BANDWIDTH SYNTHESIS ON THE COMPACT ARRAY

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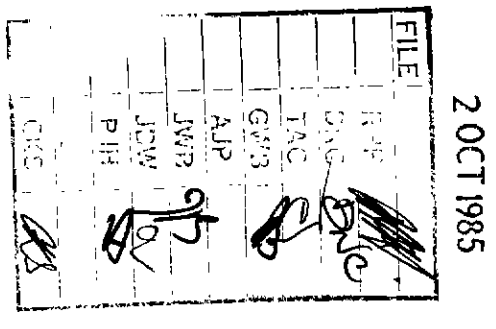
The effect of bandwidth synthesis on the performance of the Compact Array (CA) of the AT has been simulated for both 3 and 6km maximum baselines. The intention is to draw attention to the advantages of bandwidth synthesis as a means of improving the effective U-V coverage, especially for the 6km array. Clearly this technique can only be used for improvement of contiuum maps. For spectral-line maps there is no alternative to increasing the number of physical baselines.

The simulations were made using the ARRAY program developed for the CA configuration studies (AT/10.1/036). The test source SPIRAL (Fig. 1) was mapped using four-day configurations for both the 3km and 6km arrays. For the 6km array, two configurations were tested, one where both stations (at spacing increments 392 and 388) for the 6km antenna were used, and one where the 6km antenna remained at the end (392) station. U-V plots for the three trial arrays are shown in Fig. 2. Comparison of Figs 2b and 2c shows that movement of the 6km antenna has little effect in a four-day synthesis. This is because only one of the stations on the 3km track is used more than once. Substantial benefits from moving the 6km antenna are only obtained in syntheses of eight days or more.

A centre frequency of 1.6 GHz and IF bandwidth of 64 MHz were assumed. System noise was added but no gain or phase errors were added. Maps made with a single fixed RF band are compared with those made with 8 bands separated by the IF bandwidth. For the bandwidth synthesis case the total observed bandwidth is 0.5 GHz, equal to the proposed bandwidth of the L-band system (although admittedly not quite centred on it). The fractional bandwidth is 32%.

The assumption of continuous observation in 8 adjacent frequency bands is equivalent to bandwidth switching at a rate such that all bands are sampled within the normal integration time. For eight bands, this implies a switching rate of 0.8 Hz for 10-second integration times or 1.6 Hz for 5-second integration times.

The source flux density (9.5 Jy) was scaled downward for the bandwidth synthesis maps to give the same signal/ noise ratio as for the single frequency case.



