

# **System Bias Analysis of 1.2m Telescope Satellite Laser Ranging**

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# Outline

- **1.2m telescope laser ranging system and some experiments**

**kHz SLR , [Space Debris LR](#), SSPD**

- **Parts of system are upgrading now**

**[laser\(adding 1064nm output\)](#), telescope servo control system**

- **System bias and reasons finding**

**set the nearer ground target: [~1.78m\(near the second mirror\)](#), ~202.5m**

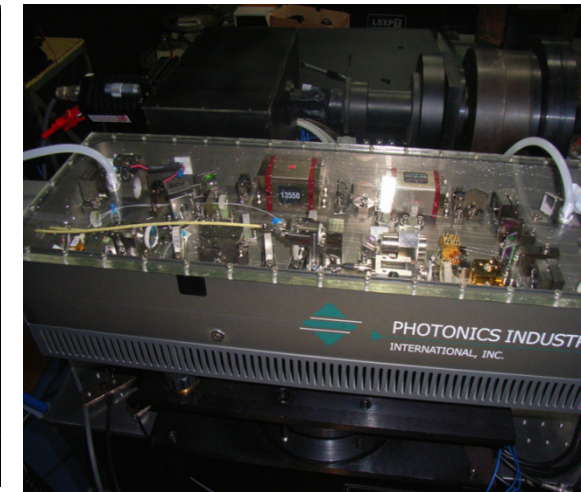
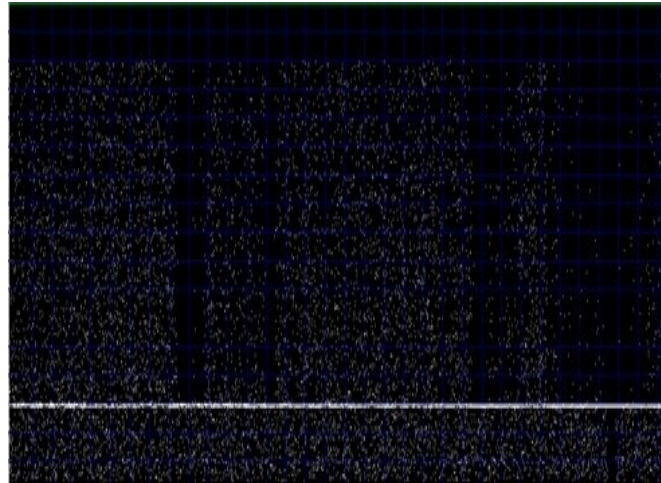
**measure reference signal stability**

**update station coordinate in time**

**monitor the laser energy stability**

- **Summary**

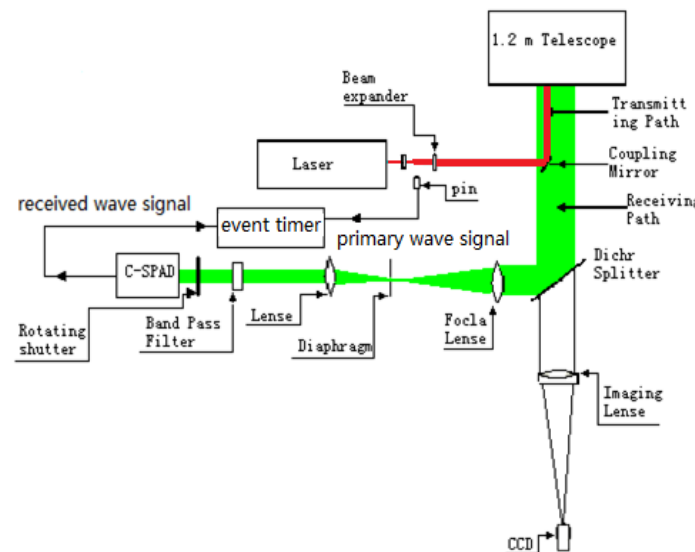
# 1.2m telescope laser ranging system---kHz system



