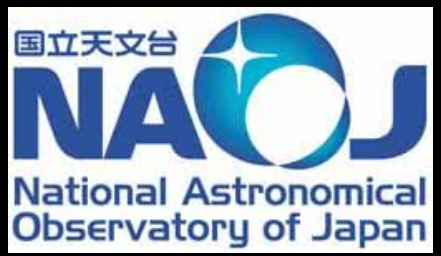
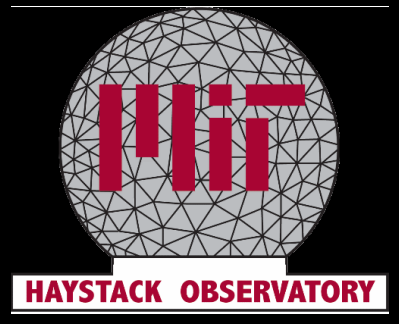
The collimation structure of the relativistic jet of 3C 273 revealed by GMVA+ALMA

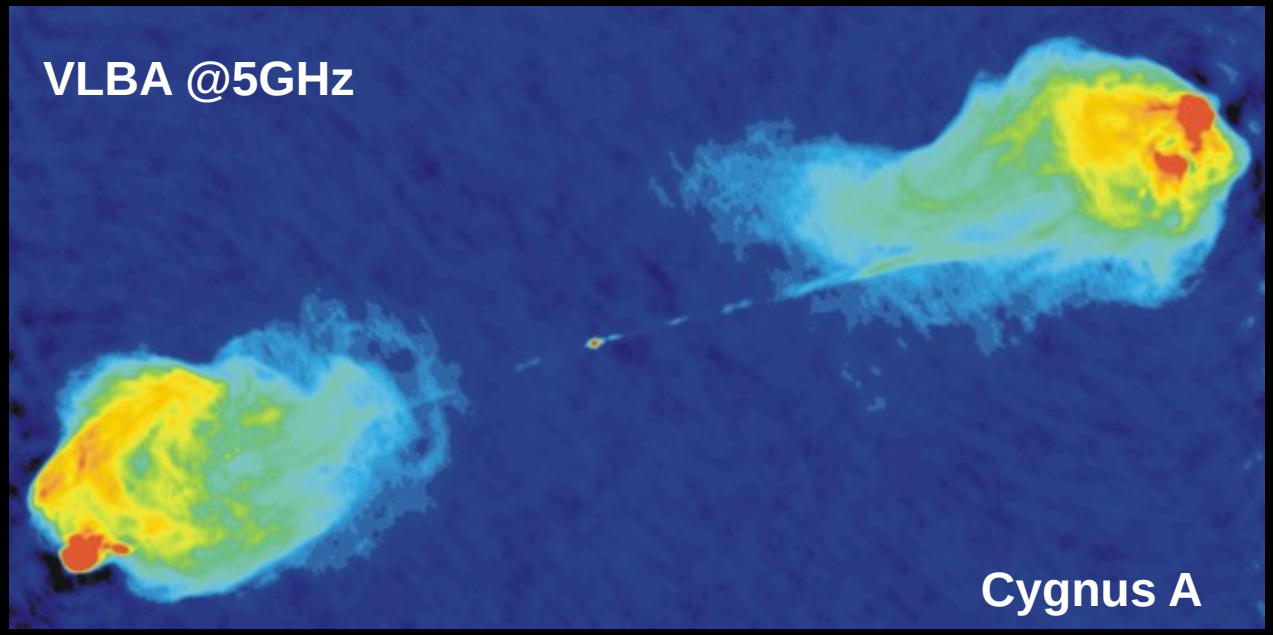
Hiroki Okino (U.Tokyo / NAOJ)

Collaborators
Kazunori Akiyama (NRAO / MIT)
Keiichi Asada (ASIAA)
GMVA+ALMA 3C273 Collabolation Team





Opened question for jets in Active Galactic Nuclei

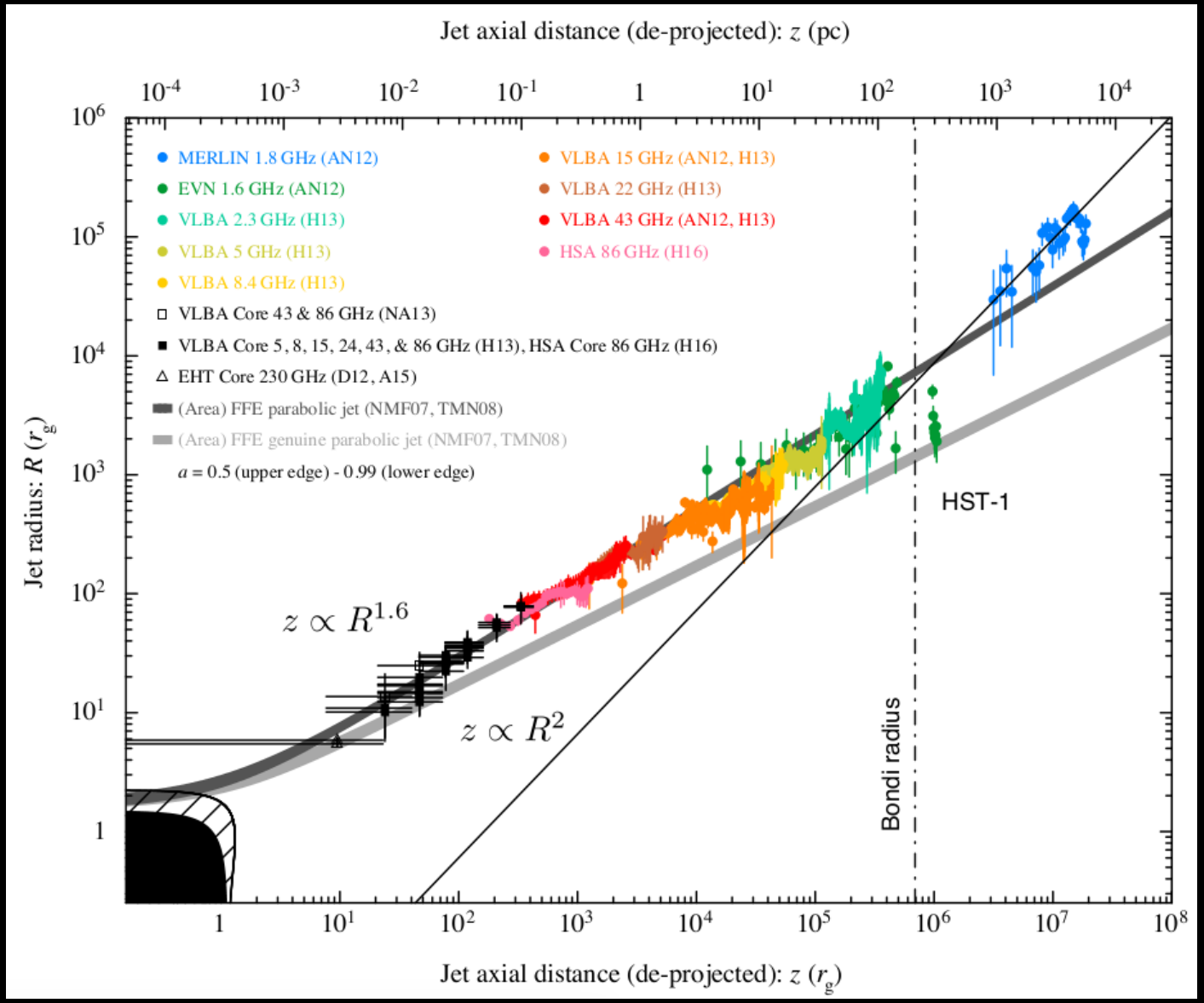


- Formation

- Collimation & Acceleration

A key clue: **Shape** of the jets!

