GRB detection with LSST

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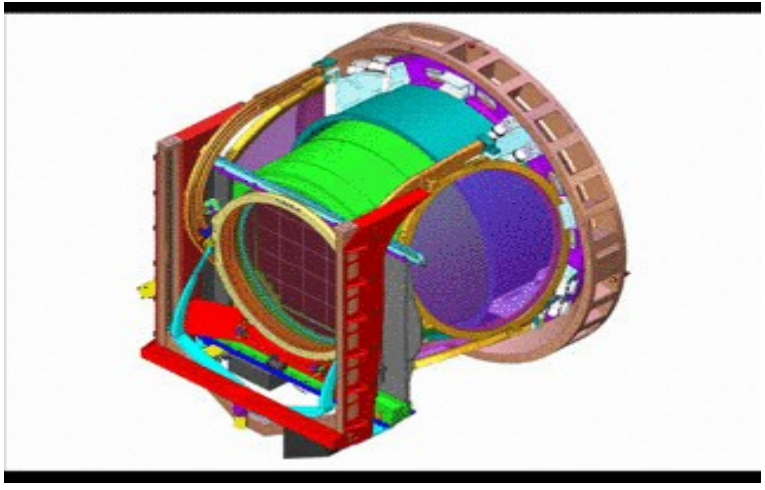
The Large Synoptic Survey Telescope

- 8.4m telescope 9.6 degree^2 field-of-view
- Survey the south hemisphere of the sky every 3-4 nights



The LSST Surveys :

Wide-fast-deep (WFD)

- 18,000 sq deg
  - A given object is observed in a given filter once every three days (up to redshift $z \sim 0.4$)

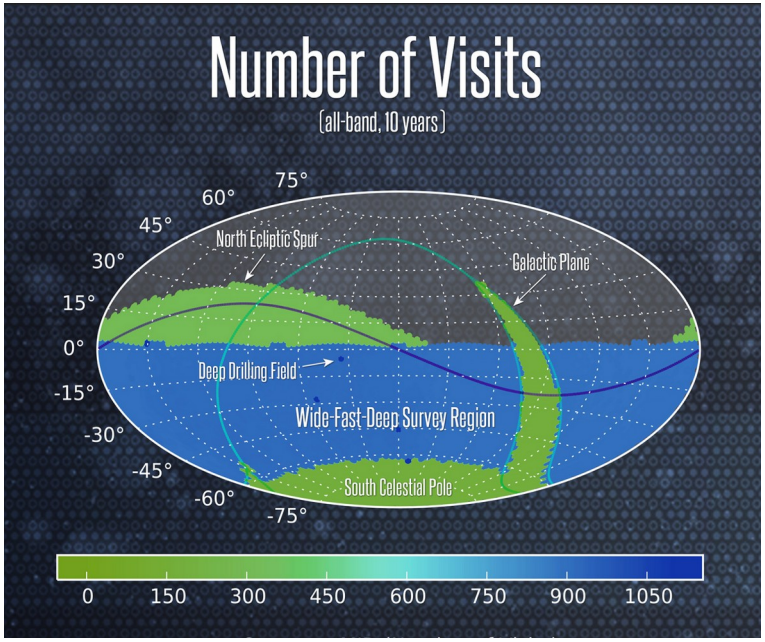
Several **Deep Drilling Fields (DDF)**

- Each of 10 sq deg
  - A given object is observed in a given filter several
  - times during one night ($0.4 < z < 1.2$)

Operations simulation (OpSim)

Baseline cadence:

- Each field will be seen twice a night (2 visits) separated by 15-20 mins
- With subsequent revisits days later
- 825 visits per field over 10 years
  (u :54, g :70, r :178, i :180,z :160,y :166)



OpSim : simulates the field selection and image acquisition process of the LSST over the 10-year life of the planned survey

The input of OpSim:
A metric defining the strategy parameters → area, revisite rate, observation time, ...

