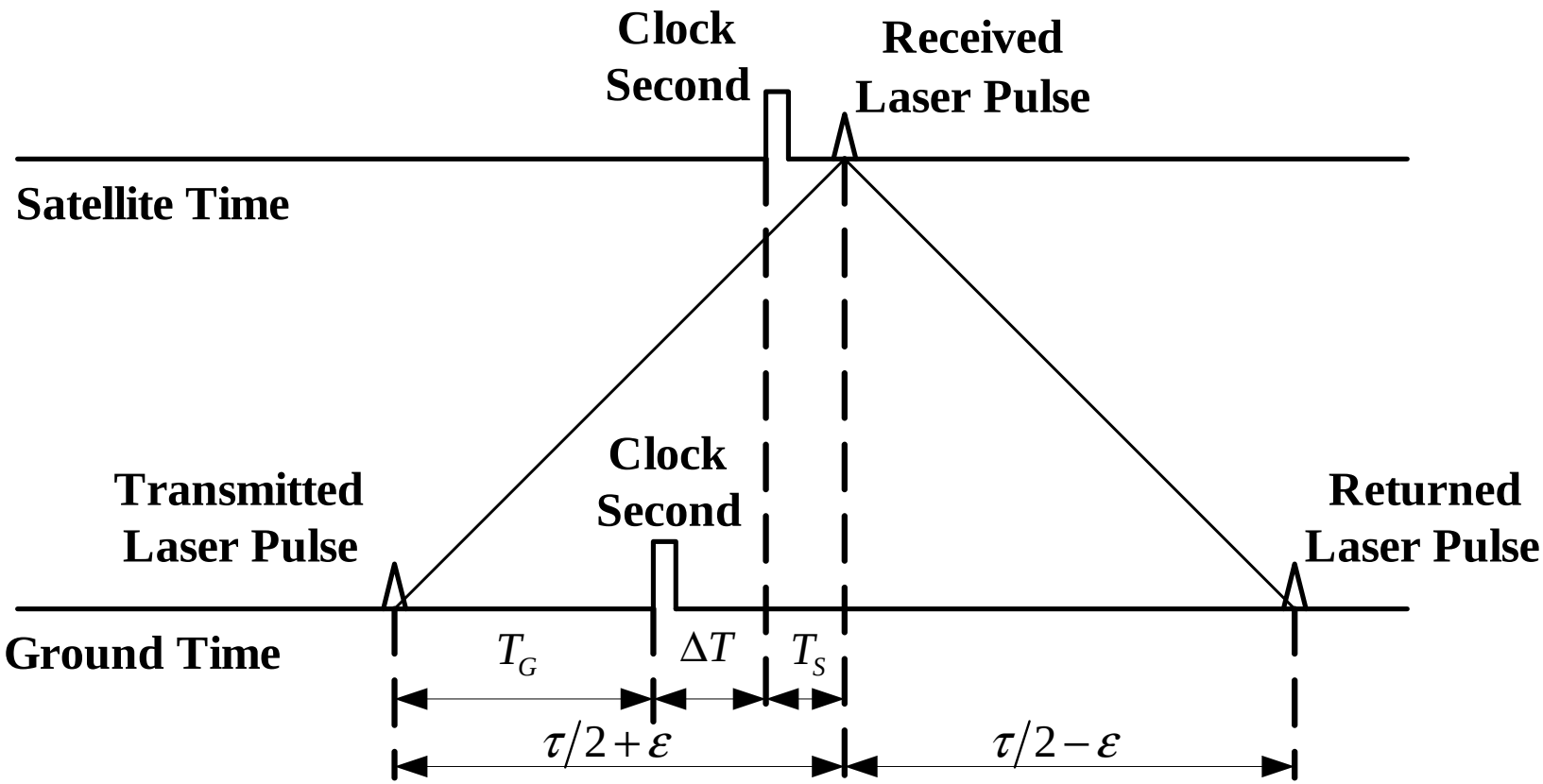
Situation of the LTT experiment

Yang Fumin(1), Huang Peicheng(1), Ivan Prochazka(2), Zhang Zhongping(1),
Chen Wanzhen(1), Wang Yuanming(1), Zhang Haifeng(1),
Zhao You(3), Fan Cunbo(3) and Han Xingwei(3)