Telescope Diameter: ~ 1.2m

Optical Path □ common

kHz SLR Established □ 2009



wavelength □ 532nm

repetition □ 1kHz

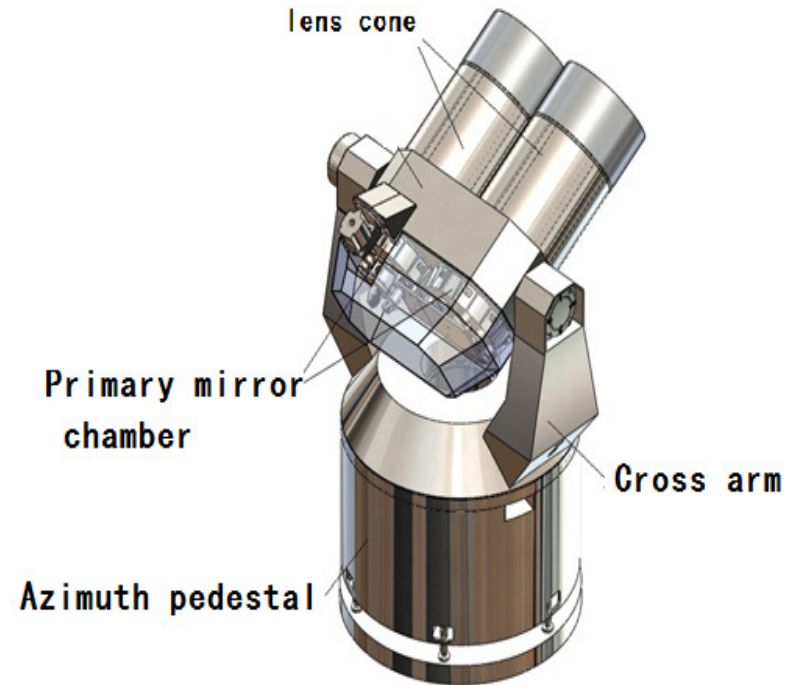
energy □ □ 0.8mJ/pulse

Pulse width □ □ 100ps

# 1.2m telescope laser ranging system---kHz uncooperate LR system



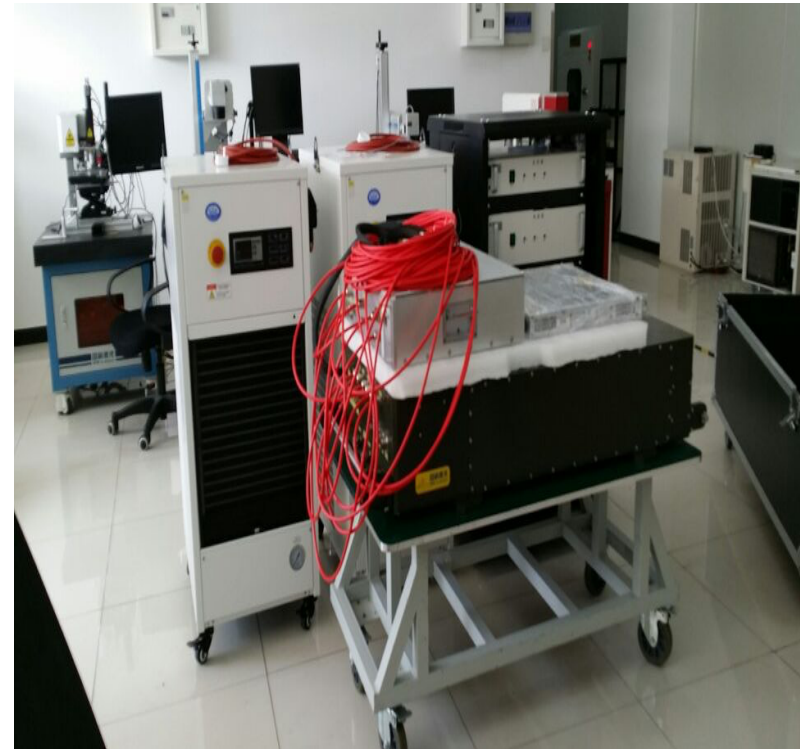
Receiving system



53cm binoculars  
transmitting telescope

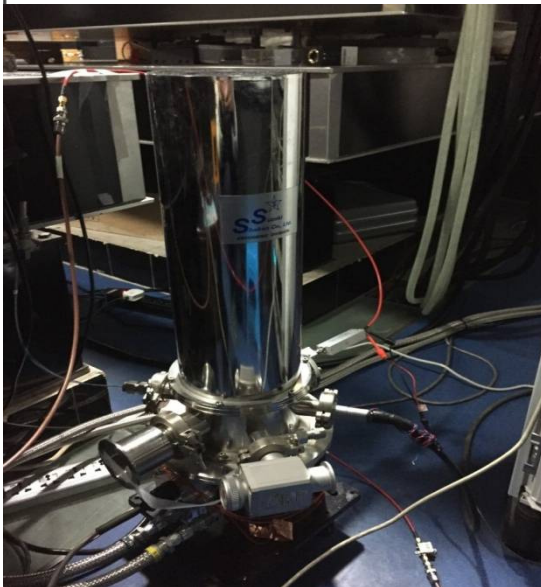
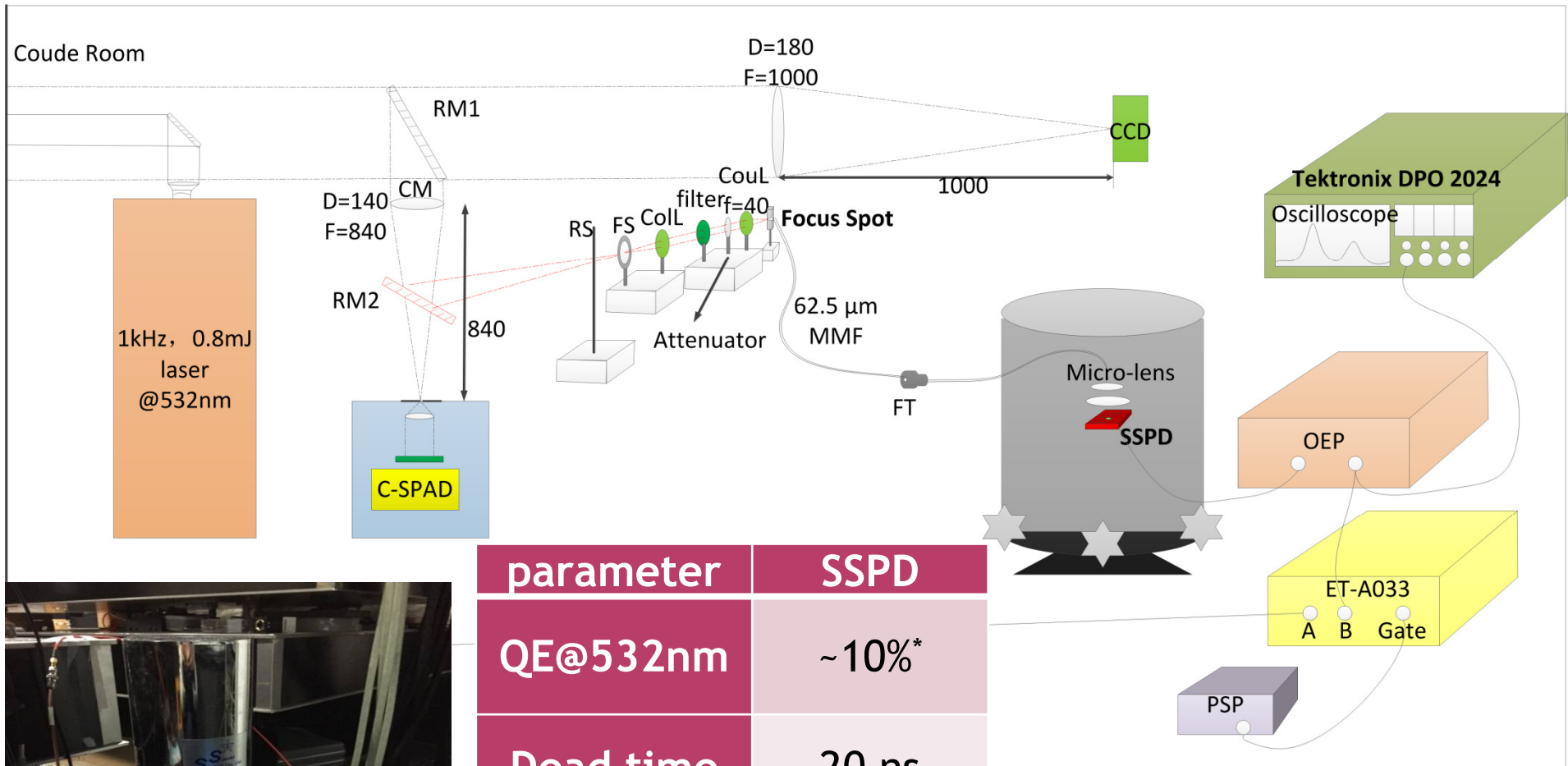
Experimental details, please see our poster—Laser Ranging Experiment with  
1.2m Co-optics Telescope Reception of Laser Emitting from 53cm Binocular

# 1.2m telescope: space debris LR



Repetition  $\square$  1000Hz  
pulse width  $\square$  750ps  
Energy  $\square$  40mW/pulse

# 1.2m telescope: SSPD LR



parameter	SSPD
QE@532nm	~10%*
Dead time	20 ns
Dark count	<100 cps
temperature	4.2K

April to May,  
2015

# 1.2m telescope: SSPD LR(19km)

预报 测距 退出 帮助(H)

云南天文台 预报计算 卫星测距 月球测距 数据处理 退出 关于

数据显示

方位(度) 高度(度) 距离(us) 126.813080 0-C(ns)

