

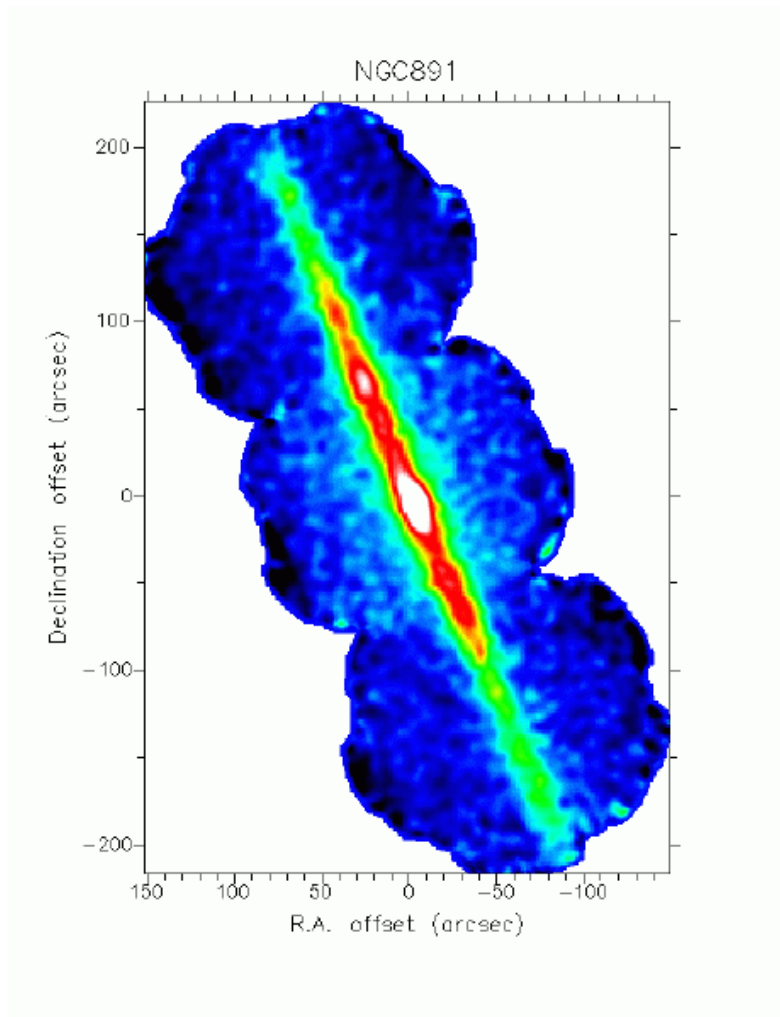
Kulia I Ka Nu'U

The JCMT Newsletter

Number 10



March 1998



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Message from the Director

Text not available at this time.



The People Page

Thomas Lowe has joined the Telescope System Specialist team.

Brian Force has joined the JCMT Receiver Group as a Senior Microwave Engineer.

Jane Greaves has joined the JCMT Receiver Group as the Project Scientist for the SCUBA Polarimeter.

Teresa Dorward has joined the Admin Division.

The following members of staff have left the JAC recently and we would like to extend our thanks and appreciation to each of them for all their hard work on behalf of the JAC, and wish them every success in the future.

Nigel Atkins has returned to the US mainland.

Richard McCarthy has returned to the US mainland.

John White has taken a position with the Gemini team.

INSTRUMENTATION



JCMT Instrumentation Status

The current state of the JCMT instruments, their availability on the telescope and their sensitivities and other observational parameters can always be located on the relevant pages within the JCMT World-Wide Web site:

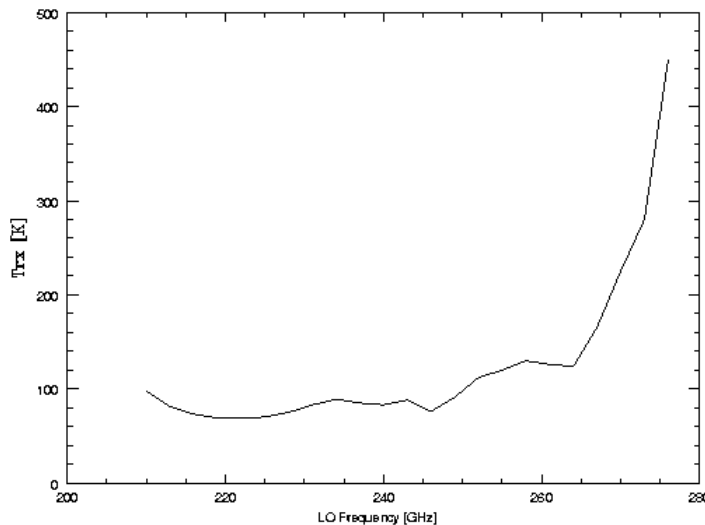


Fact Sheet for the 230 GHz Band

Correct for: February 12, 1997

- This version of the receiver has been installed in the telescope since November 1996.
- Single channel SIS receiver operating in DSB mode.
- Frequency coverage 210 to 265 GHz. It can be tuned up to 275 GHz but with poor performance.
- Predicted zenith system temperatures at 230 GHz. The CSO tau meter gives the zenith opacity at 225 GHz (τ_{225}).

	$\tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.1$	$0.1 < \tau_{225} < 0.2$	$\tau_{225} < 0.5$
T_{sys}	< 300 K	300 K - 350 K	350 K - 450 K	< 800 K



T_{rx} of RxA2 as function of LO frequency

- Efficiencies

η_{beam}	$0.79 - 5.5 \cdot 10^{-3} (v[\text{GHz}] - 200) + 3.9 \cdot 10^{-5} (v[\text{GHz}] - 200)^2 \pm 0.04$
η_{l}	0.91 ± 0.01
η_{fss}	0.80 ± 0.05
η_{A}	$0.78 \eta_{\text{beam}}$
HPBW (arcsec)	$19.52 (245.0 / v[\text{GHz}]) + 0.47 \cos(0.2428 * v[\text{GHz}] + 3.6064) \pm 0.5$

Please address any comments, suggestions or requests to: Per Friberg
friberg@jach.hawaii.edu



News on Receiver B3 (for the 345-GHz Band)

Receiver B3 is a new automated heterodyne receiver for the 345-GHz (0.8-mm wavelength) band. Built mainly at HIA in Ottawa, in collaboration with SRON/University of Groningen in Holland and CCLRC/RAL in the UK, it employs two low-noise Niobium SIS junctions which are normally used to simultaneously detect orthogonally polarised radiation. A dual-beam interferometer allows either single- or double-sideband operation. In the single-sideband mode radiation arriving in one sideband is suppressed; this will therefore be the preferred mode for observing weak lines under most conditions. The double-sideband mode allows creative use of the spectrometer backend for those cases where lines can be observed originating from both sidebands. For such instances note that the sideband separation is 8.0 GHz.

Current status

B3 was first installed in the JCMT cabin early in December 1996. To date commissioning efforts have concentrated on the functionality of the hardware and software and integration with the rest of the JCMT systems.

The receiver optics have been aligned with the optical axis of the telescope, and most instrument parameters have been measured around 345GHz. Tuning of most sections of the receiver is being done automatically, including the Gunn oscillator, multiplier and dual-beam interferometer. These have lookup tables measured (so far) over the Local Oscillator range 332 to 361 GHz (so the range of observing frequencies can be from 328 to 365 GHz).

Currently mixer B is performing reasonably reliably and its performance characteristics are given below. However, the optimum backshort positions for mixer A appear to be less reliable and may be unstable. Consequently the noise temperature values for this mixer given below are likely to be updated at some point in the future.

The final optimisation of the mixer backshorts is done with an ICL procedure, which currently takes ~4 minutes for each mixer.

So far we have tested most normal observing modes, including beam-switching, position-switching (where the baselines appear to be more stable and flat than RxB3i) and slow frequency-switching.

Current performance characteristics

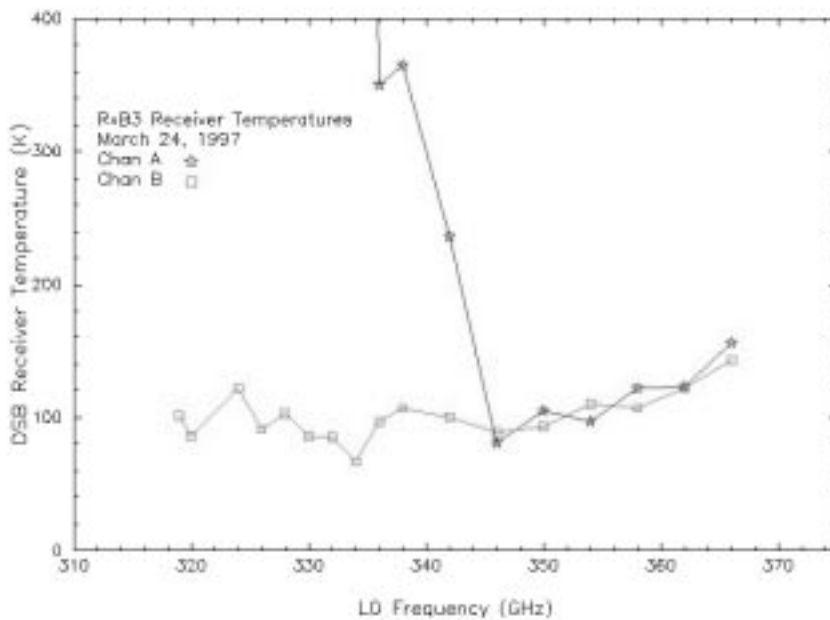
Main beam efficiency, η_{mb} : 0.65 (for Mixer A and B)

Rear spillover, scattering and blocking efficiency, η_{tel} : 0.86 (both mixers)

Forward spillover and scattering: estimated to be 0.7-0.8 (measured on tertiary mirror)

Receiver temperature

The receiver temperatures for Channels A and B as a function of Local Oscillator temperature are shown in the Figure below.



T_{rx} for Channels A and B as a function of Local Oscillator temperature.

Note that the sky frequencies are 4 GHz away from the LO frequency. Mixer B is approximately 80-100 K (DSB). Mixer A is similar to mixer B, although it deteriorates at frequencies below ~335GHz. These values are measured using an external cold load (assumed to have a radiation temperature of 75K). The SSB receiver temperatures are approximately double the DSB values.

System temperature

The following were measured in SSB mode at typical observing elevations (40-70 degrees).

- 'average' conditions (CSO tau ~0.1): 600-800K
- 'good' conditions (CSO tau ~0.04): 300-400K
- 'poor' conditions (CSO tau ~0.15): 800-1000K

The receiver can be used under worse atmospheric conditions than RxB3i because it can be tuned to single sideband; this cuts down the atmospheric contribution to the system temperature as the image sideband from the mixers is dumped in a cold load (at ~40 K).

