SPIRE ICC

User Requirements Documents
FTS Processing

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1 Introduction

1.1 Purpose & Scope

Requirements put on the ICC by the Spectrometer observing modes. It will describe the form the data is expected to take and the information required to fully characterise it. It also puts requirements on the ICC by the need to produce a data reduction process for the spectroscopic observation modes of SPIRE. These observation modes might have either a purely scientific goal or an engineering purpose. The potential users of the data reduction process might be either members of the SPIRE Consortium, or astronomers having access to the HERSCHEL observations (via the FSC). (This description was taken from RD-1). This document does not cover the requirements from the need to calibrate the modes, nor the need to command the instrument which are covered in RD-3 & RD-4.

1.2 Definitions of Terms and Acronyms

Listing of acronyms that are “unusual” to this URD

AVM	Avionics Model
CQM	Cryo Qualification Model
CS	Calibration Scientist
FTS	Fourier Transform Spectrometer of SPIRE
GST	Ground Segment Testing
ILT	Instrument Level Test
OPD	Optical path difference
PFM	Proto-Flight Model
PV	Performance Verification
SMEC	Spectrometer Mechanisms
ZPD	Zero optical path difference

In addition two web pages are available describing terms applicable to SPIRE
http://www.ssd.rl.ac.uk/spire/consortium/information/FIRSTacronyms.shtm
http://www.ssd.rl.ac.uk/spire/consortium/information/FIRSTdefinitions.asp
These are to be updated.

1.3 Related Documents

RD-1	SPIRE ICC URD Scope Document
RD-2	HERSCHEL Common Science System Development Work Report (Neal Todd, Edinburgh 20th October 2000)
RD-3	SPIRE ICC URD Calibration
RD-4	SPIRE ICC URD Common Uplink System

1.4 Overview

2 User Characteristics

2.1 The Calibration Scientists

The calibration scientist (CS) has a strong astronomical background and an in-depth knowledge of the properties and operations of the instrument. The CS plans the necessary calibration observations to characterize the instrument, determines and verifies the calibration parameters of the instrument and specifies how these parameters have to be applied in the standard product generation. [ICC actor v0.4]

2.1.1 FTS CS

A CS with special responsibilities for the FTS

2.2 Interactive Analysis Developer

The IA developer will need to be able to modify IA routines in response to proposed changes in calibration procedures.

2.3 Instrument Engineer

2.4 HSC

3 Requirements

3.1 UR-FTS-100: Instrument Modes

UR-FTS-110: Definition of various Instrument Modes

The ICC are required to define the various operating modes of the instrument

- **Source** SIRD-ICCF-055
- **Importance** Essential
- **Frequency** yearly
- **Phase** AVM

UR-FTS-120: Process specific modes

Process as applicable “specific” instrument modes (e.g. parallel and serendipity data) generated by the FTS. Deliver to the HSC.

- **Source** SIRD-ICCA-040
- **Importance** Desired
- **Frequency** yearly
- **Phase** Archive

3.2 UR-FTS-200: Development

The processing of instrument data is expected to be a continually evolving skill

UR-FTS-210: Design

The ICC is required to design the processing software

- **Source** SIRD-ICCF-130
- **Importance** Essential
- **Frequency** yearly?
- **Phase** AVM

UR-FTS-220: Implementation

The ICC is required to implement the processing software (TBD what this means), but see next section.

- **Source** SIRD-ICCF-130
- **Importance** Essential
- **Frequency** yearly
- **Phase** AVM

UR-FTS-230: Test

The ICC is required to test the processing software (TBD what this means)

- **Source** SIRD-ICCF-130
- **Importance** Essential
- **Frequency** yearly
- **Phase** AVM

UR-FTS-240: Validation

The ICC is required to validate the processing software (TBD what this means).
"support the validation of the scientific processing S/W prior to release for use by the community. Note: the scientific data processing software will evolve considerably during the mission from the basic, imperfect set available at launch. The ICC teams shall process "selected" observations in order to validate the various processing algorithms. Upon validation the S/W is released for use by the HSC and the community. The Observations to be checked shall be selected in such a way that all instrument modes (AOTs) are covered as well as possible"
"Support validation of the data products generated with improved algorithms/calibration data"

- **Source** SIRD-ICCF-130
  SIRD-ICCF-065
  SIRD-ICCA-035
- **Importance** Essential
- **Frequency** yearly
- **Phase** AVM

UR-FTS-240: Improvement

Improve processing algorithms. Deliver updates to HSC

- **Source** SIRD-ICCA-030
- **Importance** Essential
- **Frequency** yearly
- **Phase** AVM

3.3 UR-FTS-300 Interactive Analysis: General

This section indicates some general requirements of the Interactive Analysis (IA).

UR-FTS-310 Platforms

IA should be multiplatform with goal of platform independence. The platforms that are currently required are Solaris, Linux, DecAlpha with a goal of one Windows platform (NT/95/98 or 2000). The list of supported platforms will be subject to change at time scale of one tear (TBC).

- **Source** RD2
- **Importance** Essential/Desirable
- **Frequency** yearly
- **Phase** AVM

UR-FTS-320 Modularity

The IA should be designed such that new algorithms can be developed and interchanged with ease.

