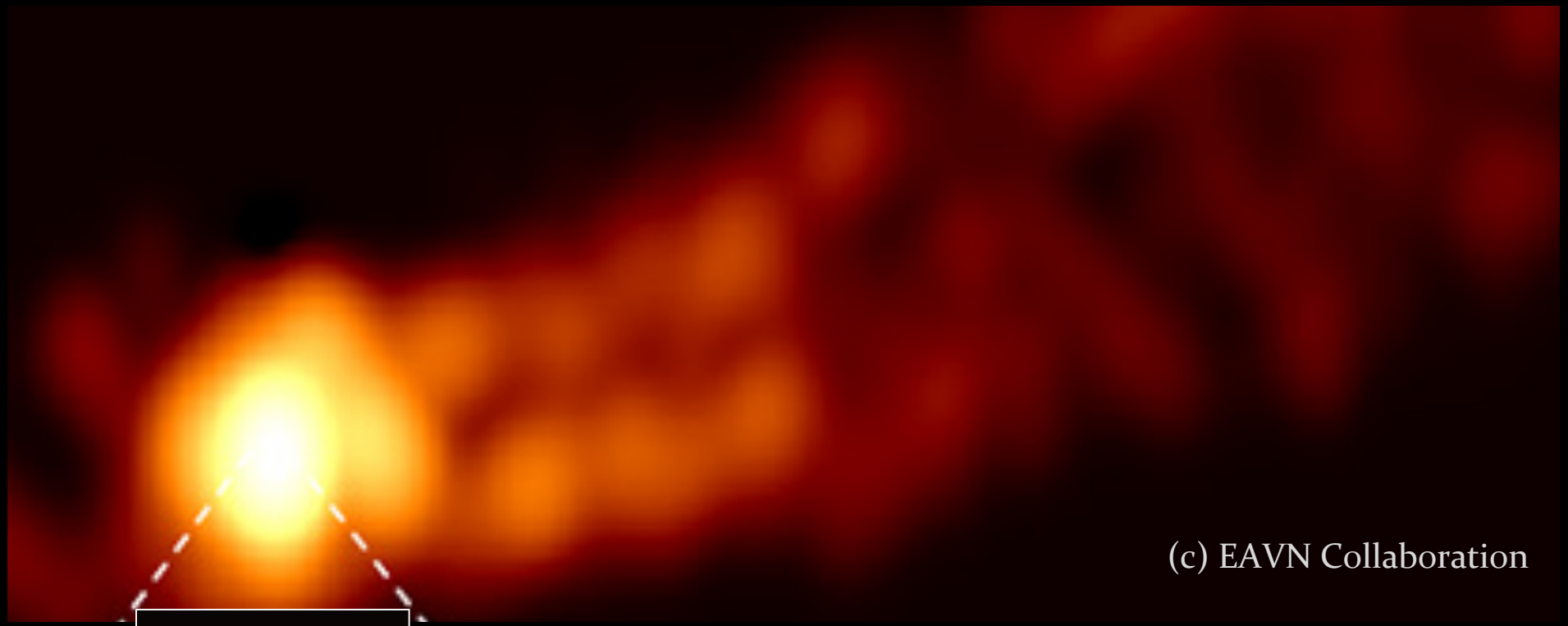
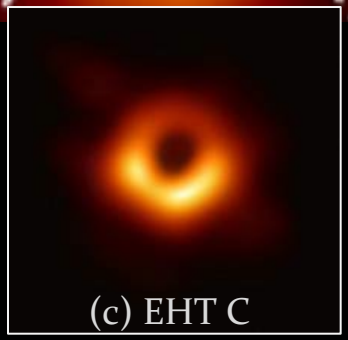
# Summary of KaVA/EAVN observations of M87 and Sgr A* in 2014-2018

M. Kino (NAOJ/KUTE) & BW Sohn (KASI)
on behalf of EAVN AGN Science WG

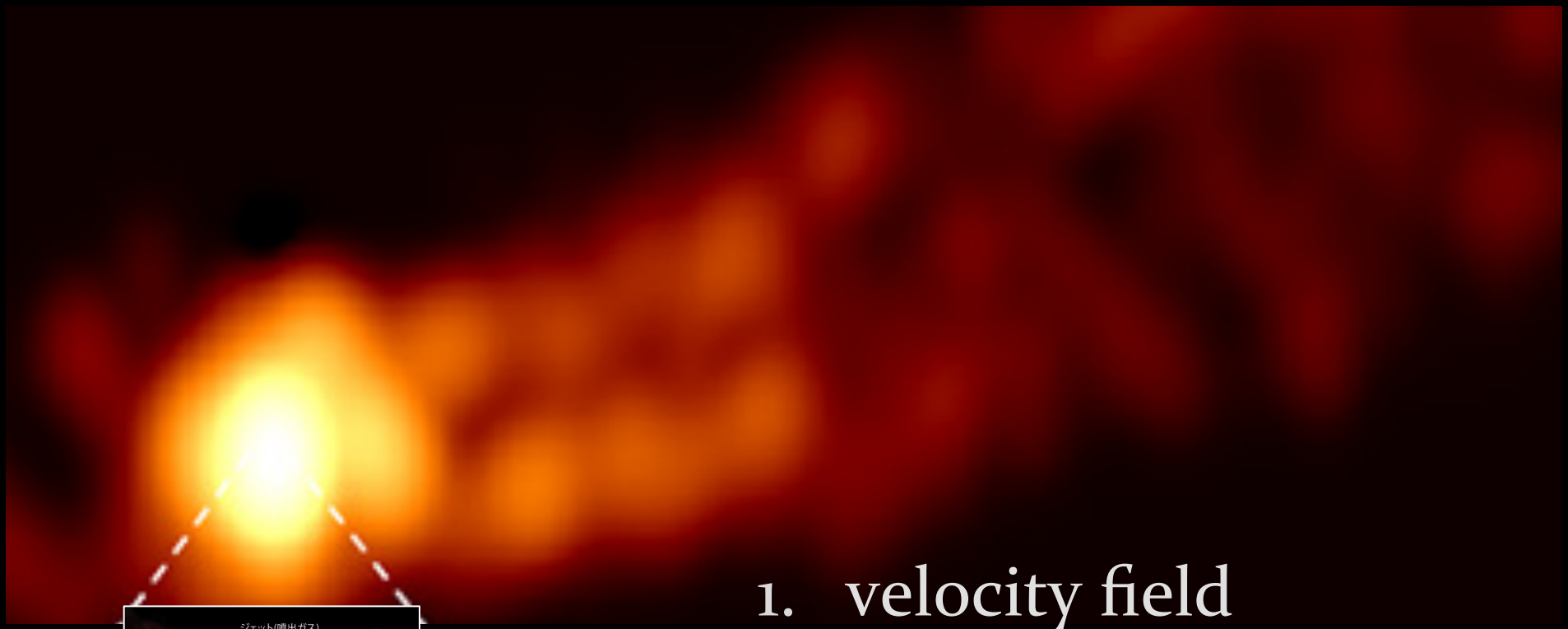
# Grand challenge #1: solving jet formation mechanism

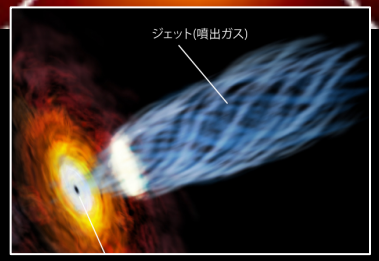



EHT talks
G. Bower (ASIAA)
F. Tazaki (NAOJ)

# To test *B*-driven jet model, we measure/constrain basic quantities of






BZ process at work?

