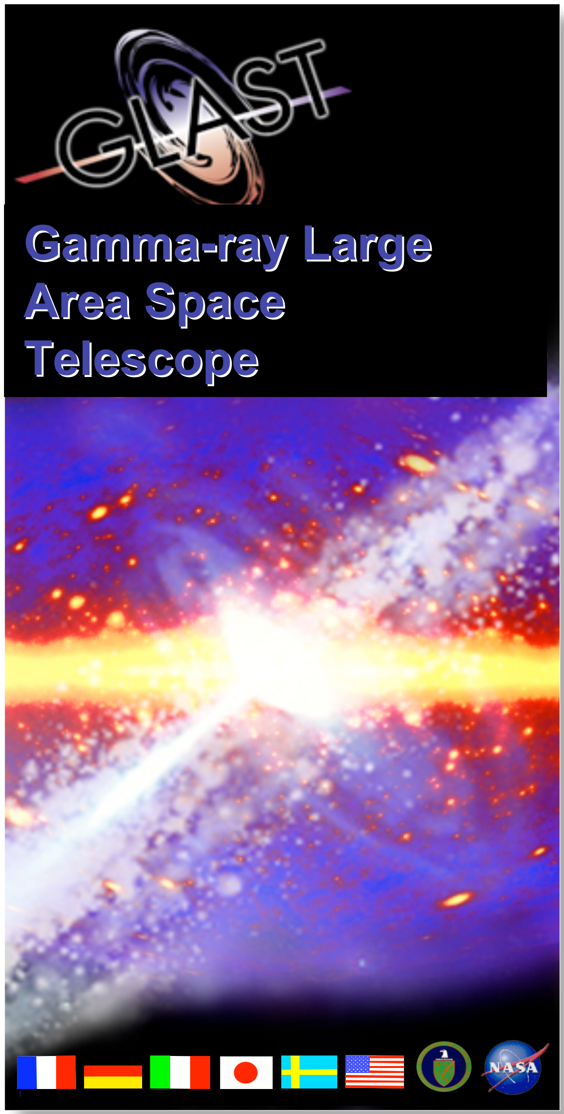


The LAT-detected Blazars Population Estimates of the Gamma-ray sky Variability Studies

Benoît Lott
SLAC/CENBG
LAT Science Group on “Blazars and other AGNs”

http://www.slac.stanford.edu/~lott/agn.html

Outline

1. EGRET legacy

2. Technicalities- Sensitivity estimates

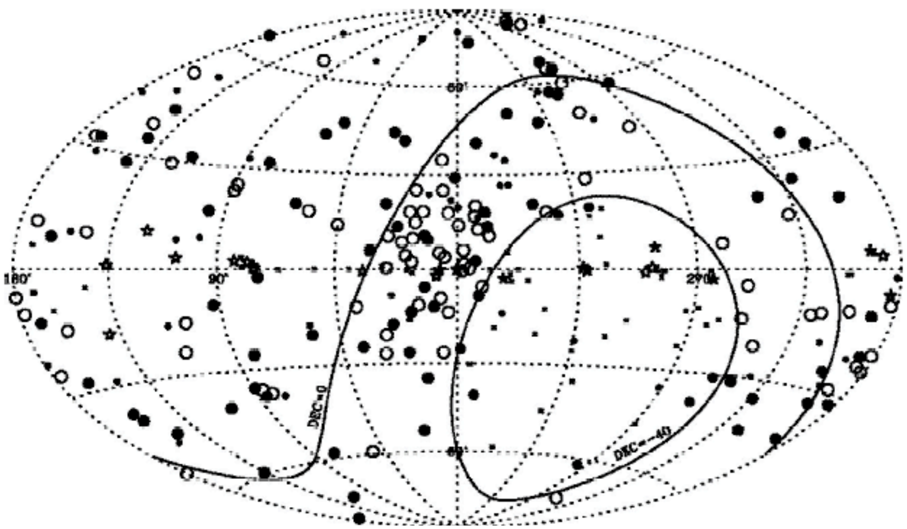
3. Population studies
   Simulations

4. Light curves- variability
   Simulations

5. Conclusion

EGRET legacy

- 271 EGRET sources in 3rd EGRET Catalog (S [E>100 MeV] > 10^{-7} ph cm^{-2} s^{-1})
- extragalactic: 105 AGN + LMC
- AGN: all radio-loud; ~ 97% blazars + 2 radio galaxies (Cen A, NGC6251)
- FSRQ/BL Lac ratio ~ 3 : 1 , LBL/HBL ratio ~ 5 : 1
- 13 AGN with S_{peak} > 10^{-6} ph cm^{-2} s^{-1}, 4 AGN with S_{peak} > 2 x 10^{-6} ph cm^{-2} s^{-1}
- 2 sources exceeded S_{peak} > 10^{-5} ph cm^{-2} s^{-1} over a lapse of few hours



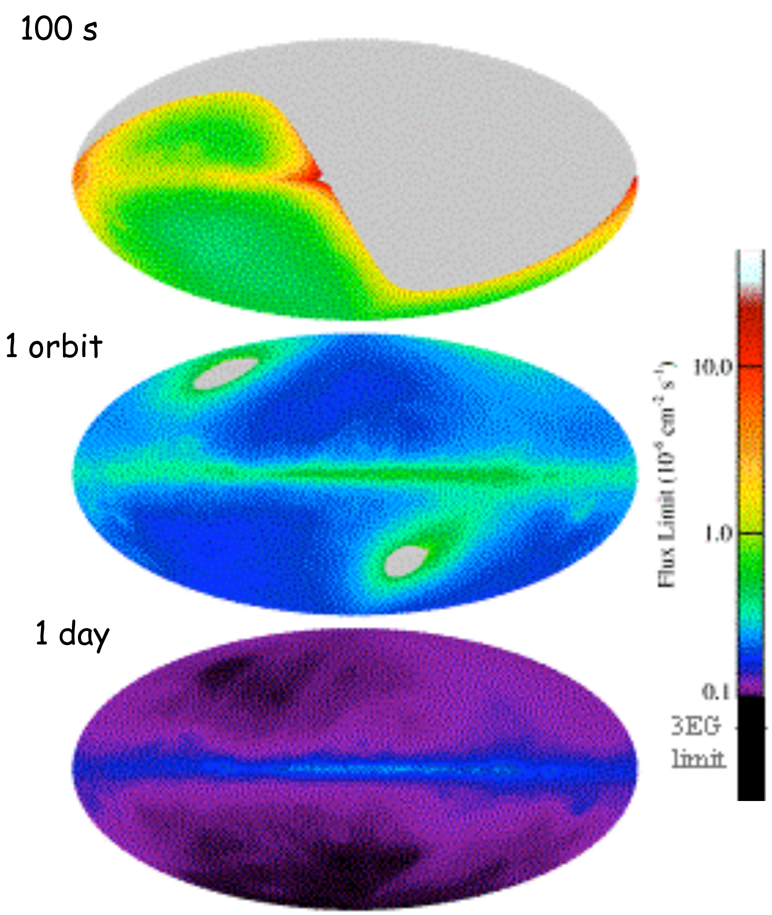
- ● high-confidence blazar;
- • plausible blazar;
- ★ pulsar;
- ☆ pulsar/plerion candidate;
- o non-blazar;
- \+ unidentified.

AGN: Sowards-Emmerd et al., 2004, 2003

FoM($S_{8.4}$,α,S_X) $S_{8.4}$: Flux at 8.4 GHz , α : radio index, S_X: Flux in X

Technicalities
Sensitivity estimates

Exposure

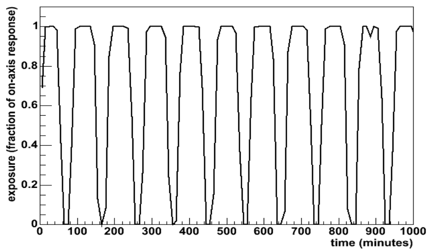


The field of view of the LAT is huge > 20% of the sky.

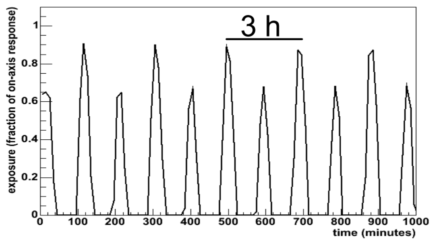
Rocking mode provides an efficient way of observing the entire sky with reasonably uniform exposure on timescales of hours.

The LAT is an all-sky montitor!!

Exposure

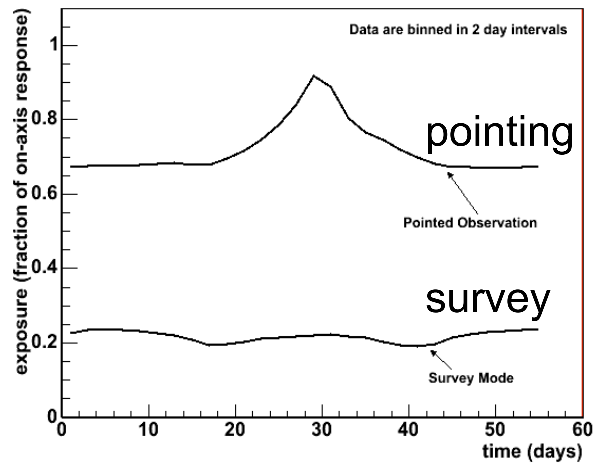


pointing mode



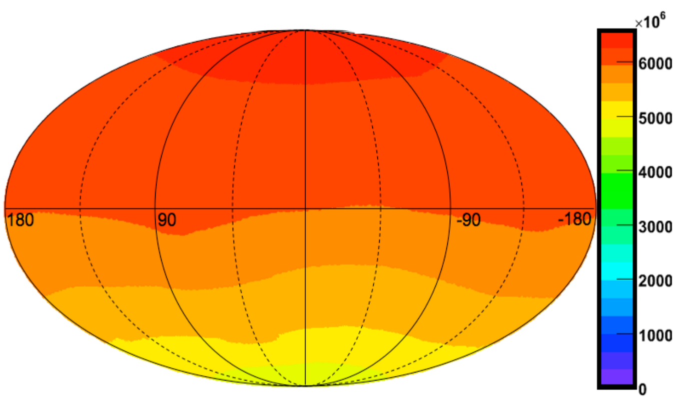
survey mode

J.McEnery

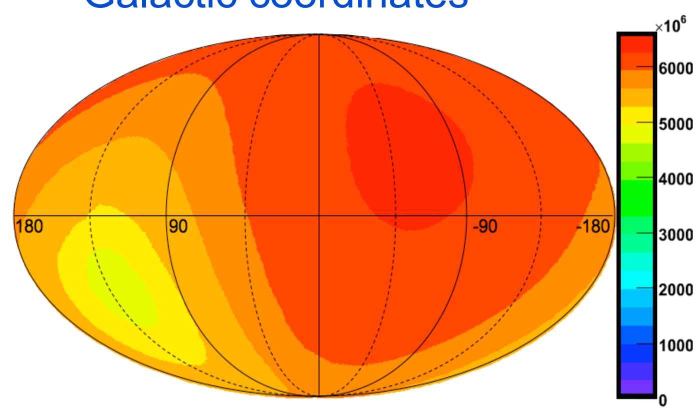


Survey mode, rocking ± 35° every second orbit
Difference North vs South due to passage in the SAA

Celestial coordinates



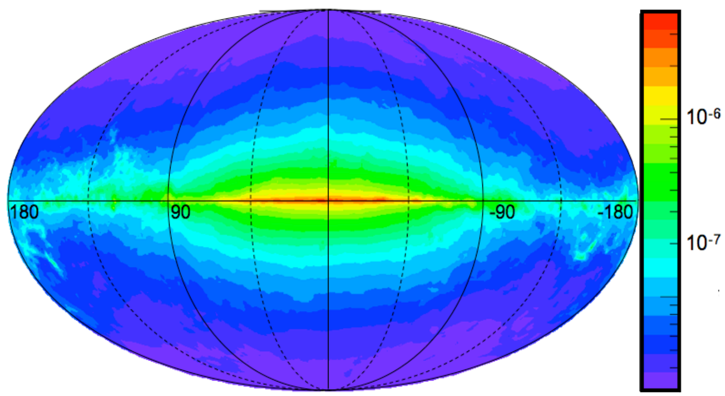
Galactic coordinates



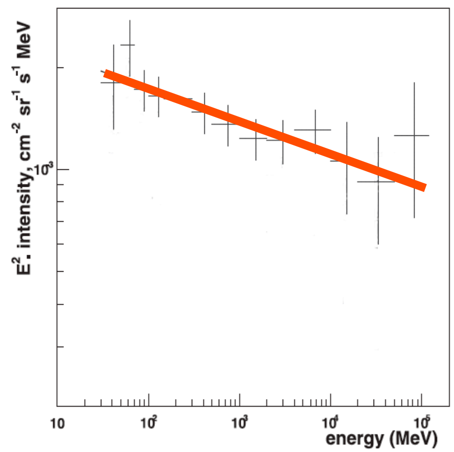
"Backgrounds"

Galactic Diffuse Emission Background

GALPROP (Strong A.W., Moskalenko I.V. 2001, *Adv. Space Res.* **27**, 717-726)

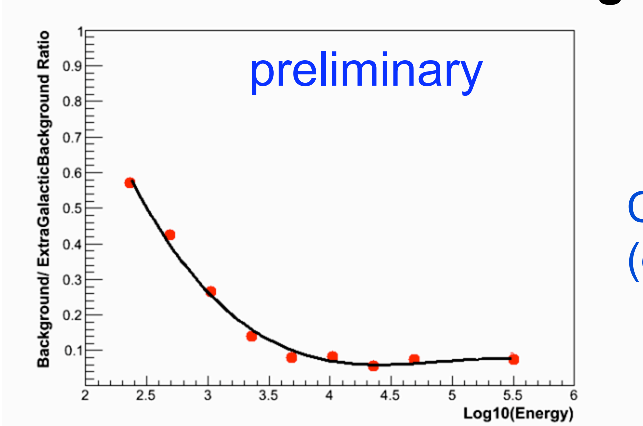


Extragalactic Gamma-Ray Background (EGRB)



Sreekumar et al. 1998, ApJ 494, 523

Residual Instrument Background



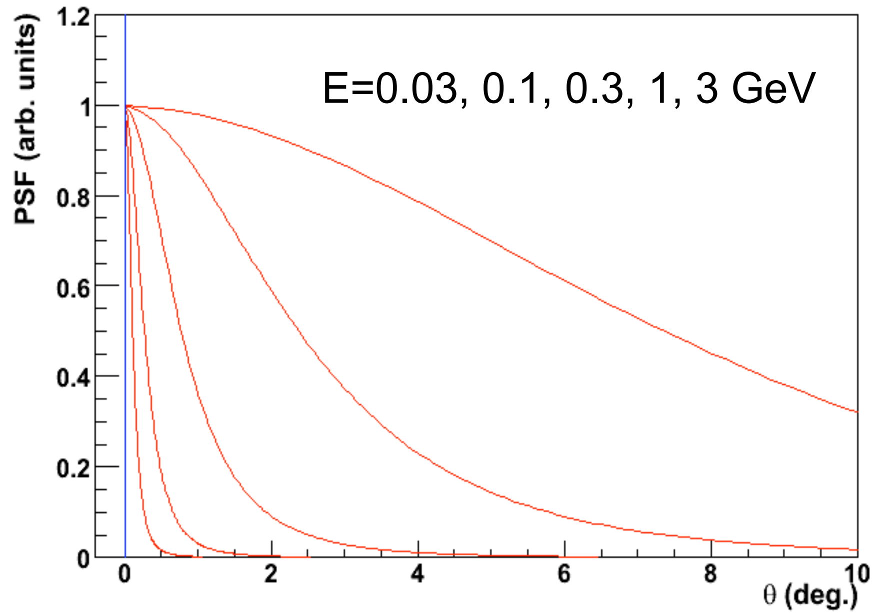
Contributions from non-rejected cosmic-rays (e^+, e^-, p, …) and albedo gammas

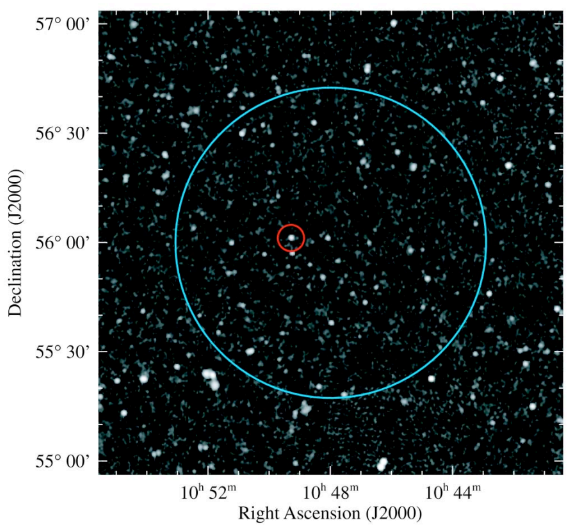
Point Spread Function

PSF: $\theta_{68\%} \propto E^{-0.8}$

Two classes of events:
-"Front" (thin conversion layers)
-"Back" (thick conversion layers)

Checked with beam tests at CERN





A better PSF increases the sensitivity and reduces the sources' error box.

