



SPIRE Fourier Transform - User Guide

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1. Background

Work Package Fourier Transform is a series of modules that reduce data from the SPIRE FTS. The inputs to the package are Spectrometer Data Products that are produced by the Engineering Data Process (EDP). The output of the package is a Spectrometer Detector Spectrum (SDS) Product. This package is located in Herschel IA under *herchel.spire.ia.modules.ft*. The following structure is used for the package:

```
herchel
  spire
    ia
      modules
        ft - Contains all pipeline module tasks.
        defns - Contains default configuration properties in ft.xml.
        doc - Contains FT documentation.
        gui - Contains GUI classes.
        util - Contains utility classes. Some utility classes are used by
              pipeline tasks, while developers or users may use others.
```

For a detailed description of Fourier Transform package modules, see Javadoc and the function guide¹.

2. How to Run the Fourier Transform Package

There are two ways to run the Fourier Transform package:

1. **Jython Scripts.** There are **FTScript** – This Jython script allows you to open saved EDP products, as well as an Optical Encoder at ZPD calibration product, and process them. The benefit of using the script is the increased flexibility that Jython provides. The drawback of using the script is that Configuration properties must be set manually or by calling *herchel.spire.ia.modules.gui.FTPROPERTYMenu*.
 - a. **ConvertExportFITStoEDP.** This script converts data products created with the **Data Export Tool** so that they resemble data products produced by the **EDP**. Edit the script to set the paths to values appropriate for your system. See §3 below for a further explanation of this script.

¹ “Function Guide for the Fourier Transformation Package”, SPIRE-UOL-DOC-002496, 25 July 2005

- b. **MakeOECalibrationProduct.** Use this Jython script to create a Calibration Product that contains the SMEC Optical Encoder (OE) value corresponding to the position of zero optical path difference (ZPD) for each pixel. Edit this script to set the paths to values appropriate for your system as well as to set an appropriate value for the SMEC OE at ZPD.
 - c. **FTScript.** This Jython script allows you to open saved EDP (or psuedo-EDP) products, as well as an Optical Encoder at ZPD calibration product, and process them using all or parts of the FT package. Please consult the FT package function guide² for details on the individual functions available in the Fourier Transform package. The benefit of using the script is the increased flexibility that Jython provides. The drawback of using the script is that Configuration properties must be set manually or by calling *herchel.spire.ia.modules.gui.FTPropertyMenu*.
 - d. **ConvertExportFITStoEDP_loop** and **FTScript_loop.** These Jython scripts the same functions as **ConvertExportFITStoEDP** and **FTScript** but do so on data for a series of observations (**N.B.** Due to running memory issues, it is advised that the loop scripts only be run on low-resolution spectrometer observations).
2. **FTExecuter.** This Java GUI, located in *herchel.spire.ia.modules.gui*, allows the user to define input and output file paths, select and configure processing steps, and output and visualize results of pipeline steps. To run this GUI, type:
- ```
from herchel.spire.ia.modules.ft.util import *
FTExecuter()
in a Jython console.
```

### 3. EDP Products

The Engineering Data Process provides the three data Products required as input to the Fourier Transform package:

1. Spectrometer Detector Timeline (SDT) – Contains bolometer signal information.
  2. Spectrometer Mechanism Timeline (SMECT) – Contains stage position information.
  3. Housekeeping Timeline (HKT) – Contains housekeeping information. For the current implementation of the Fourier Transform package, the only information required from the HKT is the SMECSTAT timeline, which keeps track of the scan number.
- (N.B. In future implementations, a Pointing Timeline product will also be required).

The products listed above are produced by the Engineering Data Process and are required by the Fourier Transform package. If the EDP is not available to create these products, there is an alternate way to create these products. The script **ConvertExportFITStoEDP** may be used to convert FITS files created with the SPIRE **Data Export Tool** into “psuedo-EDP” products. The script uses *FakeEDPFactory*, located in *herchel.spire.ia.modules.ft.util*, which creates empty products mimicking the format of

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<sup>2</sup> “Function Guide for the Fourier Transformation Package”, SPIRE-UOL-DOC-002496, 25 July 2005

the proper EDP Products. The script then copies the data from the products produced by the **Data Export Tool** into the pseudo-EDP products. These newly created products can then be used by the Fourier Transform package.

