Geodetic VLBI development at SHAO and its connection with AOV future

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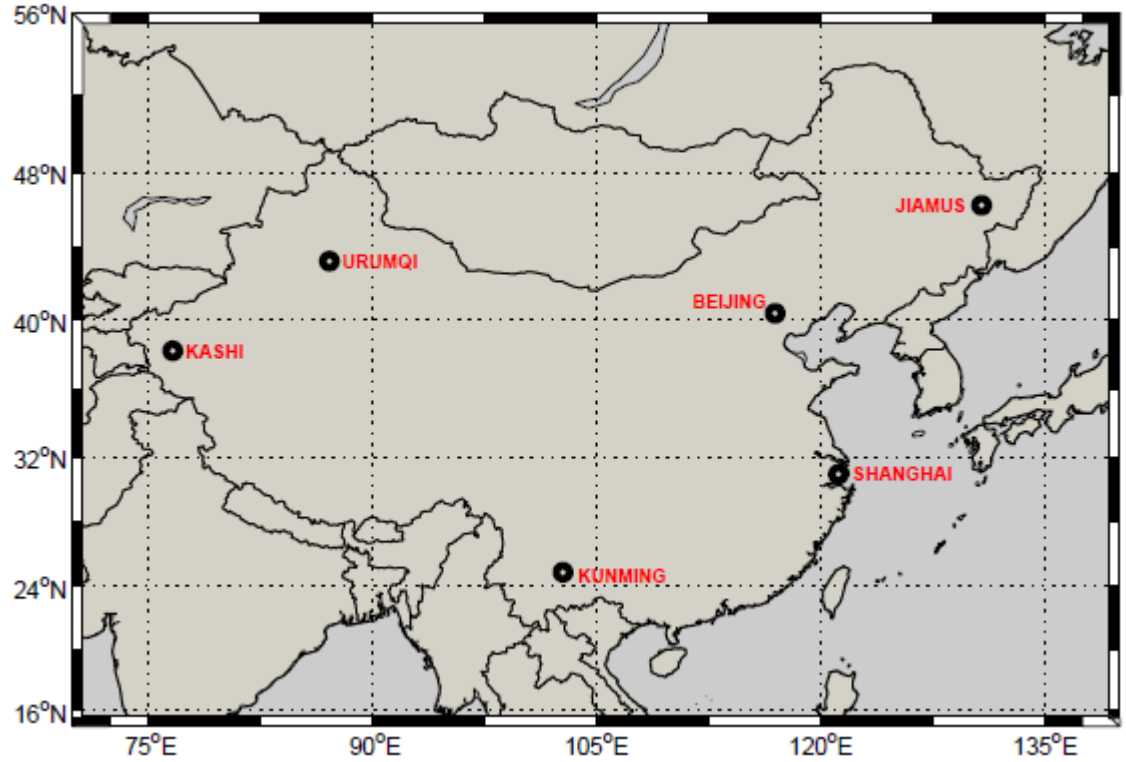
Background

- What is your vision for the AOV in science and technology development?
- What is the best observing program for the region and how can we achieve it?
- What opportunities do we have to develop technology and techniques together?
- What advantages do we have over other geodetic VLBI facilities and how can we best exploit them?
- How can your facilities and research programs (current and planned) be used within the AOV to encourage and improve collaboration?

Observing stations

- Seshan25, Tianma65: operated by SHAO
- Urumqi, Kunming: close cooperation
- Beijing(Miyun), Jiamus, Kashi: common interest



