



Shanghai correlation system upgrade for geodetic application

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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
 - >100 Gravity, leveling
 - Regional network:
 - 1000 GPS sites available
 - 1000 new sites
- Similar project: PBO (USA) – GEONET (Japan)



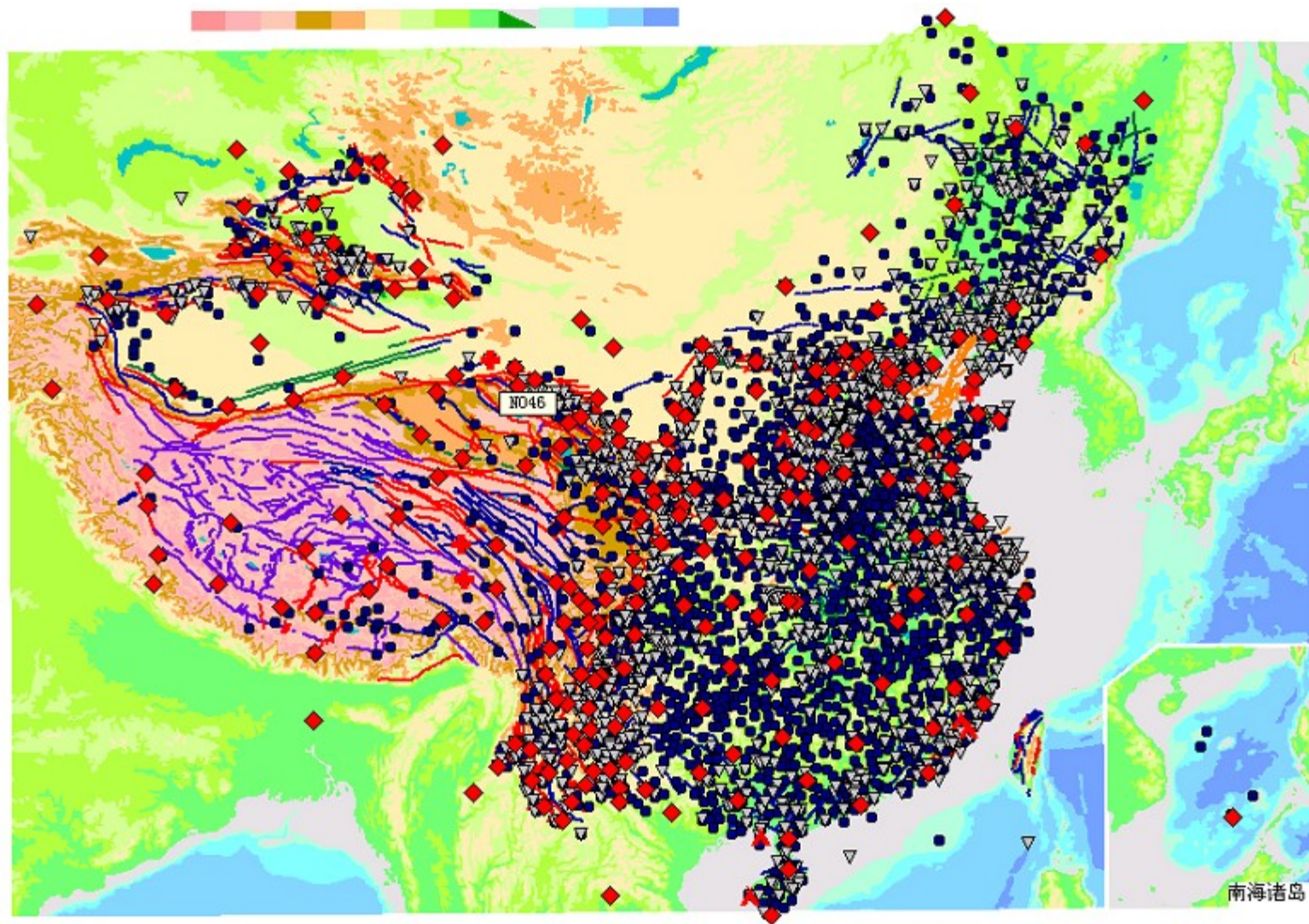
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CMONC: fiducial network stations



