SPIRE ICC

User Requirements Documents
Calibration

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Issue 1

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1   Introduction

1.1   Purpose & Scope

Requirements put on the ICC by the need to calibrate all the astronomical data taken by the instrument. This includes making calibration observations, producing calibration products and preparatory calibration observations (at other telescopes). It also includes calibration of the instrument itself.

1.2   Definitions of Terms and Acronyms

Listing of acronyms that are "unusual" to this URD

FIRST	Far InfraRed and Submillimetre Telescope
SPIRE	The Spectral and Photometric Imaging REceiver for FIRST
ICC	Instrument Control Centre
URD	User Requirement Document
ILT	Instrument Level Test
AVM	Avionics Model
CQM	Cryo Qualification Model
PFM	Proto-Flight Model
PV	Performance Verification
GST	Ground Segment Testing
SCUBA	Submm Common User Bolometer Array
Planck	Planck Surveyor
SOFIA	Stratospheric Observatory for Far Infrared Astronomy
SIRTF	Space InfraRed Telescope Facility

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
which are to be updated.

1.3   Related Documents

RD-1	SPIRE ICC URD Scope Document
RD-2	FIRST-FSC URD
RD-3	ICC actor calibration scientist v 0.4
RD-4	SPIRE ICC URD-FSC-D2
RD-5	SPIRE ICC Calibration Files (Draft 1.0)
RD-6	SPIRE ICC Calibration Plan (Draft 1.0)

1.4   Overview

2   User Characteristics

2.1   The Calibration Scientist
The calibration scientist has a strong astronomical background and an in-depth knowledge of the properties and operations of the instrument. She 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 Photometer Calibration Scientist
A calibration scientist with special responsibilities for the Photometer
2.1.2 FTS Calibration Scientist
A calibration scientist 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   Consortium Astronomers
The calibration can only be properly assessed when applied to real scientific measurements. Special scientific observations may require special calibration. Those involved with the calibration activity need to be closely corresponding with Astronomers, in particular Consortium Astronomers.
2.4   Non-Consortium Astronomers
The calibration can only be properly assessed when applied to real scientific measurements. Special scientific observations may require special calibration. Those involved with the calibration activity need to be closely corresponding with Astronomers, to a lesser extent with non-Consortium Astronomers via the FSC.

3   Requirements

3.1   UR-CAL-001: Ultimate Accuracy Goal
It is hoped that ultimately the accuracy of any reasonable scientific measurement will be limited by the statistics of the data, rather than uncertainties in the calibration. There will be certain exceptions, e.g. very deep integrations may be limited by flat-field errors which would require an excessive amount of calibration time to accommodate. The ultimate accuracy may not be achieved until sometime after the mission, the uppermost priority during the mission must be to ensure that all necessary calibration measurements are taken to meet the eventual goal.

- **Source**   here
- **Importance**   Essential
- **Frequency**   once/yearly
- **Phase**   PV

3.2   UR-CAL-100: Calibration Files
UR-CAL-110: Defining Calibration Files
The "files" (or objects or whatever) that will be required for complete calibration of instrument and scientific observations need to be defined. The specifications of these files might be different for different observing modes, although it would be an aim to keep them as similar as possible. It is hoped that most of necessary files will be specified at an early stage, although the contents of these files may not be known until much later).   However, as knowledge of the instrument improves it is inevitable that new calibration files will be required.   It should be possible to alter these files independently of any procedures that use them (I.e. calibration information should not

be hard-wired into code). The file specifications should describe the formats (or interfaces), the parameters that are to be included, whether errors are needed and an allowance a drift of parameters with time, unless there are good reasons to believe that these are immutable (e.g. filter numbers). A rough draft of these files will be given in RD-5

- **Source**   here
                          SIRD-ICCF-140
- **Importance**   Essential
- **Frequency**   yearly
- **Phase**   AVM

UR-CAL-120: Defining Calibration Procedures

Associated with the calibration files should be standard procedures for applying these files (these might be IA routines or scripts). It should be possible to modify these standard procedures independently of the content of the files themselves. It should also be possible to test new calibration procedures within the IA. Procedures demonstrably offering improvements should be implemented, though it should always be possible to use earlier procedures. It is the responsibility of the ICC to ensure that these procedures (and the associated files) represent the best achievable knowledge of the instrument at that time.

- **Source**   here
                          SIRD-ICCF-140
- **Importance**   Essential
- **Frequency**   monthly
- **Phase**   AVM

UR-CAL-130: Maintaining Calibration files

Corrupted or missing calibration files should be replaced with very little delay. The calibration files available at different sites should be the same, with a few minor exceptions that may be required e.g. while testing.

- **Source**   here
                          SIRD-ICCF-140
                          SIRD-ICCO-075
                          SIRD-ICCA-025
- **Importance**   Essential
- **Frequency**   daily
- **Phase**   AVM

UR-CAL-140: Improving calibration files

Some calibration files will require modification as a result of instrument "drifts" or as the knowledge of the instrument improves. It must be possible to make these changes either automatically e.g. as a result of a regular measurement or "interactively" perhaps in response to a one off measurement. It should always be possible to use the calibration files as they would have been at any earlier epoch.

