BNL-101698-2014-TECH

RHIC/AP/42;BNL-101698-2013-IR

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)

DISCLAIMER

AD/RHIC-AP-42

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 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 100% 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, $\varepsilon_x = 3.25$, $\varepsilon_y = 3.25$

$x_0 \simeq 12.7$ mm

Emittance growth

$$\varepsilon_{x,max} = 6.3$$

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

$$\varepsilon_{T,max} = 8.2$$

$$\left.\frac{\Delta\varepsilon_T}{\varepsilon_T}\right|_{max} = \pm .14 \text{, smear}$$

Emittance Growth Survey in ε_x and ε_y

The emittance growth is computed for various points on the surface

$$\varepsilon_{x,0} + \varepsilon_{y,0} = 6.5$$

The largest ~~worse~~ growth occurs near $\varepsilon_{x,0} \simeq \varepsilon_{y,0}$ (see figure 1.) For smaller starting emittances

$$\varepsilon_{x,0} + \varepsilon_{y,0} < 6.5,$$

the emittance growth should be smaller.

In figure 1, the large dots ● show the initial emittances $\varepsilon_{x,0}$, $\varepsilon_{y,0}$. The lines with arrows ●—▶ show the maximum emittance attained, $\varepsilon_{x\,max}$ and $\varepsilon_{y\,max}$ for the give initial ~~emittances~~ emittances, $\varepsilon_{x,0}$ and $\varepsilon_{y,0}$. $\varepsilon_{x\,max}$ and $\varepsilon_{y\,max}$ do not occur simultaneously, usually ε_x becomes large when ε_y becomes smaller and similarly for ε_y.

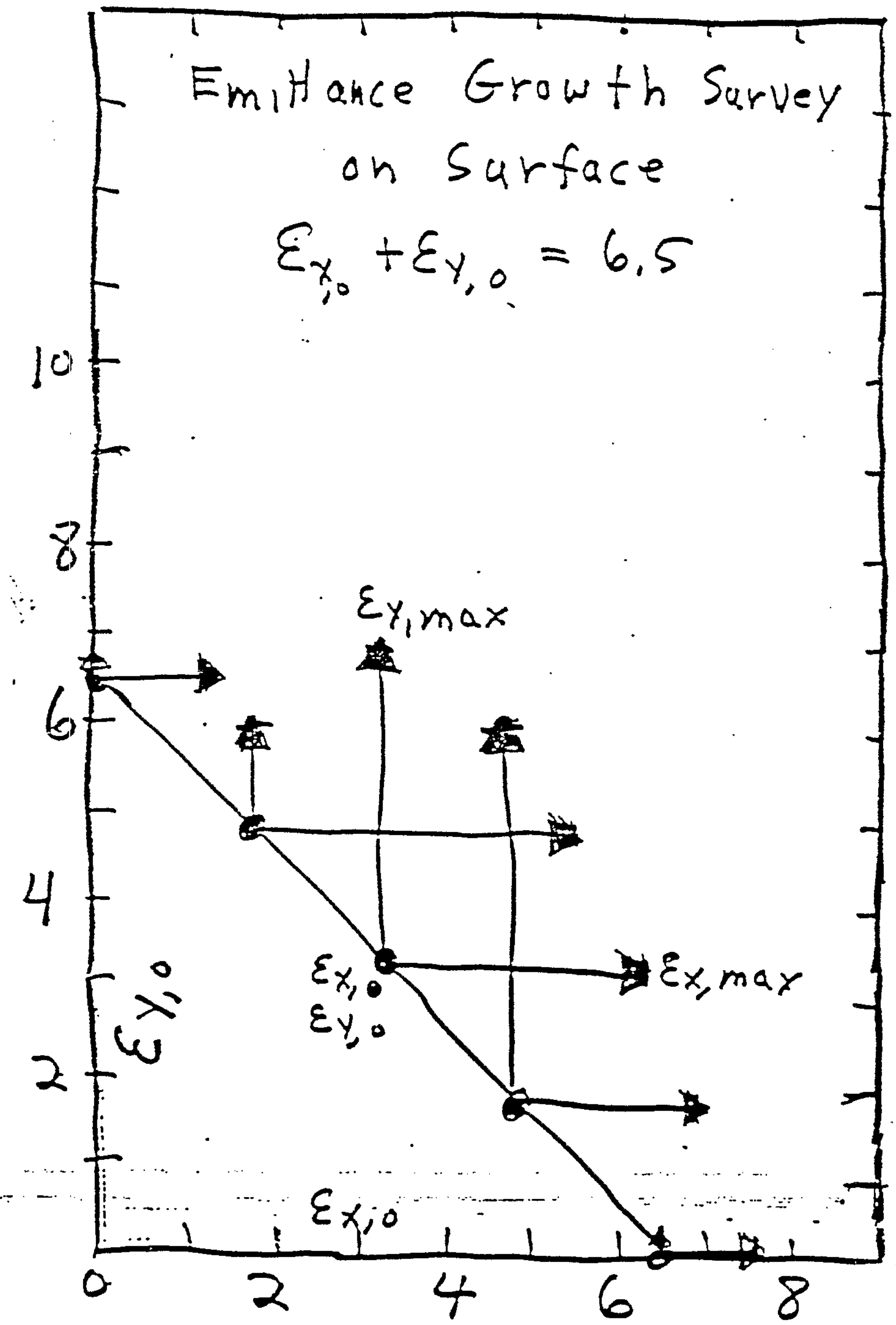
Emittance Growth Survey
on Surface
$\varepsilon_{x,0} + \varepsilon_{y,0} = 6.5$
$\varepsilon_{y,max}$
$\varepsilon_{x,max}$
$\varepsilon_{x,0}$
$\varepsilon_{y,0}$
$\varepsilon_{y,0}$
$\varepsilon_{x,0}$
10
8
6
4
2
0
2
4
6
8

Fig 4

Additional Emittance Growth due to Random Field Errors

Most of the emittance growth is due to sextupoles.
10 random multipoles present in runs done.
10 different sets of random errors studied.

Runs start with $\varepsilon_x = \varepsilon_y = 3.25$, $x' = y' = 0$

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

$\varepsilon_{x,max} = 3.7$
$\varepsilon_{y,max} = 6.8$
$\varepsilon_{t,max} = 8.2$
$\Delta\varepsilon_t/\varepsilon_t = \pm .12$

Growth due to Sextupoles + Random Errors, 10 runs

$\varepsilon_{x,max} = 4.7$
Worse run results → $\varepsilon_{y,max} = 7.7$
$\varepsilon_{t,max} = 10.5$
$\Delta\varepsilon_t/\varepsilon_t = \pm .26$ (unusual, $\pm .19$ more likely)

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