

# RR pbar Longitudinal Emittance during Beam Stacking and Unstacking and Some Issues

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- Data Collection
  - RTD720 scope and RR wall current monitor and R86 ( by Ming-Jen)
  - A TCLK event for multiple triggers in sequence (by Craig McClure and Greg Vogel)
- Case Studied
  - Pbar Stacking
  - Pbar Un-stacking
  - De-bunching and Re-bunching in 2.5 MHz rf buckets
  - Compression and De-compression
- Issues

With  
protons



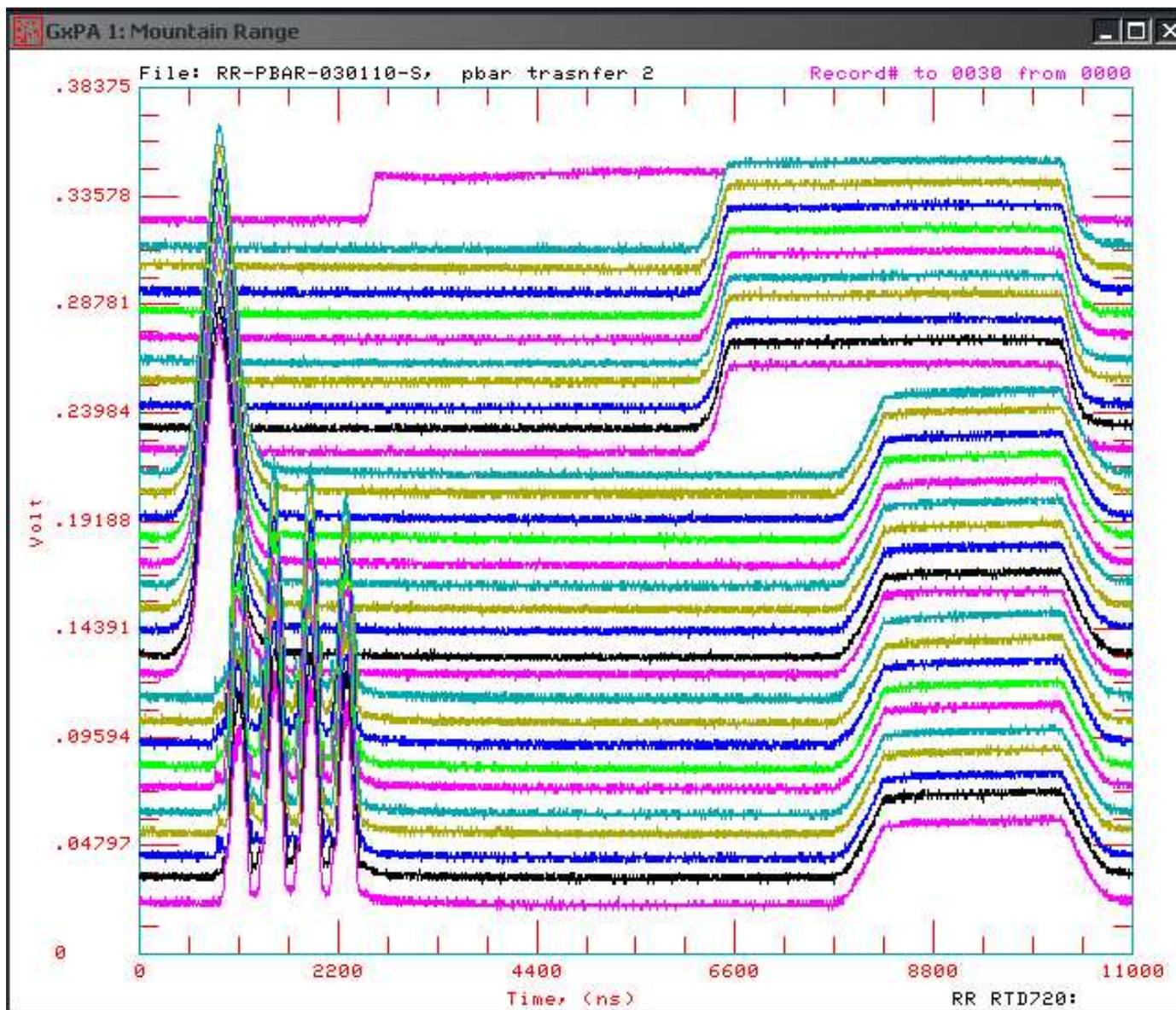
## Dedicated Variable Event

A new TCLK event E6 is allotted for this purpose for future usage

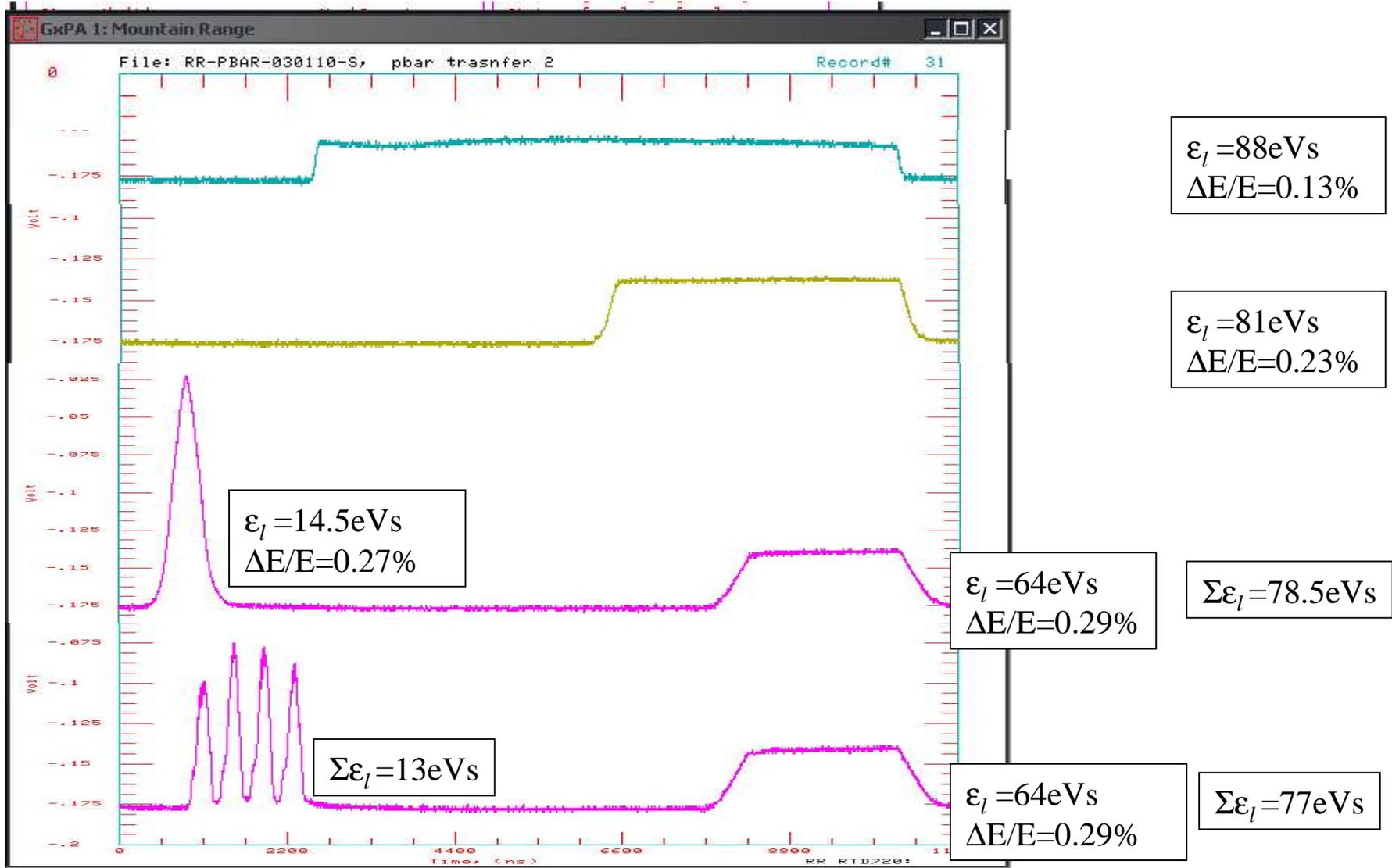
```
PA:R34 INSTRUMENT PARAMS<NoSets>
R34 RR RTD720 TRIGGER SETUP (R86) SET D/A A/D Com-U *COPIES*
-<FTP>+ *SA* X-A/D X=L:EMSHTD Y=A:QDF
COMMAND ----- Eng-U I= 1890 I= 245 , 0 , 0 , 0
-<10>+ One+ AUTO F= 2100 F= 255 , 2 , 2 , 2
TORROID flux... rad_mon doct... bpm_nod ipm.... peanuts testdev
! TRIGGER #1 FOR RR RTD720, EVENT INDEX[0..9]-R86-
-R:RTDBKT RTD720 Bucket Dly Ch 0-3 0 0 Bkts
-R:RTDSKP RTD720 SkipSample Ch 0-3 2000 2000 Turn
-R:RTDDL Y RTD720 Delay Ch 0-3 2 2 Secs
-R:RTDCNT RTD720 Samples Ch 0-3 10 10 Cnts
-R:RTDTRG RTD720 Arm Count Ch 0-3 59 59 Cnts
