SPIRE Instrument Control Centre: Time Estimator Calibration Requirements

Version 1.0
February 14th 2003
M. Sauvage

Contents

Document History

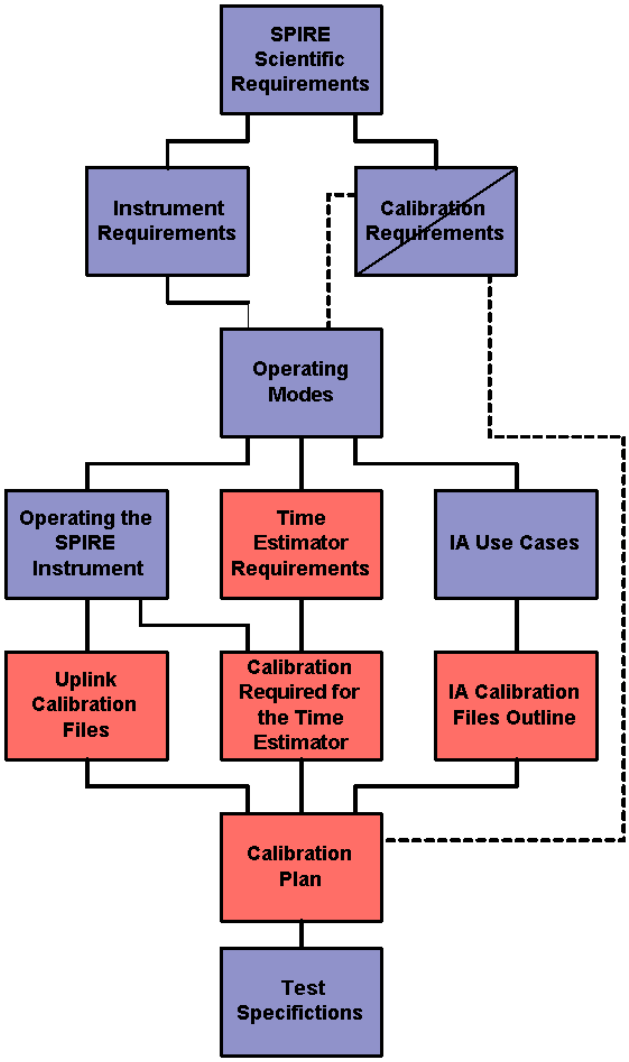
Date	Version	Changes
14/02/03	1.0	Creation from use-cases document

Applicable documents

AD1 SPIRE ICC Time estimator use-cases D1.3

Introduction

This document compiles calibration requirements derived from the analysis of AD1, the SPIRE ICC time estimator use-cases. Explicitly this lists the measurements and tests to perform on the instrument models in order to build a time-estimator that can be used as described in AD1. It is meant to be part of the series of top-level calibration requirement documents as specified in the calibration documentation tree, precisely at the box labelled "calibration required for the Time Estimator" while AD1 fits in "time estimator requirements" (that should be labelled "Time estimator use-cases").



Each requirement is given with a table that list the use-case(s) from which it derives so that its justification can be fully understood.

I have also added an "extra requirements list" which groups requirements that cannot be called calibration, but are more functional requirements. In a later revision of this document, or of the document tree, these requirements may find a better location.

Requirements list

TECR-001: Measure instrument transmission on the photometer side

We need to measure how a given flux density per beam on the sky translates into a flux per feed-horn on all the individual detectors. This is required to transform the user input into instrument information (i.e. actual flux falling on the detector). Dependence of this transmission on the actual instrument configuration (e.g. position of Beam Steering Mirror) has to be investigated.

This only includes detectors on the photometric side for which, in the framework of a time estimator, the actual spectral response can be condensed into a single number.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters

TECR-002: Characterize transmission to the entrance of the spectrometer

As for the photometer side, we need to know how a given flux (in Jy/beam) on the sky converts to a flux at the entrance of the spectrometer. Contrary to the photometer, the transmission of the signal inside the spectrometer to the detector is not in this requirement as this may depend on the actual set-up of the spectrometer (sampling rate, mirror displacement span).

UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux

TECR-003: Measure the instrument beam

Observers will want to perform time estimations on point sources or extended sources. To allow them to provide input in their favorite units (which may not be Jy/Beam) we need to know the beam profile in both the photometer and spectrometer sides of the instrument.

UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux

TECR-004: Measure detector noise characteristics

We need to have a precise characterization of the noise properties of the detectors, i.e. the NEP distribution as a function of frequency. The frequency distribution of the noise is important as, depending on the observing mode selected, different part of the noise spectrum may play an important part (i.e. low frequency noise for scan maps).