61.0 86.0 预报(us) 126.400000 413.1

DR 600 ns GW 0.00 us save 地靶 卫星

time 同步 15:44:14 自动 卫星 气象 801.9mBar +21.5C 44%

设置 RG: 20 ns fir 地靶 转镜关 频率: 0.0 H 激光 停止

starID	starName	starSIC	start	end	elevation	length	visi
<input type="checkbox"/>	8606101AJ	ajisai-1	1500	1518	1533	78	15
<input type="checkbox"/>	0200901EN	envisat-2	6179	1539	1544	42	4
<input type="checkbox"/>	6503201BE	beaconc-2	0317	1545	1549	17	4
<input type="checkbox"/>	0304206AR	larets-2	5557	1601	1609	86	8
<input type="checkbox"/>	6503201BE	beaconc-3	0317	1737	1747	31	9
<input type="checkbox"/>	0304206AR	larets-3	5557	1758	1807	35	8
<input type="checkbox"/>	6503201BE	beaconc-4	0317	1930	1942	79	11
<input type="checkbox"/>	6503201BE	beaconc-5	0317	2127	2132	17	5
<input type="checkbox"/>	0000000TG	TARGET	0921	2400			
<input checked="" type="checkbox"/>	0000000PS	POLARIS	0921	2400			

开始 | LASER Controller V1.6 | ynao\_slr - Microsoft Vis... | A033.1-S1 | 20150504 | 20150504 | #米望远镜激光测距系统... | 15:44

# 1.2m telescope: SSPD LR

- Many laser ranging satellites (such as Ajisai ) and space debris laser ranging experiments have also done, but no returns are distinguished.
- Why?
  - large tracking error (10 arcsec),
  - little tracking FOV (5 arcsec),
  - small fiber diameter (62.5  $\mu\text{m}$ ),
  - QE is low for SSPD at 532 nm ( $\sim 10\%$ ), .....
- Upgrade system!
  - do the SSPD test again



# Parts of system are upgrading

- 10Hz(1.2m)&1000Hz(53cm) lasers add 1064nm output , SSPD will be higher QE at 1064nm than 532nm
- Telescope servo-control system upgrade to improve tracking accuracy(better than 10")
- .....

