# Inhomogeneities in optical light curves of GRB afterglow

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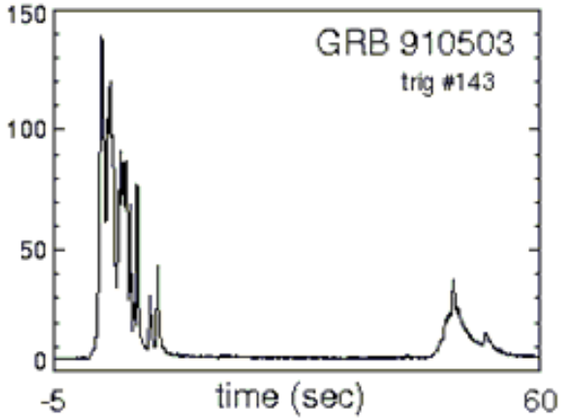
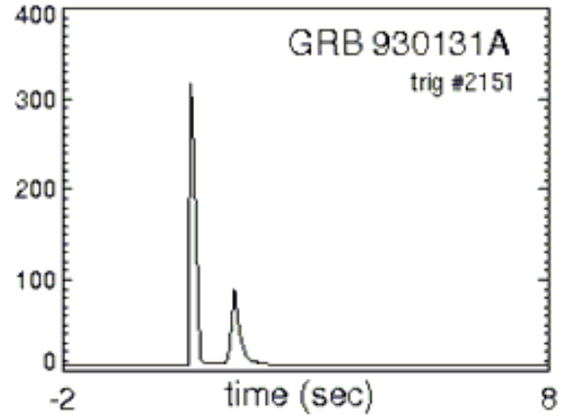
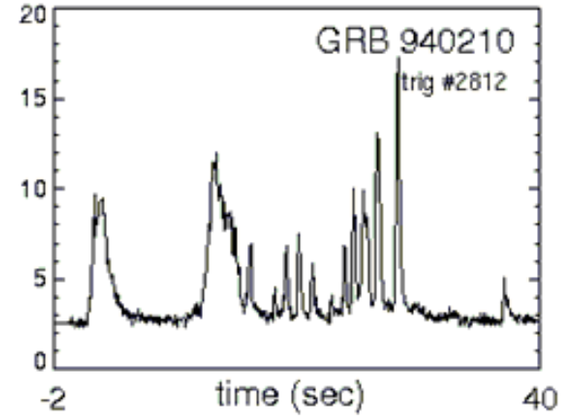
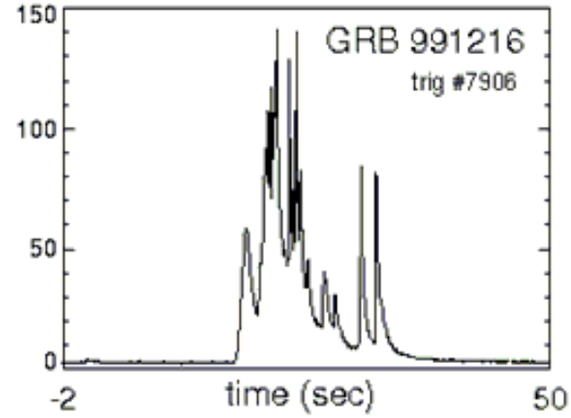
# Gamma-ray burst light curves

