# Centaurus A: High-Resolution Imaging of the AGN in our Backyard

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## Abstract

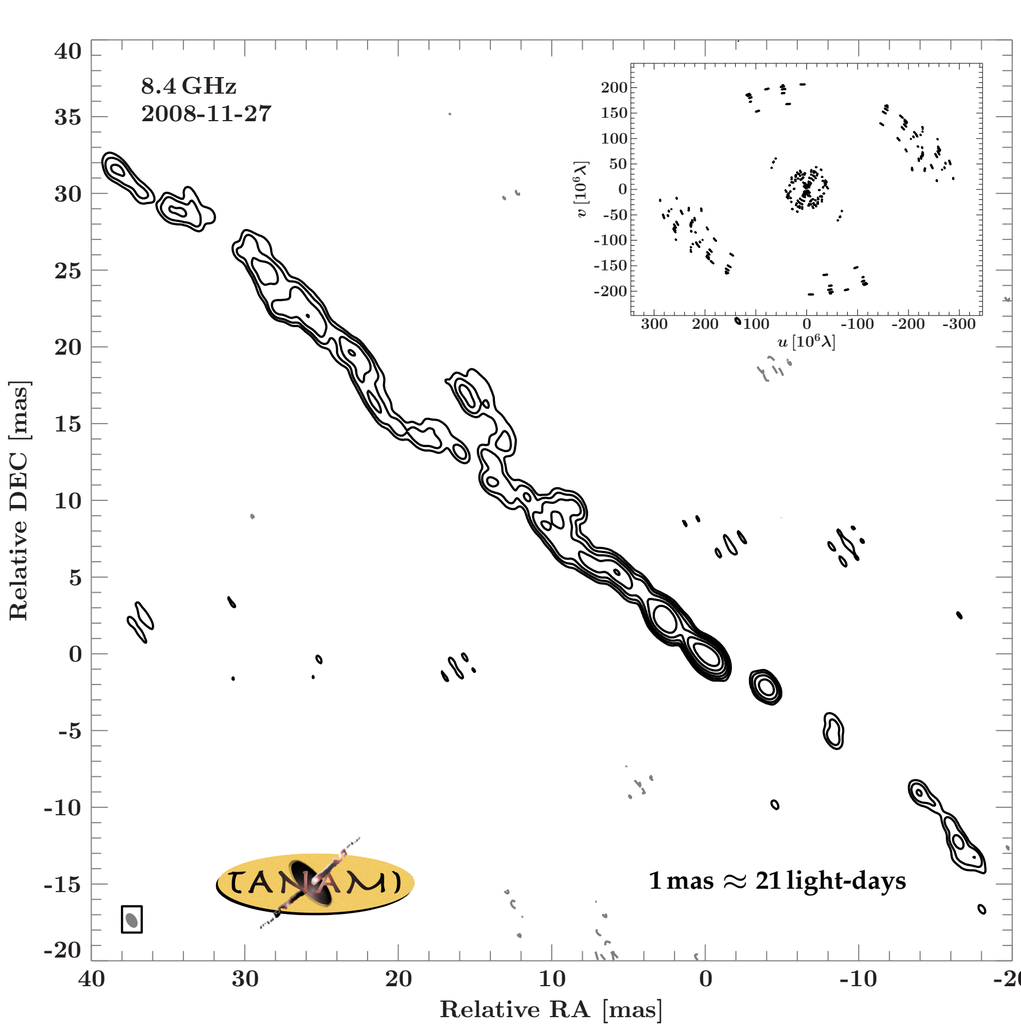
The closest radio-loud active galaxy, Centaurus A, at a distance of 3.8 Mpc is a prime target for VLBI observations providing access to unprecedented small linear scales, which is essential to studies of jet emission and propagation in the inner parsec region of an AGN. We present recent results from the AGN monitoring program TANAMI yielding a detailed cm-VLBI view of the complex central-parsec jet dynamics of Centaurus A at a resolution of tens of light-days. Additionally, we discuss the possibility of mm-VLBI observations of Centaurus A with existing and future VLBI stations, which would significantly improve the accessible linear resolution to below one light-day.