Beam size

The beam size in both mixers at an LO frequency of 341 GHz is 13.3 ± 0.2 arcsec (fwhm). See Figure 2a (mixer A) and Fig 2b (mixer B) for the beam maps taken on Mars, which had a diameter at the time of 8 arcsec. Contour levels in these maps are 2%, 4%, 8%, 12%... of the peak, and the shaded area represents a 14 arcsec diameter disc.

Mixer A. LO=341GHz. contours=2.4.8.12...

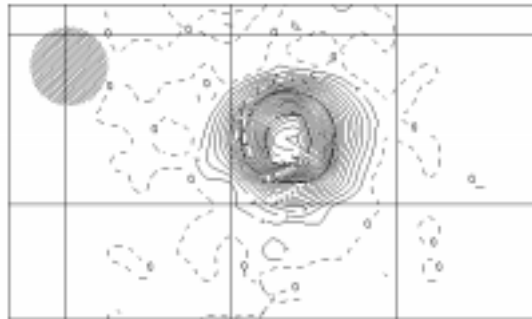


Figure 2a

Mixer B. LO=341GHz. contours=2.4.8.12...%

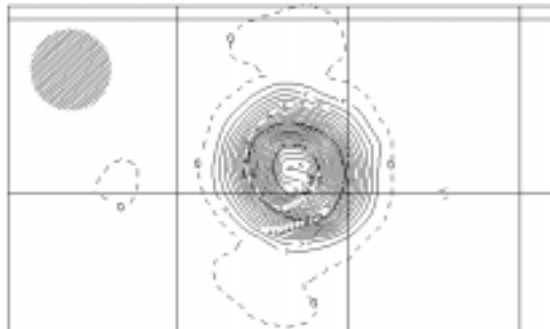


Figure 2b

Bandwidth and resolution

Up to 920 MHz of bandwidth is currently available with the DAS using both mixers. Examples of dual-channel spectra using the 920 MHz mode (averaging both mixers together) are shown in Figure 3 (good atmospheric transmission) and Figure 4 (poor atmospheric transmission).

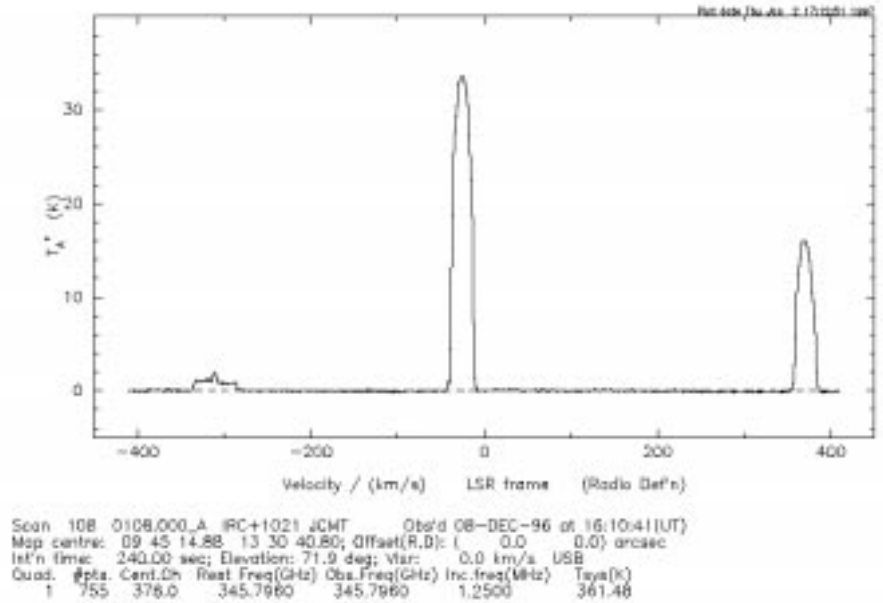


Figure 3

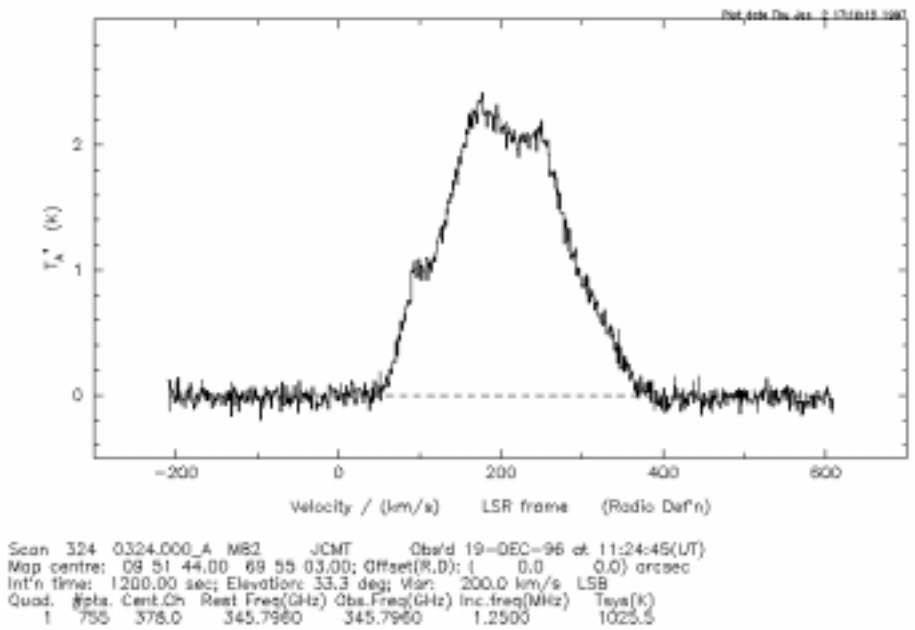


Figure 4

The image sideband suppression in SSB mode is ~11dB, somewhat worse than measured in the lab. at HIA. Some effort will be spent in investigating whether this can be improved.

Note that because of the maximum of 2048 channels in the DAS, the resolution in dual-polarisation mode will be half of that available when only one mixer is being used.

In addition, a wideband mode with 1840 MHz bandwidth can be used with one mixer at a time. This uses both halves of the DAS and splits the signal in the IF Switch. With mixer B, the receiver temperature is near-constant over the whole bandwidth, giving ~1500 km/s of available bandwidth at 345 GHz. A typical spectrum is shown in Figure 5.

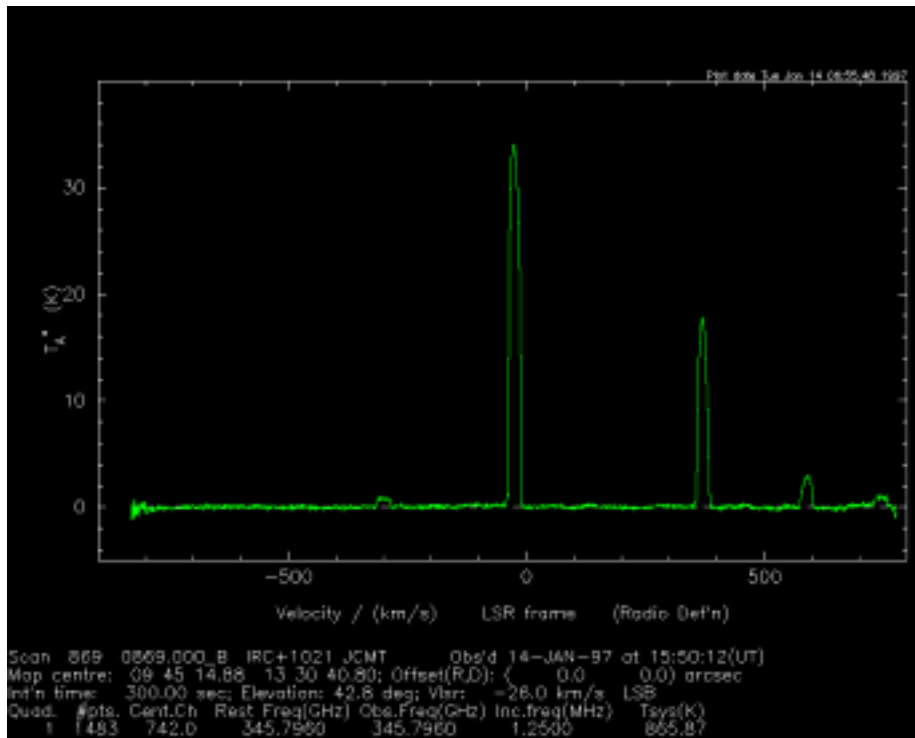


Figure 5

Regarding applications for semester 98B

The receiver is currently performing well, although because of the usual teething problems and generally poor weather in recent times, it is still not fully characterized over all of its substantial parameter space. Owing to the better noise temperatures, the dual-polarisation mixers, and the single-sideband filter, RxB3 should be about a factor of 4-8 faster than RxB3i in required observing time for a given noise level. Also, the available bandwidth is considerably greater than that offered by B3i, and allows the maximum coverage (up to 1800 MHz for one mixer alone) of the spectrometer to be used comfortably.

New information on this receiver will be posted on the instrument Web page as it becomes available.

Please address any comments, suggestions or requests to: Lorne Avery
 lwa@jach.hawaii.edu



Fact Sheet for RxB3i and the 345 GHz Band

- Single channel SIS receiver operating in DSB mode.
- Frequency coverage 300 to 380 GHz.
- Predicted zenith system temperatures at 345 GHz. The CSO tau meter gives the zenith opacity at 225 GHz (τ_{225}).

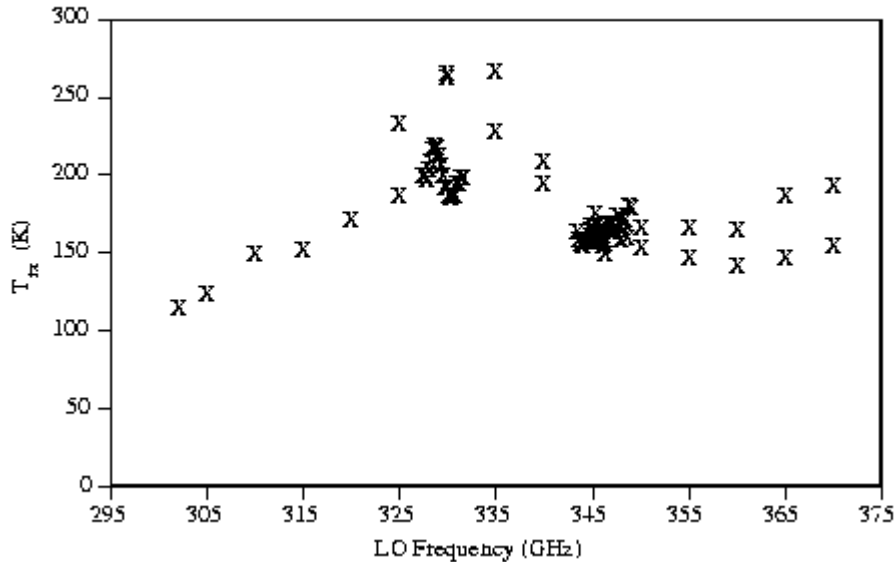
	$\tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.1$	$0.1 < \tau_{225} < 0.15$	$\tau_{225} < 0.25$
T_{sys}	$< 600 \text{ K}$	$600 \text{ K} - 800 \text{ K}$	$800 \text{ K} - 1000 \text{ K}$	$< 1600 \text{ K}$

- Efficiencies

η_{beam}	0.60 ± 0.02 (Jupiter)	0.59 ± 0.03 (Mars)
η_1	0.91 ± 0.02	
η_{fss}	0.7 ± 0.1	
η_{A}	0.41 ± 0.05	
HPBW (arcsec)	$14.3 * (340.0 / \nu[\text{GHz}]) \pm 0.5$	

The present values have applied since May, 1996.

