KaVA 43 GHz observation of Sgr A* with 1-Gbps recording

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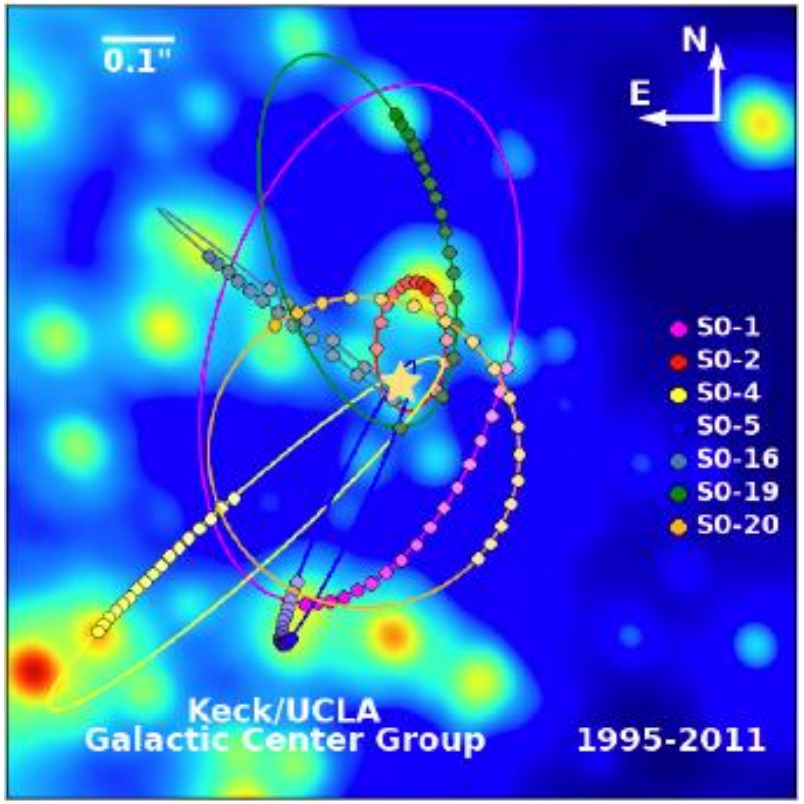
on behalf of the KaVA AGN sub-workgroup

Outline

- Introduction of Sgr A*
- Related KaVA array Key Science Project
  - uv coverage
- Preliminary results from one of the test observations
  - Observation and data analysis
  - Maps and Gaussian models
  - Comparison with previous measurements

Background: Sgr A*

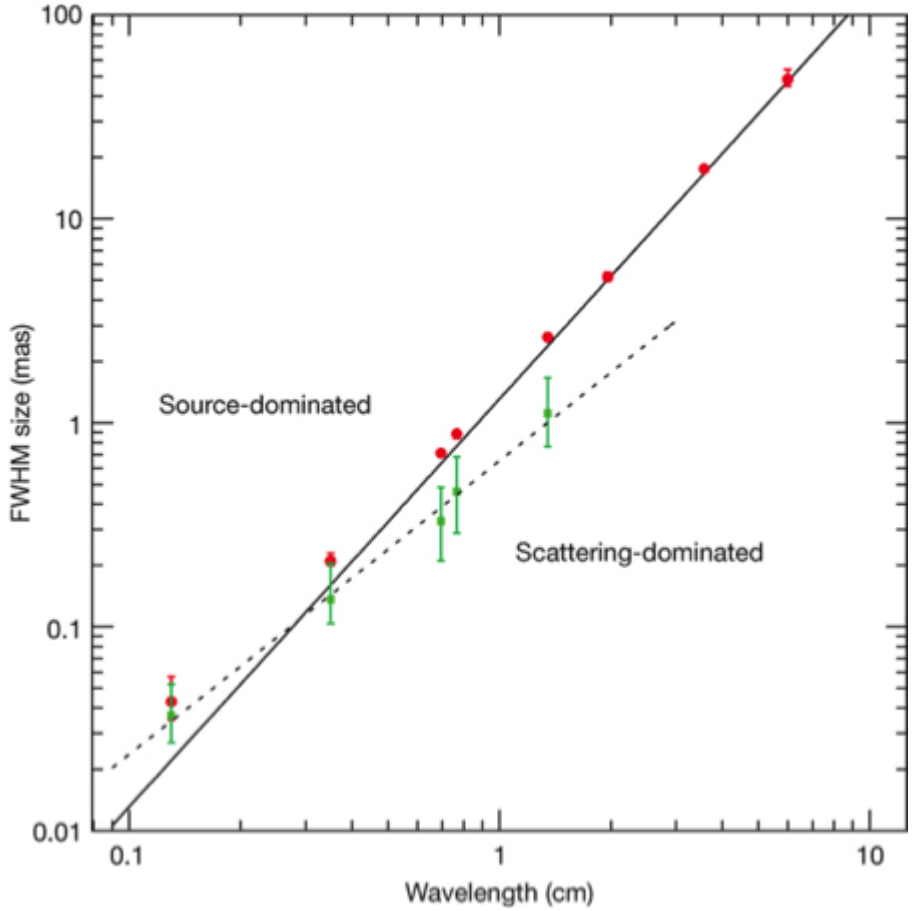
Sgr A*: The GC SMBH



- Nearest SMBH
  - ~ 4 × $10^6 M_{solar}$ BH at 8kpc
- Largest angular size
  - 1 R_s ~ 0.01 mas
- The best laboratory for studying SMBH
- Emission mechanism:
  - RIAF (Yuan+ 2009),
  - Jet (Falcke & Markoff 2000)
  - …

