

New technologies for sub – millimeter laser ranging

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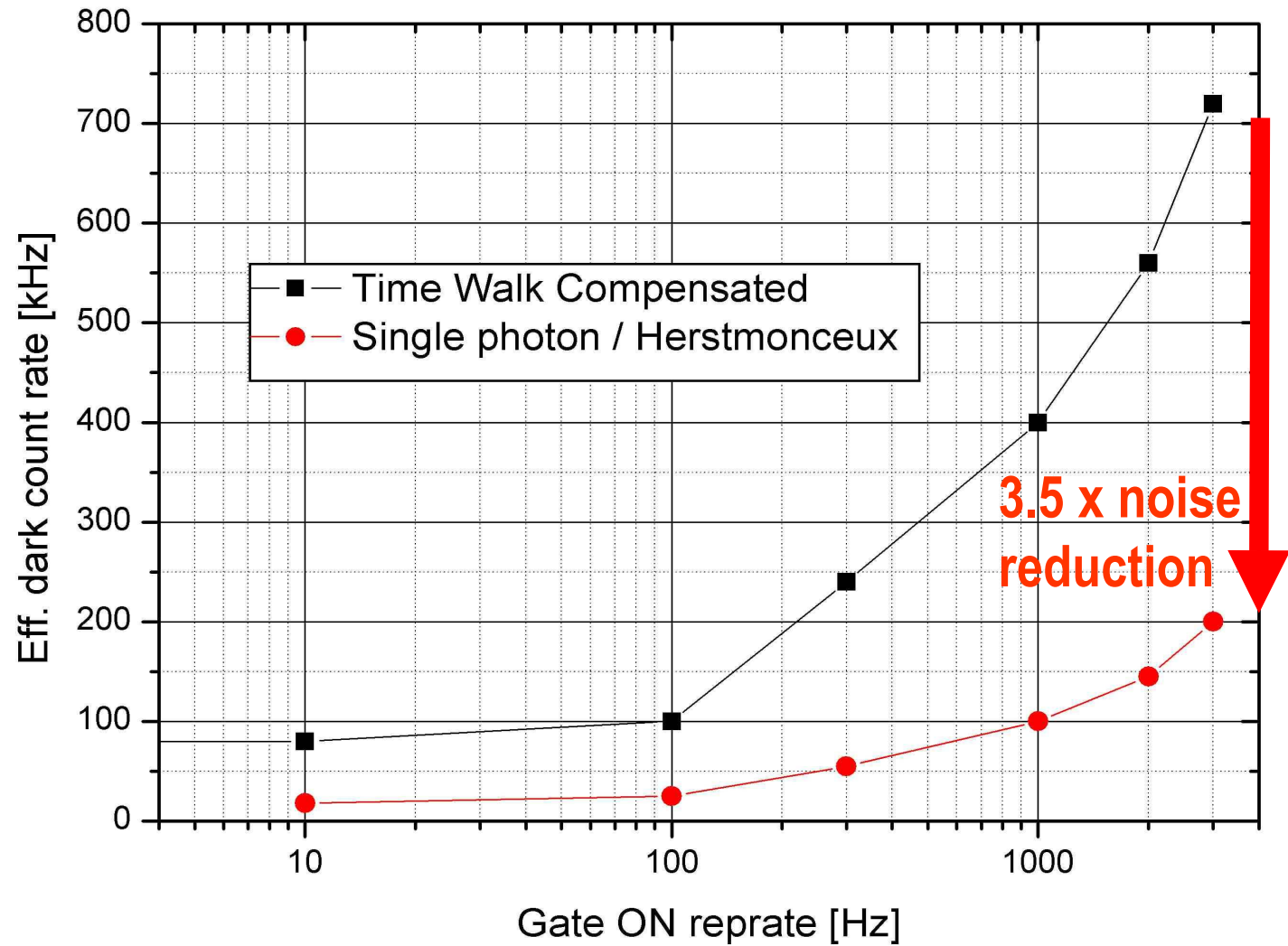
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OUTLINE

