e+/e- Single Beam Vertical Beam Systematics 1/30/07

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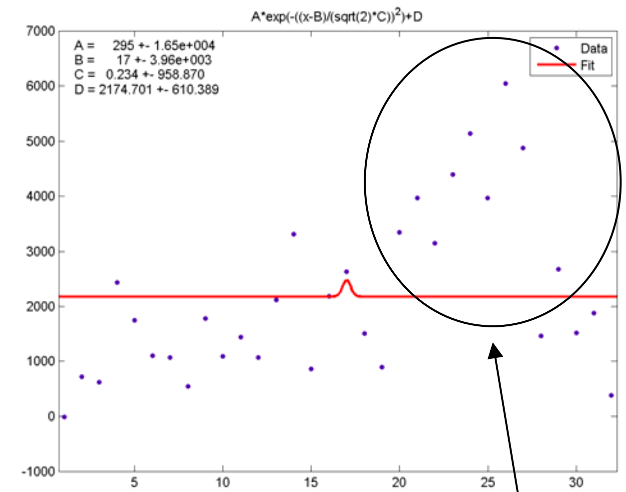
20 Bunches at 14ns Spacing – File 981

- We suspected from the measurements of vertical beam size in file 981 that some of the bunches' signals were not always hitting the PMT.
- We calculated that the range of vertical position values that hit the PMT is 0 to 3.0769mm.
- We plotted the fit vertical beam sizes and positions for all turns and bunches (bottom left and right).
- Several anomalously small σ_v values showed up.
- These values were fits to a single point at the noise level, and corresponded to data with very low peaks. However, as seen in the plot of a gaussian fit over actual data for bunch 19, turn 95 to the right, there appears to be signal on the PMT that the fitter did not catch.

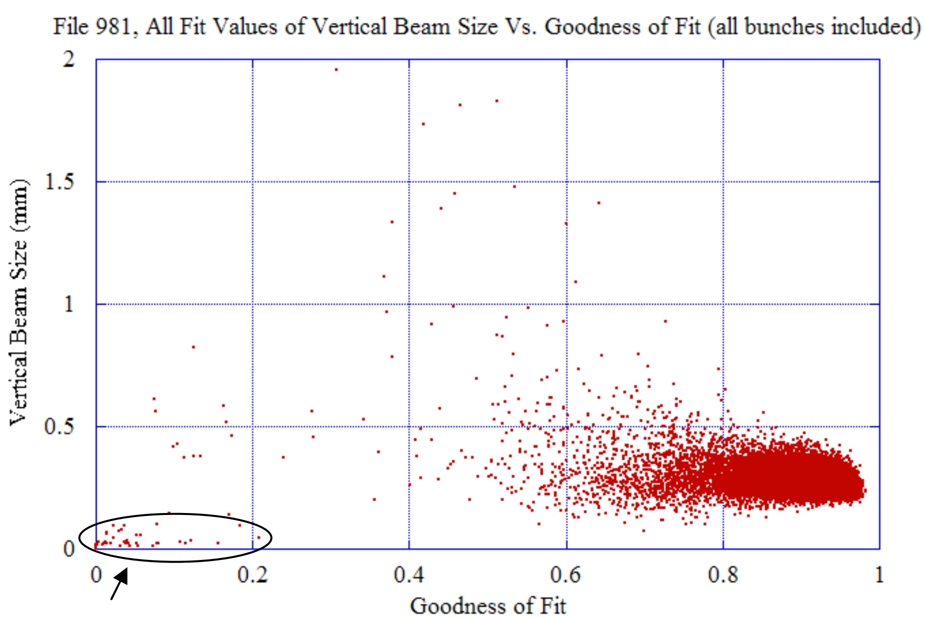
Bunch 19, turn 95

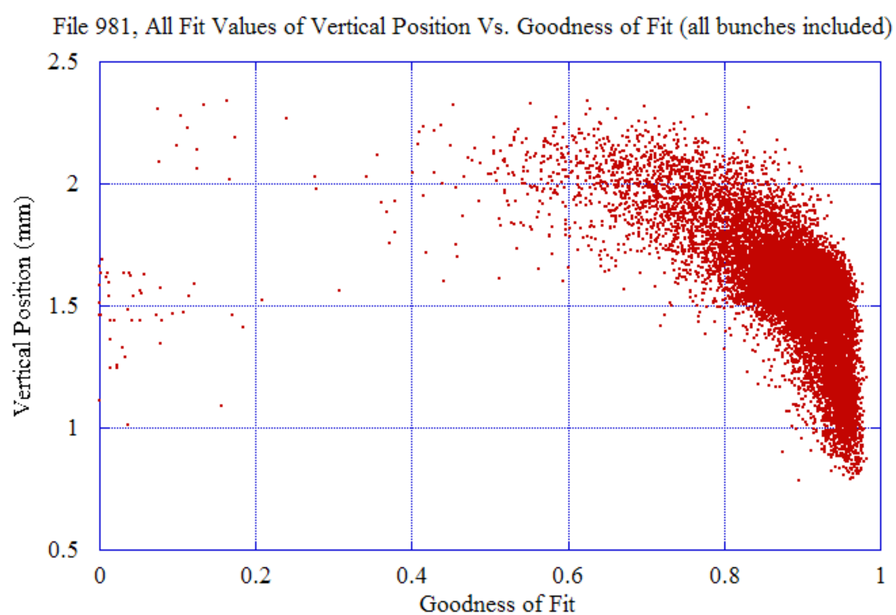


Signal

Ie+ = 0.75mA/bunch

XQ1 = -75



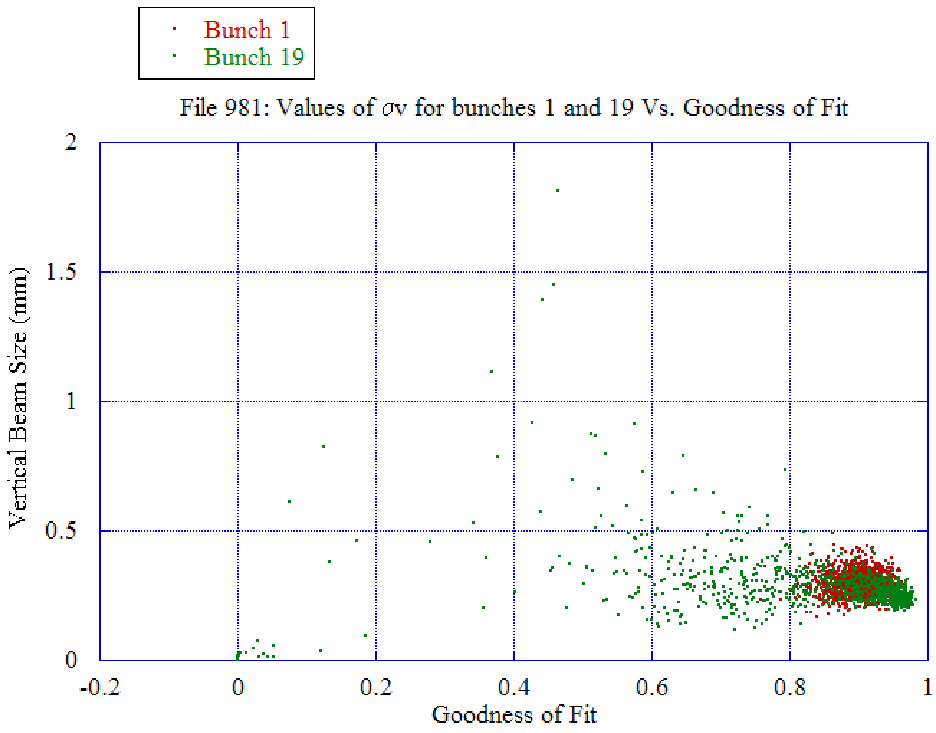


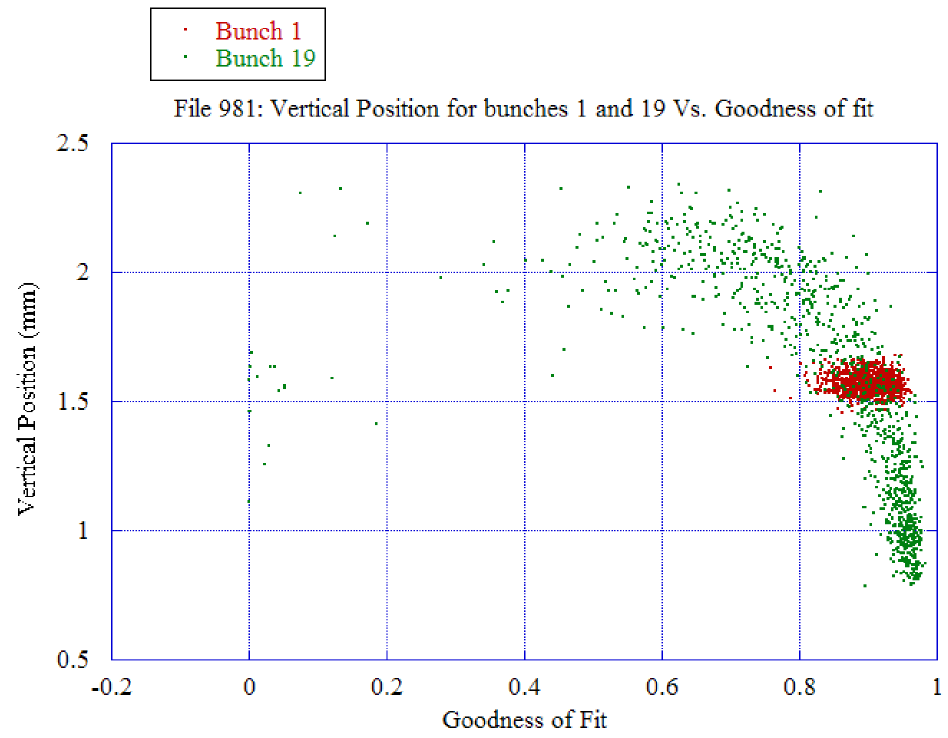
Anomalously small σ_v with poor fit.

20 Bunches at 14ns Spacing – File 981, stable and unstable

- The signals for early bunches in the train differ greatly from those late in the train. Bunches 1 and 19 from measurement 981 are compared here. Bunch 1, which is stable (see FFT slides for beam size and position), has a small range of σ_v and position values, with no goodness of fit values below 0.7. Bunch 19, which is unstable, varies widely in σ_v and position, with some goodness of fit values close to 0.
- There is a clear trend in the unstable bunch 19 for the goodness of fit to decrease as the mean vertical position increases.
- The range of position measurements for which the peak is on the PMT for e+ is 0 to 3.0769mm, so 1.5mm is approximately the center. The fits tend to be better when the position is left of the center: we initially thought this may be due to the reflection present to the left of the signal in positron data. The further to the right the signal is from the center, the less of the right tail is detected while the reflection on the left tail remains. However, subsequent studies of signal height across the PMT suggest there is a calibration problem that accounts for the difference in goodness of fit (see slides 80 – 85).

*Right meaning the direction from low channel number to high channel number.

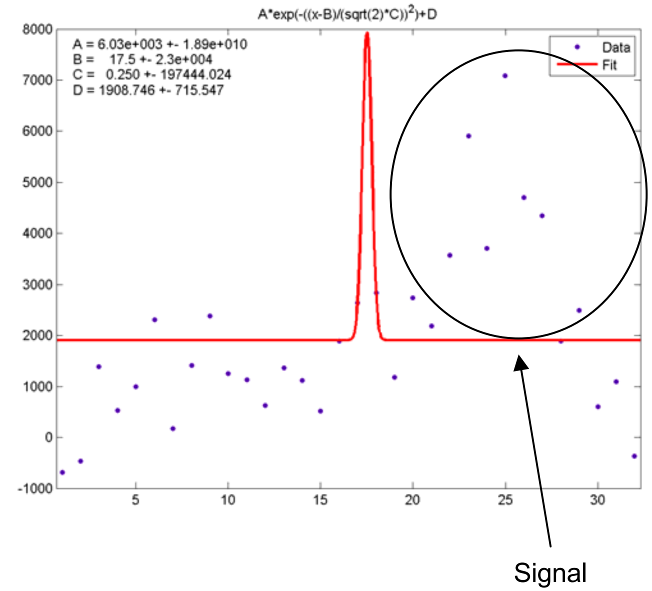


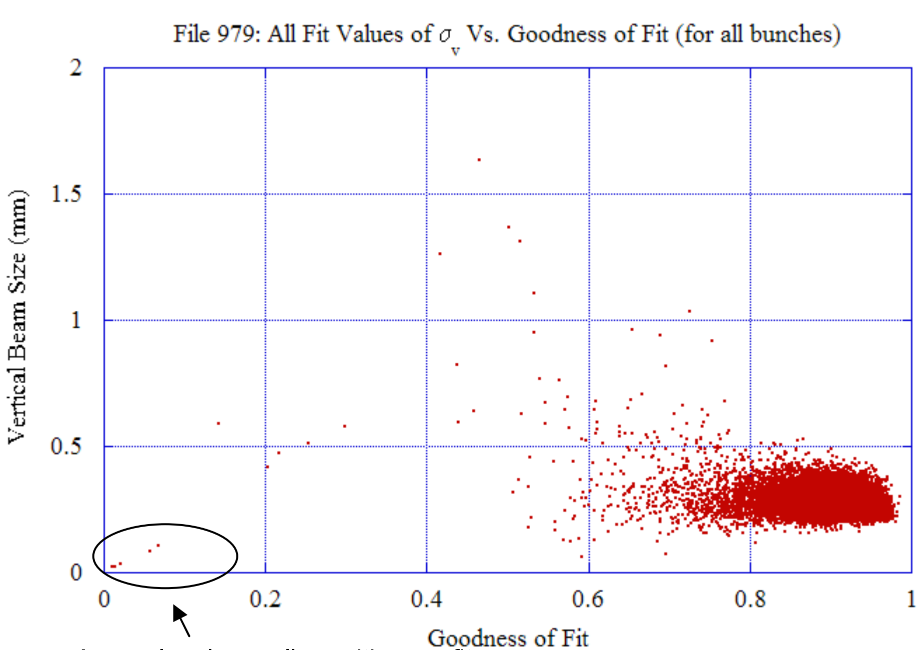


20 Bunches at 14ns Spacing

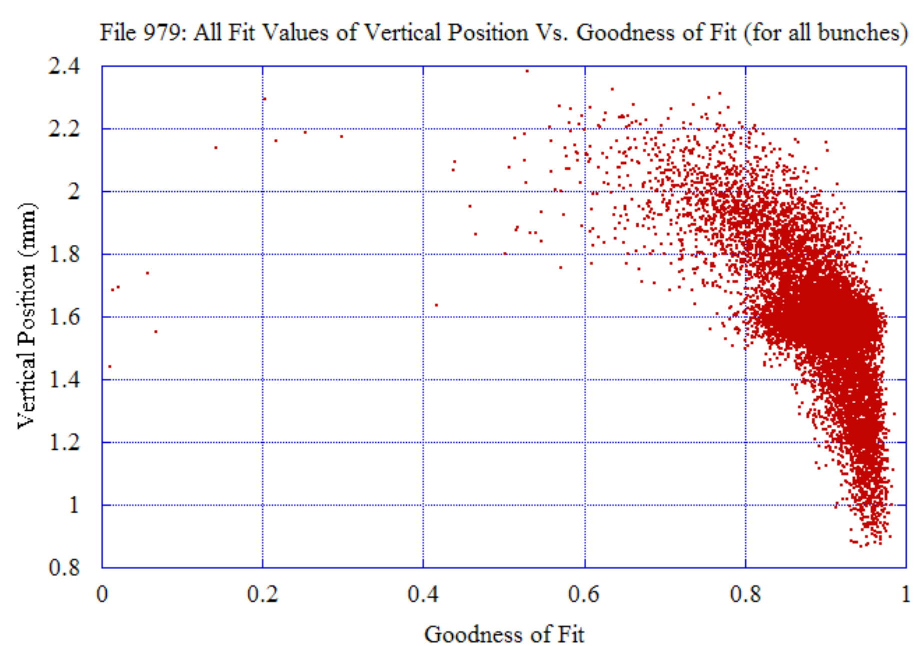
- Very few anomalous points in measurement 979.
- The plots of the gaussian over the actual data were similar to those from file 981 – the fits with very low sigma were fits to points at the noise level. However, there was noisy signal present, as seen in the plot to the right.

Bunch 20, turn 11



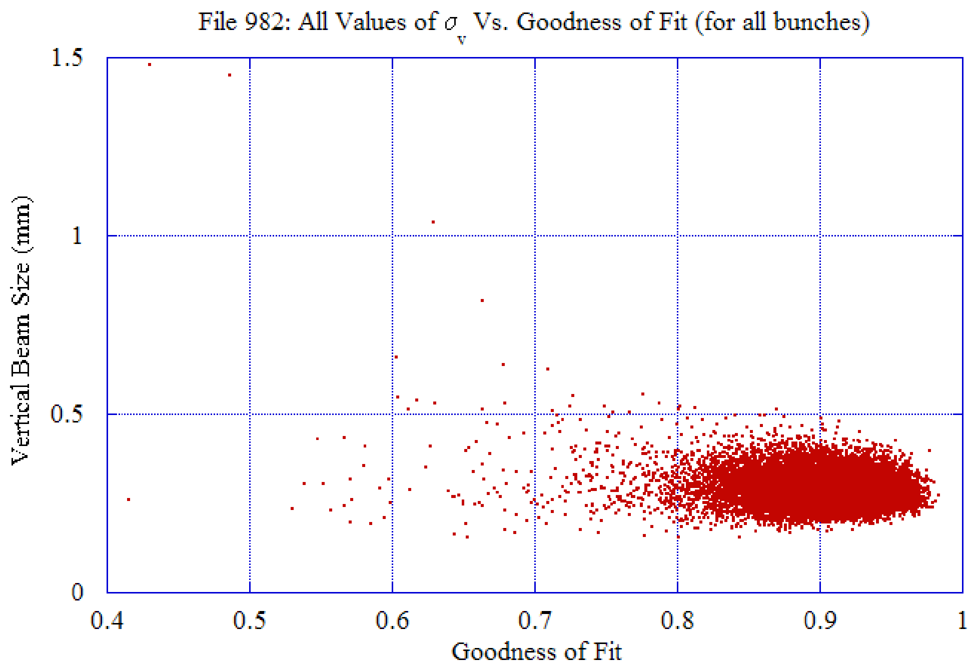


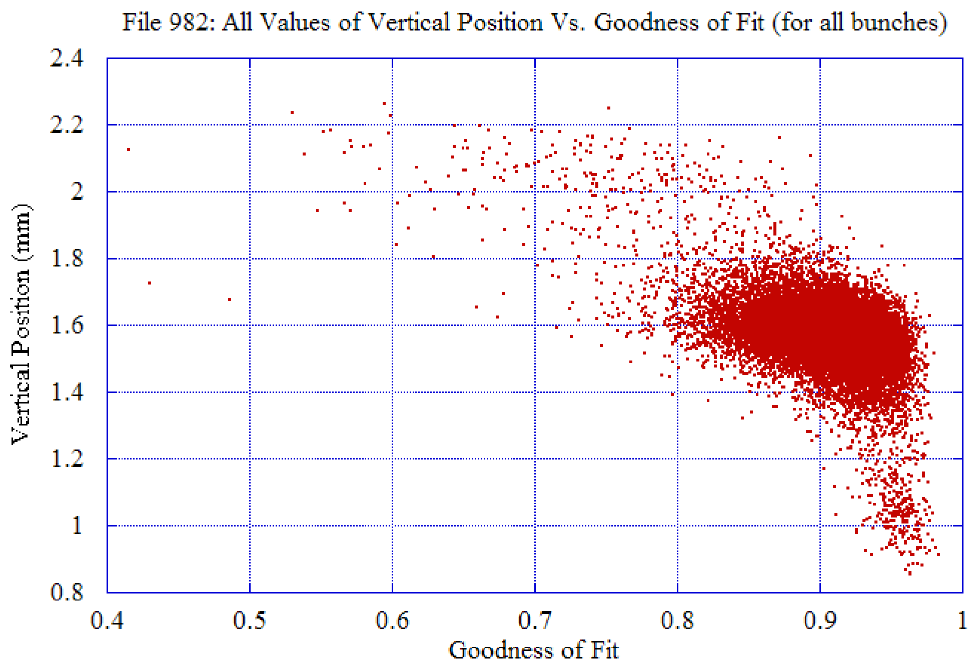
Anomalously small σ_v with poor fit.



20 Bunches at 14ns Spacing

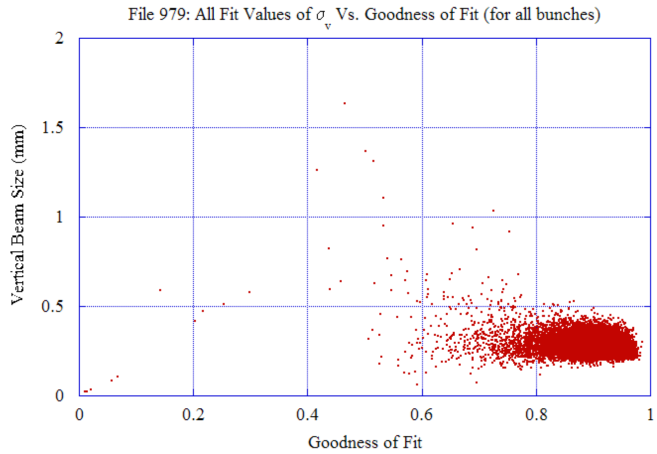
- Measurement 982 does not display any anomalously small vertical beam sizes
- This measurement has no goodness of fit values less than 0.4.
- The vast majority of the position fit values are near the center of the PMT.
- It is noted that there is a trend for the goodness of fit to decrease as the position moves toward the right of the PMT.

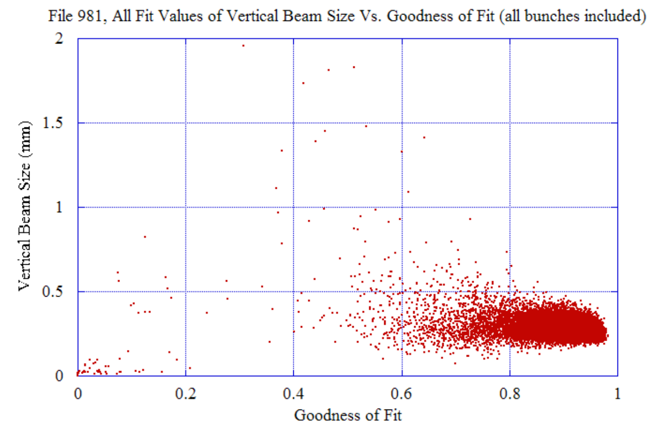


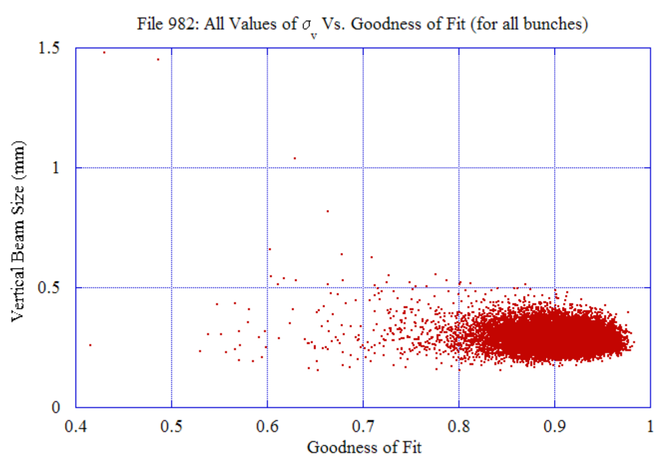


20 Bunches at 14ns Spacing

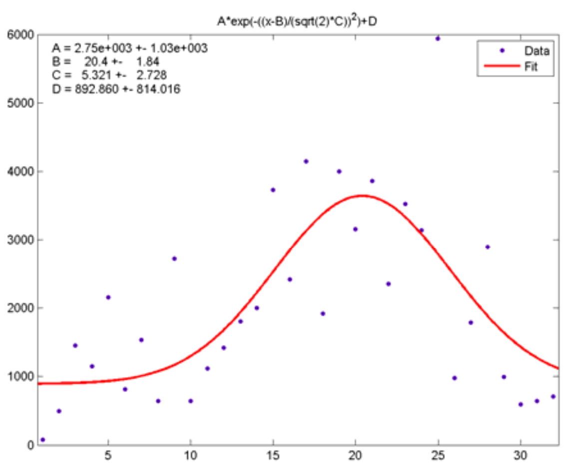
- From these plots of vertical beam size vs. goodness of fit, it becomes apparent that the goodness of fit cut at 0.8 that we have applied for previous measurements was too arbitrary.
- Both for cases 979 and 981, a cut at 0.8 would slice off part of the main body of measurements. For file 982, most of the main cluster would have been included with such a cut, but the average goodness of fit for that measurement was higher than for the other two, and it also does not contain points near 0.
- Below is a plot of bunch 19, turn 7 for file 981. With a goodness of fit of about 0.67, the fit still looks decent, and the reflection to the left is successfully not included in the fit. To its left is a plot also of bunch 19, but turn 16. The goodness of fit for the fit there was about 0.52, but the fit still basically matches the signal.
- We also saw some FFT signals that disappeared when the 0.8 goodness of fit cut was applied to data from this date. We wanted to determine if the FFT signal was real or a result of poor fits.



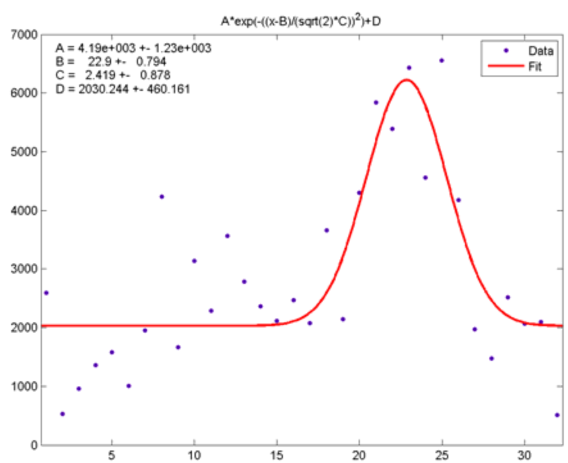




File 981, bunch 19, turn 16, goodness of fit=0.51877



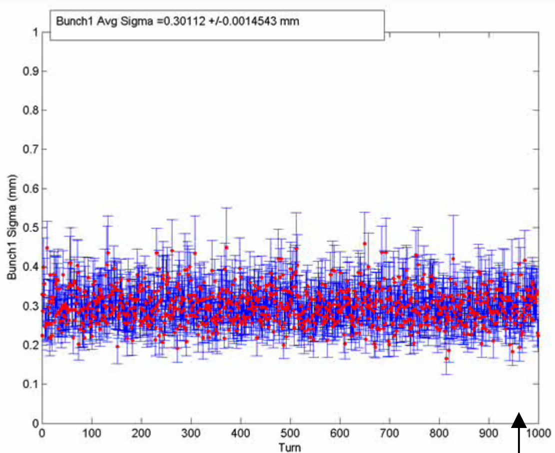
File 981, bunch 19, turn 7, goodness of fit=0.67089



20 Bunches at 14ns Spacing – Vertical Beam Size

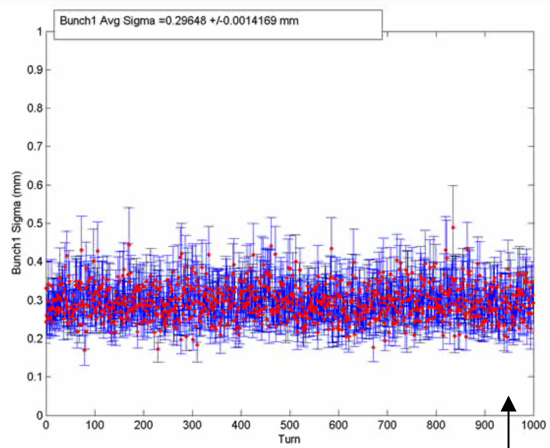
Goodness of fit cuts were subsequently applied to all data at 0.4 and 0.8, except when a very small number of points were between those two values (then only 0.8 was applied).

Movies: no cuts



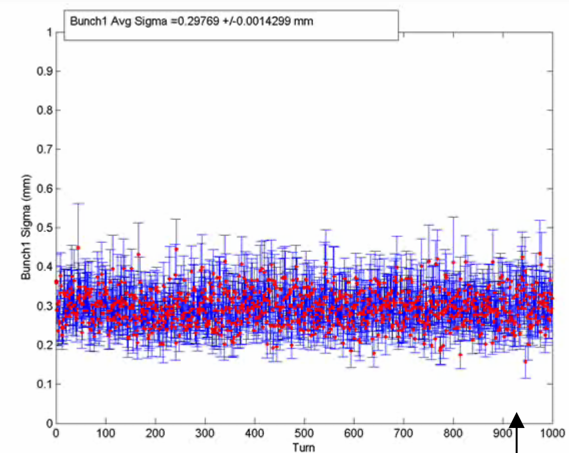
File 979: I_{e+} = 0.75mA/bunch, XQ1 = +122

Fit uncertainties increase greatly after bunch 14.



File 981: Ie+ = 0.75mA/bunch, XQ1 = -75

Fit uncertainties increase greatly after bunch 14. Some vertical beam sizes measured near 0.



File 982: Ie+ = 0.75mA/bunch, XQ1 = -75

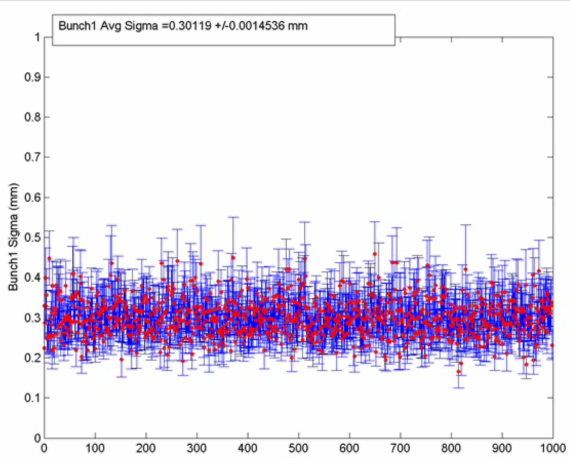
Fit uncertainties greatly increase for bunch 20.

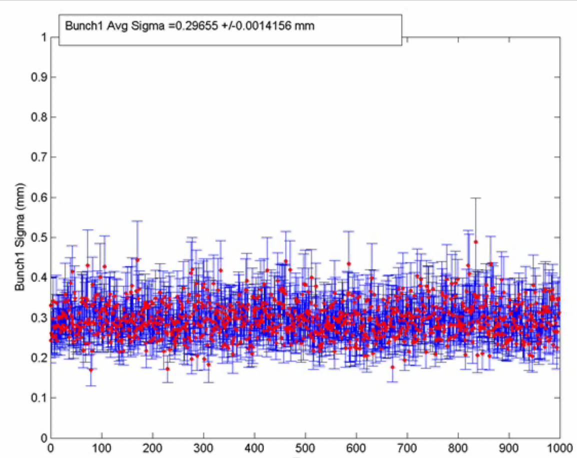
Movies: goodness of fit cut applied at 0.8

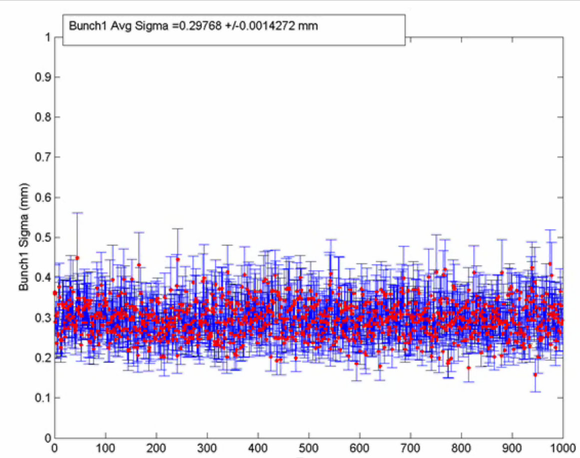
Measurements with higher uncertainties are removed.

No points with sigma near 0, but it is easy to see there are a lot fewer points for many bunches later in the train.

Bunch 20 appears to have many points removed.

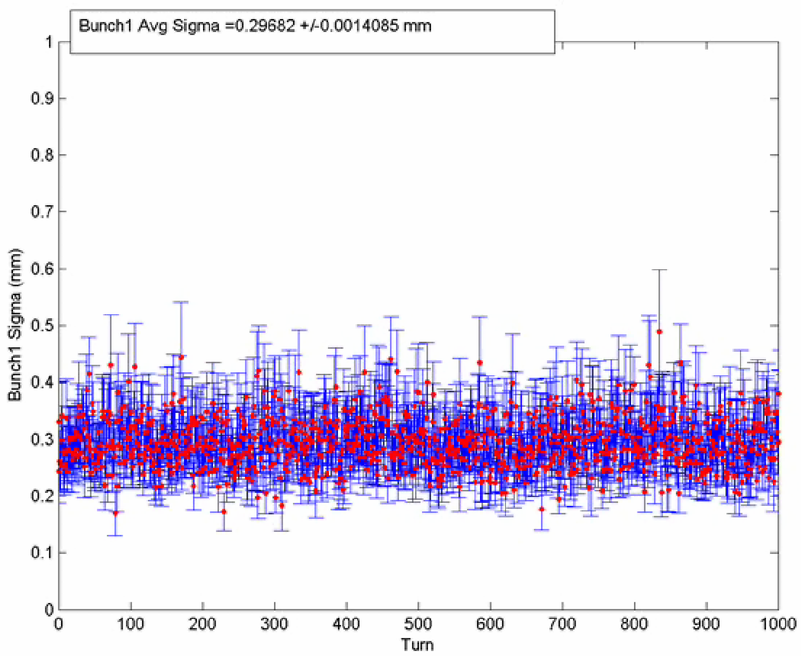


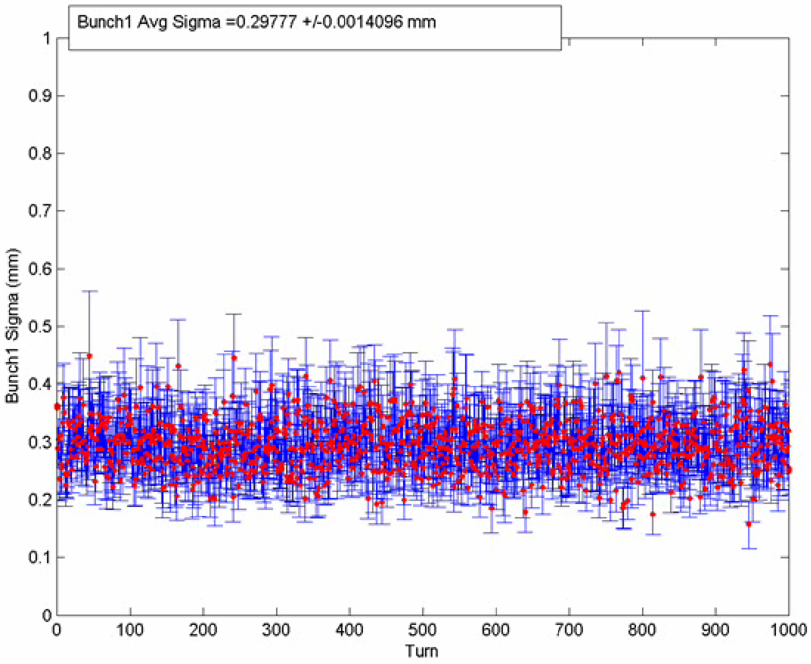




20 Bunches at 14ns Spacing – Vertical Beam Size

Movies: goodness of fit cut applied at 0.4





File 981: Ie+ = 0.75mA/bunch, XQ1 = -75

The points where the fit was among the noise have been removed, but fits to noisy signal are still included. (The more noisy signals are actually signals with lower intensity, so the noise adds more uncertainty to the fit).

File 982: Ie+ = 0.75mA/bunch, XQ1 = -75

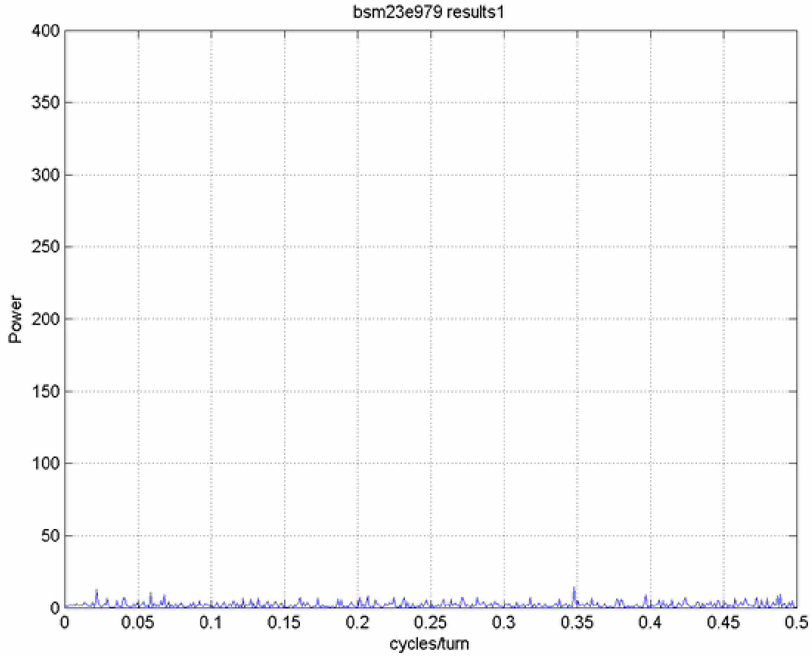
Little difference from the uncut version.

20 Bunches at 14ns Spacing – Vertical Beam Size FFT

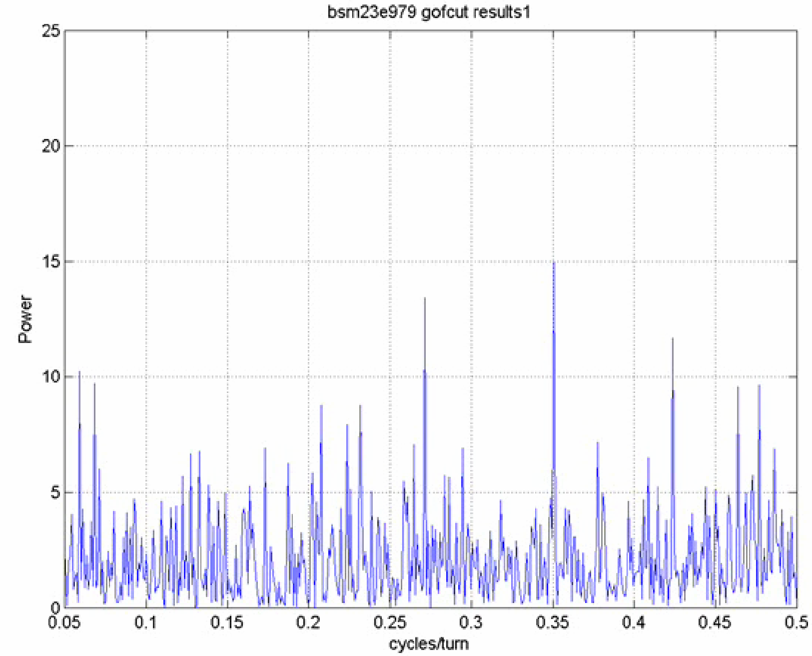
File 979

Movies

No cuts



Cut at 0.8



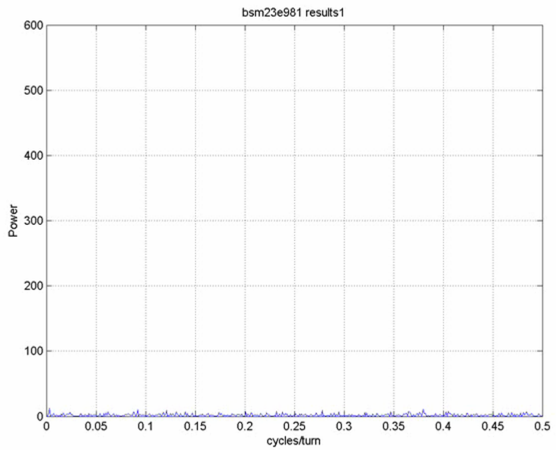
- •So few fits had a goodness of fit between 0.8 and 0.4 that applying the 0.4 cut was deemed unnecessary.
- •The 0.8 cut removes all significant detection of the line at 0.35 cyc/turn (252.9kHz). There does appear to be a line at that frequency, slightly above noise level, in the 0.8 cut data, but at a power an order of magnitude lower than in the uncut data.
- •This also suggests that applying a cut as high as 0.8 is a mistake, as the oscillation frequency detected in the uncut data is very near to the vertical tune (at which there should be some oscillation).

