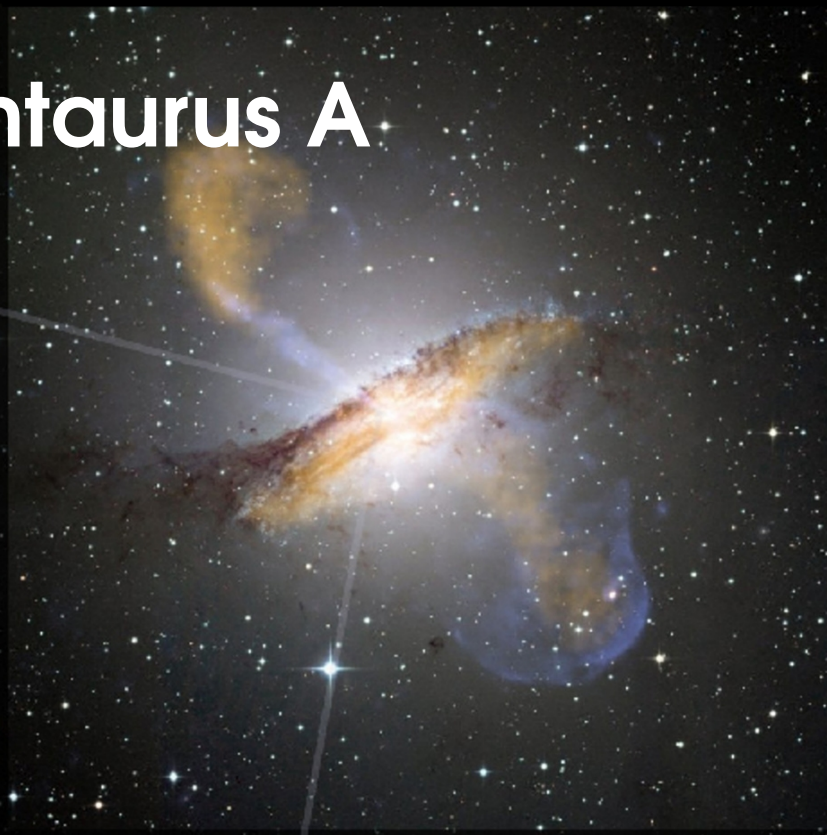
TANAMI monitoring of Centaurus A

The complex dynamics in the inner parsec of an extragalactic jet



Cornelia Müller
University of Würzburg,
Remeis Observatory Bamberg & ECAP

in collaboration with
M. Kadler, R. Ojha, M. Perucho, C. Großberger, E. Ros, J. Wilms, J. Blanchard, M. Böck, B. Carpenter, M. Dutka, P. G. Edwards, H. Hase, S. Horiuchi, A. Kreikenbohm, J. E. J. Lovell, A. Markowitz, C. Phillips, C. Plötz, T. Pursimo, J. Quick, R. Rothschild, R. Schulz, T. Steinbring, J. Stevens, J. Trüstedt, and A.K. Tzioumis

EVN Symposium 2014
October 7th, 2014

ASTRO WÜRZBURG

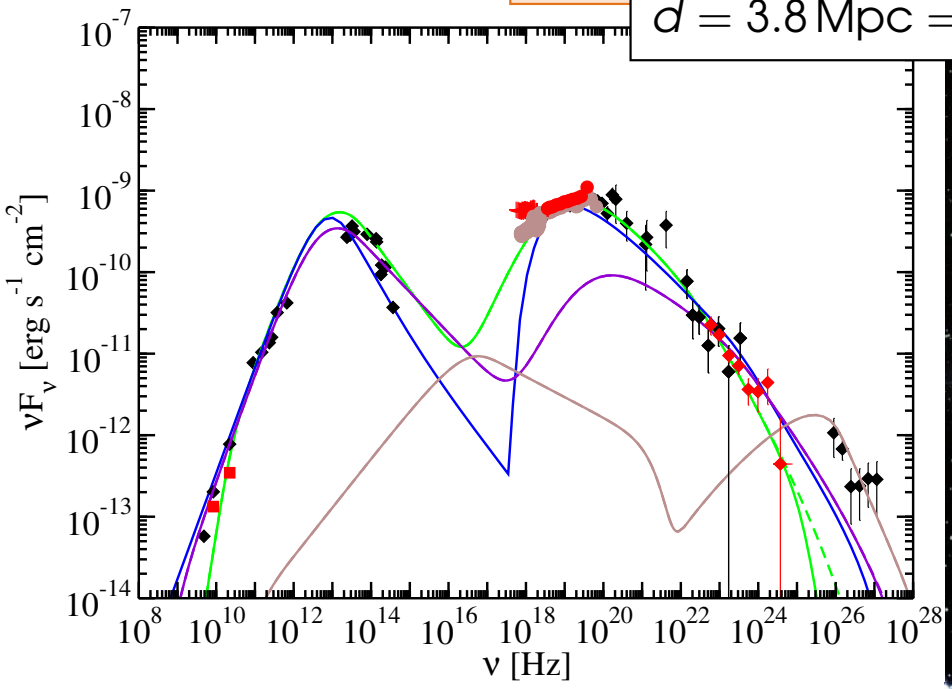
TANAMI

ECAP ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

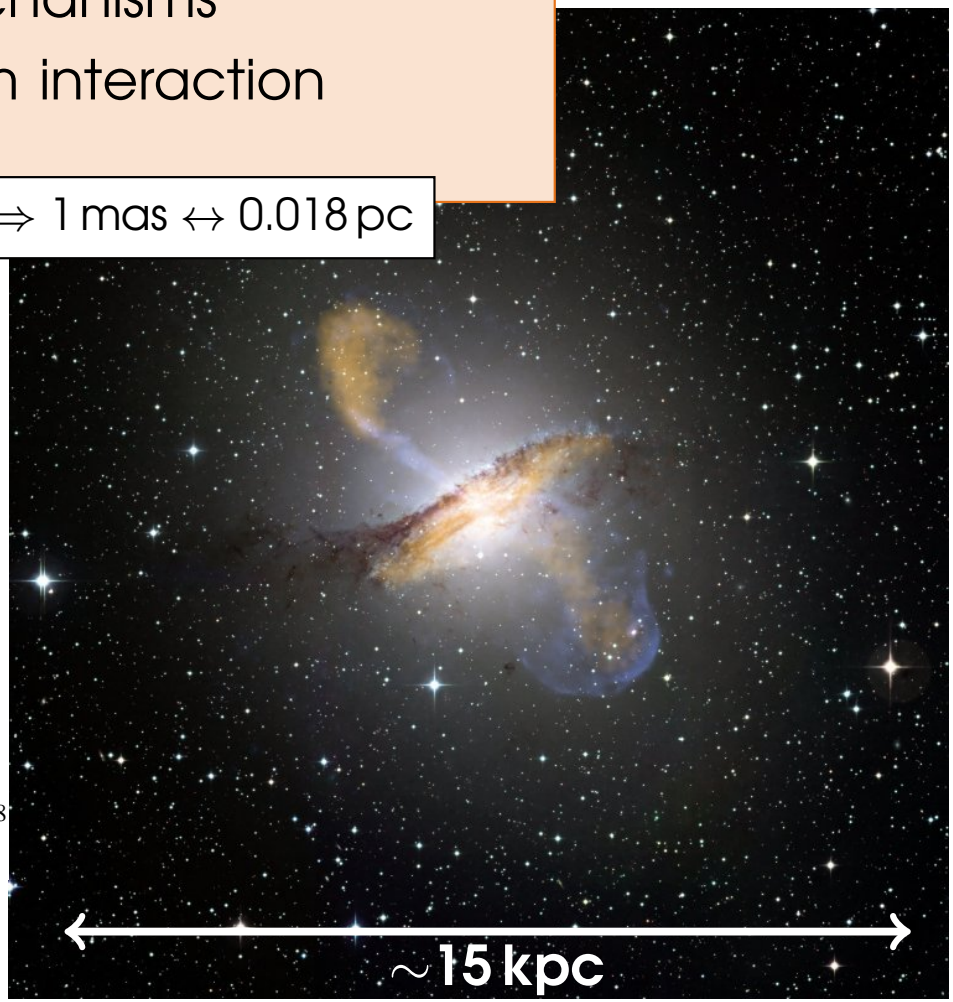
CENTAURUS A – THE IDEAL LABORATORY

- study jet at sub-parsec scales
- high energy emission origin/mechanisms
- jet-medium interaction

$d = 3.8\,\mathrm{Mpc} \Rightarrow 1\,\mathrm{mas} \leftrightarrow 0.018\,\mathrm{pc}$



Abdo+ 2010

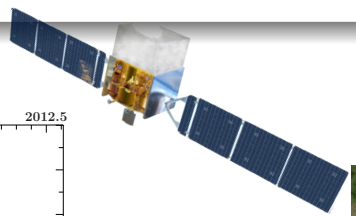


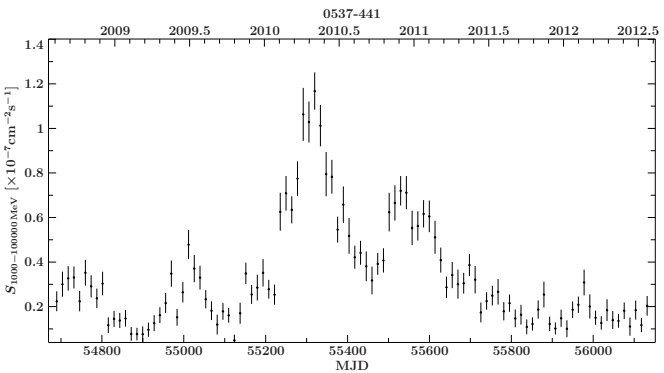
ESO/WFI;MPIfR/ESO/APEX/A.Weiss;NASA/CXC/CfA/R.Kraft

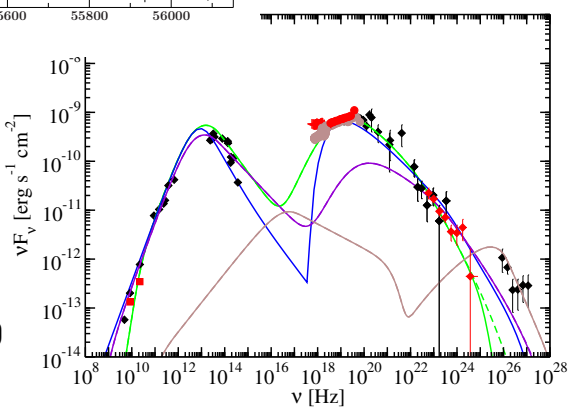
TANAMI: Tracking Active Galactic Nuclei with Austral Milliarcsecond Interferometry

Multiwavelength observations
→ *Fermi*/LAT monitoring,
simultaneous SEDs,
broadband variability

