Swift follow-up of AGILE GRBs

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INAF-IASF Palermo

6th Science AGILE Workshop
AGILE: 2 years after
April 22-23 2009

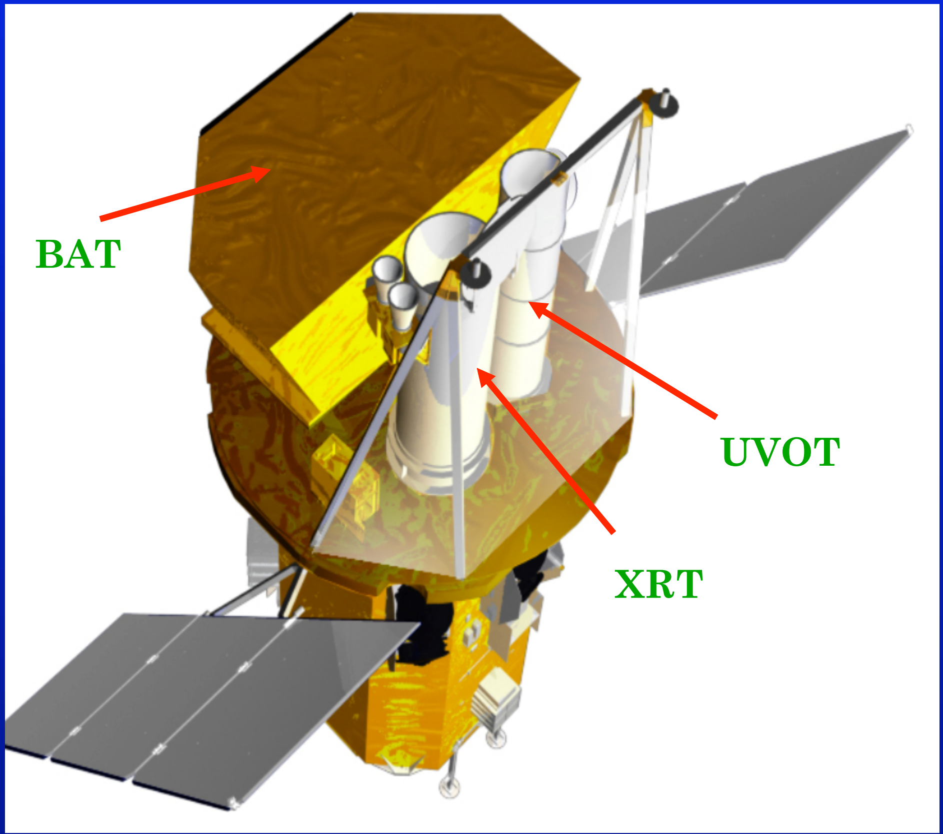
Outline

- Swift's modus operandi
- List AGILE GRBs
- X-ray details on most important GRBs
    - GRB070724B, GRB080514B
    - GRB080607, GRB080714, GRB090401B
- What next? Questions and how to improve the Swift experience

Swift Instruments

Spacecraft

- Autonomous re-pointing, <70 s
- Onboard and ground triggers



Burst Alert Telescope (BAT)

- Imaging: 15-150 keV
- Centroid accuracy: 1-4’
- Field of view: 1/6 sky
- Energy resolution 7 keV

X-Ray Telescope (XRT)

- CCD spectroscopy
- Imaging in 0.2–10 keV, res 140ev @ 5.9keV
- Centroid accuracy: 2-3”
- FOV 23.6’x23.6’

UV/Optical Telescope (UVOT)

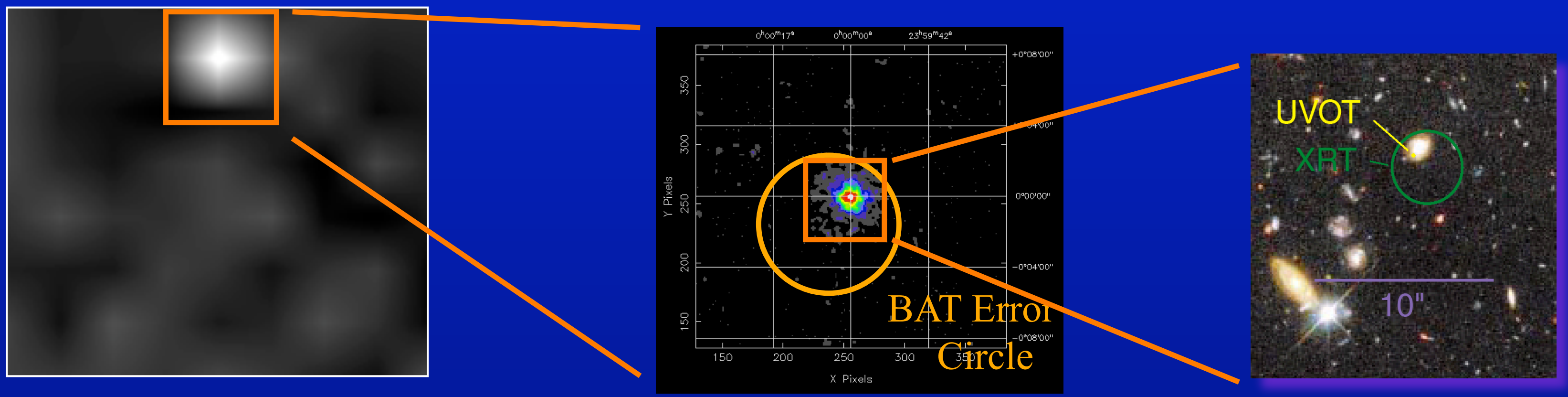
- 30cm telescope
- FOV 17’x17’
- 6 filters:1700 – 6500 Å
- Centroiding accuracy: 0.5"
- 24 mag sensitivity (wh 1000s)

GRB Observing Strategy

1. BAT triggers on GRB, calculates position to ~ 3’, and FOM
2. Spacecraft autonomously slews to GRB position in ~70 s
3. X-ray Telescope determines position to ~ 2-3”
4. UVOT images field, transmits finding chart to ground

