

Proton and Pbar Coalescing

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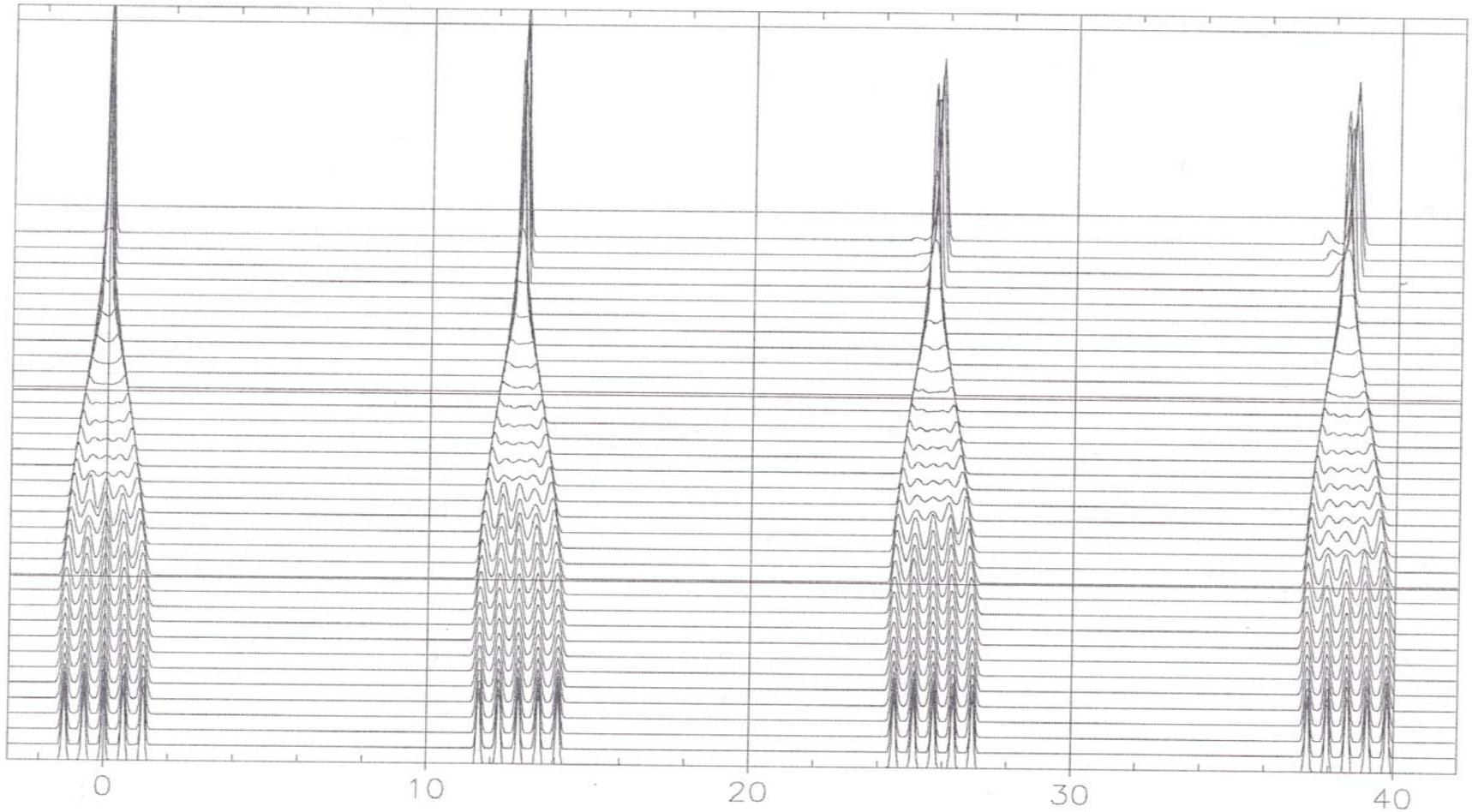
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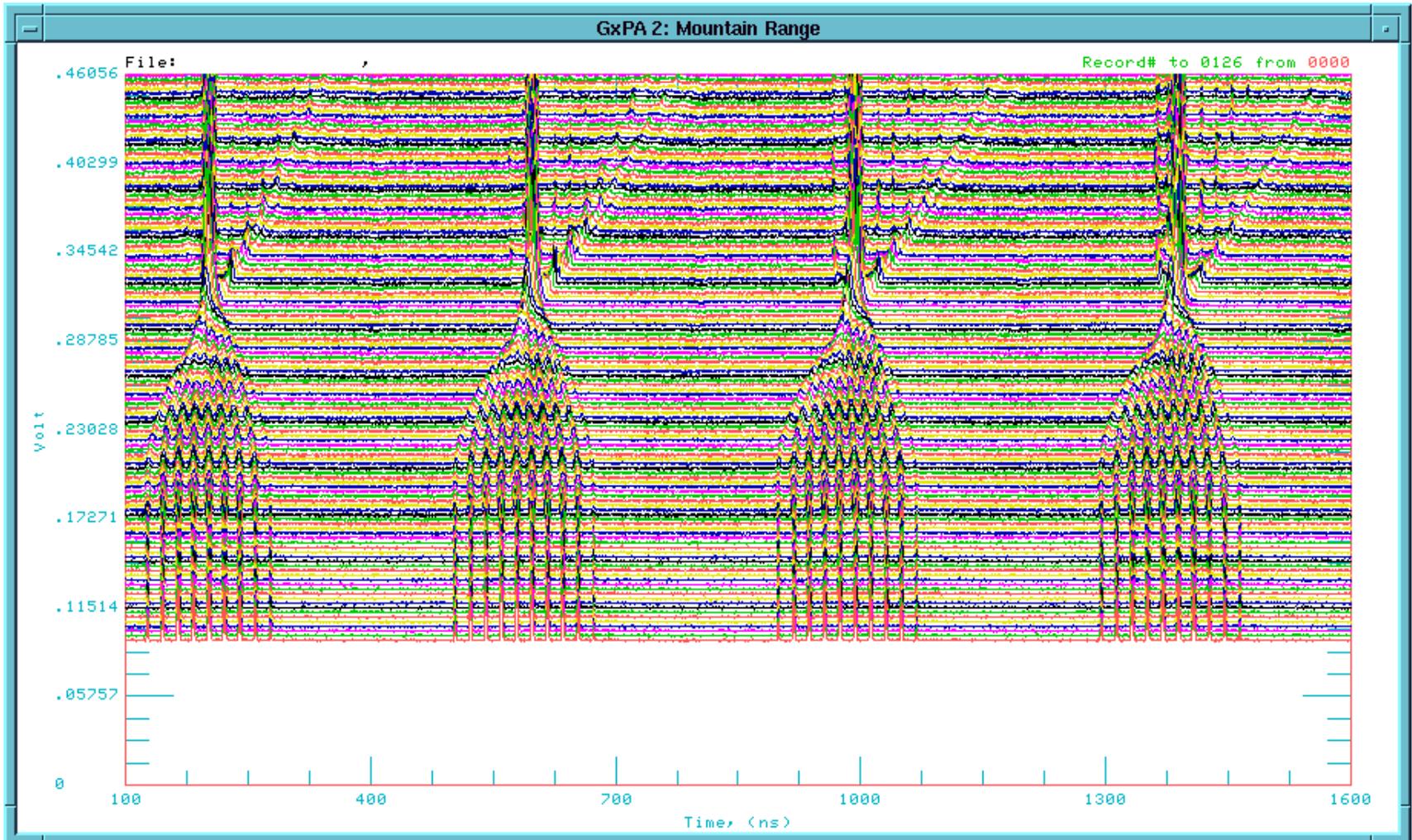
Pbar Coalescing

- ❑ Currently the average pbar Coalescing efficiency is around 86% independent of the stack size (intensity).
 - ❑ The average Coalescing efficiency at the large stacks has been increased by 10-12% with the implementation of the feed-forward beam-loading compensation.
- ❑ The average longitudinal emittance of the coalesced pbar bunches is around 2.7 eV-sec
 - ❑ No dependence of the longitudinal emittance on the position of the bunch in the train is observed.