The ***Metrics Analysis Framework (MAF) :*** a code package that enables the derivation of scientific results from the *OpSim* database

→ measurement of scientific performance, number of detections of an event

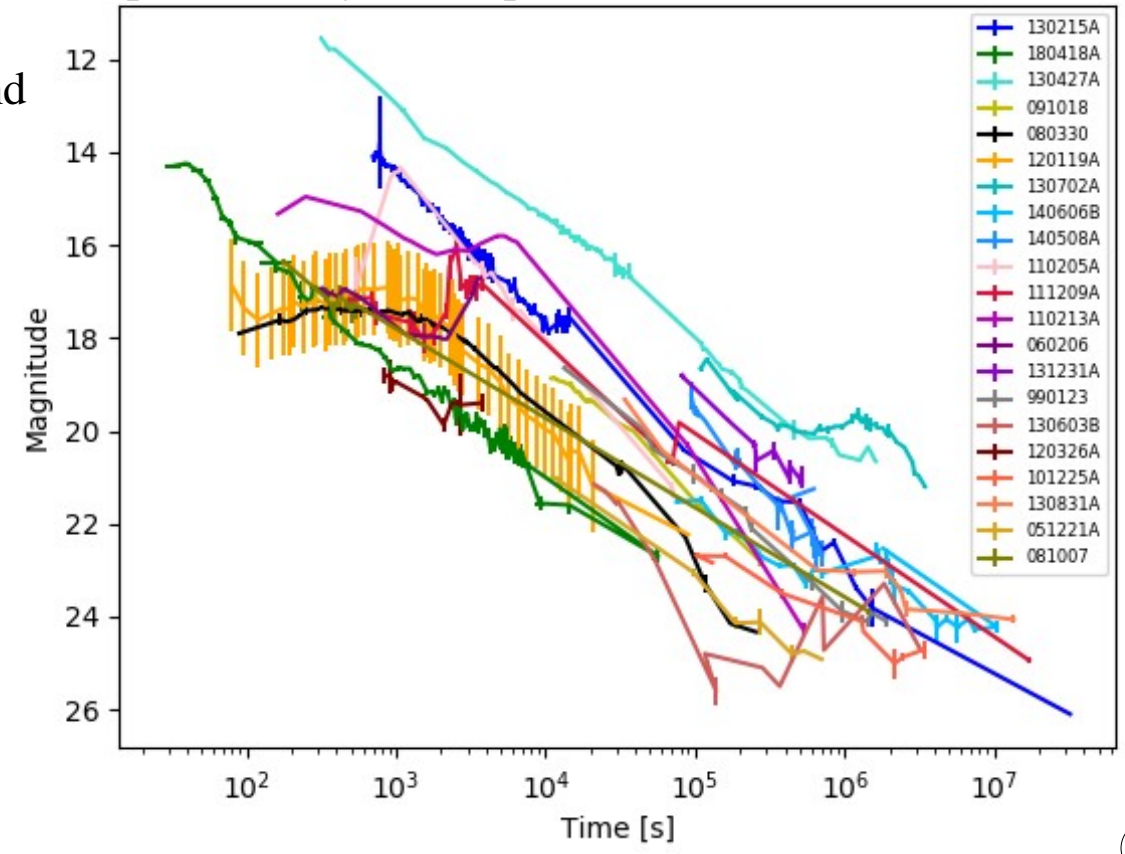
Catalog of optical GRBs

- A catalog of 549 LCs of GRBs

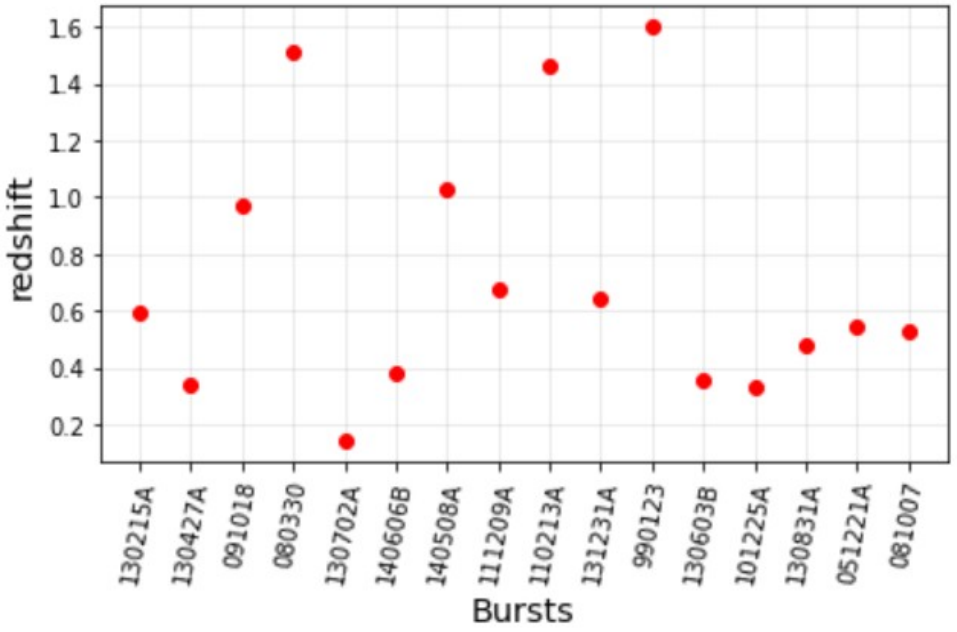
detected by optical telescopes in r and R bands (provided by D.Turpin)

