

CTA時代における TeVブレーザー探査

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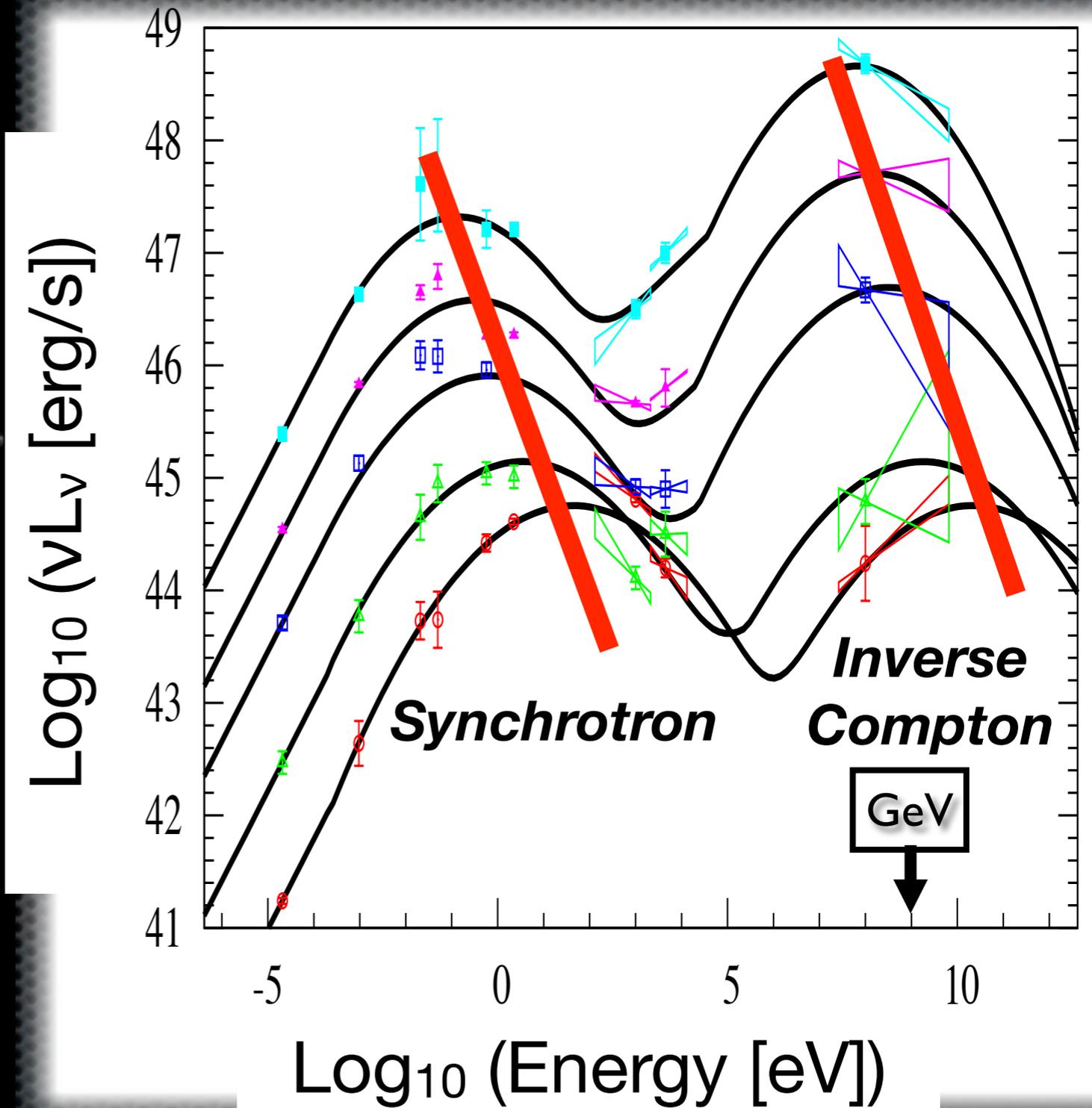
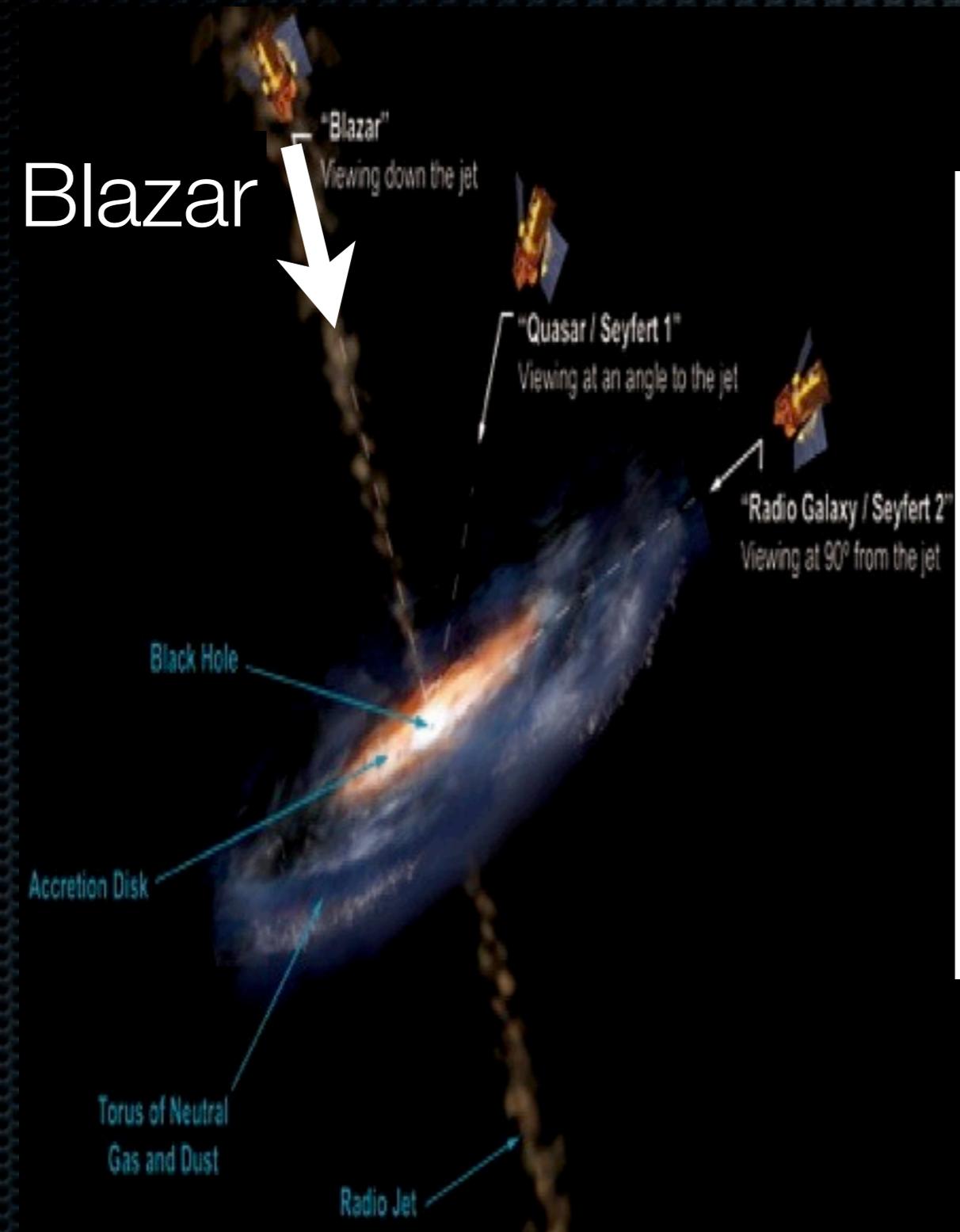
森正樹 (立命館)



CTA-Japan kick-off meeting @ Jan. 9th, 2010

What is *BLAZAR*?

