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Fermi-LAT detection of the CSO NGC 4278 during the LHAASO campaign

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on behalf of the Fermi-LAT collaboration

E. Torresi, P. Grandi, S. Buson

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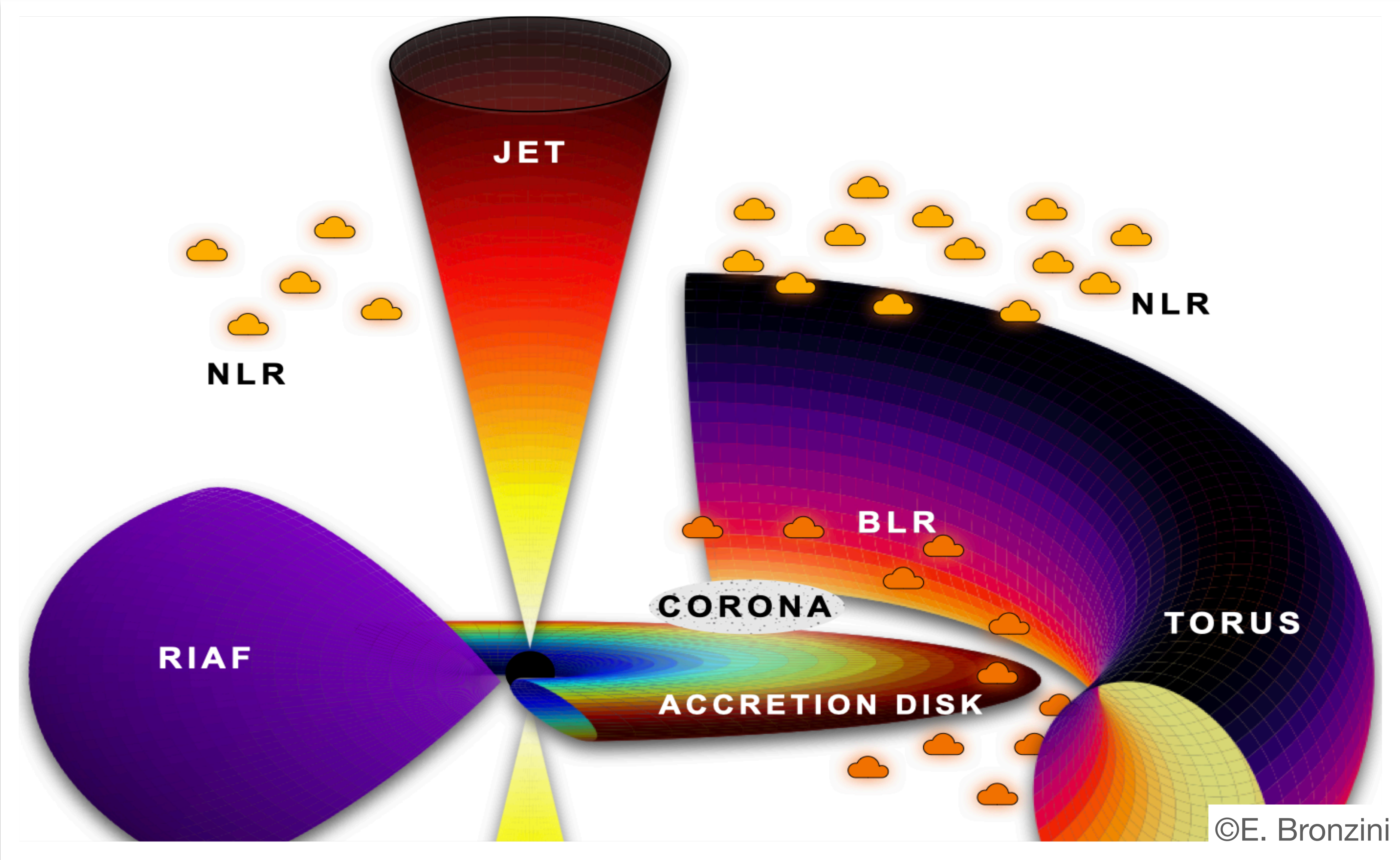
Outline

- Introduction to RL AGN
- NGC 4278
  - LHAASO results
  - *Fermi*-LAT results
- Conclusions and future prospects

Introduction to RL AGN

According to Unification Models (Antonucci93, Urry&Padovani+95), jetted AGN are split into two main classes **on the base of the jet angle**



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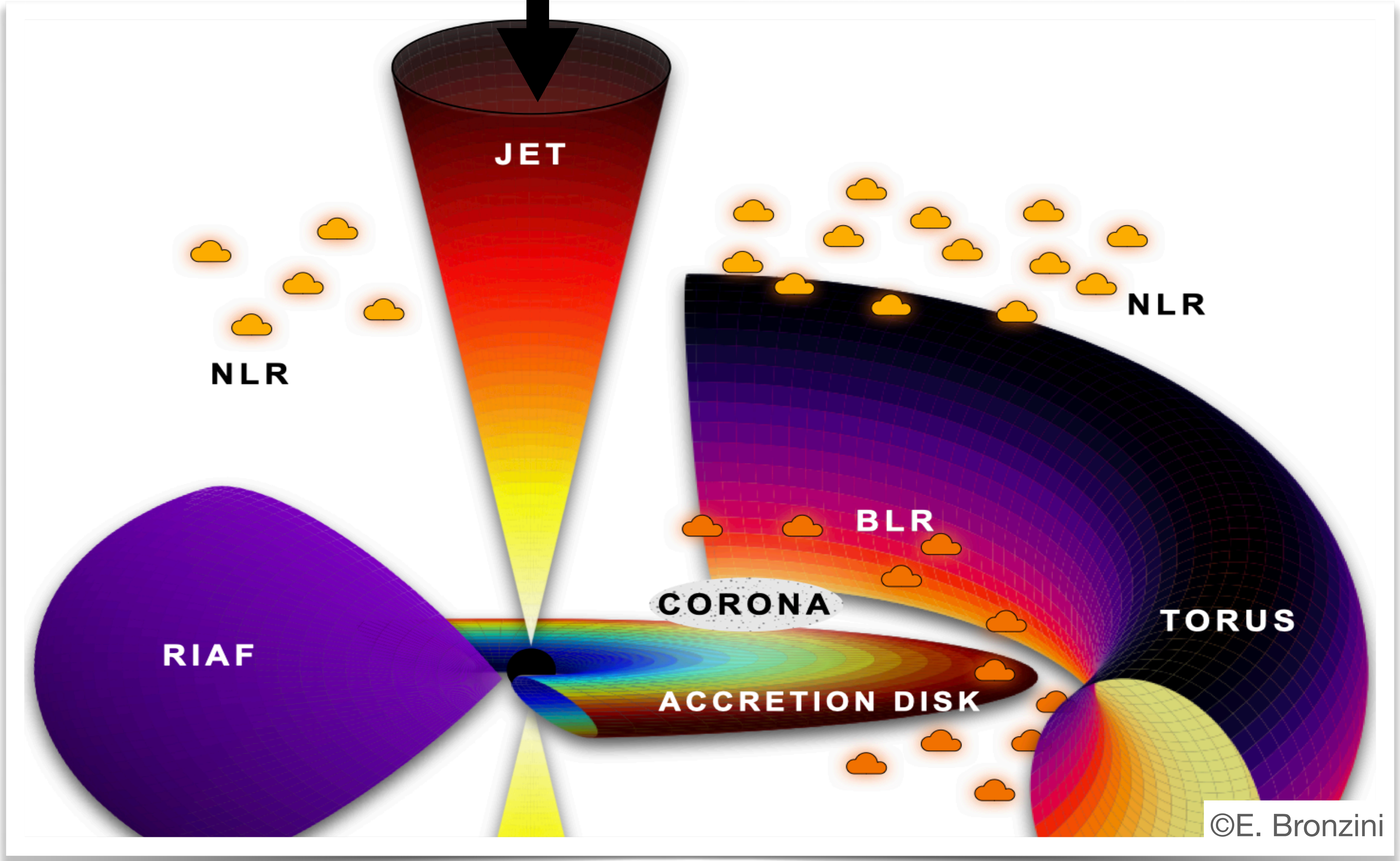
BLAZARS



Introduction to RL AGN

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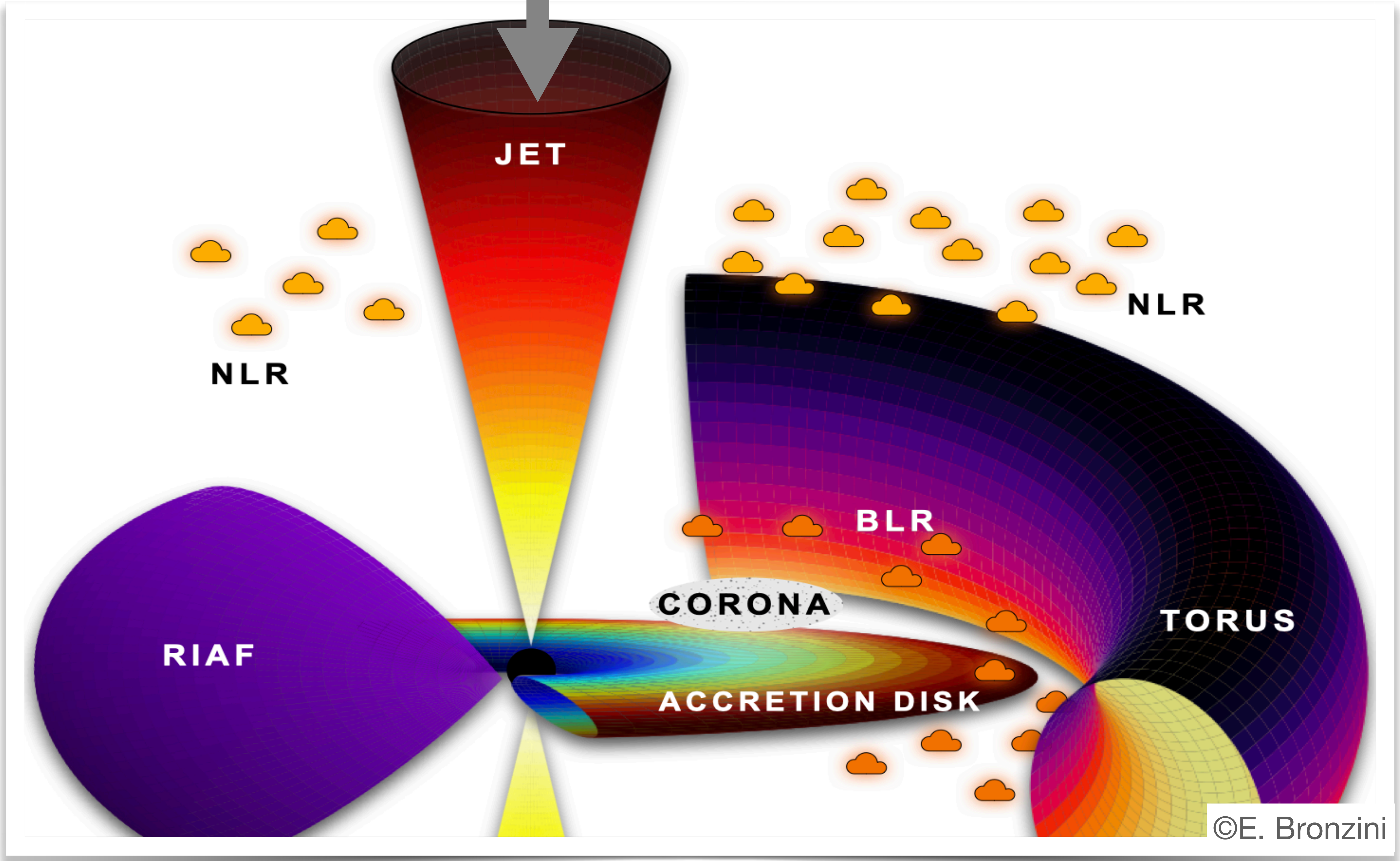
BLAZARS

