Tests of the Linearity and Stability of the A031-ET Event Timer at Graz Station

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Background

• SR620 time interval counters are popular, cheap and widespread, but show a sample-dependent nonlinearity (see below).

• The newly developed A031-ET event timer (University of Latvia) claims to be mostly free of such nonlinearities and could offer an interesting alternative to the SR620.
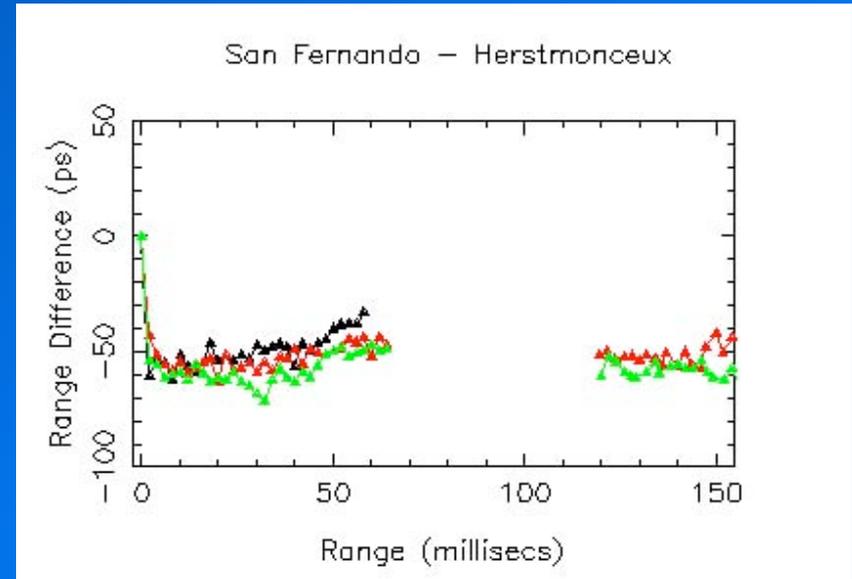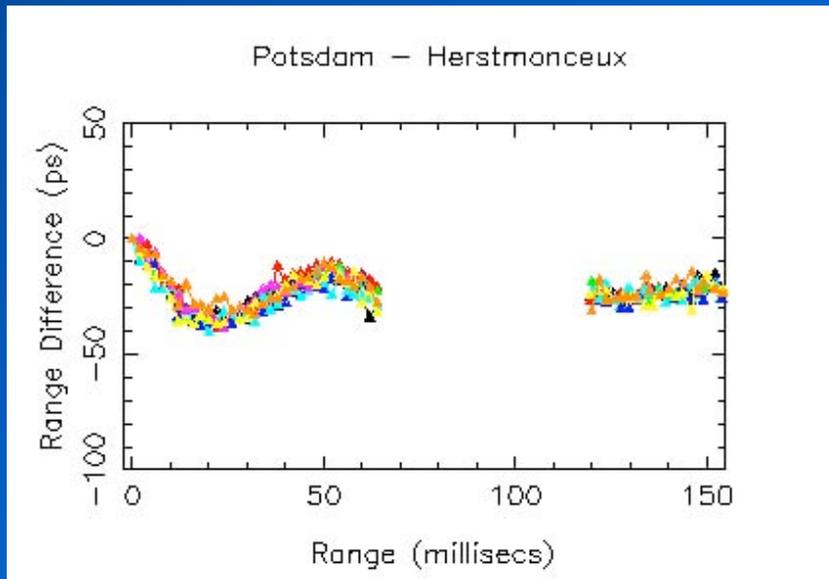
(From: P. Gibbs, 13th Laser Ranging Workshop Washington 2002)

The A031-ET Instrument
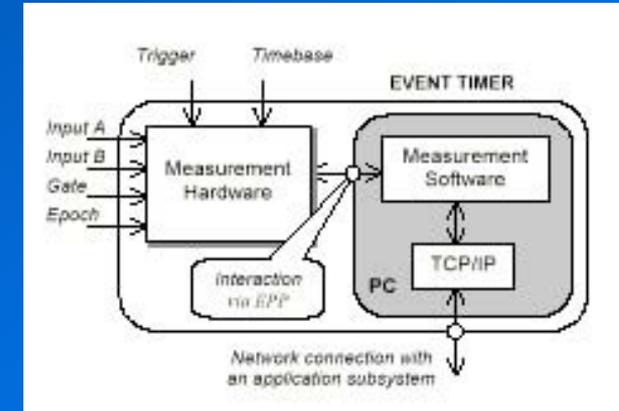
• Inputs: A, B, Gate (NIM); 10 MHz external timebase, 1 PPS external pulse for real-time clock (TTL); TI (classical time-interval) and AT mode (event timing)