1. velocity field
2. *B*-field
3. flow geometry

EAVN Workshop 2019

# v-field, *B*-field, and flow geometry of M87

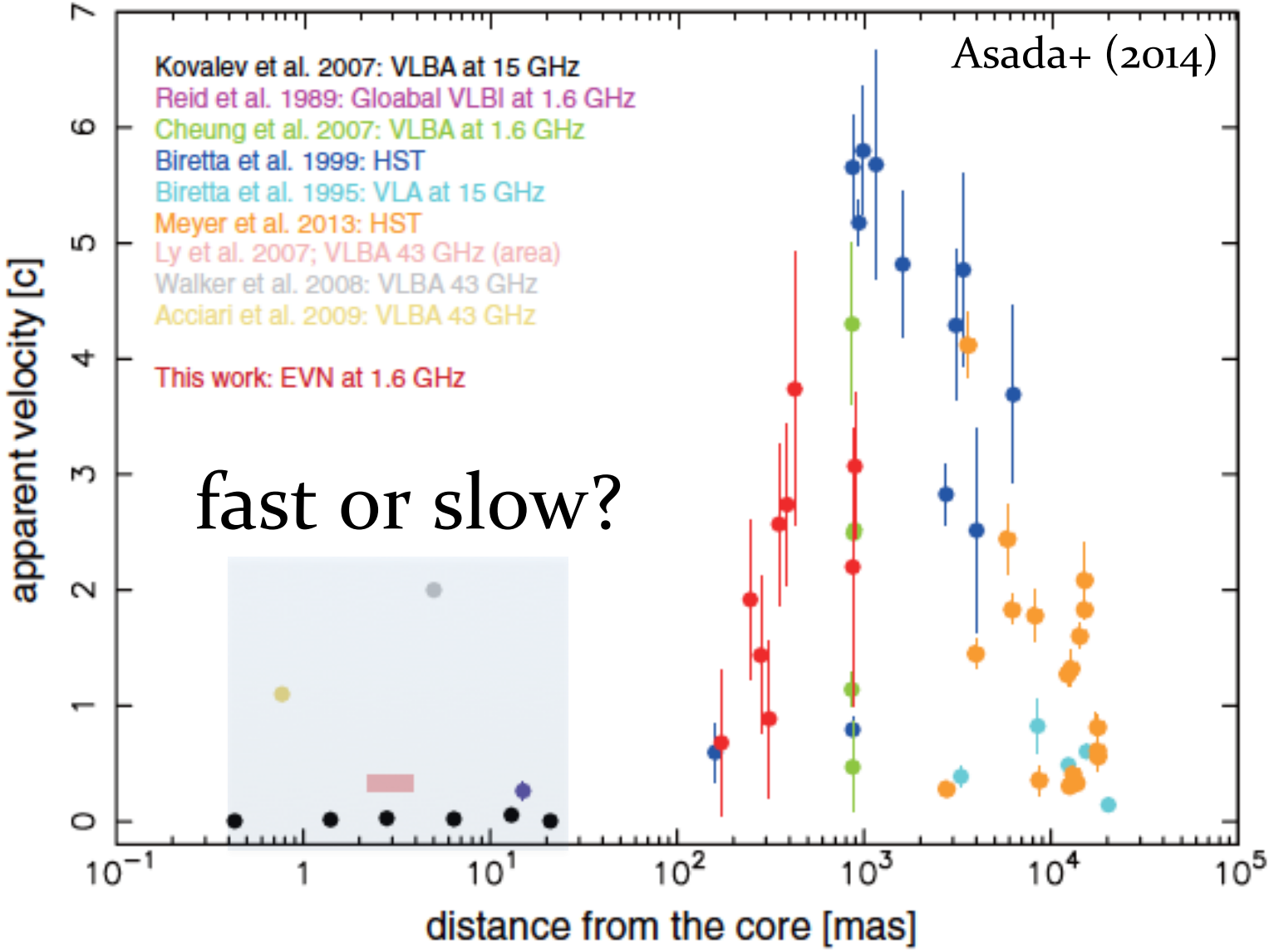
**Park+ 2019 submitted**

**Ro et al. in prep**

**Cui et al. in prep**

# Longstanding problem:

"Is the M87 jet fast or slow in the collimation zone?"

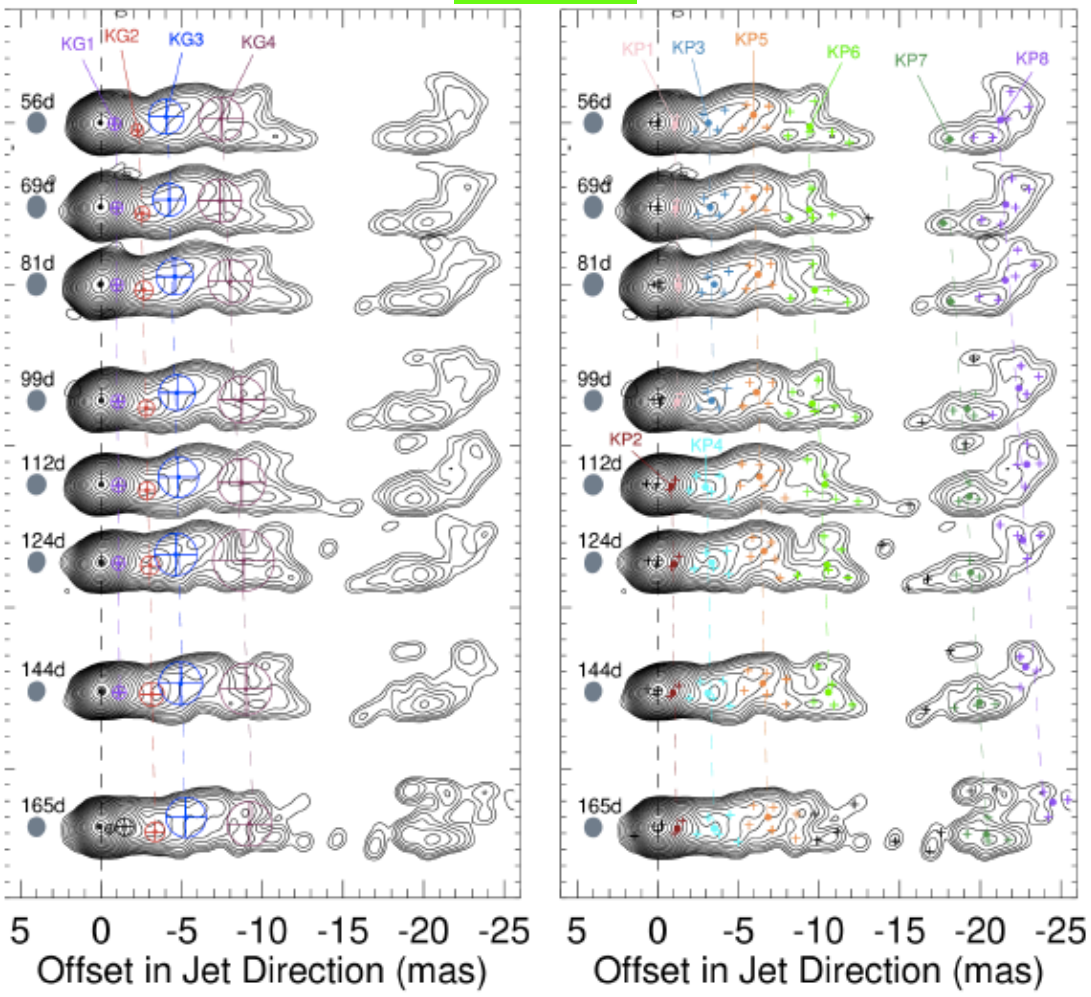


Key to resolve the problem is
**high cadence monitoring**,
which can avoid misidentifications
of the multiple jet components!

