VLBA IMAGING OF ICRF3 SOURCES

M. JOHNSON[1], L. HUNT[1,2], A. FEY[1], D. GORDON[3], & J. SPITZAK[1,4]

[1] United States Naval Observatory - USA - megan.johnson@navy.mil
[2] George Mason University - USA - lucas.hunt.ctr@navy.mil
[3] NVI Inc., NASA Goddard Space Flight Center - USA - david.gordon-1@nasa.gov
[4] Computational Physics, Inc. - USA - jspitzak@cpi.com

ABSTRACT

We present images created from the first year of an ongoing campaign to monitor sources used for the third iteration of the International Celestial Reference Frame (ICRF) with the Very Long Baseline Array (VLBA). Imaging these sources allows us to determine spectral index, peak flux density, compactness and source structure index. This information is crucial to understanding source structure and variability which better allows us to determine if a source is suitable for inclusion in the ICRF and suitability as a phase reference calibrator. We also present the current status and future of the Fundamental Reference Image Data Archive which is a new data archive to include not only images of the sources in this observing campaign, but a suite of ancillary data related to the ICRF sources.

1. INTRODUCTION

The International Celestial Reference Frame is the realization of the International Celestial Reference System and is comprised of positions of compact quasars calculated from Very Long Baseline Interferometry (VLBI) observations at 2.3 GHz and 8.4 GHz. It has now been through three full realizations (Hereafter ICRF1, ICRF2, and ICRF3) ((Ma et al, 1998; Fey et al, 2015; Charlot et al., 2020, respectively). The third realization (ICRF3; Charlot et al. in progress) was adopted by the International Astronomical Union on 1 January 2019.

The sources that make up the ICRF are compact radio quasars believed to be so distant that they have no measurable proper motions or parallax. Therefore, any observable changes in position would need to be derived from intrinsic properties of the source itself such as, outflows, hot spots within jets, shocks, or unresolved binary supermassive black holes. Understanding the physical source of positional changes and offsets for the ICRF quasars is an active area of current research. It is in this area of research that we focus our talk.

In January 2017, the United States Naval Observatory (USNO) entered an agreement with the Long Baseline Observatory to contribute 50% of the operations cost in exchange for 50% of the time on the VLBA. Because of the USNO partnership with the VLBA, the Long Baseline Observatory was disbanded and the management for the VLBA was restored to the NRAO. The USNO has since begun an imaging campaign designed to study and monitor the source structure, flux density, and positional properties of more than 3500 quasars from the ICRF.

This conference proceeding will provide an update to the imaging of the aforementioned monitoring campaign, and describe how the data will be accessible in the future.

2. USNO VLBA IMAGING CAMPAIGN

We present an update to the imaging campaign and some of the initial analysis. For more information on the details of the image calibration, processing, and methodologies, please see Hunt et al. (2019).

We observed 3,628 sources over the 20 sessions during the course of 2017. The left panel of

Figure 1 shows nearly 3,000 sources were observed only once during the year and only one source was included in every observation. The right panel of Figure 1 shows a histogram of the peak flux distribution for all of the observed sources. The peak of the distribution is ∼75 mJy/bm.

The imaging success rate for our data was ∼93% at 8.7 GHz and ∼96% at 2.3 GHz. Due to limitations in some of the data, however, about 3% of the images from each observing session did not have enough *uv* coverage to form a high fidelity image and we therefore, flagged these images out of our final queue.

We are exploring new capabilities of NRAO's Common Astronomical Software Application (CASA) for moving toward an automated calibration and imaging pipeline. We have been successful in implementing a calibration script including the new CASA task *fringefit*, which solves for antenna-based phase, delay, and rate. We have also been successful in implementing CASA's *tclean* task for producing images, which have comparable rms noise to those images produced in AIPS and DifMAP. Progress is currently ongoing in this area.

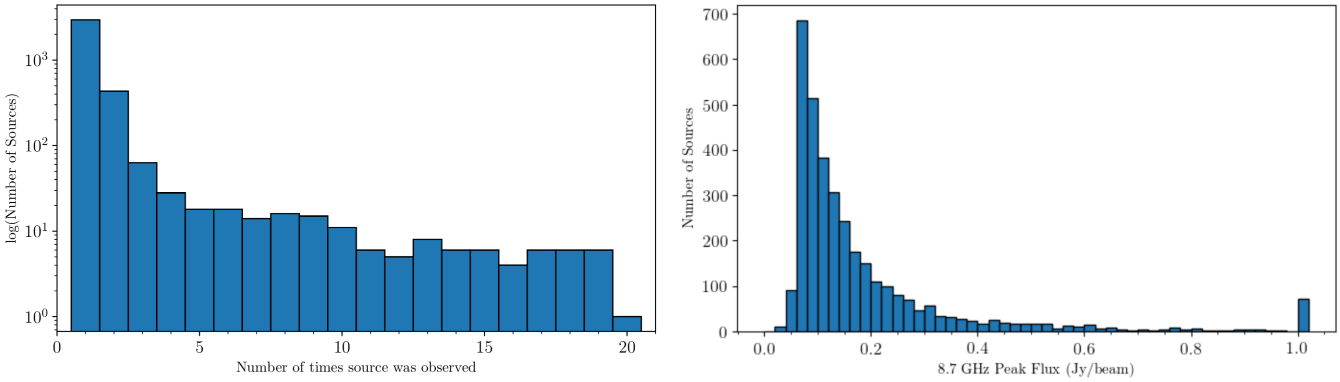

Figure 1: Left: Histogram showing how often sources were visited over 20 sessions. Right: Histogram showing peak flux distribution measured at 8.7 GHz. The bin at 1.0 includes all sources brighter than 1 Jy.

3. FUNDAMENTAL REFERENCE IMAGE DATA ARCHIVE

USNO is responsible for preparing images of sources included in the ICRF. Traditionally we have made those images publicly available to the astronomical and geodetic communities through the Radio Reference Frame Image Database. We are upgrading that website and changing the name to the Fundamental Reference Image Data Archive (FRIDA). The upgraded FRIDA website will include data from additional observations that span wavelengths from across the electromagnetic spectrum including, radio, near-infrared, optical, and X-ray. The available radio VLBI images will go back to data included in ICRF1 and include images of sources from S-band through Ka-band. The upgraded website will include data on each source including radio contour plots of the source, the calibrated data sets, and log files to show how the imaging was processed. The site will allow users to find sources based on specific search criteria, and download the data that might be useful to their research.

4. REFERENCES

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