Update on the Scene Modeling Photometry pipeline

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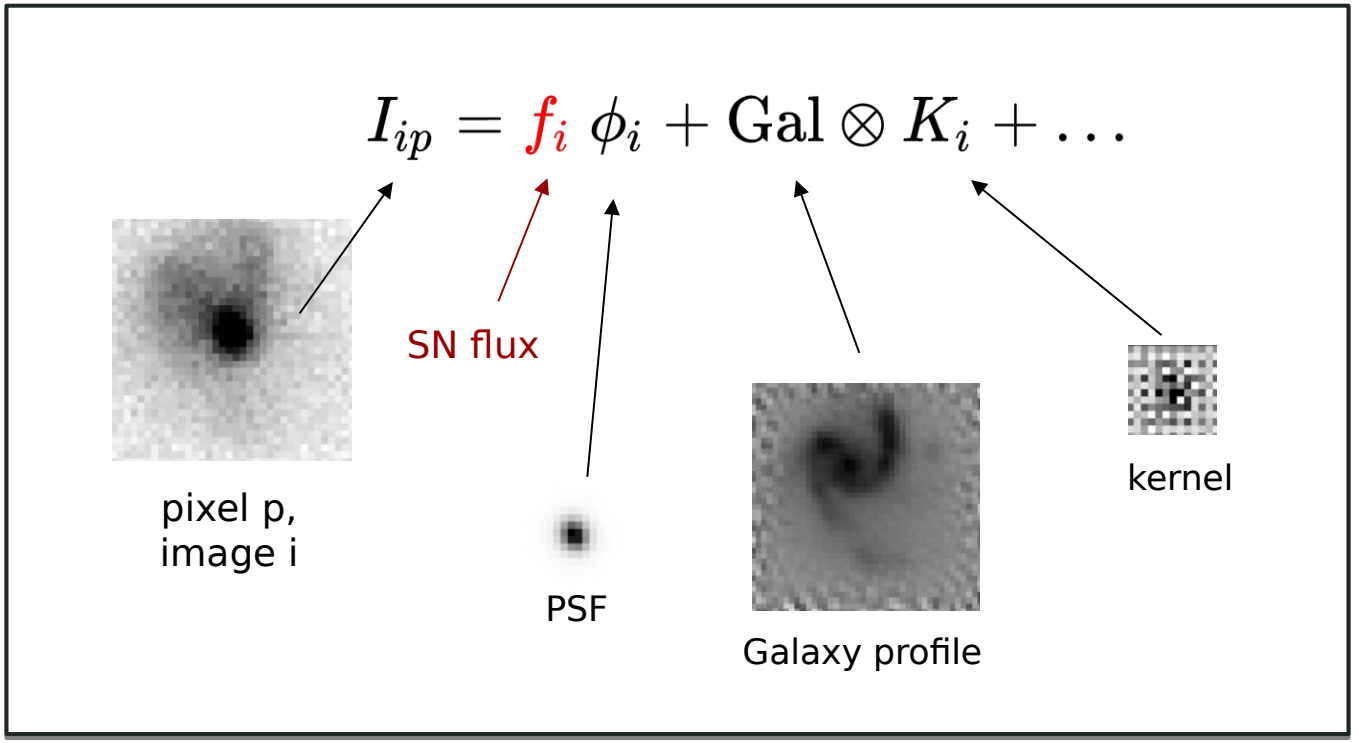
Scene Modeling Photometry - Elevator pitch

