AGN Large Program with KaVA

M. Kino (KASI)
on behalf of KaVA AGN sub-WG

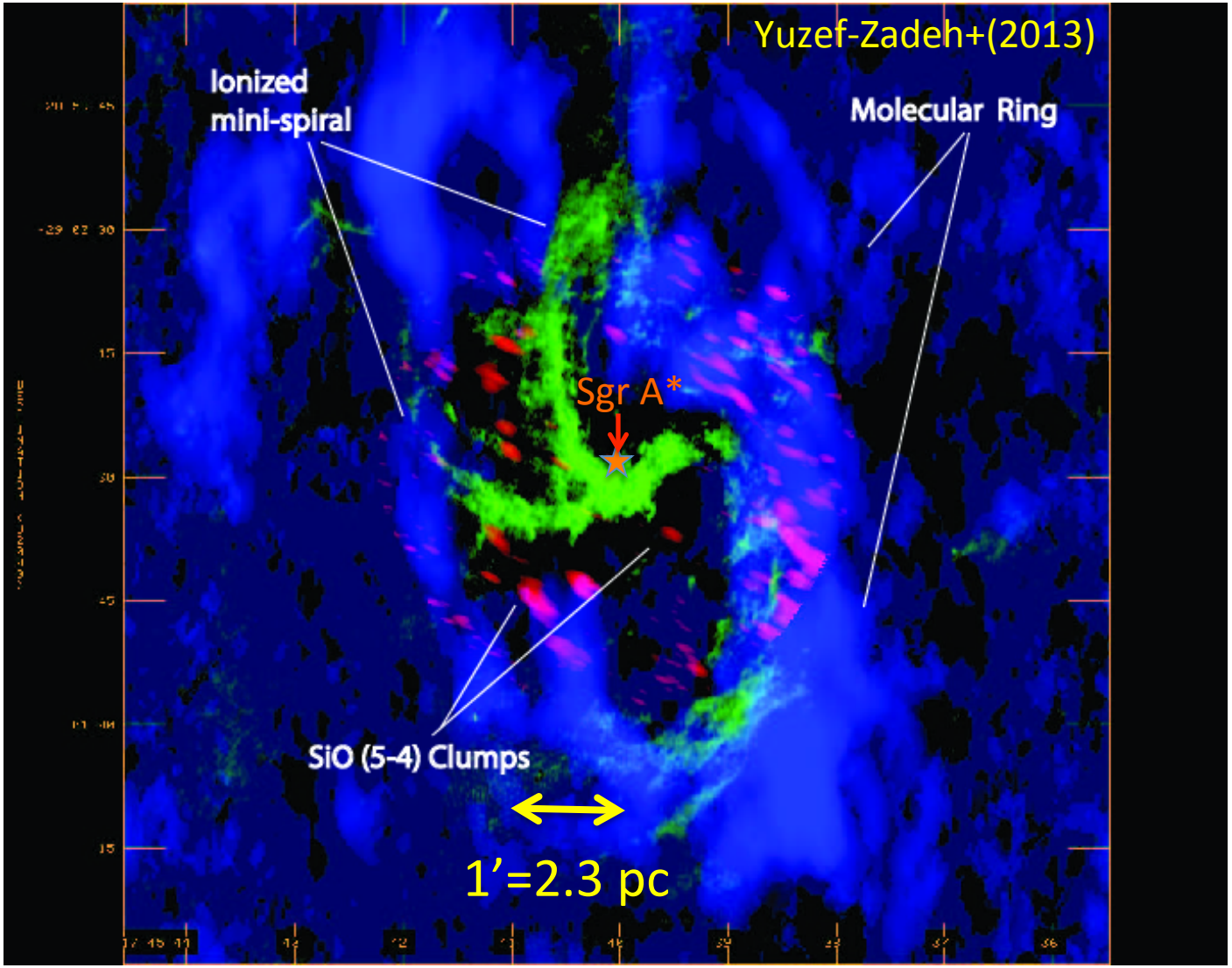
VERA users meeting
(2015/09/24 Mizusawa)

Outline

- Here, I will present you **Sgr A* (1mas=100Rs) world**.

- Next, Hada-san will talk about M87.

Best laboratory for Mass accretion onto SMBH



What happens after G2 encounter? Any imprint?

- Estimate of timescale by alpha-viscosity (α_{vis} =0.1, R=1000Rs)

$$t_{vis} = \frac{R^2}{\nu_{vis}} \sim \frac{3R^2}{2\alpha_{vis} C_s H} \sim 3\ years$$

- Currently, no evidence for enhance emission are seen by VLA/SMA/ ALMA in 2012-2014
  (Bower+ 2015, ApJ).