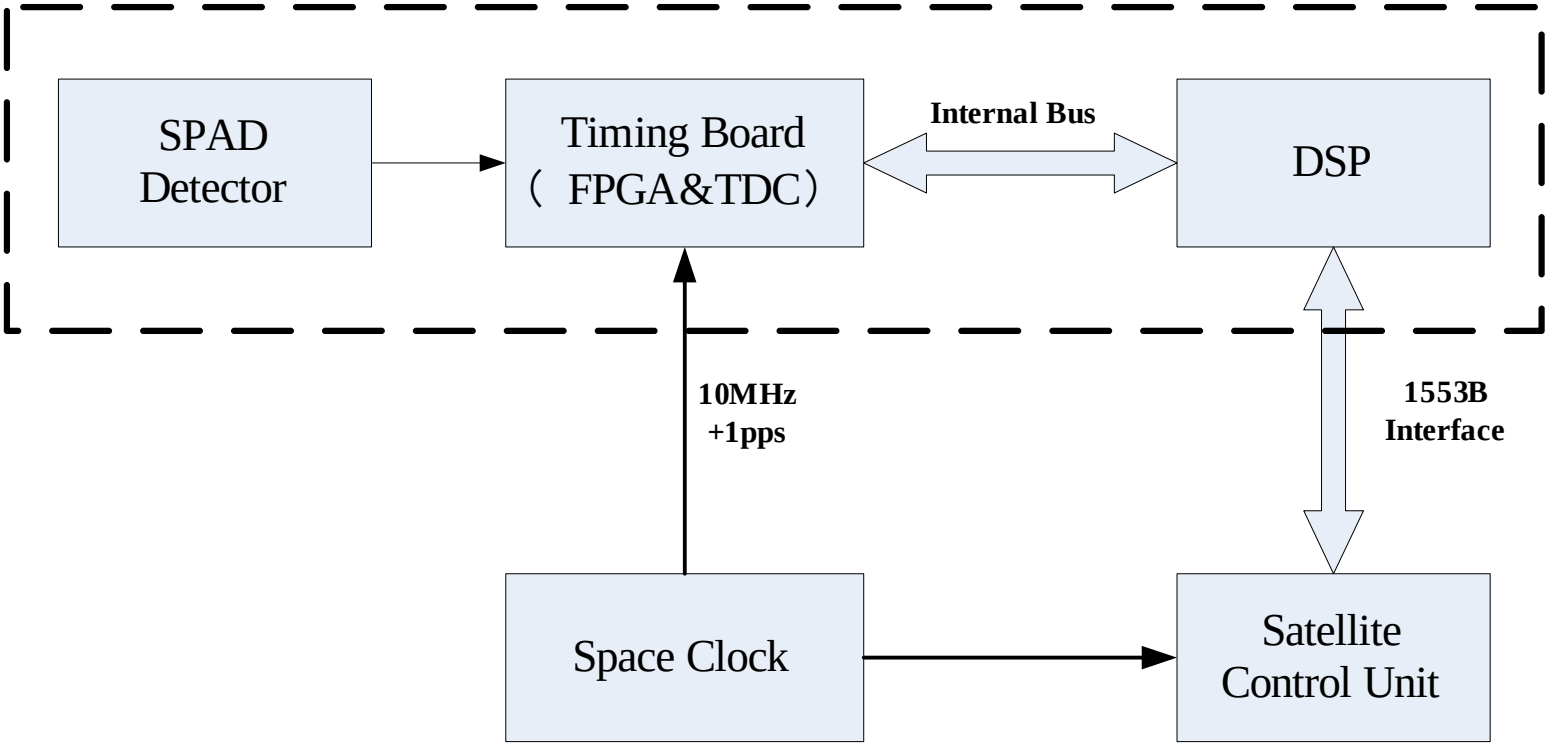
(1) Shanghai Observatory, Chinese Academy of Sciences, Shanghai, China
(2) Czech Technical University in Prague, Czech
(3) Changchun Observatory, Chinese Academy of Sciences, Changchun, China