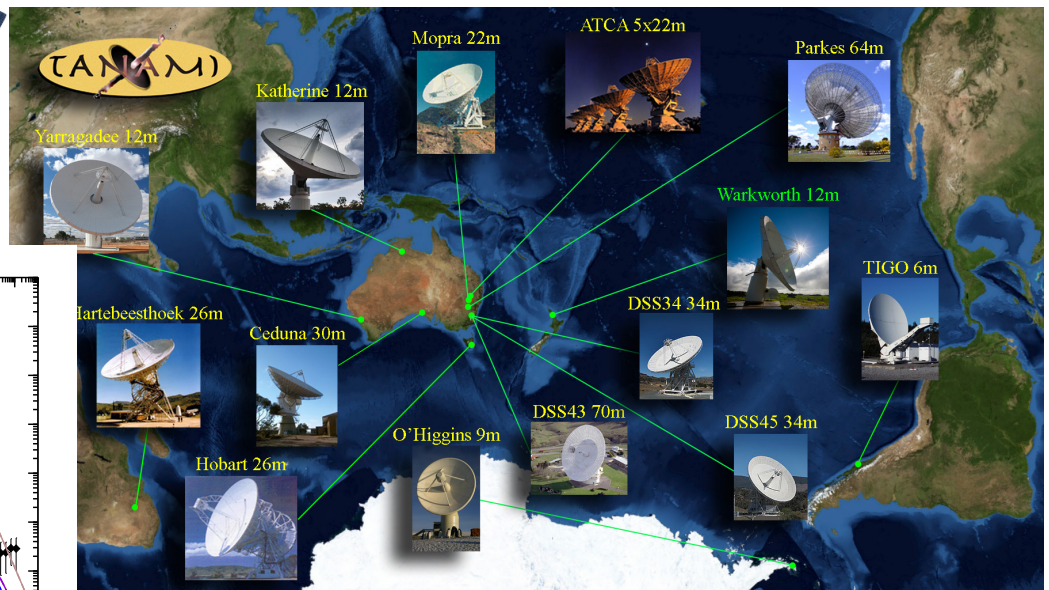
VLBI monitoring at 8 & 22 GHz
→ mas-scale morphology,
jet kinematics,
spectral index images



