GRB 190919B

Rapid optical rise explained as a flaring activity

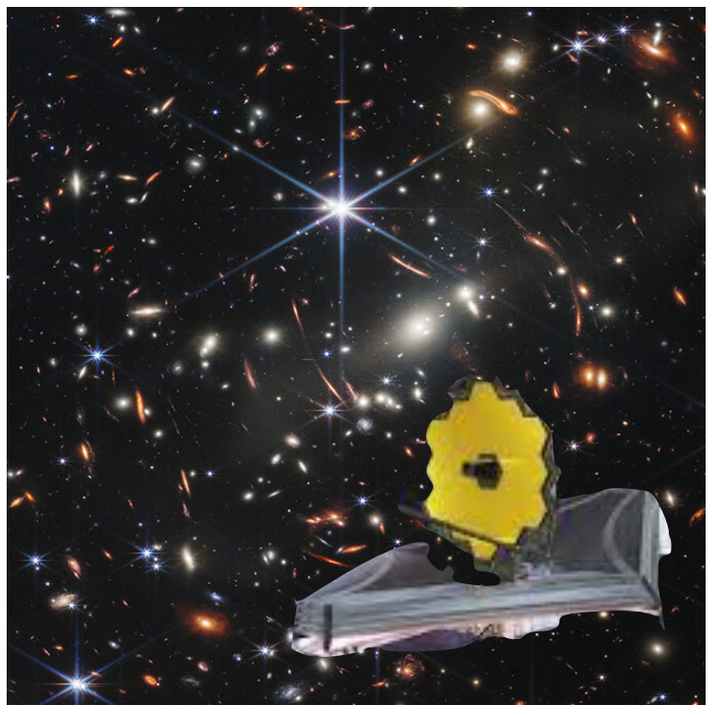
GRB-V conference @ Trieste, 12.9.2022

Martin Topinka IASF/INAF

based on A&A, Vol. 662, A126 (2022)
arXiv: 2203.11059

optical follow-up X-ray & γ-rays

Martin Jelínek[1,⋆], Martin Topinka[2,3], Sergey Karpov[4], Alžběta Maleňáková[1,5], Y.-D. Hu (胡有栋)[6], Michela Rigoselli[2], Jan Štrobl[1], Jan Ebr[4], Ronan Cunniffe[4], Christina Thoene[1], Martin Mašek[4], Emilio Fernandez-García[6], David Hiriart[7], William H. Lee[8], Stanislav Vítek[9], René Hudec[1,9], Petr Trávníček[4], Alberto J. Castro-Tirado[6], and Michael Prouza[4]

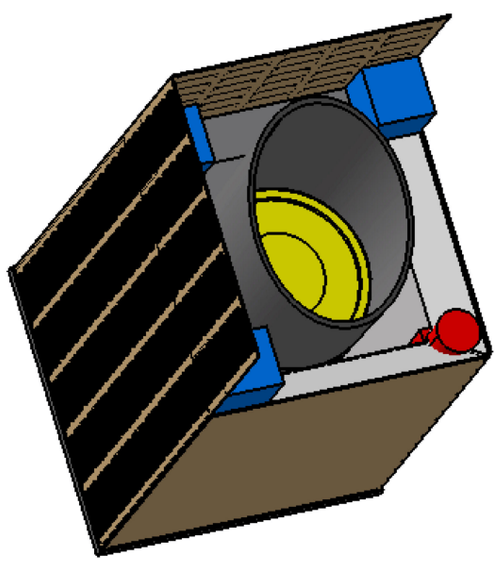


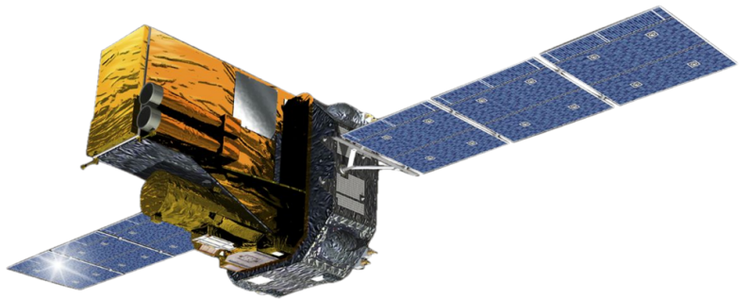
Menu of the day

GRB190919B

- prompt
- afterglow
- late flare?

