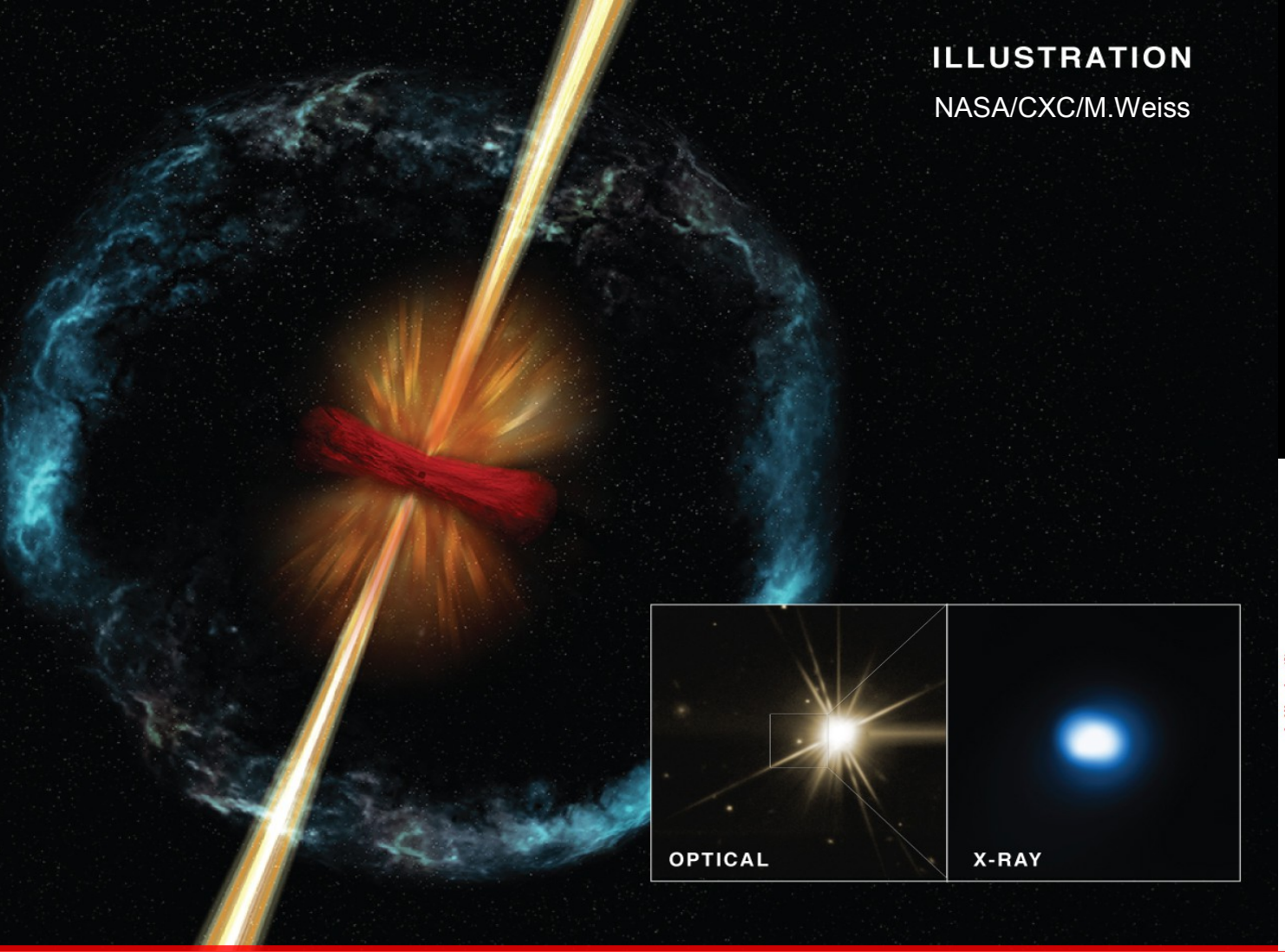
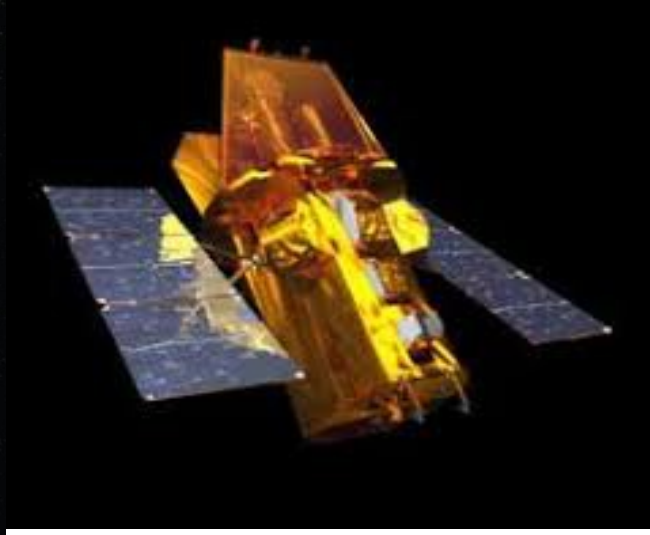
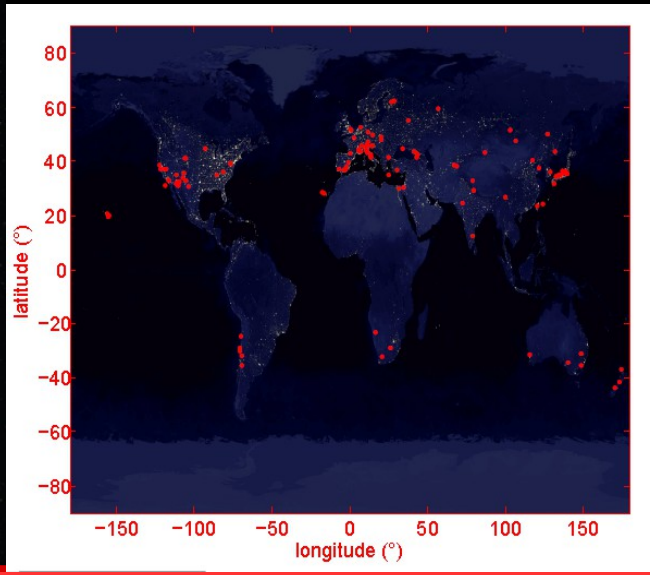






The multiwavelength emission of the GRB afterglows observed the last 2 decades

Damien TURPIN

April 25th, 2017
2nd SVOM scientific workshop – Qiannan, China

Outlines

The multiwavelength emission of the GRB afterglow

Is the standard afterglow model sufficient to explain the MW emission of the GRB afterglow ?

Conclusions and prospects

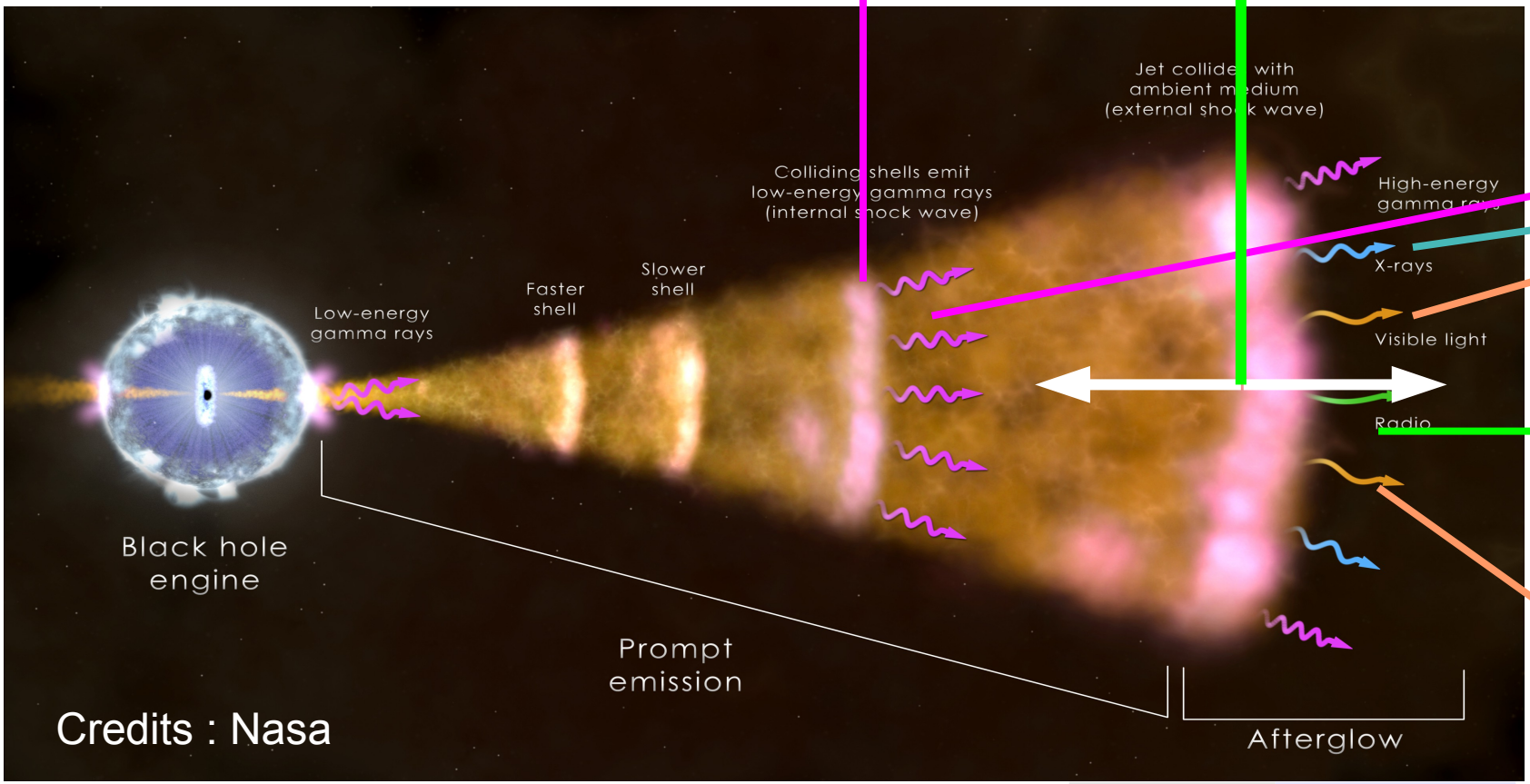
1.

