

# mosaic\_sed.pl

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Version 1.1

## Table of Contents

mosaic_sed.pl.....	1
1 Overview.....	2
1.1 Input Image Requirements.....	2
2 Input and Output.....	2
2.1 Input Data.....	2
2.2 Namelist – Configuration file.....	3
2.3 Other Options.....	4
3 Image Sorting.....	5
4 Mosaicking.....	6
4.1 Fiducial Image Frame (FIF) Computation.....	6
4.2 Image Interpolation.....	9
4.3 Co-addition.....	9
4.4 Difference Mosaic.....	9
5 Spectrum Extraction.....	9
6 References.....	12
7 Appendices.....	12
7.1 Short description of the intermediate and final products.....	12

## 1 Overview

The software in this package performs interpolation and coaddition of, and spectrum extraction in MIPS SED (spectral energy distribution) images.

### 1.1 Input Image Requirements

The input images have to be in the FITS format. The following keywords are required in the headers of the input files for the software to work: BITPIX, NAXIS, NAXIS1, NAXIS2, CRVAL1, CRVAL2, CRPIX1, CRPIX2, CTYPE1, CTYPE2, CDELTA1, CDELTA2, CROTA2, RA\_CLT, DEC\_SLT.

## 2 Input and Output

### 2.1 Input Data

The script *mosaic\_sed.pl* requires input images and a namelist (configuration) file. Table 1 lists the names of the input files for *mosaic\_sed.pl*. These names can be set in the namelist file, or on the command line; some of them have a default value. Except for the namelist, the names of the input files can be specified using a relative or absolute path. The command line settings override the namelist settings.

Input File	Default Name	Namelist name	Command line option	Required
Namelist *	mosaic_sed.nl	N/A	-n	y
List of input images	image_stack.txt	IMAGE_STACK_FILE_NAME	-I	y
List of uncertainty images	-	SIGMALIST_FILE_NAME	-S	y**
List of mask images	-	DCE_STATUS_MASK_LIST	-d	n
Pmask file name	-	PMASK_FILE_NAME	-M	n
Calibration Table	-	CALIBRATION_TABLE_FILE_NAME	-C	n

**Table 1** Input data for *mosaic\_sed.pl*. \* namelist needs to be in cdf / sudirectory. \*\* if `have_uncertainties = 1`.

## 2.2 Namelist – Configuration file

The namelist contains several blocks of various parameter settings, input image names, and running options. Most of the parameter settings for the modules are in the corresponding blocks delineated by “&” following by the capitalized module name in the beginning and “&END” at the end of the block. Several parameters affecting more than one module are set outside of the individual modules’ blocks. Also, the locations of the output final and intermediate products are set in the namelist file.

Table 2 lists the names of the modules, along with their purpose and namelist triggers. To run a module, its trigger should be set to 1.

Module	Namelist trigger	Purpose
<i>mosaic_sed.pl</i>	write_lists	Separates the input set of images into the subsets based on their position and writes the lists in the output directory
<i>sed_fif</i>	run_sed_fif	Creates a FIF (fiducial image frame) for each subset of images
<i>mosaic_int</i>	run_mosaic_interp	Interpolates the input images to the corresponding FIF’s
<i>mosaic_coadd</i>	run_mosaic_coadder	Coadds the interpolated images into tiles
<i>imlistarith</i>	run_mosaic_subtract	Subtracts the off-the-source tile from the on-the-source tile
<i>spectrum</i>	run_spectrum	Extracts the spectrum from the difference mosaic images

**Table 2** Modules, their namelist triggers, and purpose.

The intermediate and final products are written in several subdirectories. The names of the subdirectories can be specified in the namelist file. Table 3 lists the default names of the output subdirectories, the keywords used in the namelist, and all the products written in the subdirectory. OUTPUT\_DIR can be specified as a relative or absolute path.

Subdirectory set in Namelist	Default name	Output files
OUTPUT_DIR	./	Lists of the subsets of images, FIF’s, copy of the namelist, and all other subdirectories listed below
INTERP_DIR	Interp	Interpolated images
COADDER_DIR	Coadd	Co-added images
SUBTRACT_DIR	Mosaic	Difference mosaic images

**Table 3.** Output directories and the products written into them.

The subdirectories are created by *mosaic\_sed.pl*. For the complete list of products, see Table 5.

