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Article

Event Horizon Telescope observations of the jet launching and collimation in Centaurus A

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Supplementary information

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Event Horizon Telescope observations of the jet launching and collimation in Centaurus A: Supplementary Information

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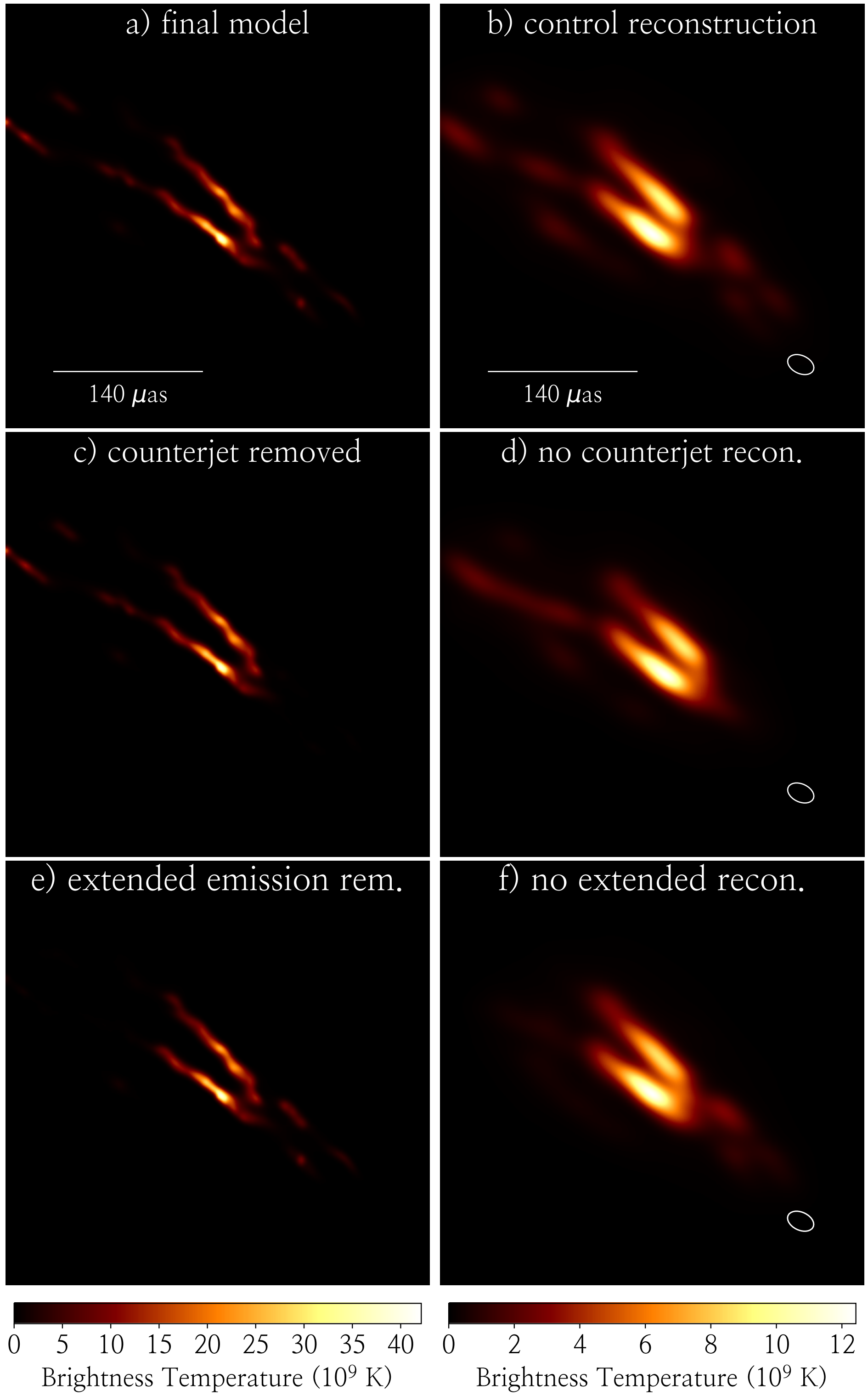
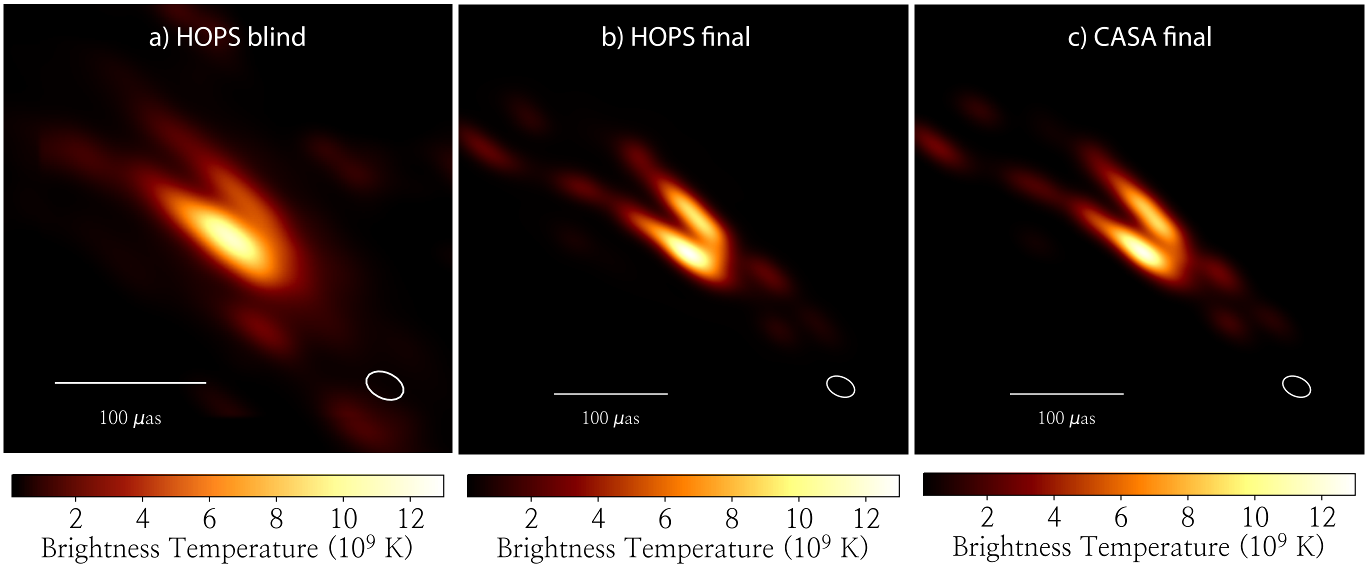
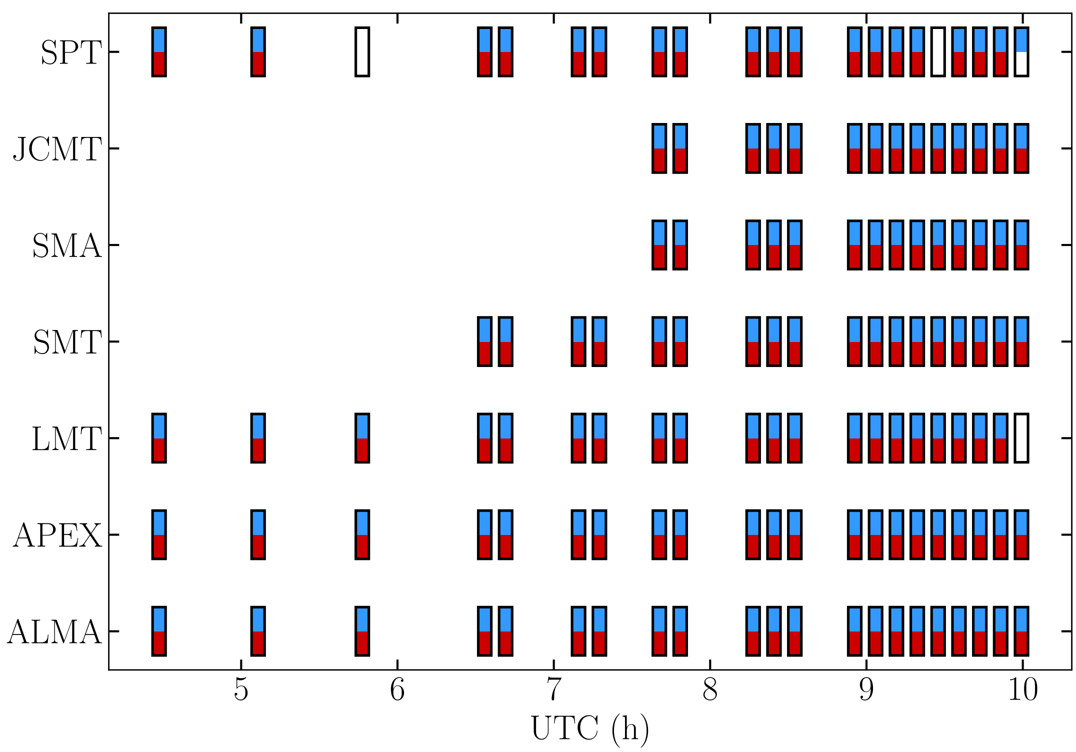


