

Beams-doc-942

Seeing Antiprotons with the Damper Board

Rob Kutschke

Dec 16, 2003

Overview

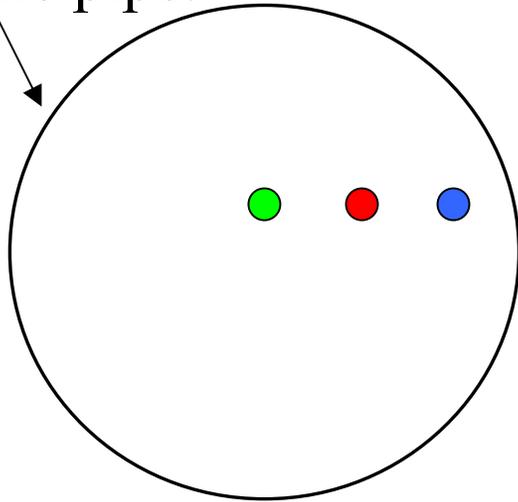
- Goal is to demonstrate the technique for cancellation of the proton contamination on the antiproton cables.
- We will show that parts of the technique work but we do not yet have a full, quantitative demonstration.
- We expect this demonstration to converge soon.
- This talk is a status report.

Configuration for These Tests

- BPM HA15 during the shot set up at about 4:30 PM on Dec 4.
- All 4 cables instrumented.
- Damper board produces I and Q signals for about 9.7 turns for each of the 4 cables.
- Define notation used in this talk:
 - **A and B**: signals on the proton direction cables.
 - **C and D**: signals on the pbar direction cables.

Predicting Pbar Position

Beampipe, view
down the pipe.



The test: can we measure
the Pbars to be where they
are predicted to be?

- Central orbit.
 - Measured with protons only before helix opened.
- Proton orbit:
 - Measured with protons only after helix opened.
- Predicted Antiproton orbit:
 - Shift wrt central orbit is equal and opposite to that of proton orbit.

