CALIFORNIA RESEARCH & DEVELOPMENT COMPANY

Process Development Division

- Livermore, California

RECD-4005

CRD-T2A-22

(FRACTION OF TOTAL BEAM CURRENT AS
A FUNCTION OF A-12 BEAM RADIUS)

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RESTRICTED DATA

FRACTION OF TOTAL BEAM CURRENT AS
A FUNCTION OF A-12 BEAM RADIUS

Hanson (UCRL 900) fits the beam profile with the following equations:

$$U = 1.031 U_a \frac{R_m}{R_0}^{-1}, \quad 0 \leq R < R_0 = 0.03 R_m, \quad (1)$$

and

$$U = 1.031 U_a \frac{R_m}{R}^{-1}, \quad R_0 = 0.03 R_m < R \leq R_m \quad (2)$$

Figure 1 shows (1) and (2) plotted to show their fit to the beam profile given by Panofsky (UCRL 820).

It is of interest to investigate the beam described by the above equations and to determine the fraction of the beam current that would pass through a circle of radius R , concentric with the beam axis.

The current I , which passes through an annulus of radius R_1 , and thickness dr , is

$$I = 2\pi R_1 U_1 dr, \quad (3)$$

where U is defined by the proper expression (1) or (2). The total current passing through a circle of radius, R , is

$$I = \int_0^R 2\pi R U dR. \quad (4)$$

This equation can be normalized by use of the factor, f , the fractional radius, defined by

$$R = f R_m. \quad (5)$$

$$\text{Then } dR = R_m df, \quad (6)$$

$$\text{and } I = \int_0^R 2\pi R_m^2 U f df. \quad (7)$$

Now, by substituting (5) into (1) and (2), and the result into (7), one finds,

$$I = 1.031 (2\pi) U_a R_m^2 (16.17 f^2), \quad 0 \leq f \leq 0.03 \quad (8)$$

and

$$I = 1.031 (2\pi) U_a R_m^2 (f - \frac{f^2}{2} - 0.015), \quad 0.03 \leq f \leq 1 \quad (9)$$

From (9), I total is found to be

$$I_{\text{total}} = 1.031 (2\pi) U_a R_m^2 (0.485) \quad (10)$$

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The fraction of the beam current, $\phi = I/I_{\text{total}}$, at any $f (= R/R_m)$ is

$$\phi = 33.34 f^2 \quad 0 \leq f \leq 0.03 \quad (11)$$

$$\phi = 2.062 \left(f - \frac{f^2}{2} - 0.015 \right) \quad 0.03 \leq f \leq 1 \quad (12)$$

Figures 2 and 3 show ϕ plotted versus f in regions of interest.

With regard to the use of the data shown in Figures 2 and 3, one should note that the integration of the approximation yields a lower result for ϕ (except in the region $0 \leq f < \sim 0.05$) than the integration using Panofsky's curve.

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FIGURE 1
BEAM CROSS SECTION
TAKEN FROM UCRL-700

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FIGURE 3

ϕ vs. f , LOW RANGE

f , FRACTIONAL RADIUS, = R/R_m