TIGO and O'Higgins Considerably Improve the TANAMI AGN Monitoring Program

– Roopesh Ojha (USNO), Matthias Kadler (University of Erlangen-Nuremberg), Christian Plötz, Hayo Hase (both BKG), and the TANAMI Team

The launch of the Fermi Gamma Ray Space Observatory (e.g., N. Gehrels and P. Michelson, Astroparticle Physics, Vol. 11, pp. 277-282, 1999) in June 2008 has ushered in an exciting era in the study of the physics of Active Galactic Nuclei (AGN). In combination with other space and ground based facilities at other wavelengths, we have the unprecedented opportunity to observe AGN across the electromagnetic spectrum almost simultaneously. VLBI observations are an essential part of such studies as they are the only way to spatially resolve the sub-parsec level emission regions where the high-energy radiation is believed to originate. VLBI observations are also the only way to directly measure the relativistic motion in AGN jets allowing us to calculate intrinsic jet parameters such as jet speed, Doppler factor, and opening and inclination angles.

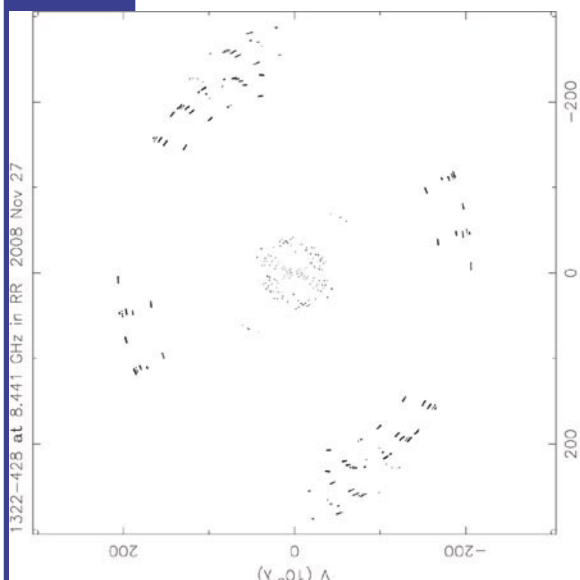

Figure 1: uv-coverage for an observation of radio galaxy Centaurus A on 28 November 2008 using the LBA, TIGO, and O'Higgins.

The TANAMI (Tracking AGN with Austral Milliarcsecond Interferometry; homepage at `http://pulsar.sternwarte.uni-erlangen.de/tanami/`) program provides parsec scale monitoring of extragalactic gamma-ray sources of the Southern Sky (e.g., R. Ojha, M. Kadler, S. Tingay, J. Lovell, and the TANAMI and GLAST/LAT AGN teams, AIP Conference Proceedings, Vol. 1053, pp. 395-401, 2008). These bimonthly observations are made at two frequencies: 8.4 and 22 GHz. Observations began in November 2007 using the Australian Long Baseline Array (LBA). The LBA normally consists of telescopes at Parkes, Narrabri, Mopra (all in New South Wales), Hobart (Tasmania), Ceduna (South Australia), and Hartebeesthoek (South Africa; currently not operational). Telescopes of NASA's Deep Space Network at Tidbinbilla (Australian Capital Territory) participate when available. Two of these antennas, Hobart and Hartebeesthoek, are also IVS Network Stations.

The LBA is a unique facility for VLBI imaging of Southern-Hemisphere sources. However, as an ad-hoc array, its uv-coverage has limitations, constraining the fidelity of the resulting images. TANAMI was granted access to two additional telescopes, TIGO and O'Higgins, through a successful IVS proposal, which was motivated by our desire to improve the uv-coverage provided by the LBA.

The German Antarctic Receiving Station at O'Higgins is a 9-m dish located on the Antarctic Peninsula in Antarctica. TIGO (Transportable Integrated Geodetic Observatory) is a 6-m dish located in Concepción, Chile. Both these telescopes are operated by the Bundesamt für Kartographie und Geodäsie (BKG) in Germany. Observations with these two telescopes commenced in November 2008 and their participation dramatically improved our uv-coverage as is evident from Figure 1, which shows the uv-coverage for an observation of Centaurus A on 28 November 2008. The uv-plane is a representation of how well the interferometer is able to map the target. It takes into account the location and orientation of each baseline and how both change during the course of the observations. In Figure 1 the inner dots are the baselines provided by the Australian antennas, while all of the outer dots are contributed by baselines to TIGO and O'Higgins. The powerful impact of including TIGO and O'Higgins is immediately obvious. So, how well does this improved uv-coverage translate into improved images?

