Fermilab

PBAR #435

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MEASURING THE WALL IMPEDANCE WITH THE NETWORK ANALYZER

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MEASURING THE WALL IMPEDANCE WITH THE NETWORK ANALYZER

Beam feedback measurements - like those used for stochastic cooling - can be used to measure the wall impedance. Consider the system shown in figure 1.

Figure 1. Functional Diagram of Measurement Technique

The network analyzer puts a voltage V_k on the beam causing a modulation I_b . The modulation current I_b interacts with the wall to produce a voltage V_w . The beam impedance Z_b is the applied voltage divided by the current:

$$Z_b = \frac{V_k + V_w}{I_b}$$

and the amplifier gain is:

$$Z_a = \frac{V_i}{I_b}$$

The network analyzer measures:

$$S_{12} = \frac{V_i}{V_k} = \frac{I_b Z_a}{V_k} = \frac{Z_a}{Z_b - Z_w}$$

Z_b can be calculated from the beam distribution and Z_a can be obtained by calibration. Thus a measurement of S_{12} yields a value for Z_w . The measurement works best, of course, if Z_b and Z_w are comparable in magnitude, i.e., if the beam is near the stability limit.

I propose we try to use this method to measure the wall impedance at harmonics 1, 2, 10, 84, and 100 longitudinally and 1, 10, and 100 transversely. The transverse measurements can be made with the damper; the longitudinal one can be made with the gap pickup and the broadband cavity or with the damper in the sum mode. It might be useful to have a stochastic cooling type transfer switch for calibration.