

Emittance Growth and Coupling Due to Chromaticity Sextupoles in RHIC

G. Parzen

January 1987

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Emittance Growth and Coupling
Due to Chromaticity Sextupoles
in RHIC

G. Parzen

BNL

February 3, 1987

Introduction

In order to understand the non-linear effects of error field multipoles, it is ~~not~~^{useful} to first know what non-linear effects are present due to Chromaticity Sextupoles alone.

It will be seen that the sextupoles produce large non linear effects, about 10% growth in the emittances and about 40% growth in the betatron amplitudes

The additional emittance growth, due to random magnet field errors, is ^{usually} small compared to the emittance growth due to the sextupoles.

Coupling and Emittance Growth due to Sextupoles Only

Sextupoles only, no random field errors

Starting emittance, $\epsilon_x = 3.25$, $\epsilon_y = 3.25$
 $\chi_0 \approx 12.7 \text{ mm}$

Emittance growth

$$\epsilon_{x, \text{max}} = 6.3$$

$$\epsilon_{y, \text{max}} = 6.8$$

$$\epsilon_{T, \text{max}} = 8.2$$

$$\frac{\Delta \epsilon_T}{\epsilon_{T, \text{max}}} = 1.14, \text{ smear}$$

Emittance Growth Survey in E_x and E_y

The emittance growth is computed for various points on the surface

$$E_{x_0} + E_{y_0} = 6.5$$

The ~~worse~~ largest growth occurs near $E_{x_0} \approx E_{y_0}$. (see figure 1.)
For smaller starting emittances

$$E_{x_0} + E_{y_0} < 6.5,$$

the emittance growth should be smaller.

In figure 1, the large dots \bullet show the initial emittances E_{x_0} , E_{y_0} .

The lines with arrows $\bullet \rightarrow \bullet$ show the maximum emittance attained, $E_{x_{max}}$ and $E_{y_{max}}$ for the given initial emittances, E_{x_0} and E_{y_0} . $E_{x_{max}}$ and $E_{y_{max}}$ do not occur simultaneously; usually E_x becomes large when E_y becomes smaller and similarly for E_y .

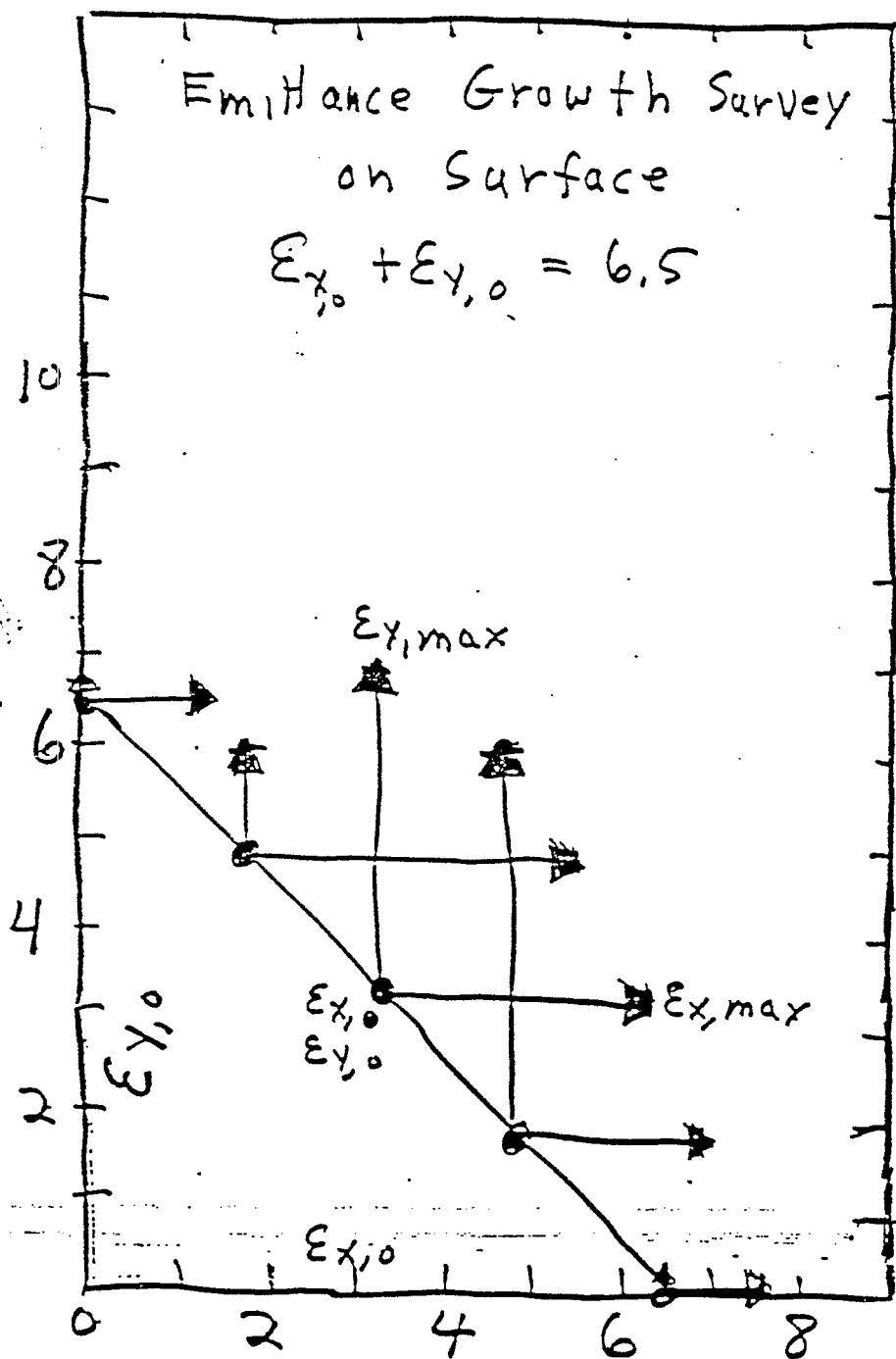


Fig 4

Additional Emittance Growth due to Random

Field Errors

Most of the emittance growth is due to sextupoles,

↳ random multipoles present in runs done.

↳ different sets of random errors studied.

Runs start with $\epsilon_x = \epsilon_y = 3.25$, $x' = y' = 0$

Growth due to Sextupoles alone ($x' = y' = 0$ run)

$$\epsilon_{x, \max} = 3.7$$

$$\epsilon_{y, \max} = 6.8$$

$$\epsilon_{t, \max} = 8.2$$

$$\Delta \epsilon_t / \epsilon_t = \pm .12$$

Growth due to Sextupoles + Random Errors, 10 runs

$$\epsilon_{x, \max} = 4.7$$

$$\epsilon_{y, \max} = 7.7$$

$$\epsilon_{t, \max} = 10.5$$

$$\Delta \epsilon_t / \epsilon_t = \pm .26 \text{ (unusual, } \pm .19 \text{ more likely)}$$

Random errors cause about 15% more growth in the emittance. Most of the growth is due to the Sextupoles.