SPIRE

SUBJECT:	SPIRE Science Implementation Plan		
PREPARED BY:	K.J. King		
DOCUMENT No:	SPIRE-RAL-PRJ-000018		
ISSUE:	1.1 Draft 2	**Date:**	18th March 2002
APPROVED BY:		**Date:**	

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Distribution

Change Record

ISSUE	DATE	Changes
Draft 1	Feb 16th 1998	Initial Draft, submitted for information with SPIRE Proposal
Issue 1.0	May 31st 2001	First issue - substantial update to all sections
Issue 1.1	18th March 2002	Update for ESA Review, incorporating workpackages based on ICC Use Cases

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Glossary

AOT	Astronomical Observation Template
CCS	Configuration Control System
CSDT	(Herschel Ground Segment) Common Software Development Team
CUS	Common Uplink System
DAPSAS	Data Processing and Science Analysis Software
DPOP	Daily Prime Operational Phase
DPU	Digital Processing Unit
DTCP	Daily Telecommunications Period
EGSE	Electrical Ground Support Equipment
FIRST	Far Infra-Red and Sub-millimetre Telescope
HCSS	Herschel Common Science System
HCSSMG	Herschel Common Science System Management Group
Herschel	Herschel Space Observatory (formerly FIRST)
HGSAG	Herschel Ground Segment Advisory Group
HGSSE	Herschel Ground Segment System Engineering (Group)
HSC	Herschel Science Centre
IA	Interactive Analysis
ICC	Instrument Control Centre
ICCDT	ICC Definition Team
ILT	Instrument-Level Test
ISDT	ICC Software Development Team
IST	Integrated System Test
MOC	Mission Operations Centre
MPS	Mission Planning System
OBS	On-Board Software
OBSM	On-Board Software Maintenance facility
PHS	Proposal Handling System
QCP	Quality Control Processing
QLA	Quick Look Analysis
RTA	Real Time Assessment
SPIRE	Spectral and Photometric Imaging REceiver
SSM	Solid State Memory
WWW	World Wide Web

1. INTRODUCTION

The primary role of the SPIRE Instrument Control Centre (ICC) is to make possible the delivery of scientifically useful data products to observers using the SPIRE instrument on the Herschel satellite. It does this by:

- providing the necessary software and expertise to allow the definition of astronomical observations and associated calibration and engineering observations.
- providing the necessary software and expertise to allow the processing of data taken from these measurements into usable products.
- monitoring and maintaining the instrument scientific performance throughout the mission.

1.1 Scope

This document describes the work that will be carried out to design, implement, validate and operate the SPIRE ICC as part of the Herschel ground segment throughout all phases of the Herschel Space Observatory programme.

Note: In this issue only the development phase of the ICC is addressed in detail. The operational phase has been analysed only at a high level in order to provide initial estimates of the required resources, as funds will not be allocated until approximately two years before launch and the Ground Segment responsibilities will be more fully investigated before that time. Other Phases are not considered at this time

The FIRST Science Management Plan (AD01) specifies the responsibilities of the PI teams with regard to setting up and operating an ICC. These responsibilities are translated in the Herschel Science Operations Implementation Requirements Document (AD03), the SIRD, into a set of requirements for implementation of the ICC and its operation in the Herschel ground segment, based on an operations concept described in the FIRST Operations Scenario Document (AD02).

This document incorporates the formal response, by the SPIRE consortium, to the requirements set out in the SIRD, but also includes those tasks necessary to implement additional requirements placed on the ICC from other SPIRE activities (for example, instrument AIV and support to the SPIRE consortium). These requirements have been derived by an analysis of the ICC functions and interfaces (both external and internal), documented in RD08.

The SPIRE ICC is one of three ICCs operated by the teams responsible for building the instruments that form the scientific payload of Herschel. Along with the Mission Operations Centre (MOC) and the Herschel Science Centre (HSC) they form the major elements of the FIRST ground segment as described in the FIRST Science Operations Concept and Ground Segment Document (RD01). For Herschel a novel distributed system for the Ground Segment is envisaged in which the mission operations team, science centre and instrument teams are not (necessarily) at the same location. In this concept the various groups access and transmit data and software through a distributed database system (the Herschel Common Science System, (HCSS)), which allows the different operational teams to be located where most of the knowledge and expertise, appropriate for the work, is already present. As a result, some of the functions that would be expected to be provided by each ICC are implemented centrally, in the HCSS. For these functions the development work is divided between the HSC and ICC staff and the workpackages presented in this document reflect this.

1.2 Structure of Document

Section 2 describes the Herschel Ground Segment as a whole and how the ICC fits into this concept.

Section 3 gives an overview of the SPIRE instrument and the impact it has on the design of the ICC.

Section 4 describes the assumptions under which the ICC has been designed to be developed and operated.

Section 5 describes the ICC overall concept and the way in which it will operate, its interfaces with the rest of the ground segment and the management plans for ensuring a timely, appropriate and efficient implementation.

Subsequent Sections describe the activities and organisation of the ICC during the major mission phases from development through post operations. Finally, detailed information that is subject to change as the project progresses (e.g. personnel associated with the ICC, facilities available to the ICC, work package breakdown, schedule etc.) are contained in a series of appendices.

1.3 Documents

1.3.1 Applicable Documents

AD01: FIRST Science Management Plan (SMP), (ESA/SPC(97)22 = FIRST/FSC/DOC/0019) Rev. 1
AD02: FIRST Operations Scenario Document, (FIRST/FSC/DOC/0114) Issue 1.0
AD03: FIRST Science Operations Implementation Requirements Document (SIRD), (PT-03646) Issue 1.1
AD04: FIRST/PLANCK Operations Interface Requirements Document (FOIRD), (FP-ESC-RS-0001)
AD05: FIRST/PLANCK Ground Segment Interface Document (GSID), (PT-04829)
AD06: Product Assurance Requirements for FIRST/PLANCK Scientific Instruments, (PT-RQ-04410)
AD07: SPIRE Product Assurance Plan, (SPIRE-RAL-PRJ-000017)
AD08: Software Engineering and PA Standards for the HCSS, (FIRST/FSC/DOC/0127)
AD09: HCSS Software PA Plan, (FIRST/FSC/DOC/0161)
AD10: HCSS Software Configuration Management Plan, (FIRST/FSC/DOC/0166)
AD11: SPIRE ICC Software Configuration Management Plan (SPIRE-RAL-PRJ-001106), Issue 1.1

1.3.2 Reference Documents

RD01: FIRST Science Operations Concept and Ground Segment Document, (PT-3056)
RD02: Herschel Ground Segment Design Description, (FIRST/FSC/DOC/0146)
RD03: Herschel Ground Segment Interface Requirements Document, (FIRST/FSC/DOC/0117)
RD04: HCSS Software Project Management Plan, (FIRST/FSC/DOC/0116)
RD05: HCSSMG Terms of Reference, (FIRST/FSC/DOC/0143)
RD06: HCSSE Terms of Reference, (FIRST/FSC/DOC/0145)
RD07: HGSAG Terms of Reference, (Ref TBD)
RD08: SPIRE ICC External and Internal Interfaces, (Ref TBD)
RD09: SPIRE ICC URDs, (Ref TBD)
RD10: SPIRE ICC Summary Use Cases, (Ref TBD)
RD11: Guide to applying the ESA Software Engineering Standards (PSS-05-0) to small Software Projects, (BSSC-96-2)
RD12 SPIRE Operating Modes Document

2. THE HERSCHEL GROUND SEGMENT

The Herschel ground segment is described in detail in the Herschel Ground Segment Design Description (RD02) and the operations concept in the Herschel Operations Scenario Document (AD02). This section gives a brief summary of these as they impact on the ICC design.

In the Herschel Ground Segment (see Figure 2-1, taken from AD03), the HSC has the responsibility to manage the execution of observations submitted as part of observing proposals from both guaranteed-time and open-time observers. By monitoring progress of the various proposals and subsequently adjusting scheduling properties the HSC ensures that observations are scheduled such that the scientific aims of the mission are fulfilled.

In routine operations the HSC prepares sets of science and calibration observations to be executed within the next scheduling period (this may include test and calibration observations submitted by the ICC). A detailed observing schedule is then created by the MOC by interleaving these science observations with the necessary satellite operations taking into account the constraints on visibility of the targets and timing. The final schedule is subsequently translated into satellite and instrument commands and uplinked via the Herschel ground station during the Daily Telecommunications Period (DTCP). During the subsequent operational period observations are executed and data from the instruments is stored into an on-board Solid State Memory (SSM). This data is telemetered to the ground station in the next DTCP and transmitted to the MOC where it is temporarily stored before being delivered, with associated ground data, to the HSC Archive. The MOC monitors the instrument health and safety from the housekeeping data in the telemetry and, if any problems are found, takes appropriate action based on procedures supplied by the instrument teams (this may include switching the instrument off or disabling particular observation types etc.). The HSC and instrument ICC will be notified of any problems found and the action taken.

The observation data available on the HSC Archive is used for analysis of the instrument performance (by the ICC) and, subsequently for processing into scientific products (by the FSC).

2.1 The Herschel Common Science System (HCSS)

Following the Ground Segment concept the Herschel Ground Segment System Engineering group (HGSSE) has generated an overall system design described in RD02. In this a single system, the HCSS, contains all Herschel Ground Segment functionalities that are common to the science and instruments operations. It includes the major following functions.

- Definition of proposals and observations
- Scheduling of observations
- Observations commanding generation
- Analysis of the instrument science data
- Processing and quality assessment of observation science data
- The storage and retrieving of all instrument and science relevant data

Each of these major functions is implemented by an HCSS subsystem or component. The HCSS includes the following subsystems:

- Common Uplink System (CUS): definition of observation templates and observation commanding generation
- Proposal Handling System (PHS): definition of proposals and observations
- Mission Planning System (MPS): scheduling of observations
- Configuration Control System (CCS): for HCSS data and SW
- Browsers
- Interactive and Quick-Look Analysis (IA/QLA): processing and analysis of the instrument science data
- Quality Control Processing (QCP): processing and quality assessment of observation science data

