

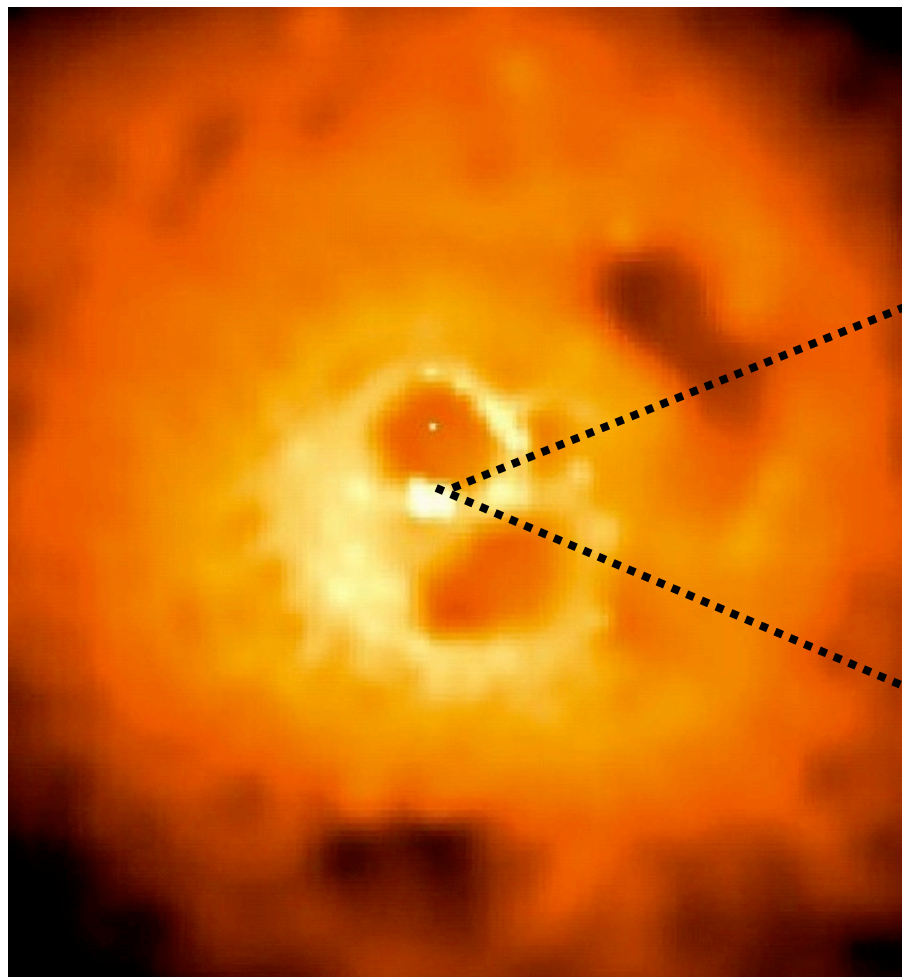
# 電波銀河3C84における カウンタージェット的时间変動

新沼浩太郎 (山口大学)

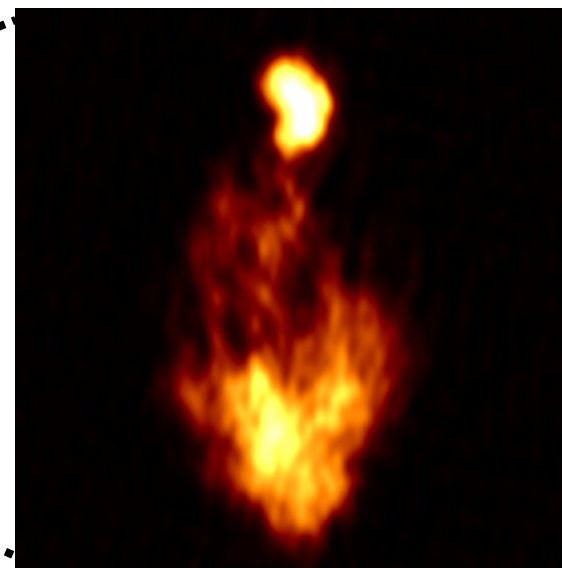
共同研究者：紀 基樹 (工学院大/NAOJ)、ほか

- Radio galaxy 3C 84 and VLBI scale structure
- KaVA monthly monitor@43GHz
- Interaction between C3 and inhomogeneous surrounding medium
- pc-scale counter-jet: discovery and time-variability

**Target: 3C 84 (NGC 1275)  $z = 0.0176$**



**Core of Perseus cluster**



**Recurrent jets**

**$\sim 10$  pc**

Asada + 2006

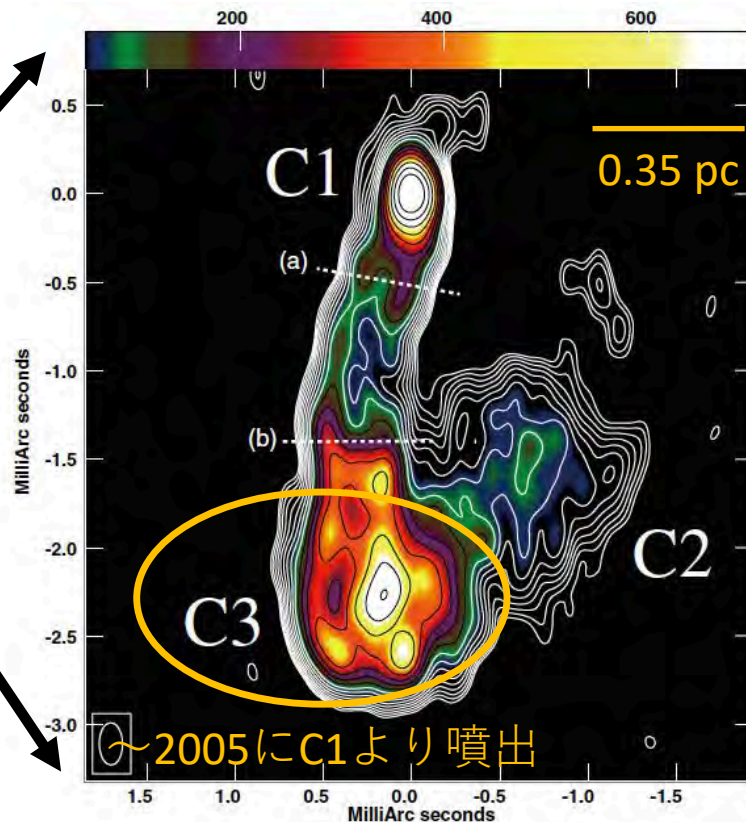
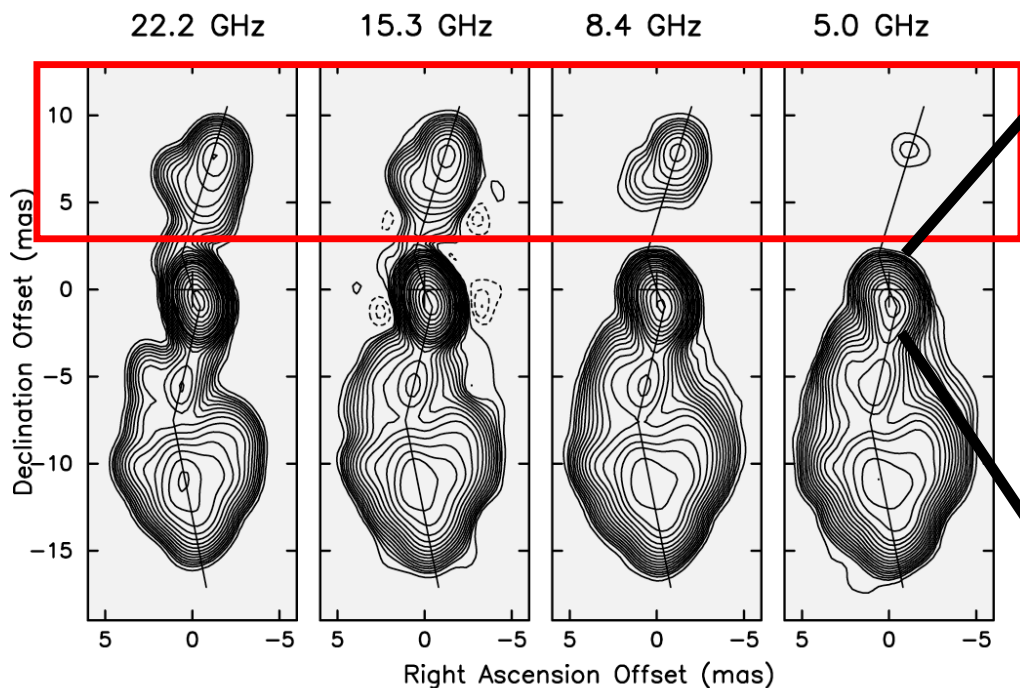
Best laboratory for investigating  $<$  pc scale jet-surrounding medium interaction.

# parsec / sub-parsec scale jet

カウンタージェットで周辺トラスによる自由-自由吸収が見られる

サブパーセクスケールを詳細に解像可能

Jan 95



Walker et al. (2000)

