

Statistical analysis of GRB properties

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GRB optical transients: prompt observations - important

Understanding GRB optical transient:

- Outer shock - responsible for (late) afterglow
- Inner shock - direct connection with GRB engine

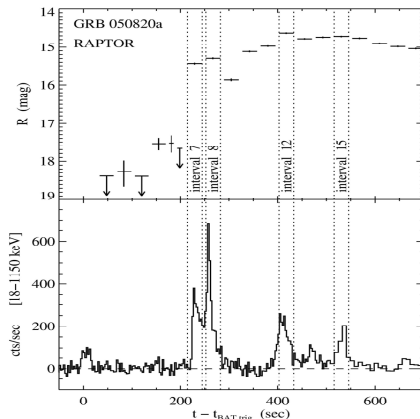
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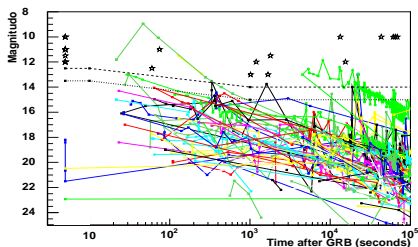
Only one „inner shock” observed! -
Raptor, GRB050820a

...triggered by a GRB precursor

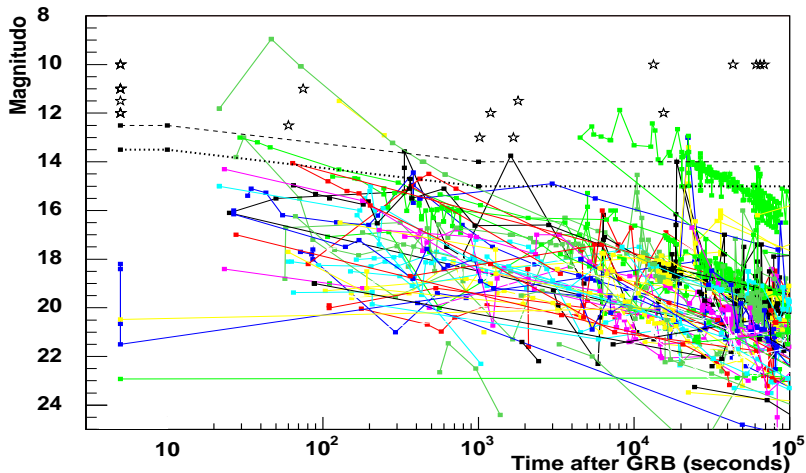


GRB optical transients: observations timing - current status

Lack of early observations:

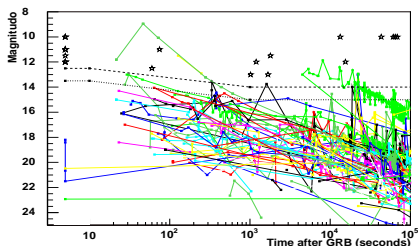


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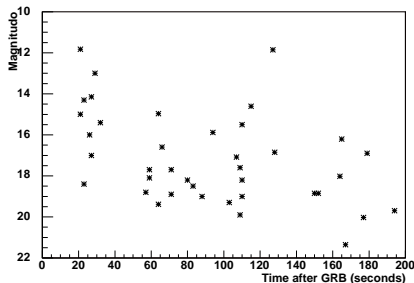


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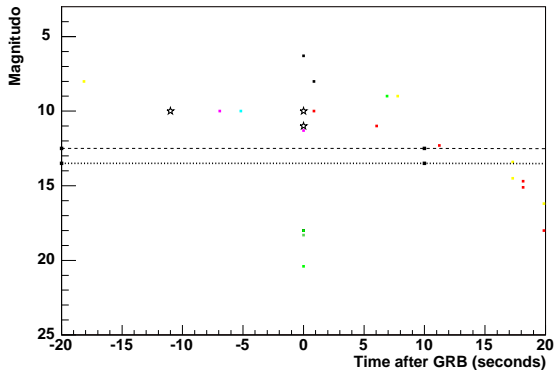
Only about 20 OT observations
 $< 100s$, 9 $< 40s$ and 1 $< 20s$



„ π ” should be able to fill the gaps!

