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Pbar Note 693

StackTail Studies Performed during Summer 2004

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July 15, 2004

# StackTail Phasing

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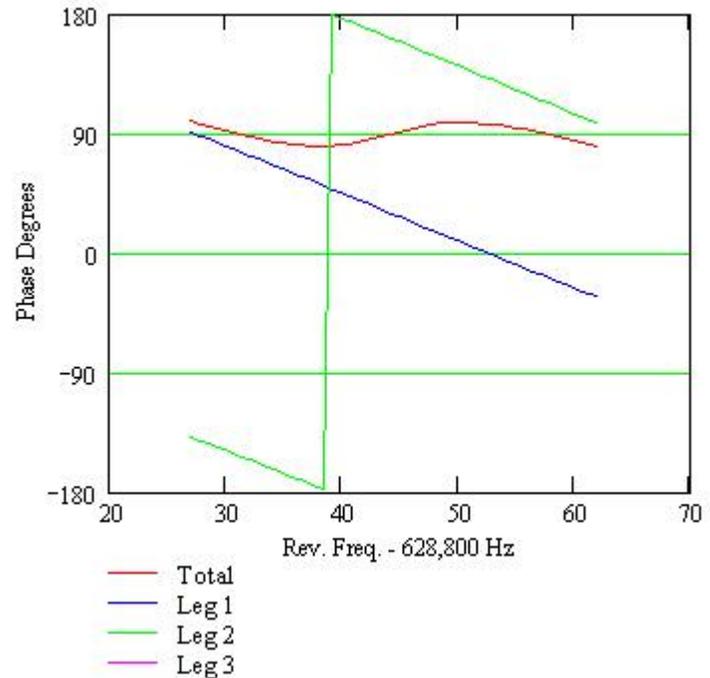
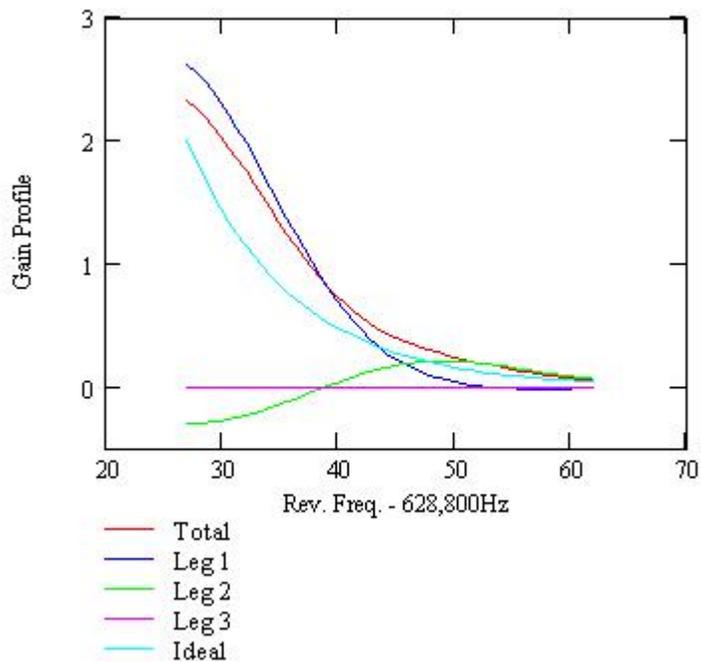
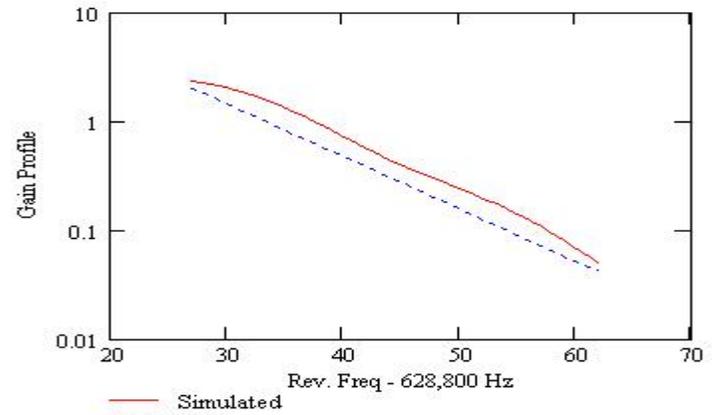
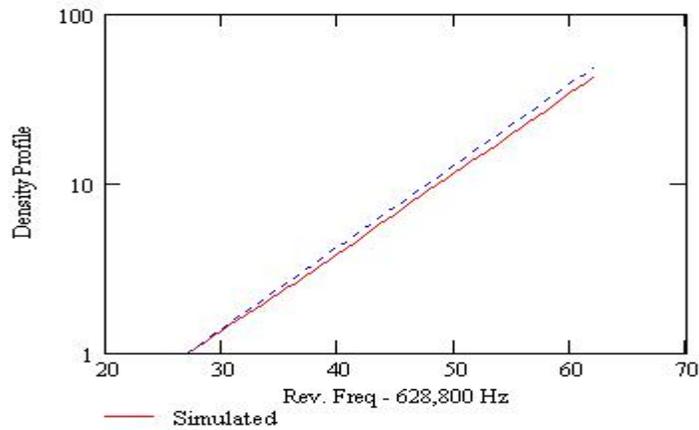
- Beam transfer function measurements were done with the beam placed on at revolution frequencies of 628,840 Hz (very close to the Leg 2 pickup) and 628,850 Hz
  - Beam was scraped to a width of 2Hz and scrapers were left in to ensure that beam width stayed at 2Hz
  - Fan-in and Fan-out were phased with very little changes made.
  - Trunk Beam transfer functions were made for all three legs independently.
    - Long leg of notch filters were left out for all legs
    - Saturation of amplifiers was checked by adjusting the network analyzer power and the trunk gain independently