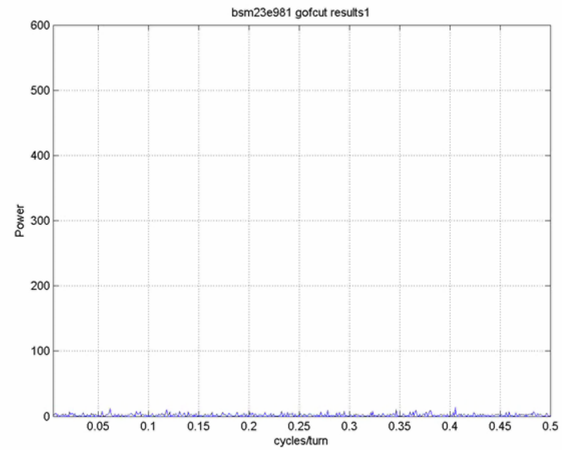
20 Bunches at 14ns Spacing – Vertical Beam Size FFT

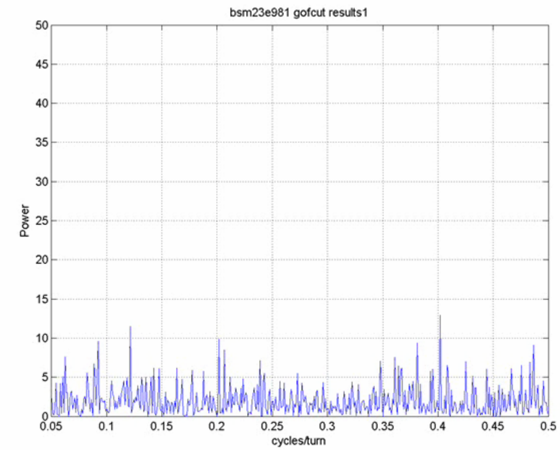
File 981

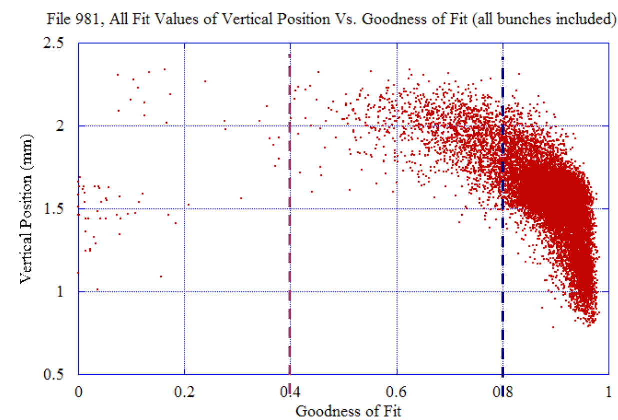
Movies

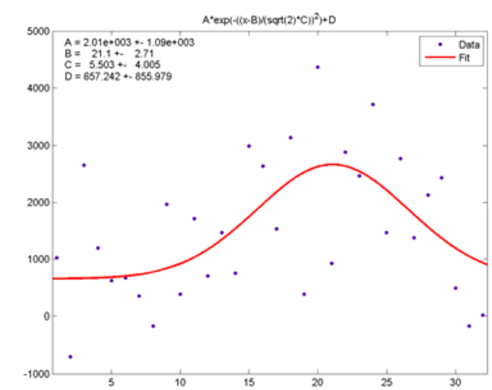
No cuts	Cut at 0.4	Cut at 0.8











•Applying the goodness of fit cut at 0.8 has removed all detection of beam size oscillations near the tune frequency.

•We know from the plots on the first slide that the incorrect noise-level fits have been removed by the 0.4 goodness of fit cut, but the FFT still detects the oscillation near the vertical tune, at approximately the same power.

•Because the 0.8 cut removed all detection of this oscillation (and because, as seen from the plot to the left and in slide 1, nearly all of the points removed were to the right* of the PMT's center, drawing attention to the general trend that lower goodness of fit values tend to be toward the right of the PMT), we suspect that there is a problem detecting signal to the right of the PMT's center.

•The average position of points cut out by the 0.4 cut is still toward the right, but it includes the entire main body of data while ensuring that points with extremely small beam sizes (fits to noise) are removed. The plot to the bottom right is a fit with goodness of fit 0.34245 (bunch 19, turn 47). The data here is poor enough that the fit is nearly meaningless. Data like this is removed by the 0.4 cut.

*Right meaning the direction from low channel number to high channel number.

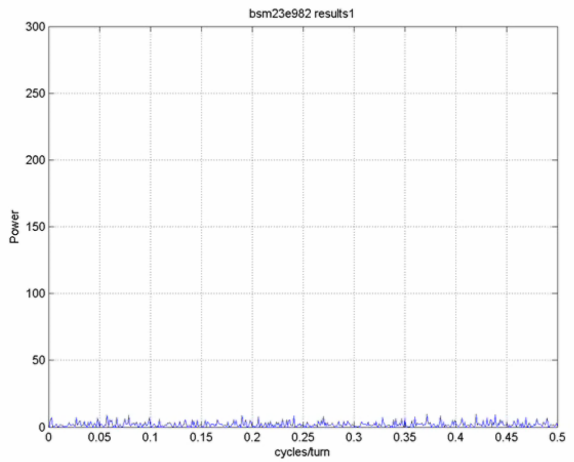
20 Bunches at 14ns Spacing – Vertical Beam Size FFT

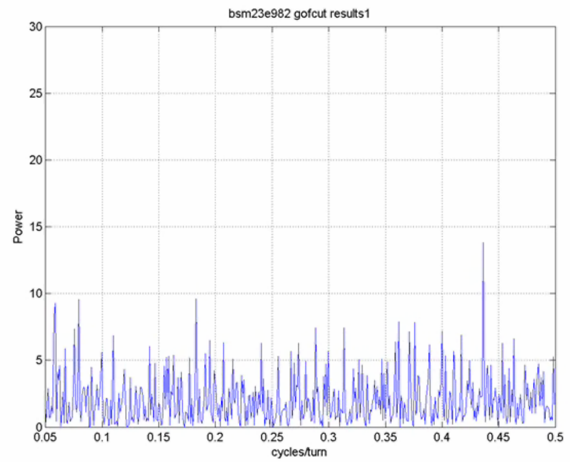
Movies

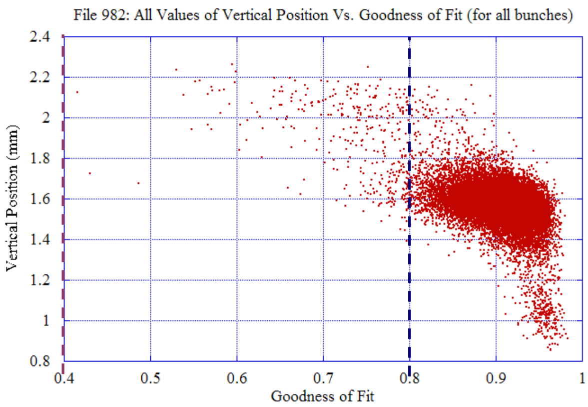
File 982

No cuts

Cut at 0.8



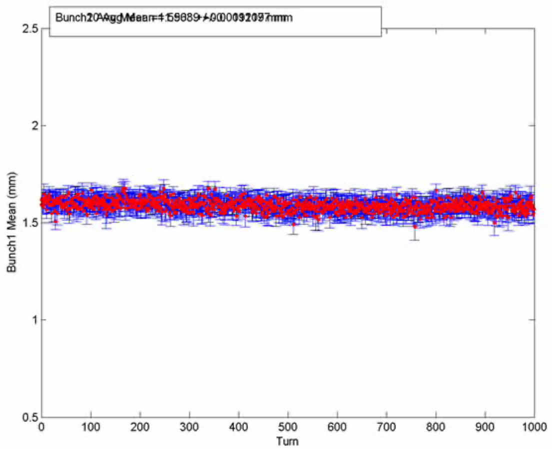


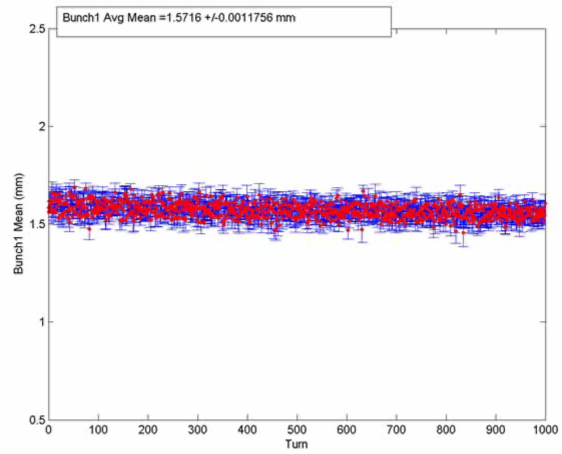


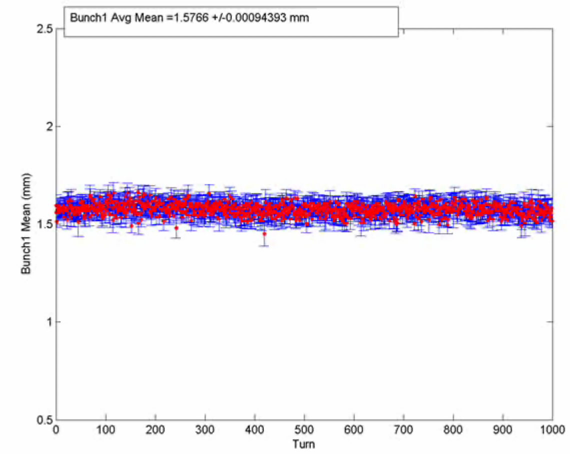
- Applying the goodness of fit cut at 0.8 again decreases the power of the tune-related line by an order of magnitude.
- Again we see that as goodness of fit decreases, the average position of the bunch signal moves toward the right of the PMT. The 0.8 cut removes points almost exclusively to the right of the PMT center.

20 Bunches at 14ns Spacing – Vertical Position

Movies: no cuts







File 979:

I_{e+} = 0.75mA/bunch, XQ1 = +122

After bunch 12, the bunches are clearly oscillating along the vertical position axis.

File 981:

Ie+ = 0.75mA/bunch, XQ1 = -75

After bunch 4, the bunches show clear oscillation along the vertical position axis.

File 982:

Ie+ = 0.75mA/bunch, XQ1 = -75

All bunches appear to show oscillation along the vertical position axis.

Movies: goodness of fit cut applied at 0.8

The points cut are toward the right of the PMT center.

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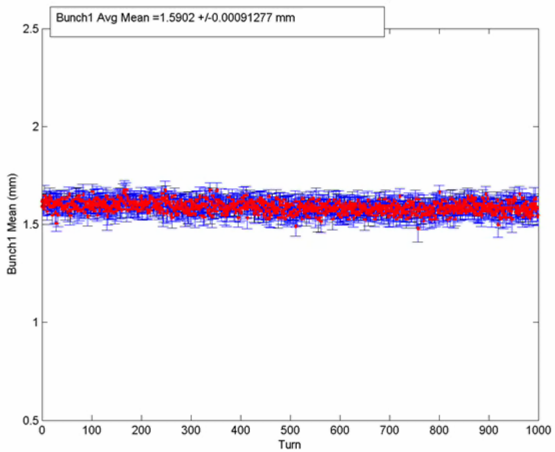
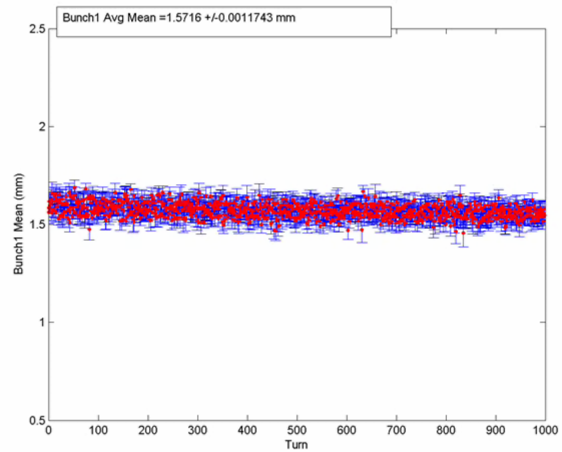
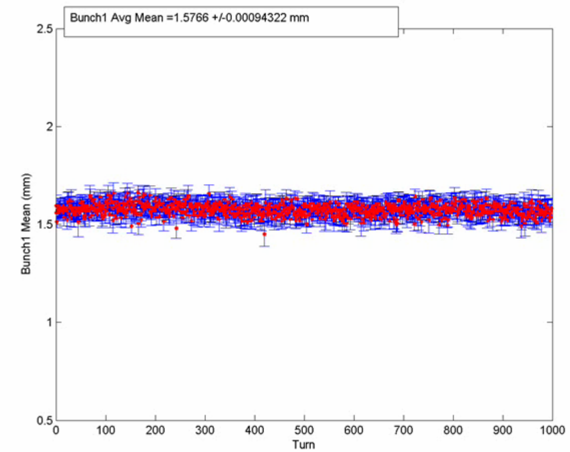
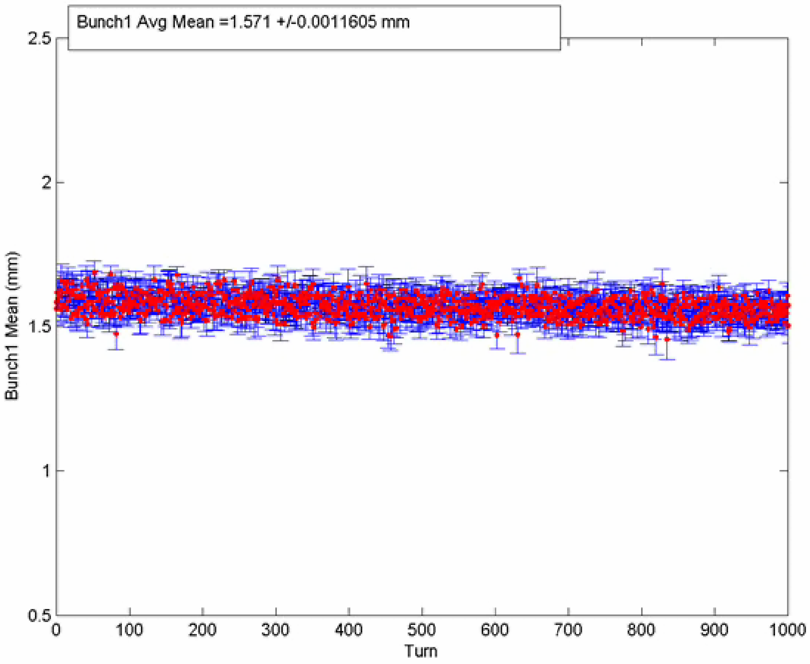


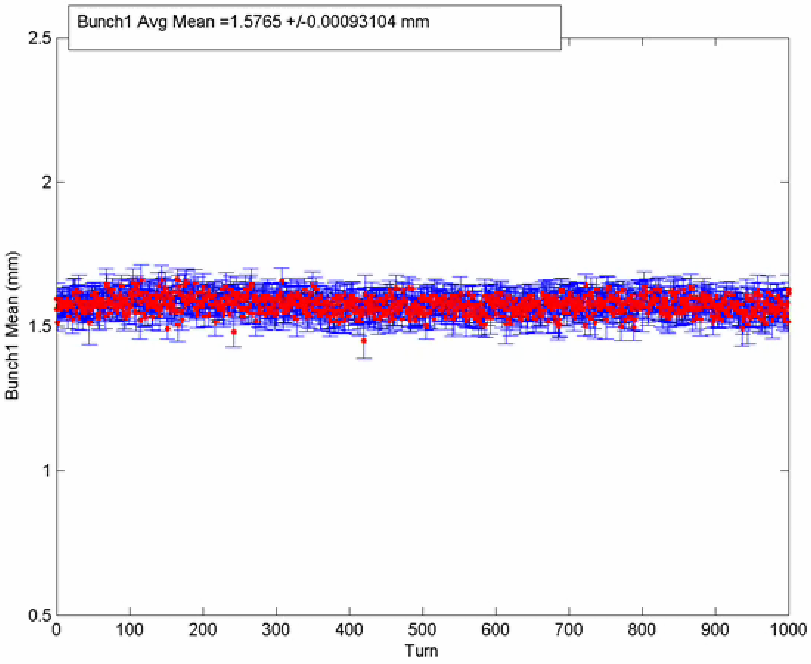




20 Bunches at 14ns Spacing – Vertical Position

Movies: goodness of fit cut applied at 0.4





File 981:

Ie+ = 0.75mA/bunch, XQ1 = -75

File 982:

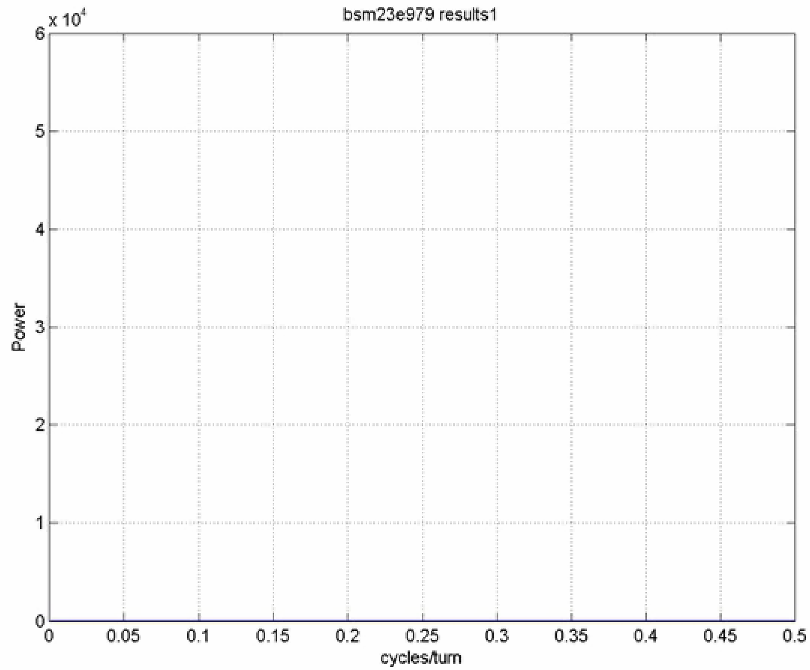
Ie+ = 0.75mA/bunch, XQ1 = -75

20 Bunches at 14ns Spacing – Vertical Position FFT

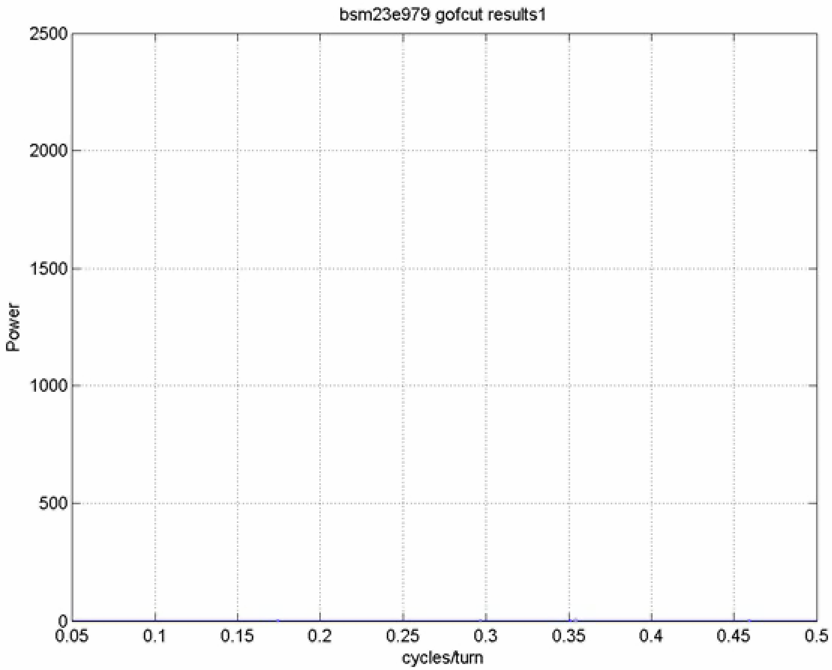
File 979

Movies

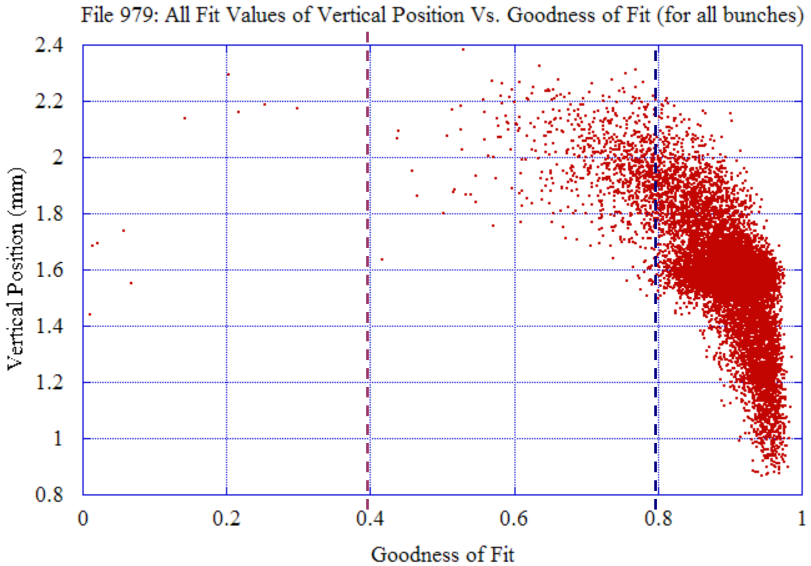
No cuts



Cut at 0.8



•The 0.8 cut decreases the detection of the 0.35 cyc/turn line by more than an order of magnitude, but the line is still far above the noise level in this case. This is further evidence that for the other measurements, this beam size oscillation is real (not an artifact of the bunch moving off the PMT).

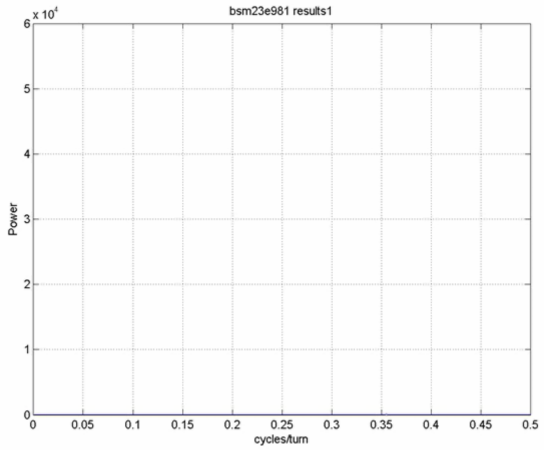


20 Bunches at 14ns Spacing – Vertical Position FFT

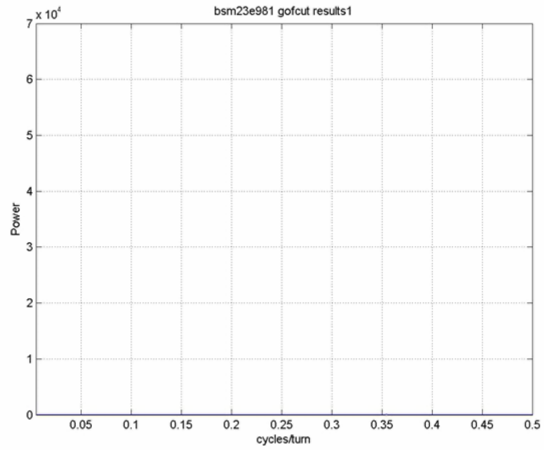
Movies

File 981

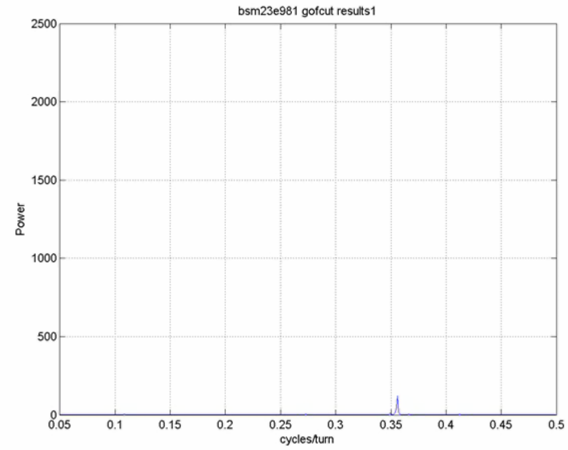
No cuts



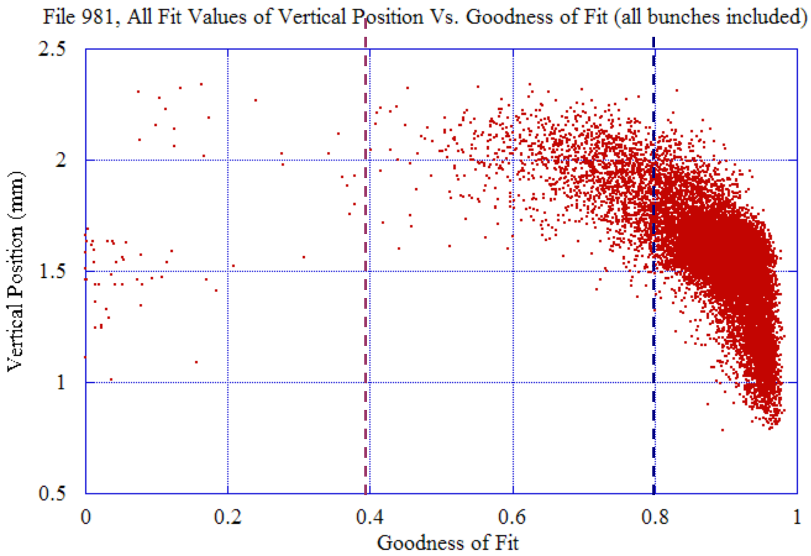
Cut at 0.4



Cut at 0.8



- Applying the goodness of fit cut at 0.8 again decreases the power of the vertical tune-related line by more than an order of magnitude, while the application of the cut at 0.4 increases it slightly.

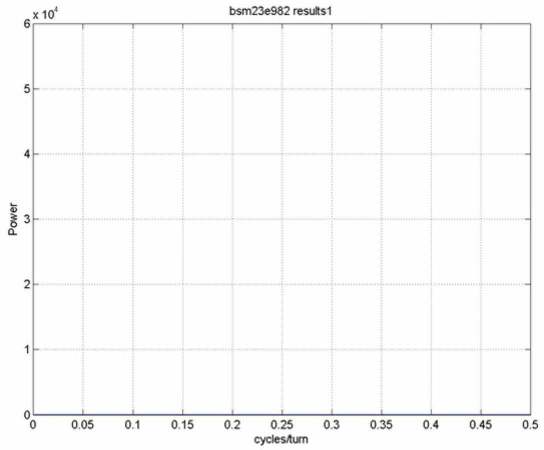


20 Bunches at 14ns Spacing – Vertical Position FFT

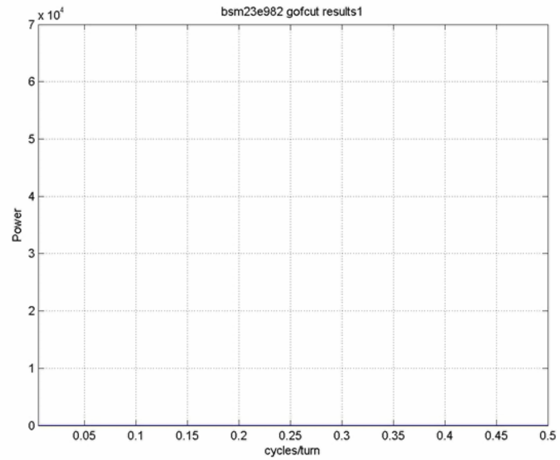
Movies

File 982

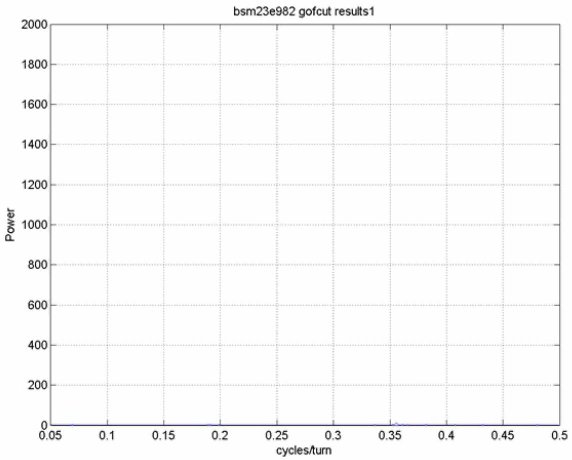
No cuts



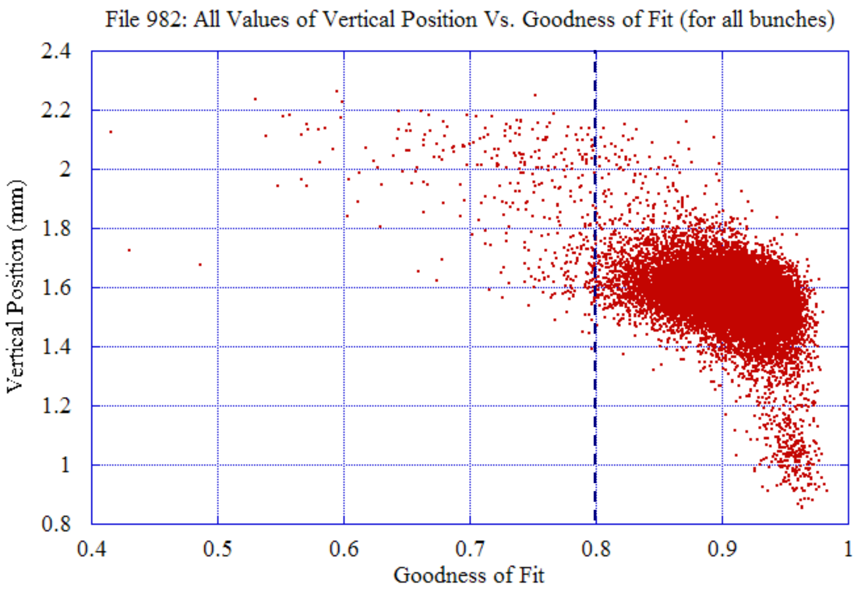
Cut at 0.4



Cut at 0.8

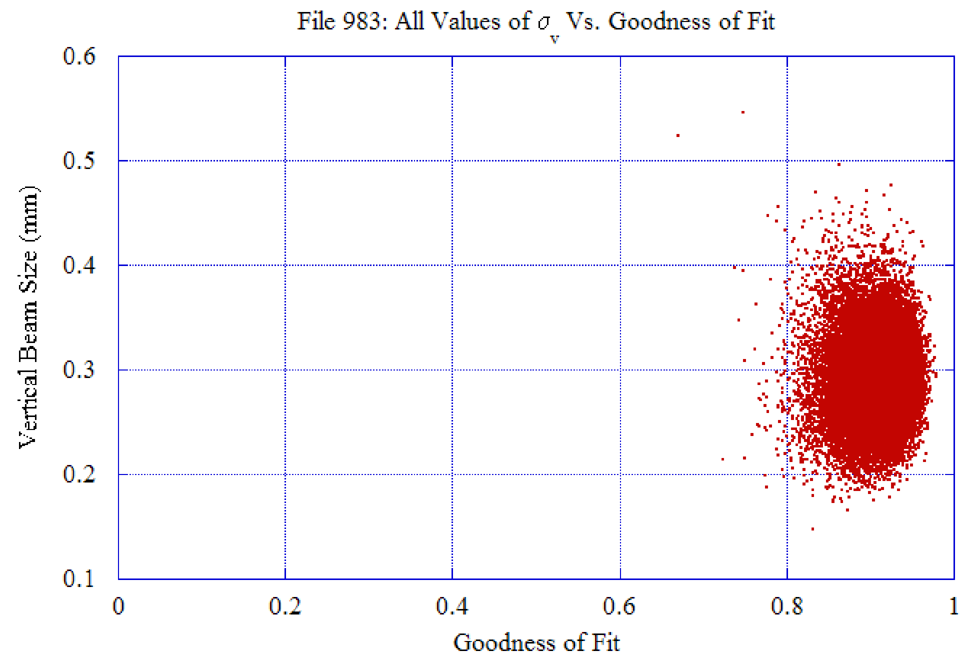


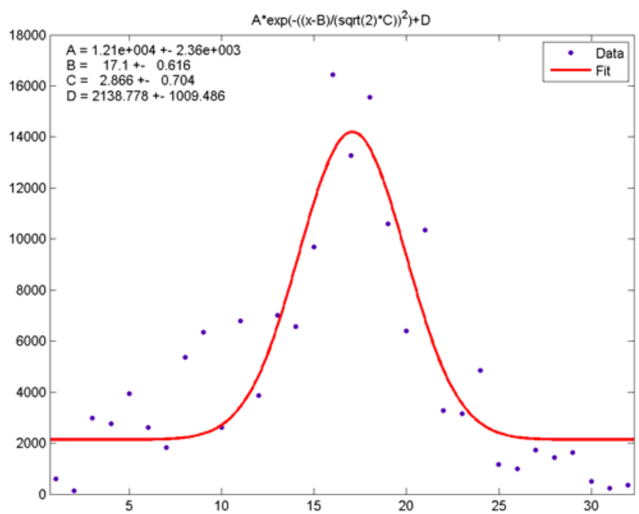
- Applying the goodness of fit cut at 0.8 decreases the power of the vertical tune-related oscillation by an order of magnitude, but the application of the cut at 0.4 increases it slightly.

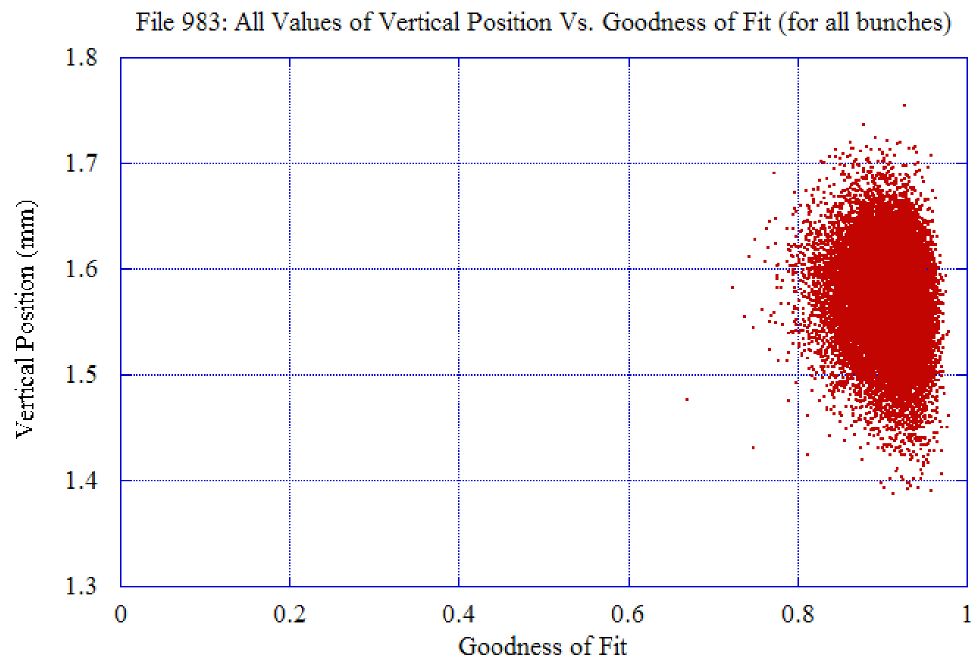


25 Bunches at 14ns Spacing

- Measurement 983 does not display any anomalously small vertical beam sizes
- There are no points with a goodness of fit below 0.4.
- The patterns in the plots of Beam Size Vs. Goodness of fit and Position Vs. Goodness of fit again suggest that 0.8 is too high of a cut to apply to data from the PMT.
- Below is a plot of the data for bunch 19, turn 3, and the fit to it (which had a goodness of fit of 0.81). The fit is quite reasonable, and picks out the main peak rather than the reflection to its left.

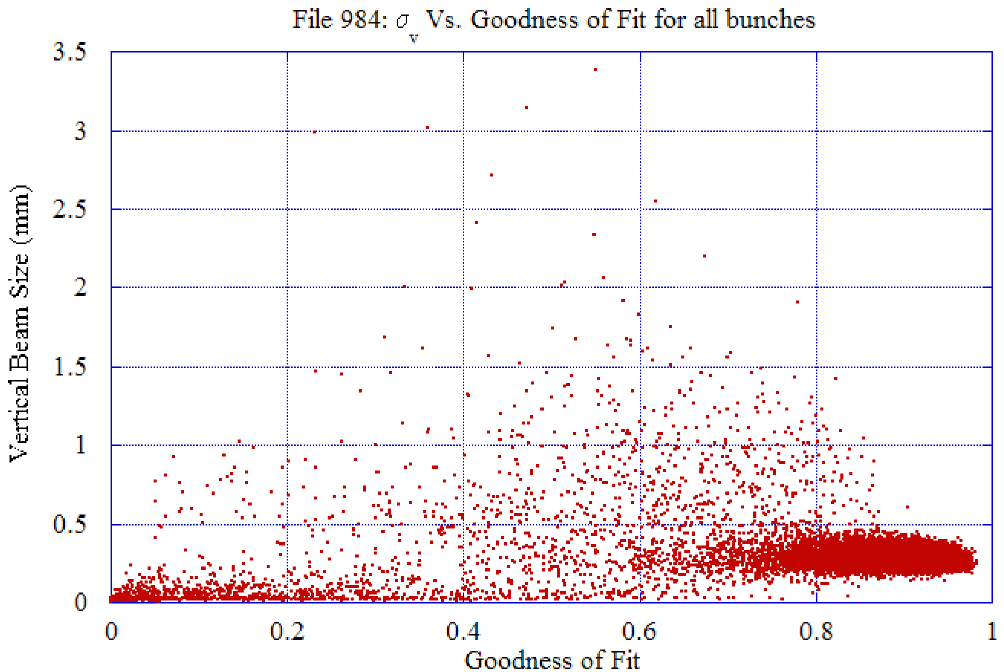


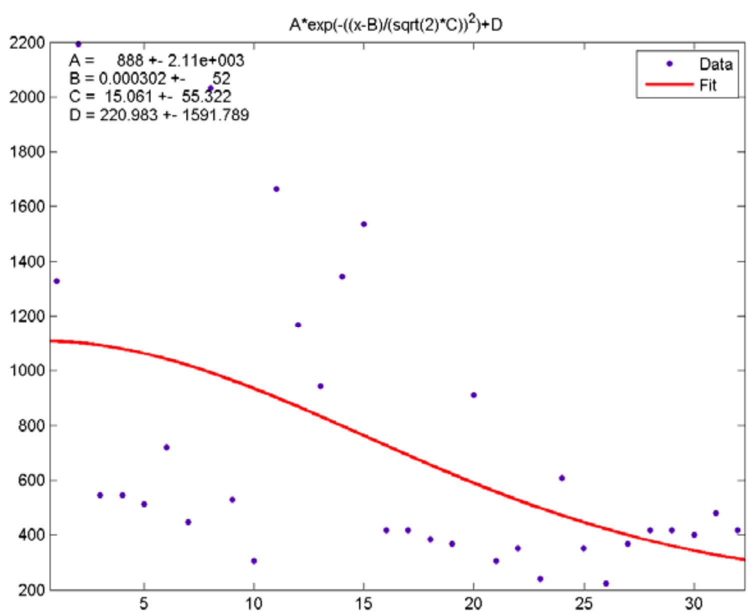


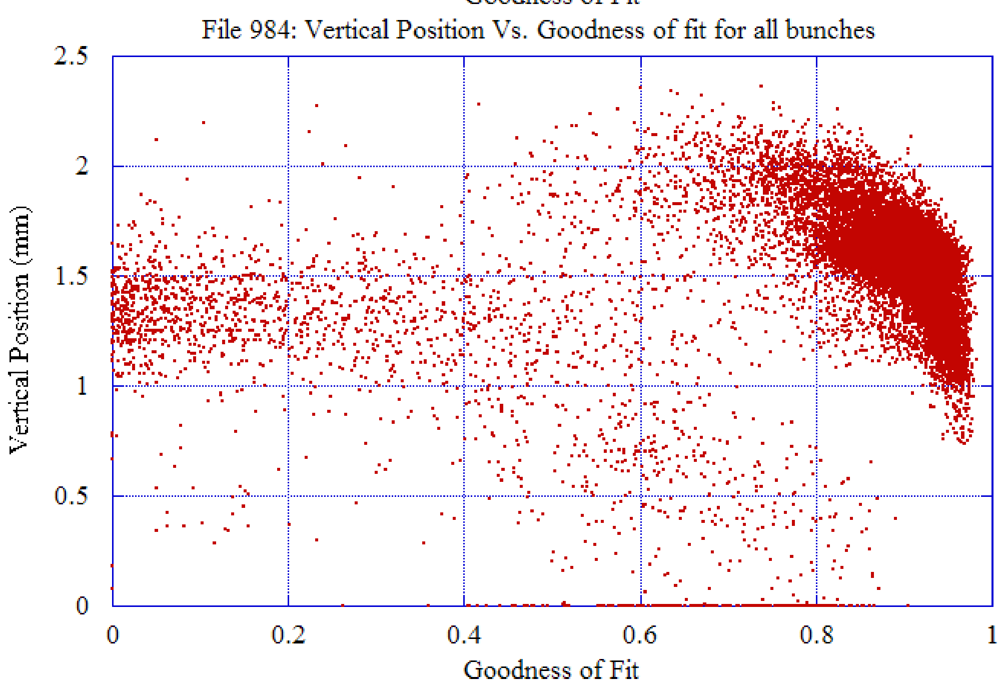


25 Bunches at 14ns Spacing

- Measurement 984 displays many anomalously small beam sizes. A goodness of fit cut at 0.8 will remove nearly all of them, but would also slice off a large chunk of normal data.
- Quite a few beam position values are 0 or very close to 0. Below is a plot of the fit and data for one such datapoint. There is no appreciable signal in the data, as noise levels in other plots are of the same order of magnitude as the supposed "signal" the fitter finds.
- Most of the fits that are similar to the one below have goodness of fit values greater than 0.4, based on the plot to the lower right. Quite a few of them are also above 0.8. This suggests that a 2nd type of cut may need to be applied in future, removing fits with position values at or past the edge of the PMT.

