependant on overall numbers in the team) will be required through all phases.

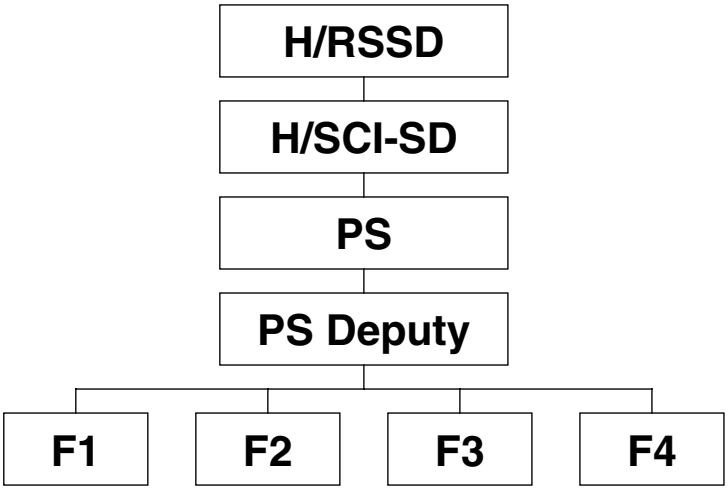


Figure 7.2 *HSC internal organisation during the post in-orbit operational phase. In the absence of direct spacecraft operational functional tasks the HSCOM position has been suppressed, and the team structure has been streamlined. The exact number and nature of the 'functional groups' (labelled Fi) are yet to be defined; examples of such groups are e.g. mission planning and hardware maintenenace. The HSC 'Exec' consists of the PS and PS Deputy.*

7.2.3 Computer Administration

System management for all computer hardware and software in the HSC is required throughout all phases. They will be responsible for the maintenance and upgrade of all HSC H/W. This task covers the routine back-ups, installation of new operating systems, first diagnostics of failure, liaising with H/W supplier, installation of new devices, preventive maintenance, assistance to users, liaising with computer support for all network related activities, ensuring that communication within the Ground Segment and between HSC and the outside world is satisfactory.

It is assumed that the maintenance of the overall HSC internal network and communications to the external world will be provided by third parties (e.g. computer support and MOC respectively). H/W Maintenance together with Computer Support will make sure that all the availability and performance criteria outlined in the SIRD are met, especially with regard to the HCSS- (+ network links) and HCSS database hardware. Unacceptable long unavailability or bad-performance because of software sub-systems or database configuration is managed by HSC Software Maintenance.

7.3 Research and Scientific Support

7.3.1 Scientific Research

All astronomers in HSC must spend 30% of their nominal working time doing scientific research linked, but not necessarily restricted to 'Herschel science'. The astronomers in HSC must have a detailed and cur-

rent understanding of the facilities an observatory is expected to provide to scientists. This knowledge can only be achieved by doing actively research. For their 'Herschel science' the HSC astronomers must use the same tools made available for the community. This way the astronomers gain the most relevant information in view of understanding what kind of support is most urgently needed by the astronomical community in large.

7.3.2 Scientific Satellite Characterisation and (Cross-)Calibration Coordination

The understanding of the satellite and instruments behaviour in orbit must be finalized during this phase. The collaboration with the ICCs in certain calibration aspects, and the cross-calibration activities carried out by the HSC instrument specialists during the development and operational phases will continue in the Post-operational phase. It will be a major task for the HSC astronomers the coordination of the cross-calibration between instruments, with models and with data from other observatories. This work will be carried out in cross-calibration working groups specialized in different calibration aspects.

7.3.3 Community Support

The HSC will be the main responsible to provide community support. Helpdesk, consisting of HSC astronomers and technical assistants, will continue as a main Herschel contact point. In particular, community support tasks will be:

- Updating and consolidating the Instrument Data User's Manuals
- Assisting observers in data reduction, both remotely and on-site at the HSC
- Definition and production of catalogues and atlases. As a result of the Herschel surveys and observations, the discovery of a significant number of new objects is expected. Therefore catalogues will be produced to provide the corresponding information in a comprehensive way, and which will be part of the Herschel legacy.
- Organization of workshops on specific topics to improve the interaction and transfer of knowledge between instrument/data reduction experts and the general community.

7.3.4 Information, Public Relations and Communications

HSC is a single-point interface for the astronomical community, the press and the general public to contact the Herschel observatory and to obtain both general information as well as more specific information regarding the status and scientific achievements of the mission.

HSC is responsible for the communication of the Herschel science opportunities and results directly to the general astronomical community, and to support the ESA Science Communication service in its role of providing information to the 'general public'.

This task includes:

- the preparation of Web pages, which will provide information both for the astronomical community and (in collaboration with the Science Communication service) the general public. They will contain

the description of the mission, its status, achievements and main discoveries in a clear and direct way, where appropriate making use of multimedia capabilities. It will also include links to the Web pages of the instrument teams, and other relevant mission and sites. For the astronomical community, it will contain lists (and links, if possible) to Herschel publications in astronomical journals, and information on Herschel conferences and workshops. For non astronomers there should be material tailored for different groups such as for instance the general public, the interested layman, and schools.

- the preparation of the Herschel Newsletter.
- the organisation of workshops on specific Herschel topics and edition of the Proceedings.
- collaborating in the organisation of special Herschel sessions in scientific conferences (e.g., EAS, IAU).
- the organisation (and/or supporting, cf. below) of press conferences.
- (supporting) the preparation of material and, possibly, commissioned articles for amateur astronomer magazines (e.g., Sky and Telescope, Astronomy, Ciel et Espace, Sterne & Weltraum, etc.).
- (supporting) the preparation of material and, possibly, commissioned articles for monthly and weekly magazines (e.g. National Geographic, GEO, Time, Newsweek, Stern, Spiegel, Focus, etc.)

HSC will provide support to the ESA Science Communications service by working in close collaboration with the Herschel Science Writer, who will be responsible for the preparation of ESA press releases and ESA information notes related to Herschel. The specific HSC Public Relations tasks are:

- support to ESA communications events,
- support to press releases preparation (e.g. information notes each about 1-2 pages long or picture releases with captions) at a frequency of 1 every 4-12 weeks,
- support in writing/polishing of Herschel materials to be distributed directly by ESA (e.g. brochures, posters, slide sets, PR CD-ROMs, etc.).

7.4 Archiving Activities

7.4.1 Rundown Monitoring

The HSC will monitor that all satellite data and MOC knowledge relevant to the mission have been stored and are accessible through HCSS. This includes real time operations reports, satellite documents, operations procedures, satellite anomaly or non-conformance reports, technical notes (e.g. pointing performance, temperature variations), spacecraft and auxiliary data.

7.4.2 Consolidation

The archive hardware, contents (in HCSS) and the Archive Access Interface have been defined and imple-

mented during the development and operational phases. It corresponds to the post-operational phase to upgrade and consolidate the Herschel archive mainly focusing on the requirements driven by the astronomical community archive usage. This includes:

- Upgrade of hardware, physical storage and optimization of communication lines
- Consolidation of the archive data contents, that is, telemetry, calibration data, auxiliary data (satellite files, mission planning files, diagnostic data), standard processed data and ancillary data (e.g. space weather reports).
- Consolidation, with the ICCs, of the software required for interactive analysis and standard processing of the data.
- Consolidation, with the ICCs, of the software used to derive calibration files.
- Consolidation, with the ICCs, of the software to carry out diagnostics, like Trend Analysis.
- An important task of the consolidation effort is to ensure that all the knowledge gained during the mission (from MOC, HSC and ICCs) is kept and that the corresponding documents and technical notes are written. The HSC will coordinate this effort among all the parties involved. One important group of documentation is a set of end-of-mission reports from various groups and teams within HSC.

7.4.3 Archive Upgrades and Reprocessing

Standard products resulting from the standard processing software will be produced when all the Herschel data becomes public. This will imply to reprocess all the observations though the QCP subsystem and make them available through the Archive Access Interface. The standard products generated in this way will be a consistent set derived with agreed versions of the software and calibration files. In view of the virtual observatory concept, which is expected to be fully operational when the Herschel archive becomes public, it is anticipated that changes to the products and their quality information as well as to the archive interface are required to make the legacy archive virtual observatory compatible.

7.4.4 Planck Data Archiving

Planck level 4 product ingestion into the archive and providing access to the community will require development effort.

7.4.5 Transfer into Historical Archive

The transfer into the historical archive phase will involve the consolidation of the archive (user interface, speed, help facilities) and contents (software, data, documentation), as described in Section 6.4.7 for the post-operational phase, but now with the purpose of providing the best possible framework for the legacy of the Herschel mission. This will imply the reprocessing through QCP of all observations with the final versions of software and calibration files.

In the end of the post-operational phase, it is expected that the documentation on calibration, instrument behaviour, and satellite issues will be updated and finalized by the HSC and ICCs. This includes the publi-

cation of the final accuracy figures in instrument calibrations (e.g. relative and absolute errors in wavelength and flux calibration).

7.5 Software Maintenance

Contrary to ISO, where preparation of the legacy archive was only started several months after the end of in-orbit operations, with a significant amount of effort going into what was an entirely new development during which operational data from uplink, downlink and the MOC were brought together into a single archive for the first time, the concept of establishing such an archive already during development and migrating it through in-orbit operations (HCSS) should lead to a situation in which all the ingredients of the legacy archive are available when the last bit of operational data has been ingested. Nevertheless, refining calibration and processing algorithms usually require changes in the software. The anticipated existence of Virtual Observatory concept is also likely to add new requirements on the archive. Therefore the software maintenance team has to have sufficient man power to allow some development effort on top of the primary maintenance tasks. In order to guarantee as complete and correct legacy archive as possible, it is necessary to include in the software maintenance team dedicated man power to database administration.

