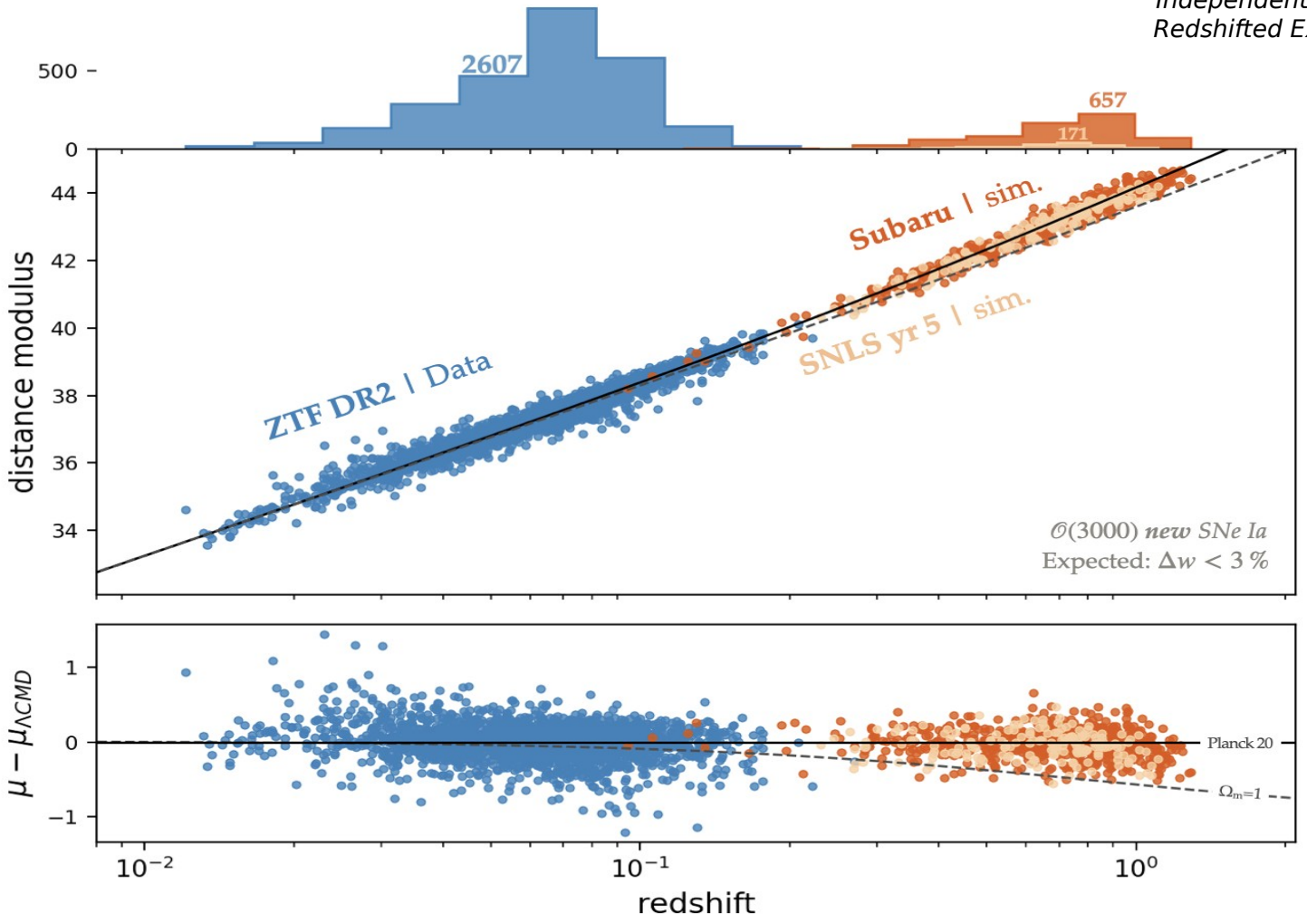
Thomas de Jaeger (LPNHE - CNRS - Université Pierre & Marie Curie)

PETS : building the ZTF cosmology sample

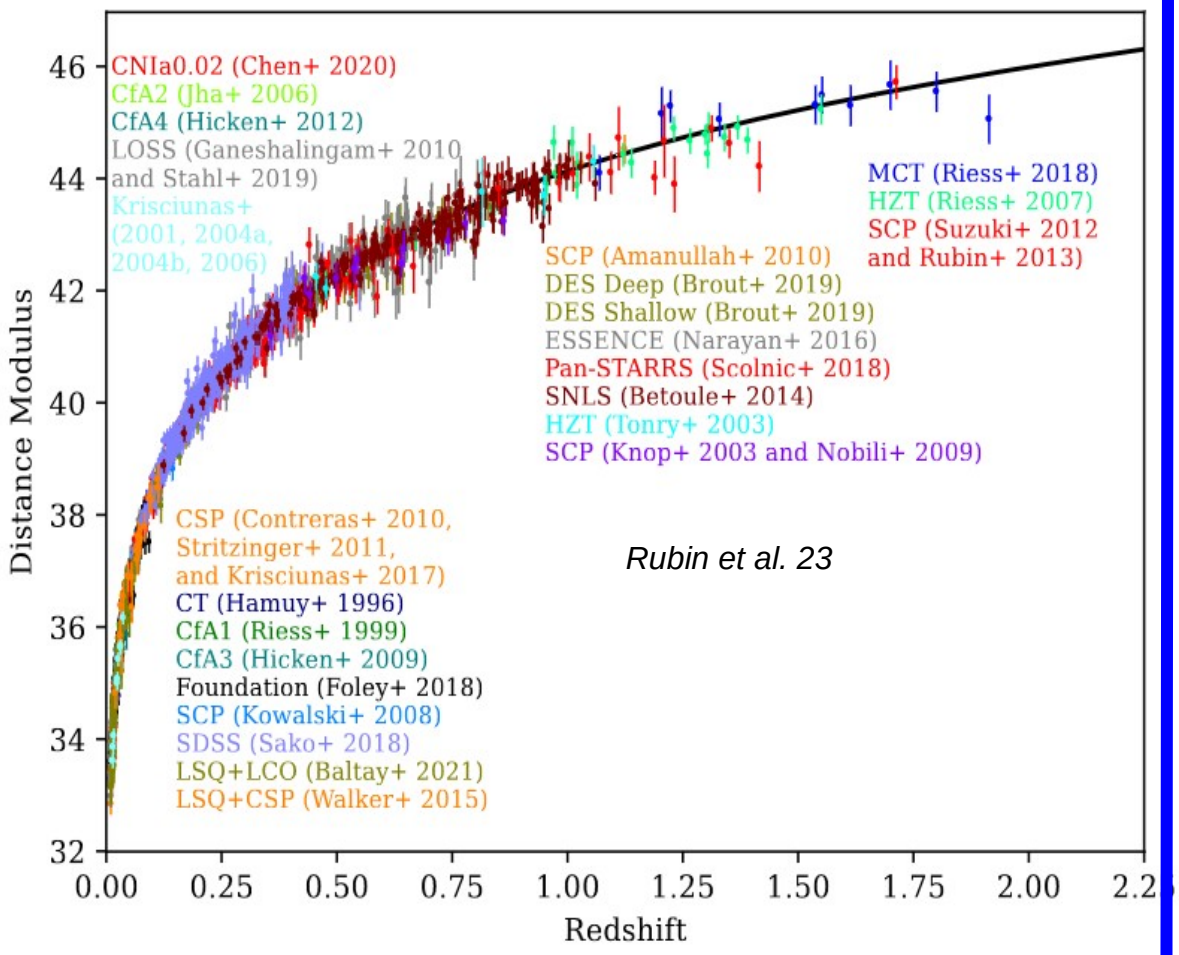
Goals

The *Lemaître* Hubble diagram

Latest Extended Mapping of Acceleration with an Independent Trove of Redshifted Explosions



Why?



