What are ultra-long GRBs? The case of GRB 130925A*

Phil Evans, Dick Willingale et al,

(on behalf of a large collaboration)

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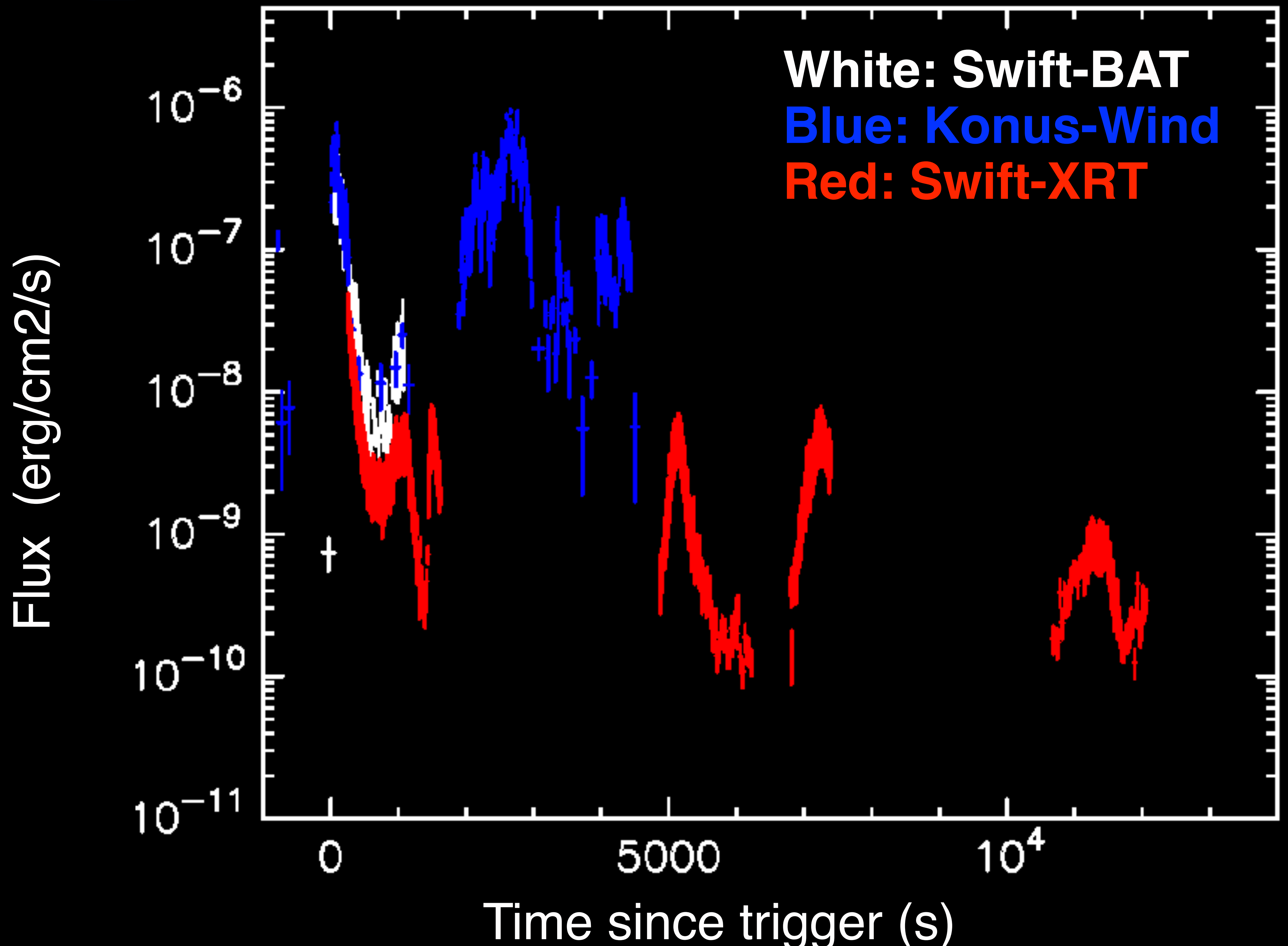
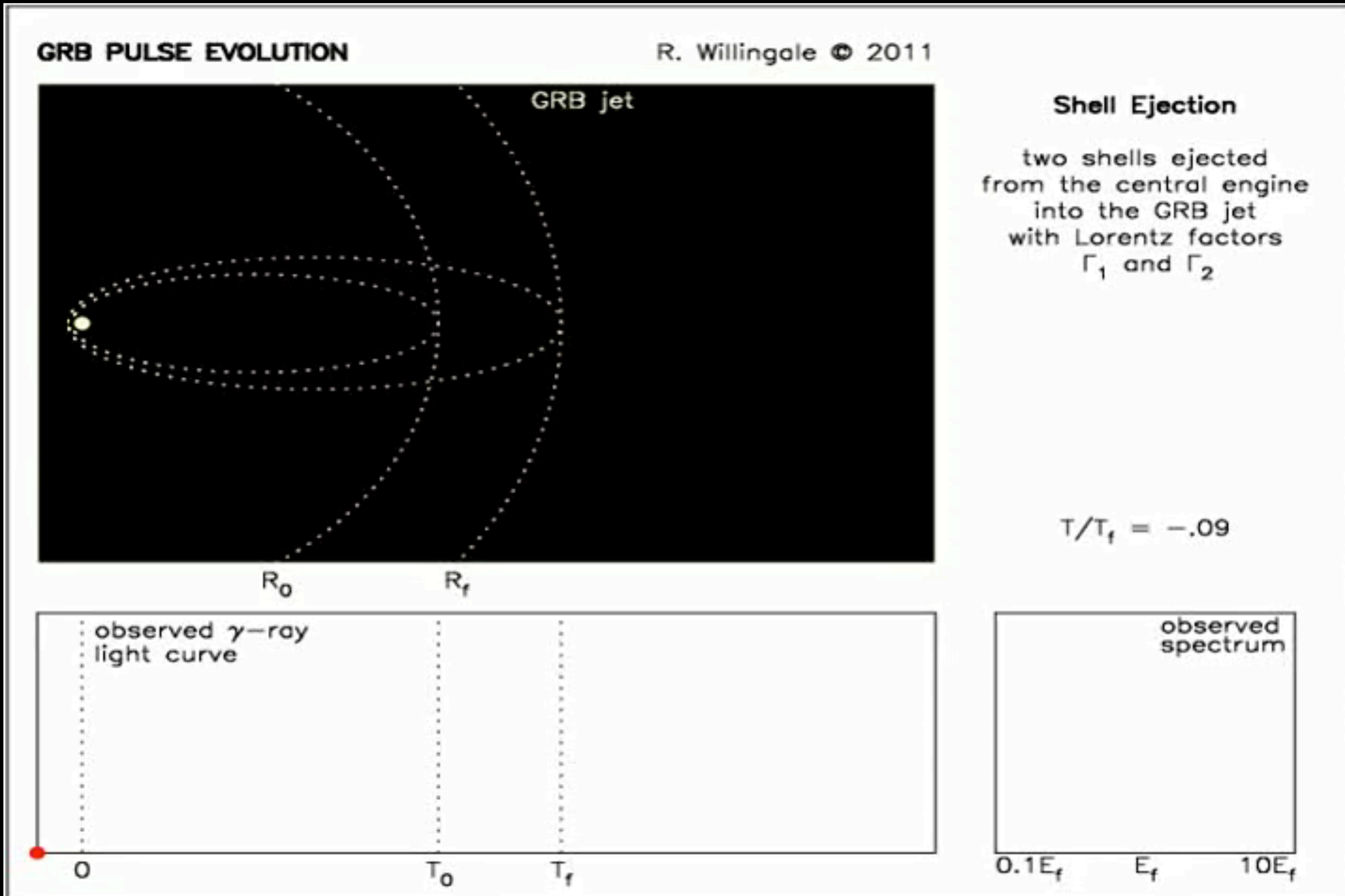
* *Nearly* a year on….

