Application of GT668 Event Timer in Satellite Laser Ranging

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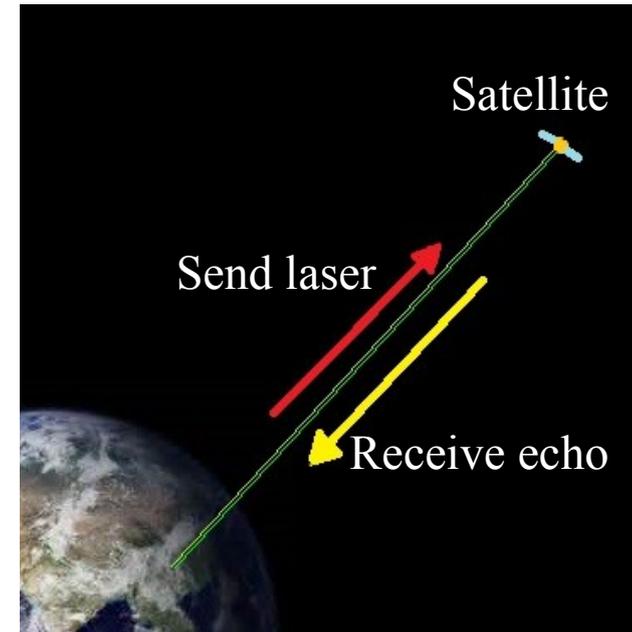For ILRS General Topic and Addendum Poster Session

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Some Basics

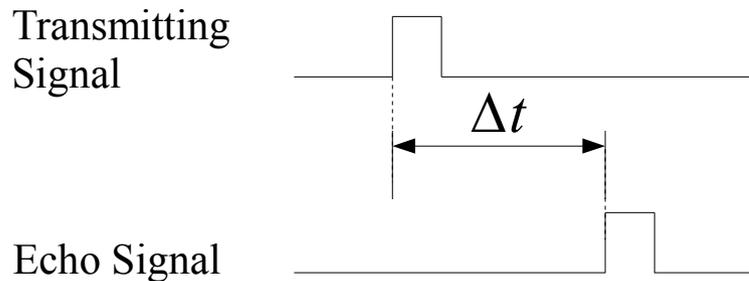- ## Principle of Laser Ranging

  - Send laser pulse toward the Satellite and record the transmitting time point

  - Receive the echo and record the returning time point

  - Calculate the distance (Ideal):

