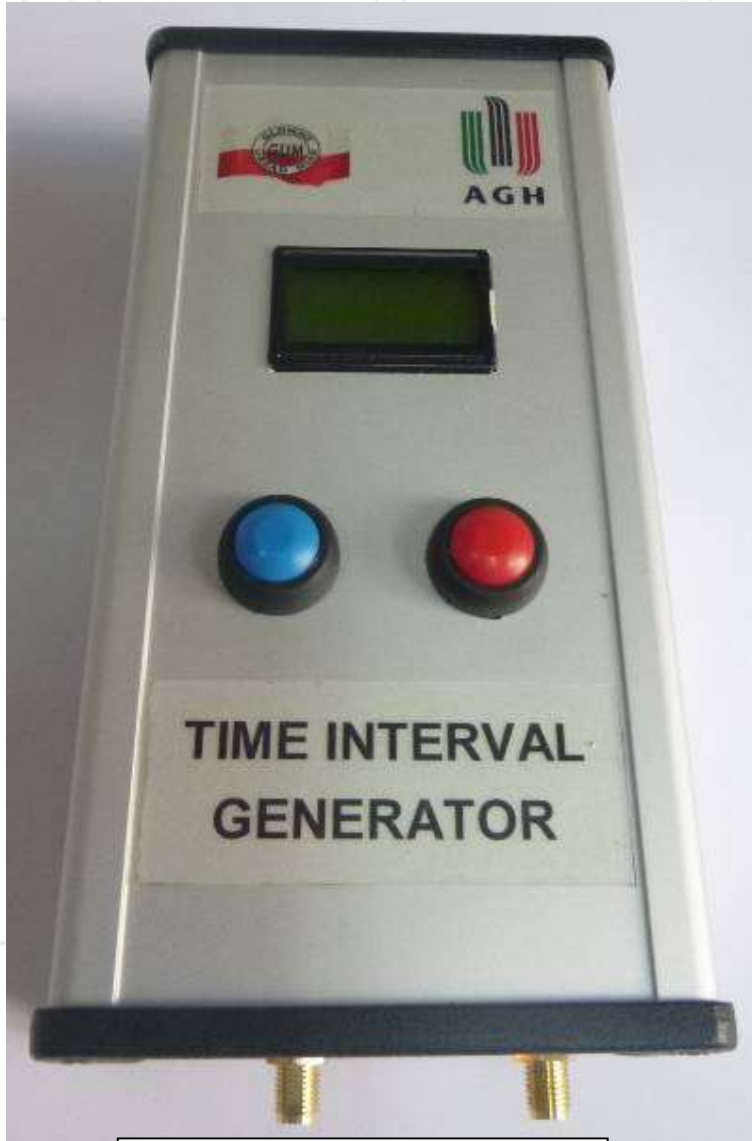


#1288 EURAMET Project

Final Report – Appendix 1

**TIGen – Time Interval Generator based
on PLL loops and programmable logic
and counters**

TI Gen standard – developed by AGH-GUM



a general view



