

Perspective of detecting VHE gamma-ray emission from AGN with LHAASO

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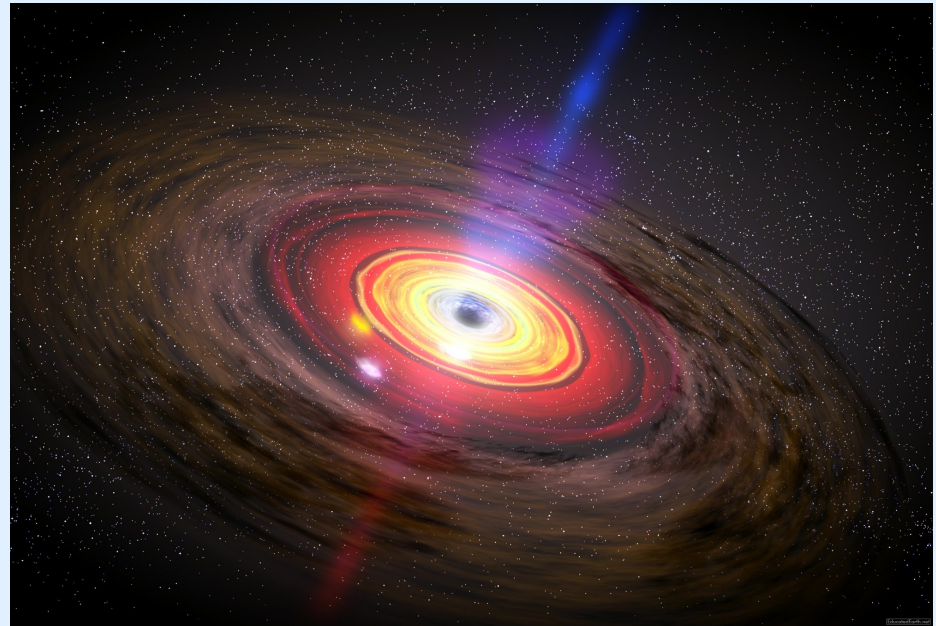
Outline

- * Active Galactic Nuclei
- * LHAASO
- * Detecting AGN with LHAASO
- * Summary

* AGN (Active Galactic Nuclei)

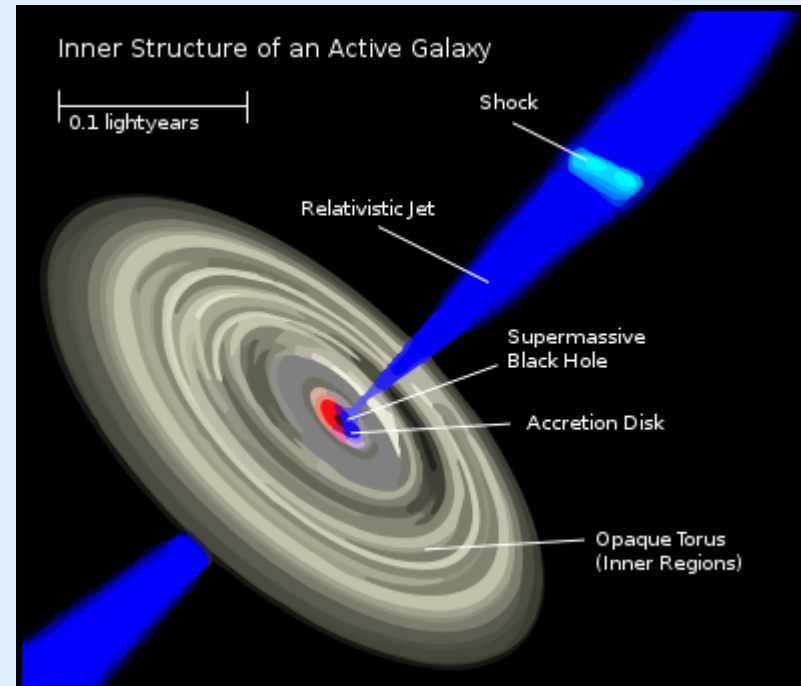
1、 Observational characteristics

- Variable with time scales from seconds to years
- Emission from radio to very high energy gamma-rays
- The most abundant population of extragalactic gamma-ray sources (and probably neutrinos)