Rubin et al. 23

Simplification:

→ 12 bands vs 100 bands to intercalibrate
→ Same codes for the photometry
→ same sky

Independent data

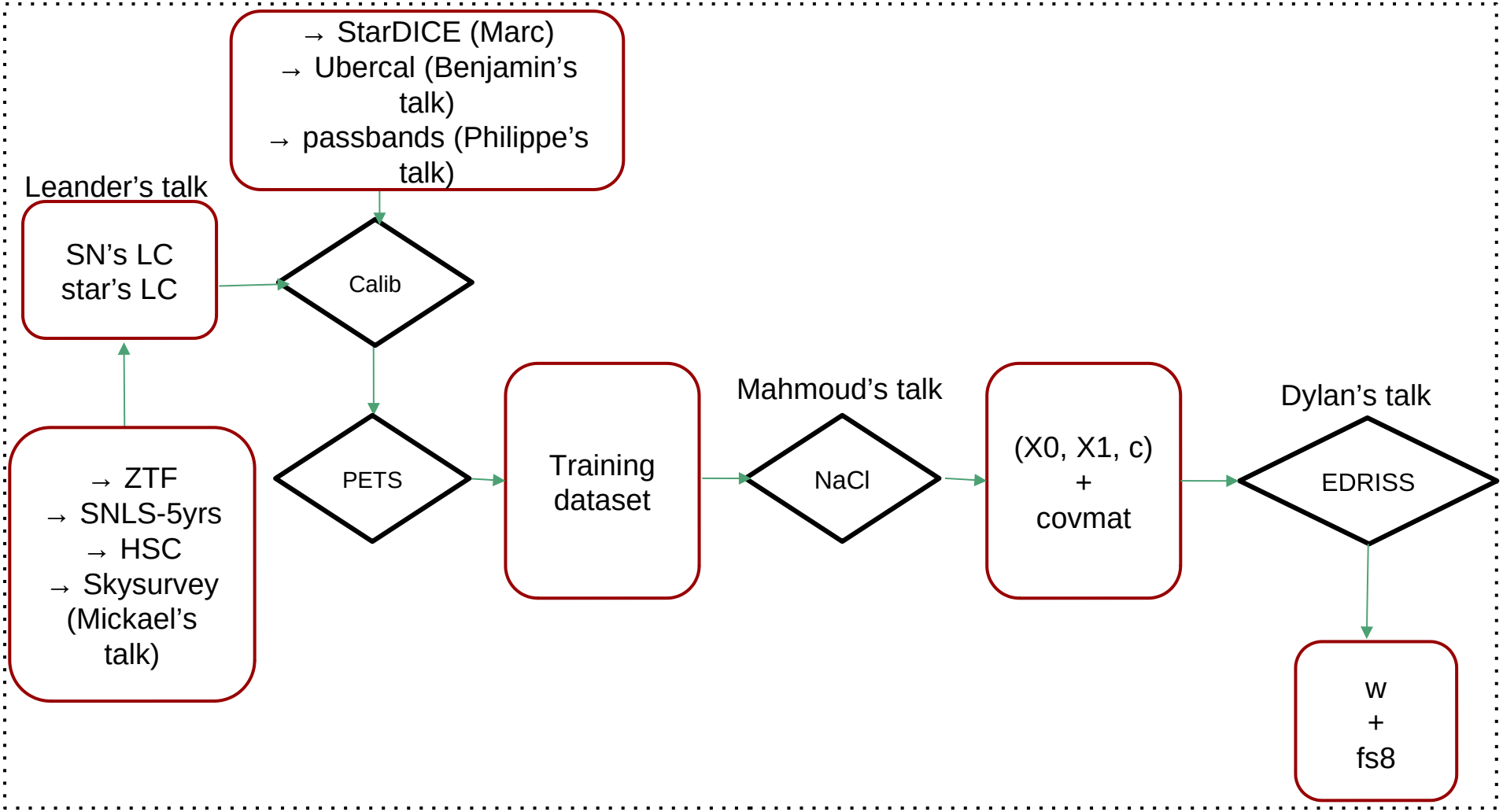
→ ZTF, SNLS-5yrs, HSC are not public

New methodology

→ New SNe Ia fitter: NaCl
→ Training sample selection

How?

Inference framework (from light curves to distances)



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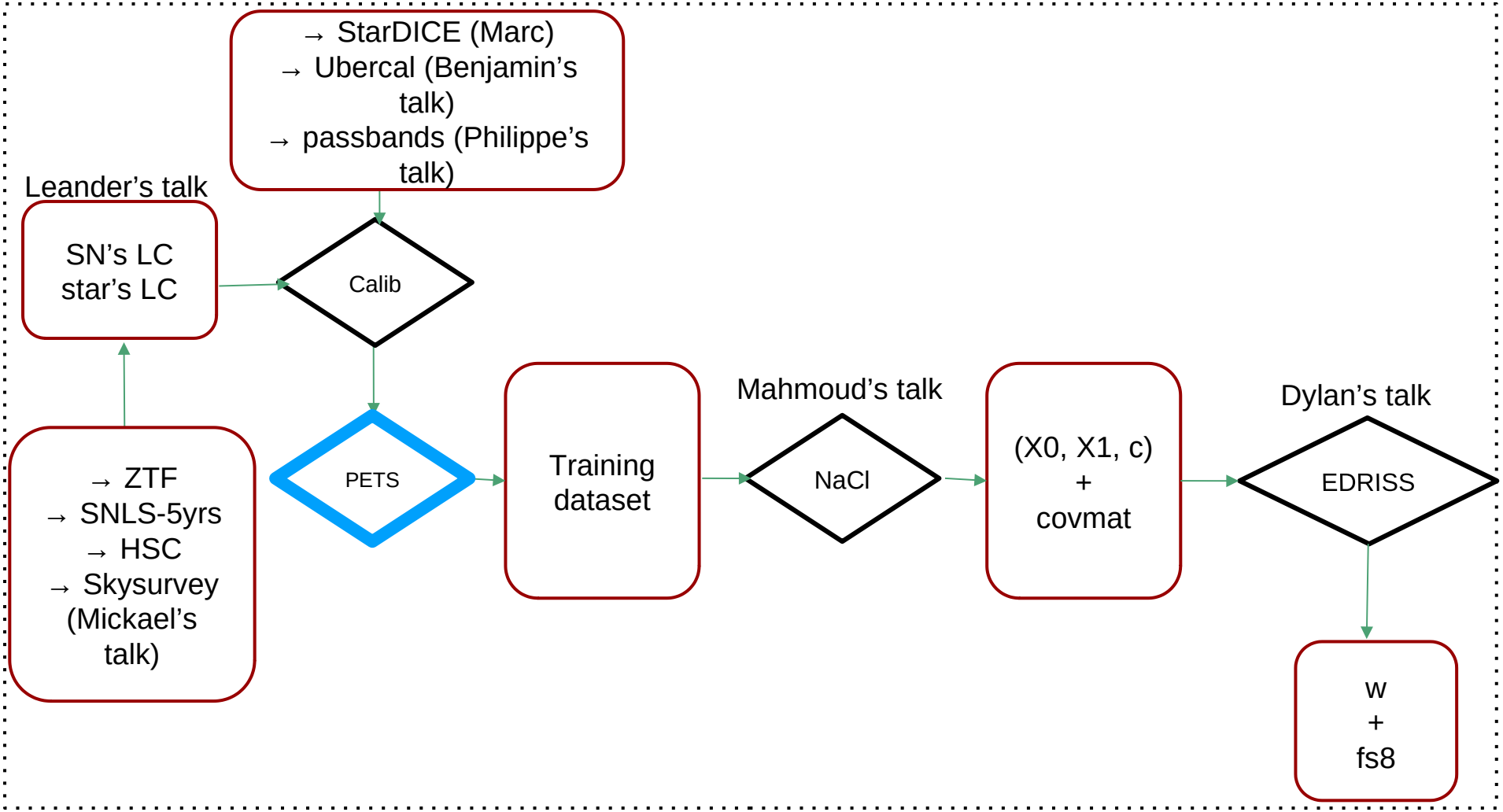
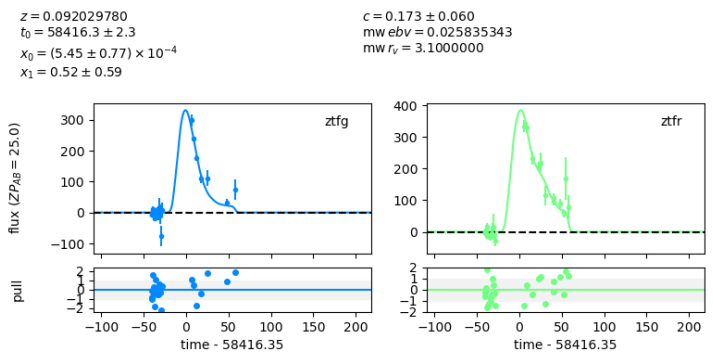
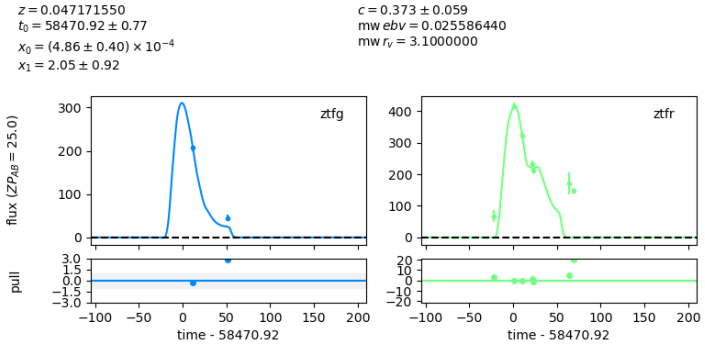
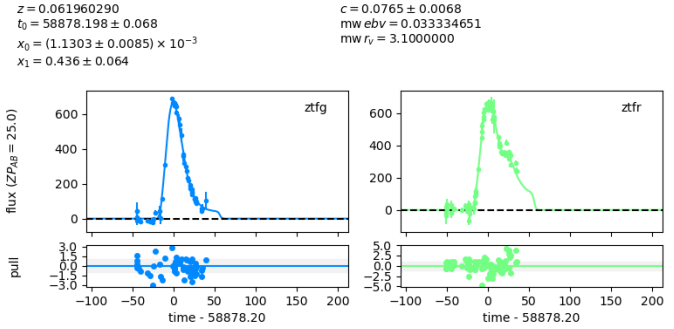


