# The TANAMI Program:

## Southern-Hemisphere VLBI Monitoring of Relativistic Jets in Active Galaxies

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**We describe the observation strategy and source-selection criteria of the TANAMI program and present first 22 GHz images of Fermi/LAT detected AGN jets.**

*Abstract*

TANAMI (Tracking Active Galactic Nuclei with Austral Milliarcsecond Interferometry) is a monitoring program to study the parsec-scale structures and dynamics of relativistic jets in active galactic nuclei (AGN) of the Southern Hemisphere with the Australian Long Baseline Array (LBA) and the trans-oceanic antennas Hartebeesthoek, TIGO and O'Higgins. TANAMI is a unique complement to other ongoing VLBI monitoring programs of AGN as it focuses on extragalactic sources south of $-30$ degrees declination with observations at $8.4$ GHz and $22$ GHz every two months at milliarcsecond resolution. The initial TANAMI sample of 43 sources has been defined to include the most promising candidates for bright $\gamma$-ray emission known to detections of the Large Area Telescope (LAT) of *Fermi*. Since November 2008, we have been adding new sources to the sample, which now includes all known radio- and $\gamma$-ray bright AGN of the Southern Hemisphere. The combination of VLBI and $\gamma$-ray observations is crucial to understand the broadband emission characteristics of AGN and the nature of relativistic AGN jets. Here, we introduce the TANAMI program and present selected images at $8.4$ GHz and for the first time at $22$ GHz.

## Observations:

TANAMI observations are made with the five antennas of the Long Baseline Array (LBA), the $70$ m and $34$ m telescopes at NASAs Deep Space Network (DSN) located at Tidbinbilla, $26$ m South-African Hartebeeshoeck antenna (until 2008), the $9$ m German Antarctic Receiving Station (GARS) in O'Higgins, Antarctica, and the $6$ m Transportable Integrated Geodetic Observatory (TIGO) in Chile. One 24-hour epoch at each frequency is observed approximately every two months. For this array, the typical angular resolution achieved is $(1.5-4.0)$ mas by $(0.5-1.0)$ mas. A typical (u−v)-coverage is shown in Fig.3.

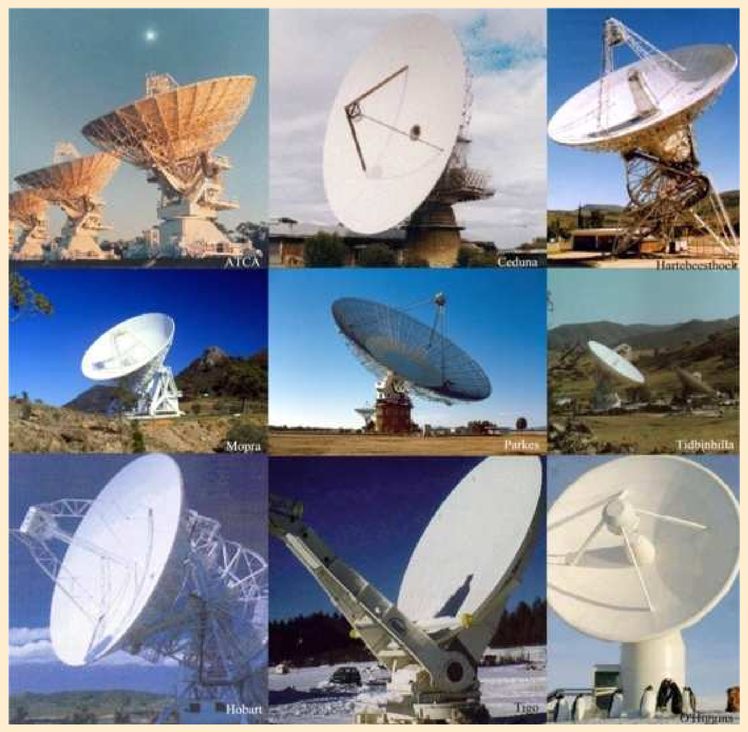


Fig.1: TANAMI observations are made with the Australian Long Baseline Array (LBA), using the Australian antennas at ATCA ($5\times22$ m), Ceduna ($30$ m), Hobart ($26$ m), Mopra ($22$ m),Parkes ($64$ m), and Tidbinbilla (DSN $70$ m or $34$ m) and the South-African antenna in Hartebeesthoek ($26$ m). Since 2009, TIGO in Chile ($6$ m) and OHiggins in Antarctica ($9$ m) compensate the currently inoperativ Hartebeesthoek telescope.