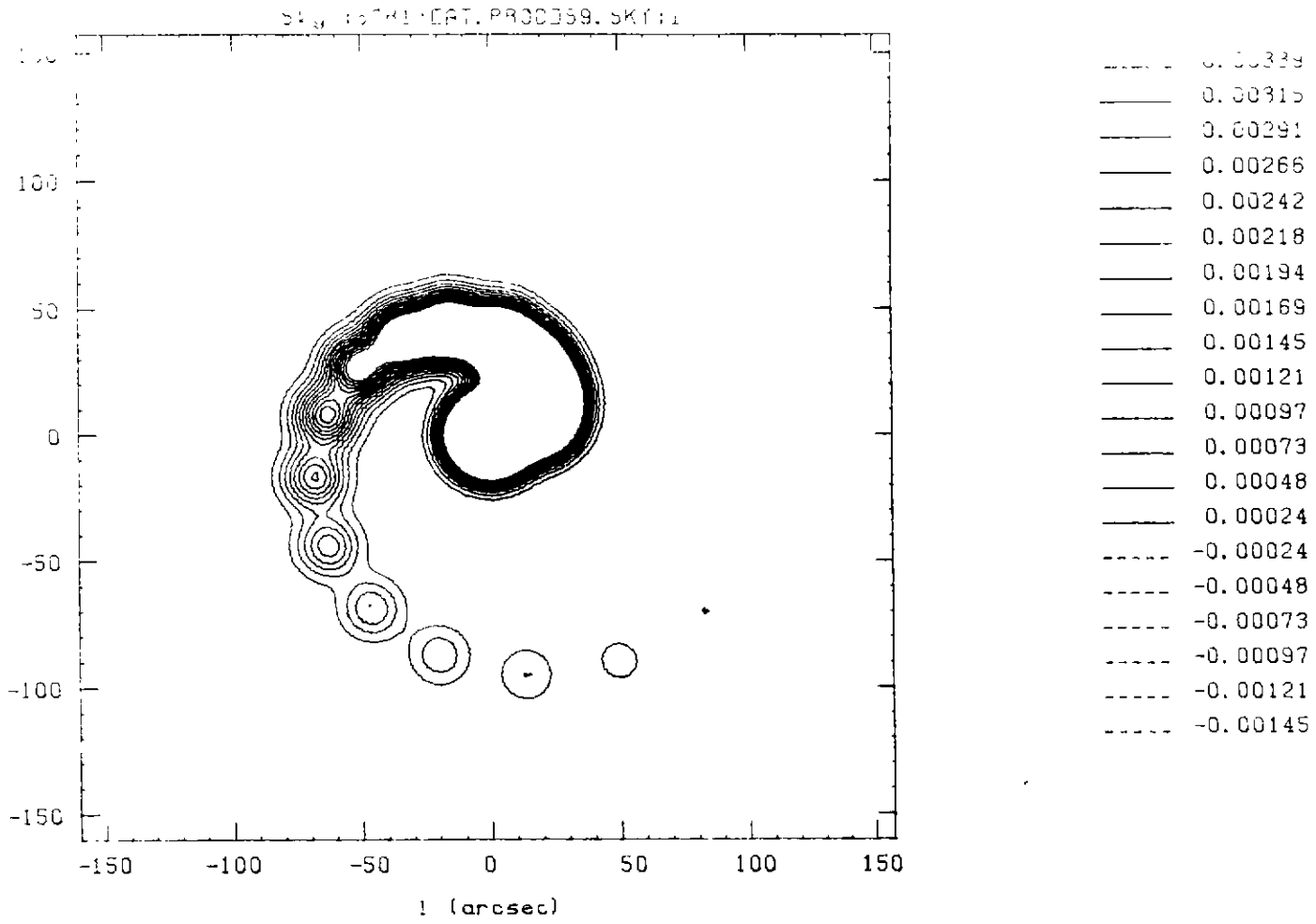
Figures 3 and 4 show raw maps for the 3km array and the 6km array with a fixed 6km antenna for both the single frequency and bandwidth synthesis cases. Similar maps for the 6km case with a moveable antenna were indistinguishable from those shown in Figure 4. Raw maps are compared since, as a general rule, the dynamic range of a cleaned map is closely related to the original sidelobe level. These maps therefore indicate the relative performance of the different configurations. The final dynamic range will depend on the level of system errors, at least for relatively strong sources, and is not easily predictable. Dynamic ranges and fidelities (for definition see AT/10.1/036) for the four maps are as follows:

	Dynamic Range	Fidelity
3km, single frequency:	9.1db	4.6db
3km, bandwidth synthesis:	14.6db	14.6db
6km, single frequency:	11.8db	13.5db
6km, bandwidth synthesis:	21.4db	20.2db

It is clear from the figures and from this table that bandwidth synthesis is going to be very beneficial, leading to dynamic range improvements of 5-10 db. This will be especially true of longer observations on the 6km array as it will be more effective than moving the 6km antenna in filling the U-V plane.

