

RHIC Performance With Intrabeam Scattering

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U.S. Department of Energy

USDOE Office of Science (SC)

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RHIC-PG-49

RHIC PERFORMANCE
WITH INTRABEAM SCATTERING

G. Parzan

BNL - April 16, 1984

RHIC Performance

RHIC3

4/16/84

t = 10 hrs

$X_p = 1.39$

$N_b = 1.2 \times 10^9$

$\beta_x = 51.4$

$v = 1.2 \times 10^6$

| γ | 5 | 12 | 20 | 30 | 50 | 75 | 100 | δt |
|--|-------|-------|-------|-------|-------|-------|-------|------------|
| $\delta_0 / 10^{-3}, t=0$ | .818 | .678 | .696 | 1.261 | .643 | .452 | .359 | |
| $\sigma_{z0}, t=0$ | 128. | 63.3 | 36.9 | 45.2 | 53.2 | 50.5 | 47.7 | |
| $\epsilon / 10^{-6}, t=10$ | 89.0 | 44.5 | 35.8 | 33.2 | 27.7 | 27.8 | 27.8 | |
| $\epsilon / 10^{-3}, t=10$ | 1.411 | 1.563 | 1.792 | 1.985 | 1.548 | 1.274 | 1.099 | |
| $\sigma_{z0}, t=10$ | 221. | 146. | 95.0 | 71.7 | 128. | 142. | 146. | |
| Av. Lum./ L_0 | .162 | .319 | .389 | .422 | .476 | .471 | .470 | |
| RF | | | | | | | | |
| $2.5 \epsilon / 10^{-3}$ | 3.53 | 3.91 | 4.48 | 4.96 | 3.87 | 3.18 | 2.74 | |
| $\Delta P/P \text{ bucke} / 10^{-3}$ | 2.28 | 3.82 | 6.72 | 9.95 | 4.31 | 3.19 | 2.68 | |
| Aperture | | | | | | | | |
| $X_p \epsilon$ (mm) | 1.96 | 2.17 | 2.49 | 2.76 | 2.15 | 1.77 | 1.53 | |
| $\sigma_H = \sigma_V$ (mm) | 12.4 | 5.64 | 3.92 | 3.08 | 2.18 | 1.78 | 1.54 | |
| $2.5 X_p \epsilon$ | 4.90 | 5.42 | 6.22 | 6.90 | 5.38 | 4.42 | 3.82 | |
| $2.5 \sigma_H$ | 31.0 | 14.1 | 9.80 | 7.70 | 5.45 | 4.45 | 3.83 | |
| Beam Half Width | | | | | | | | |
| $2.5 (\sigma_H + X_p \epsilon)$ | 35.1 | 19.1 | 15.7 | 14.3 | 10.6 | 8.70 | 7.52 | |
| $2.5 \sigma_V$ | 31.0 | 14.1 | 9.80 | 7.70 | 5.45 | 4.45 | 3.83 | |
| Physical Half-Aperture | | | | | | | | |
| $2.5 X_p \epsilon + 6 \sigma_H$ | 78.9 | 39.1 | 29.6 | 25.2 | 18.3 | 15.0 | 13.0 | |
| $6 \sigma_V$ | 74.4 | 33.8 | 23.5 | 18.5 | 13.1 | 10.7 | 9.24 | |
| Av. Lum./ $L_0, t=7.5$ | .150 | .299 | .368 | .401 | .457 | .452 | .452 | |
| Luminosity/ 10^{26} | .100 | .475 | .965 | 1.57 | 2.95 | 4.38 | 5.83 | |
| Luminosity = $12.4 \times 10^{26} \times \text{LUMAV} \times \delta / 100$ | | | | | | | | |

