

Detecting Gamma-Ray Bursts Originating from Star Explosions

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Why am I here?

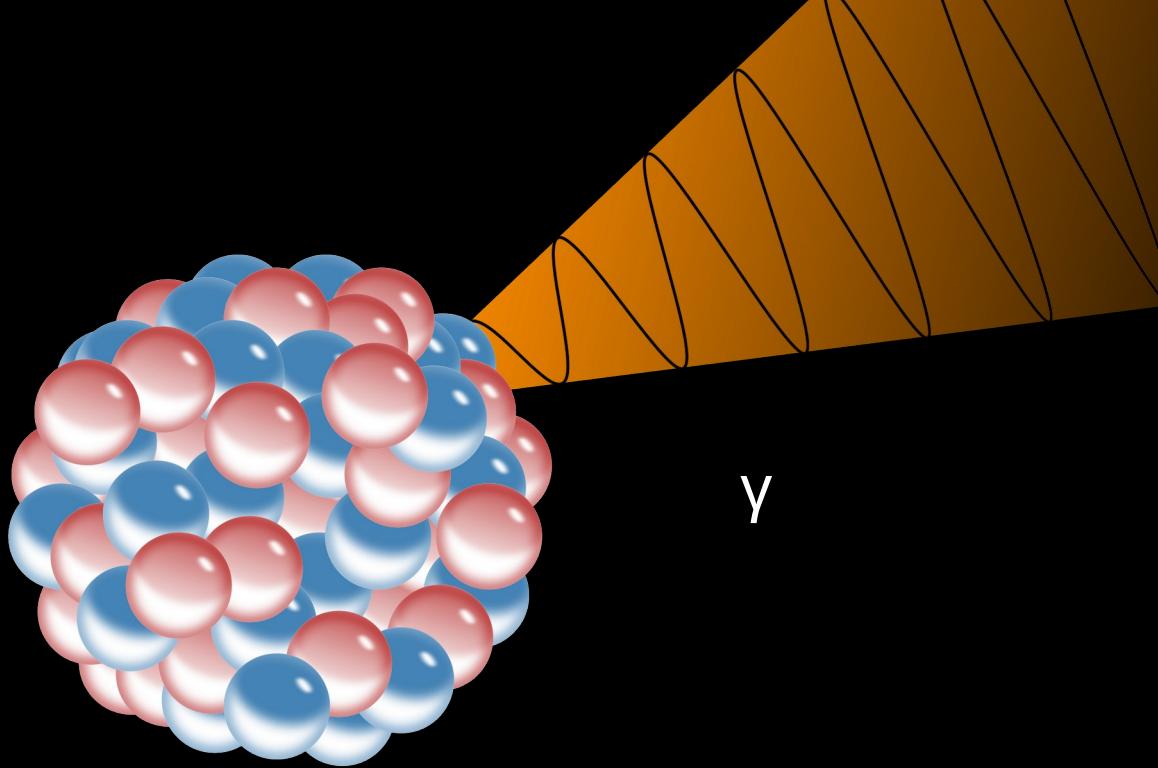
- Space is vast!
- Planet, stars, black holes, galaxies... oh my!
- The data informs us.
- What if it's automated?

Part I of III

Background Information



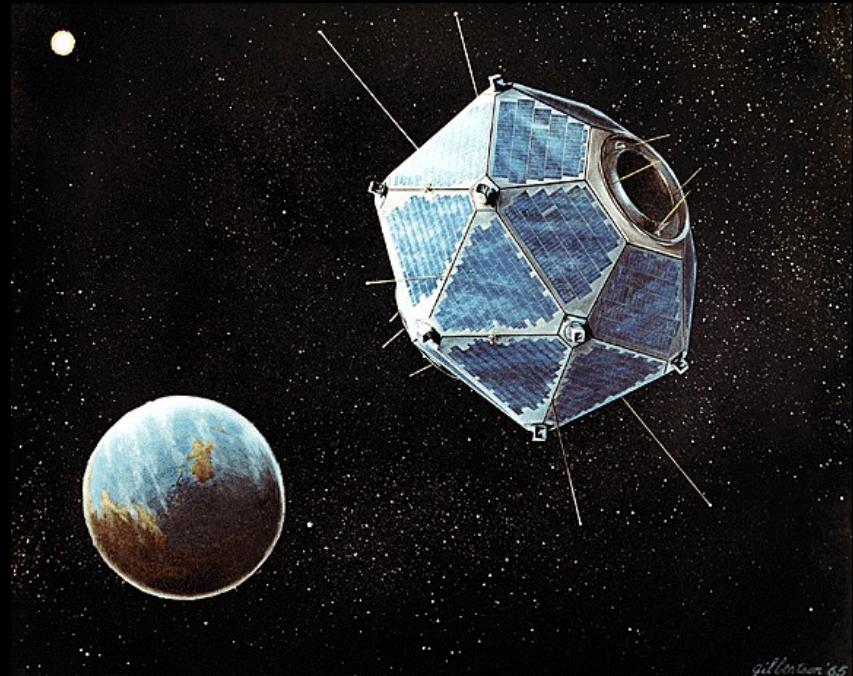
Credit: Universal Pictures



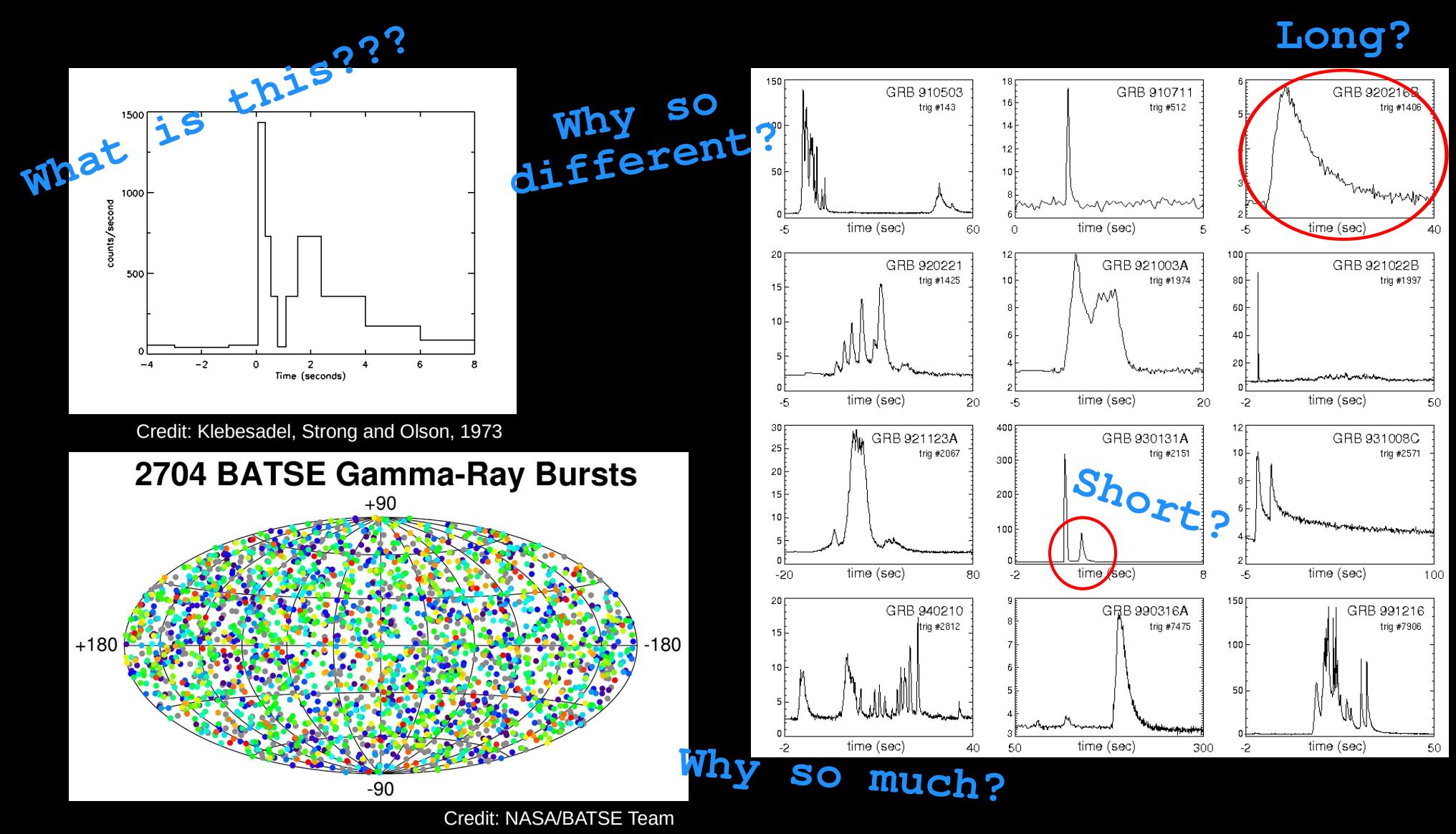
Smallest wavelengths
Highest frequencies



