also AT/20.1.1/053
26/7/91

AT.39.3/012

AT primary beam measurements at 20cm

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Measurements of the AT antenna primary beam were made at 20cm to facilitate better beam correction for off-axis sources. The data were taken at UT 0h on 19 July 1991 at a frequency of 1472 MHz and a bandwidth of 128 MHz (4 MHz channels). The 0.375 km compact+6 km configuration was in use. The source observed was 0537-441 (~3 Jy). Its azimuth and elevation were 205 deg and 74 deg at the time of the observation. The subreflector focus position was the 'X-band compromise', i.e. optimised for performance at 3cm, although the 20 cm performance is relatively insensitive to this setting. Two sets of data were taken: (1) spot observations taken by moving the whole array off-source to different offset positions (out to 12 arcmin); and (2) a scanned observation made by halting antenna 1 and letting the source drift through the voltage beam pattern (out to 3 deg). The spot and scan observations were made at a astronomical position angles of 225 deg and 270 deg, respectively. The corresponding projected angles to the nearest feed legs were about 15 deg and 30 deg.

Figure 1 plots the beam pattern out to just beyond the second null which is at 75 arcmin. The four discrete points are the mean of the spot measurements from all interferometers excluding those involving antenna 6 (to avoid bandwidth smearing) after calibration and phase centre shifting. The solid line is the square of the output from baseline 1-6 from the scan measurement (when the phase centre was kept on the source). The full width half power diameter of the primary beam is 32 arcmin. The first null is at 40 arcmin, and nulls out to number 5 are detected. The peak power in the first sidelobe is 3% of the maximum. Figure 2 shows the sidelobes out to 180 arcmin in more detail in a log plot. Polarizations XX and YY are shown for comparison. Figure 3 plots the interferometer phases during the scanned observation. Note the alternate 0 and 180 degree phase flips following each null.

The measurement of the primary beam out to the first 'null' ($\sim$ 0.2% of peak) is adequately parameterized by the polynomial expression

$$B(x) = \frac{1}{1 + a_1x + a_2x^2 + a_3x^3 + a_4x^4} \tag{1}$$

where $B(x)$ is the beam response and x is the square of the distance from the beam centre (arcmin) multiplied by the square of the observing frequency (GHz). In this form the results may be applied at other frequencies (with less accuracy when different feeds are used) and, more importantly, the coefficients a_1 to a_4 can be directly used in the AIPS PBCOR primary beam correction program where they replace the default VLA parameters in BPARM(6) to BPARM(9) (with BPARM(5) being fixed at 1.0). A least squares fit gives $a_1 = 1.301599 \times 10^{-3}$, $a_2 = 5.850791 \times 10^{-7}$, $a_3 = -2.347042 \times 10^{-10}$ and $a_4 = 8.666800 \times 10^{-13}$. Although a good fit to the data out to the first null, equation (1) should not be considered representative of the true beam beyond the 20% point due to beam asymmetries imposed by the subreflector truss and beam distortion due to zenith angle changes. Fig.1 shows the PBCOR fit superimposed on the data.

