GRANDMA / SNEWS

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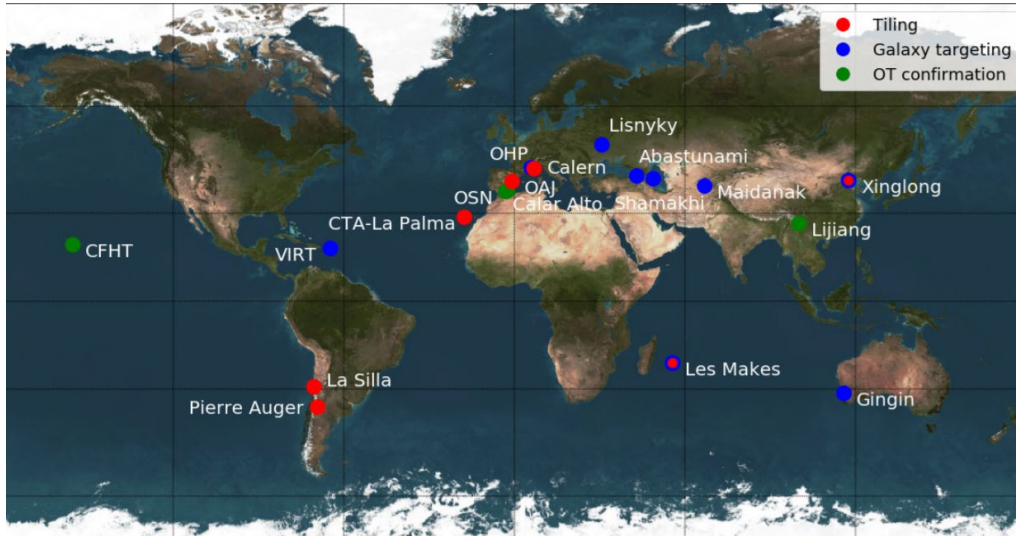
GRANDMA / SNEWS

- GRANDMA : a world wide robotic telescope network.
- SNEWS: SuperNova Early Warning System
  - 7 Neutrinos detectors

  -> SuperK, LVD, KamLAND, Ice Cube, KM3NeT, Borexino, HALO.



- Detect MeV neutrinos
- SNEWS plan to trigger alert as soon as galactic CCSN detected + triangularize the source location (similar to LIGO/VIRGO)

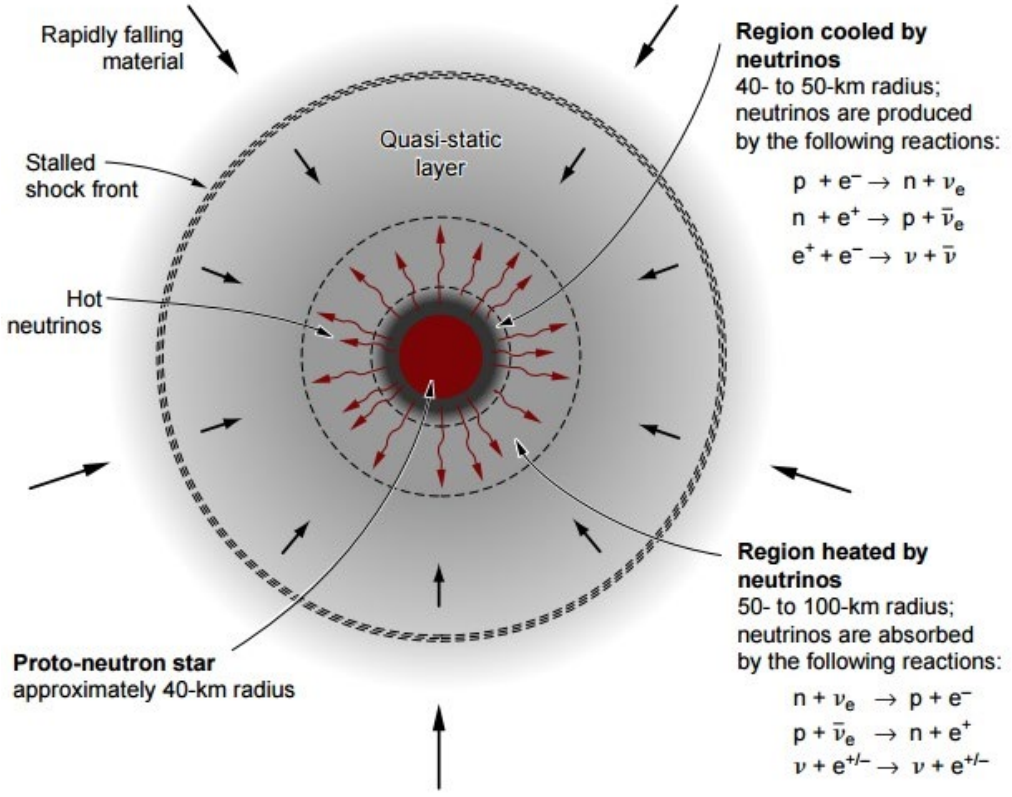
Credit: [GRANDMA: A NETWORK TO COORDINATE THEM ALL]

