Slow extraction for RSVP experiments at Brookhaven's AGS

K.A. Brown

Collider Accelerator Department, BNL

BROOKHAVEN NATIONAL LABORATORY

RSVP Review

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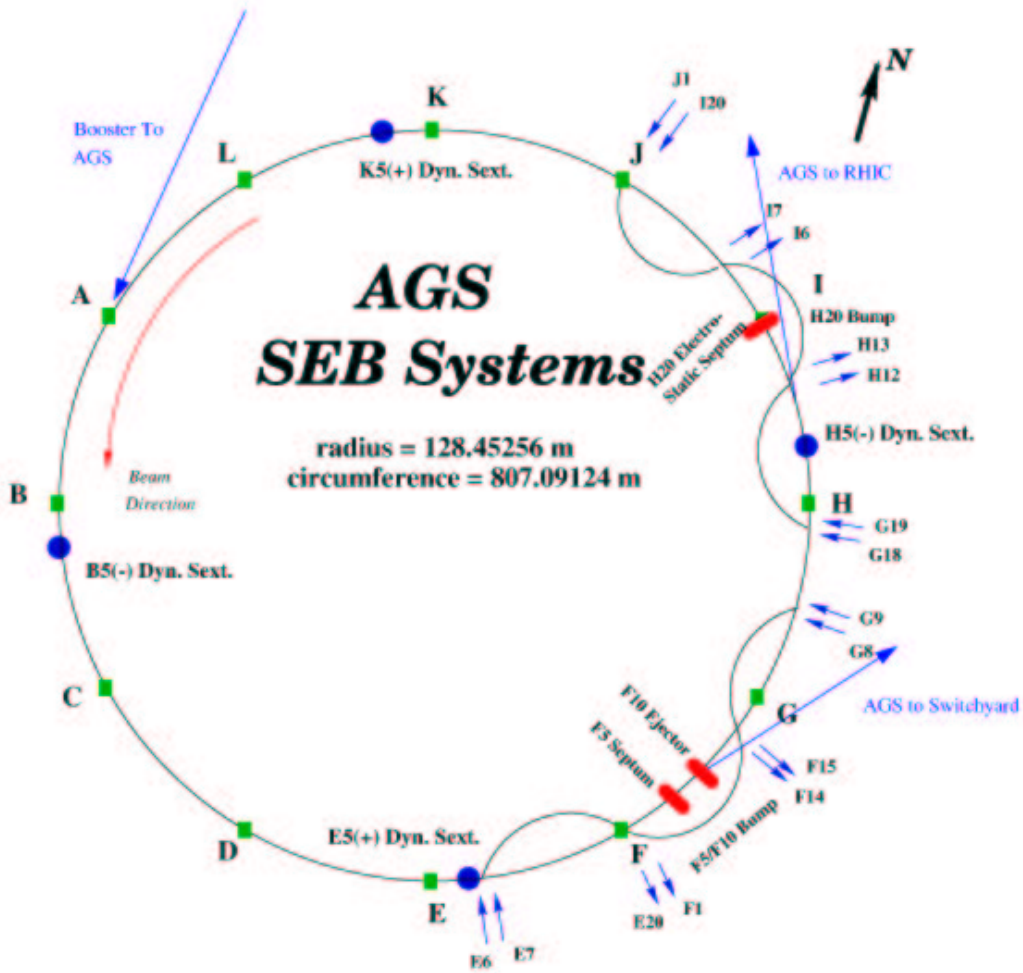
Overview of AGS Slow Extraction



1/3 integer resonant extraction system

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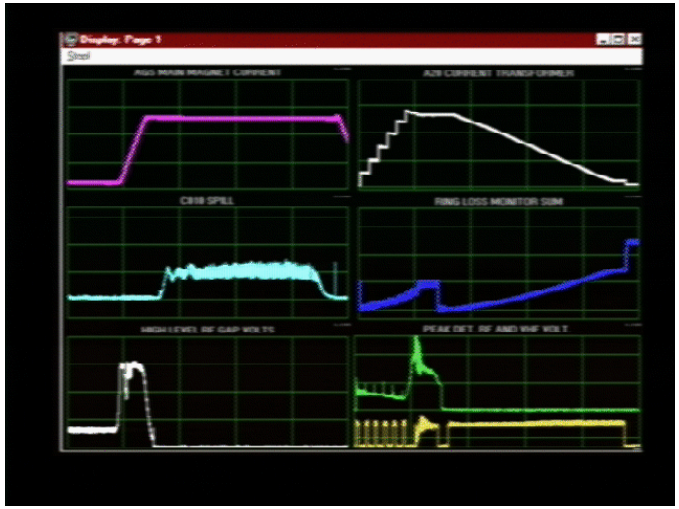
Overview of AGS Slow Extraction



