AGS beam intensity upgrades

What has been achieved

Sextupole power supply upgrades

Bunch manipulation and merging

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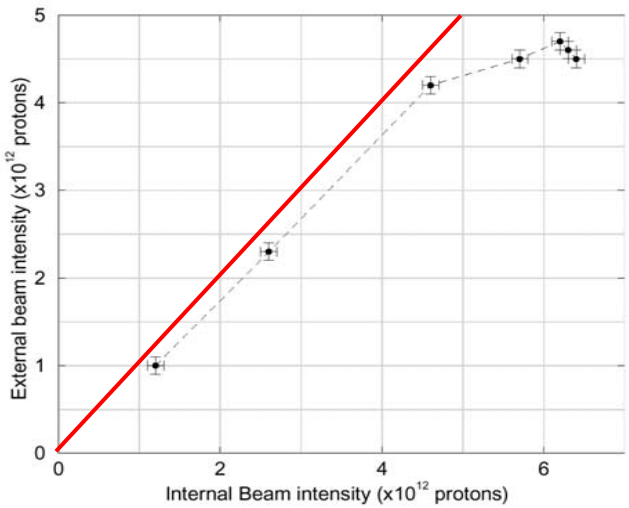
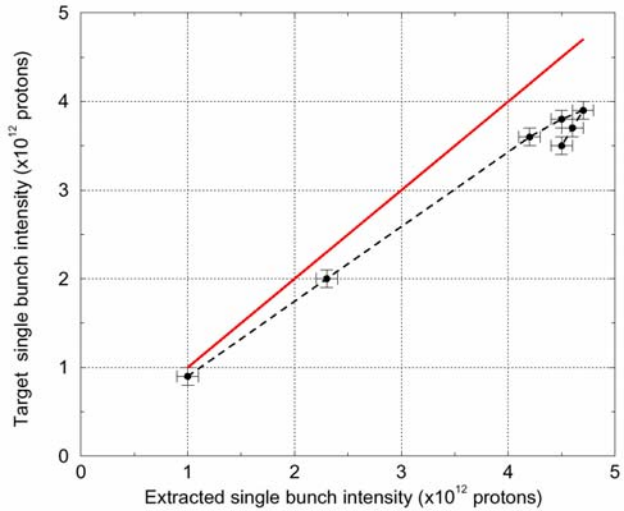
Thomas Roser
Muon collaboration meeting
February 8-10, 2002

What has been achieved

- Single bunch extraction: 6 TP circulating in AGS, 4.5 TP in beam line, 3.7 TP at target (Goal: 16 TP)





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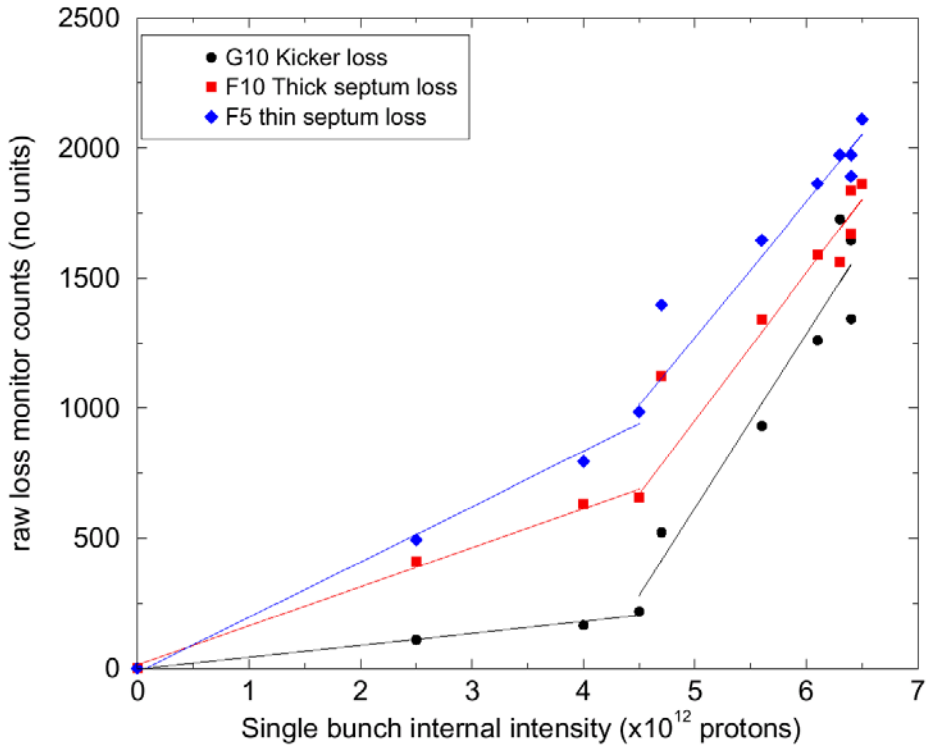
What has been achieved