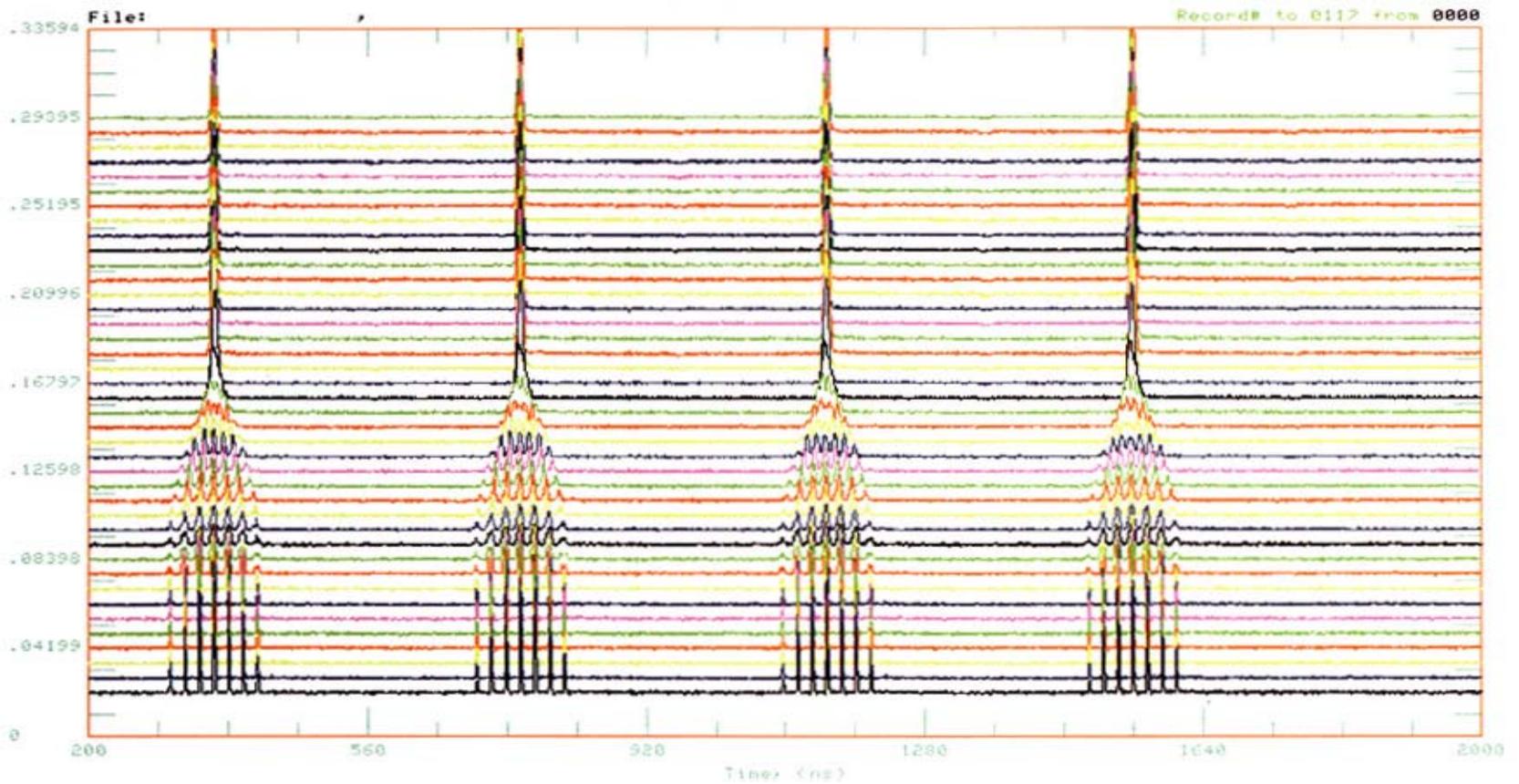
Mountain Range Picture of Pbar Coalescing (ESME Simulation)



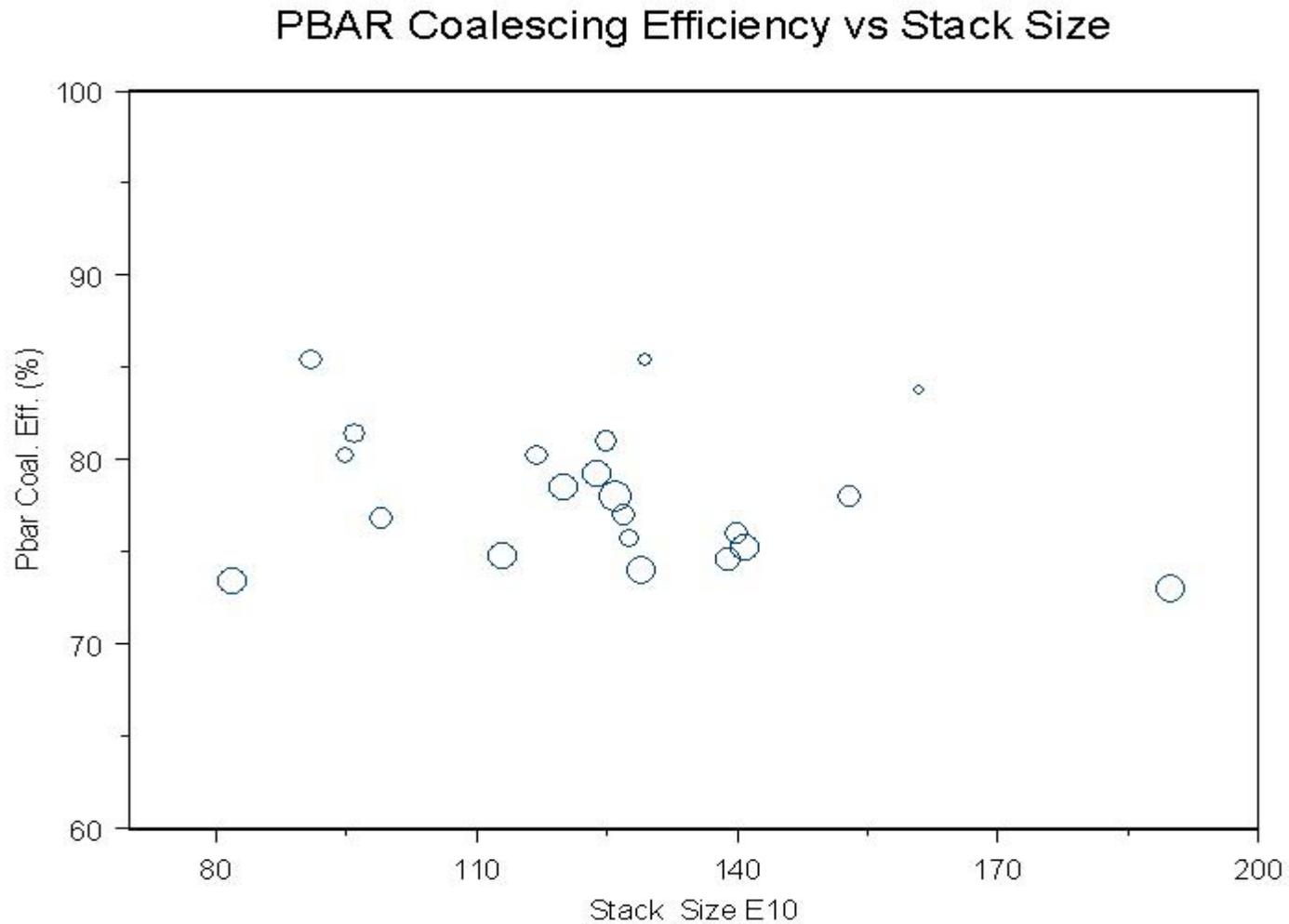
Mountain Range Picture of Pbar Coalescing without Beam Loading Compensation