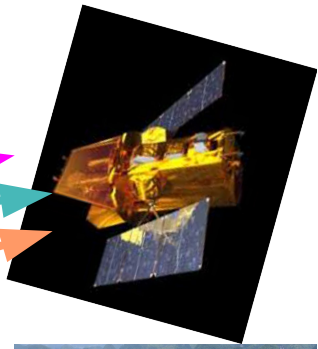
The multiwavelength emission of the GRB afterglow

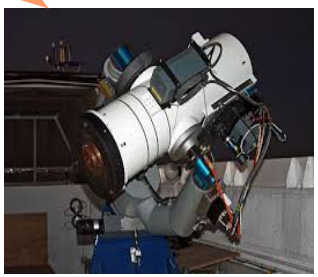
The GRB phenomenon

Microphysics in the shocked regions

$$\varepsilon_e, \varepsilon_B, \varepsilon_p, \Gamma, \eta_\gamma \longrightarrow \varepsilon_e, \varepsilon_B, n_0, p$$





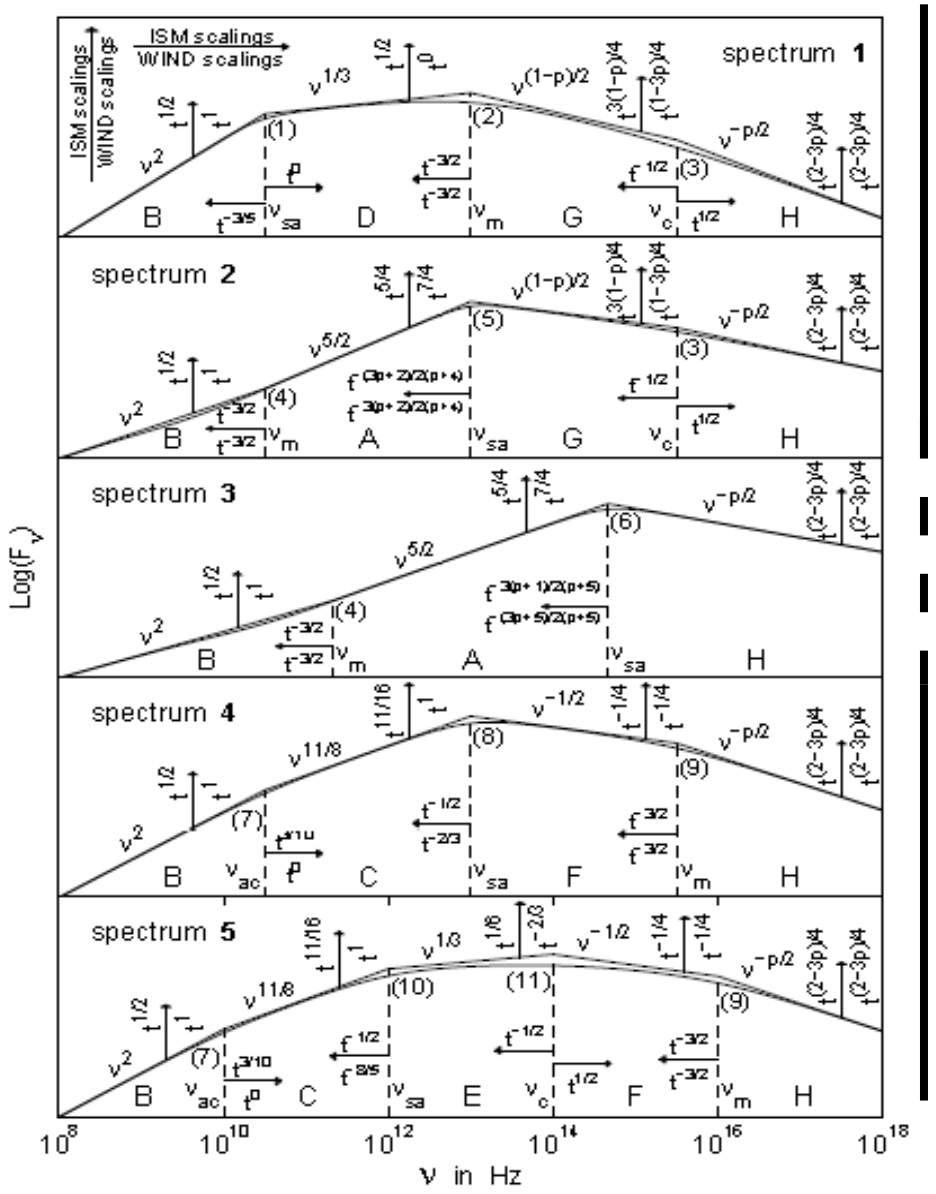


Reverse shock	Forward Shock

Prediction of the standard model

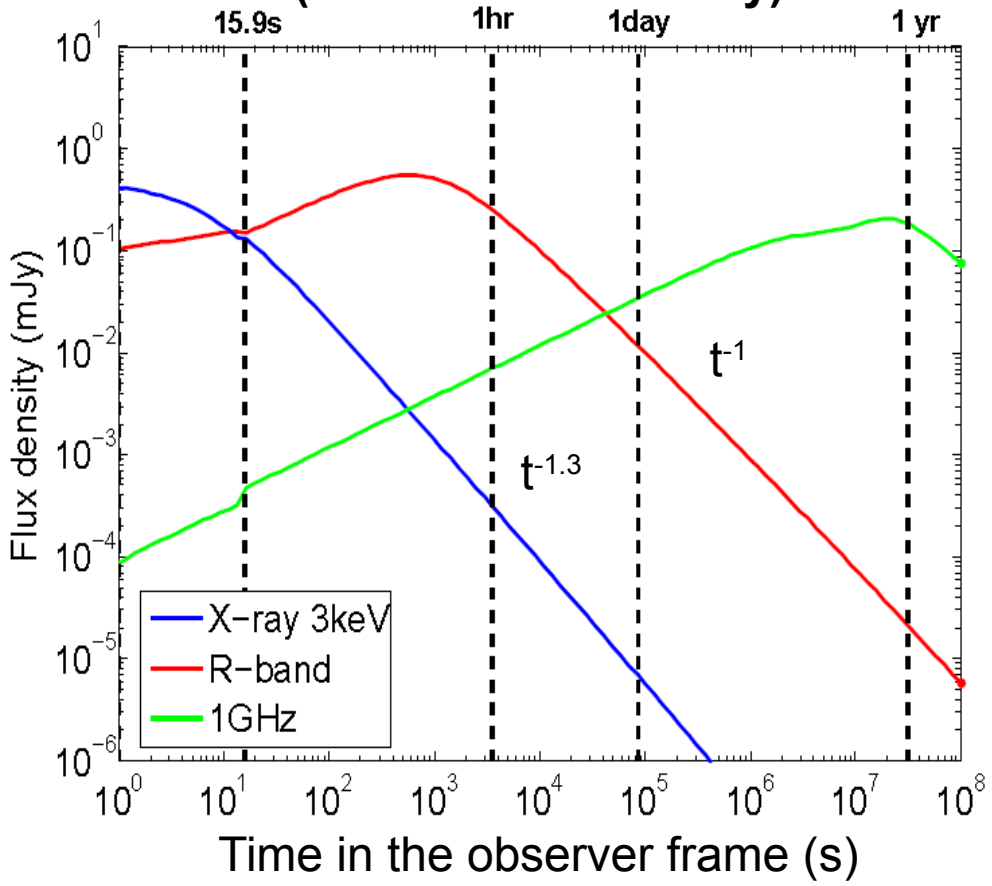
Forward Shock only

Synchrotron spectrum of GRB afterglows



Granot & Sari 2002

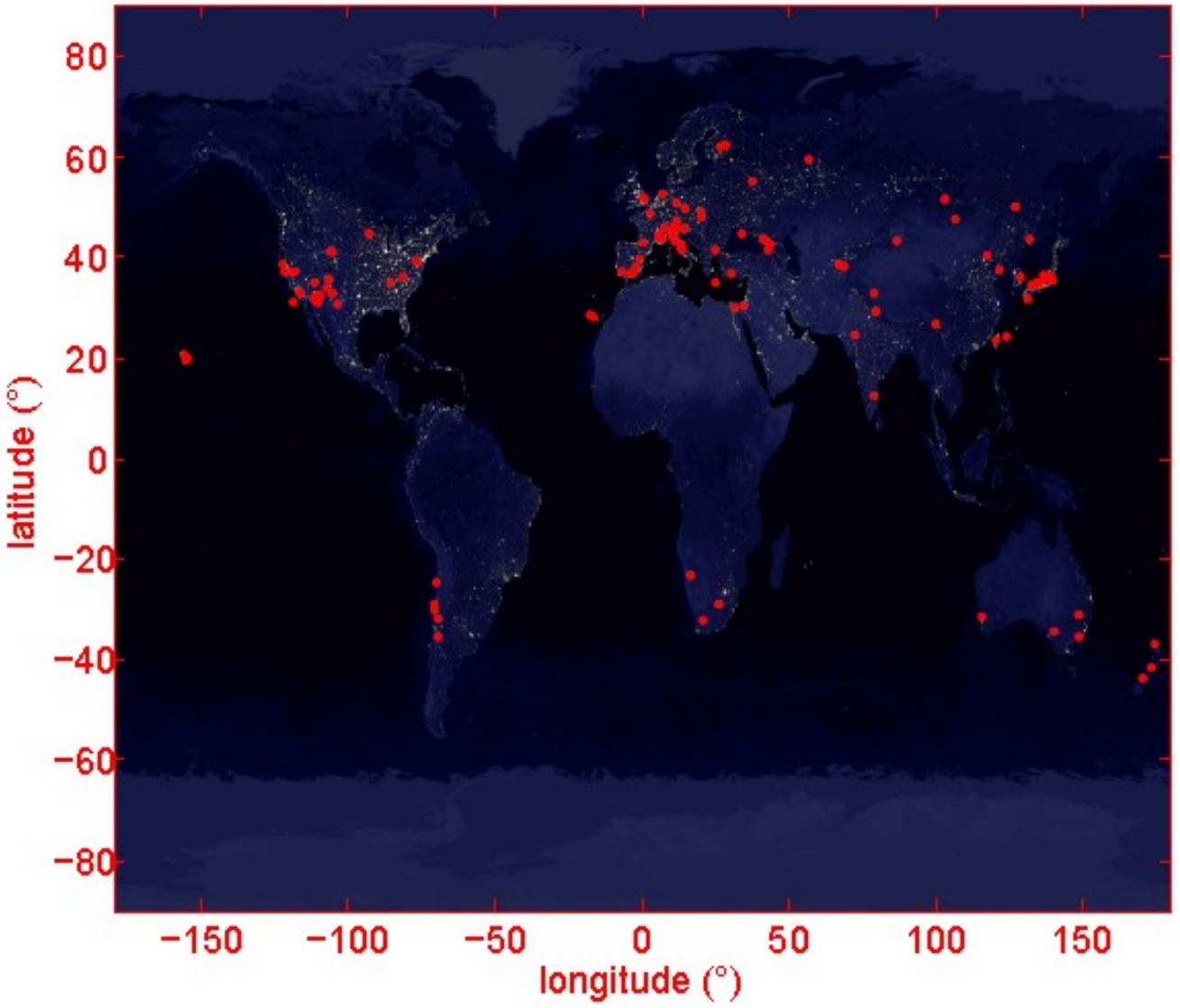