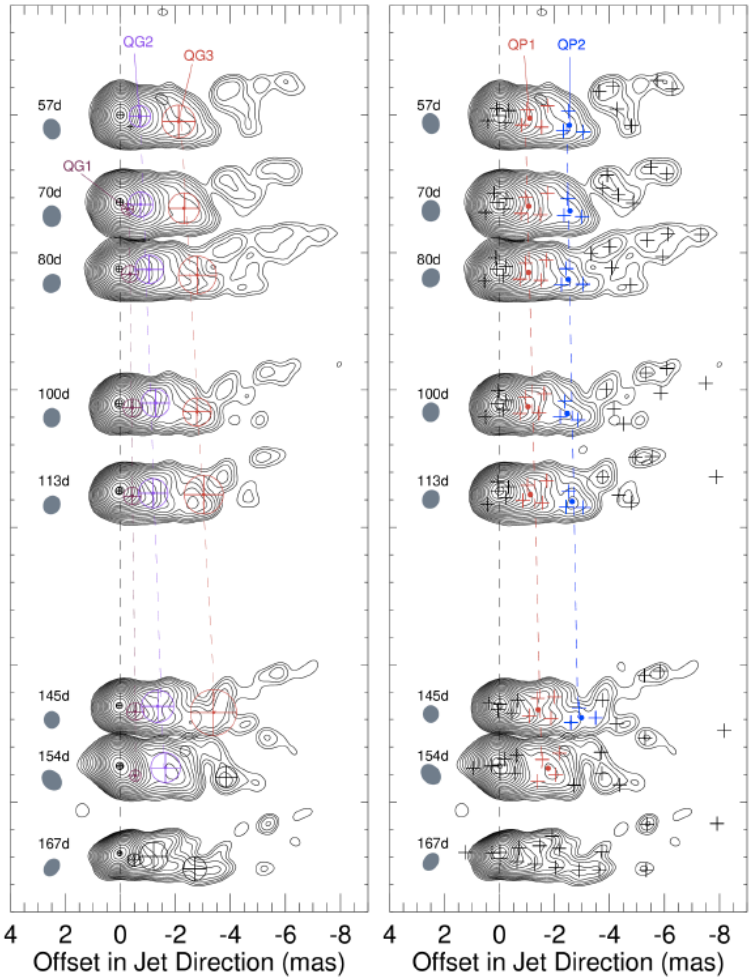
Park+ *submitted*

# The KaVA high-cadence (bi-weekly) monitoring in 2016 reveals the profile of M87's jet velocity field.

22GHz

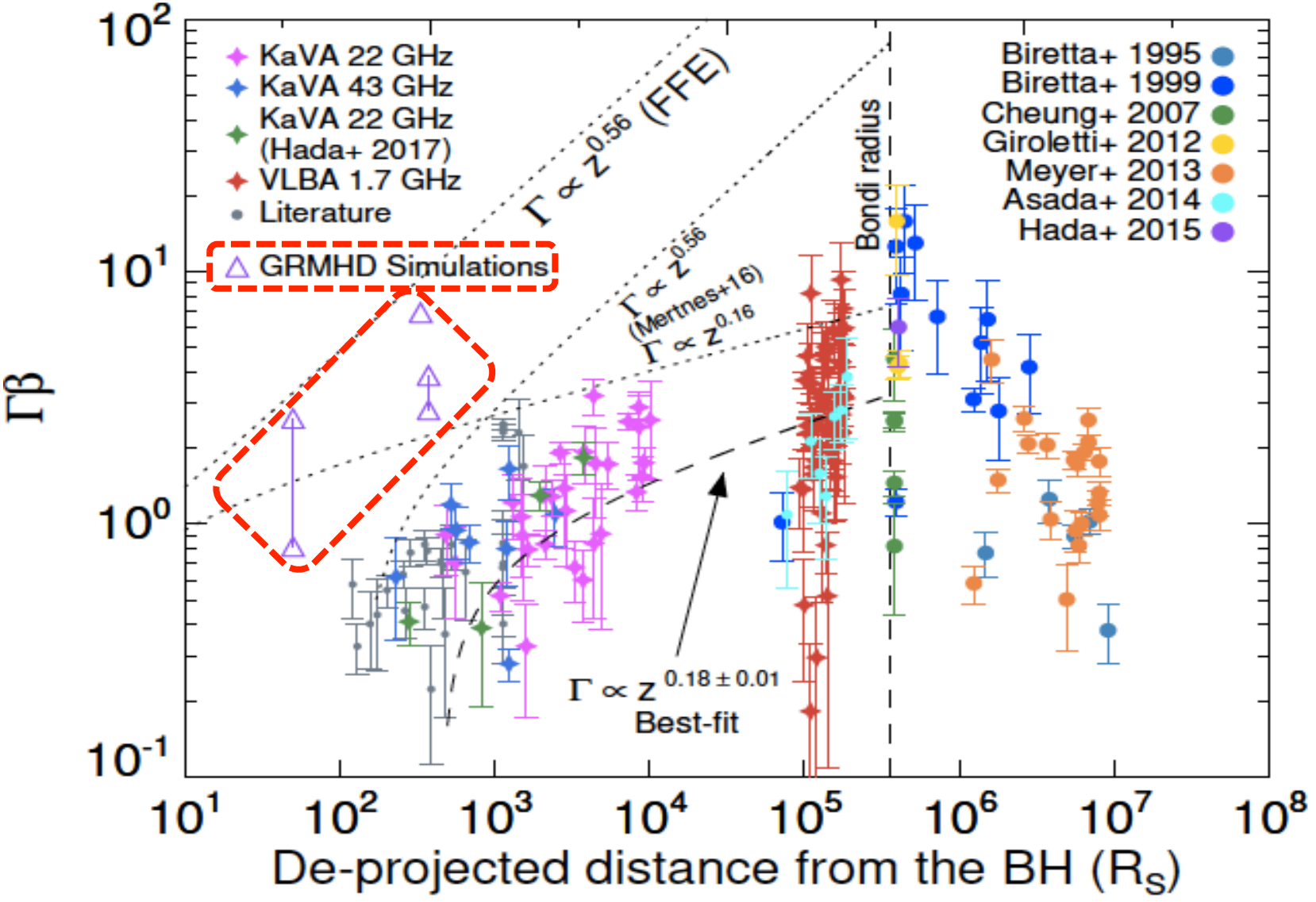



43GHz



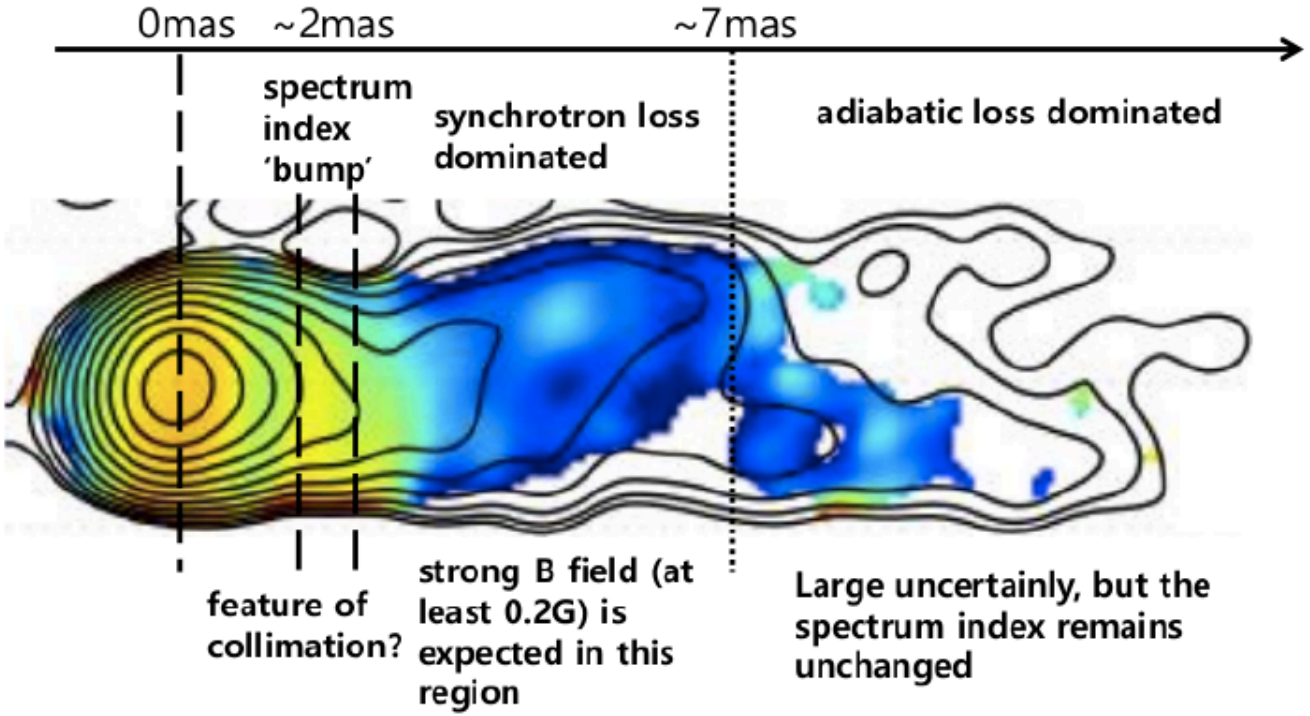
Park+ *submitted*

# 1. Velocity stratification!
# 2. Discrepancy btw. observation and GRMHD?!



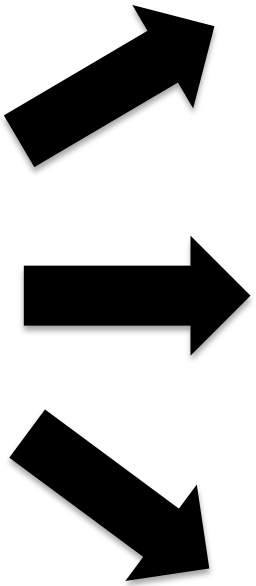
Ro+ *in prep*

# Constraining *B*-field in M87 at 22/43GHz (2015-2016 data)




H. Ro will