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Intrabeam Scattering with Stochastic Cooling

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

ε_x blow up Solution

Initial $\varepsilon_x = 10$ blown up to $\varepsilon_{x,0} = 60$ (Au, $\gamma = 100$)
This gives $V_{RF} \leq 4.5$ MV
$\varepsilon_x = 60$ grows to $\varepsilon_x = 69$
Luminosity reduced by factor 3.

Longitudinal Stochastic Cooling

Suggested by AG Ruggiero; Cooling time ~ 10 hrs
to Keep $V_{RF} \leq 4.5$ MV

Solution with only longitudinal Cooling

Au → $\gamma = 100$

GRSCL = 1/9
$V_{RF} \leq 4.5$ MV (reacheat at $t = 5$ hrs)
final $\varepsilon_x = 37$
3% less luminosity.

Equations Used

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

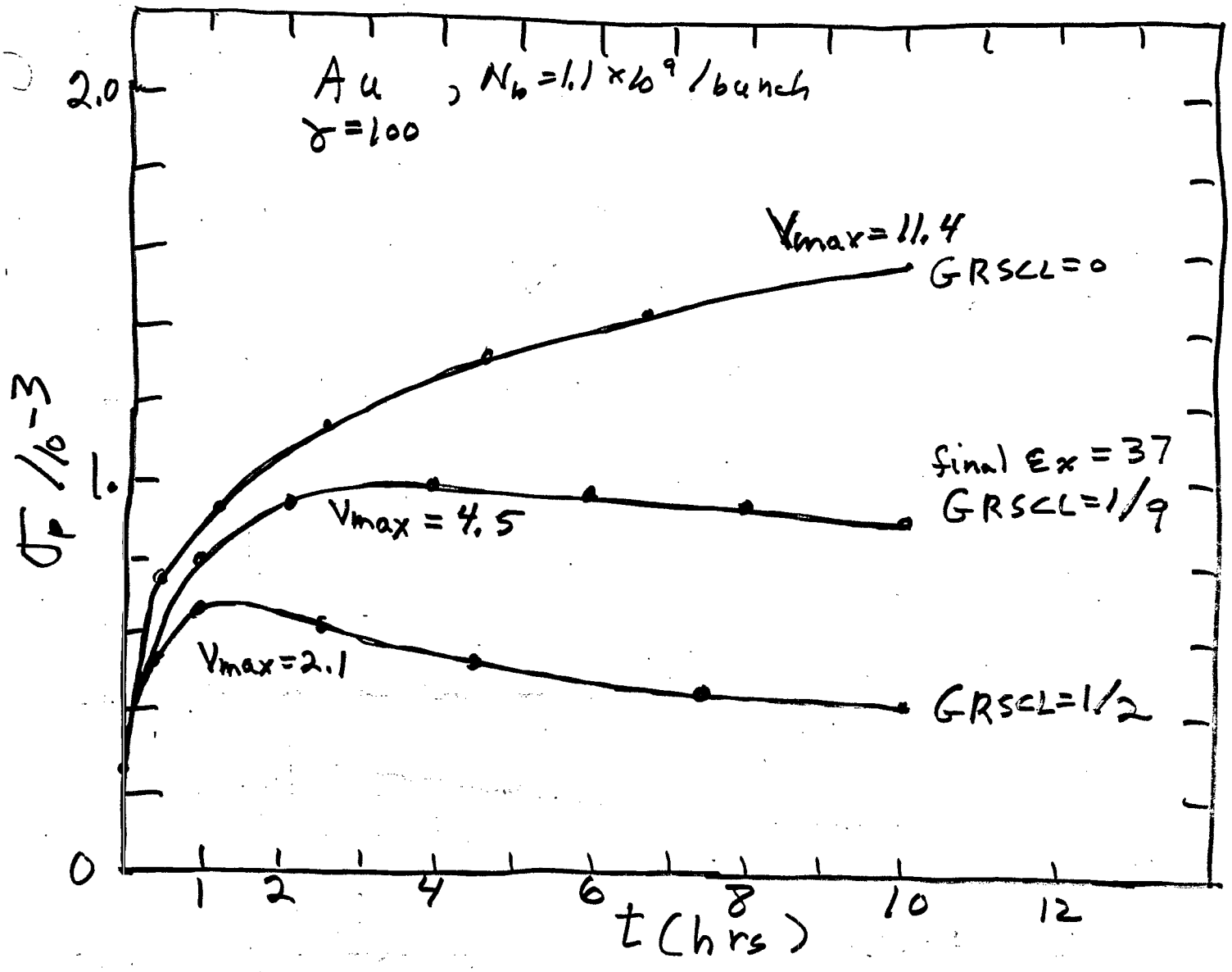
$$\frac{1}{\sigma_x}\frac{d\sigma_x}{dt} = f_2(\sigma_x, \sigma_p)$$

