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Change Record

Issue	Date	Section(s) Affected	Description of Change / Change Request Reference / Remarks
0.1	17/06/02	All	First draft
1.0	17/10/06	All	CDR version
2.0	20/08/12	All	Fixed hyperlinks. Updated to current status.

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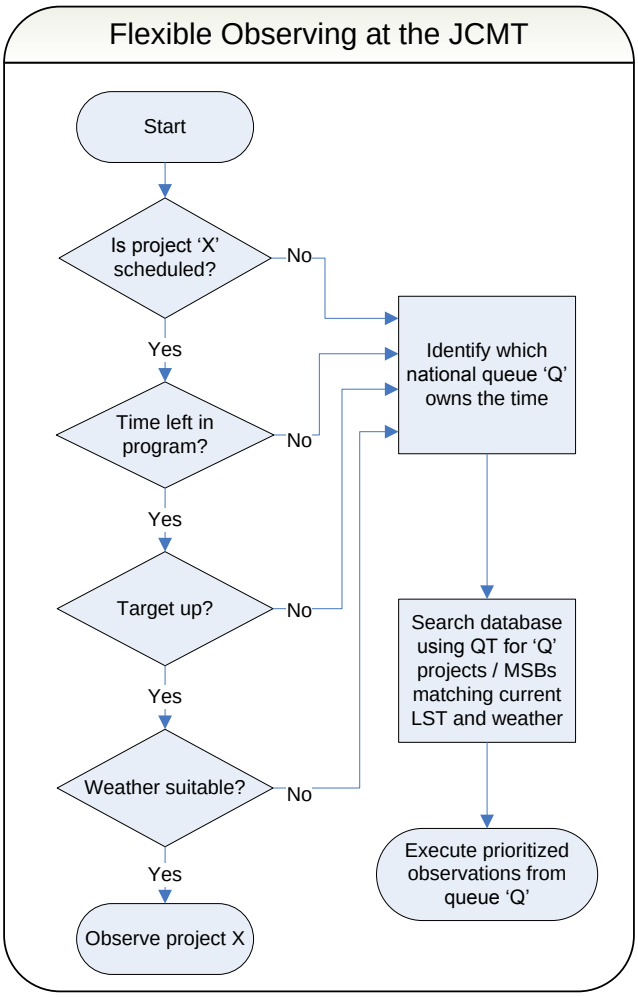
1. Introduction

FTS-2 observations are complicated by the fact that the differencing input ports of the interferometer rotate on the astronomical source as a function of time and telescope elevation angle. (Details of the FTS-2 port geometry are found in document SC2/FTS/OPT/002. The required coordinate transformations for FTS-2 are described in SC2/FTS/OPT/003.) Since the images recorded during an FTS-2 observation represent the interferometric difference between pixels in the 2 input ports, the content of the second input port must be known in order to produce sensible spectra. In practice, the second port must be placed on a region with minimum emission relative to the target under study.

2. JCMT Observation Scheduling

JCMT observations are defined using the JCMT Observing Tool (JCMT-OT) and then placed in a queue where they are flexibly scheduled based on weather conditions, source availability and priority (see below).



The scheduling system unfortunately does not support scheduling observations on specific dates and times. Indeed, the JCMT-OT only provides the following constraints for defining observations:

- Priority
- Weather band and seeing
- Target Ra/Dec
- Earliest/latest schedule date
- Min/max elevation
- Target rising/setting

The following sections explore how these constraints must be chosen to properly align the FTS-2 ports when observing various typical sources.

3. FTS-2 Observation Case Studies

Three source regions were selected to illustrate typical FTS-2 observation strategies over a range of declinations: Ophiuchus, Orion KL and Taurus. Simulated observations were constrained to night-time observing at source elevations between 30° and 88°. For each source, the centre of one port of the FTS (typically port '1') is used for tracking, and the second port (typically port '2') moves in an arc around the pointing centre. The intensities seen by the pixels in the background port were compared to the corresponding pixels in the source port, and the allowed observing times were defined by when the intensities in the background port pixels corresponding to the region of interest were below a given threshold.