Receiver Noise Temperature



T_{rx} of RxA2 as function of Lo frequency

Please address any comments, suggestions or requests to: Per Friberg
 friberg@jach.hawaii.edu



Fact Sheet for the 460/490 GHz Band

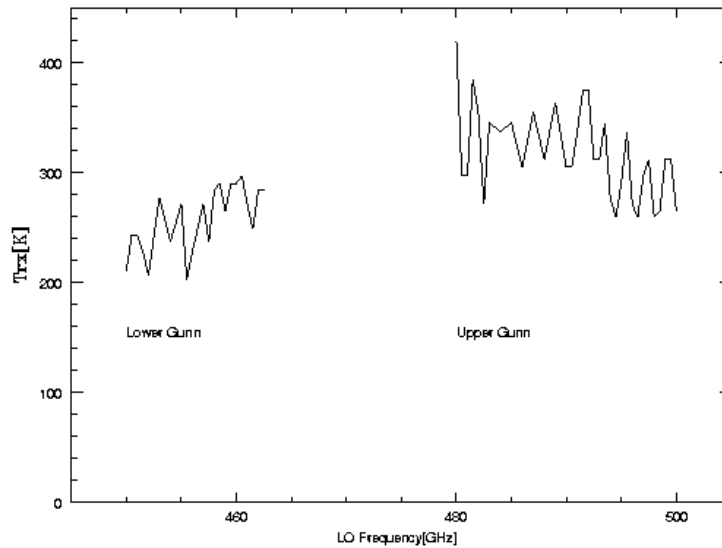
- Single channel SIS receiver operating in DSB mode.
- Frequency coverage 450 to 505 GHz.
- Predicted zenith system temperatures at 462 and 492 GHz. The CSO tau meter gives the zenith opacity at 225 GHz (τ_{225}).

	$\tau_{225} < 0.03$	$0.03 < \tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.075$	$\tau_{225} < 0.1$
$T_{\text{sys}} (462)$	$< 1200 \text{ K}$	1200 K - 1700 K	1700 K - 2600 K	$< 4000 \text{ K}$
$T_{\text{sys}} (492)$	$< 1900 \text{ K}$	1900 K - 3200 K	3200 K - 5700 K	$< 10000 \text{ K}$

- Efficiencies

η_{beam}	0.53 ± 0.05 (Mars)
η_1	0.88 ± 0.03 (462 GHz) and 0.78 ± 0.05 (492 GHz)
η_{fss}	0.7 ± 0.1
η_A	0.42 ± 0.05
HPBW (arcsec)	$10.57 * (475.0 / \nu[\text{GHz}]) \pm 0.5$

- The beam and aperture efficiency will decrease during daytime when the antenna is warmer. Beam efficiencies down to about 0.30 have been recorded at the start of first shift and the end of second shift.
- Due to very limited calibration data obtained in 1997 it is very important that efficiency observations are performed as part of your program.



T_{rx} of RxC2 as function of LO frequency

Please address any comments, suggestions or requests to: Per Friberg
friberg@jach.hawaii.edu



The current SCUBA sensitivities

The current Noise-Equivalent Flux Densities (in mJy/rtHz) per pixel in the SCUBA filter bands are as follows.

Measured sensitivities

Wavelength (microns)	Best NEFD	Average NEFD	Notes
2000	120	120	Remains unchanged from previous measurements
1350	60	60	Remains unchanged
1100	-	-	Not usable at present
850	75	90	Remains unchanged
750	110	140	Better characterised - slight improvement
450	450	700	Remains unchanged
350	1000	1600	Improved by new filter (see note)

Note : New 350 micron filter was installed in November. The new NEFDs are not well characterised, and as with 450 microns, depend very significantly on the dish surface accuracy.

Please address any comments, suggestions or requests to: Wayne Holland
wsh@jach.hawaii.edu



Short Baseline Interferometry

It is anticipated that there will be an opportunity to participate in an SBI run around October/November 1998. The optimum period in which to arrange this 'block' of observations has not yet been decided. Further details on the availability of SBI will be found on the JCMT homepage, and via the e-mail exploder, nearer the event.

Interested applicants are requested to submit their applications by the appropriate deadlines for either JCMT or for CSO. The allocation of a block of time for SBI does depend on scientifically competitive proposals being approved by the time allocation groups for the two telescopes.



RxW

The commissioning dates for RxW are provisionally placed within Semester 98A. Unfortunately, the dates are likely to be after the regular PATT deadline, possibly even after the ITAC meeting which will be awarding time during semester 98B. It will not be possible to accept applications which specifically require the features and sensitivities of the RxW instrument. Therefore the D-band (690 GHz) section is **NOT** available for semester 98B. C-band observations can be

applied for assuming that the project can be completed using the existing RxC2. If, and when, RxW is commissioned, all outstanding C-band applications will be transferred to use the new instrument.



SCUBA

The SCUBA homepage has recently been updated concerning latest developments and information regarding applications for semester 98B.



Applying for observing time in Semester 98B

The next deadline for JCMT applications is 31st March 1998. This note describes some of the technical considerations applicants should be aware of when applying for SCUBA time.

1: General information

As for semester 98A there are again no time restrictions either per source or per proposal. Accepted proposals will most likely be flexibly scheduled in blocks, with designated observers performing the observations. Short programmes, requiring less than a shift (8 hours) will be probably be done in serviced mode, although depending on resources the observations may not be done by JCMT staff, but astronomers from the user's country. International proposals in this category will normally be undertaken by staff astronomers.

2: Which observing modes are available?

There will be four basic observing modes available for semester 98B -

- Photometry
- Jiggle-mapping
- Scan-mapping
- Polarimetry

For observations with the arrays, applications will be accepted for photometry at 450:850 microns simultaneously, 350:750 microns simultaneously, or any combination **separately**. Mapping applications (both jiggle and scan map) will be accepted for 450:850 or 350:750 simultaneously. There is no advantage in asking for maps at individual wavelengths separately since the data at the other wavelength comes automatically. It should be noted, that because of the NEFDs, observations at 350:750 are generally much more time consuming than those at 450:850.

Applications will also be accepted for photometry or mapping with the 2000 and 1350 microns photometric pixels. Although the 1100 micron pixel is currently unavailable, it is hoped that it will be repaired for semester 98B. However, at this stage, proposals should **NOT** rely on this being available. The photometric pixels look out simultaneously but are offset from each other on the sky, so simultaneous photometry is not possible. Mapping is obviously very inefficient with the photometric pixels compared with the arrays, and should be restricted to small areas (i.e. less than about 2 arcminutes square for jiggle-map, and 3-4 arcminutes for scan-map).

3: Current system sensitivities

The current NEFD per pixel remains largely unchanged from the previous announcement, except that some limited observations have shown a noticeable improvement in NEFD at 350 microns (a new filter was installed in late November). The current NEFDs per pixel are shown earlier in this newsletter. These numbers may improve in the near future, particularly at the shortest wavelengths, with an improvement in the dish surface accuracy.

Sensitivity, particularly at the shorter array wavelengths (350 and 450 microns), depends very much on the weather, but also on the elevation of the source. The table of sensitivities indicates the best sensitivity achieved in each filter, i.e. under very good conditions and close to zenith. Also included in the table are figures that we believe are more representative of 'average' conditions. In calculating integration times it is also necessary to take into account the average elevation of the source during the proposed observation.

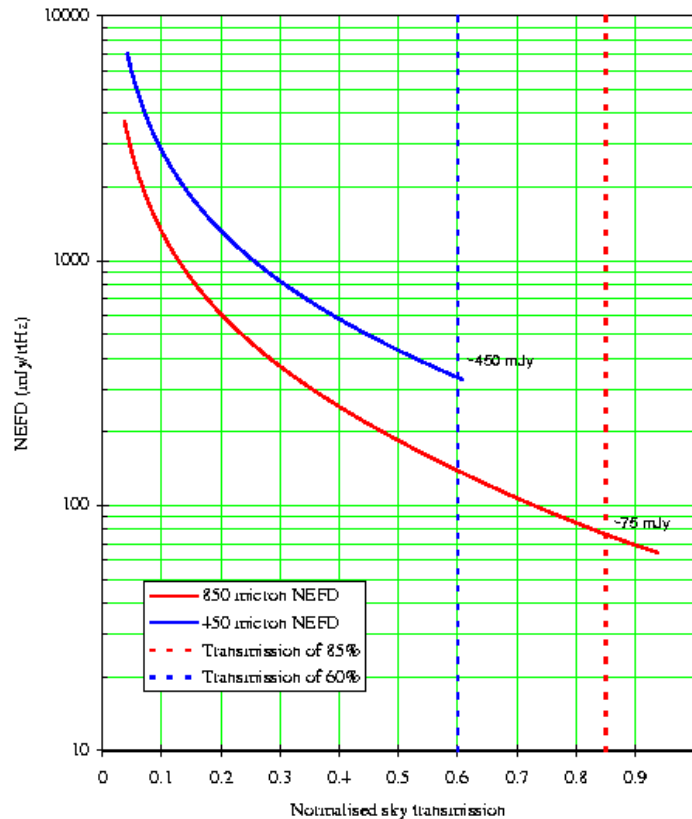


Figure 1

Figure 1 shows a plot of the expected variation of NEFD at 850 and 450 microns with sky transmission, where the sky transmission is simply $\exp(-\tau \cdot \text{airmass})$, and so observing at low elevations on a very good night is equivalent to observing at high elevations on a poor night. The two vertical lines correspond to the best transmissions at 850 microns (0.15) and 450 microns (0.6). For 'average' nights the zenith optical depths (τ) are around 0.22 (850) and 0.8-0.9 (450). The form of the variation for 750 microns is similar to 850, and likewise 350 microns is very similar to 450. For the photometric pixels (1350

and 2000 microns) the variation is essentially ignored, except under very poor conditions.

