

## Scenario For The Case Of No RF Stacking

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SCENARIO FOR THE CASE OF NO RF STACKING

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(BNL, December 5, 1983)

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of no RF stacking

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## Formulae

luminosity :

$$L = \frac{N^2 B f_{rev}}{4\pi \sigma_v^* \sigma_H^* f}$$

Beam-Beam Tune-Shift :

$$\Delta \nu = \frac{N r_0 \beta_v^* Z^2}{4\pi \sigma_v^* \sigma_H^* f \gamma A}$$

$f$ , correction factor =  $\sqrt{1 + \rho^2}$

$$\rho = \frac{\alpha \sigma_e}{2\sigma_H^*}$$

## General Parameters

Circumference , $2\pi R$	3833.8 m
Revolution Frequency , $f_{rev}$	78.194 kHz
Element :	Gold (Au)
$A$ , atomic mass	197
$Z$ , atomic number	79
Kinetic Energy	100 GeV/A
Rest Energy	0.9381 GeV/A
$\gamma$	107.60
$\beta$	0.999957
Rigidity , $B\rho$	839.72 T.m
Momentum	100.93 GeV/c/A
No. of AGS pulses / Ring	57 box-car
No. of bunches / AGS pulse	1
No. of ions / AGS bunch	$1.87 \times 10^9$
Total No. of ions / Ring	$1.07 \times 10^{11}$
AGS Cycle Time	2.0 sec
Filling Time	2 rings $\times$ 2min

AGS Bunch Area at Transfer  
 Normalized Emittance,  $H$  and  $V$   
 Emittance @ 100 GeV/A  
 (95% of beam population)

0.1 eV/A-sec  
 10.  $\pi$  mm-mrad

0.1  $\pi$  mm-mrad

RF Harmonic Number,  $h$

171

RF Frequency,  $f_{RF}$

13.37 MHz

Transition Energy,  $E_T$

35

Average Beam Current, particle  
 electric

1.34 mA

0.106 Amp

Regular Cell, average  $\beta$ -value  
 average  $\eta$ -value

30. m

0.5 m

no special  
magnetseptum  
magnetcommon  
magnet

Crossing Angle, $\alpha$ mrad	1.	2.	0.
No. of Bunches/Beam, B	171	171	57
No. of Ions/Bunch, N	$6.24 \times 10^8$	$6.24 \times 10^8$	$1.87 \times 10^9$
Rms Bunch Length, $\sigma_e$ , cm	15.	15.	90.
Rms Energy Spread, $\sigma_E/E$	$1. \times 10^{-3}$	$1. \times 10^{-3}$	$.3 \times 10^{-3}$
Bunch Area, eV/A-sec	0.625	0.625	1.125
RF Voltage, kV	200	200	100
$\beta_v^*$ m	2.0	2.0	1.0
$\beta_H^*$ m	32	2.0	1.0
$\sigma_v^*$ cm	0.0183	0.0183	0.013
$\sigma_H^*$ cm	0.073	0.0183	0.013
$p = \alpha \sigma_e / 2 \sigma_H^*$	0.82	0.82	0.
$f = \sqrt{1 + p^2}$	1.2932	1.2932	1.
rms Interaction Length, cm	7.5	7.5	45.
Luminosity, $\text{cm}^{-2} \text{s}^{-1}$	$0.25 \times 10^{27}$	$1.0 \times 10^{27}$	$0.8 \times 10^{28}$
Beam-Beam Tune Shift, $\Delta \nu$	0.0003	0.0012	0.0047
Peak Current, particle, mA	80.	80.	40.
electric, Amp	6.3	6.3	3.15
$ Z/n $ allowable, ohm	114	114	20.5
Initial Luminosity			
Loss Rate, $\text{h}^{-1}$	0.732	0.732	0.945



## Lattice :

### Regular Cells :

No. of Regular Cells  
Length (Full)  
Phase Advance (Full)

96  
24.514 m  
125.2°

$\beta_{\max}$

56.6 m

$\beta_{\min}$

3.4 m

$\eta_{\max}$

0.722 m

$\eta_{\min}$

0.278 m

Bending Angle / Half Cell

32.151 mrad

Contribution to  $\beta$ -Tune

32.

