# A 53cm-binoculars telescope debris laser ranging system

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# Introduction

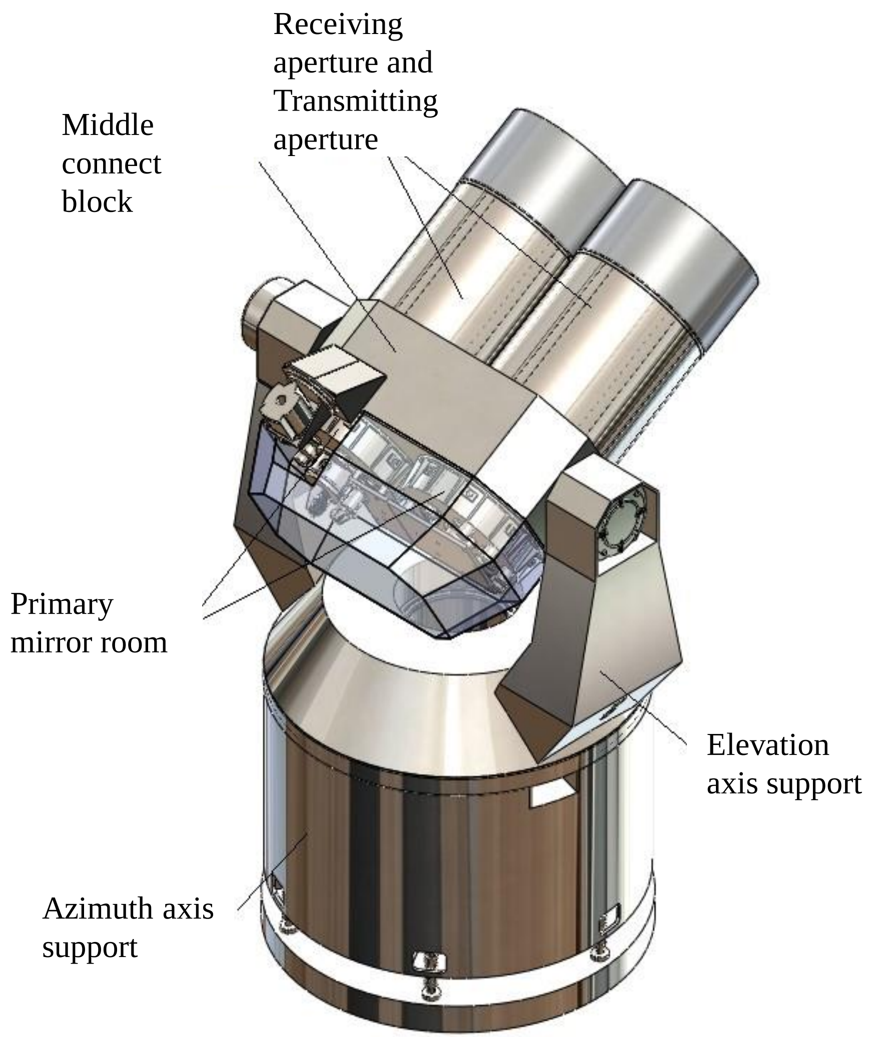
- Based on equipments like the 1.2m telescope and high-power laser generator, a 10Hz debris laser ranging experiment platform is established in the Yunnan Observatories, and detected echo signal of the rocket remain on Jun.07 2010.

- This paper is on the development of the 53cm binocular telescope debris laser ranging system and realization of debris detection with the capability of detecting meter-level target.