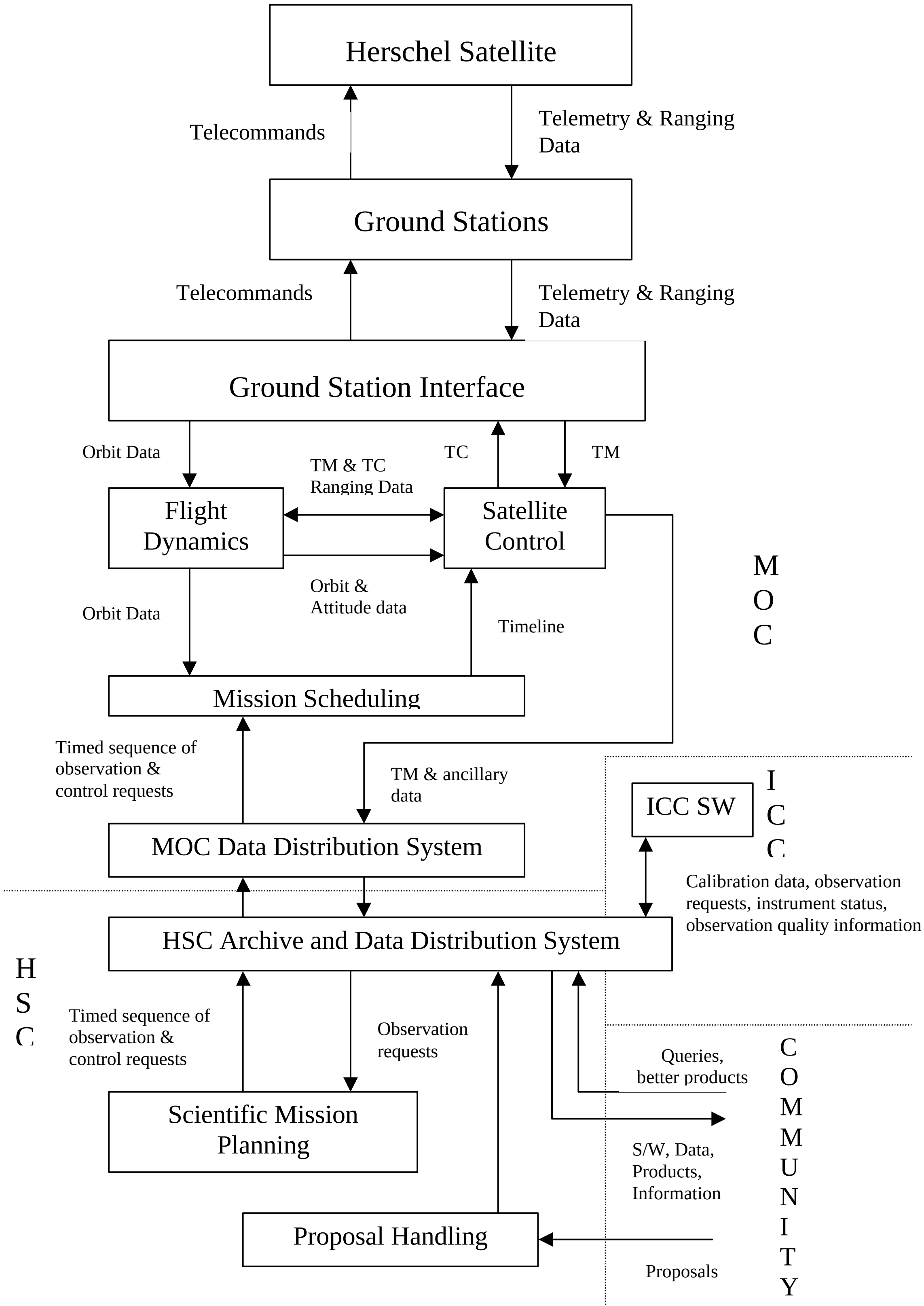

Figure 2-1 Ground Segment Oveview

At the heart of the HCSS is a storage mechanism for all the artefacts relevant to science and instruments operations. This storage mechanism is known as the HCSS Archive and will act as a data server for each of the HCSS sub-systems defined above as well as for the external Real-Time Analysis (RTA) and On-Board Software Maintenance (OBSM) facilities. All the above HCSS sub-systems, as well as RTA and OBSM are acting as clients to the Archive and are using it to retrieve/store their inputs/outputs. Figure 2-2 shows the Herschel Ground Segment as it looks during routine operations.

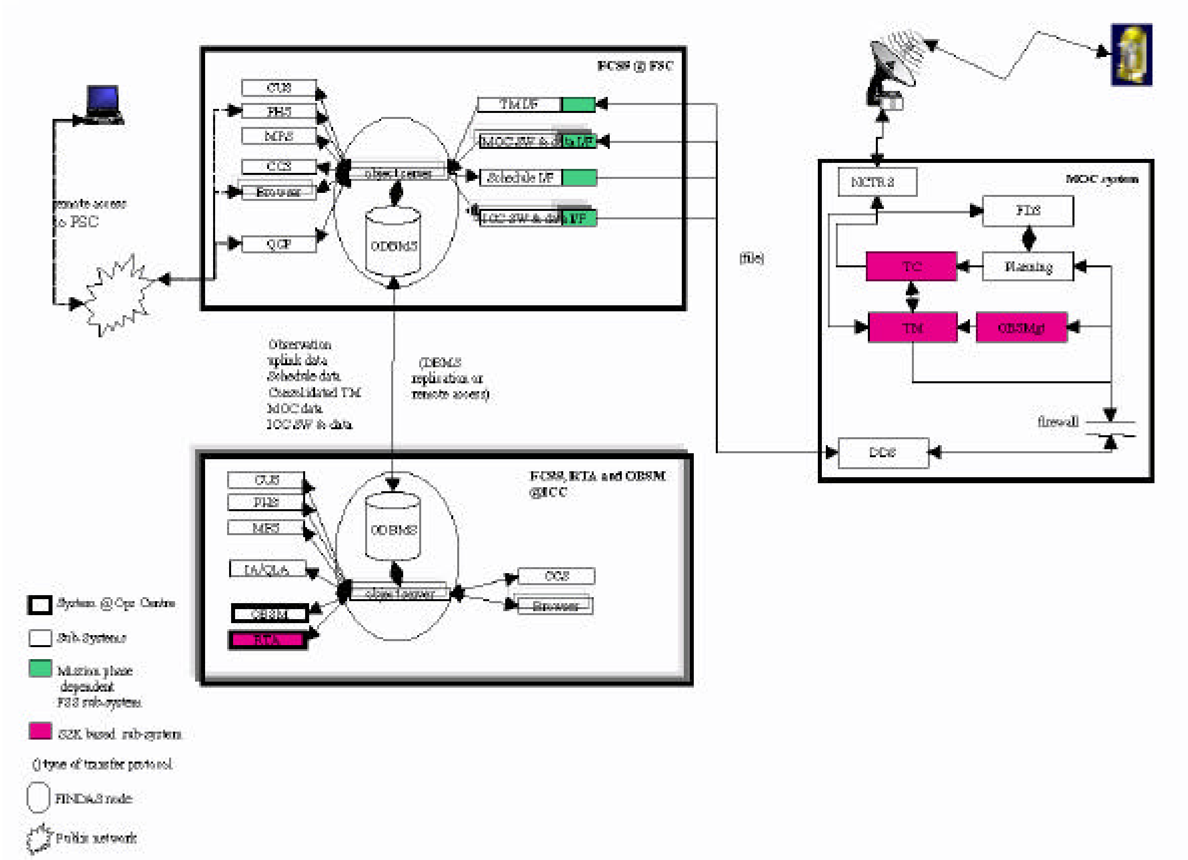

Figure 2-2 The Herschel Ground Segment in Routine Operations Phase

3. THE SPIRE INSTRUMENT

SPIRE (the Spectral and Photometric Imaging REceiver) is one of three cryogenic focal plane instruments for ESA's Herschel mission. Its main scientific goals are the investigation of the statistics and physics of galaxy and structure formation at high redshift and the study of the earliest stages of star formation, when the protostar is still coupled to the interstellar medium. These studies require the capabilities to carry out large-area (many tens of square degrees) deep photometric imaging surveys at far-infrared and submillimetre wavelengths, and to follow up these systematic survey observations with spectroscopy of selected sources.

SPIRE contains two separate sub-instruments utilising a common set of fore-optics: a three-band imaging photometer and an imaging Fourier Transform Spectrometer (FTS), both of which use 0.3-K feedhorn-coupled "spider-web" NTD germanium bolometers cooled by a ^{3}He refrigerator.

3.1 Photometer

Three bolometer arrays provide broad-band photometry ($\lambda/\Delta\lambda \sim 3$) in wavelength bands centred on 250, 350 and 500 μm. The field of view of the photometer is 4 x 8 arcminutes, the largest that can be achieved given the location of the SPIRE field of view in the Herschel focal plane and the size of the telescope unvignetted field of view. The field of view is observed simultaneously in all three bands through the use of fixed dichroic beam-splitters. Spatial modulation can be provided either by a Beam Steering Mirror (BSM) in the instrument or by scanning the telescope across the sky, depending on the type of observation. An internal thermal calibration source is available to provide a repeatable calibration signal for the detectors.

3.2 Spectrometer

The FTS uses novel broadband intensity beam dividers, and combines high efficiency with spatially separated input ports. One input port covers a 2.6-arcminute diameter field of view on the sky and the other is fed by an on-board calibration source. Two bolometer arrays are located at the output ports, one covering 200-300 μm and the other 300-670 μm. The FTS will normally be operated in continuous scan mode, with the path difference between the two arms of the interferometer being varied by a constant-speed mirror drive mechanism. The spectral resolution, as determined by the maximum optical path difference, will be adjustable between 0.04 and 2 cm-1 (corresponding to $\lambda/\Delta\lambda$ = 1000 - 20 at 250 μm wavelength.

3.3 Operations

The photometer and spectrometer are not designed to operate simultaneously (due to thermal dissipation considerations) and because the standby configuration for each sub-instrument is different, they will, in general, be operated in different operational days (it could take several hours to switch sub-instruments).

When in photometer mode the instrument will take serendipity data during the time taken to slew the telescope to each new source. The SPIRE ICC has to process this data as it will not normally be processed in the HSC.

An additional mode is envisaged where the SPIRE instrument is operated in parallel to the PACS instrument. In this case SPIRE will be in one of its normal photometric modes but the science data from the instrument will be compressed to keep the total data rate from the two instruments within the required limit.

4. IMPLEMENTATION ASSUMPTIONS

4.1 General Assumptions

The following is assumed:

- Herschel is launched in early 2007 – current funding is limited to the ICC development and test activities up to launch and its operation to the end of the Commissioning Phase, assumed to end one month after launch. Any delay of the launch beyond this time would be problematic.
- Operations are performed on a daily (24hr) basis with approximately 4 hrs of contact time with the satellite each day. This contact time normally occurs during the working day in Europe. There is therefore no need for the ICC to work outside normal offices hours during the week. At the weekend ICC staff will be on standby in case of problems
- All data necessary for the ICC to carry out its work, whether proprietary or not, is available to the ICC.
- SCOS2000 will be used as the instrument/satellite control system, both during ground testing and in flight operations
- The ICC and other Herschel Ground Segment centres are linked by networks providing continuous access to s/w and data.
- Support from ESA? For testing or s/w development

4.2 Scope of work

The following items are assumed to be excluded from the scope of the SPIRE SIP and therefore from the resources and work estimated:

- The SPIRE ICC will not provide an environment for scientific validation of the Data Processing and Science Analysis Software (DAPSAS). It is expected that the HSC will provide a test environment, identical to that in which the data processing software will run to allow generation of test products for validation of the software by the ICC.
- As part of the ground segment infrastructure, ESA will provide all necessary specialised communication links (e.g. leased lines to guarantee data transmission rates) to implement the distributed HCSS concept.

4.3 Collaboration

The ICC will be implemented as part of a closely integrated ground segment development programme. There will therefore be areas of work where it is important that the different groups adhere to agreed tasks and timescales, otherwise other parts of the programme will be affected. These are described below.

4.3.1 Smooth transition between mission phases

The HCSS will be the prime means of transferring data and information between the teams contributing to the FIRST ground segment. It will also provide facilities for configuration control of software developed at the different centres. In order to reduce effort involved in maintaining instrument software and data archives it is important that the relevant parts of the HCSS are available early in the development phase. For the instrument teams, these activities start with the storage of software, test data and procedures well before the start of the development phase for the ICCs themselves. For this reason it is important that;

- The HCSS be available for use during the first instrument-level tests with the capability to store and retrieve data and to support configuration control of software and test procedures.
- The HCSS allows real-time interaction with the instrument EGSE and Quick-Look Analysis system in time for integration tests of the instrument checkout equipment
- The HCSS has the capability to house all the SPIRE data from the mission, including, ground test data, in-flight instrument data, software and documentation.

In many cases the software will first be used by the instrument hardware teams (usually during the instrument-level test activities). This will require early input by the ESA teams at a time when traditionally this is not provided. It is assumed that this support will be made available.

4.3.2 Commonality

Wherever possible, development of (software) systems that are common between centres will be carried out in collaboration with the other ground segment groups. For such development efforts it is assumed that joint teams will be established and costing of the workpackages is based on this assumption. The common systems identified are:

- the HCSS structure and facilities
- definition of data objects stored in the HCSS
- the data processing and analysis environment
- the quick-look analysis environment
- the Common Uplink System
- the AOT translator
- time estimator(s), (TBC)

5. SPIRE ICC OVERALL CONCEPT

5.1 The role of the ICC

Within the ground segment, the prime operational responsibility of the ICC is to maintain the scientific performance of the instrument through the mission and to make possible the processing of the instrument data into scientifically useful products. It does this by continuously monitoring the health and status of the instrument, analysing its engineering and scientific performance, scheduling test and calibration observations, adjusting observational and operational procedures, generating calibration data and developing data processing software.

This clearly requires the ICC to have access to personnel with an intimate knowledge of the instrument hardware at system and subsystem level, its operational modes and their scientific purpose, how to process the data from the instrument and how to calibrate it. Thus it is important that the maximum amount of the expertise gained during the design, manufacture and, in particular, the testing of the instrument hardware is retained during the instrument operational phase. I.e. the ICC should make use of existing staff with directly relevant expertise as much as possible.

The Herschel Ground Segment concept already envisages a distributed operational system for this reason and this concept has been carried over into the ICC design.