Ultra-long prompt emission



Fitting the prompt emission



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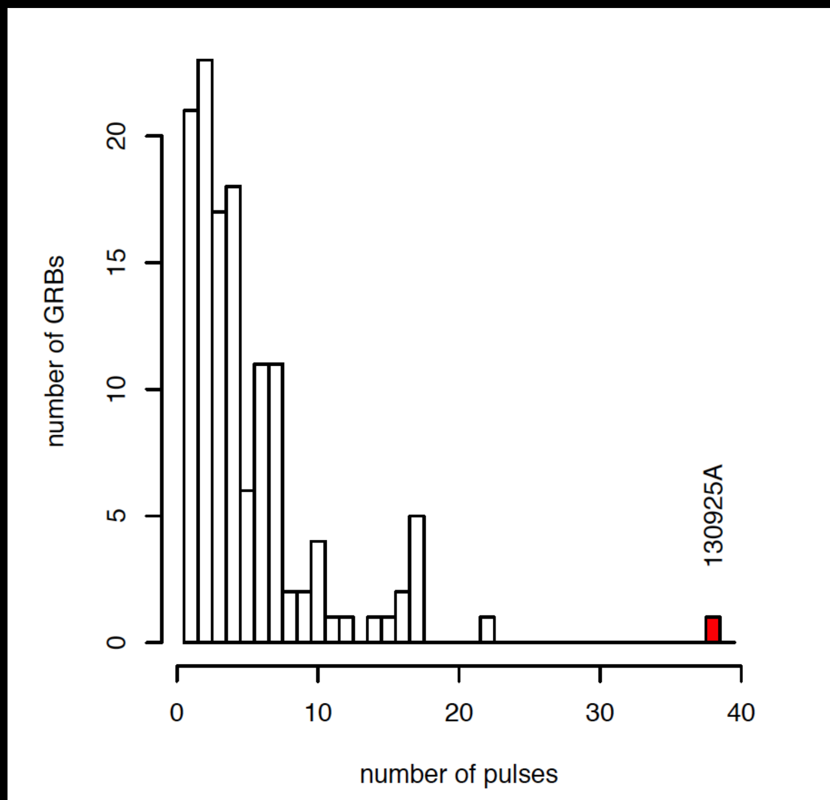