- Statistically optimal maximum likelihood flux estimator

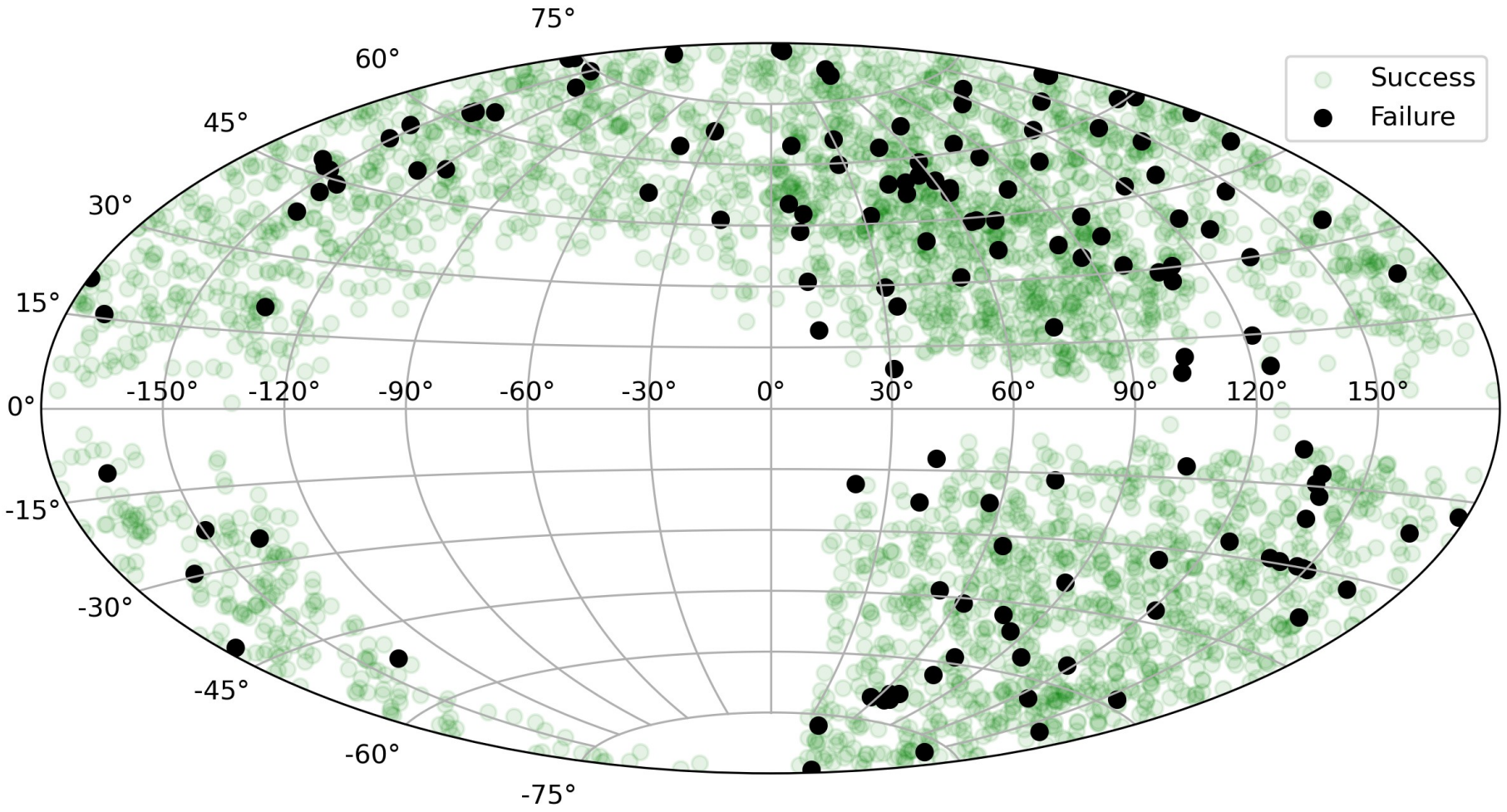


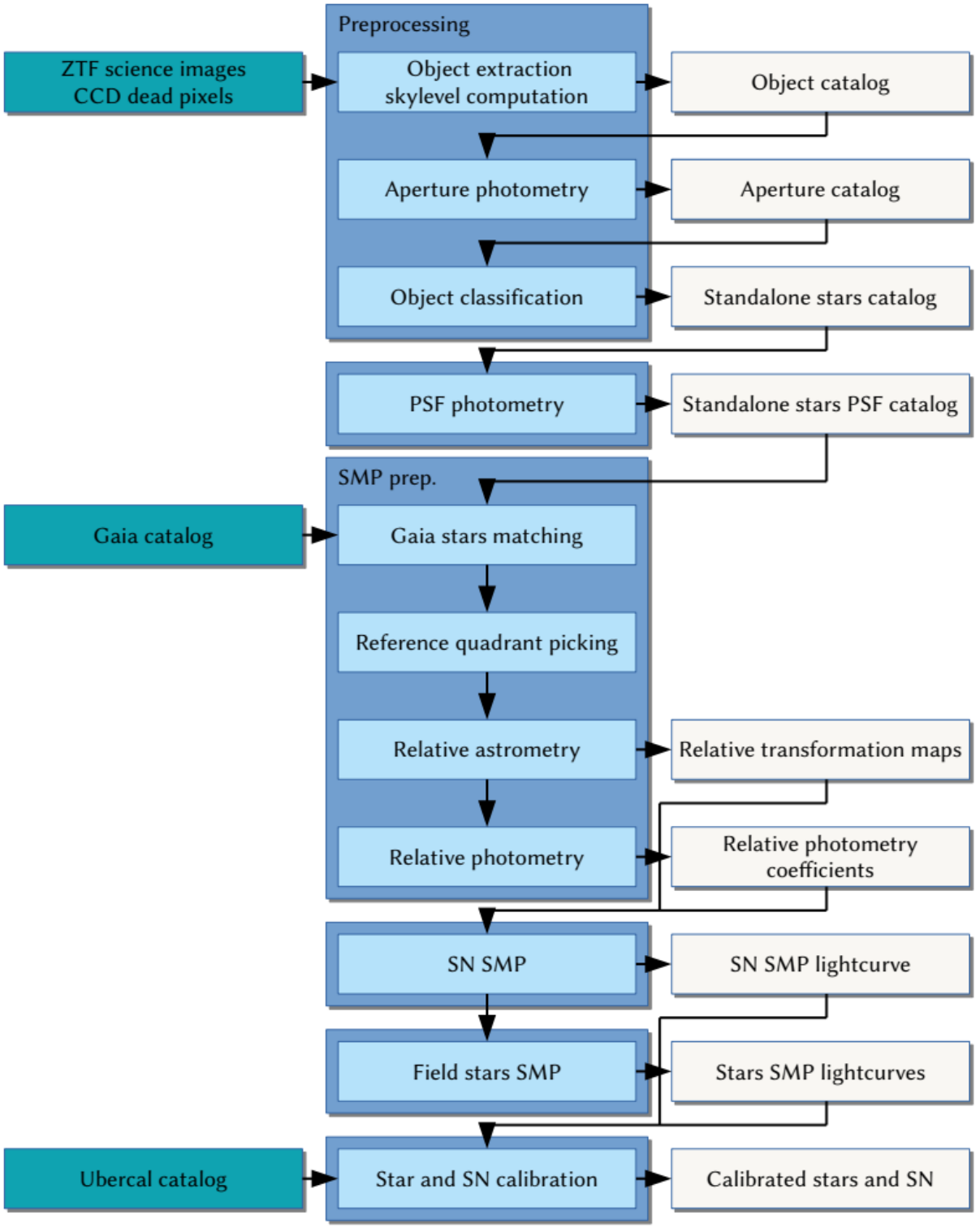
Simultaneously fit:
- SN flux sequence
- SN position
- Empirical galaxy profile

Current status of the run and pipeline

- Major milestone reached: full implementation of the pipeline
  - From pixels to calibrated SN and star lightcurves
- Excellent success rate on the full DR2 sample:
  - Out of ~9800 lightcurves, ~9400 succeeded – 96%
  - ~ 1 week worth of computing (180 TB of pixels)
- Failures:
  - ~200 due to OOM – easy fix: reschedule with more memory
  - Most remaining LC are of no scientific value

- **Conclusion**: DR2 SMP lightcurves close to release state


Distribution of failed SN lightcurves on the sky
Success
Failure
75°
60°
45°
30°
15°
0°
-15°
-30°
-45°
-60°
-75°
-150°
-120°
-90°
-60°
-30°
0°
30°
60°
90°
120°
150°