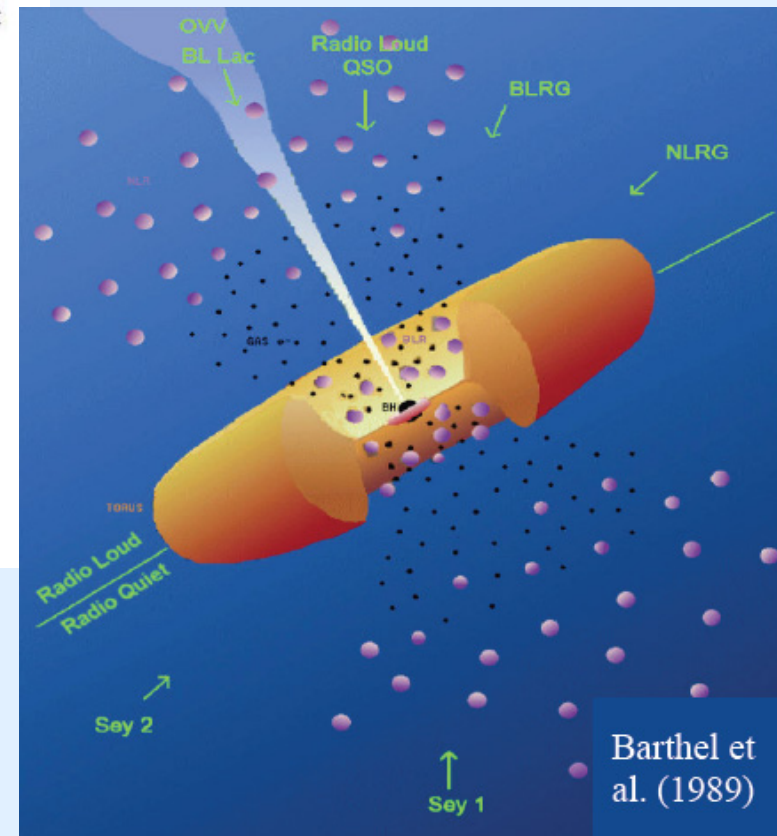
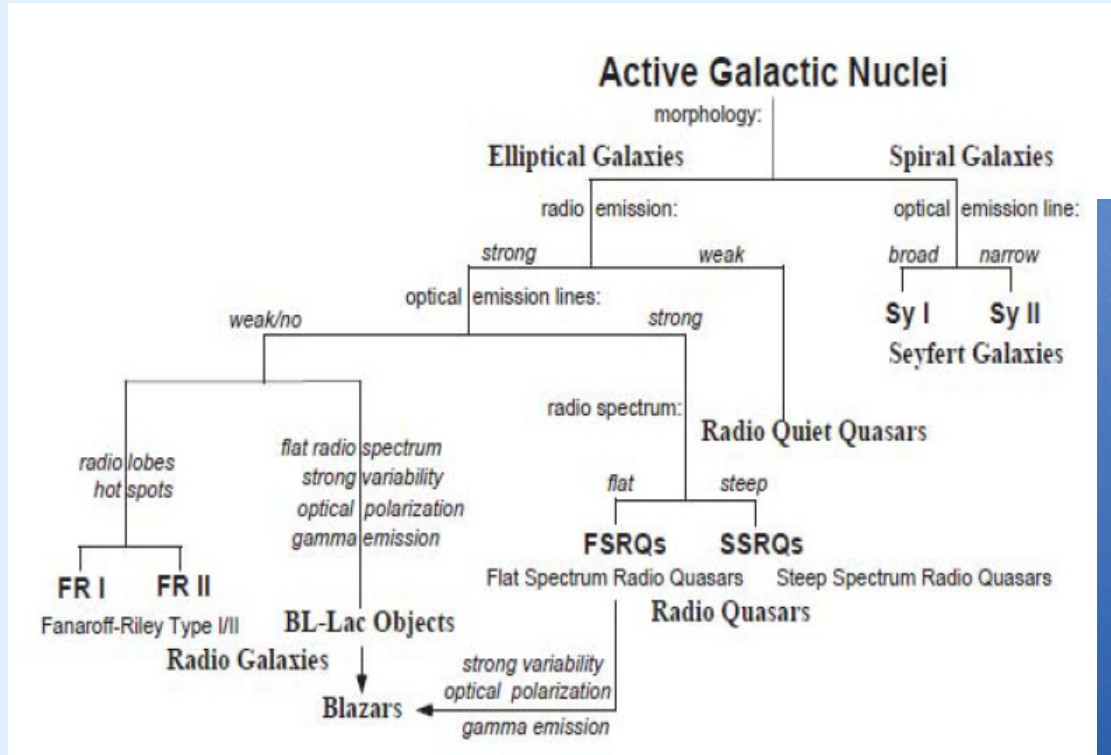