yangfm@shao.ac.cn

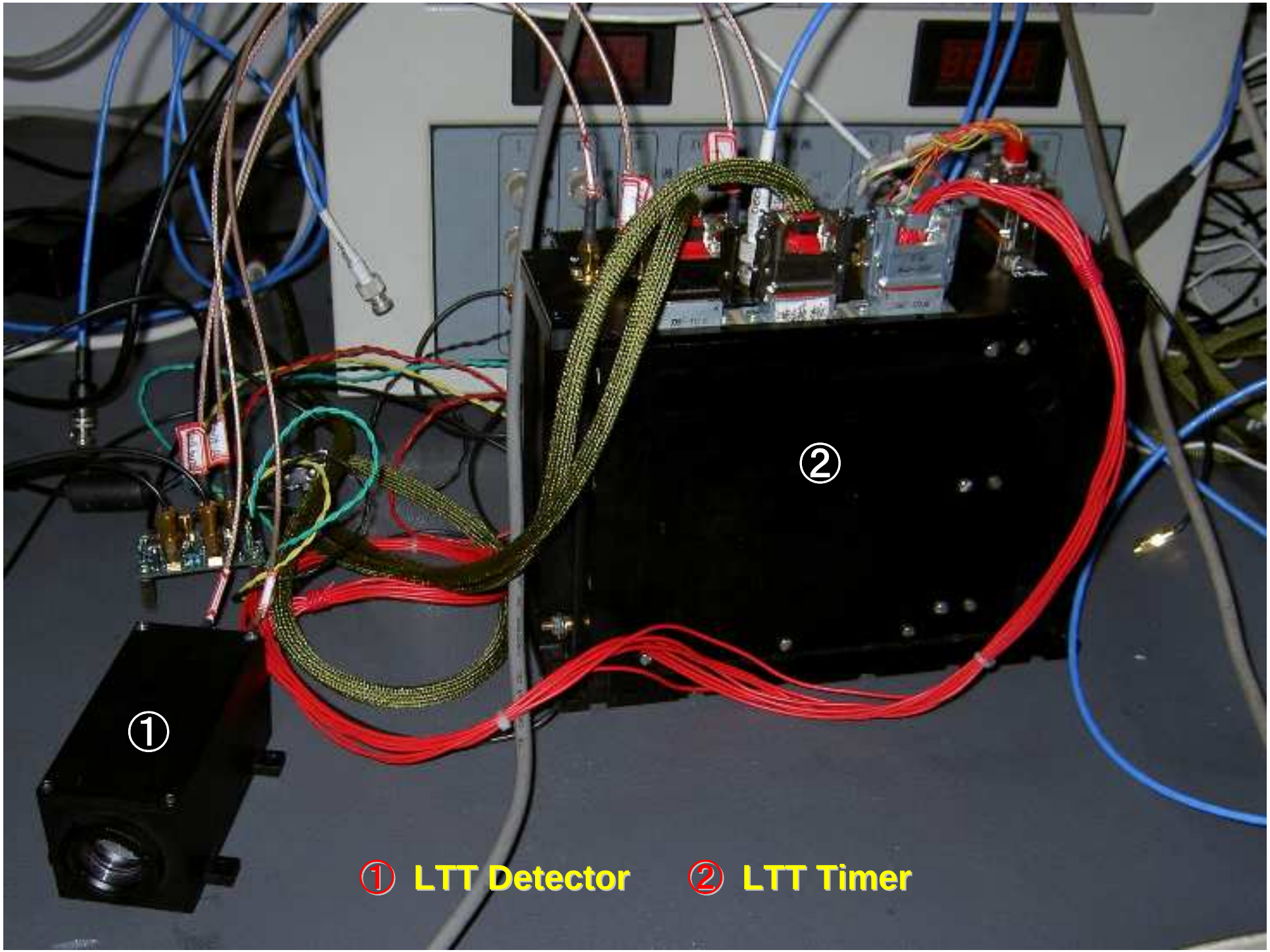
Principle of Laser Time Transfer (LTT)



$$\Delta T = \frac{\tau}{2} - T_G - T_S + \varepsilon$$



Block Diagram of LTT Module


①
②
① LTT Detector
② LTT Timer

Laser Firing Control

- No gating on the 40um SPAD detector onboard.
- To keep from the noises produced by the albedo of the Earth, the ground station will be asked to control strictly the laser firing epoch according to the flight time from ground station to satellite ,etc, and let the laser pulse arrive at the detector just after the second pulse of the clock onboard by 100 ns or so. So it is equal to have a gate onboard.
- To meet the timing requirement, the laser on the ground station should be actively switched, and the passive switch (or active-passive) can not be used.
- The firing jitter at Changchun now is 10ns.

