SPIRE ICC

User Requirements Document
Astronomical Observation Preparation

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1 Introduction and context

This subsection of the SPIRE ICC URD is intended to cover the topics described in the URD Scope Description as follows:

> **Requirements for the need to be able to prepare astronomical observations using the instrument. Those preparing observations might be ICC calibration scientists or astronomers interacting with the ICC via the FSC.**

One should note that the FSC indeed expects the SPIRE ICC to provide a software tool to allow the preparation of SPIRE observations by non-specialist SPIRE users. One should also note that this is different from a tool that would allow to actually enter an observation into the database of schedulable FIRST observations. It is expected that this tool will be produced and developped in the FSC, incorportating the AOT to instrument logic "translator" developped by the SPIRE ICC (which is not referred to either in this section, see below).

This document is written under the following assumptions:

- SPIRE observing modes (the AOTs) have been defined and documented.
- The logic that converts AOT parameter values into actual command sequences for SPIRE exists or is well documented.
- A detailed knowledge of the instrument performances will have been gathered from ground-based calibration.

We also remind that the aim of such a facility is to allow the preparation of astronomical observations, therefore its aims are not to fully simulate the observation (e.g. from a model of the sky to a model of the output data, an aspect covered in another section of the URD) but rather to help observers compute the value of the different AOT parameters that will allow them to reach their scientific/calibration goals in terms of signal-to-noise ratio.

Following the above remarks, it is clear that the main users of the facility will be observers (from the ICC or external to it). However, as one could foresee that the instrument capacities could vary, which should then have to be reflected in this observing time estimator tool, developers of the system can also be thought of as users, in the sense that the necessity of being able to adapt the system to new instrument conditions also place requirements on it.

Therefore the requirements are distributed in 3 sections:

- Systems requirements that cover issues dealing with the conception, functioning and upgrading of the system
- Observers requirement that deals more specifically with those driven by the main users of the system.
- Host requirements, which stems from the fact that the ICC will be the host for the system development and quite likely its use as well, and this implies the definition of some interfaces and policies with the users.

In the rest of this document, the above-mentionned facility or system will be called "time estimator tool". As a final note, we mention that the URD listed here could be considered more as URD on the tool itself, rather than on the ICC. However, given that it is the ICC's responsibility to develop and maintain such a tool, it seems that any requirement on the system actually places a requirement on the ICC.

Note: (MS) in short, it seems to me that for a system that has to be developped in the ICC, any requirements such as "the system shall be able to do that" can be rephrased as "the ICC shall ensure that the system is able to do that".

2 System requirements

2.1 development

2.1.1 Readiness

The time estimator is one the key element in estimating the actual feasibility of given science programs (the other one being the simulator tool described in another section of the URD). Therefore it should in principle be available at the time the Guaranteed Time science program is elaborated.

2.1.2 Portability

Almost by definition, the time estimator tool is destined to be run at different institutes (an alternative to that is to have it available through a WWW interface but at times, this may mean a heavy load on the server). It is therefore advisable that the tool be written in a language that require little modification to run on different platforms. This can be achieved either in using a platform independent language (i.e. Java) or embedding it in an application that has been already ported to many platforms (i.e. IDL).

2.1.3 Supported AOTs

Although this is already implicit, the time estimator should support all official SPIRE observing modes, for both broad-band imaging and spectro-imaging.

2.1.4 Files for instrument parameters

One must be able to modify the instrument parameters (noise levels, conversion factors from fluxes to digital units, transmission, …) as our knowledge of them evolves. Therefore all instrument parameters should be stored in external, well identified and documented files, that the tool accesses when it is being activated. No instrument parameter should be hard-coded into the system.

2.1.5 Values of instrument parameters

To avoid mismatches between predicted times and actual observing times, values of the instrument parameters should strictly reflect our knowledge of them. No rounding should occur.

2.1.6 Instrument's logic

The instrument's logic and principally its timing, should be followed as close as possible. This is in order to include all possible dead-times (telescope motion, buffer times to avoid command collisions…) so that the time computed to reach a certain goal is as close as possible to the actual observing time. Any modification of the instrument's logic shall be reflected in the time estimator tool as soon as possible

2.1.7 Outputs

The time estimator tool is however not meant to produce a meaningful instrument command sequence, which is of no use to the observer. Rather, given AOT parameter values, sky and source configuration, the tool should compute the resulting on-source signal to noise ratio. As an advanced feature, the tool could produce graphs showing the evolution of the signal-to-noise ratio as a function of some AOT-meaningful time (i.e. time per individual pointing, scanning speed, time per scan leg…).

2.2 Maintenance

2.2.1 Documentation

It is expected that, due to the rather long lifetime of the FIRST telescope, the time estimator tool will be maintain by persons that may not have participated in its development. Thus the tool and its parameter files shall be well documented, both in its algorithmic part and in its structure, to allow quick identification of the parts to upgrade.