Background: Sgr A*

Angular size: scattering and intrinsic size

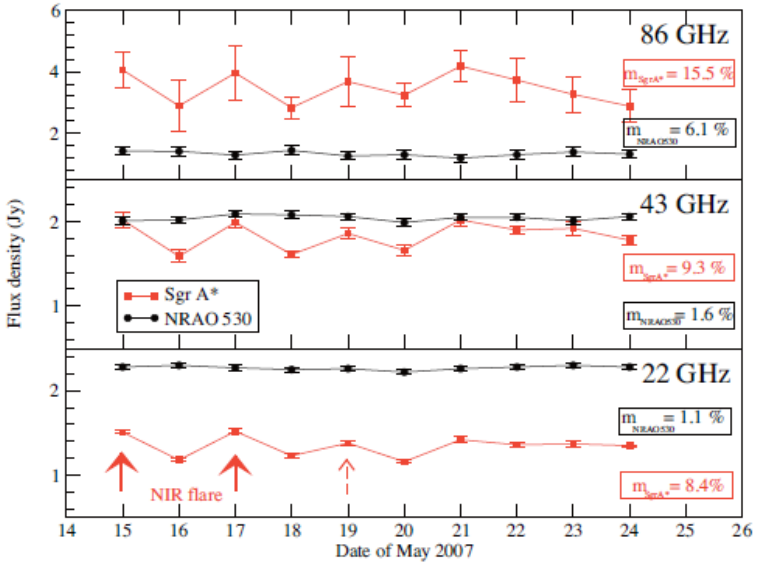


Doeleman+ 2008

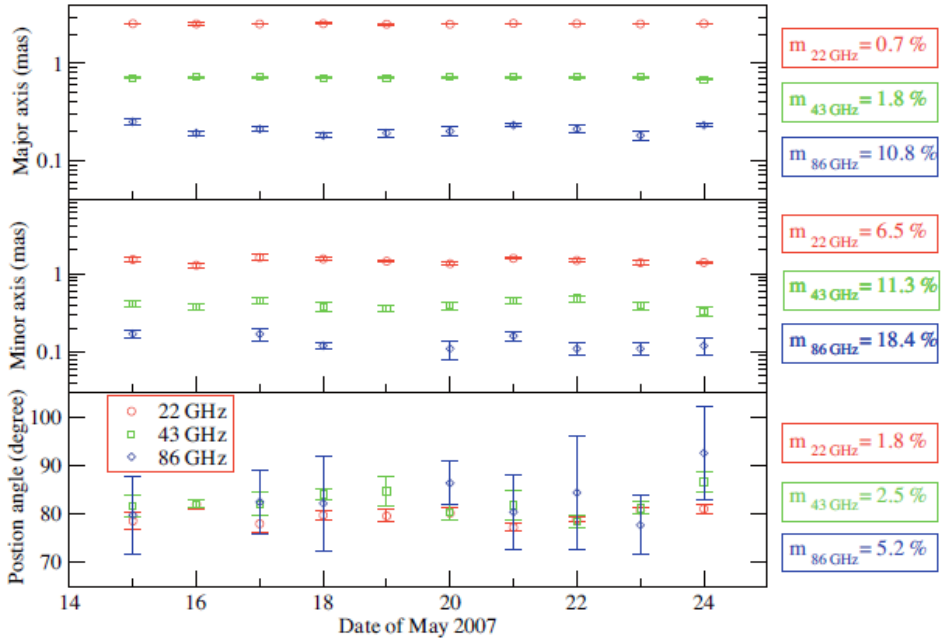
- Observed size: λ^2 relation
  - Interstellar scattering
  - Less dominate at above 22 GHz
- Intrinsic size:
  - λ- dependence
  - photosphere of an optically thick plasma (Loeb & Waxman 2008)

Background: Sgr A*

Variability



(a) The light curve of Sgr A* (Lu et al. 2011)



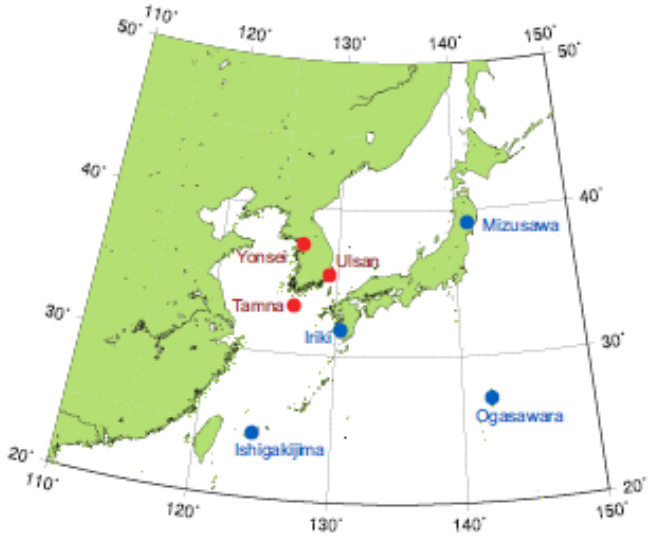
(b) Variability of the source structure of Sgr A* (Lu et al. 2011)

KaVA Array

KaVA

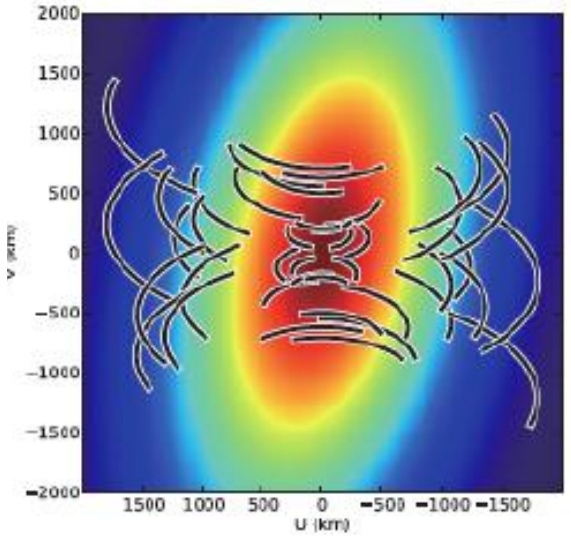
Imaging capability of KaVA : Niinuma-san's talk