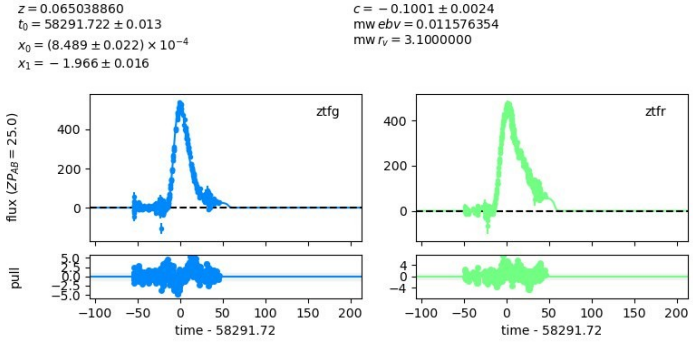
PETS

PETS: Preprocessing and sElection of a Training Sample









Problems

Need a well defined Tmax: any bias in Tmax introduces a bias in the parameters needed to estimate a distance (magnitude, shape and colour)

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Table 6. Number of supernovae discarded by the successive cuts applied to the SDSS-II sample before inclusion in the training sample.

	Discarded	Remaining
Initial	-	507
$z < 0.25$	170	337
$\sigma(t_0) < 0.5$	85	252
$\sigma(X_1) < 0.5$	14	238
$-0.3 < C < 0.3$	9	229
$-3 < X_1 < 3$	1	228
$E(B-V)_{\rm mw} < 0.15$	1	227
Other[a]	24	203

Betoule+14

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Betoule+14

Problems

A SN can pass all the cuts but are poorly sampled which is not good for the training sample!!

-> Need a visual inspection… so it is not the best

Last, a proper and stable determination of the date of maximum is necessary for SNe Ia entering in the training sample, because the date of maximum is held fixed in the training. We looked for remaining poorly sampled light curves in the training sample, and discarded the following nine SNe (only from the training sample):

1. Too few observations after the epoch of peak brightness (despite a reported uncertainty on t_0 passing the cuts): SDSS10434, SDSS19899, SDSS20470, SDSS21510.
2. Too few observations before the epoch of peak brightness: SDSS6780, SDSS12781, SDSS12853 (2006ey), SDSS13072, SDSS18768.

Betoule+14

Motivation

We want a method to select a training sample where all the SN have well defined Tmax.

- Unlike in the literature, we want a method not based on SALT2 parameters because we will retrain NaCl

- All the cuts in x1, c will be done during the fitting process (NaCl)

- Finally, we want to apply the same method to all the surveys (ZTF, SNLS, HSC), i.e., well sampled or not well sampled light curves

Method: Produce the likelihood profile, i.e., we look at the chi2 for different Tmax

→ **Using sncosmo fit all the LC with Tmax, x0, x1, c as free parameters**
→ **Fit all the LC with Tmax fixed and x0, x1, c as free parameters**

→ As model, we use the model produced by Mahmoud trained on the SN factory data. Model without model error.
→ Wavelength ranges from 2000 Å to 11000 Å and phase ranges from -100 to 200

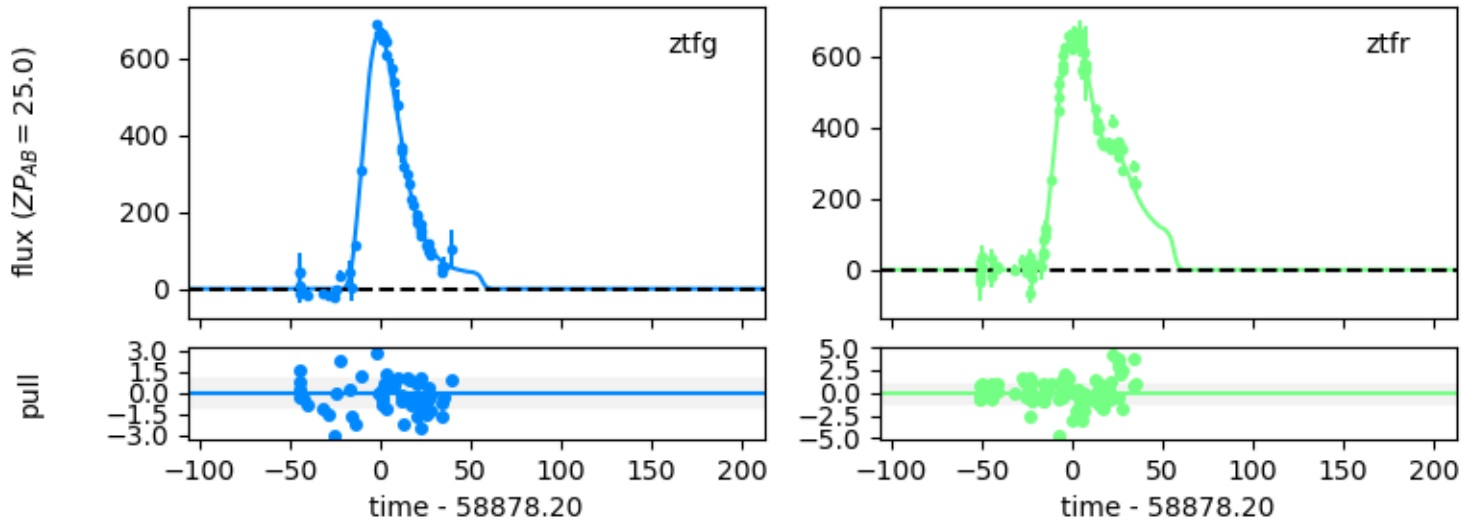
We do not use SALT2.4 because we wanted a model a larger phase range.

Method: profile likelihood

$z = 0.061960290$
$t_0 = 58878.198 \pm 0.068$
$x_0 = (1.1303 \pm 0.0085) \times 10^{-3}$
$x_1 = 0.436 \pm 0.064$