Summary of emittance measurements.

note: β and α are referred to F13

	$\epsilon_x^{95\%,N}$	β_x (m)	α_x	$\epsilon_y^{95\%,N}$	β_y (m)	α_y
1980 Meas.	31.9	57.61	-6.636	38.8	3.249	0.8708
1997 Meas.	64.37± 9.60	8.77 ± 1.4	−0.92± 0.2	54.71± 5.0	4.18 ± 0.4	1.01 ± 0.09

1980 measurements are pre-Booster beam.

1997 measurements are post-Booster beam.

New tune for switchyard matching section successfully implemented for high intensity proton running using 1997 measurements.

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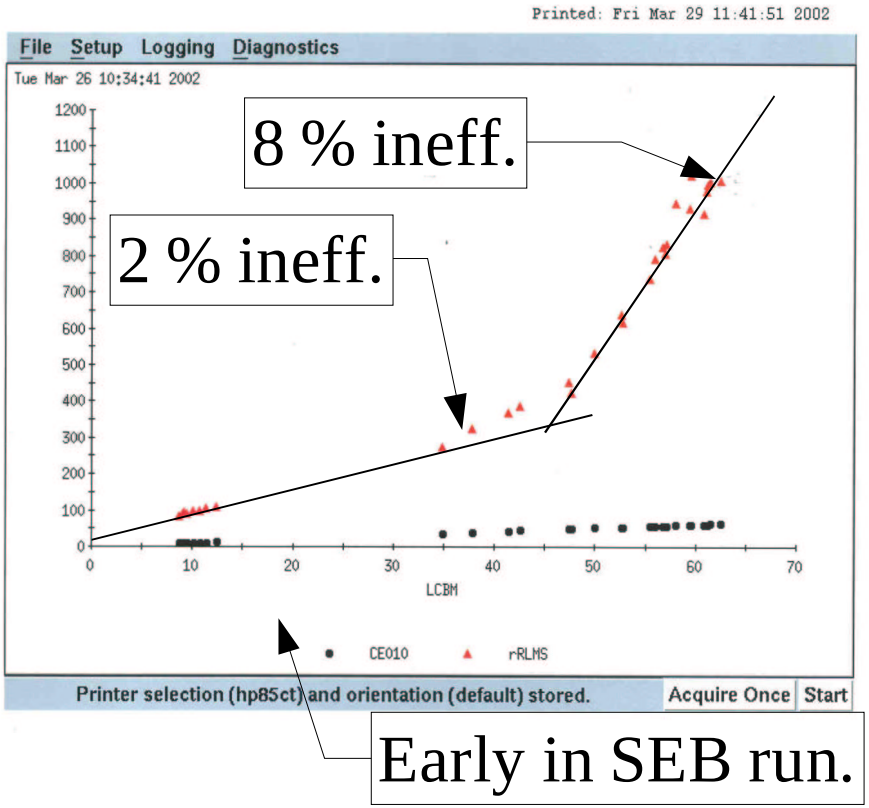
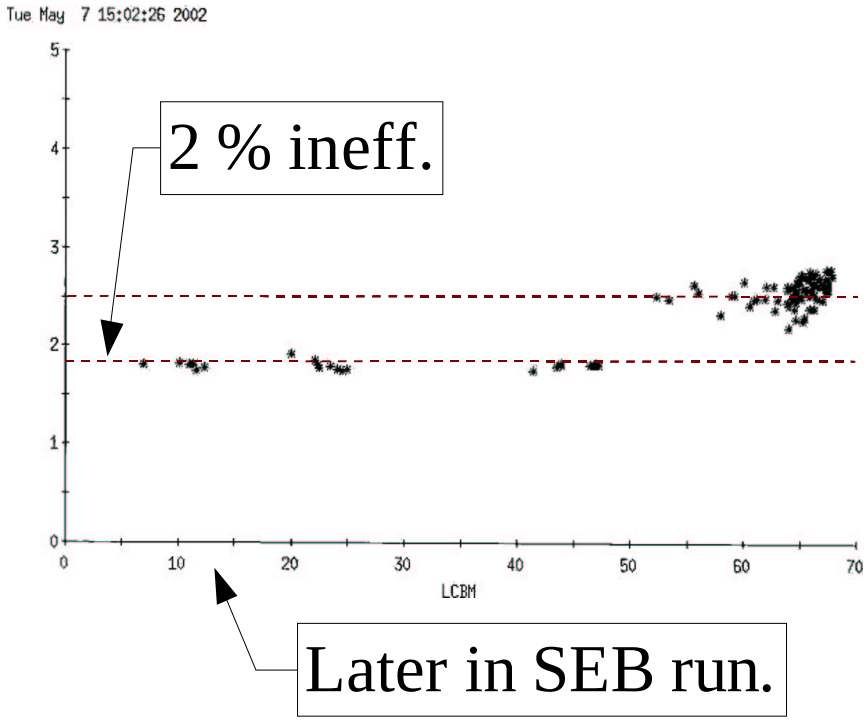
High Intensity Slow Extraction