Physics of Core collapsing SN

- Massive stars progenitors (>8 Msun)
- SN type Ib/c and SN II

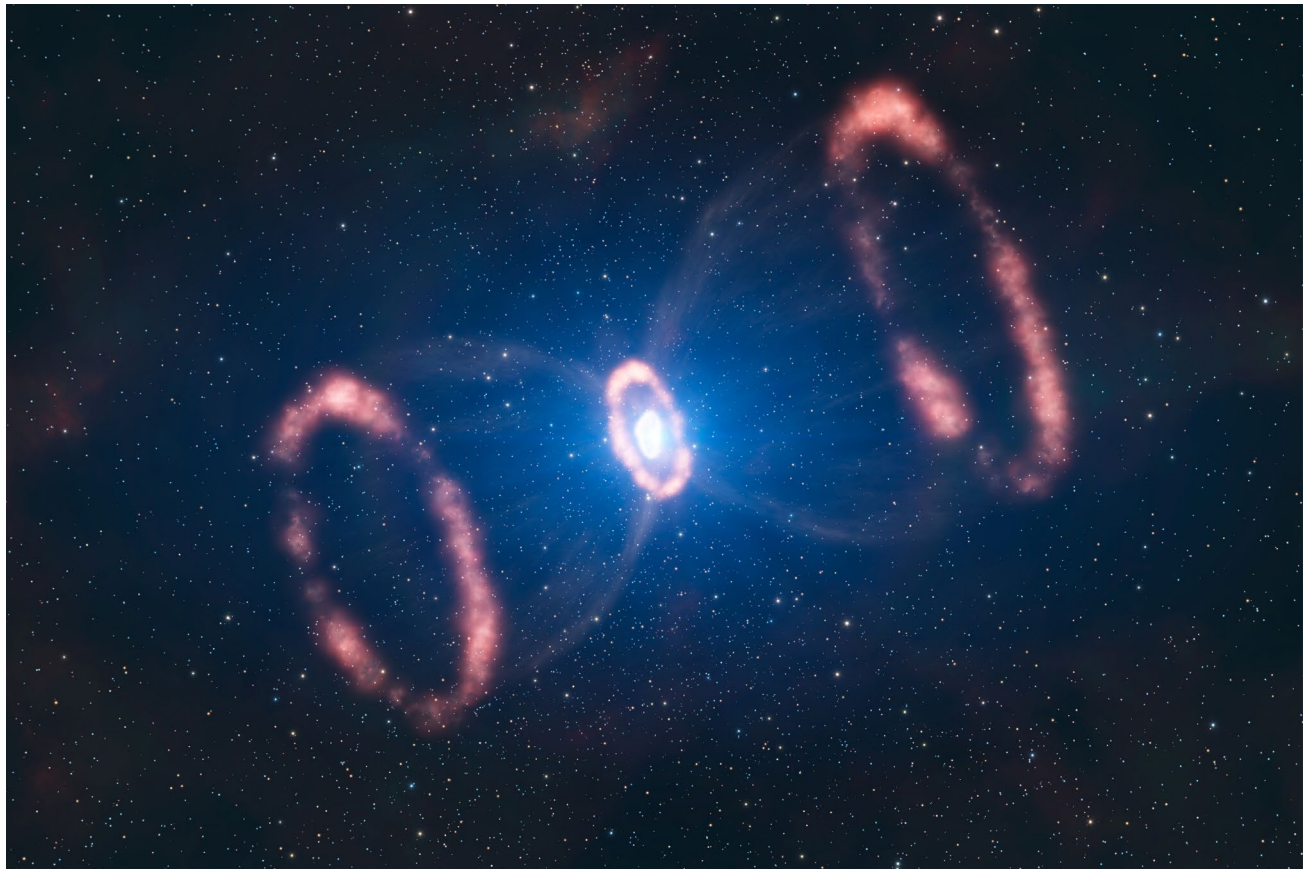
1. Core collapse (neutrinos are immediatly emitted)
2. Progenitors density ~atomic density = bounce + shock breakout

- Neutrinos = 99% of energy
- Photons = ~0.01% of energy
- Matter = ~0.99% of energy (kinetic energy)



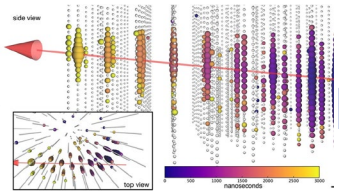
Stakes

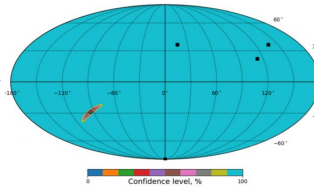
- SN1987a (Magellanic cloud)-> Neutrino detection first and EM detection (confirm general idea about explosion mecanism)
- Many unsolved problems about CCSNe mecanism
- Detect EM signal with a great binning of the light curve as soon as possible after the Neutrino signal.
- Indirect probes of CCSNe with extragalactic events
- Inside the Milky Way (access to neutrino detection)
- Last observed Galactic CCSN -> SN1604
- ~3.2 galactic CCSNe per century (Adams et al. 2013)



Process

My work

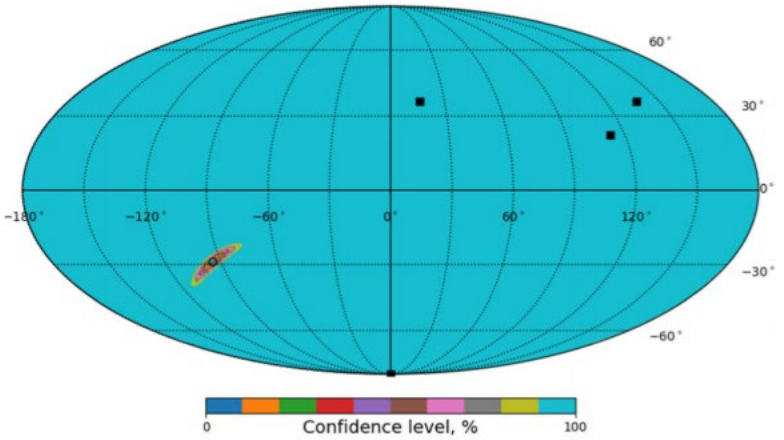




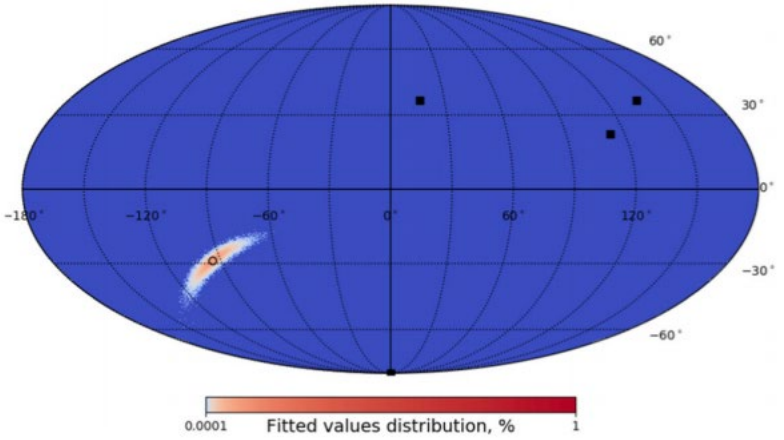
CC SN explosion → Neutrino détection → Triangulation → SNEWS alert → GRANDMA trigger → Follow up

Goals

- Where should we look ? (DONE)
  - Constrain the region in the sky corresponding to the neutrino detection. (Coleiro et al., 2020)