Supplementary Figure 1: **SYMBA synthetic data imaging tests.** The left panel shows the input models $\mathcal{M}$, which are based on our observational image reconstruction. The corresponding reconstructions $\mathcal{I}$ from the SYMBA pipeline are displayed in the right panel. (a-b) a control study, where the final model $\mathcal{M}_{\text{final}}$ underlying the image reconstruction $\mathcal{I}^{(\text{obs})}_{\text{final}}$ from the observational rPI-CARD data is passed through SYMBA. (c-d and e-f) same as (a-b) but the counterjet and extended jet emission features have been removed. The SYMBA reconstructions are convolved with a restoring beam, which matches the nominal resolution of the observation (shown in the bottom right corner).



Supplementary Figure 2: **Image consistency across data sets.** Left (a): Average image of six blind reconstructions from early EHT-HOPS low band (226 – 228 GHz) data, which was prepared with outdated a priori calibration parameters. Middle (b) and right (c): Images from the EHT-HOPS and rPICARD data, respectively, reconstructed with the final imaging parameters (Table 1). The restoring beams are plotted in the bottom right corner.

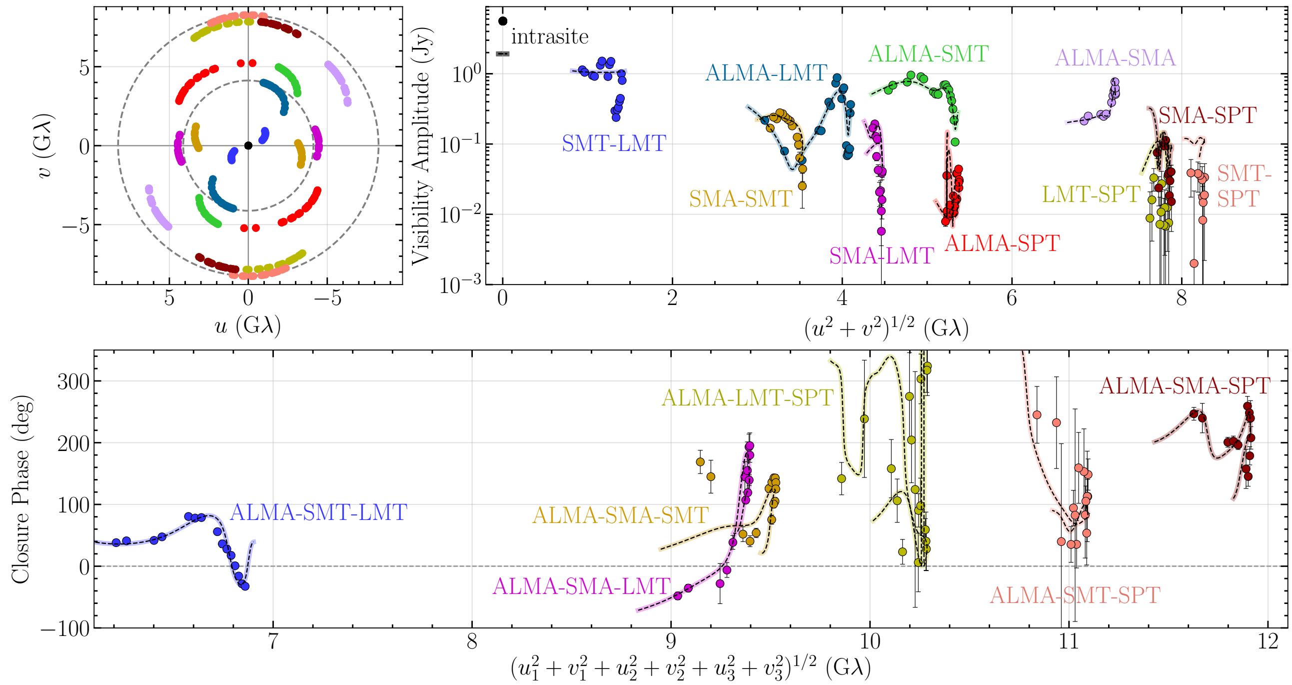


Supplementary Figure 3: **Centaurus A (Cen A) observing block.** The boxes show the planned VLBI scans in the observational VEX file. Blue (top) and red (bottom) markers in each box show detections in the EHT-HOPS and rPICARD data, respectively.

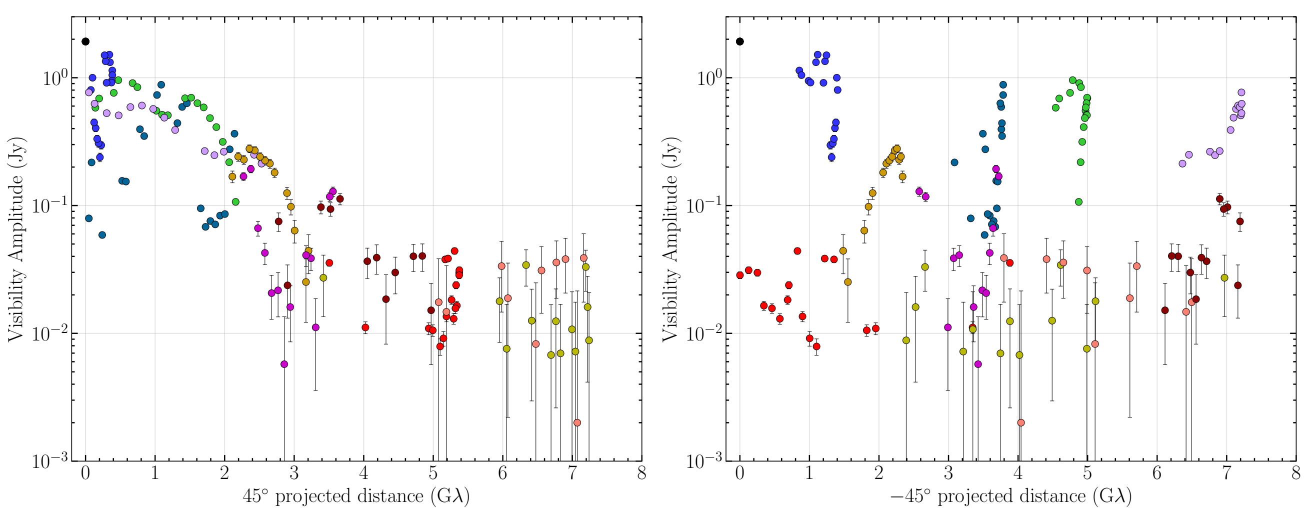
Supplementary Table 1: Final imaging parameters.

