



# Chinese VLBI Network and its application

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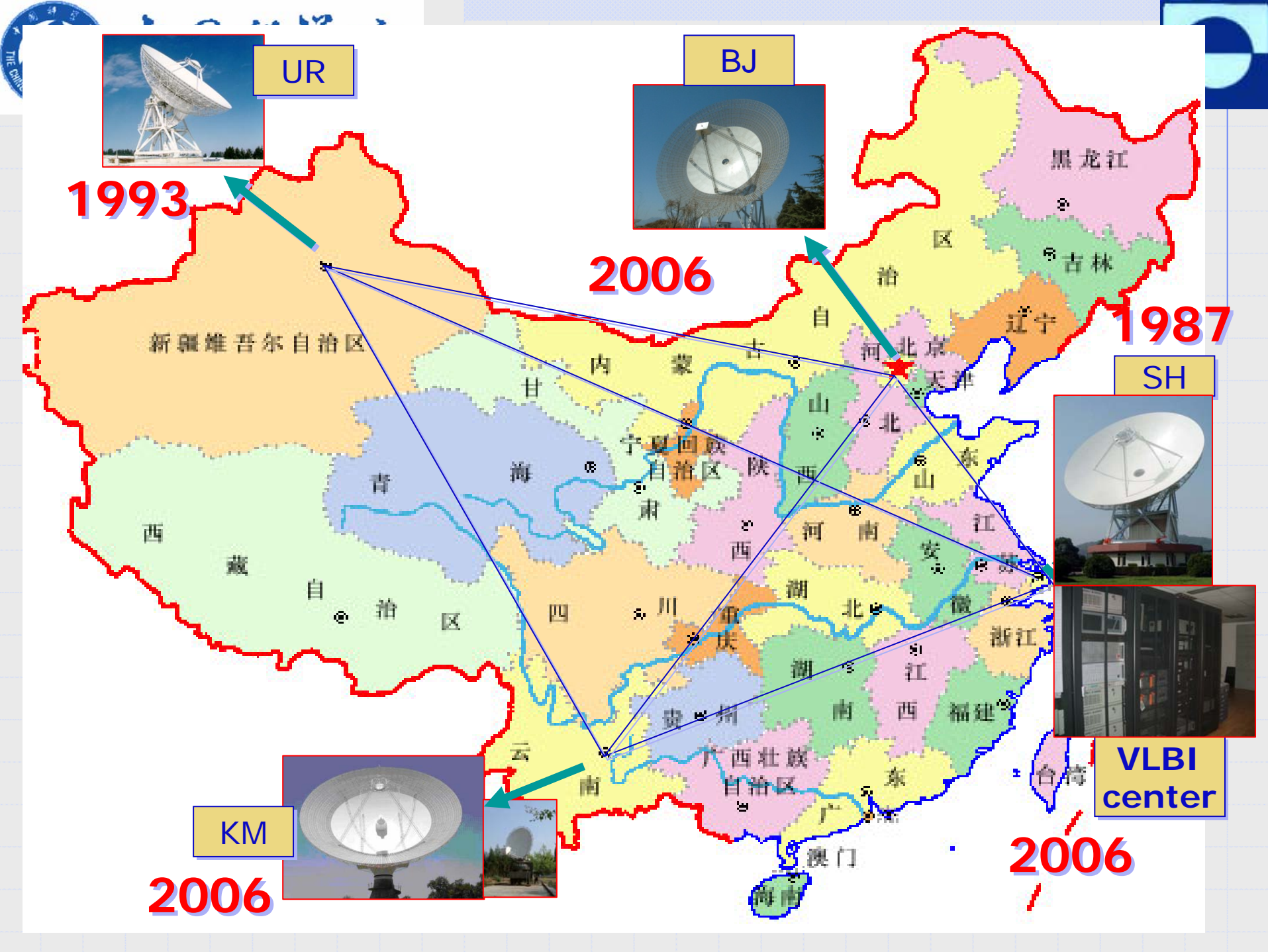


## outline

### 1. CVN – History

- ◆ – Shanghai station
- ◆ – Urumqi station
- ◆ – Miyun station
- ◆ – Kunming station
- ◆ – correlator
- ◆ – future plan

### 2. Application -- -- sciences & CE-1



UR

BJ

SH

KM

VLBI center

1993

2006

1987

2006

2006



## First VLBI Experiment between Shanghai and Effelsberg

- ◆ **1981** Completion of the construction of a 6m radio telescope in SHAO
- ◆ Carried out the first trans-Eurasian continent VLBI experiment at L-band between 6m telescope, Shanghai and 100m telescope, Effelsberg, West Germany, November, 1981.

Effelsberg 100m



Shanghai 6m







## VLBI Experiments between Shanghai and Kashima

❖ **1984/5** Two VLBI experiments at X-band between 6m telescope, Shanghai and 26m telescope, Kashima were performed in 1984/1985. The accuracy of the baseline measurements is about a few centimeters.



