SPIRE Point Source Mode: Release Note

Version 1.0: 30th April 2010 **Prepared by the SPIRE ICC**

Introduction

This note covers the release of the SPIRE Point Source observation mode for scheduling of observations. The SPIRE Point Source mode is also referred to as the 7-point jiggle and the POF-2 mode. This observing mode is optimized for observations of isolated point sources with accurate astrometry. The mode is not suitable for the observation of faint sources close to the confusion limit. The mode incorporates a 7-point hexagonal jiggle pattern around the target source to ensure reconstruction of the signal flux. The telescope beam is chopped using the SPIRE Beam Steering Mirror (BSM) to encode the signal at a frequency above that of the systematic drifts, such as 1/f noise. Nodding is performed with the telescope to subtract the different amounts of ambient background power received by the detector at the two different chop positions. Note that during an observation, 3 co-aligned detectors see the source and the central co-aligned detector sees the source on both Nods (with positive signal in prime central detector and 2 half negative signals in the off source detectors).

Recommended Usage

The SPIRE Point Source mode is recommended for bright isolated sources in the range 0.2-4Jy where the astrometry is accurately known and accurate flux measurement is required.
For sources fainter than 200mJy (where the background produces a significant contribution) or at fluxes higher than ~4Jy (where pointing jitter can introduce large errors) the Small Scan Map mode is preferable.

Operation

The Point Source mode observes a target using the following algorithm;

1. At first nod position (Nod **A**)
   - At the first Jiggle Position, carry out 8 cycles of chopping on and off source
   - Repeat at other 7 Jiggle positions (the last position returning to the first position)
2. Move to second nod position (Nod **B**) and repeat for all Jiggle positions
3. Stay at Nod **B** and repeat
4. Move to Nod position **A** and repeat

One repetition of this mode thus corresponds to a single **ABBA** cycle of nodding. The observation parameters for a single ABBA cycle are summarized in the table below;

Parameter	Value
Chop Throw	126” (± 63”)
Chopping frequency	1Hz
Jiggle position separation	6 arcsec
Nod Throw	126” (± 63”)
Central co-aligned detector	PSW E6, PMW D8, PLW C4
Off-source co-aligned detectors	PSW E2,E10, PMW D5,D11, PLW C2,C6
Number of ABBA repeats	1
Integration time	272 s
Instrument/observing overheads	93 s
Observatory overheads	180s
Total Observation Time	561 s

Sensitivity and accuracy estimation

The SPIRE Point Source mode is optimized for observations of relatively bright isolated point sources. In this respect the accuracy of the measured flux is more relevant than the absolute sensitivity of the mode. The noise will be a function of three contributions. For a single ABBA repetition;

- The instrumental noise will be some constant value.
- There will be some underlying confusion noise which will vary from field to field.
- There will be a flux dependent uncertainty introduced by pointing jitter that will be some fraction of the total flux.

The current 1 σ instrumental noise uncertainties for a single ABBA repetition using the central co-aligned detector are tabulated below. The instrumental noise decreases as the reciprocal of the square root of the number of ABBA repetitions however note that the instrumental noise for a single repetition of this mode is expected to equal the extragalactic confusion noise, for sources fainter than 1 Jy;

Source flux range	**1 sigma instrumental noise level**		
	250μm	**350μm**	**500μm**
0.2 - 1 Jy	7 mJy	7 mJy	7 mJy
< 4 Jy	S/N ~ 200		
> 4 Jy	S/N ~ 100		

Beam profiles

Since the 7 points of the Jiggle pattern are close to the peak of the beam, characterisation of the beam is challenging. Thus, currently the beam shape (FWHM) is fixed to be identical to the Large Map mode when the fitting to the 7-point pattern is performed.

Flux density calibration

Identical to the Large Map Mode (See Large Map Mode Release note)

Pointing

The uncertainty for the fitting of the point source position from the pipeline is around 0.8 arcsec. Additionally, the telescope pointing has an APE of ~2 arcsec which should be added in quadrature to obtain an approximate astrometric accuracy of ~2.15 arcsec. Note that the nature of the Jiggle mode allows accurate flux determination by fitting the source usingh the 7-point Jiggle pattern.

Pipeline status and Data Products

The current Point Source pipeline (referred to as POF-2) is available from HIPE v.3.0 onwards. The algorithms and calibration files are stable.

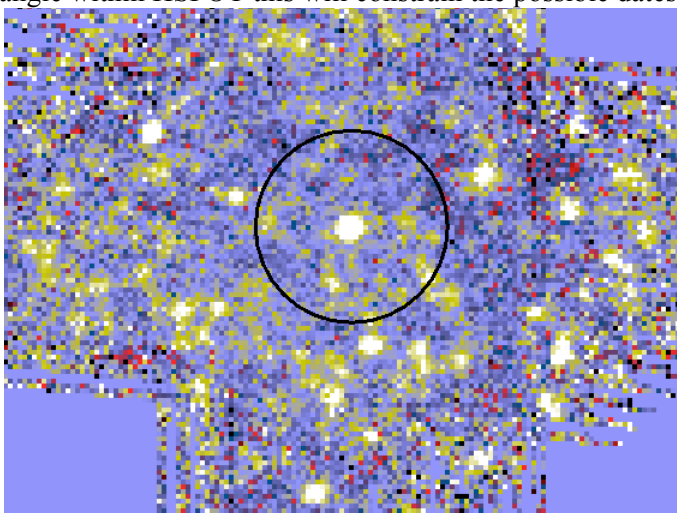
In the future, additional modifications of the pipeline algorithms are expected to further improve the stability and accuracy of the mode.

The pipeline currently provides;

- A measurement of the in beam point source flux density and associated error.
- Fitted positional offsets & uncertainties for the source
- Optional Sparse map of the detectors (currently not included in the pipeline script)

Caveats of the Point Source Mode

For Point Source mode, the effective sky confusion level is increased due to chopping and nodding (by a factor of approximately 22% for the case of extragalactic confusion noise) and should be added in quadrature to the quoted instrumental noise levels. The result of the measurement is therefore affected by the specific characteristics of the sky background in the vicinity of the source and will depend on the chop/nod position angle in the event of an asymmetric background. Note that although it is possible to set a chop avoidance angle within HSPOT this will constrain the possible dates for the observation



The example on the left shows a scan map observation of a ~220mJy source. The circle drawn around the source corresponds to the chop and/or nod throw used in the Point Source mode. Moving around the circumference of the circle it is found the background can vary between ±30mJy depending on the chop/nod position angle used for the observation. Therefore, due to the problems of confusion noise, and the dependence of the result on the position angle of the observation, the point source AOT is not recommended for sources fainter than ~200mJy, for which a small scan map will produce a better measurement including an accurate characterisation of the background.

For Point Source mode observations of bright sources (>~ 4 Jy) the uncertainties are dominated by pointing jitter and nod-position differences, resulting in a S/N on the order of 100 at most (the uncertainties in the data will also be limited by the accuracy of the flux calibration, which will be at least 5%). Users should be aware of these effects and take them into consideration.