Nagai+14

# 日韓合同VLBI観測網 (KaVA)



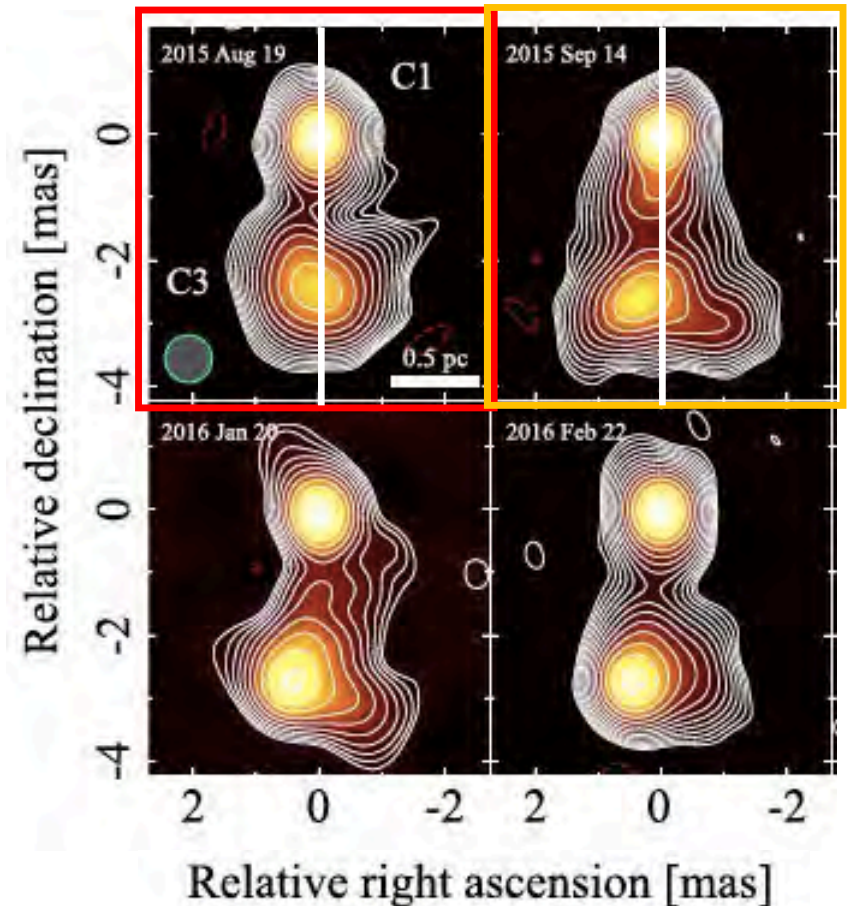
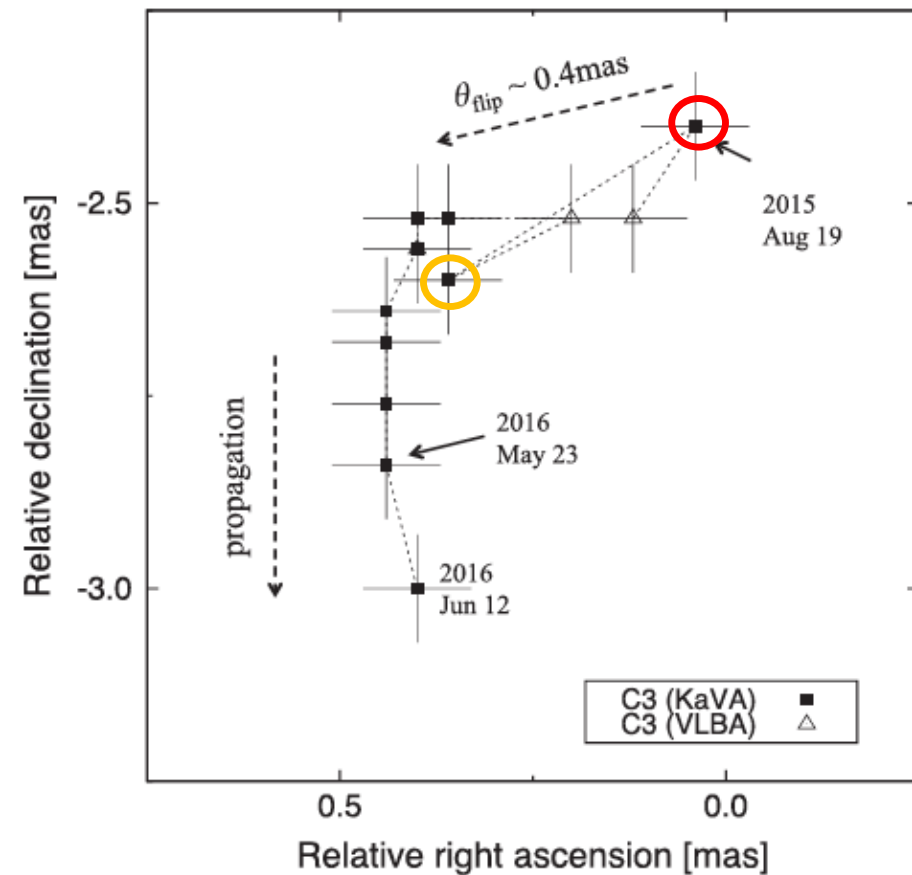
- **43GHzで長期モニターの実施(PI: 紀)**  
2015 Aug – 2018 May
- **<pcスケールの運動を詳細にモニター**





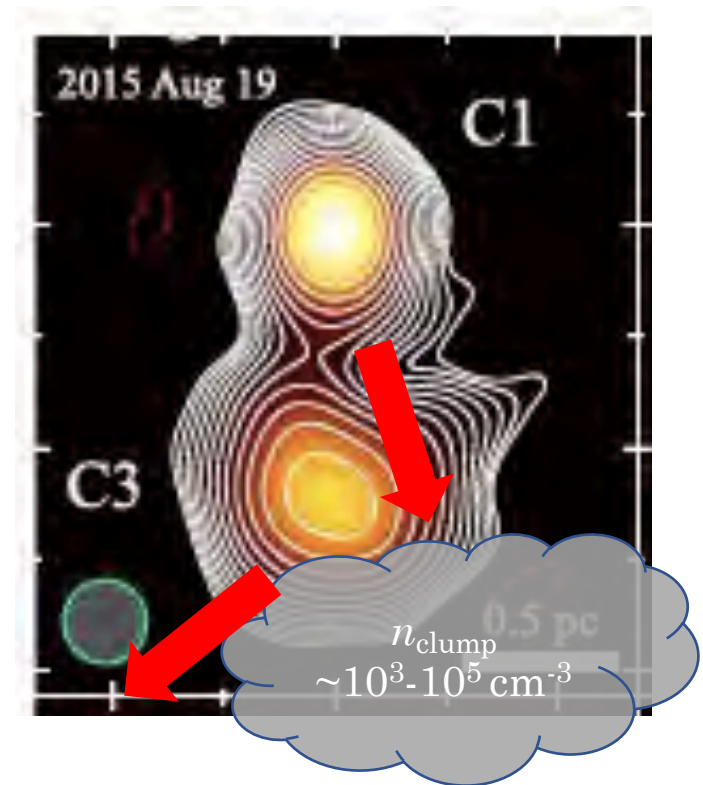
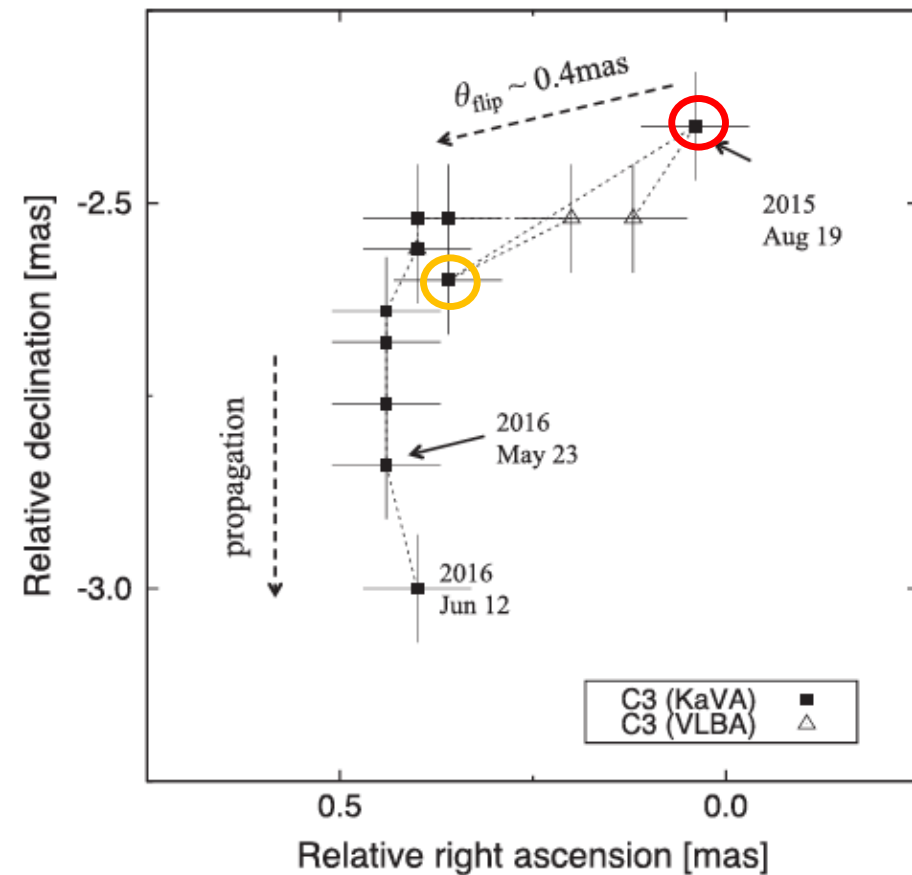
# C3: flip motion (Kino et al. 2018)

