

# Gamma-ray counterparts to high-energy neutrinos

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# Outline

## Motivation:

- 2 out of 39 IC events with one gamma-ray counterpart positionally coincident
- IC-170922A in spatial coincidence with blazar TXS 0506+056 and temporal coincidence with gamma-ray flare + archival neutrino flare in 2014/15 (*Aartsen et al. 2018*)
- One well-reconstructed archival HESE event (HESE-63) was spatially coincident with Fermi-LAT blazar

## This talk:

- Dedicated gamma-ray analysis of the two regions in the full range 100 MeV – 1 TeV with 9.6 years of Fermi-LAT data:
  - TXS 0506+056 (IC-170922A)
  - GB6 J1040+0617 (IC-141209A)

**IC-170922A**

**TXS 0506+056**

# IC-170922A and TXS 0506+056 region

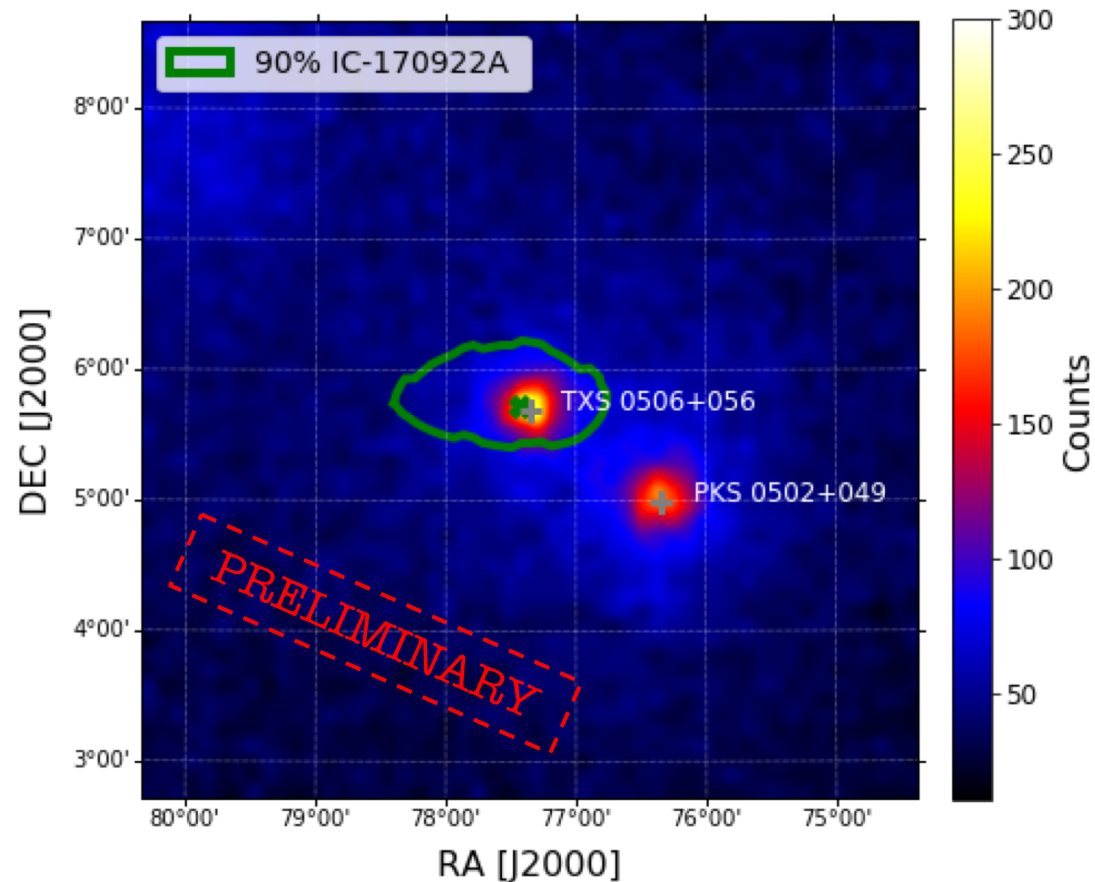
Fermi-LAT analysis from 100 MeV

## IC-170922A

- MJD 58018.87
- (Ra , Dec) = (77.43°, 5.72°)
- $E_\nu \sim 290$  TeV

## TXS 0506+056

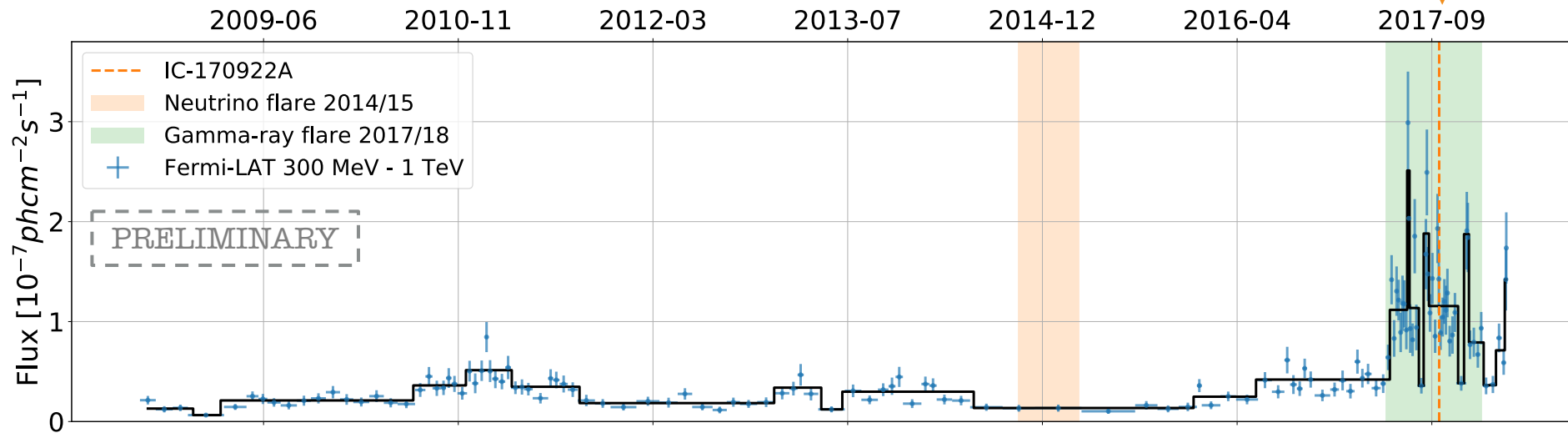
- BL Lac, ISP
- 3FGL/3FHL J0509.4+0541
- $z = 0.3365 \pm 0.0010$



Garrappa+ (in preparation)