For more information on the data products see the SPIRE Data Products document<sup>3</sup> (available on the SPIRE Bulletin Board → Data Products → SPIRE Data Product description document Ver. 1.4).

## 4. Calibration Products

Calibration Products are used in various steps of the pipeline. Calibration Products are generated by CalibrationProductFactory, located in the folder *util*. Calibration Products are currently stored in a Product array, which is also generated by CalibrationProductFactory. The location of each product in the array is defined by a map, which is itself defined in CalibrationProductFactory. A description of the calibration products used by the Fourier Transform package is given in Table 1.

| Name       | Array Index  | Description                                          | Where Used                | Required |
|------------|--------------|------------------------------------------------------|---------------------------|----------|
| Band Limit | BL_MAP       | Contains band limits for SLW and SSW                 | RegSampledPhaseCorrection | N        |
| Bad Pixel  | BP_MAP       | Identifies bad pixels not to be processed            | RegSampledIfgmCreation    | N        |
| Bad Scan   | BS_MAP       | Identifies bad scans not to be processed             | RegSampledIfgmCreation    | N        |
| Lvdt OPD   | LVDT_OPD_MAP | Scale for converting LVDT DC to OPD                  | RegSampledIfgmCreation    | N        |
| Oe OPD     | OE_OPD_MAP   | Scale for converting Optical Encoder position to OPD | RegSampledIfgmCreation    | N        |
| Phase      | PHASE_MAP    | Provides known instrumental phase                    | RegSampledPhaseCorrection | N        |
| ZPD Lvdt   | ZPD_LVDT_MAP | Location of ZPD in LVDT DC (per pixel)               | RegSampledIfgmCreation    | N        |
| ZPD Oe     | ZPD_OE_MAP   | Location of ZPD in OE (per pixel)                    | RegSampledIfgmCreation    | N        |

**Table 1: Fourier Transform package calibration products.**

## 5. Configuration Properties

Configuration properties for the Fourier Transform package are located in the Configuration path *spire.ia.modules.ft*. Each task in the Fourier Transform package has its own subtree (e.g. properties for the IfgmCreation Task are located in *spire.ia.modules.ft.ifgmcreation*). In addition to task specific properties, there are some properties that apply to the entire Fourier Transform package.

Table 2 describes the general configuration properties, which are located in *spire.ia.modules.ft*. The GUI and Script columns indicate whether a given property is used by the FTExecuter GUI and FTScript, respectively. Other properties are in place but

<sup>3</sup> “SPIRE Data Products”, version 1.4, 04 May 2005

currently do not have any effect on the data processing. For example, the `intype` and `outtype` properties indicate the file format of the saved input and output products. The current implementation of the Fourier Transform package software is only set up to handle FITS file formats.

| Name                    | Description                                                                                                                                                      | GUI | Script | Default   |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|-----------|
| <code>intype</code>     | Format of input products.                                                                                                                                        | N   | N      |           |
| <code>outtype</code>    | Format of input products.                                                                                                                                        | N   | N      |           |
| <code>inpath</code>     | Path of input products                                                                                                                                           | Y   | N      |           |
| <code>outpath</code>    | Path to output products, and logging file                                                                                                                        | Y   | N      |           |
| <code>rootname</code>   | Name that identifies a group of EDP products belonging to the same observation. Input files must contain this name and output files will also contain this name. | Y   | N      | ROOT_NAME |
| <code>loglevel</code>   | Level of messages to log. Levels are defined in <i>java.util.logging.Level</i>                                                                                   | Y   | Y      | WARNING   |
| <code>edpexamine</code> | Boolean indicating whether or not to examine EPD products with PixelScanMasker prior to running the pipeline.                                                    | Y   | N      | false     |

**Table 2: Fourier Transform package: General properties.**

The properties that are common to each module in the Fourier Transform package are shown in Table 3. These properties appear under each `spire.ia.modules.ft` property subtree. As an example, the `saveplot` property appears under `spire.ia.modules.ft.ifgmcreation` and `spire.ia.modules.ft.driftremoval`.

