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Systematic Multipoles in the Dipoles and Their Effect on Dynamic Aperture and A ?-Spread

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Introduction

Two effects of the systematic multipoles in the dipoles were studied:

1) the effect on the dynamic aperture
2) The ν-spread in the beam at $\gamma = 30$.

The ν-spread in the beam may be the more important effect, as it can be fairly large when compared with the available ν-space of $\Delta\nu = 33 \times 10^{-3}$. The ν-spread appears to be largely due to the systematic by. Thus, it can be reduced by about a factor of 2 using the by correction system. It may be desireable to farther reduce by below a certain tolerance level given below.

The ν-spread due to random multipoles is also large of the order of $\Delta\nu_{spread} \simeq 17 \times 10^{-3}$. This may be partially correctable. It still may be desireable to reduce the ν-spread due systematic multipoles as much as possible.

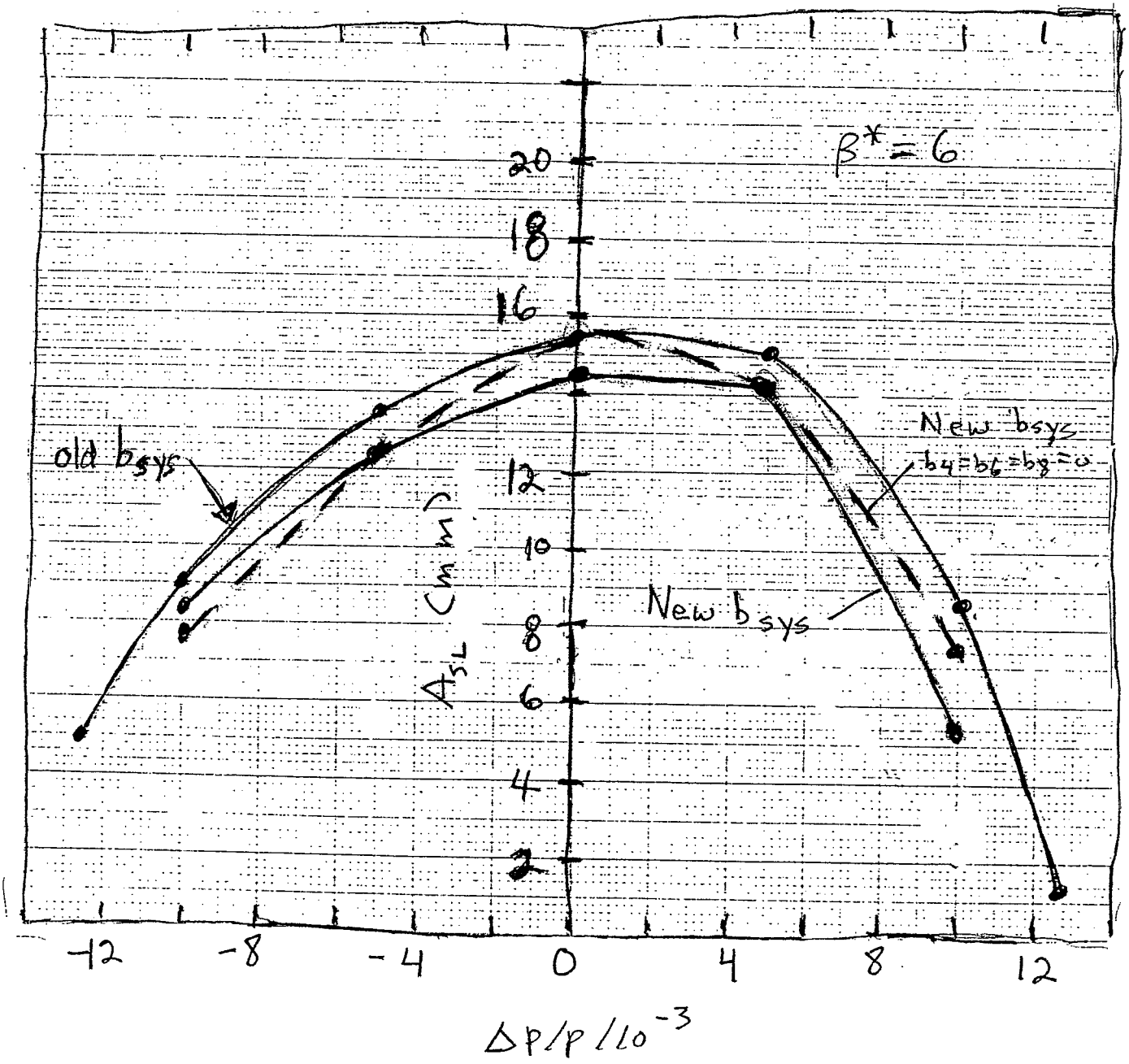
Data for Systematic b'_K

K	old	New 5/89
2	.02	2.24
4	.009	.75
6	.003	.303
8	.005	.181
10	.016	−.039
12	.565	.754
14	.182	.247
16	−.19	−.232
18	.036	.153

Above data due to Pat Thompson.

This study uses the New data in the third Column

Effect of the Systematic b_K on the Dynamic Aperture



