Simulation of a Delta-t Scan of SNS DTL Tank #6

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The purpose of this note is to determine whether using delta-*t* phase scans, or delta-*E* delta-*t* phase scans [1], are suitable for commissioning DTL tank #6.

DTL tank #6 is about 6.35 meters long, has input and output energies of 72.495 MeV and 86.821 MeV respectively, a synchronous phase angle of about –30°, and a longitudinal phase advance of about 149°.

For this simulation, two phase detectors are used. Phase detector *B* is located immediately downstream of the DTL. Phase detector *C* is located 12.212 meters (the length of CCL module #1) downstream of phase detector *B.*

In Figure 1, *dTC* (the deviation in the time delay of the beam at phase detector C), is plotted against the deviation in *dTB* (phase detector B). The deviations are the changes in ps from the expected phase for various settings in the RF amplitude, RF phase, and input energy. The plots are variable phase scans; for each setting of the RF amplitude, the phase of the RF power is varied from -35° to -25° in 0.2°steps.

Five clusters of 3 phase scans are shown. Each cluster represents a different input beam energy, in 50-keV steps. The 3 red lines in each cluster represent phase scans for different RF amplitude settings; 0.98, 1.00, and 1.02. The phase scans each range from –35° to -25°. The 3 blue lines represent the locus of points for phase errors of -2°, 0°, and +2°. Thus to achieve static phase and amplitude settings of ±2°and ±2%, the settings must be inside 3 the blue lines, and inside the cluster of 3 red lines.

In Figure 2, *dTC-dTB* (the deviation in the phase of phase detector *C* minus detector *B*), is plotted against the deviation in *dTB* (phase detector *B*). This is sometimes referred to as a delta-*E* delta-*t* scan because *dTC-dTB* represents the time of flight deviation between phase detectors *B* and *C*, which is related to the deviation of the output beam energy.

In both figures, the slope of the phase scan lines is very large. This is due to the fact that the longitudinal phase advance is less than 180°. If the longitudinal phase advance were 180°, the slope of the phase scan lines would be at 45° in Figure 1, and 0° in Figure 2.

Both figures imply that the phase measurement resolution should be ±5 ps or better in order to use delta-t measurements to set the phase and amplitude of DTL tank 6. This severe resolution requirement is due to a combination of the shortness of DTL tank 6, and the small longitudinal phase advance. Commissioning probably will have to be done using absorber-collectors.

[1]. “The Delta-t Tuneup Procedure for the LAMPF 805 MHz Linac”, K. R. Crandall, LA-6374-MS (1976).

Figure 1. Simulated delta-t variable phase scan of DTL tank #6.

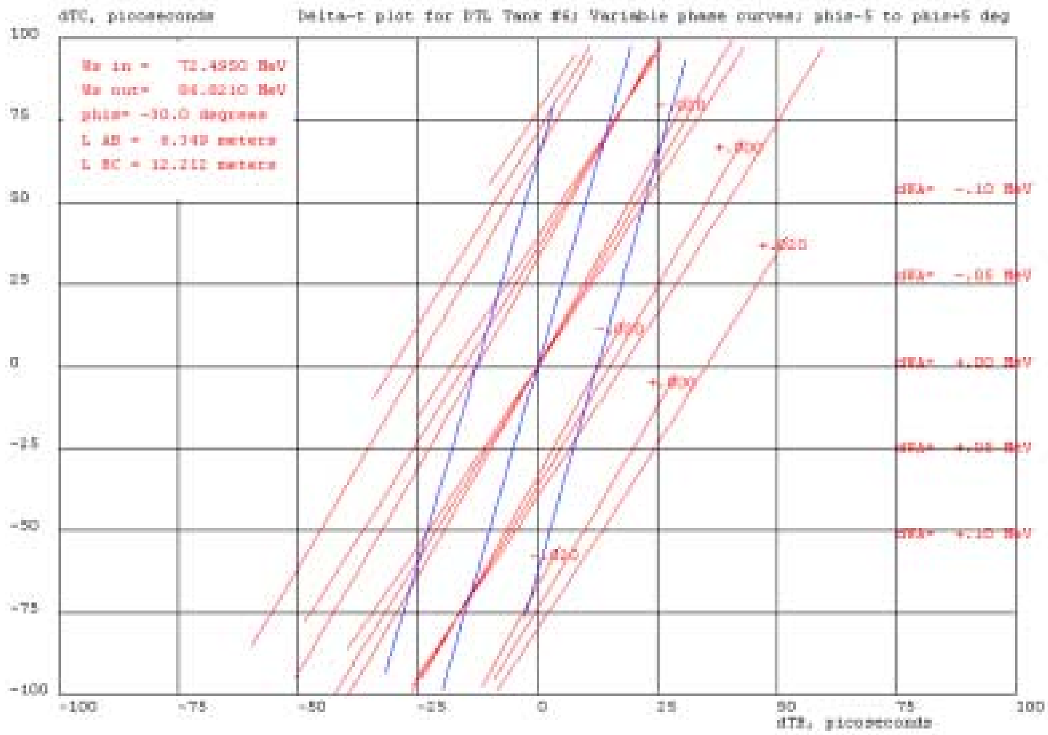

Figure 2. Simulated delta-E, delta-t variable phase scan of DTL tank #6.