The Progress of CVN Software Correlator and Its Application

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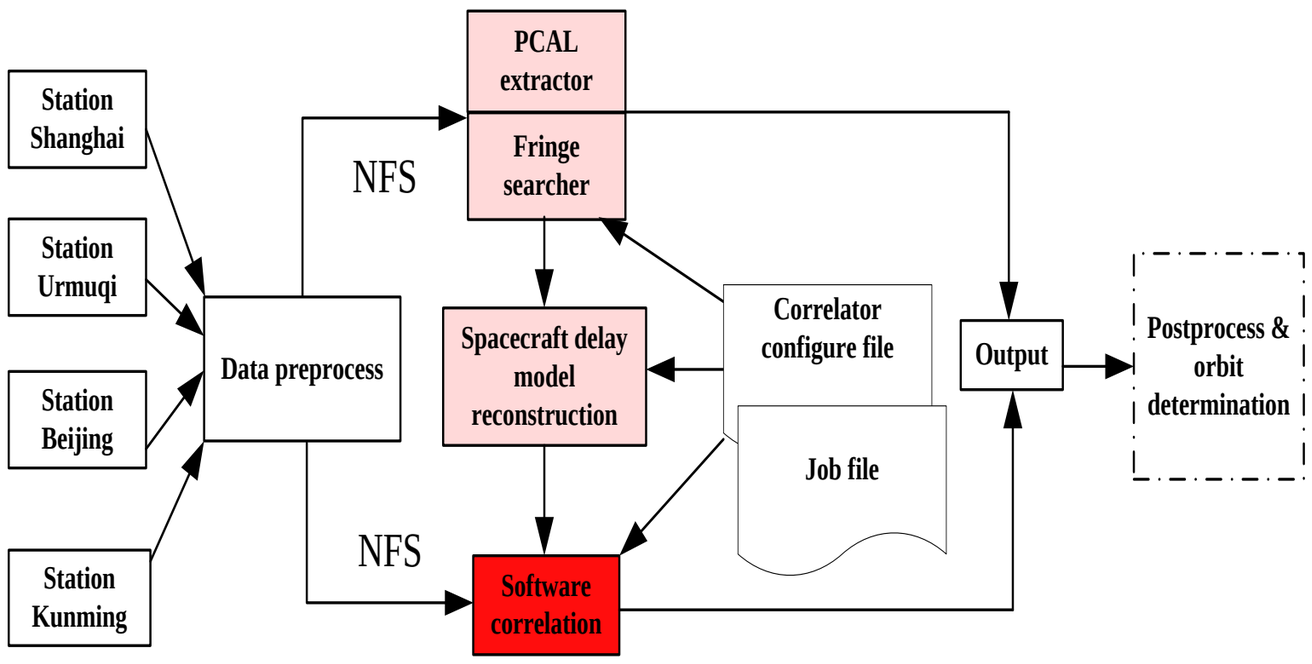
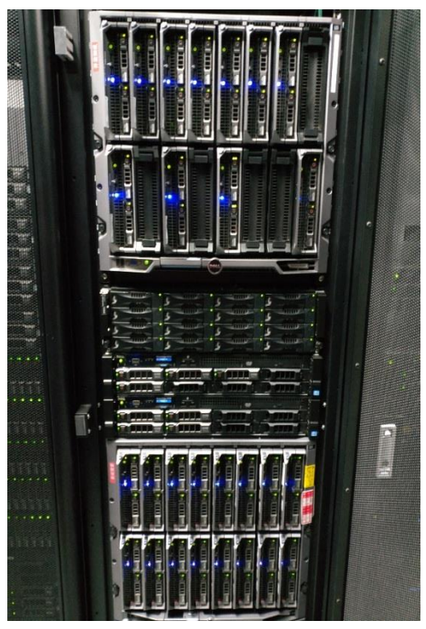
CVN software correlator structure:



- **Update for the lunar mission:**
  - phase center → 2 phase centers for two-probe same beam VLBI tracking
  - Single object fringe search → 4 objects fringe search
    GPU+ local correlation
  - Phase reference VLBI →FITS-IDI
- **Specifications:**
  - Input format: Mark4/Mark5B/VDIF
  - Output format: CVN/FITS-IDI/MK4
  - Graphical user interface
- **Applications：**
  - Probe phase referenced VLBI
  - IVS data processing →MK4



Built in 2012 - 2017, supported by Chinese Lunar Project.