Appendix A: SIP -> SIRD COMPLIANCE

SIP WP	SIRD requirement
5.1.1	FSCF-135 FSCF-150 FSCF-200 PERF-000 PERF-014 PERF-024 PERF-042 PAQA-004 PAQA-005 PAQA-032a
5.1.2	FSCF-100 FSCO-035 PERF-000 PERF-001 PAQA-004 PAQA-005
5.1.3	FSCF-100 PERF-000 PERF-001 PERF-013 PERF-040 PERF-041 PERF-042 PAQA-004 PAQA-005
5.2.1	FSCF-140
5.2.2	FSCF-140
5.2.3	FSCF-140 PERF-004 PERF-030 PERF-050 PERF-051 PERF-052 PERF-053 PERF-054 PAQA-030
5.3.1	FSCF-005 FSCF-010
5.3.2	FSCF-005 FSCF-010 FSCF-060 FSCF-065 FSCF-075 FSCF-080 FSCF-090
5.3.3	FSCF-005 FSCF-010 FSCF-055 FSCF-070 FSCF-075 FSCF-080 FSCF-090
5.3.4	FSCF-005 FSCF-010 FSCF-055
5.3.5	FSCF-005 FSCF-010 FSCF-020 PERF-013 PERF-040 PERF-041 PERF-042
5.3.6	FSCF-005 FSCF-010 FSCF-015 FSCF-020
5.3.7	FSCF-005 FSCF-010 FSCF-025
5.3.8	FSCF-005 FSCF-010 FSCF-030
5.4.1	FSCF-035 FSC-105 FSCF120 FSCF-125 FSCF-130
5.4.2	FSCF-035 FSC-105 PERF-000 PERF-004 PERF-010 PERF-011 PERF-013 PERF-015 PERF-016 PERF-017 PERF-020 PERF-021 PERF-023 PERF-030 PERF-031 PERF-050 PERF-051 PERF-052 PERF-053 PERF-054 PERF-055 PERF-056 PERF-057 PERF-059a PERF-059b PERF-060b PERF-070
5.4.3	FSCF-035 FSCF-040 FSC-105 PERF-000 PERF-004 PERF-010 PERF-011 PERF-013 PERF-015 PERF-016 PERF-017 PERF-020 PERF-021 PERF-023 PERF-030 PERF-031 PERF-050 PERF-051 PERF-052 PERF-053 PERF-054 PERF-055 PERF-056 PERF-057 PERF-059a PERF-059b PERF-060b PERF-070

SIP WP	SIRD requirement
5.4.4	FSCF-035 FSCF-040 FSC-105
5.4.5	FSCF-035 FSCF-040 FSC-105 PAQA-022
5.5.1	FSCF-045 FSCF-145 FSCF-150 FSCF-152 PERF-052 PERF-060a
5.5.2	FSCF-150 FSCF-155 FSCF-160 FSCF-171 FSCF-210 FSCF-220 FSCF-230 PERF-014 PERF-024 PERF-042
5.5.3	FSCF-150 FSCF-165 FSCF-180 FSCF-185
5.5.4	PAQA-001 PAQA-031 PAQA-033a
5.6.1	FSCF-100 FSCF-155 FSCO-010
5.6.2.1	FSCF-045 FSCF-100 FSCF-160
5.6.2.2	FSCF-045 FSCF-100 FSCF-160
5.6.3.1	FSCF-045 FSCF-050 FSCF-100 FSCF-175
5.6.3.2	FSCF-045 FSCF-100
5.6.3.3	FSCF-100 FSCF-140
5.6.4	FSCF-095 FSCF-100 FSCF-190 FSCF-195 PAQA-024 PAQA-020 PAQA-025
5.6.5	FSCF-095 FSCF-100 FSCF-190 FSCF-195 PAQA-023 PAQA-026
5.6.6	FSCF-100 FSCO-040
5.6.7	FSCF-085 FSCF-100 FSCO-040
5.6.8	FSCF-100 FSCO-030
6.1	FSCO-045 FSCO-080 FSCO-085 PERF-000 PERF-001 PERF-003 PERF-040 PERF-041 PAQA-004 PAQA-005
6.2.1	FSCF-140
6.2.2	FSCF-140
6.2.3	FSCF-140 FSCO-075 PERF-004 PERF-030 PERF-050 PERF-051 PERF-052 PERF-053 PERF-054 PAQA-030
6.3.1	FSCF-005 FSCF-010
6.3.2	FSCF-005 FSCF-010 FSCF-060 FSCF-065
6.3.3	FSCF-005 FSCF-010 FSCF-055
6.3.4	FSCF-005 FSCF-010 FSCF-055
6.3.5	FSCF-005 FSCF-010 FSCF-020 FSCO-015 FSCO-025 FSCO-070 PERF-040 PERF-041
6.3.6	FSCF-005 FSCF-010 FSCF-020

SIP WP	SIRD requirement
6.3.7	FSCF-005 FSCF-010 FSCF-050
6.3.8	FSCF-005 FSCF-010 FSCF-030 FSCO-020
6.4.1	FSCO-010
6.4.2	FSCO-040
6.4.3	FSCO-060
6.4.4	FSCO-055 FSCO-065 FSCO-067 PERF-060
6.4.5	FSCO-069
6.4.6	FSCO-012 FSCO-069
6.4.7	FSCF-110
6.5.1	FSCF-145 FSCF-150 FSCO-075
6.5.2	FSCF-150 FSCO-050 FSCO-055 FSCO-060 FSCO-065 FSCO-067 FSCO-068 FSCO-069 FSCO-070 FSCO-075 PAQA-002 PAQA-031
7.1	FSCA-001 PAQA-004 PAQA-005
7.2.1	FSCF-140
7.2.2	FSCF-140
7.2.3	FSCF-140 PERF-004 PERF-030 PERF-050 PERF-051 PERF-052 PERF-053 PERF-054
7.3.1	FSCF-005 FSCF-010 FSCA-004
7.3.2	FSCF-005 FSCF-010 FSCF-055 FSCF-060 FSCF-065 FSCA-004
7.3.3	FSCF-005 FSCF-010 FSCF-020 FSCA-004
7.3.4	FSCF-005 FSCF-010 FSCF-030 FSCA-004
7.4.1	FSCA-002
7.4.2	FSCA-O003
7.4.3	FSCA-004
7.4.4	FSCA-005
7.4.5	FSCA-005
7.5	FSCF-150 FSCA001

Appendix B: SIRD -> SIP COMPLIANCE

SIRD requirement	SIP WP
FSCF-005	5.3 6.3 7.3
FSCF-010	5.3 6.3 7.3
FSCF-015	5.3.6
FSCF-020	5.3.5 5.3.6 6.3.5 6.3.6 7.3.3
FSCF-025	5.3.7
FSCF-030	5.3.8 6.3.8 7.3.4
FSCF-035	5.4
FSCF-040	5.4.3 5.4.4 5.4.5
FSCF-045	5.5.1 5.6.2 5.6.3.1 5.6.3.2
FSCF-050	5.6.3.1 6.3.7
FSCF-055	5.3.3 5.3.4 6.3.3 6.3.4 7.3.2
FSCF-060	5.3.2 6.3.2 7.3.2
FSCF-065	5.3.2 6.3.2 7.3.2
FSCF-070	5.3.3
FSCF-075	5.3.2 5.3.3
FSCF-080	5.3.2 5.3.3
FSCF-085	5.6.7
FSCF-090	5.3.2 5.3.3
FSCF-095	5.6.4 5.6.5
FSCF-100	5.1.2 5.1.3 5.6
FSCF-105	5.4
FSCF-110	6.4.7

SIRD requirement	SIP WP
FSCF-120	5.4.1
FSCF-125	5.4.1
FSCF-130	5.4.1
FSCF-135	5.1.1
FSCF-140	5.2 5.6.3.3 6.2 7.2
FSCF-145	5.5.1 6.5.1
FSCF-150	5.1.1 5.5 6.5 7.5
FSCF-152	5.5.1
FSCF-155	5.5.2 5.6.1
FSCF-160	5.5.2 5.6.2
FSCF-165	5.5.3
FSCF-171	5.5.2
FSCF-175	5.6.3.1
FSCF-180	5.5.3
FSCF-185	5.5.3
FSCF-190	5.6.4 5.6.5
FSCF-195	5.6.4 5.6.5
FSCF-200	5.1.1
FSCF-210	5.5.2
FSCF-220	5.5.2
FSCF-230	5.5.2
FSCO-010	5.6.1 6.4.1
FSCO-012	6.4.6
FSCO-015	6.3.5
FSCO-020	6.3.8
FSCO-025	6.3.5
FSCO-030	5.6.8
FSCO-035	5.1.2
FSCO-040	5.6.6 5.6.7 6.4.2
FSCO-045	6.1

SIRD requirement	SIP WP
FSCO-050	6.5.2
FSCO-055	6.4.4 6.5.2
FSCO-060	6.4.3 6.5.2
FSCO-065	6.4.4 6.5.2
FSCO-067	6.4.4 6.5.2
FSCO-068	6.5.2
FSCO-069	6.4.5 6.4.6 6.5.2
FSCO-070	6.5.2 6.3.5
FSCO-075	6.2.3 6.5.1 6.5.2
FSCO-080	6.1
FSCO-085	6.1
FSCA-001	7.1 7.5
FSCA-002	7.4.1
FSCA-003	7.4.2
FSCA-004	7.3 7.4.3
FSCA-005	7.4.4 7.4.5
PERF-000	4.3.3 5.1.1 5.1.2 5.1.3 5.4.2 5.4.3 6.1
PERF-001	4.1 5.1.2 5.1.3 6.1
PERF-002	Not applicable
PERF-003	6.1 Figure 6-1
PERF-004	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-010	5.4.2 5.4.3
PERF-011	5.4.2 5.4.3
PERF-013	5.1.3 5.3.5 5.4.2 5.4.3
PERF-014	5.1.1, 5.5.2
PERF-015	5.4.2 5.4.3
PERF-016	5.4.2 5.4.3
PERF-017	5.4.2 5.4.3
PERF-020	5.4.2 5.4.3
PERF-021	5.4.2 5.4.3

SIRD requirement	SIP WP
PERF-023	5.4.2 5.4.3
PERF-024	5.1.1, 5.5.2
PERF-030	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-031	5.4.2 5.4.3
PERF-040	5.1.3 5.3.5 6.1 6.3.5
PERF-041	5.1.3 5.3.5 6.1 6.3.5
PERF-042	5.1.3 5.3.5 5.1.1 5.5.2
PERF-050	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-051	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-052	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3 5.5.1
PERF-053	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-054	5.2.3 6.2.3 7.2.3 5.4.2 5.4.3
PERF-055	5.4.2 5.4.3
PERF-056	5.4.2 5.4.3
PERF-057	5.4.2 5.4.3
PERF-059a	5.4.2 5.4.3
PERF-059b	5.4.2 5.4.3
PERF-060	6.4.4
PERF-060a	5.5.1
PERF-060b	5.4.2 5.4.3
PERF-062	Not applicable
PERF-070	5.4.2 5.4.3
PAQA-001	5.5.4
PAQA-002	6.5.2
PAQA-004	5.11 5.1.2 5.1.3 6.1 7.1
PAQA-005	5.11 5.1.2 5.1.3 6.1 7.1
PAQA-010	see documentation section
PAQA-010a	see documentation section
PAQA-010b	see documentation section
PAQA-010c	see documentation section