2、 Structure

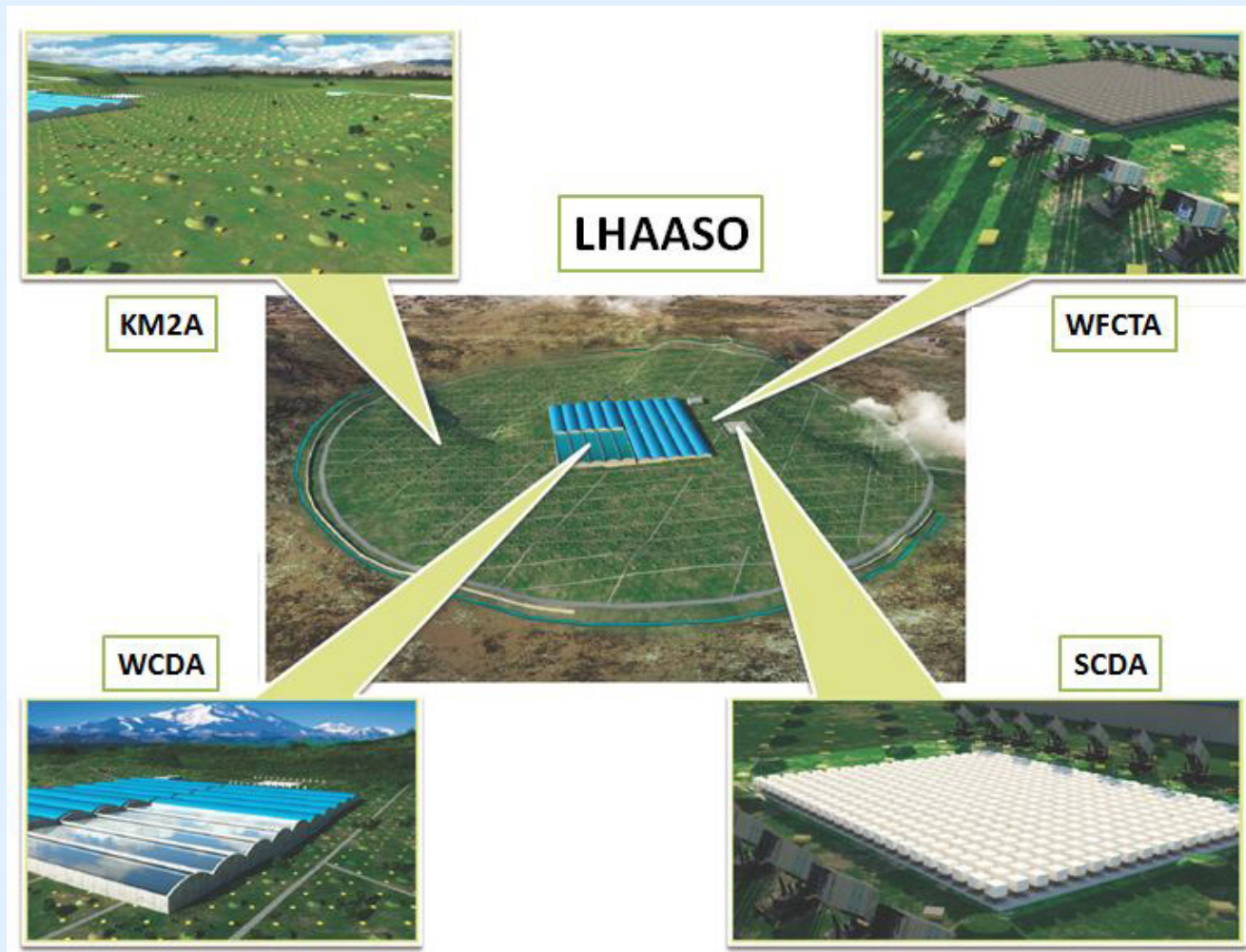
- Black hole in the centre ($10^5 \sim 10^9 M_{\odot}$)
- Accretion disk
10~1000 R_s , radio, microwaves, infrared, optical, ultra-violet, X-ray and gamma ray wavebands
- Jet
0.1~ 10^6 pc, shocks, synchrotron and inverse-Compton scattering emission
- Obscuring torus
1 pc~100 pc



