

Time walk compensation of a SPAD with a linear photodetection

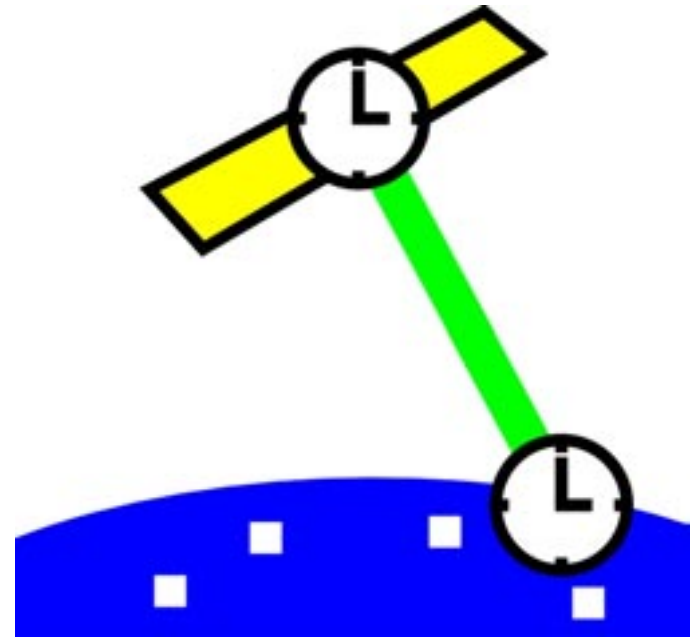
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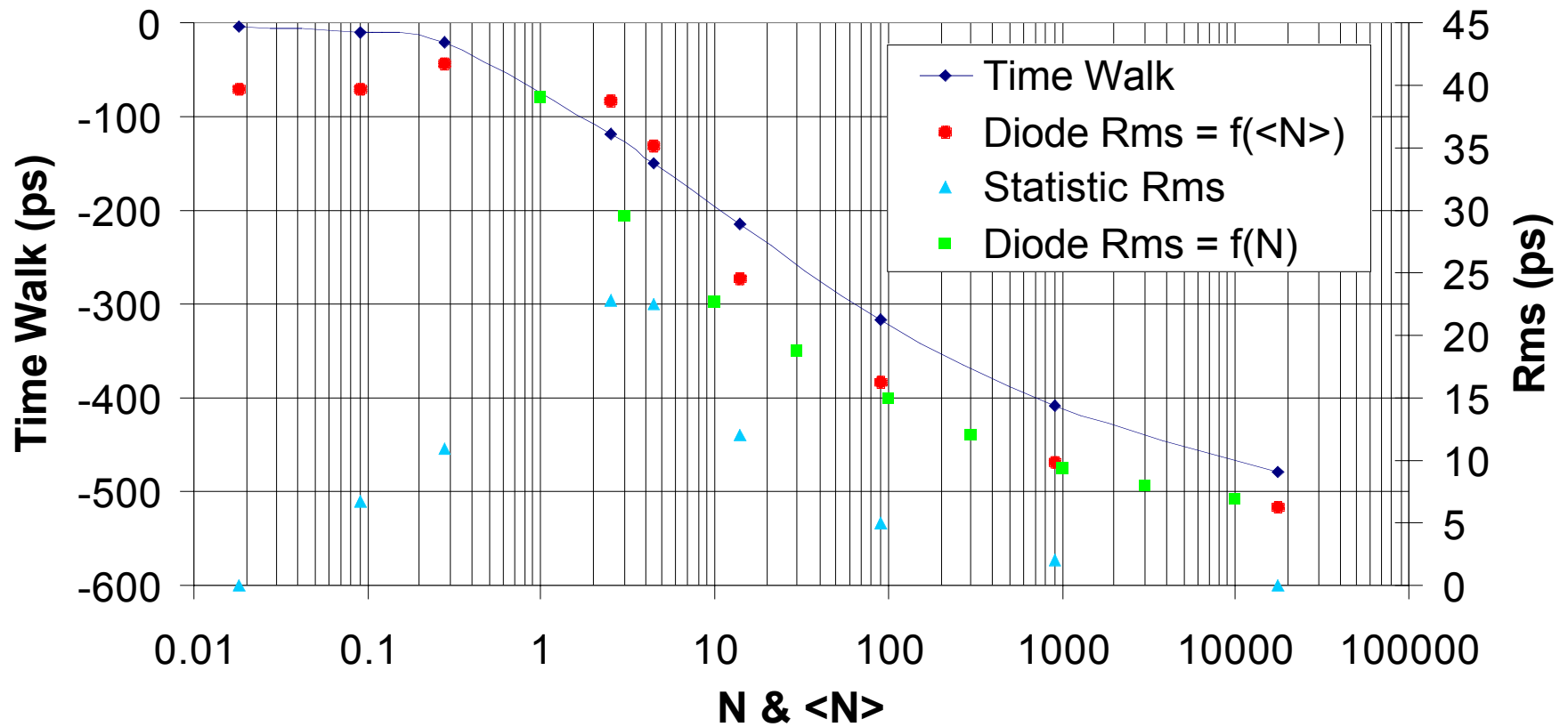


Specifications

- Multi-photons mode with a dynamic of 10^4
- Time stability below 1 ps over 1000 s
- Precision better than 20 ps rms
- Insensitive to the laser pulse width (20 - 200 ps)
- Asynchronous detection mode

