Portable - Pico Event Timer Upgrade

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To reach the millimeter satellite laser ranging accuracy the Portable - Pico Event Timer [1,2] has been upgraded in 2002. The main objectives of the upgrade were to achieve a timing jitter below 3 psec, to decrease the temperature and temporal drift of an entire device and to enable the operation of the Portable Calibration Standard based on an upgraded P-PET at the stations equipped with the multi kHz lasers.

Within the upgrade, the P-PET has been equipped with the recent models of the Thales (Dassault) timing and frequency synthesis modules providing timing resolution of 1.2 psec with the timing jitter below 2.5 psec per channel. The new input board has been constructed, providing the advanced gating and arming options. This upgrade, together with the built in software modifications, gives to P-PET the possibility to cooperate with the high repetition rate laser ranging systems. The maximum rate is 100 P-PET measurements per second. If the laser system under test is operating at repetition rate higher than 100 Hz, the P-PET samples the measurements with the repetition rate of 100 measurements per second. The repetition rate of the laser system under test may be as high as 2 MHz. The timing linearity self test option has been included into the P-PET. In the self test operation mode, the lowest 12 bits of the epoch (corresponding to the interval 0-5 nsec) is output from both the timing modules. The dependence of the measured interval in the "cable ranging test" on the reading of one of the timing modules gives an estimate of the timing modules linearity within the 5 nsec window. The master clock frequency of the timing modules is 200 MHz, thus the 5 nsec window is of the main concern for linearity. The non-linearity has been measured to be 2.8 psec.

References

1. K.Hamal, I.Prochazka, *Picosecond event timer for millimeter laser ranging*, Annales Geophysicae Suppl.,Vol.16, 1998
2. K.Hamal, I.Procházka, J.Bla_ej, *Contribution of the picosecond event timer to the satellite laser station performance improvement*, 1999, SPIE 3865-05, ISBN 0-8194- 3460-4

Goals

- timing <u>resolution</u> increase to 2.5 psec/channel
  - new Dassault ETM modules

- measurement <u>repetition rate</u> increase
  - higher communication speeds

- increased timing <u>stability</u>
  - new input circuits

- timing <u>linearity self-test</u> built in
  - new HW and SW package

- capability to co-operate with <u>multi kHz</u> systems
  - advanced input arming logic

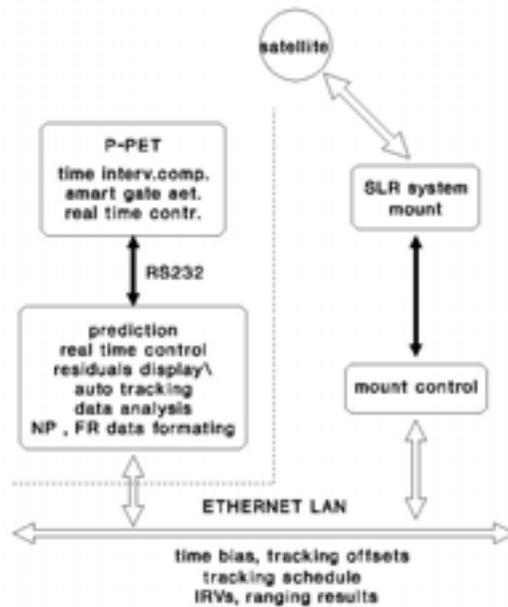K. Hamal, I. Prochazka, Prague, September 2002
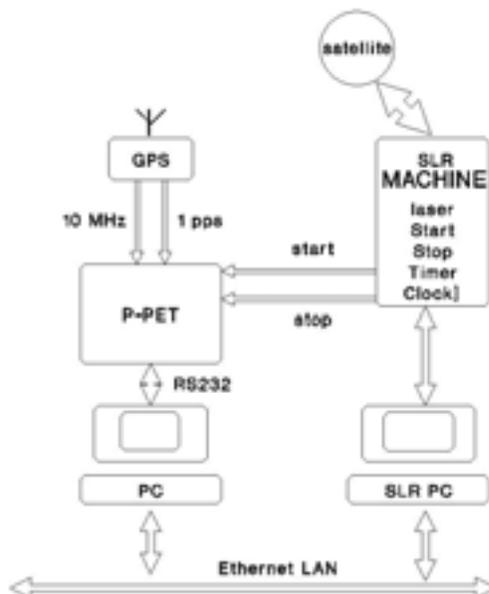
SLR INTEGRATION

