



Momentum Mining in the Recycler

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All Experimenters Meeting
November 22, 2004

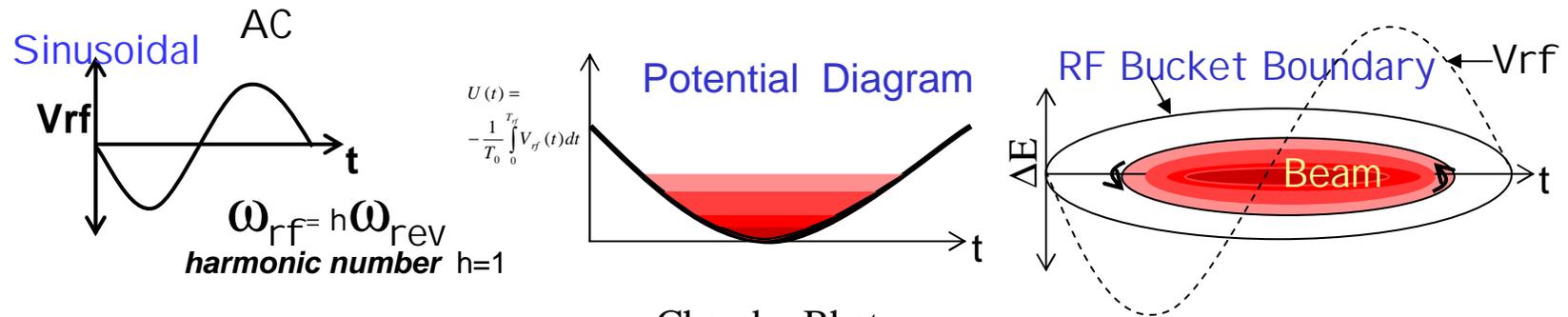
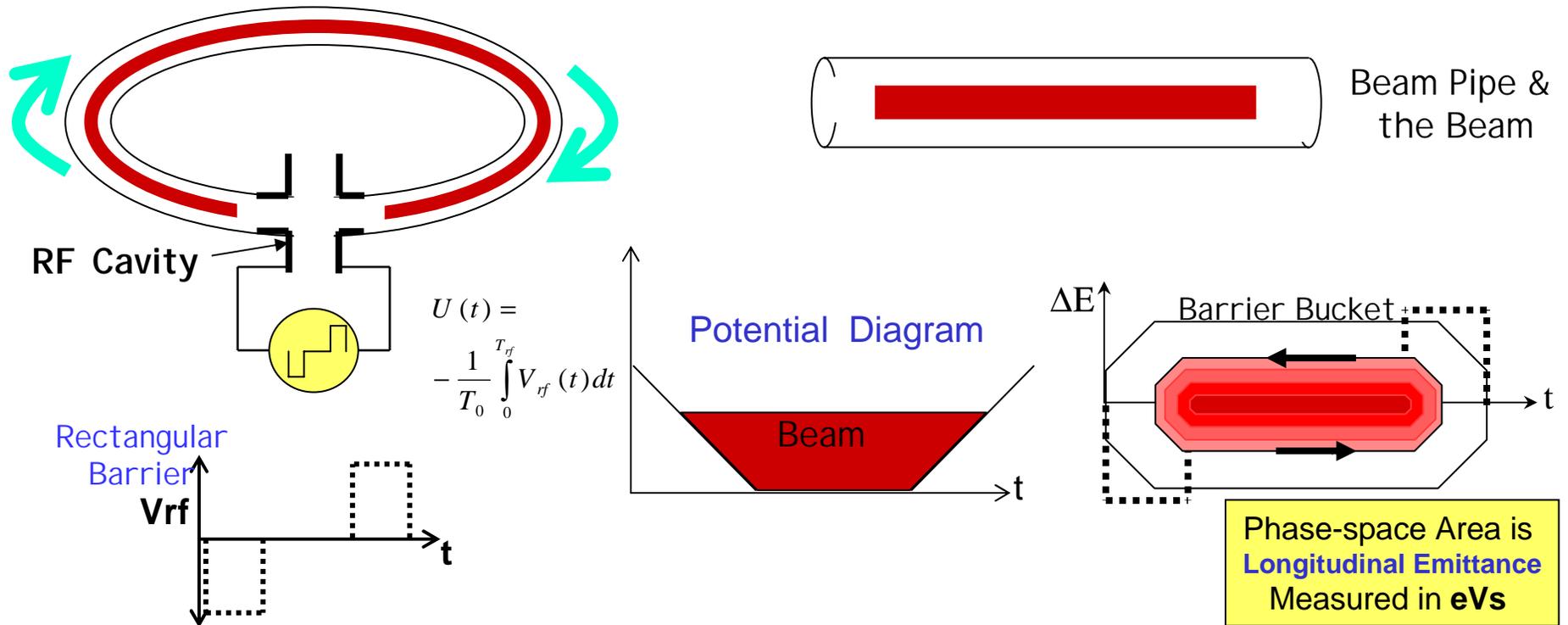
B. Chase, P. Joireman, (RF group),
C. Gattuso (Recycler Group)