Benoit Lott

Log-likelihood

Log-likelihood:

$$\ln(L) = \sum_i \ln(M_i) - N_{pred}$$

model density at the coordinates (ra,dec, E) of event i

$A_{eff}(E)$:effective area

differential source spectrum (power law)

Point Spread Function

differential background spectrum per solid angle unit

number of photons predicted by the model

T_0 :accumulation time

$T_0 \times A_{eff}(E)$: exposure

Source significance obtained by comparing $\ln(L)$ with and without the source :

$$\Delta\ln(L) = \sum_i \ln\left[1 + \frac{A_{eff}(E_i)\, S_S(E_i) F(r_i,E_i)}{S_B(E_i)}\right] - N_{SRC}$$

$$\int \left[g(r,E) \right] \ln\left[1 + g(r,E)\right] - g(r,E)\, d\Omega$$

Defining:

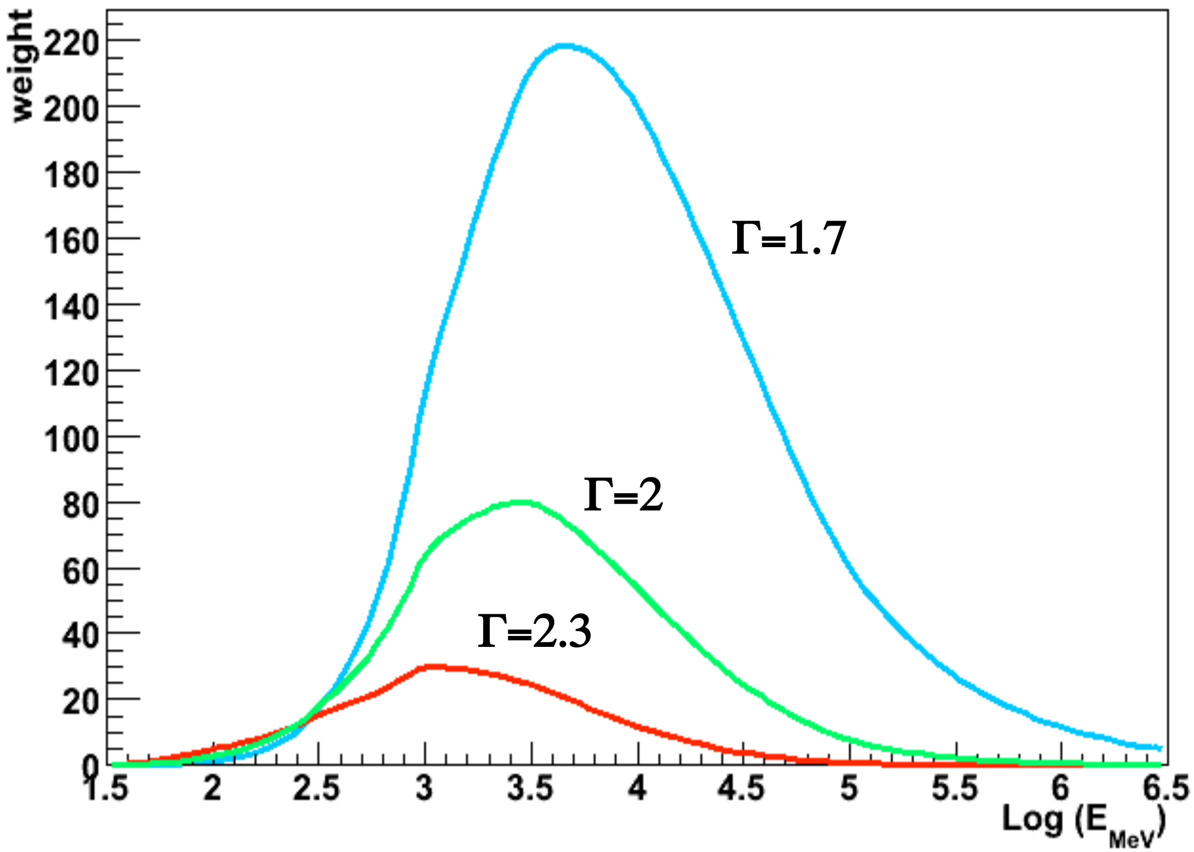
$$g(r,E) = \frac{S_S(E) F(r,E)}{S_B(E)}$$

Test Statistic : $TS = 2\Delta\ln(L)$ (behaves as χ_1^2). For N_σ large enough, $TS = N_\sigma^2$

Statistical uncertainties on the power-law parameters are estimated from the Hessian matrix.

Significance weights

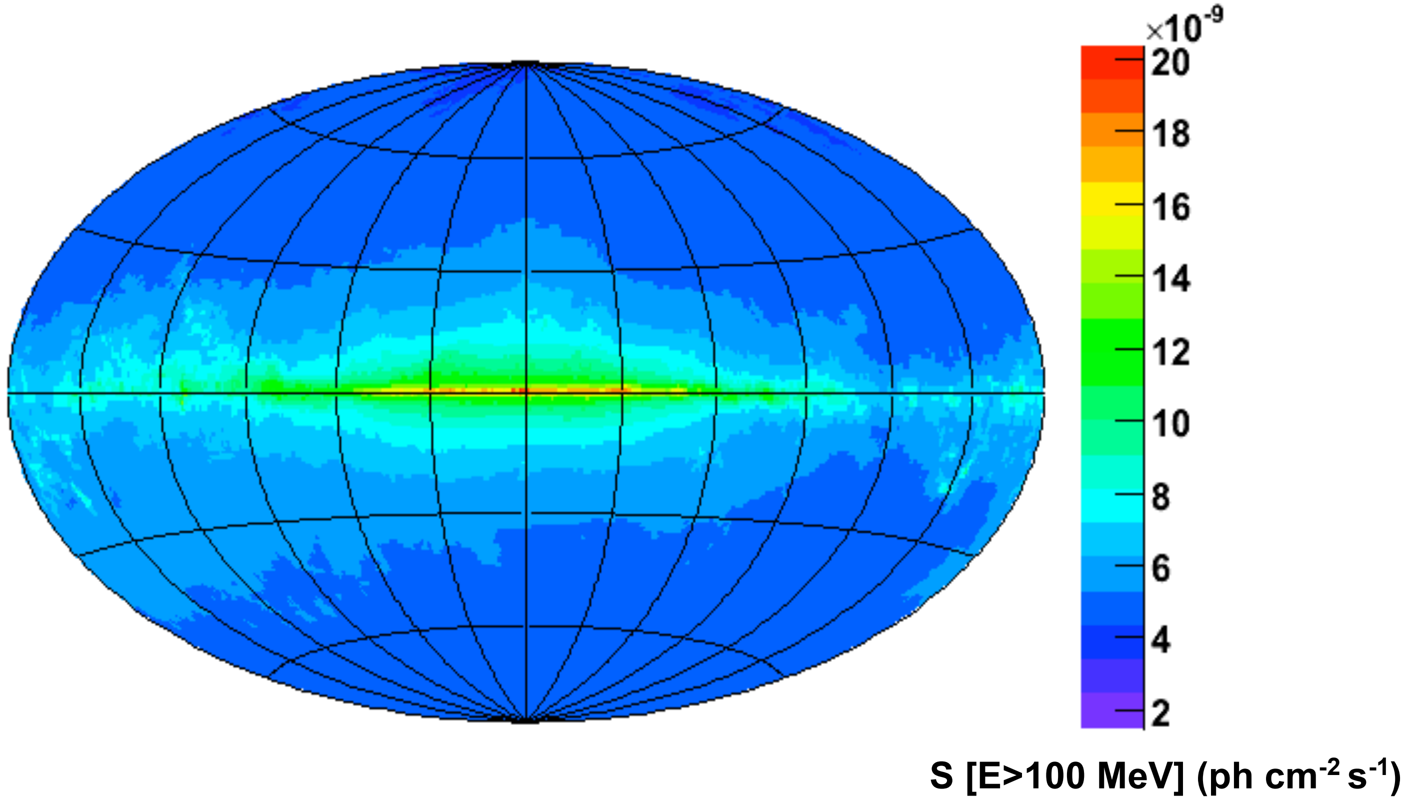
$$TS = 2T_0 \int A_{eff}(E) S_B(E) dE \int [1 + g(r,E)] \ln[1 + g(r,E)] - g(r,E) d\Omega$$



$S_s(E) \propto E^{-\Gamma}$

Maximum of sensitivity between 1 and 10 GeV

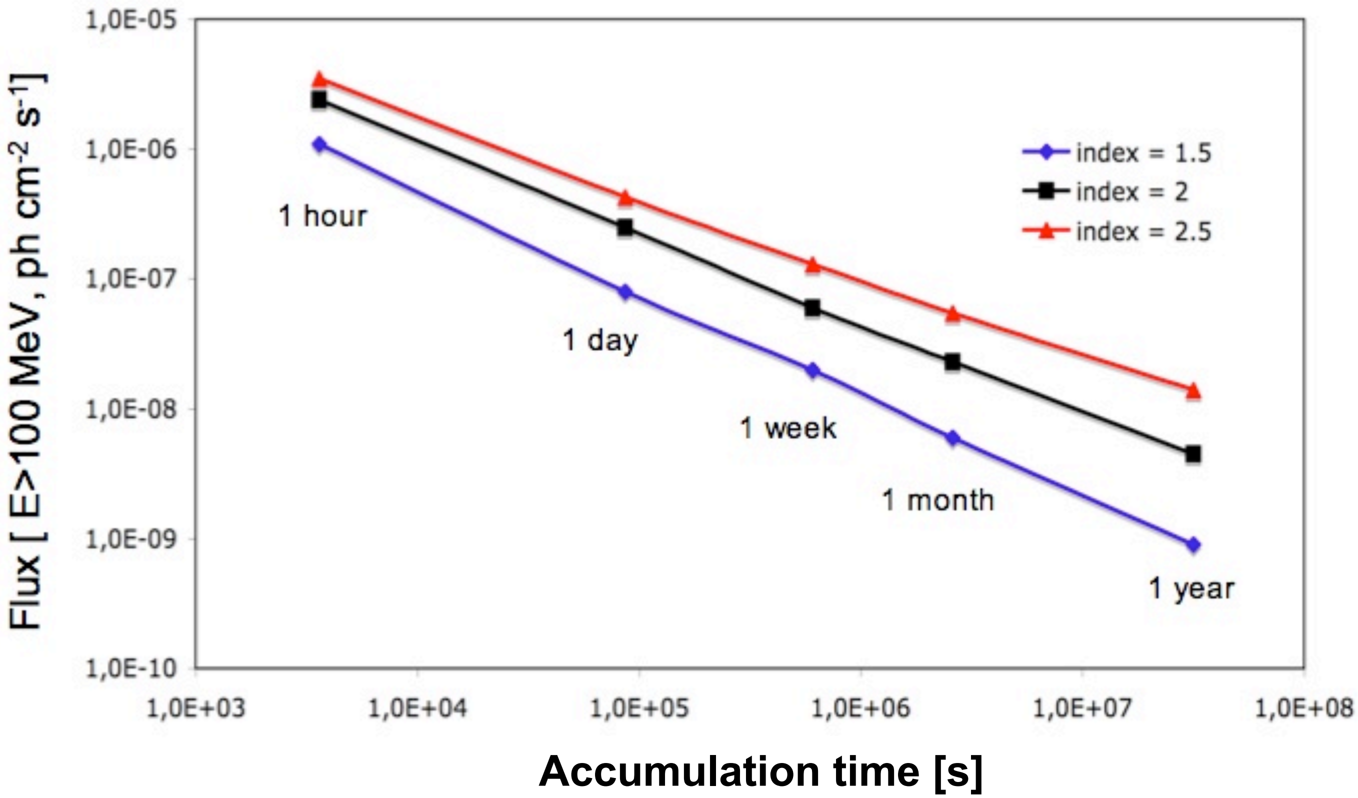
One-year 5-σ sensitivity map



At high latitude: S [E>100 MeV] ~ 4 x 10^{-9} ph cm^{-2} s^{-1}

νF_ν ~ 6.5 x 10^{-13} erg cm^{-2} s^{-1}

"5-σ" time



V. Lonjou

LAT performance estimates for EGRET blazars

Source	EGRET Flux	index	ra	dec	time	EGRET peak flux	time
	(ph m $^{-2}$ s $^{-1}$)		(deg)	(deg)	(d)	(ph m $^{-2}$ s $^{-1}$)	(d)
3EGJ0038-0949	1.20e-03	2.70	9.74	-9.82	11.51	3.77e-03	1.58
3EGJ0118+0248	5.10e-04	2.63	19.60	2.81	42.46	2.36e-03	2.89
3EGJ0130-1758	1.16e-03	2.50	22.70	-17.97	7.89	1.38e-03	5.89
3EGJ0204+1458	8.70e-04	2.23	31.11	14.97	7.88	5.28e-03	0.50
3EGJ0210-5055	8.55e-03	1.99	32.58	-50.93	0.16	1.34e-02	0.09
3EGJ0215+1123	9.30e-04	2.03	34.00	11.38	4.06	1.80e-03	1.56
3EGJ0222+4253	1.87e-03	2.01	35.70	42.90	1.88	2.53e-03	1.21
3EGJ0237+1635	2.59e-03	1.85	39.36	16.59	0.65	6.51e-03	0.19

Source	EGRET Flux	index	ra	dec	time	EGRET peak flux	time
3EGJ0404+0700	1.11e-03	2.65	61.15	7.00	12.35	3.22e-03	1.93
3EGJ0412-1853	9.10e-04	3.25	63.14	-18.88	20.86	4.95e-03	0.91
3EGJ0422-0102	1.63e-03	2.44	65.65	-1.04	4.37	8.17e-03	0.33
3EGJ0423+1707	1.58e-03	2.43	65.92	17.13	4.91	5.48e-03	0.65
3EGJ0439+1105	1.25e-03	2.37	70.55	-0.55	6.02	8.59e-03	0.29