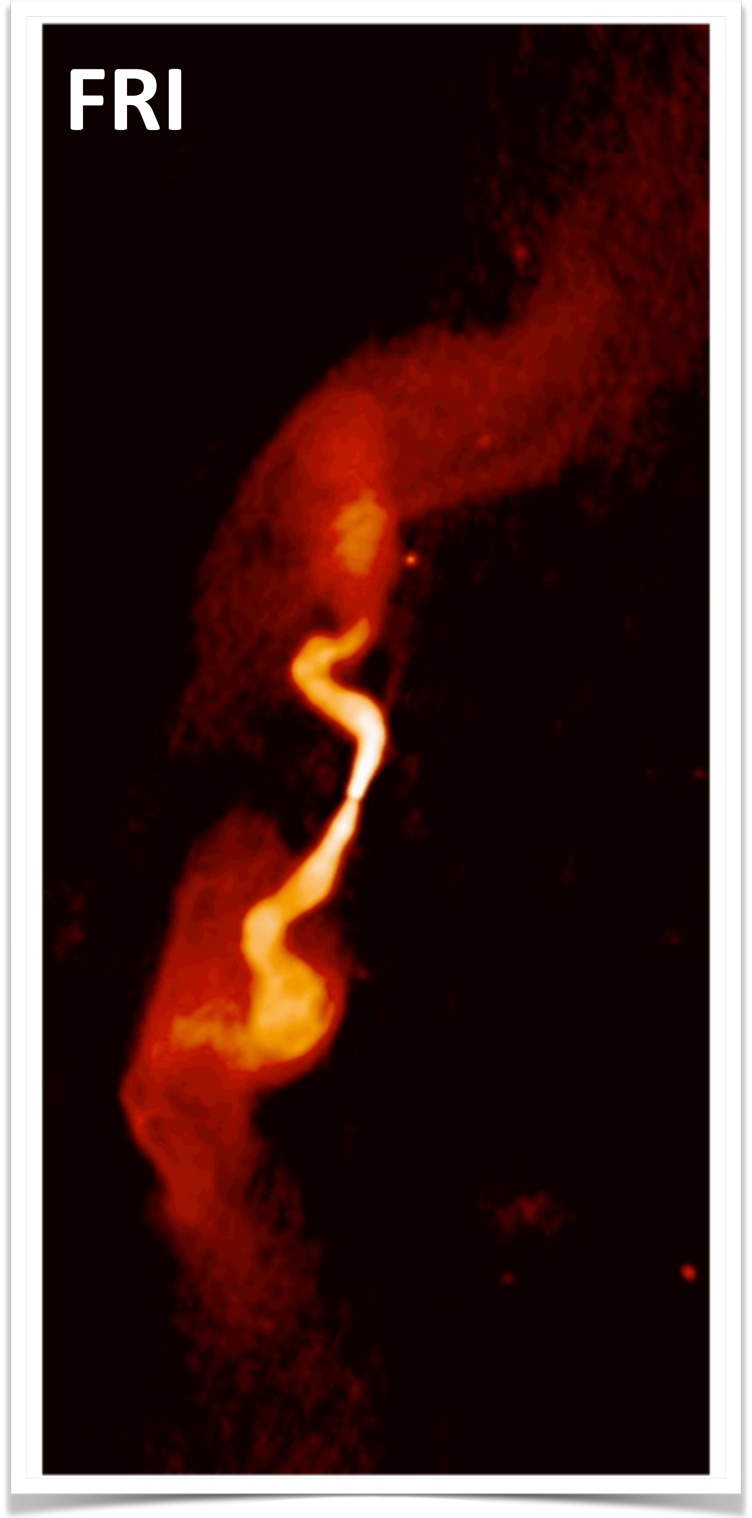
RADIO GALAXIES

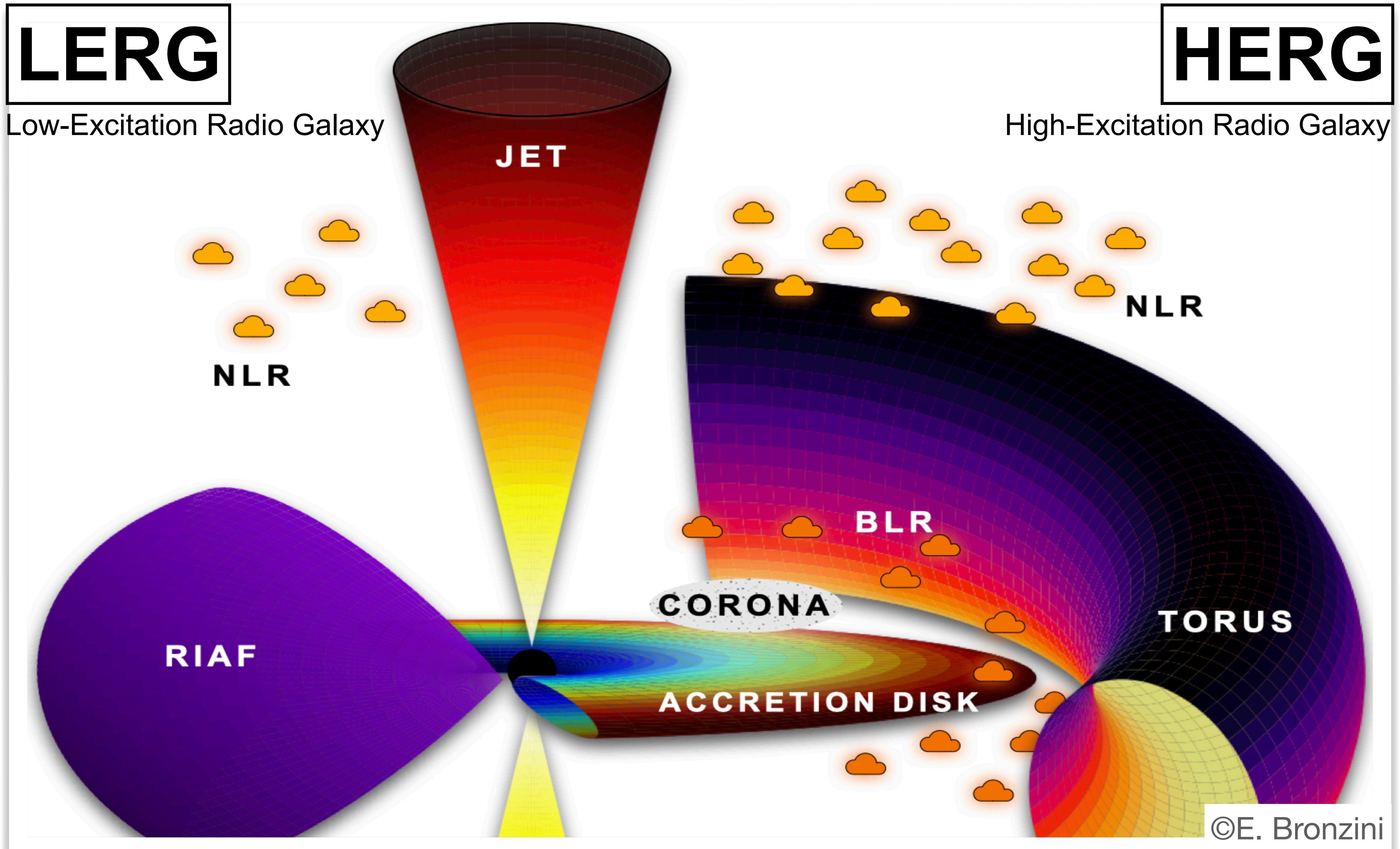


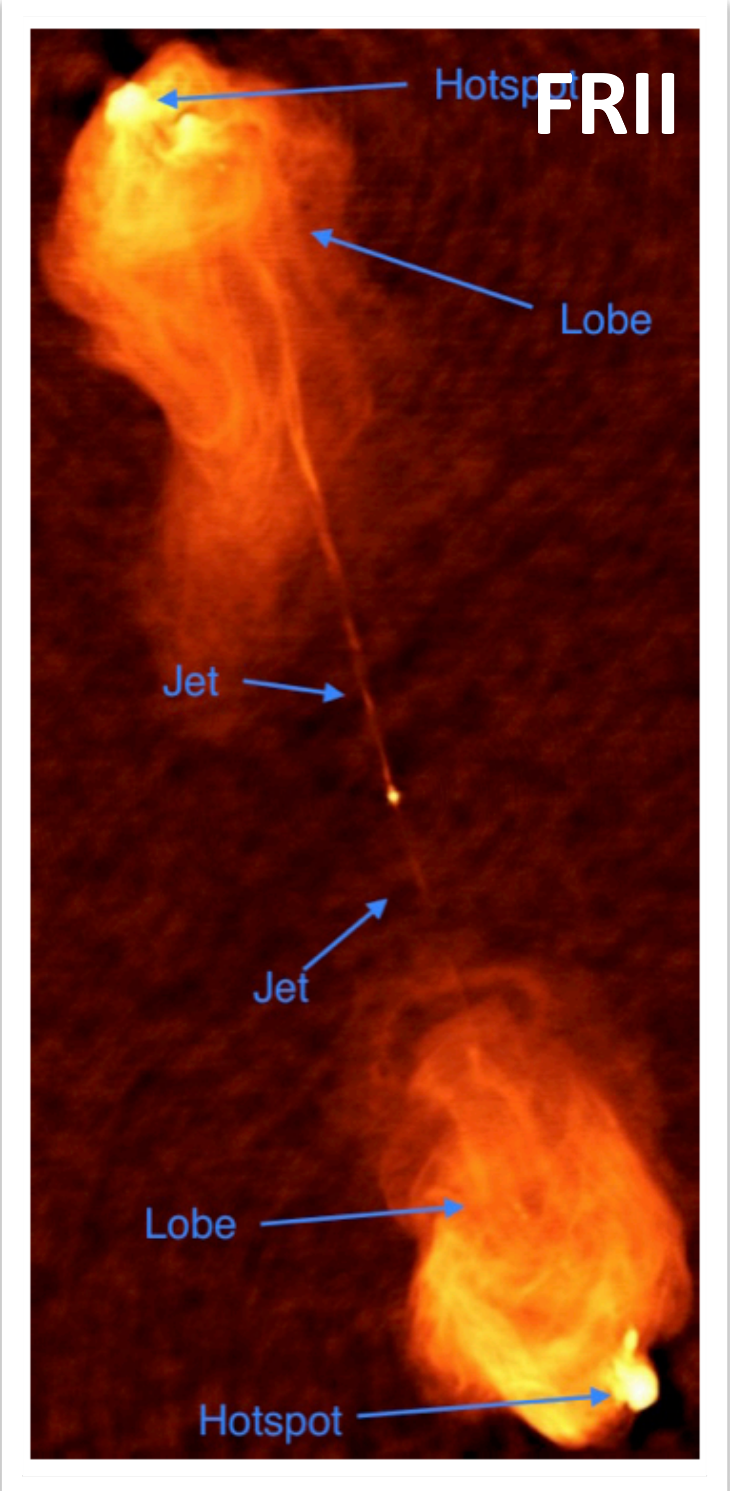
RADIO GALAXIES

Introduction to RL AGN

Different excitation modes of the gas in the Narrow Line Region (NLR) reflect different accretion flow configurations (Jackson&Rawlings+97)

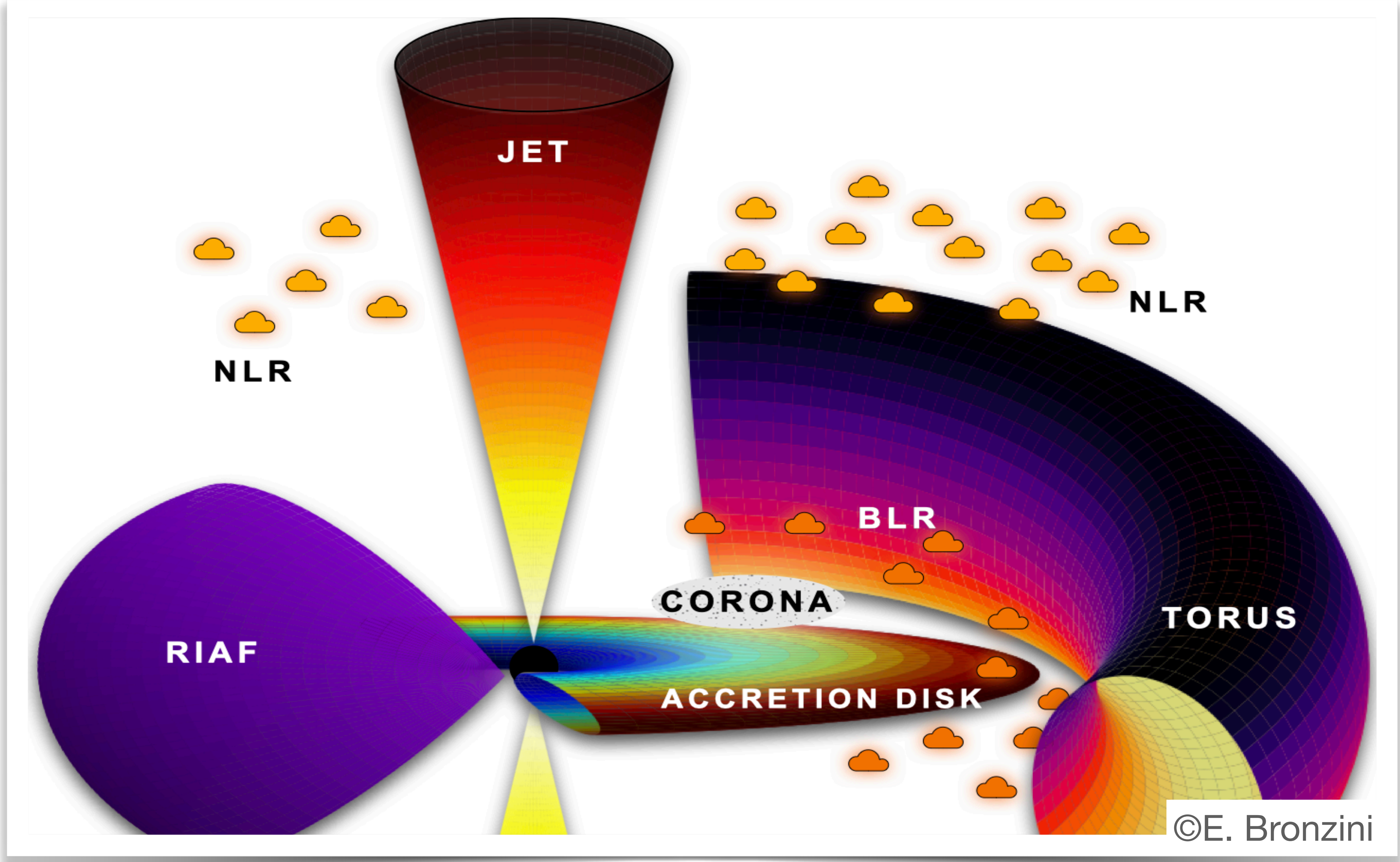






Why studying RL AGN

- In **blazars**, the overall emission is overwhelmed by the jet, due to strong beaming effects —> **very bright** at very high-energies (easier to detect at GeV-TeV energies)
- In **radio galaxies**, the jet emission is less amplified:
  - Cons: more difficult to detect at very high-energies