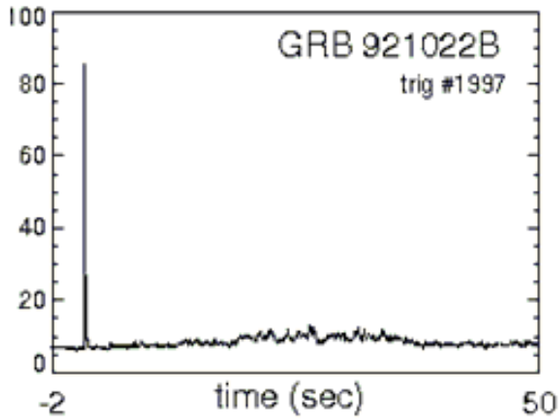
## Gamma-ray

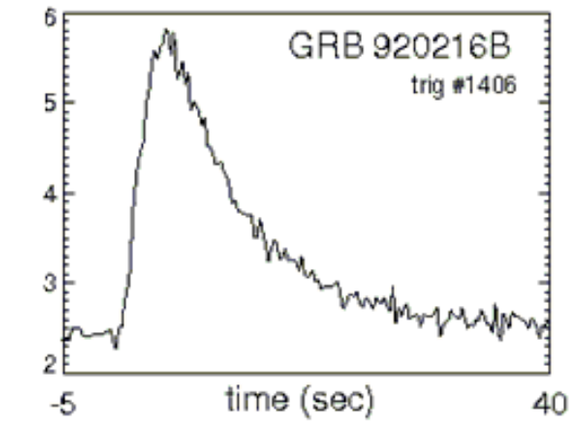


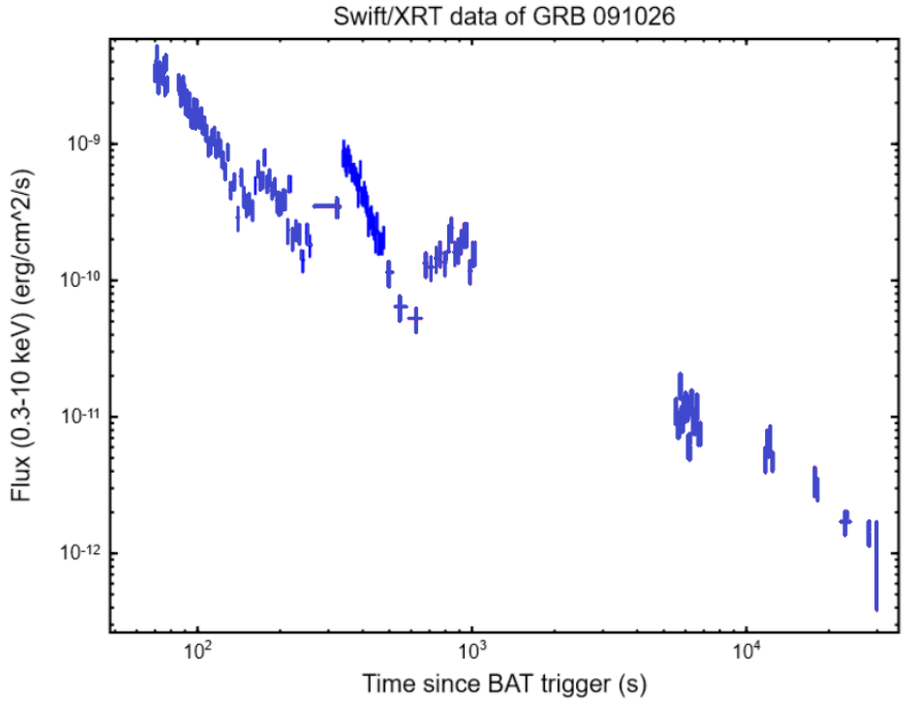



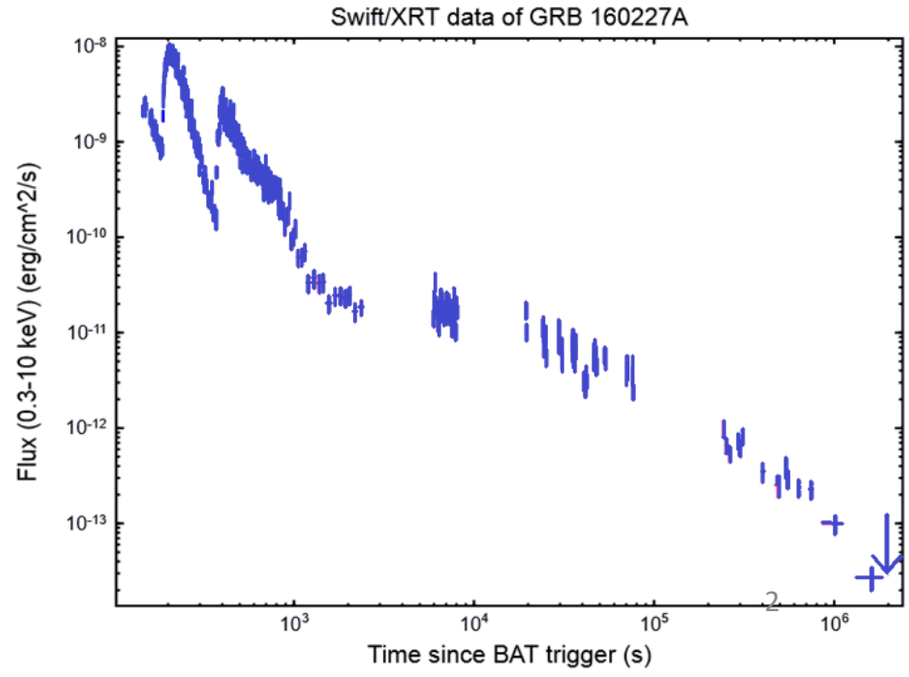



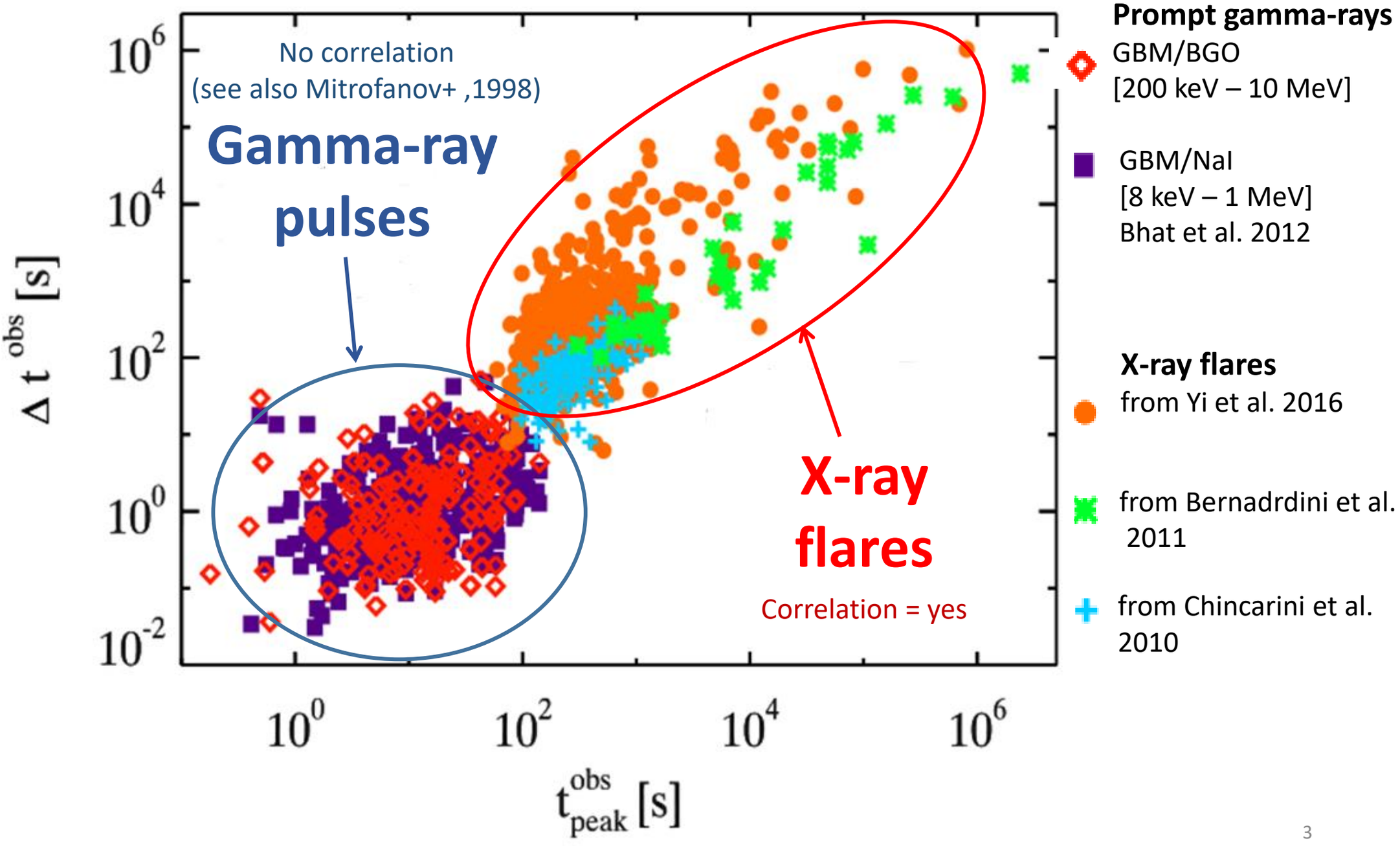