Bonus: QUVIK announcement





Prompt

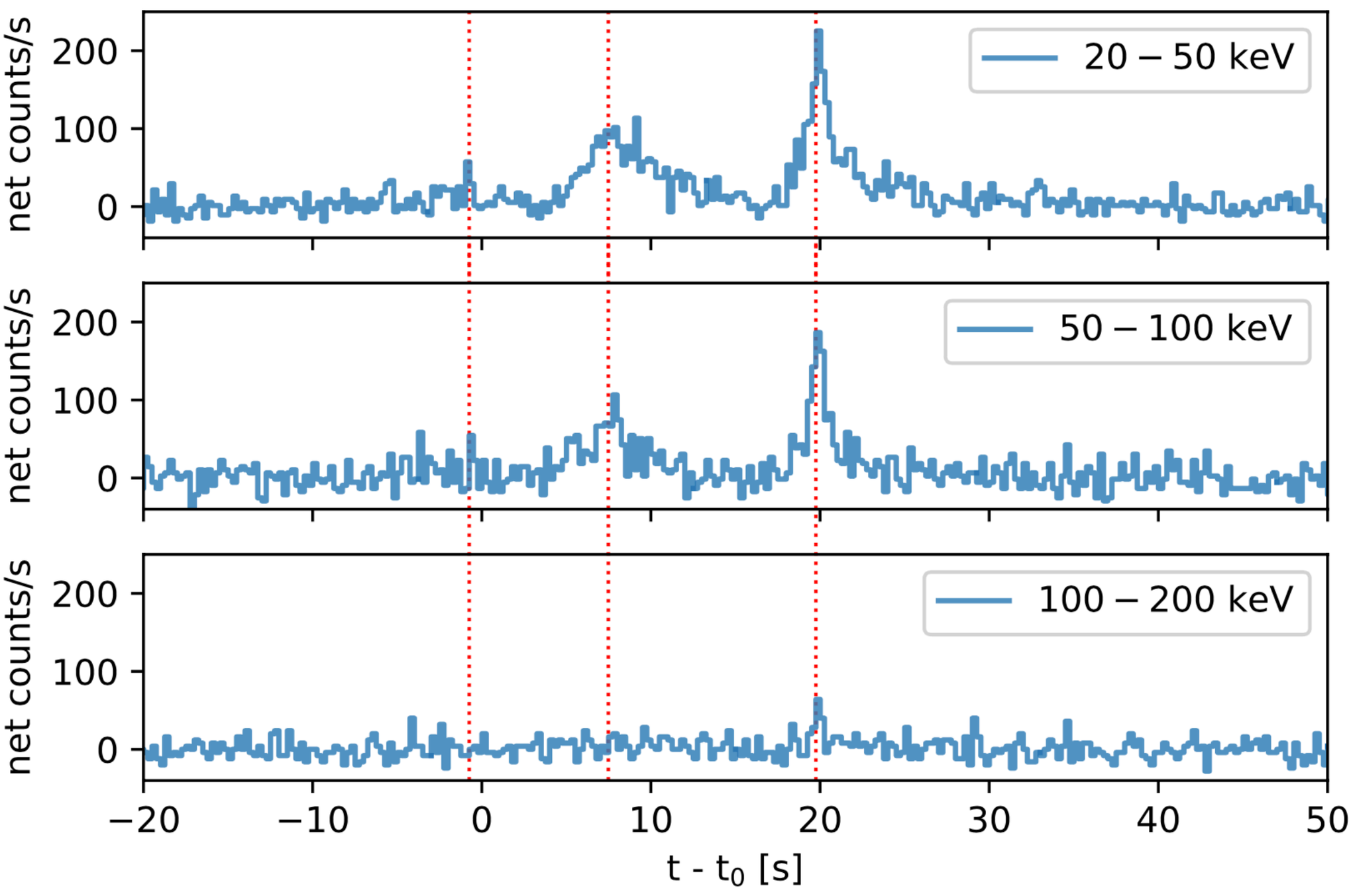
1.5’ localisation within 34.6s

$\alpha = 20{:}47{:}30.615 \quad \delta =$ -44:41:43.03

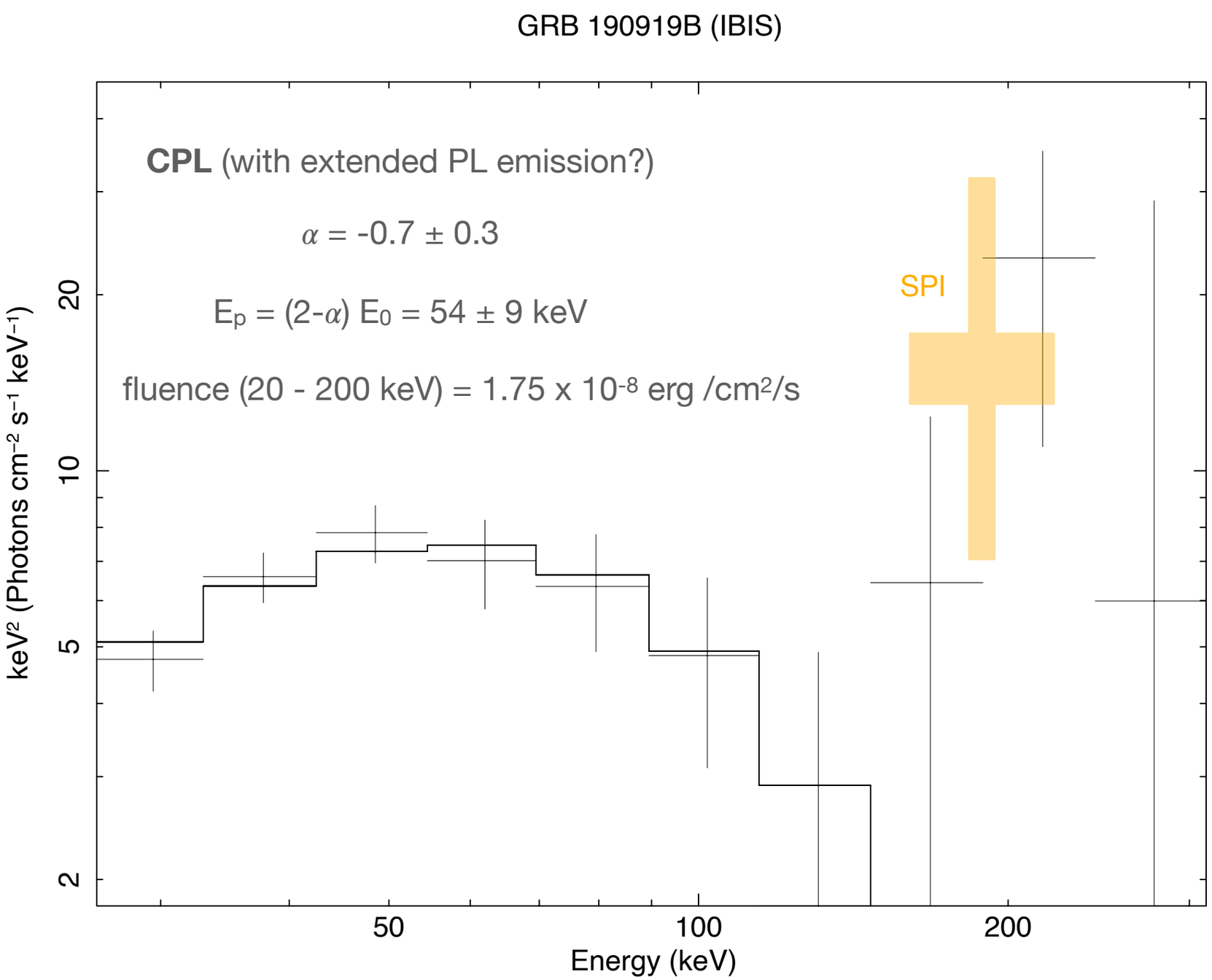
8.9° off-axis

IBIS 🟢 SPI 🟡 JEM-X 🚫 OMC 🚫)

T_{90} = 28.5 ± 0.6 s



faint, soft, long GRB

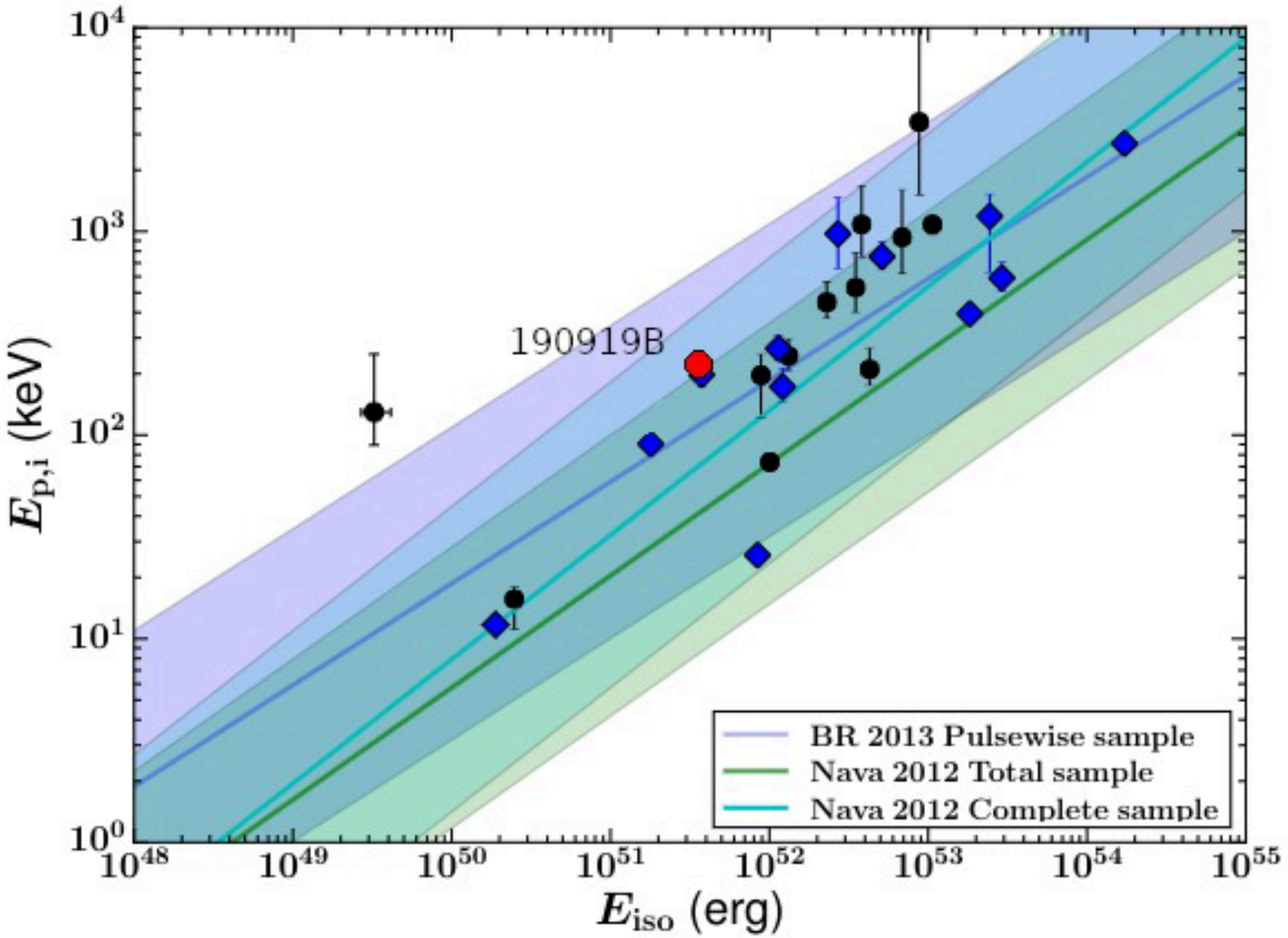


no spectral lag
in either of the bright pulses
(upper limit <150 ms)