# Telescope

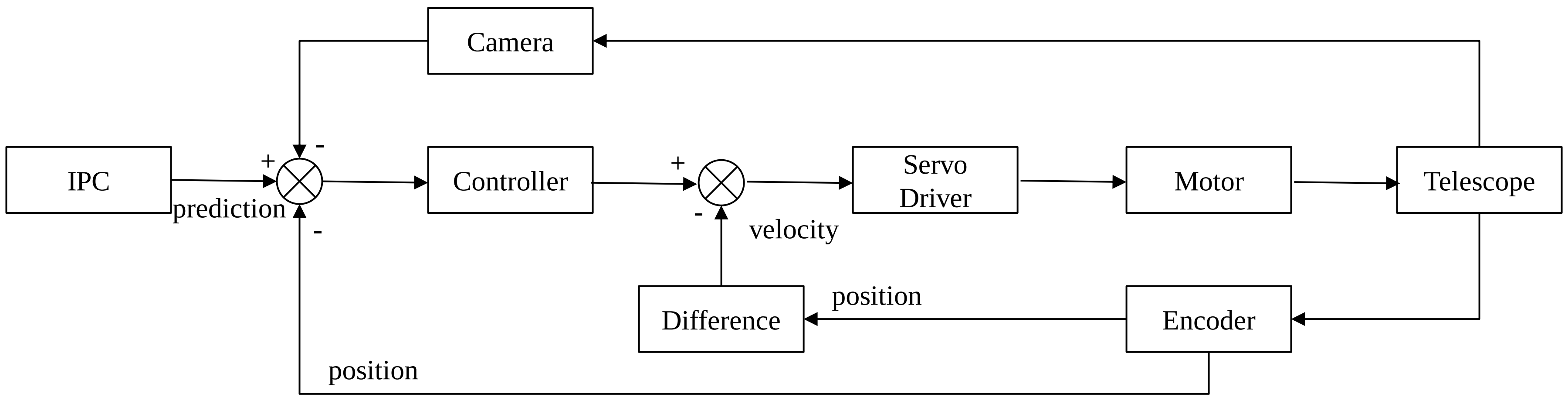
| parameters | Transmitting aperture | Receiving aperture |
|---|---|---|
| Primary mirror effective diameter | 510mm | 510mm |
| Focal length of primary mirror | 1078mm | 1400mm |
| Secondary mirror effective diameter | 48mm | 160mm |
| Focal length of secondary mirror | 93mm | 650mm |
| Shielded ratio | <4.4% | ≈17% |
| Multiplying power | 11.5× | |
| surface figure accuracy | λ/12 | |