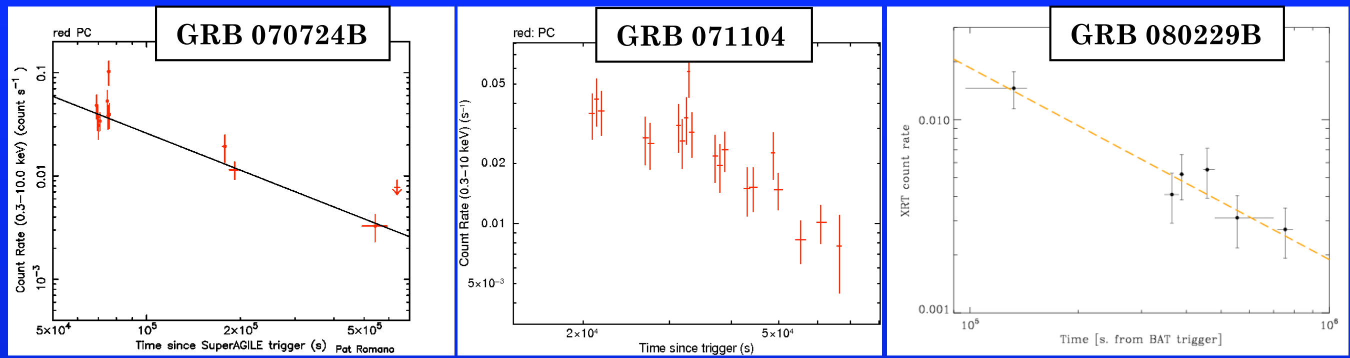
April 22 421 bursts / 379 followed by XRT / 356 detected

