Time scales and the origin of Swift 1644+57

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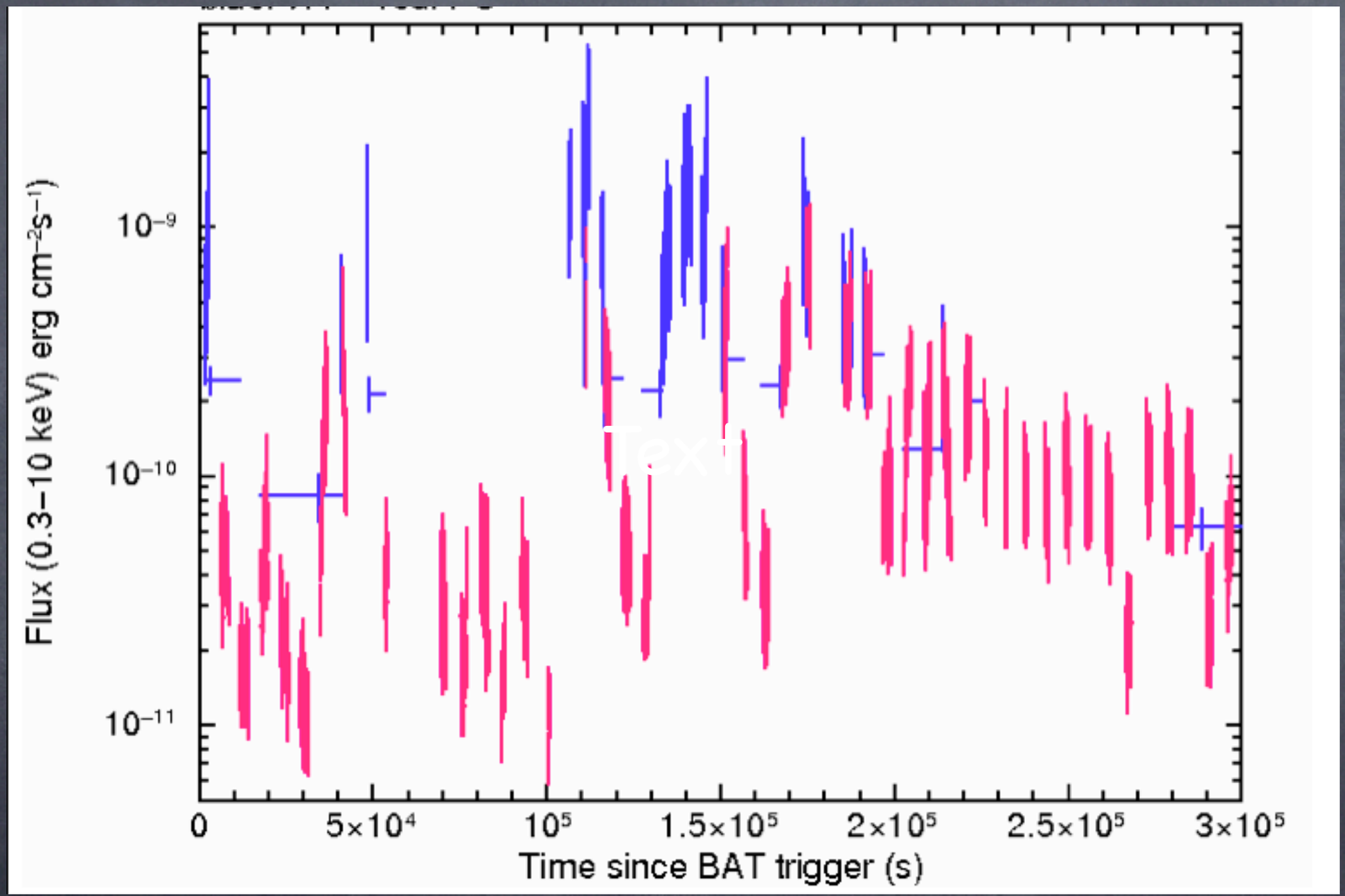
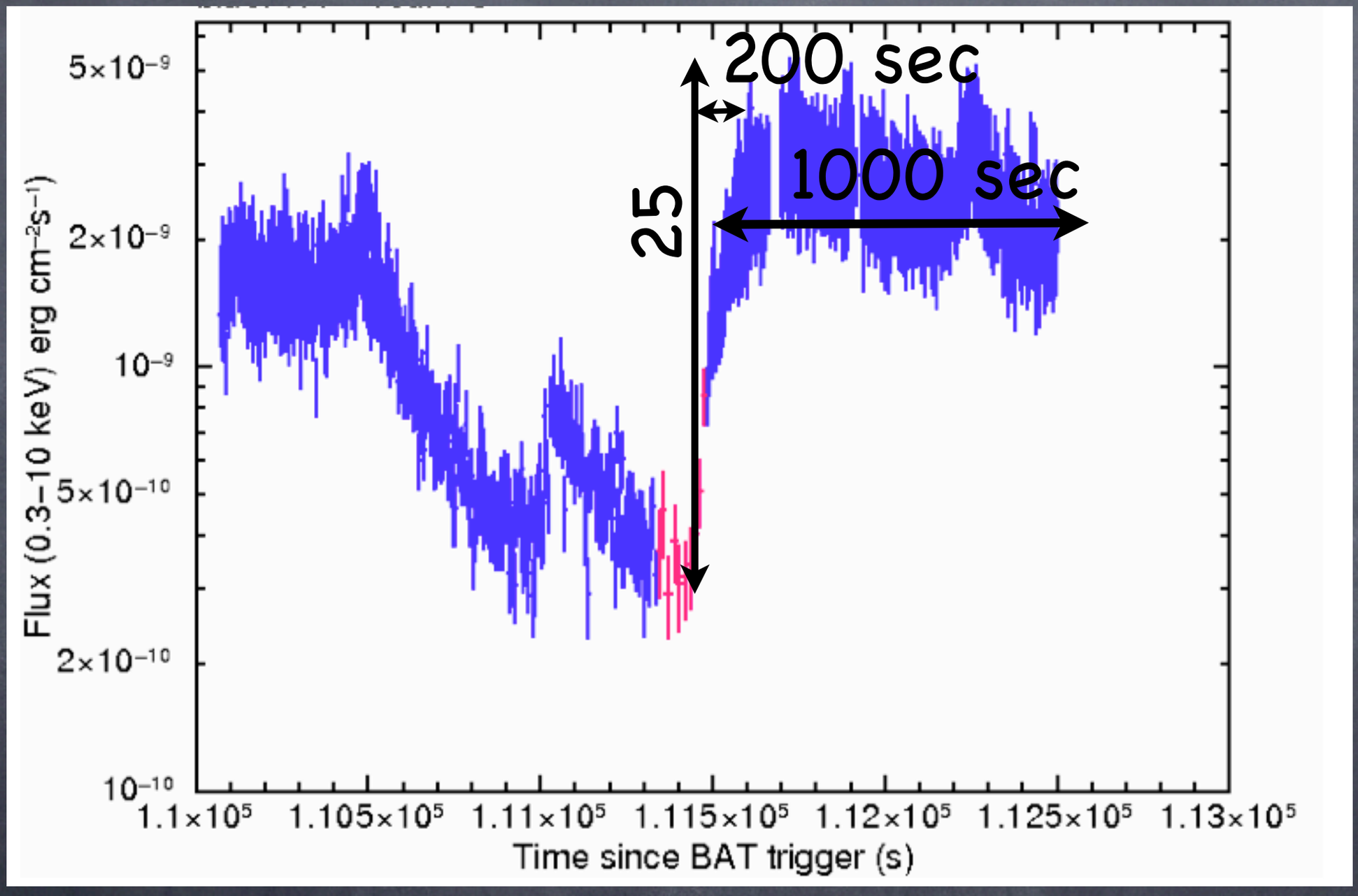