- How do we get to robust, mm accuracy ranging ?
- photon counting, high replate, high stability, correct calibration are prerequisite for mm accuracy
- we have learned from European Laser Timing R&D
- new SPAD detector for high replate SLR at 1 Photon level
- sub-picosecond timing system NPET1 for SLR
- new Start detector + discriminator
- low temperature drift cables
- Overall ranging performance

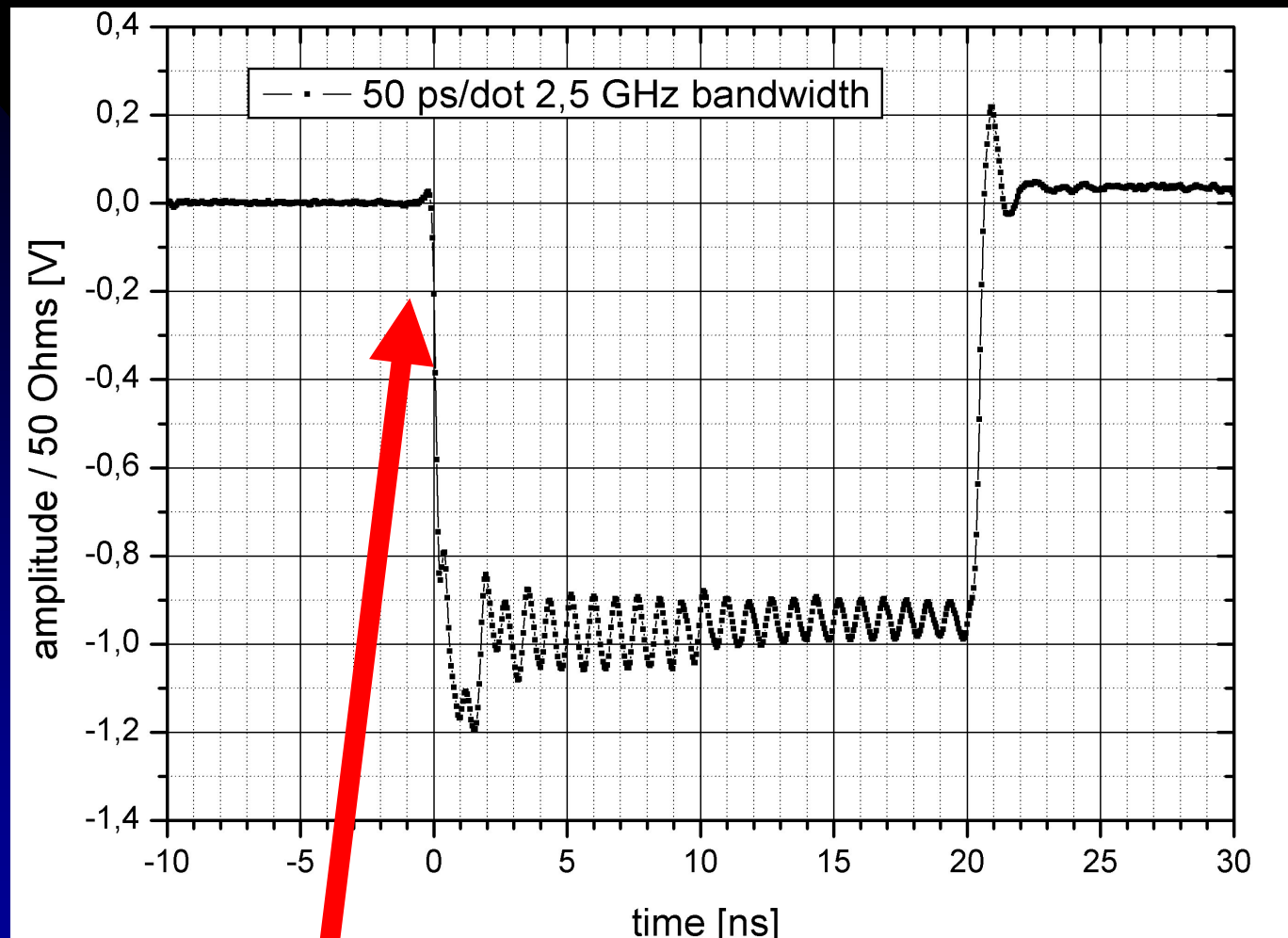
New SPAD detector for high replate SLR

Lower eff. dark count rate at kHz Gate



New SPAD detector for high rebrate SLR # 2

Ultrafast output signals / edges

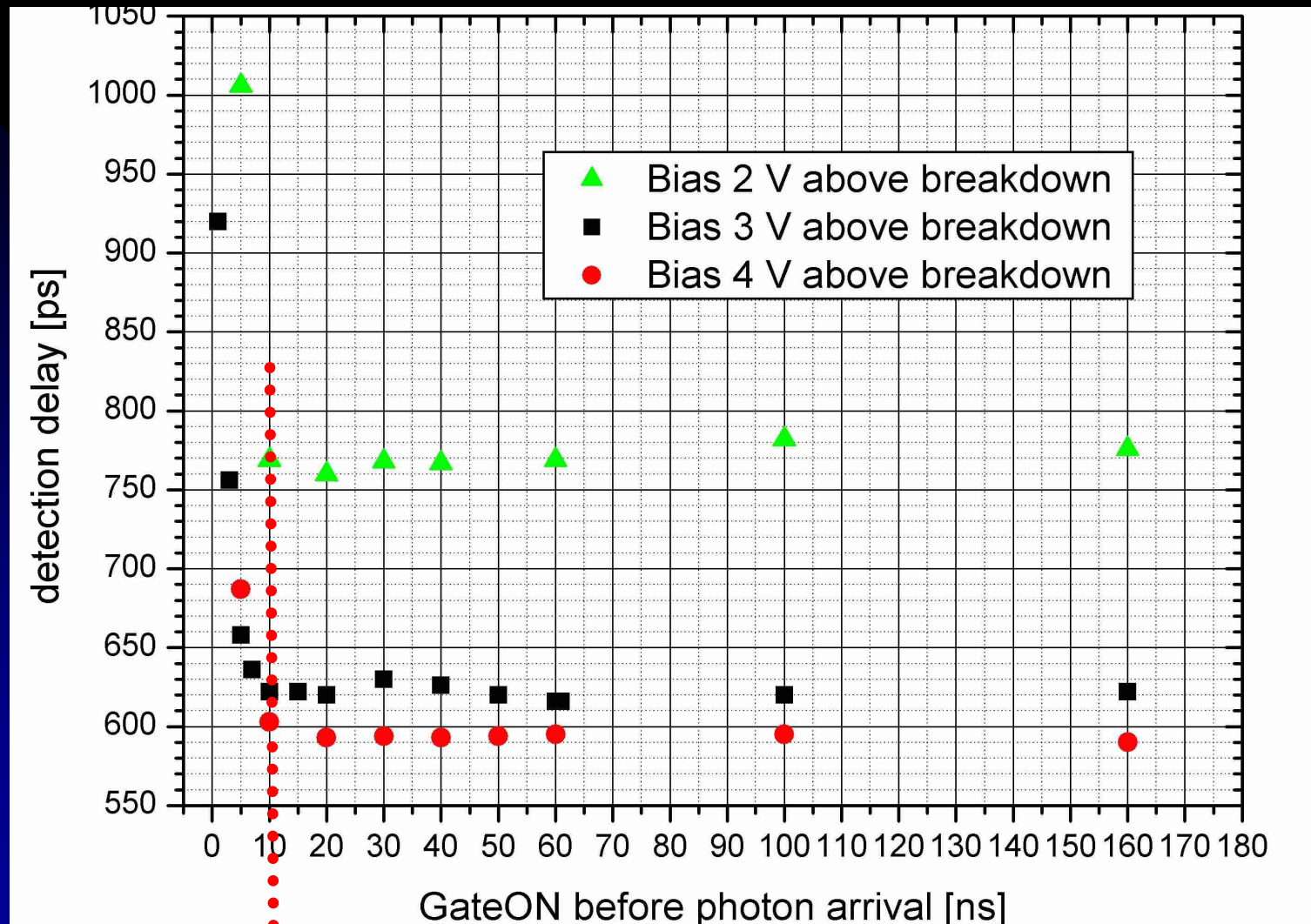


Fast NIM, fall time < 150 ps => higher stability

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New SPAD detector for high replate SLR # 2