2.2.2 Versions

It is almost inescapable that the time estimator will be upgraded to reflect either real changes in the instrument performances, modification of AOTs, or improvements regarding the knowledge of the instrument. Release of the time estimator tool should therefore proceed through clearly identified and documented versions (as few as possible) in order to minimize the risk of users unknowingly running obsolete versions. Once again such a risk is minimized if the tool is available via a WWW interface.

2.2.3 Evolving calibration

Given the foreseen lifetime of FIRST/SPIRE, it is clear that the tool will be used during the mission, and there is a high probability that instrument parameters will vary. Thus care should be taken to reflect any modification of the instrument parameters that could be introduced in other ICC subsystems in this system as well. A ideal mechanism for that is that the time estimator reads the instrument parameters value in the same files as other ICC subsystems, however this may not be feasible given that development of the time estimator will probably have to start at a time when the format of these files cannot be frozen. Thus care should be taken that the maintenance of the time estimator is overseen by the same person that takes care of other calibration subsystems.

3 Observer requirements

3.1 Inputs

3.1.1 Sources

The tool is not intended to provide an accurate simulation of the actual observation, but rather allow the observer to find an instrumental set-up that will permit to reach the scientific goals. Therefore the tool should be able during its computation to distinguish between point and extended source (selected by the user), but it is not required that it is able to simulate the observation of a given map.

3.1.2 Backgrounds

In the operating wavelength range of SPIRE, the background can be important and place limitations to the observing capabilities of some AOT. Since the FIR/Submm background is not constant on the sky, the time estimator tool should be able to retrieve measured values of the background by experiments such as IRAS or COBE. At least, the tool should allow its user to enter background values.

3.1.3 Target coordinates

The previous requirement implies that the tool be able to accept target coordinates, in order to obtain a relevant background measurement. The presence of these coordinates in the input should not be mandatory. When absent, standard, documented background values should be used.

3.1.4 Spectral energy distribution

SPIRE has broad imaging bands and is also a spectrometer. Therefore a complete description of the targets also includes their spectral energy distributions. The time estimator tool should allow its user to choose between various spectral energy distributions (grey-bodies, power-law…) and modify their parameters at will.

3.1.5 Noises

All sources of noise should be included in the computation of the estimated signal-to-noise ratio, i.e. all instrumental but also all sky sources of noise. Confusion noise should thus be considered as well in the computation. Given that the value of the confusion noise can be definition-dependent, the noise sources and their amplitude should be well-documented.

3.2 Outputs

3.2.1 Synthetic output formats

It is foreseen that users will play with the time estimator tool, make a number of test cases, and then use them off-line to design an observing strategy. Therefore the tool shall be able to create synthetic outputs where the values of input parameters (sources, background, AOT parameters), the time estimator tool version number, and the result of its computations (preferably on a graphic form) are all available.

3.2.2 Set-up file

The tool should be able to write in an editable file the value of all its parameters for a given run. This will give the user the possibility to replay exactly a given set-up, without having to rely on memory or notes. This will also allow quick comparison between different versions of the tool.

3.3 Interaction with the tool

3.3.1 Main command mode

The main mode of interaction with the time estimator tool should be through a graphical user interface, allowing selection of input information from buttons, menus and command boxes.

3.3.2 Replay mode

The tool should be able to read its complete set-up from an editable file (see above) so that the user can rapidly configure the tool in a given set-up and replay a test case.

4 Host requirements

4.1 Commonalities

It is clear that the system described here shares some common modules with the instrument simulator described in another section of this URD, although it is intended toward simpler-minded users that do not make a complete simulation of the sky they want to observe. Therefore the ICC shall make sure that common modules between the time estimator tool and the instrument simulator are identified and developed only once, or at least by the same team.

4.2 Overview

A number of systems are already identified that provide some sort of simulation of the instrument. The ICC shall regularly survey the internal consistency of all these systems, and take appropriate actions when such a consistency is no longer maintain.

4.3 User's training

First users of the time estimator tool will be members of the SPIRE consortium. The ICC shall therefore ensure that it has the proper resources, both manpower and documentation, to provide the necessary training for the consortium member

4.4 Interface with the FIRST Science Center - Development

The time estimator tool is expected to be delivered to the FSC for use by the broader community of FIRST observers. The SPIRE ICC shall ensure that the development choices made for the time estimator tool comply with the FSC expectation.

4.5 Interface with the FIRST Science Center – Delivery

General observers will use the time estimator tool independently of the ICC, and will only interact with the FSC. In SPIRE's interest, the ICC shall make sure that along with the tool's actual delivery, necessary expertise and documentation are also transfered to the FSC.

4.6 Interface with the FIRST Science Center – Person

It is expected that the FSC will probably not be able to handle all user's question on the time estimator tool, or will discover problems in the tool's functionning. The ICC shall identify a contact person, in the team responsible for the development and maintenance of the time estimator tool, to ensure proper information exchange between the ICC and the FSC.