5.2 System Overview

The SPIRE ICC will be implemented in three centres representing the main areas of expertise in the consortium:

- The ICC Operations Centre will be, primarily, responsible for maintaining the operational status and performance of the instrument. This will be located at RAL, which also has the responsibility for the testing and ground calibration of the instrument, and will be staffed by personnel from the consortium who have been involved in the development and testing of the instrument and its associated software. Additional support will be provided by the consortium as and when necessary (particularly during the Commissioning and PV Phases of the mission). This centre will be the single interface between the ICC and the rest of the Ground Segment.

- Two ICC Data Processing and Science Analysis Software (DAPSAS) Centres located at ICSTM (UK) and CEA, Saclay (France), both of which have significant relevant expertise in data processing software (e.g. for ISO and SCUBA). These centres will have access to the scientific knowledge and experience which is essential for monitoring the scientific quality of the science products, and for designing the science processing and analysis software, that is distributed through the whole SPIRE consortium. They will provide co-ordination of all the scientific data processing and analysis software development and maintenance activities. The staff from these Centres will participate in the instrument development, AIV and calibration activities during the ICC development phase in order to build up expertise in the instrument and its operation.

They will additionally be responsible for the generation and validation, to the relevant standards, of each version of the Interactive Analysis software delivered to the HSC. (Note: the Operations Centre will be responsible for its delivery and configuration control.)

5.3 ICC Organisation

5.3.1 ICC Development

Many of the activities of the ICC during the development phase will be distributed amongst the groups contributing to the instrument hardware development, manufacture and testing as this is where the expertise resides. It is intended that those involved in this work will transfer to the ICC for the Operations Phase, bringing this expertise.

To co-ordinate the work amongst these groups **an ICC Definition Team** (ICCDT) will be set up to define the ICC design and operations concept. Members of this team will be taken from the groups contributing to the ICC and will include the ICC Scientist, ICC Development Manager and ICC Software Manager, It will:

- Define the requirements on the ICC.
- Define an operations concept for the ICC within the Herschel Ground Segment
- Generate a set of work packages for the implementation and operation of the ICC though the different mission phases

It is expected that the development process will follow the Object Oriented Design paradigm with the requirements specified in terms of use-cases, which will be used both to elaborate the design of the system and to verify the implementation.

The **ICC Steering Group**, formed under the chairmanship of the ICC Scientist, will monitor this design process, and review the outputs of the ICC Definition Team. One of its prime responsibilities is to agree on the assignment of ICC workpackages to appropriate centres. This group will comprise the PI, the Co-PI, The Project Scientists, the Instrument Scientist, the Systems Engineer, the managers of the two DAPSAS Centres and the ICC Development Manager. The ICC Development Manager will be responsible for overseeing the implementation of these decisions through the DAPSAS Centres' Managers. He/she will also be the formal interface between the ICC and ESA and will attend all Ground Segment related meetings.

Once the workpackages have been defined and allocated, the **ICC Software Development Team (ISDT),** led by the ICC Software Development Manager, will be responsible for delivery of the software systems. This team will consist of software engineers from all the contributing countries.

5.3.2 ICC Operations

The SPIRE Operations Centre is responsible for the routine operation and monitoring of the instrument on a day to day basis. An Operations Team based at the centre will perform these activities.

The Operations Centre forms the single formal point of contact between the ICC and the HSC and MOC for deliveries of software, data files and other information identified in the ICC/HSC and ICC/MOC interface documents. For this reason the ESA provided link to the HSC will connect to this centre.

The DAPSAS Centres are responsible for; monitoring the scientific quality of the processed data from the instrument and upgrading the data processing and science analysis software to reflect improved knowledge and experience of the instrument. This includes carrying out periodic reviews of the calibration status and AOT optimisation in the light of in-flight instrument performance; and analysis of data from parallel and serendipity modes. They will also provide support to the HSC (via the Operations Centre) in relation to these matters.

Co-ordination of this work will be through a Data Analysis Group (consisting of all interested parties), which will meet regularly; to discuss the quality of the scientific products; to identify processing anomalies and effects; to suggest ways of investigating these; to determine solutions and to assign tasks for carrying these out.

5.4 Interfaces

With a distributed development and operational system, communications is one of the most important issues to resolve early and completely. A Communications Plan will be written which will contain all details (required hardware, facilities, etc.) and procedures relevant for ICC communications.

Interfaces to the other ground segment Centres will be detailed in the GSID (AD05).

5.4.1 ICC Internal

The prime medium for transfer of information between the ICC Centres will be the Herschel documentation system (currently held on Livelink)

- The ICC will have regular internal meetings. Depending on the phase of the mission these will be daily (PV, check out, ILT's), weekly (operations) or monthly or quarterly (development and post operations). Subgroups within the ICC will have separate working level meetings as needed. At all meetings, minutes (or as a minimum, clear decision and/or action lists) will be made which will be added to livelink for later reference.
- All team leaders will submit status reports with a frequency of TBD, again depending on the phase of the project. These will be compiled by the ICC Manager into overall ICC status reports that will be stored on Livelink and accessible to all ICC members. They will also be the basis for status reports to ESA.
- Documents, progress reports, meeting minutes and action lists will all be made available through Livelink.

The ICC will also make use of the SPIRE Project World Wide Web (WWW) site to inform the wider SPIRE community of the status of ICC work. This may involve duplication of some of the information on livelink for those sites which do not have access to it.

The ICC will use the SPIRE Project Office facilities for dissemination of information throughout the SPIRE consortium.

When needed, personnel may be stationed at different consortium institutes, or ESA sites, for appropriate periods.

The ICC will also make use of standard facilities such as telephone, FAX, electronic mail and other internet facilities (joint whiteboarding etc.).

During development it is likely that to save on travel expenses many meetings will be held as video- or tele-conferences.

5.4.2 Instrument Hardware Group

The instrument hardware development teams will have access, via Livelink and the WWW, to all information that the ICC provides and the reverse will also be true.

During the development phase some members of the ICC will spend part of their time performing as members of the instrument development and test teams in order to obtain expertise in instrument operations.

ICC Development Manager (or deputy) is always present in the SPIRE project meetings.

5.4.3 Herschel Project

The formal point of contact from the ICC to the Herschel Project is the ICC (Development or Operations) Manager. He/she will attend meetings of the HGSAG.

Deliveries of items such as documents and software will be made through either Livelink, the SPIRE Project Office or the Herschel configuration control system.

5.4.4 MOC

Throughout the development phase the main communication to the MOC will be through the HGSAG (via the ICC (Development or Operations) Manager and through the HCSSE (via the ICC Systems Engineer).

Deliverables and delivery procedures (wherever possible using HSC facilities) will be established jointly and documented in the GSID (AD05).

5.4.5 HSC

Throughout the development phase communication to the HSC will be through the HGSAG (via the ICC (Development or Operations) Manager and at a lower level through the HCSSMG and CSDT.

Deliverables and delivery procedures (wherever possible using HSC facilities) will be established jointly and documented in the GSID (AD05).

5.4.6 Other ICCs

Throughout the development phase the main communication to the other ICCs will be through the HGSAG (via the ICC (Development or Operations) Manager and at a lower level through the HCSSMG and CSDT.

Deliverables and delivery procedures (wherever possible using HSC facilities) will be established jointly and documented in the GSID (AD05).

5.5 Management

The SPIRE management organisation is shown Figure 5-1. The ultimate responsibility for the ICC rests with the PI but the day to day management of the ICC schedule and resources is carried out by the ICC Development Manager, during the development phase, who reports to the SPIRE Project Manager.

The ICC Development Manager will establish, distribute and monitor the work packages defined by the ICC Definition Team (given in the appendix). The ICC Development Manager also will compile the status reports from the three ICC Centres into general ICC status reports. He will plan and chair ICC progress meetings and monitor progress on action items to be fulfilled by ICC Centres.

The ICC Development Manager is supported by two DAPSAS Centre managers who are responsible for the implementation of their designated work packages and an ICC Software Manager who is responsible for the implementation of the overall ICC software.

During the operations phase the ICC Operations Manager replaces the ICC Development Manager and reports directly to the PI. An additional group, the Data Analysis Group, consisting of all interested parties, will advise the Operations Manager on the tasks to be carried out, particularly by the DAPSAS centres, and their priority.

5.5.1 Work Breakdown

The work packages are given in the Appendix

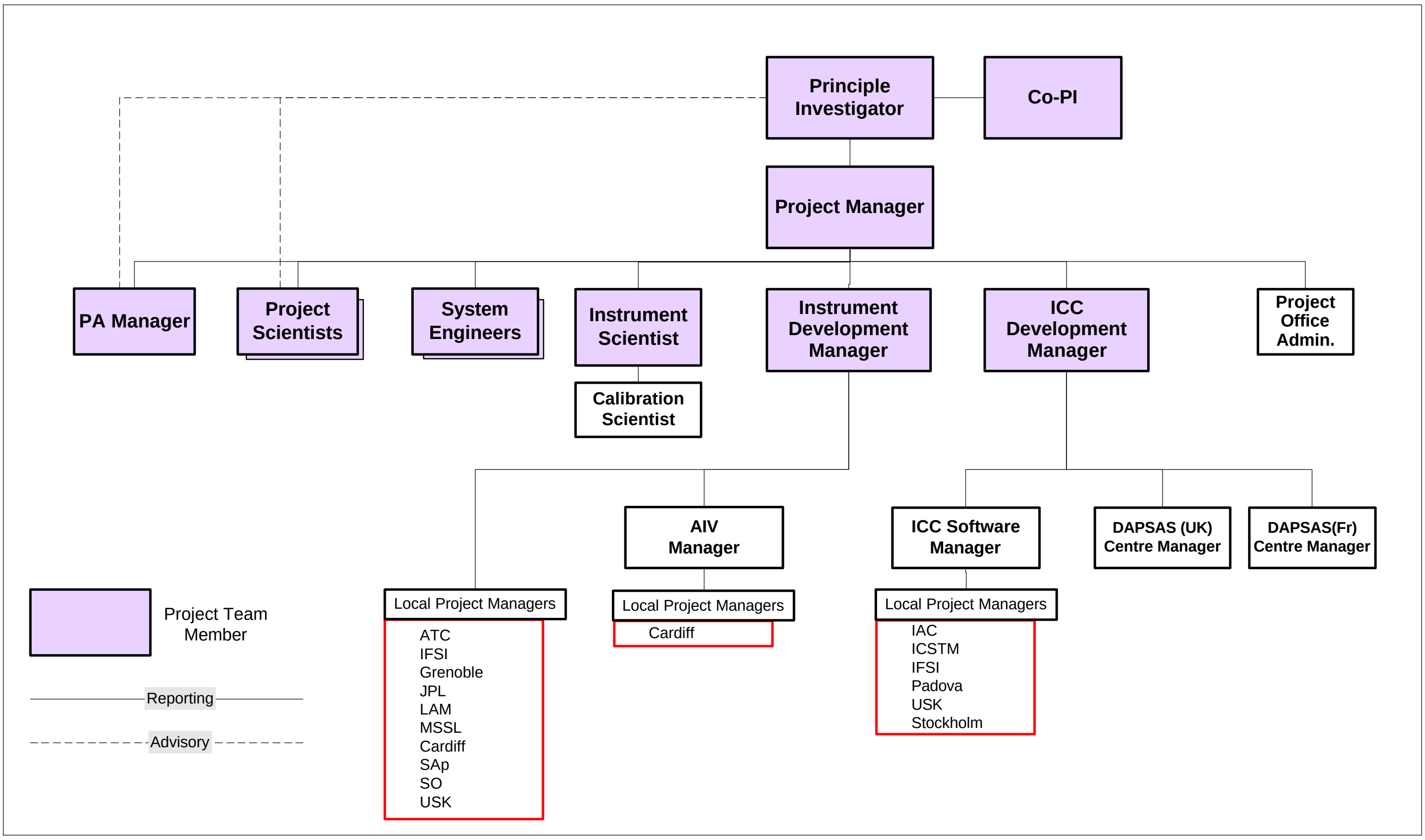

Figure 5-1 SPIRE Management Structure

5.5.2 Schedule

The schedule is based on the Ground Segment Review Milestones provided in the SIRD but also take into account the fact that the instrument hardware schedule also impacts on the ICC schedule. The major milestones relating to the ICC work are given below:

(1)	SIP Review (Start)	3rd April 2002	
(2)	ICC Requirements Review	May 2002	
(3)	SPIRE AVM ILT Starts	June 2002	
(4)	**Ground Segment Requirements Review**	**Feb 2003**	**(L-4 years)**
(5)	SPIRE CQM ILT Starts	Mar 2003	
(6)	ICC Design Review	May 2003	
(7)	**Ground Segment Design Review**	**Feb 2004**	**(L-3 years)**
(8)	SVT-0	Aug 2005	(L-18 months)
(9)	**Ground Segment Implementation Review**	**Feb 2006**	**(L-1 year)**
(10)	SVT-1	April 2006	(L-10 months)
(11)	SVT-2	Aug 2006	(L-6 months)
(12)	**GroundSegment Readiness Review**	**Oct 2006**	**(L-4 months)**
(13)	Operations Readiness Review	15th Jan 2007	(L-1 month)
(14)	Launch	15th Feb 2007	(L)
(15)	**Mission Commissioning Review**	**May 2007**	**(L+3 months)**

Table 5-1 SPIRE ICC Milestones

5.6 Product Assurance

The PA Manager for the SPIRE project shall be responsible for ICC product assurance and configuration control. The PA Manager will make change proposals where necessary to bring ICC products to the standards as laid out in the FIRST Product Assurance Requirements Document (AD06). There will be persons responsible for PA activities appointed at each of the ICC Centres.

