



Pushing the Limits: High Redshift Fermi-LAT Blazars



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Workshop on Perspectives on the Extragalactic Frontier: from Astrophysics to
Fundamental Physics, Trieste



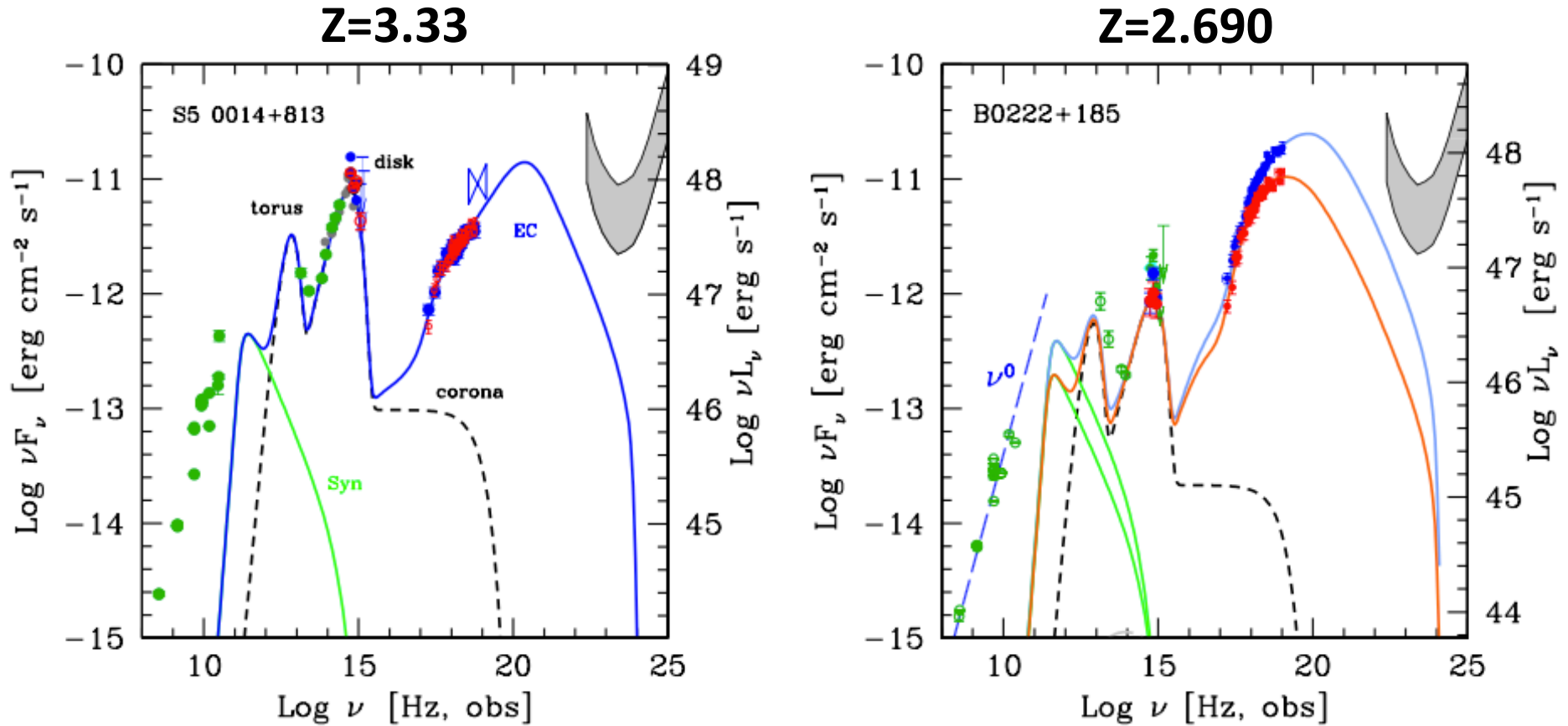
Why do we care?



- High redshift \rightarrow IC peak \rightarrow MeV blazars
- Most extreme subset of blazars (Ghisellini et al. 2010):
 - highest luminosities,
 - high jet-powers,
 - accretion disk luminosities,
 - BH masses $> 10^9 M_{\odot}$
- They trace the evolution of gamma-ray blazars
- Excellent tool to study EBL and thus the gamma-ray horizon



