

# PBAR NOTE 578

## NEW DEFINITION OF STOCHASTIC COOLING KICKER AND PICKUP IMPEDANCES

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### Transverse

The old definition of the pickup impedance for the difference mode was:

$$P_{\Delta} = Z_{\Delta pu} \left( \frac{i_b}{2} \right)^2 \left( \frac{y}{d/2} \right)^2 \quad (1)$$

where  $P_{\Delta}$  is the total power received from the pickup,  $i_b$  is the beam current,  $y$  is the distance between the beam and the mid-plane of the pickup and  $d$  is the transverse beam-pipe size.

The new definition of transverse pickup impedance is:

$$P_{\Delta} = \frac{1}{2} (Zn_{\Delta pu}) i_b^2 \frac{\epsilon_b}{1\pi - \text{mm} - \text{mrad}} \quad (2)$$

where  $P_{\Delta}$  is the total power received from the pickup,  $i_b$  is the beam current,  $\epsilon_b$  is the un-normalized beam emittance. Note that  $Zn_{\Delta pu}$  has units of Ohms. The relationship between the old impedance and the new impedance is:

$$Zn_{\Delta pu} = \frac{1}{2} Z_{\Delta pu} \frac{1\pi - \text{mm} - \text{mrad}}{\epsilon_A} \quad (3)$$

where  $\epsilon_A$  is the un-normalized acceptance of the beam pipe.

The old definition of the kicker impedance was:

$$P_{\Delta} = \frac{1}{2} \frac{\left( \frac{\Delta pc}{q} \right)^2}{Z_{\Delta kr}} \quad (4)$$

where  $P_{\Delta}$  is the total power supplied to the kicker structure,  $\Delta pc$  is the change in transverse momentum, and  $q$  is the charge of the particle. The new definition of kicker impedance is:

$$P_{\Delta} = \frac{1}{2} \frac{\left( \sqrt{\beta_k} \frac{\Delta pc}{q} \right)^2}{Z\beta_{\Delta kr}} \quad (4)$$

where  $\beta_k$  is the beta function at the kicker. The relationship between the new and old kicker impedance is:

$$Z\beta_{\Delta kr} = \beta_k Z_{\Delta kr} \quad (5)$$

Note that  $Z\beta_{\Delta kr}$  has unit of Ohms-meters.

### **Longitudinal**

The old longitudinal impedance for the pickup was given as:

$$P_{\Sigma} = Z_{\Sigma pu} \left( \frac{i_b}{2} \right)^2 \quad (6)$$

where  $P_{\Sigma}$  is the total power received from the pickup. The new definition is:

$$P_{\Sigma} = \frac{1}{2} Z_{\Sigma pu}^{new} i_b^2 \quad (7)$$

The relationship between the old and new definitions is:

$$Z_{\Sigma pu}^{new} = \frac{1}{2} Z_{\Sigma pu} \quad (8)$$

The definition of kicker impedance is unchanged:

$$P_{\Sigma} = \frac{1}{2} \frac{\left( \frac{\Delta pc}{q} \right)^2}{Z_{\Sigma kr}} \quad (9)$$

where  $P_{\Sigma}$  is the total power supplied to the kicker structure,  $\Delta pc$  is the change in longitudinal momentum, and  $q$  is the charge of the particle.