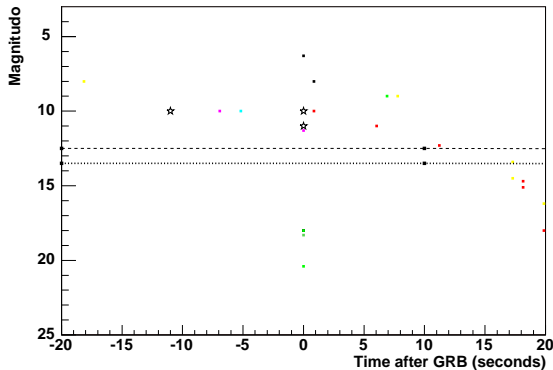
GRB optical transients: observations timing - current status

Even better with limits on maximal brightness:



GRB optical transients: observations timing - current status

Even better with limits on maximal brightness:



But large area coverage
means low range...

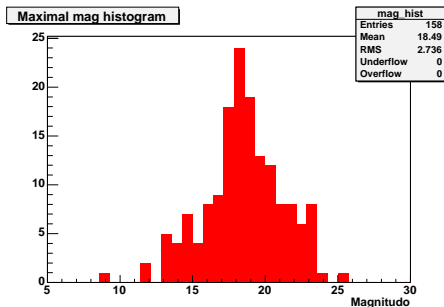
Will „ π of the sky” see
anything?

GRB OT extrapolation to early times

- „ π ” maximal range: $14^m - 15^m$
- GRB OT maximal brightness?

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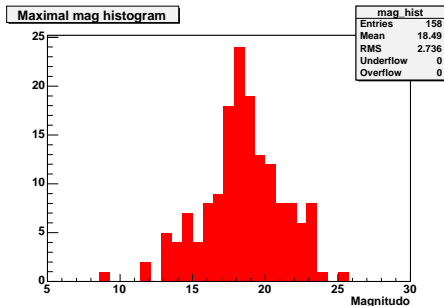


But most observations - long time after GRB...

...what is the early brightness?

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Estimation - power law decay

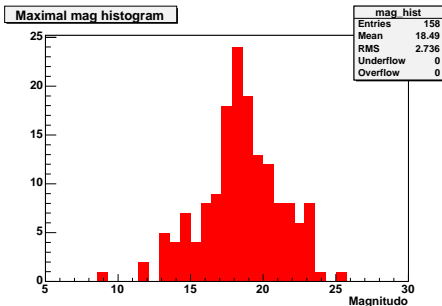
$$F \propto t^\gamma, \quad m = -2.5 \log \frac{F}{F_0}$$

Linear fit extrapolation:

$$m(30s) = a \log(30s) + b$$

GRB OT extrapolation to early times

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But most observations - long time after GRB...

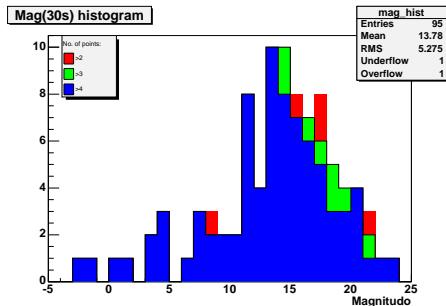
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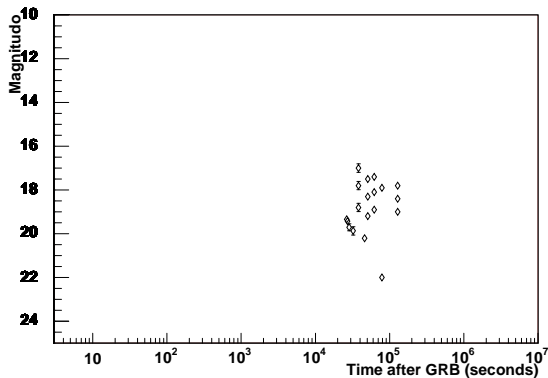
$$m(30s) = a \log(30s) + b$$



Lightcurves problems 1 - measurements quality

Problem: Observations are often not consistent with each other:

- different filters
- no uncertainties for $\frac{1}{4}$ of the measurements
- other factors with impact often bigger than uncertainty



Lightcurves problems 2 - lightcurve break

Lightcurve break: after order of 1000 – 10000 seconds decrease of OT brightness should become much more rapid:

- linear fit in both or late time range does not give proper extrapolation
- most of the lightcurves consist mainly of late measurements (large telescopes)

Early measurements

- few (often one) points from a single experiment
- → large dispersion of points in the lightcurve
- larger uncertainties (low range of fast telescopes)

Lightcurves solution attempt 1 - early fits

Solution for the lightcurve
break:

- Fit two lines in
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- Simple way: fit only early lightcurve measurements (eg. $t < 5000s$)