Swift light curve on a linear scale

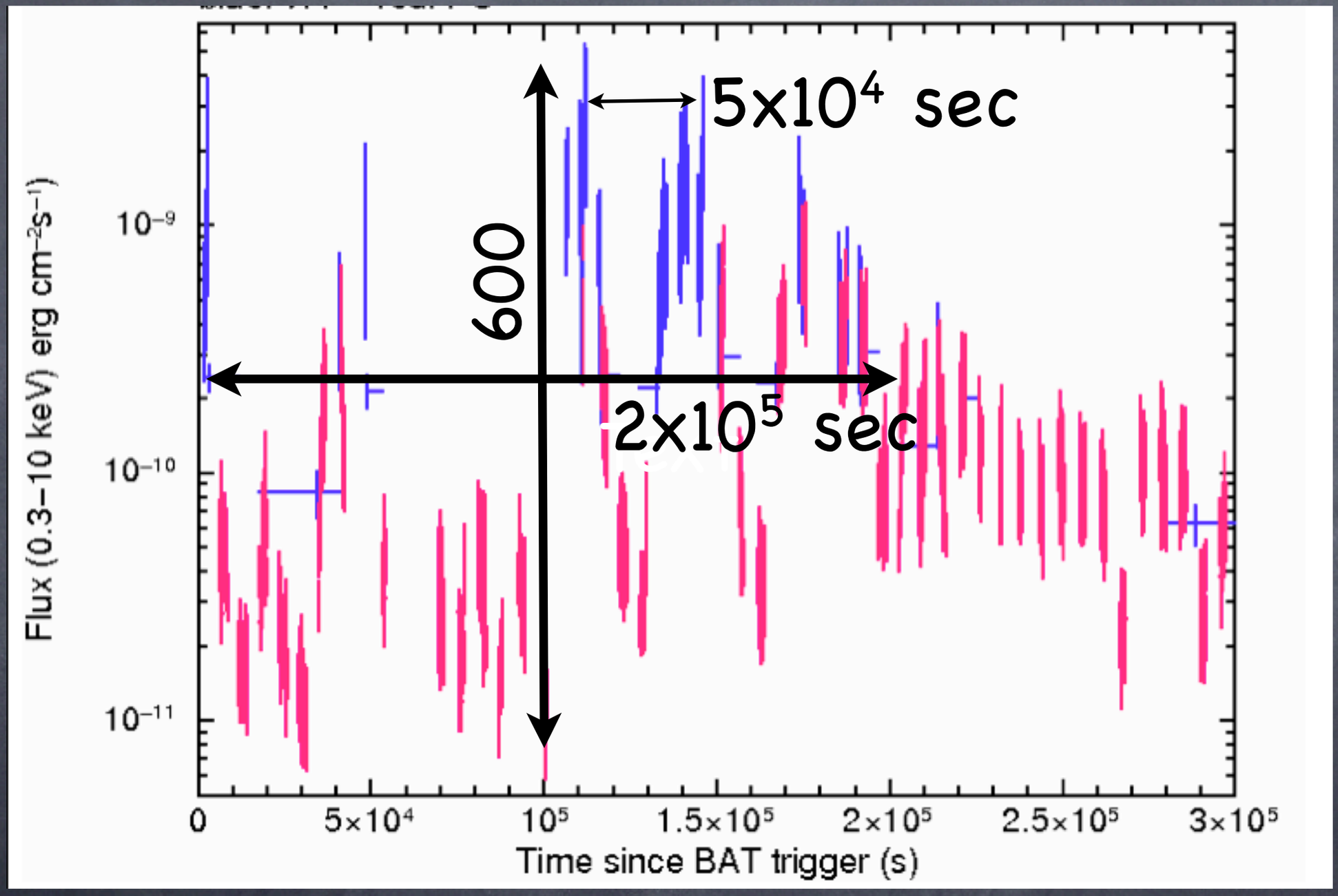
The Third Flare



Light curve from 1.1×10^5 to 1.13×10^5 sec

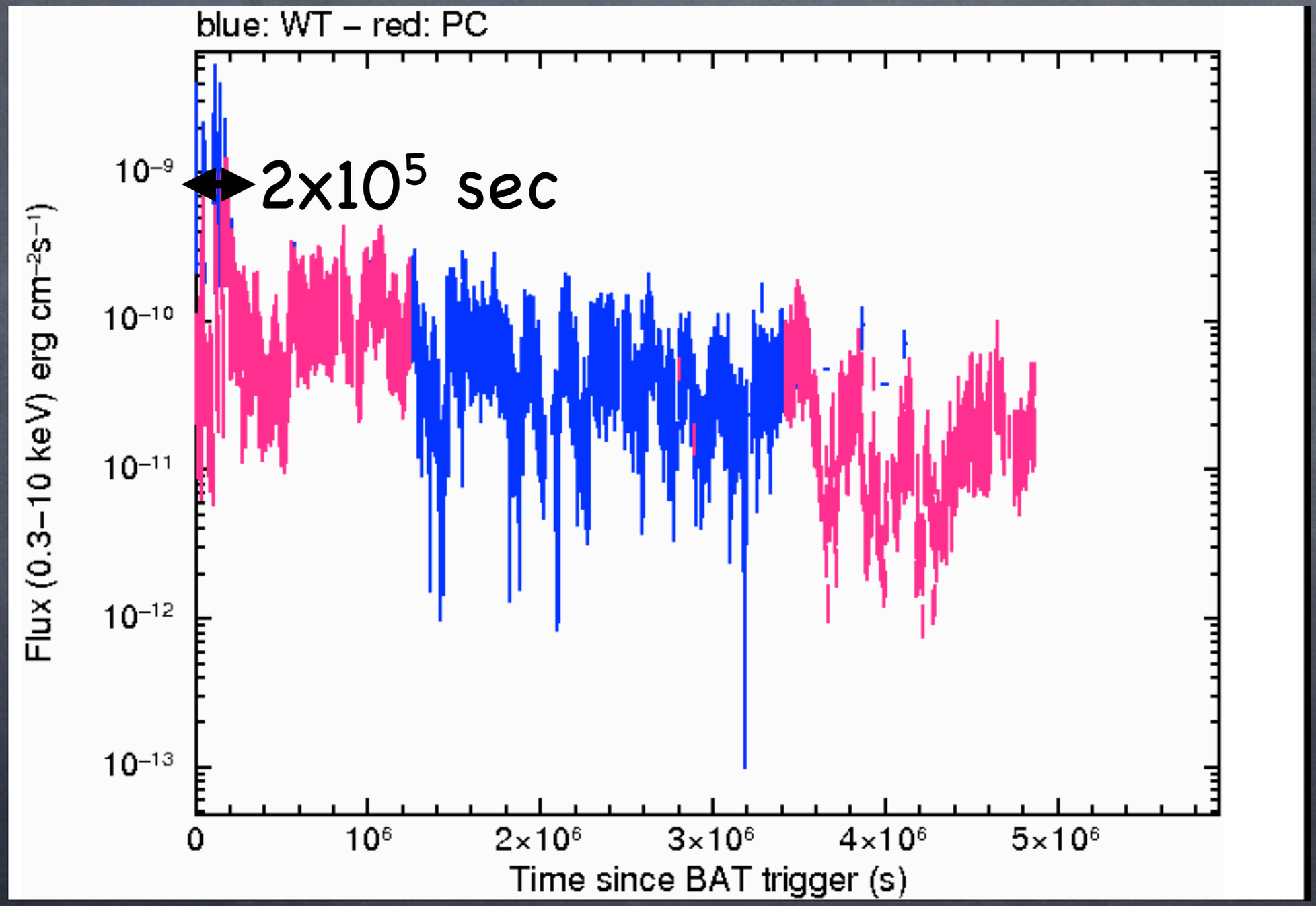
Light curve properties

- Strong variability on 100 sec time scale
- Flares last about 1000-2000 sec



Swift light curve on a linear scale

Overall Duration



Light curve properties

- Strong variability on 100 sec time scale
- Flares last about 1000-2000 sec
- Minima between the flares is a factor of 600 below the maxima
- 3×10^4 sec between flares
- 2×10^5 sec - duration before onset of a gradual decay

The "standard" model - tidal disruption of MS

- 100 sec -> limit on the black hole mass
  - t_{grav} < 100sec -> $M_{bh}<10^7\ M_o$
  - t_{isco} < 100sec -> $M_{bh}<10^6\ M_o$
- 1000 sec ?
- 40000 sec ?
- $2x10^5$ sec - infall time from a disk? $t^{-5/3}$?

A tidal disruption of a main sequence star

$$R_T/r_g = R_*(k/f)^{1/6}(M_{BH}/M_*)^{1/3}/(GM_{BH}/c^2) = \ 50(k/f)^{1/6}M_{BH,6}^{-2/3}\mathcal{M}_*^{2/3},$$

k is the apsidal motion constant (determined by the star's radial density profile)

f is its binding energy in units of GM_*^2/R_*

$$P_{\rm orb}(R_T) = \ 10^4\mathcal{M}_*\ {\rm s}, \quad \sim (G\rho_*)^{-1/2} \quad \textit{independent}\ {\rm of}\ M_{BH}$$

- What generates the extremely bright compact and short lived knots that are assumed to account for the flares?