## StackTail Phasing

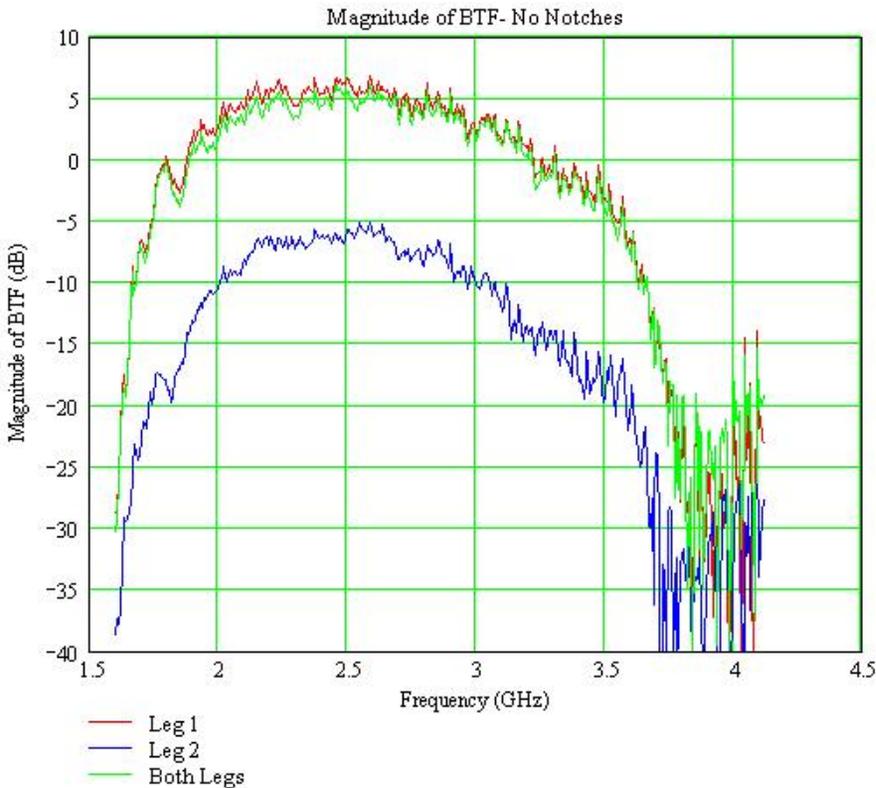
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- Using the real beam measurements at 628,840 Hz, the stacktail profile was optimized
  - with a static-Fokker-Plank solver
  - with no phase shifter changes in the legs
  - With a gain slope of 9Hz
  - With notches at L1 = 628,873Hz, L2=628,887Hz, Trunk=628,887Hz
- The system was simulated to support a static flux of 29.5 mA/hr

# Fokker-Plank Simulation Results



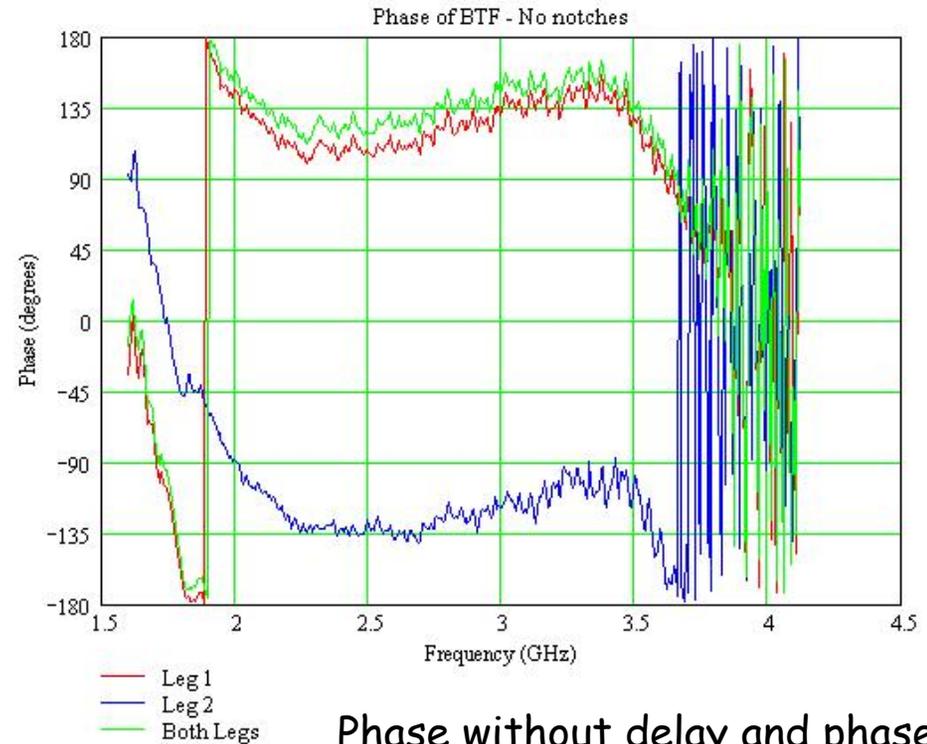
# Magic Numbers at 628,840 Hz with No Notch Filters