Table 4 lists all the parameters, along with their default values (if any) a short description, and the name of the module(s) using this parameter

Parameter Name	Description	Default	Module
MOSAIC_PIXEL_SIZE_X	The size in degrees of mosaic pixel in the $x$ - direction. MOSAIC_PIXEL_SIZE_X should be negative according to the convention that $CDELTA1 < 0$ . Takes precedence over MOSAIC_PIXEL_RATIO_X (float)	-	<i>mosaic_int</i>
MOSAIC_PIXEL_RATIO_X	The ratio of the input pixel $x$ -size to the mosaic pixel $x$ -size. (float)	1	<i>mosaic_int</i>
EDGE	The padding in arcsec added to the FIF in positive and negative $x$ -directions (int)	0	<i>sed_fif</i>
INTERP_METHOD	Interpolation method. The choices are 1,2,3,4. The default is 1 (int)	1	<i>mosaic_int</i>
N_Columns	Number of columns to be used to extract the spectrum. Defined in terms of the detector pixels (int).	3	<i>spectrum</i>
Max_Bad_Pixels_In_Column	Maximum number of bad pixels in a column for the column to be included in spectrum computation (int)	10	<i>spectrum</i>

Table 4 The processing parameters for *mosaic\_sed.pl*. The shaded fields are for the parameters set outside of the individual module blocks.

### 2.3 Other Options

1. Switch *combine\_clusters*. If set, the script doesn't split the input images based on their clusters positions. The only separation is into the on-the-source and off-the-source subsets. The default is 0.
2. Switch *have\_uncertainties*. If set, the script expects to find a list of input uncertainties and use them in interpolation, coaddition, and spectrum extraction. The default is 0.
3. Switch *sigma\_weighted\_coadd*. If set, the interpolated images are coadded weighted with the uncertainty images. The default is 0. If the input uncertainty

images are not given (`have_uncertainties = 0`) a warning is issued and the script proceeds making unweighted coadded images.

4. Switch `create_unc_mosaic`. If set, the input uncertainty images are interpolated and coadded into mosaic images. The default is 1. If the input uncertainty images are not given (`have_uncertainties = 0`), a warning is issued and the script proceeds without making a mosaic of uncertainty images.
5. Switch `create_std_mosaic`. If set, mosaic images of the standard deviation in the stack of the interpolated images are created. The default is 0.
6. Switch `use_unc_for_extract`. If set, the mosaics of the input uncertainty images are used by module *spectrum* to compute the uncertainties of the spectrum extraction. The default is 1. If the uncertainty mosaics are not made (`create_unc_mosaic = 0`), a warning is issued and the script proceeds without computing the uncertainties of the spectrum.
7. Switch `use_std_for_extract`. If set, the std uncertainty mosaics are used by module *spectrum* to compute the uncertainties of the spectrum extraction. The default is 0. If the std uncertainty mosaics are not made (`create_std_mosaic = 0`), a warning is issued and the script proceeds without computing the uncertainties of the spectrum. `use_unc_for_extract` takes precedence over `use_std_for_extract`.
8. Switch `NICE`. If `NICE = 1` all the modules called by the script using “nice 19.” The default is 0.
9. Switch `save_namelist`. The namelist used in the current run is always copied to the output directory. By default the name of the namelist is not changed. By setting `save_namelist = 1` in the namelist the namelist copied to output directory will be given a unique name, which is created by appending the namelist name to the time of execution. For example, if you ran “`mosaic_sed.pl -n myname.nl`” at 12:32:53, then the namelist will be copied to the output directory as `12h32m53s_myname.nl`. The default is 0, in which case the file is copied as `myname.nl`.
10. Switch `delete_intermediate_files`. If `delete_intermediate_files = 1` is set in the namelist the products of all the modules run this time will be deleted except for the last module. The default is 0. (LIEN – not implemented yet)

### 3 Image Sorting

An SED AOR consists of a set of bcd’s observing several positions in the sky called the cluster positions. For each cluster position there are on-the-source and off-the-source bcd’s. The script reads in the list of input images and splits them into cluster positions and on-the-source and off-the-source subsets. If `combine_clusters = 0` in the namelist (default), the lists are separated into the on- and off-the-source subsets only. The lists of the subsets of input images are written in the output directory. There are two kinds of clustering used by SED observations.