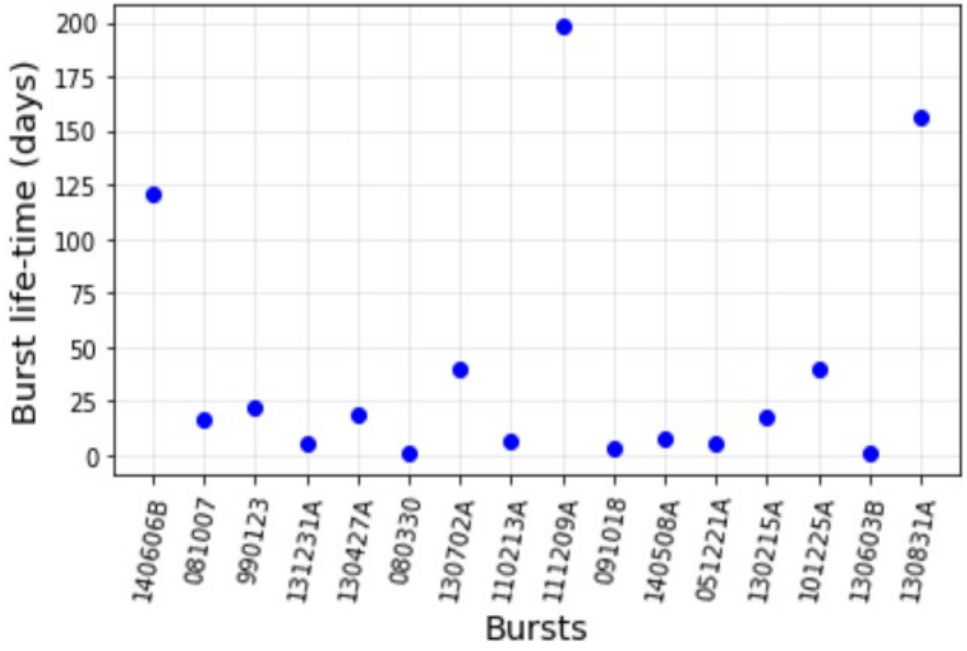
Available information : time, magnitudes and their errors

- Only 21 GRBs have sampled LCs in ‘r’
- 16 GRBs among 21 have a life-time longer than 1 day