Definition of A and B

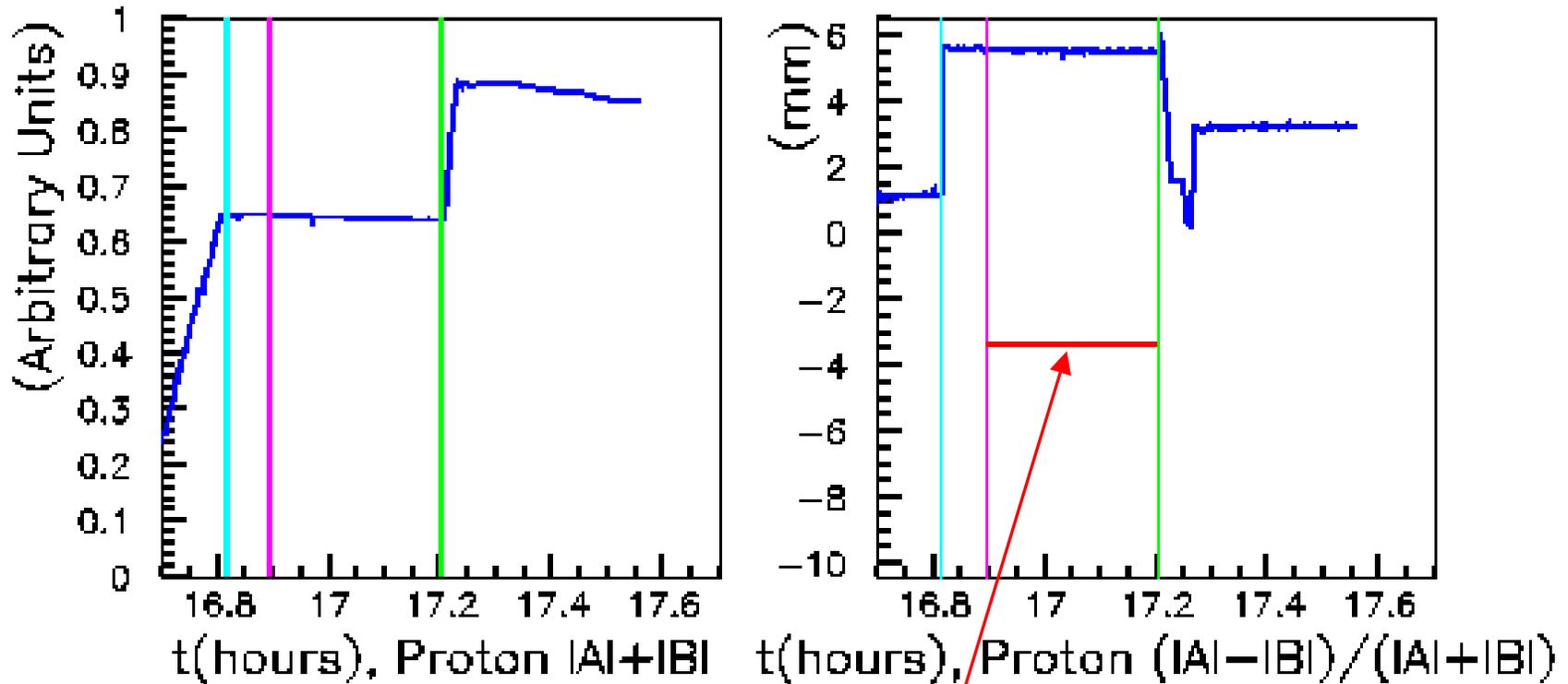
$$I_A = \sum_n I_n$$

$$Q_A = \sum_n Q_n$$

$$A = \text{Complex}(I_A, Q_A)$$

- I_n and Q_n are the outputs of the damper board DDC.
- New (I_n, Q_n) every ≈ 99 ns.
 - Exactly $\frac{1}{4}$ of time between bunches.
- Sum runs over all data, about 9.7 turns.
- Similarly for B, C, D.
- Cancellation of proton contamination on C and D will be discussed later.

Proton Information



Helix opens

Pbar injection starts

Ramp 150 to 980 GeV

Predicted Pbar position: Central-(Proton-Central).

Define A_0 , B_0 , C_0 , D_0 as values just after helix opens.

Notes on Previous Slide

- During energy ramp, the bunch gets shorter and the power at 53 MHz increases. This causes the A+B signal to change with energy. Will be calibrated out.
- Prediction of Pbar position only valid from Pbar injection to start of ramp.
 - Central orbit may move during ramp, injection point cogging and low beta squeeze.

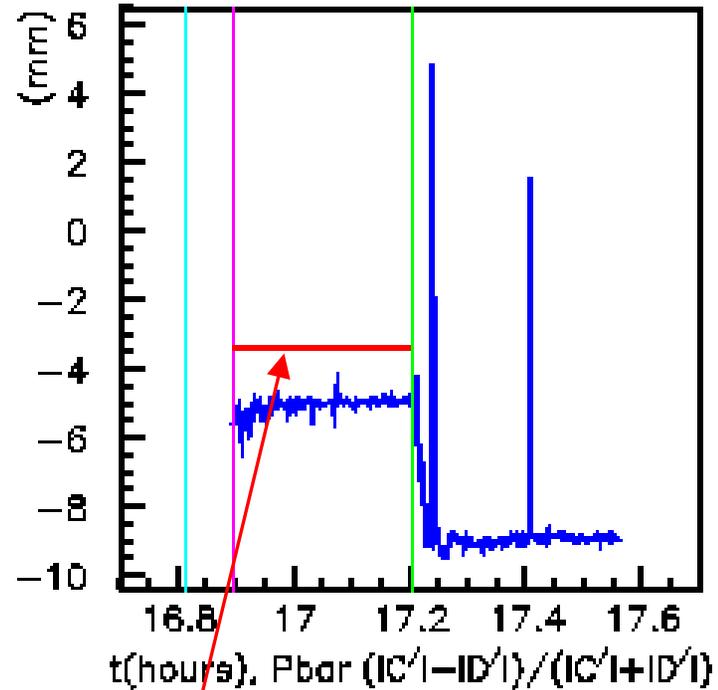
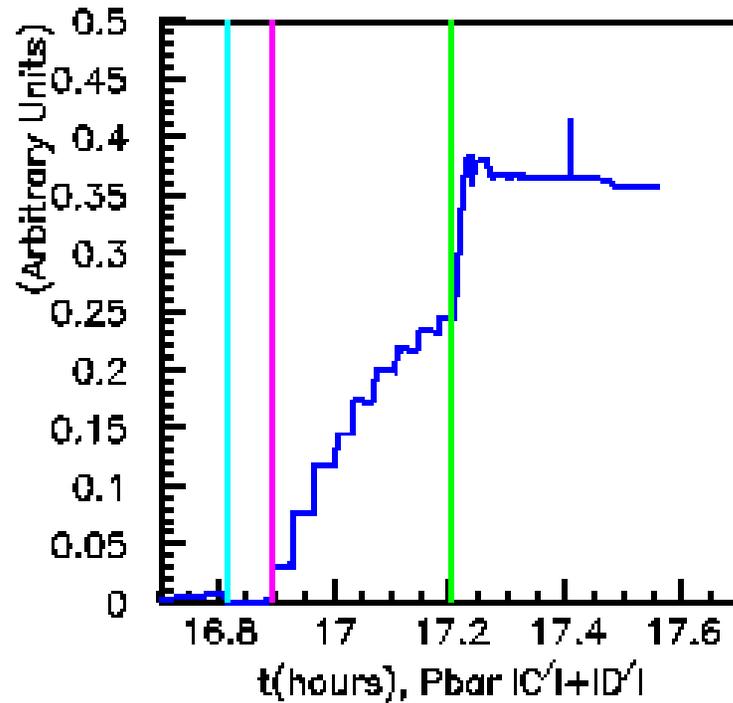
Removing Proton Contamination