The following rules apply (as a minimum) for all ICC deliverables (internal or external):

- PA/QA for ICC related matters shall follow the general PA/QA strategy detailed in the SPIRE Product Assurance Plan (AD07).
- All software deliverables shall be constructed according to the Guide to applying the ESA Software Engineering Standards (PSS-05-0) to small Software Projects (RD11).
- All ICC documentation will be maintained using the Livelink system.
- All ICC software (and related documentation) will be configured following the ICC Software Configuration Management Plan (AD11).

5.6.1 Quality Assurance

- The ICC shall use the SPIRE Project facilities for Quality Assurance described in the SPIRE Product Assurance Plan (AD07).

5.6.2 Configuration Management

All ICC software (and related documentation) will be configured following the ICC Software Configuration Management Plan (AD11).

5.6.3 Review Procedures

Reviews of all stages of major software systems shall be attended by the SPIRE PA Manager or his representative.

5.7 Science

The performance of the instrument and the quality of the data and calibration are best evaluated in the context of the science that is to be carried out with the instrument. Therefore all (qualified) ICC personnel will be given the opportunity to spend a reasonable amount of time on scientific research based on data obtained with the FIRST instruments. They will be encouraged to participate especially in the SPIRE guaranteed time projects.

At all times, ICC work will take priority over science. Therefore ICC composition is aimed to be such that under normal operational conditions between 10 and 20% of the time can be dedicated to scientific research. It is expected that no significant time will be available around the busy in-orbit check out and performance verification phases.

6. DEVELOPMENT PHASE

This phase is defined to start with instrument selection and to continue until the end of the Ground Segment testing, culminating with the Ground Segment Readiness Review. At this point the ICC comes under the control of the ICC Operations Manager.

The activities in this phase cover; the design of the ICC, bearing in mind its relationship with the other parts of the Herschel Ground Segment; development of Software used by the ICC and other parts of the Herschel ground Segment (including collaboration with other groups); Preparation for Operations; and support to the SPIRE Instrument Team, who are responsible for the instrument hardware, which carries on into the Commissioning Phase of the Herschel Mission

6.1 ICC Development Phase Activities

6.1.1 ICC Continuous Tasks

These cover all ICC management, co-ordination and administration activities, which continue throughout the ICC Development Phase. These include; ICC development activities; interfaces with teams outside the ICC; and operation of ICC facilities as they are brought on-line.

6.1.1.1 Support to Ground Segment Meetings

The ICC Development Manager will be a member of the HGSAG and will attend all relevant ground segment meetings and reviews. The ICC Systems Engineer will be a member of the HGSSE .

6.1.1.2 Control and Maintenance of ICC Schedule

This follows on from the definition of the responsibilities of the different ICC contributors and the work packages provided in this document. Managers of the SPIRE ICC Centres will report regularly to the ICC Development Manager against an agreed set of work packages and schedule. These reports will form the basis of the status report from the ICC development Manager to ESA.

6.1.1.3 Product/Quality Assurance

The SPIRE Project PA Manager will be responsible for these activities.

6.1.2 Generation of Instrument information

The ICC is responsible for providing the instrument databases, procedures and documentation necessary to operate the instrument. It gets much of this information from the instrument hardware development teams and brings it together in the form necessary to be useable in the Ground Segment.

6.1.2.1 Instrument Users' Manual

The Instrument Users Manual is a repository of information from many of the groups involved in the definition and manufacture of the instrument. The Instrument Scientist will be responsible for co-ordinating inputs from the other consortium members into a single coherent document.

6.1.2.2 Instrument Databases

The ICC will require databases of information relating to the instrument operation (instrument parameters, conversion curves, limits etc.) and its calibration. This information will be mostly generated as a part of the instrument development programme and as a direct result of data collected during the testing and calibration activities at RAL. The ICC is responsible for taking this information, defining the instrument databases in the HCSS database and populating them.

6.1.2.3 Observation Definition

The instrument Operating Modes are defined in RD12. The ICC Scientist is responsible for taking these and defining them in terms of commands to the instrument, which are defined as mnemonics in the CUS database. The command sequences arising from this definition are then implemented in the CUS database as building blocks and AOT templates.

6.1.3 Development Activities

The main activity of the development phase is the development of the software systems required for operations. This occurs on two fronts; joint development with other teams of software which forms part of the HCSS; and SPIRE ICC specific software, which is for internal use by the ICC.

The SPIRE ICC software development is a collaborative effort with staff being provided at various times from different consortium institutes. This effort will be combined into an ICC Software Development Team (ISDT) whose work will be coordinated by the ICC Software Development Manager.

6.1.3.1 Contributions to HCSS software development

The ICC Scientist and ICC Development Manager will attend meetings of the Ground Segment definition working groups, which will provide a definition of the common systems (the HCSS) required by all ICC Centres in terms of workpackages. The ICC Development Manager will provide sufficient resources (agreed with other groups' managers) to develop and maintain the work packages for which SPIRE will have responsibility. The staff assigned to this work will be part of a Common Software Development Team (CSDT) and will follow the standards defined in a Software Quality Assurance Plan. The CSDT will be controlled by a management group (HCSSMG), containing the ICC Development Manager.

6.1.3.2 ICC Specific Software

This is identified by the ICC Definition Team as part of their work in defining the ICC. The Systems identified will be broken down into workpackages, which will be the responsibility of a single institute, as far as possible. (the allocation of workpackages to institute is the responsibility of the ICC Steering Group)

The main systems are expected to be:

6.1.3.2.1 Quick-Look Analysis

This software provides a means to assess the status of the instrument and to analyse its performance during an sequence of operations. It is used to monitor the housekeeping parameters from the instrument and to display science data. It is used during all phases of the instrument development and operations.

Some of the analysis algorithms will be also required for processing instrument data in the Operations Phase. Thus the QLA will act as a 'test-bed' for data processing modules used by the Interactive Analysis system.

6.1.3.2.2 Interactive Analysis

This system will provide a user interface to allow users; to perform and control each step in the science data processing chain; to 'plug in' new modules to replace the current version at each step; and to display and/or modify the data at the end of each step before continuing with the processing. It is expected that initially some of the steps in the data processing chain will also require interactive input from the user and that several iterations round a series of steps may also be necessary. Hopefully later versions of the software will require less interaction. This system will provide the prime method of testing new data processing modules and their associated calibration files. These tested modules will form the basis of the data processing software provided to the HSC. (It is presently assumed that the SPIRE 'pipeline' will be a non-interactive version of the Interactive Analysis System, delivered to the HSC for processing of Open-time observers data. This may require the software to be run by the observer at their own institute, or be made available to be run by the observer at the HSC.)

It is expected that the IA will be based on a framework, common to all instruments, which will be integrated into the HCSS. Data processing modules will be 'plugged in' to this framework to allow specific data processing to be carried out. As many of the processing functions required are not instrument specific it is assumed that these 'common' modules will be developed in cooperation with the other instrument teams and ESA.

6.1.3.2.3 Calibration Analysis

This software will process the instrument data from calibration (and possibly other) observations into calibration products that will be stored in the calibration database. It will be implemented as additional Interactive Analysis processing modules, which may replace normal processing steps. The purpose of the software is to create a set of calibration products, which are used by the data processing software.

6.2 Support to Instrument Team Activities

The Instrument Team is responsible for development, test and delivery of the instrument hardware. It needs support of the ICC in several areas:

- The Electrical ground Support Equipment (EGSE) used for both ILT and IST tests uses ICC software/hardware systems as part of the complete EGSE configuration. The ICC will be responsible for providing these systems and supporting their use during testing. For example, the EGSE uses a local HCSS system for the storage of the test procedures, scripts and telemetry generated during the tests. This data will be made available to the ICC and Instrument Team staff for analysis through a second HCSS system mirrored from the ILT test system. The ICC is responsible for installation and maintenance of his system.
- The Instrument Team is responsible for producing the SPIRE Calibration Plan and for the initial calibration of the instrument, however the ICC will be responsible for the calibration in flight. In order to gain knowledge of the instrument calibration requirements the ICC staff will contribute to the Calibration Plan and initial calibration, by
    - Contributing to the definition of the Calibration Requirements and Plan
    - Defining the calibration database structure and implementing it in the HCSS database
    - Analysing calibration data and populating the database
    - Carrying out specific tests.
- The ICC will provide a plan for verification of the instrument scientific performance. It will also carry out that plan before launch and feedback to the Instrument Team any problems that are found.

6.3 ICC Operations Preparation

6.3.1 Facilities

Besides the three centres contributing to the ICC (the ICC Operations centre, the DAPSAS (UK) and the DAPSAS(Fr) centres), each of which provide their own infrastructure and computing hardware, the ICC will also provide the following facilities:

- The OBS maintenance facility. This facility will reside in the ICC Operations Centre. It is still TBD to what extent the Operations Centre staff will be familiar with the operation of this facility, but it is expected that they will be able to generate new OBS images which can be tested on the facilities available. However, it remains the responsibility of IFSI, who developed the OBS, to implement and test the actual changes released. Staff from IFSI will be available to come to the Operations Centre to carry out this work.
- The AIV Test Facility at RAL will be maintained throughout the Operations Phase in preparation for testing changes to the instrument OBS and/or procedures. The ICC will take over the facility at the end of Flight Spare testing and put it into a standby configuration. It is assumed that the Flight Spare instrument will remain in the Cryostat, unless required by the Instrument Team. The facility will be operated once every 6 months, or so, in order to maintain the instrument and facility operational.

6.3.2 Operations Planning

In preparation for the Operations Phase the ICC will generate the following documentation

- Operations Plan and procedures
  - Operations Plan
  - ICC Operational procedures
  - Instrument Flight Operations Procedures
  - Science Data Analysis Procedures
- Definition of ICC Operational Interactions with other Ground Segment groups (i.e HSC, MOC and other ICCs)
  - Definition of interactions
  - Definition of procedures

6.3.2.1 Training

The ICC development team will carry out a training programme for incoming Operations Team members in time for their participation in the Ground Segment testing programme.

They will also provide training for consortium members in the use of the interactive analysis system that will be made available to them from the HSC.

It is expected that staff from other interested centres (HSC, IPAC etc) will wish to receive training in the SPIRE instrument and its operation. The intention is that this should be provided as ‘hands on’ experience during the instrument testing activities.

6.3.3 Commissioning Phase

During the Commissioning phase the Instrument Team will be executing a subset of the instrument functional and performance tests carried out in the Instrument –Level Tests to commission the instrument. This will be carried out at the Mission Operations Centre (MOC). The ICC will support the installation of the systems required at the MOC. These are delivered to the MOC before launch and will stay there throughout the operations phase, in case it is required for further testing of the instrument. The system is identical to those used during the instrument and system-level testing and should require little testing for integration into the MOC.

The actual execution of the Commissioning Phase tests remains the responsibility of the Instrument Team members situated at the MOC, but the ICC Operations Centre will be operational and will accept telemetry from the instrument via the HSC in the normal way. In the event of any anomaly being found the relevant instrument experts will either already be at the Operations Centre, or will attend and analysis of the problem and its resolution will be directed from the ICC. There will need to be direct contact (telephone, videoconferencing, and internet communication – email, ftp, telnet etc) available at this time.