-R:RTDEV RTD720 Arm Event Ch00-39 00EC 00EC
-R:RTDEV [1] RTD720 Arm Event Ch00-39 00FF 00FF
! TRIGGER #2, EVENT INDEX [10..19]
-R:RTDBKT[1] RTD720 Bucket Dly Ch 0-3 0 0 Bkts
-R:RTDSKP[1] RTD720 SkipSample Ch 0-3 2000 2000 Turn
-R:RTDDL Y[1] RTD720 Delay Ch 0-3 24 24 Secs
-R:RTDCNT[1] RTD720 Samples Ch 0-3 10 10 Cnts
-R:RTDTRG[1] RTD720 Arm Count Ch 0-3 49 49 Cnts
-R:RTDEV [10] RTD720 Arm Event Ch00-39 00EC 00EC
-R:RTDEV [11] RTD720 Arm Event Ch00-39 00FF 00FF
! TRIGGER #3, EVENT INDEX [20..29]
-R:RTDBKT[2] RTD720 Bucket Dly Ch 0-3 0 0 Bkts
-R:RTDSKP[2] RTD720 SkipSample Ch 0-3 2000 2000 Turn
-R:RTDDL Y[2] RTD720 Delay Ch 0-3 53 53 Secs
-R:RTDCNT[2] RTD720 Samples Ch 0-3 50 50 Cnts
-R:RTDTRG[2] RTD720 Arm Count Ch 0-3 46 46 Cnts
-R:RTDEV [20] RTD720 Arm Event Ch00-39 00EC 00EC
-R:RTDEV [21] RTD720 Arm Event Ch00-39 00FF 00FF
! TRIGGER #4, EVENT INDEX [30..39]
-R:RTDBKT[3] RTD720 Bucket Dly Ch 0-3 0 0 Bkts
-R:RTDSKP[3] RTD720 SkipSample Ch 0-3 2000 2000 Turn
-R:RTDDL Y[3] RTD720 Delay Ch 0-3 134 134 Secs
-R:RTDCNT[3] RTD720 Samples Ch 0-3 40 40 Cnts
-R:RTDTRG[3] RTD720 Arm Count Ch 0-3 1 1 Cnts
-R:RTDEV [30] RTD720 Arm Event Ch00-39 00EC 00EC *
-R:RTDEV [31] RTD720 Arm Event Ch00-39 00FF 00FF *
```