$$C'(t) = \frac{C(t) - \frac{C_0}{A_0} A(t)}{1 - r_p r_{\bar{p}}}$$

$$r_p = \frac{C_0}{A_0}$$

- Similarly for D.
- **Approximation:** In the following pages we set the denominator to 1 and hope it's good enough.
- Equation (9) in beams-doc-884. (or talk by Jim Steimel).
- C_0 and A_0 measured using protons only.
- Ratios r_p and $r_{\bar{p}}$ are directionality of the plates times transmission coeff's.
- Need measurements with anti-protons only to measure $r_{\bar{p}}$.
 - These are planned.

Pbar Signals After P Cancellation



Helix opens

Pbar injection starts

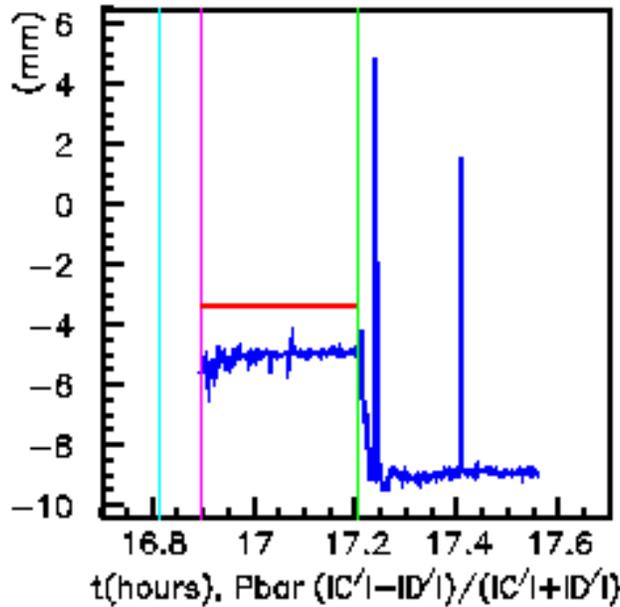
Ramp 150 to 980 GeV

Predicted Pbar position using central and proton orbits.
This prediction is valid only until ramp, when central orbit may change.

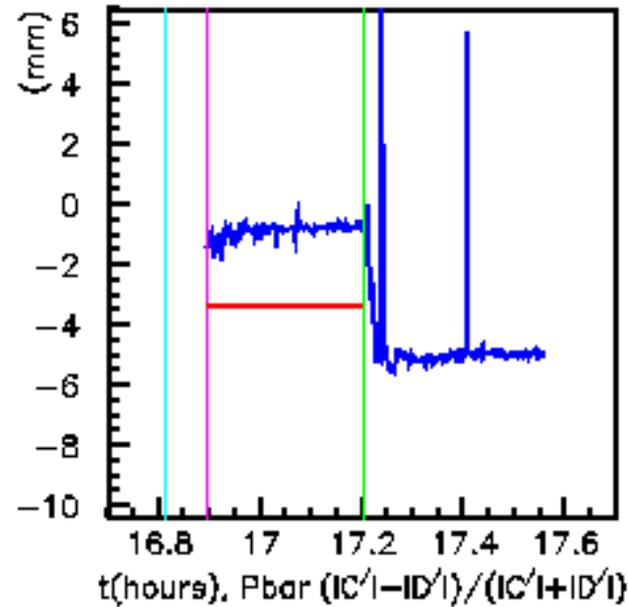
Comments on Previous Slide

- Pbar injection comes in 9 steps with first steps bigger than last.
 - We see this.
- Obvious scale problem in position plot. We think that the directionality factors can fix this.
- Not known if big spikes are noise or due to real effects, such as cogging.
- Noise on position decreases with increasing intensity.