MW light curve of GRB afterglows (Forward Shock only)



The shape, the delay and the amplitude of the MW afterglow spectrum/light curves (here, FS only) depends on :

η, ε_e, ε_B, p, n_0, Γ, $E_{k,jet}$, θ_{jet}

Who is observing GRB afterglows ?



Observatory all over the world :

N~150

Optical telescope participating to GRB afterglow follow-up :

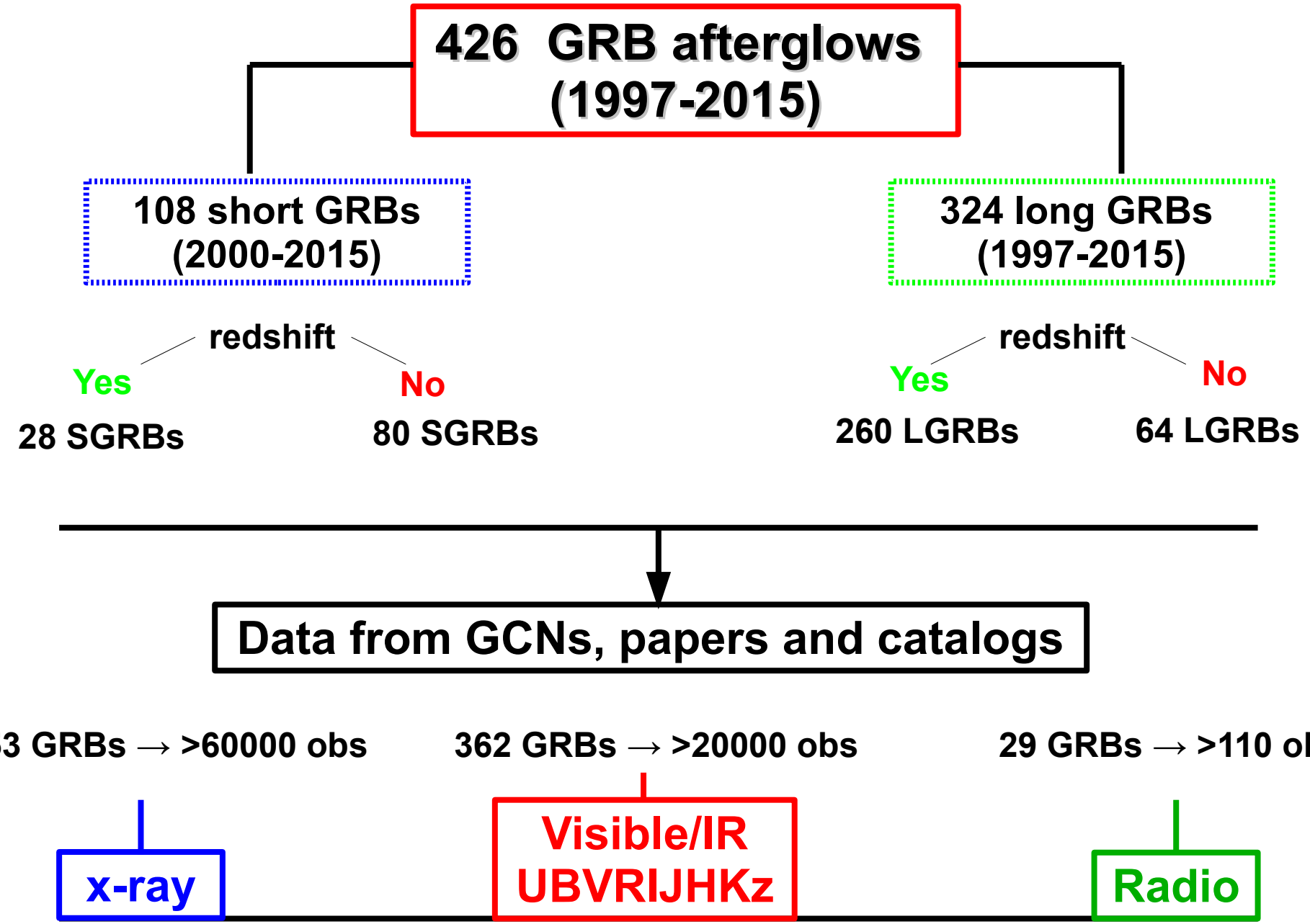
N~320

Telescopes's instruments used for GRB afterglow follow-up :

N~650

The GRB sample (1997-2015)

database still under construction : "***GRBase***"
B. GENDRE, D. TURPIN & A. KLOTZ