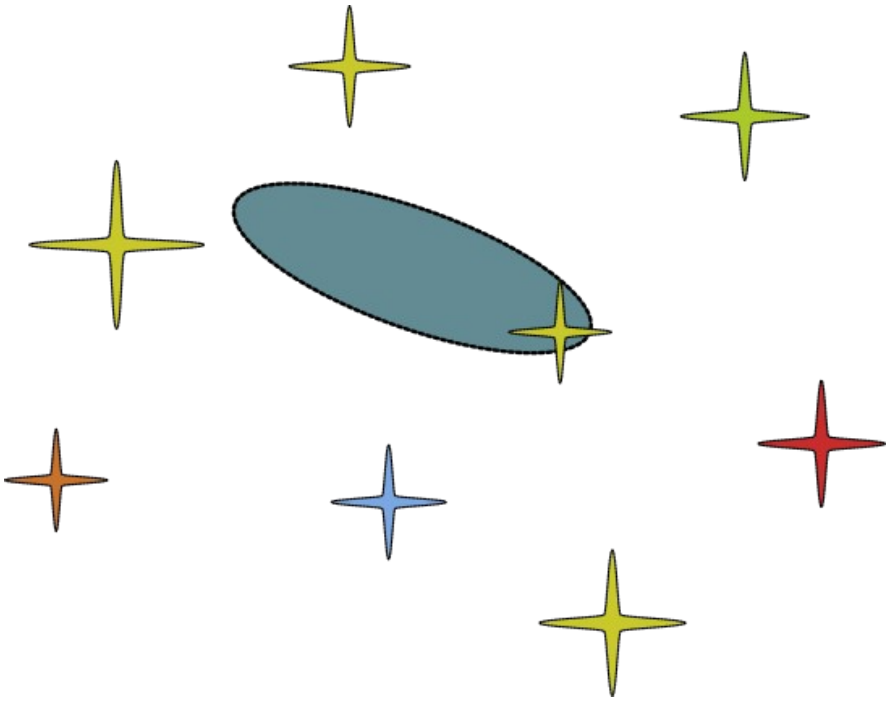

Preprocessing
ZTF science images
CCD dead pixels
Object extraction
skylevel computation
Object catalog
Aperture photometry
Aperture catalog
Object classification
Standalone stars catalog
PSF photometry
Standalone stars PSF catalog
SMP prep.
Gaia catalog
Gaia stars matching
Reference quadrant picking
Relative astrometry
Relative transformation maps
Relative photometry
Relative photometry
coefficients
SN SMP
SN SMP lightcurve
Field stars SMP
Stars SMP lightcurves
Ubercal catalog
Star and SN calibration
Calibrated stars and SN

What's next to do before DR2

- Just finished calibrating lightcurves on PS1
- Analyse and produce final uncertainties, repeatability
- Calibrate on Ubercal
  - Check for PSF chromaticity
- 2 formats:
  - Training dataset for NaCl
  - SNCosmo fits

Calibrating SN lightcurve: sketch

- **Goal:** express SN lightcurves flux into some common magnitude unit e.g. AB mag



- 2 steps:
  - Fit non variable star model on nearby stars
  - Find a Zero Point (ZP) for the reference exposure
    - Compare star magnitude to external catalog

Star lightcurves

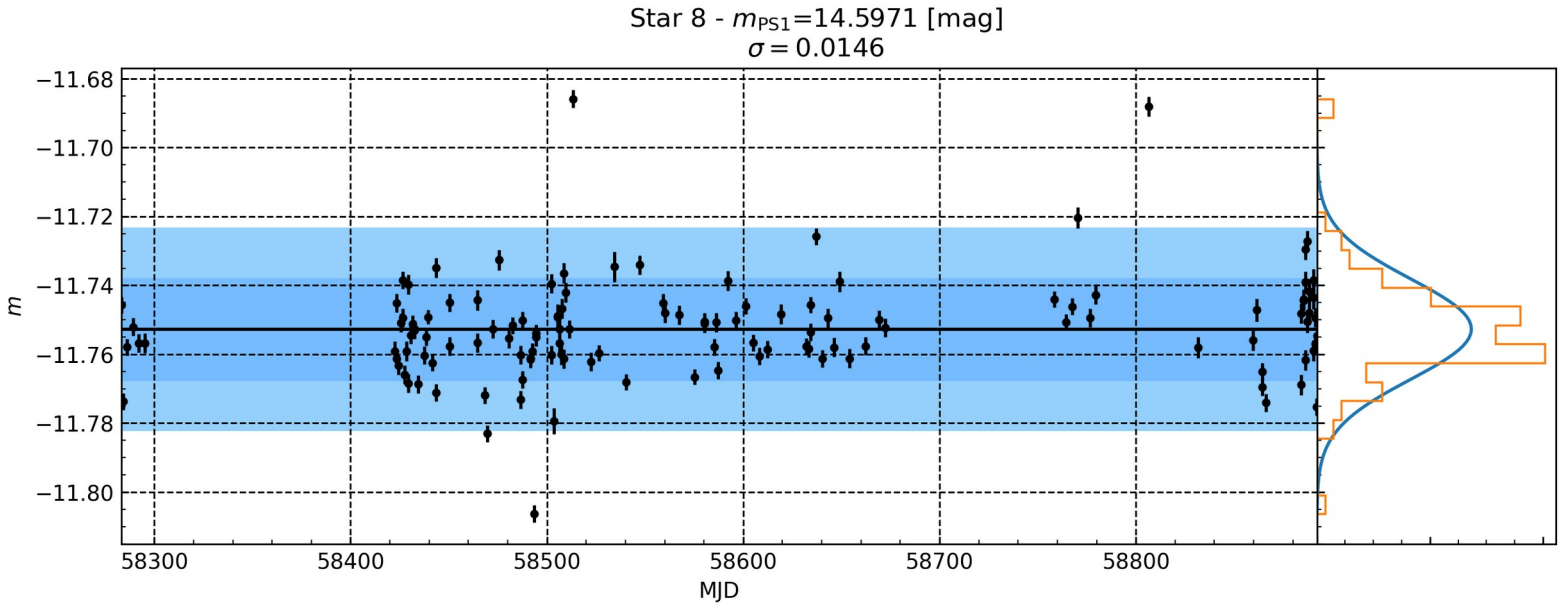
- Fit constant star model for each star lightcurves

