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Intrabeam Scattering with Stochastic Cooling

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November 2, 1988

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Intrabeam Scattering with Stochastic Cooling

V_{RF} problem, $V_{RF} \leq 4.5 \text{ MV}$

E_x blow up Solution

Initial $E_x = 10$ blown up to $E_{x,0} = 60$ ($A_u, \gamma = 100$)

This gives $V_{RF} \leq 4.5 \text{ MV}$

$E_x = 60$ grows to $E_x = 69$

Luminosity reduced by factor 3.

Longitudinal Stochastic Cooling

Suggested by AG Ruggiero; cooling time $\sim 10 \text{ hrs}$
to keep $V_{RF} \leq 4.5 \text{ MV}$

Solution with only longitudinal Cooling

$$GRSCL = 1/9$$

$$V_{RF} \leq 4.5 \text{ MV} \quad (\text{reaches at } t = 5 \text{ hrs})$$

$$\text{final } E_x = 37$$

32% less luminosity.

$A_u \rightarrow$
 $\gamma = 100$

Equations Used

$$\frac{1}{\sigma_p} \frac{d\sigma_p}{dt} = f_1(\sigma_x, \sigma_p) - \text{GRSCL}$$

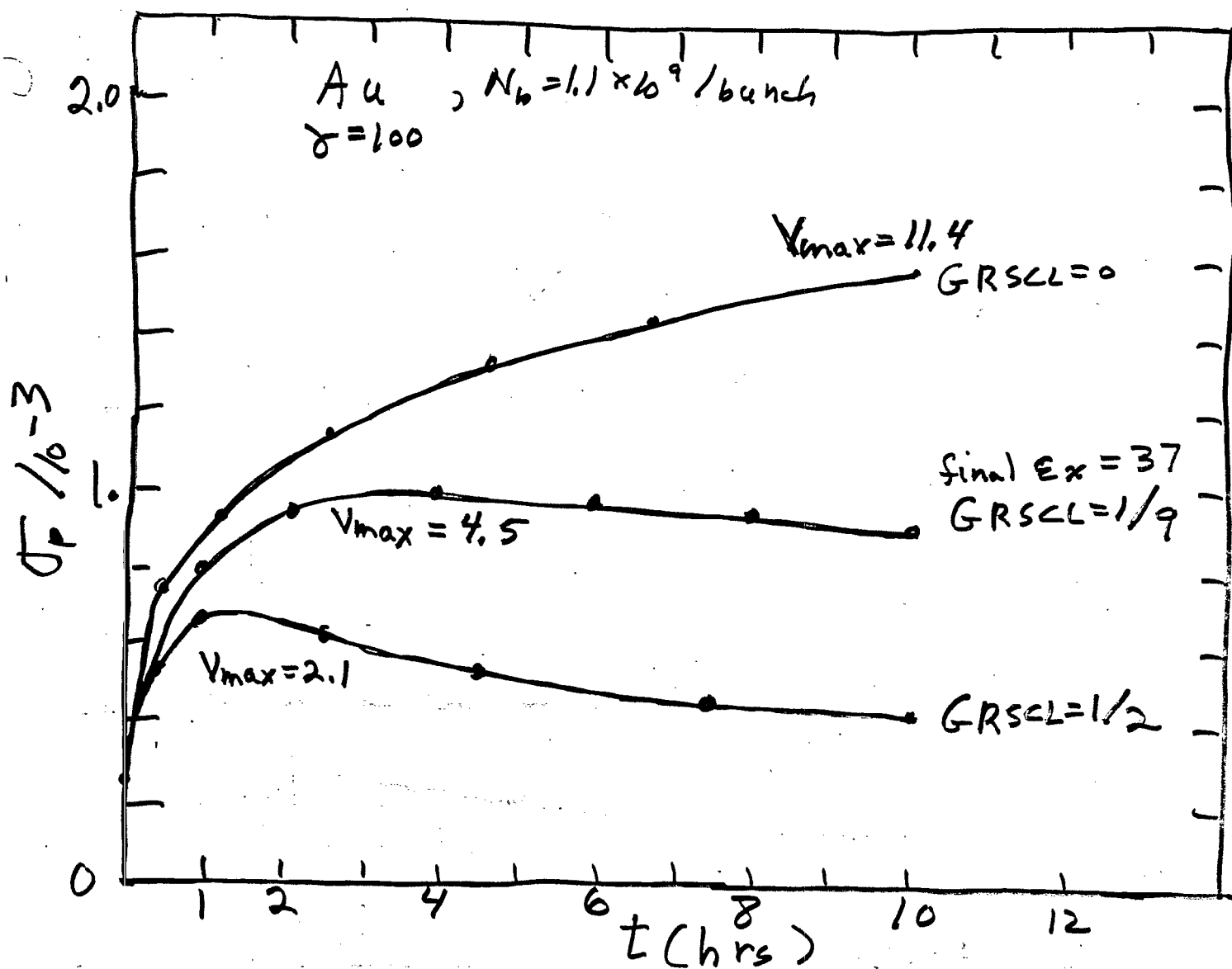
$$\frac{1}{\sigma_x} \frac{d\sigma_x}{dt} = f_2(\sigma_x, \sigma_p)$$

