Beams-doc-1300-v1
August 10, 2004

Next Look at the BPM's in A3

Rob Kutschke

Abstract

This note describes data taken on Aug 10, 2004 using the new Echotek board in the A3 house. Many of the problems described yesterday have been fixed and the new Echotek board gives the same resolution as does the Recycler Echotek board in the A1 house. Several open questions remain: the phases of the A and B measurements take on all values, whereas previously they took on discrete values, and there are some small discrepancies between the values of the position as computed online and offline.

1 Introduction

This work follows on Beams-doc-1299, which describes the first data taken with the new Echotek board. That work uncovered some problems that were fixed quickly by Luciano. The problems affected only the reported I and Q values, not the reported position.

The data described here were taken between 11:49 AM and 11:55 AM on August 10, 2004, after Luciano's fix was installed. At this time an HEP store was in progress, so both protons and anti-protons were in the machine. The HEP store was extended beyond the planned end of store because of problems in other parts of the accelerator complex. So the beam currents were lower than normal.

2 The Data

Figure 1 shows a set of plots for data taken at VA35 using the new Echotek board. Figure 2 shows the same set of plots for data taken at HA34, also using the new Echotek board. For reference, figures 3 and 4 show the same plots for data taken at the same time using the Recycler Echotek board at VA14 and HA15 The description below is written for the first of these figures but it applies to all of them.

The upper left plot in Figure 1 shows a time series of the proton position at VA35. The blue data points show the value of the device T:VPPA35 taken from the data logger. This is the position as computed in the front end. The red data points show the position as computed offline. In both cases the contamination of the proton signal by the anti-proton beam was ignored and the position, in mm, was computed as:

$$P = \pm 26 \frac{|B| - |A||}{|B| + |A|} \tag{1}$$

where the + sign was used offline and the − was used online. Here A and B are the complex numbers (I, Q) which come from the Echotek.

There is one other difference between the online and offline positions. The offline position is computed from a single (A, B) measurement while the online position is computed as the mean of 32 position measurements. This will be discussed further in section 3.2.

The middle row of plots in Figure 1 shows the the two time series projected onto the position axis. The RMS of these distributions is 13.6 μm for the online measurement and 13.5 μm for the offline measurement. These resolutions are comparable to the resolutions which have been achieved previously. See, for example, Figure 3.

The top right plot in Figure 1 shows the phase of the proton A signal plotted against the position, as computed offline. The phase is defined as the argument of the complex number (I, Q).

The bottom left plot in Figure 1 shows the proton sum signal, $|A| + |B|$, for this time period. And the bottom right plot shows the value of the ACNET variable IBEAM for this time period.

3 Open Questions

3.1 Discrete Phases

Refer to the upper right plot in each figure. In data taken with the Recycler Echotek board the phase of A takes on discrete values but, for data taken with the new Echotek board, it takes on all values. Compare the upper right plot in figures 1 and 2 with that in figures 3 and figure 4. Presumably the reason for the difference has something to do with timing — the problem might be on the Echotek board or elsewhere. Dehong and Luciano have some ideas on how they can look into this.

3.2 Resolution Questions

After correcting for the sign change, the position computed online and that computed offline are not exactly the same. For HA34 the distribution of the difference is approximately a gaussian with a mean of 0 and an RMS of 4 μm.

This is hard to understand. If the online and offline measurements use data taken at the same time, then the RMS of the difference distribution should be zero.

The data extracted from the data logger are in a text format but they are printed with enough significant figures that the difference cannot be explained by loss of precision in the data transfer via the data logger and text file.

On the other hand, if the online and offline measurements were taken at different times then one would expect an RMS which is the sum, in quadrature, of the RMS of the online and offline distributions. That is, it should be about 42 μm, not 4 μm.

I asked Dehong about this and he told me that when an online position measurement is requested, the front end uses the most recent 32 (A,B) pairs in the buffer. From these 32 (A,B) pairs, the front end computes 32 positions, and computes their mean. The front end returns this mean position.

When the front end is asked to return (I,Q) data it returns the most recent data in the buffer.

Therefore it is possible for the online and offline measurements to differ.