Jet collimation of LLAGN : M87



Nakamura+ 2018

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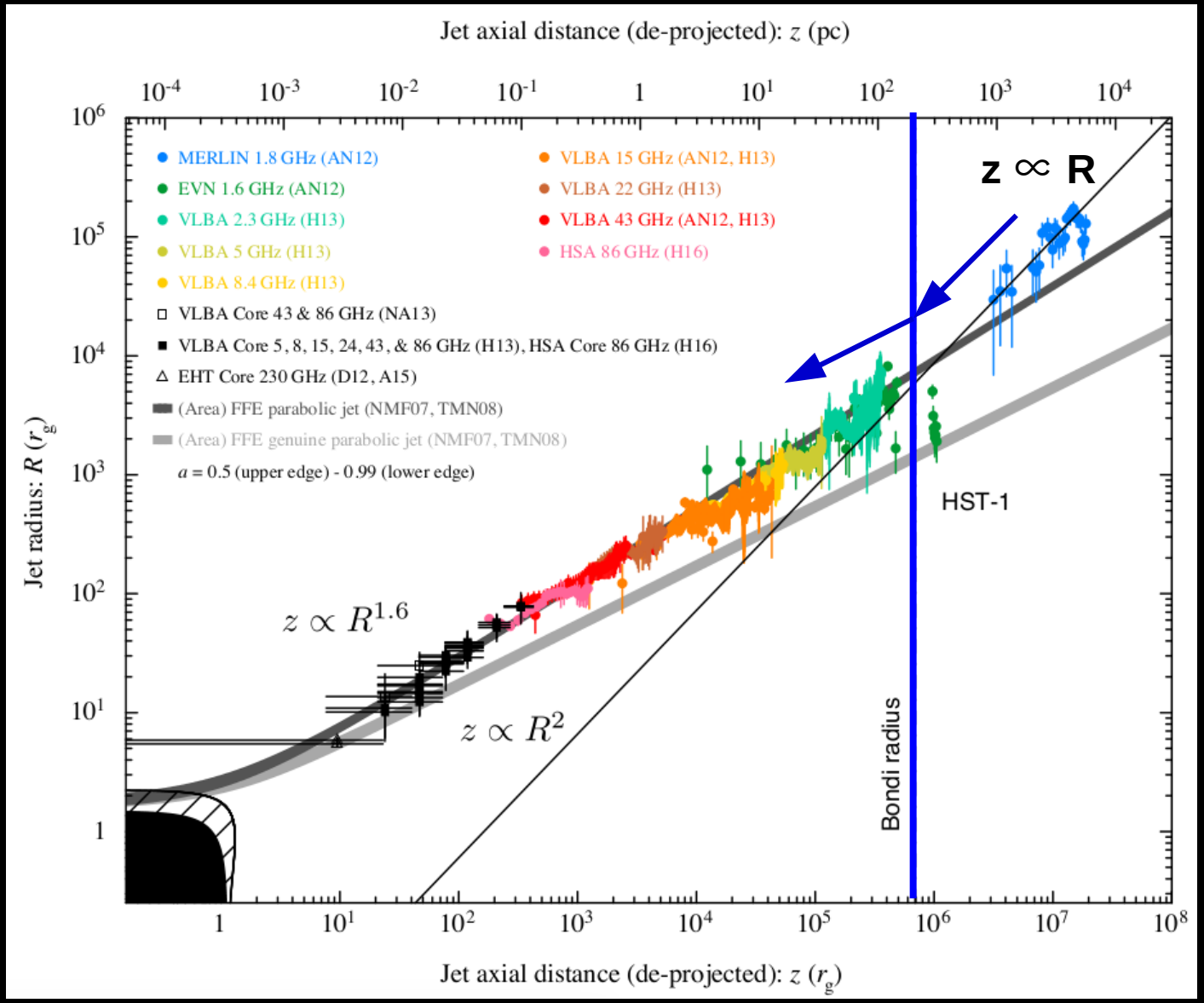


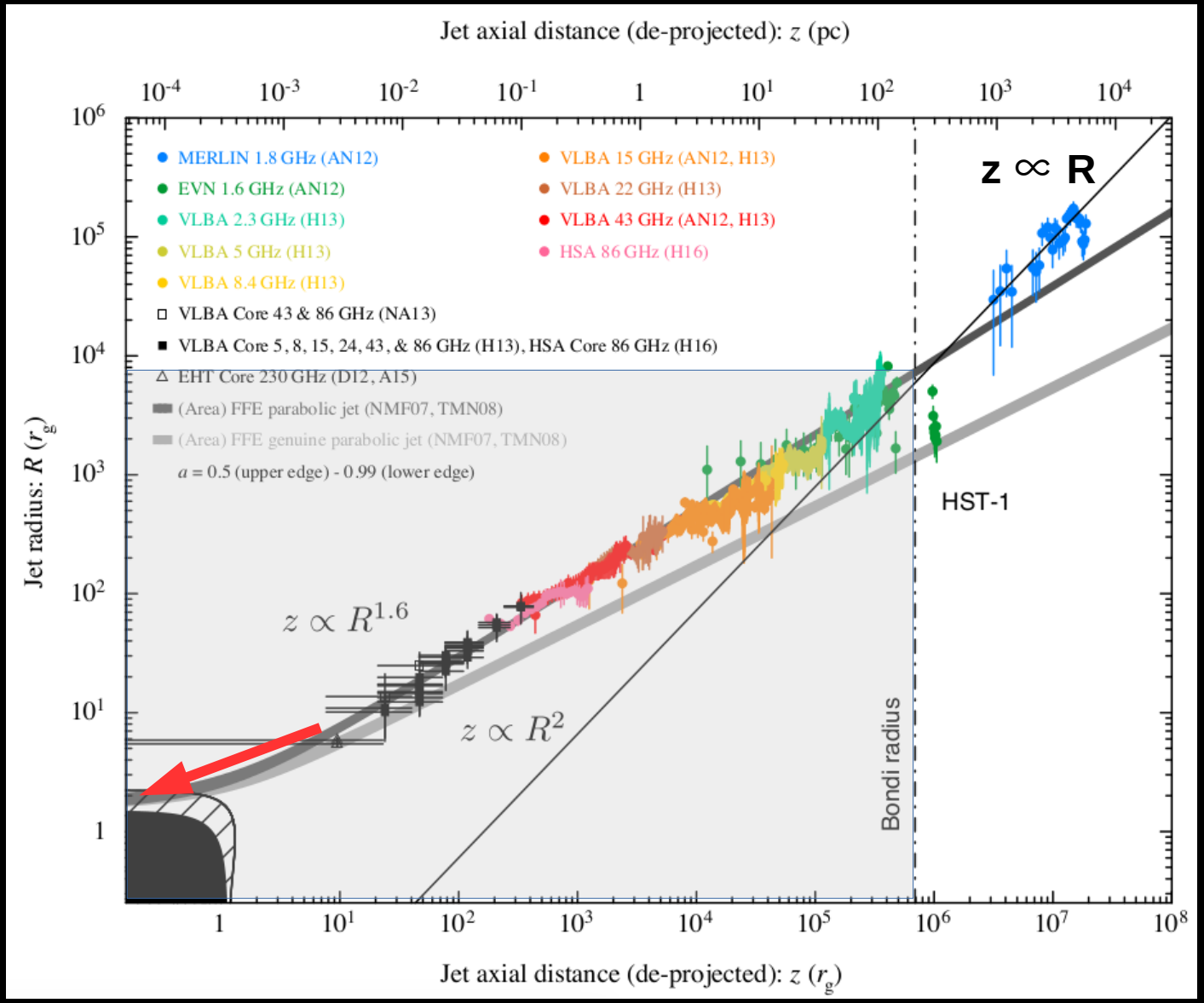
Transition at close to the **Bondi radius**

$r_B \sim 10^5\, r_g$

e.g.
NGC6251** Tseng+ 2016
NGC4261 Nakahara+ 2016
1H 0323+342 Hada+ 2018
3C84 Nagai+ 2014
Cygnus A Boccardi+ 2016

Nakamura+ 2018

Jet collimation of nearby LLAGN



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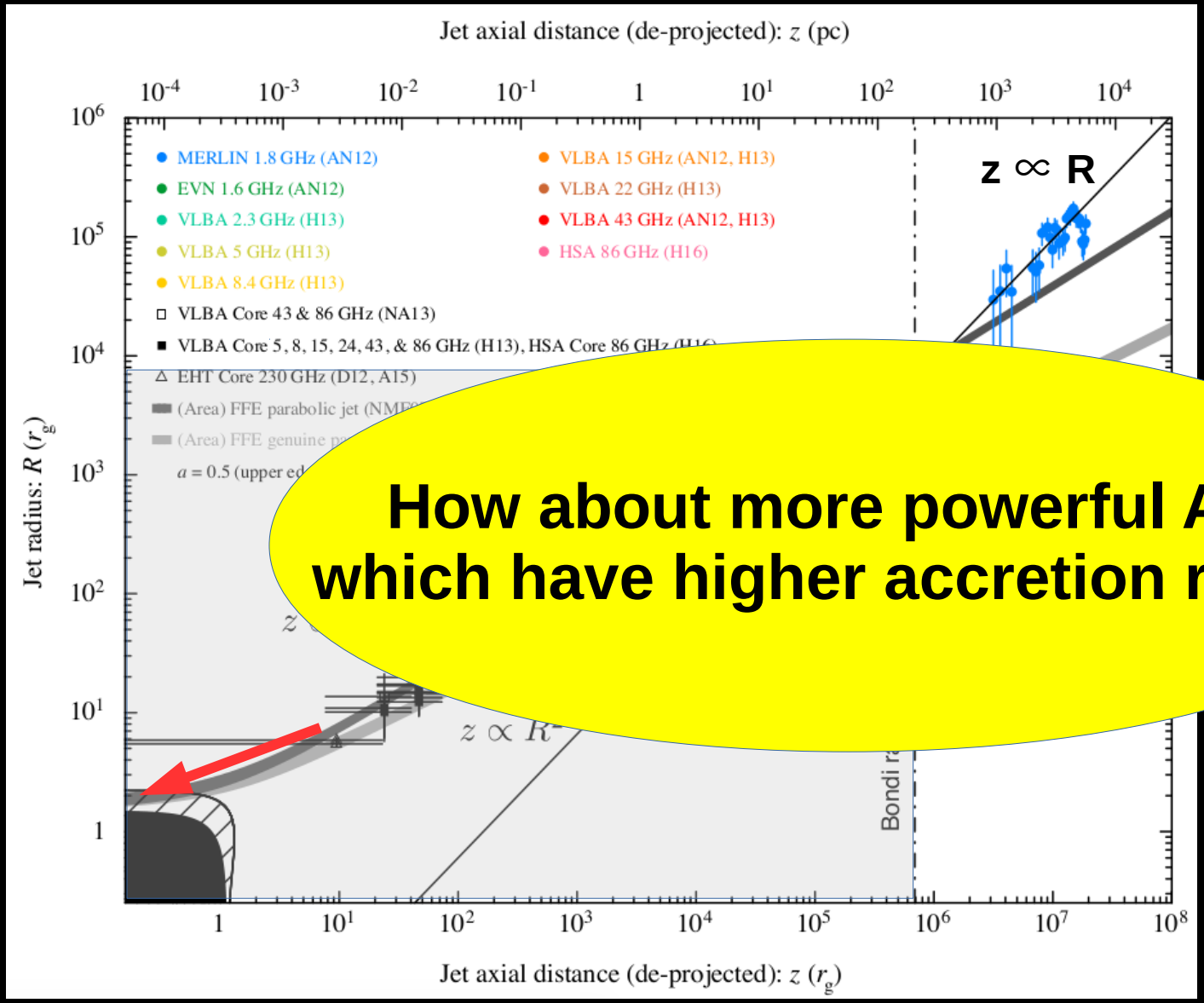
Collimation profile is consistent with field lines from the **black hole** (Nakamura+ 2018)

