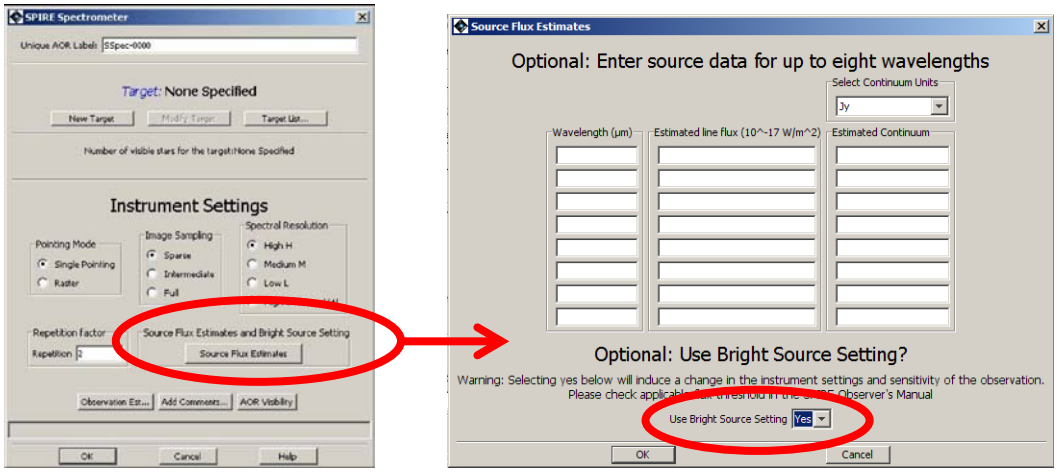
Release Note for the
SPIRE Spectrometer Bright Source Mode

Prepared by the SPIRE ICC
7 September 2010

Introduction

The bright source mode for the spectrometer is designed to allow observations of sources which would otherwise saturate the detectors. This mode can be used with any of the spectrometer AOT combinations. It can be selected from within the "Source Flux Estimates" panel of HSpot:



The yes/no toggle for bright source mode is independent of whether any estimated fluxes have been entered into the boxes above it.

What is bright mode?

The spectrometer measures an interferogram of the source spectrum where the total power received from the source is reflected in the amplitude of the modulation of the interferogram at zero path difference. This means that once a certain source strength is reached, the amplitude of modulation may exceed the dynamic range and the interferogram can be clipped. Signal clipping can occur either at the maximum or the minimum of the interferogram – it can be corrected if there are only a small number of consecutive clipped samples, but for very bright sources, the clipping can be more severe. In cases where it is impossible to correct for clipped interferograms close to zero path difference (ZPD), the continuum shape and level will be affected across the spectrum. The bright source mode addresses this problem by using a different bias amplitude and phase for the bolometers to lower their responsivity and so reduce the maximum modulation in the interferogram (this leads to a reduction in sensitivity – see later).

For mapping observations in bright mode, the dynamic range of the detectors is set at every jiggle position to maximize the number of interferograms within the dynamic range (for nominal mode, this is only done once at the beginning of the observation).

Advantages/disadvantages of bright mode

The advantage in using bright mode is that clipping is significantly reduced (and in most cases should be eliminated for the central detector pair) for sources up to the strength of Mars (~15,000 Jy). This means that the absolute calibration (and shape) of the spectrum can be well calibrated. However, due to the reduction in responsivity needed for bright mode, the sensitivity is reduced compared to nominal mode by the factors shown in the following table.

Array	Degradation in sensitivity
SSW	×4
SLW	×2

As clipping occurs around the peak modulation in the interferogram, spectral lines are relatively unaffected (the information about spectral lines is spread through the interferogram up to large optical path difference).

The bright mode is advantageous for jiggle mapping observations where there are large brightness gradients across the region to be mapped. In nominal mode mapping observations, the absolute and dynamic range of the detector readout is set once, at the beginning of the observation. For regions with large brightness contrast, and/or containing embedded bright sources, this is insufficient to ensure that the optimum readout range is set for every jiggle position. For some jiggle positions, interferograms could be completely out of range – i.e. completely saturated. This problem is avoided in bright mode because the readout range is set for every jiggle position. The cost is a slight increase in the overhead time by ~25 seconds per jiggle position.

When to use bright mode?

The central detector pair (SSWD4/SLWC3) have been found to show clipping for sources brighter than Uranus (~400 Jy at centre of SSW band and ~200 Jy at centre of SLW band). This indicates that for sources much brighter than this, the bright mode should be considered in order to obtain the best calibration of the continuum and not lose information through clipping. However, in light of the sensitivity penalty the optimum cutoff in source brightness between nominal and bright modes is somewhat subjective. The pipeline clipping task has been shown to successfully "reconstruct" interferograms with a few consecutive clipped points, and so if the main goal of the observation is the detection of weak lines, it may still be preferable to use the nominal mode above the threshold (albeit with a cost in accuracy of the continuum).

In summary, our best recommendation is:

- If the source is less bright than Uranus, use nominal mode.
- If the source is around or just brighter than Uranus (by a couple of hundred Jy), there may be clipping in nominal mode, but it can be reconstructed in the data reduction – therefore use nominal mode unless it is critical to get the best possible calibration of the absolute continuum shape.
- If the source is much brighter than Uranus (a thousand/thousands of Jy) and a factor of 2-4 loss in sensitivity is not critical, it is best to use bright mode.
- If sensitivity is critical, and accuracy of the continuum is not, nominal mode could be used for sources brighter then Uranus (contact the HSC/ICC for further advice if in doubt).
- For mapping observations of areas containing bright sources, or large brightness gradients, use bright mode.

Examples

The bright mode has been successfully used for point sources up to the brightness of Mars (~15,000 Jy in SSW). The Orion Bar (max. 600 Jy in-beam in both bands) has been successfully observed using nominal mode, but Orion OMC1 (~5,000 Jy) required bright mode (particularly for mapping).

Data Processing

At the current time (HCSS v4), flux calibration of bright mode observations is not applied by the standard pipeline, and additional interactive processing is required. Some calibration updates will be made for HCSS v5, but full calibration of bright mode data in the standard pipeline will not be available until HCSS v6.