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Searching for High Quality VLBI Calibrators

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Abstract

Phase referencing techniques are now commonly used with VLBI astronomical observations for the imaging of weak radio sources, and for the determination of relative positions with accuracies as small as tens of micro-arcseconds. This observing scheme alternates observations every few minutes between the target source and a suitable calibrator detectable in a few minutes, typically with correlated flux density > 50 mJy, less than several degrees from the target source. Over the last seven years, a VLBA Calibrator Survey (VCS1) with dual-frequency S/X observations has been made for over 1800 radio sources. Most sources are suitable for phase referencing, and some of these sources are potential ICRF candidates. We are continuing the search for calibrators in regions of the sky with a low density of calibrators.

1. The VCS1 Calibrator Survey

The VCS1 observations were made with the VLBA in ten 24-hr sessions between August 1994 and August 1997; a full description of these observations and results are given elsewhere [1]. The observing scheme used a dual-frequency geodetic mode, observing simultaneously at 2.3 and 8.4 GHz, with a 100 MHz spanned bandwidth at 2.3 GHz and 400 MHz at 8.4 GHz to provide accurate group delays. Most of the sources were selected from the Jodrell Bank–VLA astrometric survey (JVAS) [2]. For all sessions, JVAS sources were selected from a limited range of declination, but were interspersed with 57 well-observed ICRF sources around the sky in order to determine the necessary geodetic/astrometric parameters needed for accurate position determination. For each source in a session, two or three scans, each of length 1.5 minutes, were made.

Using the AIPS calibration package, we applied the apriori amplitude calibration of the telescopes and then detected the source using fringe-fitting techniques. The data were then edited, imaged and self-calibrated using the Caltech Difmap package. The typical result for a sources suitable as a phase reference is shown in Figure 1. Approximately 1300 of the sources had significant emission in a compact component with flux density > 100 mJy and are suitable for phase referencing with a sensitive system such as the VLBA.

Astrometric processing of the sources was made using the NASA Goddard Space Flight Center Calc/Solve software package. Solve solutions were made for each session to determine large position offsets and to flag bad data. However, the final positions were generated from a solution made from all ten sessions. Over half of the sources have an estimated position error < 1 mas, and those few sources with errors larger than 10 mas are very resolved. Some of the weaker but point-like sources have positions derived only from the 8.4 GHz data. Relevant information on the VCS1 sources can be found in http://magnolia.nrao.edu/vlba_calib/index.html.