SED Sequence



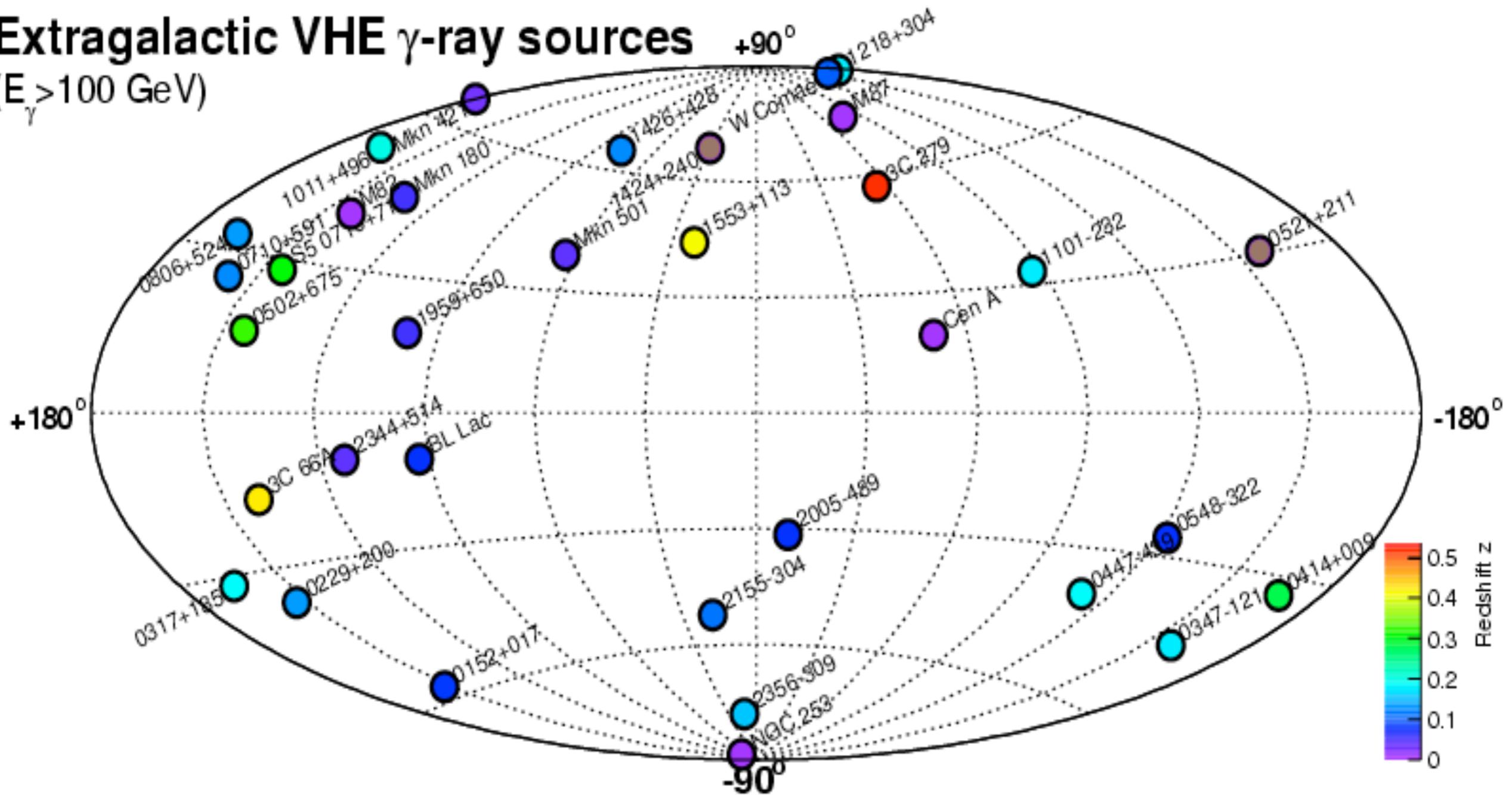
<http://www.nasa.gov/>

(Fossati+'97,'98; Kubo+'98; Donato +'01, but see also Padovani+'07)

Current TeV Blazars

Extragalactic VHE γ -ray sources

($E_{\gamma} > 100$ GeV)



2009-12-17 - Up-to-date plot available at <http://www.mppmu.mpg.de/~rwagner/sources/>

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~25 TeV blazars/~100 TeV sources

TeV Blazars Survey by CTA

- ✦ High energy phenomena around supermassive black holes.
- ✦ Statistical analysis of TeV blazars
 - ✓ AGN population
- ✦ Constraints on Extragalactic Background Light (EBL)
 - ✓ Star & Galaxy formation history

Blazar Survey Method

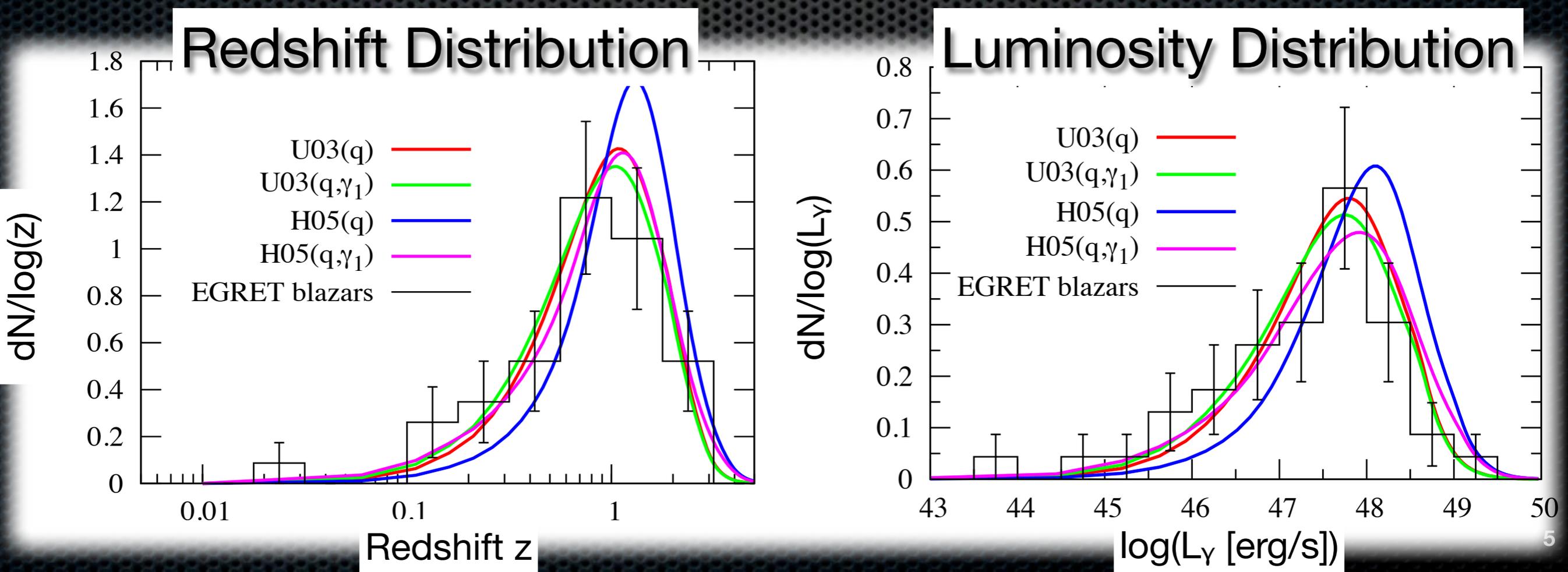
- 1) Blank Field Sky Survey (Extragalactic version of the Galactic plane survey by H.E.S.S.).
 - 2) Following up other wavelength observations (e.g. Fermi).
- Which is better for CTA ?
 - Gamma-ray luminosity function and SED are required.