VLBI data processing center at SHAO

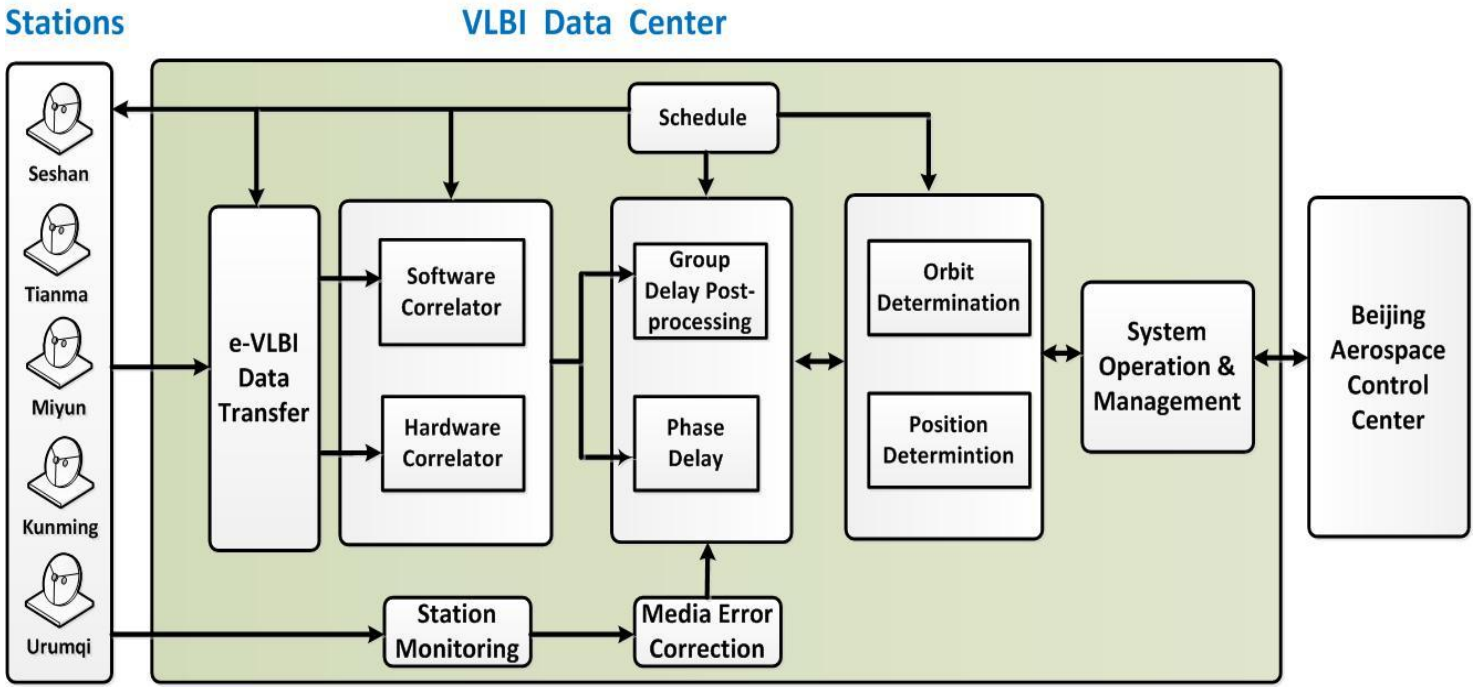
Hardware development

Figure 1. Hardware correlator

Figure 2. CDAS system

Software development for satellite VLBI tracking

- Scheduling, software correlator, post-correlation, atmo/iono correction and orbit determination



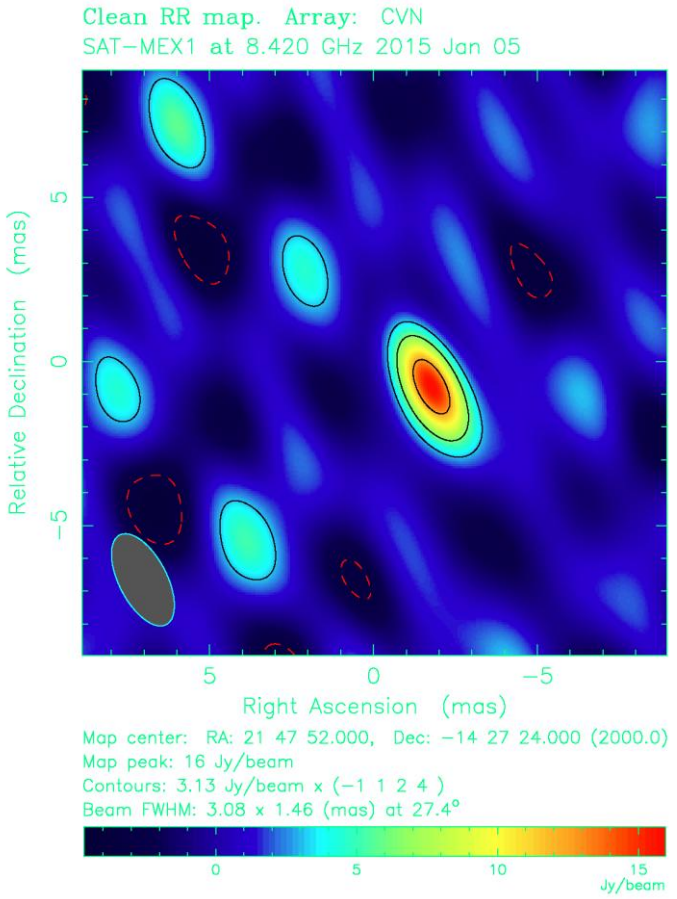
Engineering navigation in Chang'E mission