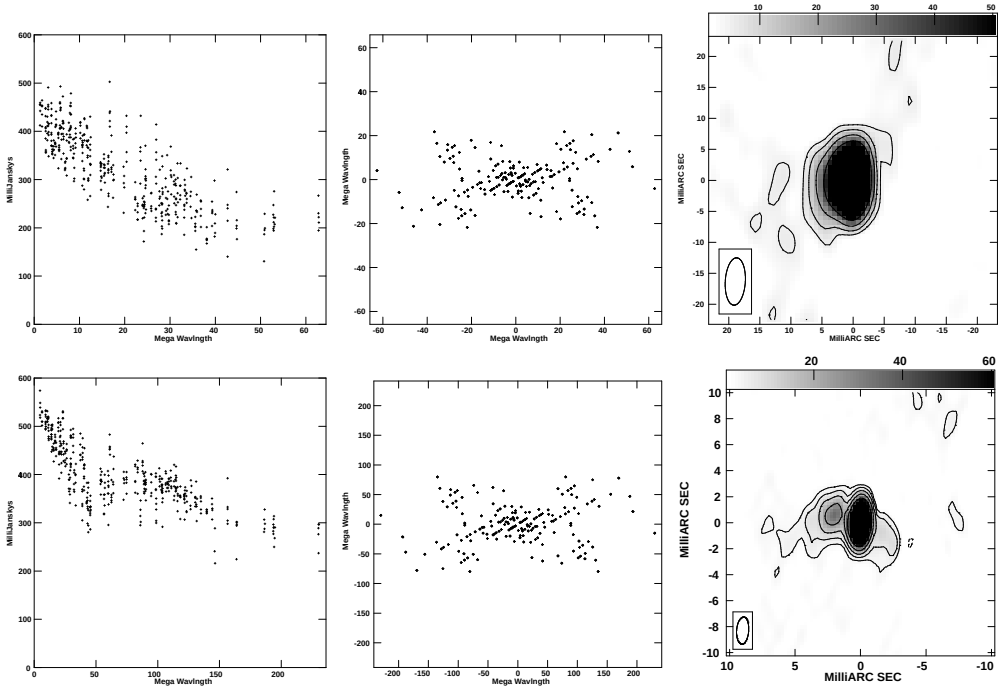

Figure 1. **Results for J0004−1148:** Top Line=2.3 GHz; Bottom Line=8.4 GHz. Left=visibility versus baseline length; Center=u-v coverage; Right=radio image. Bottom contour is 5 mJy at 2.3 GHz and 3 mJy at 8.4 GHz, with contour levels at -1,1,2,4,8,16,32,64. The resolution is shown by the ellipse in the bottom left of each contour plot.

2. The VCS2 Survey Extension

Two additional 24-hour sessions (VCS2) are scheduled for observations in Jan 2002 and April 2002 to fill existing holes in the present sky coverage of calibrators: in the declination range $-20°$ to $-45°$; near the galactic plane; and for ICRF sources with somewhat limited structural information. A total of about 500 additional potential calibrator sources will be checked, with emphasis on filling the obvious holes shown in the sky coverage in Figure 2, bottom.

The density of calibrator sources is becoming sufficiently large so that phase referencing calibrators within a few degrees of most targets will be available north of declination $-40°$. In order to obtain a deeper net of calibrators, as weak as 20 mJy, target-specific observation will be necessary.

3. Acknowledgements

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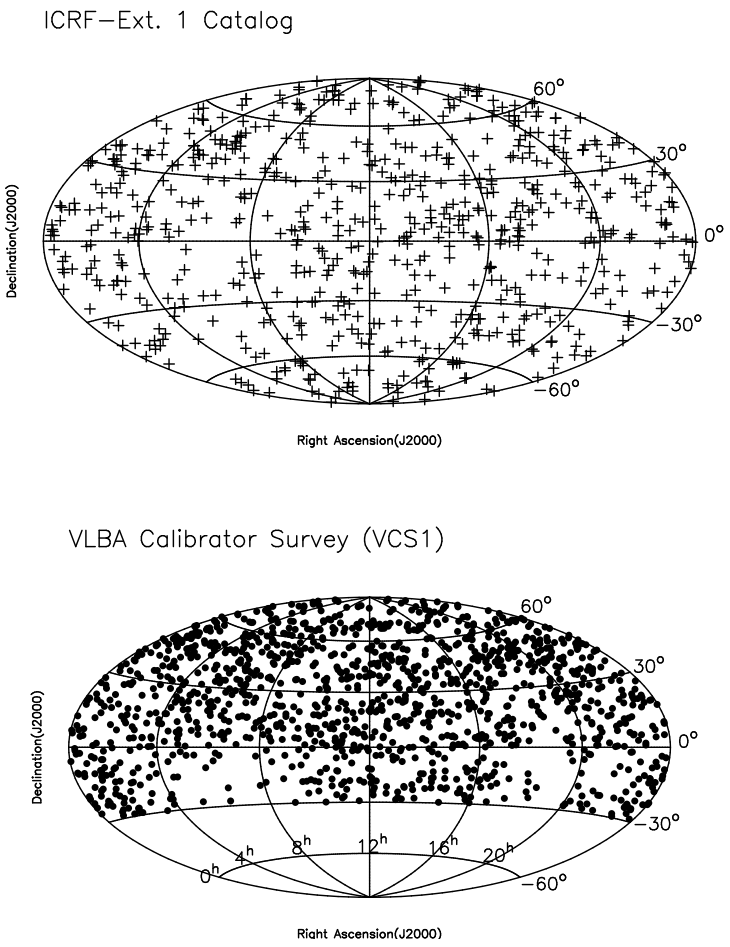

Figure 2. **Sky Coverage:** Top, ICRF-Ext 1 sources list; Bottom, VCS1 Catalog. The VCS2 observations will attempt to fill in the holes down to $-40°$.

References

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