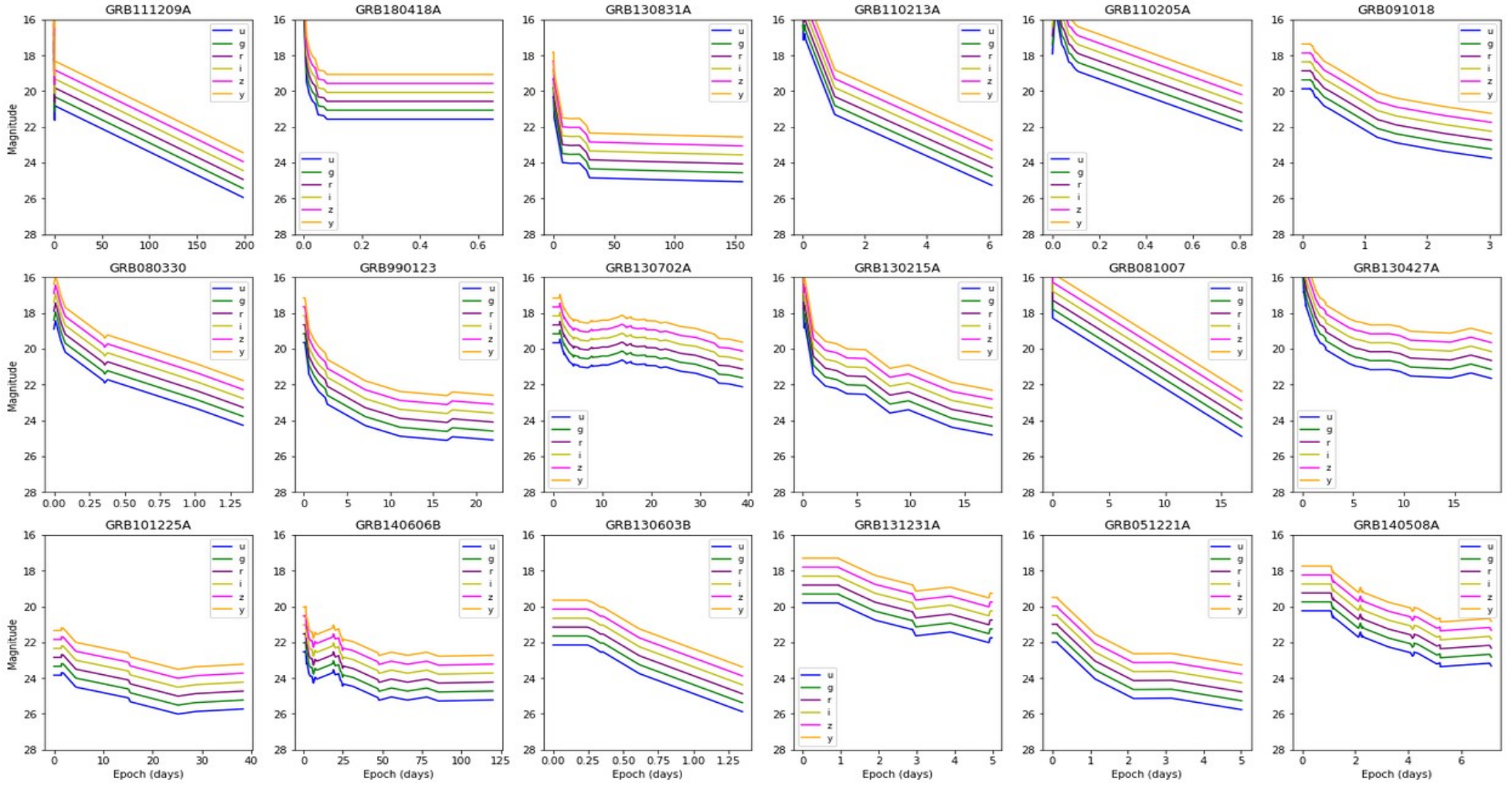
Catalog of optical GRBs





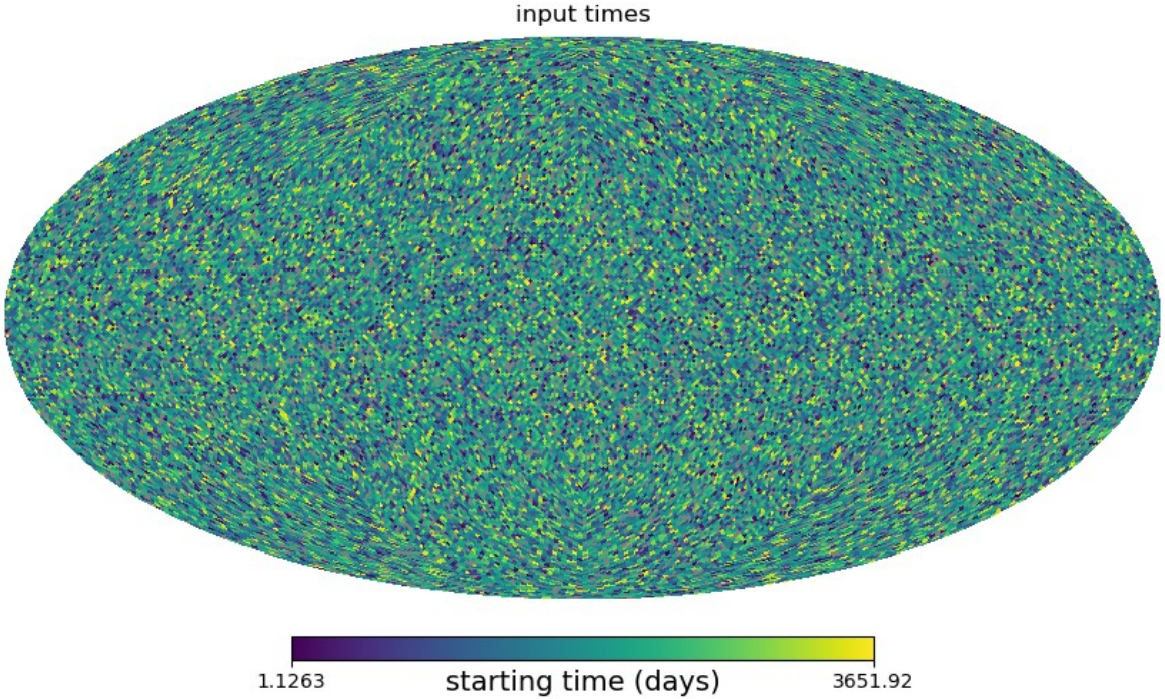
- Redshift between 0.145 and 1.6
- LC duration between 1.3 and 200 days
- Add fake LCs in ugizy with 0.5 difference between the consecutive filters
- Convert the redshift to distance (di) in Mpc using ΛCDM model (H_0= 70 km/sec/Mpc, Ωm_0= 0.3)