	Chang'E 3		Chang'E 1	
	Achieved	required	achieved	required
ΔDOR technique	yes	yes	no	no
Same beam VLBI	yes	yes	no	no
Delay error	0.5 ns	4 ns	6 ns	12 ns
Orbit error	< 100m	1000m	no	no
Related position error of YuTu	~1 m	500m	no	no
Data latency	15-40 sec	1 min	6 min	10 min

- For Chang'E-5 mission, we need to tracking 2 targets in one session.

Phase referencing observations of MEX

- Stations: Sh, Bj, Km, Ur, Bd
- Time range:
  2015-01-05
  08:20:00 ~ 09:58:40
- Frequency: 8420 MHz
- Calibrator: 2155-152
- Agree with ESA orbit
  at the level of 1 mas



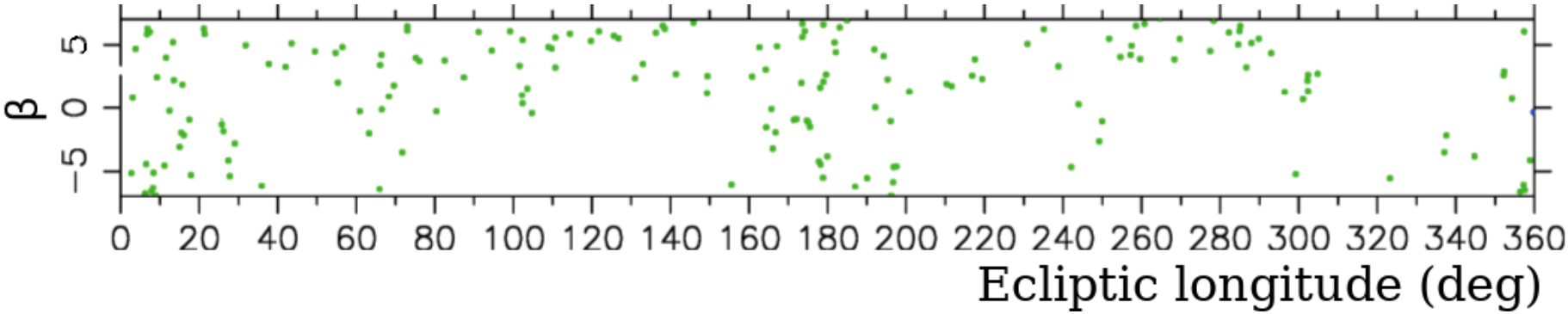
Geodetic observing program

- Chinese domestic geodetic sessions
  - CMONOC: seshan25, Kunming, Urumqi
  - Chang'E: Beijing
  - CDSN: Jiamus66, Kashi35