But this is hard to reconcile with the observation that the online and offline have almost the same RMS: if the online uses 32 times more data, then its RMS should be smaller than that of the offline by a factor of $\sqrt{32}$. This is not observed.

So there remains a question about why the online and offline report different positions.

Dehong was not certain that the all 32 of the measurements in the buffer were valid and independent. If there is indeed a problem here, it could explain the observations.

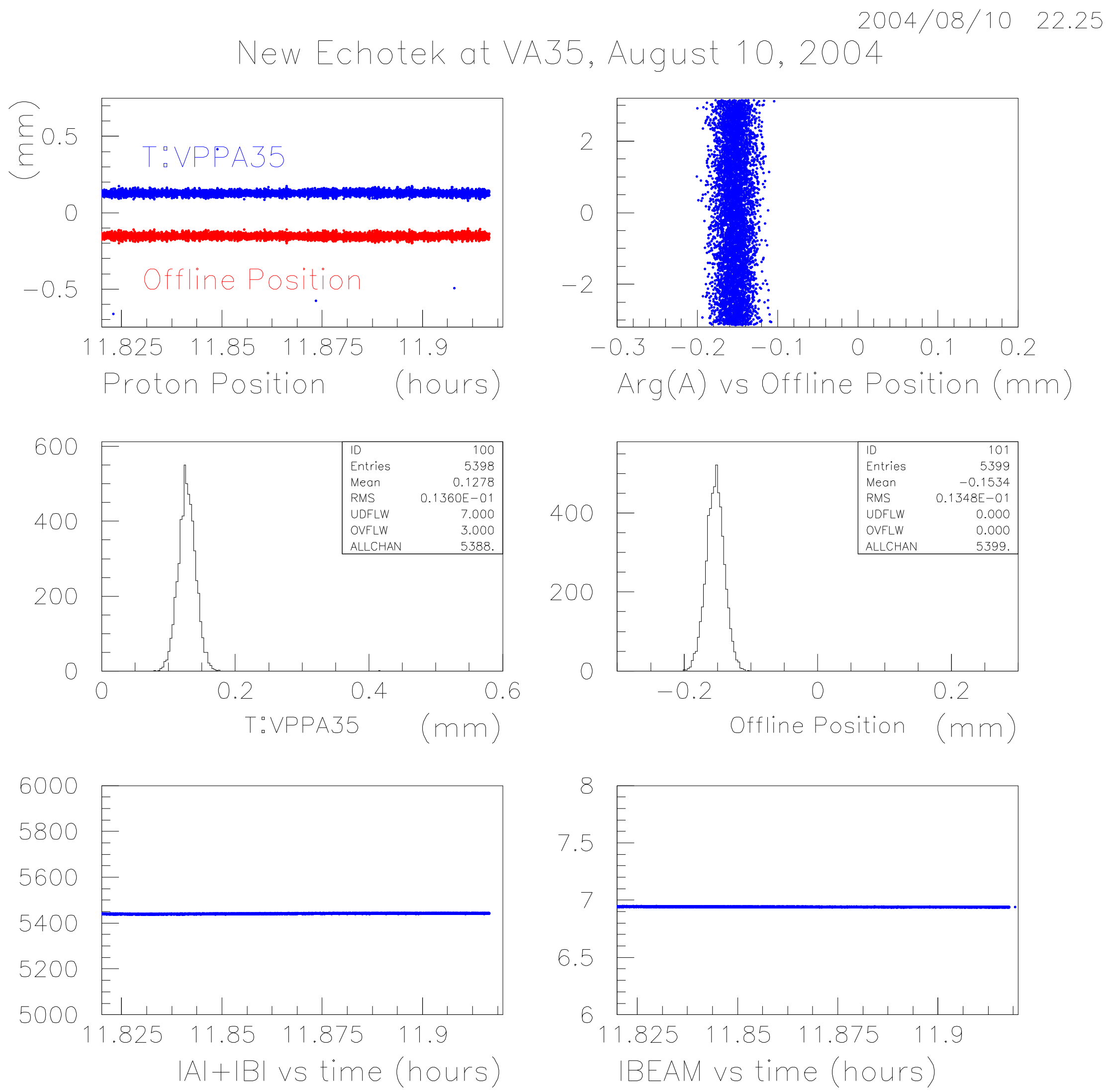

Figure 1: Study of proton position resolution at BPM VA35 using the new Echotek board. The plots are described in the text.