Difficult Fermi detection



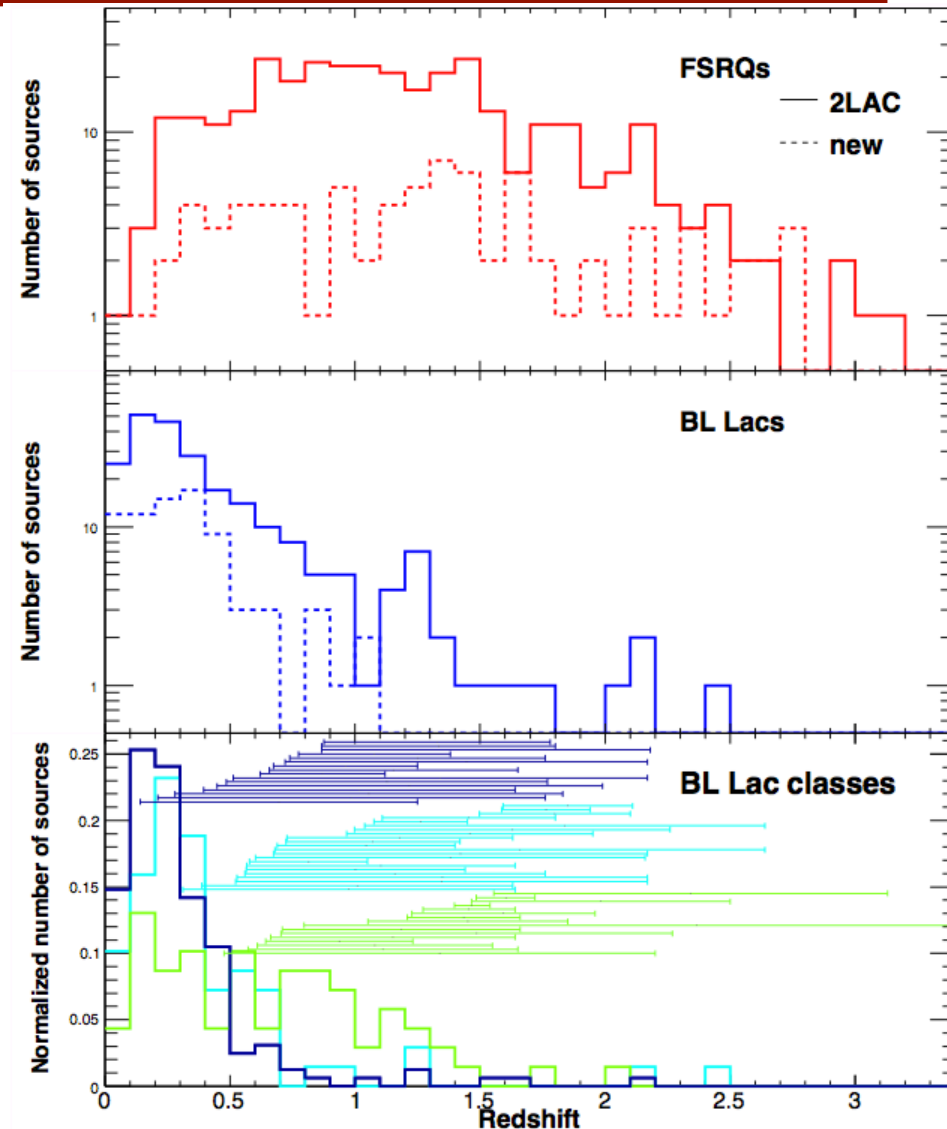
From Sbarrato et al. 2015



State of the art: 3LAC



- Most distant PKS 0537-286 at $z=3.1$
- Four FSRQs have $2.94 < z < 3.1$
 - Already present in 2FGL and 1FGL
- Q0906+690 at $z=5.47$ UL by EGRET (Romani et al. 2004).
 - No LAT detection...yet!





Why now?



- Gamma-ray soft spectra
- Difficult to resolve from the background
- More integration time
- Pass 8 is the really game changer



