Comparison of VSB from BATSE, KONUS and SWIFT

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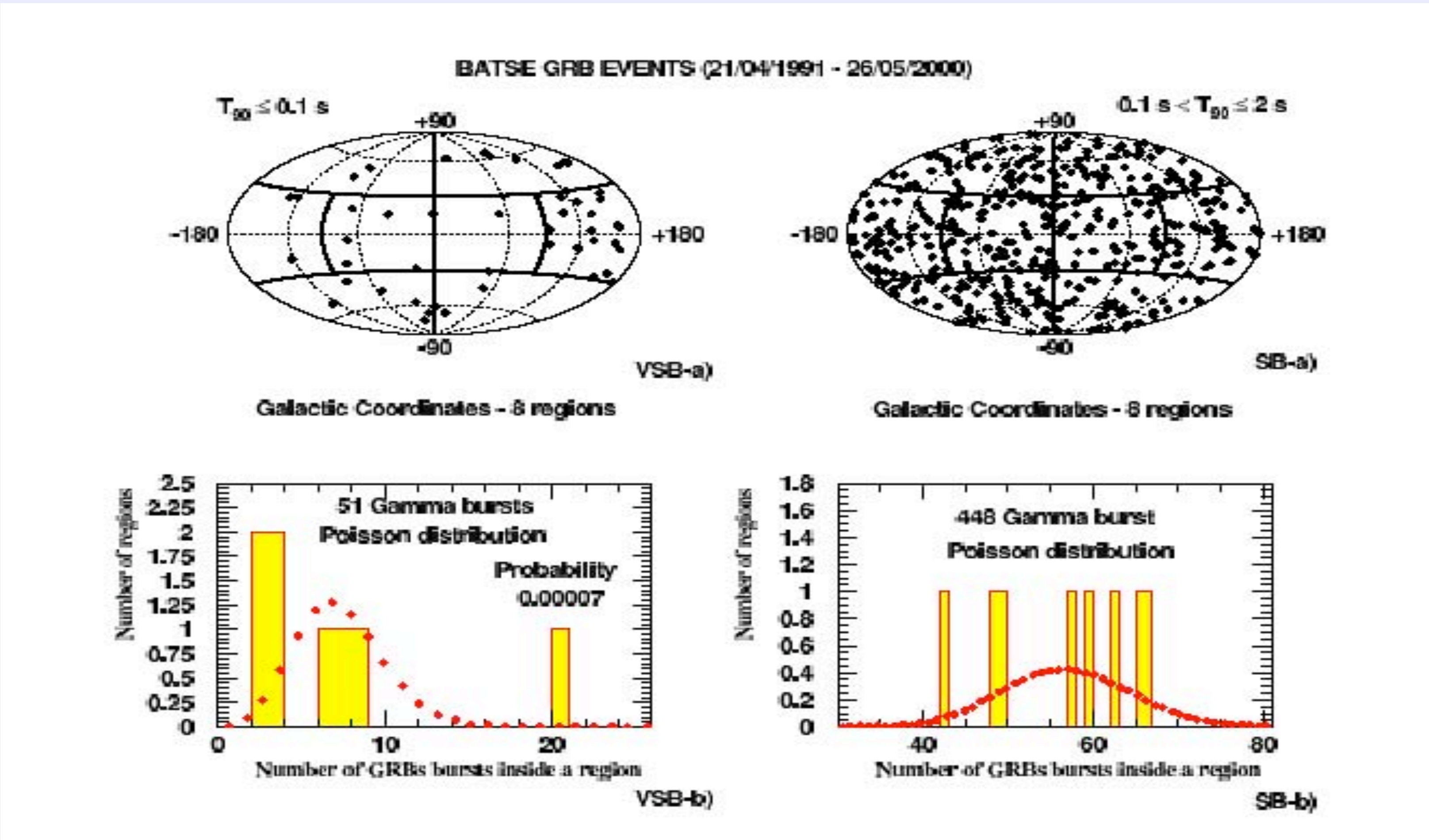
Abstract. We show the locations of the SWIFT short hard bursts (SHB) with afterglows on the galactic map and compare with the VSB BATSE events. As we have pointed out before, there is an excess of events in the galactic map of BATSE VSB events. We note that none of VSB SWIFT era events fall into this cluster. More SWIFT events are needed to check this claim. We also report a new study with KONUS data of the VSB sample with an average energy above 90 keV showing a clear excess of events below 100 ms duration (T_{90}) that have large mean energy photons. We suggest that VSB themselves consist of two subclasses: a fraction of events have peculiar distribution properties and have no detectable counterparts, as might be expected for exotic sources such as primordial black holes. We show how GLAST could add key new information to the study of VSB bursts.