70 TP Slow extracted beam observations. Vertical Chromaticity is kept positive after transition.





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Normal SEB AGS Parameters

Parameter	Value	Units
Peak Intensity	76.0	10^{12} protons/pulse
Extraction Efficiency	97-98	%
Rep Period/Flattop Length	4-8/2-6	Seconds
Spill Lengths	1.8 – 5.8	Seconds
Working Point	8.667 / 8.78	Horiz./Vert. Tune
Normalized Chromaticity	-2.5 / 0.05	Horiz./Vert. Chrom.
Extraction Momentum	25.5	GeV/c

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RSVP Parameters

	Normal SEB	KOPIO	MECO
P (GeV/c)	25.5	25.5	< 8.1
Rep. Time (sec)	5	5	1
Spill Length (sec)	3	3	0.5
Intensity	> 70 TP/pulse	100 TP/pulse	40 TP/pulse, 2 bunches
Bunch lengths / spacing	DC	200 psec / 40 nsec	~10 nsec / 1.35 usec
$\Delta p/p$ (%)	0.7 - 0.9	< 0.5	~ 1.0
Extinction	NA	10^{-3}	10^{-9}

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AGS Equipment for RSVP

For KOPIO

- 25 MHz RF Cavity and Power amplifier. To be designed and built at TRIUMF. Based on RHIC 28 MHz RF Cavity design.
- 100 MHz RF cavity

For MECO

- Upgrade AC Dipole for CW operation.
- Install HV pulsers for strip-line kickers, in an existing 5' straight section (many available).

RSVP Common Issues:

RC Networks, Extraction Septa, AGS Impedance.

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Extraction for KOPIO: micro-bunching

8.1 apr05,apr06,apr08; $\xi = -15.7$, 25 MHz

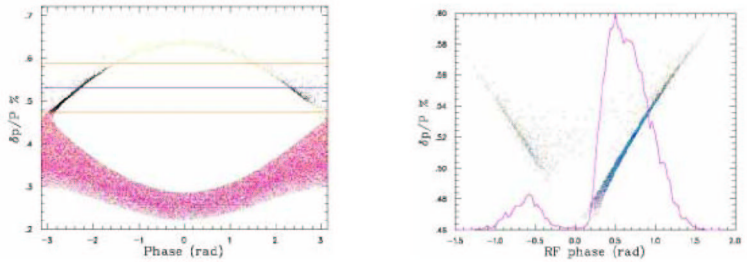

Figure 4: phase space (95ms) and micro-bunch, 05apr, $\Delta p/p\% = 0.46$; $\sigma_\phi = 3$ ns

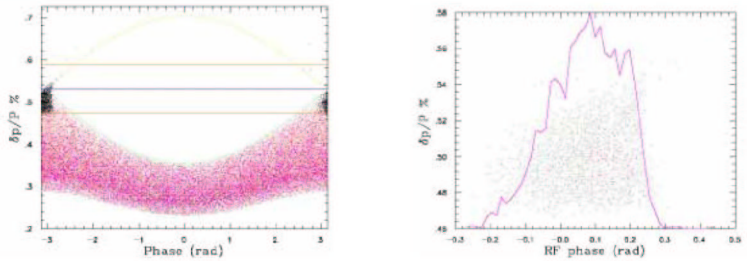

Figure 5: phase space (95ms) and micro-bunch, 06apr, $\Delta p/p\% = 0.53$; $\sigma_\phi = 0.67$ ns