$B' \times l_q$

121.65 Tesla

Quadrupole Gradient,  $B'$

6.1 KG/cm

Quadrupole Length,  $l_q$

2.0 m

Dipole Length,  $l_B$

8.257 m

Dipole Field

3.27 Tesla

Sagitta

3.3 cm

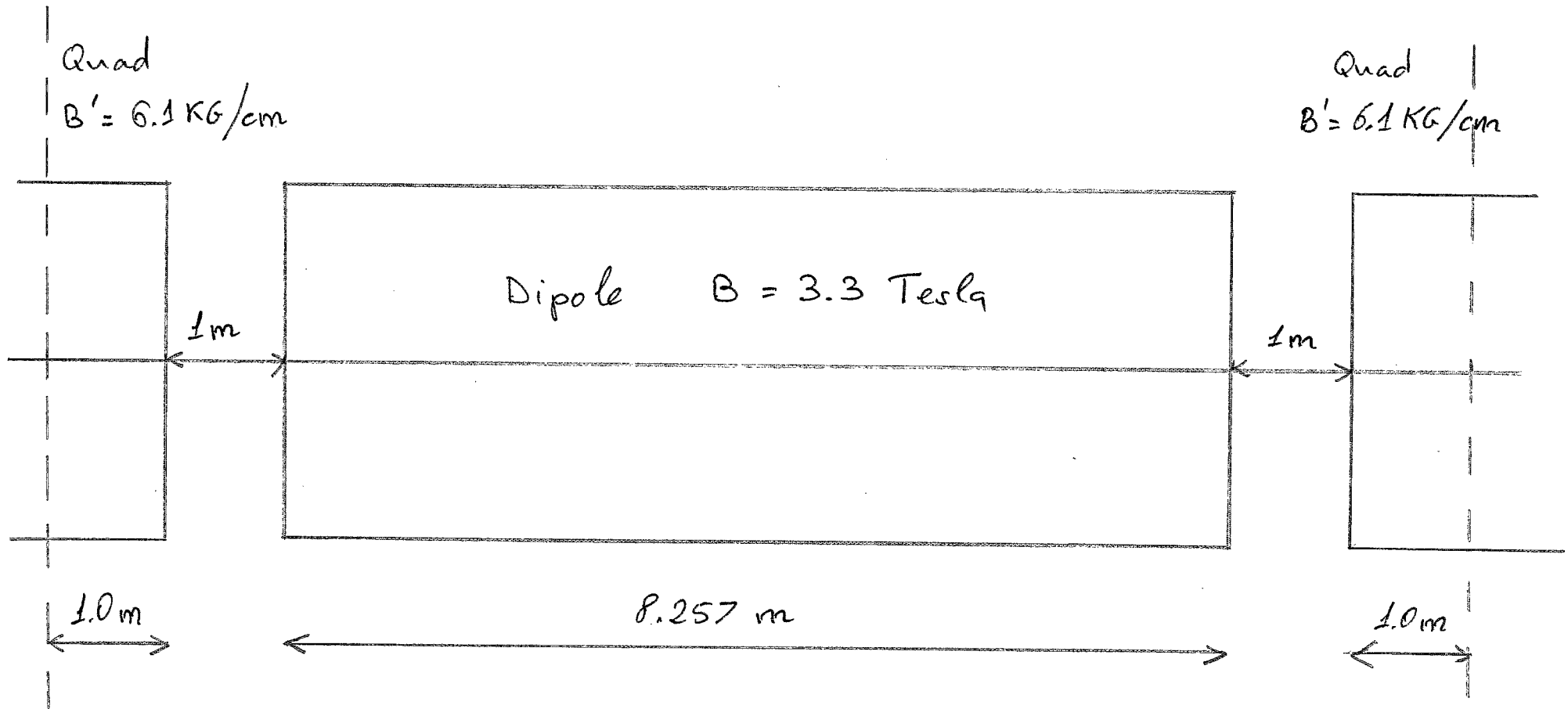
Bending Radius,  $\rho$

256.8 m

Drift between dipole and quad

1.0 m

# Half-Regular Cell



No. of Dipoles / Ring = 192

No. of Quads / Ring = 192

Special Dipoles and Quads not included

## Beam Size (Max.)

Energy	Height ( $\pm 2.5\sigma$ )	Width ( $\pm 2.5\sigma$ )
100 GeV/A	$\pm 2.4$ mm	$\pm 3.0 / 4.2$ mm
12	6.6	6.8 / 8.4
5	9.7	9.9 / 11.5

Circular Vacuum Chamber  
with i.d.

