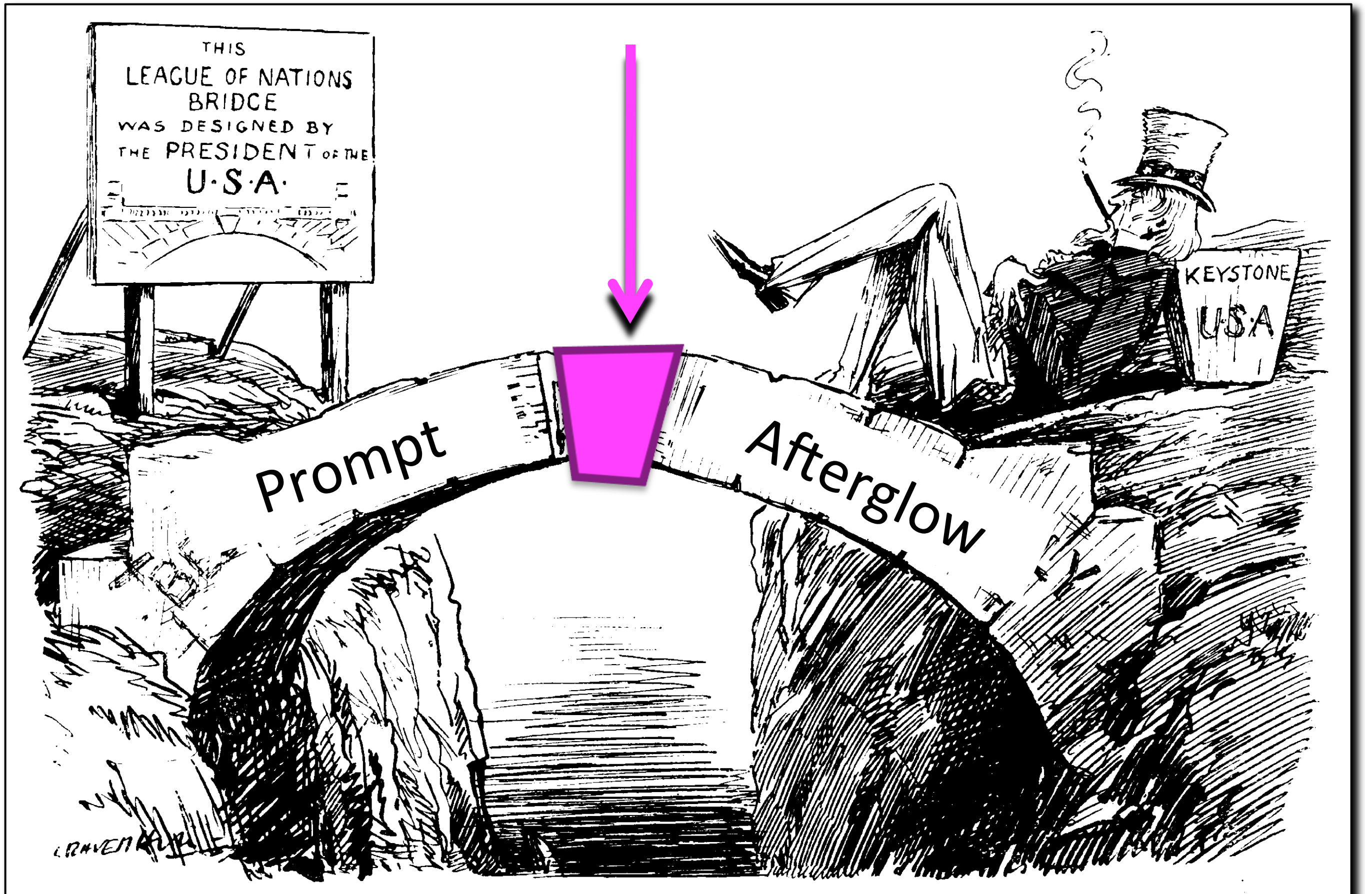


THE GAP IN THE BRIDGE.

The prompt-afterglow connection in Gamma-Ray Bursts: a comprehensive statistical analysis of Swift X-ray light-curves

R. Margutti
Harvard University

E. Zaninoni, G. Bernardini, G. Chincarini
on behalf of
the Swift-XRT team

Munich, May 8th

?

Link between the prompt and the X-ray afterglow **1**

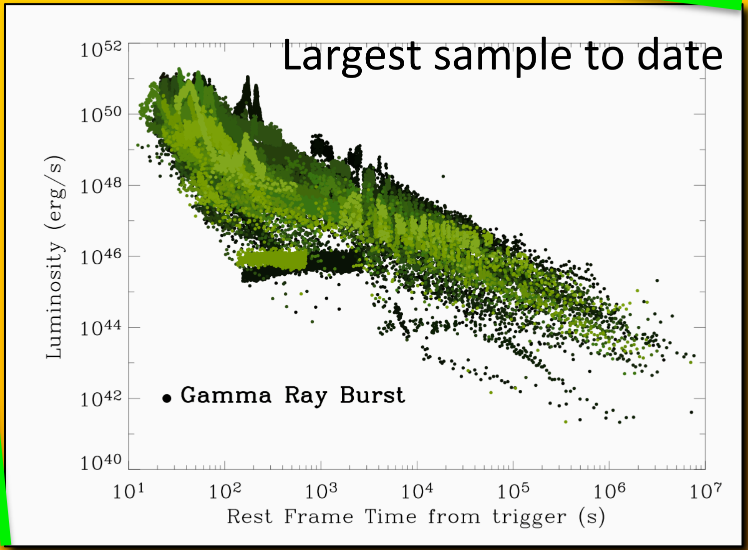
Short GRBs vs long GRBs X-ray afterglow properties **2**

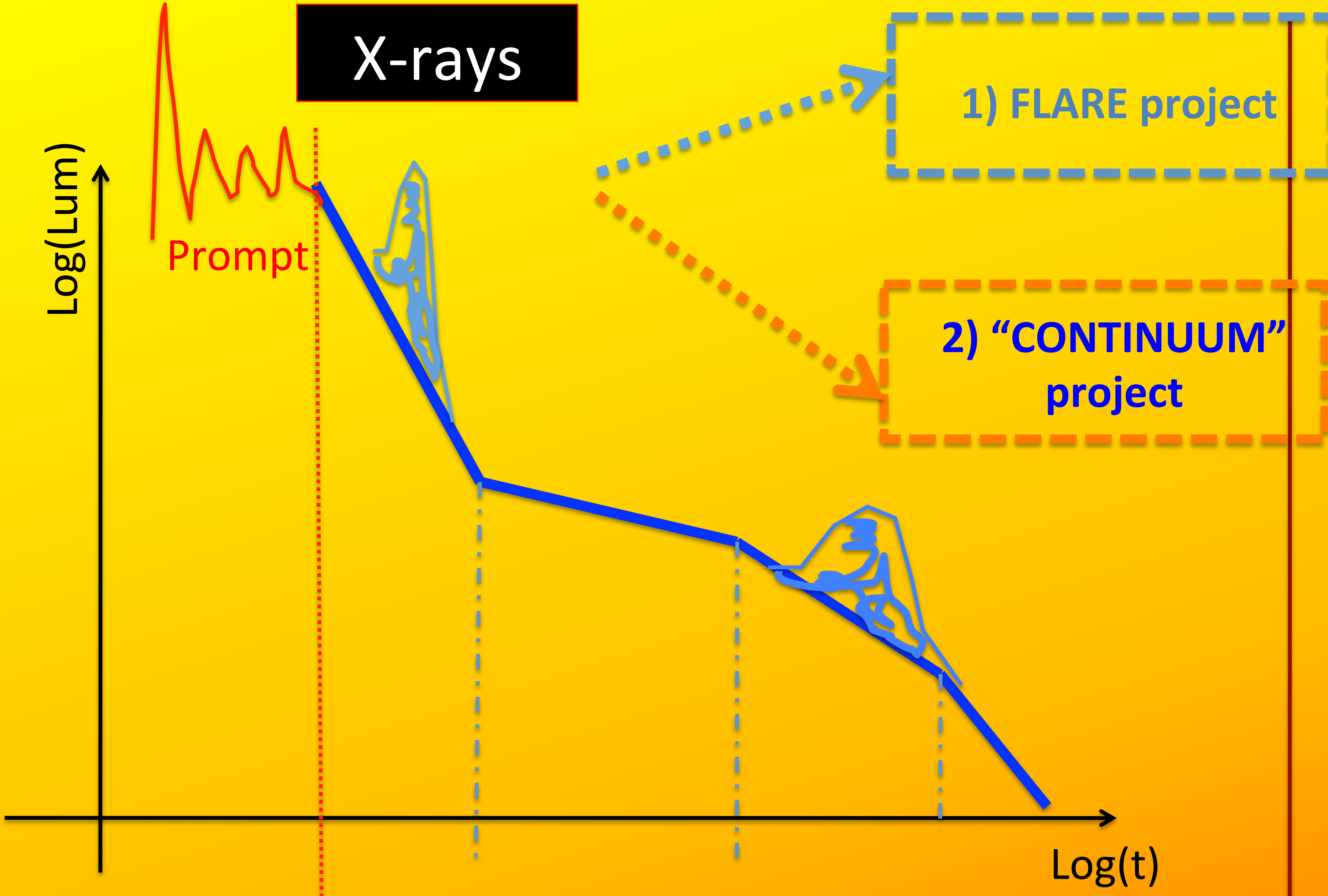
The prompt-afterglow connection in Gamma-Ray Bursts: a comprehensive statistical analysis of Swift X-ray light-curves

More than **650** GRBs

165 with redshift

Energetics
Intrinsic Time Scales




X-rays
Log(Lum)
Prompt
1) FLARE project
2) "CONTINUUM" project
Log(t)

GRB X-ray Flares

Catalog of LONG GRB early time flares
(Chincarini, Mao, Margutti, 2010, MNRAS, 406, 2113)

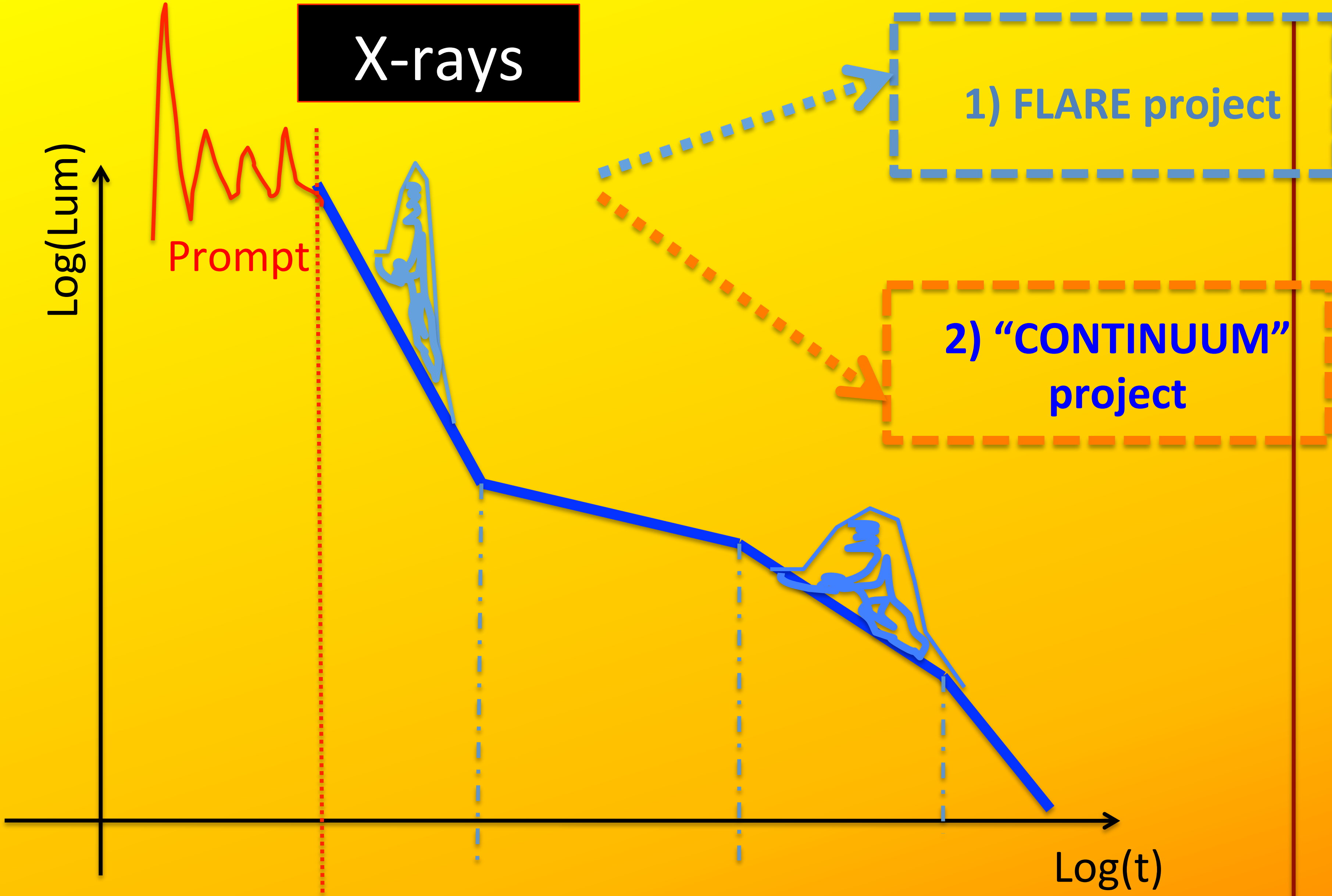
Flare in SHORT GRBs
Margutti, 2011, MNRAS 417, 2144

