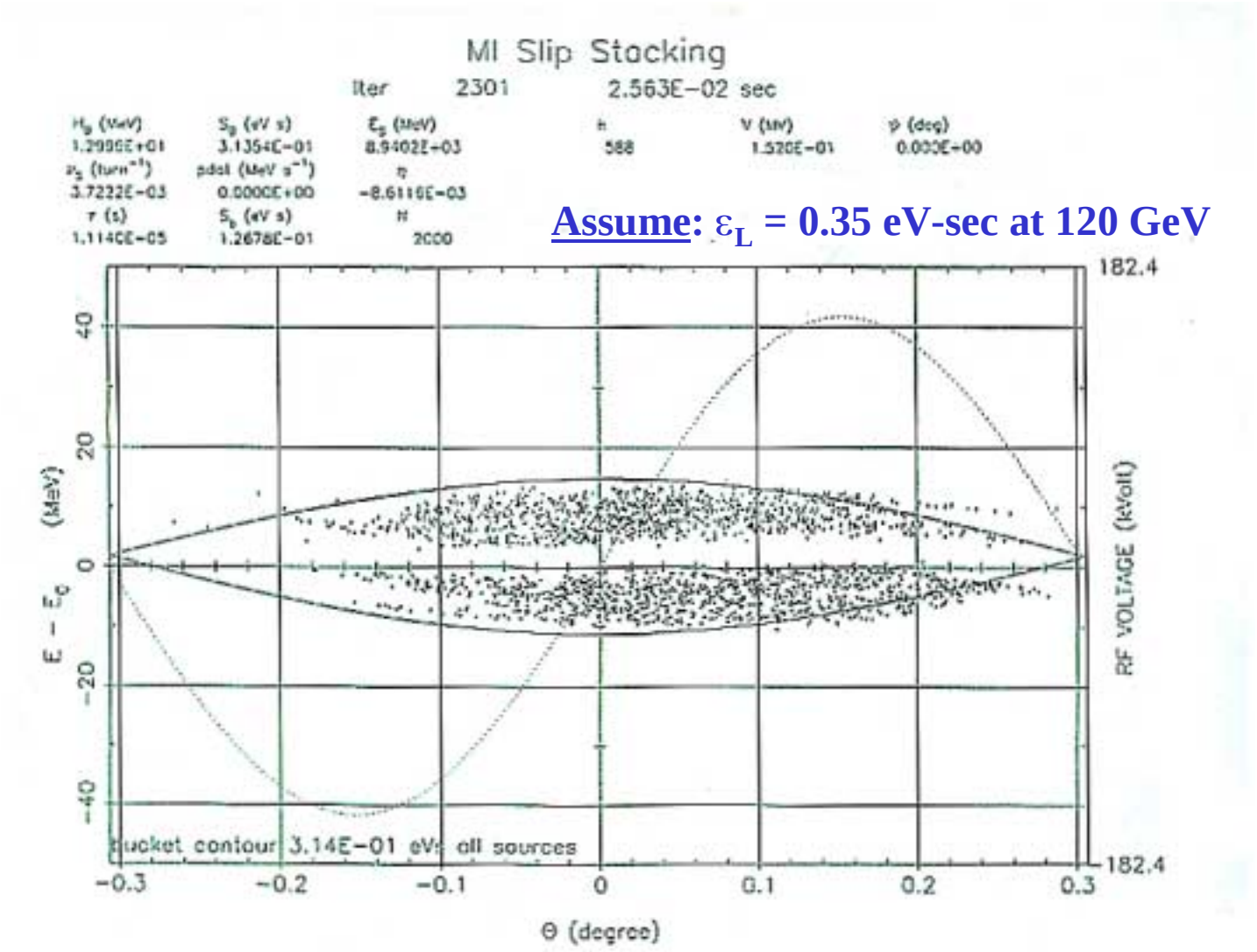
$\bar{p}$ Stacking Longitudinal Phase Space

