Bordeaux Observatory Analysis Center Report

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Abstract

This report summarizes the activities of the Bordeaux Observatory Analysis Center in 2007. During this period, we have continued the VLBI imaging activity initiated previously. A total of 574 VLBI maps have been produced by full imaging of three RDV sessions. Other activities focus on regular processing of the IVS-R1 and IVS-R4 sessions and calculation of additional structure indices to refine our source categorization based on this criterion. Newly developed activities include simulations to study the imaging capabilities of the next generation VLBI system and, on the observational side, the initiation of a VLBI survey of weak sources that are potential candidates to link the ICRF and the future GAIA frame. Plans for 2008 follow the same analysis and research lines, with also specific contributions in the framework of the Working Group on the Second Realization of the International Celestial Reference Frame.

1. General Information

The Bordeaux Observatory is located in Floirac, near the city of Bordeaux, in the southwest of France. It is funded by the University of Bordeaux and the CNRS (National Center for Scientific Research). VLBI analysis and research activities are primarily developed within the M2A group ("Métrologie de l'espace, Astrodynamique, Astrophysique") led by P. Charlot.

The contribution of Bordeaux Observatory to IVS has been mostly concerned with the maintenance, extension, and improvement of the International Celestial Reference Frame (ICRF). This includes regular VLBI imaging of the ICRF sources and evaluation of their astrometric suitability, as well as developing specific VLBI observing programs aimed at extending the frame.

In addition, the Bordeaux group is in charge of the VLBI component in the multi-technique GINS software [1] as part of a collaborative effort within the French "Groupe de Recherches de Géodésie Spatiale" (GRGS) to combine VLBI and space geodetic data (SLR, GPS, DORIS) at the observation level. This effort also involves space geodesy groups in Toulouse, Grasse, and Paris.

2. Description of Analysis Center

The Bordeaux Observatory Analysis Center routinely analyzes the weekly IVS-R1 and IVS-R4 sessions. This analysis is now based on the GINS software, whereas it was carried out with the JPL VLBI estimation software MODEST [2] in previous years. Results derived with GINS have been checked against IVS solutions [3]. In the fall of 2007, we installed the Linux version of GINS (GINS-PC) in Bordeaux, which should facilitate the production of future operational solutions.

Another activity is focused on producing VLBI maps of the ICRF sources by analysis of data from the RDV sessions. This analysis is conducted with the AIPS and DIFMAP calibration and imaging software. The aim of such regular imaging is to compare source structural evolution and positional instabilities. The maps are also used to derive "structure indices" in order to characterize the astrometric suitability of the sources. Such studies will be important in the framework of the realization of the next ICRF by a joint IAU/IVS/IERS working group within the coming year.

In addition, the Bordeaux group has been involved in the VLBI2010 activities. This includes studies of source structure effects from wide band delay measurements and simulations of VLBI maps for the evaluation of the imaging capabilities of VLBI2010 test networks.

3. Scientific Staff

The IVS group in Bordeaux comprises the following five individuals who are involved either part time or full time in VLBI analysis and research activities, as described below:

- Patrick Charlot (50%): overall responsibility for Analysis Center work and data processing. His major research interests include the densification and extension of the ICRF and studies of source structure effects in astrometric VLBI data.
- Antoine Bellanger (100%): engineer with background in statistics and computer science. His main role is to conduct initial VLBI data processing and develop analysis tools as needed. He is also the Web master for the M2A group.
- Géraldine Bourda (50%): postdoc fellow funded by the French space agency (CNES). She is in charge of the VLBI analysis with GINS for combining space geodesy data at the observation level. She is also leading an observing program for linking the ICRF and the GAIA frame.
- Arnaud Collioud (100%): engineer with background in astronomy and interferometry. His task is to process the RDV sessions with AIPS and DIFMAP for imaging the sources. In addition, he develops simulations to study the imaging capabilities of VLBI2010 networks.
- Alain Baudry (10%): radioastronomy expert with specific interest in radio source imaging and astrometric VLBI.

4. Analysis and Research Activities during 2007

As noted above, a significant part of our activity consists of systematic imaging of all extragalactic sources observed during the RDV sessions. During the past year, three such sessions have been processed (RDV26, RDV62, and RDV64), resulting in 574 VLBI images at either X or S band for 200 different sources. See Fig. 1 for a sample of the images derived from the RDV64 session, observed on 2007 July 10. Overall, we have now produced a total of 1122 images for 264 different sources. The imaging work load has been shared between USNO and Bordeaux Observatory since 2007: the USNO group processes the odd-numbered RDV sessions while the Bordeaux group processes the even-numbered ones. In addition, we collaborate with Whittier College (USA) and the Max Planck Institute for Radioastronomy in Bonn for analysis of the earlier RDV sessions.

In order to make these images available, we have developed a prototype database which also includes the structure correction maps and structure indices derived from the VLBI images. Calculation of structure indices is useful to categorize the sources and to identify those that remain astrometrically suitable over time. Based on our VLBI images and those from the Radio Reference Frame Image Database (RRFID), we have obtained 2697 structure indices at X band (from 577 different ICRF sources) and 2388 structure indices at S band (from 492 different ICRF sources), with up to 28 VLBI epochs available for the most intensively observed sources [4]. Among these, there are about 200 sources that are found to be astrometrically suitable at any epoch. Such sources are potential candidates to serve as defining sources in the next realization of the ICRF.