# TXS 0506+056

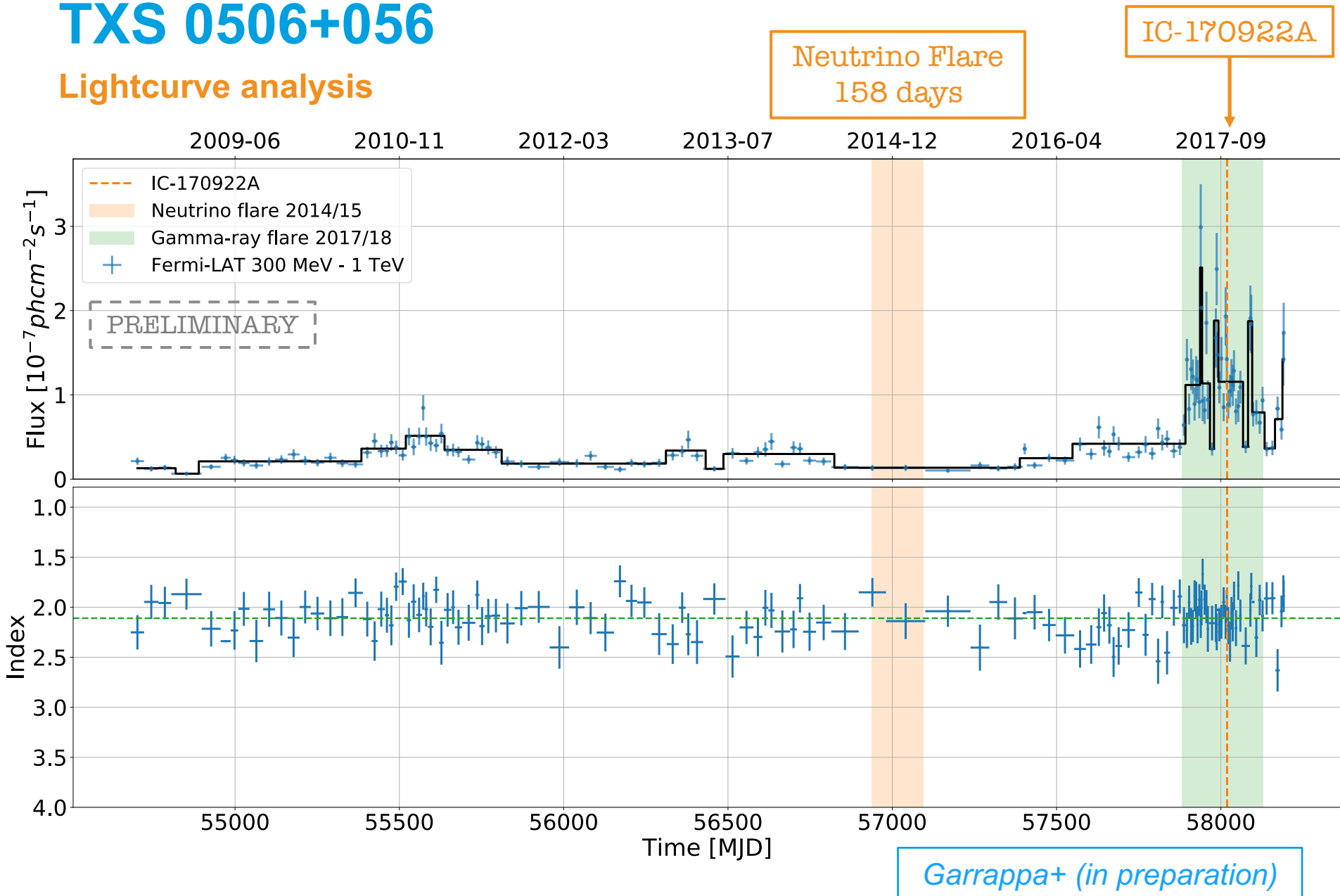
## Lightcurve analysis