BAT Burst Image **XRT Image** **UVOT Image**

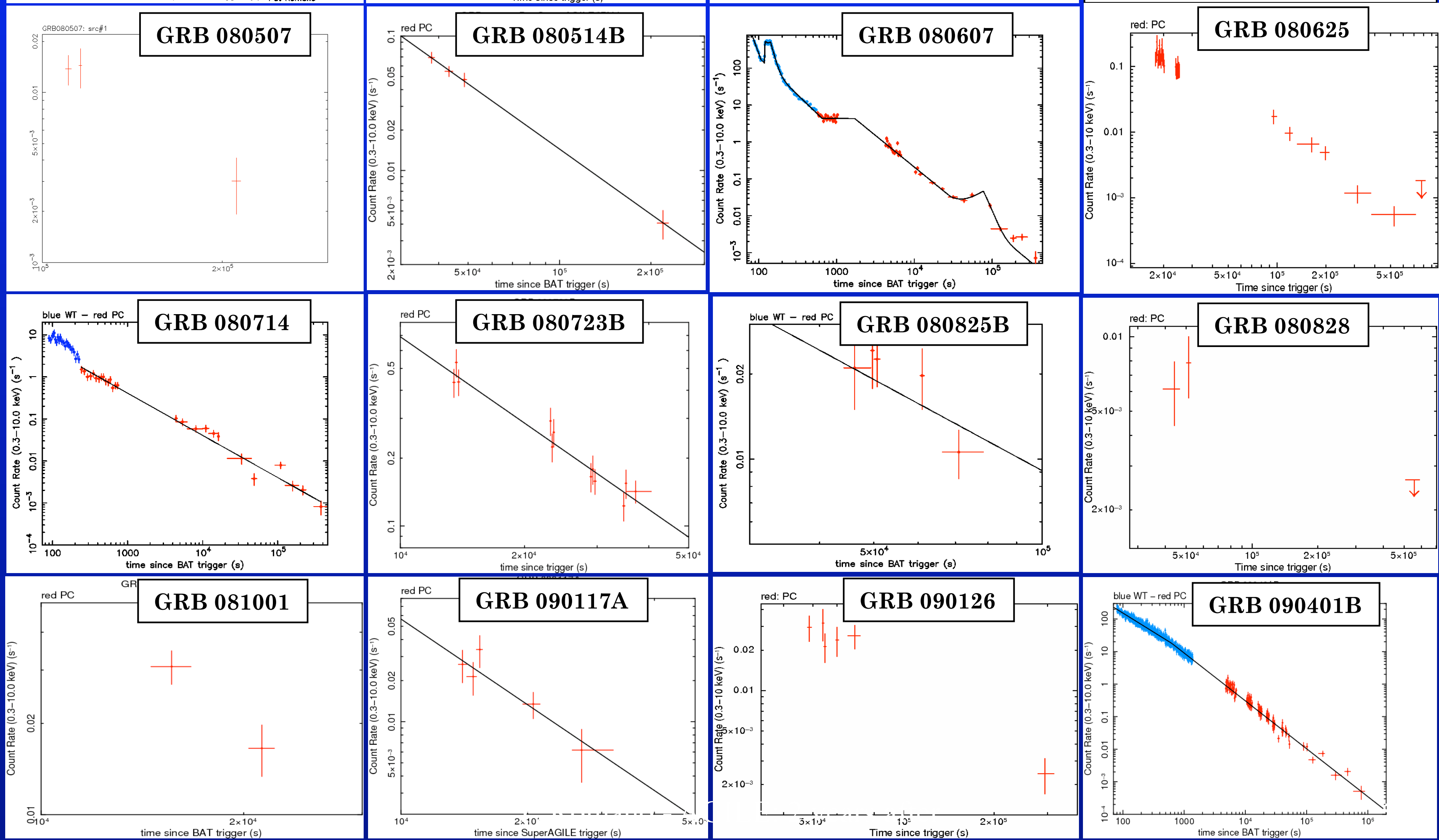


T~10 sec ***T~100 sec*** ***T~300 sec***

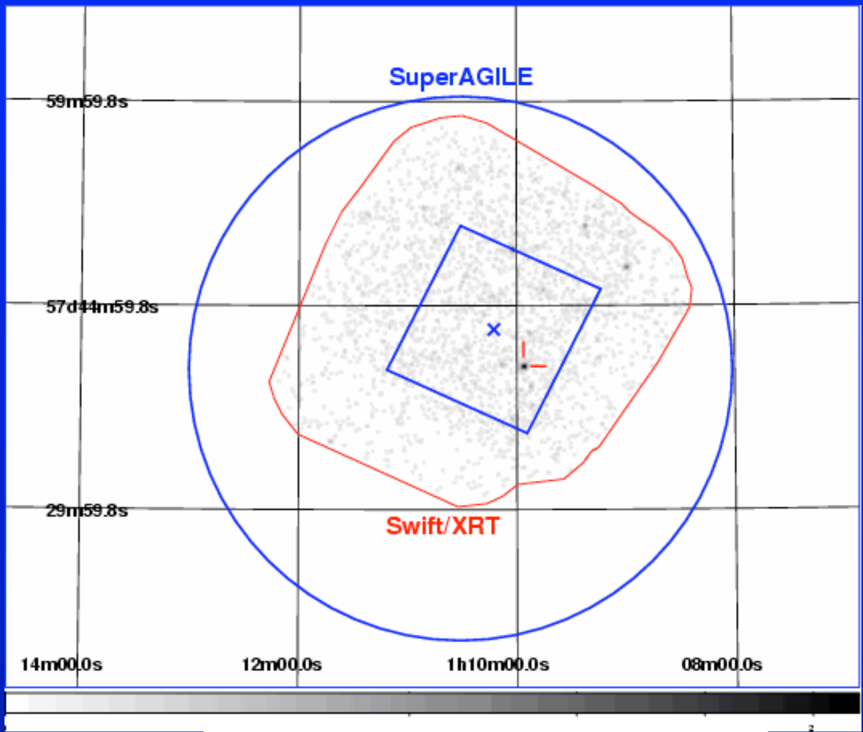
AGILE GRB List



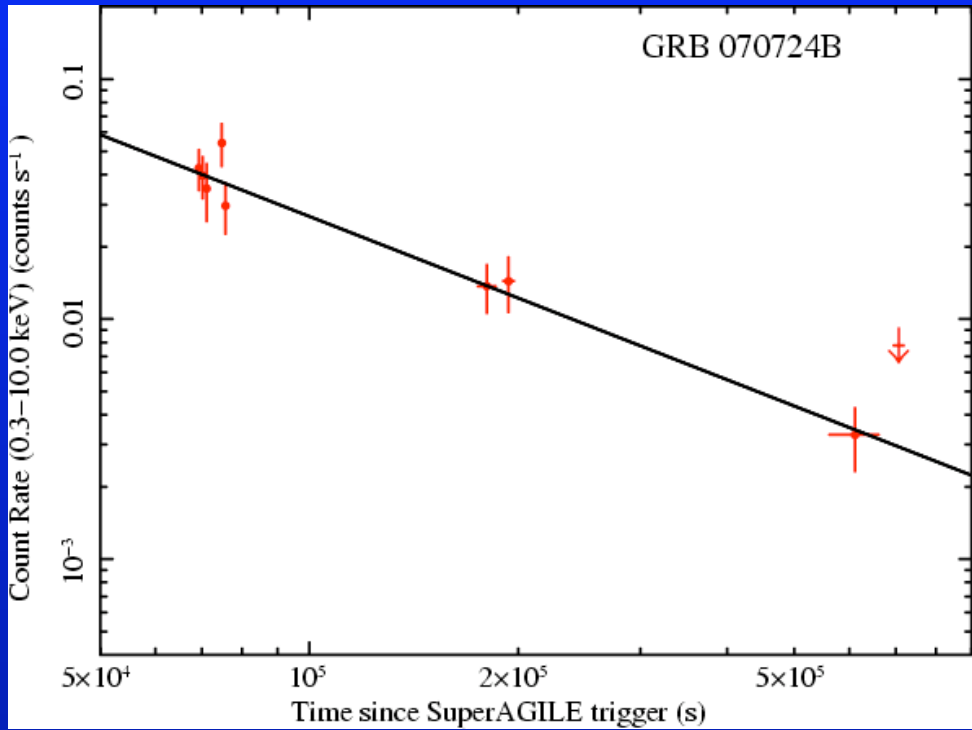
080408
[080726, 090324]



GRB 070724B SA/KW/WAM



Del Monte et al 2008



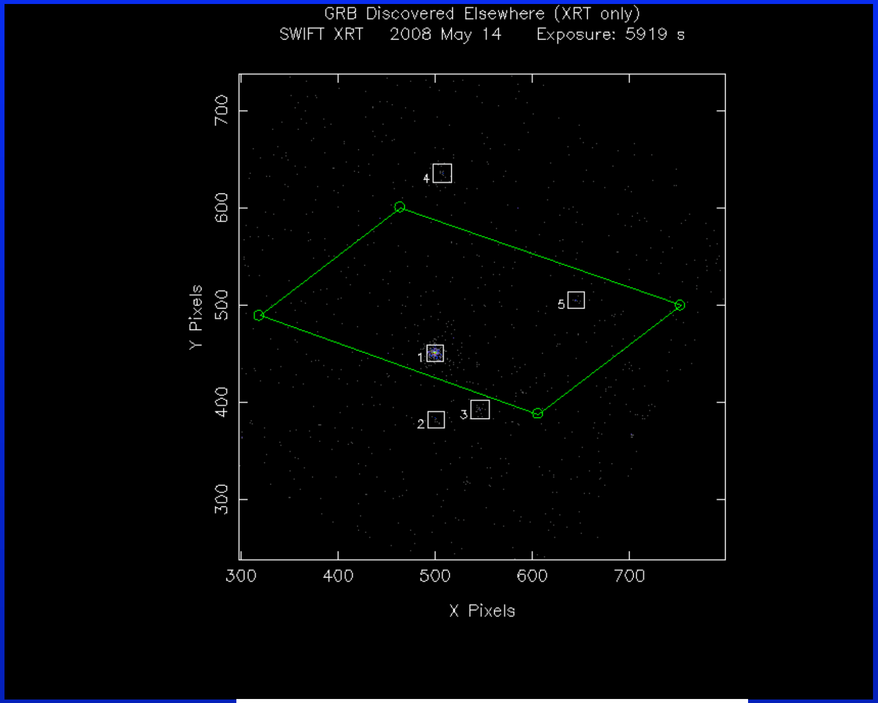
First GRB Localization by
SuperAGILE onboard:
20 arcmin radius