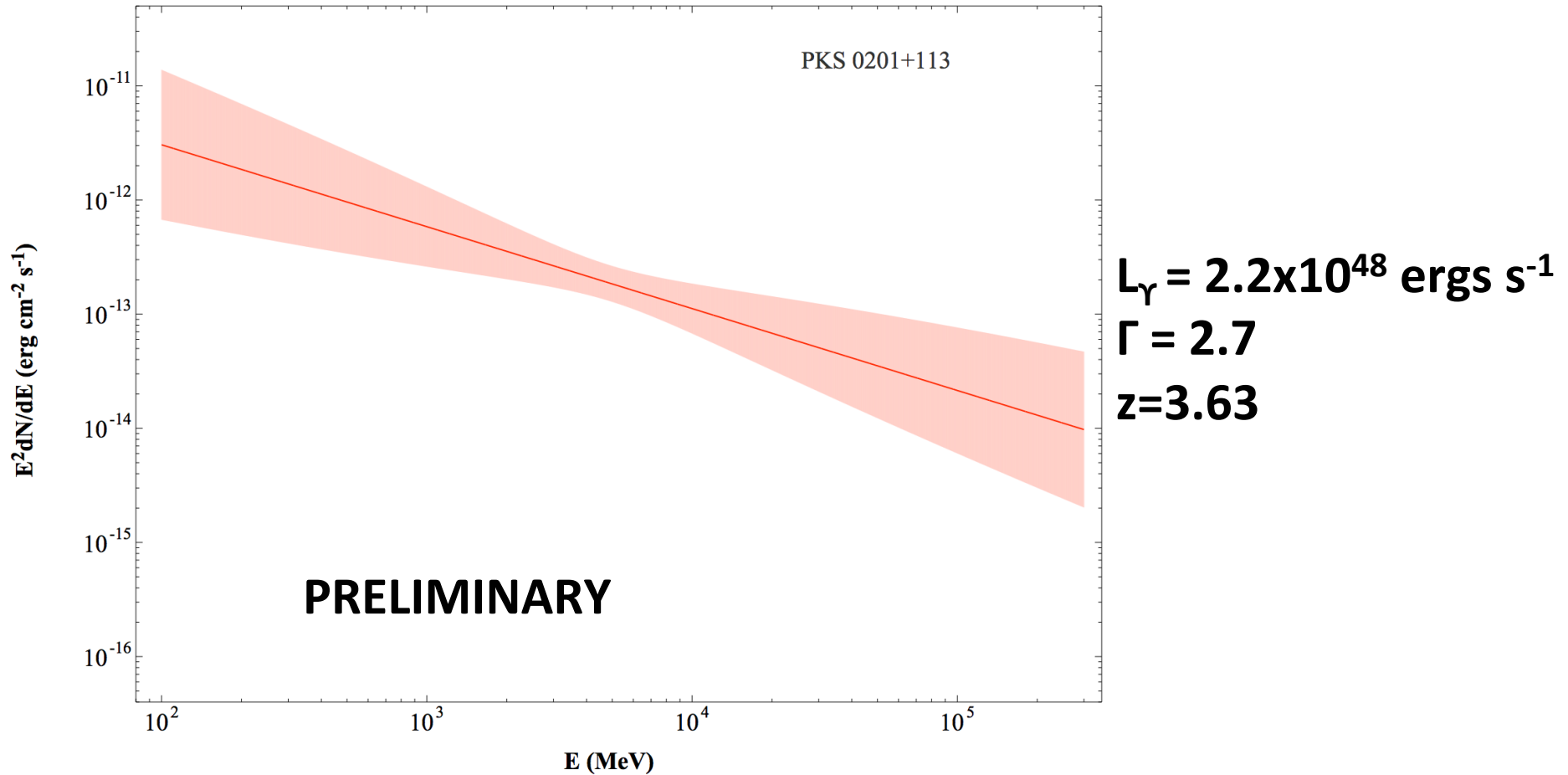
News from 4FGL



- 4FGL list is very very preliminary
- Up to now 4 sources with $z > 3.5$
- All FSRQ
- Fine tuning of the analysis is on going
 - Few others could pop up



PKS 0201+113



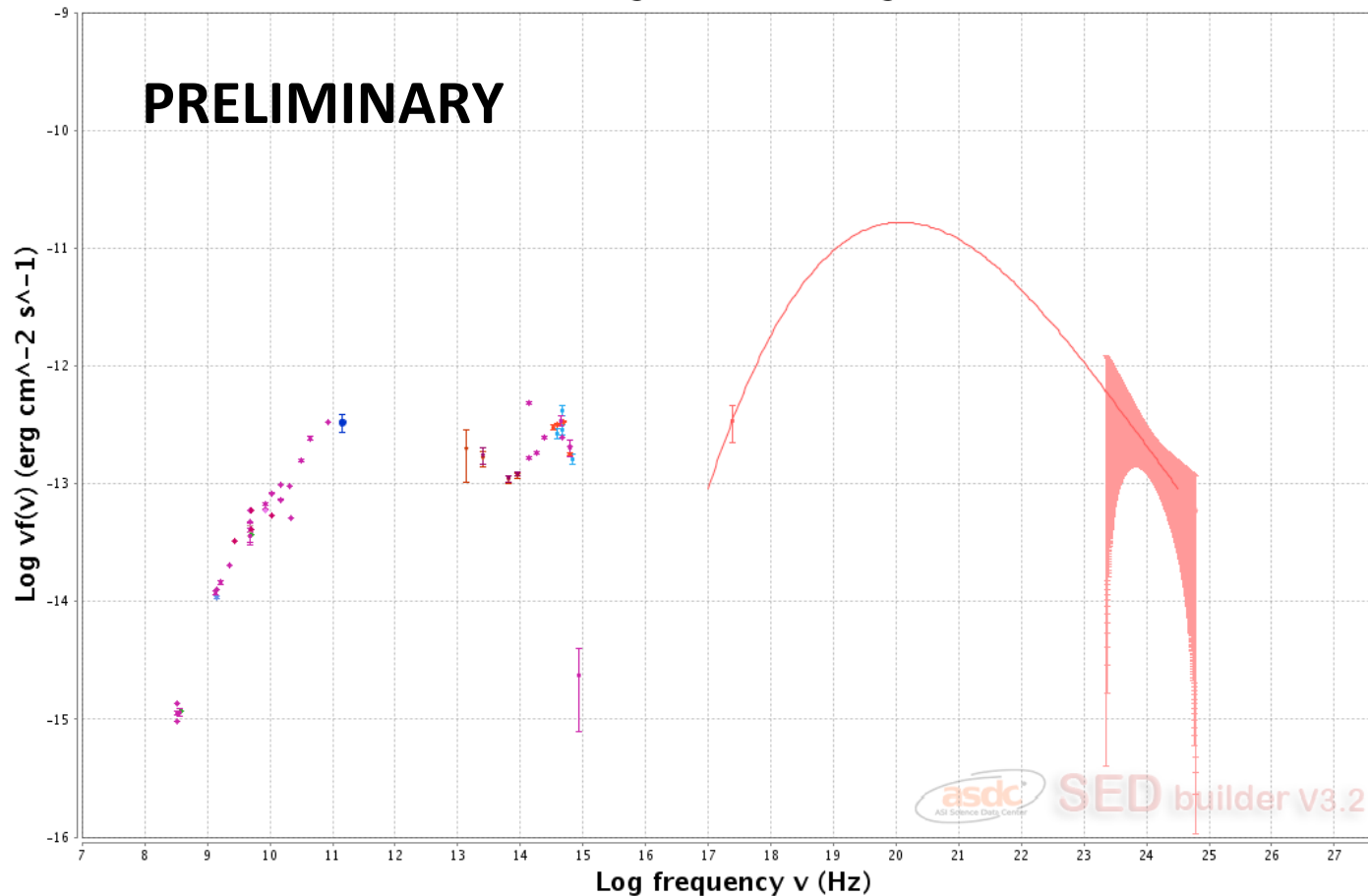
Fermi-LAT spectrum of PKS 0201+113 during the period 2008-Aug-04 15:43:36 to 2015-Oct-07 07:25:21. The line is the best fit over the full energy range The shaded area is the statistical uncertainty around the best fit for a PL.