An animation showing how the FTS-2 port rotate over the range of suitable orientations can be found at:

http://research.uleth.ca/scuba2/documents/simulation/orionklanimation.gif.

In this animation, beams that exceed the flux threshold are highlighted in blue.

3.1. Ophiuchus region

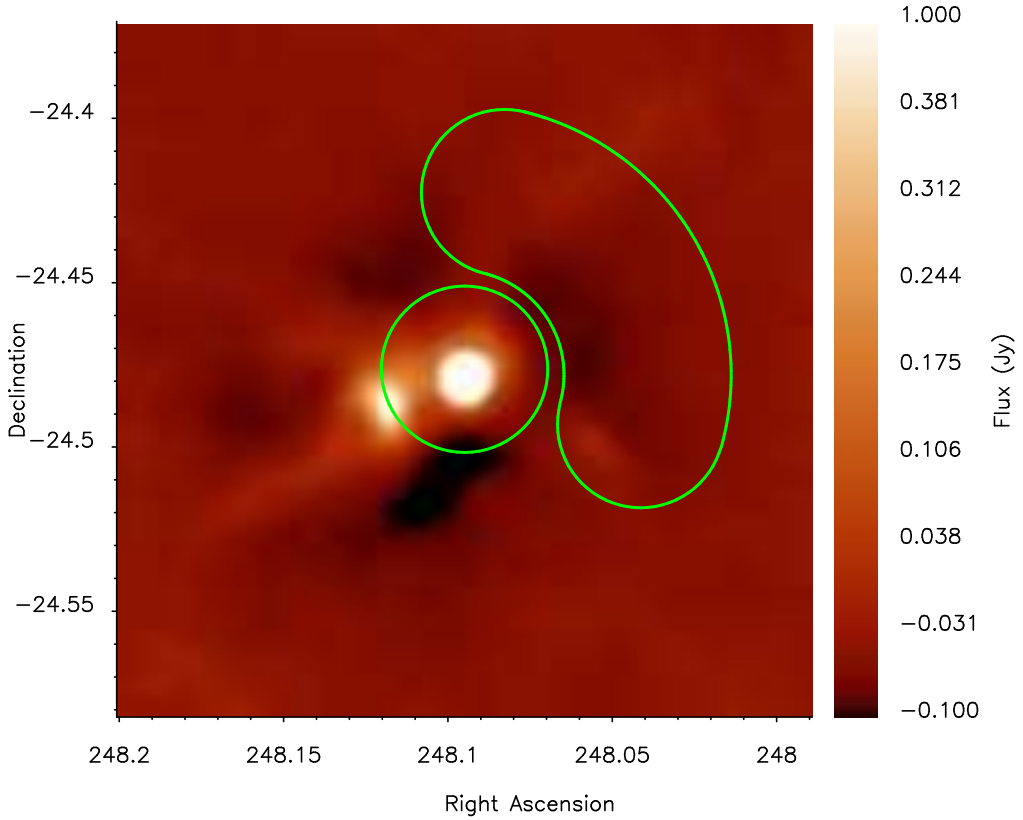


Figure 1. 1629A in the Ophiuchus region. Flux values have been clipped to between -0.1 and 1 Jy.

Right Ascension (hh:mm:ss.ss)	Declination (dd:mm:ss.ss)	Opposition	Peak Intensity (Jy)	Peak Altitude (dd:mm:ss)
16:32:22.982	-24:28:37.89	May 30	9.6	45:41:46

Figure 1 shows the SCUBA image of source 1629A in the Ophiuchus region which is well suited to observations with FTS-2. The green outlines show the extents of a circular field of view (FOV) when the FOV in port 1 is centred on the source. The elongated region represents the area covered by port 2 over all the allowed observation times when the source is above 30°. This source is an ideal candidate since there is relatively little structure in the second port.