Leg1 at 628,840 Hz

Delay = -26 pS

Phase = -149.5 degrees



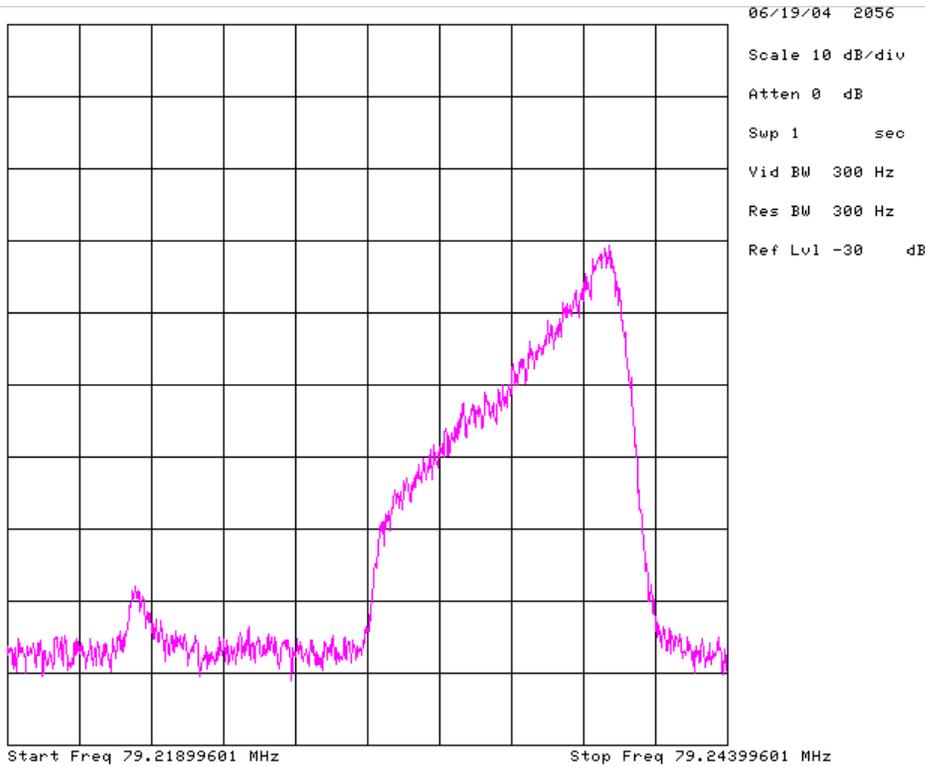
Phase without delay and phase intercept removed