Situation of the LTT project (1)

- Flight module for LTT experiment has been completed last September
- With a built-in spare parts together
  - Mass 4.6Kg
  - Power consumption 18W
  - Dimensions:
    - 240×100×167mm (dual-timer, interfaces and power supply)
    - 105×70×50mm (dual-detector)
- It is shown by indoor tests that the uncertainty of measurement for the relative frequency differences by laser link for two rubidium clocks is:
  - 4.0×10^{-13} in 200 seconds
  - 5×10^{-14} in 1000 seconds

Situation of the LTT project (2)

- The LTT payload onboard the Chinese experimental navigation satellite <Compass-M1> was launched on April 13,2007. The orbital altitude of Compass-M1 is 21500km.
- The LTT experiment between the ground and the LTT payload has been done at the Changchun SLR station since July 2007.

Situation of the LTT project (3)

Upgrading of Changchun SLR

- New laser: (a loan from NCRIEO)
  Active-active mode locked Nd:YAG laser
  100-150mJ in 532nm, 250ps, 20Hz
- New Coude mirrors
- 210mm diameter transmitting telescope
  10 aresec laser beam divergency
- 2 sets of event timer (Riga Univ.)
- 1 set of hydrogen maser
- LTT software: laser firing control, LTT data analysis

Changchun SLR House


Active-active mode-locked Nd:YAG laser
100-150mJ (532nm), 250ps, 20Hz
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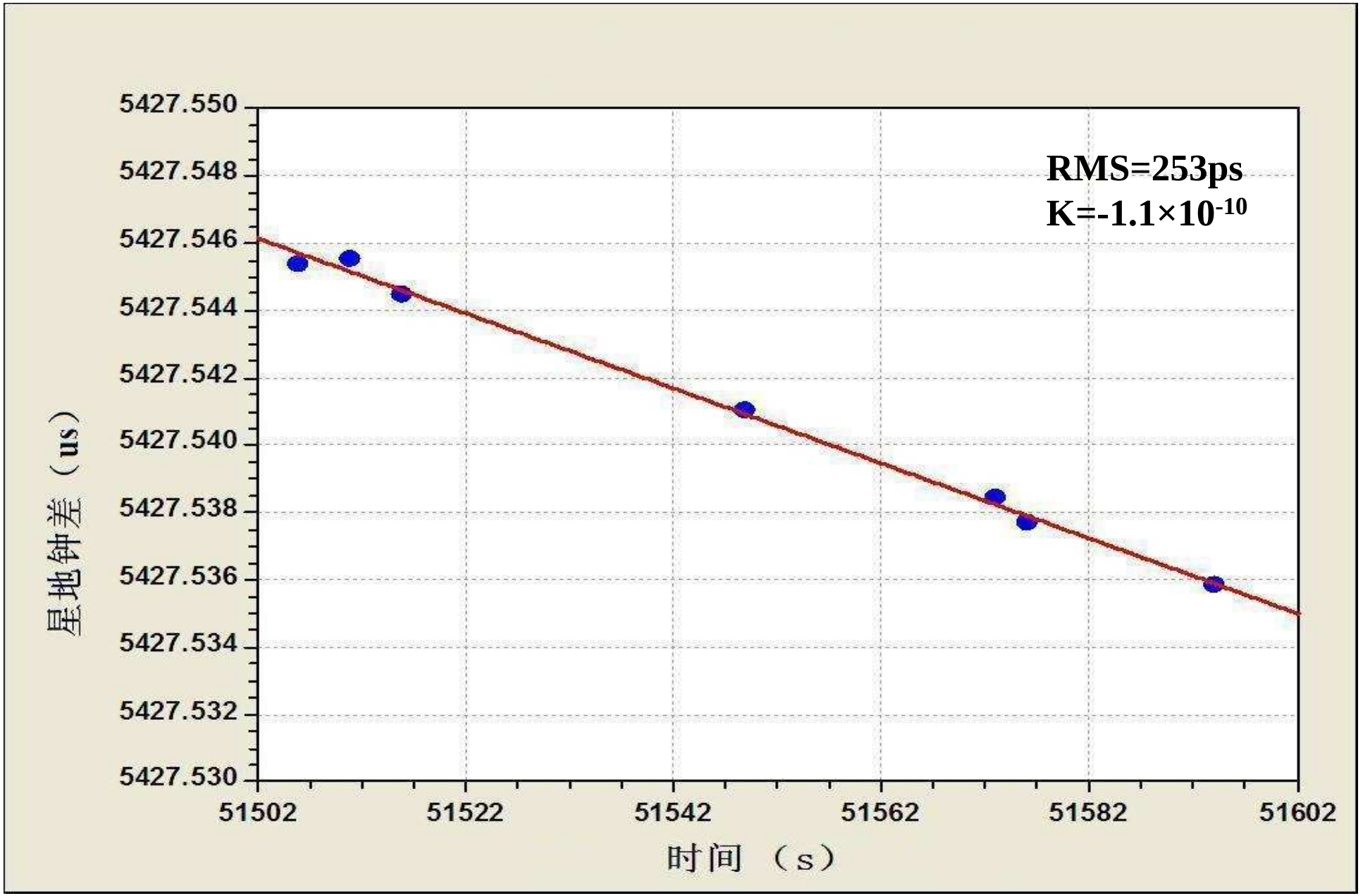
Changchun SLR Telescope