- To get low loss extraction it was necessary to run with negative vertical chromaticity. This seems to cause vertical transverse instabilities at higher intensities.



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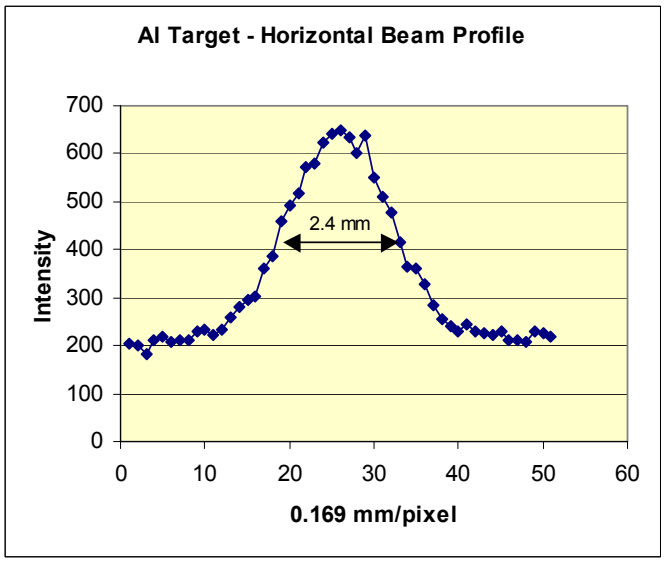
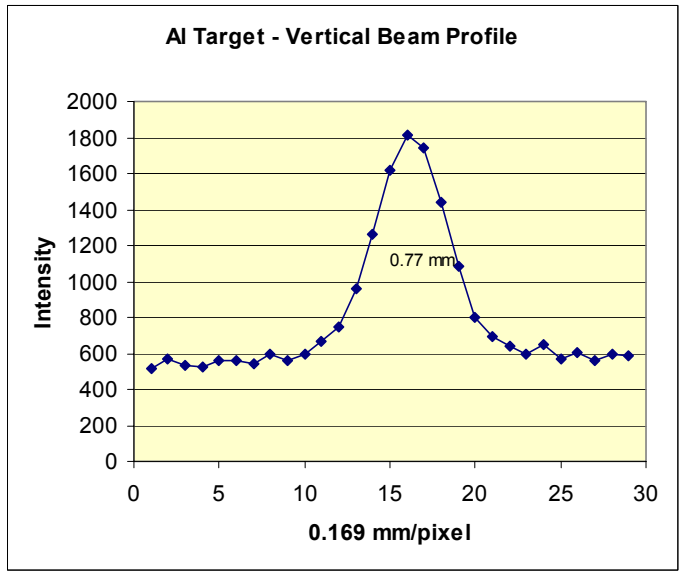
What has been achieved

- Spot size: $\sigma^2 \sim 1$ mm^2 measured by flag (Goal: 1 mm^2)
- Spot size measured by foil activation: $\sigma^2 \sim 0.4$ mm^2





