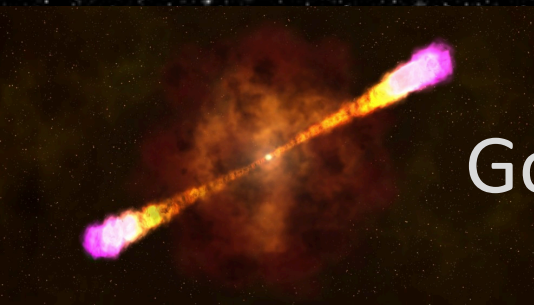




# Gamma-ray Bursts from *Swift*

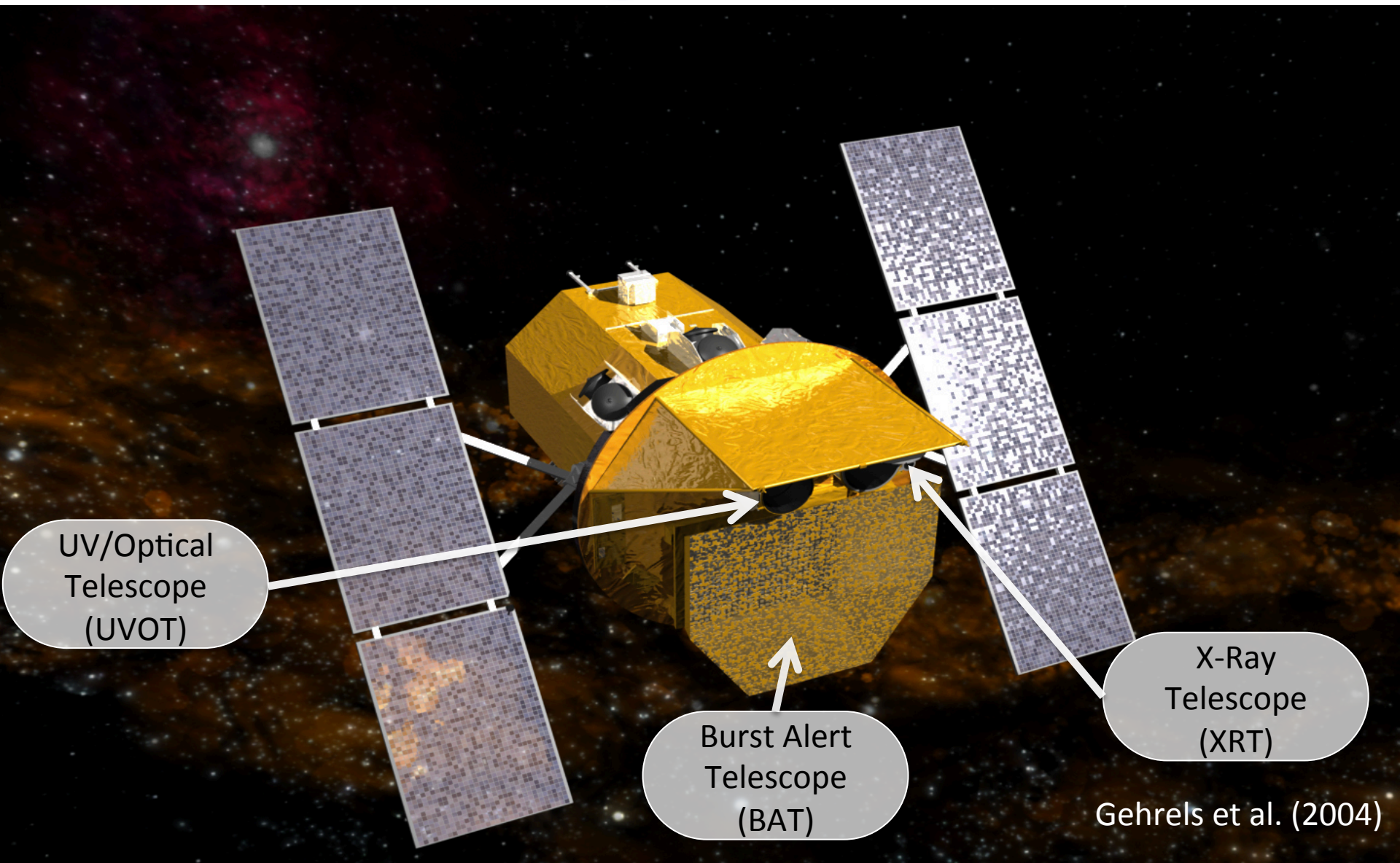
Amy Lien

Goddard Space Flight Center



ASTR 288C, Lecture 3, 2017/09/18

*Swift*



UV/Optical  
Telescope  
(UVOT)