Spectral and temporal study of the bright sample
(Margutti et al., 2010, MNRAS,406, 2149)

Average flare luminosity evolution with time
Margutti et al., 2011, MNRAS,410, 1064

Catalog of LONG GRB LATE-time flares
Bernardini, Margutti 2011, A&A, 526A, 27B

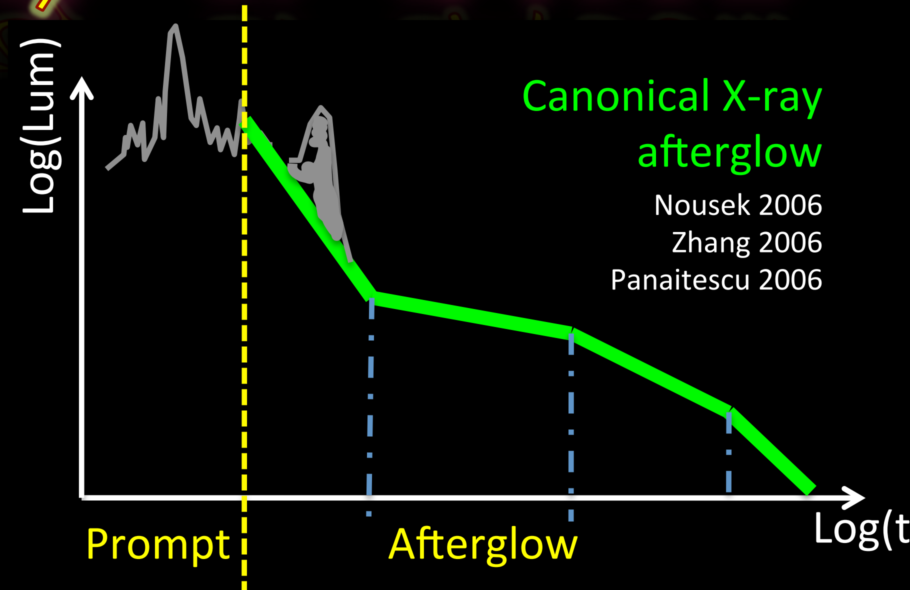
… see Poster on flares in Short GRBs…

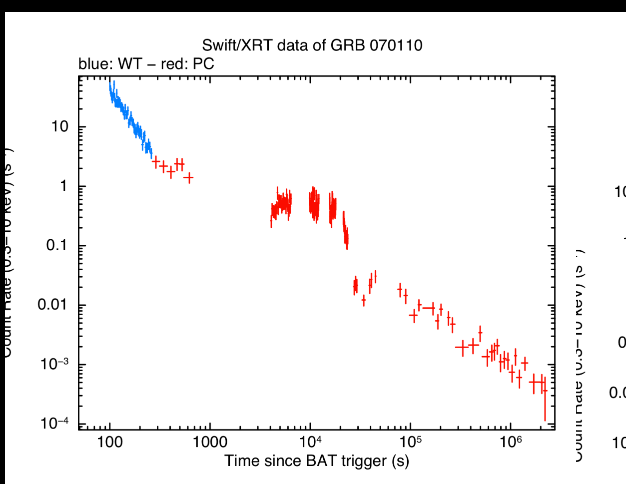


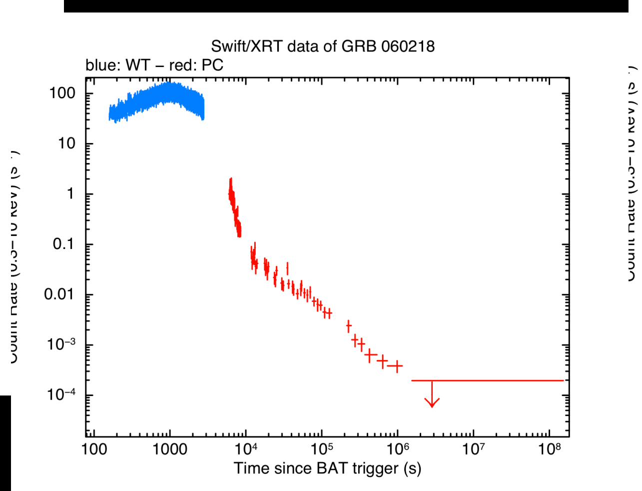
…but all the information about the superimposed variability is stored and **available online**

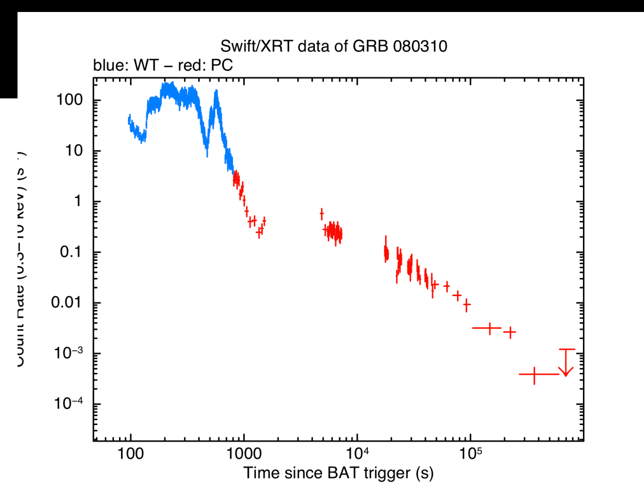
The "complexity" of GRBs...

$\int$ (PROGENITOR
ENVIRONMENT
EMISSION MECHANISM
OBSERVATIONAL EFFECTS) $dx =$









http://www.grbtac.org/xrt_demo/

alpha1= 2.6 +\- 0.3
alpha1(T90)= 1.3 +\- 0.2

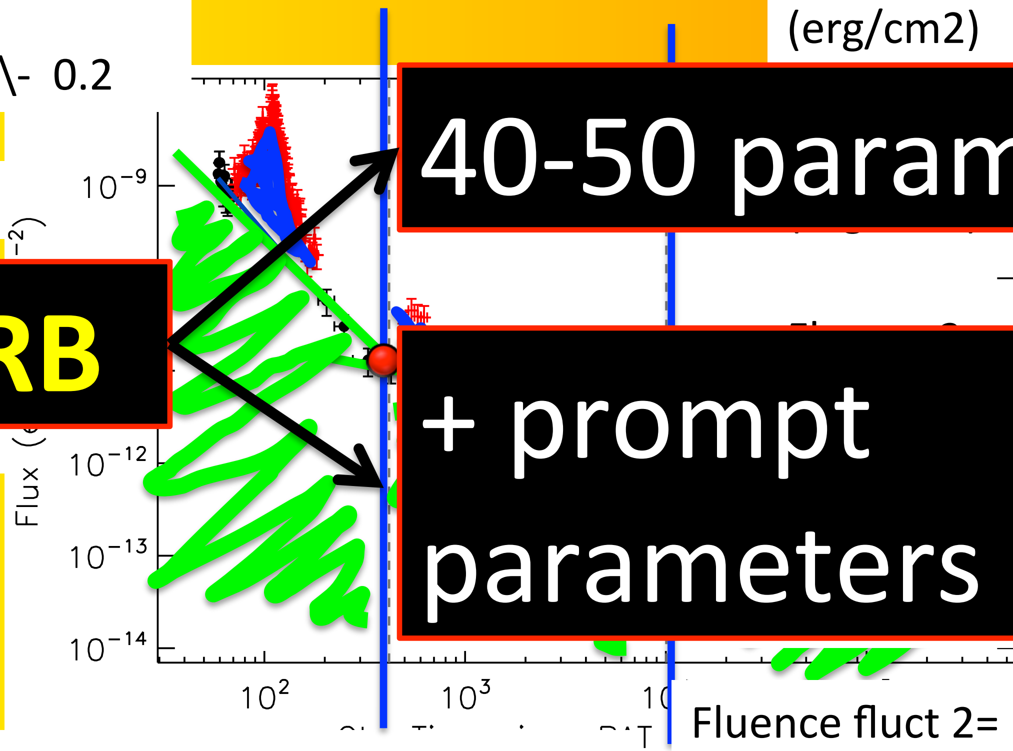
alpha2=0.2+\- 0.3

alpha3=1.

T_begin= 418 s

T_end= 10 ks

Fluence1 = (4.4 +\- 0.4) e-08 (erg/cm2)



GRB

40-50 parameters

+ prompt parameters

Fluence fluct 2= (5

Flux Begin Plateau= (1.4 +\- 0.2

Blind search for correlations

Flux End Plateau= (2.3 +\- 0.3) e-12 (erg/cm2)