The dependency of the noise characteristics on the actual wavelength of the signal also has to be characterized.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity

UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters

TECR-005: Identify and quantify pseudo noise sources

A pseudo noise source is anything that induces an uncontrollable variation of the input flux level. Such sources in SPIRE could be the Beam Steering Mirror and the FTS mirror. These are moving parts and when their motions depart from the nominal ones, they induce uncontrollable flux variations that add to the noise.
This also includes the impact that uncertainties in the FTS mirror position has on the spectrum reconstruction.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST108	Obtain the sensitivity as a function of varying any SPIRE parameters

TECR-006: Investigate the effect of flux level on detector characteristics

SPIRE observations will be made with a strong background (imposed mostly by the telescope) superposed to the sources we want to observe. We need to investigate whether the detector characteristics (noise mostly) are very sensitive to the background level and quantify that sensitivity.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST108	Obtain the sensitivity as a function of varying any SPIRE parameters

TECR-007: Characterize detector time response

Some observing modes, if not all, create a temporal variation of the signal arriving on the detectors (i.e. motion of the Beam Steering Mirror during jiggle mapping, motion of the satellite during scan mapping). This time modulation is convolved with the detectors time response to give the time modulation that will actually be observed in the output signal. We need to fully characterize the time response of the detector as this could set some limit on the feasibility of some observing techniques. For instance is the satellite scans too fast, the detector slower time response will result in a degraded point spread function.

UC-EST103	Estimate the time needed to map a given area

UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST108	Obtain the sensitivity as a function of varying any SPIRE parameters

TECR-008: Investigate the sensitivity of the instrument to particle impacts

Particle impacts on the detectors or elsewhere in the instrument may have an adverse effect on the achieved sensitivity (or spectral characteristics of the spectrometer). We need to quantify that effect in order to estimate the limitations they bring on the performances.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST108	Obtain the sensitivity as a function of varying any SPIRE parameters

TECR-009: Characterize the uncertainty on pixel-to-pixel gain variation

The time estimator will assume that a method to correct for the flat-field is available. However we need to incorporate an estimate of the accuracy of this correction into our sensitivity calculations. The stability of the flat-field (or its drift rate) also has to be measured.

UC-EST101	Estimate the sensitivity of an observational set-up
UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters

TECR-010: Characterize recommended flux ranges

This is both to avoid saturation, non-linearity, and other effects of the like that make a given observation unfeasible.

UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area

TECR-011: Characterize achievable spectral resolution

The spectral resolution is a key input parameter in spectroscopic observations. The achievable performances will select among all possible science objectives. We therefore need to characterize how the spectral resolution varies with the length of the mirror motion parameters and possibly sampling rate. The variation of spectral resolution with wavelength also needs to be mapped.

The behaviour of the achievable spectral resolution will be a factor in deciding whether observing modes can be "optimized" for SED or line measurement.

UC-EST104	Estimate the time needed to obtain a SED

UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters

TECR-012: Characterize photometric accuracy of the spectrometer
Given that we detect interferograms in the spectrometer, the detector noise will propagate into the signal reconstruction, leading to photometric errors that may have a very different behaviour than on the photometer side. The observer will still want to achieve a given S/N on a continuum or a line. We need to evaluate how the set-up of the spectrometer affects the achievable photometric accuracy.

UC-EST104	Estimate the time needed to obtain a SED
UC-EST105	Estimate the time needed to obtain a line flux
UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST108	Obtain the sensitivity as a function of varying any SPIRE parameters

TECR-013: Measure relative spatial positions of the detectors
In some case the output of the Time Estimator will be a map of the coverage and sensitivity. To do that, we in principle need to know how each of the array project on the sky (although in a simple Time Estimator, we can assume nominal respective positioning).

UC-EST103	Estimate the time needed to map a given area

Extra requirements list

TEECR-001: measure commands execution time
We need to know the execution time of every commands passed to the instrument in order to incorporate this time into the total observing time returned by the time estimator.

UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area
UC-EST104	Estimate the time needed to obtain an SED
UC-EST105	Estimate the time needed to obtain a line flux

TEECR-002: measure efficiency of commands
An important element in selecting an observing strategy is its efficiency. Thus for any command which is executed, we know the fraction of time actually spent integrating signal (for some commands it will be 0).

UC-EST107	Obtain the observation efficiency as a function of varying allowed SPIRE parameters
UC-EST107	Obtain the observation efficiency as a function of varying any SPIRE parameters

TEECR-003: Establish accepted range for tunable SPIRE parameters
A large number of instrument parameters can be changed on the SPIRE instrument. We need to firmly establish the set of parameters accessible to the observer and the accepted ranges of variation.

UC-EST106	Obtain the sensitivity as a function of varying allowed SPIRE parameters
UC-EST107	Obtain the observation efficiency as a function of varying allowed SPIRE parameters

TEECR-004: Investigate optimization possibilities on the photometer side
Although all three bands of the photometer are always available, there may be some program that only need one of these bands, or where one is more important that the others. We should know whether there is a way to optimize SPIRE for these observations.

UC-EST102	Estimate the time needed to reach a given sensitivity
UC-EST103	Estimate the time needed to map a given area