Shanghai 6m



Kashima 25m

# CVN—Shanghai station



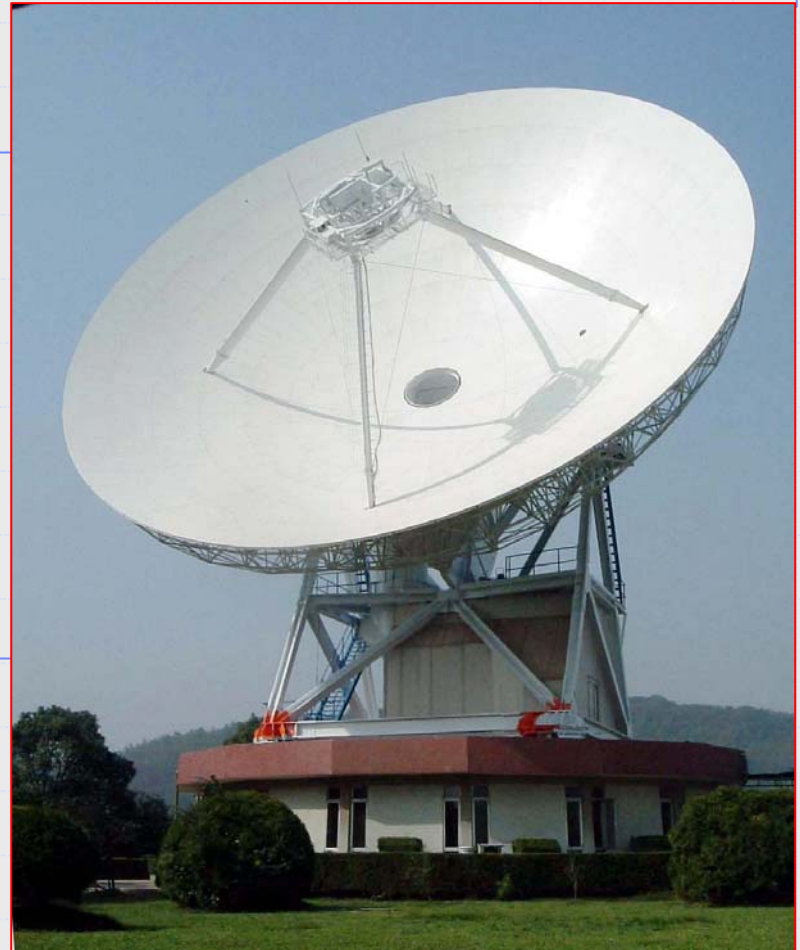
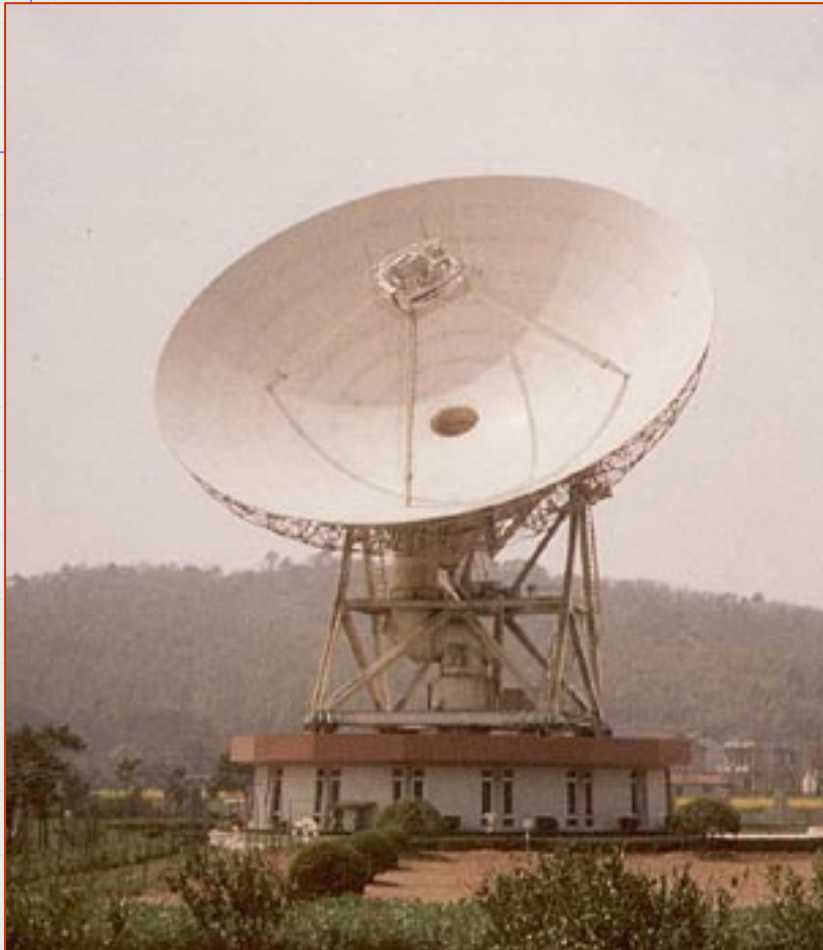
The SHAO 25 antenna was installed in the test ground of the factory in 1984.







**The 25m antenna was installed in Sheshan site, about 30km far away from Shanghai in 1986/1987 and started routine international VLBI experiments since November, 1987.**





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**Diameter: 25m**

**Band: L, S/X, C, K(22GHz)**

**Recoding system: MK2, S2, MK3, MK4, MK5A**

**Member of EVN , IVS**







# CVN—Urumqi station

November, 1993



November, 1993



September 26, 1992

**Diameter:25m**

**Band: P, L, S/X,C, K(22GHz),  
also 30 and 49 cm**

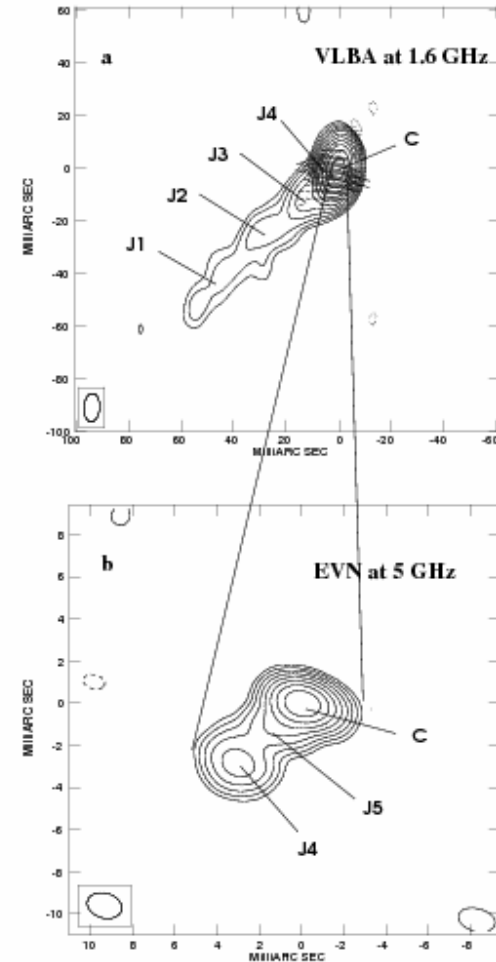
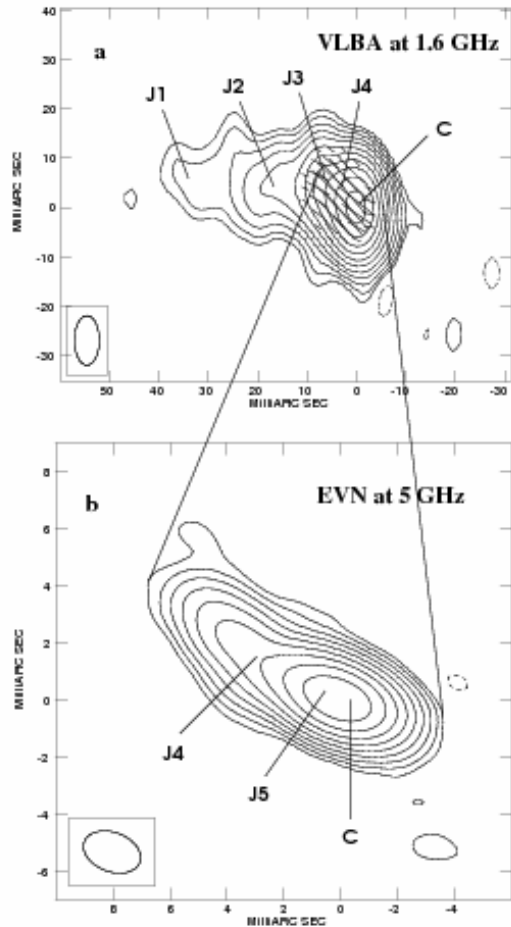
**Recoding system: MK2, MK3, MK4, MK5A  
K-4, K-5**

**Member of EVN , IVS**





# Sheshan and Urumqi are the member of EVN and IVS







## Mobile VLBI

A Mobile VLBI System with 3m antenna was constructed by SHAO for the Xi'an Surveying and Mapping Institute in 2000 which is located in the Yunnan Astronomical Observatory.





# CVN—Kunming station

**Antenna Construction**

**Started at 2005.6**

**Ended at 2006.5.21**





# The Kunming 40-m Radio Telescope

Diameter; 40m

Band : S/X

Recording system: MK5A;

Hydrogen maser;

GPS







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## CVN – Beijing Station







**Diameter: 50m**  
**Band: S/X**  
**Recording system: MK5A**  
**Hydrogen maser; GPS**



## CVN --VLBI data processing center

Hardware correlator (5 station)

Software correlator (4 Station)

Output data: CE-1 format

FITS format (will be available)

Software for CE-1 data processing  
(near real time, in 5 min.)