SIRD requirement	SIP WP
PAQA-011	see documentation section
PAQA-012	see documentation section
PAQA-020	5.6.4
PAQA-022	5.4.5
PAQA-023	5.6.5
PAQA-024	5.6.4
PAQA-026	5.6.5
PAQA-030	5.2.3 6.2.3
PAQA_031	5.5.4 6.5.2
PAQA-032a	5.5.1
PAQA-033a	5.5.4

Appendix C: HSC DELIVERABLES

HSC DELIVERABLE ITEM		DATE
General. Management, Facilities		
Herschel Space Observatory Operations Scenario	v1.0	November 2000
Herschel Ground Segment Design Description		December 2001
HSC Science Implementation Plan		June 2002
HSC Ground Facility URD		March 2004
HSC H/W Configuration Plan		March 2005
HGS Interface Requirements Document	v2.0	December 2001
Software Development		
HCSS User Requirements Document	v2.0	August 2001
HCSS Software Project Management Plan	v2.1	May 2001
HCSS Software Product Assurance Plan		November 2000
HCSS Software Configuration Management Plan		November 2000
HCSS Software Verification and Validation Plan		December 2002
Software Engineering and Product Assurance Requirements for the HCSS		August 2000
HSC-ICC ICDs		As defined in SPMP
Other HSC Software documents: Detailed user requirements/Use Cases Use-Case Analysis Domain Model Core Class model Integration and Test documents		As defined in SPMP
HCSS	v0.1	May 2002
	v0.2	December 2002
	v0.3	December 2003
	v0.4	December 2004

HSC DELIVERABLE ITEM		DATE
	v0.5	December 2005
	v1.0	December 2006
Legacy HCSS		December 2015
HCSS Integration and Test Plan		an issue 8 months before each HCSS release
HCSS Acceptance and System Test Plans		an issue 3 months before each HCSS release
HCSS Acceptance Test Reports		an issue for each HCSS release
SSO ephemerides		November 2003
Scientific Mission Planning		
Scientific Requirements Scheduling Document		October 2005
Long Range Scientific Mission Plan	Draft 1	December 2006
	v1.0	July 2007
Observation schedules		From EE1
EE Tests HSC contribution		
HSC EE1 Test procedures		June 2006
HSC EE1 Test Reports		September 2006
HSC EE2 Test procedures		October 2006
HSC EE2 Test Reports		January 2007
HSC Simulations Plan		October 2006
HSC Training Plan		July 2005
HSC Operations documents		
HSC Commissioning Operations Plan		September 2006
HSC Commissioning Phase GS procedures		October 2006
HSC PV phase Operations Plan		March 2006
PV phase observations timeline		April 2007
HSC PV phase GS procedures		October 2006
HSC Routine Operations Plan		March 2006
HSC Routine GS procedures		August 2006
HSC Operational ICDs (HSC to ICCs)		September 2005

HSC DELIVERABLE ITEM		DATE
HSC Facility Operations Handbook		November 2006
Calibration		
Cross Calibration Plan		December 2004
In-orbit Calibration Plan		December 2004
Community support		
Community Support Plan		December 2006
Proposal statistics and reports to HOTAC, KP		August 2004
Proposal statistics and reports to HOTAC, GT		August 2005
Proposal statistics and reports to HOTAC, OT		August 2006
Proposal statistics and reports to HOTAC, OT, 2nd call		April 2009
Proposal Technical Feasibility		from January 2006
Call for proposals documents	Release 1	February 2004
	Release 2	February 2005
	Release 3	February 2006
	Release 4	February 2008
Instrument Data User's Manual	v1.0	July 2007
	v2.0	July 2008
	V3.0+	from July 2009
HCSS Legacy Documents		December 2015
Herschel Catalogues and Atlases		December 2015
HSC Services		
Herschel information web pages		from 2000
Organize scientific meetings and produce proceedings		from December 2000
Herschel seminars		from January 2004
Herschel newsletter		from October 2003
Helpdesk		from February 2004
Herschel Archive (facility and contents)		from December 2002
Quality control of observation data		from L
Access to on-demand processing and IA for the general astronomer		from July 2007

HSC DELIVERABLE ITEM	DATE
Data reduction workshops	from October 2010
Scientific Publications	from 1999

Appendix D: HSC RECEIVABLES

HSC RECEIVABLE ITEM (from each ICC)	DATE
Software Development	
IA User Requirements Document	September 2002
IA SSD	TBC
IA Users Manual	December 2006
Observer's IA	December 2006
Instrument Simulator URD	TBC
Instrument Simulator User's Manual	August 2005 (TBC)
Instrument Simulator	August 2005 (TBC)
CUS/Time estimator	As specified in SPMP
Standard Product Generation Modules	As specified in SPMP
Instrument operations	
Command sequences, AOTs	December 2003
On-board Software documents	June 2006
On-board Software uplink images	June 2006
On-board Control Procedures updates	June 2006
Instrument Database updates	from June 2006
Instrument User Manuals	TBD
Instrument Apertures Pointing Misalignment updates	from L
End-to-end Tests Observations	June 2006
Commissioning Phase Observations	June 2006
PV Phase Observations	June 2006
Routine Phase Calibration and Engineering Observations and scheduling constraints	from June 2007
Uplink Calibration Data	March 2006

HSC RECEIVABLE ITEM (from each ICC)	DATE
Downlink Calibration Data	March 2006
Instrument Health Reports	from L
Instrument mode validation status	from June 2007
Observation Analysis reports	from June 2007
Instrument Calibration Plan	December 2004
ICC Operations Plan	March 2006
Instrument Specific Data Analysis recipes	from June 2007

HSC RECEIVABLE ITEM (from MOC)	DATE
MOC/HSC Interface Documents	as specified in MIP
S/C slew time and path predictor algorithm and data	July 2003
S/C Attitude constraint algorithm and data	July 2003
Mission Planning Files	from EE1
Consolidated TM	from EE1
Ancillary Data	from EE1
Instrument Memory image	from EE1
S/C and instruments databases	from EE1
Instrument apertures pointing misalignment	from L
SSO Database	from L
S/C General information	from L
Instrument mal-functions or operation problems information	from L

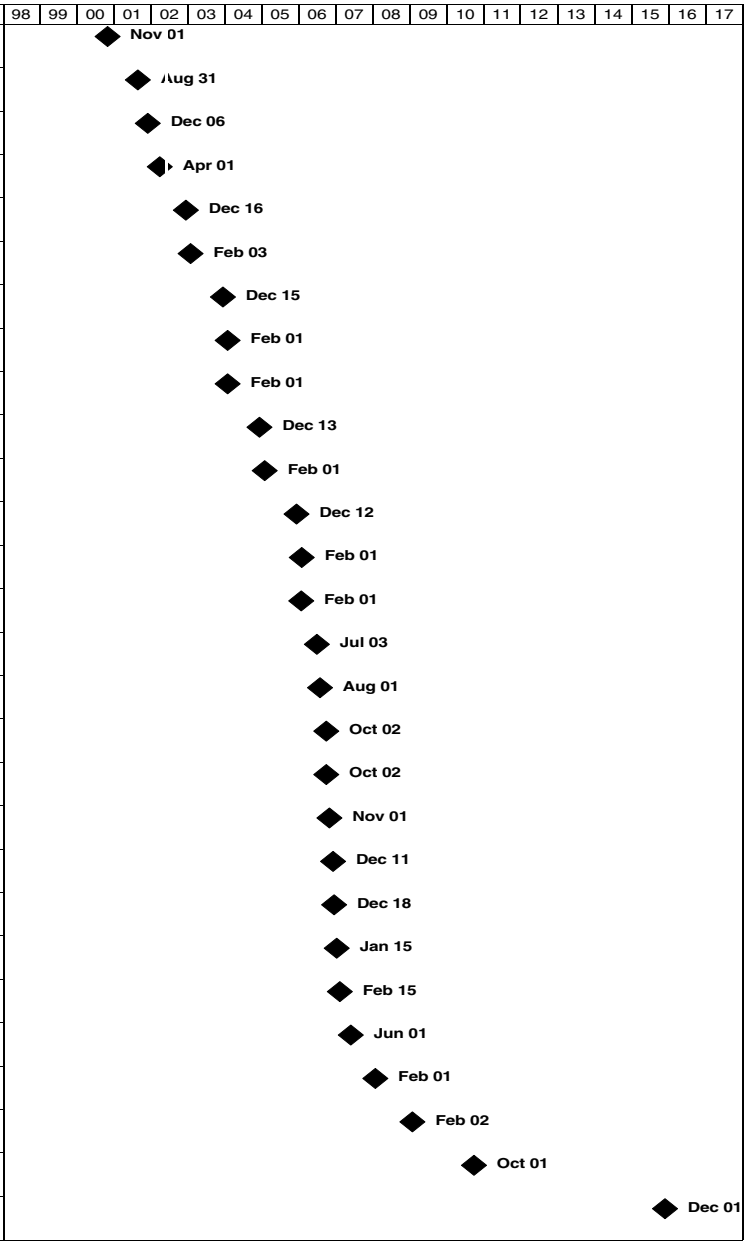
HSC RECEIVABLE ITEM (from astronomical community, HOTAC)		DATE
Key Programs Proposals	Phase 1	July 2004
	Phase 2	March 2005
Guaranteed Time Proposals	Phase 1	July 2005
	Phase 2	February 2006

HSC RECEIVABLE ITEM (from astronomical community, HOTAC)		**DATE**
Open Time Proposals	Phase 1	July 2006
	Phase 2	February 2007
Open Time Proposals (2nd call)	Phase 1	February 2008
	Phase 2	August 2008
Open Time Proposals (3rd call)	Phase 1	February 2009
	Phase 2	August 2009
Target of Opportunity proposals		from July 2005
Discretionary Time Proposals		from L
HOTAC results, Key Programs		October 2004
HOTAC results, Guaranteed Time		October 2005
HOTAC results, Open Time		October 2006
HOTAC results, Open Time 2nd call		May 2008
HOTAC results, Open Time 3rd call		May 2009
HOTAC results ToOs		from L

Appendix E: SCHEDULE MILESTONES

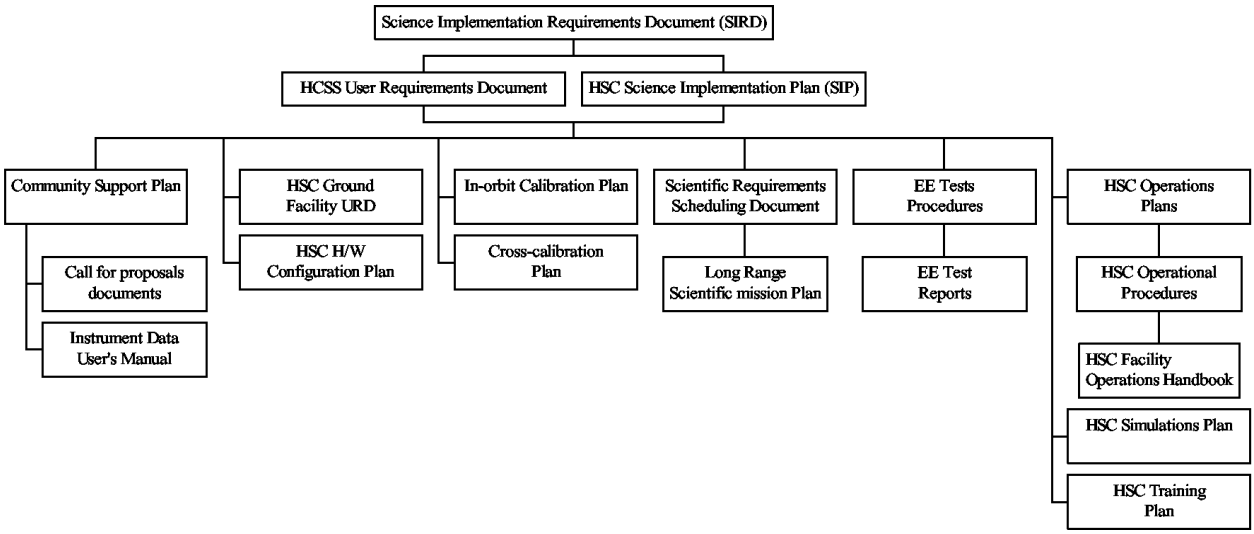
The schedule milestones are shown below.