We have provided a new Web-based observing tool to assist with the calculation of integration times. The Integration Time Calculator can be accessed on the Web and more details are given in section 5 below.

4: Which observing mode to use?

It may seem an obvious statement, but the observing mode you choose depends on precisely what you want to do!

* **Photometry** - If you have a completely isolated point source, with a known accurate position, then the **photometry** mode is your best bet. If you want 850 micron photometry then 450 comes for free (even if you don't detect it at 450), and similarly, 350 microns comes for free with 750. However, if you suspect your source might be slightly extended, OR you are interested in the field around your source, OR your position isn't very reliable, then you should almost certainly take a map.

* **Jiggle mapping** - When it comes to mapping there are two basic options: jiggle-mapping and scan (or raster) mapping. **Jiggle mapping** is the preferred mode for sources that are smaller than the array field-of-view. Limited mosaicing of jiggle maps is also possible, although care must be taken to avoid chopping onto extended emission. To obtain a fully-sampled map using the jiggle method requires taking data at 16 positions (see Figure 2). Therefore, the sensitivity per sampled point is 1/4 that of a point-source observation for the same integration time. However, this is only true if you wish to retain the full spatial resolution of the map. On many occasions you are most likely interested in the total flux of an object (eg. an unresolved core in a map), and in such cases you can afford to bin pixels (i.e. degrade the resolution) in order to gain signal-to-noise.

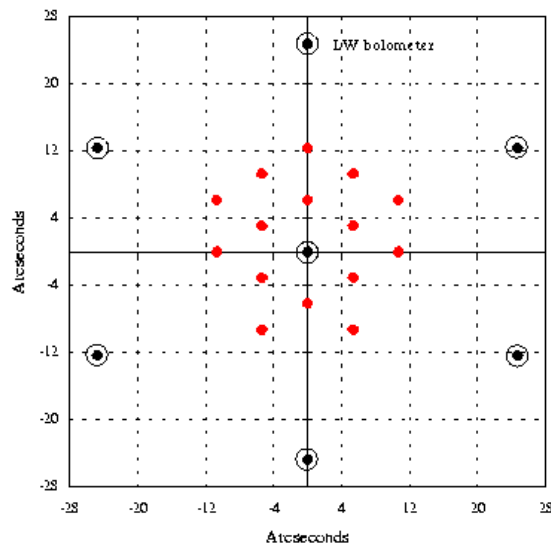


Figure 2: Jiggle 16 mapping

For example, for a perfectly pointed observation a calculation using the measured SCUBA beam profiles suggests that if you add together the signals

measured on a point source over the 16 positions (1 second at each) of a jiggle-map, we would get a S/N approximately 3 times worse than if we'd simply sat on the peak for 16 seconds. In reality, there is always a residual pointing error for stare photometry, plus the effects of seeing to take into account, and tests during commissioning have shown that under good conditions the S/N on a point source is 2 - 2.3 times lower with a jiggle map than with photometry. If the seeing is poor, OR if the source is slightly extended, then the difference is smaller, and the two modes may even be comparable. In such circumstances it may be better to take a fully-sampled map rather than photometry. **However, it should be pointed out that by binning pixels together you are degrading the resolution of your map.**

* **Scan mapping** - The **scan-map** mode is the preferred mode for sources that are bigger than the array, and works particularly well for sources in confused regions. This mode works in a similar way to the old 'on-the-fly' raster mapping with UKT14, but, of course, we have an array rather than a single pixel. The telescope moves the array in a raster pattern across the source, and as with jiggle-mapping, integrations can be coadded to improve the S/N. As the telescope is scanning the secondary mirror is also chopping and measures the difference in signal between two points a short distance apart (typically 30-60 arcseconds). Full image sampling along the scan direction is achieved by adjusting the scan rate and sampling frequency. One demodulated data sample is obtained for each cycle of the secondary chopper, so if the chop frequency is 7.8125 Hz (as currently used for scan map), a 3 arcseconds spacing (to produce fully-sampled maps at 450 and 850 microns) will be produced by a scan rate of 24 arcsec/second. We arrange the direction of the scan such that the bolometer rows cross the region at an angle shown in Figure 3, so that one single scan fully samples the map area. The black dots represent the bolometer positions for the Long-Wave array, and the slight distortion from a true hexagon shape is because of field curvature caused by the SCUBA optics. This technique has the disadvantage that it fixes the angle of the scan on the sky, so we cannot expect to scan in azimuth. Although sky rotation has a minimal effect on the sampling for each scan across the map area, it may cause the edges of successive maps not to butt together correctly. There is no real cure for this in the current system, so we allow a substantial overlap of the array between scans and between maps.

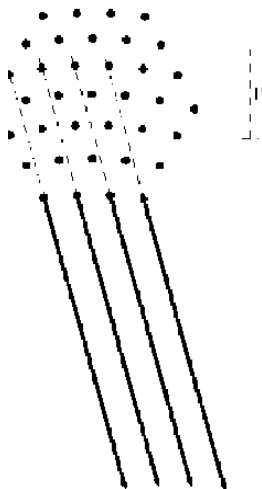


Figure 3

Recently, we have adopted a new method for acquiring scan map data, known (locally) as the 'Emerson2' technique. This method is described in detail by Jenness et al. (SPIE Vol. **3357**, 1998, in press). The technique reduces the severity of some of the problems associated with the traditional EKH restoration, and results in a significant improvement in S/N. It is not necessary to know exactly how this new method works to write your proposals, but if you are interested please refer to the link on the Web page. An effective method of removing sky noise from scan map data is currently under development and should be available for semester 98B.

One obvious question that one may ask concerns the relative merits of jiggle and scan map for particular types of observation. If you have a source smaller than the array field of view, and are confident of chopping onto 'blank' sky, then jiggle map is almost always the preferred mode. It is fair to say (and we have proven this empirically) that if you used both observing modes to map, say, a 8 arcminute long edge-on galaxy (where the width of the galaxy is < 1 arcminute), then mosaicing jiggle maps will almost certainly always give a lower noise level for the same effective integration time. This is most likely due to residual low-level noise from the restoration of scan map data. This may change as we become more experienced in the use of the scan map observing mode. However, for large, roughly circularly-symmetric sources (bigger than the field of view), or sources in confused regions, then scan map is probably your best bet.

* **Polarimetry** - The SCUBA polarimeter was successfully commissioned in October 1997, and will be offered again in Semester 98B. Observations can be made at all SCUBA wavelengths, using either the 'array' waveplate (350-850 microns) or the 'photometric' waveplate (1350,2000).

The polarimeter operates in 'step-and-integrate' mode, in which photometry is carried out at each of a number (10 or 16) of equally-spaced waveplate positions between 0 and 360 degrees. The amplitude and phase of the resulting sinusoidal modulation of the photometric signal can be used to deduce the Stokes parameters of the source, and subsequently the degree of linear polarisation and position angle. For each source position this waveplate cycle can be repeated a number of times to improve the statistical estimation of the polarisation parameters. Since 'step-and-integrate' polarimetry relies on obtaining good S/N photometry, the observations with the polarimeter are subject to the same problems resulting from atmospheric noise that affect normal SCUBA observations. A cycle of the waveplate is usually a compromise between spending long enough at each waveplate position to obtain good photometry, and completing the cycle in sufficiently short time to render changes in sky transparency and emission negligible.

Note that changing the waveplate is time-consuming, so you should not plan to do this during an observing shift. For the arrays, data will be obtained from all bolometers, but proposals should request to use NO MORE than the inner 7 pixels of the long-wavelength array (and/or the 7 on the short-wavelength array). It is advantageous to use the outer pixels for sky noise subtraction, so sources should be compact - less than 1.5 arcmin across. Full imaging polarimetry is NOT offered this semester, and proposals to observe more extended regions should be postponed until semester 99A.

These limitations arise because (a) reduction software for imaging polarimetry is not yet available, and (b) instrumental polarization data is only available for a few pixels. Data will have to be reduced by the observer on a 'point-by-point' basis. (Reduction software and its documentation will be supplied by the JAC.) A modified 'jiggle' technique can be used to obtain data at beamwidth spacings, but note that this increases the observing time by the number of

pointings used. For example, at 850 microns, 4 pointings are needed for beamwidth sampling.



The SCUBA Polarimeter

For more details, including a report on the October 1997 commissioning, please go to the SCUBA Polarimeter WebPage.

5: Calculating integration times

Calculating integration times for the various SCUBA observing modes has never been easier! We now have an Integration Time Calculator (ITC) available on the Web for use in writing proposals. The following sections detail the calculations included in the ITC, as well as containing some examples.

(i) Photometry

For photometry the rms noise (in mJy) after t seconds is simply $NEFD/\sqrt{t}$.

As an example, consider we have a point-like source that we think is around 50 mJy at 850 microns (the flux estimate may have come from an extrapolation from other wavelengths). We would like, say a 10-sigma detection on this source, and so the integration time required is :

$$t = \left[\frac{NEFD}{F} \right]^2 \sigma^2$$

where F is the estimated source flux (in mJy) and σ is the signal-to-noise ratio . So, using the 'average NEFD' of 90 mJy at 850 microns (the ITC will allow a more accurate value to be used), means that we would require 324 seconds to give a 10-sigma detection.

Similarly we can invert the above equation, and find that in one-hour integration time we should reach a rms noise level (1-sigma) of 1.5 mJy/pixel. In 8 hours (i.e. one-shift of telescope time) we can expect to achieve close to 0.5 mJy. A table of the sensitivity limits (1-sigma) for the average achievable NEFDs is given below for 350, 450, 850 and 1350 microns.

When carrying out photometry using one of the array wavelengths, it is possible to chop between 2 bolometers on the array. This would mean that no time is

'wasted' looking at blank sky during the chop cycle. This has still not been tested extensively, although it has been used in semester 97B. It is available for semester 98B with some caveats.

Wavelength (μm)	NEFD ($\text{mJy}/\sqrt{\text{Hz}}$)	1-hr (mJy)	10-hrs (mJy)	25-hrs (mJy)
350	1600	27	8.4	5.3
450	700	12	3.7	2.3
850	90	1.5	0.5	0.3
1350	60	1.0	0.3	0.2

Table of SCUBA sensitivity limits

Such a refinement should theoretically gain you a factor of 2 in integration time (or 1.414 in noise). However, the chop will most likely not be in azimuth, since the bolometers are arranged in a hexagon. Further complications arise because of the field curvature aberration caused by the SCUBA optics. This means that while chopping between 2 bolometers works fine, chopping between 3 bolometers as required for the full nod cycle, does not work properly (since the bolometers do not lie on a straight line). From the (very) limited tests we have performed so far the improvement in noise is more like a factor of 25-30% on a single chop cycle. Applicants are asked NOT to include this potential gain in their calculations, *unless it is absolutely essential to make the programme feasible*. In addition, if this mode is deemed suitable to a particular programme by the JCMT support staff, then it may be used to improve the S/N.