# WCM data of Pbar stacking

(AR → MI → RR Transfer 2, January 10, 2003)

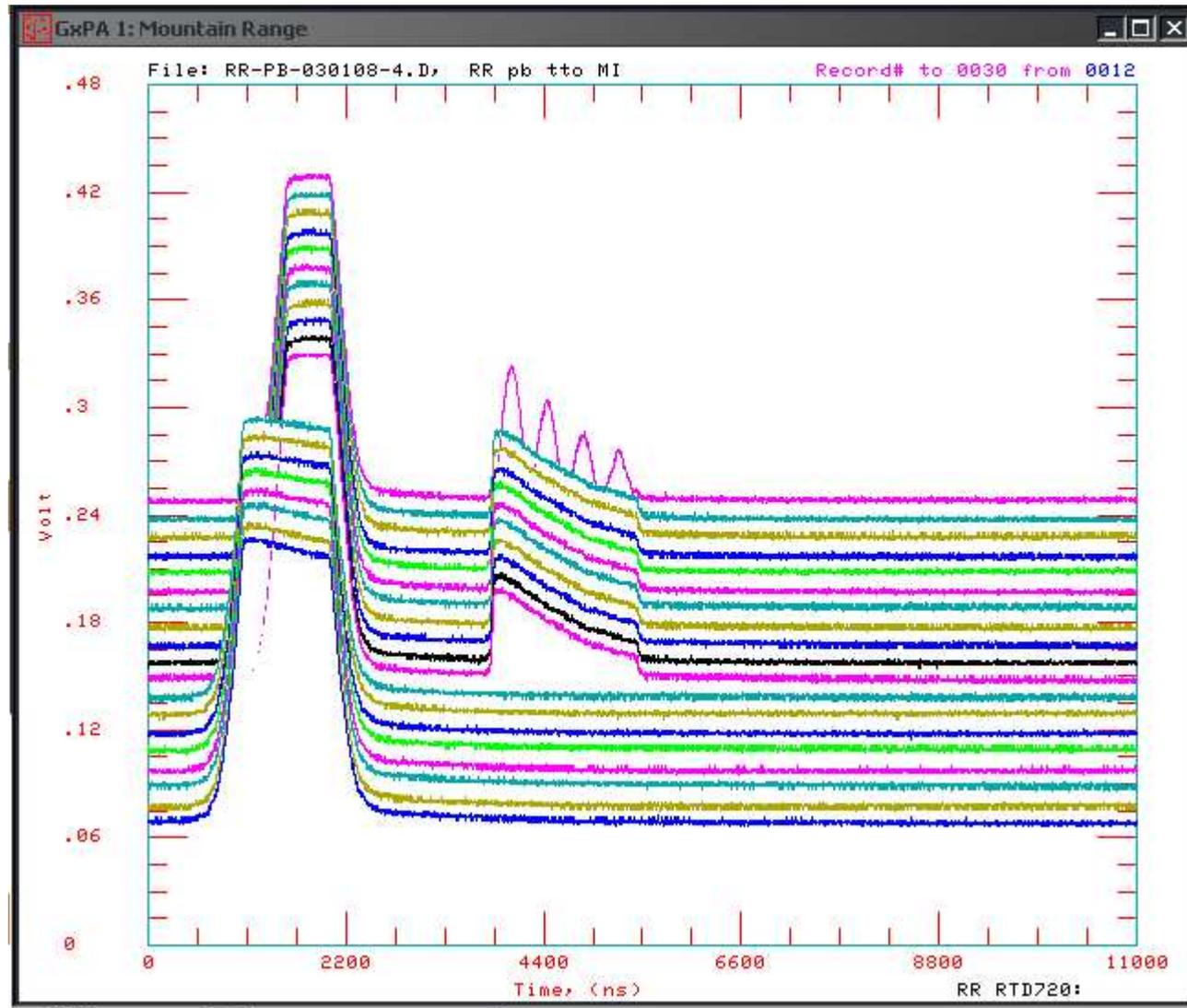


# Four Different Timing during Stacking

