

Phasing of Debuncher Stochastic Cooling Transverse systems.

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With the higher frequency of the cooling systems in the Debuncher, a modified method of making transfer functions has been developed for transverse systems. (Measuring of the momentum systems is unchanged.) Speed in making the measurements is critical, as the beam tends to decelerate due to vacuum lifetime. In the 4-8 GHz band, the harmonics in the Debuncher are 6,700 to 13,400 times the revolution frequency. Every Hertz change in revolution frequency is multiplied by this harmonic number and becomes a frequency measurement error, which is an appreciable percent of the momentum width of the beam. It was originally thought that a momentum cooling system would be phased first so that the beam could be kept from drifting in revolution frequency. As it turned out, the momentum cooling was so effective (even with the gain turned down) that the momentum width normalized to f_0 became less than one Hertz on the Schottky pickup. A beam this narrow requires very precise measurement of tune and revolution frequency. It was difficult to get repeatable results.

For initial measuring of the transverse arrays, relative phase and delay is all that is required, so the measurement settings outlined below will suffice. Once all input and output arrays are phased, a more precise measurement of all pickups to all kickers can be done with more points and both upper and lower side bands, as in figure 1.

Settings on the network analyzer were adjusted for maximum measurement speed. Data is not analyzed until a complete set of measurements is taken. Start and stop frequencies should be chosen to be just slightly wider than the band being measured.

For transverse systems, select betatron USB for the measurement type. This will make the measurement two times faster. Select 101 for the number of points, sweep time of 5 seconds, IF bandwidth 30 Hz, averages = 1.

It is important during the phasing to continually measure the revolution frequency and beam width of the beam for transverse systems. Beam width is defined as the 3 dB bandwidth of the momentum Schottky divided by 127 (the harmonic of the Schottky pickup in the Debuncher.) Every three to five minutes, the beam drifts enough to make a significant change in the data. Knowing the revolution frequency and beam width to 0.5 Hz is important. If the beam width exceeds 10 Hz, the quality of the measurement will be impaired. Large beam widths can be caused by excessive forward proton beam current. There are also signs that the front-end amplifiers saturate with beam currents above several hundred microamps. The cooling systems were designed to be very sensitive, (that's why the front end is at liquid helium temperature) so a hundred microamps will go a long way. It should be possible to phase the systems with Pbars as a signal to noise ratio of 30 dB was observed with 100 microamps of beam current.

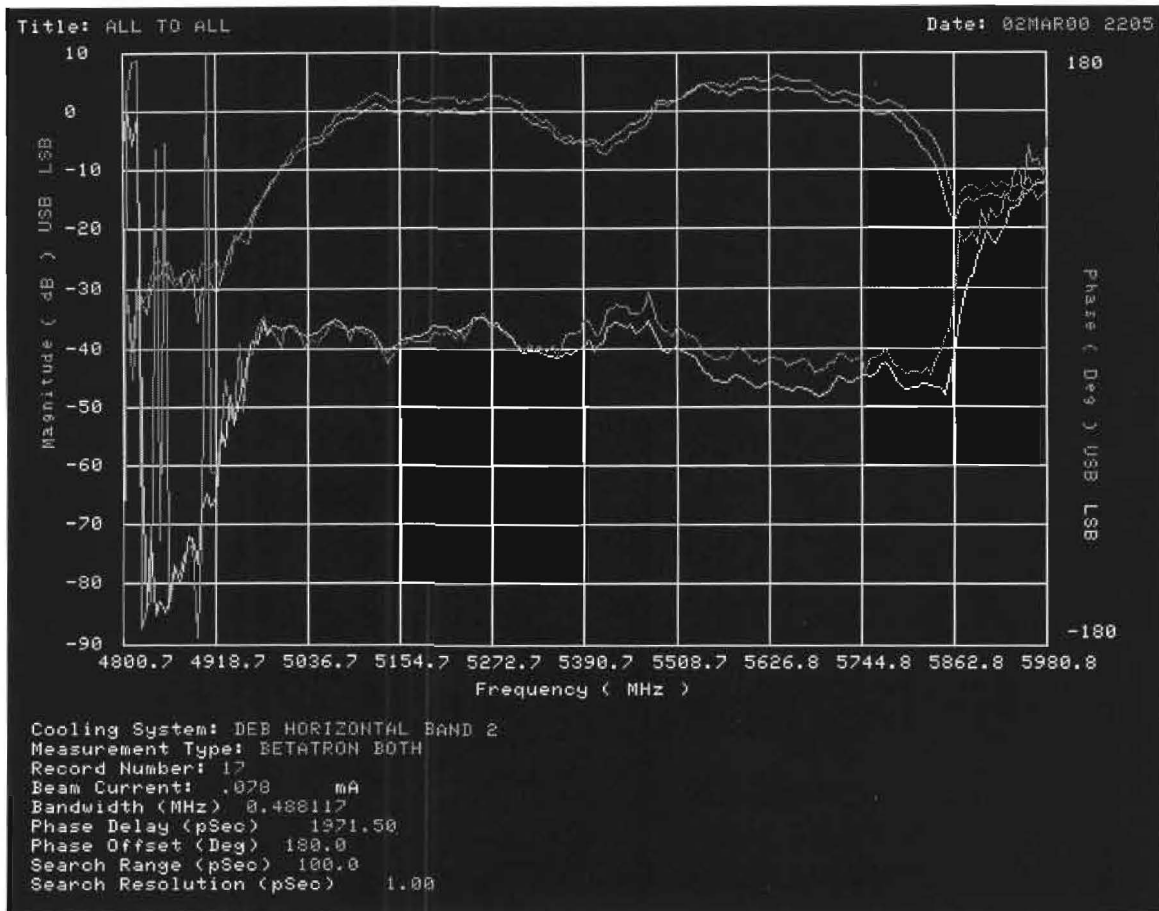


Figure 1. Horizontal Band 2 transfer function with both USB and LSB. Beam current is 78 microamps.