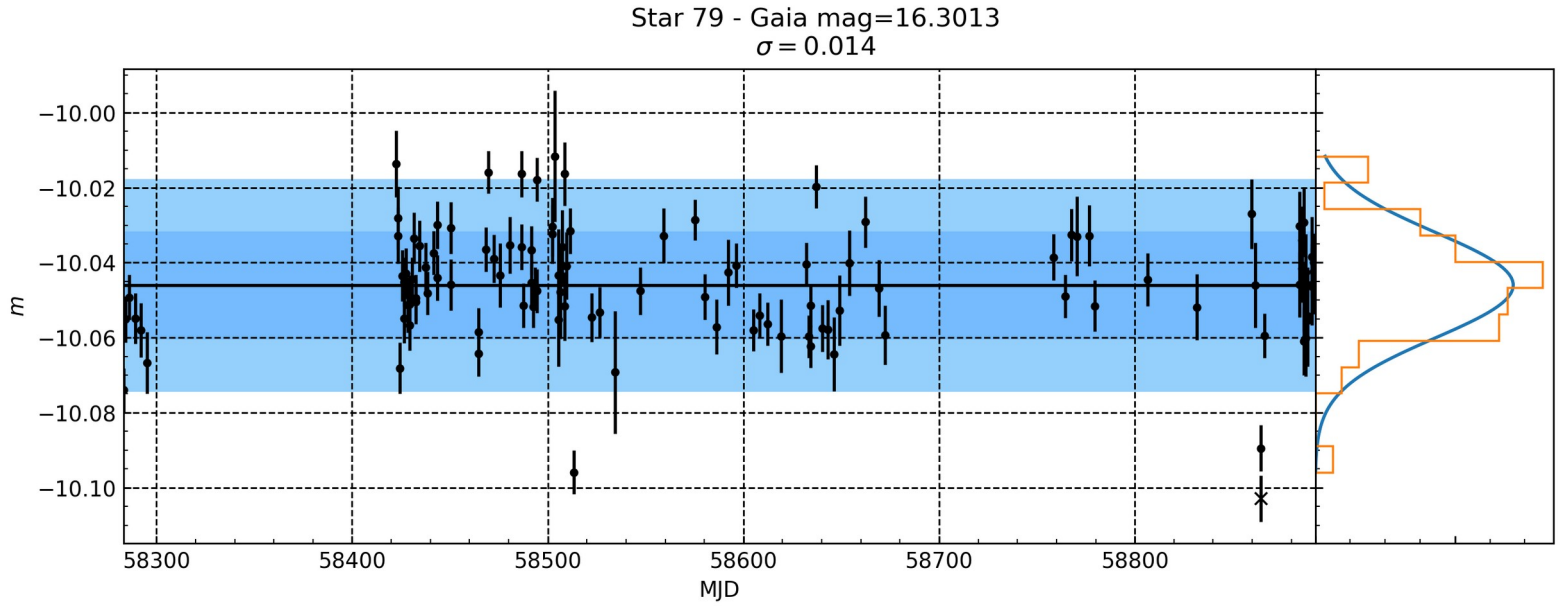
$$m_i = -2.5 \log_{10} \langle f_{ij} \rangle_i$$

  - Remove variable stars (high χ^2)
  - Standard deviation of residuals give reached repeatability