= 2ks

968

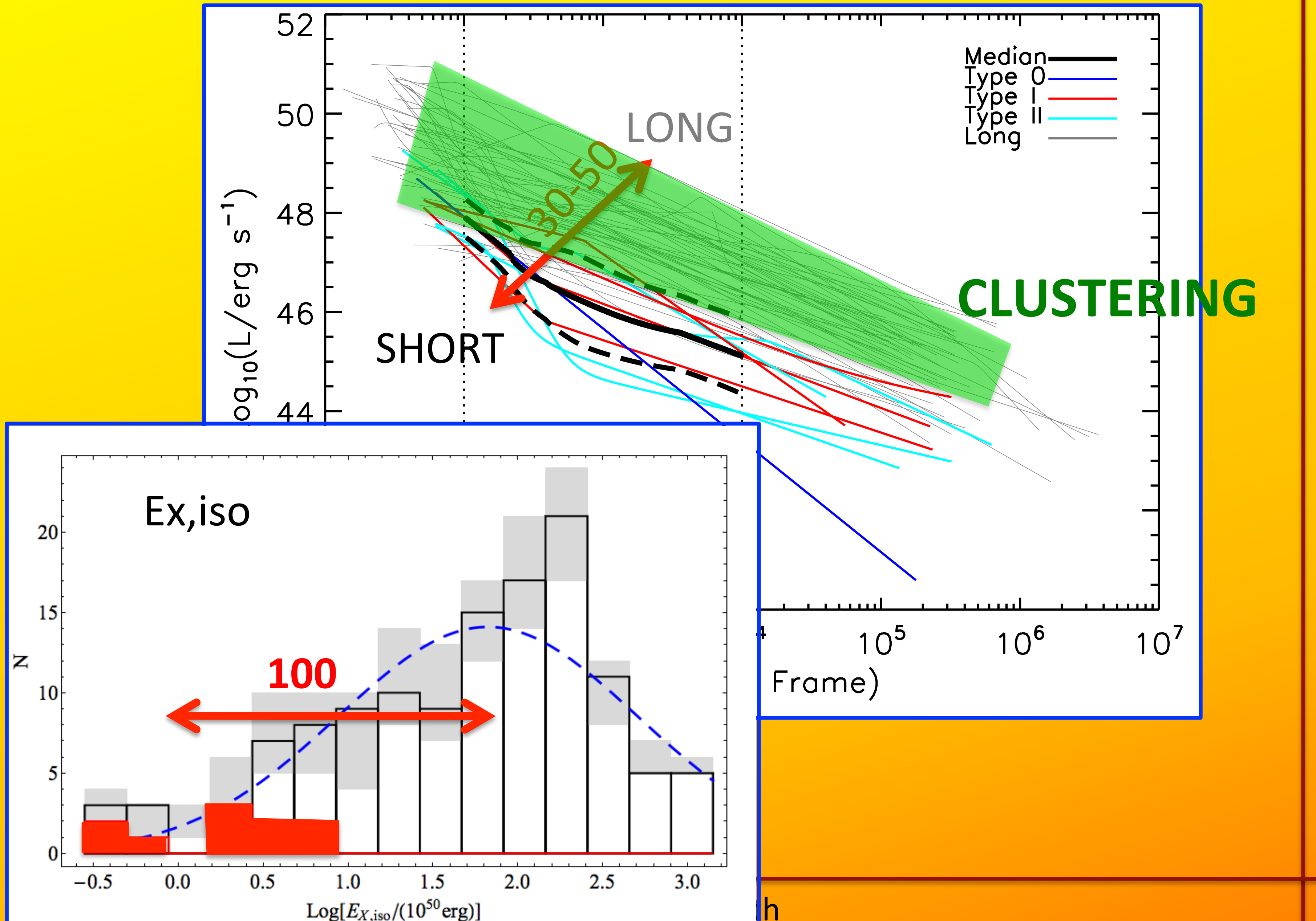
Retrieve lc + Retrie ... spec

http://www.grbtac.org/xrt_demo/

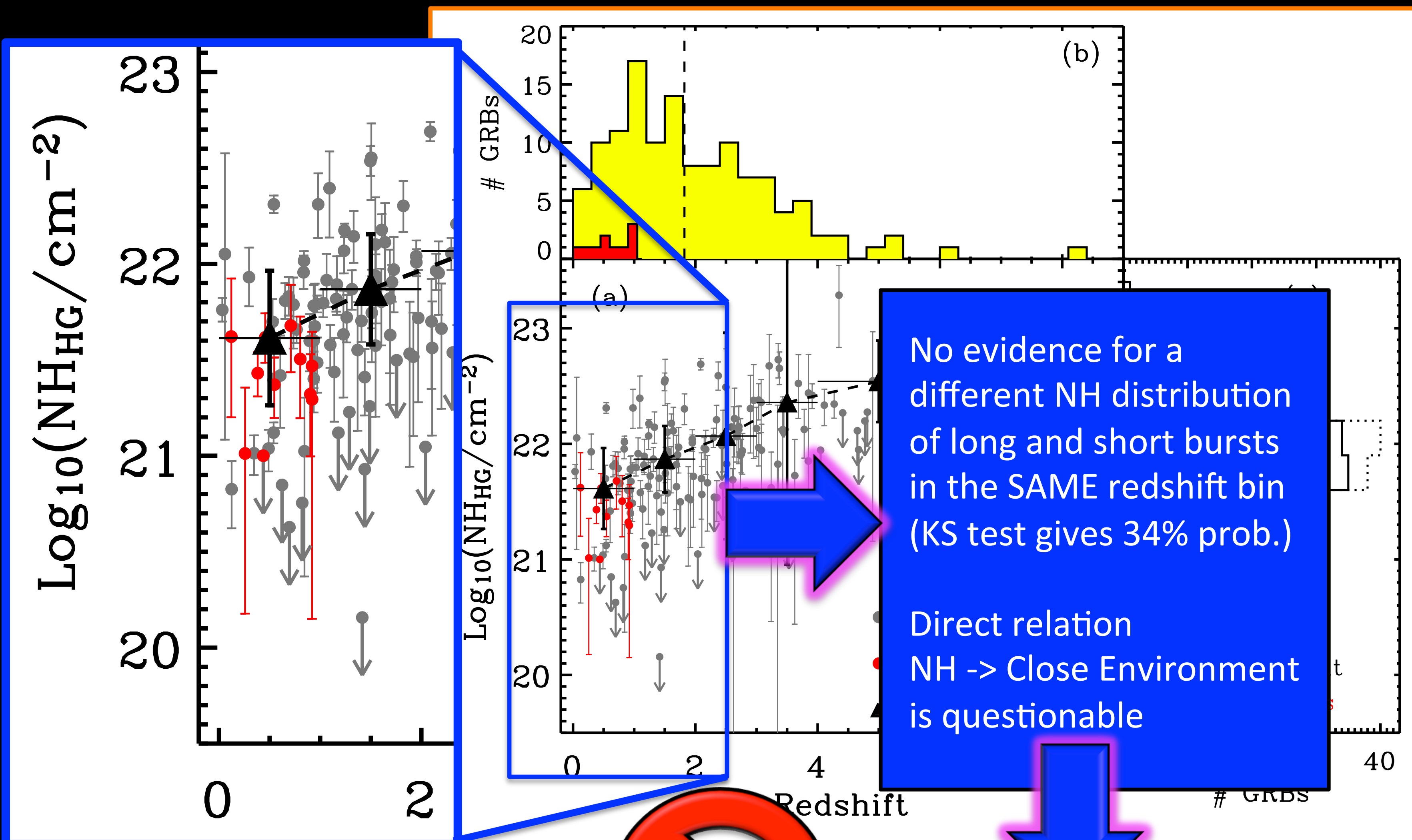
→ **short vs. long**

→ **3-par correlation**

0.3-30 keV k-corrected REST FRAME



NH short vs. long



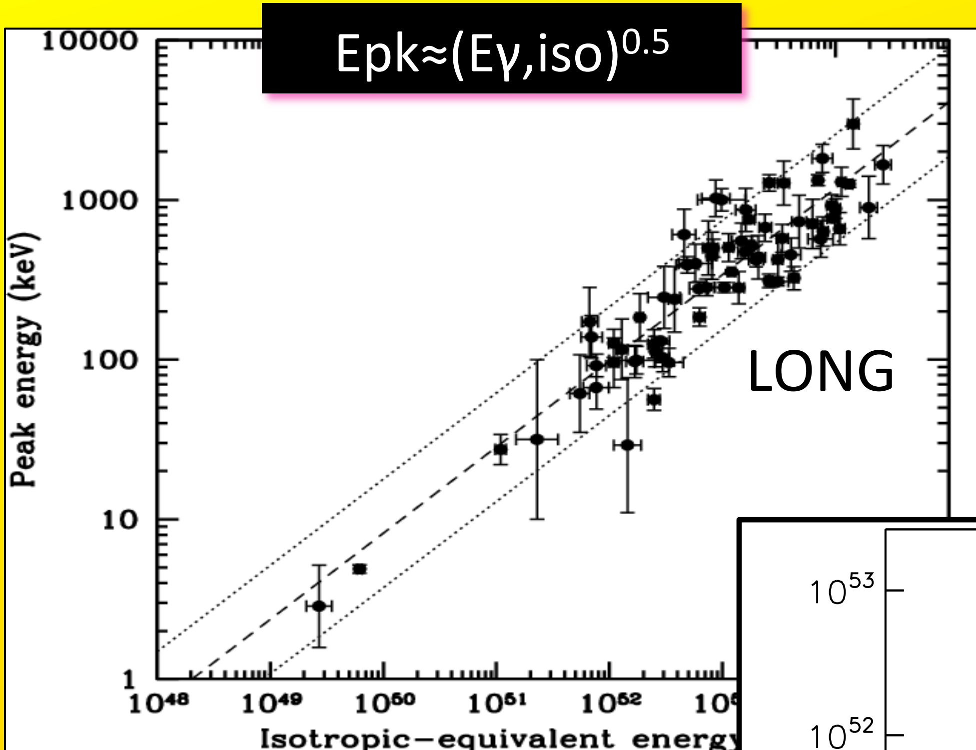
No evidence for a different NH distribution of long and short bursts in the SAME redshift bin (KS test gives 34% prob.)

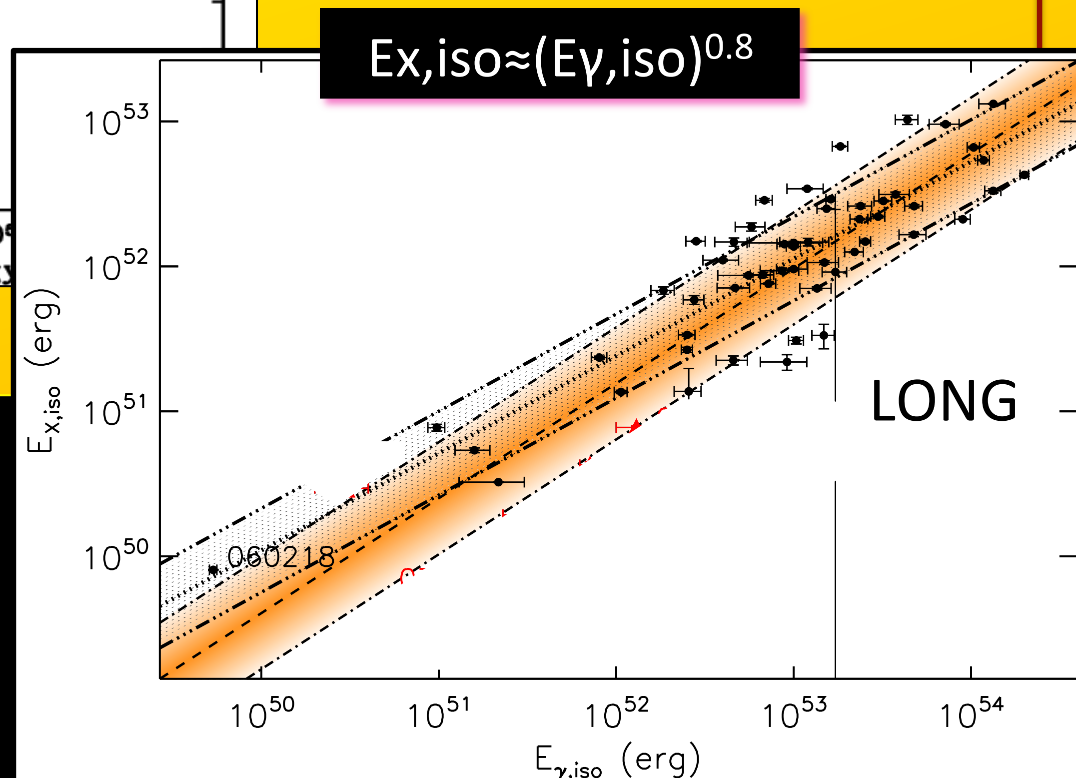
Direct relation
NH -> Close Environment
is questionable

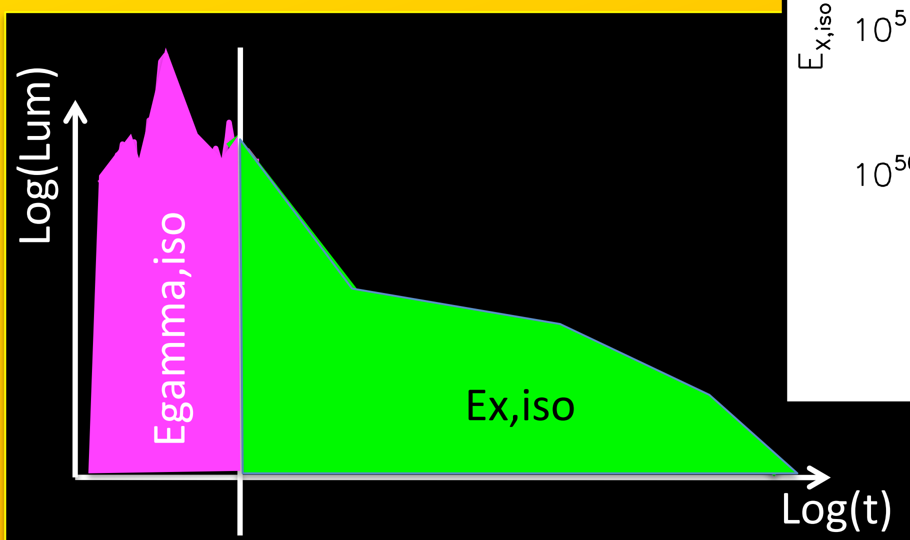
High (intrinsic) NH absorption= Link to STAR formation http://www.grbtac.org/xrt_demo/