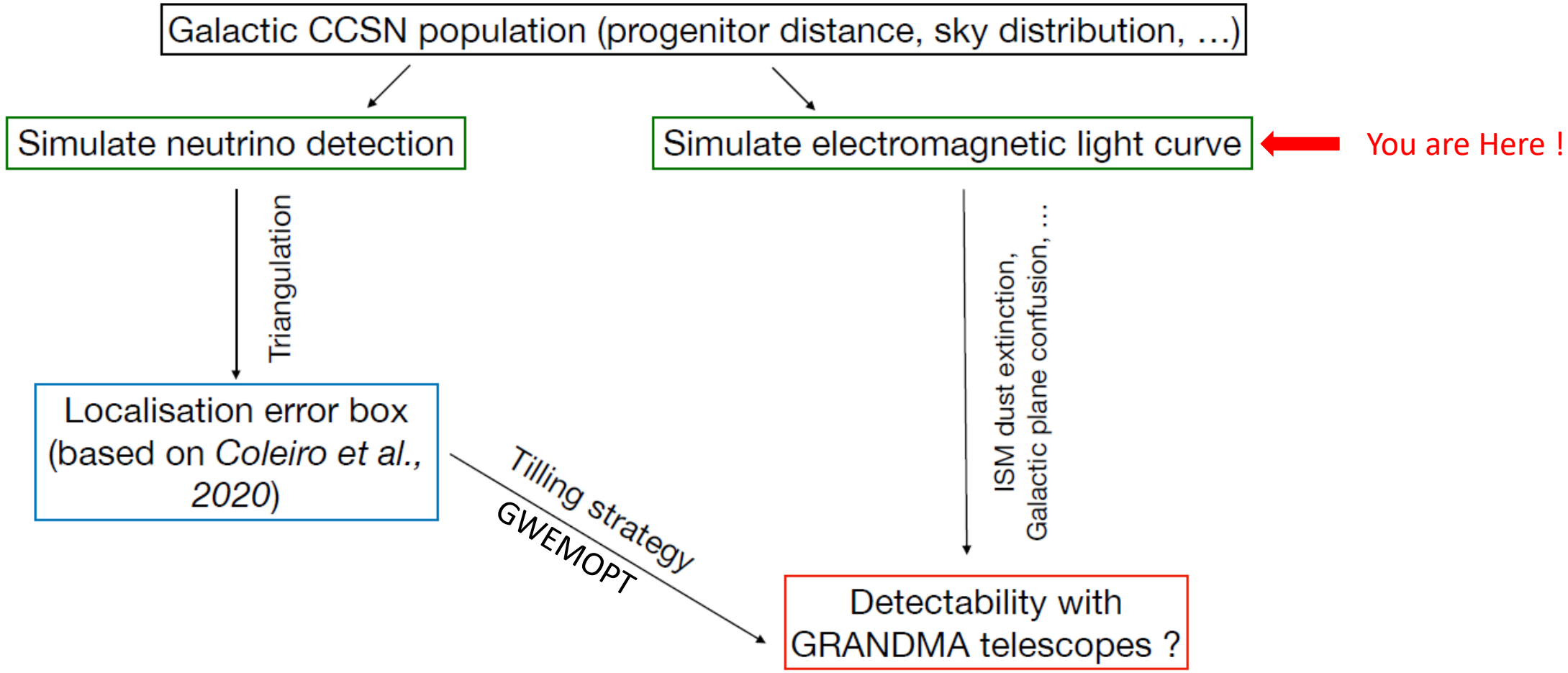


- Will we be able to look ? When ? Which instruments to use ?
  - Simulate galactic CCSNe light curves + EM follow up.



Optimization of the follow-up strategy

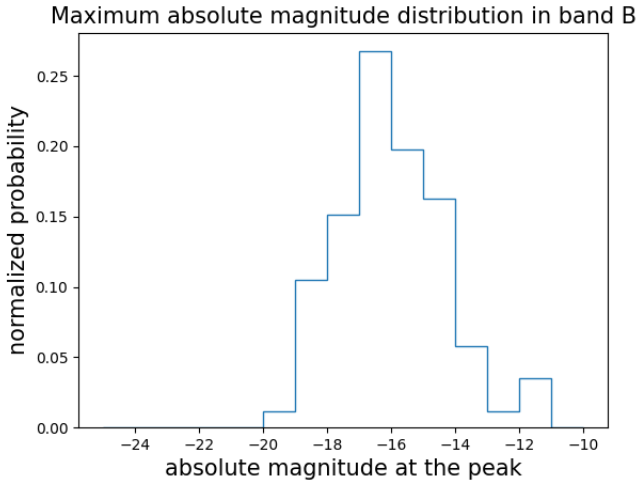
When should we look ? Where should we look ?

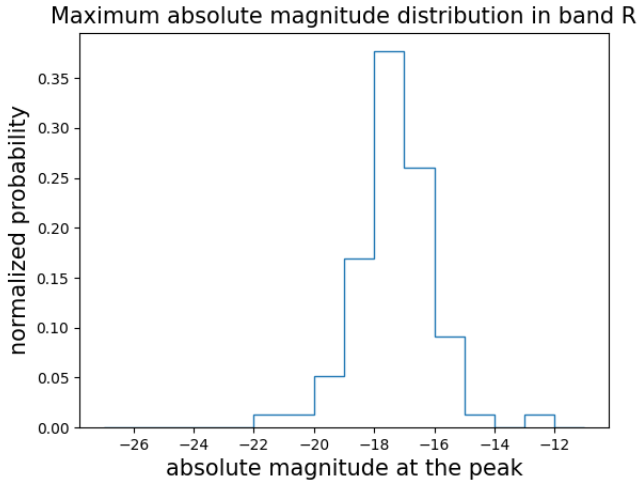


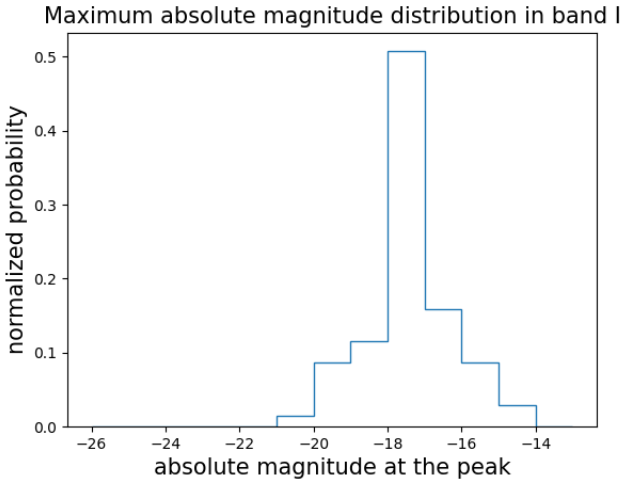
⇒Run Monte-Carlo simulations to optimize the follow-up strategy