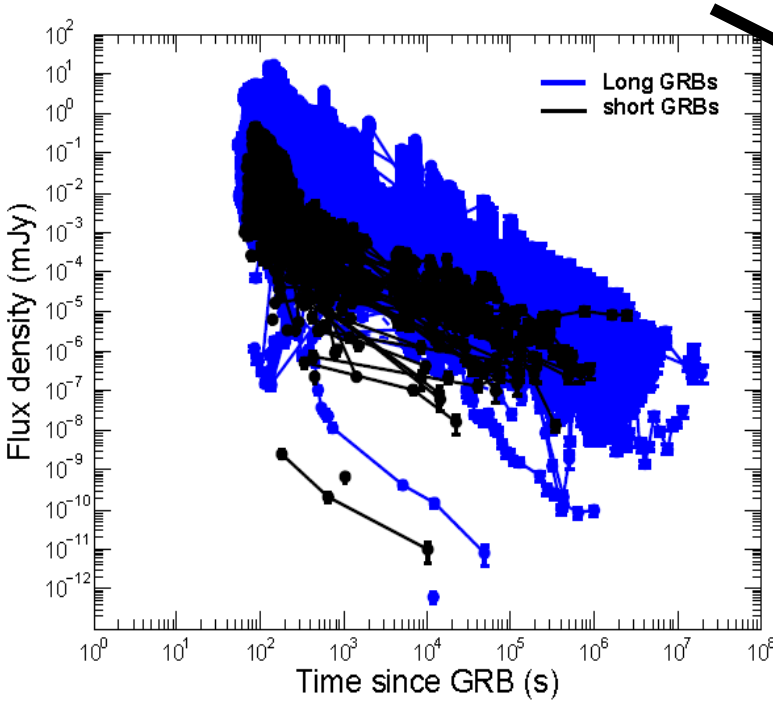


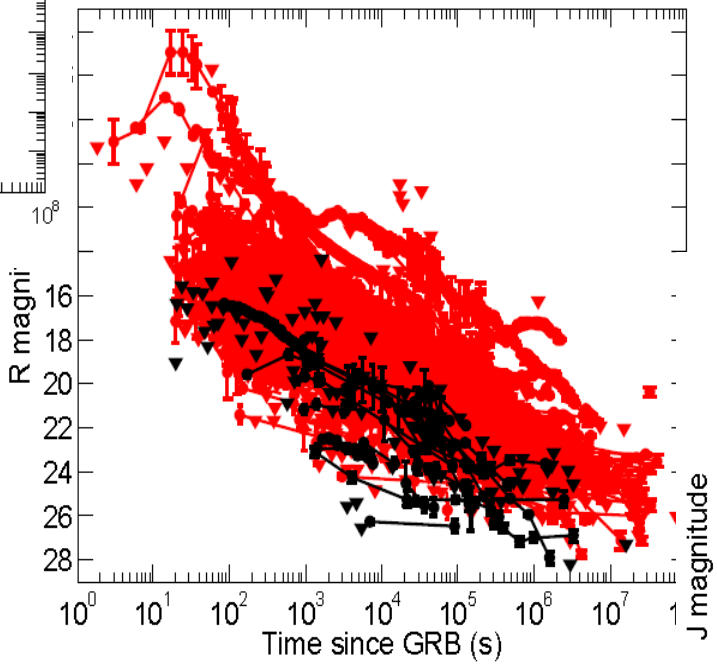
The GRB afterglow observations

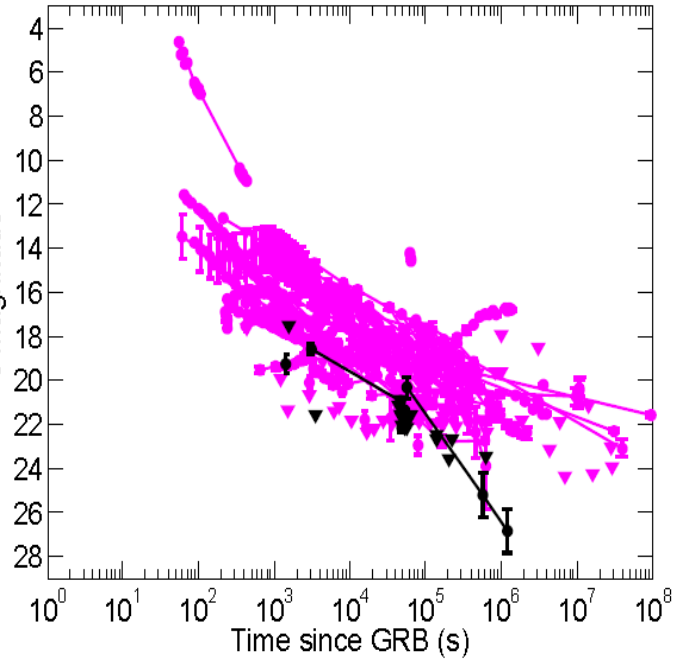
x-rays

R-band

J-band

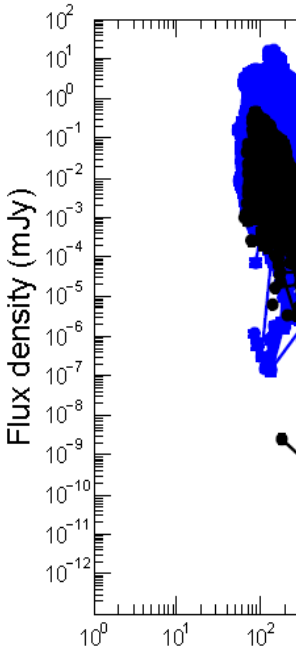


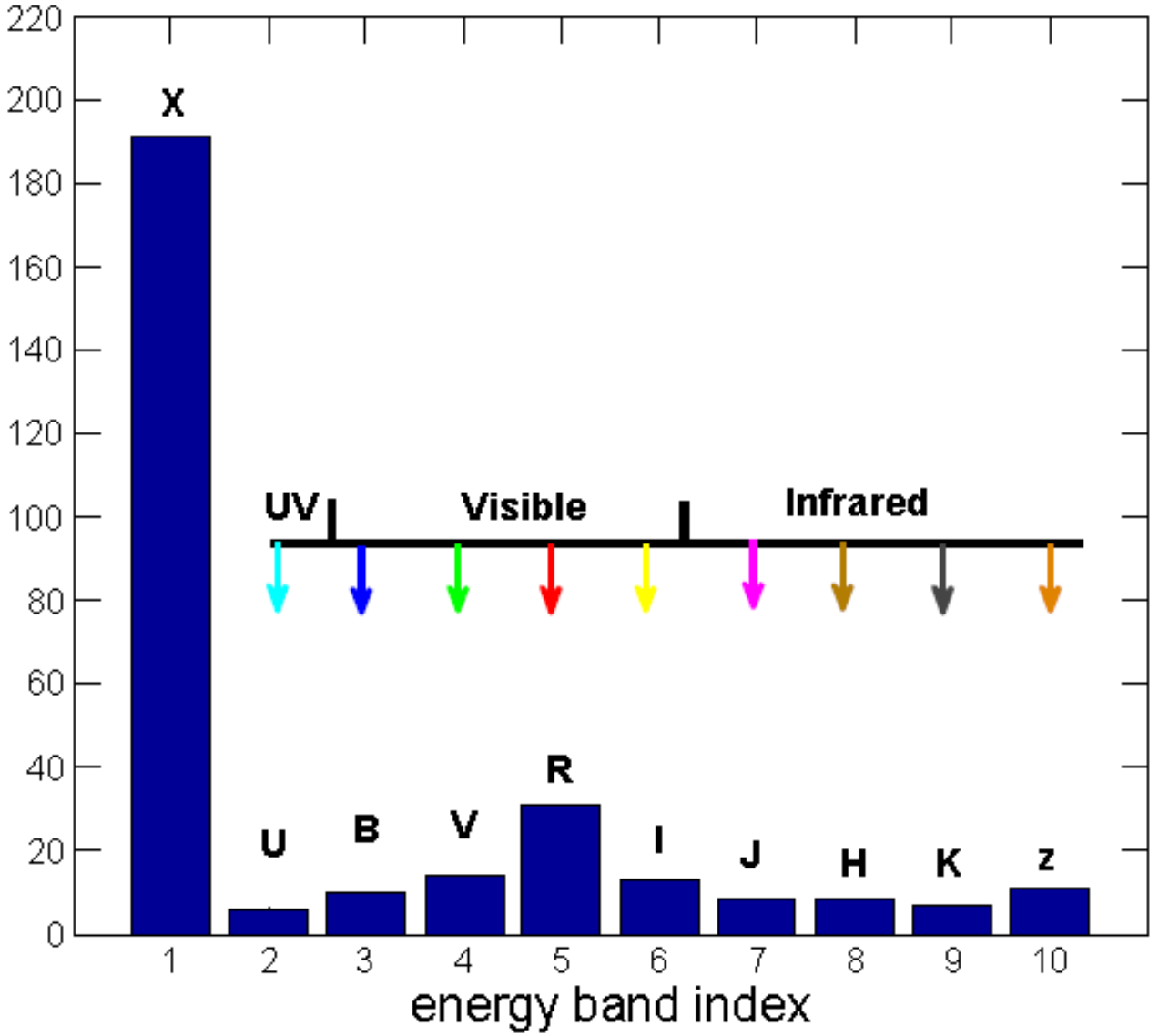




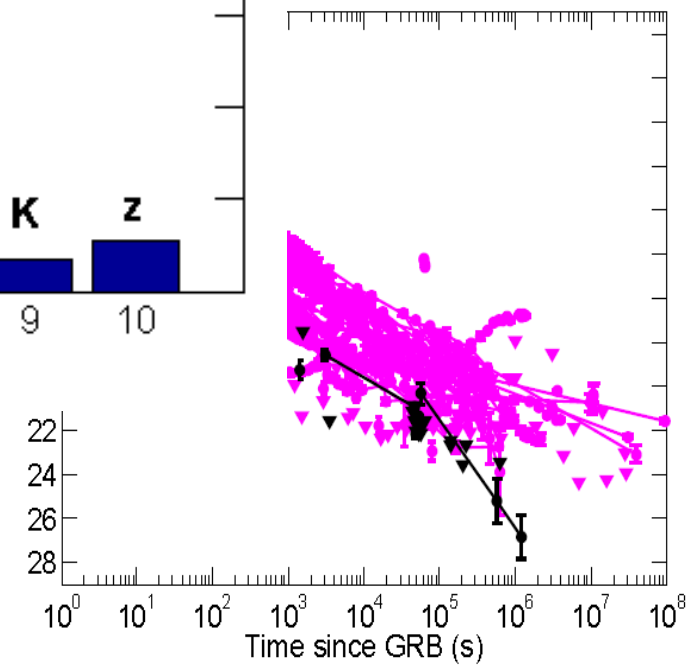
Poor observations in the IR domain

Distribution of the obs./energy band





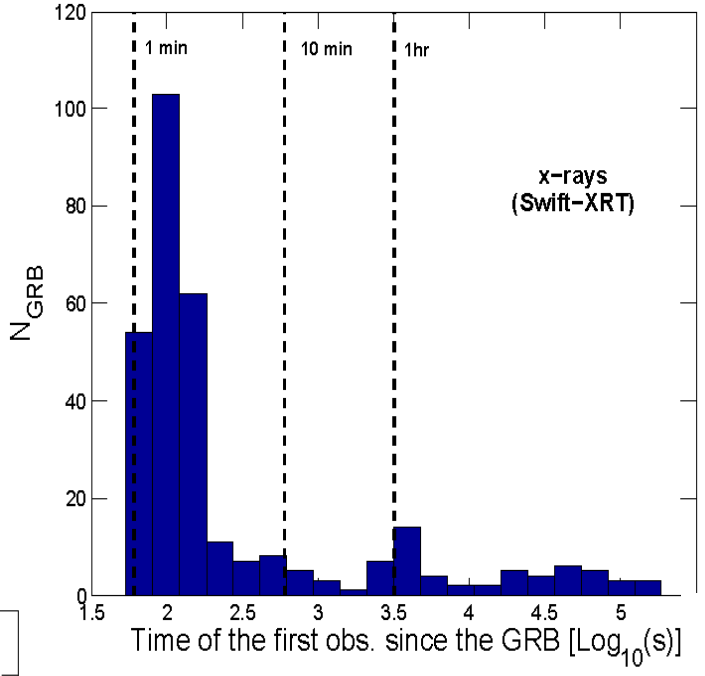
J-band



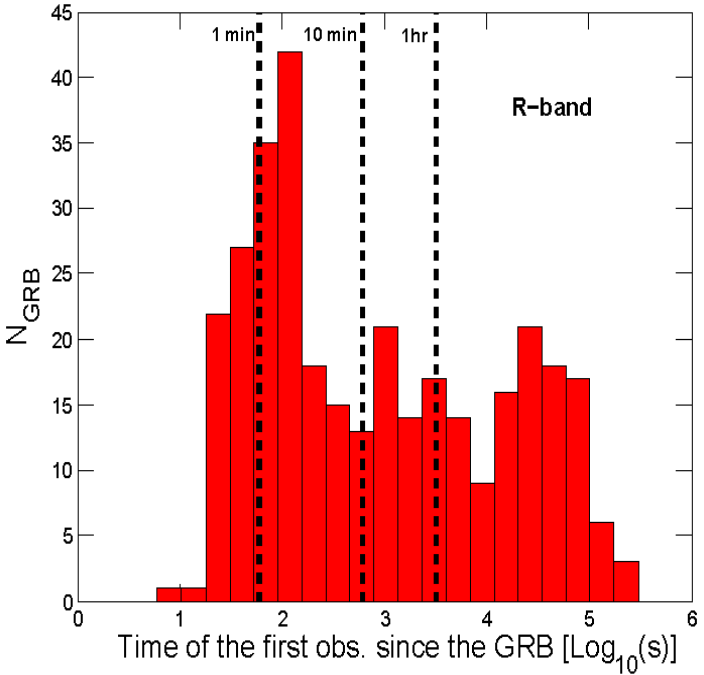
A poor sampling in the optical band and particularly in the IR domain