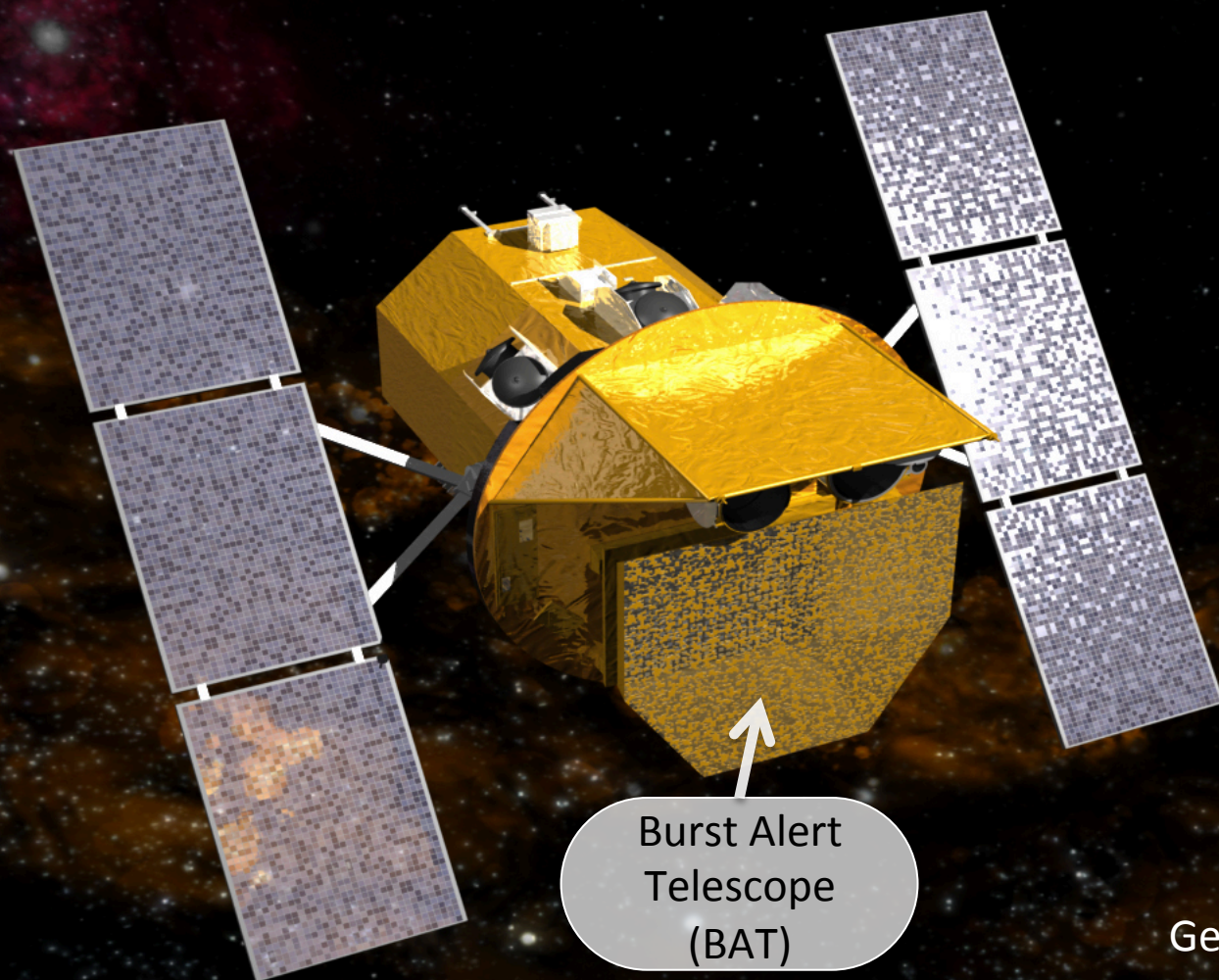
Burst Alert  
Telescope  
(BAT)

X-Ray  
Telescope  
(XRT)

Gehrels et al. (2004)