Angular distribution of the GRBs in galactic coordinates and the corresponding histograms, in comparison with Poisson distribution for two different T_{90} ranges (full circles).



The map of the sky in galactic coordinates. Black dots mark the VSB from BATSE, triangles mark new SWIFT/HETE events with afterglows and squares mark VSB from SWIFT without afterglows. One event on the plot has a T_{90} of 3 sec.

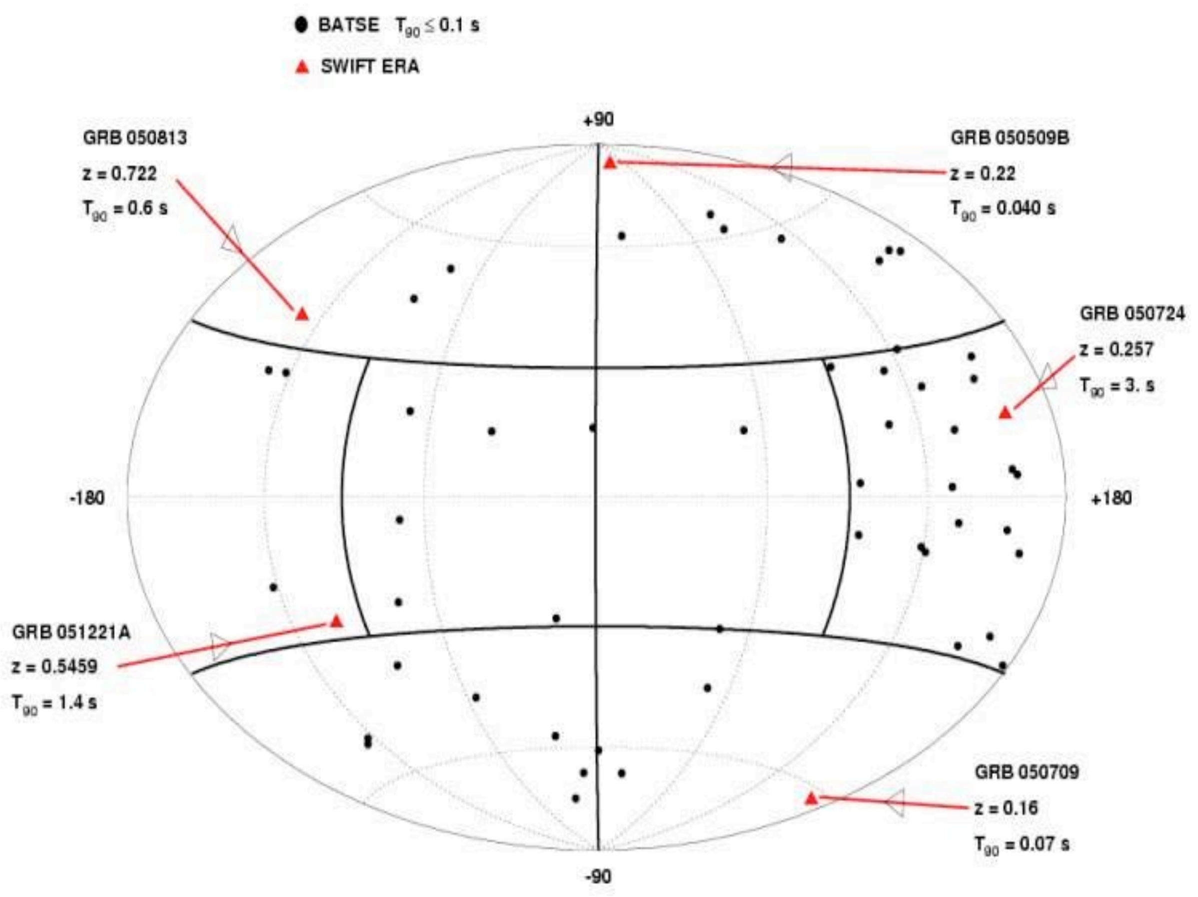


Fig.1 GRBs - Gallactic Coordinates

Angular Anisotropy of Very Short Gamma Ray Bursts

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***Abstract*— In the present work we studied quantitatively the unexpected divergence of isotropy found recently for the class of very short Gamma Ray Bursts (vsGRB). The 'prior-free' determination of the significance of this anisotropy is given. We found that the chance probability of the clustering such as seen for vsGRB is about few times 10^{-5} thus the effect itself is on the 4σ level.**

