BBDEV. MEMO #022
2008 June 15

To: VLBI2010 Broadband Development Group

From: Brian Corey

Subject: Addendum to June 10 memo on "Modulation during first hour of 2008 May 23 GGAO-Westford BBD test"

Bill Petrachenko has hypothesized that the sample level plots in figures 3 and 4 of the original memo may be hiding much larger, anti-correlated 1/20-Hz variations in the positive and negative high-magnitude sample counts. His hypothesis is correct for most, but not all, frequency channels.

Each 2-bit sample represents one of four possible voltage states. In order of decreasing voltage, common designations for the states are:

large positive	*or*	+ +
small positive	*or*	+
small negative	*or*	–
large negative	*or*	– –

The "bias" and "level" statistics shown on fourfit fringe plots and in the June 10 memo are constructed from the counts of samples in the four states as follows:

bias = [(# of + + and + samples) – (# of – – and – samples)] / (# samples in all 4 states)

level = (# of + and – samples) / (# samples in all 4 states)

Some information has obviously been lost when only two statistics are used to represent the distribution of state counts. Figures 1 and 2 below correct this deficiency. They show the fraction of all samples in each state (or *sample rates*) for the same scan as in figures 3 and 4 of the earlier memo.

Figures 3 and 4 below show the same sample rates as in figures 1 and 2 except that only the first five minutes of the scan are included, to allow the oscillations to be seen more distinctly. The time series have been rearranged from figures 1 and 2 to put the rates for all four states in a single panel for each frequency channel, and the mean rate has been subtracted from each time series.

In the R-pol frequency channels, the 1/20-Hz oscillations for + + and – – samples are anti-correlated, as are the + and – samples in most cases. Furthermore, the + + and + curves are correlated in most cases, as are the – – and – curves. The one definite exception is channel 8, where only the + + and – – pattern of the other channels holds up.

L-pol is another matter. In five channels, + + and – – are anti-correlated; in the other three channels, where the oscillations are generally weaker, they are correlated. The other state pairs are roughly equally divided between being correlated and anti-correlated.