PKS 0201+113



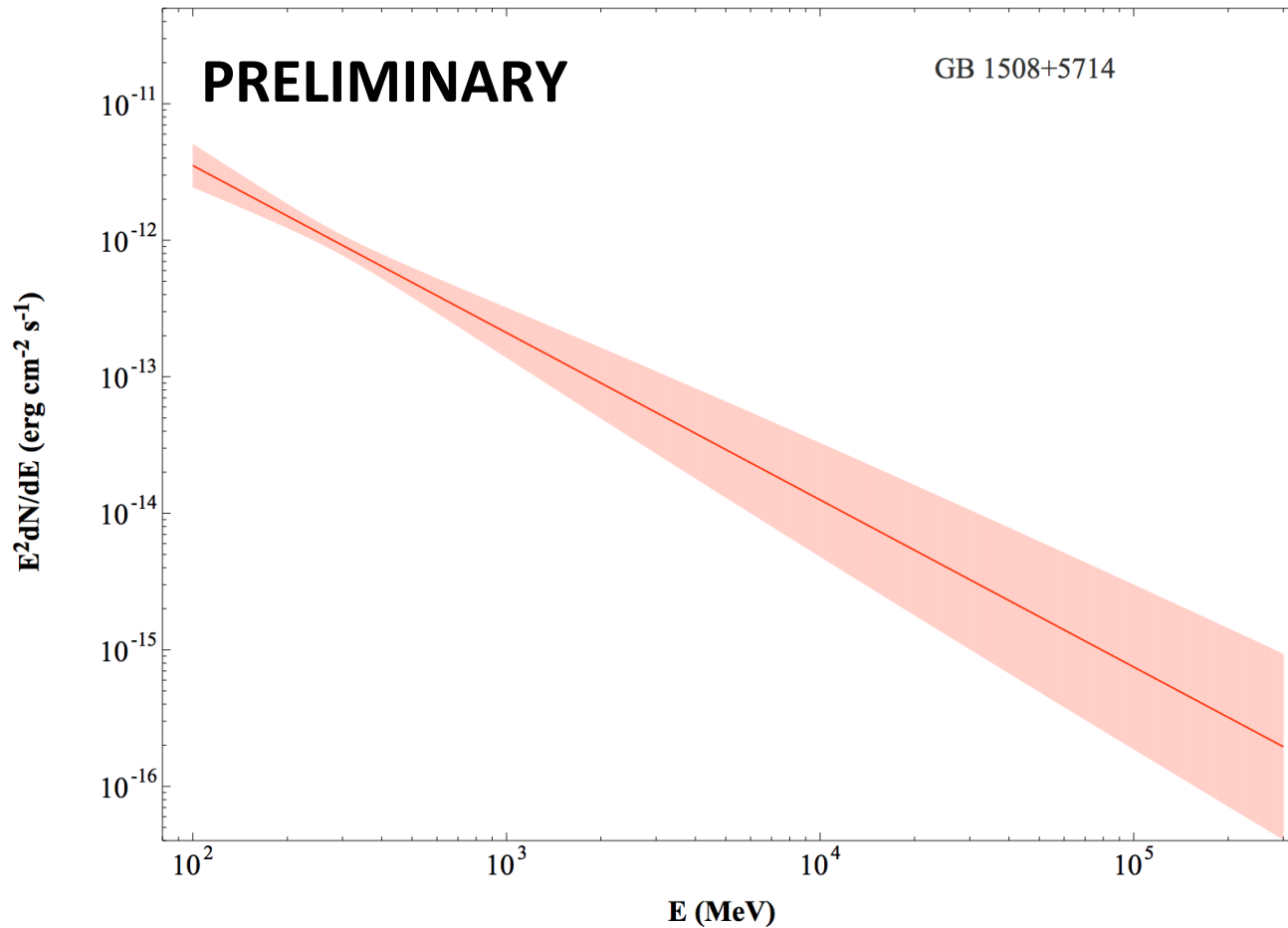
PKS 0201+113 Ra=30.94440 deg Dec=11.57928 deg (NH=6.0E20 cm⁻²)



Spectral Energy Distribution for the high redshift FSRQ PKS 0201+113 using non-simultaneous data. It suggests an IC peak at about 10²⁰Hz.