VLT/X-shooter (Chile)
z = 3.225 (Pugliese et al. 2019)
4.87 h after the burst

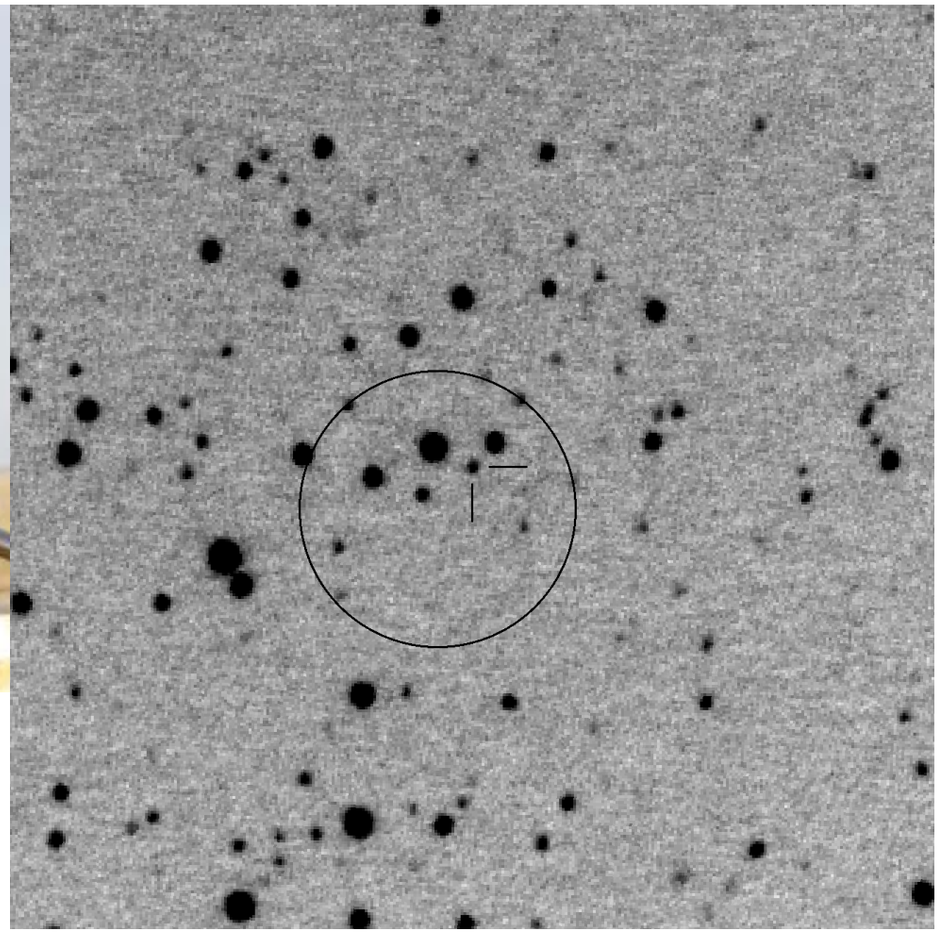
$E_{iso} = 3.6 \times 10^{51}$ erg

Amati relation



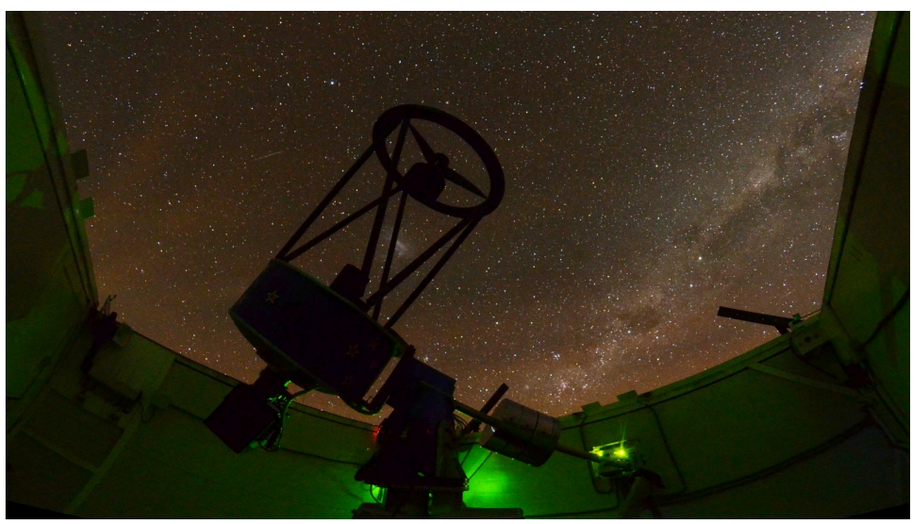
Follow-up

FRAM (Argentina) 53.5 s after the burst

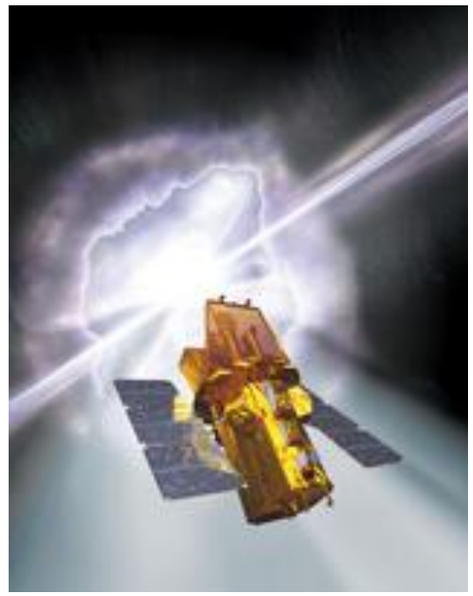


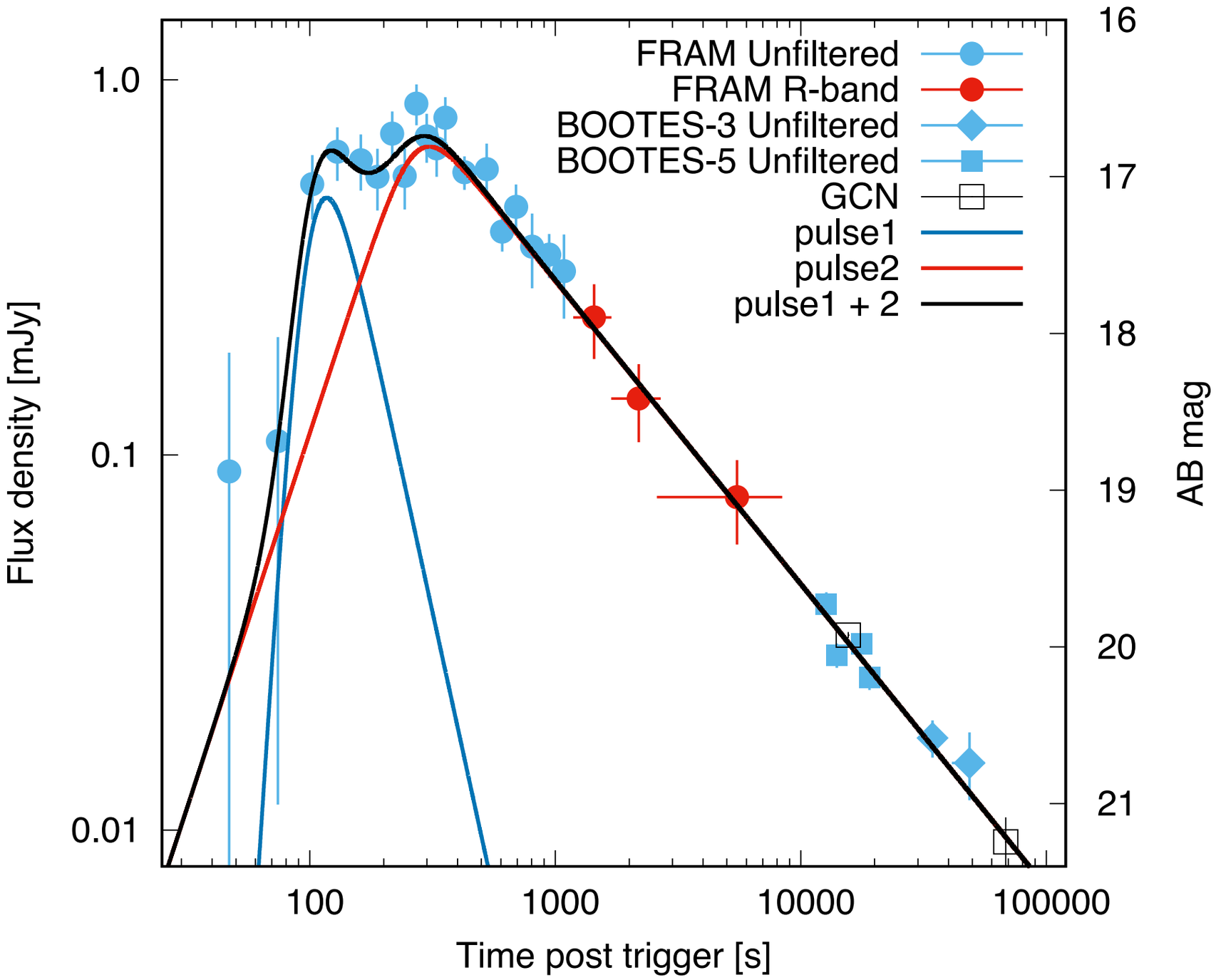
BOOTES-5 (Mexico) 3.33 h after the burst

