

UHE emission from γ -ray loud binaries LSI 61⁰303 and LS 5039

Cong Li, Xuqiang Dong, Guangman Xiang, Hongkui Lv, Huihai He, Jianeng
Zhou

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On behalf of LHAASO Collaboration

Location: $29^{\circ}21'27.6''N$ $100^{\circ}08'19.6''E$

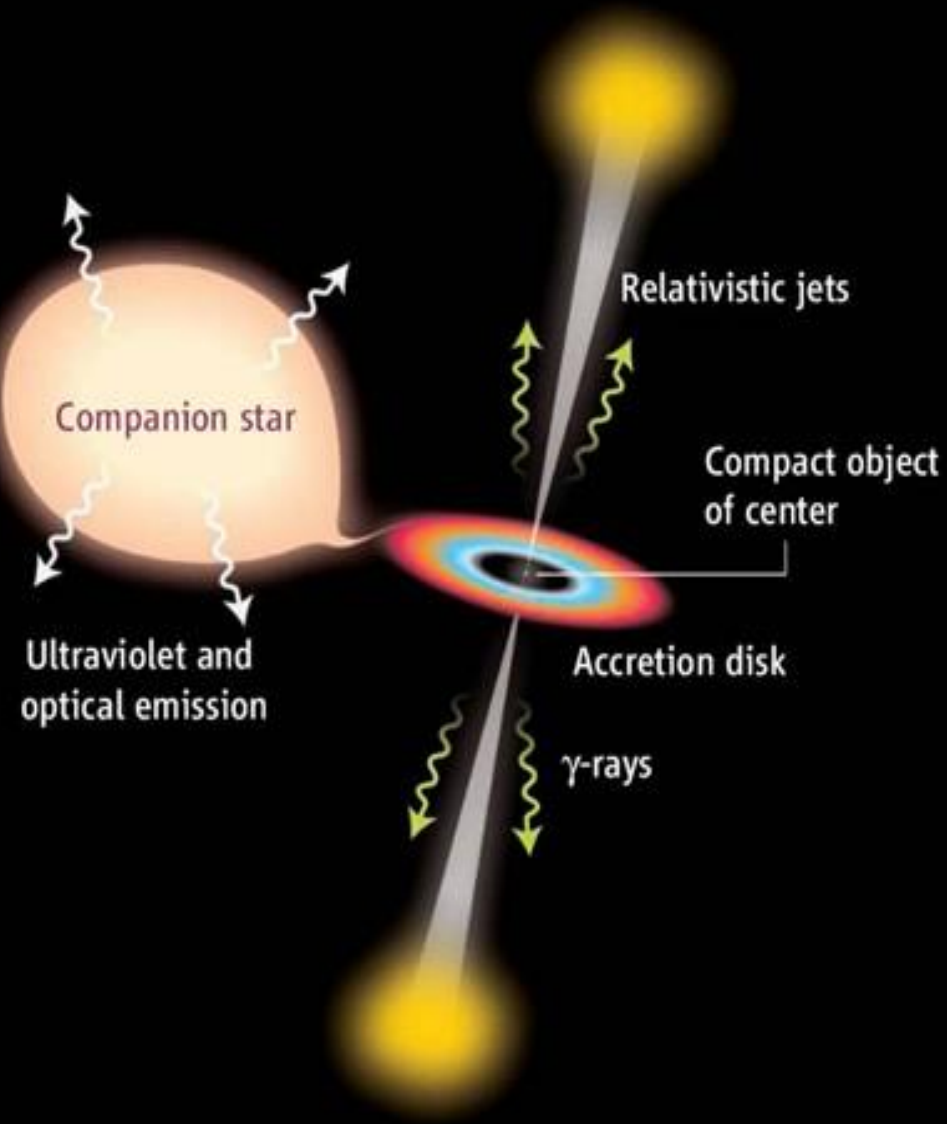
Altitude: $4410m$ *a.s.l*