◆ Fiducial ▽ Earthquake ■ Weather



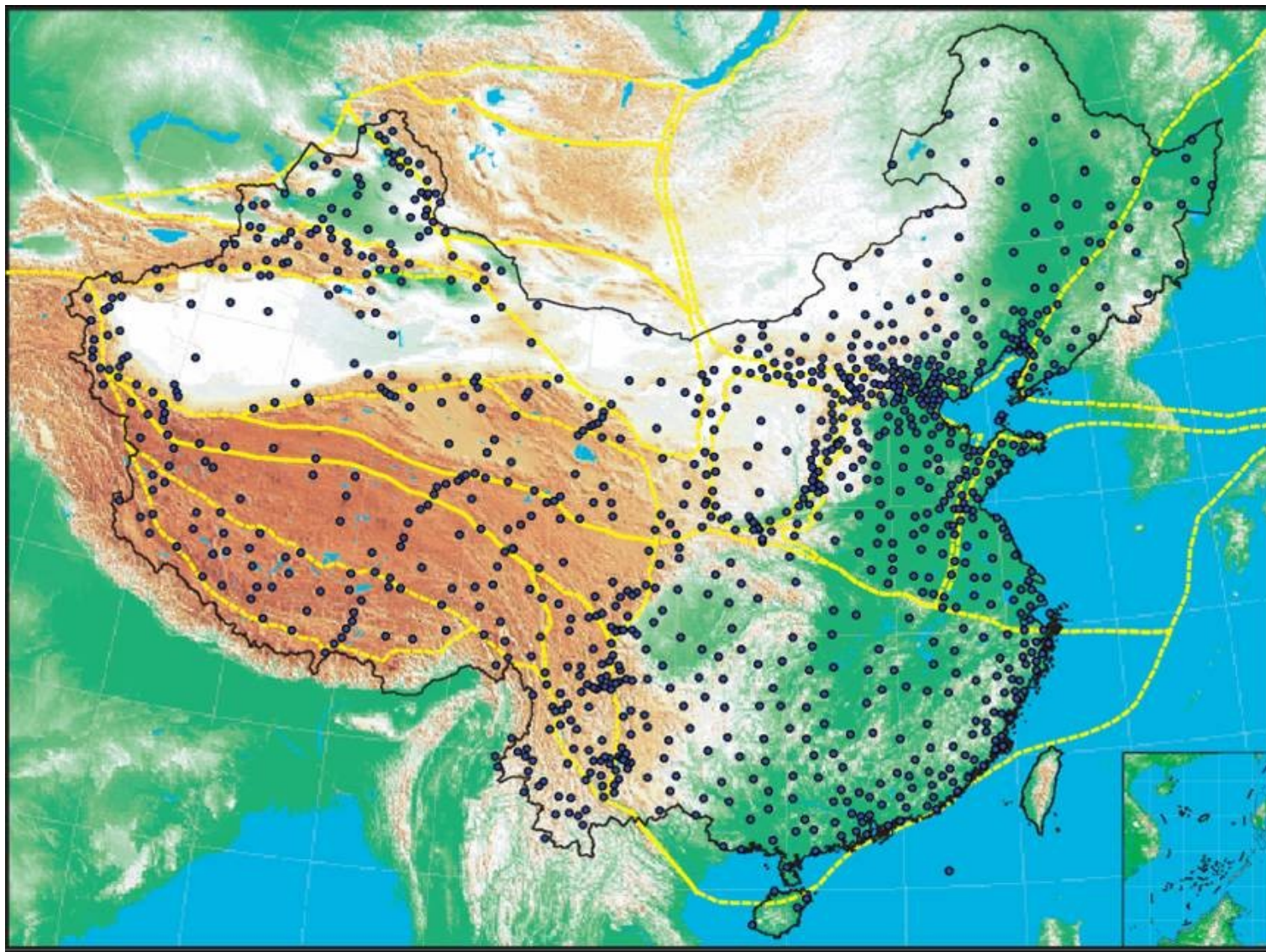
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CMONC: regional network stations