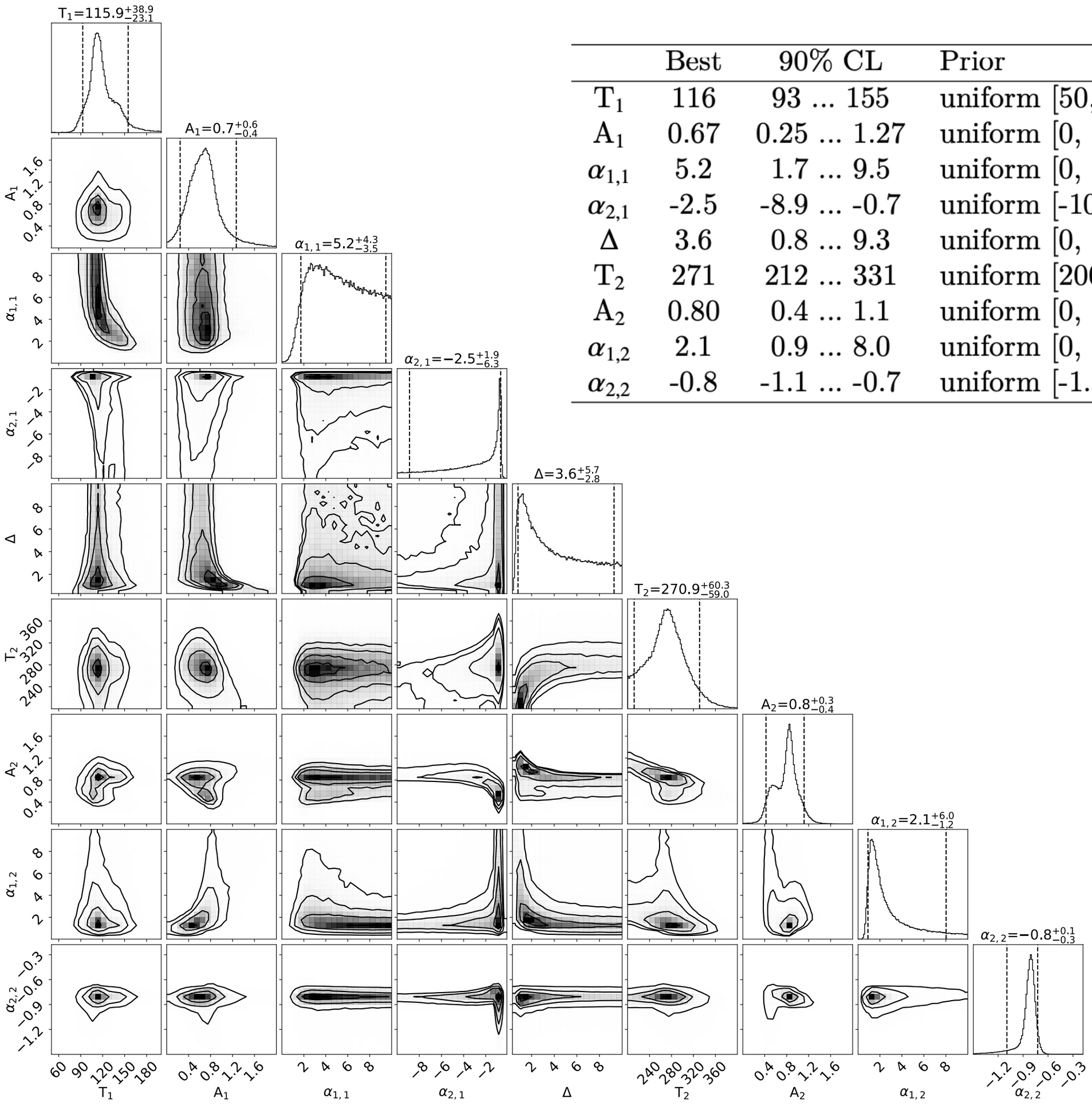
BOOTES-3 (New Zealand) 9 h after the burst