• Single-shot RMS   < 15 ps (10-12 ps typical)

• Dead time   70 ns

• Buffer memory size   6550 time-tags before readout by PC

• Measurement rate   up to 3 kHz with fast PC (Pentium IV) and TCP/IP

In order to test for non-linearities of the A031-ET over the full range of time intervals for SLR applications, the crew of Graz SLR station 7839 offered the opportunity to perform intercomparisons vs. their famous

„E.T.“

References for both timing systems:

• G. Kirchner, F. Koidl: „Graz Event Timing System: E.T.“

> Proc. 12th Intern. Workshop on Laser Ranging, Matera / Italy 13-17 November 2000

• Yu. Artyukh, V. Bespalko, E. Boole, K. Lapushka: „A010 Family of Time Interval Counters Adapted to SLR Applications“

> Proc. 13th Intern. Workshop on Laser Ranging, Washington D.C. 07-11 October 2002

Comparison A031-ET vs. SR620 in Potsdam
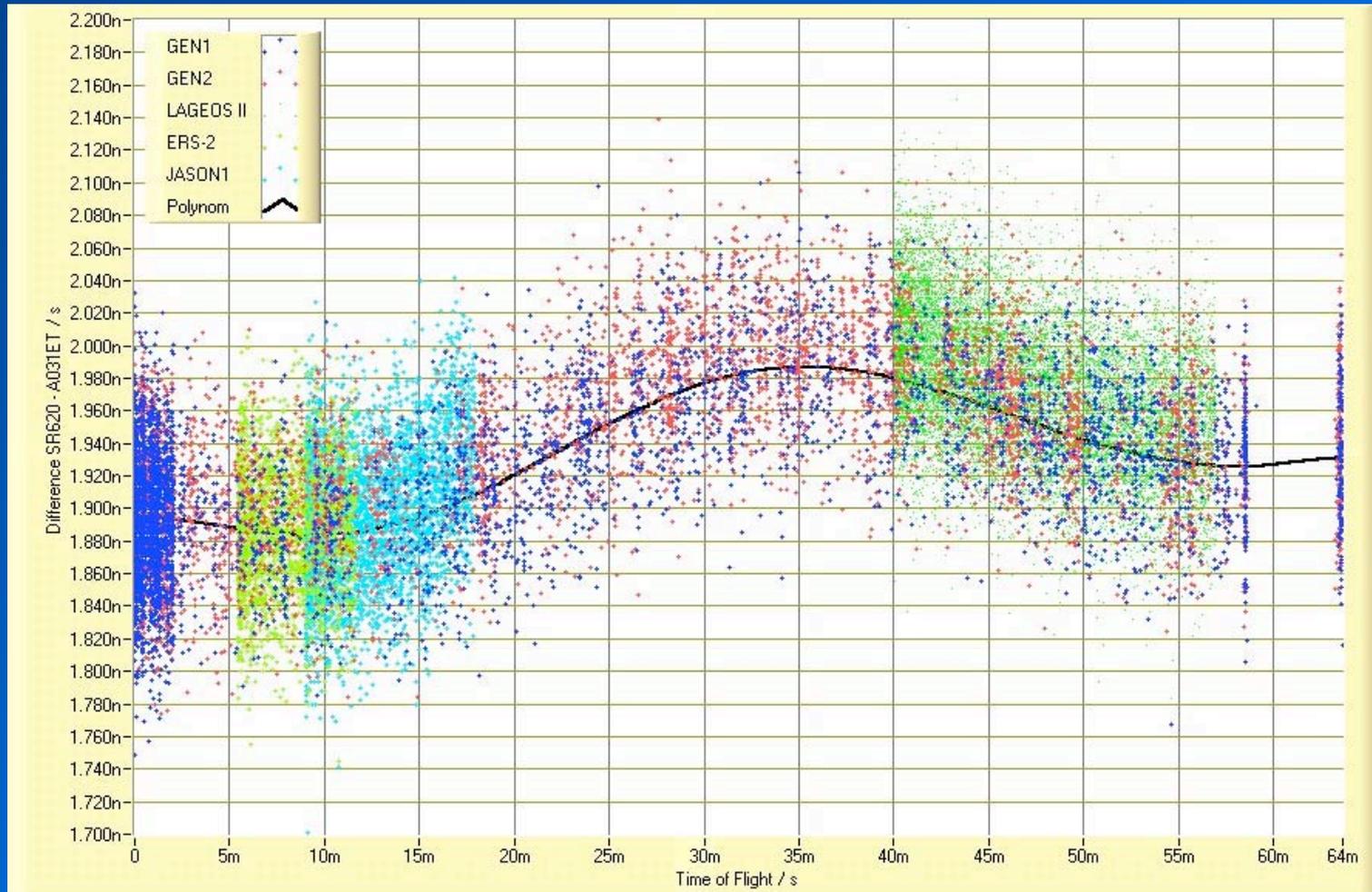
Measurement setup at Graz SLR station

