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A CHIRPED ACCELERATOR?*

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Dave Farkas' elegant pulse compression scheme¹ suggests that other pulse compression schemes also might be worth investigating. In Dave's scheme, compression is achieved by slicing the pulse in time, delaying the later slices so that they occur simultaneously with the first slice, and then adding them all together. In radar technology, pulse compression is achieved by "chirping"; that is, by varying the pulse frequency in time, delaying the later frequencies relative to the first, and then allowing them all to act together. One sees that chirping is, in the frequency domain, the analogue of Dave's slicing in the time domain.

Now for a simplified analysis of how chirping works.² Suppose the original pulse is characterized by a frequency f_0 , within a rectangular envelope of time duration T . To chirp this pulse, we modulate the frequency so that it varies linearly with time over a range of frequencies Δ ; say, $f_0 - \Delta/2$ at $t = 0$, to $f_0 + \Delta/2$ at $t = T$.

The next step is to pass the chirped pulse through a network that delays each frequency component by an amount proportional to its frequency. If the highest frequency, $f_0 + \Delta/2$, is delayed by a time T , and the lowest frequency, $f_0 - \Delta/2$, is not delayed at all, the output of the delay network (a dispersive device) consists

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of a group of frequency components, all equal in amplitude, acting simultaneously, and covering a range of frequencies Δ . This combination produces a $\sin(x)/x$ pulse of duration, $\tau \sim 1/\Delta$ and amplification $\sqrt{D}$, where, by conservation of energy, $D = T/\tau \sim T\Delta$. Clearly, D is the power amplification factor and $\sqrt{D}$ is the amplitude amplification factor.

More elaborate calculations produce refinements of these simple results, but at this introductory stage the rough estimates above are adequate to show the potential of a chirped pulse. For example, if $T \sim 5 \mu\text{s}$, and $\tau \sim 2.0 \mu\text{s}$, the voltage amplification factor is 1.6 and the range of frequencies in the output pulse, Δ , is .5 MHz, a variation that is easily accommodated by the accelerating structure. If T is increased to 20 μs , the voltage amplification factor becomes 3.2.

Now the practical questions arise. Are the required devices — the frequency modulator and the dispersive delay network — available? Should one use active or passive devices? What is the optimum pulse shape? What about the additional signals due to the presence of "side lobes" outside the main components of the $\sin(x)/x$ function? How does chirping compare with time-compression? And so on, problems that will determine whether the basic concept is sound and promising.

I hope to resolve some of these questions, time permitting.

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