



Project Document

SPIRE ICC Operations Description

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Glossary

ESAC	European Space Astronomy Centre
HSC	Herschel Science Centre (at ESAC)
MOC	Mission Operations Centre



1. INTRODUCTION

This document presents an overview of the post-launch SPIRE activities and obligations on each of the participating groups during the post-launch phases of the mission.

1.1 Scope

In this analysis, we note that

- activities supported by the ICC are limited to the ICC's obligations to ESA and the general astronomical community –any special or specific support by any institute of their local scientific community is not discussed;

1.2 Structure of Document

Section 2 describes the different centres that make up the SPIRE ICC and details the tasks that each centre will undertake during the operational phases of the mission.

Section 3 describes the organisation of the ICC personnel, identifying the different teams and their responsibilities

1.3 Documents

1.3.1 Applicable Documents

AD01 FIRST Scientific Management Plan (SMP) (FIRST/FSC/DOC/0019), Rev 1

1.3.2 Reference Documents

RD01 Operational Day Logging Tools Requirements (SPIRE-RAL-DOC-003092), Issue 1.0

RD02 SPIRE Trend Analysis System (SPIRE-UCF-DOC-003136), Issue 1.0

RD03 SPIRE ICC Operations Centre Infrastructure Requirements (SPIRE-RAL-DOC-002889), Issue 1.0



2. ICC OPERATIONS PHASE ACTIVITIES

During the Operations Phase the Herschel instrument ICCs are responsible for (See AD01):

- (i) maintaining the health and safety of the instrument and continuously monitoring its operation and performance in order to identify possible future problems;
- (ii) optimising the scientific quality of the data produced for the users of SPIRE and Herschel by monitoring the scientific data products and updating the observing modes and data processing software, as necessary;
- (iii) supporting the Herschel Science Centre's activities and liaison with Herschel users by providing expert advice and answers to technical queries.

The first of these activities will be carried out under the control of the SPIRE Operations Team based at the SPIRE Operations Centre (SPOC), located at RAL. This 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. Because of this all the daily activities requiring access to real-time data or to software systems in the Herschel Science Centre (HSC), for example delivery of calibration or engineering observations and access to telemetry data, shall be carried out at the SPOC. In addition, the testing and delivery of new software and/or calibration data shall be handled through the SPOC.

The second activity will include monitoring and reviewing the instrument performance and calibration status and the quality of its scientific products, identifying and investigating processing imperfections, anomalies and effects, determining solutions and implementing them in terms of improved observations and data processing software. It will be carried out jointly by the ICC Data Processing and Science Analysis Software (DAPSAS) Centres (located at ICSTM, CEA and Lethbridge), with significant support and participation by other major SPIRE hardware groups - these are: LAM Marseille (FTS hardware behaviour and low-level FTS data processing), IFSI Rome (OBS maintenance), Cardiff University (detector and filter expertise, instrument photometric modelling and simulation, absolute calibration, FTS data processing expertise) and IPAC (Interactive Analysis and scientific data processing software support).

The third activity will be channelled through the SPOC, but will involve participation by the instrument experts in various SPIRE institutes, especially the ones mentioned above.

2.1 Operations Centre (SPOC)

The Operations Centre will carry out the following activities:

2.1.1 Continuous Tasks

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

- Management and general organisation of the work within the SPIRE ICC.
- Ground Segment activities: participation in Ground Segment systems and management groups, and liaison with other centres (especially the Herschel Science Centre)
- Provision of a Project Office to
 - support the organisation of ICC activities and communication within the ICC and with the rest of the Ground Segment;
 - provide administrative support to the PI and ICC Operations Manager, and other team members in their regular interaction with the ESA Herschel Project Team and the Herschel Science Team.
- Management and organisation of the day-to-day operations of the ICC



- Product/Quality Assurance, including configuration control for deliveries of software, calibration data and other information provided by the ICC.
- Provision and maintenance of ICC operational systems, including data interfaces with the HSC and continued operation of the documentation and SPR/SCR/NCR CVS systems in use during development.