present new constraints on *B*-field properties via radial profile of the spectral index. Stay tuned!

# Flow geometry at the jet base

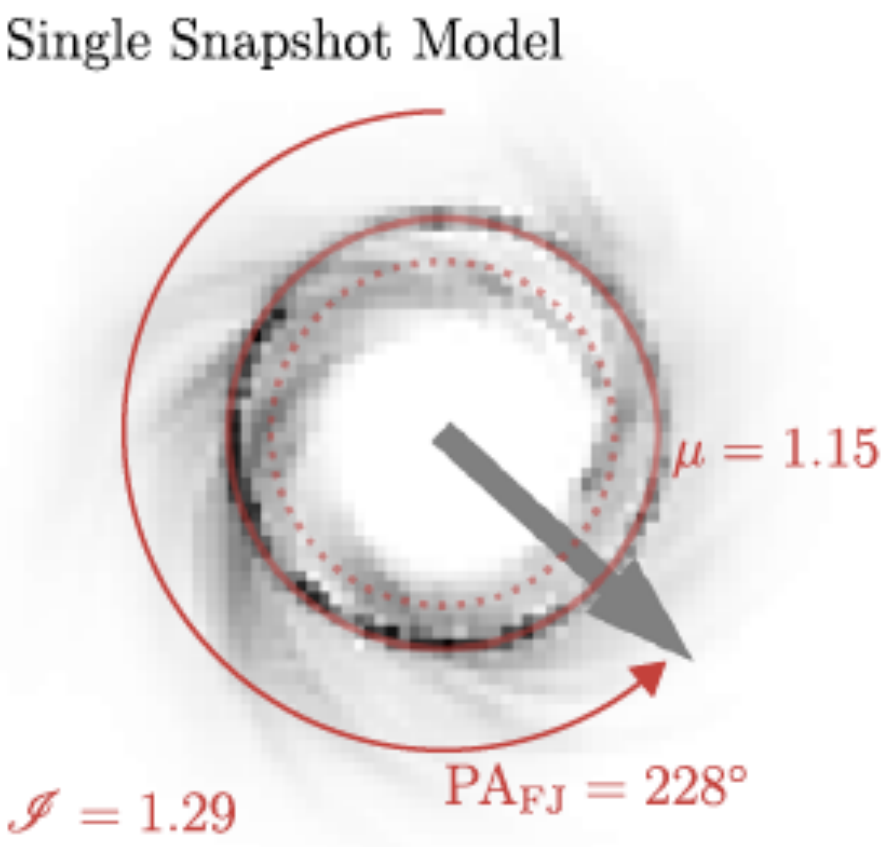


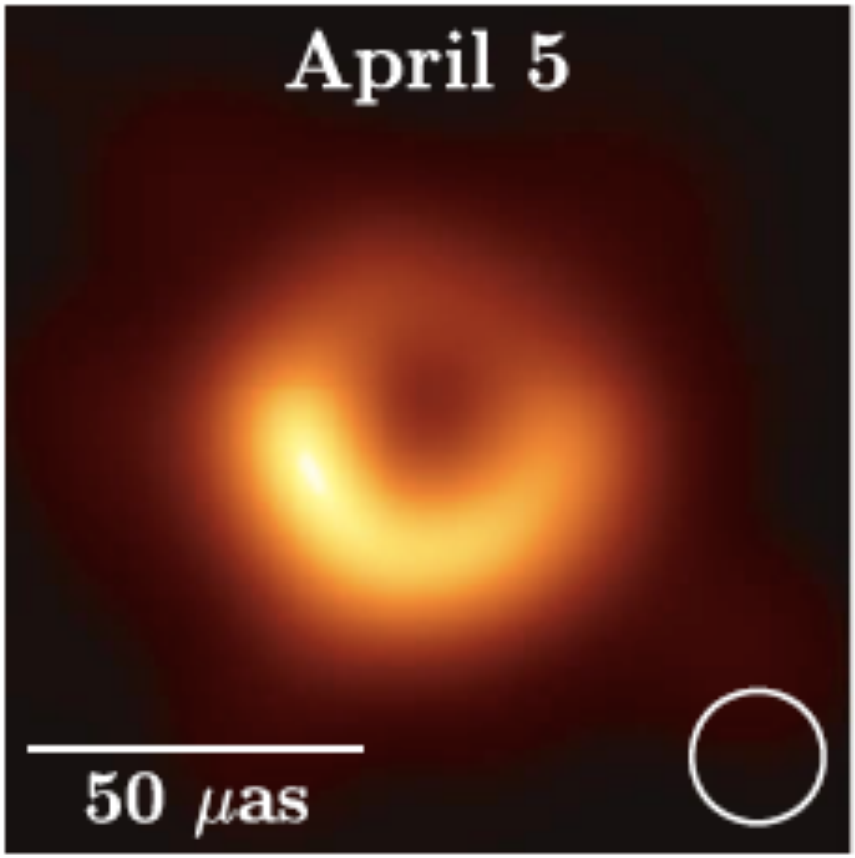
which direction?
jet opening angle?

- Unfortunately, EHT could not detect the jet emission in EHT 2017.

EHTC+ 2019, ApJL

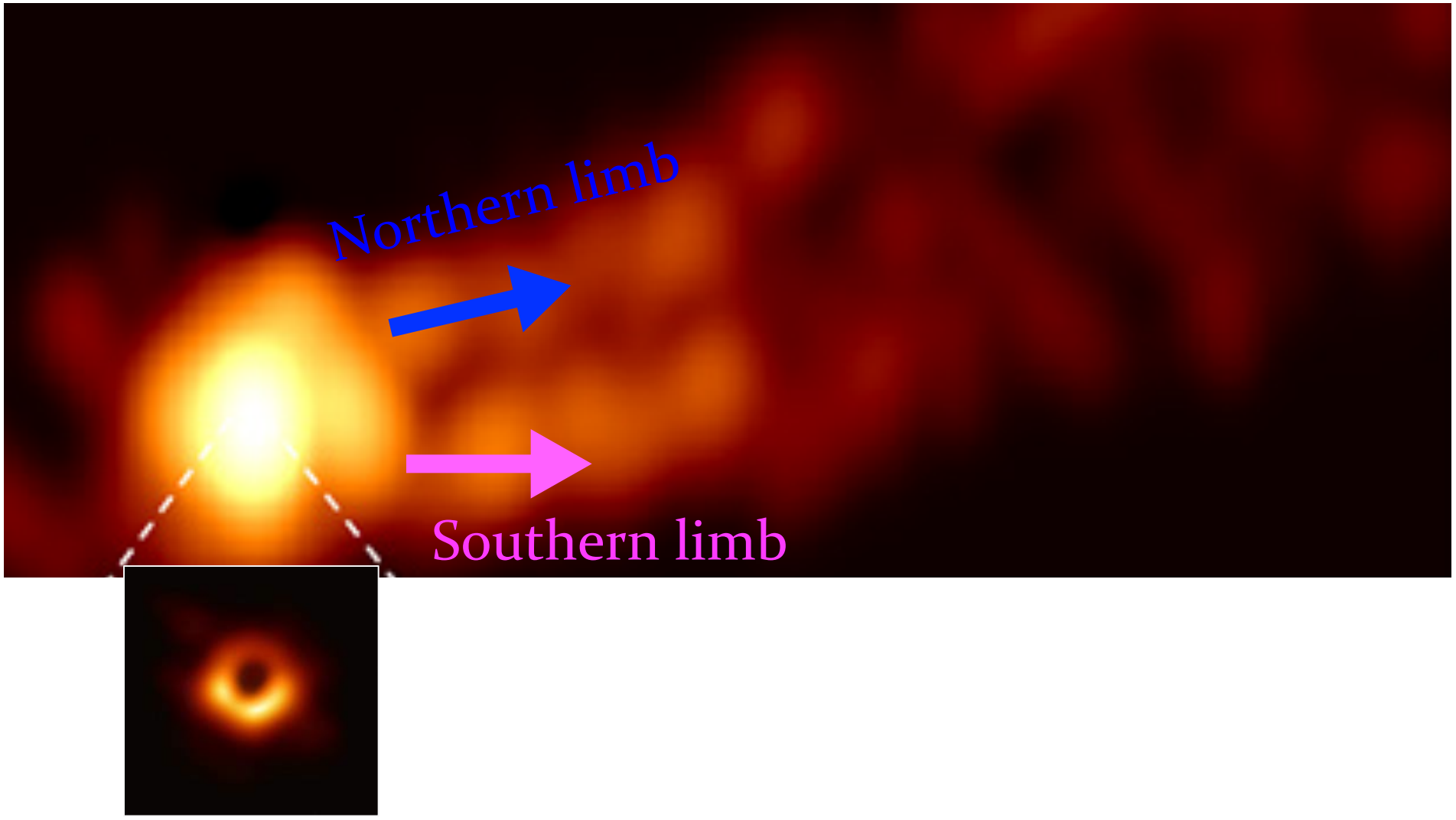
# EHTC's estimate of Position Angle (PA) of Forward Jet (FJ) via matching GRMHD snapshot to the photon ring