It clearly indicates a jet-clump interaction



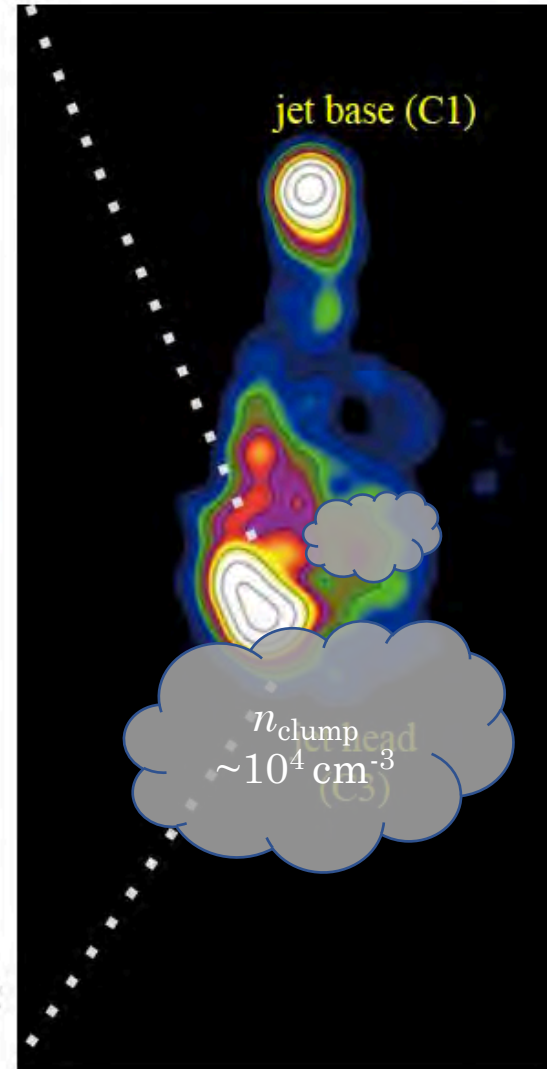
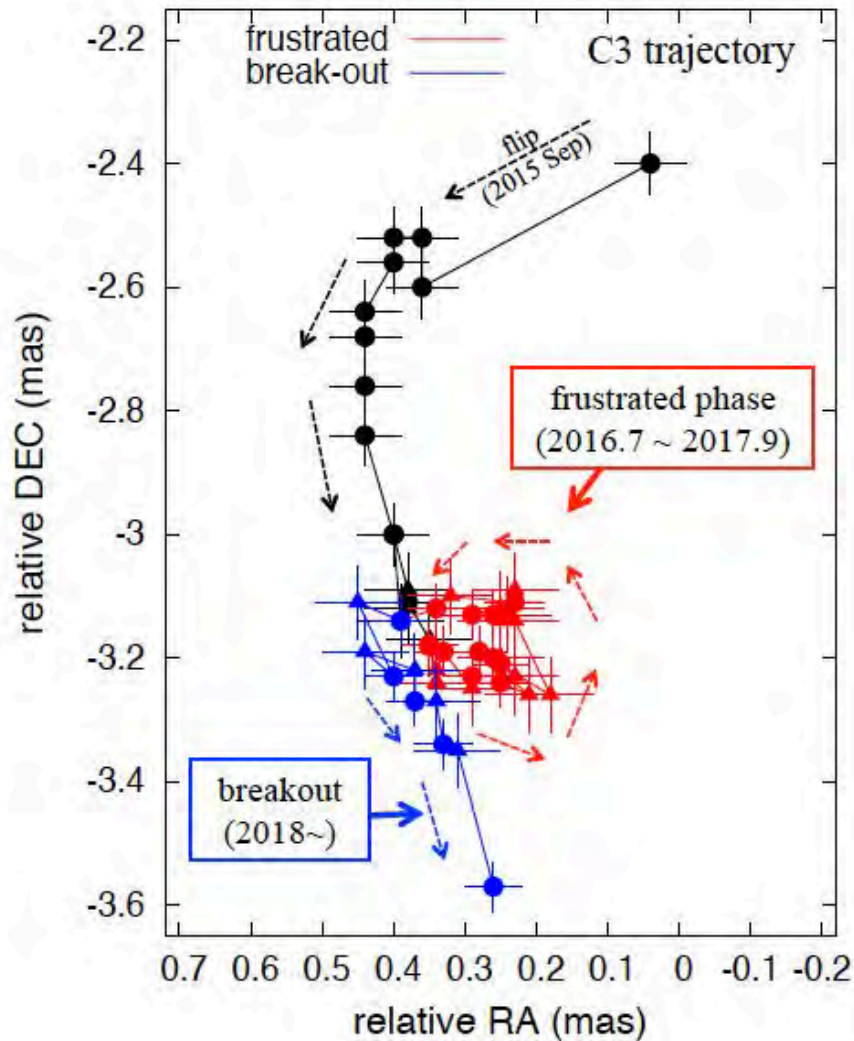
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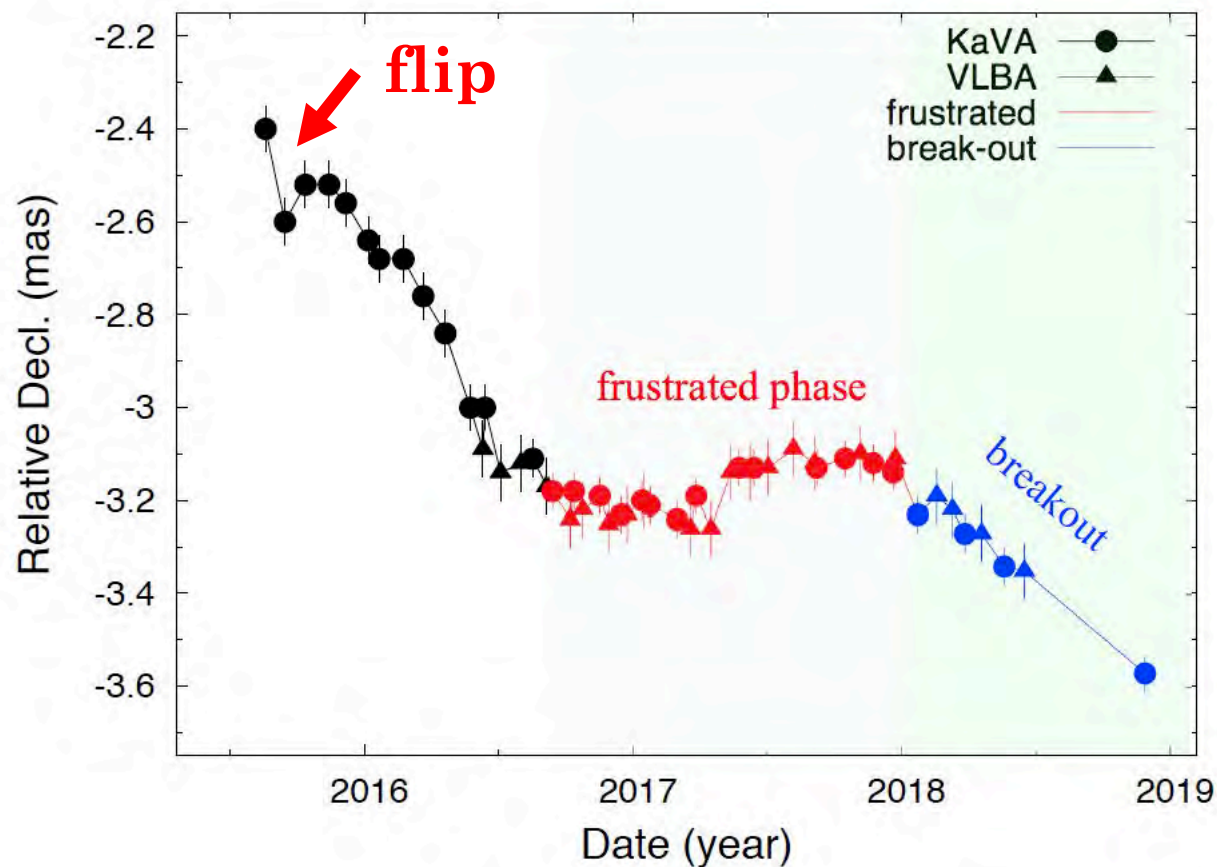


# C3: head-on collision with clump!

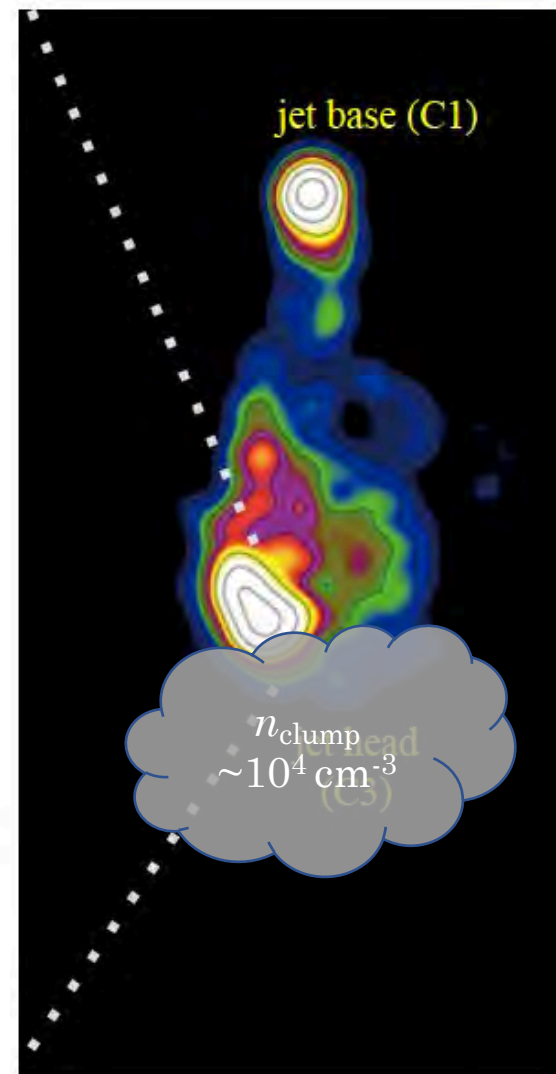
(Kino, KN, Hirano+ in prep.)



# C3: head-on collision with clump! (Kino, KN, Hirano+ in prep.)



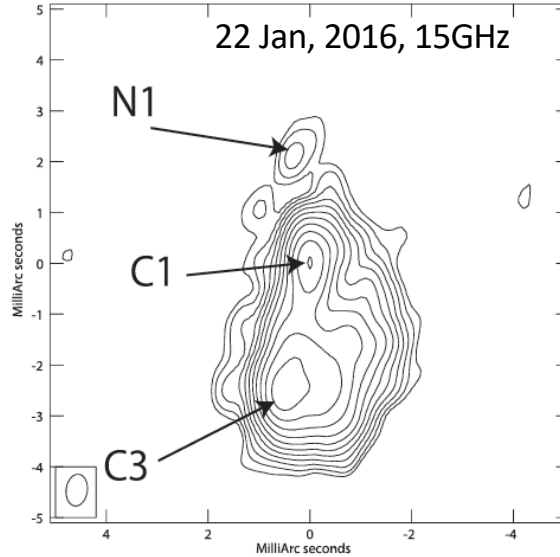
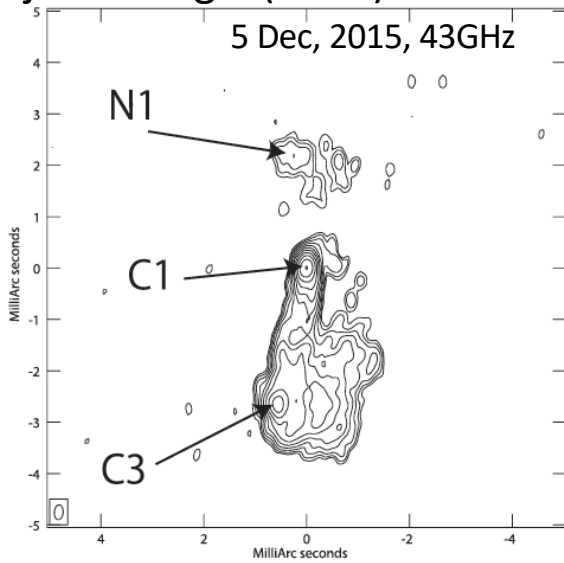
一方、2005年以降C3に対応する  
カウンタージェットは検出されていない。





# Discovery of N1 (counter jet)

Fujita & Nagai (2017)



N1: C3に対応する  
カウナージェット?

$$\alpha_N(15-43\text{GHz}) = 1.61$$

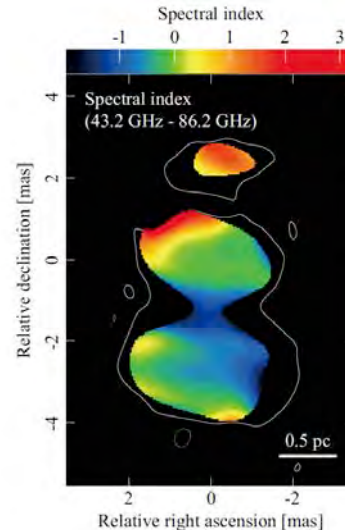
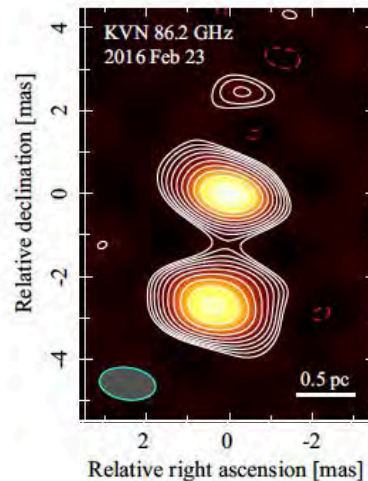
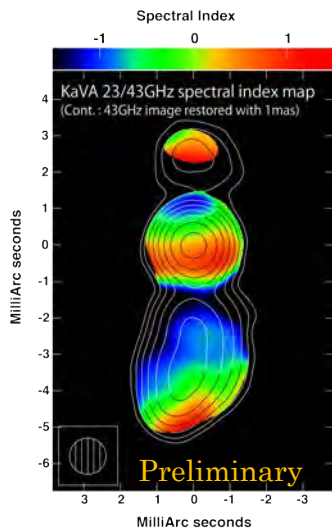
Fujita&Nagai (2017)

$$\alpha_N(23-43\text{GHz}) = \sim 1$$

(Preliminary, PI: Kino)