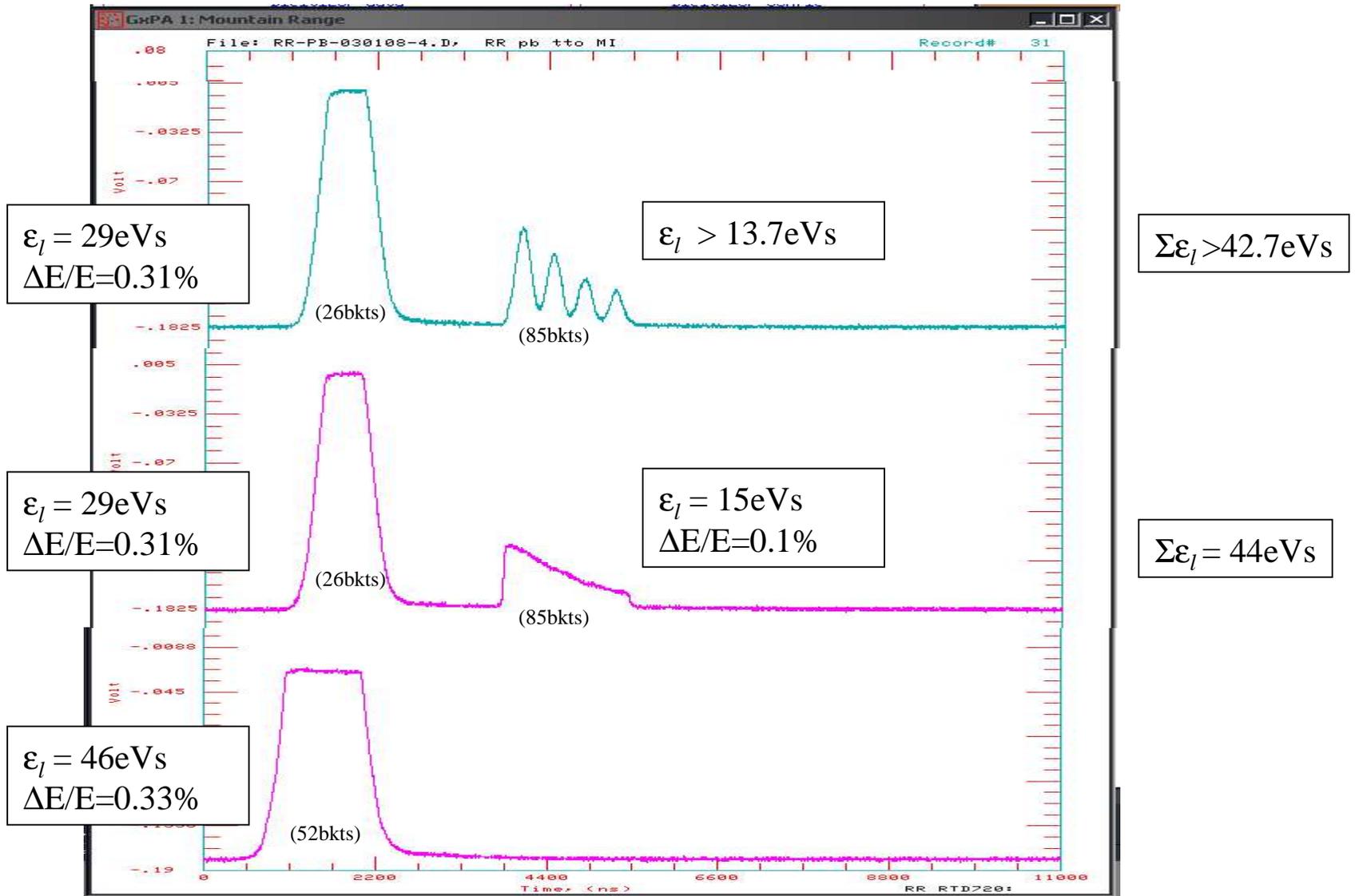


# RR WCM data of Pbar Un-stacking

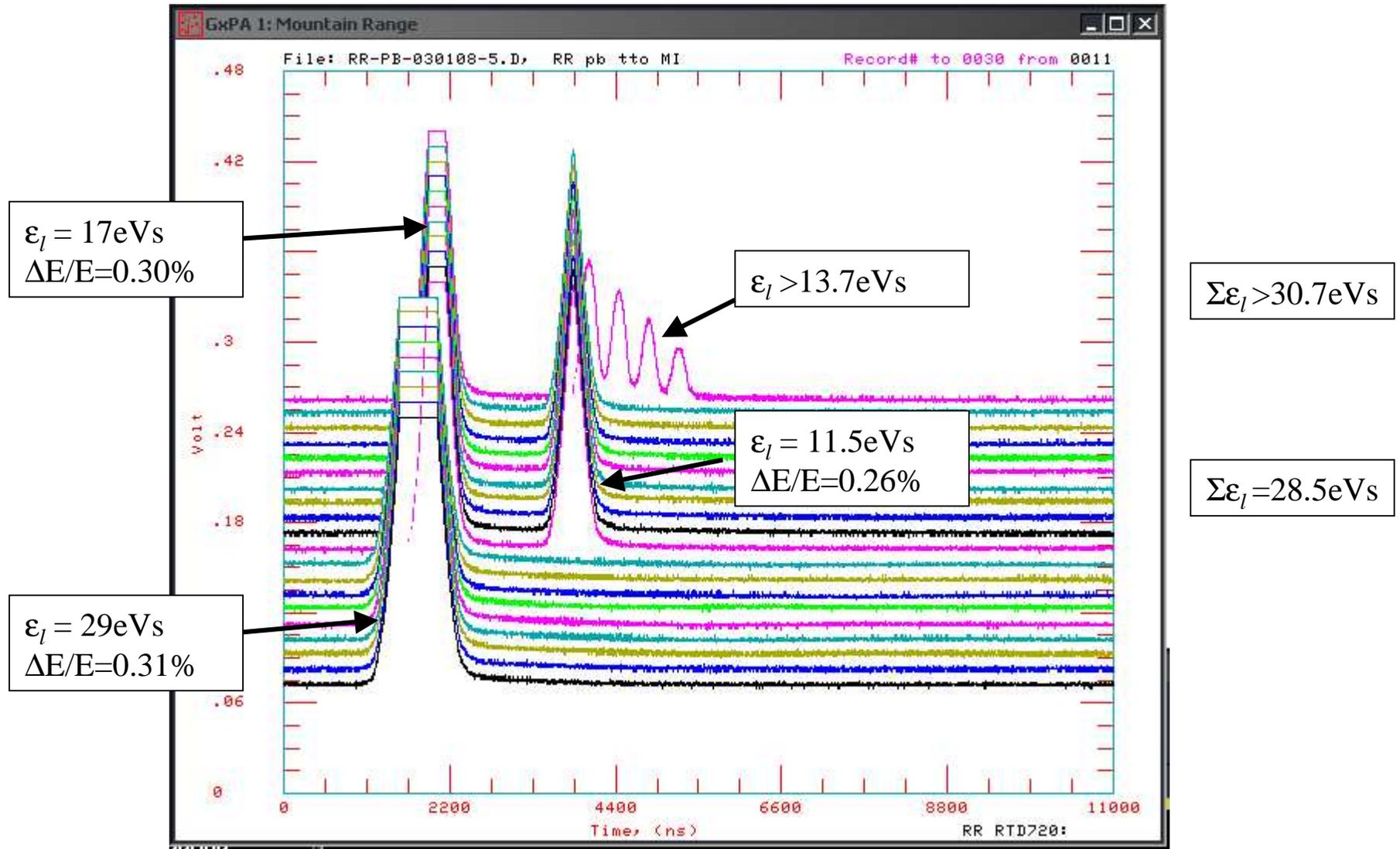
(RR→MI Transfer 4, January 8, 2003)