## CVN – Future plan

Technical developmemnt

correllator more stations, 10?

more flexible

FITS format

digital BBC

Astronomy application

C band may be possible for BJ and KM ?



## Deliha telescope for VLBI

- ◆ Diameter: 13.7m
- ◆ Band: 3mm, 7mm





# New telescope in Shanghai

- ◆ Diameter: 65m
- ◆ Bands: 8 bands



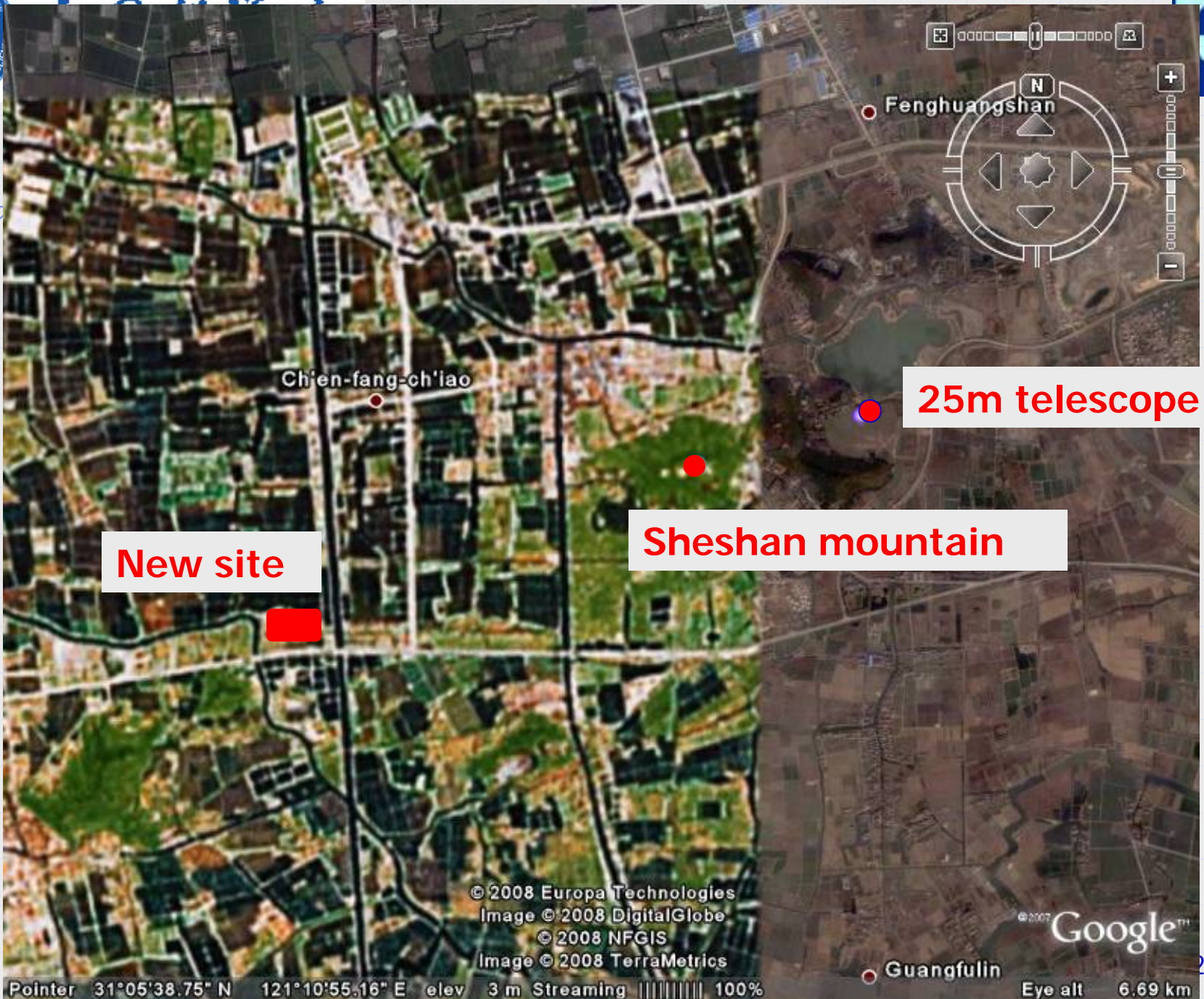
band	wavelength (cm)	Bandwidth (GHz)	Pol.
L	21/18	1.30~1.75	dual
S	13	2.20~2.45	dual
C	6/5	4.50~7.00	dual
X	3.6	8.00~9.00	dual
Ku	2.5/2.0	12.00~15.00	dual
K	1.35	21.00~24.00	dual
Ka	0.9	30.00~34.00	dual
Q	0.7	40.00~46.00	dual

S/X, X/Ka





1. Astrophysics research with single dish, special for some spectral line.
2. Astrophysics research with VLBI.
3. Astrometry research with VLBI.
4. Applications for space projects.







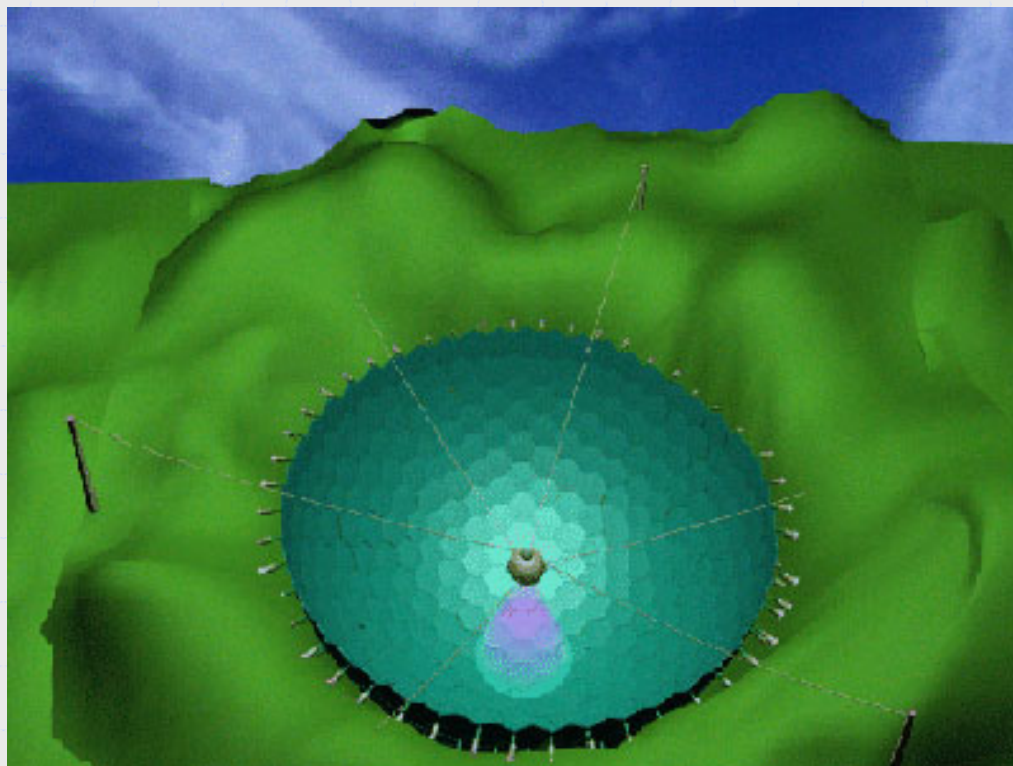
- ◆ Shanghai government offers us a land about 150X400 m
- ◆ The new telescope will be supported by Shanghai government and Chinese Academy of Sciences.
- ◆ The new telescope should be ready in 2012.
- ◆ Looking forward for advice and the cooperation.