- What does the light crossing time of the BH has to do with the flares within the jet?
- How are the deep minima produced?

A tidal disruption of a White Dwarf

$$P_{orb}(R_T) \simeq 9\mathcal{M}_*^{-1} \text{ s},$$

$$R_T/r_g > 1 \longrightarrow M_{BH,6} < 0.3\mathcal{M}_*^{-1}$$

$$t_{\rm in} \sim (P_{\rm orb}/2\pi)\alpha^{-1}(R_T/H)^2$$

$$P_{orb}(R_c) \sim \frac{2\pi}{(2f)^{3/2}}\left(\frac{M_{BH}}{M_*}\right)\left(\frac{R_*^3}{GM_*}\right)^{1/2} \sim 6\times 10^4 \mathcal{M}_*^{-2} M_{BH,4} \text{ s}.$$

for $R < 3R_{ISCO}$, $t_{\rm in} \sim 10P_{orb}(R)$.

- 100 sec rise time - onset of accretion
- 1000 sec flare duration - the "drainage" time of a small accretion disk forms in a partial disruption event.
- 5×10^4 sec between flares - orbital time
- Precurse three days before the event is the "first" tidal passage

A tidal disruption of a White Dwarf - Drawbacks

- BH is smaller than in the Main Squence case.
  - $L>>L_{EDD}$ - But $L>>L_{EDD}$ (only factor of 10 less) for MS.
  - A small BH at the galaxy center - But it is smaller than expected also for MS.
- Number density of WD is comparable to number density of MS, but capture radius is smaller and so is the rate $\simeq 2\times10^{-3}(\mathcal{M}_{*,\rm wd}\mathcal{M}_{*,\rm ms})^{-2/3}$ - But (i) Capture is probably at $10R_T$. (ii) Rate is highly uncertain.