



Shanghai Astronomical Observatory  
Chinese Academy of Sciences

# **The mission of Chinese Space VLBI and Laser Ranging support for VLBI satellites**

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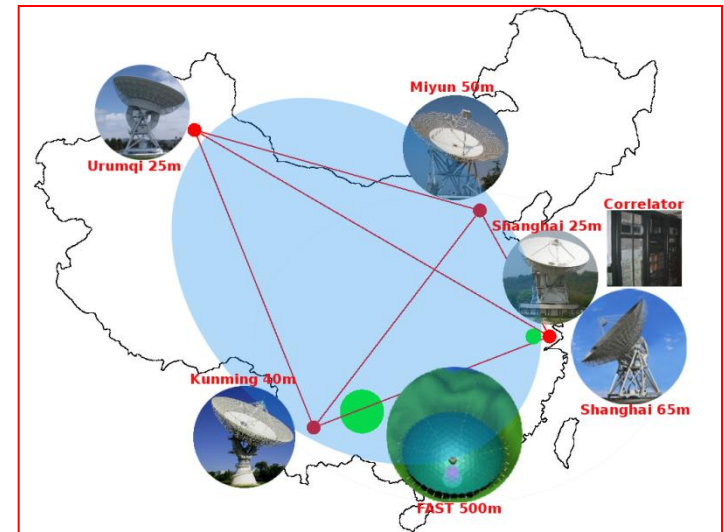


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# VLBI Development in China

- 1970s VLBI Network Concept
- 1980s Shanghai 25m
- 1990s Urumqi 25m
- 2000s Beijing and Kunming
- (CVN : 4 Ant. + correlator)
- 2010s FAST (500m) + Shanghai 65m ...)
- 2020s QQT(110m) + space VLBI



Chinese VLBI Network

# VLBI Development in China

Shanghai 65m radio telescope



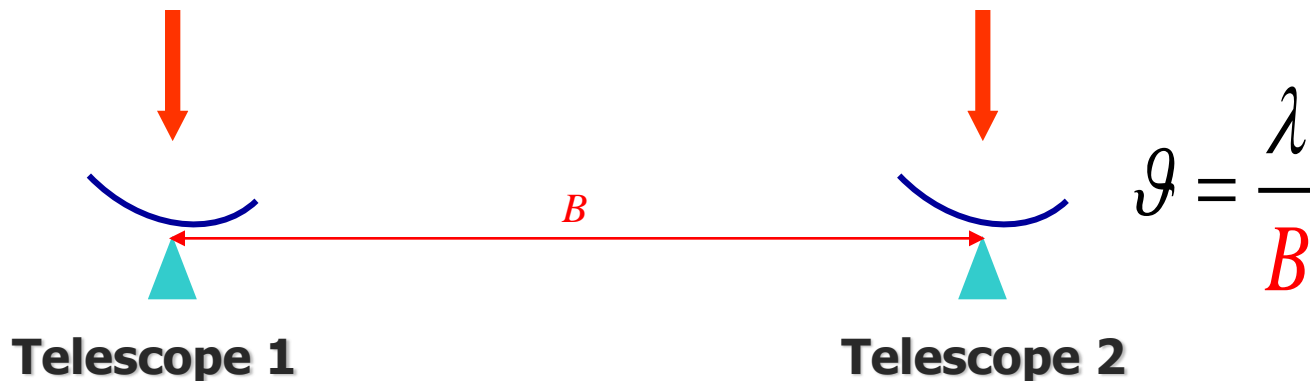
FAST 500m



**VLBI became famous in China after the application of VLBI to support Chinese lunar mission in 2007**

# The mission of Space VLBI

- The **sensitivity and resolution** of VLBI  $\propto$  the baseline length between VLBI telescopes
- The maximal baseline length on the ground is 2 times of radius of the Earth
- **Higher sensitivity and higher resolution** for Radio Astronomy science purpose to need longer baseline.

