SPIRE ICC

User Requirements Documents
FTS Processing

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Draft 1

Thursday, 16 November 2000

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 FIRST 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

ILT	Instrument Level Test
AVM	Avionics Model
CQM	Cryo Qualification Model
PFM	Proto-Flight Model
PV	Performance Verification
GST	Ground Segment Testing
FTS	Fourier Transform Spectrometer of SPIRE
CS	Calibration Scientist
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	FIRST 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 scientists (CS) have a strong astronomical background and an in-depth knowledge of the properties and operations of the instrument. Each 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 FSC

3 Requirements

3.1 Real-Time Analysis

3.2 Quick Look Analysis

It is hoped that the Quick Look Analysis will be a sub-set of the Interactive Analysis

3.3 Interactive Analysis: General

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

3.3.1 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

3.3.2 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

3.3.3 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

3.3.4 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

3.3.5 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

3.3.6 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

3.3.7 User Help
IA will have a help system including reference guides and recipes

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

3.3.8 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

3.3.9 History
The product generation history will be a component part of the products

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

3.3.10 Data Products

3.4 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. The procedures described here are currently indicated in a flow chart in the Appendix.

3.4.1 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)

3.4.1.1 Data from FINDAS
Includes all SPIRE relevant data

3.4.1.2 Injection into SPIRE pipeline

3.4.1.3 QLA visualisation
Two points are indicated where QLA visualisation routines would be required. I.e. 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 (or engineering values)

3.4.1.4 Construct Inst. Mode/Status history from H/K
Self explanatory. May be checked against requested mode?

3.4.1.5 Reports
Flagging missing and Bad data.

3.4.1.6 Stored data
There are two points at which data is stored. 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.
The two points indicated here for storage are not cast in stone, but appear after what are presumed to be reasonable stable processes

3.4.1.7 Converting raw data to Engineering values
Engineering values would be Volts, SMEC positions in seconds, angles in degrees, etc. (TBC)

3.4.1.8 Validation of mechanical data
Checking e.g. that the position of the SMEC is appropriate (dependent on mode?). This includes checks which would not have been trapped by the usual out of limits (hard or soft). Flagging and reporting wrong positions and anomalous SMEC speed parts.

3.4.1.9 Calibration Tables
Required as input to the conversion processes. Presumably these are likely to be look-up tables or parameters for simple algorithms

3.4.2 SOF1: Point Source Spectrum: low or medium resolution
TBD

3.4.3 SOF2: Point Source Spectrum: high resolution
TBD

3.4.4 SOF3: Fully sampled spectral map within FOV: low or medium resolution
TBD

3.4.5 SOF4: Fully sampled spectral map within FOV: high resolution

3.4.5.1 1st Order Deglitching
Filtering out very high significance, short time-scale spikes in the time-line