$$\alpha_N(43-86\text{GHz}) = 1.19$$

Wajima+ submitted



$$S \propto \nu^\alpha$$

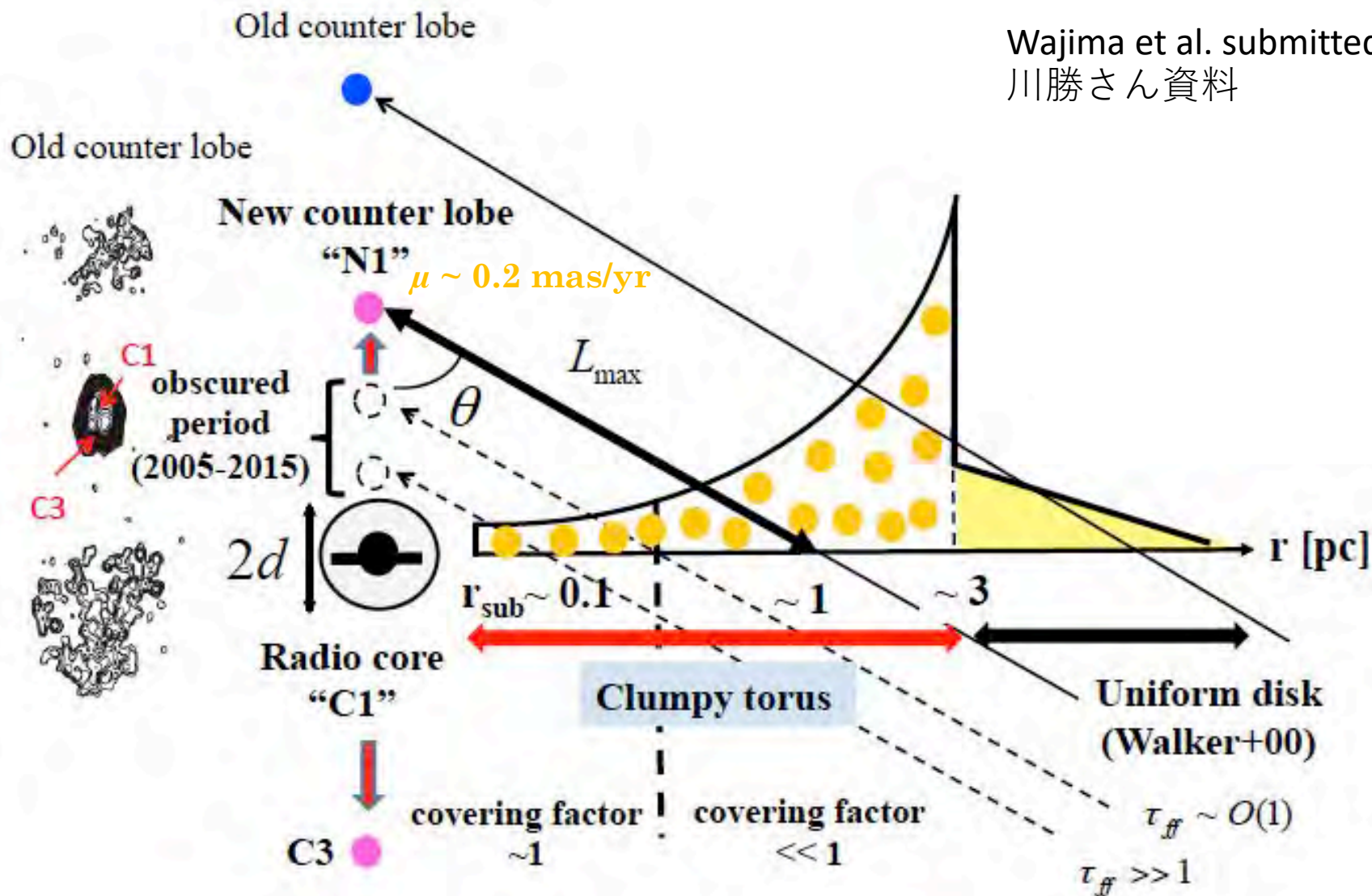


非一様遮蔽体  
によるFFA

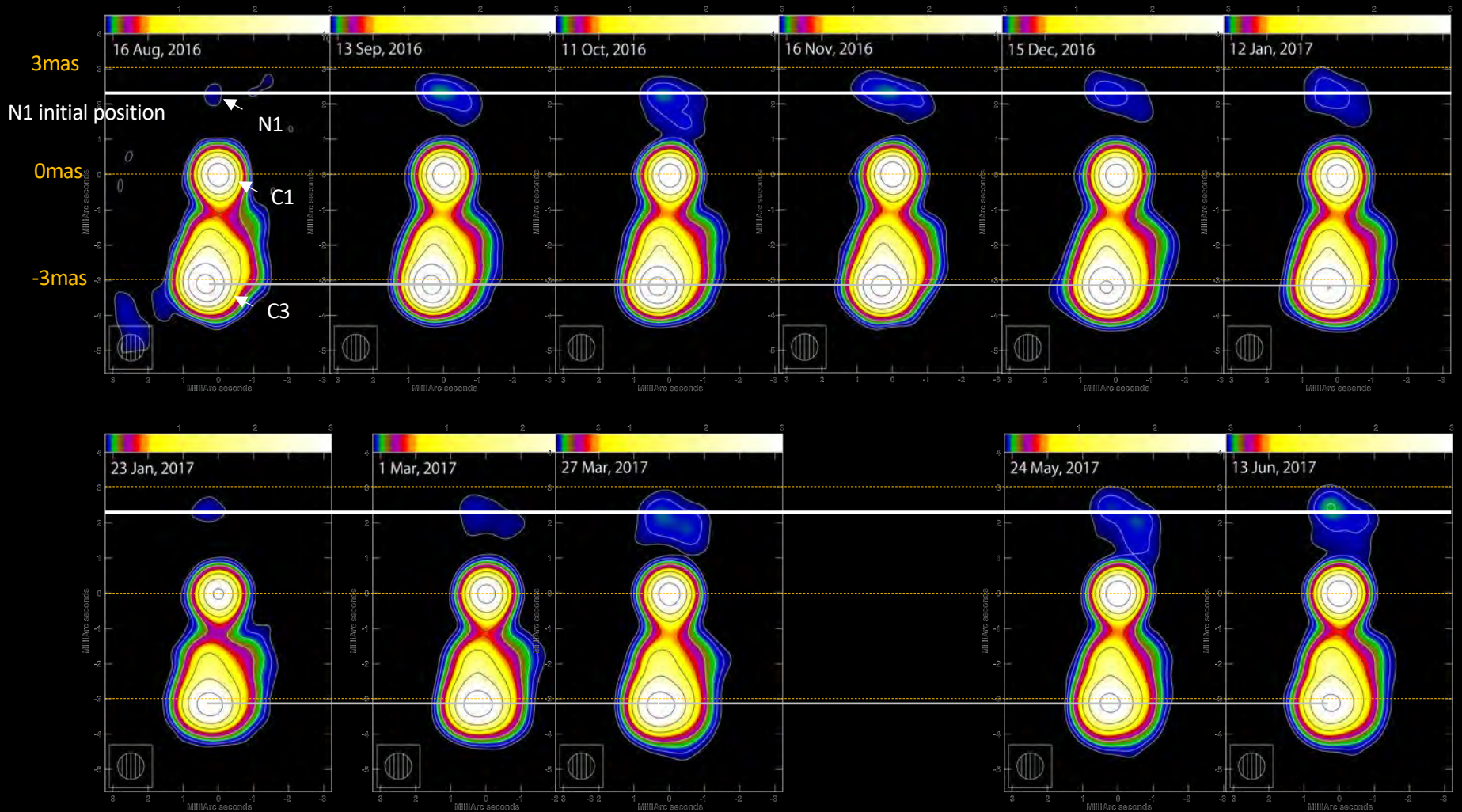
Wajima+submitted

# クランプ状トーラスによる遮蔽

Wajima et al. submitted  
川勝さん資料



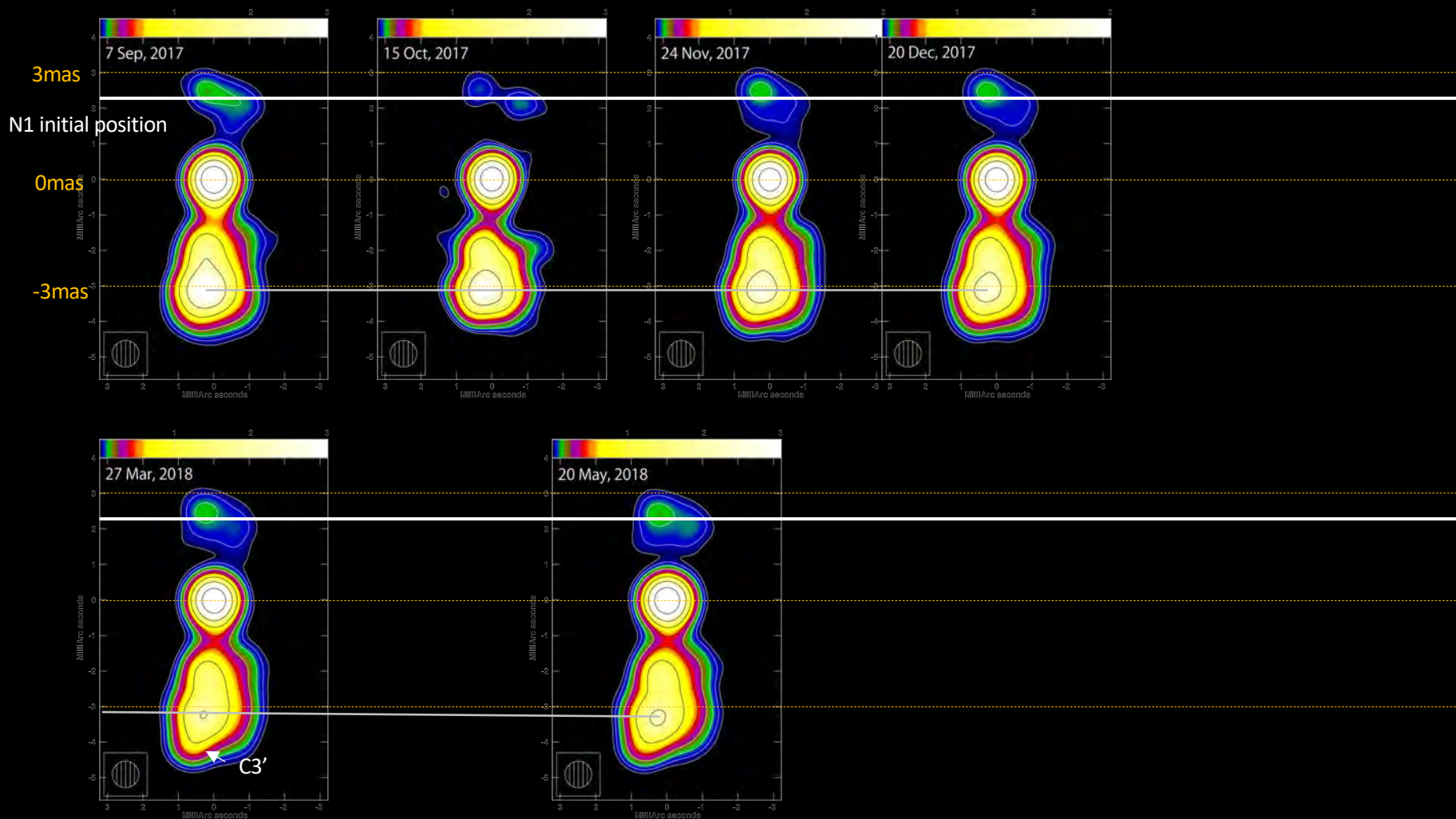
# Time variation of N1 (KN, Kino in prep)