Silicon Sensor ADH230 SPAD

Time walk and precision

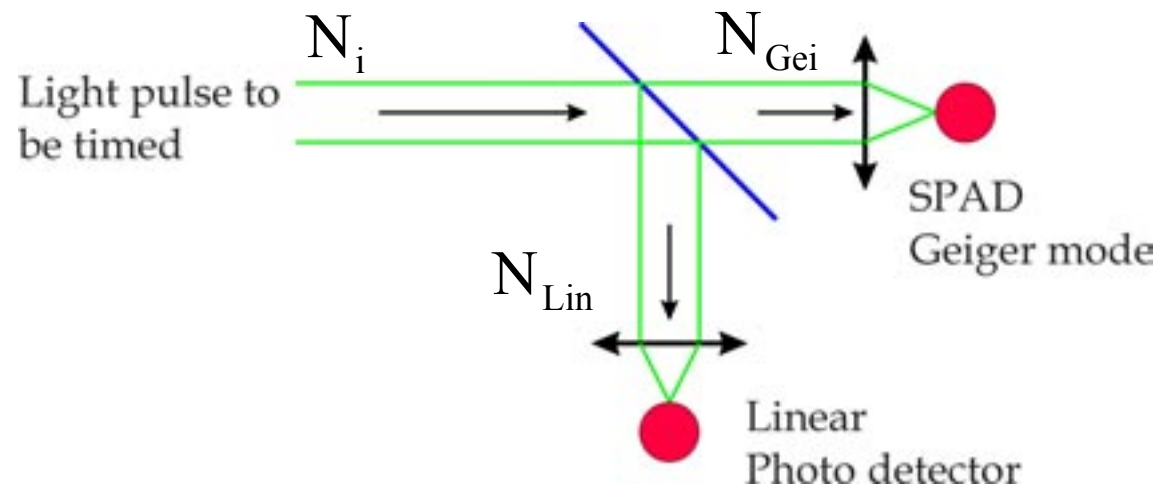


Photon statistic

$$N_{\text{Gei}} = \frac{1-r}{r} N_{\text{Lin}}$$

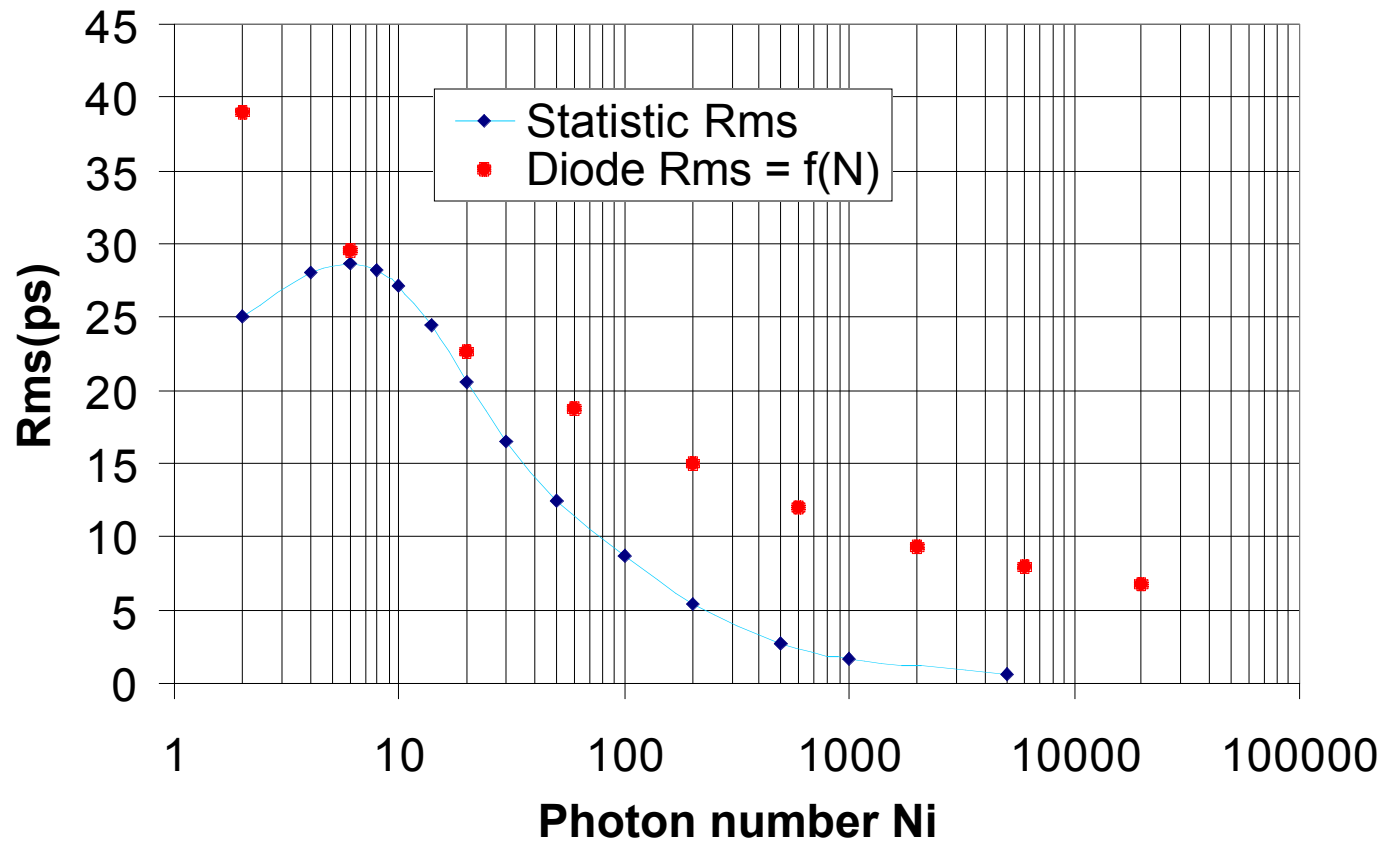
$$\sigma \approx \frac{\tau}{N_{\text{Gei}} \ln 10} \cdot \frac{0,34}{r \cdot p(N_i, N_{\text{Lin}})}$$

$$p(N_i, N_{\text{lin}}) = C_{N_i}^{N_{\text{lin}}} (1-r)^{N_i - N_{\text{lin}}} r^{N_{\text{lin}}}$$