New Blazar Gamma-ray Luminosity Function (Yi & Totani '09)

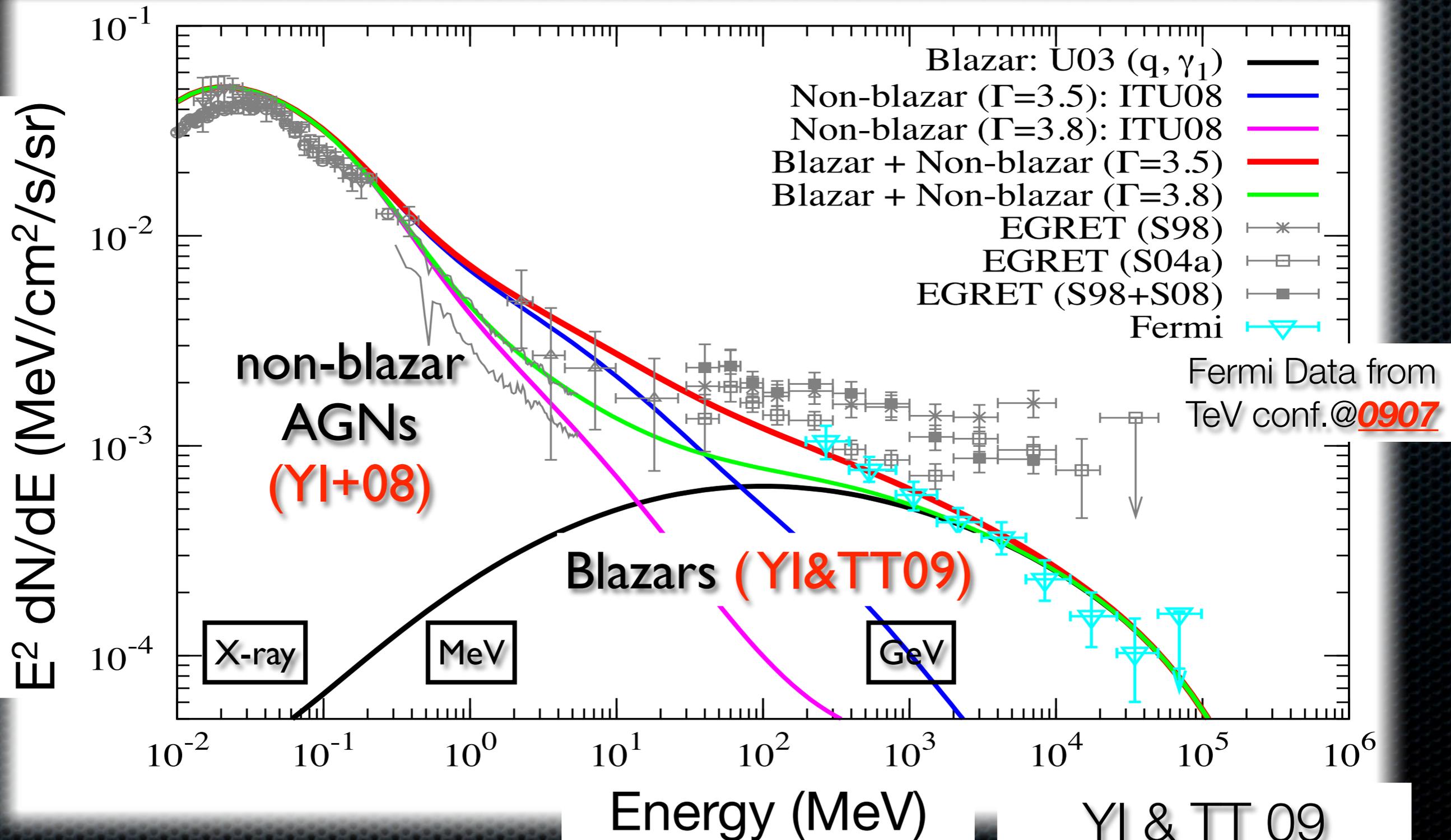
Basic assumptions for blazar GLF construction

- Blazar SED sequence.
- AGN X-ray Luminosity Function (Ueda+'03:hereafter U03).
Assuming " $L_{\text{jet, bol}} \propto L_{\text{disk, X}}$ ".

Constraining GLFs from EGRET data.