During the past year, we also initiated a new VLBI observational program dedicated to observing 450 weak sources that are potential candidates to link the ICRF and the future GAIA frame. These candidates were selected on the basis of their optical counterpart ($V \leq 18$), their total flux density ($S \geq 20$ mJy) and their declination ($\delta \geq -10^\circ$) so that they can be observed with northern

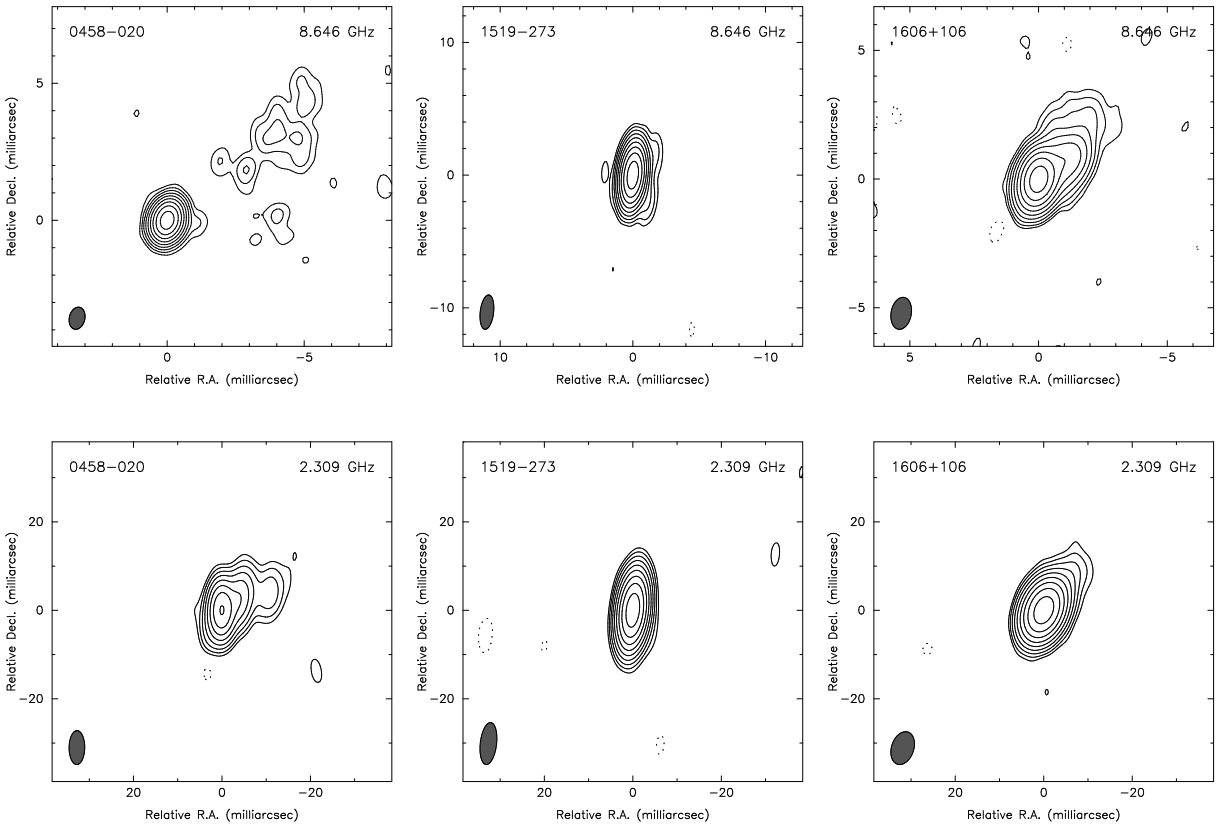

Figure 1. VLBI images at X band (upper panel) and S band (lower panel) for three ICRF sources (0458−020, 1519−273, and 1606+106) as derived from the data of the RDV64 session conducted on 2007 July 10.

VLBI arrays. Pilot observations were carried out with the European VLBI Network (EVN) in June and October 2007 in order to identify which sources are detectable with VLBI. Interestingly, about 90% of the targets turned out to be detected, with typical VLBI flux densities of 25 mJy at X band and 45 mJy at S band [5]. This very high detection rate sets excellent prospects for follow up imaging and precise astrometry on these targets and, in the longer term, for the ICRF–GAIA link.

Another activity that was initiated during the past year is the study of the imaging capabilities of the next generation VLBI system as a contribution to the work of the VLBI2010 Committee. To this end, a pipeline that simulates VLBI images from VLBI2010 schedules has been developed. Based on this pipeline, simulated VLBI images have been successfully produced for various schedules depending on the network configuration, the number of observations per day, and the observing strategy. A major conclusion of this study is that a 16-station network fails to properly reconstruct extended structures for sources at low declination, whereas a 32-station network reconstructs such structures in a reliable way for sources at any declination. Details of the pipeline and results of the simulations will be reported at the forthcoming IVS General Meeting [6].

5. Outlook

For the year 2008, our plans include the following:

- Keep on analyzing the new IVS-R1 and IVS-R4 sessions as they become available and develop appropriate procedures for future operational analysis with GINS.
- Continue the processing of the RDV sessions to monitor the X and S band structural variability of the ICRF sources in cooperation with USNO and other groups that contribute to the imaging of these sessions.
- Continue to evaluate the astrometric suitability of the ICRF sources as new maps become available and categorize the sources according to our structure index criterion.
- Contribute to the work of the IAU/IVS/IERS Working Group on the Second Realization of the ICRF with emphasis on the selection of defining sources and identification of unstable sources.
- Finalize the prototype database that holds our source maps, structure correction maps, and structure indices so that these can be made publicly available through the Web.
- Pursue further our studies of the imaging capabilities of the next generation VLBI system by carrying out additional simulations within the framework of the VLBI2010 Committee.

References

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