$c = 0.0765 \pm 0.0068$
mw $ebv = 0.033334651$
mw $r_v = 3.1000000$

ZTF17aadlxmv



Method: profile likelihood

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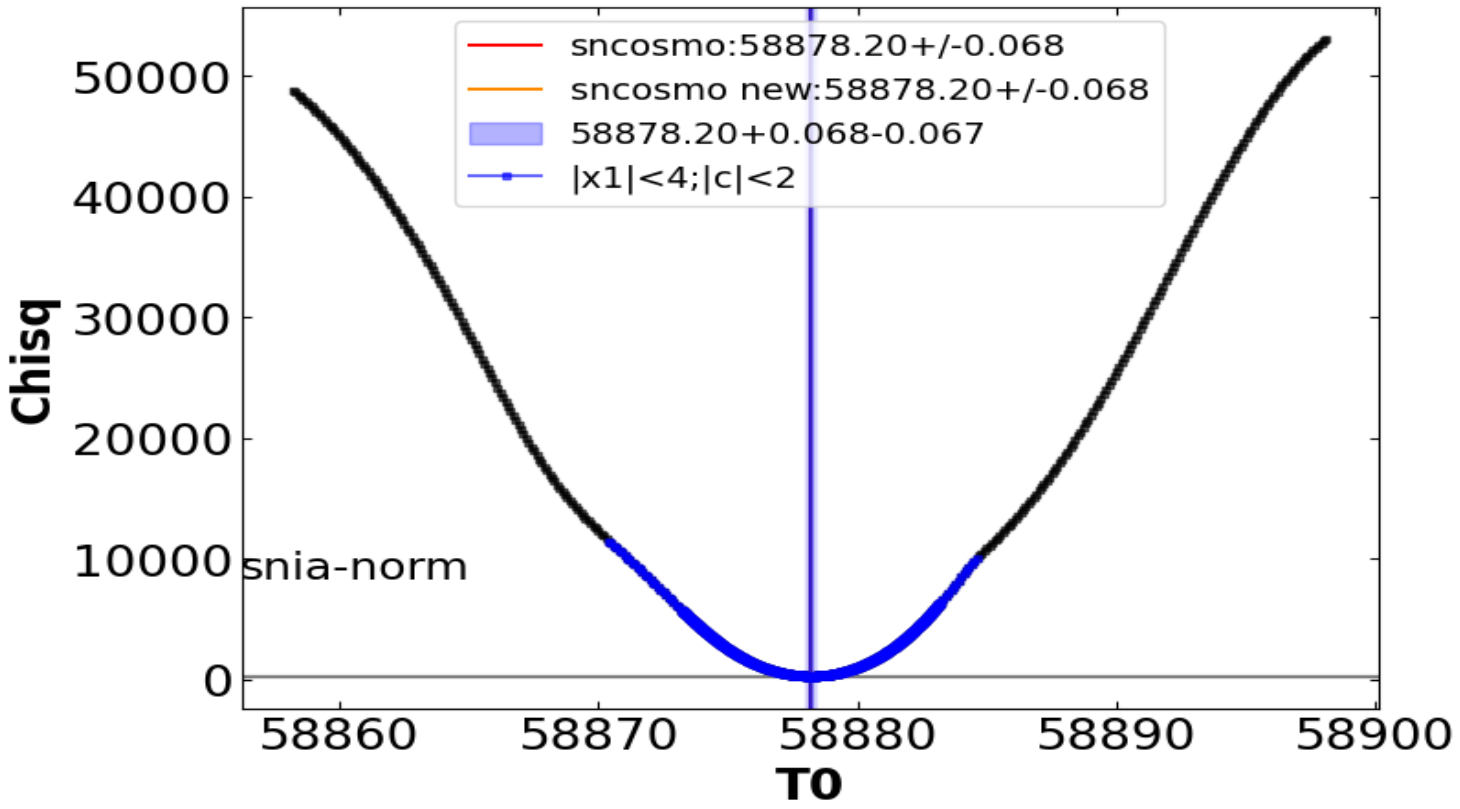

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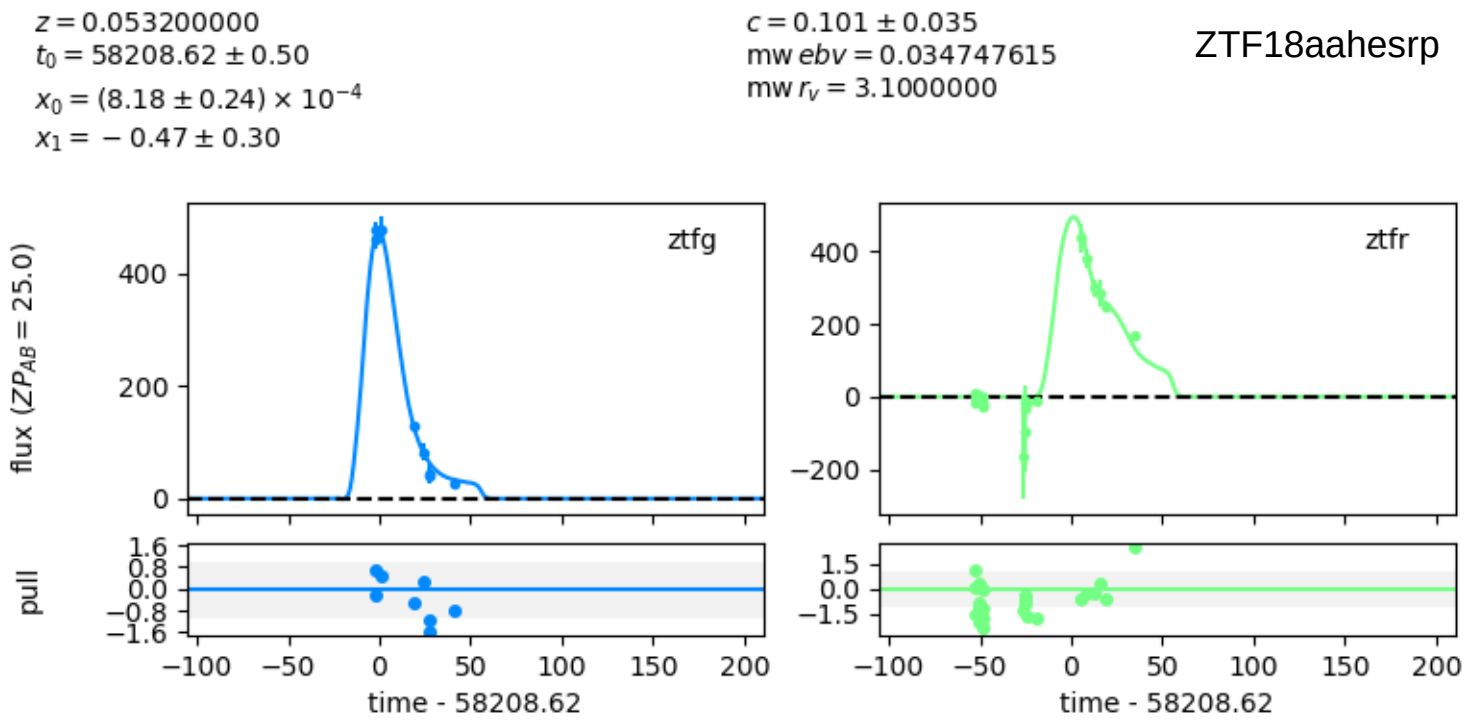

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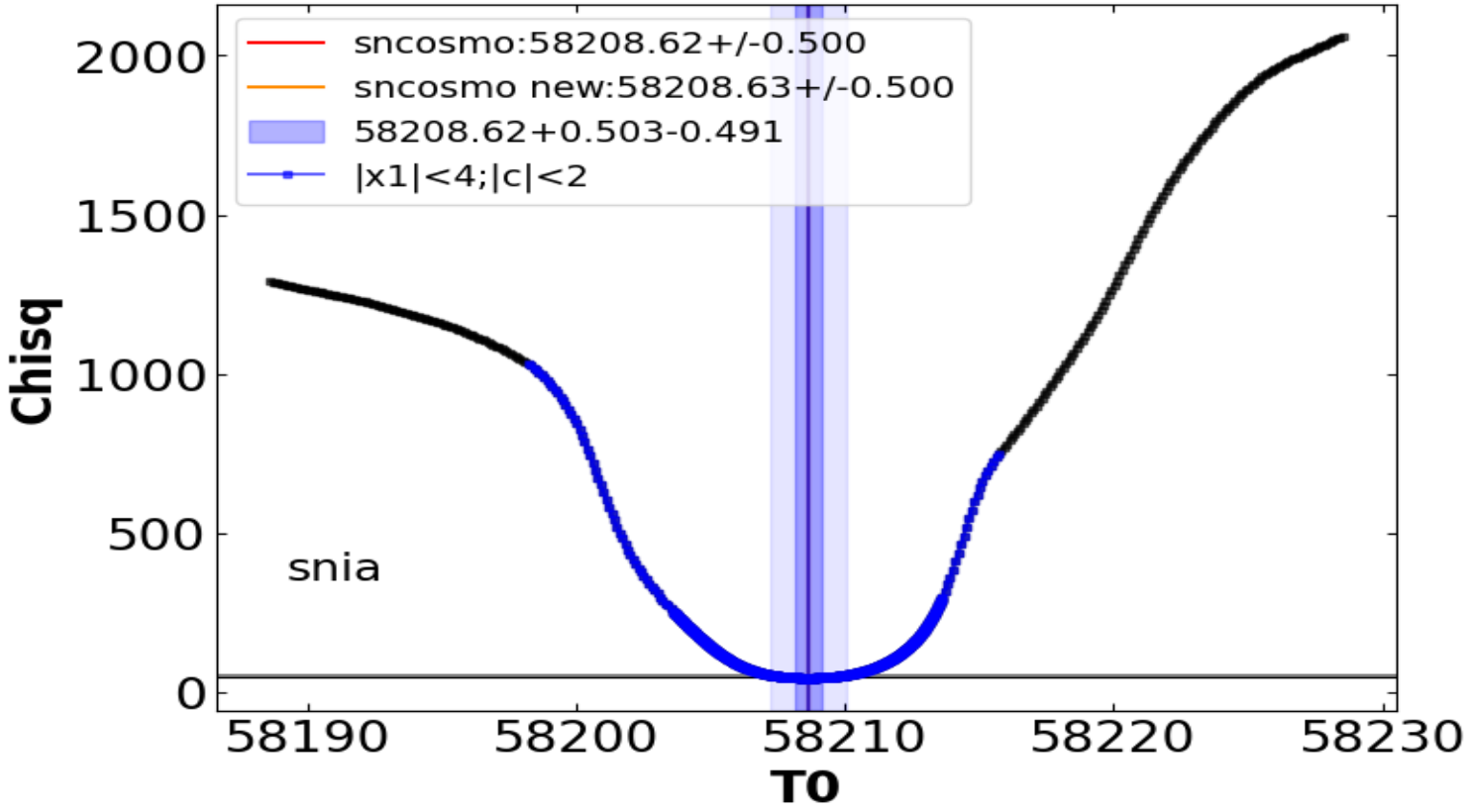


