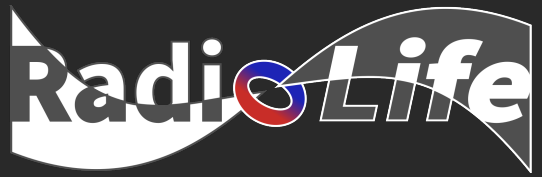
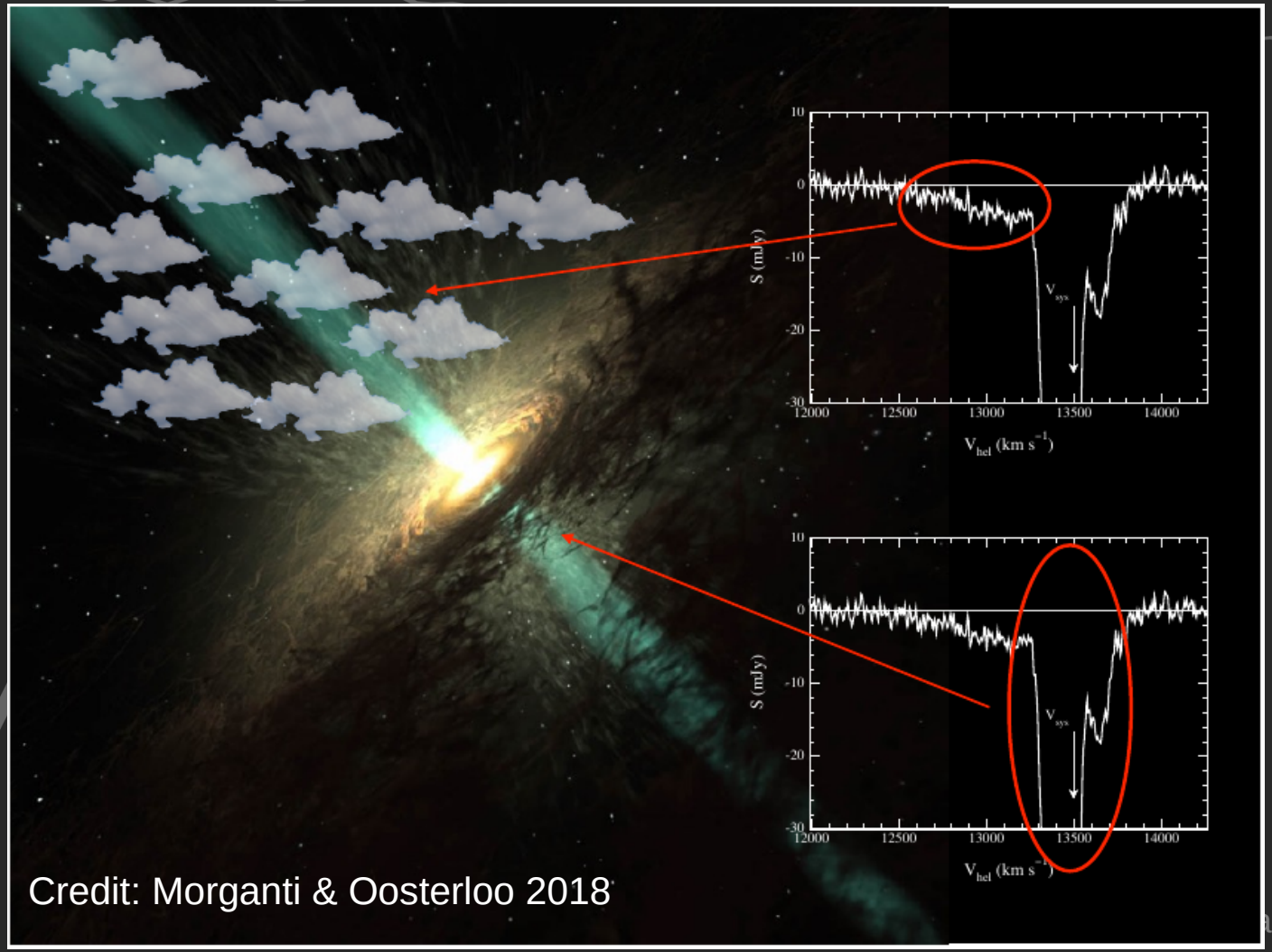
Tracing AGN feedback in powerful radio galaxies with VLBI

Robert Schulz
(ASTRON)

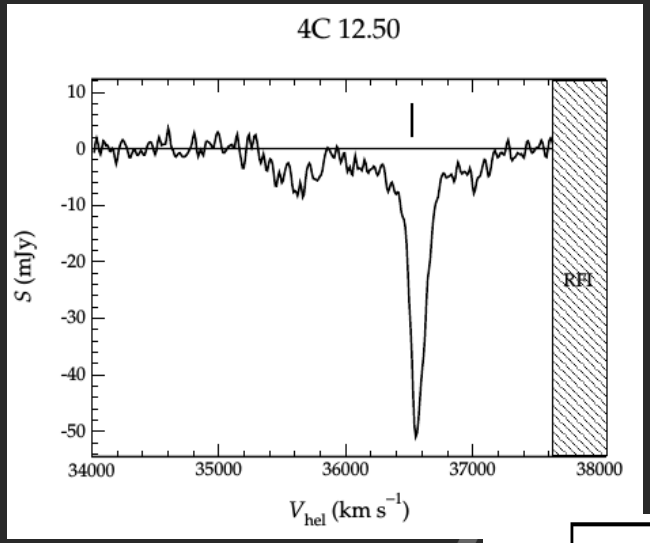
R. Morganti (ASTRON), K. Nyland (NRAO), Z. Paragi (JIVE),
T. Oosterloo (ASTRON), E. Mahony (Univ. Sydney)