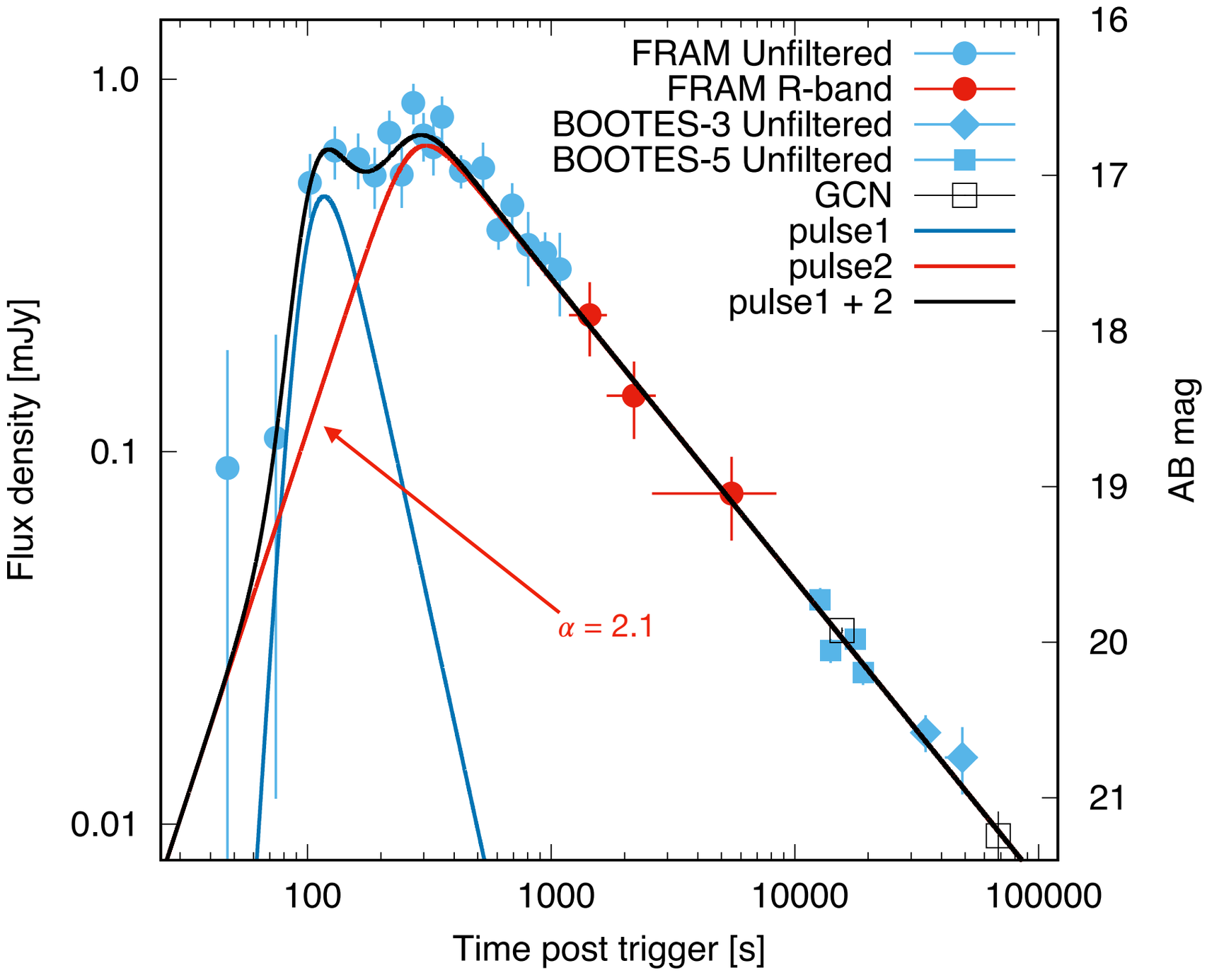
SWIFT ~ 30 ks (128 ks) after the burst

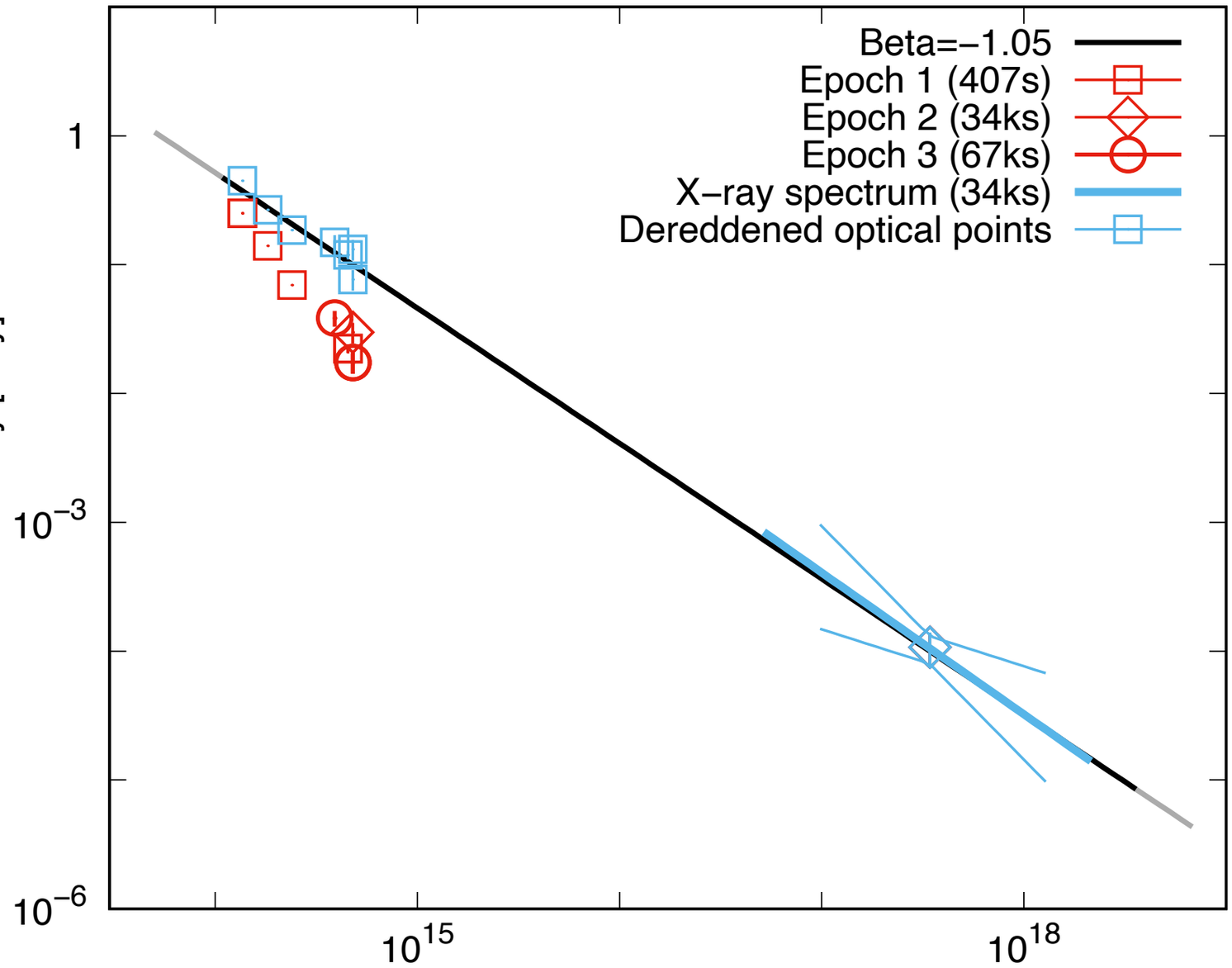



FRAM Unfiltered
FRAM R-band
BOOTES-3 Unfiltered
BOOTES-5 Unfiltered
GCN
pulse1
pulse2
pulse1 + 2
Flux density [mJy]
1.0
0.1
0.01
AB mag
16
17
18
19
20
21
100
1000
10000
100000
Time post trigger [s]



	Best	90% CL	Prior
T_1	116	93 ... 155	uniform [50, 200]
A_1	0.67	0.25 ... 1.27	uniform [0, 2]
$\alpha_{1,1}$	5.2	1.7 ... 9.5	uniform [0, 10]
$\alpha_{2,1}$	-2.5	-8.9 ... -0.7	uniform [-10, 0]
Δ	3.6	0.8 ... 9.3	uniform [0, 10]
T_2	271	212 ... 331	uniform [200, 400]
A_2	0.80	0.4 ... 1.1	uniform [0, 10]
$\alpha_{1,2}$	2.1	0.9 ... 8.0	uniform [0, 10]
$\alpha_{2,2}$	-0.8	-1.1 ... -0.7	uniform [-1.5, 0]


FRAM Unfiltered
FRAM R-band
BOOTES-3 Unfiltered
BOOTES-5 Unfiltered
GCN
pulse1
pulse2
pulse1 + 2
α = 2.1
Flux density [mJy]
AB mag
Time post trigger [s]
1.0
0.1
0.01
16
17
18
19
20
21
100
1000
10000
100000