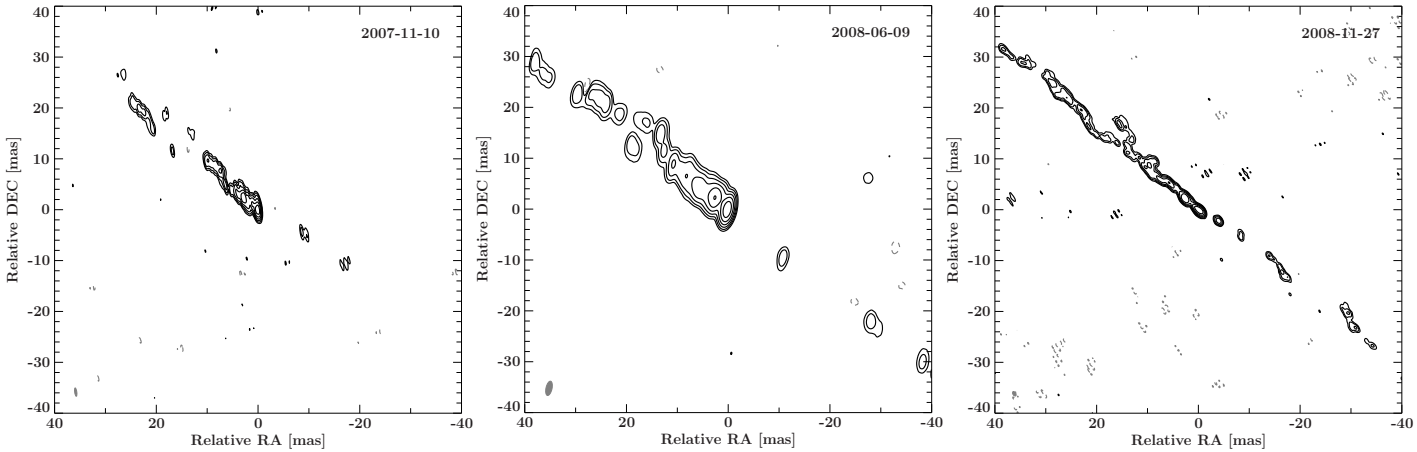




Abdo+2010

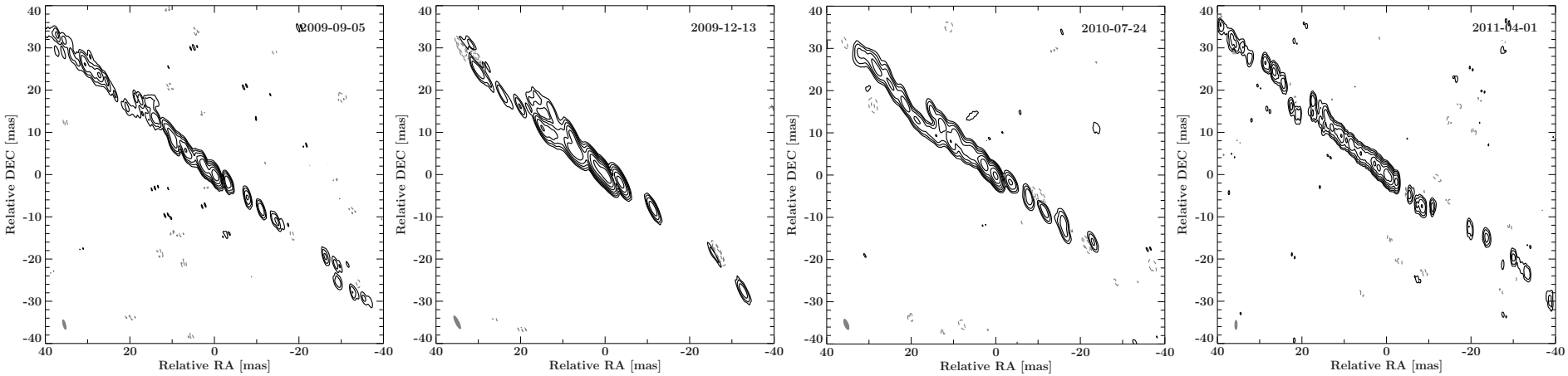


VLBI MONITORING



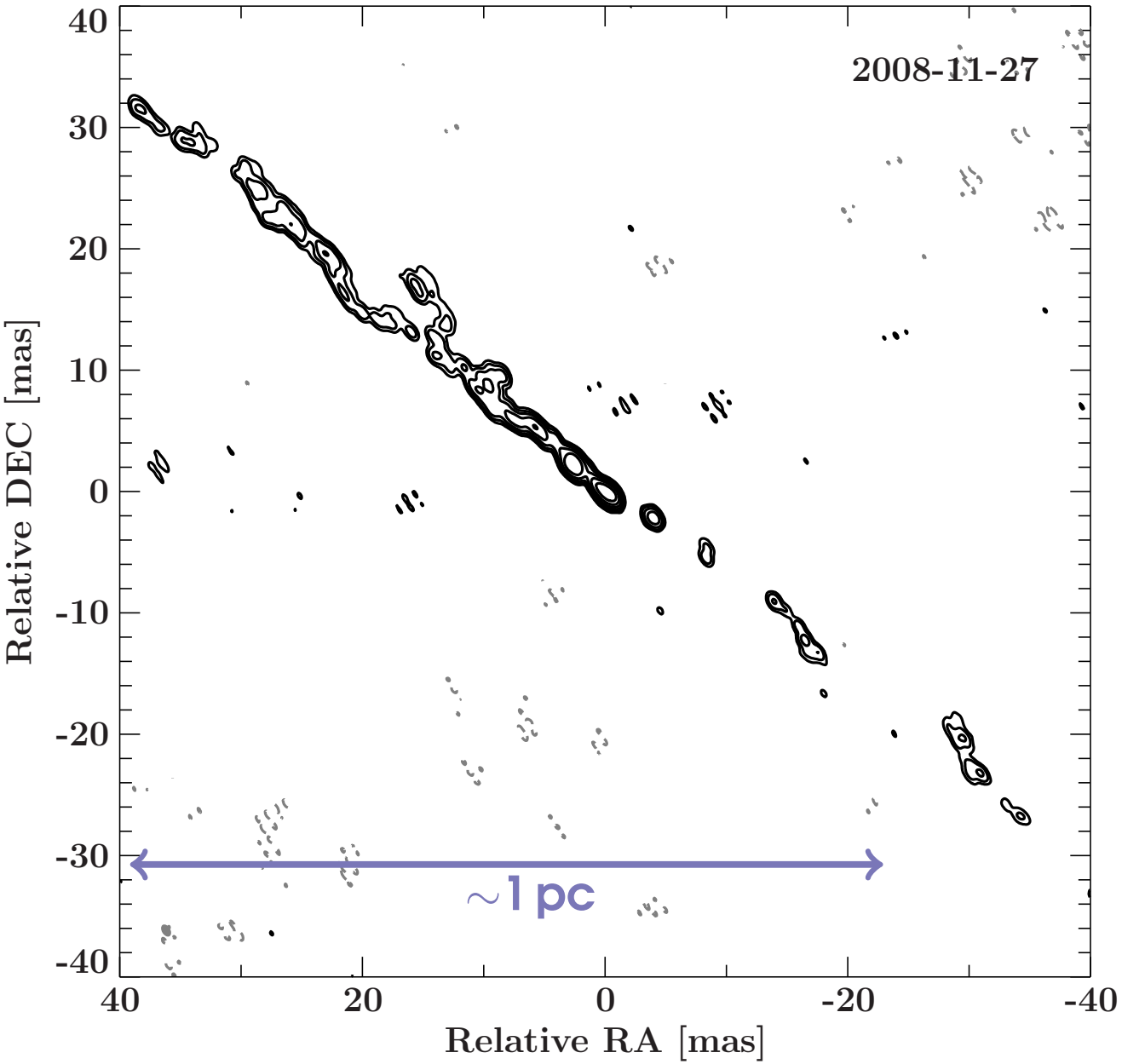
8.4 GHz

~1 mas resolution

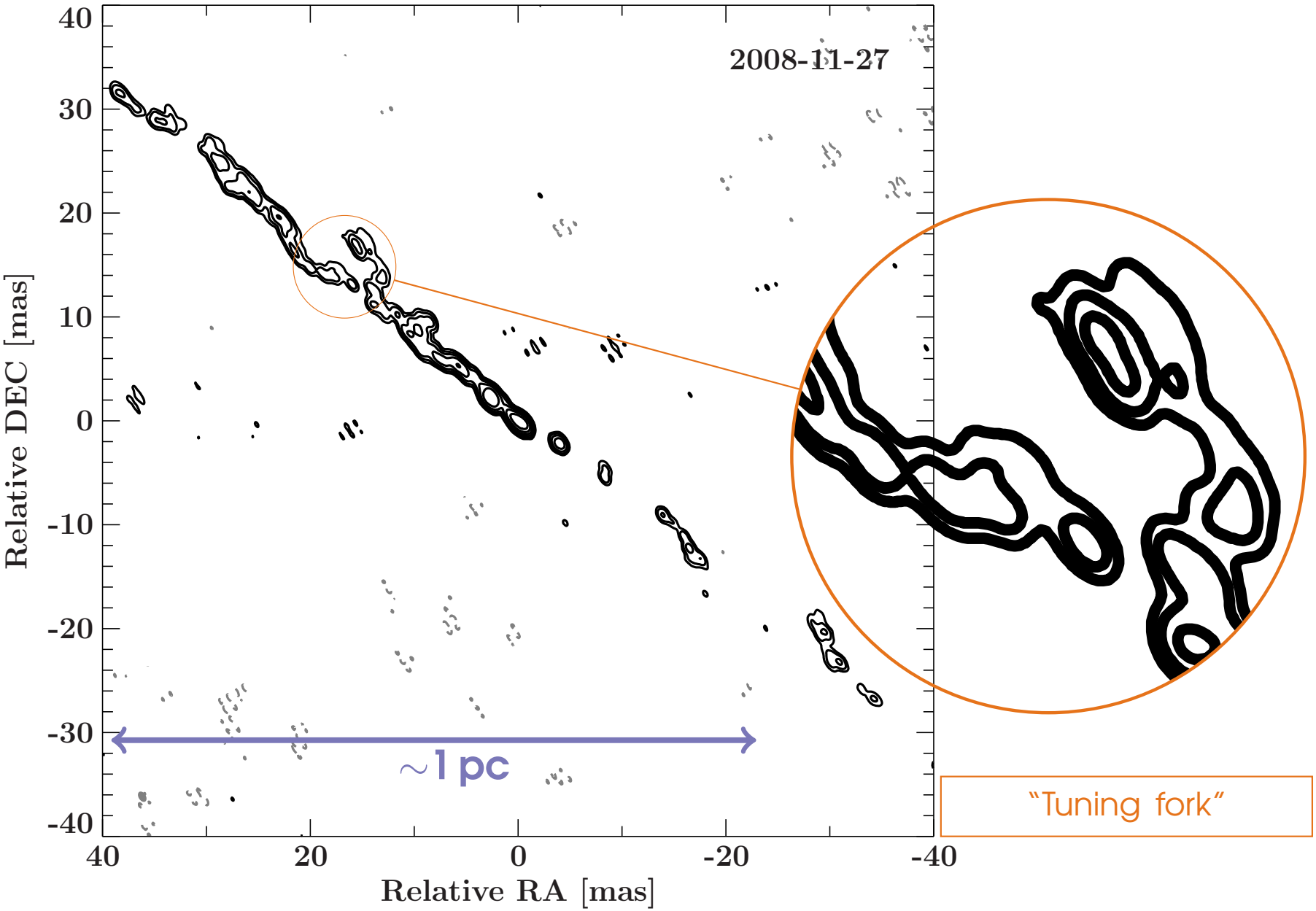


Müller et al., A&A 569, A115

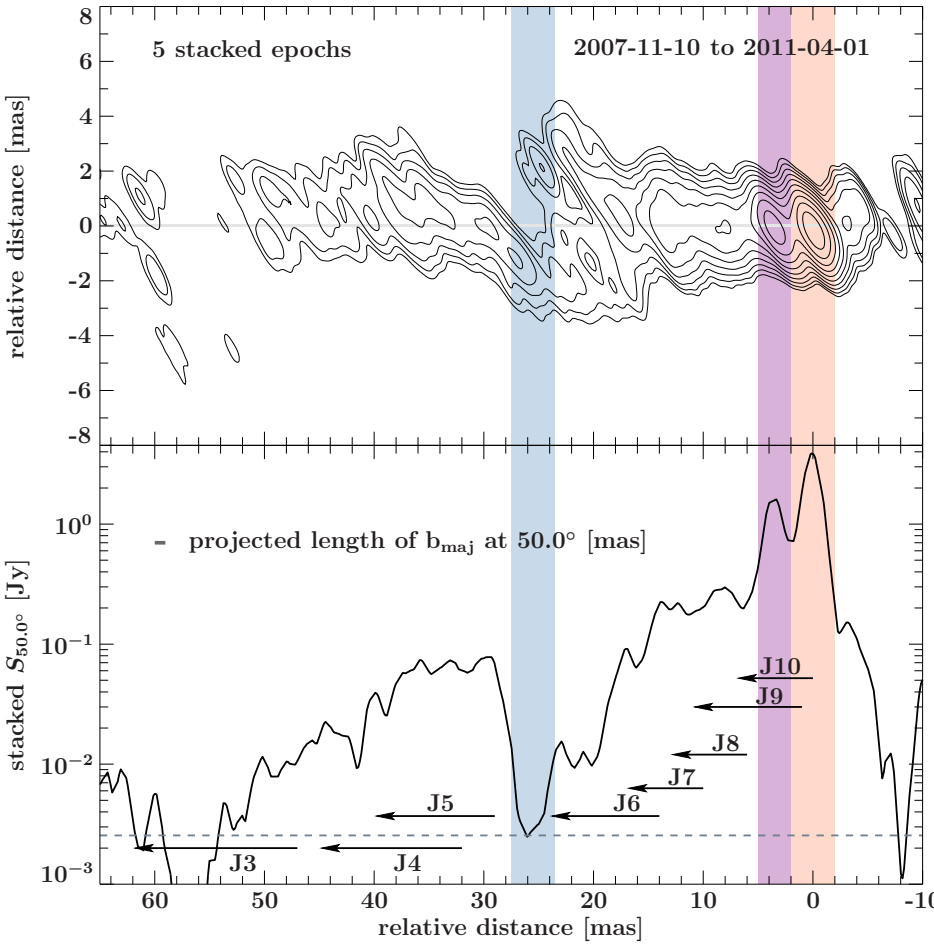
JET STRUCTURE

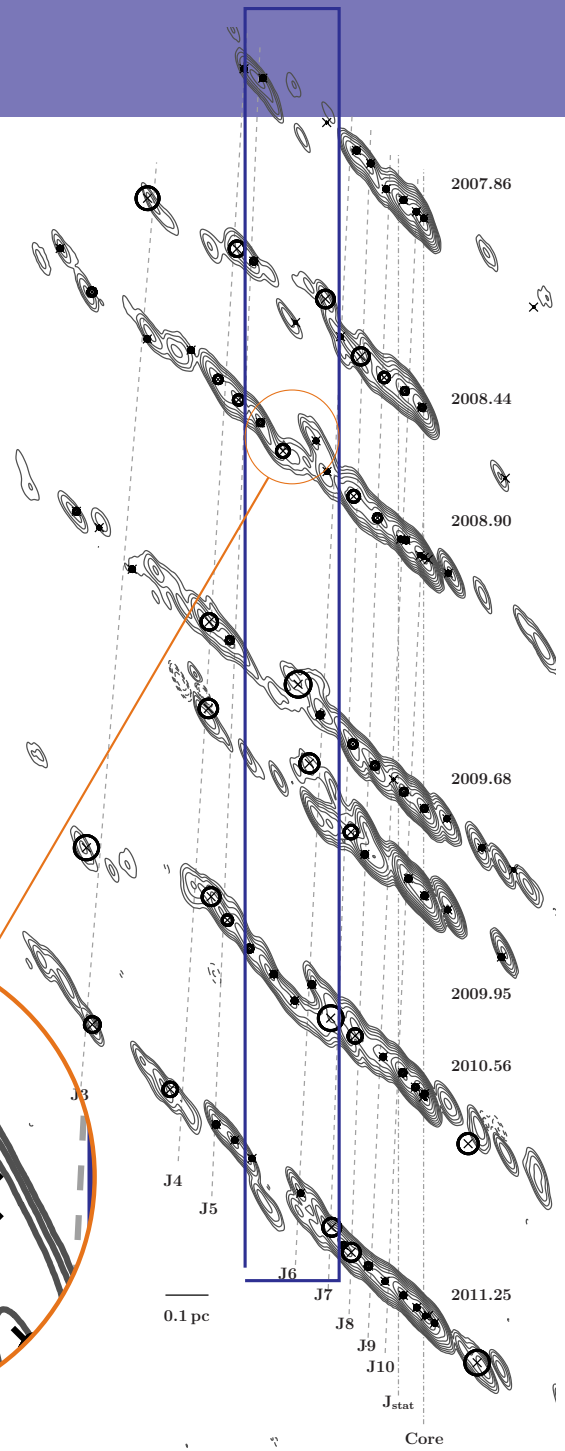


Jet structure



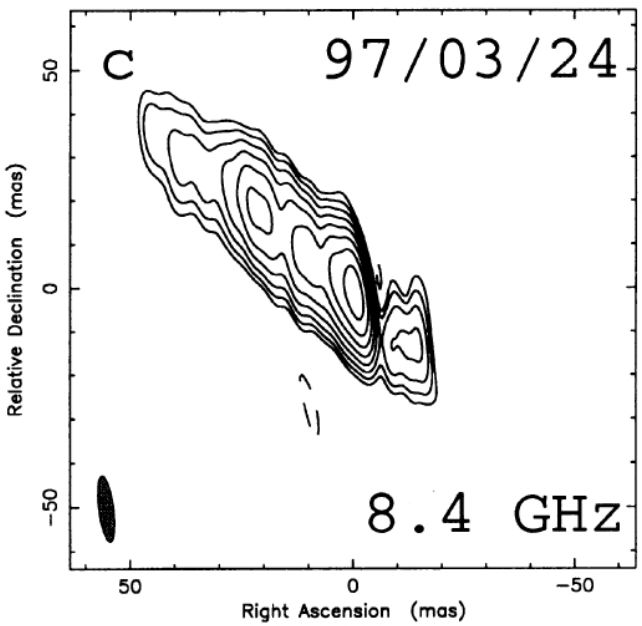
The "tuning fork"