3.4.5.2 Correction for missing or bad data
Use a digital filtering when possible

3.4.5.3 Gain Drift correction
Probably requires sensitivity measurements as a function of time and interpolates between

3.4.5.4 Telescope/calibrator emission drift correction
TBC

3.4.5.5 Conversion of SMEC positions in optical path differences

3.4.5.6 Low resolution double-side FT
Recover phase information and true ZPD

3.4.5.7 Phase correction of interferograms
SHOULD ACTUALLY BE ITERATIVE WITH PREVIOUS STEP

3.4.5.8 Cross-talk
Use of cross-talk matrix

3.4.5.9 2nd order deglitching

3.4.5.10 Correction for pointing drifts
TBC

3.4.5.11 Stored data

3.4.5.12 Full FT of the 3D interferogram cube

Real part of the FTs

3.4.5.13 Flat fielding

Taking out the differing responsivity of the different detectors

3.4.5.14 Spectral energy distribution calibration

In Jy or W.m-2.Hz-1 or W.m-2

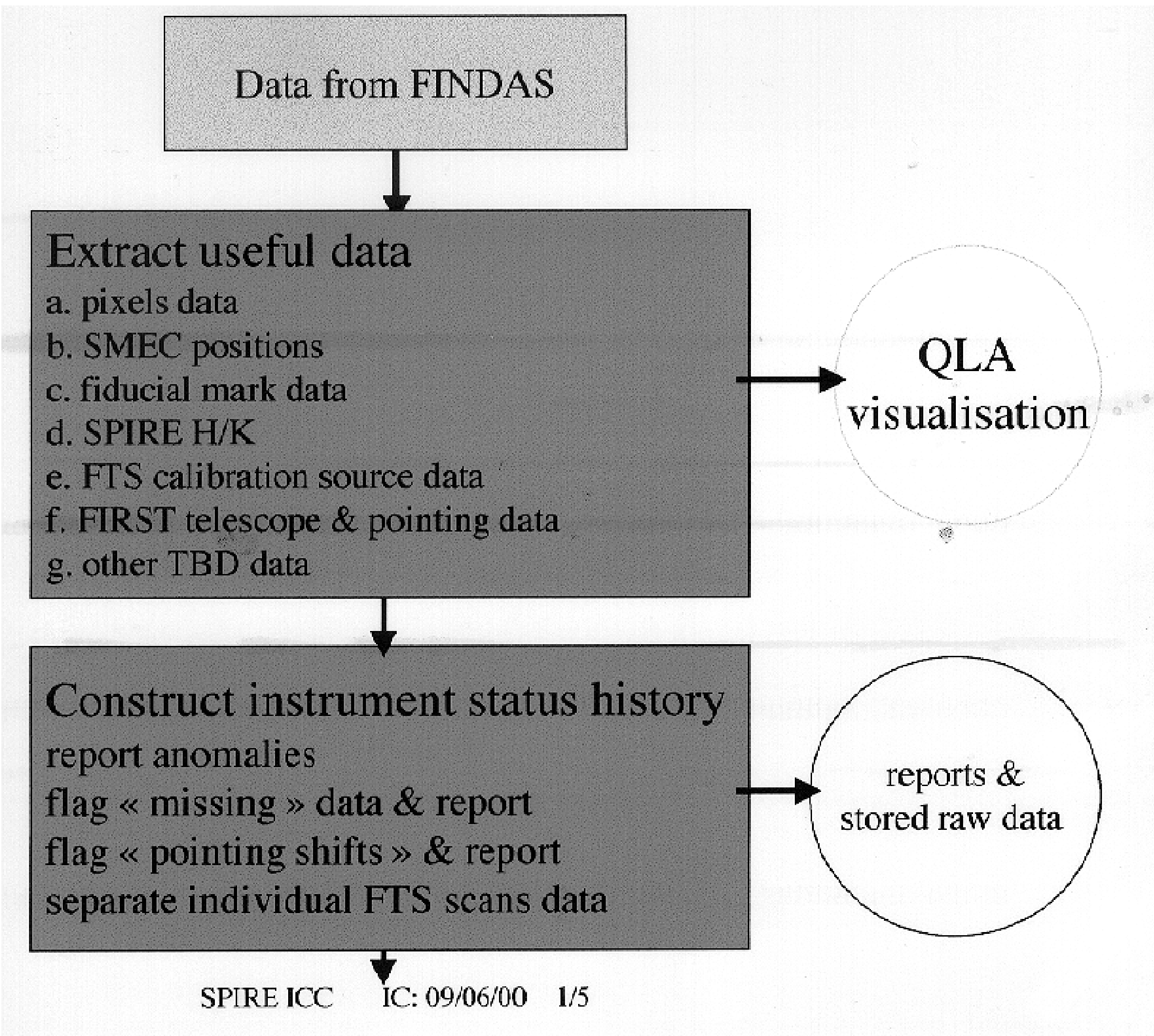
3.4.5.15 Average over jiggle position

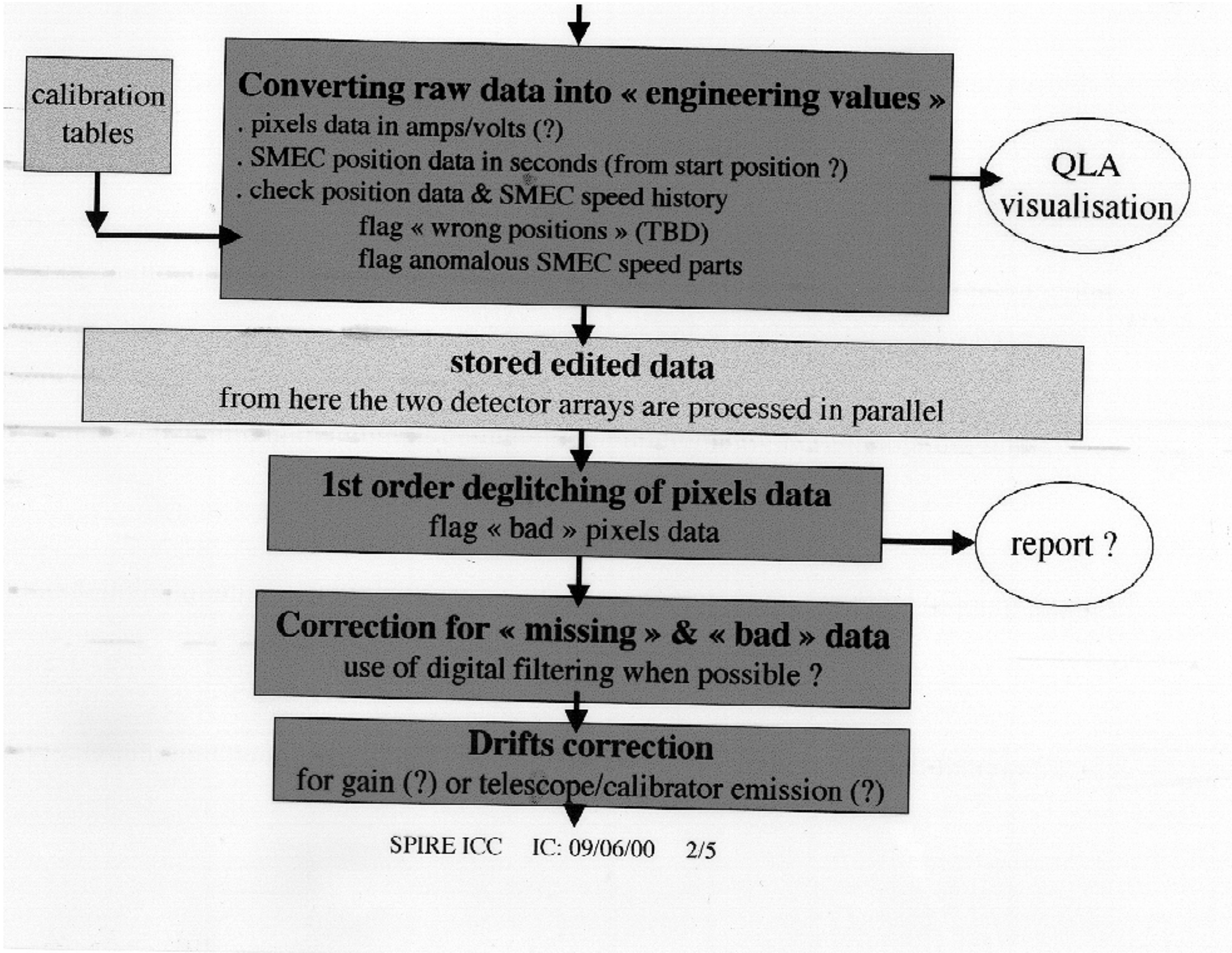
Average together all chop cycles at a single jiggle pointing. I think pointing is a better word than position here since we return to this jiggle position later. SHOULD ACTUALLY BE ITERATIVE WITH PREVIOUS STEP