I. Introduction

The absence of the anisotropy of directions of Gamma Ray Bursts (GRB) was rather unexpected when the GRB were discovered and draw to them the attention of physicists as to the most powerful events in the Universe (since the Big Bang). Since that time - the discovery not the Big Bang - the question of the GRB origin was a mystery up to almost now, when progenitors of some of them have just been seen. Since about 1997 as a result of BeppoSAX satellite observations there is believed that the GRB of the duration longer than about 2 seconds originate as result of the explosive collapse of the cores of young massive stars in the star-forming galaxies at the redshift of $z = 1-2$. Quite recently the shorter bursts were identified with something closer ($z \approx 0.2$), thus less energetic which is consistent with the hypothesis of the merger of two neutron stars, or of a neutron star with a black hole. Both classes of GRB agree very well with the isotropic distribution of their directions. Thus the isotropy seems to be immanent attribute of GRB.

However the third class of GRB bursts was found - the very short burst (vsGRB). The confusion was stronger when it was found that this, not very numerous class seems to be anisotropic on the sky [1].

The effect is so astonishing that it is worth to know precisely the degree of belief of the vsGRB clustering seen by "necked eye" in the Fig. 1.

II. The method

To study grouping of any items it is convenient to use a correlation measure. The one we prefere are factorial moments

$$F_q(\Delta) = \frac{1}{M} \sum_{m=1}^{M} \frac{\left\langle n_m^{[q]} \right\rangle}{\langle n_m \rangle^q} = \frac{1}{M} \sum_{m=1}^{M} \frac{\int d\Omega \, n_q(i_1, i_2, \ldots, i_q)}{\int d\Omega \, n(i_1) n(i_2) \ldots n(i_q)}, \quad (1)$$

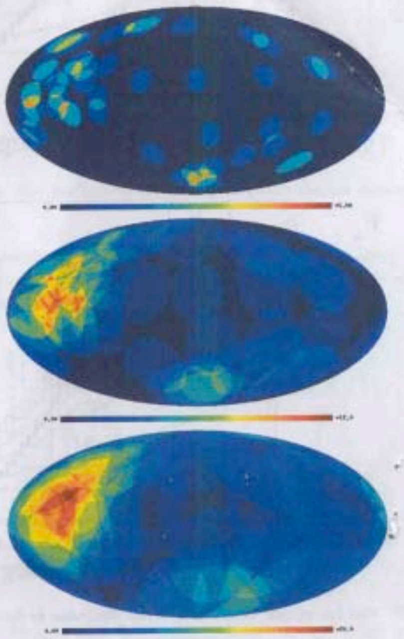


Fig. 1. Short gamma ray burst counting (see text) within 10° (top), 25° (middle), and 40° (bottom) radius cone around each vsGRB.

and cumulants

$$K_q = F_q - \sum_{m=1}^{q-1} \binom{q-1}{m} K_{q-m} \, F_m. \quad (2)$$

The numerator in Eq.(1) can be actually computed simply by counting q-tuples that have a "width" smaller than Δ [2]:

$$\int d\Omega \, n_q(i_1, i_2, \ldots, i_q) = \left\langle q! \sum_{i_1, i_2, \ldots, i_q} \Theta\left(\Delta - \mathrm{width}(i_1, i_2, \ldots, i_q)\right) \right\rangle. \quad (3)$$

TABLE 2

List of Konus GRBs with $T_{90} \leq 0.1$ s

No.[a]	GRB	Konus T_{90} (s)	Peak Flux (ergs cm^{-2} s^{-1})	Fluence (ergs cm^{-2})	Energy Interval (keV)	Satellite/Trigger	BATSE T_{90} (s)
110	010420a	0.01	1.2E−005	2.3E−007	15–1000	...	...
32	970625a	0.03	3.8E−005	9.4E−007	15–3000	...	...
18	960803	0.05	2.1E−005	8.9E−007	15–5000	B/5561	0.10
57	980904	0.05	3.5E−005	1.3E−006	15–2000	B/7063	0.13
27	970427	0.06	1.0E−005	3.9E−007	15–1000	B/6211	0.07
37	970921	0.06	1.0E−004	4.5E−006	15–8000	...	...
79	970427	0.06	1.0E−005	3.9E−007	15–1000	...	...
6	950610b	0.07	1.6E−005	7.1E−007	15–1000	...	...
75	990504	0.08	1.5E−005	1.2E−006	15–2000	...	...
83	990831	0.08	5.9E−006	3.8E−007	15–1000	...	...
40	971118	0.08	2.7E−006	1.7E−007	15–1000	B/6486	0.07
86	991226b	0.08	7.7E−006	3.9E−007	15–1000	...	...
117	020116	0.08	...	...	...	...	...
34	970704	0.09	1.5E−003	4.2E−005	15–10000	B/6293	0.19
95	000607[b]	0.09	1.2E−004	5.4E−006	15–3000	U, N	...
119	020218a	0.09	...	...	...	...	...
48	980330a	0.10	5.2E−005	3.0E−006	15–5000	B/6668	0.12
112	010616	0.10	1.8E−005	1.5E−006	15–1000	...	...