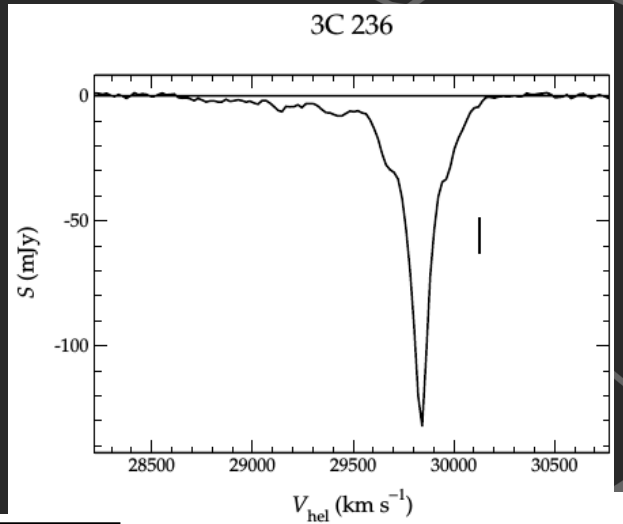


AGN feedback



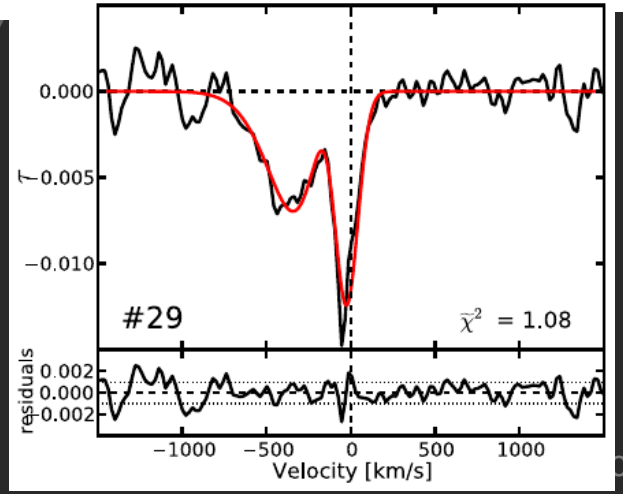
The sample

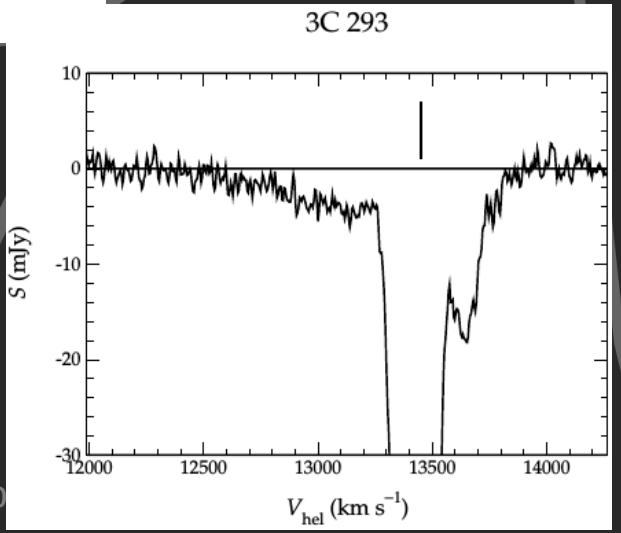




All sources are low-excitation radio galaxies (LERGs)

4C 52.37





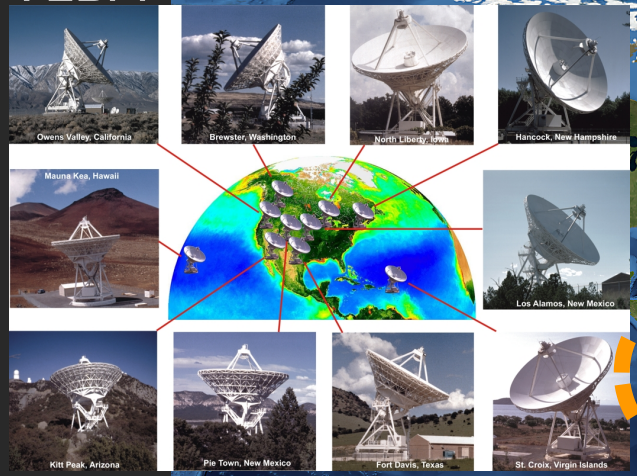
Morganti et al. 2005
Gereb et al. 2015

Global VLBI HI Observation

JIVE
Joint Institute for VLBI ERIC

EUROPEAN VLBI NETWORK

VLBA



Credit: NRAO

Onsala
Metsähovi
JIVE
WSRT
Torun
Svetloe
Jodrell Bank
Zelenchukskaya
Irbene
Badary
Yonsei
Cambridge
Wettzell
Effelsberg
Tamna
Medicina
Yebes
Sardinia
Urumqi
Noto
Ulsan
Tianma
Arecibo
Hartebeesthoek