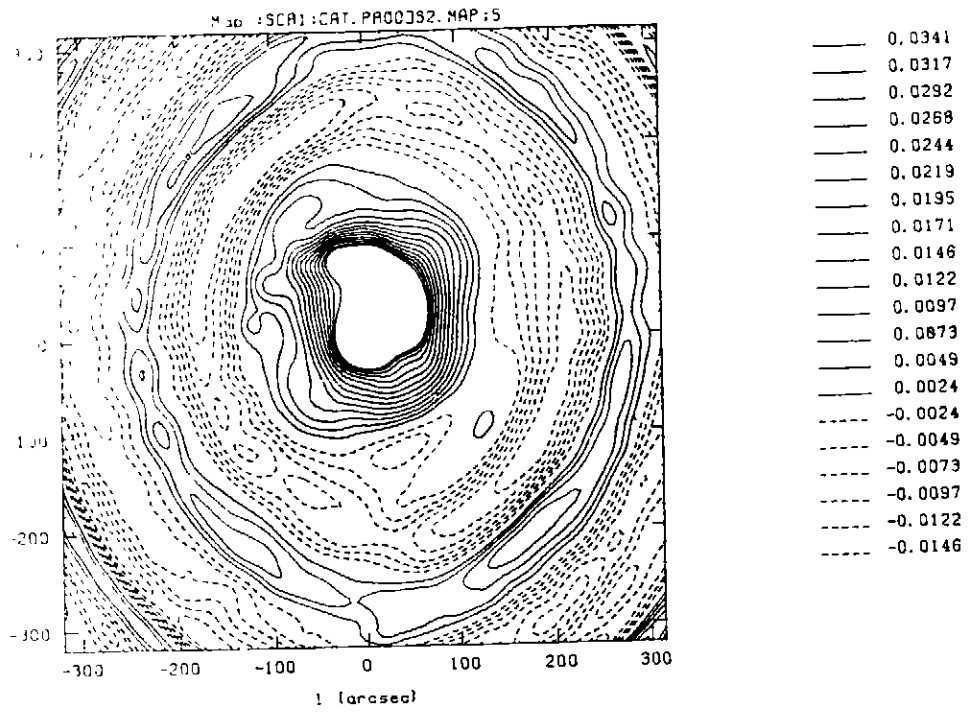
These simulations assumed a source with spatially uniform spectral index. For many real (continuum) sources this will be an adequate assumption, at least over the 30% bandwidth assumed here. However in other cases it will not be adequate and the simple summing of U-V data will lead to errors. This can be turned to advantage if a processing algorithm which simultaneously solves for intensity and spectral index is employed. Such algorithms are currently under development (e.g. Cornwall and Wietfeldt, VLA preprint).

I thank Ray Norris for the initial setting up the COM files for the simulations.



B1:CAT.PRODJS9.PAR;1
y distribution generated 30-SEP-85 22:00:28
y maximum = 0.4842E-01 Sky minimum = 0.0000E+00
otted: 1-OCT-85 08:41:31 for DICK

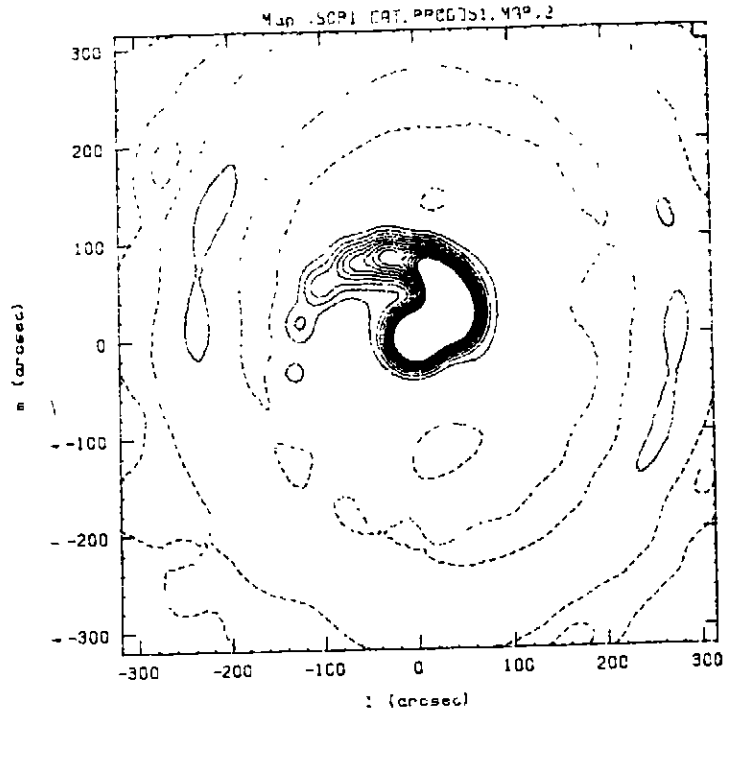
Figure 1. Sky distribution for the test source SPIRAL. Contour spacing is 0.5%.