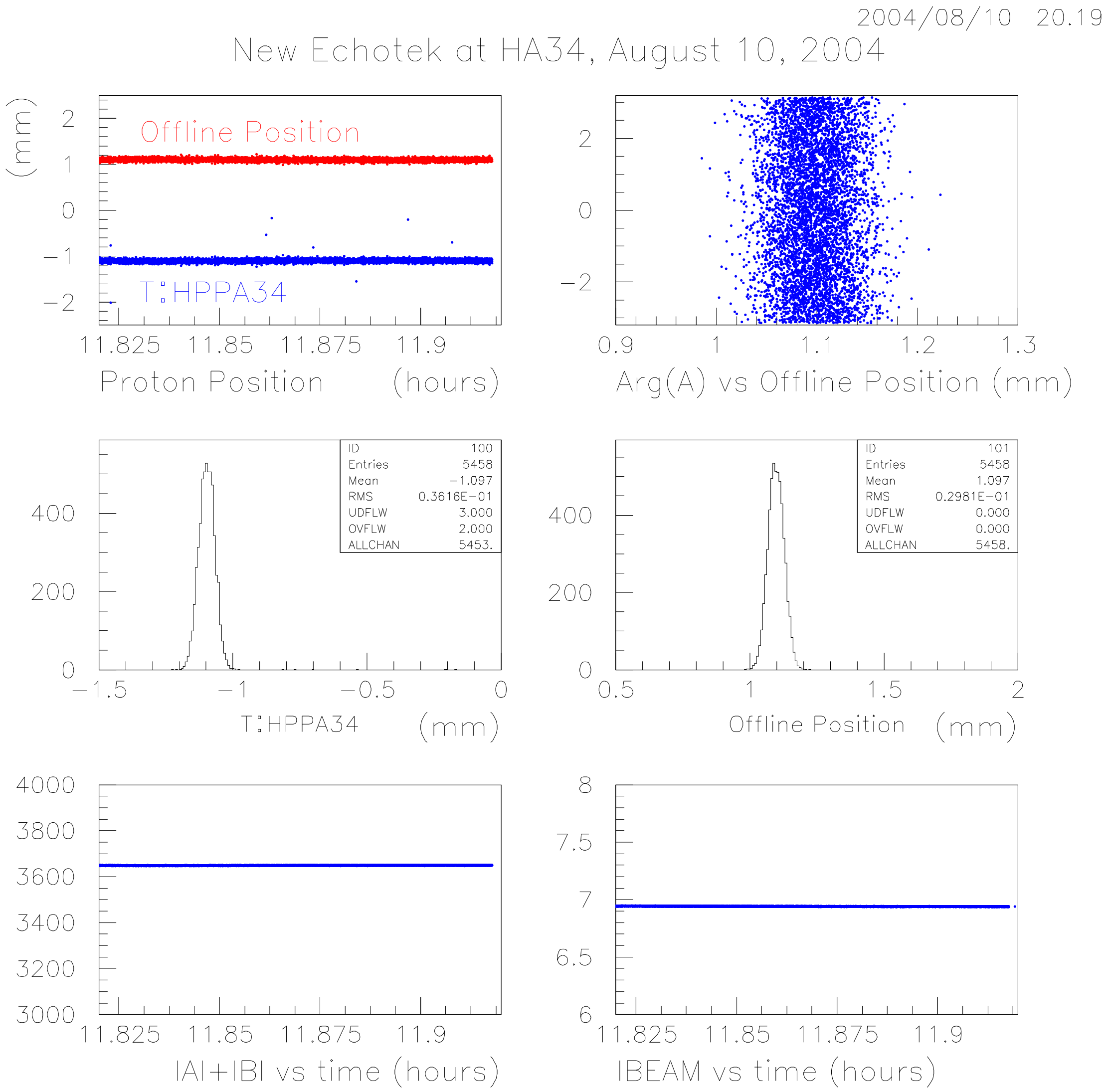

Figure 2: Study of proton position resolution at BPM HA34 using the new Echotek board. The plots are described in text.

