



# Towards establishing a Chinese geodetic VLBI observing system

Shu, Fengchun(1); Zheng, Weiming(1); Zhang, Xiuzhong(1);  
Hong Xiaoyu(1); Yusup Aili(2); Wang Ming(3)

(1)Shanghai Astronomical Observatory

(2)Urumqi Astronomical Observatory

(3)Yunnan Astronomical Observatory

Sixth IVS General Meeting February 7-13, 2010  
Hobart, TAS, Australia



# Background

---

- A long history to develop VLBI technique in China, but no full functional geodetic VLBI observing system
  
- It become practical just in recent years
  - technique and human resource from Chang'E-1 project
  - Budget from CMONC project
  
- Towards an operational geodetic VLBI observing system
  - Full functional system
  - Full compatible with international VLBI community
  - Operational in stand-alone mode with independent network based on CVN
  - Routine service with product quality data, to meet the requirements of geodetic and astrometric research



# Chinese VLBI Network (CVN) for CE-1 project





## CMONC project

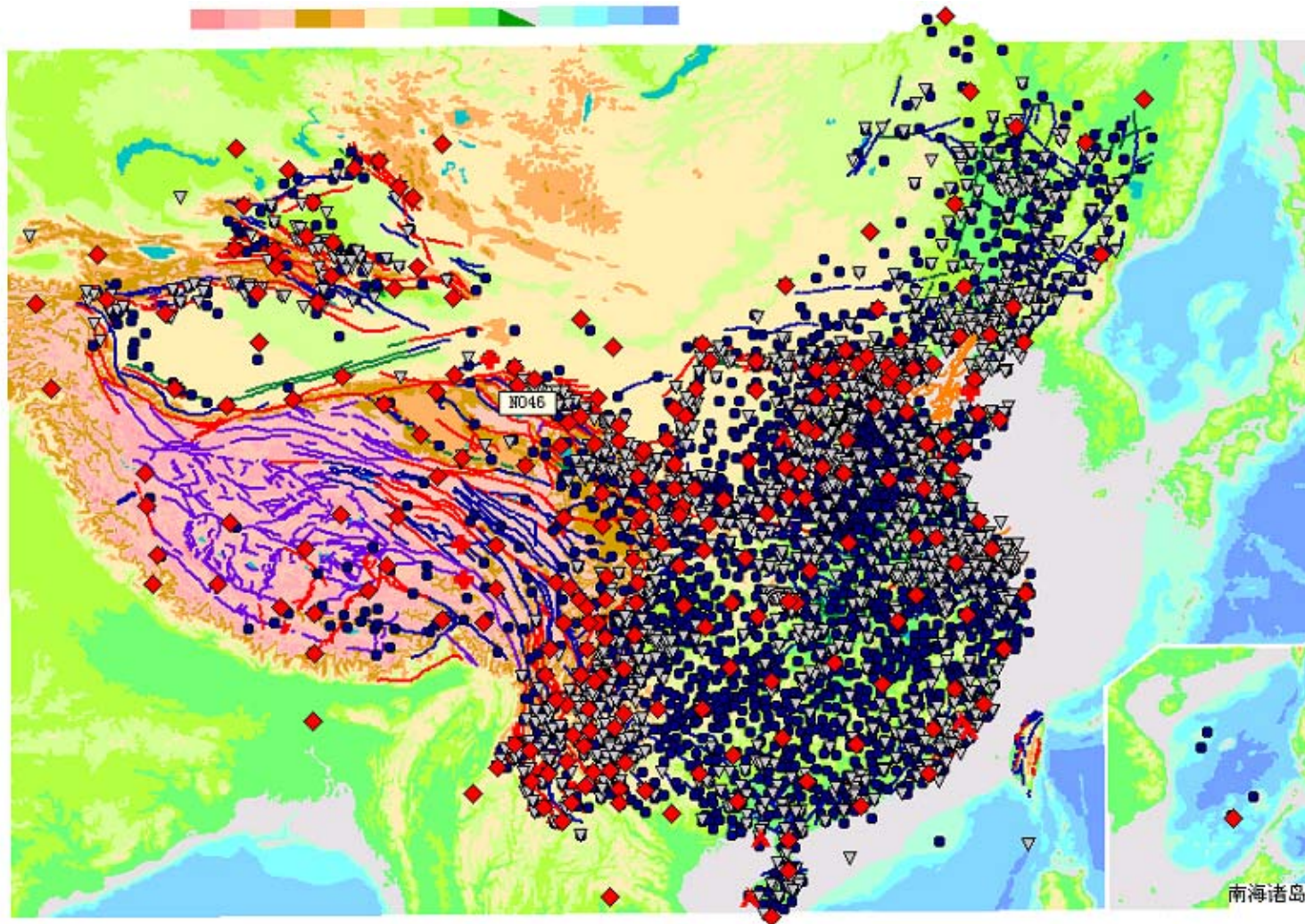
---

- the National Key Scientific Infrastructure Project: Crustal Movement Observation Network of China (CMONC)
  - Fiducial network:
    - 260 permanent GPS stations
    - 6 SLR stations + 1 mobile SLR station
    - 3 VLBI stations + 1 correlator center
    - >100 Gravimeter, leveling
  - Regional network:
    - 1000 GPS sites available
    - 1000 new sites
  - Data system
    - 1 data center + 5 shared subsystem