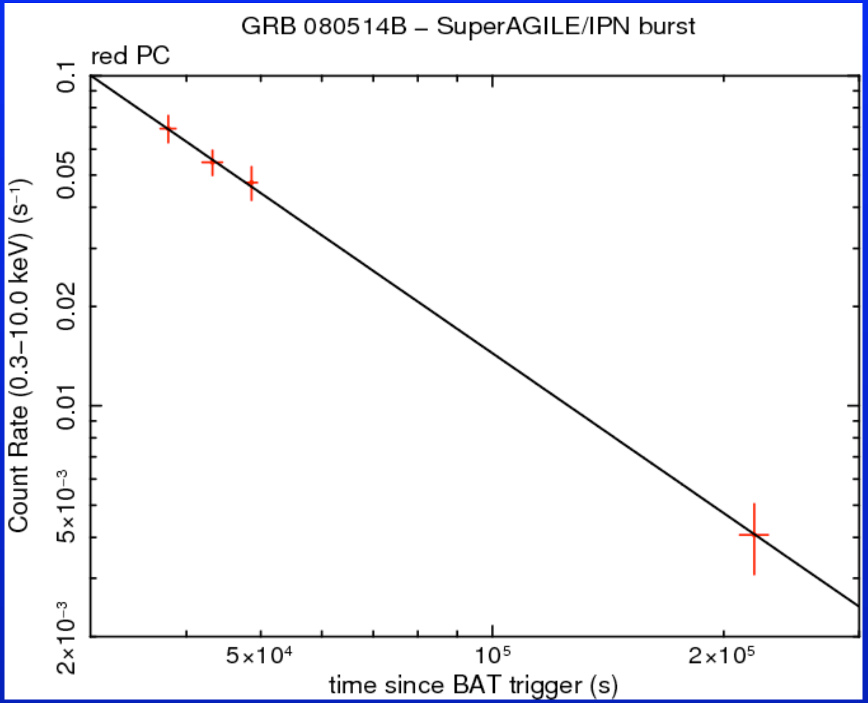
XRT FoV 23.6 x 23.6 arcmin
=> tiling

α=1.13+0.23-0.18 (>19h)
Γ=2.4±0.5
N_H=(7±3)E21 cm^{-2}

No GRID, No optical,
no radio detect.
KW + Suzaku/WAM

GRB 080514B SA/GRID/KW/WAM





Giuliani et al 2008

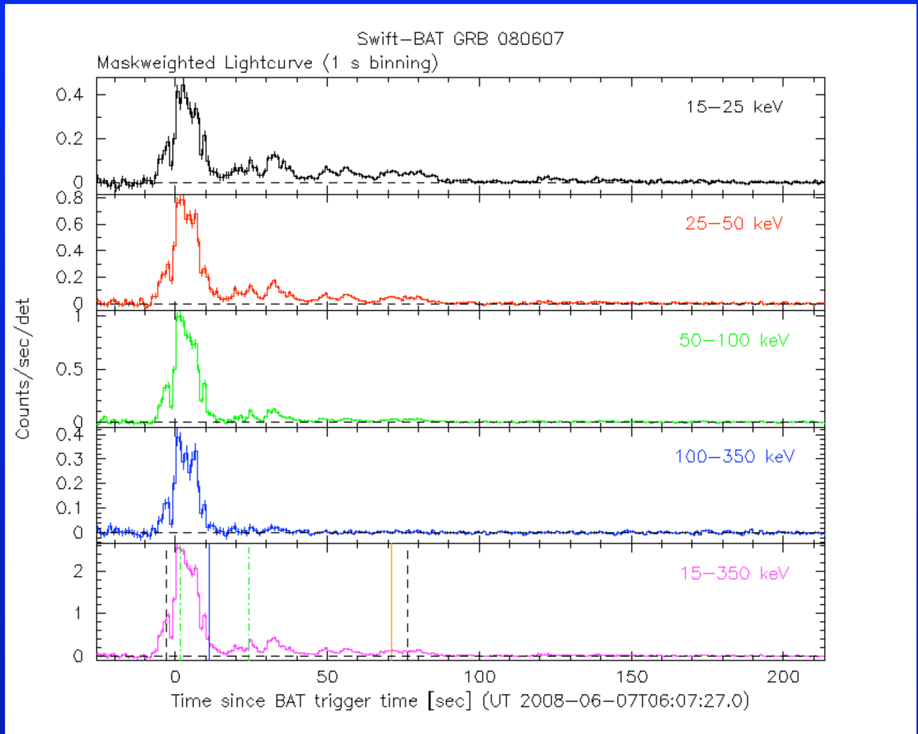
First AGILE/GRID GRB :
Localization Super AGILE+IPN

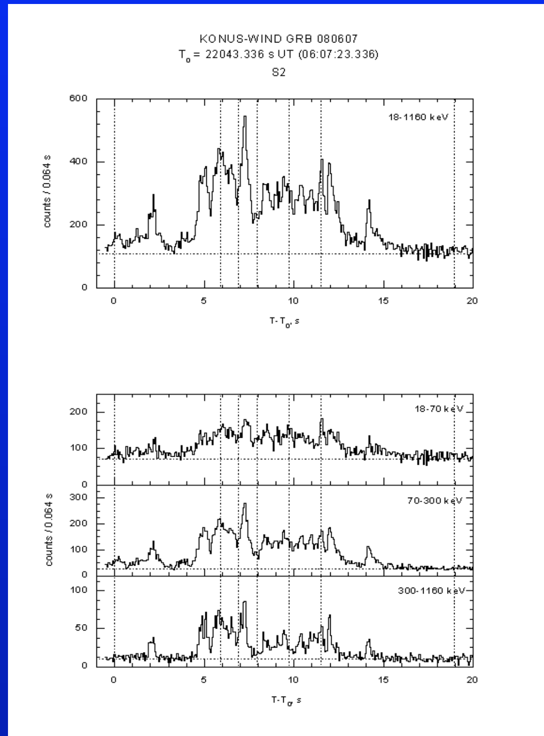
AG candidate
-de Ugarte Postido (0.8m IAC80)
-A. Rossi (GROND) z=1.8+0.4-0.3
-K.L. Page (Swift/XRT)