# System Bias and reasons finding

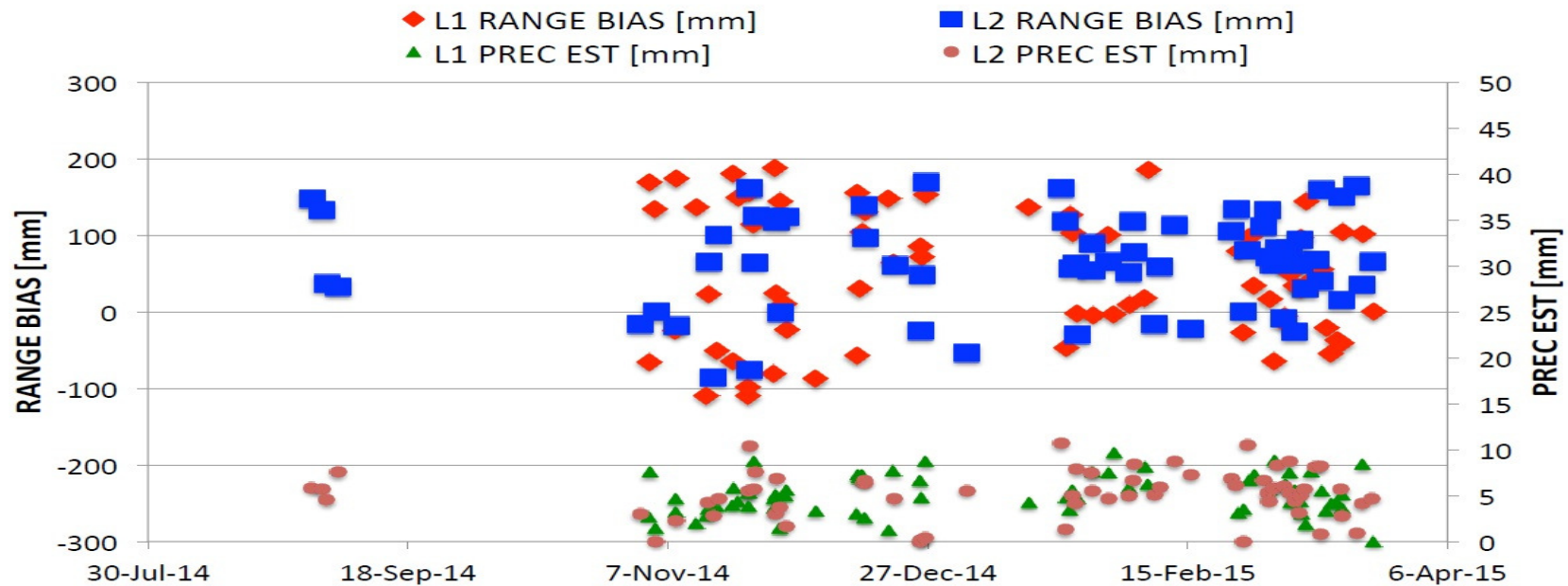
## LAGEOS 1

78208201 L1	PREC EST [mm]	RANGE BIAS [mm]
Mean	5.1	46.3
STD	2.1	85.4
RMS	5.4	95.8
Point	66	66

&

## LAGEOS 2

78208201 L2	PREC EST [mm]	RANGE BIAS [mm]
Mean	5.3	67.9
STD	2.5	62.6
RMS	5.8	90.6
Point	64	64



Before 2015.04.08-----Evaluated by E.C.Pavlis & M.Kuzmizc-Cieslak

# ground target

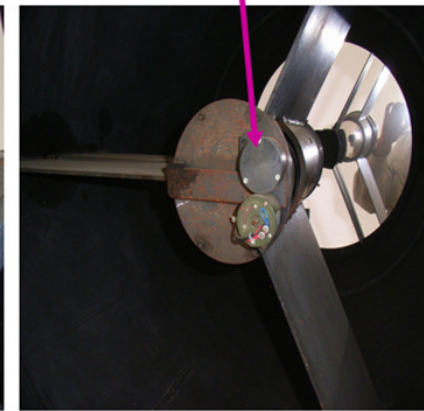
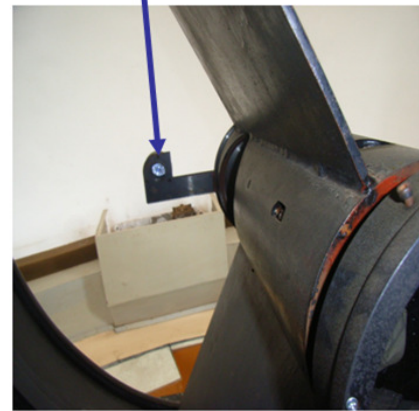
## 200m distance ground target



## new nearer ground target

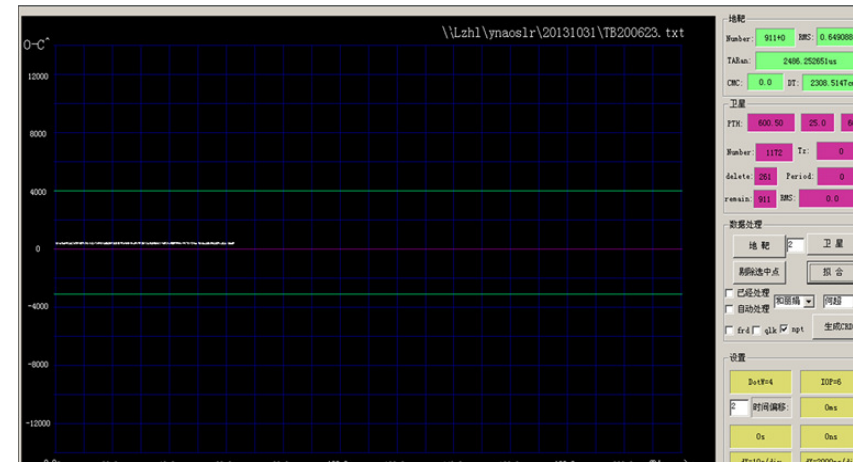
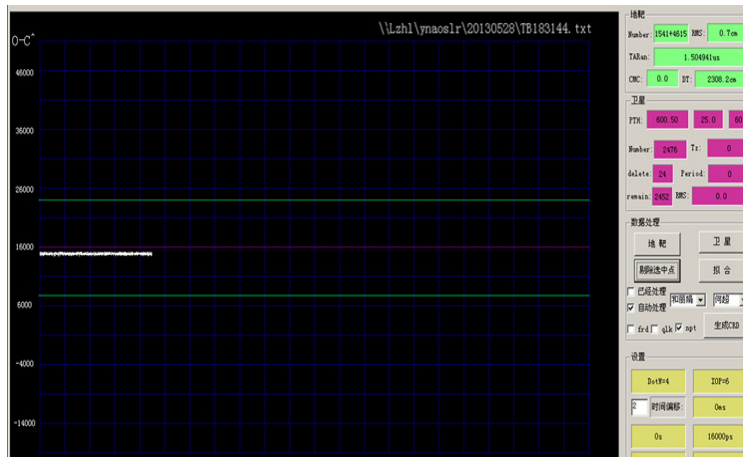
Ground target

