

VLBA PROPOSAL COVERSHEET

DEADLINES: 1st of Feb., June, Oct.

rcvd:

- (1) Date Prepared: September 30, 2005
- (2) Title of Proposal: GaPS: Galactic Plane Survey — search for more K-band calibrators suitable for VLBA and VERA

(3) AUTHORS (Add * for new location)	INSTITUTION	E-mail	Students Only		
			G/U	For Thesis?	Ph.D. Year
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(4) Related previous or current VLBI proposal(s): BB023, BF071, BP110, BP118, Resubmission
BK124, BR076, BL115, BL122

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(7) Scientific Category: astrometry & geodesy galactic extragalactic other:
Rapid Response Science: Known Transient Exploratory Target of Opportunity

(8) Wavelength(s) requested (those not available on the global network are indicated with a small circle):
 90cm 50cm 30cm 21cm 18cm 13cm 6cm 5cm 3.6cm 3.6/13cm
 2cm 1.3cm 7mm 3mm
 Global Network standard bands Special frequencies: _____

(9) Recording format: Default continuum setup (VLBA only), VLBA/MkIV, MkIII: Mode _____
 Bandwidth per BaseBand channel: 8 MHz
 Aggregate bit rate: 256 (8 BB channels at 16 MSamples/sec of 1 bit, 2 bit)

(10) Multi-epoch observation: _____ epochs of _____ hours each, separated by _____

(11) Network	Requested antennas	Total time requested
EVN & MERLIN		
VLBA	ALL	3 × 24 hours
other NRAO		
Non-VLBI Instruments		

(12) ABSTRACT (Do not write outside this space. Please type)

The success of VERA and VLBA phase-referencing projects at frequencies above 15 GHz critically depends on the availability of calibrators within a few degrees of the target source. In particular, the insufficient number of calibrators near the Galactic plane severely affects studies of weak galactic objects, since this limits the number of sources which can be imaged and positioned.

In coordination with a current VERA fringe-search survey of 3000 objects near Galactic plane, $|b| < 5^\circ$, and at the distance $< 10^\circ$ from the Galactic center, we request three 24 hour sessions with the VLBA for follow-up observation of ~ 500 good candidates detected with VERA to determine their mas-accurate positions and radio structures. The VLBA observations will dramatically increase the number of calibrators at K-band near the Galactic plane, and be extremely valuable for VERA with a calibrator-target separation range of 0.3° to 2.2° . Results will be available on-line within 20 days after completion of correlation.

Scheduler use only
(8/03)

- (13) Observation type: Interferometry, Spectroscopy, Pulsar, Phase referencing
- (14) Proposal is Suitable for dynamic scheduling.
- (15) Polarization: Single Polarization Dual Circular Polarization
Global network standard for single polarization is LCP for all λ s except 13cm (RCP) and 3.6cm (RCP).
- (16) Tape usage (Show <recording time>/<total time>): _____
- (17) Assistance required:
Observation Setup: Consultation, Extensive help, Observe file preparation
Postprocessing: Consultation, Extensive help, Calibration service
- (18) Processor: Socorro, JIVE, Haystack, Bonn, Washington, Other _____
Special processing: XPol, Pulsar gate, Multiple Fields: _____
Averaging time: 1 sec Spectral channels per baseband channel: 64
 Other special processing: _____
- (19) Postprocessing Location: NRAO-CV, NRAO-GB, GSFC
- (20) Source list: J2000 B1950
If more than 4 sources, please attach list. If more than 30, give only selection criteria and GST range(s)

	Source 1	Source 2	Source 3	Source 4
Name(s)	ALL SKY			
RA (hh mm)	0-24h			
Dec (dd.d)	-40d to +70d			
GST range (Europe)				
GST range (US)	0-24h			
GST range (Other)				
Band(s)	K			
Flux density (Total, Jy)	>80 mJy			
Flux density (correlated, mJy)	>50 mJy			
RMS needed (mJy/beam)	3-5 mJy			
Peak/RMS needed	>30:1			

- (21) Preferred VLBI session or range of dates for scheduling, and why:
Three sessions, each must be 24 hours in length. Winter preferred for phase stability. After Jan 1, 2006 when VERA reductions will be finished.
- (22) Dates which are NOT acceptable, and why:
- (23) Attach a self-contained scientific justification, not in excess of 1000 words.
Preprints or reprints will not be forwarded to the referees.

Information about the capabilities of the VLBA may be found on the World Wide Web by starting at the NRAO home page, <http://www.nrao.edu>, and selecting the VLBA from "Sites and Telescopes."

A brief summary of the capabilities of the EVN antennas is given in the EVN STATUS TABLE in the EVN USER GUIDE, which may be found at http://www.evlbi.org/user_guide/user_guide.html.

Please include the full postal addresses for first-time users or for those that have moved (if not contact author).

GaPS: Galactic Plane Survey — search for more K-band calibrators suitable for the VLBA and VERA

1 Summary

We request three 24 hour sessions with the VLBA for observing 500 candidates in order to dramatically increase the number of calibrators at K-band near the Galactic plane for supporting VERA and VLBA experiments focused on the study of galactic objects. Previous observations with the VLBA in 1994–2005 in S/X produced a list of 2834 sources, with position accuracy better than 5 mas and with S/X images. However, the density of this catalogue is not sufficient to provide enough calibrators closer than 4° near the Galactic plane for VERA and VLBA observations of many interesting galactic objects. VERA observations, in particular, critically depends on availability of calibrators within 2.2° of a target source.

In October–November 2005, VERA is observing a list of 3000 potential candidates for fringe searching at K-band. Any source with a detectable fringes will then be followed up by the proposed VLBA observations.