- **Source**   here
                          SIRD-ICCF-140
                          SIRD-ICCO-075
                          SIRD-ICCA-025
- **Importance**   Essential
- **Frequency**   yearly
- **Phase**   AVM

3.3   UR-CAL-200 Calibration observations & Analysis Pre-Launch
UR-CAL-210: Calibration plan

The ICC shall be responsible for producing a calibration plan. That is a sequence of observations, measurements and analysis that are necessary to provide the data to populate all the required

calibration files. Before operations this plan needs to be updated rarely (yearly?) to account for changes in instrument knowledge or measurement/observing facilities. A rough draft of this plan will be given in RD-6

- **Source**   here
                     SIRD-ICCF-145
- **Importance**   Essential
- **Frequency**   yearly
- **Phase**   AVM

UR-CAL-220: Ground based Laboratory measurements
The ICC needs to ensure that the necessary laboratory measurements of the instrument are made and that the analysis necessary to turn the laboratory data into calibration files is undertaken.

- **Source**   here
                     SIRD-ICCF-145
- **Importance**   Essential
- **Frequency**   hourly-weekly
- **Phase**   AVM

UR-CAL-230: Ground based preparatory observations
The ICC needs to ensure that the necessary ground-based astronomical observations are made (or have been made) and need to undertake the analysis necessary to turn these data into calibration files.

- **Source**   here
                     SIRD-ICCF-145
- **Importance**   Essential
- **Frequency**   yearly
- **Phase**   AVM

UR-CAL-240: Space based preparatory observations
The ICC needs to ensure that the necessary space-based astronomical observations are made (or have been made) and need to undertake the analysis necessary to turn these data into calibration files.

- **Source**   here
                     SIRD-ICCF-145
- **Importance**   Essential
- **Frequency**   yearly
- **Phase**   SIRTF (2002)/SOFIA(2002)/ASTRO-F(2004)/Planck(2007)

UR-CAL-250: Calibration Analysis
Where astronomical or laboratory measurements exist the ICC need to perform the data reduction and analysis necessary to transform these data into calibration files. Where these analysis are repetitive and/or laborious it may be convenient to have these analysis performed automatically.

1. **Source**   here
2. **Importance**   Essential
3. **Frequency**   daily (automatic) weekly (manual)
4. **Phase**   AVM

3.4   UR-CAL-300: Calibration observations & Analysis Post-Launch
A number of requirements in this section come from the FSC and are described in more detail in RD-3

UR-CAL-310: Calibration plan
The ICC shall be responsible for producing a calibration plan. That is a sequence of observations, and analysis that are necessary to provide the data to (re)populate all the required calibration files. Under normal circumstances this plan will be updated monthly, it needs to be possible to change this plan more rapidly in response to rejected calibration observations, anomalies in the instrument or in the PV phase.

- **Source**   here
                      SIRD-ICCO-042
                      SIRD-ICCO-050
- **Importance**   Essential
- **Frequency**   daily/monthly
- **Phase**   PV/Operations

UR-CAL-320: SPIRE calibration observations
The ICC needs to ensure that the necessary observations with SPIRE (and other FIRST instruments are and need to undertake the analysis necessary to turn these data into SPIRE calibration files.

- **Source**   here
                      SIRD-ICCO-042
                      SIRD-ICCO-050
- **Importance**   Essential
- **Frequency**   hourly
- **Phase**   PV/Operations

UR-CAL-330: Calibration Analysis
Where astronomical or laboratory measurements exist the ICC need to perform the data reduction and analysis necessary to transform these data into calibration files. Where these analysis are repetitive and/or laborious it may be convenient to have these analysis performed automatically.

- **Source**   here
                      SIRD-ICCF-145?
                      SIRD-ICCO-042
                      SIRD-ICCO-050
- **Importance**   Essential
- **Frequency**   daily (automatic) weekly (manual)
- **Phase**   AVM

UR-CAL-340: Scientific Assessment of Calibration
The calibration activity needs to be assessed in the context of real scientific measurements. Is the calibration adequate for the main scientific goals? Is the calibration accuracy sufficient, over specified, or lacking? Do new calibrations need to be made to address specific scientific goals? What are the calibration priorities?

- **Source**   here
                      SIRD-ICCF-145?
                      SIRD-ICCO-042
                      SIRD-ICC0-050
- **Importance**   Essential
- **Frequency**   daily (automatic) weekly (manual)
- **Phase**   AVM

UR-CAL-350: Repeat Observations (RD-4 2.1.1)
- **Source**   SIRD-ICC0-050
                  RD-4 2.1.1

UR-CAL-360: Observation Timescales (RD-4 2.1.2)
- **Source**   SIRD-ICC0-050
                 RD-4 2.1.2

UR-CAL-370: Observation Day (RD-4 2.1.3)
- **Source**   SIRD-ICC0-050
                 RD-4 2.1.3

UR-CAL-380: Failed Observations (RD-4 2.1.4)
- **Source**   SIRD-ICC0-050
                 RD-4 2.1.4

UR-CAL-390: Rejected Observations (RD-4 2.1.5)
- **Source**   SIRD-ICC0-050
                 RD-4 2.1.5

UR-CAL-400: Removed Observations (RD-4 2.1.5)
- **Source**   SIRD-ICC0-050
                 RD-4 2.1.5