

# The mission of Chinese Space VLBI and Laser Ranging support for VLBI satellites with Retro-reflectors

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**Abstract:** The mission of Chinese Space VLBI has been taken into the agenda since 2009 to construct the larger base line VLBI observations in conjunction with the global VLBI network. In the first stage, the two space VLBI telescopes with aperture of 10 meter will be built at the orbit altitude 1,200~60,000km in next decades years. For precise orbit measurement for Space VLBI satellites and construction of a high-precision celestial coordinate frame, SLR technology will be adopted while satellites at the distance of over 10,000km and the laser retro-reflector will be made by Shanghai Astronomical Observatory. In order to meet the requirement of large effective area and light weight, the concept of the annular-planar retro-reflector arrays around the satellite-ground communicating link antenna will be adopted.

## 1. Chinese VLBI network

The Chinese VLBI Network concept was initiated from 1970s. In 1980s Shanghai Observatory had finished the first set of VLBI telescope in China with the aperture of 25 meter and the same size of VLBI telescope was established at Urumqi Observatory in 1990s. In 2000s Beijing and Kunming' Observatory respectively built the VLBI telescopes with the aperture of 50 meters and 40 meters. In 2012, the 65cm-VLBI telescope was successfully seated at Shanghai Observatory, the largest one in Asia. Shanghai Astronomical Observatory is the data correlative process center of Chinese VLBI network. Fig.1 shows the distribution of telescopes in Chinese VLBI network.

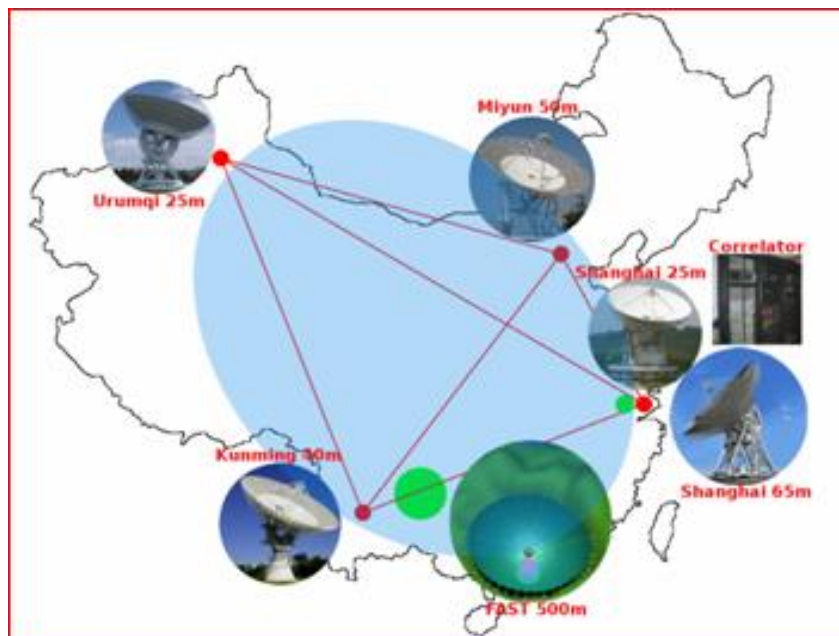


Fig.1 Chinese VLBI network

## 2. Chinese space VLBI mission

As we all known, the resolution of VLBI system has the relation to the length of baseline between VLBI telescopes. The intercontinental combination of VLBI telescopes has been realized in the world and the development of VLBI between space and ground is going on.

The mission of Chinese Space VLBI has been taken into the agenda since 2009-2010 to construct the larger base line VLBI observations in conjunction with the global ground radio telescope network. In the first stage, the two space VLBI telescopes with aperture of 10 meter will be built in the following ten years. Fig.2 shows the Chinese future two space VLBI telescopes. The main parameters of VLBI satellites are following:

- Apogee: 60,000 km
- Perigee: 1,200 km
- Inclination: 28.5 deg
- Angle between two orbital planes  $\sim 120$  deg