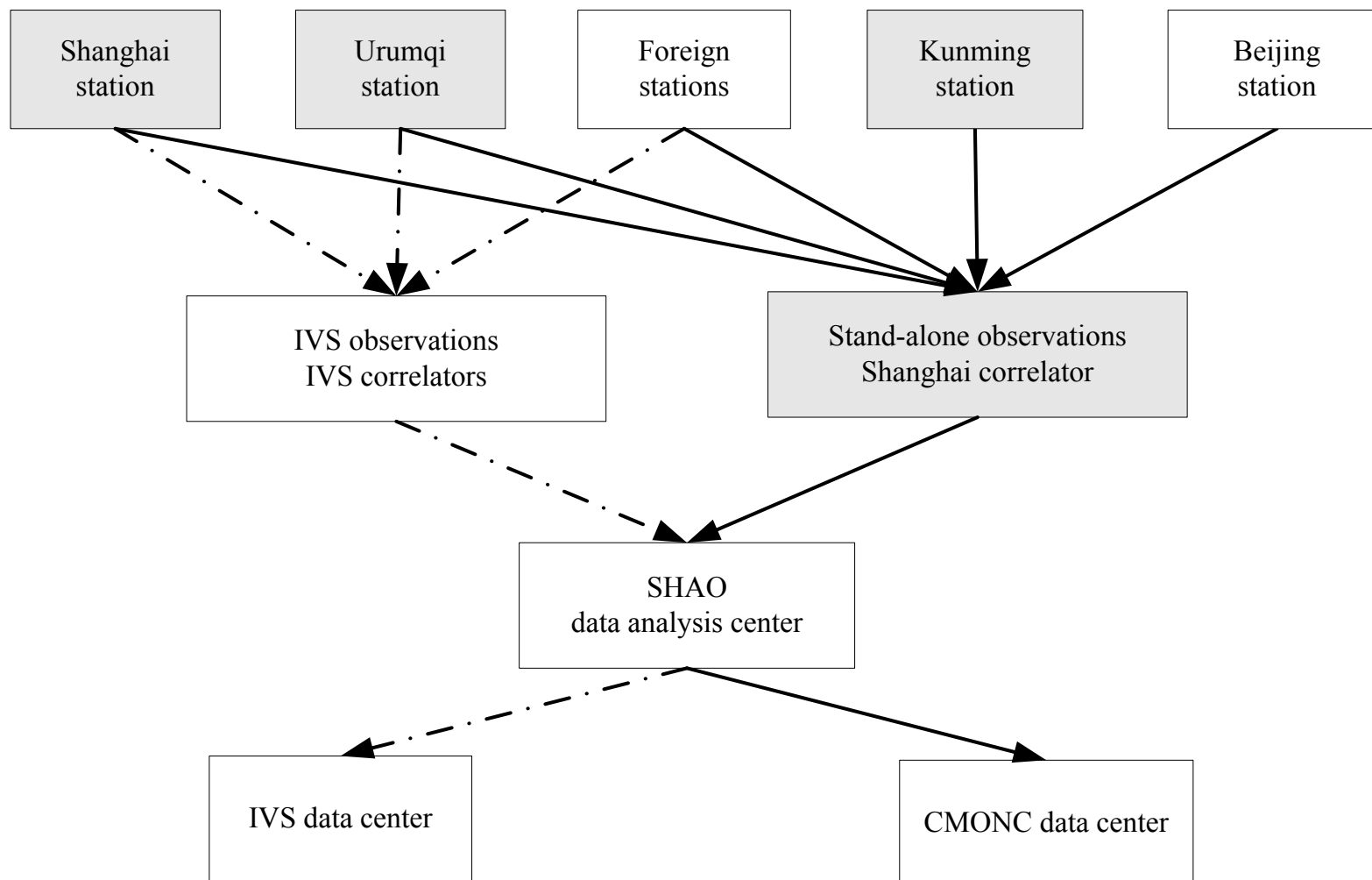


Chinese geodetic VLBI observing system

- ❑ Upgrade plan under the framework of CMONC
 - towards an operational geodetic VLBI observing system
 - proposed in 2006
 - approved in 2007
 - under development 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 built
- ❑ Kunming VLBI station
 - Co-located with GPS+SLR
- ❑ Shanghai correlation system
 - Supporting domestic geodetic VLBI observation
 - Expanding to astronomical application (not funded project)