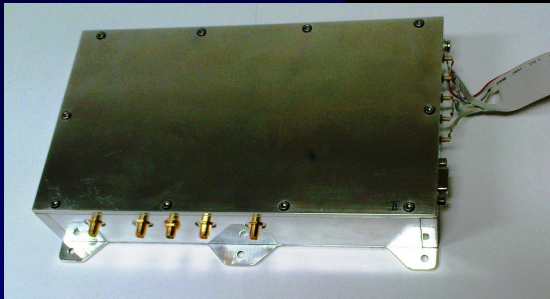
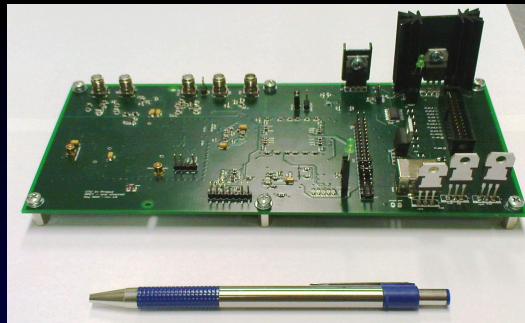
Fast "Gate On" response



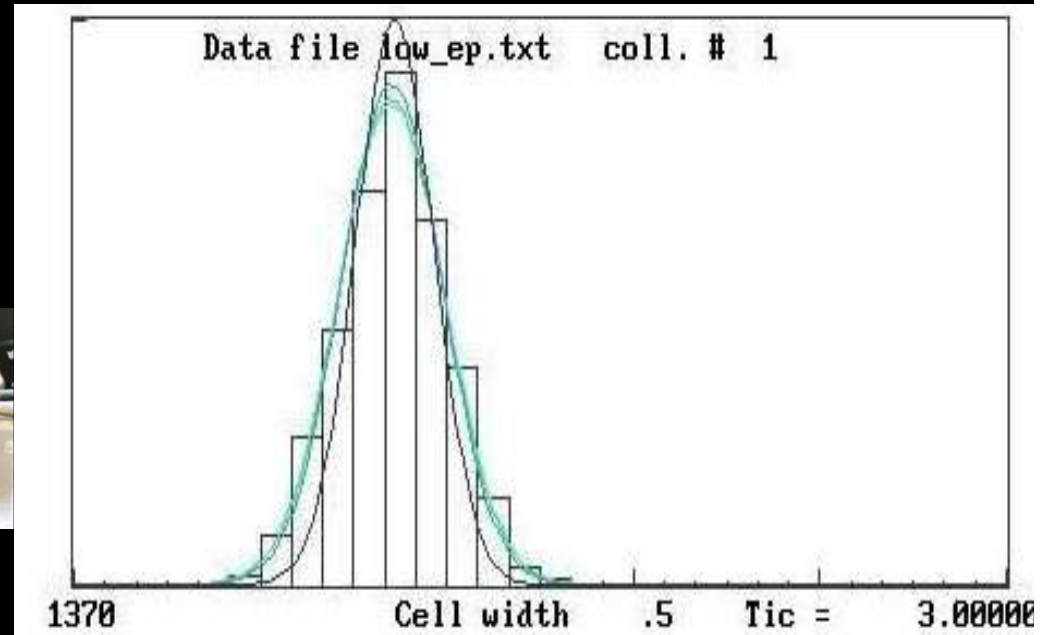
~1 mm stability in < 10 ns, ultimate in 50 ns

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Sub-ps Timing system for SLR



- Based on SAW filter excitation, P.Panek 2005
- Two INDEPENDENT channels in one device
- Single PCB, passive heat flow control
- Linear power supplies
- > 1 kHz / USB
- > 10 kHz Ethernet (end 2011)
- fs stability and linearity