parameters of the telescope




53cm binocular telescope

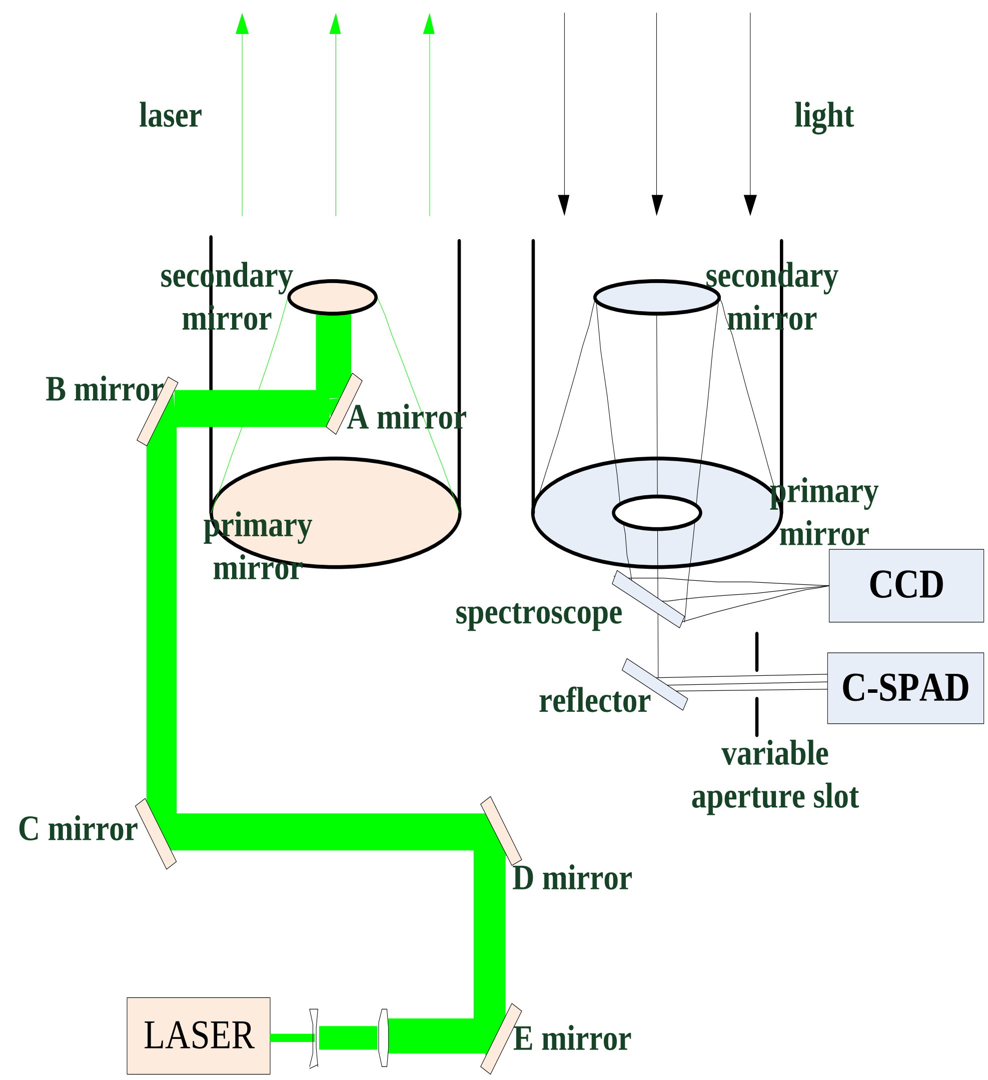
# Servo Control




The servo control of the 53cm telescope is capable of fast and stable tracking of debris which is above 400km with the presision better than 5'' (RMS<3''). The principle is shown in figure.

# Optic path

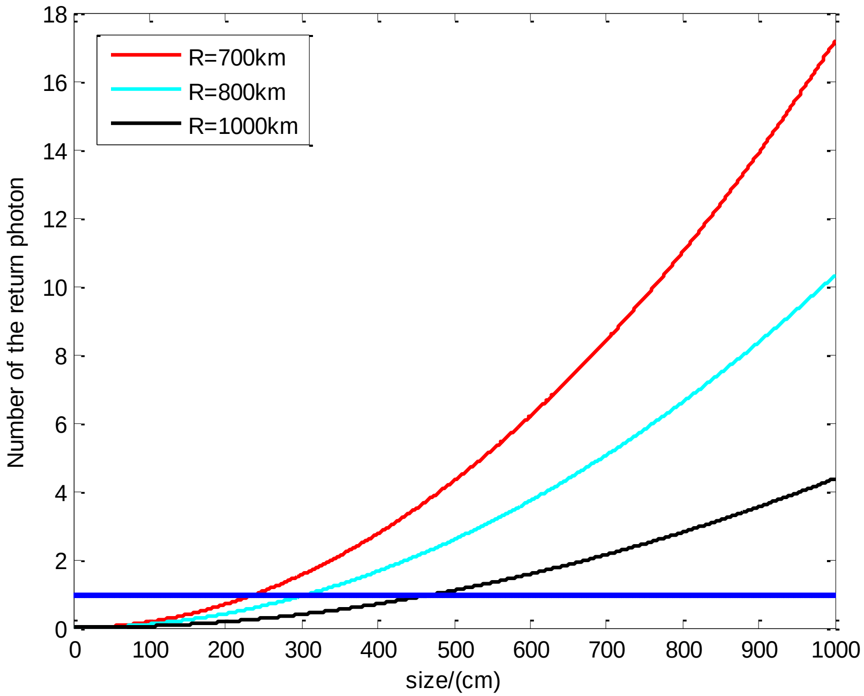
- It is shown in figure the transmitting/receiving optical path of the 53cm telescope.
- During ranging, laser is generated and passes through lv.1 beam expander system, then travels to reflecting mirrors: E, D, C, B and A, then reaches Secondary mirror. After lv.2 beam expander in Secondary mirror, the laser is transmitted to spacial target.
- Photon signals reflected by the target travel back to the ground and enter the receiving aperture, and are then reflected to spectroscope, reflector, and enter C-SPAD after beam condensing system.