GB 1508+5714

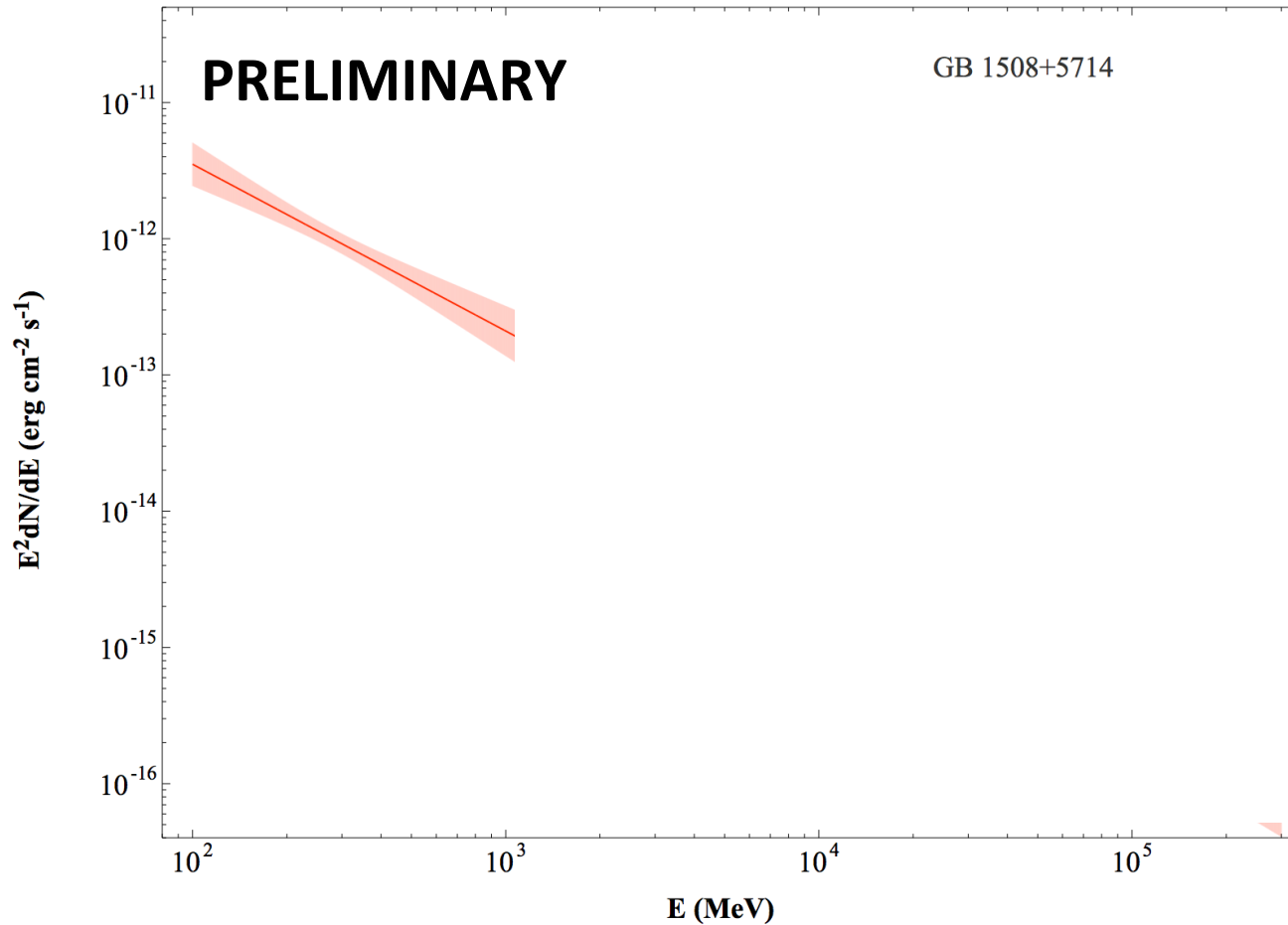


$L_\gamma = 1.9 \times 10^{48}$ ergs s⁻¹
 $\Gamma = 3.22$
 $z = 4.30$

Fermi-LAT spectrum of GB 1508+5714 during the period 2008-Aug-04 15:43:36 to 2015-Oct-07 07:25:21. The line is the best fit over the full energy range The gray-shaded area is the statistical uncertainty around the best fit