front panel



rear panel



DC power supplier

TIGen – the main features

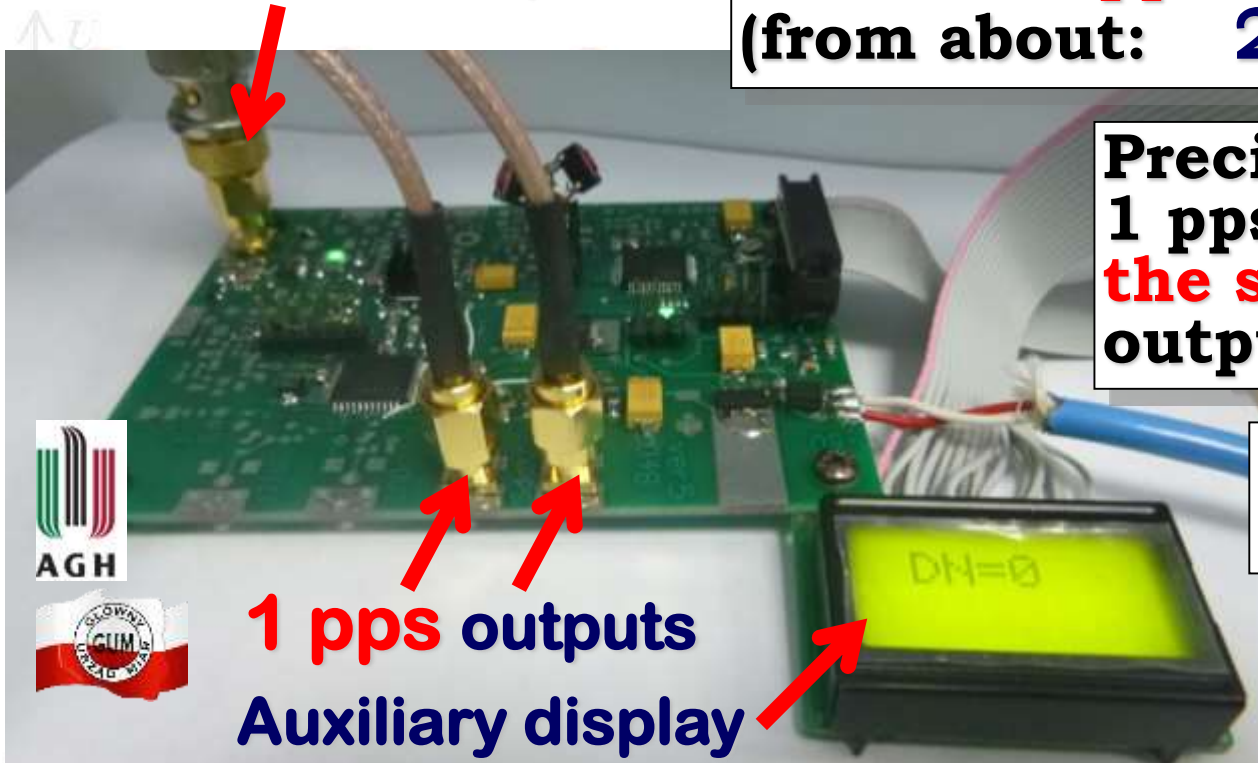
Required:
Ext. 10 MHz input

127 different **Time Intervals**
between **1 pps outputs**
(from about: **20 ns** to **12 μ s**)