← USSR and US signed the Nuclear Test Ban Treaty (1963)



VELA from Los Alamos
monitored gamma-rays →

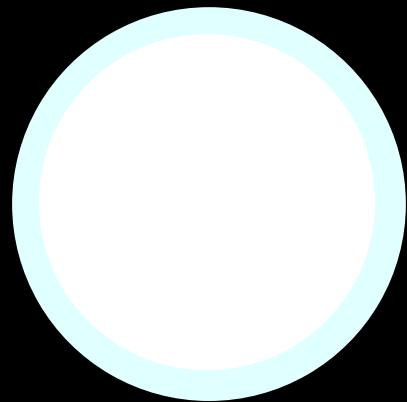


Type II supernova: collapse and explosion (death) of a massive star



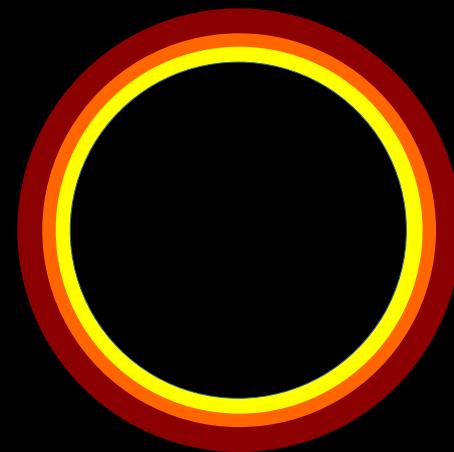
Credit: NASA

But wait, there's more!



Neutron star

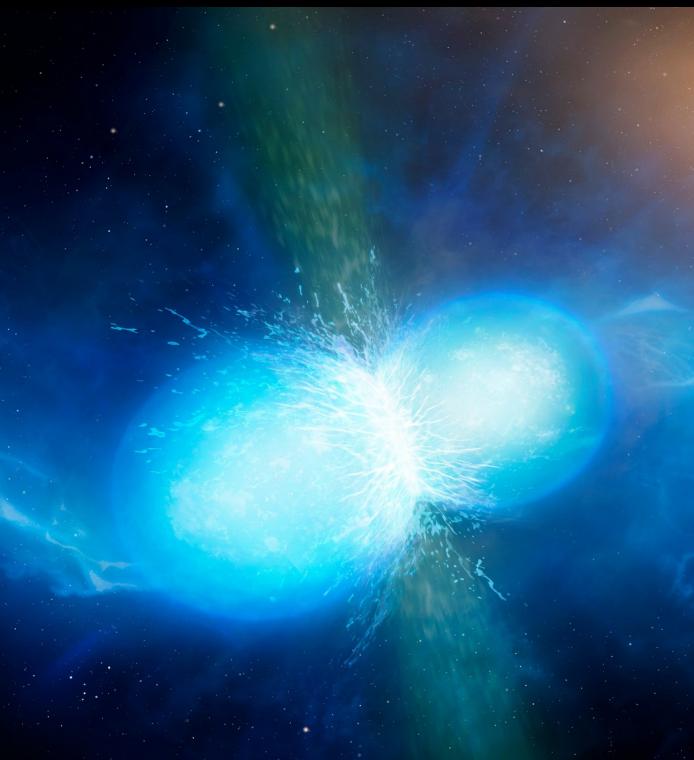
or



Black hole

...is based on initial mass.

Short GRBs come from “mergers” :