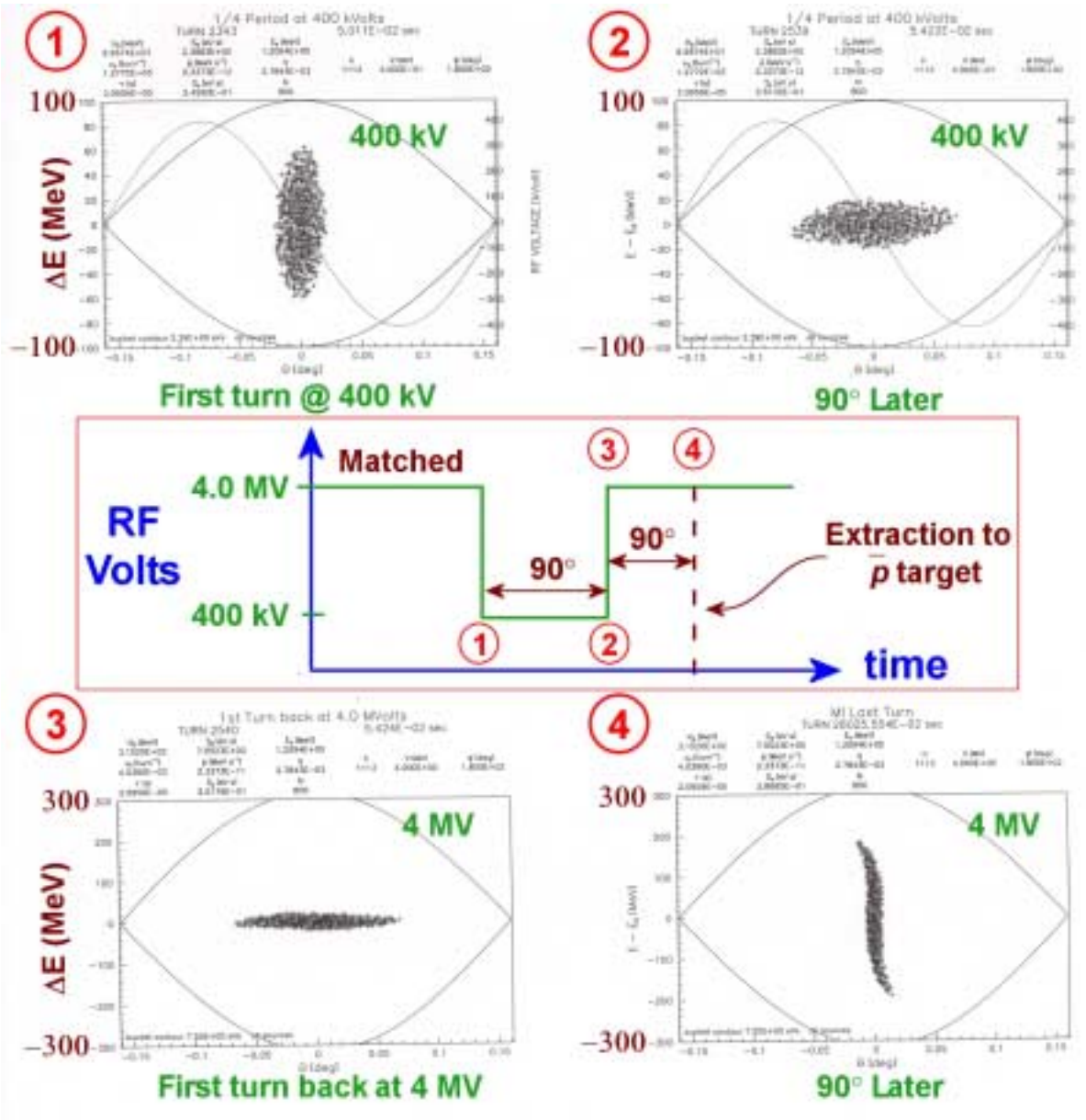
Steve Werkema
November 20, 2001

- Main Injector Bunch Rotation
- Debuncher Bunch Rotation
- Debuncher Cooling
- Why this matters