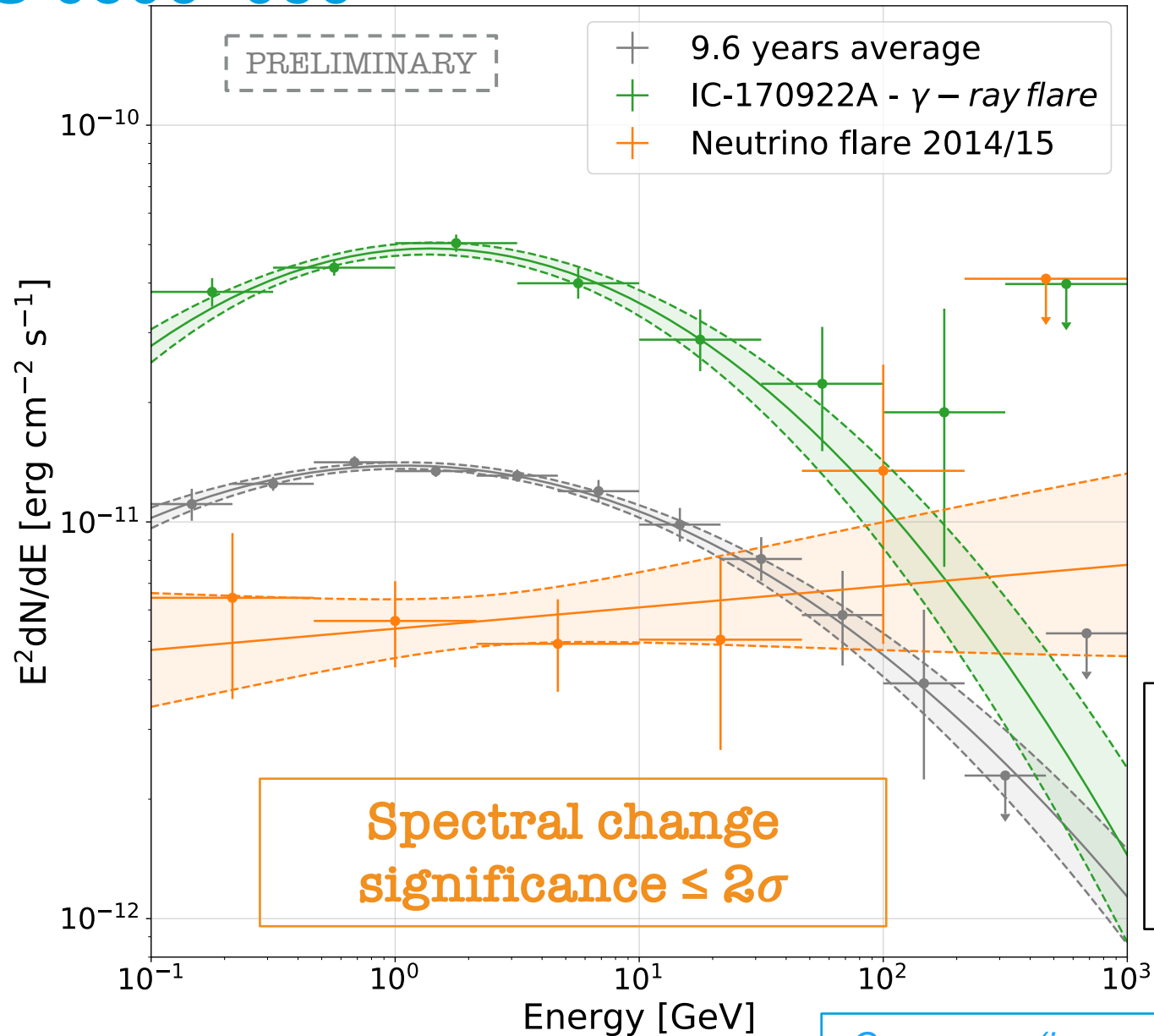
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# TXS 0506+056