Credit: University of Warwick/Mark Garlick

**Neutron star-
neutron star**



Credit: Carl Knox

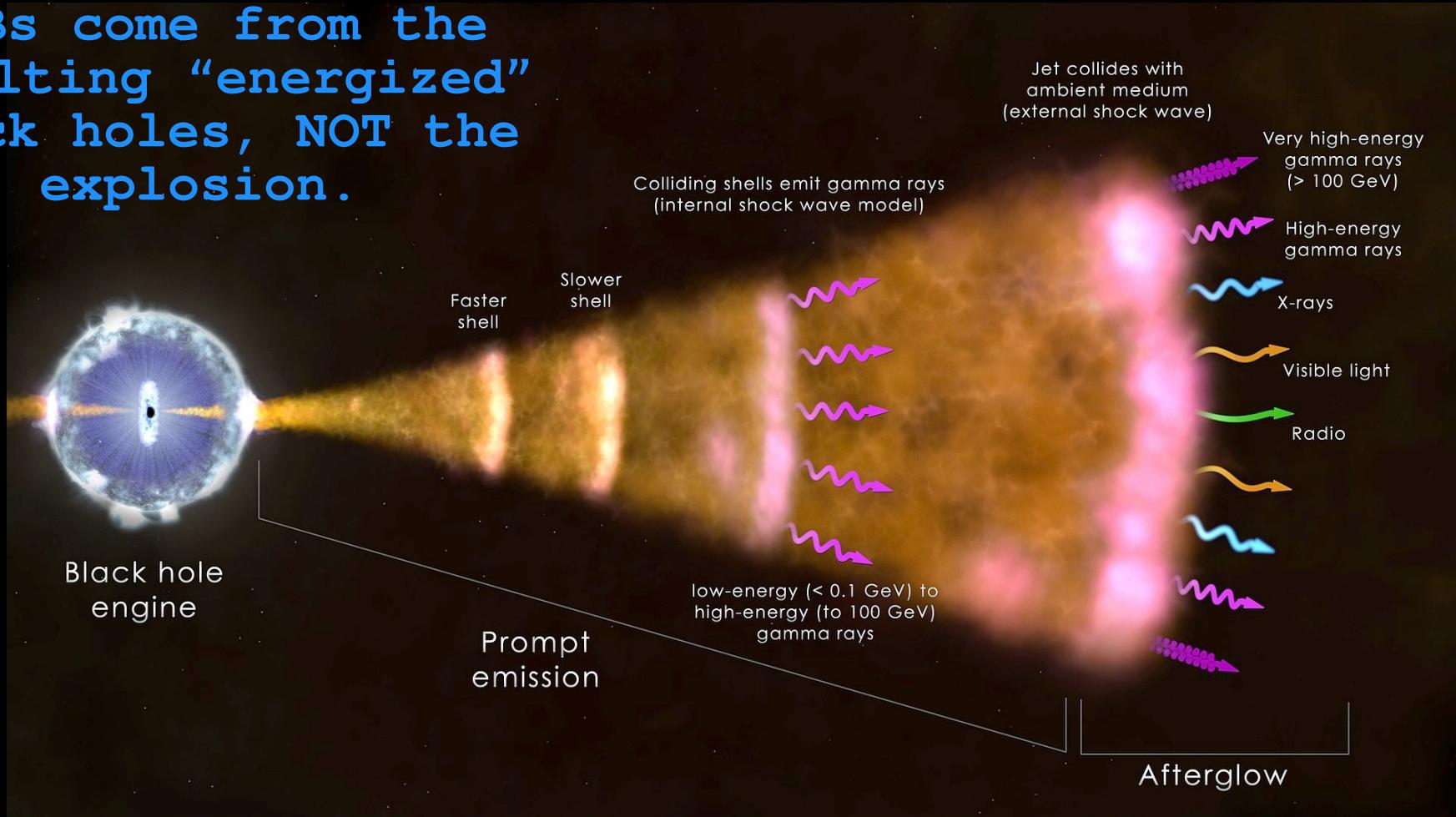
**Neutron star-black
hole**



Credit: Jurik Peter/Shutterstock.com

**Black hole-black
hole**

GRBs come from the resulting “energized” black holes, NOT the explosion.

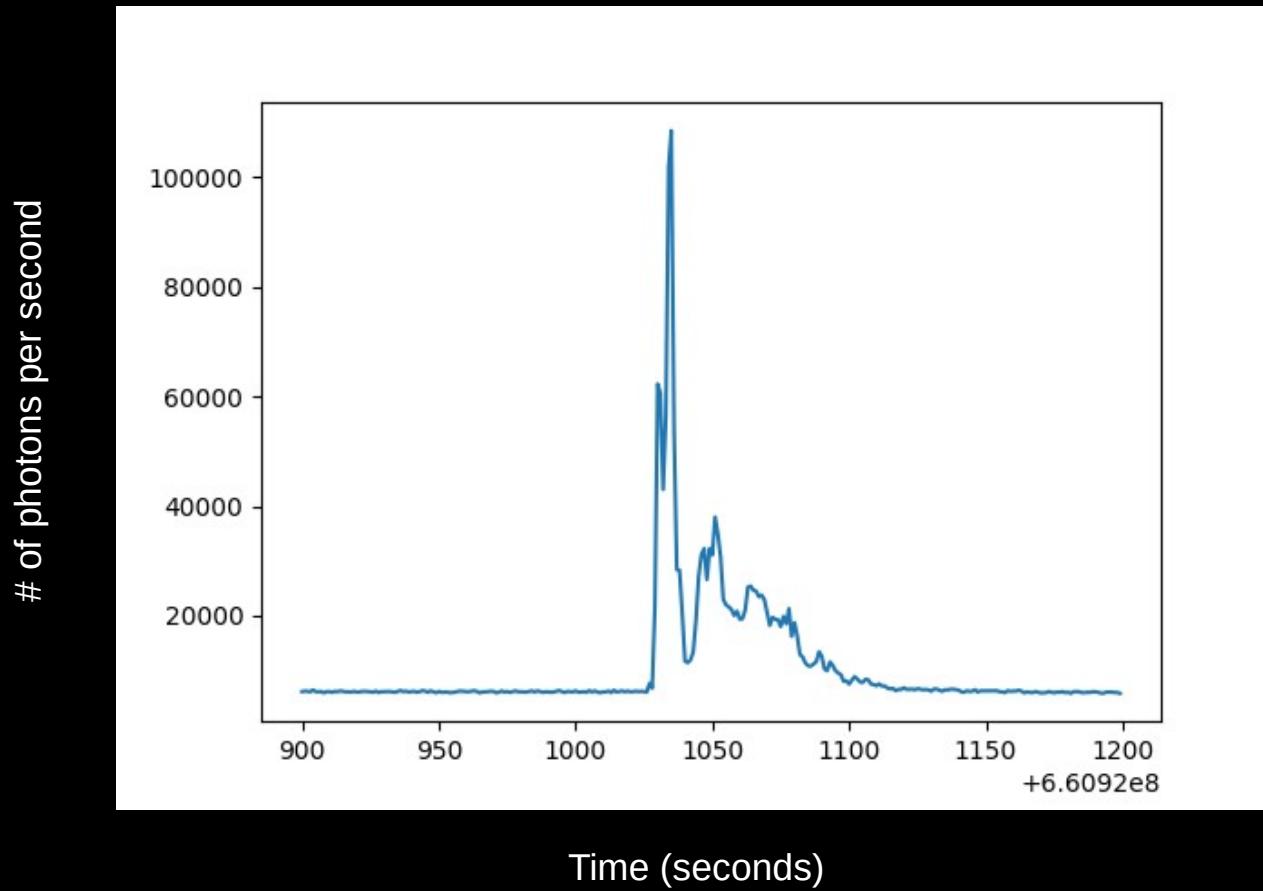


Part II of III

Visualizations

Time series: data set that tracks a sample over time.

