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Gold Performance in RHIC at High Intensities

G. Parzen

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Collider Accelerator Department
Brookhaven National Laboratory

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RHIC-AP-34

Gold Performance in RHIC
at High Intensities

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November 2, 1986

G. Parzen, 10/29/86

Possible Beam Limits

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

Intra beam Scattering Results

$$\underline{N_b = 5.5 \times 10^9 / \text{bunch}}, A_u = 10 \text{ ns}, Q = 79, A = 199$$

After 10 hrs

$$\sigma_H = 2.03 \text{ mm}, 6\sigma_H = 12.2 \text{ mm}$$

$$\sigma_z = 190 \text{ cm}$$

$$\delta = 1.43 \times 10^{-3}, 2.5\delta = 3.6 \times 10^{-3}$$

$$E_N = 49 \times 10^{-6} \pi$$

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

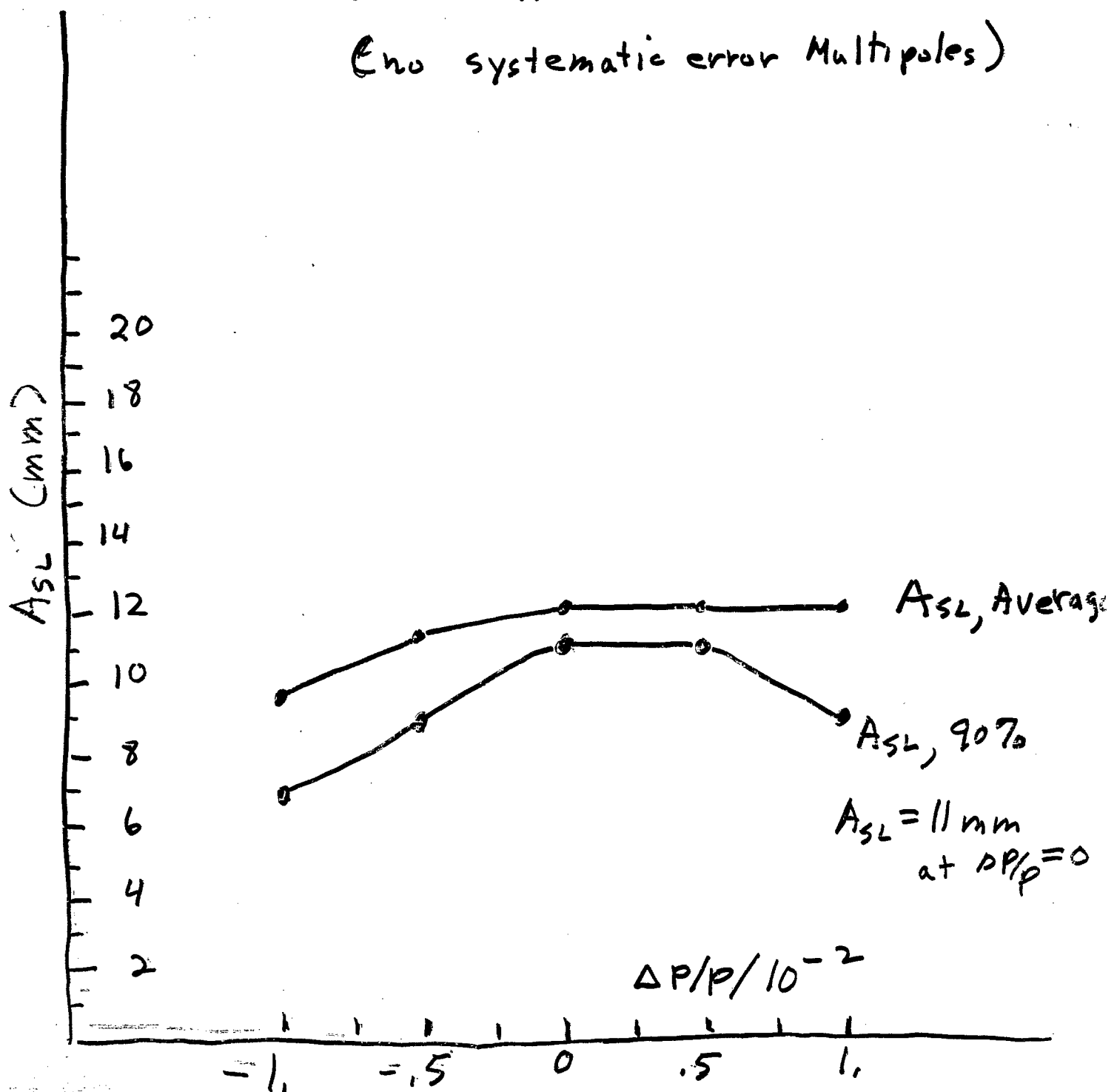
$$E_N = 31 \times 10^{-6} \pi, \sigma_H = 1.61 \text{ mm}, \delta = 1.07, \sigma_z = 142 \text{ cm}$$

$$6\sigma_H = 9.6 \text{ mm}$$

(1A)

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

With Random Error Multipoles
(no systematic error Multipoles)



Dynamic Aperture

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

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

RF Bucket

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

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

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

Beam-Beam Limit

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

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

$$= 1.9 \times 10^{-3} \text{ at } t=10 \text{ hrs}$$

for Head-on Collisions

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

$$\Delta V_{bb} \sim \frac{N_b}{E_N} \text{ for head-on collisions}$$

$$\Delta V_{bb} = 1.9 \times 10^{-3} \times \frac{5.5}{1.1} \times \frac{31}{49} \text{ after 10 hrs}$$

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

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

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

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

Gold Ion Performance in RHIC

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$N_b / 10^9$		1.1	5.5
B		57	57
γ		100	100
$\epsilon_N / \pi / 10^{-6}$	m	31	49
σ_H	mm	1.61	2.03
$A_{SL} = 6\sigma_H$	mm	9.6	12.2
$\Delta_B (V=6.24V) / 10^{-3}$		2.68	—
$\Delta_B (V=2.44V) / 10^{-3}$			3.67
$\xi / 10^{-3}$		1.07	1.43
$\Delta E/E = 2.5 \xi / 10^{-3}$		2.62	3.6
σ_H^*	mm	.39	.50
σ_E	m	1.42	1.90
α		0	0
$\Delta V_{EB} / 10^{-3}$.9	2.8
$L / 10^{-6} \text{ cm}^{-2} \text{ sec}^{-1}$		4.4	6.9