Timing Tests with the CERN type wire scanner in respect of their use in the Linac Test Facilities

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In Ref. : 1 we proposed the use of the CERN Type wire scanner for the Linac Test Facilities. The parameters of the scanner satisfies the conditions of the Linacs. Only the synchronization jitter[1] of the scanner was not known at that time. A jitter of $\Delta t \approx 100\mu s$ can be tolerated at a scanning speed of 1 m/s at the TTF. The measurements of this jitter are presented in the following

Assembly:

We used the CERN VME electronic for this test. The movement of the scanner is programmed in an EPROM of the motion-control-card. Pin 7 of IC40 gives a reference signal (target) at exact half of the scanning distance. That means that the scanner should be at that position. A control loop always adjust the driver to follow the EPROM values by comparing the values of the EPROM and of the potentiometer.

The real position of the scanner was measured with the reference signal from the optical ruler (Pin 11 of IC34). This signal is created by a reference mark on the optical ruler. Then the jitter of the scanner can be measured as the time difference jitter of this two signals ($\Delta t = \Delta(t_{target} - t_{ref})$).

The signals were connected to a PC-card (PTIME2) which is able to measure time differences between 0.5 ns to 6 µs and 2 µs to 6 ms with a resolution of 0.02. The time difference of the two signals was about 17 ms with t_{target} first. Therefore a delay of t_{target} by a fixed amount of time t_{delay} = 18.4 ms was necessary done by a very fast and stable NIM electronic with a jitter of much less than 10 µs (see Fig. 1). So we start a measurement with a trigger on the TTL signal of t_{ref}, connected to channel 1 of PTIME2, and we stop it with the delayed signal of t_{target} (t_{delay}; NIM-level), connected to channel 2.

50 successive scans with constant speed were performed and the time was measured for different speeds.

Results and discussion

Figs. 2-4 show the time-jitter at a scanning speed of 0.4, 0.8 and 1.0 m/s, respectively. The electronic delay was constant for all experiments. The total delay depends on the speed of the scan (1.1 ms at 0.4 m/s to 5.6 ms at 1 m/s). This is not a critical problem as long as only one speed is used. The jitter for each 50 scan cycle is always in the order of 100 µs which fulfill the LINAC requirements. At the start of each cycle we have had different conditions at the scanner, like different temperatures of the motor and the driver, we include resistors in the cables to the motor to simulate a long cable between the electronic and the scanner and some not known or documented conditions. Probably some of the measured drifts during a cycle might come from the increasing temperature of the scanner motor. However, the jitter between different cycles with the same speed do not exceed more than 300 µs, which is still adequate for the LINACs.

Nevertheless, a measurement of the total time delay, when using the scanner at the LINAC, could be most helpful. In this case, one can use different speeds, one can observe problems related to the timing and is able to correct them by adjusting the delay time between a trigger signal and the scan. This leads to a requirement for a programmable (VME) delay card with a resolution of about 10 µs. The total delay time should be in the order of the Linac repetition time (100 ms) to provide a pre-trigger for the next scan.

The time jitter between the start-the-scan signal (external trigger) and the EPROM Signal can be expected to be less than 10 µs because of no mechanical parts in this signal chain.

References:

Ref. 1: K. Wittenburg, H. Schultz, DESY; A proposal for using Wire-Scanners at the LINAC Test Facilities; DESY-TESLA-94-15 (1994)

