

ARGONNE NATIONAL LABORATORY
HIGH ENERGY PHYSICS
December 13, 1985
Y. CHO

TO: Y. Cho

HEP

DEC 13 1985

FROM: W. Praeg

ETP

SUBJECT: 6 GeV Booster RMS Current

The dc power dissipation in the booster ring magnets during bypass operation should be the same as during normal pulsed operation. Therefore, the dc current (bypass) should be the same as the booster rms current. A general booster current shape is shown in Fig. 1. Its rms value is:

$$I = \left(\frac{1}{T} \int_0^T i^2 dt \right)^{1/2},$$

$$I = \left[i_o^2 \frac{2t_o + t_3}{T} + i_o(I_p - i_o) \frac{t_1 + t_3}{T} + (I_p - i_o)^2 \frac{t_1 + t_3}{3T} + I_p^2 \frac{t_2}{T} \right]^{1/2} \quad (1)$$

For a symmetrical pulse with $t_1 = t_3$:

$$I = \left[i_o^2 \frac{2t_o + t_1}{T} + \left\{ 2i_o(I_p - i_o) + \frac{2}{3}(I_p - i_o)^2 \right\} \frac{t_1}{T} + I_p^2 \frac{t_2}{T} \right]^{1/2} \quad (2)$$

For $i_o = 0$:

$$I = I_p \left[\frac{t_1 + 3t_2 + t_3}{3T} \right]^{1/2} \quad (3)$$

The booster injection current is 6.5% of the peak current ($i_o = 0.065I_p$). For this case and with $t_o = 0.20s$, $t_1 = t_3 = 0.25s$, $t_2 = 0.01s$, we have from (2) an rms current of $I = 0.516I_p$, which is very close to your estimate of $0.5I_p$. (This paragraph was revised on Dec. 26, 1985. See attached)

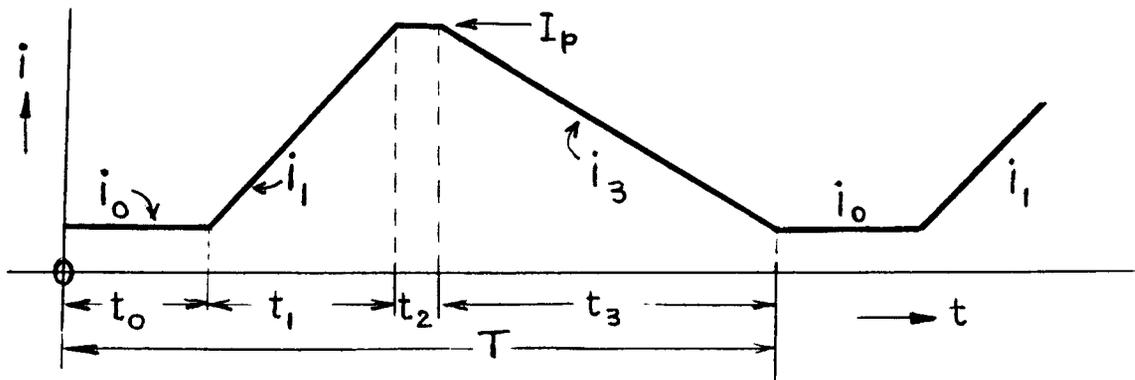


Figure 1

WP:er

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DEC 26 1985

December 26, 1985

TO: Y. Cho LS Project
FROM: W. Praeg ETP
SUBJECT: Revised Booster Currents

This confirms our conversation of December 23 changing the booster magnet current shape and the repetition rate. This will greatly simplify the transition into a 0.01% regulated flat top and will also reduce the magnet voltage. However, it will increase the rms current as compared to the waveshape calculated in my letter to you dated December 13, 1985.

The new current shape is as follows:

injection time	$t_0 = 1/6s$
current raise time	$t_1 = 1/3s$
flat top time	$t_2 = 1/6s$
current decay time	$t_3 = t_1 = 1/3s$
repetition time	$T = 1s$

For the dipole magnets, with an injection current of $i_0 = 42A$ and a peak (flat top) current of $I_p = 644A$ we have an rms current of

$$I_D = \left[i_0^2 \frac{2t_0 + t_1}{T} + \left\{ 2i_0(I_p - i_0) + \frac{2}{3}(I_p - i_0)^2 \right\} \frac{t_1}{T} + I_p^2 \frac{t_2}{T} \right]^{1/2},$$

$$I_D = 409.5A = 0.636 I_p.$$

For the quadrupole magnets with $i_0 = 44.4A$ and $I_p = 681A$, we have an rms current of $I_Q = 482.2A = 0.708 I_p$.

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