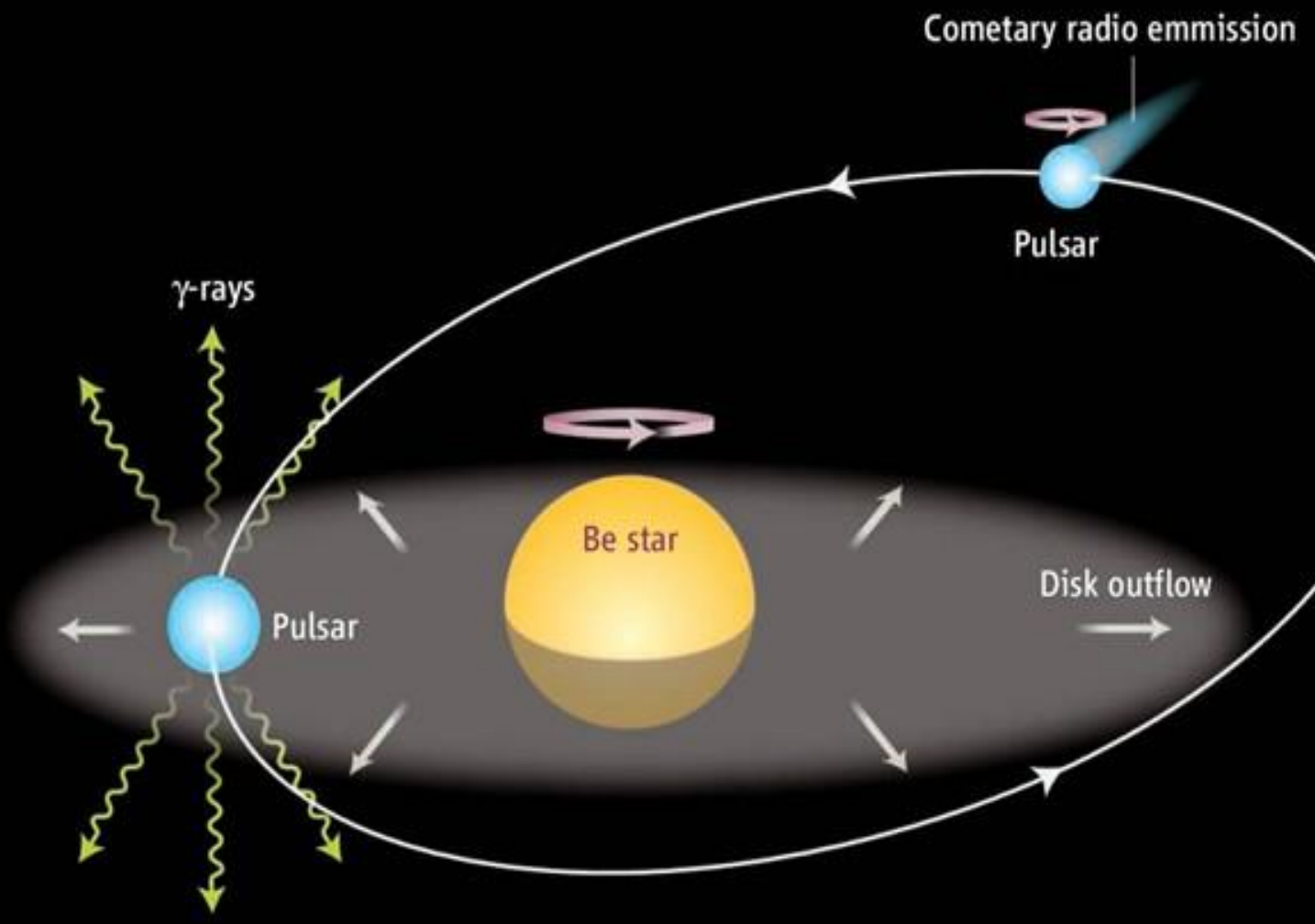
Outline

- Motivation
- Results from LHAASO
- Conclusion and prospect

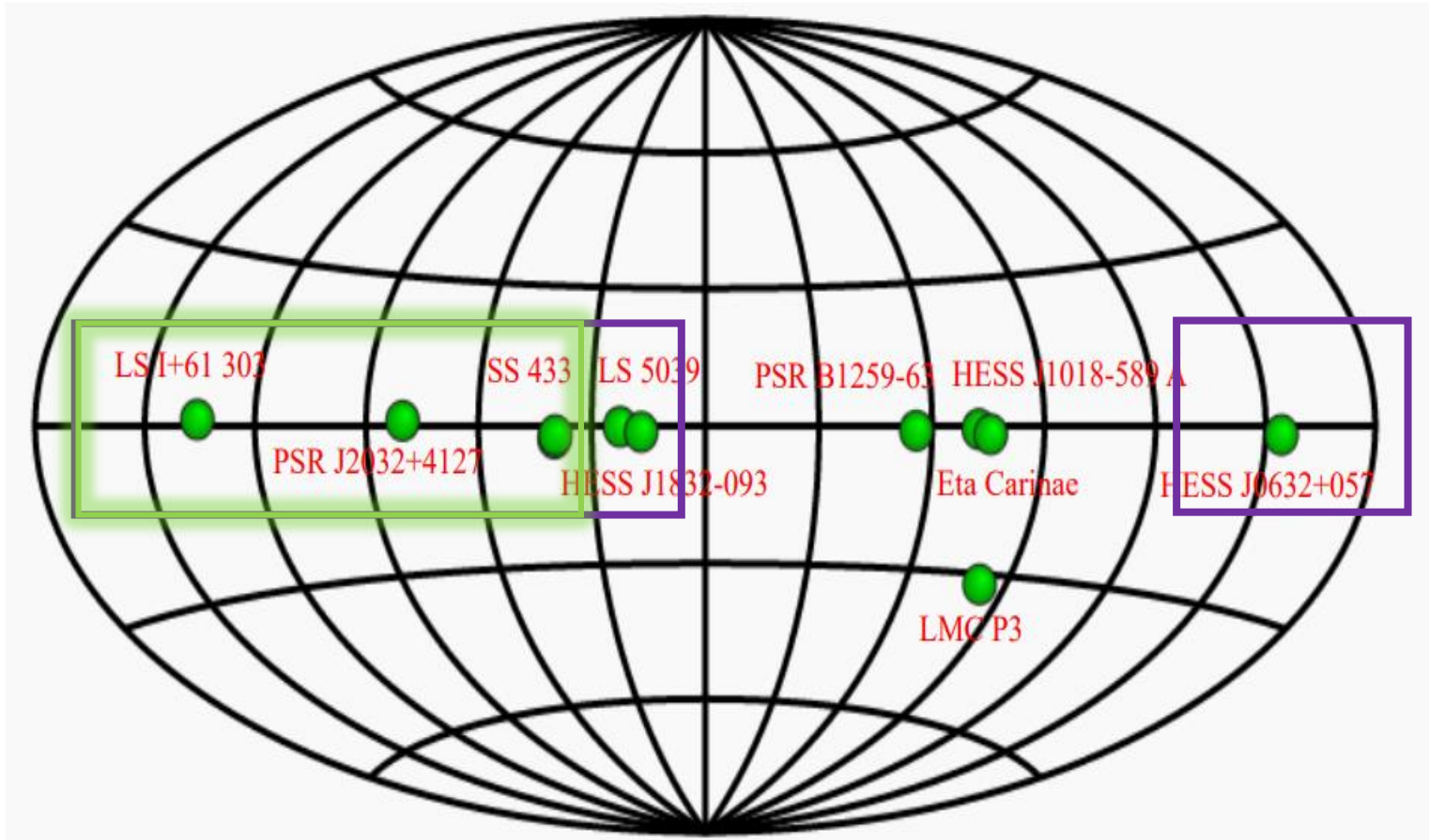
MICROQUASAR



BINARY PULSAR



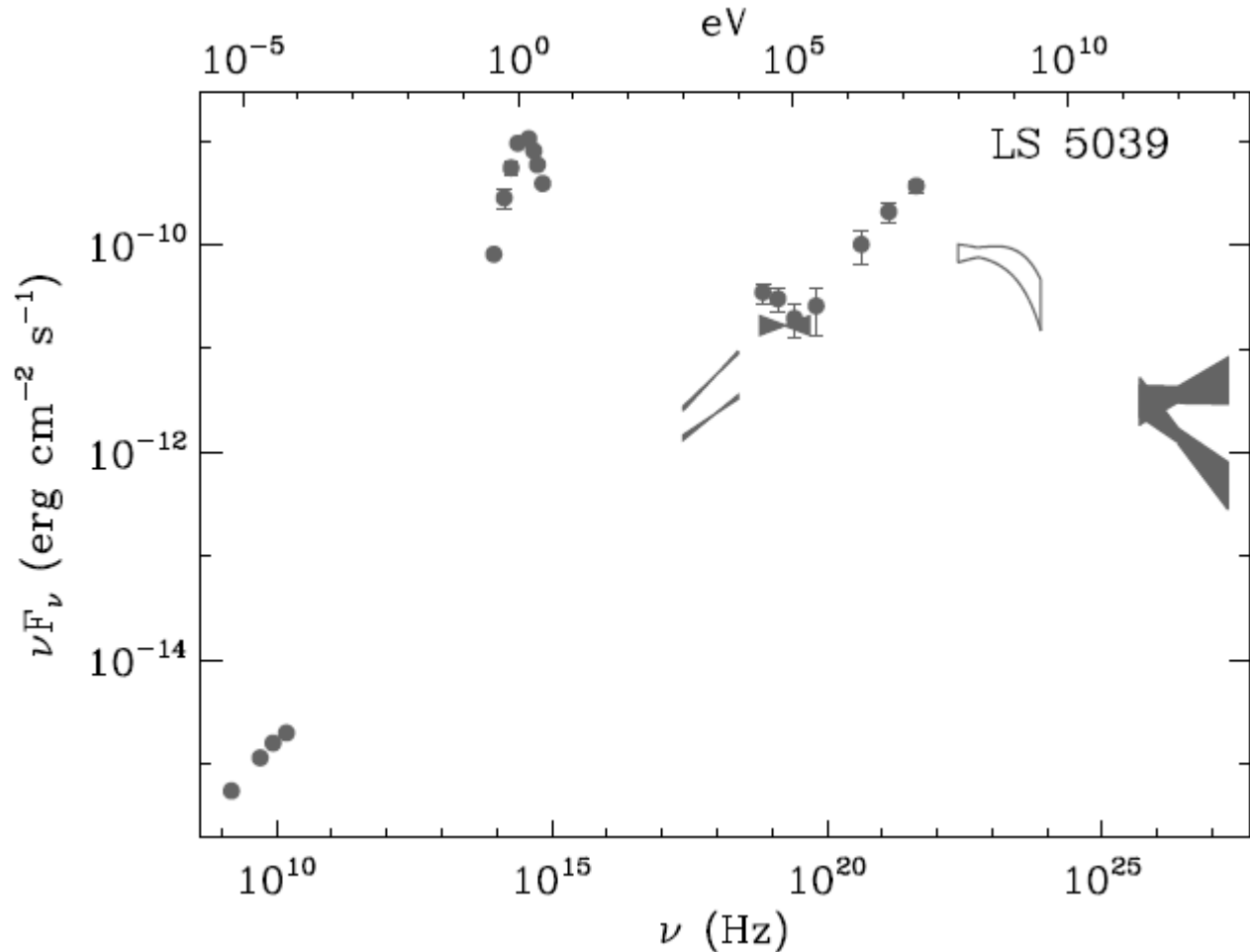
Binaries at TeV



10 Binaries in TeVCat

- PSR?+Massive star: 8
- Micro quasars: SS433+V4641 Sgr?
- Others: Eta Carinae
- ◆ 6 binaries are in LHAASO's view.

γ -ray loud Binary