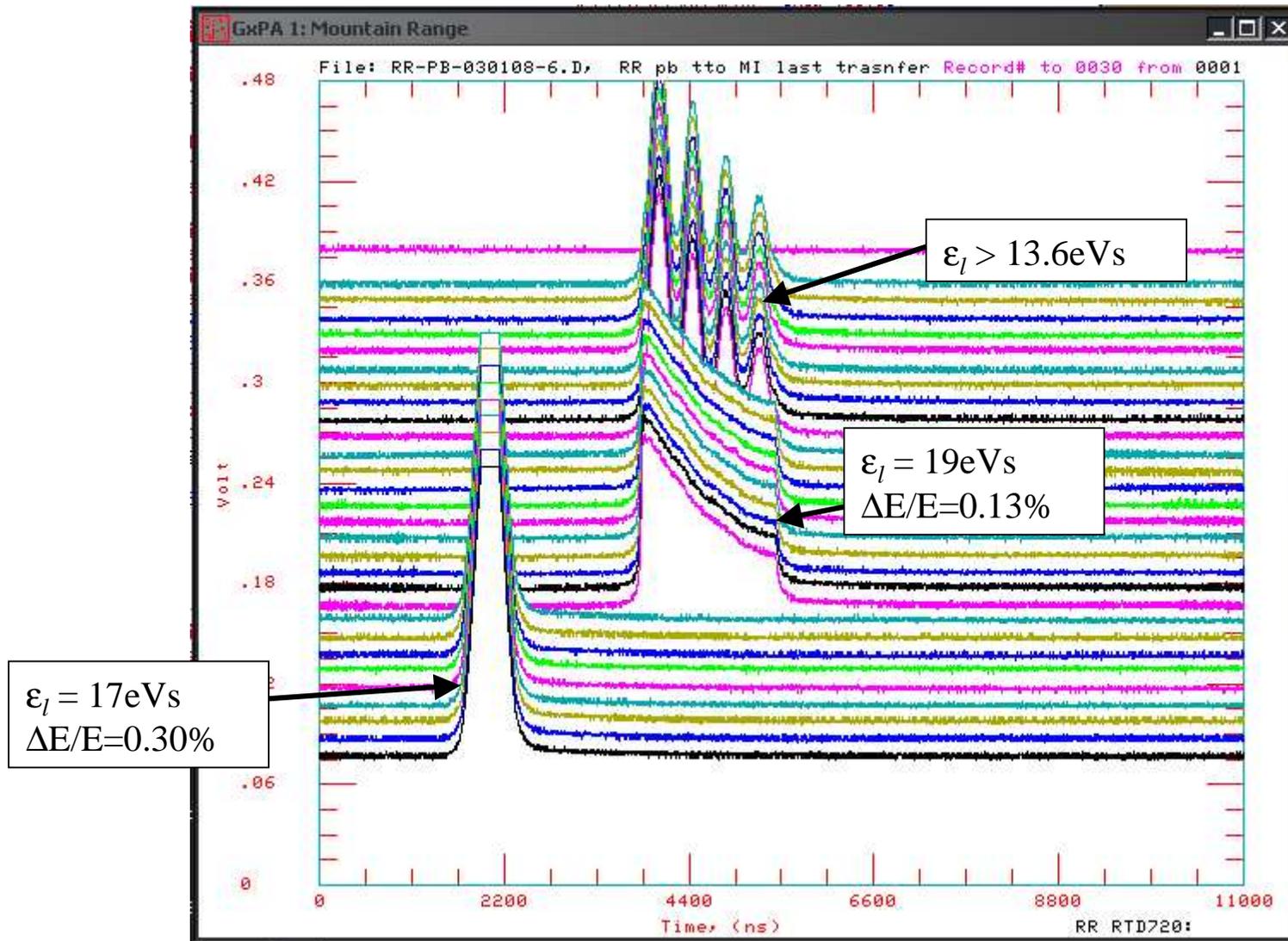
# Three Different Timing during Un-stacking



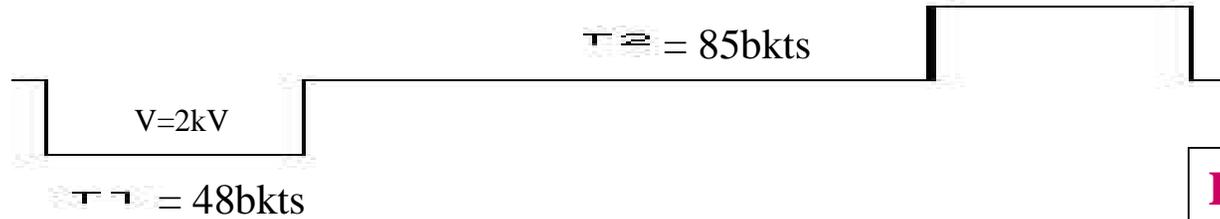
# Pbar Un-stacking (RR→MI Transfer 5, January 8, 2003)