Nakamura+ 2018

Jet collimation of nearby LLAGN



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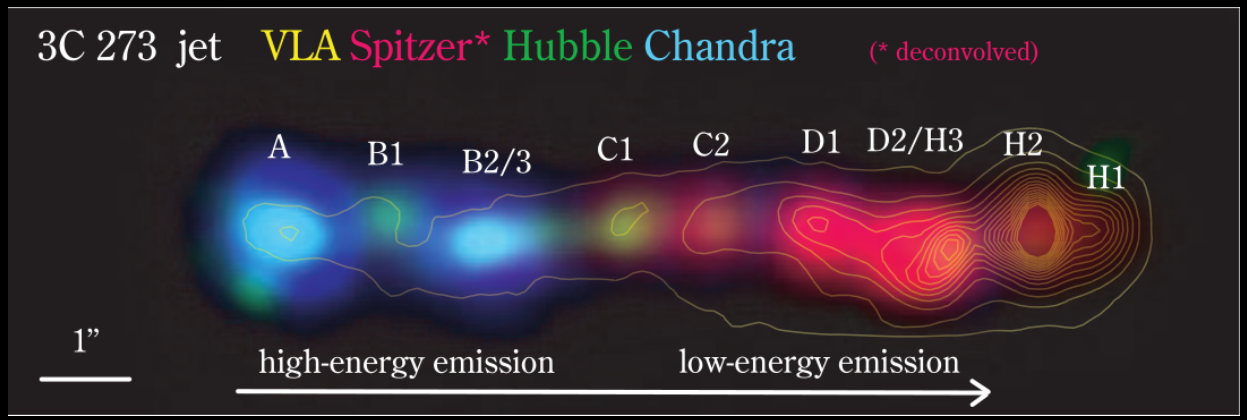
Nakamura+ 2018

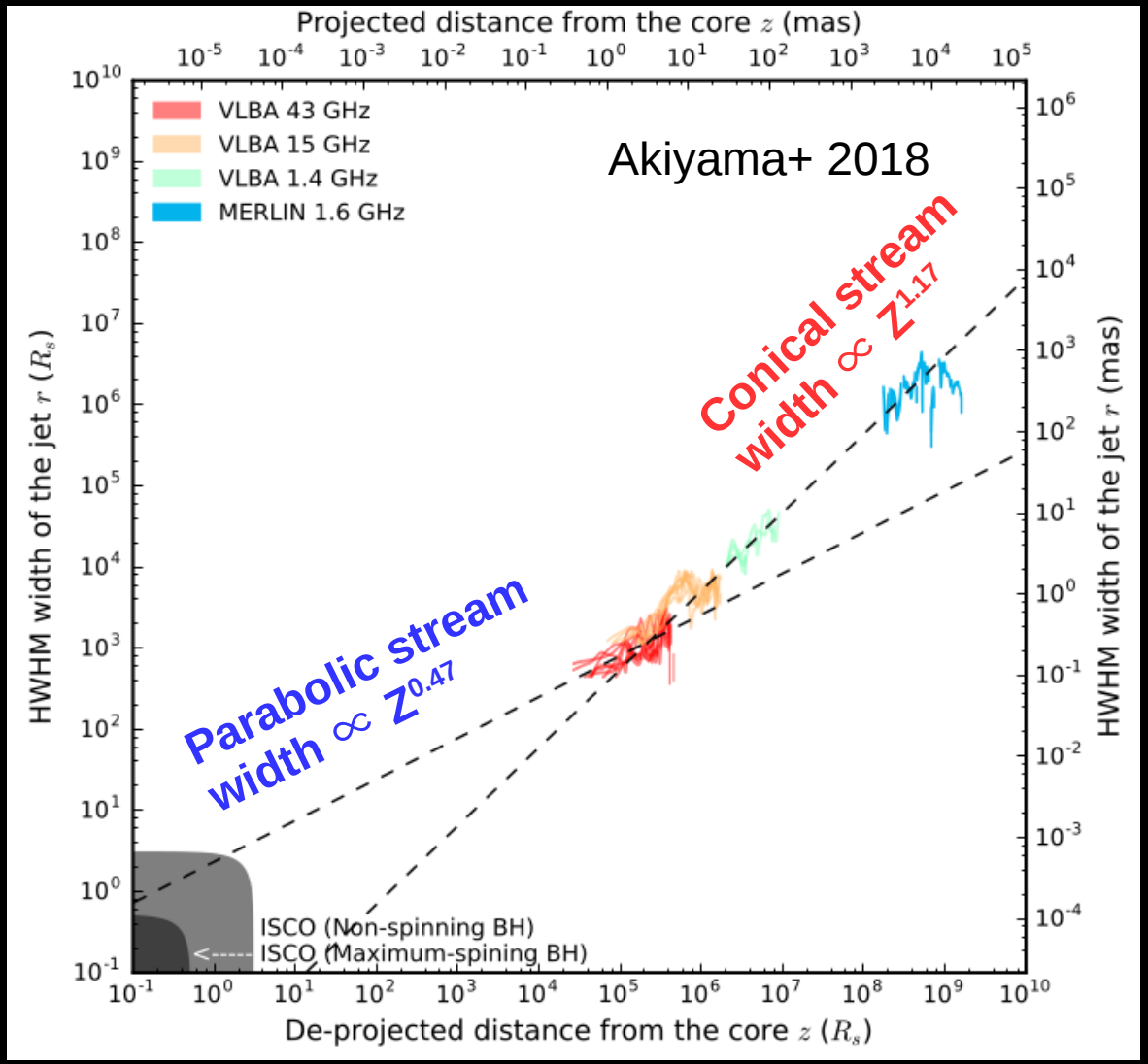
Target source: Quasar 3C 273

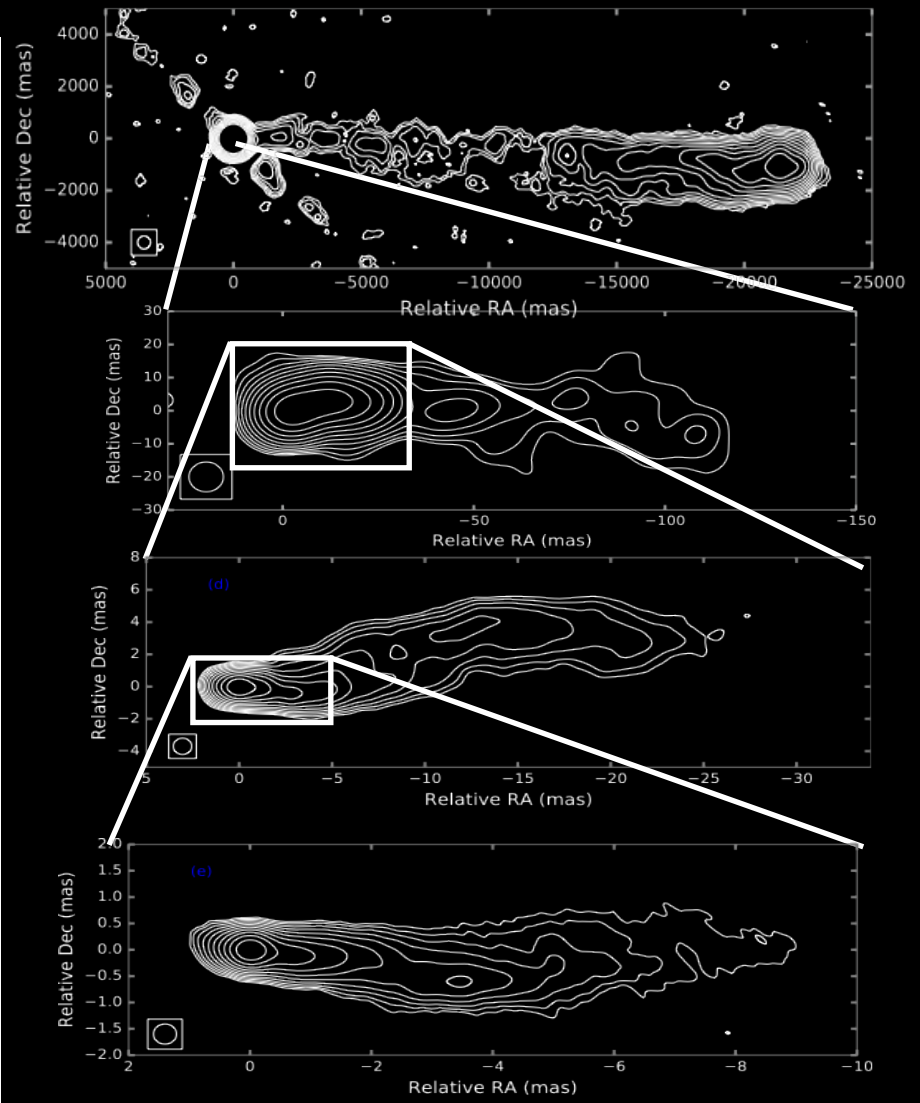
- One of the most well-known bright quasars (Schmidt 1963)
- Redshift **z=0.158**
- Black Hole Mass **~6.59×10^9 M$_{sun}$** (Paltani+ 2005)
- The Largest angular diameter (**1 mas= 2.7pc=4.8×10^3 Rs**)
- Bolometric luminosity **~10^47 [erg/sec] ~ 0.13 - 0.53 L$_{edd}$**
- It's **Jet** have been studied in multi "scales" and "wavelengths" in the last decades