- γ -ray loud binary is a kind of source that emits gamma rays.

- The flux modulated by the orbital phase.
- It has flares at gamma ray bands sometimes.
- ...

LHAASO data analysis



◆ Data:

- KM2A: Half array(299days)+quarter array(218days)+full array(884days);
- WCDA: Full array(~880days);

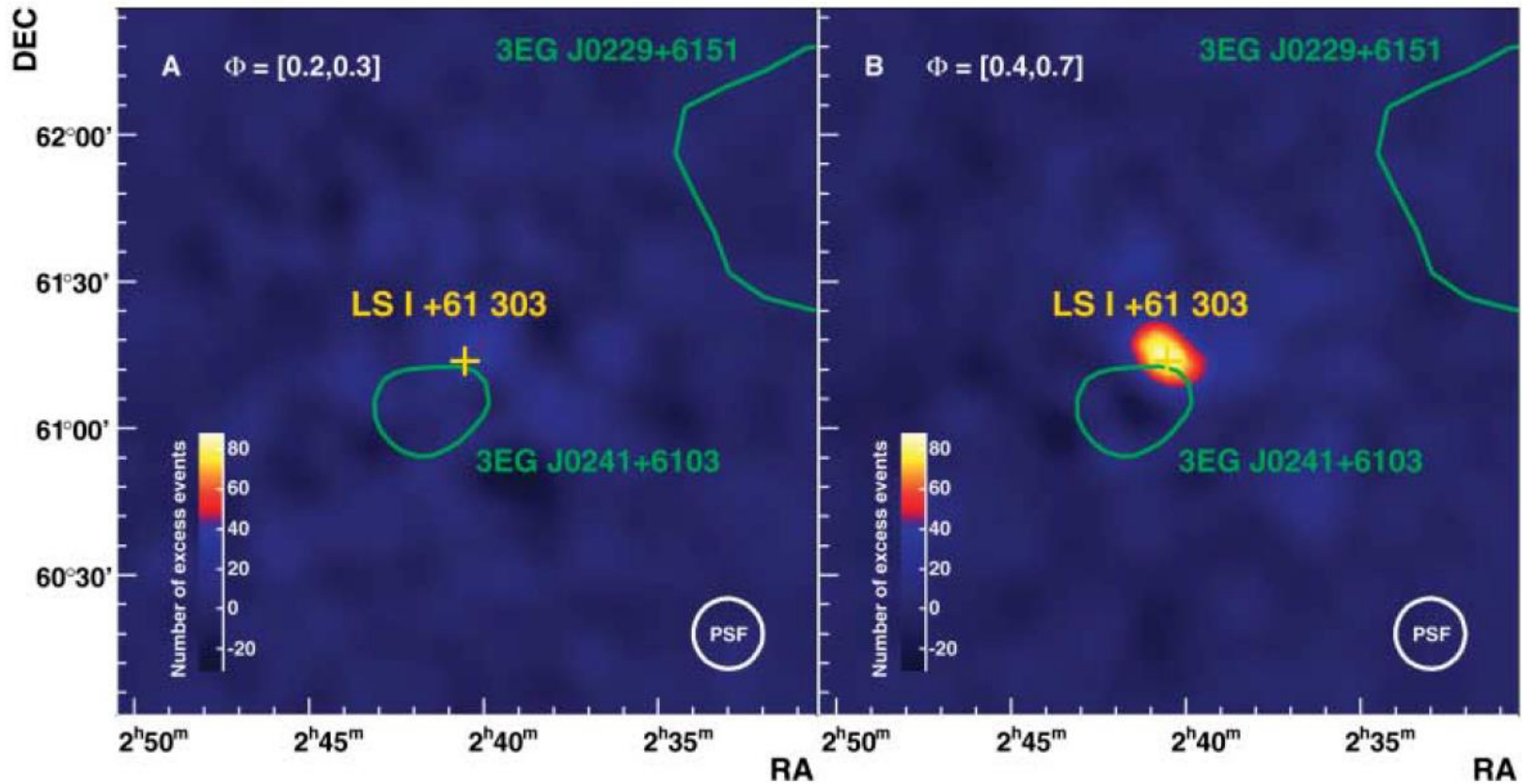
◆ CR background estimation:

- Direct integration method
- Region with distance less than 10deg from Galactic plane are masked

◆ Analysis method:

- A 3D likelihood fitting framework is developed

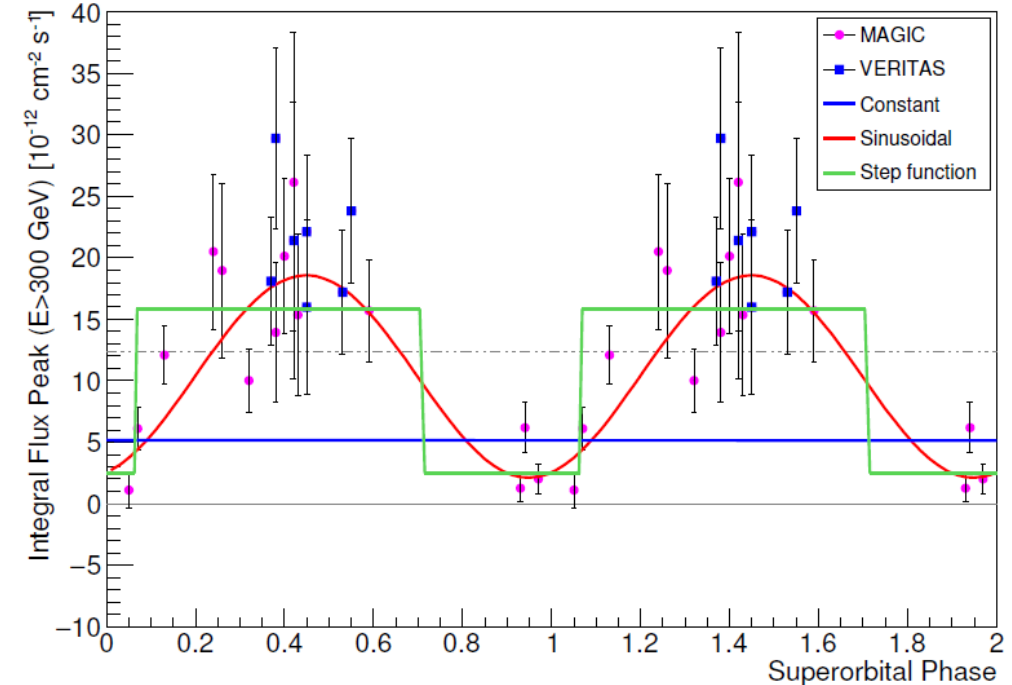
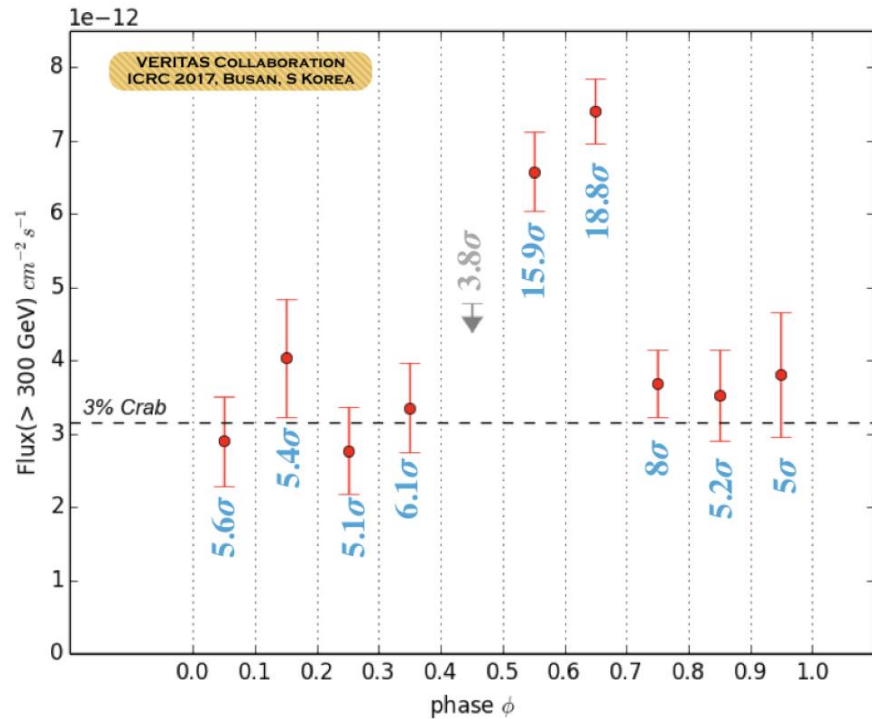
LSI 61⁰303



- Companion star: Be star;
- Compact object: Unknown;
- Orbital period: 26.4960 days;