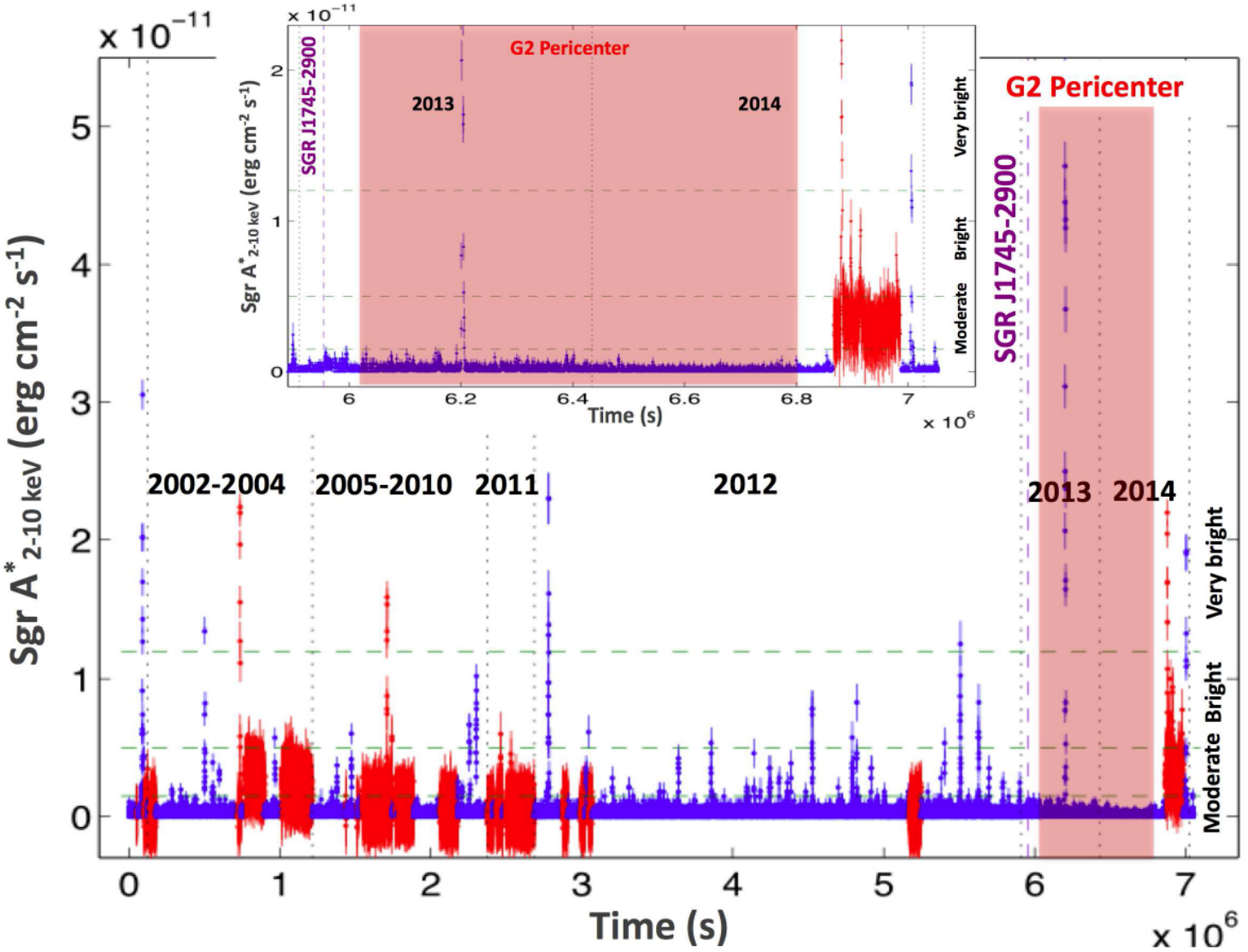
- KaVA Sgr A* monthly monitoring is the only one VLBI monitoring in 2013~2014. What happens within ~100 Rs scale?
  (G. Zhao & KaVA AGN sub-WG *in preparation*)

- What about X-ray view and theoretical prediction?
  (Ponti+ 2015, MNRAS in press; Kawashima+ *in preparation*)

Ponti+ (2015)