3、Classification



* L H A A S O



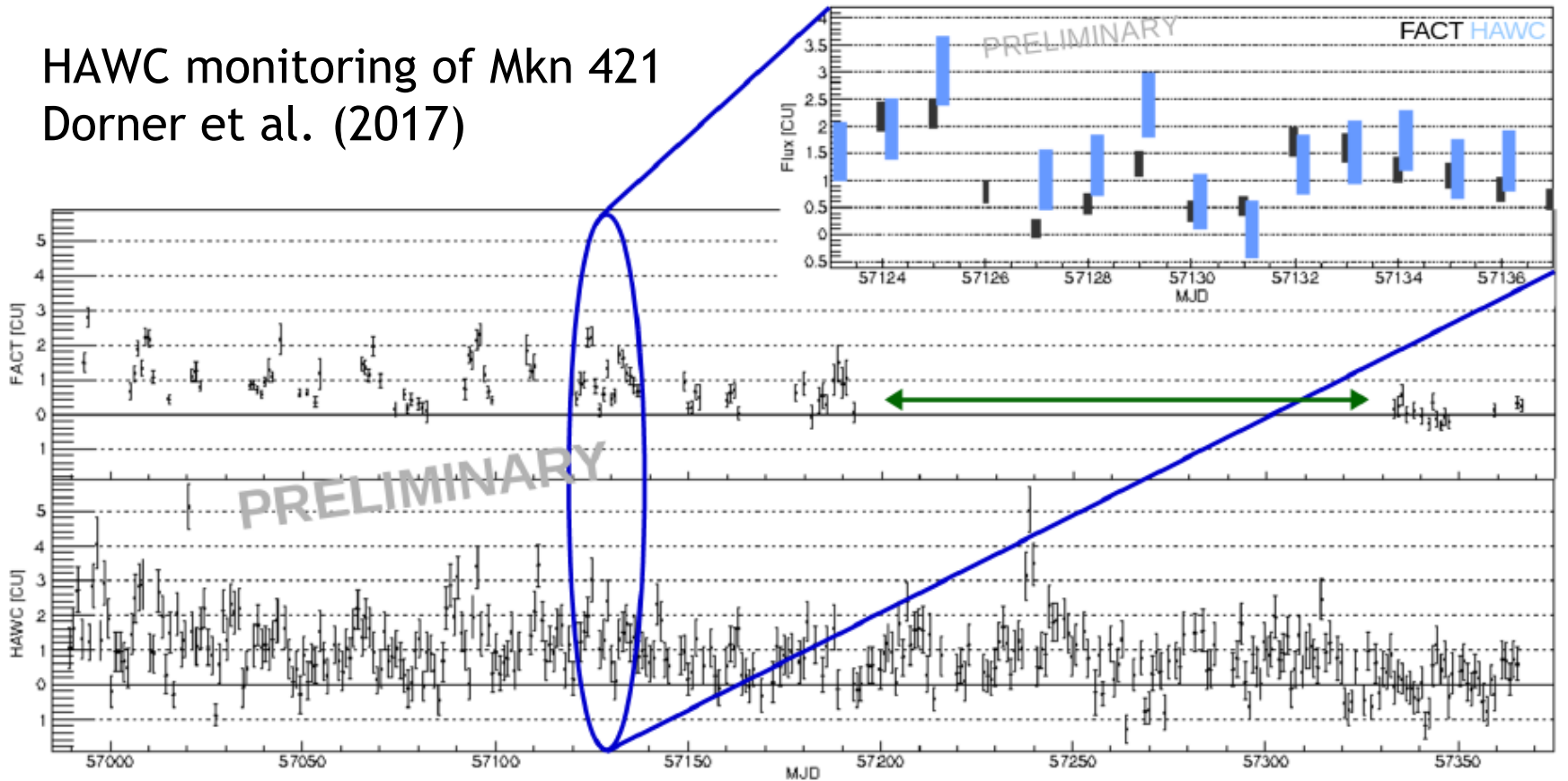
Scientific objectives of LHAASO

- looking for CR sources and new gamma-ray sources;
- precisely measuring the CR spectrum at the knee region and beyond;
- detecting the anisotropy of CR;
- exploring the structure of DM in the Milky Way;
- interdisciplinary research;
-

* Expected performance on AGN observations with LHAASO

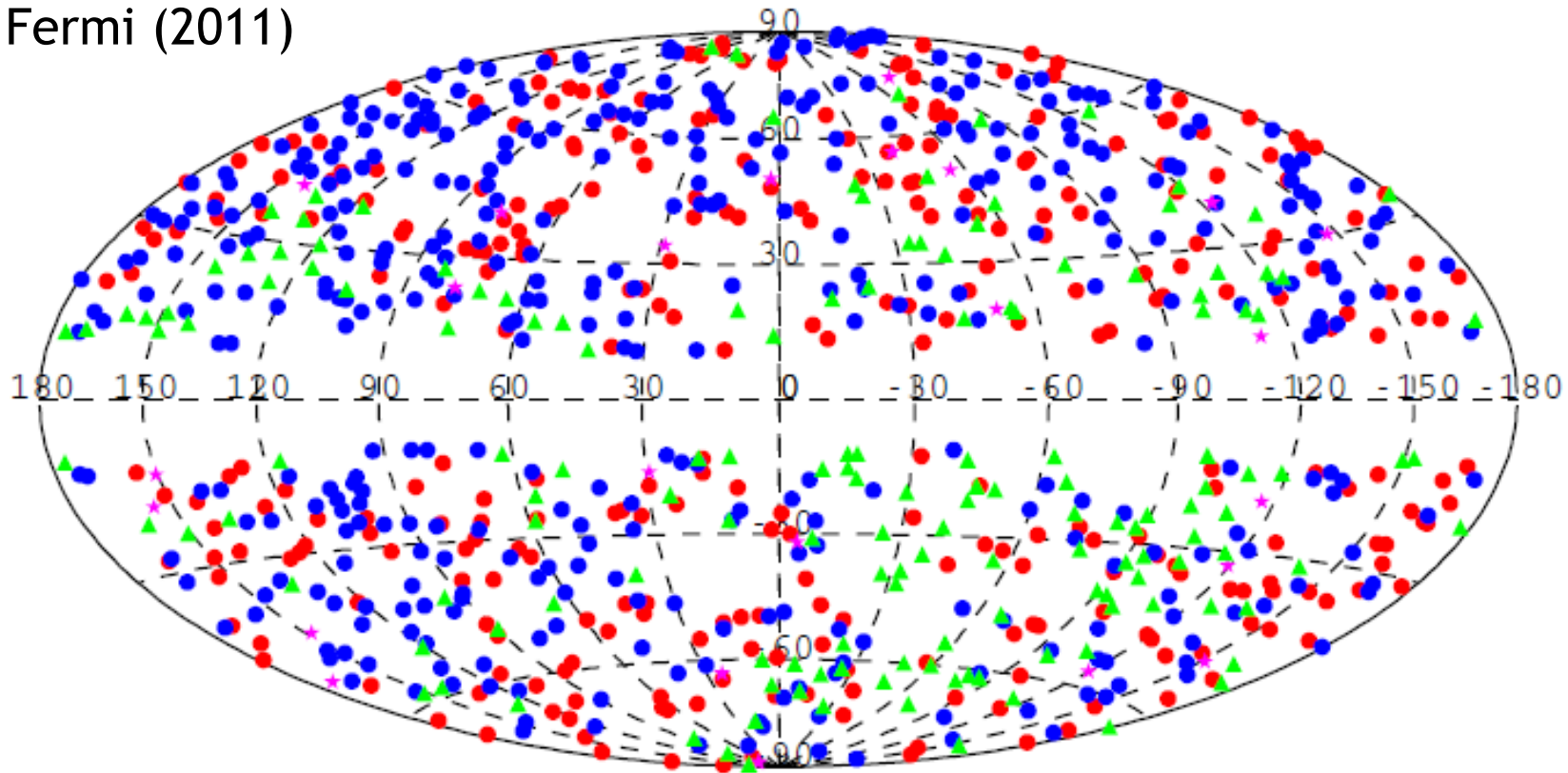
It's difficult, because strong variabilities of AGNs ...