The following table lists the scheduling parameters that produce a suitable orientation of the FTS ports on the source and background locations for a given flux threshold for the background pixels and number of pixels in the region of interest (ROI). In general, the observation window for a given source can be extended by reducing the ROI to a smaller subset of pixels at the centre of the port or by accepting a larger flux in the background port.

Table 1. Viewing times for Ophiucus

Source Port	ROI (pixels)	Flux threshold (Jy)	Rising Setting	Min Elev (deg)	Max Elev (deg)	Min LST (hh:mm)	Max LST (hh:mm)	First Viewable Day	Last Viewable Day
1	Full	0.05	N/A	30	Peak	13:48	19:20	Jan 15	Oct 15
2	Full	0.05	N/A	30	Peak	13:48	19:20	Jan 15	Oct 15
1	5x5	0.005	Rising	30.9	Peak	13:52	16:32 [a]	Mar 4	Sept 3
1	5x5	0.005	Setting	45.6	Peak	16:32 [a]	16:36	Jan 22	Aug 28

a) LST equals the source RA

3.2. Orion KL region

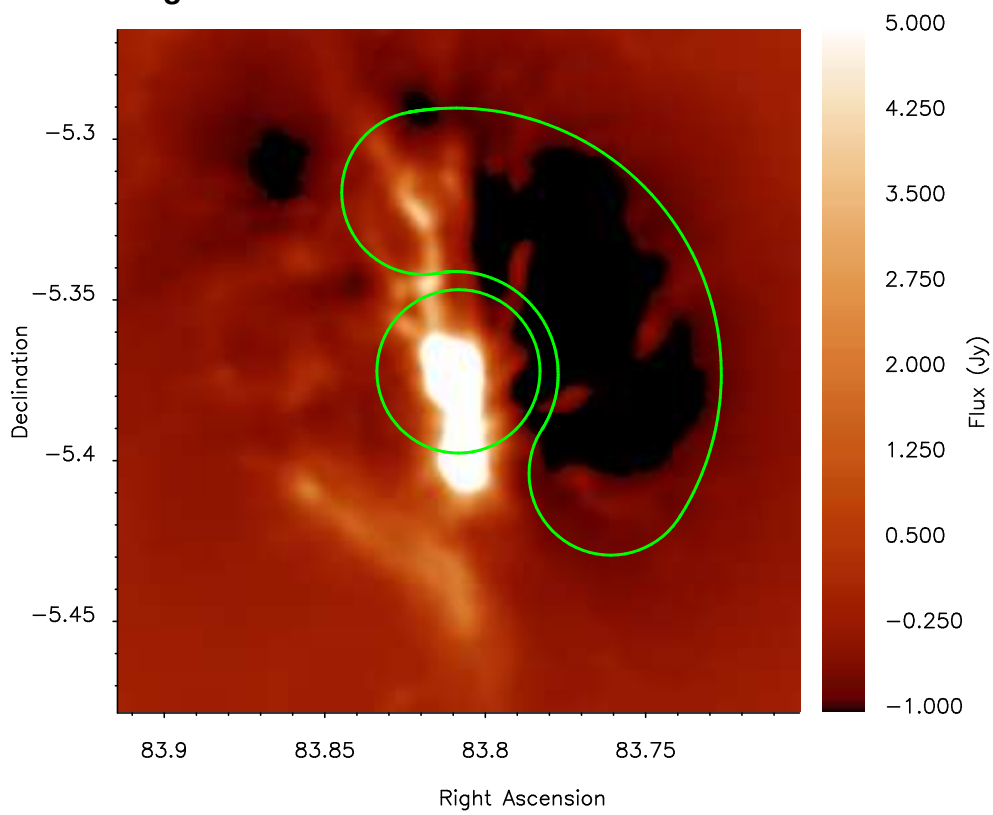


Figure 2. A source in the Orion KL region. Flux values have been clipped to between -1 and 5 Jy.