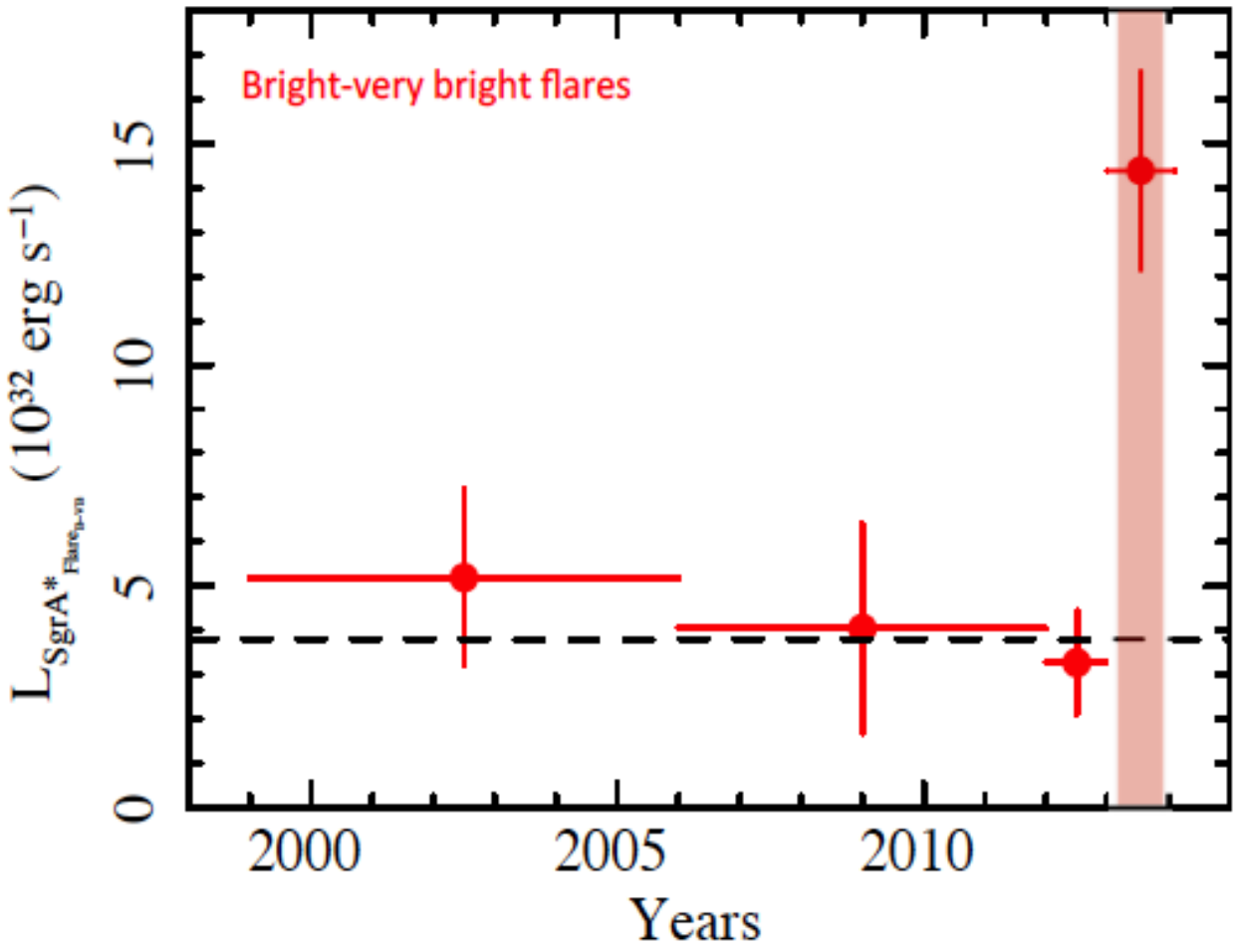
Recent increase in bright X-ray flare rate!

A sign of excess of accretion rate?