• Both event timers (A031 and Graz E.T.) operated in parallel, supplied with the clock and reference frequency from the SLR system

• In order to cover the full range from target distance up to 200 ms, several different test setups were used:

• For target and satellite measurements both instruments were simply operated in parallel with the normal SLR station cycle.

• For time intervals 1-200 ms, the range gate was stepped in ms-steps every 2 seconds and the first noise pulse after gate opening was recorded as stop pulse.

• For 100 ns - 1 ms: manual stepping of pulse generator delay time.

Data processing

Processing steps for data which were registered by both E.T.s in parallel:

- 2.2-sigma filtering

- computation of the mean value for each ms-step (red curve below)

- low-pass filtering with $f_u = 0.02$ Hz (eq. 0.5 Hz scan rate, blue curve)
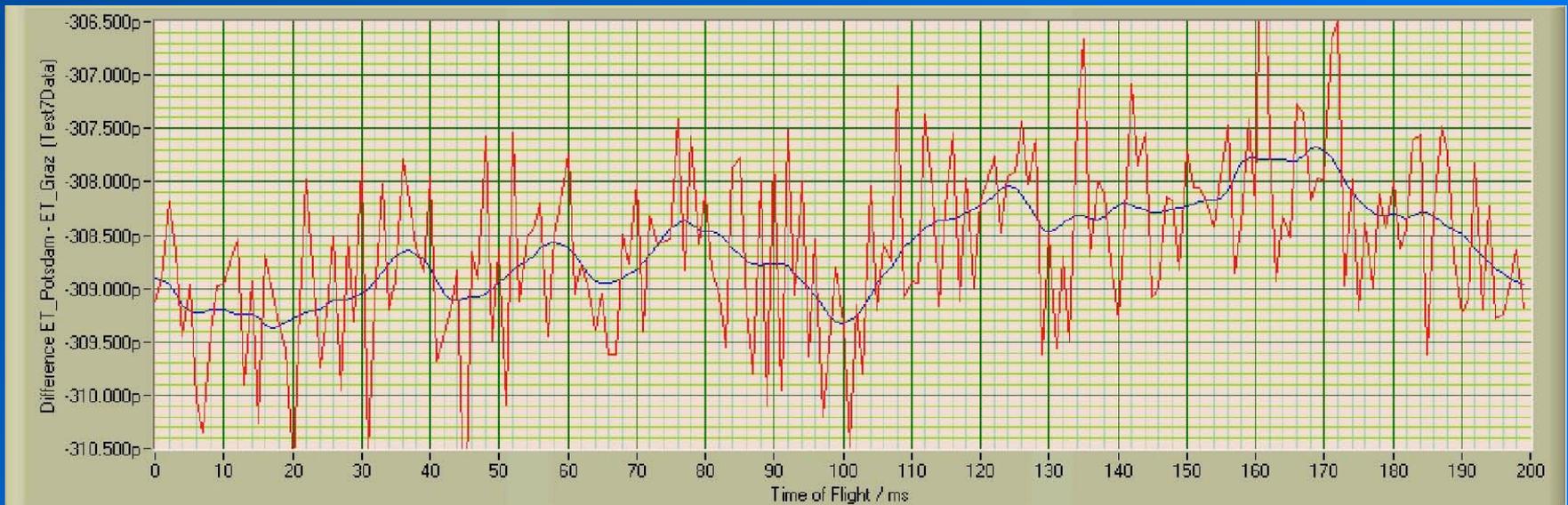
Simulation measurement on 11 Feb. 2004, 500 Hz repetition rate