0.0341
0.0317
0.0292
0.0268
0.0244
0.0219
0.0195
0.0171
0.0146
0.0122
0.0097
0.0073
0.0049
0.0024
-0.0024
-0.0049
-0.0073
-0.0097
-0.0122
-0.0146

SCA1:CAT.PA00352.PAR;5
Array generated 6-FEB-84 17:09:08
USA0:CAT.PA00300304.AAA;1
Sky distribution generated 30-SEP-85 09:29:10
SCA1:CAT.PA00352.SKY;5
Map generated 30-SEP-85 10:21:33
Ha= -6.00 6.00, ha step= 0.02, dec= -60.00, elev lim= 10.00
Freq= 1.6 GHz, bandwidth= 64.0 MHz, nch= 1
Pixel= 5.000 sec. Noise & errors added
Day range for synthesis is 1 to 4
Uniform weighting.
Kaiser-Bessel convolution function
Map max= 0.1219 min= -0.1431E-01 rms= 0.6355E-02
Convolution correction applied
Fidelity (to 0.10%) (dB): 4.6 Dynamic Range (dB): 9.1
Plotted: 30-SEP-85 10:25:18 for NORRIS

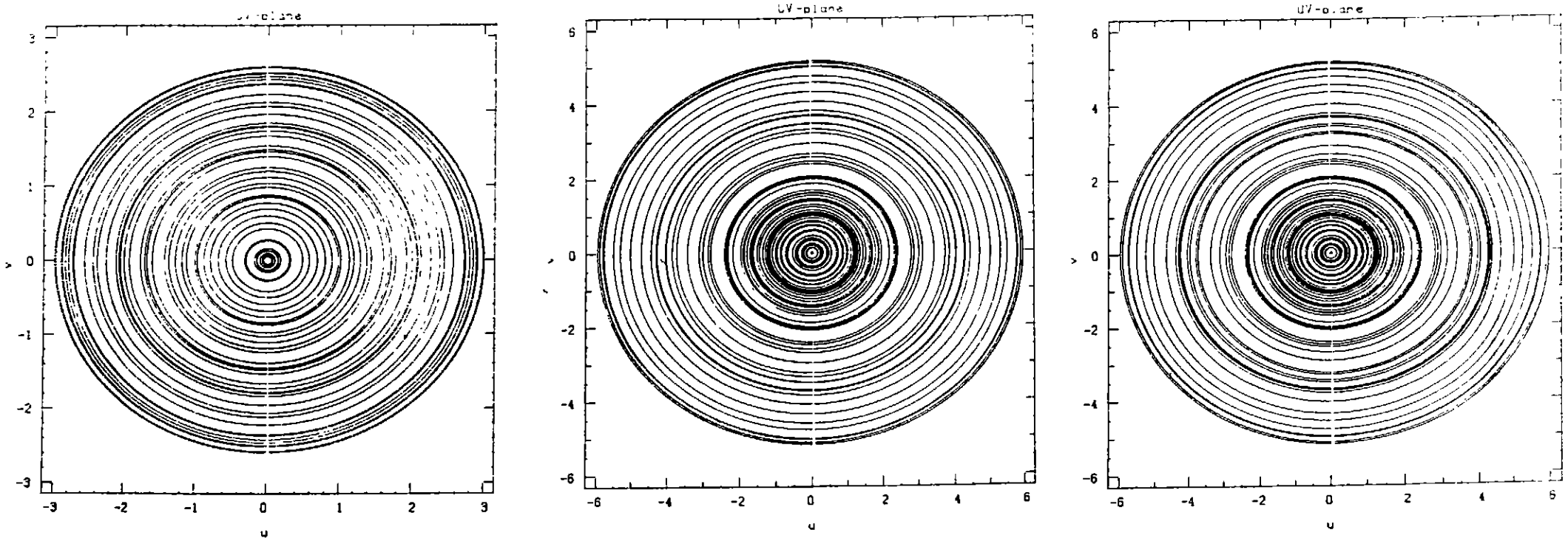
(a)