Changchun SLR Control Room



First results of LTT experiment on August 1, 2007

Summary

- The LTT payload has been in space since April 2007.
- The LTT experiment has been carried on since July 2007. The parameters of the LTT module is normal from the telemetric data.
- Preliminary results of the LTT experiment have been obtained. But until now, the experiment time has been limited by the weather and the visible condition for the satellite in the nighttime. Further experiment will be done in several months.

Thank you

Abstract

The Laser Time Transfer (LTT) payload onboard the Chinese experimental navigation satellite Compass M1 was launched on April 13, 2007.
The payload includes a single photon detector, a timer, DSP, interface and power supplies.
The LTT experiment between the ground and the LTT payload has been done at Changchun SLR station since July 2007.
The instrument and time comparison method are introduced. The preliminary results are also presented.


中电11所研制的激光器
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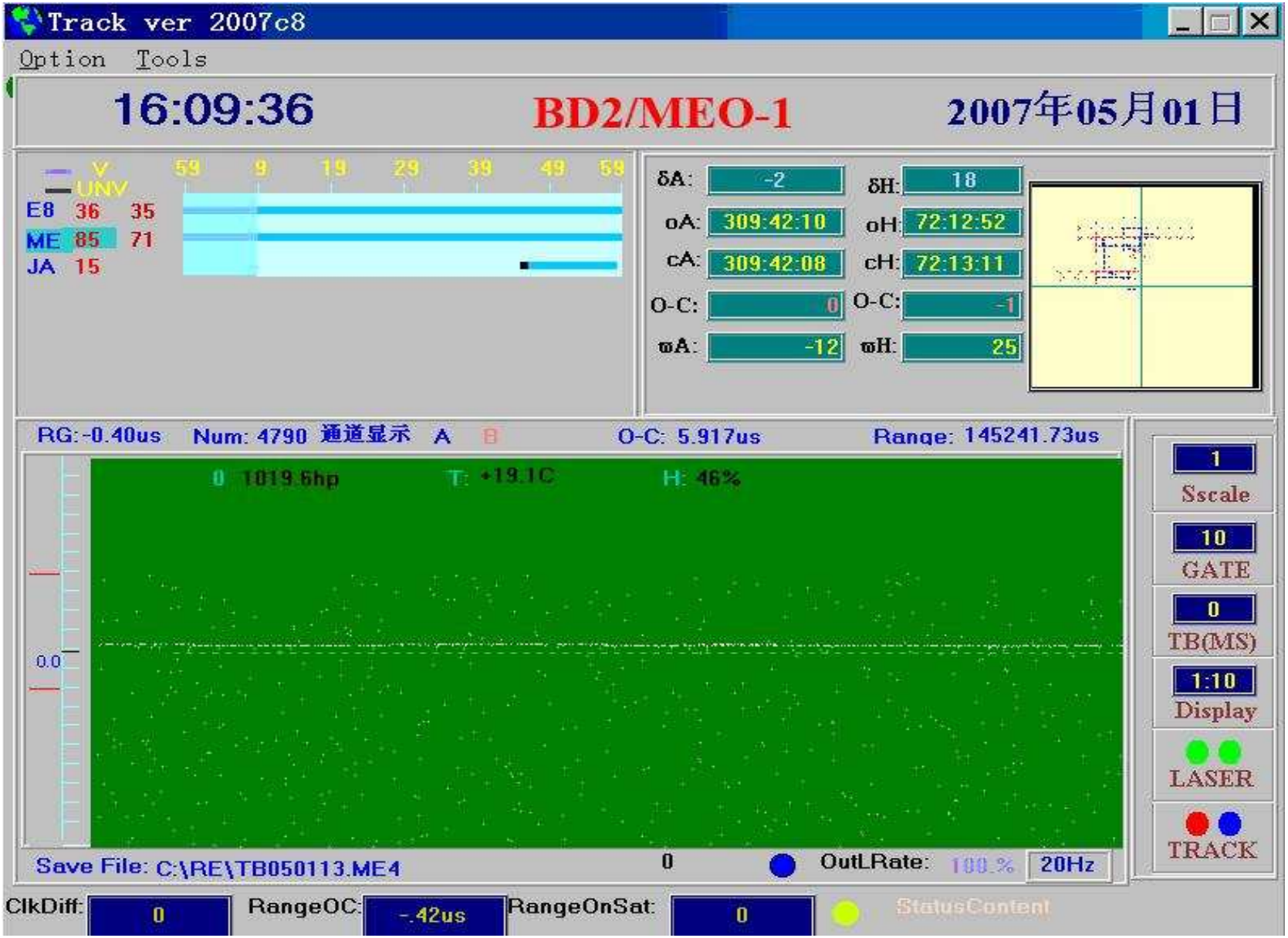
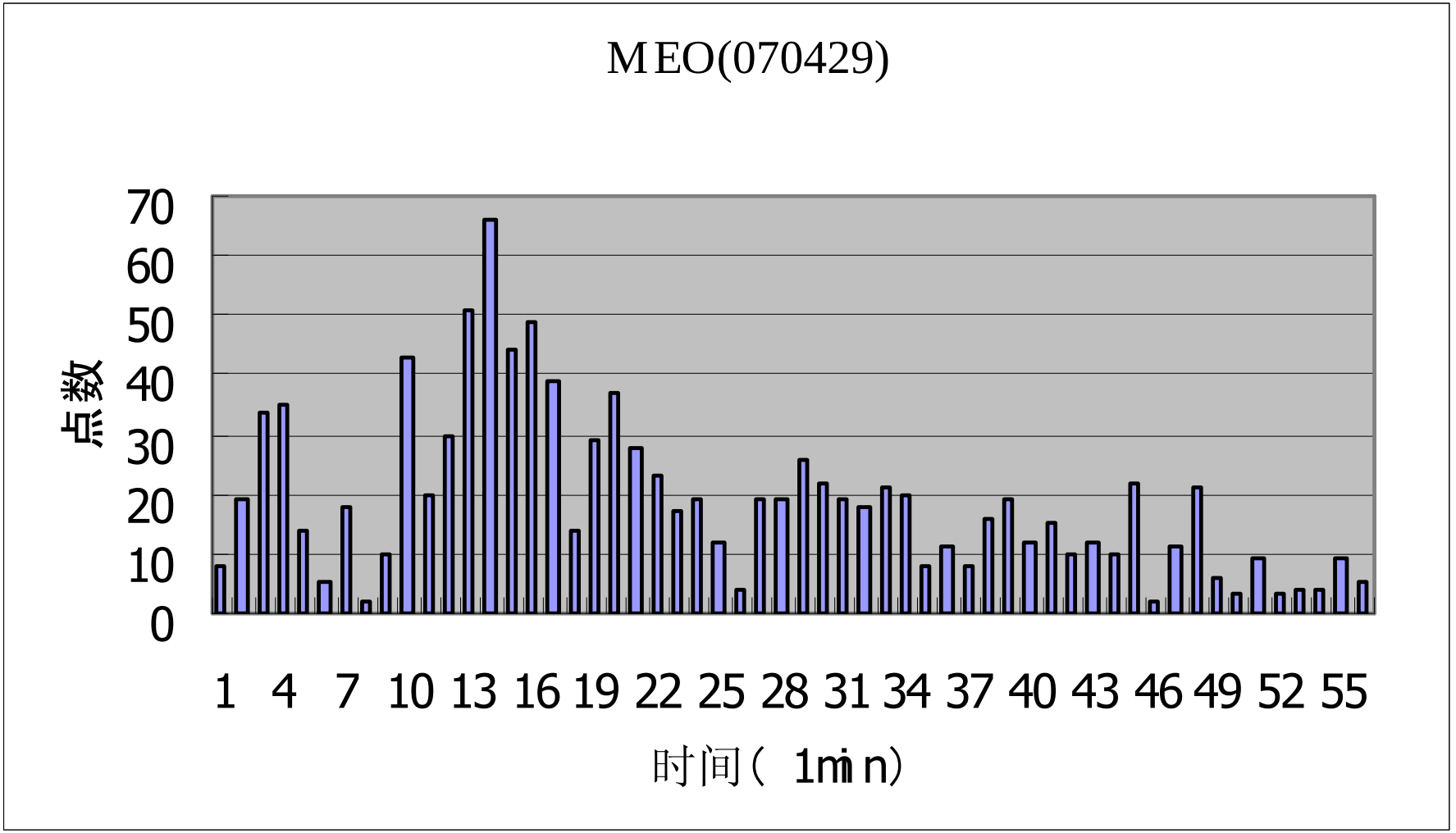
长春站激光测距望远镜