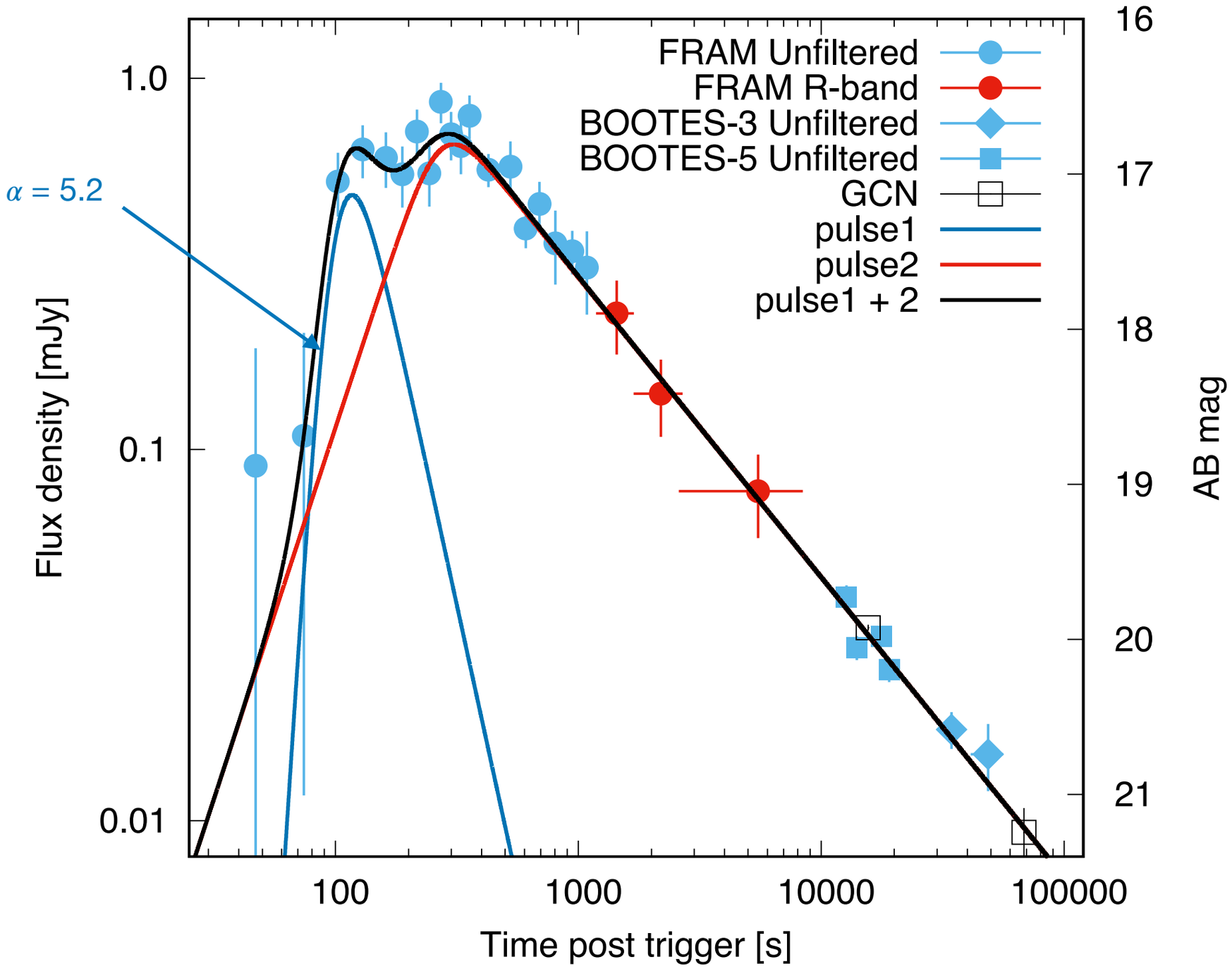


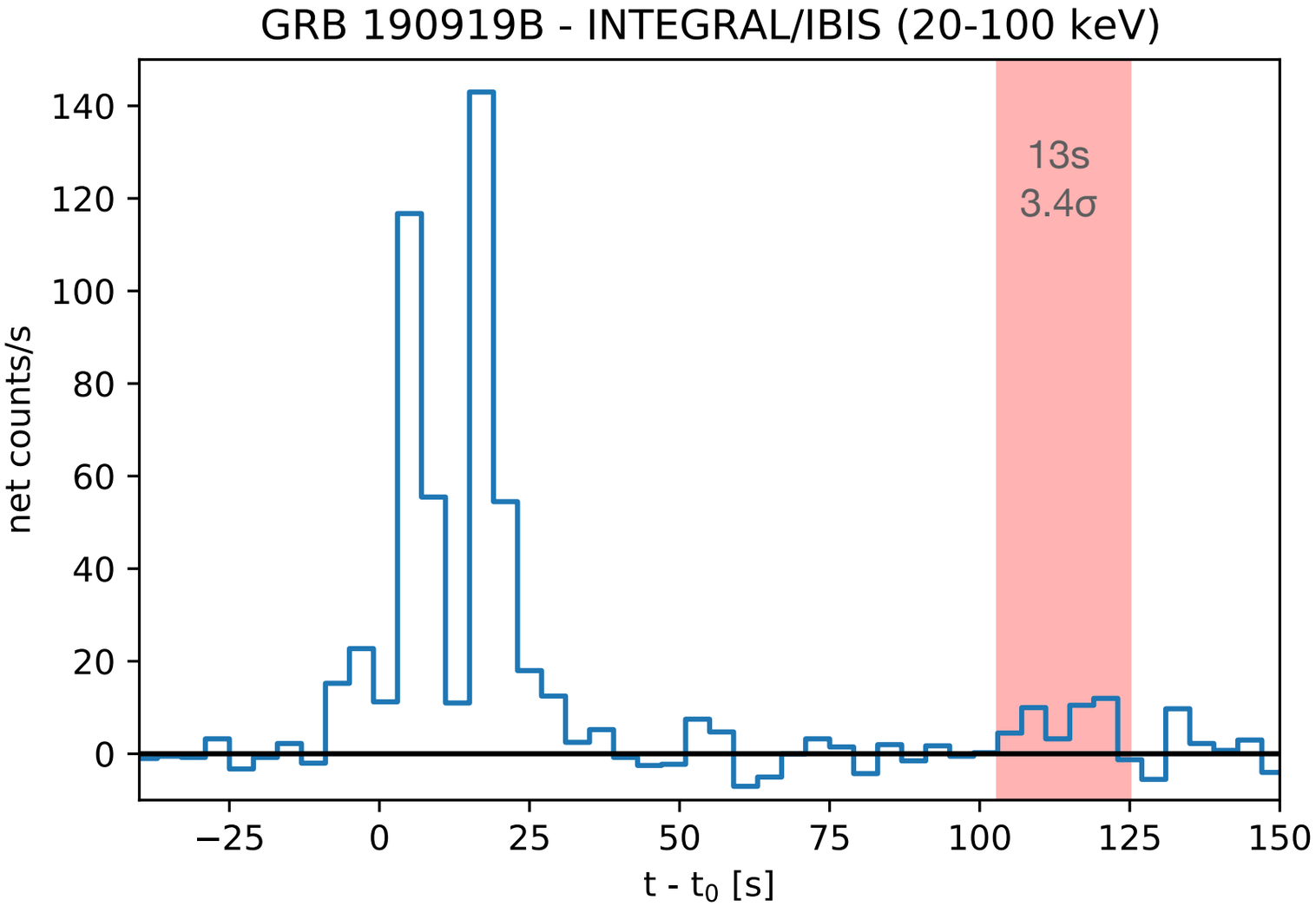
Afterglow "closure relation" $\beta = 2\alpha/3 + 1/2 = 1.05$

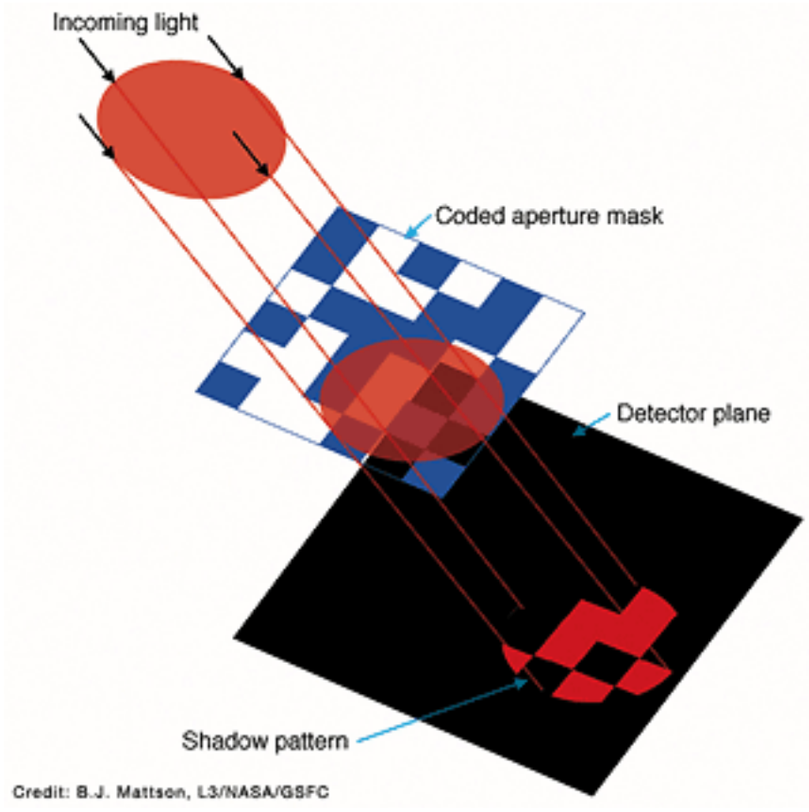
$\alpha = 3(1-p)/4 \Rightarrow p = 2.08 \pm 0.13$

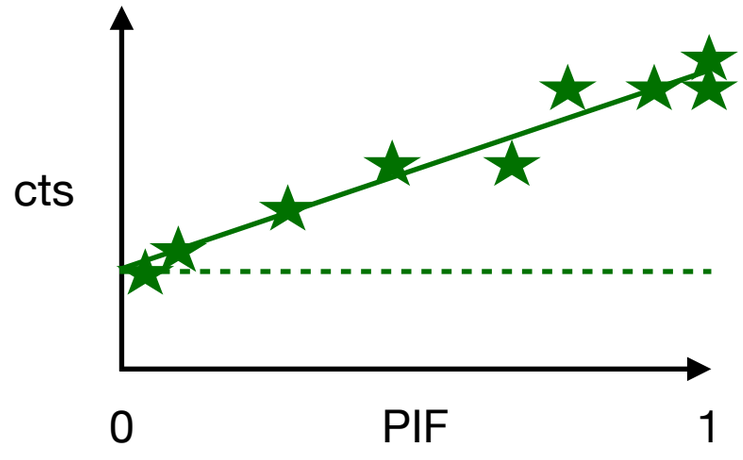
Swift XRT $\beta_X = 1.1$ agrees with $\beta = p/2$

with host extinction E(B-V)host = 0.28 => $\beta = 1.05$


FRAM Unfiltered
FRAM R-band
BOOTES-3 Unfiltered
BOOTES-5 Unfiltered
GCN
pulse1
pulse2
pulse1 + 2
α = 5.2
Flux density [mJy]
AB mag
1.0
0.1
0.01
16
17
18
19
20
21
100
1000
10000
100000
Time post trigger [s]