RHIC Performance

RHIC3

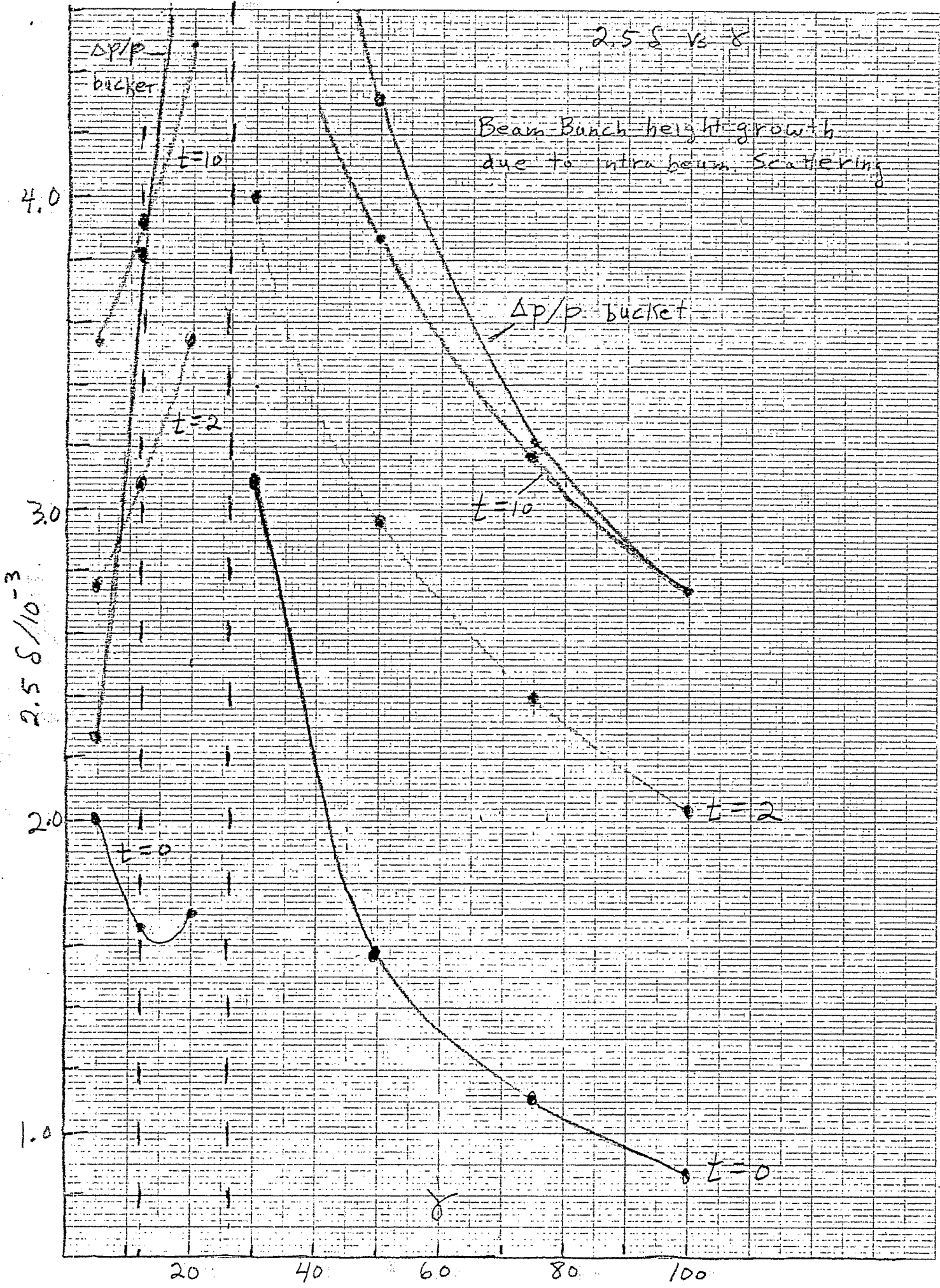
4/17/84

t=2 hrs

$X_p =$

$P_x =$

| γ | 5 | 12 | 20 | 30 | 50 | 75 | 100 | δt |
|--------------------------------------|-------|-------|-------|-------|-------|------|------|------------|
| $\delta_0 / 10^{-3}, t=0$ | .818 | .678 | .696 | 1.261 | .643 | .452 | .359 | |
| $\sigma_{z0}, t=0$ | 128. | 63.3 | 36.9 | 45.2 | 53.2 | 50.5 | 47.7 | |
| $\epsilon / 10^{-6}, t=2$ | 54.2 | 27.4 | 22.4 | 20.4 | 18.3 | 18.5 | 18.7 | |
| $\delta / 10^{-3}, t=2$ | 1.104 | 1.230 | 1.414 | 1.604 | 1.180 | .951 | .817 | |
| $\sigma_z, t=2$ | 173. | 115. | 75.0 | 57.5 | 97.7 | 106. | 109. | |
| Av. Lum./ L_0 | .267 | .506 | .596 | .645 | .677 | .665 | .663 | |
| RF | | | | | | | | |
| $2.5 \delta / 10^{-3}$ | 2.76 | 3.08 | 3.54 | 4.01 | 2.95 | 2.38 | 2.04 | |
| $\Delta P/P \text{ bucke} / 10^{-3}$ | 2.28 | 3.82 | 6.72 | 9.95 | 4.31 | 3.19 | 2.68 | |