# CMONC: fiducial network stations



◆ Fiducial ▽ Earthquake ■ Weather





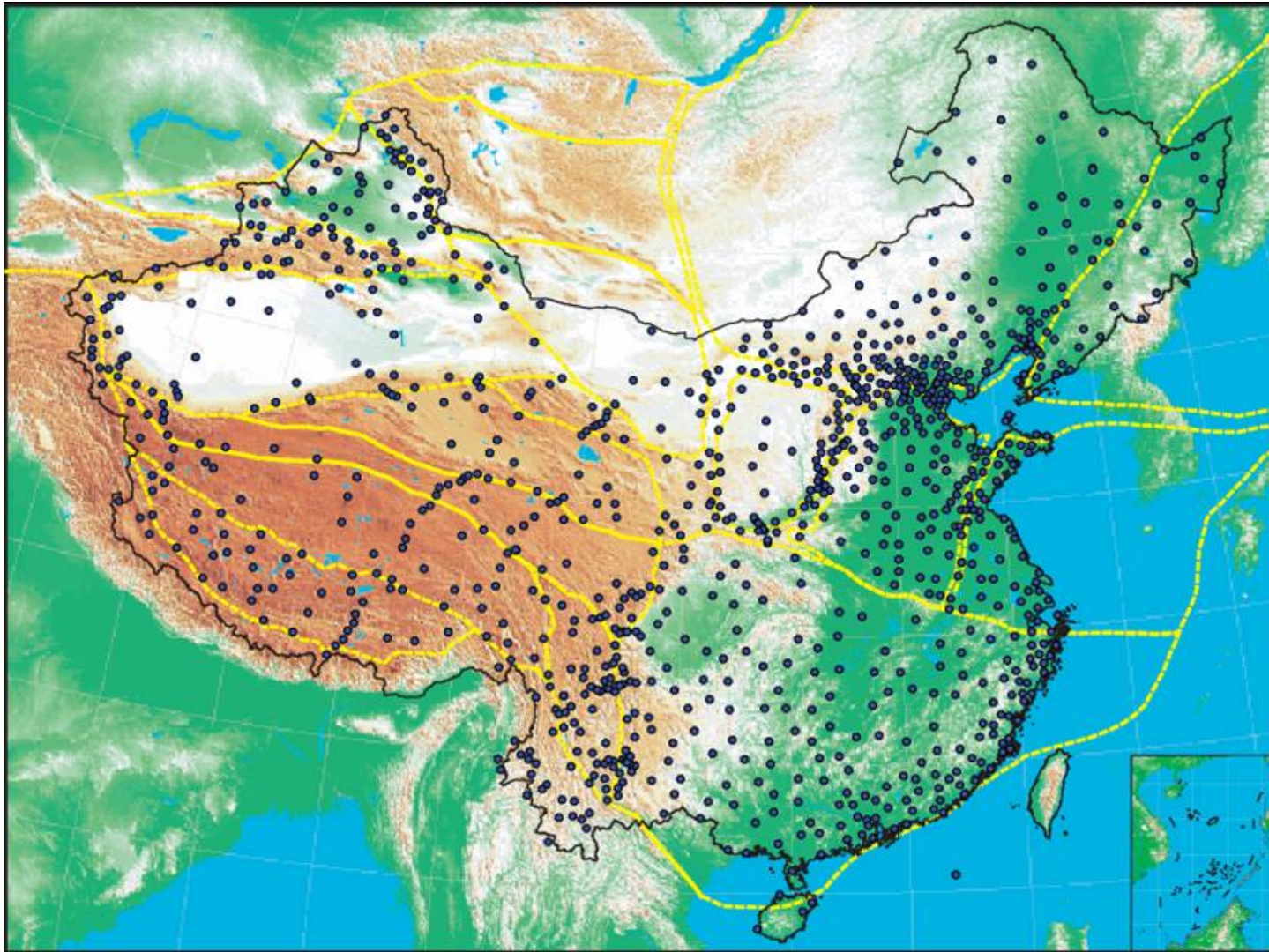
中国科学院  
CHINESE ACADEMY OF SCIENCES

上海天文台

Shanghai Astronomical Observatory

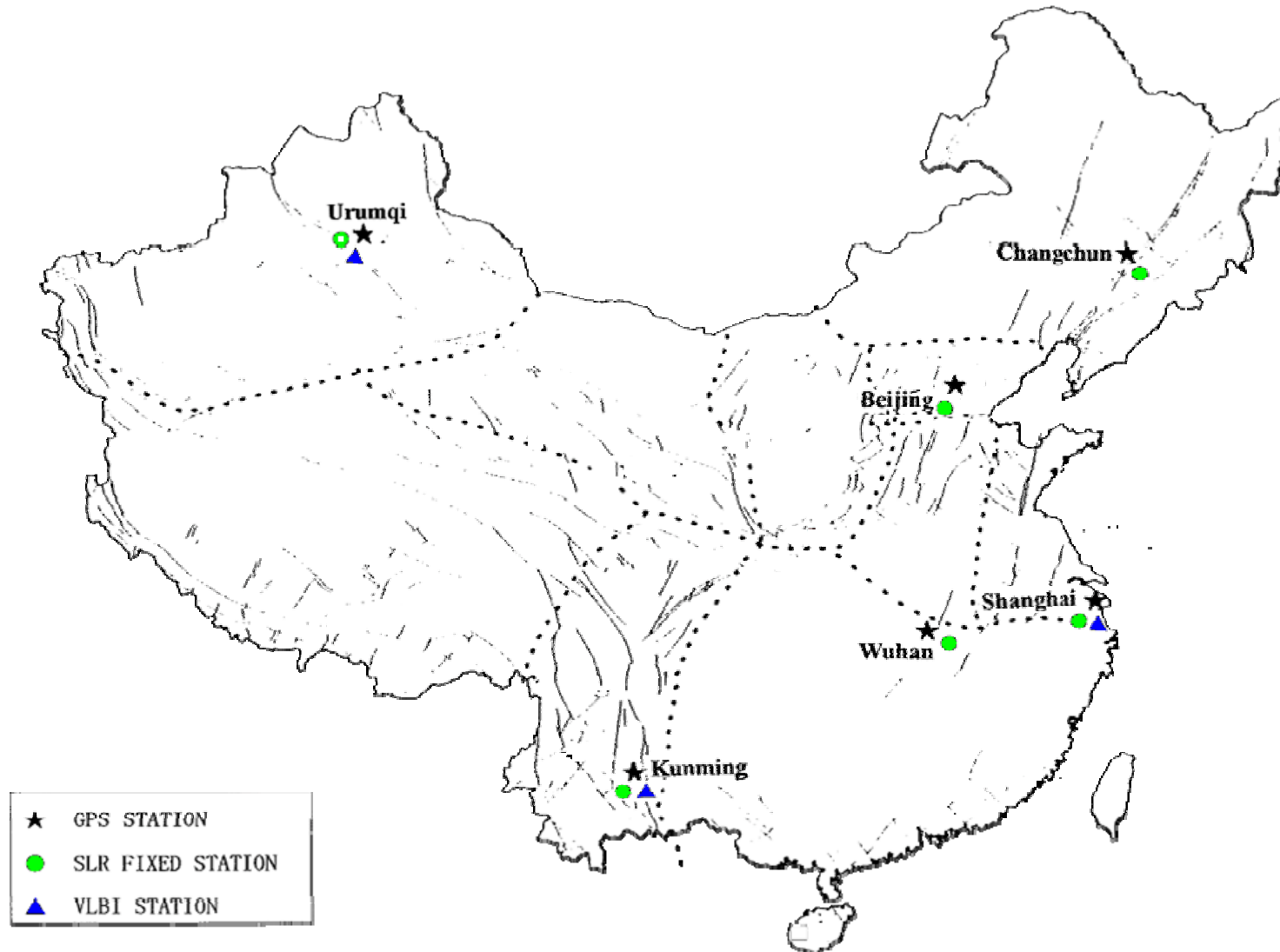


# CMONC: regional network stations





# CMONC: VLBI and SLR stations





# Chinese geodetic VLBI observing system

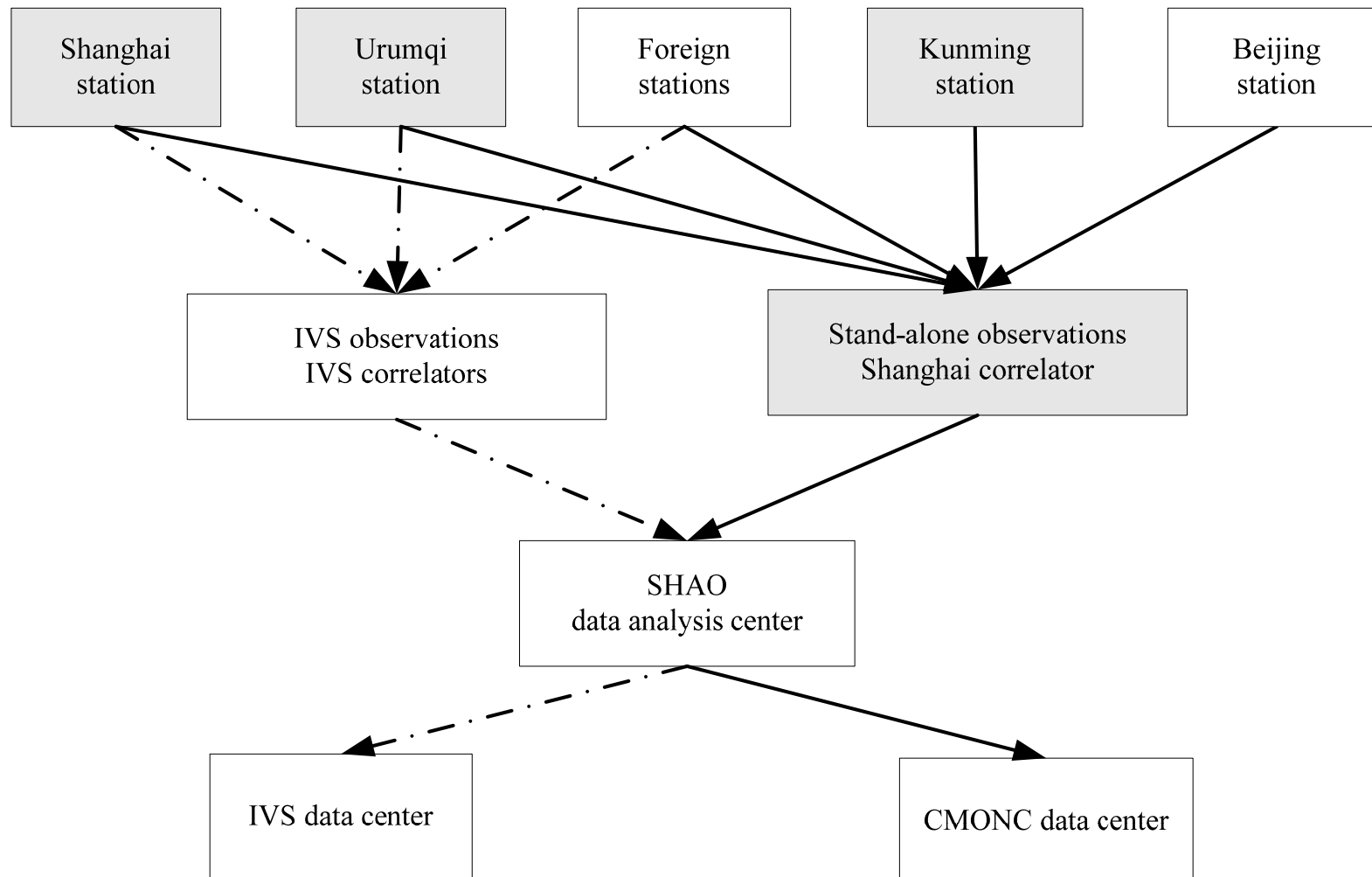
---

- Upgrade plan under the framework of CMONC
  - proposed in 2006
  - approved in 2007
  - under development in 2008~2010
- Shanghai VLBI station
  - Co-located with GPS+SLR
- Urumqi VLBI station
  - Co-located with GPS+ a few mobile SLR observations
  - A new SLR station with 1-meter telescope and kHz laser ranging system to be proposed
- Kunming VLBI station
  - Co-located with GPS+SLR
- Shanghai correlation system
  - Supporting domestic geodetic/astrometric VLBI observation
  - Expanding to astronomical application





# Chinese geodetic VLBI observing system





# Upgrade outline

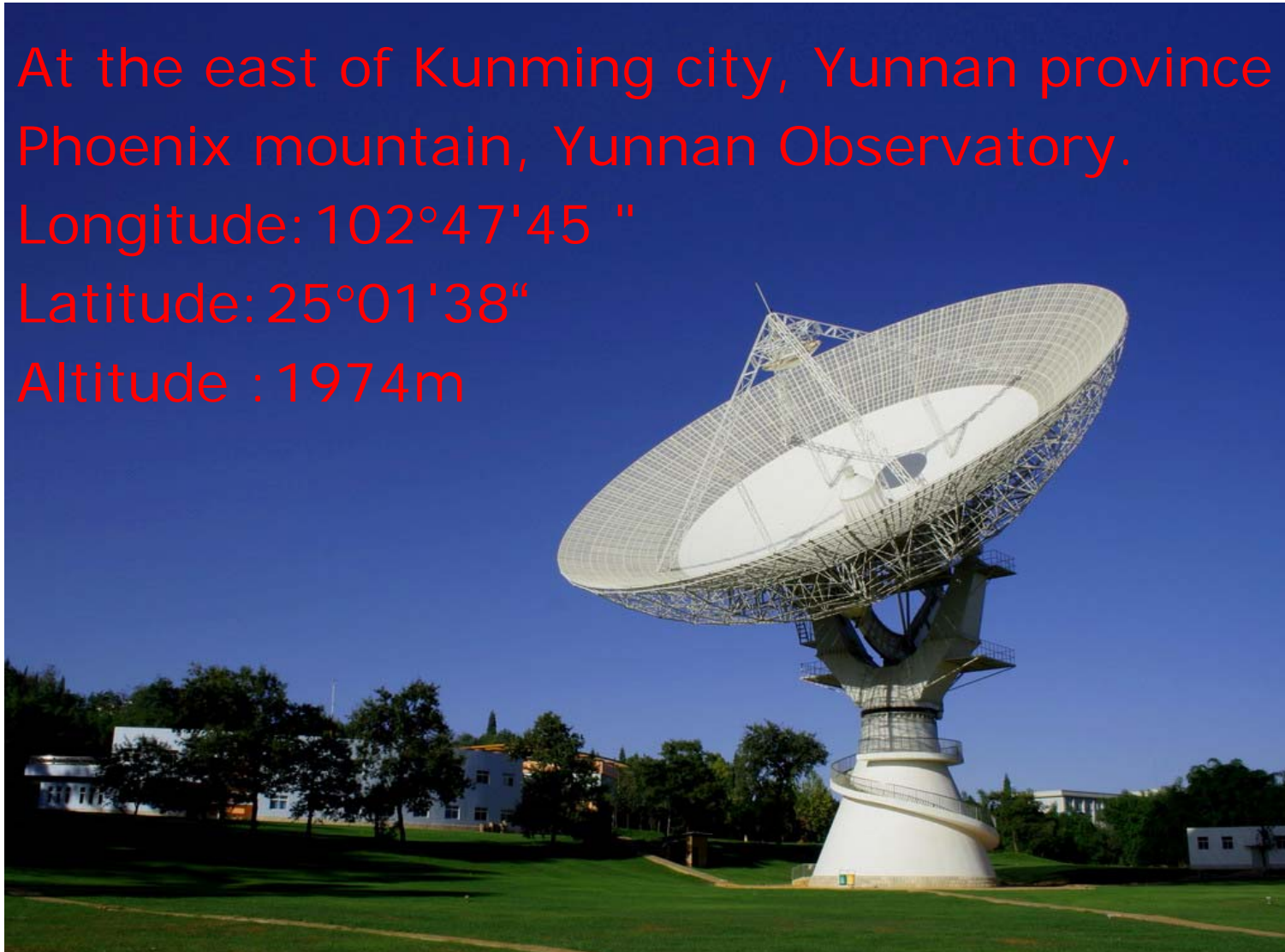
---

- Shanghai VLBI station
  - VLBI Standard Interface + MK5B recording system
  - Replace an old hydrogen maser
- Urumqi VLBI station
  - VLBI Standard Interface + MK5B recording system
  - Replaced with a new wide X-band feed (8.2~9.0GHz)
- Kunming VLBI station