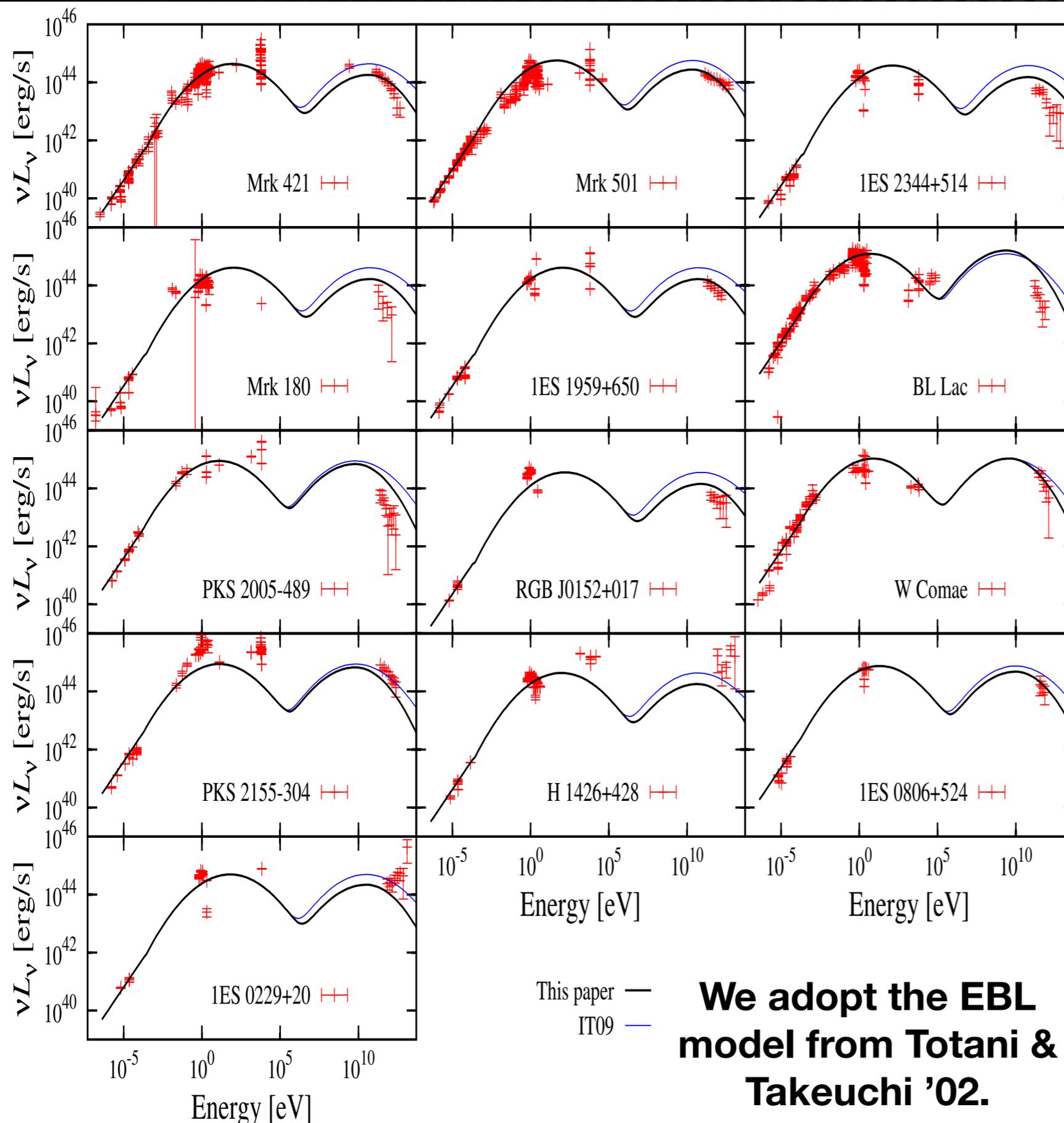


Cosmic X-ray and Gamma-ray Background in the Fermi era



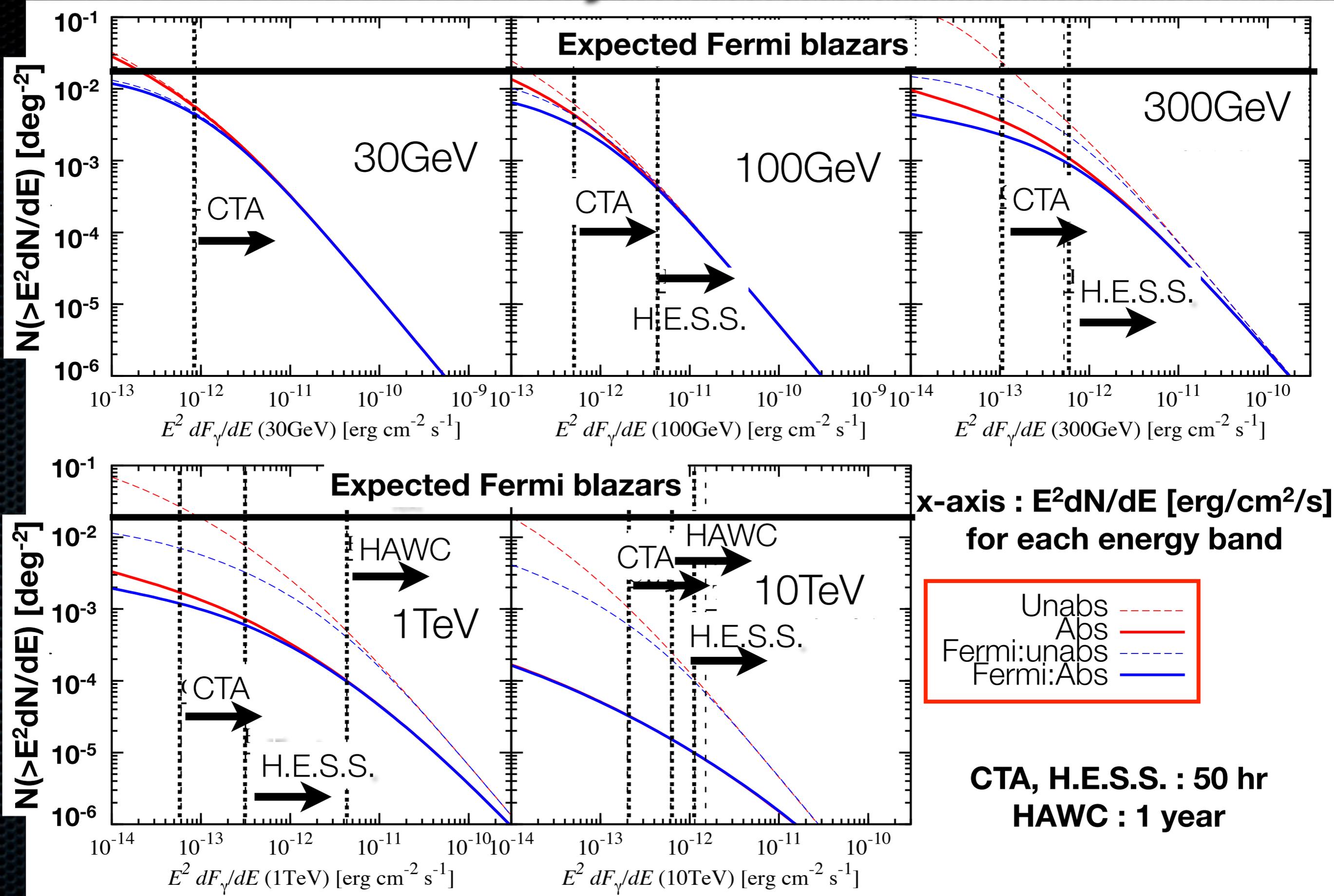
Our prediction matched with the Fermi data very well.