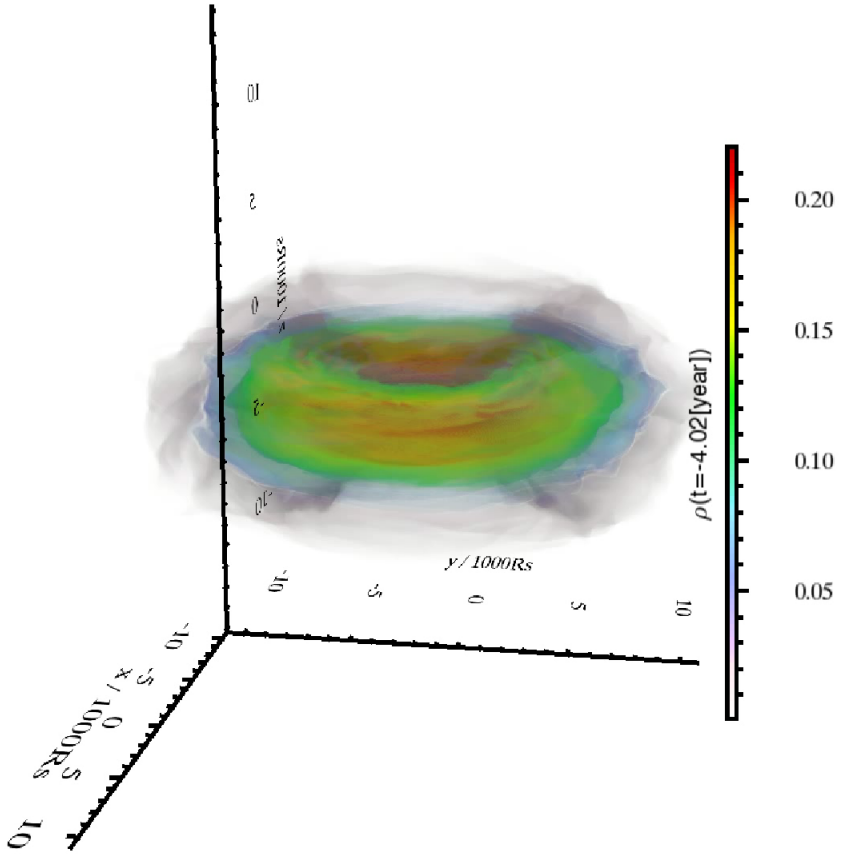


Ponti+ (2015)