Precise matching of
1 pps outputs = close
the same shape of
output signals

Rising slope:
< 0.5 ns/V

SMA connectors
50 Ω

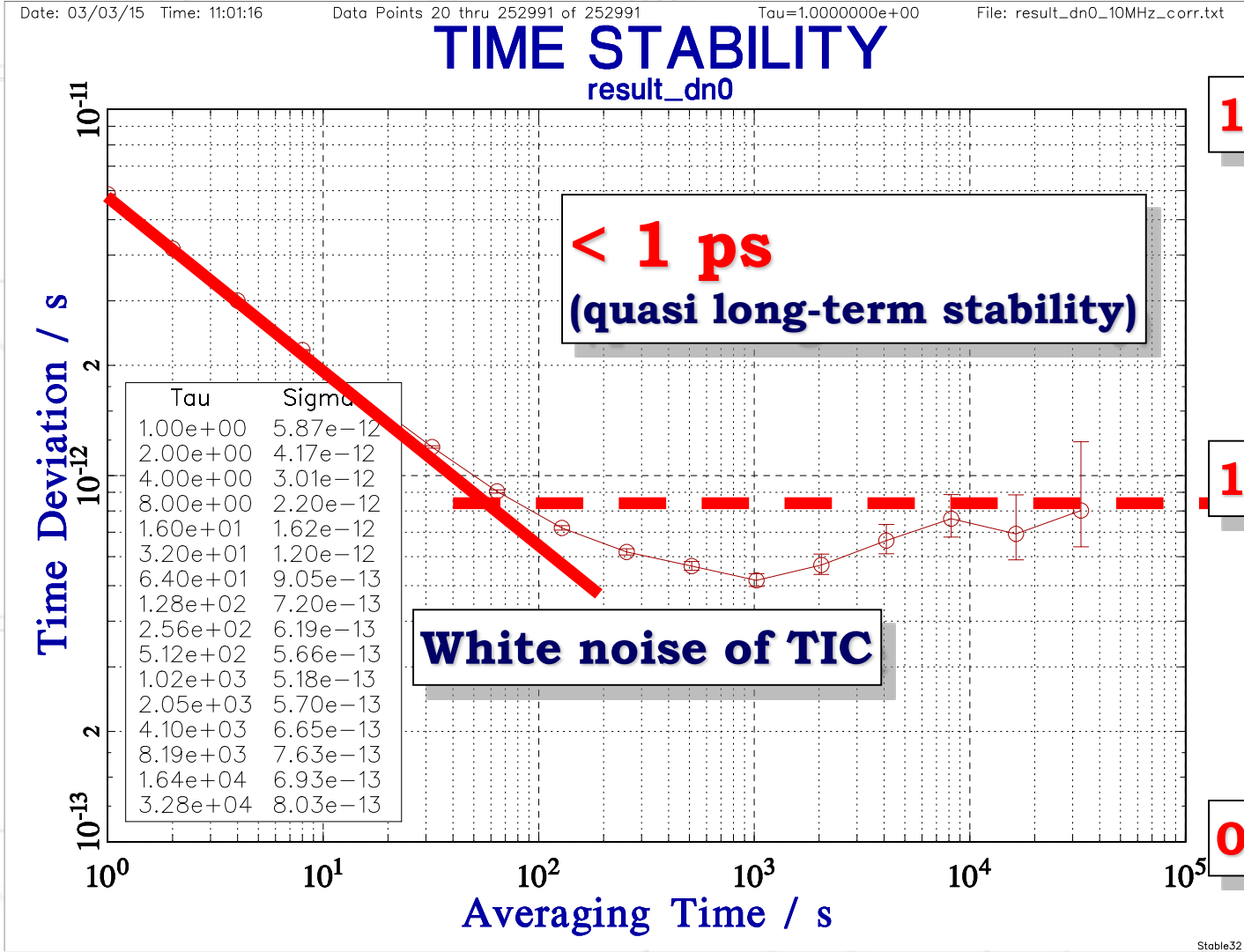


1 pps outputs
Auxiliary display

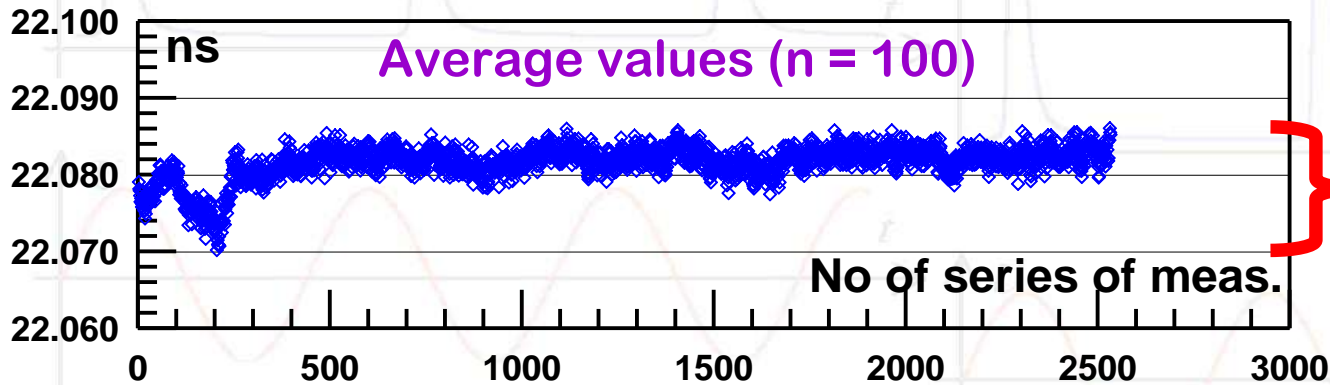
Electronic board mounted inside and auxiliary display

Electronic based Time Interval generator
(PLL loops and programmable logic and counters)