Incorporating TeV blazars data in SED sequence

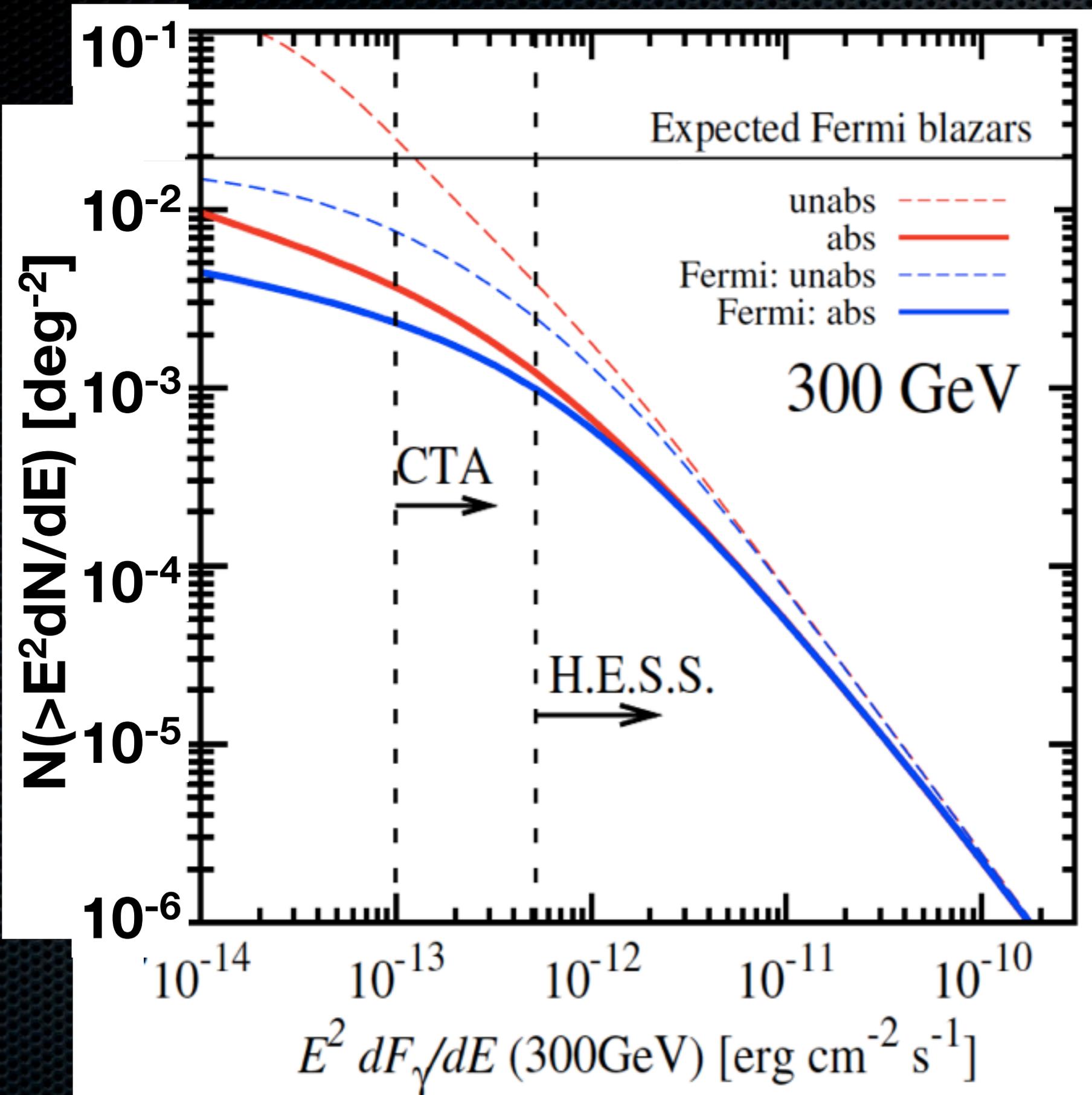


- New SED sequence model taking into account nearby TeV blazars data.
- A new GLF with this SED model.
 - Predictions for Fermi are not so different from IT09.
 - New model : ~720 blazars for 1-year survey
 - IT09 : ~750 blazars for 1-year survey