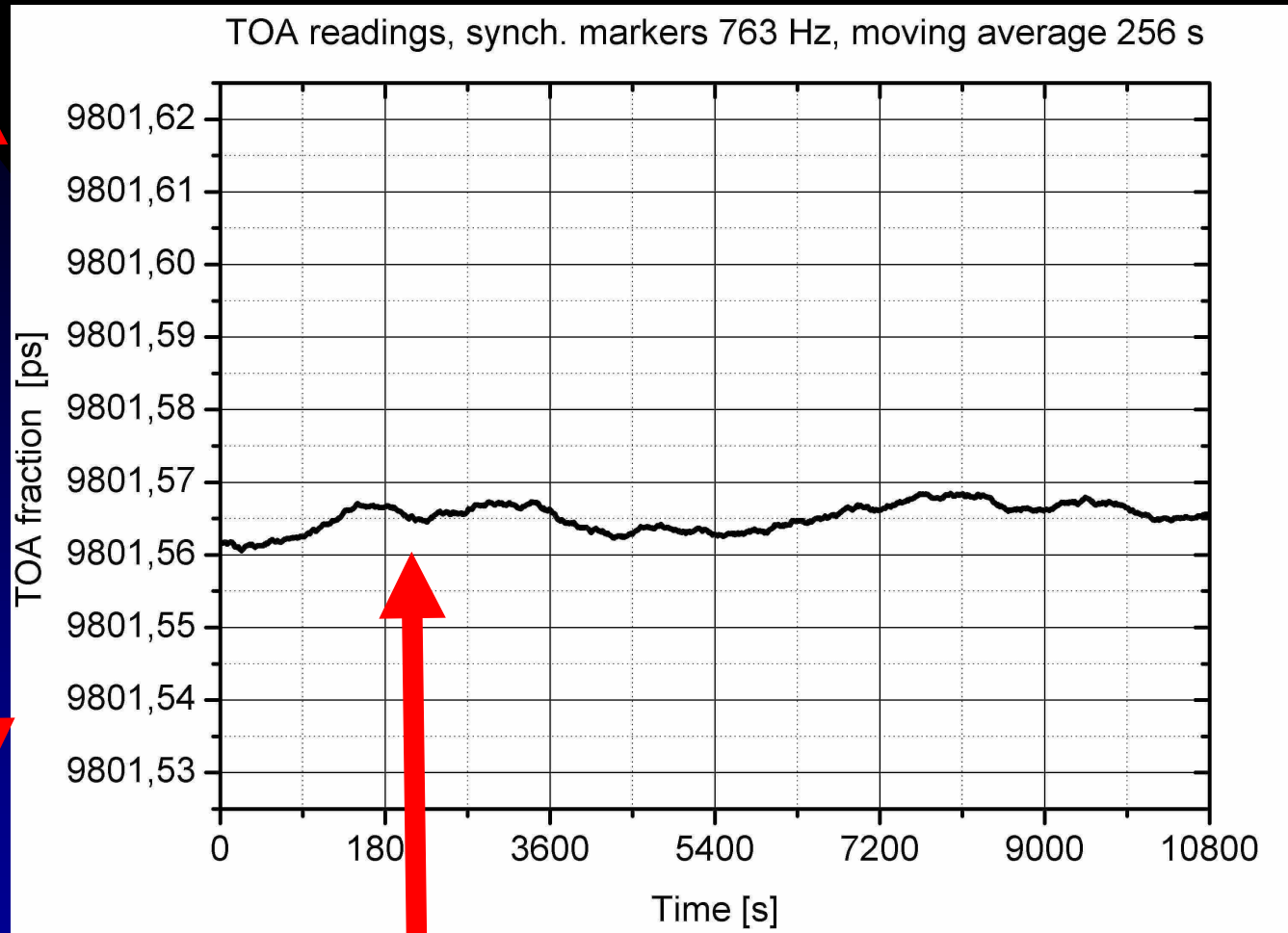
Jitter ~ 800 fs / channel

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Sub-ps Timing system for SLR