Figure 2: AT primary beam at 1472 MHz

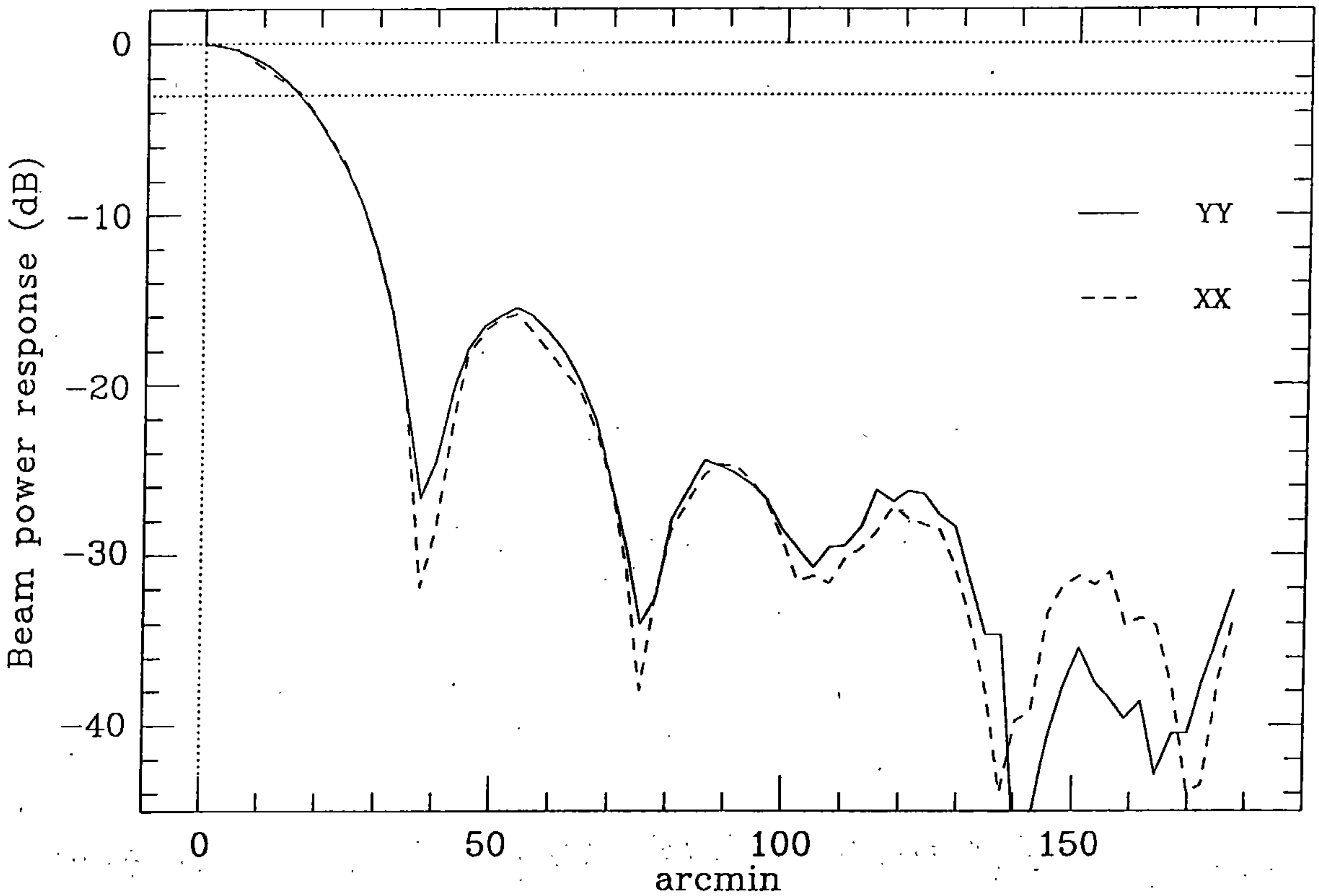

Figure 1: AT primary beam at 1472 MHz

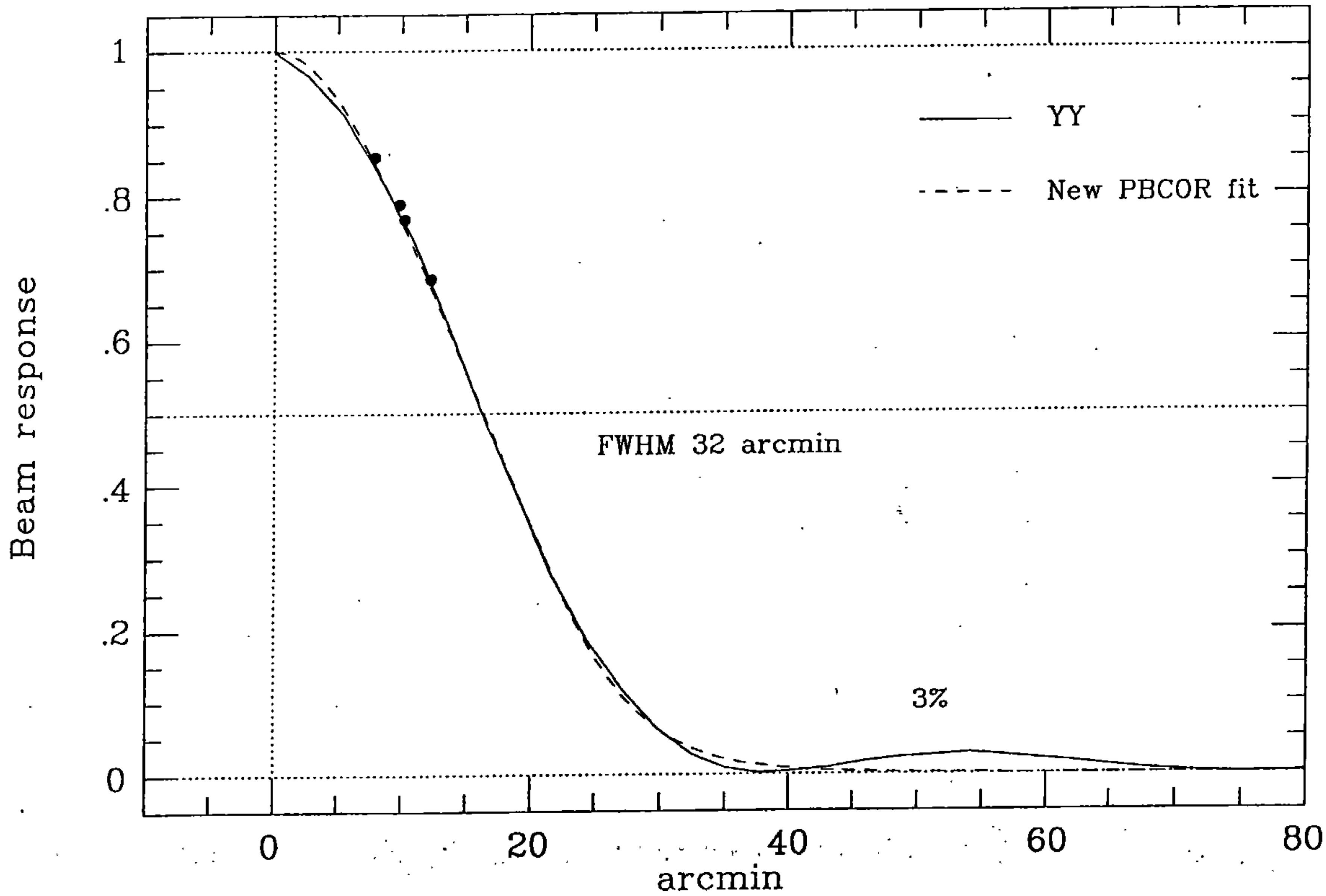

Figure 3: AT primary beam phase at 1472 MHz