## X-ray

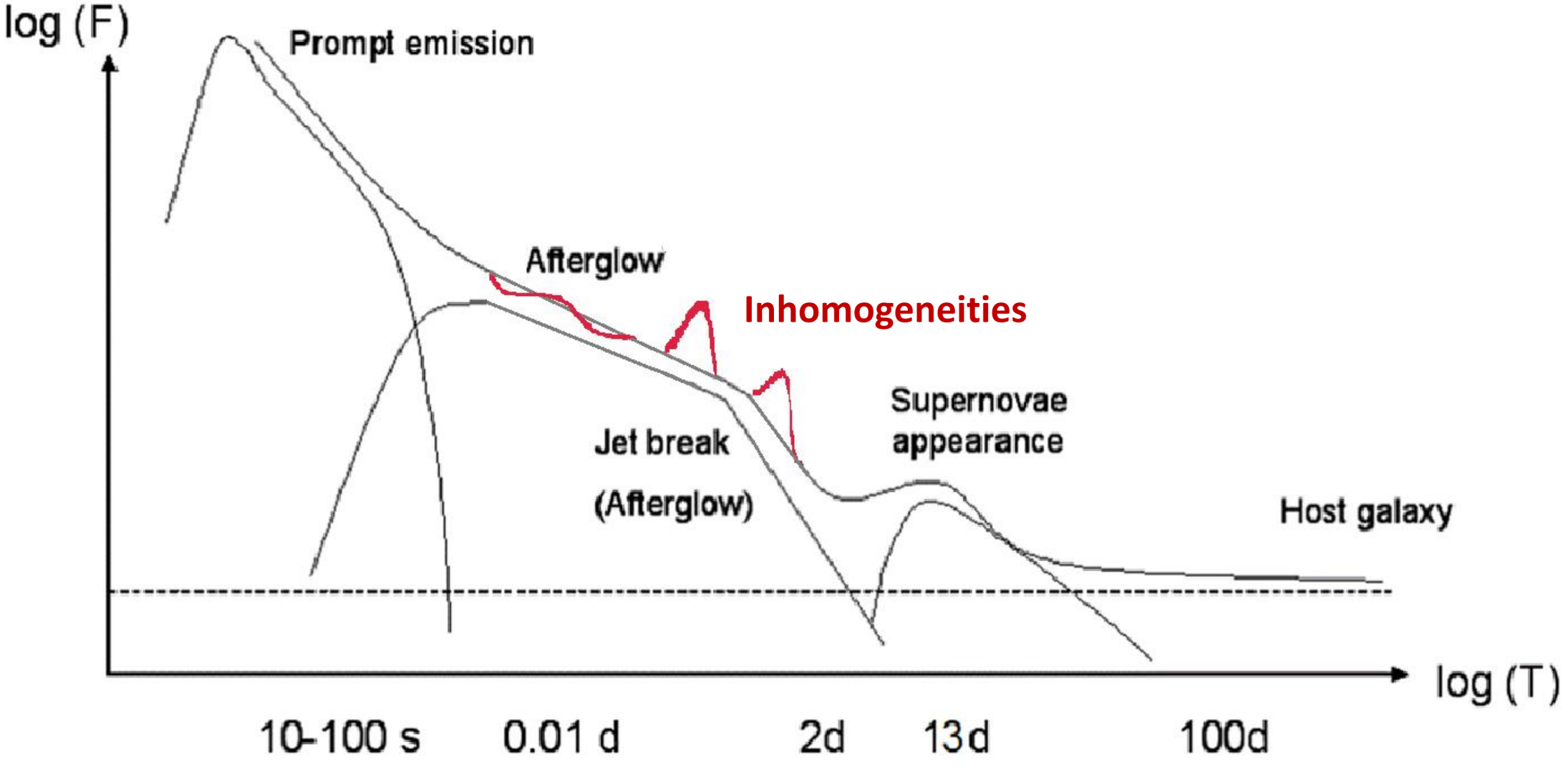


# Duration versus peak time [Pescalli et al. 2018]



# Schematic optical light curve



# IKI GRB Follow-up Network

(used for this work)

