# Stacktail Pulse Evolution Measurements
# Pbar Note 681

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**Abstract**

By injecting single pulses into the Accumulator, I can study how well the stacking simulation matches the hardware performance in a simplified situation. The movement of the mean and the RMS width of the pulse are the measures used in this comparison.

## 1 Measurement method

All measurements use the 79 MHz Accumulator longitudinal schottky, at the $126^{th}$ harmonic of the accumulator revolution frequency, input to the HP 89410A Vector Signal Analyzer (VSA). The VSA is centered at 79.23636 MHz with a span of 16128 Hz. I use rms averaging over 3 traces, with updates every 3 traces. In this way, each average trace is independent of the previous and following trace. The VSA is operated in armed trigger mode, with the arm on event (D:MOUNTT) at \$90 + 1.7 seconds (as RF deceleration to the deposition orbit and debunching is complete) and arm off (D:BEEPT) at \$90+9.7 seconds. A 10 second cycle time for \$29 events is used. Waterfall mode is turned on, with buffer depth of 100. The trace buffer is saved and then cleared before the next measurement. A:SCRES (which generates the \$90) is turned off once a pulse has been injected into the Accumulator.

## 2 Data Analysis

The trace buffer is converted from SDF file format (native to the VSA) to ASCII using the DOS program SDFPRINT. The resulting file is read and analyzed, computing the mean of the distribution, the RMS of the distribution, the power within $\pm 4\times$ the RMS, and the fraction of the pulse that has cleared the deposition area. All calculations subtract out a noise floor, which is measured for each trace by looking at a region where there is no beam. Figure 1 shows a sample trace after 7.83 seconds. The 10% region at the high end of the frequency range is used to calculate the noise floor.

A key element of this analysis is assigning times to traces. Data was taken with the standard setup, varying the amount of time the trigger was armed. I then counted traces in the trace buffer for each time period, which varied from 8 to 32 seconds. Based on the data in table 1, I used a $\delta t = 0.348$ seconds between traces.

In Figure 2, I show the data for a single 8 second time period. This pulse had the default trunk gain settings. On the left are the individual traces in the buffer, with the horizontal axis