## FAST for VLBI

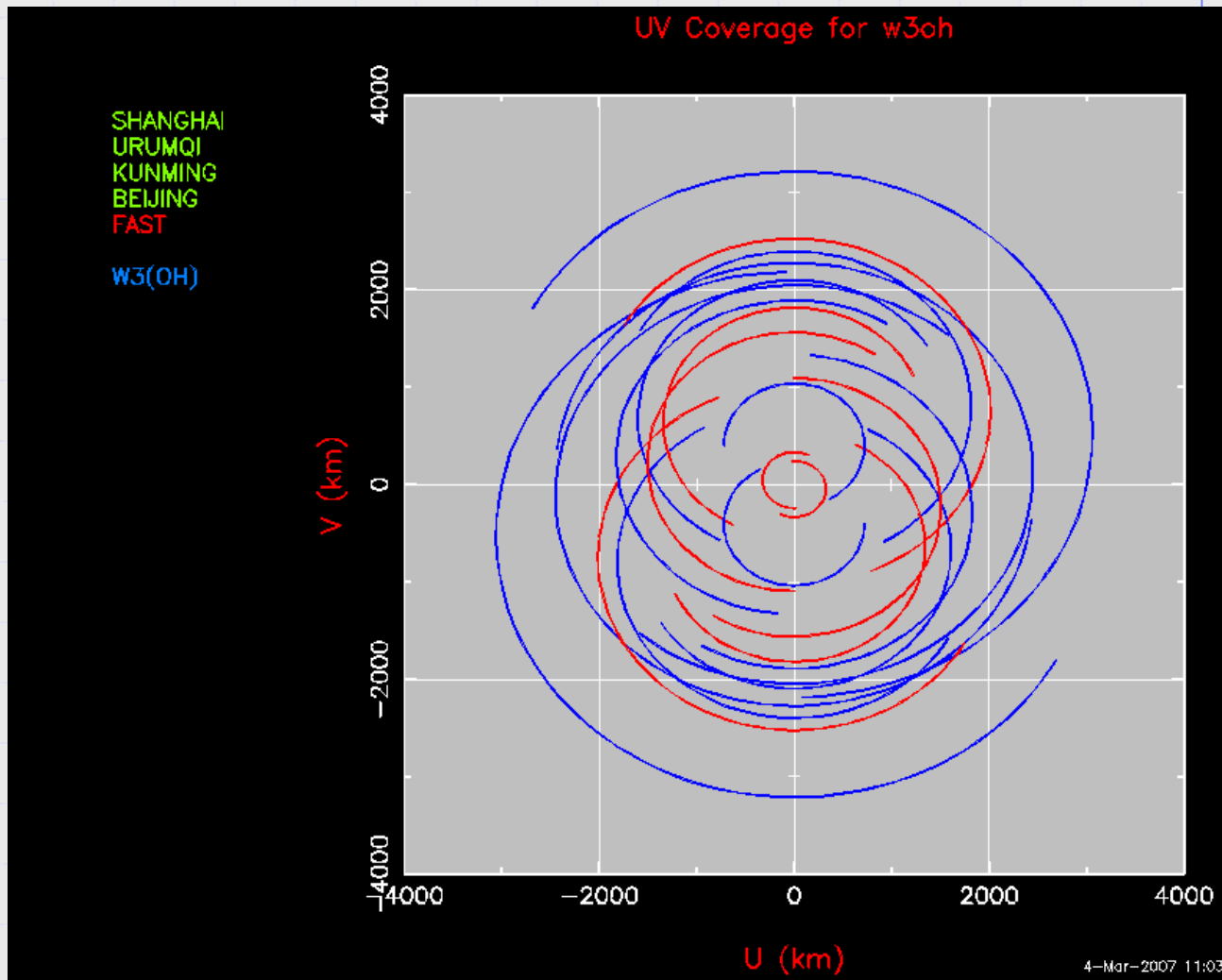
- ◆ 70 MHz – 3 GHz
- ◆ Extending to 8 GHz





# 5 stations uv coverage

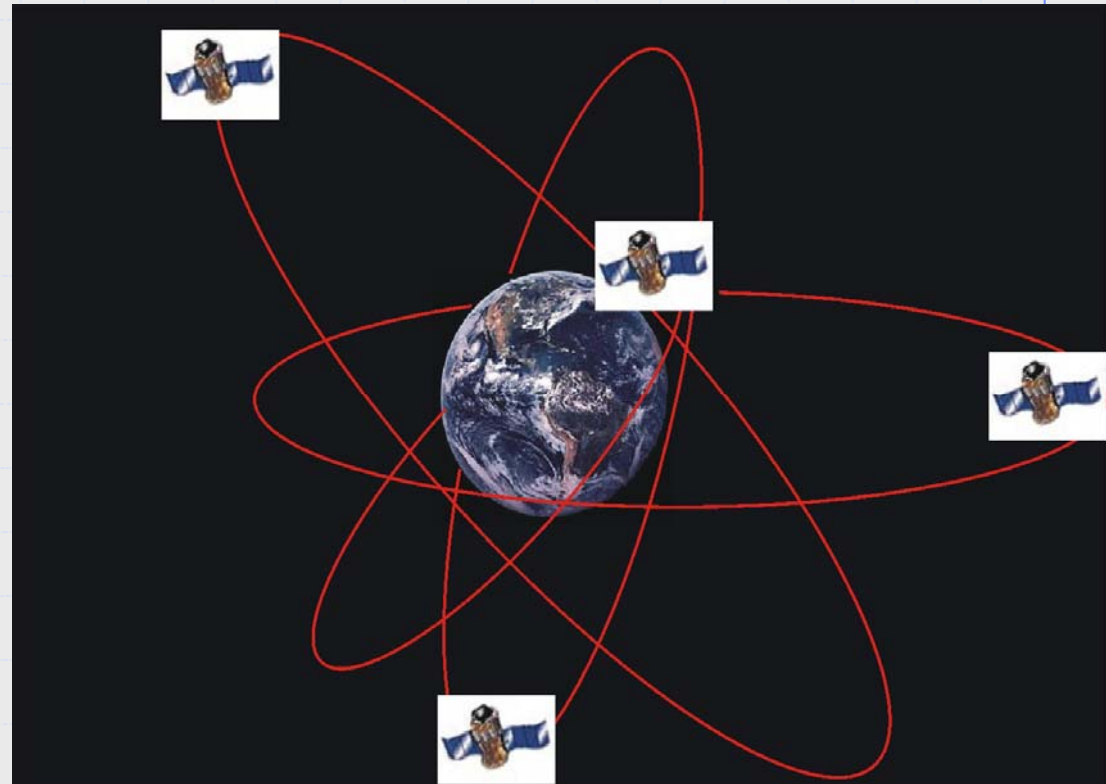
- ◆ Shanghai
- ◆ Urumqi
- ◆ Kunming
- ◆ Beijing
- ◆ FAST