Basics of an RF Bucket



Bunched Beam with Energy $E_0 \pm \Delta E$

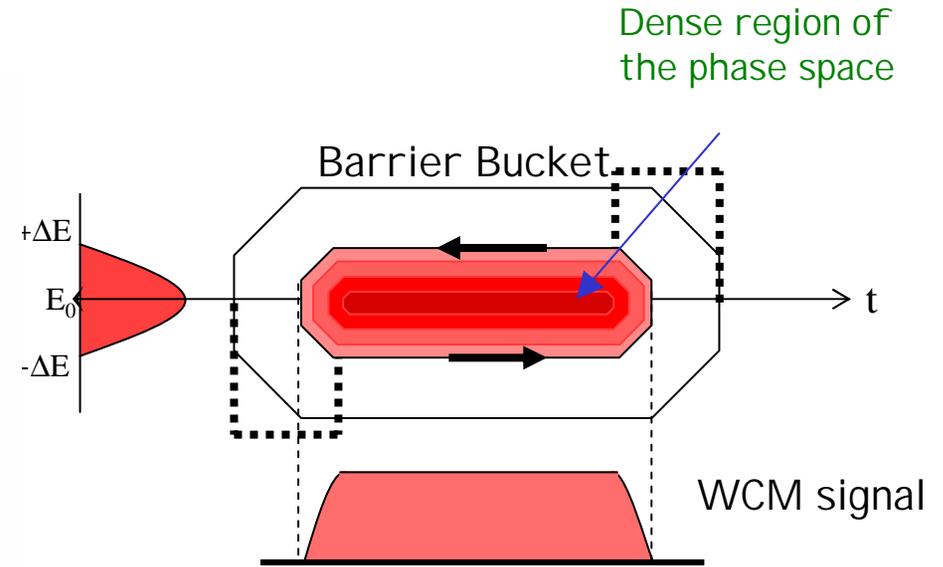
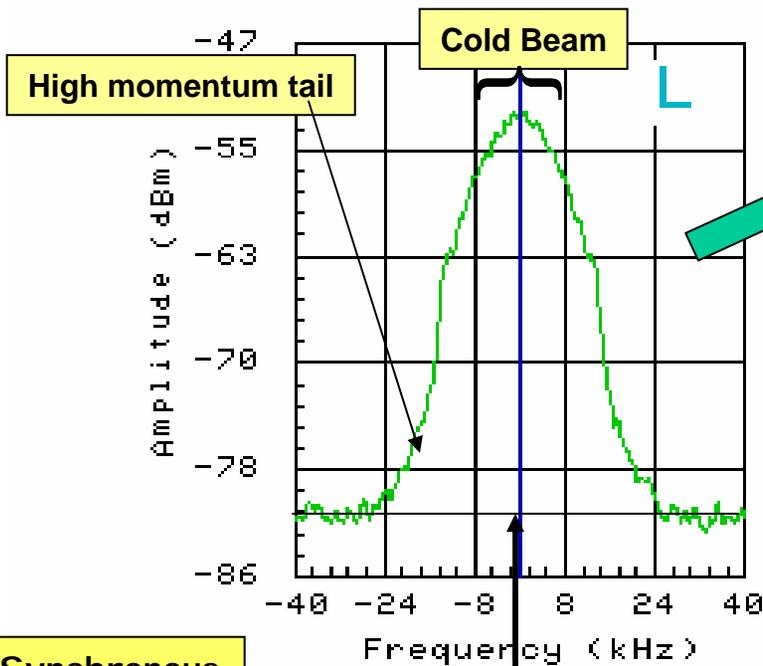