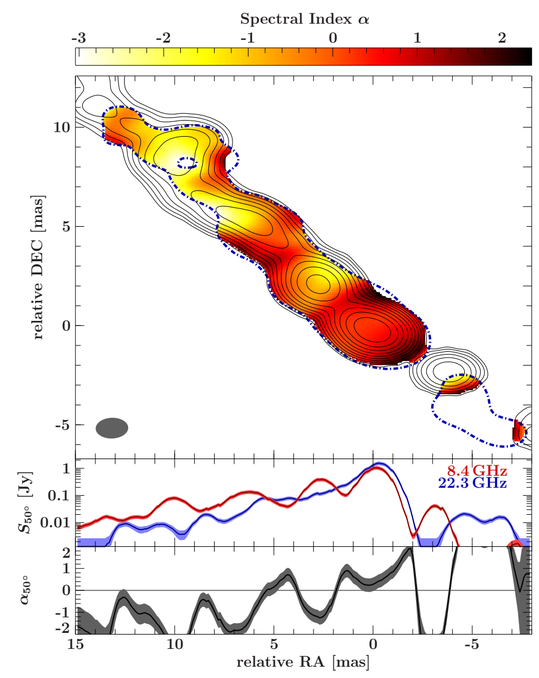
## TANAMI Results on Cen A

Published in Müller et al. 2014, A&A 569, A115:

- seven observations at 8.4 GHz over 3.5 years
- including the highest resolution image of Cen A (left figure, $(u, v)$-coverage is shown in the inset)
- kinematic analysis reveals apparent acceleration along the jet; best explained as a spine-sheath structure
- jet-widening at ∼25 mas from the core is a persistent feature; can be interpreted by a jet-star interaction

Have a look at a movie of the jet kinematics via the QR code




Spectral index map ($S_\nu \propto \nu^\alpha$) between 8.4 GHz and 22.3 GHz (Müller et al. 2011, A&A 530, L11). Top panel: 8.4 GHz image (black contours) overlayed with the 22.3 map (blue contour) and the resulting spectral index map. Middle and bottom panel: flux density profile and the resulting spectral index profile along the position angle of the jet.

## Prospects for mm-VLBI of Cen A

- Cen A provides the **highest accessible linear resolution for AGN**:

| Source | $M_{\rm BH}$ $[10^8\,M_\odot]$ | 50$\mu$as $[R_{\rm Sch}]$ | 50$\mu$as [light-days] | 20$\mu$as $[R_{\rm Sch}]$ | 20$\mu$as [light-days] |
|---|---|---|---|---|---|
| Cen A | 0.55 | 170 | **1.1** | 70 | **0.44** |
| M87 | 62 | 6.8 | 4.8 | 2.7 | 1.9 |

Values for M87 adapted from Doeleman et al. 2012, Sci. 338, 355. 50$\mu$as and 20$\mu$as are the assumed FWHM for 3 mm and 1.3 mm.