Dependence of GRSCL on σ_p

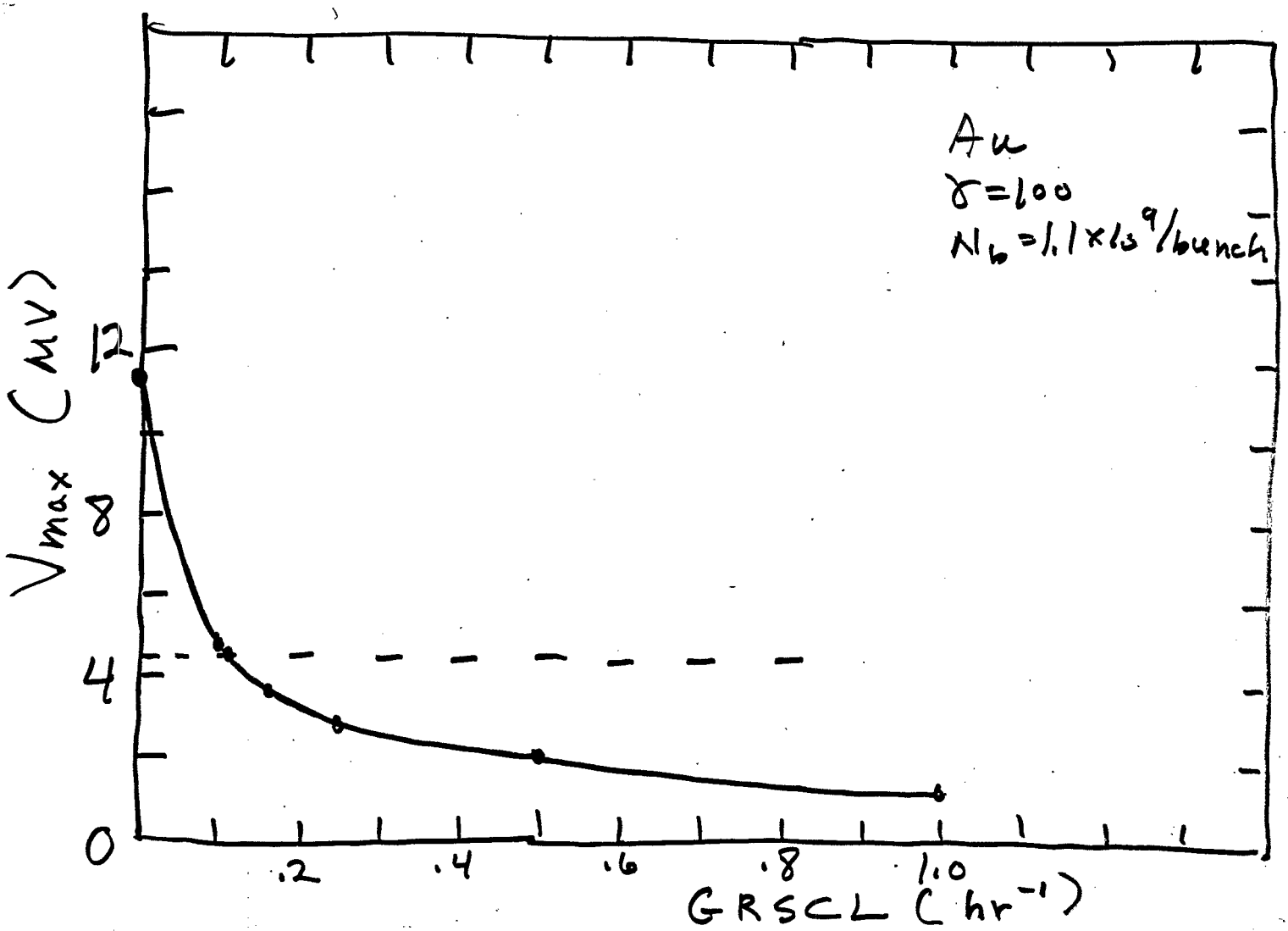
At the beginning, when σ_p is small — Cooling plays little role — I.B.S. dominates.

One needs to have the desired value of GRSCL when $\sigma_p \sim 1\times10^{-3} \Rightarrow V_{RF} = 4.5$ MV; that is, $\text{GRSCL} \sim f_1(\sigma_x, \sigma_p)$ when $\sigma_p \sim 1\times10^{-3}$

Growth in energy spread with time
with
longitudinal Cooling only



Maximum RF Voltage Required
Versus
the Longitudinal Cooling Rate, GRSCL



Transverse Stochastic Cooling, GRSCT

GRSCT ≠ 0 requires more longitudinal cooling to keep $V_{RF} \leq 4.5$ MV

Transverse Cooling will give a higher and more constant luminosity

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

a reasonable compromise maybe

GRSCL = 1/6
GRSCT = 1/10
final $\varepsilon_x = 17$
about 50% more averege luminosity
$V_{RF} \leq 4.5$ MV
40% drop in luminosity with time

Beam Growth with Transverse Cooling and Longitudinal Cooling