The first kind is a raster map. The cluster positions constitute a regular grid of `NROWS` rows and `NCOLS` columns. `NROWS` and `NCOLS` are fits header keywords. The positions of each bcd in the map is determined by the fits header keywords `ROW` and `COLUMN`.

The second kind is an irregular cluster mode. The cluster number is specified by the CLPOSNUM fits header keyword.

The separation into the on-the-source and off-the-source subsets are based on the value of the CSM\_AVG fit header keyword. The sign of the value of this parameter depends on the position of the bcd. It is the same for all the on-the-source bcd' and for all the off-the-source bcd's. Since the stims are always off-the-source, the sign of CSM\_AVG of an off-the-source bcd is defined by the sign of this keyword in a stim. For a stim the fits header keyword STMFL\_70 != 0. The stims themselves are excluded from mosaicking.

The following naming convention is adapted. If the input image list is named ImageList.txt, then the on-the-source and off-the-source lists for the #-th cluster are named ImageList.txt\_ON\_# and ImageList.txt\_OFF\_#, accordingly. The number # is formatted as ROW\_COLUMN for the raster mode, and CLPOSNUM for the irregular cluster mode. E.g for ROW=1, COLUMN=2 the on-the-source list is named ImageList.txt\_ON\_1\_2; for CLPOSNUM=12 the off-the-source list is named ImageList.txt\_OFF\_12. If the cluster positions are combine into one mosaic, i.e. if combine\_clusters = 1 in the namelist, then the suffix “\_#” is omitted in the file list names.

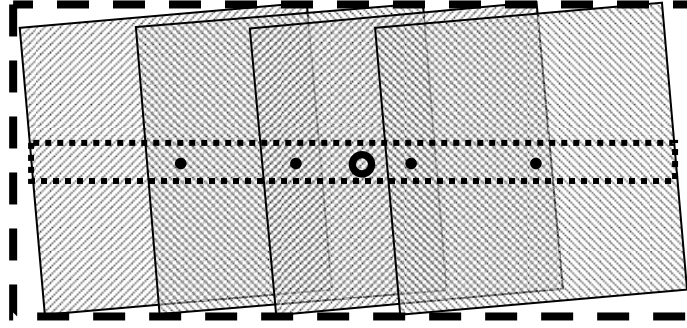
Most of the MIPS-SED observations are done in the non-mapping mode, i.e. a cluster of only 1 cluster position. In this case the value of combine\_clusters is irrelevant.

## 4 Mosaicking

### 4.1 Fiducial Image Frame (FIF) Computation

Module *sed\_fif* creates a frame that is used for creating a mosaic image. A separate FIF is created for each on-the-source and off-the-source cluster position. The following fits header keywords are used in computing the FIF for a set of bcd's: CRVAL1, CRVAL2, CRPIX1, CRPIX2, CROTA2, CDELTA1, CDELTA2, NAXIS1, NAXIS2, RA\_CLT, DEC\_SLT. Keywords RA\_CLT, DEC\_SLT specify the sky position of the center of the slit. They correspond to the pixel position CRPIX1, CRPIX2. There is a tilt between the slit and the x-axis in a bcd. The keyword CROTA2 specifies this angle. The units in the y-direction (CDELTA2) are microns, the units in the x-direction (CDELTA1) are degrees. CRVAL1 always set to 0.

The y-axis keywords - CRVAL2, CRPIX2, CDELTA2, NAXIS2 - are copied from the input bcd's into the FIF table.



**Figure 1.** The 4 shaded squares here are 4 bcd's for one cluster position. The slit centers in the bcd's are shown as solid dots. The slit is shown with the dotted line. The circle indicates the position of the reference point of the corresponding FIF. The FIF is shown with the dashed line.

First, the sky position  $(\alpha_{FIF}; \delta_{FIF})$  of the reference point of the mosaic frame is found. We assume that the centers of the slits for each bcd form a straight line. We find the two outermost bcd's and place the mosaic reference point in the middle. We use the notation of  $\alpha_i \equiv \text{RA\_SLT}_i$  and  $\delta_i \equiv 90^\circ - \text{DEC\_SLT}_i$  for the slit center of image  $i$  and find the corresponding Cartesian coordinates  $(x, y, z)$  of the point on the unit sphere:

$$\begin{aligned} x_i &= \sin \alpha_i \sin \delta_i; \\ y_i &= \cos \alpha_i \sin \delta_i; \\ z_i &= \cos \delta_i. \end{aligned}$$