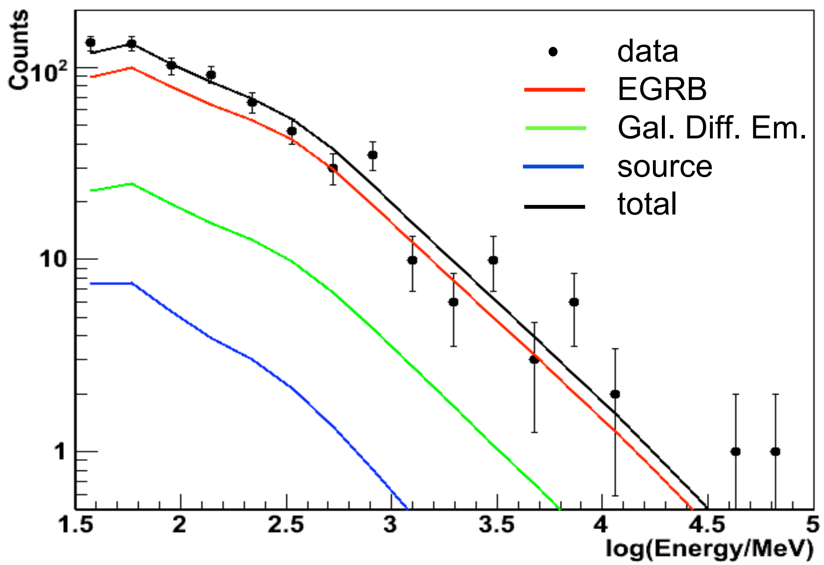
3EGJ0459+0544	6.10e-04	2.36	74.93	5.75	19.94	5.20e-03	0.63
3EGJ0459+3352	1.35e-03	2.54	74.78	33.87	12.77	3.56e-03	2.32
3EGJ0500-0159	1.12e-03	2.45	75.10	-1.99	8.51	6.82e-03	0.45
3EGJ0510+5545	2.13e-03	2.19	77.63	55.77	2.84	6.19e-03	0.55
3EGJ0512-6150	7.20e-04	2.40	78.15	-61.84	16.33	2.88e-03	1.65
3EGJ0530+1323	9.35e-03	2.46	82.74	13.38	0.33	3.51e-02	0.04
3EGJ0531-2940	6.90e-04	2.47	82.91	-29.68	19.53	3.50e-03	1.30
3EGJ0533+4751	1.40e-03	2.55	83.32	47.85	16.36	4.79e-03	1.84
3EGJ0540-4402	2.53e-03	2.41	85.02	-44.05	2.18	9.11e-03	0.29
3EGJ0542+2610	1.47e-03	2.67	85.69	26.17	14.57	7.40e-03	0.80

http://www.slac.stanford.edu/~lott/3EG_blazar_time.pdf

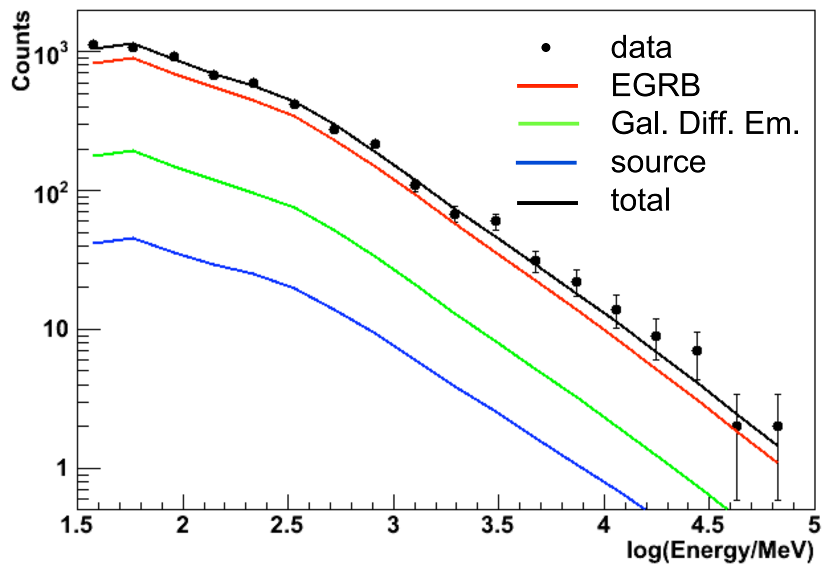
Spectra

Output of likelihood tool (“gtlikelihood”) developed as part as the Standard Analysis Environment

S [E>30 MeV] =10^{-6} ph cm^{-2} s^{-1} Γ=2 galactic latitude= 60°



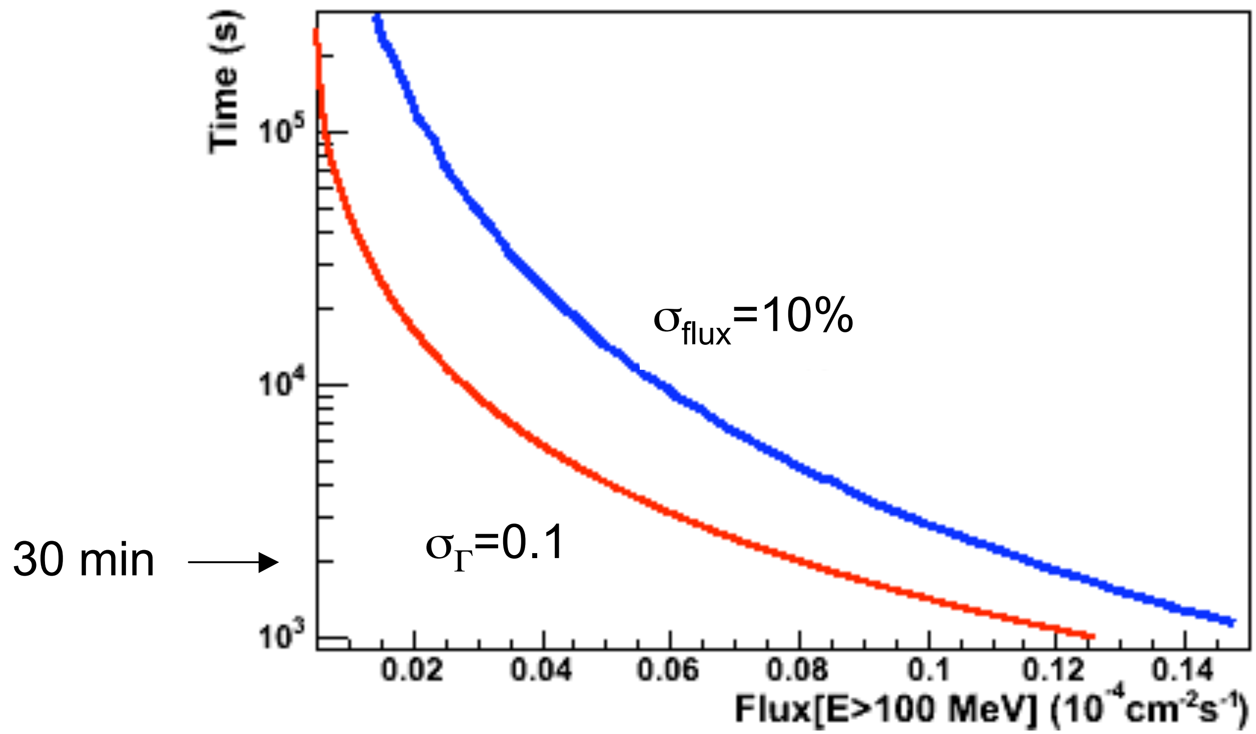
T=10^4 s



T=10^5 s

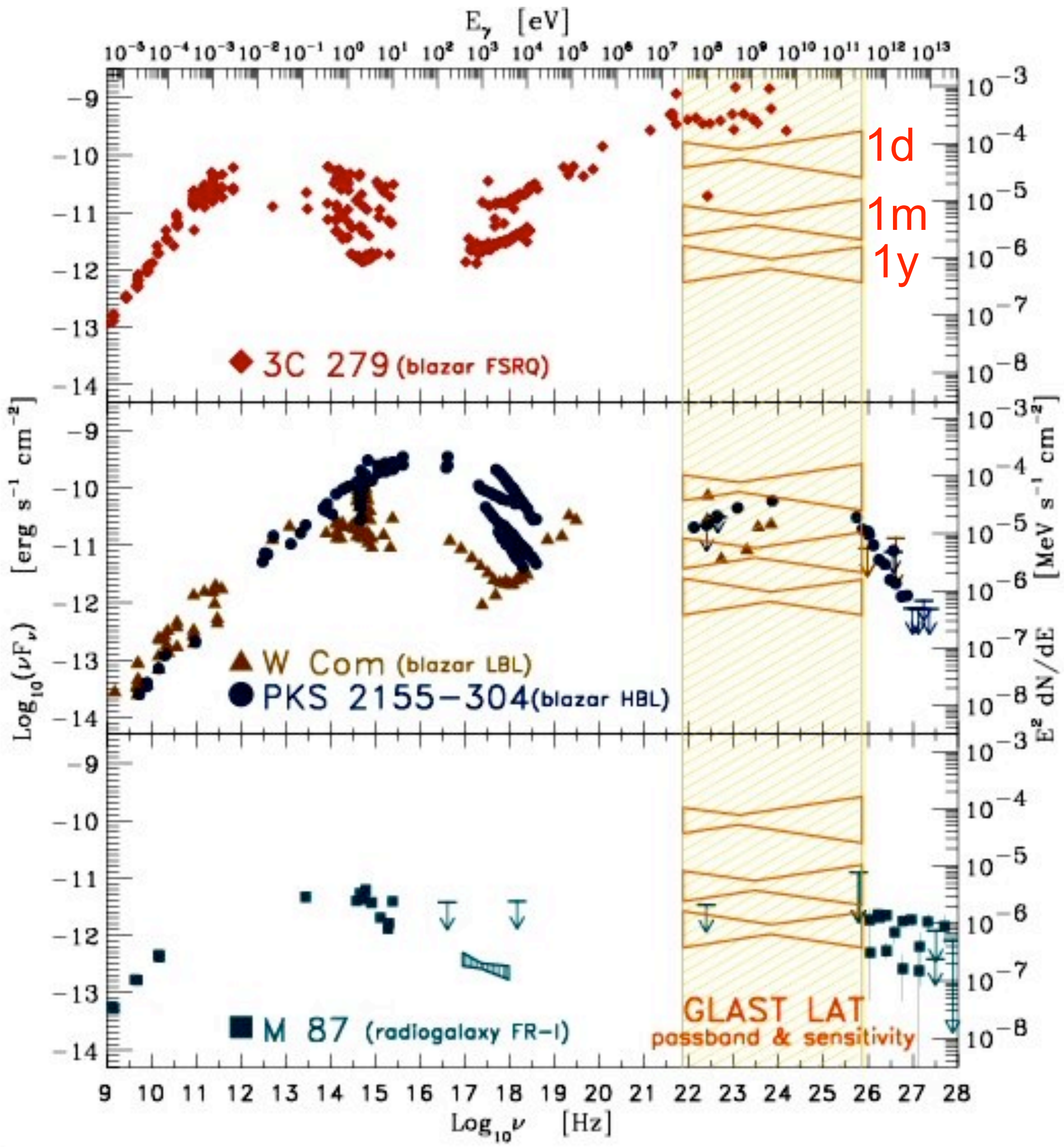
integration over a region 40 deg across

Statistical accuracy on flux/index



Note:The good accuracy on the index measurement may appear surprising. Proposed explanation: strong dependence of PSF on E.

Differential Sensitivity



20% accuracy on flux

S.Ciprini

Blazar Populations

Science Goal Document (part A)

A.1 What are the general properties of gamma-ray emitting blazars: their log (N) - log (S) function, "unbeamed" luminosity function? What is the cosmological evolution of blazars?

A.2 Are there multiple classes of gamma-ray emitting blazars? Is there a blazar sequence, relating the overall properties (location of the LE and HE peaks) to other properties such as luminosity and the highest energies where the gamma-rays are observed?

A.3 Can the range of properties inferred in A.2 be mainly due to orientation /environment effects?

A.4 What is the distribution of the Lorentz factors of the relativistic jets? Is evolution of the Lorentz factor with the distance from the black hole apparent?

A.5 More detailed studies of individual sources that might "break" trends above, e.g.: what makes some blazars brighter in gamma-rays? Why is that 3C345 was not detected by EGRET?

A.6 Do gamma-ray flares generally coincide with the emission of new radio components?

A.7 What do parsec-scale structures - and the relationship to gamma-ray properties - tell us about jet confinement and collimation?

A.8 What is the contribution of the known AGN to the gamma-ray background?

Authors: Greg Madejski & Greg Taylor

http://www.slac.stanford.edu/~lott/AGN_Sci_goals_v_Apr20.pdf

Estimates of Blazar Populations: Gamma-Ray Luminosity Function

Issue closely related to estimating the contribution of unresolved blazars to the Extragalactic Gamma-Ray Background (EGRB)

Stecker and Salamon (1996, ApJ, 464, 600) based on radio-γ-ray connection (radio luminosity function, RLF)

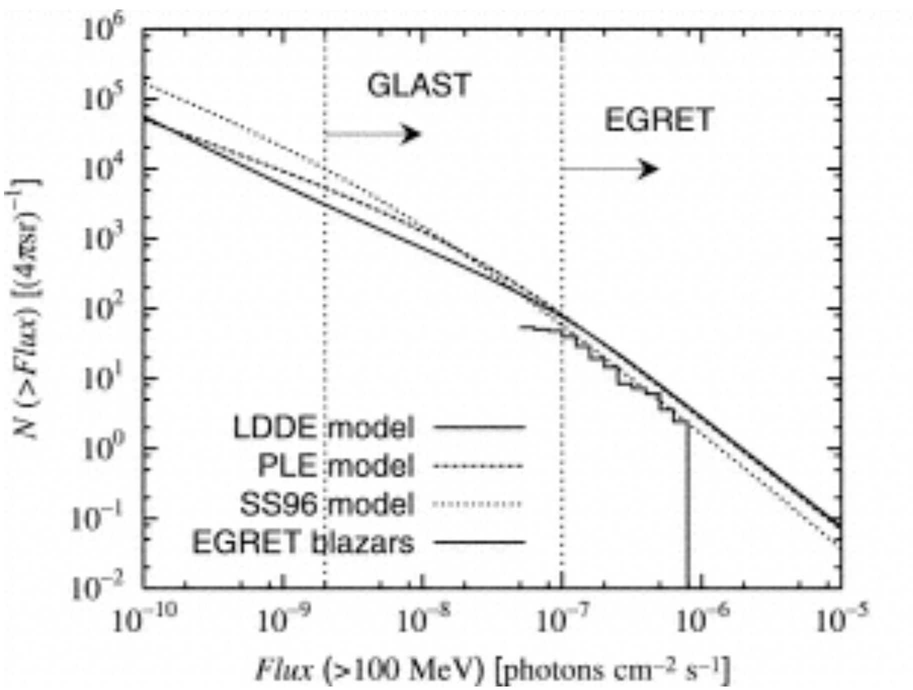
Mücke and Pohl (2000, MNRAS 312, 177) based on a physical model, $n(\gamma_e)$ injected in the jet (properties infered from FR1 and FR2 for BL Lac and FSRQ respectively)

Narumoto and Totani (2006, ApJ, 643, 81), assumed
- Pure Luminosity Evolution (PLE) based on RLF
- Luminosity-Dependent Density Evolution (LLDE) based on SXLF
(peak z of density evolution increases with luminosity)