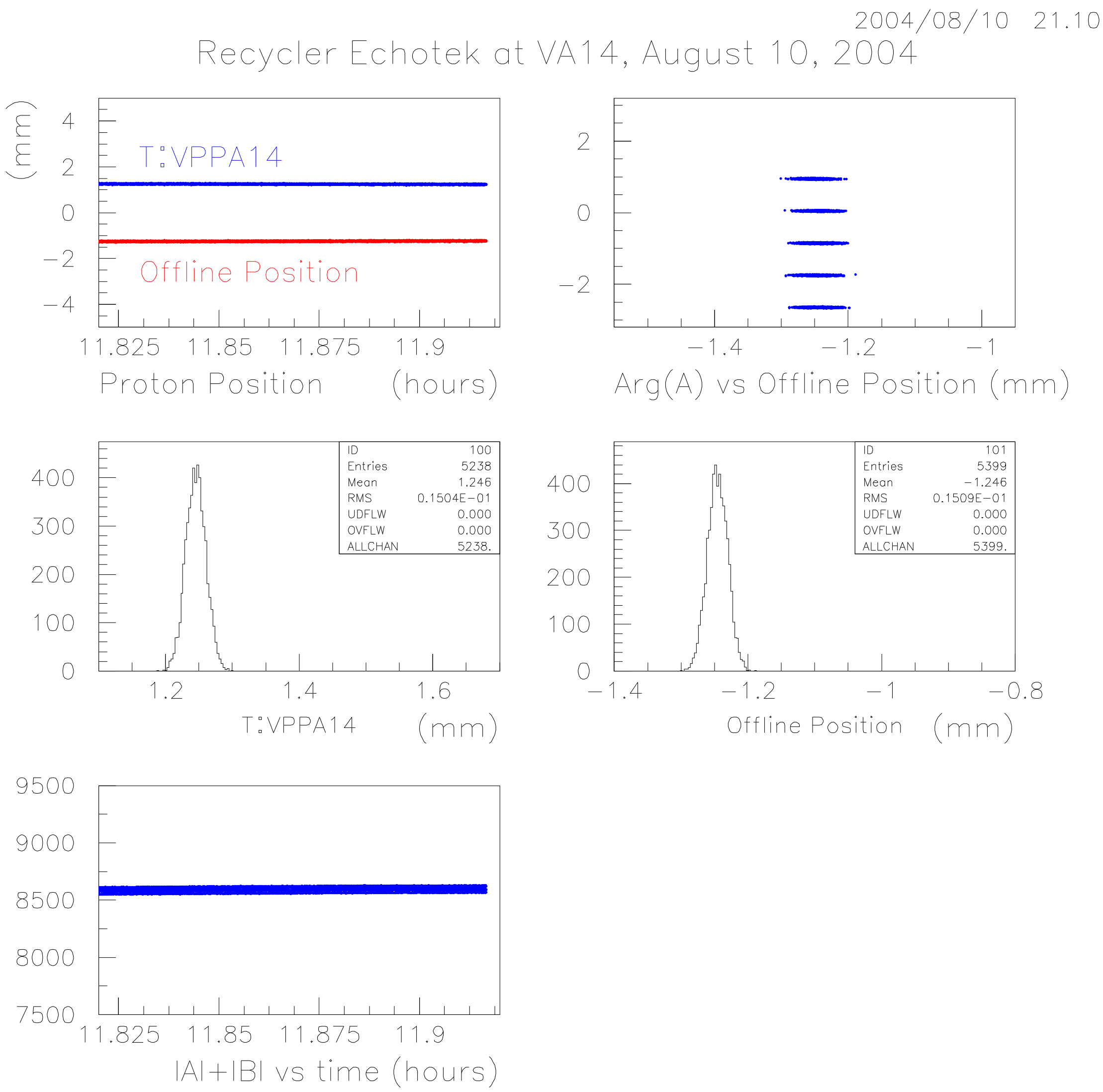

Figure 3: Study of proton position resolution at BPM VA14 using the Recycler Echotek board. The plots are described in text.