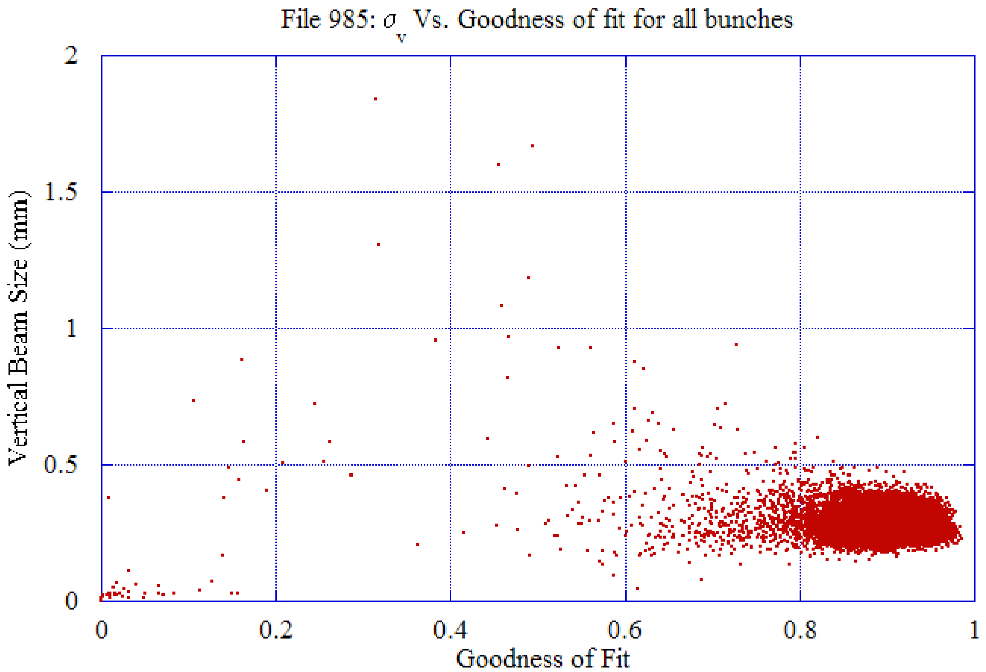


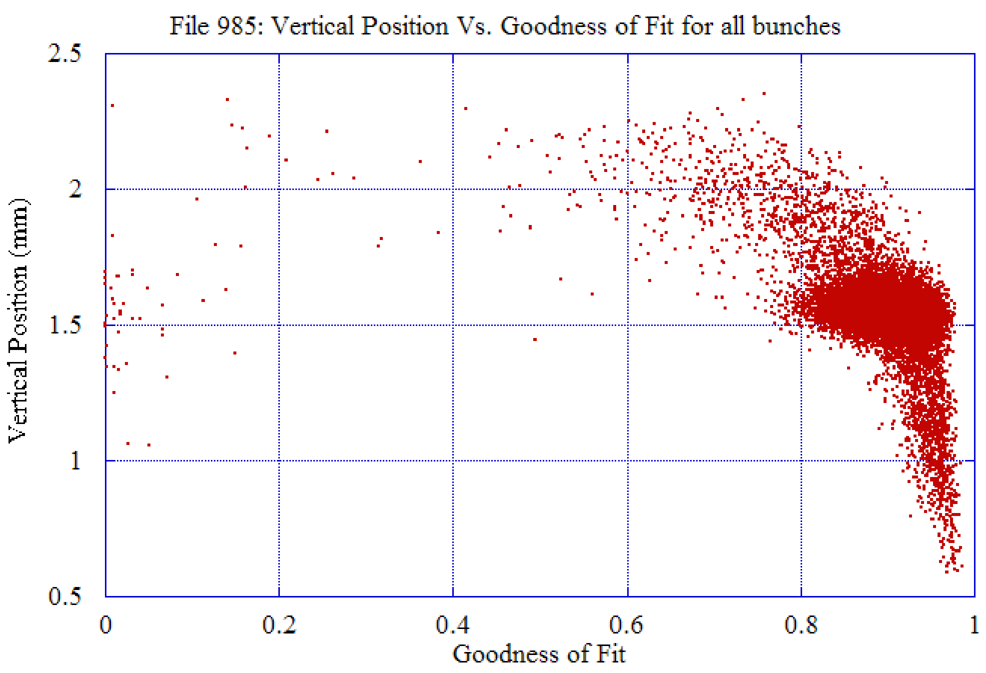




25 Bunches at 14ns Spacing

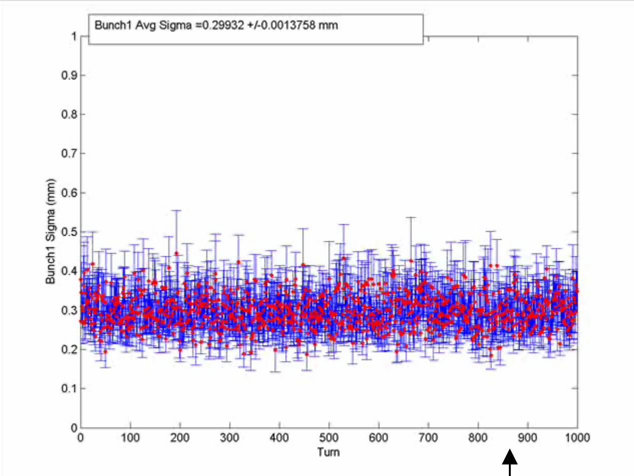
- Measurement 985 displays a small number of points with anomalously small vertical beam sizes.
- The trend for signals to the right of the PMT to have lower goodness of fits is again apparent.





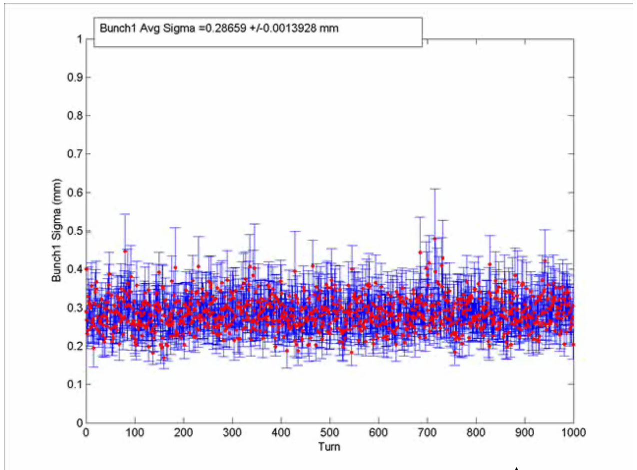
25 Bunches at 14ns Spacing – Vertical Beam Size

Movies: no cuts



File 983:

I_{e+} = 0.75mA/bunch, XQ1 = +341

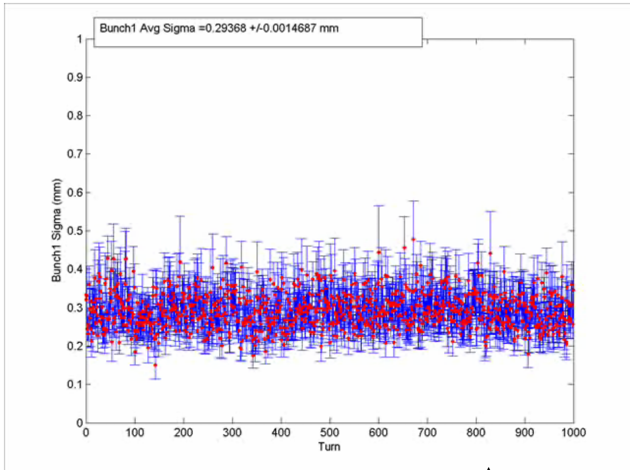


File 984:

Ie+ = 0.75mA/bunch, XQ1 = -75

After bunch 14, most of the bunches have very large errors in fit parameter sigma.

Bunches 20 and 21 appear to have been lost.

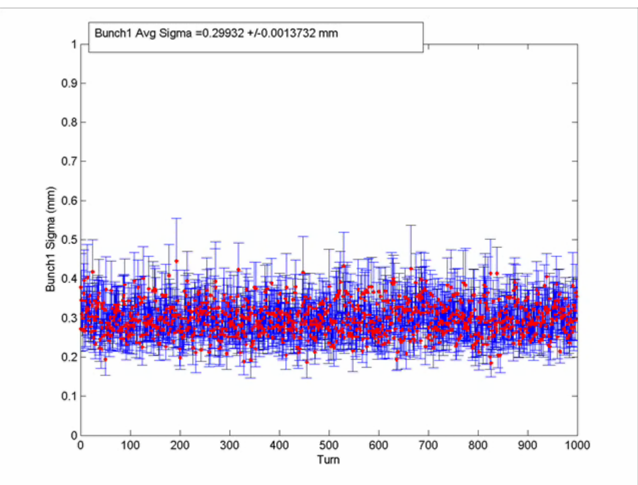


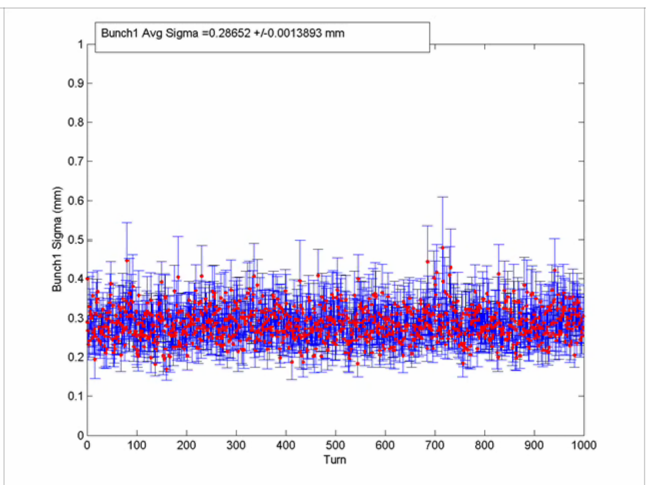
File 985:

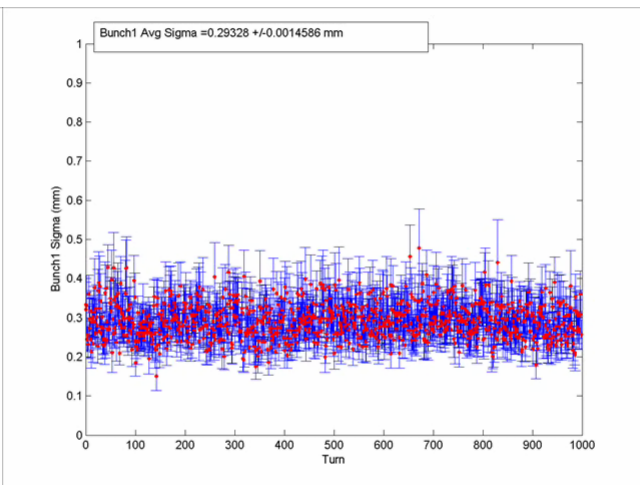
Ie+ = 0.75mA/bunch, XQ1 = +99

After bunch 22, errors in fit parameter sigma increase greatly.

Movies: goodness of fit cut applied at 0.8

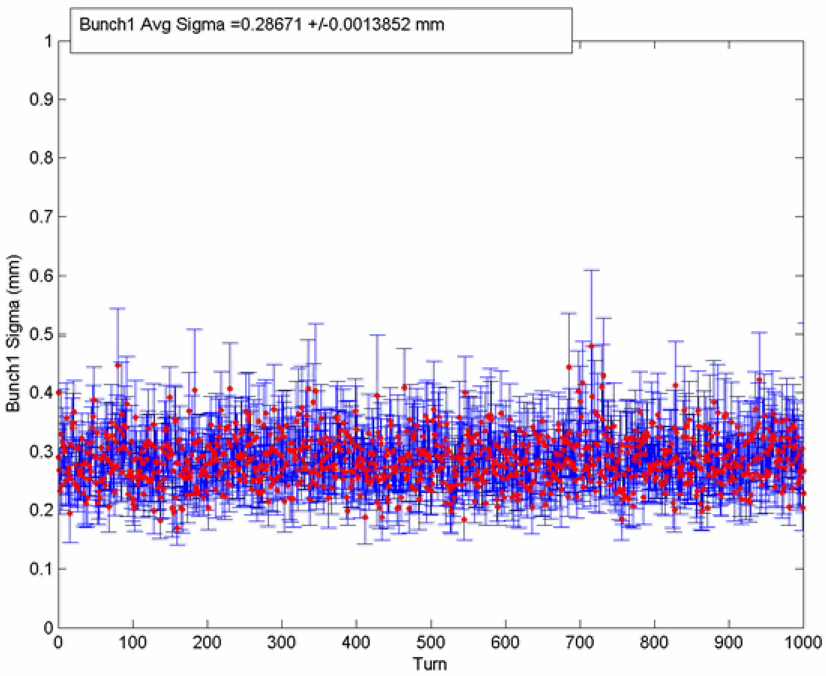


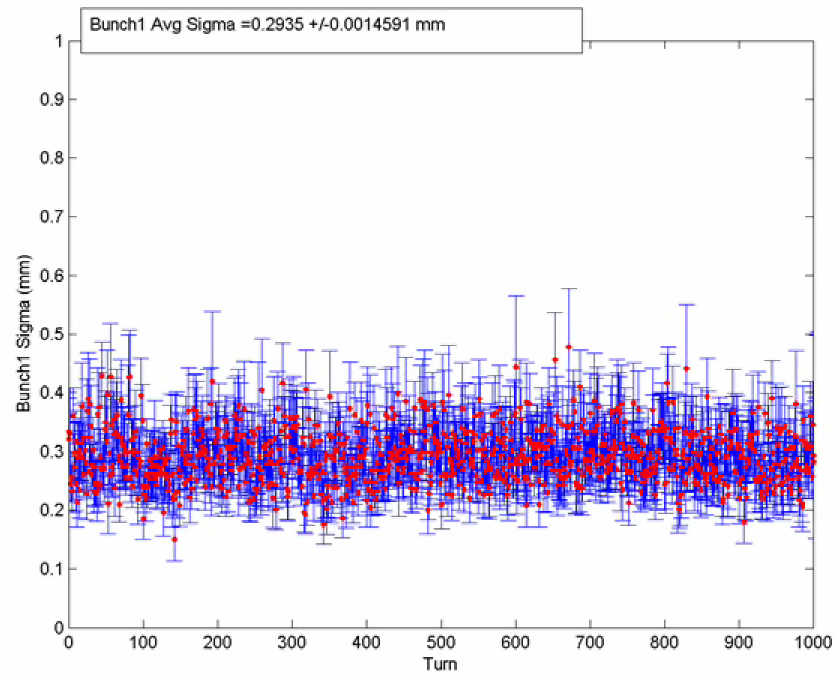




25 Bunches at 14ns Spacing – Vertical Beam Size

Movies: goodness of fit cut applied at 0.4





File 984:

Ie+ = 0.75mA/bunch, XQ1 = -75

Bunches 20 and 21 appear to have been lost.

File 985:

Ie+ = 0.75mA/bunch, XQ1 = +99

After bunch 22, errors in fit parameter sigma increase greatly.

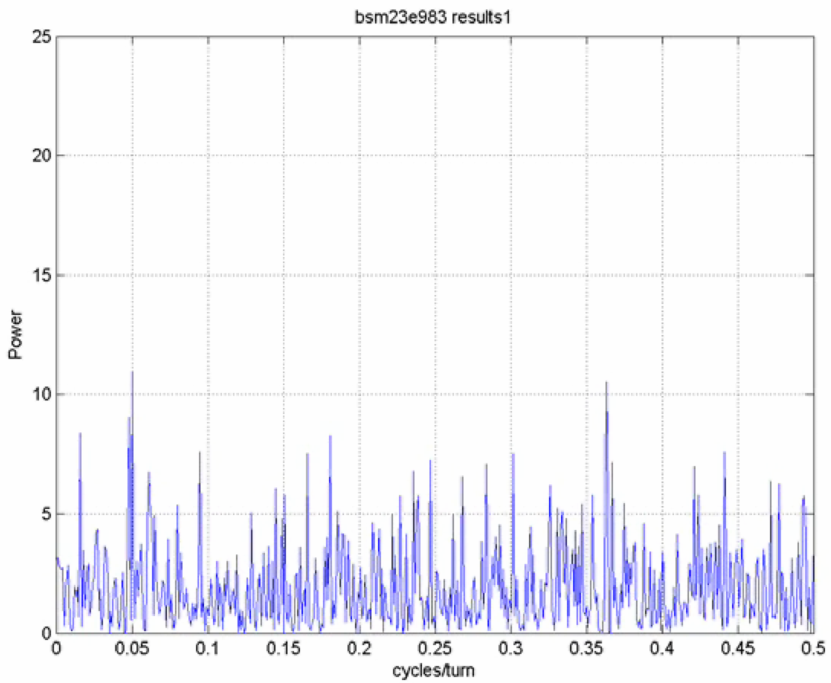
25 Bunches at 14ns Spacing – Vertical Beam Size FFT

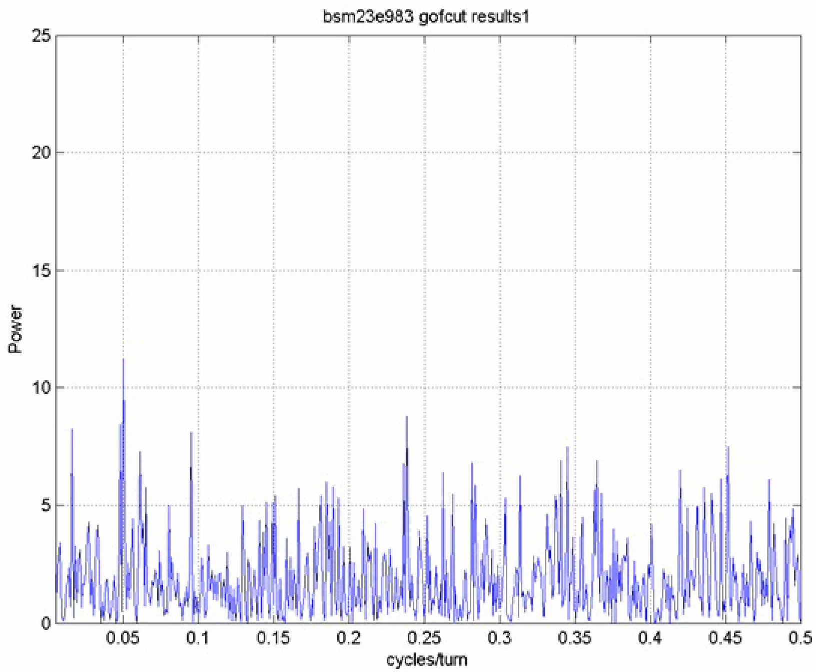
File 983

Movies

No cuts

Cut at 0.8





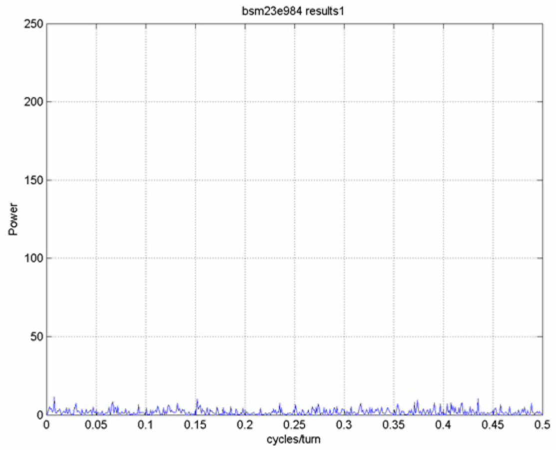
•No significant detections of vertical beam size oscillation in either case. (Very few points cut).

25 Bunches at 14ns Spacing – Vertical Beam Size FFT

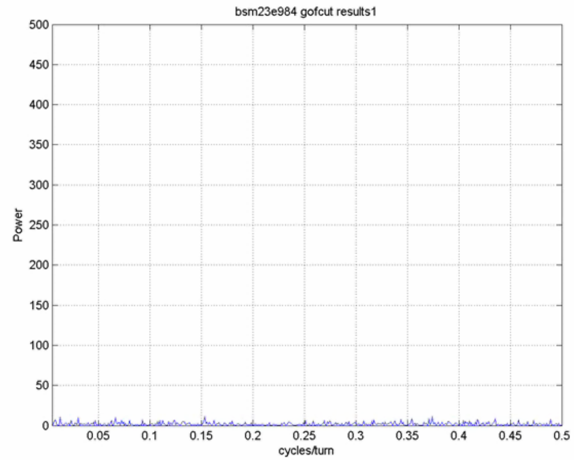
Movies

File 984

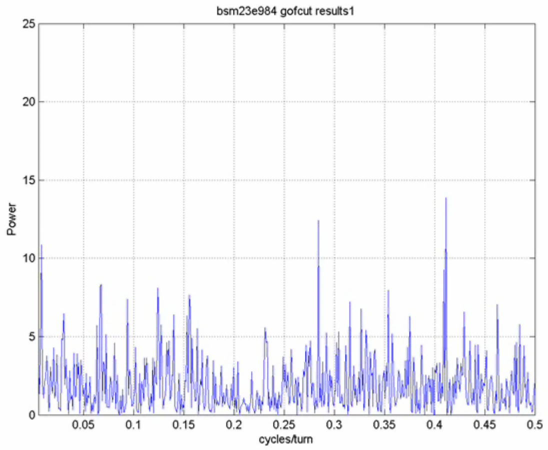
No cuts



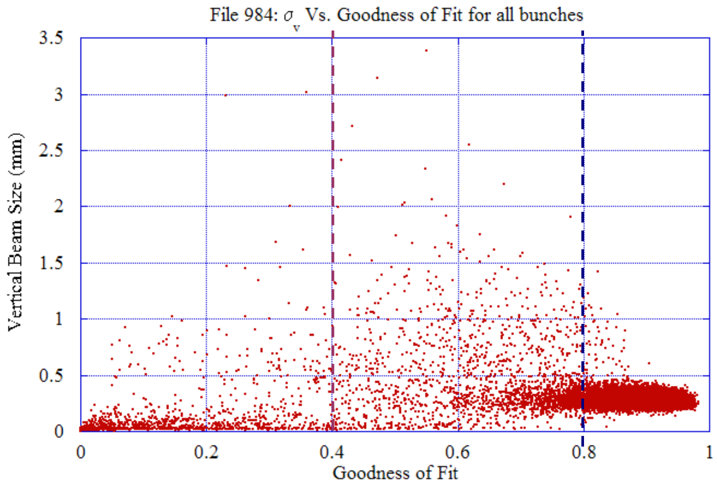
Cut at 0.4



Cut at 0.8



- Applying the goodness of fit cut at 0.8 decreases the power of the oscillation detection near the vertical tune by an order of magnitude.
- The 0.4 goodness of fit cut removes the majority of points with anomalously small vertical beam sizes, while preserving all the data that is likely to be good.
- While the 0.8 fit cuts nearly all of the data with extremely small vertical beam sizes (likely to be fits to noise), it cuts out too much good data to use.
- Bunches 20 and 21 were lost during this measurement. They are not present in the data without cuts, and their FFTs are meaningless in the cut data.

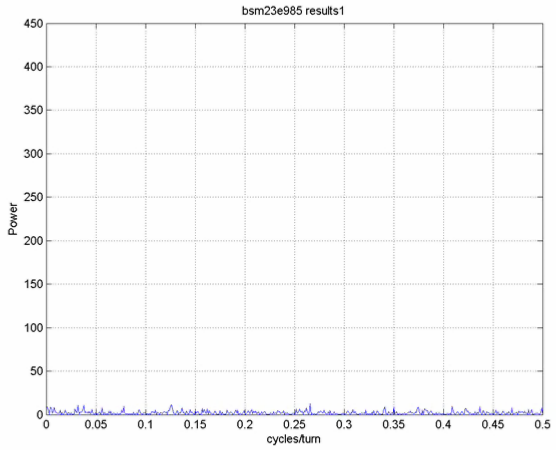


25 Bunches at 14ns Spacing – Vertical Beam Size FFT

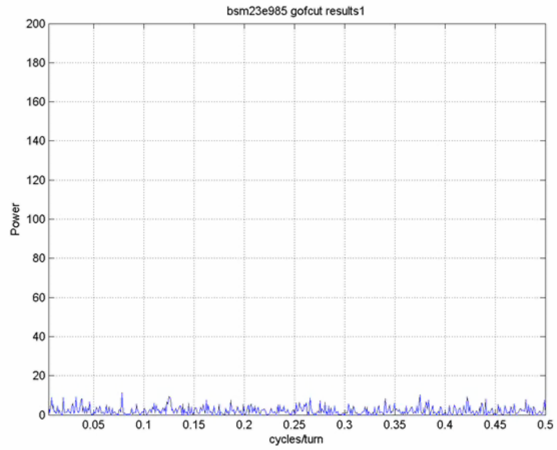
Movies

File 985

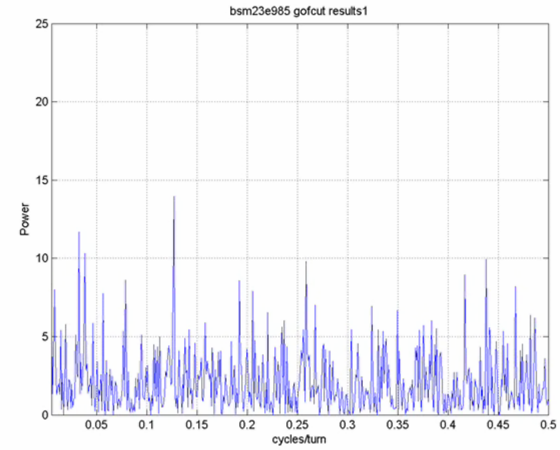
No cuts



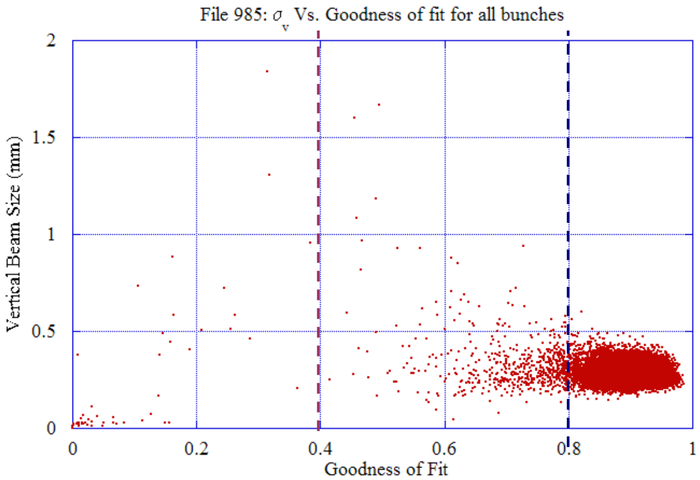
Cut at 0.4



Cut at 0.8

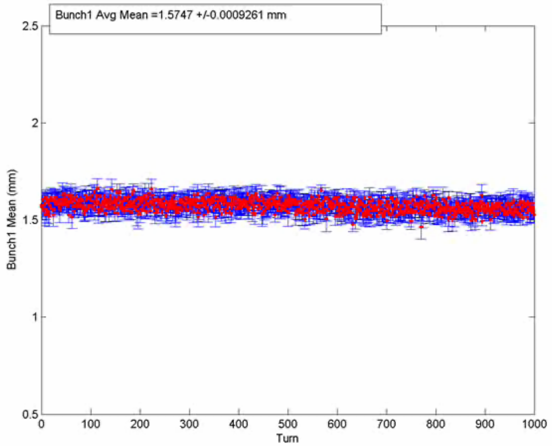


- Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by an order of magnitude, while the application of the cut at 0.4 decreases it by a factor of two.
- The 0.4 goodness of fit cut removes all points with anomalously small beam sizes, while the 0.8 cut cuts off the tail end of useable data.



25 Bunches at 14ns Spacing – Vertical Position

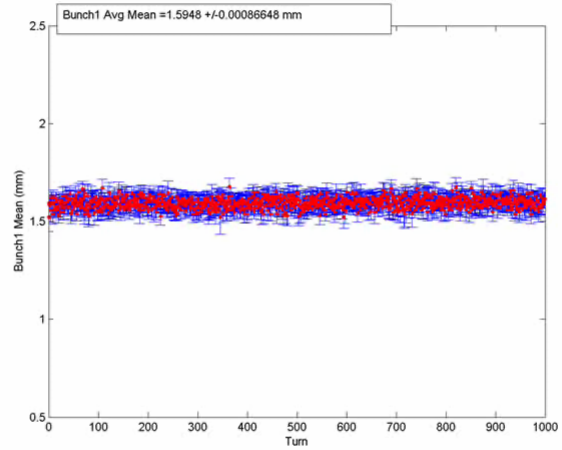
Movies: no cuts



File 983:

I_{e+} = 0.75mA/bunch, XQ1 = +341

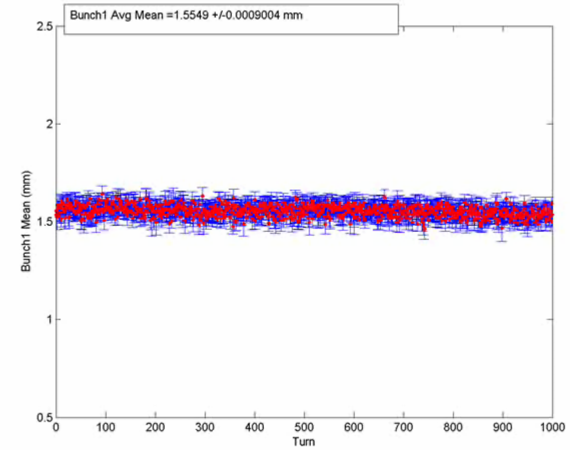
After bunch 7, an oscillation in vertical position is clearly visible.



File 984:

Ie+ = 0.75mA/bunch, XQ1 = -75

After bunch 3, oscillations in vertical position are clearly visible. Bunches 20 and 21 were lost.

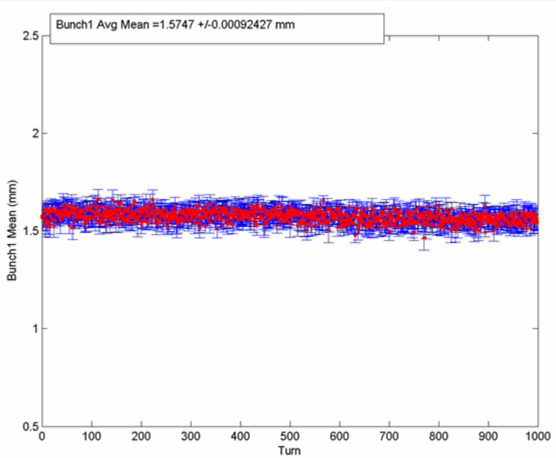


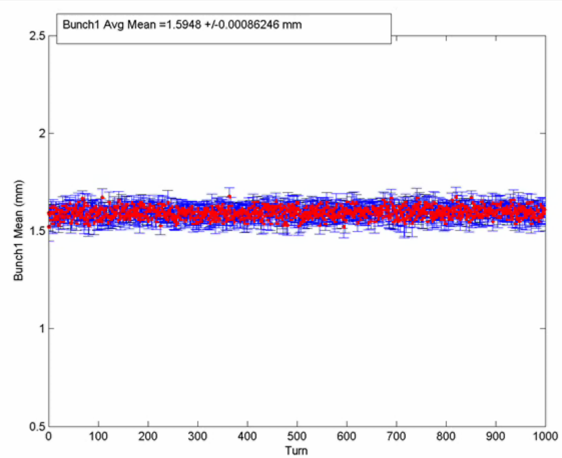
File 985:

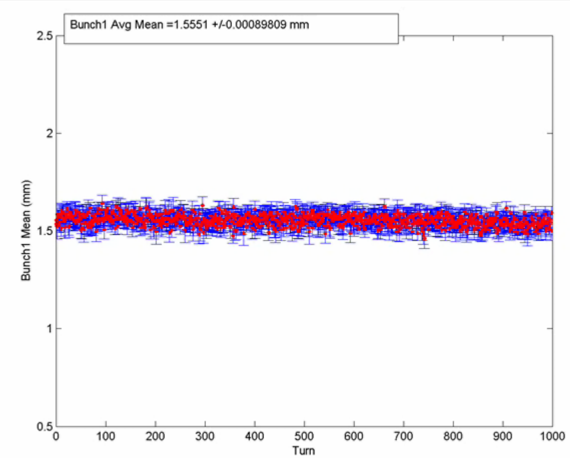
Ie+ = 0.75mA/bunch, XQ1 = +99

After bunch 4, oscillations in vertical position are clearly visible.

Movies: goodness of fit cut applied at 0.8

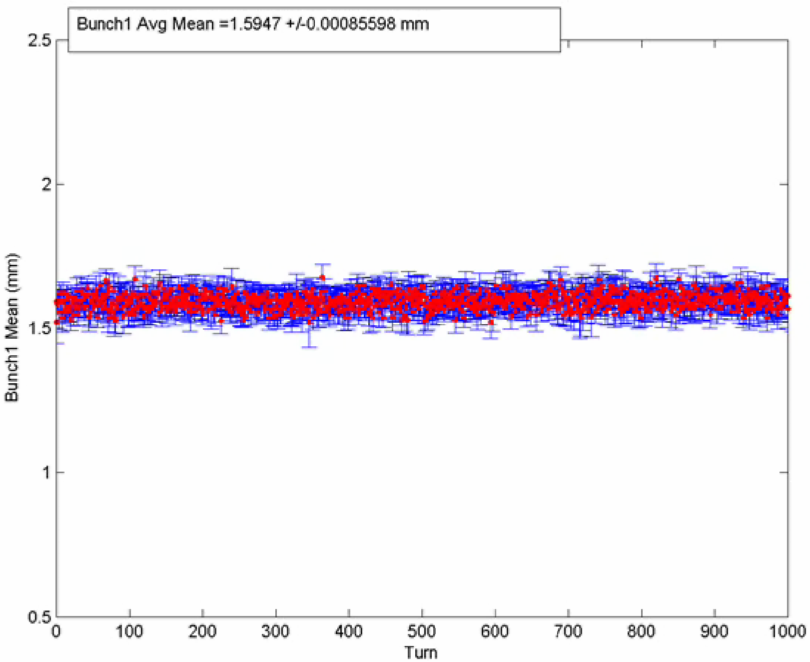


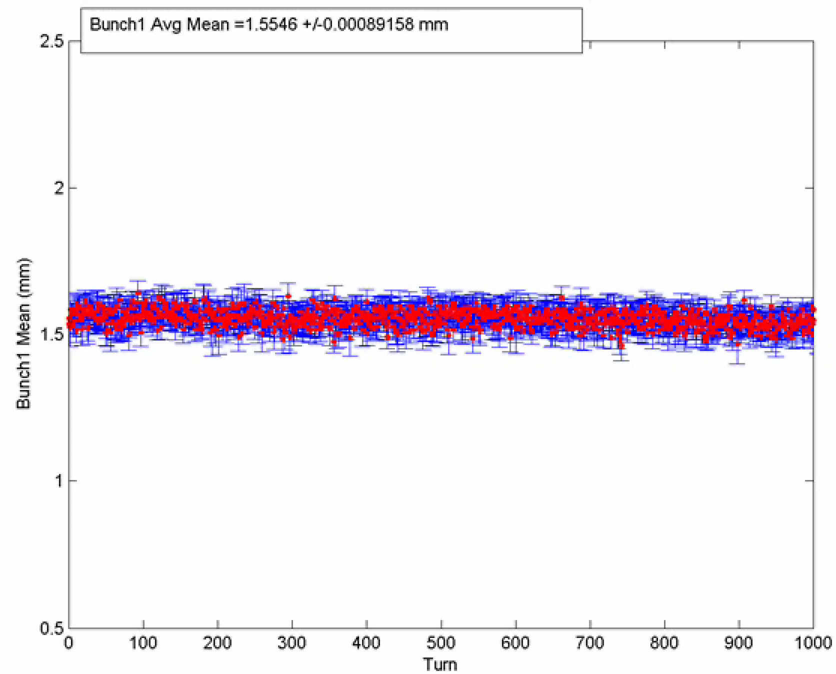




25 Bunches at 14ns Spacing – Vertical Position

Movies: goodness of fit cut applied at 0.4





File 984:

Ie+ = 0.75mA/bunch, XQ1 = -75

After bunch 3, oscillations in vertical position are clearly visible. Bunches 20 and 21 were lost.

File 985:

Ie+ = 0.75mA/bunch, XQ1 = +99

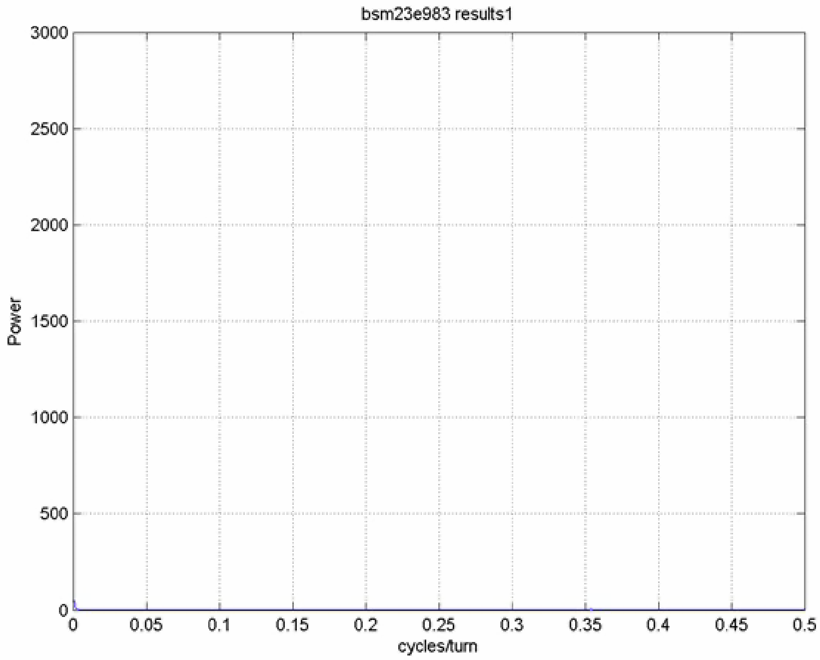
After bunch 4, oscillations in vertical position are clearly visible.

25 Bunches at 14ns Spacing – Vertical Position FFT

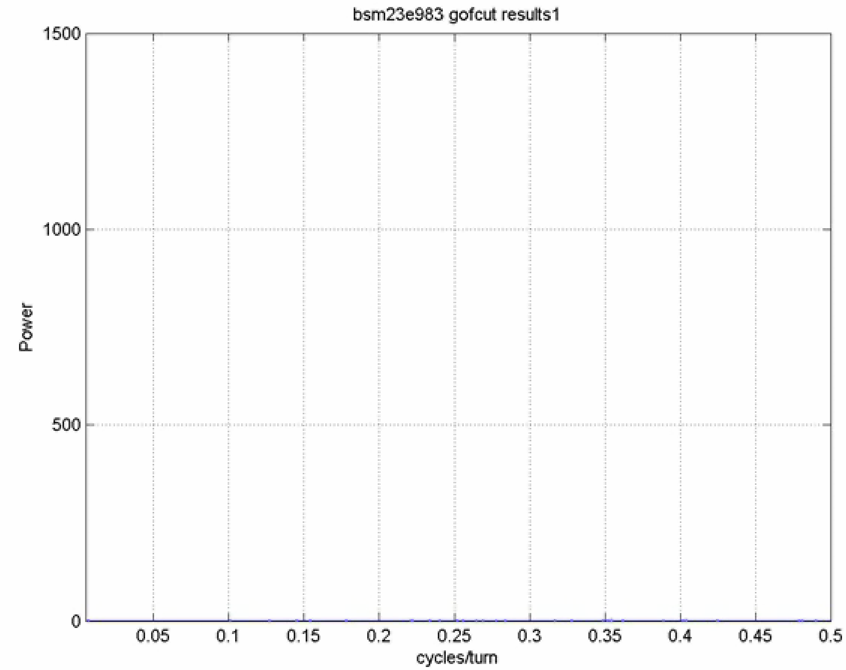
File 983

Movies

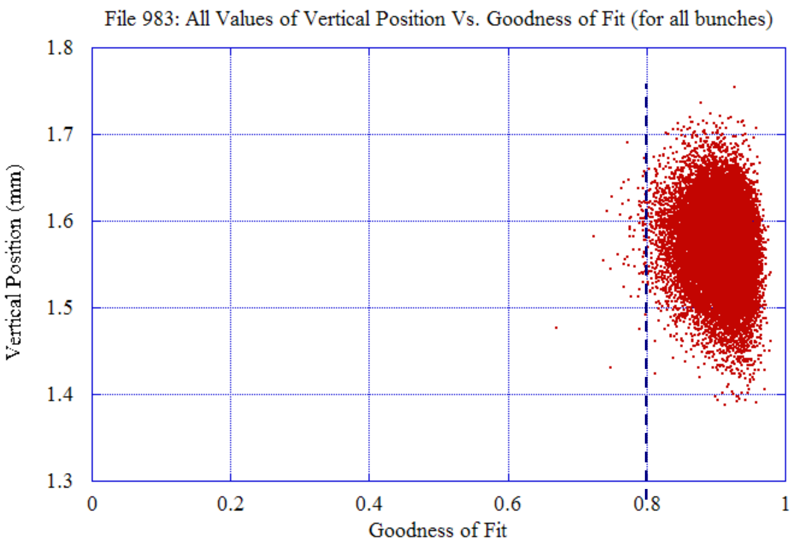
No cuts



Cut at 0.8



•The line near the vertical tune is detected well above the noise level for both the uncut data and the data cut at a goodness of fit of 0.8, although the cut decreases the signal by about half. This may be because, as seen in the plot to the right, most of the fits cut were to the right of the PMT center.