HAWC monitoring of Mkn 421
Dorner et al. (2017)



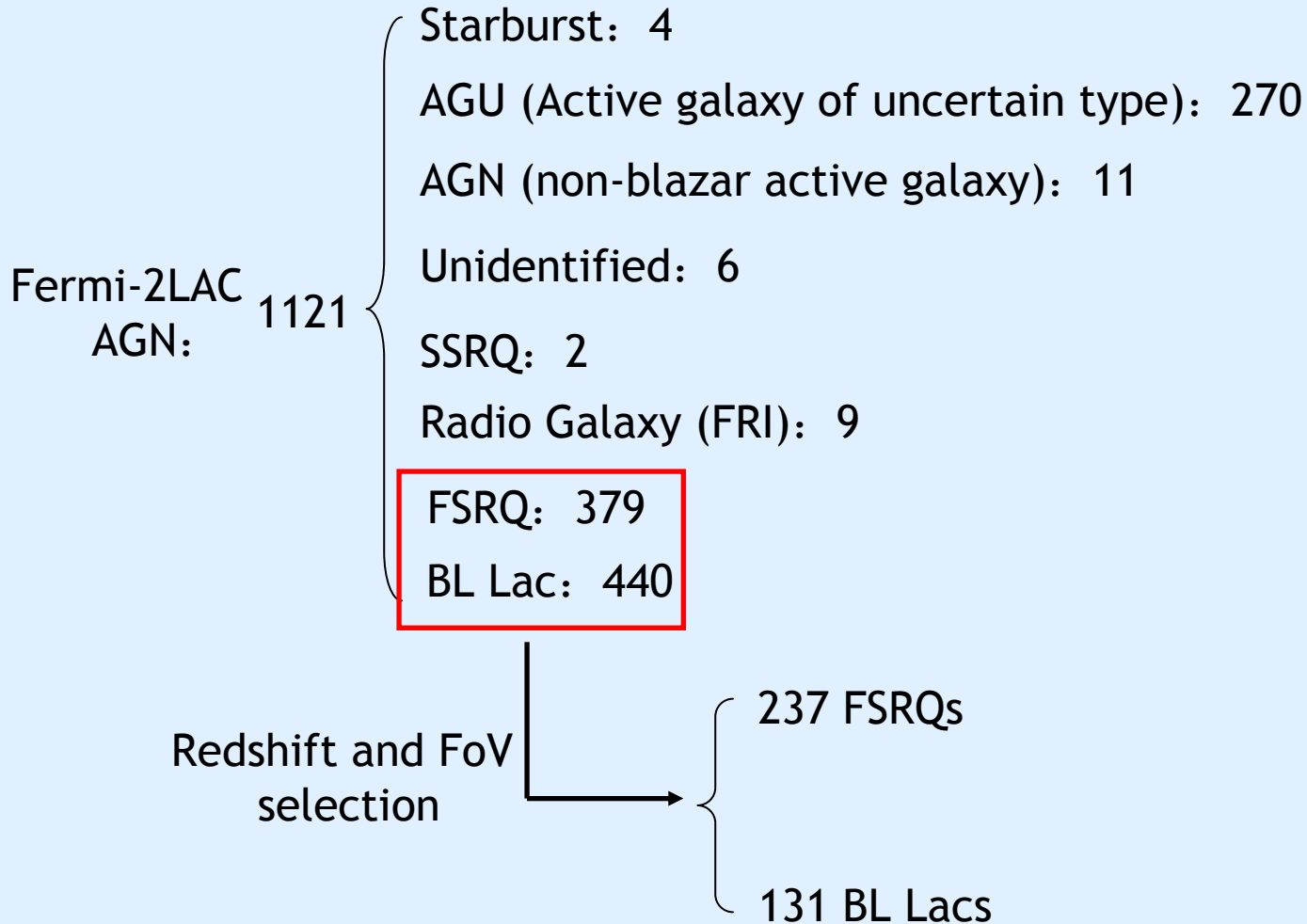
What we do is based on Fermi's AGN catalog (2LAC),
extrapolating to TeV band to estimate their *average* fluxes

Fermi (2011)