LMT Gaussian	Θ_{maj}	major axis of Gaussian self-calibration model	60 μas
self-calibration	Θ_{min}	minor axis of Gaussian self-calibration model	60 μas
	Θ_{PA}	position angle of Gaussian self-calibration model	0°
	S_G	flux density of Gaussian self-calibration model	0.6 Jy
Imaging	Φ_{maj}	major axis of Gaussian image prior	70 μas
priors	Φ_{min}	minor axis of Gaussian image prior	18 μas
	Φ_{PA}	position angle of Gaussian image prior	45°
	Z_0	flux density of Gaussian image prior	2 Jy
Regularizer	β_z	weight for Z_0	0.1
weights	β_{MEM}	weight for maximum entry minimization	10
Data	$\alpha_{\mathrm{amp}}^{(1,2,3)}$	incremental weights for measured amplitudes	$0.2, 2, 10$
weights	$\alpha_{\mathrm{cp}}^{(1,2,3)}$	incremental weights for measured closure phases	$1, 10, 20$
	$\alpha_{\mathrm{lca}}^{(1,2,3)}$	incremental weights for measured log closure amplitudes	$1, 10, 20$
rPICARD image	χ^2_{amp}	goodness of fit for amplitudes	1.0
goodness	χ^2_{cp}	goodness of fit for closure phases	1.8
of fit	χ^2_{lca}	goodness of fit for log closure amplitudes	2.3
	$\mathcal{A}_{\mathrm{intra}}^{(\mathrm{sc})}$	mean self-calibration gain for co-located stations	0.98
	$\mathcal{A}_{\mathrm{LMT}}^{(\mathrm{sc})}$	LMT mean self-calibration gain	1.13
	$\mathcal{A}_{\mathrm{SMT}}^{(\mathrm{sc})}$	SMT mean self-calibration gain	1.01
	$\mathcal{A}_{\mathrm{SPT}}^{(\mathrm{sc})}$	SPT mean self-calibration gain	1.03
EHT-HOPS image	χ^2_{amp}	goodness of fit for amplitudes	1.2
goodness	χ^2_{cp}	goodness of fit for closure phases	2.1
of fit	χ^2_{lca}	goodness of fit for log closure amplitudes	1.2
	$\mathcal{A}_{\mathrm{intra}}^{(\mathrm{sc})}$	mean self-calibration gain for co-located stations	0.98
	$\mathcal{A}_{\mathrm{LMT}}^{(\mathrm{sc})}$	LMT mean self-calibration gain	1.15
	$\mathcal{A}_{\mathrm{SMT}}^{(\mathrm{sc})}$	SMT mean self-calibration gain	1.01
	$\mathcal{A}_{\mathrm{SPT}}^{(\mathrm{sc})}$	SPT mean self-calibration gain	1.00

