national accelerator laboratory

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(Revision 1)

NOTES ON THE LINAC SYSTEM TIMING PROBLEM

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These notes are intended as an informal summary of the situation as I understand it at present. Comments and corrections will be appreciated.

2. The linac must deliver pulses of 200 MeV proton beam to the booster at the time when the booster magnetic field is correct. The booster operates at 15 pps with a field which can be considered a sine wave (possibly with some second harmonic component) offset so that the field never reverses, and so that the minimum value of the field is correct for injection of 200 MeV protons. A pair of kicker magnets will be used to put a time-varying bump in the equilibrium orbit of the booster during injection.

3. The booster will have a peaking strip or similar device which will produce a timing pulse about 1.5 milliseconds before minimum field is reached. This will serve the linac as a "precursor" or "prime" pulse; all the linac functinns can be timed from that pulse.

4. As soon as the prime pulse is received, the quadrupole power supplies should be pulsed on. (The individual supplies have time delays which can be adjusted to correct the group-to-group constant variations, so that all quadrupoles will reach their operating current at the same time.)

5. After an adjustable time delay, the tank drive rf systems should be pulsed on. The tank rf level will begin to rise.

6. After another time delay, the ion source should be pulsed on. Within a few microseconds the injector beam current will stabilize and the tank level servos will settle down.

7. The system should now be ready to provide beam for the booster. The total of delays should be such that this state is reached by the earliest time the booster can accept beam.

8. The stable, full beam current condition should continue for a period of time as long as the longest time the booster will require beam (probably not over 28 microseconds, which would correspond to ten turns of injection) plus enough to cover the uncertainty in the interval between the arrival of the "prime" pulse and the time the booster is actually ready to receive beam, and the uncertainty in the linac timing system delays.

9. It seems reasonable at this time that the uncertainty in the booster timing can be kept to less than ± 10 microseconds, and that in the linac timing system to less than ± 1 microsecond. Then the total linac stable beam current duration need not exceed 28 + 20 + 2, or 50 microseconds. Allowing five microseconds for beam turn-on and stabilization time, the maximum ion source on time will not exceed 55 microseconds.

10. After the latest possible time that beam may be wanted, the ion source pulser and tank rf modulators may be turned off. No "off" function is required by the quadrupole power supplies. Turning off the rf modulators is optional; it is neater to turn them off together, but they will all turn off on their own internal timing delays anyway.

.1. In addition to the above machine functions, the linac timer should also provide one or two adjustable sampling pulses to the sample-and-hold circuits.

12. It should be possible to operate for test from an internal 15 pps signal derived from the power line, or from an external pulser of adjustable rate for use when slow repetition-rate pulsing is needed. A single-pulse button is also convenient.

13. It is expected that fast inhibiting circuits will be provided which will not permit the ion source to be turned on until the accelerating cavity field strengths have reached the proper level. A suitable signal can be obtained each pulse from the level control servo amplifiers. A similar requirement may be made on the quadrupole currents. Of course the ion source pulse, and possibly also the rf drive pulse, must be interlocked with the radiation enclosure system.