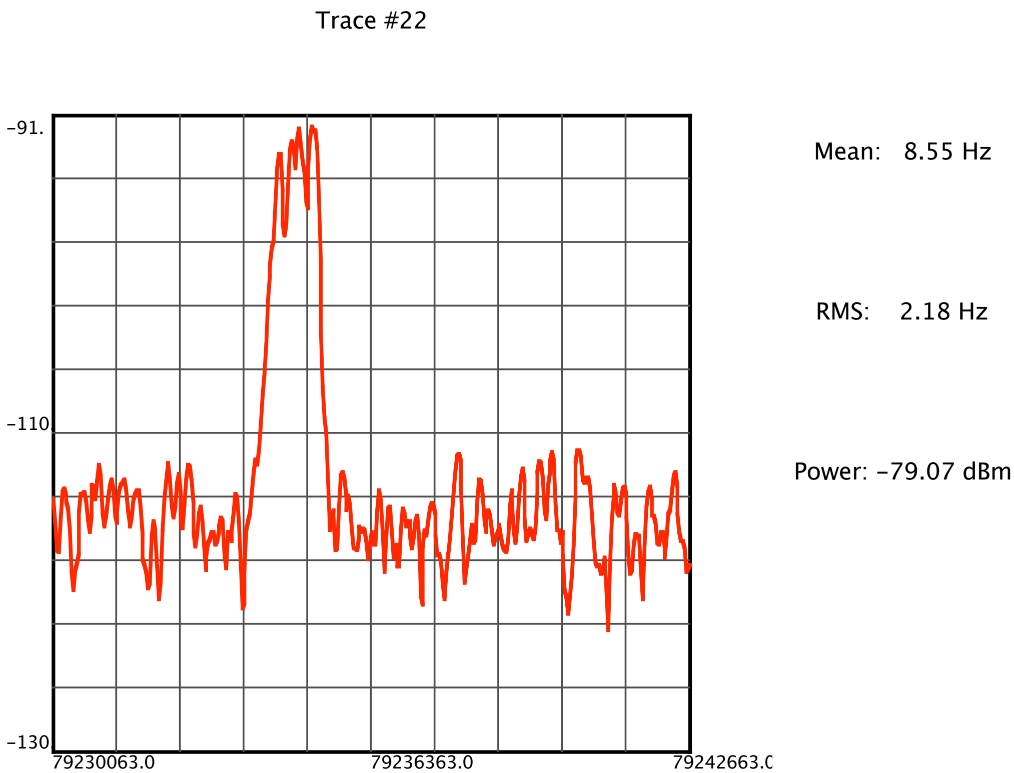


Figure 1: A sample trace after 7.83 seconds. The horizontal axis is frequency in MHz, the vertical axis is power in dBm.

| Time period | Number of traces | $\delta t$ (seconds) |
|---|---|---|
| 8 second | 23 | 0.348 |
| 16 seconds | 46 | 0.348 |
| 20 seconds | 58 | 0.345 |
| 24 seconds | 69 | 0.348 |
| 25 seconds | 72 | 0.347 |
| 30 seconds | 87 | 0.345 |
| 32 seconds | 92 | 0.348 |

Table 1: Defining timing for VSA setup. The trigger was armed for a defined time period and the trace buffer was saved. $\delta t$ is defined as the time period / number of traces. Based on this data, I will use 0.348 seconds as the time between traces.

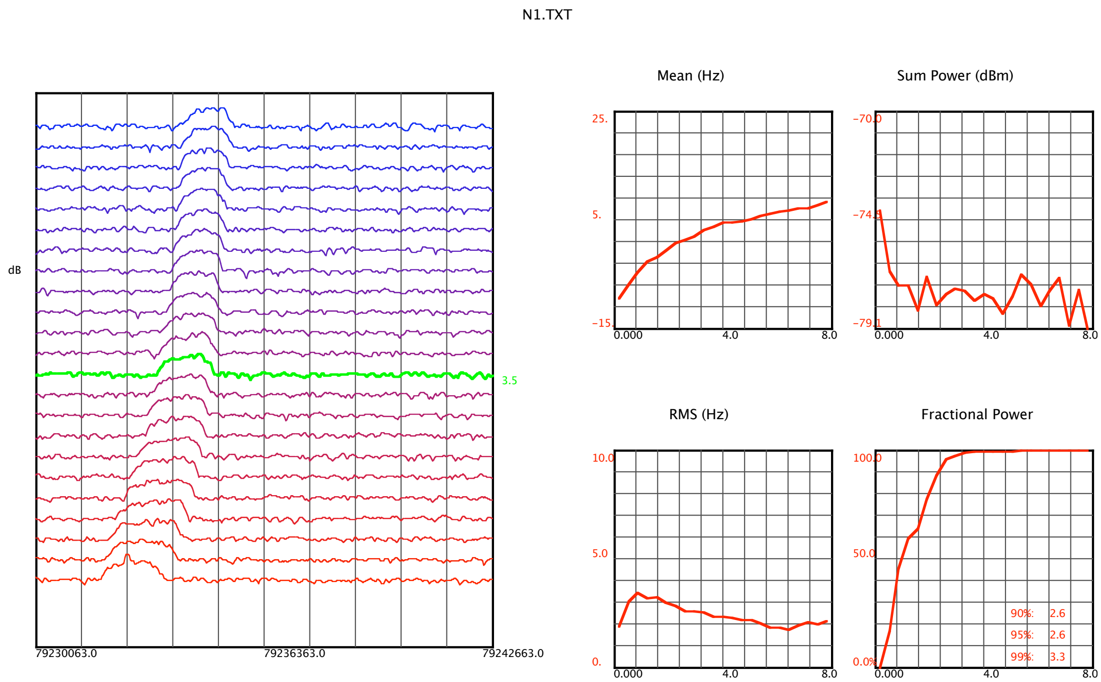


Figure 2: Summary data for an example pulse. The left plot shows the individual traces in the buffer, the green line indicates the trace where the pulse is 100% clear of the input pulse. The plots on the right show the mean (with respect to 628840 Hz), the power (within $\pm 4\times$ the RMS), the RMS of the distribution, and the fractional power clear of the input pulse (defined to be the mean $+3\times$ the RMS of the initial pulse). In these plots, the horizontal axis is time (in seconds).

the frequency in MHz and vertical power in dBm. The plots on the right show the mean (with respect to 628840 Hz), the power (within $\pm 4\times$ the RMS), the RMS of the distribution, and the fractional power clear of the input pulse (defined to be the mean $+3\times$ the RMS of the initial pulse). In these plots, the horizontal axis is time (in seconds).