Uchiyama+ 2016

Previous works of 3C 273 jet collimation profile





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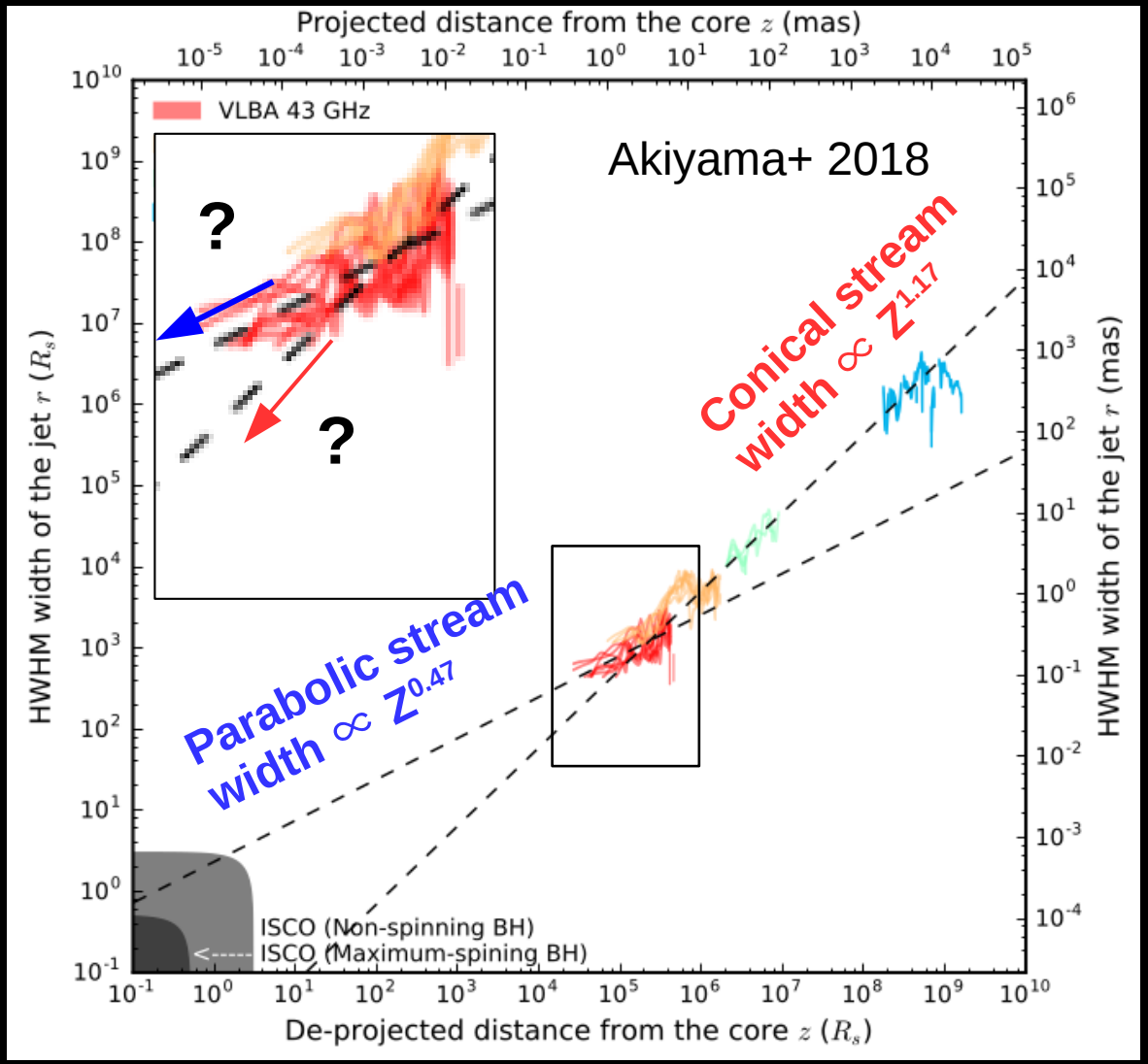
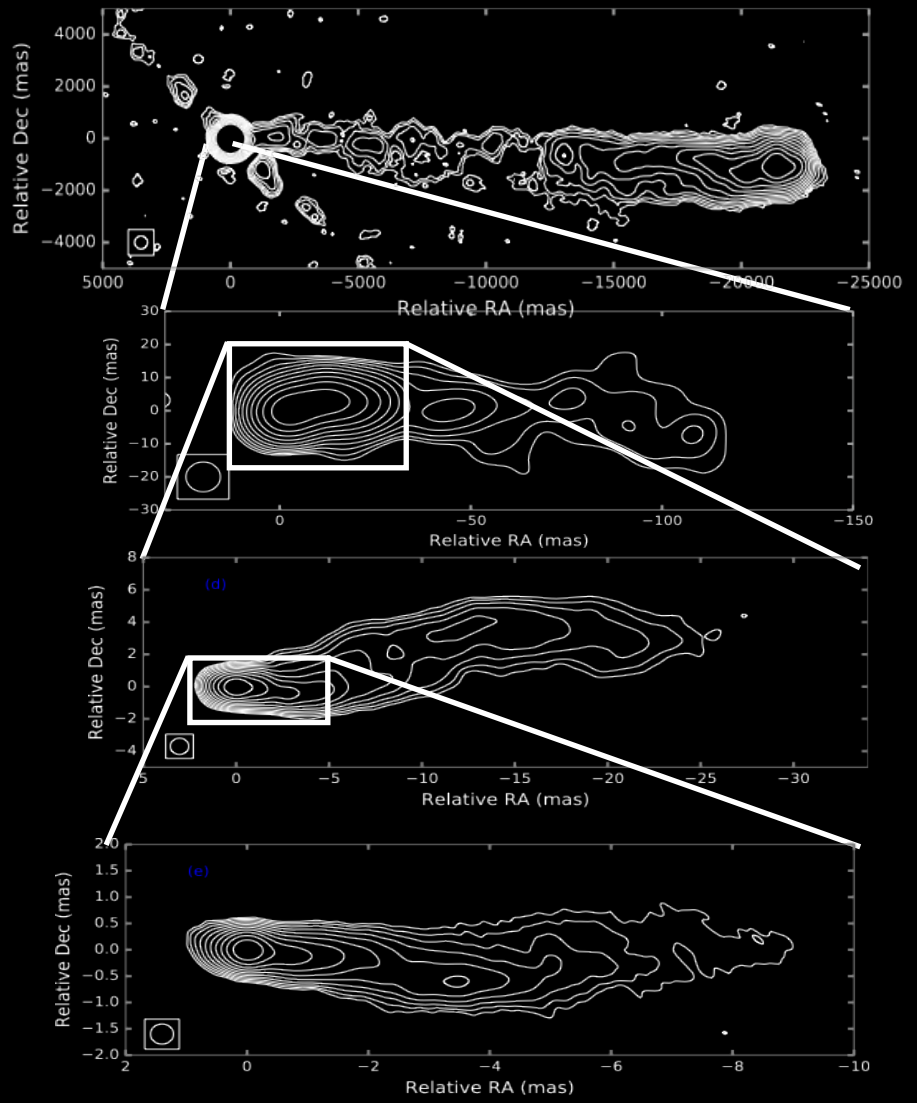
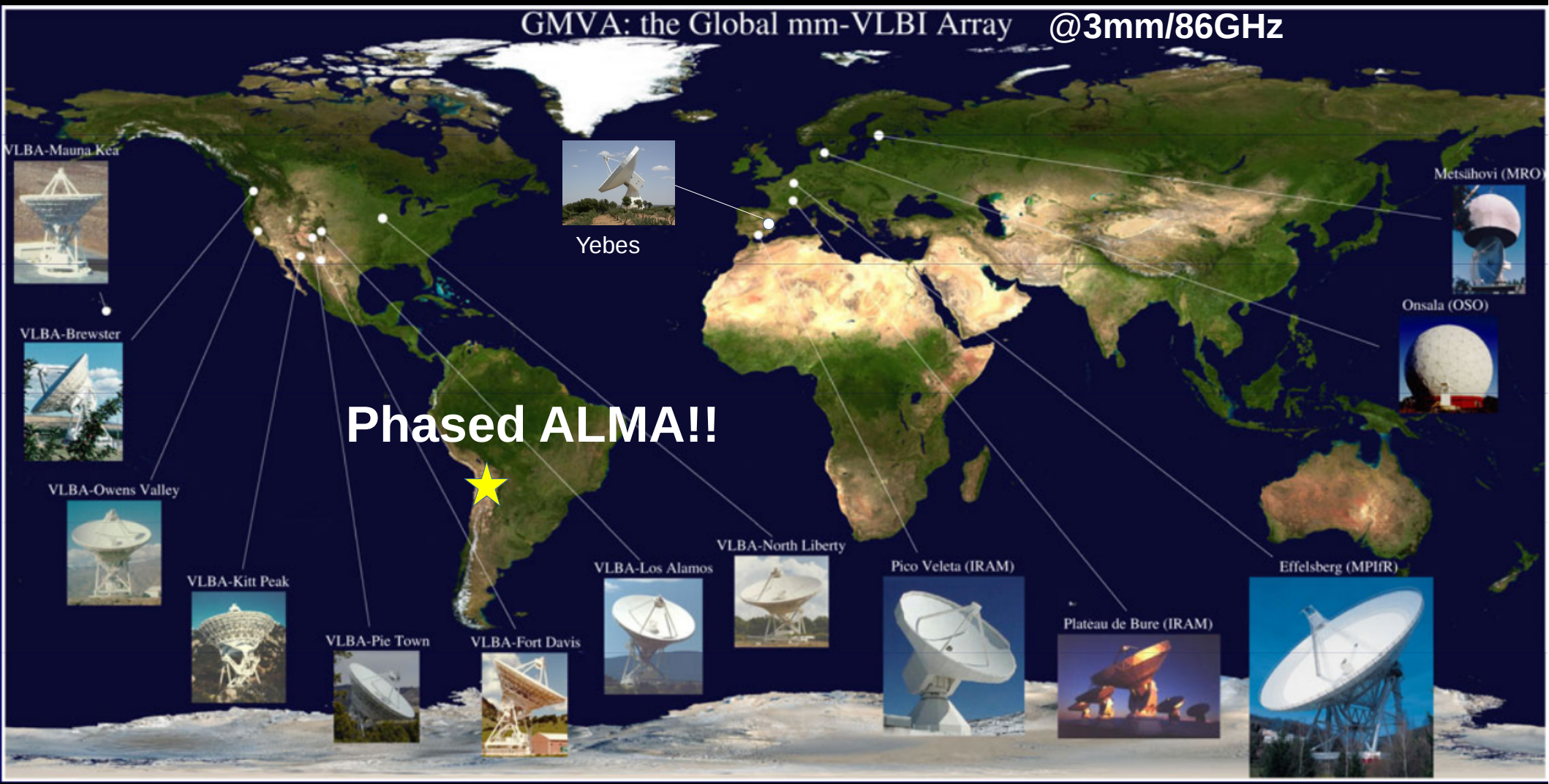