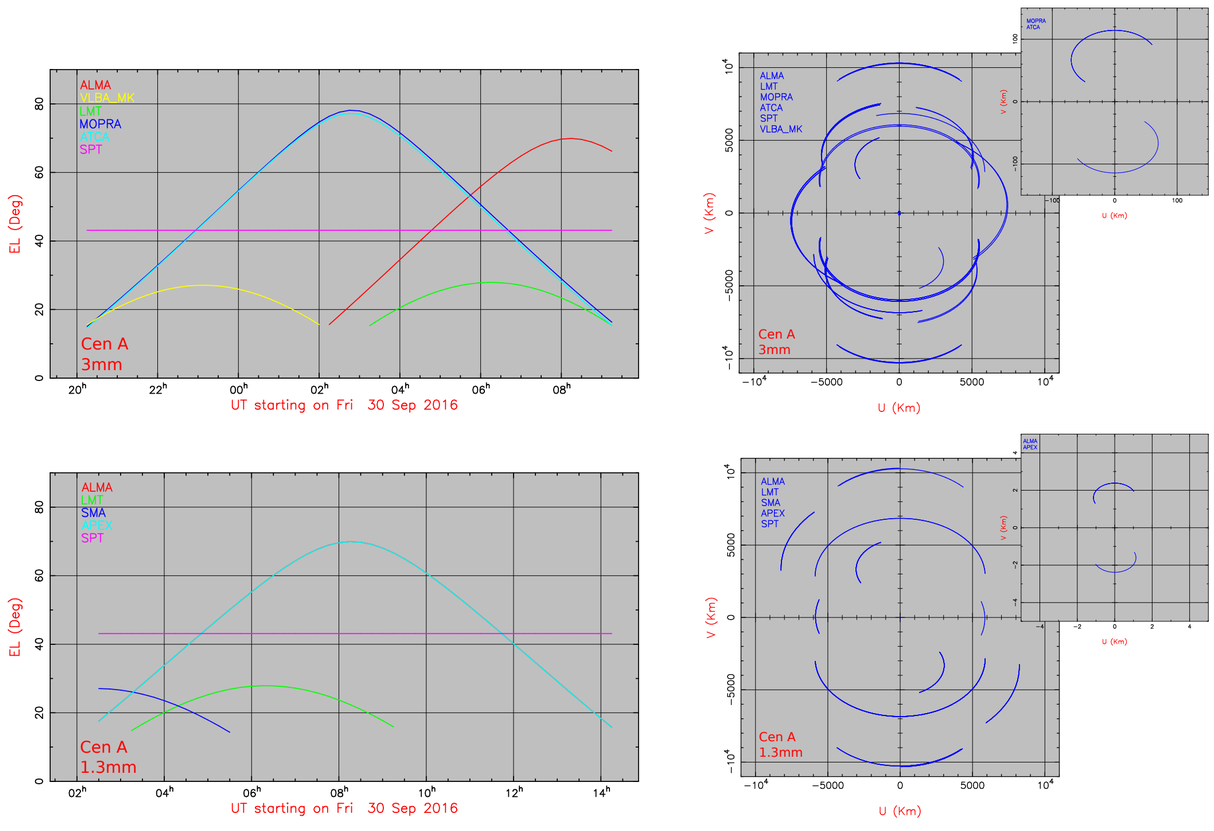
- valuable information on the small scale variability and emission

| $\nu$ [GHz] | $\langle S_{\rm SEST}\rangle^a$ [Jy] | $S^b_{\rm VLBI}$ [Jy] |
|---|---|---|
| 8.4 | - | 3.9 (TANAMI) |
| 22 | - | 3.4 (TANAMI) |
| 90 | ∼8.0 | ∼2.8 (extrapolated) |
| 230 | ∼6.3 | ∼2.5 (extrapolated) |
| 345 | ∼6.3 | ∼2.3 (extrapolated) |

[a] SEST data (Israel et al. 2008, A&A 483, 741; Tornikoski et al. 1996, A&AS 116, 157) averaged,
[b] TANAMI VLBI flux densities from Müller et al. 2011 (A&A 530, L11); 90 GHz, 230 GHz, and 345 GHz flux densities extrapolated from the TANAMI data

- List of available and potential mm-VLBI stations suitable for observing Cen A at an elevation > 15 degrees:

| Telescope | Location | 3mm | 1.3mm | 0.87mm |
|---|---|---|---|---|
| ALMA | Chile | yes | yes | potential |
| LMT | Mexico | yes | planned | potential |
| ATCA | Australia | yes | - | - |
| Mopra | Australia | yes | - | - |
| SMA | USA | - | yes | potential |
| MK (VLBA) | USA | yes | - | - |
| APEX | Chile | - | yes | potential |
| SPT | South Pole | potential | planned | potential |




Top: Simplified full-track uptime plot (left) and $(u, v)$-coverage (right) for 3mm-VLBI observations. Note the short-spacings provided by ATCA-Mopra baselines (small image). Bottom: Simplified full-track uptime plot (left) and $(u, v)$-coverage (right) for 1.3mm-VLBI observations. Note the short-spacings provided by APEX-ALMA baselines (small image) and the overlapping of both stations in the uptime plot. We assume Cen A to be visible for at least three stations at an elevation > 15 degrees.

## Contact

For further information, please contact
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or have a look at the TANAMI website
*http://pulsar.sternwarte.uni-erlangen.de/tanami/*.