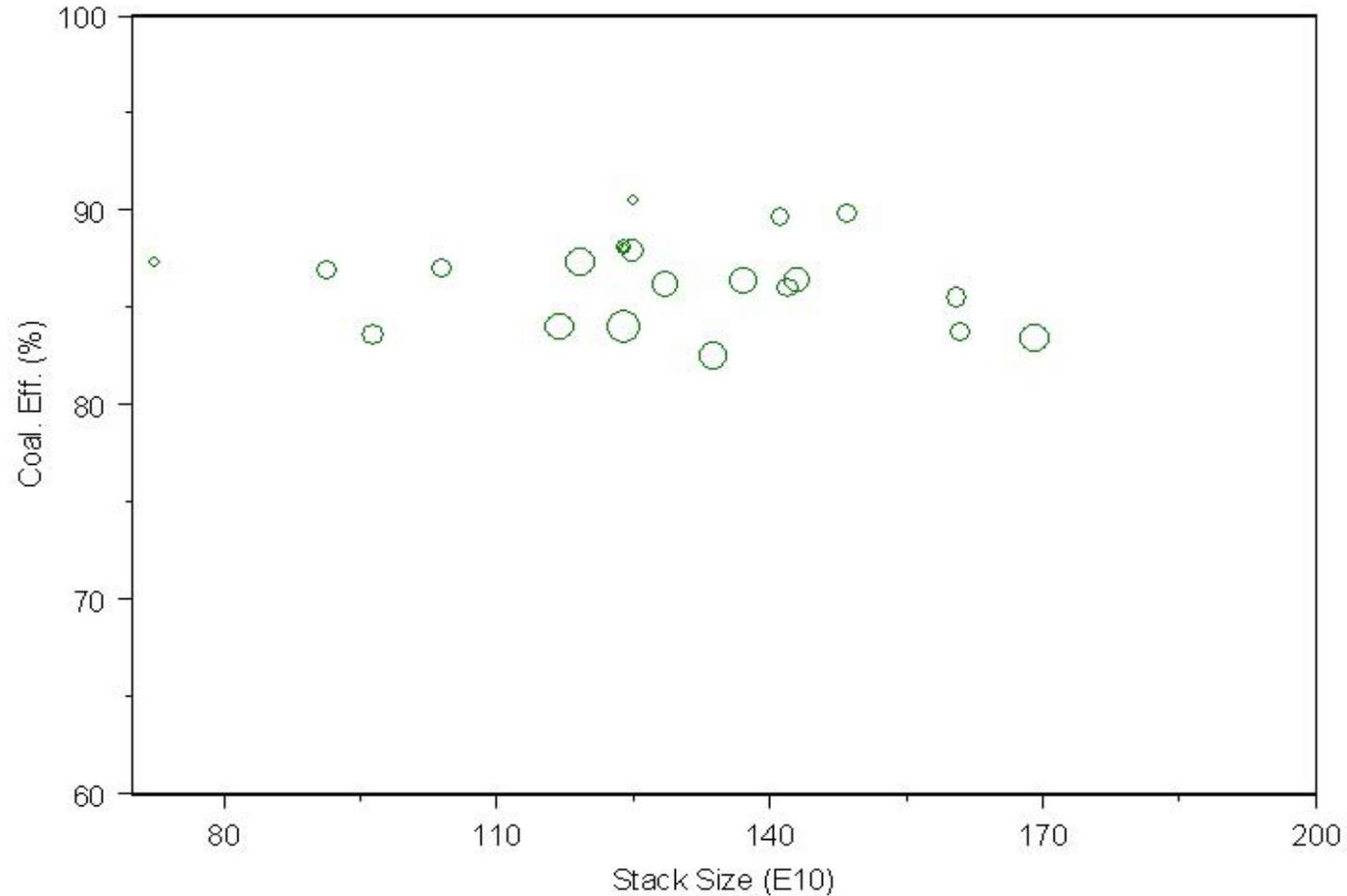
Pbar Coalescing Mountain Range Picture with Feed-forward Beam Loading Compensation



