TIME TRANSFER BY LASER PULSES BETWEEN GROUND STATIONS

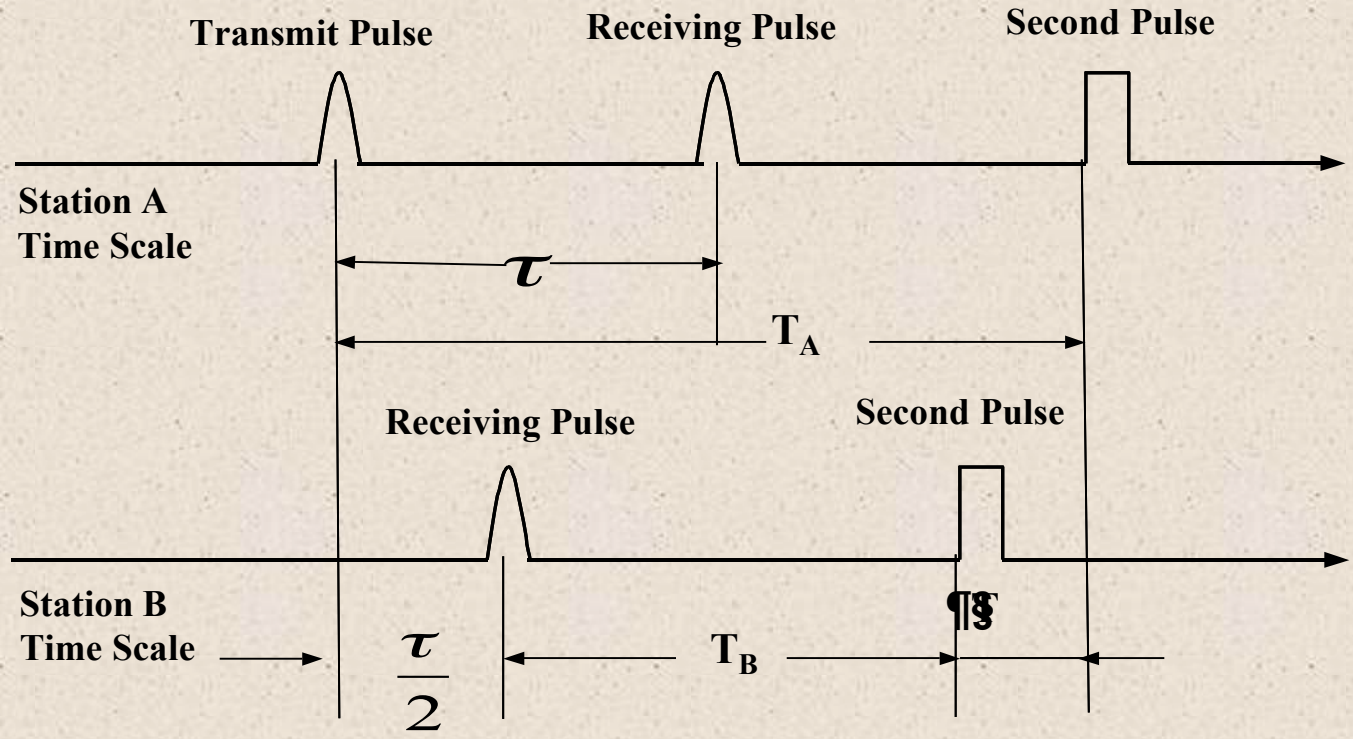
Yang Fumin, Zhang Zhongping,
Chen Wanzhen, Li Xin,
Chen Juping, Wang Bin