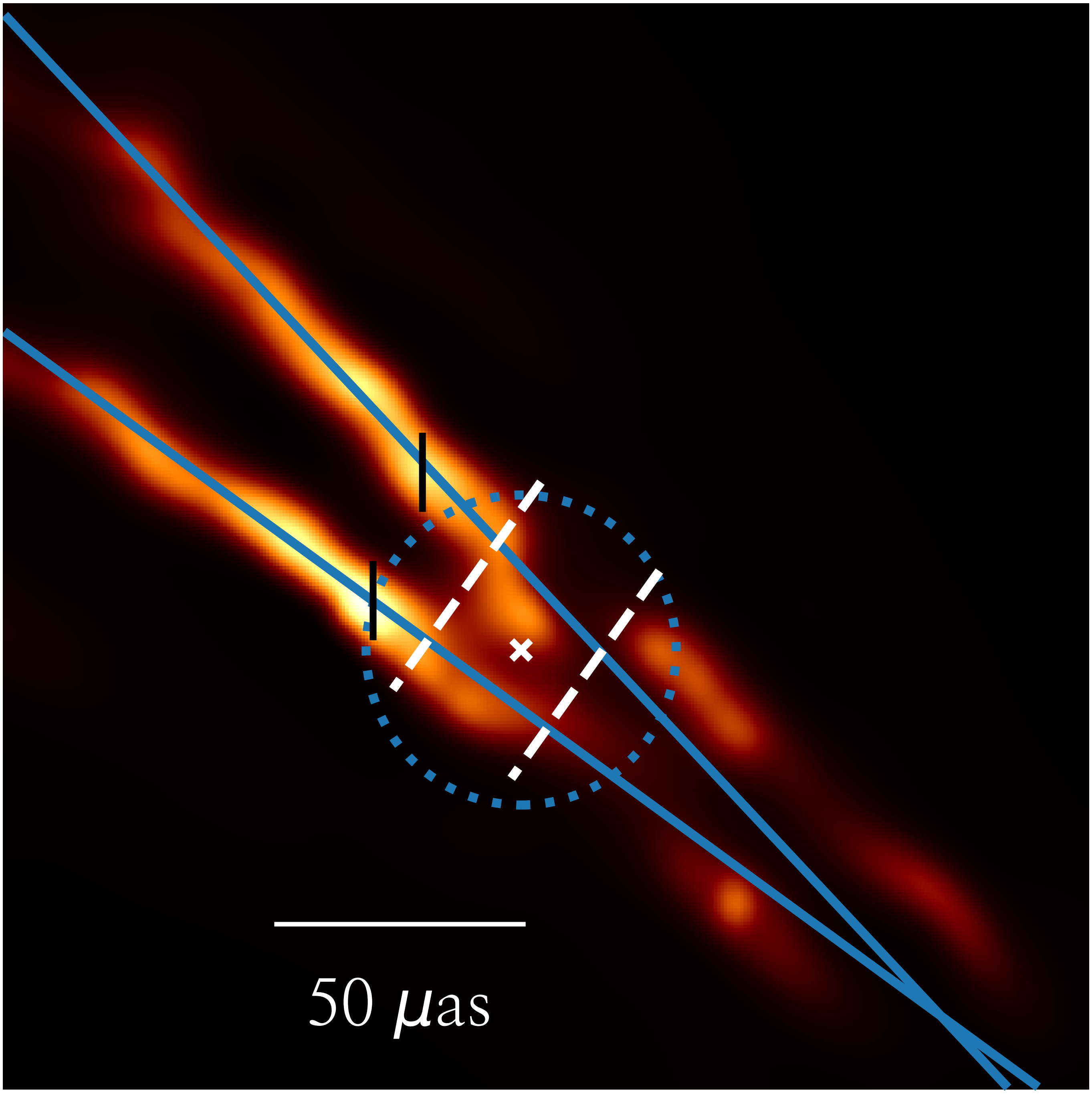
Note – $\mathcal{A}_{\mathrm{intra}}^{(\mathrm{sc})}$ corresponds to the mean gain of Atacama Large Millimeter/submillimeter Array (ALMA), Atacama Pathfinder Experiment (APEX), James Clerk Maxwell Telescope (JCMT), and Submillimeter Array (SMA).



Supplementary Figure 4: **Cen A data properties from April 2017.** The top left panel shows the (u, v) coverage. A priori calibrated amplitude (before self-calibration) and closure phase data points are shown in the top right and bottom panel, respectively, overplotted with lines from the final image model as a function of (u, v) distances. The error bars indicate thermal noise and 5 % non-closing error uncertainties added in quadrature, which are smaller than the plotted symbols in some cases. The color-coding shows different baselines. Amplitudes projected along and perpendicular to the jet position angle are given in Supplementary Fig. 5.



Supplementary Figure 5: **Source structure along specific position angles on the sky.** A priori calibrated amplitudes are shown projected along the jet position angle (PA) on the sky in the left panel and perpendicular to the PA in the right panel. The color coding and error bars shown are the same as in Supplementary Fig. 4.



Supplementary Figure 6: **Determination of the jet apex location.** A zoomed-in version of the final image model is shown. The solid blue lines show simple linear extrapolations of the inner NW and SE jet arms, which would place the jet apex well within the counterjet region. The dashed white lines mark the certain edges of the approaching jet and the counterjet. The quadrangle enclosed by the solid and dashed lines is the region where the jet apex is located. Inside this quadrangle, a tentative convergence of the two streamlines can be seen. The apex position assumed in this work is indicated with a white cross. The surrounding blue dashed circle corresponds to the $z_{\rm col} = 32\,\mu$as distance. Vertical black bars mark the brightest regions along each jet arm, which correspond to the assumed location of the radio core.