7. OPERATIONS PHASE

7.1 ICC Continuous Tasks

During the Operations Phase there are tasks that will be ongoing throughout this time. These are

- Operations management and general organisation of the ICC work
- Provision of a Project office and support to the ICC
- Product/Quality Assurance, including configuration Control for ICC and IA
- Consortium Support – e.g. arranging meetings, workshops, further training activities etc.

7.2 Routine Operations Activities

7.2.1 Monitoring Instrument Health

Data from the instrument for each 22 hour Daily Prime Operational Phase (DPOP) is received on the ground, during the following 2 hour Daily Telecommunications Phase (DTCP). Initially, the ICC will provide 7 days a week operation (during normal office hours) to allow it to monitor the instrument status daily. This will provide reaction to any instrument problems within 48hrs of their occurrence. This may be relaxed as confidence in the instrument is gained – it is expected that eventually the ICC will be staffed for 5 days per week, with staff 'on-call' at weekends in case of problems.

The accumulated instrument science data will take, approximately 12 hrs to transmit from the MOC, through the HSC, to the ICC (24hrs of data @ 130kbps through a 256kbps link), with the time possibly extended if other HSC/ICC communications are taking place at the same time. The ICC cannot, therefore, monitor the instrument and take action in real time, based on the complete set of telemetry data available from the satellite. The monitoring activity will then be spilt into two stages; the first taking place during the DTCP when the possibility of commanding the instrument in real time is available; the second, after the DTCP when the full telemetry from the instrument is available.

7.2.1.1 During DTCP

The ICC instrument monitoring will take advantage of the ability of the satellite Data Handling Sub-System (DHSS) to transmit to the ground a mixture of real-time telemetry and selected data stored in the Solid State Recorder Mass Memory (SSR).

The ICC will receive, in parallel, the real-time instrument housekeeping telemetry and the 'event packets' in the stored instrument housekeeping telemetry. These will be monitored for: parameters out of limits; unexpected instrument configurations; correct command execution and autonomous actions taken by the instrument On Board Computer.

In the case of a serious problem, the ICC will have the option to execute any agreed contingency procedures (which may include real-time commanding of the instrument and require real-time instrument science data) in order to clarify, and possibly correct, the situation. The ICC may then take the decision; to continue with the scheduled observations, to reset the instrument to its normal mode and continue with the schedule, or to suspend the schedule until the problem has been diagnosed. A report on the instrument health will be generated daily.

7.2.1.2 Post DTCP

The ICC will request the complete instrument telemetry, both housekeeping and science data, from the previous DPOP and will monitor the instrument status information through that period. A report on the instrument status will be generated.

During this activity, data for the analysis of trends in instrument parameters, both housekeeping and science, will be generated and stored in Trend Data Files.

7.2.2 Calibration Processing

All calibration observations (and some normal observations that are appropriate) will be processed through the calibration analysis modules in IA and the data generated will be processed into calibration products and stored into the Calibration Database.

7.2.3 Performance monitoring and Trend Analysis

These activities look at the long-term changes in calibration and housekeeping parameters in order to identify possible future problems. Certain observations will be executed repeatedly to monitor any changes in the instrument response (for example, detector sensitivity, saturation, spiking, noise, dark current etc.), over time.

7.2.4 Quality Control

The purpose of this function is to assess the quality of the products being provided by the HSC through the use of the instrument science processing software. Products from selected observations will be requested, routinely, from the HSC and analysed to identify possible problems with the science processing This will include analysis of the processing status reports (e.g. identification of failed processing steps, comparison of instrument science parameters (e.g. detector noise) with expected values, etc.) and analysis of the final products for obvious anomalies (e.g. zero detector output, negative fluxes, etc.). Status reports will be generated for each observation assessed.

The HSC has the responsibility for performing some of this analysis on every observation. The ICC will provide an IA script which will provide this functionality, but will not provide resources to carry out this activity.

Assessment of the scientific quality of the products from an observation cannot always be made without the involvement of the PI for that observation. For this reason the members of the instrument consortium will be fully involved in the scientific quality assessment of their own guaranteed-time observations. They will make use of the instrument Interactive Analysis and Scientific Analysis software systems described below.

7.2.5 Help Desk

The HSC has the responsibility for supporting the astronomical community in the use and exploitation of the Herschel instruments. The ICC will provide instrument-specific support to this work by offering training opportunities to personnel from the HSC during the Development Phase (it is hoped that HSC staff will take part in the AIV and Ground Calibration activities and Ground Segment tests). In addition, the ICC will provide some support to the HSC helpdesk in resolving instrument specific problems. All requests for help will be made through the ICC Operations Centre, who will pass them on to the appropriate personnel.

The help desk also has the responsibility to support the SPIRE consortium members working on the analysis of SPIRE data. However, the staff of the three ICC Centres cannot encompass the expertise held within the consortium as a whole. At times consortium members will be required to support the ICC staff in their work. They will be expected to be available for the following tasks; support to analysis of data in the PV phase; support to Operations centre in the investigation of instrument anomalies; and support to the DAPSAS Centres in the investigation of data processing anomalies.

7.2.6 Generating Observations

For the purposes of calibration and instrument problem investigation the ICC will need to generate observations and get them scheduled. It is envisaged that this will be done using the HSC facilities for observation handling through the Internet from the ICC (I.e. ICC staff will be able to execute observation handling software from the ICC).

7.3 Non-Routine Activities

The following activities will be executed as necessary during the operations Phase:

7.3.1 Performance verification

Before a new release of the data processing software is made available it will be scientifically verified. This will involve running a set of observations through the data processing software and evaluating the results against the product produced from previous versions and the expected output.

Any proposed new science processing software delivery will be checked by processing a set of observations, which will be selected to exercise all modules in the software. (This test-set will expand during the Operations Phase as new modules are produced and 'problem' observations are found.) The complete set of tests and expected results will be documented in an Acceptance Test Plan. The test results will be provided with the delivered software.

After acceptance, an additional set of observations will be processed, selected to allow validation of the scientific results from the data processing (again this set will expand in time). The products from these observations will be made available to the PI of the observation for them to report on the acceptability of the product. (Note: in general these observations will be selected from the guaranteed-time of the consortium, but they may include open-time observations, if these are the only data available to validate parts of the data processing chain) These reports, and any caveats on the use of the data products produced, will be provided with the delivered software.

In order to check the data processing will operate correctly once installed in the HSC it is expected that a data processing 'sandbox' will be provided to emulate the processing environment at the HSC which can be used by the ICC as a final step prior to the formal delivery of the instrument software.

7.3.2 Key programmes

It is expected that the initial observational phase of the Herschel mission will be made up of a few large Key Programmes. These will be used to generate a large homogenous set of observations of particular source types or large areas of sky (surveys). In the latter case it will be necessary to process the data from the Key Programme as quickly as possible in order to make the results available in time for Open-Time observations of interesting objects to be provided. It is expected that much of this processing activity will fall on the ICC as it is likely that the data processing will not be fully non-interactive at this time.

7.3.3 Problem Handling

This activity will take place as necessary. It will involve the following steps:

- Analysis of problems (including MRBs) – may generate Engineering Observations
- Implementation of solution – may generate Engineering Observations
- Testing of solution
- OBS Maintenance

7.3.4 Calibration evolution

It is possible that the calibration strategy for the instrument will need to be updated in the light of results from in-flight observations. It will involve the following steps:

- Define new Calibration Requirements
- Update Calibration Plan
- Define and test new Calibration Observations

7.3.5 Use of Test Facilities

The ICC will maintain test facilities (Flight Spare in the SPIRE AIV facility, AVM model, Instrument Simulator etc) for testing possible upgrades to command procedures and the OBS. These will be operated as necessary.

7.3.6 Software Evolution

Initial versions of the data processing software will be produced during the development phase, based on requirements identified during the AIV and ground calibration activities. Subsequently, when operations begin, it will become necessary to upgrade the software to take account of anomalies and problems with the data processing and science analysis software identified during the execution of the above monitoring functions and as a result of better understanding of the instrument. Facilities to allow the development and testing of software modules and the analysis and investigation of their utility will be provided in the Interactive Analysis System

New and updated processing algorithms will be prototyped and tested within this system by members of the consortium, particularly those with expertise related to instrument subsystems, until satisfactory performance is achieved. Subsequently, these algorithms will be ‘converted’ into new modules following the ICC software development standards before submission to the HSC.

7.4 Organisation

7.4.1 Operations Centre

7.4.1.1 Operations Teams

These teams perform the functions of the SPIRE ICC Operations Centre as described above. In the initial phases of the operations (Commissioning and PV phases) they will be augmented by staff from other consortium institutes.

All Operations Centre staff will be encouraged to take part in analysis and scientific data processing activities in order to contribute to the software development work at the DAPSAS centres.

The Operations Centre will consist of three teams;

7.4.1.1.1 Operations Team

This team will be responsible for;

- monitoring the status of the instrument
- trend data extraction and analysis
- calibration data extraction (generation of calibration files is a responsibility of the DAPSAS centres, TBC)
- anomaly investigation (with help from instrument subsystem experts)
- generation of new observations (new calibration observations, investigative observations etc)
- update of the AOT implementation
- generation of new and updated operations procedures

The Operations Team will be available normally during office hours 5 days a week. However, the requirement to monitor the instrument status on a daily basis will mean that this function (probably taking one person a few hours) will be performed 7 days a week by rote.

During the Commissioning and PV phases the Operations Centre will be staffed 7 days a week and the Operations Team will be augmented by visiting staff from other institutes.

7.4.1.1.2 Software Team

This team will be responsible for;

- maintenance of the ICC software
- maintenance of the On-Board Software
- maintenance of the Signal Processing Unit Software (TBC)
- acceptance testing of new science processing software and calibration files and its installation into the testbed
- delivery of science processing software updates to the FSC after validation.
- Configuration control of all deliverable software and data.

This team will operate during office hours for 5 days per week.

7.4.1.1.3 Facilities Team

The Facilities Team will be responsible for maintenance of the computer hardware and other equipment at the Operations Centre. They will operate during office hours for 5 days a week (possibly being on call at weekends to support the Operations Team)

7.4.1.2 Infrastructure and Hardware

The Operations Centre is responsible for the routine operation and monitoring of the instrument on a day to day basis. It forms the single formal point of contact between the ICC and the FSC and MOC for deliveries of software, data files and other information identified in the ICC/FSC and ICC/MOC interface documents. For this reason the ESA provided link to the FINDAS will connect to this centre.

Facilities provided will include a Project Office for management, administrative and secretarial support, offices, meeting rooms and equipment for the Operations Centre teams and additional office space for visitors expected during the Instrument Commissioning and Performance Verification Phases and at other times.

The Operations Centre will be provided with the following computing hardware;

- a Quick Look Facility (with redundancy), comprising a workstation plus additional displays running the RTA/QLA software developed during the AIV and Calibration activities, which will provide display and analysis facilities for monitoring of the instrument status. It is expected that this will be a copy of the Quick Look Facility used during the instrument testing and provided to the MOC for the Satellite Commissioning Phase with additional software for use in an operational environment.
- an Operations Computer to support the work of the Operations Team in data processing and analysis. This machine will also have to be able to run software provided by ESA, such as time estimators, command translator etc. A server-class machine is envisaged with large on-line disk space (for temporary storage of data under analysis) and peripherals (storage devices, printers etc.) with terminals for each team
- a Software Development Computer (identical to the Operations Computer, to provide redundancy in the case of failure of the prime machine) used by the software maintenance team for its tasks.
- a copy of the instrument software simulator to allow testing of updated instrument command sequences, AOTs etc.
- An On-Board Software Maintenance Facility, to allow generation and testing of updates to the on-board software.
- A Signal Processing Unit Software Maintenance Facility (TBC), to allow generation and testing of updates to the SPU software.
- A substantial data storage facility (TBC) to provide storage for large amounts of data used in testing and validation of data processing software. (With the link rate available (64kbps) it would take a long time to extract all the data needed for a validation exercise from FINDAS every time.)

In addition the Operations Centre will retain the Flight Spare Model of the instrument and the calibration and test facilities available, at short notice, in order to support investigation of anomalies and to test new command sequences during the routine phase.