## Lightcurve analysis



# TXS 0506+056



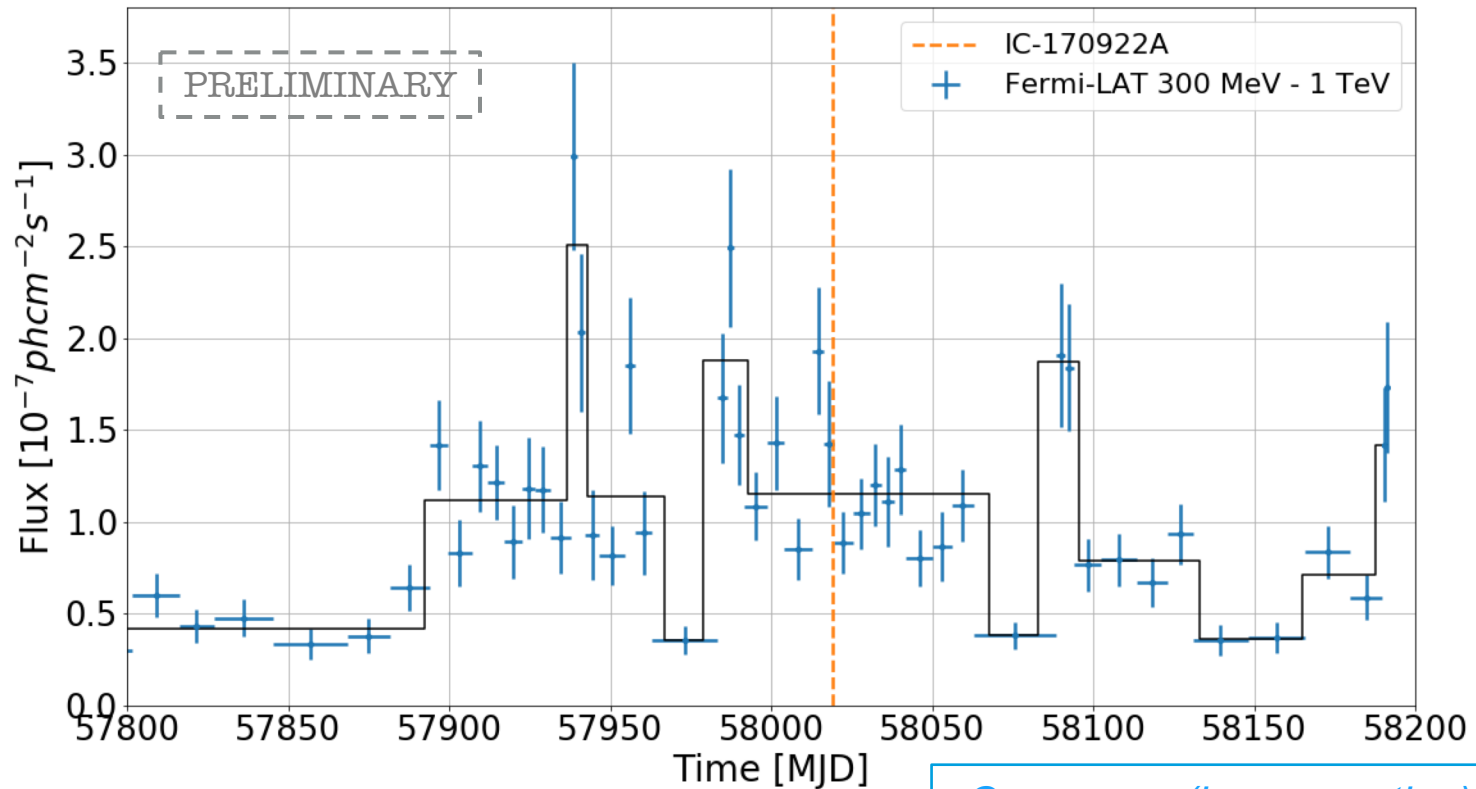
See also  
*Padovani et al.*  
2018  
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*T. Glauch talk on*  
*Monday*

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# TXS 0506+056

## IC 170922A , gamma-ray flare

- Three bright subflares detected in the 2017/18 bright gamma-ray flare
- We find similar spectral shapes compared to the average 9.6 years SED
- Significant structures are found also on a ~daily timescale



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# TXS 0506+056, a summary

- Detection of flaring blazar within the error region of IC-170922A
- The bright 2017/18 gamma-ray flare shows fast variability on ~daily timescale, suggesting a compact emission region (*Ahnen et al. 2018*)
- During 2014/15 neutrino flare no significant gamma-ray flaring activity or spectral change have been observed