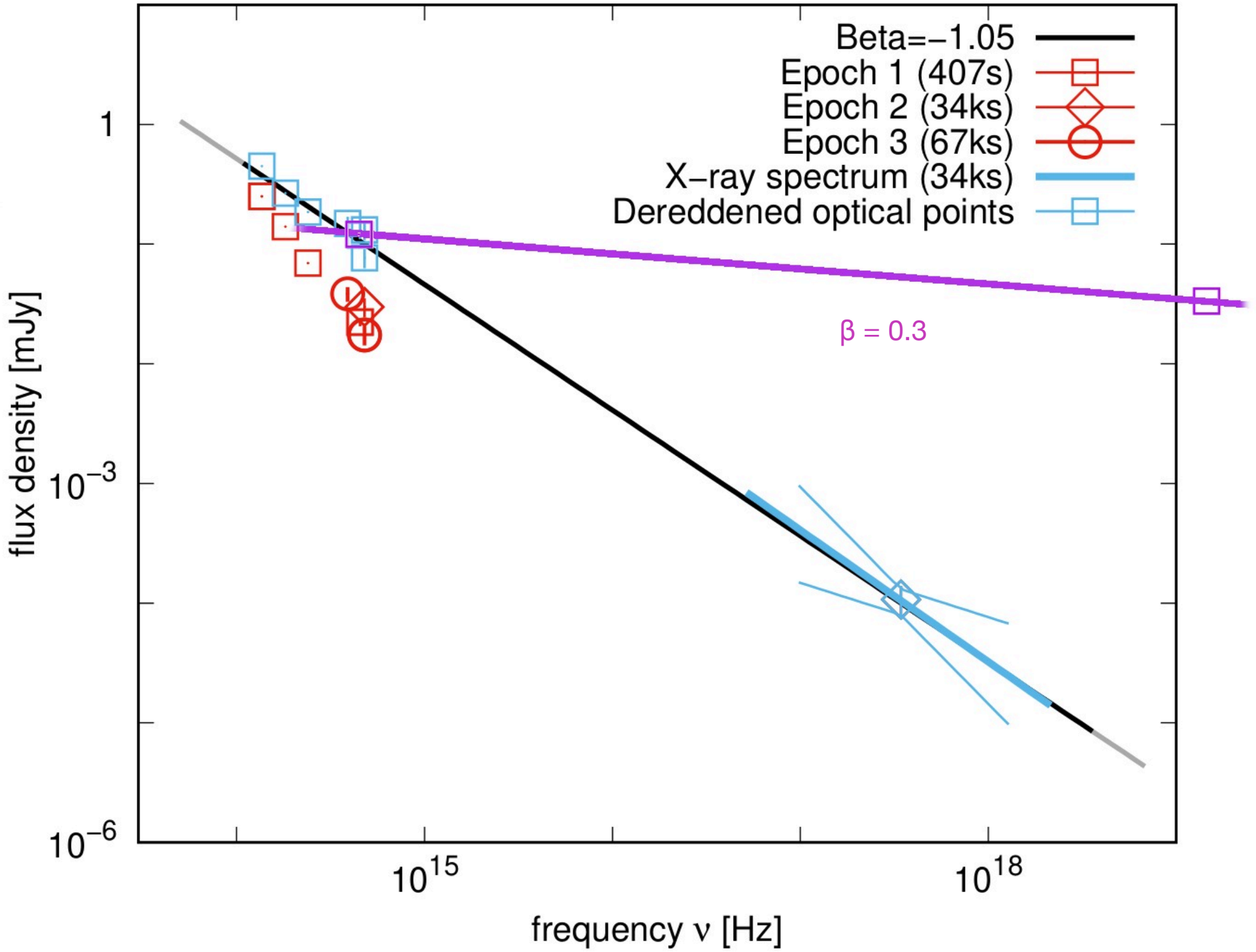






$S = \sqrt{(-2 \ln \lambda)}$, $\lambda = \mathcal{L}(b)/\mathcal{L}(s+b) = 3.11\sigma$ (2.96σ)

for comparison, S (GRB190919B) = 23.9σ
random empty 13s block = 0.06 — 0.10σ


Beta=−1.05
Epoch 1 (407s)
Epoch 2 (34ks)
Epoch 3 (67ks)
X−ray spectrum (34ks)
Dereddened optical points
β = 0.3
1
10^{-3}
10^{-6}
flux density [mJy]
10^{15}
10^{18}
frequency ν [Hz]

Discussion of α ~ 5.2 ± 0.6

& Conclusion

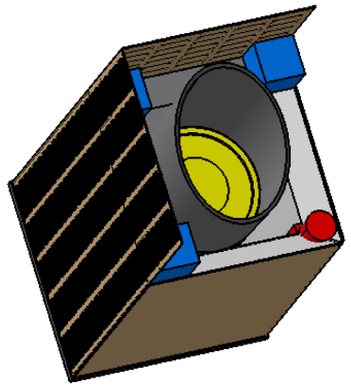
- $\Gamma_0 = 2\Gamma(t_{peak}) = 250$ <= $\Gamma(t_{\rm peak}) \approx 160 \left[\frac{E_{\gamma,53}(1+z)^3}{\eta_{0,2} n_0 t^3_{\rm peak,2}} \right]^{1/8}$
- hydrodynamical RS: α = +3 or α = +4

- Reverse Shock Emission in Gamma-Ray Bursts Revisited, He Gao & P. Mészáros (2015)
  reverse shock, extremely thick shell α_{11} = +6
  not match with the expected FS α_{21} = +1/2, RS α_{12} = -1/2

- earlier onset t_0
  no emission at $t_0 < 0$ for (α_{11} = +3, either α_{11} = +4) found

- **ongoing activity of the internal engine, triggered before the t_0**

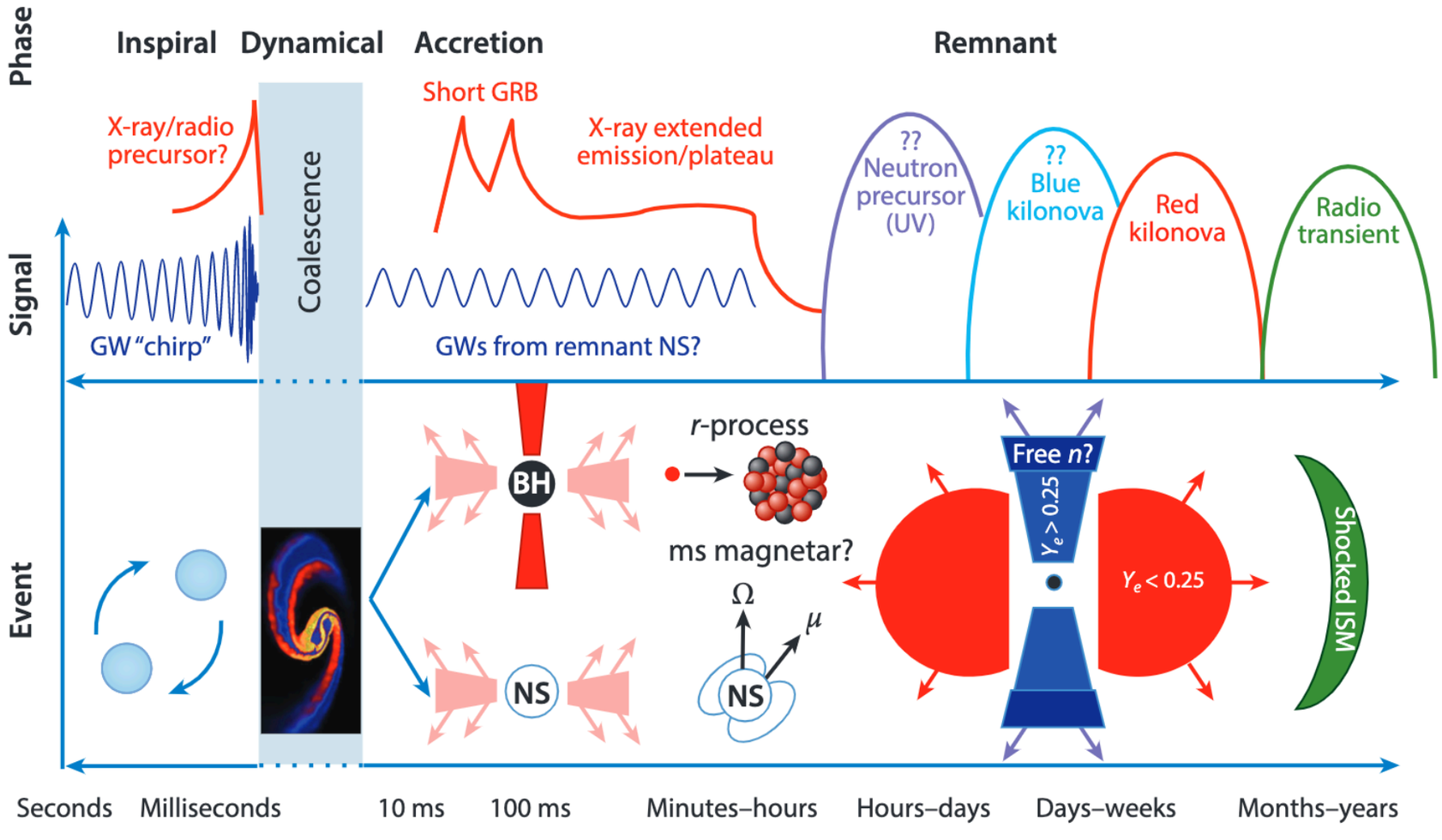
- XRF 071031 (Krühler et al. 2009), also β~0.3