6.0 cm

Requirement on Good Field  
Region :

@ 5 GeV/A  
100 GeV/A

$\pm 2.5$  cm  
 $\pm 1.0$  cm

$$\sigma_E/E = 10^{-3}$$

$$\gamma = 100$$

$$I = 1 \text{ A-electric}$$

Gold

# 57

$\varepsilon_N$	$\chi_E^{-1}$	$\chi_H^{-1}$	$\chi_V^{-1}$
5 $\pi \text{ mm.mrad}$	.1538 $h^{-1}$	.2523 $h^{-1}$	-.0554 $h^{-1}$
8	.1007	.1032	-.0227
10	.0816	.0669	-.0147
12	.0684	.0467	-.0103

$$\varepsilon_N = 10 \pi \text{ mm.mrad}$$

$\sigma_E/E$	$\chi_E^{-1}$	$\chi_H^{-1}$	$\chi_V^{-1}$
$0.5 \times 10^{-3}$	.5415 $h^{-1}$	.1110 $h^{-1}$	-.0244 $h^{-1}$
0.8	.1547	.0812	-.0178
1.0	.0816	.0669	-.0147
1.2	.0474	.0560	-.0123

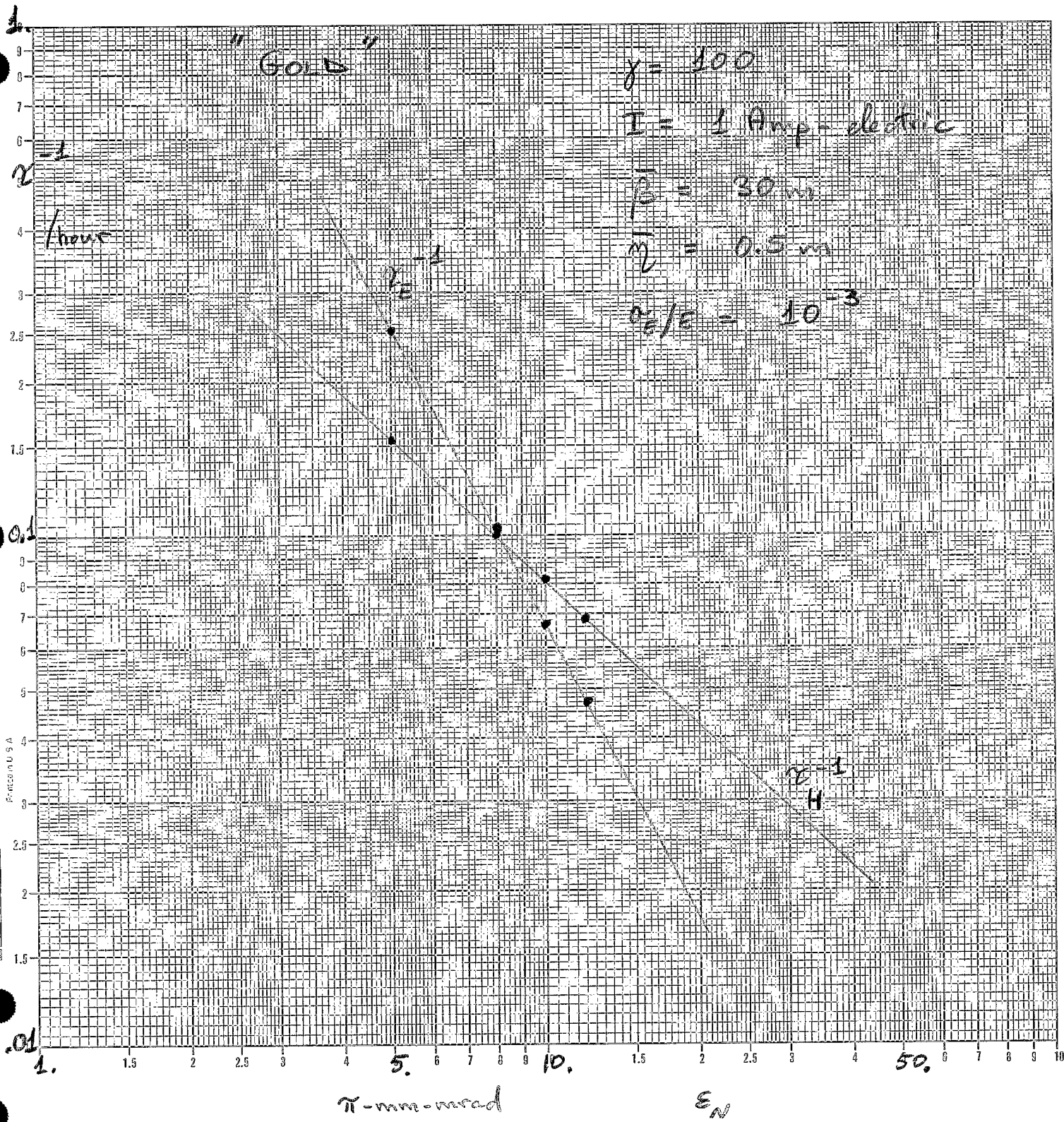
Comparison of Diffusion Rates vs. normalized  
emittance  $\varepsilon_N$  and rms energy spread  $\sigma_E/E$