**Still a lot to learn!**

**HESE 63**

**GB6 J1040+0617**

# GB6 J1040+0617

## Counterpart for HESE 63

### IC-141209A

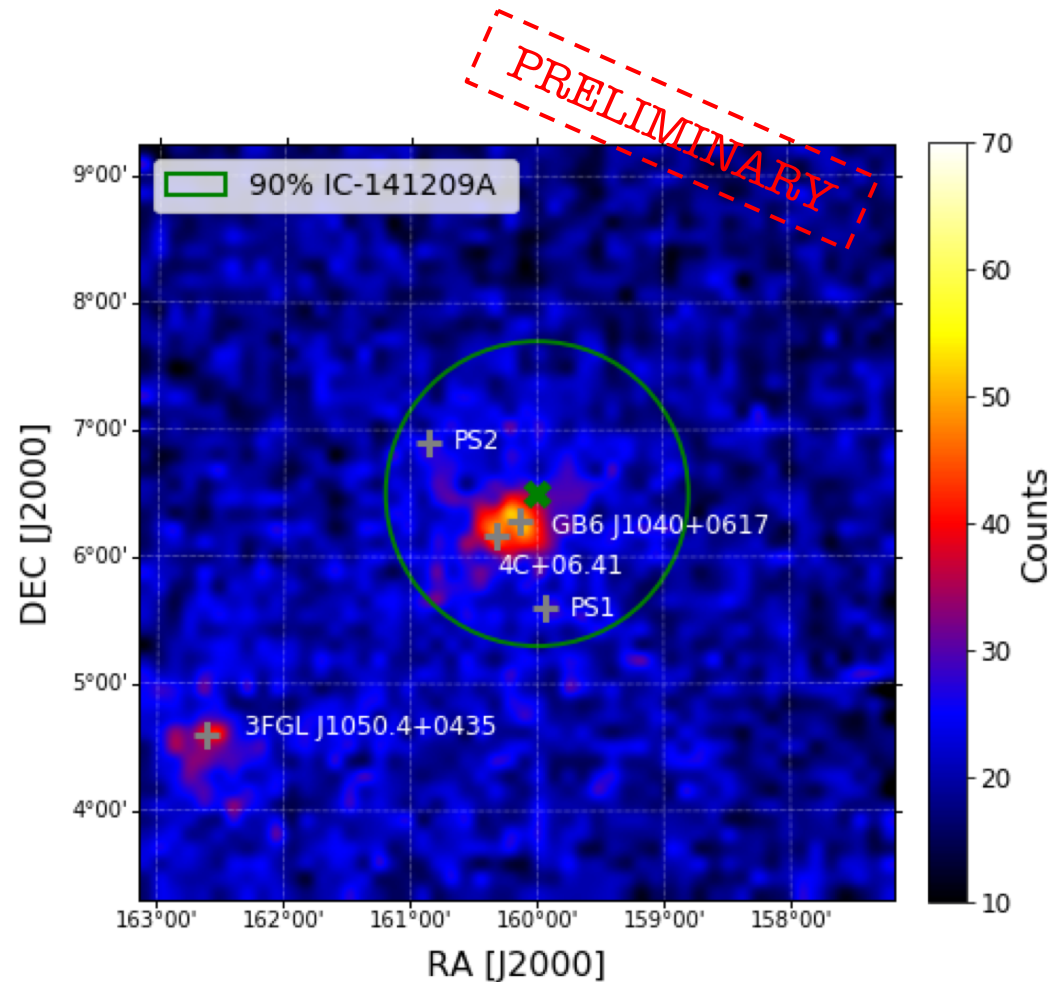
- MJD 57000.14
- (Ra , Dec) = (160.0°, 6.5°)
- Ang. Err. (90%) : 1.2°

### GB6 J1040+0617

- BL Lac, LSP
- 3FGL J1040.4+0615
- $z = 0.7351 \pm 0.0045$ \*
- Dist. from IC-141209A: 0.27°

### ROI

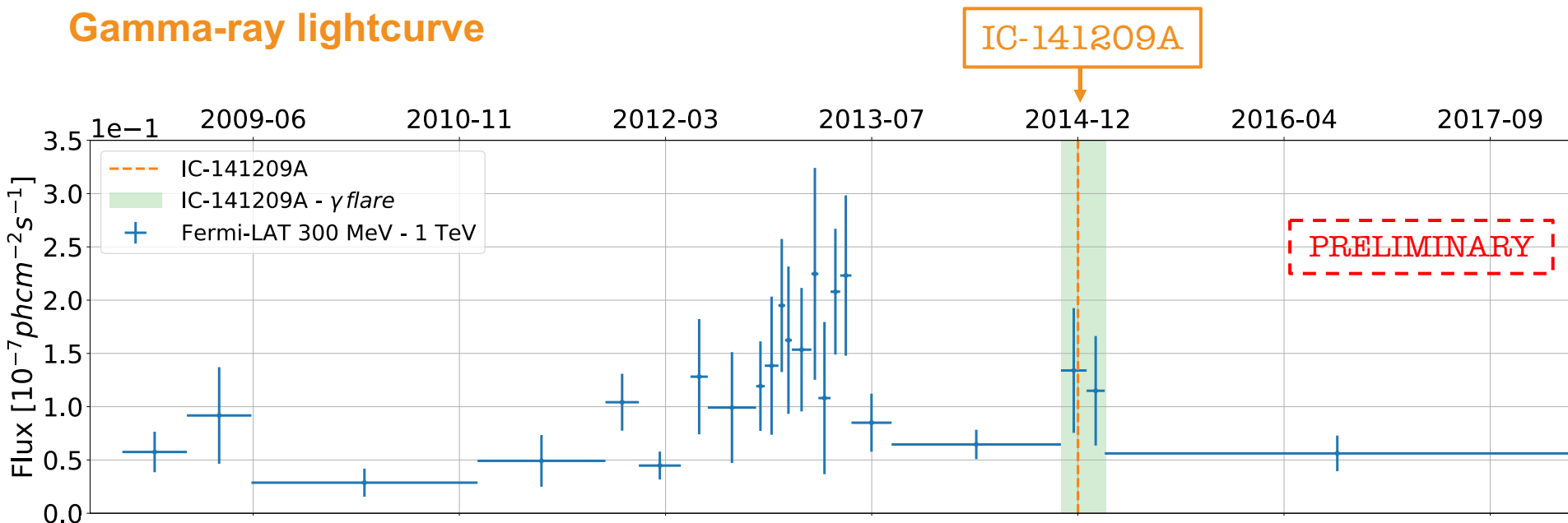
- 4C+06.41 (QSO)
- Two additional sources (PS1 and PS2) found using 9.6 years of data
- PS2 also included in FL8Y as FL8Y J1043.3+0651
- Very dim, can be excluded as possible counterparts.