[a] Number of trigger on list of short GRBs.

[b] See Hurley et al. (2000).

GLAST will allow a study of the VSB energy spectrum to ~50 MeV to compare with the SHB spectrum

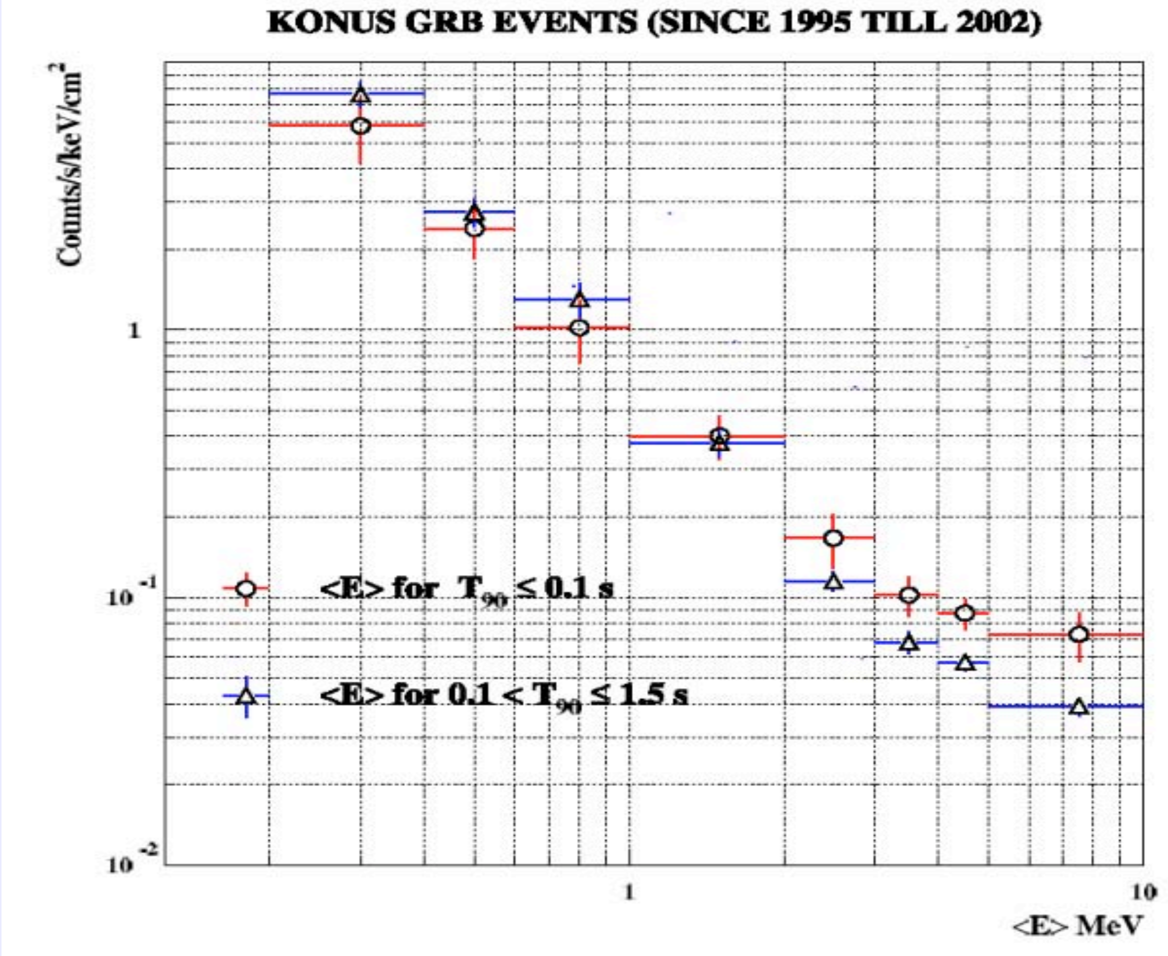
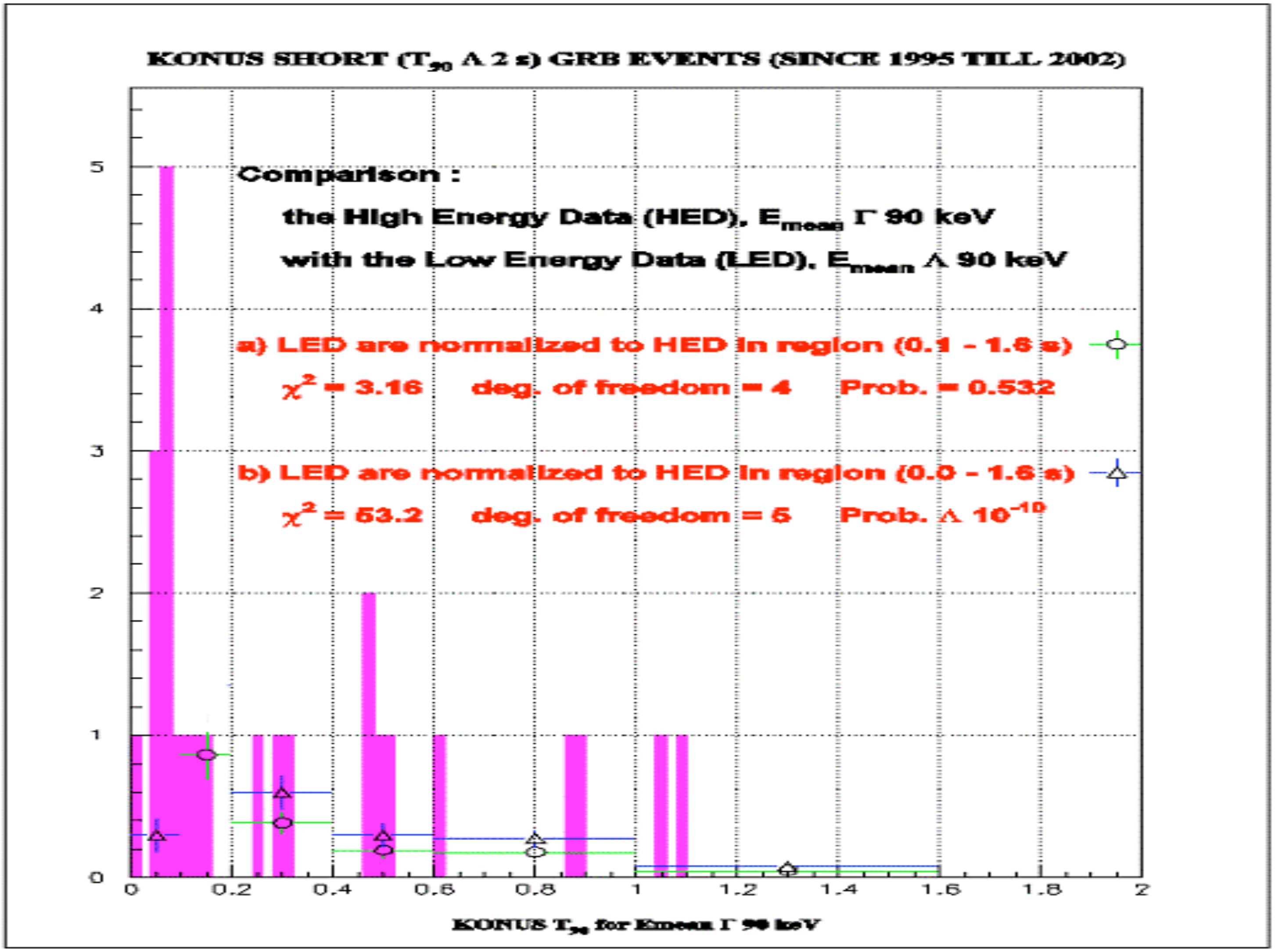
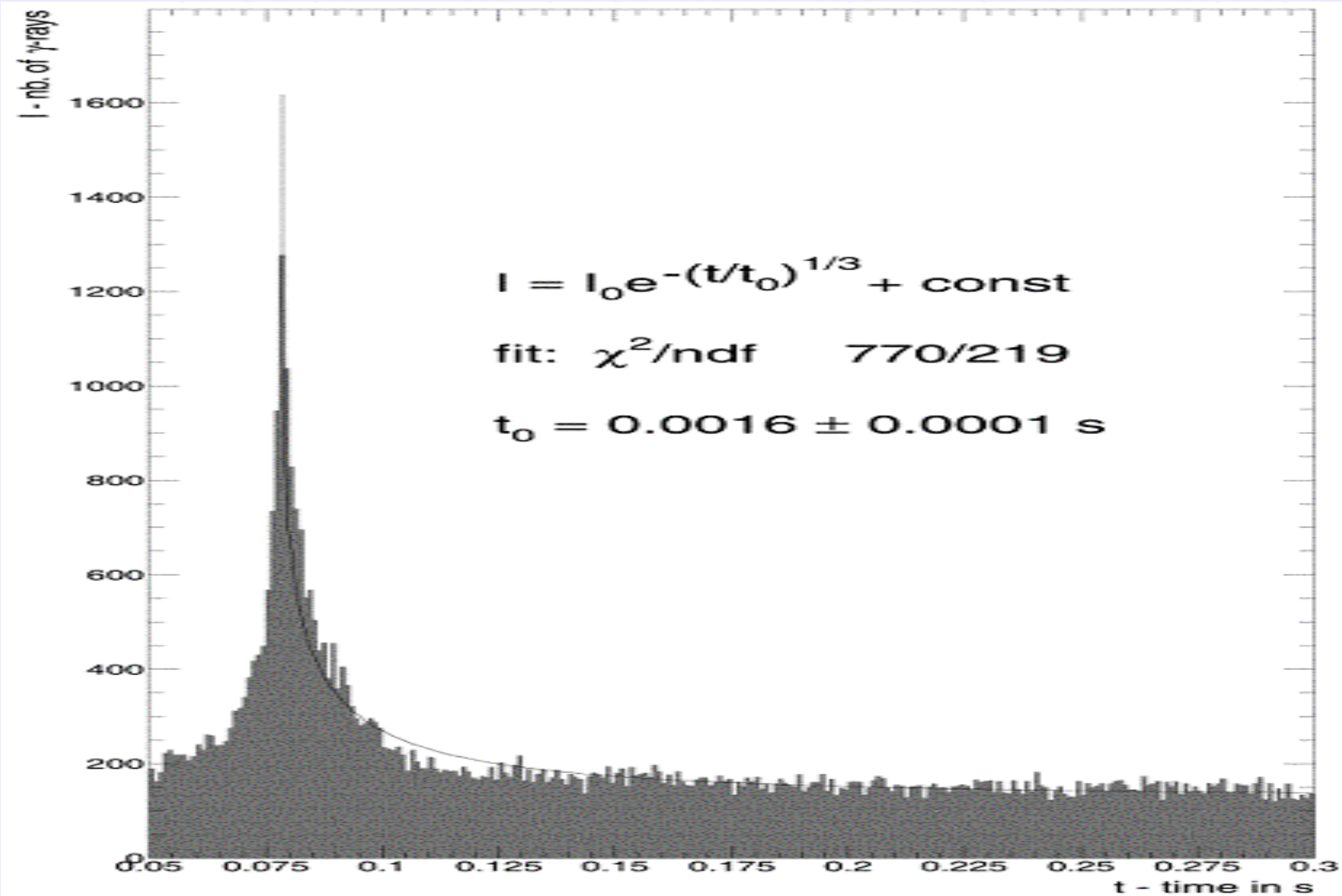


Fig. 4.— Mean Energy distribution for KONUS Short and Very Short Bursts.

KONUS data with different cuts on the average photon energy <Eγ>



Result of applying the statistical Stern analysis to the sum of 12 short GRBs



Summary

In this talk we have documented two new aspects of the VSBs:

•(a) The two VSB Swift/HETE events are not located in the excess region observed in the BATSE data. It is not possible to measure the high energy part of the energy spectrum so we cannot test whether these events are in the same class of the BATSE VSB or not.

•(b) A new study of KONUS data indicates that VSB events are much harder than the rest of the SHB events, strongly suggesting a new physics origin of these events. The results of our enhancement below T90 of 100 ms is confirmed by other types of analysis of BATSE data discussed here. This likely indicates some new source of these events such as primordial black hole evaporation in the galaxy near the solar system.

•(c) The detecttion of GLAST VSB GRBs could lead to a clear separation from the SHB sample.