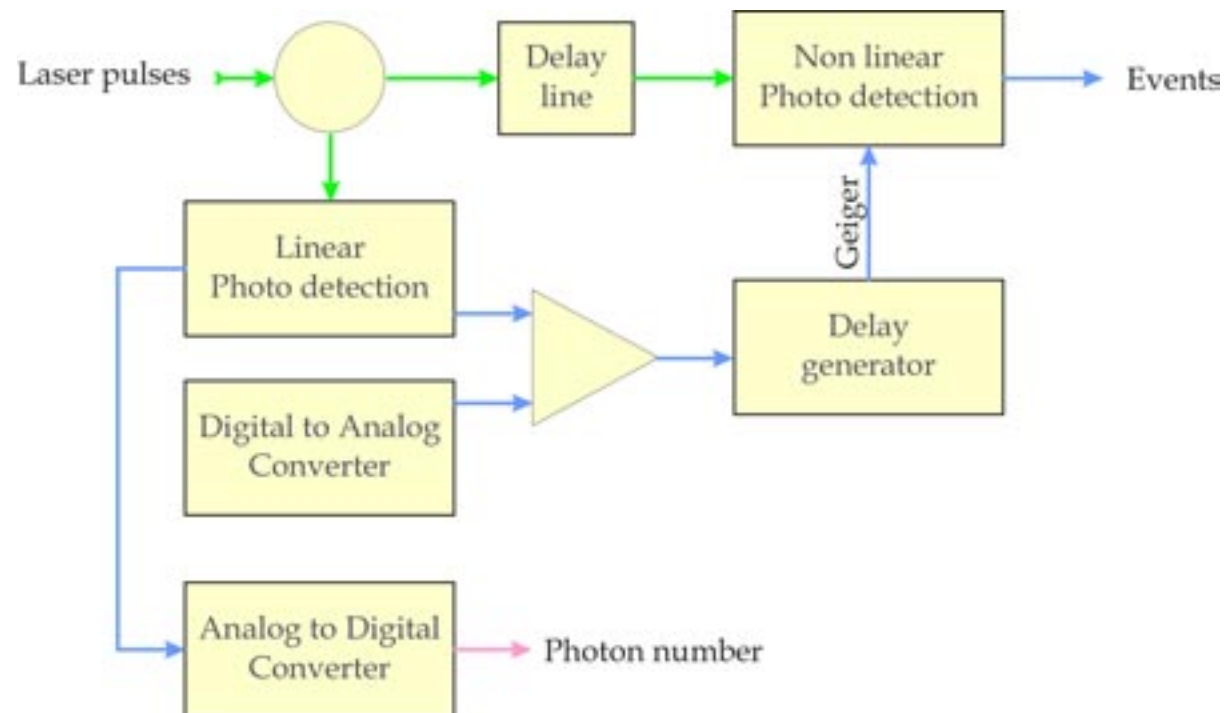


Photon statistic

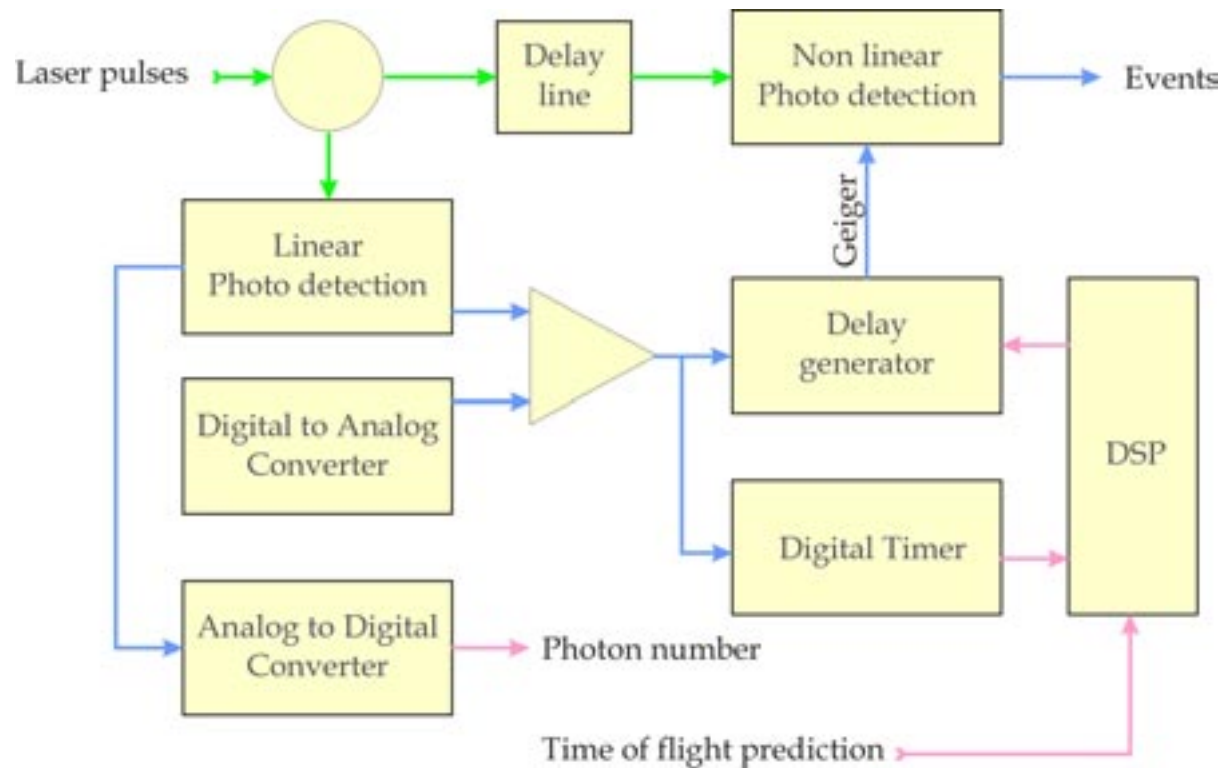
- Time walk : 100 ps/decade
- $r = 0.5$



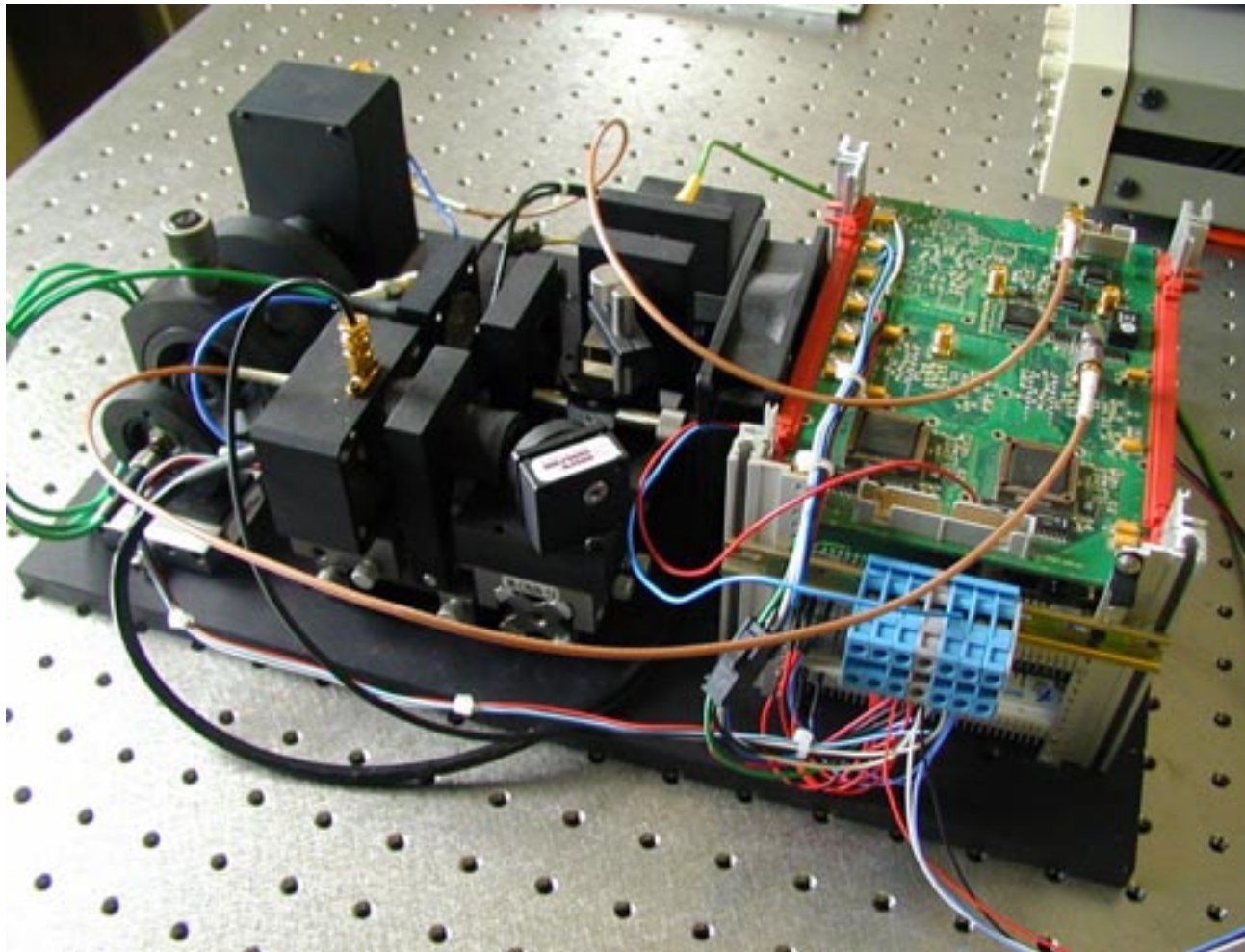
Synoptic of T2L2 Space detection



Synoptic of Ground detection