| Name                    | Description                                                                                                                                                                                                                                                                                                                                                    | GUI | Script | Default                      |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------|------------------------------|
| <code>saveplot</code>   | Boolean indicating whether to save plots useful for task debugging to a <i>herchel.spire.ia.modules.ft.util.DebugProduct</i> . If true, the <i>DebugProduct</i> is accessible from the “debug” output <i>TaskParameter</i> after the task has executed. <i>DebugProducts</i> may be inspected by using <i>herchel.spire.ia.modules.ft.gui.ProductBrowser</i> . | Y   | Y      | false                        |
| <code>saveresult</code> | Boolean indicating whether to save task result to FITS. Save location is defined by <code>spire.ia.modules.ft.outpath</code> (see above).                                                                                                                                                                                                                      | Y   | N      | false                        |
| <code>execute</code>    | Boolean indicating whether to run the task or not.                                                                                                                                                                                                                                                                                                             | Y   | N      | Default depends on the task. |
| <code>visualize</code>  | Boolean indicating whether to view the task result using <i>herchel.spire.ia.modules.ft.gui.PixelViewer</i> .                                                                                                                                                                                                                                                  | Y   | N      | false                        |

**Table 3: Fourier Transform package properties common to each Task.**

Properties specific to individual Fourier Transform package tasks are presented in Table 4.

| Task                         | Sub-package  | Name             | Description                                                                                                                                             | Default |
|------------------------------|--------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| RegSampledIfgmCreation       | ifgmcreation | useOECalibration | Boolean indicating whether to use ZPD_OE calibration for ZPD location.                                                                                  | true    |
|                              |              | interpoltype     | Type of interpolation to use during re-gridding                                                                                                         | SPLINE  |
| DriftRemoval                 | driftremoval | polydegree       | Degree of polynomial to fit interferogram to. Generally, use 1 <sup>st</sup> degree low-res scans and 2 <sup>nd</sup> degree for high-resolution scans. | 2       |
| IfgmDeglitcher               | deglitch     | type             | Type of deglitching to use. Deglitching is still in development so types are likely to change.                                                          | STDDEV  |
| RegSampledApodization (pre)  | preapod      | apodfunction     | Apodization function to use.                                                                                                                            | aNB_15  |
| RegSampledFT (double-sided)  | dsft         | zeropad          | Boolean indicating whether or not to zeropad interferograms                                                                                             | true    |
| RegSampledPhaseCorrection    | phasecorrect | polydegree       | Degree of polynomial of phase fit                                                                                                                       | 1       |
|                              |              | pcfapodfunction  | Apodization function to be performed on PCF                                                                                                             | aNB_15  |
|                              |              | pcfsize          | Size of truncated PCF                                                                                                                                   | 256     |
| RegSampledApodization (post) | postapod     | apodfunction     | Apodization function to use.                                                                                                                            | aNB_15  |
| RegSampledFT (single-sided)  | ssft         | zeropad          | Boolean indicating whether or not to zeropad interferograms                                                                                             | true    |
| SpecCoaddition               | speccoadd    | separateupdown   | Boolean indicating whether coadd up and down scans separately.                                                                                          | false   |

**Table 4: Fourier Transform package properties specific to individual Tasks.**

## 6. Visualization Tools

Three Graphical User Interfaces (GUIs) have been developed for visualizing and inspecting data products. Each GUI class is located in *herschel.spire.ia.modules.ft.gui* and is useful for specific situations. In the current implementation, each GUI runs as a blocking dialog. Table 5 describes the GUIs:

| Name            | Applicable Products    | Description                                                                                                                                                                                        | Jython usage                     |
|-----------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| ProductBrowser  | SDI, SDS, DebugProduct | Provides a tree view of datasets on the left side of the GUI. Plottable nodes appear as leafs in the tree. Clicking on the node displays the plot on the right side.                               | ProductBrowser(prod)             |
| PixelScanMasker | EDP Products           | This GUI allows user to view raw bolometer signal, stage position, and LVDT DC. In addition this GUI can be used to create Bad Scan and Bad Pixel calibration (see §4).                            | PixelScanMasker(sdt, smect, hkt) |
| PixelViewer     | SDI, SDS               | Provides a visual representation bolometer arrays. Bolometers are colored in gray according to intensity of the selected scan and slice in OPD or Wavenumber. Clicking on a pixel displays a plot. | PixelViewer(prod)                |

**Table 5: Description of Fourier Transform package GUIs.**

For more information on the visualization tools, see the Javadoc.