| Aperture | | | | | | | | |
| $X_p \delta$ (mm) | 1.53 | 1.71 | 1.97 | 2.23 | 1.64 | 1.32 | 1.14 | |
| $\sigma_H = \sigma_V$ (mm) | 9.64 | 4.42 | 3.09 | 2.91 | 1.77 | 1.45 | 1.26 | |
| $2.5 X_p \delta$ | 3.82 | 4.28 | 4.92 | 5.58 | 4.10 | 3.30 | 2.85 | |
| $2.5 \sigma_H$ | 24.1 | 11.0 | 7.72 | 6.02 | 4.42 | 3.62 | 3.15 | |
| Beam Half Width | | | | | | | | |
| $2.5 (\sigma_H + X_p \delta)$ | 27.4 | 15.0 | 12.4 | 11.4 | 8.36 | 6.80 | 5.88 | |
| $2.5 \sigma_V$ | 24.1 | 11.0 | 7.72 | 6.02 | 4.42 | 3.62 | 3.15 | |
| Physical Half-Aperture | | | | | | | | |
| $2.5 X_p \delta + 6 \sigma_H$ | 61.6 | 30.7 | 23.4 | 19.9 | 14.6 | 12.0 | 10.4 | |
| $6 \sigma_V$ | 57.8 | 26.5 | 18.5 | 14.5 | 10.6 | 8.70 | 7.57 | |
| Av. Lum/ $L_0, t=7.5$ | .224 | .442 | .534 | .588 | .623 | .611 | .612 | |
| Luminosity/ 10^{22} | .165 | .753 | 1.48 | 2.40 | 4.20 | 6.18 | 8.22 | |