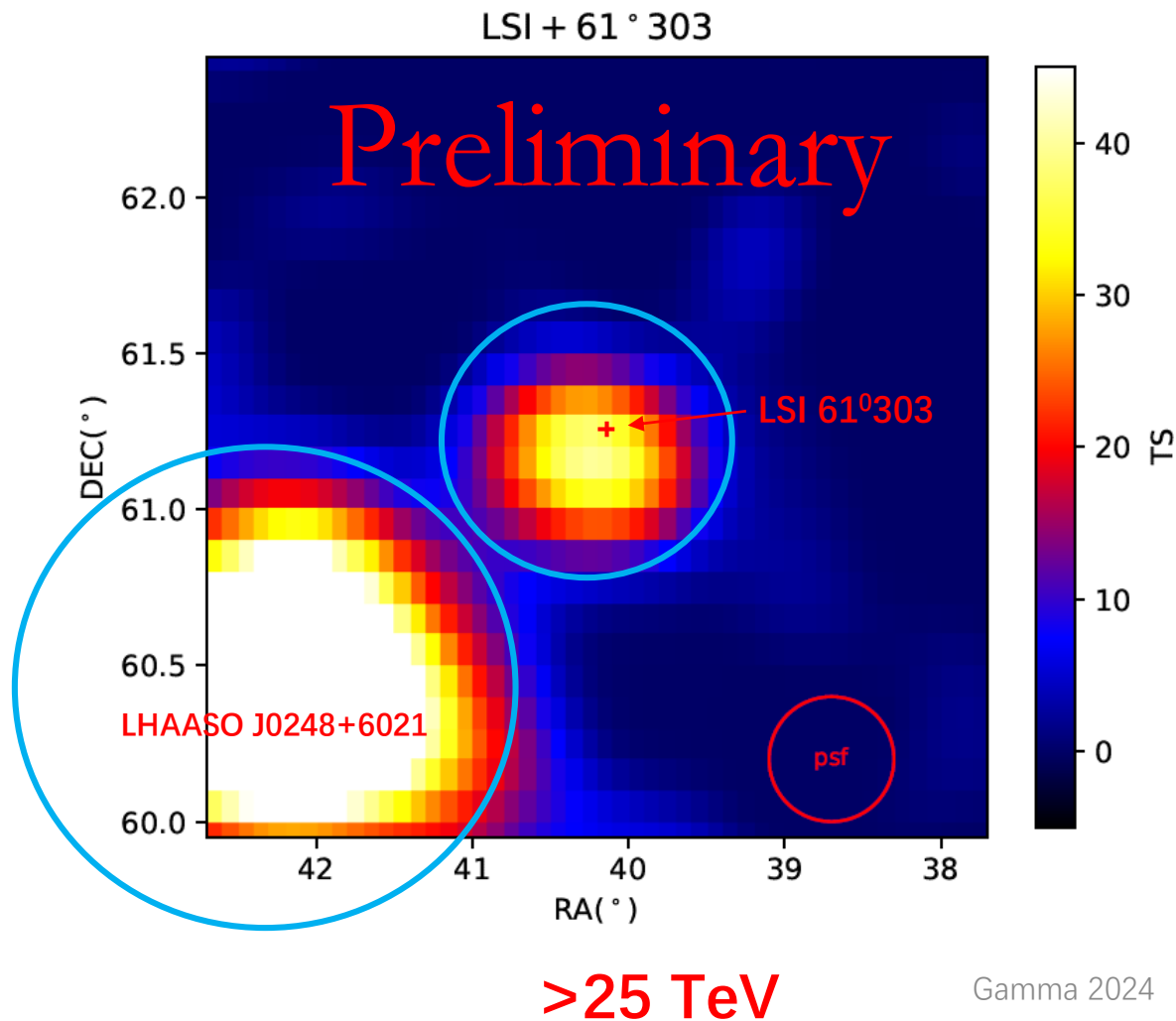
Detected from radio to very high energy (VHE) gamma rays.

Orbital modulation



- Orbit-to-orbit variability has been associated with a super-orbital modulation at a period of 1667 ± 8 days.