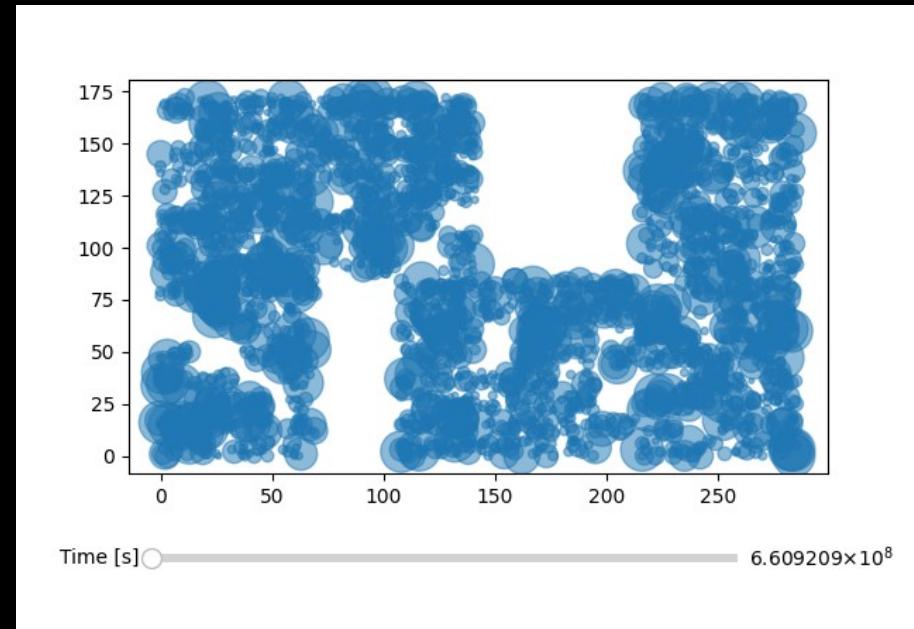
The Time Series



Start: 660920900
End: 660921200

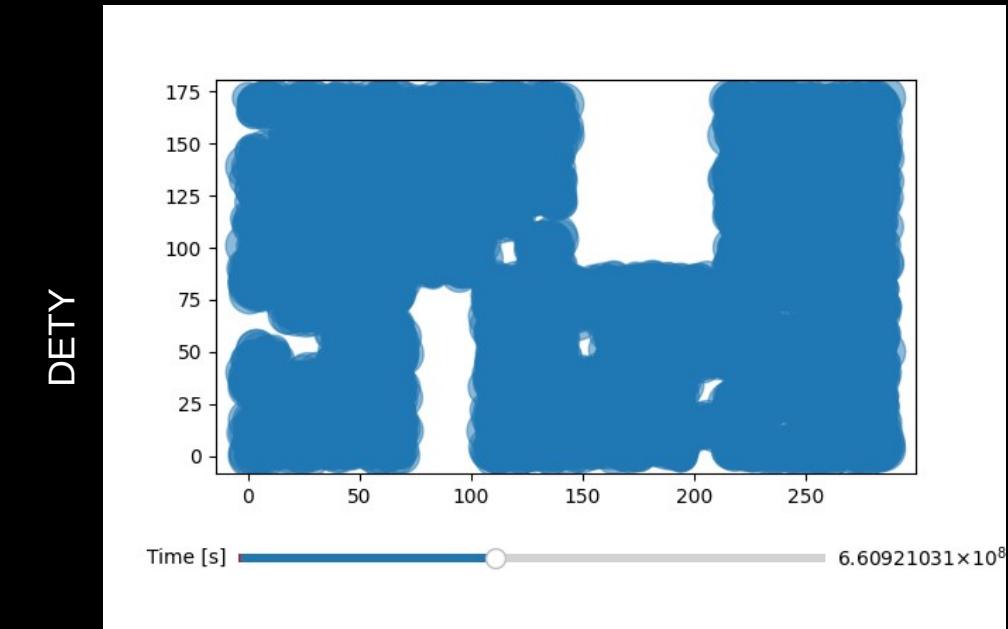
From NASA's satellite, Swift

Scatter Plots



DETX

Initial

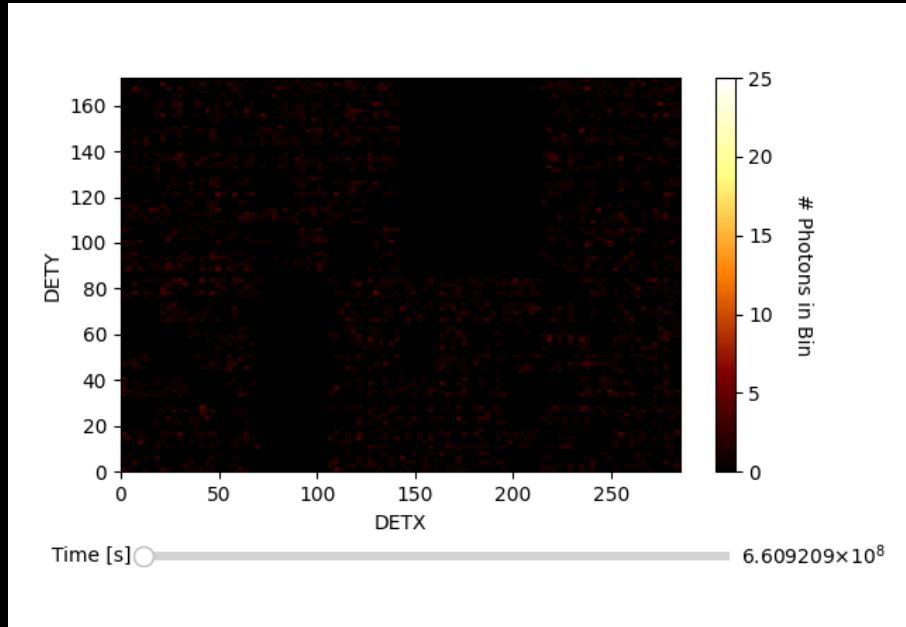


DETX

Estimated Start of Burst