Configuration

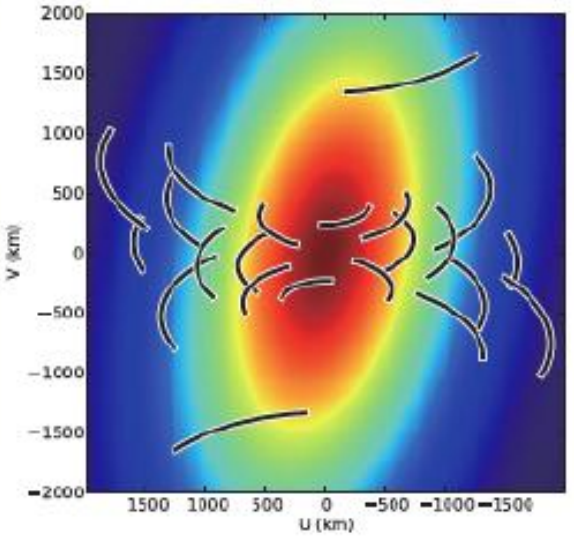


uv coverage for Sgr A*

KaVA



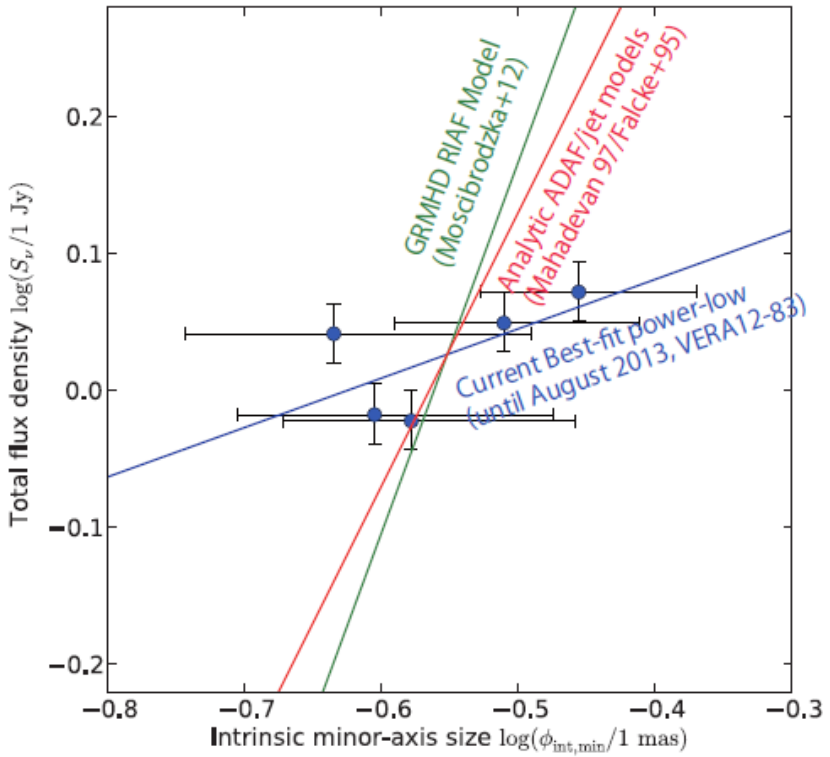
VLBA



KaVA KSP

monthly monitoring of Sgr A* at 43 GHz as part of the KSP

Starts in September 2014, after several test observations



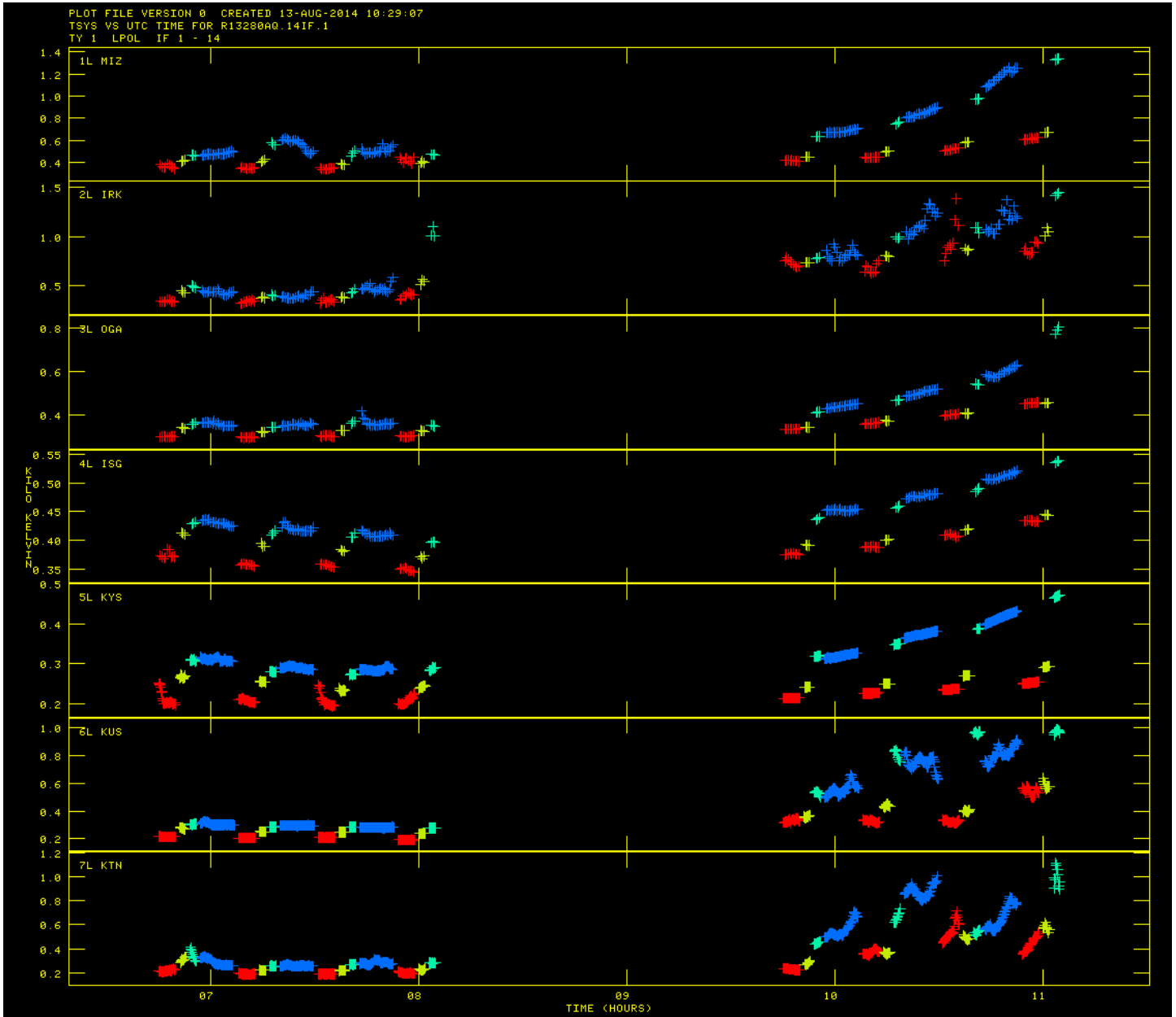
Kino-san's talk

Test Observation: R13280A

- 2013 Oct 07
- 1-Gbps recording
- K & Q frequency switching

  UT 05:15~06:35 K; 06:45~08:05 Q; 08:15~09:35 K; 09:45~11:05 Q
- Target: Sgr A*; Calibrators: NRAO530, Sgr B2 (K), VX Sgr (Q), OH0548 (Q)
- Obs_log
  - R13280a<a-d> (SrgA* at Q)
    - Mark5B & DIR-1000
    - Missing Scan 1-2 at Yonsei during r13280ac
    - Rain at Tamna between r13280ac - ad

Tsys plot Q band



Data analysis

- Amplitude calibration
  - A priori: ACCOR+ APCAL
  - Template method: ACFIT(calsour VX Sgr, OH 0548)

- Manual P-Cal with FRING
  - calsour ‘nrao530’