ID	Task Name	Milestone
1	Herschel Space Observatory Operations Scenario	Nov 01
2	HCSS User Requirements Document, issue 2.0	Aug 31
3	HGS Interface Requirements Document, issue 2.0	Dec 06
4	HCSS v0.1	Apr 01
5	HCSS v0.2	Dec 16
6	Ground Segment Requirements Review	Feb 03
7	HCSS v0.3	Dec 15
8	Ground Segment Design Review	Feb 01
9	Call for Key project observation proposals	Feb 01
10	HCSS v0.4	Dec 13
11	Call for Guaranteed Time observation proposals	Feb 01
12	HCSS v0.5	Dec 12
13	Ground Segment Implementation Review	Feb 01
14	Call 1 for Open Time Observation proposals	Feb 01
15	End-to-End Test 1	Jul 03
16	Transfer of HSC to operational location	Aug 01
17	Ground Segment Readiness Review	Oct 02
18	End-to-End Test 2	Oct 02
19	Ground Segment Simulations	Nov 01
20	HCSS V1.0	Dec 11
21	HCSS Readiness Review	Dec 18
22	Operations Readiness Review	Jan 15
23	Launch	Feb 15
24	Mission level In-orbit Commissioning Review	Jun 01
25	Call 2 for Open Time Observation proposals	Feb 01
26	Call 3 for Open Time Observation proposals	Feb 02
27	End in-orbit phase	Oct 01
28	End of Post-operations phase	Dec 01



Appendix F: DOCUMENT TREE

The document tree is shown below.



Appendix G: WORK BREAKDOWN STRUCTURE

The Work Breakdown Structure (WBS) is shown on the following page.

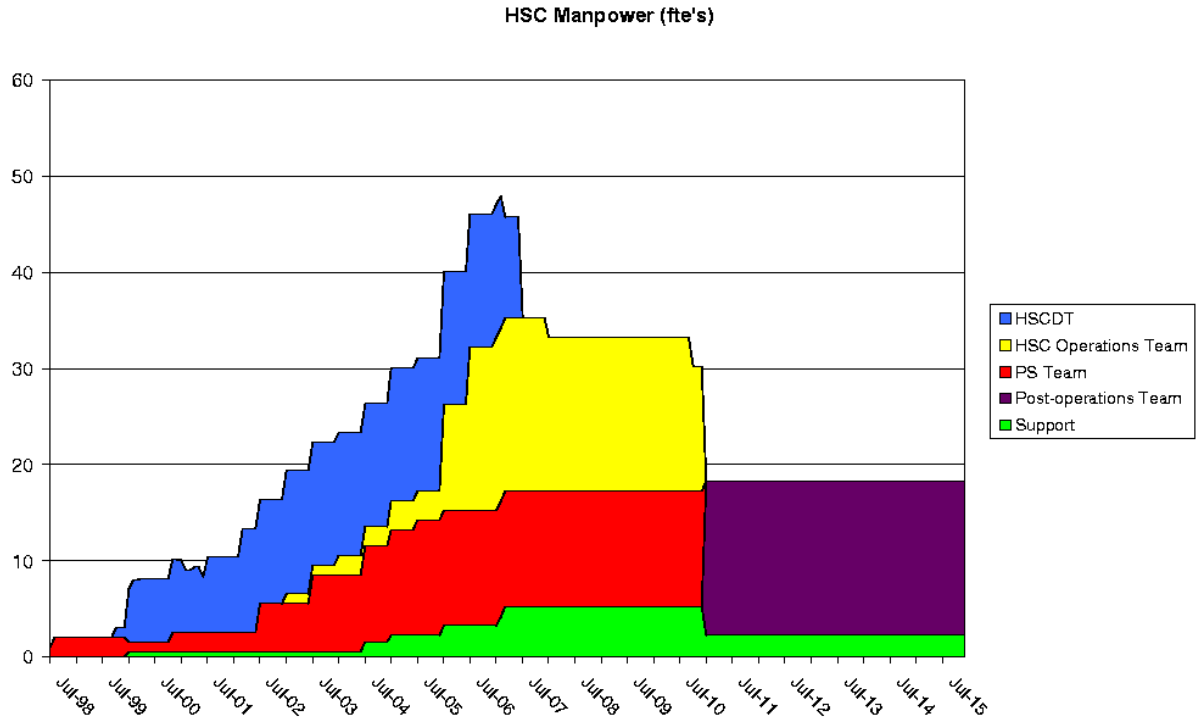
HSC Top Level WBS

WBS	Task Name
	Herschel Science Centre
5	**Development**
5.1	Management
5.1.1	HSC Development Management
5.1.2	HSC Operations Manager
5.1.3	HSC Team Management
5.2	Support to HSC
5.2.1	Project control
5.2.2	Secretarial support
5.2.3	Computer administration
5.3	Research and Scientific Support Activities
5.3.1	Scientific Research
5.3.2	Calibration coordination
5.3.3	Instrument characterisation
5.3.4	Scientific satellite characterisation
5.3.5	Community support
5.3.6	HOTAC support
5.3.7	Coordination of KP & GT
5.3.8	Information, Public relations and communication
5.4	Definition of HSC
5.4.1	Pre-development consolidation
5.4.2	Preparation of URD
5.4.3	Definition of user requirements
5.4.4	Tests and user trials
5.4.5	Acceptance testing of subsystems
5.5	HCSS Development
5.5.1	System engineering
5.5.2	Software development
5.5.3	Software maintenance
5.5.4	Support functions
5.6	Operations preparations
5.6.1	PHS
5.6.2	Mission planning
5.6.3	Operations implementation
5.6.4	SVTs and E-to-E tests
5.6.5	Simulations
5.6.6	Commisioning phase
5.6.7	PV phase
5.6.8	Training of staff
6	**Operations**
6.1	Management
6.2	Support to HSC
6.2.1	Project control
6.2.2	Secretarial support
6.2.3	Computer administration
6.3	Reasearch and Scientific Support Activities
6.3.1	Scientific Research
6.3.2	Calibration and cross-calibration coordination
6.3.3	Instrument characterisation
6.3.4	Scientific satellite characterisation
6.3.5	Community support
6.3.6	HOTAC and its support
6.3.7	Scientific mission planning strategy
6.3.8	Information, Public relations and communication
6.4	HSC operations activities
6.4.1	Operate PHS
6.4.2	Support to commissioning, PV and early operations phases
6.4.3	Operate the mission planning subsystem
6.4.4	Ingestion of data into HCSS
6.4.5	Operate the quality control processing
6.4.6	Perform data quality assessment
6.4.7	Post-operations preparations
6.5	HSCC maintenance
6.5.1	System engineering
6.5.2	Software maintenance
7	**Post-operations**
7.1	Management
7.2	Support to HSC
7.2.1	Project control
7.2.2	Secretarial support
7.2.3	Computer administration
7.3	Research and Scientific Support Activities
7.3.1	Scientific Research
7.3.2	Scientific satellite characterisation and cross calibration coordination
7.3.3	Community support
7.3.4	Information, Public relations and communication
7.4	Active archive support
7.4.1	Rundown Monitoring
7.4.2	Consolidation
7.4.3	Archive upgrades and reprocessing
7.4.4	Preparation of end-of-mission reports
7.4.5	Planck data archiving
7.4.6	Transfer into historical archive
7.5	Software maintenance

Appendix H: STAFFPOWER RESOURCES

The staffpower (without regard to whether staff or contractors are used) required to execute all tasks described in the SIP has been estimated. From this estimate a staff complement has been derived, and an allocation of the tasks to the complement has been performed in a consistent way.

The total number of FTEs as a function of time in the various 'teams' in the HSC is shown in the Figure below.



In this Appendix the assigned staffpower resources for each SIP task during each year can be found. Each WBS label ocrresponds to a subsection in the SIP. Note that the numbers in the year columns give efforts in ('pure') staff months. One staff year equals 9.6 staff months, however, at the present time the average allocation is 9 months per staff and year, thus leaving a ~7% contingency.

The costing of the staffpower and other resources necessary for the implementation and running of the HSC is given in the 'Herschel Science Centre SIP: Costing and CaC' document [RD15], where the calculation of the resulting HSC CaC is provided.