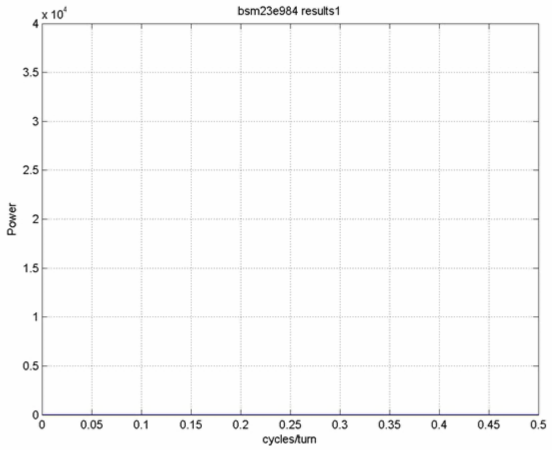


25 Bunches at 14ns Spacing – Vertical Position FFT

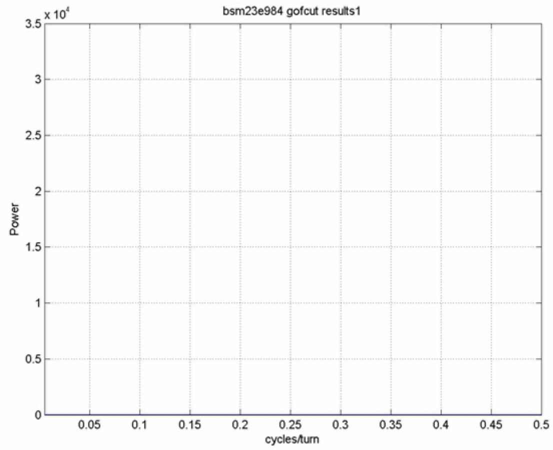
Movies

File 984

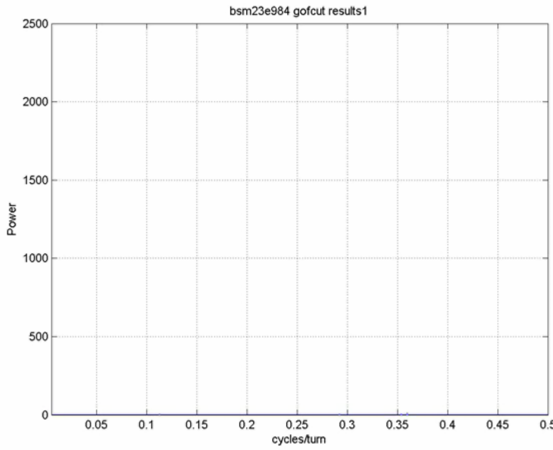
No cuts



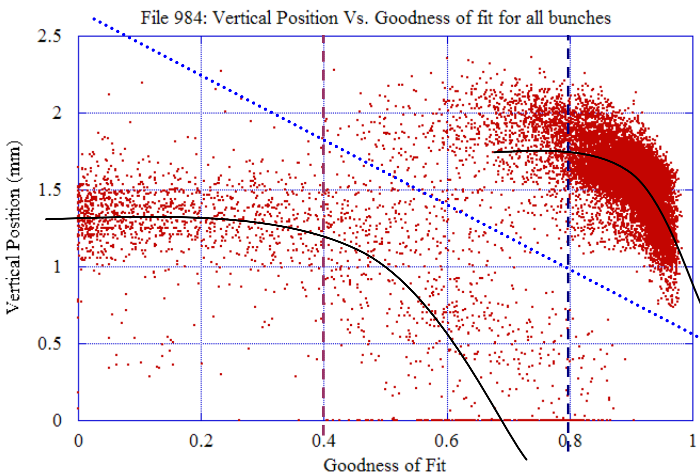
Cut at 0.4



Cut at 0.8



•Applying the goodness of fit cut at 0.8 decreases the power of the vertical tune-related line by more than an order of magnitude, while the application of the cut at 0.4 decreases it slightly.



•In the plot of vertical position vs. goodness of fit to the right, two trends in the dataset have been loosely identified. Both have roughly the same shape, but span different regions on the PMT, as shown by the solid black curves (note: curves were hand-placed).

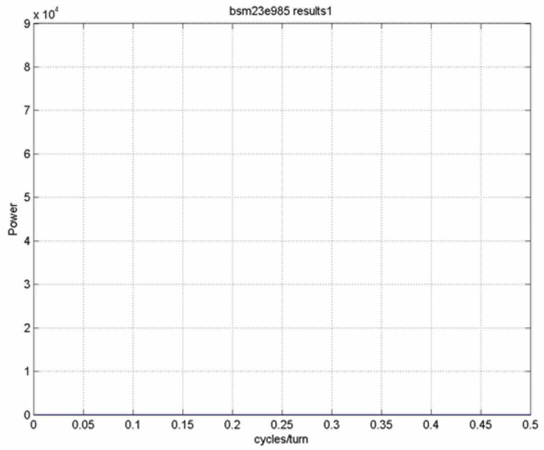
•For this dataset, it is not clear what a good cut to implement would be. A rough separation between the two trends is shown by the orange dotted line.

25 Bunches at 14ns Spacing – Vertical Position FFT

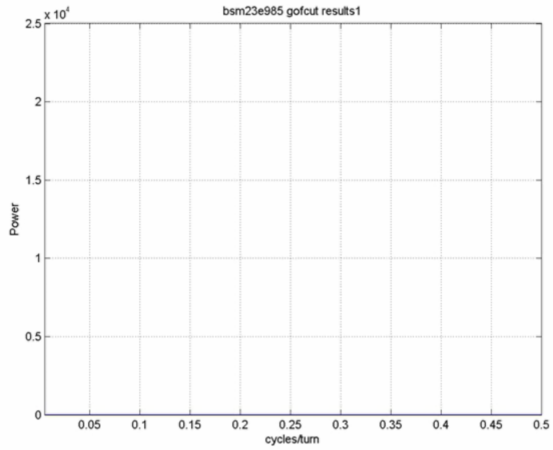
Movies

File 985

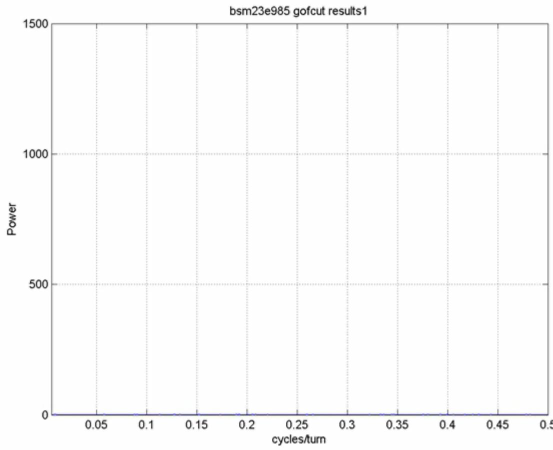
No cuts



Cut at 0.4

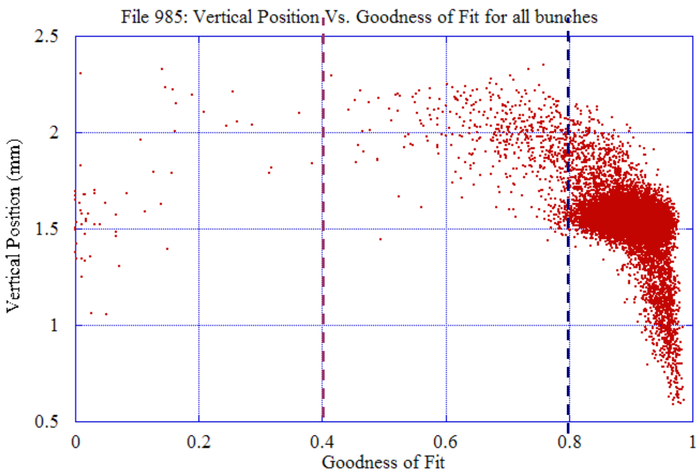


Cut at 0.8



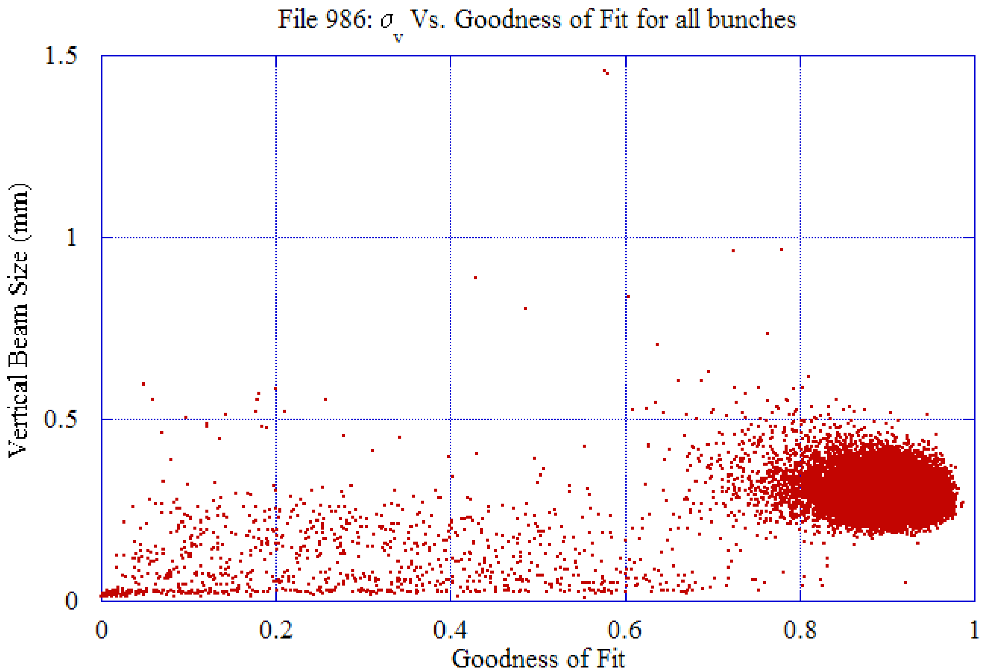
•Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by more than an order of magnitude, while the application of the cut at 0.4 decreases it by about a factor of three.

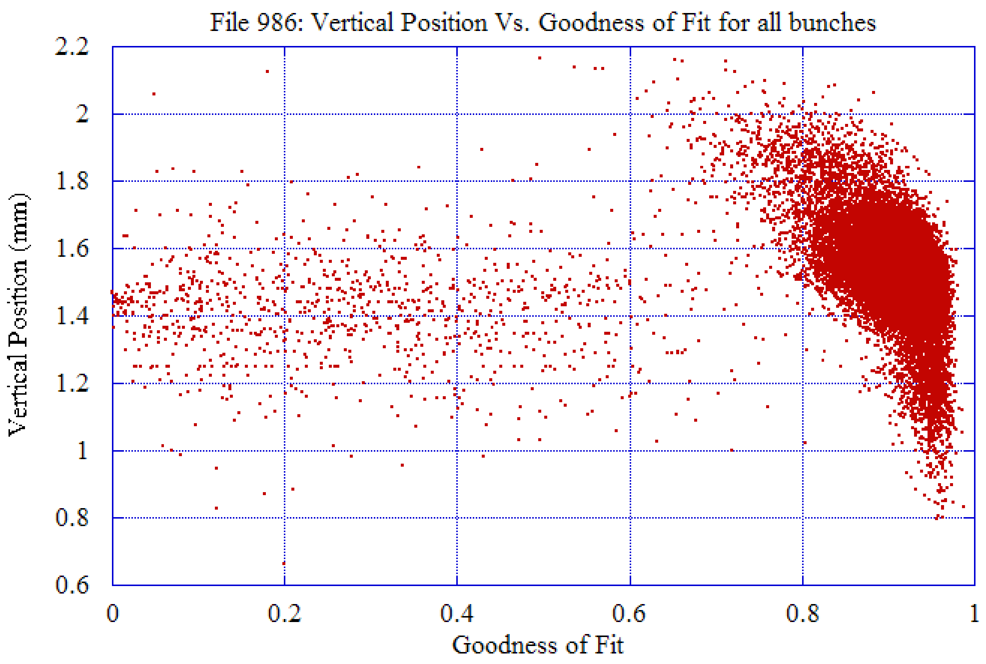
•Again, most of the points cut by the 0.8 goodness of fit cut were to the right of the PMT's center. The 0.4 cut keeps most of these points in, but removes the fits that were likely to just be fits to noise.



30 Bunches at 14ns Spacing

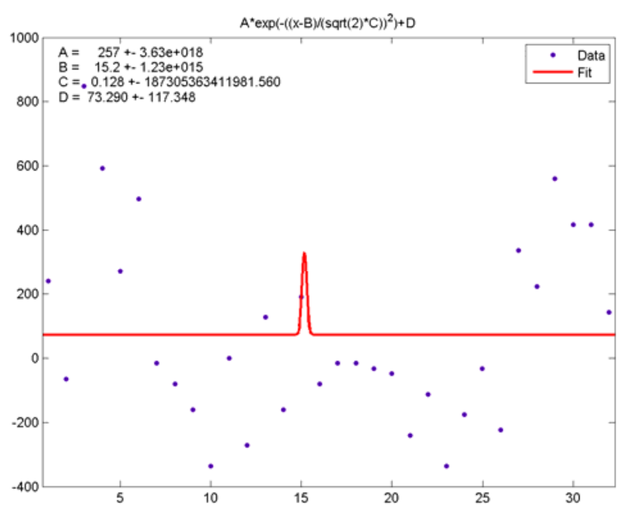
- Measurement 986 has a large number of fits with very small vertical beam sizes.
- It appears at first glance that all of these anomalous points correspond to noise-level fits (based on all of them being clustered around the PMT center, which is where poor fits to noise tend to be centered).

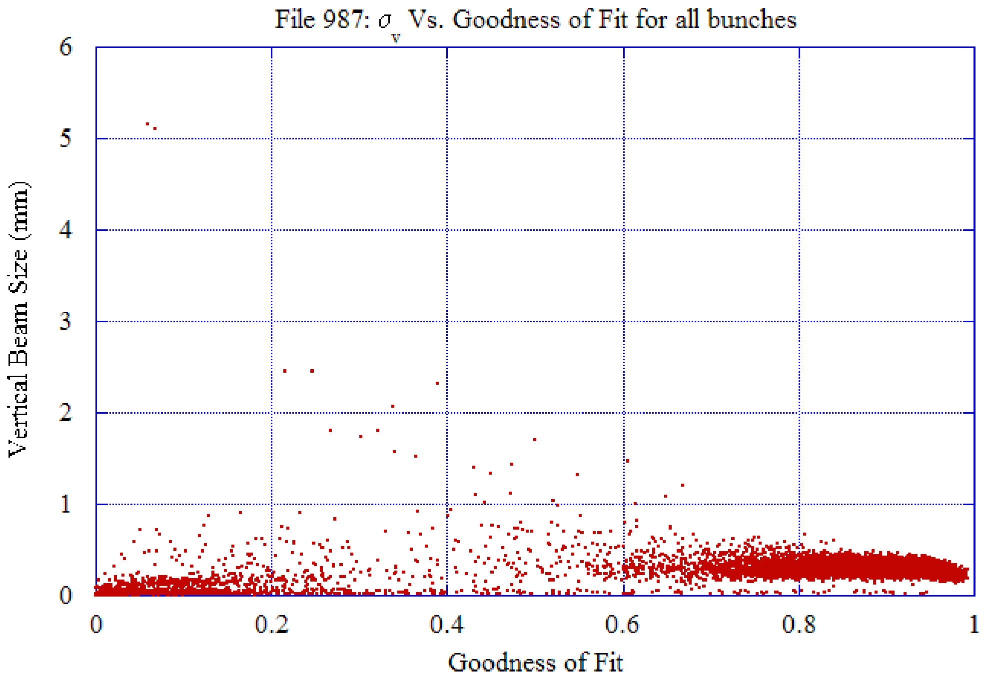


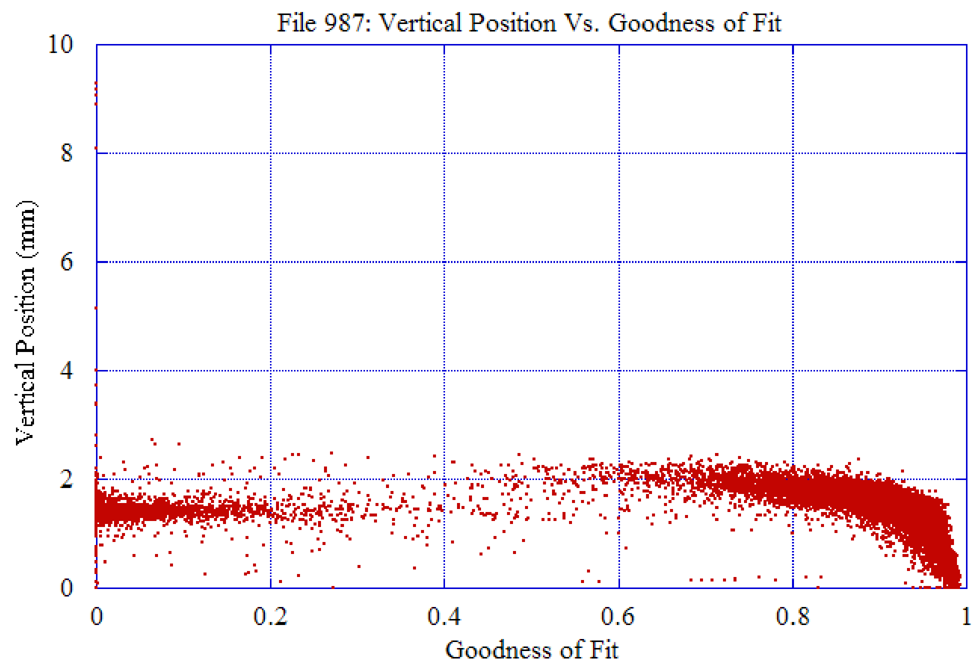


30 Bunches at 14ns Spacing

- Measurement 987 has a large number of fits with very small vertical beam sizes.
- These fits appear to correspond to a large number of vertical position fit values near the PMT center but with very poor goodness of fit values. This points to noise-level fits, such as that in the plot below of the data and fit to bunch 27, turn 66. There appears to be no real signal in this data.
- A few fits have extremely large vertical beam size values (likely fits to a curved background).

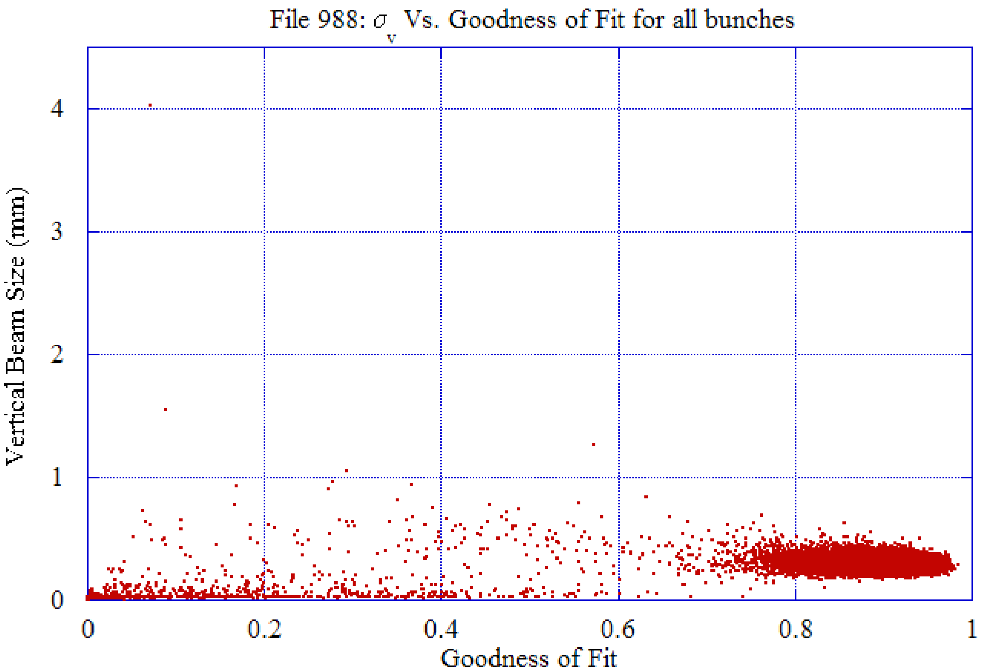


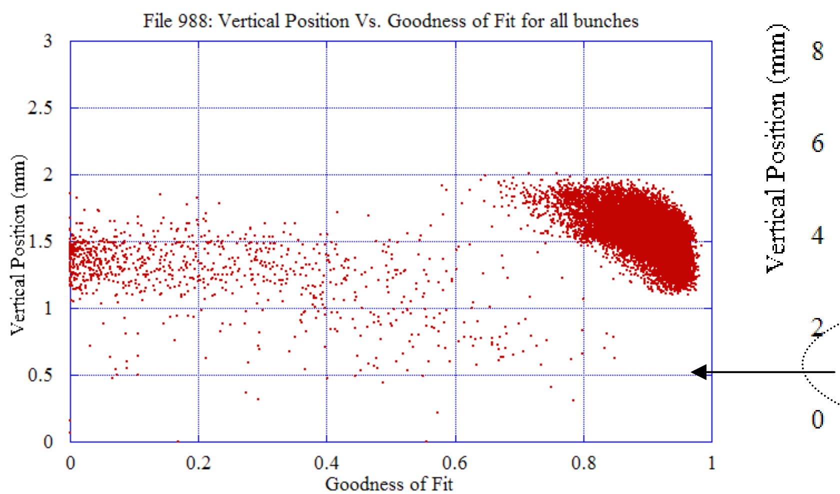


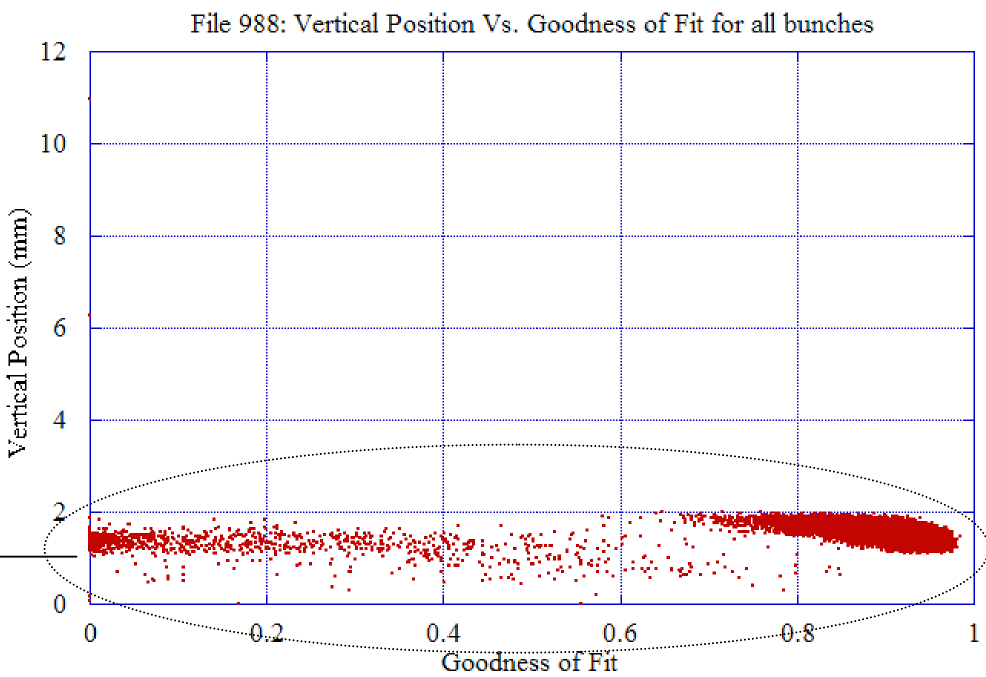


30 Bunches at 14ns Spacing

- Measurement 988 again has many tiny vertical beam size fit values.
- Again we see the trend for goodness of fit to decrease as the signal moves to the right of the PMT (until about a goodness of fit of 0.6). However, the points with the lowest goodness of fit values (and the smallest beam values (and the smallest beam sizes on average), are toward the center of the PMT. It is likely that these are noise-level fits again.

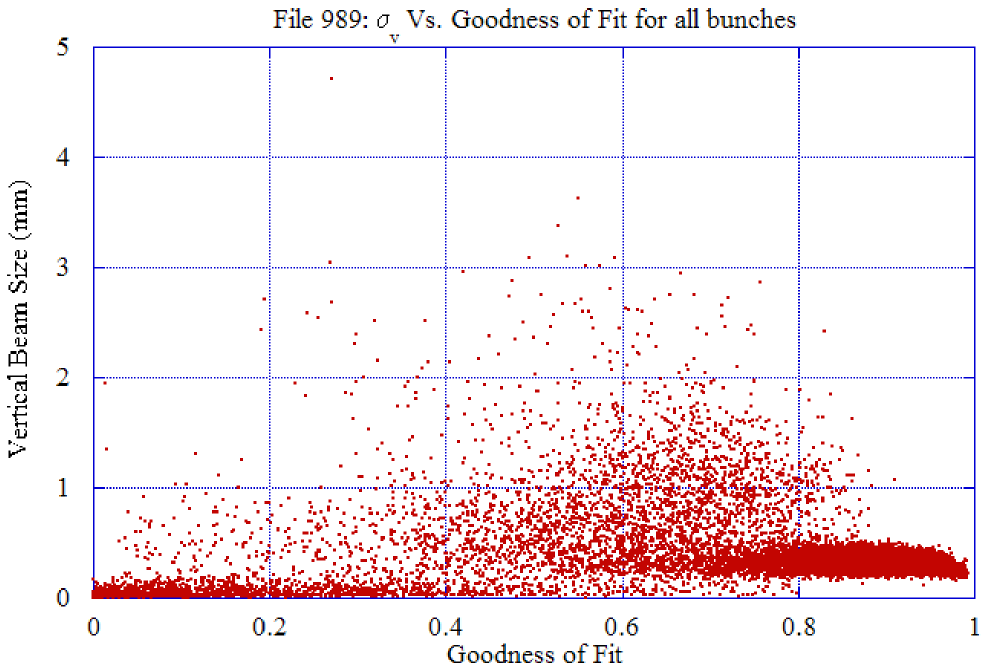


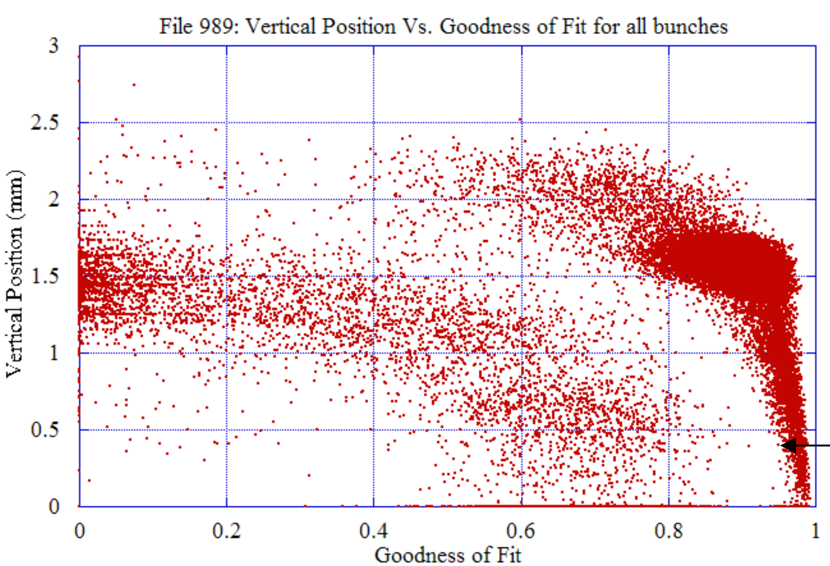


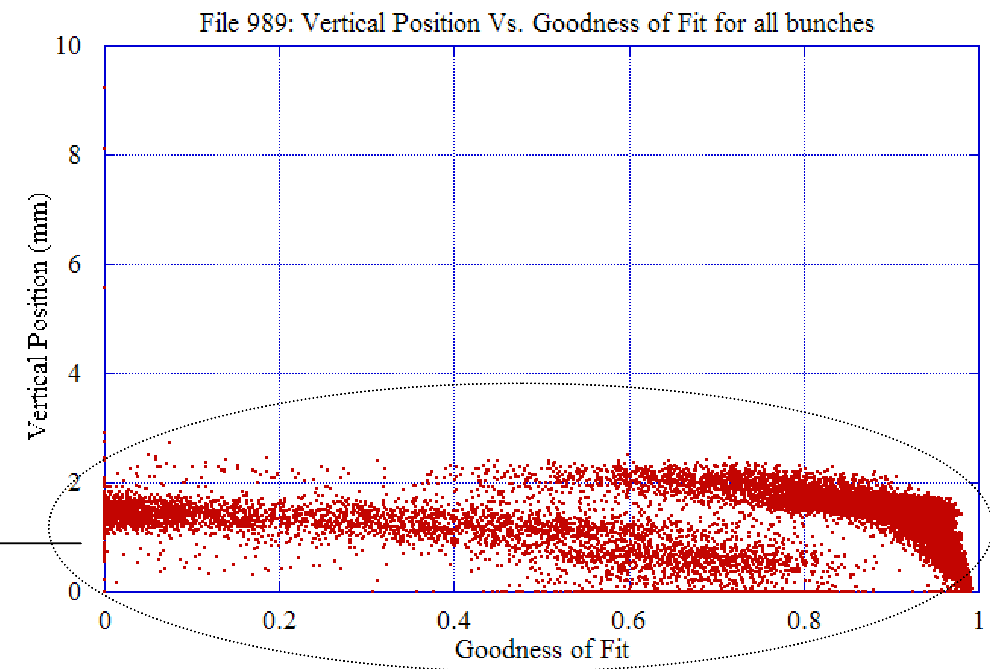


30 Bunches at 14ns Spacing

- Measurement 989 displays many anomalously small vertical beam size values as well as a much wider range of beam sizes than most of the other datasets.
- The vertical position of this bunch for the main body of data (the solid red clump in the plot below and its tails) tends to reach much closer to the "left" edge of the PMT than in the other measurements.
- The trend in which goodness of fit generally decreases toward the right of the PMT is again noted. As in measurement 984, there appear to be two separate trends.

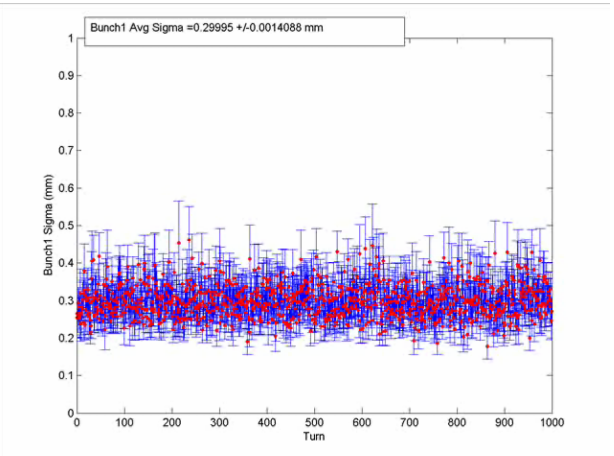






30 Bunches at 14ns Spacing – Vertical Beam Size

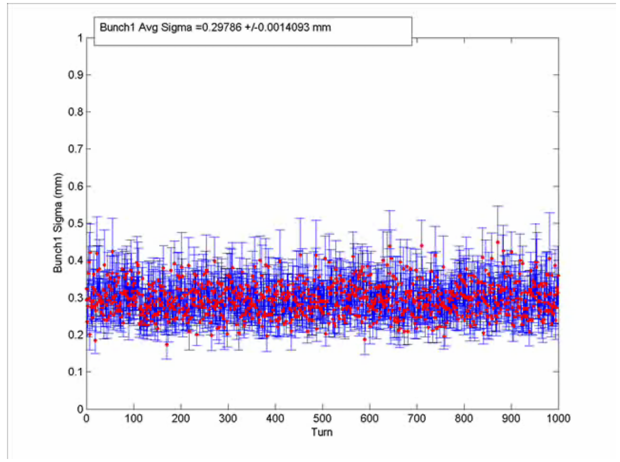
Movies: no cuts



File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

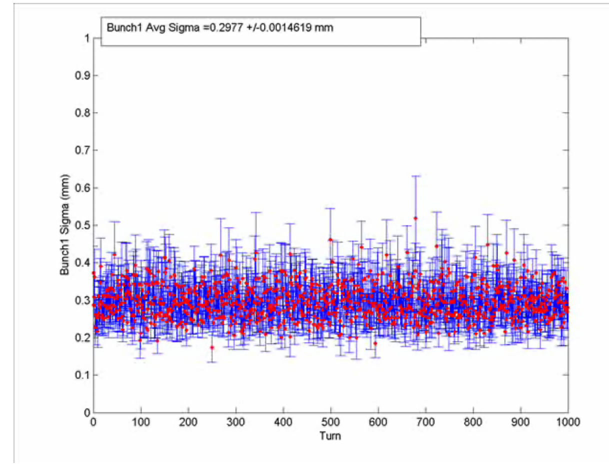
It looks as if bunch 30 may have been lost.



File 987:

Ie+ = 0.75mA/bunch, XQ1 = +75

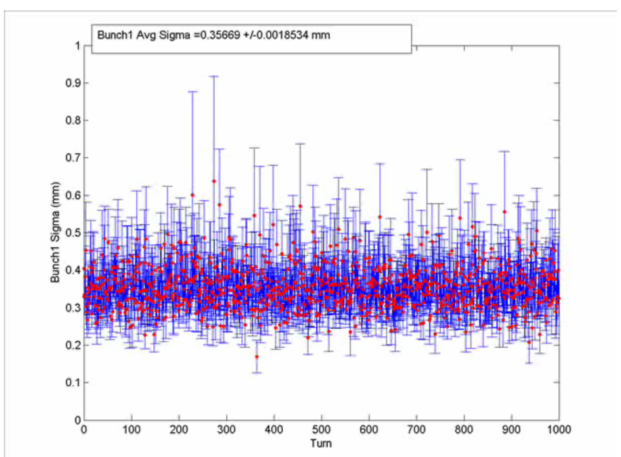
Starting with ~bunch 20, it looks like vertical position oscillation caused the loss of beam size data.



File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99

It looks as if bunch 30 may have been lost.



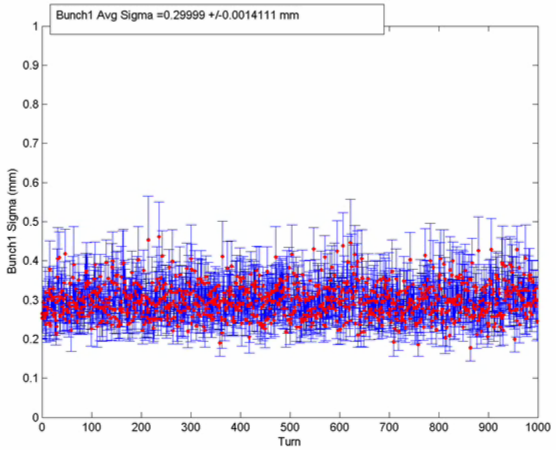
File 989:

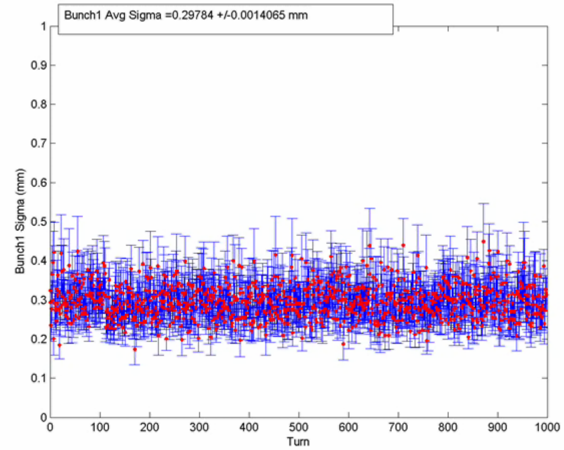
Ie+ = 0.75mA/bunch, XQ1 = +99

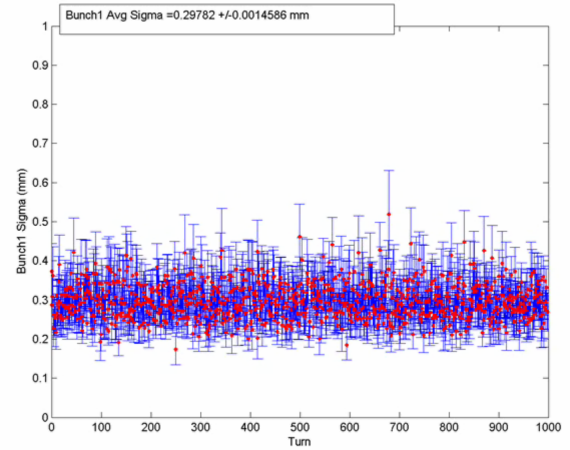
Starting with bunch 13, it looks like a lot of beam size data was lost due to vertical position oscillation.

30 Bunches at 14ns Spacing – Vertical Beam Size

Movies: goodness of fit cut at 0.8







File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

It looks as if bunch 30 may have been lost.

File 987:

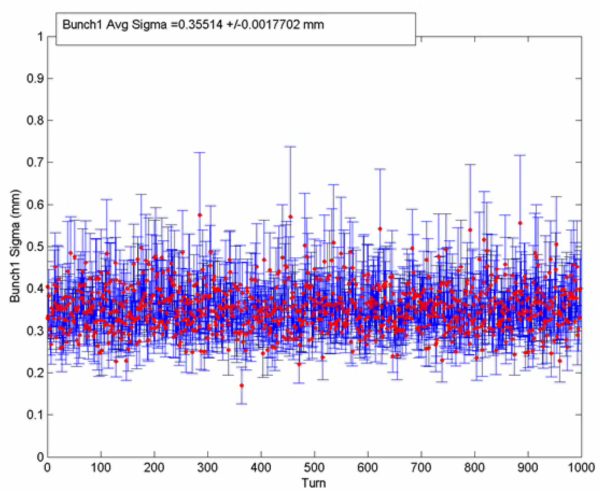
Ie+ = 0.75mA/bunch, XQ1 = +75

Starting with ~bunch 20, it looks like vertical position oscillation caused the loss of beam size data.

File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99

It looks as if bunch 30 may have been lost.



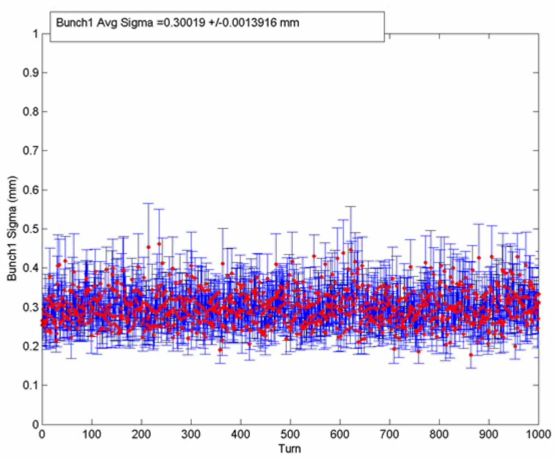
File 989:

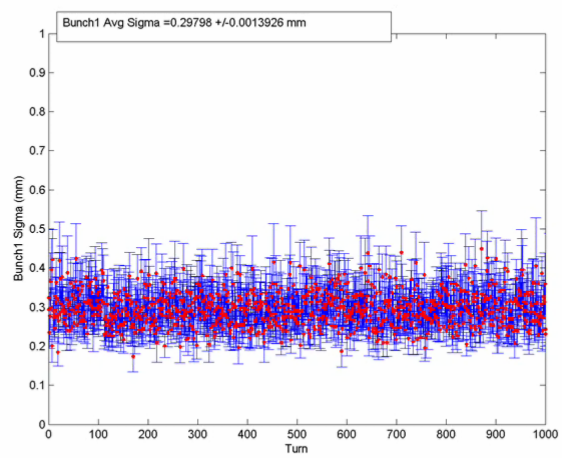
Ie+ = 0.75mA/bunch, XQ1 = +99

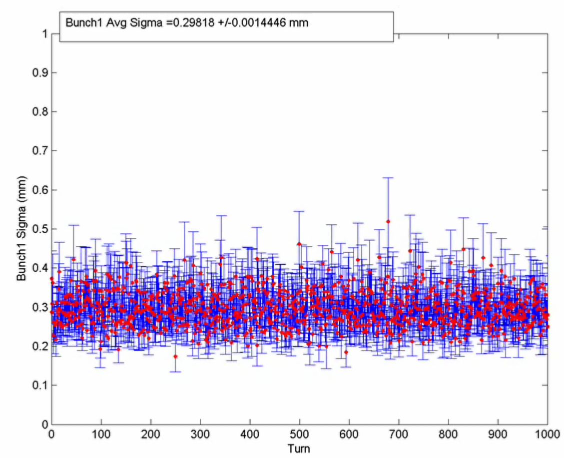
Starting with bunch 13, it looks like a lot of beam size data was lost due to vertical position oscillation.