The angles  $\varphi_{ij}$  between the reference points of image  $i$  and  $j$  are equal to

$$\varphi_{ij} = \arccos(x_i x_j + y_i y_j + z_i z_j).$$

We find the greatest  $\varphi_{ij} : i = l, j = m$ . We use the images  $l$  and  $m$  to compute the coordinates of the reference point of the fiducial reference frame

$$\begin{aligned} x_{FIF} &= x_l + x_m; & y_{FIF} &= y_l + y_m; & z_{FIF} &= z_l + z_m; \\ r_{FIF} &= \sqrt{x_{FIF}^2 + y_{FIF}^2 + z_{FIF}^2}; \\ x_{FIF} / &= r_{FIF}; & y_{FIF} / &= r_{FIF}; & z_{FIF} / &= r_{FIF}; \\ \delta_{FIF} &= \arccos z_{FIF} /; & \alpha_{FIF} &= \arccos \left( \frac{x_{FIF}}{\sin \delta_{FIF}} \right) \end{aligned}$$

Since the function  $\arccos$  returns values from 0 to  $\pi$  and  $\alpha_{FIF}$  ranges from 0 to  $2\pi$  one has to pick the correct solution. To this end  $\alpha_{FIF}$  is compared with  $\alpha_l$ . If

$|\alpha_{FIF} - \alpha_l| > |\alpha_{FIF} + \pi - \alpha_l|$ , then  $\alpha_{FIF} = \alpha_{FIF} + \pi$ . This will not give the correct solution when  $\alpha_{FIF} \rightarrow 0$ , but it is too tedious to derive the correct solution in this case (LIEN).

This position is written in the FIF table and subsequently into the headers of the mosaic images using keywords  $\text{RA\_SLT} \equiv \alpha_{FIF}$ ,  $\text{DEC\_SLT} \equiv 90^\circ - \delta_{FIF}$ .

In order to identify the orientation of the slit we find the angle ROT\_SLT between the slit direction and North.

$$\cos(\text{ROT\_SLT}) = \frac{\sin(\delta_m - \delta_l)}{\sin \varphi_{lm}}$$

In order to use the standard coordinate transformation routines we need to compute a meaningful values for the CRVAL1 for the input bcd's. It is set to the angle  $\varphi_i$  from the FIF reference point  $(\alpha_{FIF}; \delta_{FIF})$  to the slit center  $(\alpha_i; \delta_i)$ :

$$\varphi_i = \arccos(x_i x_{FIF} + y_i y_{FIF} + z_i z_{FIF}).$$

Since the values of  $\varphi_i$  depend on all the bcd's in the set of images, it is not a property of one bcd alone. Consequently, it is not written in the header of the bcd, but rather saved in the FIF file in the table; the column name is crval1.

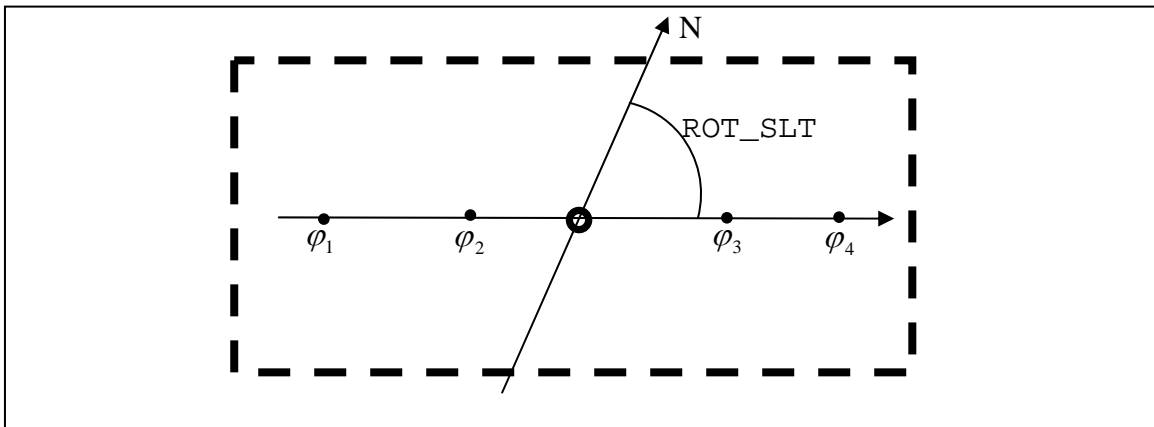
Another quantity that is computed and saved in the FIF table is an ancillary quantity `delta`. It measures (in degrees) the distance from a bcd's center slit position to the line connecting the two slit centers of the two outermost bcd's:

$$\text{delta}_i = \frac{180}{\pi} \frac{x_i(y_l z_m - z_l y_m) + y_i(z_l x_m - x_l z_m) + z_i(x_l y_m - y_l x_m)}{\varphi_{lm}}.$$