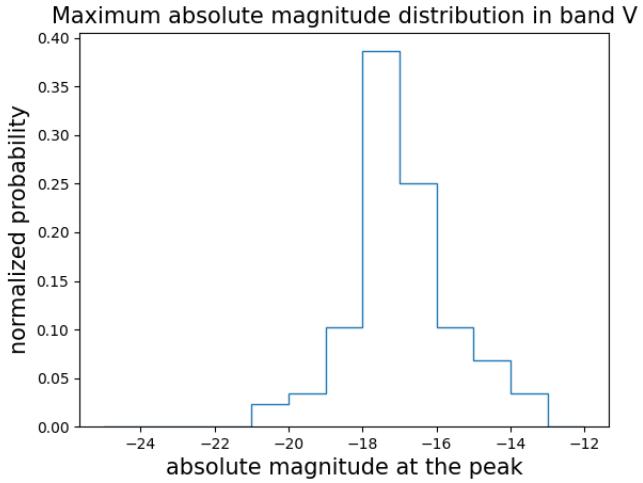
Maximum absolute magnitude distribution

- Get 89 extra galactic SN Ib/c photometric and meta data from The Open SuperNova Catalog
- Over 89 SN I b/c events :
  - Get the apparent magnitude at the peak
  - Correct the dust extinction for each photometric filter with E(B-V) + extinction law (Cardelli et al. 1989)
  - Compute the absolute magnitude knowing the distance
- Randomly choose an absolute magnitude following these distributions





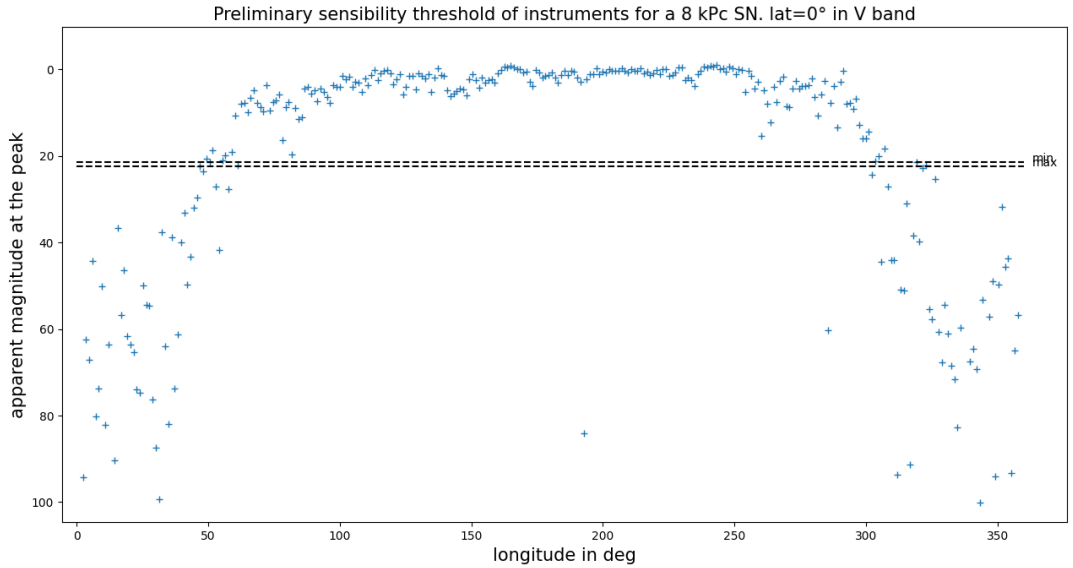


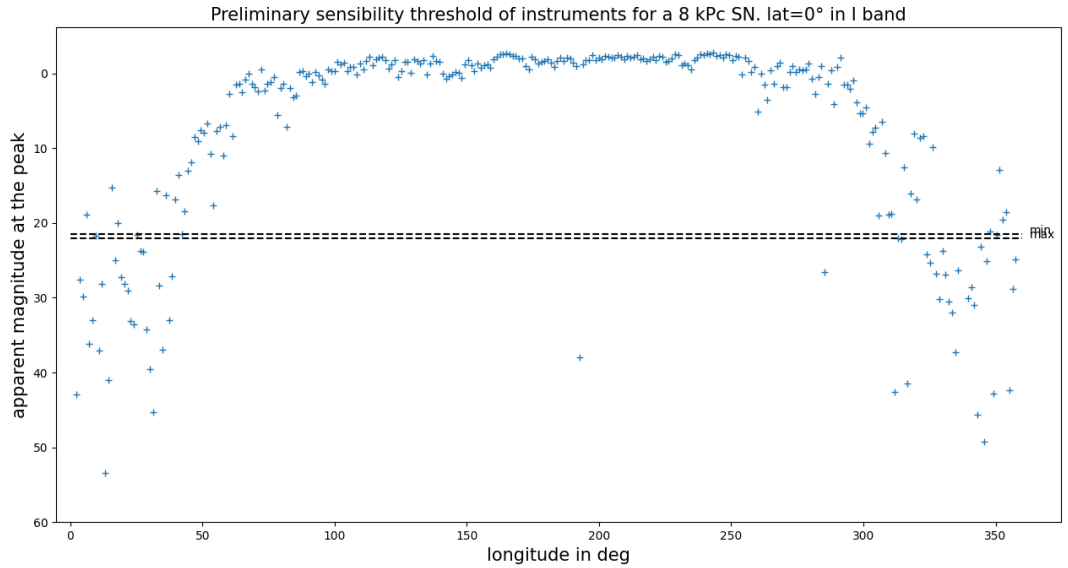


Apparent magnitude vs longitude

- Latitude=0° (Galactic coordinate)
- Peak value (randomly chosen)
- 8 kpc
- Galactic dust extinction (thanks to a galactic dust map (IRSA-Caltech))
- Plot the apparent magnitude vs longitude
- Max= maximum sensitivity of GRANDMA
- ~50° to ~300°: possibility to observe
- Wider range in IR (weaker extinction)