2D Histograms

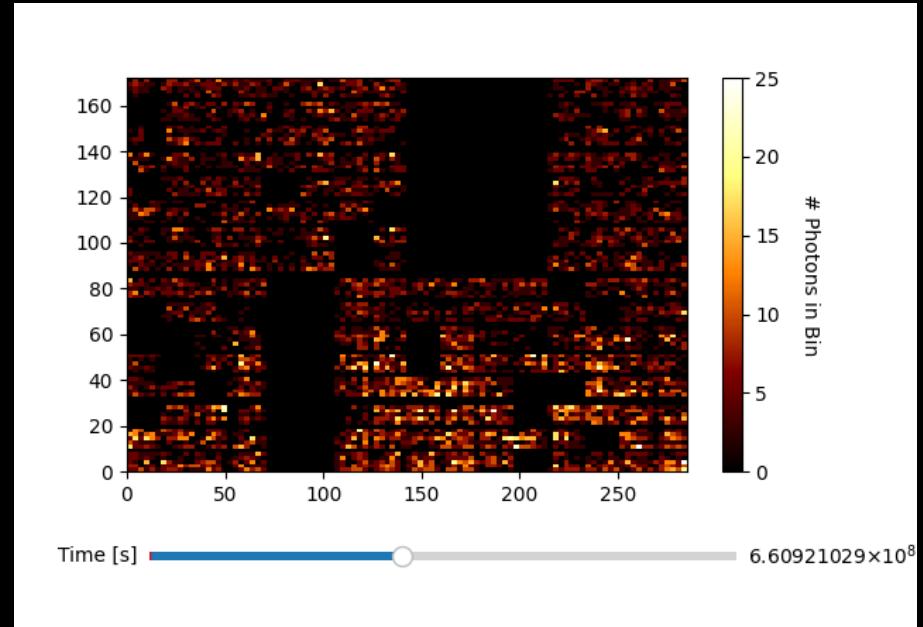
DET_Y



DET_X

Initial

DET_Y



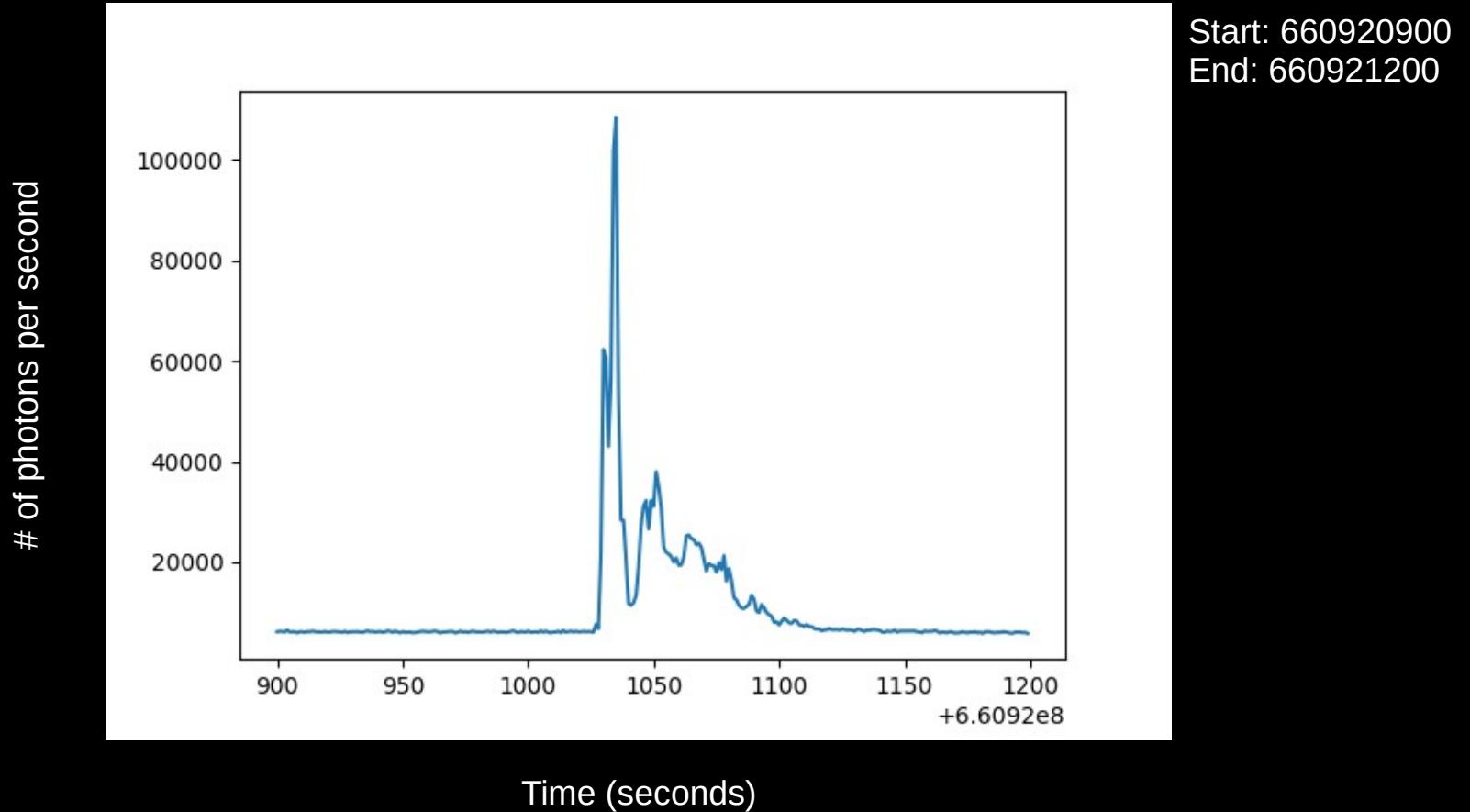
DET_X

Estimated Start of Burst

Part III of III

Detection Methods

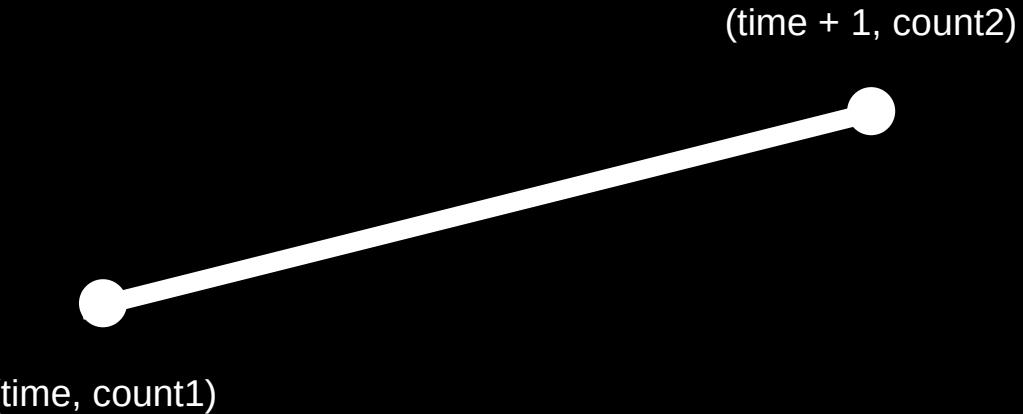
The Time Series (again)