  - VLBI Standard Interface + MK5B recording system
  - Station control system: international VLBI compliance
  - Adding an new hydrogen maser
- Shanghai correlation system
  - Correlation software upgraded from CE-1 project
  - A new standalone hardware platform



# Location of Kunming station

- At the east of Kunming city, Yunnan province
- Phoenix mountain, Yunnan Observatory.
- Longitude:  $102^{\circ}47'45''$
- Latitude:  $25^{\circ}01'38''$
- Altitude : 1974m





## Antenna performance for Kunming station

Items	Specifications
Prime dish Diameter	40m
Mounting	Azimuth-Zenith
Surface(<26m)	Solid aluminum panel
Surface(26-40m)	Stainless steel welded wire mesh
Surface r.m.s (<26m)	<0.259mm
Surface r.m.s (26-40m)	<3mm
Pointing accuracy	<30''
Slew rate (Zenith)	0.55 <sup>0</sup> /s
Slew rate (Azimuth)	0.96 <sup>0</sup> /s
Optics	Cassegrain focus , f/D=0.35





# VLBI activities at Kunming station

---

- Domestic VLBI observations
  - Satellite tracking experiments
  - DBBC fringe tests
  - A few astronomical test observations
  - Regular geodetic observations from 2011 onward
- EVN observations
  - MK4 terminal sent from Westerbork, plan to order VSI-H card for MK5B recording
  - Most likely to join in this year, but only S/X available
- IVS observations
  - Be willing to join in
  - No technical problems