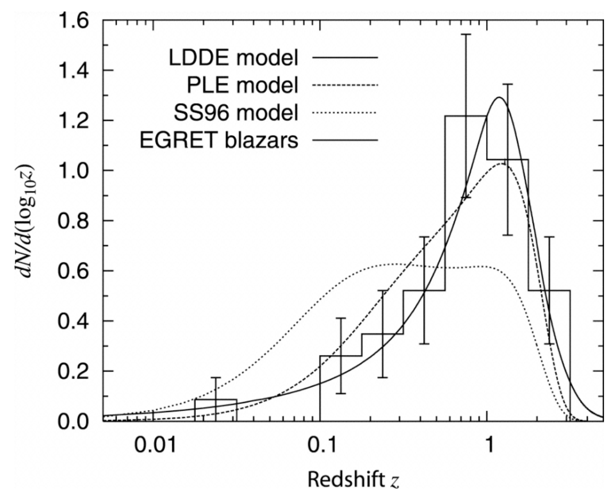
Dermer (2006, astro-ph/0605402, ApJ in press) based on a physical model with parameters adjusted on EGRET data only (BL Lac: SSC, FSRQ, EC)

Population estimates

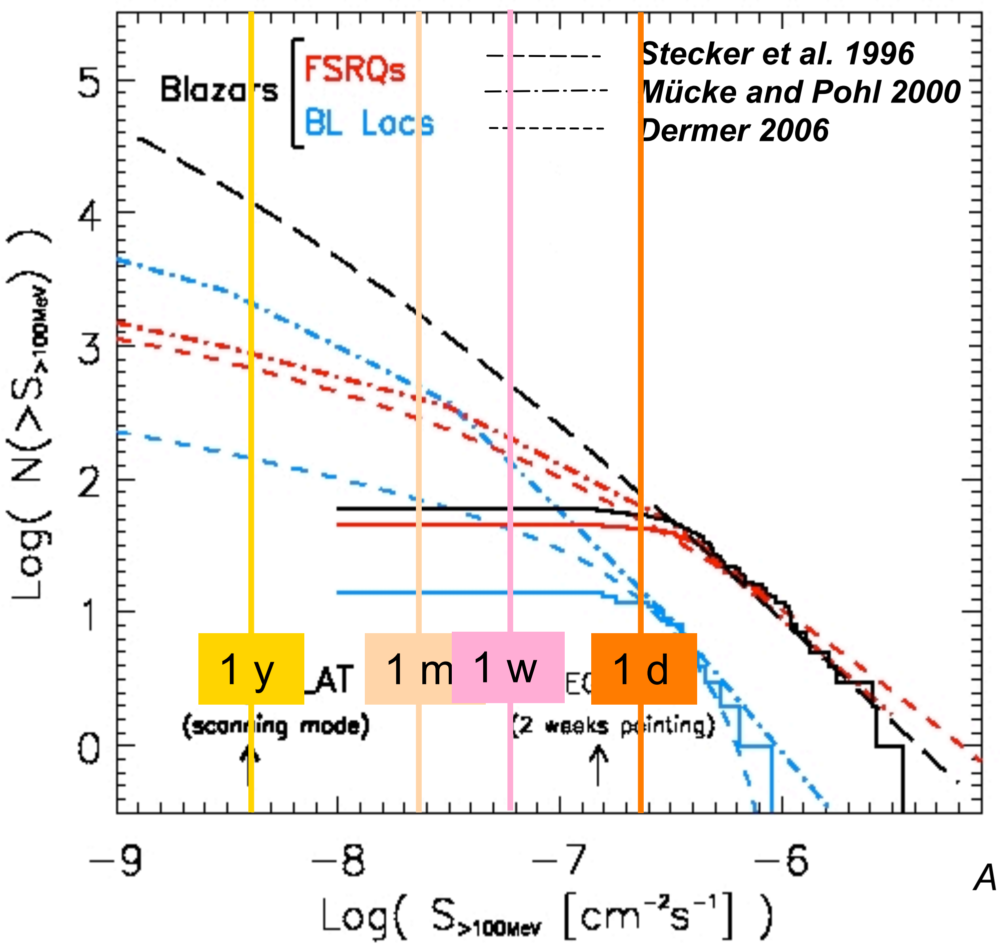
log N-log S



redshift distribution



Stecker and Salomon 96: ~10000 blazars with GLAST
Narumoto and Totani 06: Pure Luminosity Evolution (PLE) ~ 5000
Luminosity Dependent Density Evolution (LDDE) ~ 3000



Time	FSRQ	BLLac
1 d	~60	~15
1 w	150-200	50-150
1 m	250-400	70-500
1 y	800-1000	200-2000

A. Reimer & C. Dermer

LBL vs HBL

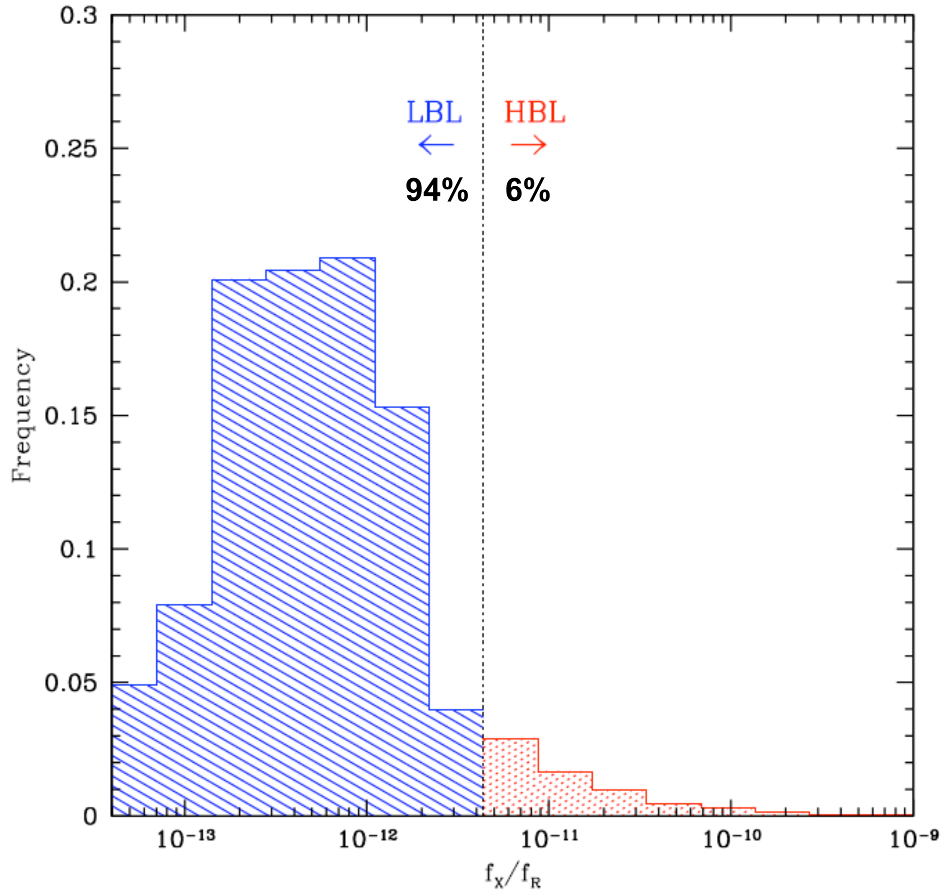


Fig. 4. The f_x/f_r distribution of Blazars estimated from the 1Jy-ANR and from a sample of about 2000 HBL Blazar candidates (see text for details).

P. Giommi et al., 2006, A&A, 445, 843

ANR:ASDC-NVSS-RASS
f_r >1Jy @1.4GHz

HBL are faint in the GeV domain, but usually have a hard spectrum.

CGRaBS=Candidate Gamma-Ray Blazar Survey

R. Romani, S. Healey et al.

Radio + Optical Survey
Hobby-Heberly telescope

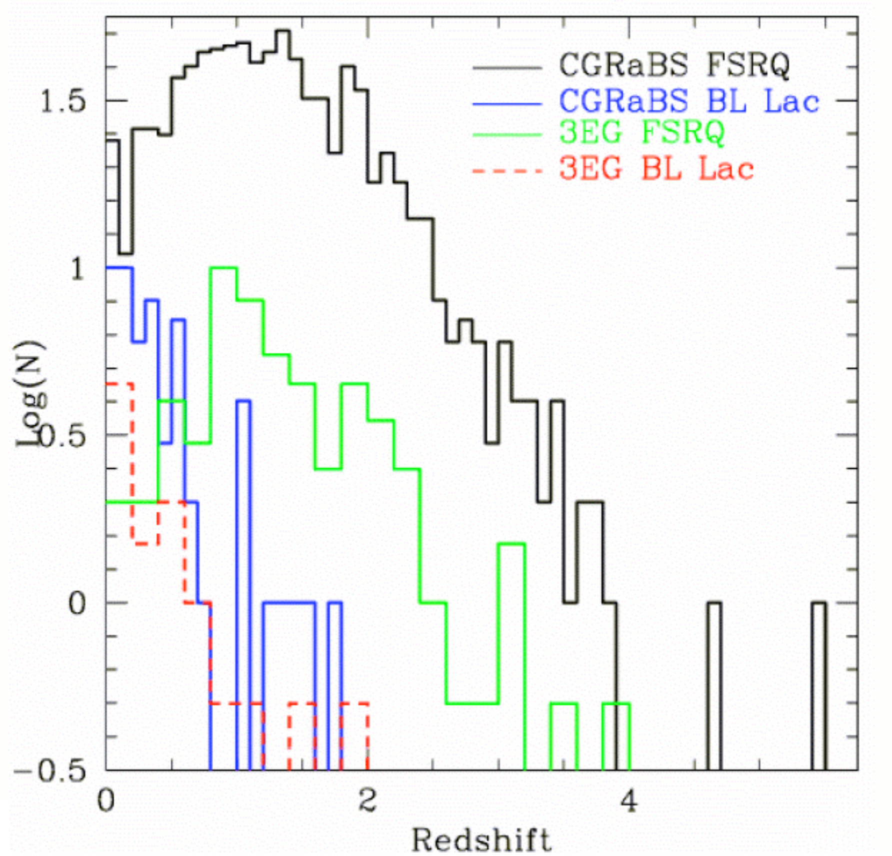
Uses Figure-of-Merit
devised for 3EG blazars
(D. Sowards-Emmerd et al.)
FoM($S_{8.4}$,α,S_X)
$S_{8.4}$= Flux at 8.4 GHz
α = radio index
S_X= Flux in X
"EGRET-like" objects

~ 1500 candidates

Redshift Distribution – FSRQ/BLL

- High-z tail…
- 3EG
  - 9 z>2.5
  - 5 z>3
- CGRaBS
  - 86 z>2.5
  - 30 z>3

z_{max}=5.48

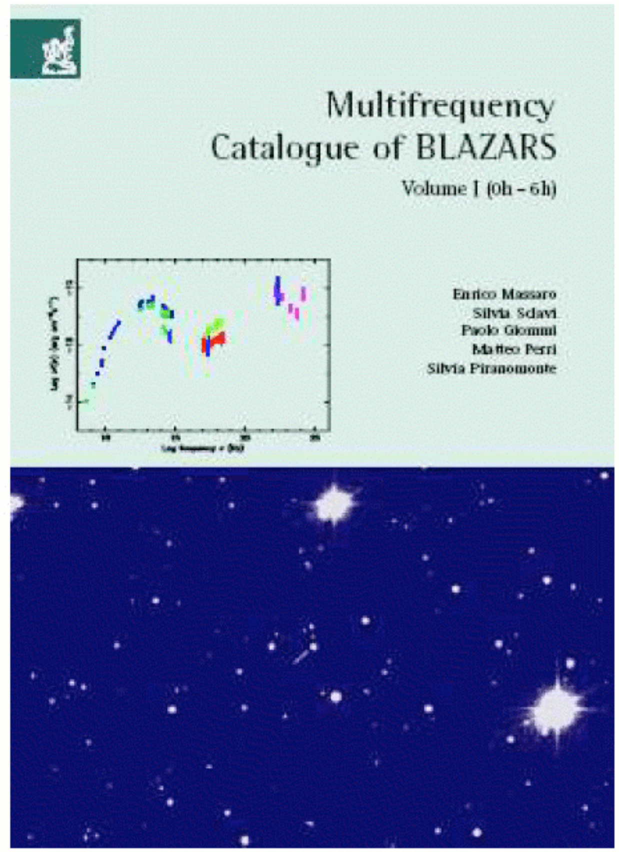


The BZ Catalog (ASDC-Roma U.)

E. Massaro, P. Giommi et al.
4 volumes (end of 2007)
ultimately ~ 2400 blazars
essentially all known BL Lac are included and most FSRQ

- Main goals:

1. **to have the most complete list of published blazars**
2. **to have a basic sample for the identification of γ-ray sources detected by LAT**
3. **to have a source population useful to select samples for statistical studies of blazar properties and evolution**
4. **to have a large database of broad-band spectral energy distributions (SED) of different types of blazars to investigate radiation processes**



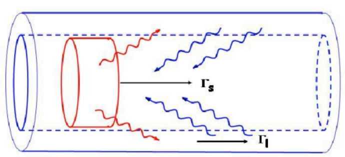
Radio galaxies

EGRET detected 2 radio galaxies:
-Cen A, FRI, z=0.0018, $\theta \sim 70°$, L=10^{41} erg/s
-NGC 6251 (3EGJ1621+820), z=0.0234, $\theta \sim 45°$,L=10^{43} erg/s
- 3C111?
Much less than a typical EGRET blazar (L=10^{48} erg/s)

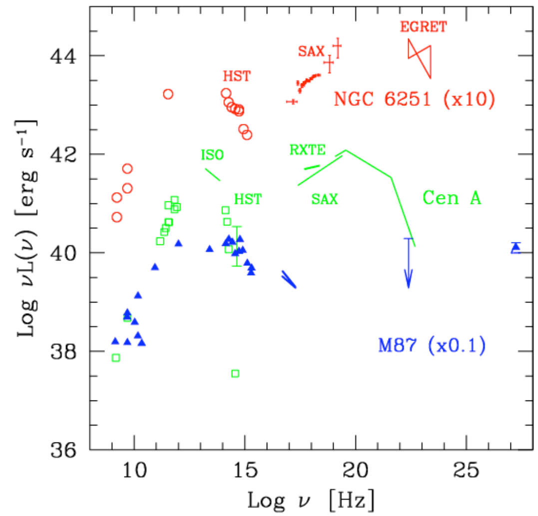
M87 detected at TeV energies (HEGRA, HESS):
Possibly due to emission in the large scale (>kpc) jet
(Stawarz et al., 2006)

$L(\theta) \propto \delta^q$ q~2-3 deamplification at large angle

Structured/decelerated jets? Fast spine/slow layer (Ghisellini et al., 2005) or decreasing bulk Lorentz factor (Georganopoulos et al. 2005).



Ghisellini et al. (2005) predict about 10 3CR radiogalaxies to be detected by GLAST.