# Space mm-VLBI array

- ◆ SMVA  
(Space mm VLBI Array)
- ◆ 4-6 antennas
- ◆  $\sim 20$  GHz- $\sim$  THz







# CVN for Sciences

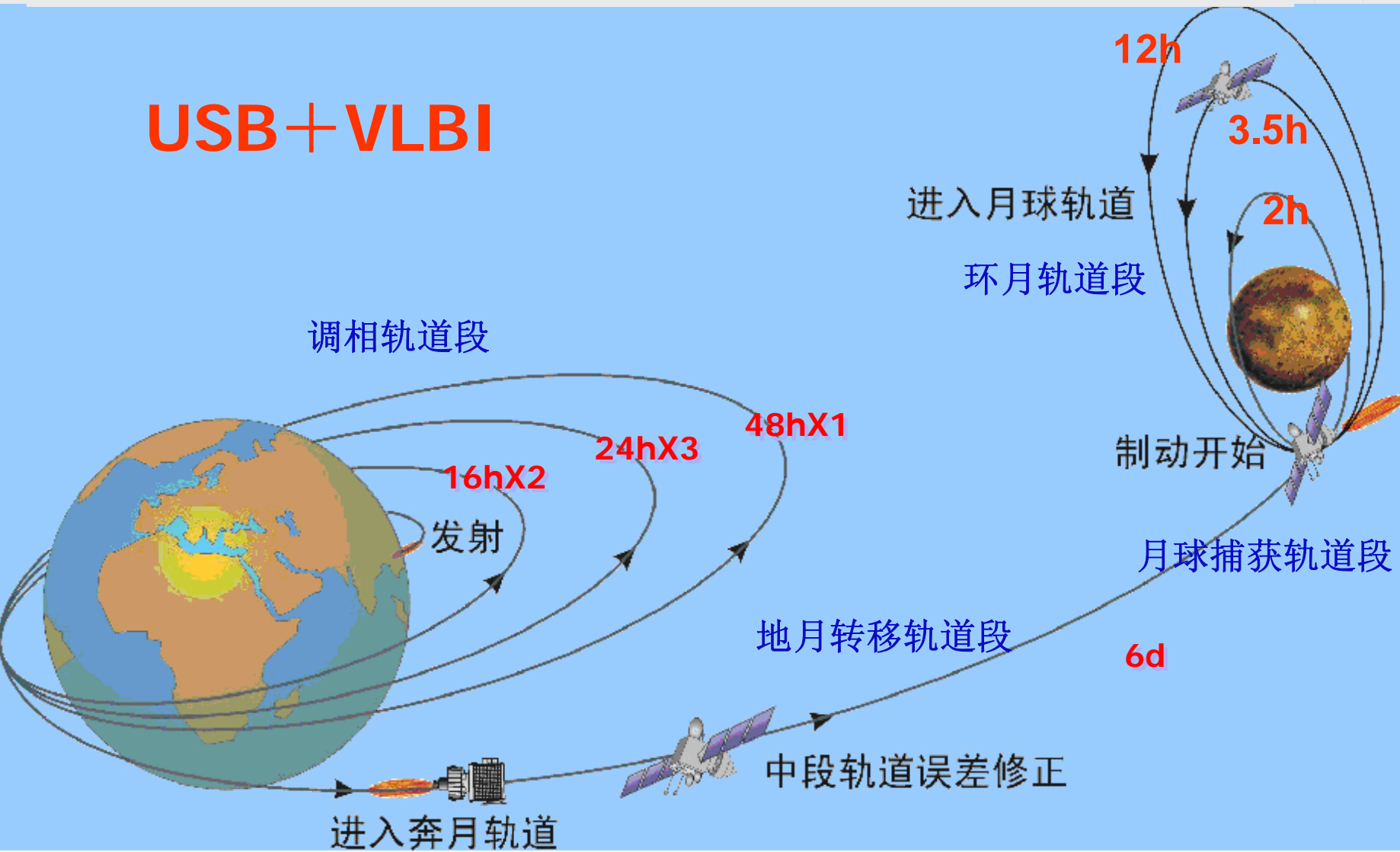
## 4 stations VLBI Network

- 1) 13/3.6 cm (s/x) geodesy, AGN
- 2) 6 cm (C) 4.2-7.7 GHz  
AGN, Pulsar, CH<sub>3</sub>OH
- 3) 18、20 cm (L) AGN, Pulsar, OH