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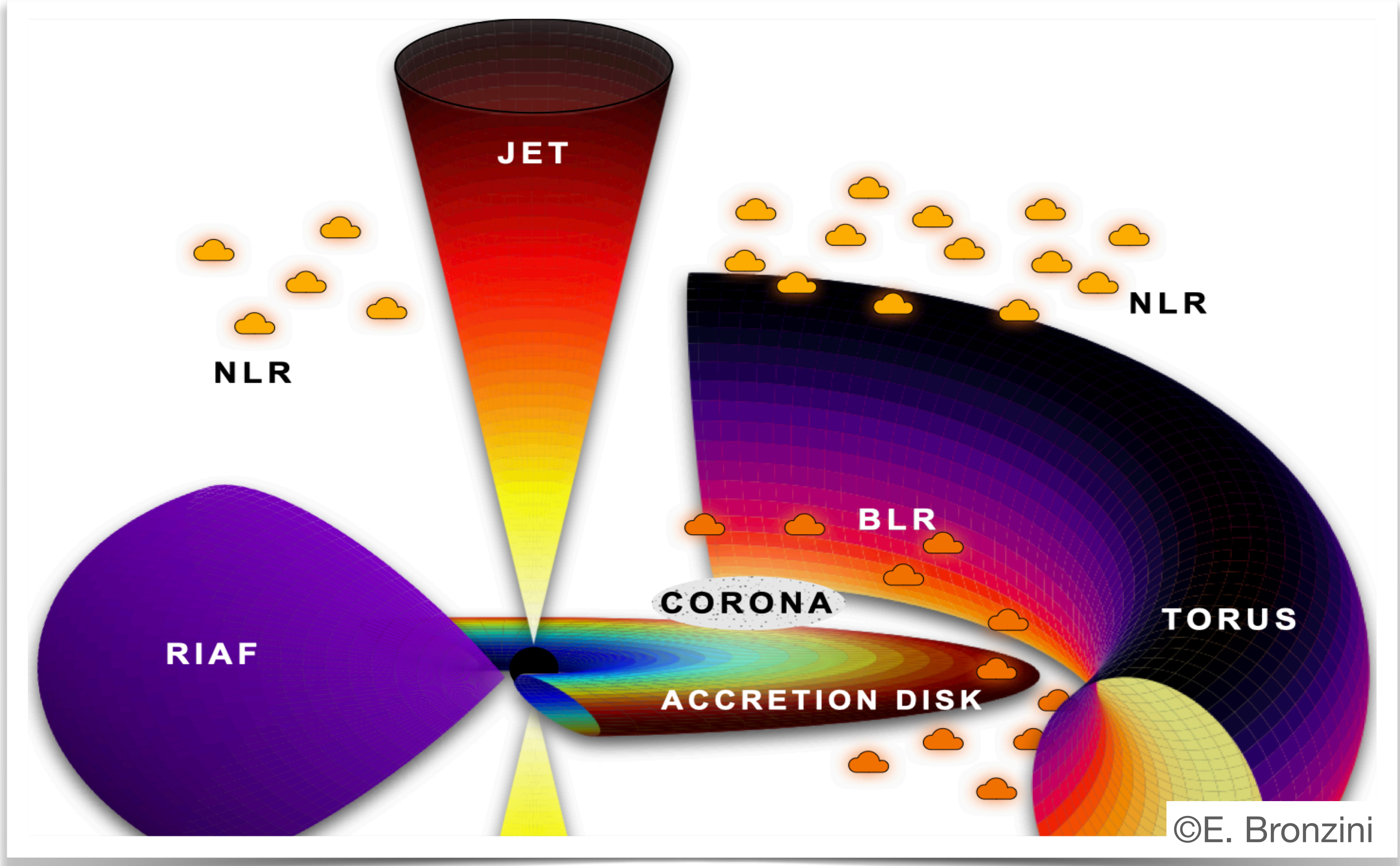
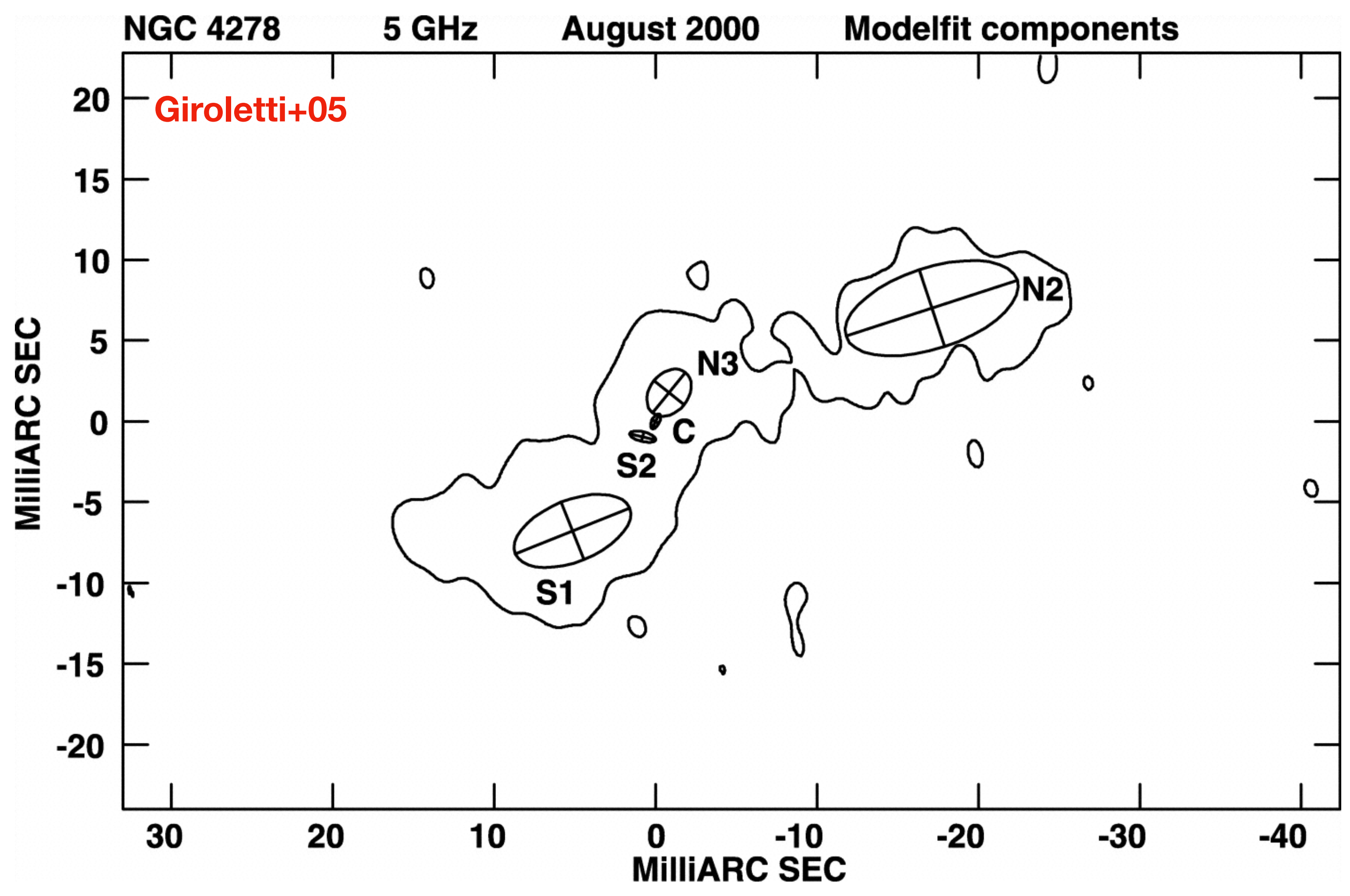
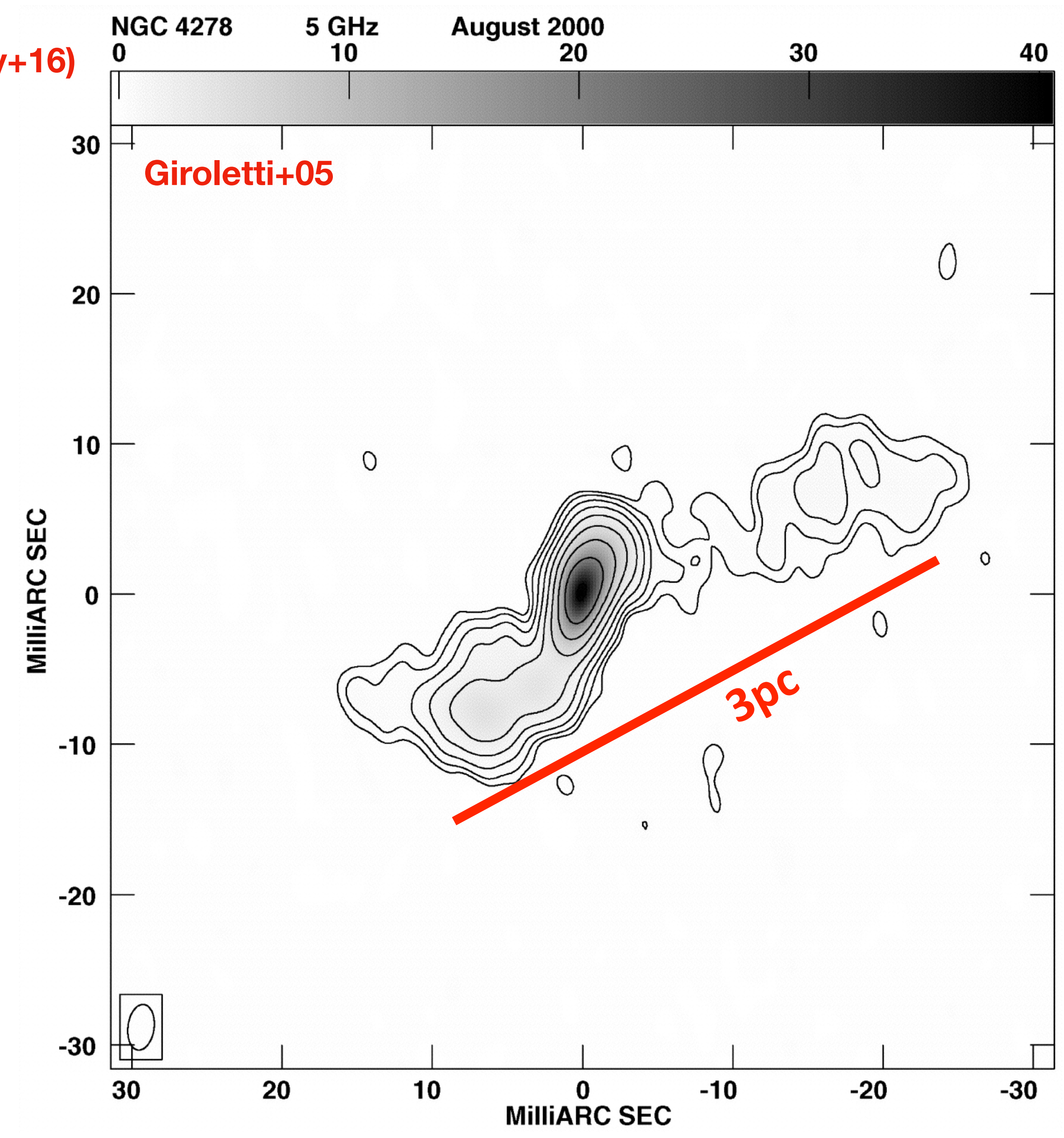
  - Pros
    - direct observation of both **accretion and ejection processes**
    - opportunity to study of the **jet structure and kinematics** from sub-pc up to kpc scales

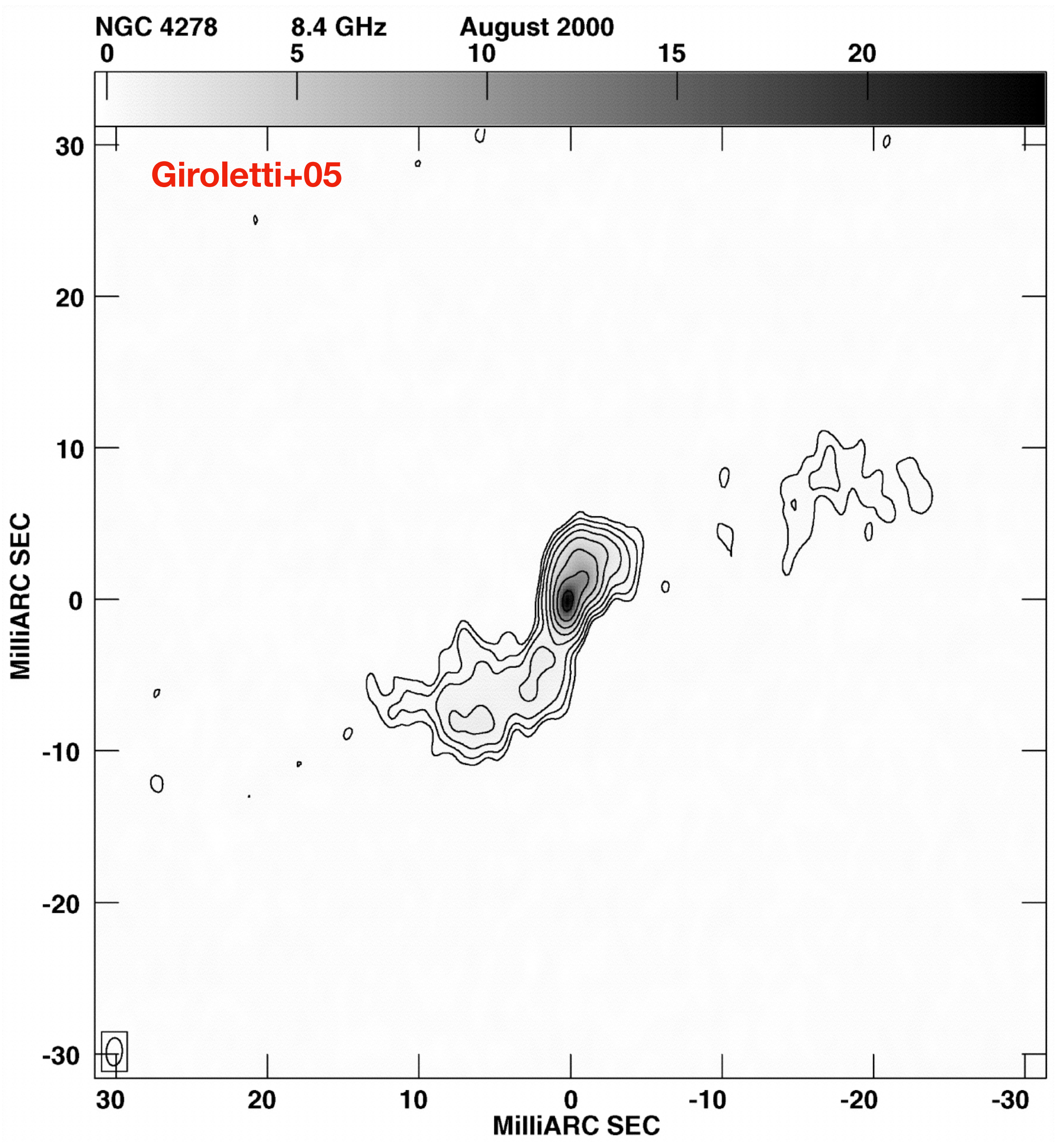


NGC 4278: a general overview

- **Nearby** (~16.4 Mpc) radio loud AGN (Terashima&Wilson03)
- **Compact** (~3 pc) symmetric radio structure (CSO) (Giroletti+05)
  - Mildly relativistic jets ($\beta \sim 0.75$) (Giroletti+05)
  - Likely (young) intermittent source ($\text{age} \lesssim 100\ \text{yrs}$) (Giroletti+05, Tremblay+16)