Combined observations by EVN + VLBA + Arecibo

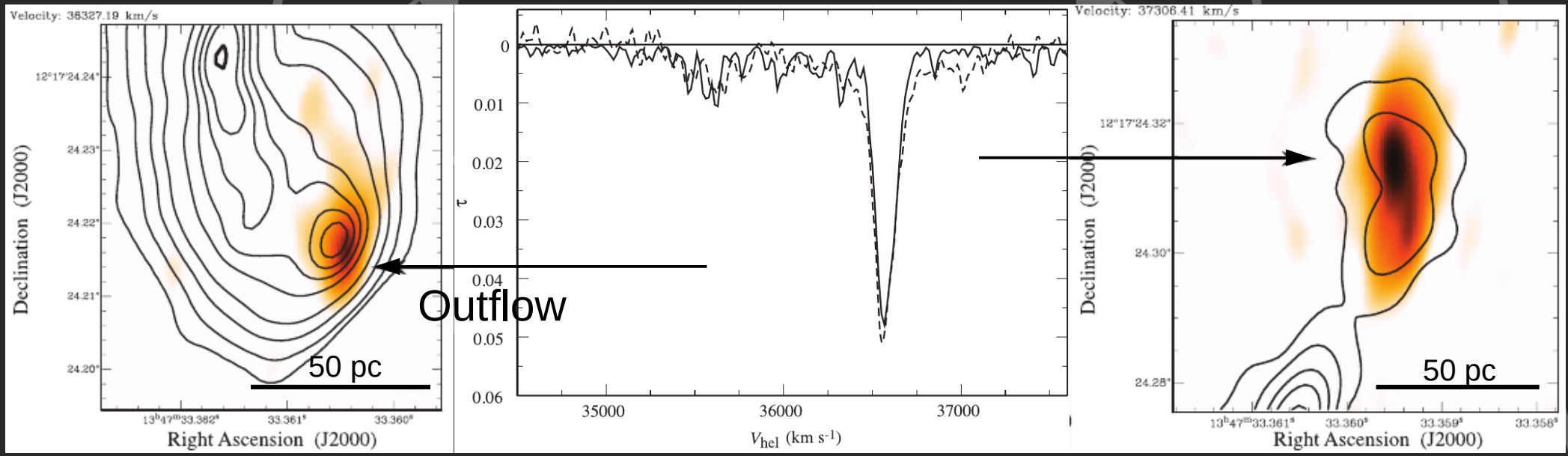
Coordination, correlation and support provided by JIVE

Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

4C 12.50

VLBI and WSRT spectrum match

Compact clouds (<50pc) with average densities 150 - 300 cm^{-3}

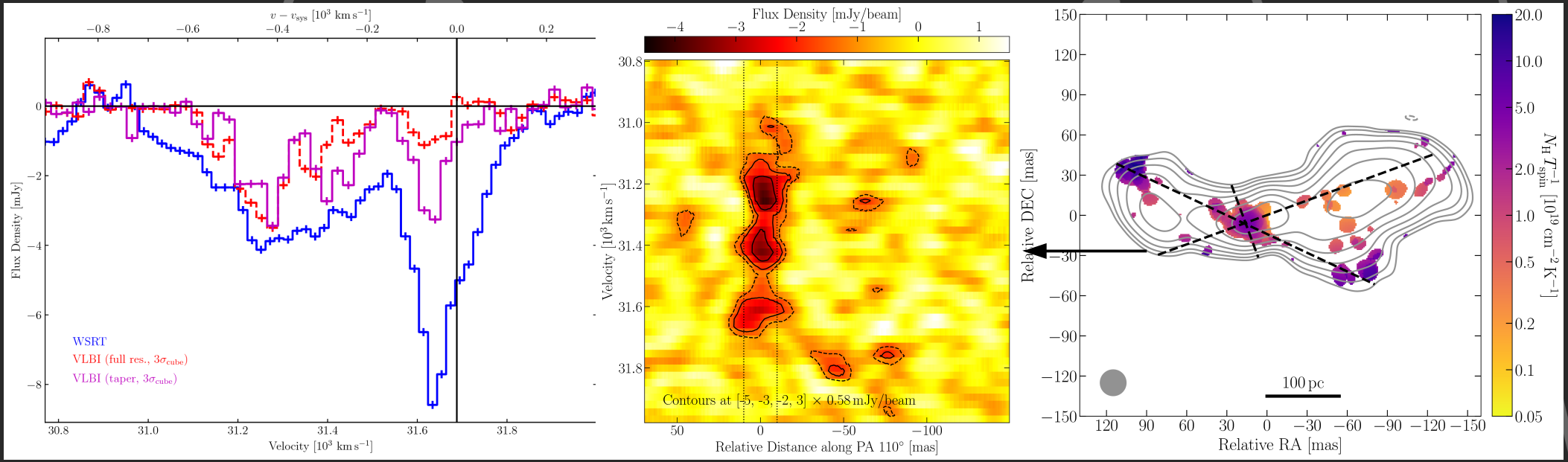


Morganti et al. 2013

4C 52.37

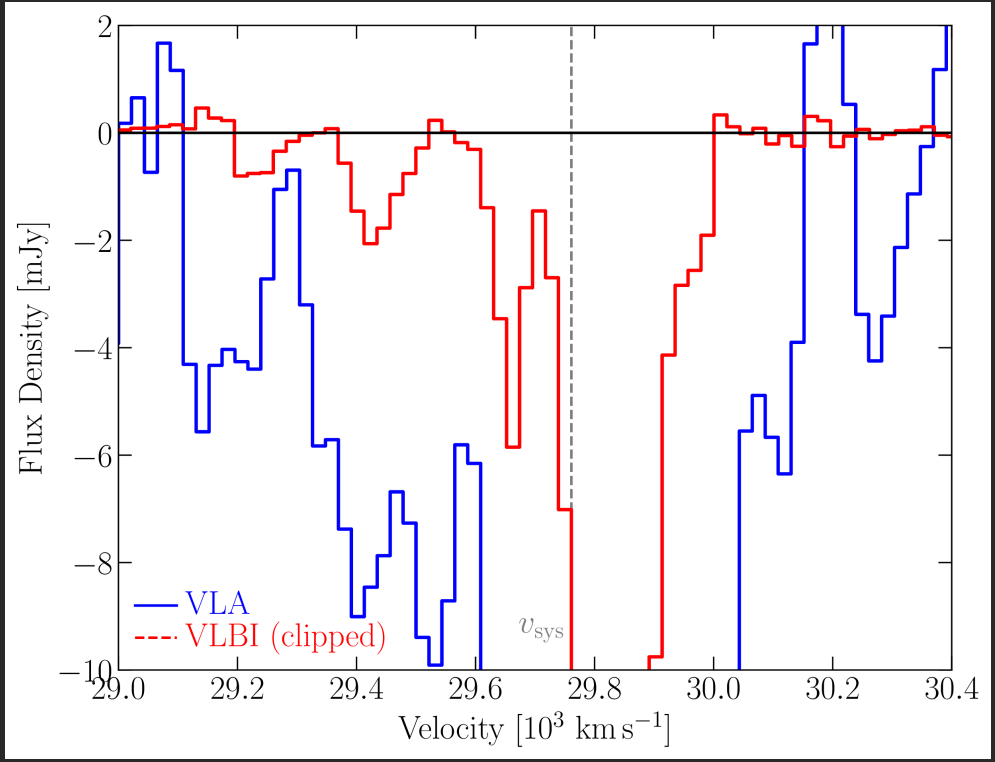
VLBI recovers most of the outflow (at multiple resolutions)

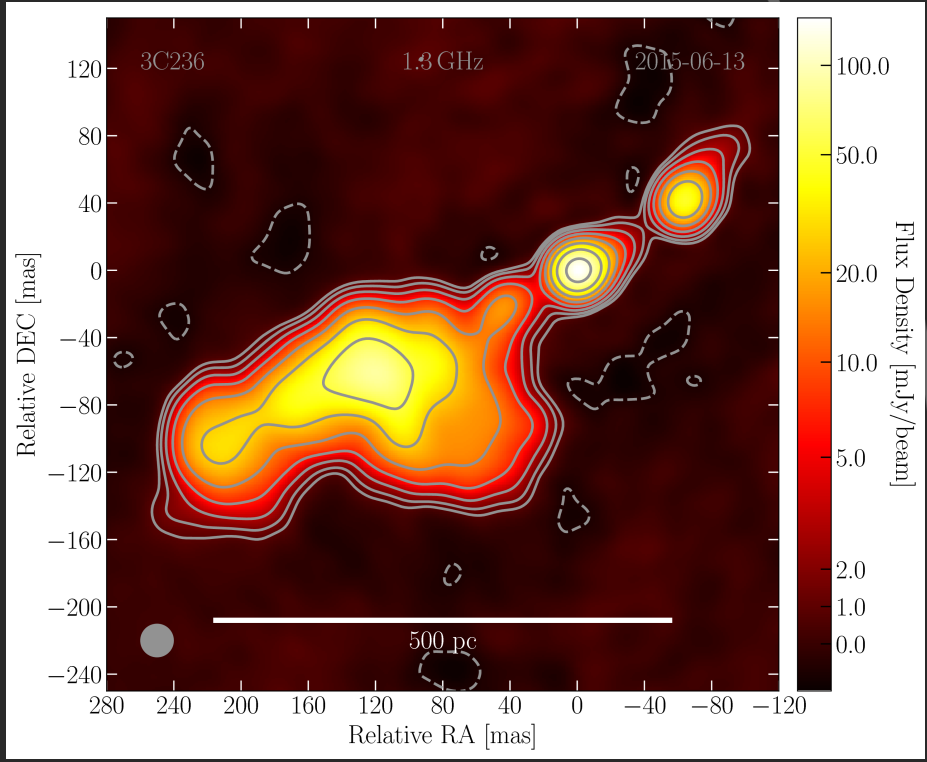
Compact (<40pc) clouds with N_{HI} ~2 x 10^{19} $cm^{-2}K^{-1}$