TDev of output TI measurements

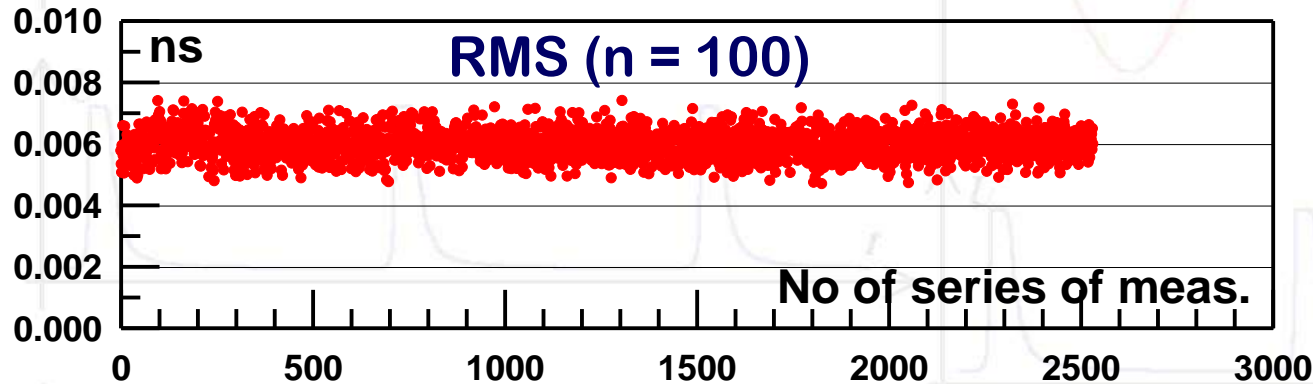


Exemplary continuous measurements of output signals

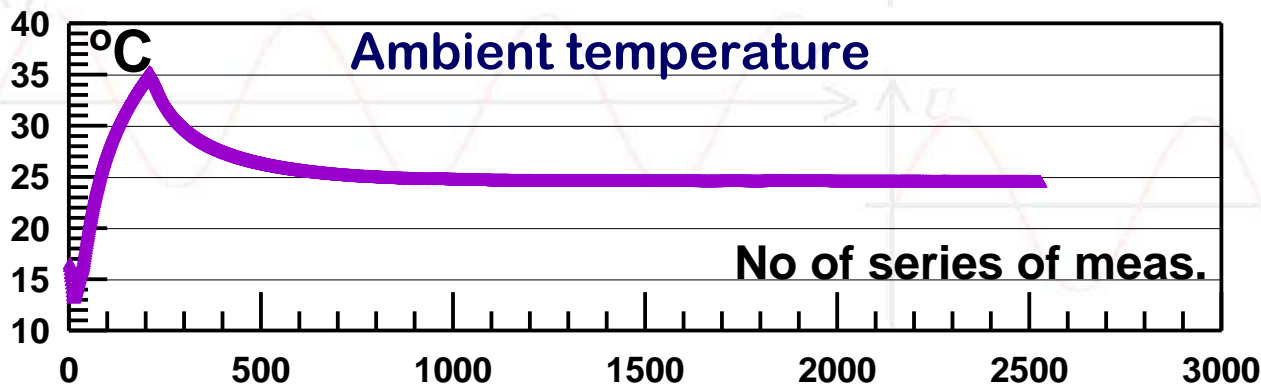


TI \approx 20 ns

13 ps
(peak-to-peak)



Raw measurement data - no correction for