Leg2 at 628,840 Hz

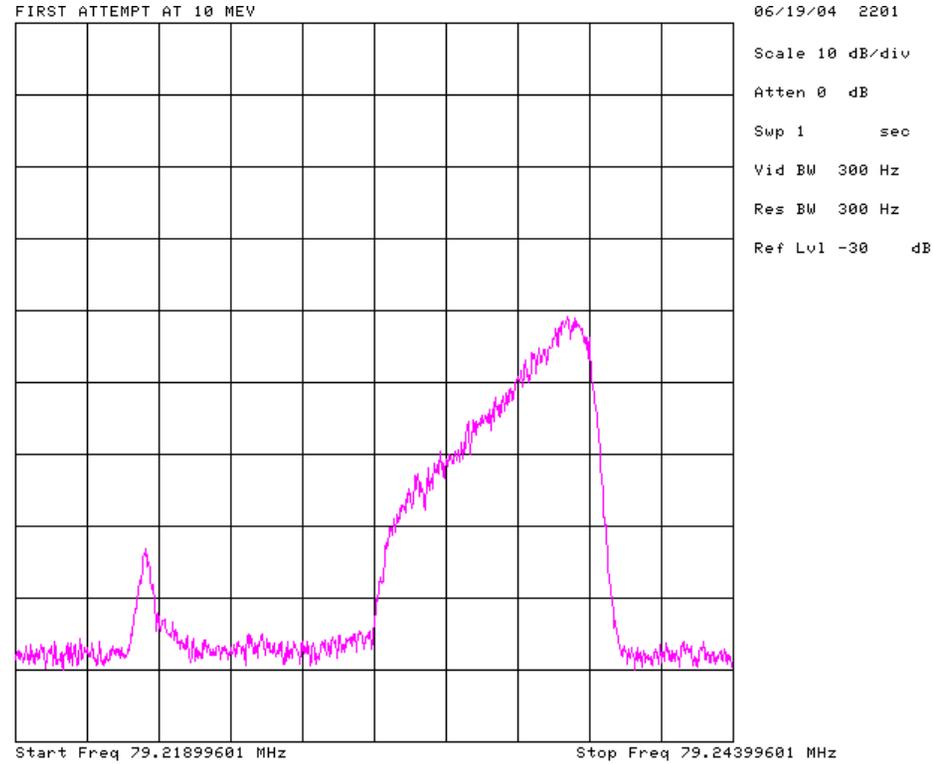
Delay = -47 pS

Phase = 75 degrees

# Stacktail Profile with 9 Hz Slope



Profile Before Changes

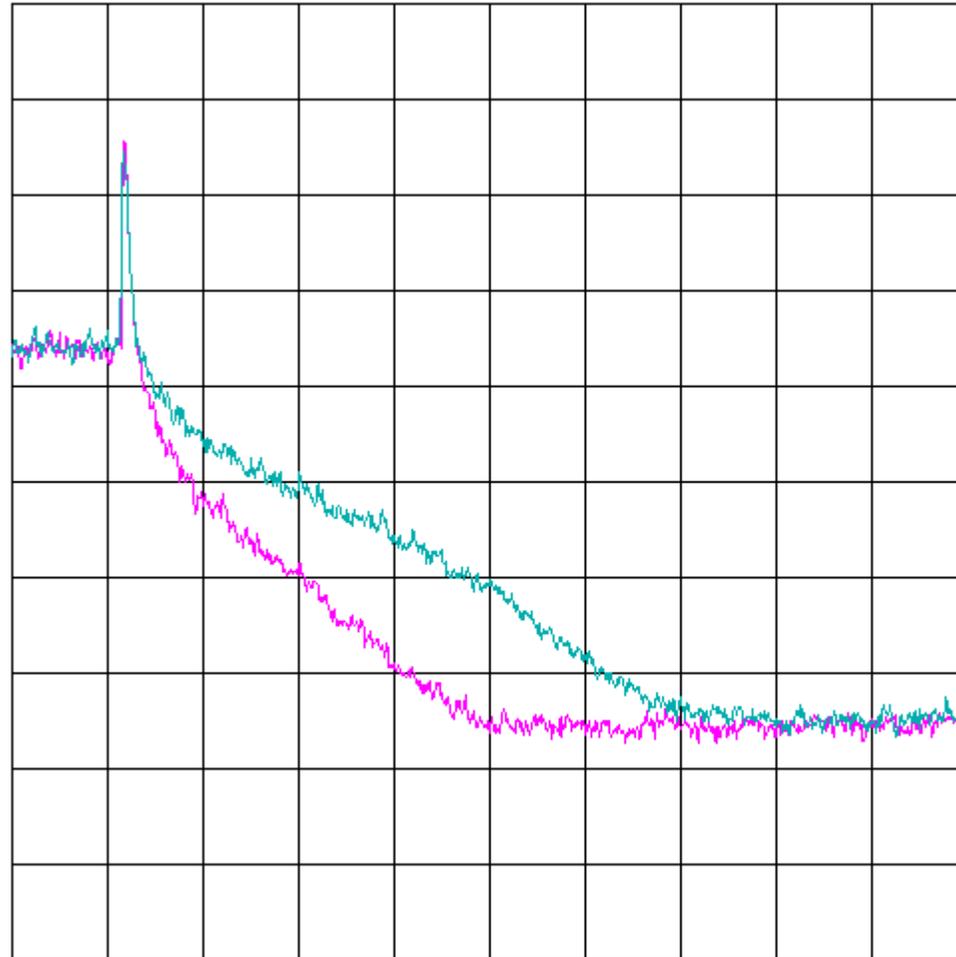


Profile After Changes