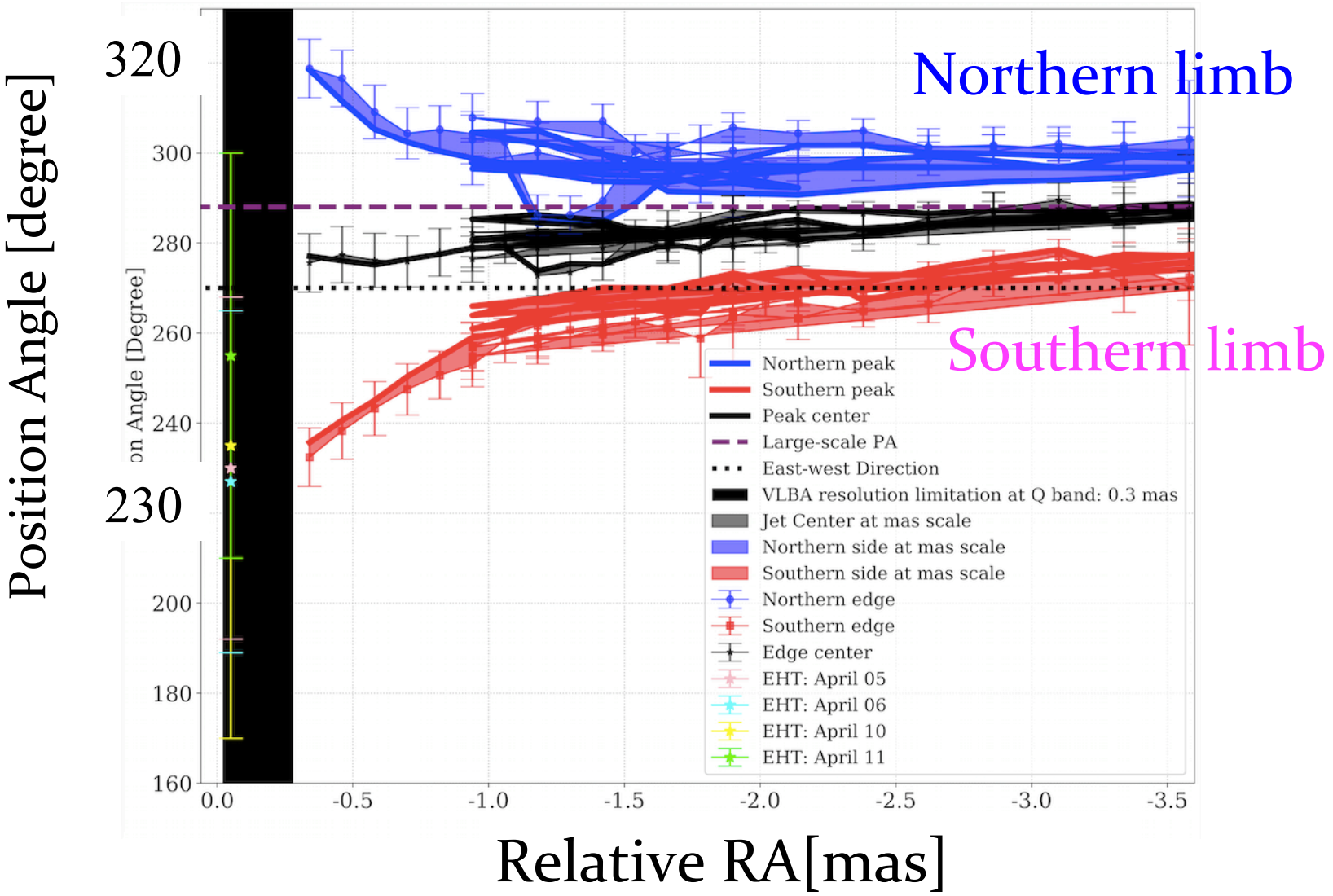
Cui+ *in prep*

# EAVN measure the real jet PA in 2017 April



Cui+ *in prep*

From the EAVN data, we find that (1) wide jet-opening angle, and (2) EHTC estimates of PA_FJ reasonably agree with EAVN jet.



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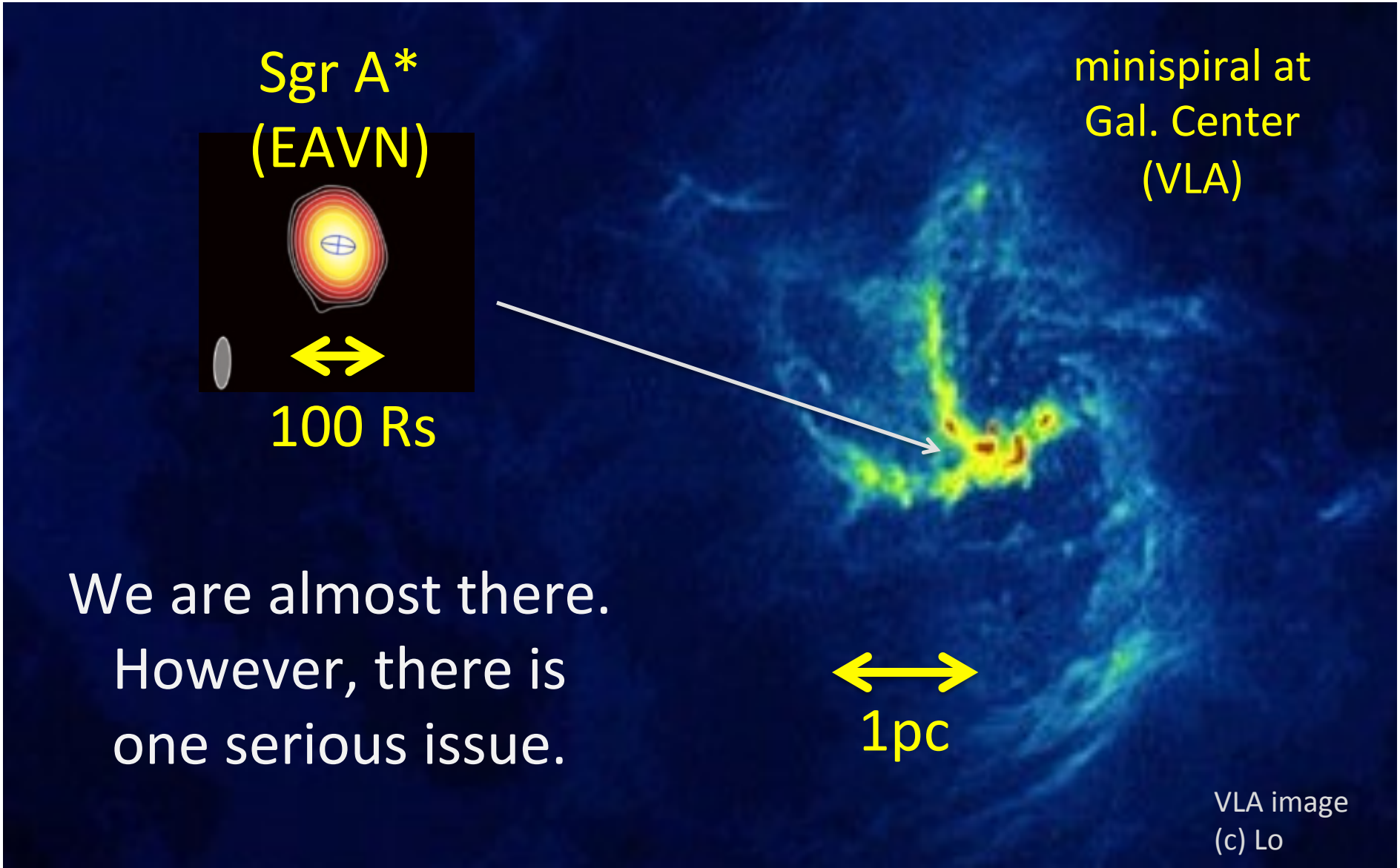
# Probing real vicinity of SMBH

**Cho+ in prep**

**(Zhao+ in prep)**

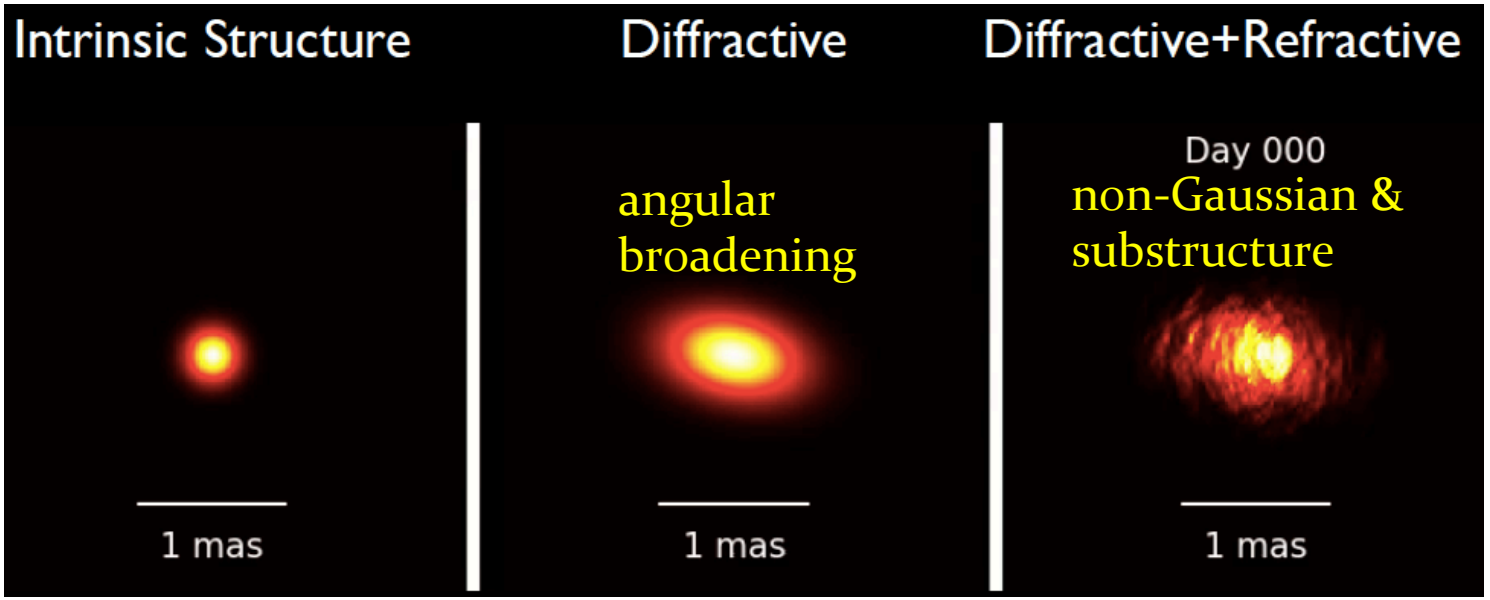
# Grand challenge #2: Unveiling accretion flow onto SMBH




We are almost there.
However, there is
one serious issue.