Name	log $F_{R,core}$ (5 GHz) erg cm^{-2} s^{-1} Hz^{-1}	log $\nu_\gamma F_\gamma$ (100 MeV) erg cm^{-2} s^{-1}
3C 84	–21.37	– 9.67±0.5
3C 274	–22.40	–10.70±0.5
3C 78	–23.02	–11.32±0.5
3C 317	–23.41	–11.71±0.5
3C 270	–23.51	–11.81±0.5
3C 465	–23.57	–11.87±0.5
3C 346	–23.66	–11.96±0.5
3C 264	–23.70	–12.00±0.5
3C 66	–23.74	–12.04±0.5
3C 272.1	–23.74	–12.05±0.5
3C 315	–23.82	–12.12±0.5
3C 338	–23.98	–12.28±0.5
3C 293	–24.00	–12.30±0.5
3C 29	–24.03	–12.33±0.5
3C 31	–24.04	–12.34±0.5
3C 310	–24.10	–12.40±0.5
3C 296	–24.11	–12.41±0.5
3C 89	–24.31	–12.61±0.5
3C 75	–24.41	–12.71±0.5

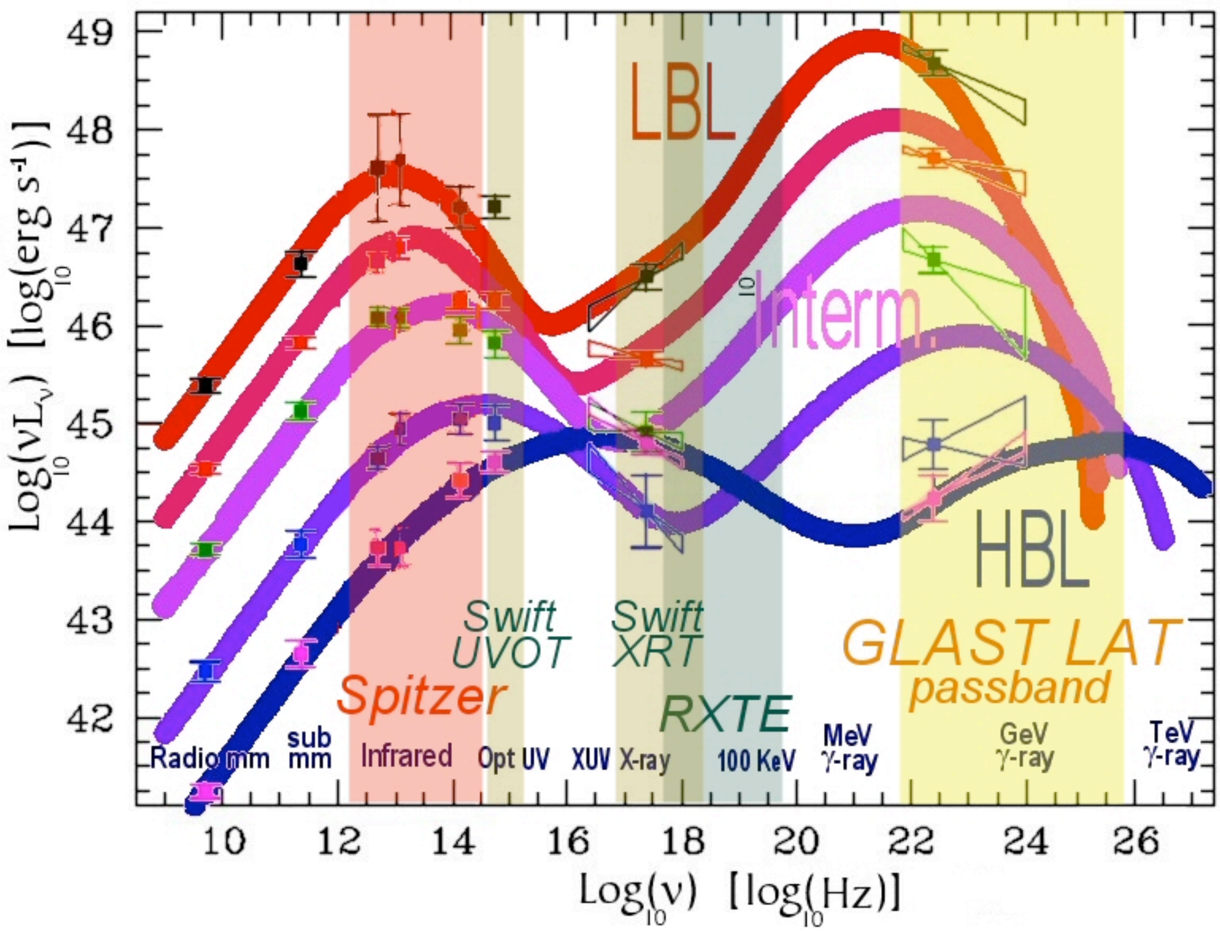
Test of Blazar Sequence

Fossati et al.(1998), Donato et al. (2002)

Average SEDs of blazars binned according to radio luminosity

126 blazars in total
28 with a spectral index measured by EGRET

$\nu_{peak} \propto L^{-1}$

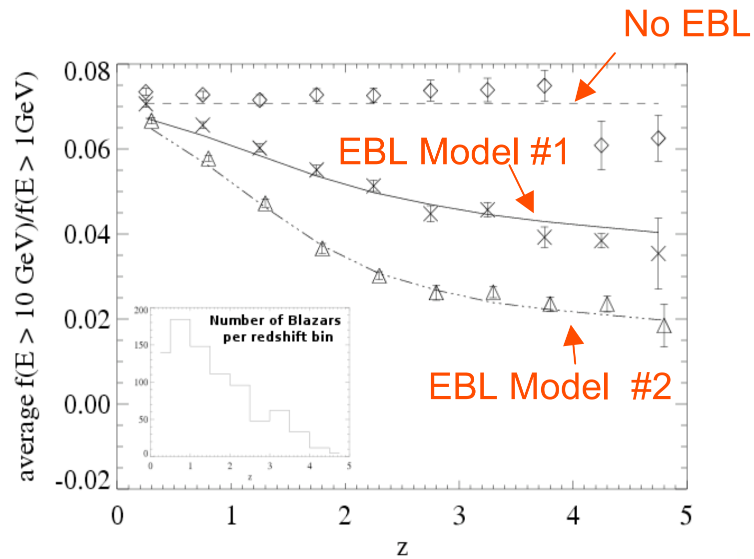


S.Ciprini

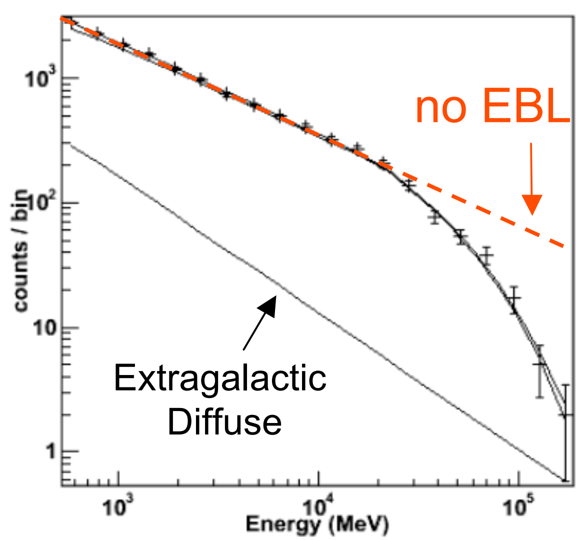
Spitzer data will also be very useful in this regard

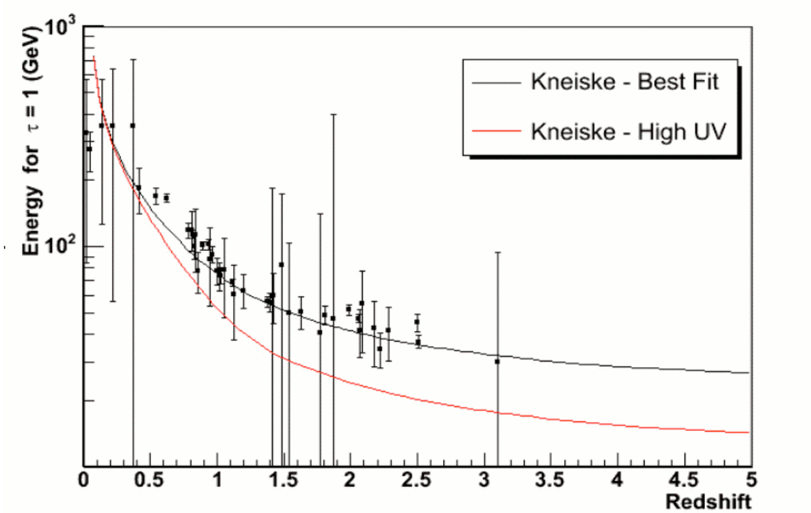
Extragalactic Background Light

Ground-based telescopes:
EBL optical-MIR density
GLAST: EBL optical-UV density
and cosmic evolution
Discrimination between EBL and intrinsic absorption is an issue.
(A. Reimer, to be published)
Large population is needed!



1-year GLAST simulation of Blazar at z = 1





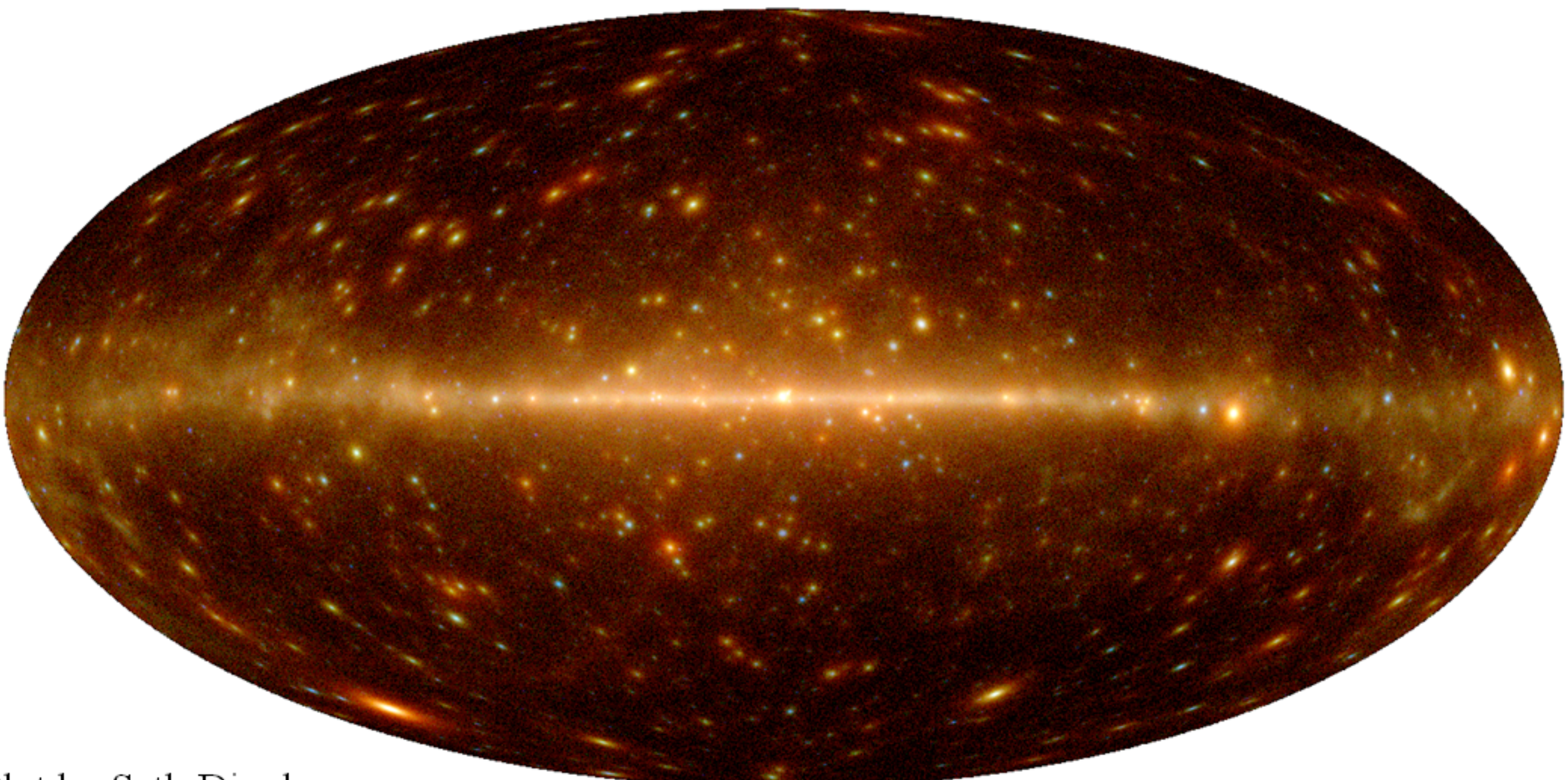
L. Reyes, poster at First Glast Symposium

Simulations

Data/Service Challenges

"Data/Service Challenges" allow us to exercise the Source detection algorithms/analysis tools using "realistic" Monte-Carlo data.

DC1: 1 week worth of data, DC2: 55 days, Service Challenge: 1 year



Plot by Seth Digel

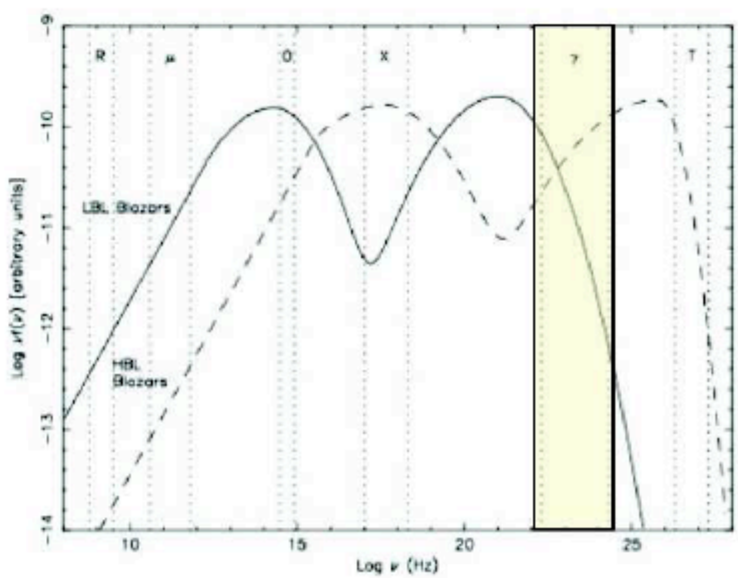
Blazar sky model (1)

Blazar sky implemented by Jim Chiang using Paolo Giommi's MC code
(P. Giommi et al., 2006, A&A, 445, 843)

- Sample radio luminosity functions (e.g., Urry & Padovani 1995) separately for LBL, HBL, and FSRQs.
- Assume no evolution for BL Lacs. Use pure luminosity evolution for FSRQs:

$$L(z) = L(0)e^{2.2z/(1+z)} \quad (1)$$

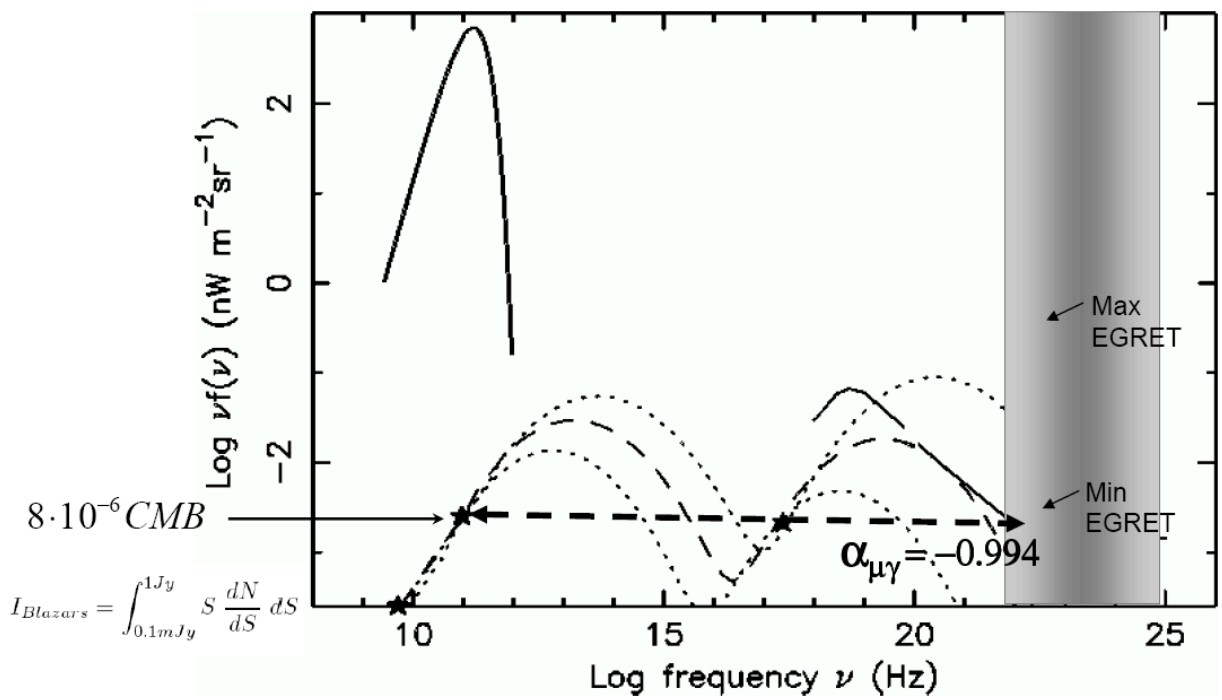
- Standard SSC SEDs are used to extrapolate from radio flux to microwave, optical, X-ray, and γ-ray wavebands:



Slide by J. Chiang

Blazar sky model (2)

– A duty cycle correction is applied to the γ-ray fluxes in order not to overproduce the extragalactic diffuse γ-ray background (Giommi et al. 2005):

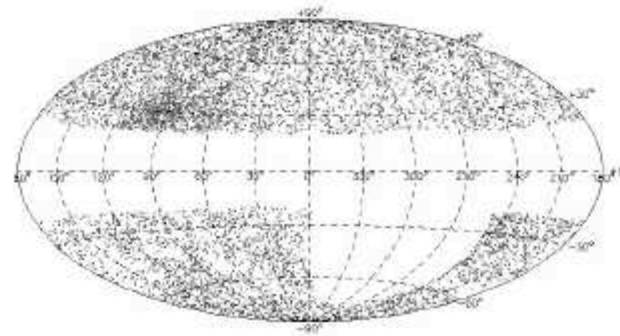


Blazar sky model (3)

– Validate population sampling against existing surveys, after applying relevant selection criteria, e.g., RASS:

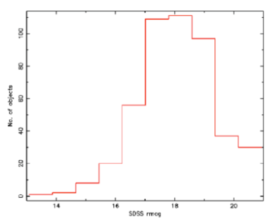
Data from RASS-NVSS-SLOAN Blazar Sample **Simulation**

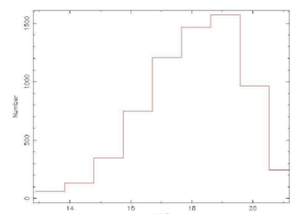
simulation



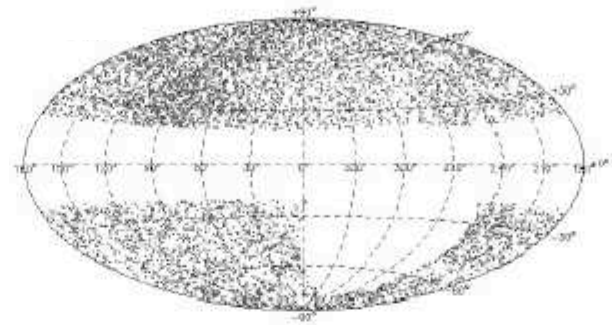
Radio flux

Vmag

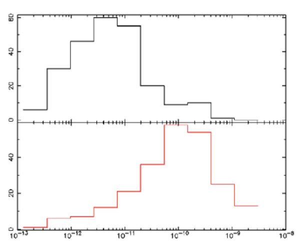


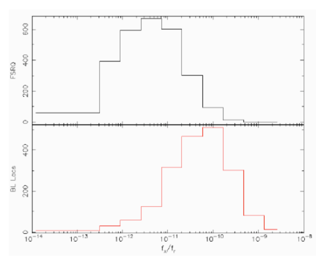


data



f_x/f_r



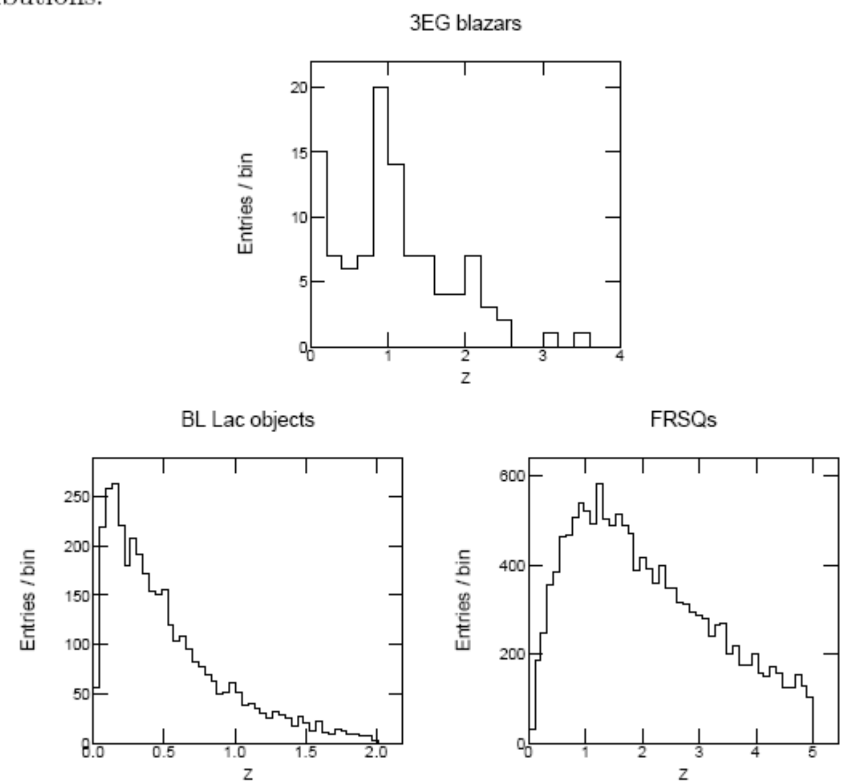


– For DC2, populations were generated assuming very weak X-ray and radio flux limits to avoid imposing selection effects on the γ-ray sample.

Slide by J. Chiang

Blazar sky model (4)

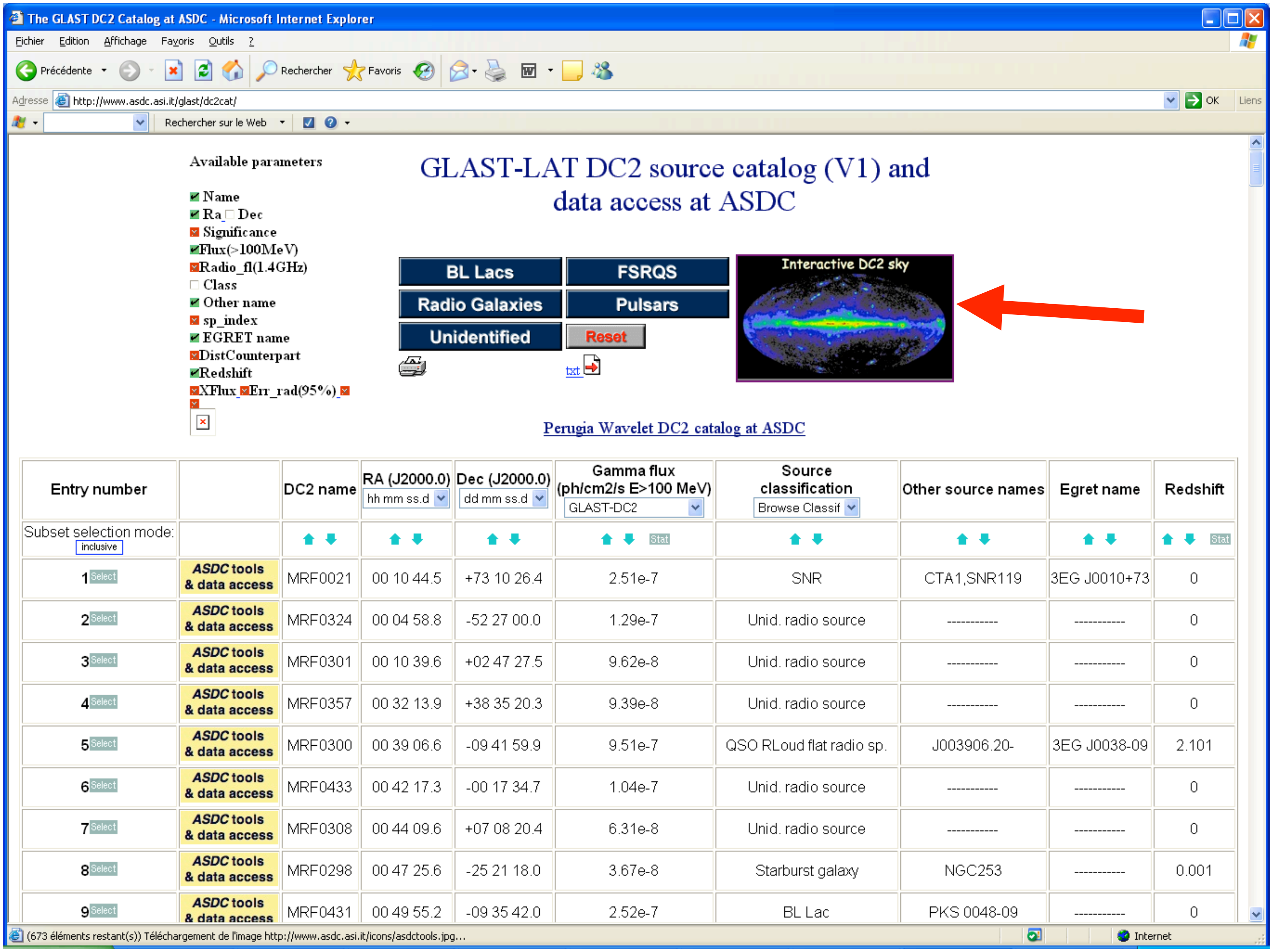
- Redshift distributions:



Light curves generated by Gino Tosti.

Slide by J. Chiang

ASDC GLAST Catalog



The GLAST DC2 Catalog at ASDC - Microsoft Internet Explorer

http://www.asdc.asi.it/glast/dc2cat/

Available parameters

Name
Ra Dec
Significance
Flux(>100MeV)
Radio_fl(1.4GHz)
Class
Other name
sp_index
EGRET name
DistCounterpart
Redshift
XFlux Err_rad(95%)

GLAST-LAT DC2 source catalog (V1) and data access at ASDC

BL Lacs | FSRQS | Radio Galaxies | Pulsars | Unidentified | Reset

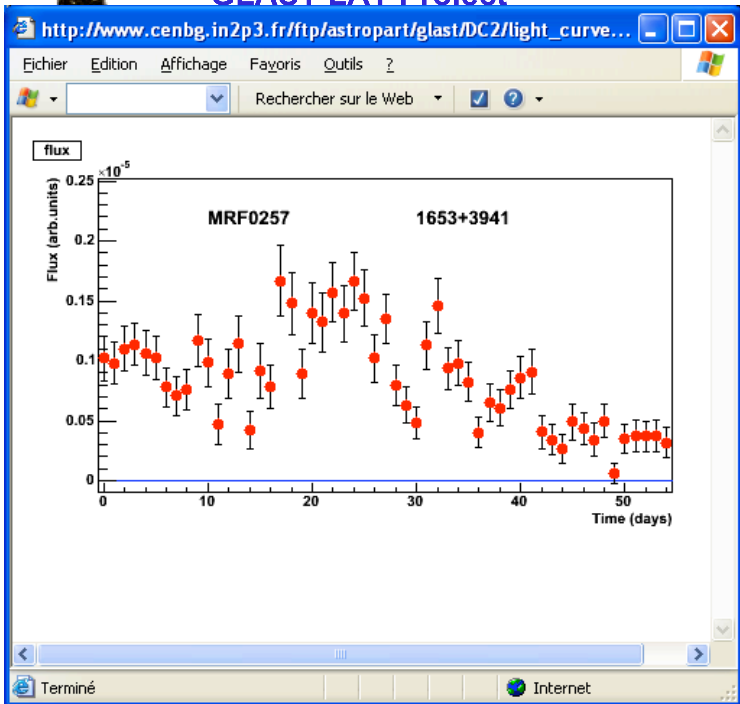
Interactive DC2 sky

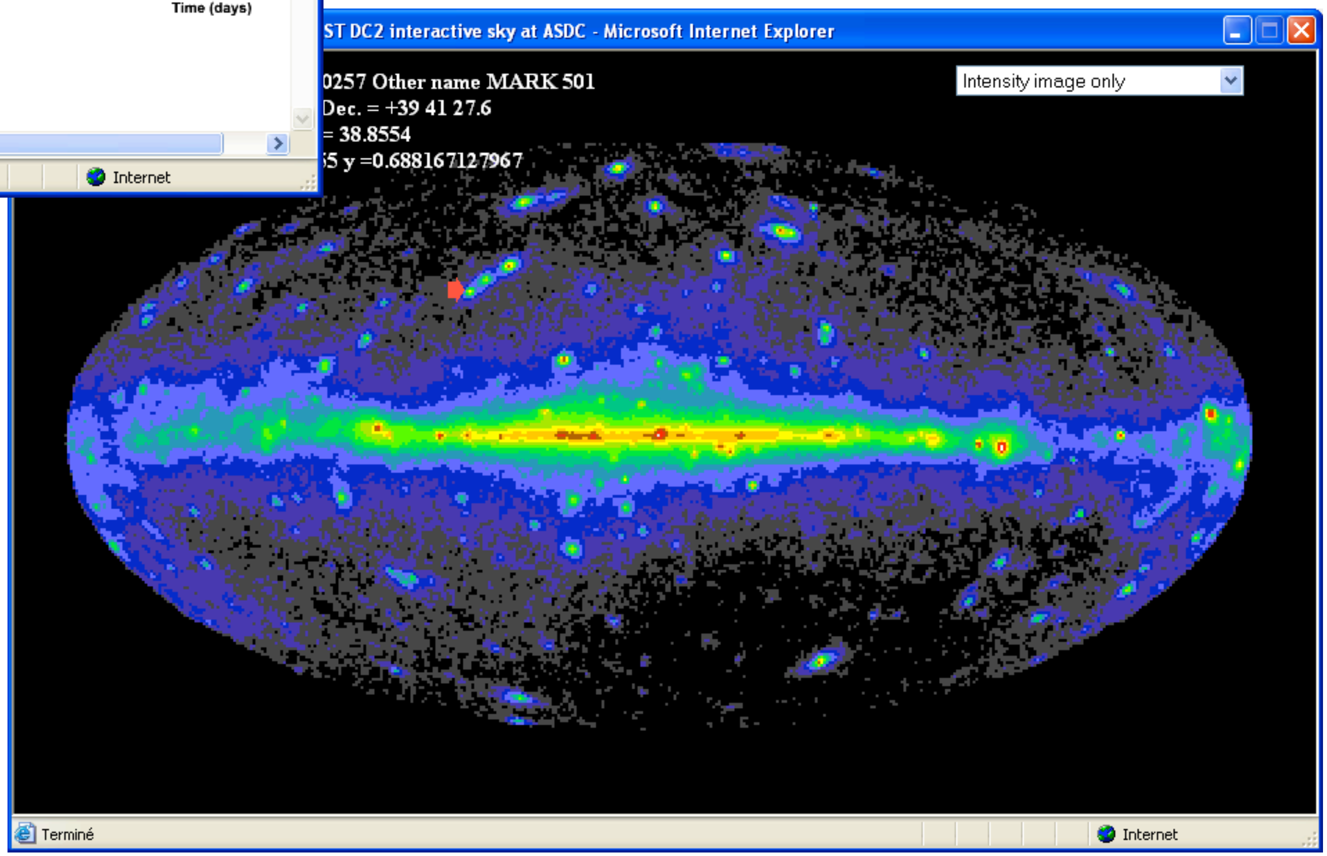
Perugia Wavelet DC2 catalog at ASDC

Entry number		DC2 name	RA (J2000.0) hh mm ss.d	Dec (J2000.0) dd mm ss.d	Gamma flux (ph/cm2/s E>100 MeV) GLAST-DC2	Source classification Browse Classif	Other source names	Egret name	Redshift
Subset selection mode: inclusive					Stat				Stat
1 Select	ASDC tools & data access	MRF0021	00 10 44.5	+73 10 26.4	2.51e-7	SNR	CTA1,SNR119	3EG J0010+73	0
2 Select	ASDC tools & data access	MRF0324	00 04 58.8	-52 27 00.0	1.29e-7	Unid. radio source	-----------	-----------	0
3 Select	ASDC tools & data access	MRF0301	00 10 39.6	+02 47 27.5	9.62e-8	Unid. radio source	-----------	-----------	0
4 Select	ASDC tools & data access	MRF0357	00 32 13.9	+38 35 20.3	9.39e-8	Unid. radio source	-----------	-----------	0
5 Select	ASDC tools & data access	MRF0300	00 39 06.6	-09 41 59.9	9.51e-7	QSO RLoud flat radio sp.	J003906.20-	3EG J0038-09	2.101
6 Select	ASDC tools & data access	MRF0433	00 42 17.3	-00 17 34.7	1.04e-7	Unid. radio source	-----------	-----------	0
7 Select	ASDC tools & data access	MRF0308	00 44 09.6	+07 08 20.4	6.31e-8	Unid. radio source	-----------	-----------	0
8 Select	ASDC tools & data access	MRF0298	00 47 25.6	-25 21 18.0	3.67e-8	Starburst galaxy	NGC253	-----------	0.001
9 Select	ASDC tools & data access	MRF0431	00 49 55.2	-09 35 42.0	2.52e-7	BL Lac	PKS 0048-09	-----------	0

(673 éléments restant(s)) Téléchargement de l'image http://www.asdc.asi.it/icons/asdctools.jpg...