Results from LHAASO

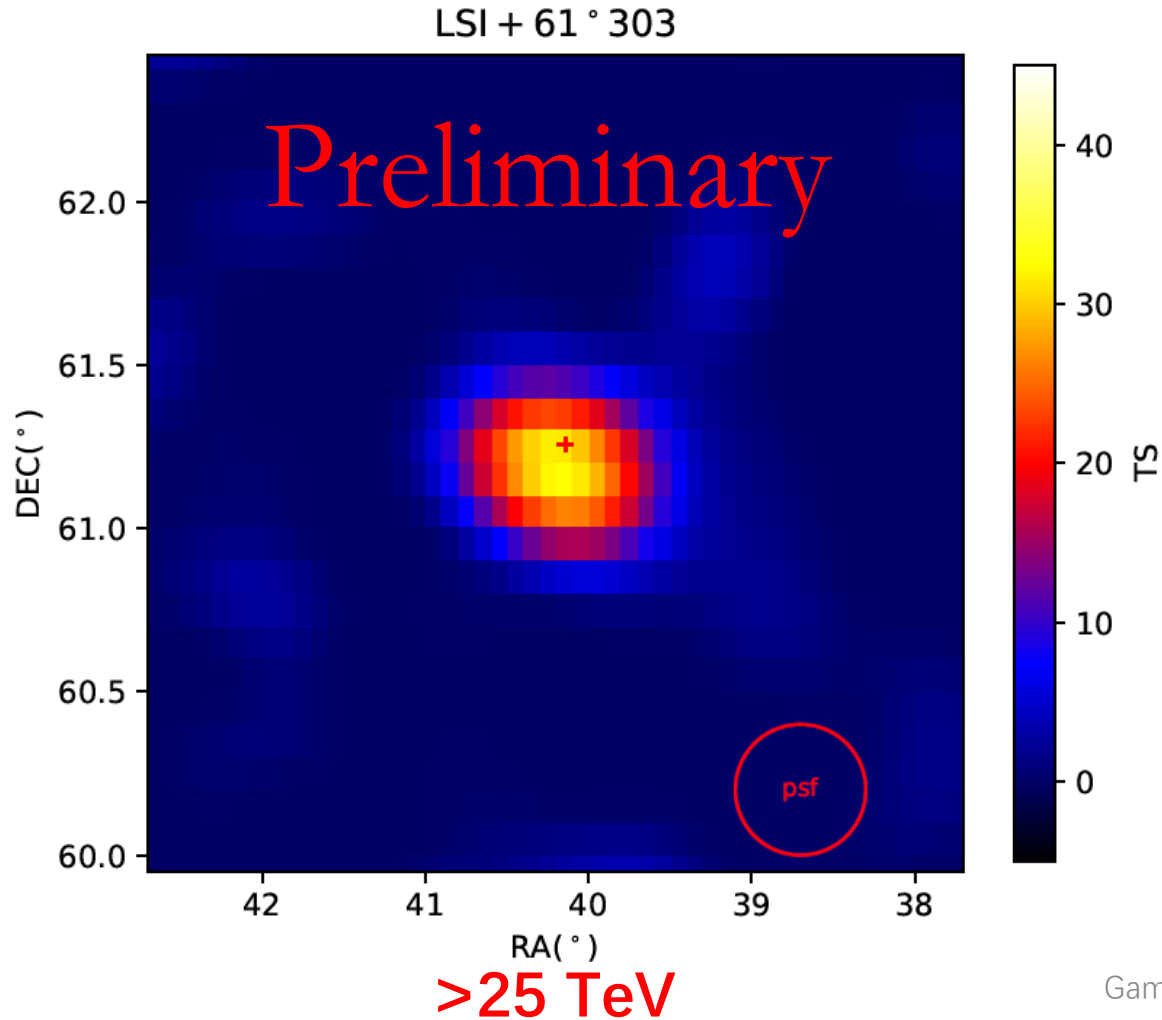


- Clean environment

The most nearby source is LHAASO J0248+6021, which is about 2 degrees from LSI 61°303 and might be a pulsar halo or PWN.

- ◆ The two sources are fitted simultaneously using 2D Gaussian model to describe the morphology of the sources.

LSI 61⁰303



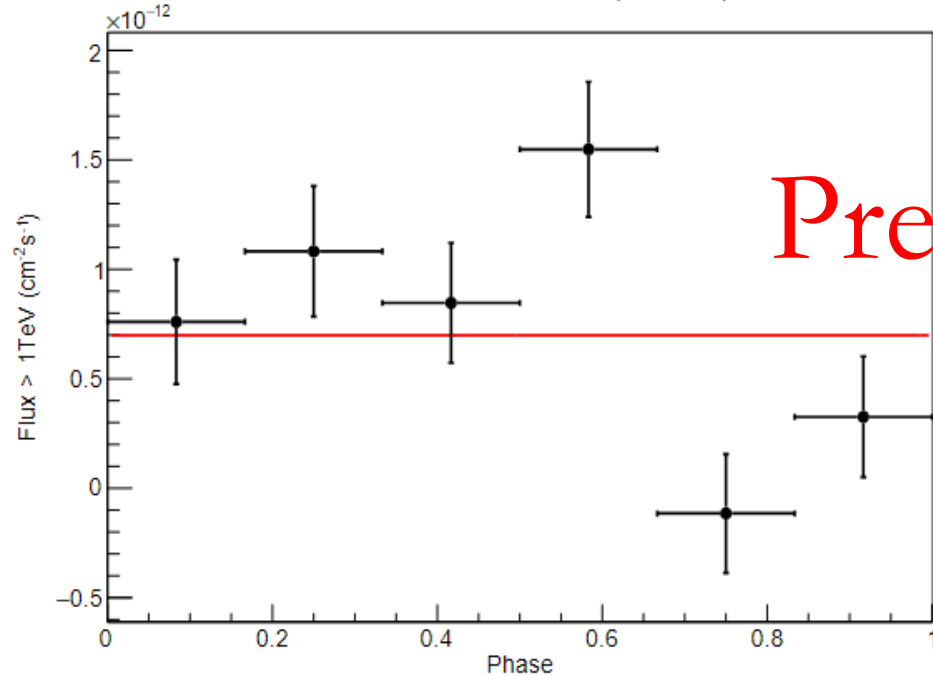
- ◆ A point source is detected at a significance of more than **5 sigma** by both KM2A and WCDA.

$RA: 40.16 \pm 0.11(stat) \pm 0.03(sys);$
 $DEC: 61.17 \pm 0.05(stat) \pm 0.03(sys);$

Orbital light curve

1-25 TeV

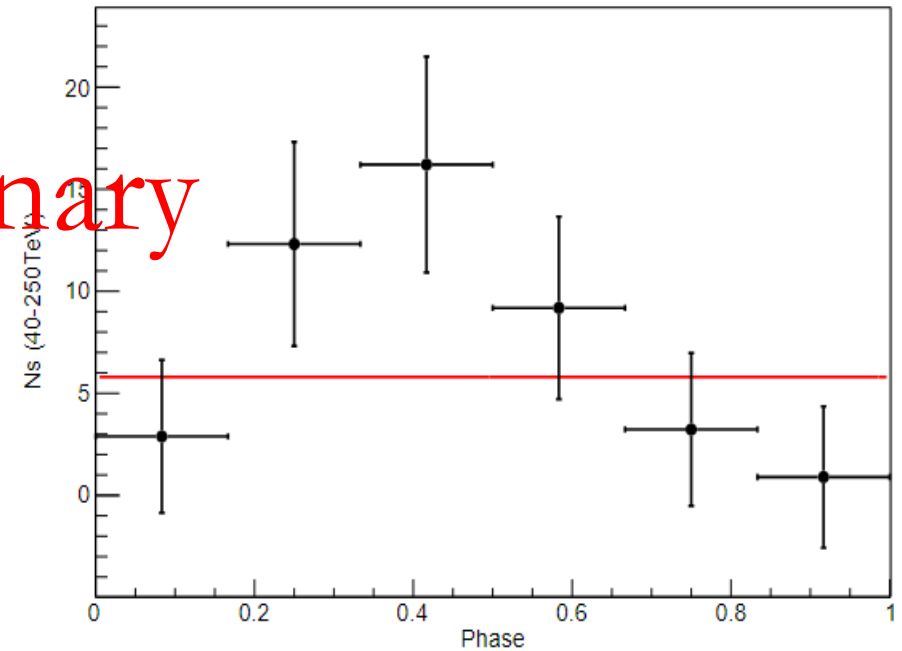
Distribution of Phase(WCDA)



$$\frac{\chi^2}{ndf} = 20.36/5 = 4.07$$

>40 TeV

Distribution of Phase(KM2A)



