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Phase Pattern with the New Echotek Board

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Abstract

This note describes the pattern in the phases produced by the new Echotek board. There is a clear pattern but I don't yet understand its origin. Hopefully the pattern will help us to understand what the board is actually doing.

Beams-doc-1299 and 1300 described a problem with the new Echotek boards which were installed in A3 for testing. It was expected that the phases of the A and B outputs would appear as five discrete values. However the data in beams-doc-1299 and 1300 appear to take on all values. In this note I will show that there is structure to the phase variation.

The top part of figure 1 shows the phase of the proton A signal plotted as a function of time for about 5000 consecutive measurements taken at a rate of 15 Hz. The data were taken from about 8:25 AM to 8:30 AM on August 13, 2004, during normal HEP running. The data come from T:HPA34A which was data logged at 15 Hz. There is a clear pattern that the data lie in bands. A line through any fixed time intercepts exactly 7 of the bands. One band takes about 1328 ticks of the 15 Hz clock, or about 88.6 seconds, to move from $+\pi$ to $-\pi$.

The bottom part of figure 1 shows a detail of the first few seconds from the upper figure. The red circles are the measurements and the blue lines are drawn to highlight the bands seen in the figure above. Note that the lowest line from the left edge of the plot wraps around to become the top line near the right edge. The data clearly come in clean 3x7 clusters but the time ordering is such that the tail end of one of these clusters is mixed in with the front end of the next cluster.

Figure 2 shows the same data as the lower part of figure 1, plus an extra second or so of data. The black line connecting the first 21 points marks the unit cell of the repeating pattern. The pattern is repeated by the next 21 points, connected by the green line, and by the next 21 points, connected by the yellow line. Inspection will show that the purple line connects points which fall in the same pattern; recall the lowest band wraps around to become the top band. And the blue line marks the pattern repeating a fifth time.

I have not yet checked see how long this pattern persists.

1 Discussion

I don't yet understand the pattern but I am trying out a few ideas. If anyone has an idea, let me know.

I am surprised that the pattern is as stable as it is. There should be periodic breaks in the pattern unless the 15 Hz data logging clock is very, very stable. With the recycler board there were 5 stable phases but I never did find a pattern in the order in which the phases recurred. So it is a surprise to see such a simple pattern here.

