Short summary on the IRTS/FIRP data

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This document is intended to provide minimal information which would be needed to use the FIRP data. This is still 'under construction' and is subject to change without notice. Users of the FIRP data are advised to check the web site where you got this document for a revised version.

1 Instrument

The Far Infrared Photometer (FIRP) onboard the Infrared Telescope in Space (IRTS) is a four-band photometer which was optimized to observe diffuse sky emission at sub-mm wavelengths. The FIRP was capable of doing absolute photometry at 4 wavelengths (150, 250, 400, 700 μm) simultaneously. The Ge composit bolometers were used with the AC-biased bridge circuit followed by cold J-FETs and low- noise lockin amplifiers as the readout electronics. The bolometers were cooled down to 300mK using the ^{3}He closed cycle refrigerator that was specially designed to work at zero-gravity environment. Further description for the FIRP instrument is appeared in Lange et al.(1994).

2 Observation

Observations started on 1995 March 30, and terminated on 1995 April 24, when the liquid ^{4}He ran out. Three ^{3}He condensations were performed during the observation. While these condensation period, the detectors had no response to the incident light. From Apr.6 to Apr.9, the FIRP was turned off to eliminate the electrical interference to the other focal plane instruments. Therefore the FIRP observation were separated into three periods.

1. Mar.30 - Apr.5
2. Apr.10 - Apr.18
3. Apr.19 - Apr.24

3 Data reduction

The basic strategy of the data reduction is described in Hirao et al. (1996a,b) although some minor changes were applied when building the datasets released this time. It must be mentioned that the results are consistent despite the changes.

4 Data Products

The FIRP data are available in sky map formats. The data products give the sky brightness as observed. By the time of writing this document, most of the 250 μm data are opened to public. The rest of the data, except the degraded and scientifically meaningless data, will be available as soon as they will be ready.

4.1 Mission Average Sky Maps

All of the sky brightness data, except the degraded data, are averaged into each pixel for each of the channel. Standard deviation and the number of the samples coadded are also provided for each pixel. Since no object suitable for the flux calibration was observed during the whole observation period, the output voltages were converted to the actual sky brightness using the COBE/DIRBE 240 μm channel data. Because the DIRBE's passbands and the FIRP's are similar, this should give reasonable results.

The brightness data , I_ν, are expressed in W/m^2/Hz/sr at fixed nominal frequencies, assuming the source spectrum is νI_ν = constant. If the source spectrum is different from this assumption, a color correction must be applied. This is the IRAS convention and further explanation is given in the "IRAS Catalogs and Atlases Explanatory Supplement" p.VI-27 and "COBE/DIRBE Explanatory Supplement" p.58 section 5.5.

4.1.1 Formats

The averaged sky brightness data, the standard deviation and the number of the samples coadded are stored as FITS images. Therefore three FITS files are provided for each region. The filenames are in a format of

```
(instrument)-(wavelength)-(region No.)-(raw,err,smp).fits.
```

"raw", "err" and "smp" represent the calibrated sky brightness, standard deviation and the number of the samples, respectively. Below is an example of the filename for the FIRP 250 μm data at SS44 region.

```
firp-250-ss44-raw.fits     - Sky brightness -
firp-250-ss44-err.fits     - Standard deviation -
firp-250-ss44-smp.fits     - number of samples -
```

4.1.2 Pixelization

The time-ordered data includes sky brightness value and position data in Galactic coordinates for each position. The position data were converted to pixel coordinates using the Gnomonic projection. The Galactic coordinates at the center of each map are given in their FITS header (`CRVAL1, CRVAL2`). Each pixel correspond to approximately $0.2^\circ \times 0.2^\circ$. List 1 and List 2 are the C functions for Galactic coordinates to pixel coordinate conversion, pixel coordinates to Galactic coordinates conversion, respectivery. These functions are based on IRAS Explanatory Supplements (1997).

List 1: The C function to make a conversion from Galactic coordinates to pixel coordinates

```
int lb2linesamp(double ll, double bb, double ll0, double bb0,
double scale, double *line, double *sample)
/*
  scale:  number of pixels per degree in the map
  ll, bb:  Galactic coordinates of a given position
  ll0, bb0:  Galactic coordinates of the map center

  All angle unit must be in radian.
*/
{
  double A, F;

  A = cos(bb) * cos(ll - ll0);
  F = scale * (180/kPI)/(sin(bb0) * sin(bb) + A * cos(bb0));
  *line = -F * (cos(bb0) * sin(bb) - A * sin(bb0));
  *sample = -F * cos(bb) * sin(ll - ll0);
}
```

List 2: The C-function to make a conversion from pixel coordinates to Galactic coordinates

```
int linesamp2lb(double line, double sample, double scale,
double ll0, double bb0, double *ll, double *bb)
{
  double X, Y, D, B, XX, YY;
```

```
    X = sample/(scale * 180/kPI);
    Y = line/(scale * 180/kPI);
    D = atan2(sqrt(X*X + Y*Y), 1);
    B = atan2(-X, Y);
    XX = sin(bb0) * sin(D) * cos(B) + cos(bb0) * cos(D);
    YY = sin(D) * sin(B);

    *ll = ll0 + atan2(YY, XX);
    *bb = asin(sin(bb0) * cos(D) - cos(bb0) * sin(D) * cos(B));
    /*
      NOTE:  The arctangent functions for B and ll must be
             four-quadrant arctangents.
    */
  }
```

4.2 Known bugs

- `CDELT3` keyword in all fits files is incorrect.
- `BSCALE, BZERO, BUNIT` keywords are not set properly in `firp_*_err.fits` file and in `firp_*_smp.fits` file.

References

[1] *COBE Diffuse Infrared Background Experiment (DIRBE) Explanatory Supplement version.2.3* (1998), Hauser,M.G. et al., eds. *COBE Ref. Pub. No. 98-A*, (Greenbelt, MD: NASA/GSFC), available in electronic form from the NSSDC.

[2] Hirao,T. et al., "Flight performance of the Far-Infrared Photometer (FIRP)" (1996a), *Proc. SPIE*, **2817**, 276.

[3] Hirao,T. et al., "Submillimeter Observations of the Galactic Plane by the IRTS" (1996b), *PASJ*, **48**, L77.

[4] *IRAS Explanatory Supplement* (1997), Beichman,C.A. et al., eds. (http://www.ipac.caltech.edu/ipac/iras/iras.html).

[5] Lange,A.E. et al., "The Far-Infrared Photometer on the Infrared Telescope in Space" (1994), *ApJ*, **428**, 384.