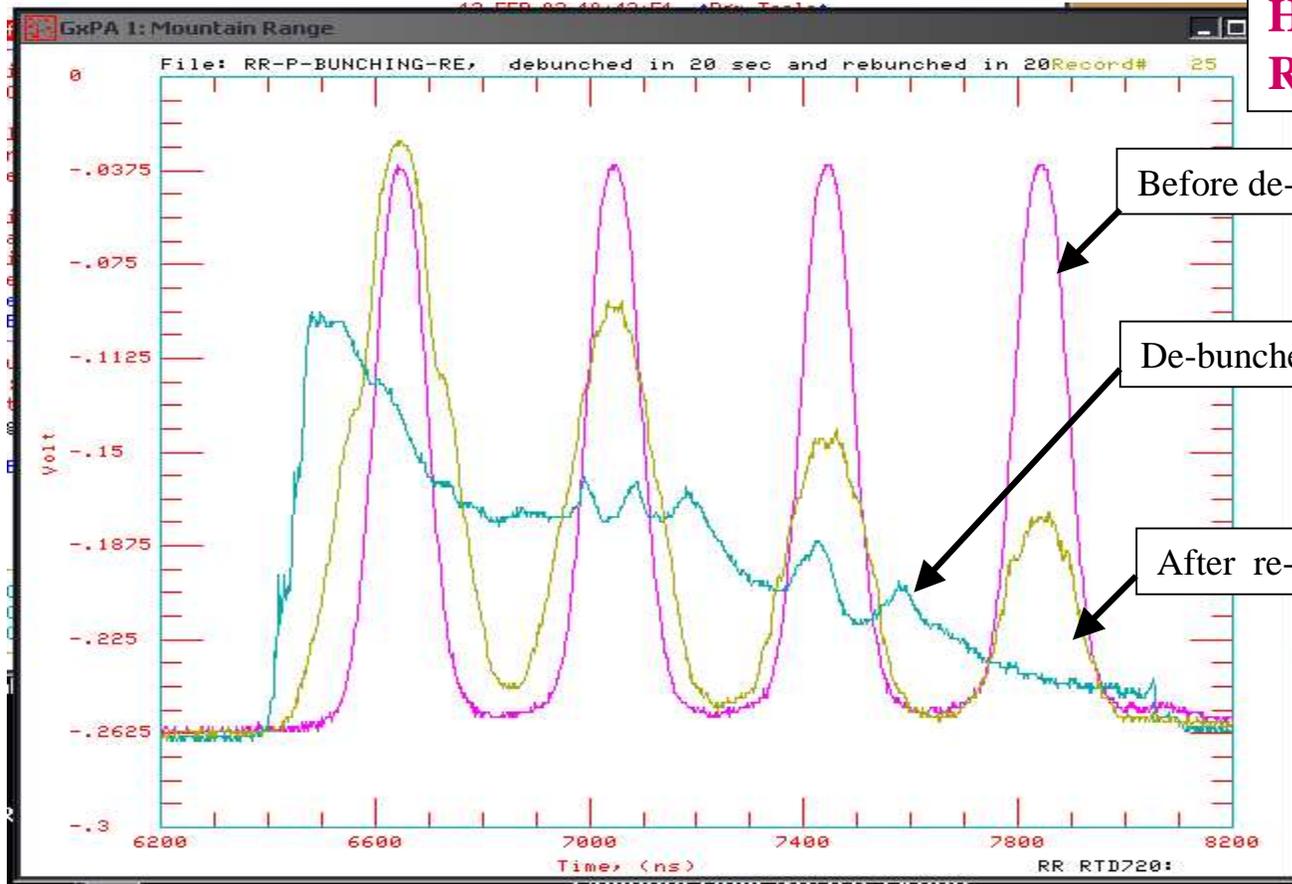
# Pbar Un-stacking (RR→MI Transfer 6, January 8, 2003)



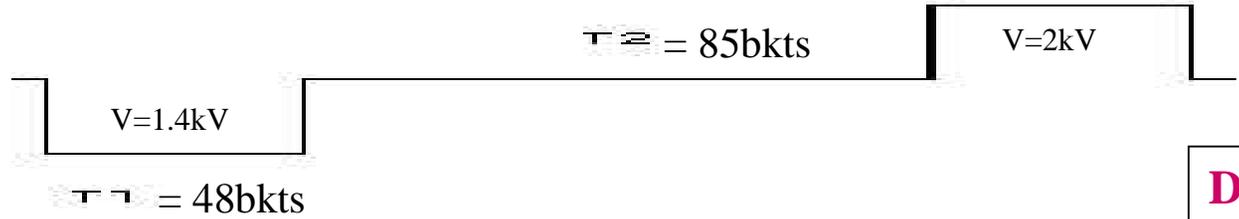
# De-bunching and Re-bunching in 2.5 MHz rf buckets