2.1.2 Monitoring Instrument Health

Data from the instrument for each 21-hour Daily Prime Operational Phase (DPOP) is received on the ground, during the following 2 hour Daily Telecommunications Phase (DTCP) however it can take in the order of 12 hours for the accumulated instrument science data to be transmitted from the MOC, through the HSC, to the ICC (24 hrs of data @ 130 kbps through a 256-kbps link), with the time possibly extended if other HSC/ICC communications are taking place at the same time. The Operations Team cannot, therefore, monitor the instrument and take action in real time, based on the complete set of telemetry data available from the satellite.

Initially, the instrument health monitoring will take advantage of the ability of the satellite Command and Data Management System (CDMS) 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 immediately for: parameters out of limits; unexpected instrument configurations; correct command execution and autonomous actions taken by the instrument On Board Software.

In the case of a serious problem, the Operations Team 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. They 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.

Following the DTCP the Operations Team will process the complete instrument telemetry, both housekeeping and science data, from the previous DPOP and will monitor the instrument status information through that period. A daily report on the instrument status will be generated along with a log of instrument operations during this period.

The requirements on these activities are described in RD01.

During this activity, data for the analysis of trends in instrument parameters, both housekeeping and science, will be extracted and stored for later analysis (see 2.1.4).

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 48 hrs 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.

2.1.3 Calibration Processing

Once the performance of the instrument has been ascertained regular calibration observations will be performed to monitor the change in certain calibration parameters throughout the mission. These calibration observations (and some normal observations that are appropriate) will be routinely



processed, by the Calibration Team, and the data generated will be processed into calibration products and stored into the Calibration Database.

2.1.4 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 and these, along with output from the instrument health monitoring task, will be analysed. Regular reports will be produced on the long-term performance of the instrument.

This activity is described in RD02

2.1.5 Generating/Scheduling Observations

For the purposes of performance verification, routine calibration and instrument problem investigation the ICC will need to generate observations and get them scheduled. This will be done using HCSS facilities for proposal handling and mission planning installed at the SPOC. The Operations Teams will routinely generate the appropriate calibration observations as demanded in the Calibration Plan and will generate other observations as requested and agreed by the ICC.

2.1.6 Problem Handling

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

- Analysis of problems (including MRBs) – this may require the generation of diagnostic engineering observations.
- Implementation of a possible solution
- Testing of solution using ground based test facilities and/or engineering observations
- Possible OBS Maintenance. IFSI will remain responsible for all modifications to the OBS. They will support the ICC in the investigation and recovery from OBS anomalies identified by the MRB.

2.1.7 Use of Test Facilities

The Operations Centre will maintain test facilities (the SPIRE Flight Spare model in the SPIRE AIV facility, the AVM model, the Instrument Simulator etc.) for testing possible upgrades to command sequences, procedures and the OBS. These will be operated as necessary, throughout the mission, although the Flight Spare will be operated regularly (approximately every six to eight months) to ensure its operability.

2.1.8 Software Delivery

Following development of new/updated Data Processing software modules the ICC will perform the necessary (system/acceptance) tests before delivering the new software to the HSC.

2.1.9 PA/QA

The SPOC will maintain and operate a configuration control system for handling changes to software and calibration data within the ICC and will be responsible for ensuring that deliveries to the HSC and other Ground Segment centres follow agreed procedures and are accompanied by the appropriate documentation.

2.2 DAPSAS Centres

The DAPSAS Centres will be responsible for the following activities



2.2.1 Continuous Tasks

- Consortium Support – e.g. arranging scientific performance review meetings, workshops, training activities etc.
- Management and organisation of the day-to-day operations of the DAPSAS Centre
- DAPSAS Facilities maintenance

2.2.2 Quality Control

The purpose of this function is to assess the quality of the products produced from a particular observation with the purpose of assessing the need to remake the observation and to feed back this information to the observer.

The HSC has the responsibility for performing some of this assessment on every observation and the SPIRE ICC will provide software as part of the SPIRE pipeline to provide this functionality, but will not provide resources to carry out this activity. Problems found with the processing will be fed back to the ICC for further analysis.