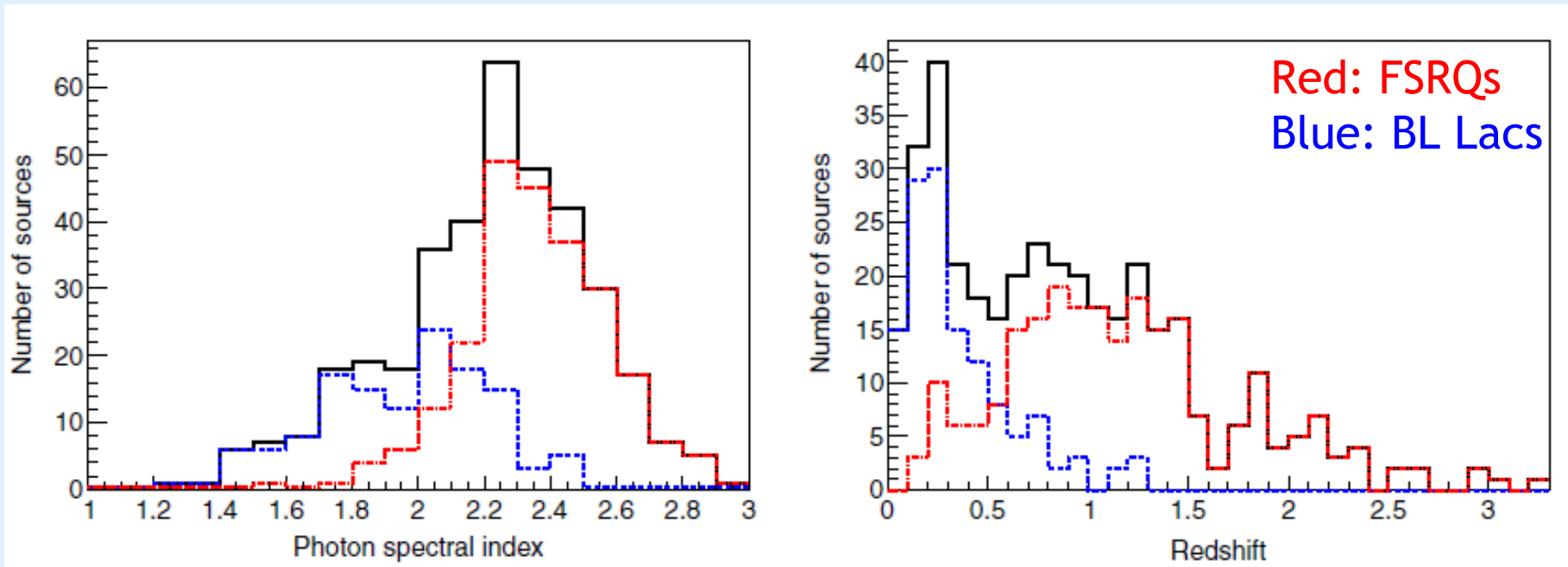


Red: FSRQs; Blue: BL Lacs; Green: unknown type

Sample selection



Distributions of spectral indices (left) and redshift (right) of 368 2LAC within LHAASO's FoV

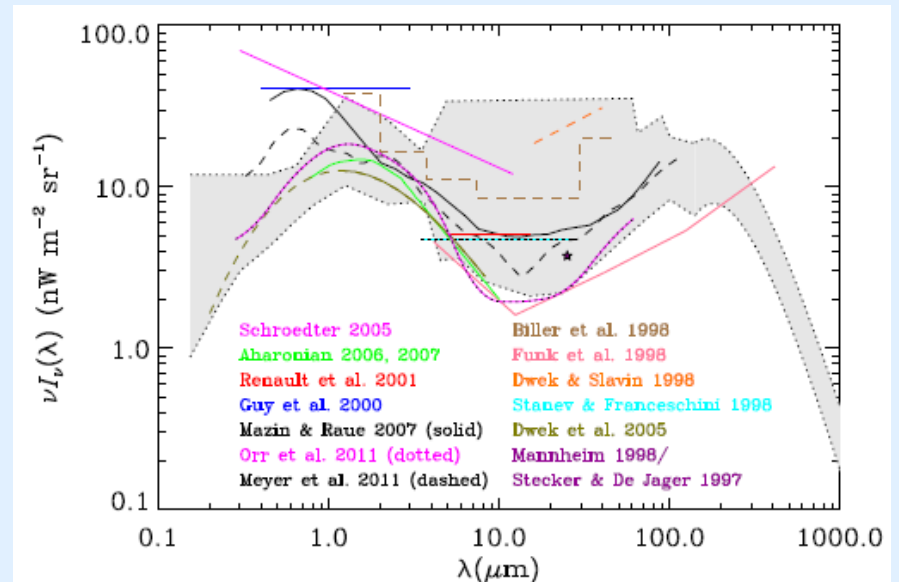
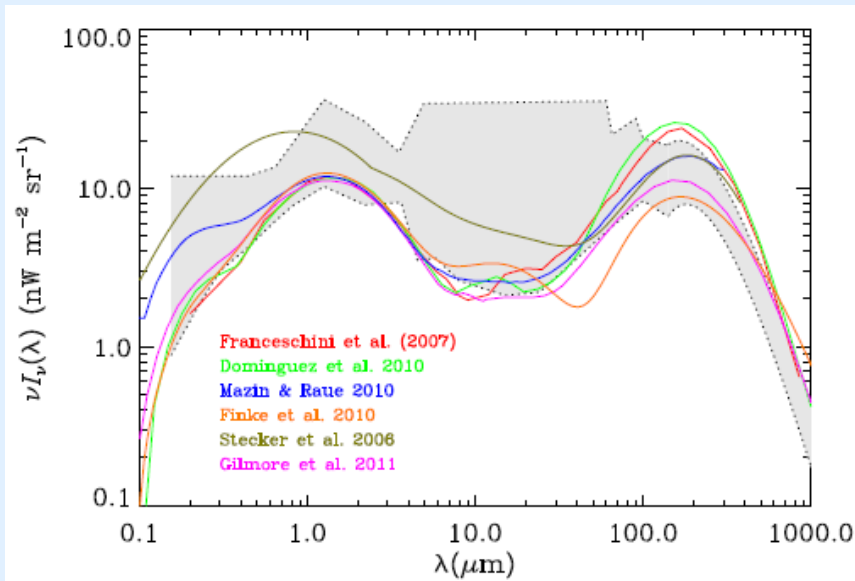