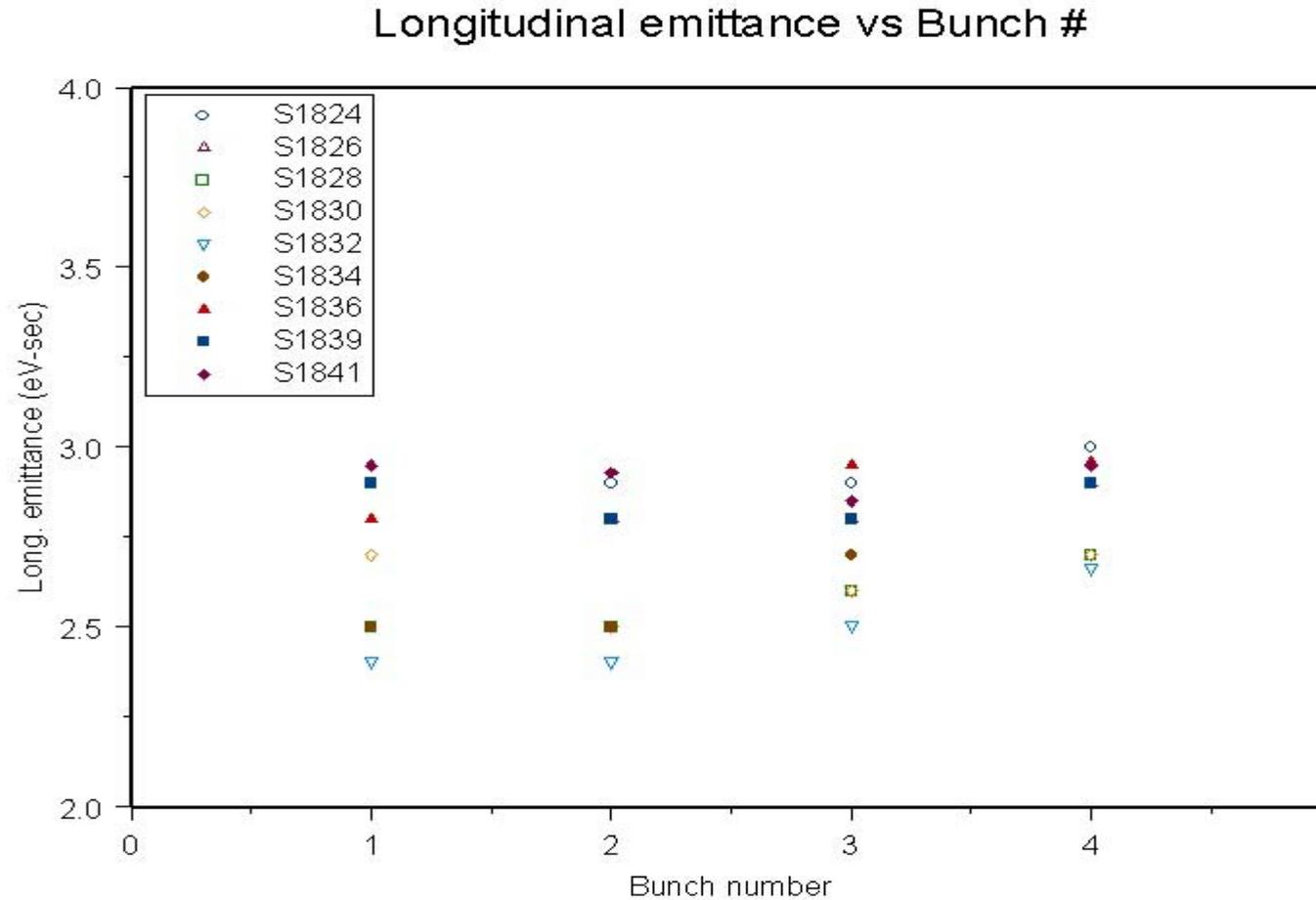
Average Pbar Coalescing Efficiency vs Stack Size without Beam-loading Compensation



Average Pbar Coalescing Efficiency vs Stack Size with Feed-Forward Beam Loading Compensation



Pbar Coalescing Efficiency vs Bunch Number with Feed-Forward Beam-loading Compensation



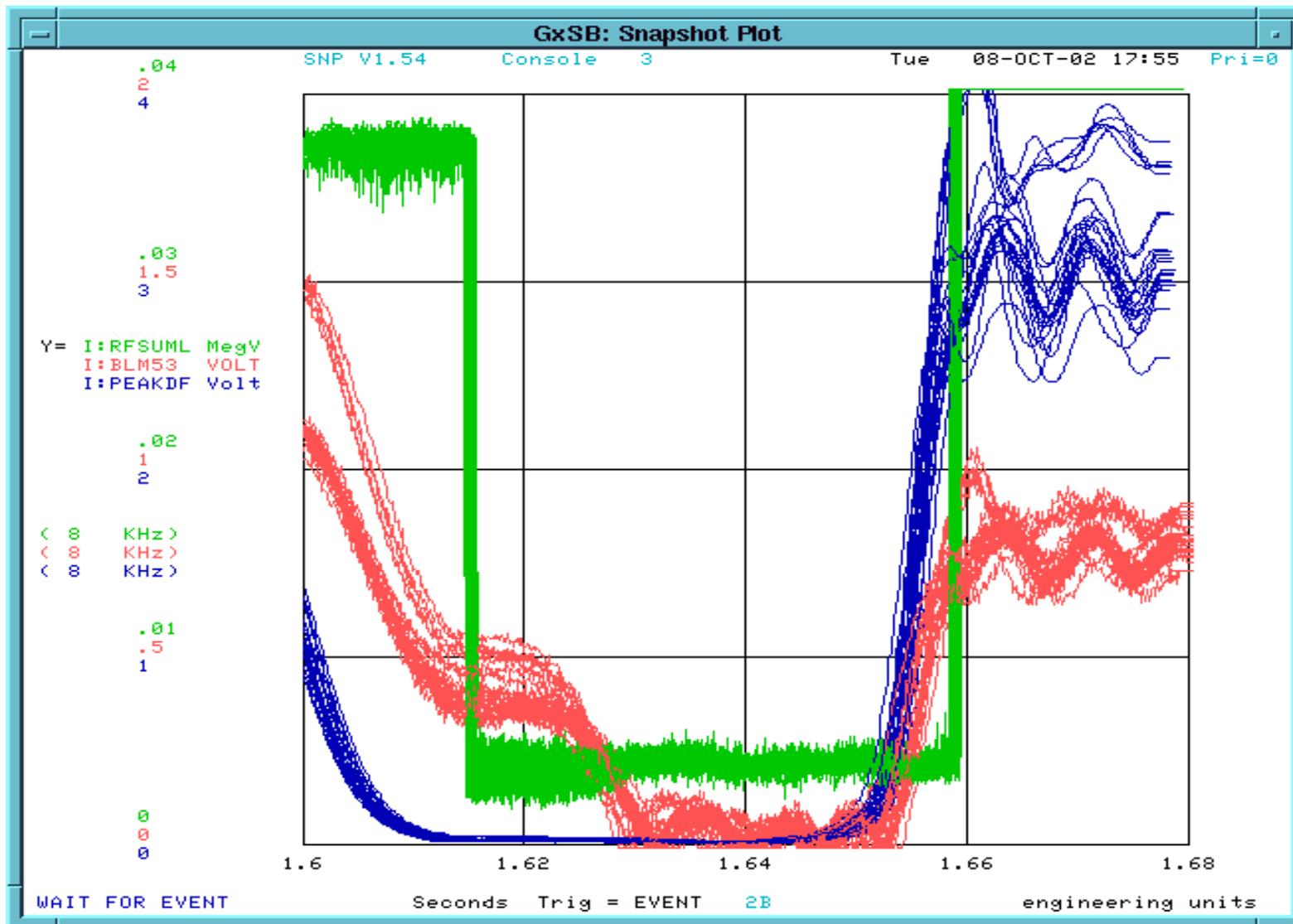
Further improve the Pbar Coalescing efficiency

- ❑ Understand and reduce (eliminate) any longitudinal emittance blow-up before coalescing.
 - ❑ Verify and correct the SPD long. emittance calculations.
 - ❑ Retune injection and transition
 - ❑ Optimize the gain and curves of the feedback loops
- ❑ Further optimize coalescing
 - ❑ Optimize the first rotation (rotation voltage , second harmonic)
 - ❑ Optimize the 2.5 MHz voltage and the 5 MHz amplitude and phase.