*Swift*



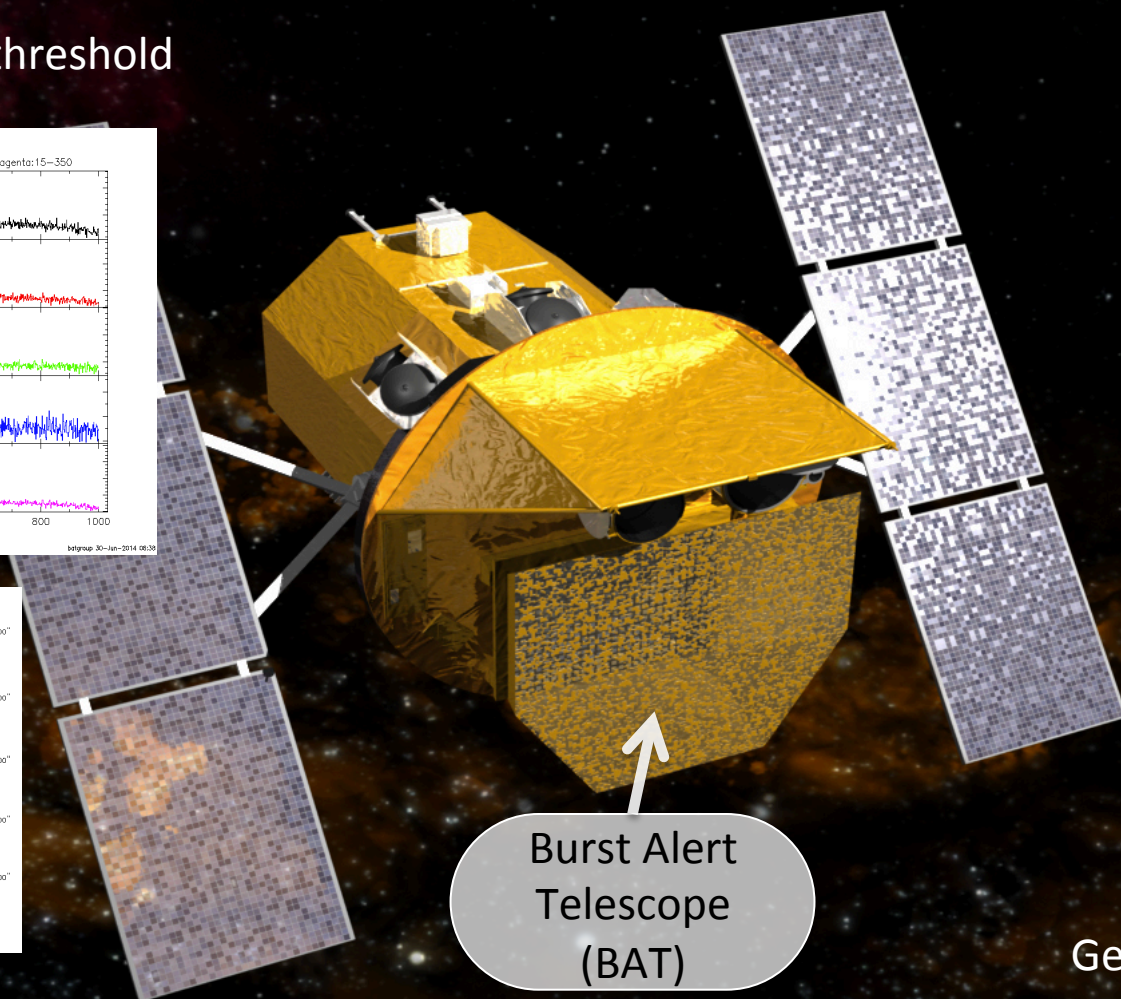
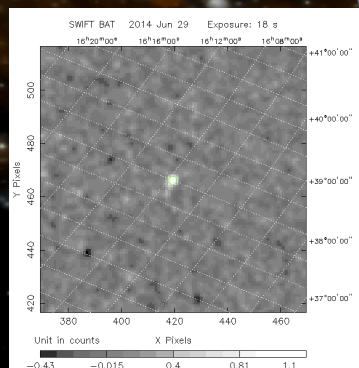
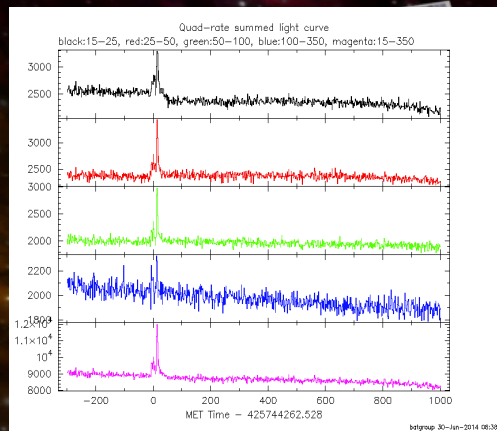
Gehrels et al. (2004)



## A. Rate trigger:

Stage 1: Rate trigger

Stage 2: Image threshold



Burst Alert  
Telescope  
(BAT)

Gehrels et al. (2004)

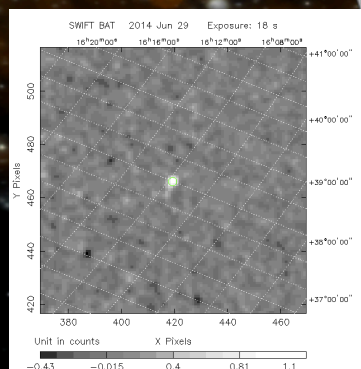
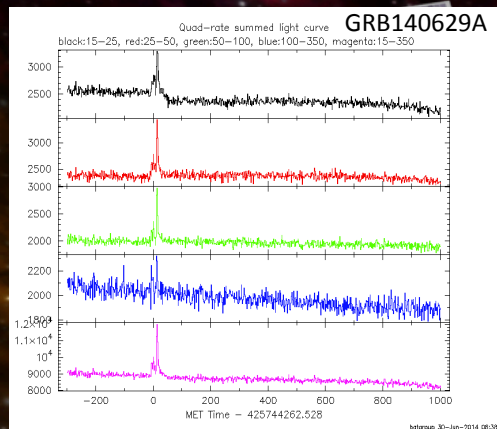