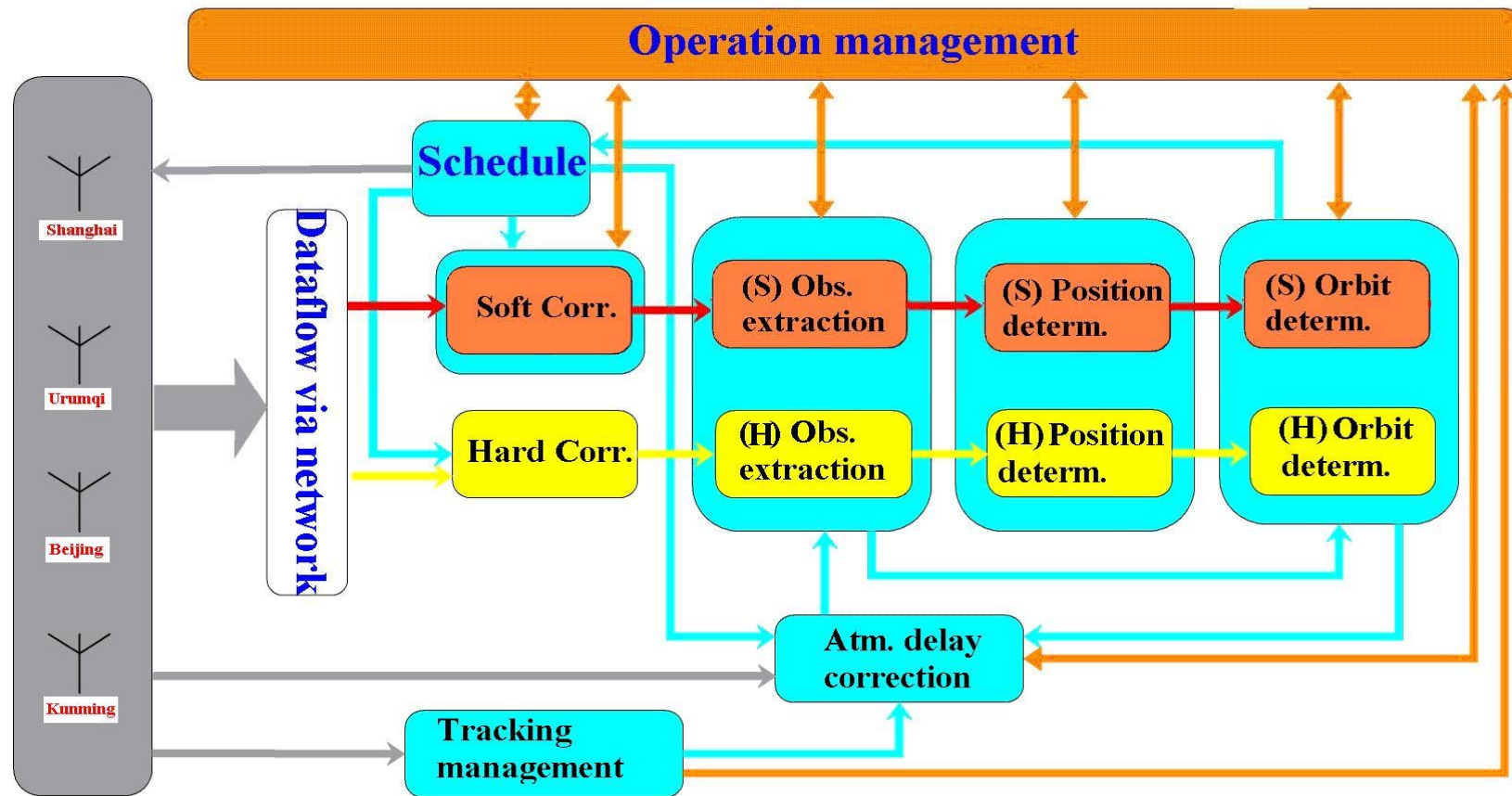
# Chang'E-1 project correlation system

---

- Currently available correlators
  - Specially designed for the tracking of Chang'E 1 lunar satellite
  - Operational since May of 2006, as part of VLBI tracking system
  
- Main limitations
  - only VEX schedule supported: subarray/scan length
  - 1 minute continuous correlation output: long integration
  - $\Delta$  VLBI observable output: compatibility



# Data processing of the VLBI tracking system





# Shanghai correlation system upgrade

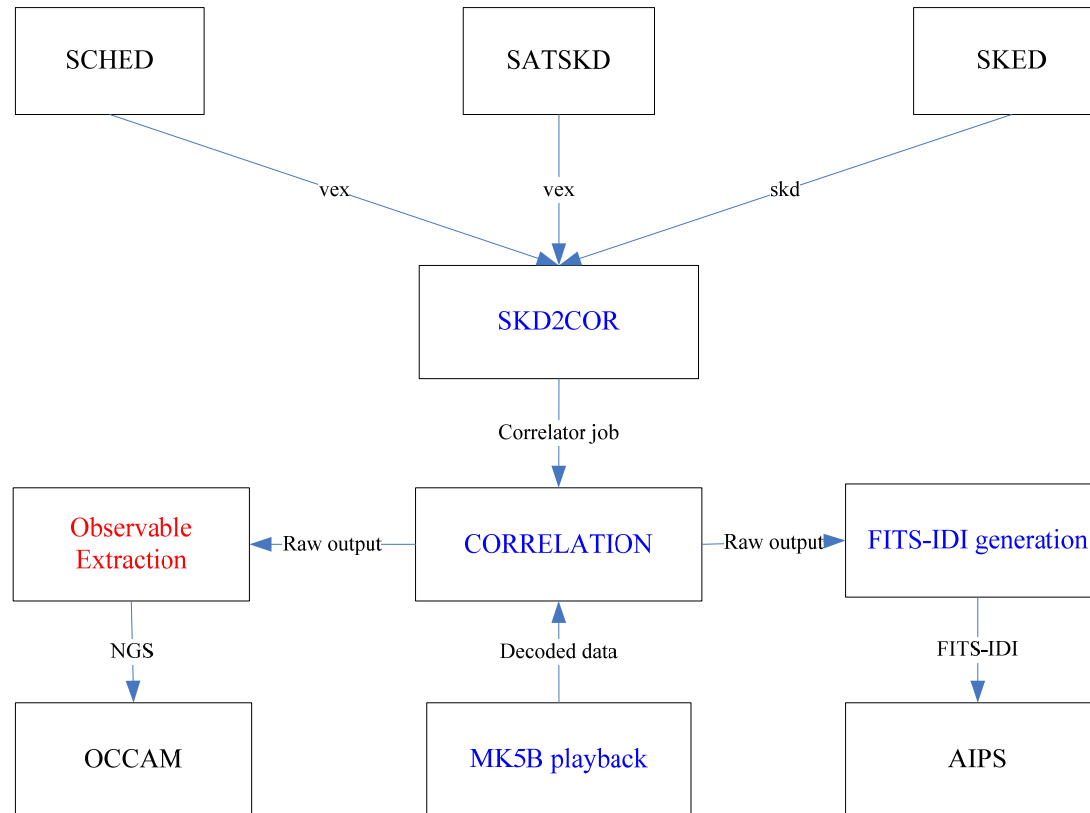
---

- correlator control system
  - SKED/SCHED/SATSKD interface
  - Scan-based processing
  - FITS-IDI file generation
- observable extraction
  - A new software like fourfit, KOMB
  - Basic function: flag, fringe fit, phase calibration, bandwidth synthesis
  - Graphic display, data quality statistic
  - NGS format output
- MK5B playback capability
  - 4 Chinese VLBI stations will soon adopt MK5B system
- Web based Database
  - Data management/search/download
  - LAMP (Linux+Apache+MySQL+PHP)