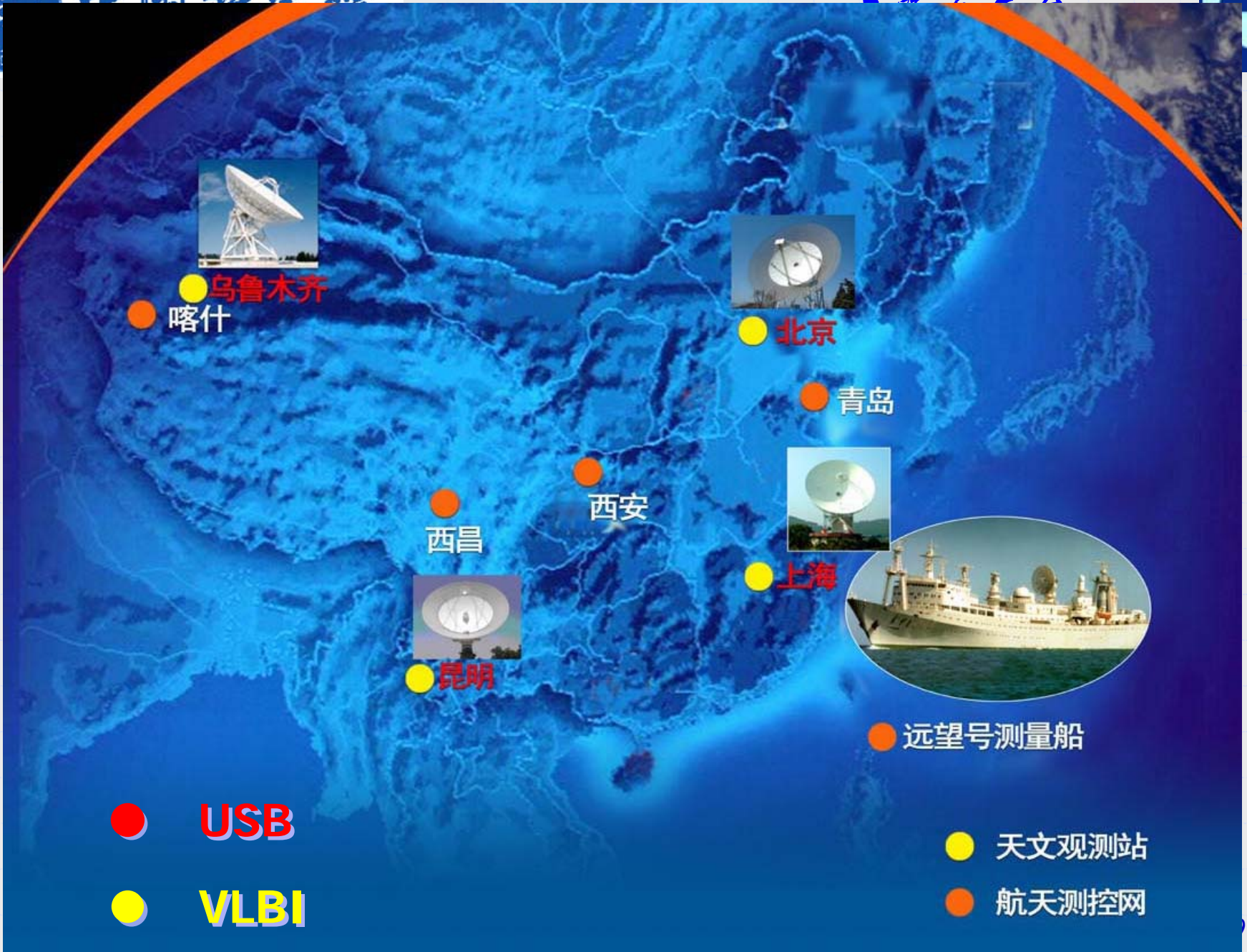


# CVN -- Application for CE-1

## USB+VLBI







● USB  
● VLBI

● 天文观测站  
● 航天测控网



1) stations



2) Network 16Mbps

3) VLBI center



VLBI data

In 5 min.

USB data

Beijing center





- ◆ Orbit determination: USB+VLBI
- ◆ VLBI tracking
  - distance  $> 20000\text{km}$
  - elevation  $> 5$  degree
  - output data: baseline delay
    - baseline rate
    - angular position
  - output delay time:  $< 10\text{minutes}$



- ◆ correction for the clock and instruments delay:  
Quasars observation
- ◆ Correction for atmospheric effect:  
GPS & station weather parameters



- ◆ Hardware correlator + post- processing software
- ◆ Software correlator + post- processing software

Two system parallel work at same time

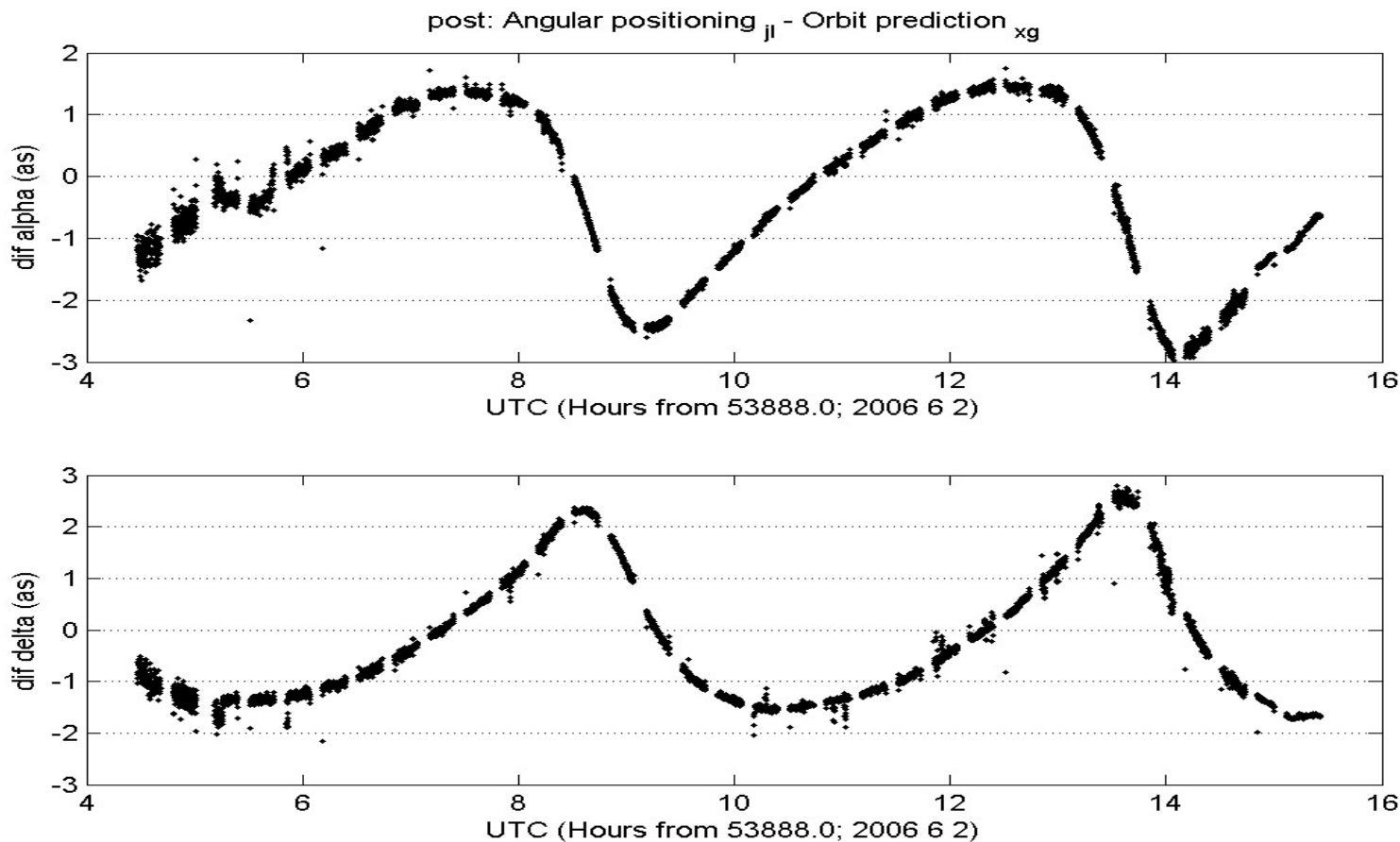




- ◆ 27 Oct.– 30 Nov. 2007  
real time mode tracking
- ◆ from Dec.2007: 2 days/week  
recorded in the hard disk  
output data : two weeks late