SCA1:CAT.PA00351.PAR;2
Array generated 6-FEB-84 17:09:08
USA0:CAT.PA00300304.AAA;1
Sky distribution generated 2-AUG-82 17:14:46
USA0:CAT.PA00SPIRALL.SKY;1
Map generated 14-SEP-85 01:58:49
Ha= -6.00 6.00, ha step= 0.02, dec= -60.00, elev lim= 10.00
Freq= 1.6 GHz, bandwidth= 64.0 MHz, nch= 8
Pixel= 5.000 sec. Noise & errors added
Day range for synthesis is 1 to 4
Uniform weighting.
Kaiser-Bessel convolution function
Map max= 0.3115E-01 min= -0.8887E-03 rms= 0.1163E-02
Convolution correction applied
Plotted: 18-SEP-85 21:23:13 for NORRIS
Fidelity 14.0 db D.R. 14.6 db

(b)

Figure 3. Simulated maps for the 3km array. (a) No bandwidth synthesis. (b) With bandwidth synthesis over a 32% bandwidth. Contour interval 2%



Array generated 6-FEB-84 17:09:08
USRO:CAT.PRODJOA304.AAA;1
Ha= -6.00 to 6.00 (hours).
Dec= -60.00 (degs). lat= -30.00 (degs)
Elevation> 10.00 (deg).
Plotted: 17-SEP-85 22:04:45 for NORRIS

(a)

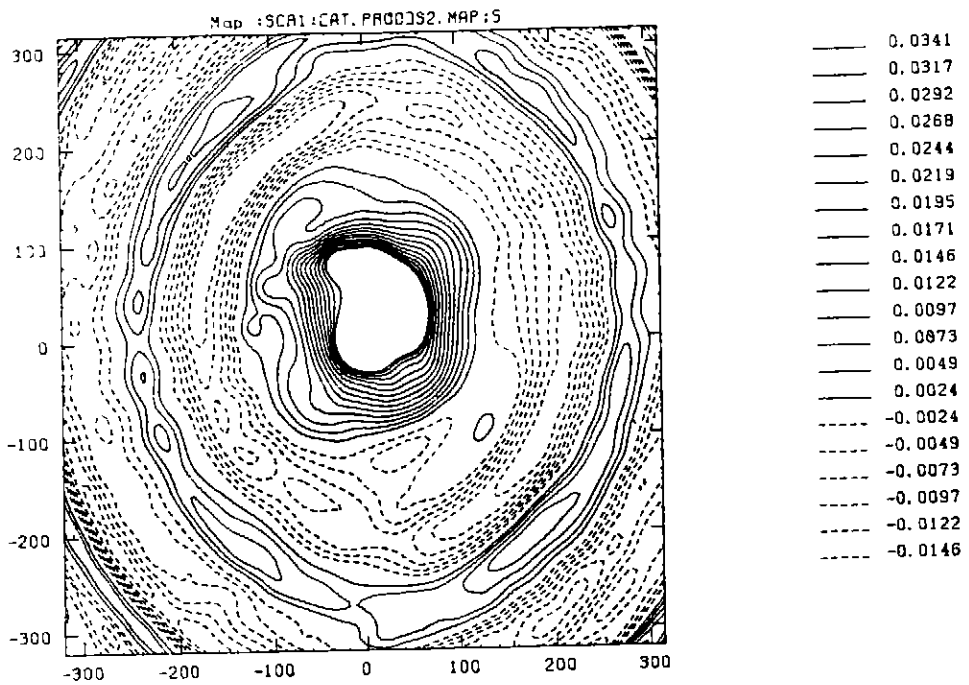
Array generated 30-SEP-85 14:55:56
USRO:CAT.PRODJOMA6A.AAA;1
Ha= -6.00 to 6.00 (hours).
Dec= -60.00 (degs). lat= -30.00 (degs)
Elevation> 10.00 (deg).
Plotted: 1-OCT-85 01:04:35 for NORRIS

(b)

Array generated 30-SEP-85 14:50:33
USRO:CAT.PRODJOMA6.AAA;1
Ha= -6.00 to 6.00 (hours).
Dec= -60.00 (degs). lat= -30.00 (degs)
Elevation> 10.00 (deg).
Plotted: 1-OCT-85 08:40:12 for DICK

(c)

Figure 2. U-V plots for the three arrays, all 4-day syntheses. (a) 3km array (DR3D4). (a) 6km array with fixed 6km antenna (DMR6A). (c) 6km array with the two 6km stations used (DMR6).