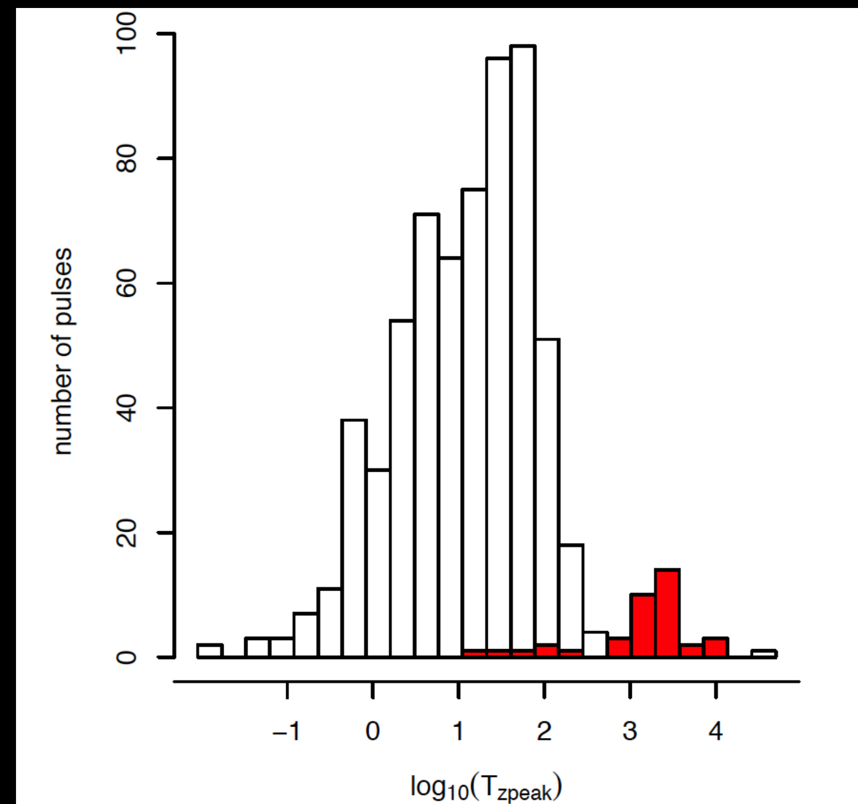

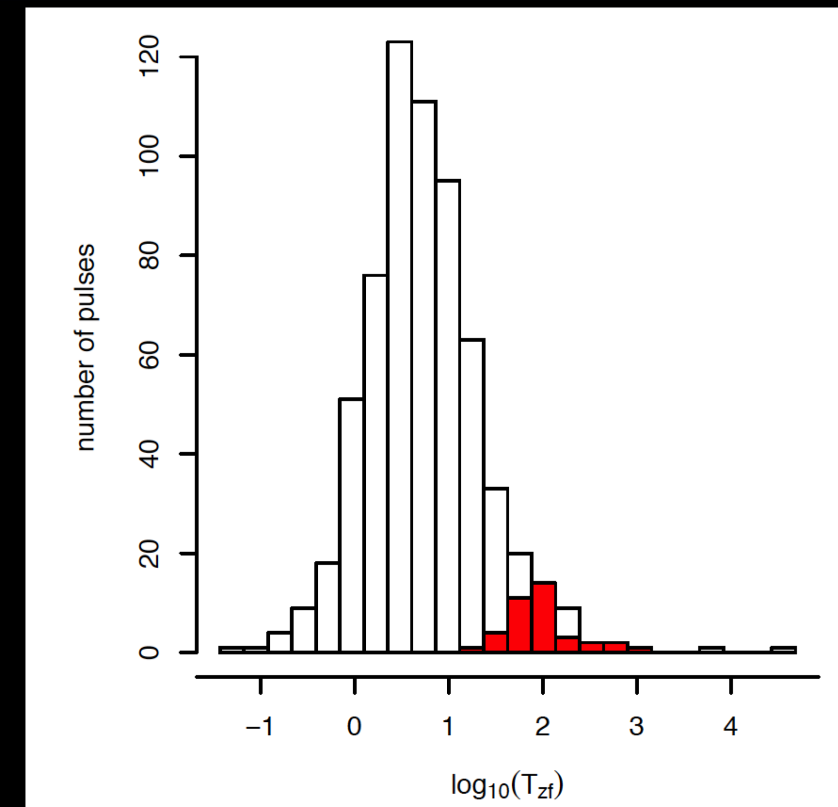

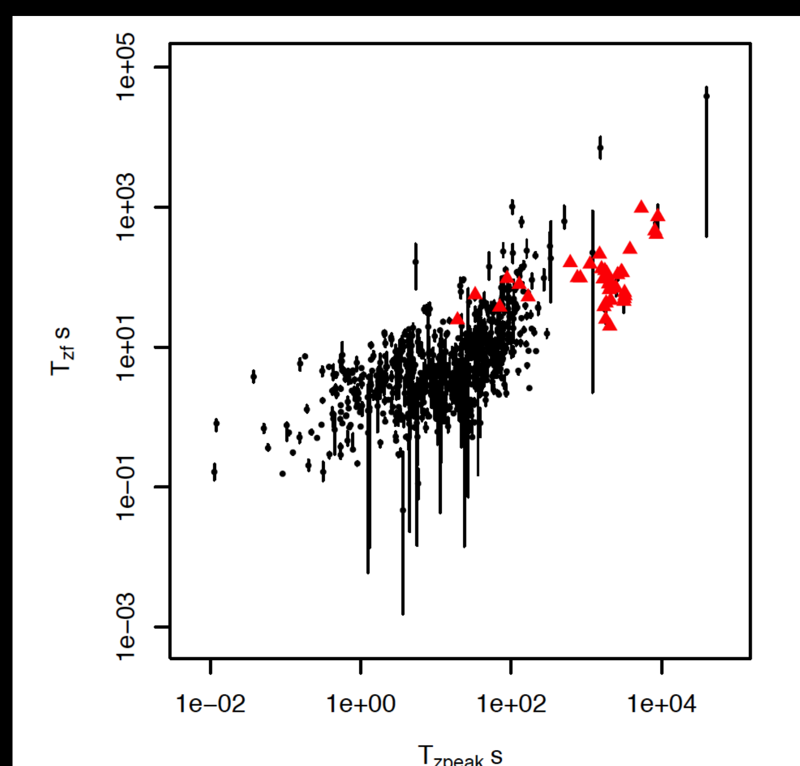

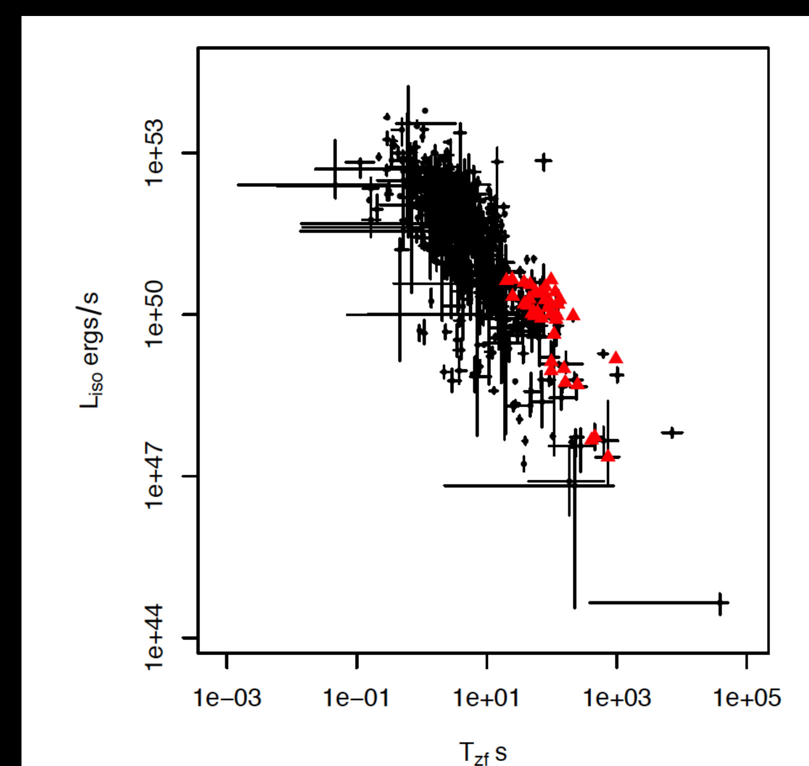