# Clearing Beam off the Stacktail Deposition Orbit

SP12 SCH WITH GAIN AT 10.5 DB

06/19/04 2245



Scale 5 dB/div

Atten 0 dB

Swp 3 sec

Vid BW 30 Hz

Res BW 10 KHz

Ref Lvl -69 dB

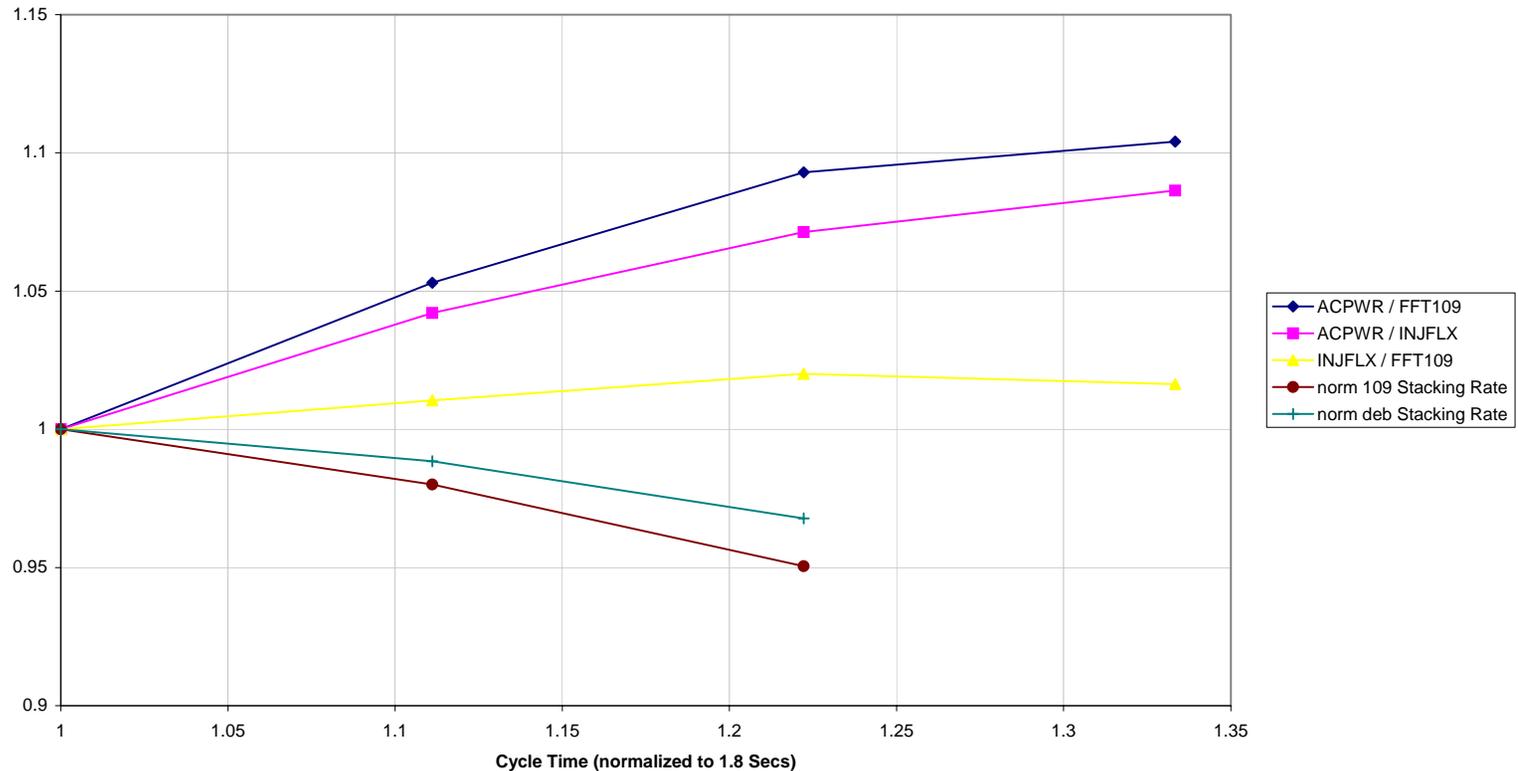
Cyan Trace with attenuator  
at 10.5 dB clears in 1.8  
secs