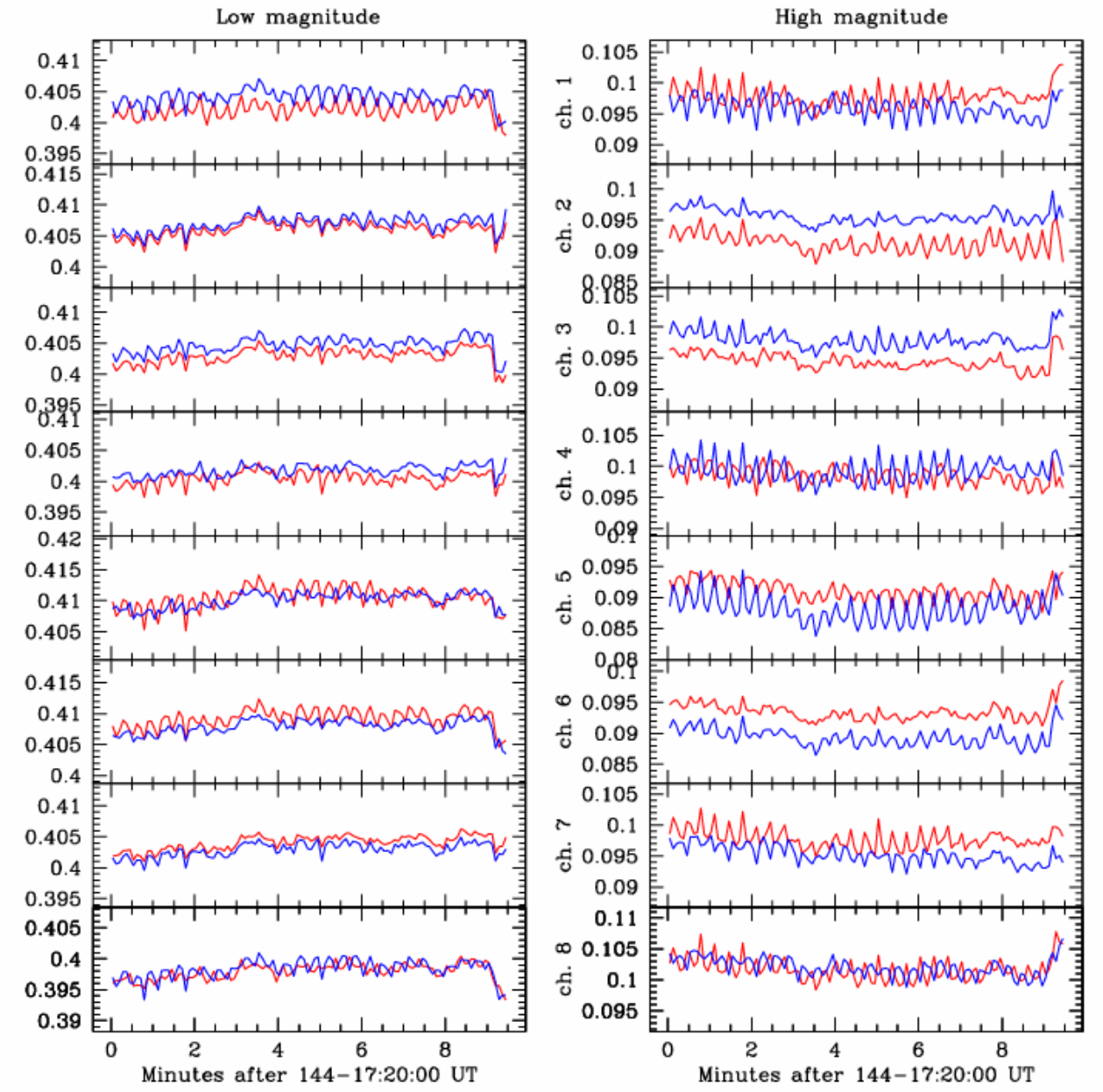

Figure 1. Fraction of 2-bit samples in each of the four states for Westford L-pol scan 144-1720, by frequency channel. Lefthand panels: + states are in red, – states in blue. Righthand panels: + + states are in red, – – in blue. All ordinates have a max-min span of 0.02. Data are five-second averages.