Momentum Mining



Frequency (Energy)
Spectrum of the Recycler Beam



Is it possible to **isolate** the **cold beam** from the high momentum tail of a beam distribution without emittance growth and use only the cold beam and use the leftover hot beam after further cooling?

Synchronous Particles

$F_{rev} = 89812.078$ Hz
 $D_p(\text{sig}) = 3.2$ MeV/c
 $D_p(90\%) = 10.6$ MeV/c



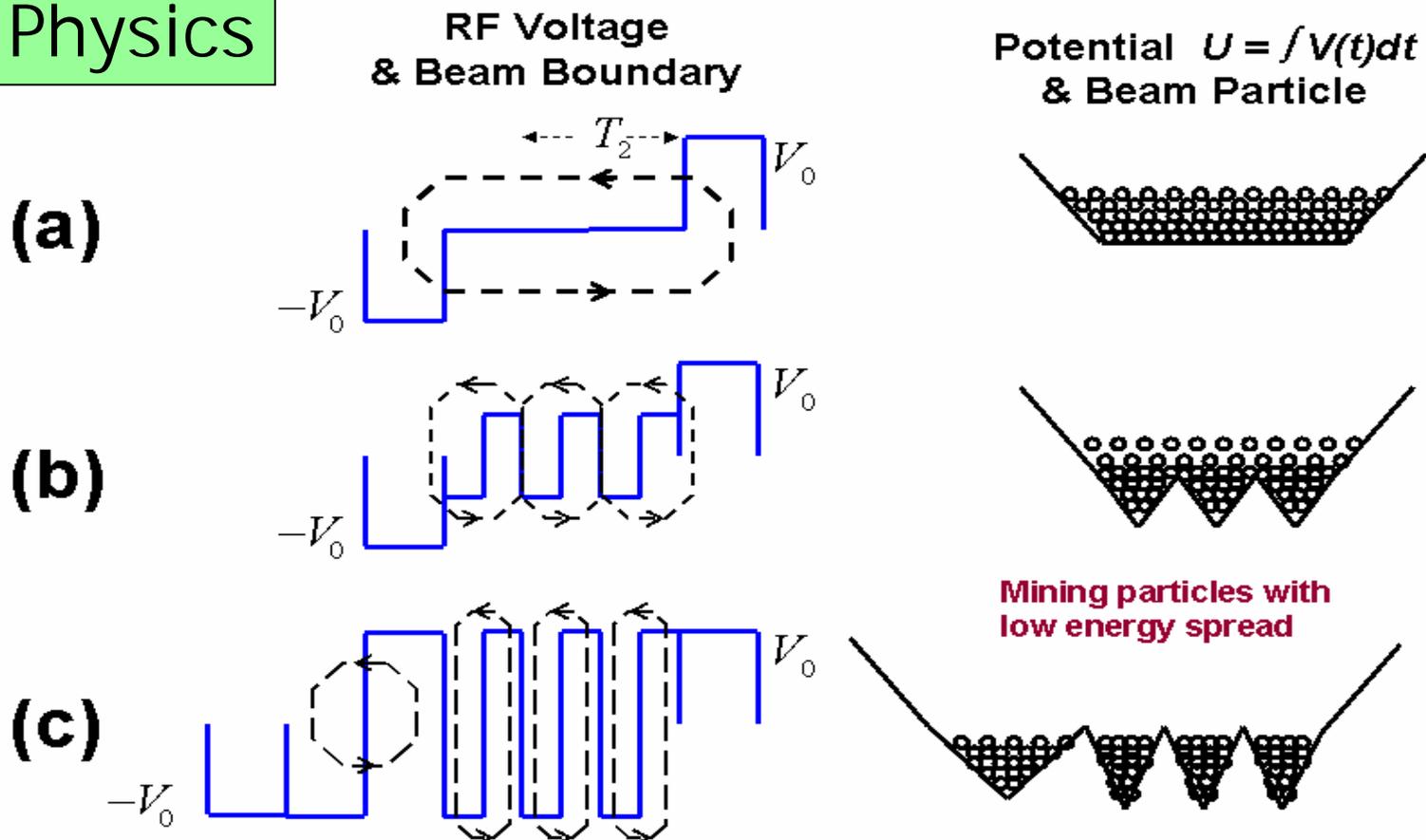
Longitudinal Momentum Mining in a Synchrotron