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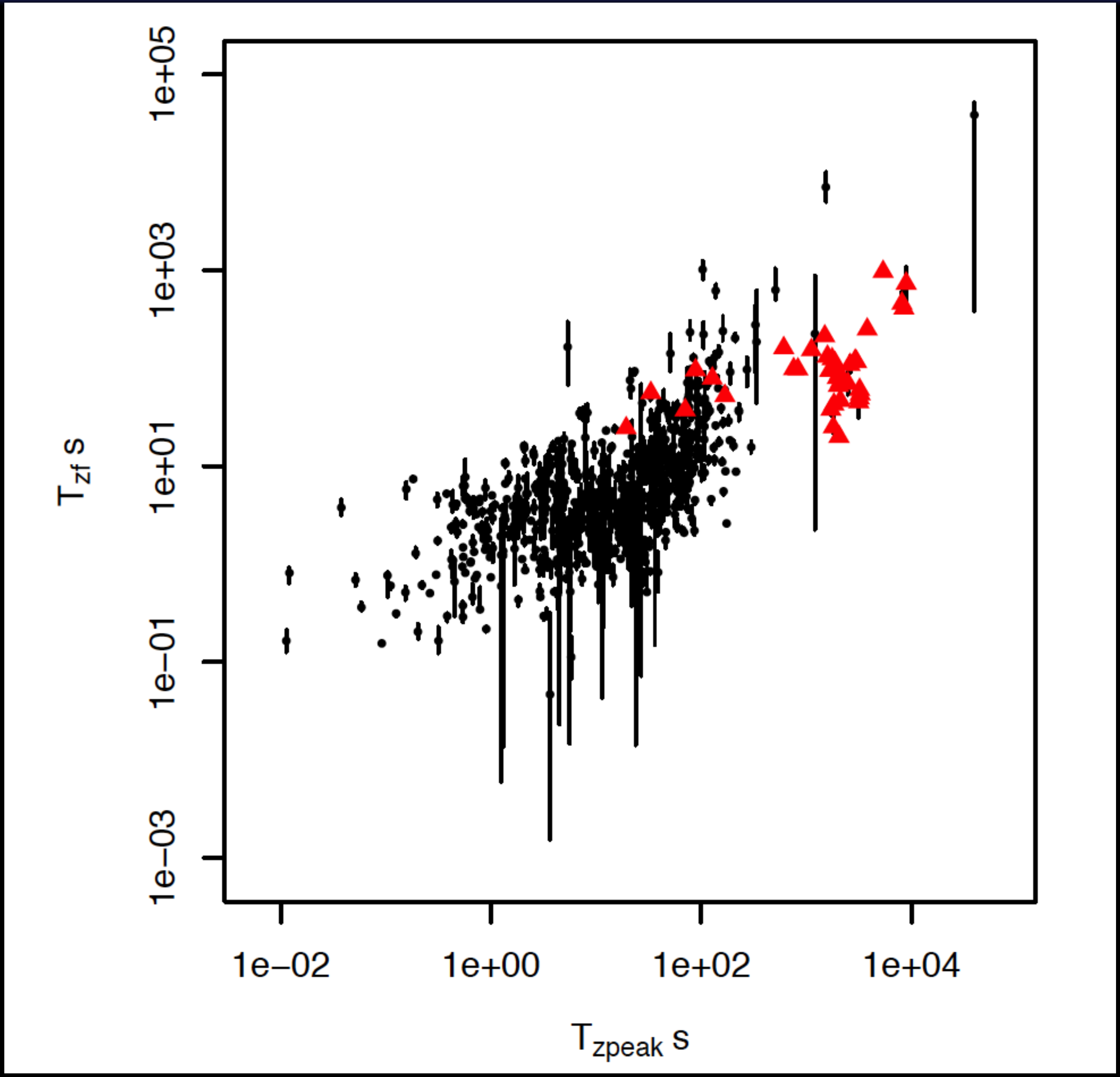
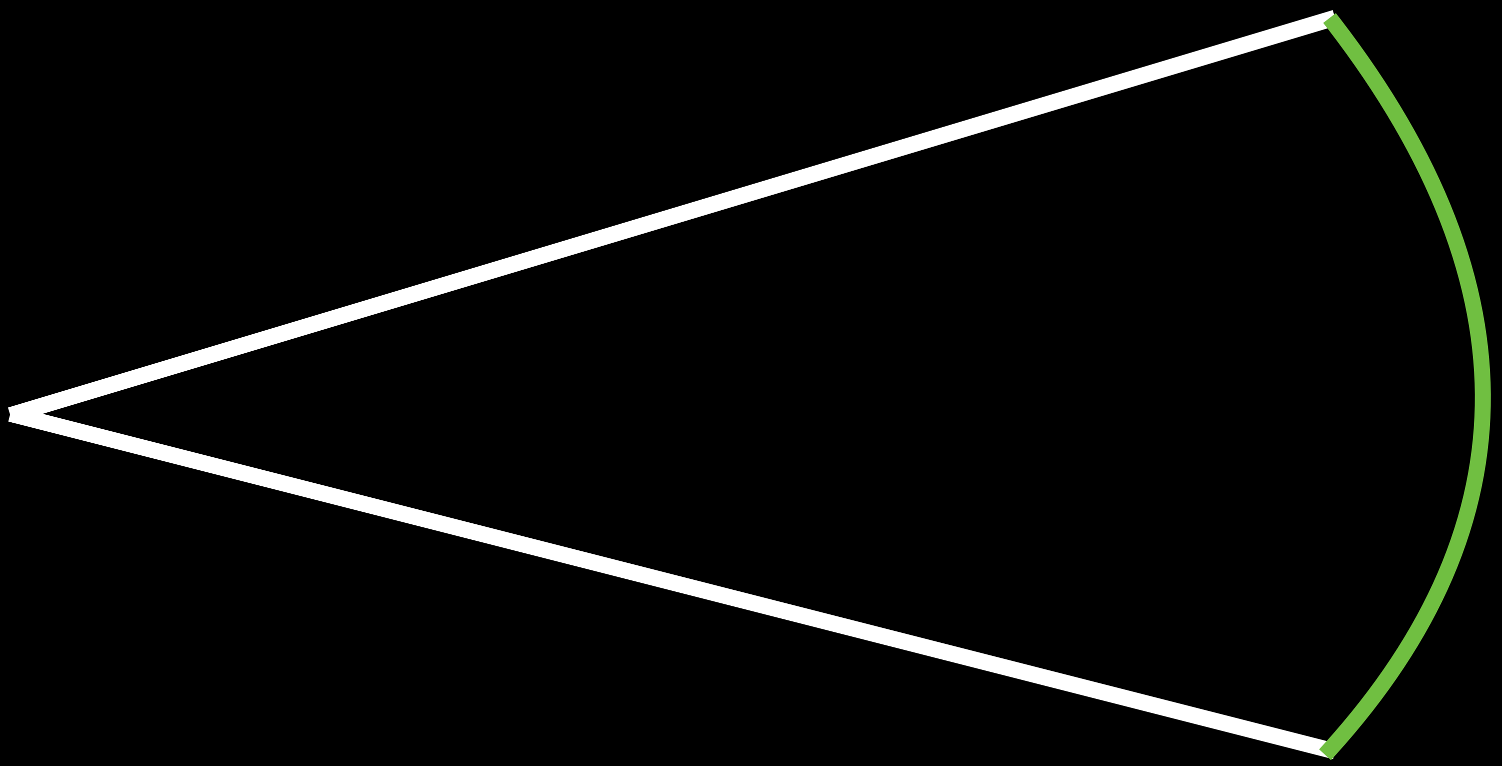
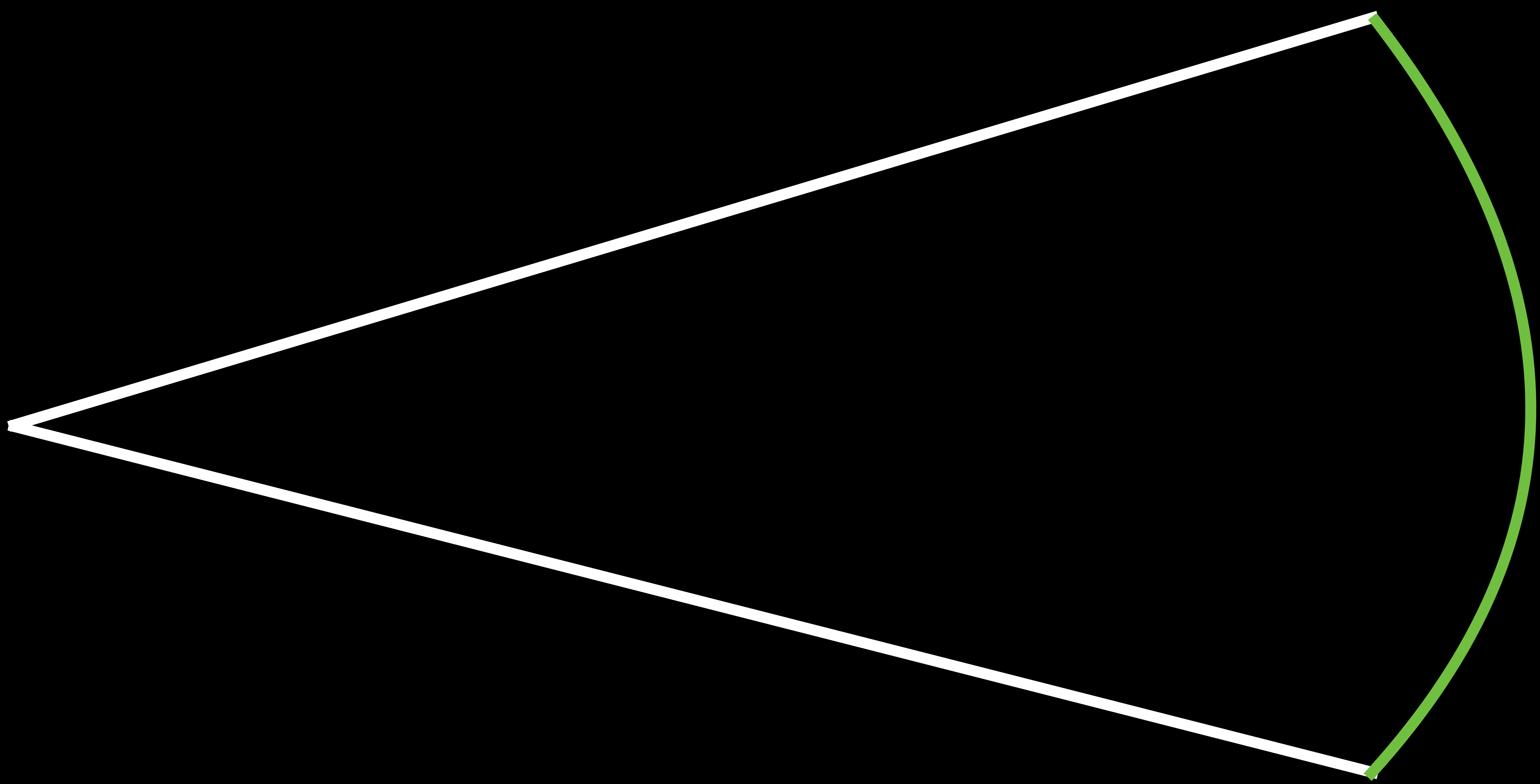