The delays between the GRB trigger

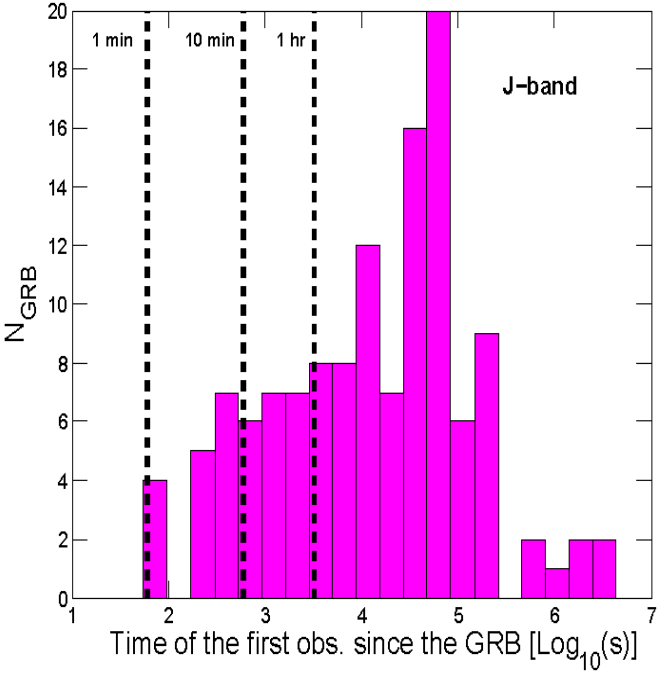
First obs. : ~1 min



First obs. : >5 min



First obs. : >15 h



Need for afterglow follow-up improvements in the optical domain

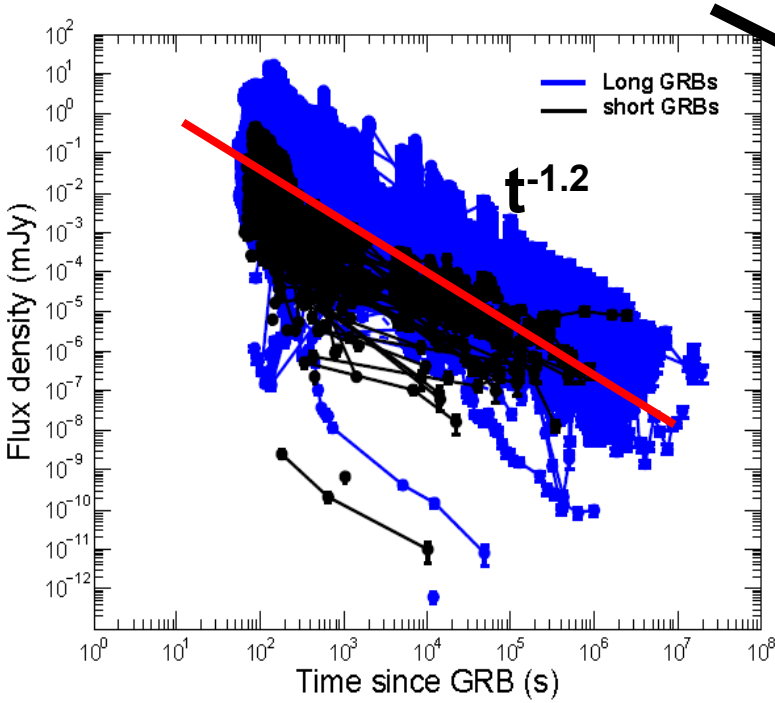
→ need for dedicated telescopes

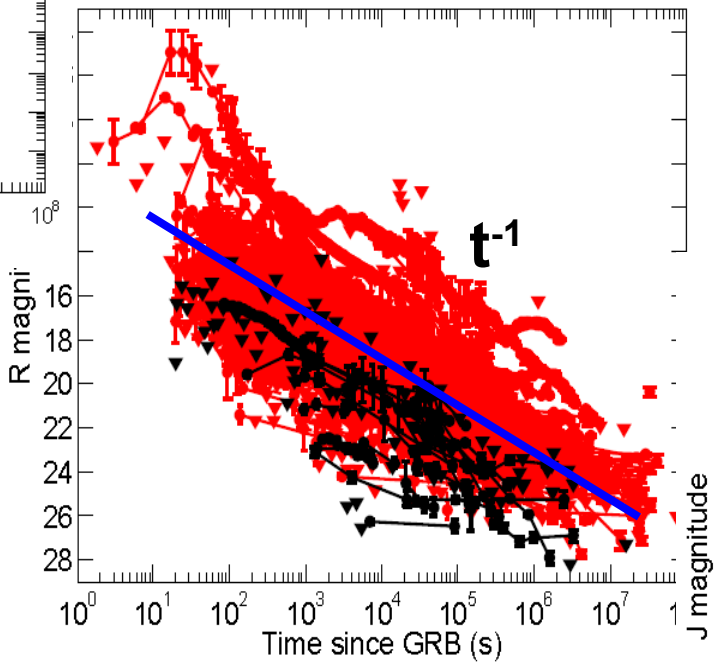
The GRB afterglow observations

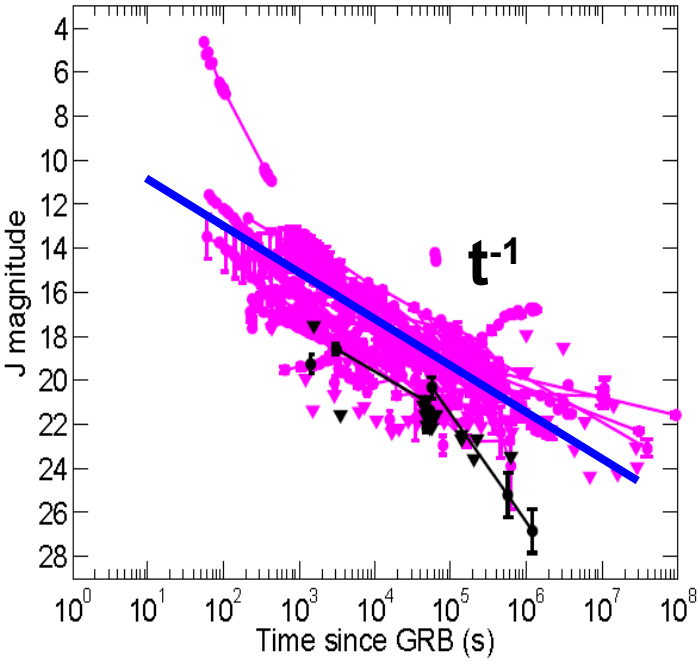
x-rays

R-band

J-band