TeV Blazar Survey

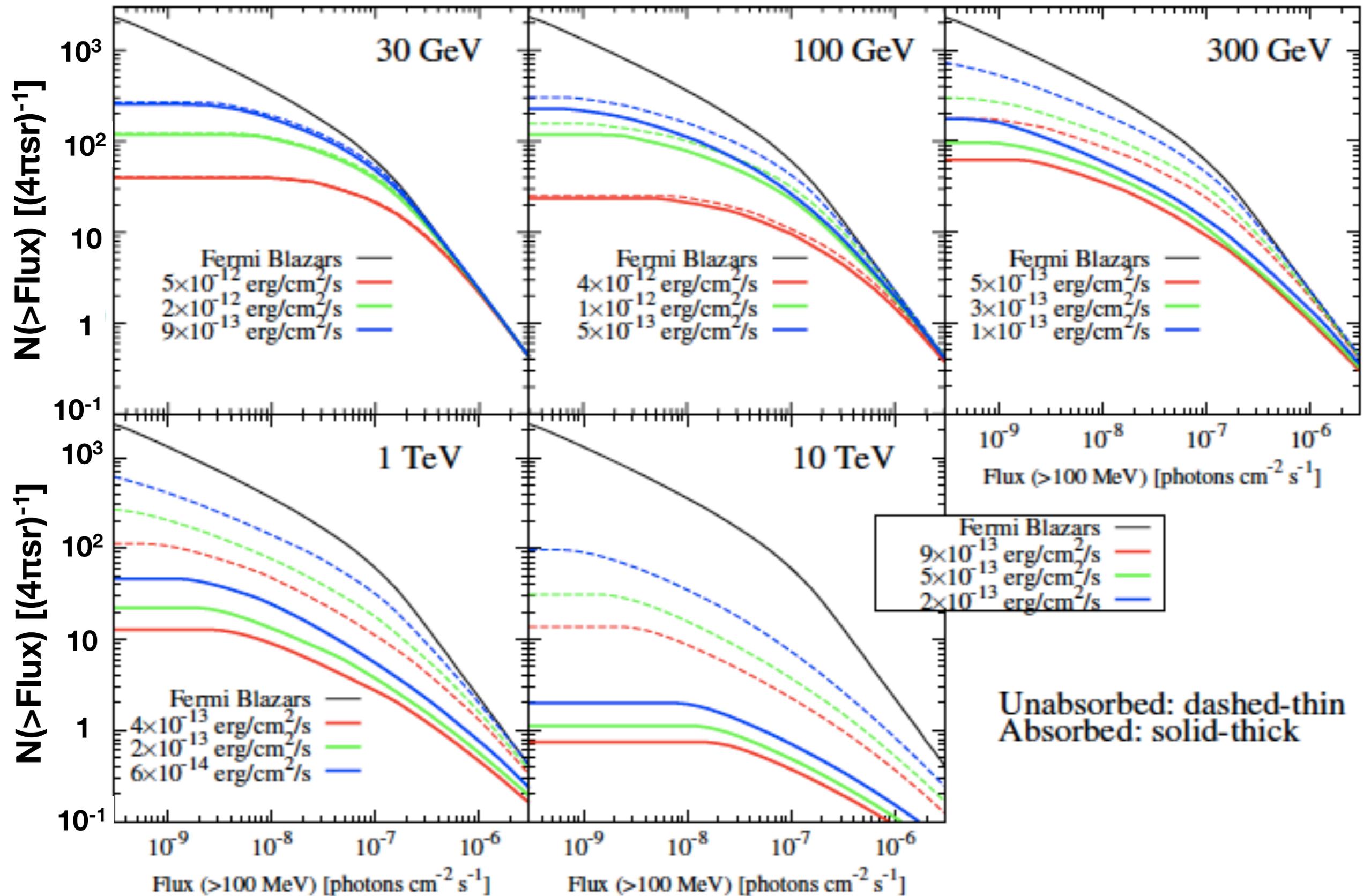


TeV Blazar Survey @300 GeV

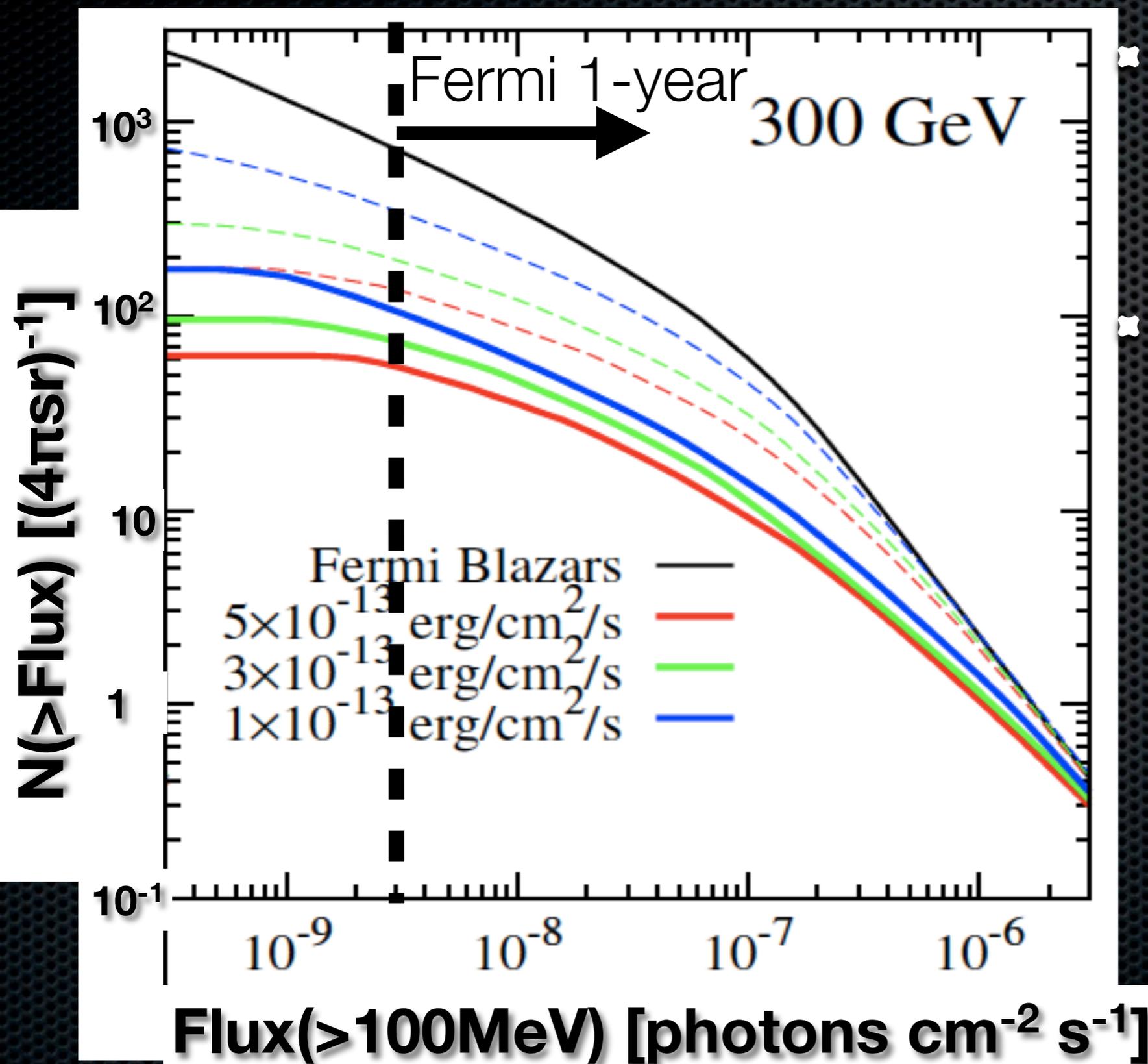


- Blank field sky survey
 - ~ 1 blazar / 200 deg^2 .
 - FoV of CTA is ~ 6 deg^2 .
 - Unrealistic to do a blind field sky survey.
- Following up Fermi blazars is more promising.

Counts of Fermi blazars detectable by CTA



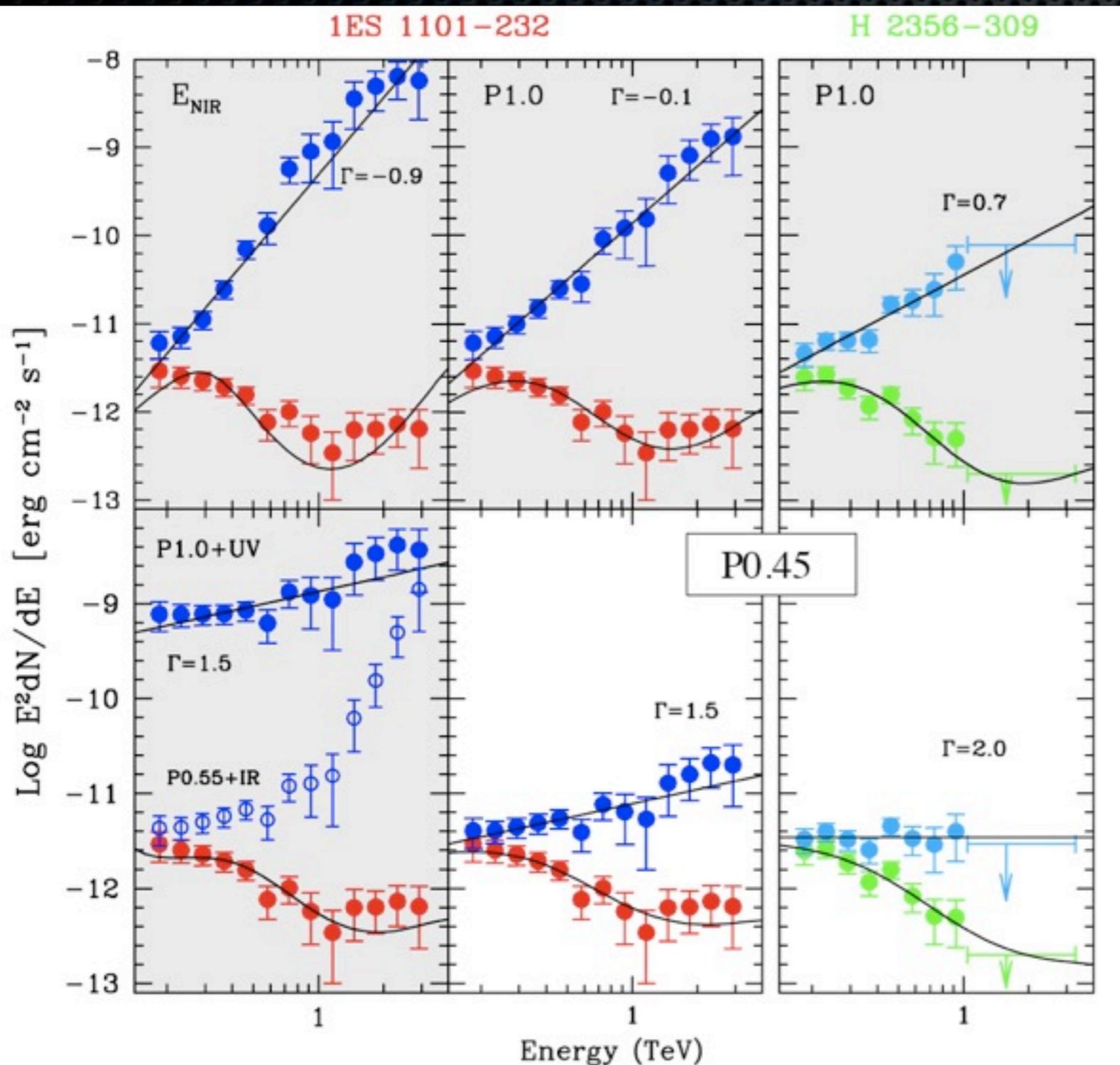
Counts of Fermi blazars detectable by CTA @300GeV



- 200 hr observation will give ~ 80 TeV blazar samples.
- How to follow up efficiently?
 - Fermi gives flux (>100 MeV), redshift, and photon index.
 - Estimate TeV flux from these data and EBL optical depth.