[1] The time jitter between a start-the-scan signal and the crossing of the beam

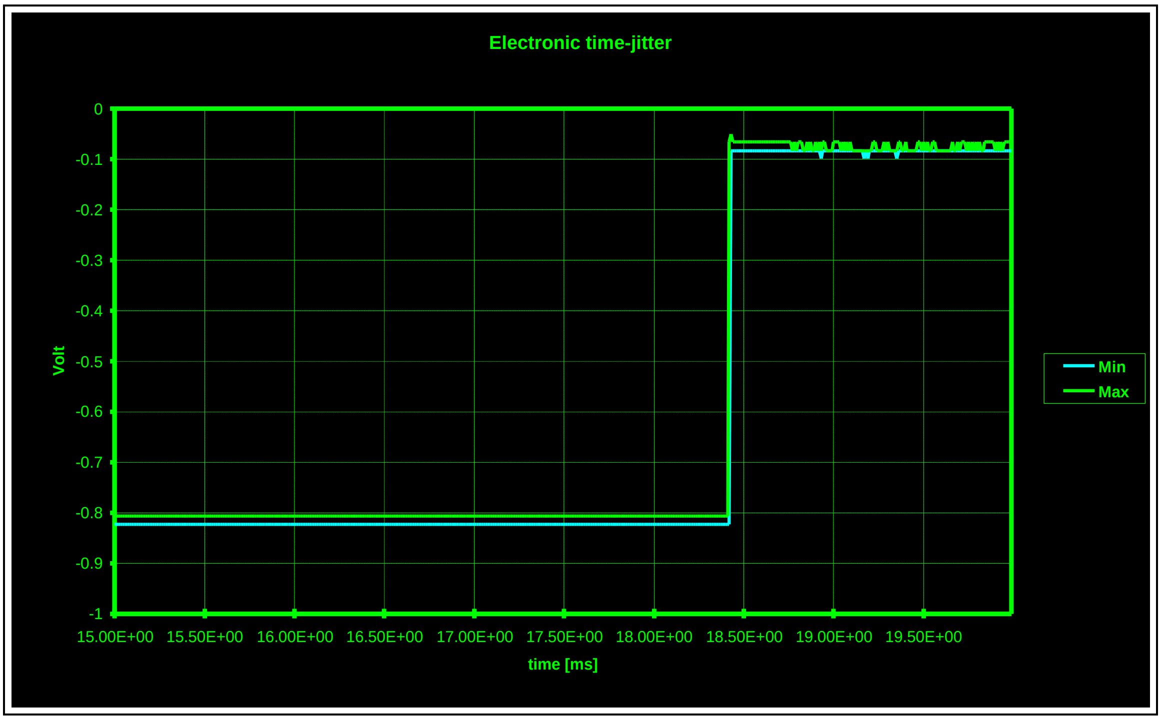

Fig. 1: The jitter of the electronic delay. One digit in x is 10 µs (500 µs/div). The delayed edge of the signal is displayed.

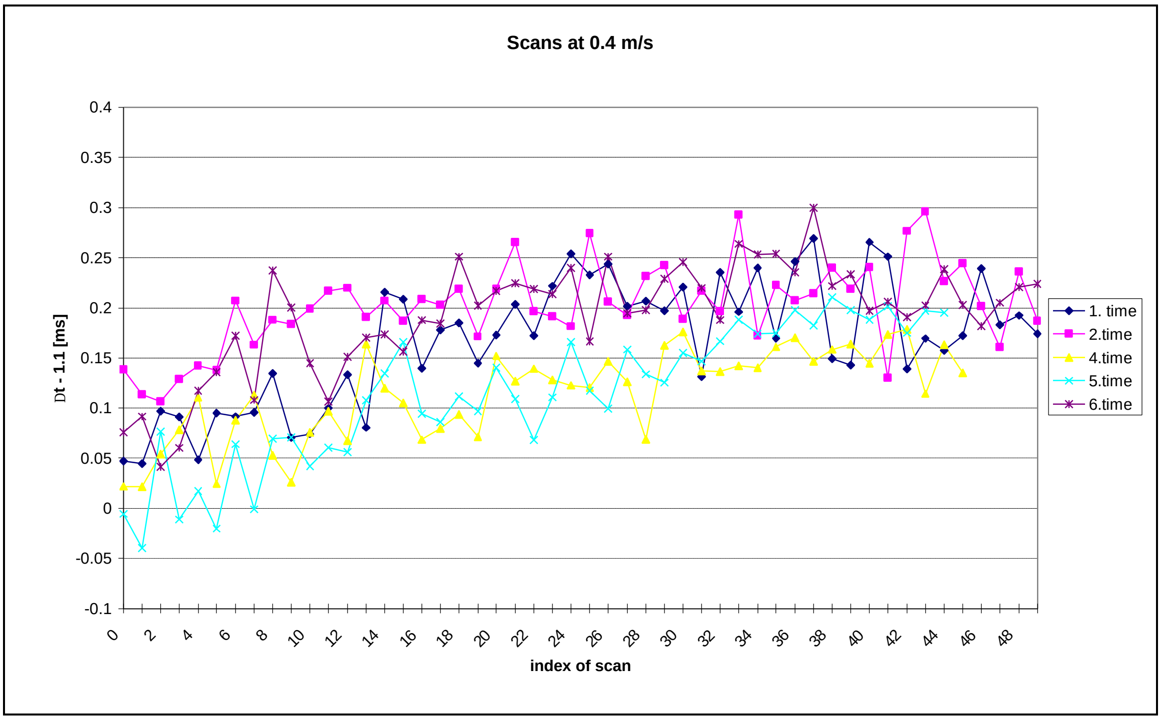

Fig. 2: Different cycles of scans at a speed of 0.4 m/s. Δt is the time between the start and the stop signal.