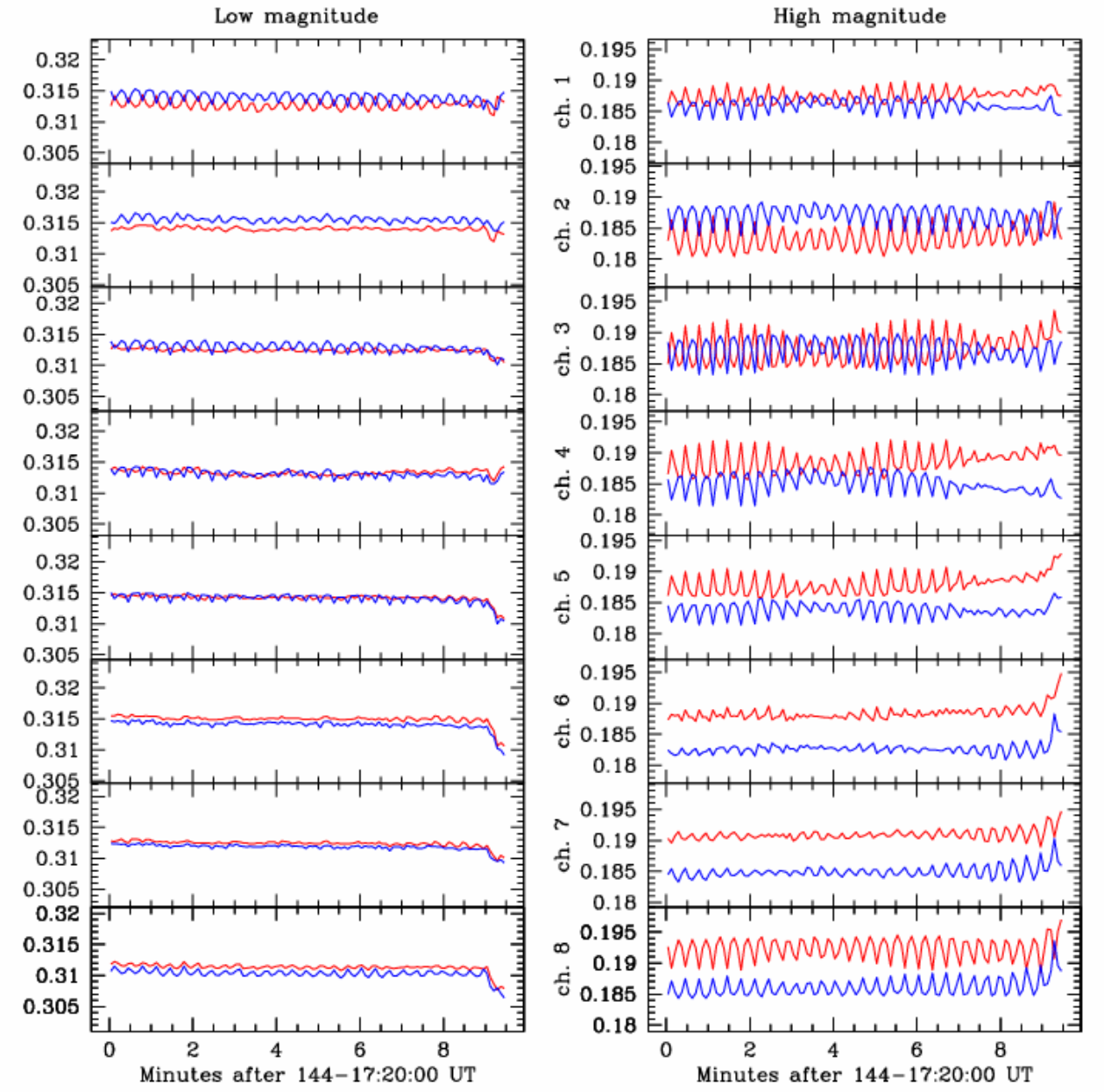

Figure 2. Same as figure 1 except that samples are R-pol.

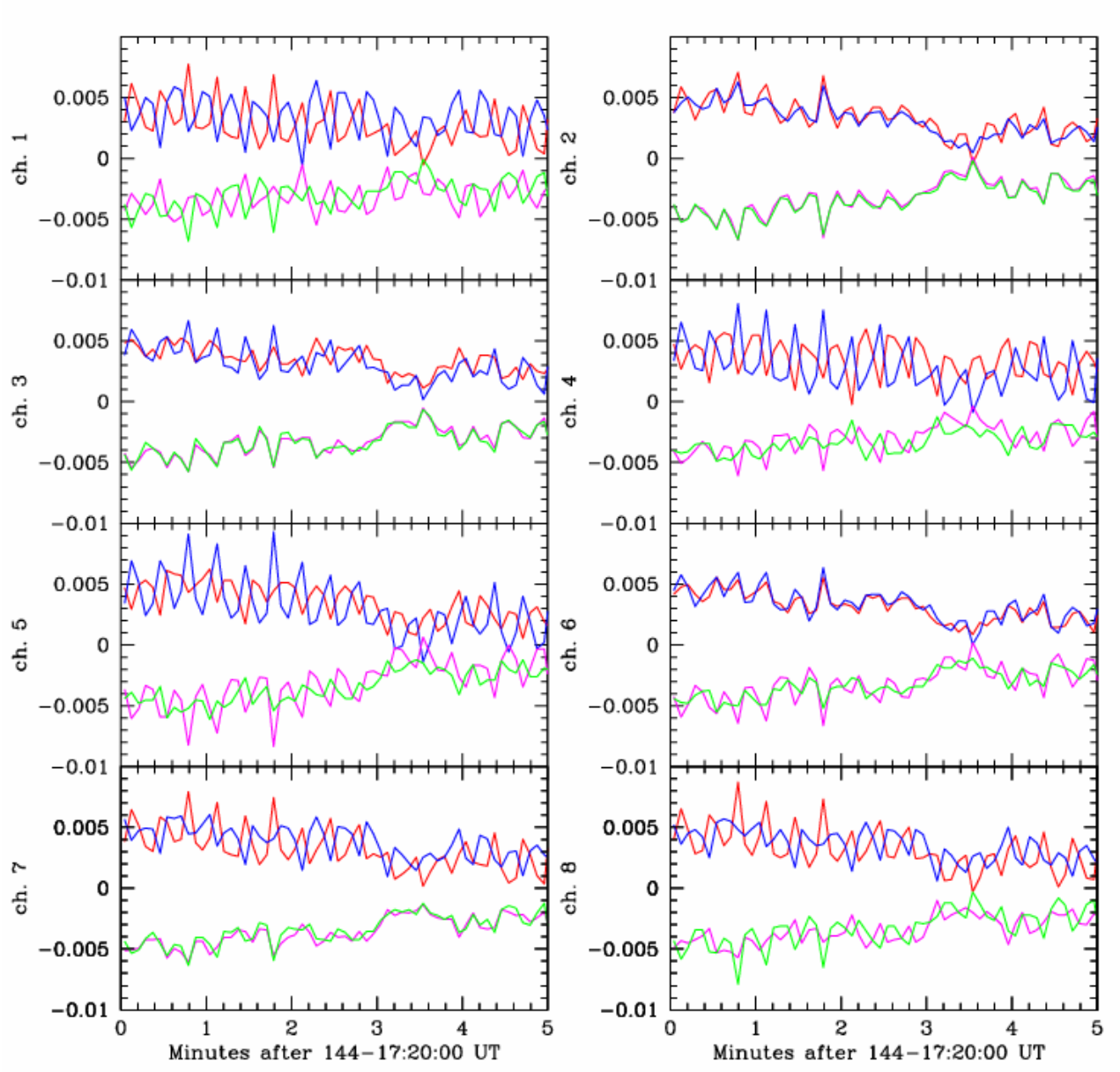

Figure 3. Variations in fractions of 2-bit samples in each of the four states for the first five minutes of Westford L-pol scan 144-1720, by frequency channel. In each panel, + + states are in red, – – states in blue, + states in magenta, and – states in green. The mean fraction over the scan in each state has been subtracted from each time series, in order to be able to plot all four curves in the same panel. The + + and – – curves have been offset by +0.003, and the + and – curves by -0.003, in reduce clutter. The ordinates run from -0.01 to +0.01. Data are five-second averages.