# Comparison of Diffusion Rates with Lattice Choice

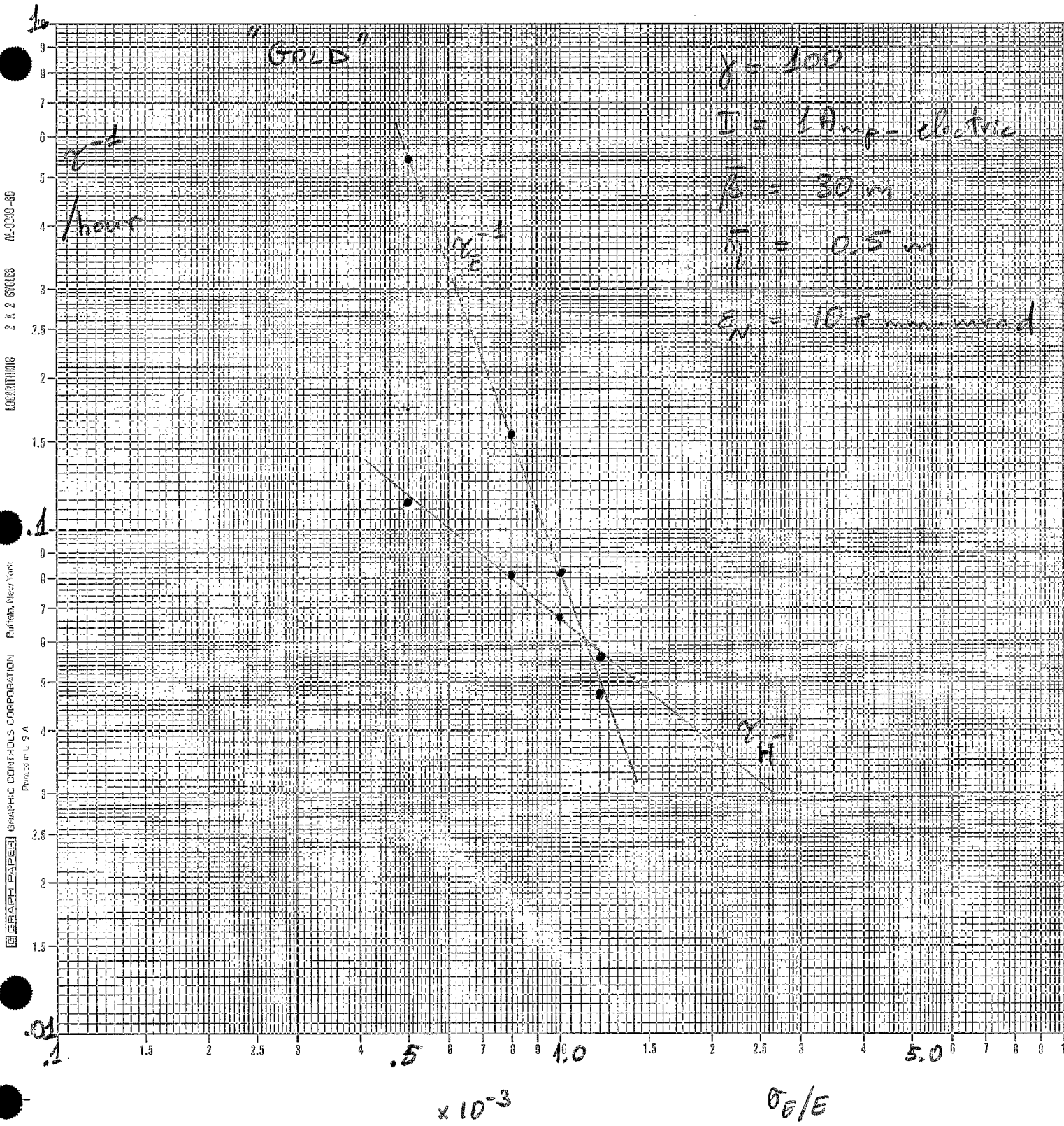
$\bar{\beta}$	m	25	30	35	40		
$\bar{\eta}$	m	.5	.5	.5	.5	$\Leftarrow$	
case #		46	57	68	79		
$\chi_E^{-1}$	$h^{-1}$	.0964	.0816	.070	.0607		
$\chi_H^{-1}$	$h^{-1}$	.1012	.0669	.0453	.0307		
$\chi_v^{-1}$	$h^{-1}$	-.0145	-.0147	-.0147	-.0146		
<hr/>							
$\bar{\beta}$	m	25	30	35	40		
$\bar{\eta}$	m	1.0	1.0	1.0	1.0	$\Leftarrow$	
case #		47	58	69	80		
$\chi_E^{-1}$	$h^{-1}$	.0837	.0744	.0665	.0596		
$\chi_H^{-1}$	$h^{-1}$	.3891	.2842	.2139	.1646		
$\chi_v^{-1}$	$h^{-1}$	-.0126	-.0134	-.0140	-.0143		
<hr/>							
$\sigma_E/E = 10^{-3}$				$\gamma = 100$			
$E_N = 10 \pi \text{ mm. mrad}$							
Gold				$I = 1.0 \text{ Amp-electric}$			

