

# PROGRESS ON VLBI ECLIPTIC PLANE SURVEY

FENGCHUN SHU<sup>1</sup>, LEONID PETROV<sup>2</sup>, WU JIANG<sup>1</sup>, JIM LOVELL<sup>3</sup>, SANG-OH YI<sup>4</sup>, KAZUHIRO TAKEFUJI<sup>5</sup>, JINLING LI<sup>1</sup> <sup>1</sup>SHAO, <sup>2</sup>Astrogeo Center, <sup>3</sup>UTAS, <sup>4</sup>NGII, <sup>5</sup>NICT

# MOTIVATION

A dense grid of calibrators along ecliptic plane with very accurate coordinates is required for many applications, including observations of spacecrafts in the phase referencing mode. Such observations could contribute to many scientific goals.

- 1. Spacecraft navigation
- 2. Improvement of planet and lunar ephemerides
- 3. Determination of the Moon's libration

### RESULTS



4. Study the variations of the Mars orientation parameters from planned VLBI phase referencing observations of the Mars lander.

## SENSITIVITY

We call a calibrator a source that is brighter than 30 mJy on baselines longer than 5000 km. In order to search for more calibrators, baseline sensitivities need to be improved with higher recording rate by taking advantage of modern digital backends, which maximum capability has not yet been fully explored. Here are some digital backends tested with compatibility.

- 1. RDBE: 2Gbps recording mode is operational in VLBA observations
- CDAS: 2Gbps mode has been tested and used in China since 2010
  DBBC2: widely used in Europe and Australia
  K5/ADS3000+: new backends developed by NICT

**Upper plot**: Phase-A sources. Among 2216 sources (blue), 1903 sources observed (green), 251 sources detected (red).

Lower plot: Phase-B sources. Among 4802 sources (blue), 324 sources observed (green).

Among the observed 8 sessions, the first 6 sessions have been processed. We detected 251 sources in 3 or more observations from

1450 sources. Their median position precision is about 3.6 mas. The estimation of the correlated flux densities is better than 15%.

Preliminary results are available at http://astrogeo.org/veps.

# VEPS PROGRAM

Since February 2015, we have been observing **all objects** within 7.5° of the ecliptic, brighter than 50 mJy at 5 GHz, from the PMN and GB6 catalogues except for those

- 1. that have been detected with VLBI before
- 2. that were observed with VLBI in a high sensitivity mode (detection limit better than 20mJy), but have not been detected.

### STATIONS

The VEPS observing program is underway with participation of 3 core Chinese VLBI stations: Seshan25, Kunming and Urumqi, and several international stations that join on ad hoc basis. For each session, a network with 3-4 stations is required.



#### **OBSERVATIONS**

So far 8 sessions have been observed. Each target source is observed in two scans of 90 seconds. 4 calibrators are observed every 1 hour for atmospheric effects reduction and amplitude calibration.

Date	Time	Dur	Code	Stations	Data	# Targets
(yyyy-mm-dd)	UT	hrs			(TB)	
2015-02-13	05h00m	24	VEPS01	$\mathrm{ShKmUr}$	48	293
2015-02-14	06h00m	24	VEPS02	$\mathrm{ShKmUr}$	48	338
2015-04-23	05h00m	24	VEPS03	ShKmUrKv	56	300
2015-04-24	06h00m	24	VEPS04	$\mathrm{ShKmUrKv}$	56	400
2015-08-10	05h00m	25	VEPS05	ShKmKvHo	42	252
2015-08-19	05h00m	25	VEPS06	ShKmKvHo	42	277
2016-03-02	08h30m	24	VEPS07	ShKmUrKb	52	333
2016-03-11	05h00m	24	VEPS08	ShKmUrKb	60	477

The observations are performed at 2048 Mbps with 16 IFs (2048-16-2) spread over X-band. For Sejong, its maximum rate is 1024 Mbps so the mode 1024-16-1 was used. For Hobart26, its 32MHz bandwidth had not been tested at that time so the mode 1024-16-2 was used.

**Phase-A** — Observations of 2216 sources that have total flux density at 5 GHz > 100 mJy

**Phase-B** — Observations of 4802 sources that have total flux density at 5 GHz in a range [50, 100] mJy

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#### **DATA CORRELATION**

We process the VEPS data with the DiFX correlator at Shanghai, which is also served as one of the IVS correlators.

The data volume for each session is much larger than that of regular geodetic sessions. The technique challenge include the correlation of mixed observing modes with different bandwidths or sampling bits.

#### NEXT STEPS

To finish the survey of remaining sources, additional 400-hour observing time is required.

To improve the position accuracies of ecliptic sources, a 24-hour VLBA proposal has been approved. More S/X-band observations with large network at 2 Gbps will be organized.