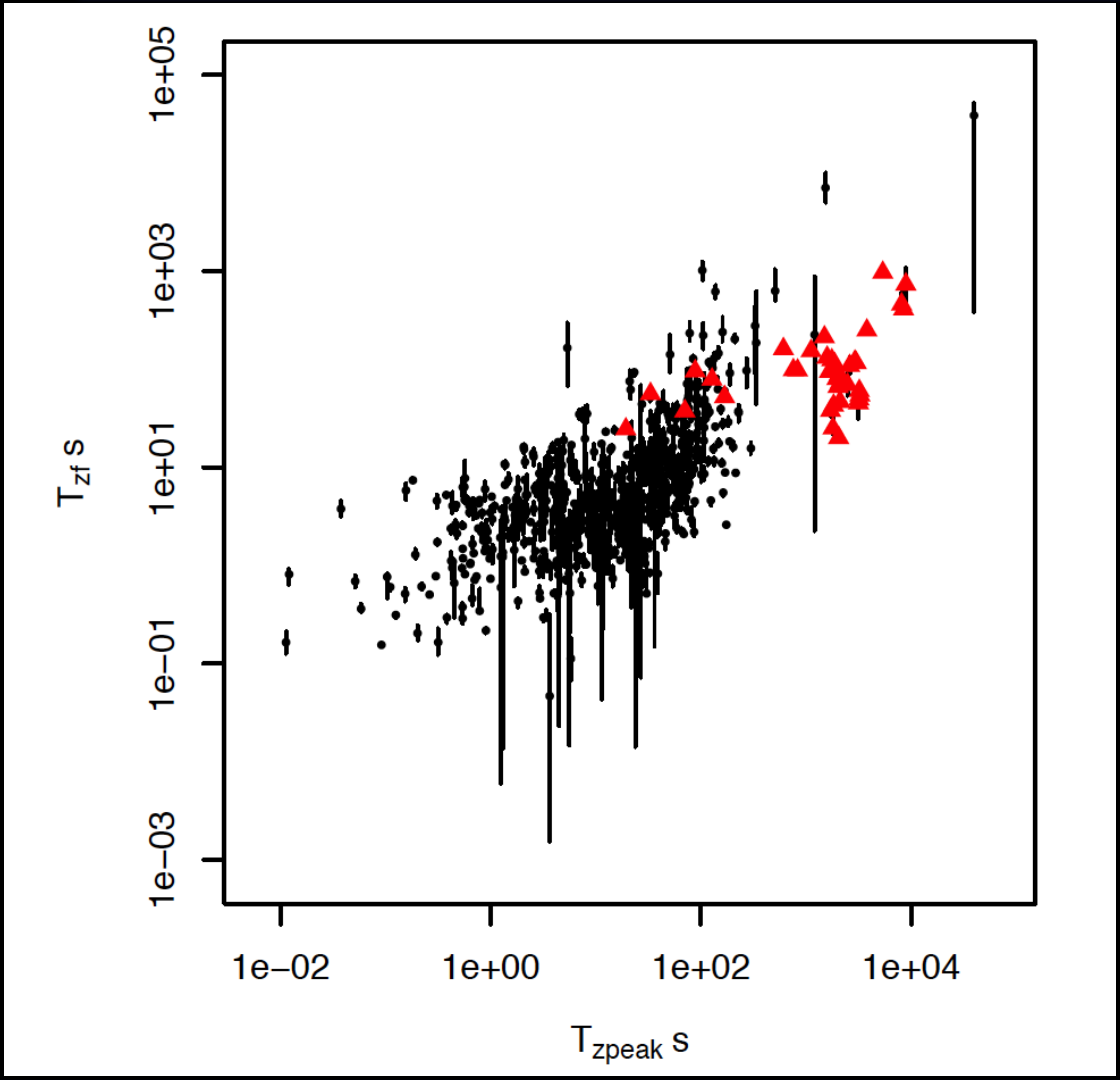
Decay timescale vs time



Decay timescale vs time

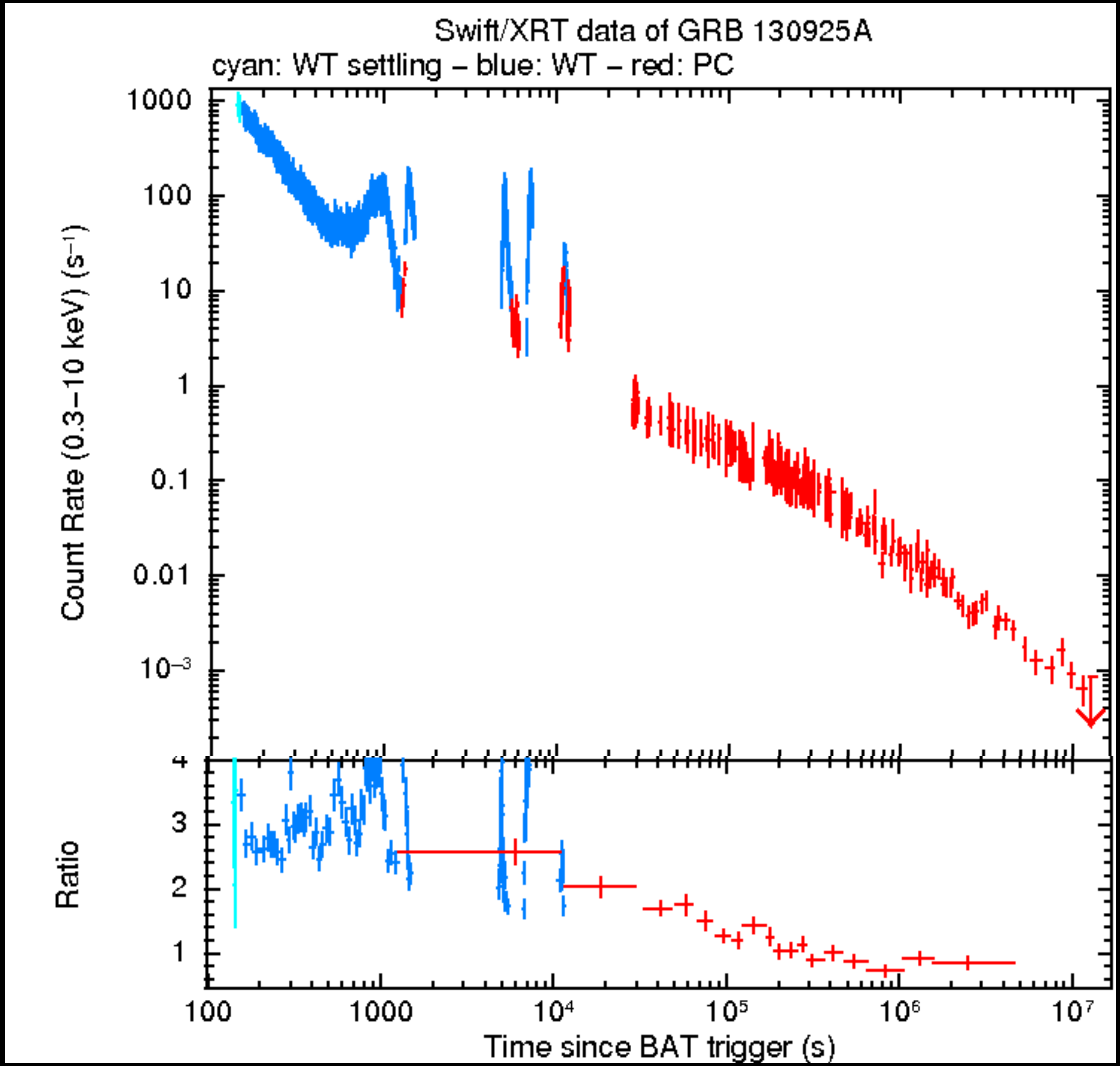


Fitting the prompt emission



RESULT 1:
The later pulses occur further from the GRB than the earlier pulses, and the pulses of "normal" long GRBs.

Evolving afterglow emission

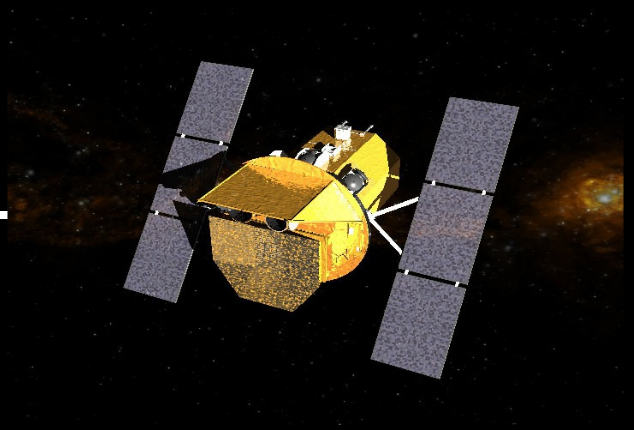


Made 27 spectra, fitted as evolving power-law, cooling break, and evolving thermal emission.

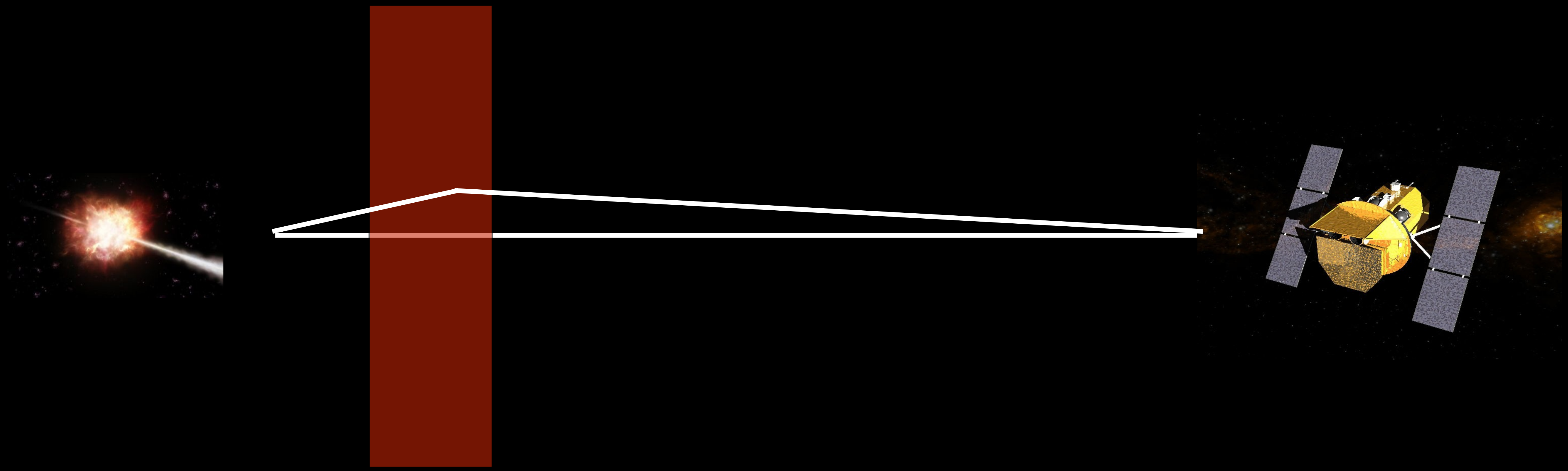
Only the evolving PL gave sensible results.

This is expected from dust scattering.

