RHIC-AP-34

Gold Performance in RHIC at High Intensities

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Possible Beam Limits

1) Intra beam Scattering
2) Dynamic Aperture
3) RF bucket
4) beam - beam effects

Intra beam Scattering Results

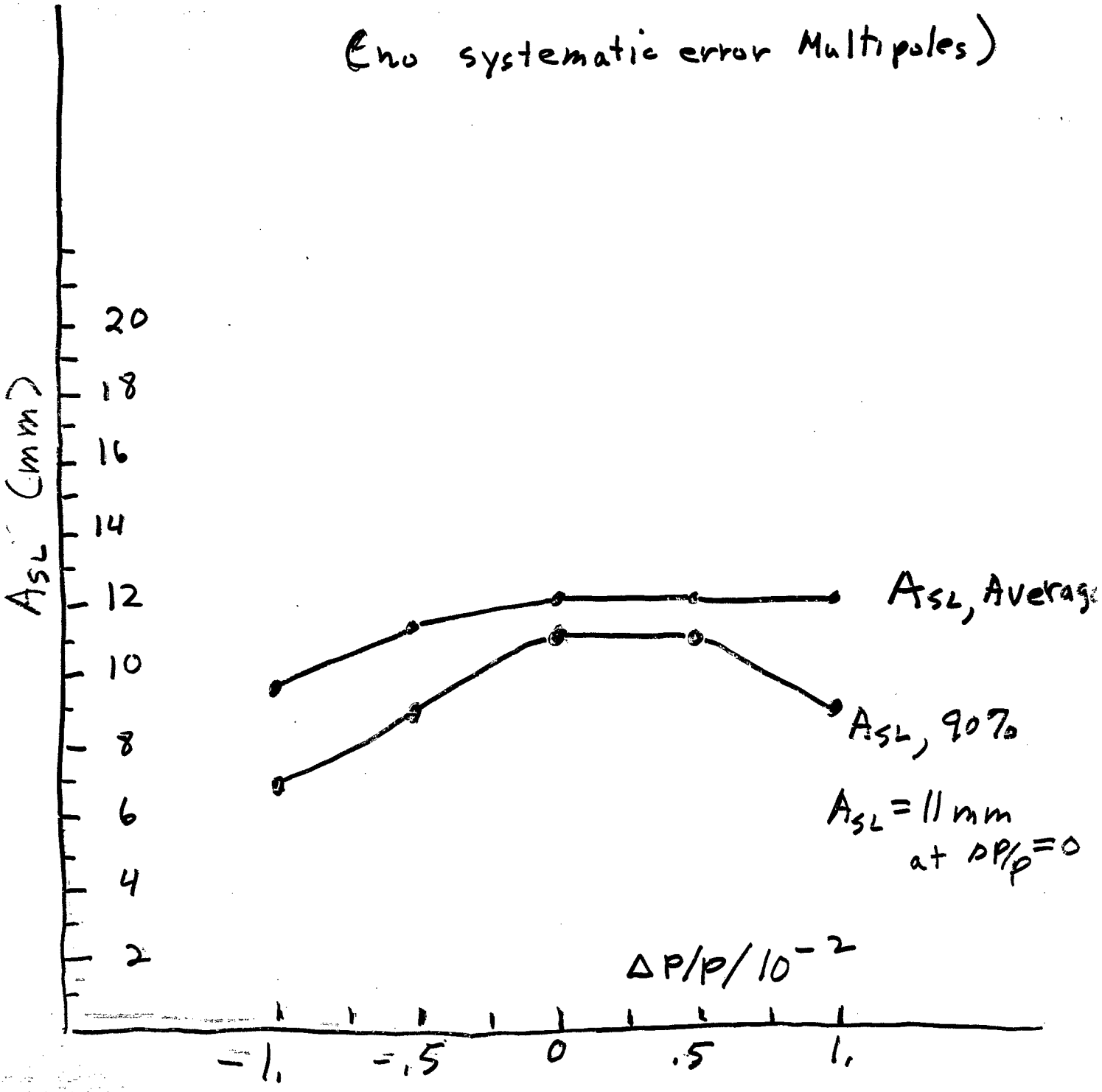
$N_b = 5.5 \times 10^9$ /bunch, Au ions, $Q = 79$, $A = 199$
After 10 hrs