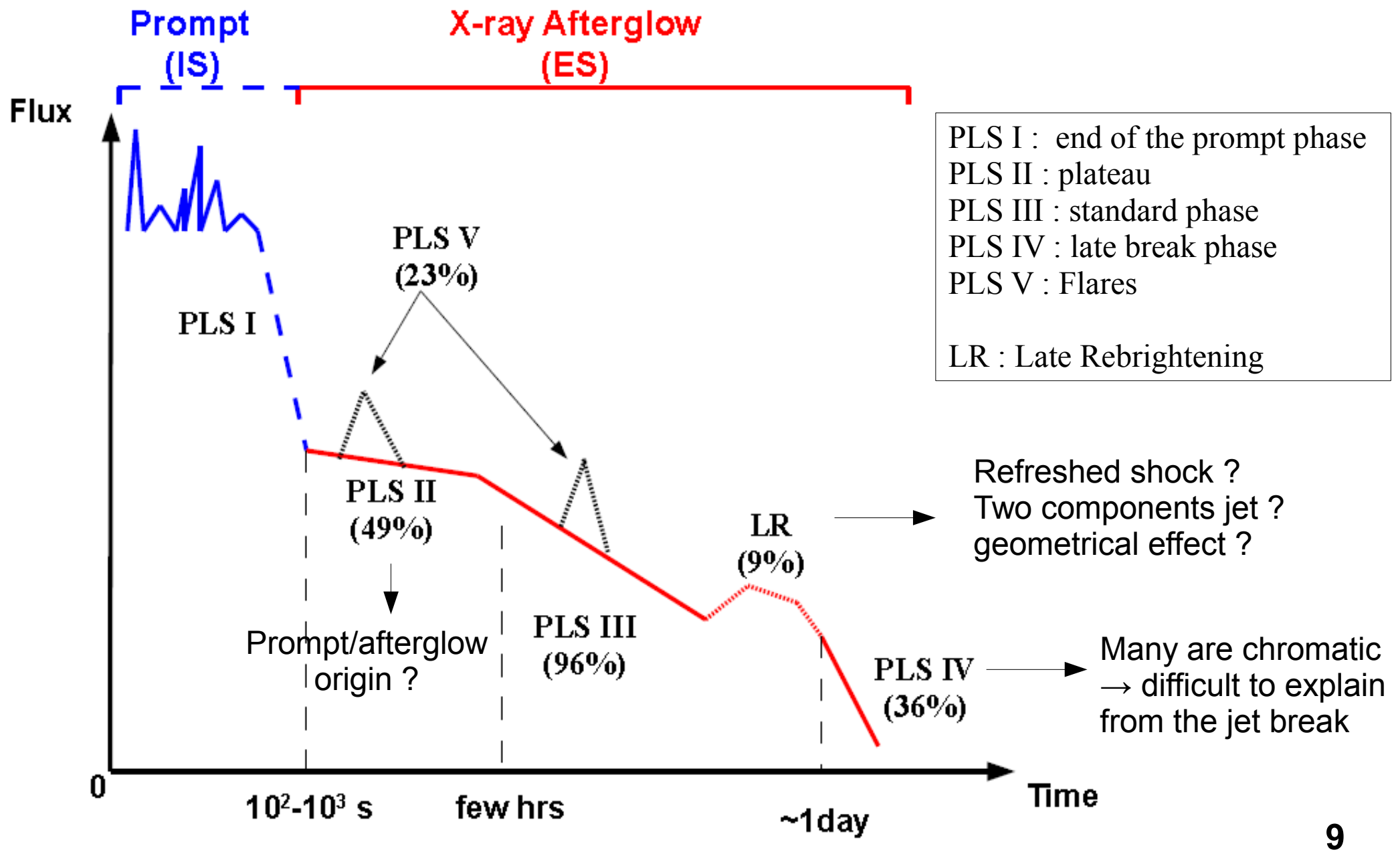
At first sight → good agreement with the theoretical expectations

II.

Is the standard afterglow model sufficient to explain the MW emission of the GRB afterglows ?

The canonical x-ray afterglow light curves

based on 273/353 Swift x-ray afterglows

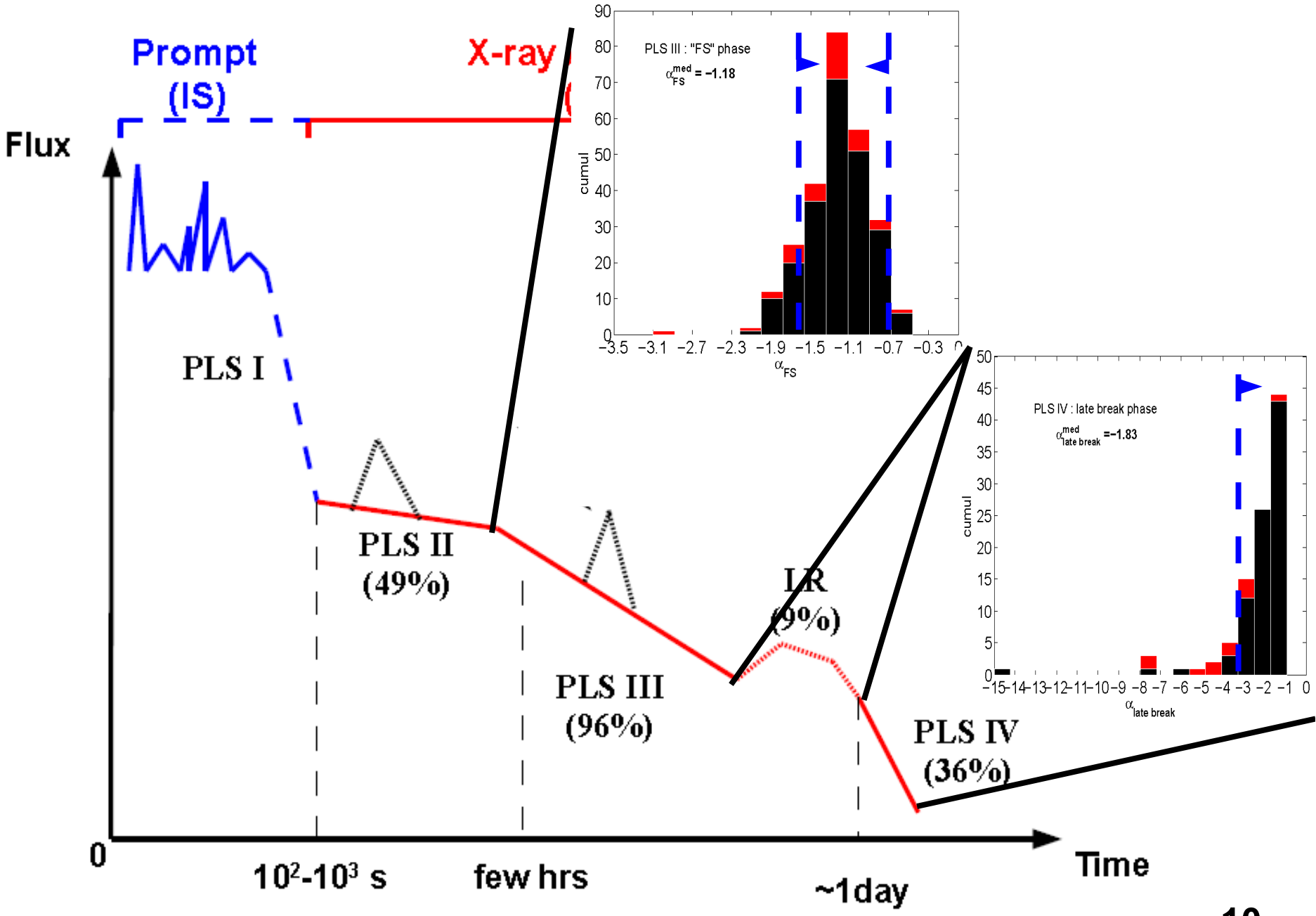


PLS I : end of the prompt phase
PLS II : plateau
PLS III : standard phase
PLS IV : late break phase
PLS V : Flares