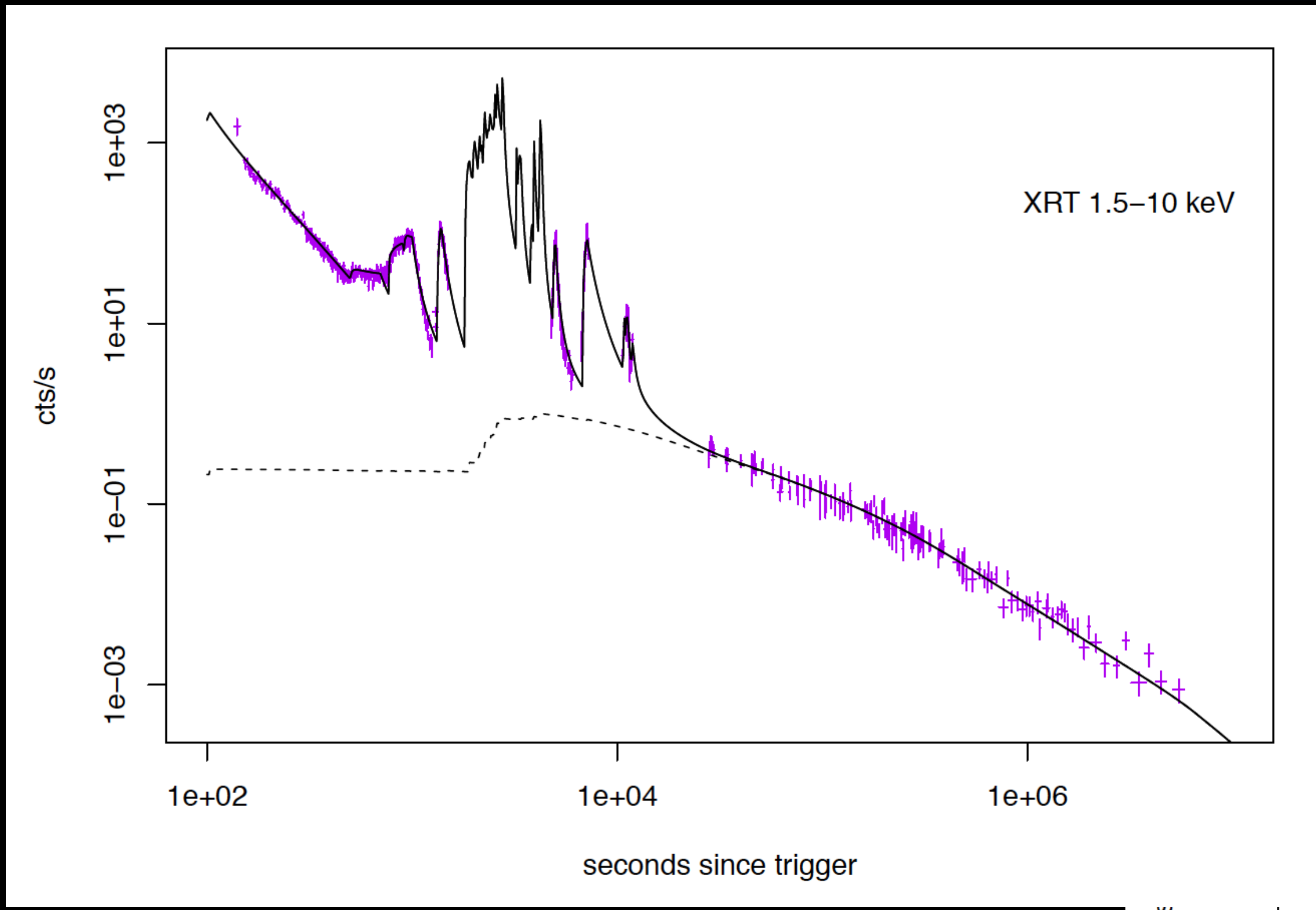
Dust scattering

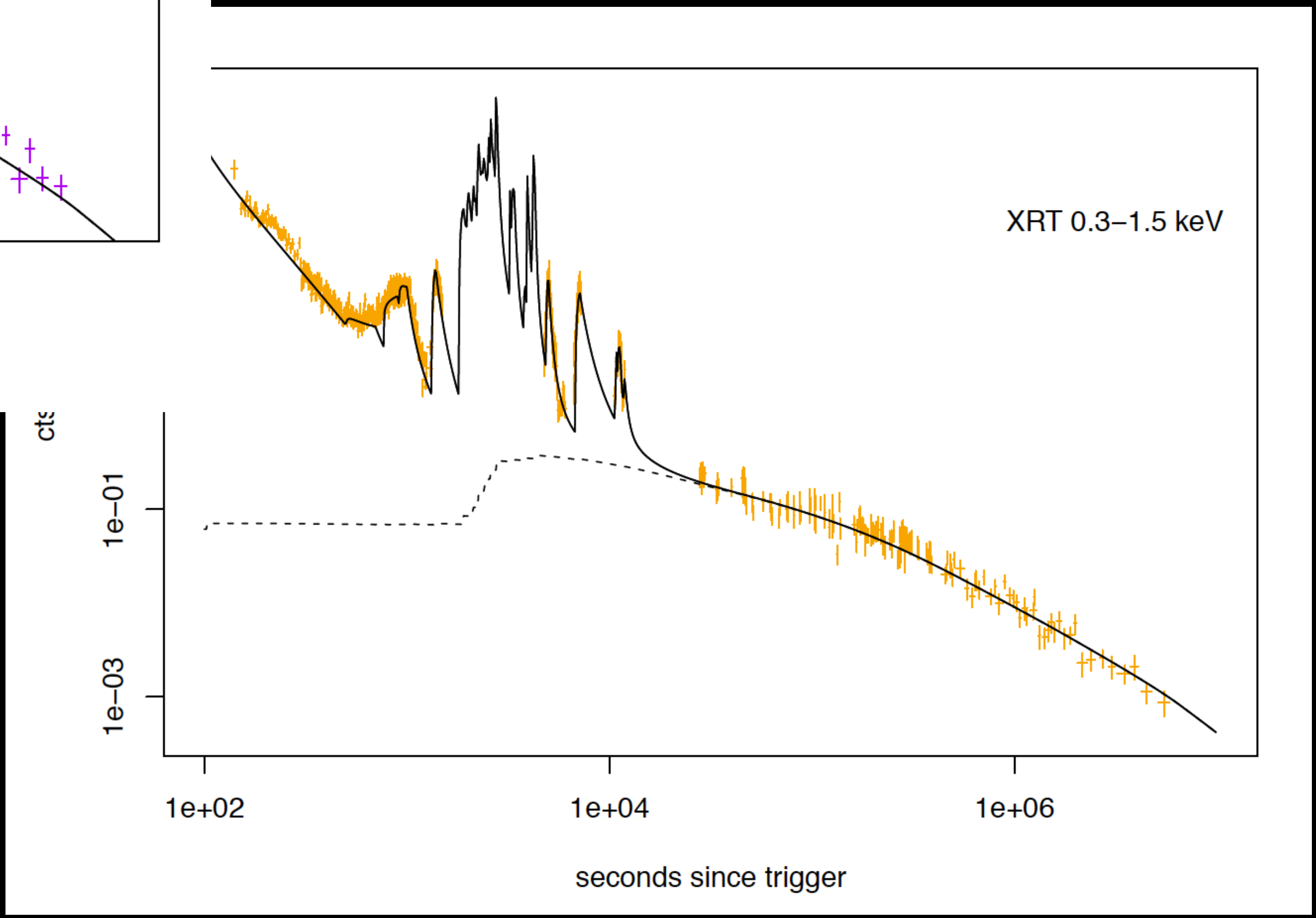


Dust scattering

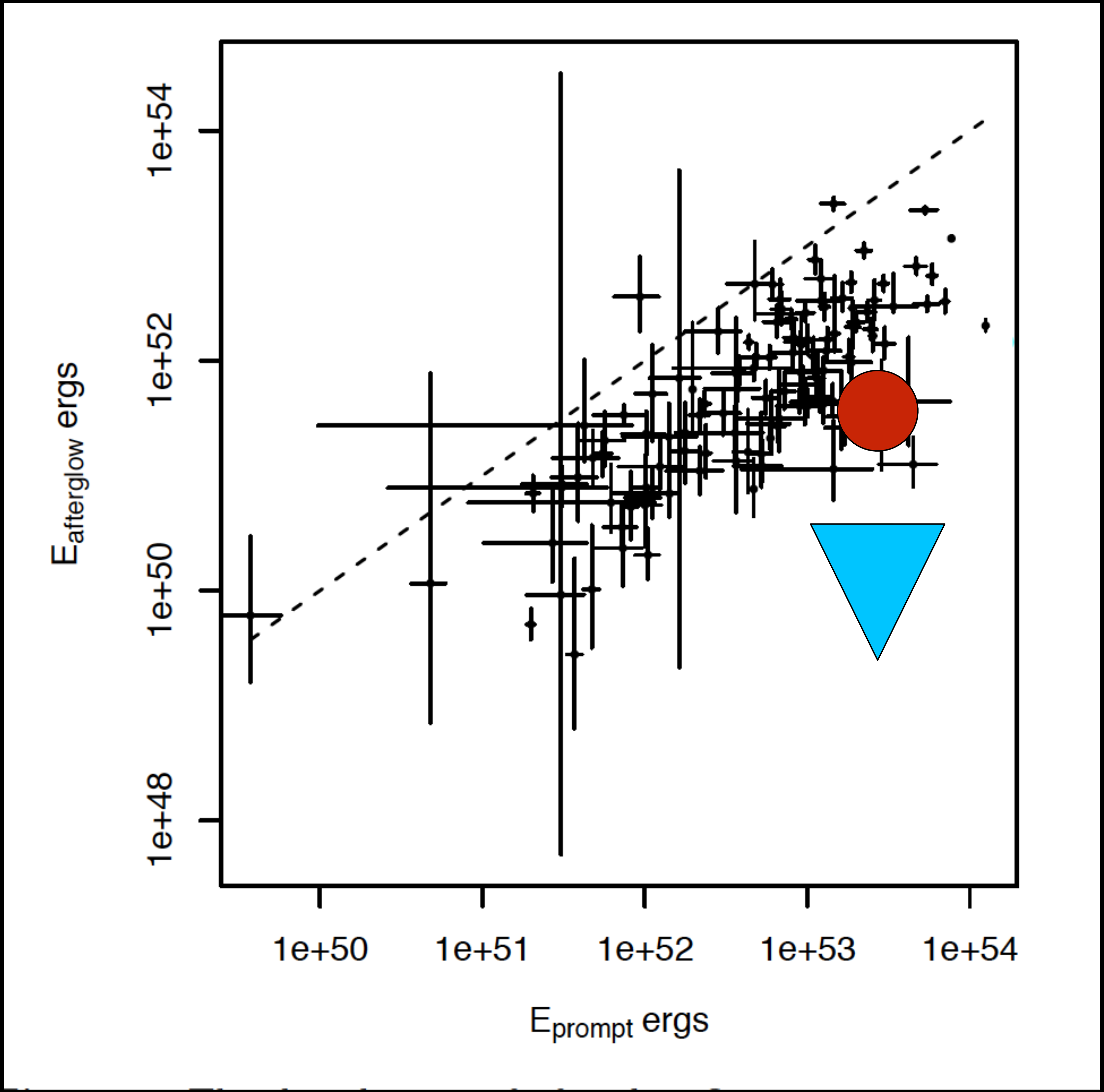


Modelling the X-rays as dust





Where is the external shock?



RESULT 2: The late-time emission was fainter than normal, and was not from the external shock.

The limit on external shock emission is much lower than seen from normal GRBs.

What we need to explain

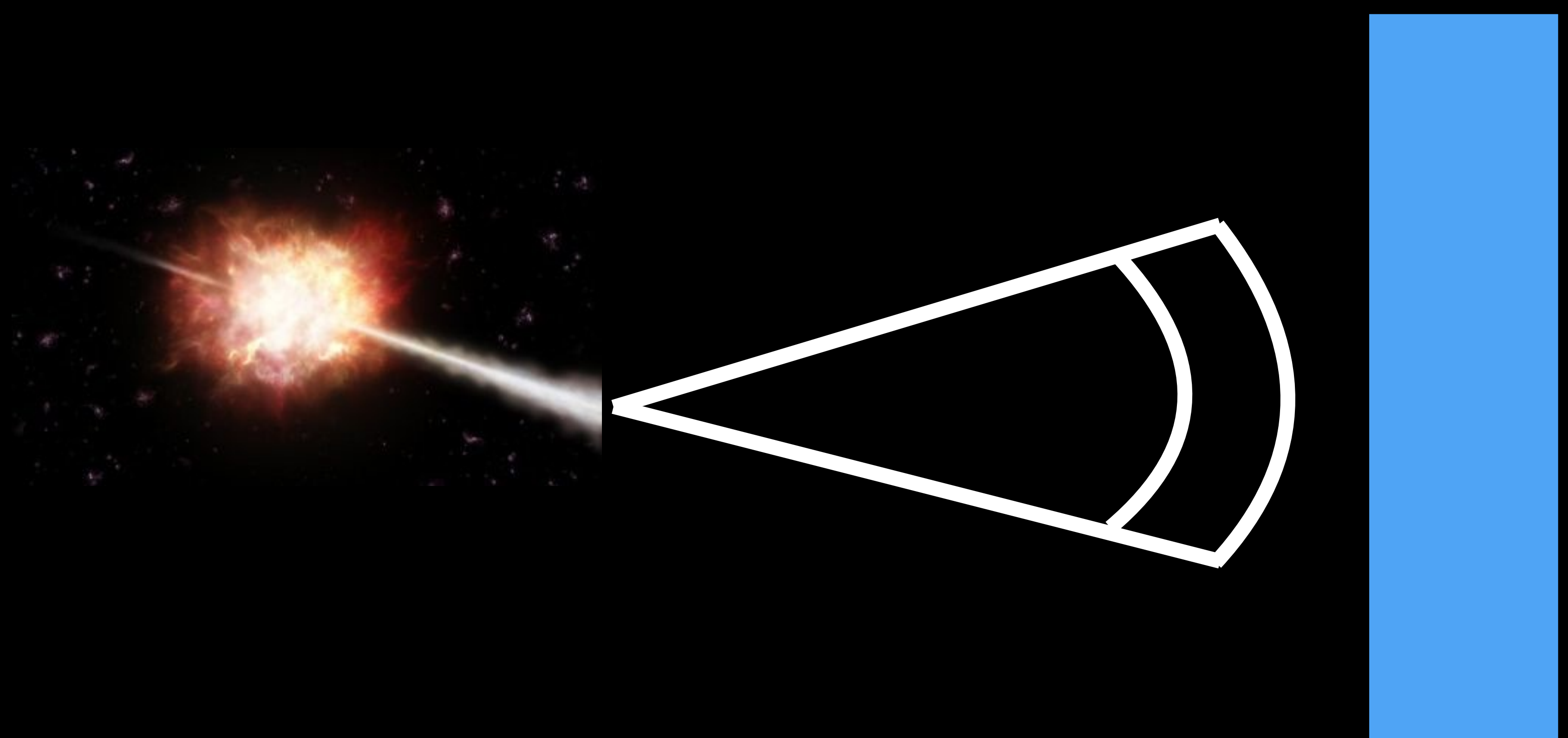