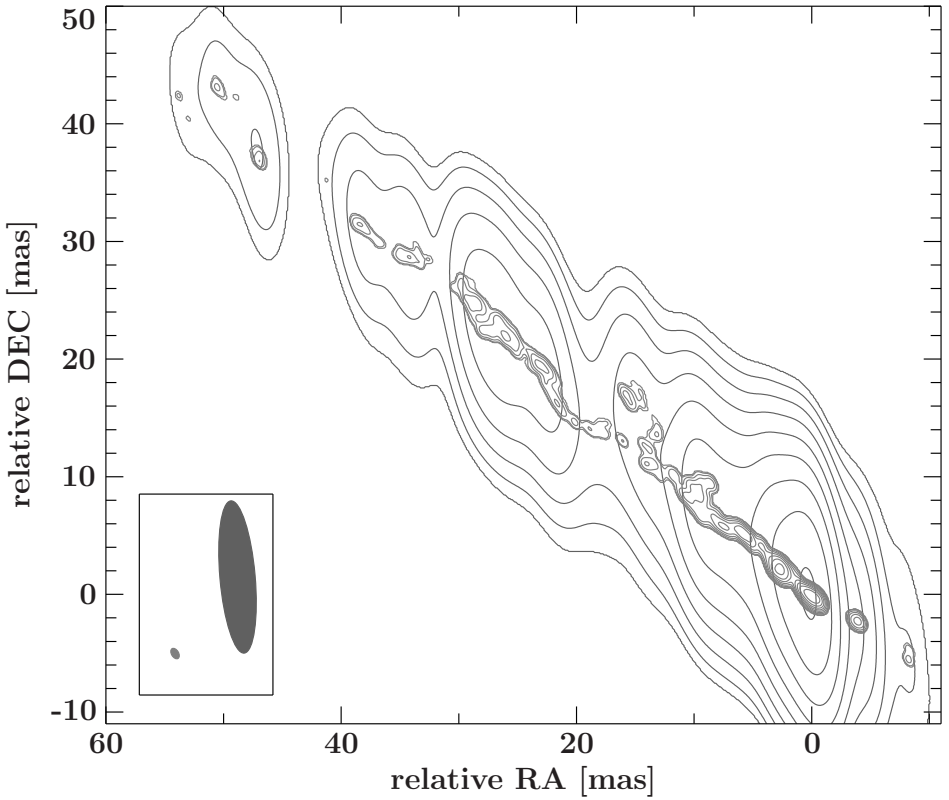


~~Recollimation shock~~
Jet-star interaction

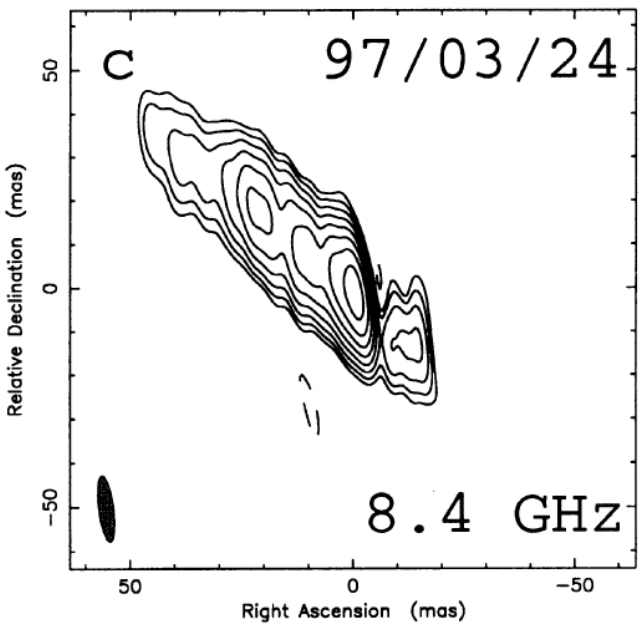
STABLE JET FLOW



Tingay+2001



STABLE JET FLOW



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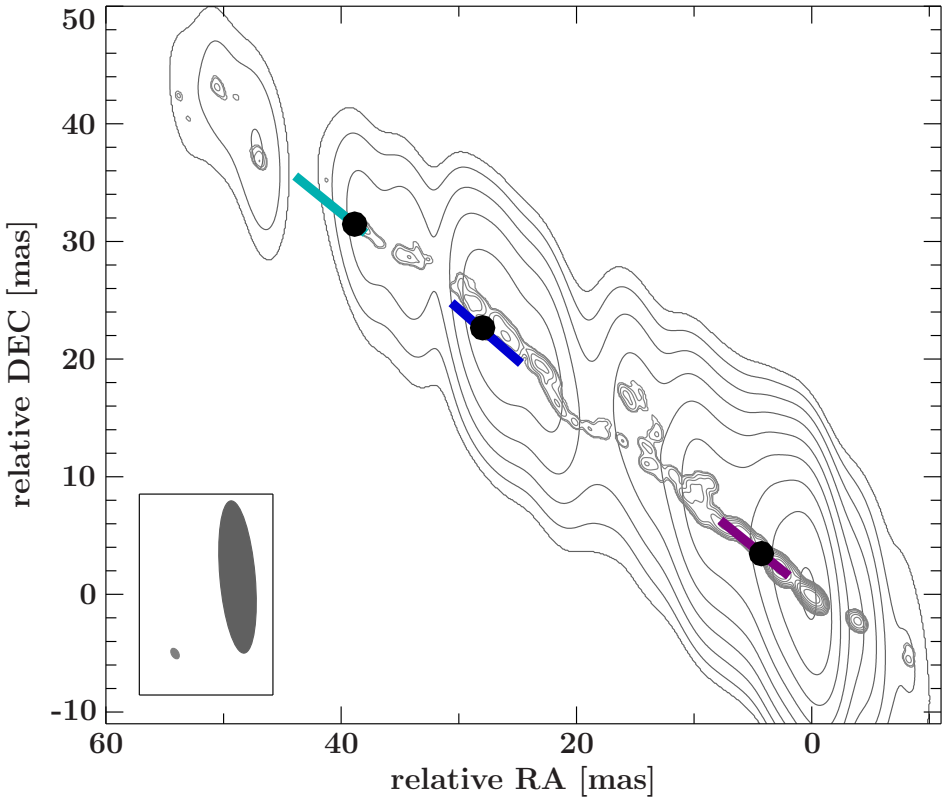
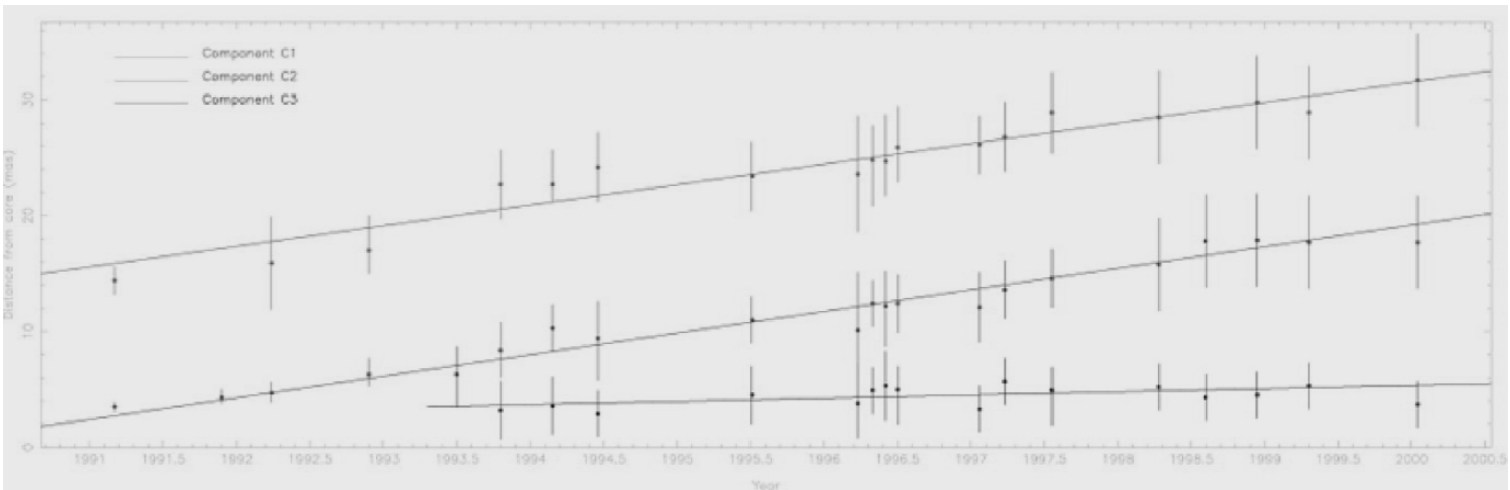
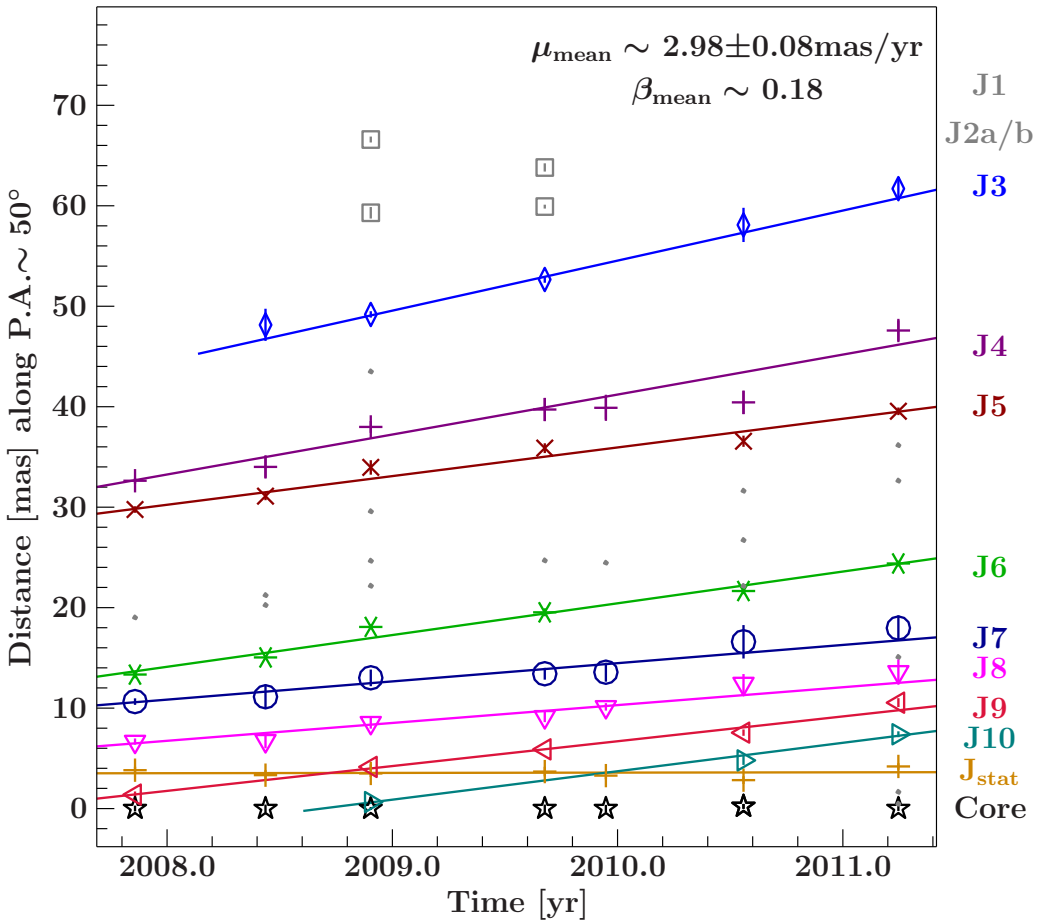
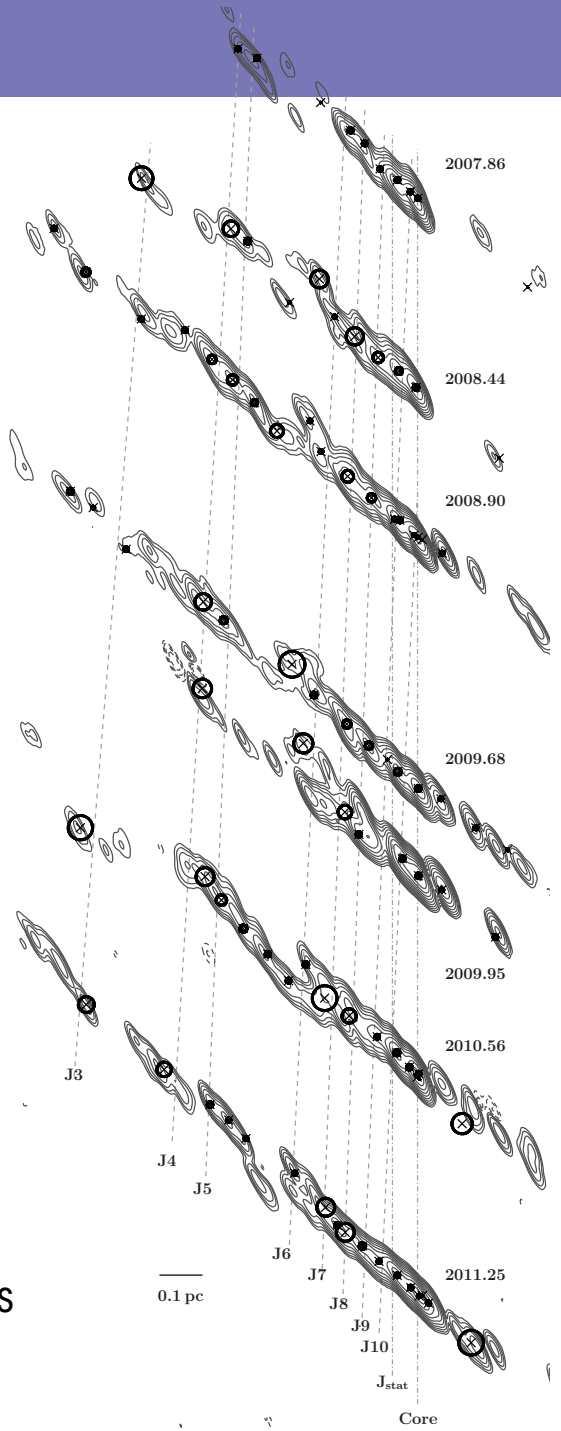