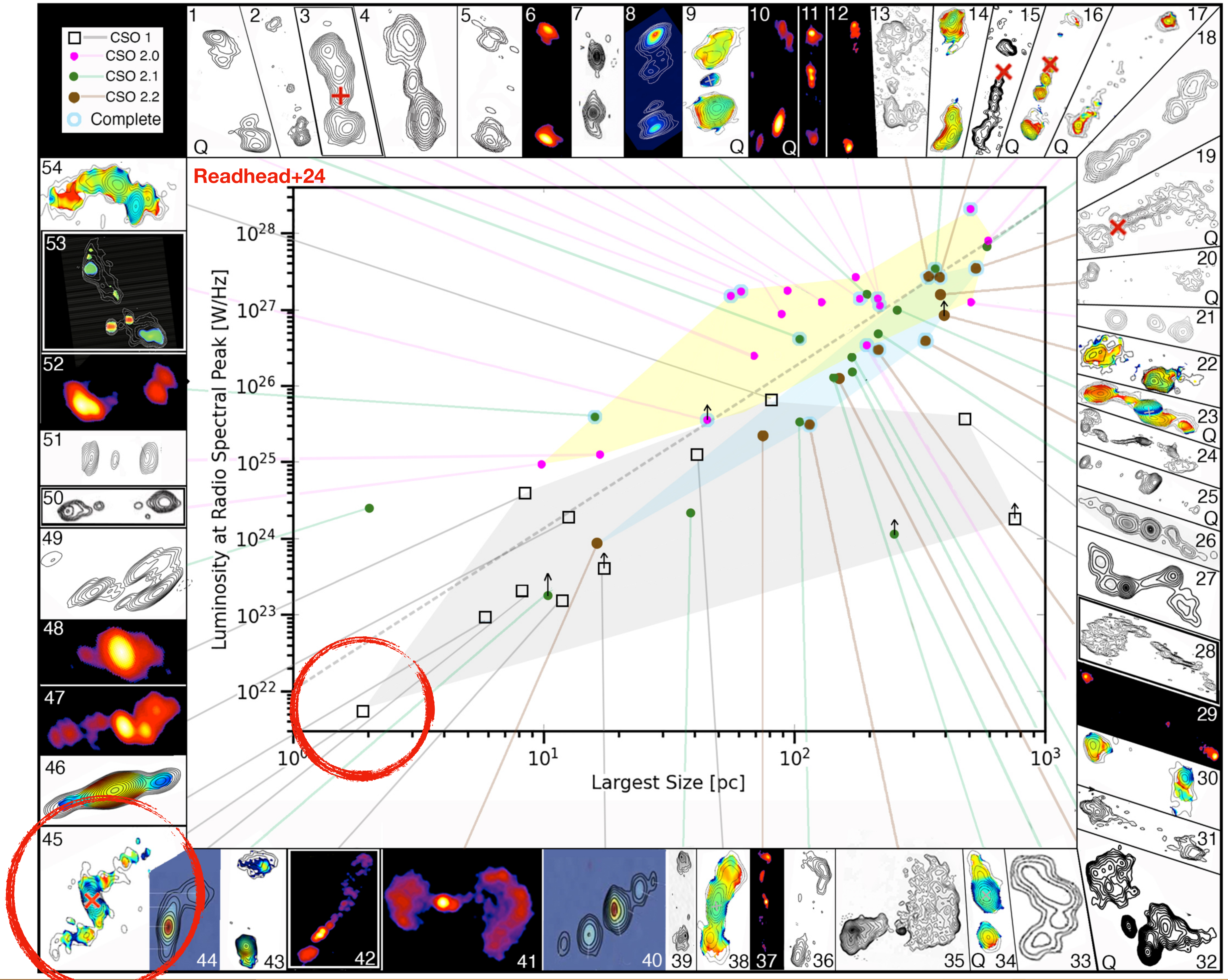






NGC 4278: a general overview

- Optically classified as a LERG (e.g., Tang+11, Molina+14)
  - $L_{\rm bol}/L_{\rm Edd} \sim 10^{-6}$ (e.g., Eracleous+10, Nemmen+11)
- The most compact (~ 3 pc, Giroletti+05) and the radio faintest ($P_{\rm jet} \sim 10^{42}$ erg/s, Giroletti+05, Pellegrini+12) CSO



NGC 4278: a general overview

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    - $L_{bol}/L_{Edd} \sim 10^{-6}$ (e.g., Eracleous+10, Nemmen+11)
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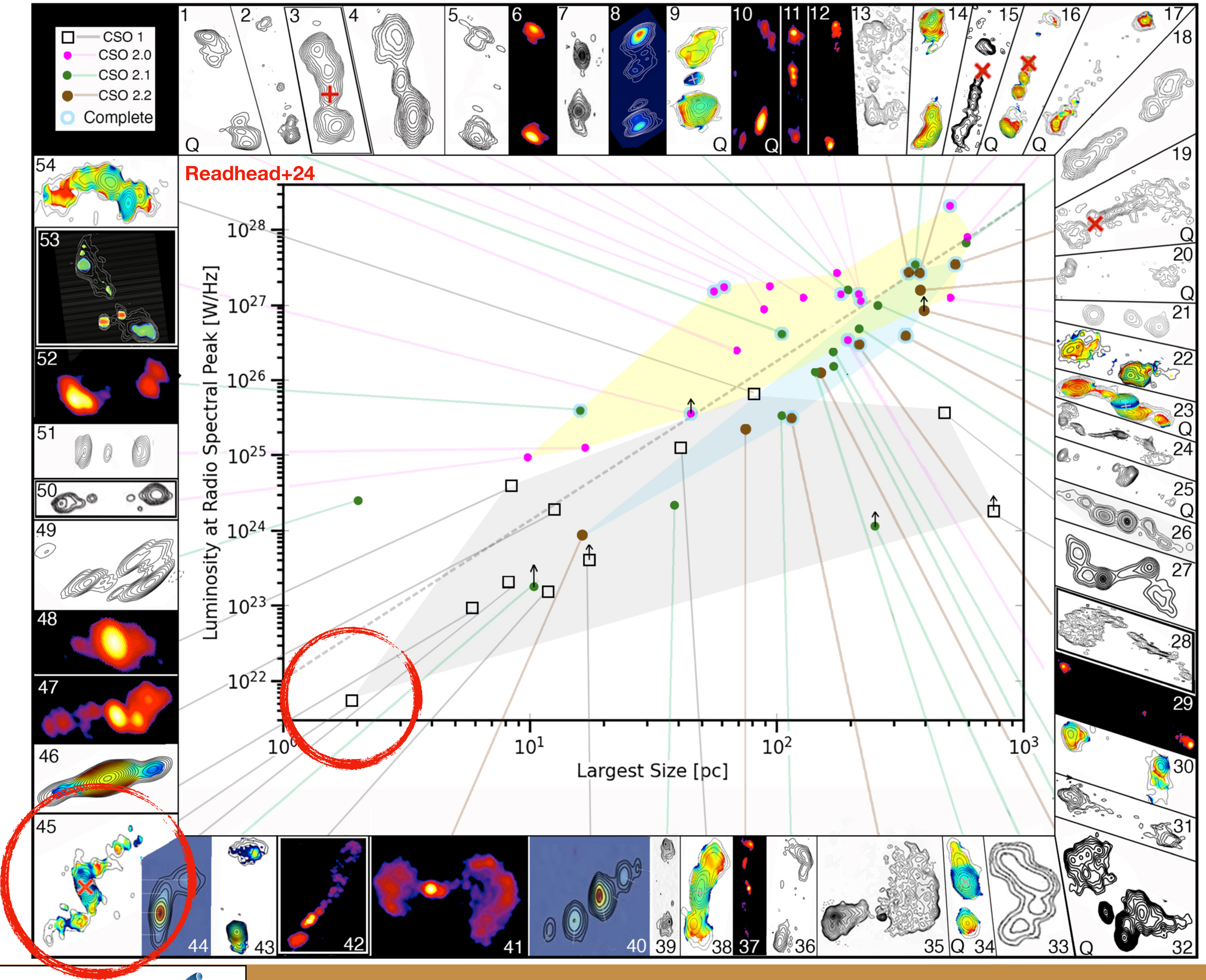
- **Variable** radio-to-X ray emission (Giroletti+05, Cardullo+09, Pellegrini+12)
- Not included in any "standard" xFGL catalog
    - detection in a monthly flare in 2009 (1FLT, Baldini+21) (but P=34% of being a false positive)



NGC 4278: VHE band

So, why is NGC 4278 interesting for the HE-VHE community?

NGC 4278: VHE band

Cao+24a

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The First LHAASO Catalog of Gamma-Ray Sources

Zhen Cao[1,2,3], F. Aharonian[4,5], Q. An[6,7], Axikegu[8], Y. X. Bai[1,3], Y. W. Bao[9], D. Bastieri[10], X. J. Bi[1,2,3], Y. J. Bi[1,3], J. T. Cai[10], Q. Cao[11], W. Y. Cao[7], Zhe Cao[6,7], J. Chang[12], J. F. Chang[1,3,6], A. M. Chen[13], E. S. Chen[1,2,3], Liang Chen[14], Lin Chen[8], Long Chen[8], M. J. Chen[1,3], M. L. Chen[1,3,6], Q. H. Chen[8], S. H. Chen[1,2,3], S. Z. Chen[1,3], T. L. Chen[15], Y. Chen[9], N. Cheng[1,3], Y. D. Cheng[1,3], M. Y. Cui[12], S. W. Cui[11], X. H. Cui[16], Y. D. Cui[17], B. Z. Dai[18], H. L. Dai[1,3,6], Z. G. Dai[7], Danzengluobu[15], D. della Volpe[19], X. Q. Dong[1,2,3], K. K. Duan[12], J. H. Fan[10], Y. Z. Fan[12], J. Fang[18], K. Fang[1,3], C. F. Feng[20], L. Feng[12], S. H. Feng[1,3], X. T. Feng[20], Y. L. Feng[15], S. Gabici[21], B. Gao[1,3], C. D. Gao[20], L. Q. Gao[1,2,3], Q. Gao[15], W. Gao[1,3], W. K. Gao[1,2,3], M. M. Ge[18], L. S. Geng[1,3], G. Giacinti[13], G. H. Gong[22], Q. B. Gou[1,3], M. H. Gu[1,3,6], F. L. Guo[14], X. L. Guo[8], Y. Q. Guo[1,3], Y. Y. Guo[12], Y. A. Han[23], H. H. He[1,2,3], H. N. He[12], J. Y. He[12], X. B. He[17], Y. He[8], M. Heller[19], Y. K. Hor[17], B. W. Hou[1,2,3], C. Hou[1,3], X. Hou[24], H. B. Hu[1,2,3], Q. Hu[7,12], S. C. Hu[1,3,25], D. H. Huang[8], T. Q. Huang[1,3], W. J. Huang[17], X. T. Huang[20], X. Y. Huang[12], Y. Huang[1,2,3], Z. C. Huang[8], X. L. Ji[1,3,6], H. Y. Jia[8], K. Jia[20], K. Jiang[6,7], X. W. Jiang[1,3], Z. J. Jiang[18], M. Jin[8], M. M. Kang[26], T. Ke[1,3], D. Kuleshov[27], K. Kurinov[27], B. B. Li[11], Cheng Li[6,7], Cong Li[1,3], D. Li[1,2,3], F. Li[1,3,6], H. B. Li[1,3], H. C. Li[1,3], H. Y. Li[7,12], J. Li[7,12], Jian Li[7], Jie Li[1,3,6], K. Li[1,3], W. L. Li[20], W. L. Li[13], X. R. Li[1,3], Xin Li[6,7], Y. Z. Li[1,2,3], Zhe Li[1,3], Zhuo Li[28], E. W. Liang[29], Y. F. Liang[29], S. J. Lin[17], B. Liu[7], C. Liu[1,3], D. Liu[20], H. Liu[8], H. D. Liu[23], J. Liu[1,3], J. L. Liu[1,3], J. Y. Liu[1,3], M. Y. Liu[15], R. Y. Liu[9], S. M. Liu[8], W. Liu[1,3], Y. Liu[10], Y. N. Liu[22], R. Lu[18], Q. Luo[17], H. K. Lv[1,3], B. Q. Ma[28], L. L. Ma[1,3], X. H. Ma[1,3], J. R. Mao[24], Z. Min[1,3], W. Mitthumsiri[30], H. J. Mu[23], Y. C. Nan[1,3], A. Neronov[21], Z. W. Ou[17], B. Y. Pang[8], P. Pattarakijwanich[30], Z. Y. Pei[10], M. Y. Qi[1,3], Y. Q. Qi[11], B. Q. Qiao[1,3], J. J. Qin[7], D. Ruffolo[30], A. Sáiz[30], D. Semikoz[21], C. Y. Shao[17], L. Shao[11], O. Shchegolev[27,31], X. D. Sheng[1,3], F. W. Shu[32], H. C. Song[28], Yu. V. Stenkin[27,31], V. Stepanov[27], Y. Su[12], Q. N. Sun[8], X. N. Sun[29], Z. B. Sun[33], P. H. T. Tam[17], Q. W. Tang[32], Z. B. Tang[6,7], W. W. Tian[2,16], C. Wang[33], C. B. Wang[8], G. W. Wang[7], H. G. Wang[10], H. H. Wang[17], J. C. Wang[24], K. Wang[9], L. P. Wang[20], L. Y. Wang[1,3], P. H. Wang[8], R. Wang[20], W. Wang[17], X. G. Wang[29], X. Y. Wang[9], Y. Wang[8], Y. D. Wang[1,3], Y. J. Wang[1,3], Z. H. Wang[26], Z. X. Wang[18], Zhen Wang[13], Zheng Wang[1,3,6], D. M. Wei[12], J. J. Wei[12], Y. J. Wei[1,2,3], T. Wen[18], C. Y. Wu[1,3], H. R. Wu[1,3], S. Wu[1,3], X. F. Wu[12], Y. S. Wu[7], S. Q. Xi[1,3], J. Xia[7,12], J. J. Xia[8], G. M. Xiang[2,14], D. X. Xiao[11], G. Xiao[1,3], G. G. Xin[1,3], Y. L. Xin[8], Y. Xing[14], Z. Xiong[1,2,3], D. L. Xu[13], R. F. Xu[1,2,3], R. X. Xu[28], W. L. Xu[26], L. Xue[20], D. H. Yan[18], J. Z. Yan[12], T. Yan[1,3], C. W. Yang[26], F. Yang[11], F. F. Yang[1,3,6], H. W. Yang[17], J. Y. Yang[17], L. L. Yang[17], M. J. Yang[1,3], R. Z. Yang[7], S. B. Yang[18], Y. H. Yao[26], Z. G. Yao[1,3], Y. M. Ye[22], L. Q. Yin[1,3], N. Yin[20], X. H. You[1,3], Z. Y. You[1,3], Y. H. Yu[7], Q. Yuan[12], H. Yue[1,2,3], H. D. Zeng[12], T. X. Zeng[1,3,6], W. Zeng[18], M. Zha[1,3], B. B. Zhang[9], F. Zhang[8], H. M. Zhang[9], H. Y. Zhang[1,3], J. L. Zhang[16], L. X. Zhang[10], Li Zhang[18], P. F. Zhang[18], P. P. Zhang[7,12], R. Zhang[7,12], S. B. Zhang[2,16], S. R. Zhang[11], S. S. Zhang[1,3], X. Zhang[9], X. P. Zhang[1,3], Y. F. Zhang[8], Yi Zhang[1,12], Yong Zhang[1,3], B. Zhao[8], J. Zhao[1,3], L. Zhao[6,7], L. Z. Zhao[11], S. P. Zhao[12,20], F. Zheng[33], B. Zhou[1,3], H. Zhou[13], J. N. Zhou[14], M. Zhou[32], P. Zhou[9], R. Zhou[26], X. X. Zhou[8], C. G. Zhu[20], F. R. Zhu[8], H. Zhu[16], K. J. Zhu[1,2,3,6], and X. Zuo[1,3]
(The LHAASO Collaboration)