**CrAO**
ZTSh (2,6),
AZT-11 (1,25),
AZT-8 (0,7)

**SAO**
Zeiss-1000

**Abastumani**
AS-32 (0,7)

**ISON-Kislovodsk**
K-800 (0,8)

**ISON-NM**
(0,45)


**Mondy**
AZT-33IK
(1,5)

**ISON-Khureltogoot**
ORI-40 (0,4)

**TSHAO**
Zeiss-1000

**Maidanak**
AZT-22 (1,5)

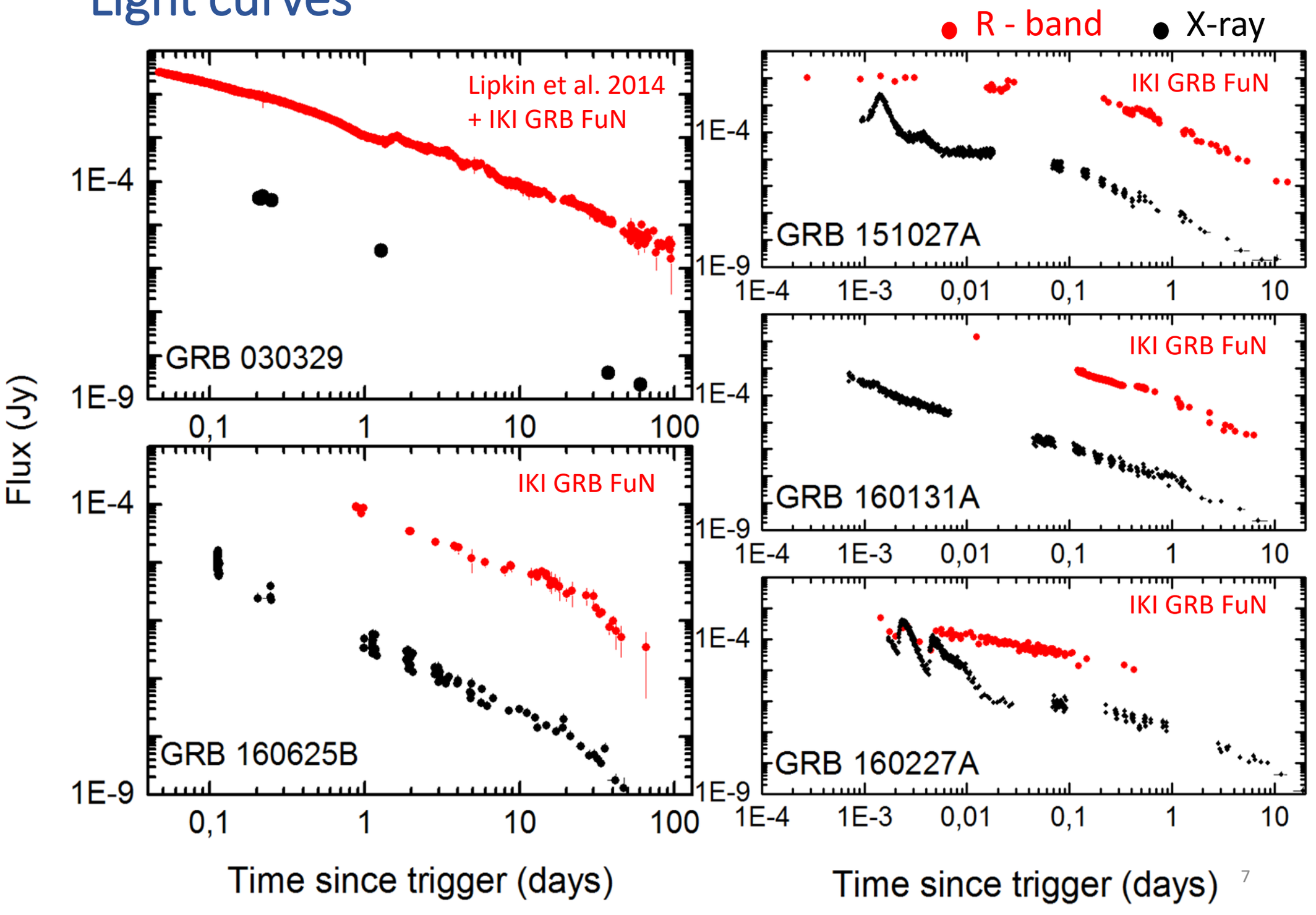
# Properties of the analyzed GRBs.

| GRB | $T_{90}$ (sec) | Redshift | Number of photometry measurements |
|---|---|---|---|
| 030329 | 22.9 | 0.1685 | 452 + 2873 |
| 151027A | $130 \pm 6$ | 0.81 | 189 + 27 |
| 160131A | $325 \pm 72$ | 0.972 | 553 + 9 |
| 160227A | $317 \pm 75$ | 2.38 | 60 + 31 |
| 160625B | $35.1 \pm 0.2$ | 1.406 | 38 + 0 |

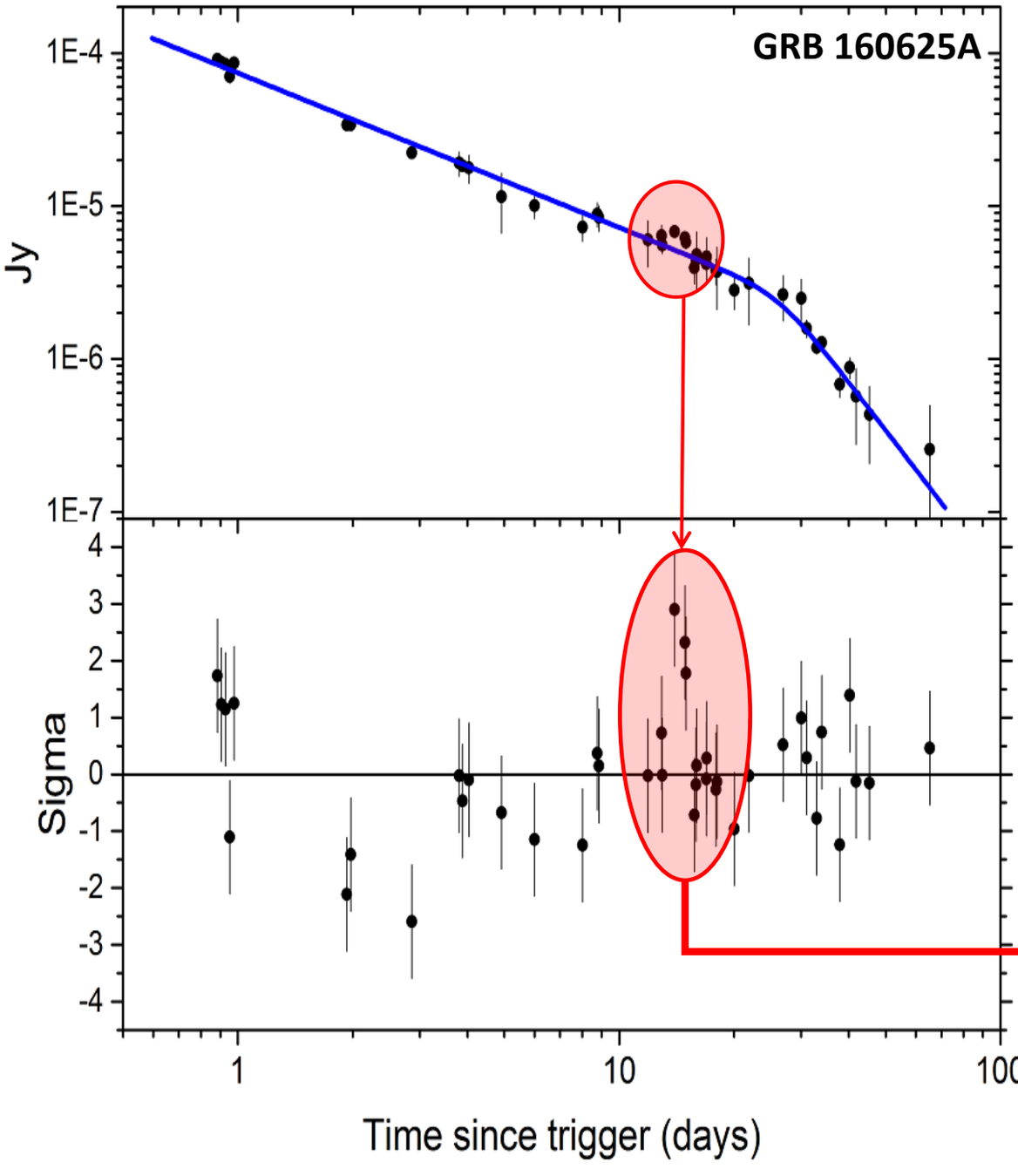
The optical data were obtained by IKI GRB FuN