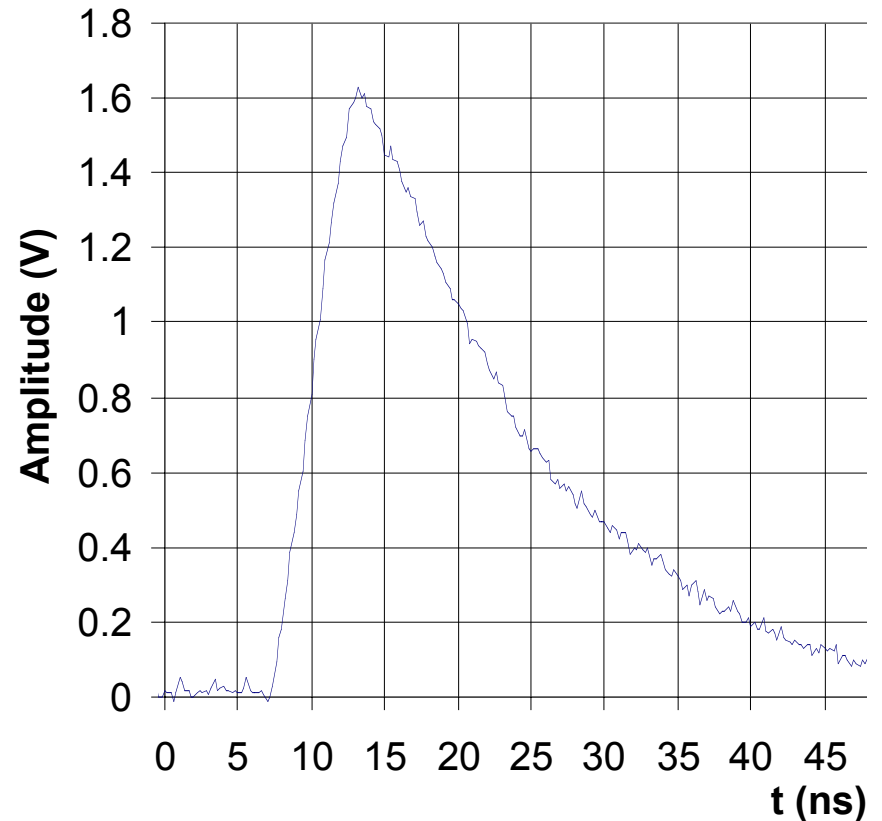


Space segment prototype



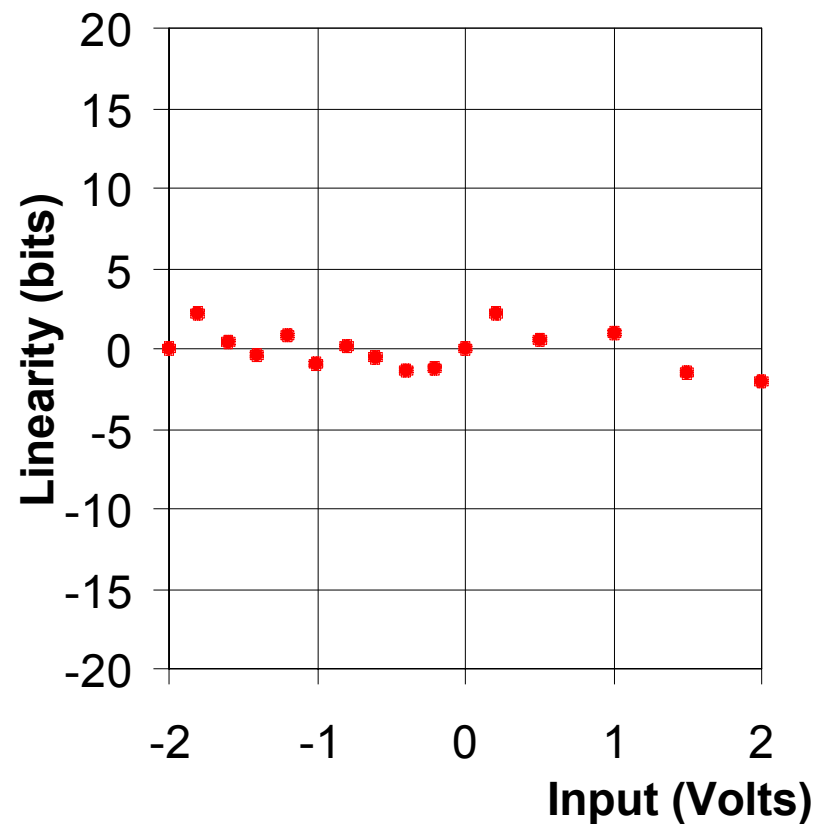
Linear Photodetection

- Avalanche photodiode in Gain Mode (RCA 902S)
- Low noise integrator amplifier
- Min threshold level $< 100 \text{ h}\nu \text{ e}^-$
- Dynamic: 10^4