  $$DISTANCE = (t|_{receive} - t|_{transmit})*C$$

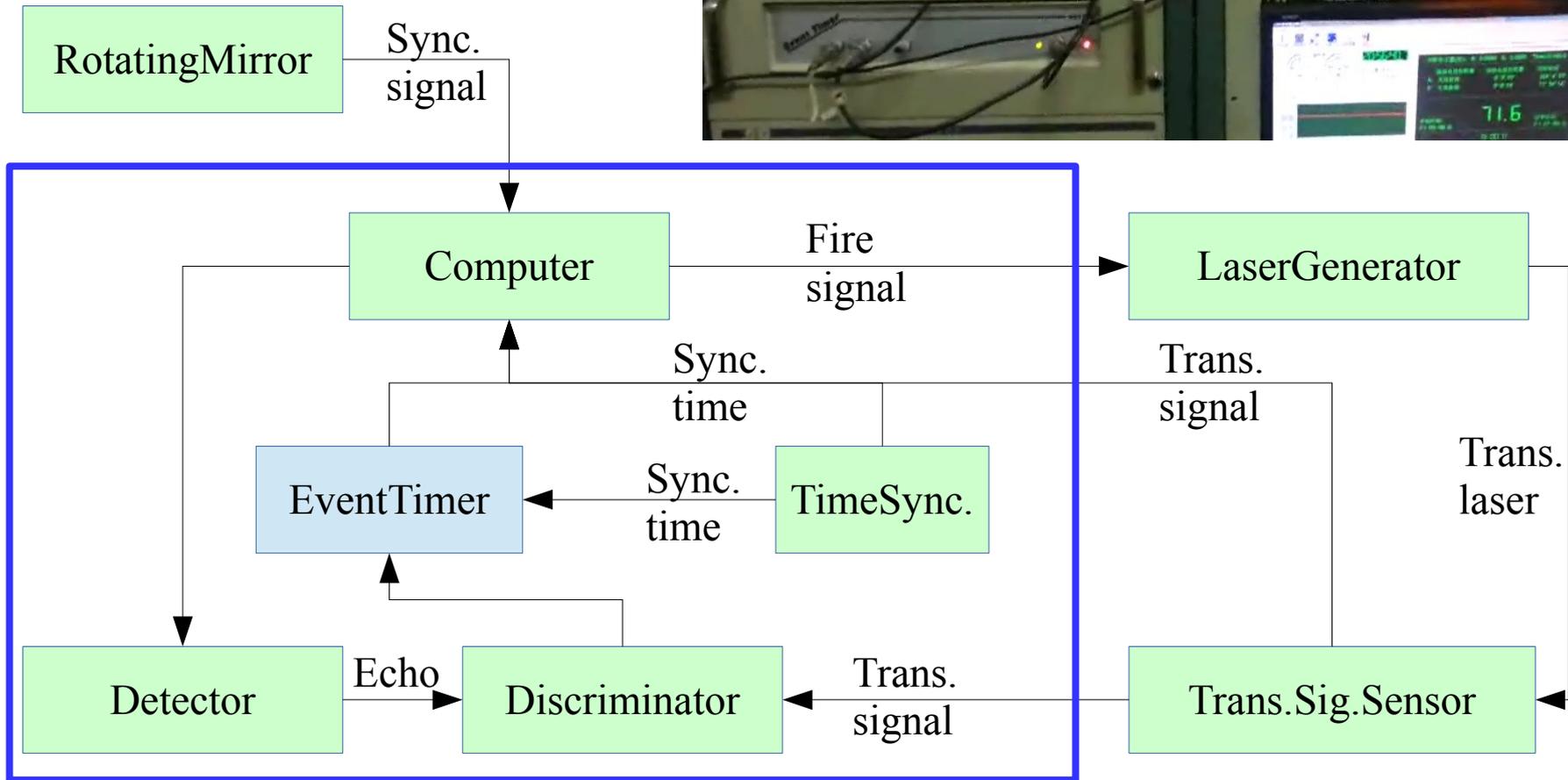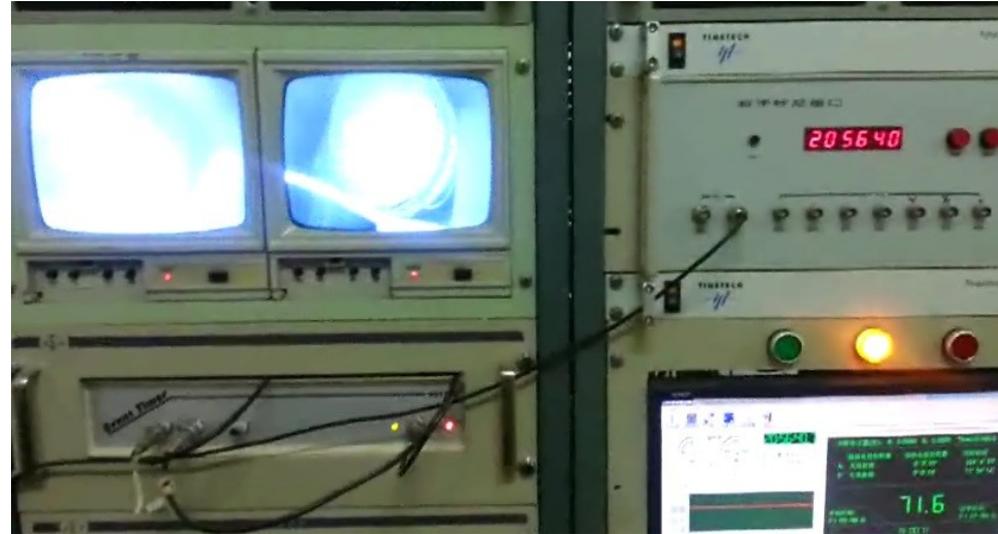- ## Event Timer: Epoch Measurement

Time tag listed by Event Timer

Time data view of An Event Timer

Events	Time/second
t0	1234.0012345678
t1	1234.0022345678
...	...

About Our System

Upgrade from the previous system with gate-control

Previous Ranging system →

RotatingMirror —Sync. signal→ Computer

Computer —Fire signal→ LaserGenerator

EventTimer ←Sync. time— TimeSync.