Shanghai Observatory, China

PURPOSE

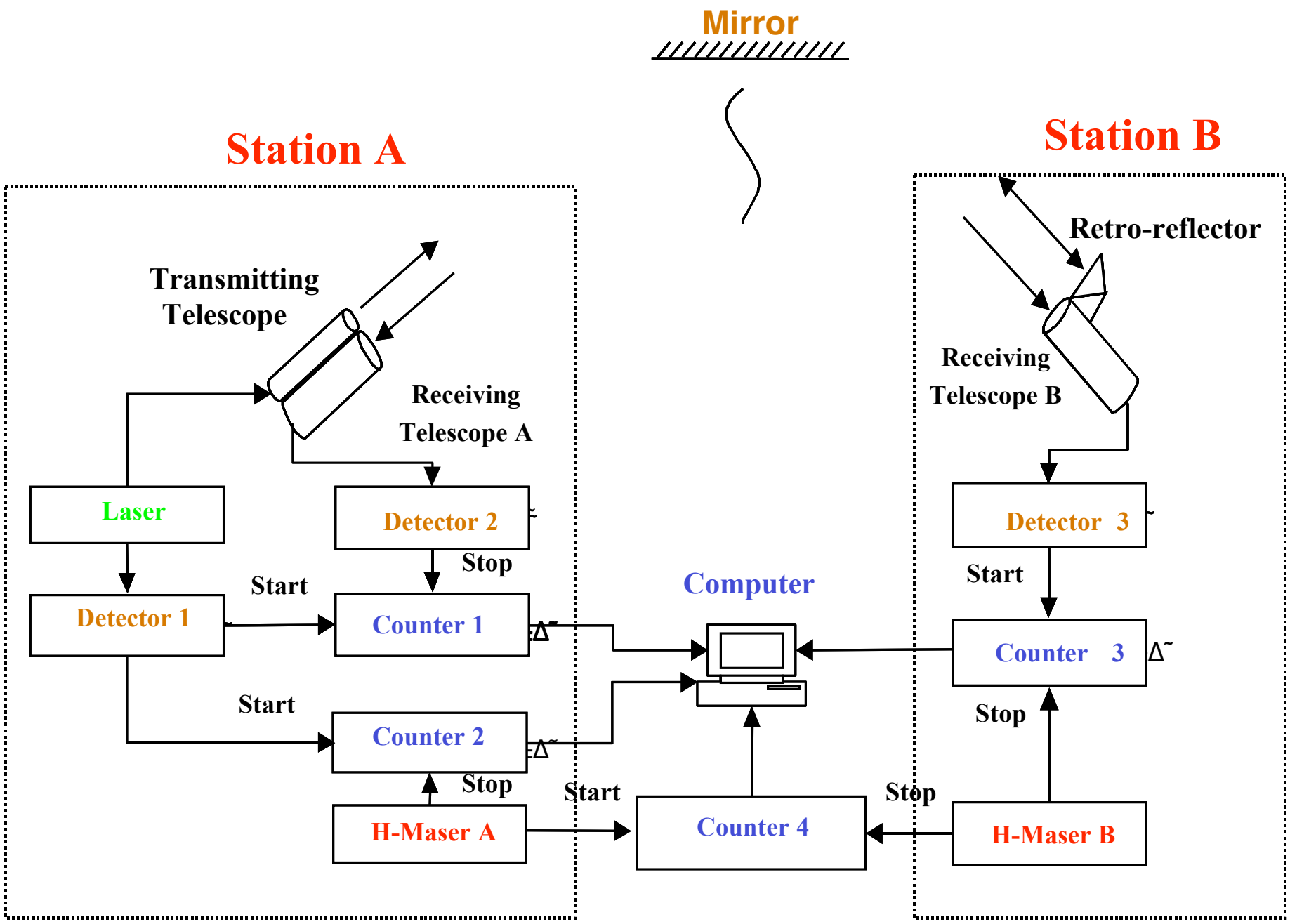
- Verification of precision of time transfer by laser pulses
- Preparation for future global time transfer experiments

PRINCIPLE



$$\Delta T = T_A - T_B - \frac{\tau}{2}$$

CONFIGURATION OF SYSTEM



Block Scheme of Local Time Transfer by Laser Pulses

- Actually, two stations (A and B) located in a same room
- A mirror for reflecting laser beams was set up at 250 meters away
- Both stations equipped with hydrogen masers that were directly compared with a SR-620 timer continuously, but without temperature control