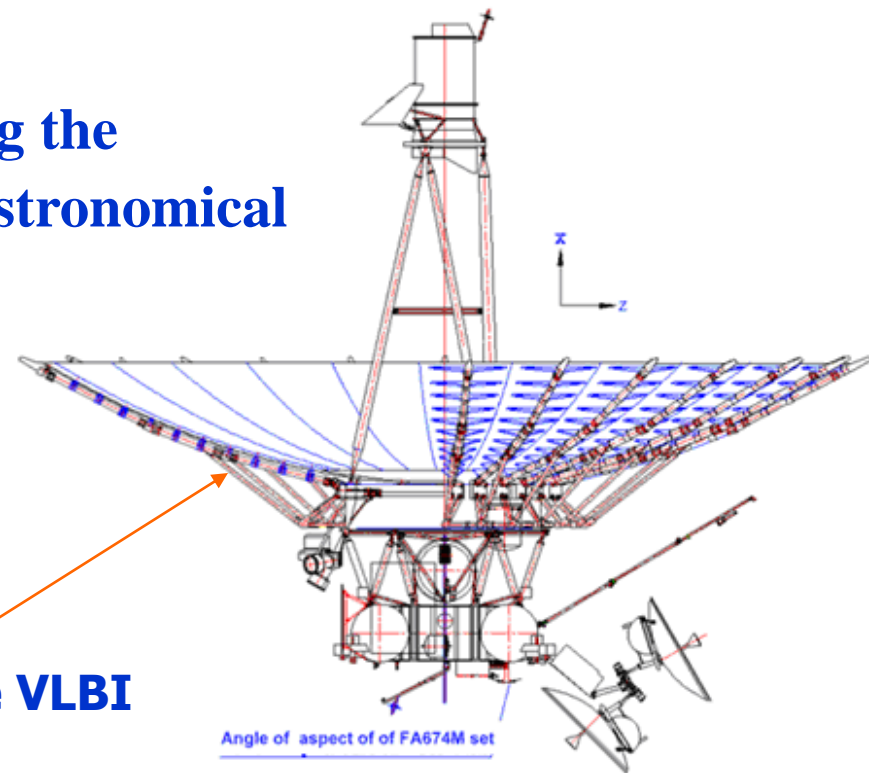




# The mission of Space VLBI

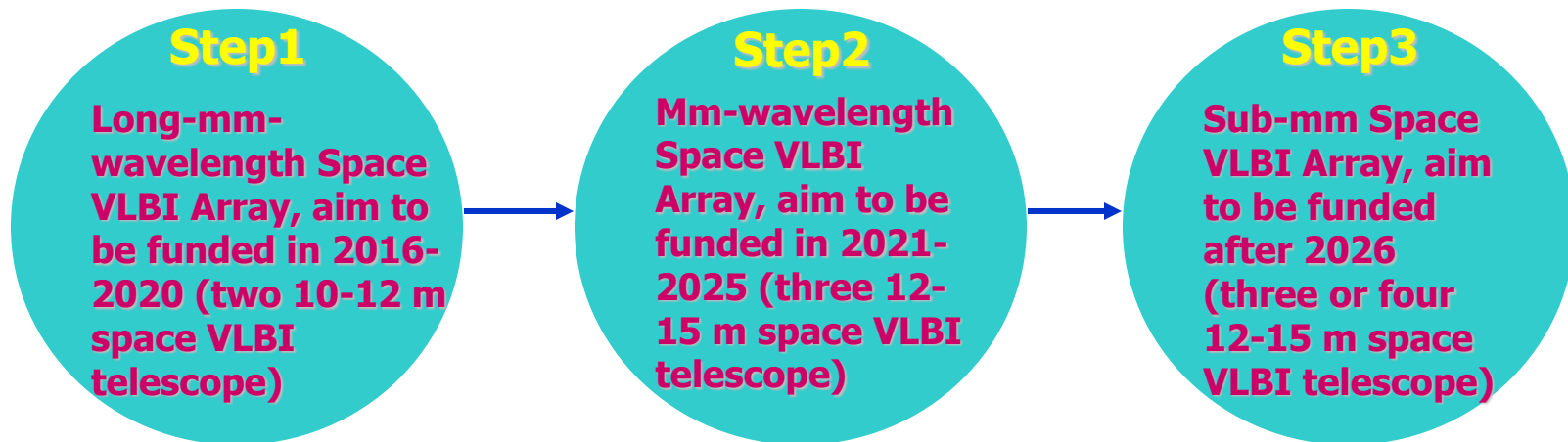
- Development of VLBI between space and ground will meet the length requirement of baseline.
- In July 2011, one 10 meter radio telescope in RadioAstron project sponsored by Lavochkin Association of Russia was launched.
- Japan has also the plan of utilizing the space VLBI technique for radio astronomical studies.
- **Altitude: 500-350,000 km**
- **Inclination: 51.4 degree**
- **Orbital Period: 8.5-9.0 days**