Test for day-to-day stability

11 Feb. 2004, 2kHz
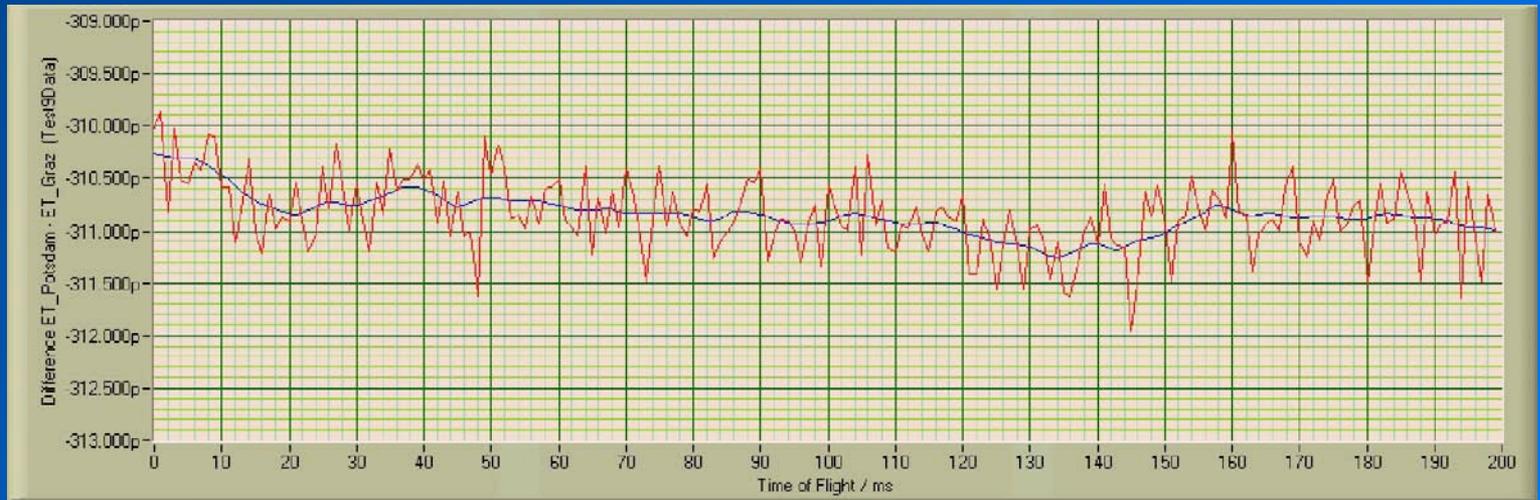
12 Feb. 2004, 500 Hz
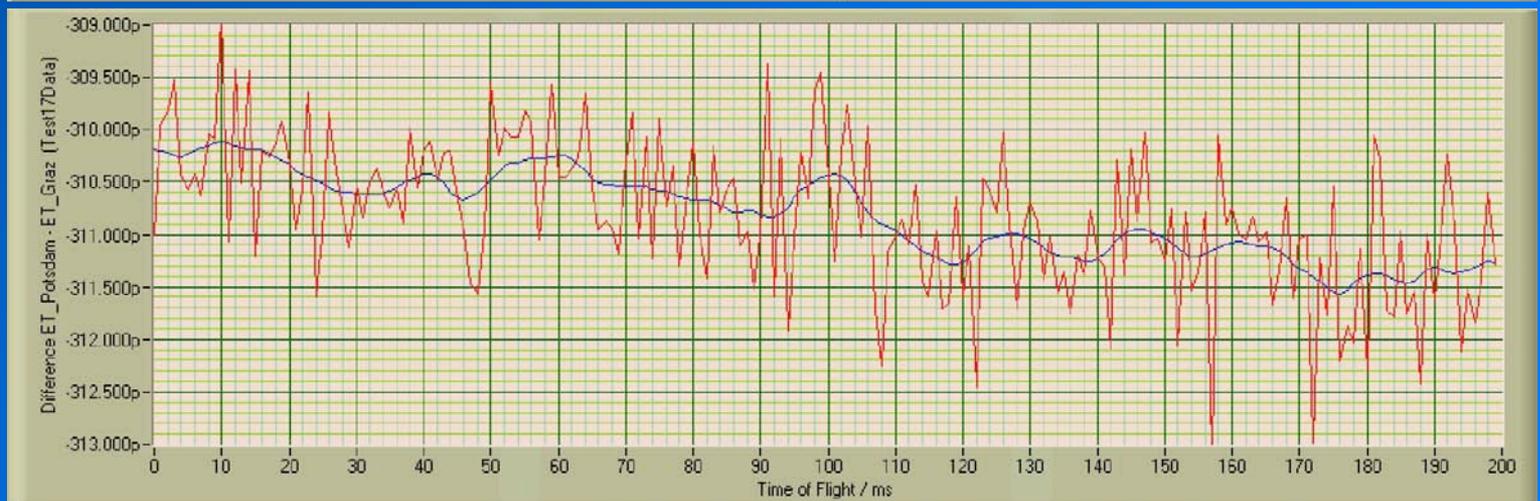
Combined test results at Graz SLR station
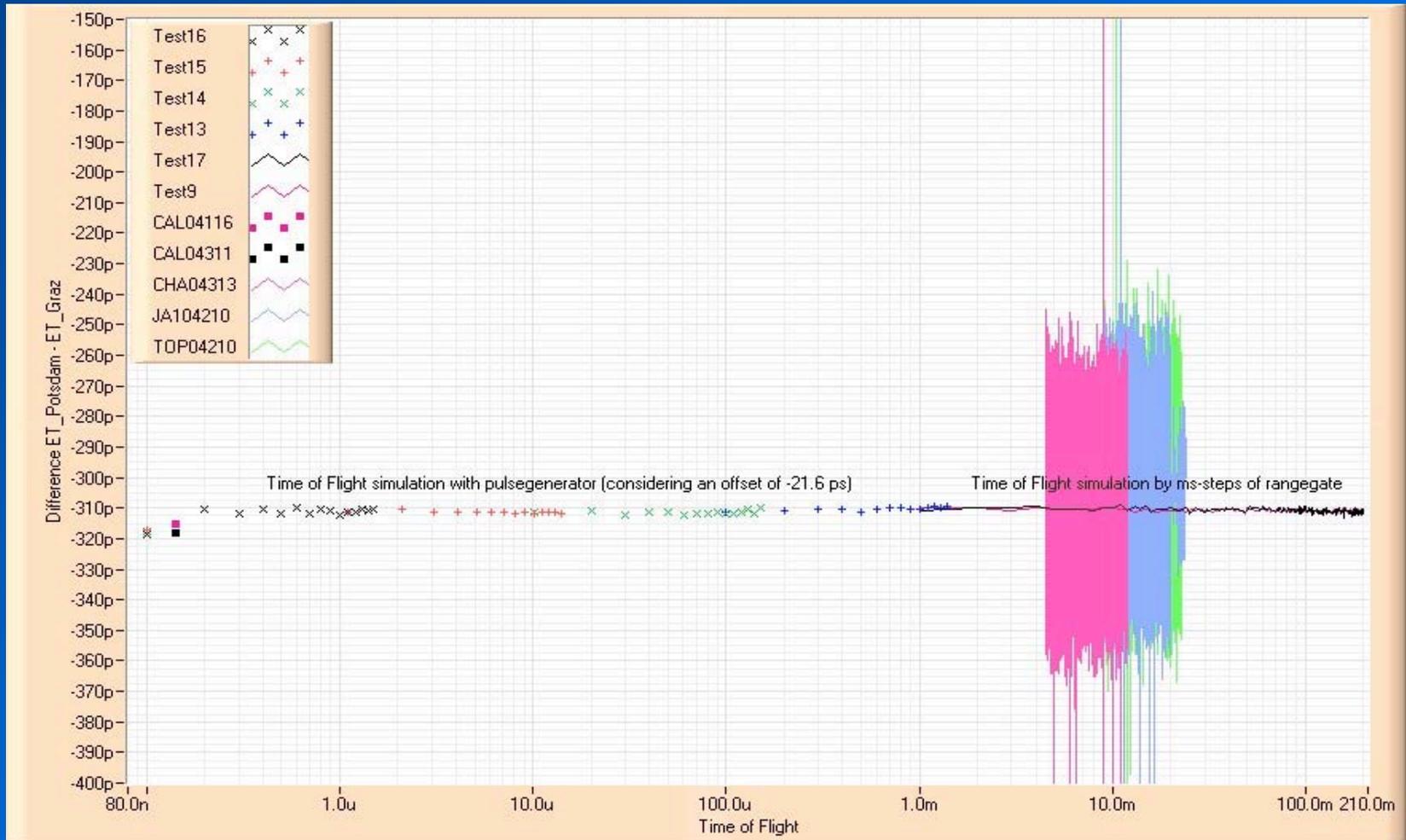
Results and Conclusions

Assuming that the Graz E.T. was well within its specifications over the full range of measured intervals (non-linearity <2.5 ps) during the intercomparisons of both units we can state:

- Temporal stability and non-linearity of the A031-ET are excellent over the full range of SLR ranging intervals (few picoseconds).