Extragalactic background light (EBL) attenuation

$$F_{obs} = e^{-\tau} F_{int}$$

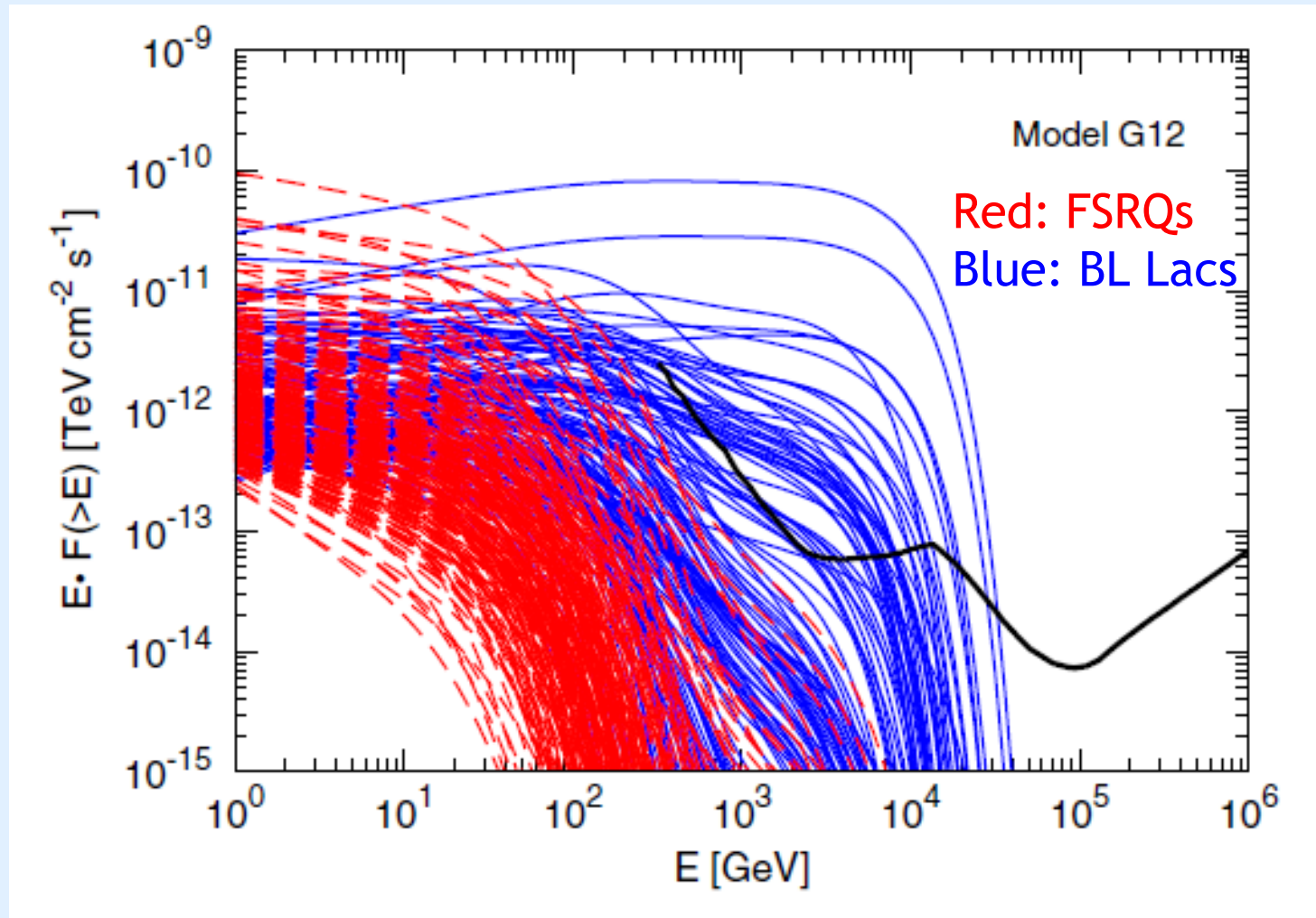
$$\tau(E, z) = \int dl \int d\cos\theta \frac{1 - \cos\theta}{2} \int d\epsilon n(\epsilon, z) \sigma(E, \epsilon, \cos\theta)$$

$$dl = c dt = \frac{c}{H_0} \frac{dz}{(1+z) \sqrt{0.28(1+z)^3 + 0.72}}$$



Dwek & Krennrich (2013)