α=1.53+0.27-0.20 (>10h)
Γ=2.00+0.24-0.26
NH=(1.2+0.8-0.6)E21 cm^{-2}

KW + Suzaku/WAM

GRB 080607: BAT/KW/MCAL





T90~16 s

Fluence (20keV-4MeV) =8.9±0.5 E-5 erg cm^{-2}

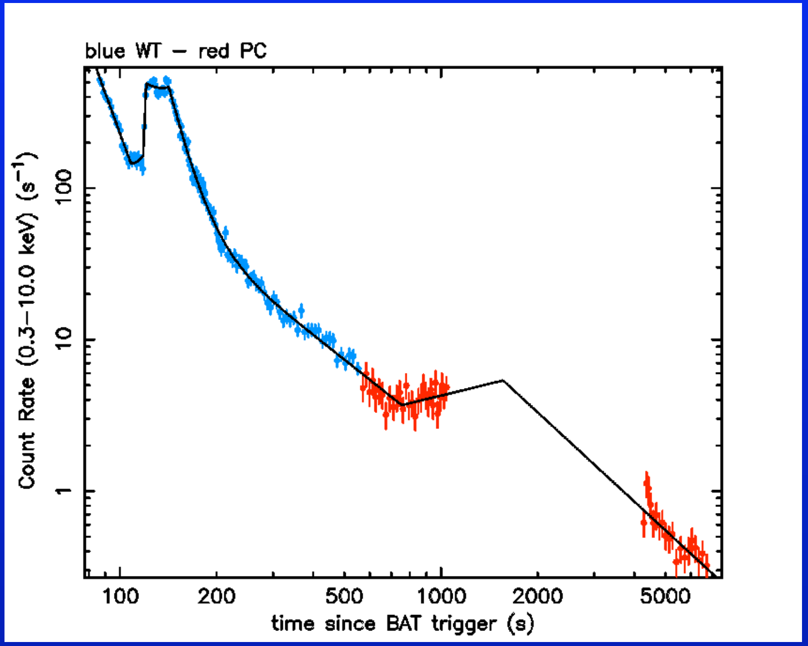
T90 (15-350keV) =79±5 s
Fluence(15-150keV)=2.4E-5 cgs
Γ=1.31±0.04

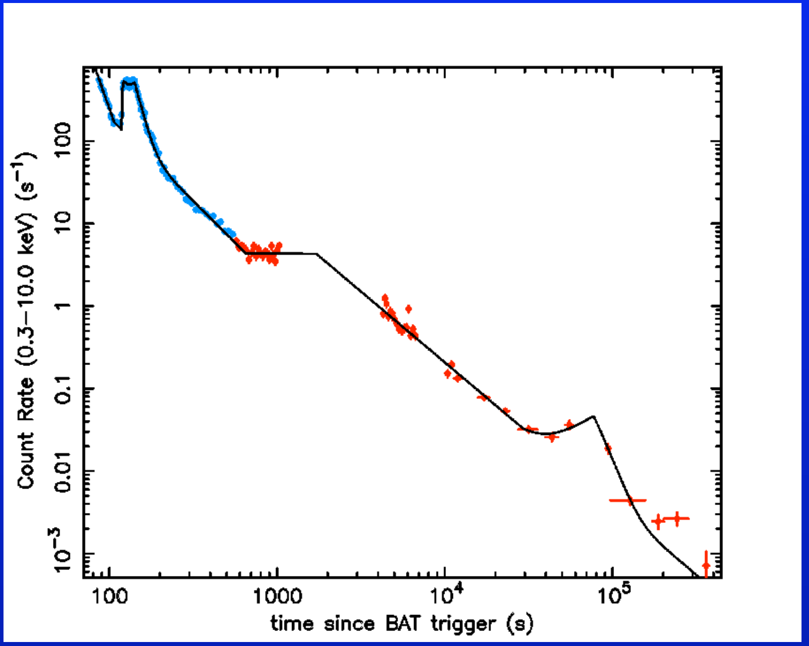
Optical z=3.036

Expo cutoff: α=-1.08(-0.06,+0.07)
Ep = 419(-38,+46) keV
Band: α= -1.06(-0.08+0.09), β < -2.28 Ep = 394(-54,+58) keV

E_{iso} = 1.87(-0.10, +0.11)E54 erg,
(L_iso)max = (2.27 +/- 0.46)E54 erg/s
Ep_rest ~1600 keV.

GRB 080607 – *Swift*/XRT





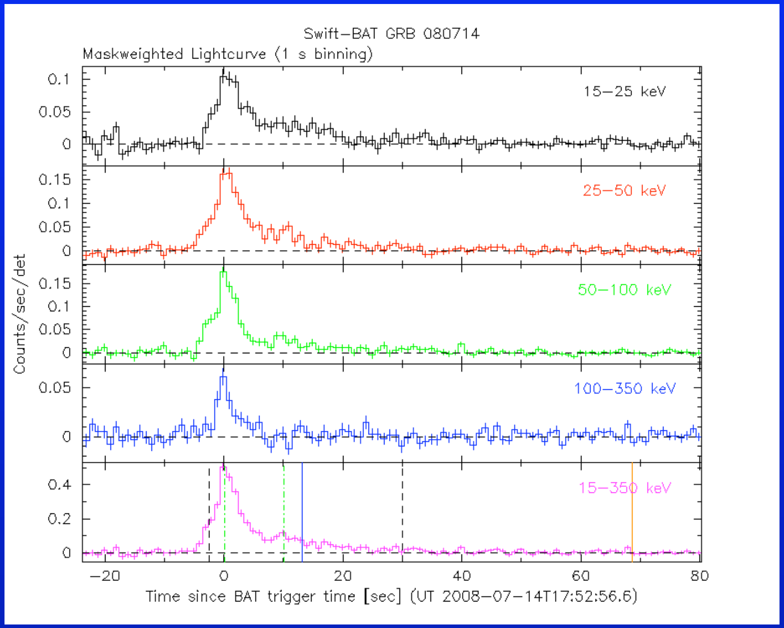
Sbarufatti et al in prep

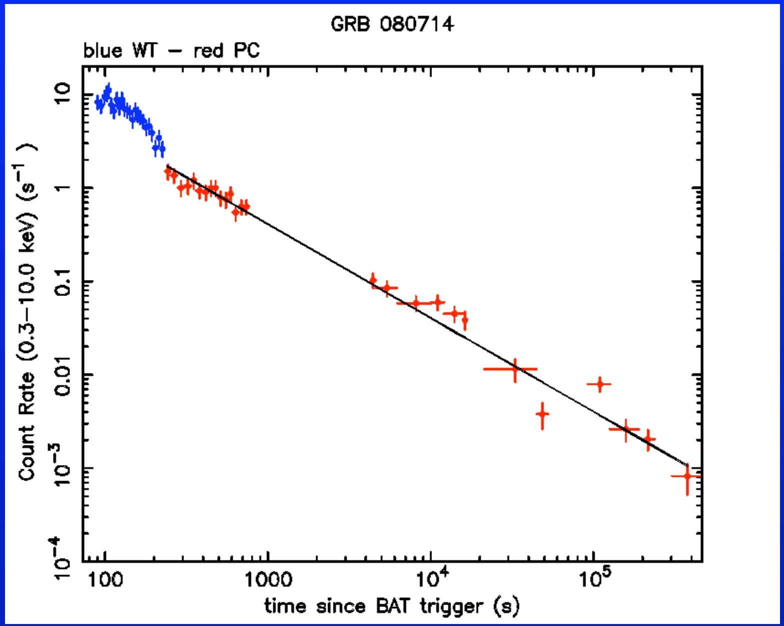
α1=5.8±0.4 α2=1.7±0.1
α3=0.5±1.3 α4=2.0±0.5