3C 236

VLBI recovers fraction of HI absorption

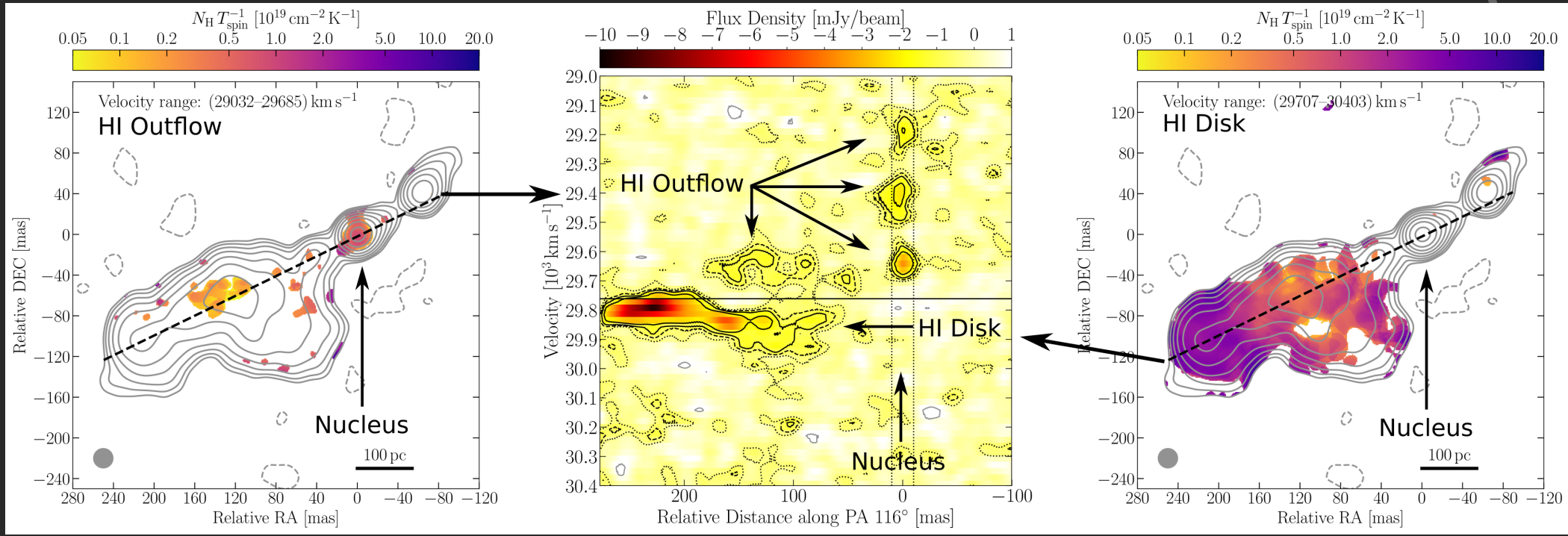




3C 236

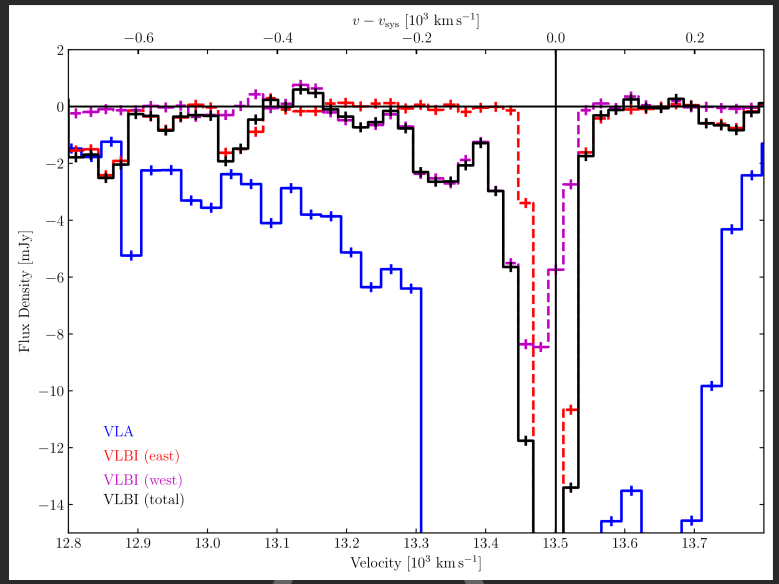
Clouds with 0.28-1.5 x 10^4 M_{Sun} towards nucleus (<40pc)