Right Ascension (hh:mm:ss.ss)	Declination (dd:mm:ss.ss)	Opposition	Peak Intensity (Jy)	Peak Altitude (dd:mm:ss)
05:35:14.1	-05:22:21.5	December 15	118	64:48:02

Orion KL is slightly more difficult to observe since there is structure along the filament as well as to the side. However, since the source intensity is large, it may be acceptable to allow the second port to cover a relatively large area as shown in the figure. The path indicated in the figure corresponds to the full time that the source is above 30 degrees.

Table 2. Viewing times for Orion KL

Source Port	ROI (pixels)	Flux threshold (Jy)	Rising Setting	Min Elev (deg)	Max Elev (deg)	Min LST (hh:mm)	Max LST (hh:mm)	First Viewable Day	Last Viewable Day
1	Full	0.05	Rising	30.0	Peak	01:56	05:32	July 19	March 3
1	Full	0.005	Rising	30.0	Peak	01:56	05:32	July 19	March 3
1	5x5	0.05	Rising	30.0	Peak	01 56	05:35 [a)]	Sept 14	March 13
1	5x5	0.05	Setting	63.5	Peak	05:35 [a)]	06:08	July 21	March 11
1	5x5	0.005	Rising	30	Peak	01:56	05:35 [a)]	Sept 14	March 13
1	5x5	0.005	Setting	63.5	Peak	05:35 [a)]	06:08	July 21	March 11

a) LST equals the source RA.

3.3. Taurus region

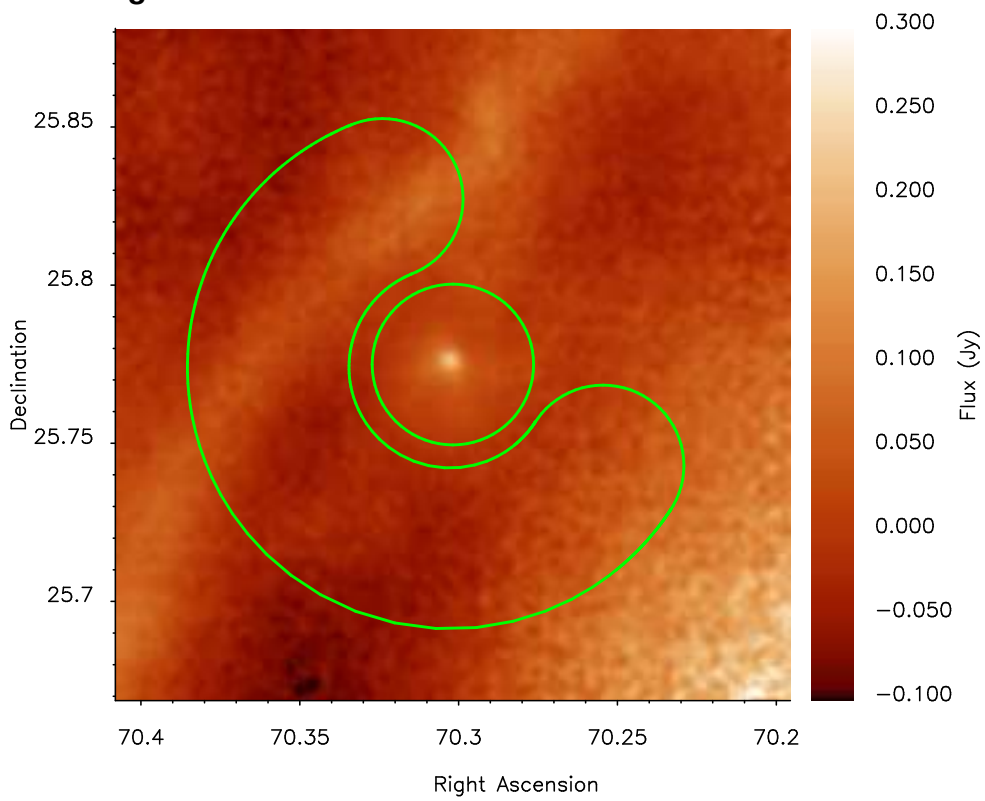


Figure 3. Source TMC 1 in Taurus. Flux values have been clipped to between -0.1 and 0.3 Jy.