DC GLAST Catalog





Spectral index

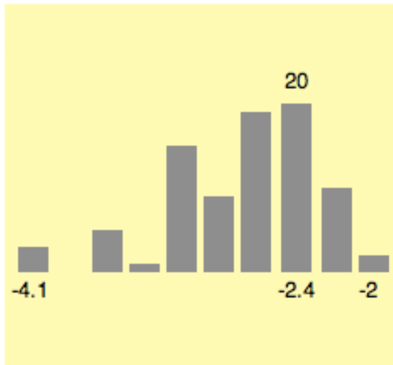
FSRQ (84 sources)

Netscape

Sp. index: basic statistics

Number of points =84
Minimun value =-4.2
Maximum value =-1.8
Bin size =0.24
Average =-2.734
Standard deviation =0.488
Skewness =-0.757
Curtosis =0.489

Close Window



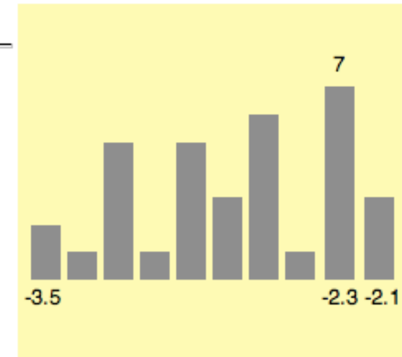
BL Lacs (34 sources)

Netscape

Sp. index: basic statistics

Number of points =34
Minimun value =-3.5
Maximum value =-2
Bin size =0.15
Average =-2.677
Standard deviation =0.421
Skewness =-0.2
Curtosis =-1.13

Close Window



Redshift

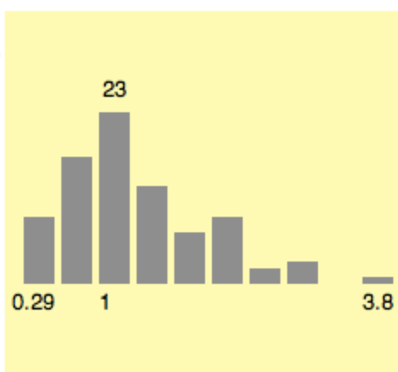
(8 BL Lacs with redshift unknown)

Netscape

Redshift: basic statistics

Number of points =84
Minimun value =0.103
Maximum value =4
Bin size =0.389
Average =1.295
Standard deviation =0.748
Skewness =0.93
Curtosis =1.07

Close Window

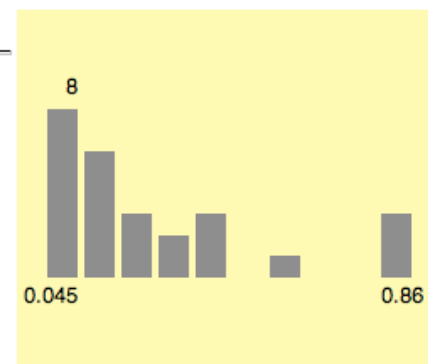


Netscape

Redshift: basic statistics

Number of points =26
Minimun value =0.000
Maximum value =0.909
Bin size =0.0909
Average =0.2677
Standard deviation =0.278
Skewness =1.26
Curtosis =0.399

Close Window



Light curves-variability
Time-resolved SEDs

Motivations for studying blazar variability

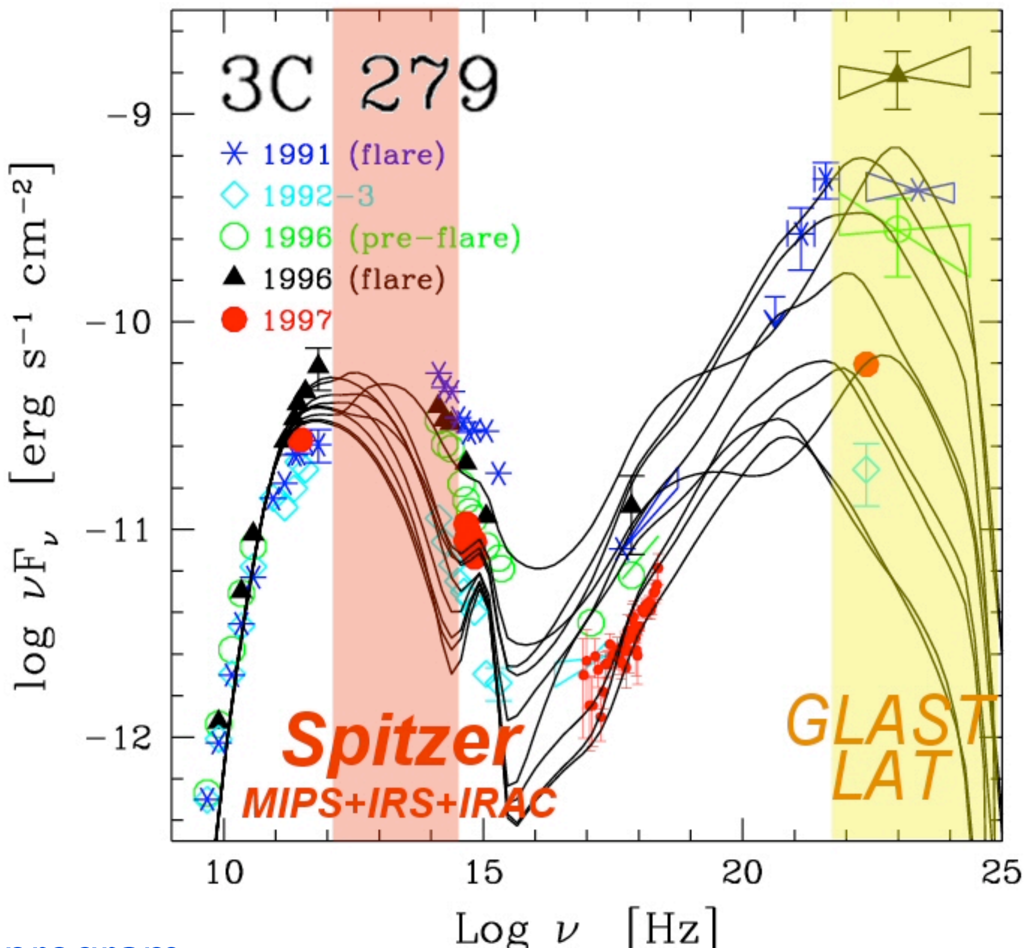
- Variability time scale: origin of flares
  jet matter content (e^+/e^- vs p^+/e^-)
  constraints on source size ⇒ beaming tests, bulk motion
  identification of source as a blazar
- Correlated variability – time lags: acceleration/ cooling processes
  source geometry (one zone…)
  importance of external fields: disk, BLR, torus
- Loop diagrams (flux vs index): acceleration/ cooling, SSC vs ERC models
- "Orphan" flares – anomalous components: test of SSC models
  jet matter content (e^+/e^- vs p^+/e^-)
  UHECR acceleration?
- Radio knot ejection after GeV flares?: jet launching sites, jet acceleration/deceleration
- X-ray precursor: jet matter content (e^+/e^- vs Poynting flux, p^+/e^-), jet environment
- Correlated variability in different bands: counterpart association
- Steady component: distinction between inner jet and extended Chandra jets

Science Goal Document (part B)

Issue	Approach	Targets	Data (quality)
Jet structure/ composition: innermost part (ionic,e^+e^-,Poynting flux)	Search for "X-ray pre-cursors" to γ-flares, time delays (reveal e^+e^- content)	flaring bright blazars	soft X-ray, pre- to post-flare (~2 weeks, sample every 3 hrs)
Jet structure/ composition: γ-ray emitting part (pe^-,e^+e^-,B)	Identify operating radiation processes via broadband modeling with state-of-the-art emission models leptonic vs hadronic models?	bright variable FSRQs, LBLs	Simultaneous broadband SED + variable info (hysteresis, light curve, flare profiles)
	Estimate total jet luminosity: $U_{particle} + U_B + U_{kin,jet}$	blazars that are hard X-ray sources	hard X, soft γ–ray data
	Search for neutron-decay/cascade features	flaring bright QSOs, HBLs, radio galaxies	X and TeV; multi–λ at most highly variable synchrotron flares
Location of γ-ray production site	LE/HE cospatial/single zone? - measure lags of IR/opt/UV/X-ray/TeV to γ-rays	flaring HBLs	Simultaneous monitoring in IR/opt/UV/X-ray/TeV to temporally resolve flares
Location of energization site	$\tau_{\gamma\gamma}$ to set minimum distance of emitting region from black hole, and Γ_{bulk}	FSRQs	correlated X-ray
γ-ray flare production: importance of external photon fields	Measure of putative target photon fields (BLR, torus, accretion disk)	FSRQs, LBLs	BLR line strength during γ–activity
γ-ray flare production: relation to U_B dissipation	Modeling of correlated variability behavior between opt-GeV,X-TeV	flaring bright blazars	Simultaneous monitoring in IR/opt/UV/X to temporally resolve flare, long data trains
	Polarization behavior near LE-peak at time of γ-flare	bright QSOs with peak at IR/optical	Optical polarization at hour temporal resolution

Authors: Greg Madejski, Anita Reimer & Chuck Dermer

Time-resolved SEDs

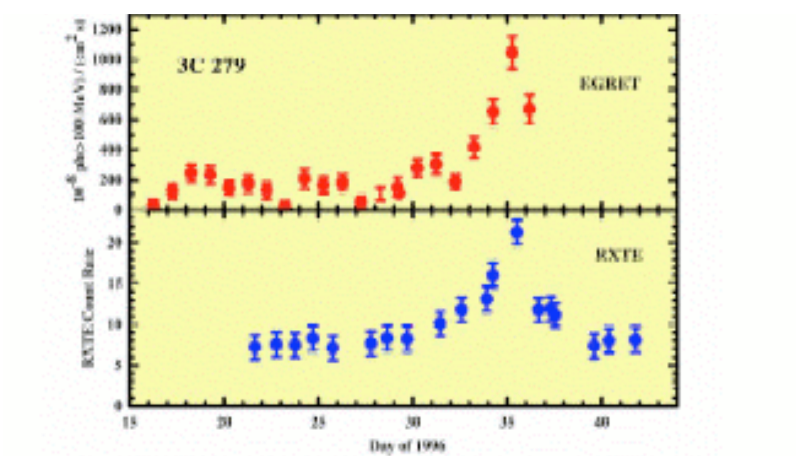


Agressive MW program being prepared

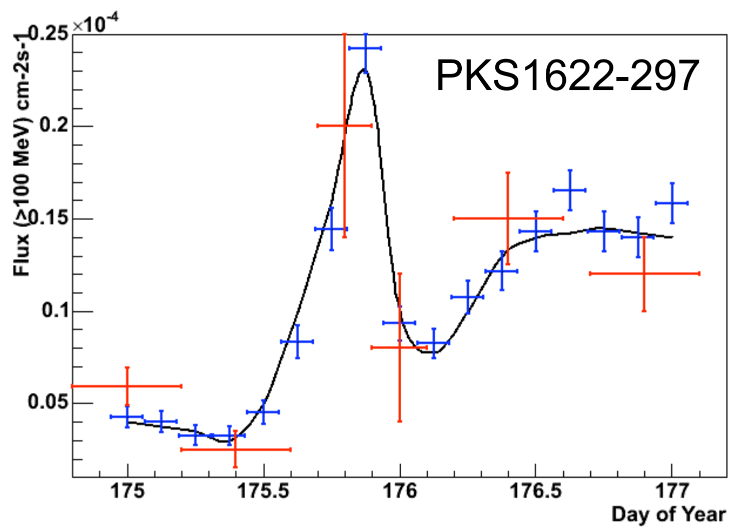
S.Ciprini

Blazar flares

The LAT will detect most blazars in a flaring state, as did EGRET.