KaVA 43 GHz images restored with 0.75mas circular gaussian (cont. : 0.03Jy/b x 1,2,..., color: 0.03 - 3 Jy/b)



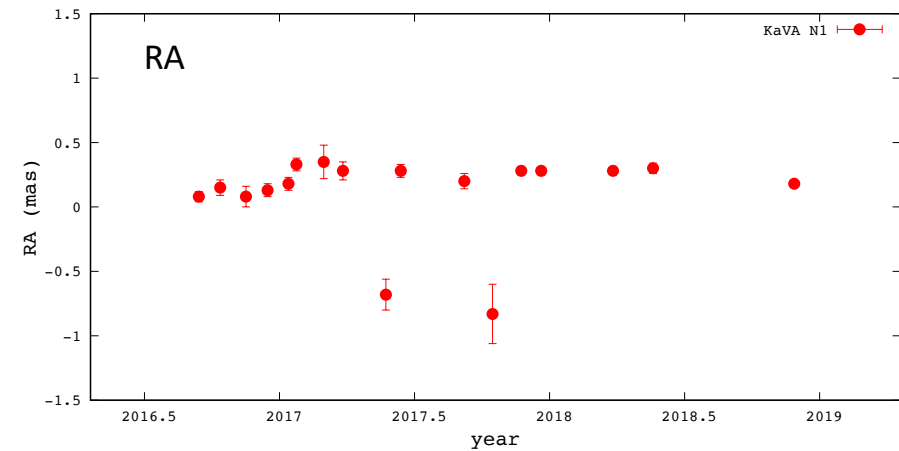
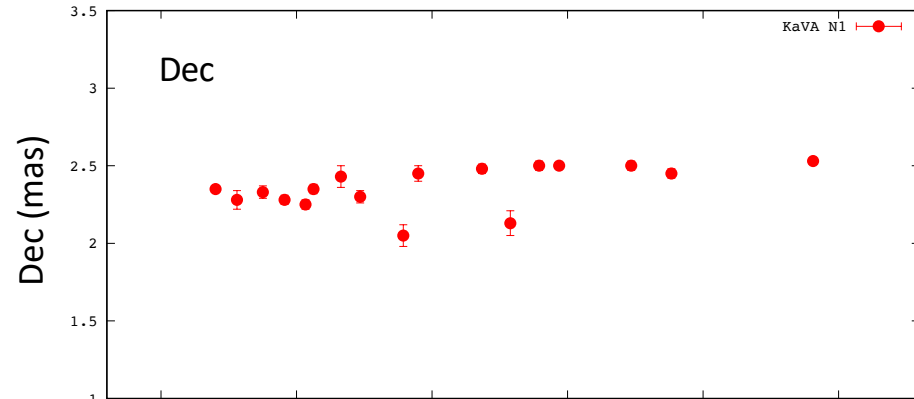
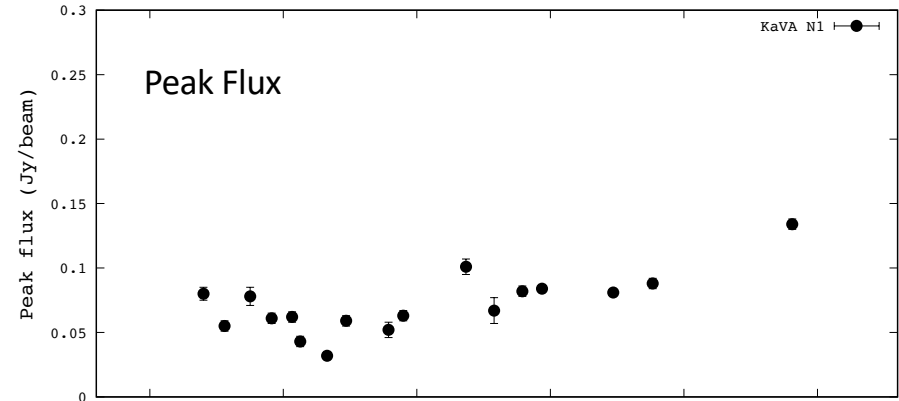
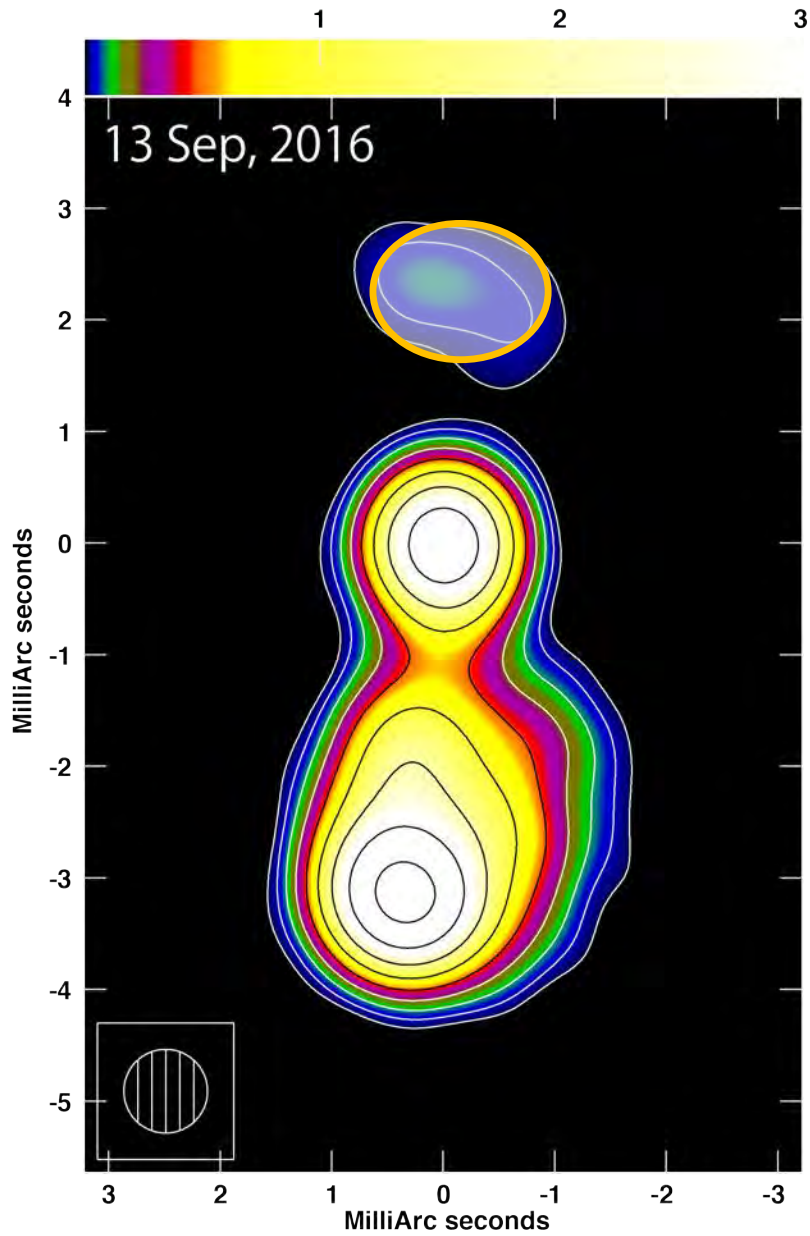
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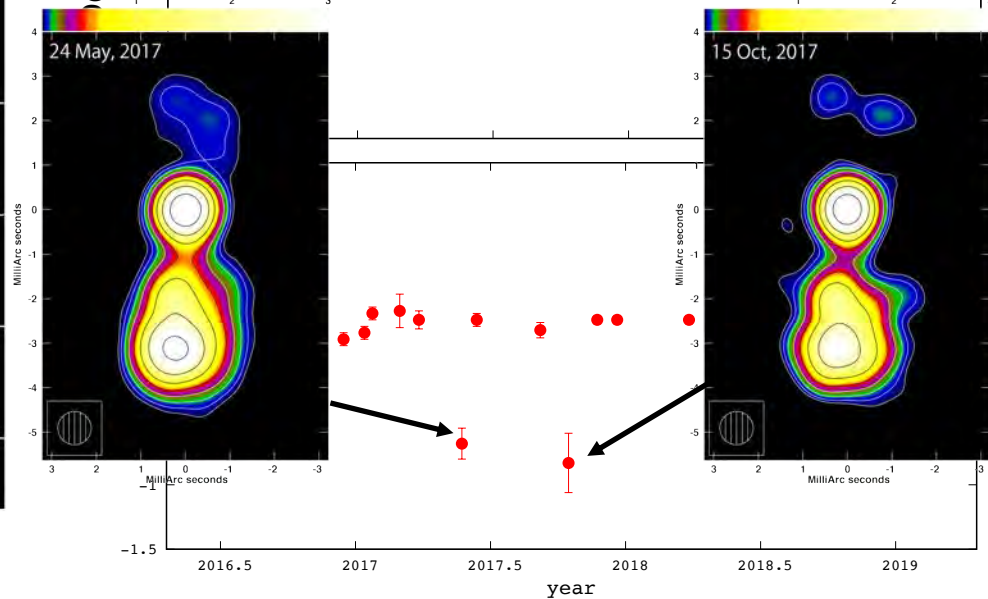
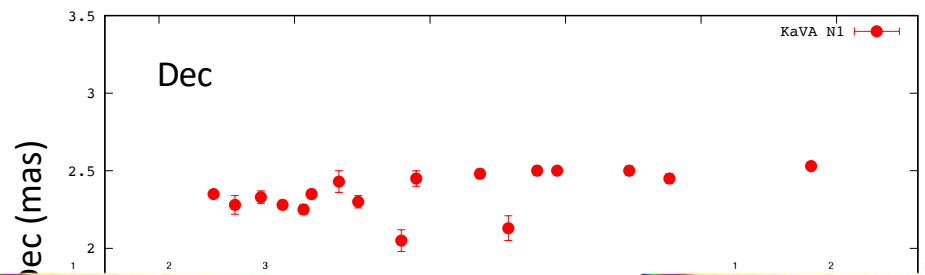
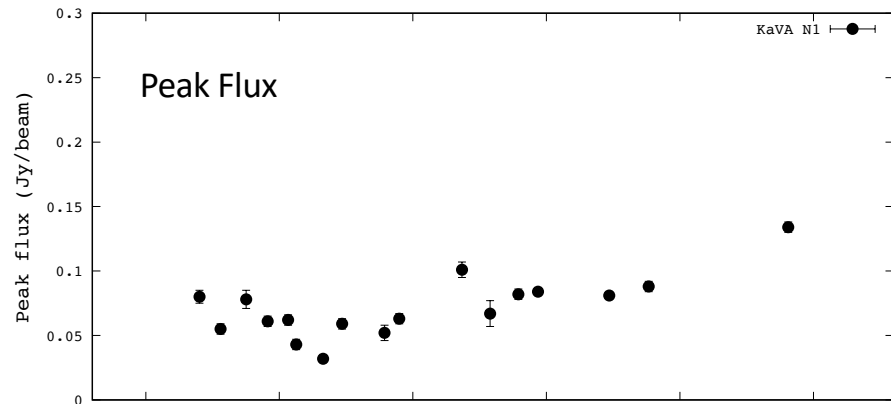
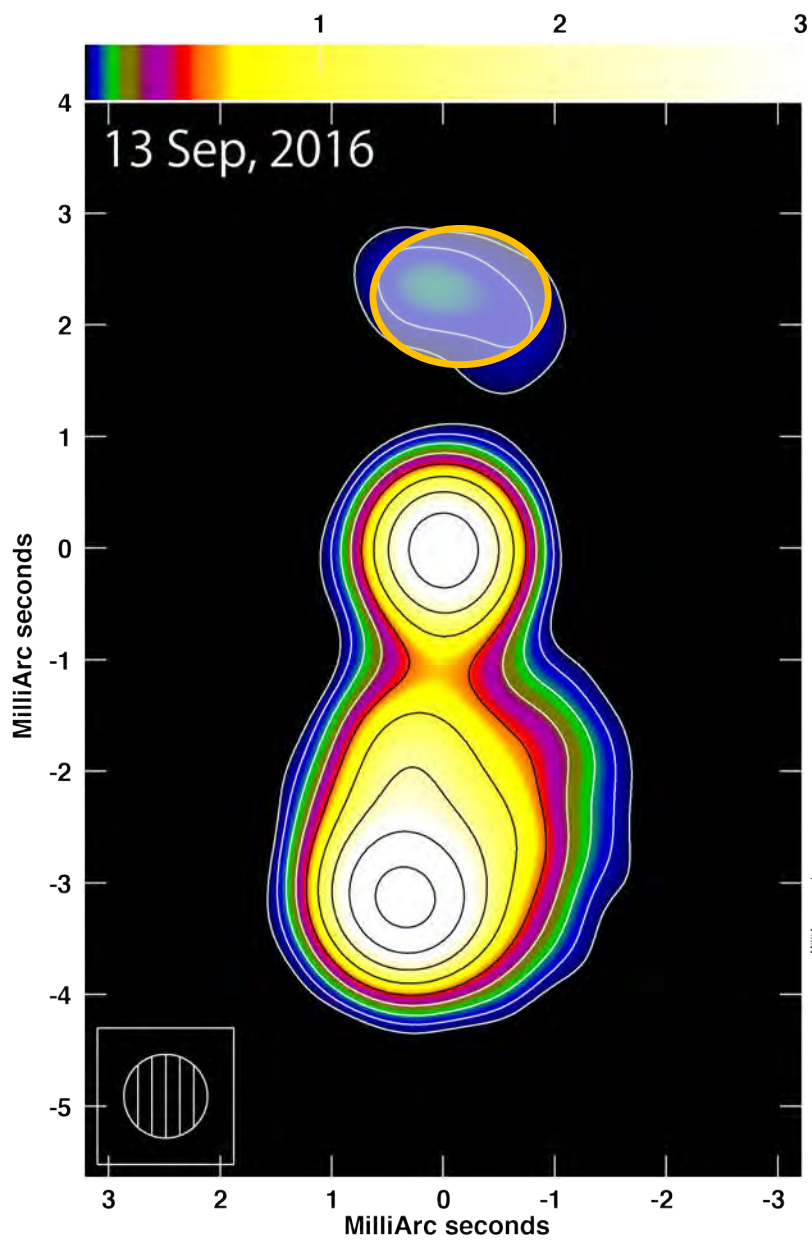
KaVA 43 GHz images restored with 0.75mas circular gaussian (cont. : 0.03Jy/b x 1,2,..., color: 0.03 - 3 Jy/b)