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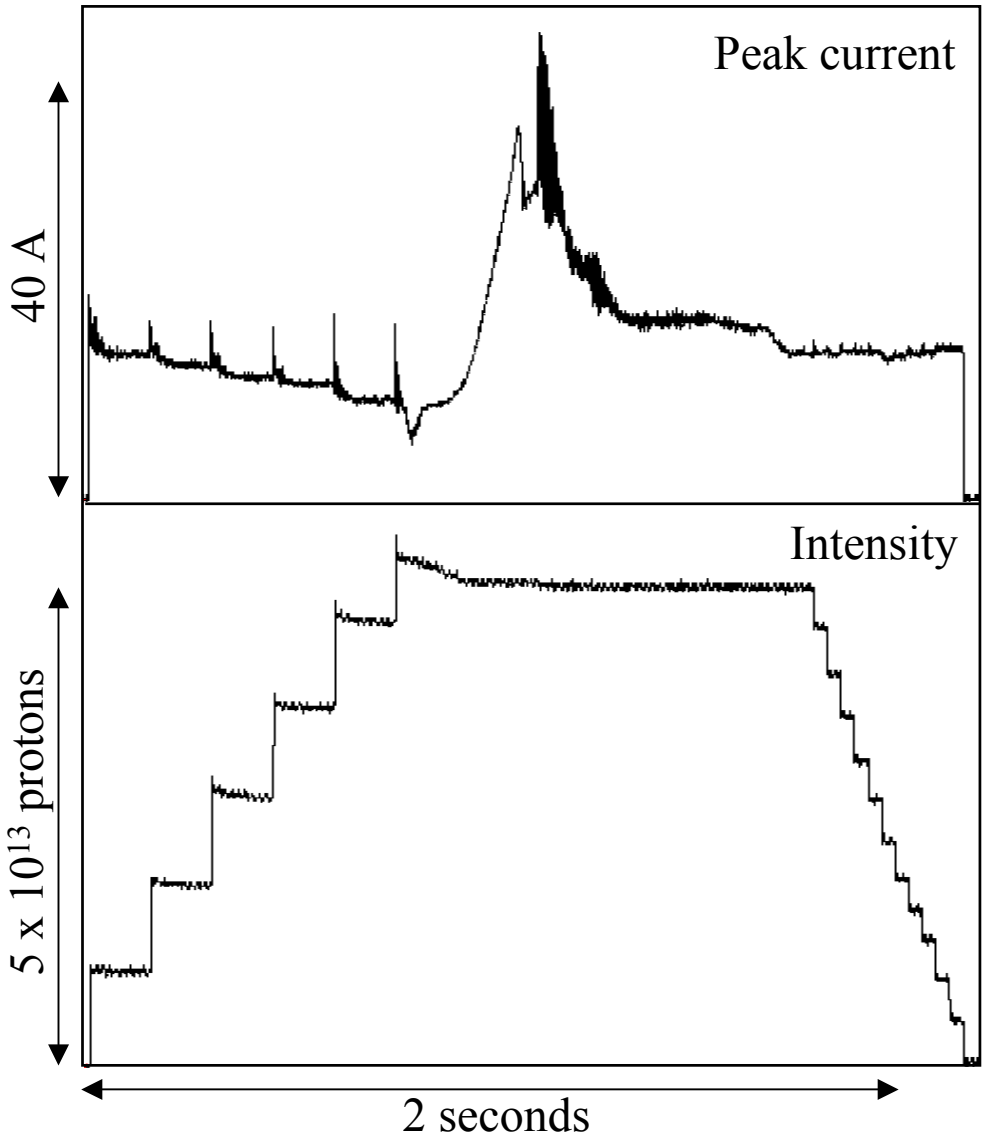
Upgrades

- New separate power supply for vertical sextupole (F7) to keep losses low with positive vertical chromaticity ($75k)
- New power supply to allow for positive horizontal chromaticity after transition ($150k)
  - CERN PS experience:
    with gammat jump and chromaticity jump (-1 -> +0.1) reached
    7 TP/bunch with 2.2 eVs [3.2 TP/eVs]
  - Limited by beam break-up instability (transverse microwave inst.)
  - AGS has gammat jump but large negative horizontal chromaticity (~ -2). Limited to about 1 TP/eVs after transition.
  - With new supply could get 10 TP/bunch in ~ 4 eVs ->
    bunch length at extraction ~ 50 ns (peak current: 65 A)

AGS performance for g-2 operation

- 6 single bunch transfers from Booster
- Peak intensity reached: 72 × 10^{12} ppp
- Bunch area: 3 eVs at injection
  10 eVs at extraction
- Intensity for g-2 ops: 50-60 × 10^{12} ppp
- Strong space charge effects during accumulation in AGS
- 2nd order transition energy jump limits available momentum aperture.
- Chromatic mismatch at transition causes emittance dilution
- Dilution needed for beam stability