In addition, the ICC will process selected observations and analyse them, in depth, 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.

Assessment of the scientific quality of the products from an observation cannot always be made without knowledge of the object being observed and the reason for the observation. The involvement of the PI for that observation will therefore sometimes be necessary and it is expected that 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 software described below.

2.2.3 Help Desk

The HSC has the responsibility for supporting the astronomical community in the use and exploitation of the Herschel instruments and all requests for help from observers will initially be made through the HSC, who will assess them and pass them on to the appropriate personnel.

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 support to the HSC helpdesk in resolving instrument specific problems.

2.2.4 Key programmes

It is intended 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 large homogenous sets 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.

There is currently no provision for effort in the ICC to develop specific software for dealing with these data. Key programme teams will be required by ESA to demonstrate that they have the resources and



expertise needed to analyse the observations, to generate archival data products easily usable by the community, and to make available to the HSC software and data processing tools that they have developed in the course of their work. The ICC will endeavour to evaluate and incorporate these tools into the standard SPIRE data processing system.

2.2.5 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:

- defining new calibration requirements;
- updating the Calibration Plan;
- defining and testing new Calibration Observations;
- updating procedures to process the new calibration data;

2.2.6 Data Processing Software Evolution

• Data Processing Module development

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 Data Processing 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.

• Scientific verification

Before a new release of the data processing software is made available it will be verified to be scientifically acceptable. 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 (improved) output.

Any proposed new science processing software delivery will be comprehensively evaluated 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.



2.3 Additional Activities

These activities are not the responsibility of particular institutes but are undertaken by those staff that have the expertise to deal with the work.

2.3.1 Performance Verification

Following instrument commissioning, the ICC is responsible for verifying that the set of observation types and the corresponding data processing software provided before launch are executing correctly. This will involve executing observations using all observing modes and with different types of scientific output in order to test all major modes of the instrument and confirm the adequacy of the data products. This is a collaborative phase of operations with both the ICC and other consortium members being involved.

2.3.2 HCSS/DP Software Maintenance

During the Operations Phase the ICC Software Development Team (ISDT) will continue to maintain the ICC delivered software. This will include:

- Provision of support to maintenance of the HCSS and IA framework (in areas where they have the expertise);
- Ensuring that any modified algorithms conform to the HSC software development standards before submission for inclusion in the next release of IA;
- Performing the necessary (acceptance) tests before and after delivering the new software to the HSC.

2.3.3 Consortium Support to the ICC

The staff of the three ICC Centres cannot encompass the expertise held within the consortium as a whole, and will not be funded to support consortium scientific activities. At times consortium members not funded directly to work in the ICC will be called upon 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 the Operations Centre in the investigation of instrument anomalies; and support to the DAPSAS Centres in the investigation of data processing anomalies.

2.3.4 Serendipity Observations

Analysis of data from serendipity observations may be undertaken on a best-efforts basis.

2.3.5 DP Extension Workpackages

In order to provide data products adequate for scientific data analysis (so-called level 2 products), additional data processing modules are being developed to produce maps, source lists and data cubes. These will need to be verified and maintained during the operations phase.

3. ORGANISATION

The organisation of the ICC during operations is shown below

3.1 ICC Teams

The functions of the SPIRE ICC as described above will be performed by teams of staff with appropriate expertise. They directly follow on from the corresponding teams from the Development



Phase in order to transfer expertise into the Operations Phase. In the initial phases of the operations (Commissioning and PV phases) they will be augmented by staff from other consortium institutes.

3.1.1 Operations Team

This team will be responsible for:

- Participation in Herschel Ground Segment operational meetings and working groups
- Execution of the in-orbit checkout and satellite commissioning support
- Monitoring and reporting on the status of the instrument;
- Trend data extraction and analysis;
- Instrument anomaly investigation (with help from instrument subsystem experts);
- Generation of new observations required for investigation of anomalies, or for obtaining new information about the instrument;
- Scheduling of calibration and engineering observations
- Update of the AOT implementations;
- Generation of new and updated operations procedures;
- Provision and operation of the SPIRE FS and other test facilities
- Maintenance of the SPIRE instrument Simulator
- PA/QA for all formal deliveries to the Herschel ground Segment
- Liaison with the Herschel Science Centre for helpdesk queries
- Configuration control of all deliverable software and data.