Indications for outflow also towards radio lobe



3C 293

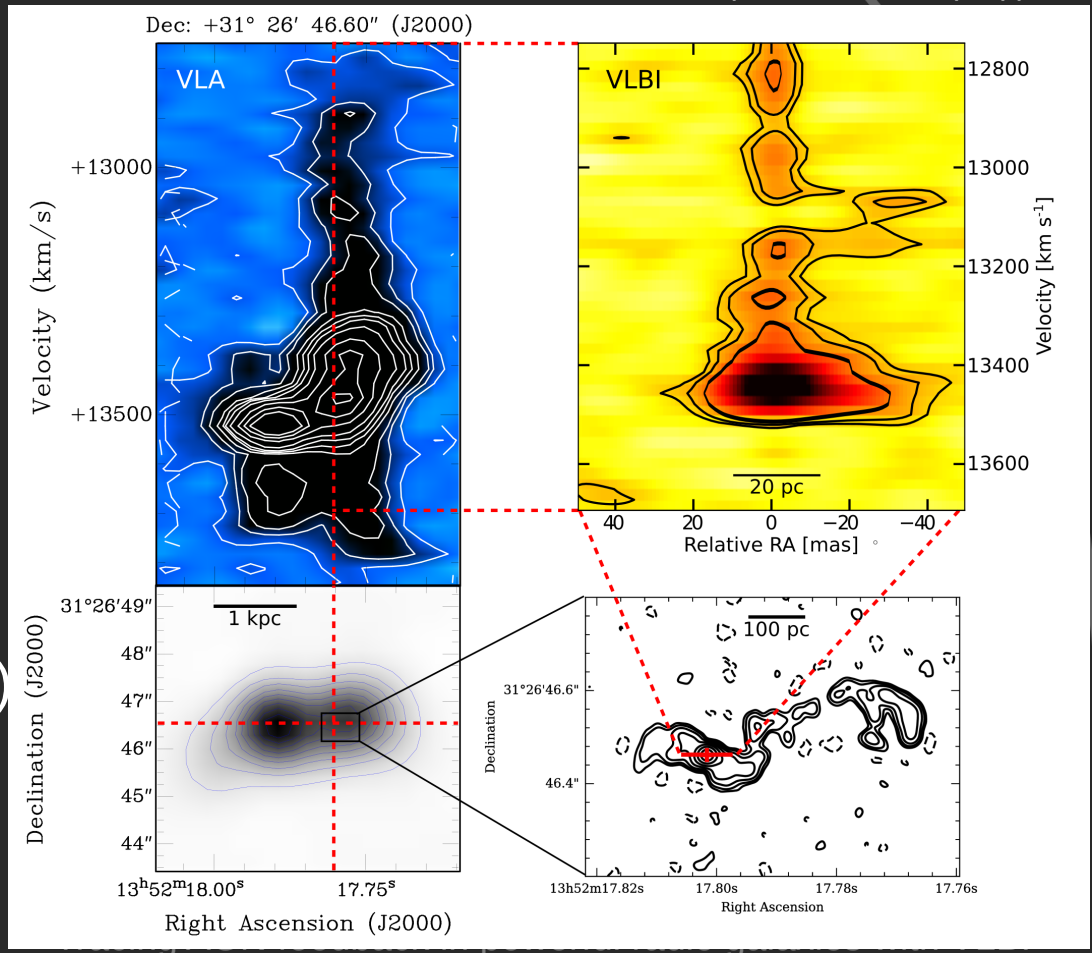
VLBI HI detection limited



HI clouds towards VLBI core (<50pc)

From VLA: outflow extends ~0.5kpc

VLA (Mahony et al. 2013) VLBI (Schulz et al. in prep)



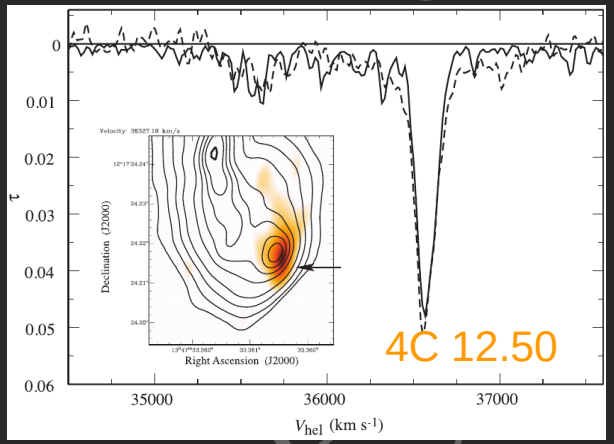
Tracing AGN Evolution?

Smaller / Younger?

Stronger interaction?

Larger / Older?

Tracing AGN Evolution?