(ii) Jiggle mapping

As mentioned above jiggle mapping requires taking data at 16 positions to produce a fully-sampled map.

Therefore, in this case the time estimate for a fully-sampled map is:

$$t = 16 \left[\frac{NEFD}{F} \right]^2 \sigma^2$$

When we use both arrays simultaneously we adopt a 64 position jiggle pattern (see Figure 4). This is usually split into 4 sets of 16, and after each 16 jiggles (each jiggle takes one second) the telescope is nodded. However, the integration time calculation is still the same, since we sample at around 3 arcsecs. This ensures that we cover the same area between the LW array bolometers, at the resolution required by the SW array (since the spacing of the SW bolometers is about half that of the LW). So at 850 microns we are effectively oversampling by a factor of 4.

As an example, consider a map of say a 1 arcminute core, which we again estimate has a peak flux of about 50 mJy. We would again like 10-sigma on the peak and so using the above equation we would require an integration time of 1.44 hrs, or obviously 16 times longer than our point-source photometry. Again, as mentioned in section 3, if you are intending to bin pixels (i.e. degrade resolution) then the factor of 16 in the above equation can be dropped to around 4-5.

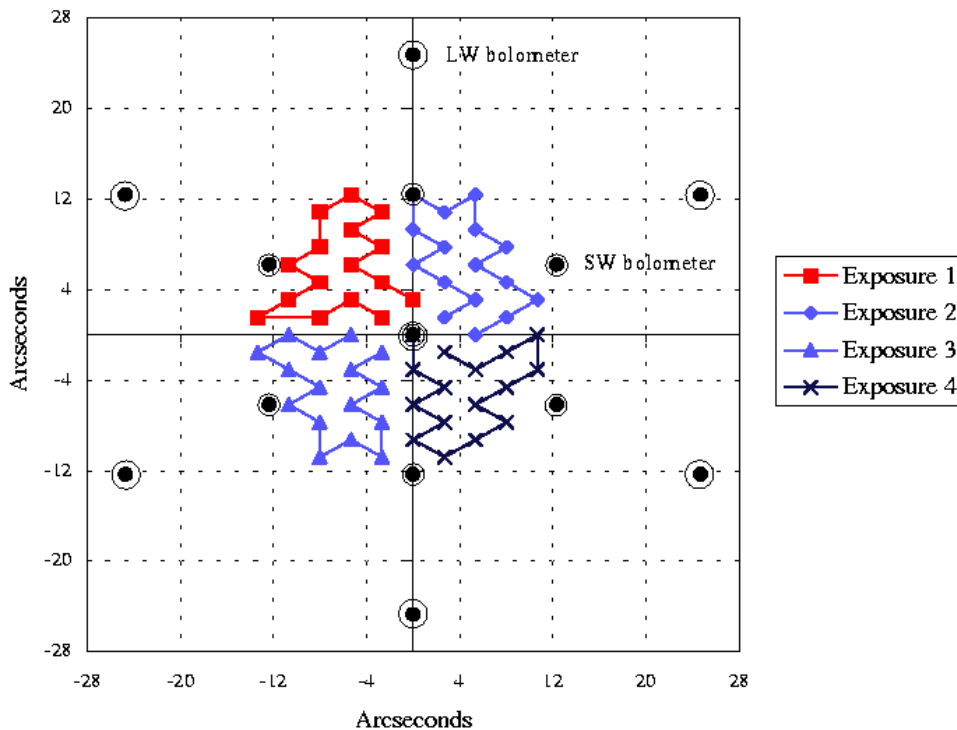


Figure 4: A 64 position jiggle pattern.

(iii) Scan mapping

Scan mapping is a relatively new mode for SCUBA, and we are continually improving the efficiency (eg. by cutting down on the overheads - see section 6). The following equation has been found to work satisfactorily for estimating scan map integration times:

$$t = \frac{(x+L)W}{d^2N} \left(\frac{NEFD}{F} \right)^2 \sigma^2$$

where L is the length of the map in the scan direction (in arcseconds), W is the width (arcseconds), d is the pixel resolution required (arcseconds), and N is the number of array elements. To ensure that we produce a fully-sampled map of the selected area we conservatively allow an overlap of half the array diameter at the beginning and end of each scan. Hence there is a factor, x (equal to 138 arcseconds) which needs to be added to the length of a scan.

Consider an example: Suppose we wish to scan-map a 10 x 10 arcminute region, with the default 3 arcsecond sampling. The brightest source in the image is

estimated to be about 300 mJy at 850 microns, and we would like at least 10-sigma on this peak. Using an NEFD of 90 mJy/rHz, the above equation gives an integration time of 3.3 hr. However, you have to remember that in sampling at 3 arcseconds we are effectively oversampling by a factor of 4 at 850 microns, and so a scan map to produce an rms noise level of 30 mJy would therefore take about 0.8 hr (plus overheads, as discussed in section 6). Depending on the spectrum of your source you might do better or worse (usually worse!) at 450 microns. For example, if the source described above had a ν -squared spectrum the signal-to-noise at 450 microns (NEFD of 700 mJy) would only be around 3.5 for the same integration time.

(iv) Polarimetry

The default mode for carrying out polarimetry observations will be the 'step-and-integrate' technique (similar to the way that the UKT14 polarimeter used to operate).

To obtain a polarisation signal-to-noise, σ_{pol} , for a source of flux, F , it is necessary to integrate for the following time:

$$t = 18 \left[\frac{NEFD \cdot \sigma_{pol}}{p \cdot F} \right]^2$$

where p is the expected percentage polarisation level. This equation assumes that 16 waveplate positions will be used in the data acquisition, which was generally the preferred mode of taking data with the old UKT14 polarimeter. The equation also includes losses in transmission due to the wire grid and waveplate itself. A full derivation of this expression is available on the Web.

Consider a couple of examples: Suppose we have a 1 Jy protostar, for which we estimate a polarisation level of about 2%. To obtain a 5-sigma detection, at 850 microns, under average conditions would take about 2.5 hrs. Now consider a 0.2 Jy blazar, which may be typically 5% polarised. To obtain a 5-sigma detection at 1350 microns would take about 4.5 hrs.

6: Estimating overheads

Although we have made significant progress in reducing some software overheads, there are still substantial overheads to be added to the above integration times for *all observing modes*. There are two types of overheads: 'observational overheads' which are associated with the setup and carrying out of a particular observation, and 'calibration overheads', which includes pointing, focussing, slewing, skydips and other calibration (eg. beam maps). The ITC now calculates the observational overheads for you.

For 'observational overheads' here are a few examples: A 10 minute on-source photometry observation currently take about 15 minutes in total, i.e. an overhead of 50%. If your programme consists of photometry observations of this type (or even shorter integration times), then the total overhead, to include calibration and slew times, should be more like 100%. So for every 4 hours applied for, you should add another 4 hours to the time requested.

For jiggle mapping, it again depends on the length of the observation, but typically one might map for a longer time eg. 30-60 minutes at a time (if the weather allows). A 40 minute jiggle map typically takes about 52 minutes total time, and so the overhead is only about 30% (this is mainly because the time between nods is longer than for photometry). You should probably add another 50% for calibration, giving a total overhead of closer to 80%.

Scan mapping still has a large observational overhead which we are hoping to improve. At the present time we estimate that this will be something like 50% for semester 98B proposals. Again, an additional 50% for calibration should be added, giving a total overhead of approximately 100%.

For polarimetry the overheads involved in moving the waveplate are quite high. Calibration is not so critical in polarimetry (unless you are trying to measure the source flux as well as the polarisation level!), and so the overall overheads are likely to be around 100% again.

Good luck with your proposals! Please address any queries to Wayne Holland
wsh@jach.hawaii.edu



Secondary Calibrators for SCUBA

Source	Photometry / 64-point jiggle maps 850	450	Pointing maps 850
CRL618	4.57 ± 0.21(24)	11.9 ± 1.9(22)	Phot
	4.56 ± 0.17(25)	11.2 ± 1.4(18)	Maps 4.67 ± 0.32(28)
CRL2688	5.88 ± 0.22(6)	24.8 ± 2.4(6)	Phot
	5.93 ± 0.39(12)	23.2 ± 1.9(12)	Maps 6.14 ± 0.25(7)
HL Tau	2.32 ± 0.11(8)	10.4 ± 1.4(6)	Phot
	2.34 ± 0.15(13)	9.7 ± 1.1(13)	Maps 2.28 ± 0.15(25)*
IRC+10216	6.12 ± 0.19(15)	13.1 ± 1.8(13)	Phot
	6.07(1)	12.9(1)	Map 6.12 ± 0.32(12)
16293-2422	16.3 ± 10%	78.1 ± 20%	Maps
OH231.8	No data yet reduced, but can be used as a calibrator		

* - all 850 map data added to pointing set.

Recently planets are unavailable for calibration of SCUBA data. We have therefore selected a sub-set of calibrators used for UKT14 (Sandell, 1994, MNRAS, **271**, 75). This subset is chosen from sources that are compact, non-variable, and located in regions free from confusing background emission. We also added HL Tau as a new secondary calibrator, because the star is unresolved and isolated, i.e. it has no surrounding cloud emission.

However, because these selection criteria left us without calibrators in the whole LST range from 9 - 17 hours, we have added IRC+10216 and 16293-2422 to the list. **IRC+10216** is variable (period ~ 635 days) and also extended at 850 micron, because of its unusually large and bright CO envelope, but can be observed without problems with a chop throw of 60" or larger. **16293-2422** is a young bright protostellar binary in Ophiuchus, surrounded by rather extended dust emission and a second cloud core about 80" west. The source is elliptical, especially at 450 micron, and should not be used as a pointing source.

Note: if used for photometry and map calibration, I recommend that 16293-2422 be observed with a chop of 60" or larger at a position angle of 30 degrees (a north-south, i.e. chop in Declination is acceptable but 30 degrees preferred).

The Table above lists the results of SCUBA observations that we have obtained so far. Note that calibration with SCUBA has only been attempted at 850/450 micron. For other filters we still have to rely on old UKT14 data. In the Table I have kept photometry and map calibration separate, but for these sources the results should be the same, which is indeed supported by the results in the table. For the larger data sets I believe the true errors may be close to the quoted errors (one standard deviation from the mean). For small data sets the quoted errors are simply too optimistic, and should perhaps be doubled. All flux densities in the table below are given in Jy/beam. The number of data points used for the mean and rms of each flux density is given in parenthesis. The last Table heading, Pointing maps, refers to calibrated pointing observations (16-point jiggle maps), which are expected to be identical to other calibrated maps.