Cuts

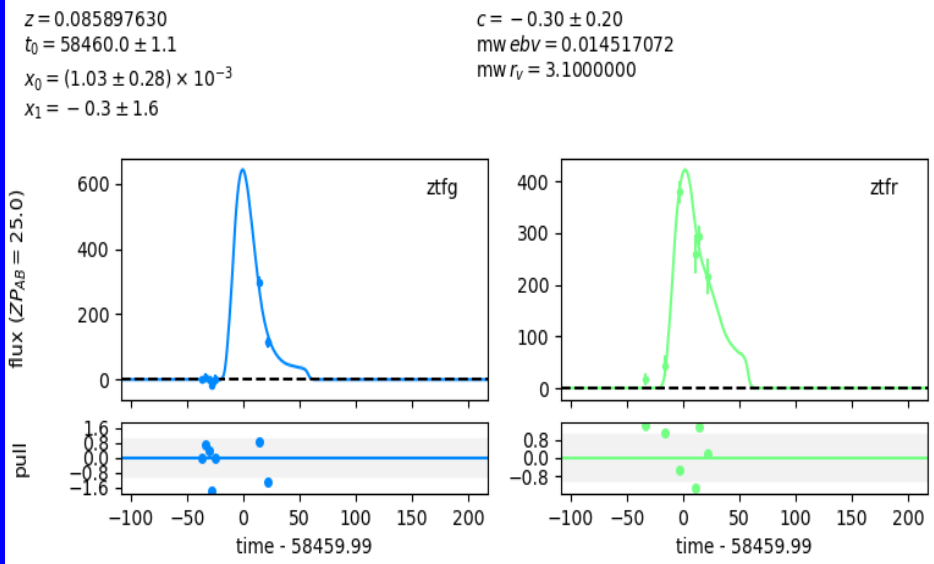
- **sncosmo converged**
  → purpose: have data and found a minimum

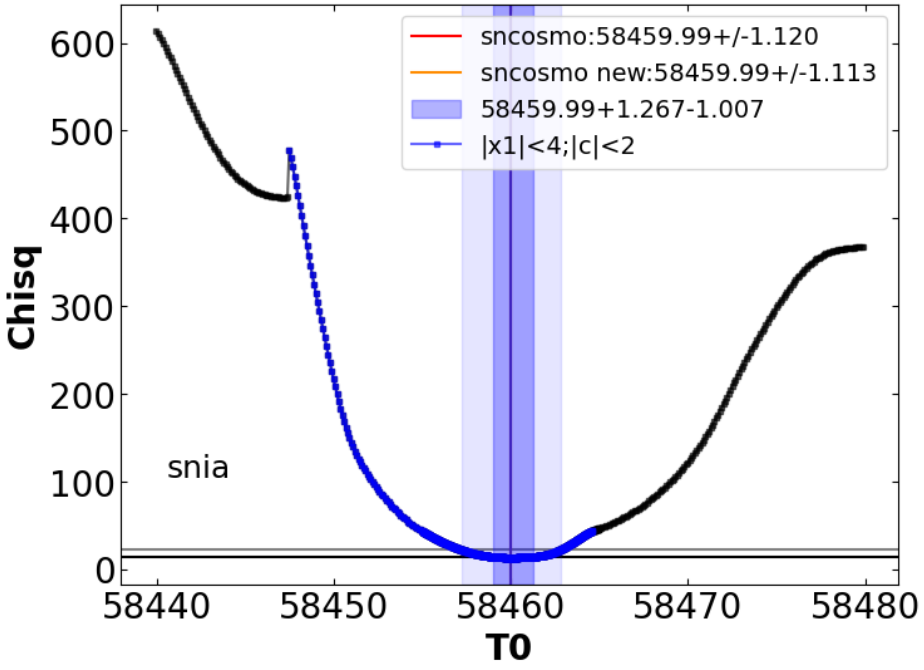
- **eTmax from chi2<1 day**
  → purpose: Tmax well defined