2 Previous Observations

VLBA calibrator surveys, BB024, BF071, BP110, BP118 and BK124, were designed to expand the list of calibrator sources suitable for phase referencing and as target for geodetic observations. Twenty one VLBA Calibrator observing sessions, each of 24 hours, were made between 1994 and 2005. Each source was observed 2–3 times at different hour angles for 1.5–5 minutes. In this way up to 200 sources could be observed in each 24 hour session with sufficient sensitivity and u - v coverage to determine their suitability as phase-reference calibrators. Analysis of these observations produced images and milli-arcsecond accurate positions of observed sources.

The results from the above observations were published (Beasley et al, 2002; Fomalont et al, 2003, Petrov et al, 2005a, Petrov et al, 2005b, Kovalev et al, in preparation) and were made available on the Web at <http://www.vlba.nrao.edu/astro/calib/> and <http://gemini.gsfc.nasa.gov/vcs/>. In the web sites, all sources within a specified distance from a selected target position can be found, images, u - v plots and coordinates for each potential calibrator can be scrutinized. However, only 177 S/X calibrators are known near the galactic plane, and many may not be suitable as K-band calibrators. Thus, there is a dearth of good calibrations near the galactic plane.

A small subset of VCS sources, 374 objects, was re-observed at K-band in 2002–2004 for future support of space navigation, proposals BR076, BL115, BL122, Jacobs et al, 2003. Among 252 detected objects, 14 are within $|b| < 5^\circ$. These observations showed that a) a majority of bright S/X calibrators were detected at K-band; b) the difference in position from K-band observations and X-band observations did not exceed 1 mas; c) the effect of ionosphere at K-band did not significantly degrade estimates of positions.

3 Impact of expected results

The dual-beam, four station radio interferometer VERA is designed for direct measurements of the parallax of hundreds of radio sources, such as H₂O, SiO masers and late type stars, perhaps with accuracy as good as 10 μ as. These measurements involve simultaneous observations of a pair calibrator-target separated within 0.3 – 2.2° and recorded with independent receivers at K or Q bands. One of the primary goals of VERA mission is to improve the accuracy of the scale of distances used in astronomy, since at the 10 μ as precision level trigonometric parallax of almost any object in the Galaxy can be directly determined. This scale of distances has a fundamental importance for various astrophysical applications.

VLBA phase-referencing observations at high frequency of galactic objects is also a significant part of its proposal load. Often, the limitation above 15 GHz for image quality and positional accuracy is caused by the loss of coherence in the image because of the relative large distance of the calibrator from the target. Thus, the new list of calibrators in the Galactic plane will significantly expand the list of VERA target sources and will improve the phase-referencing VLBA projects studying weak galactic objects.

4 Proposed VLBA and VERA Observations

Because the area near the galactic plane is not well surveyed, the list of suitable candidates for VLBI calibrators is difficult to compile. First, a list of 3000 sources will be selected from several catalogs (NVSS, CLASS, etc.) utilizing the CATS database capabilities (Verkhodanov, et al., 1997) and using a rigorous procedure based on evaluation of a priori probability of detection developed by Petrov et al., 2005b. Applying this procedure in BP118 observing campaign resulted in an impressive detection rate of 65% in the zones where no compact sources were previously found. Second, all 3000 of the sources will be observed by VERA in October-November 2005 in one scan each for 2 minutes at K-band recorded with 240 MHz bandwidth. Third, those sources for which fringes are detected, will be on the list for the VLBA observations we propose here. We estimate that up to 500 sources will be detected by the VERA observations. This estimate is based on extrapolating the number of sources in the VCS sample, which is complete at the 200 mJy level of the correlated flux density, to 60 mJy, the detection limit of VERA fringe searching observations. VERA system does not have capabilities to provide good maps and determine absolute position of sources with 1-mas accuracy which is required for support of dual-beam observations for measurements of parallaxes of galactic objects with $10\mu\text{as}$ accuracy. Thus, the VERA fringe searching survey is designed only to detect sources at K-band. But VERA has the sensitivity comparable to the VLBA, and the pre-selection of sources will significantly increase the yield of VLBA observations.

We, thus, request three 24 hour observing sessions with the VLBA to observe about 500 candidates sources from the VERA fringe-search in the zone $\delta > -40^\circ$, $|b| < 5^\circ$ as well as within 10° from the Galactic center. We will use eight IF channels, spanned over 500 MHz around 24 GHz, with a total bandwidth of 64 MHz at 2 bit sampling, 256 Mb/s in order to reach the maximal sensitivity to reach the approximate VERA sensitivity. We request the same correlator setup as in the BP110, BP118 and BK124 proposals: 64 spectral channels in each IF and integration time 1 sec. This will give us an extra-wide search window needed for fringing sources with poorly known a priori positions. The calibration and imaging will be made in Charlottesville and Green Bank by using standard packages AIPS and difmap. Positions will be determined with Calc/Solve at GSFC.

The observation plan will be similar to the previous VCS schemes. Each source will be observed in two scans in different hour angles for 150 seconds. Every 1.5 hours, three to four troposphere calibrators will be observed. These calibrators are selected from the list of sources from the 2 cm VLBA survey (Kovalev et al., 2005), which are brighter than 0.5 Jy and have compactness index greater than 0.5 at 15 GHz. During a burst of tropospheric calibrator observations, the sources are selected in such a way that each antenna would observe at least one source at elevation below 20° and at least one source at elevation 50° above the horizon. Results of the VLBA Calibrator survey showed that observing tropospheric calibrators and estimation of troposphere path delay in zenith direction together with other parameters reduces the contribution of the unaccounted tropospheric path delay to less than 0.5 mas.

References

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