## 3 Results

In January 2003, data was taken with three different stacktail gain settings: nominal +3 dB, and $-3$ dB. Changes were made to the trunk attenuator A:SPPA06 to vary the gain settings. 3 pulses were taken at each gain setting. The values of the means for the three pulses are averaged. In Figure 3, the average mean vs time is compared to the simulation predictions. The simulation gain and initial position was varied to match (by eye) the change in the mean vs time seen in the data. No other parameters were varied. Simulation files with +3 dB gain (figure 4) and $-3$ dB gain (figure 5) were also created. For the region {-10:5} Hz, the simulation behavior agrees very well with the data, and the agreement is not as good for larger values of the mean. In the region {-10:0} Hz, the gain shape is dominated by the response of leg 1. For larger values of the mean, it is the relative balance between leg 1 and leg 2 that define the gain shape. I believe that the difference between simulation and data indicates that my current model of the stacktail does not describe well the relative gain and phase of the two legs in the tunnel hardware. Other measures (e.g., the energy slope of the beam distribution) also indicate that the hardware has a different mix between the two legs than the simulation.

While the behavior of the mean appears to be reasonably well described, the behavior of the RMS width is more problematic. As can be seen in figure 6, the data shows an initial growth in the RMS width and then a reduction in the width. The simulation does not show the same behavior.

# 4 Conclusions

For the understanding of the system for the Run II upgrades, the most important measurement is how the beam behaves under the influence of leg 1. Simulation studies have shown that clearing the beam off the deposition orbit will constrain the cycle time and the stack rate. The good match in the behavior of the mean is encouraging. Further studies into the behavior of the RMS width and the longer time scale motion will be performed.