2.5 δ vs δ

Beam Bunch height growth due to intra-beam scattering

$\Delta p/p$ bucket

$t=10$

$t=2$

$t=10$

$t=2$

$t=0$

4.0

3.0

2.0

1.0

20

40

60

80

100

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60
40
20

σ_e vs. δ

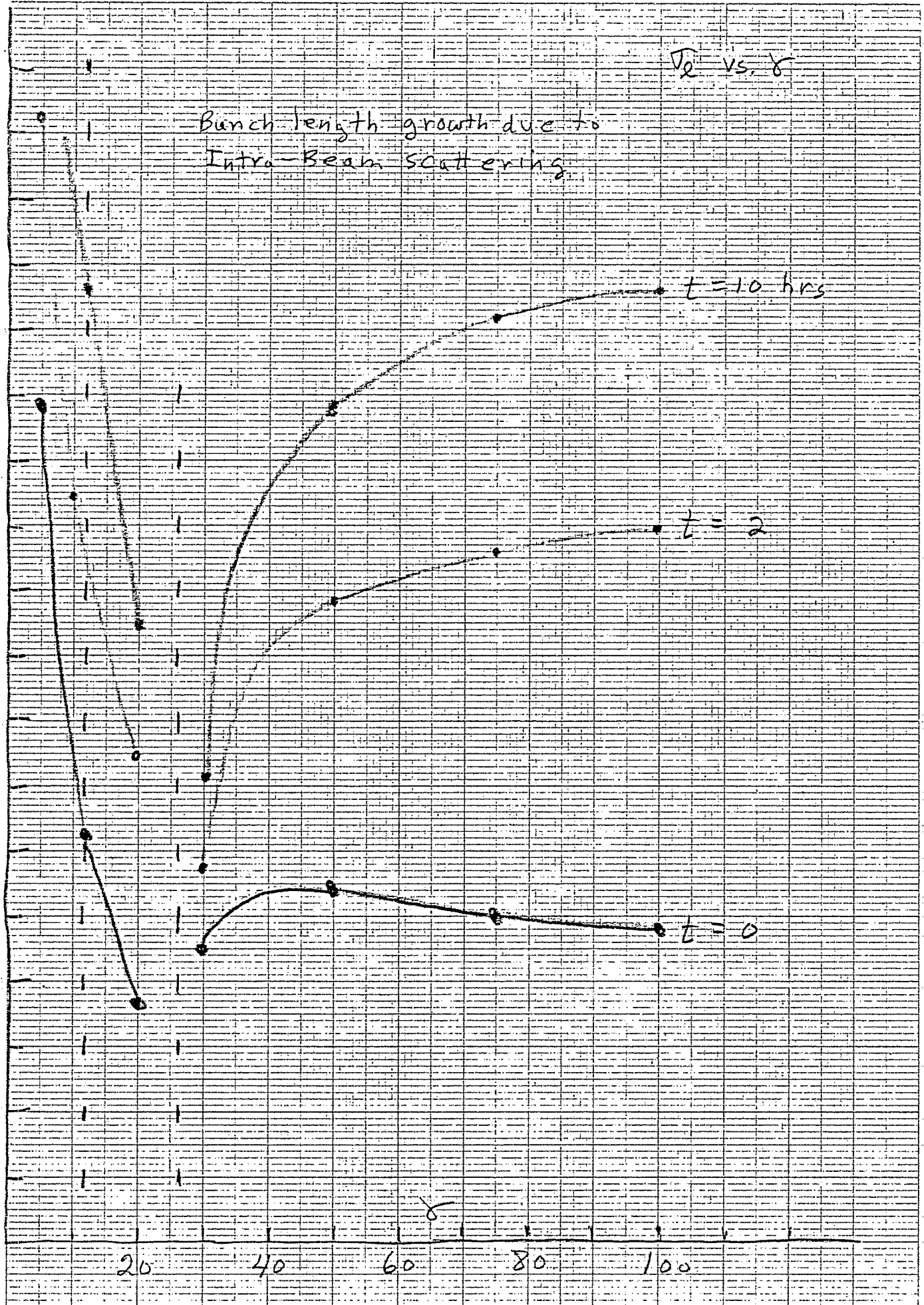
Bunch length growth due to
Intra-Beam scattering.