- **abs(eTmax-eTmin) at 3sig<0.3**
  → purpose: having minimum symetric

- **Only 1 min at 3sig**
  → purpose: having only one clear minimum

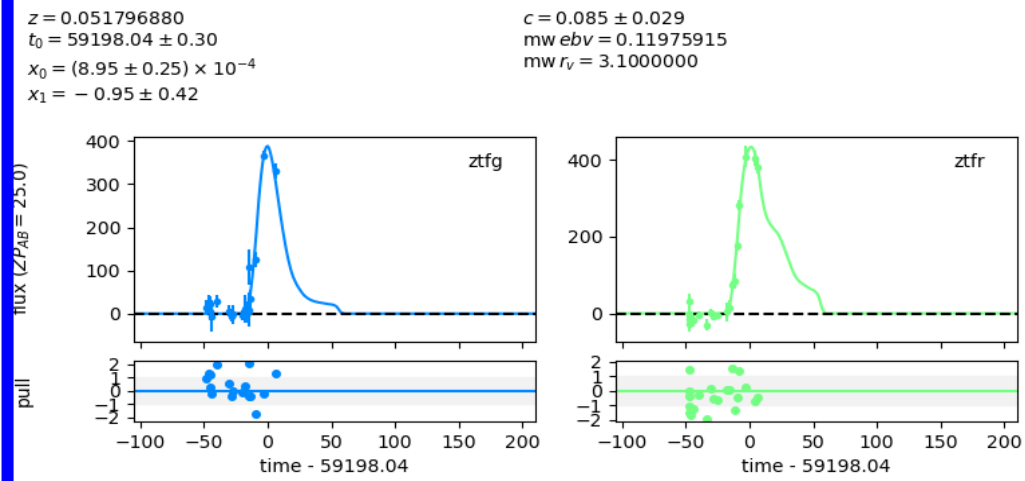
eTmax from chi2<1 day



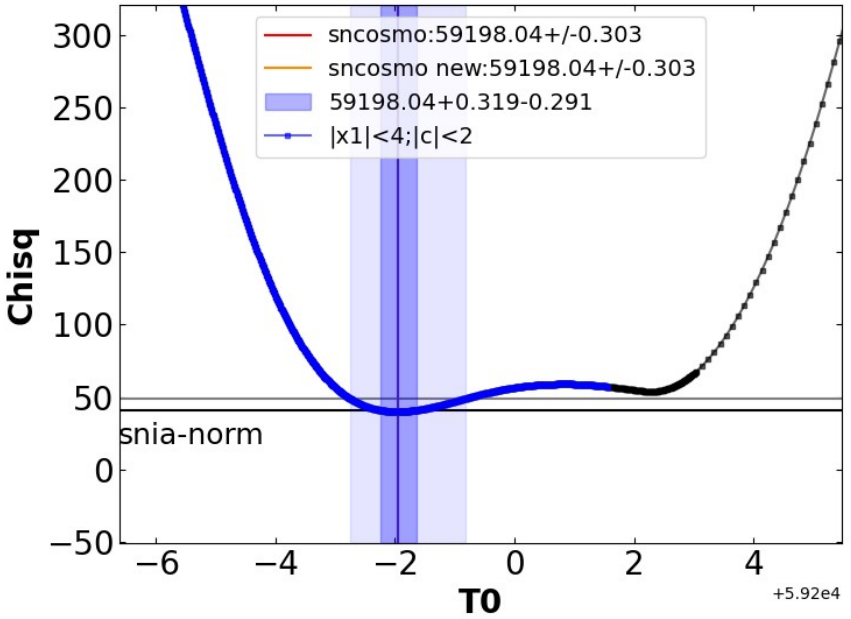


ZTF18actxxcx not in DR2

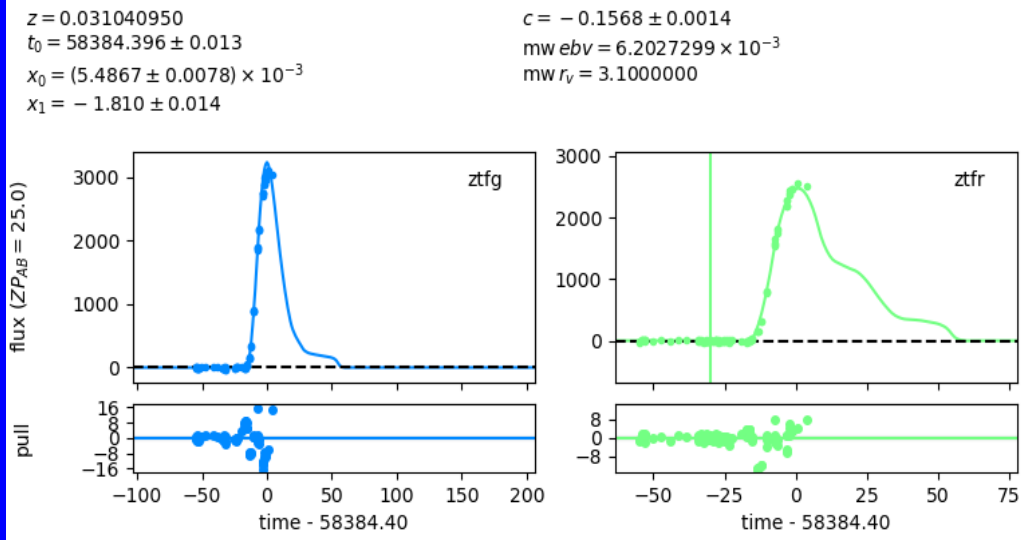
abs(eTmax-eTmin) 3sig<0.3

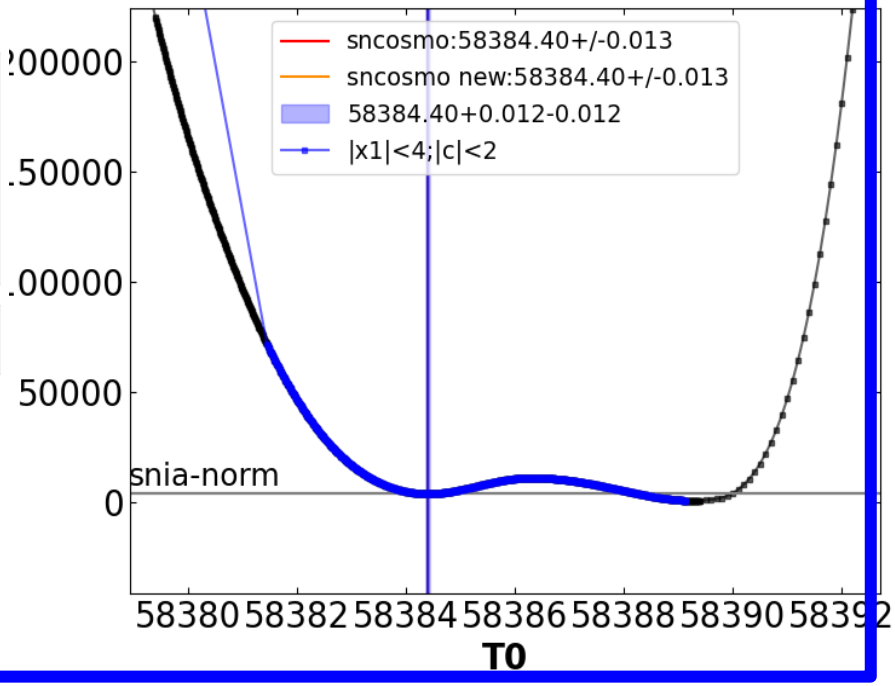


ZTF20acvbcrd in DR2



Only 1 min at 3sig





ZTF18abuqugw in DR2

FINAL ZTF SAMPLE

Cut	Discarded	Remaining
Tot	-	3627
sncosmo converged	198	3429
eTmax<1	57	3372
abs(eTmax-eTmin) 3sig<0.3	171	3201
Only 1 min at 3sig	18	3183
abs(X1_chi2)<4	0	3183
abs(col_chi2)<2	0	**3183**

DR2 cosmo

- lccoverage_flag:
  - Detections in at least 2 filters
  - Detections in at least 2 filters pre-max
  - Detections in at least 2 filters post-max
  - At least 7 detections across all filters

- lcquality_flag:
  - SALT2 fit successful
  - |x1|<3 and |c|<0.3
  - (sigma_x1, sigma_c, sigma_t0) < (1, 0.2, 2)
  - fitprob>1e-5 and frac_fitted>0.9

→ Total= **2380**

New cut vs DR2 cosmo

- **52 SNe in DR2** cosmology but they do not pass our cut
- **855 SNe not in DR2** cosmology but they pass our cut

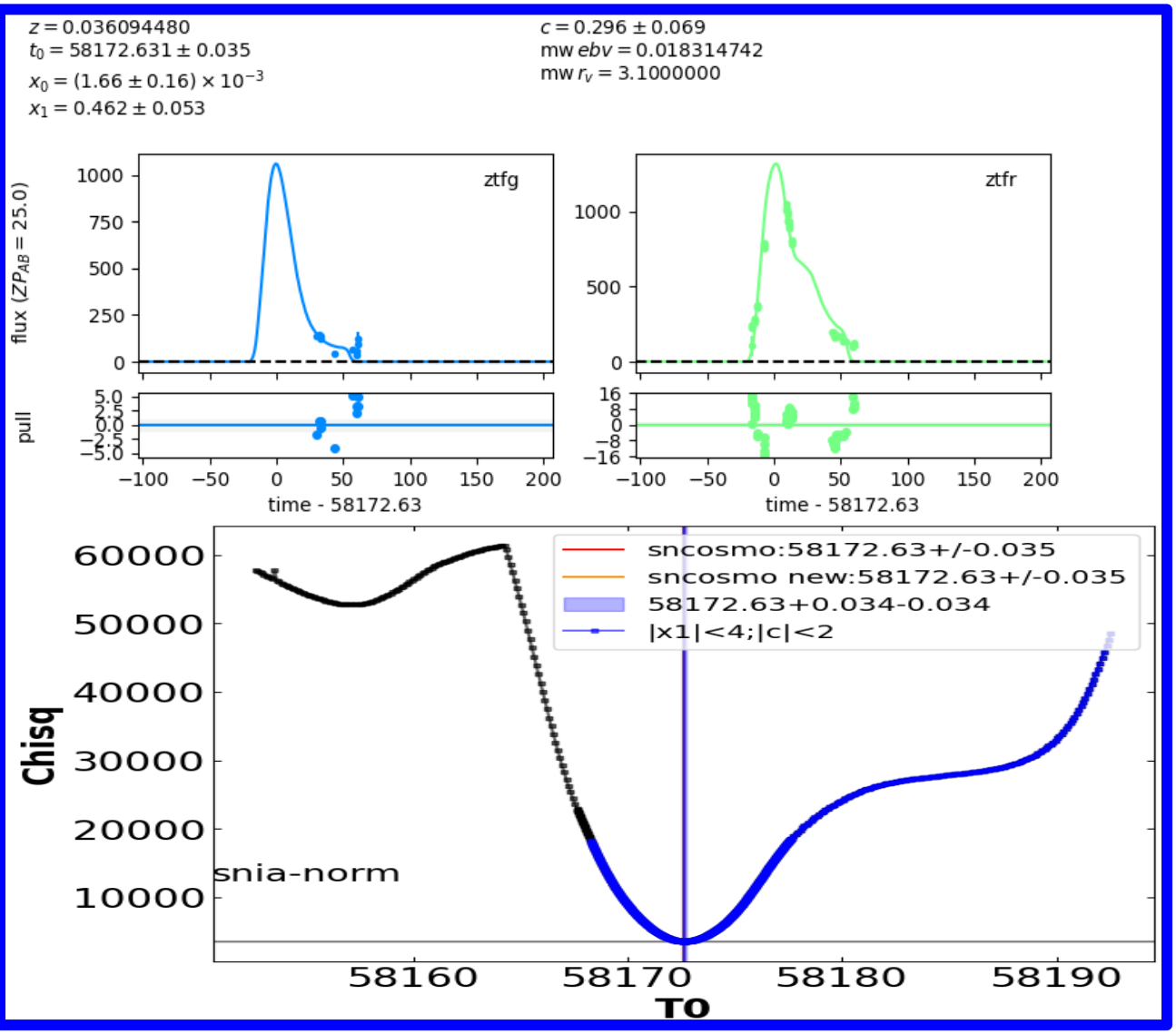
If we applied the lcquality flag to our sample (x1,c,ex1,ec):