Can r_p and r_{pbar} Fix The Scale?



$$r_p = r_{\bar{p}} = 0$$



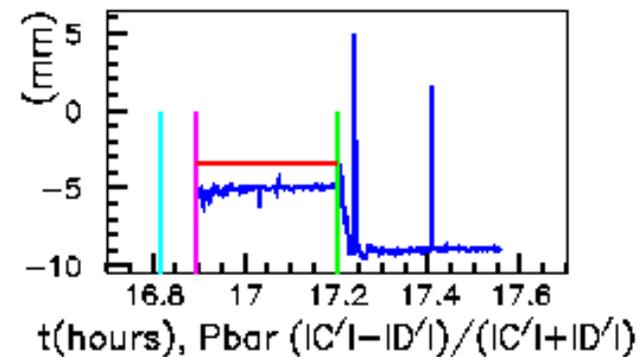
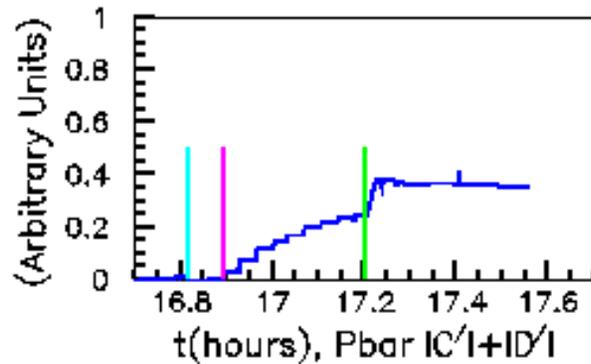
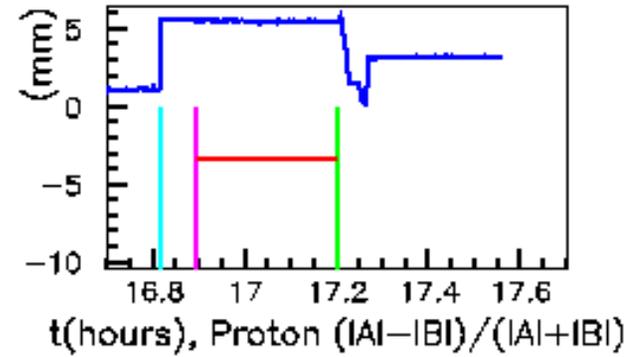
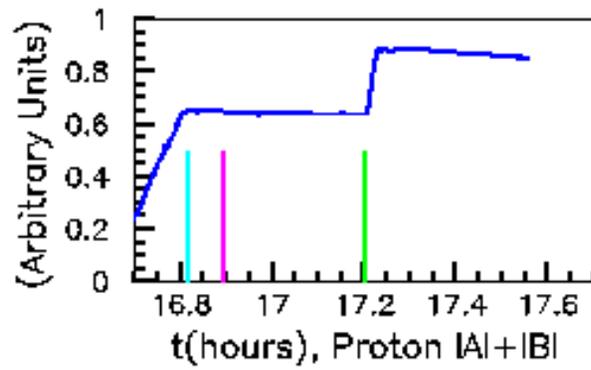
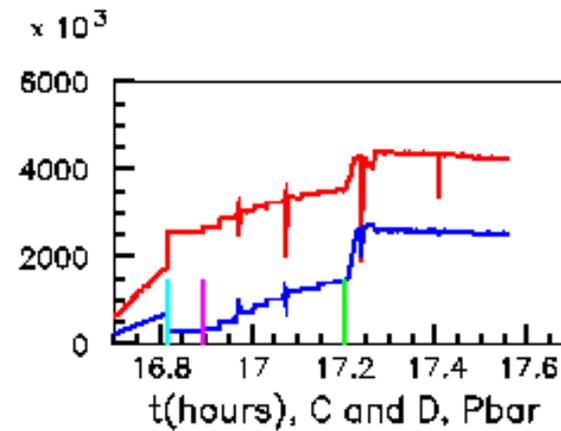
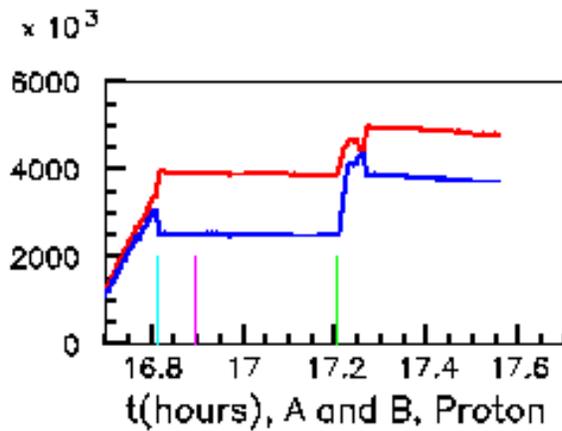
$$r_p = r_{\bar{p}} = \frac{C_0}{A_0}$$