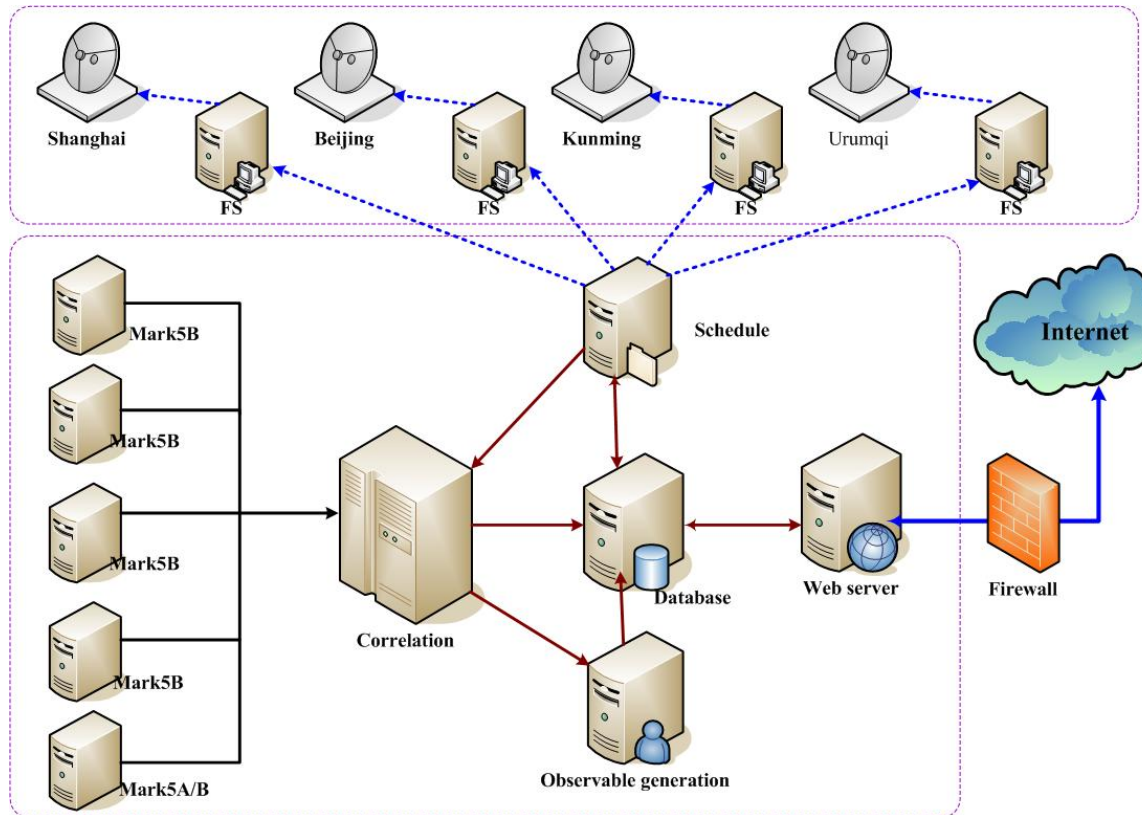
# Software architecture





# Correlation system hardware

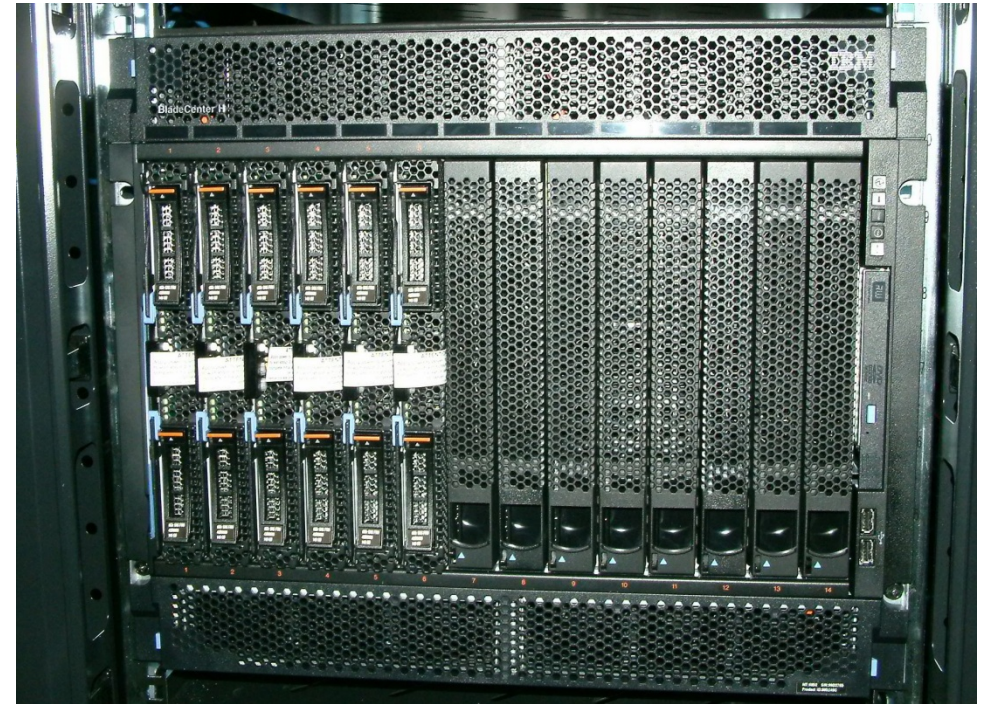
- 5 MK5B units and 30 disc modules have been ordered
- Correlation server under installation and test





# Platform for correlation

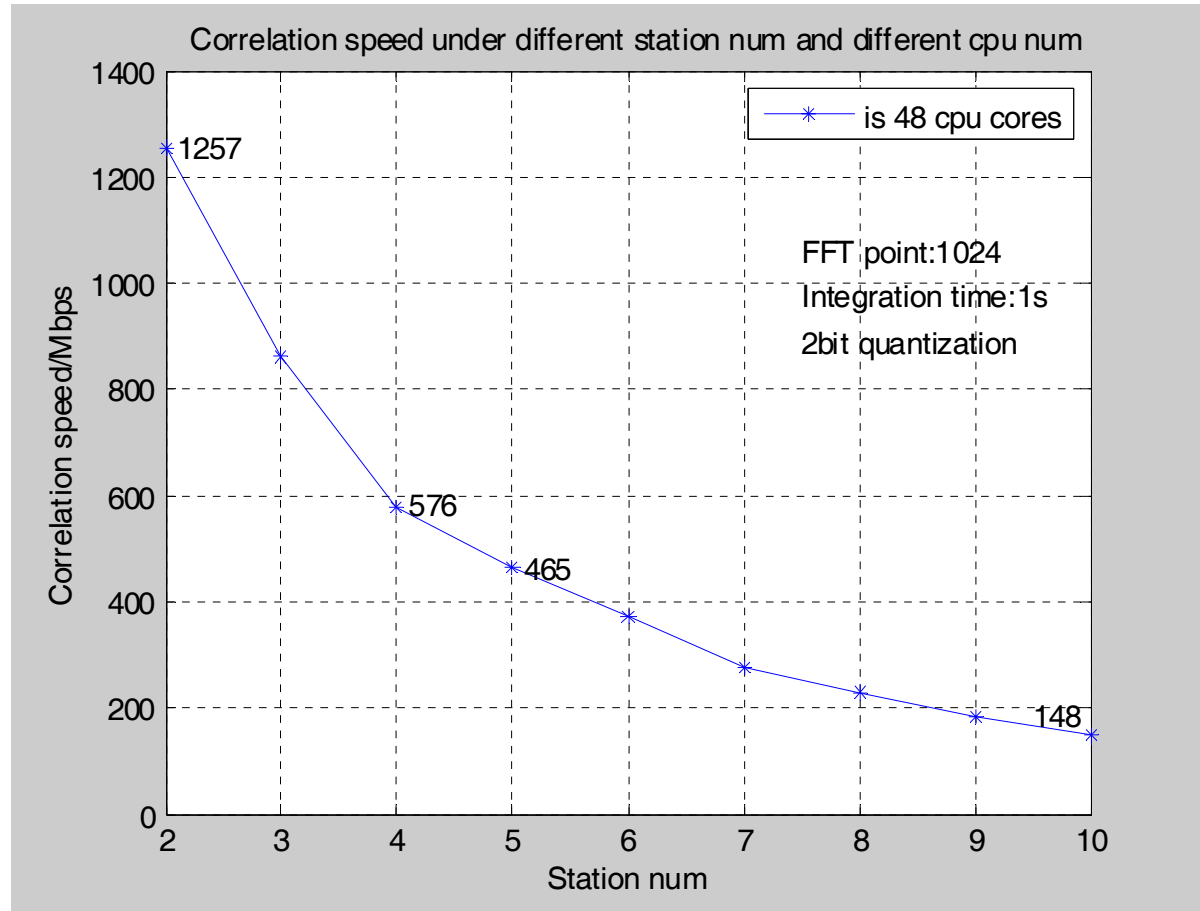
- Blade Cluster
  - 6 x Blade Server
  - Blade Configuration:  
2xIntel Xeon 5570  
(2.93G),
  - 12G DDR3 Memory,
  - 10GbE NIC with TOE  
&& RDMA
  