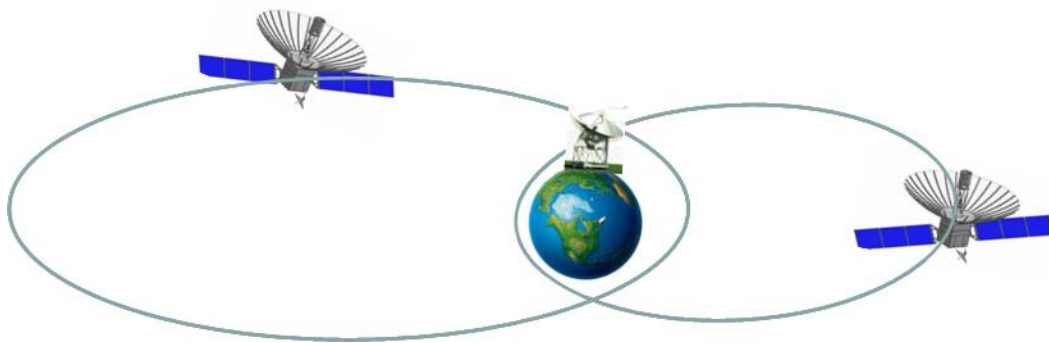


Fig.2 The orbit of two space VLBI telescopes

### 3. Laser retro-reflector design and laser tracking to Chinese space VLBI satellite

For high precise orbit measurement for Space VLBI satellites and construction of a high-precision celestial coordinate frame, SLR technology will be adopted. The designer of laser retro-reflector arrays (LRAs) and coordinator of laser ranging to Space VLBI satellites are Shanghai Astronomical Observatory. In this mission, the laser observations will be implemented while the satellites at the orbital altitude of over 10,000km. In order to get the laser returns when the satellites are on the high orbit, the concept of the annular-planar arrays (about 200 corner cubes) around the satellite-ground communicating link antenna with the diameter of 1.5m directing to the earth will be adopted. Fig.3 shows the design of LRAs for space VLBI satellites.

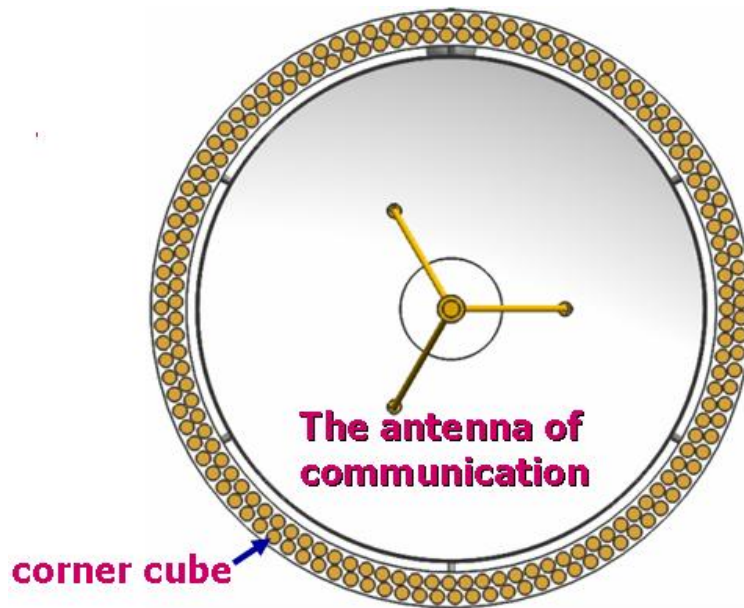


Fig. 3 The design of LRAs for Chinese Space VLBI satellites

For the compensation of velocity aberration, the  $5\pm 1^\circ$  divergence angle of single corner cube will be adopted. To receive the enough laser returns the effective reflective area of retro-reflector will be designed over  $1600\text{cm}^2$ . In order to lighten the LRAs, the optimized design methods will be considered for the optical material and mechanical structure.

Laser Ranging supports for VLBI satellites are following:

- SLR tracking stations: ILRS stations
- Orbit accuracy required: 10cm or better
- SLR data accuracy: better than 5cm for single shot
- Data analyzing and orbit prediction: by Shanghai Observatory
- Operations requirements mission coordinator: by Shanghai Observatory

#### 4. Summary

The high precise laser measurement for Space VLBI satellites will help to perform the mission of VLBI observation in space. The Chinese SLR stations had finished kHz ranging system upgrading under support of CMONOC (Crustal Movement Observation Network of China) in 2011. Shanghai, Changchun, Beijing SLR stations have the capability of kHz ranging up to GEO satellites (36,000km). The Chinese SLR stations will do the best to support this challenging works. And the involved SLR stations will also be under the lead of ILRS to observe the Chinese VLBI satellites.