HSC WPs

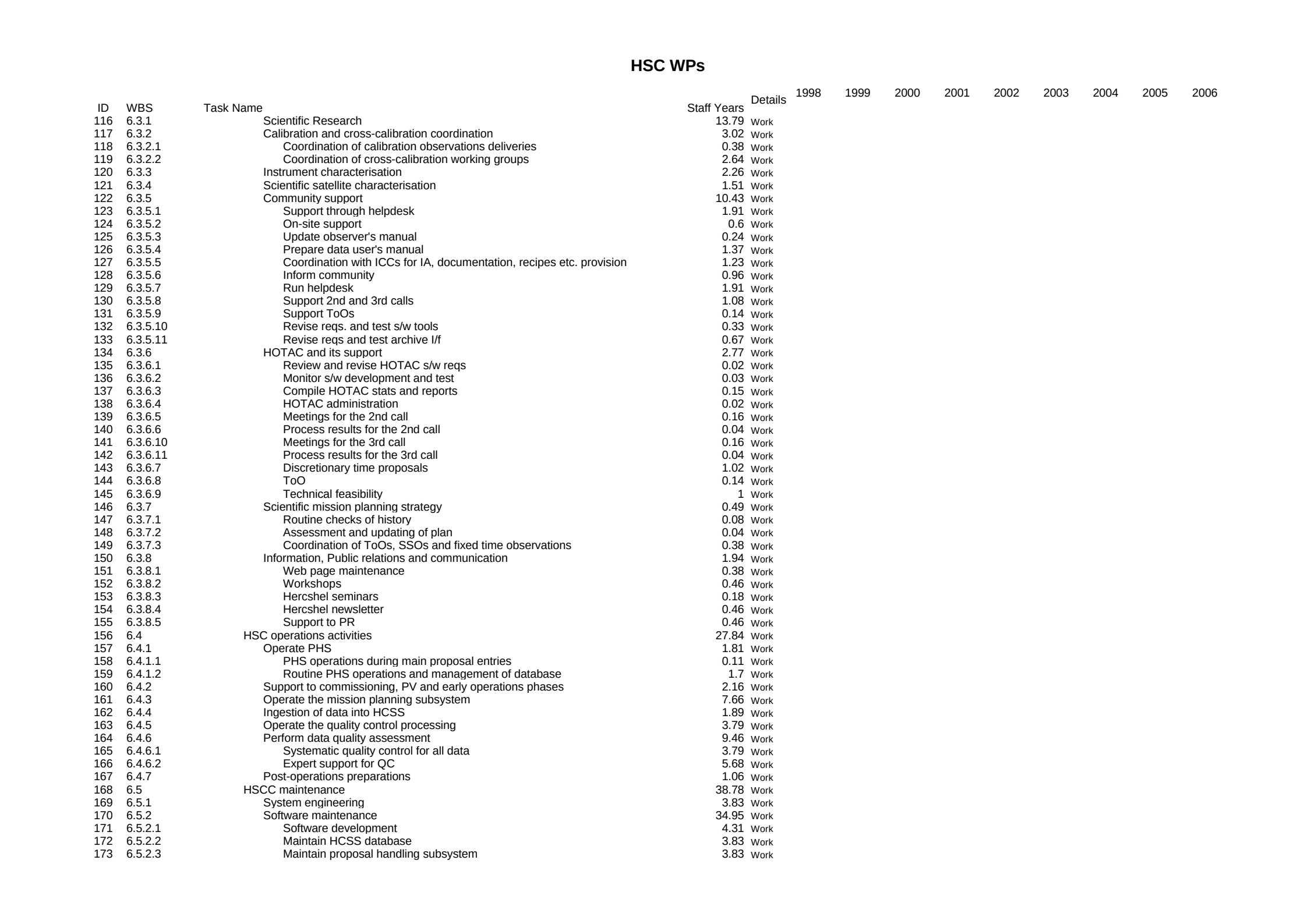
ID	WBS	Task Name	Staff Years	Details	1998	1999	2000	2001	2002	2003	2004	2005	2006
0		***Herschel Science Centre***	388.8	Work	8.3mo	21.63mo	78.6mo	90.97mo	131.86mo	196.25mo	236.77mo	279.22mo	360.49mo
1	5	**Development**	161.59	Work	8.3mo	21.63mo	78.6mo	90.97mo	131.86mo	196.25mo	236.77mo	279.22mo	360.49mo
2	5.1	Management	16.94	Work			9.57mo	9.61mo	14.04mo	28.81mo	28.96mo	28.7mo	28.7mo
3	5.1.1	HSC Development Management	7.61	Work			9.57mo	9.61mo	9.61mo	9.61mo	9.65mo	9.57mo	9.57mo
4	5.1.2	HSC Operations Manager	4.42	Work						9.59mo	9.65mo	9.57mo	9.57mo
5	5.1.3	HSC Team Management	4.91	Work					4.43mo	9.61mo	9.65mo	9.57mo	9.57mo
6	5.2	Support to HSC	8.56	Work			5.26mo	5.28mo	5.28mo	5.28mo	9.74mo	21.52mo	21.52mo
7	5.2.1	Project control	1.9	Work			2.39mo	2.4mo	2.4mo	2.4mo	2.41mo	2.39mo	2.39mo
8	5.2.2	Secretarial support	2.77	Work							4.43mo	9.57mo	9.57mo
9	5.2.3	Computer administration	3.88	Work			2.87mo	2.88mo	2.88mo	2.88mo	2.9mo	9.57mo	9.57mo
10	5.3	Research and Scientific Support Activities	36	Work	2.49mo	5.77mo	3.59mo	7.69mo	16.88mo	45.05mo	68.14mo	85.18mo	77.29mo
11	5.3.1	Scientific Research	15.95	Work	2.49mo	5.77mo	3.3mo	5.77mo	9.76mo	18.4mo	25.83mo	32.88mo	34.43mo
12	5.3.2	Calibration coordination	4.6	Work					2.48mo	6.8mo	10.06mo	10.62mo	10.04mo
13	5.3.2.1	Calibration working groups	2.74	Work					1.81mo	4.69mo	6.27mo	5.84mo	5.26mo
14	5.3.2.2	Cross calibration	0.55	Work							0.89mo	1.91mo	1.91mo
15	5.3.2.3	Calibration requirements and plans	1.31	Work					0.67mo	2.11mo	2.9mo	2.87mo	2.87mo
16	5.3.3	Instrument characterisation	6.1	Work					3.1mo	9.83mo	16.4mo	16.1mo	8.38mo
17	5.3.3.1	Characterise instrument and monitor development	2.63	Work					1.33mo	4.21mo	5.79mo	5.74mo	5.74mo
18	5.3.3.2	Instrument tests	1.88	Work					1.33mo	4.21mo	5.79mo	5.58mo	
19	5.3.3.3	PV plan	0.72	Work							2.9mo	2.87mo	0.73mo
20	5.3.3.4	Maintain instrument documentation	0.87	Work					0.44mo	1.4mo	1.92mo	1.91mo	1.91mo
21	5.3.4	Scientific satellite characterisation	1.11	Work							1.77mo	3.83mo	3.83mo
22	5.3.5	Community support	4.41	Work					0.83mo	8.08mo	6.32mo	11.76mo	9.83mo
23	5.3.5.1	Preparing call documentation	0.82	Work						6.25mo	1.18mo		
24	5.3.5.2	Updating call documentation to GT	0.07	Work							0.53mo	0.07mo	
25	5.3.5.3	Updating call documentation to OT	0.18	Work								1.05mo	0.55mo
26	5.3.5.4	Phase 1 KP	0.1	Work							0.9mo		
27	5.3.5.5	Phase 1 GT	0.1	Work								0.9mo	
28	5.3.5.6	Phase 1 OT	0.1	Work									0.9mo
29	5.3.5.7	Phase 2 KP	0.4	Work							0.01mo	3.59mo	
30	5.3.5.8	Phase 2 GT	0.4	Work								1.36mo	2.24mo
31	5.3.5.9	Phase 2 OT	0.4	Work									1.36mo
32	5.3.5.10	Define s/w tools req.	0.03	Work					0.26mo				
33	5.3.5.11	Monitor and test s/w	0.27	Work					0.56mo	1.84mo			
34	5.3.5.12	Run helpdesk	1.55	Work							3.7mo	4.78mo	4.78mo
35	5.3.6	HOTAC support	1.29	Work					0.27mo	0.52mo	2.11mo	2.4mo	5.87mo
36	5.3.6.1	Define s/w tools req.	0.01	Work					0.09mo				
37	5.3.6.2	Monitor and test s/w	0.03	Work						0.25mo			
38	5.3.6.3	Design panel structure	0.02	Work					0.15mo				
39	5.3.6.4	Administration	0.03	Work					0.03mo	0.27mo			
40	5.3.6.5	Stats and reports KP	0.1	Work							0.9mo		
41	5.3.6.6	Stats and reports GT	0.06	Work								0.5mo	
42	5.3.6.7	Stats and reports OT	0.07	Work									0.6mo
43	5.3.6.8	Panel meetings KP	0.12	Work							1.12mo		
44	5.3.6.9	Panel meetings GT	0.16	Work								1.4mo	
45	5.3.6.10	Panel meetings OT	0.16	Work									1.4mo
46	5.3.6.11	Process results KP	0.01	Work							0.09mo		
47	5.3.6.12	Process results GT	0.06	Work								0.5mo	
48	5.3.6.13	Process results OT	0.11	Work									1mo
49	5.3.6.14	Technical feasibility	0.37	Work									2.87mo
50	5.3.7	Coordination of KP & GT	0.08	Work								0.48mo	0.27mo
51	5.3.8	Information, Public relations and communication	2.46	Work			0.29mo	1.92mo	0.44mo	1.42mo	5.66mo	7.11mo	4.63mo
52	5.3.8.1	Web page maintenance	0.34	Work							0.97mo	0.96mo	0.96mo
53	5.3.8.2	Hercshel workshop organization and proceedings	0.7	Work			0.29mo	1.92mo	0.22mo	0.61mo	0.86mo	1.1mo	1.15mo
54	5.3.8.2.1	Toledo	0.24	Work			0.29mo	1.92mo					
55	5.3.8.2.2	Other workshops	0.46	Work					0.22mo	0.61mo	0.86mo	1.1mo	1.15mo
56	5.3.8.3	Hercshel seminars	0.58	Work							2.11mo	2.87mo	0.23mo
57	5.3.8.4	Hercshel newsletter	0.39	Work						0.19mo	0.86mo	1.1mo	1.15mo