- Storage
  - 2x10TB Raid, 10GbE  
NIC





# Expected performance of the correlator

- 3 stations:
  - ~800Mbps
- 5 stations:
  - ~400Mbps
- 10 stations:
  - ~140Mbps





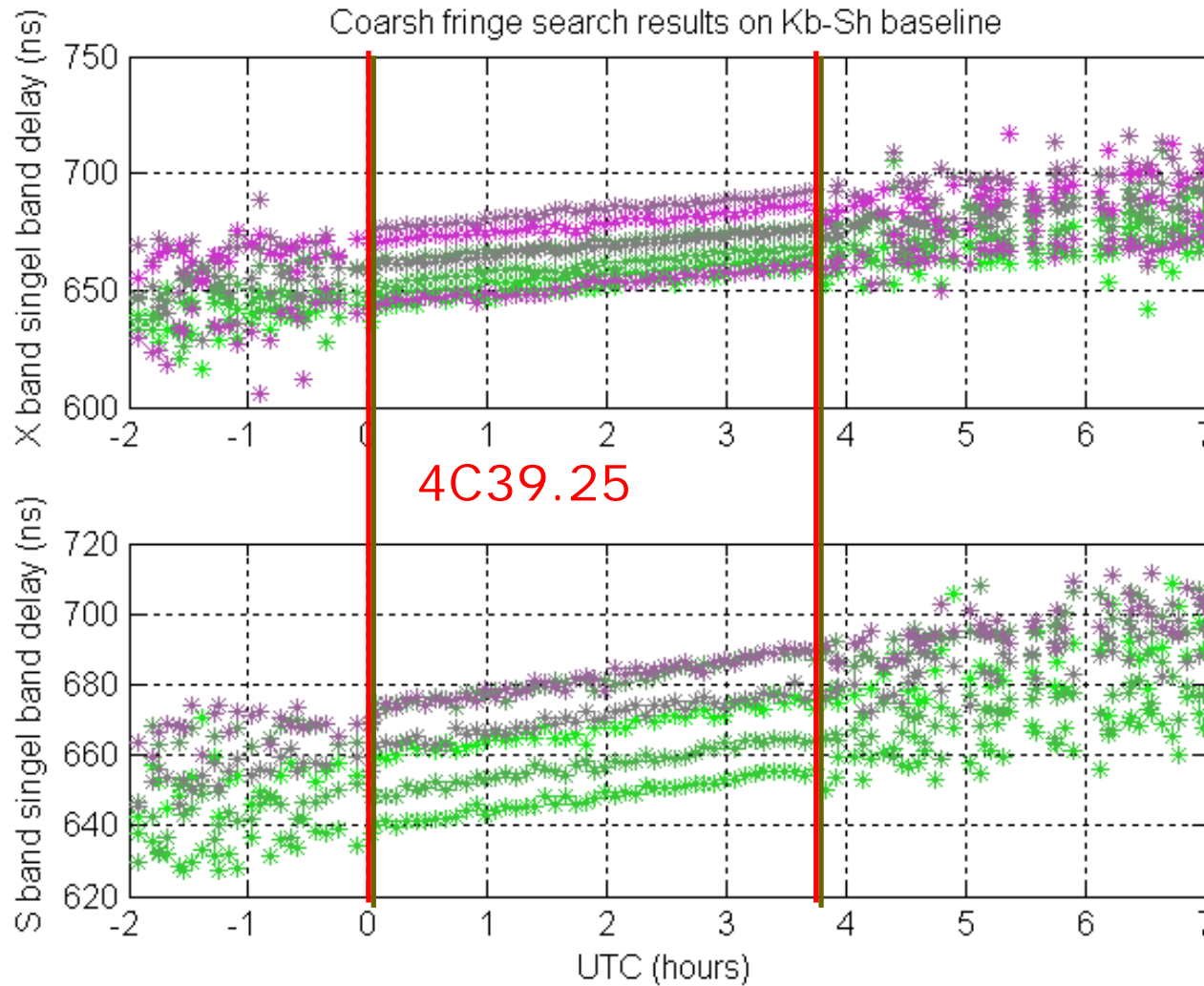


# Geodetic test observation (1)

- Kb-Sh-Ur
  - Jul.22, 2009
  - MKIV.16ch1bit1:2
  - F CDP-SX SX KASHIM34 SESHAN25 URUMQI
- |   |    |   |         |         |    |         |      |         |
|---|----|---|---------|---------|----|---------|------|---------|
| C | SX | X | 8210.99 | 10000.0 | 1  | Mk341:2 | 4.00 | 1(-1,3) |
| C | SX | X | 8220.99 | 10000.0 | 2  | Mk341:2 | 4.00 | 1(7)    |
| C | SX | X | 8250.99 | 10000.0 | 3  | Mk341:2 | 4.00 | 1(11)   |
| C | SX | X | 8310.99 | 10000.0 | 4  | Mk341:2 | 4.00 | 1(15)   |
| C | SX | X | 8420.99 | 10000.0 | 5  | Mk341:2 | 4.00 | 1(19)   |
| C | SX | X | 8500.99 | 10000.0 | 6  | Mk341:2 | 4.00 | 1(23)   |
| C | SX | X | 8550.99 | 10000.0 | 7  | Mk341:2 | 4.00 | 1(27)   |
| C | SX | X | 8570.99 | 10000.0 | 8  | Mk341:2 | 4.00 | 1(0,4)  |
| C | SX | S | 2217.99 | 10000.0 | 9  | Mk341:2 | 4.00 | 1(8)    |
| C | SX | S | 2222.99 | 10000.0 | 10 | Mk341:2 | 4.00 | 1(12)   |
| C | SX | S | 2237.99 | 10000.0 | 11 | Mk341:2 | 4.00 | 1(16)   |
| C | SX | S | 2267.99 | 10000.0 | 12 | Mk341:2 | 4.00 | 1(20)   |
| C | SX | S | 2292.99 | 10000.0 | 13 | Mk341:2 | 4.00 | 1(24)   |
| C | SX | S | 2302.99 | 10000.0 | 14 | Mk341:2 | 4.00 | 1(28)   |
| R | SX |   | 8.000   |         |    |         |      |         |