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# GB6 J1040+0617

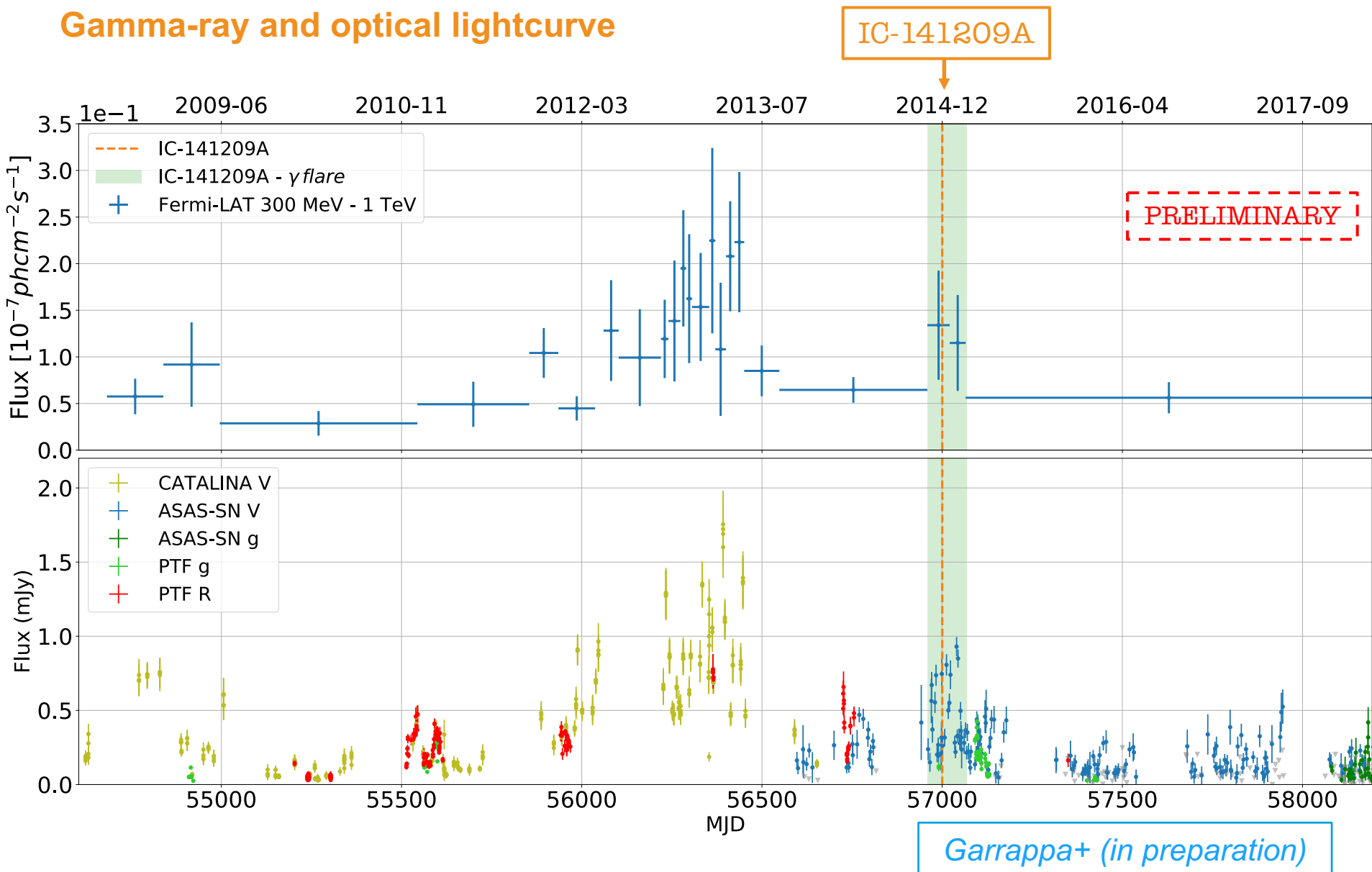