→ We obtain a total of **2882** SNe

→ **67 SNe in DR2** and not in our sample

→ **569 SNe not in DR2** and in our sample

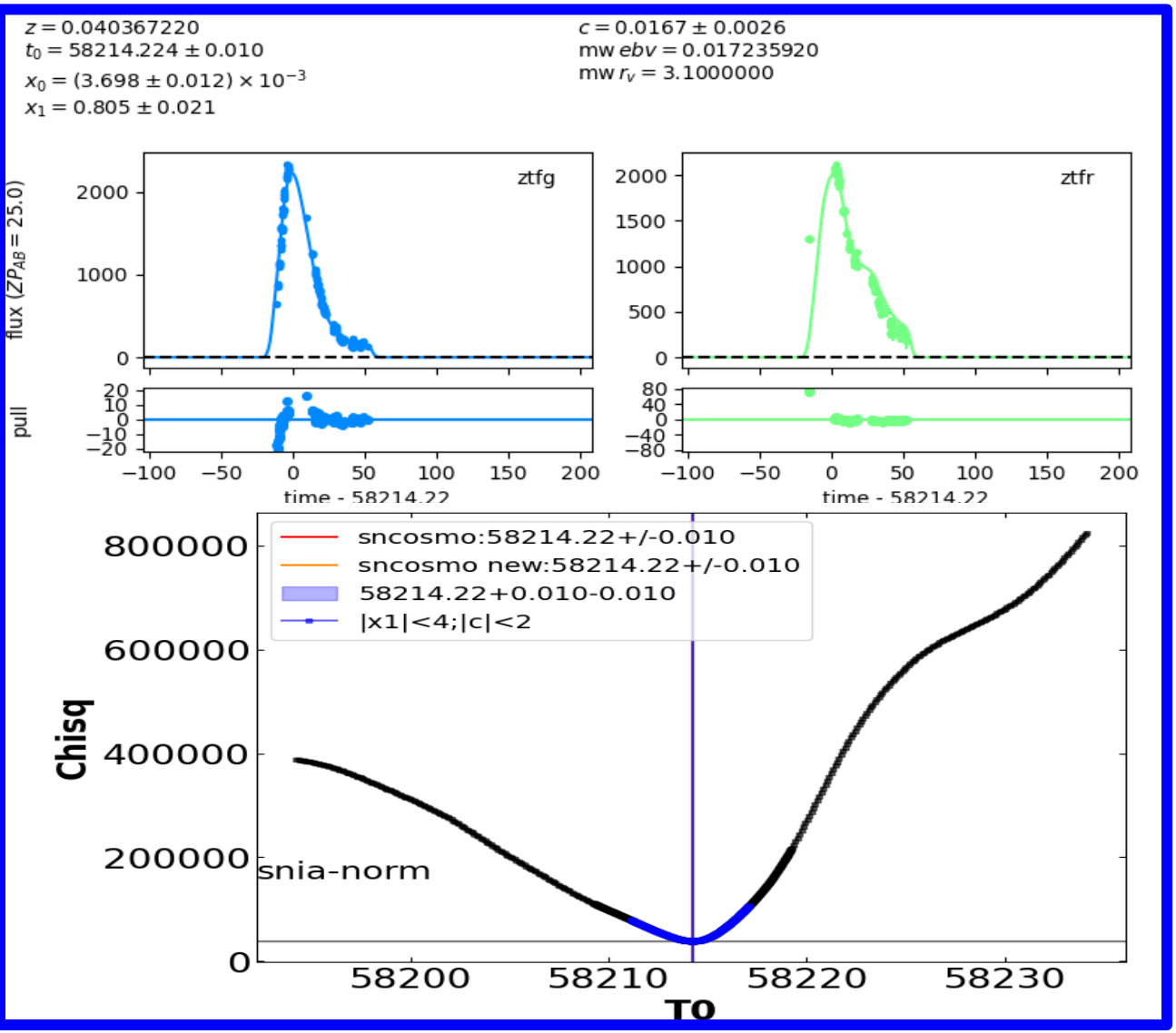
Examples, not in DR2 cosmo but in our sample



- lcquality_flag=4
  → c=0.53
- lccoverage_flag=1
  → ok

ZTF18aabqgnb

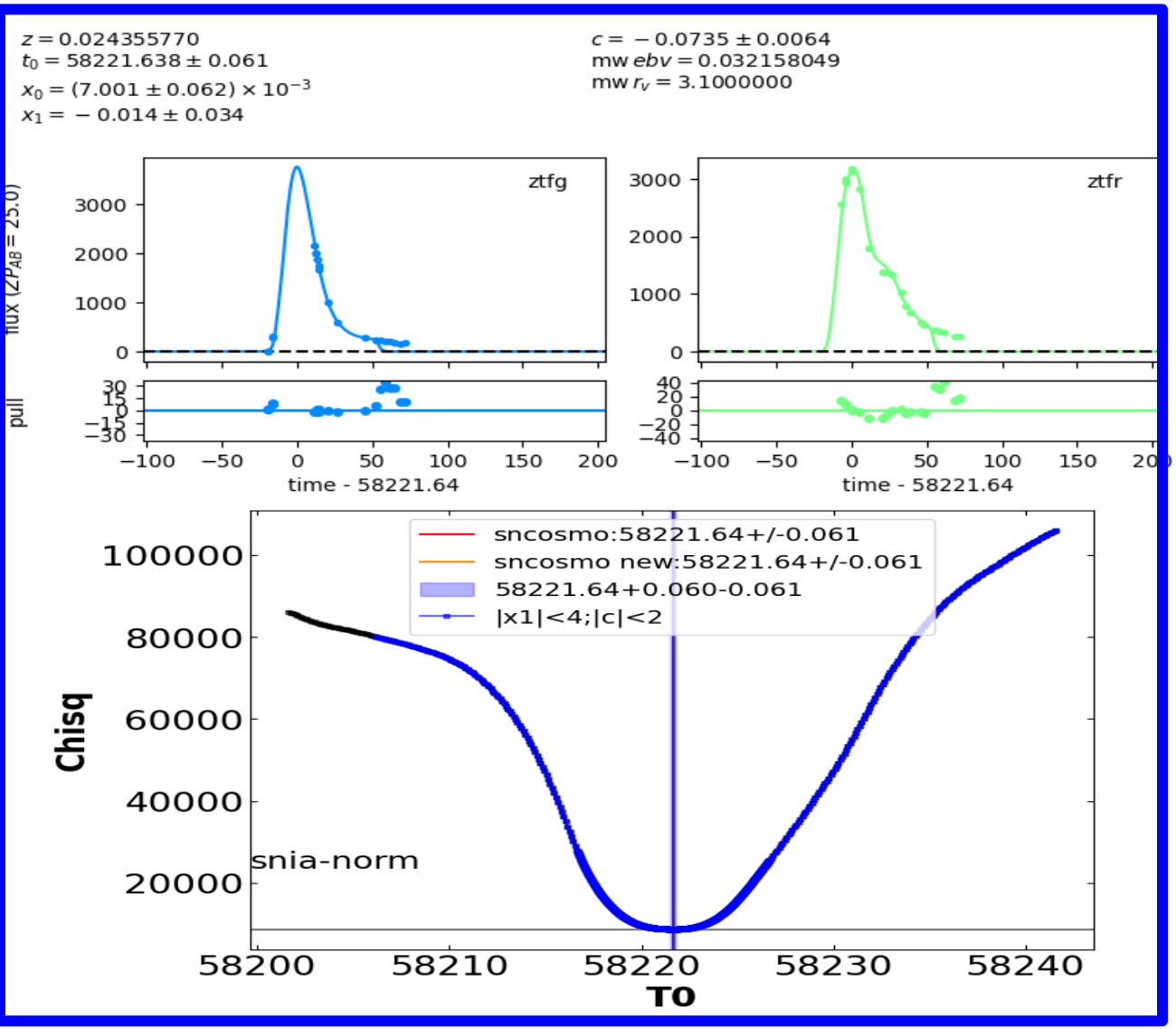
Examples, not in DR2 cosmo but in our sample