The team will consist of primarily Instrument engineers, who have a good in-depth knowledge of the operation of the instrument

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 Team will be augmented by visiting staff from other institutes and will operate 7 days a week. In addition, during the Commissioning Phase a members of the Operations Team will be present at the MOC to support real-time activities

3.1.2 Calibration Team

This team will be responsible for:

- Maintenance and updating of the Calibration Plan
- Generation of new calibration procedures and observations;
- Generation of all instrument and data calibration files;
- Calibration data extraction and processing to generate calibration products;
- Monitoring of long term trends in calibration data.
- Data product quality processing, analysis and reporting
- Liaison with consortium on subsystem and astronomical calibration
- Development, refinement and documentation of the astronomical calibration scheme
- Support to the Herschel cross-calibration activities
- Maintenance of the instrument sensitivity model

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

During the Commissioning and PV phases the Calibration Team will be operating 7 days a week, as necessary to support these phases



3.1.3 Software Team

This team will be responsible for:

- Maintenance and upgrade of the SPIRE pipeline data processing modules;
- Performance monitoring of the SPIRE DP system and calibration software;
- Maintenance and upgrade of the Quality Control pipeline;
- Analysis and investigation of DP and pipeline problems
- Liaison with Herschel Science Centre and consortium with respect to pipeline revision and upgrade
- Software PA/QA activities
- Maintenance and upgrade of the On-Board Software;
- Maintenance and upgrade of some HCSS packages
- System/Acceptance testing of new science processing software and calibration files;
- Delivery of science data processing software updates to the HSC after validation;

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

Management Team

This team will be responsible for:

- Provision and operation of the SPIRE Project Office;
- Management (planning, monitoring and prioritising) all SPIRE activities;
- Managerial liaison with ESA (participation in management meetings and groups)
- ICC top-level management and SPIRE Co-I activities
- Management and organisation of the SPOC day-to-day operations
- Internal management of the programmes of the institutes contributing to the ICC

3.2 Team Location

The core ICC teams will be distributed between the four ICC Centres, as in the Development Phase, except that the a member of the Operations Team will always reside at the Operations Centre because of the need to be contactable and to respond quickly in case of emergency. Meetings of the other teams will take place at different centres, as necessary.

Members of other teams may be co-opted to the Operations Team to carry out activities for which they have the expertise (for example a member of the Calibration Team may be co-opted to the Operations Team to schedule and process calibration observations). During this time they will be under the control of the Operations Team Leader.

All ICC staff will be encouraged to take part in analysis and scientific data processing activities in order to contribute to the science data reduction software development work. As a consequence they will be able to relocate to any of the Operations or DAPSAS Centres, if necessary to interact with the appropriate people.

3.3 Infrastructure and Hardware

3.3.1 Operations Centre

Facilities provided will include a Project Office for management, administrative and secretarial support, office space for visitors, a meeting room with tele/video conferencing facilities and equipment for the



Operations Centre teams. Additional office space for visitors during the Instrument Commissioning and Performance Verification Phases will be available. This is described in RD03

In particular 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 System (with redundancy) to support the work of the Operations Team in off-line 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 Data Processing System used by the Calibration and Software Teams for their tasks. This will be a general purpose system containing large data storage and fast processing capabilities to support substantial data processing activity (for performance verification) and software development.
- 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 substantial data storage facility to provide storage for large amounts of data used in testing and validation of data processing software. (With the link rate available (256kbps, tbc) it would take a long time to extract all the data needed for a validation exercise from the HSC every time.)

In addition the Operations Centre will retain and operate as required 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.

3.3.2 DAPSAS Centres

Each DAPSAS Centre 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.



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ICC Organisation