One namelist parameter is used by module `sed_fif`. `EDGE` specifies the size of the margin in arcsec padded or subtracted around the FIF on the two vertical sides. This parameters is used to compute `NAXIS1` of the FIF. We add the size of one bcd (`naxis1`) and the margin `EDGE` to the distance  $\varphi_{lm}$  between the two farthest bcd reference points converted to pixels:

$$\text{NAXIS1} = \text{naxis1} + (\text{EDGE}/3600 + \varphi_{lm})/\text{CDELTA1}.$$

The `NAXIS1` for the corresponding on-the-source and off-the-source FIF's is set to be the same, equal to the larger of the two `NAXIS1`.



**Figure 2.** The 4 points represent the slit centers of the four frames coadded into one mosaic image. The circle represents the reference points of the mosaic with the coordinates  $(\alpha_{FIF}; \delta_{FIF})$ .  $\varphi_i$  is the distance in degrees from the mosaic reference point to the slit center in image  $i$ . The mosaic frame is shown with the dashed line. Also shown here is the angle ROT\_SLT between the slit and North.



The product of this step is the FIF\_#\_on.tbl or FIF\_#\_off.tbl file. The numbering convention is the same as for the subsets file lists (see above in Section 3). Below is a sample FIF table.

```

\char comment = Output from SED_FIF Version 1.0
\char Date-Time = Mon Jul 11 17:04:08 2005
\real CRVAL1 = 0.000000
\real CRVAL2 = 79.060500
\real CRPIX1 = 15.500000
\real CRPIX2 = 16.500000
\real CROTA2 = 0.000000
\real RA__SLT = 165.943804
\real DEC__SLT = 56.875891
\real ROT__SLT = 23.343522
\int NAXIS1 = 30
\int NAXIS2 = 32
\real CDELTA1 = -0.002722222
\real CDELTA2 = 1.710000000
\char CTYP1 = "ANGLE"
\char CTYP2 = "WAVELEN"
\int INPUT_N = 6
|input_id |crvall1 |delta |
|-----|-----|-----|
| 1 | -0.007344 | -7.76e-11 |
| 2 | -0.007346 | 1.07e-09 |
| 3 | -0.007351 | 7.86e-16 |
| 4 | 0.007327 | 8.10e-09 |
| 5 | 0.007351 | 7.86e-16 |
| 6 | 0.007350 | -9.50e-11 |

```

## 4.2 Image Interpolation

Image interpolation is performed the same way it is done for regular FITS files. See Spitzer\_mosaicker.doc for the details. The only difference is that the CRVAL1 value from the header of each input bcd is replaced internally with the corresponding value of crvall1 from the FIF table.

## 4.3 Co-addition

Interpolated image coaddition is performed the same way it is done for regular FITS files. See Spitzer\_mosaicker.doc for the details.

## 4.4 Difference Mosaic

For each cluster position the off-the-source coadded tile is subtracted from the on-the-source coadded tile. Module *imlistarith* is run to do the subtraction. The uncertainty images are added in quadrature.

# 5 Spectrum Extraction

Module *spectrum* extracts the spectrum from the mosaic image and saves it in a table. It finds the  $N_b$  brightest consecutive columns. The namelist parameter N\_Columns is used to input the aperture size with the default set at 3. This number is defined in the units of the detector pixel size. If the pixel size of the mosaic is different, the number of columns in the mosaic  $N_b$  is rescaled accordingly:  $N_b = N\_Columns * MOSAIC\_PIXEL\_RATIO\_X$ .

If the number of bad pixels in a column is greater than the maximum number specified by the user with the keyword `Max_Bad_Pixels_In_Column` in the namelist, the column is rejected. The  $N_b$  brightest consecutive columns may not include a rejected column. If for example column 6 is rejected but the combined flux of columns 5 and 7 is still greater than the combined flux of any three consecutive columns, the columns 5 and 7 are not selected as the brightest ones. The number of columns and the column numbers used for spectrum estimation are recorded in the header of the output file with the keywords `N_Columns` `Column_#`.