differential cables and channels delays



No significant influence of temperature

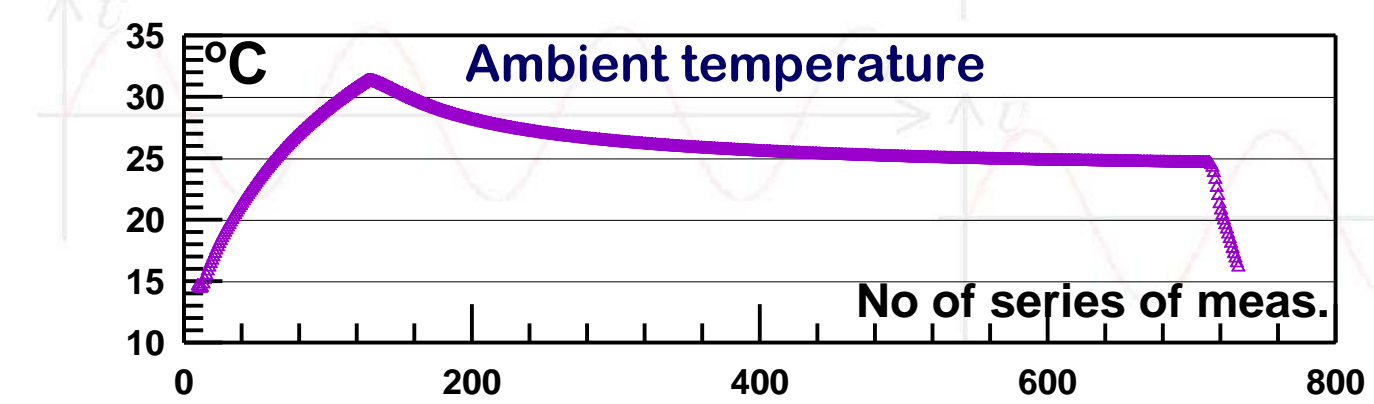
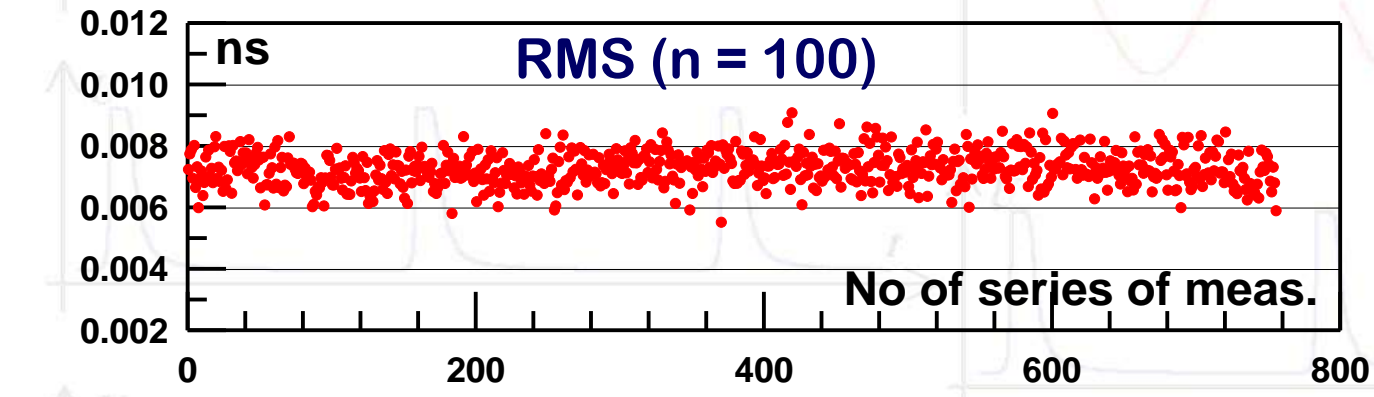
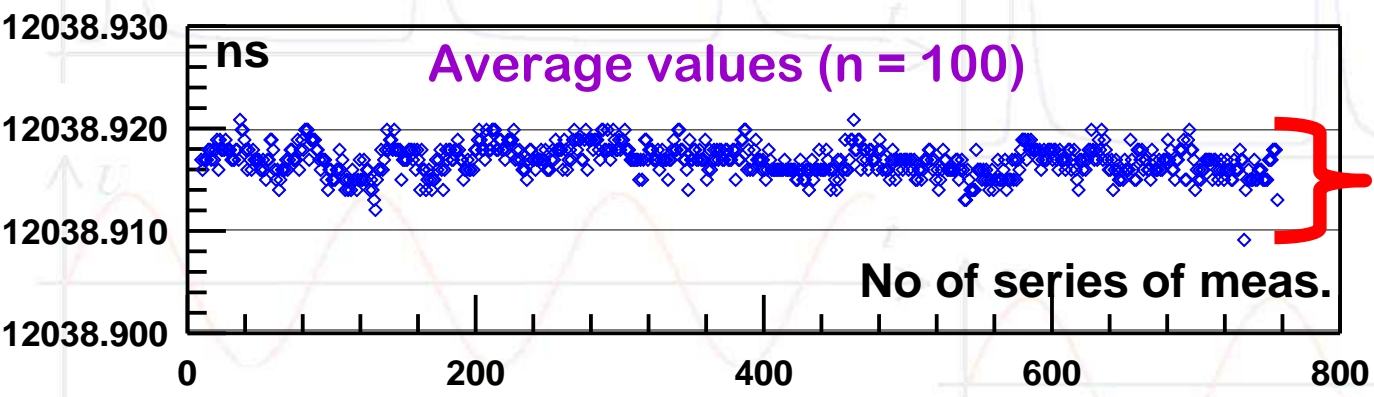
Exemplary continuous measurements of output signals