LR : Late Rebrightening

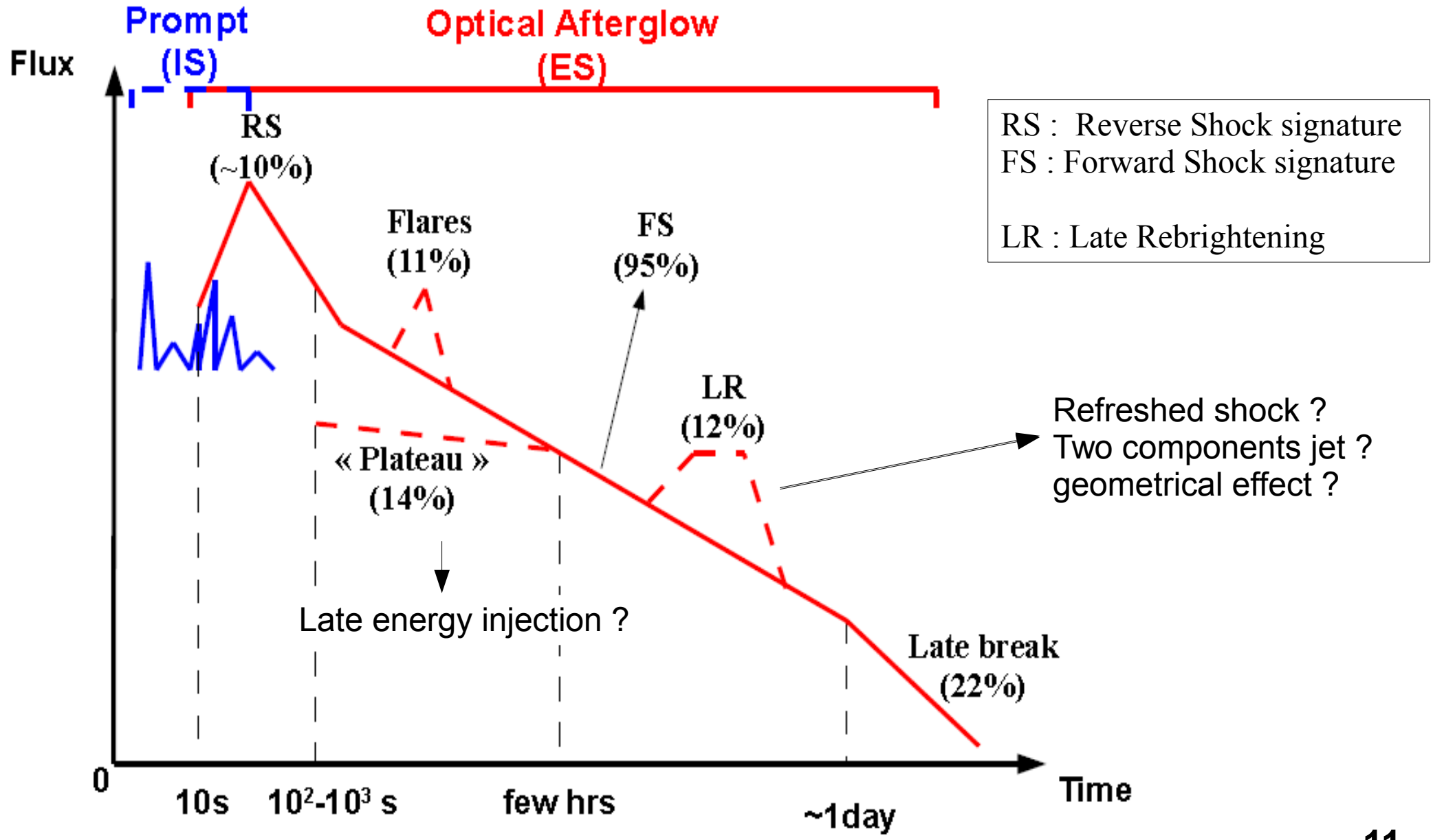
The canonical x-ray afterglow light curves