## Gamma-ray lightcurve



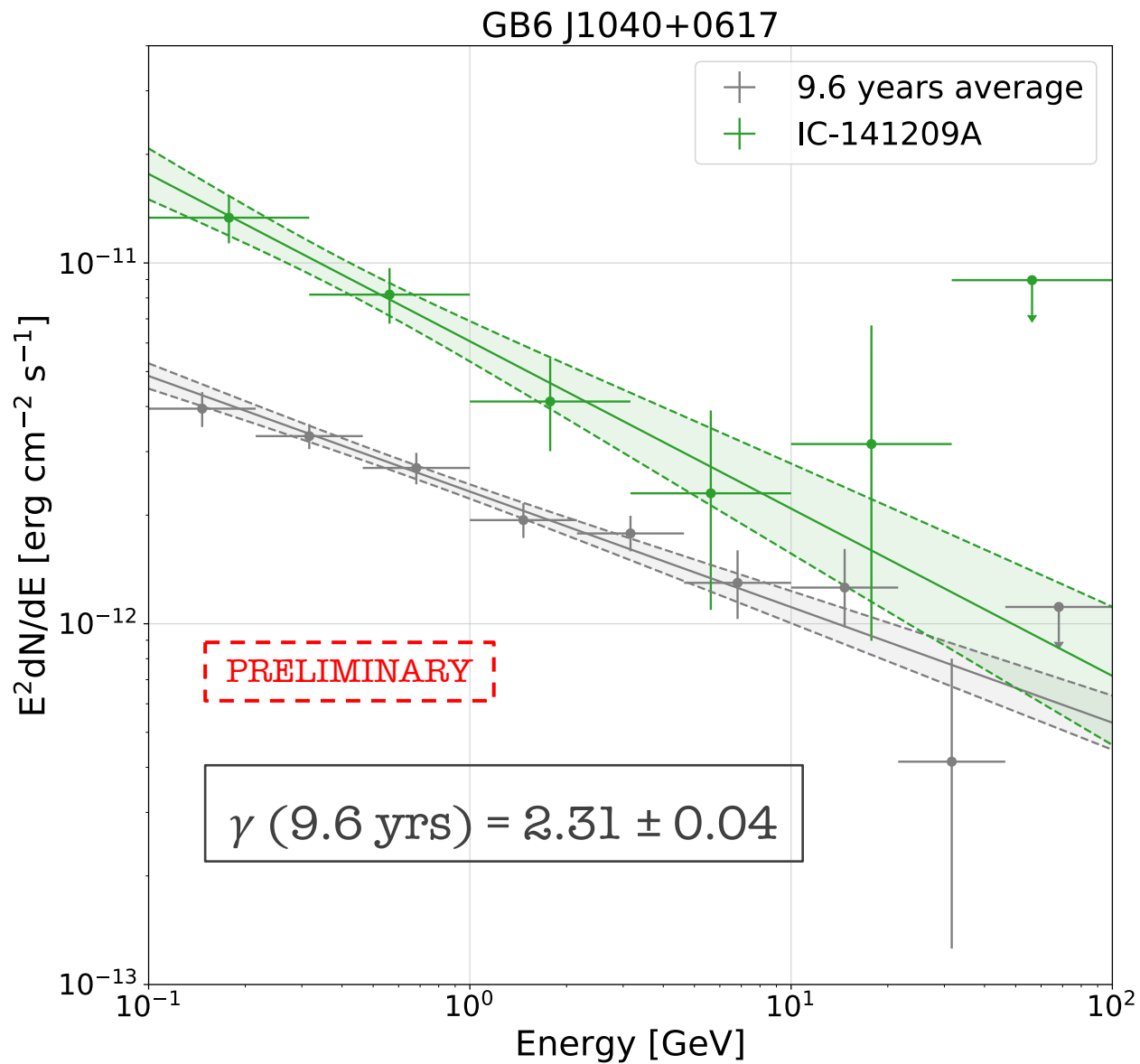
Garrappa+ (in preparation)

