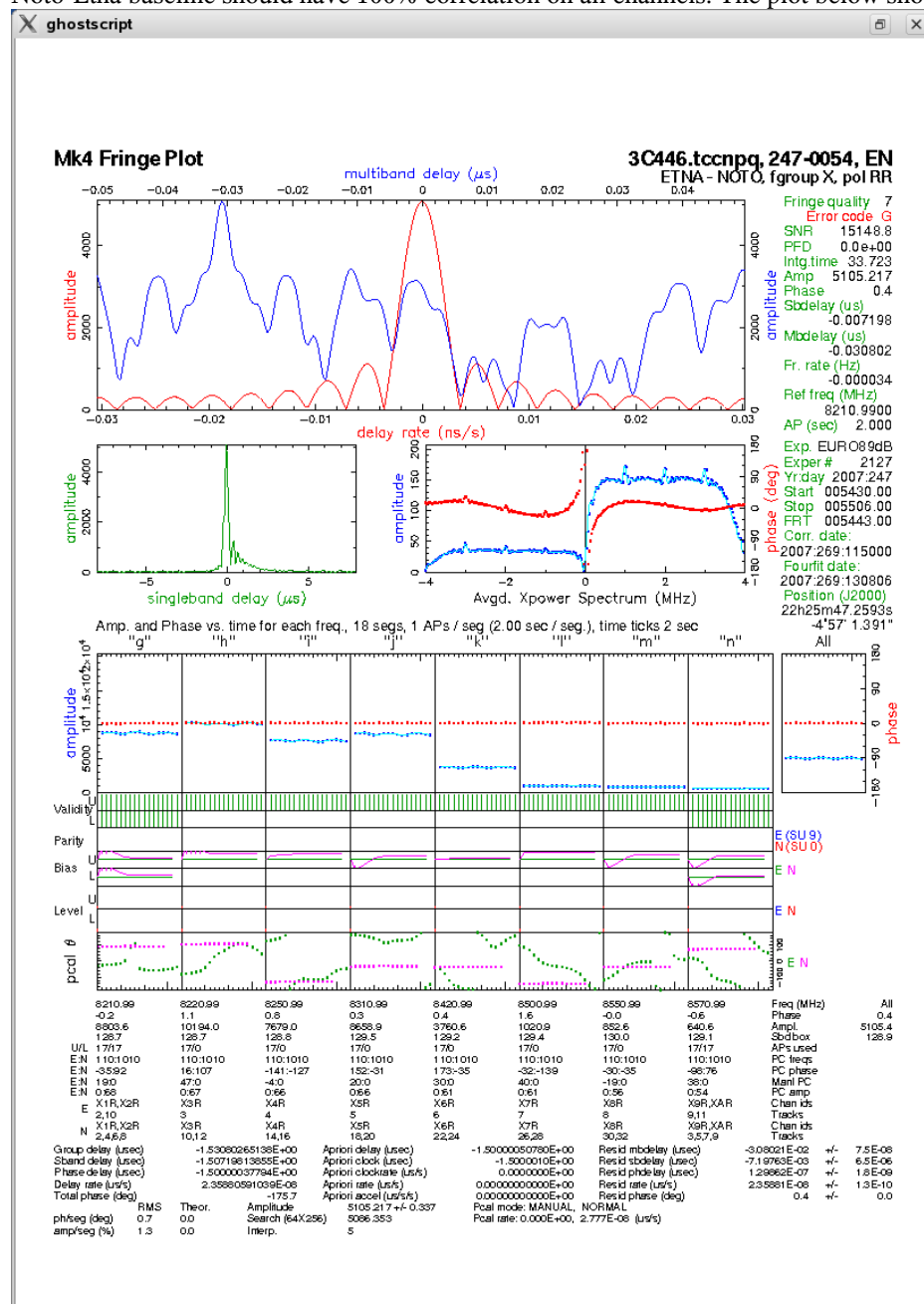


## Successful EURO89 dBBC Test

Noto observed with VLBA/Mk5A and dBBC/Mk5B in Euro89 for 12 hours. The correlation was set up as a triangle /Noto/"Etna"/Wetzell, experiment #2127. The dBBC was connected to X-band. The Noto-Etna baseline should have 100% correlation on all channels. The plot below shows this baseline