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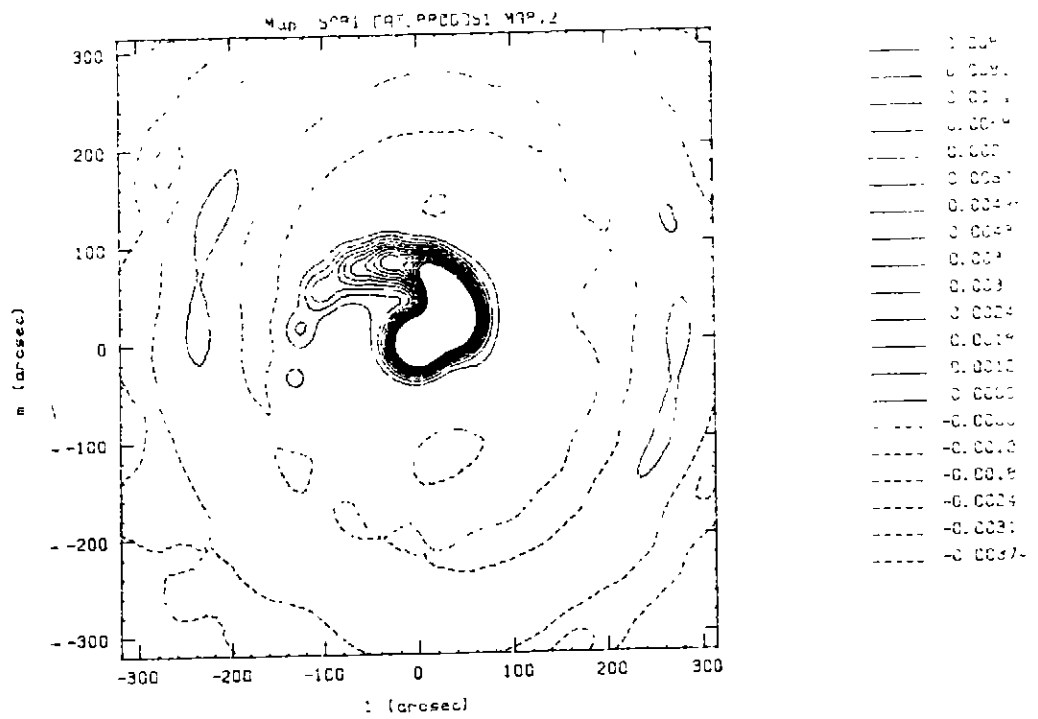
Array generated 6-FEB-84 17:09:08
USRO:CAT.PRODJDA304.AAA:1
Sky distribution generated 30-SEP-85 09:29:10
SCA1:CAT.PRODJS2.SKY:5
Map generated 30-SEP-85 10:21:33
Ha= -6.00 6.00, ha step= 0.02, dec= -60.00, elev lim= 10.00
Freq= 1.6 GHz, bandwidth= 64.0 MHz, nch= 1
Pixel= 5.000 sec. Noise & errors added
Day range for synthesis is 1 to 4
Uniform weighting.
Kaiser-Bessel convolution function
Map max= 0.1218 min= -0.1431E-01 rms= 0.6355E-02
Convolution correction applied
Fidelity (to 0.10%) (dB): 4.6 Dynamic Range (dB): 9.1
Plotted: 30-SEP-85 10:25:18 for NORRIS

(a)



SCA1:CAT.PRODJS1.PAR:2
Array generated 6-FEB-84 17:09:08
USRO:CAT.PRODJDA304.AAA:1
Sky distribution generated 2-AUG-83 17:14:46
USRO:CAT.PRODJSPIRALL.SKY:1
Map generated 14 SEP-85 01:58:49
Ha= -6.00 6.00, ha step= 0.02, dec= -60.00, elev lim= 10.00
Freq= 1.6 GHz, bandwidth= 64.0 MHz, nch= 8
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Fidelity 14.0 db D.R. 14.6 db

(b)

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