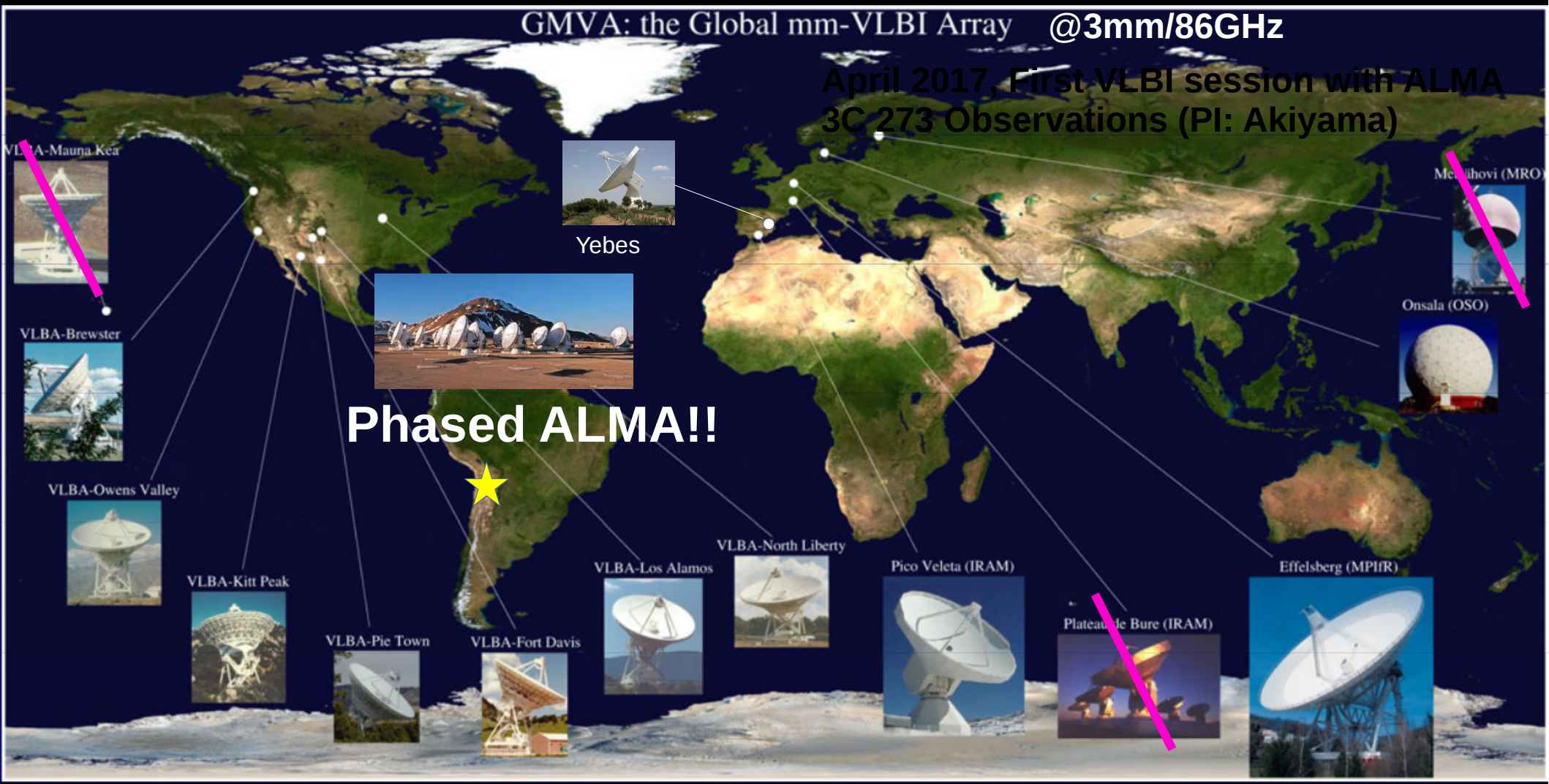


Global Millimeter VLBI Array Observations with ALMA



Credit of original map : Max-Planck-Institute for Radioastronomy

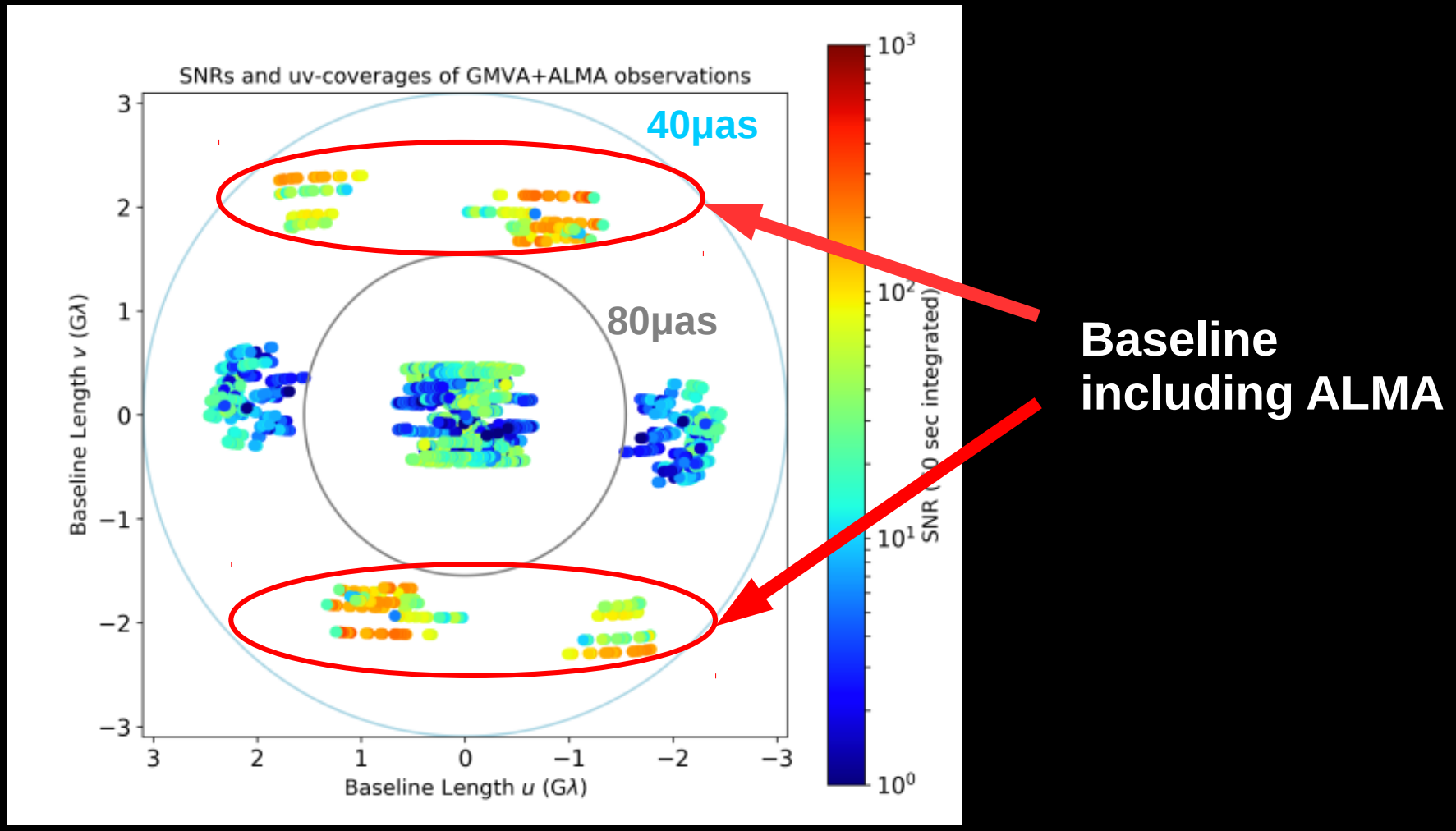
Global Millimeter VLBI Array Observations with ALMA