7.4.2 DAPSAS Centres

These centres are responsible for; monitoring the scientific quality of the processed data from the instrument and upgrading the data processing and science analysis software to reflect improved knowledge and experience of the instrument; carrying out periodic reviews of the calibration status and AOT optimisation in the light of in-flight instrument performance; and analysis of data from parallel and serendipity modes. They will also provide support to the FSC (via the Operations centre) in relation to these matters.

Co-ordination of this work will be through a Data Analysis Group (consisting of all interested parties), which will meet regularly; to discuss the quality of the scientific products; to identify processing anomalies and effects; to suggest ways of investigating these; to determine solutions and to assign tasks for carrying these out.

7.4.2.1 Infrastructure and Hardware

Each will provide infrastructure and computing facilities for their expected staff, plus visitors, and will be linked via the internet (using ISDN, TBC) to the Operations Centre. They will also provide internet access for remote login by consortium members not located at a DAPSAS Centre to allow their participation in the software development and maintenance.

8. POST-OPERATIONAL PHASE

TBW

9. ARCHIVE PHASE

TBW

10. APPENDICES

10.1 Appendix A: SIP WP-SIRD Compliance Matrix

GHS11X1000	ICCF-010, ICCF015, ICCF-020, PAQA-010, PAQA-010a, PAQA-010b, PAQA-010c, PAQA-012, MNGT-001, MNGT-010, MNGT-011, MNGT-011a, MNGT-011b, MNGT-011c, MNGT-011d, MNGT-011e, MNGT-011f, MNGT-012, MNGT-020, MNGT-024, MNGT-024a, MNGT-024b, MNGT-024c, MNGT-024d, MNGT-024e, MNGT-024f, MNGT-024g, MNGT-025	
GHS11X2000	ICCF-005, ICCF-025, ICCF-040, ICCF-080, ICCF-120, ICCF-125, ICCF-175, ICCF-210, ICCF-215	
GHS11X3000	ICCF-185, PAQA-001, PAQA-005, PAQA-011, PAQA-030, PAQA-032b, PAQA-033a, PAQA-033b	
GHS11X4000	ICCF-005, ICCF-025, ICCF-030, ICCF-035, ICCF-040, ICCF-175, ICCF-180, PAQA-004, PAQA-032a, MNGT-022, MNGT-023	
GHS11X5000	ICCF-045	
GHS11X6000		
GHS12X1000	ICCF-090	
GHS12X2000	ICCF-050, ICCF-060, ICCF-065, ICCF-075, ICCF-080, ICCF-085, ICCF-160	
GHS12X3000	ICCF-055, ICCF-060, ICCF-070, ICCF-090	
GHS12X4000	ICCF-075, ICCF-095	
GHS12X5000	ICCF-102	
GHS12X6000		
GHS13X1000	ICCF-105, PAQA-031	
GHS13X2000		
GHS13X3000	ICCF-185	
GHS13X4000	ICCF-130	
GHS13X5000	ICCF-130, PERF-062	
GHS13X6000	ICCF-130	
GHS13X7000	ICCF-130	
GHS13X8000	ICCF-130	
GHS13X9000	ICCF-130	
GHS13XA000	ICCF-130, ICCF-153, PAQA-023	
GHS13XB000	ICCF-130	
GHS13XC000		
GHS13XD000	ICCF-150, PAQA-023	
GHS13XE000		
GHS14X1000		
GHS14X2000		
GHS14X3000		
GHS21X1000		
GHS21X2000		
GHS21X3000		
GHS21X4000		
GHS21X5000		

GHS22X1000		
GHS22X2000		
GHS22X3000		
GHS23X1000	ICCF-135	
GHS23X2000	ICCF-135, ICCF-145	
GHS23X3000	ICCF-140	
GHS23X4000	ICCF-015, ICCF-140	
GHS24X1000	ICCO-065	
GHS24X2000	ICCO-065	
GHS31X1000	ICCF-045, ICCF-205, PERF-000, PERF-004	
GHS31X2000	ICCF-045, PERF-000, PERF-004	
GHS31X3000	ICCF-045, PERF-000, PERF-004	
GHS31X4000	ICCF-155, PERF-000, PERF-004	
GHS31X5000	PERF-000, PERF-004	
GHS32X1000	ICCF-075, ICCF-095, ICCF-100 ICCF-115	
GHS32X2000	ICCF-165	
GHS32X3000	ICCF-170	
GHS32X4000	ICCO-005	
GHS32X5000	ICCO-010	
GHS33X1000	PAQA-020, PAQA-022, PAQA-023	
GHS33X2000	ICCF-195, ICCF-200, PAQA-020, PAQA-022, PAQA-023	
GHS33X3000	ICCF-195, ICCF-200, PAQA-020, PAQA-022, PAQA-023, PAQA-024, PAQA-025, PAQA-026	
GHS34X1000		
GHS34X2000	ICCO-015, ICCO-035, ICCO-040, ICCO-042	
GHS41X1000	ICCO-055, ICCO-085, PERF-002, PERF-003, MNGT-020	
GHS41X2000	PAQA-012	
GHS41X3000	ICCO-080, PAQA-001, PAQA-002	
GHS41X4000		
GHS41X5000		
GHS42X1000	ICCO-045	
GHS42X2000	ICCO-050	
GHS42X3000	ICCO-040, ICCO-045, ICCO-075	
GHS42X4000	ICCO-040, ICCO-050	
GHS42X5000	ICCO-070	
GHS42X6000	ICCO-025	
GHS42X7000		
GHS42X8000	ICCO-050	
GHS42X9000	ICCO-050	
GHS43X1000	ICCO-042	
GHS43X2000		
GHS43X3000	ICCO-020, ICCO-030, ICCO-035, ICCO-040, ICCO-055	
GHS43X4000	ICCO-080	
GHS43X5000	ICCO-020	
GHS44X1000	ICCO-080	
GHS44X2000	ICCO-065, ICCO-090, ICCO-080	
GHS44X3000	ICCO-080	
GHS44X4000	ICCO-080	
GHS45X1000		
GHS45X2000	ICCO-080	

GHS45X3000	ICCO-080	
GHS45X4000	ICCO-080	
GHS46X1000	ICCO-080	
GHS46X2000	ICCO-080	

10.2 Appendix B: SIRD – SIP WP Compliance Matrix

Functional Requirements

ICCF-005	GHS11X2000, GHS11X4000	
ICCF-010	GHS11X1000	
ICCF-015	GHS11X1000, GHS23X4000	
ICCF-020	GHS11X1000	
ICCF-025	GHS11X2000, GHS11X4000	
ICCF-030	GHS11X4000	
ICCF-035	GHS11X4000	
ICCF-040	GHS11X2000, GHS11X4000	
ICCF-045	GHS11X5000, GHS31X1000, GHS31X2000, GHS31X3000	
ICCF-050	GHS12X2000	
ICCF-055	GHS12X3000	Definition of modes is an Instrument Team activity – this WP implements these modes
ICCF-060	GHS12X2000, GHS12X3000	
ICCF-065	GHS12X2000	
ICCF-070	GHS12X3000	
ICCF-075	GHS12X2000, GHS12X4000, GHS32X1000	
ICCF-080	GHS11X2000, GHS12X2000	
ICCF-085	GHS12X2000	
ICCF-090	GHS12X1000, GHS12X3000	
ICCF-095	GHS12X4000, GHS32X1000	
ICCF-100	GHS32X1000	
ICCF-102	GHS12X5000	
ICCF-105	GHS13X1000	
ICCF-110	deleted	
ICCF-115	GHS32X1000	
ICCF-120	GHS11X2000	
ICCF-125	GHS11X2000	
ICCF-130	GHS13X4000, GHS13X5000, GHS13X6000, GHS13X7000, GHS13X8000, GHS13X9000, GHS13XA000, GHS13XB000	
ICCF-135	GHS23X1000, GHS23X2000	The Instrument Team retains responsibility for the Calibration Plan before the Operations Phase
ICCF-140	GHS23X3000, GHS23X4000	
ICCF-145	GHS23X2000	
ICCF-146	deleted	
ICCF-150	GHS13XD000	
ICCF-152	deleted	
ICCF-153	GHS13XA000	
ICCF-155	GHS31X4000	
ICCF-160	GHS12X2000	TBC

ICCF-165	GHS32X2000	
ICCF-170	GHS32X3000	
ICCF-175	GHS11X2000, GHS11X4000	
ICCF-180	GHS11X4000	
ICCF-185	GHS11X3000, GHS13X3000	
ICCF-190		This is an Instrument Team responsibility for all Hardware related documentation. ICC Software subsystems documentation will be written as part of the development WP and placed on Livelink
ICCF-195	GHS33X2000, GHS33X3000	
ICCF-200	GHS33X2000, GHS33X3000	
ICCF-205	GHS31X1000	
ICCF-210	GHS11X2000	
ICCF-215	GHS11X2000	

Operational Requirements

ICCO-005	GHS32X4000	
ICCO-010	GHS32X5000	
ICCO-015	GHS34X2000	Partly provided by the Instrument Team
ICCO-020	GHS43X3000, GHS43X5000	
ICCO-025	GHS42X6000	
ICCO-030	GHS43X3000	Assumes changes arise as a result of anolmalies
ICCO-035	GHS34X2000, GHS43X3000	
ICCO-040	GHS34X2000, GHS42X3000, GHS42X4000	
ICCO-042	GHS34X2000, GHS43X1000	
ICCO-045	GHS42X1000, GHS42X3000	
ICCO-050	GHS42X2000, GHS42X4000, GHS42X8000, GHS42X9000	
ICCO-055	GHS41X1000, GHS43X3000	
ICCO-060		TBD
ICCO-065	GHS44X2000, GHS24X1000, GHS24X2000	
ICCO-070	GHS42X5000	
ICCO-075	GHS42X3000	
ICCO-080	GHS41X3000, GHS43X4000, GHS44X1000, GHS44X2000, GHS44X3000, GHS44X4000, GHS45X2000, GHS45X3000, GHS45X4000, GHS46X1000, GHS46X2000	
ICCO-085	GHS41X1000	
ICCO-090	GHS44X2000	

Post-Operational Requirements

ICCA-005		
ICCA-010		
ICCA-015		
ICCA-020		
ICCA-025		
ICCA-030		
ICCA-035		
ICCA-040		
ICCA-045		
ICCA-050		

Performance and Availability Requirements

PERF-000	GHS31X1000, GHS31X2000, GHS31X3000, GHS31X4000, GHS31X5000	
PERF-001	N/A	
PERF-002	GHS41X1000	
PERF-003	GHS41X1000	
PERF-004	GHS31X1000, GHS31X2000, GHS31X3000, GHS31X4000, GHS31X5000	
PERF-060	N/A	
PERF-060a	N/A	
PERF-060b	N/A	
PERF-061	Deleted	
PERF-062	GHS13X5000	
PERF-070	N/A	

Product Assurance and Quality Assurance Requirements

PAQA-001	GHS11X3000, GHS41X3000	
PAQA-002	GHS41X3000	
PAQA-003	Deleted	
PAQA-004	GHS11X4000	
PAQA-005	GHS11X3000	
PAQA-010	GHS11X1000	To be found in SPIRE document tree
PAQA-010a	GHS11X1000	To be found in SPIRE document tree
PAQA-010b	GHS11X1000	To be found in SPIRE document tree
PAQA-010c	GHS11X1000	To be found in SPIRE document tree
PAQA-011	GHS11X3000	
PAQA-012	GHS11X1000, GHS41X2000	ICC will use SPIRE livelink site for documentation delivery
PAQA-020	GHS33X1000, GHS33X2000, GHS33X3000	
PAQA-021	Deleted	
PAQA-022	GHS33X1000, GHS33X2000, GHS33X3000	
PAQA-023	GHS13XA000, GHS13XD000, GHS33X1000, GHS33X2000, GHS33X3000	
PAQA-024	GHS33X3000	
PAQA-025	GHS33X3000	
PAQA-026	GHS33X3000	
PAQA-030	GHS11X3000	
PAQA-031	GHS13X1000	
PAQA-032a	GHS11X4000	
PAQA-032b	GHS11X3000	
PAQA-033a	GHS11X3000	
PAQA-033b	GHS11X3000	