Right Ascension (hh:mm:ss.ss)	Declination (dd:mm:ss.ss)	Opposition	Peak Intensity (Jy)	Peak Altitude (dd:mm:ss)
04:41:12.531	25:46:28.11	December 1	0.26	84:03:08

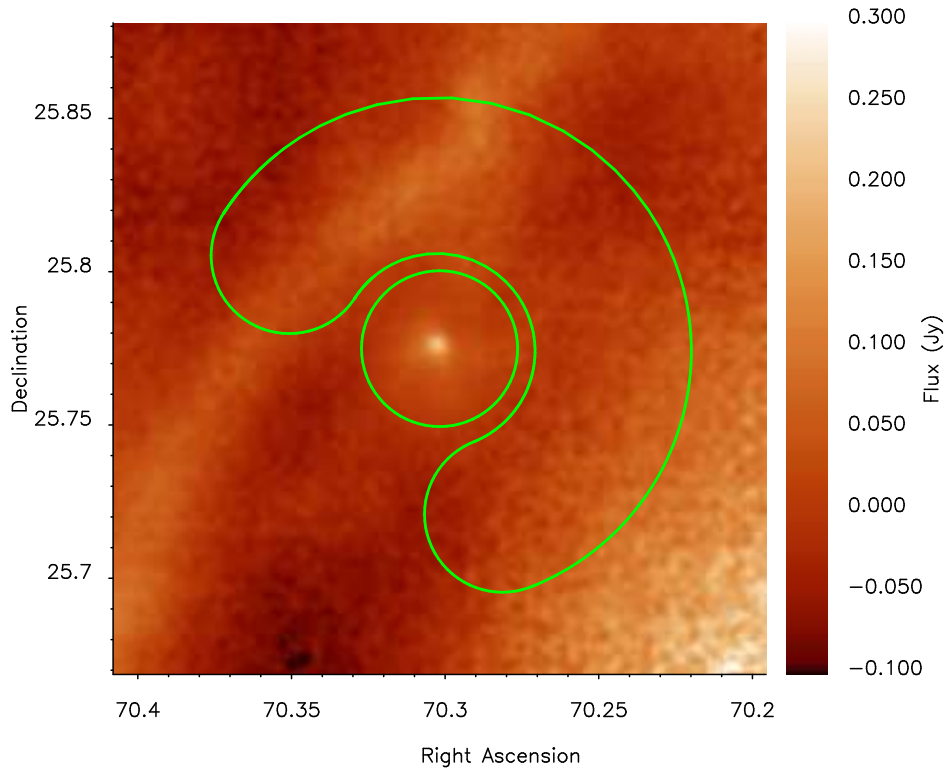


Figure 4. The same source in Taurus, except with port 2 used as the tracking centre.