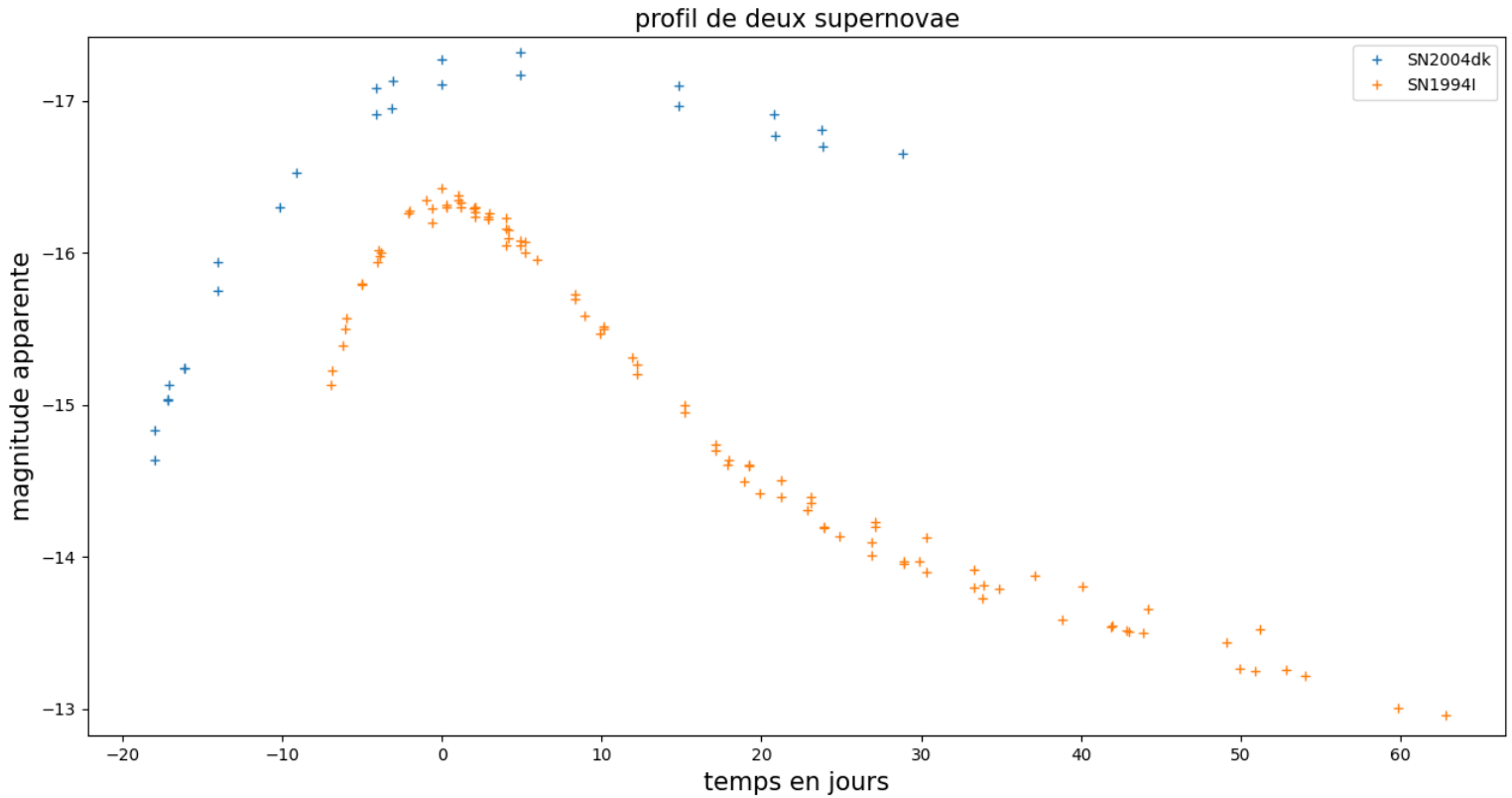
- Can add a limit for brightest sources





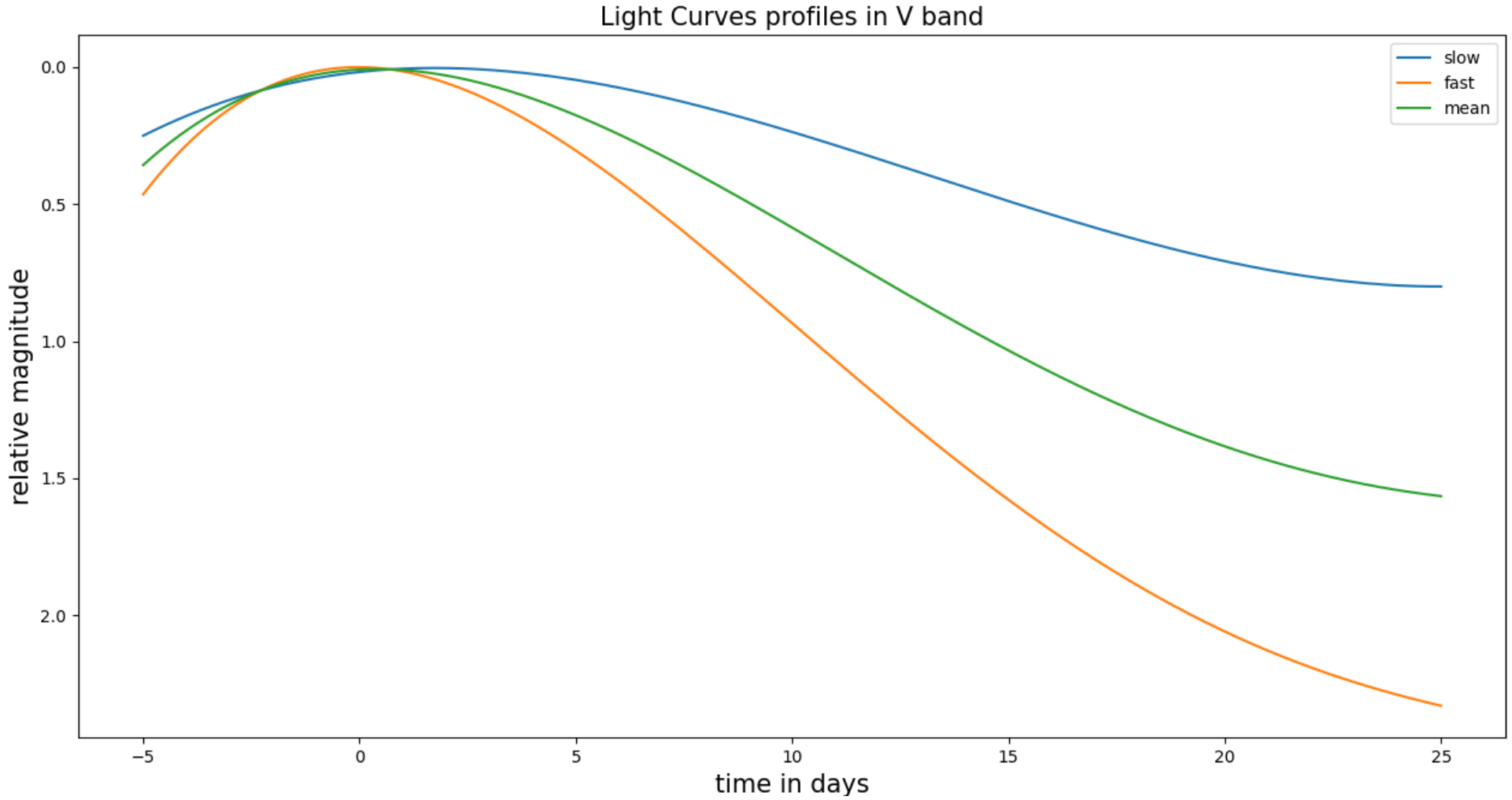
How to simulate these light curves ?