2 June 2006 Smart-1:  
Angle differences between VLBI measured and predicted values

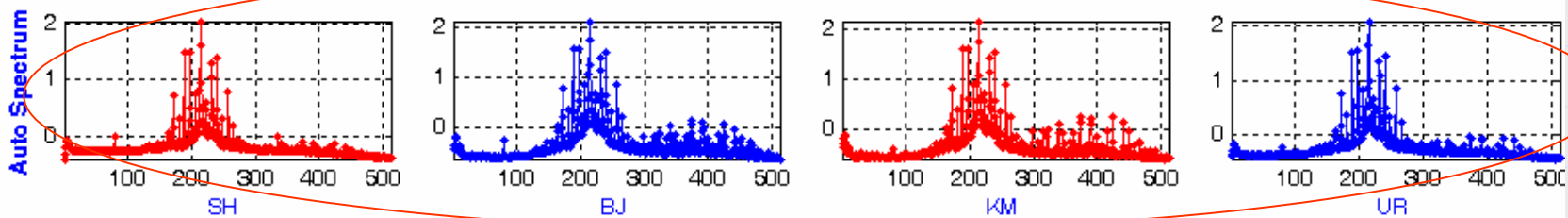




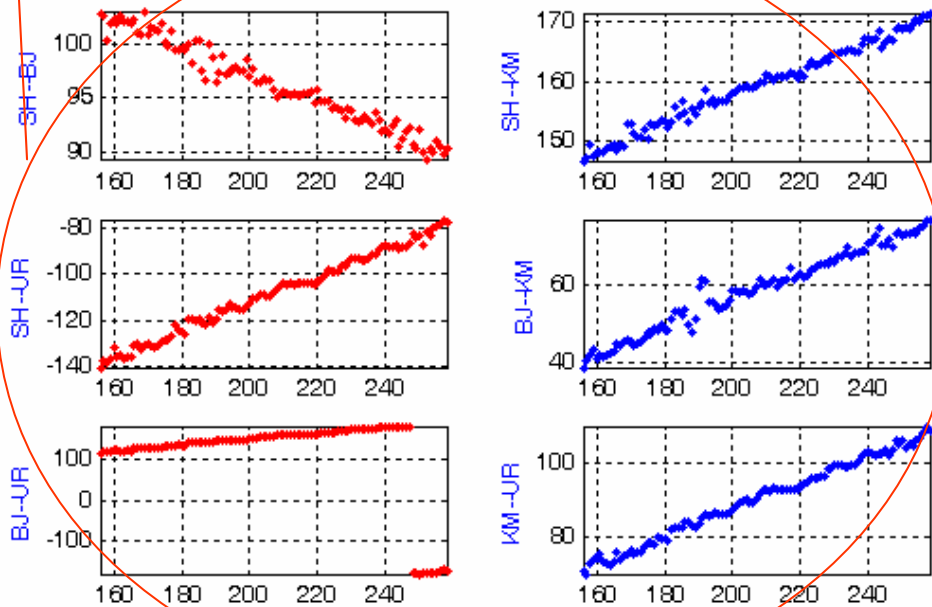
S band signal

delay

Auto spectrum



===Baseline Cross

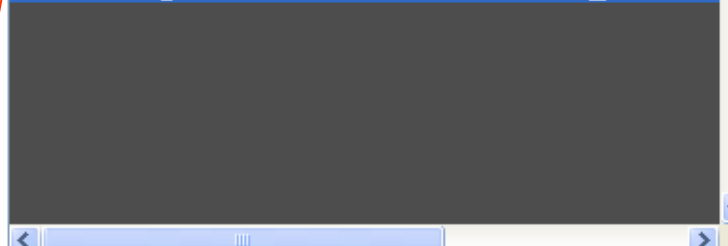


S.Interval(s)	6	NFFT Avg. to	-1
BandWidth(MHz)	2	Nfft	512
Int.Time(s)	1.048576	FFTPages	57

BBC Freq. Setup:

01#2233.69; 02#2209.99; 03#8439.01; 04#8459.01;

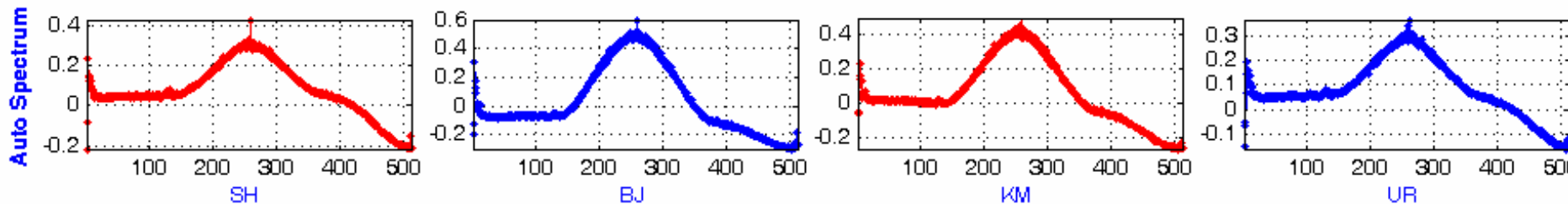
Processing FILE 203 2007310233300000\_SAT-CE