- lcquality_flag=7
  → ok
- lccoverage_flag=0

ZTF18aagstdc

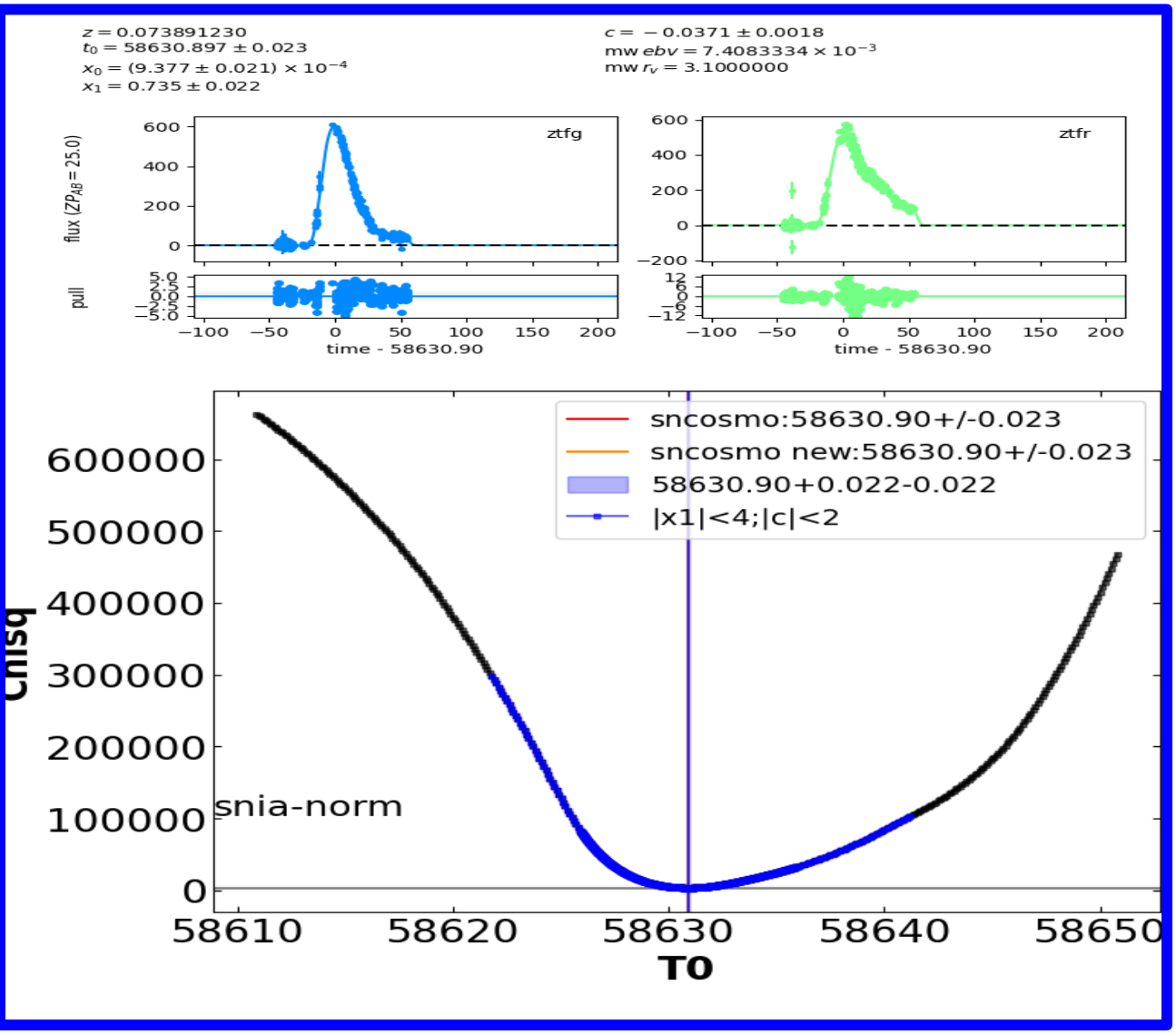
Examples, not in DR2 cosmo but in our sample



- lcquality_flag=7
  → ok
- lccoverage_flag=0

ZTF18aahfzea

Examples, not in DR2 cosmo but in our sample

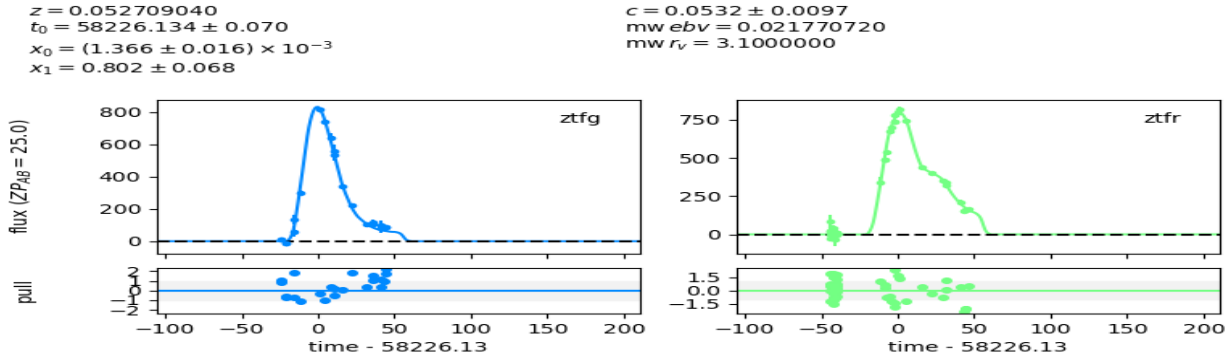


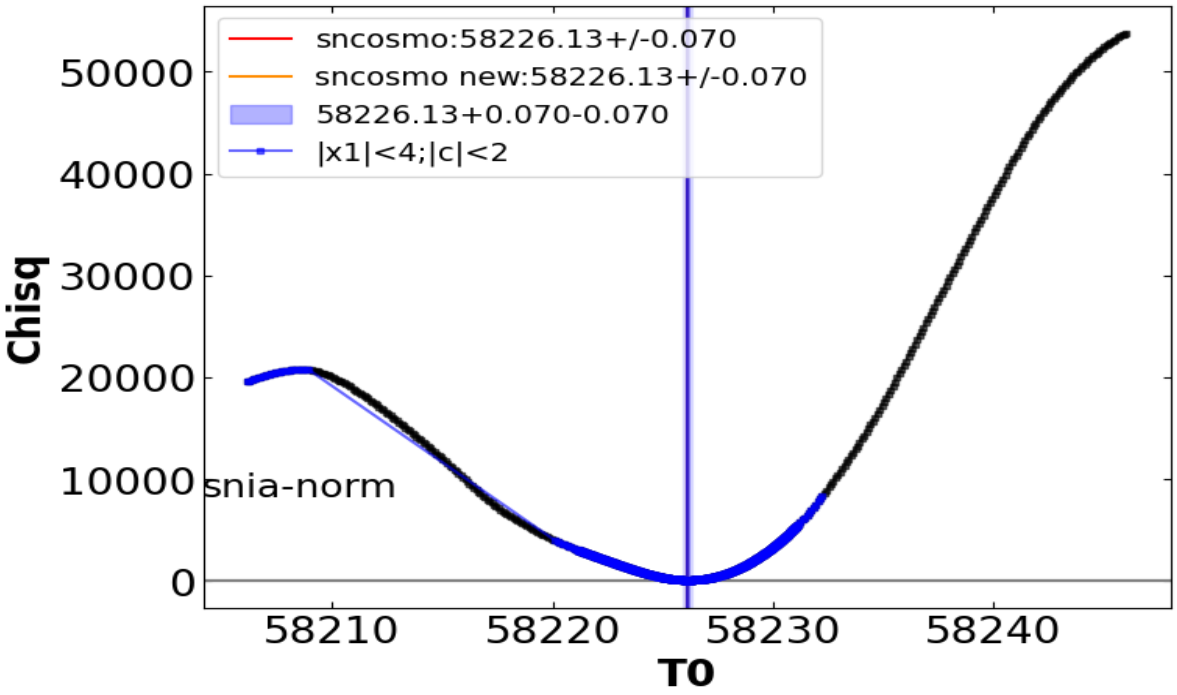
- lcquality_flag=3
  → x1,c=(1.05,-0.0514)
  → fitprob>1e-5 and frac_fitted>0.9

- lccoverage_flag=1
  → Ok

ZTF19aaurhox

Examples, not in DR2 cosmo but in our sample





- lcquality_flag=7.0
  → ok
- lccoverage_flag=0

ZTF18aahheaj

Conclusions

- We developped a likelihood profile method without using any SALT2 parameters cut
- All our selected SNe for the trianing sample have a likelihood with a Gaussian profil which ensures that the Tmax is well defined for all the objects.
- The methodology also works for SNLS and will be implemented for HSC soon.
- We Need to implement cuts on the model fit quality. It will be done when we have a good model error (see Mahmoud’s talk).