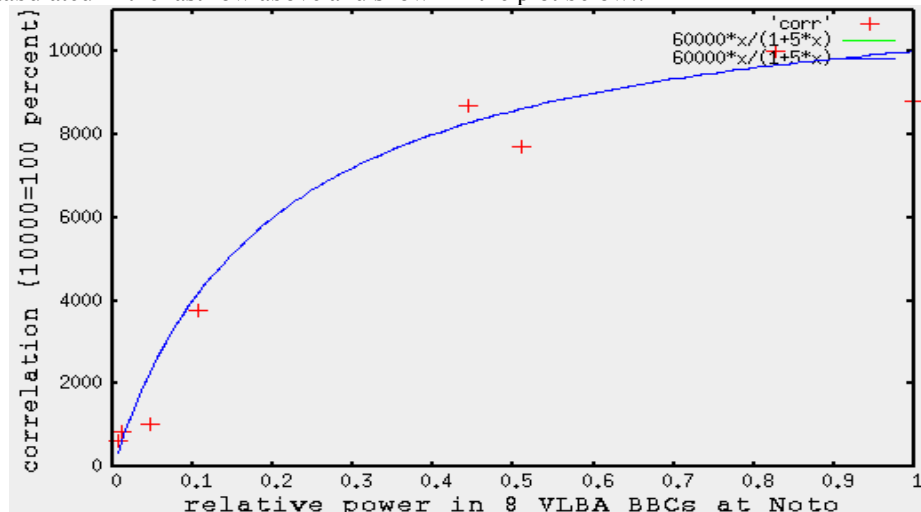
Here manual phase cal has been inserted and a USB/LSB phase difference of  $-170$  degrees. Because of the phase changes within the 4MHz band, LSB and USB do not add perfectly and a correlation of only 8900 is seen on channel 1, instead of 100% (amplitude 10000). Channel 2 has 100% correlation. This is a considerable improvement over the EURO86 test, which had a maximum correlation amplitude of 6700. The correlation remains high over the first four channels. If fourfit is used to fit these channels only, a fourfit code '9' results. However subsequent channels show a rapid falloff in amplitude. This effect was already obvious in the euro86 test. It seems to be caused by a slope of over 20dB in the signal from the Noto X-band receiver between the lowest and highest frequency used. Since both the VLBA equipment and the dBBC receive the same signal, the 'tpgain' information from the VLBA terminal gives us approximately the analogue levels at each frequency on the dBBC input. In the following table the power in the first VLBA BBC is normalised to 1, power levels in the other BBCs are given in relative terms in the 3<sup>rd</sup> row.

<i>channel</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
IF freq	610	620	650	710	820	900	950	970
rel. pwr	1	0.827	0.510	0.444	0.107	0.047	0.011	0.006
meas corr	8800	10000	7700	8700	3760	1021	853	641
empir.	10000	9665	8622	8276	4198	2295	650	358

The row “measured correlation” gives fringe fitting output, where 100% correlation is 10000. On the assumption that bandpass slope reduces correlation at high frequencies, we attempted to find an empirical function which reproduces the effect. For instance if each filter has a passband/stopband ratio of 26dB, we are selecting a 4MHz portion of an approximate 150MHz wide signal, reducing the SNR to 26-16=10dB. We expect the wanted signal in dBBC5, where power is reduced by 10dB, to be approximately equal to noise, and this is approximately seen. A reduction in signal level at 970 MHz (dBBC8) of 150 times relative to the lower frequencies should then give 10dB-22dB, so the signal should be 12dB **below** noise in the 970MHz channel, and the measured value is 12dB (640/10000). If 'g' is given as the relative gain, then the approximate correlation amplitude here is given by

$$\text{empirical\_ampl} = 10000 * (1+5) * g / (1+5*g).$$

This is tabulated in the last row above and shown in the plot below.



The performance in the first four channels is good, and the other channels would have been OK if the input passband had been flat. With a full 500MHz flat passband the SNR in each channel would have been approximately 6dB. The improvement compared to previous tests seems to have been achieved at the cost of a less steep rise in the individual passbands at the low frequency end, meaning that 10kHz phase cal cannot be used with dBBC but this may not be a problem..

A passband/stopband ratio of at least 35dB is needed, see for instance Iguchi et al. in PASJ 57,259 (2005) (<http://pasj.asj.or.jp/v57/n1/570123/57012675.pdf>). Even with this improved ratio the input band should be flat within 10dB everywhere. Also, if bandwidths narrower than 4MHz are used, or in the case of strong interference (S-band, UHF.. !), analogue pre-filtering to narrow the bandwidth of the signal to the A/D converter will be needed.

### Summary

- Performance better than EURO86 test, now should be good enough for serious measurements, but 10dB further improvement needed to have a robust system.
- In this test, performance was limited by telescope analogue signal.
- Demonstrates necessity for very flat input passband and careful attention to input level setting
- small frequency offset still in use, so phasecal does not work.
- Must extract phasecal signal at 510kHz, 1010kHz or higher.