Management Requirements

MNGT-001	GHS11X1000, GHS41X1000	
MNGT-002	N/A	
MNGT-003	N/A	
MNGT-004	N/A	
MNGT-010	GHS11X1000	
MNGT-011	GHS11X1000	
MNGT-011a	GHS11X1000	
MNGT-011b	GHS11X1000	
MNGT-011c	GHS11X1000	
MNGT-011d	GHS11X1000	
MNGT-011e	GHS11X1000	
MNGT-011f	GHS11X1000	
MNGT-012	GHS11X1000	
MNGT-020	GHS11X1000, GHS41X1000	
MNGT-021	N/A	
MNGT-022	GHS11X4000	
MNGT-023	GHS11X4000	
MNGT-024	GHS11X1000	
MNGT-024a	GHS11X1000	
MNGT-024b	GHS11X1000	
MNGT-024c	GHS11X1000	
MNGT-024d	GHS11X1000	
MNGT-024e	GHS11X1000	
MNGT-024f	GHS11X1000	
MNGT-024g	GHS11X1000	
MNGT-025	GHS11X1000	

10.3 ICC Work Packages Summary

GHS1	ICC Development Phase Activities

GHS11	ICC Continuous Tasks
GHS11X1000	**ICC Development Phase Management**
GHS11X2000	ICC System Engineering
GHS11X3000	Product/Quality Assurance
GHS11X4000	Support to Herschel Ground Segment Development
GHS11X5000	ICC Operations during development
GHS11X6000	Information Dissemination and Communications

GHS12	Generation of Instrument Information
GHS12X1000	Provision of Instrument Users Manual
GHS12X2000	Provision of Instrument Database (MIB)
GHS12X3000	**Definition of Instrument Observations**
GHS12X4000	Definition of Operating Procedures
GHS12X5000	Provision of Observers Manual
GHS12X6000	Get External Information (e.g.on Spacecraft)

GHS13	Development Activities
GHS13X1000	**Contributions to External Development Activities**
GHS13X2000	**ICC Design**
GHS13X3000	**Provision of Software Infrastructure**
GHS13X4000	Interactive Analysis Framework
GHS13X5000	**Quick Look Analysis**
GHS13X6000	**Data Processing Modules**
GHS13X7000	Calibration Analysis Modules
GHS13X8000	Trend Analysis Modules
GHS13X9000	Diagnostic tools
GHS13XA000	Support Tools
GHS13XB000	Quality Control Software
GHS13XC000	Key Programmes
GHS13XD000	Instrument Simulator
GHS13XE000	Software Development Meetings

GHS14	Training
GHS14X1000	Training in use of HCSS Systems
GHS14X2000	Training in use of External Systems
GHS14X3000	Other Training

GHS2	Support to Instrument Team Activities

GHS21	**ILT Support**
GHS21X1000	Provision of ILT System(s) – includes integration of ILT systems
GHS21X2000	Produce validation software to validate scripts and observation requests
GHS21X3000	Produce Command Validator
GHS21X4000	Populate Calibration Database (ILT data)
GHS21X5000	Support to ILT Tests

GHS22	**IST Support**
GHS22X1000	Provision of IST System(s)
GHS22X2000	Populate Calibration Database (IST data)
GHS22X3000	Support to IST Tests

GHS23	**Calibration Support**
GHS23X1000	Define Calibration Requirements (contribution)
GHS23X2000	Define Calibration Plan (contribution)
GHS23X3000	Define and Create Calibration Database (uplink and downlink)
GHS23X4000	Populate Calibration Database

GHS24	**Science Verification**
GHS24X1000	Science Verification Plan
GHS24X2000	Pre-Launch Science Verification

GHS3	**ICC Operations Preparation**

GHS31	**Facilities**
GHS31X1000	ICC Operations Centre
GHS31X2000	DAPSAS (UK) Centre
GHS31X3000	DAPSAS (Fr) Centre
GHS31X4000	On Board Software Maintenance Facility
GHS31X5000	ICC Test and Maintenance Facilities

GHS32	**Operations Planning**
GHS32X1000	Provision of Operations Plans
GHS32X2000	ICC/HSC Operational Interactions
GHS32X3000	ICC/MOC Operational Interactions
GHS23X4000	Operations Team Setup and Training
GHS23X5000	Training of External Staff

GHS33	**Integration and Test**
GHS33X1000	ICC Integration
GHS33X2000	Ground Segment Integration
GHS33X3000	Ground Segment Testing

GHS34	**Commissioning Phase**
GHS31X1000	Provision of Commissioning Phase System (ICC@MOC)
GHS34X2000	Commissioning Phase Support

GHS4	ICC Operations Phase

GFS41	ICC Operations Continuous Tasks
GHS41X1000	Operations Management
GHS41X2000	Project Office
GHS41X3000	Product/Quality Assurance
GHS41X4000	Support to Consortium
GHS41X5000	Recurrent Costs

GHS42	Routine Operations Activities
GHS42X1000	Monitor Instrument Health
GHS42X2000	Calibration Processing
GHS42X3000	Performance Monitoring
GHS42X4000	Trend Analysis
GHS42X5000	Quality Control
GHS42X6000	HelpDesk
GHS42X7000	Information dissemination
GHS42X8000	Generate Calibration Observations
GHS42X9000	Scheduling Observations

GHS43	Non-Routine Activities
GHS43X1000	Performance verification
GHS43X2000	Key Programmes
GHS43X3000	Problem Handling
GHS43X4000	Calibration Evolution
GHS43X5000	Use of Test Facilities

GHS44	Software Evolution
GHS44X1000	IA Framework Evolution
GHS44X2000	**Data Processing Modules evolution**
GHS44X3000	Calibration Analysis Modules Evolution
GHS44X4000	Trend Analysis Modules Evolution

GHS45	Software Maintenance
GHS45X1000	SPIRE Contribution to HCSS S/W Maintenance
GHS45X2000	Interactive Analysis Framework and Modules Maintenance
GHS45X3000	Software Infrastructure Maintenance
GHS45X4000	Other ICC Software Maintenance

GHS46	Facilities Maintenance
GHS46X1000	**Infrastructure Maintenance**
GHS46X2000	Computer System Maintenance

10.4 ICC Costs

WBS	Task Name	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	SY
GHS1 - ICC Development Phase Activities												
GHS11	**ICC Continuous Tasks**	**0.00**	**0.00**	**1.25**	**1.50**	**2.10**	**1.95**	**1.95**	**2.00**	**2.05**	**0.53**	**13.33**
GHS11X1000	ICC Development Phase Management	0.00	0.00	0.40	0.60	0.95	0.95	0.95	0.95	0.85	0.22	**5.87**
GHS11X1100	*Overall Management Activities*			0.40	0.60	0.60	0.60	0.60	0.60	0.50	0.13	**4.03**
GHS11X1200	*DAPSAS UK Management Activities*					*0.20*	*0.20*	*0.20*	*0.20*	*0.20*	*0.05*	**1.05**
GHS11X1300	*DAPSAS Fr Management Activities*					*0.15*	*0.15*	*0.15*	*0.15*	*0.15*	*0.04*	**0.79**
GHS11X2000	ICC System Engineering			0.15	0.05	0.15	0.10	0.10	0.10	0.10	0.03	**0.78**
GHS11X3000	Product/Quality Assurance				0.05	0.20	0.20	0.20	0.20	0.20	0.05	**1.10**
GHS11X4000	Support to Herschel Ground Segment Development			0.30	0.35	0.35	0.30	0.30	0.30	0.30	0.08	**2.28**
GHS11X5000	ICC Operations during Development			0.30	0.35	0.35	0.30	0.30	0.30	0.30	0.08	**2.28**
GHS11X6000	Information Dissemination and Communications			0.10	0.10	0.10	0.10	0.10	0.15	0.30	0.08	**1.03**
GHS12	**Generation of Instrument Information**	**0.00**	**0.00**	**0.00**	**0.15**	**0.70**	**0.85**	**1.00**	**1.00**	**1.05**	**0.25**	**5.00**
GHS12X1000	Provision of Instrument Users' Manual					0.05	0.15	0.20	0.25	0.30	0.05	**1.00**
GHS12X2000	Provision of Instrument Database (MIB)				0.10	0.40	0.20	0.10	0.10	0.10	0.05	**1.05**
GHS12X3000	Definition of Instrument Observations	0.00	0.00	0.00	0.05	0.05	0.20	0.25	0.20	0.20	0.05	**1.00**
GHS12X3100	*Provision of CUS Database*											
GHS12X3200	*Definition and Test of AOTs*											
GHS12X4000	Definition of Operating Procedures					0.20	0.25	0.30	0.30	0.30	0.10	**1.45**
GHS12X5000	Provision of Observers Manual							0.10	0.10	0.10		**0.30**
GHS12X6000	Get External Information						0.05	0.05	0.05	0.05		**0.20**
GHS13	**Development Activities**	**0.00**	**0.00**	**0.00**	**2.10**	**4.78**	**4.90**	**3.90**	**4.10**	**4.31**	**1.40**	**31.61**
GHS13X1000	Contributions to External Development Activities				1.90	0.15	0.60	1.00	1.40	2.20	0.50	**7.75**
GHS13X1100	*SPIRE Contributions to HCSS*											
GHS13X1110	*SPIRE Contribution to HCSS version 0.1*											
GHS13X1120	*SPIRE Contribution to HCSS version 0.2*											
GHS13X1130	*SPIRE Contribution to HCSS version 0.3*											
GHS13X1140	*SPIRE Contribution to HCSS version 0.4*											
GHS13X1150	*SPIRE Contribution to HCSS version 0.5*											
GHS13X1160	*SPIRE Contribution to HCSS version 1.0*											
GHS13X3200	*SPIRE Contributions to HSC - Time Estimator*											
GHS13X2000	ICC Design				0.20	0.30	0.10	0.10	0.10			**0.80**
GHS13X2100	*User Requirements*											
GHS13X2200	*Use Cases*											
GHS13X2300	*ICC Operations Scenario*											
GHS13X2400	*System Design*											
GHS13X3000	Provision of Software Infrastructure					0.10	0.30	0.30	0.30	0.15	0.05	**1.20**
GHS13X3100	*Problem Report/SCR System*											
GHS13X3200	*Information Handling System*											
GHS13X3300	*Configuration Control System*											
GHS13X3400	*Access Control System*											
GHS13X3500	*Sandbox Environment*											
GHS13X4000	Interactive Analysis Framework					0.30	0.20	0.10	0.10	0.10	0.10	**0.90**
GHS13X5000	Quick-Look Analysis					0.70	0.40	0.40	0.10	0.10	0.10	**1.80**
GHS13X5100	*QLA for AVM*											
GHS13X5200	*QLA for CQM*											
GHS13X5300	*QLA for PFM*											
GHS13X5400	*QLA for Operations*											