TI $\approx 12 \mu\text{s}$

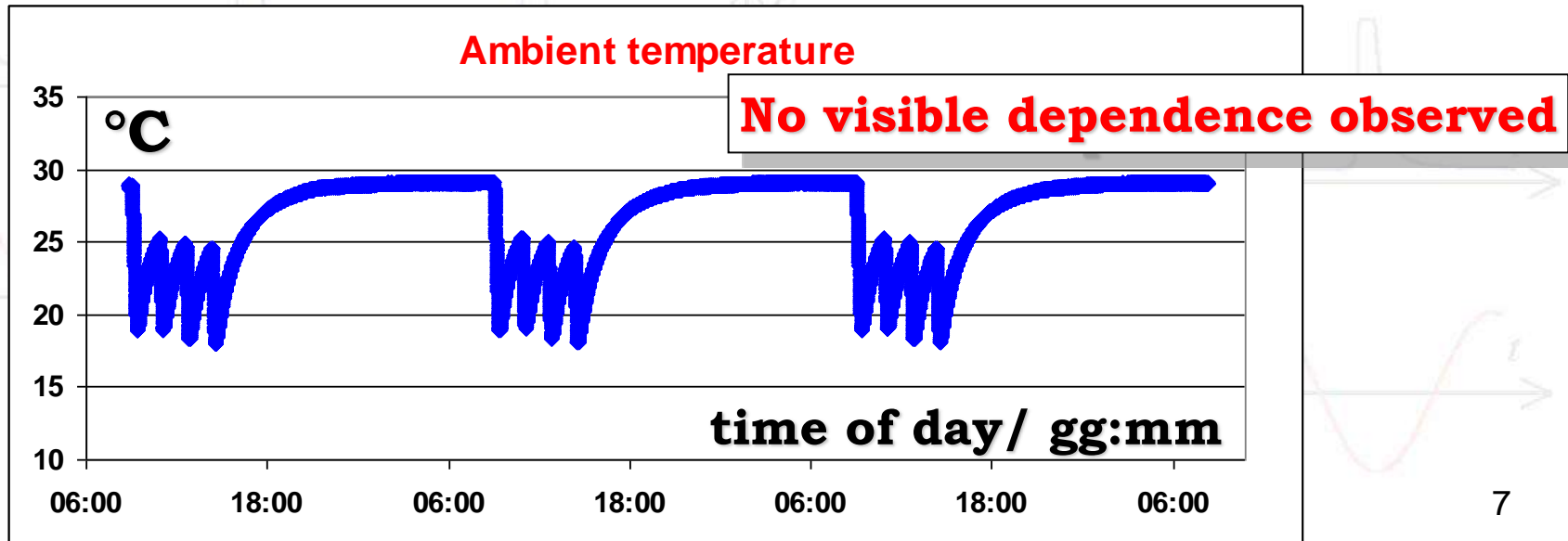
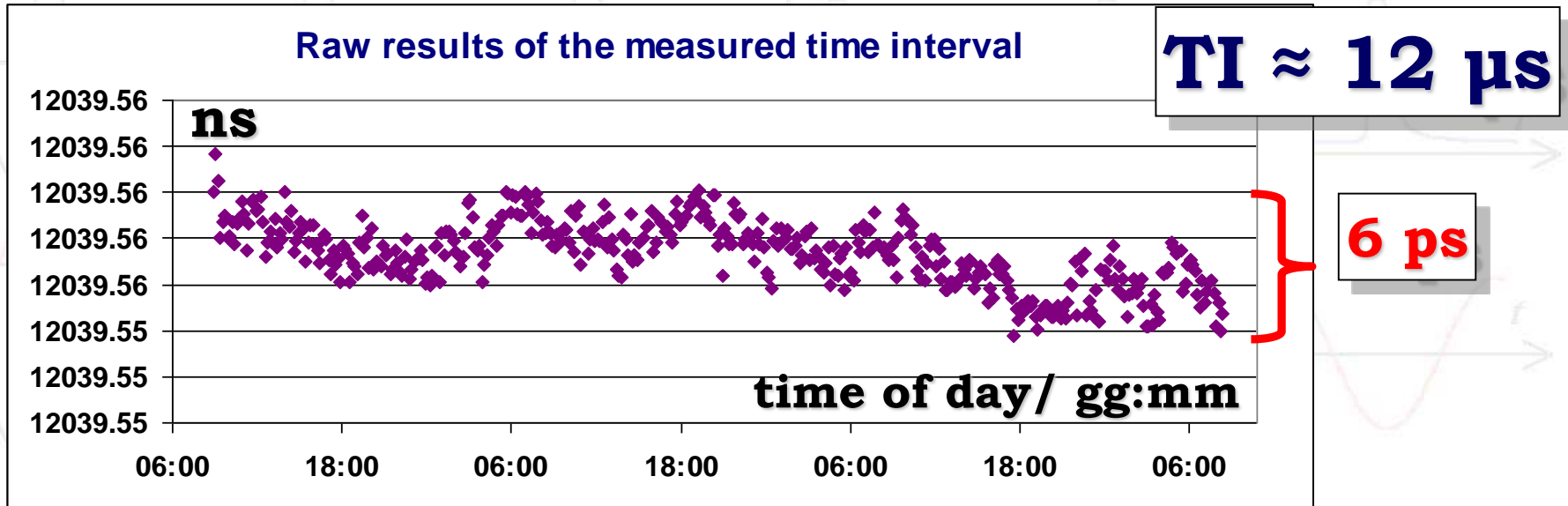
**11 ps
(peak-to-peak)**