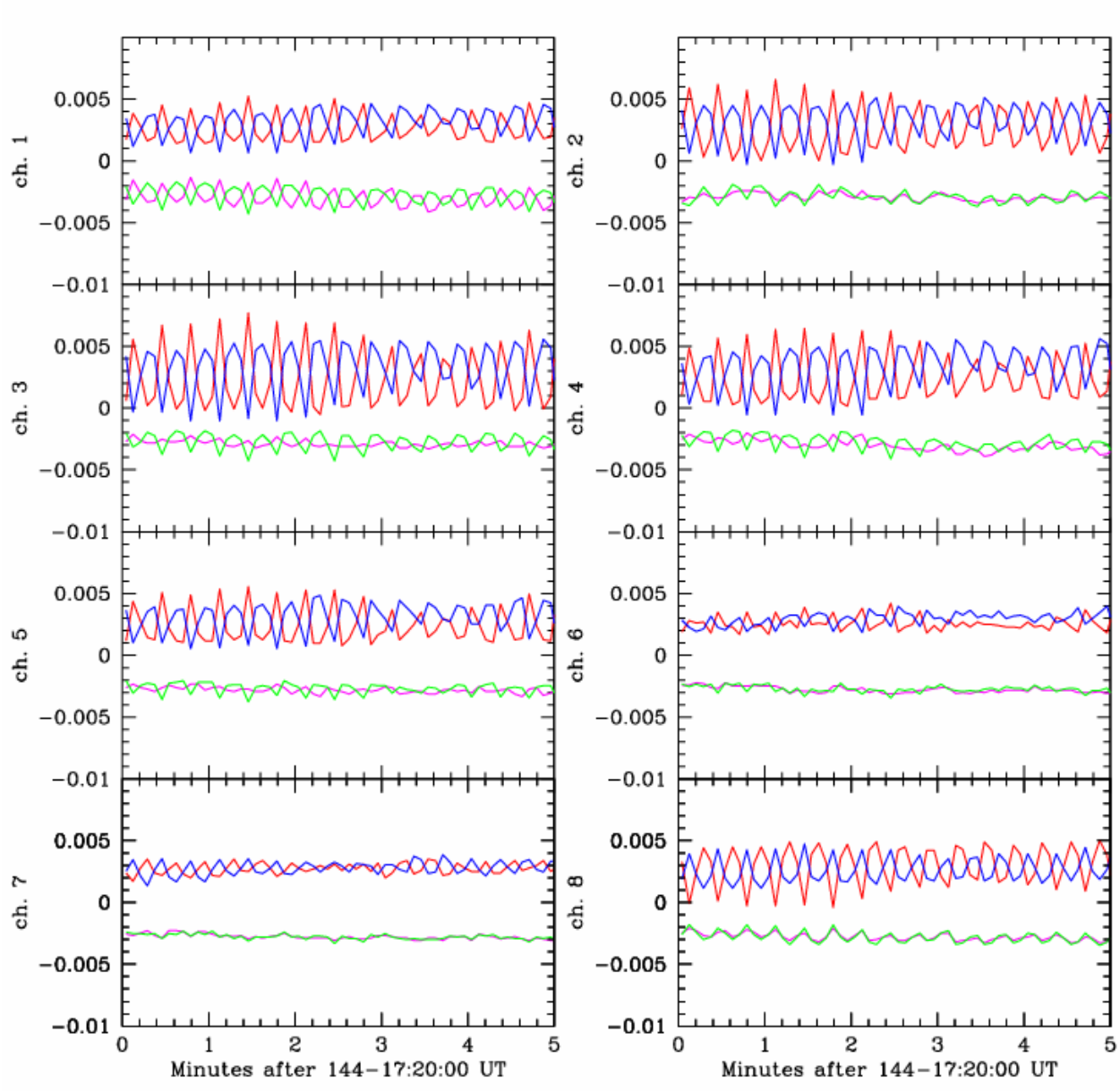

Figure 4. Same as figure 3 except that samples are R-pol.