**Russia Space VLBI**



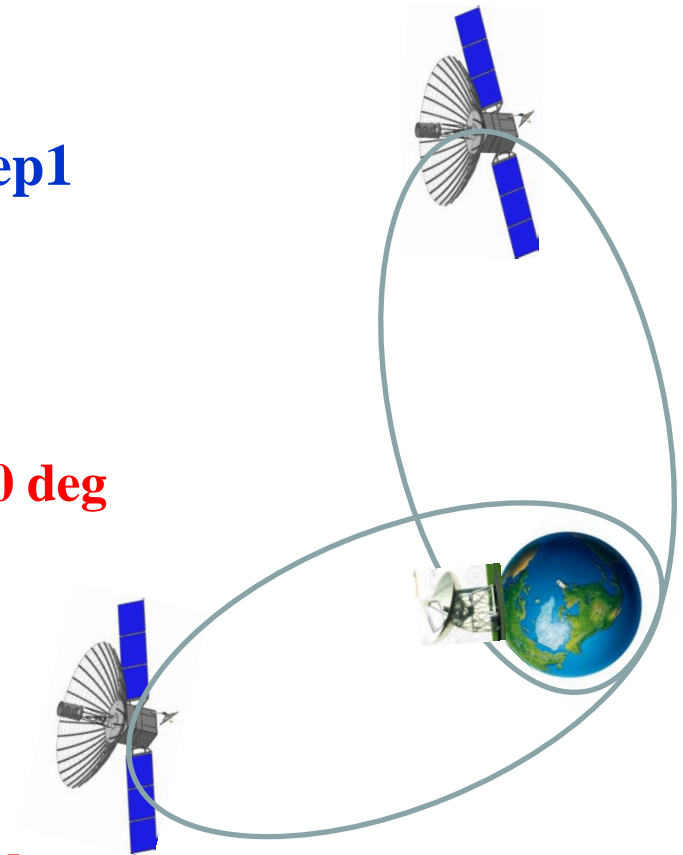
# The Chinese Space VLBI mission

- The Chinese Space VLBI mission has been taken into the agenda since 2009-2010
- Constructing the larger baseline VLBI observations in conjunction with Chinese and Global VLBI network on ground.
- Pre-research Programs of Space Science (2009)
  - **Space Millimeter VLBI Array preliminary scheme**
- Road map of millimeter/sub-millimeter space VLBI array