- Floor repeatability: 1%
- 2% repeatability up to 17 mag

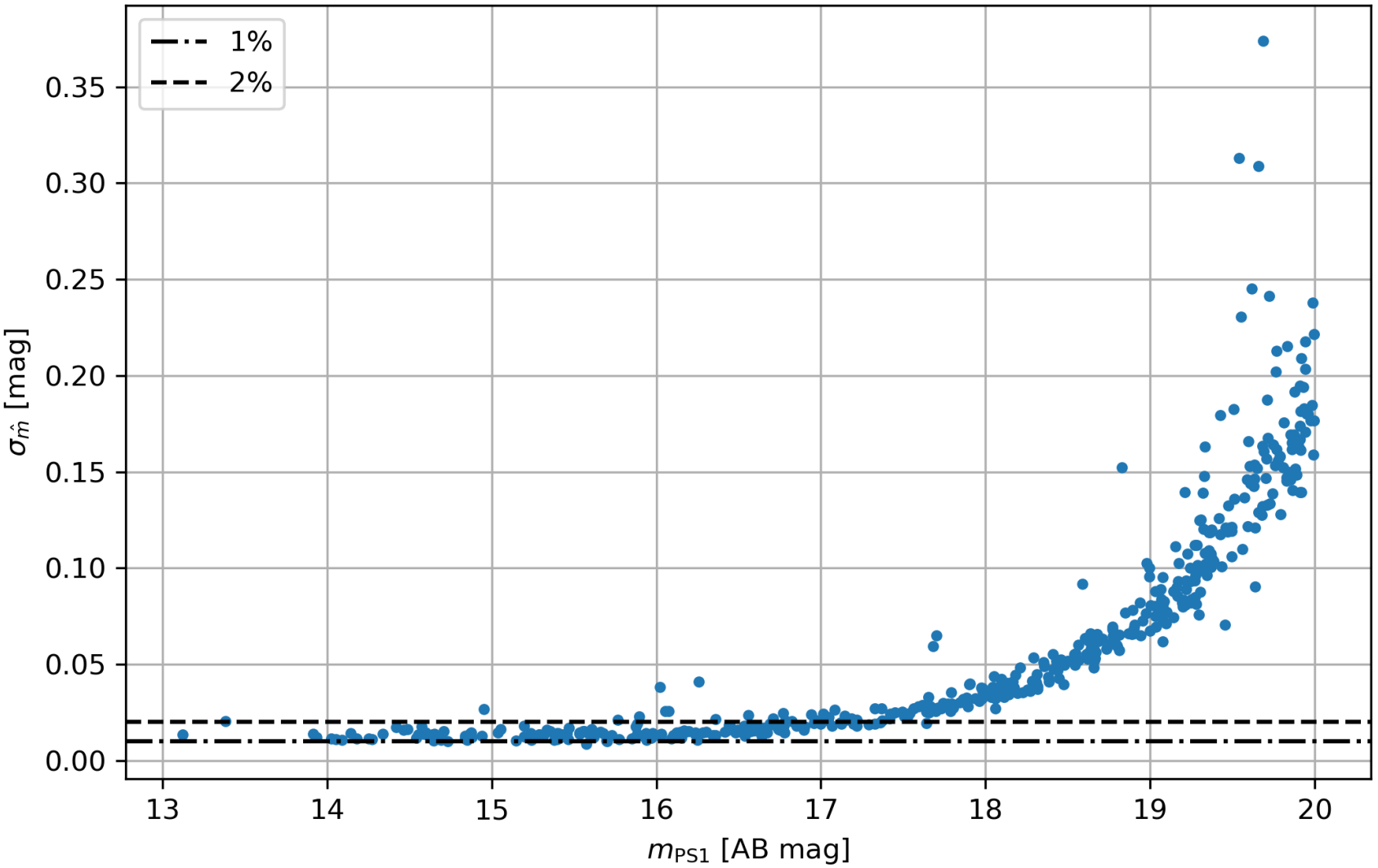
Star lightcurves

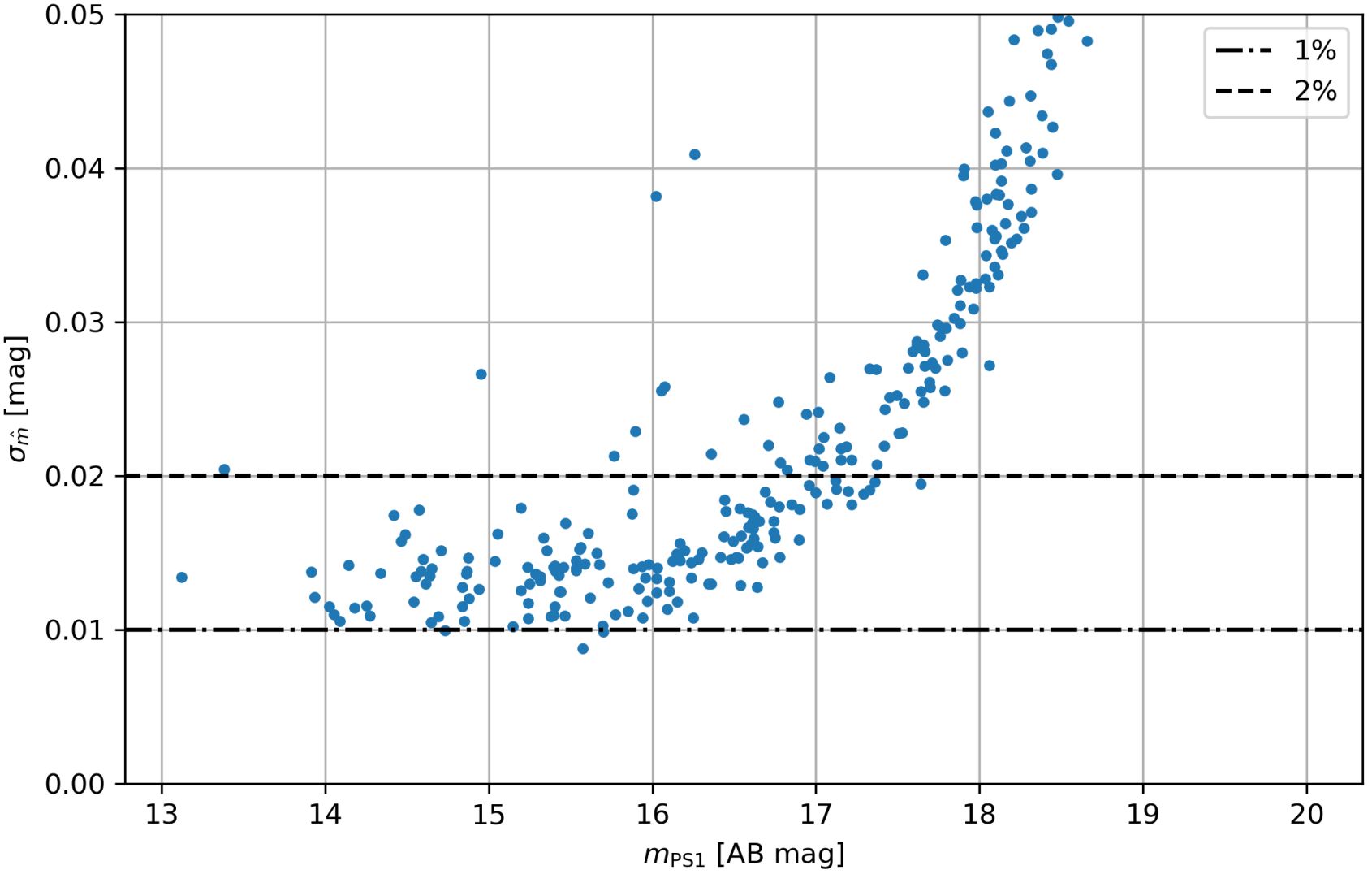




Measure error seems underestimated for bright stars

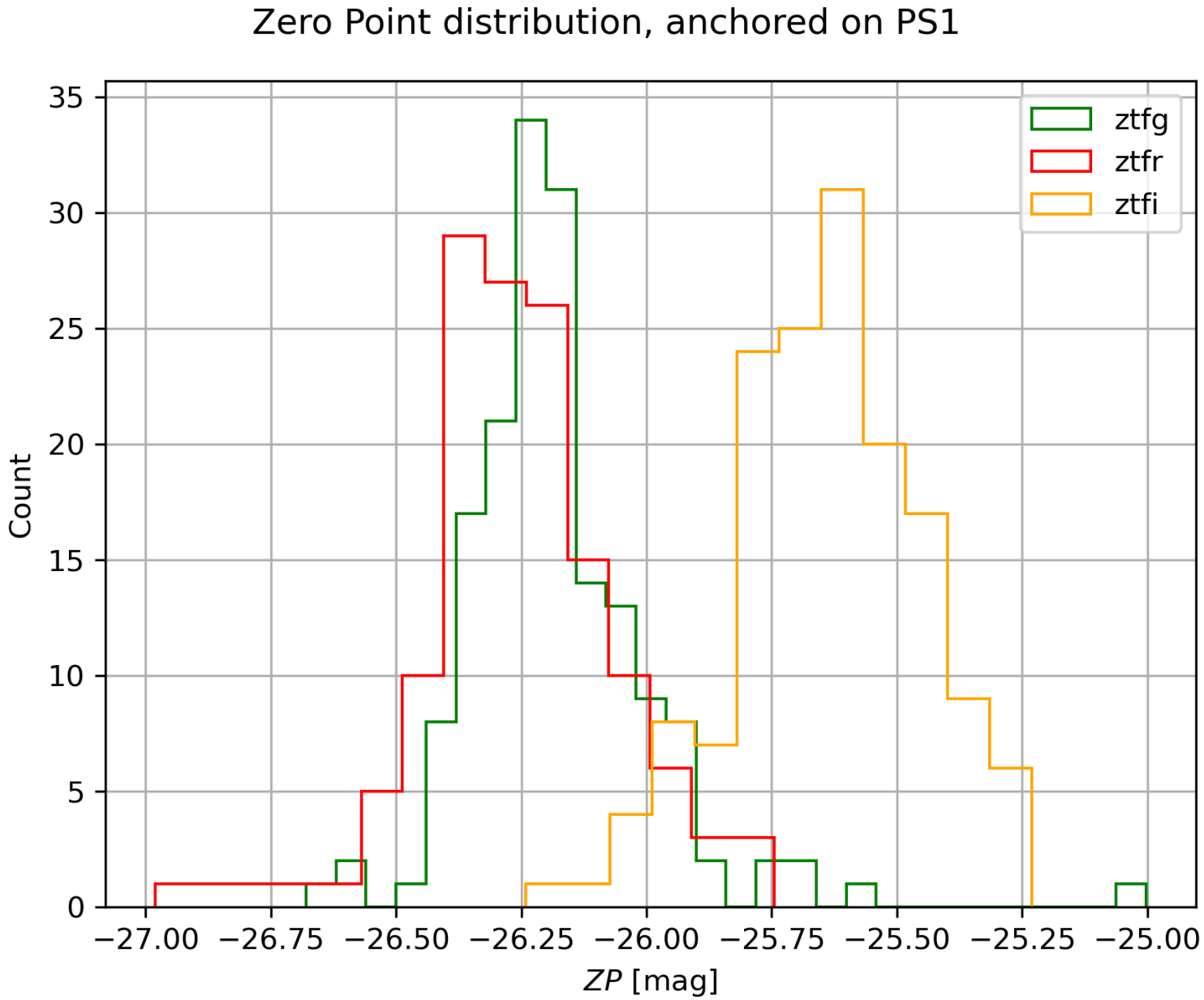
Repeatability as a function of star magnitude