GHS13X6000	Data Processing Modules	0.00	0.00	0.00	0.00	2.33	2.40	0.80	0.10	0.50	0.00	**6.13**	
GHS13X6100	*Common Modules*	*0.00*	*0.00*	*0.00*	*0.00*	*0.93*	*1.00*	*0.20*	*0.10*	*0.30*	*0.00*	***2.53***	
GHS13X6110	*Remove Bolormeter-to-Bolometer Sensitivity Variations*									*0.20*			
GHS13X6120	*Filter Data on any criteria*					*0.30*							
GHS13X6130	*Visualize any Data Product*					*0.20*	*0.20*						
GHS13X6140	*Identify and Flag Data on any criteria*						*0.20*	*0.10*					
GHS13X6150	*Import and Export Data*					*0.15*							
GHS13X6160	*Transform Spacecraft Coordinates to Sky position*									*0.10*			
GHS13X6170	*Remove Instrument Crosstalk*								*0.10*				
GHS13X6180	*Background Subtraction*						*0.20*	*0.10*					
GHS13X6190	*Resample and combine data spatially and/or temporally*					*0.20*	*0.40*						
GHS13X61A0	*Data Reduction History (recording and examining)*					*0.08*							
GHS13X6200	*Photometry Modules*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.40*	*0.00*	*0.00*	*0.00*	*0.00*	***0.40***	
GHS13X6210	*Determine and Apply Colour Correction*						*0.15*						
GHS13X6220	*Detect Sources*						*0.25*						
GHS13X6300	*Spectrometry Modules*	*0.00*	*0.00*	*0.00*	*0.00*	*1.40*	*1.00*	*0.60*	*0.00*	*0.20*	*0.00*	***3.20***	
GHS13X6310	*Reconstruct Interferogram*					*0.20*	*0.10*						
GHS13X6320	*Convert Position counter to Mechanical Mirror Position*					*0.20*							
GHS13X6330	*Convert Mechanical Mirror Position to Optical Path Difference*					*0.10*							
GHS13X6340	*Phase Correction*					*0.30*	*0.30*						
GHS13X6350	*Regrid*					*0.20*							
GHS13X6360	*Responsivity Correction*						*0.20*						
GHS13X6370	*Correct for Time-dependant Flux*							*0.20*					
GHS13X6380	*Correct for Position-dependant variation in Flux*							*0.30*					
GHS13X6390	*Apodise and Transform Interferogram*					*0.40*	*0.20*						
GHS13X63A0	*Remove Instrument Signature*						*0.20*	*0.10*					
GHS13X63B0	*Detect and Identify Lines*									*0.20*			
GHS13X7000	Calibration Analysis Modules					0.10	0.10	0.20	0.30	0.25	0.20	**1.15**	
GHS13X8000	Trend Analysis Modules							0.10	0.20	0.25	0.10	**0.65**	
GHS13X9000	Diagnostic tools					0.1	0.1	0.2	0.3	0.25	0.2	**1.15**	
GHS13XA000	Support tools	0.00	0.00	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	**0.80**	
GHS13XA100	*Science Simulator*					*0.10*	*0.40*						
GHS13XA200	*Engineering Simulator*					*0.30*							
GHS13XB000	Quality Control Software								0.3	0.1	0.05	**0.45**	
GHS13XC000	Key Programmes								0.2	0.2	0.05	**0.45**	
GHS13XD000	Instrument Simulator					0.1	0.1	0.5	0.5	0.01	0	**1.21**	
GHS13XE000	Software Development Meetings					0.20	0.20	0.20	0.20	0.20	0.05	**1.05**	**10.00**
GHS14	**Training**	**0.00**	**0.00**	**0.00**	**0.10**	**0.35**	**0.20**	**0.30**	**0.30**	**0.30**	**0.00**	**1.55**	**10.00**
GHS14X1000	Training in use of HCSS Systems					0.20	0.10	0.20	0.20	0.20		**0.90**	**2.00**
GHS14X2000	Training in use of External Systems					0.10	0.10	0.10	0.10	0.10		**0.50**	
GHS14X3000	Other Training				0.10	0.05						**0.15**	**8.00**

GHS2 - Support to Instrument Team Activities												
GHS21	**ILT Support**	**0.00**	**0.00**	**0.00**	**0.00**	**1.20**	**1.30**	**0.90**	**0.80**	**0.00**	**0.00**	**4.20**
GHS21X1000	Provision of ILT System(s)					0.50	0.20	0.10				**0.80**
GHS21X2000	Provision of Validation Software					0.20	0.10					**0.30**
GHS21X3000	Provision of Command Validator						0.20					**0.20**
GHS21X4000	Populate Calibration Database (ILT data)					0.10	0.30	0.30	0.30			**1.00**
GHS21X5000	Support to ILT Tests					0.40	0.50	0.50	0.50			**1.90**
GHS22	**IST Support**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.20**	**0.50**	**0.40**	**0.00**	**0.00**	**1.10**
GHS22X1000	Provision of IST System(s)						0.20	0.10				**0.30**
GHS22X2000	Populate Calibration Database (IST data)							0.20	0.20			**0.40**
GHS22X3000	Support to IST Tests							0.20	0.20			**0.40**
GHS23	**Calibration Support**	**0.00**	**0.00**	**0.00**	**0.00**	**0.20**	**0.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.70**
GHS23X1000	Define Calibration Requirements (contribution)					0.10	0.10					**0.20**
GHS23X2000	Define Calibration Plan (contribution)					0.10	0.10					**0.20**
GHS23X3000	Define and Create Calibration Database (uplink and downlink)						0.20					**0.20**
GHS23X4000	Populate Calibration Database						0.10					**0.10**
GHS24	**Science Verification**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.40**	**0.10**	**0.50**
GHS24X1000	Science Verification Plan									0.20	0.05	**0.25**
GHS24X2000	Pre-Launch Science Verification									0.20	0.05	**0.25**

GHS3 - Operations Preparation												
GHS31	**Facilities**	**0.00**	**0.00**	**0.00**	**0.10**	**0.20**	**0.10**	**0.05**	**0.60**	**0.15**	**0.05**	**0.85**
GHS31X1000	ICC Operations Centre				0.10	0.10	0.05	0.05	0.20	0.05		**0.55**
GHS31X2000	DAPSAS (UK) Centre								0.20			
GHS31X3000	DAPSAS (Fr) Centre								0.20			
GHS31X4000	On Board Software Maintenance Facility					0.10	0.05					**0.15**
GHS31X5000	ICC Test and Maintenance Facilities									0.10	0.05	**0.15**
GHS32	**Operations Planning**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.80**	**0.90**	**0.05**	**1.75**
GHS32X1000	Provision of Operations Plans								0.30	0.30	0.05	**0.65**
GHS32X1100	*ICC OPS procedures*											
GHS32X1200	*IFOP*											
GHS32X1300	*Data Analysis Procedures*											
GHS32X2000	ICC/FSC Operational Interactions								0.10	0.10		**0.2**
GHS32X3000	ICC/MOC Operational Interactions								0.10	0.10		**0.2**
GHS32X4000	Operations Team Setup and Training								0.30	0.10		**0.4**
GHS32X5000	Training of External Staff									0.30		**0.30**
GHS33	**Integration and Test**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.20**	**0.70**	**0.00**	**1.90**
GHS33X1000	ICC Integration								0.50	0.10		**0.60**
GHS33X2000	Ground Segment Integration								0.50	0.30		**0.80**
GHS33X3000	Ground Segment Testing								0.20	0.30		**0.50**
GHS34	**Commissioning Phase**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.50**	**0.50**
GHS34X1000	Provision of Commissioning Phase System (ICC@MOC)										0.25	**0.25**
GHS34X2000	Commissioning Phase Support										0.25	**0.25**

WBS	Task Name	2007	2008	2009	2010	2011	SY	€K
GHS4 - ICC Operations Phase								
GHS41	**ICC Operations Continuous Tasks**	**3.60**	**3.30**	**3.10**	**3.00**	**3.00**	**16.00**	**95.00**
GHS41X1000	Operations Management	0.60	0.60	0.60	0.50	0.50	**2.80**	**15.00**
GHS41X2000	Project Office	1.00	1.00	1.00	1.00	1.00	**5.00**	
GHS41X3000	Product/Quality Assurance	1.00	0.70	0.50	0.50	0.50	**3.20**	
GHS41X4000	Support to Consortium	1.00	1.00	1.00	1.00	1.00	**5.00**	
GHS31X5000	Recurrent Costs						**0.00**	**80.00**
GHS42	**Routine Operations Activities**	**3.75**	**4.00**	**4.00**	**3.50**	**3.50**	**18.75**	**0.00**
GHS42X1000	Monitor Instrument Health	0.50	0.50	0.50	0.50	0.50	**2.50**	
GHS42X2000	Calibration Processing	1.00	1.50	1.50	1.25	1.25	**6.50**	
GHS42X3000	Performance Monitoring	0.50	0.50	0.50	0.25	0.25	**2.00**	
GHS42X4000	Trend Analysis	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS42X5000	Quality Control	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS42X6000	Help Desk	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS42X7000	Information Dissemination	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS42X8000	Generate Calibration Observations	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS42X9000	Scheduling Observations	0.75	0.50	0.50	0.50	0.50	**2.75**	
GHS43	**Non-Routine Activities**	**1.30**	**1.65**	**0.95**	**0.65**	**0.65**	**5.20**	**0.00**
GHS43X1000	Performance Verification	0.50	0.25	0.25	0.25	0.25	**1.50**	
GHS43X2000	Key Programmes	0.20	1.00	0.30	0.00	0.00	**1.50**	
GHS43X3000	Problem Handling	0.20	0.20	0.20	0.20	0.20	**1.00**	
GHS43X4000	Calibration Evolution	0.30	0.10	0.10	0.10	0.10	**0.70**	
GHS43X5000	Use of Test Facilities	0.10	0.10	0.10	0.10	0.10	**0.50**	
GHS44	**Software Evolution**	**3.15**	**2.90**	**2.40**	**1.90**	**1.90**	**12.25**	**0.00**
GHS44X1000	IA Framework Evolution	0.25	0.25	0.25	0.25	0.25	**1.25**	
GHS44X2000	Data Processing Modules Evolution	0.90	0.90	0.90	0.90	0.90	4.50	0.00
GHS44X2100	*Implement New/Updated Modules*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	***1.50***	
GHS44X2200	*Deliver New//Updated Modules*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	***1.50***	
GHS44X2300	*Science Verification*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	***1.50***	
GHS44X3000	Calibration Analysis Modules Evolution	1.50	1.50	1.00	0.50	0.50	**5.00**	
GHS44X4000	Trend Analysis Modules Evolution	0.50	0.25	0.25	0.25	0.25	**1.50**	
GHS45	**Software Maintenance**	**1.80**	**1.80**	**1.80**	**1.80**	**1.80**	**9.00**	**0.00**
GHS45X1000	SPIRE Contribution to HCSS S/W Maintenance	0.50	0.50	0.50	0.50	0.50	**2.50**	
GHS45X2000	Interactive Analysis Framework and Modules Maintenance	0.50	0.50	0.50	0.50	0.50	**2.50**	
GHS45X3000	Software Infrastructure Maintenance	0.50	0.50	0.50	0.50	0.50	**2.50**	
GHS45X4000	Other ICC Software Maintenance	0.30	0.30	0.30	0.30	0.30	**1.50**	
GHS46	**Facilities Maintenance**	**1.10**	**1.10**	**1.10**	**1.10**	**1.10**	**5.50**	**105.00**
GHS46X1000	Infrastructure Maintenance	0.60	0.60	0.60	0.60	0.60	3.00	55.00
GHS46X1100	*ICC Control Centre Maintenance*	*0.20*	*0.20*	*0.20*	*0.20*	*0.20*	***1.00***	***15.00***
GHS46X1200	*DAPSAS (UK) Maintenance*	*0.20*	*0.20*	*0.20*	*0.20*	*0.20*	***1.00***	***20.00***
GHS46X1300	*DAPSAS (Fr) Maintenance*	*0.20*	*0.20*	*0.20*	*0.20*	*0.20*	***1.00***	***20.00***
GHS46X2000	Computer System Maintenance	0.50	0.50	0.50	0.50	0.50	**2.50**	**50.00**
	Totals	**14.70**	**14.75**	**13.35**	**11.95**	**11.95**	**66.70**	**200.00**

10.4.1 Notes to costing

Total Costs
Development Costs: 63sy + €240K
Operations Cost: 67sy + €200K

1. The above costs do not include the following:
    a. Cost of all network infrastructure and running costs necessary to link the ICC to the HSC in order to transfer data between the two sites
    b. The data processing modules rely on the IA infrastructure to contain libraries of general purpose mathematical, display and astronomical data processing functions. No cost have been included for providing these (assumed to be provided by the HCSS), unless resource can be found from that allocated to HCSS support.
    c. Travel and living costs for staff relocated to the ICC Operations Centre or DAPSAS Centres (primarily for the Operations Phase) as these will depend on the institute providing the resource.
    d. No costing for parallel/serendipity mode data processing has been included

2. Operations cost does not include scientific analysis and evaluation of observations, other than for calibration and performance monitoring and scientific verification purposes– this is expected to be carried out by Co-Is with additional funding

3. Total cost will be split between different funding authorities in UK, France, Italy, Sweden, USA, Canada, Spain. The workpackage allocation to each country is still TBD (except Sweden will provide the Instrument Simulator). In the event that sufficient funding is not available the following options will be considered:

    a. No processing of data from Key Programmes – this was not foreseen in the FIRST AO.

    b. No Quality Control processing at the ICC – rely on the HSC to find problems using the QC Pipeline

    c. No health monitoring – rely on MOC to identify problems

    d. Reduce training for external staff – unless they can provide sufficient support to other ICC activities after training to mitigate the cost of training

    e. No parallel/serendipity mode data processing