# GB6 J1040+0617

## Gamma-ray and optical lightcurve

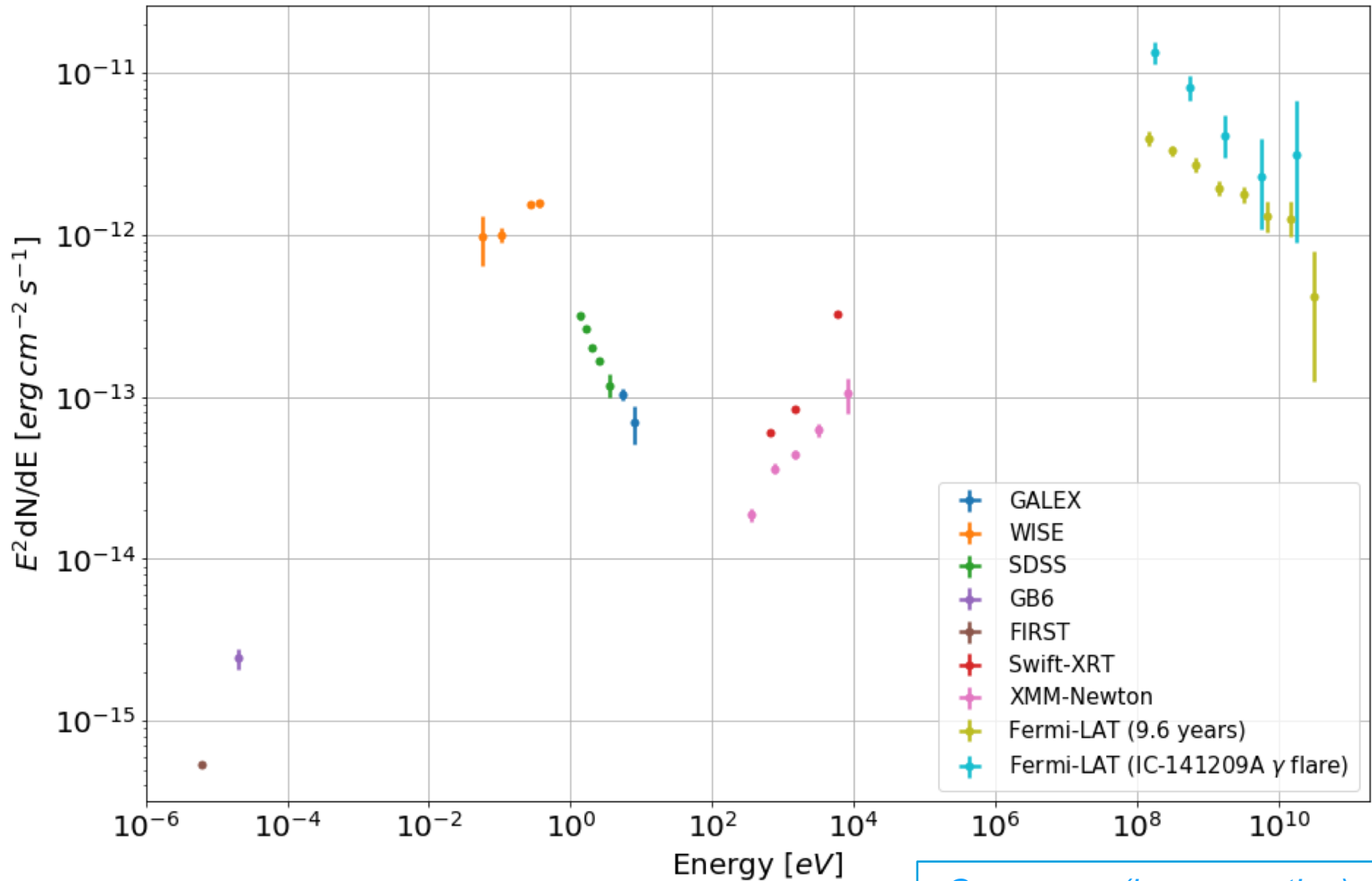


# GB6 J1040+0617



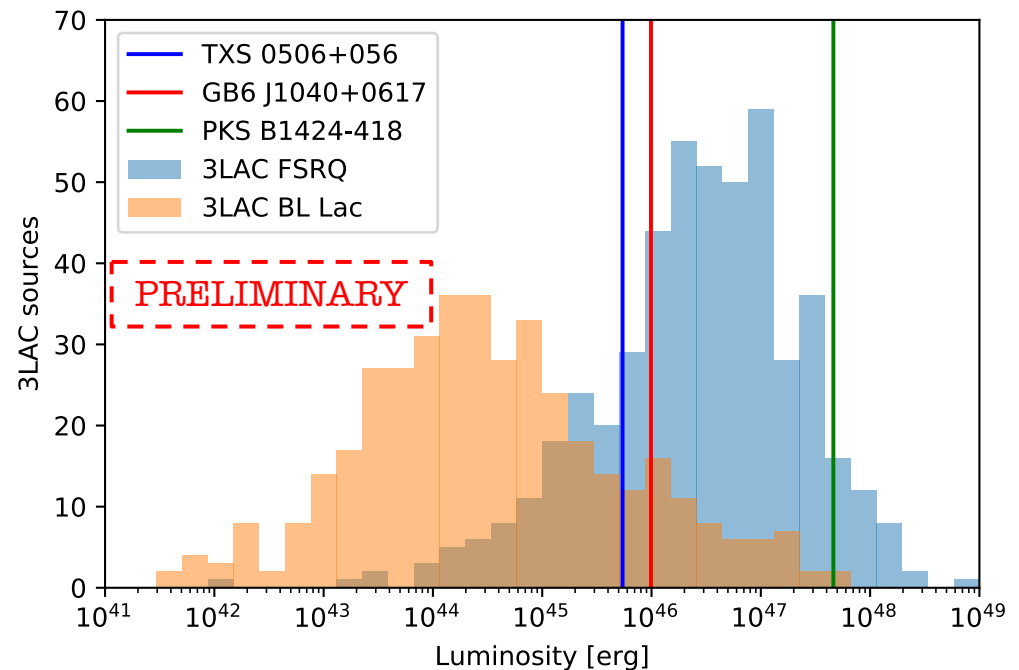
# GB6 J1040+0617

## MWL SED



# GB6 J1040+0617, a summary

- Another potential gamma-ray counterpart for a HESE neutrino event
- Mild increase in the gamma-ray flux and strong optical activity coincident with the detection of IC-141209A
- Assuming the redshift of 0.73 the obtained gamma-ray luminosity for GB6 is comparable to that of TXS and so we consider it a potential counterpart to the high-energy neutrino event IC-141209A.





# Conclusions

- Two out of 39 well reconstructed high-energy neutrino events in spatial coincidence with gamma-ray Blazars
  - Assume 50% of neutrinos are background
  - → roughly 10% contribution to diffuse flux
- Both sources are BL Lac objects (LSP/ISP)
- Similar declination where IceCube is most sensitive
- Simultaneous MWL data will be crucial in the future to identify potential counterparts of high-energy neutrino events

**Stay tuned, paper  
out soon!**

**Thank you.**