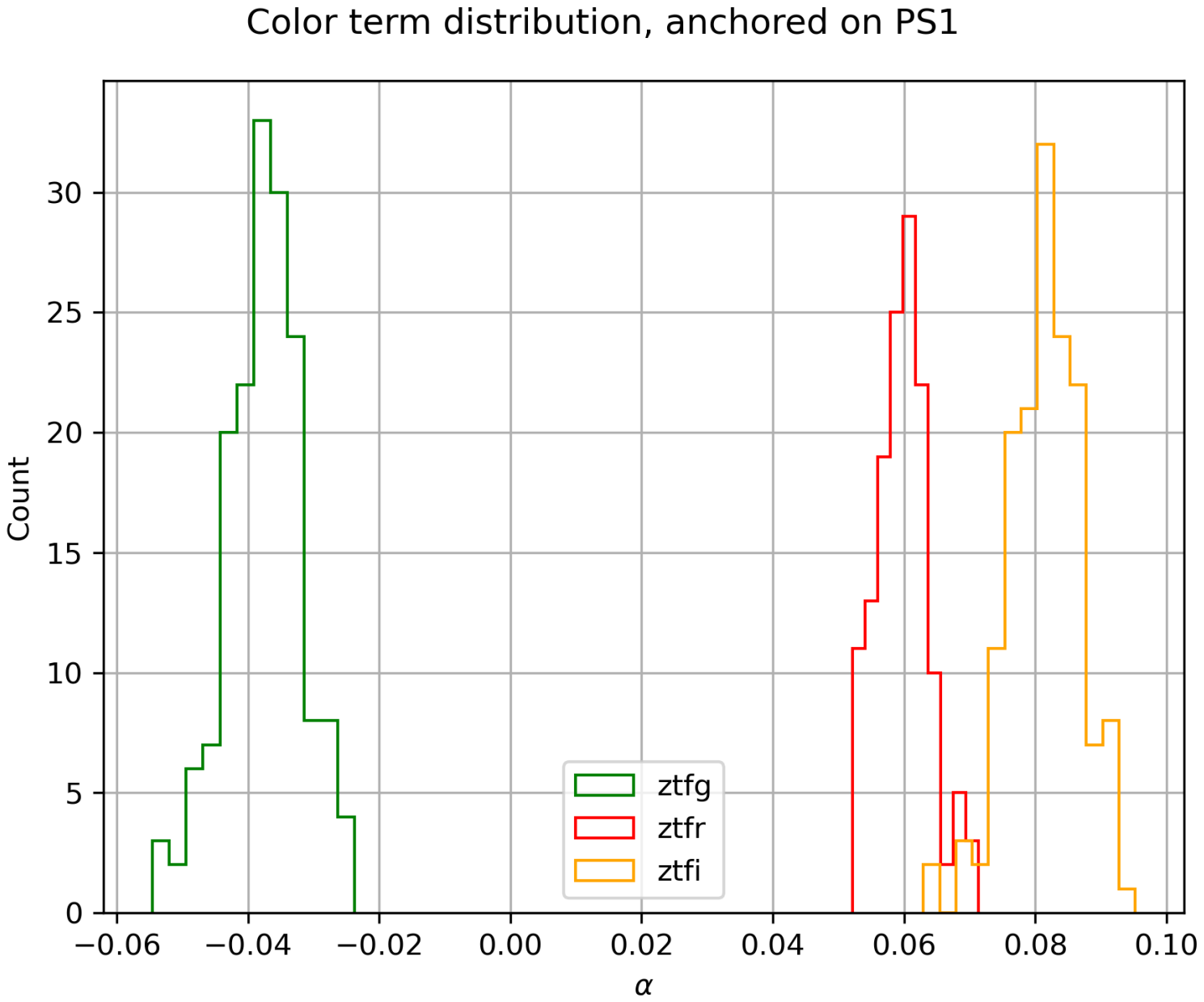



Repeatability as a function of star magnitude
0.05
0.04
0.03
0.02
0.01
0.00
$\sigma_{\hat{m}}$ [mag]
13
14
15
16
17
18
19
20
m_{PS1} [AB mag]
1%
2%

SN lightcurve calibration

- Goal: find ZP for reference exposure
- Compare fitted constant star magnitudes with external catalog
  - For now, uses PS1
- Model: $m_{\mathrm{ZTF}} - m_{\mathrm{PS1}} = \alpha c_{\mathrm{PS1}} + ZP$
- Nuisance parameter α to account for color term
  - Filter differences between ZTF and PS1
  - Should match what Benjamin & al. are measuring
  - Check filter models with synthetic photometry