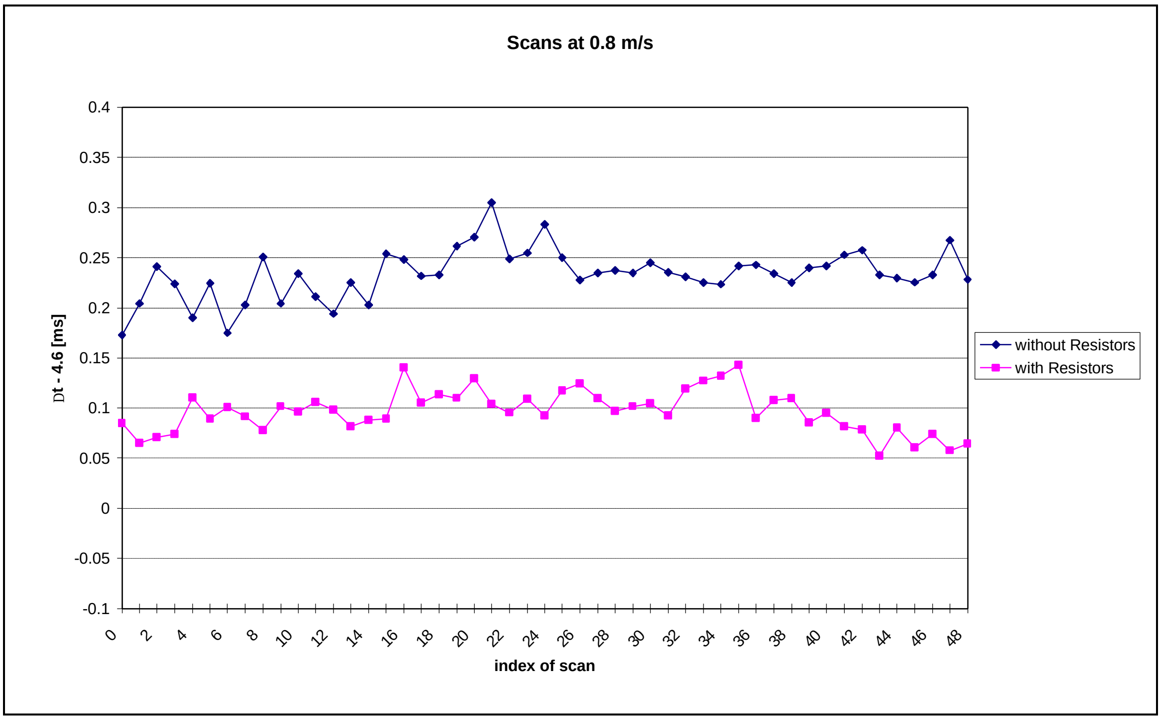

Fig. 3: Different cycles of scans at a speed of 0.8 m/s. Δt is the time between the start and the stop signal.

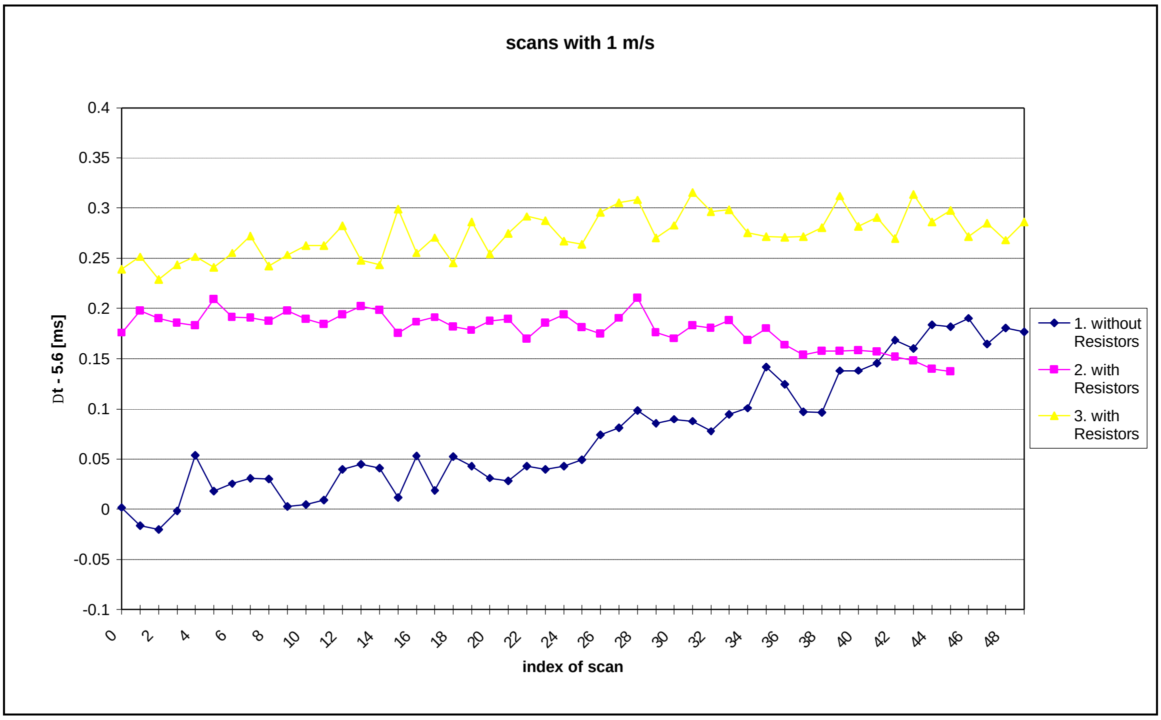

Fig. 4: Different cycles of scans at a speed of 1.0 m/s. Δt is the time between the start and the stop signal.