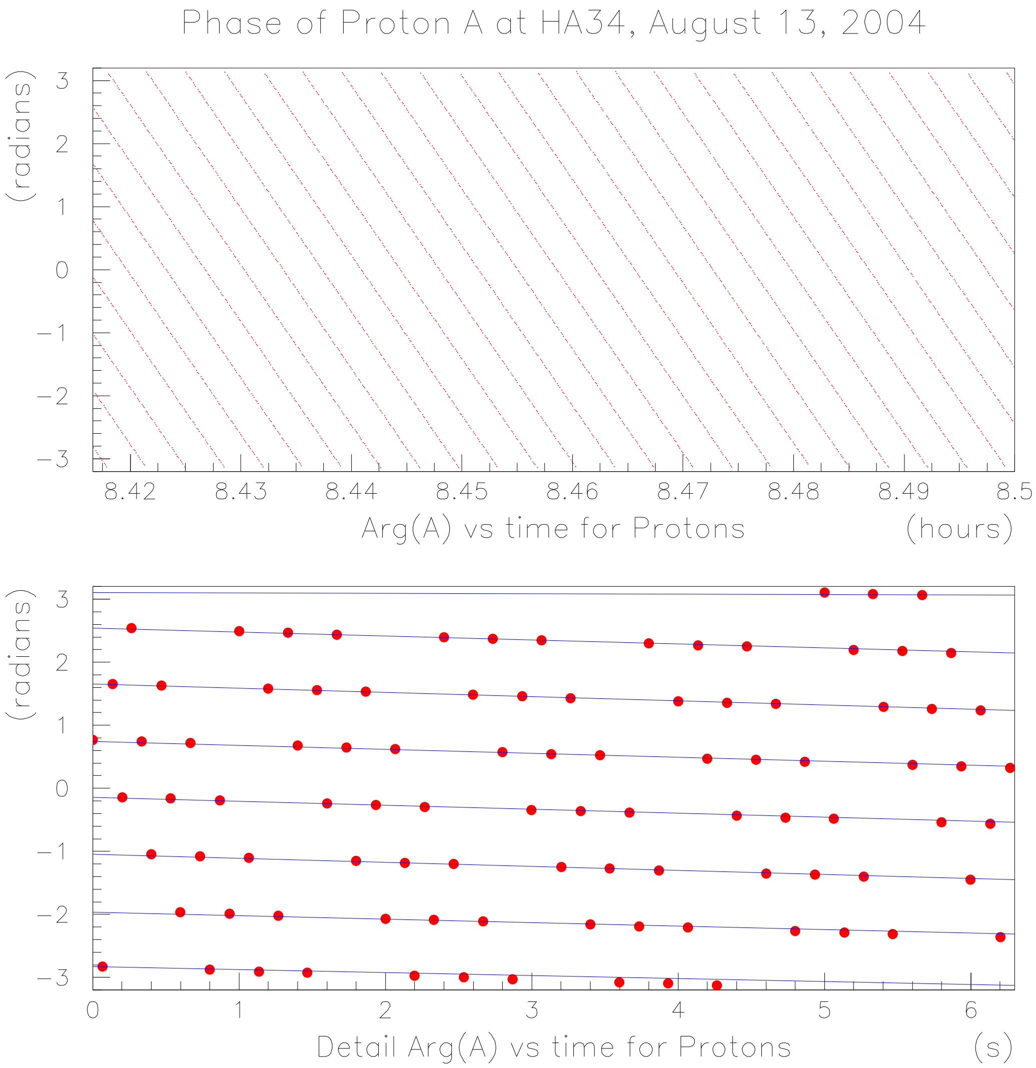

Figure 1: Both plots show the phase of the proton A signal, in radians, plotted against time. The time axis in the upper plot is hour of the day and the time axis on the bottom plot is seconds from the left edge of the plot. In the lower plot, the blue lines are drawn along the bands seen in the upper plot. The structures in the data are discussed in the text.

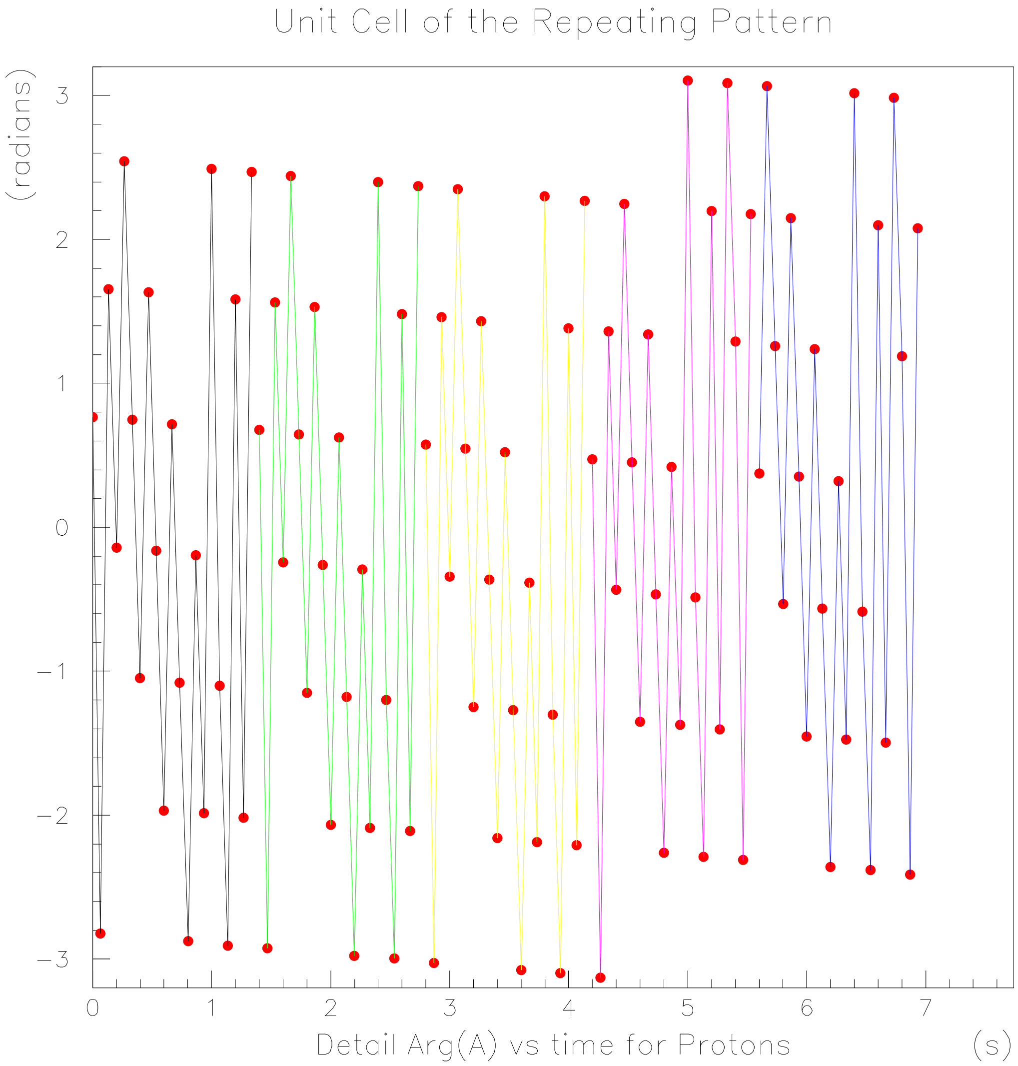

Figure 2: The same data as shown in the lower plot of figure 1, plus an extra second or so of data. The colored lines mark each cycle of the repeating pattern. Note how the pattern stays the same even as the lower band wraps around to the top of the plot. This is discussed further in the text.