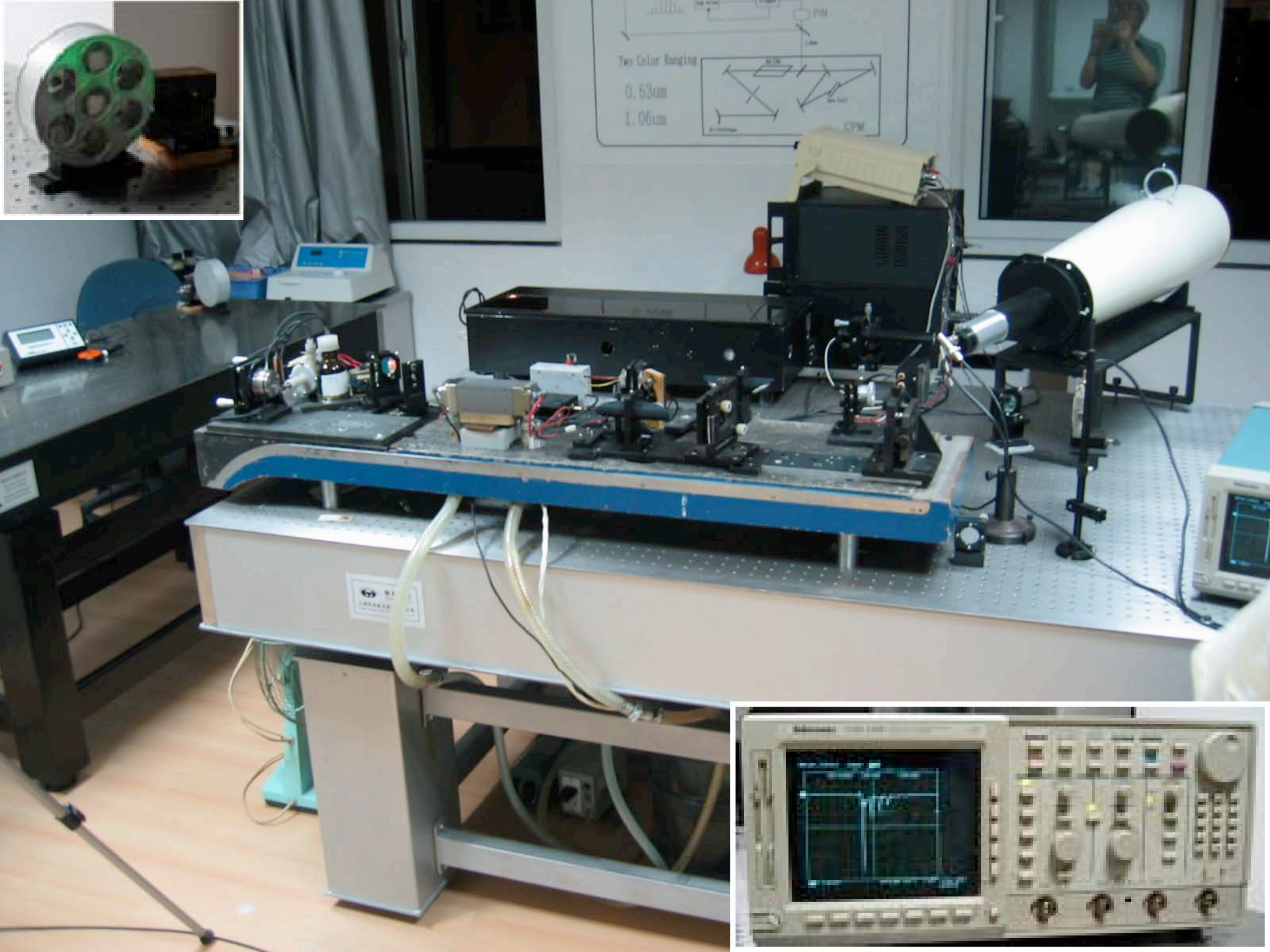
Characteristics of System

- Laser: Nd:YAG SFUR, 2mJ, 30ps, 1-10pps
- Receiver: 3 sets of Si-PIN diode
- Corner cubes
- Mirror: Dia 300mm
- Timer: 4 sets of SR620
- Clock: 2 sets of hydrogen Maser
- Discriminator: TC454
- Computer: 1 set for data acquirement of 4 timers