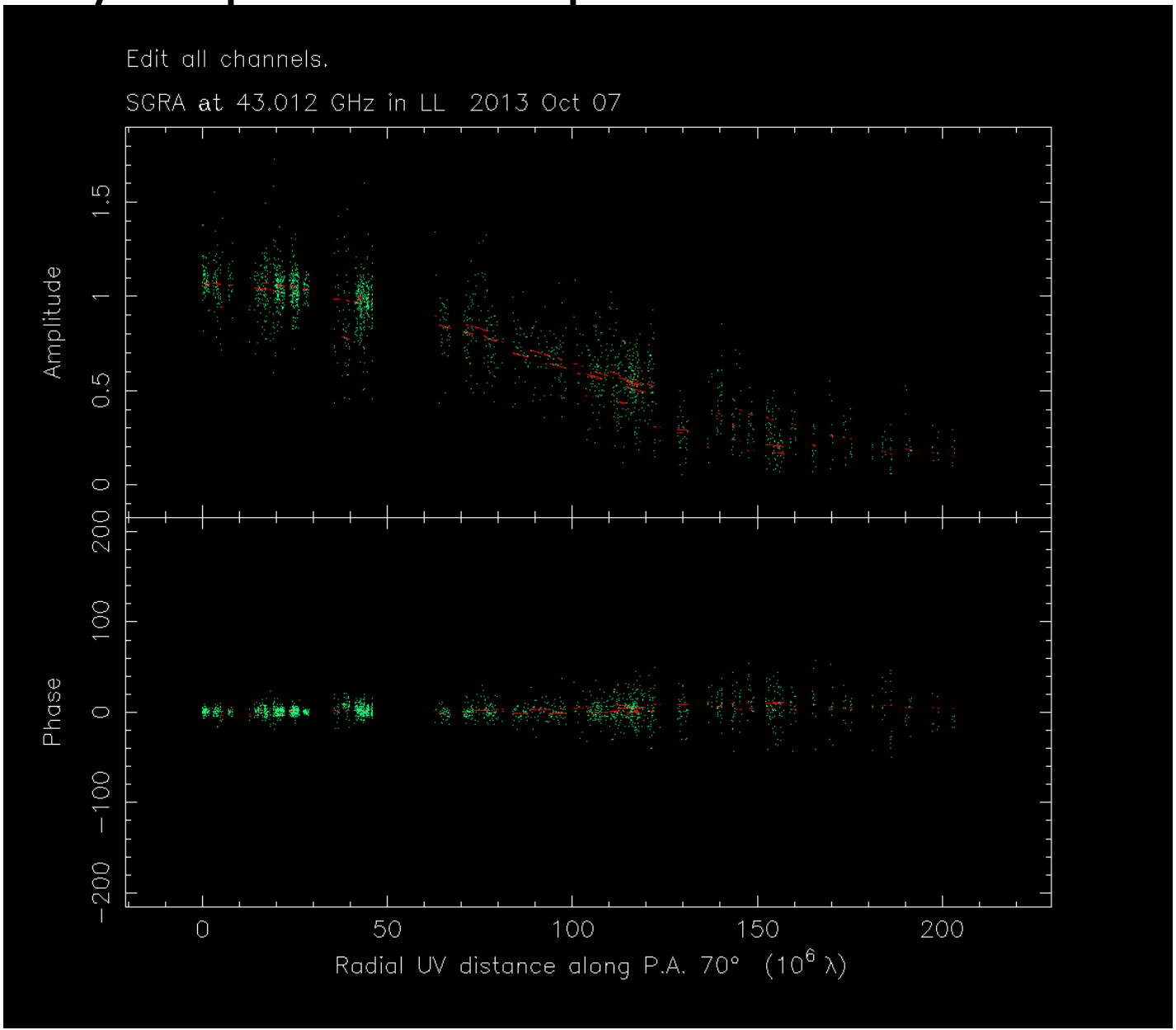
- Fringe-fitting for Sgr A*
  - Combining all Ifs
  - Narrow delay and rate search window
  - Lower SNR cutoff

Data analysis

- Bandpass calibration
  - calsour ‘nrao530’, ’sgra’
- Editing
- Calibrating
  - calsour ‘sgra’,’’
  - solint 0.1; aparm(7) 0.1
- Time averaging
  - 15 sec