- A small offset (order of 5 ps) from the mean difference for µs and ms ranges may be present for very short time intervals (100 ns).

- This performance is far superior to the SR620, so the A031-ET offers a real alternative to this popular time interval unit *at a very reasonable price!*
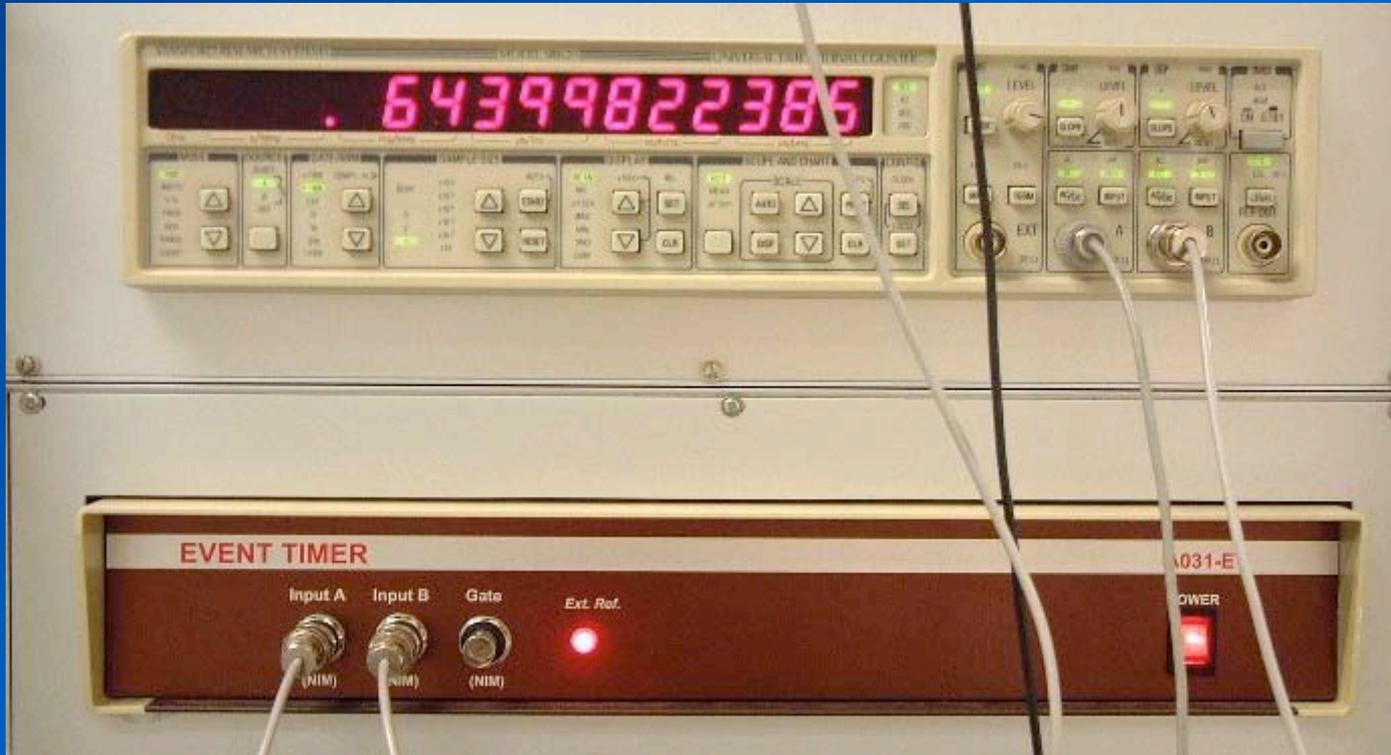
Since the successful tests at Graz SLR station, the A031-ET serves as the main time interval unit at SLR Potsdam 7841 with the SR620 only as backup.