short vs. long

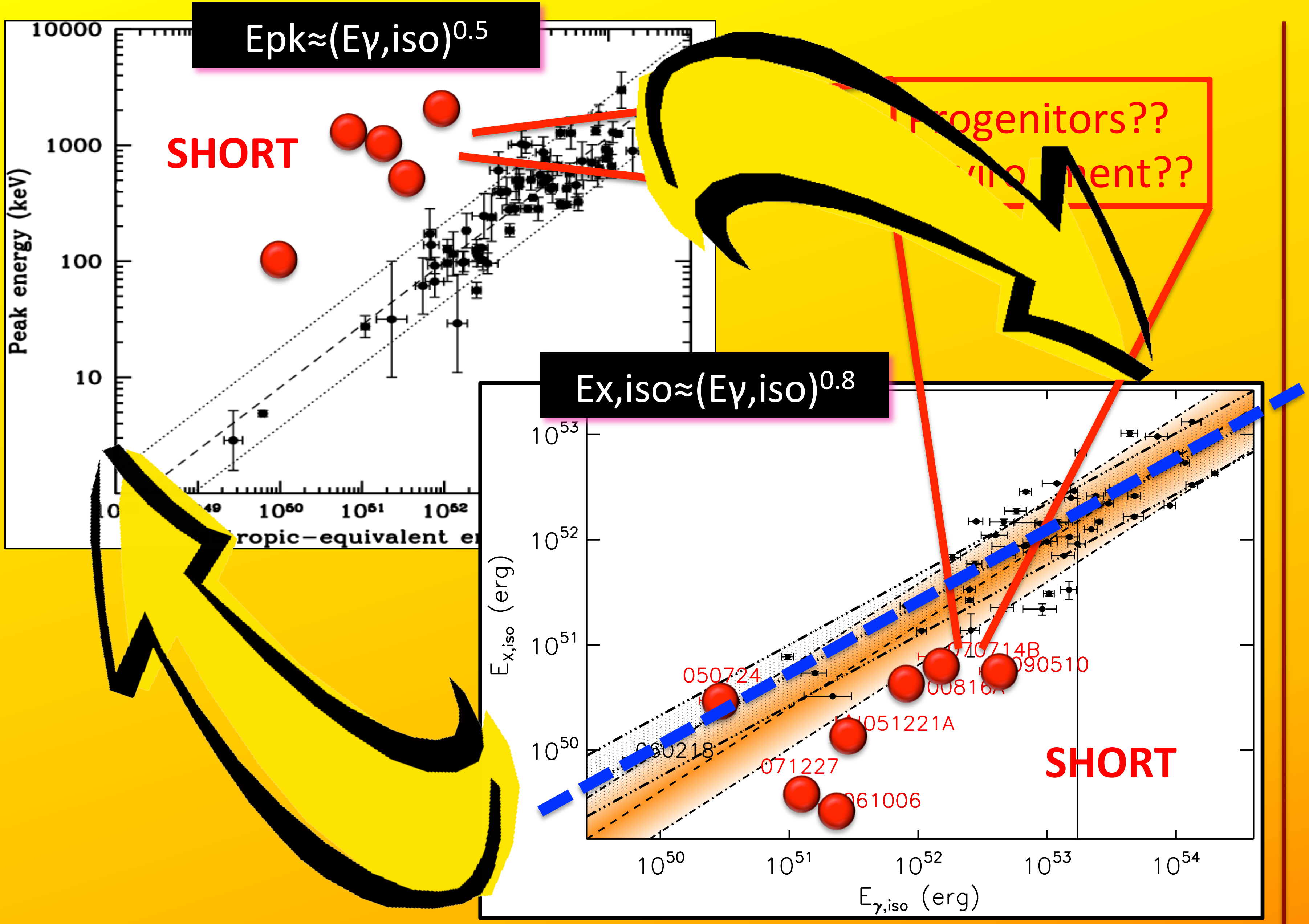
3-par correlation


Epk≈(Eγ,iso)$^{0.5}$
Peak energy (keV)
Isotropic−equivalent energy
LONG


Ex,iso≈(Eγ,iso)$^{0.8}$
$E_{x,iso}$ (erg)
$E_{\gamma,iso}$ (erg)
060218
LONG

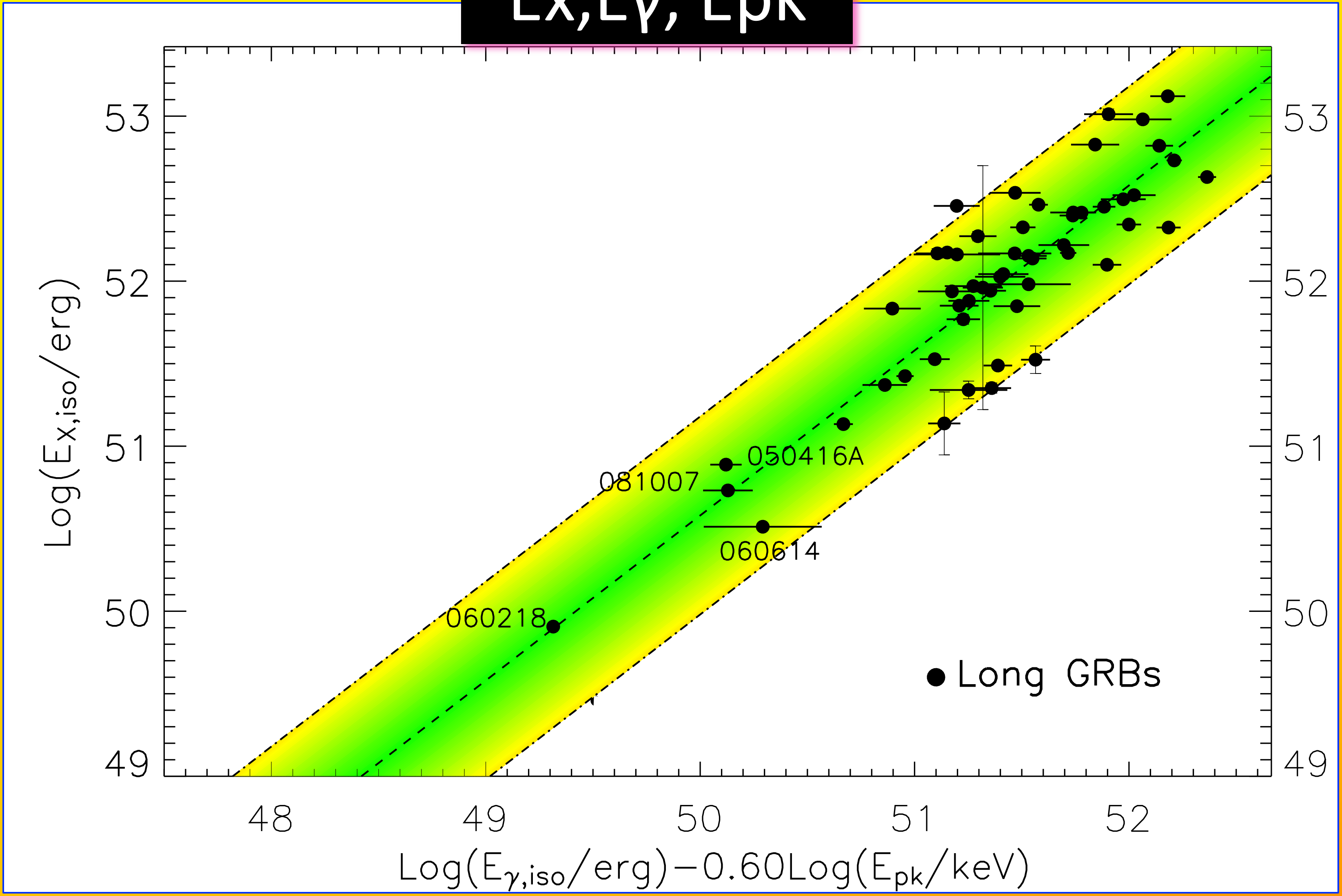

Log(Lum)
Egamma,iso
Ex,iso
Log(t)

May 8th



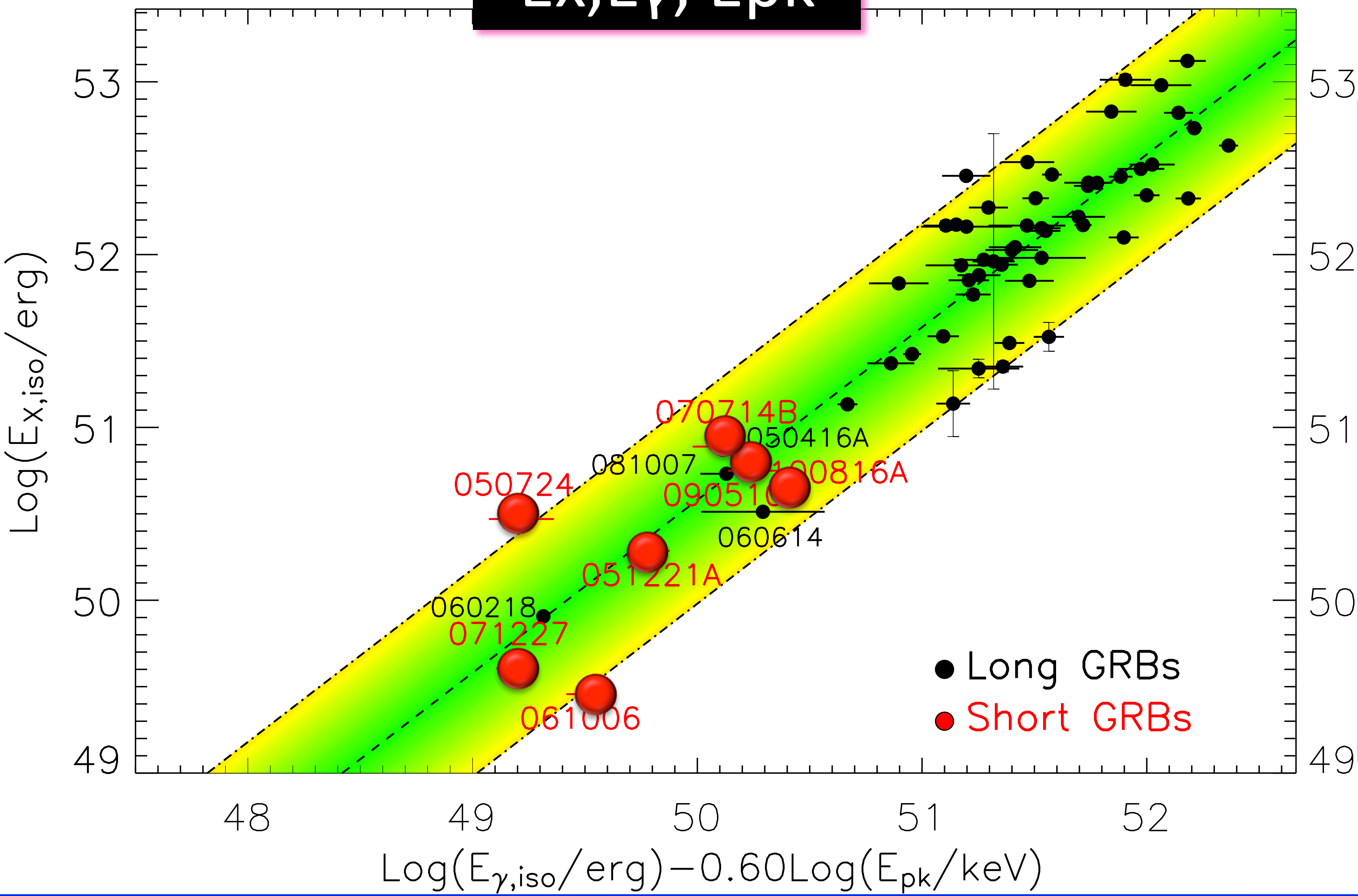
Epk≈(Eγ,iso)^0.5
SHORT
Peak energy (keV)
10000
1000
100
10
10^50
10^51
10^52
Progenitors??
...nment??
Ex,iso≈(Eγ,iso)^0.8
050724
070714B
090510
051221A
071227
061006
SHORT
E_x,iso (erg)
E_γ,iso (erg)
10^50
10^51
10^52
10^53
10^54