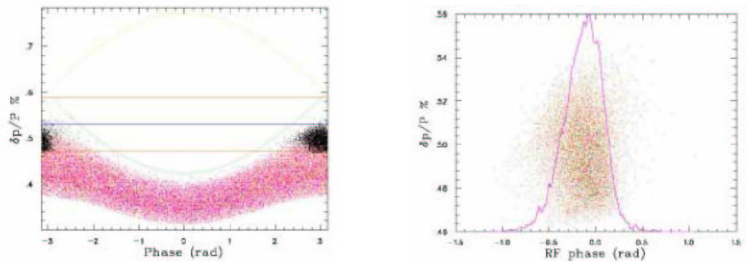

Figure 6: phase space (200ms) and micro-bunch, 08apr, $\Delta p/p\% = 0.60$; $\sigma_\phi = 1.36$ ns

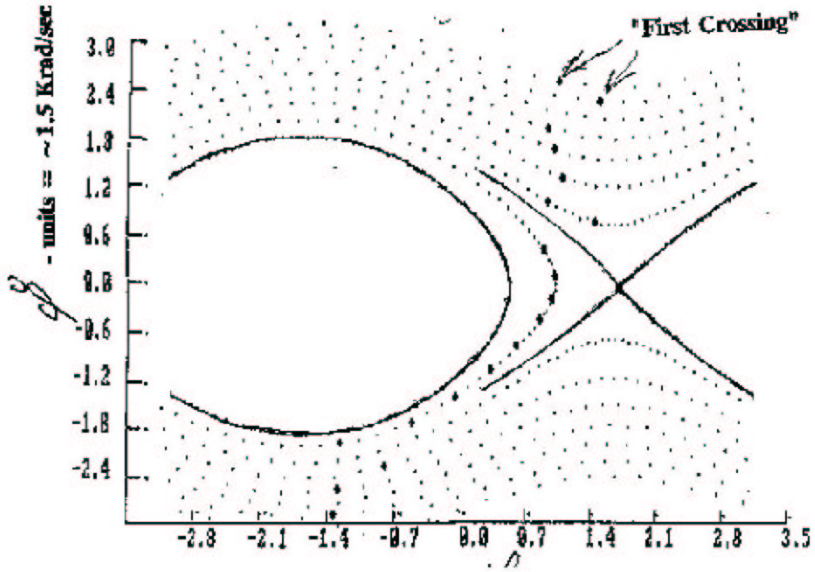

Figure 1 Particle Trajectory Between the Buckets,

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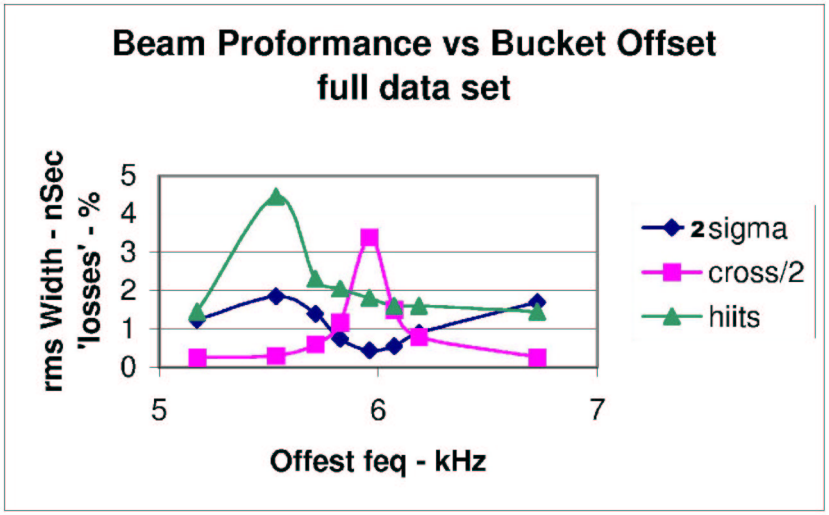
