

Tracking Considerations

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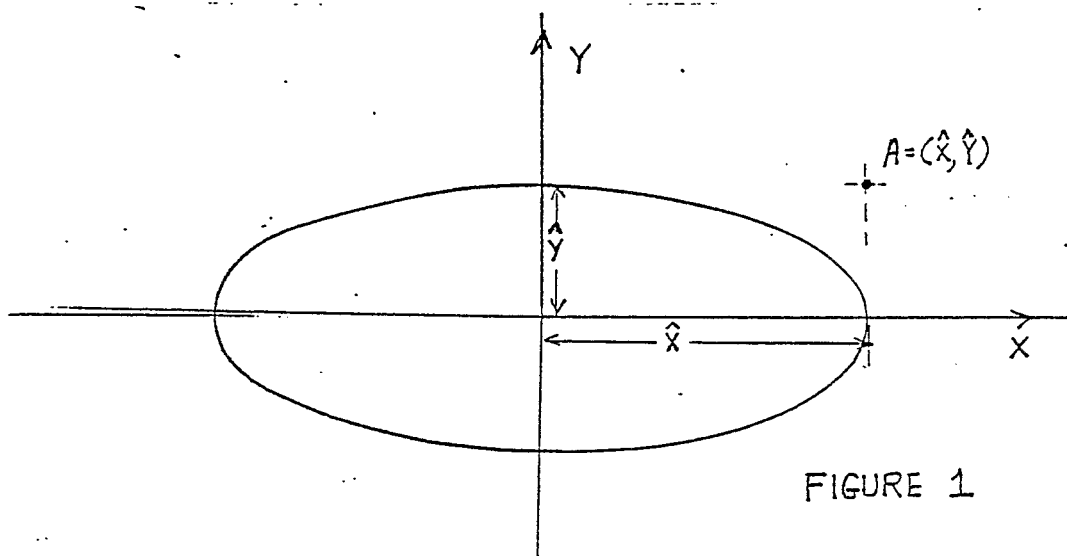
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TRACKING CONSIDERATIONS

1. DO WE INTERPRET OUR INITIAL CONDITIONS CORRECTLY?

CONSIDER A BEAM HAVING AN ELLIPTICAL PROFILE WITH HALF AXES \hat{X} AND \hat{Y} .



WE STATE THAT THE BEAM HAS EQUAL EMITTANCES IN THE X AND Y DIRECTIONS. USING THE NOTATION OF FIGURE 1,

$$\frac{\epsilon_{x_0}}{\pi} = \frac{\hat{X}^2}{\beta_x} = \frac{\epsilon_0}{\pi} = \frac{\hat{Y}^2}{\beta_y} = \frac{\epsilon_{y_0}}{\pi}$$

TRADITIONALLY WE TRACK WITH INITIAL CONDITIONS $\epsilon_{x_i} = \epsilon_{y_i}$ BUT IGNORE THE FACT THAT x_i AND y_i ARE CORRELATED BY:

$$\frac{x_i^2}{a^2} + \frac{y_i^2}{b^2} = 1 \quad \text{WITH } a = \hat{X} \text{ AND } b = \hat{Y}.$$

WHEN WE SELECT THE INITIAL VALUE OF x AS $x_i = \hat{x}$, THE VALUE OF y ($y_i = \hat{y}$) THAT SATISFIES $\epsilon_{x_i} = \epsilon_{y_i}$ GIVES AN INITIAL STARTING POINT "A" THAT DOES NOT LIE ON THE BEAM PROFILE ELLIPSE OF FIGURE 1. IN OTHER WORDS, WE ARE TRACKING A PARTICLE THAT LIES OUTSIDE OF THE BEAM AND HAS AN EMITTANCE LARGER THAN WE THINK!

2. DETERMINE x_i WHEN $\epsilon_{x_i} = \epsilon_{y_i}$,
 $x_i = \hat{x} = a = (\epsilon_0 \beta_x)^{1/2} = 18 \text{ mm}$, AND $\hat{y} = b = (\epsilon_0 \beta_y)^{1/2}$.

FOR: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, $\epsilon_{x_i} = \epsilon_{y_i}$, AND $\frac{x_i^2}{\beta_x} = \frac{y_i^2}{\beta_y}$,

$$\frac{x_i^2}{a^2} + \frac{y_i^2}{b^2} = \frac{x_i^2}{a^2} + \frac{\beta_y x_i^2}{\beta_x b^2} = \frac{x_i^2}{a^2} + \frac{\beta_x x_i^2}{\beta_x a^2} = 1.$$

THUS $\frac{2x_i^2}{a^2} = 1$ AND $x_i = \frac{a}{\sqrt{2}} = 12.7 \text{ mm}$,

AND WITH $\beta_x = 50 \text{ m}$ AND $\beta_y = 8.5 \text{ m}$, $y_i = 5.2 \text{ mm}$.

HENCE WHEN $\epsilon_{x_i} = \epsilon_{y_i}$, IT SEEMS WE DON'T NEED STABILITY TO $x_i = 18 \text{ mm}$ FOR RHIC AND THAT WE CURRENTLY SATISFY THE REQUIREMENT OF ACCOMODATING A BEAM OF $6\sigma_x$.

3. CONSIDER INITIAL TRACKING VALUES
WHEN $E_{x_i} \neq E_{y_i}$.

$$X_i = (E_{x_i} \beta_x)^{1/2}, \quad Y_i = (E_{y_i} \beta_y)^{1/2}, \quad \text{AND} \quad \frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1.$$

$$\frac{X_i^2 / \beta_x}{a^2 / \beta_x} + \frac{Y_i^2 / \beta_y}{b^2 / \beta_y} = \frac{E_{x_i}}{E_0} + \frac{E_{y_i}}{E_0} = 1.$$

THUS $E_{x_i} + E_{y_i} = E_0$, AND ANY POINT ON THE
BEAM ELLIPSE IS A VALID STARTING POINT
FOR TRACKING.

NOTE: THE TRACKING PROGRAM RACETRACK
ADJUSTS THE RELATION BETWEEN X AND Y
INTERNALLY SO THAT ALL STARTING POINTS
SATISFY THE CONDITION THAT $E_{x_i} + E_{y_i} = E_0$.