Slip Stacking Longitudinal Emittance Estimate



Main Injector Bunch Rotation – Cartoon



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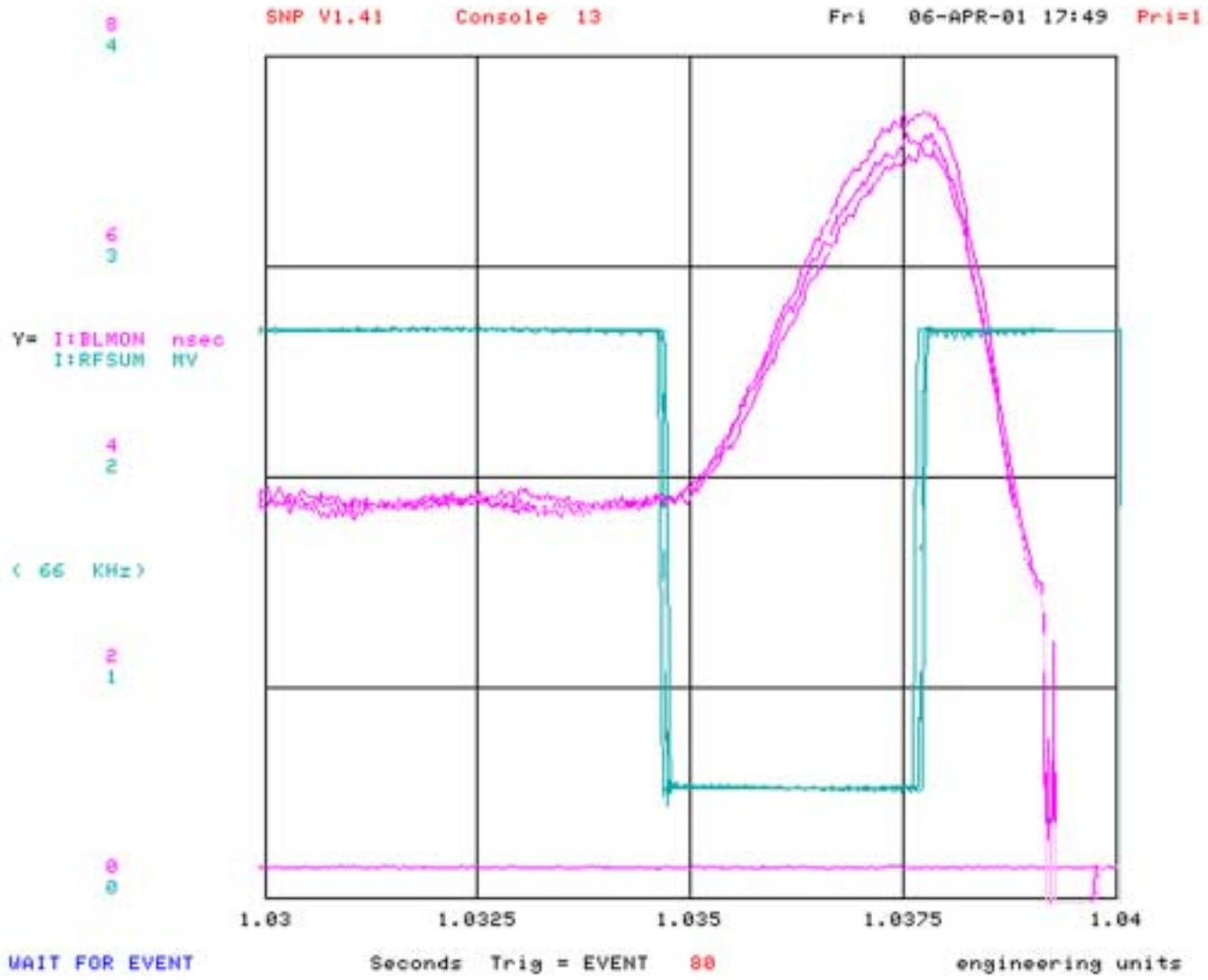
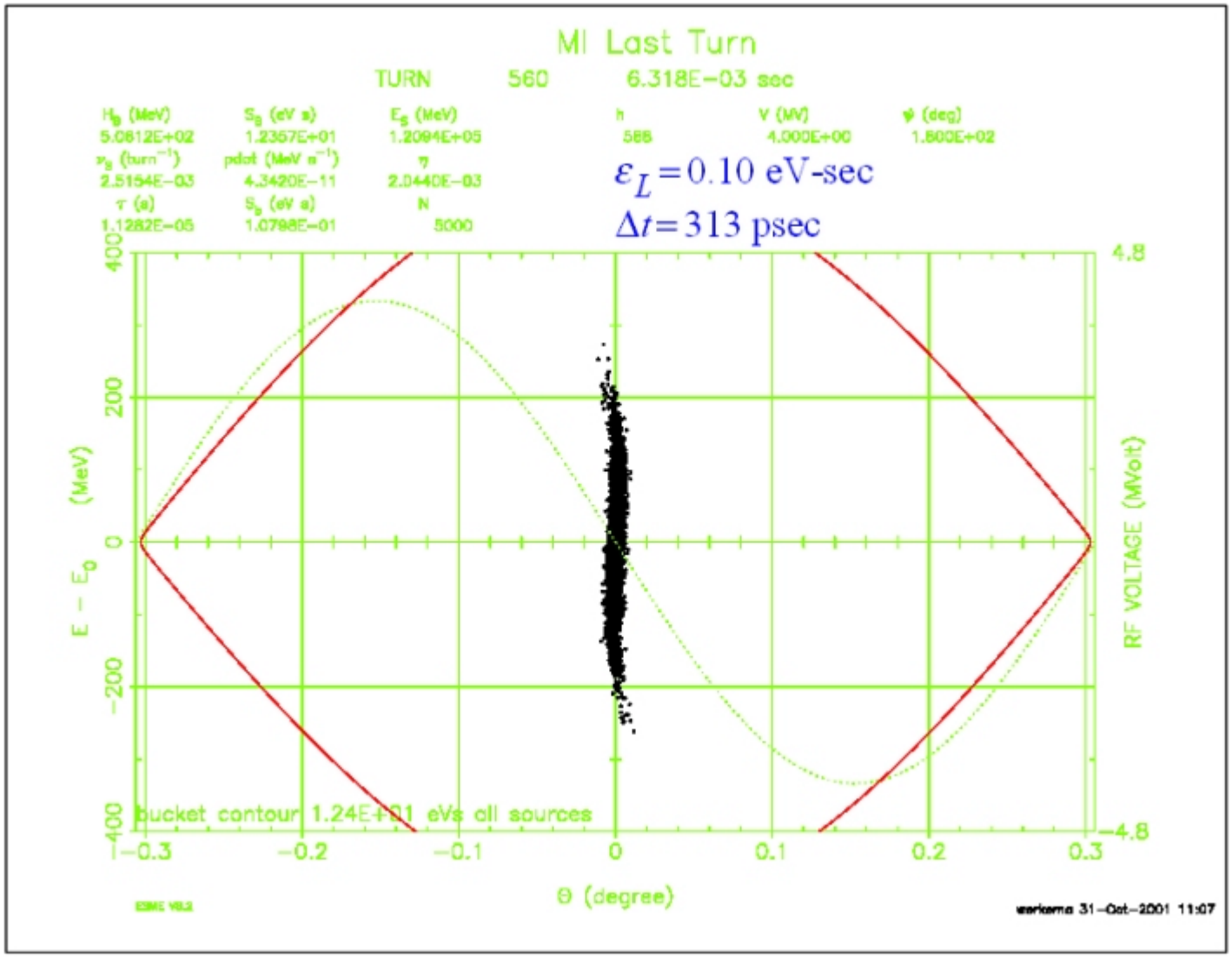
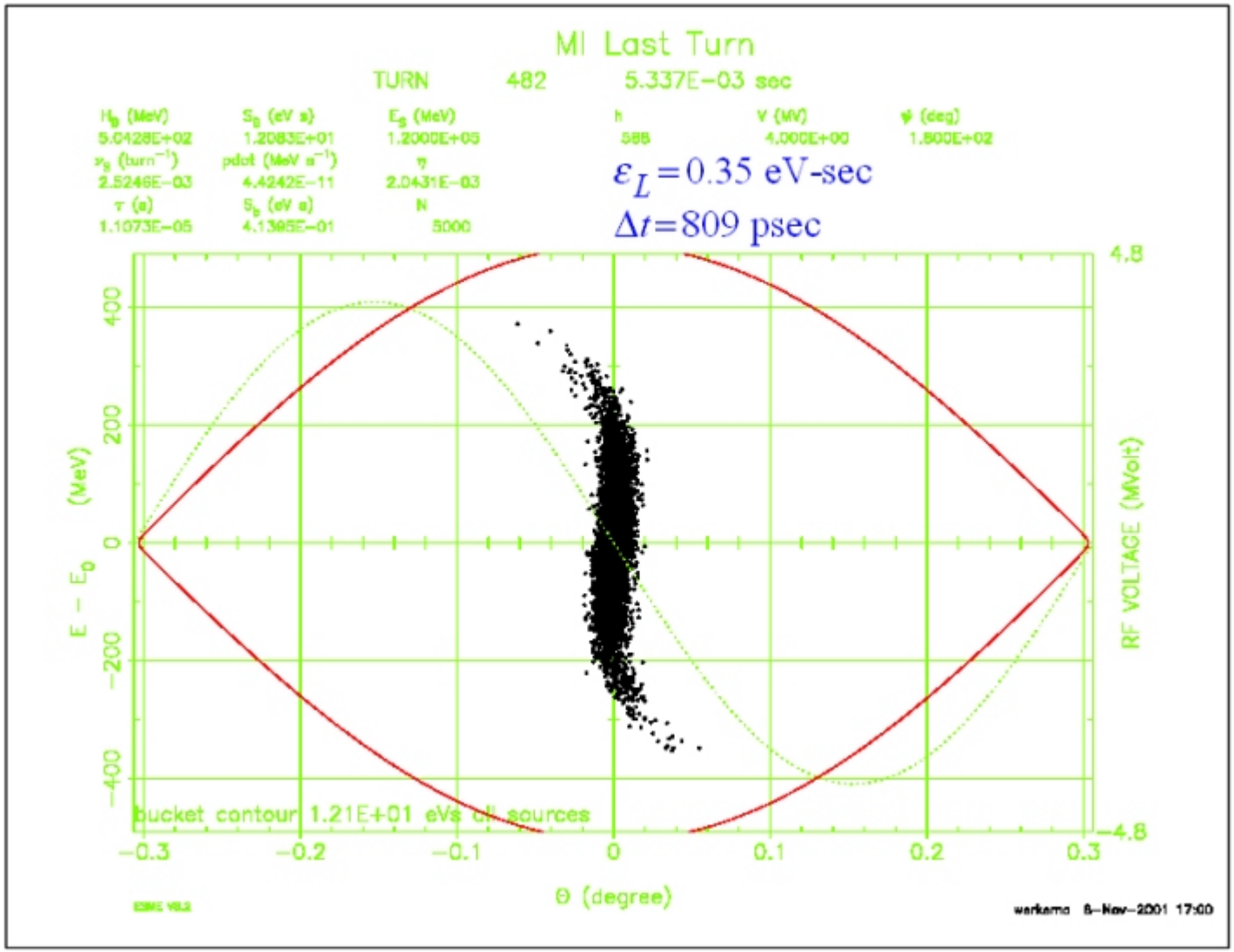
MI Bunch Rotation earlier this run:



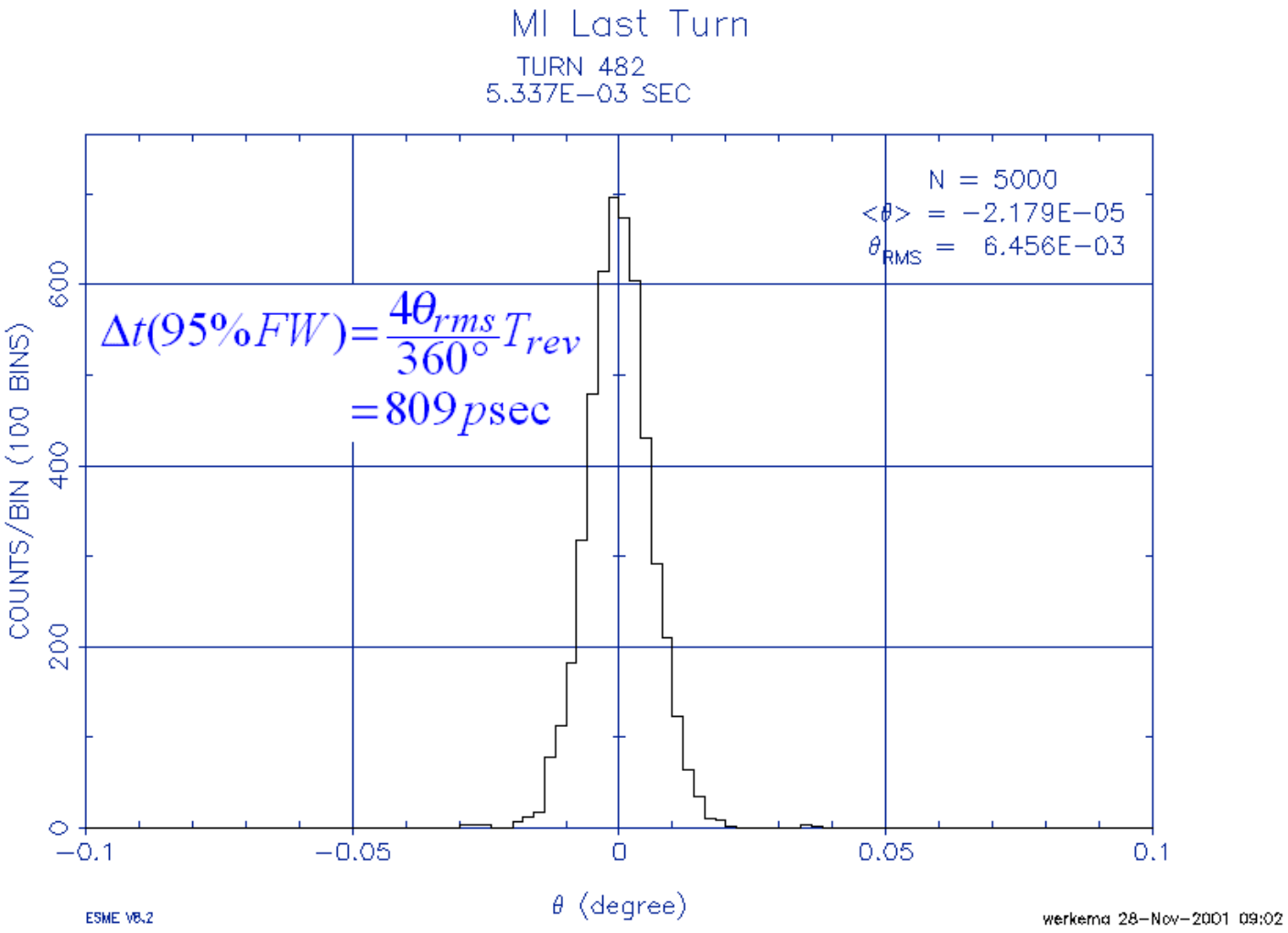
Linear Bunch Rotation:



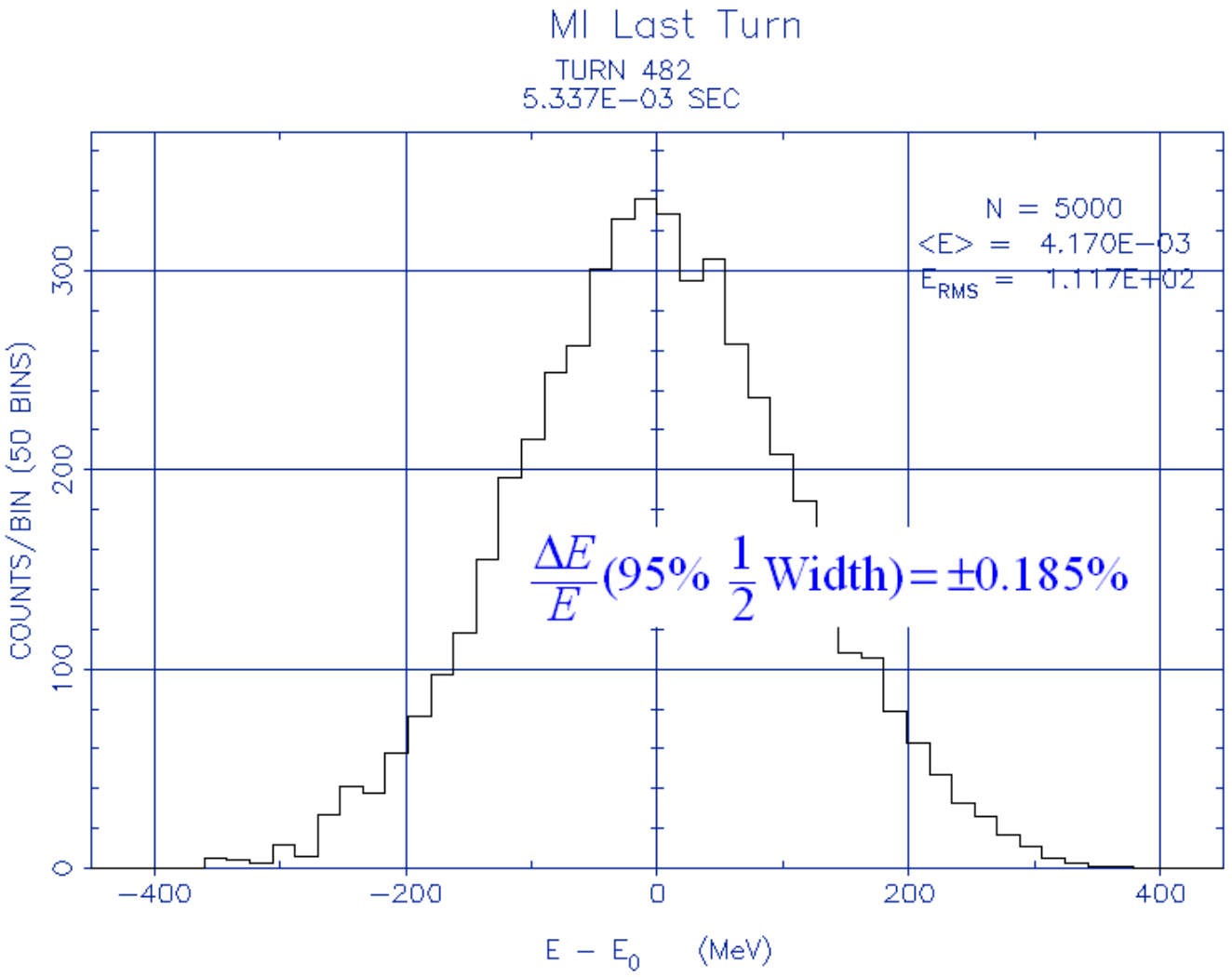
Bunch Rotation during slip stacking:



Bunch Length after MI bunch rotation:



Momentum Spread after bunch rotation:



Two minor issues:

1. *Why isn't the bunch length expected for slip stacking longer than that for Run Ia?*

Answer: This is a benefit from the smaller circumference and the smaller η of the Main Injector relative to the Main Ring.

For the same voltages

$$\Delta t_{MI} = \sqrt{\frac{\varepsilon_{MI}}{\varepsilon_{MR}}}\left(\frac{\eta_{MI}}{\eta_{MR}}\frac{h_{MI}}{h_{MR}}\right)^{\frac{1}{4}}\Delta t_{MR}$$

$$= (0.774)\sqrt{\frac{\varepsilon_{MI}}{\varepsilon_{MR}}}\Delta t_{MR}$$

2. *Issues associated with the large $\Delta p/p$ from Bunch rotation:*

Momentum aperture of P1 – target: No problem – Valeri Lebedev

Proton spot size on target: Vertical dispersion at target => slight reduction in $\bar{p}$ yield.

Note: The fixed value of the max voltage for MI bunch rotation limits the $\Delta p/p$ to less than ~0.2%.

