Romney

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To: MMA Systems Working Group,

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Attached are some notes on the BIMA Array correlator that Jack sent me, and also a page with a sketch of the basic structure of the SAO correlator that Colin Masson gave me after the MMA Advisory meeting last year. This material is relevant to the correlator and channelization of the MMA, and we should discuss it at our next meeting.

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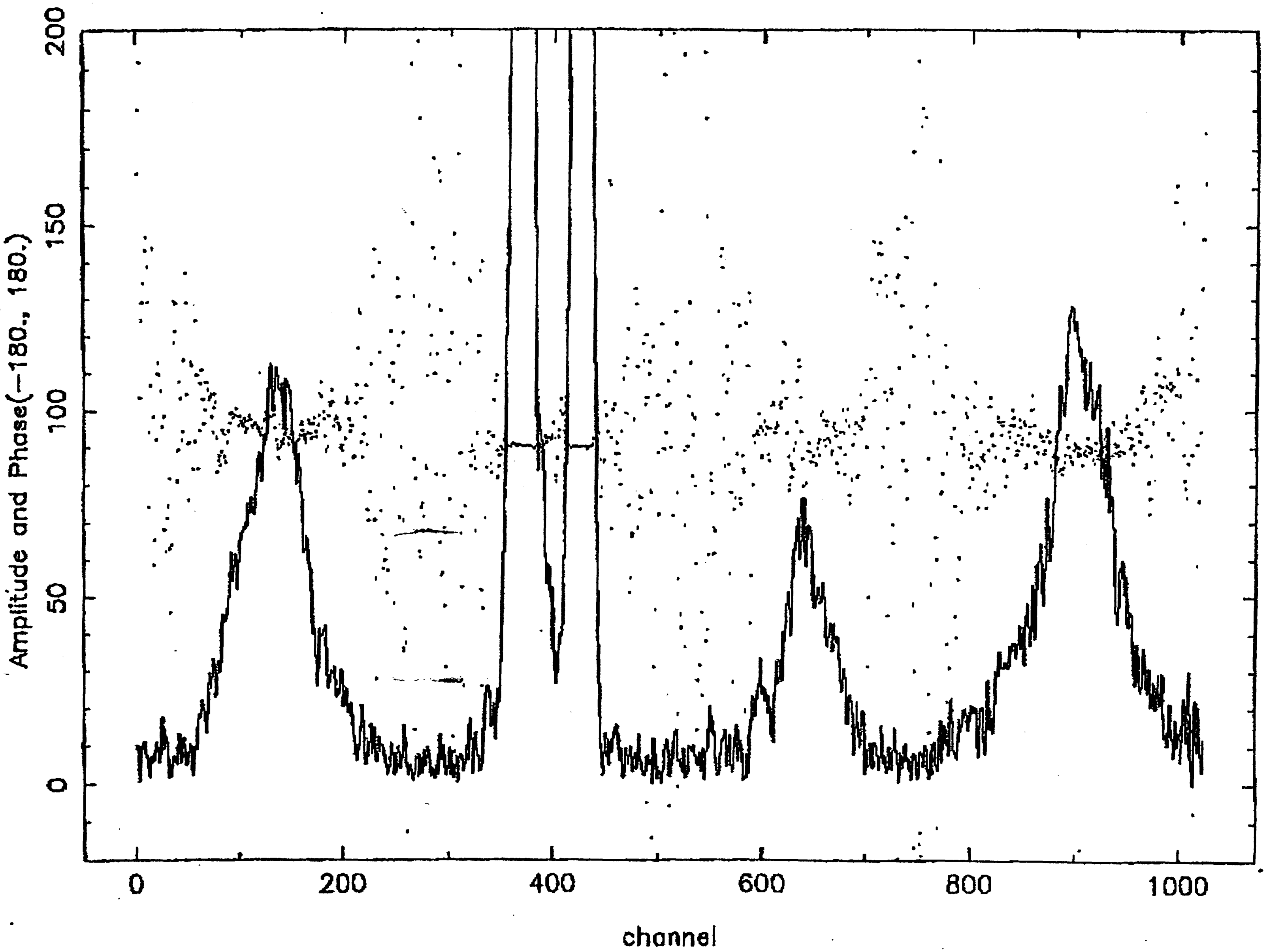
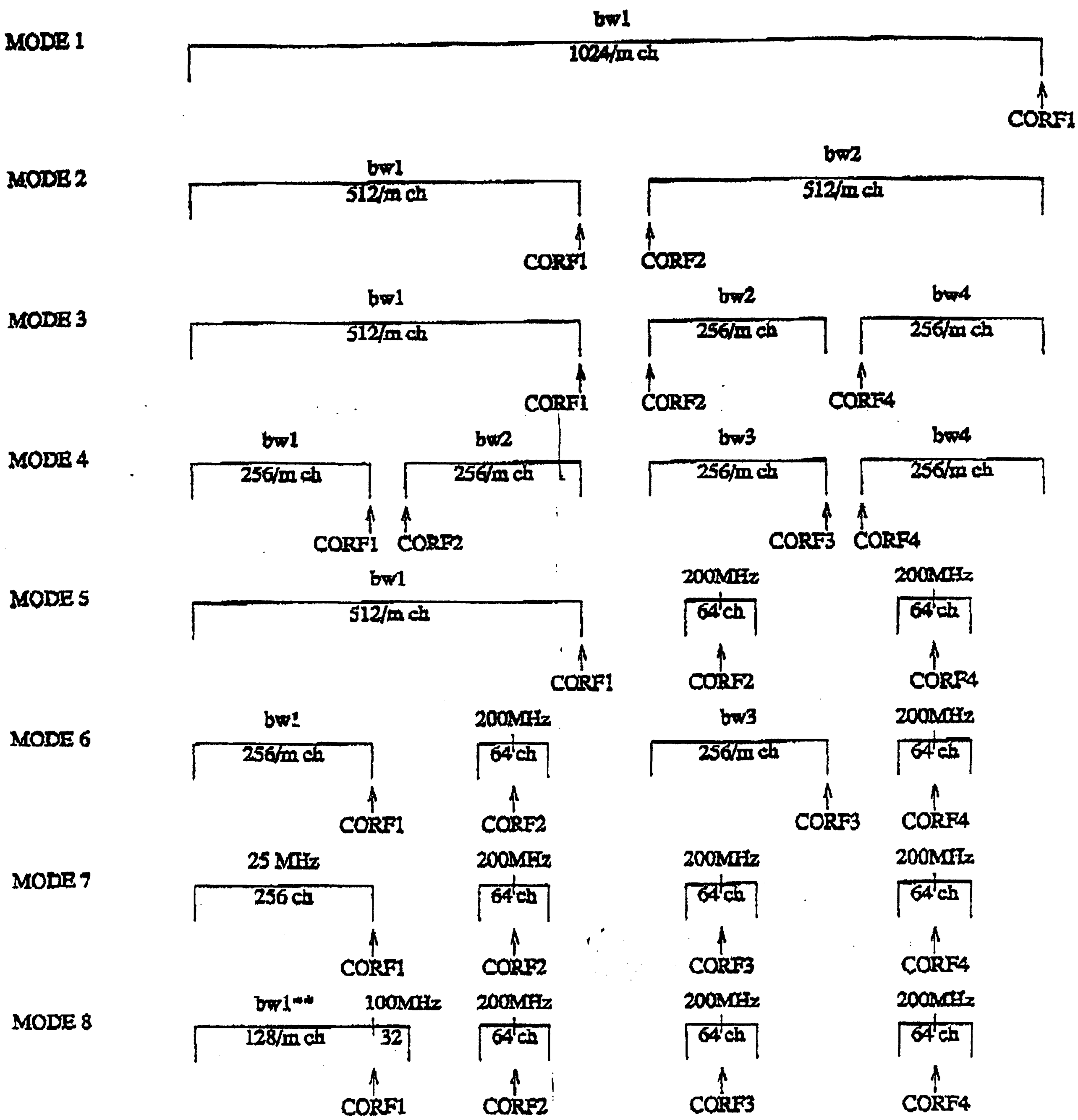