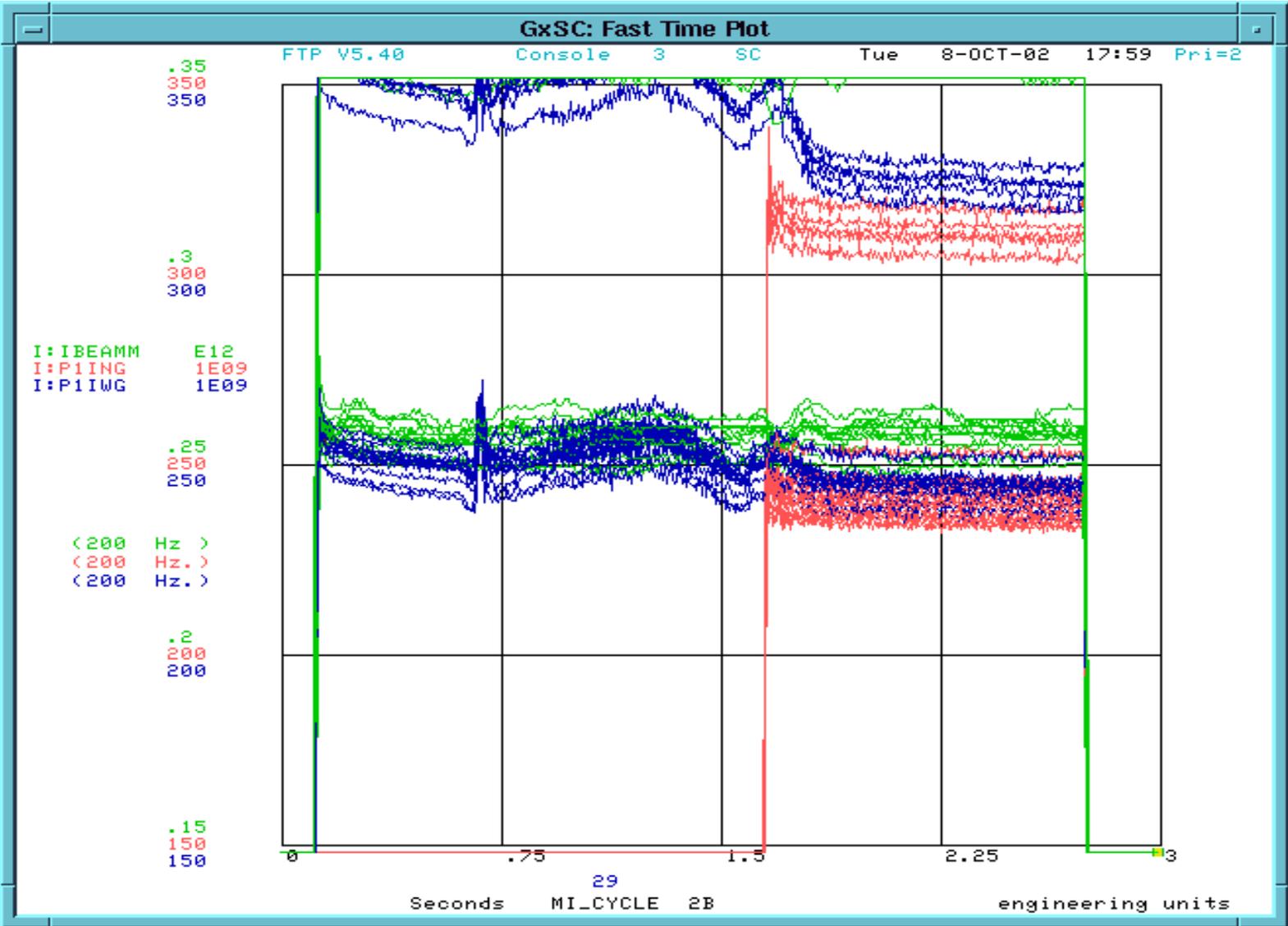
Proton Coalescing

- ❑ Currently we are coalescing 5-7 proton bunches using only the 2.5 MHz lower harmonic.
- ❑ The coalesced bunch intensities vary from $240E9$ ppb for 5 bunch coalescing to $300E9$ ppb for 7 bunch coalescing. The coalesced bunch long. emittances vary from 2.2 eV-sec to 3.2 eV-sec (SBD calculation) or 2.9 to 4.0 eV-sec (Gaussian fit). Typical longitudinal emittances before coalescing are around 0.3 eV-sec (0.35 eV-sec Gaussian fit).
- ❑ For 5 bunch coalescing the coalescing efficiency is 92% with less than 1% in satellite bunches and about 8% in DC beam.
- ❑ For 7 bunch coalescing the coalescing efficiency is 85% with 3% in satellite bunches and 12% in DC beam.
- ❑ Reducing the longitudinal emittance of the bunches before coalescing will improve both the coalescing efficiency and the longitudinal emittance of the coalesced bunches.
- ❑ Proton coalescing has been very reliable.