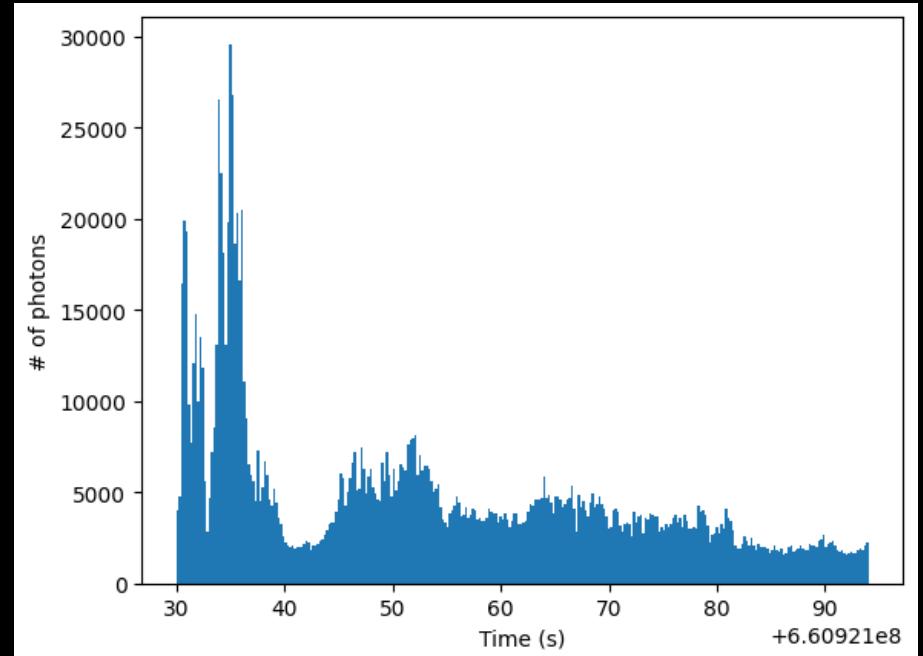
Method 1: Finding Slopes

Start: 660921030

End: 660921094



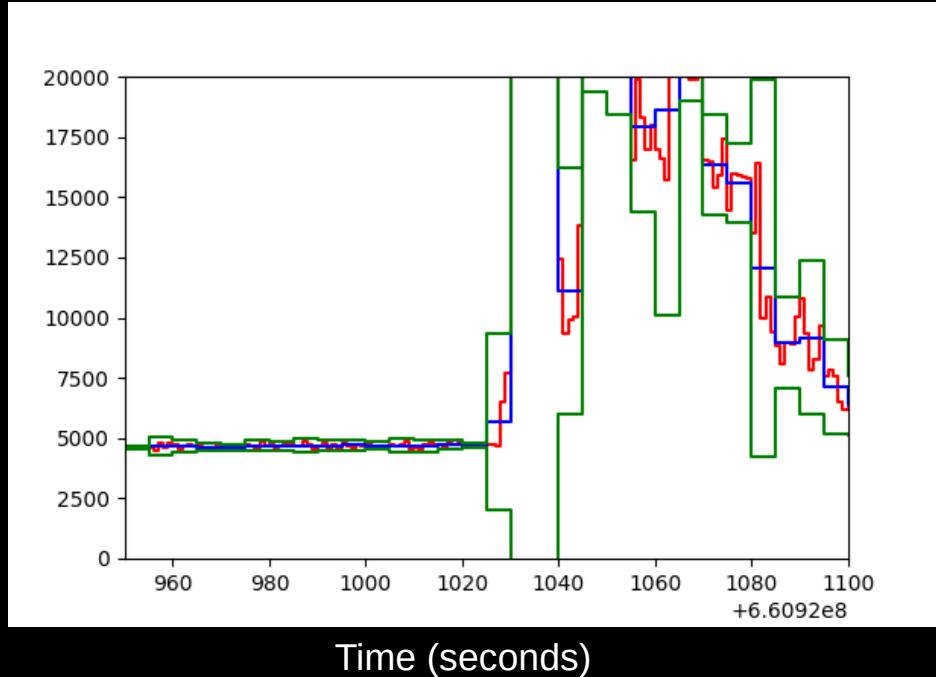
If $(count2 - count1) > 2000$, the point is considered an anomaly.



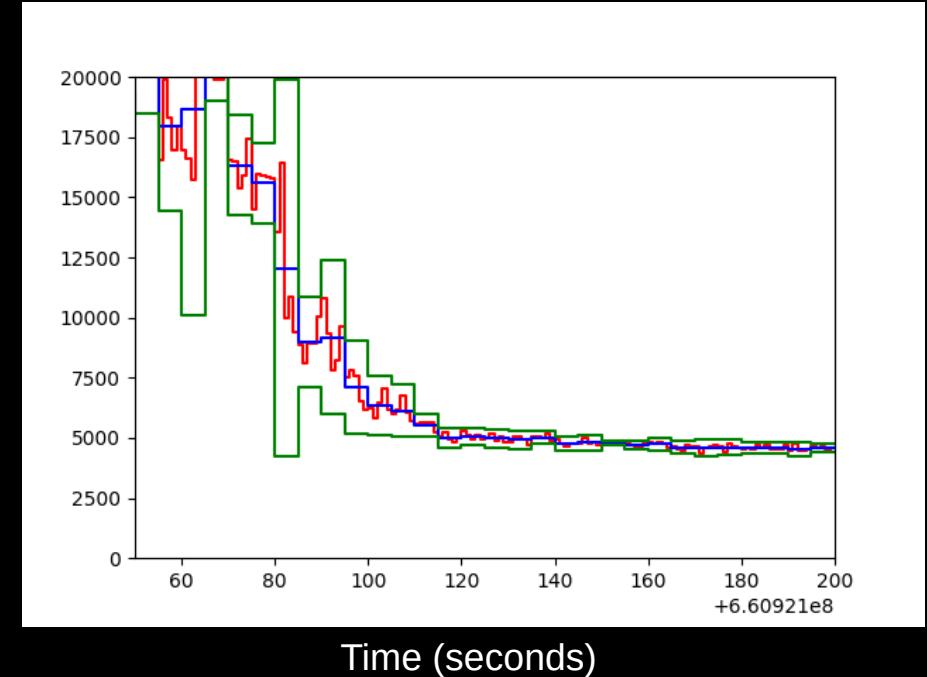
Results

Standard Deviations

of photons per second



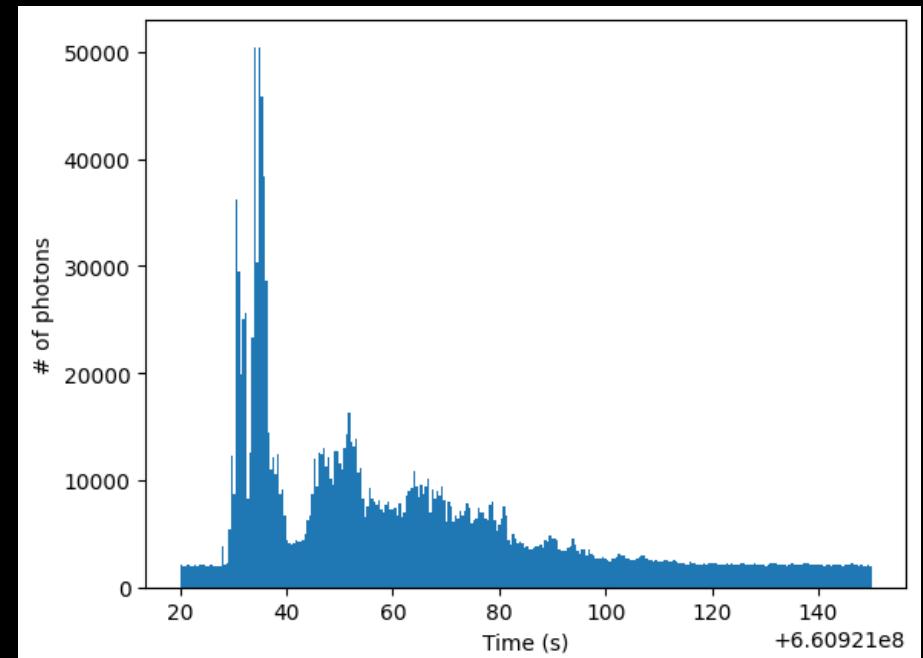
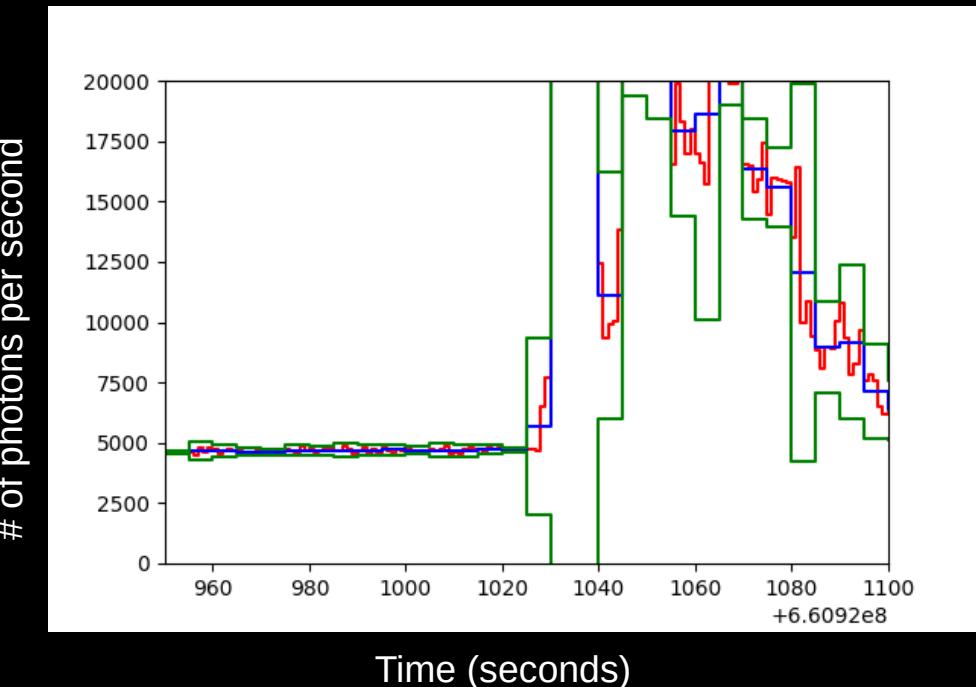
of photons per second