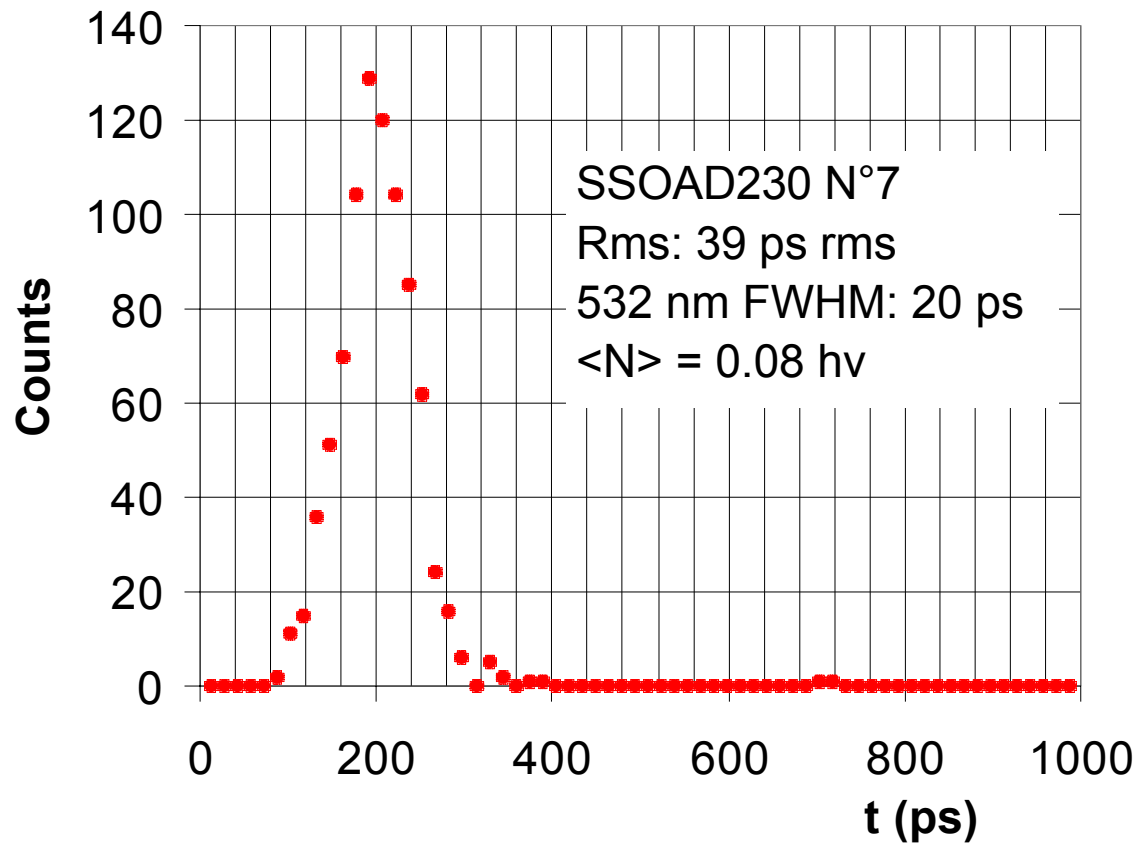
Analog to digital converter

- Resolution: 16 bits
- Input bandwidth: 200 MHz
- Linearity error: 1.3 bits rms
- Precision: 1.3 bits rms