Goeran Sandell, February 1998



SCUBA Polarimeter

The SCUBA Polarimeter will be offered again in Semester 98B. Observations can be made at all SCUBA wavelengths, using either the 'array' waveplate (350-850) or the 'photometric' waveplate (1350,2000). Note that changing the waveplate is time-consuming, so you should not plan to do this during an observing shift. It is expected that data will be obtainable with the full arrays, but that instrumental polarization data will only be available for a few central pixels. Also, the reduction software for imaging polarimetry is still being developed. Programmes should therefore be restricted to compact sources (covering < 10 pixels) which can be analysed on a point-by-point basis.

Further information on the polarimeter can be found on the webpage:

<http://www.jach.hawaii.edu/JCMT/scuba/scupol>

PATT INFORMATION



PATT Application Deadline

Deadlines for receipt of JCMT applications for semester 98B are:

for UK, Canadian, Netherlands and International applications:

31st March 1998

ALL applications have the same deadline for this semester.

Please read the next article - Special Notes for 98B Applicants before filling in your application forms for the forth-coming semester.

To ensure prompt processing, please ensure that your applications are sent to the correct establishment. Applications for JCMT time should be submitted to the national TAG of the Principal Investigator (PI) or, if the PI is not from one of the 3 partners, to the national TAG of the first named co- investigator on the application who is from one of the partners. International applications (those with no applicants from one of the partners) should be submitted to the PATT Secretariat at PPARC, Swindon. Members of the JAC staff in Hawaii count as International unless they are the PI on an application, when it should be forwarded to the appropriate national TAG.

Country paying salary of Principal Investigator

Canada	Netherlands	UK or International
Director-General's Office, National Research Council of Canada, 5071 West Saanich Road, Victoria, BC, CANADA V8X 4M6	Dr. J. M. van der Hulst, Kapteyn Astronomical Inst., Postbus 800, NL-9700 AV Groningen, NETHERLANDS	PATT Secretariat, PPARC, Polaris House, Swindon, SN2 1ET, UNITED KINGDOM



Special Notes for 98B Applicants

The deadline for ALL applications for semester 98B (August 1st 1998 through January 31st 1999) is **31st March 1998**.

All applications must arrive at their appropriate collection point by midnight on March 31st. These will be processed for the ITAC meeting to be held with the other PATT facilities in early June.

The Latex template application form (the regular PATT3 variety) can be downloaded from the JCMT homepage on the Web. An explanation of how to classify applications into UK, Canadian, Netherlands or International, the correct number of copies required, and the correct addresses of the collecting points can also be found on the Web. Electronic submissions will be most welcome in the case of Netherlands and Canadian applications. These electronic applications should be sent to their national collection point.

UK and International applications may be submitted electronically to the JAC beginning with this semester. Please read the next section for further details.

INSTRUMENTS AVAILABLE

The current status of RxA2, RxB3, RxC2 and SCUBA can be found on the Web. These instruments will be available throughout the semester.

RxW is scheduled to be commissioned on the telescope at some point during Semester 98A. This may be too late to be able to provide any parameters prior to the ITAC meeting and therefore applications should not request RxW. More specifically, any C-band applications allocated time for RxC2 will automatically be given RxW time should the C-band commissioning proceed successfully. There cannot be any D-band requests for semester 98B.

It is anticipated that there will be an SBI run around October/November 1998. Applications should be sent in as normal by the appropriate JCMT and CSO deadlines. The instruments available will be only RxA2, RxB3 and RxC2, not RxW.



Electronic Submission

UK - for the first time the JCMT is experimenting with expanding the electronic system that is a modified version of the HST submission procedures. This worked extremely well collecting the International applications for semester 98A. However, please bear with us during this expansion phase when we just from collecting and collating 20 applications to dealing with 100 applications. Fear not, however we experiment, your submissions will not be lost! See below for further details.

CN - HIA, Victoria has the ability to accept electronic submissions. Please refer to local information about formats.

NL - these applications are routinely collected electronically at University of Groningen for processing. They are FTP'ed to JAC. Please refer to local information about formats.

Int - we will continue experimenting with the electronic system that is a modified version of the HST submission procedures. Please bear with us during this phase since we have now included the UK applications into the system. Fear not, however we experiment, your submissions will not be lost! See below for further details.

UK and International Electronic Submission

1. to obtain the most recent JCMT application template, send an email to jcmtprop@jach.hawaii.edu with the phrase 'request templates' as the Subject. Any following text will be ignored. All necessary files will be emailed back to you. The PATT3 template has been slightly modified from the version used for semester 98A so please obtain a new one to complete.
2. complete the Latex template as instructed in the header section. There are only minor modifications to this template from the one that you have already

been using. These changes are necessary because, at some later date, we intend to automatically parse the returned file to generate the tables and files that the TAGs require.

3. email the completed Latex template back to 'jcmtprop'. You are also required to submit a Postscript version of your application. Each submission will be acknowledged with a number and several people here will be informed of its arrival.
4. if you do not wish to play with the electronic system, you may still, for this semester, submit your hard copies through the usual route to PATT Secretariat in Swindon, UK. However, we would like to encourage you to try out this system.



PATT ITAC Report for Semester 98A

1. Introduction

This document details the allocations for telescope time made by the ITAC for the semester 98A (1st February 1998 - 31st July 1998).

2. Allocations

The individual partner TAGs hold meetings in their respective countries prior to the PATT session to assess applications deemed by the JCMT Board rule to be from their own country. At these meetings informal numbers of shifts are nominated for each application in a priority order. The Chairpersons of each TAG bring their respective lists to the PATT where the ITAC combine the awards, include discussion of the engineering and commissioning requirements, and assess the International applications. The final allocations of shifts are made by the ITAC.

Applications considered

UK status [#]	81
Canadian status [#]	46
Netherlands status	21
International status	22
University of Hawaii	8
TOTAL:	178

two UK & one Canadian carry-overs have not been included in this total.

The PATT meeting was held at the Leofric Hotel, Coventry, UK on 3rd & 4th December 1997.

It should be noted that if the PI on an application is a JCMT staff member based in Hilo, then the application is assessed by the appropriate national TAG. However, by Board rule, International status is given to any application where the only named collaborator from any partner country is a JCMT staff member. International applications are assessed by the ITAC members at their meeting.

Time Available (in 16-hour nights)

No. of nights in semester 98A	181.0
Engineering & Commissioning	31.5
University of Hawaii (10%)	14.5
Director's discretionary use	4.0
Available for PATT science:	131.0

The above table indicates the order in which nights are removed from the total available for the semester. The table below indicates the allocations using the JCMT Board formula for attributing applications to countries.

Awards (in 16-hour nights)

UK status	62.7
Canadian status	25.7
Netherlands status	20.6
International status	22.0
University of Hawaii	14.5
TOTAL allocation:	145.5

3. Designated Service time

Allocations for this semester are:

CDN = 5.0 shifts allocated (with 1.25 shifts designated as CNflex);
NL = 0 shifts allocated (with up to 4 shifts in the Nlflex fallback program);
UK = 0 shifts allocated (with up to 7 shifts in the Ukflex fallback program);
INT = 0 shifts allocated (with 0.25 shifts designated as INTflex).

4. Non-standard Instrumentation

The University of Lethbridge FTS system was allocated time in several applications and is scheduled for late May. There was insufficient interferometry time requested to implement an SBI session with CSO this semester.

Instrument distribution

A-band	11%
B-band	17%
C-band	1%
FTS	2%
SCUBA	69%

5. Applications with Long-Term Status

L/M/97B/U65 was given a further 9 shifts in 98A to complete observations of the Hubble Deep Field. L/M/97B/U46 was given 7 shifts in 98A to continue observations of IRAS Bright Galaxy Survey sources and CFA Redshift Survey objects. The student thesis project, M/Y/C05 was also awarded a further 1 shift which should conclude this project.

6. Short Baseline Interferometry

Due to the small amount of time requested for SBI observations, it was not felt practical to organise an SBI session for this semester.

7. Engineering & Commissioning

Commissioning of the antenna and instrumentation continues, with periods required a) to characterise and improve the surface via metrology and beam map measures, b) to monitor the antenna performance and tracking through pointing and inclinometry runs, and c) to measure receiver performances and efficiencies.

Time has been allocated for commissioning of RxA3i, and for RxW according to the commissioning plans made available by the instrument builders.

8. Fallback Programmes

A number of applications have been approved by the ITAC to be included in the schedule should any of the instrumentation fail to meet their delivery schedules. The commissioning time set aside for these instruments will be apportioned according to the partner funding ratio after 10% has been given to the University of Hawaii. Applicants on these fallback programmes will be informed by the JCMT Scheduler when/if their time is to be scheduled.

9. The UKflex System

The UK TAG actually only allocated time to 104.5 shifts of its final allocation of 136 shifts. The outstanding 31.5 shifts were designated as UKflex time. A selection of heterodyne A- and B-band applications, together with SCUBA applications not requiring very stringent weather conditions, with high scientific ratings were placed on the UKflex list in priority order and with a nominal time allocation. The intention is that each high-frequency allocation be extended by a shift or two of UKflex time thus increasing the chance of obtaining suitable weather to complete the high-frequency program. Under weather conditions unsuitable for the high-frequency observing, the current observers or staff scientist would undertake observations from the UKflex list in serviced mode in priority order. Successful applicants on the UKflex list have been informed that they have to submit complete templates for their observations but that there is no guarantee that any part of their program will be done during the semester.

10. Electronic Submission

Various electronic submission procedures have been tried at other PATT facilities with varying degrees of success. Due to the international status, and because there are currently 3 different collection locations for applications to the JCMT, we have so far kept out of these experiments.

The Netherlands already implement a very successful electronic submission scheme. For the current semester 97B round all Netherlands applications were accepted electronically and made available to Hawaii via FTP. The Canadian community is encouraged to submit electronically and, although the numbers are increasing, the majority of applications are still sent as hardcopy.

A system has now been setup in Hawaii that resembles the HST electronic submission procedures. This software suite is under licence from the STScI. For semester 98A, International applicants were encouraged to submit their proposals directly to a designated account at the JAC. This trial was extremely successful then it will be expanded for semester 98B to include the UK community. The JCMT

application template (PATT3) will be modified for use by ALL applicants so that the JAC staff can link to the Canadian and Netherlands schemes.