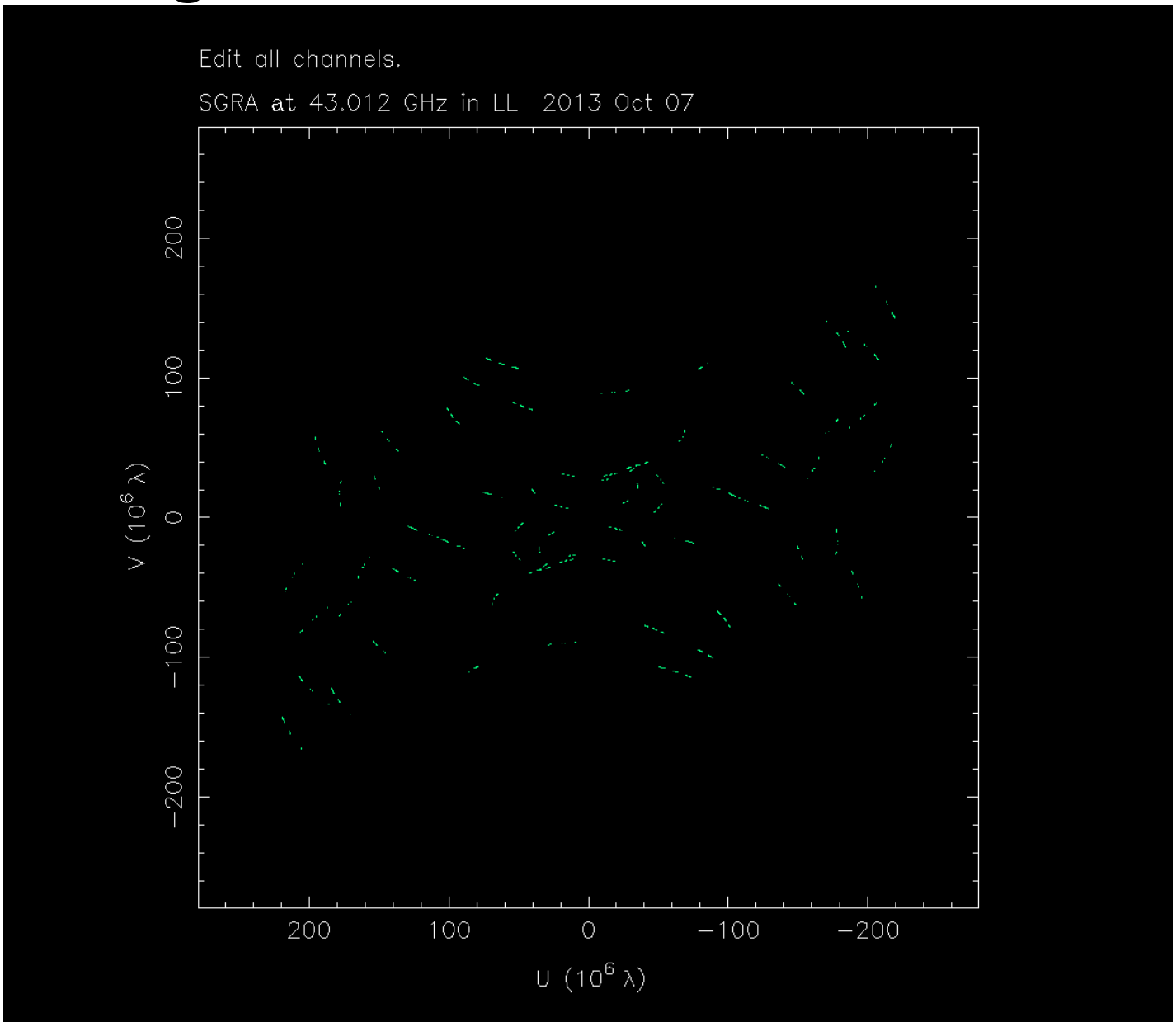
Q band Imaging of Sgr A*

- Visibility amplitude and phase vs. uv distance



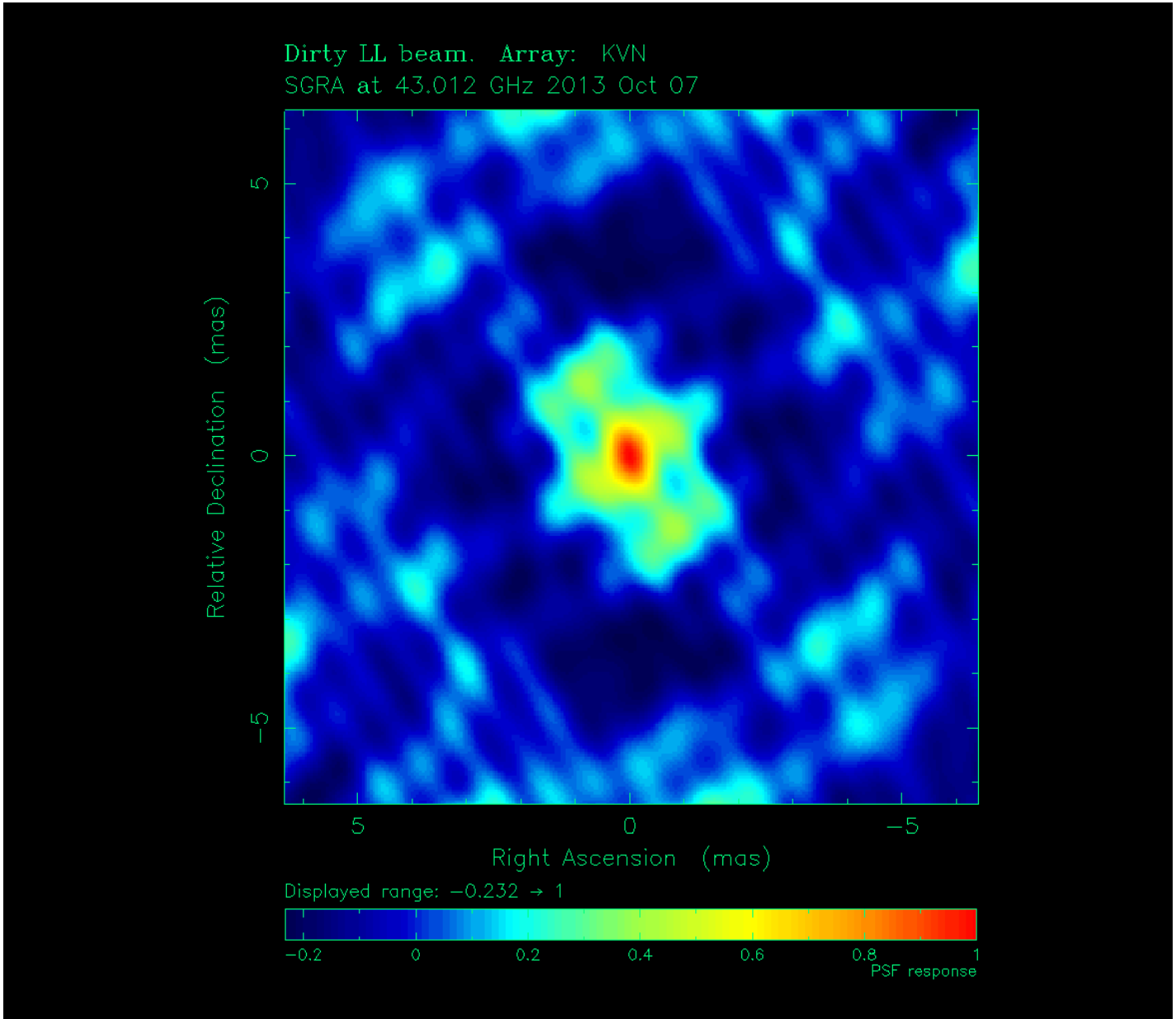
Q band Imaging of Sgr A*

- uv-coverage achieved