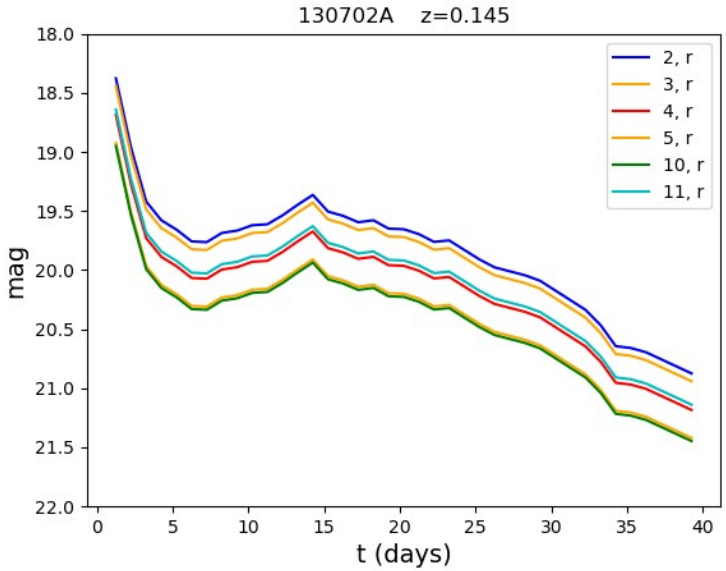
Catalog of optical GRBs



Available data

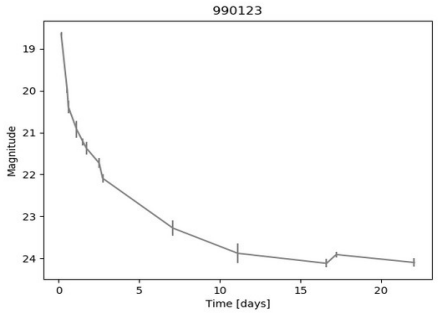
- For each GRB : Distribute 10^5 LCs uniformly in volume (increasing as a function of distance^3, following https://arxiv.org/pdf/2106.06820.pdf)
- Distance range [di-100, di+100]