Ground target



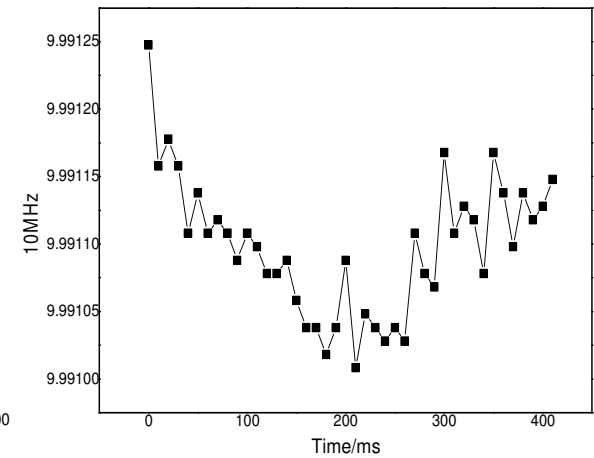
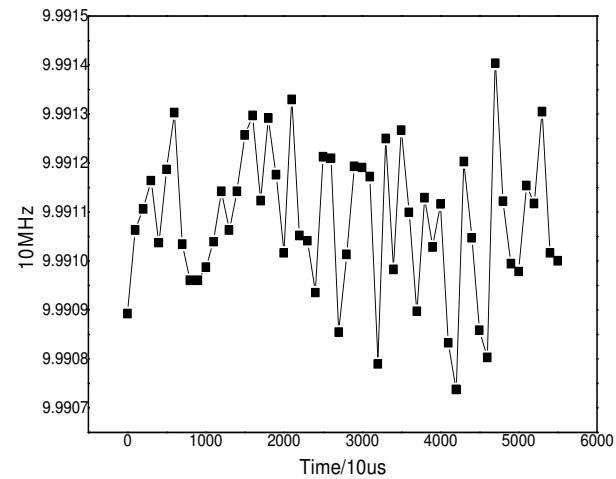
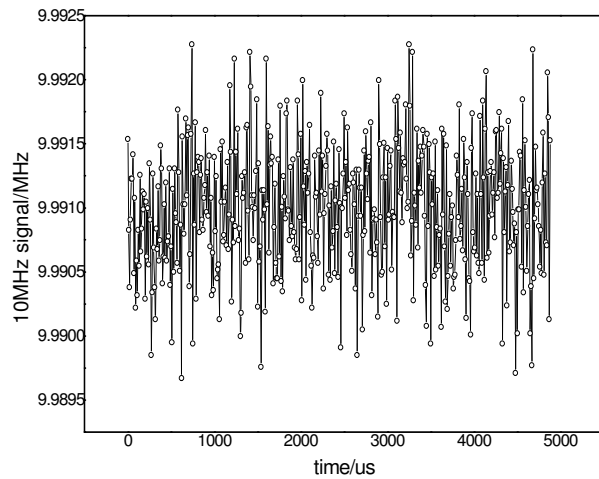
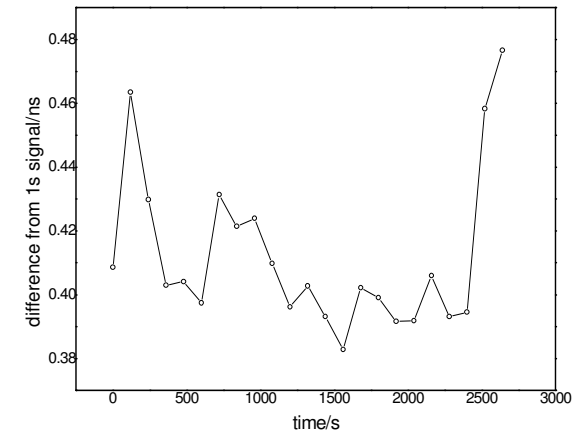
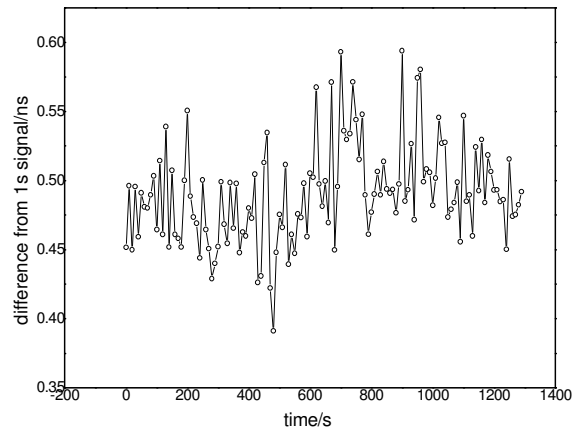
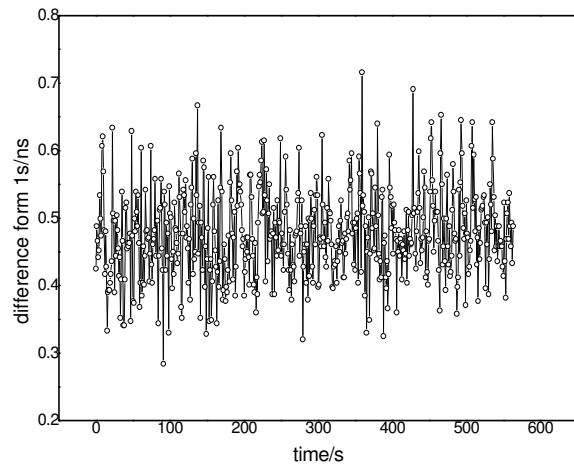
Ground target ranging