HSC WPs

ID	WBS	Task Name	Staff Years	Details	1998	1999	2000	2001	2002	2003	2004	2005	2006
58	5.3.8.5	Support to PR	0.46	Work					0.22mo	0.61mo	0.86mo	1.1mo	1.15mo
59	5.4	Definition of HSC	8.29	Work	5.8mo	13.43mo	6.83mo	9.47mo	7.1mo	3.73mo	12.78mo	15.61mo	
60	5.4.1	Pre-development consolidation	3.96	Work	5.8mo	13.43mo	4.92mo	7.55mo	4.03mo				
61	5.4.2	Preparation of URD	0.54	Work			1.91mo	1.92mo	1.03mo				
62	5.4.3	Definition of user requirements	0.48	Work					2.04mo	1.48mo	0.78mo		
63	5.4.3.1	PHS	0.1	Work					0.84mo	0.04mo			
64	5.4.3.2	QCP, data products and archive	0.26	Work					0.84mo	0.96mo	0.52mo		
65	5.4.3.3	Definition support to other systems	0.12	Work					0.36mo	0.48mo	0.26mo		
66	5.4.4	Tests and user trials	1.58	Work						2.25mo	5.32mo	6.68mo	
67	5.4.4.1	PHS i/f to general observer	0.25	Work						2.25mo			
68	5.4.4.2	QCP i/f to general observer	0.67	Work							2.66mo	3.34mo	
69	5.4.4.3	Archive i/f	0.67	Work							2.66mo	3.34mo	
70	5.4.5	Acceptance testing of subsystems	1.73	Work							6.68mo	8.93mo	
71	5.5	HCSS Development	80.82	Work		2.43mo	53.36mo	58.92mo	88.56mo	113.38mo	113.9mo	122.43mo	148.52mo
72	5.5.1	System engineering	7.88	Work		2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.65mo	9.57mo	9.57mo
73	5.5.2	Software development	32.69	Work			38.33mo	38.09mo	38.43mo	38.43mo	38.61mo	47.83mo	47.83mo
74	5.5.3	Software maintenance	3.86	Work									26.09mo
75	5.5.4	Support functions	36.39	Work			5.46mo	11.23mo	40.51mo	65.34mo	65.63mo	65.04mo	65.04mo
76	5.6	Operations preparations	10.99	Work							3.25mo	5.78mo	84.46mo
77	5.6.1	PHS	1.11	Work							1.32mo	3.05mo	4.69mo
78	5.6.1.1	Operations for calls	0.83	Work							1.32mo	2.87mo	2.87mo
79	5.6.1.2	Support to E-to-E	0.22	Work								0.18mo	1.82mo
80	5.6.1.3	Commisioning and PV entry	0.06	Work									
81	5.6.2	Mission planning	0.67	Work							0mo	1.66mo	4.34mo
82	5.6.2.1	Strategy	0.04	Work							0mo	0.4mo	
83	5.6.2.2	Long term plan	0.62	Work								1.26mo	4.34mo
84	5.6.3	Operations implementation	2.14	Work									17.86mo
85	5.6.3.1	Operational interfaces	0.21	Work									1.9mo
86	5.6.3.1.1	Operational ICD preparations	0.17	Work									1.5mo
87	5.6.3.1.2	Review of i/f and procedures	0.04	Work									0.4mo
88	5.6.3.2	Routine phase plan and procedures	0.31	Work									2.83mo
89	5.6.3.3	Provision of HSC infrastructure, H/W and Network	1.62	Work									13.14mo
90	5.6.3.3.1	Ground segment preparation	0.45	Work									4.01mo
91	5.6.3.3.2	Planning for h/w	0.07	Work									0.6mo
92	5.6.3.3.3	Installation of h/w	1.11	Work									8.52mo
93	5.6.4	SVTs and E-to-E tests	1.49	Work									13.44mo
94	5.6.5	Simulations	0.99	Work									8.9mo
95	5.6.5.1	Preparation	0.44	Work									4mo
96	5.6.5.2	Participation	0.54	Work									4.9mo
97	5.6.6	Commisioning phase	0.98	Work									8.86mo
98	5.6.6.1	Plan	0.8	Work									7.2mo
99	5.6.6.2	Procedures and h/w & s/w configuration	0.18	Work									1.66mo
100	5.6.7	PV phase	2.75	Work									21.57mo
101	5.6.7.1	Plan	0.27	Work									2.47mo
102	5.6.7.2	Commisioning and PV observations	0.33	Work									3mo
103	5.6.7.3	Generation of timeline	0.48	Work									3.28mo
104	5.6.7.4	Generation of GS procedures	0.55	Work									5mo
105	5.6.7.5	Validation of schedules with IIS	1.11	Work									7.83mo
106	5.6.8	Training of staff	0.86	Work							1.93mo	1.07mo	4.8mo
107	5.6.8.1	Training plan	0.33	Work							1.93mo	1.07mo	
108	5.6.8.2	Training courses	0.53	Work									4.8mo
109	6	**Operations**	130.6	Work									
110	6.1	Management	7.66	Work									
111	6.2	Support to HSC	20.11	Work									
112	6.2.1	Project control	0.96	Work									
113	6.2.2	Secretarial support	3.83	Work									
114	6.2.3	Computer administration	15.32	Work									
115	6.3	Reasearch and Scientific Support Activities	36.21	Work									

HSC WPs

ID	WBS	Task Name	Staff Years	Details
116	6.3.1	Scientific Research	13.79	Work
117	6.3.2	Calibration and cross-calibration coordination	3.02	Work
118	6.3.2.1	Coordination of calibration observations deliveries	0.38	Work
119	6.3.2.2	Coordination of cross-calibration working groups	2.64	Work
120	6.3.3	Instrument characterisation	2.26	Work
121	6.3.4	Scientific satellite characterisation	1.51	Work
122	6.3.5	Community support	10.43	Work
123	6.3.5.1	Support through helpdesk	1.91	Work
124	6.3.5.2	On-site support	0.6	Work
125	6.3.5.3	Update observer's manual	0.24	Work
126	6.3.5.4	Prepare data user's manual	1.37	Work
127	6.3.5.5	Coordination with ICCs for IA, documentation, recipes etc. provision	1.23	Work
128	6.3.5.6	Inform community	0.96	Work
129	6.3.5.7	Run helpdesk	1.91	Work
130	6.3.5.8	Support 2nd and 3rd calls	1.08	Work
131	6.3.5.9	Support ToOs	0.14	Work
132	6.3.5.10	Revise reqs. and test s/w tools	0.33	Work
133	6.3.5.11	Revise reqs and test archive I/f	0.67	Work
134	6.3.6	HOTAC and its support	2.77	Work
135	6.3.6.1	Review and revise HOTAC s/w reqs	0.02	Work
136	6.3.6.2	Monitor s/w development and test	0.03	Work
137	6.3.6.3	Compile HOTAC stats and reports	0.15	Work
138	6.3.6.4	HOTAC administration	0.02	Work
139	6.3.6.5	Meetings for the 2nd call	0.16	Work
140	6.3.6.6	Process results for the 2nd call	0.04	Work
141	6.3.6.10	Meetings for the 3rd call	0.16	Work
142	6.3.6.11	Process results for the 3rd call	0.04	Work
143	6.3.6.7	Discretionary time proposals	1.02	Work
144	6.3.6.8	ToO	0.14	Work
145	6.3.6.9	Technical feasibility	1	Work
146	6.3.7	Scientific mission planning strategy	0.49	Work
147	6.3.7.1	Routine checks of history	0.08	Work
148	6.3.7.2	Assessment and updating of plan	0.04	Work
149	6.3.7.3	Coordination of ToOs, SSOs and fixed time observations	0.38	Work
150	6.3.8	Information, Public relations and communication	1.94	Work
151	6.3.8.1	Web page maintenance	0.38	Work
152	6.3.8.2	Workshops	0.46	Work
153	6.3.8.3	Hercshel seminars	0.18	Work
154	6.3.8.4	Hercshel newsletter	0.46	Work
155	6.3.8.5	Support to PR	0.46	Work
156	6.4	HSC operations activities	27.84	Work
157	6.4.1	Operate PHS	1.81	Work
158	6.4.1.1	PHS operations during main proposal entries	0.11	Work
159	6.4.1.2	Routine PHS operations and management of database	1.7	Work
160	6.4.2	Support to commissioning, PV and early operations phases	2.16	Work
161	6.4.3	Operate the mission planning subsystem	7.66	Work
162	6.4.4	Ingestion of data into HCSS	1.89	Work
163	6.4.5	Operate the quality control processing	3.79	Work
164	6.4.6	Perform data quality assessment	9.46	Work
165	6.4.6.1	Systematic quality control for all data	3.79	Work
166	6.4.6.2	Expert support for QC	5.68	Work
167	6.4.7	Post-operations preparations	1.06	Work
168	6.5	HSCC maintenance	38.78	Work
169	6.5.1	System engineering	3.83	Work
170	6.5.2	Software maintenance	34.95	Work
171	6.5.2.1	Software development	4.31	Work
172	6.5.2.2	Maintain HCSS database	3.83	Work
173	6.5.2.3	Maintain proposal handling subsystem	3.83	Work



HSC WPs

ID	WBS	Task Name	Staff Years	Details
174	6.5.2.4	Maintain quality control processing	3.83	Work
175	6.5.2.5	Maintain Mission planning subsystem	3.83	Work
176	6.5.2.6	Maintain HCSS archive interface	3.83	Work
177	6.5.2.7	Maintain CUS	3.83	Work
178	6.5.2.8	Configuration control	3.83	Work
179	6.5.2.9	Quality assurance	3.83	Work
180	7	**Post-operations**	96.62	Work
181	7.1	Management	5.59	Work
182	7.2	Support to HSC	12.58	Work
183	7.2.1	Project control	1.4	Work
184	7.2.2	Secretarial support	5.59	Work
185	7.2.3	Computer administration	5.59	Work
186	7.3	Research and Scientific Support Activities	57.88	Work
187	7.3.1	Scientific Research	20.13	Work
188	7.3.2	Scientific satellite characterisation and cross calibration coordination	10.02	Work
189	7.3.2.1	Instrument characterisation	2.66	Work
190	7.3.2.2	Cross-calibration and calibration working groups coordination	5.59	Work
191	7.3.2.3	Scientific satellite characterization	1.77	Work
192	7.3.3	Community support	23.49	Work
193	7.3.3.1	Helpdesk support	5.59	Work
194	7.3.3.2	On-site support	3.58	Work
195	7.3.3.3	Update data user's manual	3.39	Work
196	7.3.3.4	Write legacy documents	1.19	Work
197	7.3.3.5	Inform community	4.47	Work
198	7.3.3.6	Run helpdesk	2.8	Work
199	7.3.3.7	Definition and production of catalogues and atlases	1.12	Work
200	7.3.3.8	Organization of data workshops	1.34	Work
201	7.3.4	Information, Public relations and communication	4.25	Work
202	7.3.4.1	Web page maintenance	0.56	Work
203	7.3.4.2	Workshops	2.01	Work
204	7.3.4.3	Hercshel seminars	0.34	Work
205	7.3.4.4	Hercshel newsletter	0.67	Work
206	7.3.4.5	Support to PR	0.67	Work
207	7.4	Active archive support	6.59	Work
208	7.4.1	Rundown Monitoring	0.07	Work
209	7.4.2	Consolidation	2.26	Work
210	7.4.2.1	Upgrade of hardware	0.53	Work
211	7.4.2.2	Consolidation of archive contents	0.75	Work
212	7.4.2.3	Consolidation of IA and processing	0.42	Work
213	7.4.2.4	Consolidation of cal file derivation	0.32	Work
214	7.4.2.5	Consolidation of diagnostic software	0.24	Work
215	7.4.3	Archive upgrades and reprocessing	2.08	Work
216	7.4.4	Preparation of end-of-mission reports	0.2	Work
217	7.4.5	Planck data archiving	0.35	Work
218	7.4.6	Transfer into historical archive	1.63	Work
219	7.5	Software maintenance	13.98	Work