The optical data were obtained by literature

# Light curves



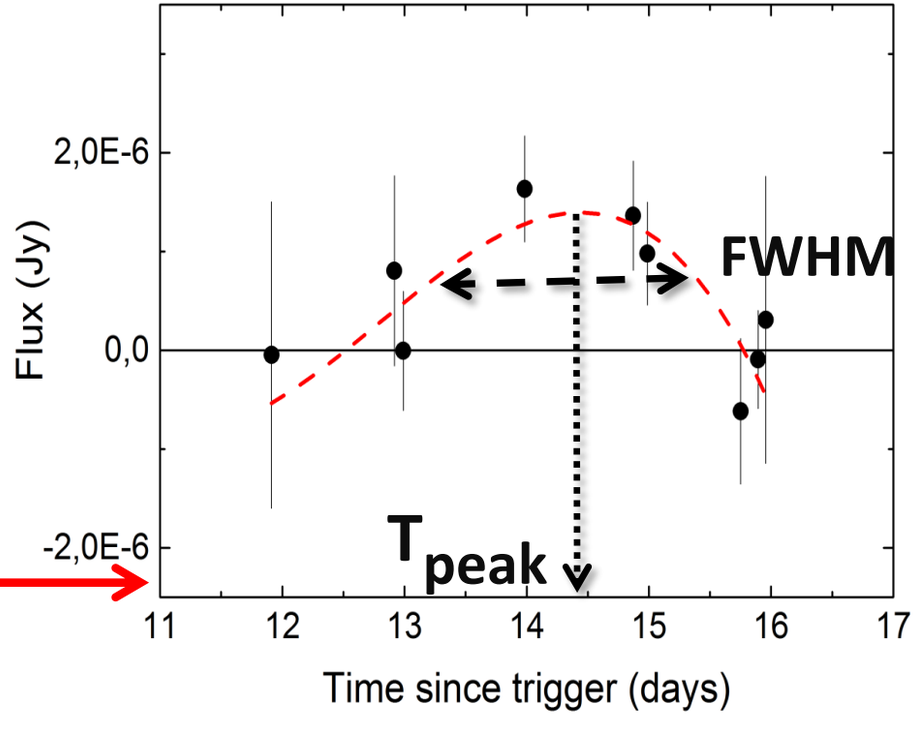
# Extraction of inhomogeneities




— Smoothly broken power-law

$$F = F_0 \left[ \left( \frac{t-t_0}{t_{jb}} \right)^{\alpha w} + \left( \frac{t-t_0}{t_{jb}} \right)^{\beta w} \right]^{-1/w}$$