GB 1508+5714



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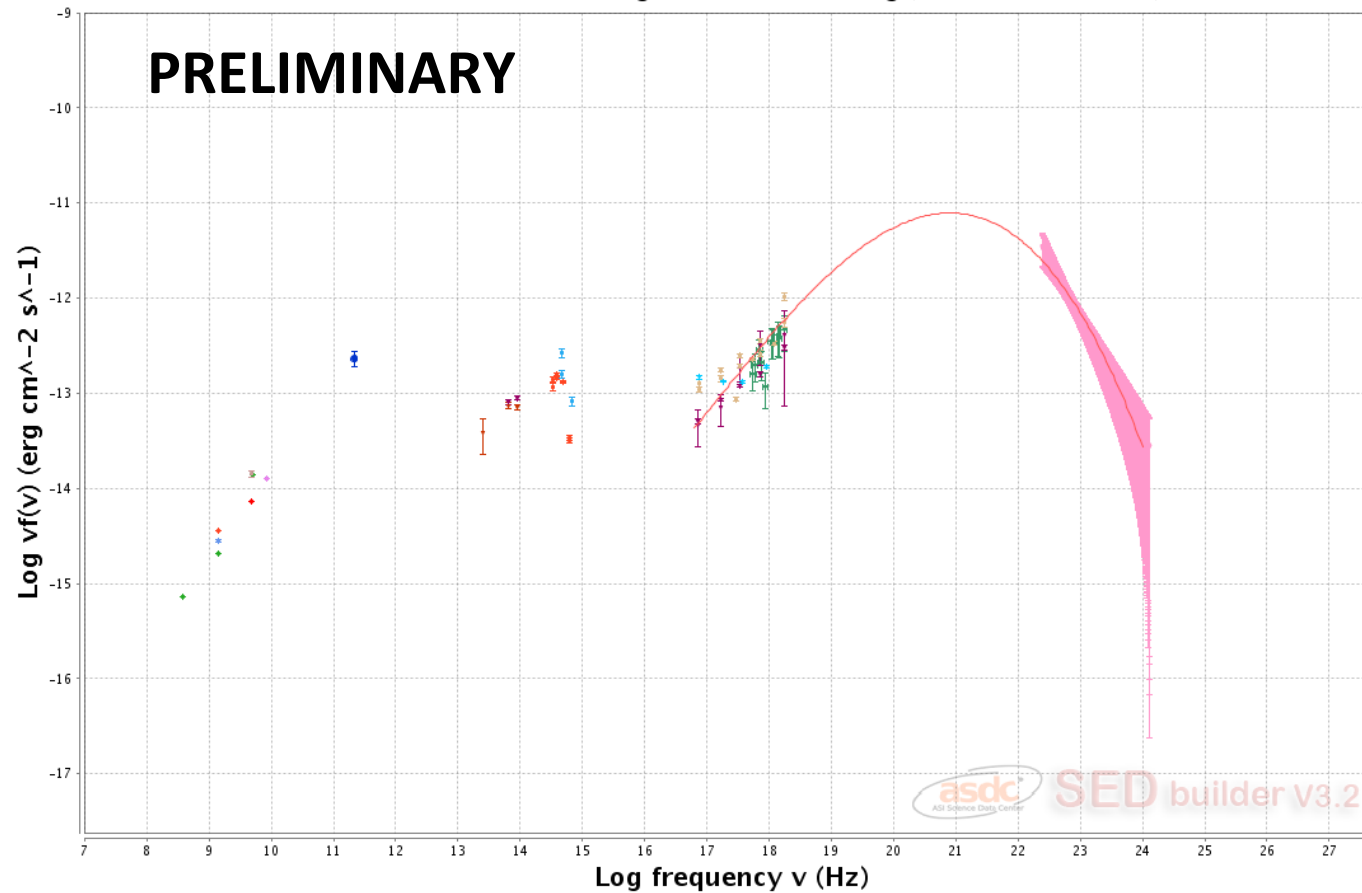
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GB 1508+5714



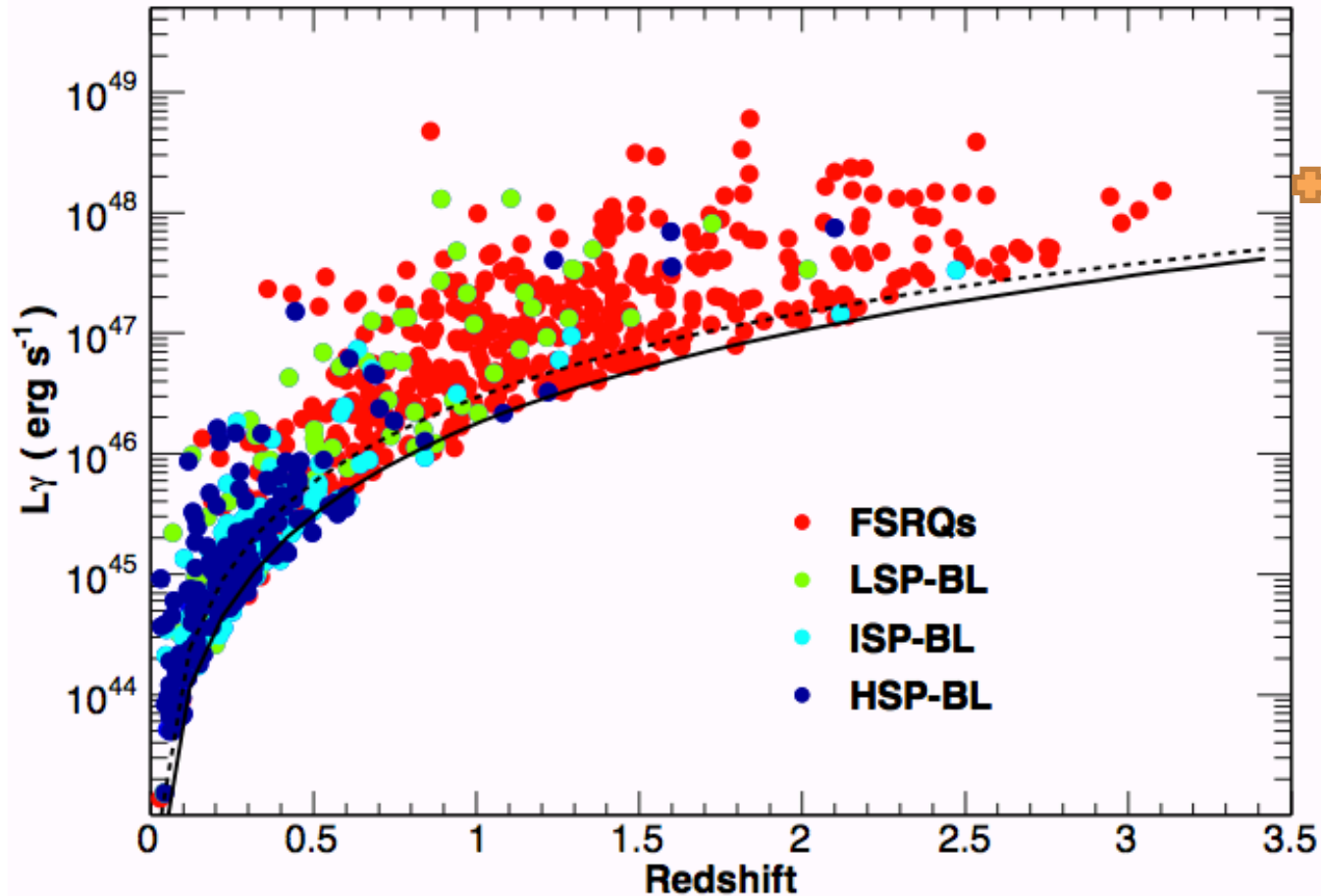
GB1508+5714 Ra=227.51167 deg Dec=57.04528 deg (NH=1.6E20 cm⁻²)