based on 273/353 Swift x-ray afterglows



The canonical optical afterglow light curves

based on 208/362 optical afterglows

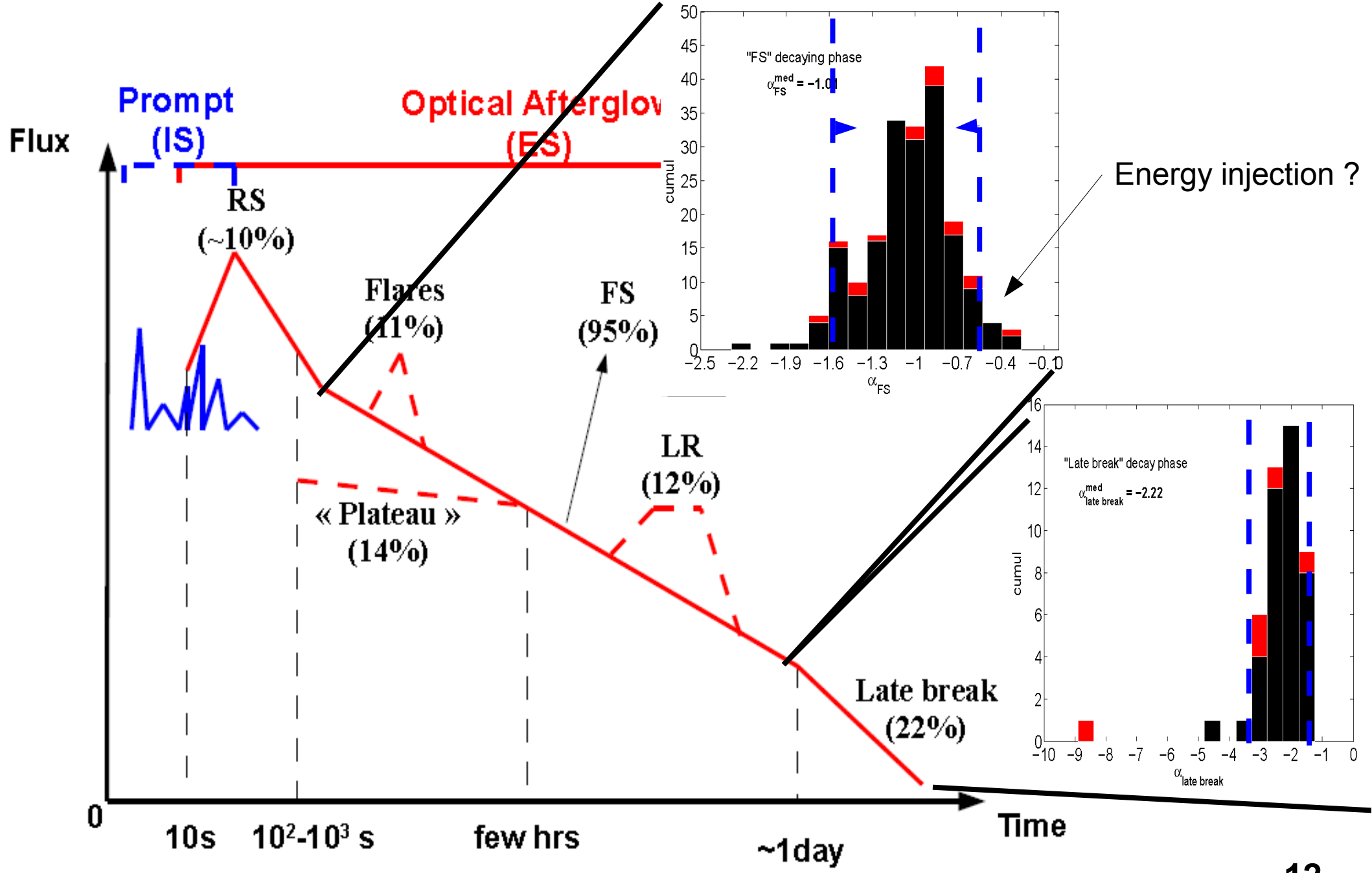


RS : Reverse Shock signature
FS : Forward Shock signature

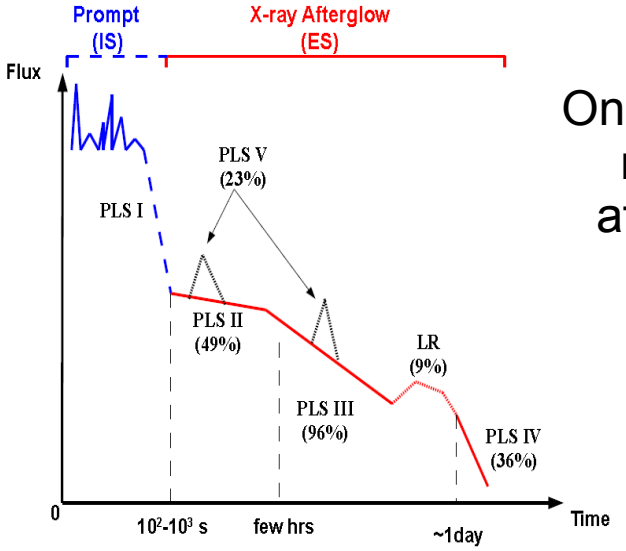
LR : Late Rebrightening

The canonical optical afterglow light curves

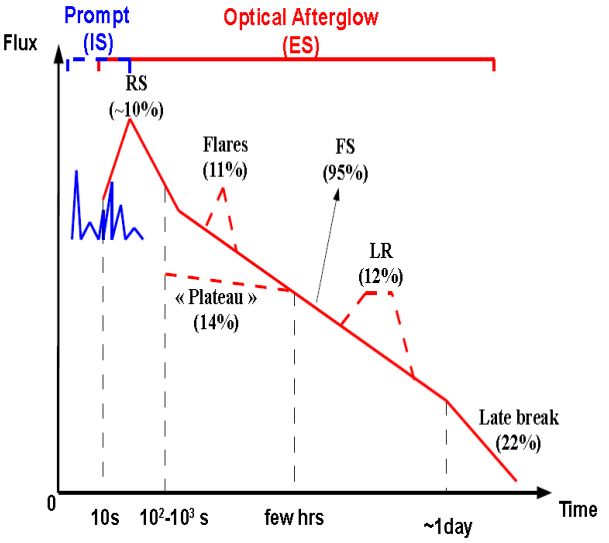
based on 208/362 optical afterglows



Combined analysis (x-ray/optical)



Only 150/426 GRBs have reliable x-ray/optical afterglow counterparts



X-rays

Optical

95% of GRBs exhibit a standard FS phase with the same properties for Short and Long GRBs

BUT

~32-77 %(worst-best cases) of GRBs are explainable with the standard GRB afterglow model + few tunings

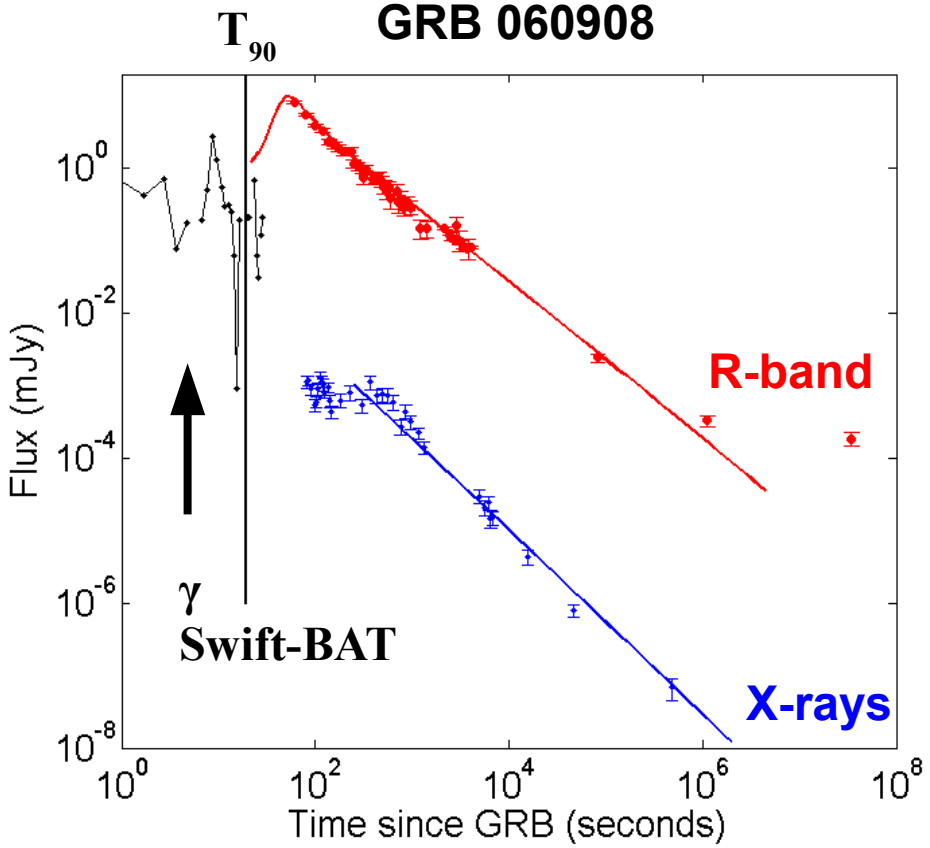
~68-23 %(worst-best cases) of GRBs are beyond the standard model predictions → chromatic behaviors

"Standard GRBs" : Constraints on the GRB physics

Needs:

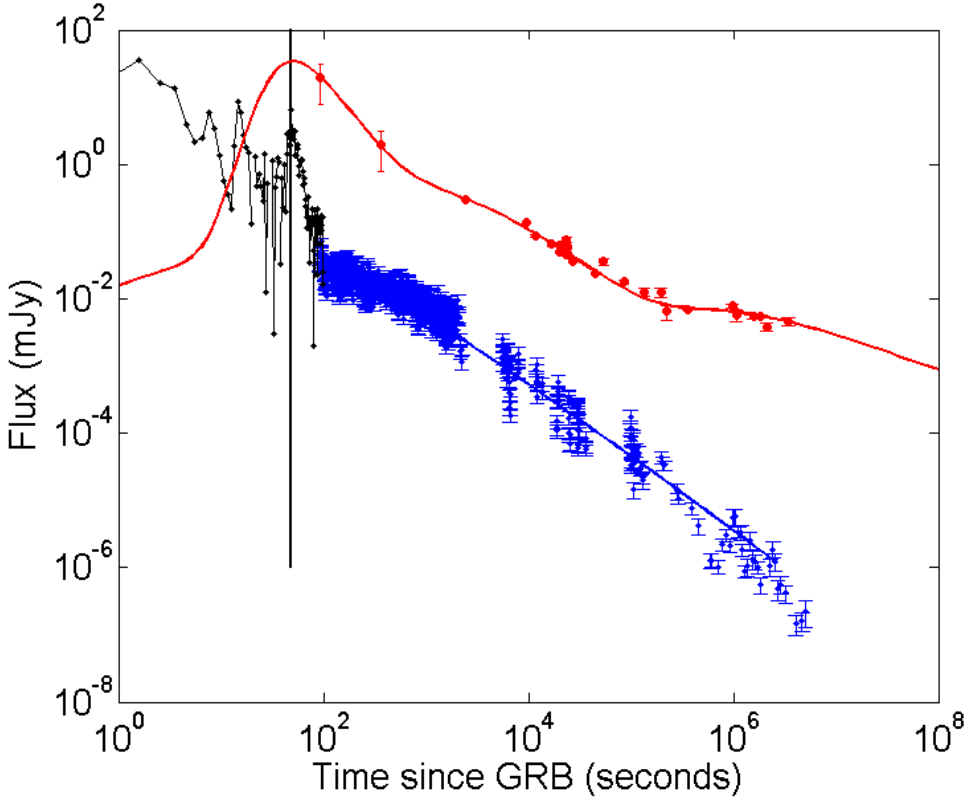
- well sampled MW afterglow light curves
- Early data
- Redshift (→ optical afterglow) + E_{iso} (prompt emission)

GRB 060908



Γ = 168 according to eq.1 *Molinari+07*
R_{dec} = 4.9 x 10^{16} cm
n_0 = 1.3 cm^{-3}
η = 70%

GRB 090424



Γ = 135 according to eq.1 *Molinari+07*
R_{dec} = 2.0 x 10^{17} cm
n_0 = 0.07 cm^{-3}
η = 74%

IV.
Conclusion and prospects

Conclusions & prospects

1- GRB afterglow observation of this last 2 decades

→ Good x-ray coverage (early and late) with a good sampling : Swift legacy
→ Visible R-band quite a good coverage but still lack of early and very late obs.
→ Still a poor IR and radio coverage

2- The main remaining unknows

→ The origin of the optical/x-ray plateaus
→ The origin of the late break phases : chromaticism
→ The origin of the Late Rebrightening and flares : chromaticism
→ time-resolved SEDs to extract the microphysical parameters
η, ε_e, ε_B, p, n_0, Γ, $E_{k,jet}$, θ_{jet} + dust extinction laws (gal+hosts)
→ Complete MW modelisations are still difficult
→ optical selection effects (redshift measurement)

More coordinated MW obs. are needed for individual/statistical studies

3- Urgent Needs for GRB studies !

(GRB Science with SVOM)

→ Early optical obs. BUT also very late obs. To catch the late break phase
→ Well sampled x-ray/optical light curves
→ Early measure of the redshifts (spectroscopy or at least photo-z)