Proton Coalescing



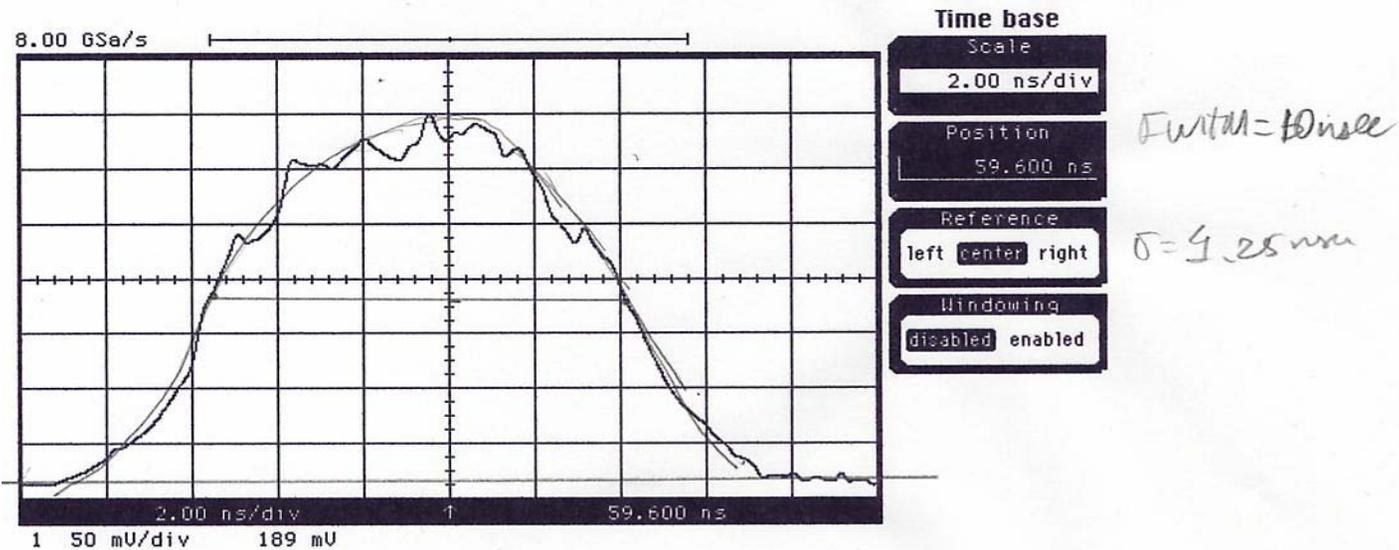
Proton Coalescing



Bunch profile for 7 Bunch Coalescing

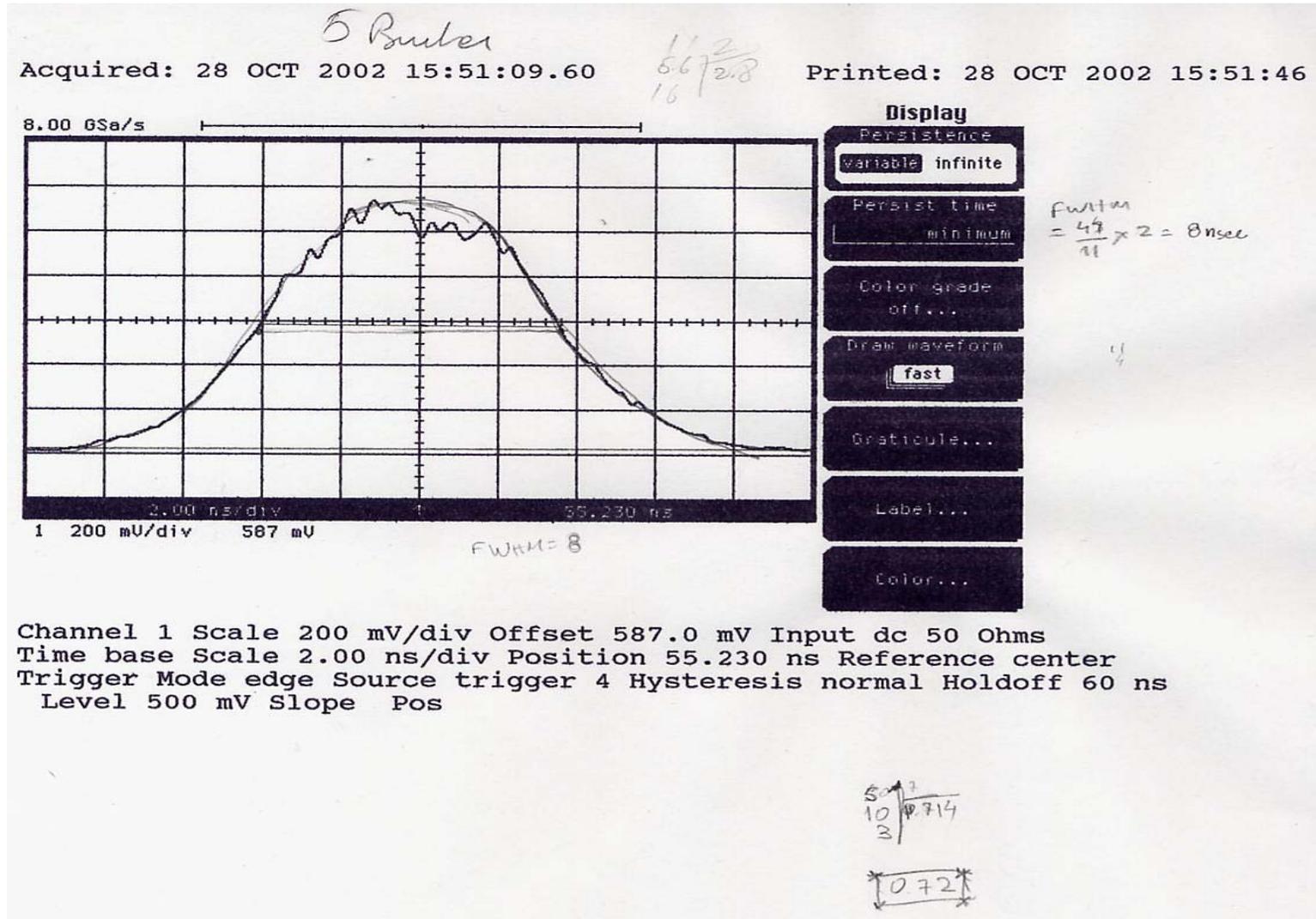
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Printed: 23 OCT 2002 17:05:52



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Time base Scale 2.00 ns/div Position 59.600 ns Reference center
Trigger Mode edge Source trigger 4 Hysteresis normal Holdoff 60 ns
Level 500 mV Slope Pos

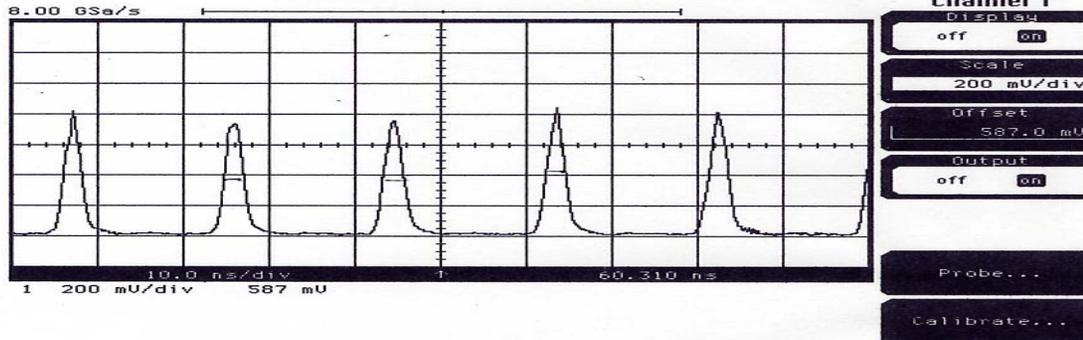
Bunch Profile for 5 Bunch Coalescing



Proton Bunches before Coalescing

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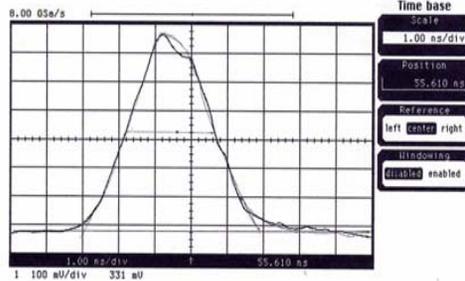
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Channel 1 Scale 200 mV/div Offset 587.0 mV Input dc 50 Ohms
 Time base Scale 10.0 ns/div Position 60.310 ns Reference center
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 Level 500 mV Slope Pos

Before Coalescing
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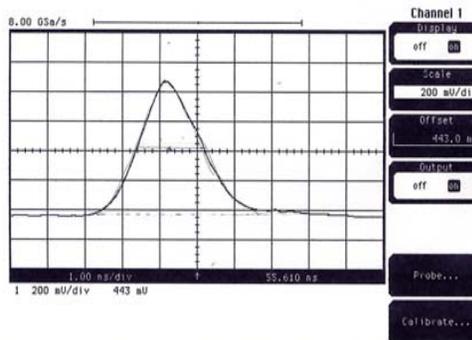
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 Level 500 mV Slope Pos