Ex,Eγ, Epk



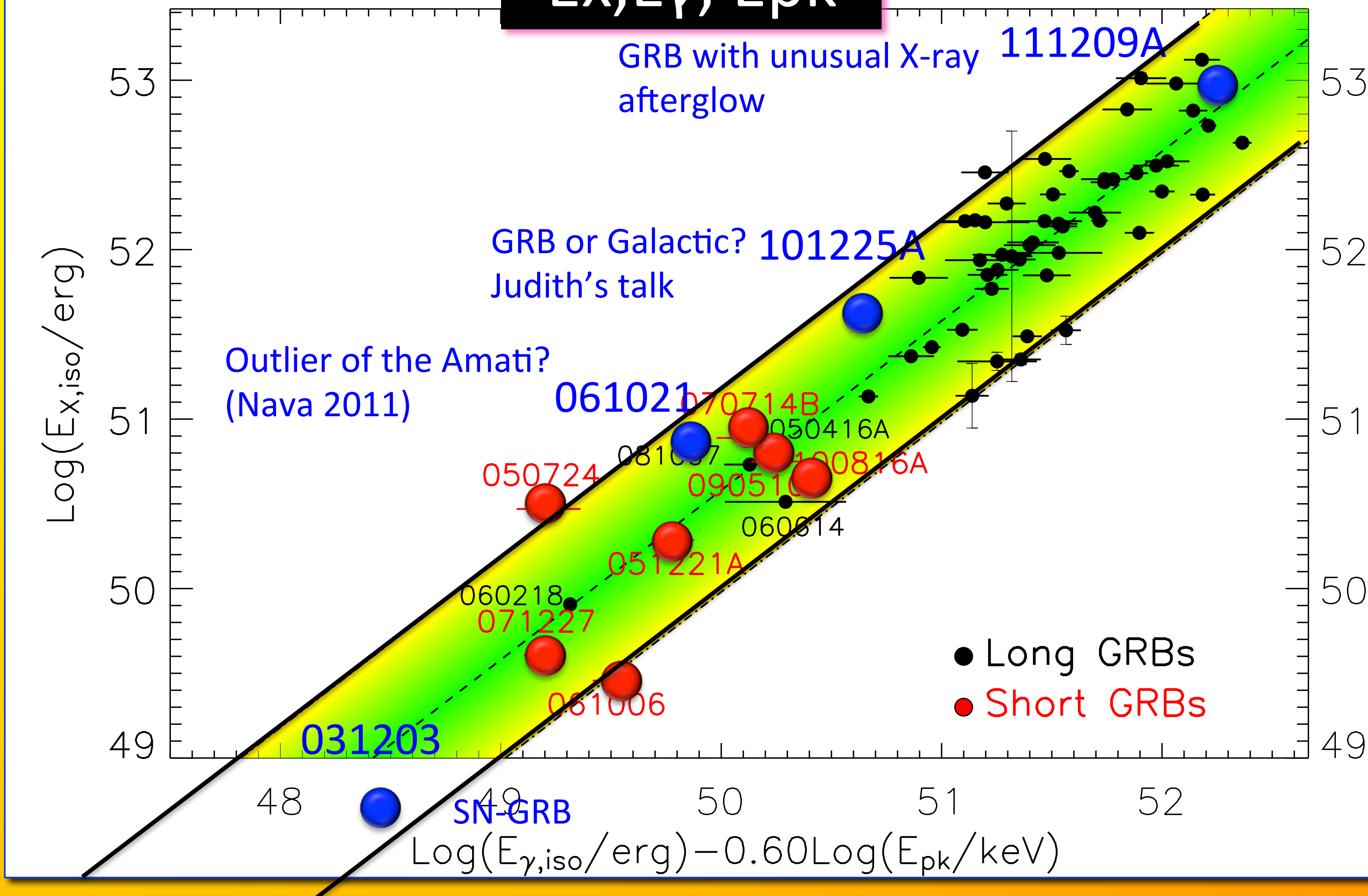
See Poster by BERNARDINI!!!

Ex,Eγ, Epk



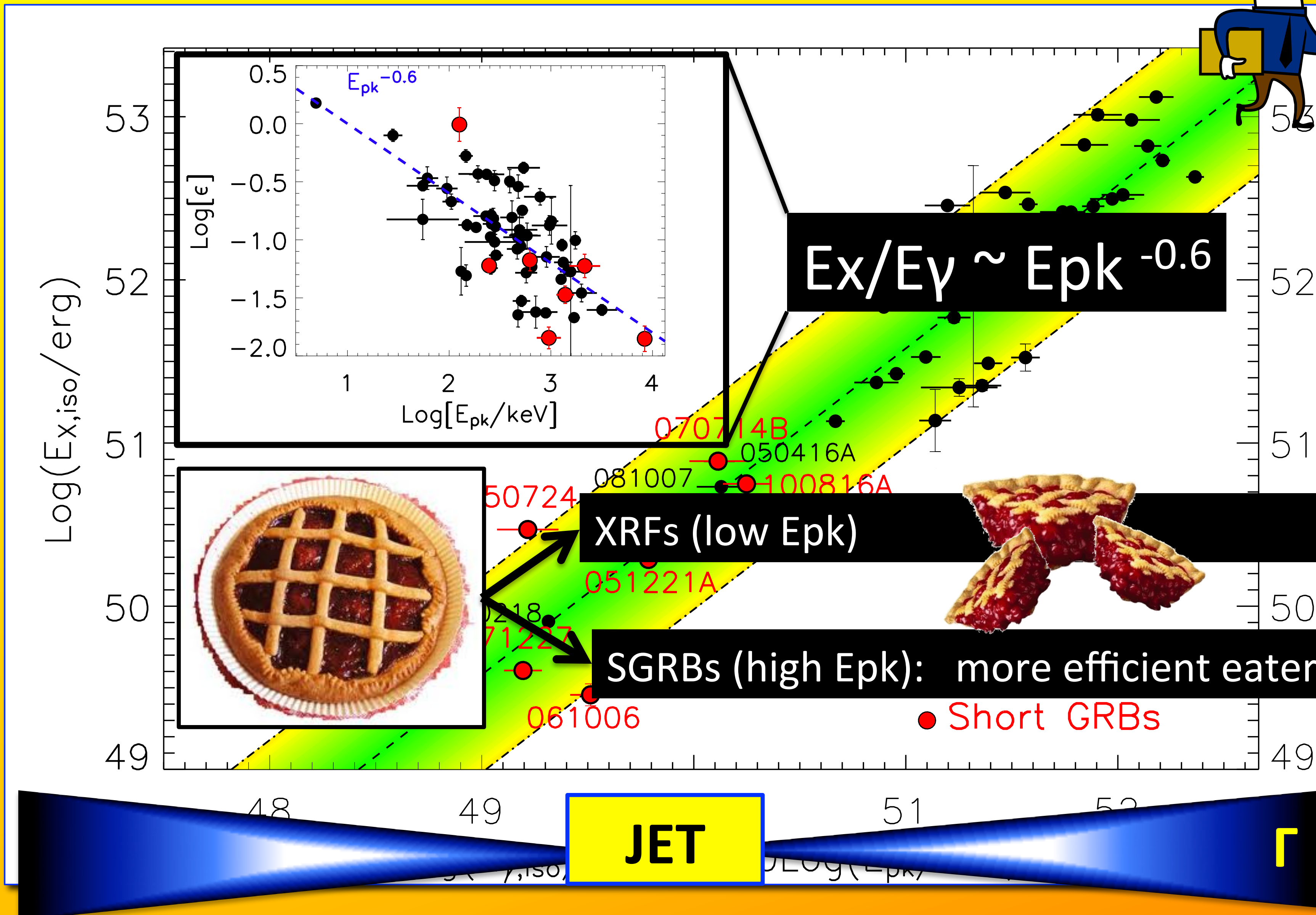
See Poster by BERNARDINI!!!

Ex,Eγ, Epk



See Poster by BERNARDINI!!!

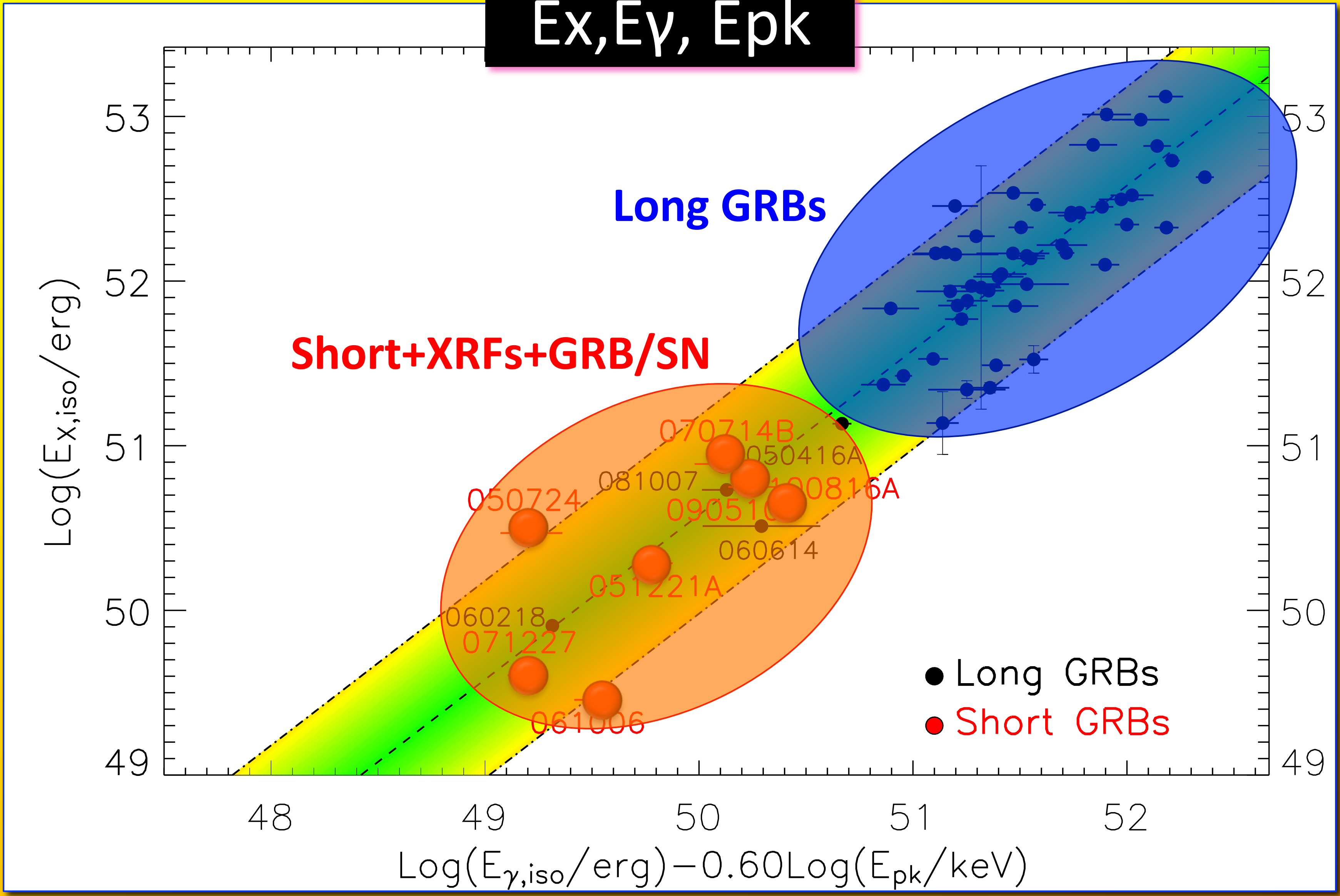
Take away message!!



See Poster by BERNARDINI!!!