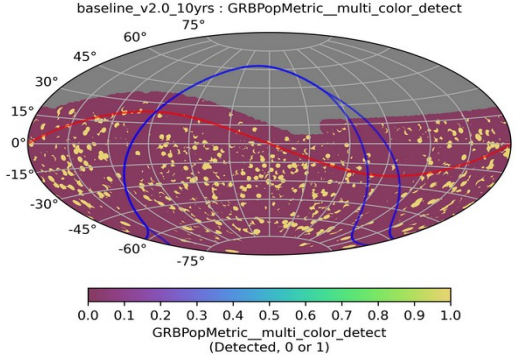


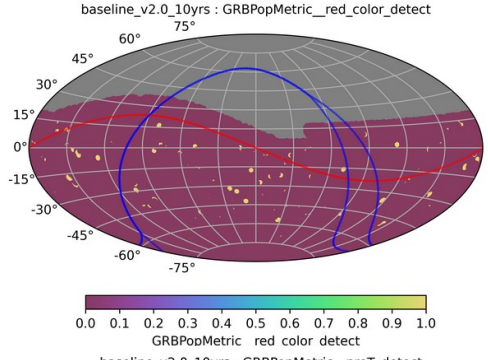


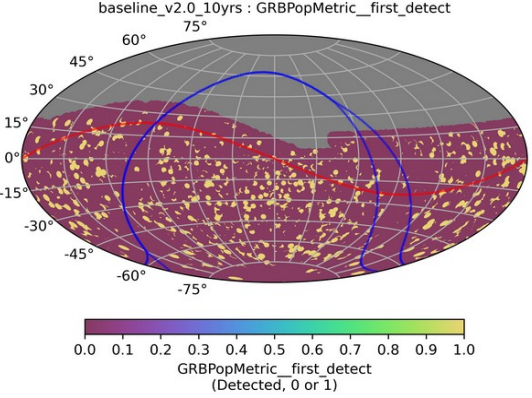
Define the detectability criteria

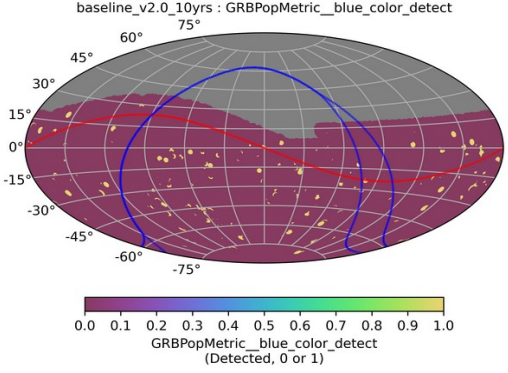
- *first_detect* : at least two detections (> 5σ) during the first 5 days
- *preT_detect* : at least two detections during the first 3 days
- *multi_color_detect*: Color-based simple detection criteria: detect at least twice, with at least two filters
- *red_color_detect*: Number of detected points in izy bands (4 detections)
- *blue_color_detect*: Detected at least in ugr colors (4 detections)