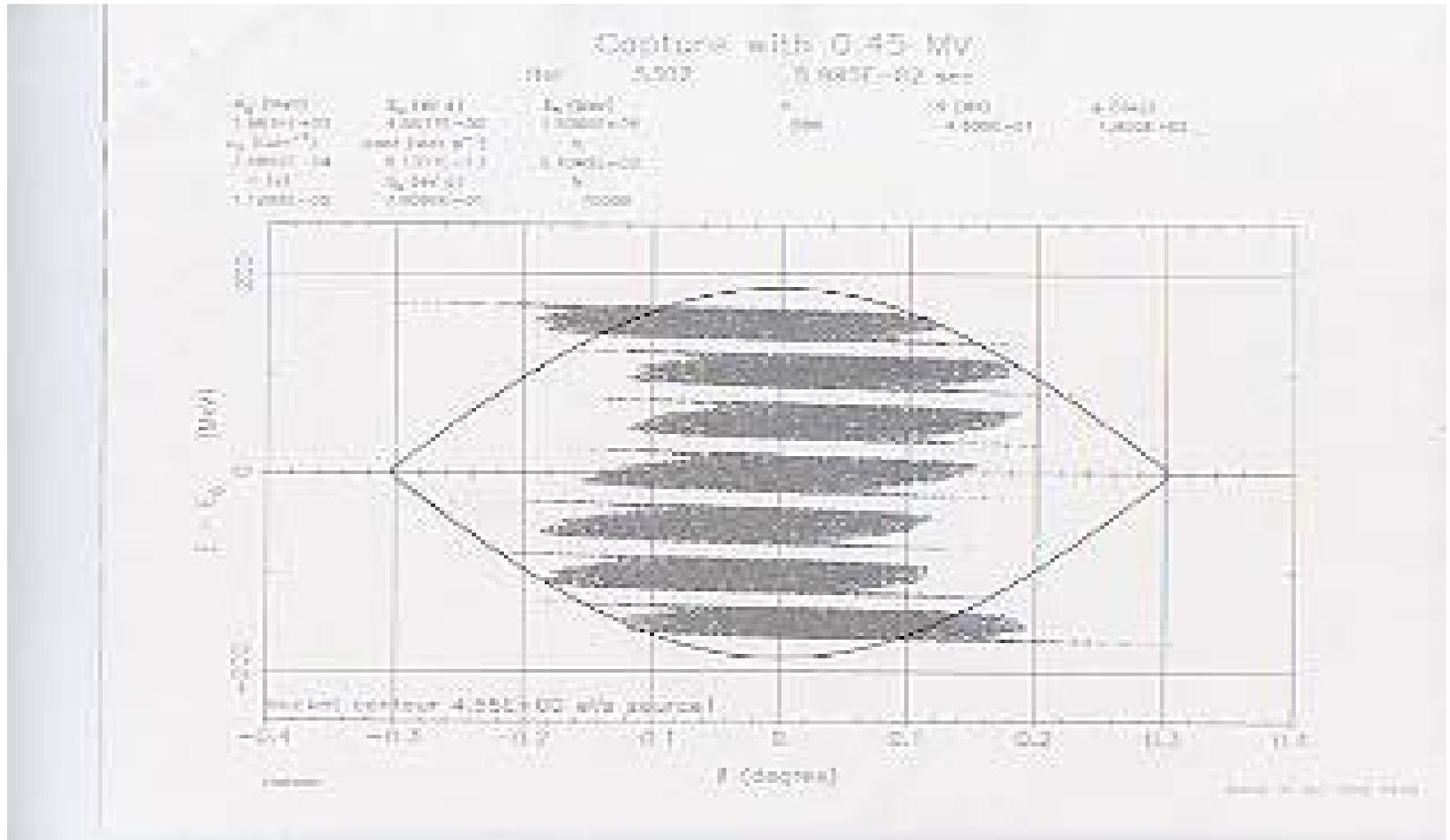
Before Coalescing
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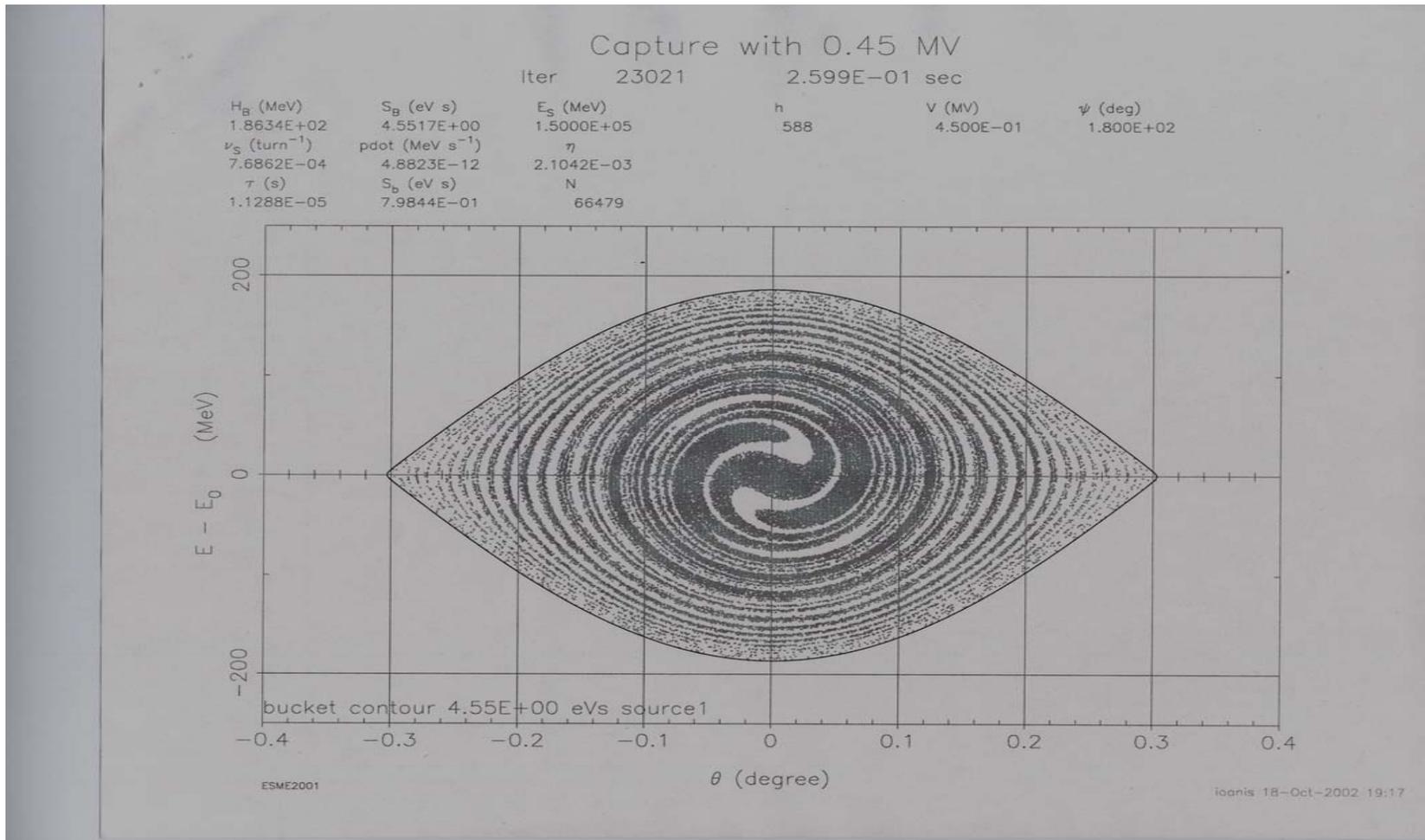


Channel 1 Scale 200 mV/div Offset 443.0 mV Input dc 50 Ohms
 Time base Scale 1.00 ns/div Position 55.610 ns Reference center