Spectral Energy Distribution for the high redshift FSRQ TXS 1508+572 using non-simultaneous data. It suggests an IC peak at about 10²¹Hz.



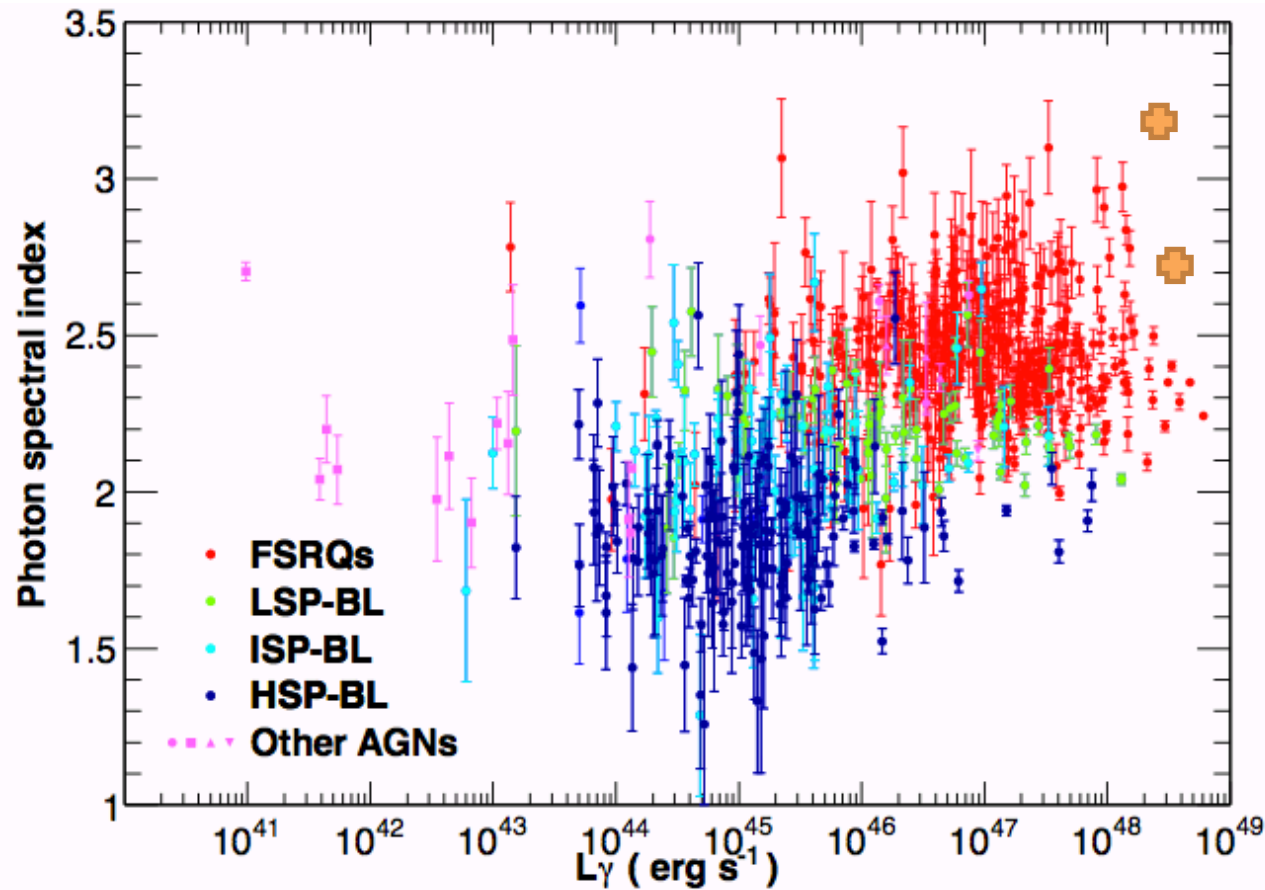
Gamma-ray Luminosity vs redshift



Gamma-ray luminosity versus redshift. Red: FSRQs, green: LSP-BL Lacs, light blue: ISP-BL Lacs, dark blue: HSP-BL Lacs. The solid (dashed) curve represents the approximate detection limit for $\Gamma=1.8$ ($\Gamma=2.2$). (Fig 13: Ackermann et al. 2015; 3LAC)