Q band Imaging of Sgr A*

- PSF



Q band Imaging of Sgr A*

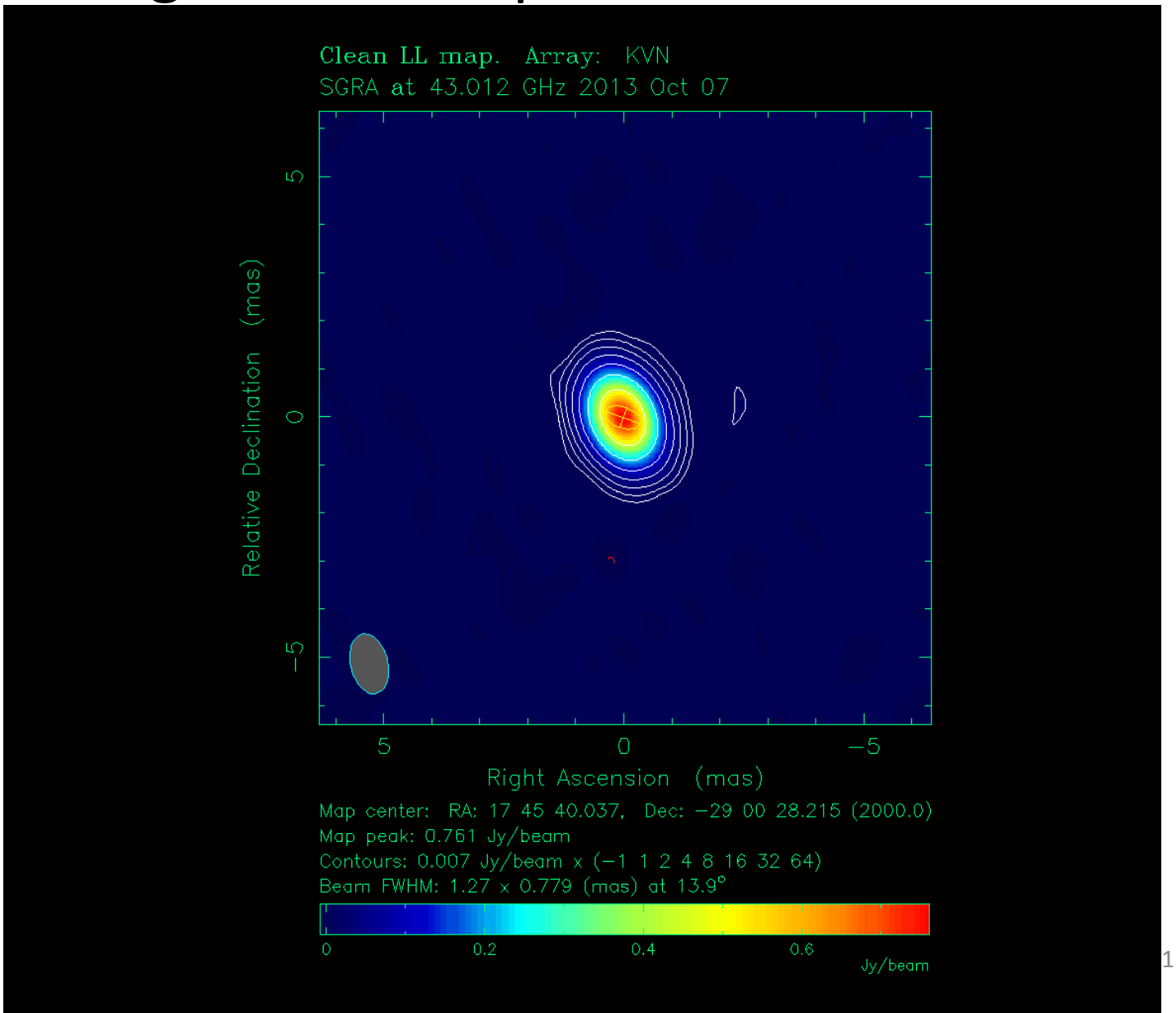
- natural weight clean map

rms

~2.3mJy/b

DR

>300



Q band Imaging of Sgr A*

- Model-fitting
- Flux

  1.086Jy
- Major axis