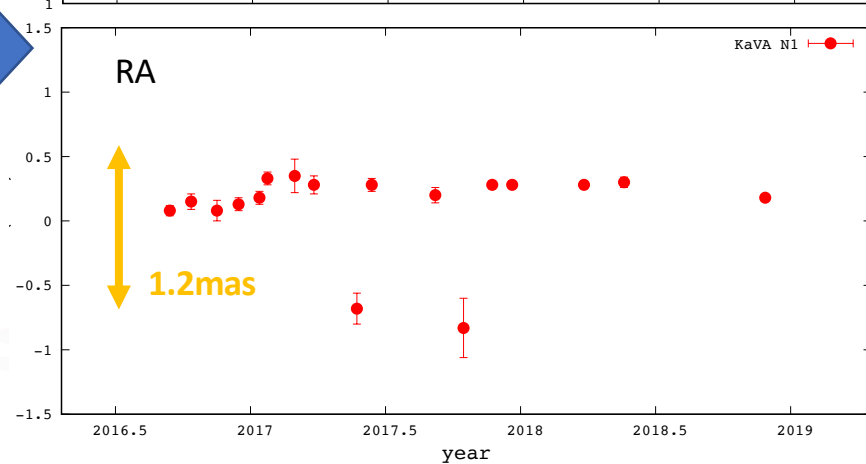
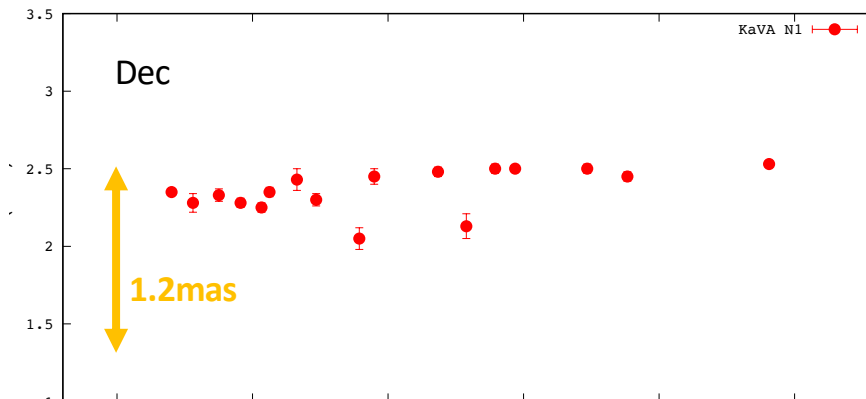
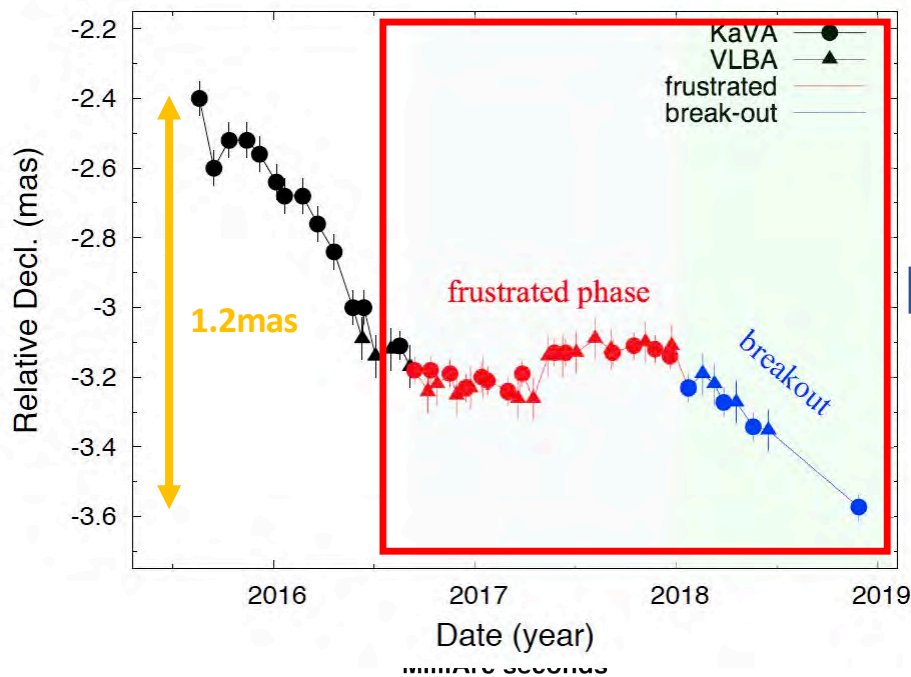
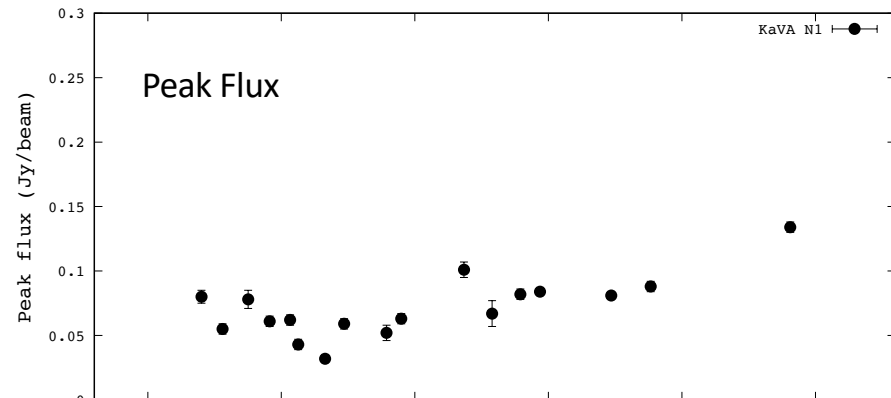
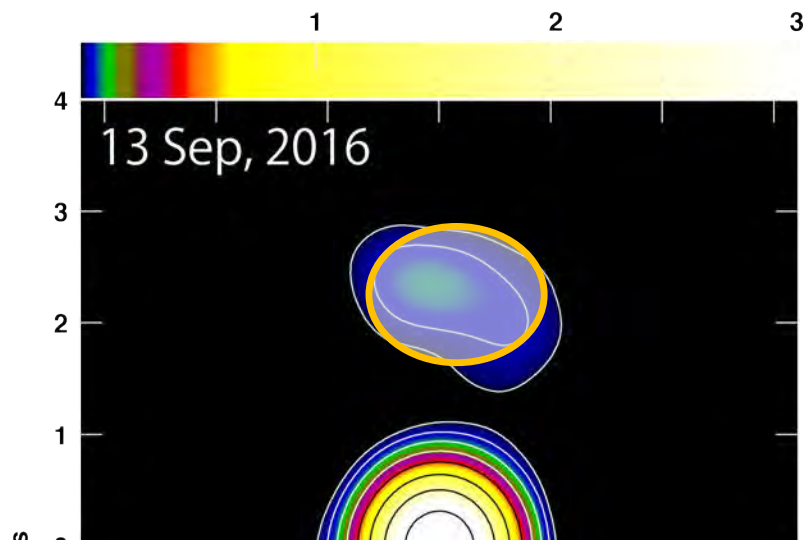
# AIPS JMFIT (画像上で model fit)