NOTES: (1) bw1,bw2,bw3,bw4 and m values

bw(MHz)	m
6.25,12.5,25	1
50	2
100	4

**(2) bw1 restricted to 25, 50 or 100 MHz in MODE 8.

Table 1: COMPLEX CORRELATOR MODES

Mode	Corf 1		Corf 2		Corf 3		Corf 4	
	lsb 1	usb 1	lsb 2	usb 2	lsb 3	usb 3	lsb 4	usb 4
1	bw1/1024	—		—	—	—	—	—
2	bw1/512	—	..	bw2/512	—	—	—	—
3	bw1/512		—	bw2/256	—	—	—	bw4/256
4	bw1/256	—	—	bw2/256	bw3/256	-	—	bw4/256
5	bw1/512	—	100/32	100/32	—	—	100/32	100/32
6	bw1/256	—	100/32	100/32	bw3/256	—	100/32	100/32
7	25/256	—	100/32	100/32	100/32	100/32	100/32	100/32
8	bw1/32	100/32	100/32	100/32	100/32	100/32	100/32	100/32

NOTE: In mode 8, bw1 is restricted to 25, 50, or 100 MHz. These same windows are repeated in both sidebands of the first LO. There are twice as many channels for autocorrelation modes.

allow substantial continuum bandwidths along with either one or two spectral lines. Only mode eight uses all eight correlators. For a purely continuum observation, this is clearly the mode to use, with 100 MHz bandwidth in each correlator including the first, giving a total of 800 MHz. Mode 8 also enables a significant single line observation (in each sideband) along with 700 Mhz of continuum. The limitations are listed in the table.

The correlator is under computer control. Changing the correlator configuration takes about 1 minute, counting passband and system temperature calibrations. The available line catalogues are available within the MIRIAD reduction software package, and the MIRIAD programs CORSET and XCORF may be used to plot the location of spectral lines within the selected frequency windows; they are useful for planning correlator configurations for observation.

Figure 7 shows the spectrum obtained on 1 baseline with a 38 min integration centered on Orion/KL Nebula. The correlator is set up to provide 8 spectral windows, each with 25 MHz bandwidth. The figure shows the amplitude (Jy) and phase (degrees) for 1-sideband of the first LO containing emission from SO(86.094 GHz), SiO v=1 (86.243 GHz), H13CN (86.340 GHz), and SiO v=0 (86.847 GHz). In the other sideband we simultaneously observe HCO+ (89.189 GHz) and 3 spectral windows which contain continuum, but no spectral line emission.

Thornton, and Hudson, 1985, PASP); it is a hybrid correlator, employing analog filters with digital sampling and correlation within the bands of the filters. The new unit has greater maximum bandwidth (by a factor of 2.5), 800 MHz, and greater flexibility in its operating modes, allowing, in particular, better combinations of continuum and spectral line coverage. There is a total of eight correlators which accept the outputs of third mixers, both upper and lower sideband. The resulting four composite windows are located by the choice of the third mixer's four local oscillators, "corfs", which may be placed at any frequencies in the 830 Mhz IF band (70 MHz - 900 MHz). The four bandwidths bw1, bw2, bw3, bw4 may be selected from 6.25/12.5/25/50/100 MHz. The correlator channels may be distributed to one up to eight windows. Different bandwidths, as well as two different clock rates, may be used at the same time, with certain restrictions.

Whereas the previous system used discrete components, the new unit employs the NFRA (Bos) 2-bit chip with a maximum clock rate of 50 Mhz (Bos, 1991). This chip allows four level quantization with an efficiency of 0.88. To attain a bandwidth of 50 MHz, one stage of time multiplexing is required; for 100 MHz, two stages of multiplexing are needed. With the introduction of each stage of multiplexing, the number of available correlations is reduced by a factor of two.