1998 1999 2000 2001 2002 2003 2004 2005 2006

HSC WPs

ID	WBS	Task Name	Staff Years	Details	2007	2008	2009	2010	2011	2012	2013	2014	2015
0		***Herschel Science Centre***	388.8	Work	362.45mo	318.33mo	317.55mo	280.93mo	166.43mo	162.29mo	164.85mo	165.31mo	165.1mo
1	5	**Development**	161.59	Work	53.57mo								
2	5.1	Management	16.94	Work	4.43mo								
3	5.1.1	HSC Development Management	7.61	Work	1.48mo								
4	5.1.2	HSC Operations Manager	4.42	Work	1.48mo								
5	5.1.3	HSC Team Management	4.91	Work	1.47mo								
6	5.2	Support to HSC	8.56	Work	3.3mo								
7	5.2.1	Project control	1.9	Work	0.37mo								
8	5.2.2	Secretarial support	2.77	Work	1.45mo								
9	5.2.3	Computer administration	3.88	Work	1.48mo								
10	5.3	Research and Scientific Support Activities	36	Work	12.66mo								
11	5.3.1	Scientific Research	15.95	Work	5.27mo								
12	5.3.2	Calibration coordination	4.6	Work	1.53mo								
13	5.3.2.1	Calibration working groups	2.74	Work	0.8mo								
14	5.3.2.2	Cross calibration	0.55	Work	0.29mo								
15	5.3.2.3	Calibration requirements and plans	1.31	Work	0.44mo								
16	5.3.3	Instrument characterisation	6.1	Work	1.18mo								
17	5.3.3.1	Characterise instrument and monitor development	2.63	Work	0.88mo								
18	5.3.3.2	Instrument tests	1.88	Work									
19	5.3.3.3	PV plan	0.72	Work									
20	5.3.3.4	Maintain instrument documentation	0.87	Work	0.29mo								
21	5.3.4	Scientific satellite characterisation	1.11	Work	0.59mo								
22	5.3.5	Community support	4.41	Work	2.98mo								
23	5.3.5.1	Preparing call documentation	0.82	Work									
24	5.3.5.2	Updating call documentation to GT	0.07	Work									
25	5.3.5.3	Updating call documentation to OT	0.18	Work									
26	5.3.5.4	Phase 1 KP	0.1	Work									
27	5.3.5.5	Phase 1 GT	0.1	Work									
28	5.3.5.6	Phase 1 OT	0.1	Work									
29	5.3.5.7	Phase 2 KP	0.4	Work									
30	5.3.5.8	Phase 2 GT	0.4	Work									
31	5.3.5.9	Phase 2 OT	0.4	Work	2.24mo								
32	5.3.5.10	Define s/w tools req.	0.03	Work									
33	5.3.5.11	Monitor and test s/w	0.27	Work									
34	5.3.5.12	Run helpdesk	1.55	Work	0.74mo								
35	5.3.6	HOTAC support	1.29	Work	0.44mo								
36	5.3.6.1	Define s/w tools req.	0.01	Work									
37	5.3.6.2	Monitor and test s/w	0.03	Work									
38	5.3.6.3	Design panel structure	0.02	Work									
39	5.3.6.4	Administration	0.03	Work									
40	5.3.6.5	Stats and reports KP	0.1	Work									
41	5.3.6.6	Stats and reports GT	0.06	Work									
42	5.3.6.7	Stats and reports OT	0.07	Work									
43	5.3.6.8	Panel meetings KP	0.12	Work									
44	5.3.6.9	Panel meetings GT	0.16	Work									
45	5.3.6.10	Panel meetings OT	0.16	Work									
46	5.3.6.11	Process results KP	0.01	Work									
47	5.3.6.12	Process results GT	0.06	Work									
48	5.3.6.13	Process results OT	0.11	Work									
49	5.3.6.14	Technical feasibility	0.37	Work	0.44mo								
50	5.3.7	Coordination of KP & GT	0.08	Work									
51	5.3.8	Information, Public relations and communication	2.46	Work	0.68mo								
52	5.3.8.1	Web page maintenance	0.34	Work	0.15mo								
53	5.3.8.2	Hercshel workshop organization and proceedings	0.7	Work	0.18mo								
54	5.3.8.2.1	Toledo	0.24	Work									
55	5.3.8.2.2	Other workshops	0.46	Work	0.18mo								
56	5.3.8.3	Hercshel seminars	0.58	Work									
57	5.3.8.4	Hercshel newsletter	0.39	Work	0.18mo								

HSC WPs

ID	WBS	Task Name	Staff Years	Details	2007	2008	2009	2010	2011	2012	2013	2014	2015
58	5.3.8.5	Support to PR	0.46	Work	0.18mo								
59	5.4	Definition of HSC	8.29	Work									
60	5.4.1	Pre-development consolidation	3.96	Work									
61	5.4.2	Preparation of URD	0.54	Work									
62	5.4.3	Definition of user requirements	0.48	Work									
63	5.4.3.1	PHS	0.1	Work									
64	5.4.3.2	QCP, data products and archive	0.26	Work									
65	5.4.3.3	Definition support to other systems	0.12	Work									
66	5.4.4	Tests and user trials	1.58	Work									
67	5.4.4.1	PHS i/f to general observer	0.25	Work									
68	5.4.4.2	QCP i/f to general observer	0.67	Work									
69	5.4.4.3	Archive i/f	0.67	Work									
70	5.4.5	Acceptance testing of subsystems	1.73	Work									
71	5.5	HCSS Development	80.82	Work	27.57mo								
72	5.5.1	System engineering	7.88	Work	1.44mo								
73	5.5.2	Software development	32.69	Work	7.38mo								
74	5.5.3	Software maintenance	3.86	Work	8.71mo								
75	5.5.4	Support functions	36.39	Work	10.04mo								
76	5.6	Operations preparations	10.99	Work	5.61mo								
77	5.6.1	PHS	1.11	Work	0.94mo								
78	5.6.1.1	Operations for calls	0.83	Work	0.44mo								
79	5.6.1.2	Support to E-to-E	0.22	Work									
80	5.6.1.3	Commisioning and PV entry	0.06	Work	0.5mo								
81	5.6.2	Mission planning	0.67	Work									
82	5.6.2.1	Strategy	0.04	Work									
83	5.6.2.2	Long term plan	0.62	Work									
84	5.6.3	Operations implementation	2.14	Work	1.48mo								
85	5.6.3.1	Operational interfaces	0.21	Work									
86	5.6.3.1.1	Operational ICD preparations	0.17	Work									
87	5.6.3.1.2	Review of i/f and procedures	0.04	Work									
88	5.6.3.2	Routine phase plan and procedures	0.31	Work									
89	5.6.3.3	Provision of HSC infrastructure, H/W and Network	1.62	Work	1.48mo								
90	5.6.3.3.1	Ground segment preparation	0.45	Work									
91	5.6.3.3.2	Planning for h/w	0.07	Work									
92	5.6.3.3.3	Installation of h/w	1.11	Work	1.48mo								
93	5.6.4	SVTs and E-to-E tests	1.49	Work									
94	5.6.5	Simulations	0.99	Work									
95	5.6.5.1	Preparation	0.44	Work									
96	5.6.5.2	Participation	0.54	Work									
97	5.6.6	Commisioning phase	0.98	Work									
98	5.6.6.1	Plan	0.8	Work									
99	5.6.6.2	Procedures and h/w & s/w configuration	0.18	Work									
100	5.6.7	PV phase	2.75	Work	3.19mo								
101	5.6.7.1	Plan	0.27	Work									
102	5.6.7.2	Commisioning and PV observations	0.33	Work									
103	5.6.7.3	Generation of timeline	0.48	Work	1.02mo								
104	5.6.7.4	Generation of GS procedures	0.55	Work									
105	5.6.7.5	Validation of schedules with IIS	1.11	Work	2.17mo								
106	5.6.8	Training of staff	0.86	Work									
107	5.6.8.1	Training plan	0.33	Work									
108	5.6.8.2	Training courses	0.53	Work									
109	6	**Operations**	130.6	Work	308.88mo	318.33mo	317.55mo	233.36mo					
110	6.1	Management	7.66	Work	16.26mo	19.3mo	19.22mo	14.34mo					
111	6.2	Support to HSC	20.11	Work	42.68mo	50.67mo	50.45mo	37.58mo					
112	6.2.1	Project control	0.96	Work	2.03mo	2.41mo	2.4mo	1.79mo					
113	6.2.2	Secretarial support	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
114	6.2.3	Computer administration	15.32	Work	32.52mo	38.61mo	38.43mo	28.63mo					
115	6.3	Reasearch and Scientific Support Activities	36.21	Work	67.7mo	98.23mo	97mo	63.71mo					