Averaged light curve

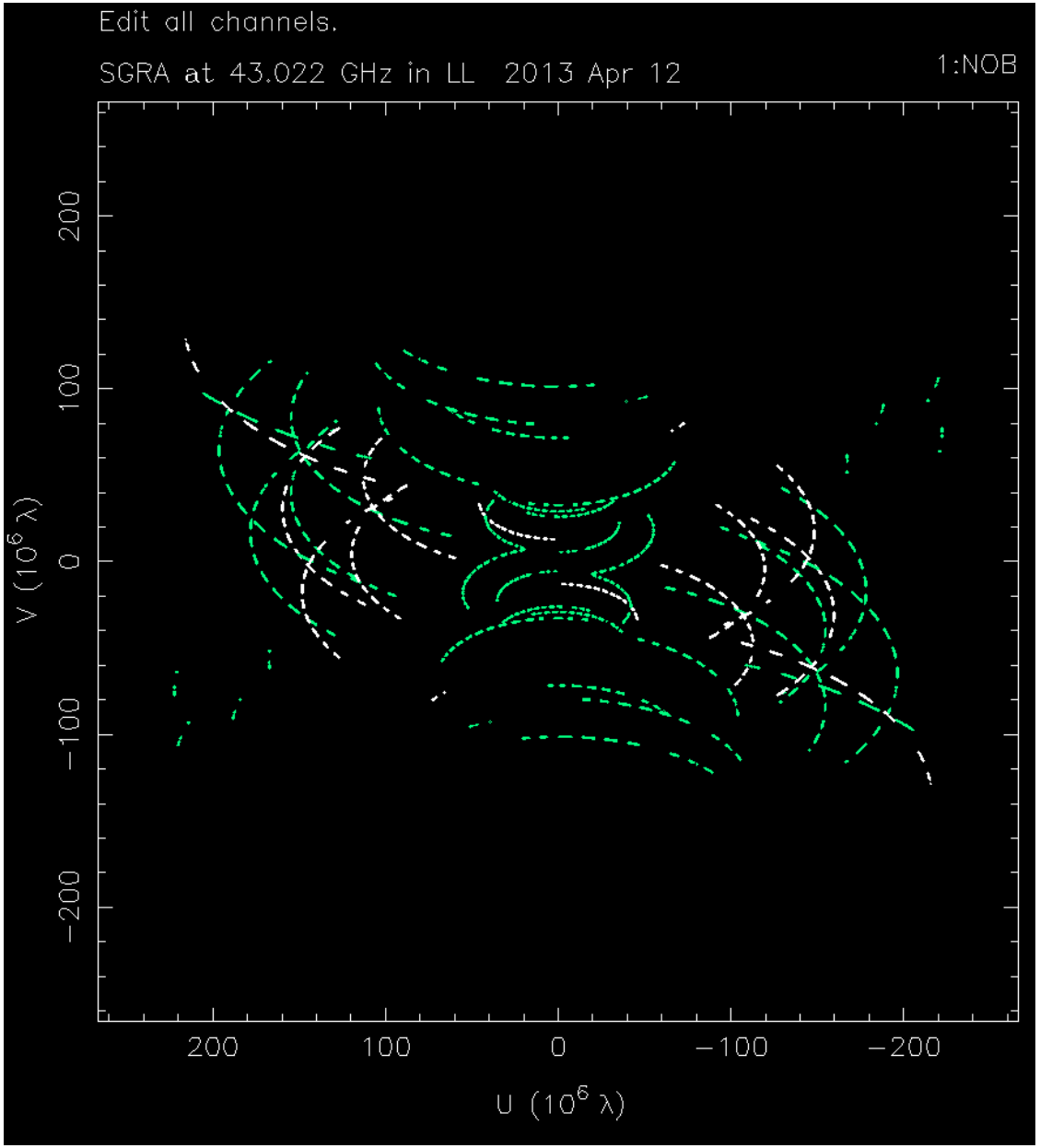


Kawashima prediction!



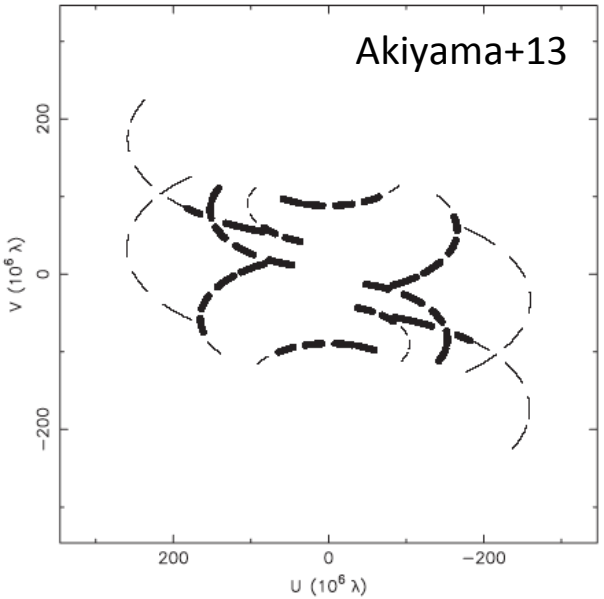
Kawashima-san predicts ***G2-collision-angle*** dependent evolution of (1) enhancement B-field (flux density), and (2) accretion-disk inclination (image size).