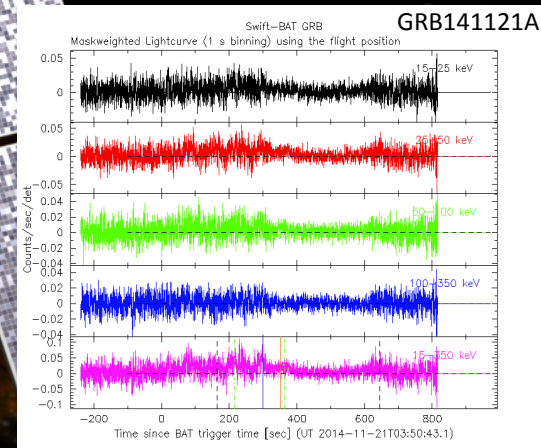
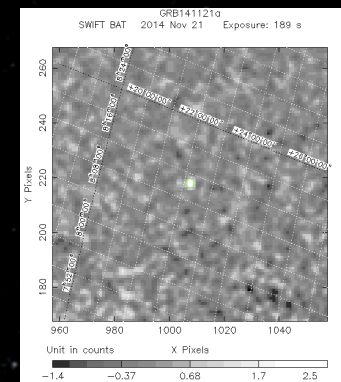
## A. Rate trigger:

Stage 1: Rate trigger

Stage 2: Image threshold



## B. Image trigger:



Burst Alert  
Telescope  
(BAT)

Gehrels et al. (2004)

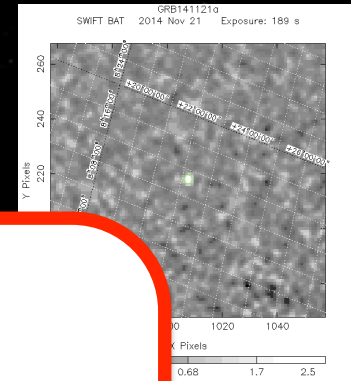
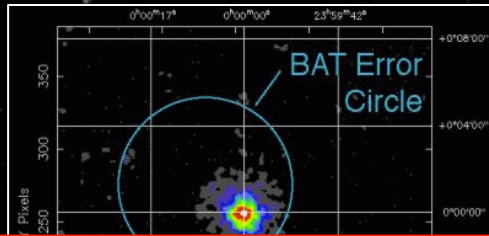