HSC WPs

ID	WBS	Task Name	Staff Years	Details	2007	2008	2009	2010	2011	2012	2013	2014	2015
116	6.3.1	Scientific Research	13.79	Work	29.27mo	34.75mo	34.59mo	25.77mo					
117	6.3.2	Calibration and cross-calibration coordination	3.02	Work	6.19mo	7.72mo	7.69mo	5.6mo					
118	6.3.2.1	Coordination of calibration observations deliveries	0.38	Work	0.77mo	0.97mo	0.96mo	0.7mo					
119	6.3.2.2	Coordination of cross-calibration working groups	2.64	Work	5.42mo	6.76mo	6.73mo	4.9mo					
120	6.3.3	Instrument characterisation	2.26	Work	4.64mo	5.79mo	5.77mo	4.2mo					
121	6.3.4	Scientific satellite characterisation	1.51	Work	3.1mo	3.86mo	3.84mo	2.8mo					
122	6.3.5	Community support	10.43	Work	15.12mo	31.44mo	29.79mo	17.78mo					
123	6.3.5.1	Support through helpdesk	1.91	Work	4.07mo	4.83mo	4.8mo	3.58mo					
124	6.3.5.2	On-site support	0.6	Work	0.67mo	1.74mo	1.73mo	1.26mo					
125	6.3.5.3	Update observer's manual	0.24	Work		2.2mo							
126	6.3.5.4	Prepare data user's manual	1.37	Work	1.76mo	3.86mo	3.84mo	2.86mo					
127	6.3.5.5	Coordination with ICCs for IA, documentation, recipes etc. provision	1.23	Work	1.58mo	3.47mo	3.46mo	2.57mo					
128	6.3.5.6	Inform community	0.96	Work	1.23mo	2.7mo	2.69mo	2mo					
129	6.3.5.7	Run helpdesk	1.91	Work	4.07mo	4.83mo	4.8mo	3.58mo					
130	6.3.5.8	Support 2nd and 3rd calls	1.08	Work		4.53mo	5.19mo						
131	6.3.5.9	Support ToOs	0.14	Work	0.18mo	0.39mo	0.38mo	0.29mo					
132	6.3.5.10	Revise reqs. and test s/w tools	0.33	Work	0.53mo	0.97mo	0.96mo	0.55mo					
133	6.3.5.11	Revise reqs and test archive I/f	0.67	Work	1.05mo	1.93mo	1.92mo	1.1mo					
134	6.3.6	HOTAC and its support	2.77	Work	4.63mo	8.39mo	9.08mo	2.9mo					
135	6.3.6.1	Review and revise HOTAC s/w reqs	0.02	Work	0.08mo	0.07mo							
136	6.3.6.2	Monitor s/w development and test	0.03	Work	0.15mo	0.15mo							
137	6.3.6.3	Compile HOTAC stats and reports	0.15	Work		0.19mo	1.17mo						
138	6.3.6.4	HOTAC administration	0.02	Work	0.15mo	0.05mo							
139	6.3.6.5	Meetings for the 2nd call	0.16	Work		1.4mo							
140	6.3.6.6	Process results for the 2nd call	0.04	Work		0.36mo							
141	6.3.6.10	Meetings for the 3rd call	0.16	Work			1.4mo						
142	6.3.6.11	Process results for the 3rd call	0.04	Work			0.36mo						
143	6.3.6.7	Discretionary time proposals	1.02	Work	1.59mo	2.9mo	2.88mo	1.87mo					
144	6.3.6.8	ToO	0.14	Work	0.21mo	0.39mo	0.38mo	0.25mo					
145	6.3.6.9	Technical feasibility	1	Work	2.44mo	2.9mo	2.88mo	0.78mo					
146	6.3.7	Scientific mission planning strategy	0.49	Work	1.01mo	1.25mo	1.25mo	0.93mo					
147	6.3.7.1	Routine checks of history	0.08	Work	0.15mo	0.19mo	0.19mo	0.14mo					
148	6.3.7.2	Assessment and updating of plan	0.04	Work	0.08mo	0.1mo	0.1mo	0.07mo					
149	6.3.7.3	Coordination of ToOs, SSOs and fixed time observations	0.38	Work	0.77mo	0.97mo	0.96mo	0.72mo					
150	6.3.8	Information, Public relations and communication	1.94	Work	3.74mo	5.02mo	5mo	3.72mo					
151	6.3.8.1	Web page maintenance	0.38	Work	0.81mo	0.97mo	0.96mo	0.72mo					
152	6.3.8.2	Workshops	0.46	Work	0.98mo	1.16mo	1.15mo	0.86mo					
153	6.3.8.3	Hercshel seminars	0.18	Work		0.58mo	0.58mo	0.43mo					
154	6.3.8.4	Hercshel newsletter	0.46	Work	0.98mo	1.16mo	1.15mo	0.86mo					
155	6.3.8.5	Support to PR	0.46	Work	0.98mo	1.16mo	1.15mo	0.86mo					
156	6.4	HSC operations activities	27.84	Work	70.21mo	63.26mo	64.41mo	53.3mo					
157	6.4.1	Operate PHS	1.81	Work	3.48mo	5.34mo	4.32mo	3.22mo					
158	6.4.1.1	PHS operations during main proposal entries	0.11	Work		1mo							
159	6.4.1.2	Routine PHS operations and management of database	1.7	Work	3.48mo	4.34mo	4.32mo	3.22mo					
160	6.4.2	Support to commissioning, PV and early operations phases	2.16	Work	19.51mo								
161	6.4.3	Operate the mission planning subsystem	7.66	Work	16.26mo	19.3mo	19.22mo	14.32mo					
162	6.4.4	Ingestion of data into HCSS	1.89	Work	3.87mo	4.83mo	4.8mo	3.58mo					
163	6.4.5	Operate the quality control processing	3.79	Work	7.74mo	9.65mo	9.61mo	7.15mo					
164	6.4.6	Perform data quality assessment	9.46	Work	19.35mo	24.13mo	24.02mo	17.88mo					
165	6.4.6.1	Systematic quality control for all data	3.79	Work	7.74mo	9.65mo	9.61mo	7.15mo					
166	6.4.6.2	Expert support for QC	5.68	Work	11.61mo	14.48mo	14.41mo	10.73mo					
167	6.4.7	Post-operations preparations	1.06	Work			2.43mo	7.17mo					
168	6.5	HSCC maintenance	38.78	Work	112.02mo	86.87mo	86.48mo	64.43mo					
169	6.5.1	System engineering	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
170	6.5.2	Software maintenance	34.95	Work	103.89mo	77.22mo	76.87mo	57.27mo					
171	6.5.2.1	Software development	4.31	Work	38.85mo								
172	6.5.2.2	Maintain HCSS database	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
173	6.5.2.3	Maintain proposal handling subsystem	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					

HSC WPs

ID	WBS	Task Name	Staff Years	Details	2007	2008	2009	2010	2011	2012	2013	2014	2015
174	6.5.2.4	Maintain quality control processing	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
175	6.5.2.5	Maintain Mission planning subsystem	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
176	6.5.2.6	Maintain HCSS archive interface	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
177	6.5.2.7	Maintain CUS	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
178	6.5.2.8	Configuration control	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
179	6.5.2.9	Quality assurance	3.83	Work	8.13mo	9.65mo	9.61mo	7.16mo					
180	7	**Post-operations**	96.62	Work				47.58mo	166.43mo	162.29mo	164.85mo	165.31mo	165.1mo
181	7.1	Management	5.59	Work				2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.6mo
182	7.2	Support to HSC	12.58	Work				5.48mo	21.52mo	21.62mo	21.62mo	21.62mo	21.61mo
183	7.2.1	Project control	1.4	Work				0.61mo	2.39mo	2.4mo	2.4mo	2.4mo	2.4mo
184	7.2.2	Secretarial support	5.59	Work				2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.6mo
185	7.2.3	Computer administration	5.59	Work				2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.6mo
186	7.3	Research and Scientific Support Activities	57.88	Work				23.71mo	96.91mo	100.31mo	103.41mo	103.33mo	94.48mo
187	7.3.1	Scientific Research	20.13	Work				8.77mo	34.43mo	34.59mo	34.59mo	34.59mo	34.57mo
188	7.3.2	Scientific satellite characterisation and cross calibration coordination	10.02	Work				4.87mo	19.13mo	19.22mo	19.22mo	18.39mo	9.6mo
189	7.3.2.1	Instrument characterisation	2.66	Work				1.46mo	5.74mo	5.77mo	5.77mo	5.27mo	
190	7.3.2.2	Cross-calibration and calibration working groups coordination	5.59	Work				2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.6mo
191	7.3.2.3	Scientific satellite characterization	1.77	Work				0.97mo	3.83mo	3.84mo	3.84mo	3.51mo	
192	7.3.3	Community support	23.49	Work				8.23mo	36.07mo	39.2mo	42.3mo	43.05mo	43.01mo
193	7.3.3.1	Helpdesk support	5.59	Work				2.43mo	9.57mo	9.61mo	9.61mo	9.61mo	9.6mo
194	7.3.3.2	On-site support	3.58	Work				1.56mo	6.12mo	6.15mo	6.15mo	6.15mo	6.15mo
195	7.3.3.3	Update data user's manual	3.39	Work					3.74mo	6.73mo	6.73mo	6.73mo	6.7mo
196	7.3.3.4	Write legacy documents	1.19	Work							3.1mo	3.84mo	3.84mo
197	7.3.3.5	Inform community	4.47	Work				1.95mo	7.65mo	7.69mo	7.69mo	7.69mo	7.68mo
198	7.3.3.6	Run helpdesk	2.8	Work				1.22mo	4.78mo	4.8mo	4.8mo	4.8mo	4.8mo
199	7.3.3.7	Definition and production of catalogues and atlases	1.12	Work				0.49mo	1.91mo	1.92mo	1.92mo	1.92mo	1.92mo
200	7.3.3.8	Organization of data workshops	1.34	Work				0.58mo	2.3mo	2.31mo	2.31mo	2.31mo	2.3mo
201	7.3.4	Information, Public relations and communication	4.25	Work				1.85mo	7.27mo	7.3mo	7.3mo	7.3mo	7.3mo
202	7.3.4.1	Web page maintenance	0.56	Work				0.24mo	0.96mo	0.96mo	0.96mo	0.96mo	0.96mo
203	7.3.4.2	Workshops	2.01	Work				0.88mo	3.44mo	3.46mo	3.46mo	3.46mo	3.46mo
204	7.3.4.3	Hercshel seminars	0.34	Work				0.15mo	0.57mo	0.58mo	0.58mo	0.58mo	0.58mo
205	7.3.4.4	Hercshel newsletter	0.67	Work				0.29mo	1.15mo	1.15mo	1.15mo	1.15mo	1.15mo
206	7.3.4.5	Support to PR	0.67	Work				0.29mo	1.15mo	1.15mo	1.15mo	1.15mo	1.15mo
207	7.4	Active archive support	6.59	Work				9.86mo	14.53mo	6.73mo	6.19mo	6.73mo	15.39mo
208	7.4.1	Rundown Monitoring	0.07	Work				0.49mo	0.11mo				
209	7.4.2	Consolidation	2.26	Work				8.89mo	11.46mo				
210	7.4.2.1	Upgrade of hardware	0.53	Work				4.8mo					
211	7.4.2.2	Consolidation of archive contents	0.75	Work				1.7mo	5.02mo				
212	7.4.2.3	Consolidation of IA and processing	0.42	Work				1.02mo	2.76mo				
213	7.4.2.4	Consolidation of cal file derivation	0.32	Work				0.78mo	2.1mo				
214	7.4.2.5	Consolidation of diagnostic software	0.24	Work				0.58mo	1.58mo				
215	7.4.3	Archive upgrades and reprocessing	2.08	Work					1.64mo	6.73mo	3.01mo	6.73mo	0.67mo
216	7.4.4	Preparation of end-of-mission reports	0.2	Work				0.49mo	1.31mo				
217	7.4.5	Planck data archiving	0.35	Work							3.18mo		
218	7.4.6	Transfer into historical archive	1.63	Work									14.73mo
219	7.5	Software maintenance	13.98	Work				6.09mo	23.91mo	24.02mo	24.02mo	24.02mo	24.01mo