Chinese geodetic VLBI observing system



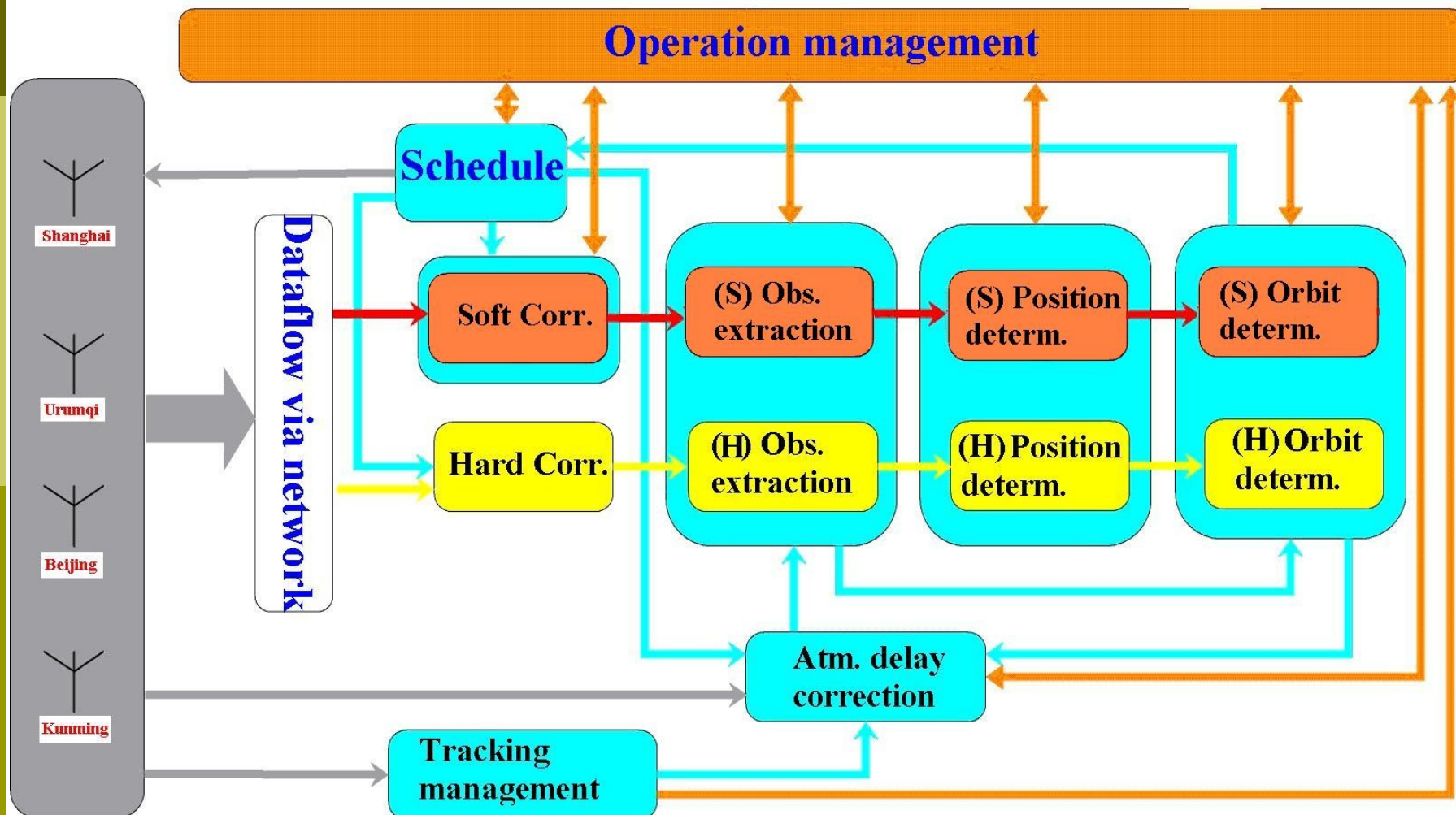


Shanghai correlation system

- ❑ 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
 - FPGA-based hardware correlator Vs. software correlator
 - ❑ Efficiency/processing speed/data latency
 - ❑ manpower/flexible
- ❑ Main limitations
 - only VEX schedule supported: subarray/scan length
 - 1 minute continuous correlation output: long integration
 - Δ VLBI observable output: compatibility