- First : Only SN Ib/c type
- Light Curve profil based on Weidong Li et al. (2018) method
- 2 sub-categories
  - Fast evolving
  - Slow evolving

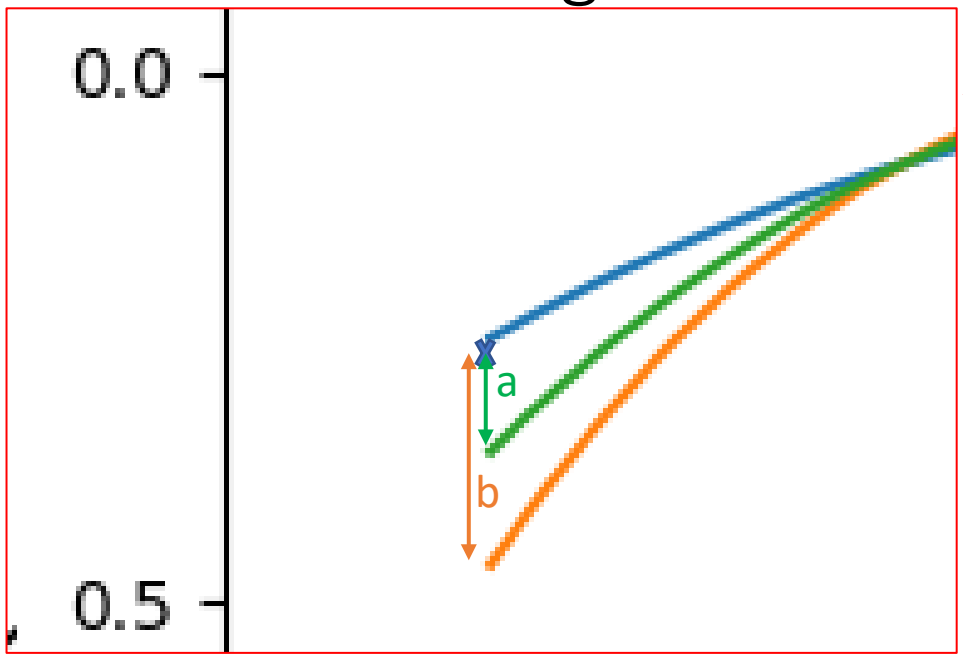


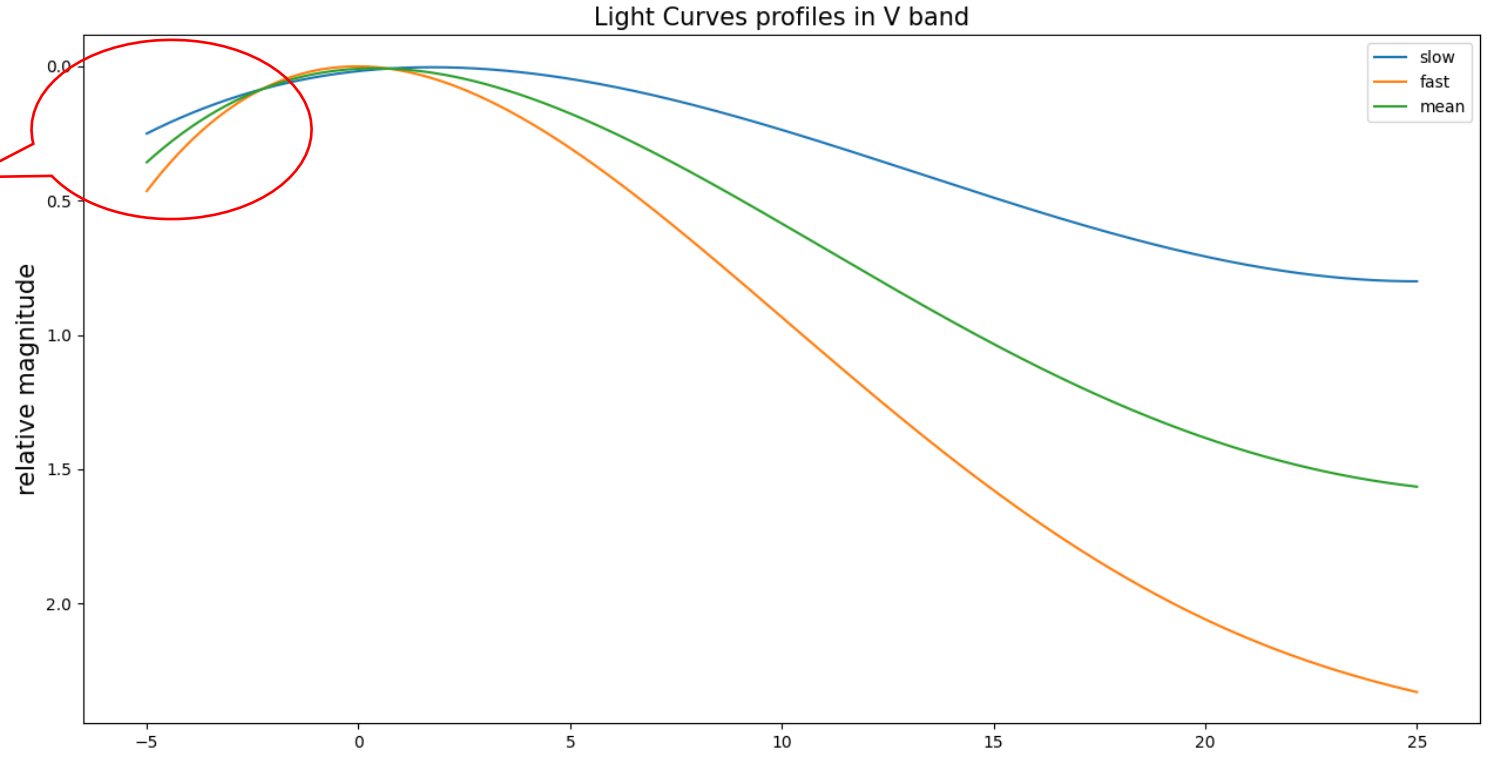
Light curve profil

- Fit Fast and Slow photometric data with Splines
- Make the mean of this 2 fits
- Set the 0 magnitude at the peak