# The Chinese Space VLBI mission

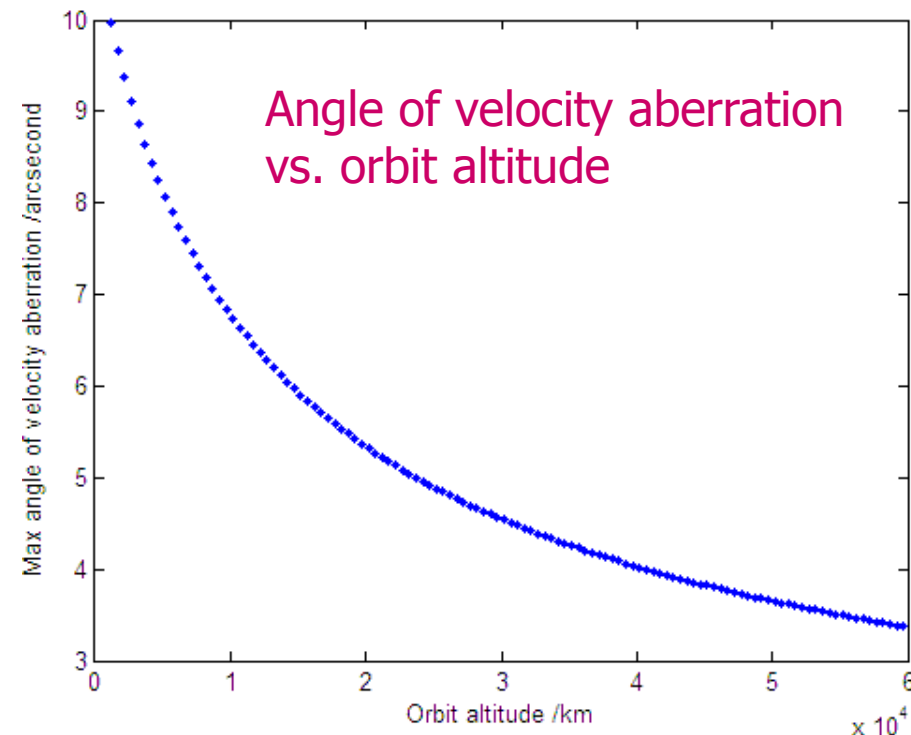
- Shanghai Astronomical Observatory and National Space Science Center, et al.
- Two Satellites (10m in diameter) in Step1
  - Apogee: 60,000 km
  - Perigee: 1,200 km
  - Inclination: 28.5 deg
  - Angle between two orbital planes ~120 deg
- Performances:
  - highest frequency 43GHz,
  - 20uas high resolution
  - good uv coverage together with ground-based telescopes for imaging





# Laser Retro-reflector Design for Space VLBI

- SLR technology adopted for centimeter-level precise orbit of Space VLBI satellites.
- The laser retro-reflector array (LRA) made by Shanghai Observatory.
- Considering the different velocity aberration when the satellites orbiting in different position
- The max angle of velocity aberration from **10" to 3.5"** (1,200-60,000km)



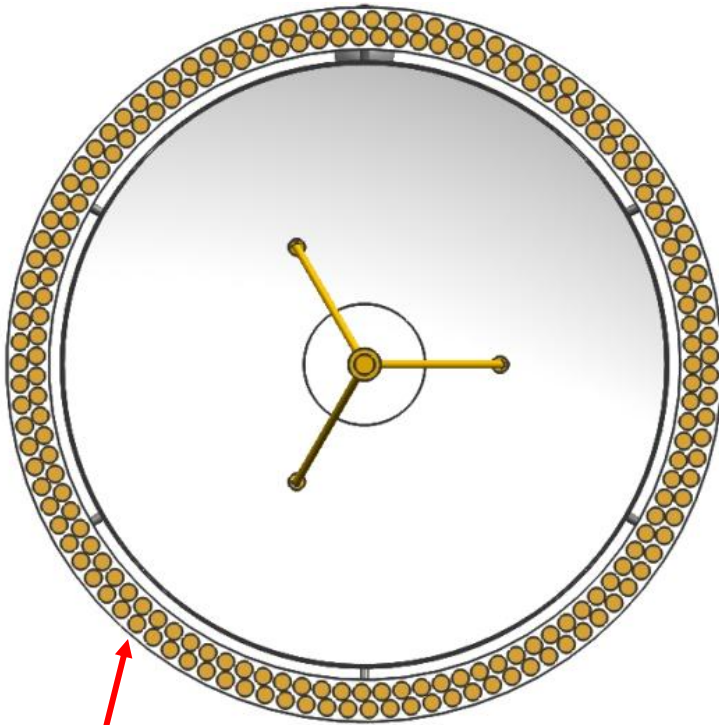
# Laser Retro-reflector for Space VLBI satellites