# Long standing problem:

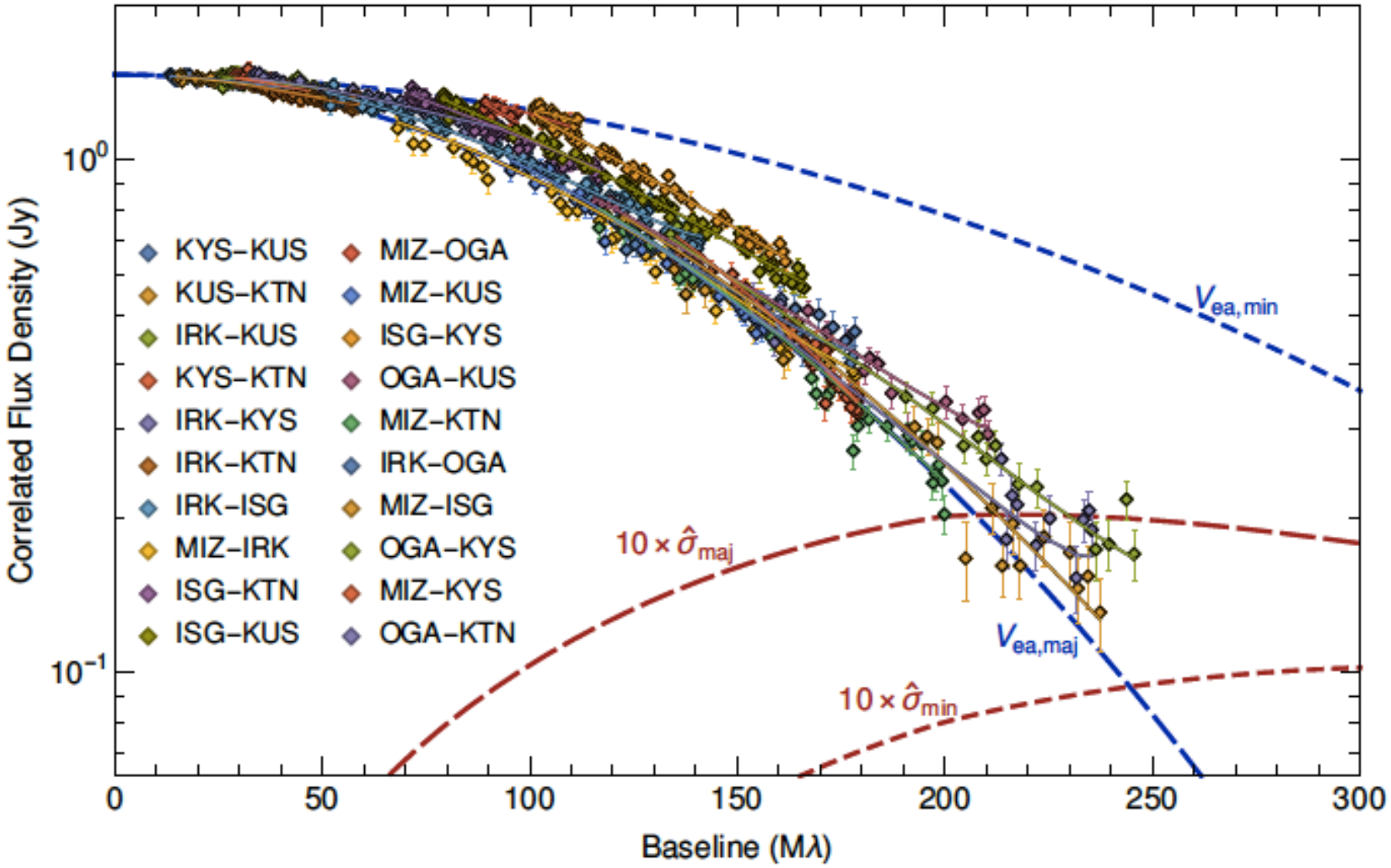
"Observed radio images of Sgr A* is dominated by interstellar scattering. So, an inference of Sgr A* image is sensitive to an assumed scattering model."