~508 days of integration time
from March 5th, 2021 to September 30th, 2022

Source Name	Components	α_{2000}	δ_{2000}	$\sigma_{p,95,\mathrm{stat}}$	r_{39}	TS	N_0	Γ
1LHAASO J1219+2915	WCDA	184.98	29.25	0.09	<0.08	50.4	0.34 ± 0.06	2.67 ± 0.17
	KM2A						<0.05	

see also talk by Chen (Monday)

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NGC 4278: VHE band

Cao+24b

The Astrophysical Journal Letters, 971:L45 (8pp), 2024 August 20
https://doi.org/10.3847/2041-8213/ad5e6d

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Discovery of Very High Energy Gamma-Ray Emissions from the Low-luminosity AGN NGC 4278 by LHAASO

Zhen Cao[1,2,3], F. Aharonian[4,5], Axikegu[6], Y. X. Bai[1,3], Y. W. Bao[7], D. Bastieri[8], X. J. Bi[1,2,3], Y. J. Bi[1,3], W. Bian[9], A. V. Bukevich[10], Q. Cao[11], W. Y. Cao[12], Zhe Cao[12,13], J. Chang[14], J. F. Chang[1,3,13], A. M. Chen[9], E. S. Chen[1,2,3], H. X. Chen[15], Liang Chen[16], Lin Chen[6], Long Chen[6], M. J. Chen[1,3], M. L. Chen[1,3,13], Q. H. Chen[6], S. Chen[17], S. H. Chen[1,2,3], S. Z. Chen[1,3], T. L. Chen[18], Y. Chen[7], N. Cheng[1,3], Y. D. Cheng[1,2,3], M. Y. Cui[14], S. W. Cui[11], X. H. Cui[19], Y. D. Cui[20], B. Z. Dai[17], H. L. Dai[1,3,13], Z. G. Dai[12], Danzengluobu[18], X. Q. Dong[1,2,3], K. K. Duan[14], J. H. Fan[8], Y. Z. Fan[14], J. Fang[17], J. H. Fang[15], K. Fang[1,3], C. F. Feng[21], H. Feng[1], L. Feng[14], S. H. Feng[1,3], X. T. Feng[21], Y. Feng[15], Y. L. Feng[18], S. Gabici[22], B. Gao[1,3], C. D. Gao[21], Q. Gao[18], W. Gao[1,3], W. K. Gao[1,2,3], M. M. Ge[17], L. S. Geng[1,3], G. Giacinti[9], G. H. Gong[23], Q. B. Gou[1,3], M. H. Gu[1,3,13], F. L. Guo[16], X. L. Guo[6], Y. Q. Guo[1,3], Y. Y. Guo[14], Y. A. Han[24], M. Hasan[1,2,3], H. H. He[1,2,3], H. N. He[14], J. Y. He[14], Y. He[6], Y. K. Hor[20], B. W. Hou[1,2,3], C. Hou[1,3], X. Hou[25], H. B. Hu[1,2,3], Q. Hu[12,14], S. C. Hu[1,3,26], D. H. Huang[6], T. Q. Huang[1,3], W. J. Huang[20], X. T. Huang[21], X. Y. Huang[14], Y. Huang[1,2,3], X. L. Ji[1,3,13], H. Y. Jia[6], K. Jia[21], K. Jiang[12,13], X. W. Jiang[1,3], Z. J. Jiang[17], M. Jin[6], M. M. Kang[27], I. Karpikov[10], D. Kuleshov[10], K. Kurinov[10], B. B. Li[11], C. M. Li[7], Cheng Li[12,13], Cong Li[1,3], D. Li[1,2,3], F. Li[1,3,13], H. B. Li[1,3], H. C. Li[1,3], Jian Li[12], Jie Li[1,3,13], K. Li[1,3], S. D. Li[2,16], W. L. Li[21], W. L. Li[9], X. R. Li[1,3], Xin Li[12,13], Y. Z. Li[1,2,3], Zhe Li[1,3], Zhuo Li[28], E. W. Liang[29], Y. F. Liang[29], S. J. Lin[20], B. Liu[12], C. Liu[1,3], D. Liu[21], D. B. Liu[9], H. Liu[6], H. D. Liu[24], J. Liu[1,3], J. L. Liu[1,3], M. Y. Liu[18], R. Y. Liu[7], S. M. Liu[6], W. Liu[1,3], Y. Liu[8], Y. N. Liu[23], Q. Luo[20], Y. Luo[9], H. K. Lv[1,3], B. Q. Ma[28], L. L. Ma[1,3], X. H. Ma[1,3], J. R. Mao[25], Z. Min[1,3], W. Mitthumsiri[30], H. J. Mu[24], Y. C. Nan[1,3], A. Neronov[22], L. J. Ou[8], P. Pattarakijwanich[30], Z. Y. Pei[8], J. C. Qi[1,2,3], M. Y. Qi[1,3], B. Q. Qiao[1,3], J. J. Qin[12], A. Raza[1,2,3], D. Ruffolo[30], A. Sáiz[30], M. Saeed[1,2,3], D. Semikoz[22], L. Shao[11], O. Shchegolev[10,31], X. D. Sheng[1,3], F. W. Shu[32], H. C. Song[28], Yu. V. Stenkin[10,31], V. Stepanov[10], Y. Su[14], D. X. Sun[12,14], Q. N. Sun[6], X. N. Sun[29], Z. B. Sun[33], J. Takata[34], P. H. T. Tam[20], Q. W. Tang[32], R. Tang[9], Z. B. Tang[12,13], W. W. Tian[2,19], C. Wang[33], C. B. Wang[6], G. W. Wang[12], H. G. Wang[8], H. H. Wang[20], J. C. Wang[25], Kai Wang[7], Kai Wang[34], L. P. Wang[1,2,3], L. Y. Wang[1,3], P. H. Wang[6], R. Wang[21], W. Wang[20], X. G. Wang[29], X. Y. Wang[7], Y. Wang[6], Y. D. Wang[1,3], Y. J. Wang[1,3], Z. H. Wang[27], Z. X. Wang[17], Zhen Wang[9], Zheng Wang[1,3,13], D. M. Wei[14], J. J. Wei[14], Y. J. Wei[1,2,3], T. Wen[17], C. Y. Wu[1,3], H. R. Wu[1,3], Q. W. Wu[34], S. Wu[1,3], X. F. Wu[14], Y. S. Wu[12], S. Q. Xi[1,3], J. Xia[12,14], G. M. Xiang[2,16], D. X. Xiao[11], G. Xiao[1,3], Y. L. Xin[6], Y. Xing[16], D. R. Xiong[25], Z. Xiong[1,2,3], D. L. Xu[9], R. F. Xu[1,2,3], R. X. Xu[28], W. L. Xu[27], L. Xue[21], D. H. Yan[17], J. Z. Yan[14], T. Yan[1,3], C. W. Yang[27], C. Y. Yang[25], F. Yang[11], F. F. Yang[1,3,13], L. L. Yang[20], M. J. Yang[1,3], R. Z. Yang[12], W. X. Yang[8], Y. H. Yao[1,3], Z. G. Yao[1,3], L. Q. Yin[1,3], N. Yin[21], X. H. You[1,3], Z. Y. You[1,3], Y. H. Yu[12], Q. Yuan[14], H. Yue[1,2,3], H. D. Zeng[14], T. X. Zeng[1,3,13], W. Zeng[17], M. Zha[1,3], B. B. Zhang[7], F. Zhang[6], H. Zhang[9], H. M. Zhang[7], H. Y. Zhang[1,3], J. L. Zhang[19], Li Zhang[17], P. F. Zhang[17], P. P. Zhang[12,14], R. Zhang[12,14], S. B. Zhang[2,19], S. R. Zhang[11], S. S. Zhang[1,3], X. Zhang[7], X. P. Zhang[1,3], Y. F. Zhang[6], Yi Zhang[1,14], Yong Zhang[1,3], B. Zhao[6], J. Zhao[1,3], L. Zhao[12,13], L. Z. Zhao[11], S. P. Zhao[14], X. H. Zhao[25], F. Zheng[33], W. J. Zhong[7], B. Zhou[1,3], H. Zhou[9], J. N. Zhou[16], M. Zhou[32], P. Zhou[7], R. Zhou[27], X. X. Zhou[1,2,3], X. X. Zhou[6], B. Y. Zhu[12,14], C. G. Zhu[21], F. R. Zhu[6], H. Zhu[19], K. J. Zhu[1,2,3,13], Y. C. Zou[34], and X. Zuo[1,3]
The LHAASO Collaboration

see also talk by Chen (Monday)

~891 days of integration time
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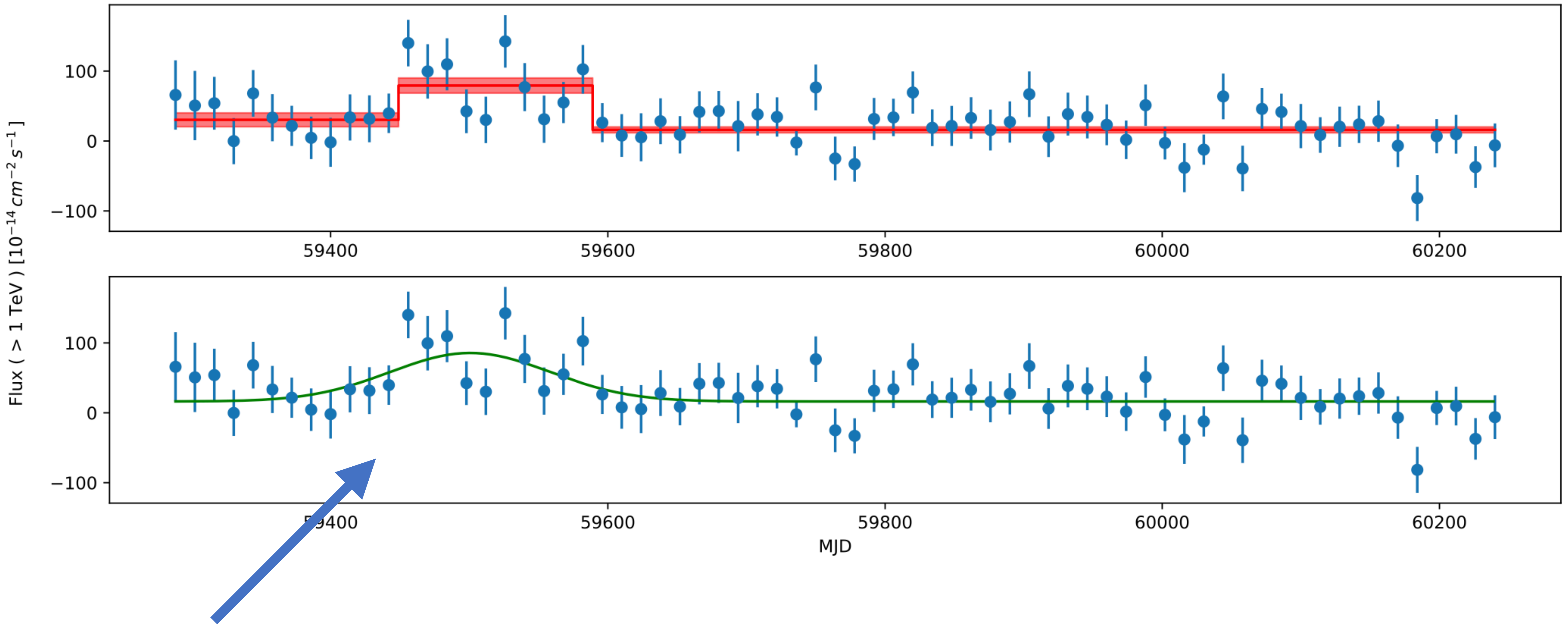

~7 times the low-state

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Fermi Gamma-ray Space Telescope

NGC 4278: γ-ray band (Bronzini et al. in prep)

- Tentative approaches to reveal GeV emission from NGC 4278 using *Fermi*-LAT, with no results (Wang+24, Lian+24, Cao+24b)

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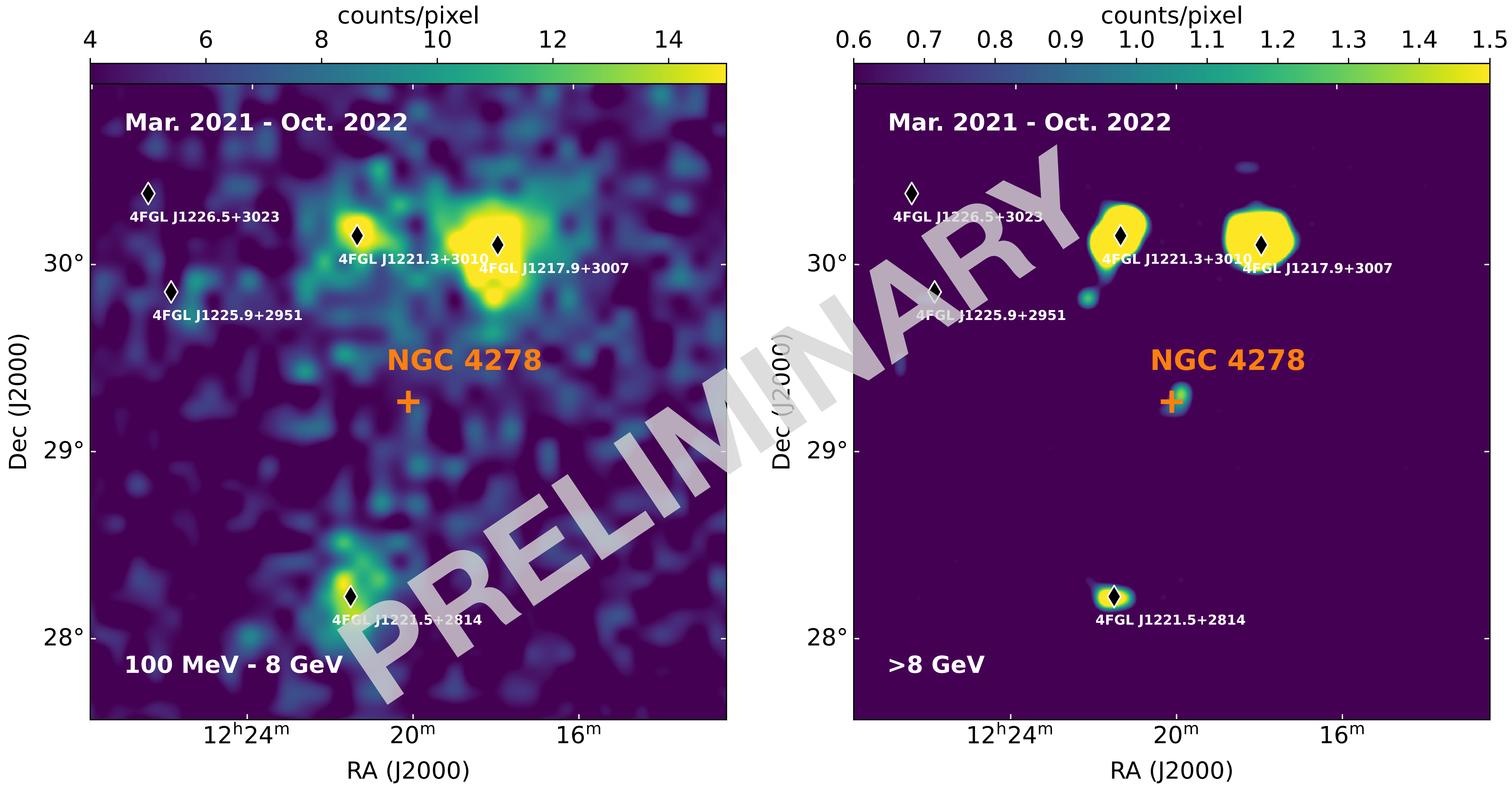
NGC 4278: γ-ray band (Bronzini et al. in prep)