$\sigma_H = 2.03$ mm, $6\sigma_H = 12.2$ mm
$\sigma_\ell = 190$ cms
$\delta = 1.43 \times 10^{-3}$, $2.5\delta = 3.6 \times 10^{-3}$
$\varepsilon_N = 49 \times 10^{-6}\ \pi$

For $N_b = 1.1 \times 10^9$ /bunch
$\varepsilon_N = 31 \times 10^{-6}\ \pi$, $\sigma_H = 1.61$ mm, $\delta = 1.07$, $\sigma_\ell = 142$ cms
$6\sigma_H = 9.6$ mm

Dynamic Aperture for RHIC $\beta^* = 3$ Lattice

With Random Error Multipoles
(no systematic error Multipoles)



Dynamic Aperture

Tracking runs give $A_{SL} = 11\,mm$ for $\beta^* = 3$. (average $A_{SL} = 12\,mm$). These results agree with F. Dell results.

$N_b = 5.5 \times 10^9$/bunch gives $6\sigma_H = 12.2$ mm after 10 hours, just acceptable within accuracy of the $A_{SL} = 11\,mm \pm 1\,mm$ tracking results.

R.F. Bucket

Present RF has $V = 1.2$ MV and $\Delta p/p$ of bucket $= \pm 2.68 \times 10^{-3}$

For $V = 2.4$ MV, $\Delta p/p$ bucket $= \pm 3.67 \times 10^{-3}$

Thus $2.5\,\delta = 3.58 \times 10^{-3}$ for $N_b = 5.5 \times 10^9$/bunch is acceptable using $V = 2.4$ MV

Beam-Beam Limit

For $N_b = 1.1 \times 10^9$ /bunch

$$\Delta\nu_{bb} = 2.5 \times 10^{-3} \quad \text{at } t = 0$$

$$= .9 \times 10^{-3} \quad \text{at } t = 10 \text{ hrs}$$

for Head on Collisions

For $N_b = 5.5 \times 10^9$ /bunch

$$\Delta\nu_{bb} \sim \frac{N_b}{\varepsilon_N} \quad \text{for head on collisions}$$

$$\Delta\nu_{bb} = .9 \times 10^{-3} \times \frac{5.5}{1.1} \times \frac{31}{49} \quad \text{after 10 hrs}$$

$$\Delta\nu_{bb} = 2.8 \times 10^{-3} \quad \text{for Head on Collisions}$$

crossing angle not needed

Luminosity

For $N_b = 1.1 \times 10^9$ /bunch, $L_{av} = 4.4 \times 10^{26}$ over 10 hrs

For $N_b = 5.5 \times 10^9$, $L \sim N_b^2/\varepsilon_N$

$$L = (15.6)\, L\,(N_b = 1.1 \times 10^9)$$

$$L = 69 \times 10^{26} \quad \text{averaged over 10 hrs}$$

Gold Ion Performance in RHIC

$N_b / 10^9$	1.1	5.5
B	57	57
γ	100	100
$\varepsilon_N / \pi / 10^{-6}$ m	31	49
σ_H mm	1.61	2.03
$A_{SL} = 6\sigma_H$ mm	9.6	12.2
$\Delta_B (V = 1.2 MV) / 10^{-3}$	2.68	—
$\Delta_B (V = 2.4 MV) / 10^{-3}$		3.67
$\delta / 10^{-3}$	1.07	1.43
$\Delta E/E = 2.5\,\delta / 10^{-3}$	2.62	3.6
σ_H^* mm	.39	.50
σ_z m	1.42	1.90
α	0	0
$\Delta \nu_{BB} / 10^{-3}$	.9	2.8
$L / 10^{26}$ cm^{-2} sec^{-1}	4.4	69

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