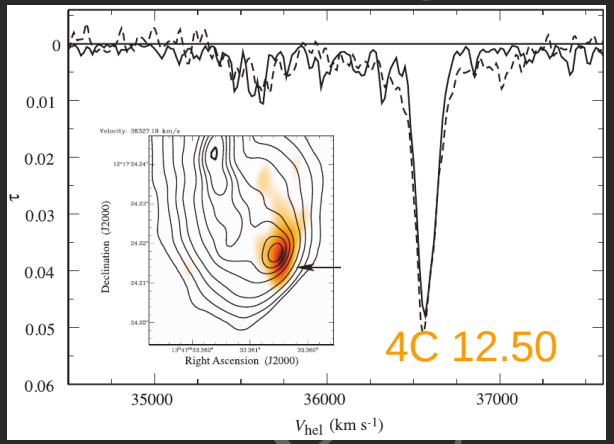


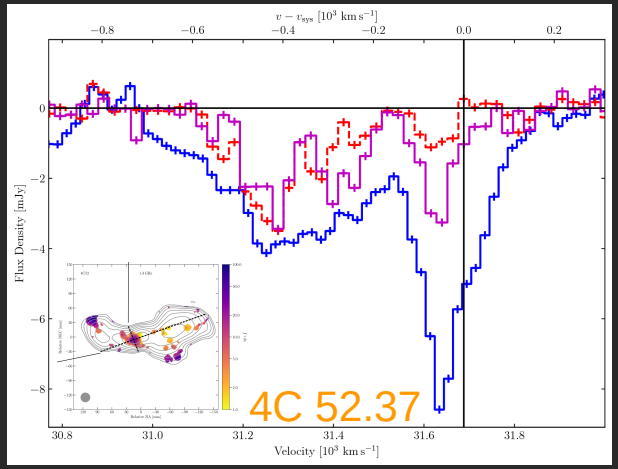
Smaller / Younger?

Stronger interaction?

Larger / Older?

Tracing AGN Evolution?



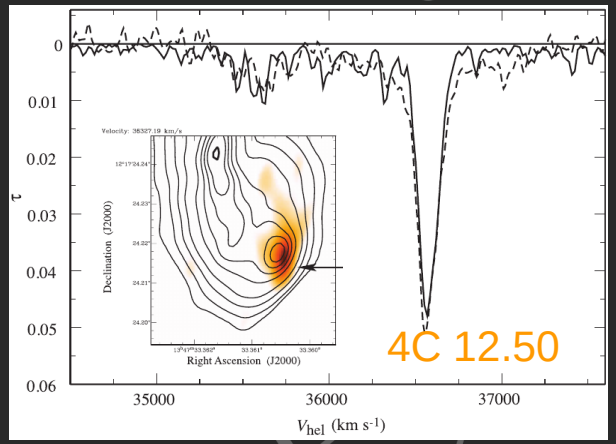


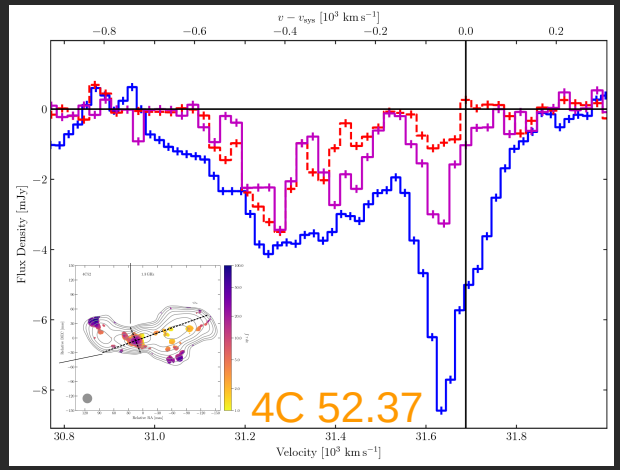
Smaller / Younger?

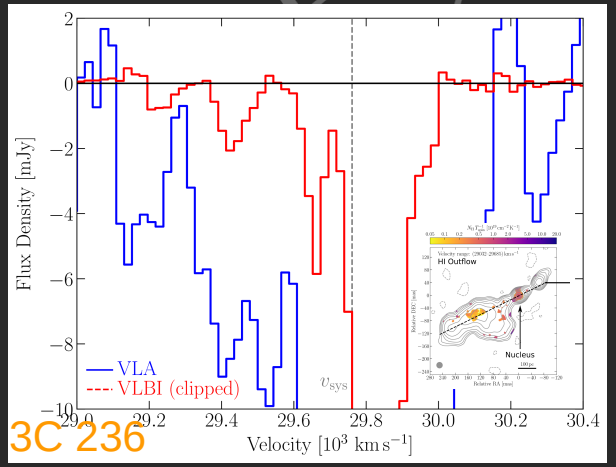
Stronger interaction?

Larger / Older?

Tracing AGN Evolution?





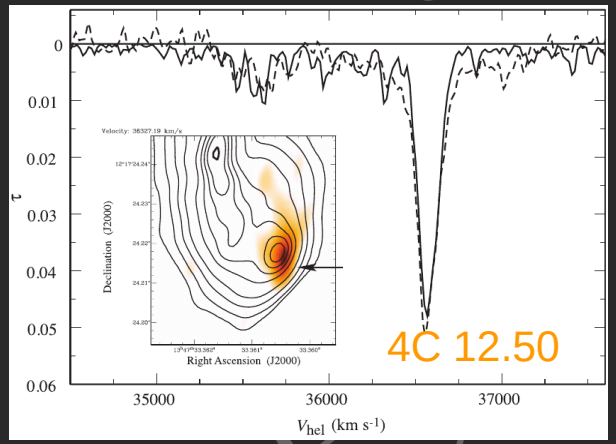


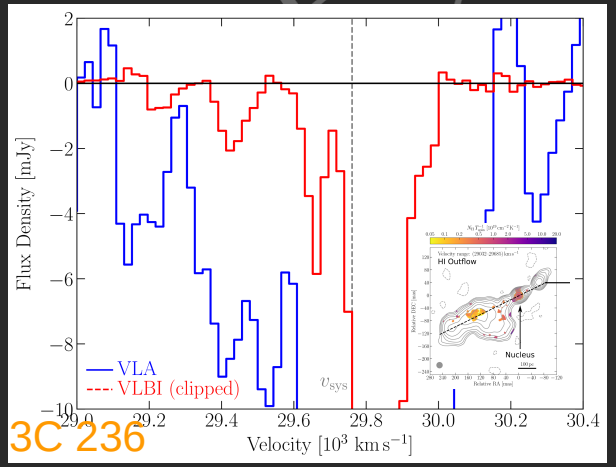
Smaller / Younger?