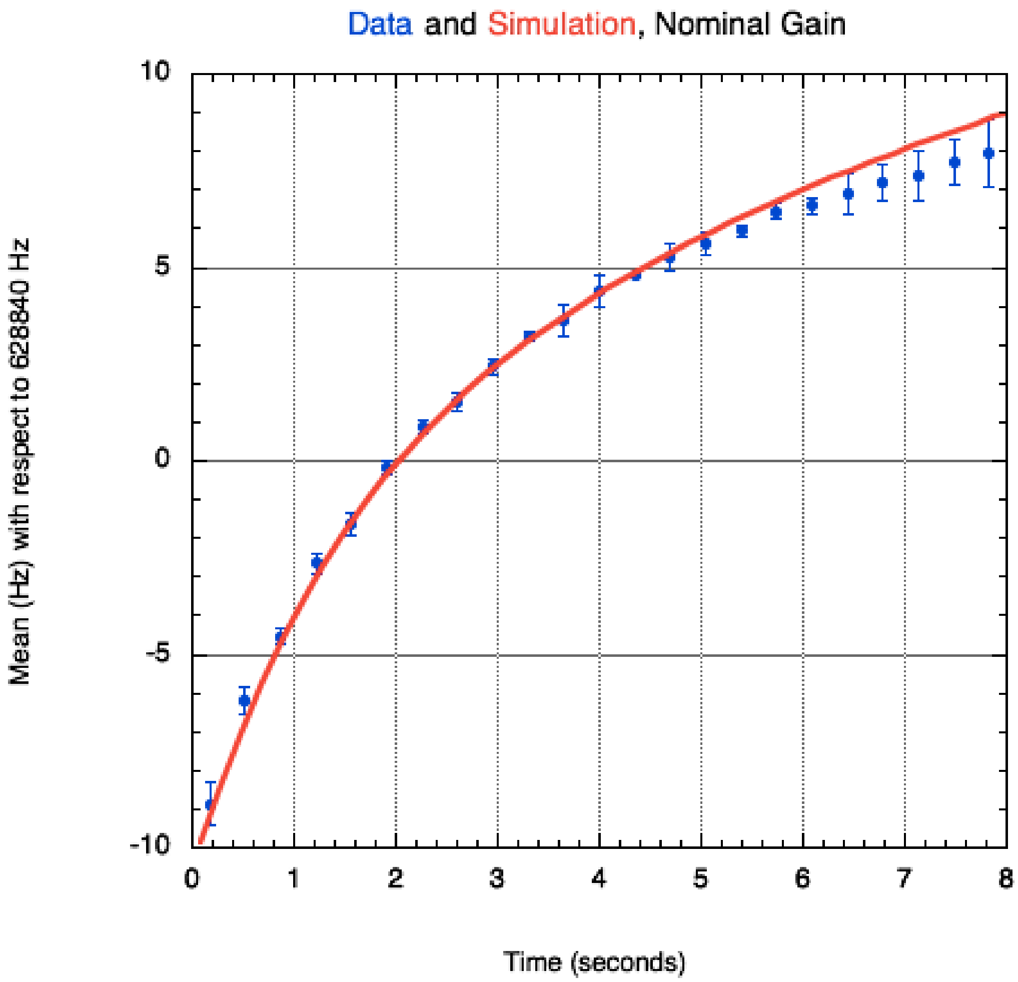


Figure 3: Comparison of data and simulation for nominal gain settings. The simulation gain was varied so the change in mean matched the data. No other parameters were varied. The horizontal axis is time in seconds, the vertical axis is mean position with respect to 628840 Hz.