Red is the data; blue is the mean of the 5-second intervals;
green is the mean +/- three times the standard deviation

Method 2: Comparing to Previous STD

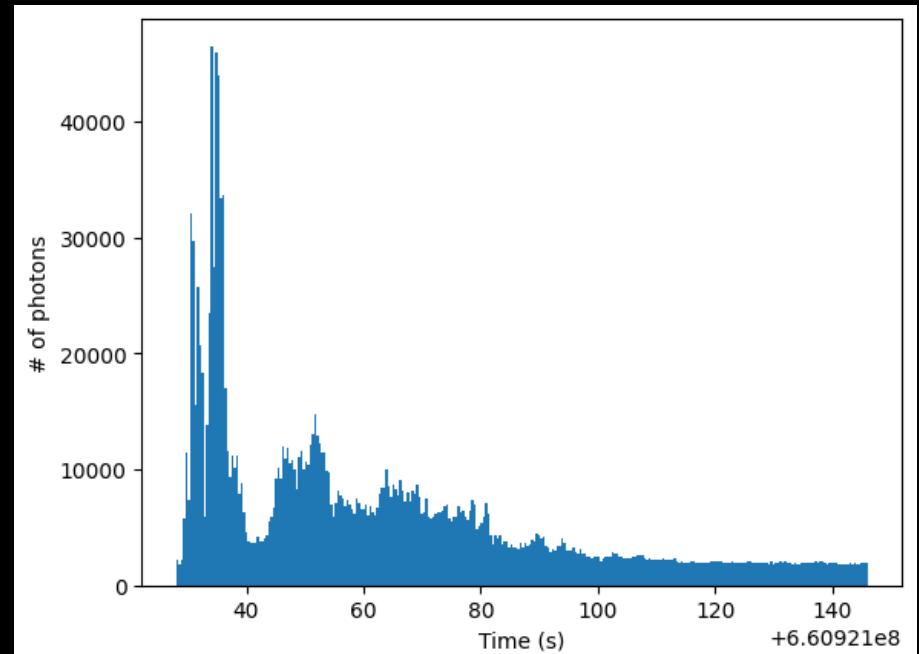
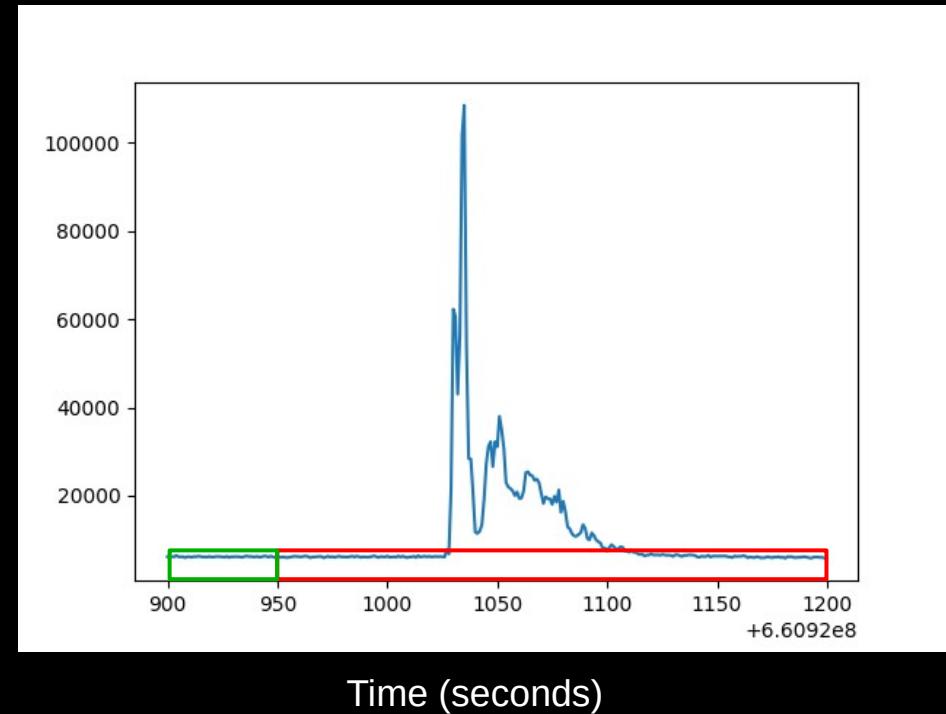
Start: 660921020
End: 660921150