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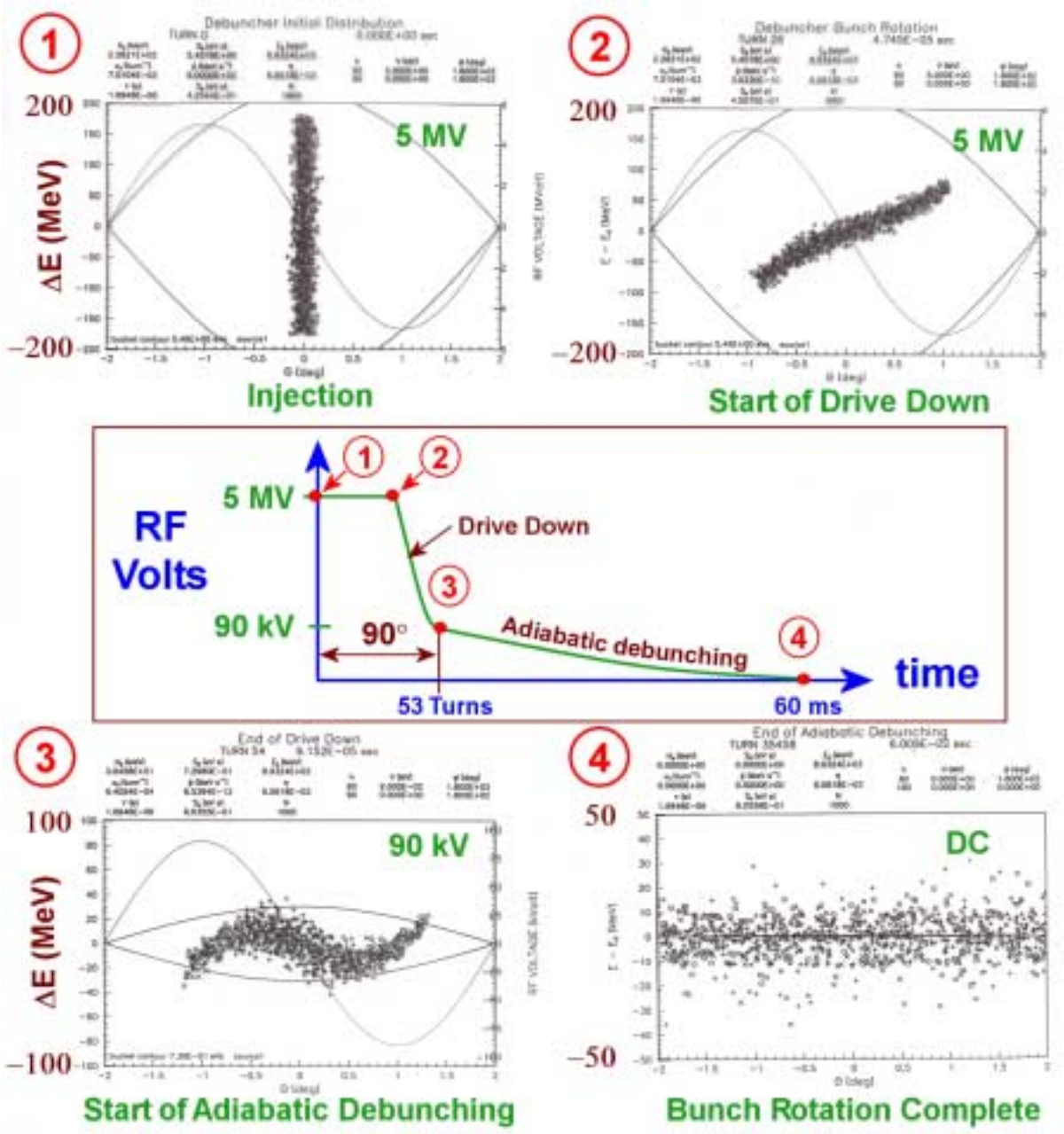