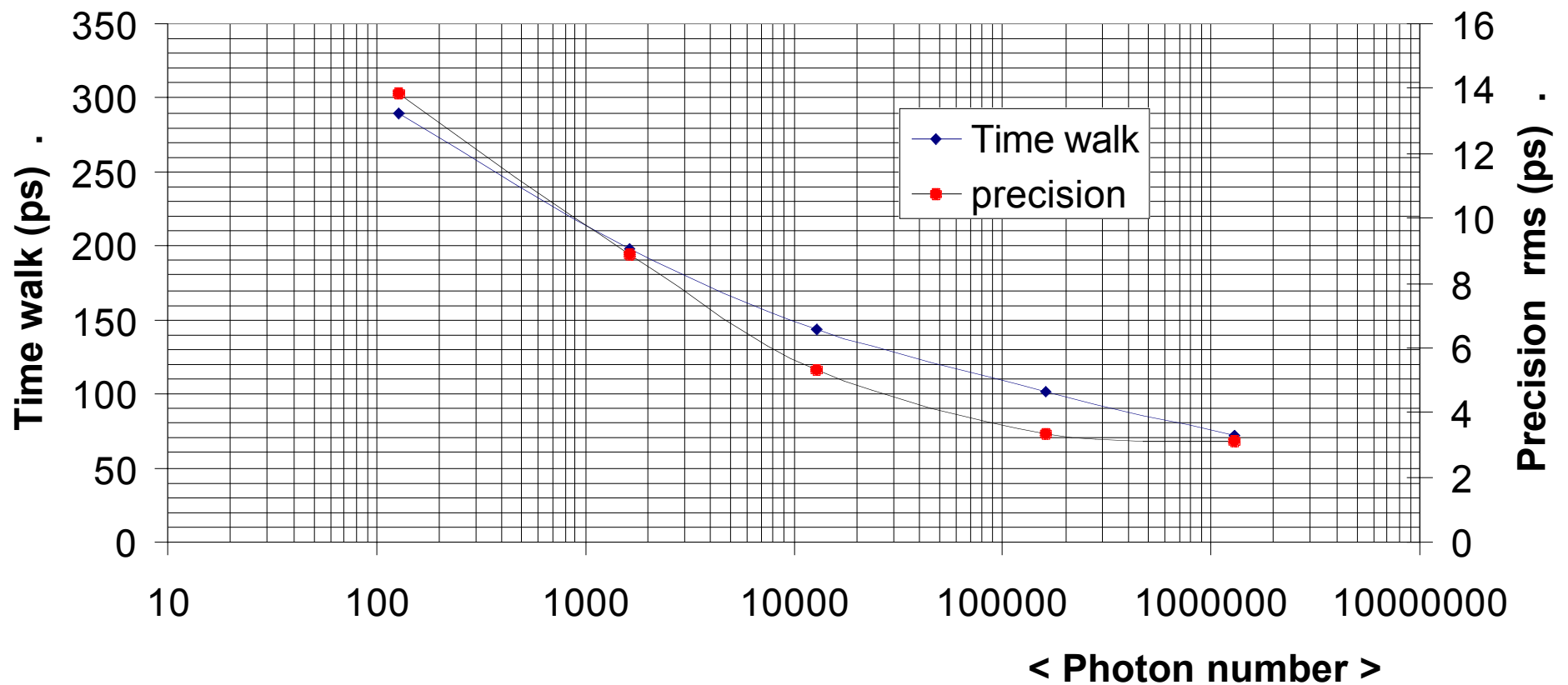


Non linear photodetection

SPAD: Silicon Sensor AD230

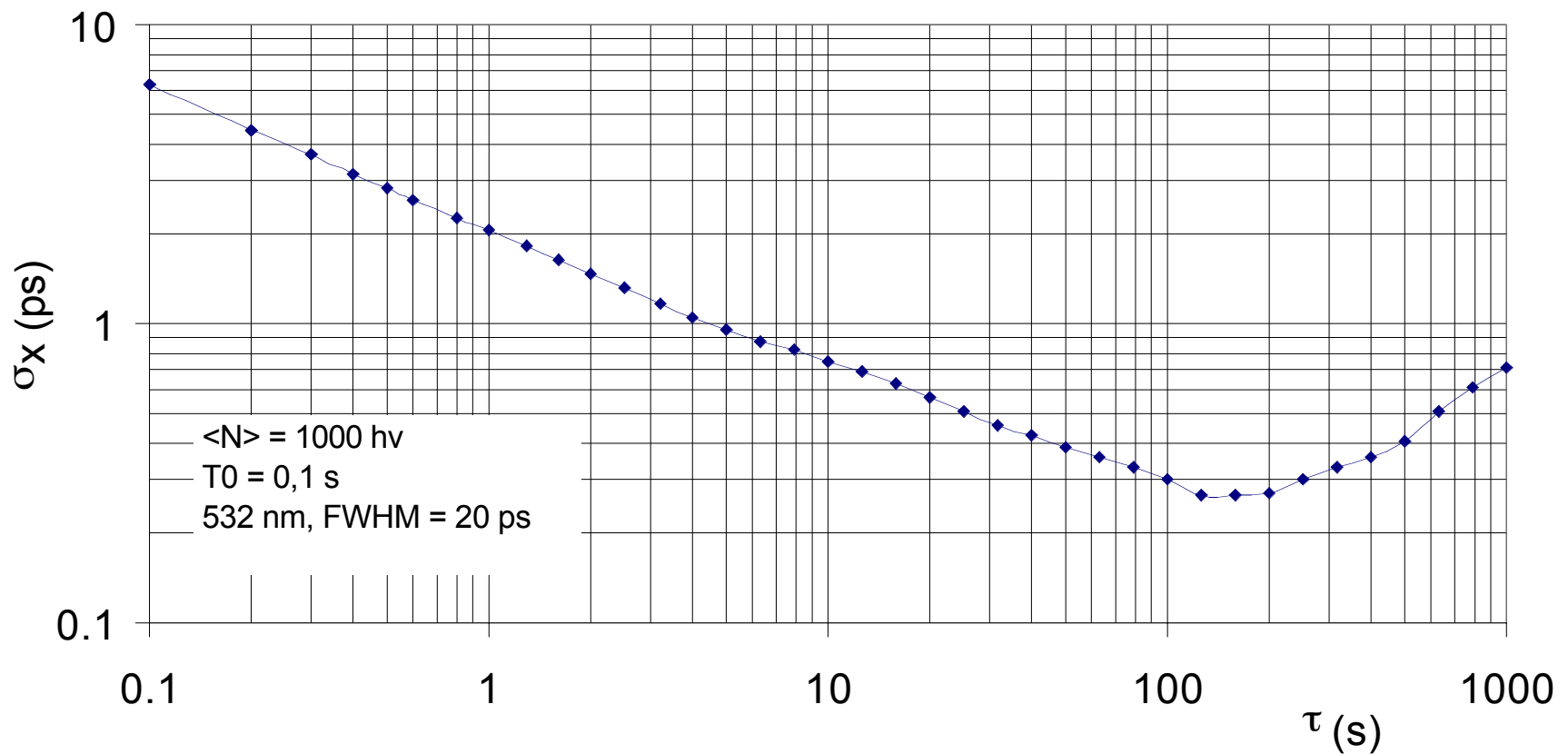


Precision and time walk Overall instrument



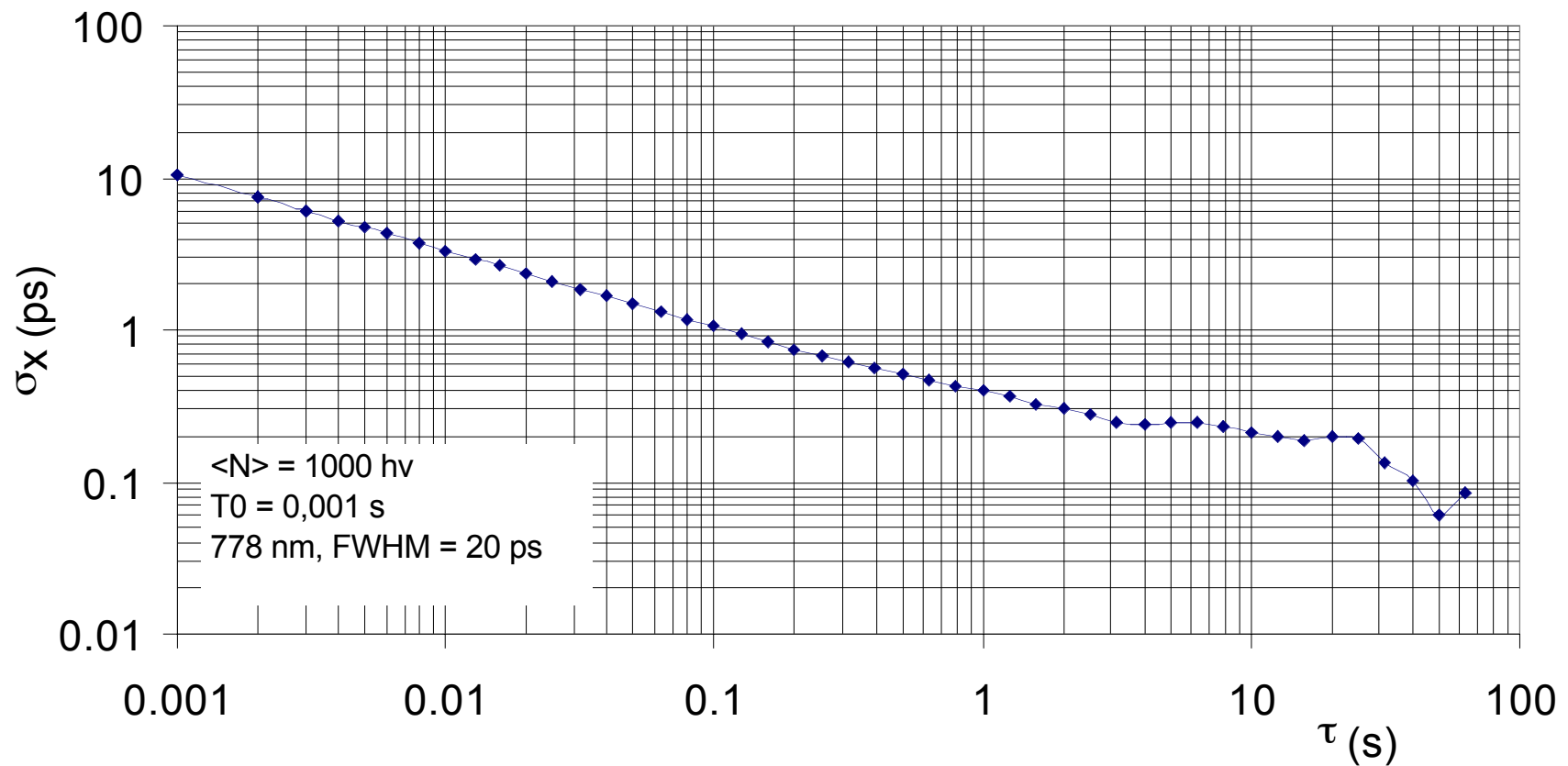
Time stability @ 532 nm 10 Hz

Overall instrument