New Technique

Ref: C. M. Bhat, Phys. Lett. A 330 (2004) 481

Physics

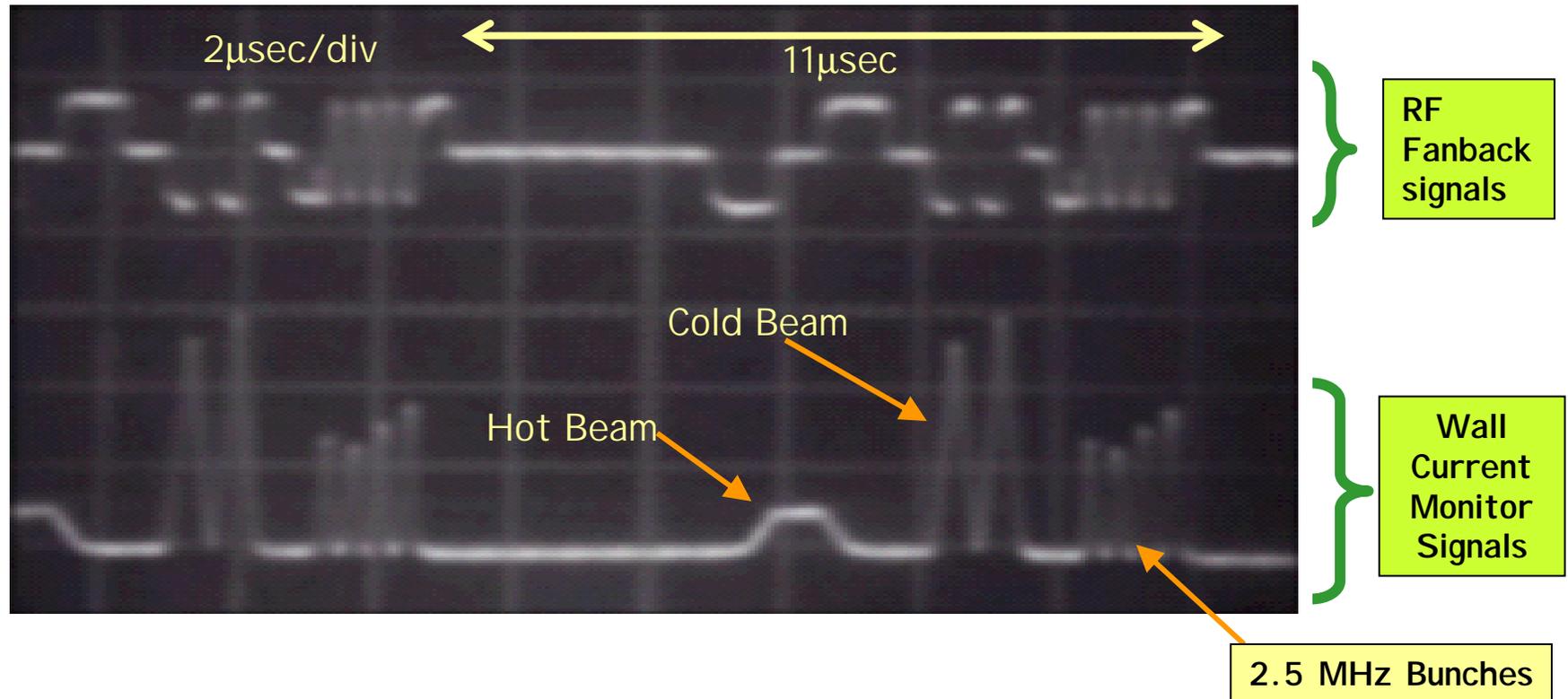


Technique is applicable to any storage ring for beam mining