- - Polynomial fitting

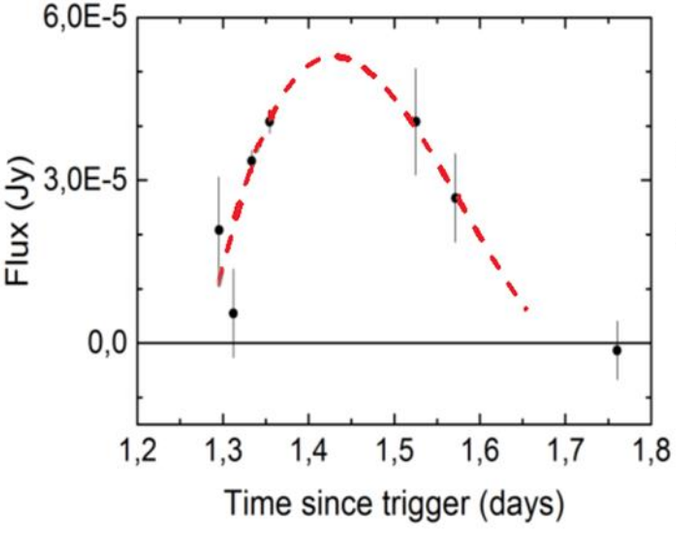


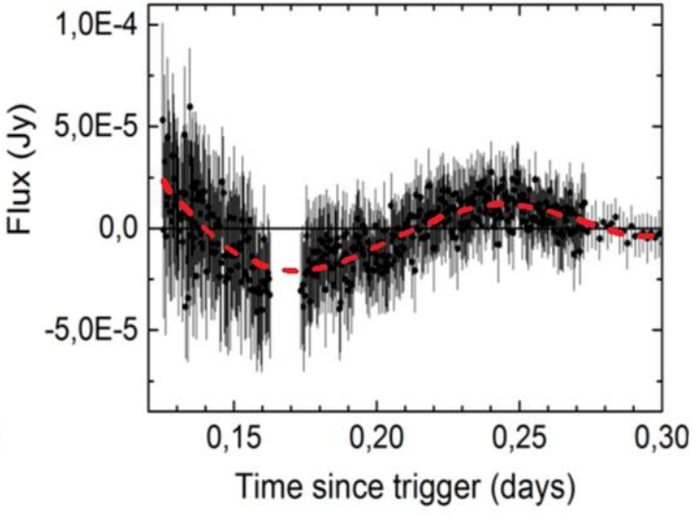
# Types of optical inhomogeneities

**Type 1 flares**

Optic - yes

X-ray - yes




**Type 3 wiggles**

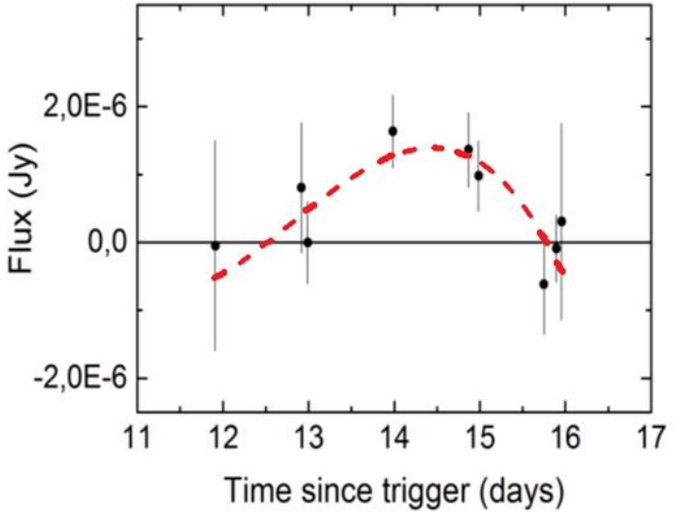
Optic - yes

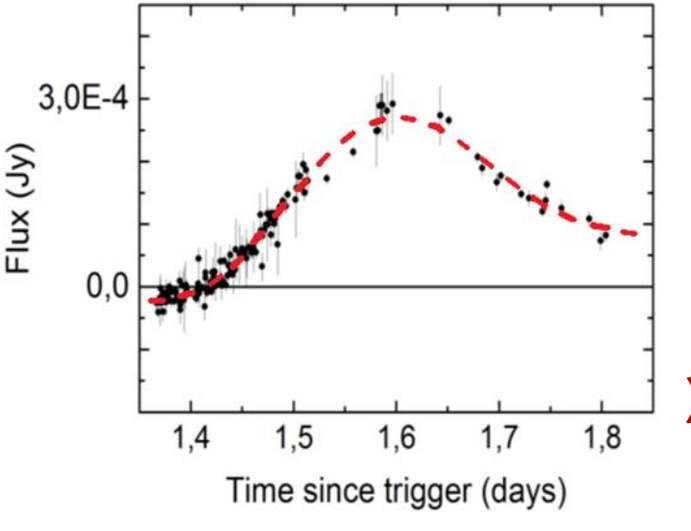
X-ray - no

**Type 2 bumps**

Optic - yes

X-ray - no



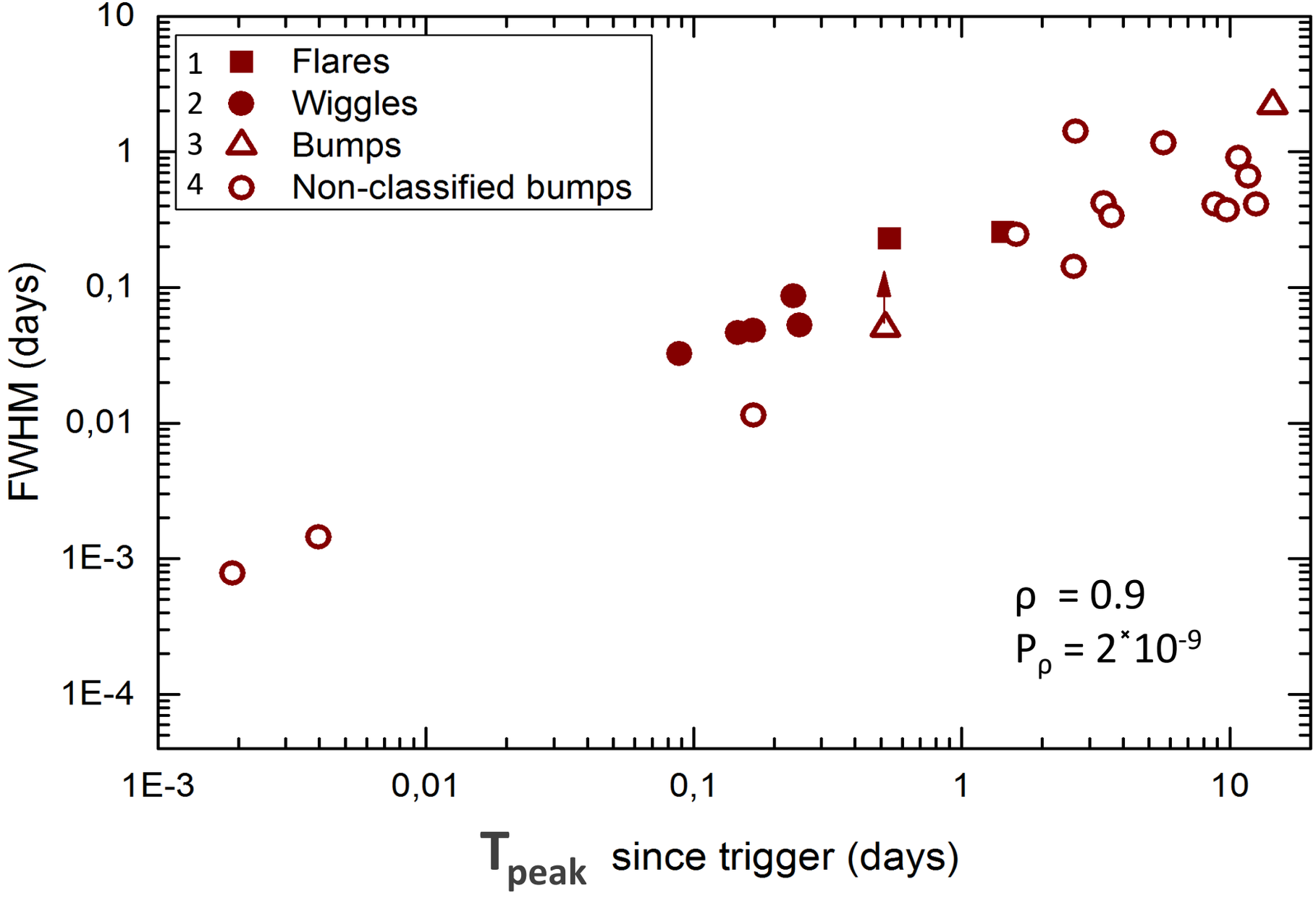