AL-0049-80  
2 X 2 INCHES  
LOGARITHMIC

GRAPH PAPER  
GRAPHIC CONTROLS CORPORATION  
Baiton, New York  
FRANCE 100 5 A



GRAPHIC CONTROLS CORPORATION Buffalo, New York  
 Model 54



$$\sigma_E/E = 10^{-3}$$

$$E_N = 10 \pi \text{ mm} \cdot \text{mrad}$$

Gold

$$I = 1 \text{ Amp} - \text{electric}$$

$\gamma$	$\tau_E^{-1}$	$\tau_H^{-1}$	$\tau_V^{-1}$
5	-3.7099 $h^{-1}$	12.904 $h^{-1}$	13.0858 $h^{-1}$
10	-0.6270	1.0605	1.1229
12	-0.315	0.4332	0.4709
20	0.0911	-0.0637	-.0818
40	0.1614	-0.0081	-0.0726
60	0.1293	0.0388	-0.0388
80	0.1017	0.0585	-0.0229
100	0.0816	0.0669	-0.0147

Comparison of Diffusion Rates vs.  $\gamma$  -



$$\bar{\eta} = 0$$

$$\gamma = 100$$

Gold

$$\sigma_E/E = 10^{-3}$$

$$\varepsilon_N = 10\pi \text{ mm.mrad}$$

$$I = 1 \text{ A electric}$$

$\bar{\beta}$	$\tau_E^{-1}$	$\tau_H^{-1} (= \tau_V^{-1})$
1. m	1.1403 h <sup>-1</sup>	-.0068 h <sup>-1</sup>
2	.7361	-.0088
3	.5624	-.0101
5	.3926	-.0118
70	.0258	-.0108
100	.0123	-.0074
200	-.0028	.0034
300	-.0069	.0125
500	-.0090	.0270
700	-.0091	.0384
1000	-.0087	.0520

# Initial luminosity loss Rates

$$\tau_L^{-1} = \frac{P^2}{f^2} \tau_E^{-1} + \left(2 - \frac{P^2}{f^2}\right) (\tau_H^{-1} + \tau_V^{-1})$$

Gold,  $\gamma = 100$ , # 57,  $I = 1$  Amp-electric

$$\sigma_E/E = 1 \times 10^{-3}$$

$$P = 0.82$$

⇓

$$\tau_L^{-1}$$

$$P = 0$$

⇓

$$\tau_L^{-1}$$

$$\varepsilon_N$$

$$5 \pi \text{ mm} \cdot \text{mrad}$$

$$.3765 \quad h^{-1}$$

$$.3938 \quad h^{-1}$$

$$8$$

$$.1691$$

$$.1610$$

$$10$$

$$.1162$$

$$.1044$$

$$12$$

$$.0857$$

$$.0728$$

$$\varepsilon_N = 10 \pi \text{ mm} \cdot \text{mrad}$$

$$\sigma_E/E$$

$$\tau_L^{-1}$$

$$0.5 \times 10^{-3}$$

$$.3561 \quad h^{-1}$$

$$.1732 \quad h^{-1}$$

$$1.8$$

$$.1635$$

$$.1268$$

$$1.0$$

$$.1162$$

$$.1044$$

$$1.2$$

$$.0889$$

$$.0874$$