KaVA+ Nobeyama *u,v* coverage for Sgr A*

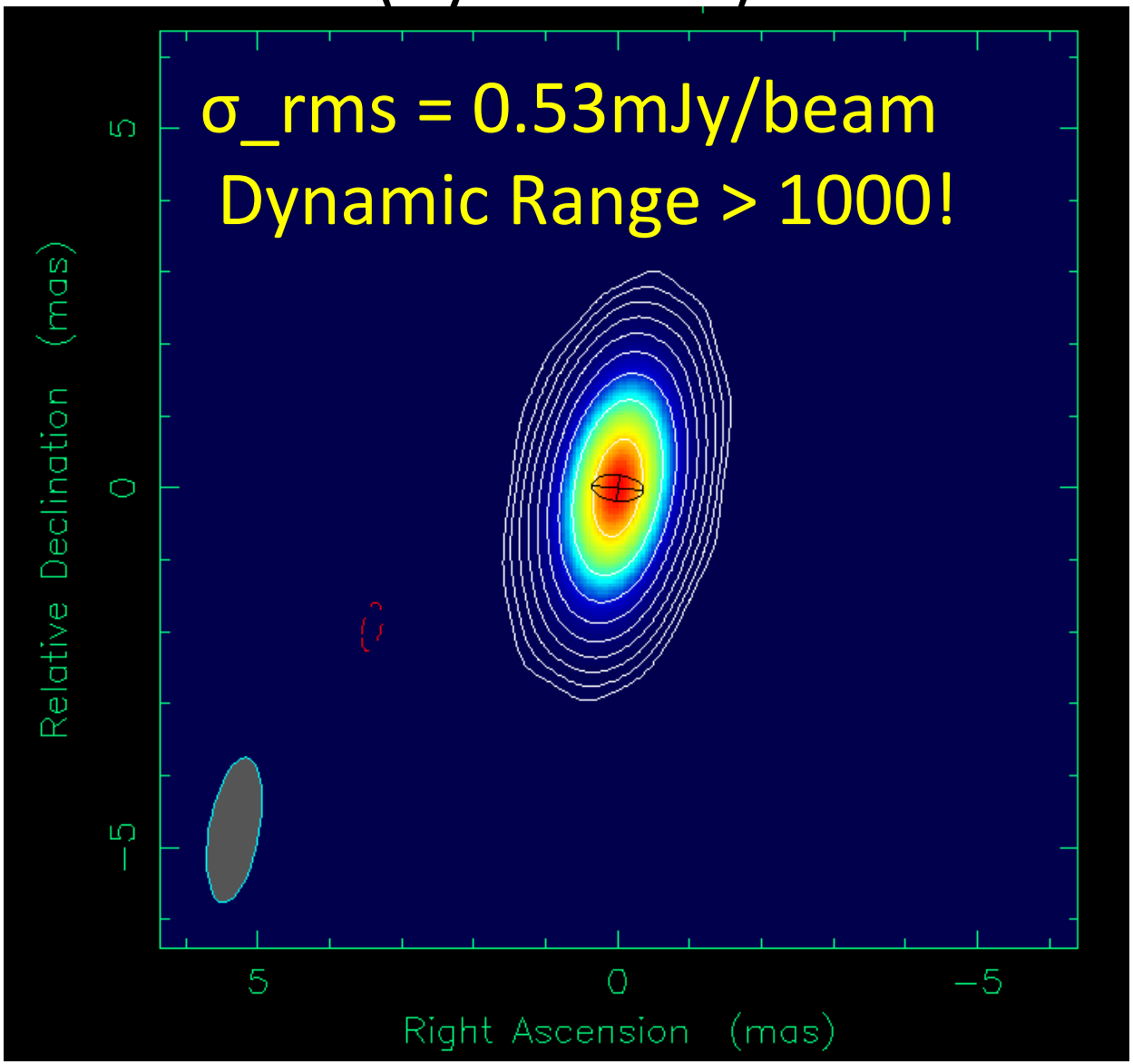


Nobeyama 45m

VERA alone



KaVA+Nobeyama image of Sgr A*@43GHz (by G. Zhao)



野辺山45m鏡のVLBI (w/ KaVA)定常運用 (22~86GHz)のためのVLBIバックエンド整備

RHCP for H40 receiver

New IFs

OCTAD (4ch) towards BW=8GMz

OCTADISK

科研費で整備予定の項目

基準信号分配器

基準信号 H- maser

今秋の科研費へ応募予定
“Black hole (M87 and Sgr A*) with KaVA + 野辺山”
PI: 新沼
小林、本間、秦、藤沢、
野辺山スタッフ etc、
KASI 紀 etc

Conclusion

- In KaVA AGN Large Program, we will look for imprint of G2 encounter in Sgr A*.
  - Viscous timescale is t_vis ~ 3 $(\alpha_{vis}/0.1)^{-1}$ years.
  - So far, no enhanced emission at radio band (Bower+ 15).
  - KaVA's Sgr A* monitoring data in 2014 (G. Zhao+ in prep)
  - Recent Increase of bright X-ray flare rate (Ponti+ 15).
  - Kawashima prediction.

- We will submit a KAKENHI application towards new implementation of VLBI backend to Nobeyama 45m (PI: Niinuma).

Fifteen years of *XMM-Newton* and *Chandra* monitoring of Sgr A*: Evidence for a recent increase in the bright flaring rate

G. Ponti[1⋆], B. De Marco[1], M. R. Morris[2], A. Merloni[1], T. Muñoz-Darias[3,4], M. Clavel[5], D. Haggard[6], S. Zhang[7], K. Nandra[1], S. Gillessen[1], K. Mori[7] J. Neilsen[8], N. Rea[9,10], N. Degenaar[11], R. Terrier[12] and A. Goldwurm[5,12]