Dynamic Aperture Continued

Effect of Increasing Radius of BC2

Will increasing RBC2 from RBC2=4 cms to RBC2 = 5 cms still increase A_{SL} with the new $b_{K,sys}$? The answer is yes.

With RBC2 = 5 cm, $\delta P/P = 0$

A_{SL} = 18.5 mm, old $b_{K,sys}$

A_{SL} = 18.5 mm, new $b_{K,sys}$

Dynamic Aperture due $b_{K,sys}$ only (No random b_K, q_K)

RBC2 = 4, $\delta P/P = 0$

A_{SL} = 16.5 mm, new $b_{K,sys}$

A_{SL} = 17.5 mm, old $b_{K,sys}$

RBC2 = 5, $\delta P/P = 0$

A_{SL} = 19.5 mm, new $b_{K,sys}$

A_{SL} = 19.5 mm, old $b_{K,sys}$

$\Delta\nu$ - spread due to Systematic b_K (no random b_K, a_K)

At $\gamma = 30$, $\sigma_x = 3.1$ mm, $\Delta p/p = 5\times10^{-3}$ after 10 hours

$\varepsilon_t = \varepsilon_x + \varepsilon_y$ for 95% of beam is at

$$x = \sqrt{10}\,\sigma_x \quad (x' = y' = y = 0)$$

$$x = 9.8 \text{ mm}, \quad \varepsilon_t = 1.92$$

$\Delta\nu$-spread is found within $\varepsilon_t = 1.92$, within 95% beam, and not within the ε_t given by 6σ rule, $\varepsilon_t = 6.5$.

3 points on ε_t surface were studied

$\varepsilon_x = \varepsilon_t$, $\varepsilon_y = 0$

$\varepsilon_x = \varepsilon_t/2$, $\varepsilon_y = \varepsilon_t/2$

$\varepsilon_x = 0$, $\varepsilon_y = \varepsilon_t$

Largest $\Delta\nu$ found for $\varepsilon_x = \varepsilon_t$, $\varepsilon_y = 0$