~2 mas/yr

Jet kinematics



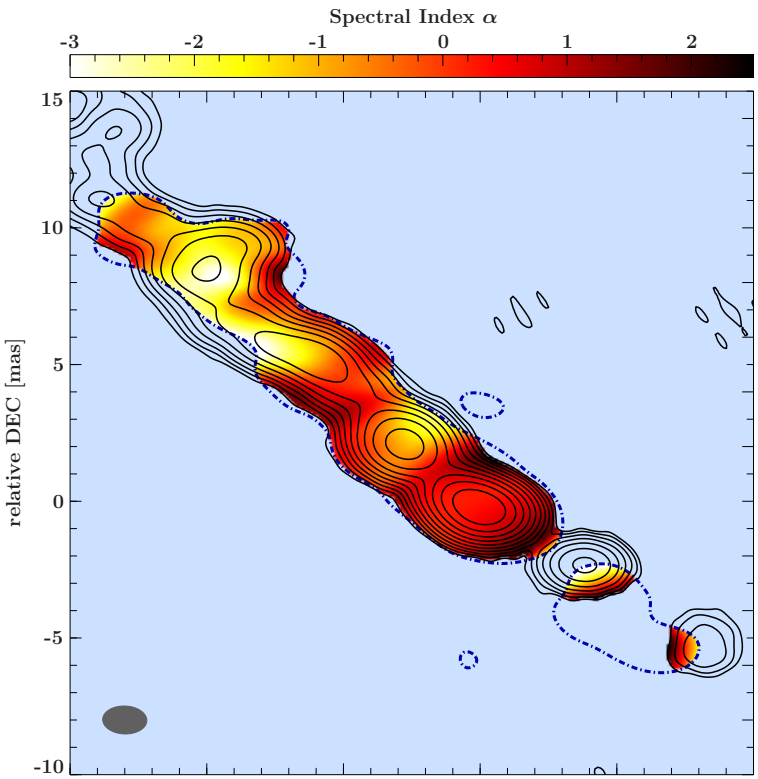


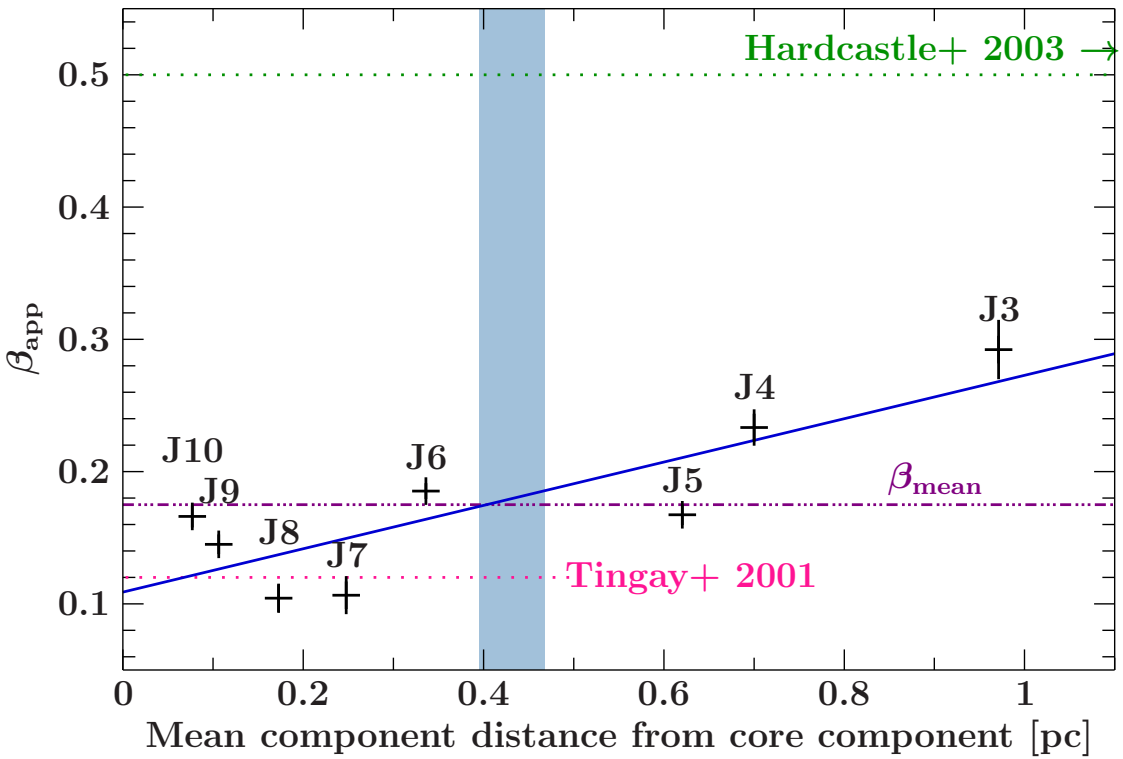
- range of speeds 0.1c to 0.3c
- larger scale structure with speed comparable to previous observations

Downstream acceleration

- faster components where jet becomes optically thin
- spine-sheath structure

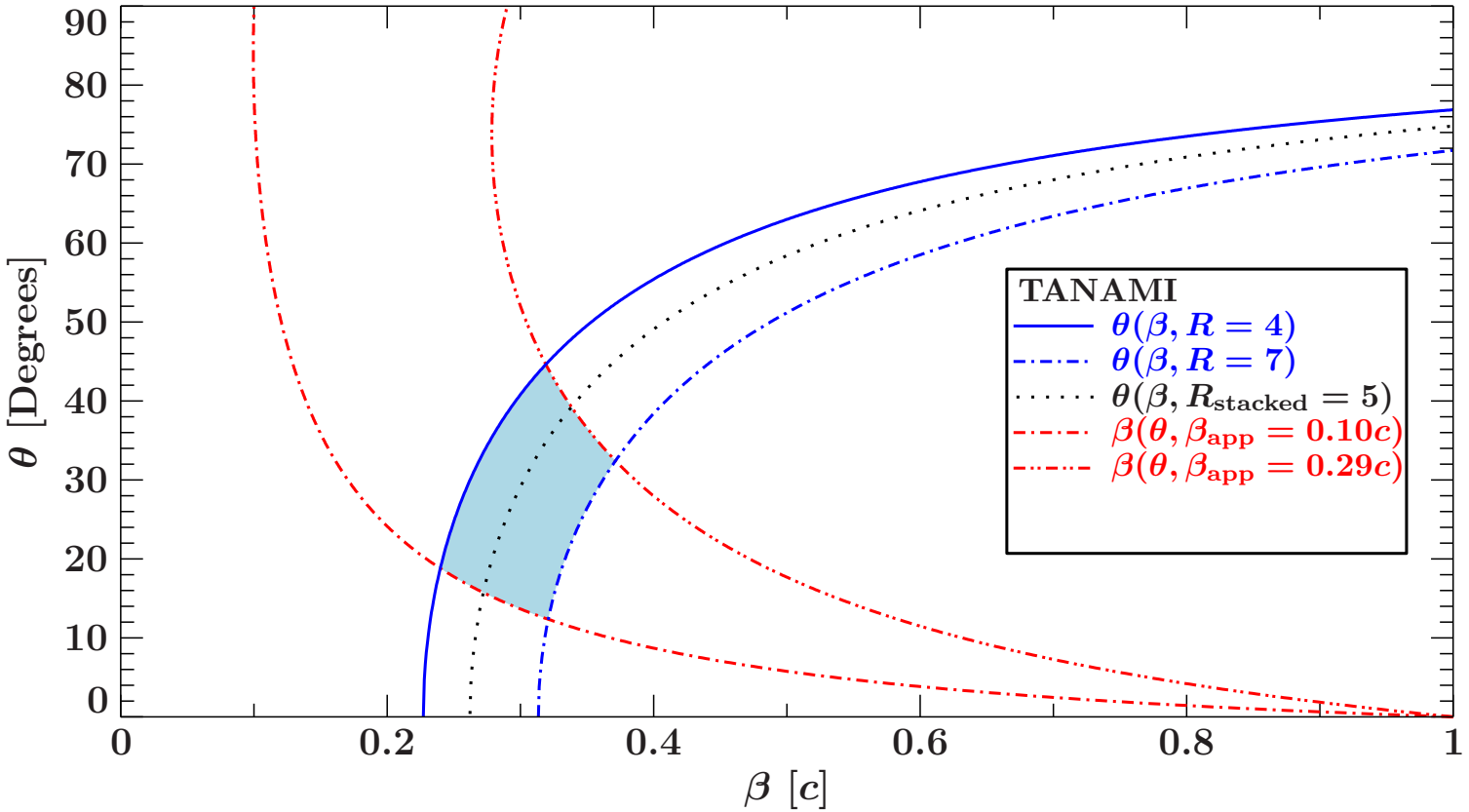
(Ghisellini+2005,Tavecchio+2008)