$t = 10$ hrs

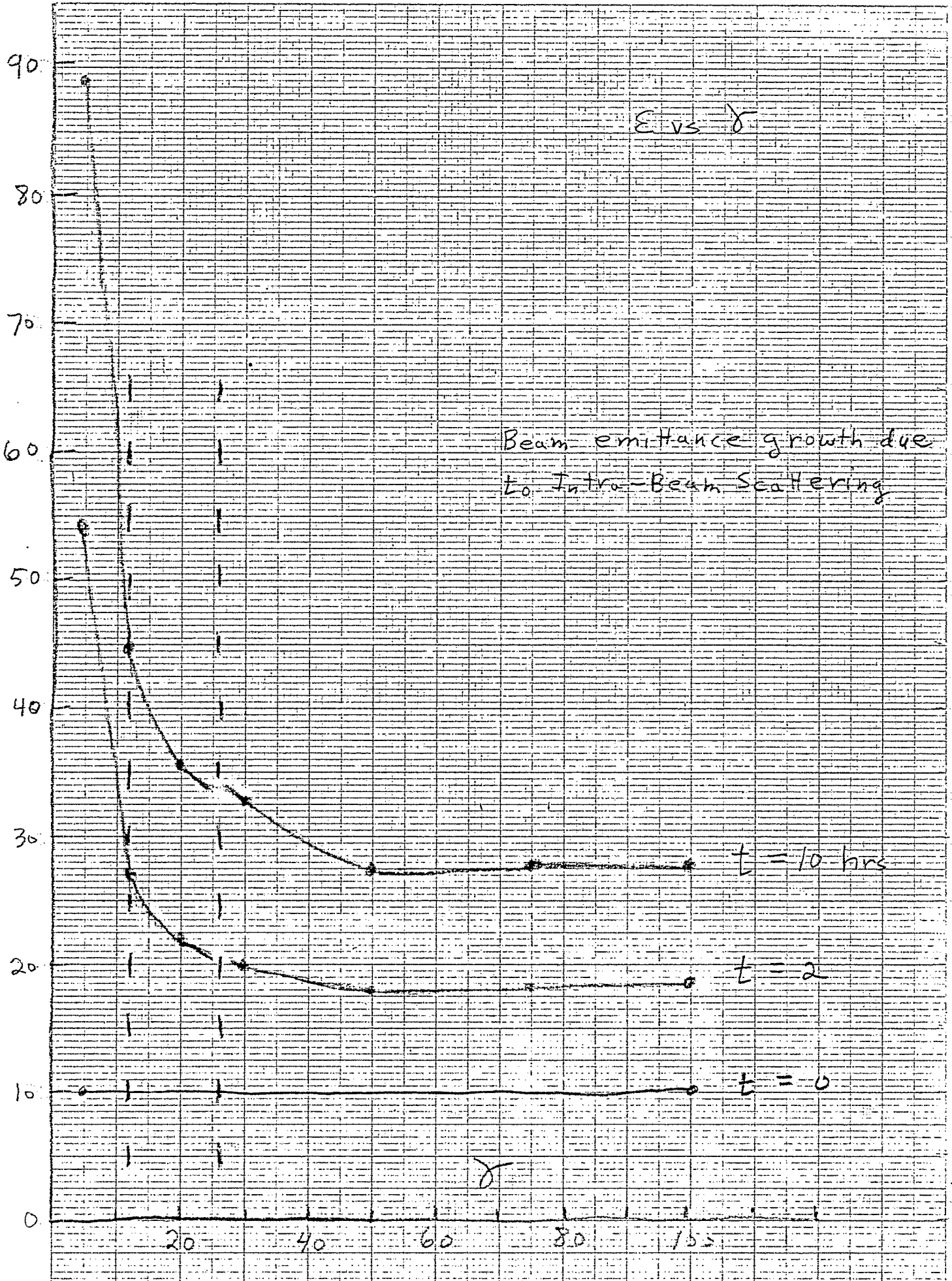
$t = 2$

$t = 0$

20 40 60 80 100



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$$2.5 (X_p \delta + \sqrt{H}) \sqrt{\delta}$$

30

20

10

(mm)

Beam half-width growth due to
Intra-Beam Scattering

t = 10 hrs

t = 2

t = 0

δ

20

40

60

80

100

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