Computer ←Sync. time— (EventTimer/TimeSync.)

Detector —Echo→ Discriminator

Discriminator ←Trans. signal— Trans.Sig.Sensor

LaserGenerator —Trans. laser→ Trans.Sig.Sensor

Trans.Sig.Sensor —Trans. signal→ (Discriminator)

SNSPD SLR Experiments

- **S**uperconducting **N**anowire **S**ingle-**P**hoton **D**etector

Working Procedure:

- Voltage kept on nano-wires;

- Photon received;

- Resistor area generated;

- Voltage change detected,
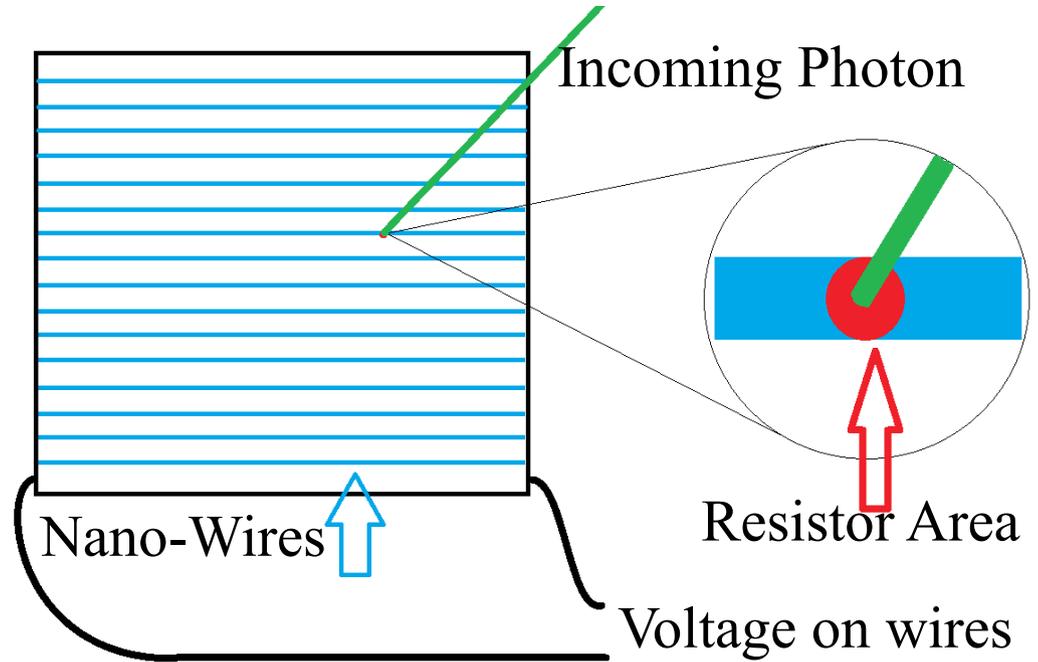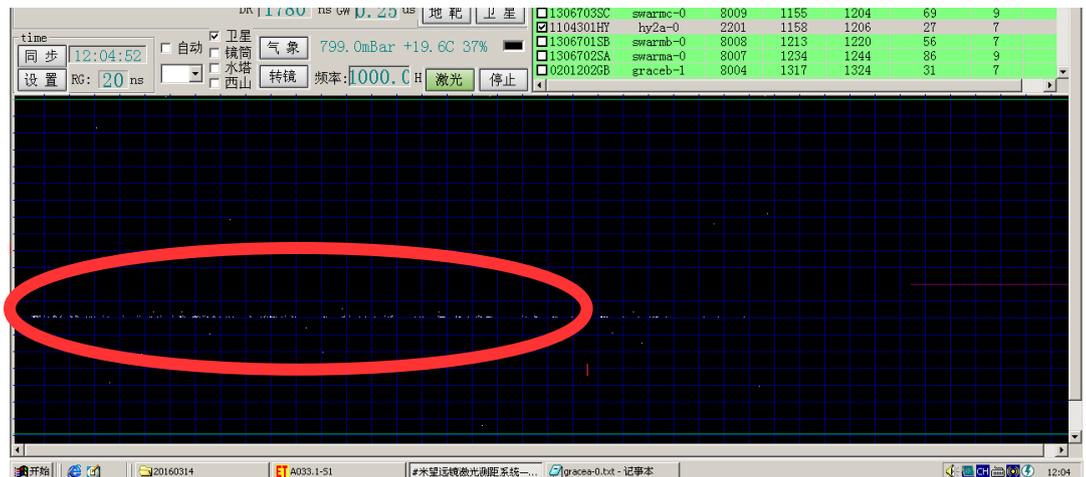 i.e. photon detected;

- Default state restored.