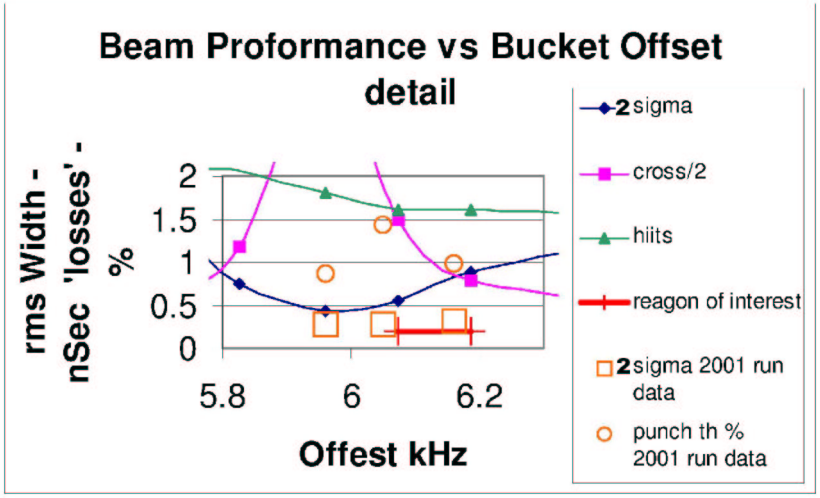
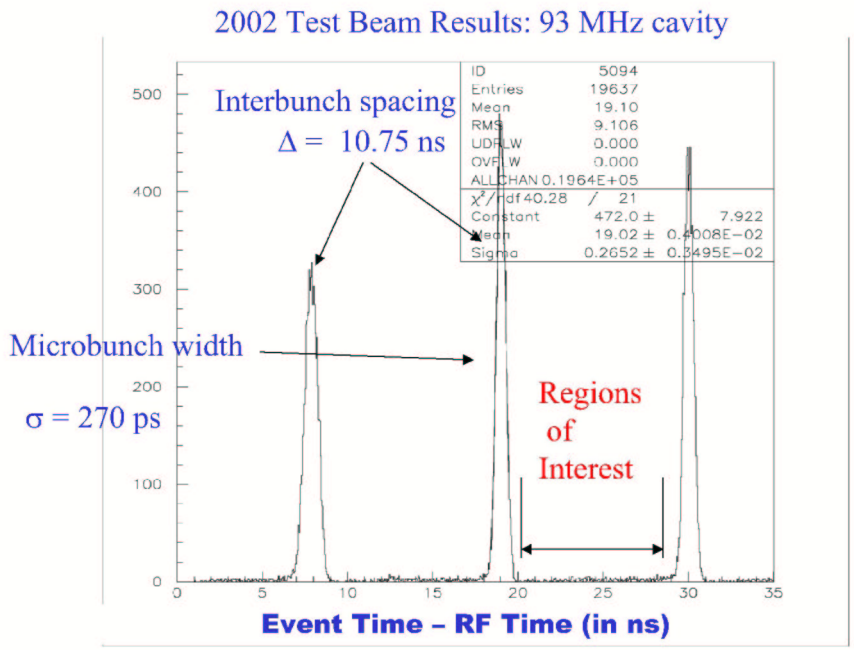
Extraction for KOPIO







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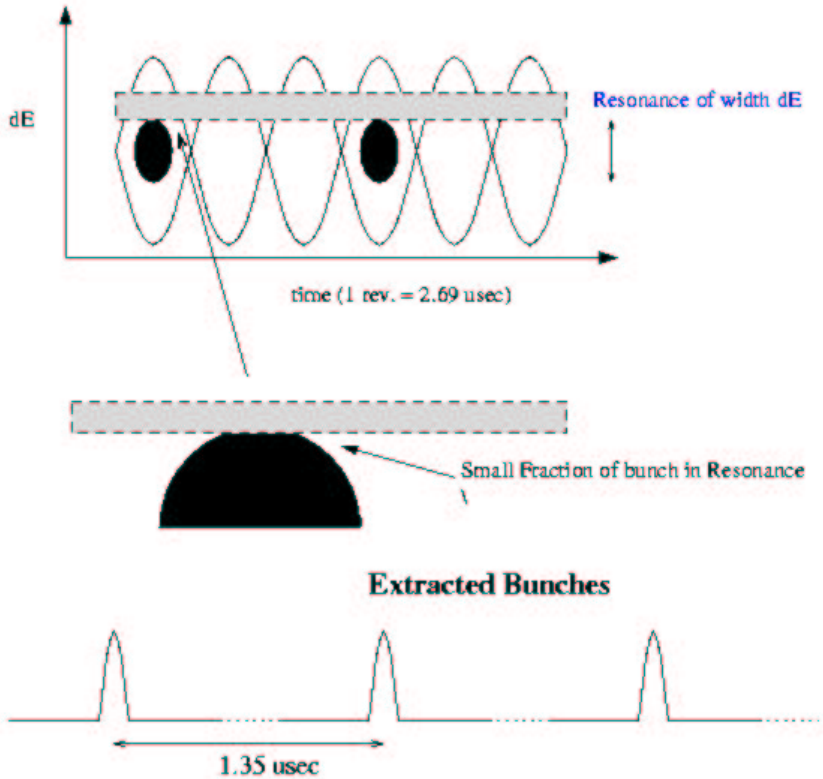
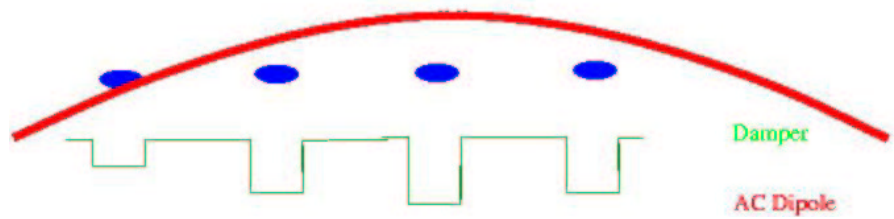
Extraction for MECO: mini-bunching