Photon Index vs gamma-ray luminosity



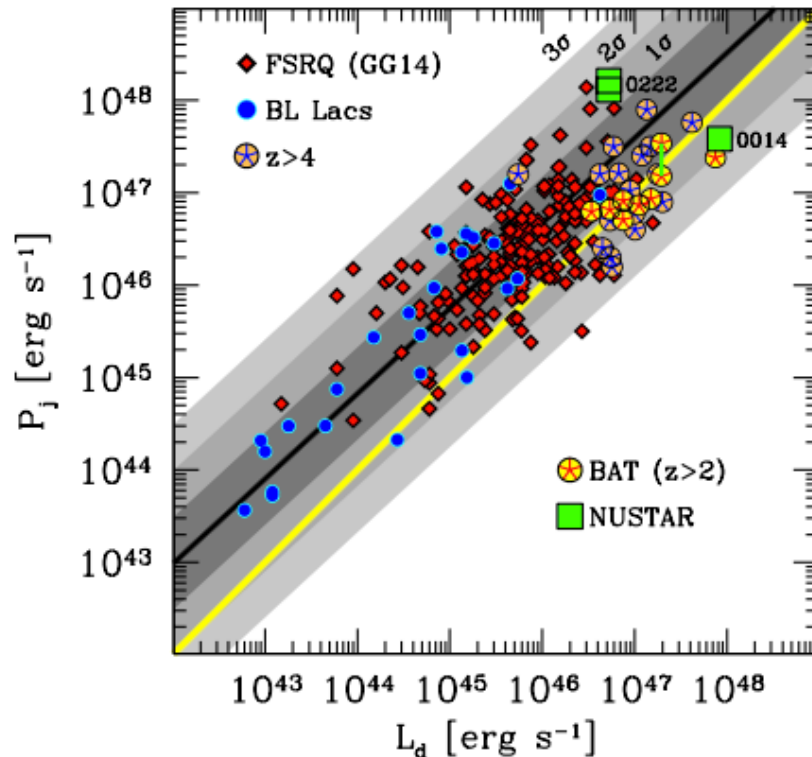
Photon index versus gamma-ray luminosity. Red: FSRQs, green: LSP-BL Lacs, light blue: ISP-BL Lacs, dark blue: HSP-BL Lacs, magenta: other AGNs (circles: NLSy1s, squares: radio galaxies, up triangles: SSRQs, down triangles: AGNs of other types). (Fig 14: Ackermann et al. 2015; 3LAC)



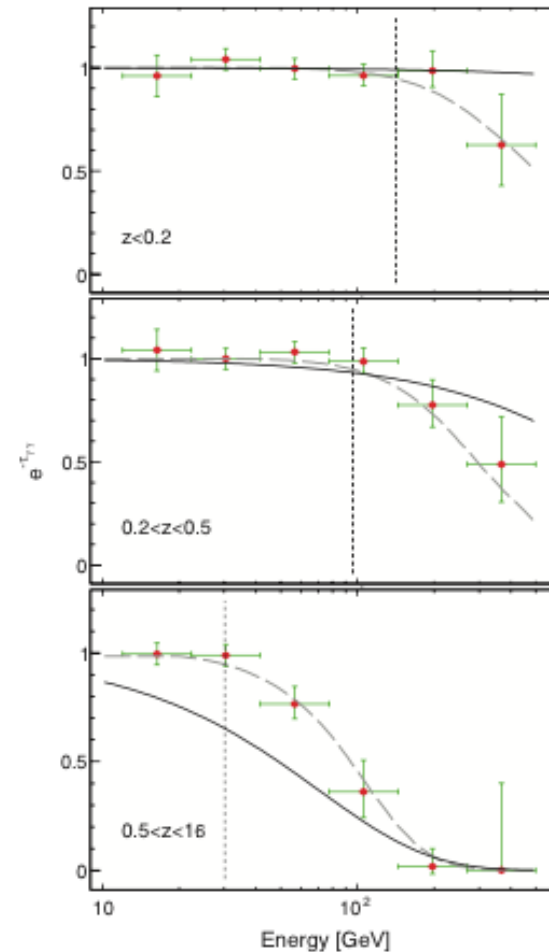
Scope



- Energetics of the blazar:
 - Relation between accretion and jet power still valid?
- Investigation of gamma rays horizon up to high redshift



From Sbarrato et al. 2015



From Ackermann et al. 2012



Summary



- Longer observations and Pass 8 are unearthing high-z blazars
- They are intrinsically interesting and also excellent tools to study the gamma-ray horizon
- NuSTAR synergy needed for IC peak estimation
- We are here