## Design

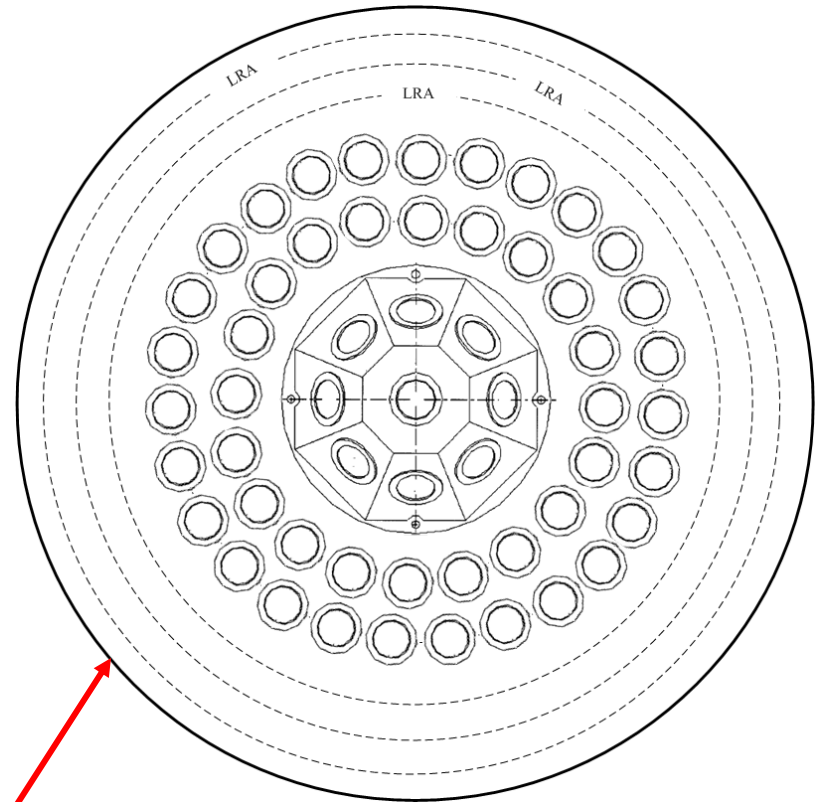
- Generally, the type of LRA is the pyramid-style array for of LEO satellites, such as **ERS-2, HY-2, ZY-3** etc and the planar-style for HEO/GEO satellites, such as **Glonass, Compass-M1/G1/I3/I5/M3**.
- The different type of LRA will be utilized according to different requirement of laser ranging:
  - Laser tracking only when satellites at around orbital apogee (regarded as HEO satellite)
  - Laser tracking when satellites both at around orbital apogee and perigee (regarded as both LEO and HEO satellite)

# Laser Retro-reflector for Space VLBI satellites Design

Type for HEO satellite



Type for both HEO and LEO satellite



➤ The corner cubes with two row around a ring.

- The inner: pyramid-style;
- The outer: planar type, around several rings;

# Laser Ranging support for VLBI satellite

- 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 Astronomical Observatory (SHAO)**
- Operations requirements mission coordinator: **by SHAO**

# Laser Ranging support for VLBI satellite

- Chinese SLR stations finished kHz ranging system upgrading under support of CMONOC (Crustal Movement Observation Network of China) in 2011.
- Shanghai, Changchun, Beijing have the capability of kHz ranging up to GEO satellites (36,000km).
- San Juan SLR station supported by National Astronomical Observatory of China has got the funding for the kHz upgrading and the modification is in process.
- Chinese SLR stations will do the best to support this challenging work.
- Welcome ILRS stations to observe the Chinese VLBI satellites



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Thank you!