- The effect the ratios is of the right size to cover the discrepancy.
- All numbers are complex. So $|1-r^2|$ can be > 0 .

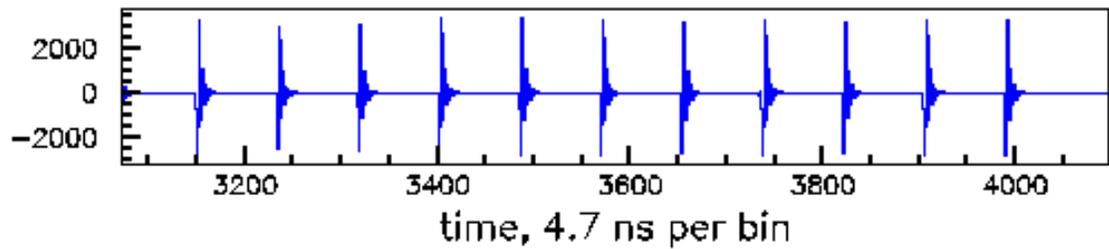
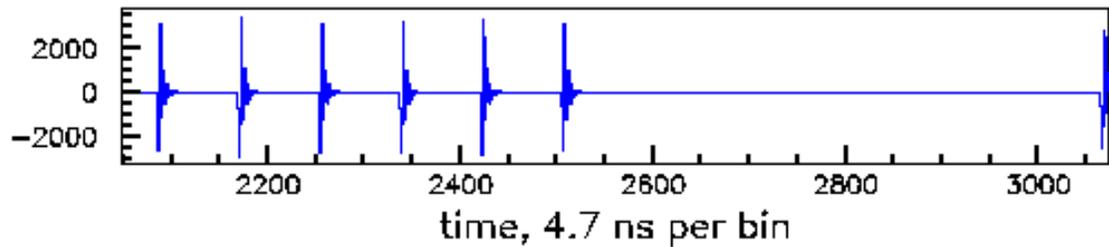
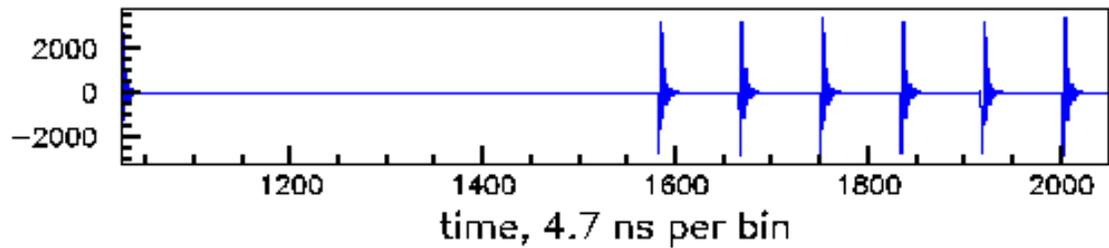
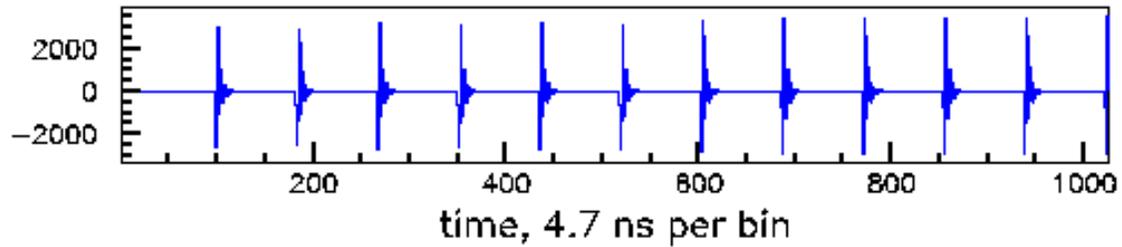
Conclusions