Credit of original map : Max-Planck-Institute for Radioastronomy

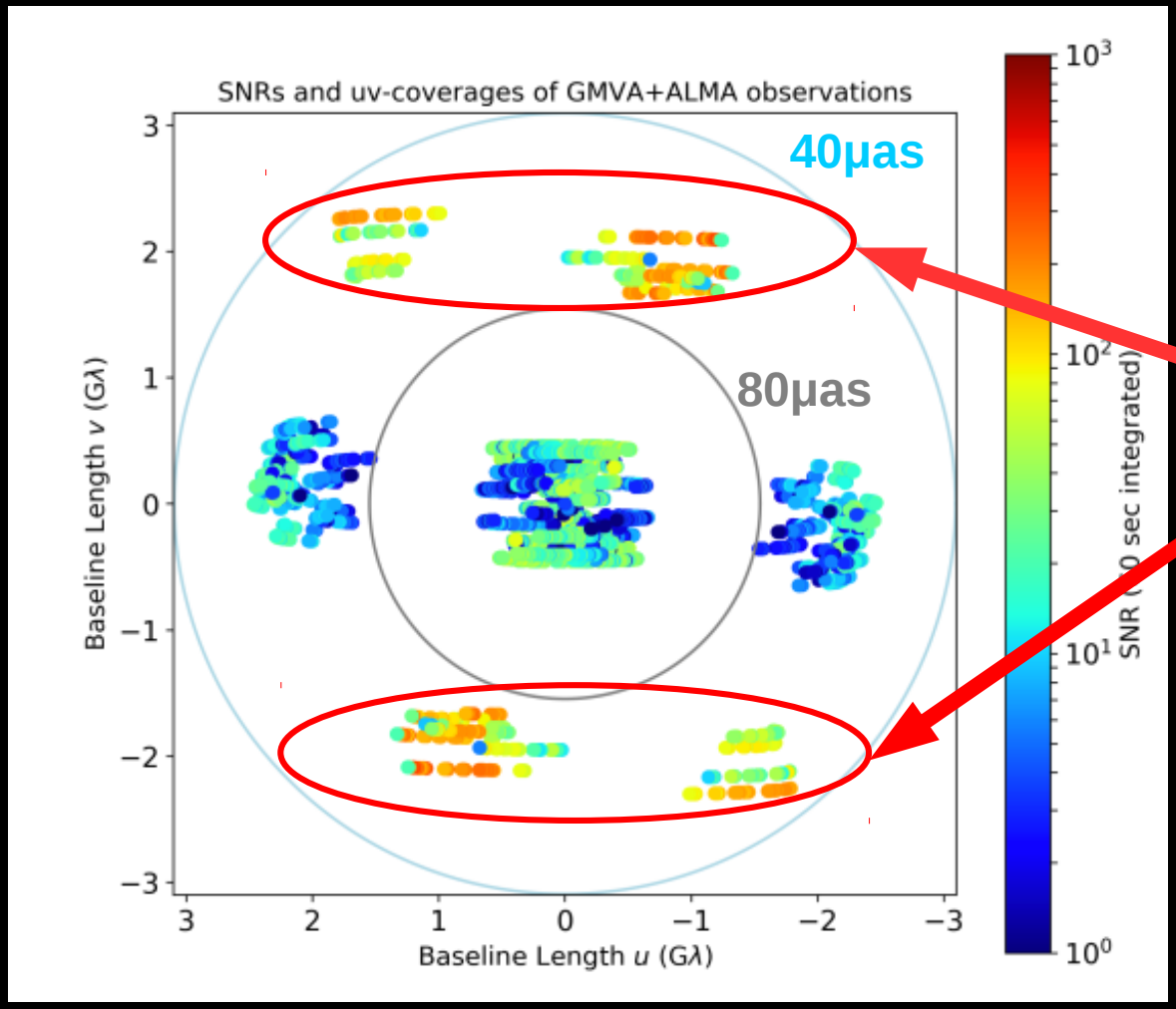
uv-coverages with ALMA

- ALMA baselines gave us high SNR! (> ~ 100)



uv-coverages with ALMA

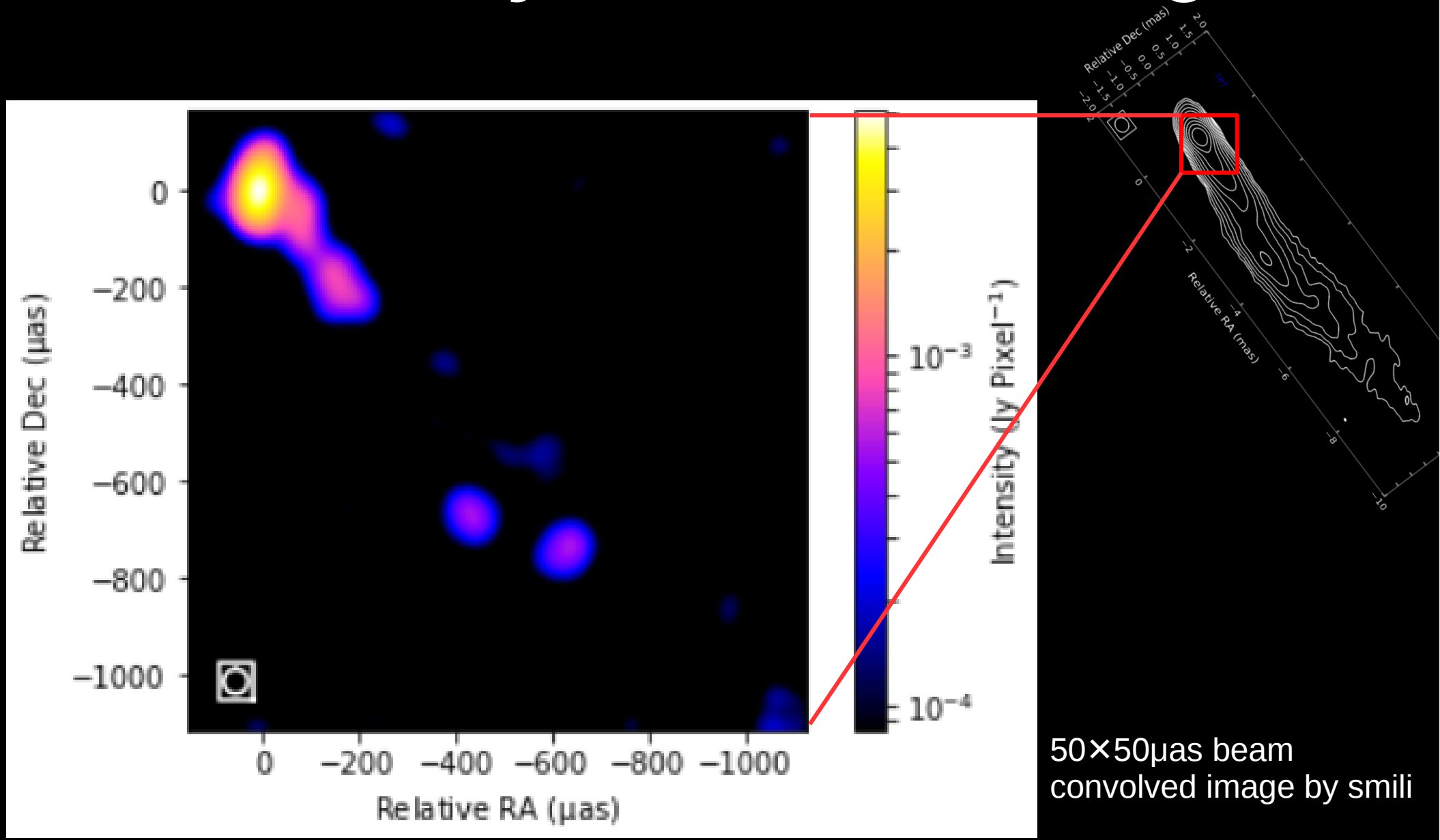
- ALMA enabled us to observe with higher resolution in N-S direction!