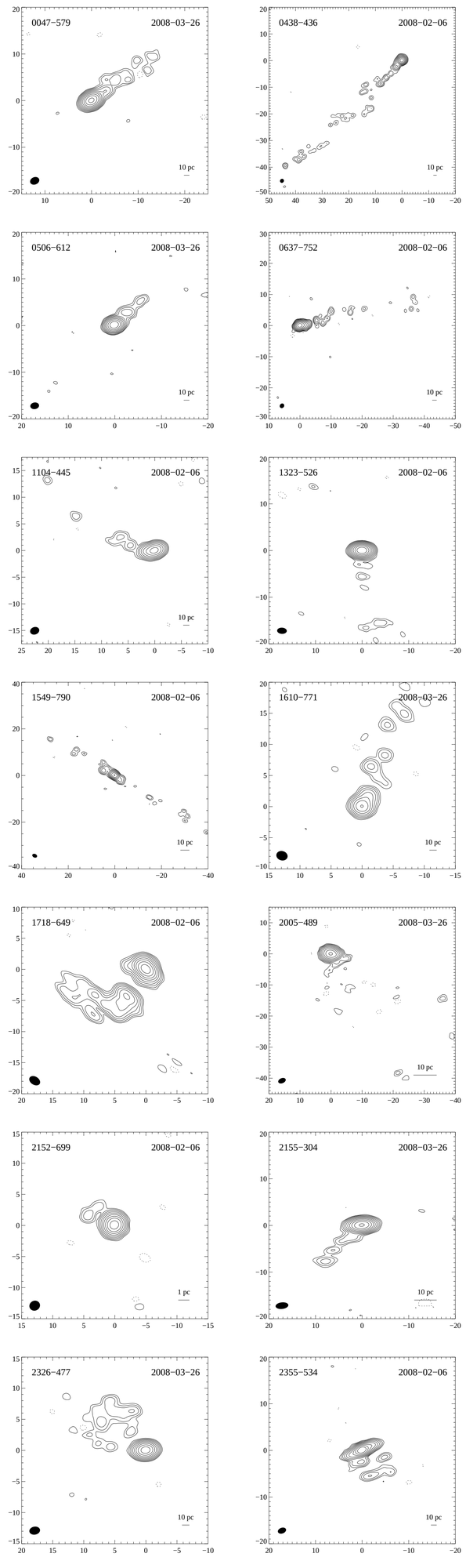


Fig.5: Selection of the first epoch $22$ GHz contour plots

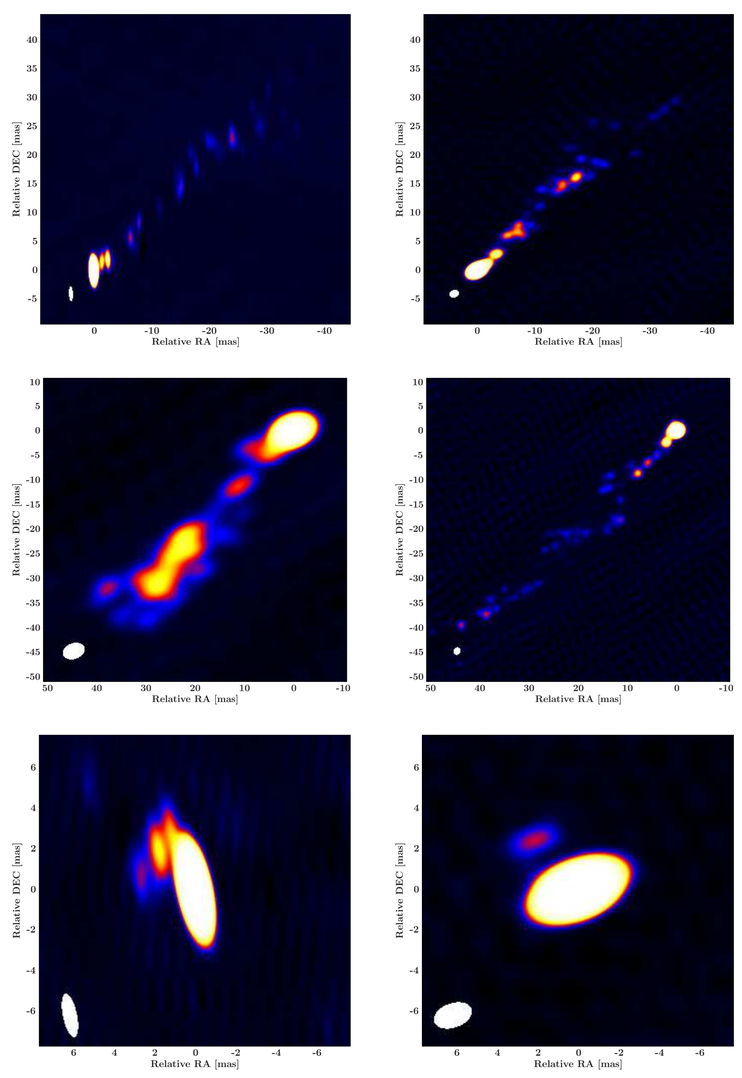


Fig.2: Tanami images of three selected sources: the $\gamma$-ray bright BL Lac object 0521−365, the distant and powerful but so-far not $\gamma$-ray detected quasar 0438−436, and the quasar 0537−441, one of the brightest $\gamma$-ray blazars in the sky and the object with the highest brightness temperature seen in first-epoch TANAMI observations of $>10^{14}$ K.
(Ojha et al.,"TANAMI First Epoch $8.4$ GHz Images", submitted to A&A)