## A. Rate trigger:

Stage 1: Rate trigger

Stage 2: Image threshold

## B. Image trigger:

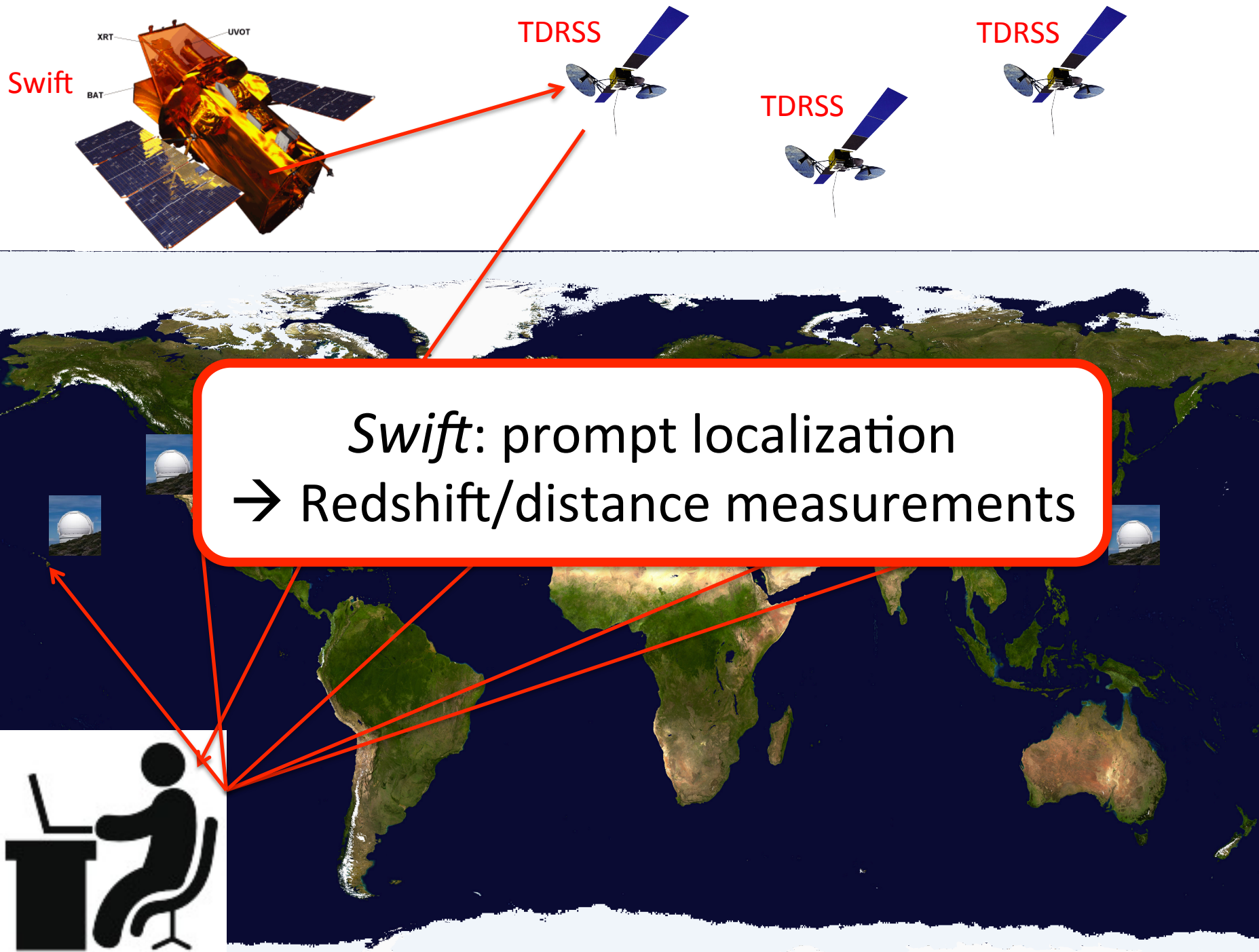


XRT localization  
 → follow-up by ground observatories  
 → take spectrum  
 → measure redshift/distance

Burst Alert  
Telescope  
(BAT)

Gehrels et al. (2004)





# Swift GRBs to date: 12 Years after Launch

- 1172 GRBs till now (GRB170912B)
  - About 2 GRBs per week
- 418 GRBs have redshift/distance measurements