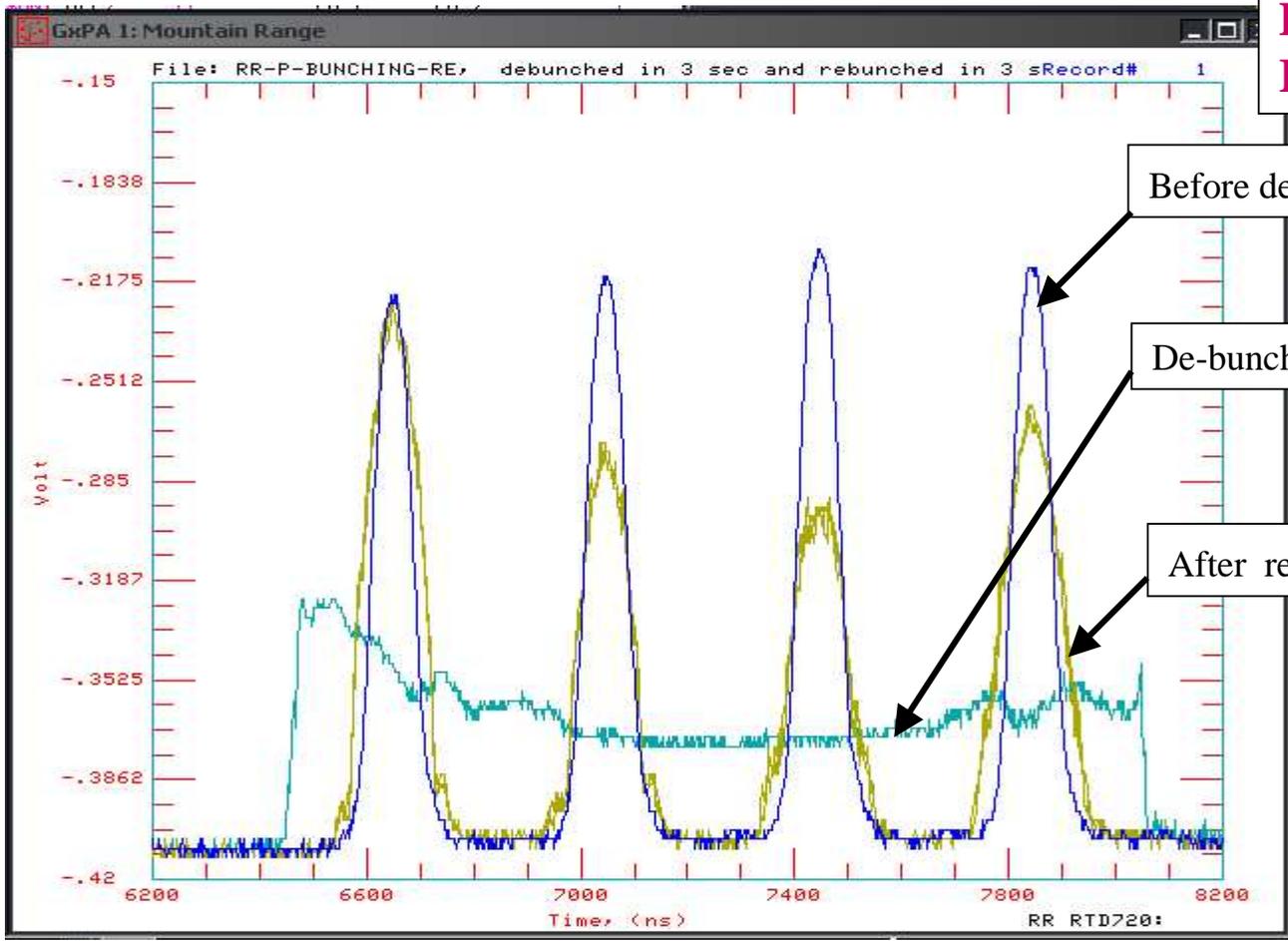
**De-bunching time = 20 sec**  
**Hold off time = 8 sec**  
**Re-bunching time = 20 sec**