Results

Method 3: Assuming the Background

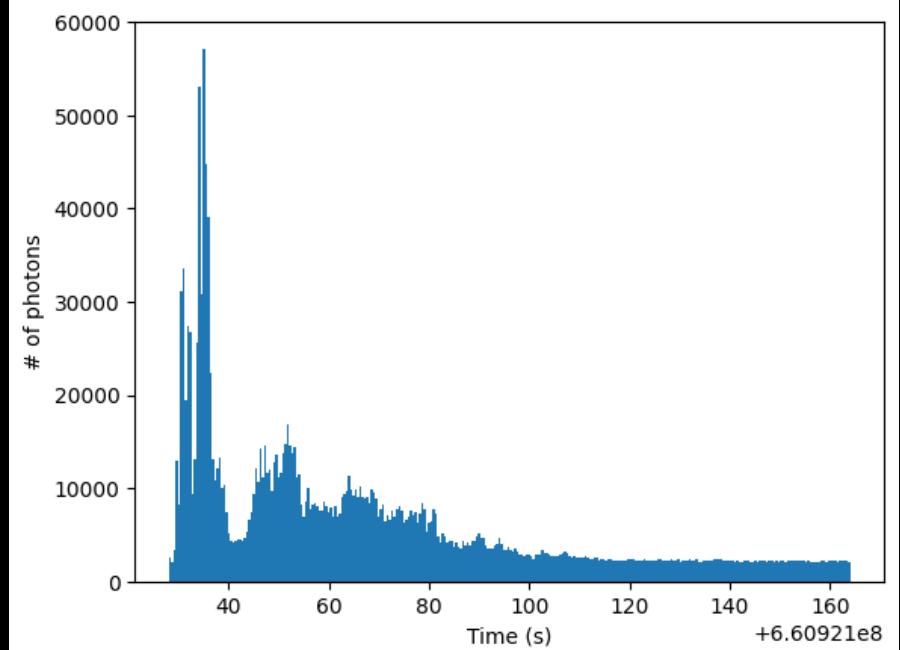
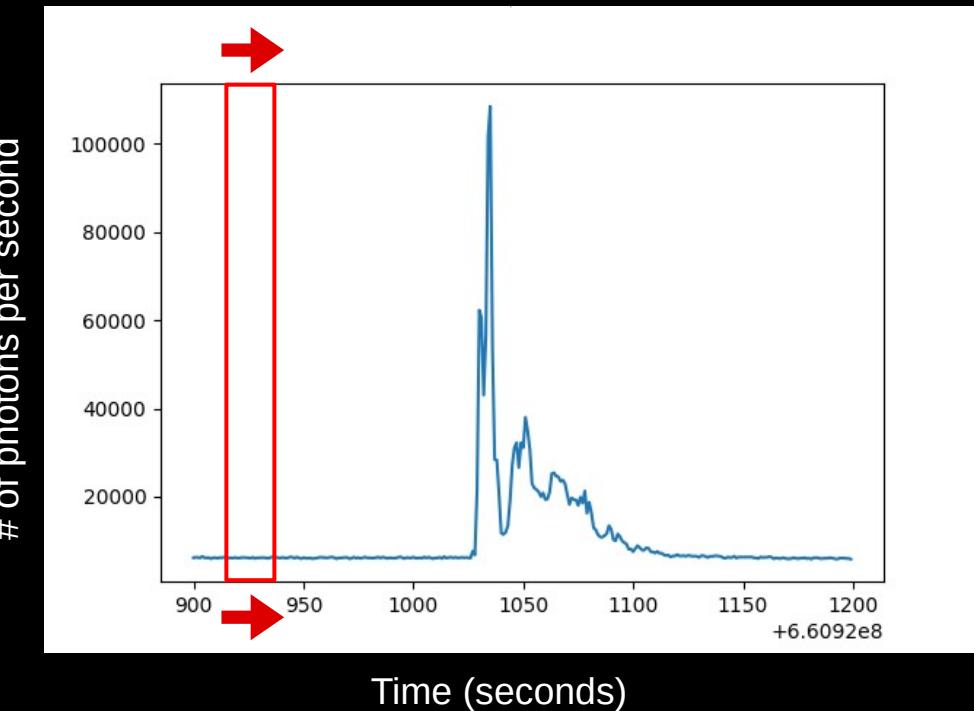
Start: 660921028
End: 660921113



Results

Method 4: Sliding Timeframe

Start: 660921028
End: 660921164



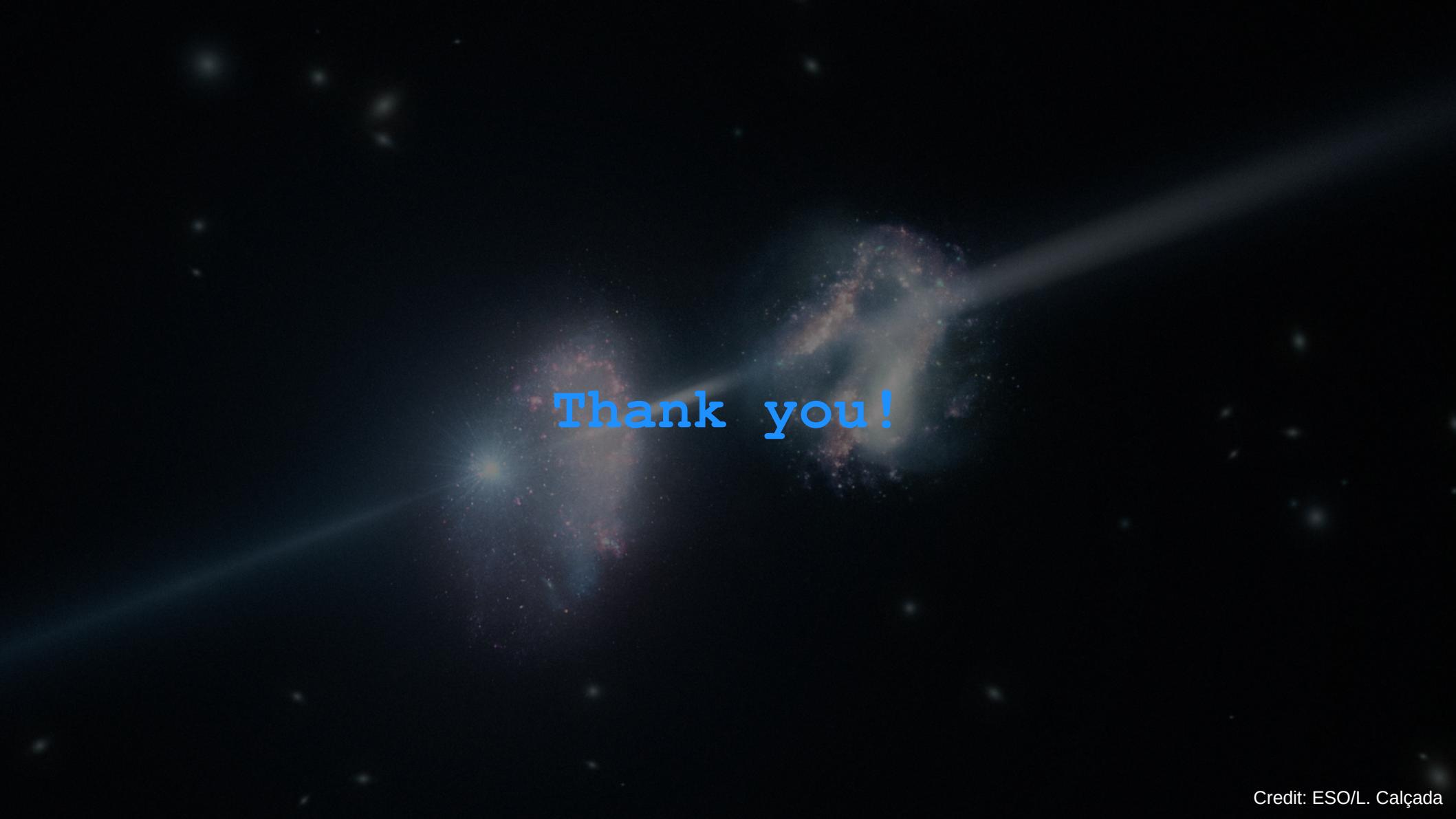
Results

Discussion

- Method 1 and 3 both make assumptions
 - Method 2 finds starting time well, but not ending time
 - Method 4 finds both starting and ending time, but only applicable to singular long GRBs
-
- Next steps: applying Method 4 to other time series and multiple GRBs

Why do we care?

- Easier process of detecting GRBs, long and short
- How stars work, live, die
- Unique cases: binary and singular star systems, mergers, black holes
- More experimentation of cosmological technology helps future



Thank you!