ABSTRACT

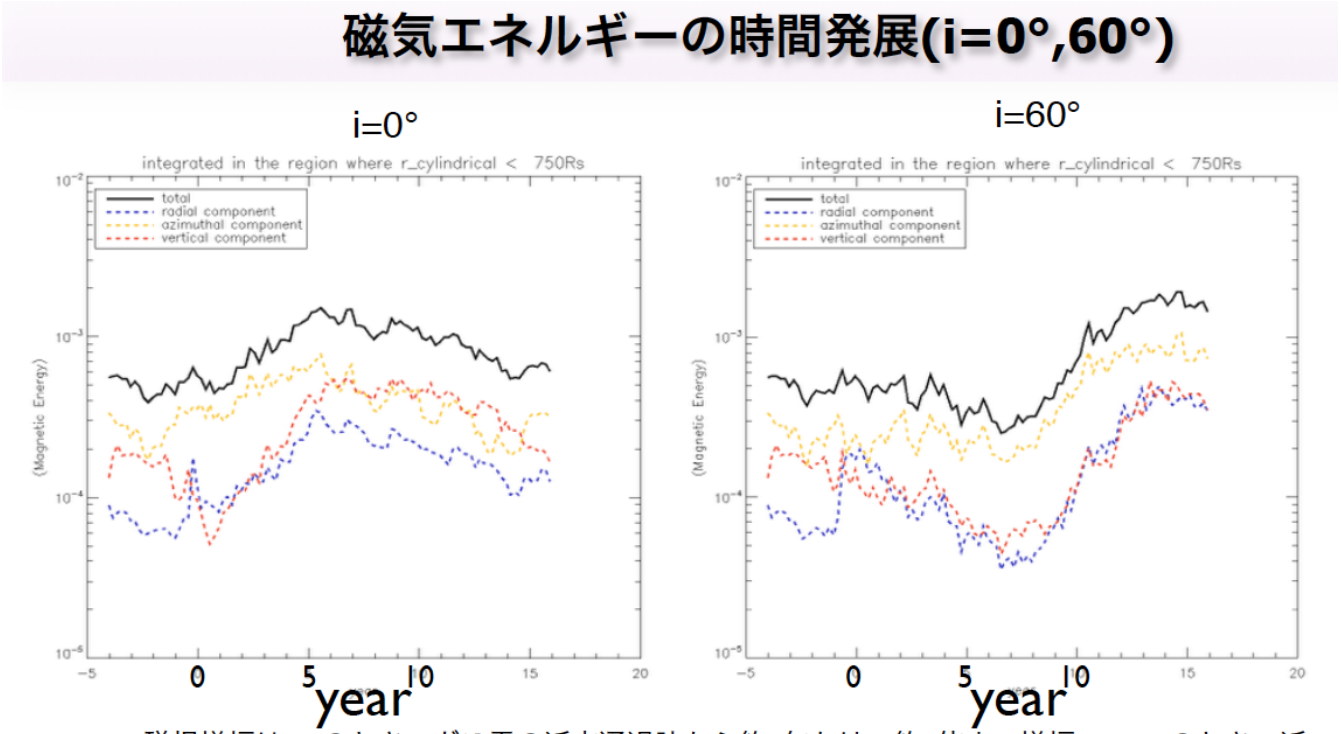
We present a study of the X-ray flaring activity of Sgr A* during all the 150 *XMM-Newton* and *Chandra* observations pointed at the Milky Way center over the last 15 years. This includes the latest *XMM-Newton* and *Chandra* campaigns devoted to monitoring the closest approach of the very red Br γ emitting object called G2. The entire dataset analysed extends from September 1999 through November 2014. We employed a Bayesian block analysis to investigate any possible variations in the characteristics (frequency, energetics, peak intensity, duration) of the flaring events that Sgr A* has exhibited since their discovery in 2001. We observe that the total bright-or-very bright flare luminosity of Sgr A* increased between 2013-2014 by a factor of 2-3 ($\sim 3.5\sigma$ significance). We also observe an increase ($\sim$ 99.9 % significance) from 0.27 ± 0.04 to 2.5 ± 1.0 day^{-1} of the bright-or-very bright flaring rate of Sgr A*, starting in late summer 2014, which happens to be about six months after G2's pericenter passage. This might indicate that clustering is a general property of bright flares and that it is associated with a stationary noise process producing flares not uniformly distributed in time (similar to what is observed in other quiescent black holes). If so, the variation in flaring properties would be revealed only now because of the increased monitoring frequency. Alternatively, this may be the first sign of an excess accretion activity induced by the close passage of G2. More observations are necessary to distinguish between these two hypotheses.