As with the previous system, the sidebands of the first local oscillator are separated by phase switching of the first local oscillator. As a result, the windows in the upper sideband also appear in the lower sideband with little cross-talk. (The residual cross-talk is less than .1%.) Doppler tracking of the windows in both sidebands is accomplished by slewing of both the first and third local oscillators. Including both sidebands, the maximum number of complex channels that can be observed is 2048 with no time multiplexing and 512 with two stages of multiplexing.

Eight different correlator observing modes are realized in the software and are set out in Table 1. The first four modes are for strictly line observations. The last four are intended to

1. Correlator

Dear Dick

As I mentioned during our last telephone call, the correlator that we are now using at Hat Creek has considerable flexibility, and, as a future user of the MMA, I hope that the MMA correlator will be at least as useful. Our unit can cover a maximum bandwidth of 800 MHz, and I would expect the MMA basic unit would cover 1 GHz, with a second 1 Ghz unit for the other polarization or second band. If we can get an IF bandwidth of 2 Ghz in each polarization, we should be able to tune the various windows of the correlator to anyplace in the 2 GHz band. That is, the baseband converters need to operate over the whole 2 Ghz IF band.

We use a fixed sample rate of 200 MHz, but we can run two halves of the correlator at different shift rates and can use different multiplexing in each window. Combining that with different analog input filters, we can operate with a variety of bandwidths and resolutions at the same time. It's common for us to setup three or four molecular lines, a recombination line, and a considerable amount of continuum bandwith, using both sidebands of the first local oscillator.

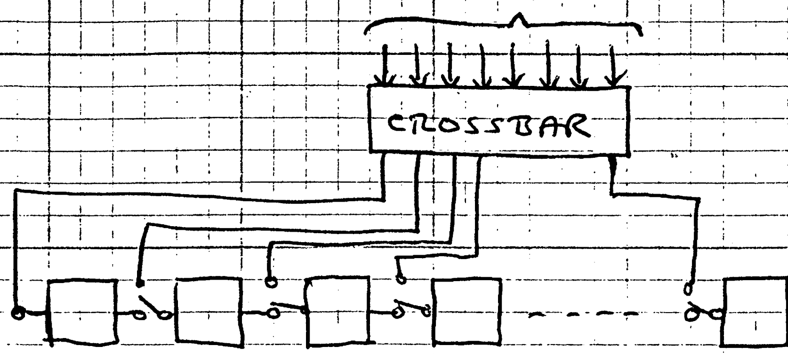
I am enclosing a few paragraphs' write-up of the correlator (from another report) as a description. One other capability that it has (that may be too hard to do in a larger correlator) is that the correlator channels may be distributed in different ways among the analog filter bands. All of the channels may be put into one window, or split between two windows, or divided between four windows. This requires a lot of complicated interconnections, but it is very useful. The correlator is being finished for 10 antennas.

I also enclose two different tabular representations of the possible set-ups.

The basic architecture of the new correlator is the same as for the previous version (Urry, 12/1/94

8 INPUT BANDS (CHUNKS)

80 MHZ SEPARATION
208 Msps SAMPLE CLOCK



16 chips in line
128 lags/chip

SIMPLIFIED SKETCH OF SMA CORRELATOR ARCHITECTURE
(IGNORING DETAILS OF DEMUX, ETC.)

- The correlator chips can be connected in chains of any length up to 16
- Any input band can be connected to any chip
- Samplers run at a fixed rate with fixed filters, always covering the entire spectrum
- No signals driven off the correlator board
- With 1 chip/chunk used for continuum, 8 chips remain ~~and~~ available for high resolution on selected parts of the band.

A NOTE FROM COLIN MASSON SHOWING BASIC ARCHITECTURE OF SAO's CORRELATOR