Dependence of GRSCL on σ_p

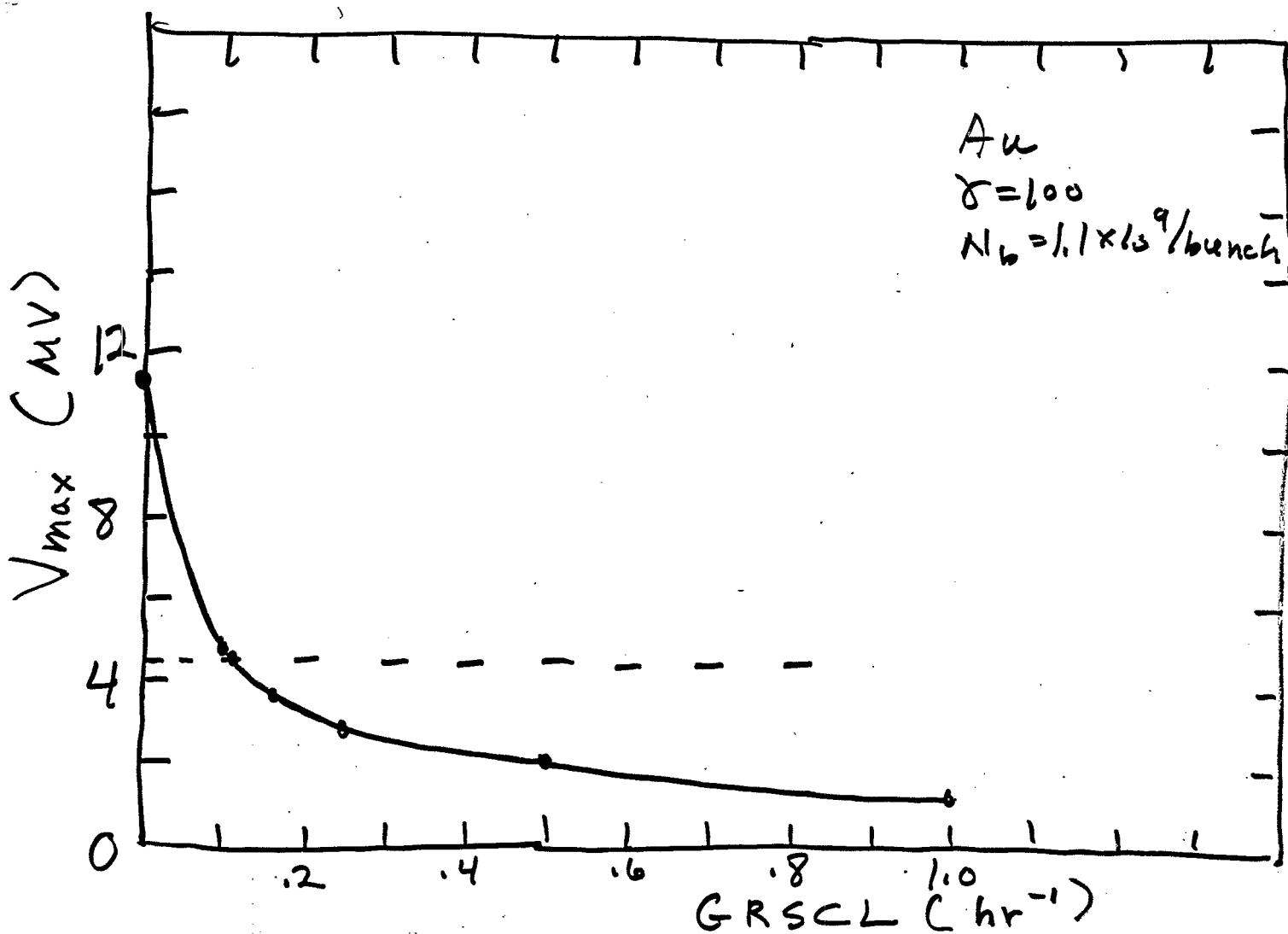
At the beginning, when σ_p is small - Cooling plays little role - I.B.S. dominates.

One needs to have the desired value of GRSCL when $\sigma_p \sim 1 \times 10^{-3} \Rightarrow V_{RF} = 4.5 \text{ MV}$, that is, $\text{GRSCL} \sim f_1(\sigma_x, \sigma_p)$ when $\sigma_p \sim 1 \times 10^{-3}$

Growth in energy spread with time
with
longitudinal Cooling only.



Maximum RF Voltage Required
Versus
the Longitudinal Cooling Rate, $GRSCL$



Transverse Stochastic Cooling, GRSC

GRSC \neq requires more longitudinal cooling to keep $V_{RF} \leq 4.5 \text{ MV}$

Transverse Cooling will give a higher and more constant luminosity

With both transverse and longitudinal cooling, there is an equilibrium value of σ_x, σ_y . The beam stops growing after 1 to 2 hours

A ~~small~~ reasonable compromise may be

$$GRSCL = 1/6$$

$$GRSCT = 1/10$$

$$\text{final } \epsilon_x = 17$$

about 50% more average luminosity

$$V_{RF} \leq 4.5 \text{ MV}$$

40% drop in luminosity with time

Beam Growth with Transverse Cooling and Longitudinal Cooling

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