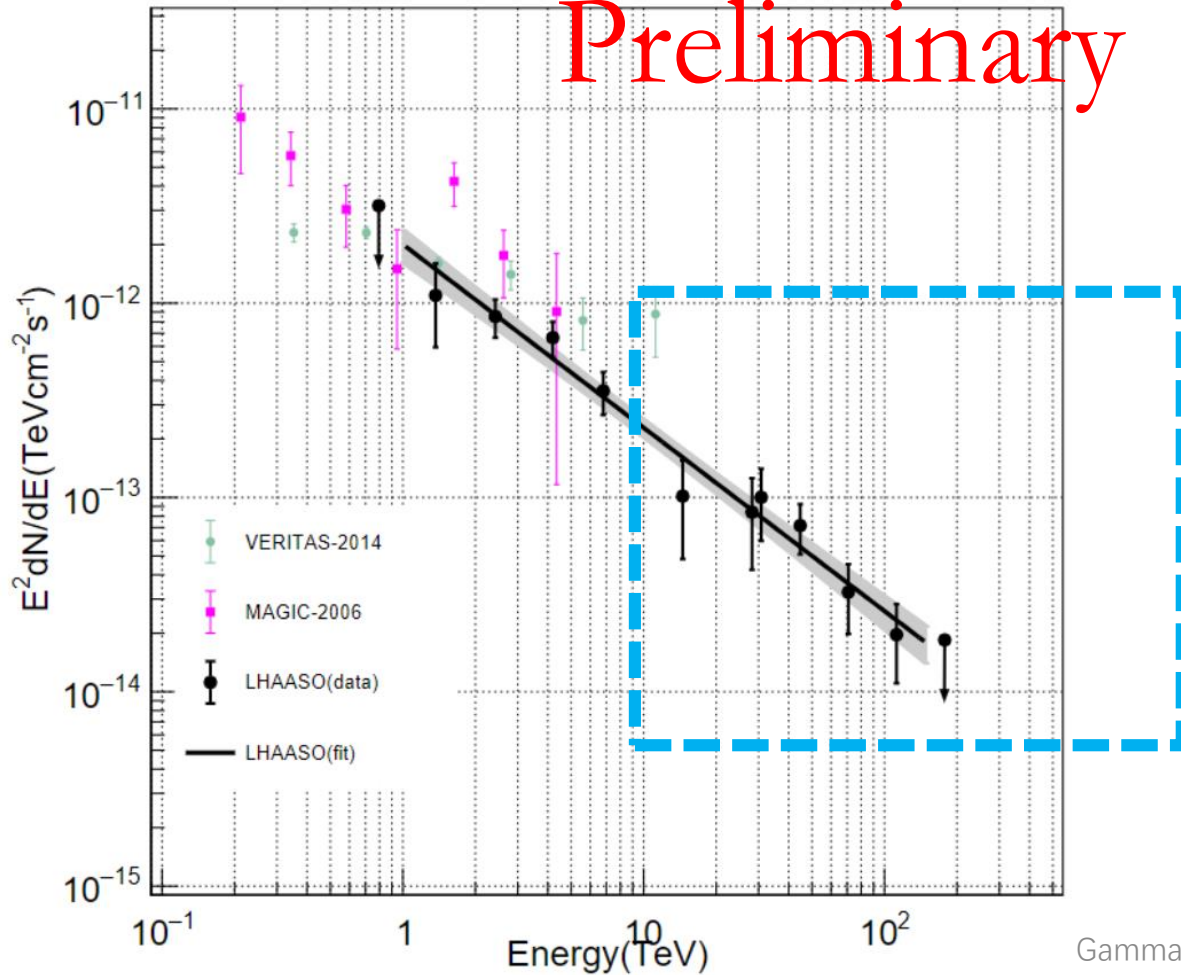
$$\frac{\chi^2}{ndf} = 9.2/5 = 1.84$$

Preliminary

Spectrum

LS I +61° 303

Preliminary



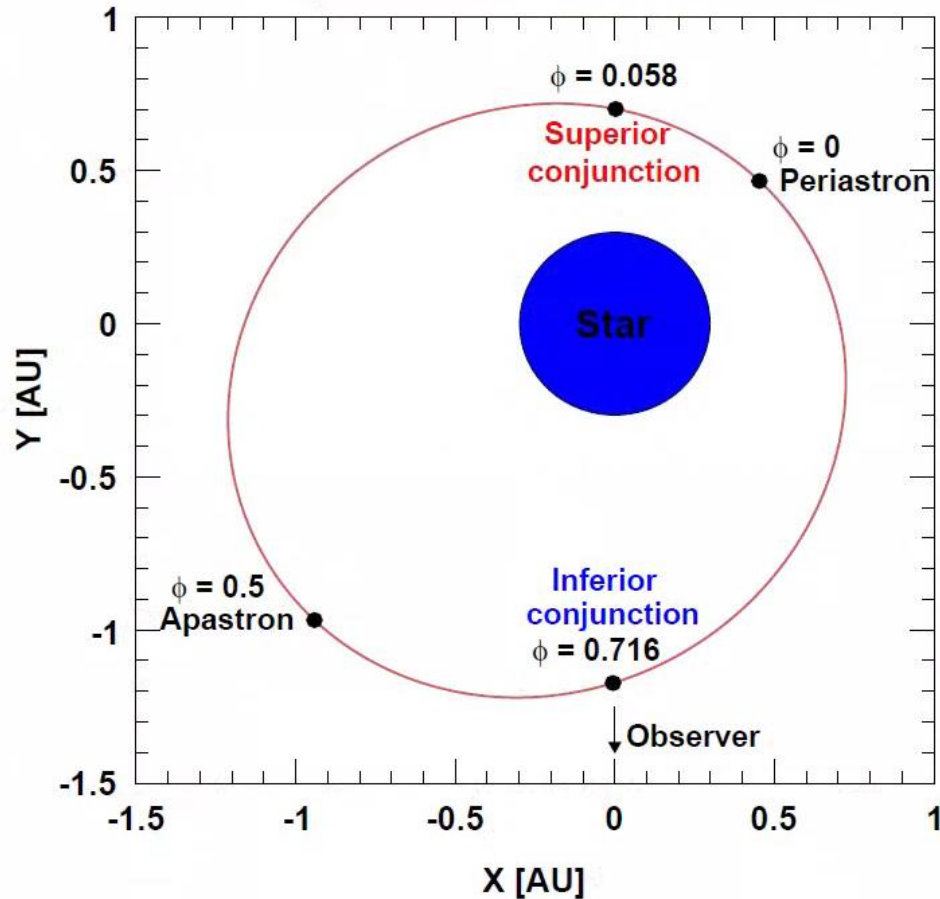
$$F = F \times \left(\frac{E}{E_0}\right)^{-\alpha}$$