11. Procedures for Semester 98B

The deadline for for semester 98B (1st July 1998 through 31st January 1999) applications is 31st March 1998 for ALL applicants. This deadline encompasses applications for all available instrumentation on the JCMT (RxA2, RxB3, RxC2, SCUBA, and the SCUBA single-pixel polarimeter). There is also likely to be an SBI run during the semester. It is not possible to apply for features specific to either RxA3i or to RxW (ie: no D-band observations) since these instruments may not have been commissioned prior to the ITAC meeting in early June.

STATISTICS



Weather and Fault Statistics

The following tables present the weather loss and fault loss for semester 97B. A more detailed description of how these tables are created is attached below.

Month	Avail	Extend	Primary	%	Backup	%
	Hrs	Hrs	Loss		Loss	
August	496.0	29.3	13.0	2.6	6.0	1.2
September	472.0	18.1	64.5	13.7	50.5	10.7
October	488.0	12.7	50.2	10.3	50.2	10.3
November	480.0	19.0	116.0	24.2	98.5	20.5
December	456.0	16.3	0.0	0.0	0.0	0.0
January	488.0	42.0	34.0	7.0	32.0	6.6
Total	2880.0	137.4	277.7	9.6	237.2	8.2

Table 1: *JCMT weather statistics.*

Month	Avail	Total	ANT	INS	COMP	SOFT	CAR	OTH
August	496.0	28.9	0.1	14.7	10.4	2.4	0.0	1.3
September	472.0	20.2	0.7	14.4	1.6	2.5	0.0	1.1
October	488.0	59.7	5.2	43.1	2.8	8.1	0.6	0.0
November	480.0	21.3	0.2	14.9	3.5	2.4	0.0	0.3
December	456.0	64.3	0.5	55.9	0.0	7.0	0.0	0.9
January	488.0	74.9	5.1	44.1	0.0	2.2	0.0	23.6
P(hrs)	2880.0	269.3	11.8	187.1	18.3	24.6	0.6	27.2
B(hrs)		13.0	0.0	1.3	0.0	0.0	0.0	11.8

Table 2: *JCMT fault statistics. Wherever possible the faults are categorised into ANT = antenna; INS = instrument; COMP = computer hardware; SOFT = software; CAR = carousel; with the remainder going to OTH = other. The figures in the table may not appear to add up correctly due to rounding in the original program. P defines the time lost from Primary projects. The category B(hrs) is the time lost to Backup projects.*



Derivation of Statistical Information

This note provides some explanation on the method of production of the weather and fault statistical summary for the performance of the JCMT. There is very little manual intervention in the generation of these tables, other than to correct obvious errors, mis-labelled categories, or to complete missing entries (where they can be found from other sources).

The data are extracted from the reports completed by the telescope operators at the end of their shift, one report for each shift (evening or morning); the shifts are normally of 8 hours duration. Because the change-over of TOs does not

occur on the shift boundaries, the shift information is handed over to the following operator who will file the report at the end of shift.

A completely separate fault reporting system is used by the TOs and other staff to record time lost to faults (including problems which have zero-time lost). This system is used by the staff to identify, trouble-shoot and solve the faults. Each fault should then have an appropriate solve report attached for future reference. This system is not used for generating statistics.

Input from the TO reports comprises

- the actual time scheduled (normally 8 hours);
- any extension of this (normally due to good weather and lack of pressing daywork);
- loss of time on primary and backup programs due to the weather.;

NB : in flexible observing mode, the move from a high-frequency primary program to a low-frequency primary program because of a deterioration of the weather conditions does not result in any entry in the 'loss to the primary program' category.

- loss of time to primary and backup programs due to faults, divided into 6 categories : ANTenna, CARousel, INSTRuments, COMputer, SOFTware, and OTHer. These categorizations are performed by the TO at the time of filing and persist in the analysis, although suggested changes in categories are suggested by the notes to the analysis.

NB : faults are defined as being in respect of subsystems that have been commissioned are therefore expected to work flawlessly. If the instrument under commissioning has a fault, this is not recorded in the log.

NB : previous correlations between faults as reported in these TO reports and via the separate fault reporting system show high levels of completeness. A similar correlation is also found between the TO reports and any completed Observer Reports for the period.

- automated retrieval of weather conditions for the shift in question. These are not analysed further and are not further correlated with the reported conditions.

Electronic submission of each report automatically triggers the summary analysis program (AUTO_STATS) for the month and semester to date, and the statistics reported to the JCMT Board and in the Annual Report are essentially these results.

The analysis performed by AUTO_STATS may be repeated following identification and correction of spurious entries, or significant errors in categorization.

Occasionally reports are not filed on time, and missing reports can seldom be reconstructed.

TECHNICAL NOTES



The UKService Program

All administrative duties associated with UKServ have now migrated to the JAC and are under the control of Iain Coulson. UK applications should now be sent to jcmtserv@jach.hawaii.edu

All other enquires should be directed to Iain (imc@jach.hawaii.edu).

Further information and a blank template may be found on the UKService webpage.

SCIENCE HIGHLIGHTS



3-D Visualisation of JCMT Data

Heterodyne receivers on the JCMT generate data which are naturally represented as 'data cubes': three-dimensional grids of points where two axes correspond to positions on the sky (or more accurately positions on the celestial sphere projected on to a plane in some fashion) and the third axis to frequency, usually displayed as velocity. It is difficult to display data cubes using conventional techniques. For example, SPECX can display data cubes as a collection of small contour maps, laid out on a grid, with each contour map corresponding to a different position on the velocity axis. However, even with this technique it is difficult to gain an impression of the overall structure in the cube.

In recent years a number of special-purpose 'visualisation packages' have been developed, some as commercial products, others in the public domain. Displaying data cubes is one of the major functions of these packages and they contain powerful and sophisticated facilities for doing so. Data cubes can be shown as animations (or 'movies') showing a slice moving through the cube or alternatively as iso-surfaces (the three-dimensional analogue of contours). The viewing direction, magnification and colour table can all be manipulated.

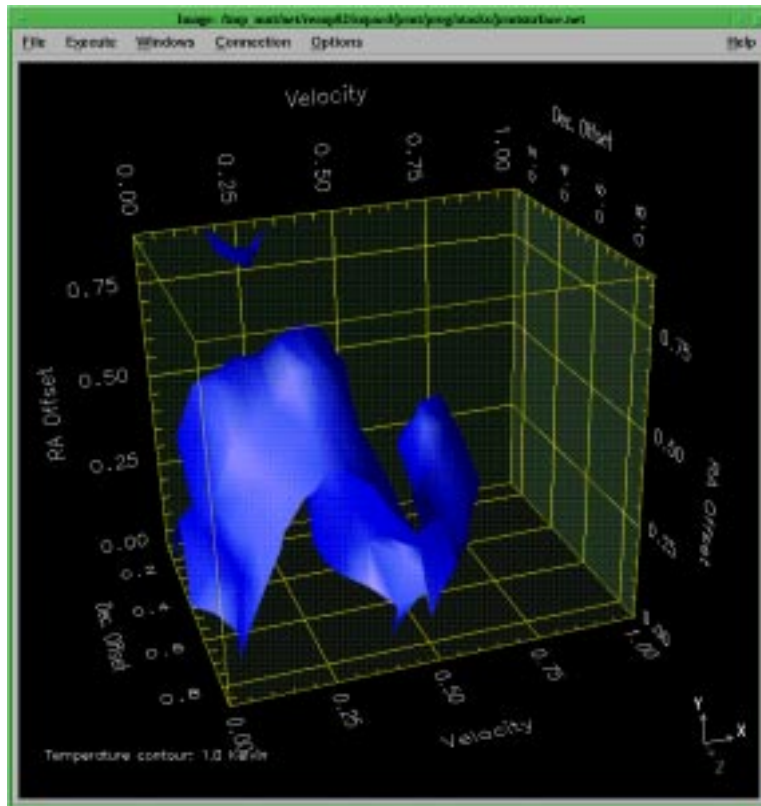


Figure 1: JCMT CO spectral line map iso-surface of the S106 molecular cloud. Note the two peaks separated in velocity.

The visualisation package recommended by Starlink is Data Explorer (DX), a commercial package from IBM. A number of Starlink sites have bought it, mainly for use in displaying numerical simulations.

Recently Starlink has done some work to facilitate visualising JCMT data cubes with DX. A new application has been written to convert JCMT data cubes into a format which can be imported into DX. **specx2ndf** converts a SPECX map file into a standard Starlink NDF (N-Dimensional Data Format) data cube. It is quite a sophisticated application which allows the dispersion axis to be expressed as either a frequency or as a radial velocity about the rest frequency of the line relative to one of a number of standards of rest. Once the data cubes have been converted to NDF format they can be imported into DX, as well as being accessible to various other Starlink packages, such as KAPPA (see SUN/95). **specx2ndf** has been added to CONVERT (see SUN/55), a package which contains applications for converting between various different formats. Additionally SC/2, **The DX Cookbook**, has been enhanced to include complete recipes for converting, importing and displaying JCMT data cubes. Simple visual programs ('networks' in the jargon of DX) for visualising the cubes are available with the Cookbook.

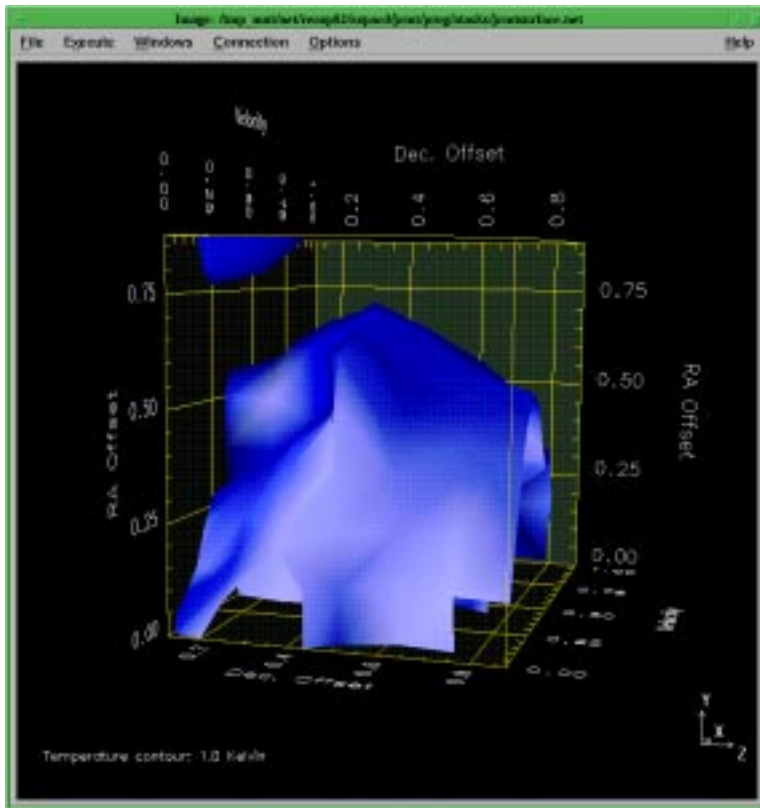


Figure 2: The same iso-surface as in Figure 1, but viewed from an angle roughly 'orthogonal' to that in Figure 1. The second peak is no longer visible.