- We can see clean signals for antiprotons in the presence of protons.
- We still need to measure one more calibration number before we can assess accuracy, resolution and stability.

Backup Slides



Raw data, Plate A Proton End



Raw data, Plate A Pbar End

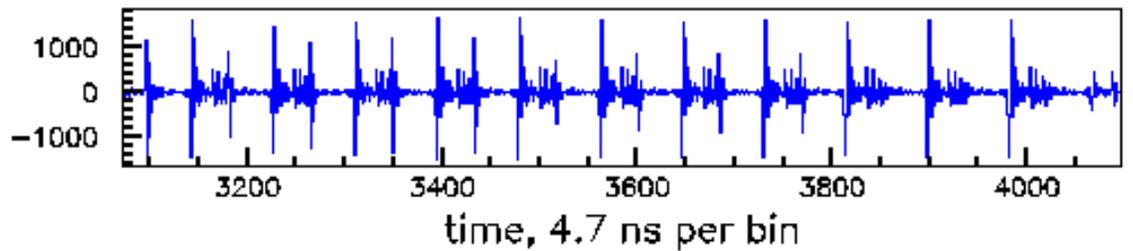
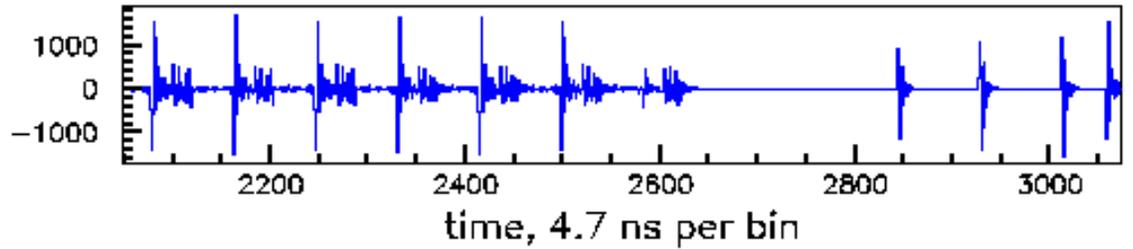
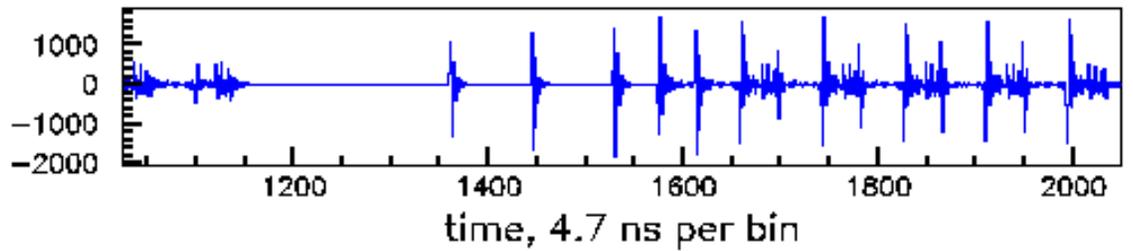
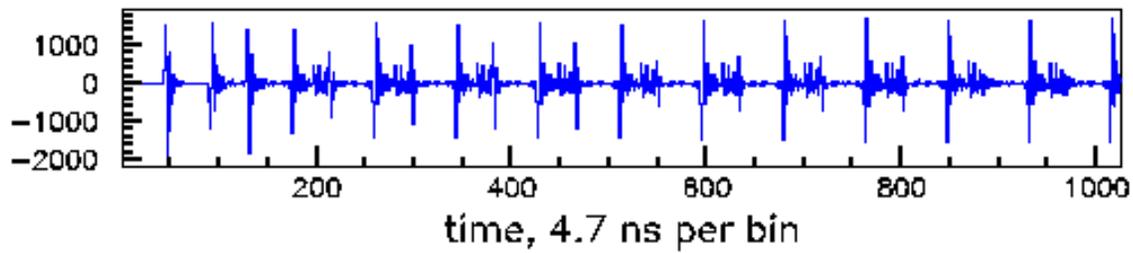