See Ghirlanda 2012, Lazzati talk

Ex,Eγ, Epk



Long GRBs
Short+XRFs+GRB/SN
070714B
050416A
081007
100816A
050724
090510
060614
051221A
060218
071227
061006
Long GRBs
Short GRBs
Log(Ex,iso/erg)
Log(Eγ,iso/erg)−0.60Log(Epk/keV)
48
49
50
51
52
53

Summary

We built a detailed OBSERVATIONAL picture of the X-ray emission after the prompt (flares + continuum)

Take away MESSAGE

Short are less luminous, less energetic, faster decay but similar intrinsic NH

We have a "Universal" GRB scaling relation

Statistical analysis of more than 650 GRBs:
GRB= 40-50 parameters

The parameter table will be on-line

Data and best-fitting profiles will be on-line

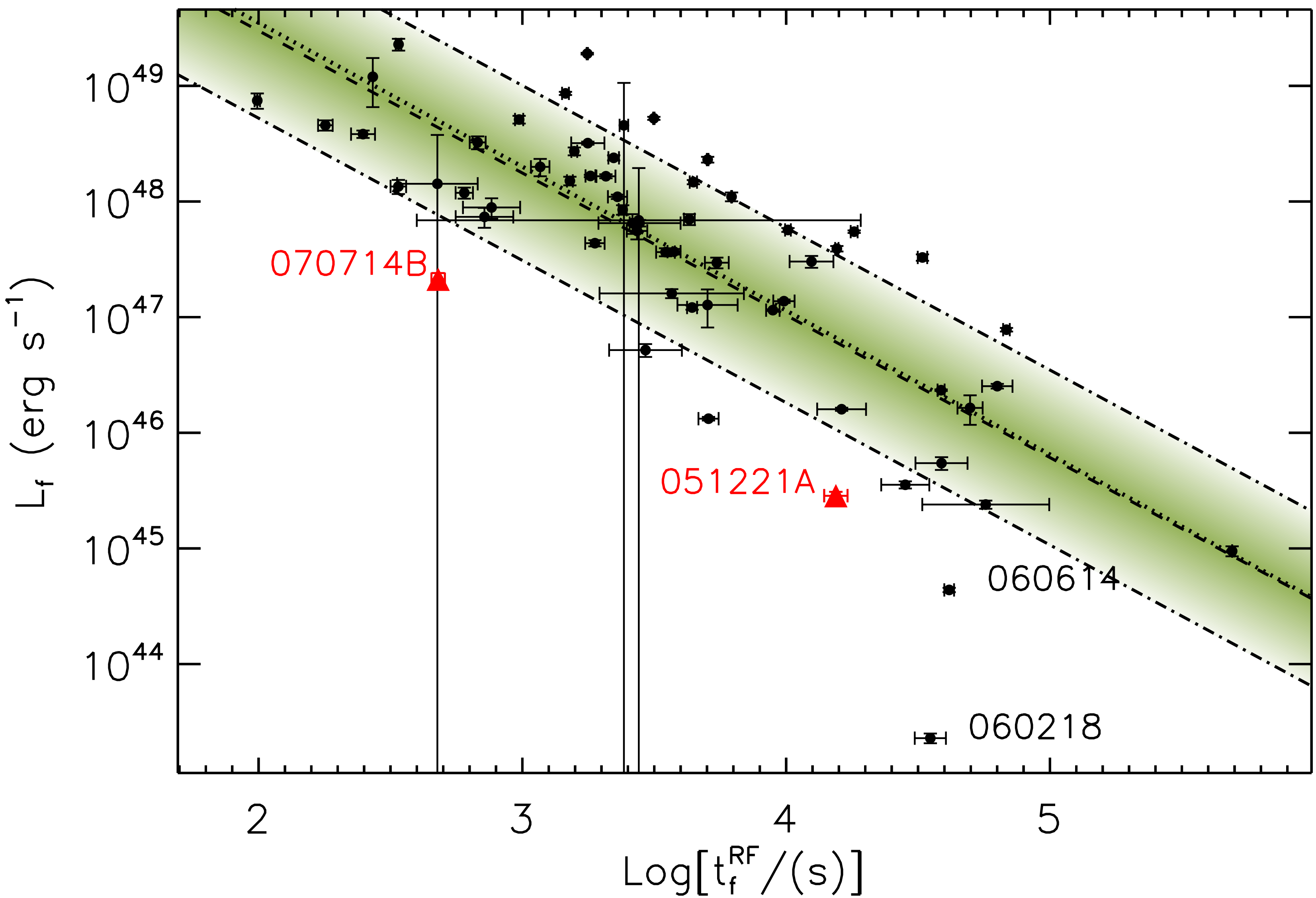
Complement these tables with parameters from other wavelengths