Data processing of the VLBI tracking system





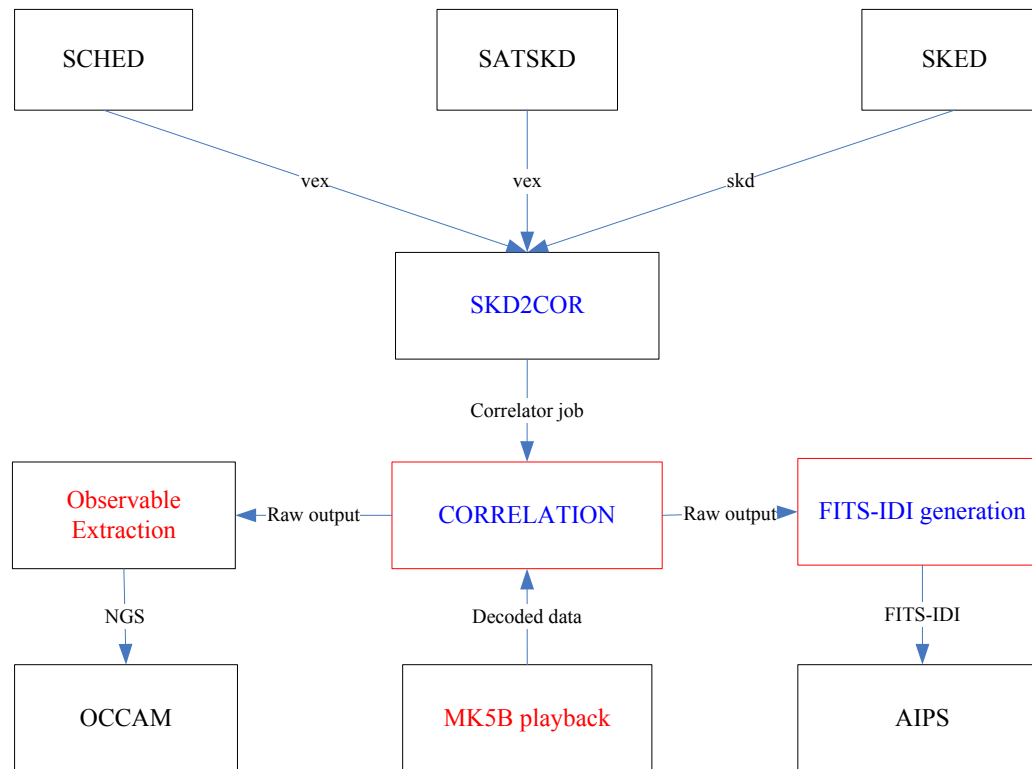
Shanghai correlation system upgrade

- ❑ correlator control system
 - **SKED**/SCHED/SATSKD interface
 - Scan-based processing (for software correlator)
 - 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 install DBBC+MK5B system
- ❑ Web based Database
 - Management/search/download
 - LAMP (Linux+Apache+MySQL+PHP)



Software architecture

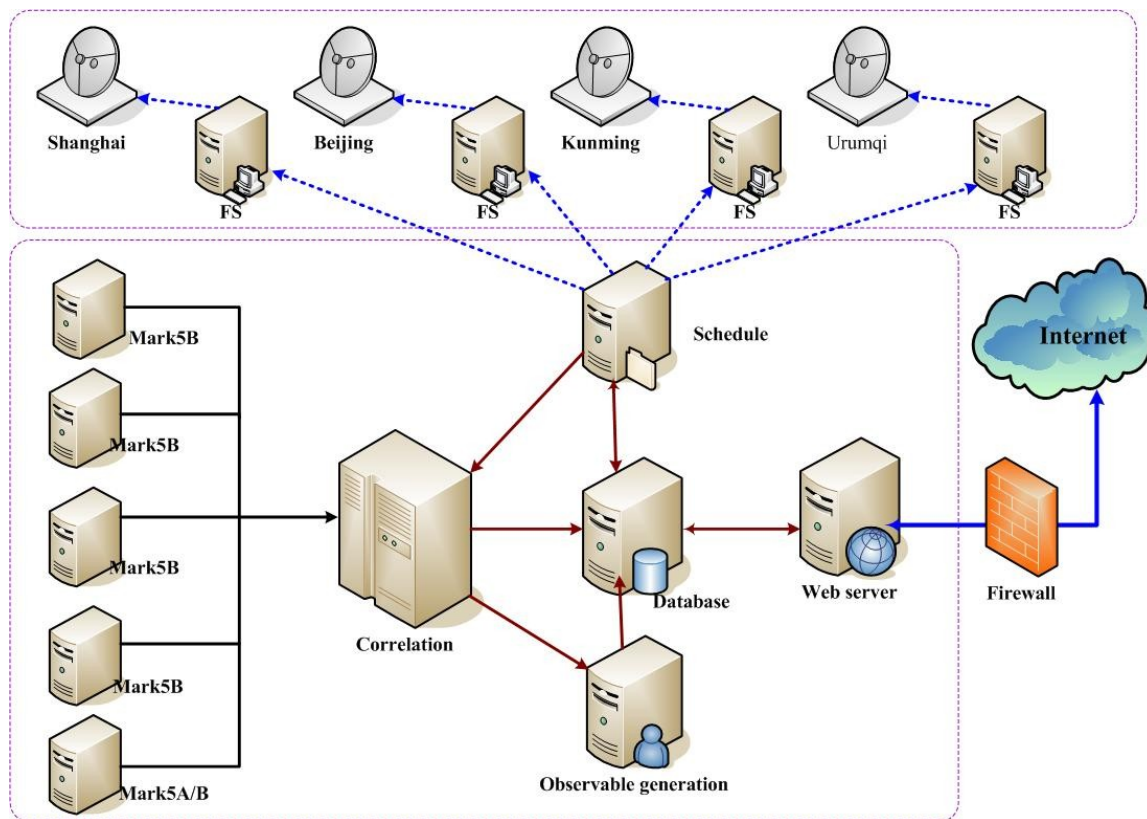
- ❑ SKD2COR: done
- ❑ Correlation/FITS-IDI generation: debugging, test, verification
- ❑ MK5B playback: developing until 2009Dec
- ❑ Observable extraction: developing until 2010Mar