  0.75 mas
- Axis ratio

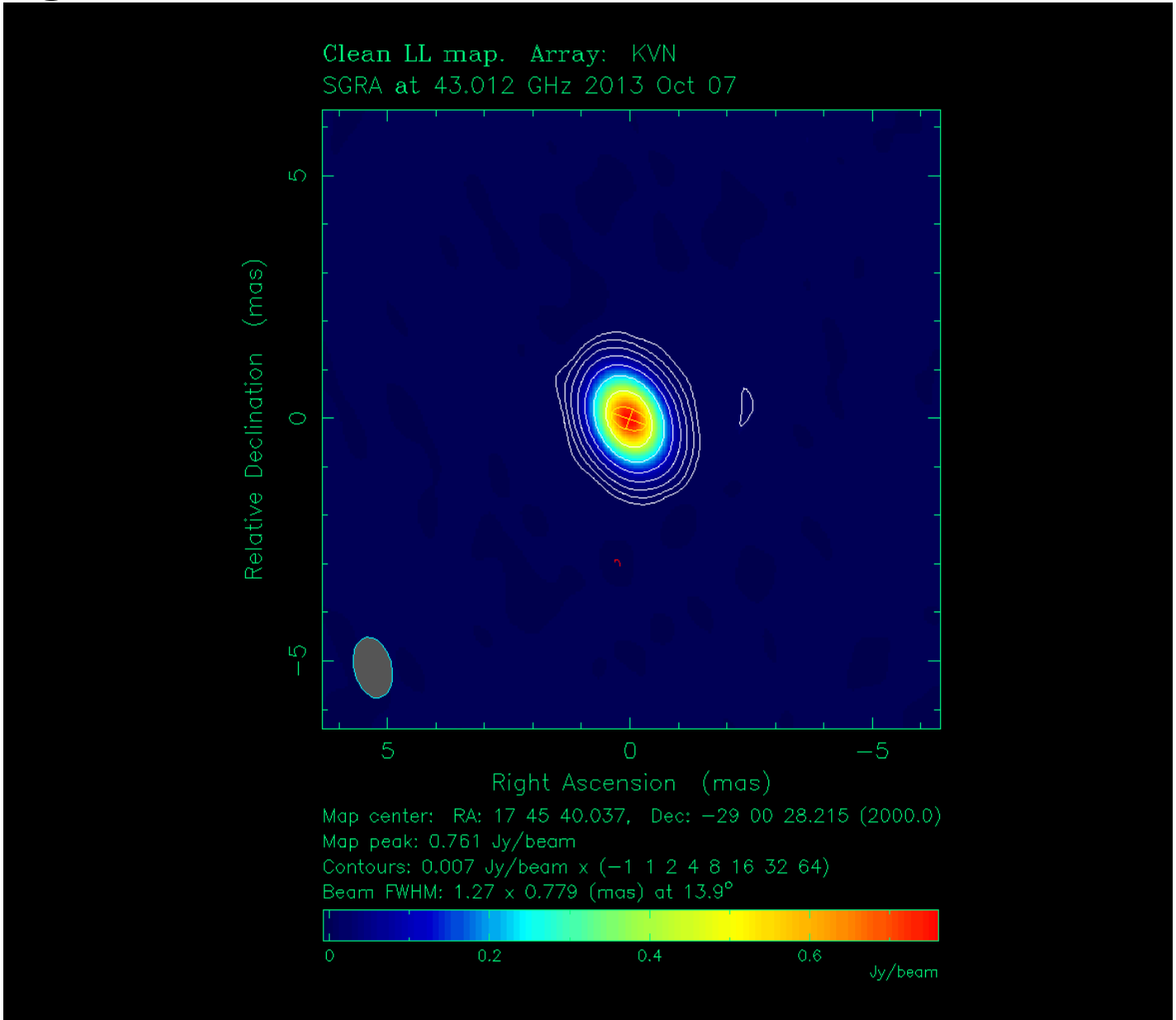
  0.57
- PA

  70.48

$$\phi_{\rm int} = \sqrt{\phi^2_{\rm maj} - \phi^2_{\rm scatt}}.$$

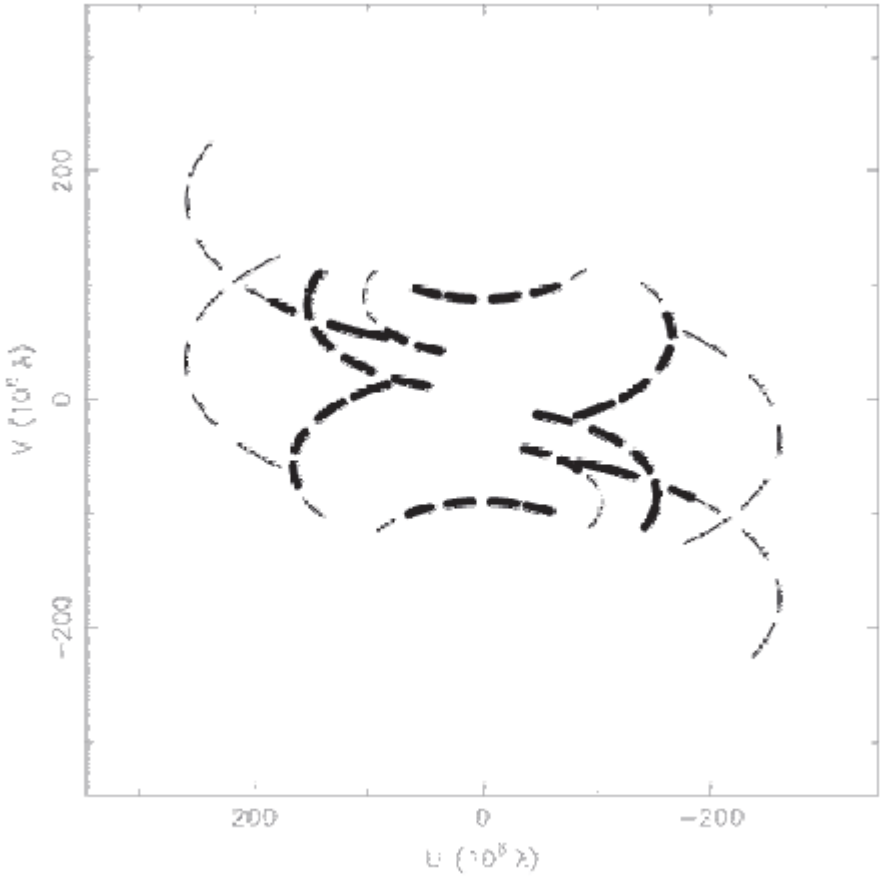
Intrinsic size:

0.36 mas



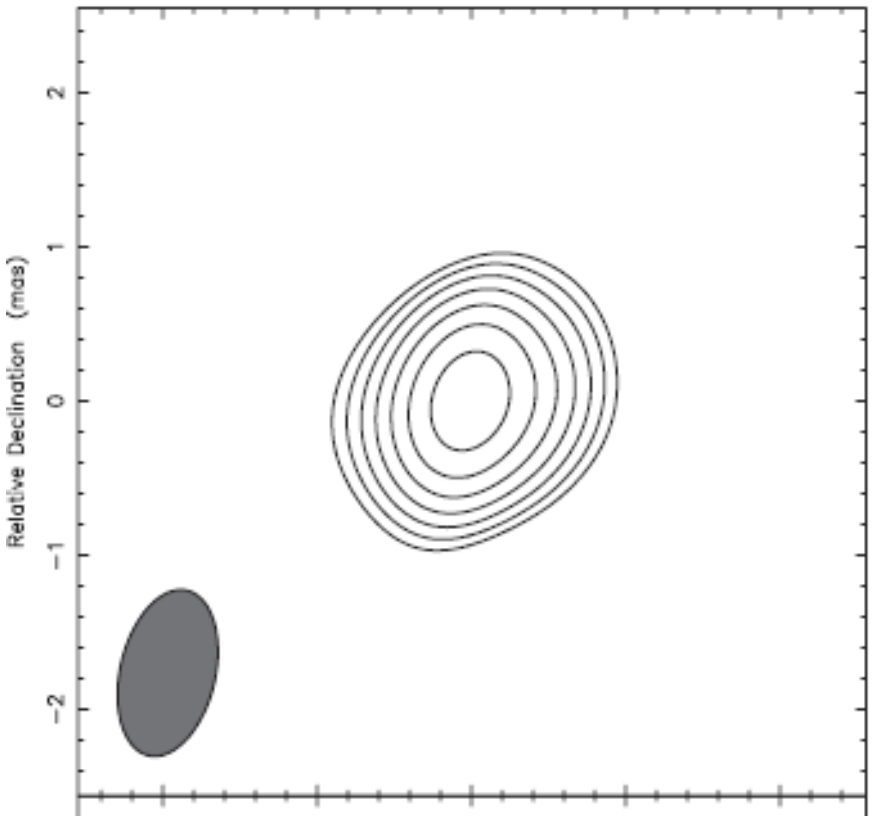
Comparing with previous VERA monitoring

- VERA uv-coverage



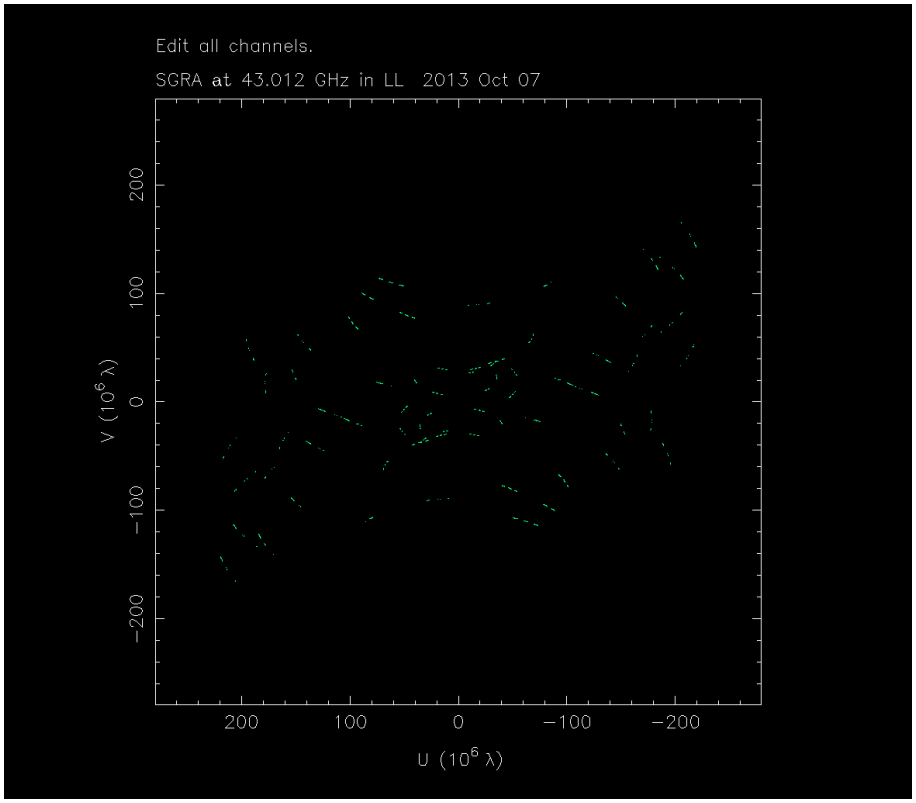
- Clean map

  DR ~60



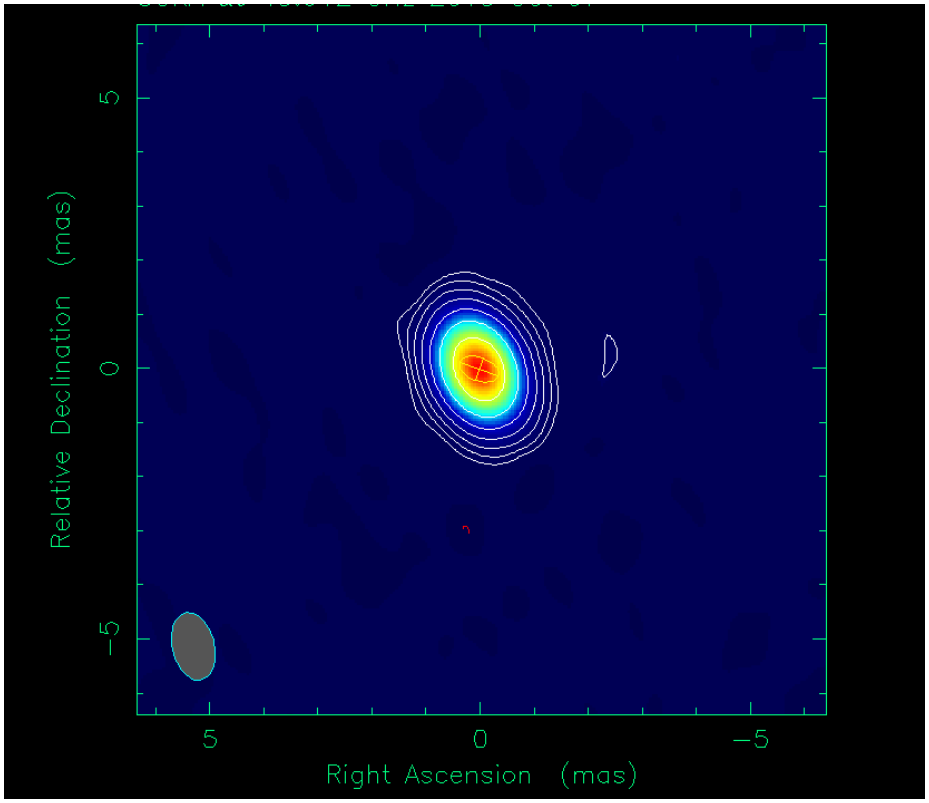
Comparing with previous VERA monitoring

- KaVA uv-coverage

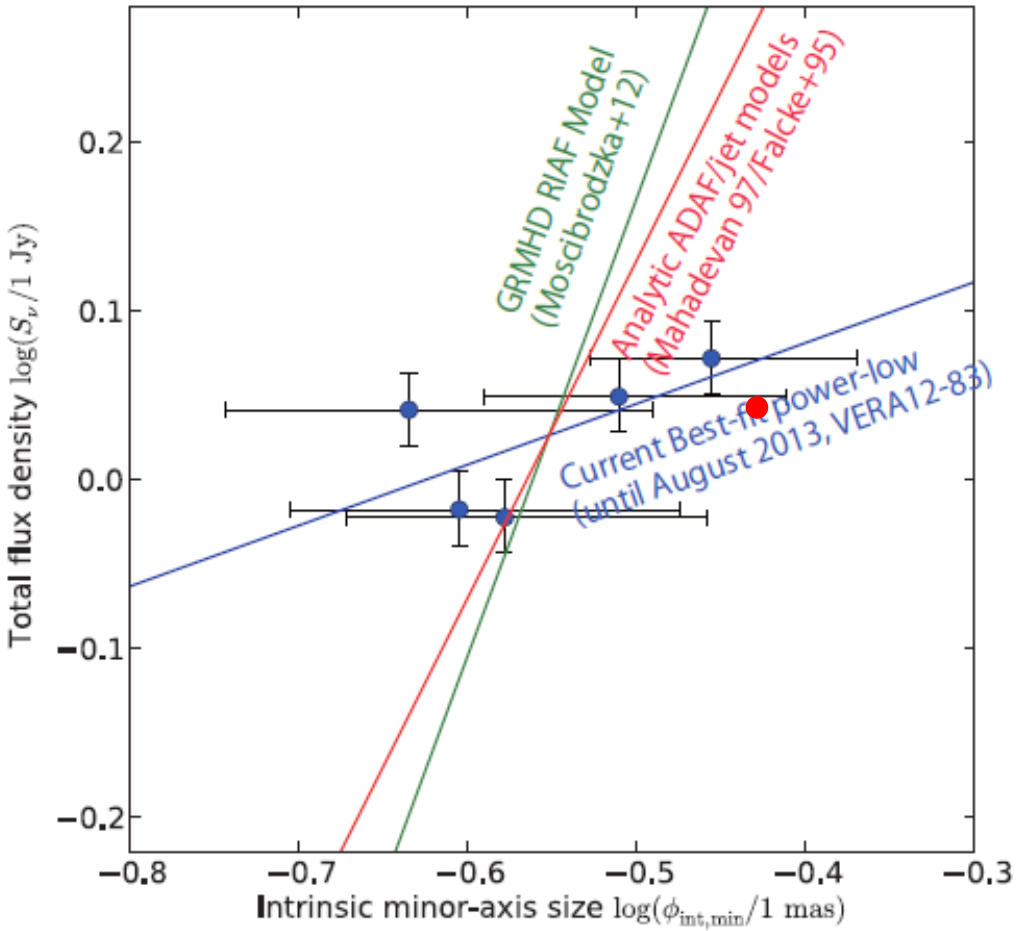


- Clean map

  DR >300



Measurements



Prelinemary!

Summary

- Sgr A* is the best laboratory for studying SMBH. Regular monitoring of the variability would be important for understanding the emission mechanism
- KaVA has started monthly monitoring of Sgr A* at Q band with 1Gbps as part of the KSP. KaVA has more shorter baselines compared to other arrays which are important for observing Sgr A*
- Comparing with VERA only observations, KaVA can provide higher quality maps and more reliable size measurements
- We could expect valuable outcome from the KaVA KSP