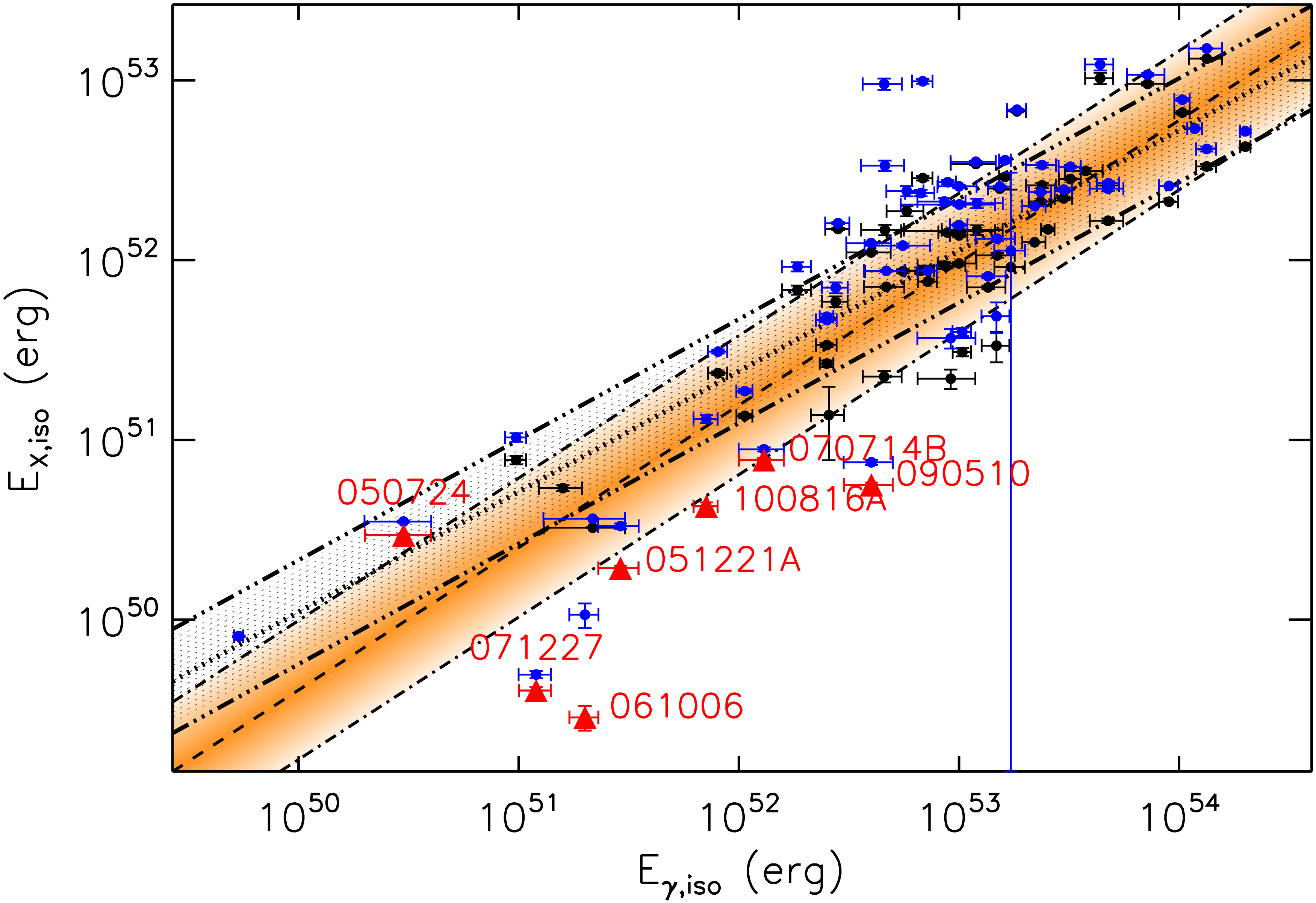
Bernardini, Margutti, ArXiv: 1203.1060

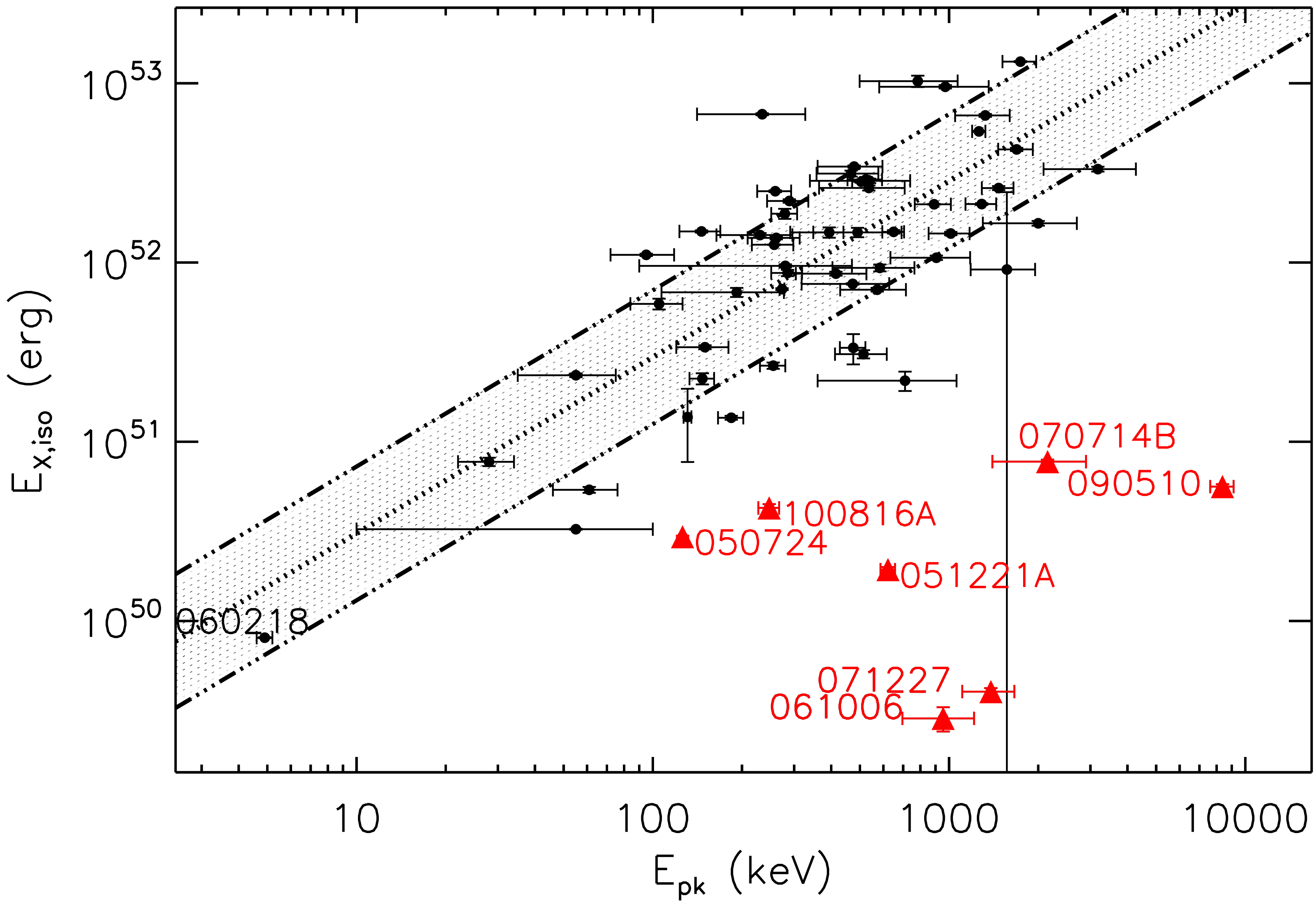
Margutti et al., 2012 ArXiv: 1203.1059

http://www.grbtac.org/xrt_demo/

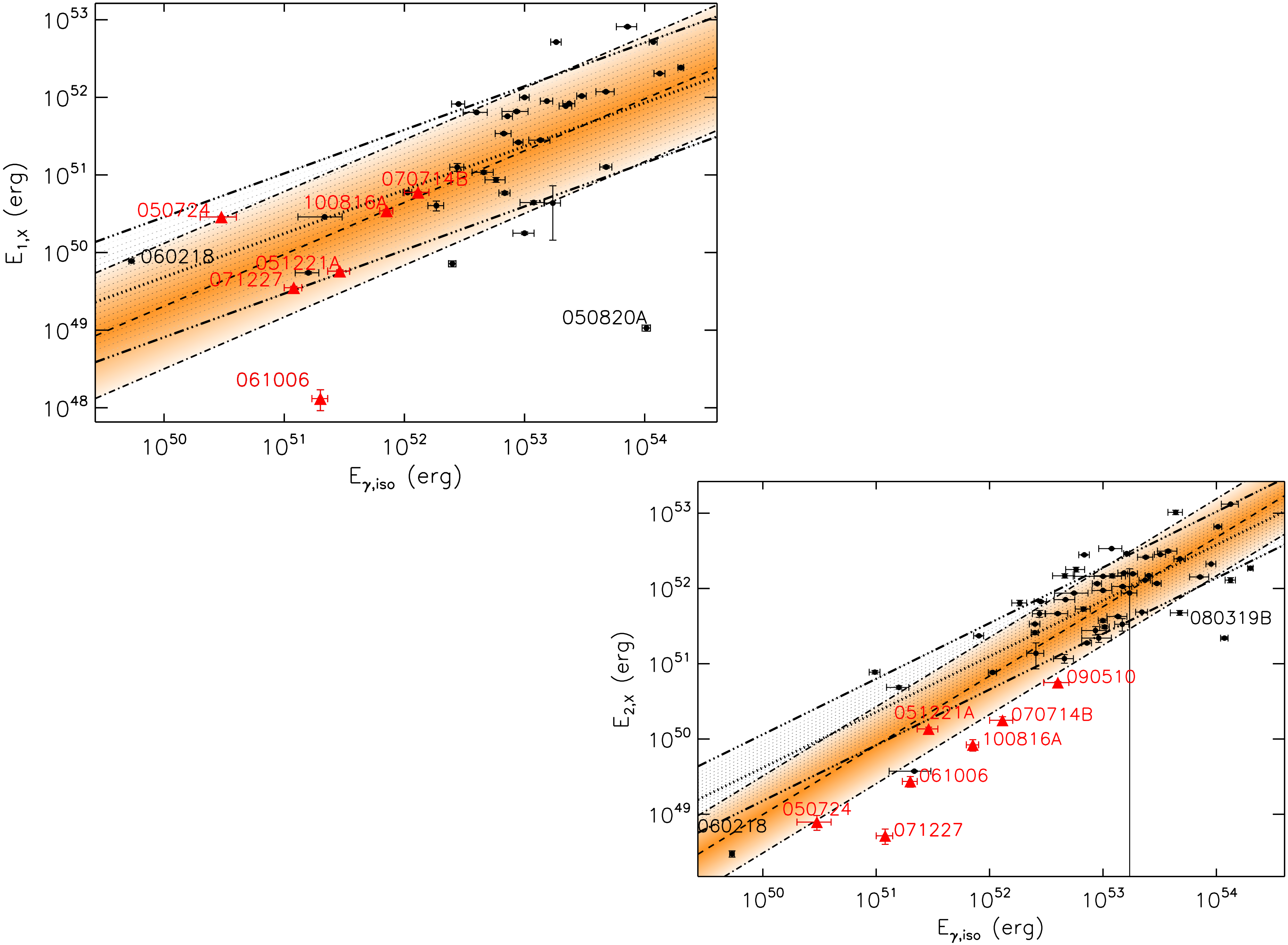
Back up slides



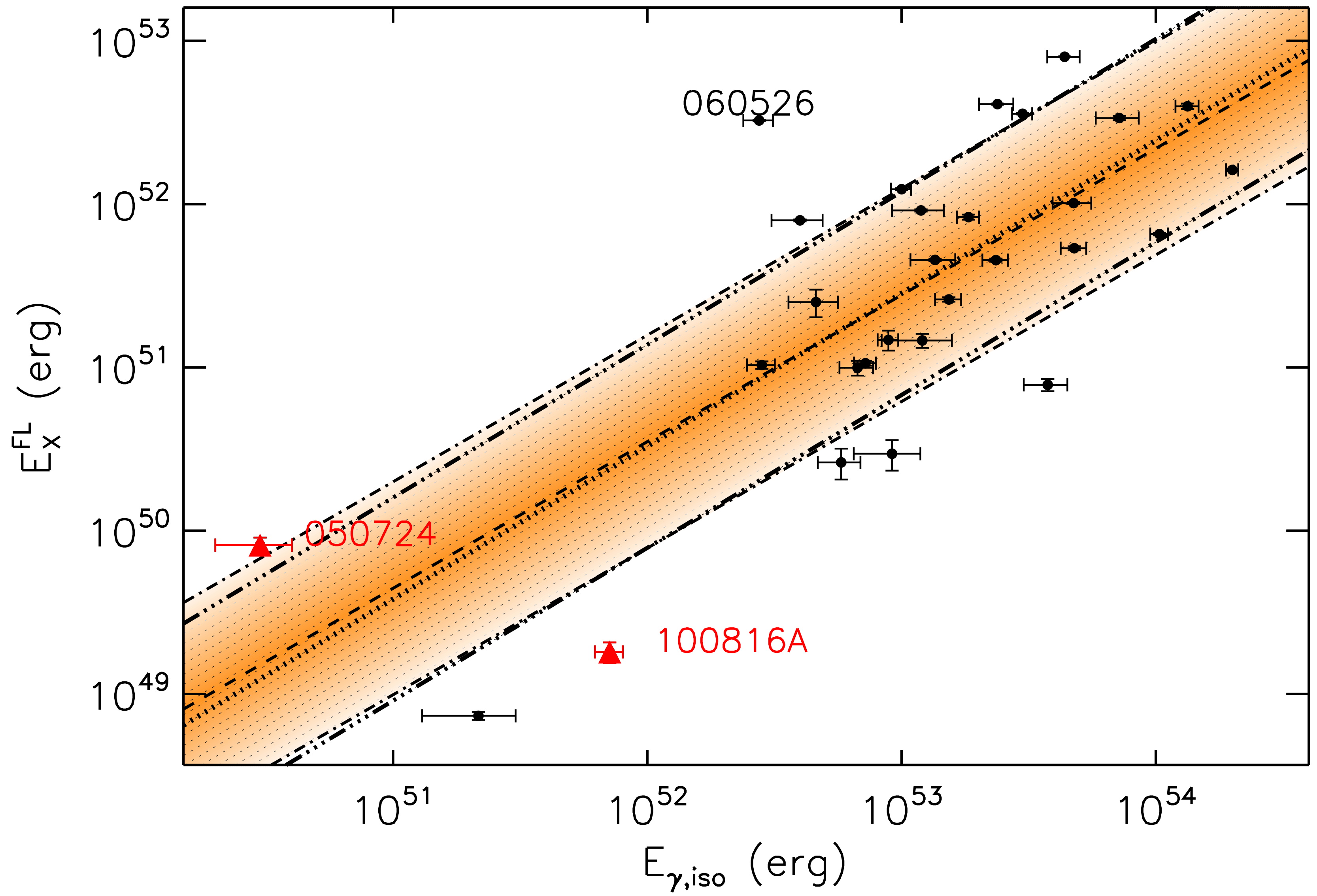

$E_{X,iso}$ (erg)
$E_{\gamma,iso}$ (erg)
10^{50}
10^{51}
10^{52}
10^{53}
10^{54}
050724
070714B
090510
100816A
051221A
071227
061006



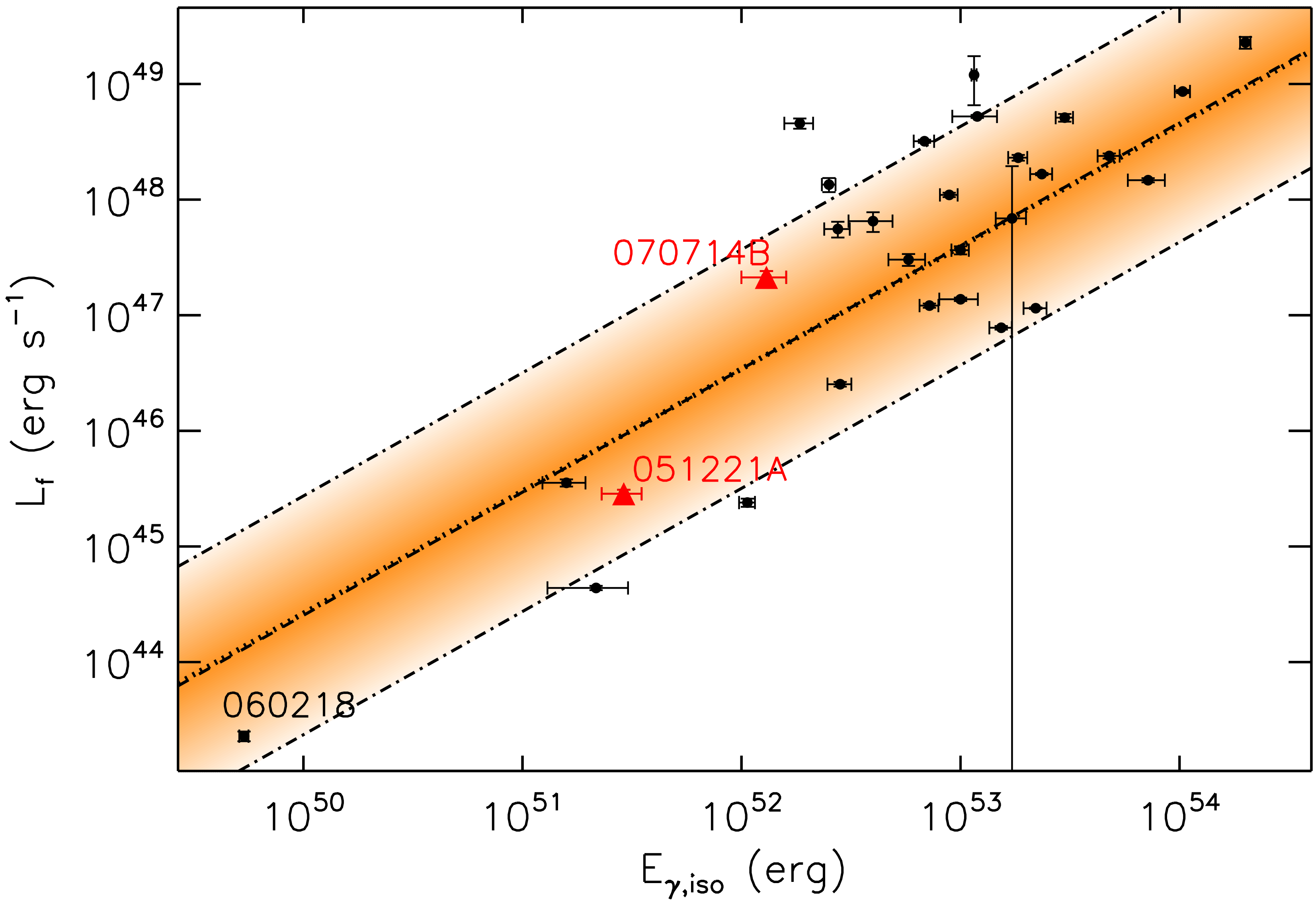
10^{53}
10^{52}
10^{51}
10^{50}
$E_{X,iso}$ (erg)
10
100
1000
10000
E_{pk} (keV)
060218
070714B
090510
100816A
050724
051221A
071227
061006



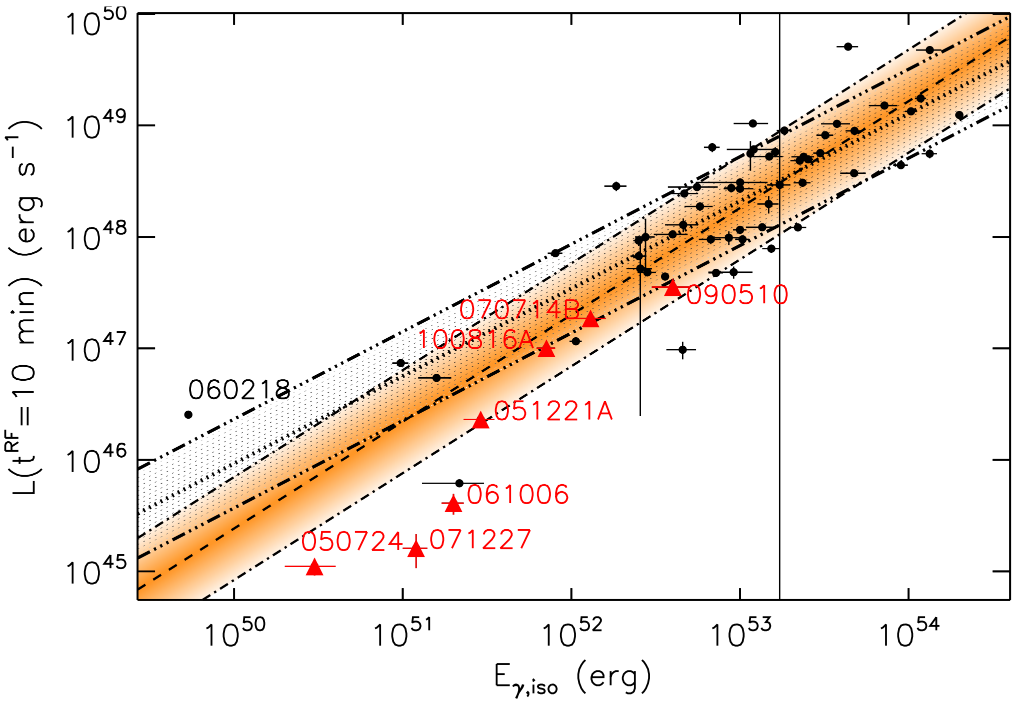
050724
100816A
070714B
060218
051221A
071227
050820A
061006
$E_{1,x}$ (erg)
$E_{\gamma,iso}$ (erg)
090510
070714B
051221A
100816A
061006
050724
060218
071227
080319B
$E_{2,x}$ (erg)
$E_{\gamma,iso}$ (erg)