3.4.5.16 Merge the two 3D spectral cubes into one

In order to cover the whole SPIRE range 200-700 mu

4 Appendix




calibration tables
Converting raw data into « engineering values »
. pixels data in amps/volts (?)
. SMEC position data in seconds (from start position ?)
. check position data & SMEC speed history
flag « wrong positions » (TBD)
flag anomalous SMEC speed parts
QLA visualisation
stored edited data
from here the two detector arrays are processed in parallel
1st order deglitching of pixels data
flag « bad » pixels data
report ?
Correction for « missing » & « bad » data
use of digital filtering when possible ?
Drifts correction
for gain (?) or telescope/calibrator emission (?)
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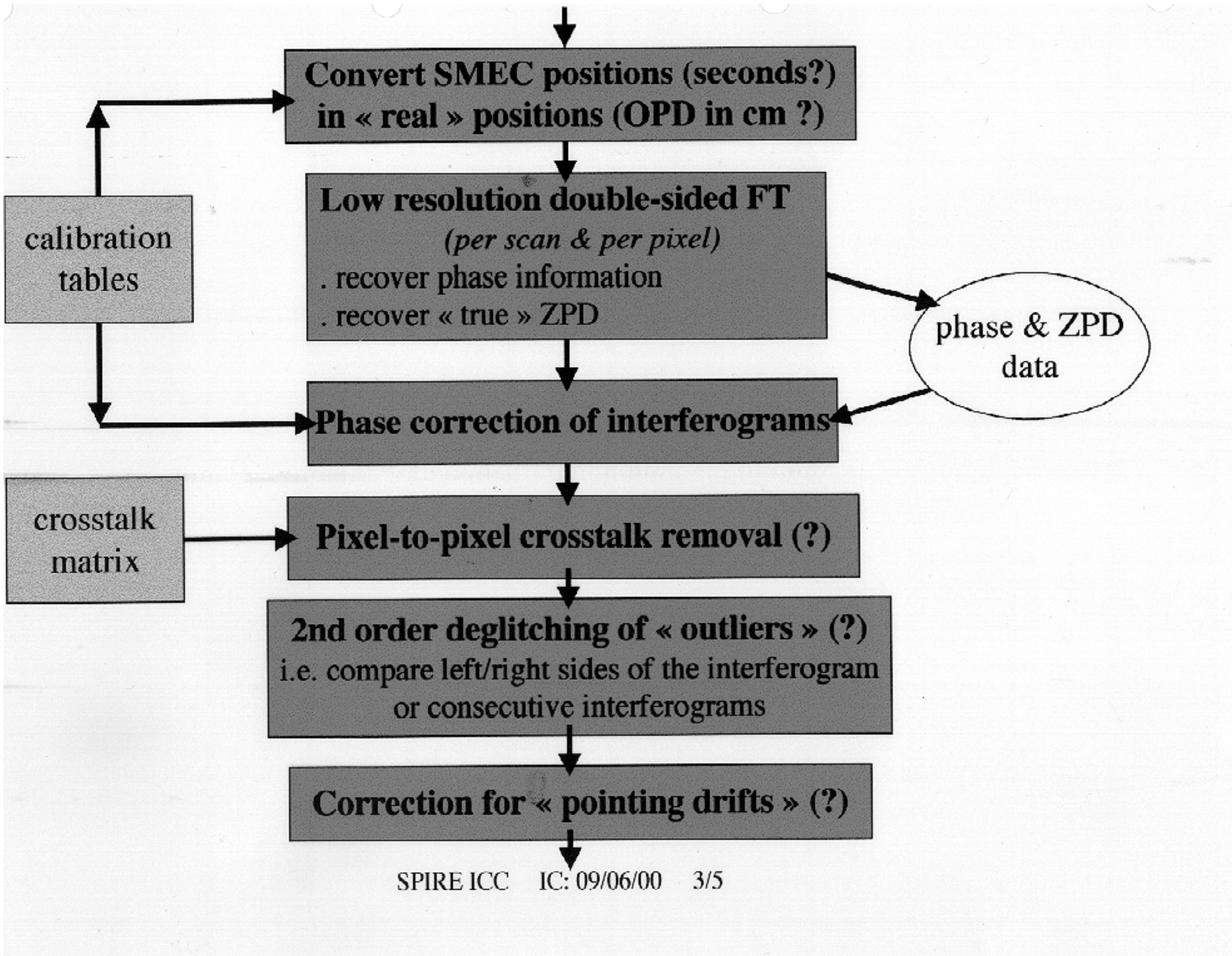
Convert SMEC positions (seconds?) in « real » positions (OPD in cm ?)
calibration tables
Low resolution double-sided FT