Why the prompt emission lasted so long.

Why the external shock was so weak.

SED modelling shows that this can't simply be a result of low density, it also requires that more of the initial energy is radiated as prompt than in normal GRBs.

Our proposed model

Deceleration radius (R_{d1})
Max GRB duration = R_{d1}/c

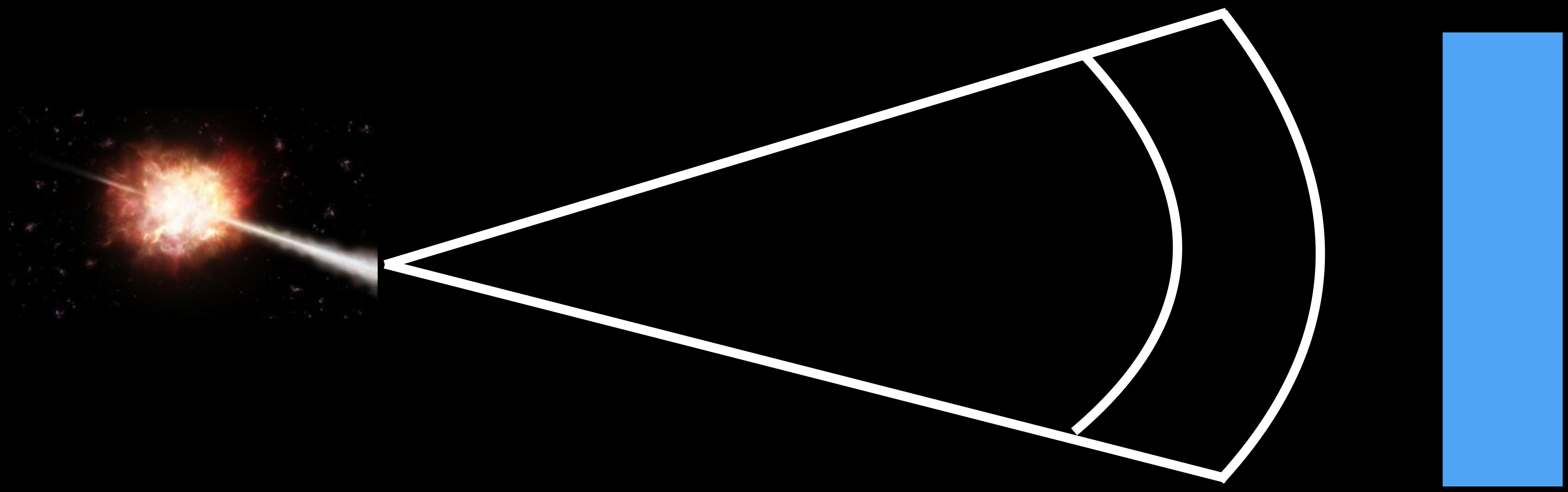


Shells interacting here give prompt emission

Shells that would interact here inject energy to the afterglow (=plateau)