(c) Akiyama

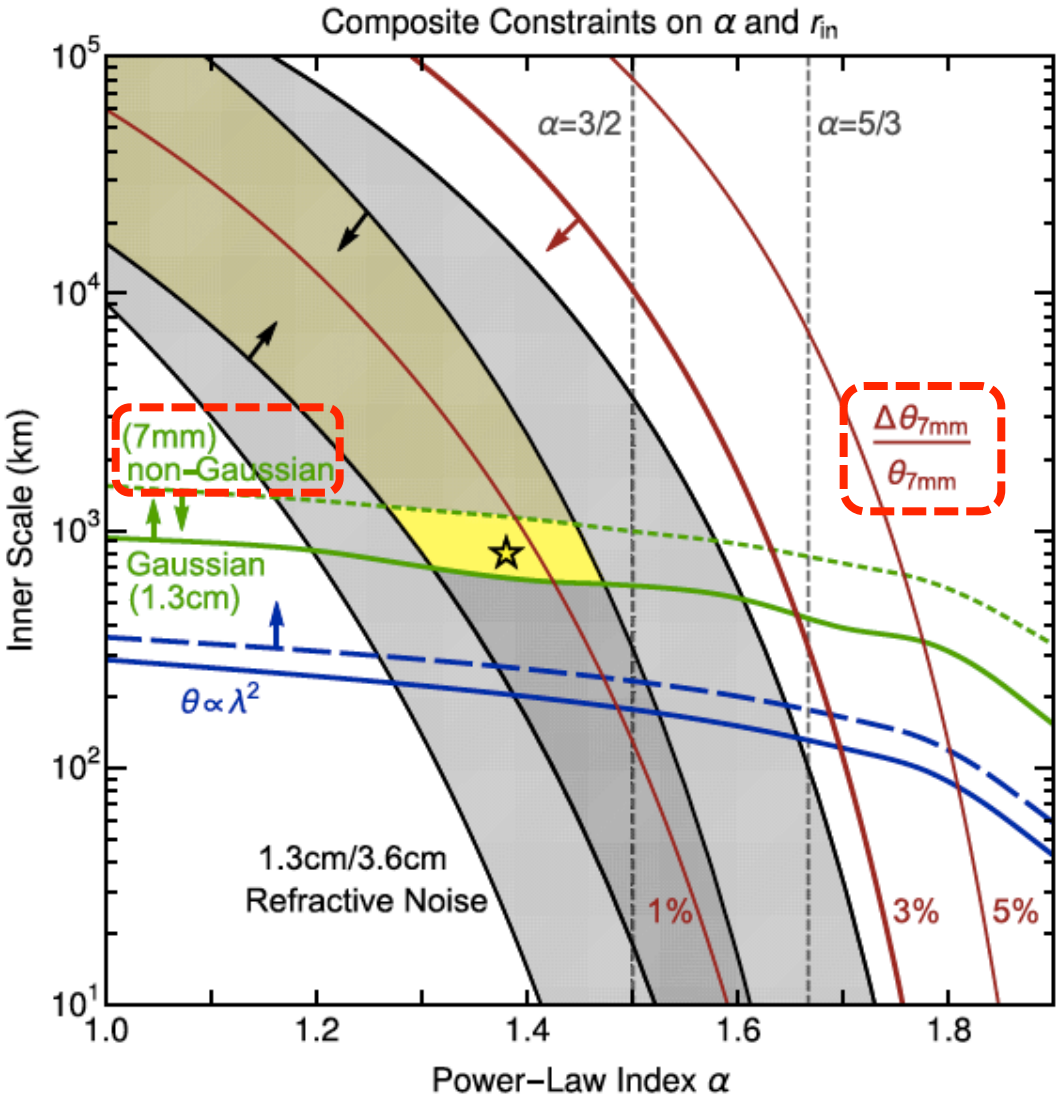
Johnson+ 2018

# KaVA 7mm data (2014 Nov) shows non-Gaussian and it significantly constrains scattering kernel.



Johnson+ 2018

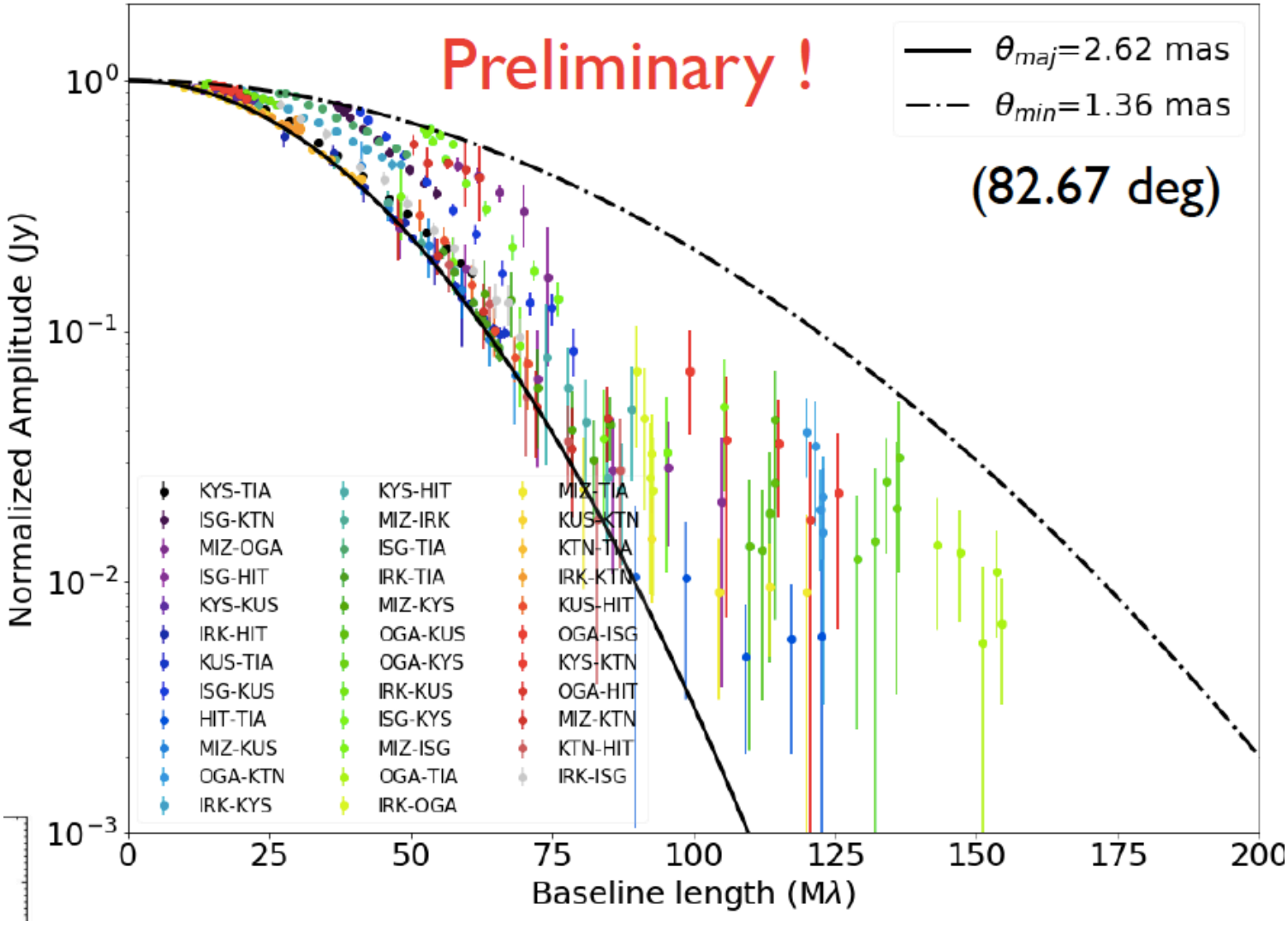
# The scattering parameters (α and r_in) are finally constrained very tightly!



So, using these parameters in Johnson +2018 we can remove the effect of the scattering and thus we can derive **intrinsic size of Sgr A*** in 2017.

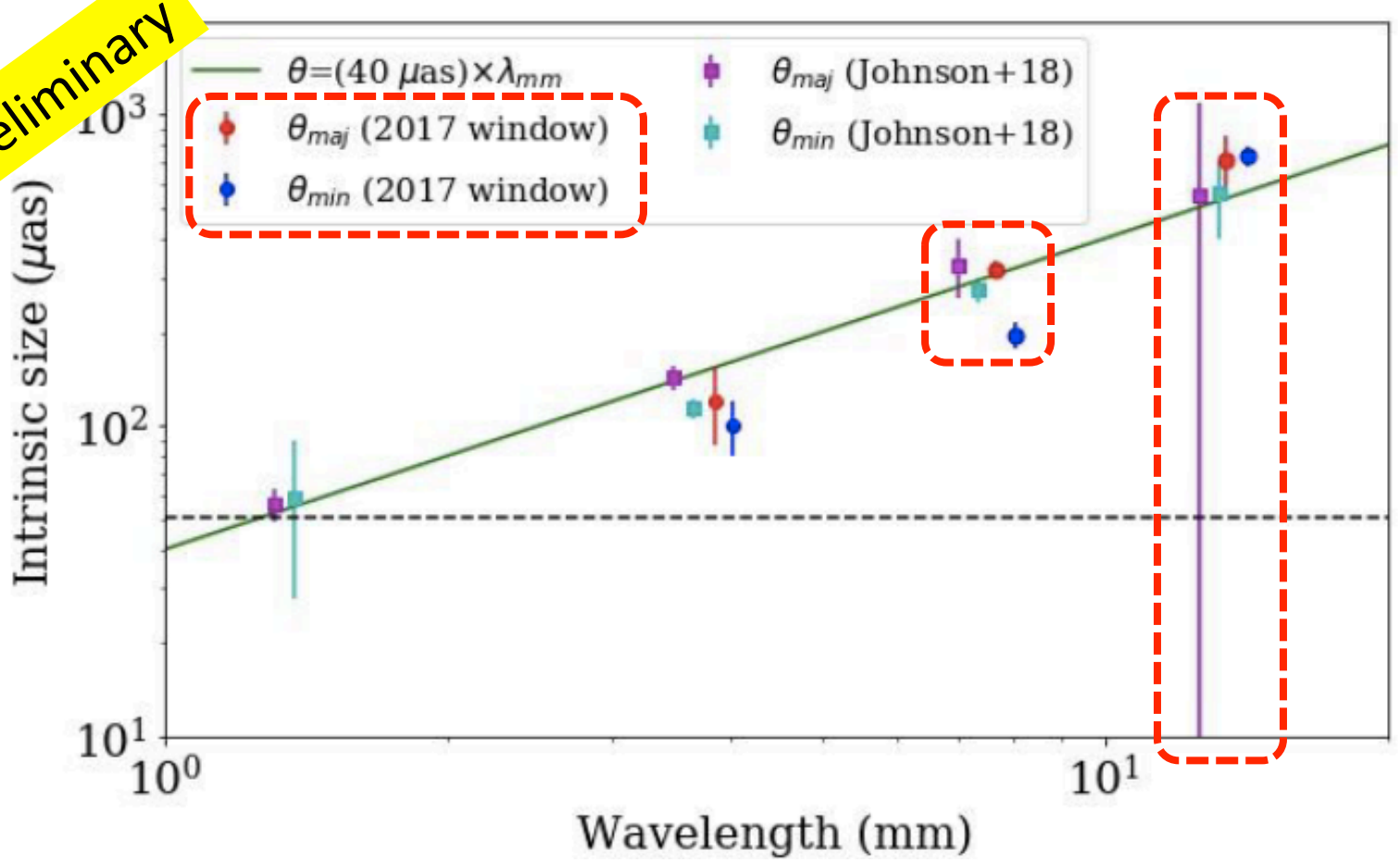
Cho+ *in prep*

# EAVN observation of Sgr A* on 2017 April 3rd @ 22GHz



Cho+ *in prep*

# Intrinsic size of Sgr A*!




From this, we can potentially constrain on geometry of Sgr A* and electron distribution in it.