**Type 4 bumps**

Optic - yes

X-ray – no data

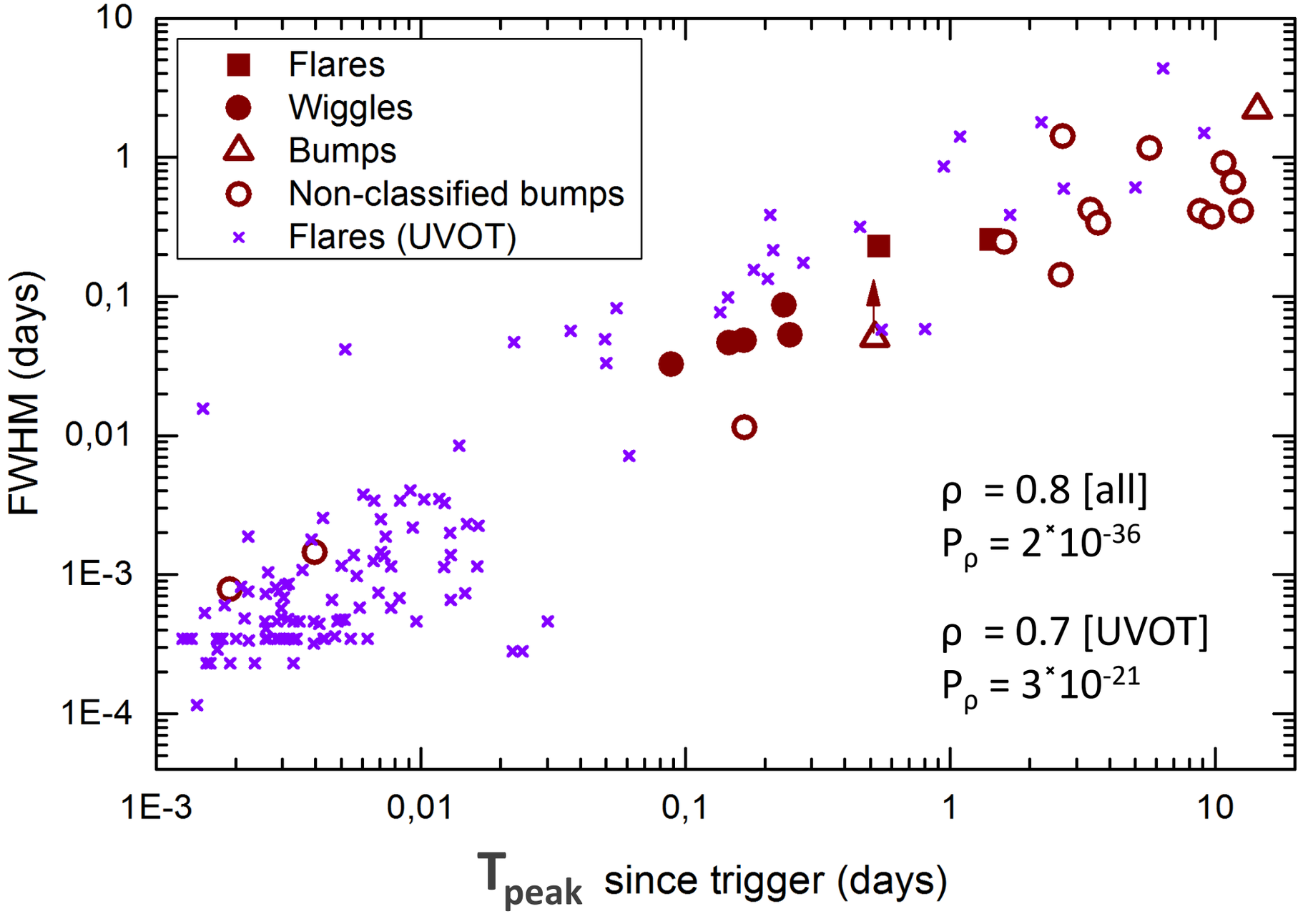
# The FWHM – $T_{peak}$ relation

23 inhomogeneities

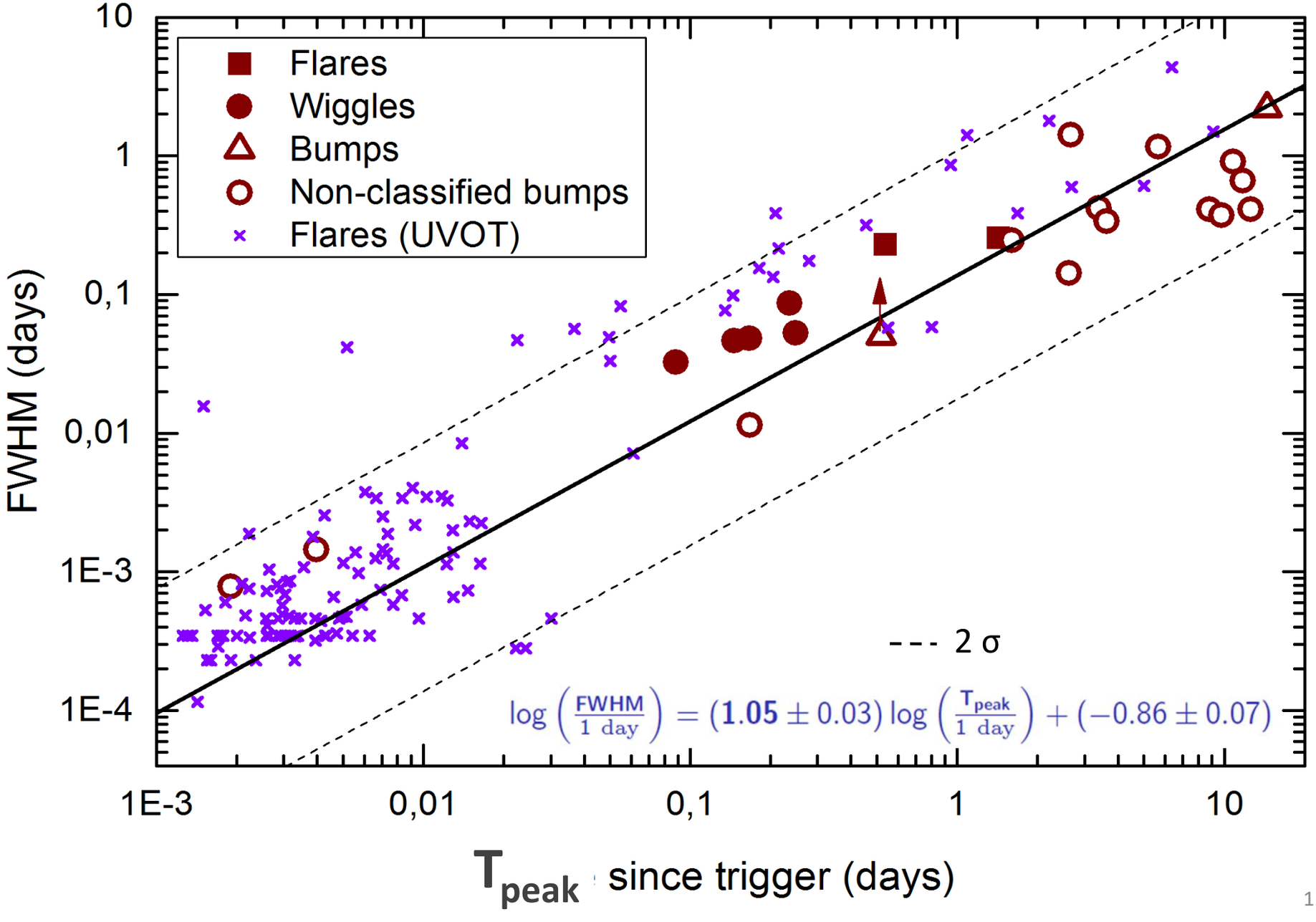


# The FWHM – $T_{peak}$ relation

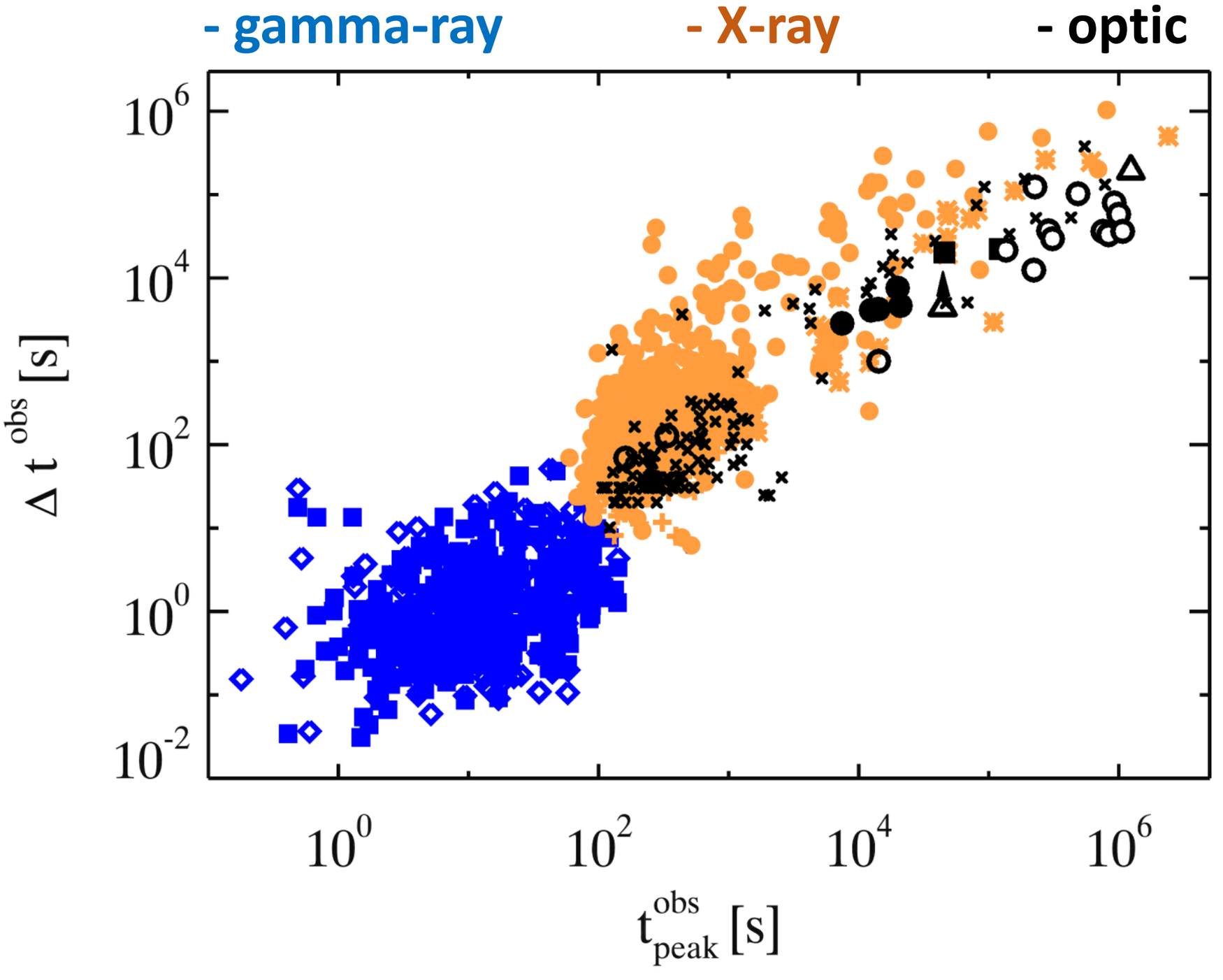
## +119 flares from UVOT (Swenson et al. 2013)



# FWHM ~ $(T_{peak})^{1.05}$



# Duration versus peak time:



# Conclusions

1. All types of the optical inhomogeneities and UVOT flares follow the same correlation between duration and peak time.
2. Inhomogeneities on ground-based telescopes can be observed for more than 10 days.
3. The correlation between the duration and peak time for inhomogeneities in the optical range coincides with the x-ray range, indicating similar nature.

**Mazaeva et al. (2018)**

Thank you for your attention!