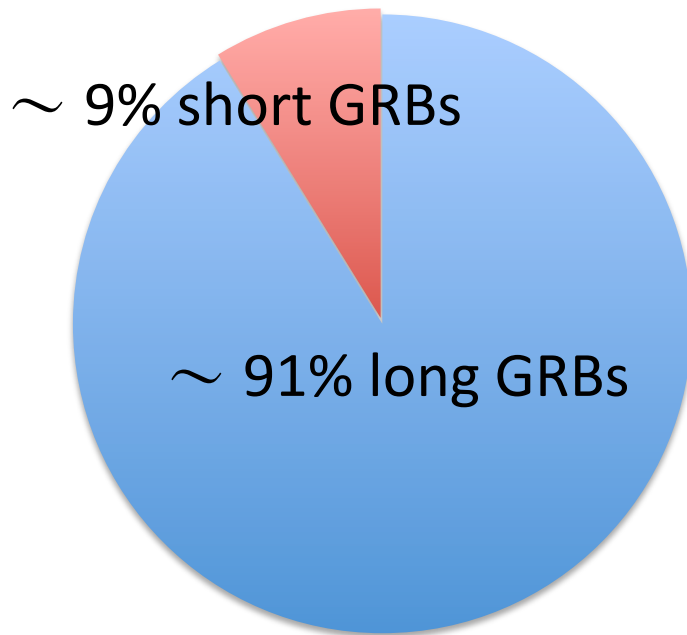


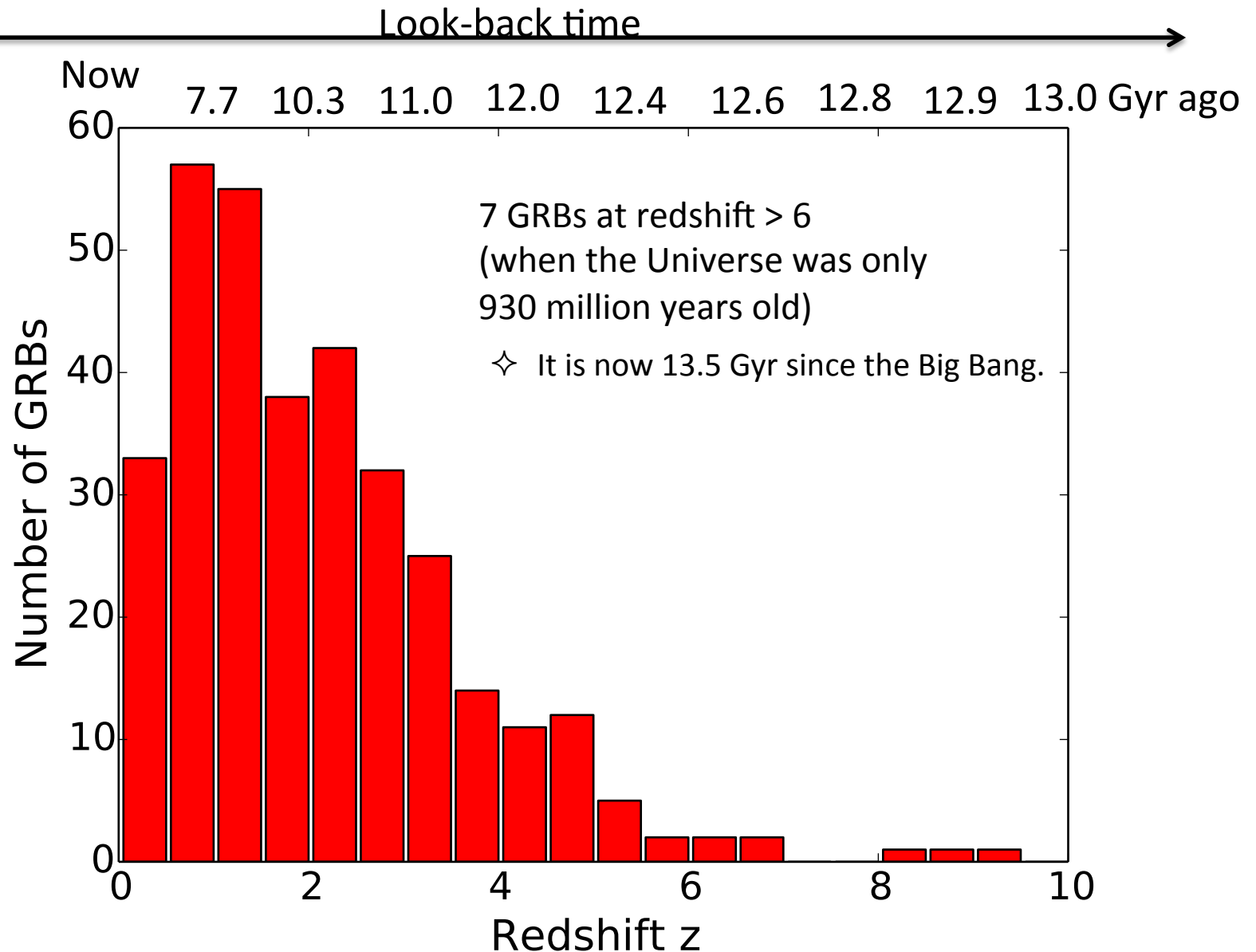
Figure credit: PSU webpage

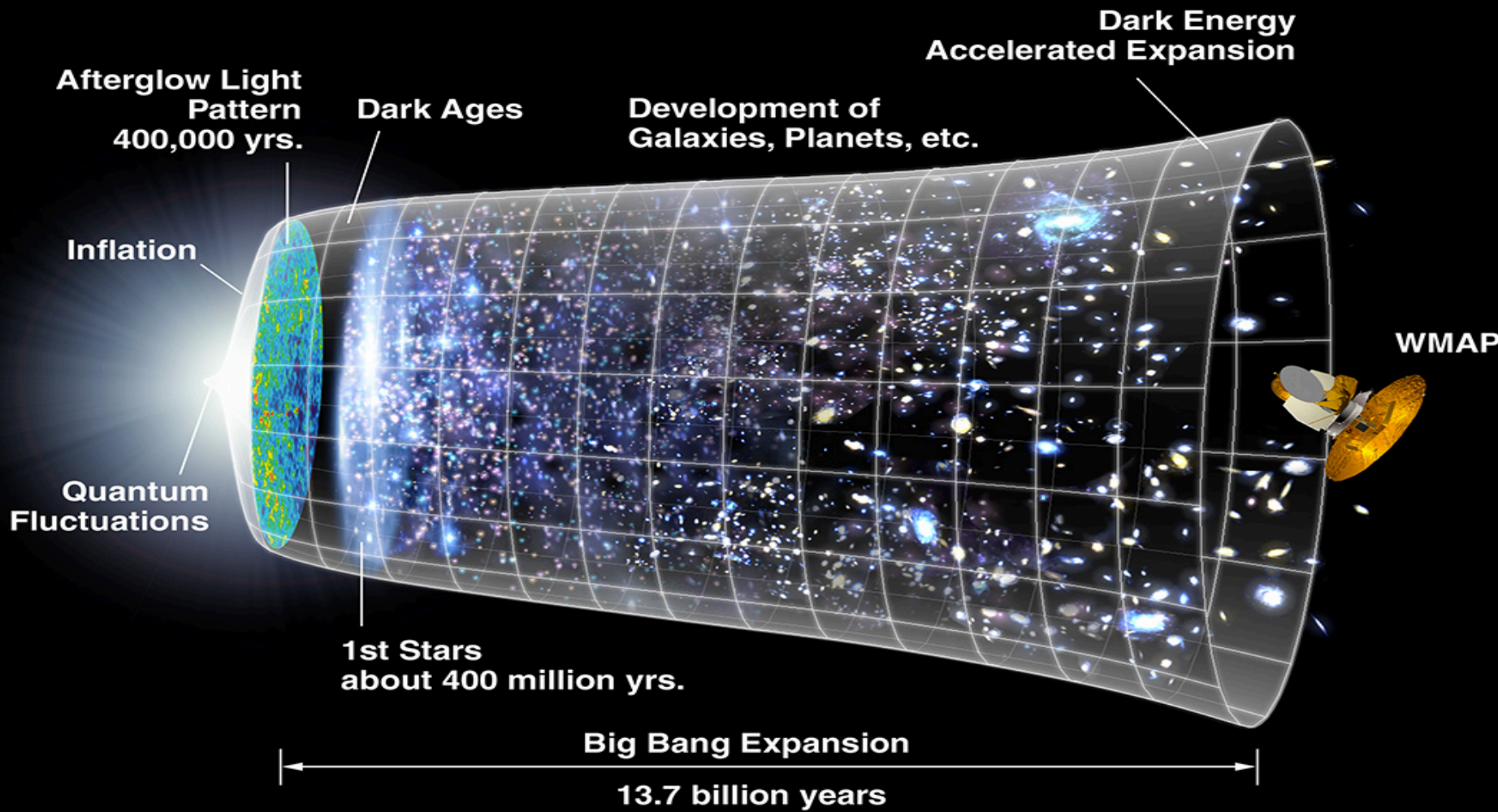


Cake Credit: Judith Racusin



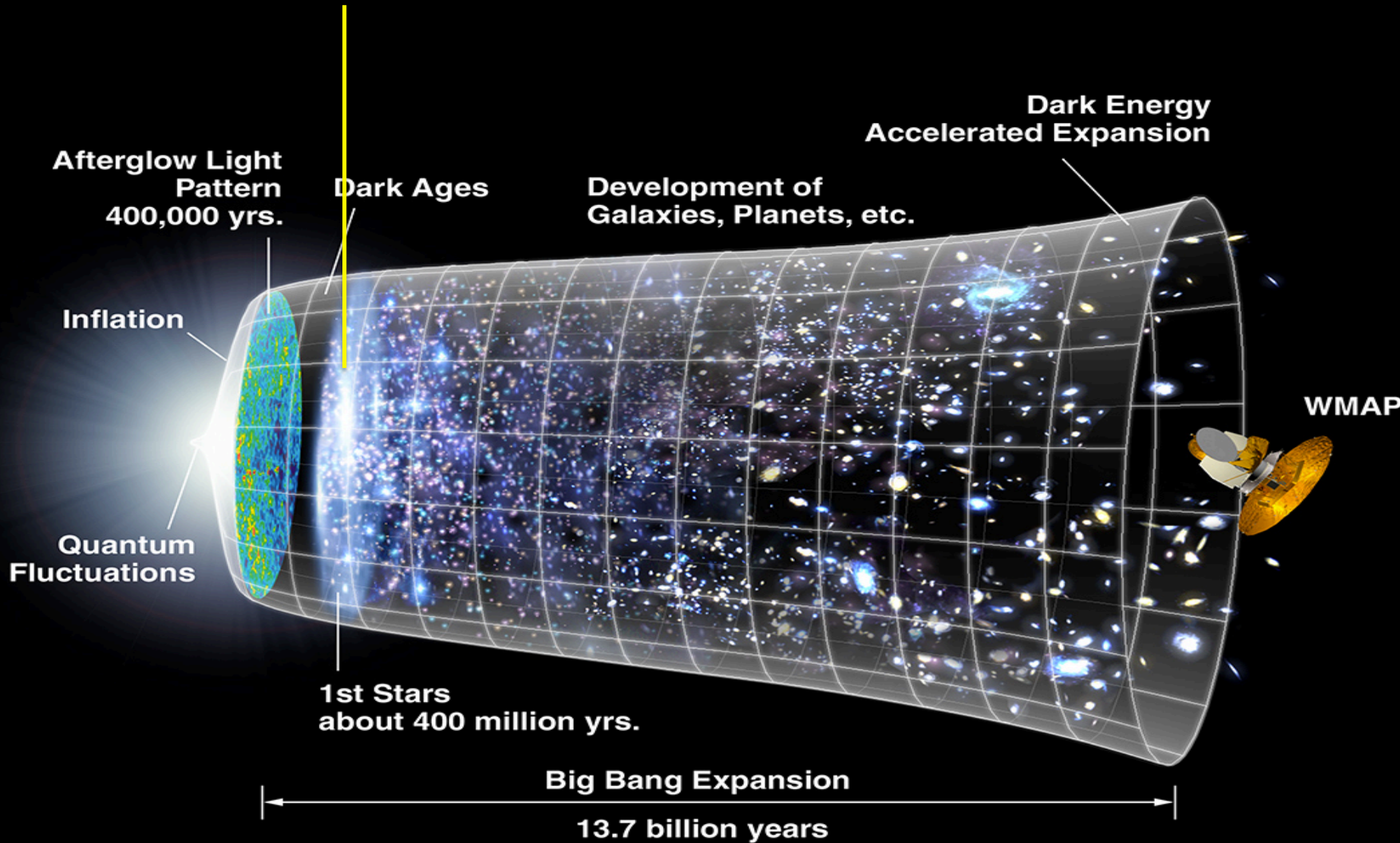
# GRB redshift distribution







GRB090423 ( $z=8.2$ ; 640 million years; Tanvir et al. 2009; Salvaterra et al. 2009)



GRB090423 ( $z=8.2$ ; 640 million years; Tanvir et al. 2009; Salvaterra et al. 2009)

Galaxy GN-z11  
( $z=11.09$ ; 400 million years;  
Oesch et al. 2016)

Afterglow Light  
Pattern  
400,000 yrs.