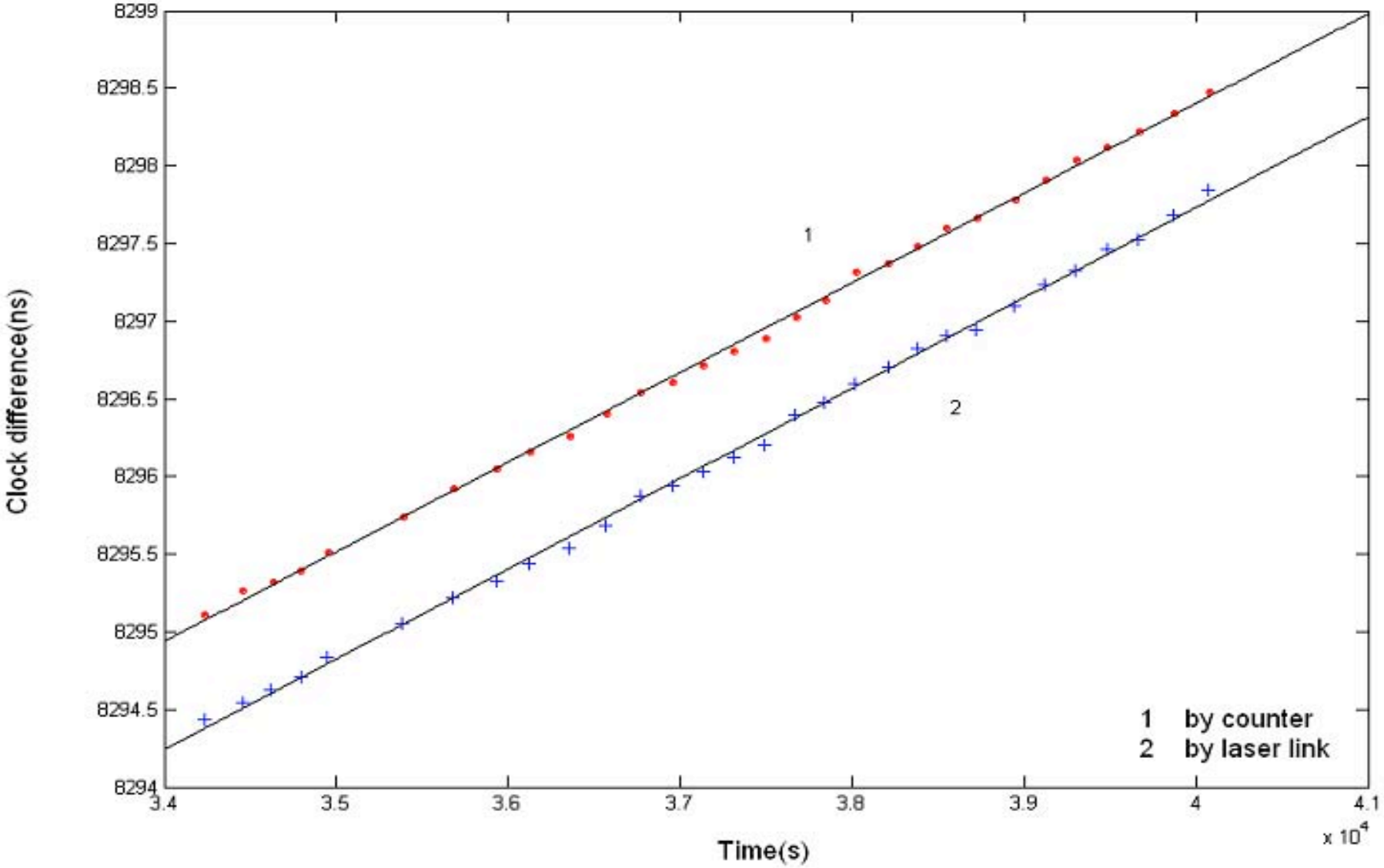
EXPERIMENT AND RESULTS

- Period of experiment: May-June of 2003
- Location: Headquarter of Shanghai Observatory (in the city)
- Photos of instrument
- Results of the time transfer experiment

Instrument for Local Time Transfer by Laser Pulses


Two Color Ranging
0.53um
1.06um
PIN
CPM

Local Time Transfer Result



Slope rates: Line 1 is 5.77°10£¥3 (directly by timer)

Line 2 is 5.82°10£¥3 (by laser link)

- Standard deviation of the mean of the clock differences determined by laser pulses is **24.1ps(rms)** for a 100sec interval
- Relative stability of frequency for two masers is **1.8°¡10$^{£≠3}$ /200sec** (Allen Deviation), due to without temperature control
- Uncertainty of measurement for the relative frequency differences by laser link for two masers is **4°¡10$^{£≠5}$ during 6000 sec**
- The comparison result by laser link is very coincident with the direct timing method

FUTURE PLANS

1. Upgrade of Performance of Clocks

- Keep the Hydrogen masers in a special clock room, variation of temperature _±0.2°C
- Better rise time of the second pulse:_4 ns

2. Upgrade of Accuracy of Time Comparison

- **Systematic biases measurement**

  Time delays by PIN diode, discriminator, timer…

- **Systematic errors analysis**

3. Low noise SPAD application

2 sets of 40um low noise SPAD will be adopted to replace the PIN diodes as the detectors for better sensitivity

4. Time comparison with high repetition rate

- 1 KHz laser, 10 ps pulse
- 1 KHz time comparison
- Clock difference measurement within one second
- Frequency difference measurement within 5-10 minutes

Thank You