Correlation system hardware

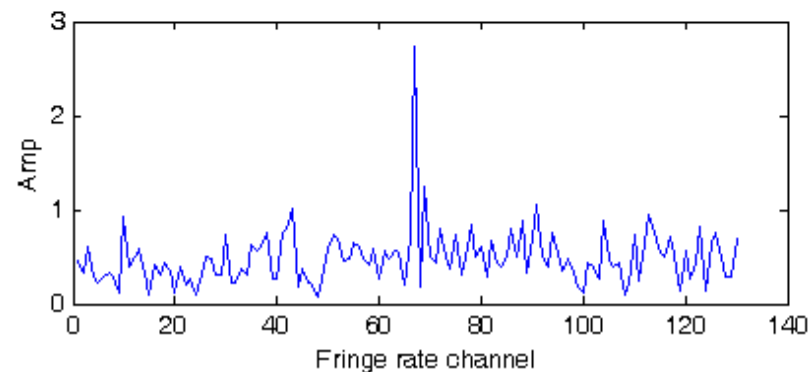
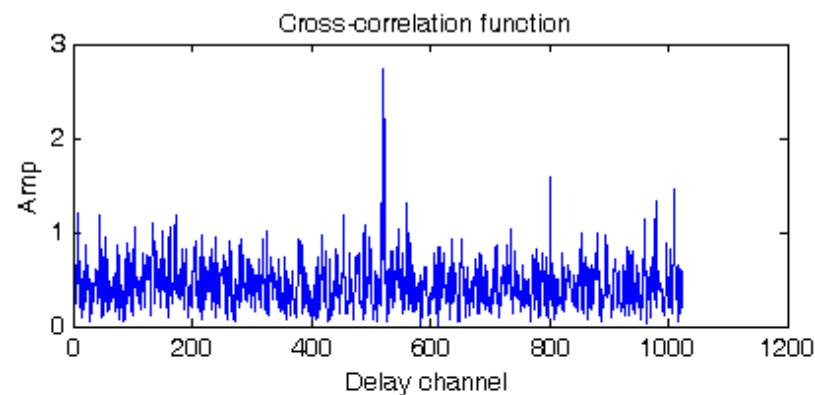
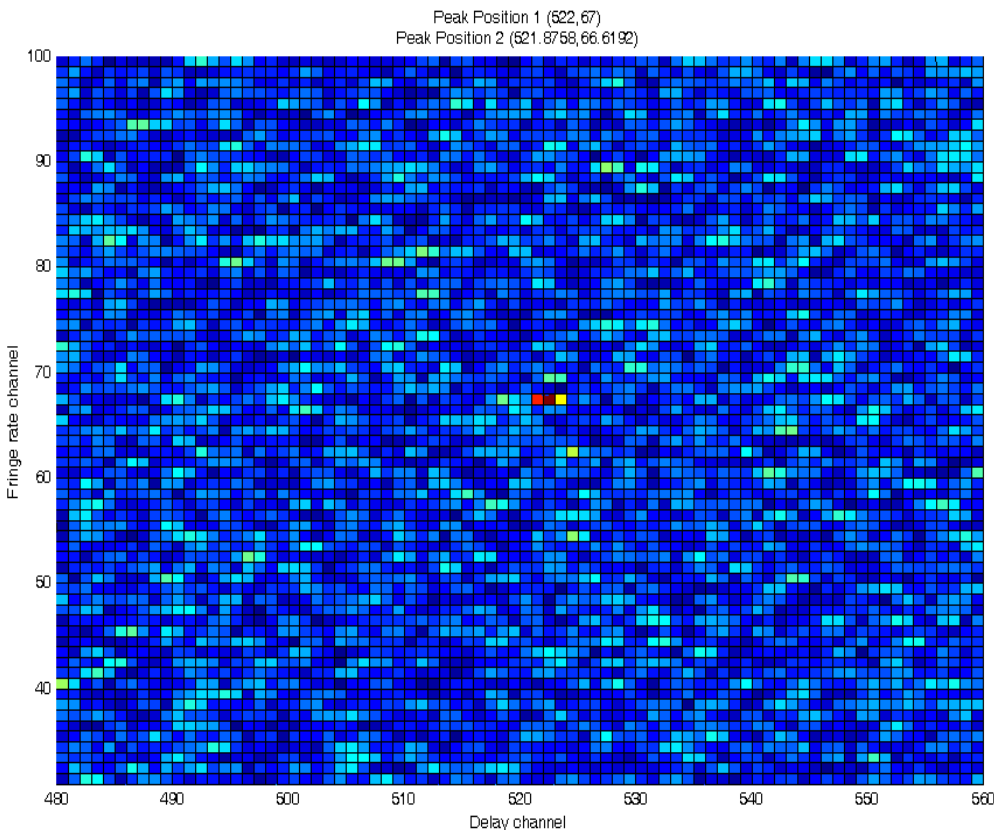
- Hardware to be setup before the end of 2009
- Only sharing MK5A/B with the satellite VLBI tracking system
- Balancing the requirements and the budget now