Meaningful point source calibration is achieved only for `N_Columns` = 3 or 5. For `N_Columns` > 5 the flux calibration is done assuming it is an extended source case. The spectrum  $S(i)$  is computed as the sum of the pixel values in the  $N_b$  brightest columns for each row  $i$ .

$$S(i) = \sum_{j=J}^{J+N_b-1} I(i, j)$$

Here  $I(i, j)$  is the value of pixel in the  $i$ -th row and  $j$ -th column,  $J$  is the first of the  $N_b$  brightest columns.  $S(i)$  is saved in the output table. The central wavelength corresponding to the center of the row is also saved in the output file. If an input uncertainty mosaic is given, the uncertainty of the spectrum  $\sigma_s$  is computed by adding the corresponding pixel values from the uncertainty mosaic in quadratures:

$$\sigma_s^2(i) = \sum_{j=J}^{J+N_b-1} U^2(i, j).$$

Here  $U(i, j)$  is the value of pixel in the  $i$ -th row and  $j$ -th column of the uncertainty image. Either of the two uncertainty images – `mosaic_unc.fit` or `mosaic_std.fits` – can be used. The namelist switches `use_unc_for_extract` and `use_std_for_extract` determine which one is used, with the `use_unc_for_extract` used by default and having the priority.

Optionally, a wavelength calibration can be performed. The calibration file name is specified in the namelist with the `CALIBRATION_TABLE_FILE_NAME` keyword. The calibration coefficients depend of the aperture size, i.e. on the value of  $N_b$ . The calibration table should have input columns named `K#`, where # is equal to  $N_b$ . For example, if `N_Columns` = 3 is set in the namelist, then the calibration file should have a column `K3`. If such a column is not found, the spectrum is computed without calibration and an appropriate warning message is issued. The calibration coefficients used by the program are saved in the output file. If no calibration was performed, the calibration coefficients in the output file are set to 1. To distinguish between the case of no calibration and the case of calibration with coefficients equal to 1, in the latter case the name of the calibration table is written in the header of the output table.

The input image units (fits header keyword `BUNIT`) are converted to Jy/pixel, so that the spectrum is in the units of Jy. The keyword `Conversion Factor` in the output table is used to record the conversion factor.

To find the position of the source, first compute the flux weighted centroid  $X_c$ .

$$X_c = \frac{\sum_{j=J}^{J+N_b-1} jW(j)}{\sum_{j=J}^{J+N_b-1} W(j)}; \quad W(j) = \sum_{i=1}^{NAXIS2} I(i, j).$$

Then the separation  $\varphi_s$  in degrees between the reference point  $(\alpha_{FIF}; \delta_{FIF})$  and the source position  $(\alpha_s; \delta_s)$  is

$$\varphi_s = (X_c - \text{CRPIX1}) * \text{CDELTA1}.$$

The orientation of the slit is given by the keyword RA\_\_SLT. From the following relationship

$$\cos(\text{ROT\_SLT}) = \frac{\sin(\delta_s - \delta_{FIF})}{\sin \varphi_s}$$

we find  $\delta_s$

$$\delta_s = \delta_{FIF} + \arcsin(\sin \varphi_s \cos(\text{ROT\_SLT})).$$

From the expression for  $\varphi_s$

$$\cos \varphi_s = \cos(\alpha_s - \alpha_{FIF}) \sin \delta_s \sin \delta_{FIF} + \cos \delta_s \cos \delta_{FIF}$$

we find  $\alpha_s$

$$\alpha_s = \alpha_{FIF} + \arccos\left(\frac{\cos \varphi_s - \cos \delta_s \cos \delta_{FIF}}{\sin \delta_s \sin \delta_{FIF}}\right)$$

The source position is recorded in the output table using keywords RA\_SOURCE  $\equiv \alpha_s$ , DEC\_SOURCE  $\equiv 90^\circ - \delta_s$ , and CRVAL\_SOURCE  $\equiv \varphi_s$ .