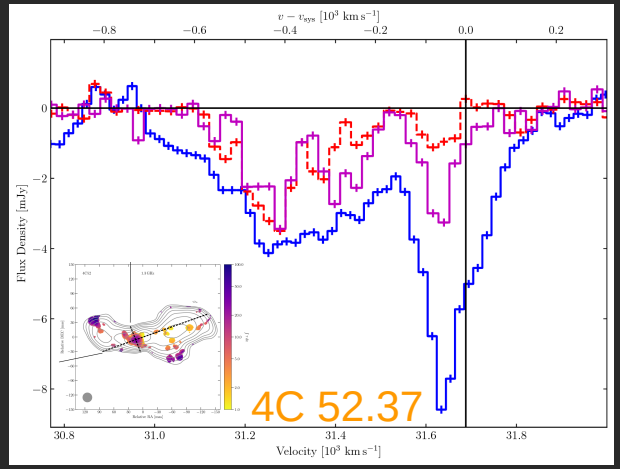
Stronger interaction?

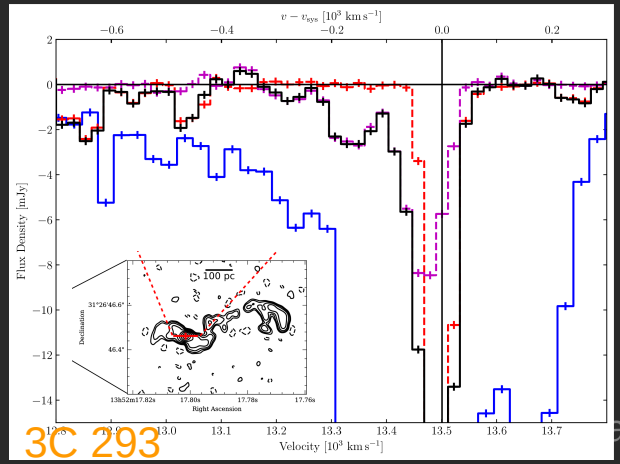
Larger / Older?

Tracing AGN Evolution?









Smaller / Younger?

Stronger interaction?

Larger / Older?

Summary

Clumpy medium observed in all sources

HI on small scales towards nuclear region (< 40pc)

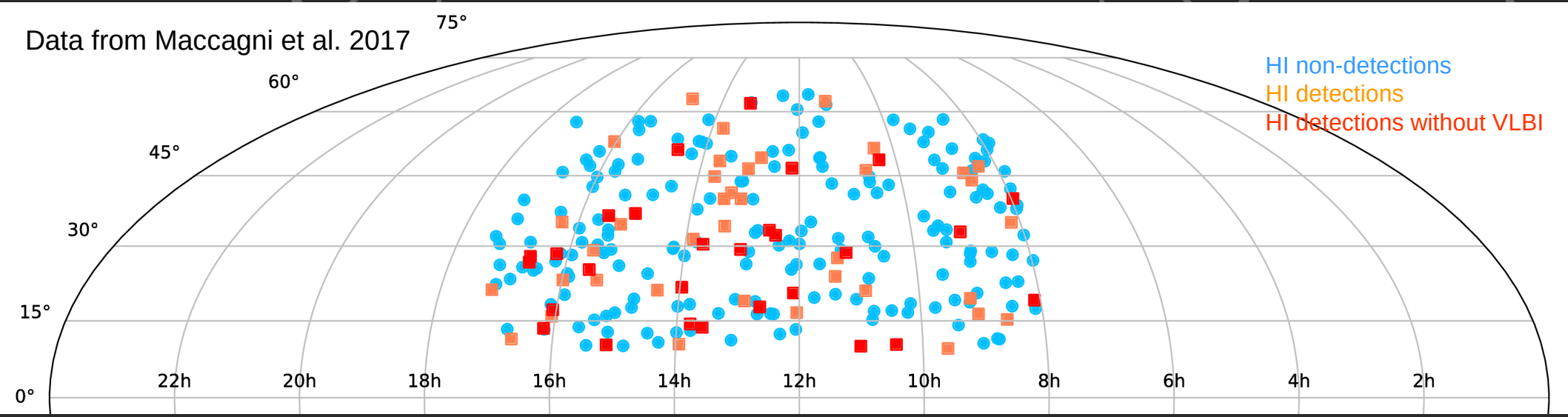
Tentative signs of evolution

- Young/smaller sources show stronger signs of interaction

Outlook

Several HI absorption surveys are underway

Recently: HI Sample from Maccagni et al. 2017



Outlook

VLBI important for follow-up investigations

Short term: Improvements

- e-MERLIN integration to provide short uv-spacings

Long term: Limitations

1) Redshift (< 0.12)
2) Number of stations