# AIPS JMFIT (画像上でfit→1成分fitのみ)

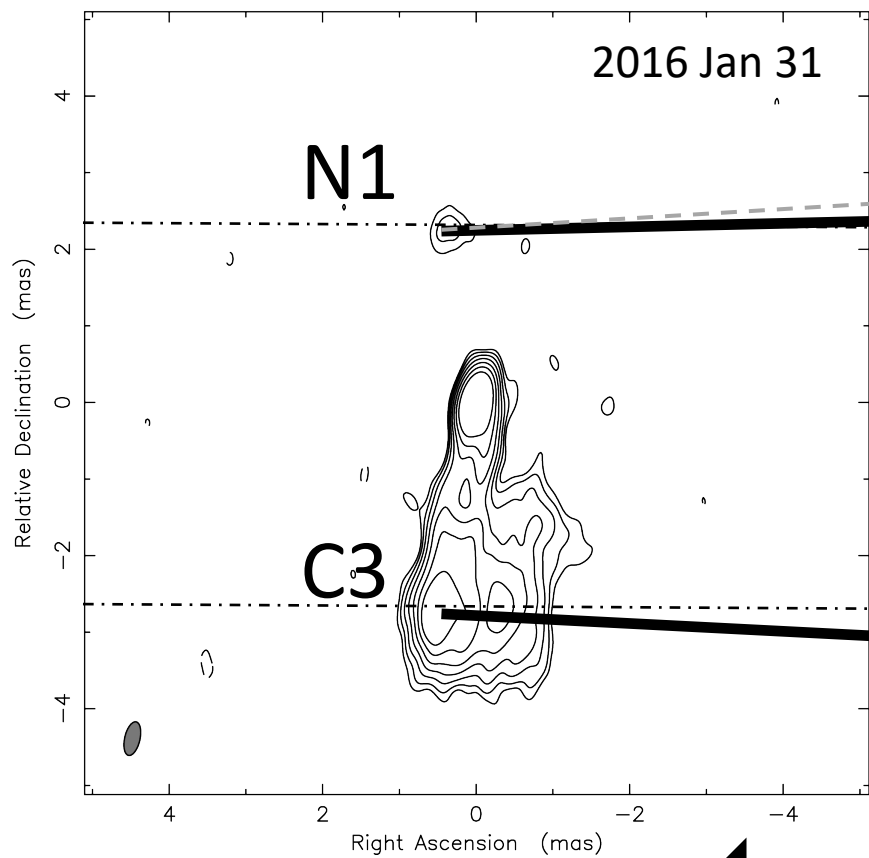


# AIPS JMFIT (画像上でfit→1成分fitのみ)

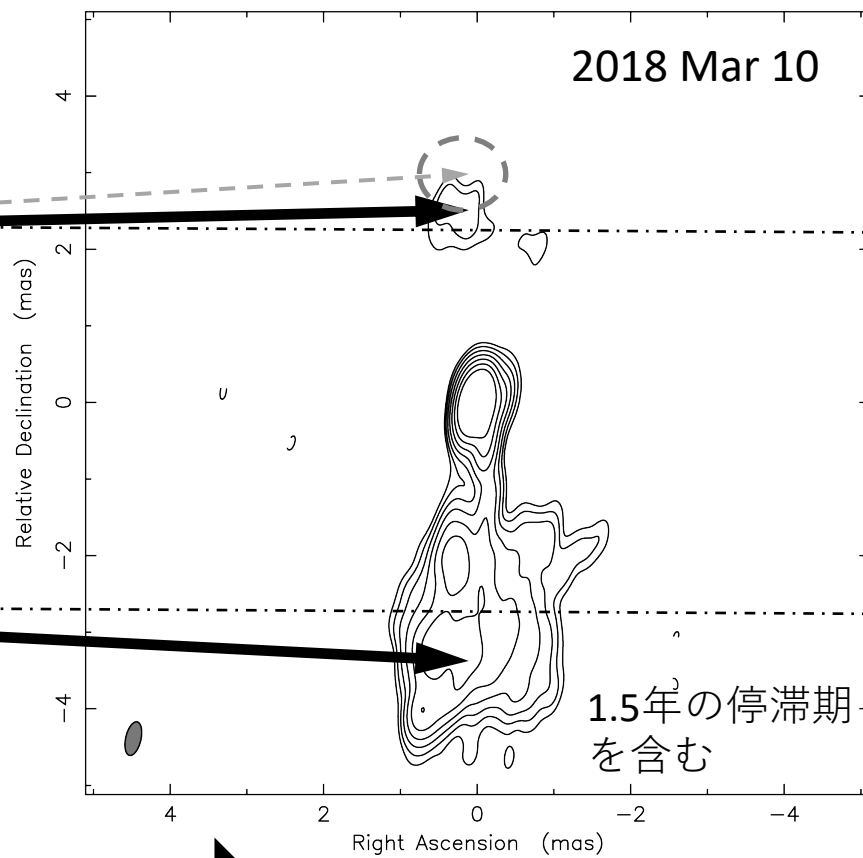


# VLBA@43GHz

Clean I map. Array: BFHKLMNOPS  
3C84 at 43.115 GHz 2016 Jan 31



Clean I map. Array: BFHKLMNOP  
3C84 at 43.115 GHz 2018 Mar 10

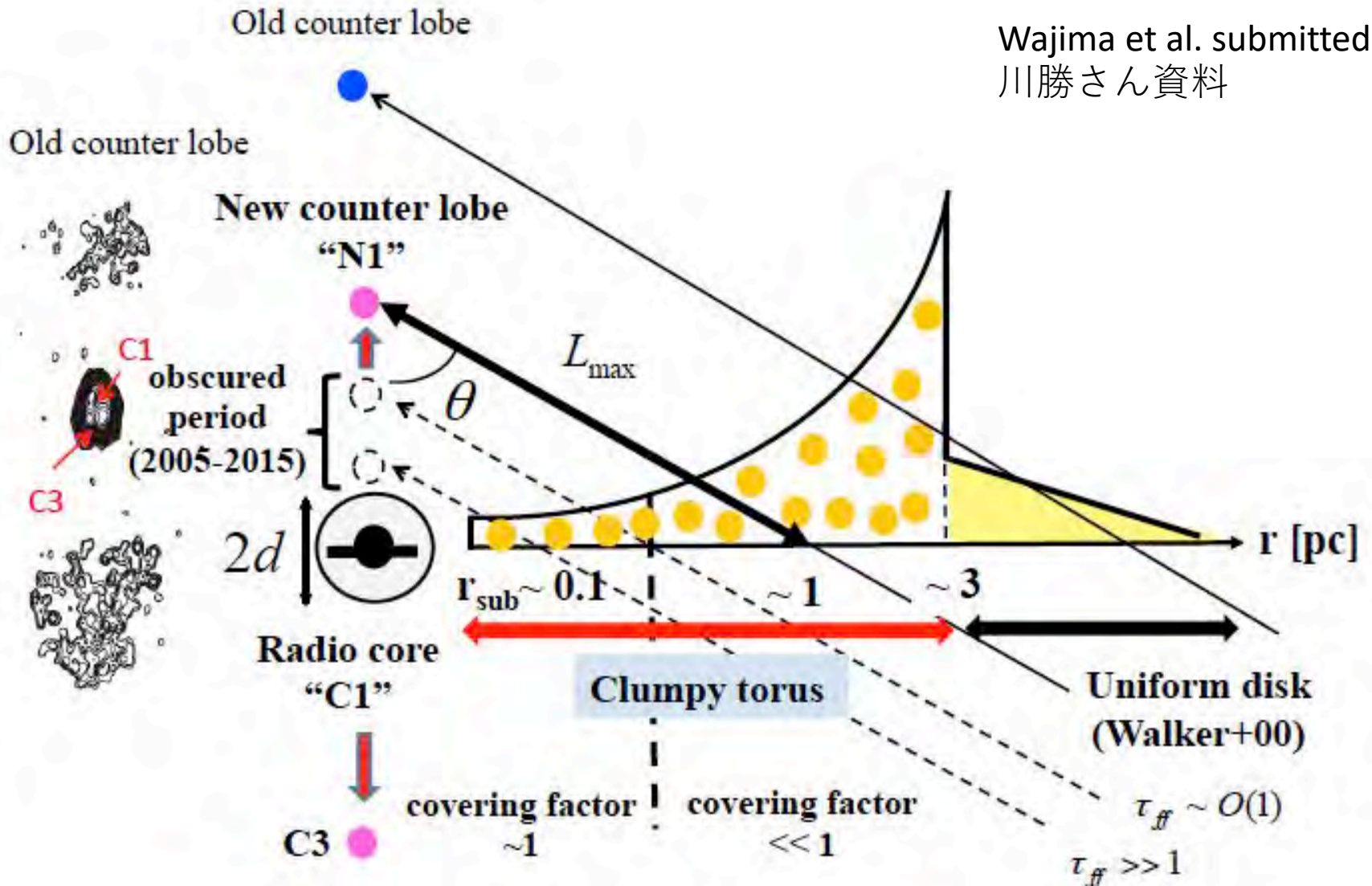


25.5ヶ月間



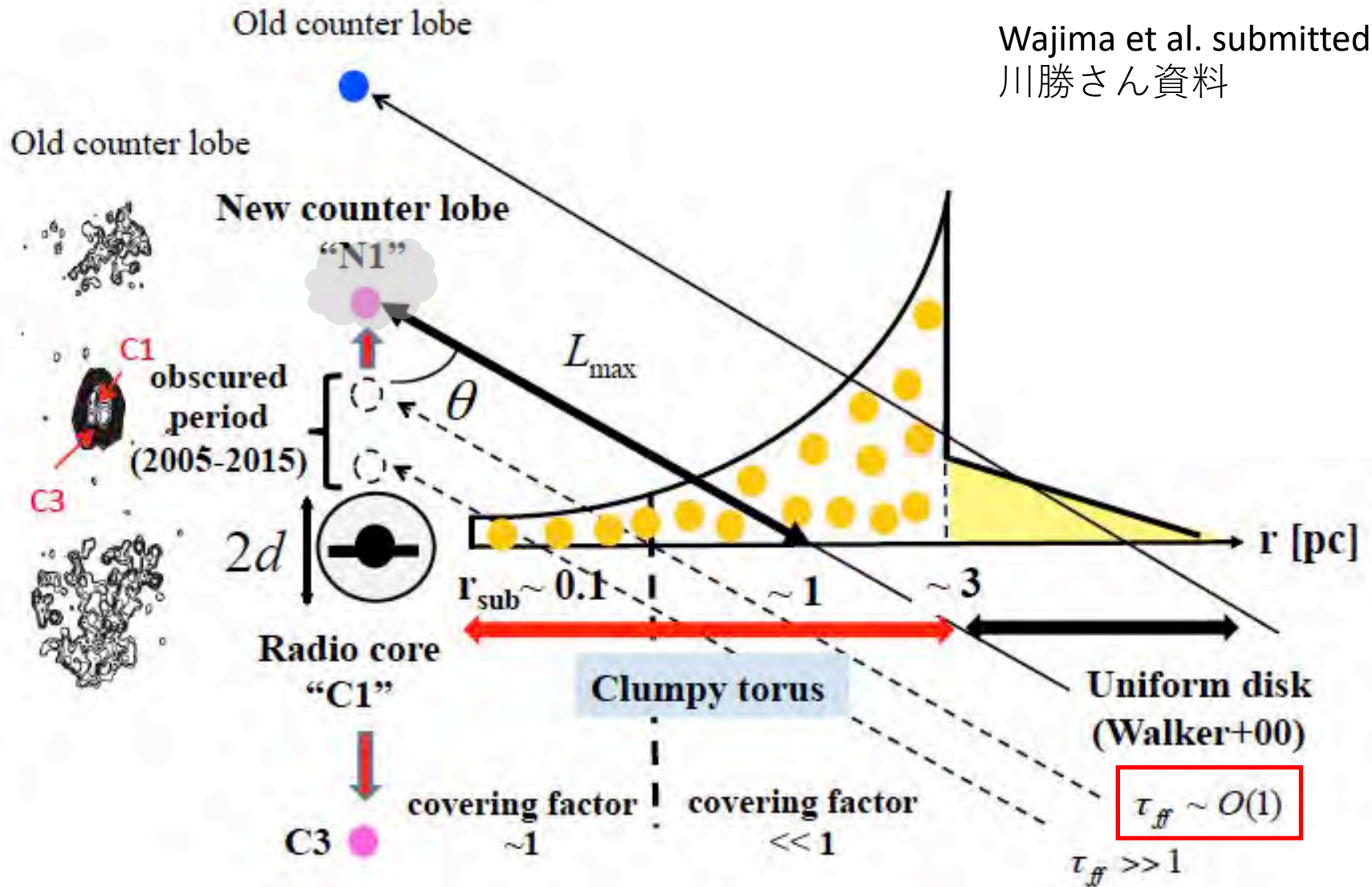
# クラump状トーラスによる遮蔽

Wajima et al. submitted  
川勝さん資料



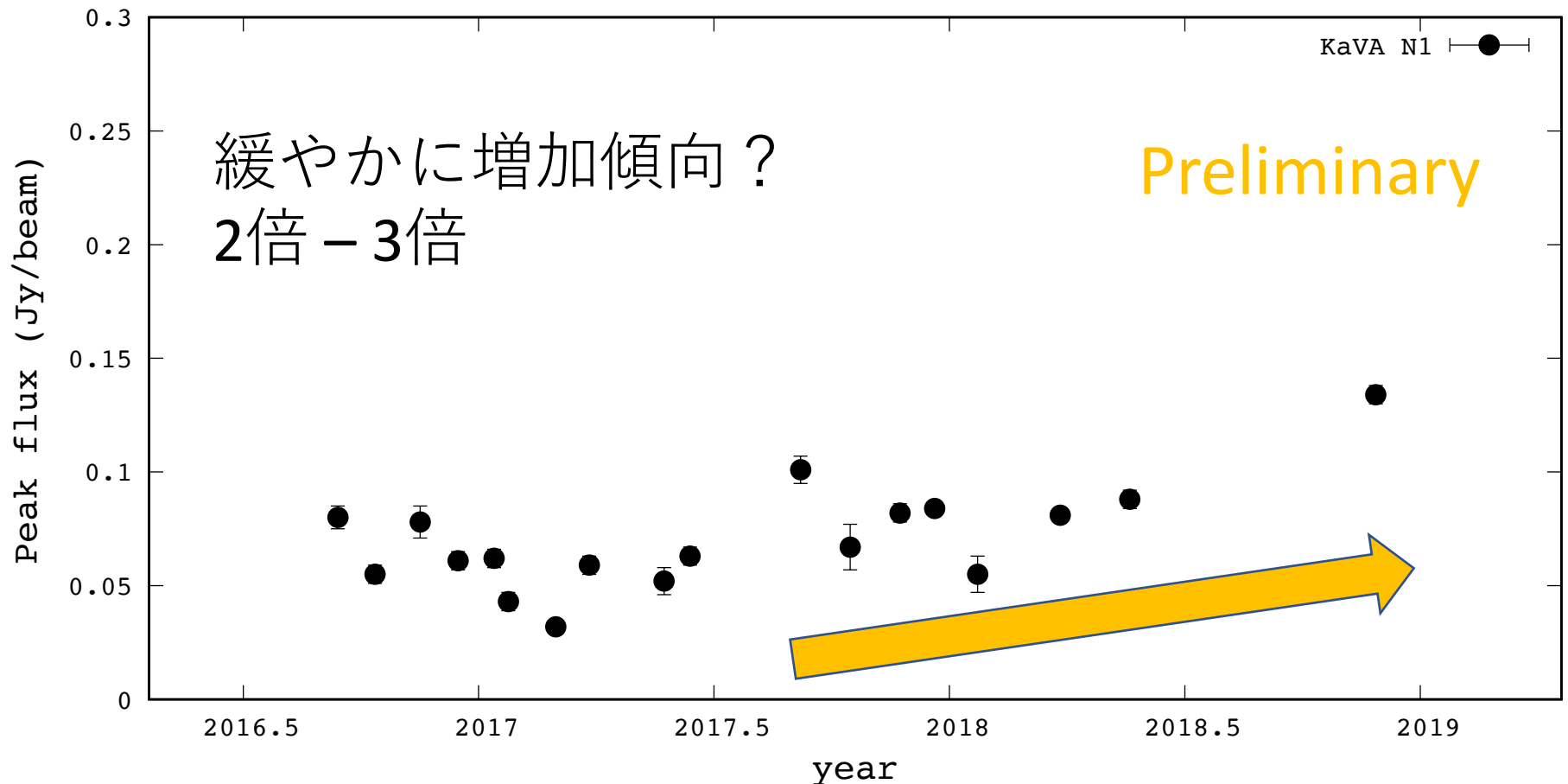
# クランプ状トーラスによる遮蔽

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川勝さん資料



# Time variation of N1

(KN, Kino in prep)

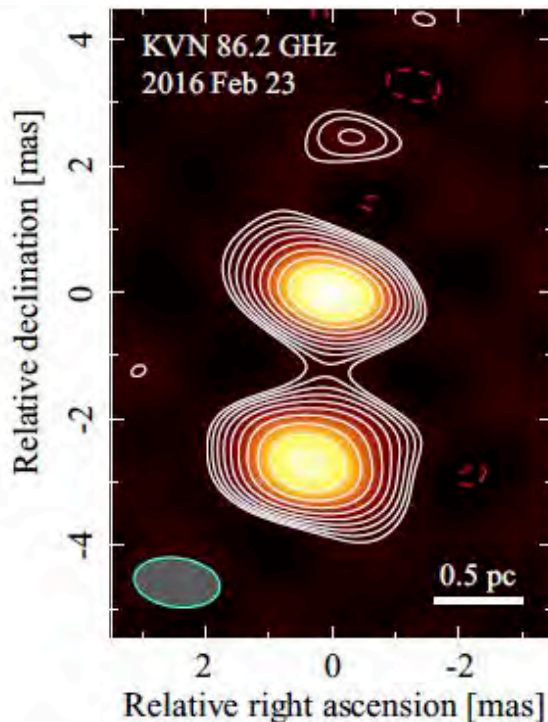