Γ(WT)=1.81±0.02 (>87s)
NH=(4.0±0.2)E22 cm^{-2} (z=3.04)
Γ(PC)=2.1±0.1

α1=5.80±0.01 tb1=107±1s
α2=2.02±0.04 tb2=670+10-25s
α3=-0.3±0.2 tb3=1590+167-100s
α4=1.69±0.04

GRB 080714 BAT/KW/SPIACS





T90 (15-350keV) =33±9 s
Fluence(15-150keV)=2.5E-6 cgs
Γ=1.52±0.08

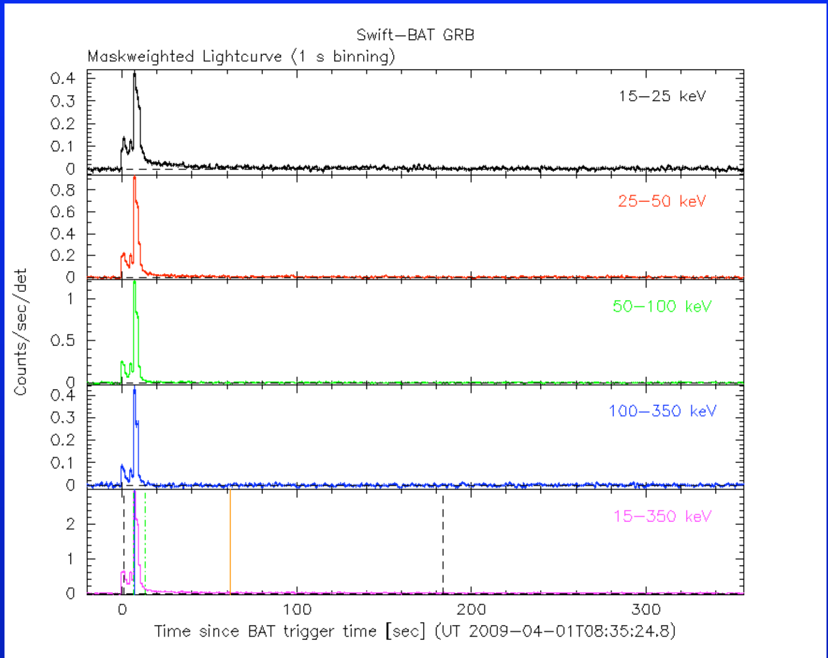
KW T90~20s 20keV-1MeV
Fluence=3.64(-0.60,+0.87)E-6 erg/cm2
Expo cutoff: α= -1.24(-0.39,+0.46)
Ep = 137(-34,+100) keV

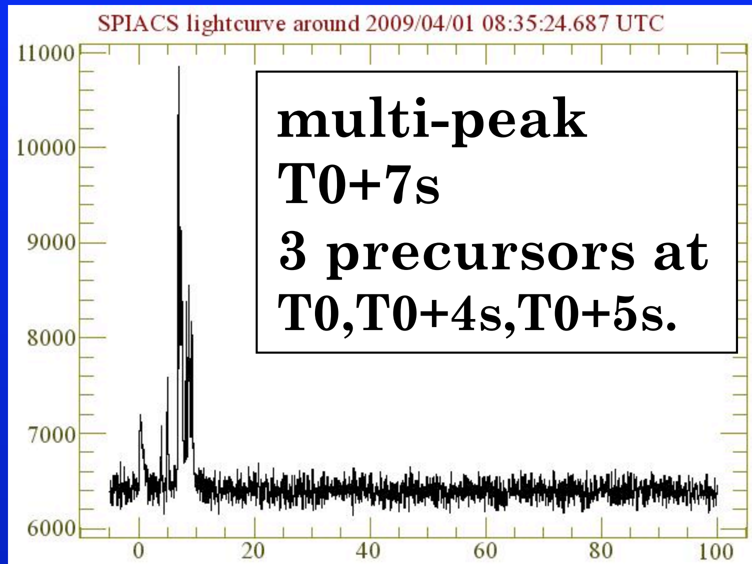
α=1.00±0.03 (>88s)

Γ=1.14±0.05 (WT)
N_H=(0.3±0.1)E22 cm^{-2}

UVOT
GROND

GRB 090401B BAT/KW/WAM/ACS/MCAL/GRID/SPIACS





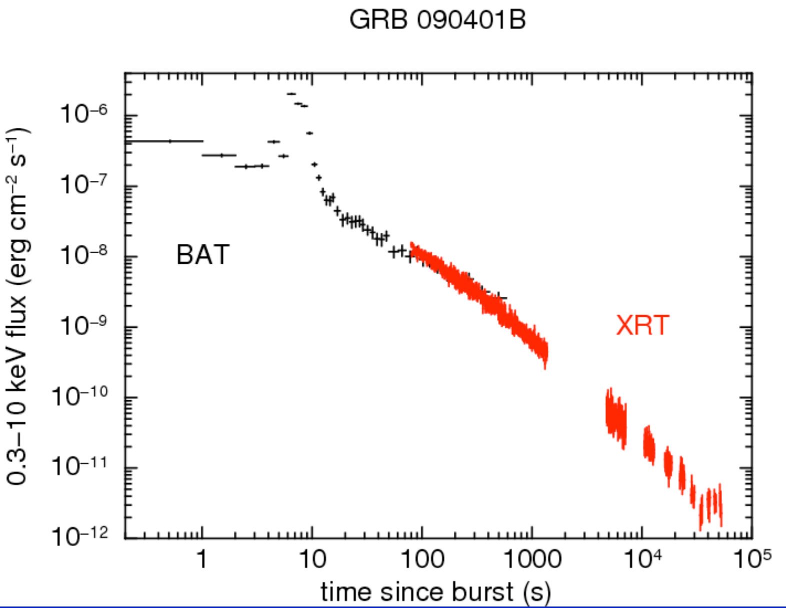
T90 (15-350keV) =112±15 s
Fluence(15-150keV)=1.1E-5 cgs
Γ=1.70±0.05