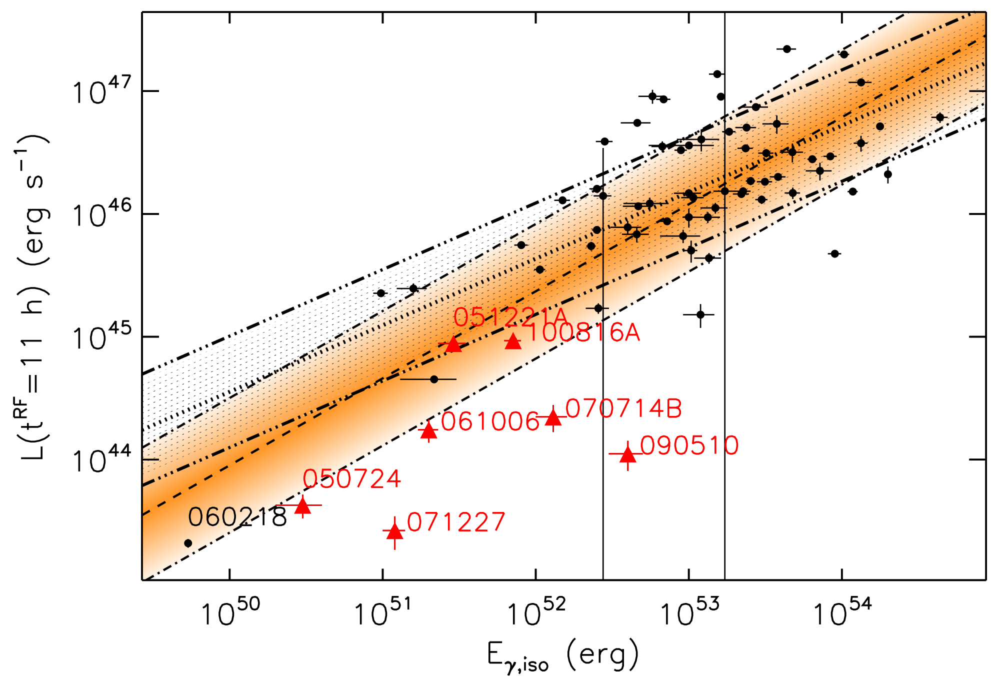
060526
050724
100816A
10^{53}
10^{52}
10^{51}
10^{50}
10^{49}
E_x^{FL} (erg)
10^{51}
10^{52}
10^{53}
10^{54}
$E_{\gamma,iso}$ (erg)



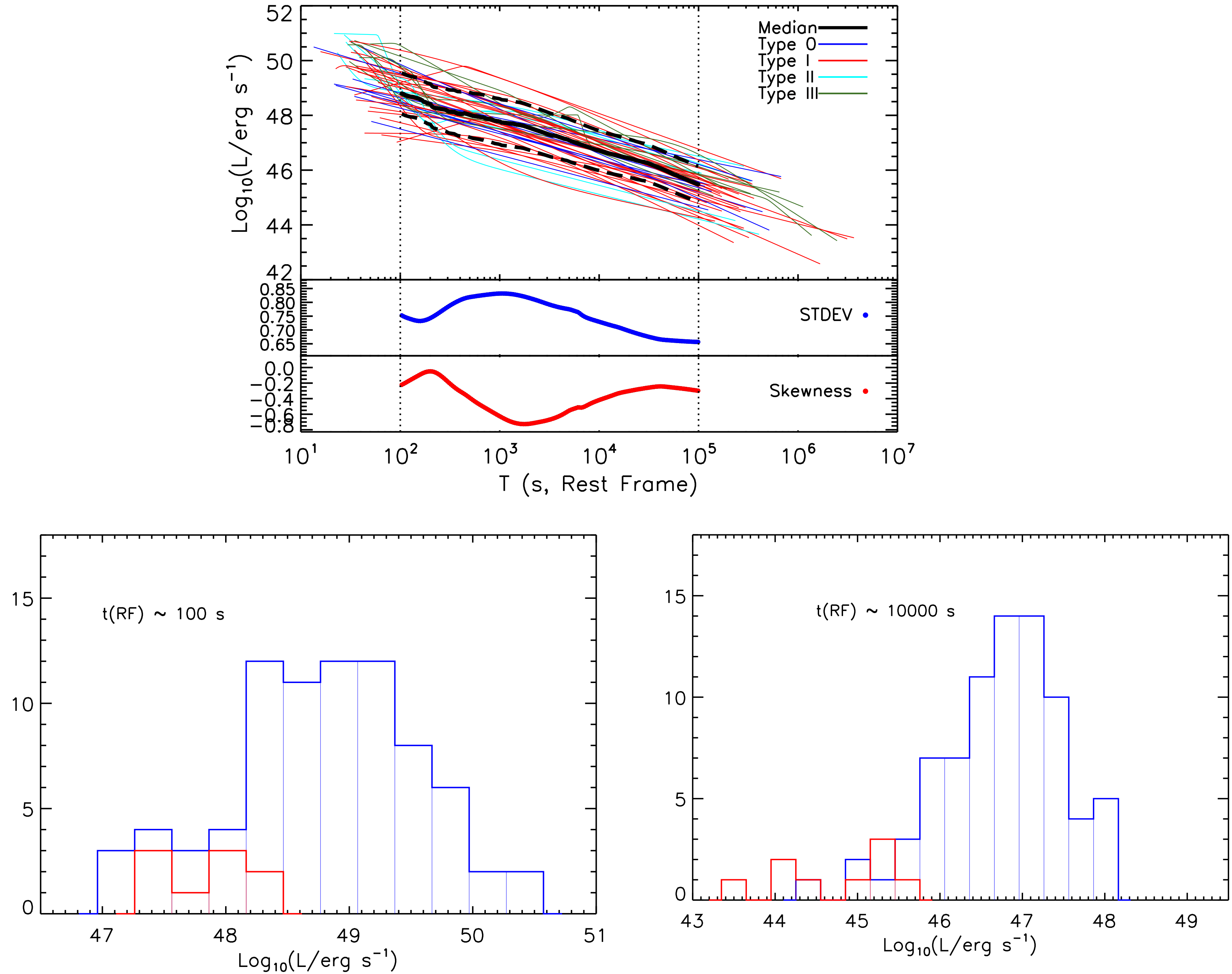
L_f (erg s^{-1})
10^{44}
10^{45}
10^{46}
10^{47}
10^{48}
10^{49}
070714B
051221A
060218
10^{50}
10^{51}
10^{52}
10^{53}
10^{54}
$E_{\gamma,iso}$ (erg)



L(t^RF=10 min) (erg s^-1)
E_γ,iso (erg)
10^50
10^49
10^48
10^47
10^46
10^45
10^50
10^51
10^52
10^53
10^54
060218
070714B
100816A
090510
051221A
061006
050724
071227

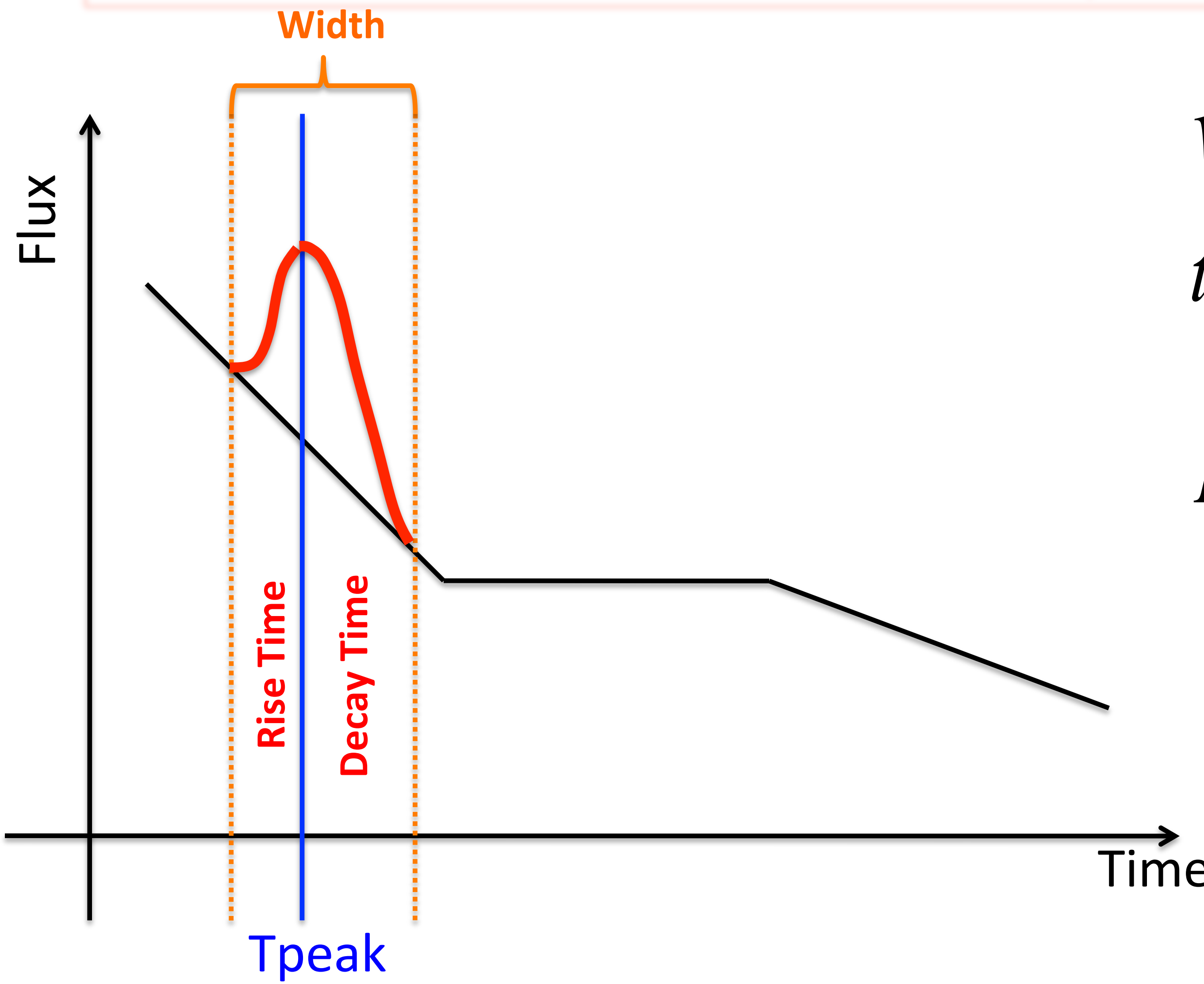


L(t^RF=11 h) (erg s^-1)
E_γ,iso (erg)
10^47
10^46
10^45
10^44
10^50
10^51
10^52
10^53
10^54
051221A
100816A
070714B
061006
090510
050724
060218
071227



Median
Type 0
Type I
Type II
Type III
STDEV
Skewness
$Log_{10}(L/erg\ s^{-1})$
T (s, Rest Frame)
t(RF) ~ 100 s
t(RF) ~ 10000 s

The FLARE observational picture:



$$w \propto 0.2 t_{peak}$$

$$t_{rise} \approx 0.5 t_{decay}$$

$$L_{peak} \propto t_{peak}^{-2.7}$$

$$Lag \propto w$$

…very different from the "prompt"

Biasses: temporal extrapolation