30 Bunches at 14ns Spacing – Vertical Beam Size

Movies: goodness of fit cut at 0.4







File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

It looks as if bunch 30 may have been lost.

File 987:

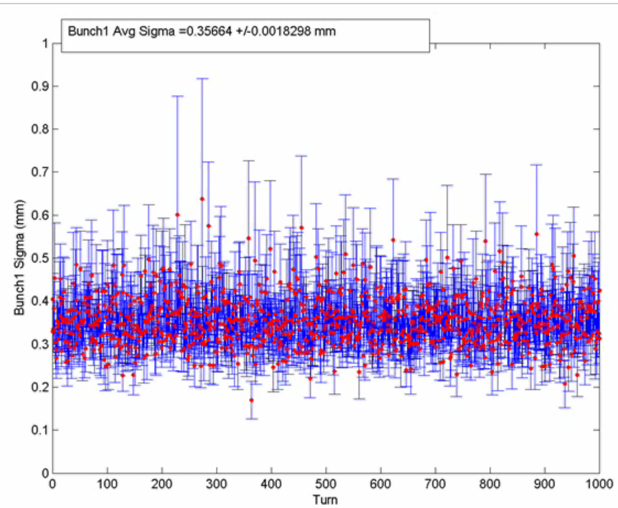
Ie+ = 0.75mA/bunch, XQ1 = +75

Starting with ~bunch 20, it looks like vertical position oscillation caused the loss of beam size data.

File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99

It looks as if bunch 30 may have been lost.



File 989:

Ie+ = 0.75mA/bunch, XQ1 = +99

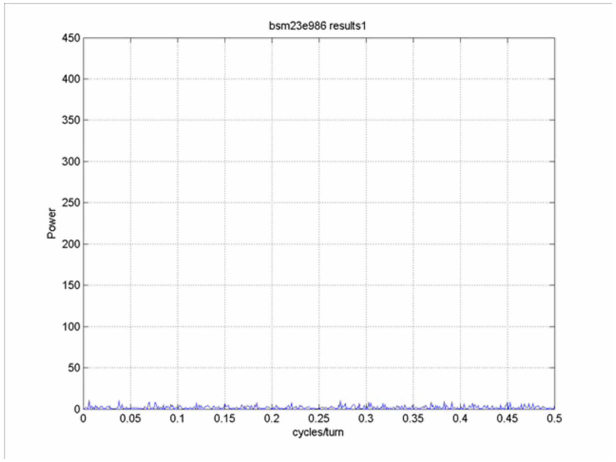
Starting with bunch 13, it looks like a lot of beam size data was lost due to vertical position oscillation.

30 Bunches at 14ns Spacing – Vertical Beam Size FFT and Systematics

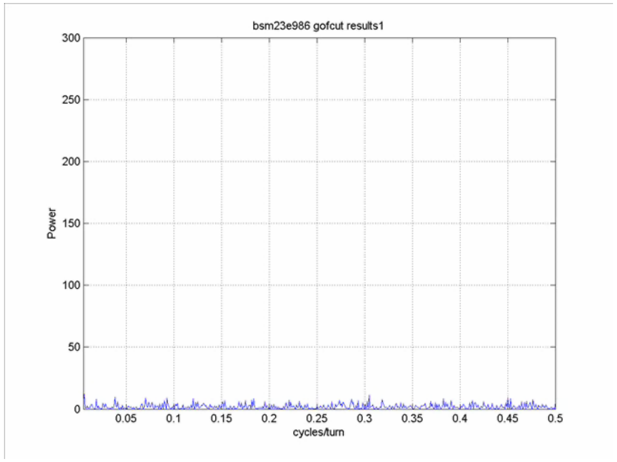
File 986

Movies

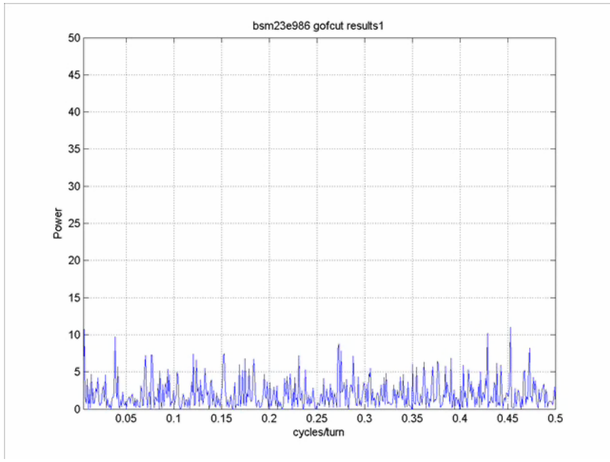
No cuts



Cut at 0.4



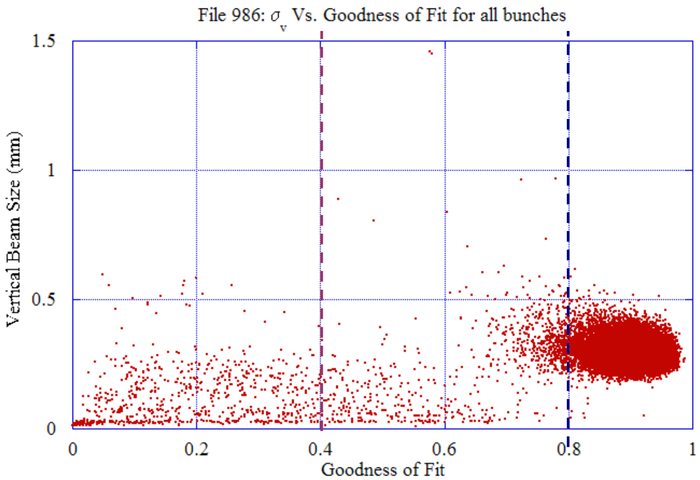
Cut at 0.8

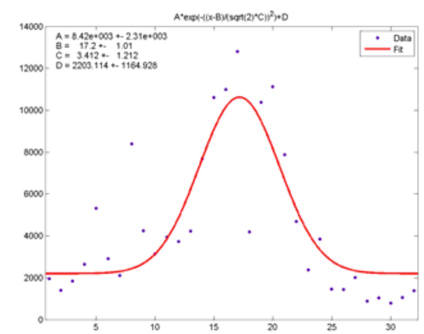


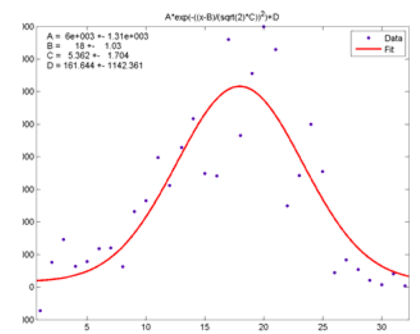
- Applying the goodness of fit cut at 0.8 decreases the power of the oscillation detection near the vertical tune by an order of magnitude, while the application of the cut at 0.4 decreases it by about a factor of two.

- The cut at 0.8 cuts off some of the main body of data. At the bottom right is a plot of the data and fit to bunch 27, turn 523, with a goodness of fit of 0.768. It's a noisy fit, but the signal is there. The bottom left is a plot of data and fit for the same bunch, turn 47, with goodness of fit 0.679. Again, the signal is there but with high noise.

- For several bunches, the near-tune line is still detected above the noise level in the 0.8 cut data.

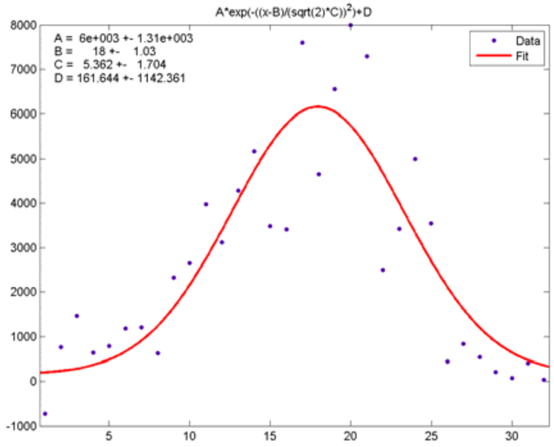


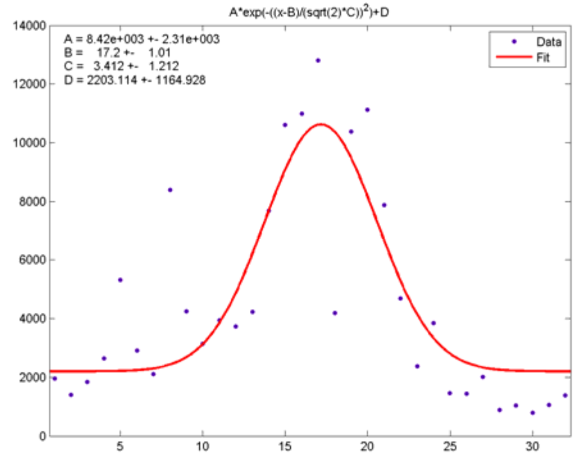


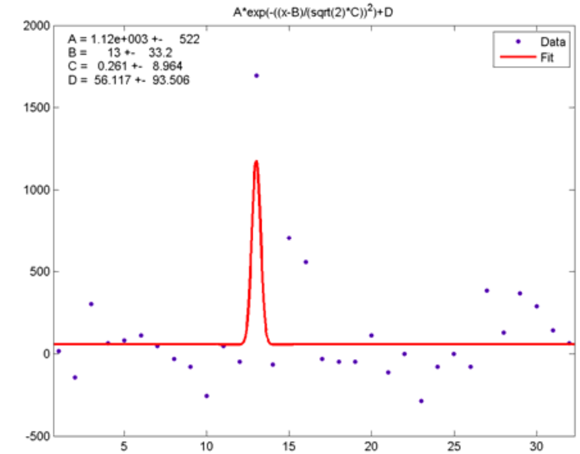


30 Bunches at 14ns Spacing – Vertical Beam Size FFT and Systematics, continued

File 986







•At the top left is a plot of the data and fit to bunch 27, turn 523, with a goodness of fit of 0.768. It's a noisy fit, but the signal is there.

•The top middle is a plot of data and fit for the same bunch, turn 47, with goodness of fit 0.679. Again, the signal is there but with high noise.

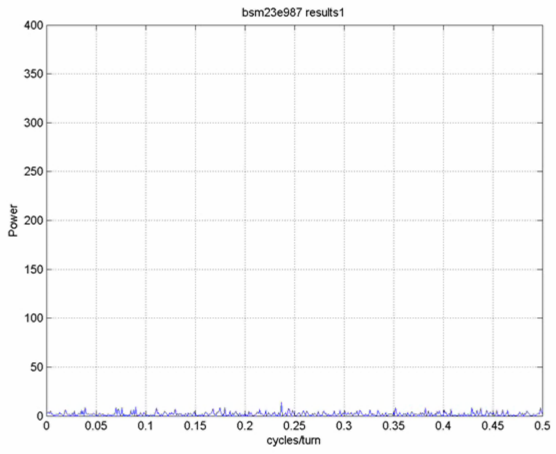
•The top right is a plot of data and fit for bunch 30, turn 62, with goodness of fit 0.575. The fit, like the other fits to noise-level data, has a very small vertical beam size, but the goodness of fit is relatively high because of how close the background points all are to the supposed "fit". This demonstrates that before applying any goodness of fit cut to a dataset, a plot of fit vertical beam size vs. goodness of fit should be studied.

30 Bunches at 14ns Spacing – Vertical Beam Size FFT

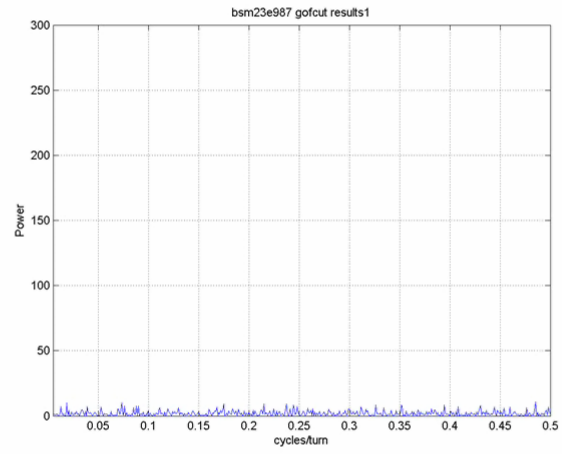
File 987

Movies

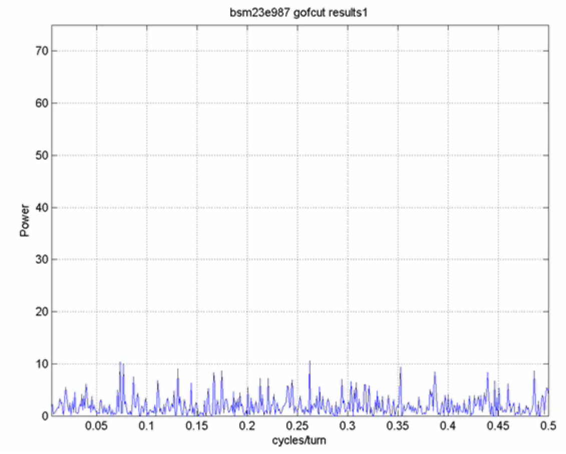
No cuts



Cut at 0.4

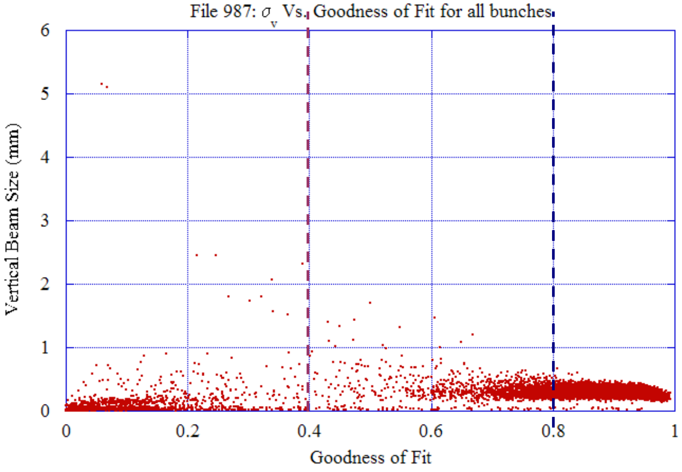


Cut at 0.8



- Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by an order of magnitude, while the application of the cut at 0.4 decreases it slightly.

- For a few bunches, that line is still detected above the noise level in the 0.8 cut data.

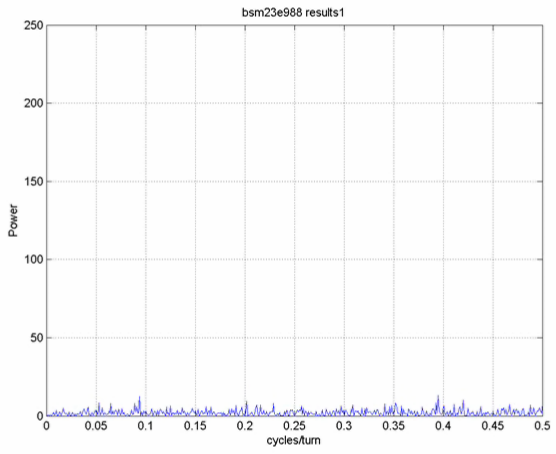


30 Bunches at 14ns Spacing – Vertical Beam Size FFT

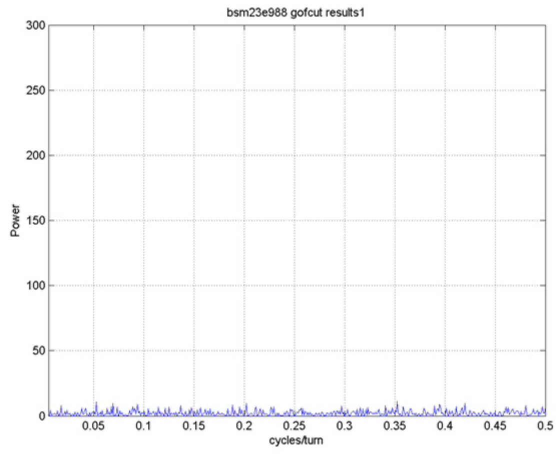
File 988

Movies

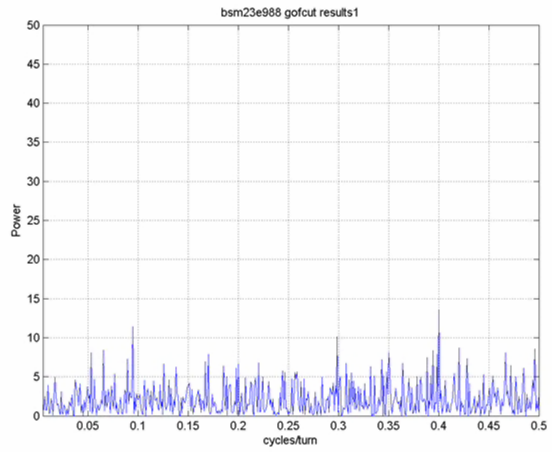
No cuts



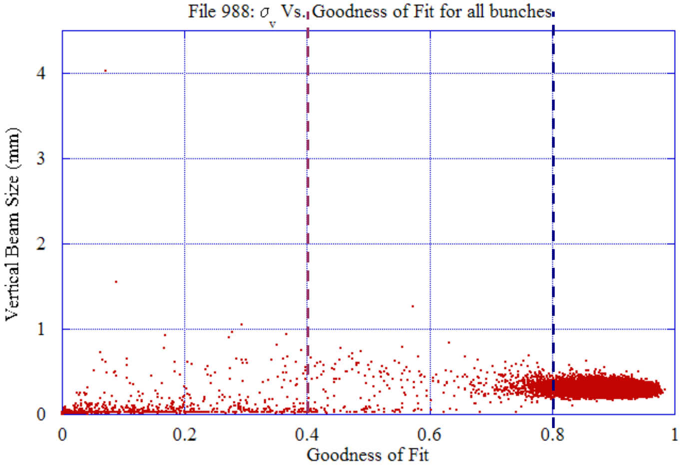
Cut at 0.4



Cut at 0.8



- Applying the goodness of fit cut at 0.8 decreases the power of the oscillation near the vertical tune by an order of magnitude, while the application of the cut at 0.4 increases it slightly.
- For several bunches, this line is still detected above the noise level in the 0.8 cut data.
- The odd power spectra in the data for bunch 30 were due to current loss.

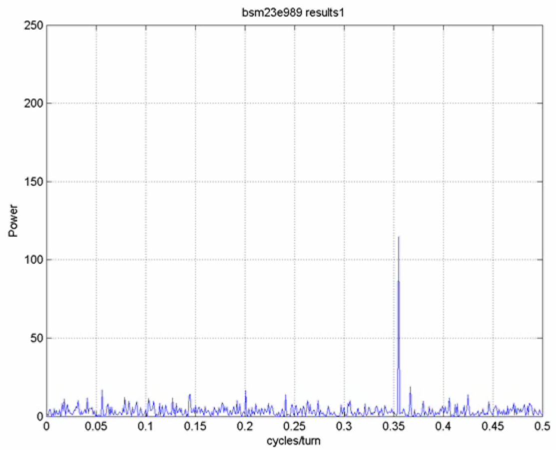


30 Bunches at 14ns Spacing – Vertical Beam Size FFT

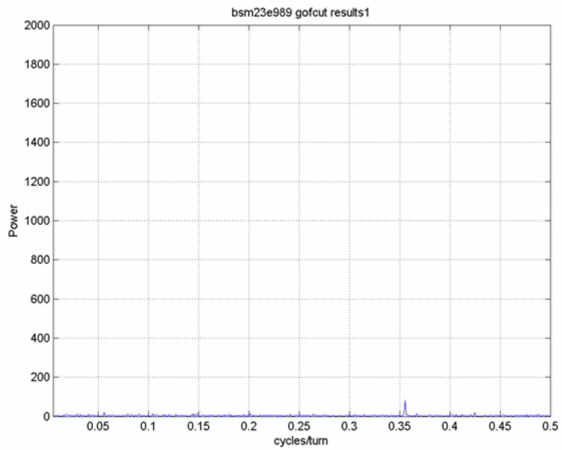
File 989

Movies

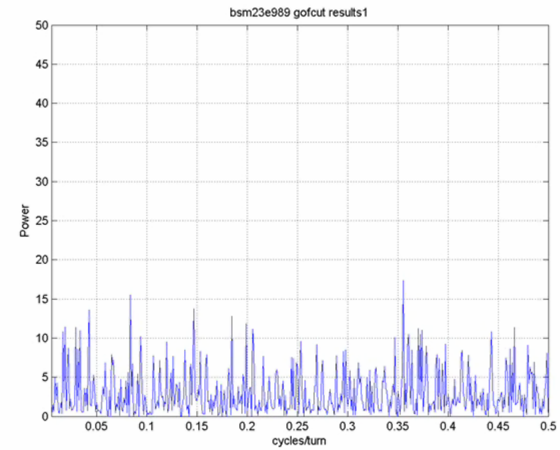
No cuts



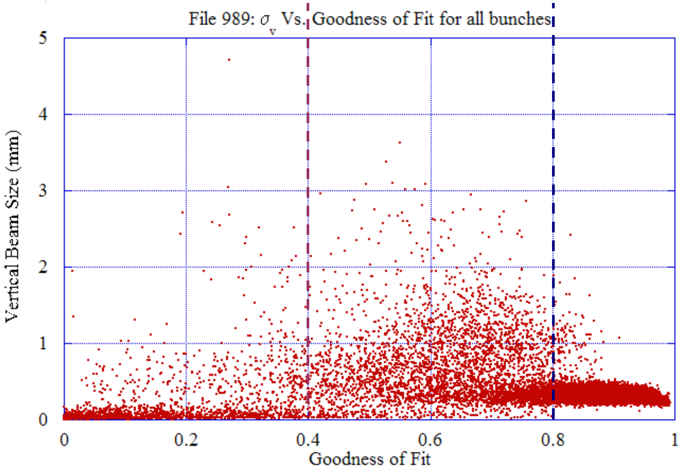
Cut at 0.4



Cut at 0.8

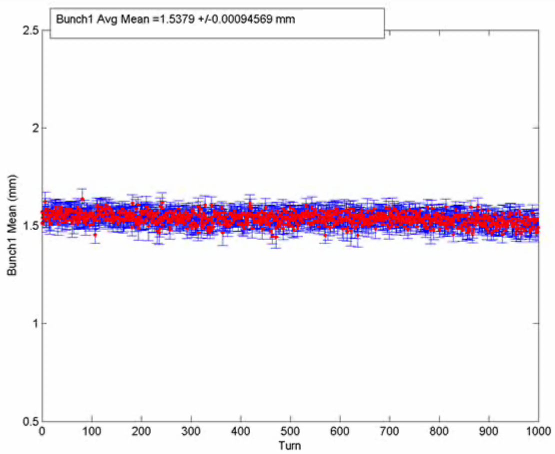


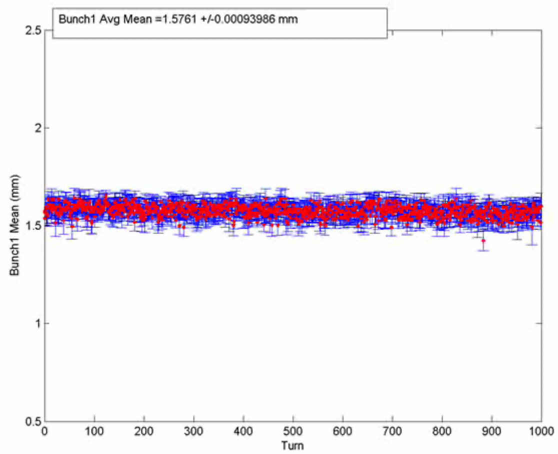
- The line near the vertical tune does not show up strongly in any case here. It is above the noise level for the uncut data and the 0.4 cut data, and basically non-existent in the 0.8 cut case.

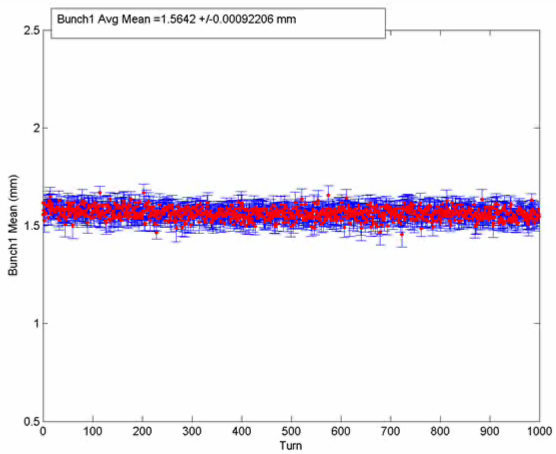


30 Bunches at 14ns Spacing – Vertical Position

Movies: no cuts







File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

Bunches later in the train are clearly unstable.

File 987:

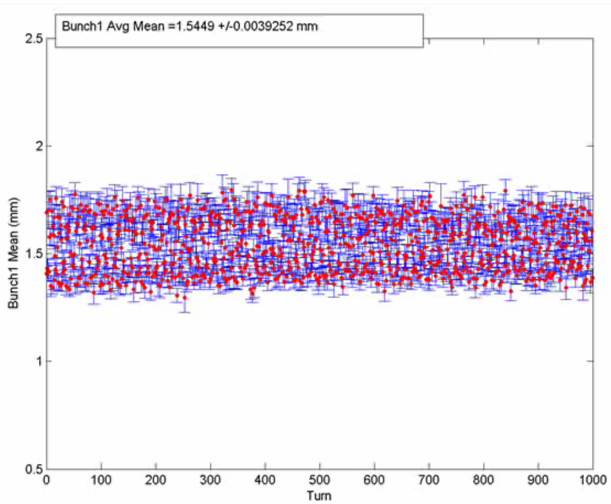
Ie+ = 0.75mA/bunch, XQ1 = +75

Bunches later in the train are unstable, and bunch 26-30 were lost.

File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99, Vertical feedback on at -2000.

Instability generally increases along the train, until bunches 29 and 30 which appear to have been lost.



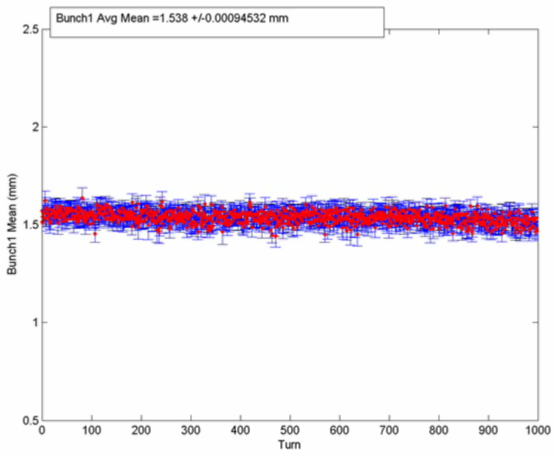
File 989:

Ie+ = 0.75mA/bunch, XQ1 = +99

Nearly every bunch is unstable, and it appears as if a few bunches were lost (check if this was current loss or if the signal went off the PMT).

30 Bunches at 14ns Spacing – Vertical Position

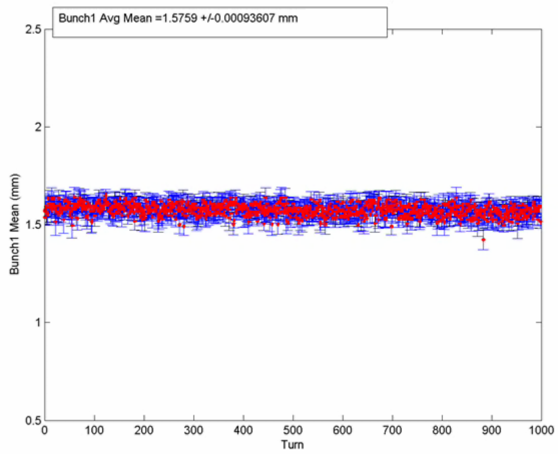
Movies: goodness of fit cut at 0.8



File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

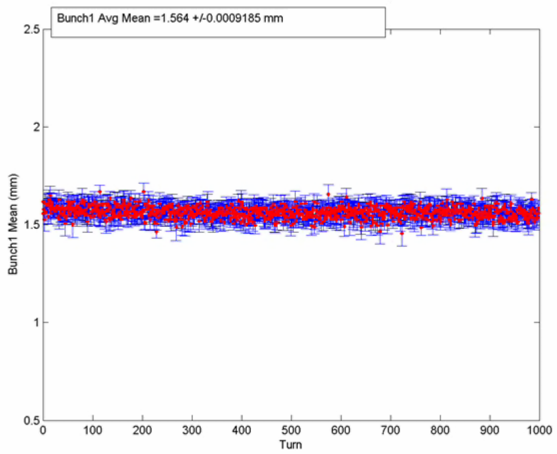
It is apparent that the points removed by this cut were to the right of the PMT's center.



File 987:

Ie+ = 0.75mA/bunch, XQ1 = +75

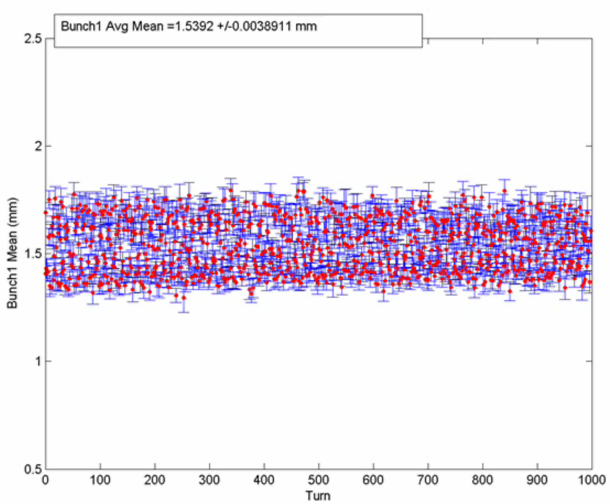
It is apparent that the points removed by this cut were to the right of the PMT's center.



File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99

The points removed were to the right of the PMT's center.



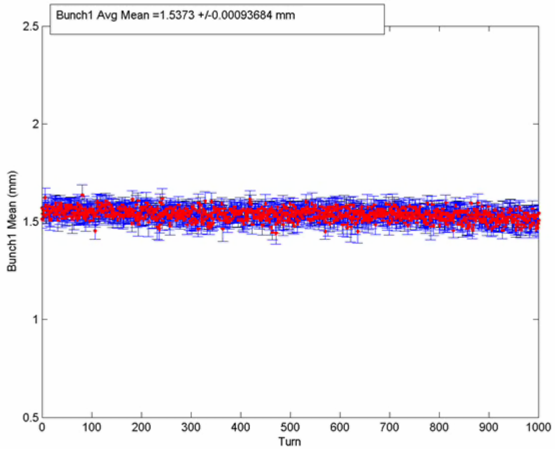
File 989:

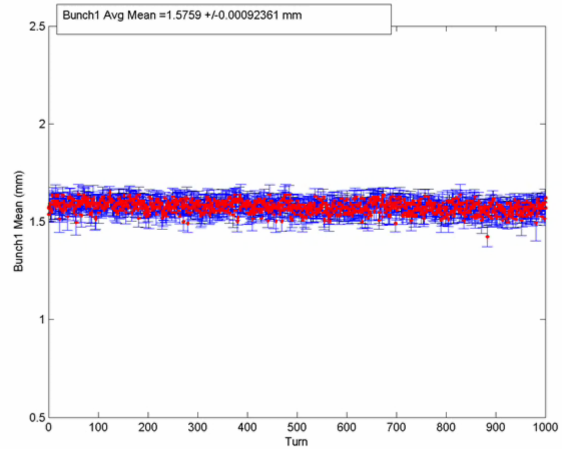
Ie+ = 0.75mA/bunch, XQ1 = +99

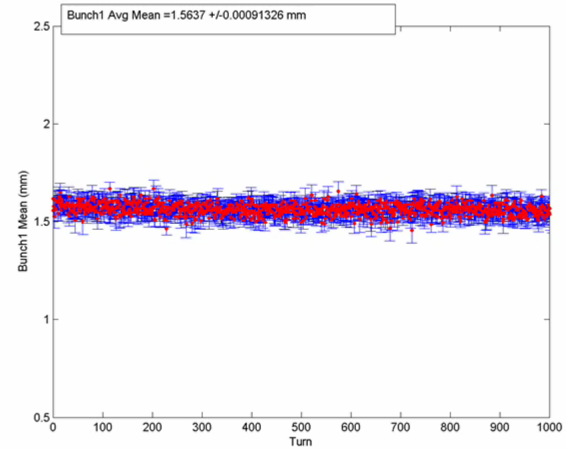
Again it is clear that the points removed by the cut were to the right of the PMT's center. Bunches 20-22 were removed almost completely.

30 Bunches at 14ns Spacing – Vertical Position

Movies: goodness of fit cut at 0.4







File 986:

I_{e+} = 0.75mA/bunch, XQ1 = +151

Most of the points in the last bunch were removed by this cut. Otherwise there is little difference between this and the uncut version.

File 987:

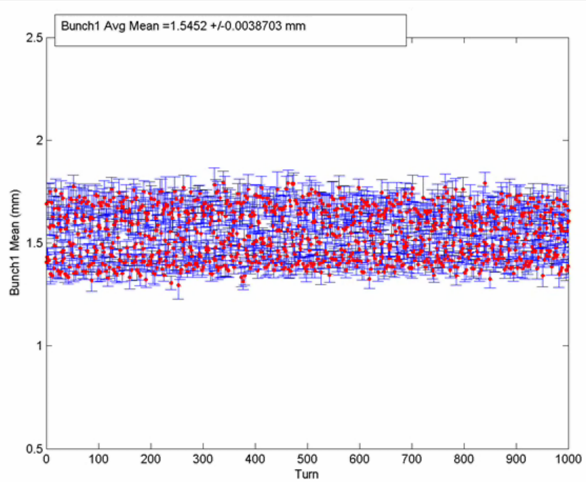
Ie+ = 0.75mA/bunch, XQ1 = +75

The bunches with current loss have essentially been cut out. There are also several cut points to the right of the PMT's center.

File 988:

Ie+ = 0.75mA/bunch, XQ1 = +99

Very similar to the uncut version.



File 989:

Ie+ = 0.75mA/bunch, XQ1 = +99

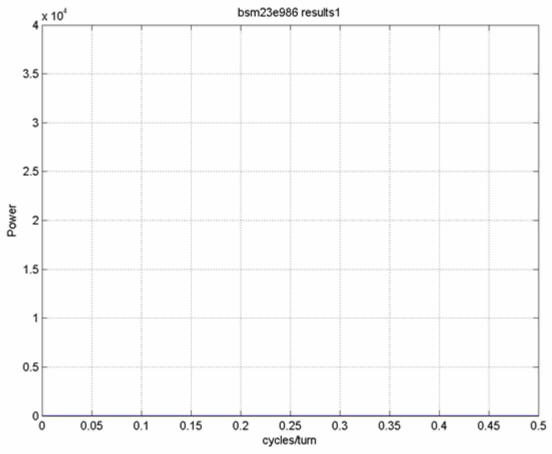
There are quite a few cut points to the right of the PMT center, as well as many cuts to the lost bunches.

30 Bunches at 14ns Spacing – Vertical Position FFT

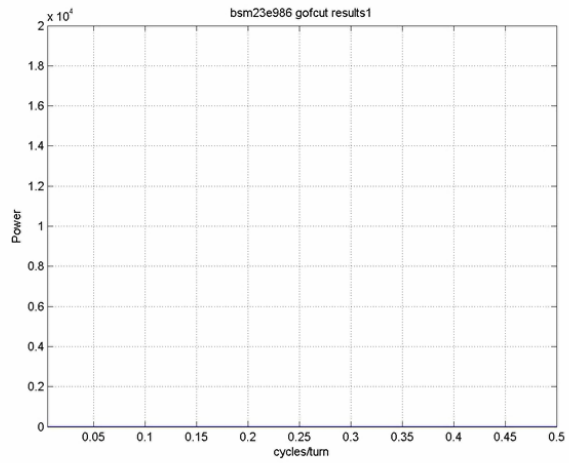
File 986

Movies

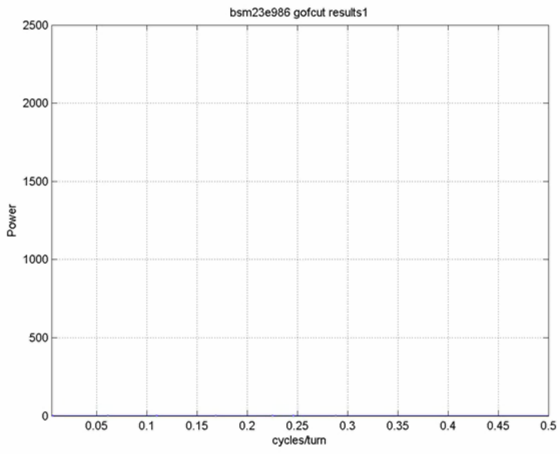
No cuts

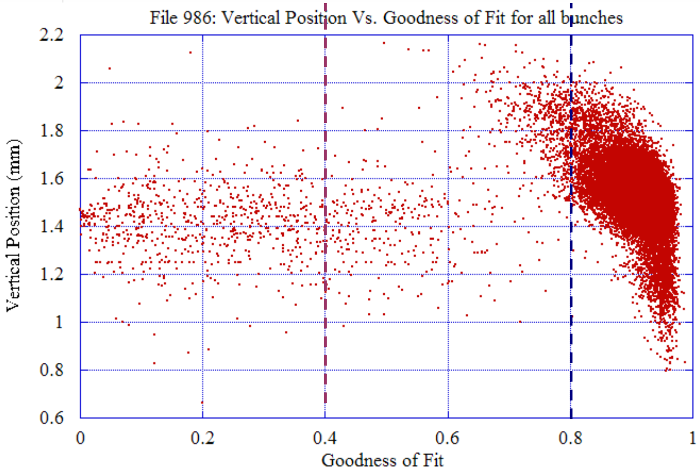


Cut at 0.4



Cut at 0.8





- Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by an order of magnitude, while the application of the cut at 0.4 decreases it by about a factor of two.

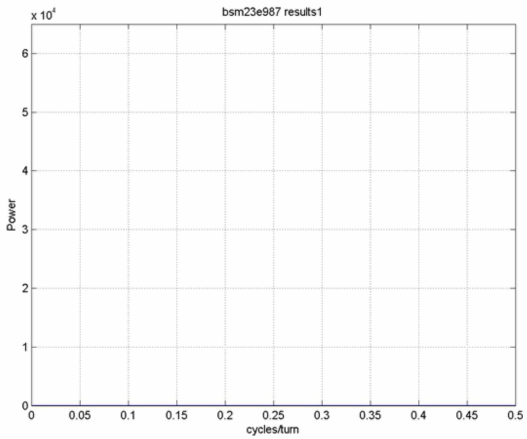
- The cut at 0.8 removes a disproportionately large amount of points to the right of the PMT center. Since the FFT was testing for oscillation in vertical position, it makes sense that such a cut would remove much of the oscillation information.