(per scan & per pixel)
. recover phase information
. recover « true » ZPD
phase & ZPD data
Phase correction of interferograms
crosstalk matrix
Pixel-to-pixel crosstalk removal (?)
2nd order deglitching of « outliers » (?)
i.e. compare left/right sides of the interferogram or consecutive interferograms
Correction for « pointing drifts » (?)
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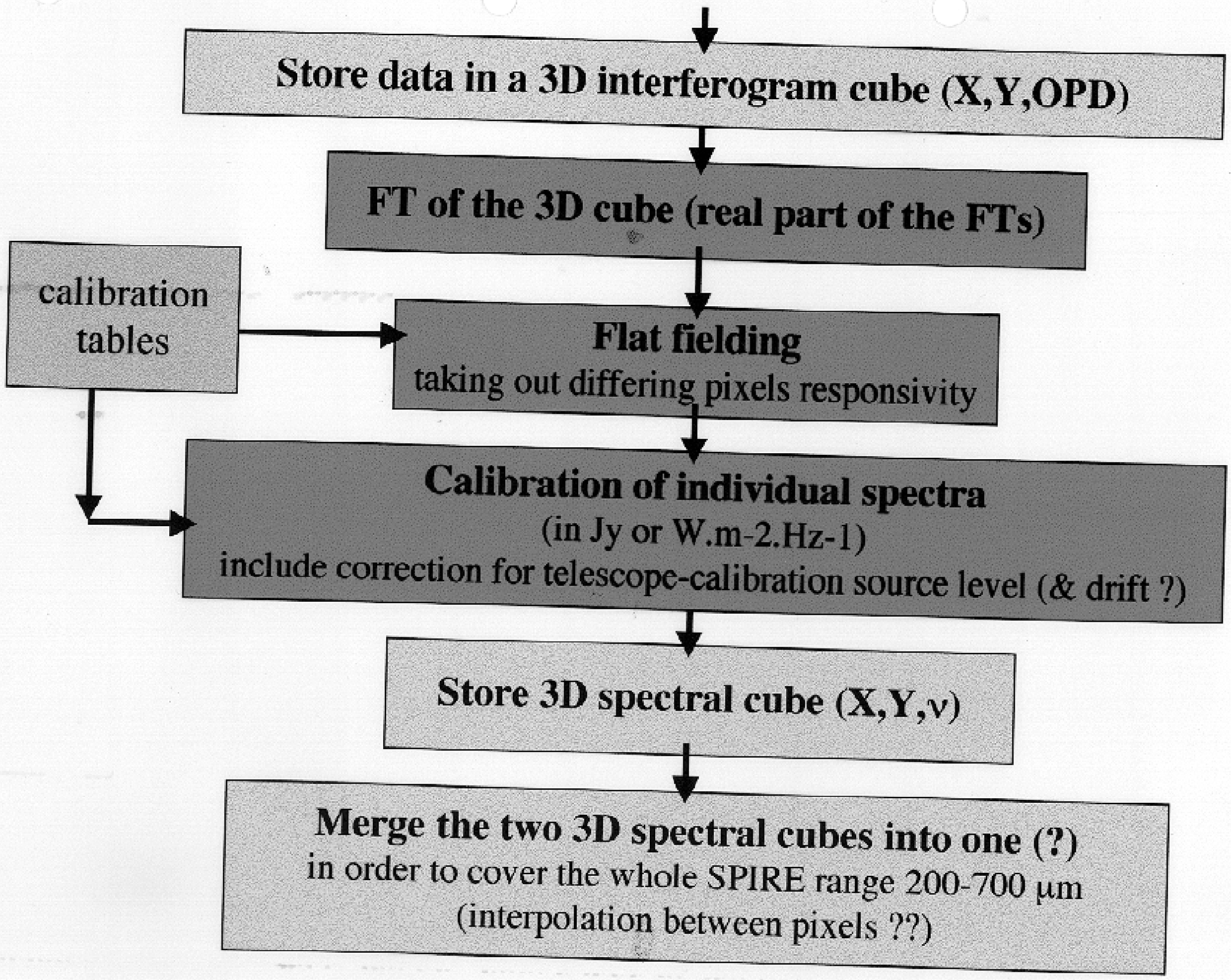
Store data in a 3D interferogram cube (X,Y,OPD)
FT of the 3D cube (real part of the FTs)
calibration tables
Flat fielding
taking out differing pixels responsivity
Calibration of individual spectra
(in Jy or W.m-2.Hz-1)
include correction for telescope-calibration source level (& drift ?)
Store 3D spectral cube (X,Y,ν)
Merge the two 3D spectral cubes into one (?)
in order to cover the whole SPIRE range 200-700 μm
(interpolation between pixels ??)