Extragalactic Background Light (EBL) Determination

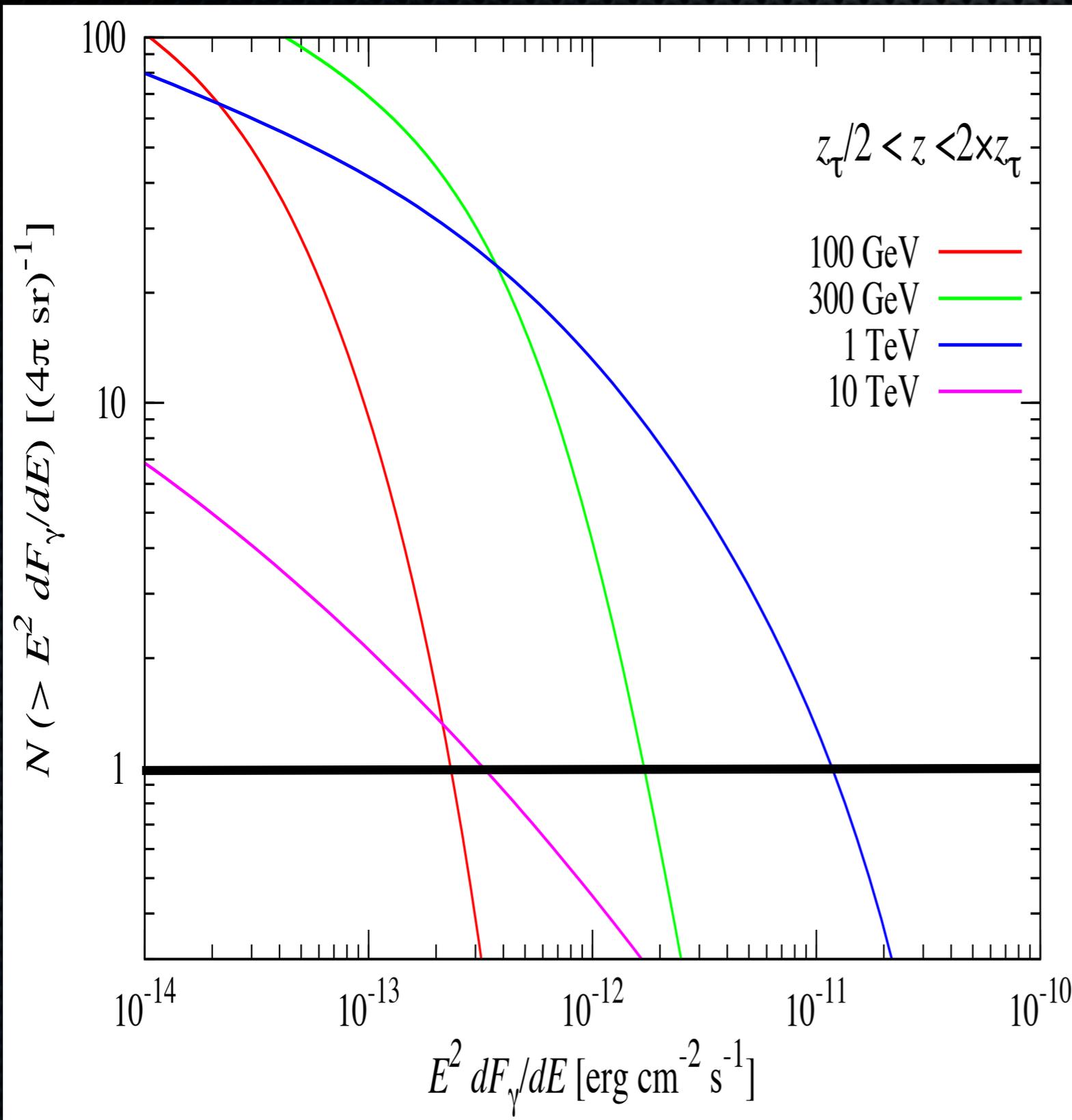
Constraint on EBL from TeV obs.



- It is difficult to observe EBL directly.
- TeV obs. is a new probe of EBL.
 $\gamma(\text{TeV}) + \gamma(\text{EBL}) \rightarrow e^+ + e^-$
- 3C279 ($z \sim 0.5$) by MAGIC is the highest redshift.
- We constrain EBL by assuming an intrinsic spectrum for each blazar.