Requirement for lc

- > 3 points in $t < 5000s$
- > 8 points in general

Lightcurves solution attempt 1 - early fits

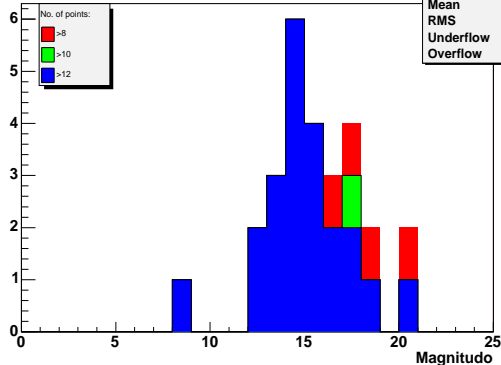
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Mag(30s) histogram



Problem: number of lc drops below 30...
But average mag ~ 15.5 still looks promising!

Lightcurves solution attempt 2 - filters shift

Part of measurements dispersion is caused by use of different filters.

How to reduce it?

- Estimation of magnitude in different filters using OT spectra...
... the spectra is not uniform for all OTs

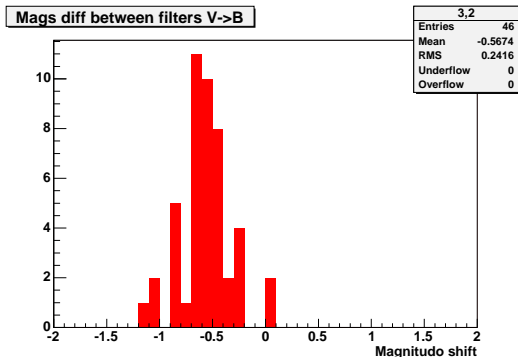
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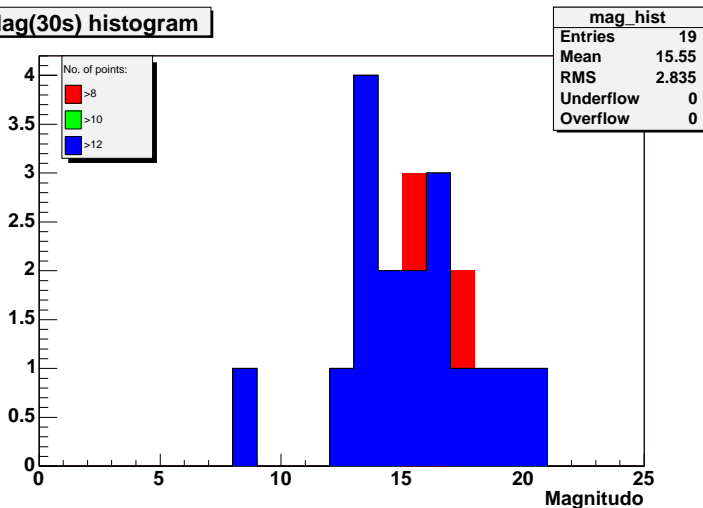
- Estimate the shift between filters from lightcurves:
→ measurements of the mag with different filters in the same time



Lightcurves solution attempt 2 - filters shift

Improvement?

Mag(30s) histogram

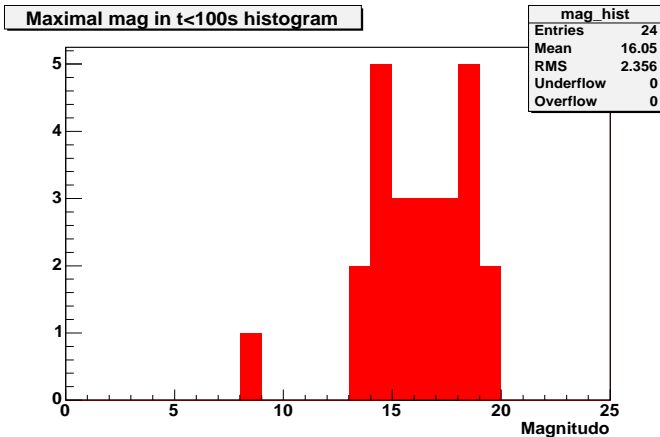


Summary

- Average brightness: $15^m - 16^m$
- „ π of the sky” should see a big part of all OTs, reduced by:
 - no day-time observations
 - no every-night observations (weather issues)
 - only southern sky
- But... shown results are only a thick estimation
- Better estimation requires
 - more sophisticated analysis
 - more lightcurves
 - better lightcurves
 - earlier lightcurves
- However, „improvements” introduced so far only **slightly changed estimation**

Summary

Still one should trust real measurements:



For „ π of the sky” they should be brighter! (different filter)