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Momentum Mining for Tevatron Collider Shots

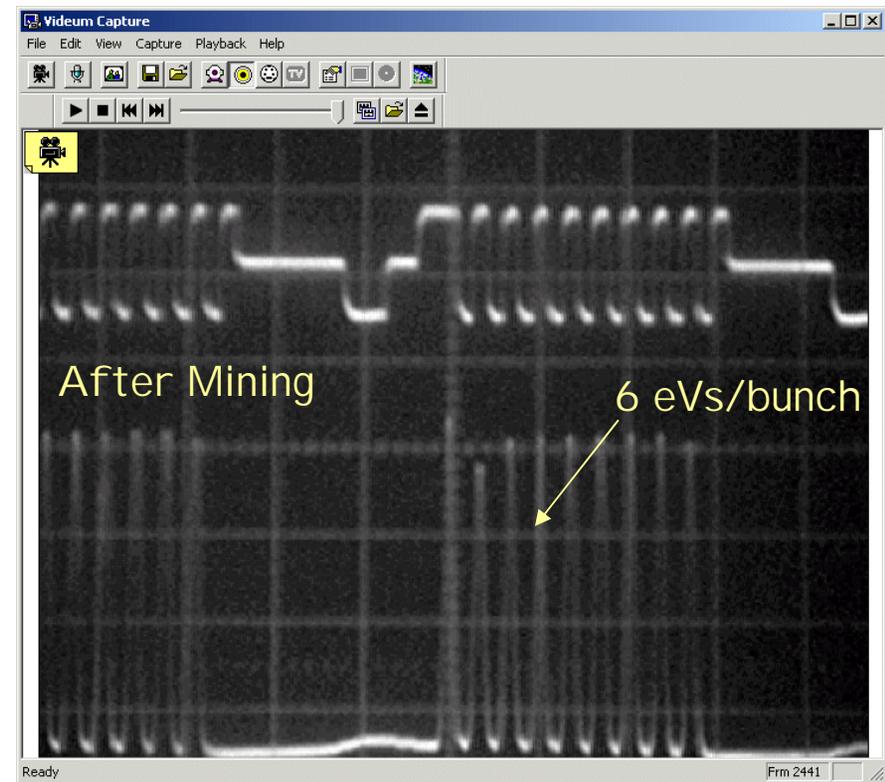
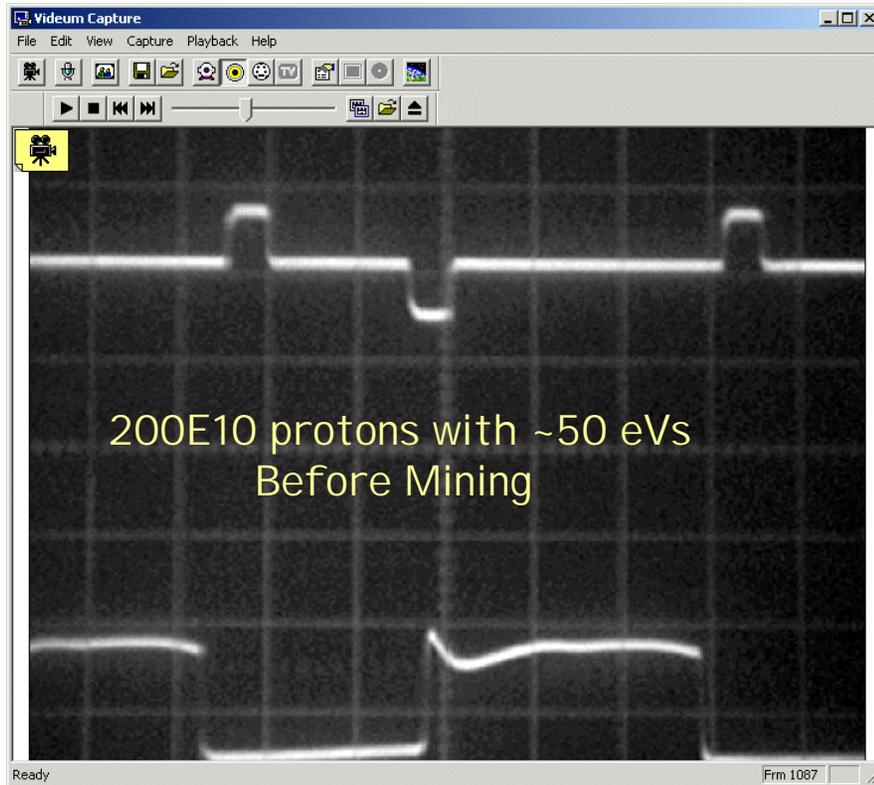


