

DEUTERIUM ARRAY MEMO #049

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To: Deuterium Array Group

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Subject: Excision of continuum RFI transients

There is evidence for occasional continuum RFI transients which produce severe spectral distortion. These transients need to be excluded from the spectral averaging. An example of an especially worrisome RFI transient occurred from 23 to 24 hours UT on day 99 (8 April) 2004. This transient signal was on the edge of the band and appeared to be coming from a high elevation so it could have been from an aircraft or satellite. The spectral distortion can be measured by fitting a polynomial to the spectrum and estimating the coefficients in units of sigma from the theory least squares. In this case

$$\sigma_k = b_k / \left[ b_0 \left\{ \left( A^T A \right)_{kk}^{-1} T \Delta f \right\}^{1/2} \right]$$

where  $b_k = k^{\text{th}}$  polynomial coefficients

$\left( A^T A \right)_{kk}^{-1}$  = covariance matrix

T = integration time (secs)

$\Delta f$  = frequency resolution (Hz)

In practice 4 coefficients,  $b_0, b_1, b_2, b_3$  representing the constant, slope, curvature and 3<sup>rd</sup> order polynomial coefficient of the spectrum provide a good measure. If  $\sigma_2$  or  $\sigma_3$  exceed a threshold of 10 sigma this time span can be marked for excision from averaging. The slope could also be used but there is an instrumental bias in the slope that needs to be removed. The detection algorithm should be run on each spectrum, the average spectrum for each station polarization and the average of all the dipole spectra. Using the average of the spectra greatly enhances the sensitivity. For the full array of 25 stations the average of all  $25 \times 24 \times 2 = 1200$  spectra increases the sensitivity by a factor of 35. The table of relative sensitivities (larger number being higher sensitivity) shows the power of using the spectral average of many elements of the array. In the case of RFI from the sky the array is a far more sensitive RFI detector than the RFI monitor.

Figure 1 shows the effect of excision of the time span during the transient RFI from the beam pointed at the Galactic anticenter during day 99 for stations 0 thru 4. The bottom plot shows the spectrum without excision of time spans for which the transient was detected in individual channels. The systematic effect of the transient is still seen in this plot because there is insufficient sensitivity to always detect the RFI. The spectrum in the top plot was derived from the averaged spectra after using average of 24 channels for detection of RFI.

|                               | From horizon |              | From zenith |                |
|-------------------------------|--------------|--------------|-------------|----------------|
| Data                          | Array        | Monitor Yagi | Array       | Monitor dipole |
| Single channel 500 secs       | 1            | 40           | 1           | 1              |
| 24 channel average 500 secs   | 5            |              | 5           |                |
| 1200 channel average 500 secs | 35           |              | 35          |                |
| Single channel 1 day          | 13           | 526          | 13          | 13             |
| 24 channel av 1 day           | 64           |              | 64          |                |
| 1200 channel av 1 day         | 455          |              | 455         |                |

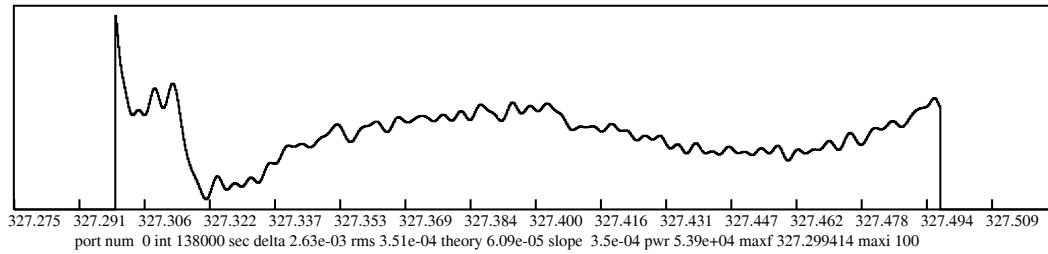
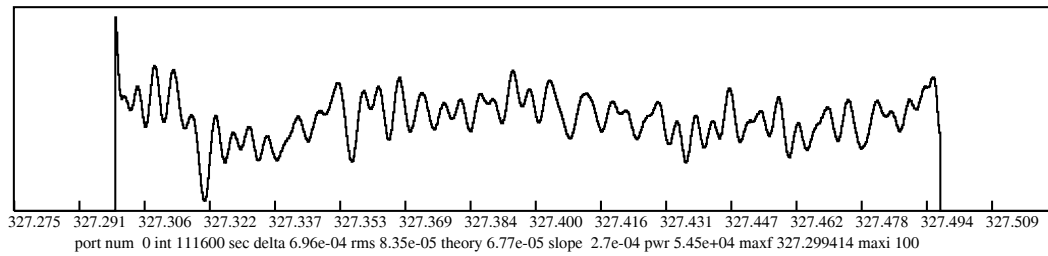
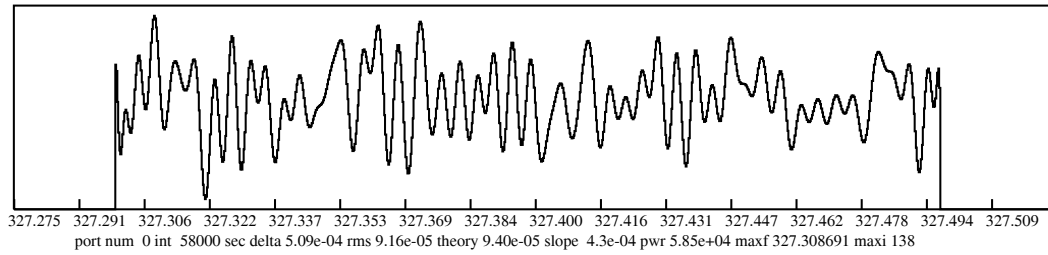
Table: Relative sensitivities of array and RFI monitor for detection of RFI

Notes:

- 1] Yagi gain 13 dBi
- 2] Array element horizon gain – 7 dBi
- 3] Dipole at zenith gain – 8 dBi
- 4] Average  $T_{\text{sys}}$  of array elements 80K
- 5] Average  $T_{\text{sys}}$  of horizon Yagis 200K
- 6] Unit horizon CW sensitivity  $\approx 1$  K into isotropic 0 dBi antenna 244 Hz resolution

The plot scales from bottom to top are 2630, 696, 509 ppm respectively. The equivalent integration times are 38, 31 and 16 hours respectively. The spectra have been smoothed to a resolution of 2 kHz.

Starts at 2004:099:00:05:41 08 Apr 2004 G183



D1 Array vlsr= 39.4 s=G183

file: /data/d04/2004\_099\_00.d04b

Thu Apr 15 22:45:17 2004