Correlation software upgrade: recent progress

- 2009Jan22 1417+385 Sh-Ur 8IF×8MHz/IF
- Integration time: 130s



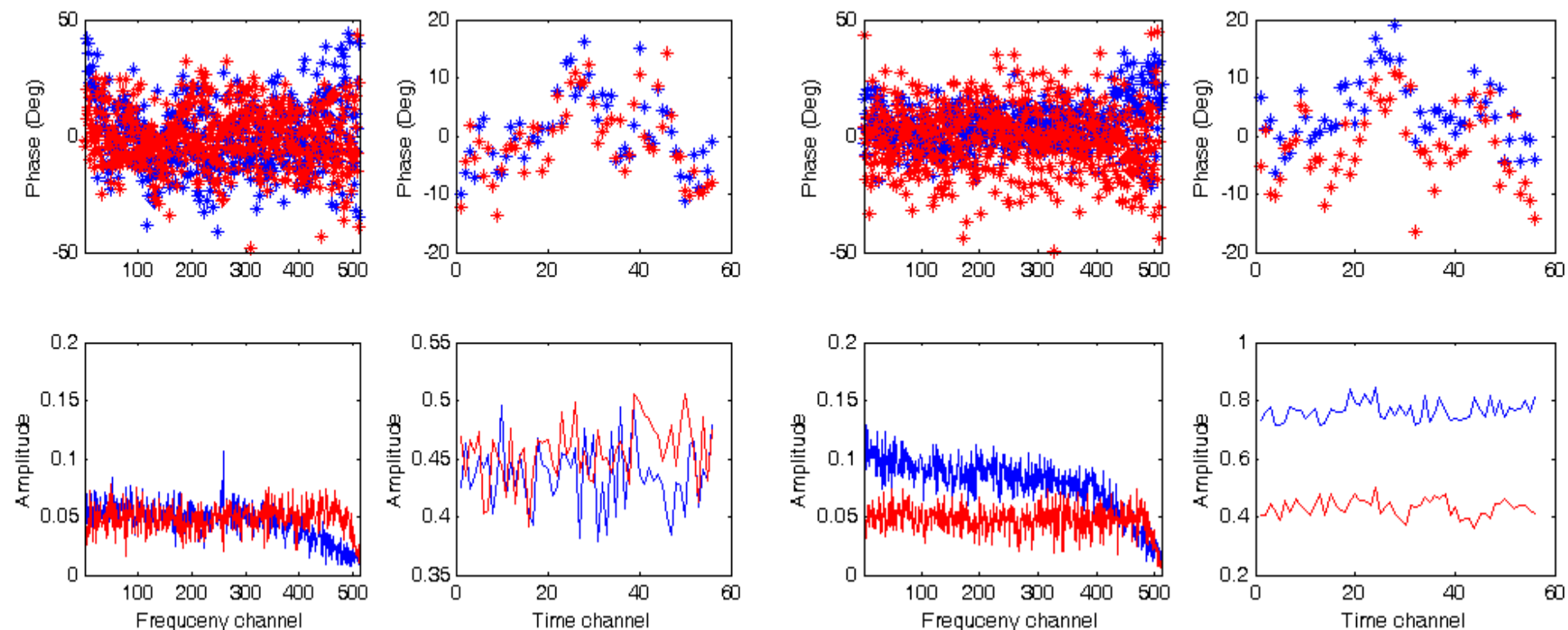


Developing MK5B playback capability: recent progress

- 2009Feb24 3C454.3 Sh-Km-Ur 8IF×8MHz/IF
- ABBC+MK5A : blue DBBC+MK5B : red
- IF1 Cross spectrum after removal of delay/rate/phase residuals