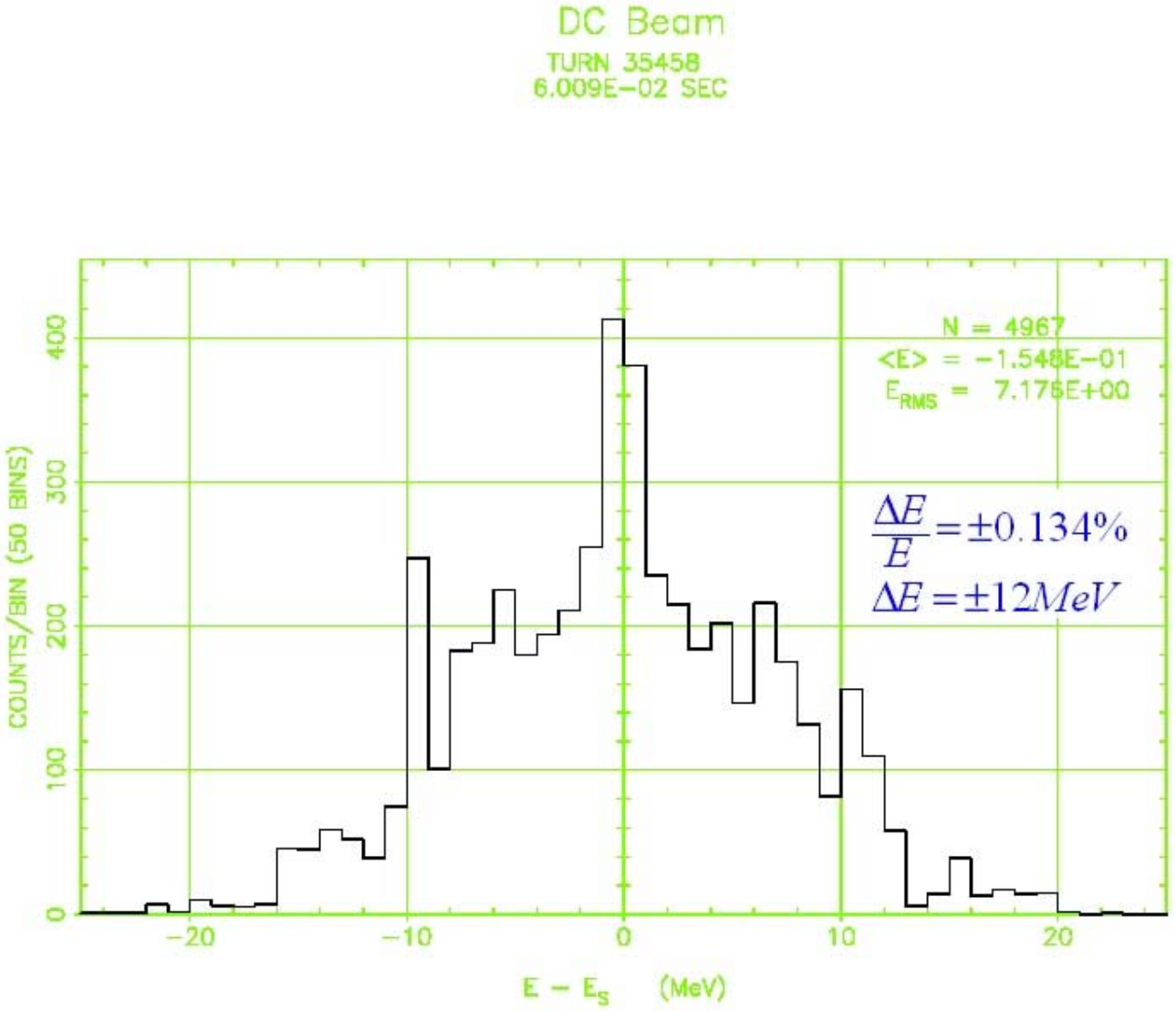
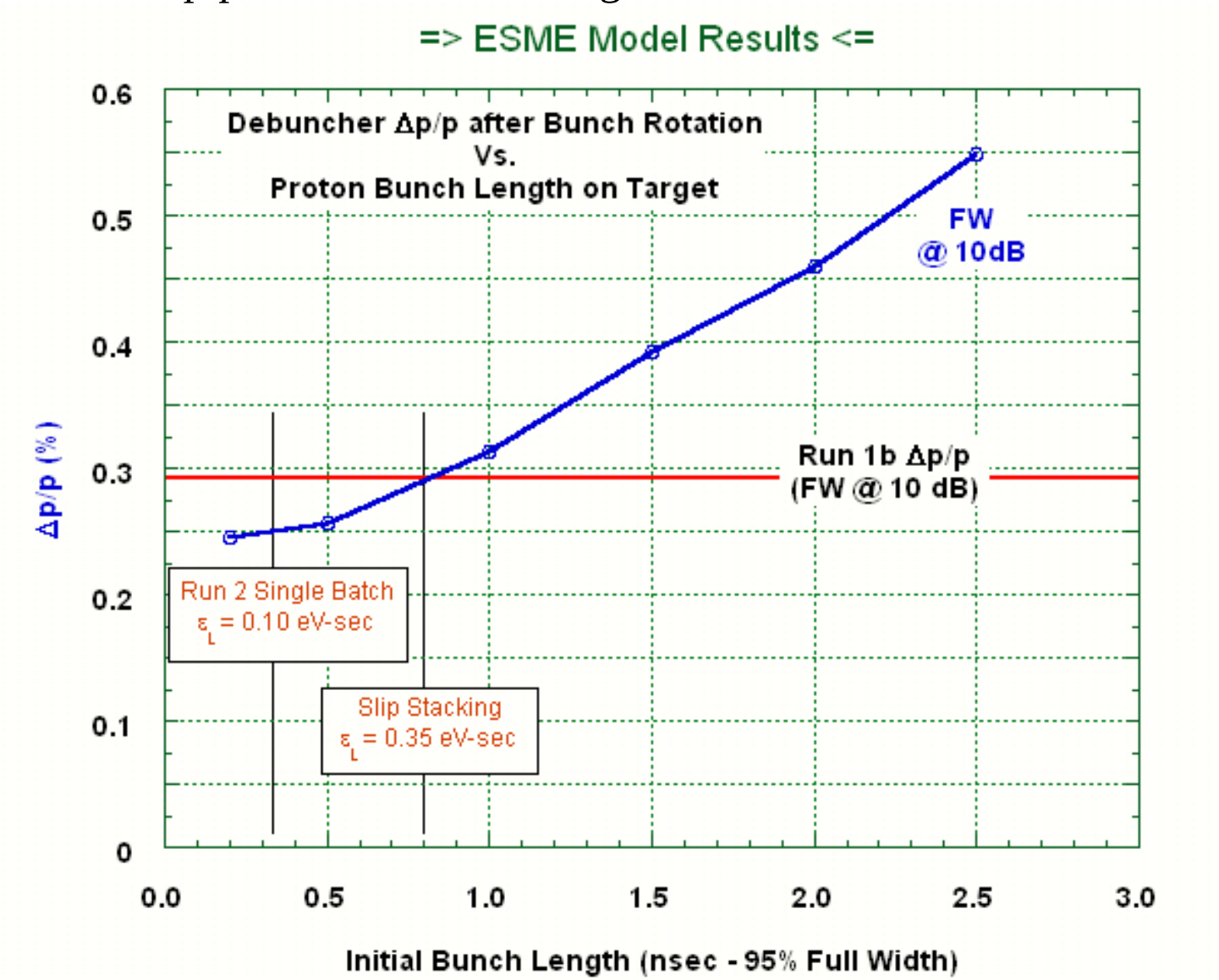
Debuncher bunch rotation cartoon:



Debuncher bunch rotation – Final Energy Spread:



Debuncher $\Delta p/p$ vs initial bunch length:



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TeV33 Debuncher Momentum Cooling Model:

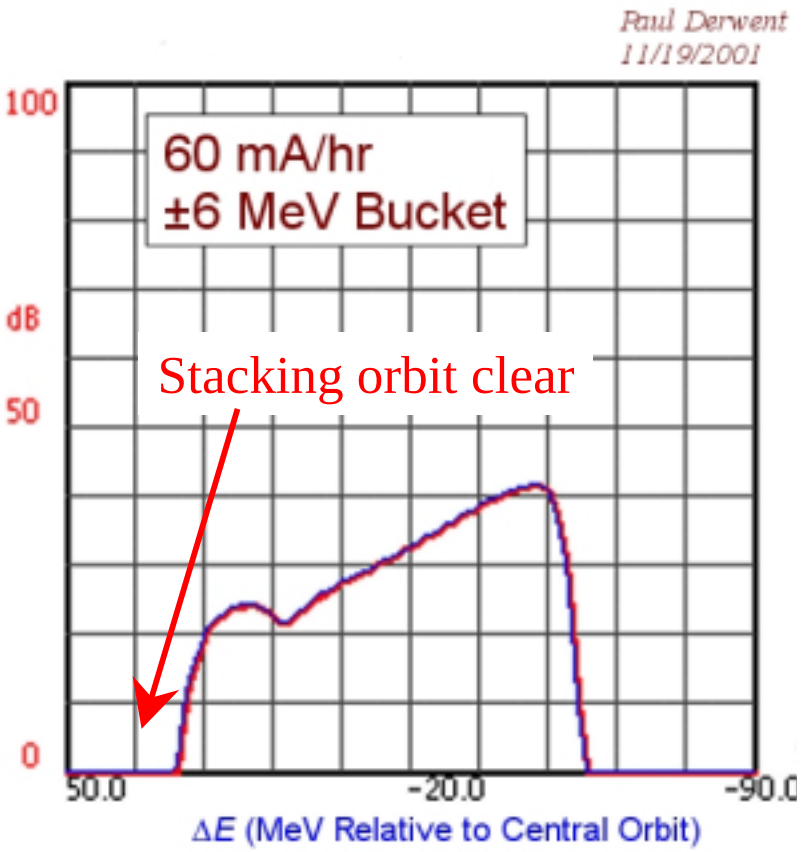
Table XI. Debuncher Momentum Cooling Parameters.

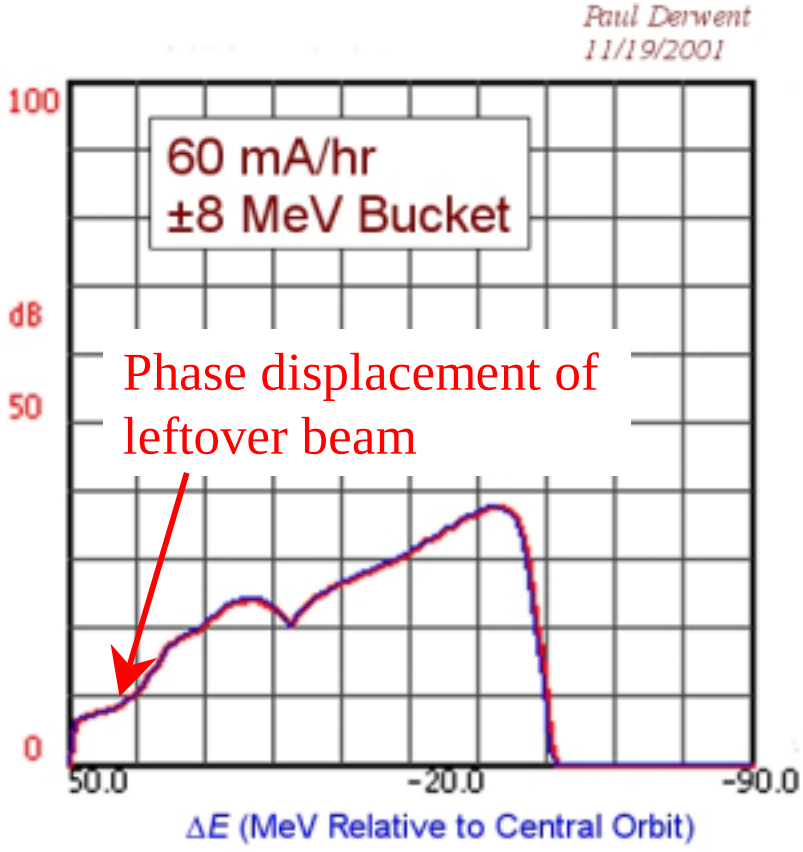
	TeV33		Run IIb
Number of particles	6×10^{8}		3.5×10^{8}
Efficiency	100	%	
Cycle time	2	sec	
Initial Momentum Spread (full)	30	MeV	24 MeV
Final Momentum Spread (full)	11	MeV	12 MeV
Frequency Band	4-8	GHz	
Number of PU's	256		
PU impedance	50	Ω	
PU sensitivity	0.7		
PU noise temperature	20	°K	} T_{eff} = 35°K
Amplifier noise temperature	40	°K	
Electronic gain	140	dB	
Number of Kickers	256		
Kicker impedance	50	Ω	
Kicker sensitivity	0.7		
Thermal noise power	110	W	
Schottky noise power	370	W	
Total power	480	W	4800 W

Marked up Table XI from TeV33 Report – John Marriner's Momentum cooling model.

Conclusion(?!): Factor of ~10 difference between performance and model

Why does it matter?





If too large a bucket (Height > 6 MeV) is required for RF stacking in the Accumulator, the stacktail cooling will not be able to clear off the central orbit prior to the arrival of the next pulse.