# Debris laser ranging

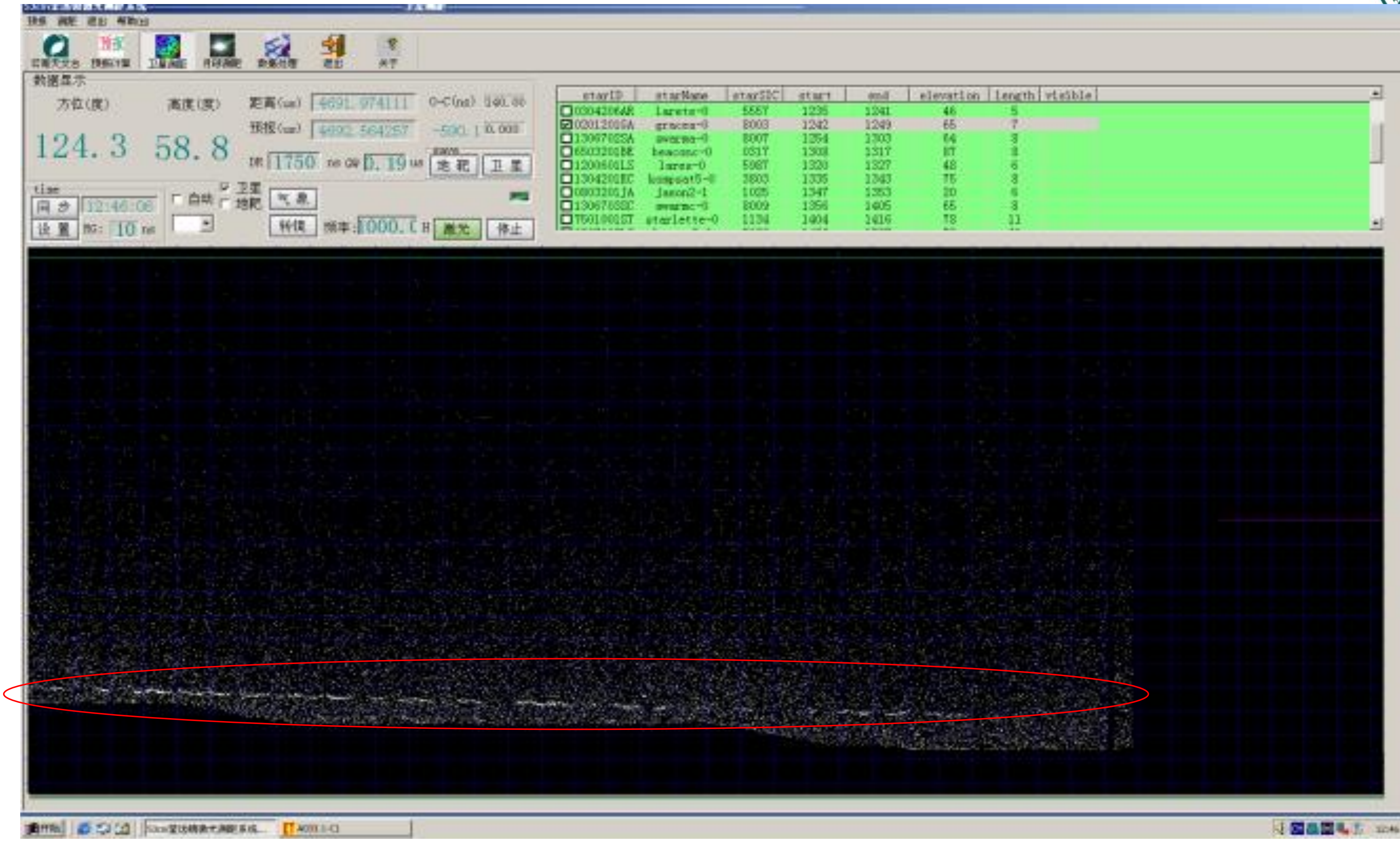
Laser：
The frequency is1kHz
The pulse width is 750ps
The wavelength is 532nm
Each pulse energy is 35mJ

Reflected photon calculation:
When the distance among debris is 700km, 800km and 1000km respectively, the echo that can be detected will approximately be 240cm, 310cm and 480cm accordingly ( debris detection with the capability of detecting meter-level target ).




reflected photon calculation of ranging system

# Debris laser ranging




This laser ranging system was applied at the beginning of 2016 for the debris laser ranging. In figure is the tracking layout of debris (Code No.20466) captured on May.31

The radar cross section (RCS) of the target is round 4.5m^2

# Conclusion

- The telescope system is capable of fast and stable tracking targets that are above 400km.
- Combined with high-frequency sub-nanosecond level laser generator and single photon detect technology.
- With the capability of detecting meter-level target.
- In future work the system will be further developed to improve the measuring capability of spacial debris.

# Thank you!