- Tentative approaches to reveal GeV emission from NGC 4278 using *Fermi*-LAT, with no results (Wang+24, Lian+24, Cao+24b)
- Our approach was to limit the the *Fermi*-LAT investigation to the same time interval as the first LHAASO catalog (Cao+24a)

Our analysis

- Period: March 1st 2021 - October 1st 2022 (MJD = 59274 - 59853)
- Energy range: 100 MeV - 1 TeV
- 4FLG-DR4
- NGC 4278 manually added to the model
- Binned likelihood with 21 components (different energy bands, Zmax, PSFs)



ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA
INAF OAS
Fermi Gamma-ray Space Telescope
Missione 4 • Istruzione e Ricerca

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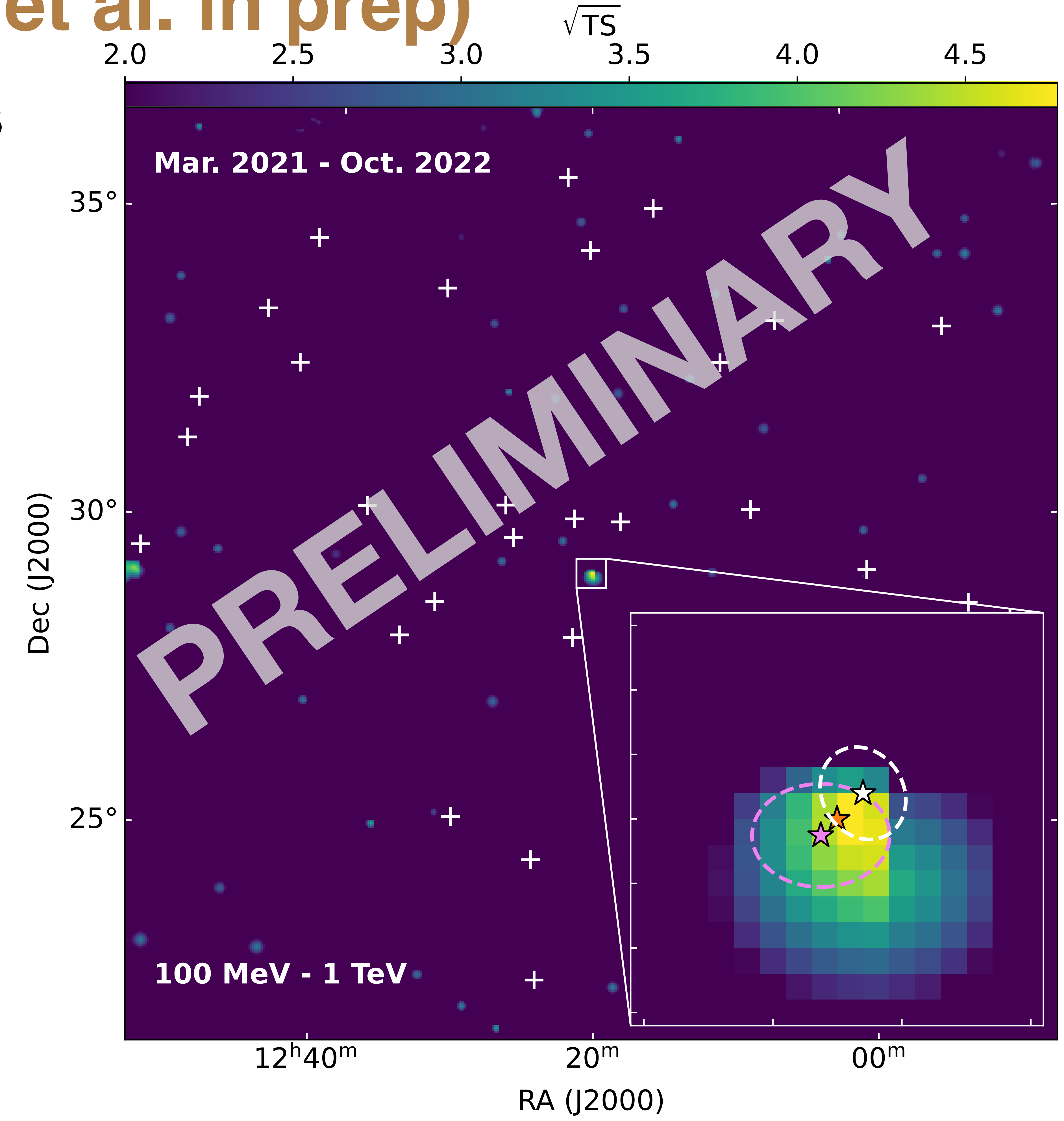
- Statistically significant (TS=29) γ-ray emission spatially coincident with NGC 4278



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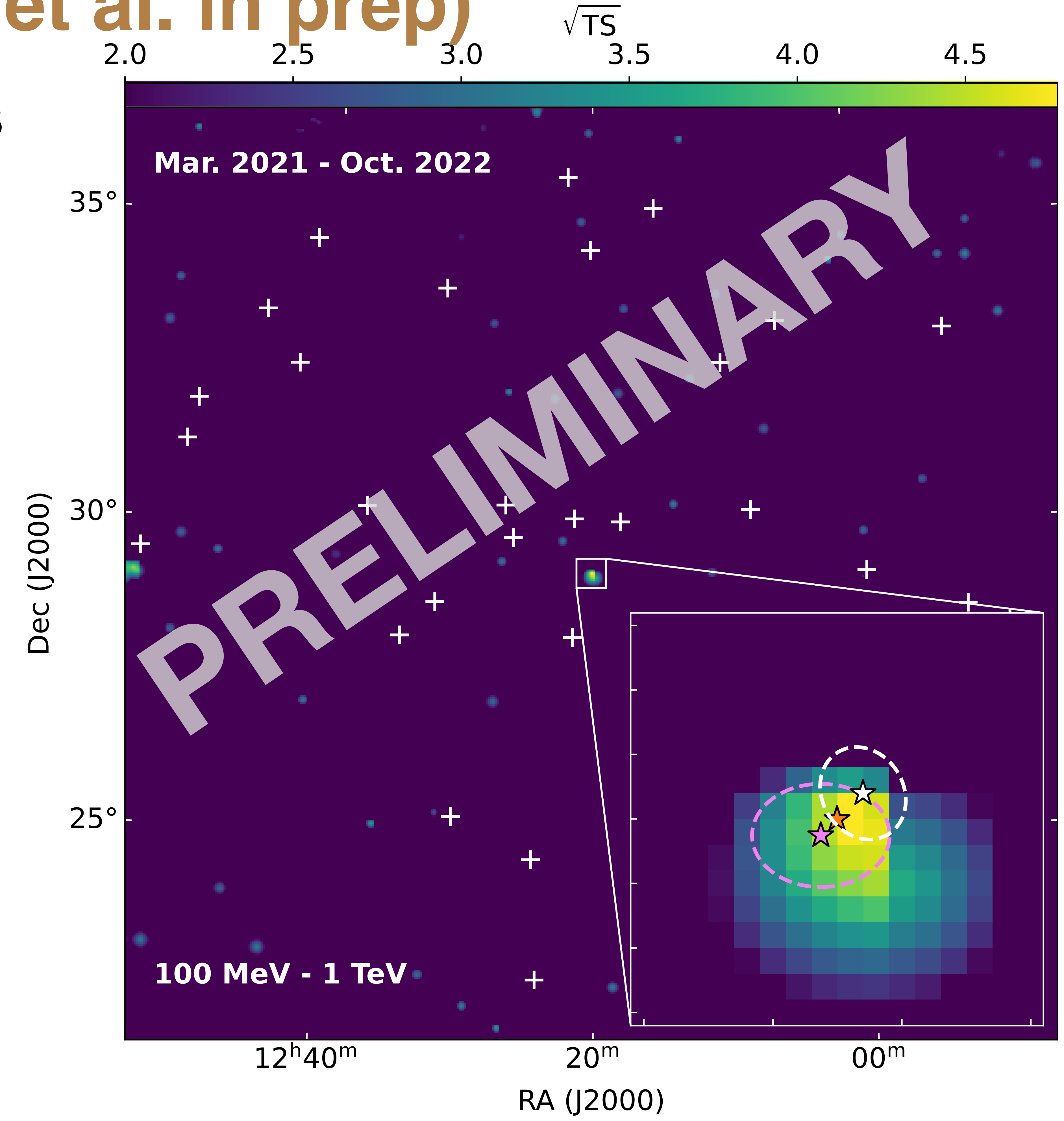
- Statistically significant (TS=29) γ-ray emission spatially coincident with NGC 4278
- Hard photon index $\Gamma = 1.3 \pm 0.3$
- Energy flux $F_{>100\,\mathrm{MeV}} = (1.2 \pm 0.9) \times 10^{-11}\,\mathrm{erg/s/cm^2}$
- Isotropic luminosity of $L_{>100\,\mathrm{MeV}} = (4 \pm 3) \times 10^{41}\,\mathrm{erg/s}$



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- We checked event by event (gtsrcprob tool)
  - **3 HE photons** with **P>90%** to be associated with NGC 4278

Energy [GeV] (1)	MJD (2)	α_{J200} [deg] (3)	δ_{J200} [deg] (4)	evclass (5)	gtsrcprob [%] (6)
8	59561	184.98	29.36	CLEAN	93.8 (3.8, 2.1)
96	59742	185.03	29.28	SOURCEVETO	99.9 (<1, <1)
103	59312	184.95	29.20	SOURCEVETO	99.2 (<1, <1)

Table 1. Properties of photons associated to NGC 4278 with a probability higher than 90%.
Notes. Column (1) reconstructed energy, (2) arrival time in modified Julian day (MJD), (3-4) reconstructed right ascension and declination, (5) event class of the reconstructed event (further details in the text), (6) association probability using the **gtsrcprob** tool for NGC 4278 and for the backgrounds in parentheses (isotropic and galactic, respectively).

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The first solid detection of NGC 4278!

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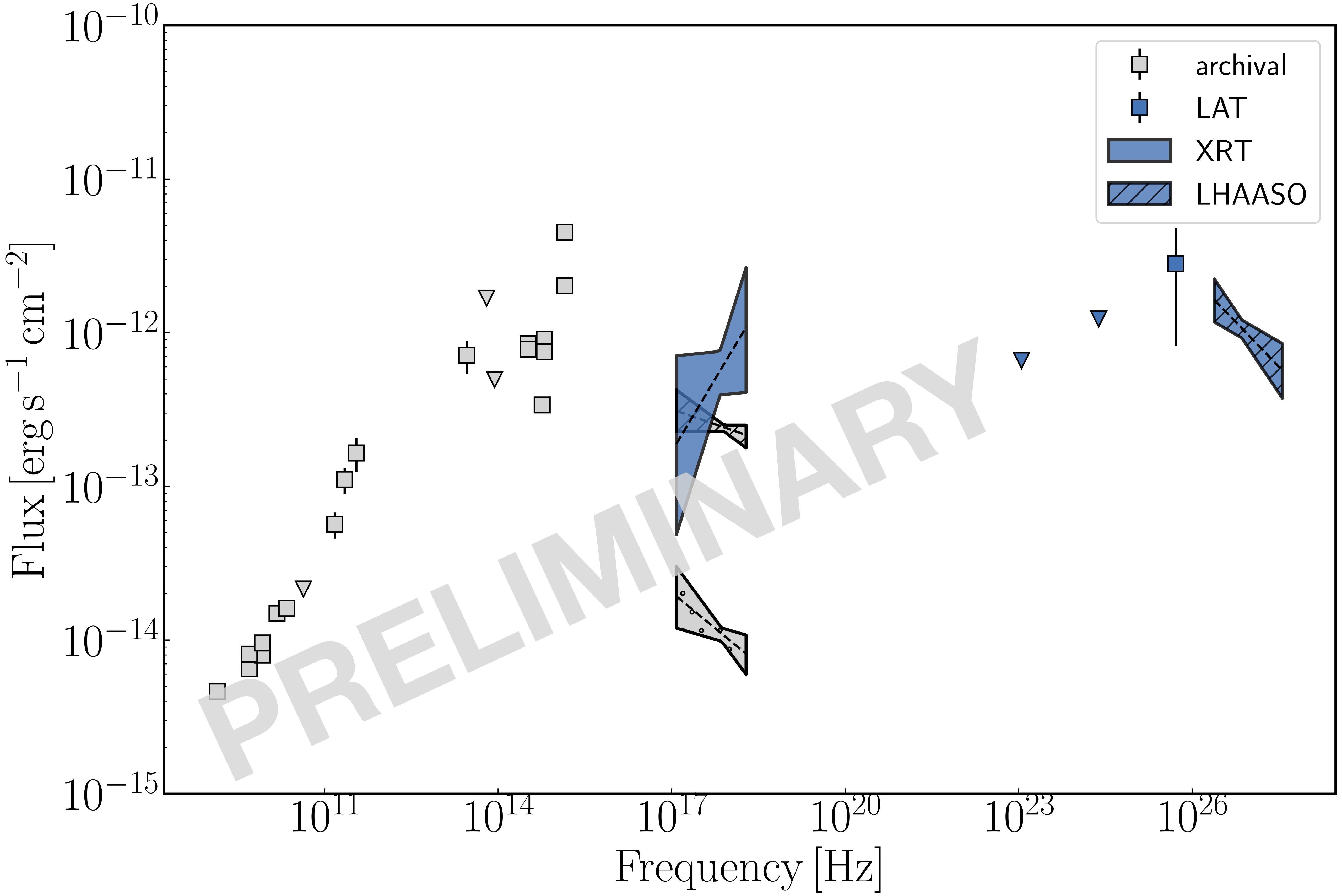
NGC 4278: X-ray band (Bronzini et al. in prep)