Benoit Lott

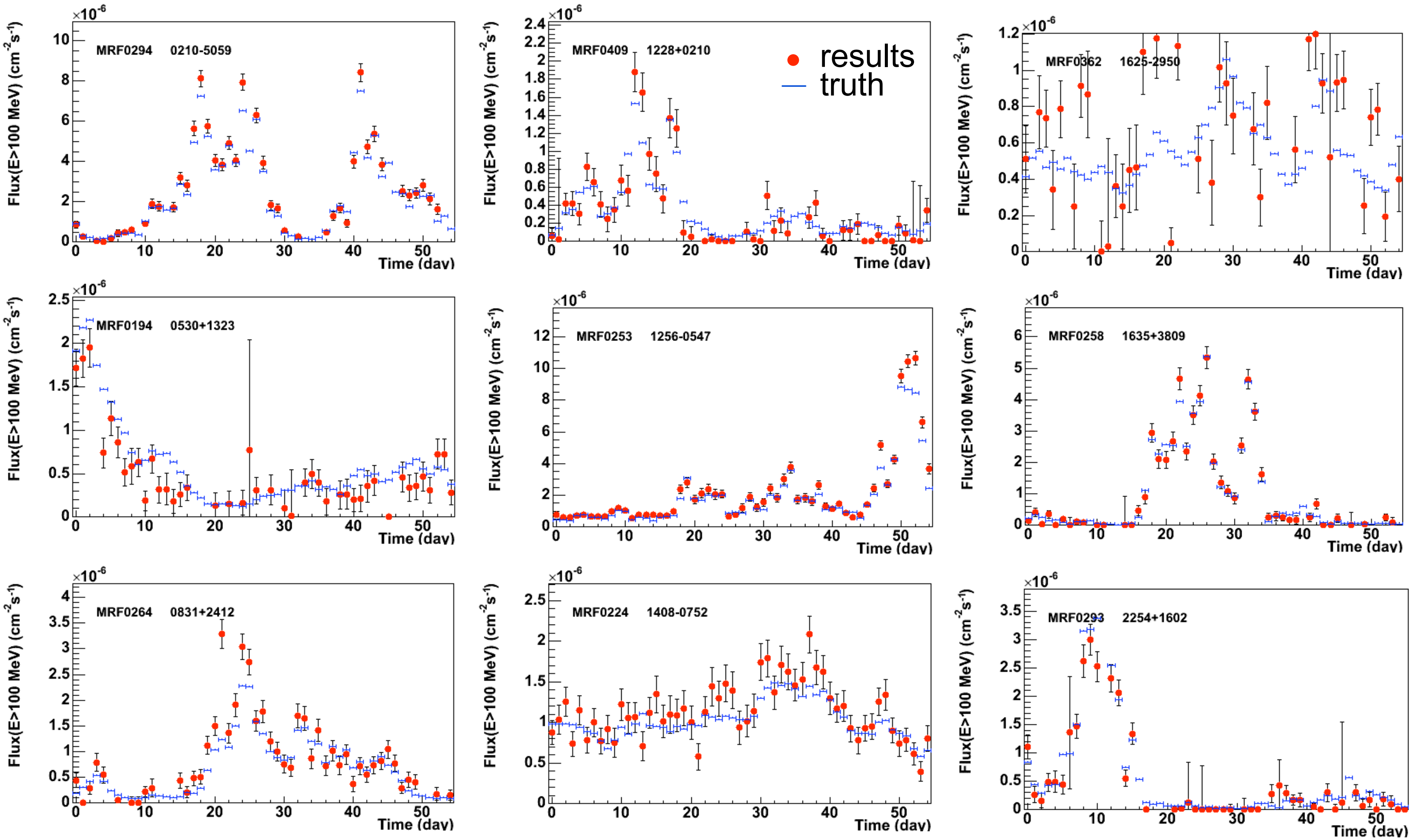


J. McEnery

Sources with light curves released during 1st Year

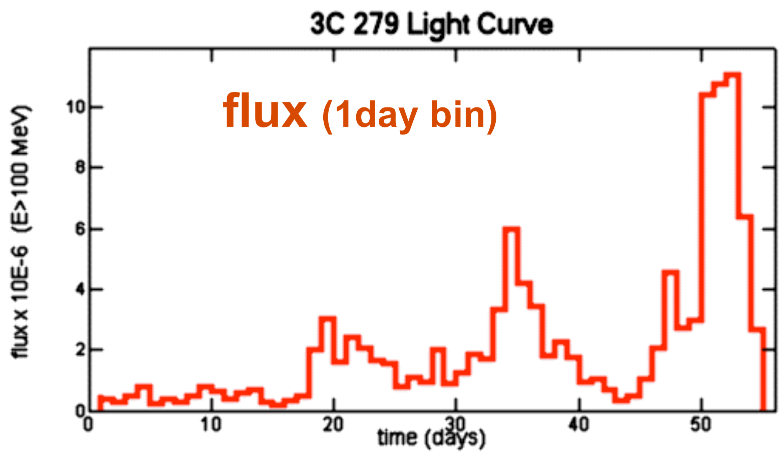
Source type	Source name	other name	Average or min. flux (10^{-8} γ cm^{-2} s^{-1})	Latitude
Sources from 3rd EGRET Catalog				
Blazar	0208-512	3EGJ0210-5055	85.5 ± 4.5	-61.9
	PKS 0528+134	3EGJ0530+1323	93.5 ± 3.6	-11.1
	0827+243	3EGJ0829+2413	24.9 ± 3.9	31.7
	Mrk 421	3EGJ1104+3809	13.9 ± 1.8	65.0
	3C 273	3EGJ1229+0210	15.4 ± 1.8	64.5
	3C 279	3EGJ1255-0549	74.2 ± 2.8	57.0
	1406-076	3EGJ1409-0745	27.4 ± 2.8	50.3
	PKS 1622-297	3EGJ1625-2955	47.4 ± 3.7	13.4
	1633+383	3EGJ1635+3813	58.4 ± 5.2	42.3
	1730-130 NRAO 530	3EGJ1733-1313	36.1 ± 3.4	10.6
	3C 454.3	3EGJ2254+1601	53.7 ± 4.0	-38.3
HMXB	LSI +61 303/ 2CG135+01	3EGJ0241+6103	69.3 ± 6.1	1.0
any source (except Crab, Vela and Geminga pulsars)			**monitor if flux exceeds 2x10^{-6} cm^{-2} s^{-1} and report flux down to 2 x 10^{-7} $cm^{-2}s^{-1}$**	
After confirmed detection by LAT				
Blazar	Mrk 501			
	W Com 1219+285	3EG J1222+2841	11.5 ± 1.8	83.5
	1ES 1959+650	TeV		
	1ES 2344+514	TeV		
	H 1426+428	TeV		
	PKS 2155-304	TeV		

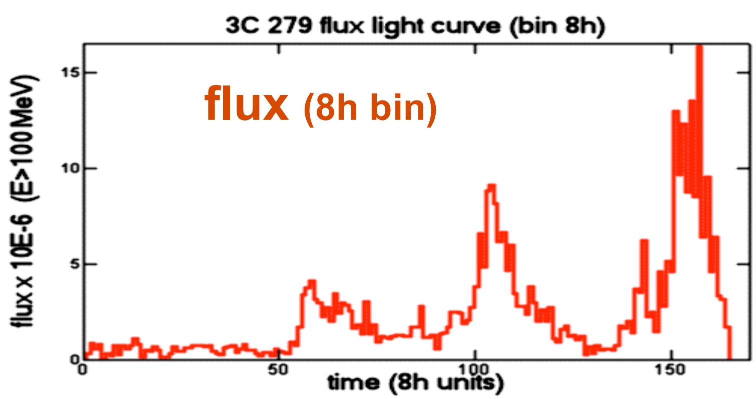
Light curves

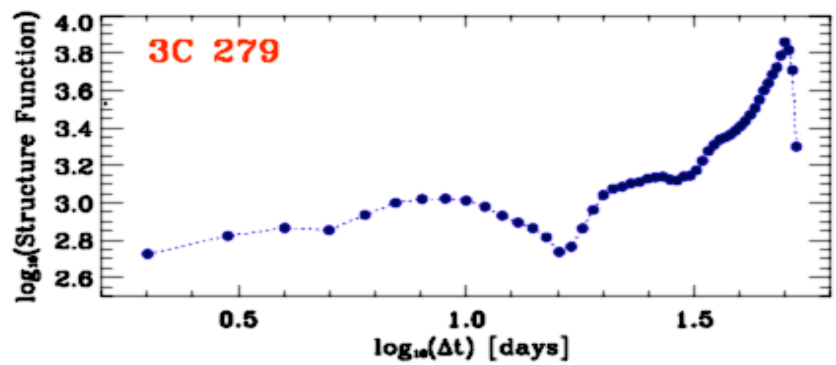


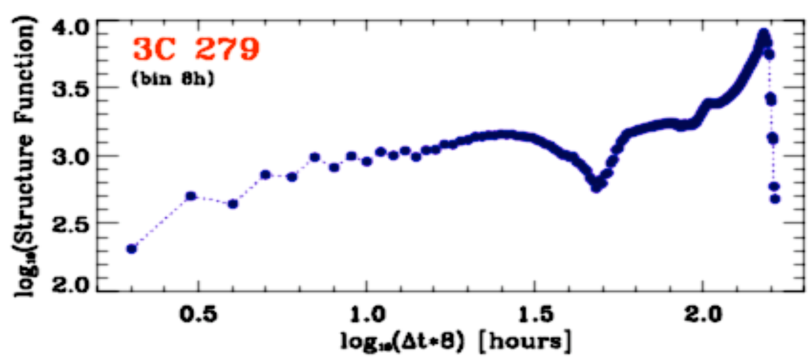
Benoit Lott

Periodicity search







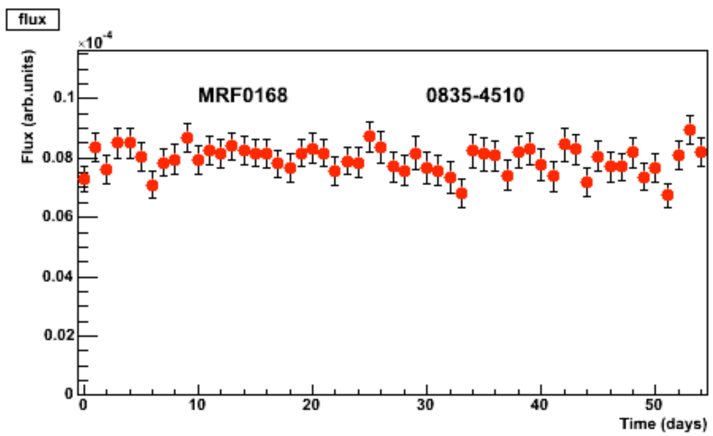


Indication for a periodicity, P ~15 d

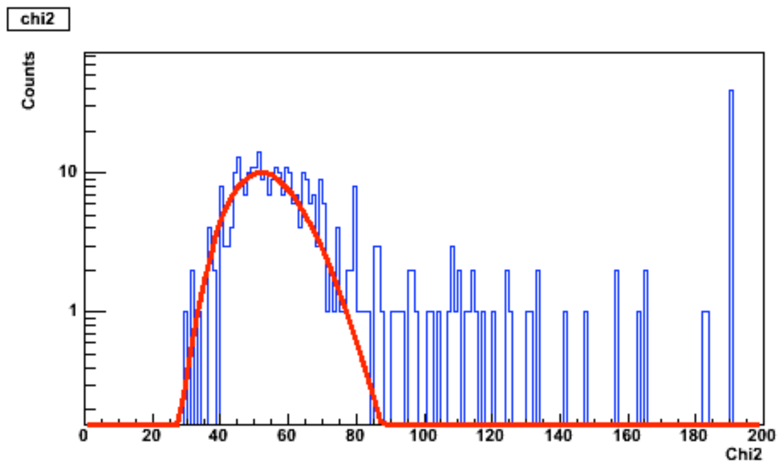
Gino Tosti – Stefano Ciprini

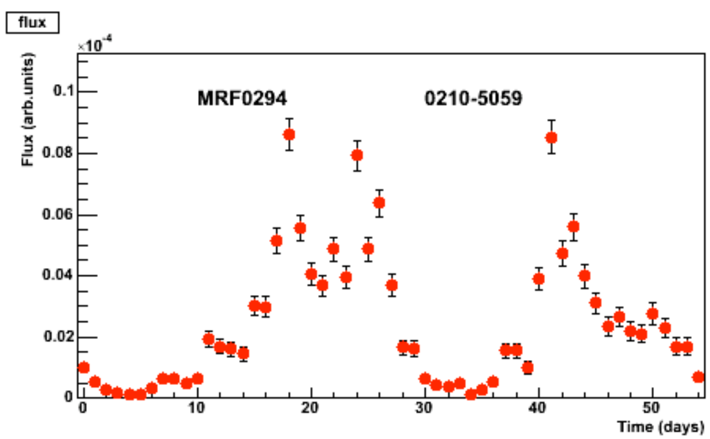
Source variability

For non-variable sources, the chi-square distribution behaves as χ^2_{54} if $N_{photons}$ is large enough.



All DC2 sources





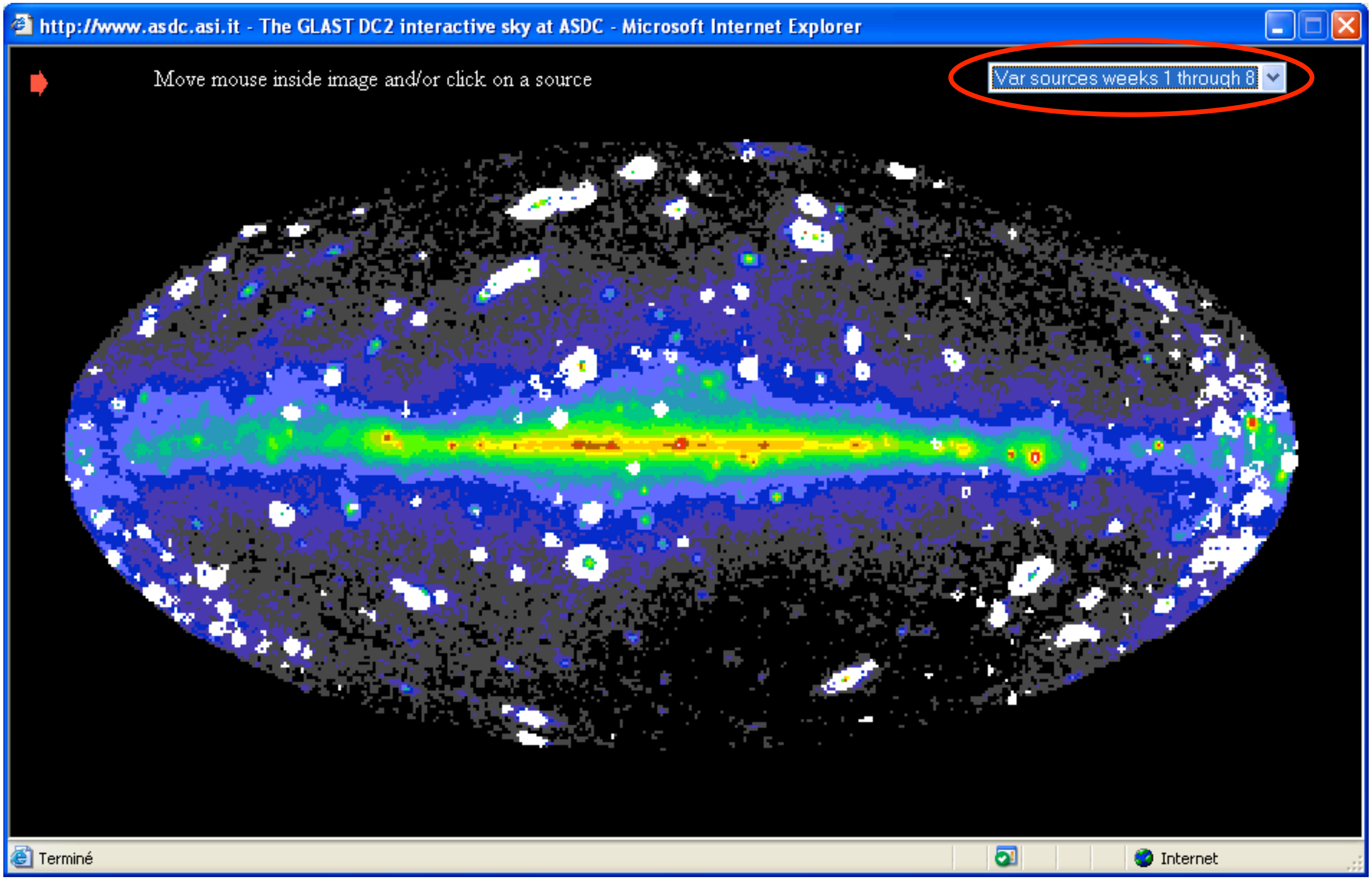
Variability index:

$$V = -\log\left(1 - P\left(\frac{n_{dof}}{2}, \frac{\chi^2}{2}\right)\right)$$

McLaughlin et al. (1996)

Benoit Lott

ASDC GLAST Catalog



Conclusion

The LAT will be a very good all-sky monitor.

Upward of one thousand blazars should be detected in the first year.

Variability studies + multiwavelength observations are key to making progress in our understanding of the blazar phenomenon.

The LAT team is working hard to make this happen, with hopes that these efforts will soon be rewarded.