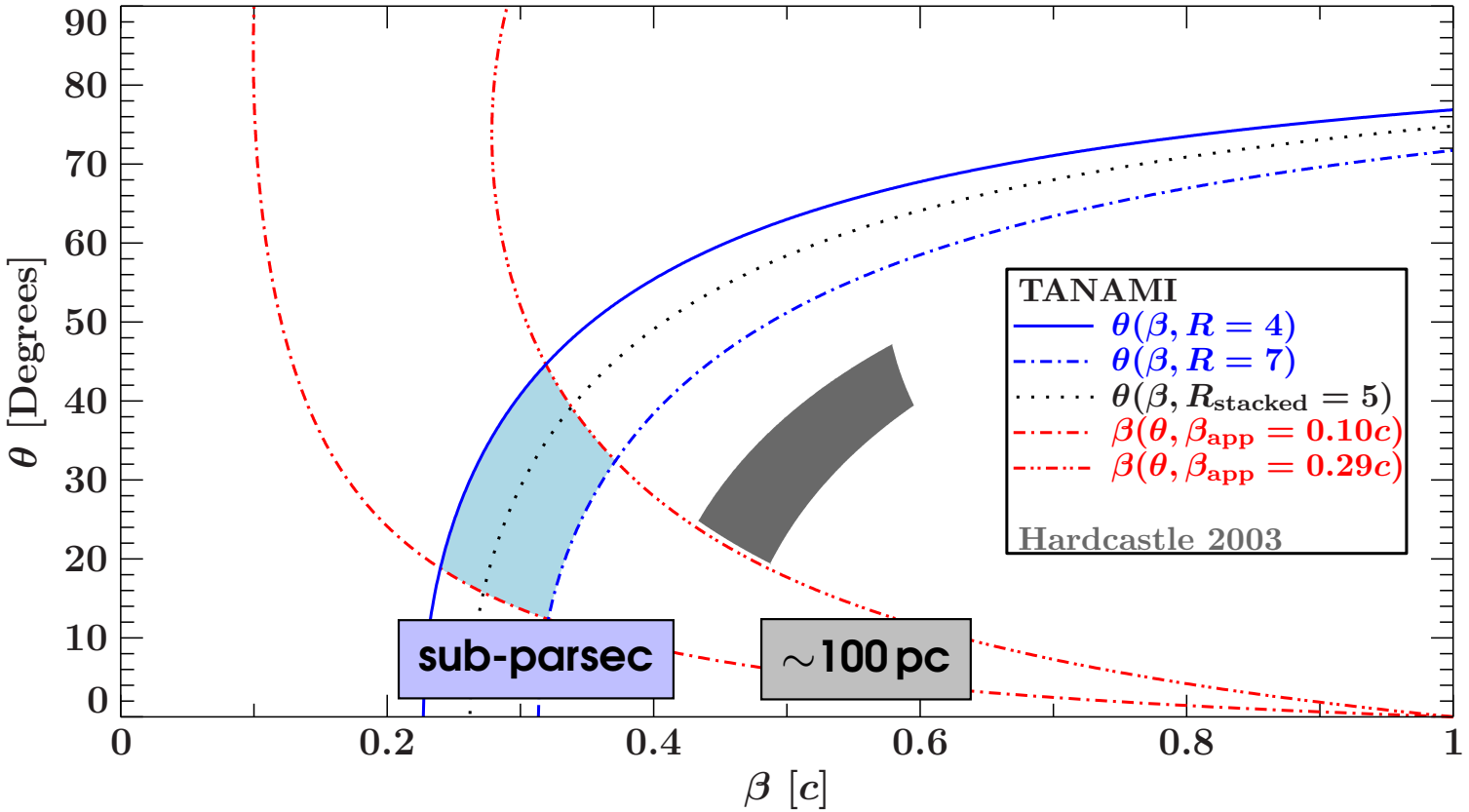
Müller+2011, A&A 530, L11

Intrinsic jet parameters



- inclination angle $\theta \sim 12° - 45°$
- intrinsic $\beta \sim 0.24 - 0.37$

Intrinsic jet parameters



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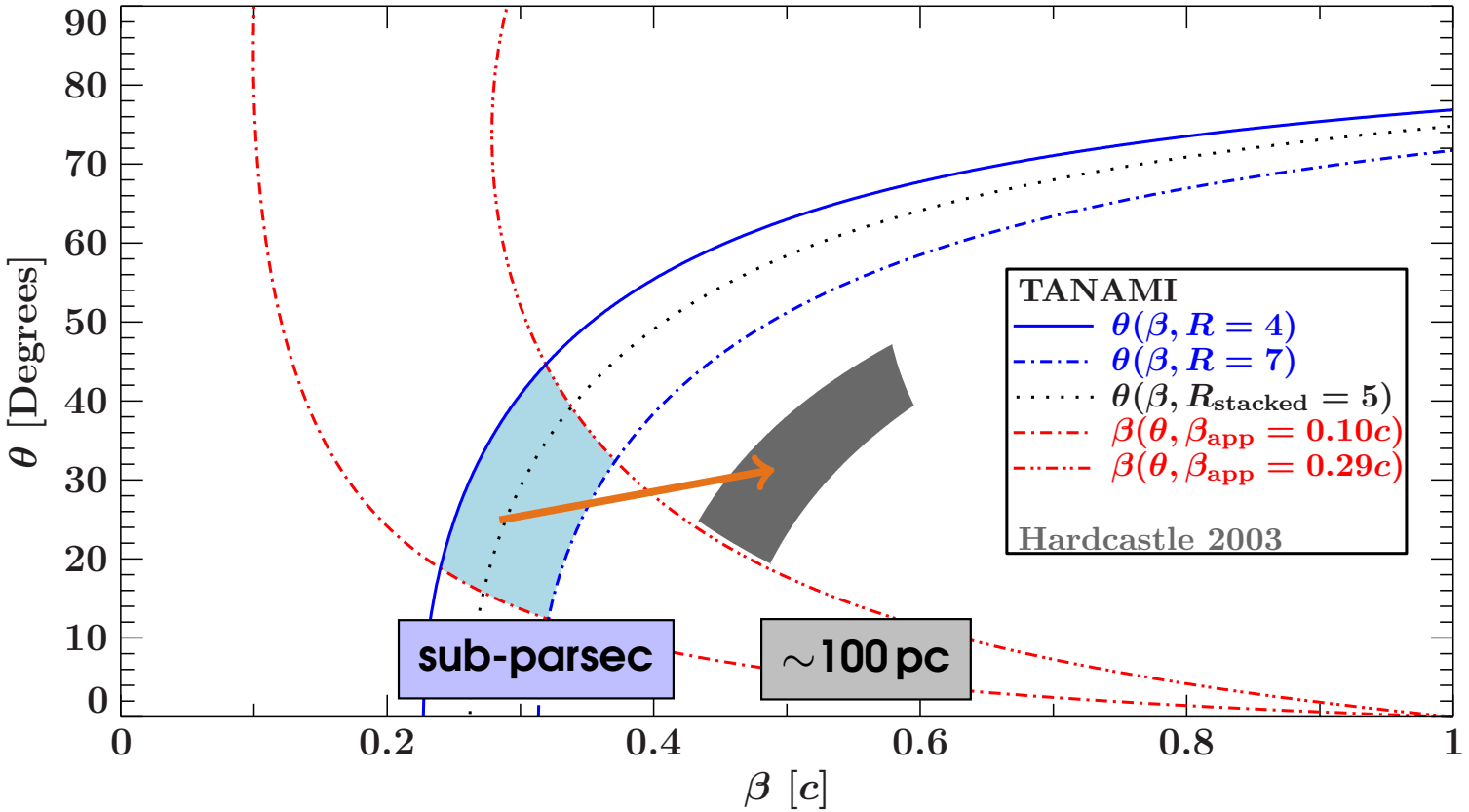
INTRINSIC JET PARAMETERS

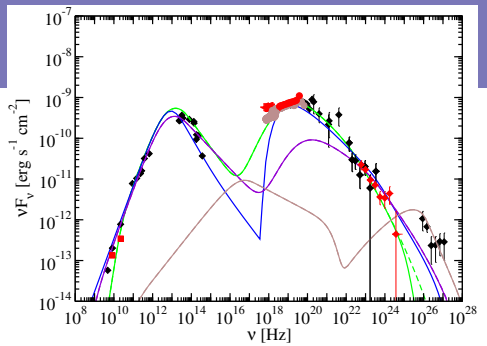


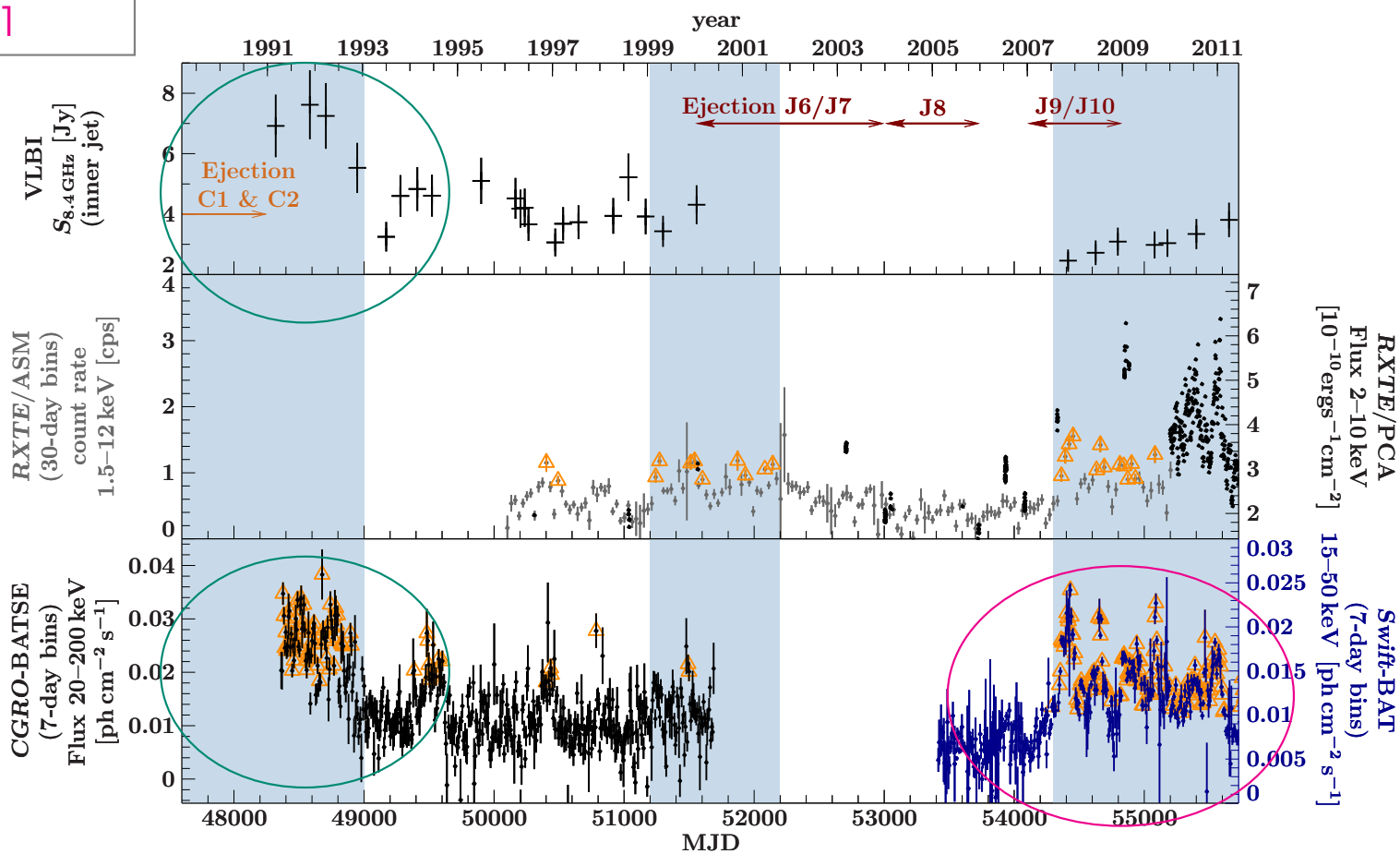
- inclination angle $\theta \sim 12° - 45°$
- intrinsic $\beta \sim 0.24 - 0.37$