K.Hamal,I.Prochazka, EurOpto, London 1997

K. Hamal, I. Prochazka, Prague, September 2002

Portable Pico Event Timer Upgrade
SLR SOFTWARE INTEGRATION

K.Hamal,I.Prochazka, EurOpto, London 1997
K. Hamal, I. Prochazka, Prague, September 2002
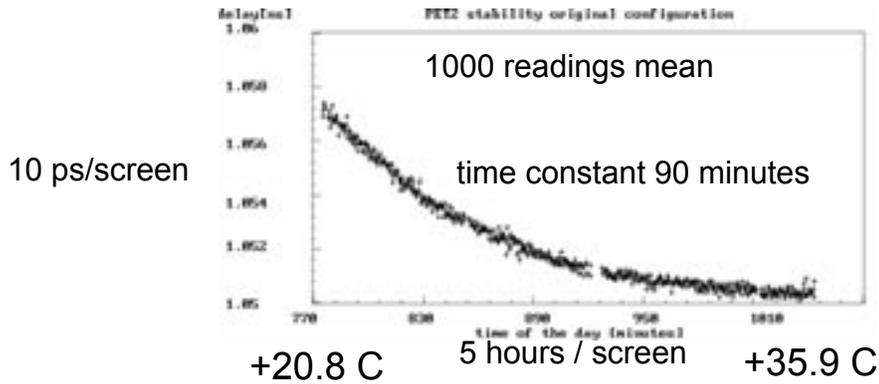

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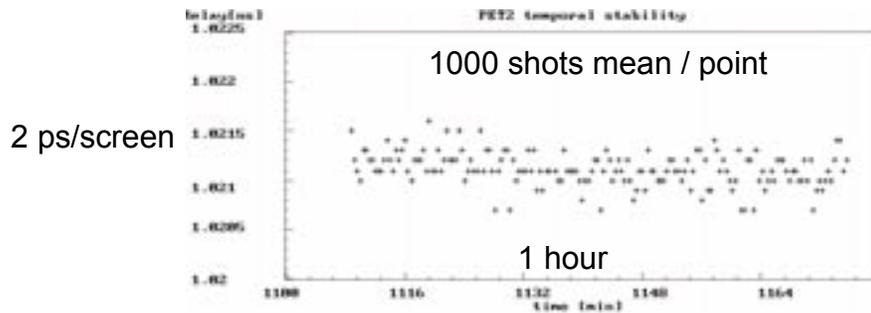
P-PET temperature drift test

Cable delay test,

10 ps/screen

1000 readings mean

time constant 90 minutes

+20.8 C   5 hours / screen   +35.9 C

PET2 time drift   -0.53 psec / K

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P-PET temporal stability test

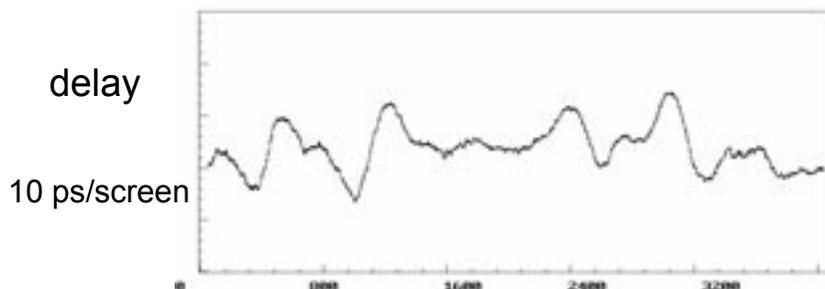Cable delay test, 1 hour series
25 +/- 1 deg. C, no airconditioning

2 ps/screen

1000 shots mean / point

1 hour

PET2 temporal stability +/- 0.45 ps 1 hour

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P-PET timing linearity test

Internal self test

delay

10 ps/screen

TDC channel No,

Cable delay timing test,
measured time interval Start=>Stop versus Start TDC channel No
moving average, 100/10 k readings

P-PET2 linearity error < +/- 2.8 ps

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Portable Pico Event Timer Upgrade

P-PET Parameters
Upgrade Summary

-           London '97 => **Wash 2002**

- timing resolution   1.2 ps
- timing jitter / channel   5 ps   **2.5 ps**
- non-linearity / channel   < 5 ps (spec)   **< 2.5 ps (meas)**
- temperature drift   < 0.7 ps/K   **< 0.53 ps/K**
- temperature time const.   **90 minutes**
- temporal stability   +/- 1.0 ps/hr   **+/- 0.45 ps/hr**
- max. repetition rate   30 Hz   **100 Hz, 2MHz sampl**
- No. of channels   2(4)
- interface   RS232
- mass transport   32 kg

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