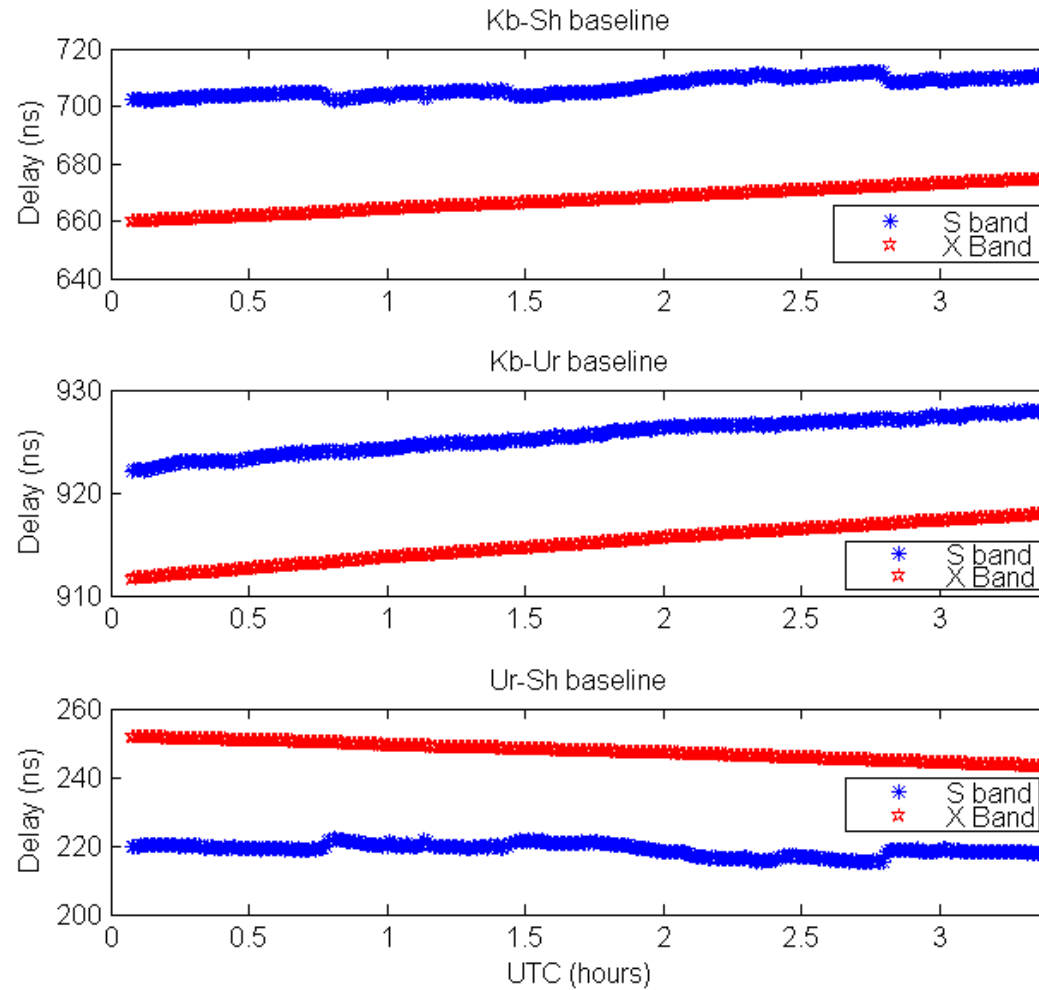


# S/X single-band delay



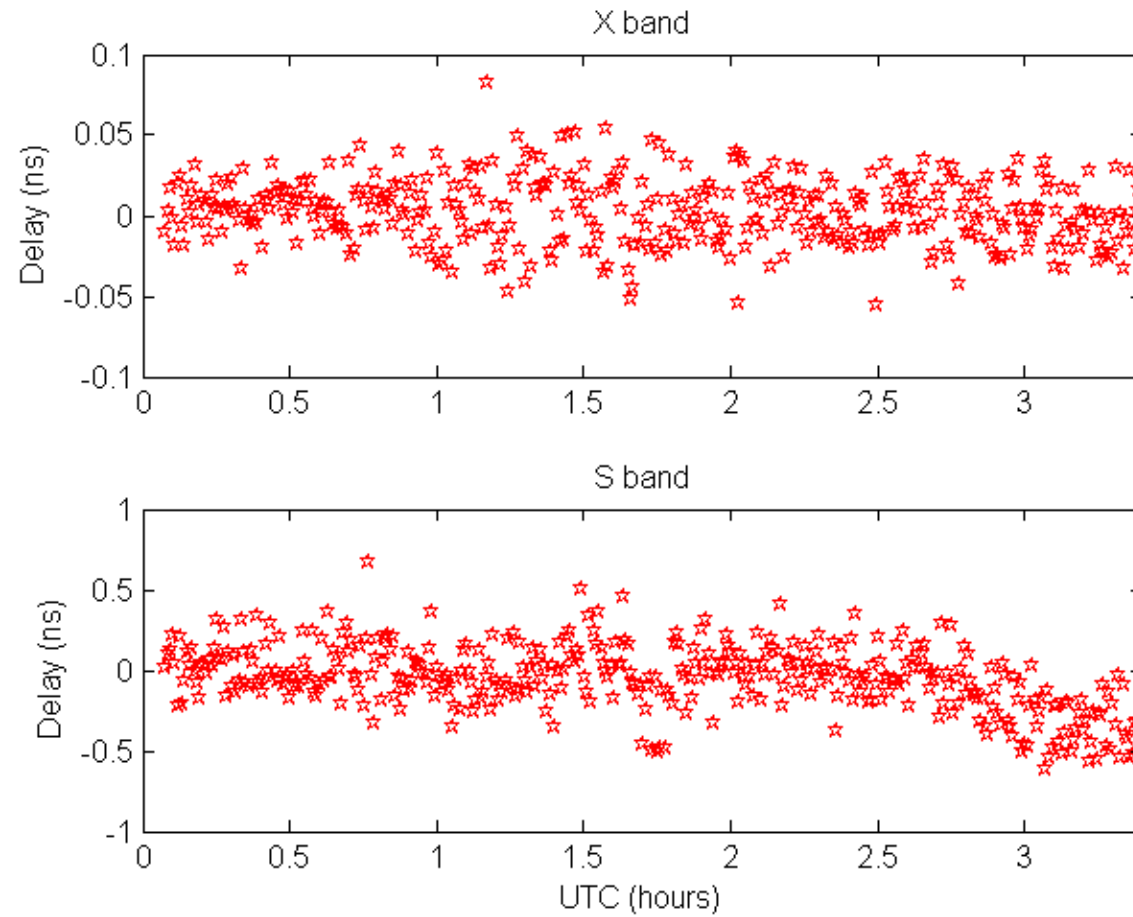


## Bandwidth synthesis delay for 3 baselines





# Kb-Sh-Ur closure delay





# Geodetic test observation (2)

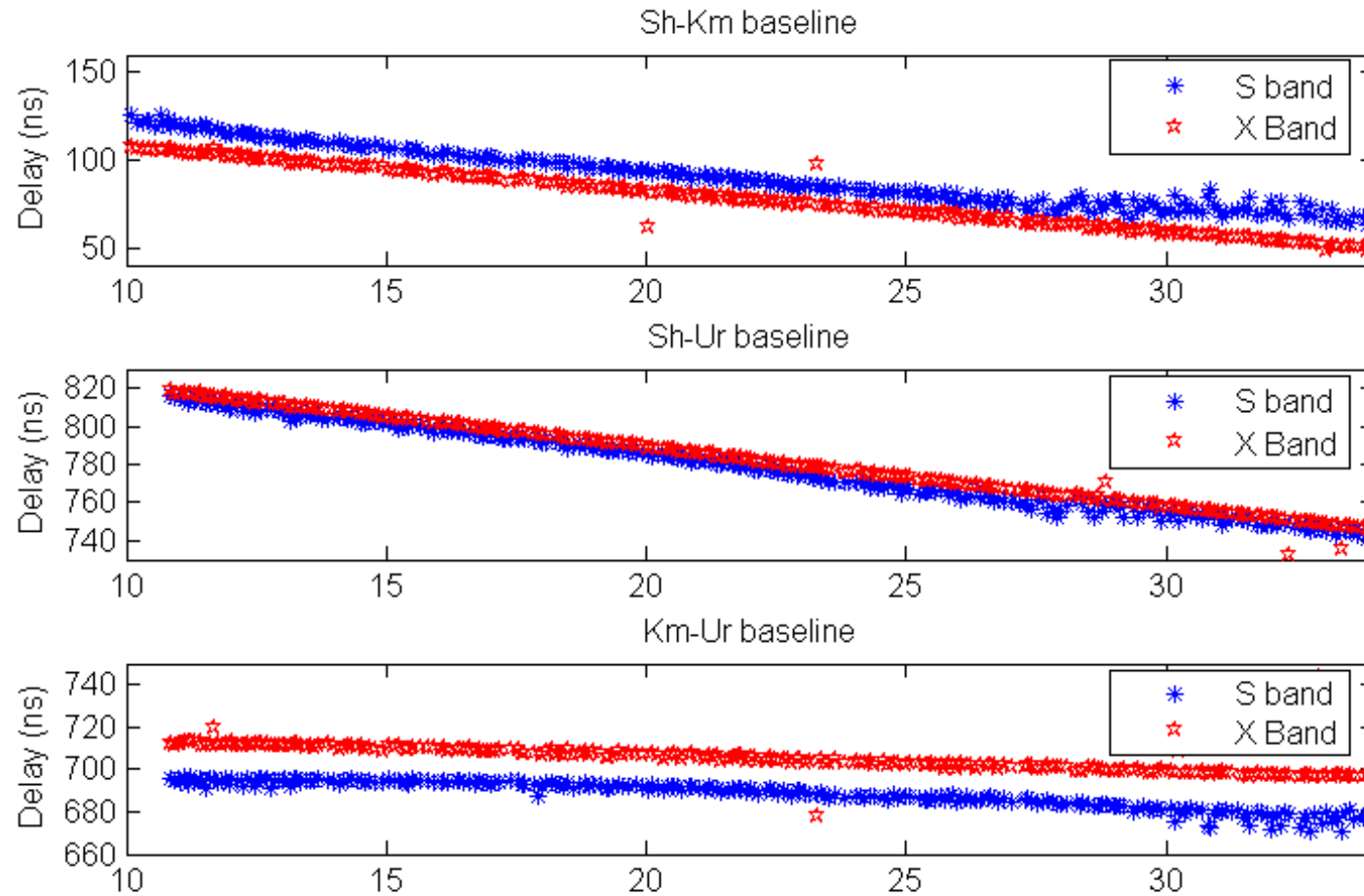
- Sh-Km-Ur
- Dec.23, 2009
- About 70 radio sources observed
- F CVN-SX SX SESHAN25

C	SX	X	8219.01	10000.0	1	VLBA1:4	8.00	1(,-1)
C	SX	X	8309.01	10000.0	2	VLBA1:4	8.00	1(,7)
C	SX	X	8539.01	10000.0	3	VLBA1:4	8.00	1(,15)
C	SX	X	8569.01	10000.0	4	VLBA1:4	8.00	1(,23)
C	SX	S	2220.99	10000.0	9	VLBA1:4	8.00	1(0)
C	SX	S	2230.99	10000.0	11	VLBA1:4	8.00	1(8)
C	SX	S	2310.99	10000.0	12	VLBA1:4	8.00	1(16)
C	SX	S	2340.99	10000.0	13	VLBA1:4	8.00	1(24)



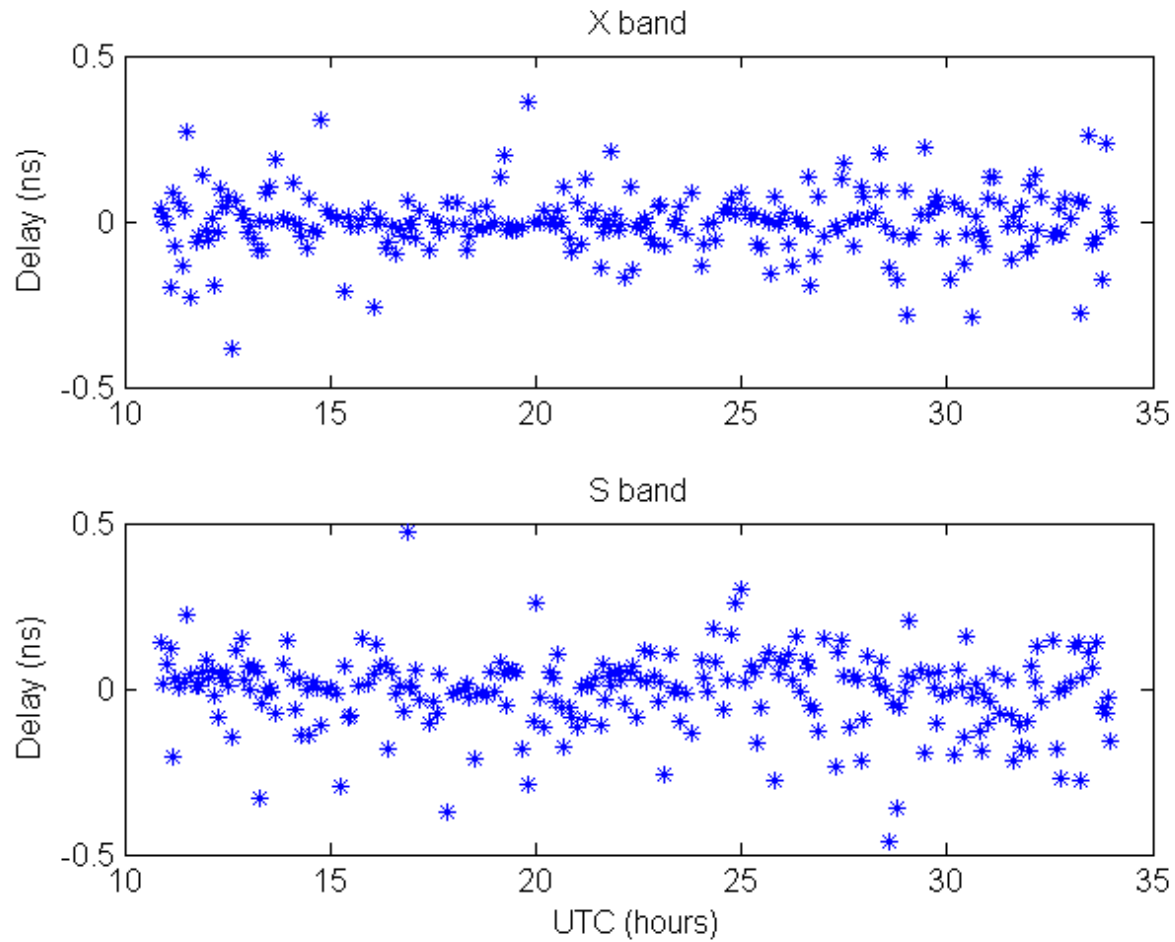


# Bandwidth synthesis delay for 3 baselines





# Sh-Km-Ur closure delay





## Summary

---

- Recent progress towards establishing an operational geodetic VLBI observing system in China are described.
- The upgrade plan for the stations is almost completed, but there are still a part of software work for the correlation system.
- A few experiments has been conducted to debug the system and the results are encouraging.



## Outlook

---

- ❑ The system will be completed this year and put into operation for the geodetic and astrometric application.
- ❑ As the newly developed components, Kunming station and Shanghai correlator will make contributions to international VLBI community.



中国科学院  
CHINESE ACADEMY OF SCIENCES

上海天文台  
Shanghai Astronomical Observatory



---

Thank you!