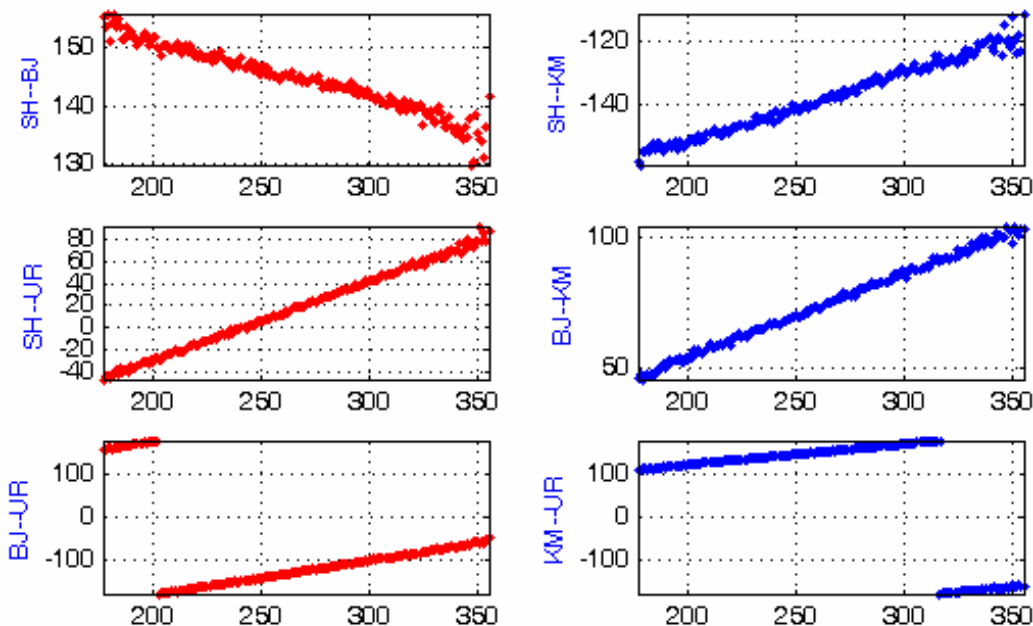




X band signal



===Baseline Cross Phase===



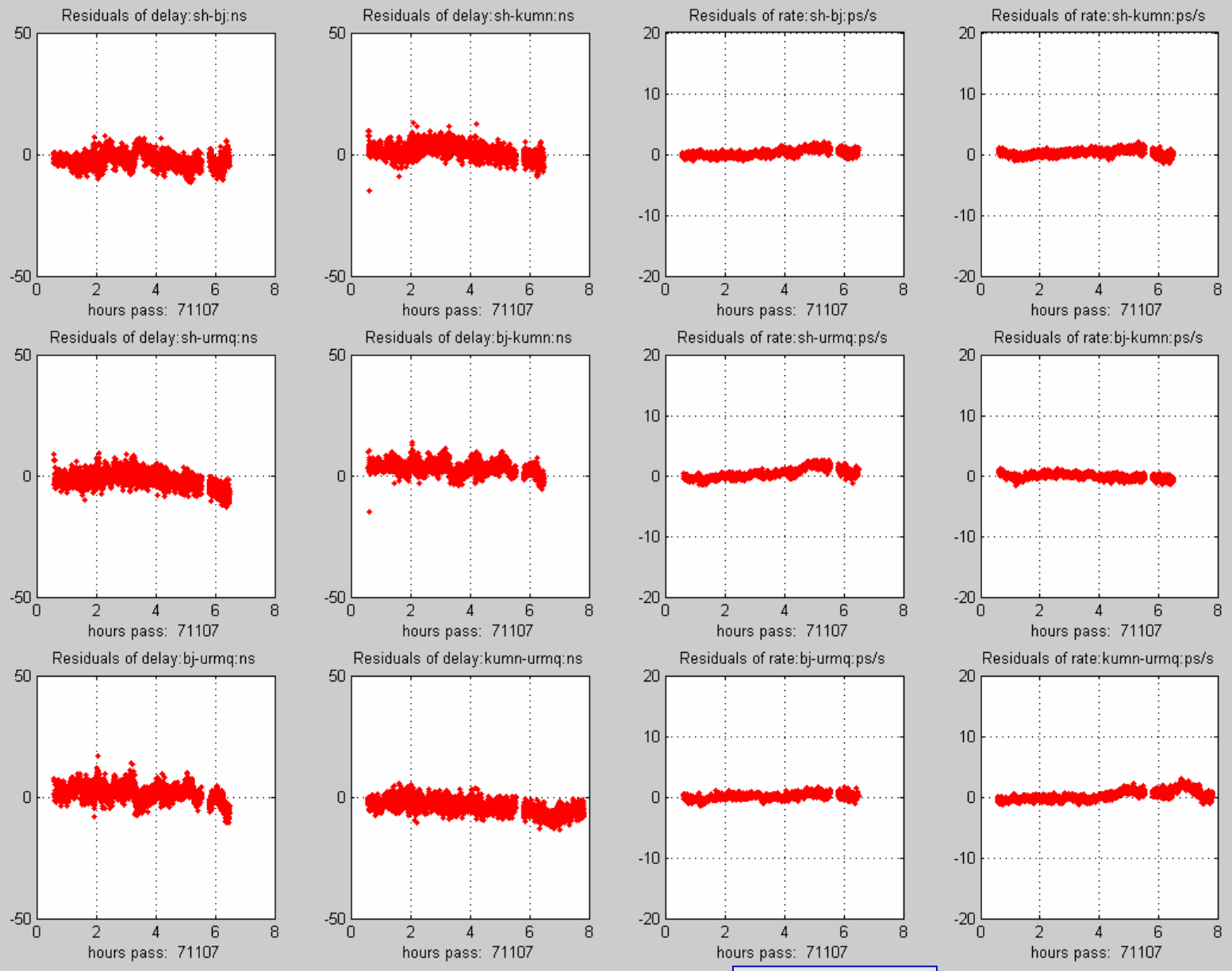
S.Interval(s)	6	NFFT Avg. to	-1
BandWidth(MHz)	2	Nfft	512
Int.Time(s)	1.048576	FFTPages	57

BBC Freq. Setup:

01#2233.69; 02#2209.99; 03#8439.01; 04#8459.01;

Processing FILE 364 200731102150000\_SAT-CE01.dat  
Warning: insufficient data points: 4 File: 364 Baseline: 1  
S-band freq is not in order

# after orbit determination



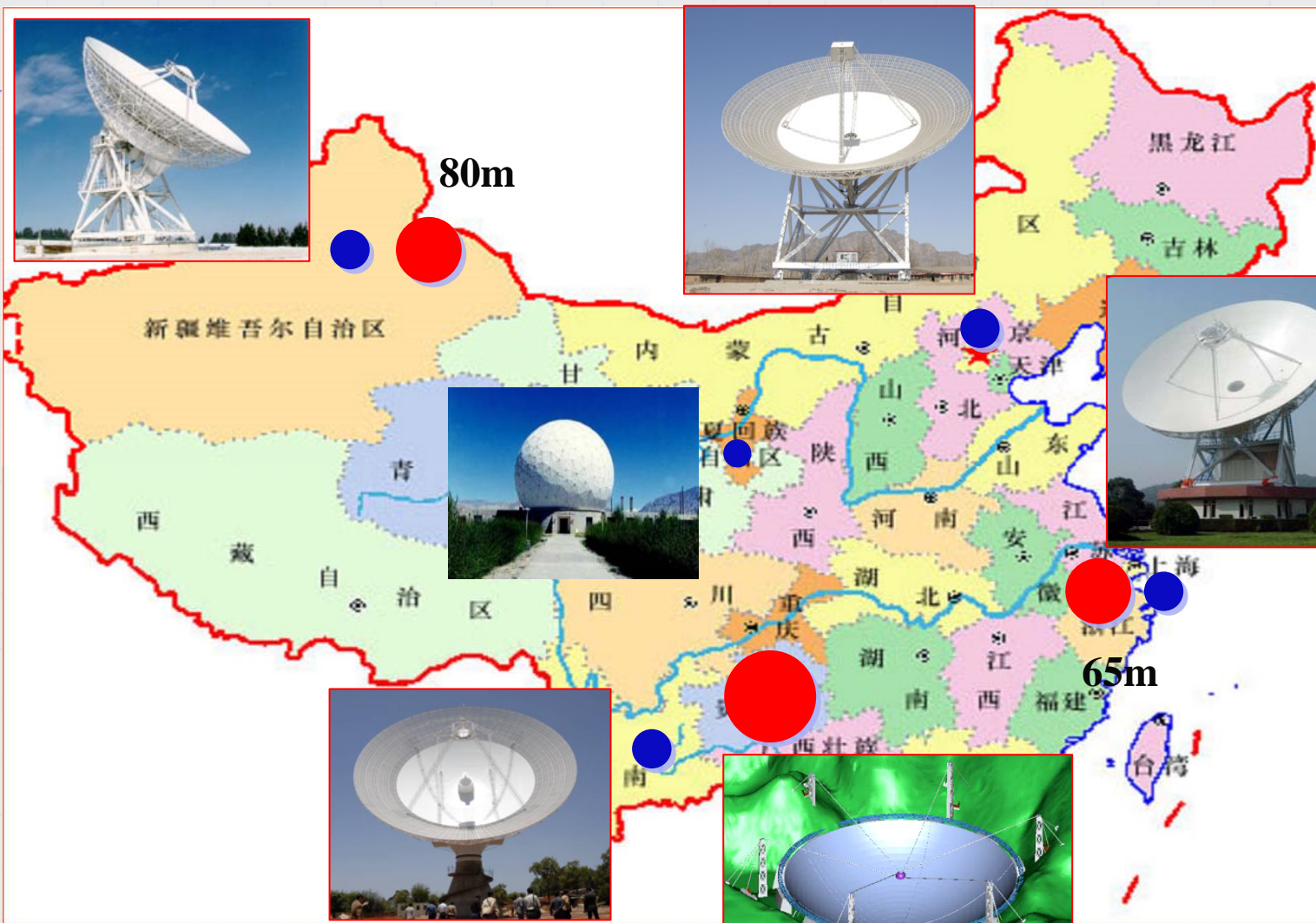
delay

rate



- ◆ CE-2 2010, orbiting
- ◆ CE-3 2013, 1014 landing
- ◆ YH-1 2010 (Mars explorer)







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**Thank you !**