- **Source** JPB (here)
- **Importance** Essential
- **Frequency** continuous
- **Phase** AVM

UR-FTS-330 IA consists of different generic types of modules

(a) <u>interactively processing data</u>
(b) <u>visualizing data;</u>
(c) <u>input/ output of data</u>

- **Source** RD2
- **Importance** Essential
- **Frequency** once
- **Phase** AVM

UR-FTS-340 Interfaces

Interactive analysis will consist of both GUIs and Command Line interfaces
A scripting language can be run within IA

- **Source** RD2
- **Importance** Essential
- **Frequency** continuous
- **Phase** AVM

UR-FTS-350 Data formats

IA will be able to export/ import data in formats than can be imported/exported to/ from other software

- **Source** RD2
- **Importance** Essential
- **Frequency** once
- **Phase** AVM

UR-FTS-360 Interfaces to other software

The possibility that the IA will allow the calling of other data reduction packages and/ or libraries (possibly in other languages) whilst in IA is an open issue. This is expected to be difficult and so is very much a goal rather than a requirement.

- **Source** RD2
- **Importance** Desirable
- **Frequency** once
- **Phase** AVM

UR-FTS-370 User Help

IA will have a help system including reference guides and recipes

- **Source** RD2
- **Importance** Essential
- **Frequency** continuous
- **Phase** AVM

UR-FTS-380 Source code

Modules will be open source so that the Astronomer can see the algorithms applied and have the facility to locally modify and run code.

- **Source** RD2
- **Importance** Essential
- **Frequency** once

- **Phase** AVM

UR-FTS-390 History
The product generation history will be a component part of the products

- **Source** RD2
- **Importance** Essential
- **Frequency** once
- **Phase** AVM

3.4 UR-FTS-400 Data Products

3.5 UR-FTS-500 Interactive Analysis: Processing of Observing Modes

The Interactive analysis must be capable of processing all observing modes. This section indicates what we currently expect to be the procedures required for each mode.

UR-FTS-510 General
The following processes will be required on all data regardless of observing mode (except where explicitly excluded in the observing mode specific sections below). The following steps are applicable for the two FTS operating modes, i.e. SOF1 (Point Source Spectrum) and SOF2 (Fully sampled spectral map within FOV).
Steps 3.4.1.1 to 3.4.1.15 will refer to the processing of any FTS 'scan'. Steps 3.4.1.16 to 3.4.1.25 will refer to link different scans relevant to one single position on the sky. Finally steps 3.4.1.26 and 3.4.1.27 producing spectral maps are used only for SOF2 processing.
Presently, the FTS/IA stops at step 3.4.1.27. We have to decide how far IA has to go before exporting (format to be defined) to another data processing package to carry out the later reduction/analysis steps.

3.5.1.1 Extraction of Data from FINDAS

Includes all SPIRE relevant data. Any observation with the FTS will consist of a number of 'scans'. All relevant data must be kept grouped by 'scan' for further data processing.

3.5.1.2 Flag bad data

Self explanatory for dead (or damaged) detector(s). Need construction of the instrument status history of both the FTS miror speed and the telemetry defects to identify bad portion(s) of the scan.

3.5.1.3 Store data (to local store)

In general data should be stored at a point in the pipe-line that one may wish to return to (to run new procedures) without having to go further back. So it is likely that data should be stored after time-consuming or stable processes.

3.5.1.4 Visualisation of raw data (interactive)

Visualisation routines would be required at some stages during the data processing. I.e., at least, we would like to be able to examine the most raw of data products, before any real processing has occurred, and we would like to be able to visualise the data in physical units.

3.5.1.5 Electrical cross-talk removal

Self explanatory (but may be difficult to implement)

3.5.1.6 Oth order deglitching

Correct for main glitches.

3.5.1.7 Convert position counter to mechanical position
Requires a calibration table.

3.5.1.8 Generate list of signal vs position
Two methods should be considered: either interpolate position to time of the detector sample or interpolate detector signal to time of the position sample. It is foreseen that this step should also be able to include/add missing data with the help of the missing position info.

3.5.1.9 Convert mechanical position to OPD for each detector
Self explanatory. Require also a calibration table.

3.5.1.10 Sensitivity correction
Needs change in sensitivity to be calculable from calibration measurements.

3.5.1.11 Correct for time-dependent variation in flux
Variation in flux may come from the emission of either the Herschel Telescope or the FTS internal calibrator.

3.5.1.12 Correct for position-dependent variation in flux
Requires a callibration table.

3.5.1.13 Correct for telescope pointing drift
Self explanatory (but may be difficult to implement)

3.5.1.14 Store and Visualisation
See points 3.4.1.3 and 3.4.1.4.

3.5.1.15 Re-grid if necessary

3.5.1.16 Correct for flux drift across multiple scans
Self explanatory.

3.5.1.17 1st order deglitching
Remove outliers (median-like method).

3.5.1.18 Phase correct, Apodise and Fourier Transform individual scans

3.5.1.19 Look for duff spectra
Automatic or interactive visualisation.

3.5.1.20 Removal of time-dependent spectral response
This should include the frequency response of each detector. Needs calibration tables.

3.5.1.21 Produce a spectrum per pixel per scan
Self explanatory.

3.5.1.22 Remove instrument signature
Remove telescope – calibrator emission.

3.5.1.23 Flat-fielding
Requires a calibration table.

3.5.1.24 Convert to relevant units
e.g. Jy or $W/m^2.cm^{-1}$ or W/m^2. Requires calibration tables.

3.5.1.25 Produce a spectrum per pixel per sky position
Average over scans.

3.5.1.26 Produce 3D data cube
3D are for the two celestial coordinates and the radiation frequency.

3.5.1.27 Select and display map over spectral range
TBC.

URD-FTS-560 Engineer Modes
TBD