Timing stability

100 fs



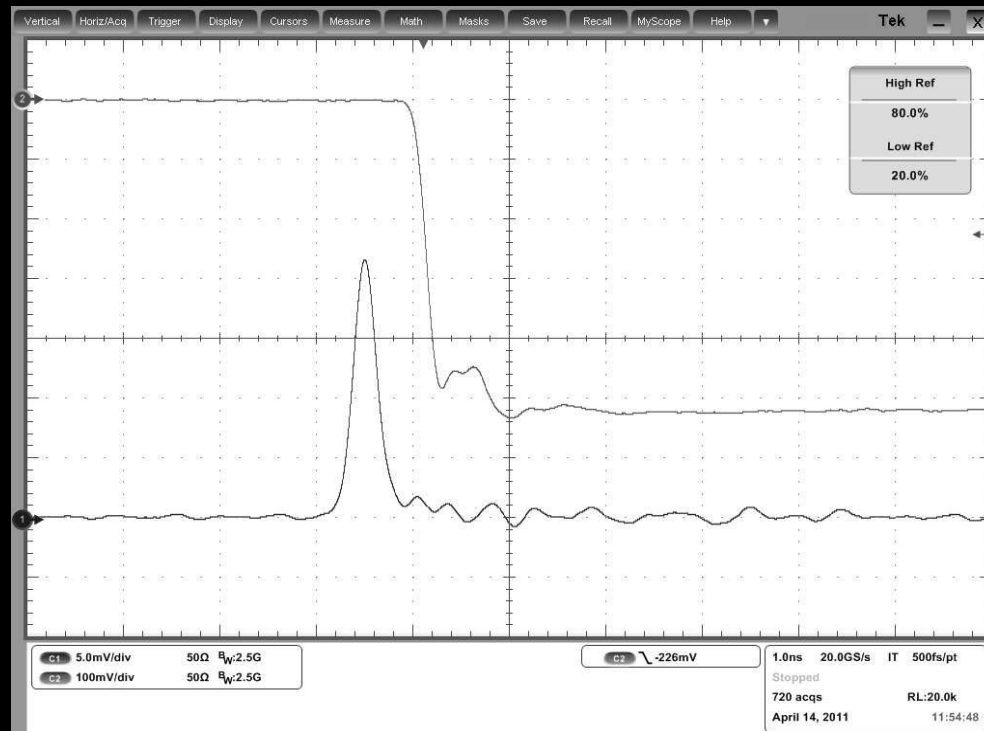
Timing stability +/- 4 fs within 3 hours

New Start detector + discriminator



- fully integrated solution to maximize the BW and to minimize drifts and RF interference
- APD + discriminator + output driver + trigger indication + power supply
- Matchbox size
- Ultrafast components BW > 9 GHz

Fall times < 100 ps
Signal monitor
Fast NIM output



Low temperature drift cables

- Standard coaxial cables change their delay ~ 1 (up to 5) ps / K / meter
- SLR cable length ~ 10 meters, \Rightarrow calibration value dependence ~ 10 ps / K
- \Rightarrow station signal cabling is a serious issue