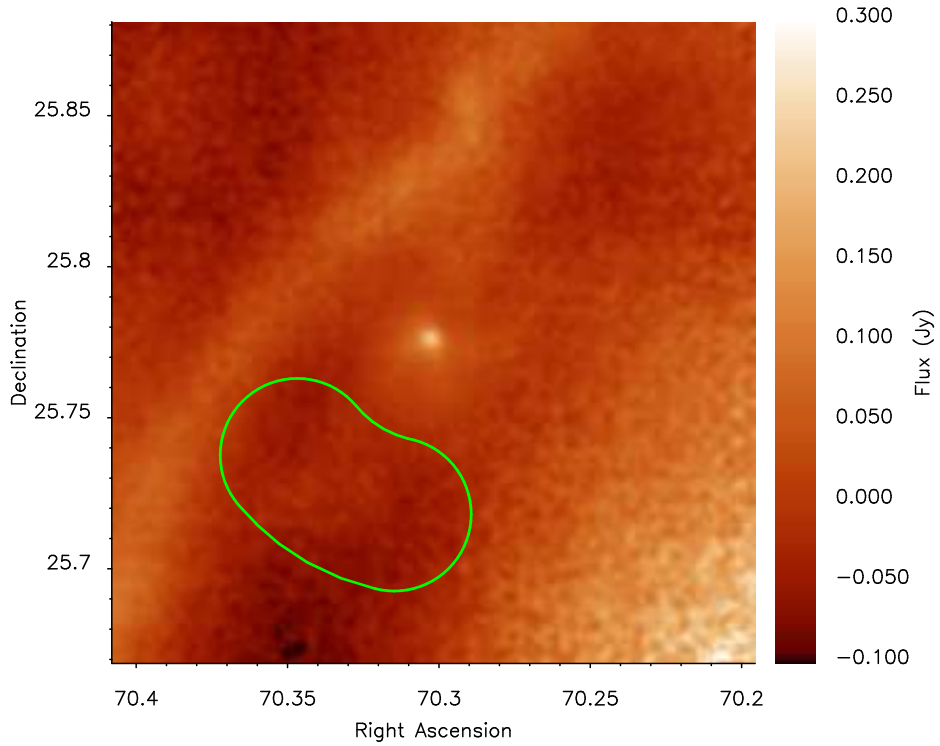


Figure 5. Same source in Taurus, showing the path of the second port with a reduced threshold on allowed flux.

This region is more difficult to observe than Orion KL or Ophiuchus since the background is relatively bright and there is structure on either side of the source. Figure 5 illustrates the small range of suitable positions for the second port if the background structure is to be avoided.

Table 3. Viewing times for Taurus.

Source Port	ROI (pixels)	Flux threshold (Jy)	Rising Setting	Min Elev (deg)	Max Elev (deg)	Min LST (hh mm)	Max LST (hh mm)	First Viewable Day	Last Viewable Day
1	Full	0.005	Setting	82.0	Peak	04:44	05:04	Aug 31	March 1
1	5x5	0.005	Rising	83.9	Peak	04:36	04:41[b)]	Aug 29	March 5
1	5x5	0.005	Setting	79.3	Peak	04:41[b)]	05:20	Aug 29	Feb 23
1	3x3	0.005	Rising	83.9	Peak	04:36	04:41[b)]	Aug 29	March 6
1	3x3	0.005	Setting	78.5	Peak	04:41[b)]	05:24	Aug 29	Feb 23
2[a)]	Full	0.005	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	5x5	0.005	Setting	80.7	82.6	05:00	05:12	Sept 4	March 4
2	3x3	0.005	Setting	80.0	83.1	04:56	05:16	Sept 3	March 5
1	Side 3x4	0.005	Rising	82.8	Peak	04:24	04:41[b)]	Aug 29	March 18
1	Side 3x4	0.005	Setting	68.2	Peak	04:41[b)]	06:12	Aug 28	Feb 23

a) No suitable times exist for this setup.

b) LST equals source RA

As one can see from the first row of the table, the observing window is only 20 minutes if port 1 is used as the tracking centre and the ROI covers the full port FOV. On the other hand, if only the central 5x5 pixels of the port are used then this time window increases to 44 minutes.

Since there is structure in the background on either side of the source, there is no advantage in using port 2 for tracking. However, if the source is centered at a location between the center of the port and the midpoint between the ports, and the ROI is reduced to a 3x4 set of pixels, then the background pixels will rotate around the pointing center with a smaller radius and miss some of the structure in the background. Using this scheme, the time window is further increased to 1 hour and 48 minutes. Under these circumstances it might be desirable to use the off-axis pixels even though the FTS performance is optimized for the central pixels (especially at high spectral resolution).

4. Conclusion

FTS-2 will likely never be used without first planning the port configuration based on existing photometric images. Scheduling FTS-2 observations would be much easier if specific dates/times could be specified, but using the existing parameters in the scheduling system should allow sufficient flexibility in planning observations. Post processing of the data may also be necessary to weight scans more heavily that were taken with the second port in optimal locations.