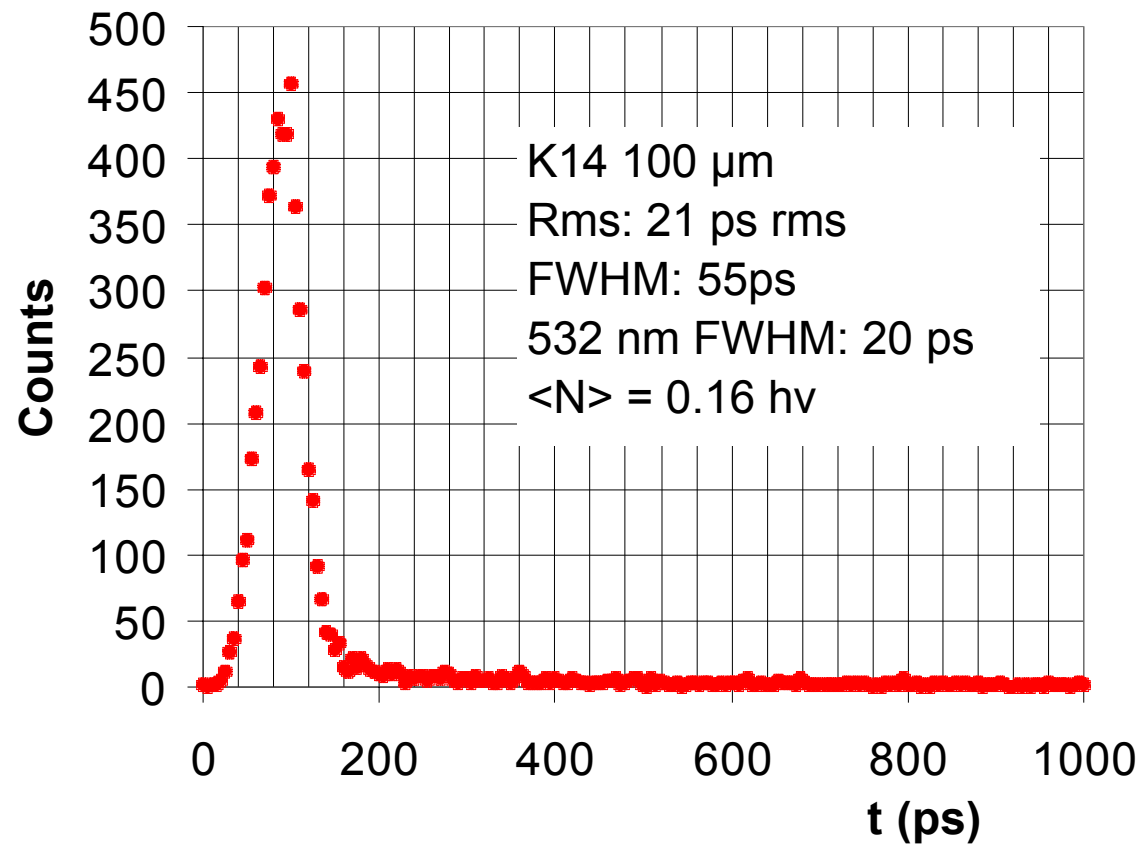
Time stability @ 778n nm 1 kHz

Overall instrument

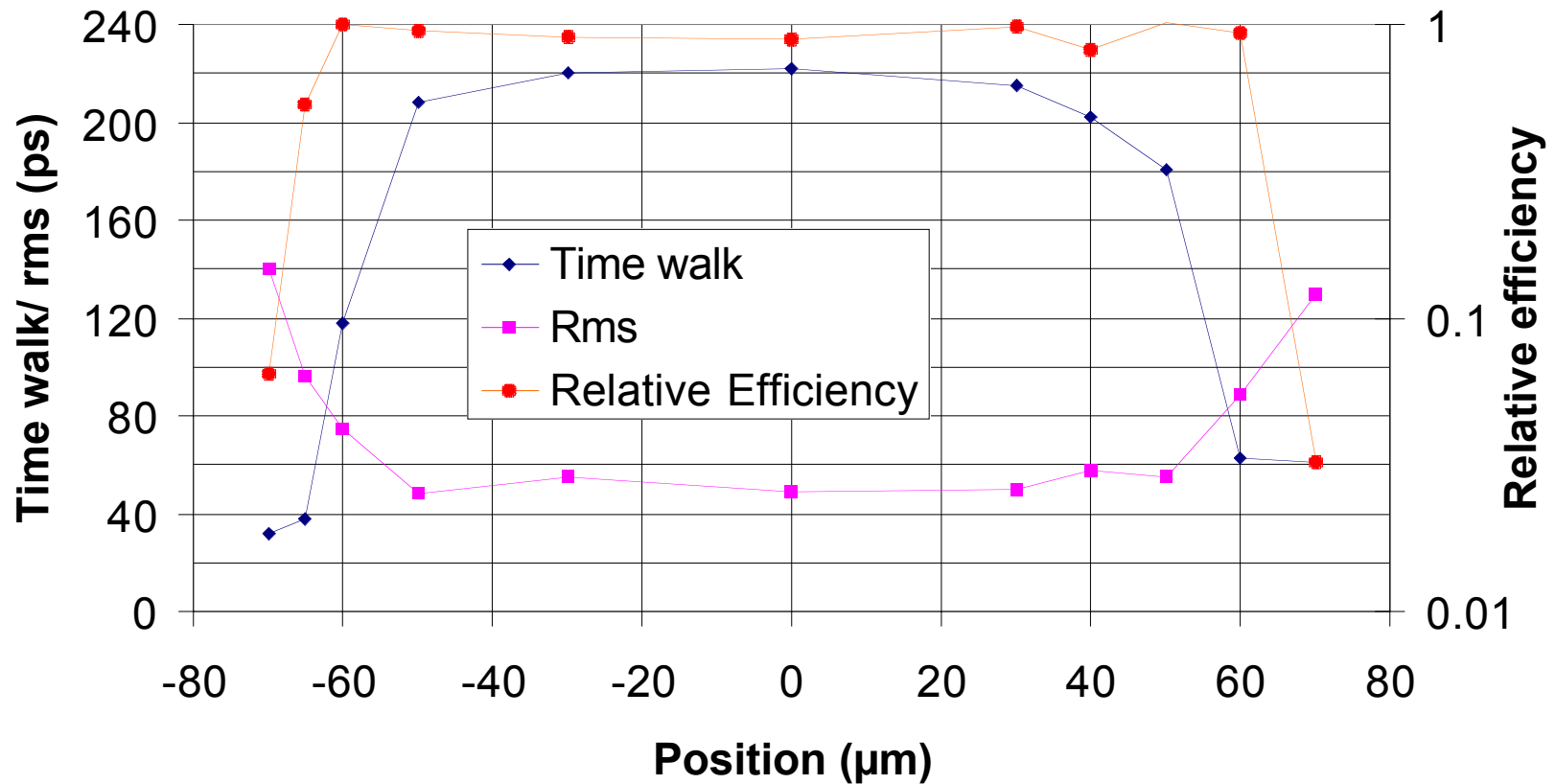


SPAD K14 100 μm

Precision - Single photon mode

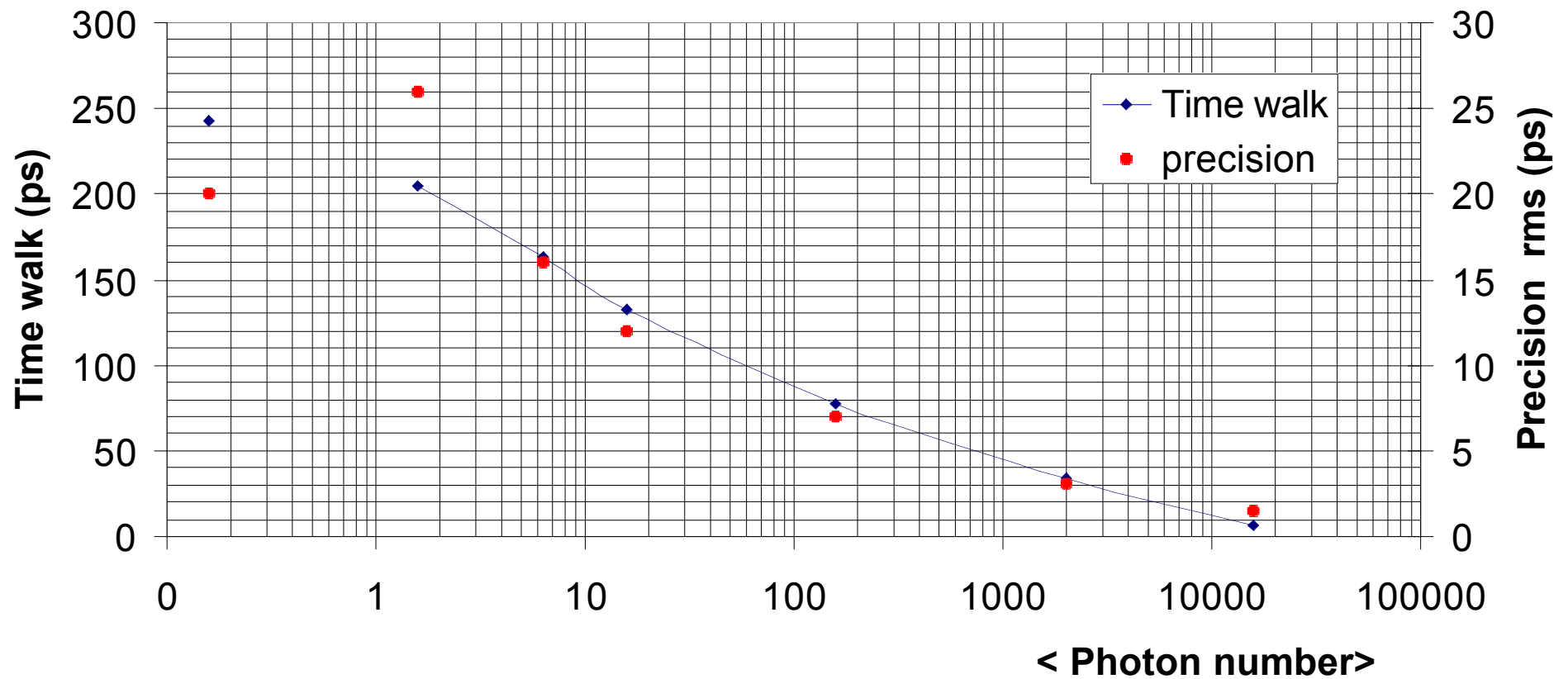


SPAD K14 100 μm Center-edge effect



SPAD K14 100 μm

Precision & TW - Multi photon mode



Conclusions

- Time walk compensated
- Precision: 15 - 3 ps over the whole dynamic
- Time stability better than 1 ps over 1000 s
- Insensitive to the laser pulse width (20 - 200 ps)
- Asynchronous detection mode

- SPAD K14: the performances will be 2 times better

Chronograph