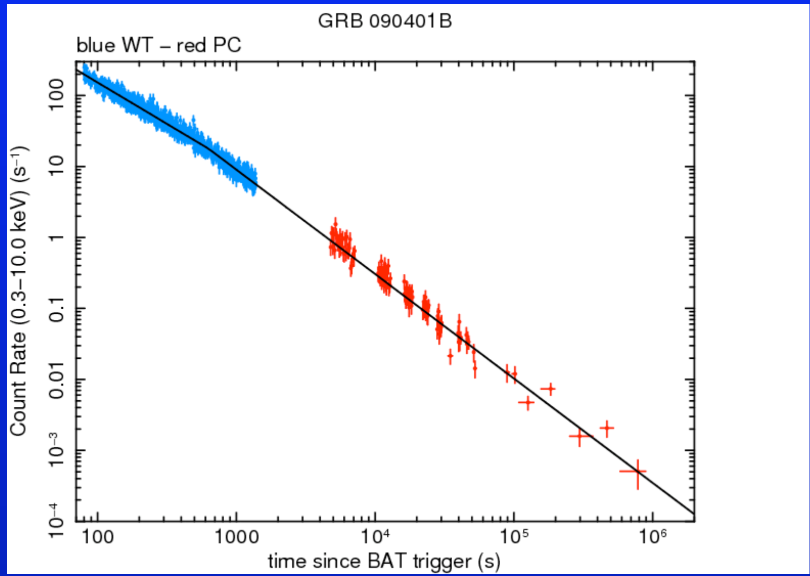
AGILE/ACS + MCAL
> 2.8MeV
GRID: > 30 MeV

KW T90~11s 20 keV-10 MeV
Fluence=6.25(-0.75,+0.78)E-5 erg/cm2
Band: α= -0.78(-0.09,+0.11)
β=-2.14(-0.23,+0.15)
Ep = 409(-60,+66) keV

Suzaku/WAM 100 keV-1 MeV
T90~9s
Fluence=2.56(-0.11,+0.09)E-5 erg/cm2
PL: Γ= 2.22(-0.09,+0.10)

GRB 090401B *Swift*/XRT

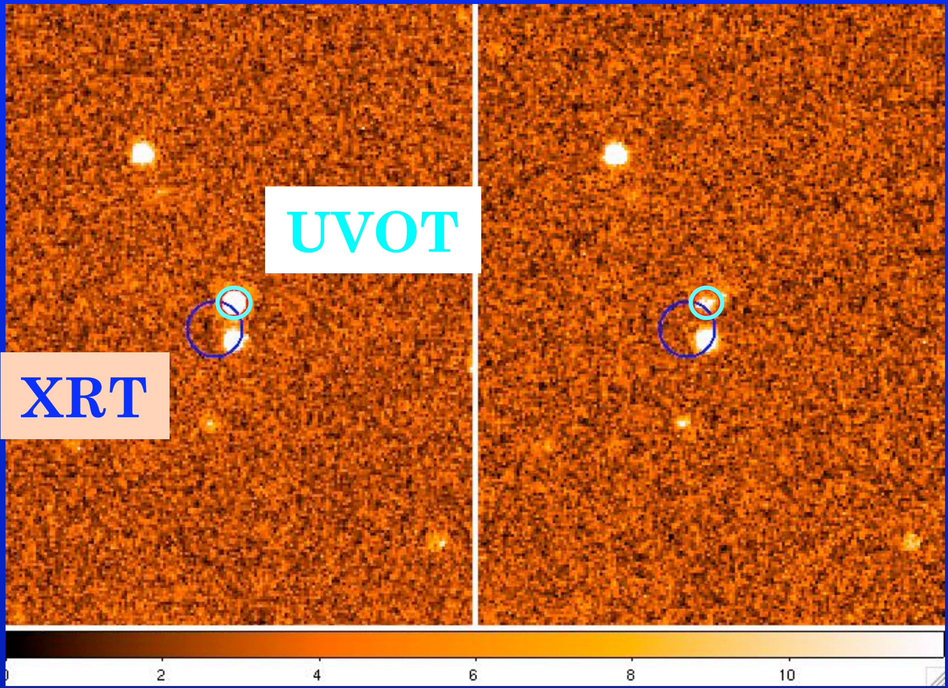


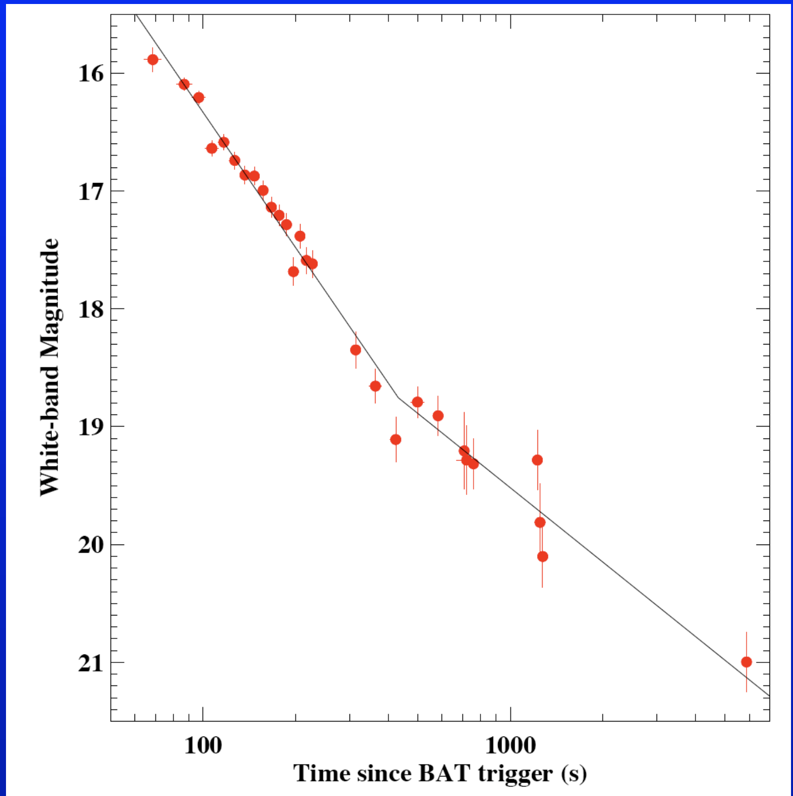


$\alpha 1 = 1.16 \pm 0.03$ $t_b = 574 + 141 - 92$s
$\alpha 2 = 1.47 \pm 0.02$

Γ(WT)=1.74±0.03 (>79s)
N_H=(3.68±0.12)E21 cm^{-2}
Γ(PC)=2.13±0.11
N_H=(4.4±0.5)E21 cm^{-2}