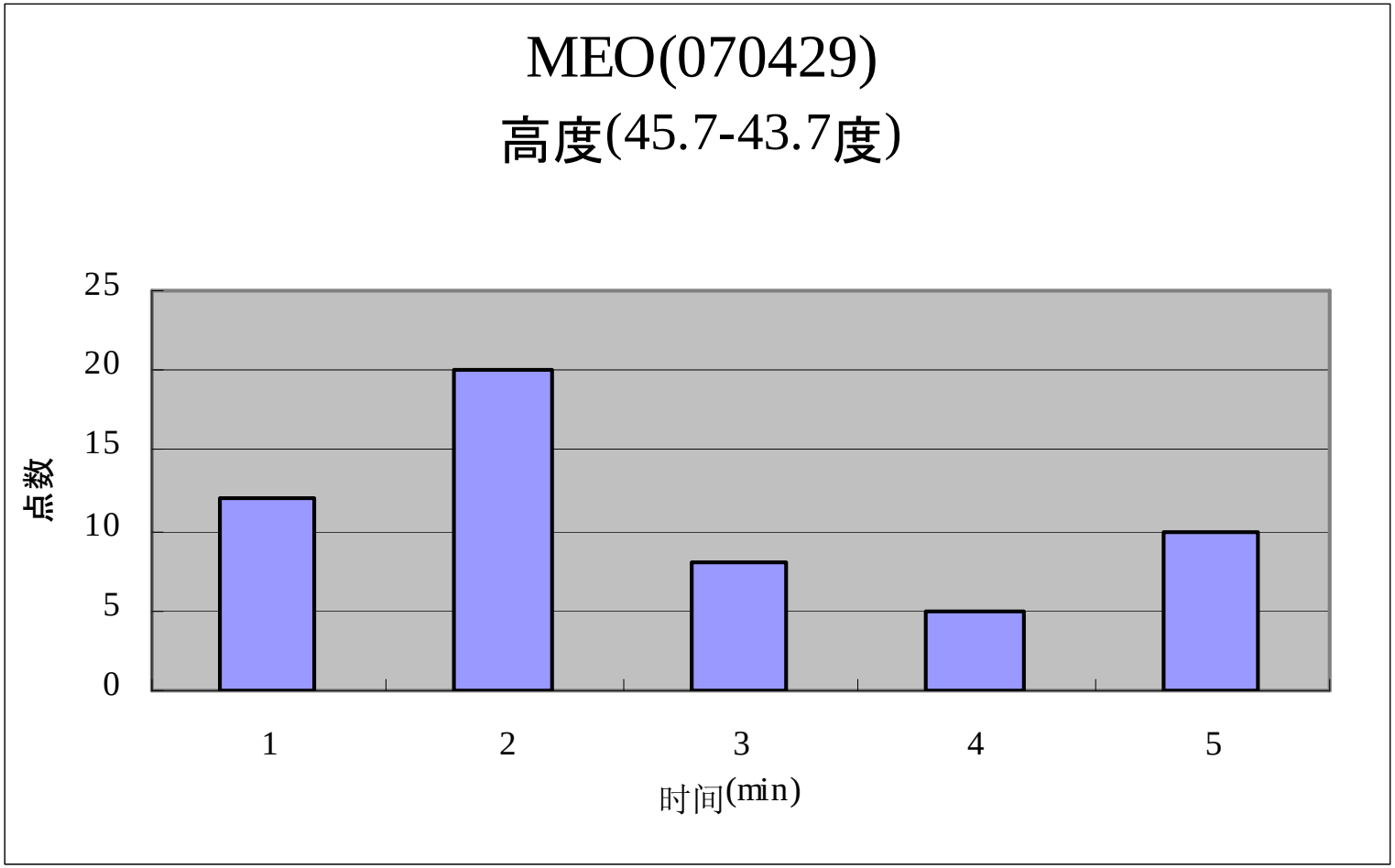
长春人卫站卫星激光测距控制室(图右为氢原子钟)