Magenta Trace with  
attenuator at 4.5 dB  
clears in 1.2 secs

Start Freq 2.500206848 GHz

Stop Freq 2.500206848 GHz

# Amount of Beam on the Accumulator Injection orbit as a Function of Cycle Time



- Injection orbit measurements were taken with the Stacktail and ARF1 off

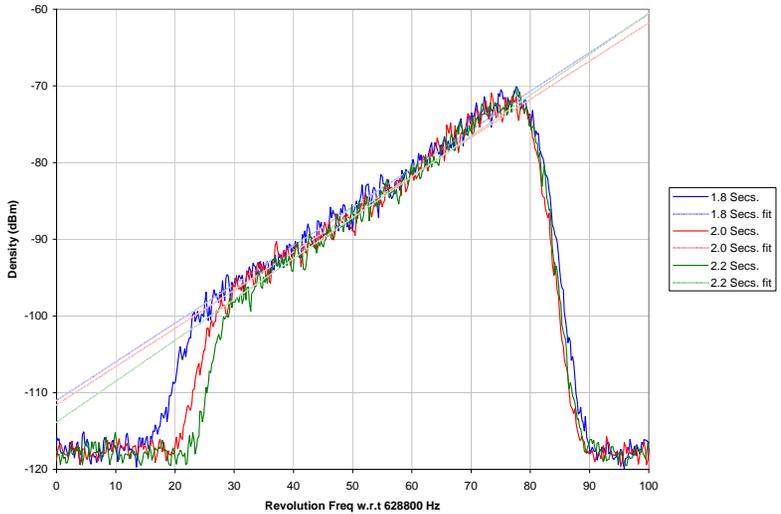
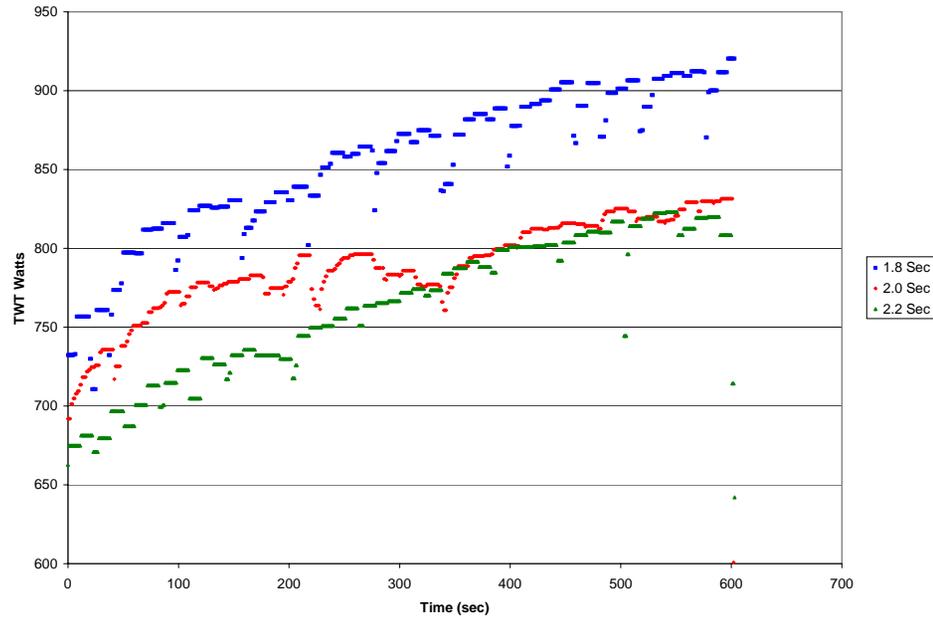
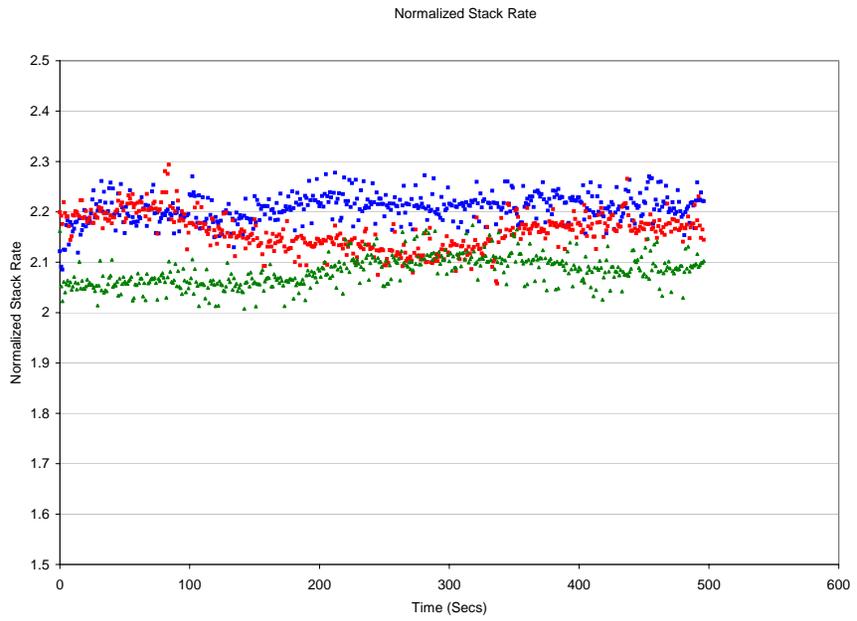
➤ The amount of beam on the injection orbit increases 9% while the cycle time increases from 1.8 to 2.2 secs

## Zero Stack Measurements with Constant Stacktail Gain and Variable Cycle Time

- Stacking measurements were taken with a fixed gain of 9 dB
- The stacking Rate falls 5% while the cycle time increases from 1.8 secs to 2.2 seconds
- If the amount of beam on the injection orbit was constant as a function of cycle time, the stacking rate should have fallen by 22% while the cycle time increases from 1.8 secs to 2.2 seconds
- We can account for 2/3 of this projected change for both the 2.0 sec cycle time and the 2.2 cycle time as compared to the 1.8 sec cycle time

Cycle time	Beam on the Acc. Inj. Orbit	Protons on Target	Pbars injected into the Debuncher	Protons on Target Normalized Stack Rate
Secs.	(uncal)	$\times 10^{12}$	(uncal)	$\times 10^{-2}$
2.4	6.982	5.56	17.395	
2.2	6.943	5.585	17.539	2.097
2	6.682	5.579	17.354	2.162
1.8	6.316	5.553	17.0944	2.206

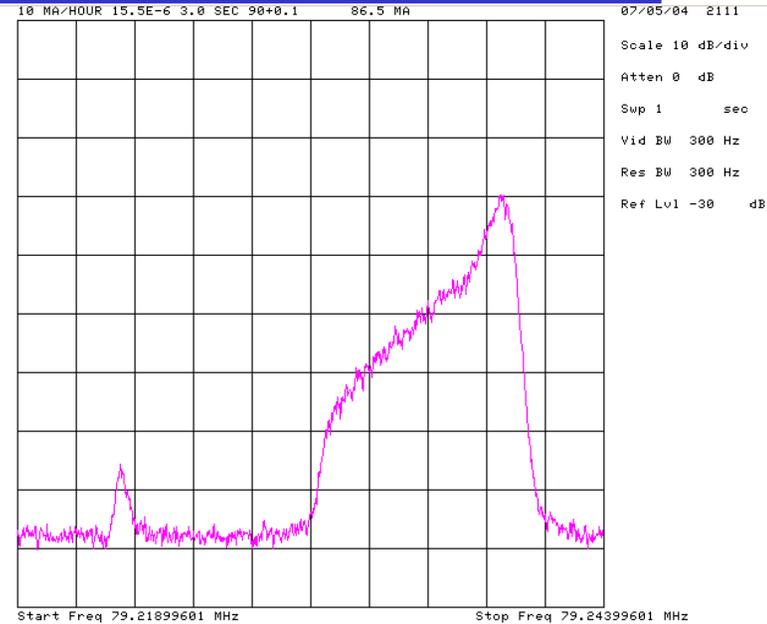
# Zero Stack Measurements with Constant Stacktail Gain and Variable Cycle Time



