

# USNO Analysis Center for Source Structure Report

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## Abstract

This report summarizes the activities of the United States Naval Observatory Analysis Center for Source Structure for calendar year 2008. VLBA RDV experiments RDV67 and RDV69 were calibrated and imaged. Images from these two experiments, together with images from RDV14, RDV17, RDV19, and RDV22, were added to the USNO Radio Reference Frame Image Database. A Southern Hemisphere imaging and astrometry program for maintenance of the ICRF continued. Activities planned for the year 2009 include continued imaging of ICRF sources at standard and higher frequencies and continued analysis of source structure and its variation.

## 1. Analysis Center Operation

The Analysis Center for Source Structure is supported and operated by the United States Naval Observatory (USNO). The charter of the Analysis Center is to provide products directly related to the IVS determination of the “definition and maintenance of the celestial reference frame.” These include, primarily, radio frequency images of ICRF sources, intrinsic structure models derived from the radio images, and an assessment of the astrometric quality of the ICRF sources based on their intrinsic structure.

The Web server for the Analysis Center is hosted by the USNO and can be accessed by pointing your browser to

[http://rorf.usno.navy.mil/ivs\\_saac/](http://rorf.usno.navy.mil/ivs_saac/)

The primary service of the Analysis Center is the Radio Reference Frame Image Database (RRFID), a Web accessible database of radio frequency images of ICRF sources. The RRFID contains 6,231 Very Long Baseline Array (VLBA) images (a 25% increase over the previous year) of 685 sources (an 8% increase over the previous year) at radio frequencies of 2.3 GHz and 8.4 GHz. Additionally, the RRFID contains 1339 images (a zero percent increase over the previous year) of 274 sources (a 1% increase over the previous year) at frequencies of 24 GHz and 43 GHz. The RRFID can be accessed from the Analysis Center Web page or directly at

<http://www.usno.navy.mil/rrfid/>

The RRFID also contains 74 Australian Long Baseline Array (LBA) images of 69 Southern Hemisphere ICRF sources at a radio frequency of 8.4 GHz.

Shown in Figure 1 is the distribution on the sky of the sources which have been imaged at 24 GHz.

## 2. Current Activities

### 2.1. VLBA Imaging

VLBA experiment RDV69 (2008MAY14) was calibrated and imaged, adding 201 (100 S-band; 101 X-band) images to the RRFID including images of 19 sources (0131-450, 0316-444, 0437-454, 0632-183, 0648-287, 0733-187, 1223-188, 1333-152, 1418-192, 1600+294, 1639-200, 1718-259, 1845-273, 1925-206, 2000-330, 2149-306, 2056-369, 2314-409, and 2329-415) not previously imaged.

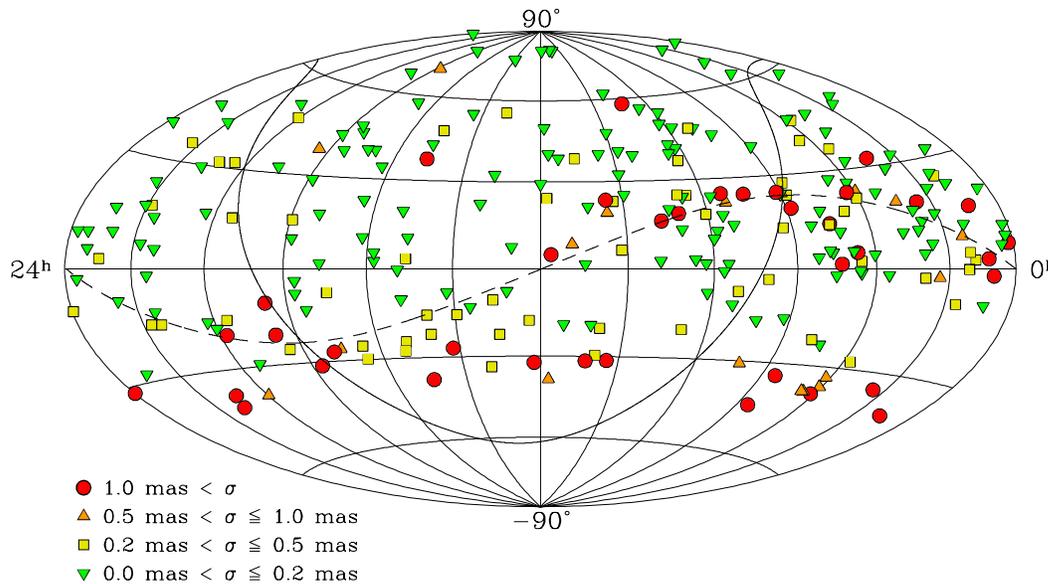


Figure 1. Distribution of the sources which have been imaged at 24 GHz shown on an Aitoff equal area projection of the celestial sphere. The different symbols represent the approximate positional uncertainty from a recent global astrometric solution (see § 2.2) as indicated by the key.