Results vs. LHAASO's sensitivity



Numbers of detectable sources (dominantly BL Lacs)

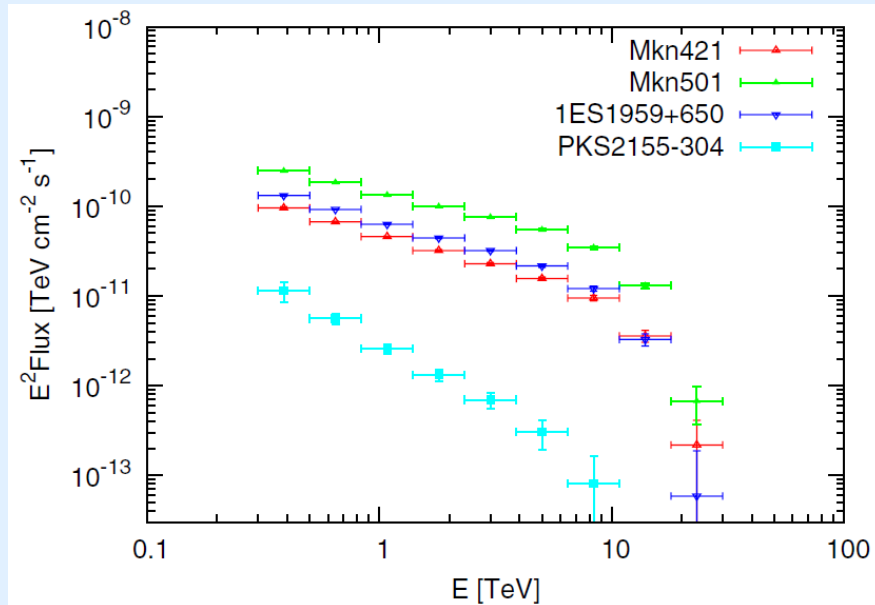
EBL model	No. for 1 yr survey (LHAASO)	No. for 4 yr survey (LHAASO)
K06	33	38
F08	39	44
F10	34	43
D11	38	44
G12	40	44

- ~60% BL Lacs do not have redshift measurements
- 1/4 AGNs with unknown type
- ~1/3 of Fermi 2FGL sources are unassociated, 40% of which could be BL Lacs
- The actual detectable number of AGNs might be $O(100)$ for 1 year survey

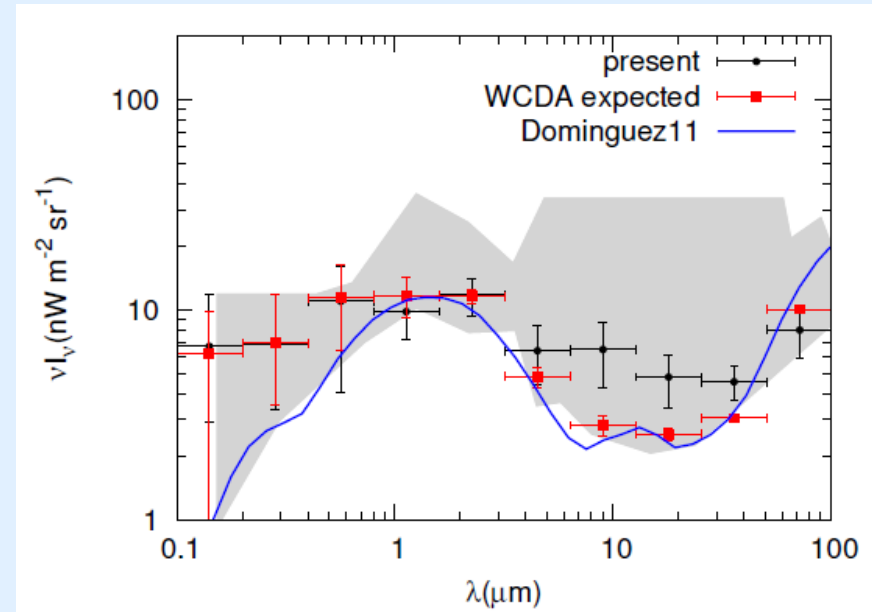
Discussion on flares

- Blazars are highly variable in gamma-rays
- Some giant flares may be $O(10)$ times brighter than the average flux, with a time-scale of days to weeks (corresponding to a ~ 10 times higher detection limit)
- The detectability of blazar flares may roughly be the same as that of the average flux discussed above

Energy spectra and constraints on the EBL intensities



Simulated energy spectra of 4 TeV BL Lacs by LHAASO-WCDA.



Comparison of the constraints on the EBL intensities by fitting the simulated energy spectra of the ~40 detectable AGNs by WCDA.

* Summary

- About 30-40 Fermi BL Lacs with redshifts could have fluxes above the sensitivity of LHAASO; such a number may be $O(100)$ if considering the sources without redshifts/type/association
- FSRQs are unlikely to be detected
- Uncertain for flares
- A large sample of extragalactic sources with good spectral measurements will effectively constrain the EBL intensities

Thank you!