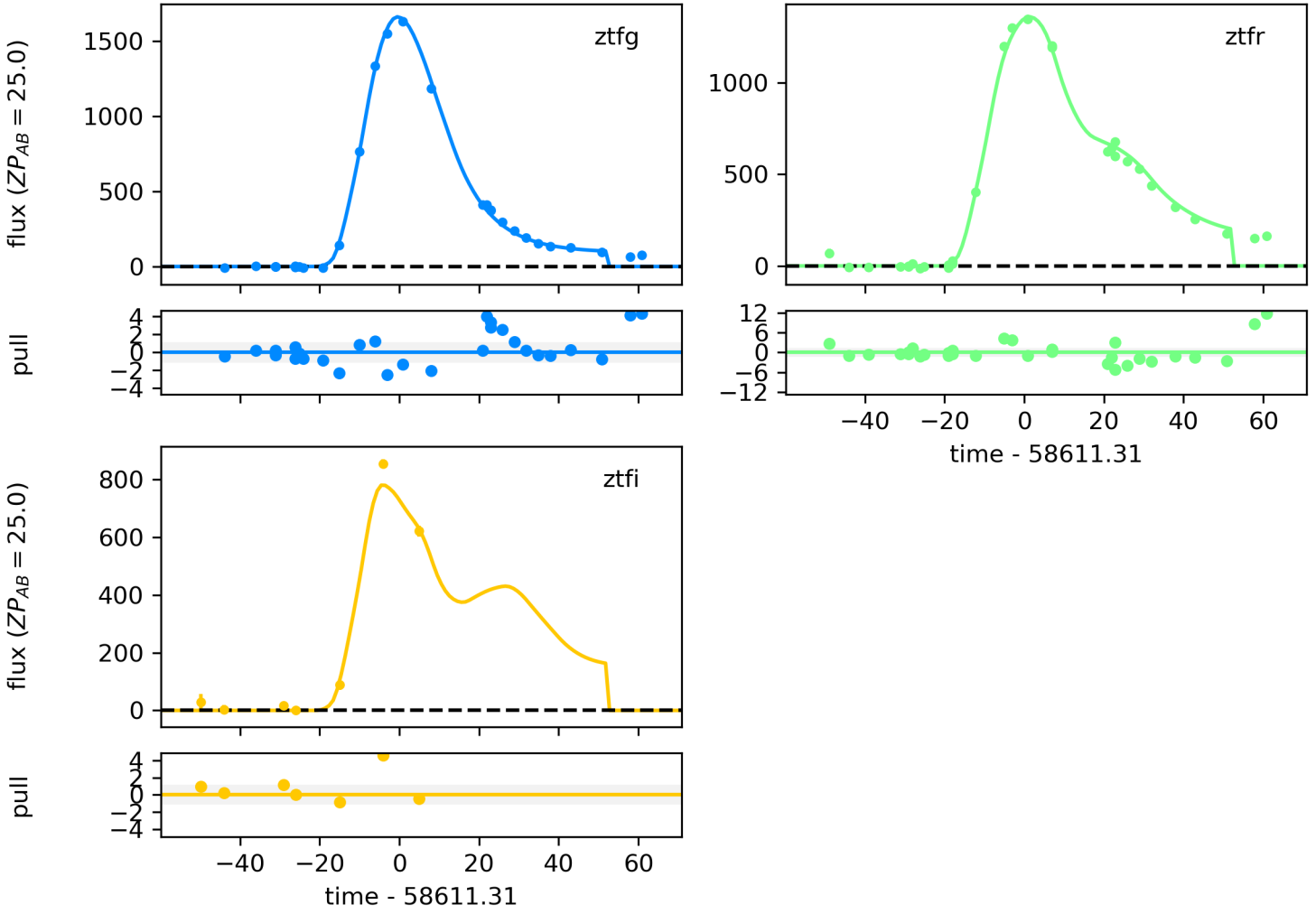

Zero Point distribution, anchored on PS1
ztfg
ztfr
ztfi
Count
0
5
10
15
20
25
30
35
−27.00
−26.75
−26.50
−26.25
−26.00
−25.75
−25.50
−25.25
−25.00
ZP [mag]


Color term distribution, anchored on PS1
Count
30
25
20
15
10
5
0
−0.06
−0.04
−0.02
0.00
0.02
0.04
0.06
0.08
0.10
α
ztfg
ztfr
ztfi

ZTF19aaripqw

$z = 0.041313380$
$t_0 = 58611.314 \pm 0.039$
$x_0 = (2.642 \pm 0.015) \times 10^{-3}$

$x_1 = 0.065 \pm 0.044$
$c = -0.0670 \pm 0.0048$



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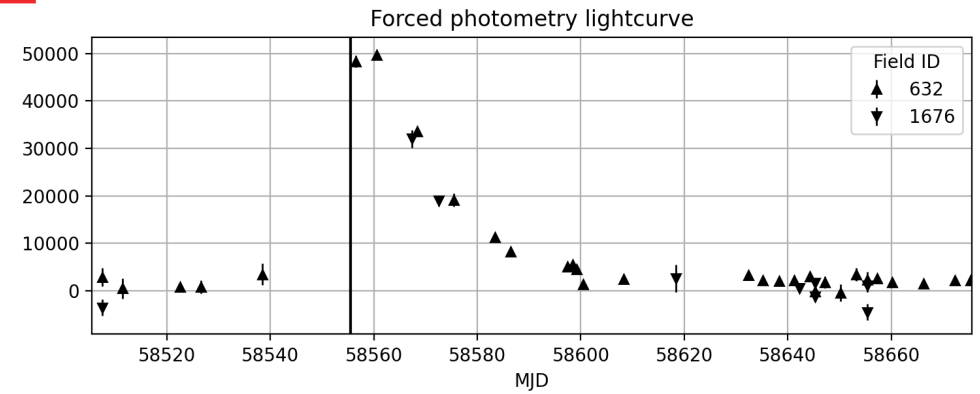