Below is a sample output table:

```
\char comment = Output from SPECTRUM, version 1.00
\char Date-Time = Sun Jul 24 23:41:13 2005
\char comment = dlimage library version 3.10
\char Input_Image_FileName = mosaic_7/Mosaic/mosaic_1.fits
\char Input_Unc_FileName = mosaic_7/Mosaic/mosaic_std_1.fits
\int N_Columns = 3
\int Max_Bad_Pixels_In_Column = 20
\int HighPrecision = 0
\char Calibration_Table_FileName = calibration.tbl
\char Output_Table_FileName = mosaic_7/Mosaic/extract_1.tbl
\int Column_1 = 66
\int Column_2 = 67
\int Column_3 = 68
\float Conversion Factor = 141.085109
\float RA_Source = 129.280092
\float DEC_Source = 56.874781
\float CRVAL1_Source = -0.004373
\char Output Flux Units = Jansky
\char Wavelength Units = micron
|
| row | wavelenth | flux | sigma_flux | calibration | |
| i | r | r | r | r | r |
| 1 | 5.256e+01 | 4.593e+06 | 2.054e+05 | 1.000e+00 |
| 2 | 5.427e+01 | 4.038e+06 | 1.932e+05 | 1.000e+00 |
| 3 | 5.598e+01 | 3.414e+06 | 2.327e+05 | 1.000e+00 |
| 4 | 5.769e+01 | 2.746e+06 | 2.582e+05 | 1.000e+00 |
```

-

32

1.056e+02

3.813e+05

4.986e+04

1.000e+00

## 6 References

All of the documents referenced in this document can be obtained from the Spitzer Science Center website, <http://spitzer.caltech.edu/SSC/>. They include:

1. Spitzer\_Mosaic

## 7 Appendices

### 7.1 Short description of the intermediate and final products

The following table lists the names of the intermediate products of *mosaic\_sed.pl* based on the assumption that the input lists are named *ImageList.txt*, *SigmaList.txt*, *MaskList.txt* and input images have names *<input\_image\_name>.fits*, and the input uncertainty images have names *<sigma\_image\_name>.fits*. # refers to the cluster number, if the images are broken into the cluster subsets. If *combine\_clusters* is set, then “\_#” is omitted in the names.

Description	Naming convention	Default Location
Fiducial Image Frame	FIF_#_on.tbl, FIF_#_off.tbl mosaic_fif_#_on.tbl, mosaic_fif_#_off.tbl	./
Lists of the subsets of input images	ImageList_ON_#.txt, ImageList_OFF_#.txt SigmaList_ON_#.txt, SigmaList_OFF_#.txt MaskList_ON_#.txt, MaskList_OFF_#.txt	./
Geometry tables, listing the size of the interpolated images and their offsets with respect to the FIF, lists of the interpolated images, uncertainty images, and coverage maps	interp_ImageList.txt_ON_#.tbl, interp_ImageList.txt_OFF_#.tbl, interp_ImageList.txt_ON_#, interp_ImageList.txt_ON_#, interp_SigmaList.txt_ON_#, interp_SigmaList.txt_ON_#, interp_covgmap_ImageList.txt_ON_#, interp_covgmap_ImageList.txt_ON_#	Interp/
Interpolated images, interpolated uncertainty images, coverage maps	interp_<input_image_name>.fits, interp_unc_<sigma_image_name>.fits, interp_<input_image_name>_covg.fits	Interp/
Co-added Image(s) - Tiles	coadd_ON_#_Tile_001_Cov.fits, coadd_ON_#_Tile_001_Image.fits, coadd_ON_#_Tile_001_Std_Unc.fits, coadd_ON_#_Tile_001_Unc.fits, coadd_OFF_#_Tile_001_Cov.fits, coadd_OFF_#_Tile_001_Image.fits, coadd_OFF_#_Tile_001_Std_Unc.fits, coadd_OFF_#_Tile_001_Unc.fits,	Coadd/

Tile geometry file, listing the size of the tile(s) and their offsets with respect to the FIF's	coadd_ON_#_tiles.tbl, coadd_OFF_#_tiles.tbl	Coadd/
Tile-input_image association file; lists the input images used in co-adding each tile	coadd_ON_#_tile_bcd.txt, coadd_OFF_#_tile_bcd.txt	Coadd/
The difference mosaic image, with the uncertainty mosaics	mosaic_#.fits, mosaic_unc_#.fits, mosaic_std_#.fits	Mosaic/
The spectrum extraction tables	extract_#.tbl	Mosaic/

**Table 5.** A list of the intermediate and final products of *mosaic\_sed.pl*.