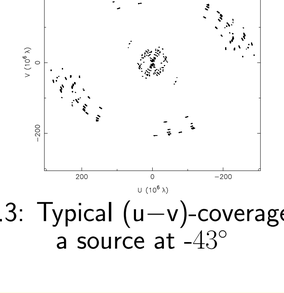


Fig.3: Typical (u−v)-coverage of a source at -43°

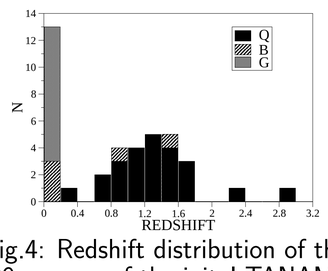


Fig.4: Redshift distribution of the 39 sources of the inital TANAMI sample with known redshift

## Sample Selection:

The initial TANAMI sample consists of 43 blazars located south of $-30$ degrees declination. It is a hybrid radio and $\gamma$-ray selected sample, which has been defined as a radio selected flux-density limited subsample and a $\gamma$-ray selected subsample of known and candidate $\gamma$-ray sources based on results of CGRO/EGRET. We included all known radio sources from the catalogue of Stickel et al. (1994) above a limiting radio flux density of $S_{5\,GHz}>2$ Jy, which have a flat radio spectrum between $2.7$ GHz and $5$ GHz. Furthermore we have been monitoring new LAT-detected AGN since November 2008. During 2009 this addition was continued so that by now our sample is composed of 65 sources.

## Source List

| IAU Name | Alt Name | LAT[a] | ID[b] | z |
|---|---|---|---|---|
| 0047−579 | | N | Q | 1.979 |
| 0055−328 | | N | U | - |
| 0208−512 | | Y | B | 0.99 |
| 0227−369 | | Y | Q | 2.115 |
| 0244−470 | | Y | U | - |
| 0302−623 | | N | U | - |
| 0332−376 | | N | U | - |
| 0332−403 | | Y | B | 1.445 |
| 0405−385 | | Y* | Q | 1.285 |
| 0412−536 | | Y* | U | - |
| 0426−380 | | N | Q | 1.1120 |
| 0438−436 | | N | Q | 2.863 |
| 0447−439 | | Y | B | 0.2050 |
| 0454−463 | | N | Q | 0.8528 |
| 0506−612 | | N | Q | 1.093 |
| 0516−621 | | Y | U | - |
| 0518−458 | PICTOR A | N | G | 0.035058 |
| 0521−365 | ESO 362−G021 | N | B | 0.055338 |
| 0524−485 | | N | U | - |
| 0537−441 | | Y | Q | 0.894 |
| 0625−354 | OH−342 | N | G | 0.054594 |
| 0637−752 | | N | Q | 0.653 |
| 0700−661 | | Y | U | - |
| 0717−432 | | N | U | - |
| 0812−736 | | N | U | - |
| 1057−797 | | Y | U | - |
| 1104−445 | | N | Q | 1.598 |
| 1144−379 | | Y | Q | 1.048 |
| 1257−326 | | N | Q | 1.256 |
| 1258−321 | ESO 443- G 024 | N | U | 0.0170 |
| 1313−333 | | N | Q | 1.21 |
| 1322−428 | CenA, NGC 5128 | Y | G | 0.001825 |
| 1323−526 | | N | U | - |
| 1333−337 | IC4296 | N | G | 0.012465 |
| 1344−376 | | N | U | - |
| 1424−418 | | N | Q | 1.522 |
| 1440−389 | | N | U | 0.0655 |
| 1454−354 | | Y | Q | 1.424 |
| 1501−343 | | N | U | - |
| 1505−496 | | N | U | - |
| 1549−790 | | N | G | 0.1501 |
| 1606−667 | | N | U | - |
| 1610−771 | | N | Q | 1.71 |
| 1714−336 | | Y | B | - |
| 1716−771 | NGC 6328 | N | U | - |
| 1718−649 | | N | G | 0.014428 |
| 1733−565 | | N | G | 0.098 |
| 1759−396 | | Y* | Q | 0.296 |
| 1804−502 | | N | Q | - |
| 1814−637 | | N | G | 0.06270 |
| 1933−400 | | N | Q | 0.965 |
| 1954−388 | | N | Q | 0.63 |
| 2005−489 | | Y | B | 0.0710 |
| 2027−308 | ESO 462−G 027 | N | G | - |
| 2052−474 | | Y | Q | 1.489 |
| 2106−413 | | N | Q | 1.058 |
| 2136−428 | | Y | B | - |
| 2149−306 | | N | Q | 2.345 |
| 2152−699 | ESO 075−G 041 | N | G | 0.028273 |
| 2155−304 | | Y | B | 0.116 |
| 2204−540 | | Y | Q | 1.206 |
| 2326−477 | | N | Q | 1.2990 |

[a] based on the LAT 3-month list (Abdo et al.,2009)
(*) denotes a low confidence detection
[b] optical counterpart, denoted as: (Q) quasar, (B) BL Lac object, (G) galaxy, (U) unclassified

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For more information on the TANAMI project, please see `http://pulsar.sternwarte.uni-erlangen.de/tanami/` or contact: Matthias.Kadler@sternwarte.uni-erlangen.de or rojha@usno.navy.mil