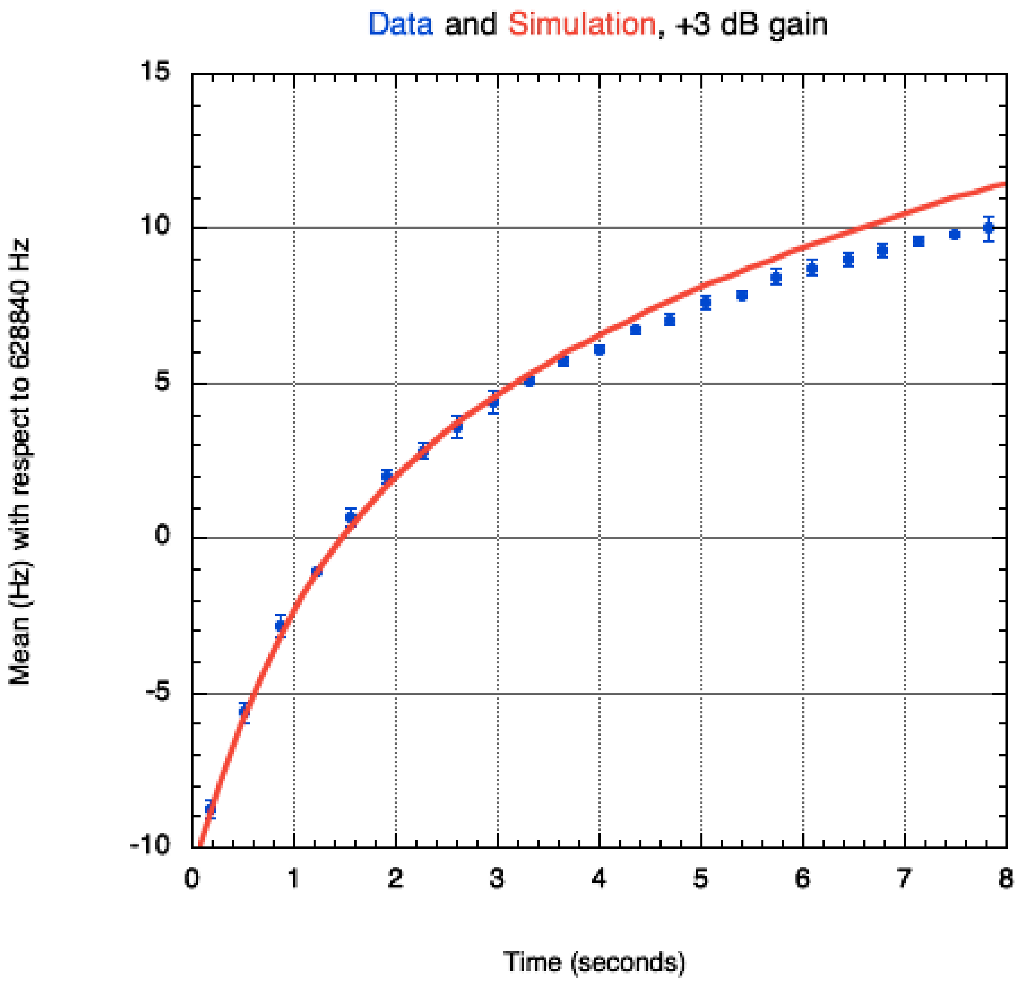


Figure 4: Comparison of data and simulation for +3 dB gain settings. No other parameters were varied. The horizontal axis is time in seconds, the vertical axis is mean position with respect to 628840 Hz.

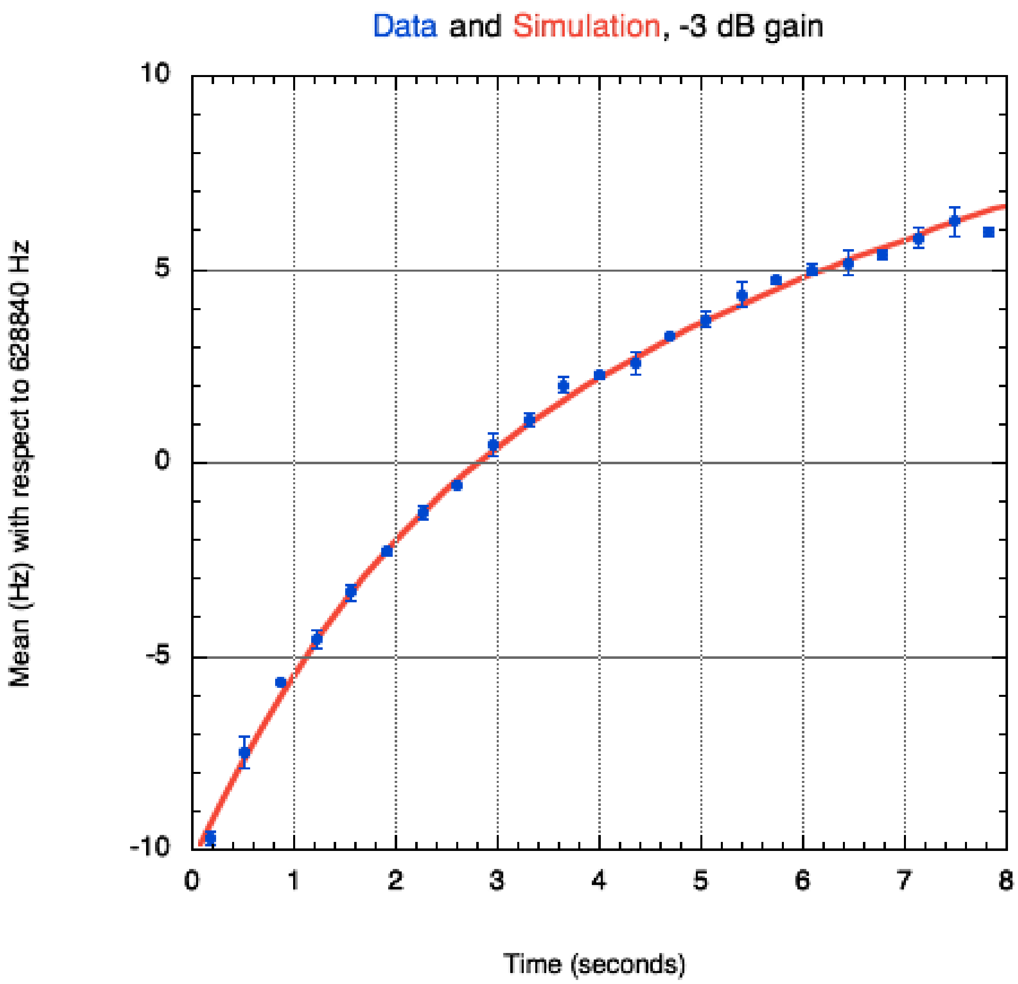


Figure 5: Comparison of data and simulation for -3 dB gain settings. No other parameters were varied. The horizontal axis is time in seconds, the vertical axis is mean position with respect to 628840 Hz.