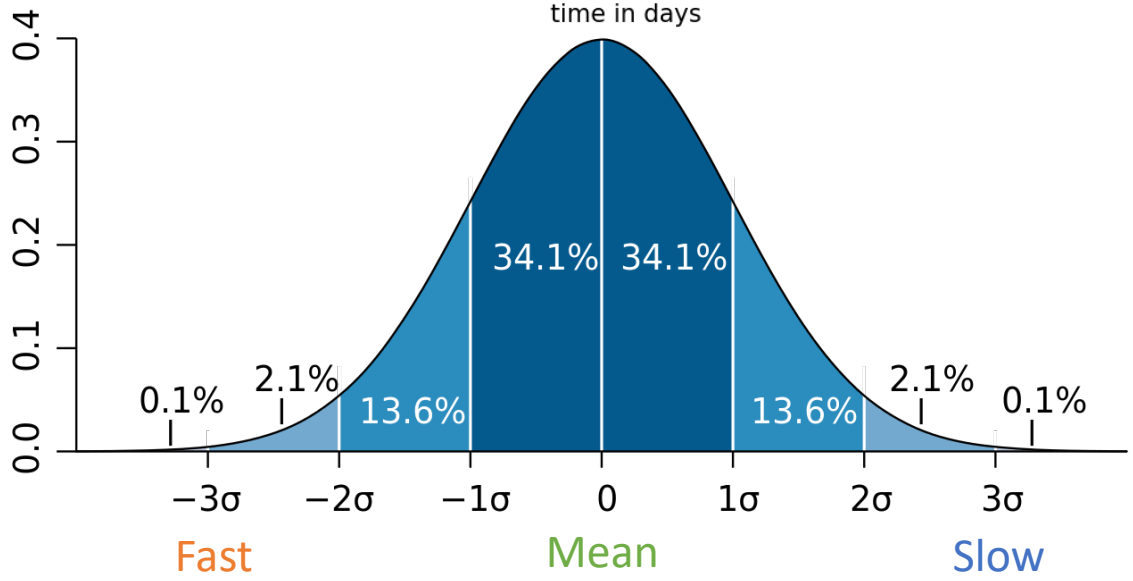


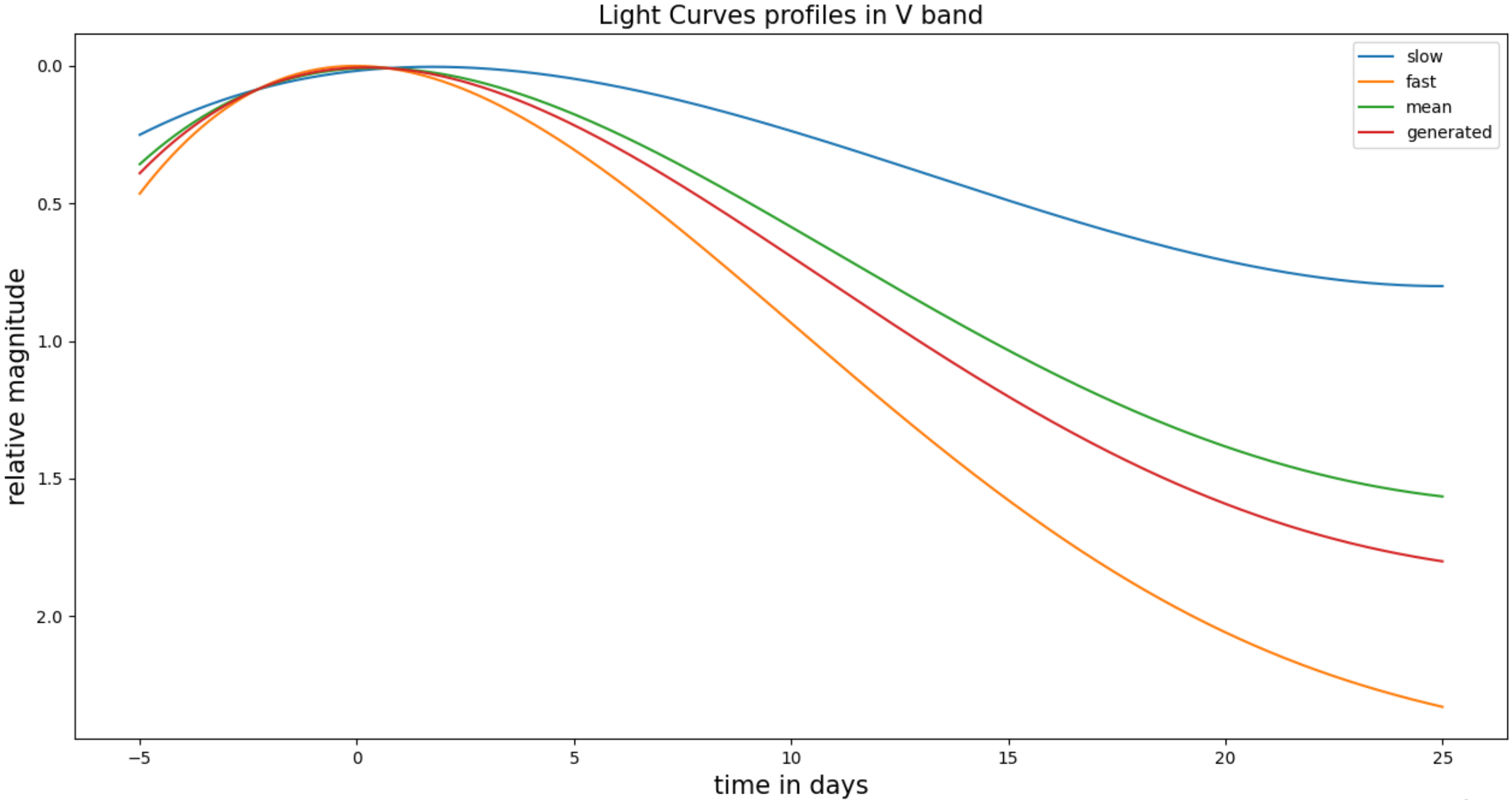
Generate light curves





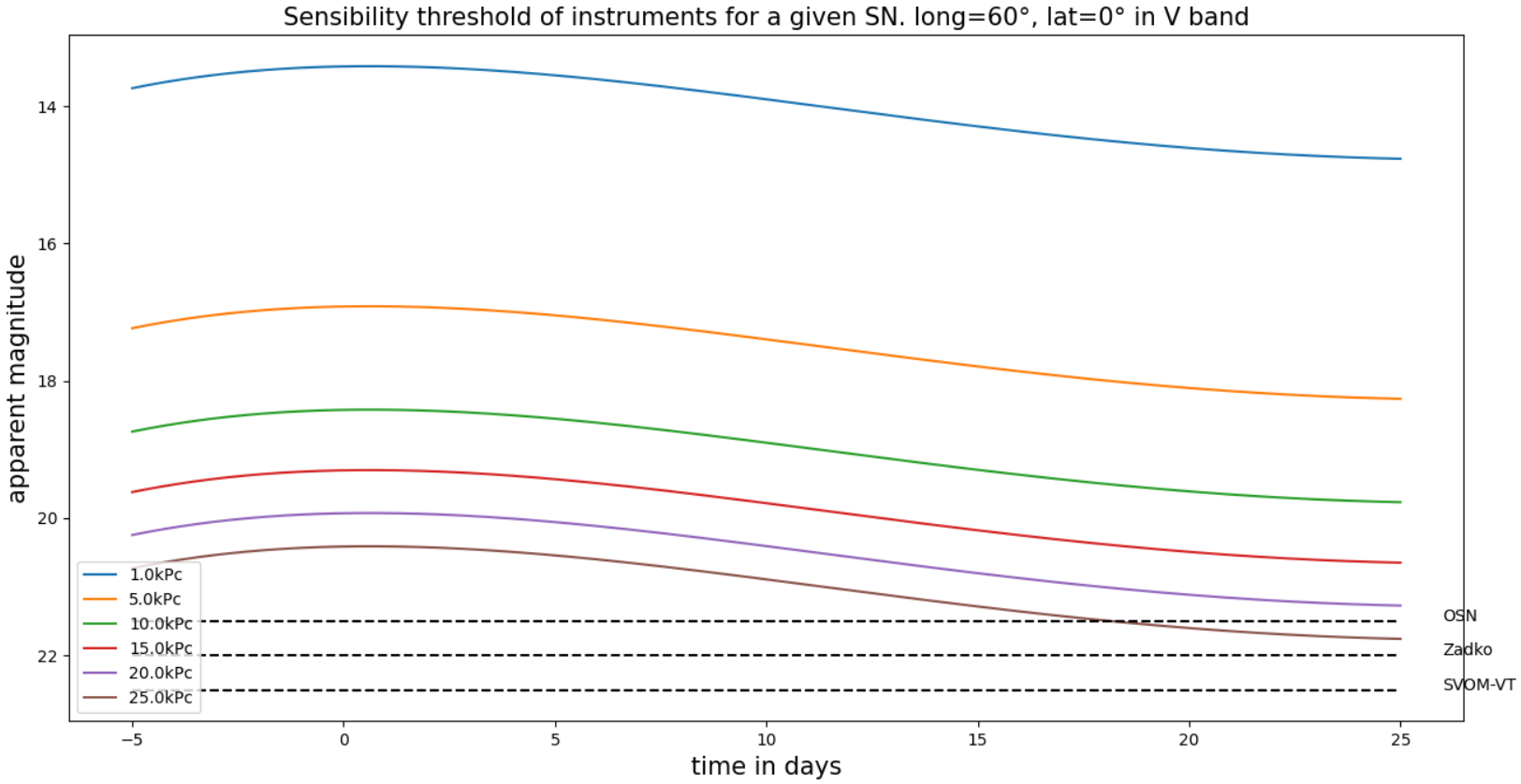
- Randomly choose a relative magnitude (gaussian distribution) at the begining
- Keep the ratio a/b all along the curve
- Translate the curve by an absolute magnitude randomly chosen
- Pass in apparent magnitude
- Add galactic dust extinction thanks to a [galactic dust map (IRSA-Caltech)]




Light Curves profiles in V band
slow
fast
mean
generated
relative magnitude
0.0
0.5
1.0
1.5
2.0
−5
0
5
10
15
20
25
time in days

Possibility to detect

- Different distances
- In the longitude range of observability
- Above the lines it is visible
- Montecarlo simulation to optimize the GRANDMA follow-up



Upcoming upgrades

- Determining the CCSN explosion date by fitting with D.F. Cowen et al. (2018) equations (-> delay time netrino-EM)
- Doing the same process with SN II
- Adding U, J, H, K bands
- Optimize the follow-up with GRANDMA using GWEMOPT
  - build cumulative distribution of absolute magnitude at peak (through Monte-Carlo simulations)
  - Compute the time delay between SNEWS alert and first CCSN detection with GRANDMA (to be optimized)