Figures 2 and 3 show images of the radio galaxy Centaurus A without and with these two additional IVS telescopes, respectively. The map resolution increases about four times when including TIGO and O'Higgins. Centaurus A is the closest radio galaxy (3.4 Mpc away) and its bright jet and faint counterjet are observable with this array at sub-parsec resolutions. In fact, this image is one of the highest resolution images of an AGN jet ever made!

Because of the high flux density of sources in the TANAMI program and given the large antenna diameters at the Australian end of the long baselines, the baseline sensitivity to the two relatively small new stations is not a limitation. Analysis of these spectacular images is in progress and can be expected to bear rich scientific fruit. This success has led to the desire to include O'Higgins more frequently in the TANAMI observation program, which is for logistical reasons not yet possible. [Note from the editor: O'Higgins observes in the southern summer when VLBI personnel man the station.]

In conclusion, the participation of TIGO and O'Higgins has resulted in a spectacular improvement in the quality of images and consequently the quality of science that the TANAMI program is producing. We look forward

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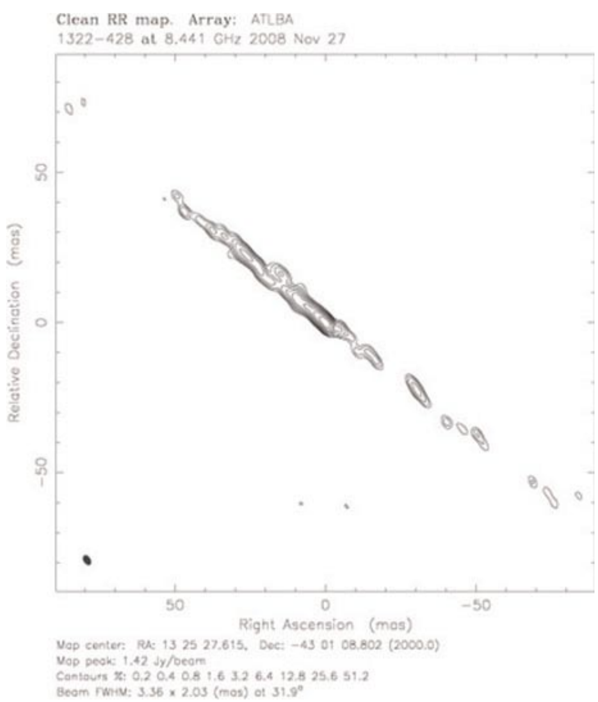

Figure 2: Image of radio galaxy Centaurus A derived from LBA data only.

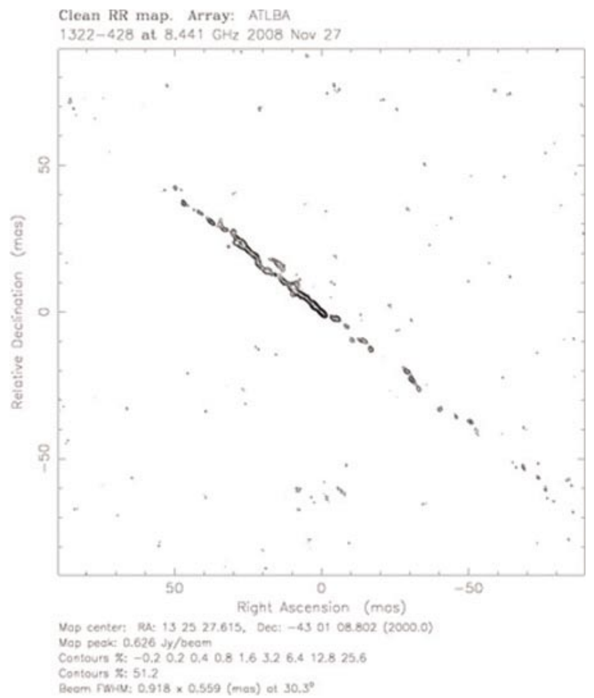

Figure 3: Image of radio galaxy Centaurus A derived from LBA, TIGO, and O'Higgins data.

to continued observations with these two telescopes for the lifetime of the TANAMI program.

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