(N-S) Δθ~70μas

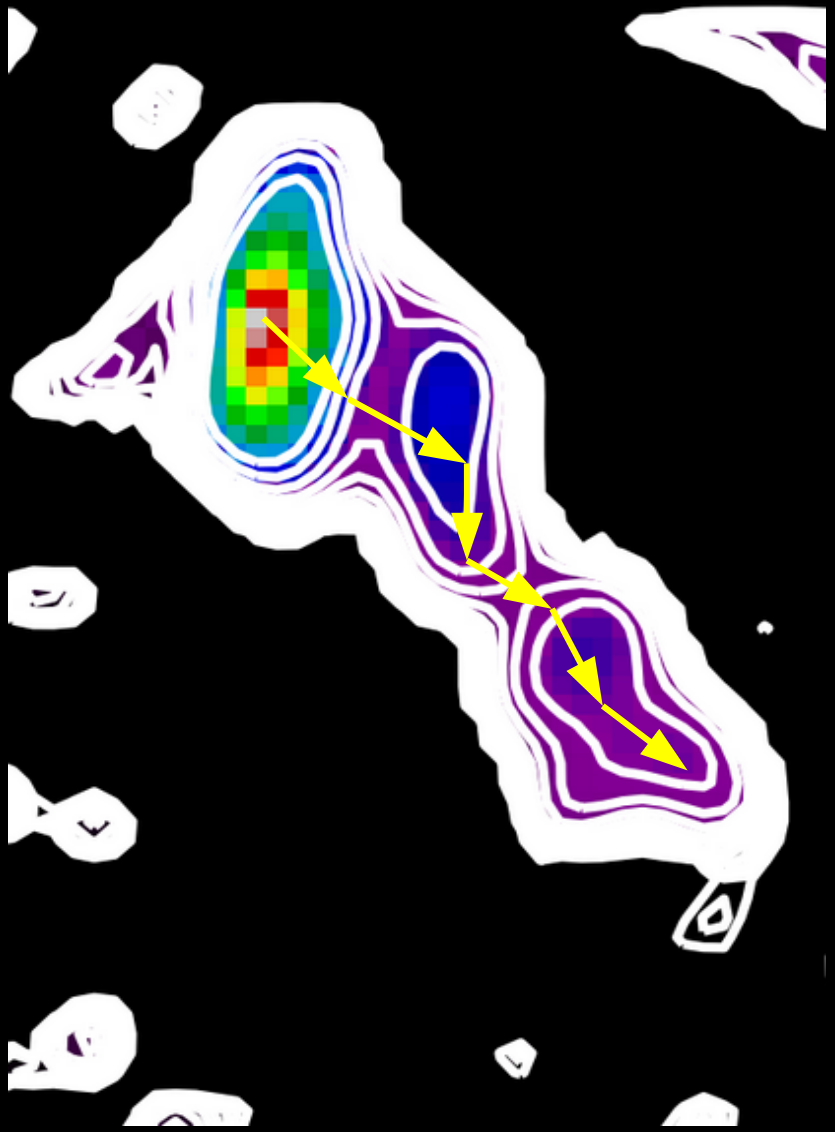
Baseline including ALMA

Preliminary full closure Image



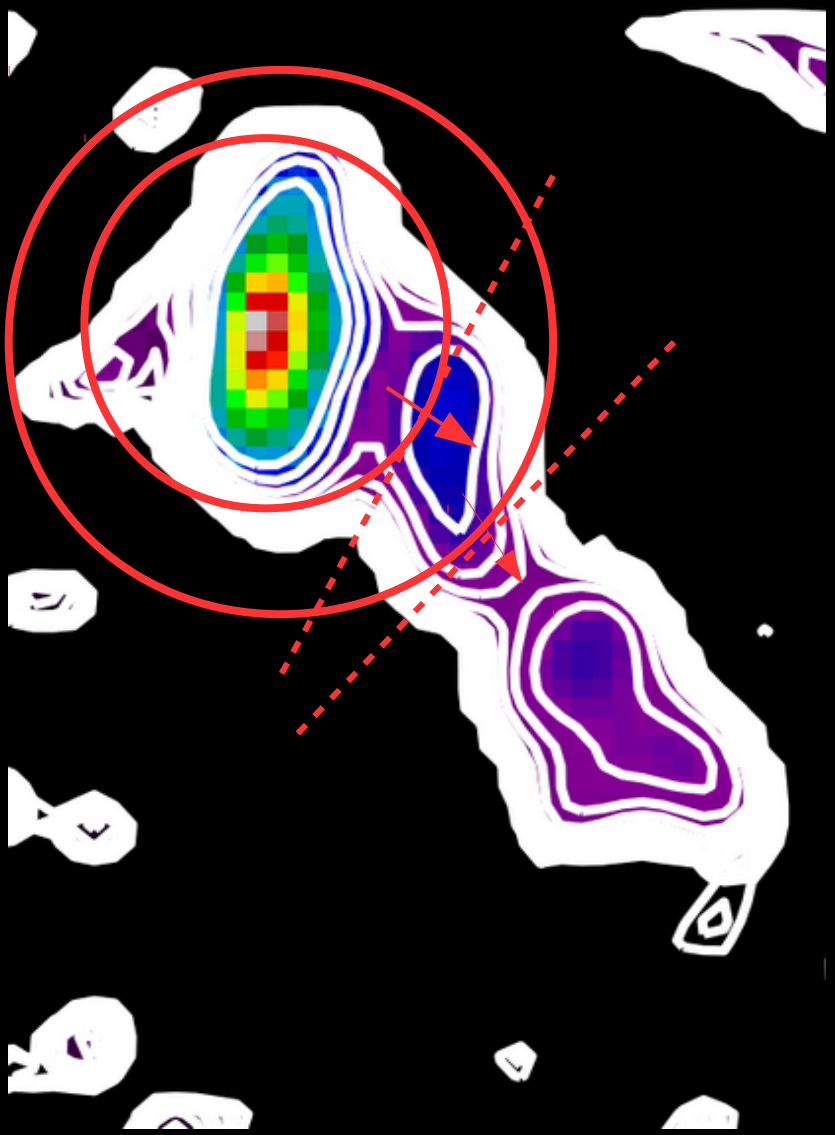
50×50μas beam
convolved image by smili

How to measure the jet width?



Jet streamline of 3C273 in this scale does not look straight….

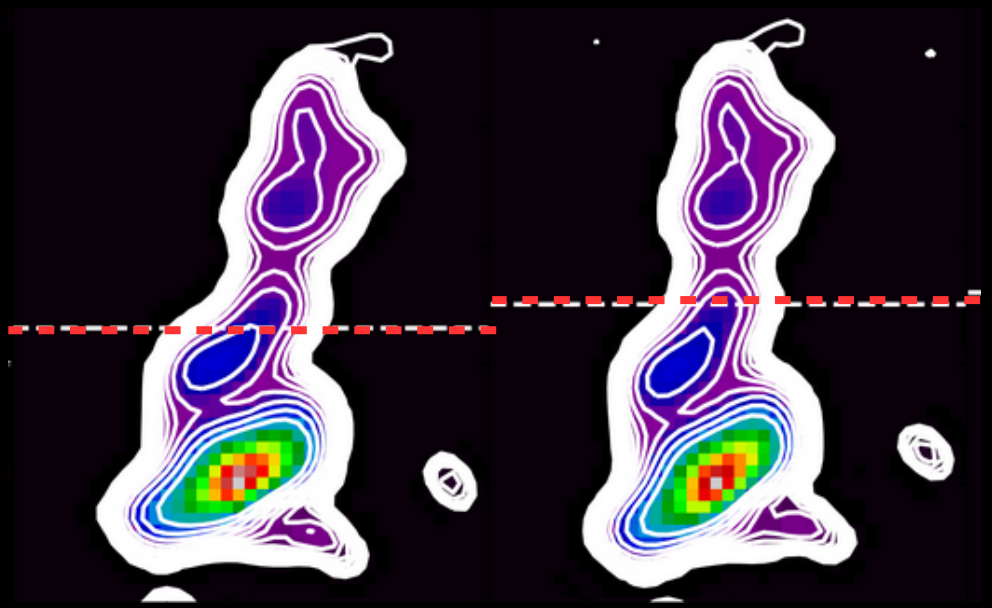
How to measure the jet width?