Figure 1 shows a single iso-surface (or three-dimensional contour) in a JCMT data cube. These data are an observation of emission from the C180 $J = 2 - 1$ transition in the molecular cloud S106. The iso-surface contour level corresponds to a brightness temperature of 1K. The cube is viewed so that velocity increases from left to right, Right Ascension increases from bottom to

top, and Declination increases 'into' the page (the units of the axes have all been normalised to run in a range from 0 to 1 for ease of viewing, but any values can be chosen). When viewed from this 'angle', the cloud can be seen to contain two main peaks, separated in velocity space, with the secondary smaller peak showing up at a higher velocity than the main peak.

Figure 2 shows the same iso-surface from a different angle, orthogonal to the first. Now Declination runs from left to right, Right Ascension still runs from bottom to top, and velocity increases into the page. This view is closer to the traditional two-dimensional rendering of an image of a molecular cloud. The secondary peak is obscured by the main peak and the velocity detail has been lost somewhat.

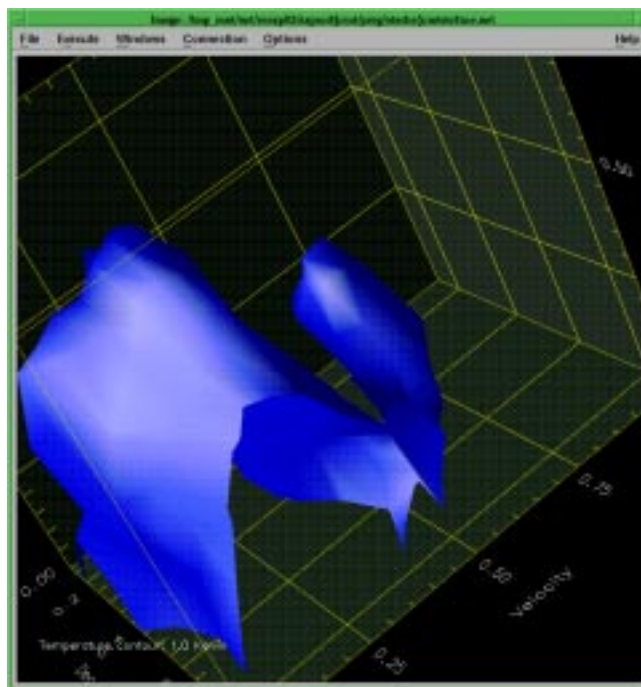


Figure 3: *The same iso-surface as in Figure 1, but viewed from an angle somewhat 'above' that in Figure 1, and 'zoomed' in. The second peak is clearly visible.*

Figure 3 shows the same iso-surface from a different angle again; similar to that in Figure 1, but zoomed in to discern the second peak more clearly, and seen from slightly 'above' the viewing angle of Figure 1. The second peak can be seen at a different velocity from the major part of the cloud emission, and hence is probably at a different distance to the main cloud. This example is very simple, but is meant merely to illustrate how DX can be used to inspect structure in JCMT spectral line maps. These Figures are just examples of the types of visualisations which can be produced with DX. It is straightforward to write DX networks to produce visualisations tailored to your own requirements.

Finding out more

DX is not available at all sites. The use of DX on Starlink systems is documented in SUN/203 and SC/2. There is a general introduction to scientific visualisation, not specific to any particular package, in SG/8. The CONVERT

package is described in SUN/55. Starlink software is available via the World Wide Web, and DX may be purchased direct from IBM.

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Bow shock entrainment in the W75N molecular outflow

With recent CO observations - obtained by Gerald Moriarty-Schieven through the service/flexible observing programme at the JCMT - we have searched for extensive outflow activity associated with a number of luminous young stars. Here we report on some striking new observations of the massive molecular outflow associated with W75N. Prior to our observing run at JCMT, wide-field near-IR images obtained at the Calar Alto observatory revealed extensive bow shocks equidistant, though on opposite sides of, the well-known, luminous cluster of massive young stars in W75N. However, it is the CO $J = 3-2$ observations which illustrate the full history of the flow, and our comparison of the two datasets which reveal the true nature of this source.

In Fig.1 we show contours of the integrated high-velocity blue-shifted (dashed lines) and red-shifted (full lines) gas in the W75N outflow. Although the blue lobe appears only as a compact peak coincident with the central core region (and presumably the outflow source) the red lobe extends almost 150 arcsecs (1.5 pc) to the southwest (note the rotated frame coordinates in the figure), stretching as far as the 'bow shock' observed in molecular hydrogen 2.122 micron emission. Indeed, the CO outflow lobe fits snugly within the curve of the bow shock. The flow lobe and bow are seemingly intimately related. In fact, W75N represents perhaps the best example yet discovered of 'bow shock entrainment', a model invoked to explain how collimated optical/Herbig-Haro jets may power massive molecular (CO) outflows. In this case, it seems likely that much of the observed high-velocity CO was swept up by the bow shock, the bow itself being driven by an 'unseen' collimated jet. Comparison of these data with numerical simulations

of jet-driven outflows certainly looks promising (the data and interpretation are discussed in detail in a paper recently submitted to MNRAS; Davis, Smith & Moriarty-Schieven 1998).

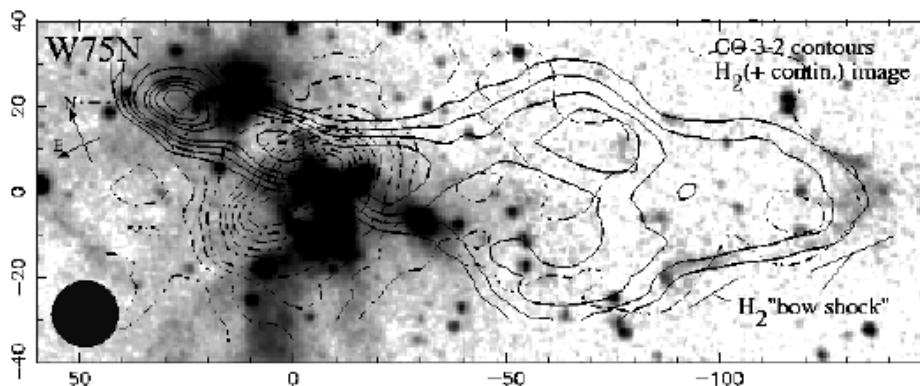


Figure 1: CO 3-2 integrated intensity map of the molecular outflow associated with W75N, superimposed onto a narrow-band H₂ (+ continuum) image of the region. The luminous source that drives this flow appears as a dark, nebulous patch in the image at the (0,0) position. The red lobe of the outflow (full contours) extends to the SW; note the orientation of N and E at left. The features labelled 'bow shock' are not evident in our continuum image of the region and are therefore thought to be the near-IR counterpart of a Herbig-Haro object.

Chris Davis, Joint Astronomy Centre



RAS Discussion Meeting Abstract: The Distribution of Dust in Nearby Spiral Galaxies

ABSTRACT

We present 450 micron and 850 micron continuum images of the nearby edge-on galaxy NGC 281. Our data are sufficiently sensitive (1 sigma of 13 mJy/beam and 3.5 mJy/beam at 450 microns and 850 microns respectively) to trace submm dust emission from 2/3 of the optical disk and also to detect dust 'chimneys' escaping from the main absorption layer up to z-heights of 2kpc. At both 450 microns and 850 microns, peak emission is associated with the nucleus but there are also 2 bright secondary maxima, one on either side of the nucleus, which probably constitute the limb of a ring with radius 4 kpc.

The submm emission resembles the distribution of molecular gas rather than that of the atomic hydrogen. A comparison between the major axis profile at 850 microns with the corresponding profile at 60 microns (IRAS HiRes data) implies that cold dust, rather than warm grains, predominates at larger radii.

Paul Alton, Simone Bianchi & Jon Davies (University of Wales, Cardiff), Richard Rand (University of New Mexico) & Manolis Xilouris (University of Crete)



RAS Discussion meeting Abstract: SCUBA and Star Formation

ABSTRACT

The understanding of low-mass star formation has made significant progress in recent years. Spectroscopic observations have detected infall in Class 0 protostars. Much current interest centres around the pre-stellar stage, which is defined as the phase in which a gravitationally bound core has formed in a molecular cloud, but no central hydrostatic protostar exists yet within the core. The significance of pre-stellar cores is that they constrain the initial conditions of protostellar collapse. We have previously shown that some pre-stellar cores have flat inner radial density profiles, and showed that this may be consistent with a mechanism for magnetic support, with evolution by ambipolar diffusion.

We have studied 44 of the starless cores from the list of Myers' ammonia cores and found 850-micron SCUBA detections of roughly half of them. Our study sample appears complete down to a central number density level of 10^4 cm^{-3} , while our detections seem to correspond to densities above 10^5 cm^{-3} . At this level we appear to detect more cores with SCUBA than would be predicted by simple ambipolar diffusion models. Hence one of the assumptions of the models may have to be revised, such as departure from cylindrical symmetry. Alternatively it is possible that significant turbulent velocity fields within the pre-stellar cores may be preventing collapse.

Derek Ward-Thompson, ROE



JAC Internal Science Seminars

All visiting astronomers are encouraged to give scientific presentations to the JAC staff after their observing run. In addition, many of the JAC staff give presentation on their current research topics.

The seminars are organised by Gerald Moriarty-Schieven (gms@jach.hawaii.edu).

A list of those given during 1997 can be viewed at:

<http://www.jach.hawaii.edu/~gms/seminars/1997.html>

A list of those given to date and arranged for the future during 1998 can be viewed at:

<http://www.jach.hawaii.edu/~gms/seminars/1998.html>



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NEXT ISSUE DEADLINE

The absolute deadline for submission of science and/or technical articles for the next issue of this Newsletter is **31st July 1998**. All communications regarding this Newsletter should be sent via email to **gdw@jach.hawaii.edu**.



Acknowledgements

The JCMT Newsletter is the official publication of the James Clerk Maxwell Telescope. These issues are ONLY available in html format on the World Wide Web. There is no paper magazine that corresponds to these pages. This is taken to be a sign of the times, where most, if not all, of the readership has access to an internet terminal. It means that the information presented can be made more up-to-date. Notice that several of the articles now refer directly to other links on the Web both internal to JCMT and on the odd occasion to external sites. It also means that the rapidly dwindling cash supply available for printing booklets can be channeled into other worthy causes.

Contributions are solicited from recent observers, instrument builders and from the staff at the Joint Astronomy Centre.

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Graeme