Revised Plan of AGN Large Project

	total epoch	Interval	1 epoch	total
M87@22GHz	12 epoch	2 weeks	7hrs	84
M87@43GHz	9 epoch (since EHT time compensates)	2 weeks	7hrs	63
Sgr A*@43GHz	10 epoch	1 month	6hrs	60
EHT campaign (M87+SgrA*) @43GHz	5 epoch	1 week	10hrs	50

194 hrs => 257 hrs

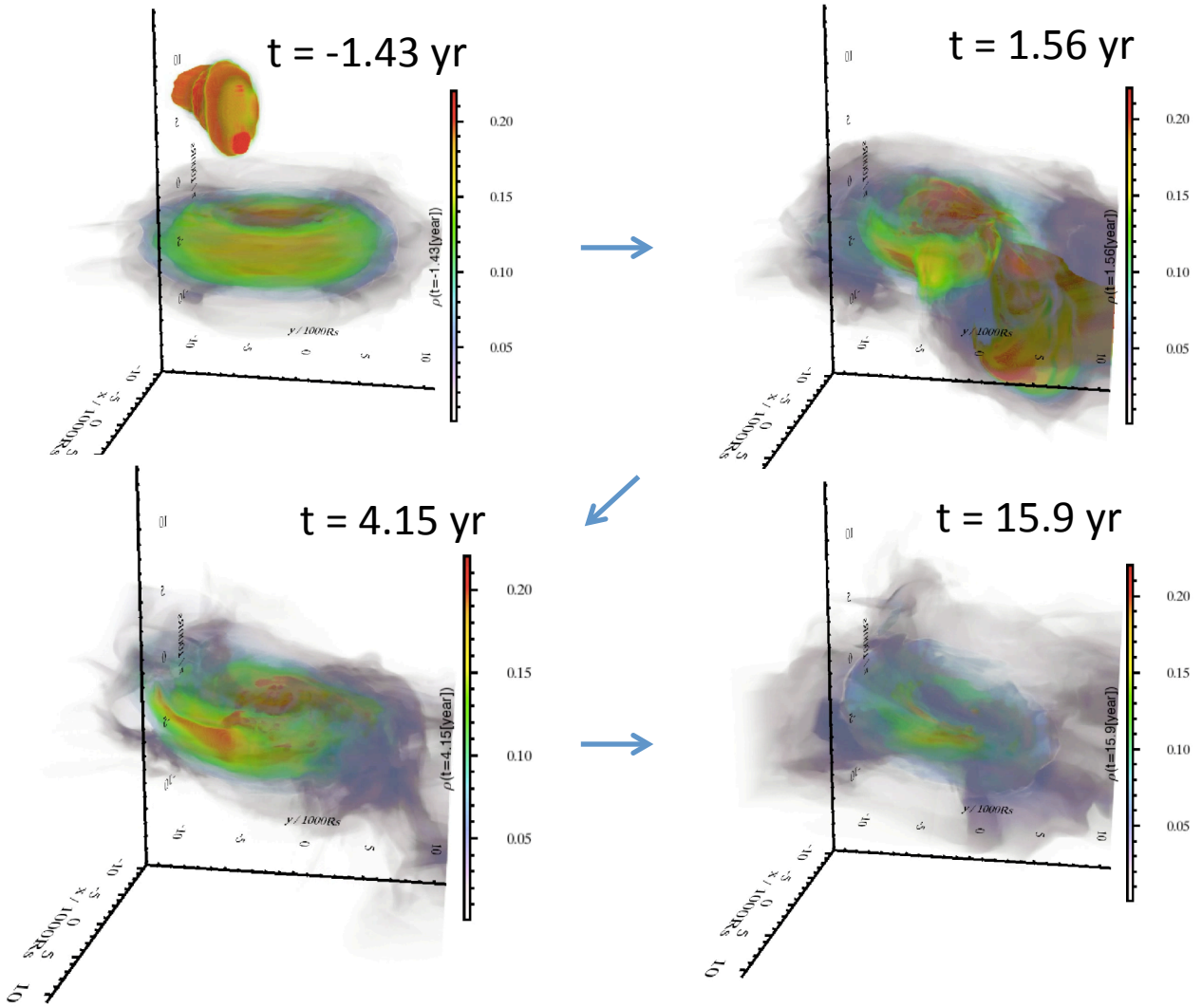
Kawashima-san predicts enhancement B-field strength with *i* dependence!



- 磁場増幅はi=0のとき、ガス雲の近点通過時から約5年かけて約4倍まで増幅。i=60°のとき、近点通過から約5年後に増幅を開始し、10年後まで増幅し続ける。
- これらの磁場増幅は4倍程度であるが、増幅の時間スケールはフレアの起こる時間スケールよりもずっと長いため、電波観測により通常のフレアと区別できる可能性がある。

Long time monitoring of Sgr A* (5-10years) is worthwhile!

Kawashima prediction!



This is the case w/ i=60°. G2 encounter dynamically changes accretion flow geometry. AGN SWG will test whether this will happen or not.