Incoming Photon

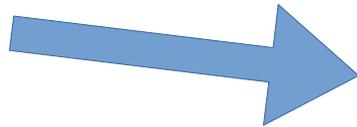Nano-Wires

Resistor Area

Voltage on wires

Figure: one of the experiment results

The detection of **Hy2a**

With accuracy of 5cm

On March.14 2016

New Event Timer for SNSPD

The Characteristics of SNSPD:

Our new requirements of Event Timer:

| Low dark noise | → | No gate-control requirement |

| Short detect cycle | → | Short device dead time |

| High repetition rate |

| Low detecting efficiency | → | High sample rate And Large storage space |

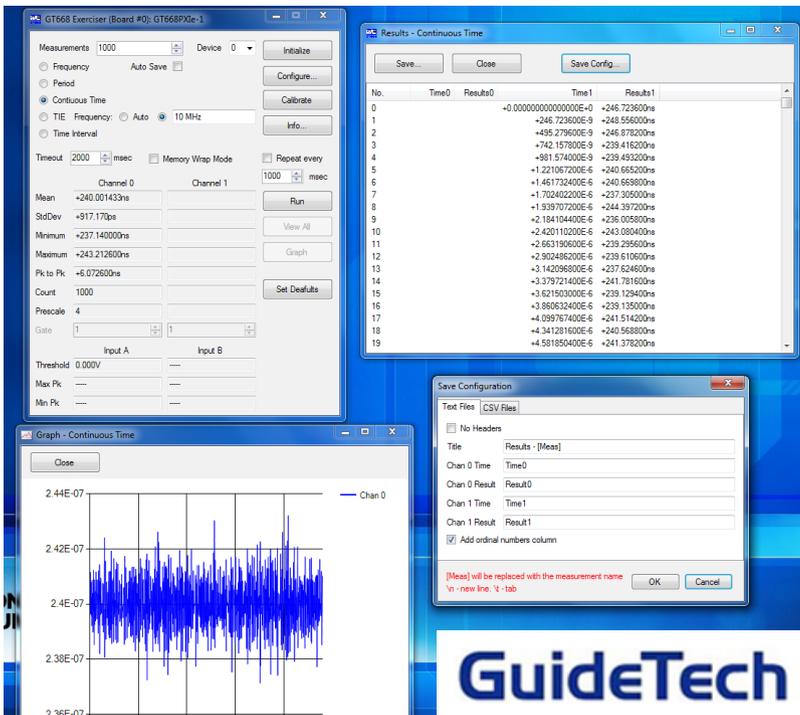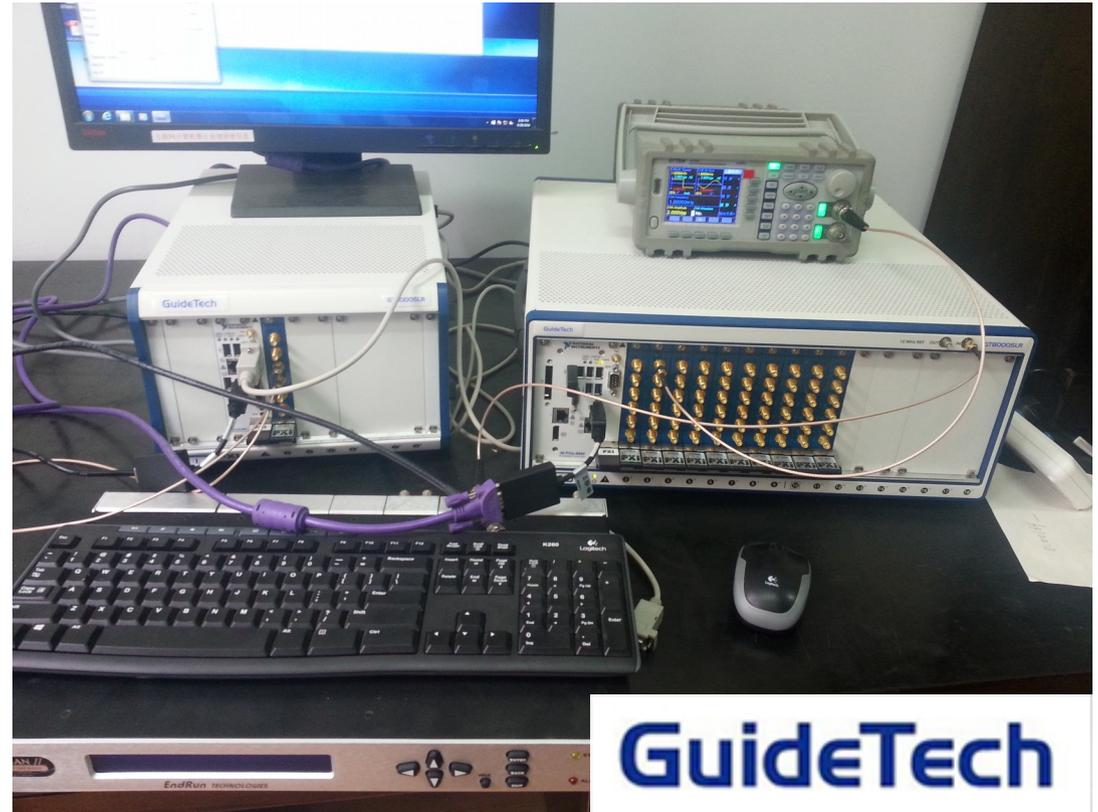And in future we also need:

| SNSPD sensor array | → | Many-channel structure |

| Remote control system | → | Fast network communication |

GuideTech GT668: Introduction

- ## Main Specification:

  Time Res. Single Shot: 0.9ps

  Freq. Res. (Digits/S): up to 12

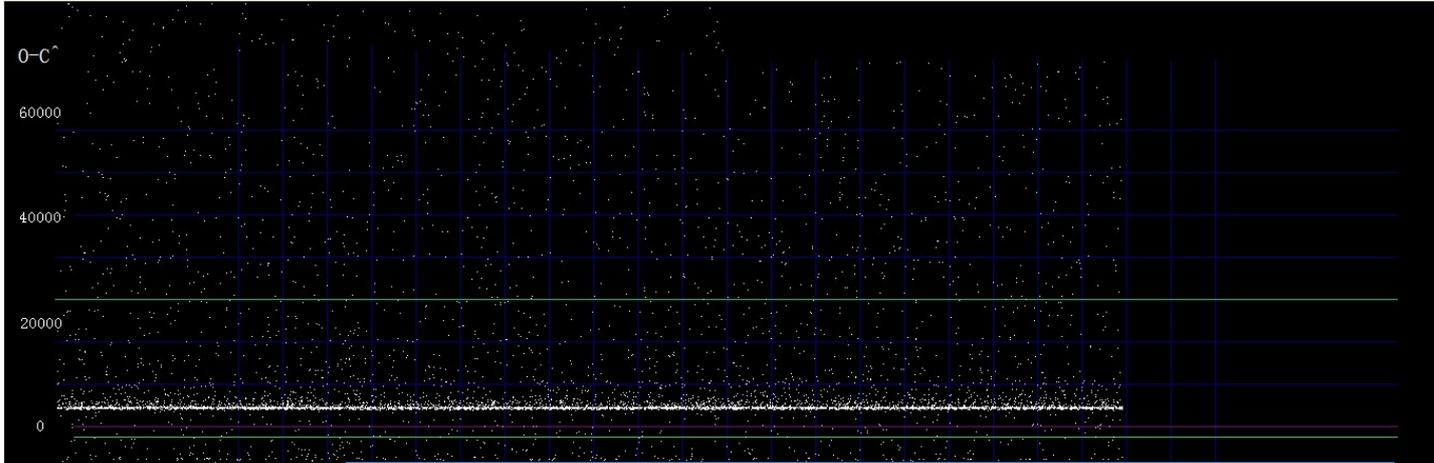 Max. Meas. Rate: 4 MSa/S

- ## Sampling Sys.Test

Sampling Signal:
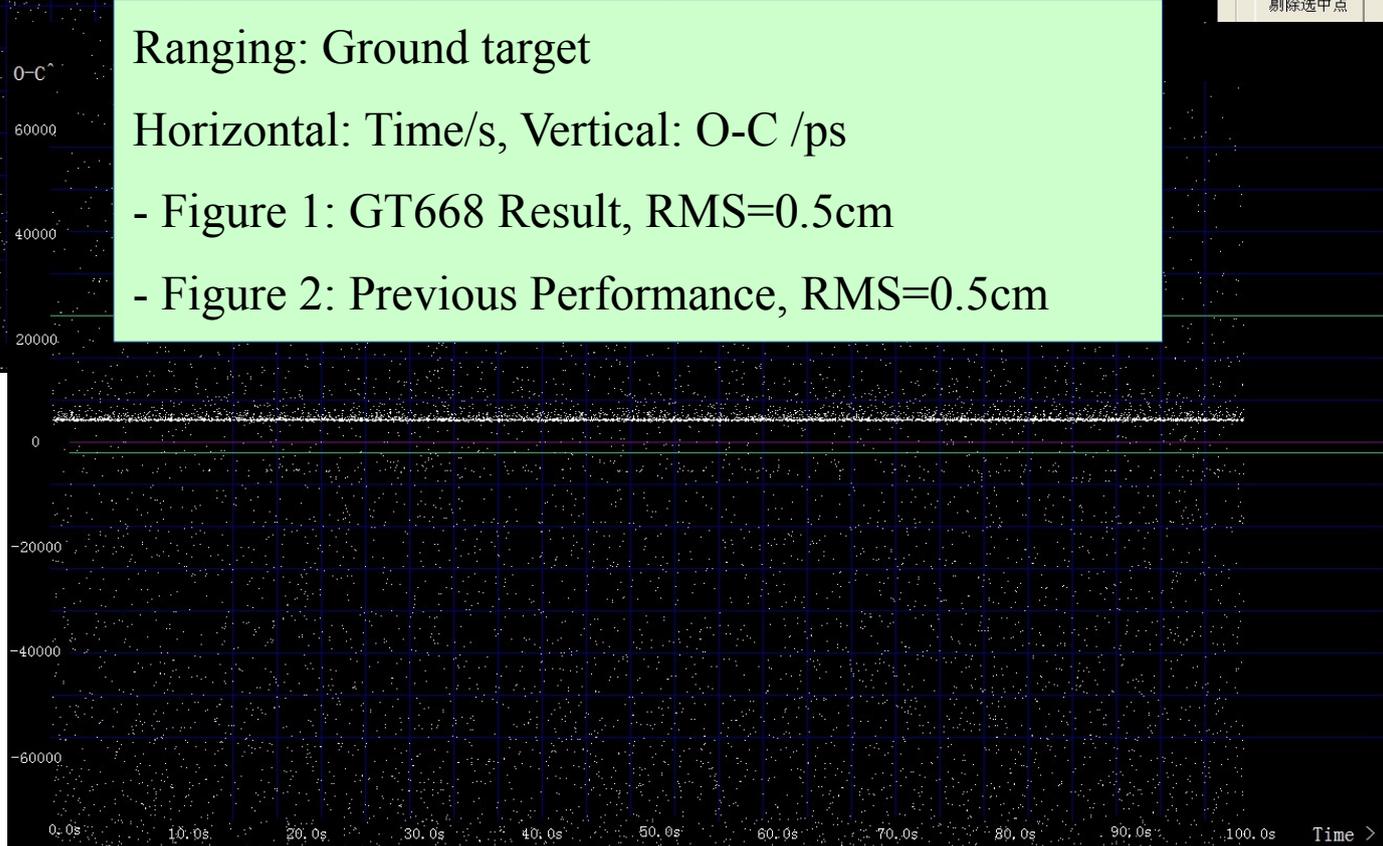
- 16MHz Signal input, i.e. one pulse per 62.5ns

- Notice the prescale factor of 4:

  $62.5*4 = 250$ns

Ground Target Ranging

Ranging: Ground target

Horizontal: Time/s, Vertical: O-C /ps

- Figure 1: GT668 Result, RMS=0.5cm

- Figure 2: Previous Performance, RMS=0.5cm

Sampling Analysis

Sampling experiments:

using previous SLR environment

Input Signal:
2 Channels with $T(n)|_{pulse\_B} - T(n)|_{pulse\_A} = 0.7us$

Sampling Duration: 120 seconds

Result:

Total 250,000 samples

RMS = $7.0920*10^{-7}$ seconds
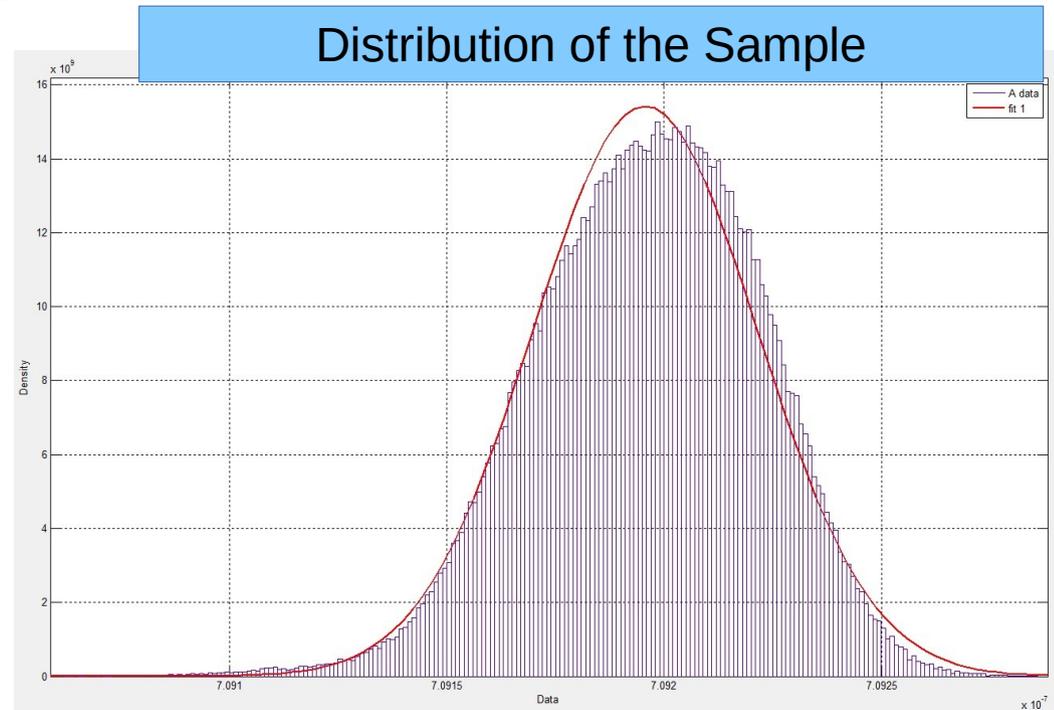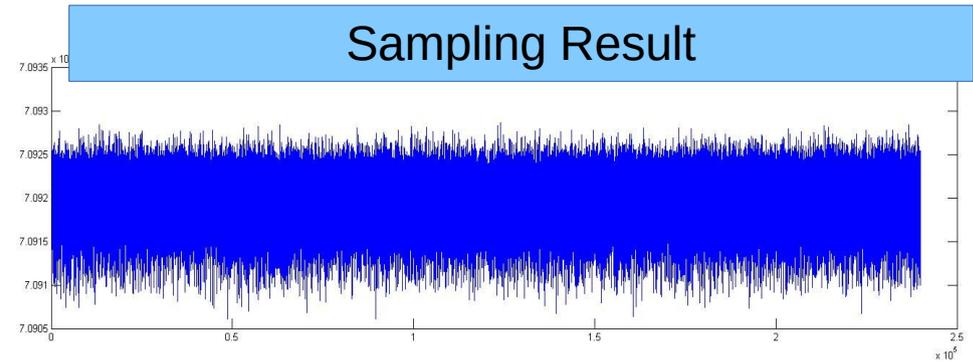
Fitting:

Distribution type: Normal

Mean: $7.09196*10^{-7}$

Variance: $6.68887*10^{-22}$

Sampling Result

Distribution of the Sample

GT668 SLR ranging pending due to telescope system upgrading.

Conclusion

- GT668 is applied for the SNSPD system, which is to be upgraded to sensor array system in future

- To meet the demand of high repetition rate of SNSPD, multiple channels of event timer are necessary

- Single channel test shows the feasibility of the event timer in a high rate sampling requiring environment, which is adapted to the previous system and integrated with the same accuracy

Future Work

- Satellite laser ranging testing using the new event timer
- System latency analysis, testing delay of the modules