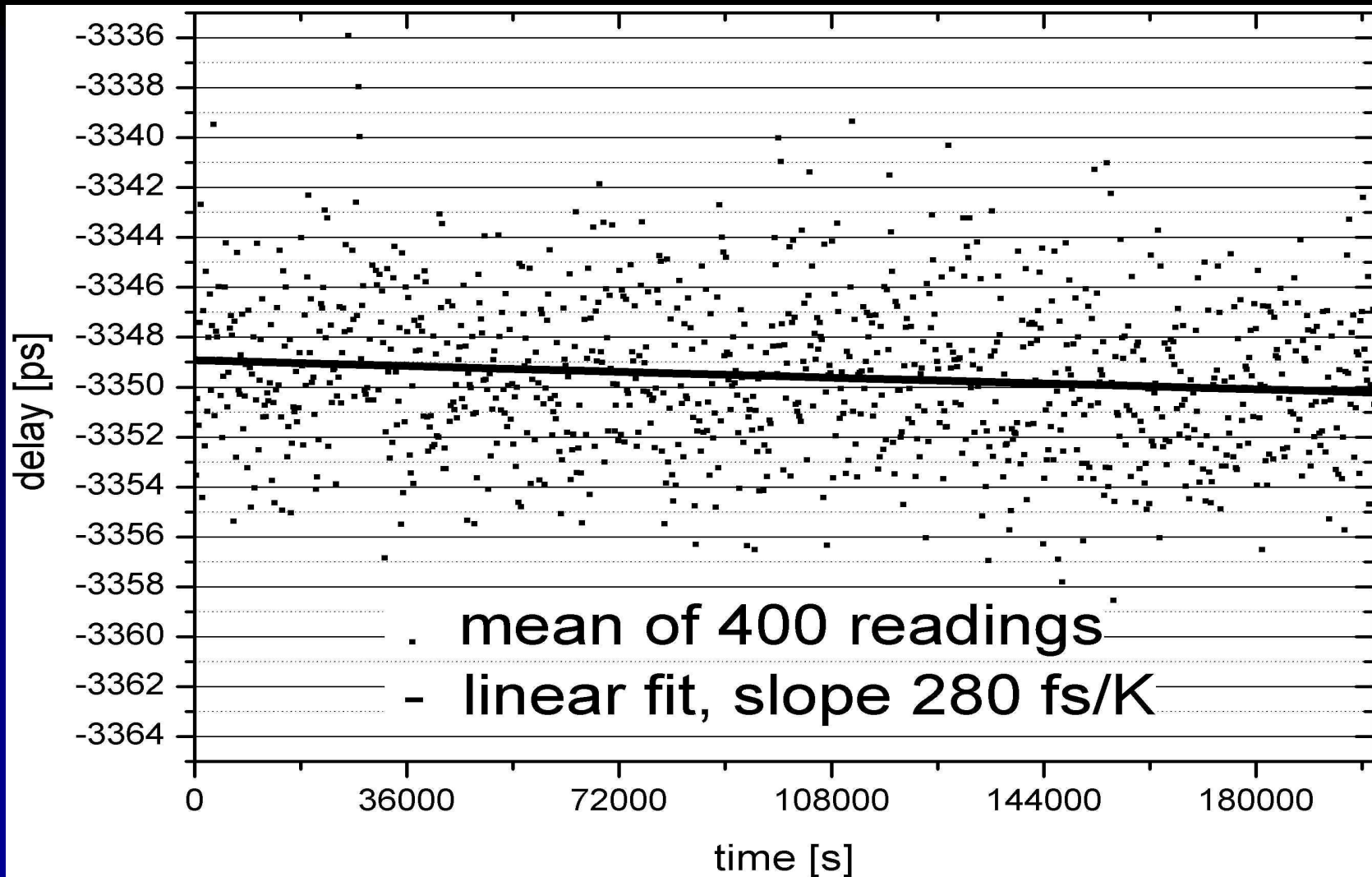


- PhaseTrack 210
- Standard diameter $1/4$ "
- Flexible , low bend radius
- Stability < 50 fs / K / m

- LDF50
- Diameter $1/2$ "
- Not flexible
- Stability < 50 fs / K / m
- Low loss at GHz