Gain Slope at ~8.6 Hz

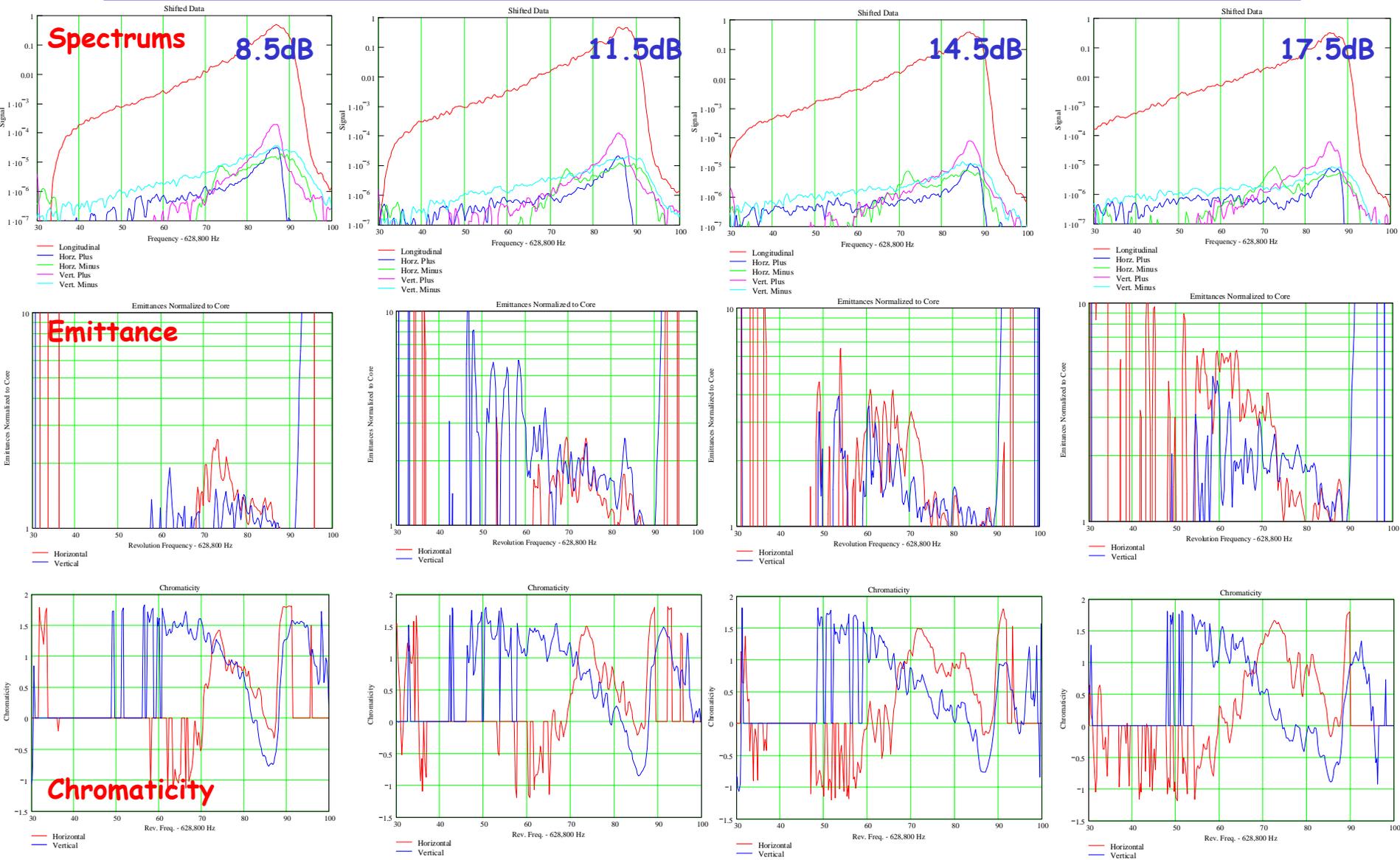
# Constant Long Cycle Time While Varying Stacktail Gain

- Ran at a slow cycle time (3.5 secs)
- The lowest Stacktail gain was set for when the Stacktail profile had a "hint" of backstreaming
- Each data point was the average of ten 60 Sec. supercycles
- Result: Small Stack Stack Rate does not seem to be a function of Stacktail Gain or Power



StackTail Trunk Attenuator	Stacktail TWT Power	Stack Rate	Production
dB	Watts	mA/hr	$\times 10^{-6}$
17.5	65	7.8	15
14.5	180	7.5	14.5
11.5	400	7.6	14.7
8.5	700	7.6	14.7