File 987

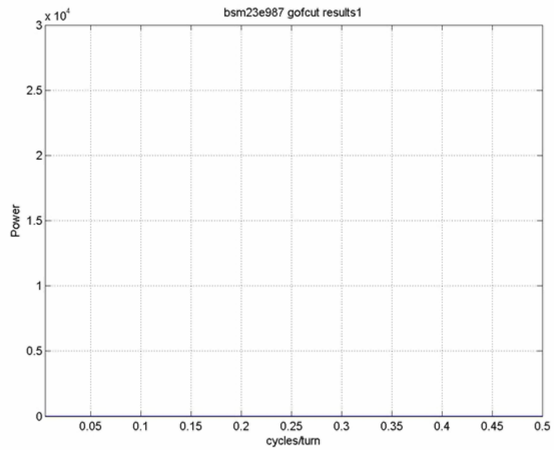
30 Bunches at 14ns Spacing – Vertical Position FFT

Movies

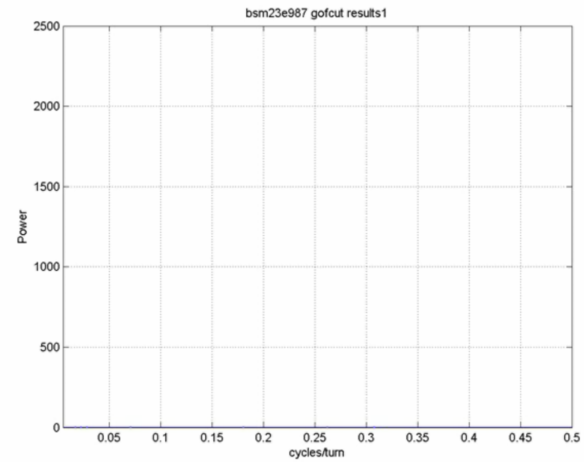
No cuts



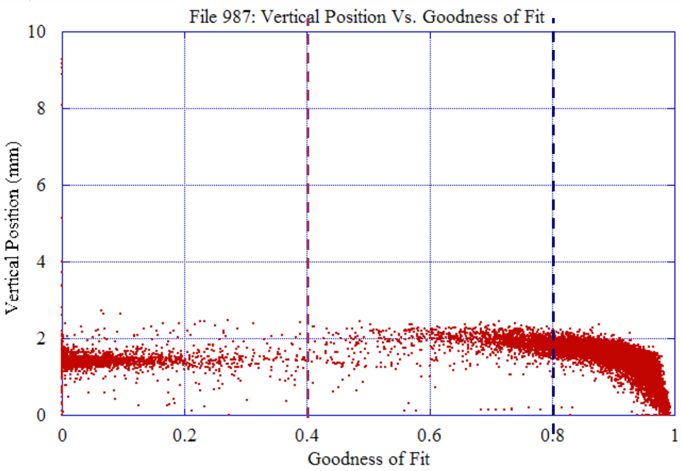
Cut at 0.4



Cut at 0.8



- Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by more than an order of magnitude (a large percentage of points to the right of the PMT's center were cut, as seen in the plot to the right), while the application of the cut at 0.4 decreases it by about a factor of two.



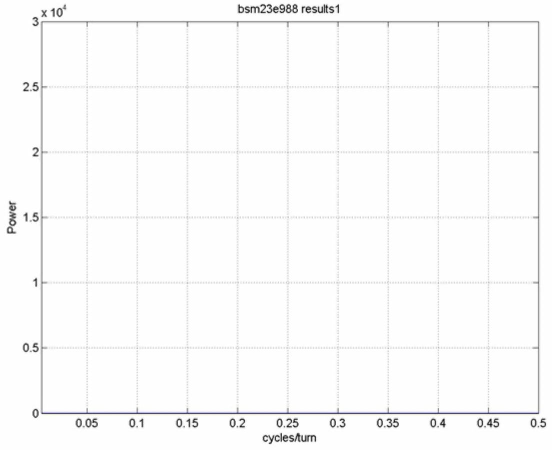
- A line that appears in the uncut case for bunches 23-26 does not appear when the 0.4 cut was applied, suggesting that it is an artifact of the signal being off the PMT. The fit values of sigma for file 987 strongly support this, as all the fits to noise-level are removed by the 0.4 cut.

File 988

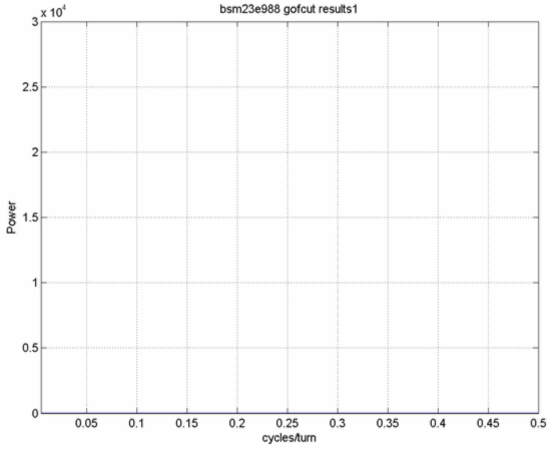
30 Bunches at 14ns Spacing – Vertical Position FFT

Movies

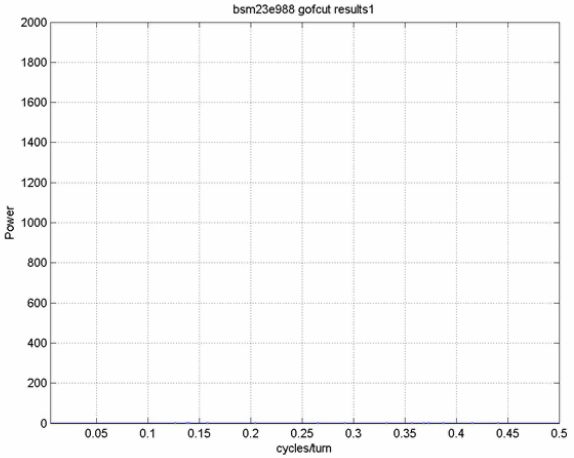
No cuts



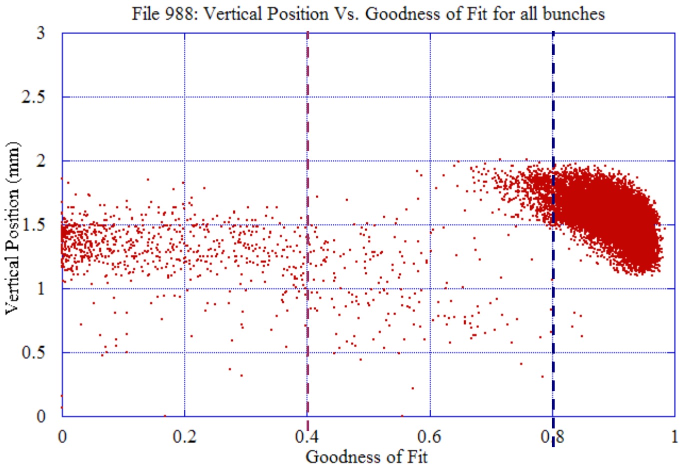
Cut at 0.4



Cut at 0.8



- Applying the goodness of fit cut at 0.8 decreases the power of the line near the vertical tune by an order of magnitude. Applying the cut at 0.4 had no significant affect on the FFT results.

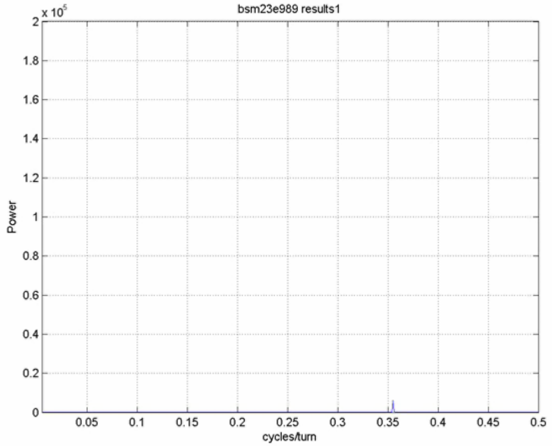


File 989

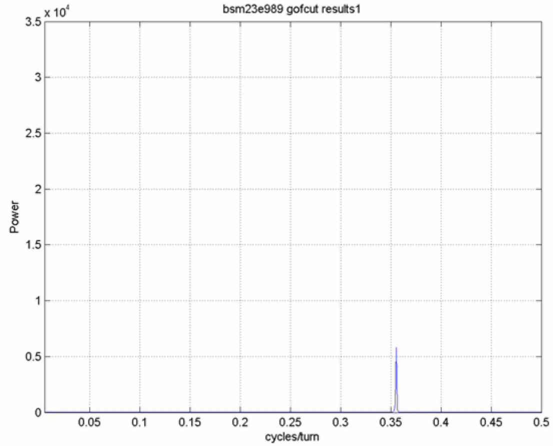
30 Bunches at 14ns Spacing – Vertical Position FFT

Movies

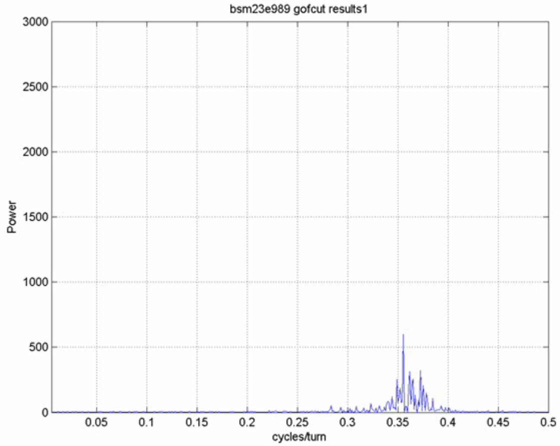
No cuts



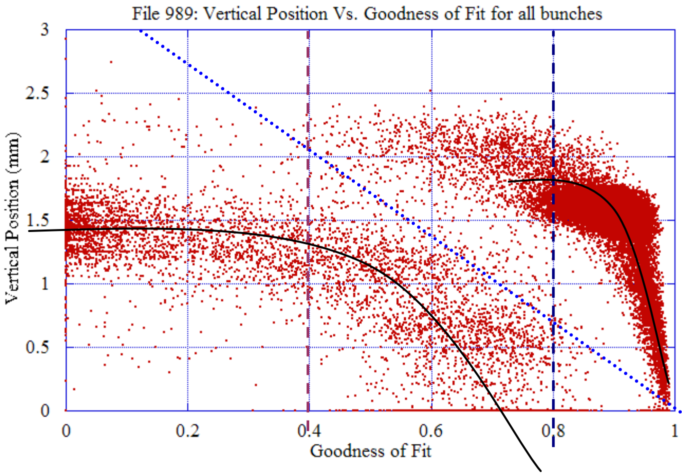
Cut at 0.4



Cut at 0.8

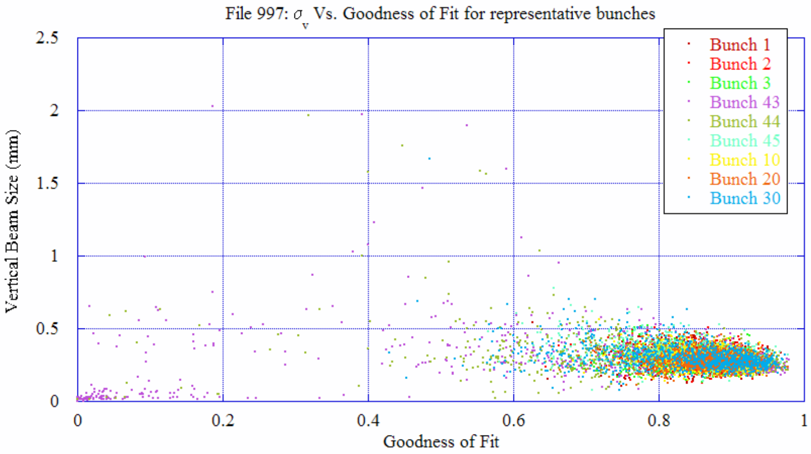


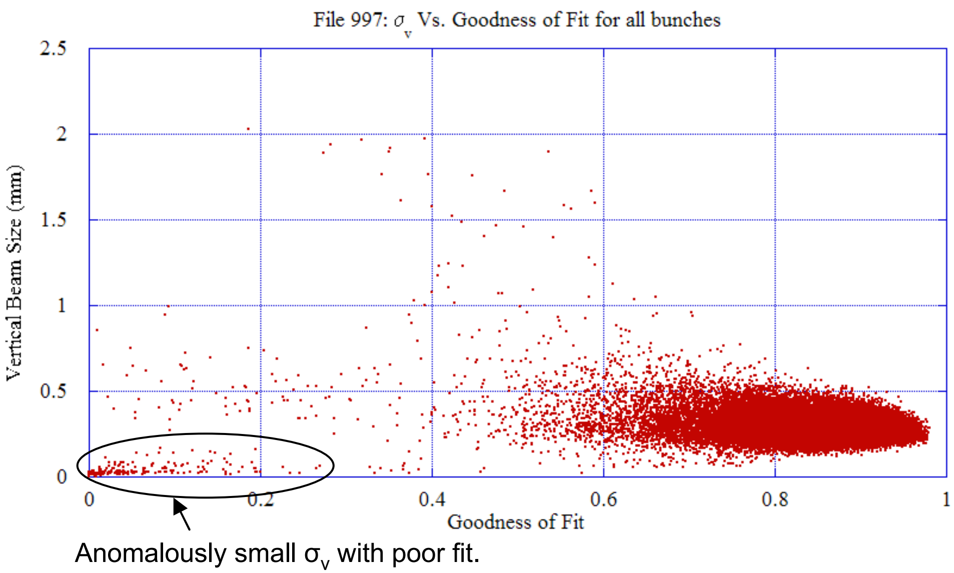
- Trends similar to that of file 984 is noted, where there are two sections of data each with their own trend to have a lower goodness of fit toward the right of the PMT. (Note: the curves were hand-shaped, as a visual tool only).
- The cut at 0.4 appears to remove many of the noise-level fits, and the prominence of a line near the vertical tune continues for most of the bunches.
- The 0.8 cut reduces the power of the vertical tune-related line by an order of magnitude.

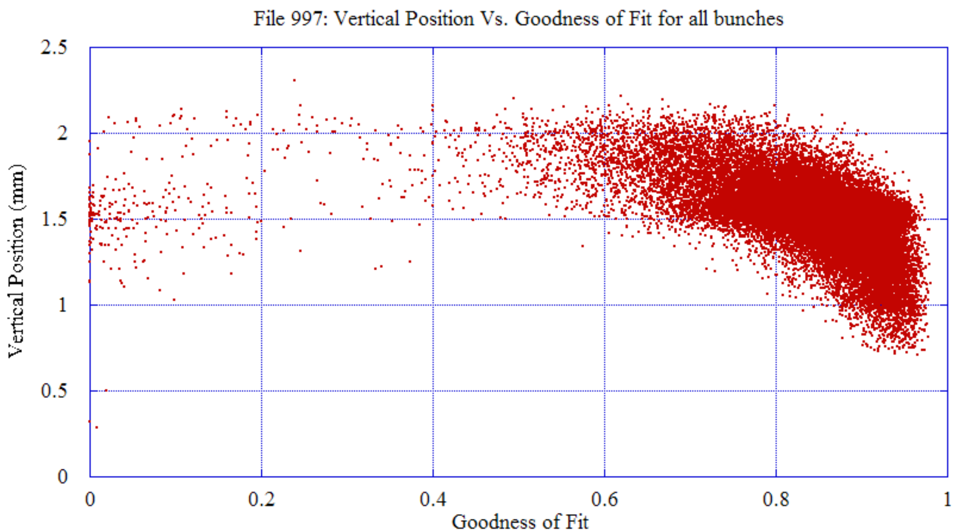


45 Bunches at 14ns Spacing

- Measurement 997 displays several anomalously small beam sizes and many fits with extremely low goodness of fit values.
- From the plot of vertical beam size vs. goodness of fit for several bunches on the left, it is evident that many of the anomalous points come from bunch 43 in particular. From the previous slide, 43 looks like it is the bunch with the most wild oscillation.
- It is less clear for this file that a goodness of fit cut at 0.4 is a good cut to apply until we look at the figure to the right. Nearly all points for the stable bunches are above a goodness of fit cut of 0.4, and a cut at 0.4 removes most of the fits with anomalously small vertical beam sizes.
- 0.8 is clearly too high of a cut to apply, as a large percentage of the fits for the stable bunches produce fits poorer than that. It is likely that nearly all oscillation data would be lost by the application of such a drastic cut.

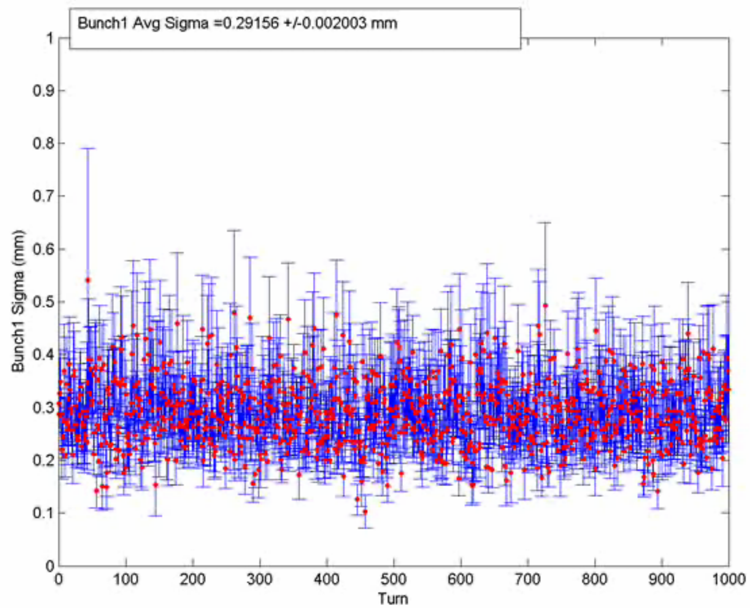




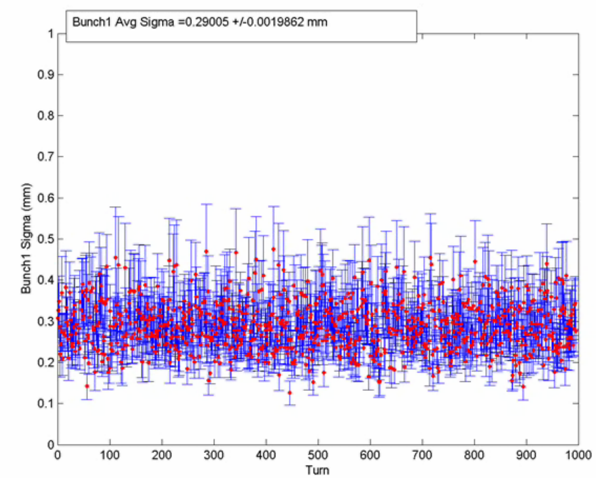


45 Bunches at 14ns Spacing – Vertical Beam Size

Movie: no cuts



Movie: goodness of fit cut at 0.8



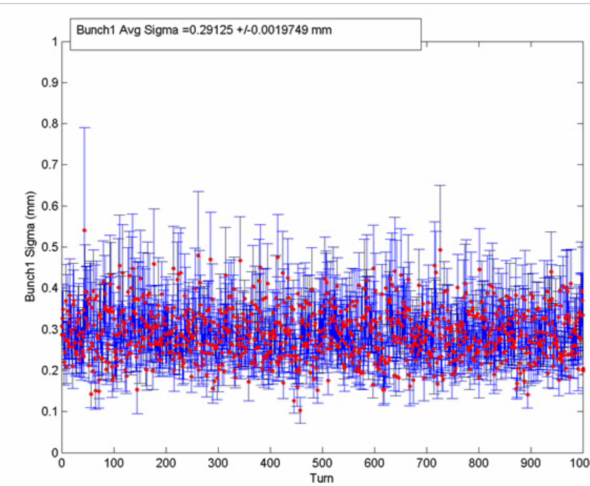
All of the points that looked like the bunch was off the PMT have been eliminated.

File 997:

I_{e+} = 0.35mA/bunch, XQ1 = -75

For some of the later bunches, it looks like many of the signals were off the PMT.

Movie: goodness of fit cut at 0.4

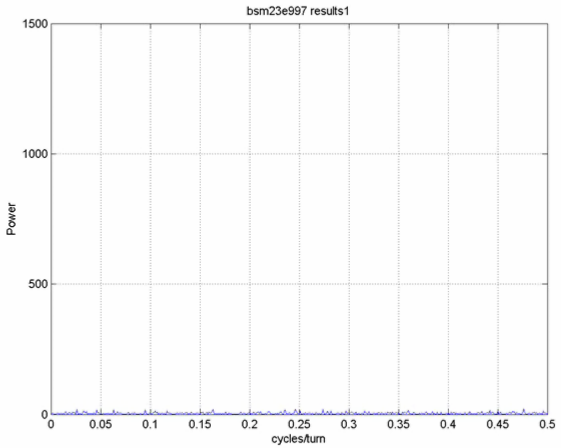


45 Bunches at 14ns Spacing – Vertical Beam Size FFT

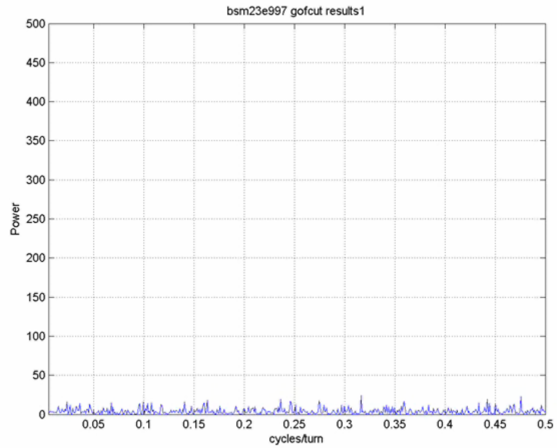
Movies

File 997

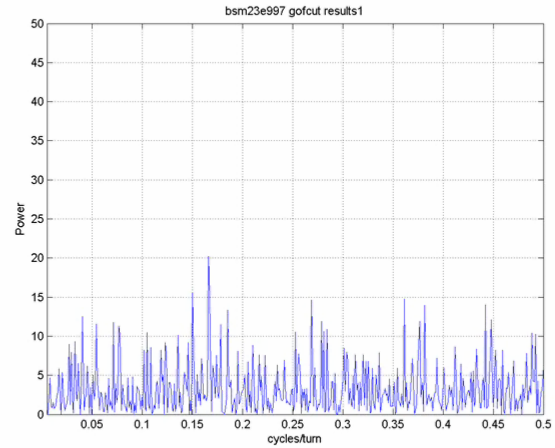
No cuts



Cut at 0.4

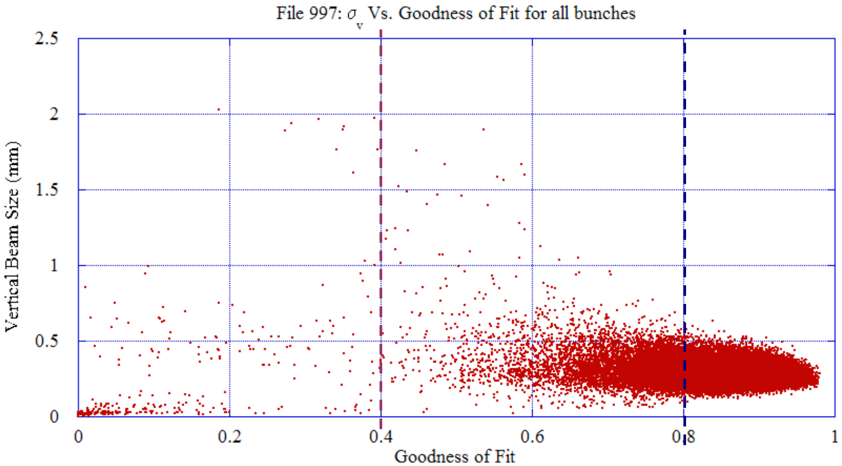


Cut at 0.8



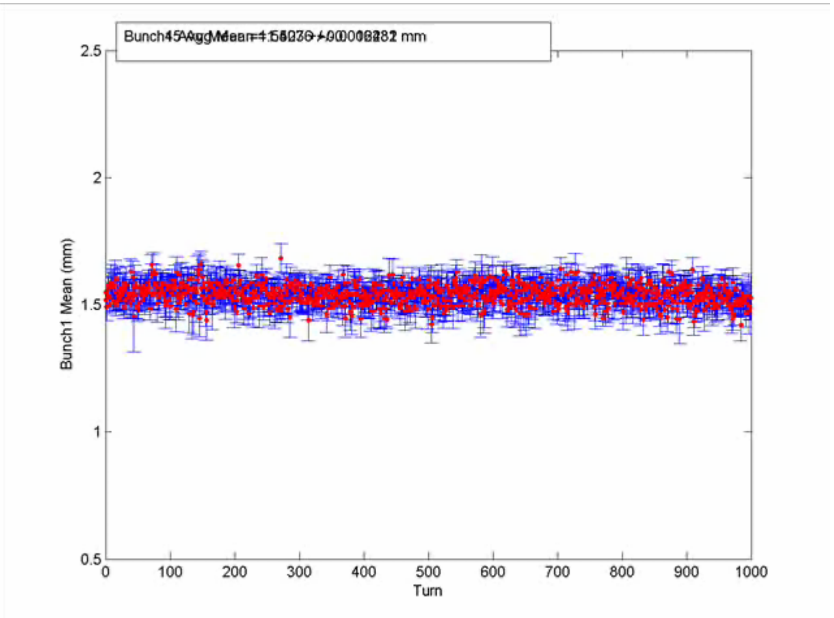
•Many of the data points for the last bunches in this measurement were bad (signal not on PMT). The cut at 0.4 removed those points. No significant lines are visible until bunch 20, at which point the line near the vertical tune appears again, well above the noise level.

•There are no significant detections when the 0.8 cut is applied (it cut out a very large percentage of the data, as seen in the plot to the right).



45 Bunches at 14ns Spacing – Vertical Position

Movie: no cuts

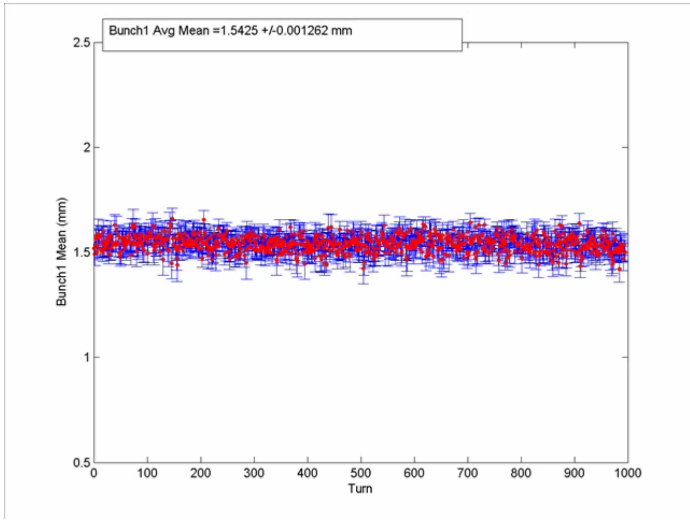


File 997:

I_{e+} = 0.35mA/bunch, XQ1 = -75

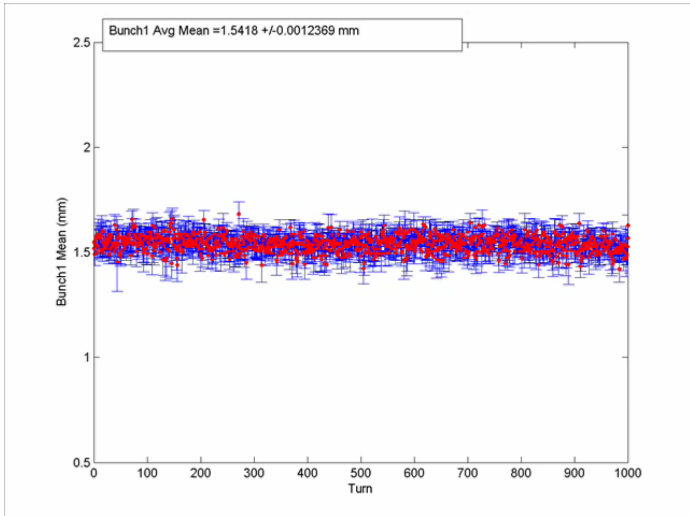
Vertical position oscillation clearly present.

Movie: goodness of fit cut at 0.8



Many of the points toward one side of the PMT have been cut, suggesting the signals were indeed off the array.

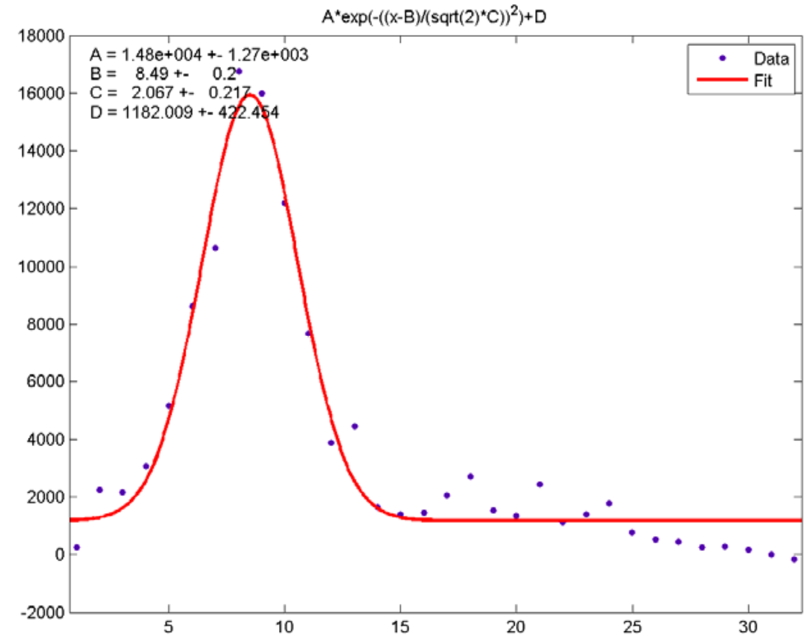
Movie: goodness of fit cut at 0.4



45 Bunches at 14ns Spacing

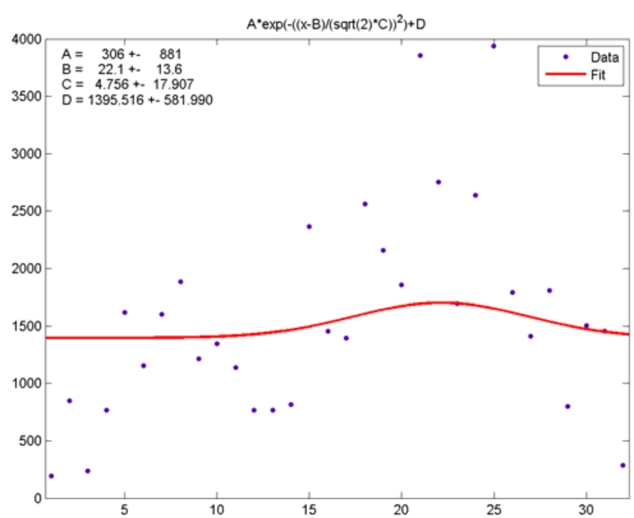
- Measurement 997 varies from clear signals well above the noise level to near-flat “signals” that would be indistinguishable from the noise in oth fits.
- A trend for the clear signals to be toward the left of the PMT center is noted.

Bunch 43, turn 50: With a peak at around 16,000 and a background level at about 1000, the fit is to a clear signal.



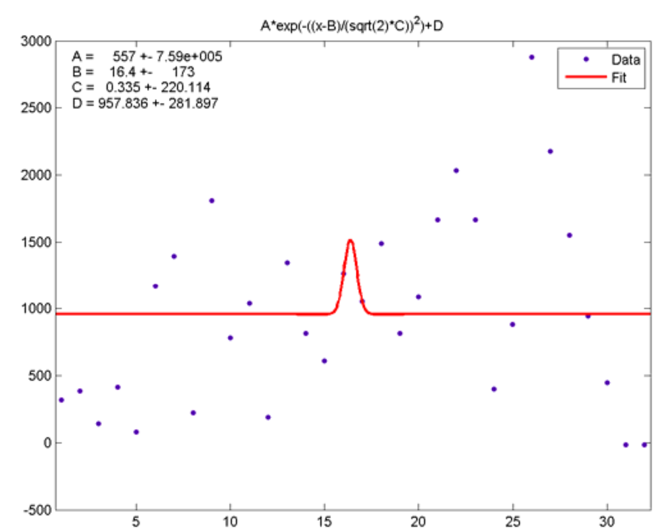
Bunch 43, turn 6:

The highest data point here is below 4000 – about ¼ of the peak for the signal at turn 50 for the same bunch. While it is possible there is no signal here, note the curved shape of the data overall.



Bunch 43, turn 100:

The highest data point here is below 3000 – less than 1/5 of the peak for the signal at turn 50 for the same bunch. It is possible there is no real signal here to fit to.

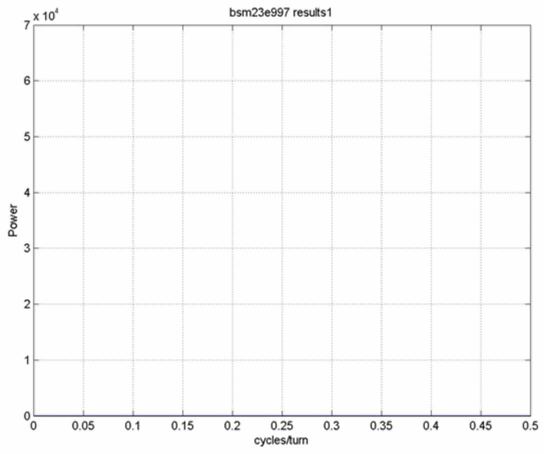


45 Bunches at 14ns Spacing – Vertical Beam Size FFT

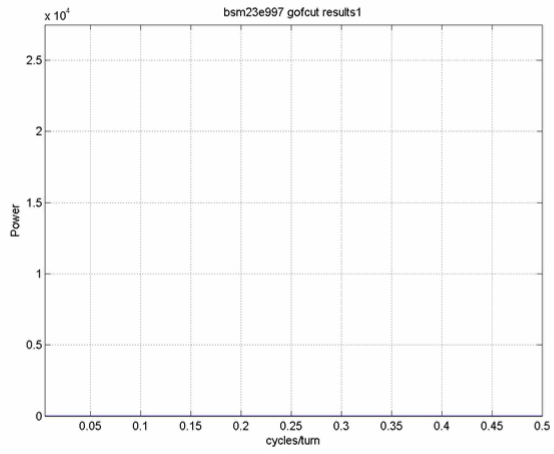
File 997

Movies

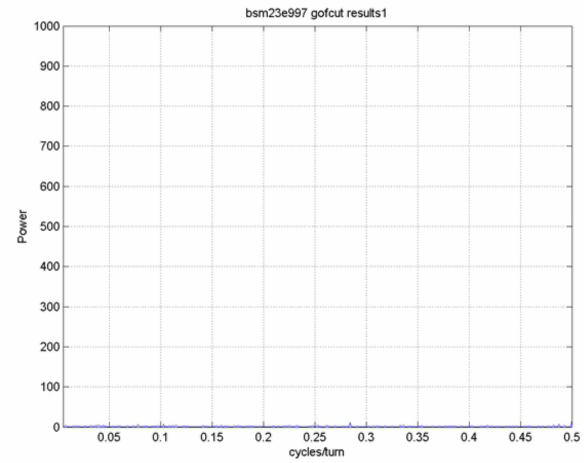
No cuts



Cut at 0.4

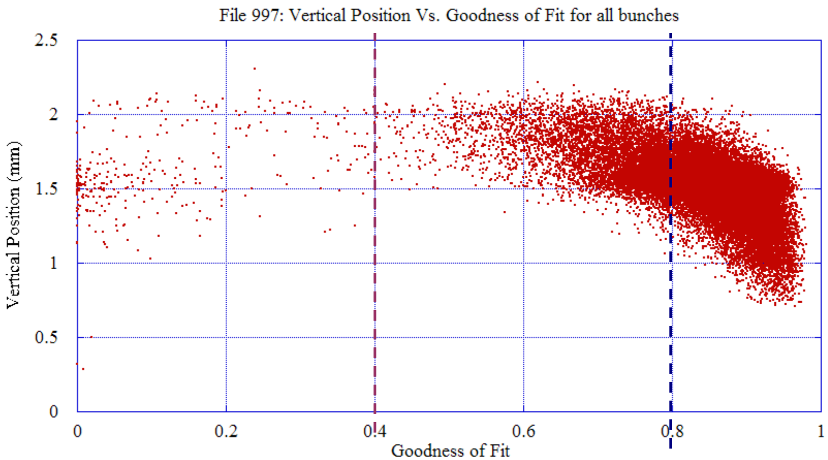


Cut at 0.8



- Many of the data points for the last bunches in this measurement were bad (signal not on PMT). The cut at 0.4 removed those points. No significant lines are visible until bunch 22 (0.4 cut) or 24 (uncut), at which point the line near the vertical tune appears again.

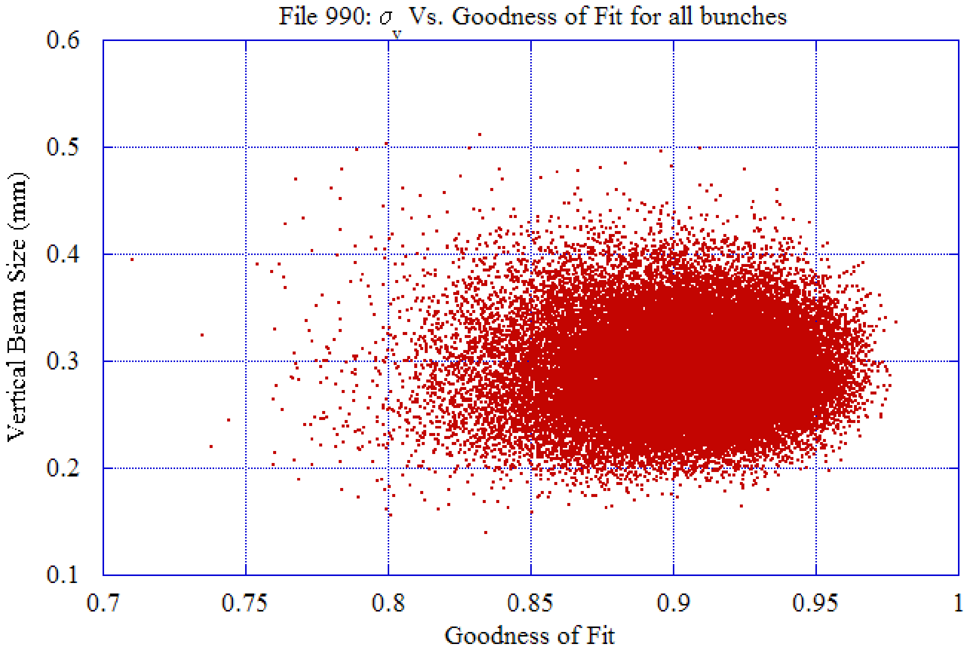
- When the 0.8 cut is applied, that line is not detected, although several lines near 0.4 and 0.45 cyc/turn appear at a power level more than an order of magnitude below the near-vertical-tune detection for the uncut and 0.4 cut cases.

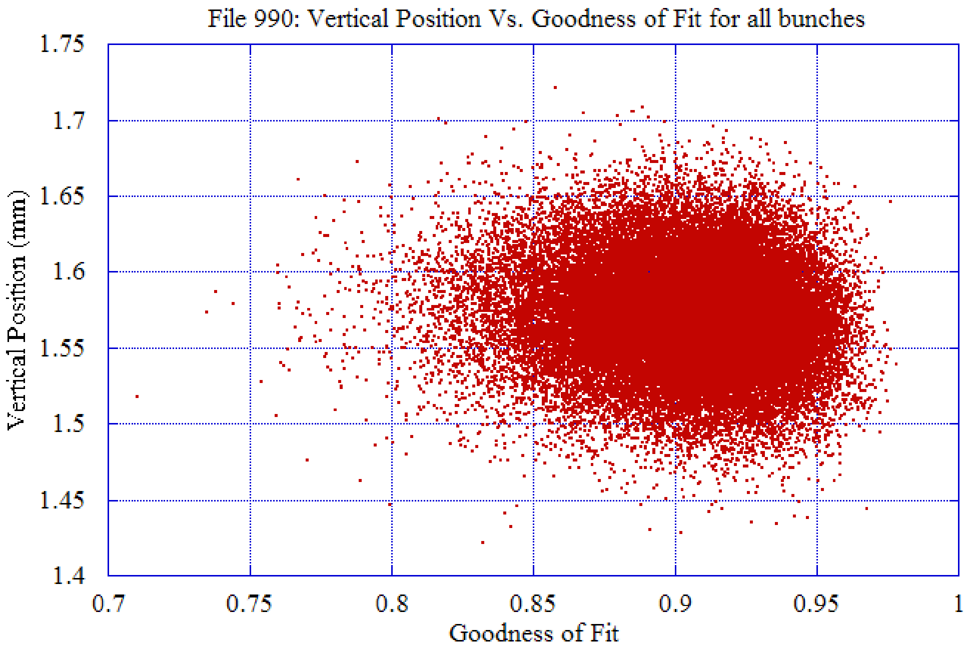


45 Bunches at 28ns Spacing

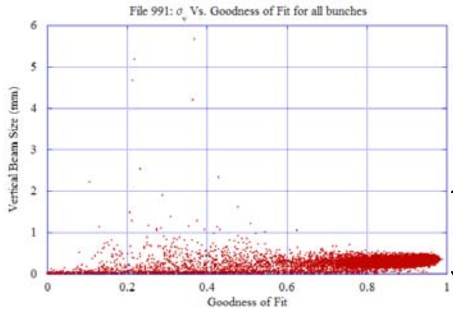
I_{e+} = 0.75mA/bunch
Vertical feedback set to -2000
XQ1 = +181

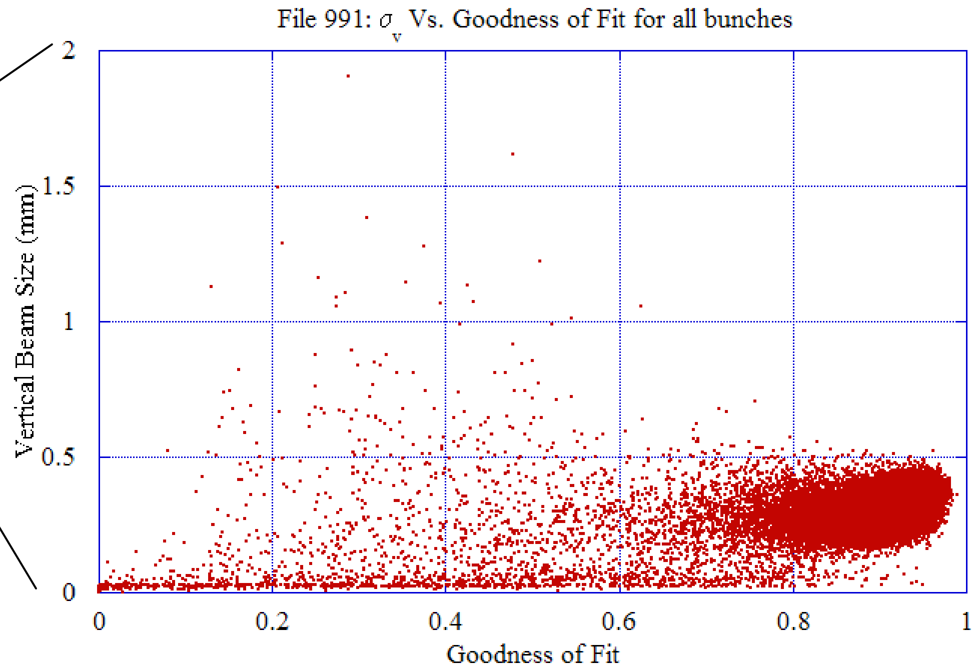
- Measurement 990 has no noticeably anomalous beam sizes and no goodness of fit values below 0.7.
- The range of vertical position values is very small in this case – no trends are observed.