北上しながらクランプ状の吸収体から抜けつつある？

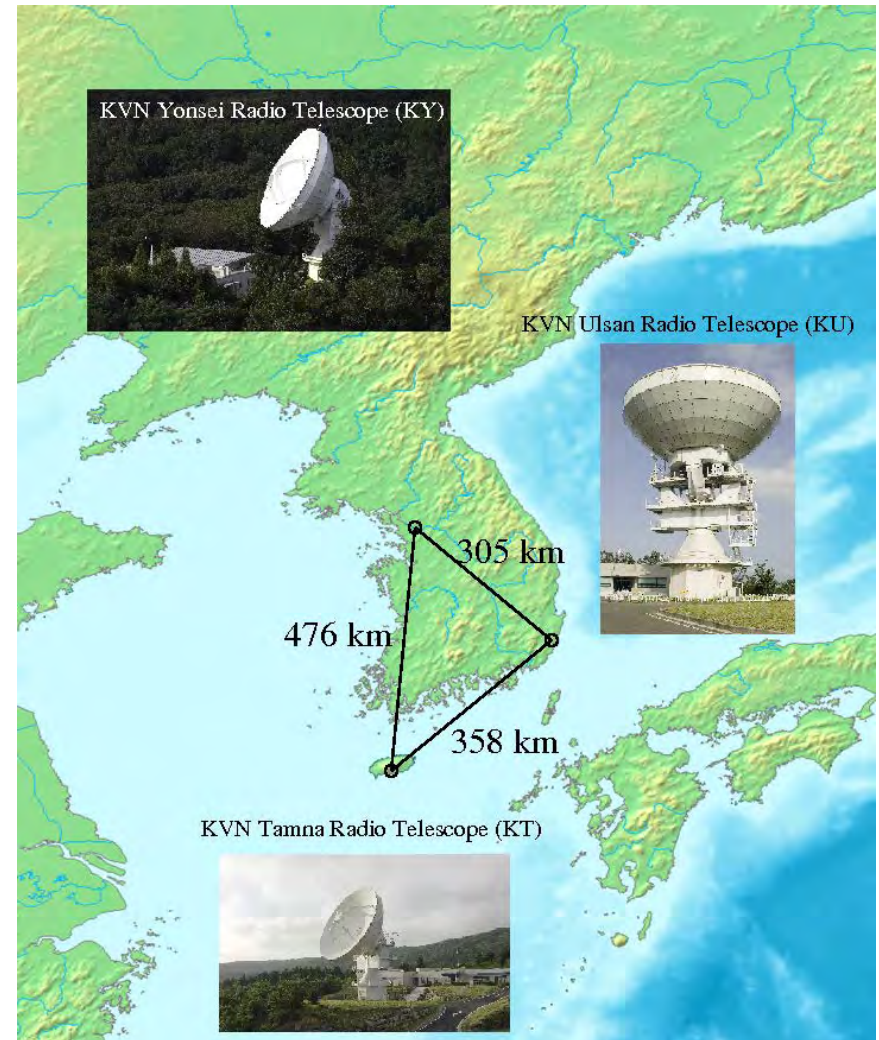


# 2-7mm VLBI w/ Korean VLBI Network Probing physical property of FFA

- Multi-epoch obs.@43-129GHzを2020Aへ提案
  - $\theta \sim 1.5 \text{ mas}@86\text{GHz}$
  - $\theta \sim 1 \text{ mas}@129\text{GHz}$



Wajima et al.  
submitted





# まとめ

- 3C84のサブパーセクスケールの運動がVLBIによって明らかに
- 2015年以降C3は複雑な運動を示しながら有意に南下（紀さん）、N1は2015年末に初めて検出（永井さん、輪島さん）
- C3, N1の振る舞い→非一様な遮蔽体（Clumpy torus）の存在を示唆（川勝さん、Fujita&Nagai 2017; Wajima+ submitted）  
→VLBIによる観測で初めて検出
- 引き続きのモニターが必要
  - 2015以降、N1の運動も停滞気味→ジェット進行方向に（C3と同じように）クランプ？ by e.g., BU@43GHz
  - N1は本当にC3のカウンターパート？光学的厚みの周波数依存性は？ By KVN@2-7mm