intrinsic acceleration

Multiwavelength variability

- hard X-ray emission jet related?
- Tingay+1998
- Fukazawa+2011





Multiwavelength variability

- hard X-ray emission jet related?
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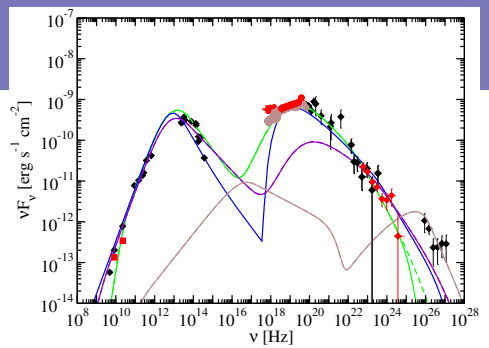
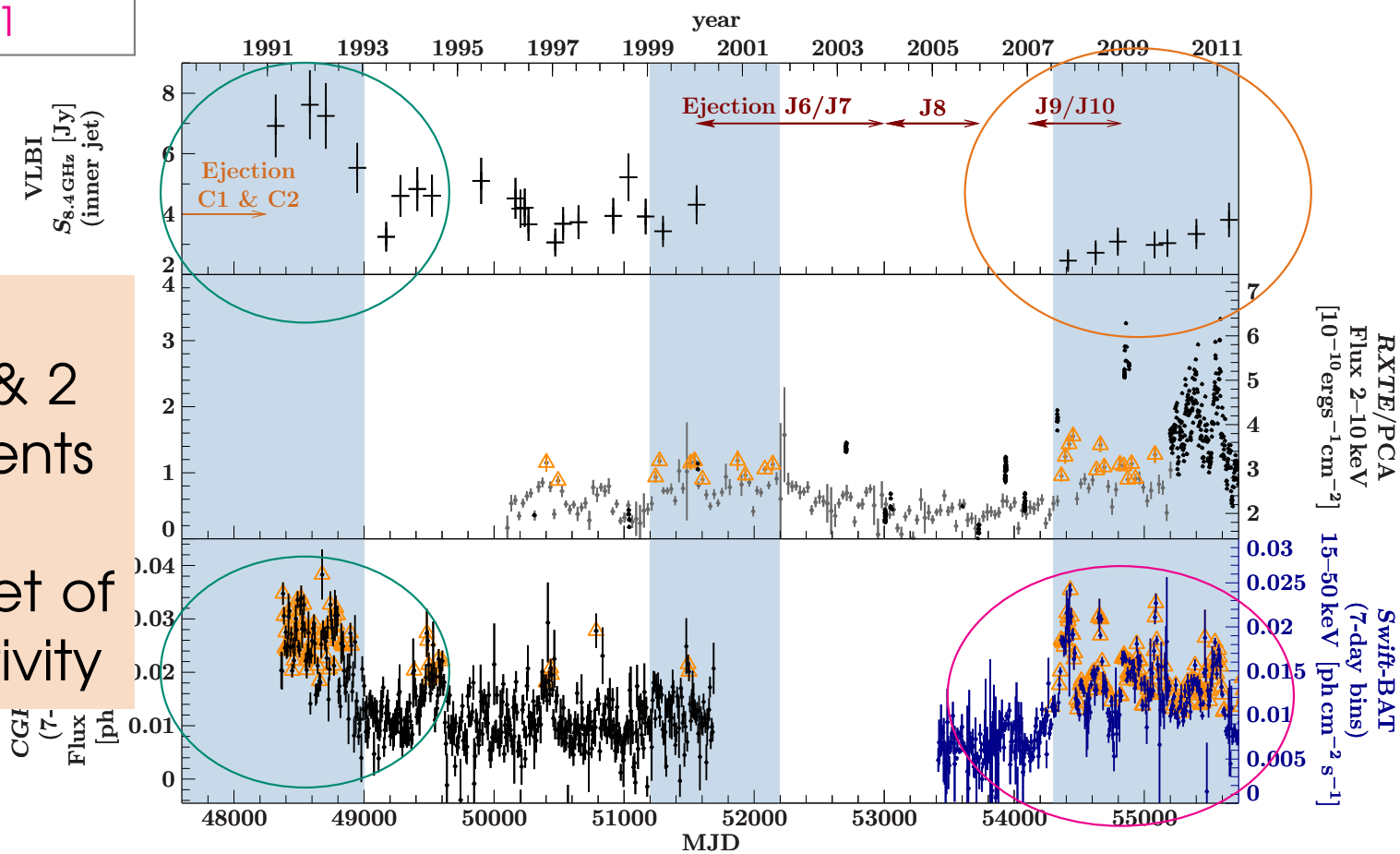
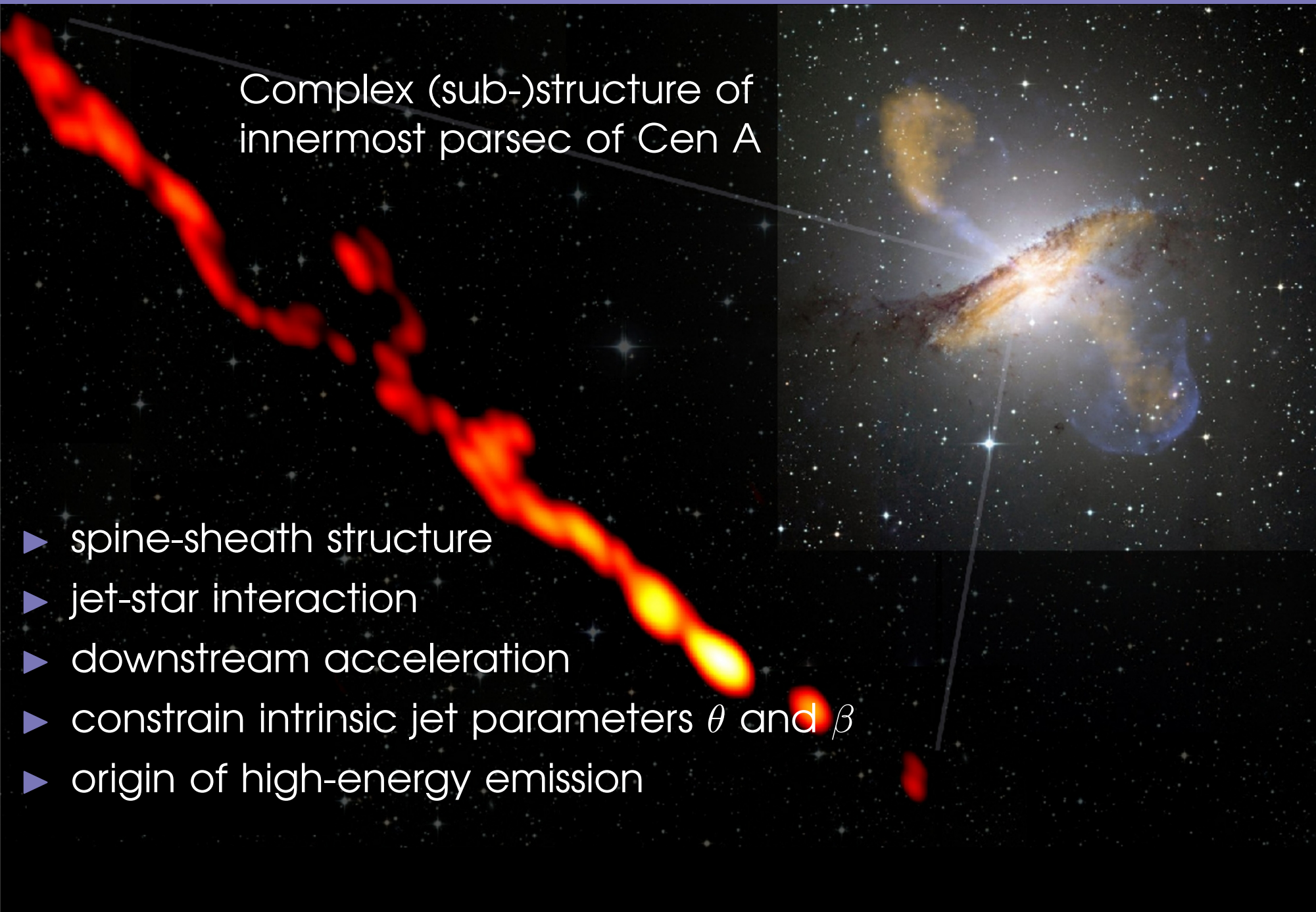
TANAMI
flux increase & 2 new components
↔
overlap to onset of hard X-ray activity





Summary & Conclusions

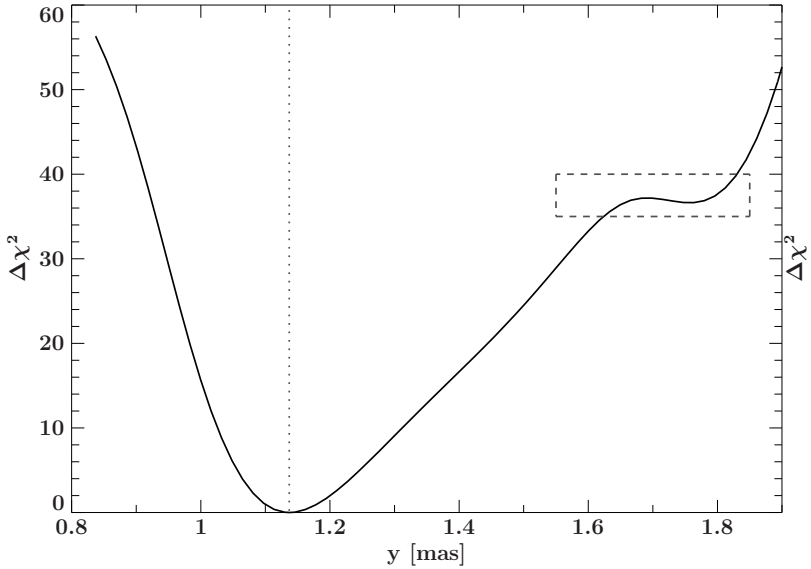


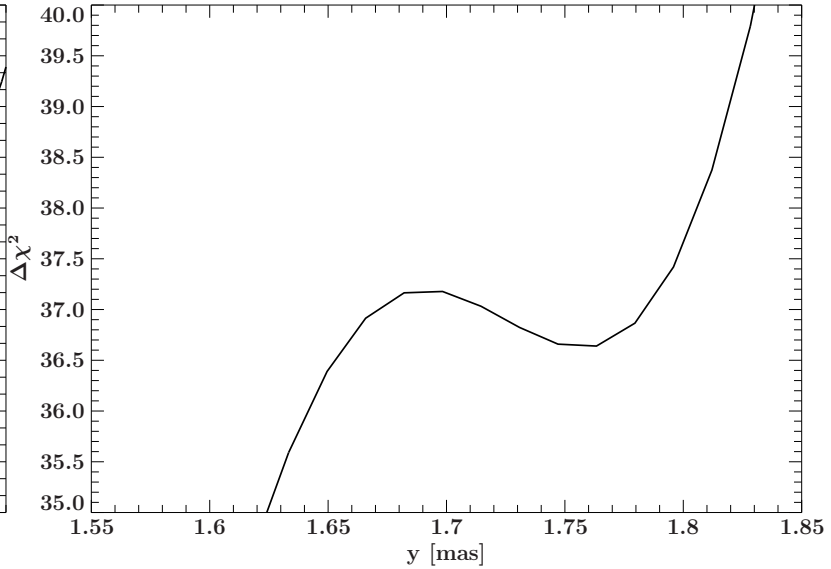
Complex (sub-)structure of innermost parsec of Cen A