Our proposed model

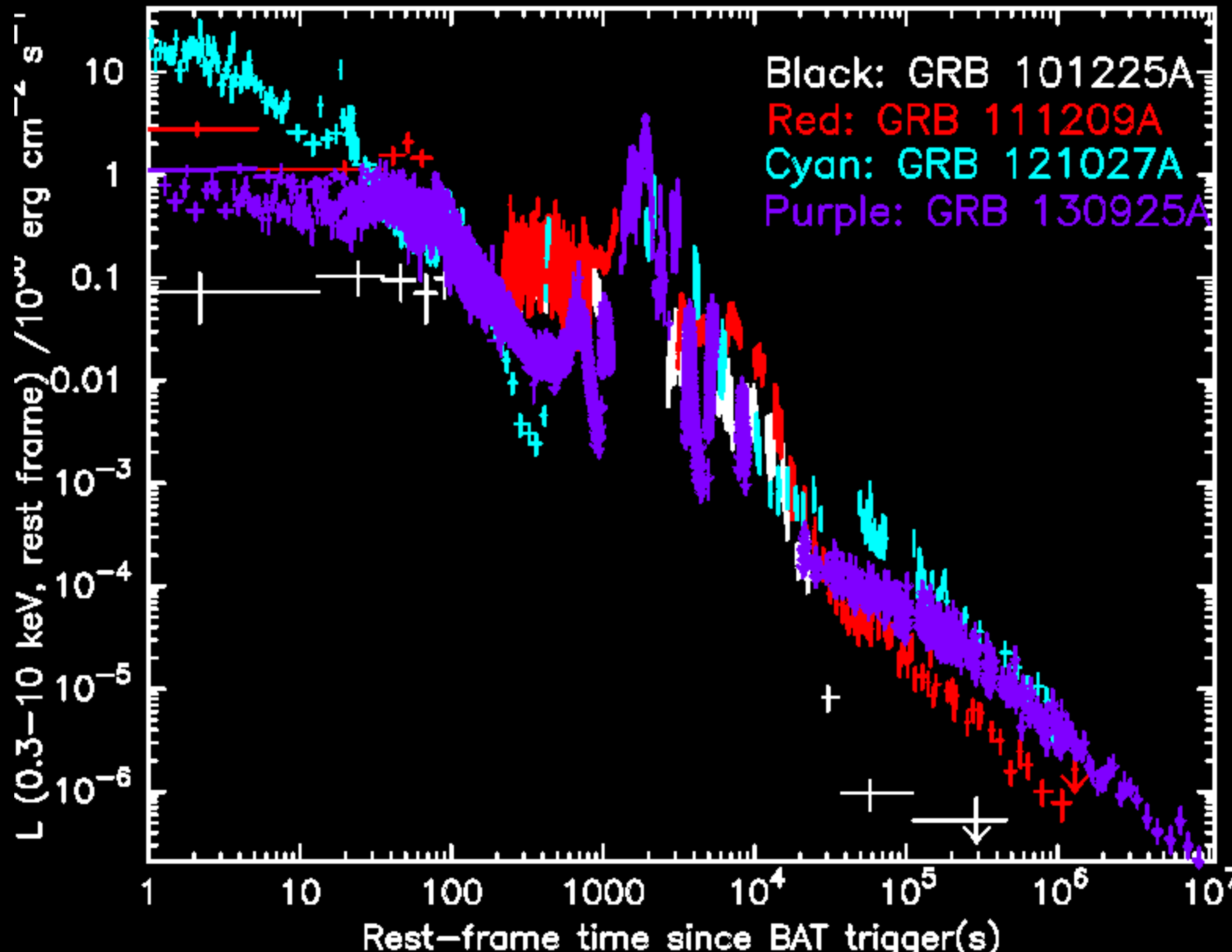
Deceleration radius (R_{d2})
Max GRB duration = R_{d2}/c



Shells interacting here give prompt emission

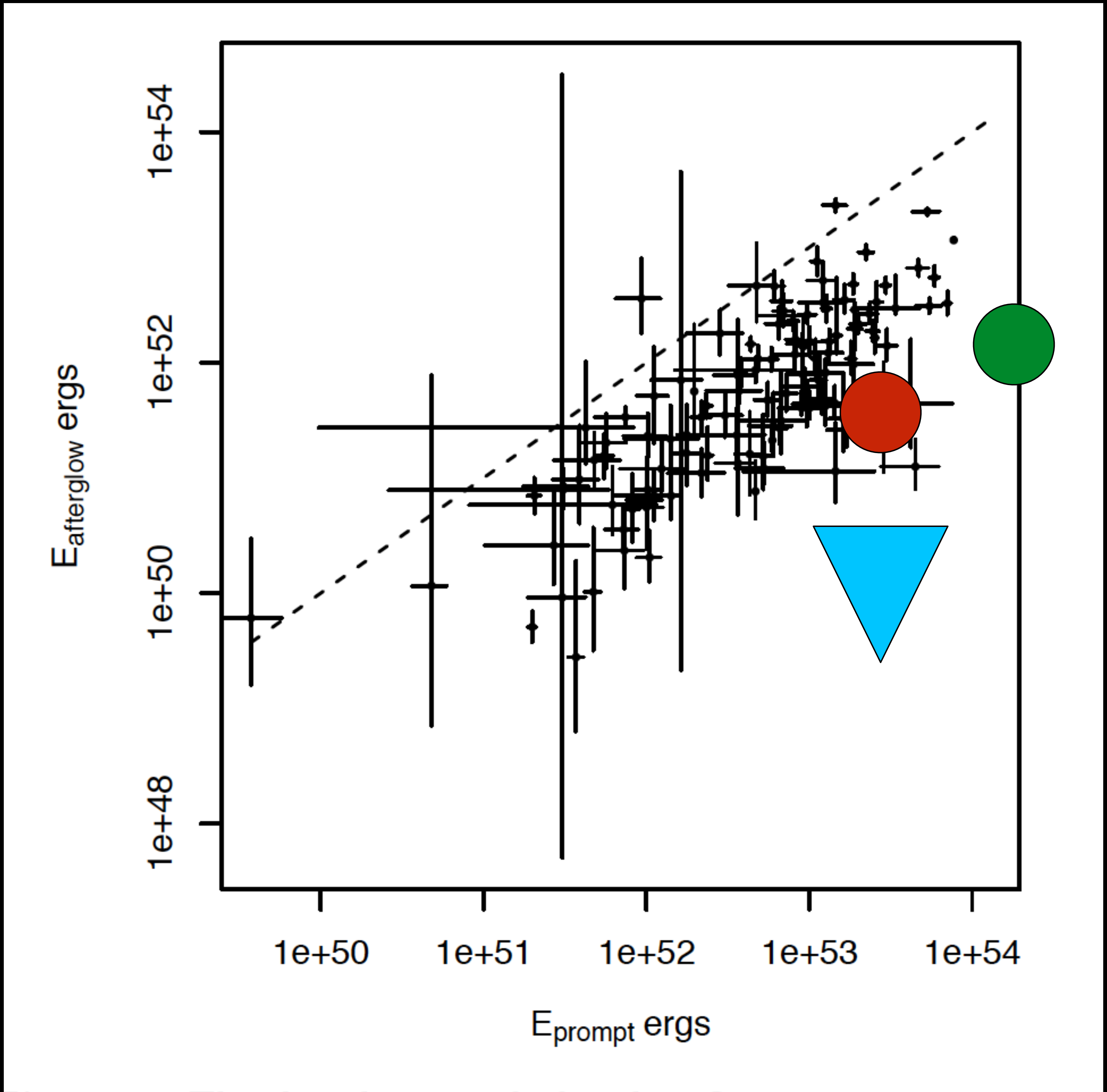
Shells interacting here give prompt emission

The other ultra-longs



RESULT 3: The Ep/Ea ratio for the ultra longs is similar to the for GRB 130925A, i.e. lower than normal.

Where is the external shock?



Conclusions

R_d is small: T90 is ‘long’, afterglow has a plateau (if the central engine keeps emitting).

R_d is large: T90 is ‘ultra-long’ (if the central engine keeps emitting), little/no afterglow plateau.

Observational support: $T_{plateau,end} \sim T_{ultralong}$

This predicts a lower $E_{afterglow}/E_{prompt}$ ratio in the ultra longs, as seen.

Large R_d implies low density: blue supergiant?