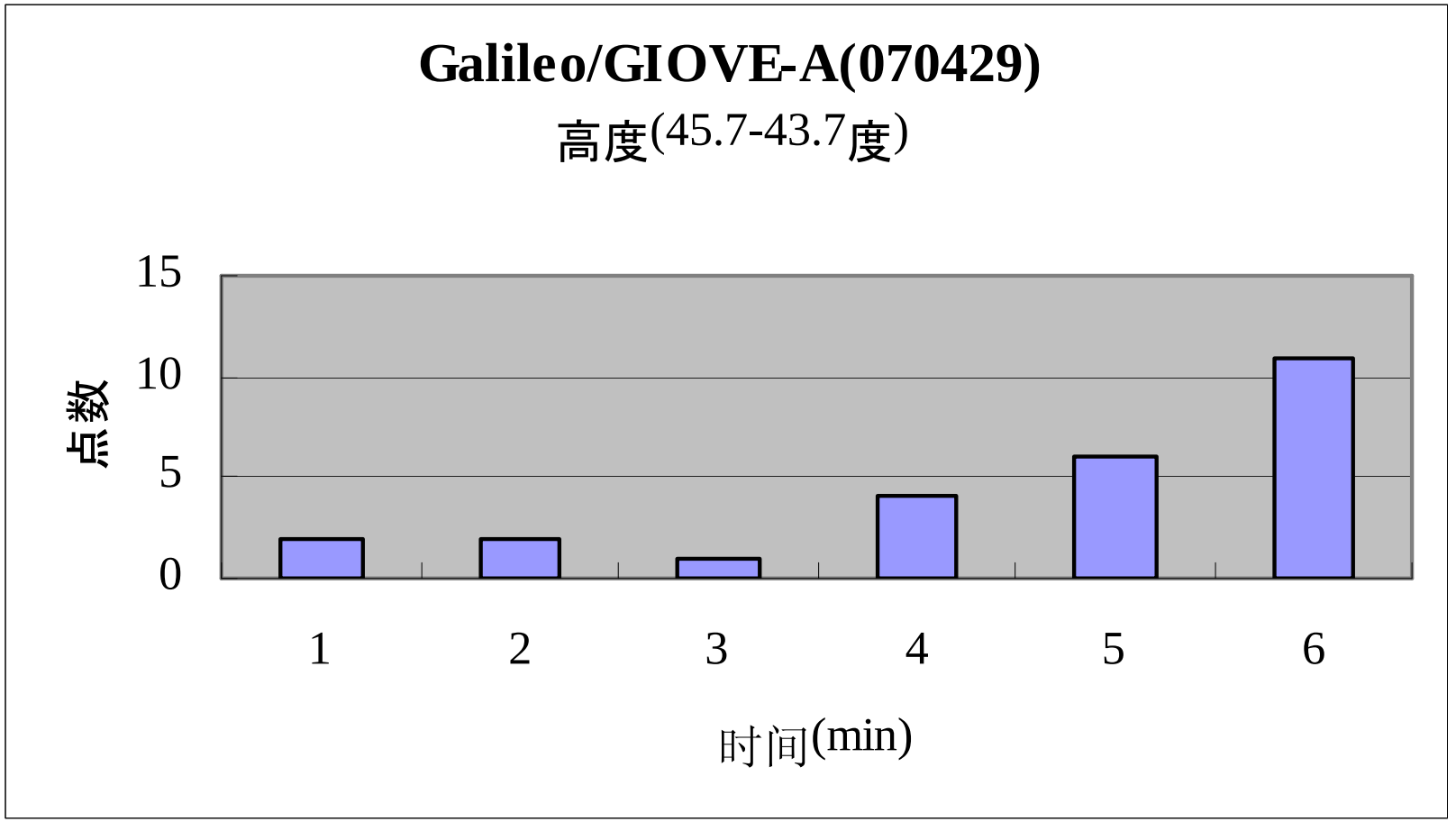
MEO试验星的实测界面



MEO试验星的实测回波统计(全弧段)



MEO试验星的实测回波统计
（12个回波/分钟）



Galileo/GIOVE-A 试验星的实测回波统计
（4个回波/分钟）