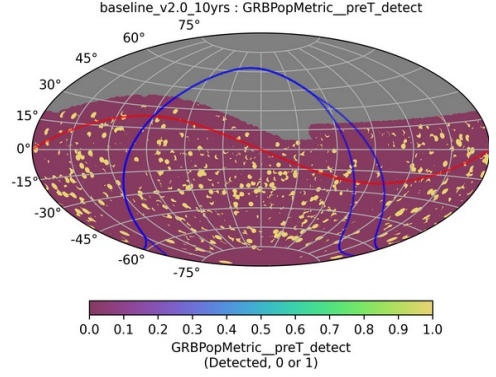




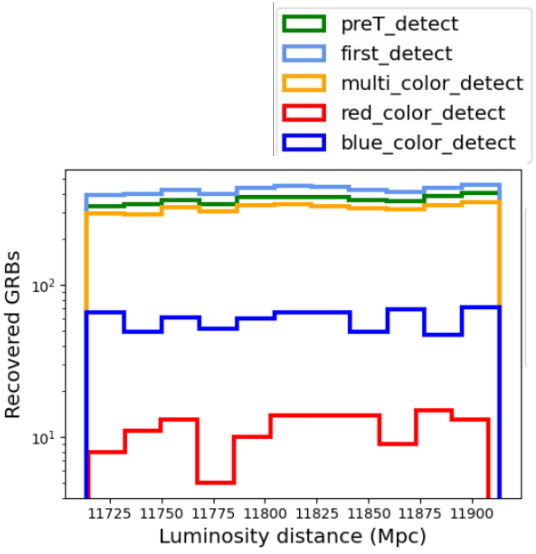




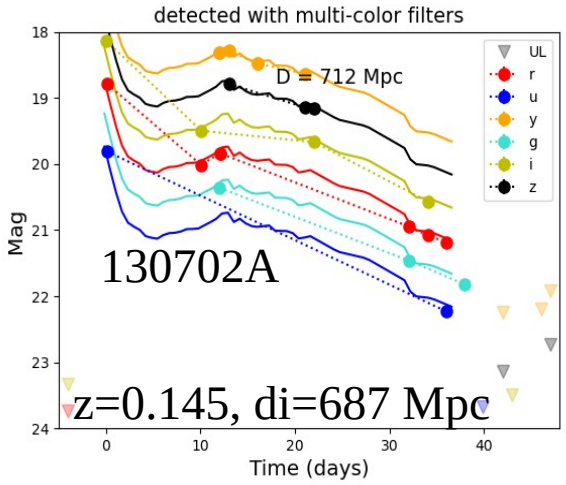


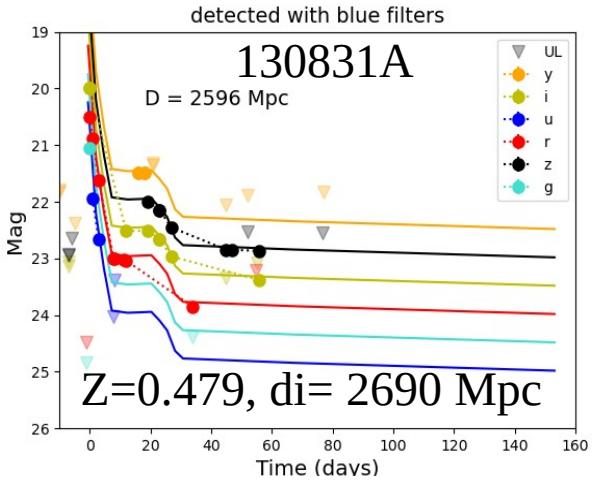


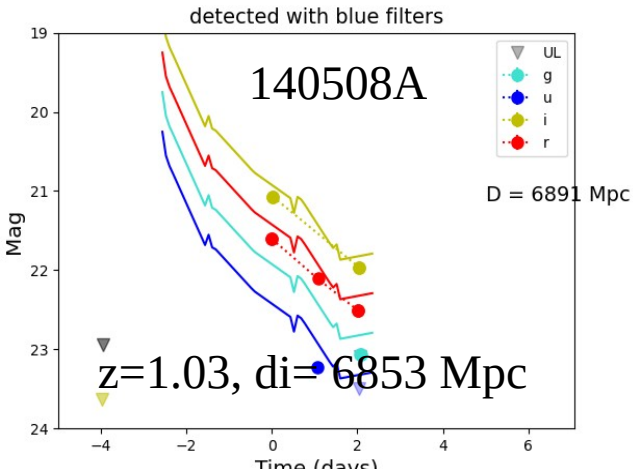
For other GRBs see here

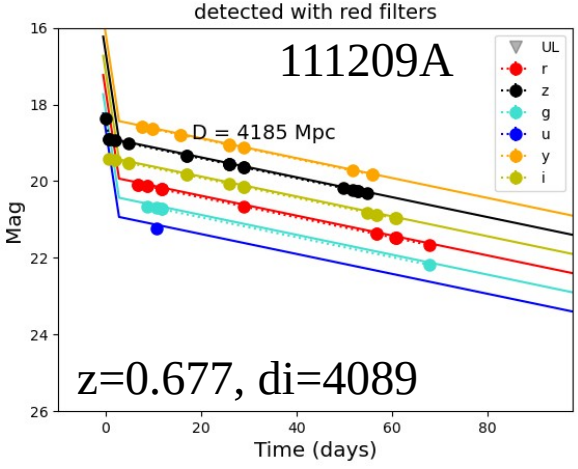


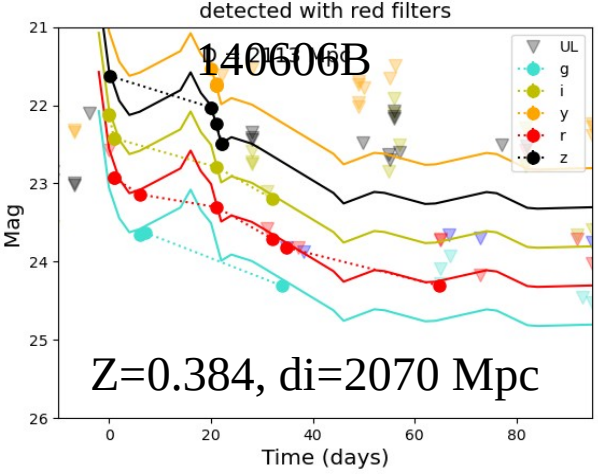
Output GRB Lcs with LSST

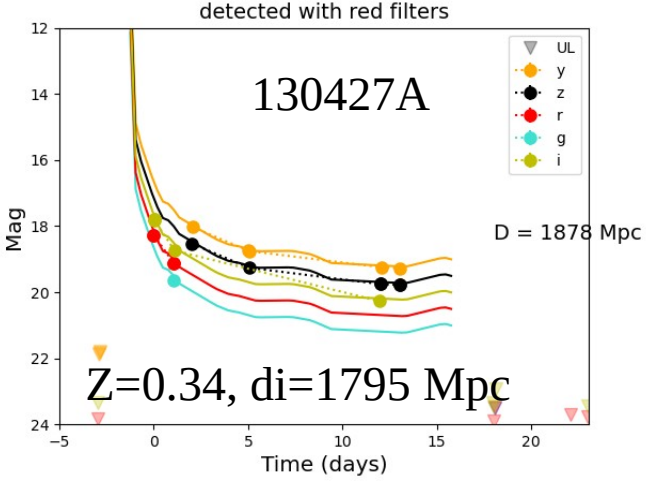




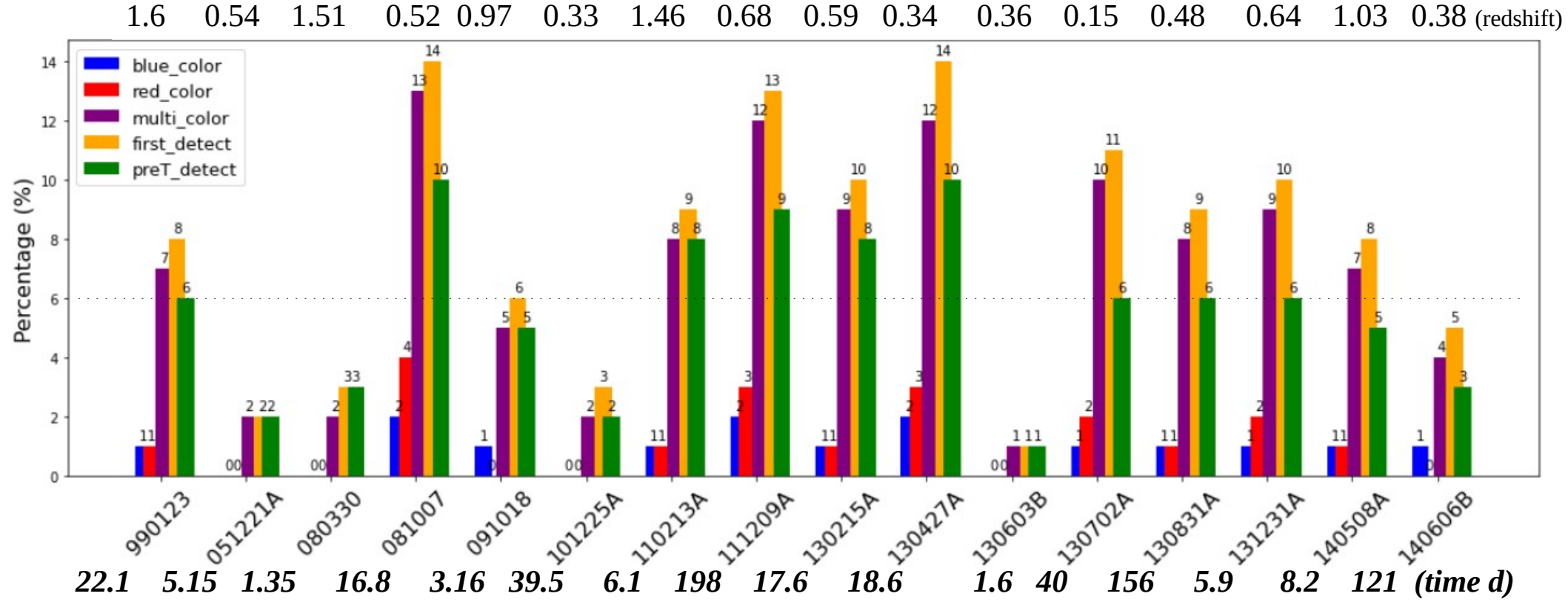








Detectability with LSST



- Short optical GRB LCs (<6 days) have a detection probability of less than 6%
- The maximum detectability for each GRB is found with the criterium first_detect (detecting at least two events during the first five days)

To-do list

- Assume a constant color variation (g-r) or (r-i) according to litterature to convert R into r data (transformation)
- Define suitable criteria for GRB analysis
- Compare between the detectability with the baseline cadence and the rolling, the ddf, the presto-color and the long-gap cadences
- Understand the effect of each of the survey strategies on the detectability of a given GRB LC
- Construct the output LCs of LSST observations and compare them with the real LCs