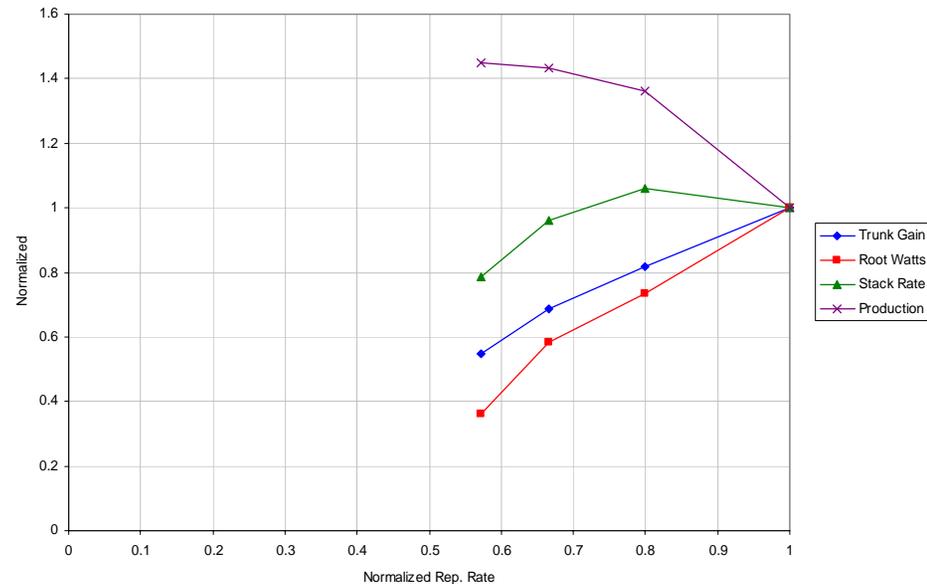
# Measuring Stacktail Emittances with Constant Long Cycle Time While Varying Stacktail Gain



# Variable Cycle Time While Varying Stacktail Gain

- The cycle time was varied from 3.5 Secs. to 2.0 Secs. in steps of 0.5 Sec.
- At each step, the stacktail gain was adjusted so that the Stacktail profile exhibited a "hint" of backstreaming.
- Each data point was the average of ten 60 Sec. supercycles

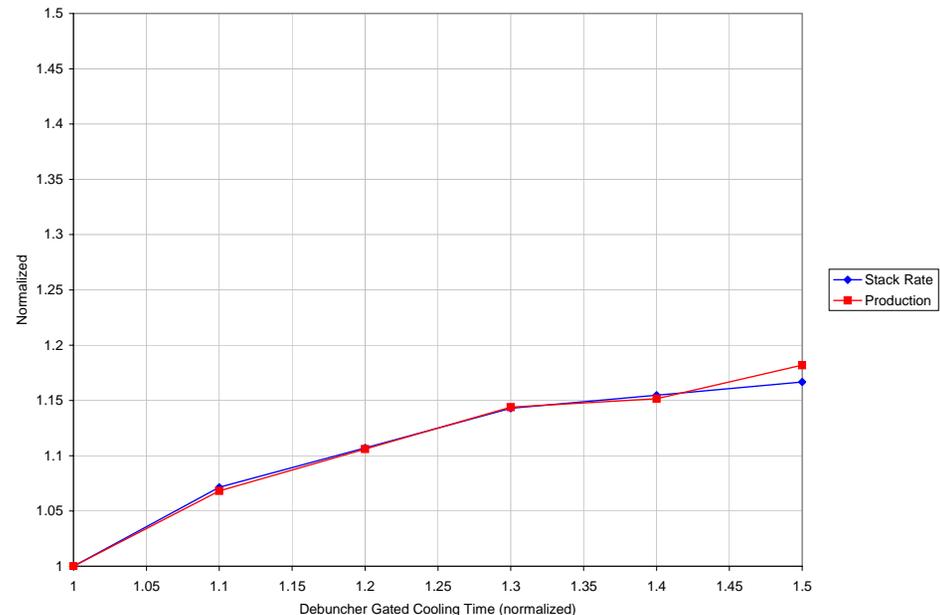
Cycle time	StackTail Trunk Attenuator	Stacktail TWT Power	Stack Rate	Production
Secs.	dB	Watts	mA/hr	$\times 10^{-6}$
3.5	17.5	65	7.8	14.8
3	15.5	170	9.5	14.6
2.5	14	270	10.5	13.9
2	12.25	500	9.9	10.2



## Long Cycle Time While Varying Debuncher Cooling Time

- Done with a small stack
- The cycle time was set at 3.0 sec so the Stacktail gain could be set low.
  - Core momentum and transverse emittances are small.
- Varied the length of time that the Debuncher cooling was on for all 3 planes using gating.

Debuncher Cooling Time	Stack Rate	Production
Secs.	mA/hr	$\times 10^{-6}$
3	9.8	15.6
2.8	9.7	15.2
2.6	9.6	15.1
2.4	9.3	14.6
2.2	9	14.1
2	8.4	13.2



# Conclusions

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- The present stacktail system with the bandwidth as measured should be capable of handling a static flux of 29mA/hr
- At small stacks, the present stacktail system can clear the deposition orbit as fast as 1.2 seconds
- At small stacks, increasing the stacktail gain or power does not affect stacking
  - It also does not seem to affect the emittances in the stacktail
- We can account for about 2/3 of the stack rate vs. cycle time by observing that the amount of beam received by the Accumulator decreases as the cycle time decreases.
- Initial measurements of Debuncher cooling gating can account for most of this observed decrease.

## Future Work

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- Dis-entangle the effects of Debuncher momentum and transverse cooling on beam received on the Accumulator Injection orbit
- Thoroughly investigate Debuncher transverse cooling.
- Investigate D/A line aperture