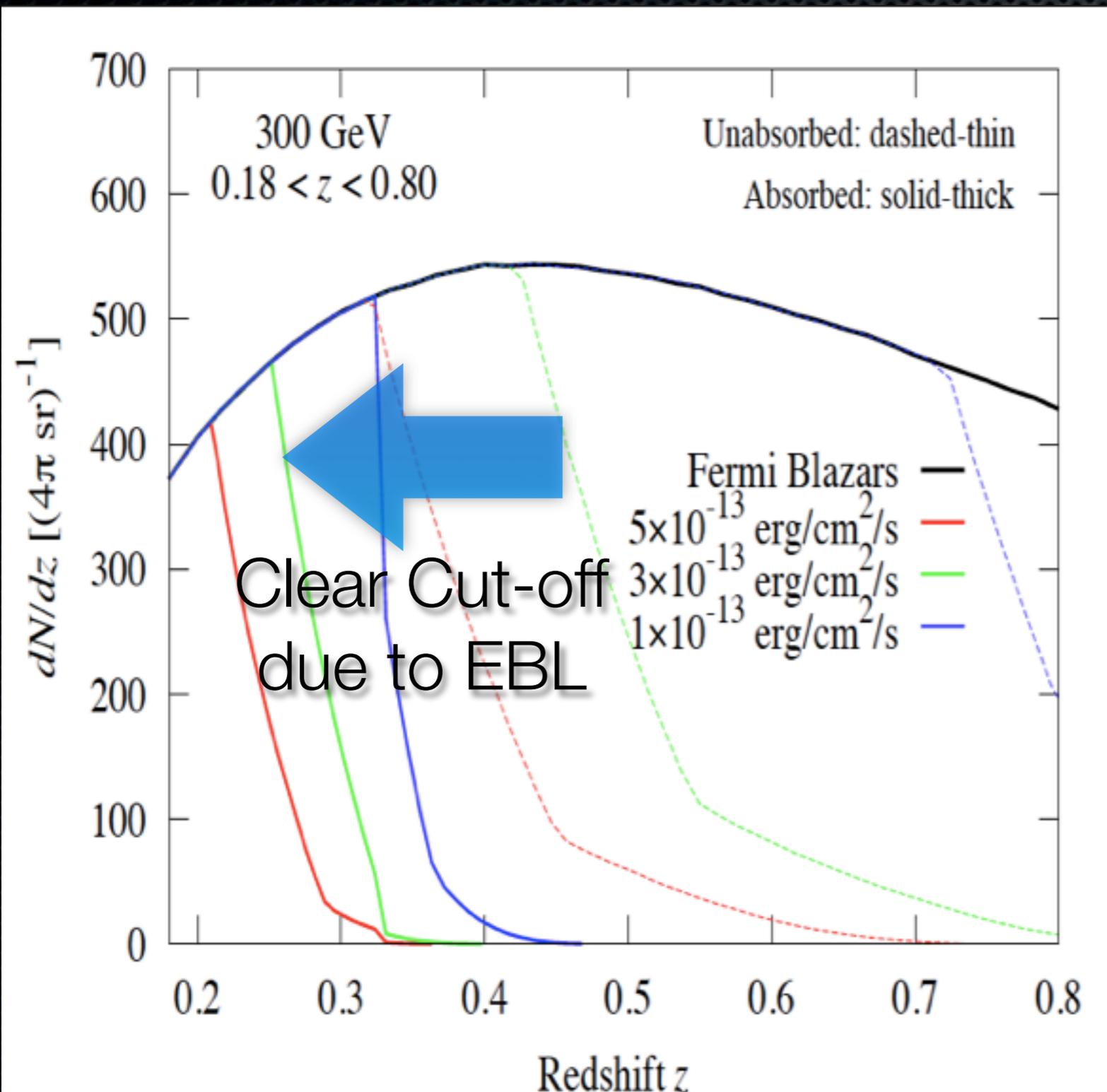
Aharonian+'06

Is it possible to detect TeV blazars around z_τ with high significance?



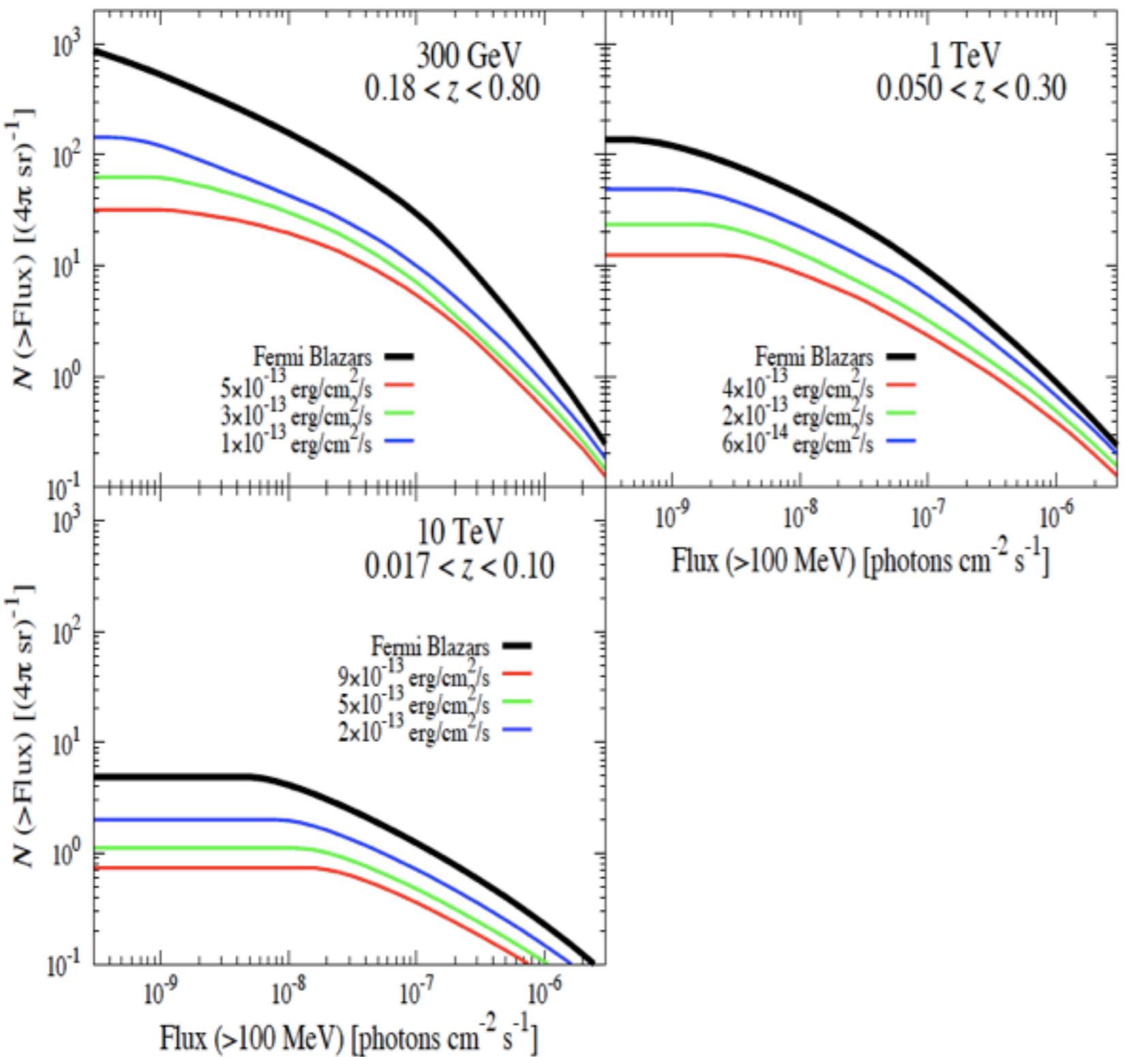
- z_τ is the redshift where $\tau = 1$.
- Current TeV telescopes constrains EBL with 5- σ detection.
- 50 hr observational time by CTA will make
 - 86- σ for 300 GeV
 - 1000- σ for 1 TeV
 - 8- σ for 10 TeV

Constraining the EBL models from z -distribution



- ✦ Difficult to detect high- z blazars due to the EBL absorption.
- ✦ A clear cut-off appears in the z -distribution of TeV blazars.
- ✦ It might be possible to constrain EBL from this cut-off.

The expected number of TeV blazars around z_{τ} .



• To construct 30 TeV blazars samples around z_{τ} , the required observational time is

- 50 hr for 300 GeV,
- 30 hr for 1 TeV,
- impossible for 10 TeV.

Summary

- ✦ Extragalactic blank field sky survey is **inefficient**.
 - ✦ ~ 1 blazar / 200 deg².
- ✦ Following up Fermi blazars is **efficient**.
 - ✦ CTA will detect **~ 80 blazars** with **200 hr obs. time** @ 300 GeV
 - ✦ CTA will detect blazars around z_{τ} with higher significance than current IACTs did.
 - ✦ Redshift distribution of TeV blazars will be a complementary way to constrain EBL.
 - ✦ e.g. **~ 50 hr obs.time** @ 300 GeV is required to do this new EBL constraint method.