- Participating in IVS sessions:
  - AOV, APSG, T2, R1/4, R&D
  - INT3

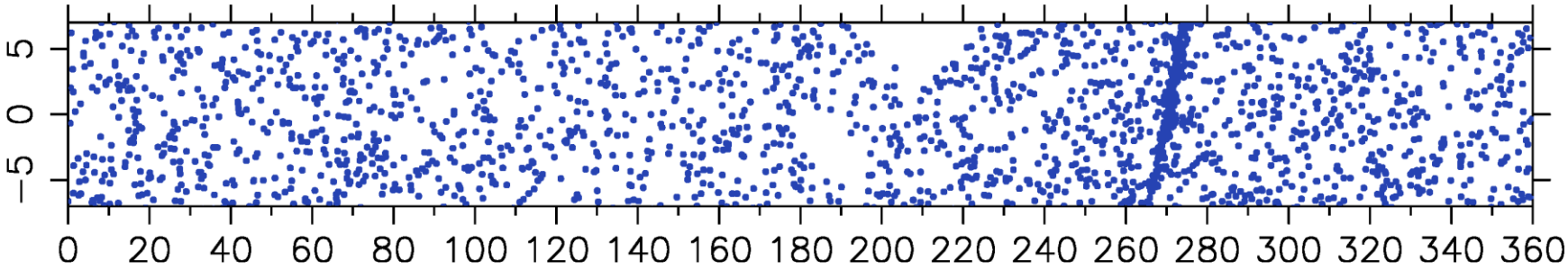
VEPS (VLBI Ecliptic Plane Survey)

- The goal is to densify VLBI absolute astrometry catalogue within 7.5° of the ecliptic plane
- In total, 1175 sources have been observed. Among them, 241 have been detected in three or more observations. The detection limit for CVN is 20 mJy.
- Positions with median accuracy 3.6 mas.
- Estimates of flux densities with accuracies 15%.



VEPS next step

- To finish observations of 2275 candidate sources brighter 100 mJy @4.8 GHz.



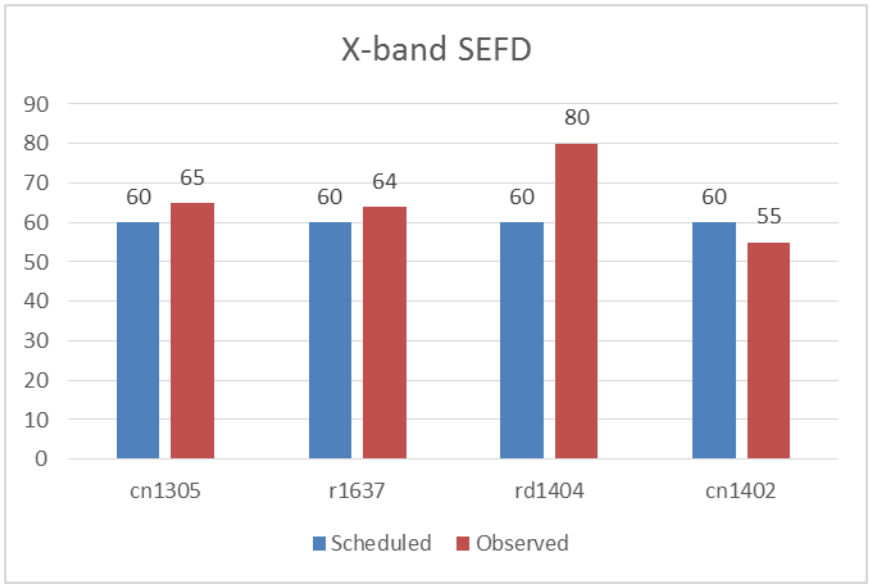
- To perform S/X dual-band observations of ecliptic sources detected before, with the goal to reach accuracy 0.3 mas for all the targets.

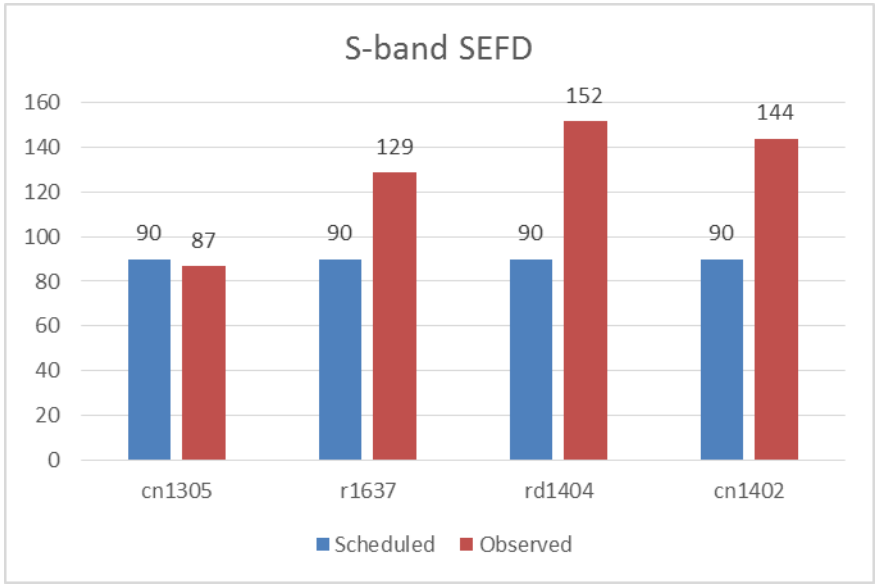
- A network need to be formed with 6-9 stations which SEFDs < 1000.