Functions introduce:

1. **PCAL extractor –** extract Phase Calibration Tone
2. **Fringe searcher -** search fringes from the spacecraft observation raw data
3. **Spacecraft delay model reconstruction –** reconstruct spacecraft delay model based on the result of Fringe Searcher and the 0-th term of the prior delay model
4. **Software correlator –** correlation processing based on the spacecraft reconstruction delay model or the prior delay model

CE-5 SW correlator platform:

- Head nodes: 2
- Computing nodes : 64, 1048 cores
  - Correlation: 8 nodes: 2×E5-2695 v4 , 128GB Mem; 32 nodes: 2× E5-2640 ,32 GB Mem;
  - Fringe Searching: 4 GPU nodes, 2×E5-2660 v3, 4 Nvidia K80 GPU, 128GB Mem
  - Dev&Testing: 5 nodes:2× E5-2667 v4, 64GB; 5 nodes:4× E7-4820, 128GB
- Networking: 40Gb Infiniband, 10Gb Ethernet
- Storage: 10 GPFS Storages Servers(200 cores), GPFS parallel filesystem, 730TB

Comparison with DiFX:

- **Imaging results:**

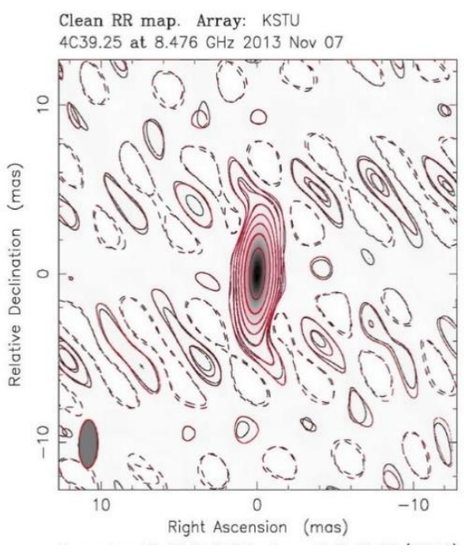


Image of 4C39.25 . CVN scorr(red line), DiFX (black line)

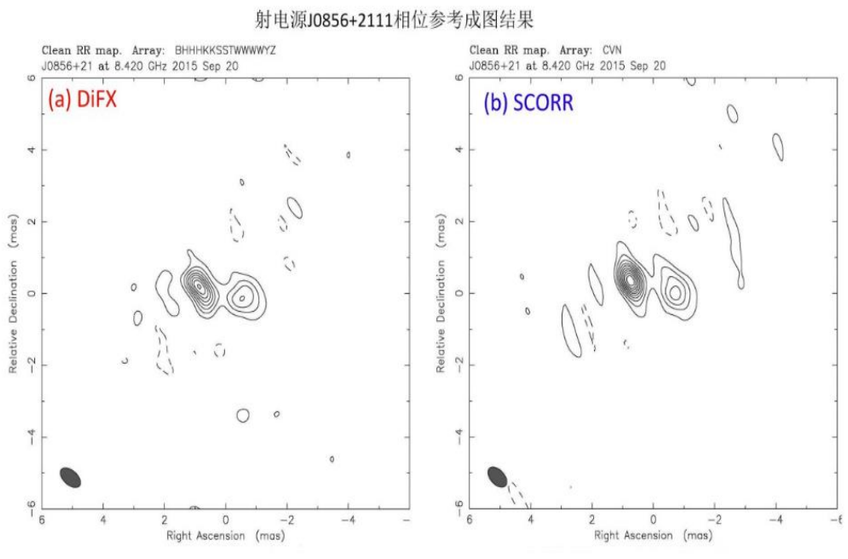


Image of J0856+2111. (a) DiFX; (b) CVN SCORR

- **Geodesy observation**

	K14349	cn1502	apsg38
Data sources	IVS	CVN	IVS
Use same delay model	Y	N	N
S band MBD Difference < 10 ps	Y	Y	Y
X band MBD Difference < 3 ps	Y	Y	Y
SNR Difference < 0.5%	Y	Y	Y

Difference between DIFX and SCORR:
✓S band MBD < 10 ps
✓X band MBD < 3 ps
✓SNR < 0.5%

Comparison with SFXC: MEX and 2155-152

We also compared CVN software correlator with SFXC based on MEX and 2155-152. (Distance: ~1.9895AU; Separation angle: < 2.5°@ X-band; Stations: SH, BJ, KM, UR, BD; VLBI observation data: ~1.5h;)
The result shows both CVN software correlator and JIVE results keep consistence with MEX precision orbit ~1mas.