Sh-Ur

Sh-Km

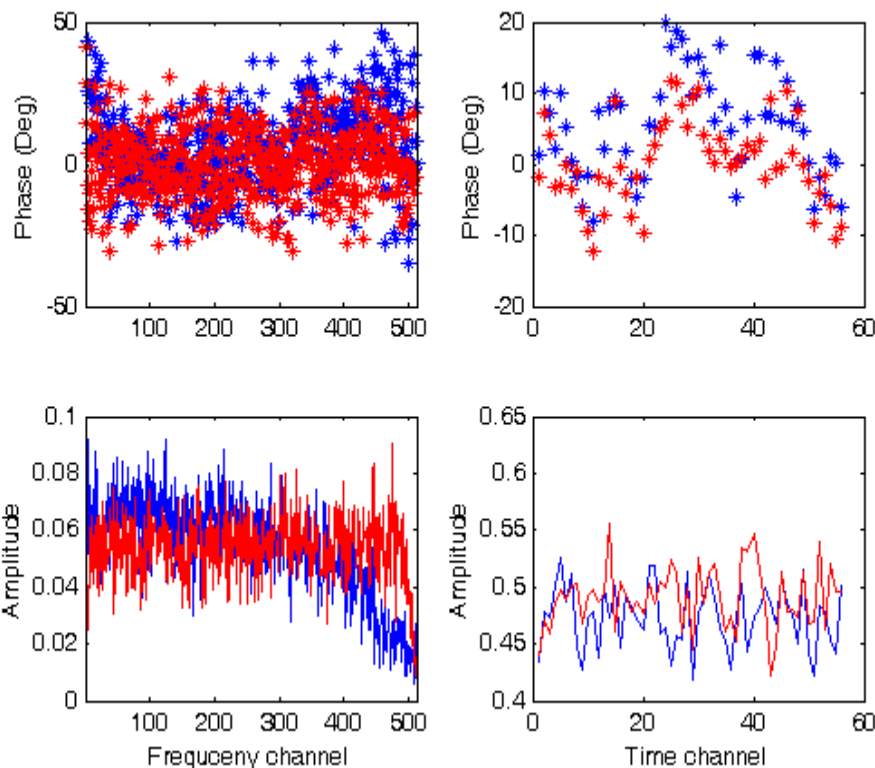




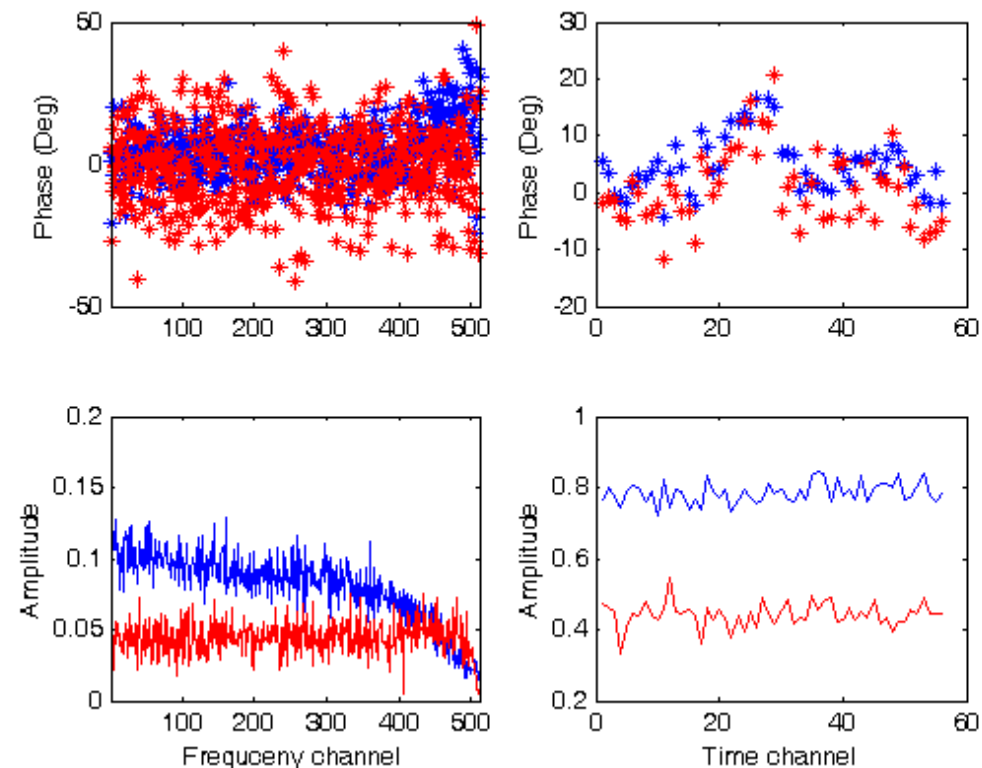
Developing MK5B playback capability: recent progress

- 2009Feb24 3C454.3 Sh-Km-Ur 8IF×8MHz/IF
- ABBC+MK5A : blue DBBC+MK5B : red
- IF2 Cross spectrum after removal of delay/rate/phase residuals

Sh-Ur



Sh-Km





TEC measurement experiment





Expecting performance

IVS observing time	≥ 240 hours (only Shanghai and Urumqi stations participating in)
Stand-alone observing time	≥ 192 hours (geodesy) + ≥ 200 hours (astronomical application)
Data quality	$\geq 85\%$
Format of raw data	MK5A, MK5B-VSI
Station number	3~4 (domestic stations) , ≤ 10 (when foreign stations available)
BBC channel number	8 (analog BBC), 8/16 (digital BBC)
Bandwidth per BBC channel	8/16MHz (analog BBC), 8/16/32MHz (digital BBC)
Typical source flux	$> 0.1 \text{ Jy}$
Typical delay precision	$\sim 50 \text{ ps}$



Conclusion

- Under the framework of the project "Crustal Movement Observation Network of China" (CMONC), an upgrade to the correlator which was originally designed for the tracking of Chang'E 1 lunar satellite has been carried out since last year. It will be completed in 2010 and put into operation for the geodetic and astronomical application of Chinese VLBI stations.
- There remain a lot of work to do.