# De-bunching and Re-bunching in 2.5 MHz rf buckets (continued)

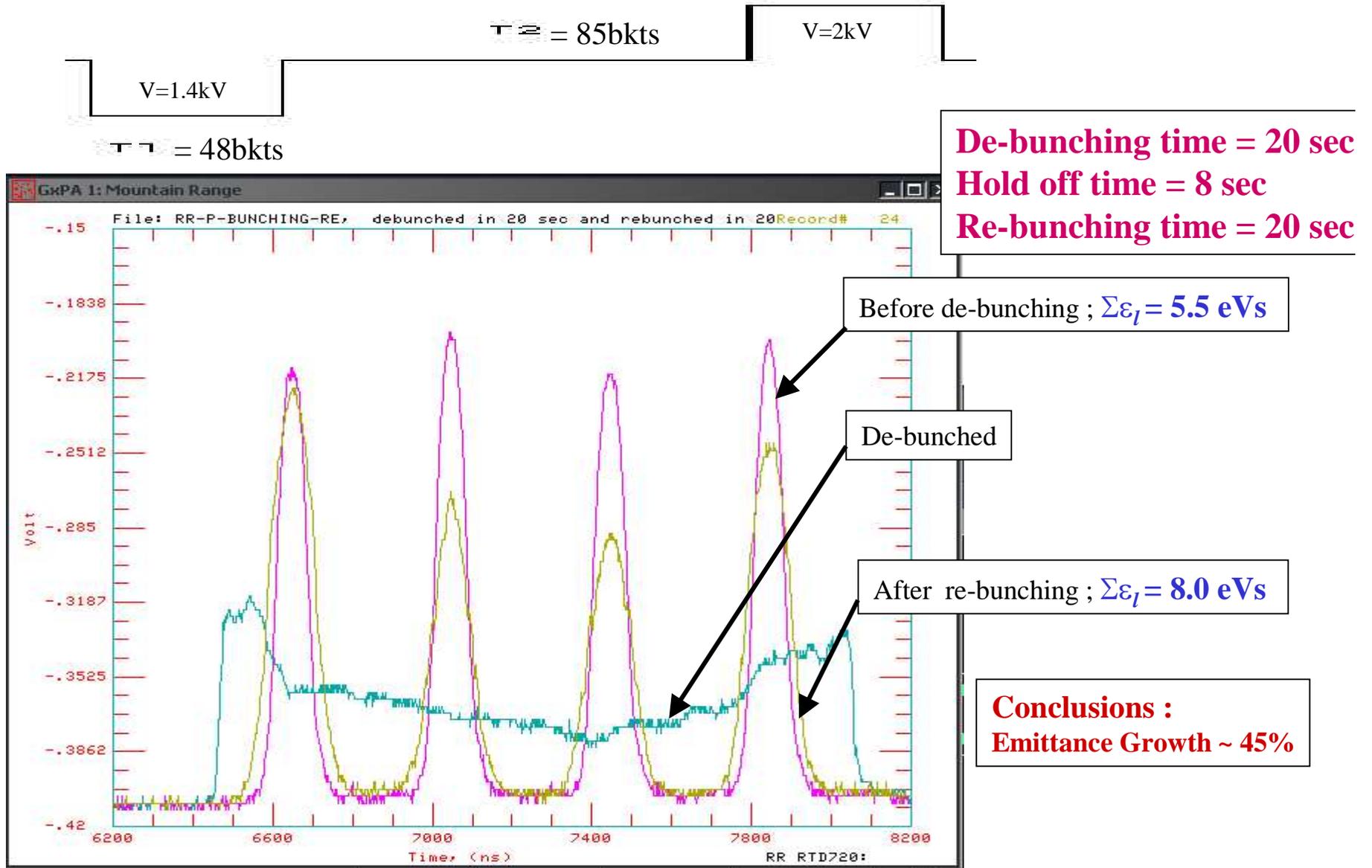


De-bunching time = 3 sec  
Hold off time = 8 sec  
Re-bunching time = 3 sec



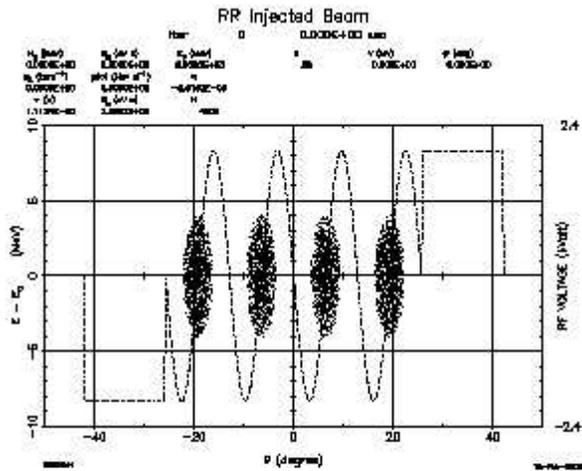
**Conclusions :**  
Emittance Growth ~30%

# De-bunching and Re-bunching in 2.5 MHz rf buckets (continued)

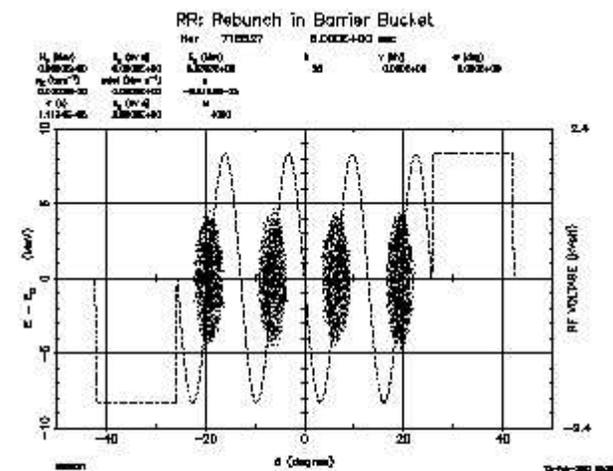


# ESME Simulations of De-bunching and Re-bunching in 2.5 MHz rf buckets

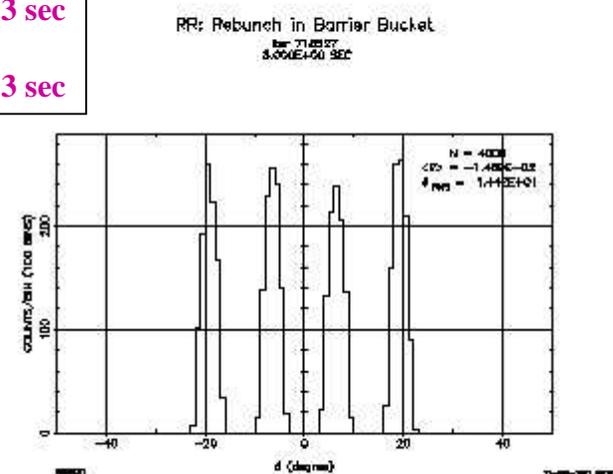
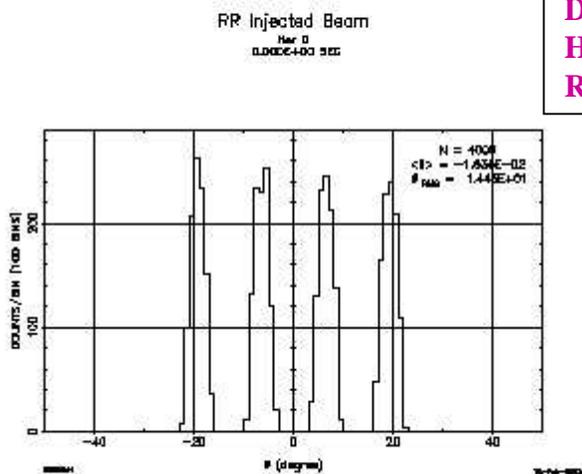
At Injection



After Re-bunching



De-bunching time = 3 sec  
 Hold of time = 2sec  
 Re-bunching time = 3 sec



## Some Issues

- The data have been analyzed using a primitive (but accurate) method. We need to automatize this. We need this information on every transfer ← This is a lots of work (we are working on it)
- By integrating the area and calibrating it with I:RBEAM we can measure beam intensity on each transfer
- We see systematic difference in emittance from sequence to sequence during stacking and un-stacking of pbars, which is indicative of emittance dilution. This needs more study. This can be done using protons
- At present the stacking and un-stacking sequences are about 100 sec long. This has impact on collider operation. We should revisit them and optimize.