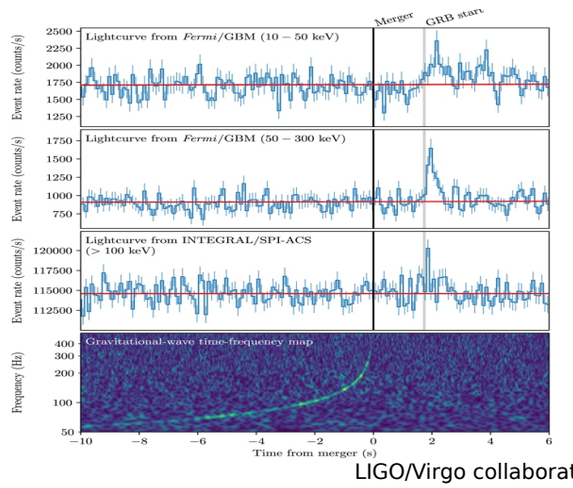
Bonus: QUVIK

Quick Ultra Vlolet Kilonova surveyor

Czech Aerospace Research Centre VZLU (prime), Masaryk University (science PI),
TOPTEC at the Institute for Plasma Physics, CAS (telescope), PEKASAT (communication)



GW170817/GRB170817A



LIGO/Virgo collaboration 18; Abbott+ 17

The kilonova was detected 11 hrs (15 hrs in UV) after the GW

Mission objectives

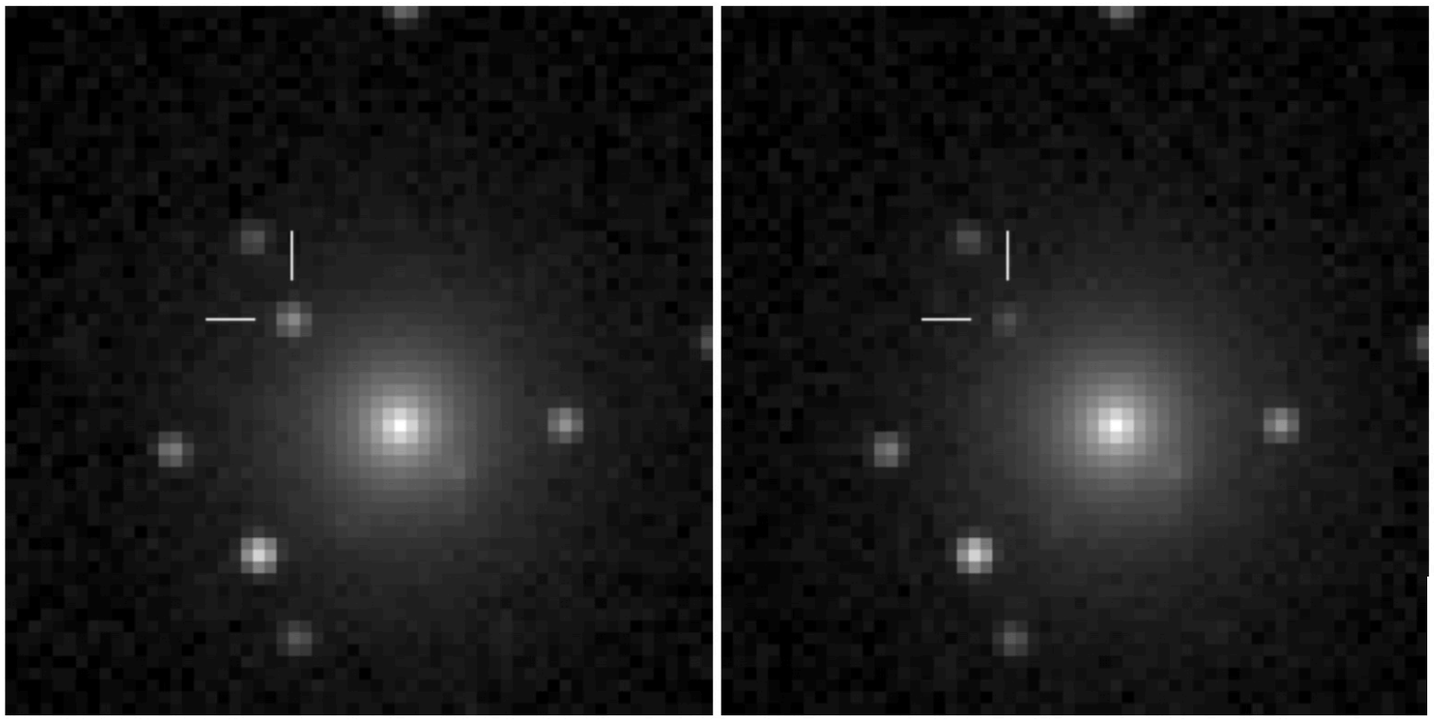
UV Space Telescope

- with a collecting area of at least 200 cm^2
- NUV bands 240-400 nm
- fast repointing capability
- near real-time communication system
- supernovae, **GRB afterglows and flares**, AGN, TDEs, exoplanets, hot stars, star clusters etc

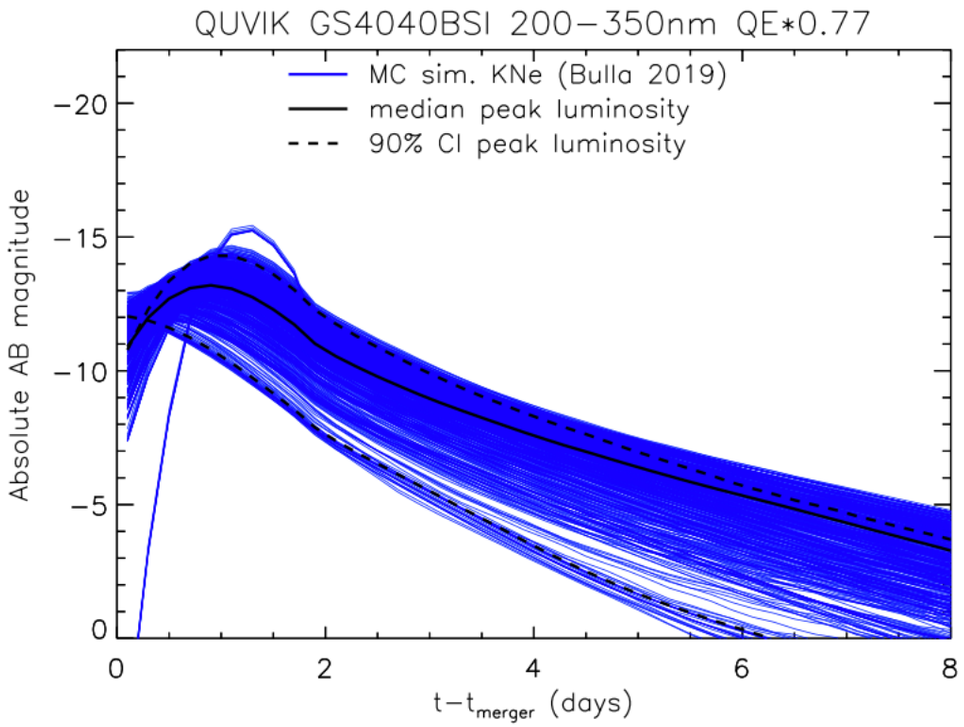
Simulated kn *QUVIK* NUV

At 100 Mpc

At 200 Mpc



- ~ 32 KN/year within 200 Mpc
- ~ AB lim. mag ~ 22
- ~ 60 GRB UV afterglows



Based on SWIFT catalog (Roming et al. 2015)