GRB 090401B *Swift*/UVOT





UVOT fading of 2 mag in ~800s

NOT (R~22.2±0.1 mag, 12.3h)

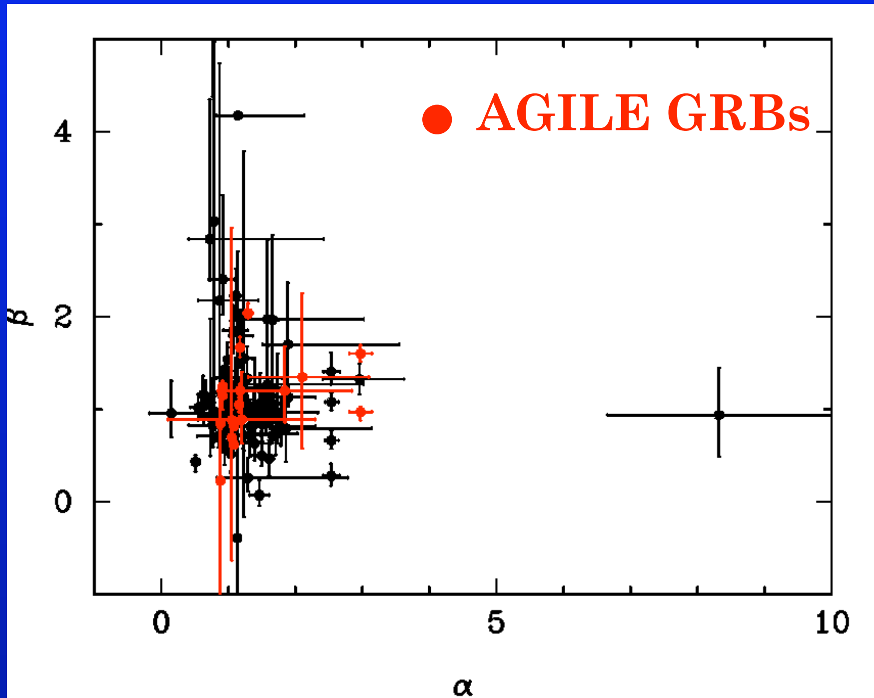
broken:

α1=1.54±0.04 t_b=423+52-25s

α2=0.83±0.09

Questions & Burst Properties

1) How many of these SA burst have a HE counterpart?
2) Can they be used to constrain the current models for HE emission?
3) How do the properties of the X-ray afterglow of the AGILE GRBs compare with the Swift GRBs?



Decay slope $\alpha = 1.20 \pm 0.03$

Spectral index $\beta = 0.97 \pm 0.04$

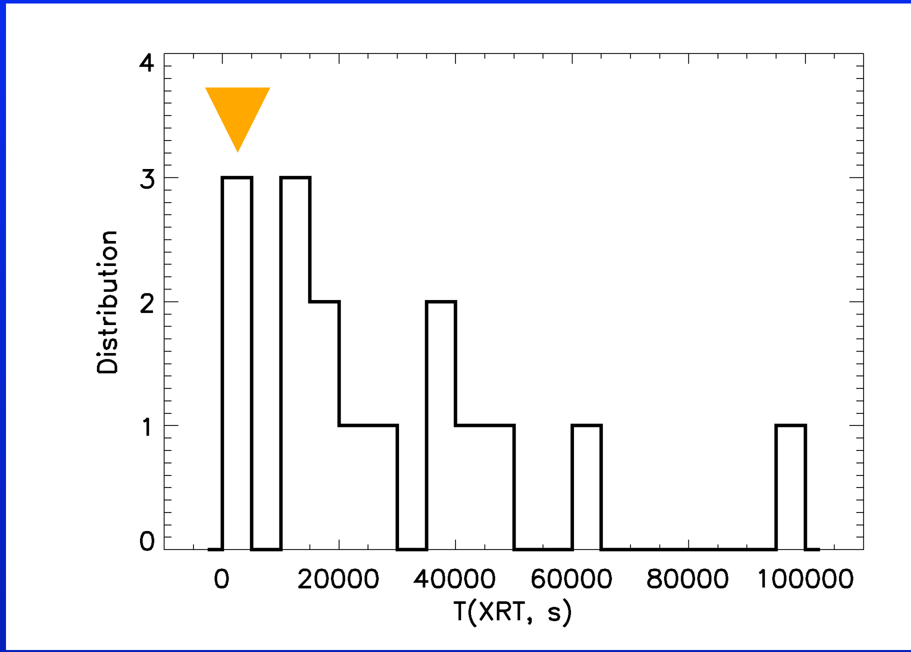
Comparison with a large sample of GRBs (318) in Evans et al 2009 (arXiv:0812.3662)

INDISTINGUISHABLE

How to improve your Swift experience

Start of Swift NFI observations

T(XRT) = [79,88],
[13400,109200] s



Current Swift Policy:
we perform observations
as soon as we become
aware of the AGILE trigger:

PI or ODS *reads* AGILE GCN = human intervention

Fastest response if arcmin position communicated as soon as available and ToO request submitted

High priority ToO (p2, response in hours to a day)

http://www.swift.psu.edu/too.html will page PI and ODS

Immediate response, unless Swift high-priority new GRB observations underway or during sleeping hours

If AGILE burst exceptional:

-especially bright or

-with strong high energy emission (GRID)

a highest priority ToO (p1, response in < 4 hours)

will wake PI and ODS up

should not be abused ☺

The End

(with many thanks to P. A. Evans
and the Swift BAs & BSs)