Plate A Proton End, I and Q Full and zoomed scales

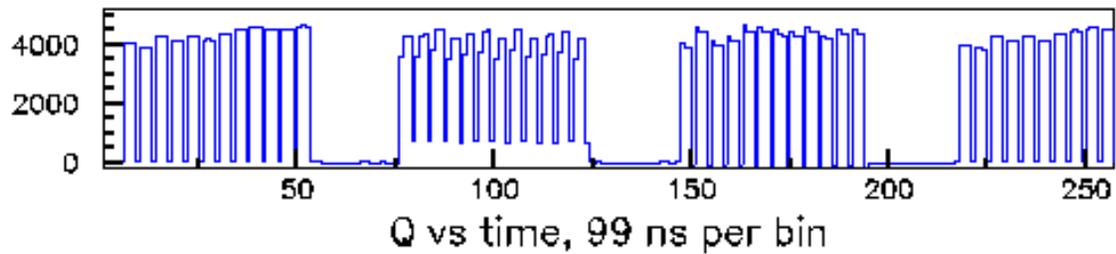
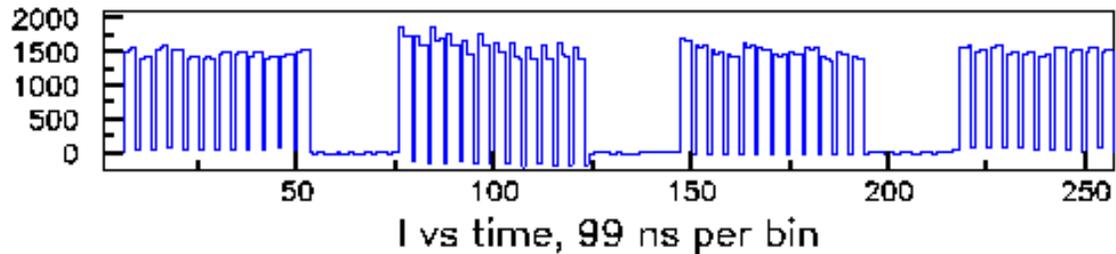
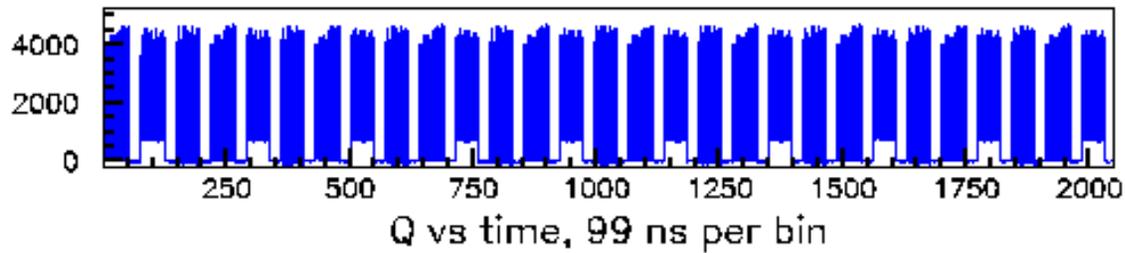
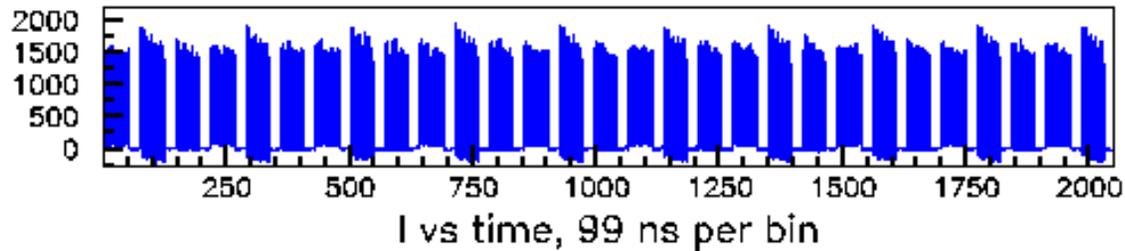


Plate A Pbar End, I and Q Full and zoomed scales