EAVN workshop 2019

# The array is in a transition phase from KaVA to EAVN.

(i) Transverse motion of the M87 jet

(ii) Origin of flares in Sgr A*

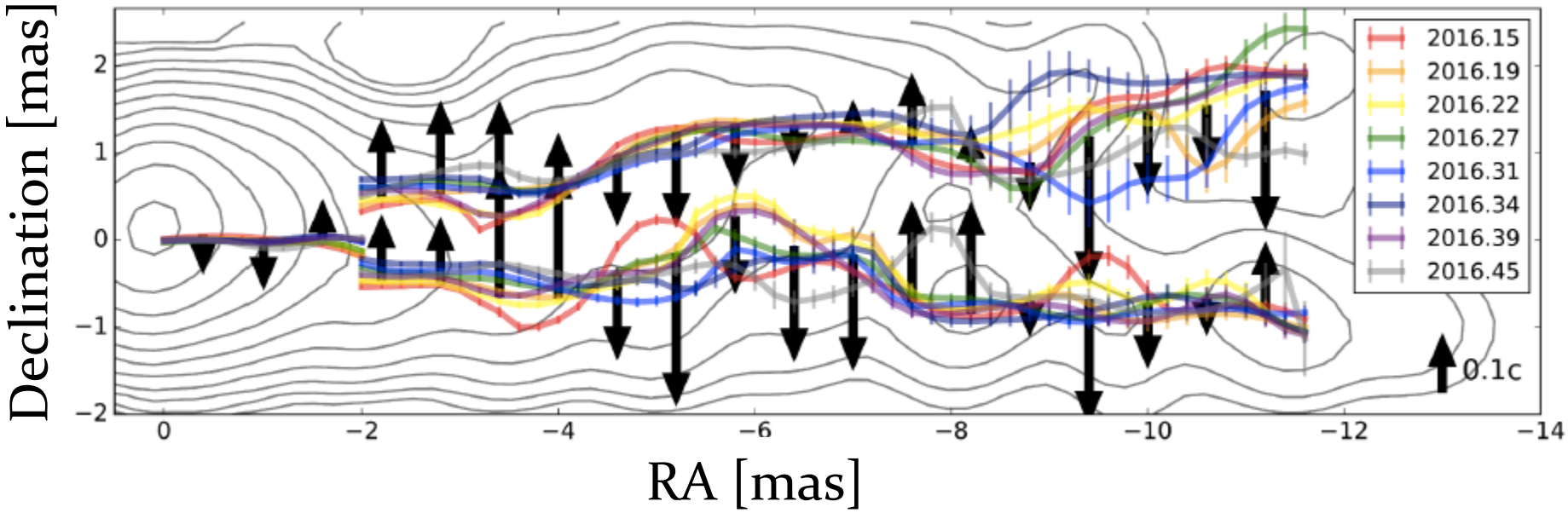
# Time allocated for initial phase of EAVN LP in 2019 Sep – 2020 Jan

| | |
|---|---|
| Title | KaVA/EAVN AGN large program monitoring of SgrA : Phase II |
| PI | Motoki Kino Ilje CHO and Guangyao ZHAO |
| Related Proposal/Publication | EAVN19A-06 |
| Time Allocated | 30 hours for KaVA, 18 hours for Tianma |

| | |
|---|---|
| Title | Investigating the Transverse Oscillation of the M87 Jet with EAVN |
| PI | Motoki Kino Hyunwook RO |
| Related Proposal/Publication | EAVN19A-06 |
| Time Allocated | 49 hours for KaVA and Nanshan |

# EAVN LP of investigating the transverse motion in M87

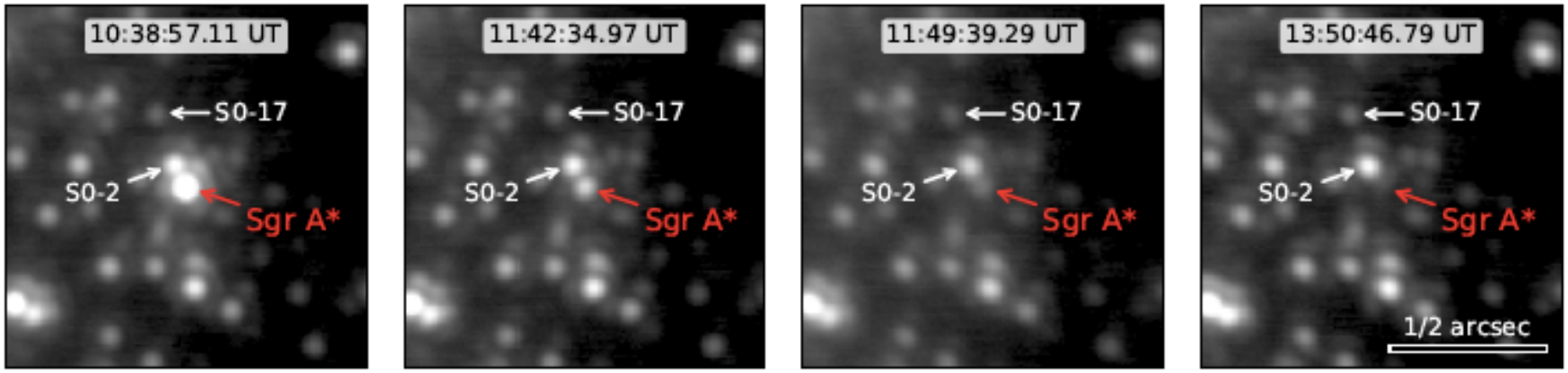
Ro+ *in prep*

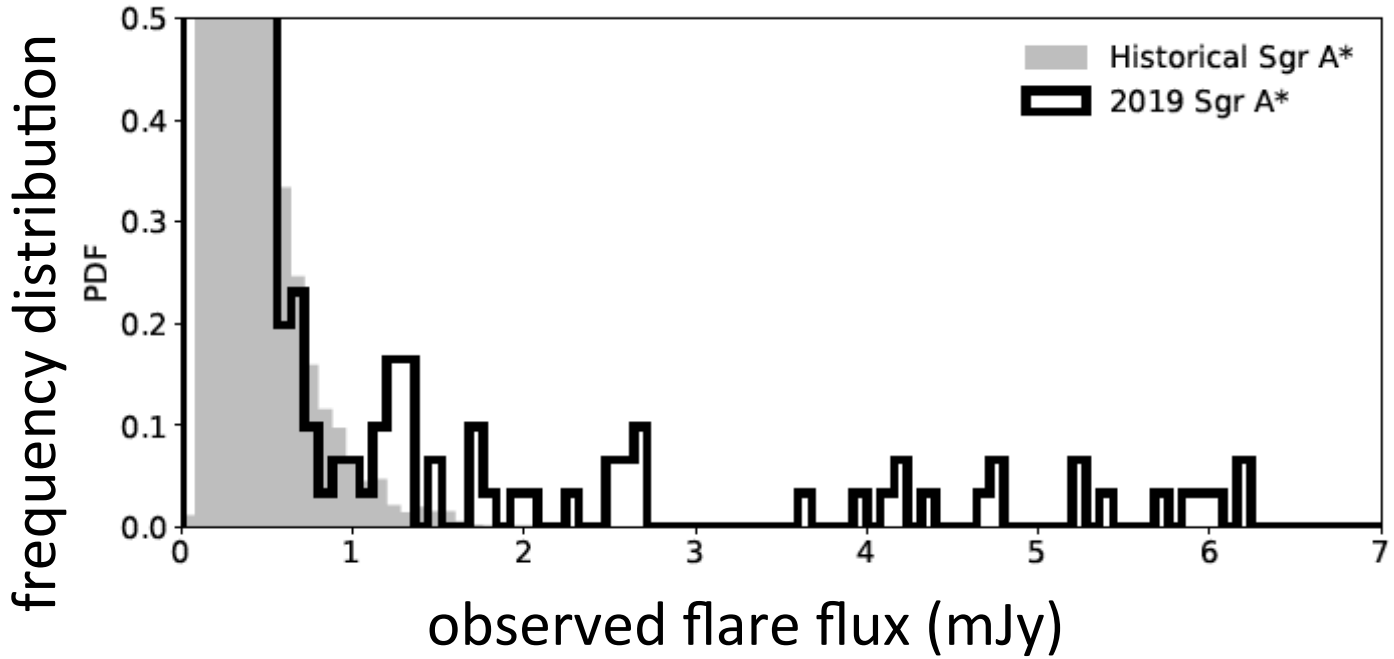



The timescale of a possible oscillation is one year scale.
Hence, long term monitoring at 22 GHz is essential to characterize its properties. We can study on instabilities in the jet.

Do et al. (2019)

# Significant IR flare activity in 2019



# The elevated IR flare activity encourages EAVN LP monitoring of Sgr A*.

Do et al. (2019) says

- "The distribution of flux variations observed this year is significantly different than the historical distribution."

- "Potential physical origins of Sgr A*'s unprecedented brightness may be from **changes in the accretion-flow** as a result of the star S0-2's closest passage to the black hole in 2018 **or from a delayed reaction to the approach of the dusty object G2 in 2014.**"

# Summary of EAVN AGN Science WG activities

- Paper drafting w/ KaVA Large Program data in 2014-2018
  - ✓ Park+ 2019 submitted (M87 velocity field in 2016)
  - ✓ Ro+ in prep (M87 magnetic field in 204-2016)
  - ✓ Cui+ in prep (M87 jet PA in 2017-2018)
  - ✓ Cho+ in prep (Sgr A* intrinsic size in 2017 April)
  - ✓ Zhao+ in prep (Sgr A* intrinsic size in 2013-2016)

- Conducting initial phase EAVN LP in 2019B
  - ✓ Transverse oscillation of the M87 jet
  - ✓ Origin of significant flares in Sgr A*

- Development/upgrade of EAVN
  - ✓ KaVA/EAVN polarimetry (BW Sohn+, K. Hada+, J. Park)
  - ✓ KaVA/EAVN phase-ref (J. Oh+)
  - ✓ EATING VLBI (M. Giroletti+)
  - ✓ EAVN-high (K. Asada+)