Overall Laser Ranging Performance, chain stability

Laser+Start+NPET+SPAD1

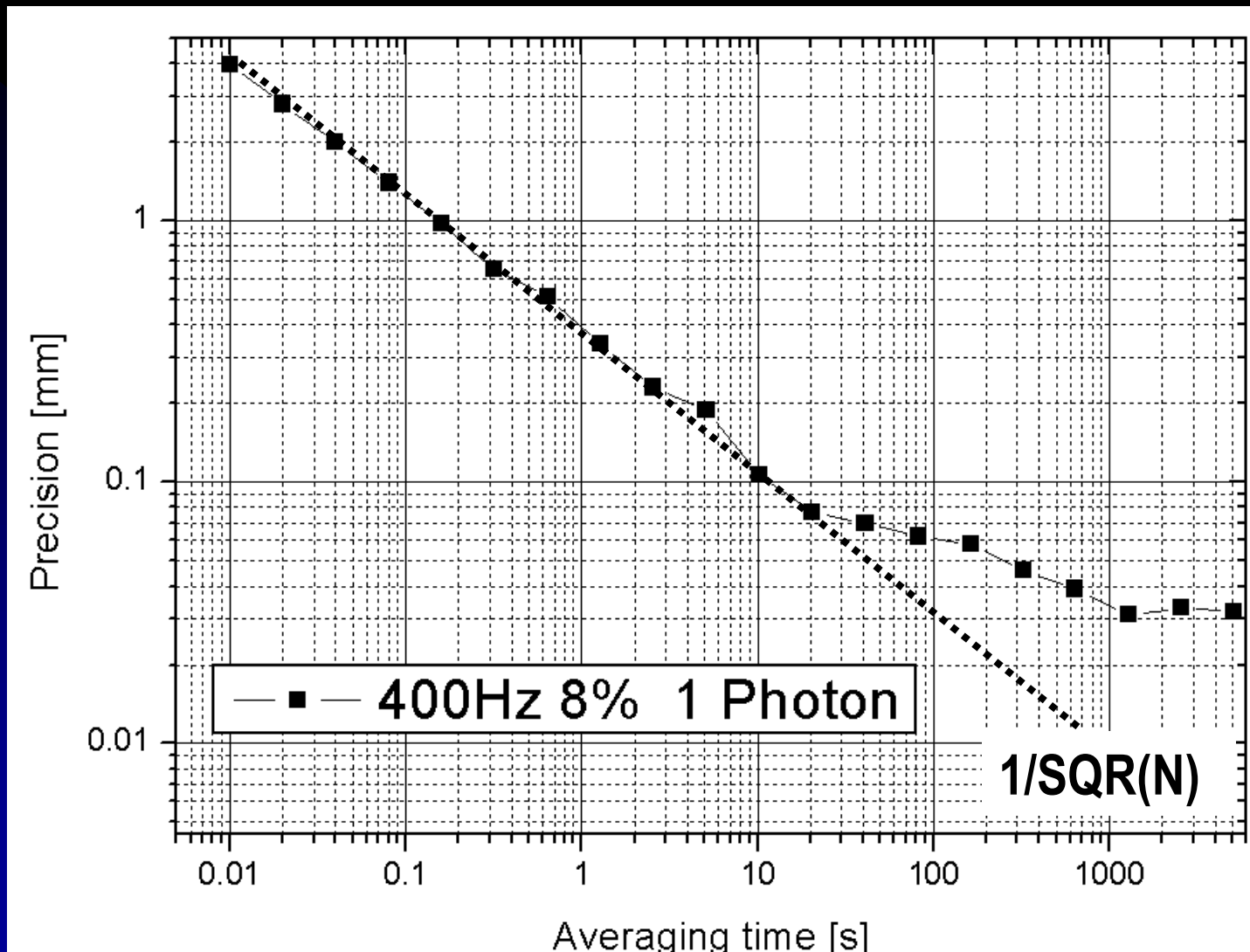


Temperature change - 4.5 K / 3 days, NO active temperature control

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Laser Ranging – indoor, ultimate precision

Laser+Start+NPET+SPAD1

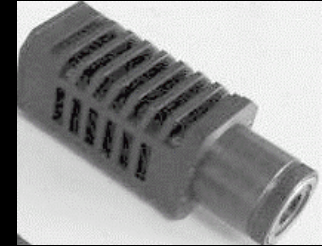


In 2kHz SLR 0.1 mm precision can be reached in 2 sec / 1 Photon

Conclusion

New technologies for sub – millimeter laser ranging

- Single Photon Avalanche Detector was optimized for \sim kHz, 1 Photon, passive temperature compensation
- New sub-ps timing system was designed providing sub-ps jitter, linearity and fs stability rate 1 kHz existing, > 10 kHz dream for 2012
- New Start detector / discriminator was constructed
- Low temperature drift signal cables are available
- The system having < 0.1 mm precision and stability has been demonstrated



Thanks for your attention