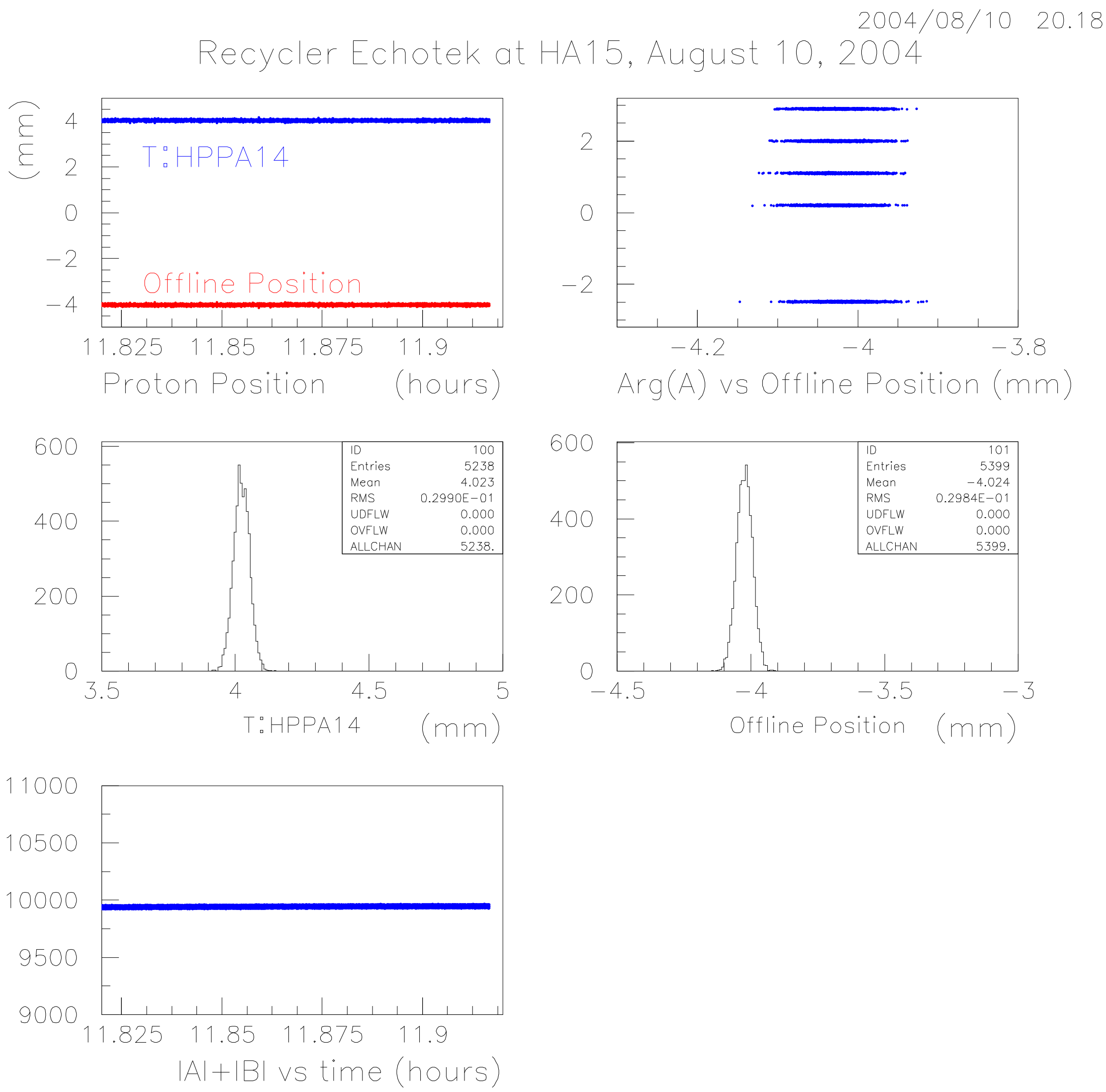

Figure 4: Study of proton position resolution at BPM HA15 using the Recycler Echotek board. The plots are described in text.