Raw measurement data - no correction for differential cables and channels delays

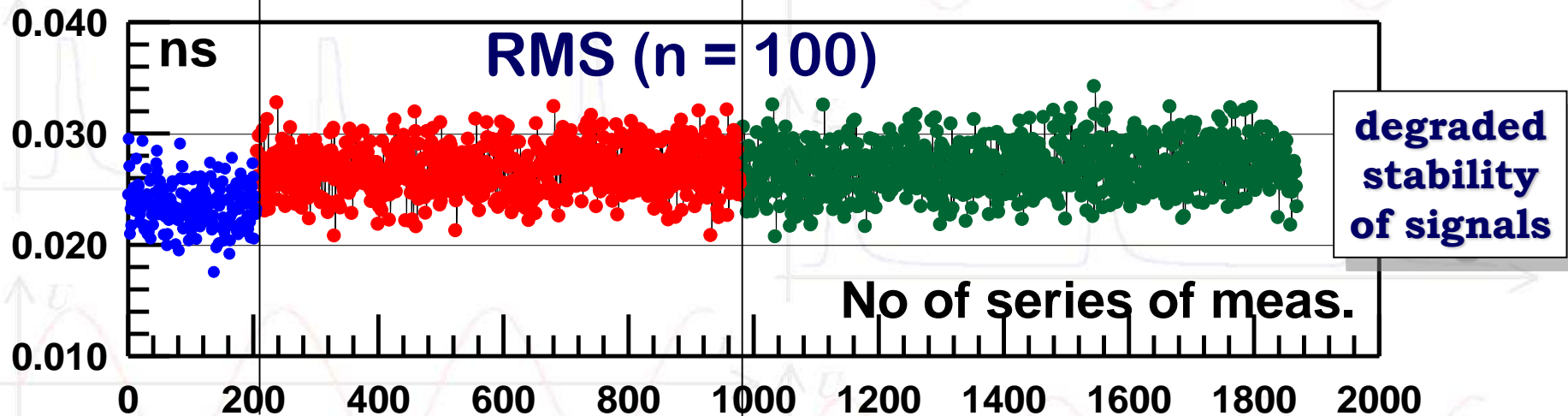
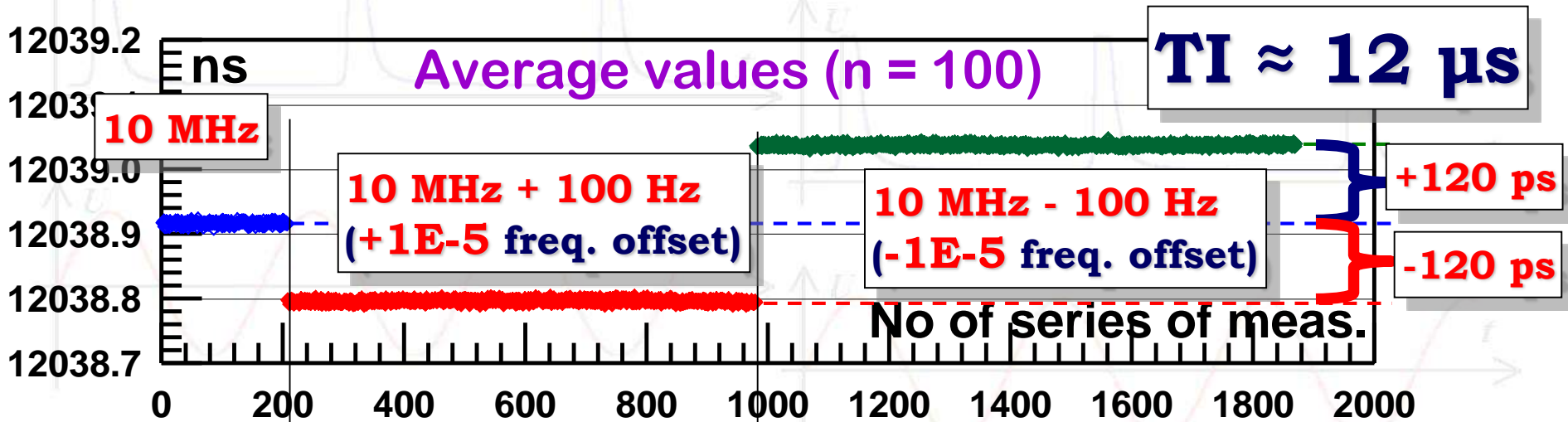
No significant influence of temperature