$$F = (2.2 \pm 0.3) \times 10^{-13} \text{ TeV/cm}^2/\text{s} @10\text{TeV}$$

$$\alpha = 2.91 \pm 0.08$$

◆ No sharp cut-off up to at least 100 TeV.

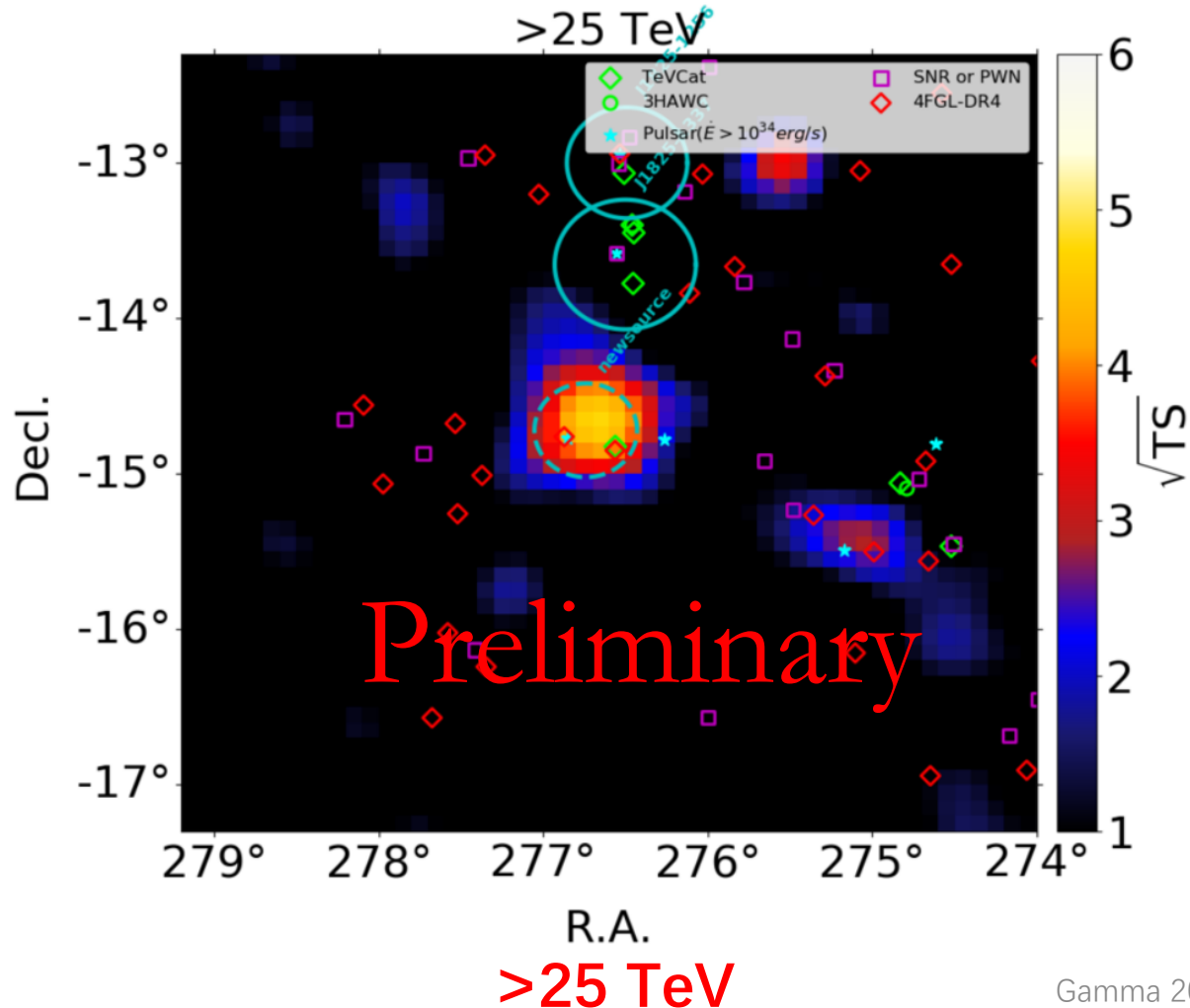
LS 5039



PoS ICRC2015 (2016), 885

- Detected by HESS at TeV;
- The minimum flux is close to superior conjunction or to periastron and maximum flux occurs around inferior conjunction .
- At INFC, the best fit spectrum is a power law with $\Gamma \approx 1.8$ and an exponential cutoff at $E_c \approx 8.7$ TeV.
- At SUPC, the source is fainter and best described by a single power-law with a softer index $\Gamma \approx 2.5$.

LS 5039



- ◆ LHAASO has detected a source with significance of more than 5sigma above 25TeV;
- ◆ The more dedicated analysis is ongoing now.

Conclusion and prospect

- LSI 61⁰303 is detected by both WCDA and KM2A;
- The orbital modulation is more significant at TeV;
- No sharp cut-off at least up to 100 TeV;
- Another interesting binary LS 5039 is also detected by LHAASO with energy above 25TeV;

Thanks !

licong@ihep.ac.cn