Satellites ranging



# reference stability measure

## 1pps signal period measurement



## 10MHz signal frequency measurement

# station coordinate

## LAGEOS 1

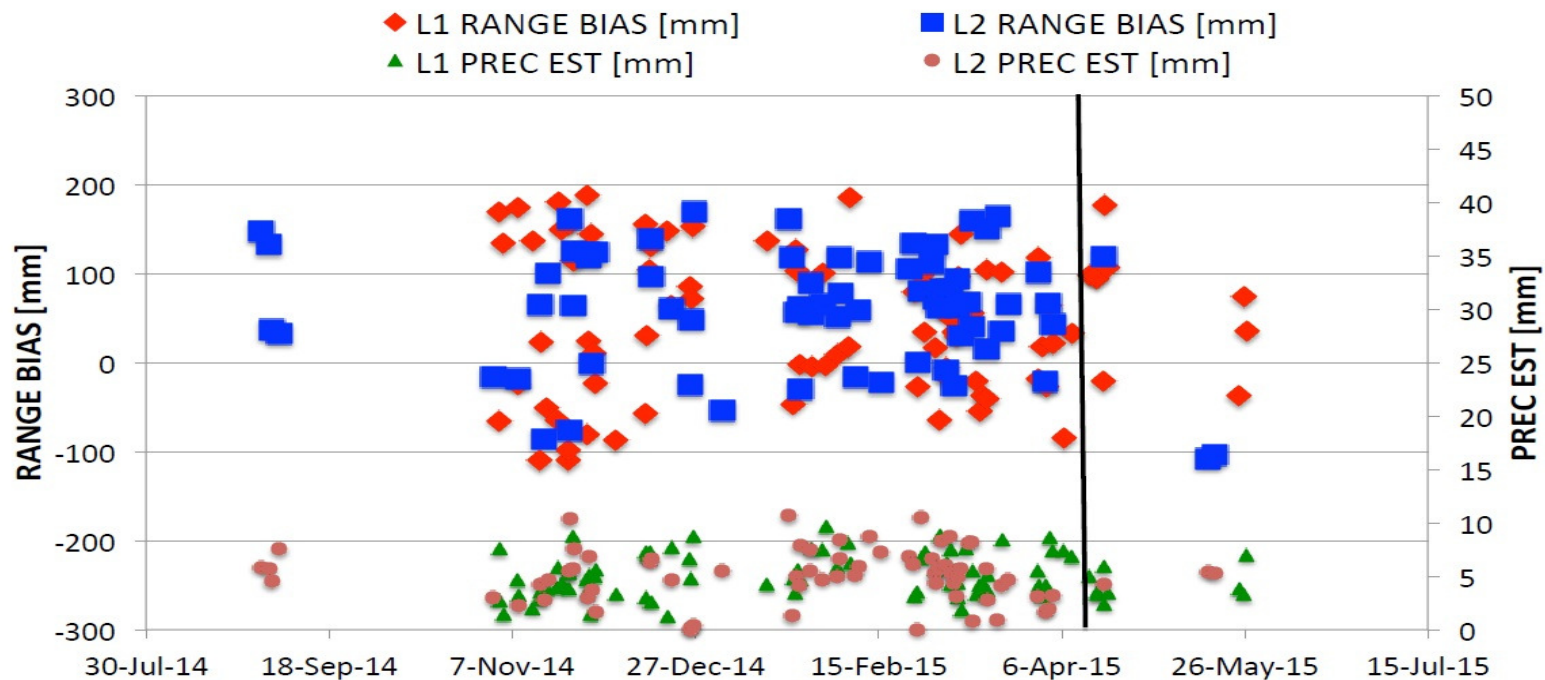
## &

## LAGEOS 2

78208201 L1	PREC EST [mm]	RANGE BIAS [mm]
Mean	5.1	45.8
STD	2.0	81.7
RMS	5.4	93.3
Point	82	82

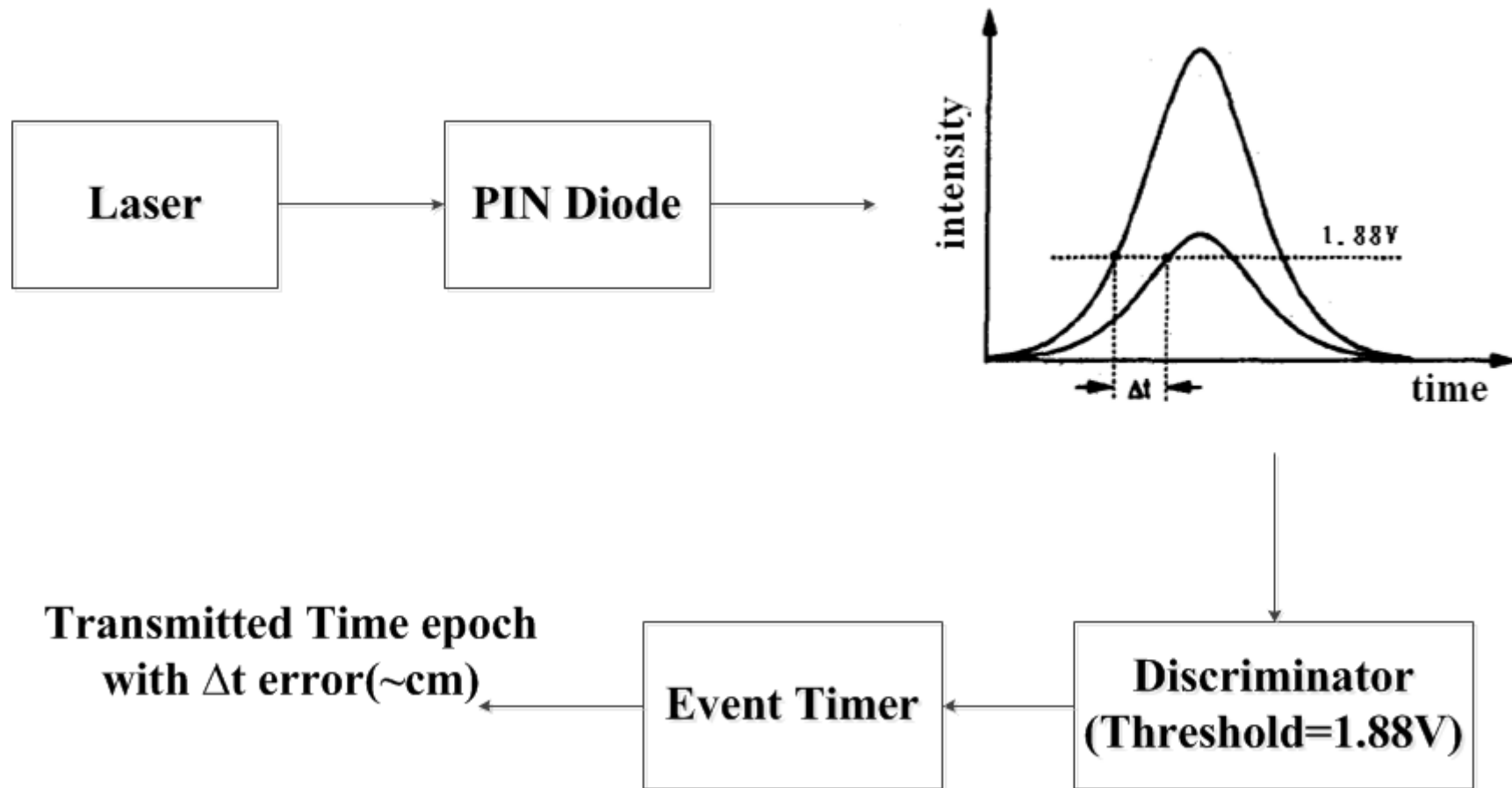
**NEW as of  
May 26, 2015**

78208201 L2	PREC EST [mm]	RANGE BIAS [mm]
Mean	5.1	62.4
STD	2.4	67.5
RMS	5.6	90.9
Point	70	70



**Before 2015.05.26-----Evaluated by E.C.Pavlis & M.Kuzmizc-Cieslak**

# laser energy stability



# summary

**Main system biases:** station coordinate, laser stability, system calibration

**Weather:** from 28<sup>th</sup> May to now, this year, it's raining or cloudy (with strong lightning and thunder), ~half a year

**Next step:**

to optimize our kHz SLR continuously (to observe GNSS satellites), and to do DLR observation, and so on.



- Thanks for your attention!
- Thanks to those people who have been helping us!
- Enjoy all of you to give us some advices and welcome to our station.