AC dipole and damper.



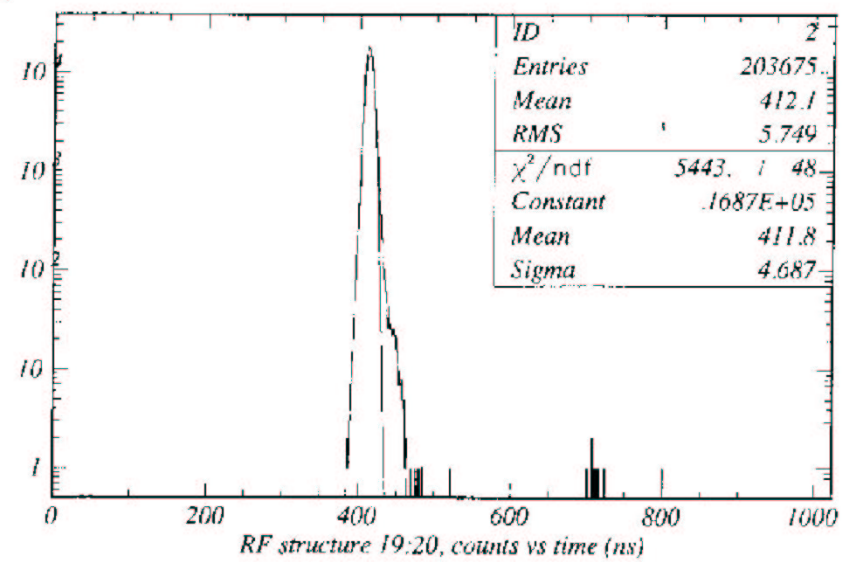


Figure 4 Single Mini-Bunch - Data

Now, how to prevent any empty bucket particles from extracting.

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SEB Experience

1. Long History of High Intensity Experience at the AGS
2. Longitudinal Phase Space Dilution Reduces Peak Current
3. Collective Effects on Losses and Spill Structure
4. Positive Vertical Chromaticity is Important
5. RF Phase Displacement using a high frequency RF cavity is important for achieving low ripple, high duty factor beam spills

RSVP Experience

KOPIO

- Beam tests demonstrate micro-bunch extraction works as predicted.
- Intra-bunch extinction requirements not yet met in beam studies.
- 250 psec bunches achieved with 93 MHz cavity

MECO

- Beam tests demonstrate mini-bunch extraction can be done.
- Intra-bunch extinction requirements not yet met in beam studies.
- Spill structure was a significant problem in beam tests.

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RSVP Summary

1. Slow Extraction for MECO and KOPIO is simply normal slow extraction with additional longitudinal manipulations.
2. Common issues are spill structure, and extraction efficiency, and normal extraction equipment maintenance.
3. For MECO the main issues are acceptance (lower energy, larger beam size), extinction, and spill structure.
4. For KOPIO the main issues are bunch lengths (<250 psec) and extinction.
5. There are No RSVP Extraction or Beam transport issues that have an affect on RHIC operations.

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