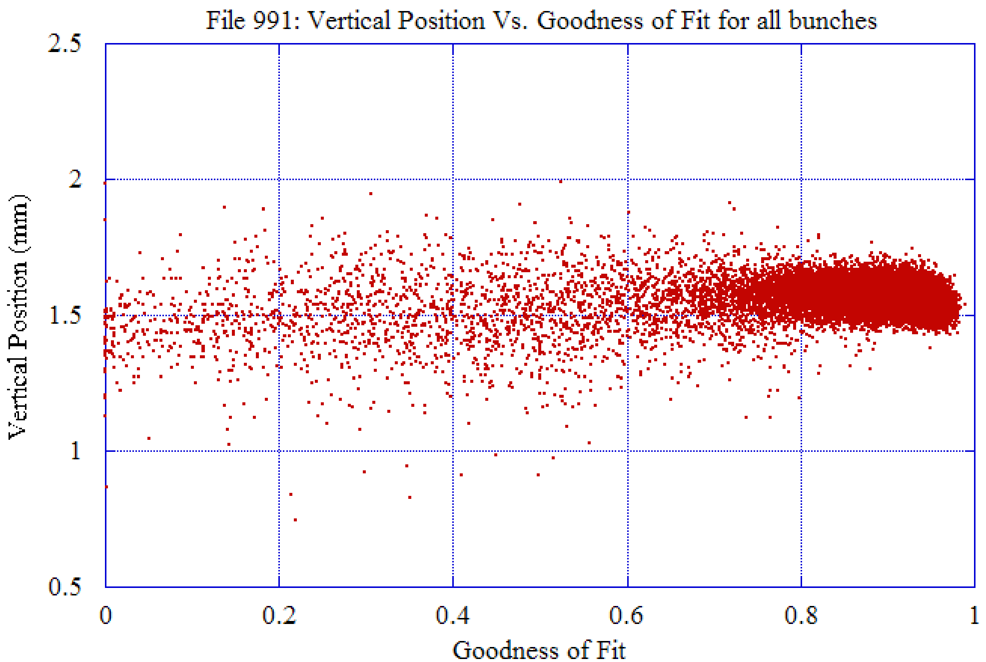


45 Bunches at 28ns Spacing

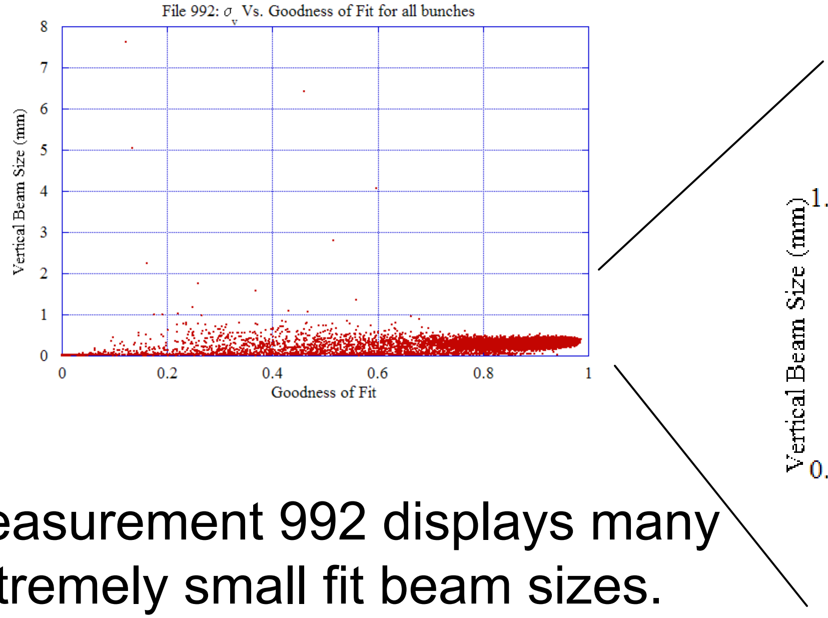


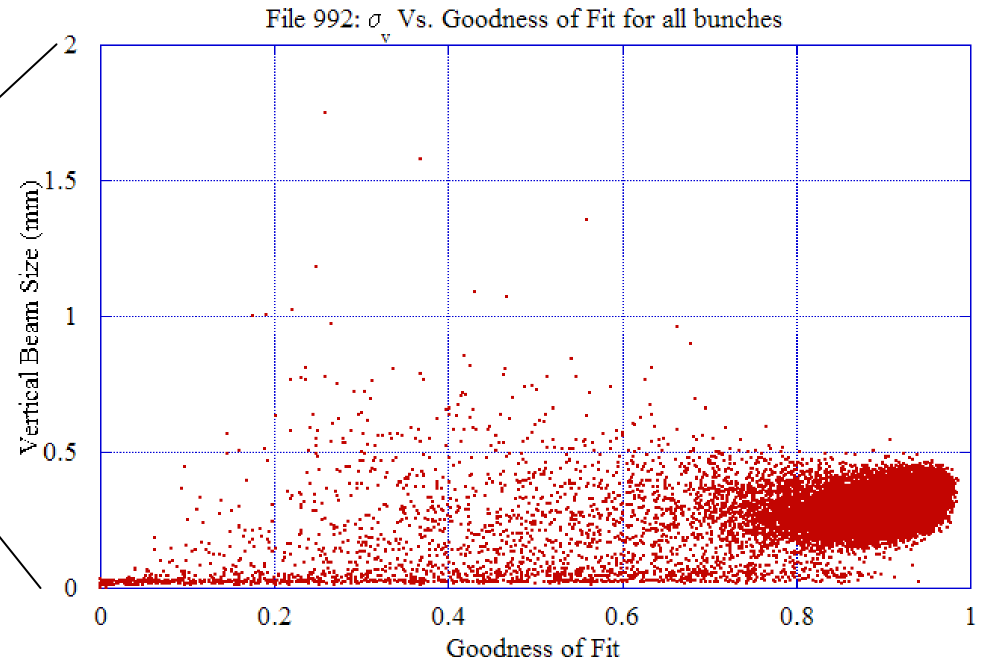


- Measurement 991 displays many extremely small beam sizes. These points already begin to show up at a goodness of fit of about 0.95. While a cut at 0.8 would remove many of these points, it would also cut off quite a few
- Nearly all of the fits in this set are very close to the center of the PMT.

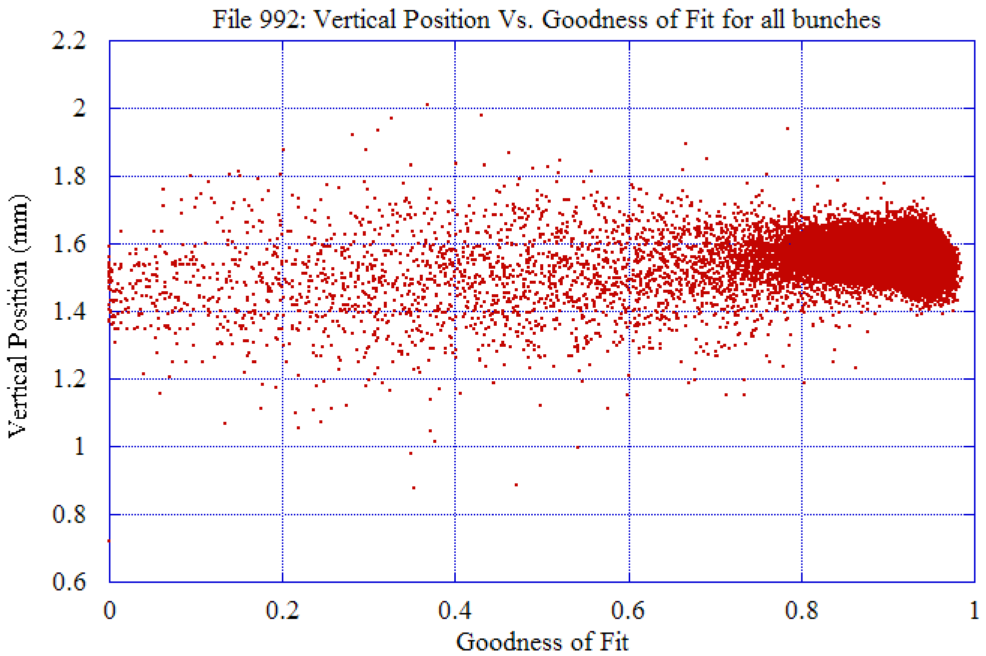


45 Bunches at 28ns Spacing



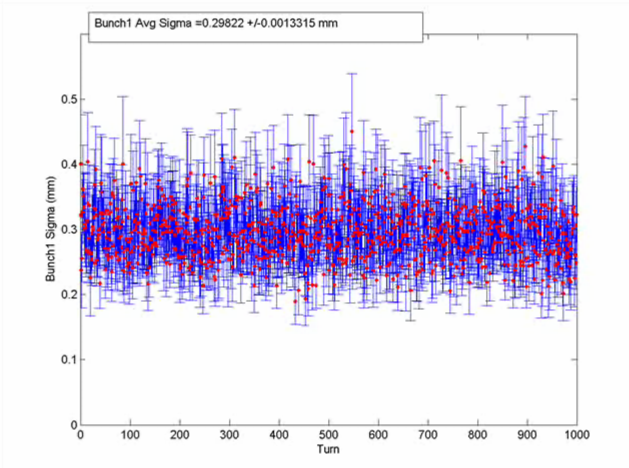


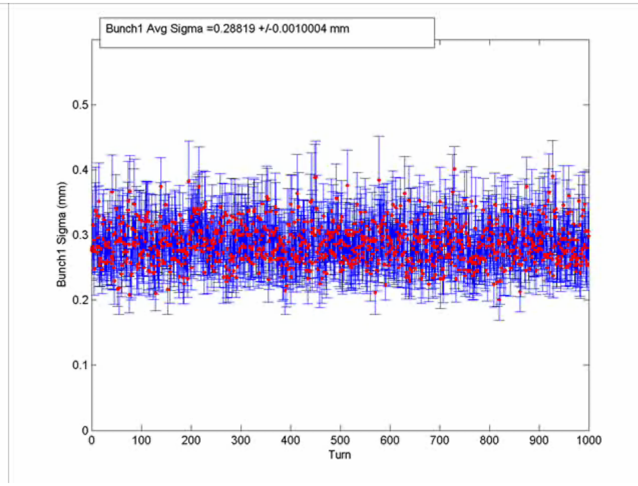
- Measurement 992 displays many extremely small fit beam sizes. They begin above a goodness of fit of 0.9. While a goodness of fit cut of 0.8 would cut out many of these points, it would also remove a large amount of good data.
- Nearly all the fits in this dataset are close to the center of the PMT.

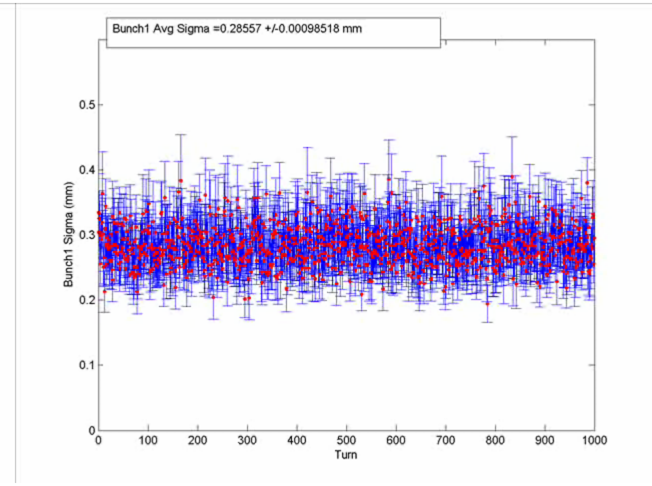


45 Bunches at 28ns Spacing – Vertical Beam Size

Movies: no cuts







File 990:

I_{e+} = 0.75mA/bunch, XQ1 = +181

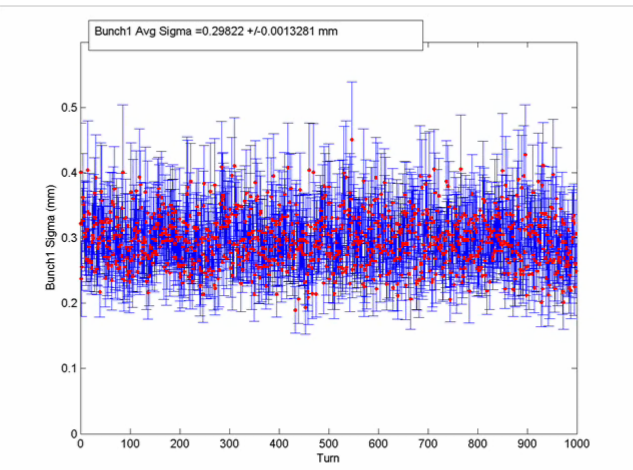
File 991:

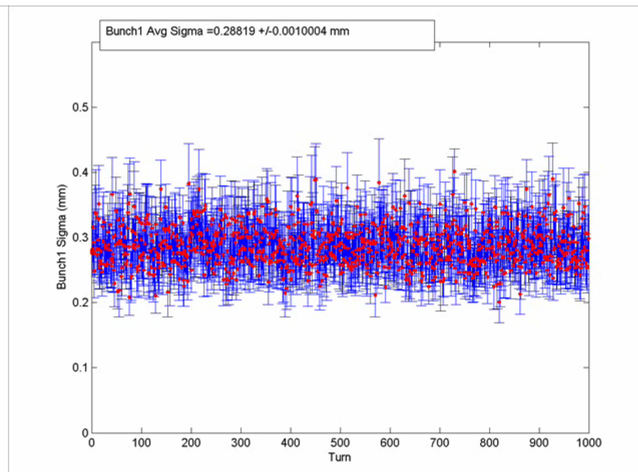
I_{e+} = 0.5mA/bunch, XQ1 = -75

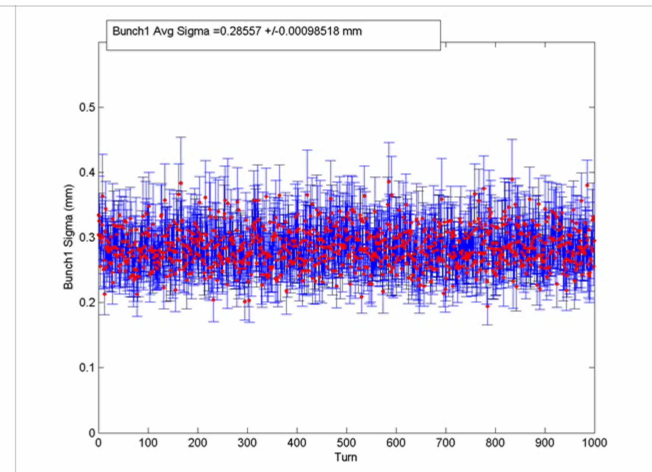
File 992:

I_{e+} = 0.35mA/bunch, XQ1 = -75

Movies: goodness of fit cut at 0.8

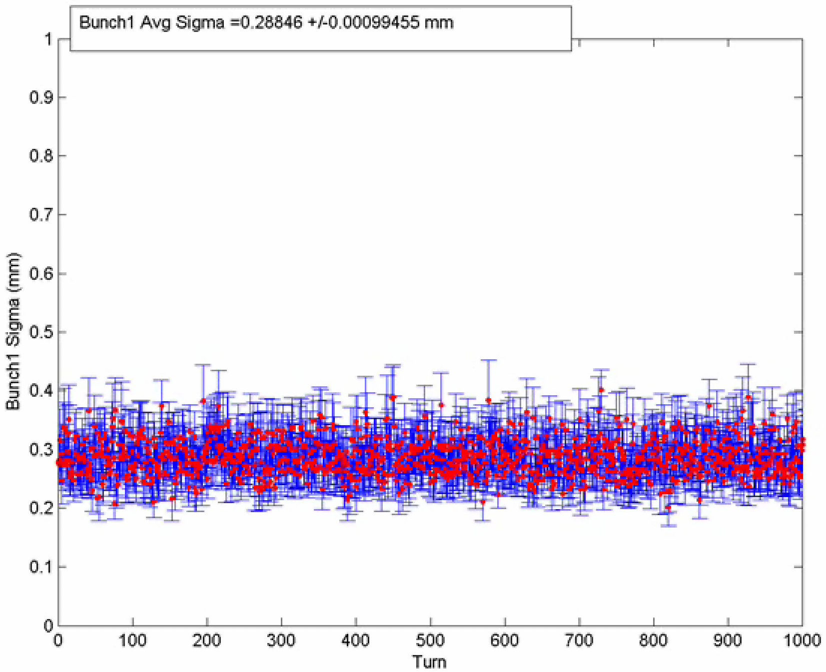


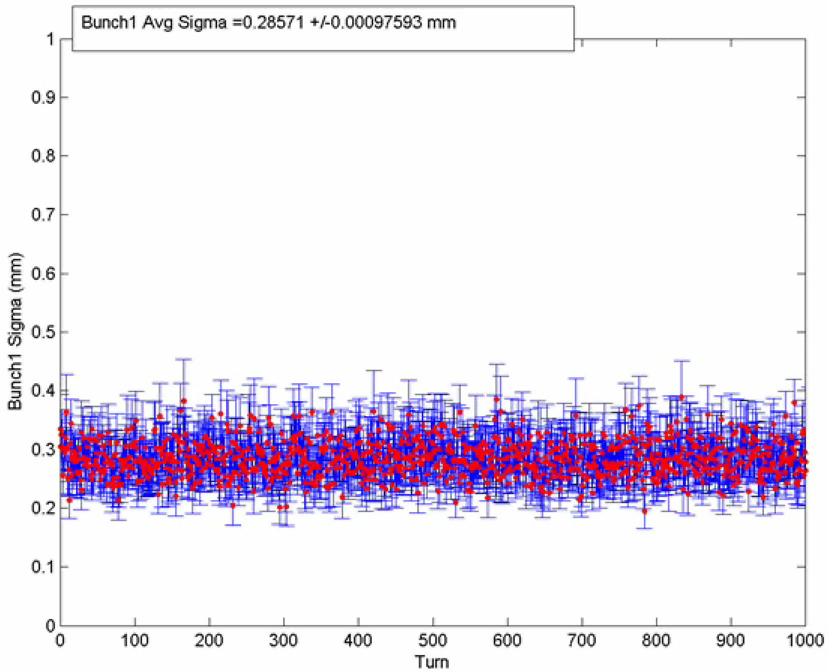




45 Bunches at 28ns Spacing – Vertical Beam Size

Movies: goodness of fit cut at 0.4





File 991:

I_{e+} = 0.5mA/bunch, XQ1 = -75

File 992:

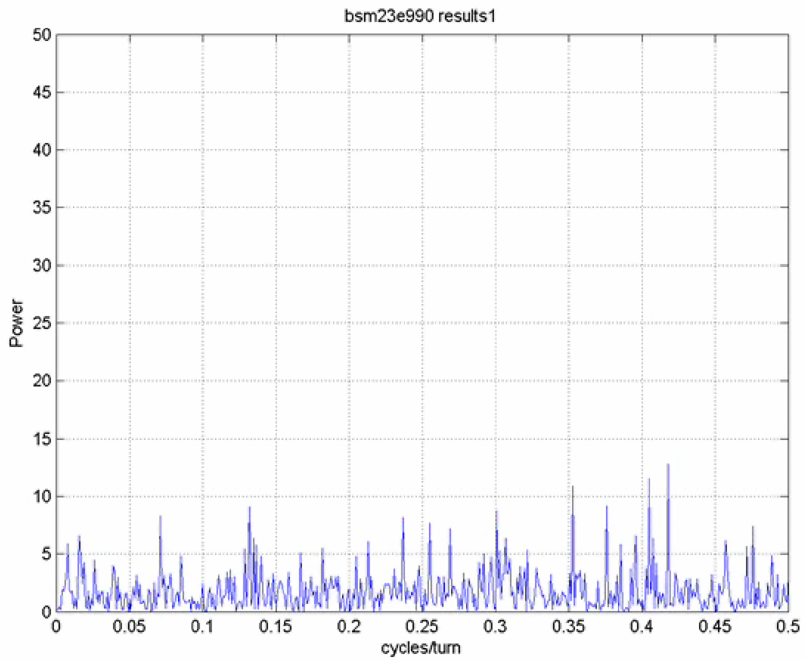
I_{e+} = 0.35mA/bunch, XQ1 = -75

45 Bunches at 28ns Spacing – Vertical Beam Size FFT

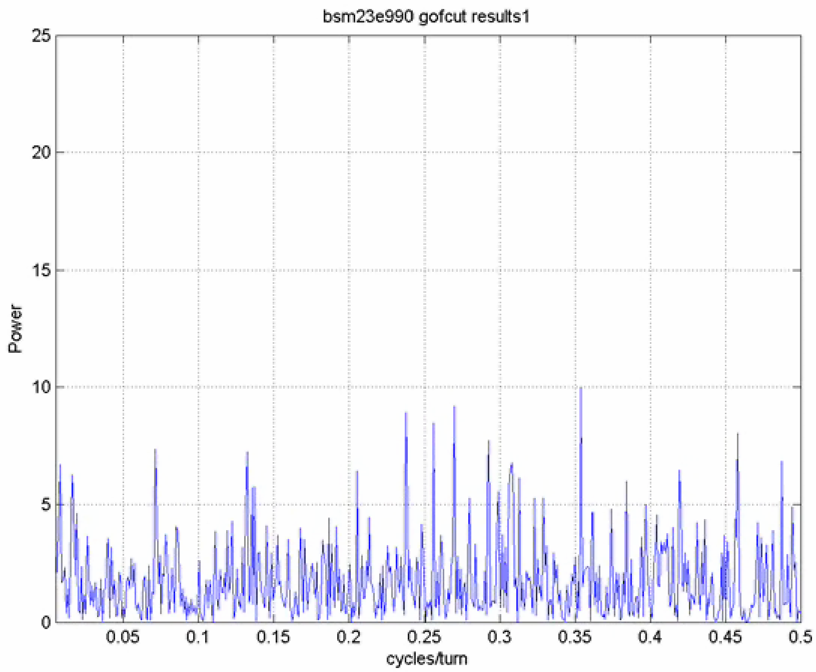
File 990

Movies

No cuts



Cut at 0.8



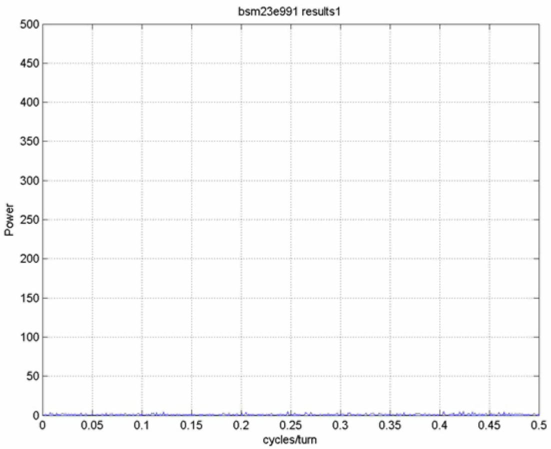
•There are no significant oscillations detected for the uncut or 0.8 goodness of fit cut case.

45 Bunches at 28ns Spacing – Vertical Beam Size FFT

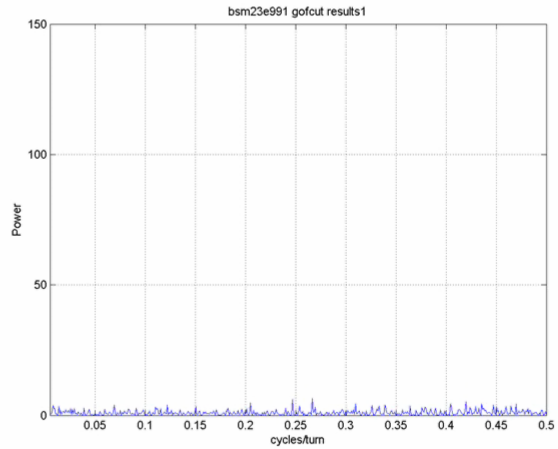
File 991

Movies

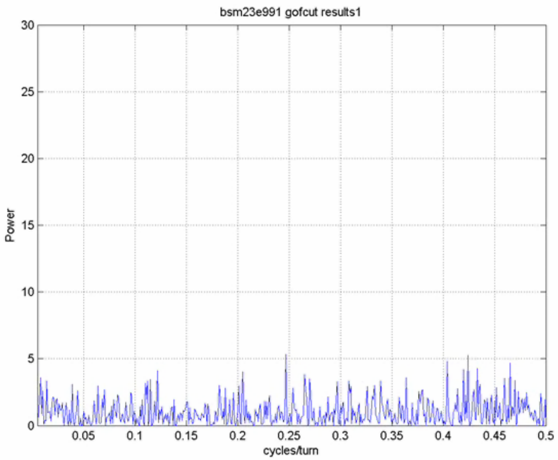
No cuts



Cut at 0.4



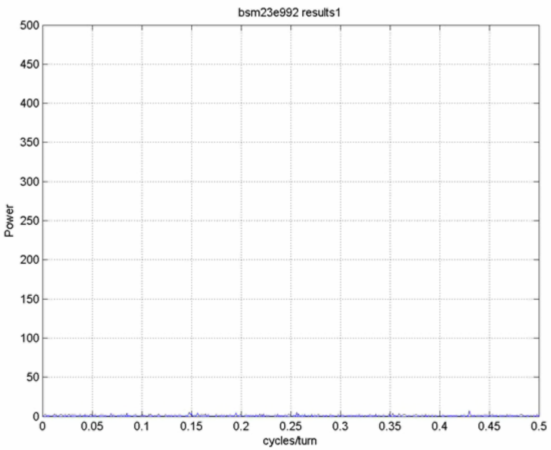
Cut at 0.8



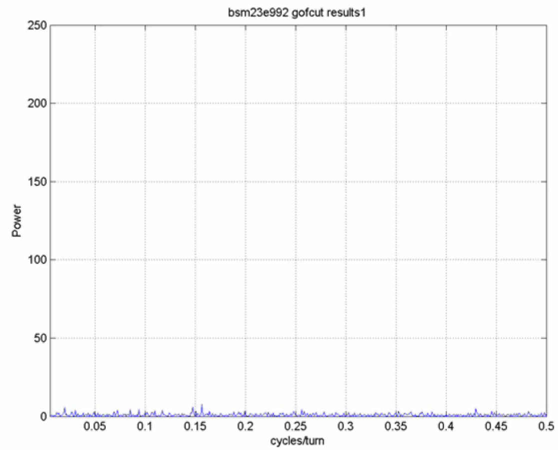
•There does not appear to be a significant beam size oscillation in this data.

File 992

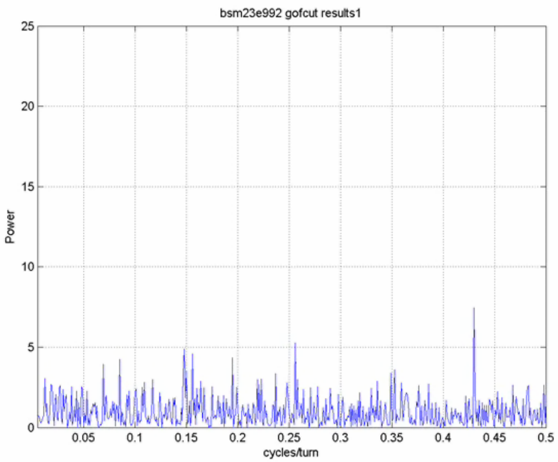
No cuts



Cut at 0.4



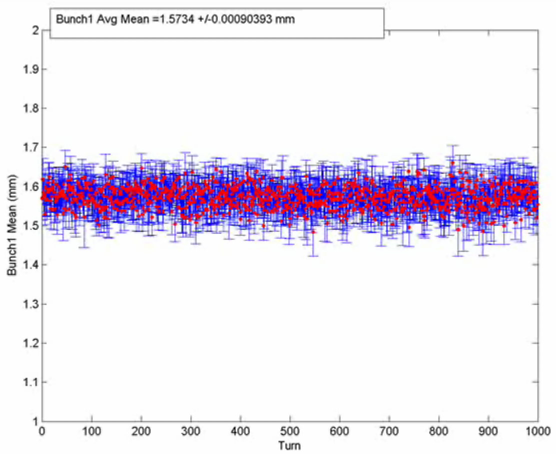
Cut at 0.8

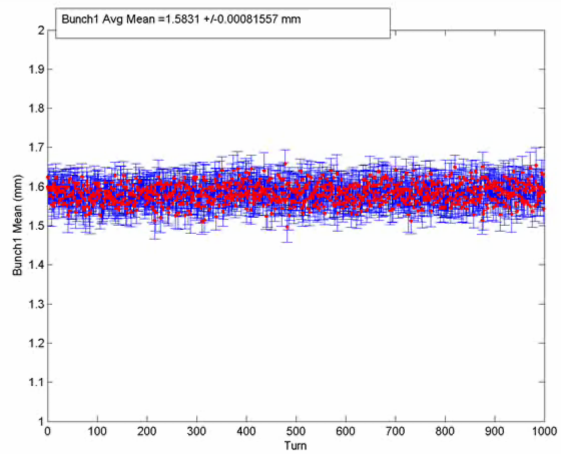


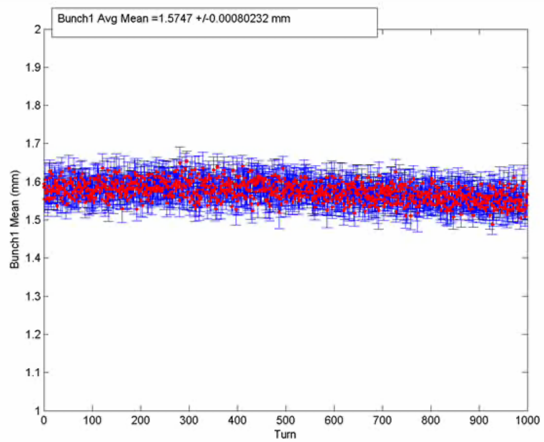
•There do not appear to be any significant detections of vertical beam size oscillation in this measurement.

45 Bunches at 28ns Spacing – Vertical Position

Movies: no cuts







File 990:

I_{e+} = 0.75mA/bunch, XQ1 = +181

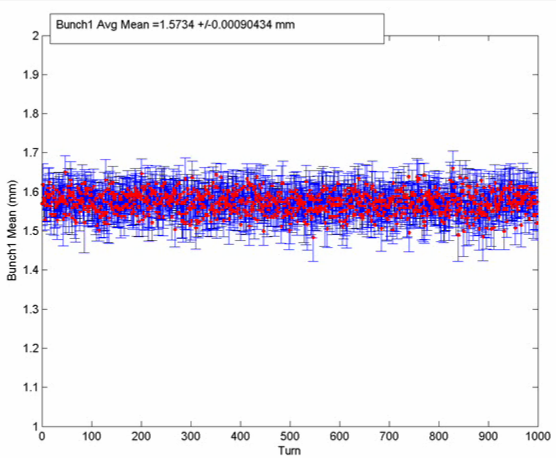
File 991:

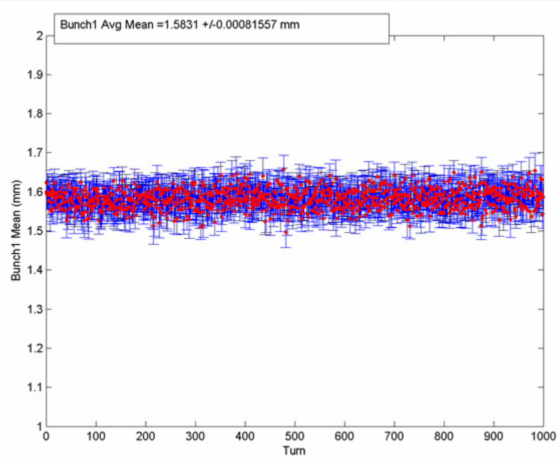
I_{e+} = 0.5mA/bunch, XQ1 = -75

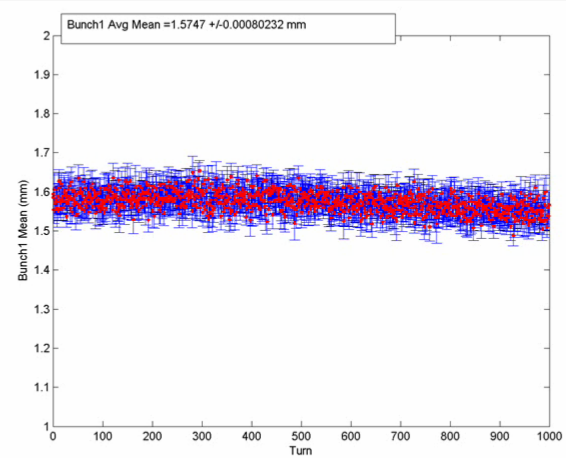
File 992:

I_{e+} = 0.35mA/bunch, XQ1 = -75

Movies: goodness of fit cut at 0.8

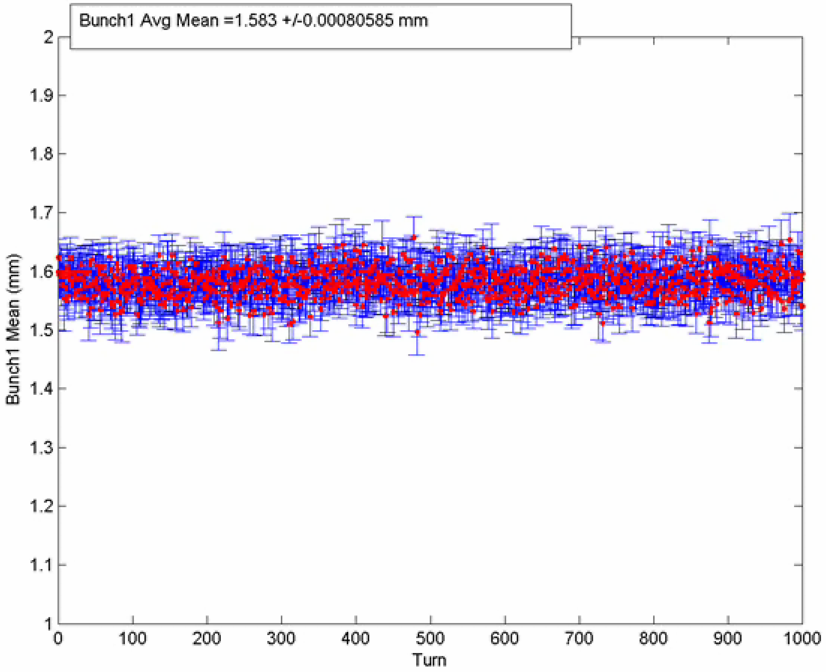






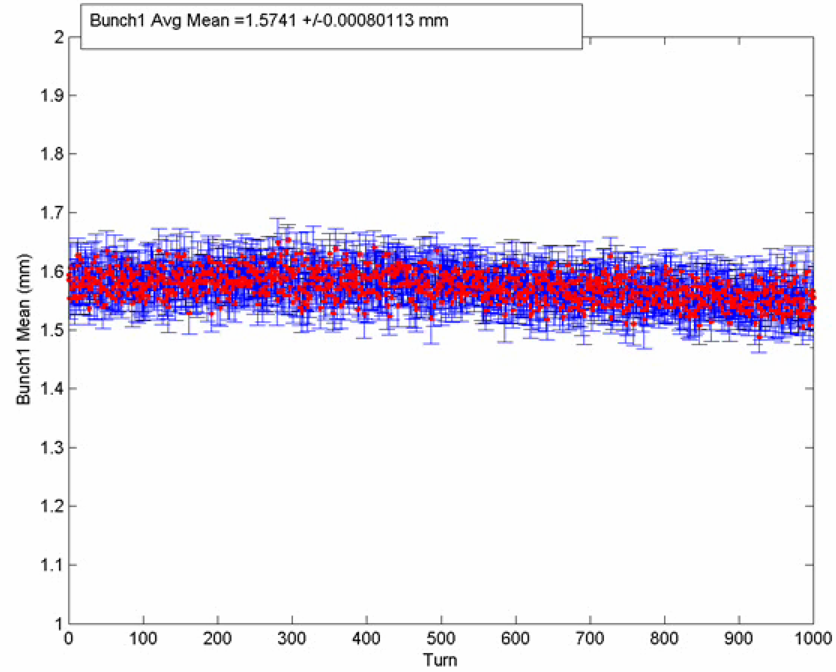
45 Bunches at 28ns Spacing – Vertical Position

Movies: goodness of fit cut at 0.4



File 991:

I_{e+} = 0.5mA/bunch, XQ1 = -75



File 992:

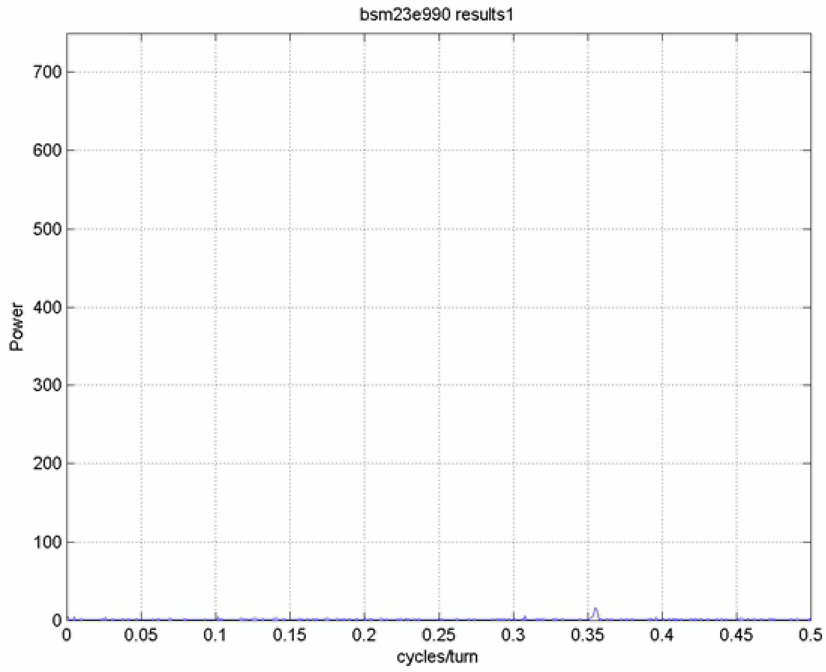
I_{e+} = 0.35mA/bunch, XQ1 = -75

45 Bunches at 28ns Spacing – Vertical Position FFT

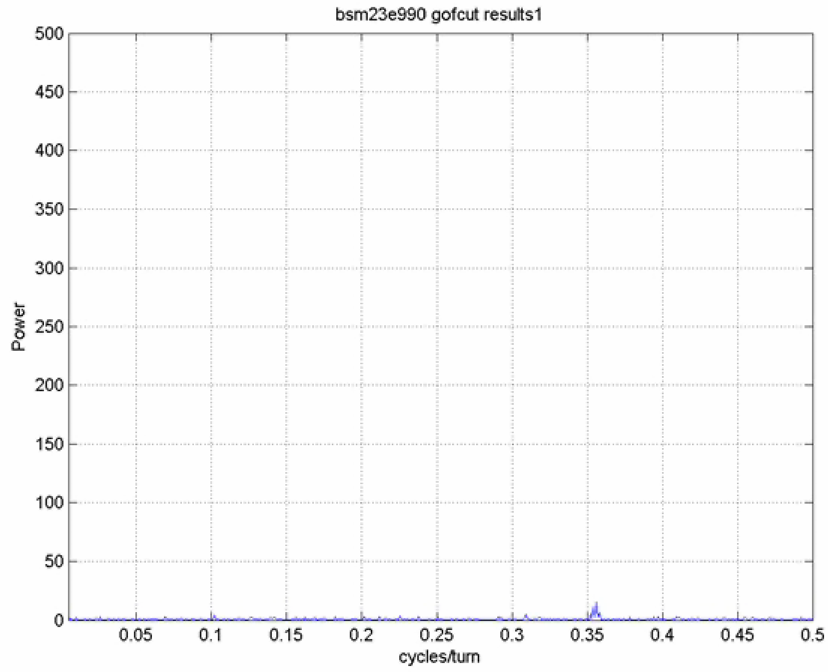
File 990

Movies

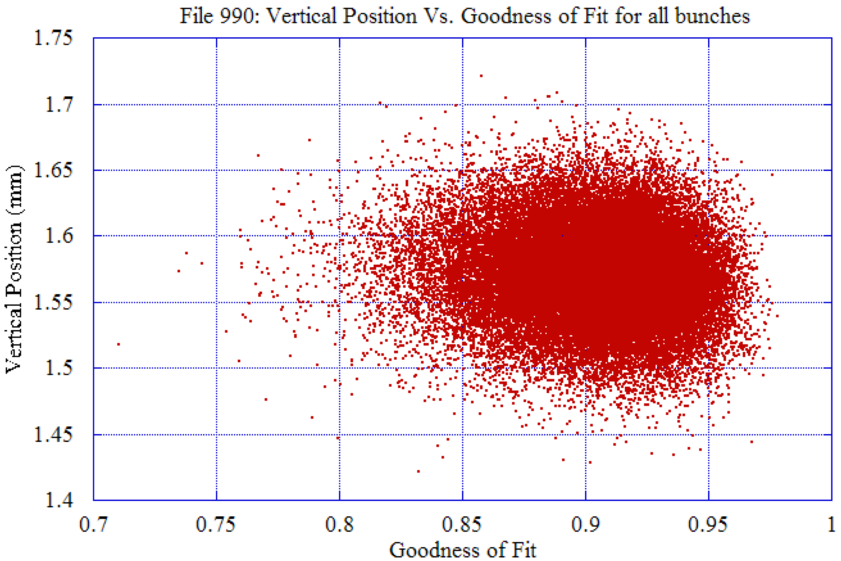
No cuts



Cut at 0.8



- A line near the vertical tune is evident well above the noise for both cases.
- The cut at 0.8 only removed a small percentage of points.