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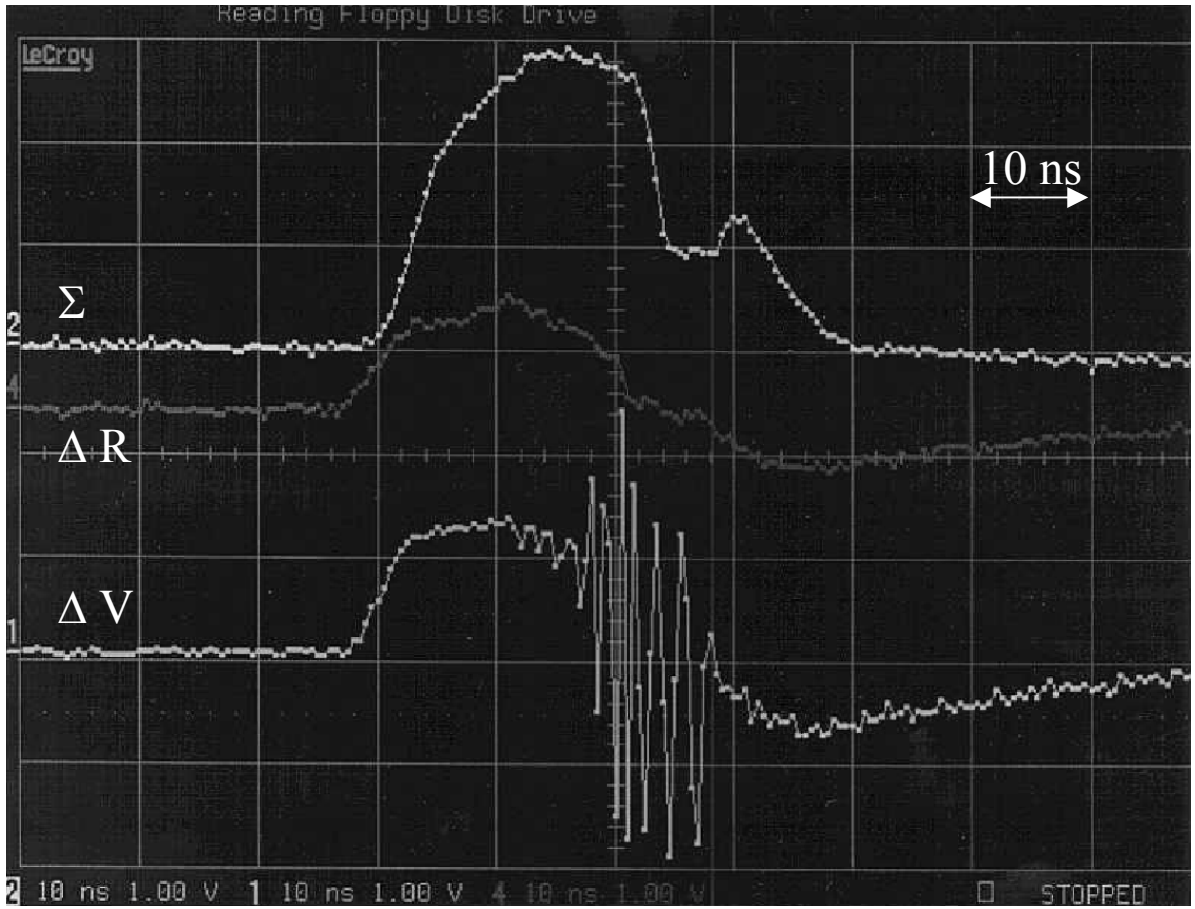
Beam break-up at CERN PS