Influence of temperature - TI Gen



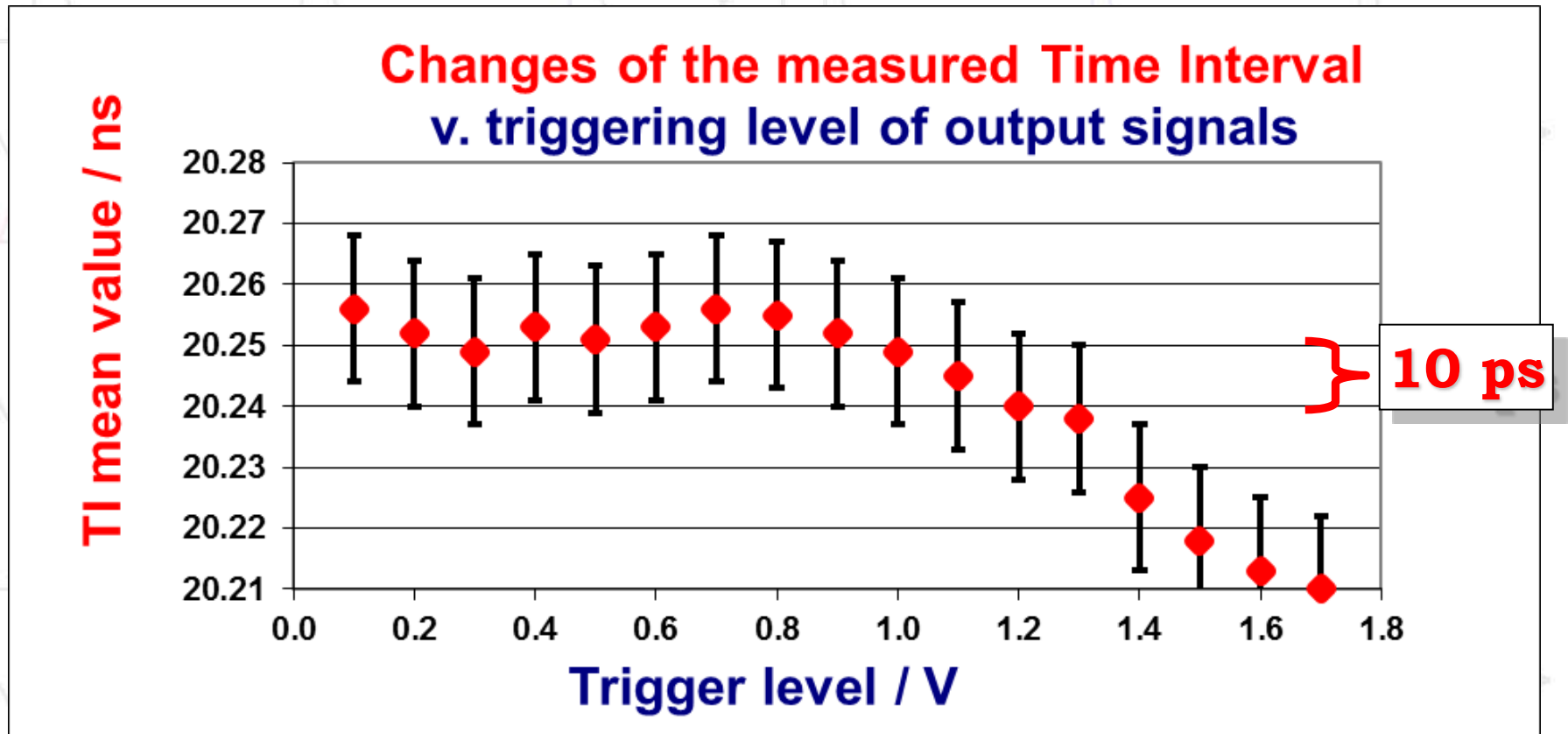
Influence of Ext. time base



10 MHz, ...: taken from 33250A generator

freq. offset $< 1\text{E-}7$ gives $< 2 \text{ ps}$ TI change

The choice of **trigger levels** of the measured signals



No visible changes between 0.2 V and 0.6 V of the trigger levels

Trigger levels should be fixed to c. 0,5 V

Characterisation of TIGen by pilot comparison (June 2015-March 2016):

„Comparison of time interval measurement with high speed oscilloscopes”

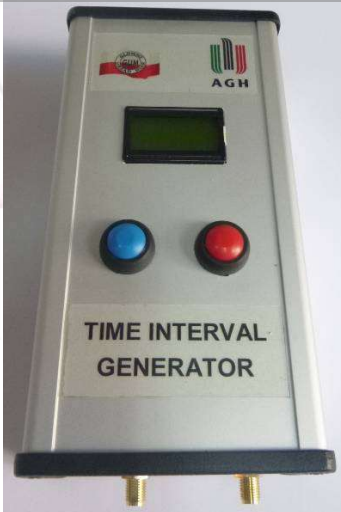
Participants: **AGH, NIT** (Poland), **UME** (Turkey), **SASO** (Saudi Arabia), **SIQ** (Slovenia)

The measured time intervals: **dn1, dn4, dn111 and dn115** (from about 70 ns to about 11 us)

Obtained the best **$U = 4 \text{ ps}$** and **6 ps** (at all time intervals)

$U_{\text{weighted_mean}} \approx 2.9 \text{ ps}$

All results are equivalent: **$|E_n| < 1$**



Comparison confirmed that:

TIGen is ready for Time Interval
Supplementary Comparison:

- about **3 ps** of assigned expanded
uncertainty of the travelling standard

- **good stability and reproducibility** of generated
Time Intervals

- **the results of Oscilloscope** measurements of
Time Intervals agree within a few ps