We have successfully implemented longitudinal momentum mining in the Recycler to inject equal emittance, equal intensity pbars bunches for Tevatron shots.

The **Longitudinal Momentum Mining** scheme is $\sim 2x$ more efficient than the "beam slicing scheme"



Mining of ~ 50 eVs (95%) beam for 9-transfers

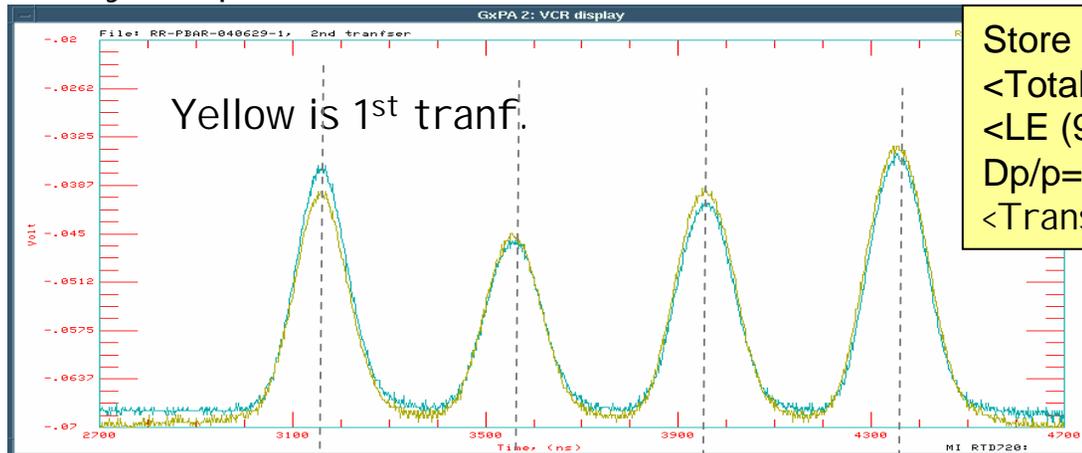




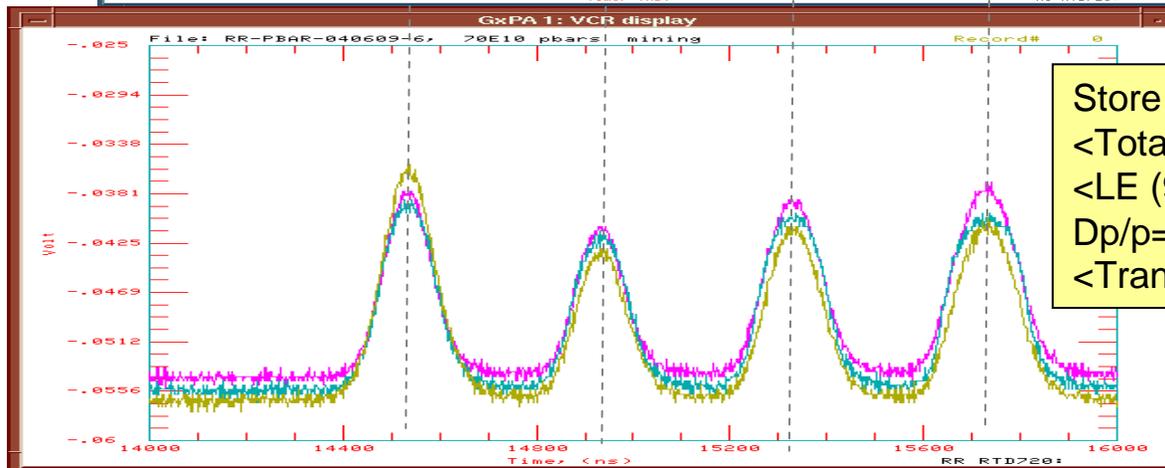
2.5MHz Bunches From RR



Recycler pbars



Store # 3597
<Total Intensity/transfer> $\approx 20 E10$
<LE (95%)> ≈ 2.3 eVs / bunch ($\pm 15\%$)
 $Dp/p = \pm 0.065\%$
<Transverse Emit.> = $3.7 \pm 0.4 \pi$ -mm-mr



Store # 3564
<Total Intensity/transfer> = $11.7 E10$
<LE (95%)> = 2.2 eVs / bunch
 $Dp/p = \pm 0.065\%$
<Transverse Emit.> = $4.1 \pm 0.3 \pi$ -mm-mr



Contribution of the Recycler to higher peak ppbar Luminosity



Use both Accumulator as well as Recycler pbars for the Tevatron shots → Mixed pbar Source Operation

Current Luminosity Record of $107.0 \text{ E}30 \text{ cm}^{-2}\text{s}^{-1}$ and the top 4 Luminosity stores } Mixed Pbar Source Operation

- So far, we had 8 Mixed Pbar Source Shot Setups
 - 3 shots to the Tevatron supplying 3 of the the 9 transfers
 - Average stash that we shot from $85.5\text{E}10$
 - Average intensity per transfer..... $23.0\text{E}10$
 - Percentage of beam captured for extraction.....83%
 - 5 shots to the Tevatron supplying 2 of the 9 transfers
 - Average stash that we shot from..... $55.0\text{E}10$
 - Average intensity per transfer..... $23.3\text{E}10$
 - Percentage of beam captured for extraction.....80%



Recent Improvements



- RF Upgrades: Baseline corrections
 - Replaced cables ← Reduces the RF waveform distortion
 - Vrf calibration
 - Dampers
 - Emittance monitor
- We can mine 1-9 transfers on demand
 - LLRF states development
 - Modification of the shot sequencer
- Smooth recovery from Mining
 - After beam transfer to the Tevatron
 - After mining but before transfer to the Tevatron if needed