Dark Ages

Development of  
Galaxies, Planets, etc.

Dark Energy  
Accelerated Expansion

Inflation

Quantum  
Fluctuations

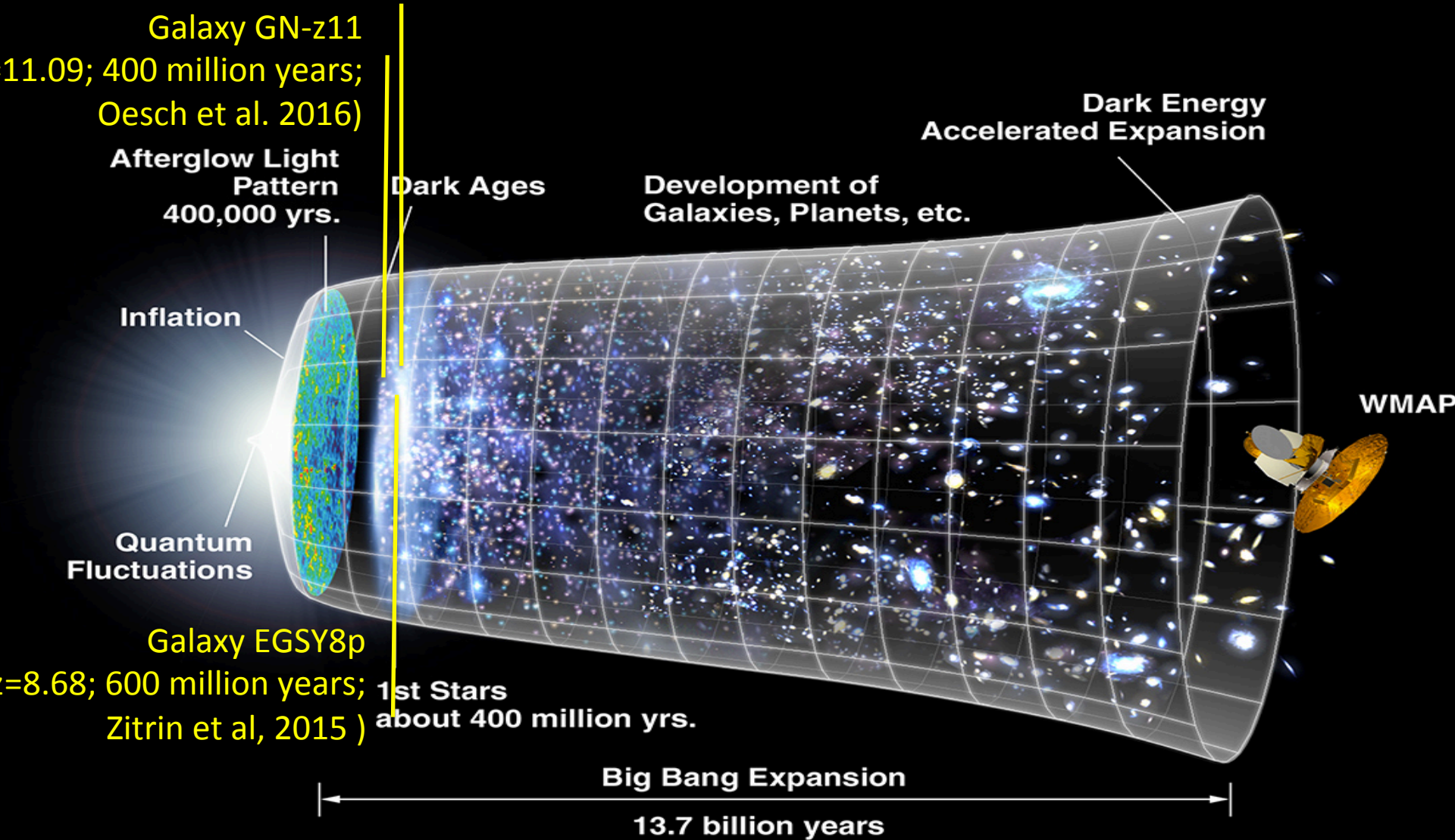
WMAP

Galaxy EGSY8p  
( $z=8.68$ ; 600 million years;  
Zitrin et al, 2015 )

1st Stars  
about 400 million yrs.

Big Bang Expansion

13.7 billion years





# Next homework

- Read two real proposals that are submitted to the *Swift* Guest Investigator Program.
- If there is any terms or concepts you do not understand, feel free to look them up online (wikipedia, ADS...etc).
- However, **the proposals are meant to write for non-expert**, so you should understand the main concept of the proposal if it is well-written.
- **We will discuss these proposals next week in the lab, to mimic a real proposal review.**