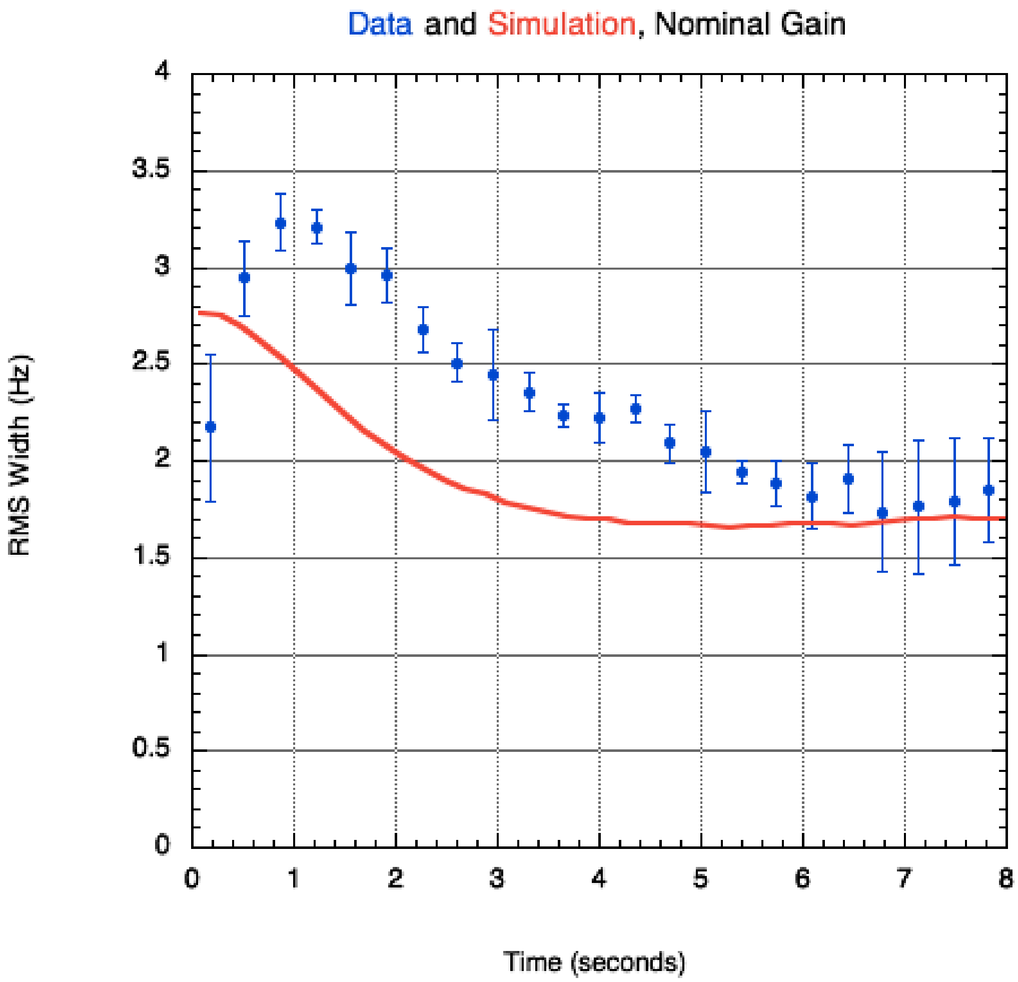


Figure 6: Comparison of data and simulation RMS widths for nominal settings. The horizontal axis is time in seconds, the vertical axis is RMS width of the pulse in Hz.