7×10^{12} ppb, > 2.2 eVs

Occurs close to transition

Cured with long. blow-up



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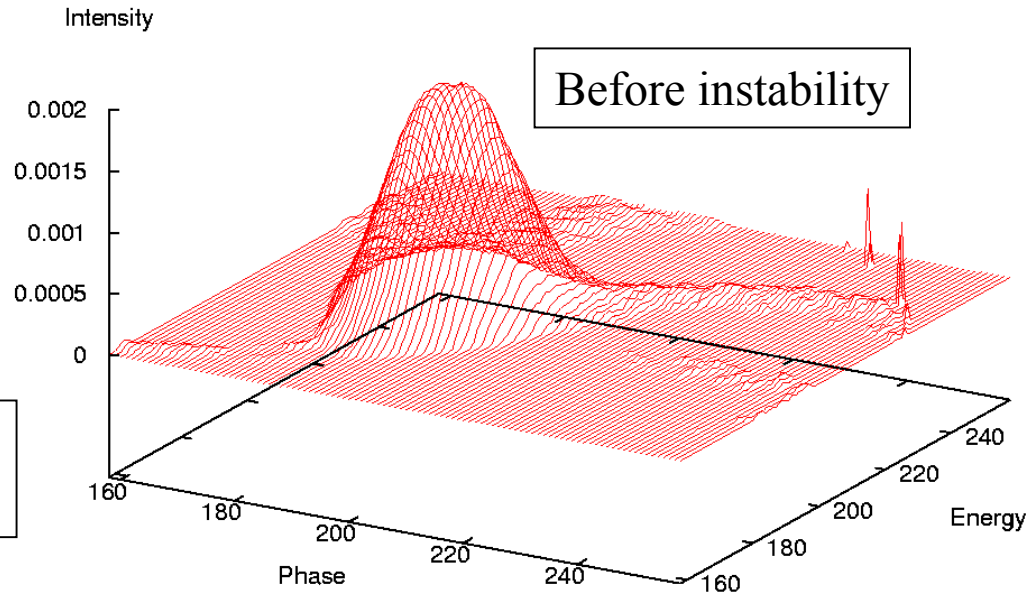
(R. Cappi, Snowmass 2001)

Fast transverse instability at RHIC

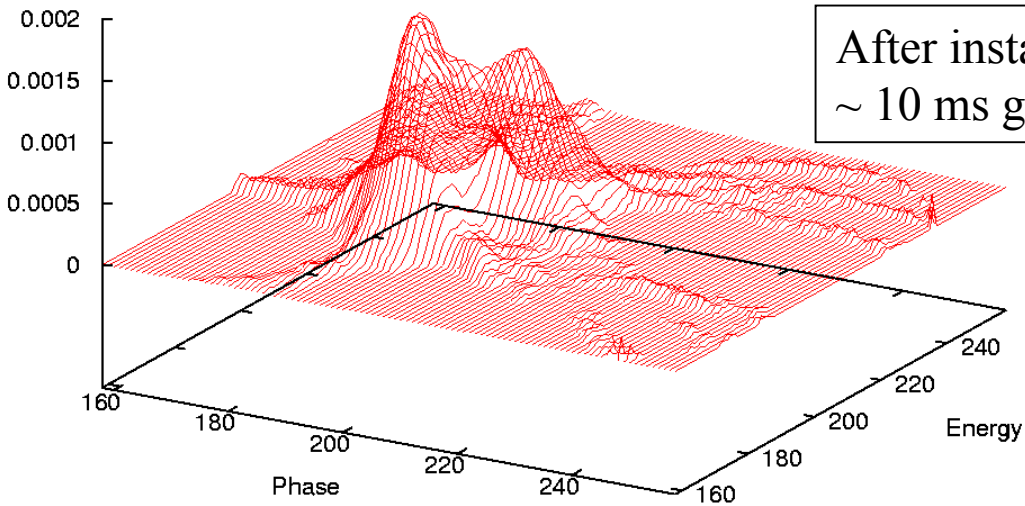
Occurs close to transition when chromaticity crosses zero

Cures: beam-beam tune spread, octupoles

Tomographic reconstruction of 2D bunch density



Before instability



After instability with ~ 10 ms growth rate

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Rf bunch merging

- Increased intensity per bunch by accelerating 2 bunches and then merge before extraction.
- Accelerate two adjacent bunches with h = 12 and then coalesce to h = 6. With the lower ramp rate of the Westinghouse motor-generator extra cavities are available for operation with two harmonic numbers
- Could reach 2 x 7 TP in the final bunch
- Need ~ 3 shifts for a dedicated study (preferred)
- Need ~ 6 shifts for a parasitic study (3 shifts to set-up ppm)