Gold Performance in RHIC at High Intensities

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DISCLAIMER

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at High Intensities

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BNL

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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

$$N_b \cong 5.5 \times 10^9 / \text{bunch}, \quad Au \ \text{ions}, \quad Q = 79, \quad A = 199$$

After 10 hrs

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

For $\underline{N_b = 1.1 \times 10^9 / \text{bunch}}$

$$\varepsilon_N = 31 \times 10^{-6} \pi, \quad \sigma_H = 1.61 \ mm, \quad \delta = 1.07, \quad \sigma_\ell = 142 \, cms$$
$$6\,\sigma_H = 9.6 \ mm$$

Dynamic Aperture
for RHIC $\beta^* = 3$ Lattice
With Random Error Multipoles
(no systematic error Multipoles)

A_{SL} (mm)

20
18
16
14
12
10
8
6
4
2

A_{SL}, Average

A_{SL}, 90%

$A_{SL} = 11$ mm
at $\Delta P/P = 0$

$\Delta P/P / 10^{-2}$

-1.   -.5   0   .5   1.
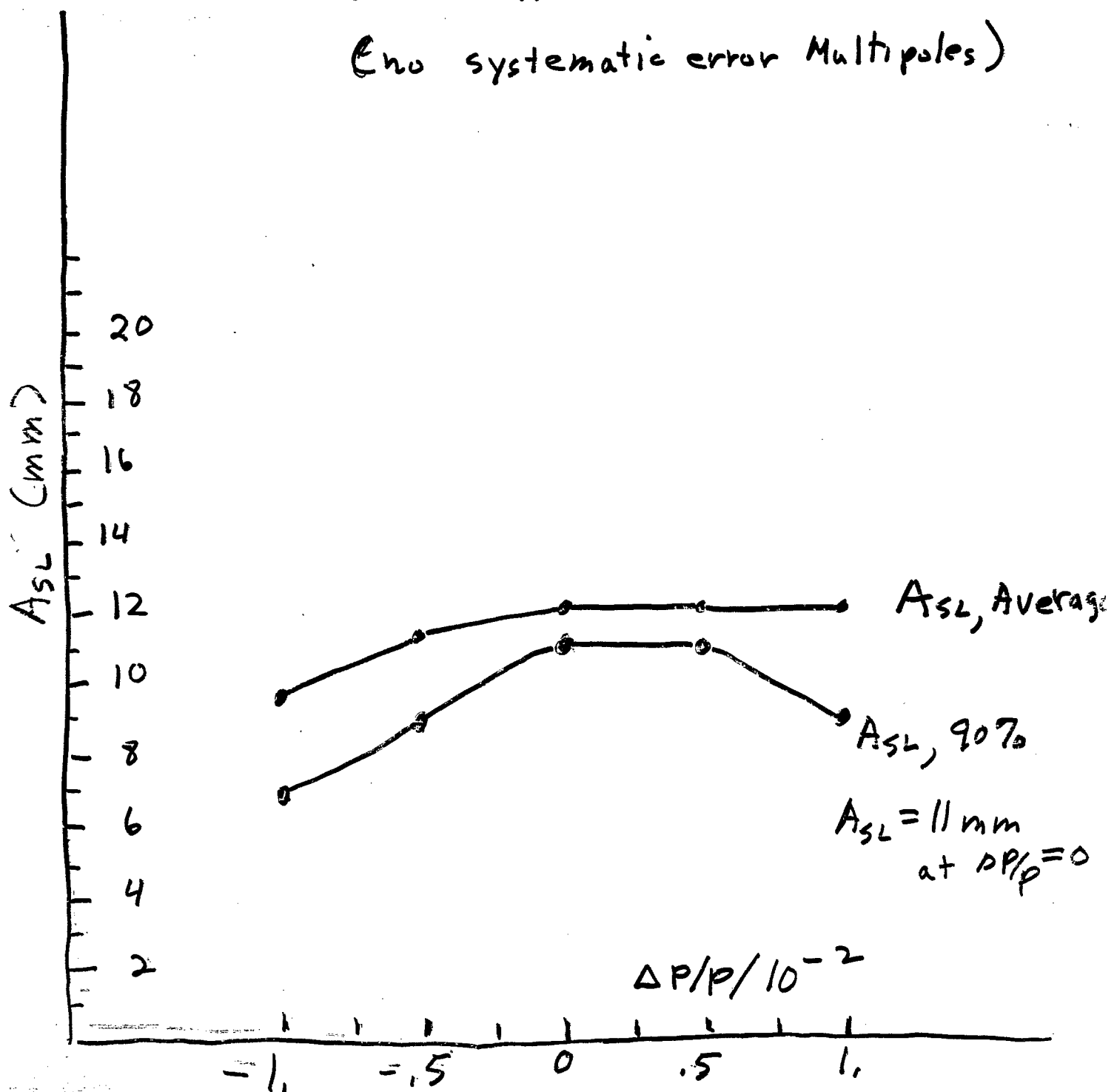
Dynamic Aperture

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 result.

RF. 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

$$\Delta \nu_{bb} = 2.5 \times 10^{-3} \quad \text{at } t=0$$
$$= .9 \times 10^{-3} \quad \text{at } t = 10 \text{ hrs}$$
$$\text{for Head on Collisions}$$

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

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

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

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

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

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

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

$N_b/10^9$	1.1	5.5
B	57	57
γ	100	100
$\varepsilon_N/\pi/10^{-6}$ m	31	49
σ_H mm	1.61	2.63
$A_{sc}=6\sigma_H$ mm	9.6	12.2
$\Delta_B(V=1.2MV)/10^{-3}$	2.68	—
$\Delta_B(V=2.4MV)/10^{-3}$		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
$\sqrt{\beta}$ 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