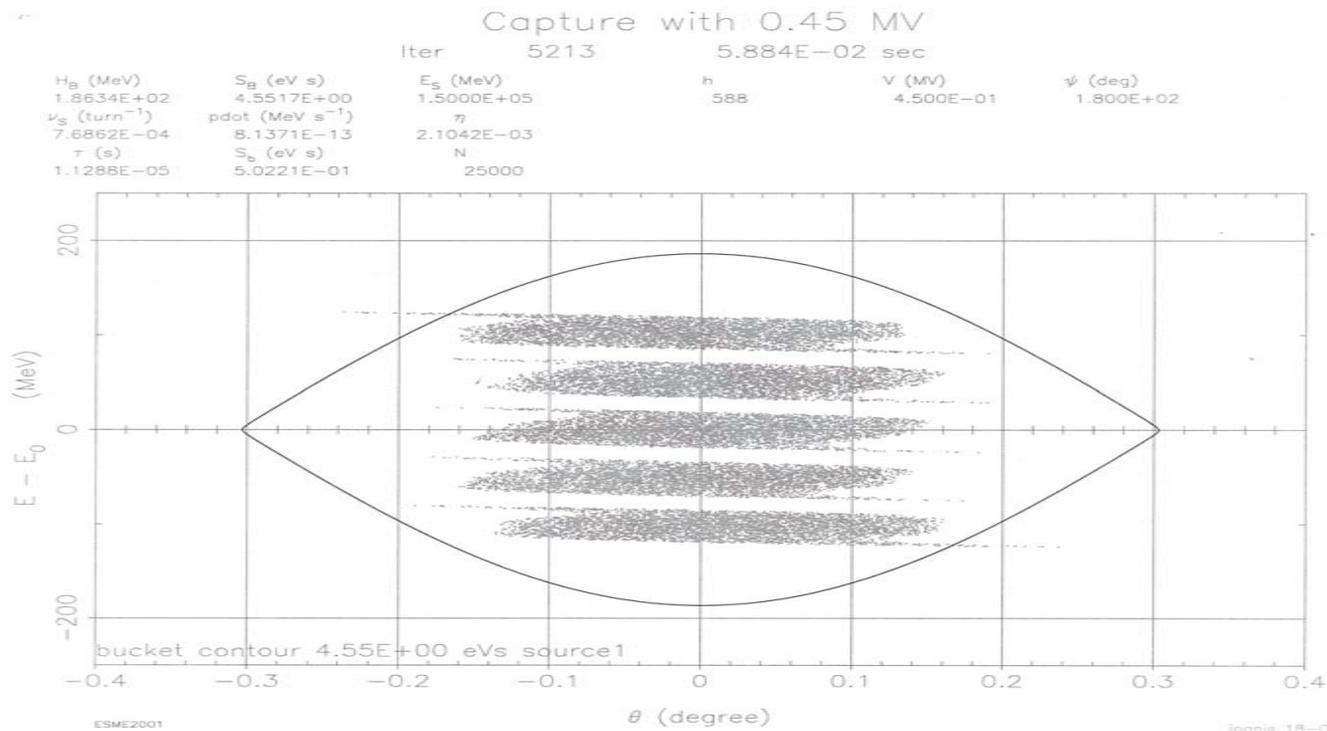
ESME Simulation of 7 Bunch Coalescing



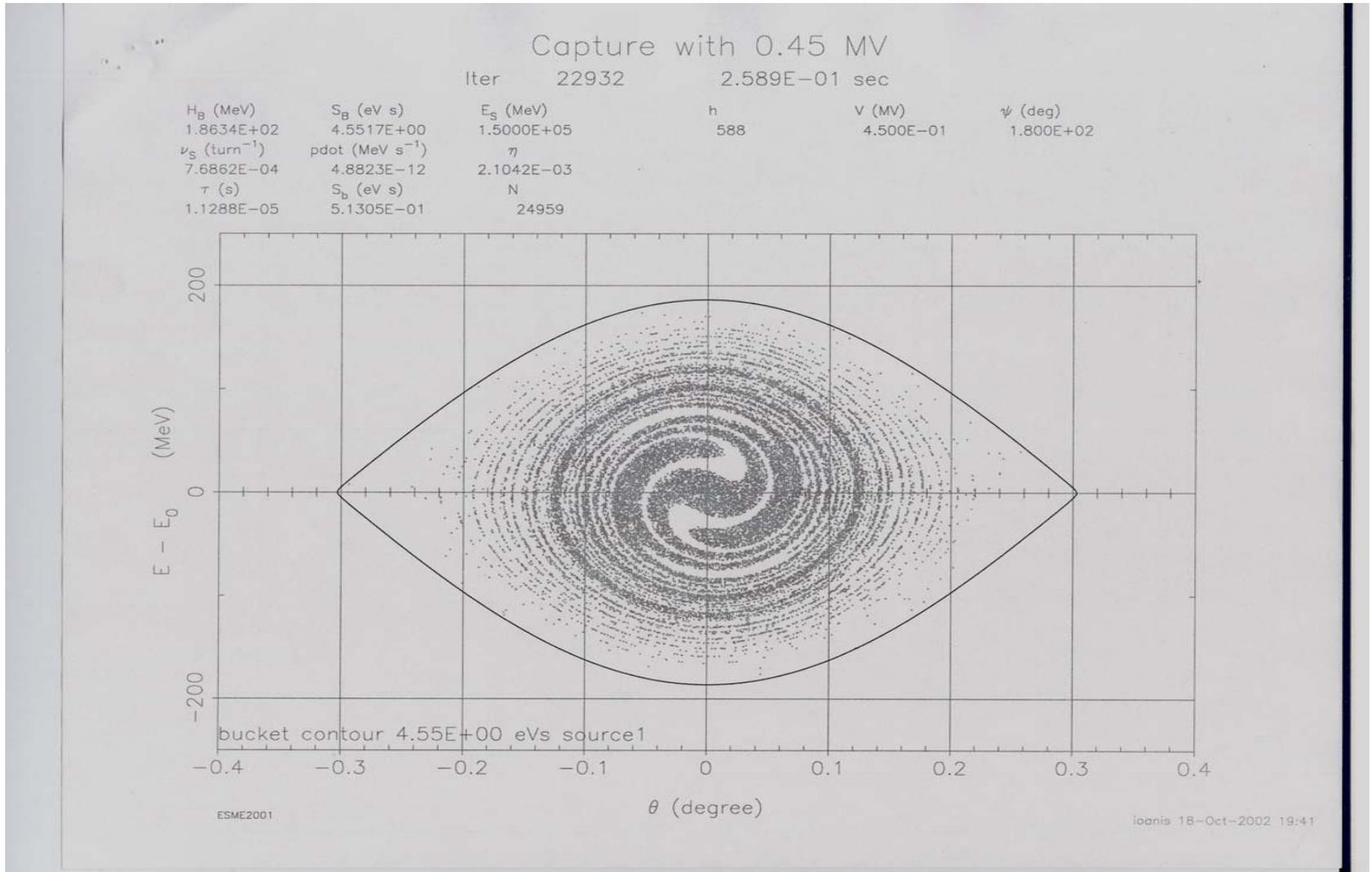
ESME Simulation of 7 Bunch Coalescing (2)



ESME Simulation of 5 Bunch Coalescing



ESME Simulation of 5 Bunch Coalescing (2)



53 MHz detector during 5 Bunch Coalescing