NGC 4278 was serendipitously **observed by *Swift*-XRT** (~1.1ks) **during the TeV active phase**

- **The source was in flare also in X-ray band!**
- Hard photon index $\Gamma = 1.4^{+0.6}_{-0.6}$
- Energy flux $F_{0.5-8\,\mathrm{keV}} = 5^{+3}_{-2} \times 10^{-12}\,\mathrm{erg/s/cm^2}$
- Isotropic luminosity $L_{0.5-8\,\mathrm{keV}} = 1.6^{+0.9}_{-0.6} \times 10^{41}\,\mathrm{erg/s}$

NGC 4278: MWL view (Bronzini et al. in prep)

Our results in X- and γ-ray bands strongly support that the **source was in an overall enhanced state** during the LHAASO campaign



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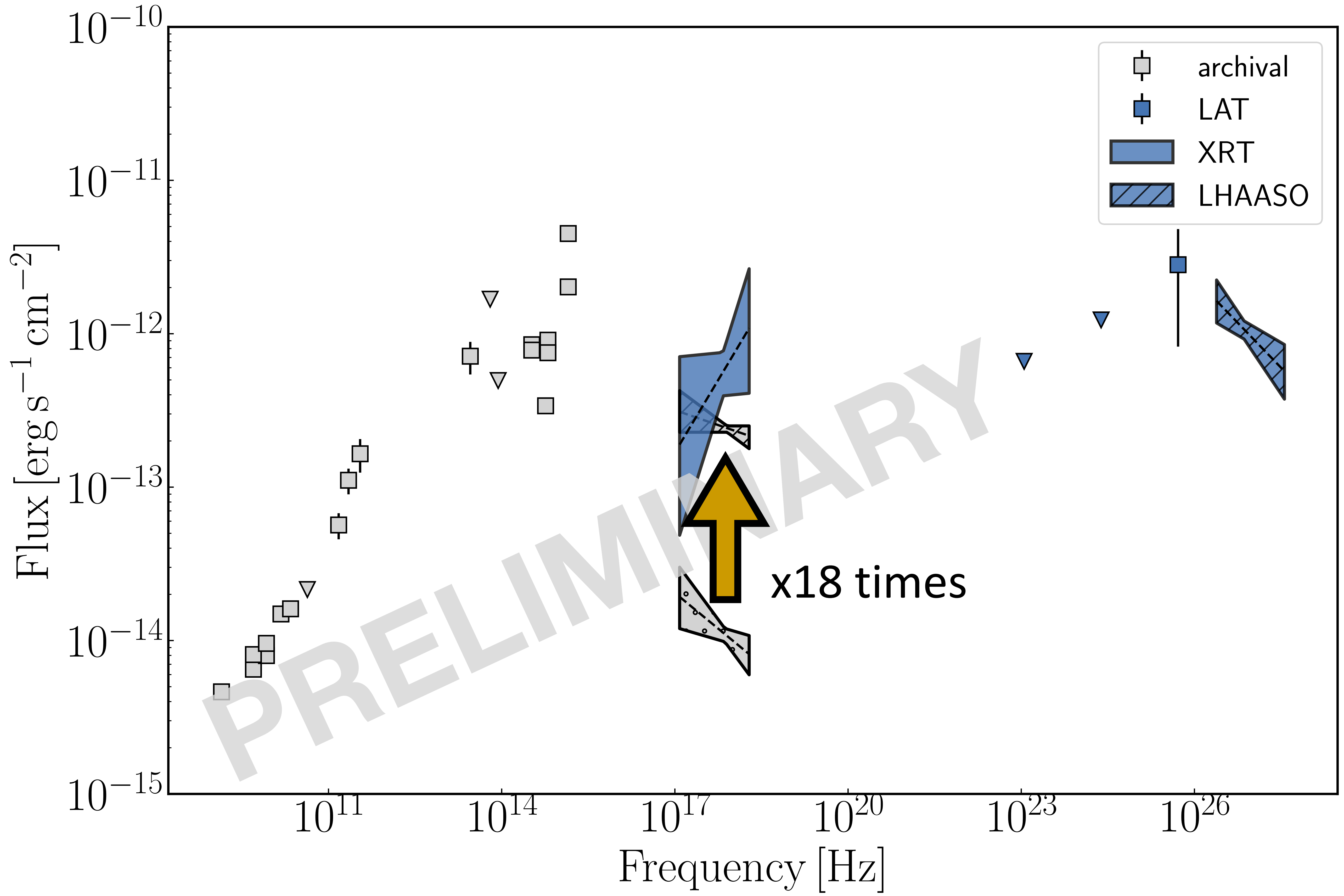

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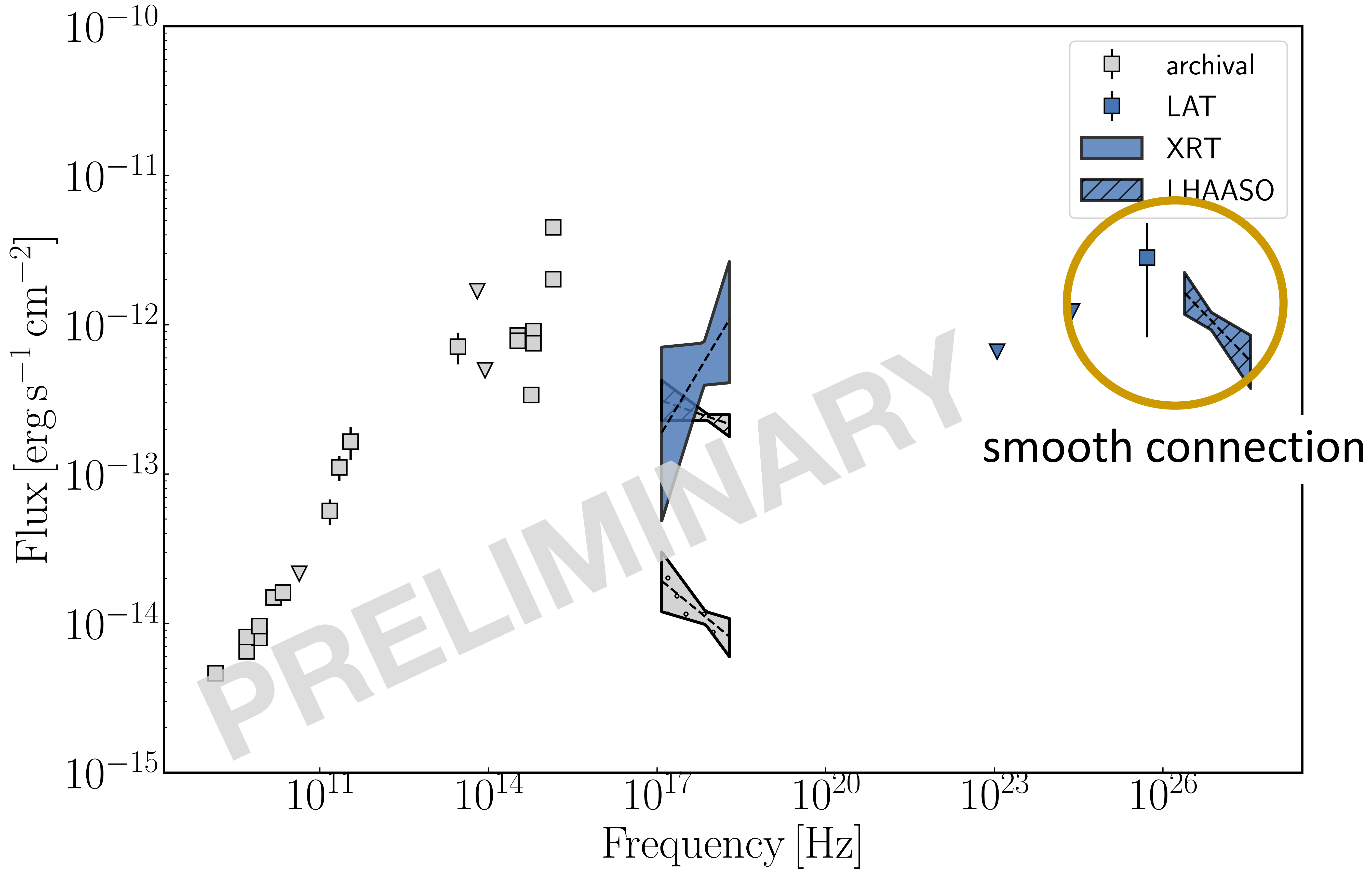

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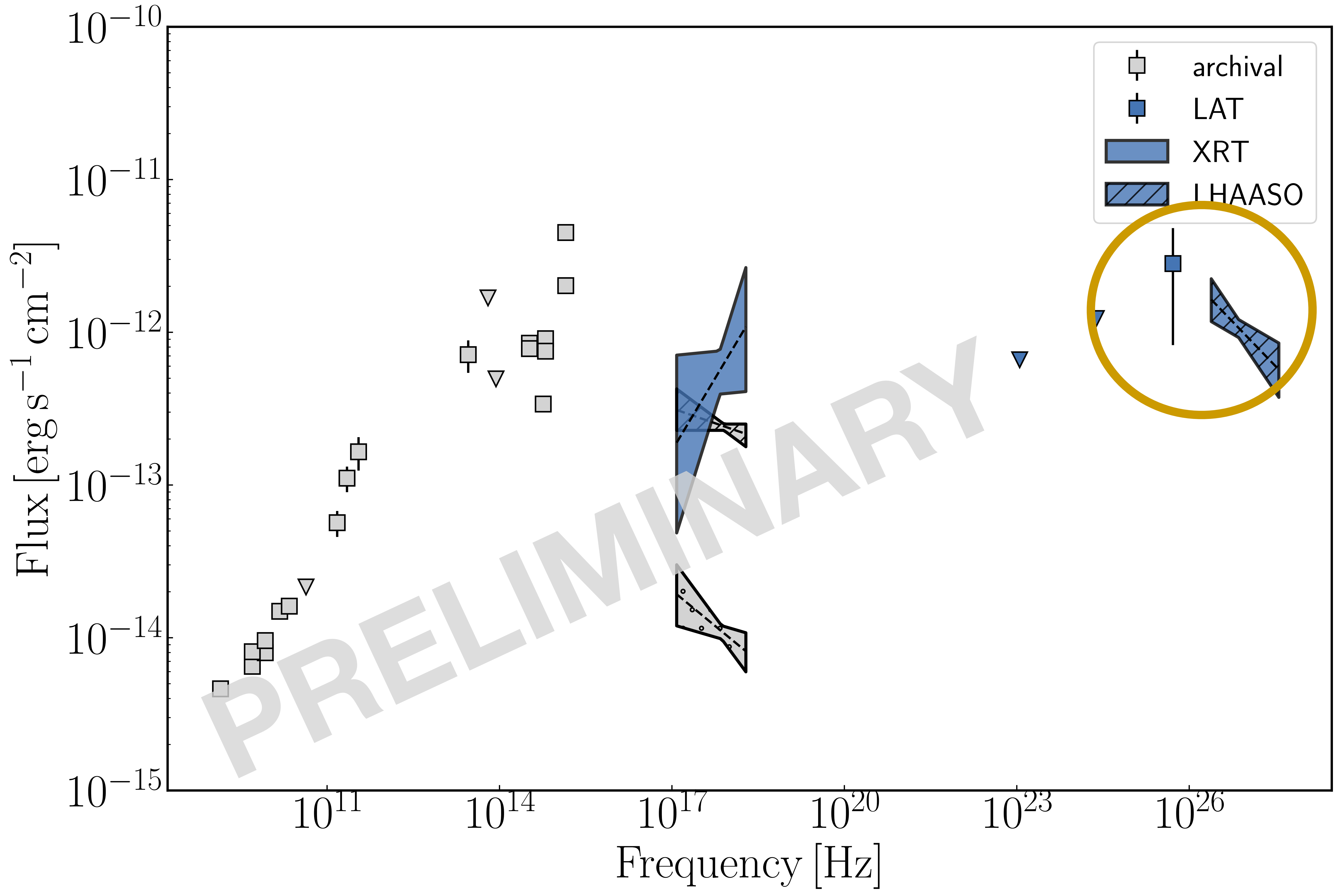


The origin of the TeV flare is currently under investigation via SED modelling!

Conclusions

- Our highly refined analysis of *Fermi*-LAT data revealed a statistically significant (~4.3σ) **detection of NGC 4278 spatially e temporally coincident with 1LHAASO J1219+2915**
- GeV and TeV data connect smoothly
- The analysis of a X-ray observation simultaneous to the LHAASO campaign confirms that the source was in a high-state

NGC 4278 represents a new class of TeV-emitting sources!

- The detection of VHE emission from NGC 4278 gives us, for the **first time**, the unique opportunity to **investigate acceleration** and **radiative mechanisms in low-power radio galaxies with pc-scale jets**.
- **LLAGN with pc-scale jets might constitute a new class of targets for upcoming Cherenkov Telescope Array Observatory (CTAO)**


That's all folks!