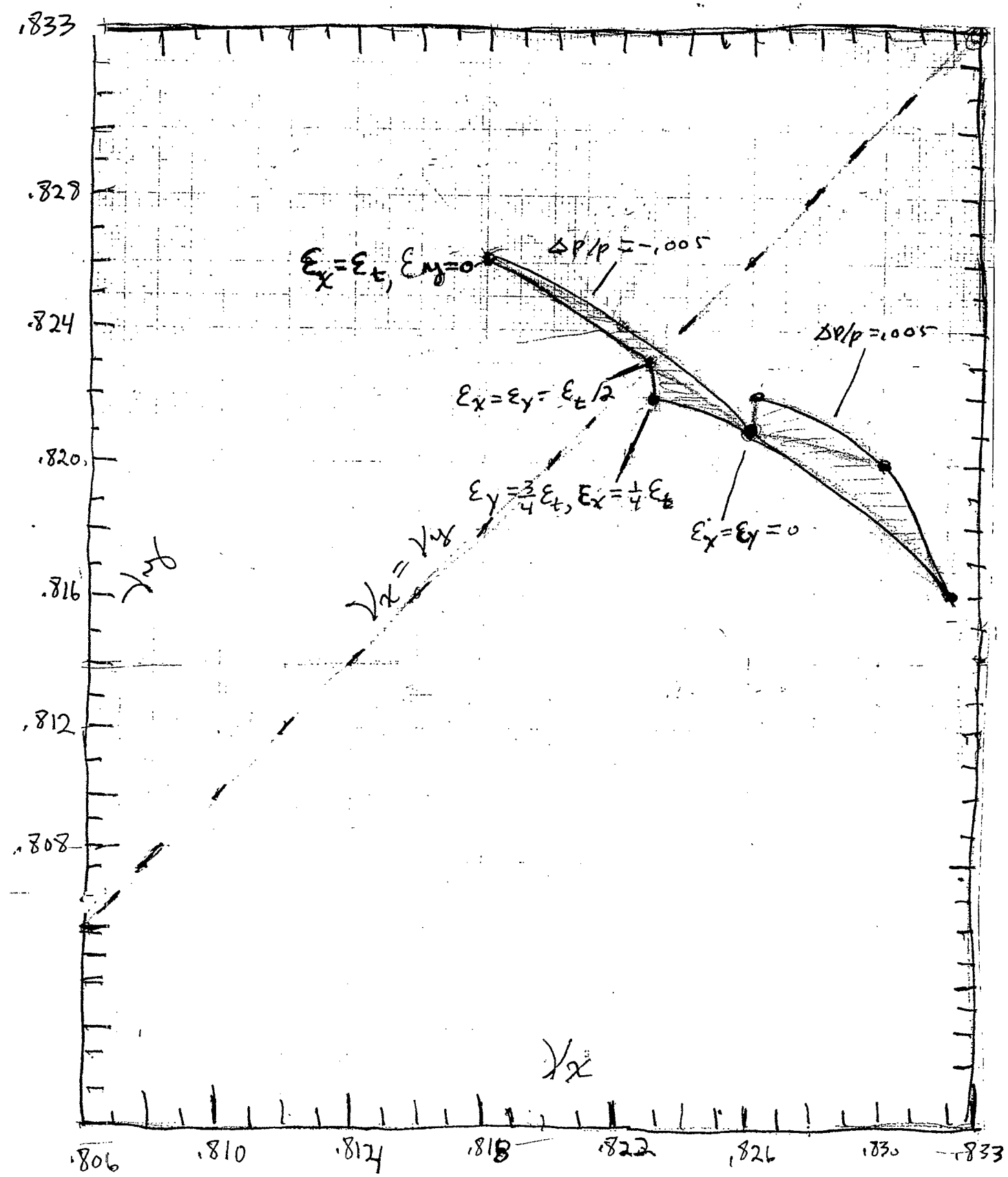
$\Delta\nu_x, \Delta\nu_y = -8.5\times10^{-3}$ $\quad \Delta p/p = -.005$

$\Delta\nu_x, \Delta\nu_y = \;\;6.-5\times10^{-3}$ $\quad \Delta p/p = .005$

Total ν-spread $= 14\times10^{-3}$

(note $b_4' = .75$ here)

γ-spread in 95% of Beam
due to bk, sys



Multipole Breakdown of $\Delta\nu$-Spread

		$\Delta p/p = -.005$ $\Delta\nu_x$, $\Delta\nu_y / 10^{-3}$	$\Delta p/p = .005$ $\Delta\nu_x$, $\Delta\nu_y / 10^{-3}$
b_2, only		0, 0	
b_4 "		-6, 5	5, -4
b_6 "		-1, 1	
b_8 "		0, 0	
b_{10} "		0, 0	
b_{12} "		0, 0	
b_{14} "		0, 0	
b_{16} "		0, 0	
b_{18} "		0, 0	
	Total	-7, 5	

$\gamma = 30$
$x_0 = 9.8$ mm
$y_0 = 0$
$\varepsilon_t = 1.92$

Tolerance on b_4' to give $\Delta\nu_{spread} = 3 \times 10^{-3}$

$$b_4' = .23 \times 10^{-4}$$

at $\gamma = 30$, for $\varepsilon_t = 1.92$, $\Delta p/p = \pm .005$

Assuming b_4 correction gives a factor 2 improvement the tolerance becomes

$$b_4' = .46 \times 10^{-4}$$