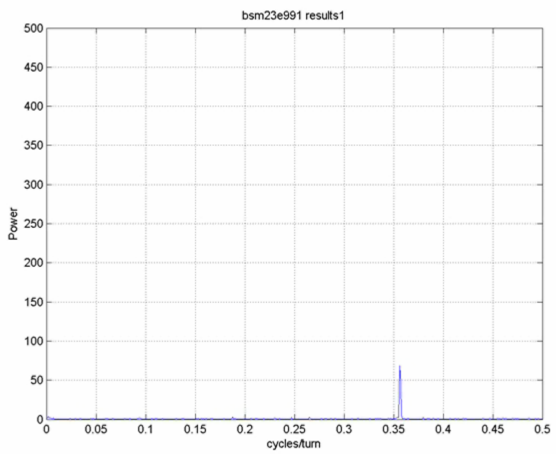


45 Bunches at 28ns Spacing – Vertical Position FFT

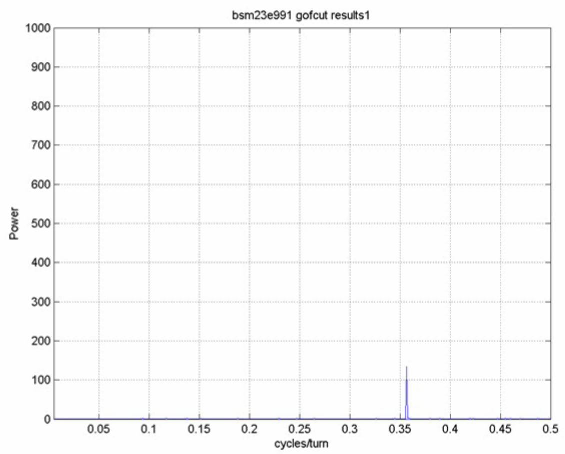
File 991

Movies

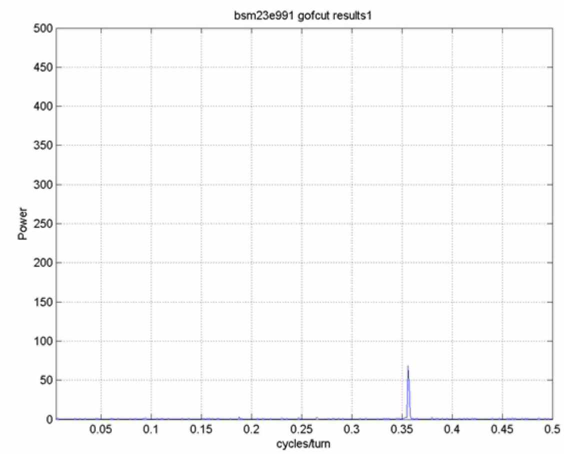
No cuts



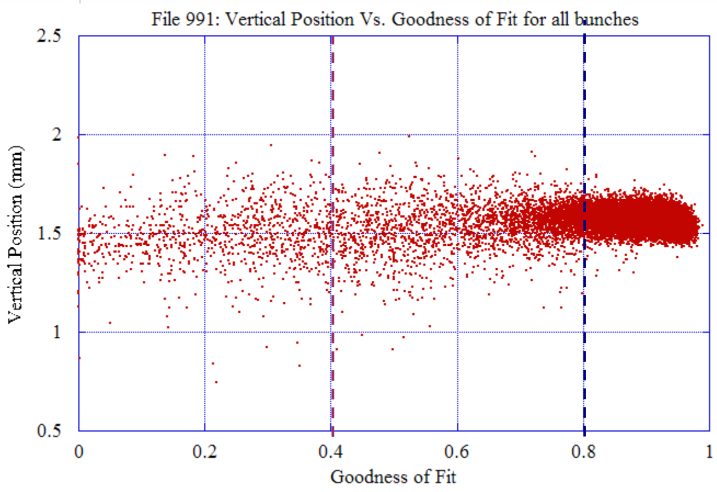
Cut at 0.4



Cut at 0.8



- The line near the vertical tune shows up in all three cases.
- The cut at 0.8 removes a large percentage of data that is likely to be good, but it appears that most of the oscillation information was preserved.

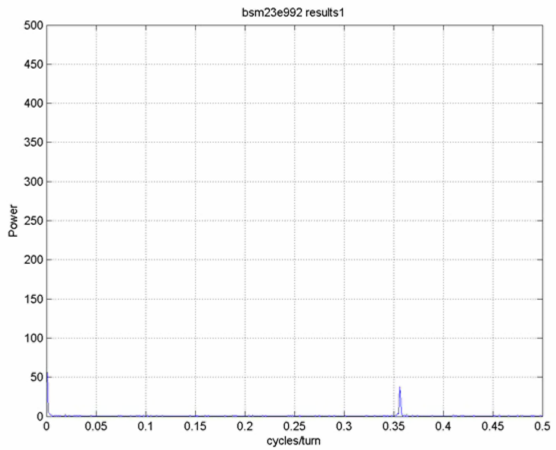


45 Bunches at 28ns Spacing – Vertical Position FFT

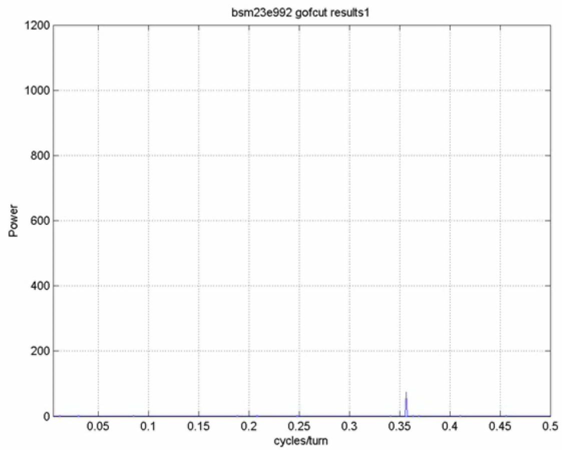
File 992

Movies

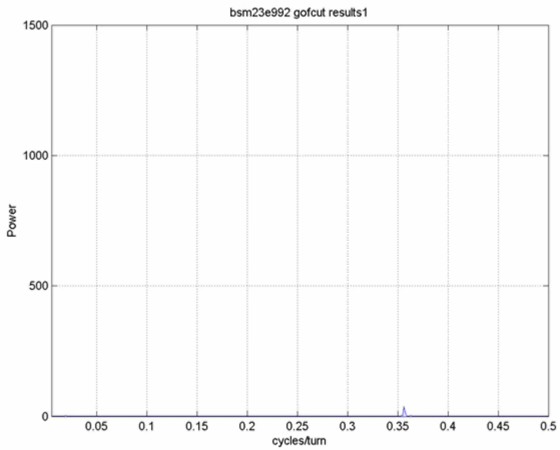
No cuts



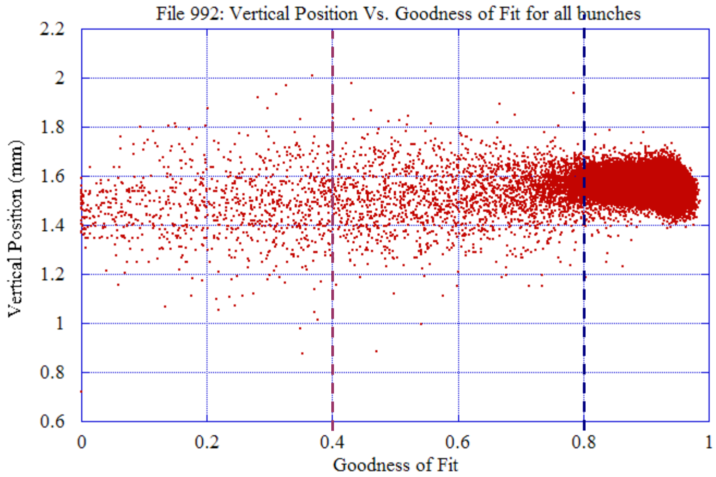
Cut at 0.4



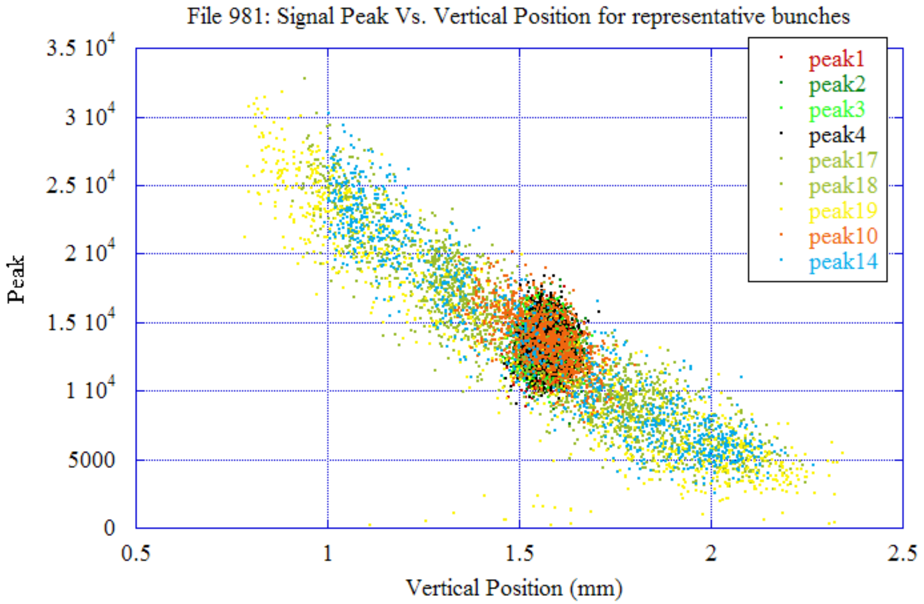
Cut at 0.8

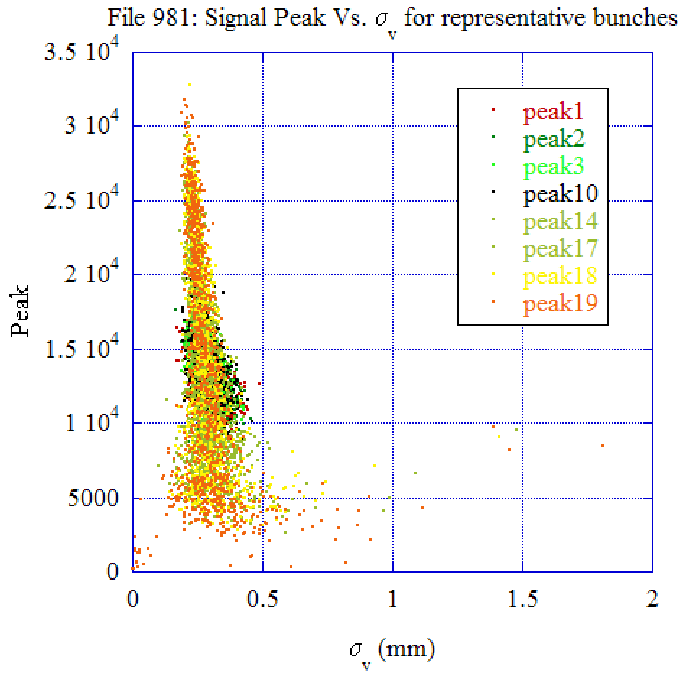


- As in the previous measurement, the line near the vertical tune is prominent in all three cases for some bunches. The 0.8 cut may not have removed as much oscillation information in this case, because it removed a more even distribution of points to the left and right of the PMT center, as seen in the plot to the right.



e+ 1/30/07





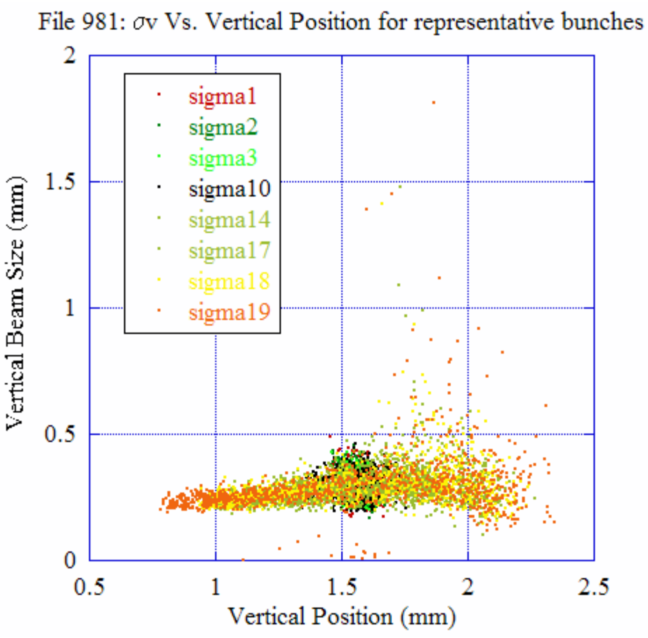
•With the prominent trend in our data for goodness of fit values to decrease toward the right of the PMT, we further investigated the behavior of the peak signal and vertical beam size as a function of vertical position.

•Bunches were chosen arbitrarily to represent the front, middle, and end of the train.

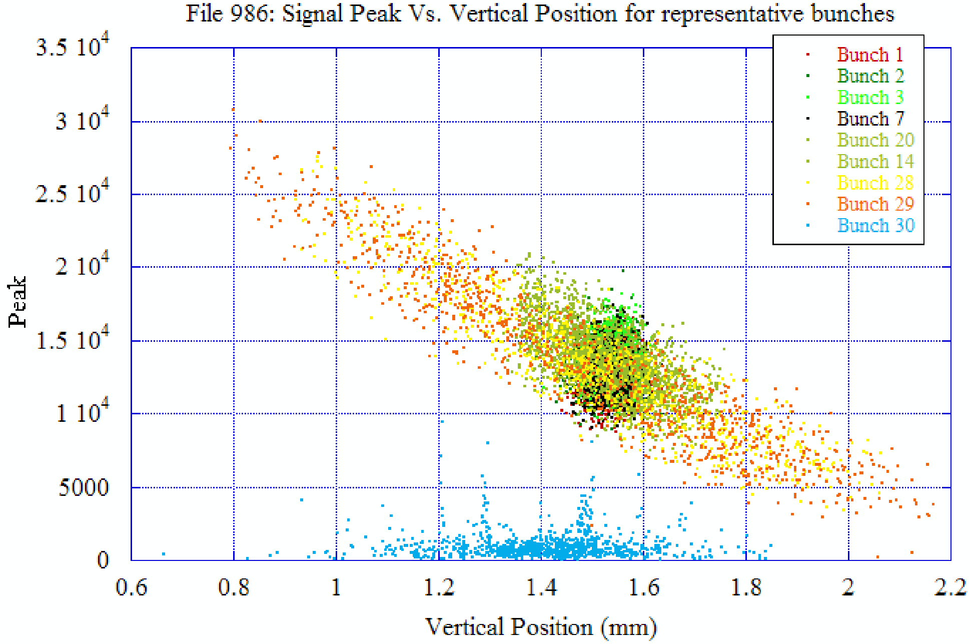
•The top left is a plot of the signal peak vs. position of that peak on the PMT. Stable bunches cluster toward the center of the board, but a striking trend emerges for unstable bunches. The average signal height 0.5mm to the left of the PMT center is an order of magnitude greater than 0.5mm to the right of the PMT center. There is a clear linear trend likely indicating that each PMT channel is less sensitive to the signal than the channel to its left. Note that the size of the PMT board is 3.0769mm wide, so there are no signals here right at the edge.

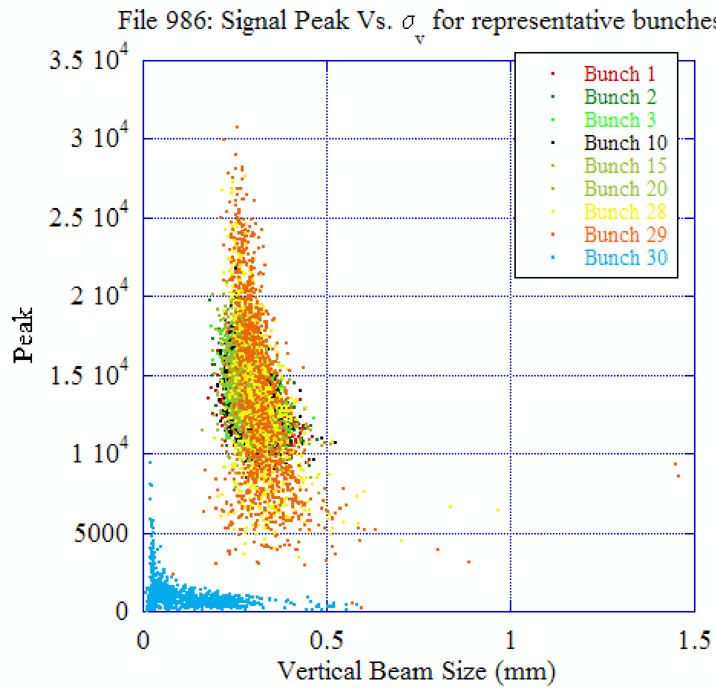
•The top right is a plot of signal peak vs. vertical beam size. For stable bunches, the values are clustered around ~1.4 X 10^4 and ~0.3mm. For unstable bunches, the signal height varies by an order of magnitude, but does not show an obvious linear trend – rather, the spread of vertical beam size values increases as the signal peak decreases. If we consider that as the peak decreases the noise ratio increases (and therefore the goodness of fit generally decreases), the wider range of sigma values for smaller peaks makes sense.

•The bottom right is a plot of vertical beam size vs. vertical position on the PMT. The average value of vertical beam size stays approximately the same across the PMT, as would be expected, though we see the spread in beam size increase again toward the right of the PMT (the direction of the decrease in peak).



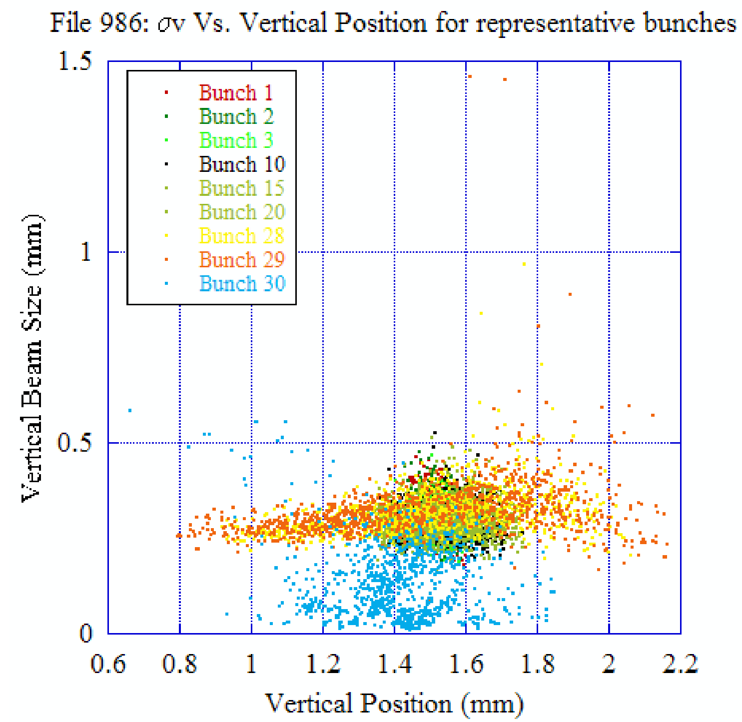
e+ 1/30/07



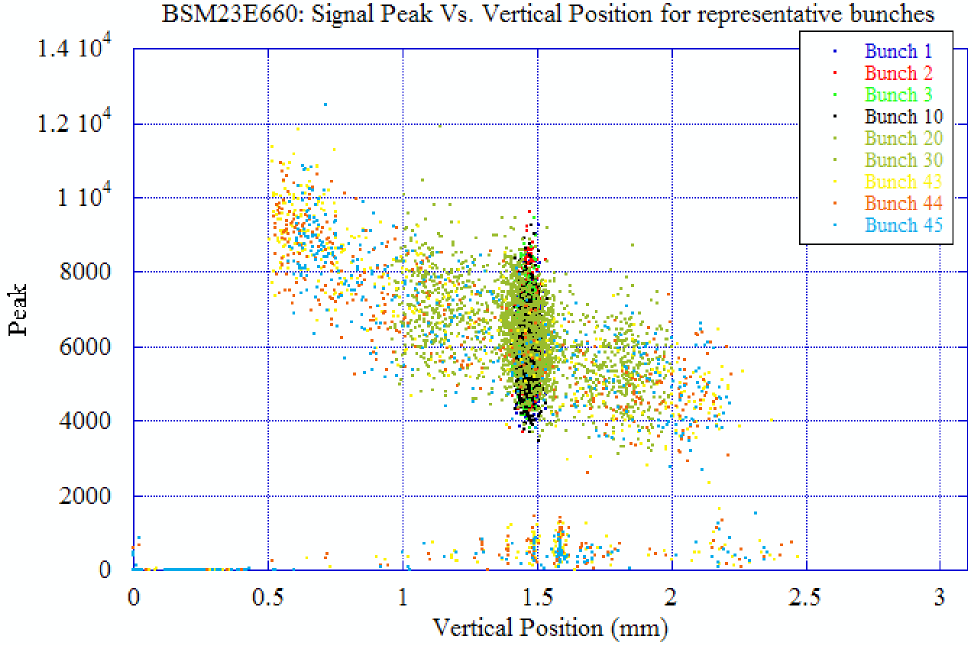


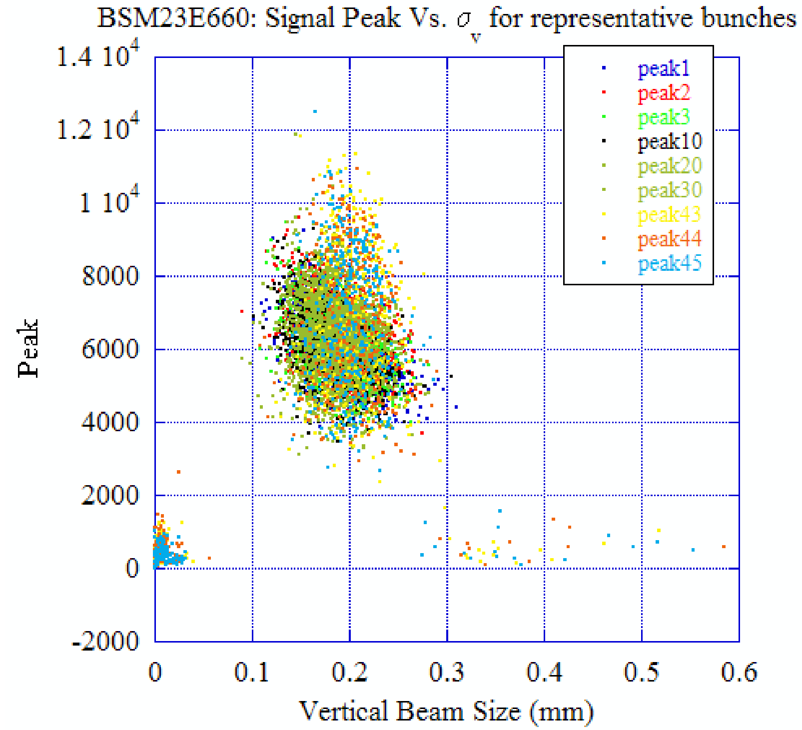
•For file 986, similar behavior is observed in signal peak vs. vertical position, signal peak vs. vertical beam size, and vertical beam size vs. vertical position as seen in file 981. The signal peak decreases linearly toward the right of the PMT, and the range of vertical beam size values increases toward the right of the PMT (in the direction of decreasing signal height and decreasing signal-to-noise ration).

•We can see clearly from these plots that bunch 30 was lost. The signal peaks are almost entirely below the smallest signal peaks for the other bunches.

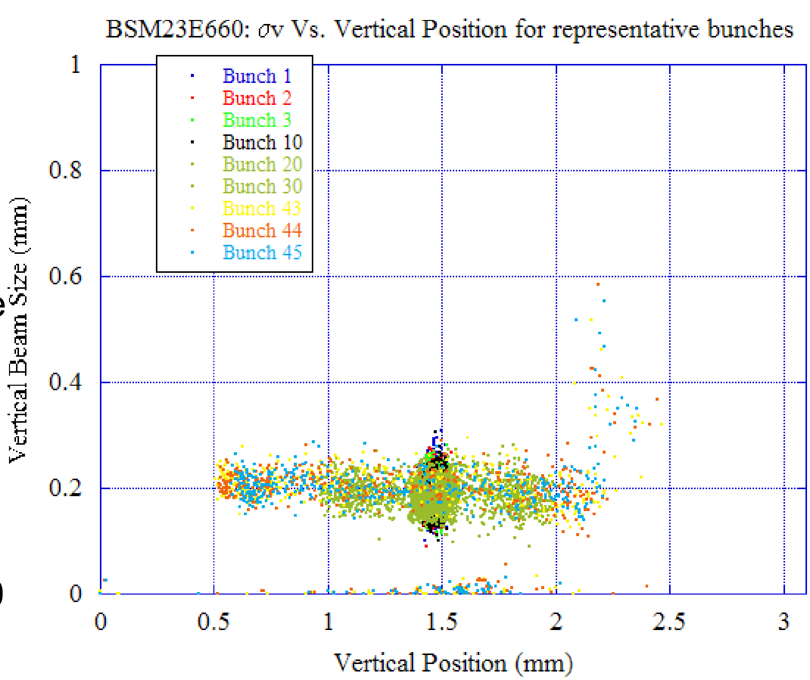


e+ 9/26/06

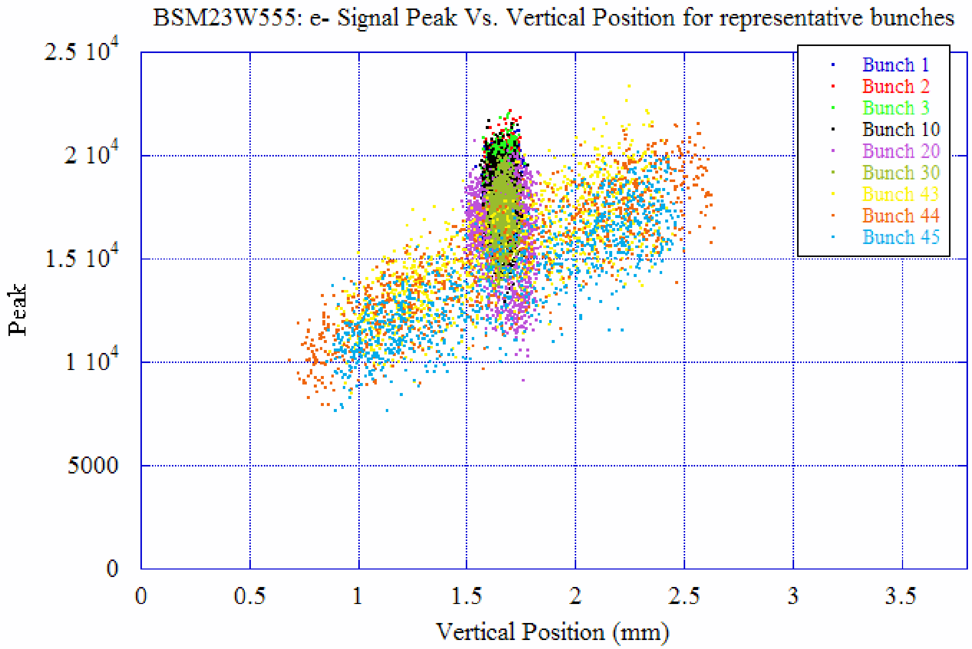


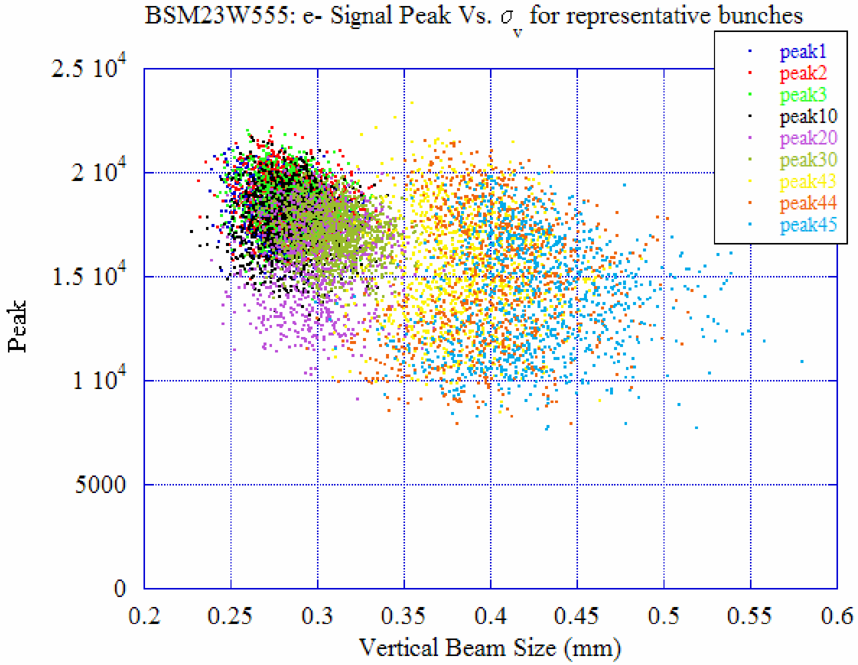


- We decided to test data from other dates to see if the same behavior occurred.
- For file 660 (positron data from 9/26/06), similar behavior is observed in signal peak vs. vertical position, signal peak vs. vertical beam size, and vertical beam size vs. vertical position as seen in files 981 and 986. The signal peak decreases linearly toward the right of the PMT, although the magnitude of the change is less by about 1/3. The range of vertical beam size values remains more constant along the PMT for this set (expected for a smaller range of signal peaks), although the average suddenly increases for the signals furthest to the right.
- There were definitely a number of noise-level fits in many different bunches in this dataset (note the peak values below 2000 that likely correspond to the sigma values near 0).



e- 9/6/06

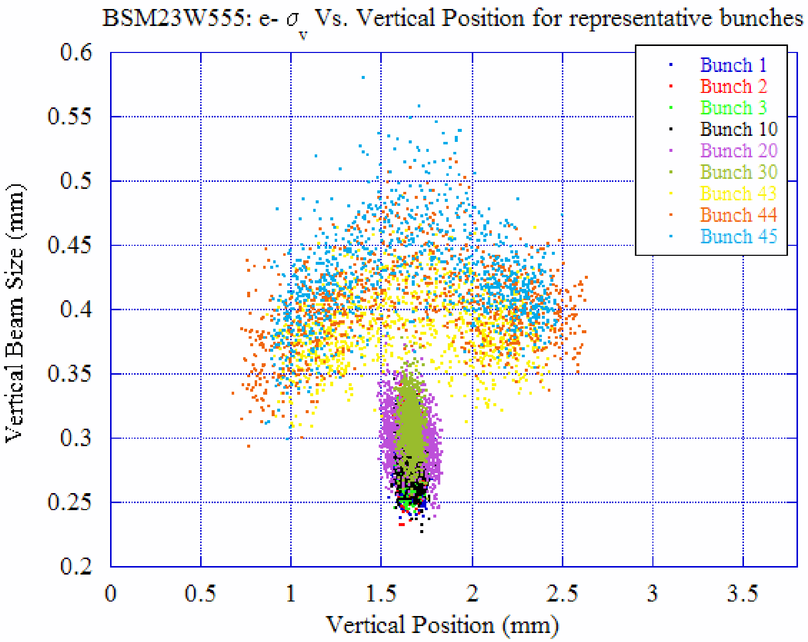




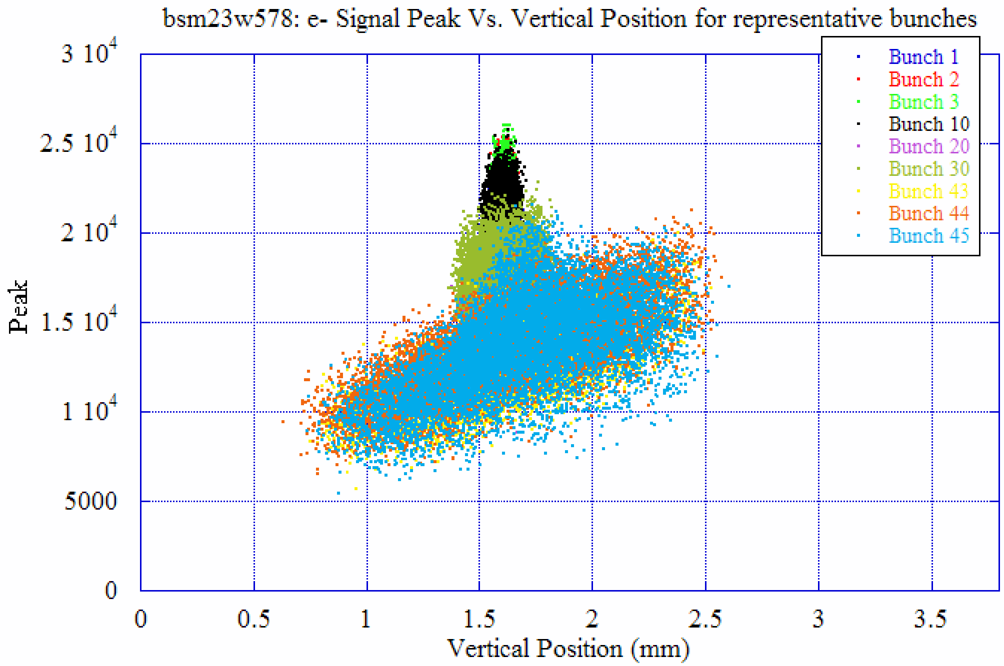
•We decided to test electron behavior. We looked at datasets with instability, since any channel-dependent trend can only be detected with signal at a wide range of positions on the PMT.

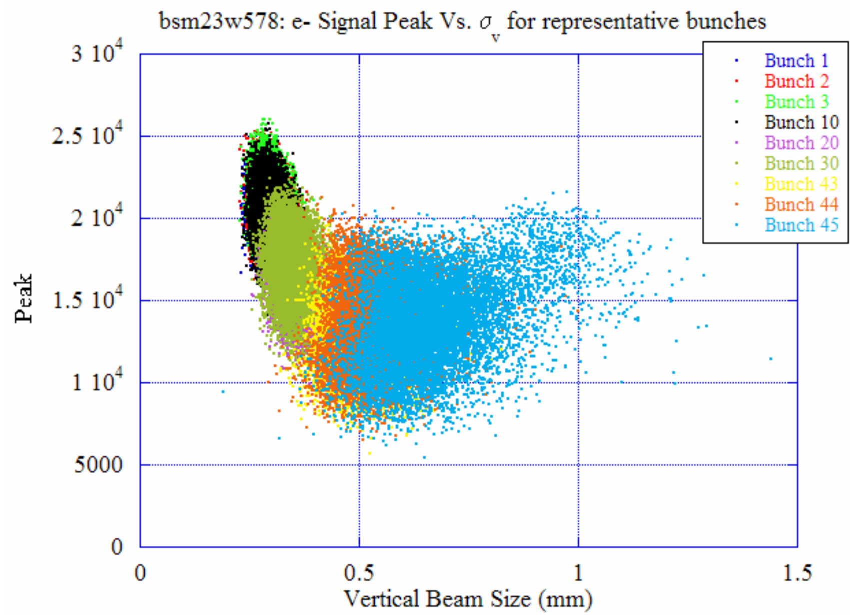
•The electron PMT is 3.7209mm wide.

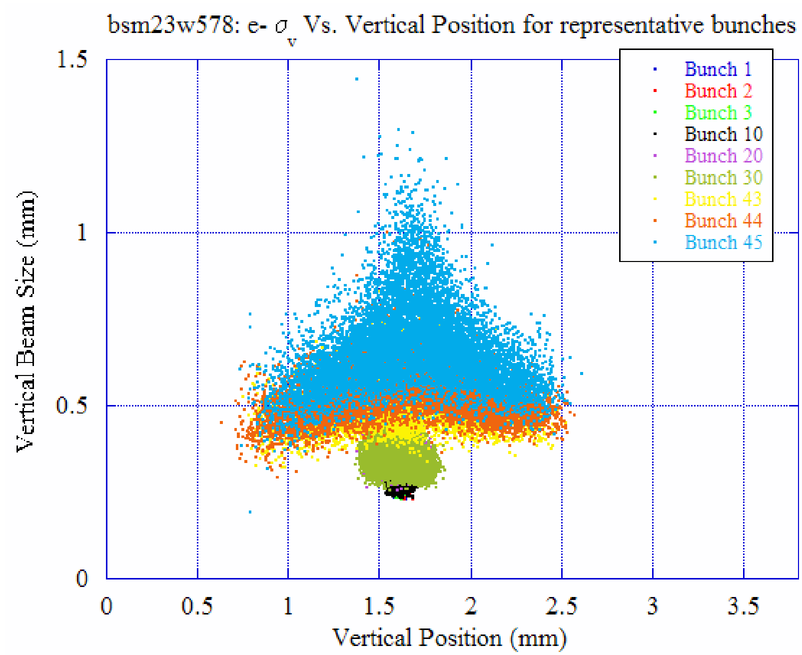
•For file 555 (electron data from 9/6/06), opposite behavior is observed in signal peak vs. vertical position. The peak signal increases toward the right of this PMT (still defined as the direction of increasing channel). There is not much spread in vertical beam size, but in the plot of vertical beam size vs. vertical position we see that the average beam size is slightly larger when the signal is toward the PMT center for the unstable bunches. The range of vertical beam size values remains more constant along the PMT for this set, although the average suddenly increases for the signals furthest to the right.



e- 9/6/06







- For file 578 (electron data from 9/6/06), similar behavior to file 555 is observed in signal peak vs. vertical position and vertical beam size vs. vertical position.
- The spread of vertical beam sizes is much wider in this set than in file 555, although the range of signal peak values is about the same. The signal peak vs. vertical beam size plot for this set has similar properties to those observed in the positron data from 1/30/07.

Summary

- In general, the application of a goodness of fit cut at 0.8 reduces the power of the oscillation detection near the vertical tune in both vertical beam size and position. In a few cases, it makes the oscillation indistinguishable from the noise. This strongly suggests that 0.8 is too high of a cut for most datasets, as oscillation near the vertical tune is expected.
- The application of a cut at 0.4 tends to cut out most of the bad data. However, as in the case of file 986, there are occasionally some points for which the fit is nonsense, but the goodness of fit is relatively high. This suggests that a goodness of fit cut is not enough. The addition of cuts based on fit values themselves, such as sigma or signal peak, should be explored to remove poor data.
- It appears likely that there is a calibration problem either with the channels on both PMTs or the optics, causing one side to receive less signal than the other.