VLBA experiment RDV67 (2008JAN23) was calibrated and imaged, adding 194 (97 S-band; 97 X-band) images to the RRFID including images of 17 sources (0131-367, 0244-452, 0451-282, 0558-396, 0625-354, 1038+52A, 1251-197, 1333-337, 1404-342, 1531-352, 1645-329, 1705-353, 1710-323, 1749+096, 1751+441, 1926+087 and 2106-413) not previously imaged.

VLBA experiment RDV22 (2000JUL06) was calibrated and imaged, adding 179 (89 S-band; 90 X-band) images to the RRFID including images of 3 sources (822-173, 1829-106, and 2211-388) not previously imaged. These results were contributed by Glenn Piner and Corey Nichols of Whittier College who calibrated, edited, and imaged the data.

VLBA experiment RDV19 (2000JAN31) was calibrated and imaged, adding 171 (85 S-band; 86 X-band) images to the RRFID including images of 3 sources (0426-380, 0430+289, and 2054-377) not previously imaged. These results were contributed by Glenn Piner and Corey Nichols of Whittier College who calibrated, edited, and imaged the data.

VLBA experiment RDV17 (1999AUG02) was calibrated and imaged, adding 159 (77 S-band; 82 X-band) images to the RRFID including images of 2 sources (0651+410 and 1125+596) not previously imaged. These results were contributed by Glenn Piner and Corey Nichols of Whittier College who calibrated, edited, and imaged the data.

VLBA experiment RDV14 (1999APR15) was calibrated and imaged, adding 180 (90 S-band; 90 X-band) images to the RRFID including images of 2 sources (0844+258 and 1239+606) not previously imaged. These results were contributed by Glenn Piner and Corey Nichols of Whittier

College who calibrated, edited, and imaged the data.

Collaborations continue with Glenn Piner at Whittier College and Patrick Charlot of Bordeaux University to calibrate and image several of the VLBA RDV experiments.

## 2.2. VLBA High Frequency Imaging

VLBA observations to extend the ICRF to 24 and 43 GHz continued in 2008. These observations are part of a joint program between the National Aeronautics and Space Administration, the USNO, the National Radio Astronomy Observatory (NRAO), and Bordeaux Observatory. During the calendar year 2008 two papers were submitted for publication in the refereed literature: 1) “The Celestial Reference Frame at Higher Radio Frequencies. I. Astrometry from VLBA Observations at 24 and 43 GHz” by Lanyi et al. and 2) “The Celestial Reference Frame at Higher Radio Frequencies. II. VLBA Imaging at 24 and 43 GHz” by Charlot et al. Shown in Figure 1 is the distribution on the sky of the sources for which accurate astrometric positions have been determined at 24 GHz.

## 2.3. ICRF Maintenance in the Southern Hemisphere

The USNO and the Australia Telescope National Facility (ATNF) continue a collaborative program of VLBI research on Southern Hemisphere source imaging and astrometry using USNO, ATNF, and ATNF-accessible facilities. These observations are aimed specifically toward improvement of the ICRF in the Southern Hemisphere. One celestial reference frame experiment, CRF-S12, was scheduled with antennas at Hobart, Australia; Hartebeesthoek, South Africa, and the 70-meter Deep Space Network antenna at Tidbinbilla, Australia.

A program to monitor the structure of quasars south of declination  $-30^\circ$  that are either known to be gamma-ray loud or are expected to be gamma-ray loud continued. The program, called TANAMI (Tracking Active galactic Nuclei with Australia Milliarcsecond Interferometry), is observing a sample of about 40 quasars at 8 GHz and 24 GHz bands, with half of the sample observed every two months.

## 3. Staff

The staff of the Analysis Center is drawn from individuals who work at the USNO. The staff are: Alan L. Fey, David A. Boboltz, Roopesh Ojha, Ralph A. Gaume, and Kerry A. Kingham.

## 4. Future Activities

The Analysis Center currently has a program of active research investigating the effects of intrinsic source structure on astrometric position determination. Results of this program are published in the scientific literature.

The following activities for 2009 are planned:

- Continue imaging and analysis of VLBA 2.3/8.4/24/43 GHz experiments
- Make additional astrometric and imaging observations in the Southern Hemisphere in collaboration with ATNF partners