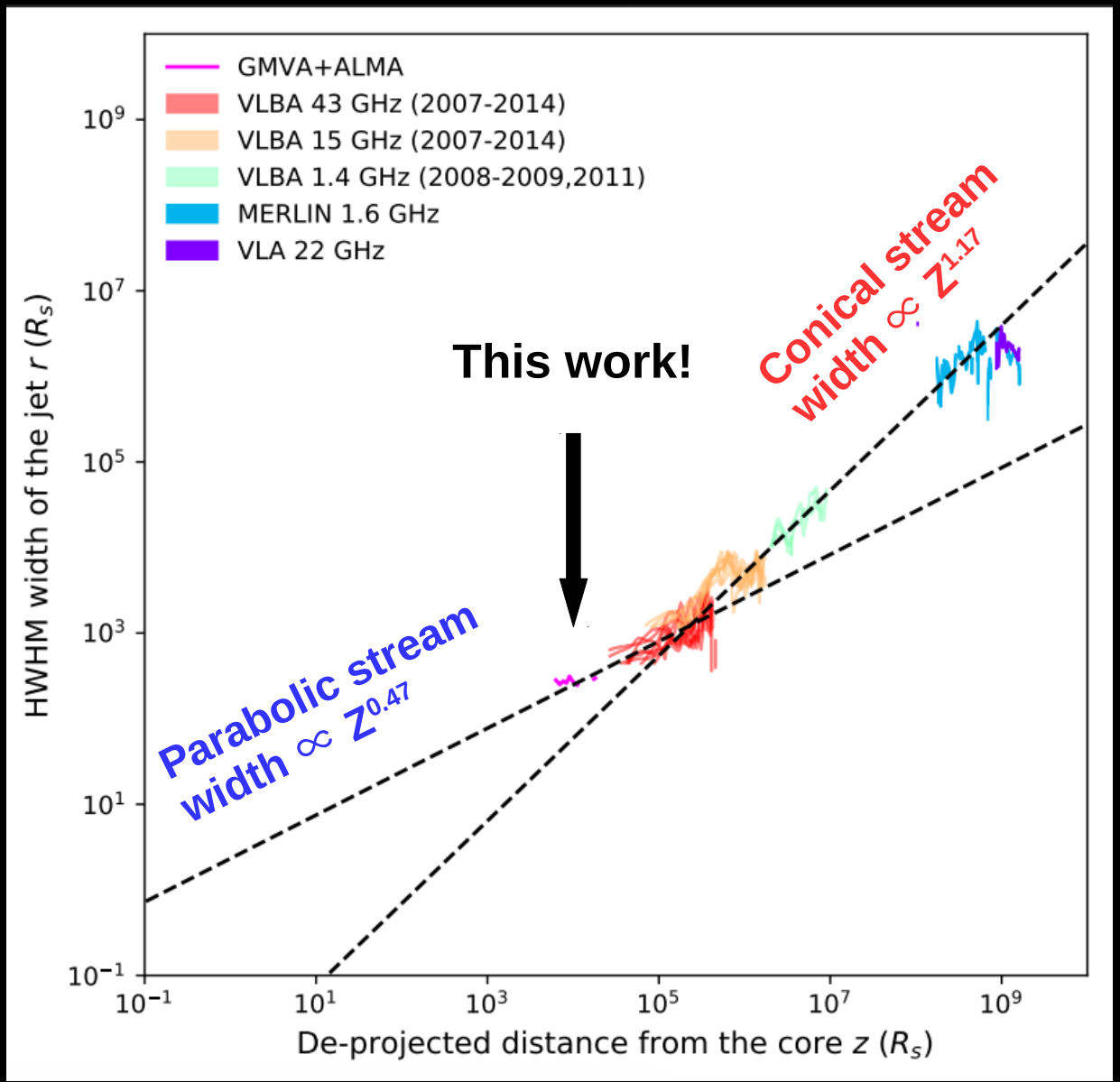
STEP1: Circularly slice the image

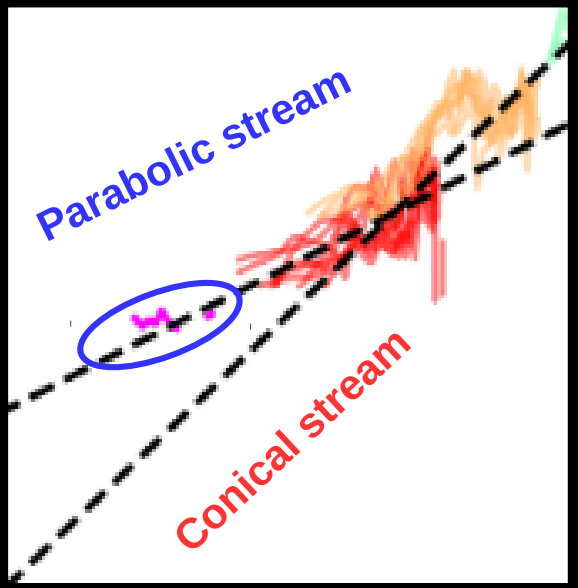
STEP2: Measure the position angle

STEP3: Measure the jet width perpendicular to position angle

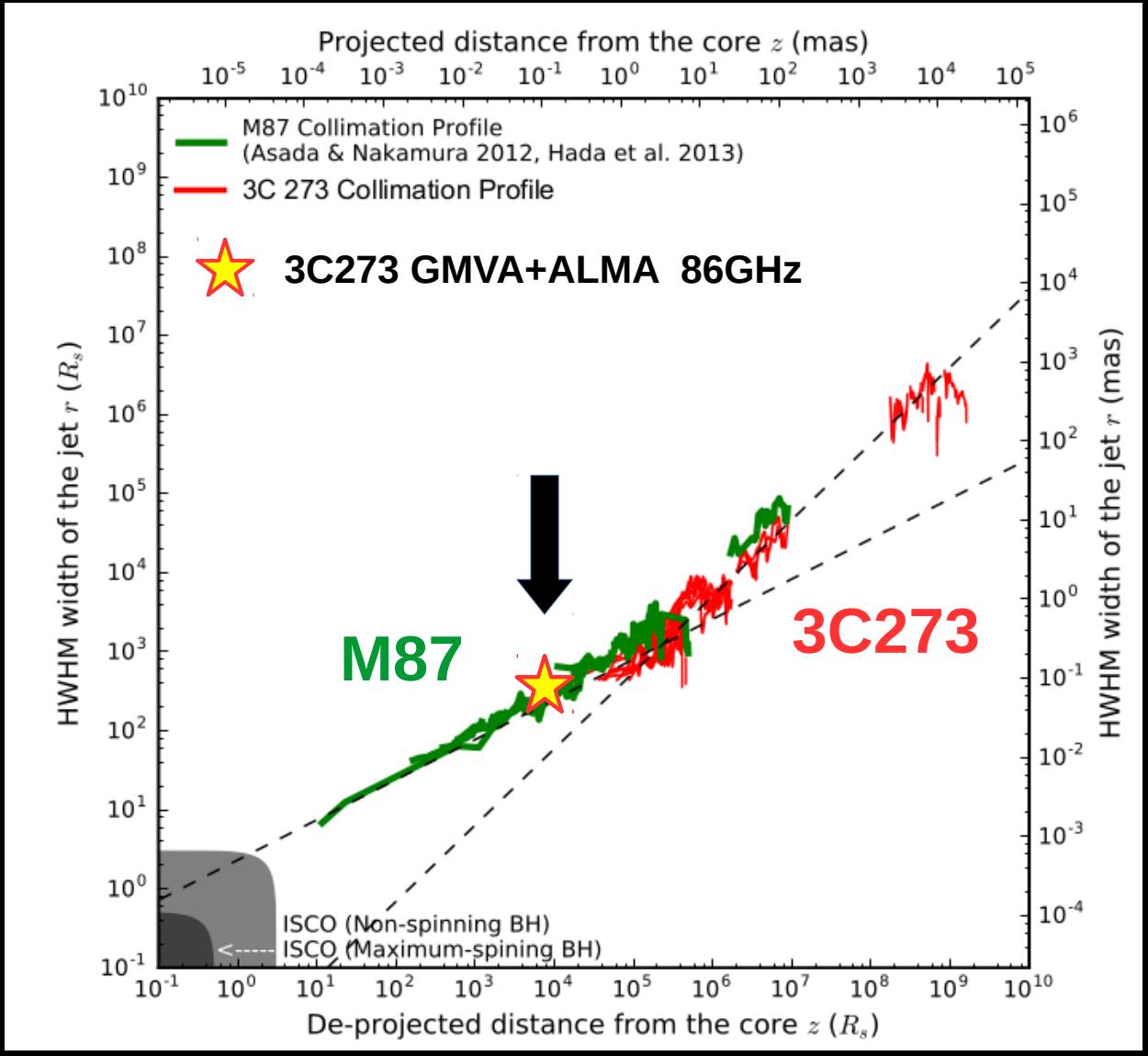


Preliminary collimation profile 3C273





Comparison with LLAGN:M87



- The jet profile of quasar 3C273 also has a transition at **~10^5 Rs**
- M87
  - **LLAGN**, **RIAF** disk
- 3C273
  - **Quasar**, **Standard** thin disk
- Above two AGNs are **different** physical state but **very similar** collimation profile

Why?
How the **disks** work with **jet**?

Summary

- We measured the jet streamline of quasar 3C273 at the most inner region 10^3-10^4 Rs with higher angular resolution of first GMVA+ALMA observation.
- The results from preliminary imaging indicate that 3C273 jet streamline have transition from conical to parabolic at ~10^5 Rs.
- Jet streamline of archetypical quasar 3C273 is quite similar to that of LLAGN:M87.
- More careful imaging and theoretical study with GRMHD simulation are important to understand properties of jets.