- spine-sheath structure
- jet-star interaction
- downstream acceleration
- constrain intrinsic jet parameters θ and β
- origin of high-energy emission

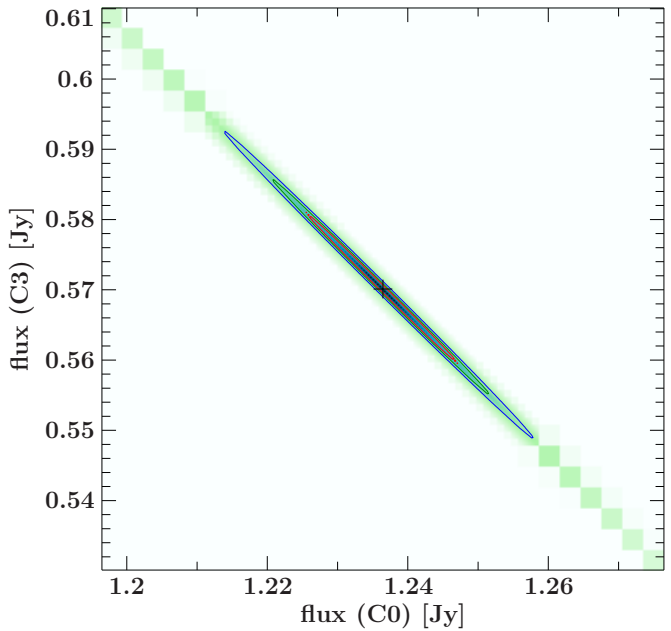
Backup Slides

Error calculation





- statistical error calculations for all modelfit parameters
- interfacing DIFMAP with ISIS
- based on χ^2-statistics

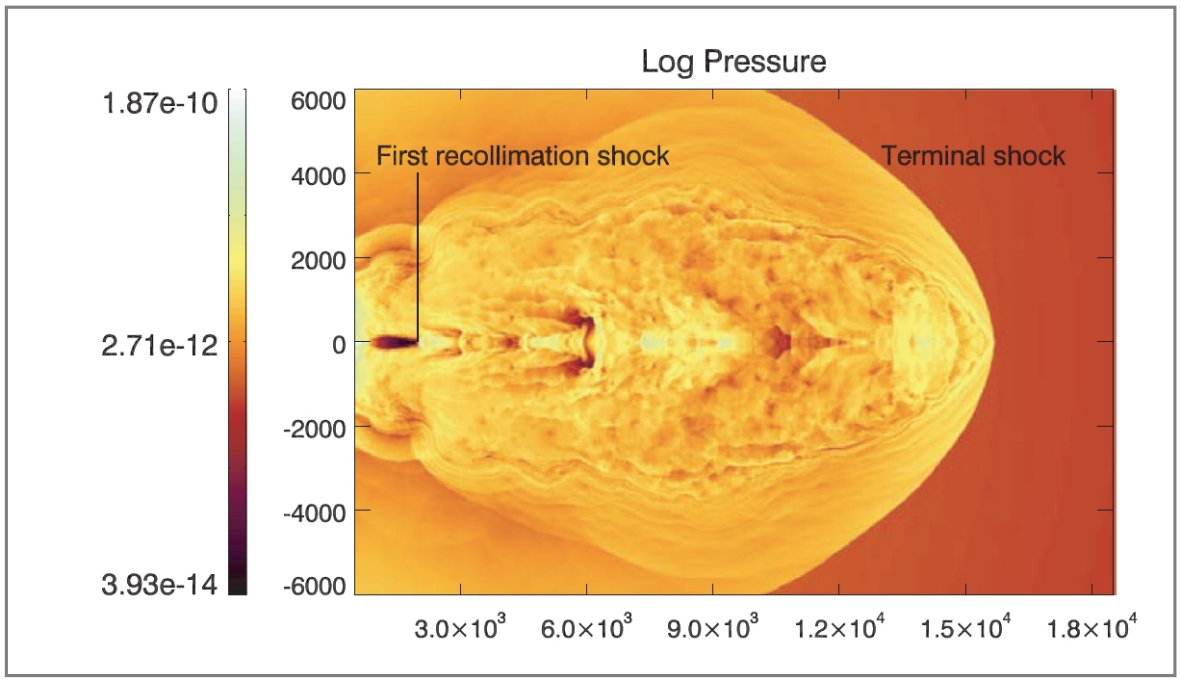


Großberger et al., in prep.

THE "TUNING FORK"

Recollimation shock?

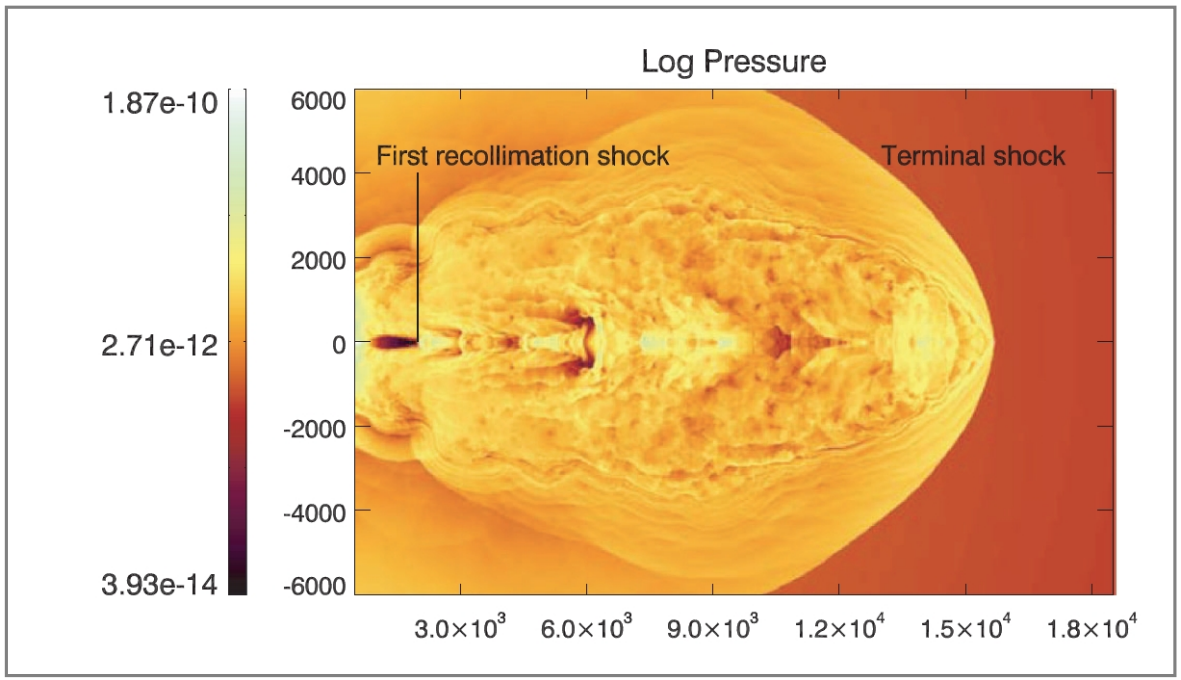
- ✓ separation of flow, surrounding central Mach disk
- ✓ acceleration of outer components
- ✓ optically thick emission zone behind shock



Perucho & Martí 2007

Recollimation shock?

- ✓ separation of flow, surrounding central Mach disk
- ✓ acceleration of outer components
- ✓ optically thick emission zone behind shock
- × no strong jet expansion prior to shock
- × no bright standing feature at Mach disk
- × no further shocks downstream



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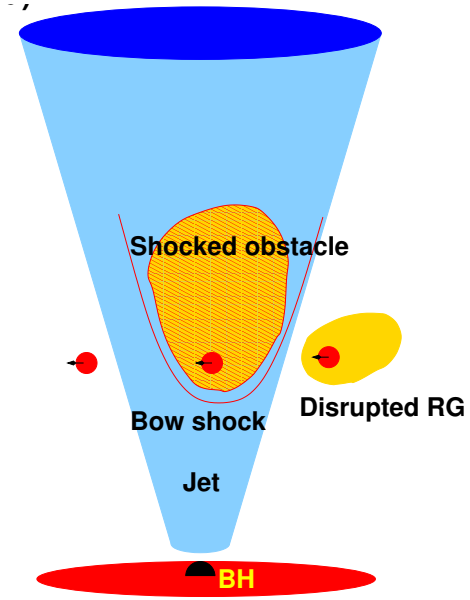

Bosch-Ramon+2012

~~Recollimation shock~~

Jet-star interaction?

- ✓ sharp flux gap
  $\rightarrow$ flow intermittent
- ✓ consistent with MIDI measurements of torus size
  (Meisenheimer+2007)
- ✓ RG with $v_{\rm wind} \simeq 100\,{\rm km\,s^{-1}}$ and $\dot{M} \simeq 10^{-8}{\rm M_\odot yr^{-1}}$

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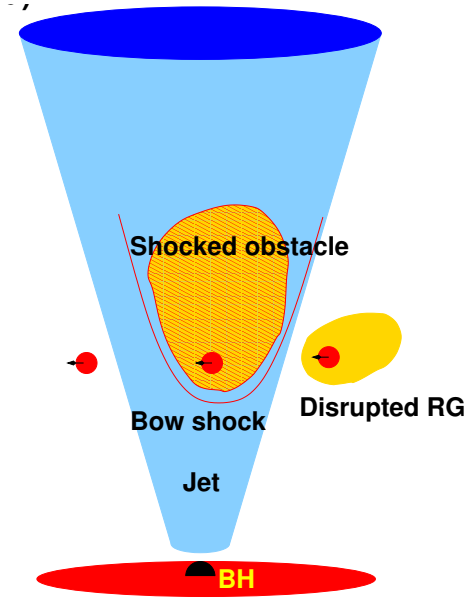

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- ▶ could explain high-energy emission (e.g. Sahakyan+2013)
- ▶ testable!