Planned programs: astrometry with Tianma65

- Densification of radio reference frames
  - absolute astrometry of more weak sources at different frequency bands.
- Connection of radio-optical reference frames
  - the array sensitivity is still very critical for VLBI astrometry of radio counterpart of optically bright quasi stellar objects.
- Connection of radio-planetary dynamic reference frames
  - differential VLBI observations of a planetary spacecraft and nearby reference radio sources are required to measure their position offset with very high accuracy.
  - accurate station coordinates are required

Observed S/X SEFD of Tianma65

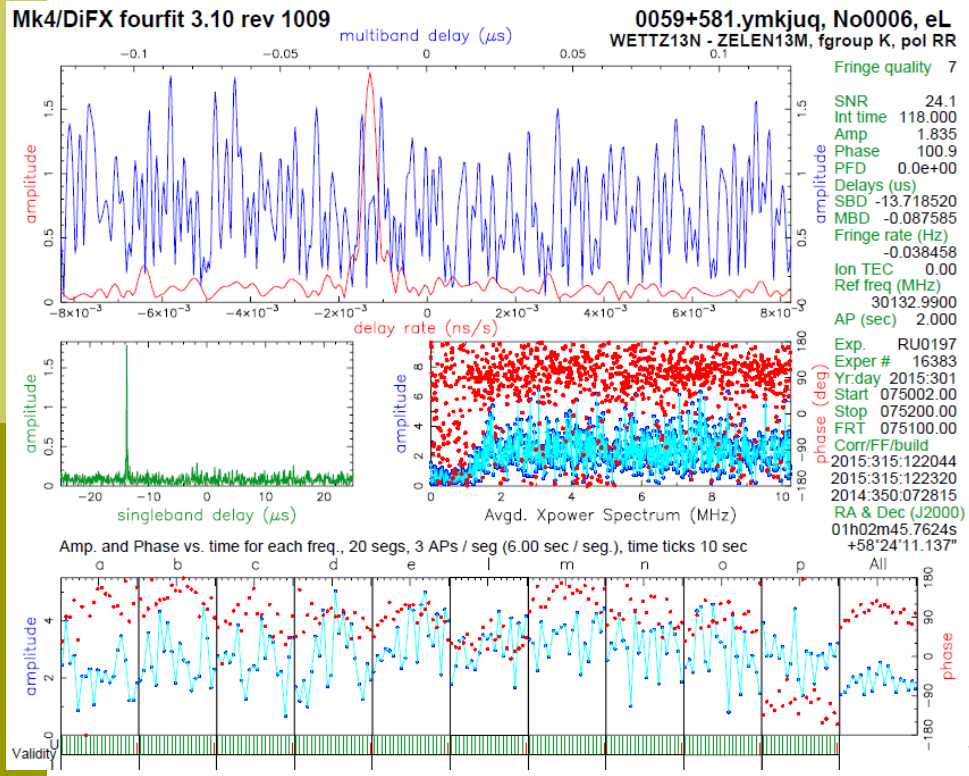


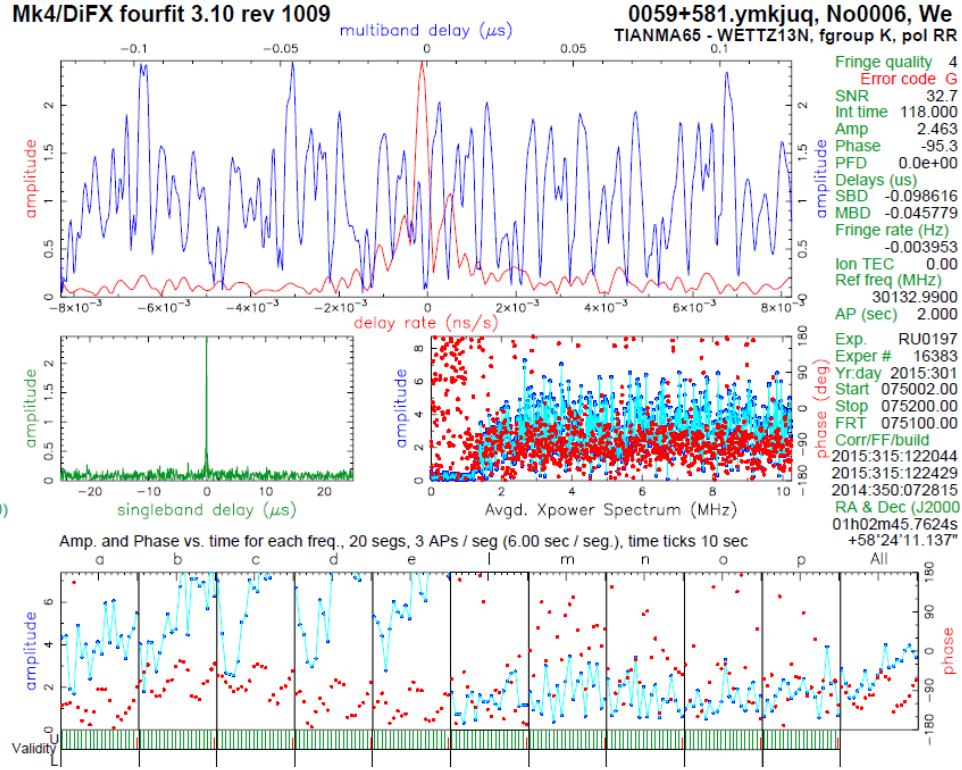


- Effelsberg: SEFD = 25@X-band, 100@S-band
- Parkes: SEFD = 150@X-band, 150@S-band

First X/Ka band fringe test for Tianma65

- Stations: T6+Wn+Zv
- Date: October 28, 2015





How can your facilities and research programs (current and planned) be used within the AOV?

- Shanghai correlator
  - AOV, APSG, CRF, CRDS, and AUA/AUG
  - open for use: D-VLBI of satellites, astrometry
- Geodetic observations
  - CMONOC → AOV
- Absolute astrometric observations
  - Tianma65
  - VLBI ecliptic plane survey
  - 2Gbps recording rate

What advantages do we have over other geodetic VLBI facilities and how can we best exploit them?

- Network geometry
  - Longer N-S baselines
  - Core stations in south hemisphere
- observations
  - Wider bandwidth: 32/64 MHz bandwidth
  - Higher data rate: 1/2 Gbps
- balance between geodesy and astrometry
  - More weak sources to be observed
  - Densification of reference sources in deep south and ecliptic plane

What opportunities do we have to develop technology and techniques together?

- Hardware
  - CDAS?
  - VGOS station construction?
- Software
  - Satellite VLBI scheduling
  - Software correlator

What is the best observing program for the region and how can we achieve it?

- Function of current AOV sessions
  - To maintain the regional geodetic reference frame
  - To carry out R&D experiments
- The best observing program
  - USA: R4, R&D, RDV, CRF, CRDS
  - EVGA: R1, T2, Ohig, Eur
  - AOV: a global observing program!
- Goal of Shanghai correlator
  - Towards the correlation of a weekly geodetic observing session on a regular basis in the future VGOS era

What is your vision for the AOV in science and technology development?

- AOV is an extension of some domestic observing programs in Australia, China and Japan
  - Jade
  - CMONOC
  - Austral
- AOV is a platform through which we can play a better role within the IVS
  - Operation center
  - Correlator center

Thank you!