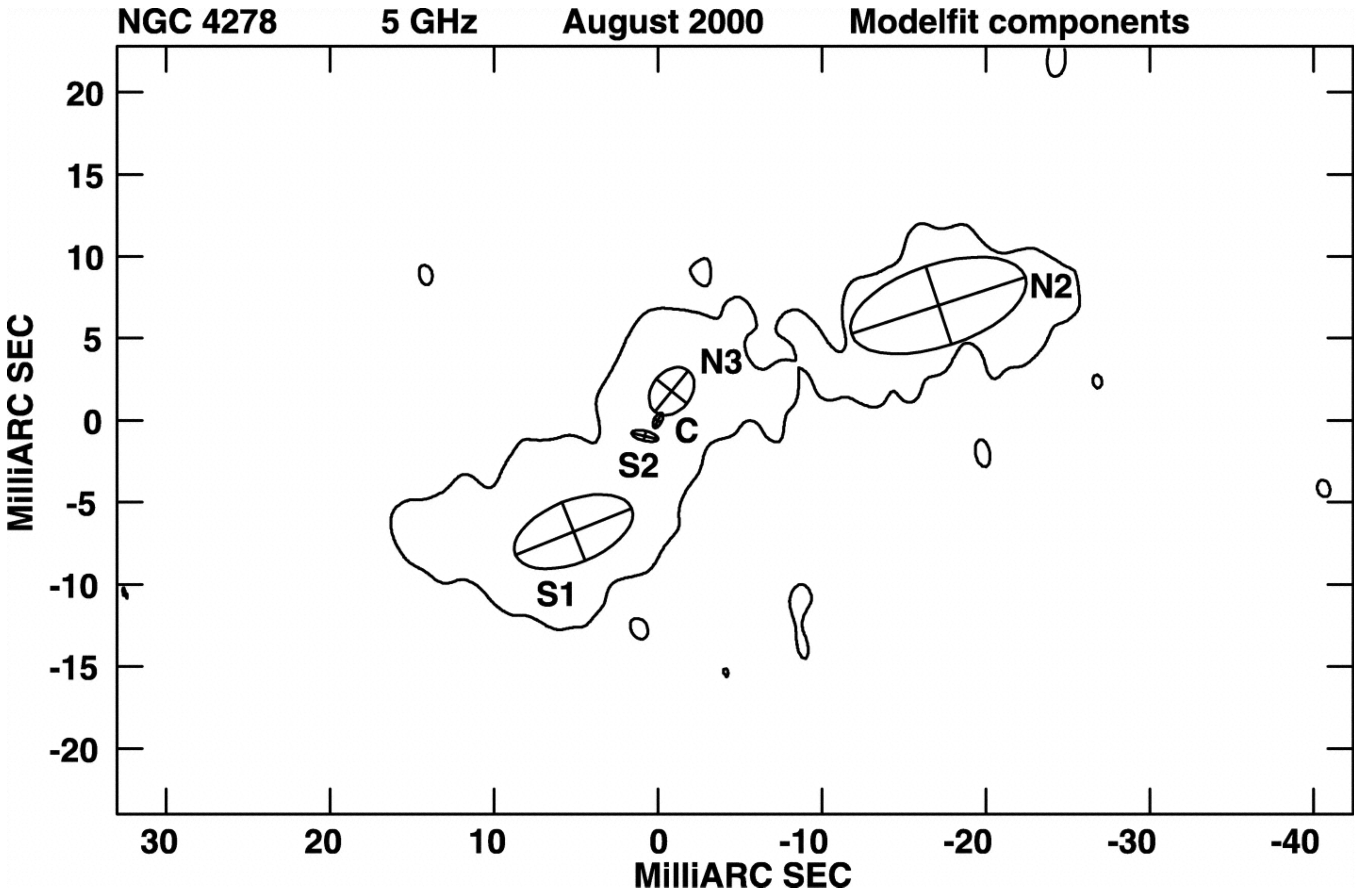
NGC 4278: radio band (Giroletti+05)

individual components **properties**

Component (1)	r (mas) (2)	θ (deg) (3)	a (mas) (4)	b/a (5)	Φ (deg) (6)	$S_{5\ GHz}$ (mJy) (7)	$S_{8.4\ GHz}$ (mJy) (8)	α (9)
C	0.00	0.0	0.99	0.48	−26.6	31.5	28.0	0.2
S2	2.57	162.0	1.65	0.36	76.4	7.5	3.0	1.8
S1	8.51	142.8	7.39	0.50	−68.3	28.0	20.8	0.6
N3	1.96	−25.1	3.23	0.74	−39.0	45.4	36.6	0.4
N2	18.46	−67.7	11.17	0.45	−71.9	8.7	6.3	0.6

individual components **proper motions**

Component (1)	Δr (mas) (2)	ρ (deg) (3)	μ (mas yr^{-1}) (4)	β_{app} (v_{app}/c) (5)	Age (yr) (6)
C			Reference		
S2	0.45 ± 0.14	148.7	0.088 ± 0.027	0.020 ± 0.006	29.1 ± 9.3
S1	0.66 ± 0.12	145.1	0.129 ± 0.024	0.030 ± 0.006	65.8 ± 12.4
N3	1.21 ± 0.09	−66.3	0.237 ± 0.018	0.055 ± 0.004	8.3 ± 0.5
N2	3.76 ± 0.65	−79.5	0.737 ± 0.128	0.171 ± 0.030	25.0 ± 4.8



NGC 4278: X-ray band

Multiple X-ray emitting components in the host galaxy of NGC 4278

-> LMXBs, GCs, multi-temperature gas, etc. revealed by *Chandra* (excellent angular resolution) (Brassington+09, Fabbiano+10, Pellegrini+12)

-> Essential to disentangle the central AGN contribution from other components when observed by telescopes with worse angular resolution (e.g. *Swift*-XRT)

Fabbiano19

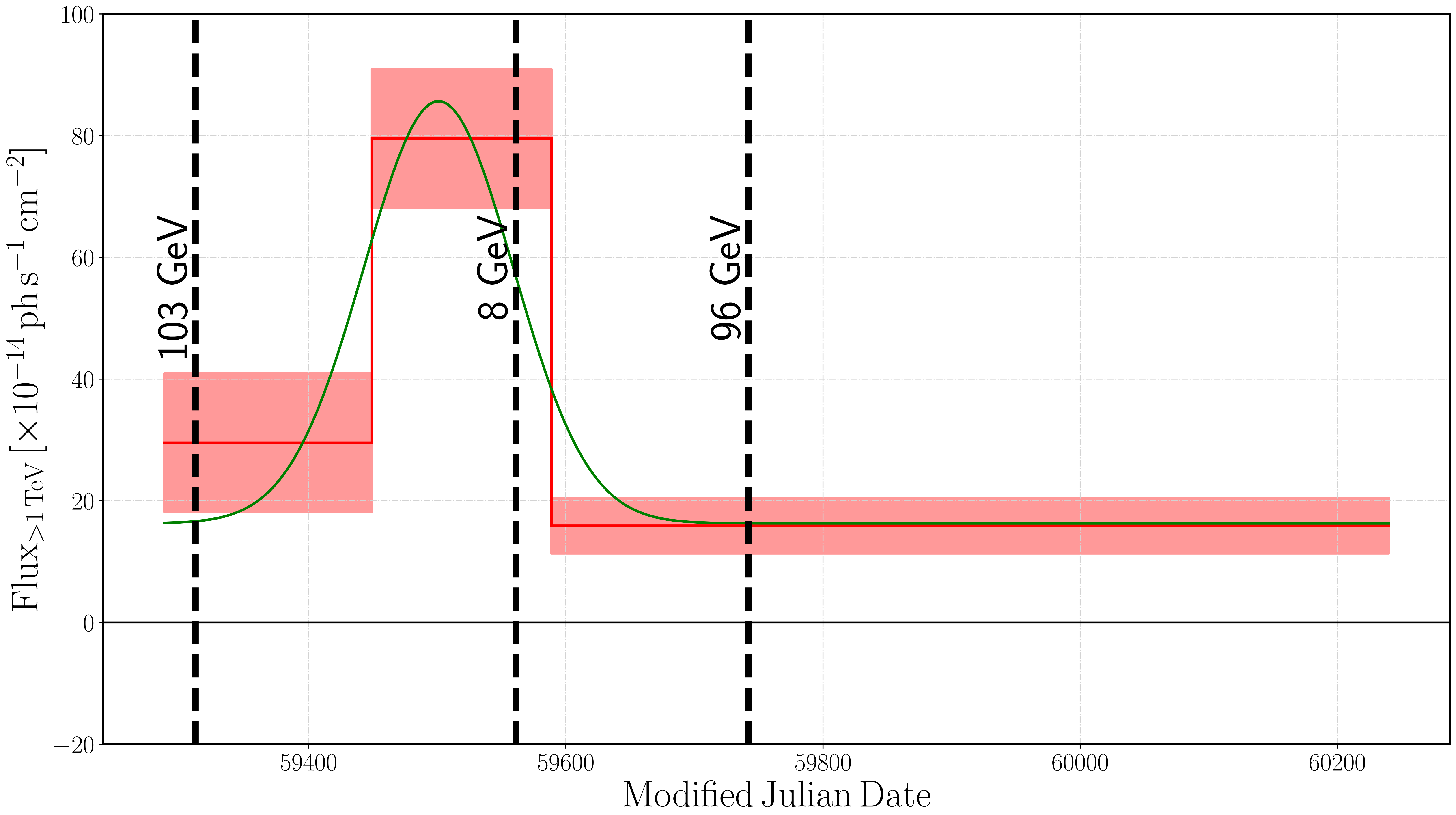
NGC 4278: γ-ray band (Bronzini et al. in prep)

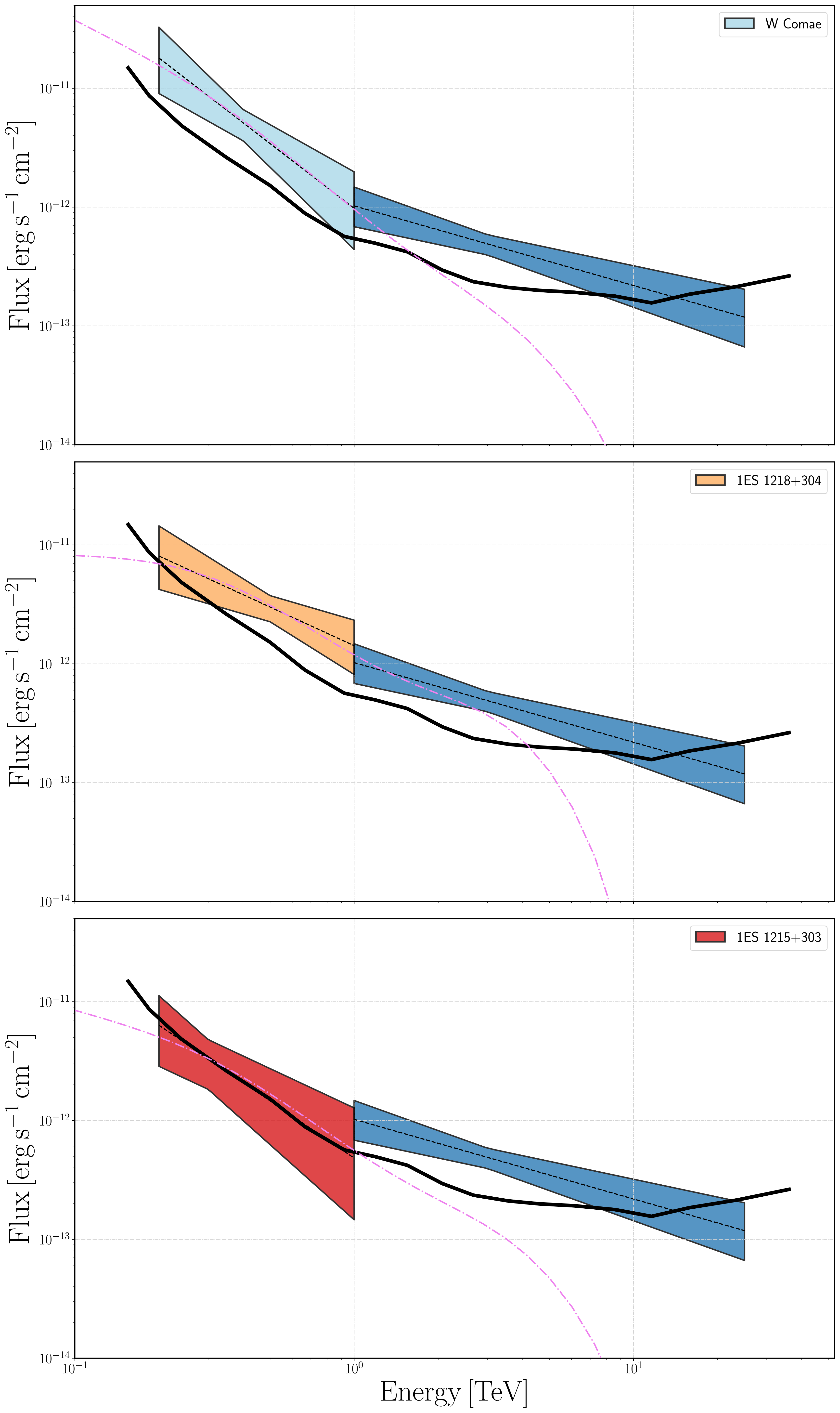
Analysis setup

- Fermipy v1.2.0 and Fermitools v2.2.0
- March 1st 2021 - October 1st 2022 (MJD = 59274 - 59853)
- 100 MeV - 1 TeV
- IRFs P8_SOURCE_V3 and SOURCE event type
- RoI=15° (centered on the radio position of NGC 4278)
- 4FGL-DR4 catalog model
- NGC 4278 manually added ($\Gamma = 2$)
- Binned likelihood with 21 components

ENERGY INTERVAL [GeV]	Z_{max} [deg]	PIXEL SIZE [deg]			
		PSF0	PSF1	PSF2	PSF3
0.1 - 0.3	90	—	—	0.6	0.6
0.3 - 1	100	—	0.4	0.3	0.2
1 - 3	105	0.4	0.15	0.1	0.1
3 - 10	105	0.25	0.1	0.05	0.04
10 - 30	105	0.15	0.06	0.04	0.03
30 - 1000	105	0.03	0.03	0.03	0.03

NGC 4278: TeV light-curve




W Comae
1ES 1218+304
1ES 1215+303
Flux [erg s^{-1} cm^{-2}]
Energy [TeV]
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-1}
10^{0}
10^{1}

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Why studying RL AGN

The vast majority of AGN in the local Universe shows low-luminosities ($L_{\rm bol} \lesssim 10^{42}$ erg/s) —> **LLAGN** (e.g, Ho 08)

- **Modest radio cores** ($L_{5\,\rm GHz} = 10^{19-21}$ W/Hz) (e.g, Ho 08) and **weak** ($P_{\rm jet} < 10^{42}$ erg/s) pc-scale **jets** (Mezua&Prieto14)
- Radiative inefficient accretion flow (RIAF) (Ichimaru77, Narayan&Yi94)
- **X-ray faint** ($L_{2-10\,\rm keV} \sim 10^{38}$ erg/s) (Ho 01)
- No LLAGN with pc scale jets was known to emit at VHE (>100 GeV) until LHAASO pointed to NGC 4278 as a possible counterpart of 1LHAASO J1219+2915 (de Menezes+20)