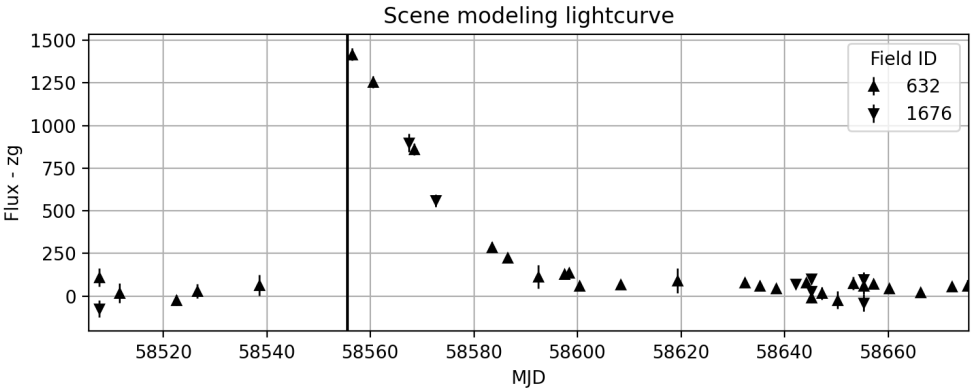

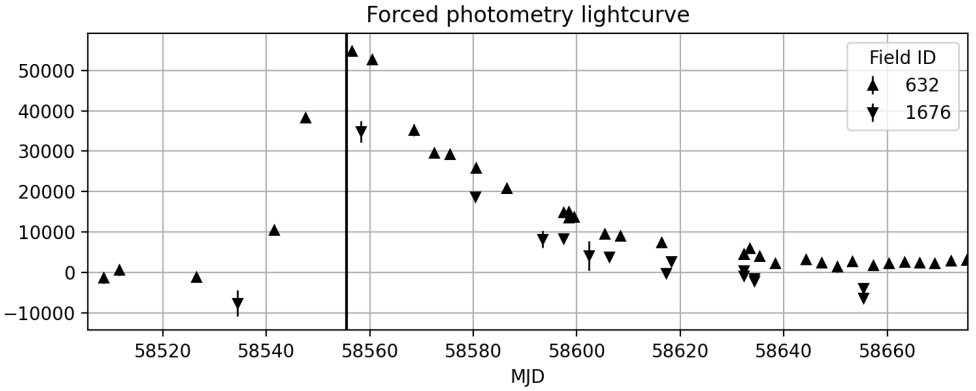

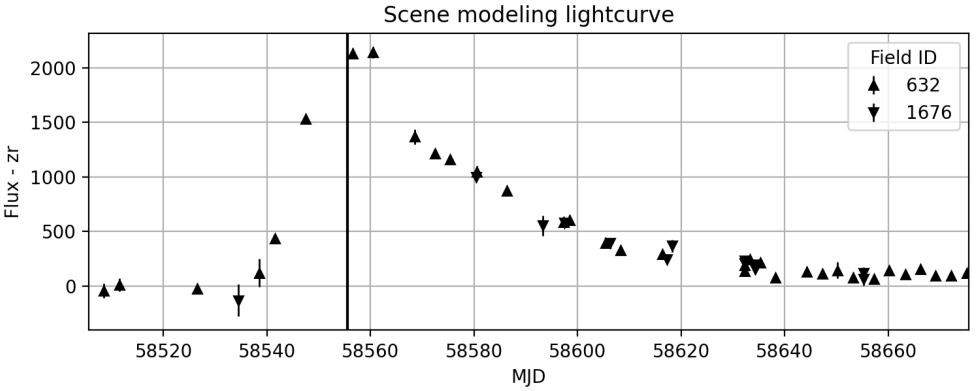

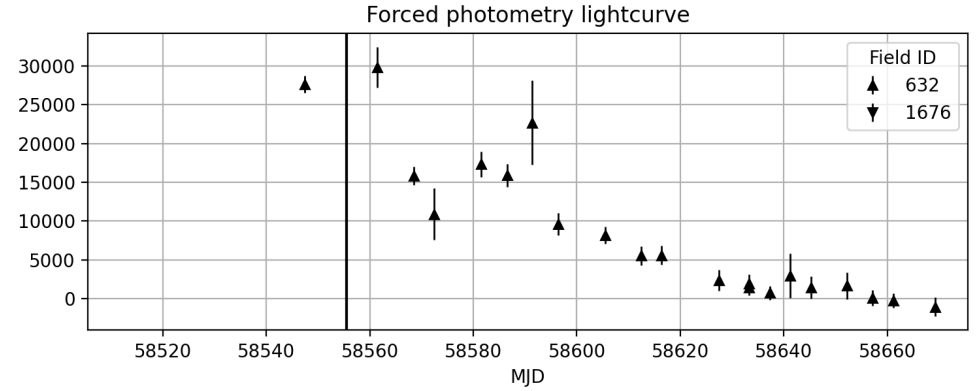

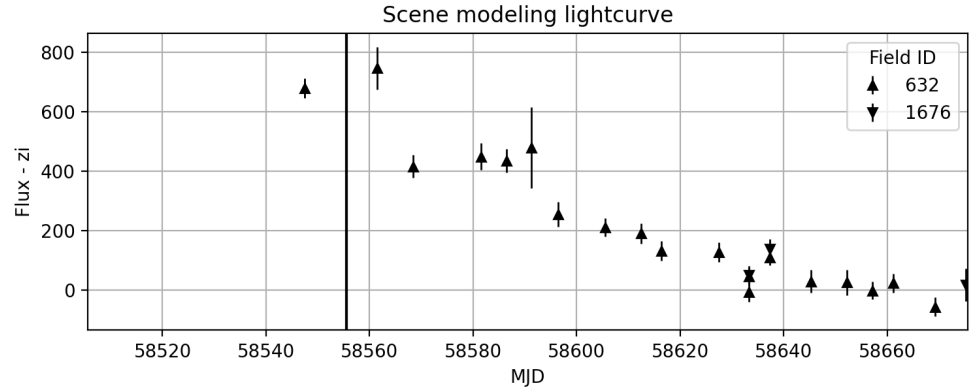

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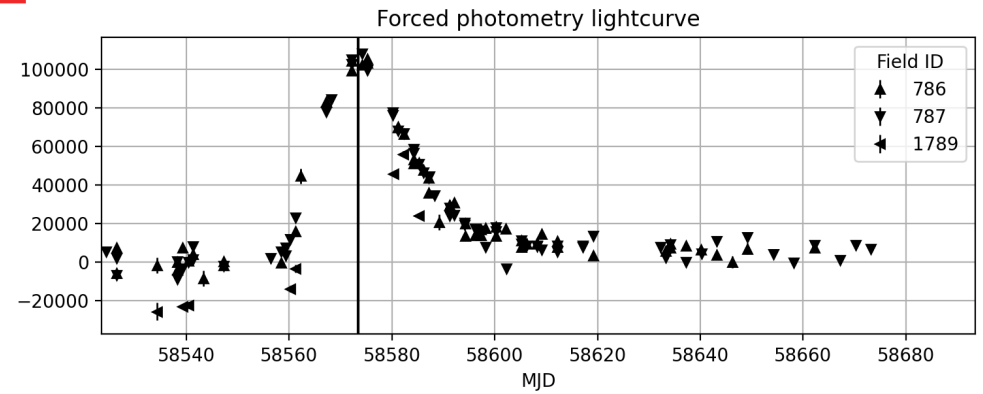

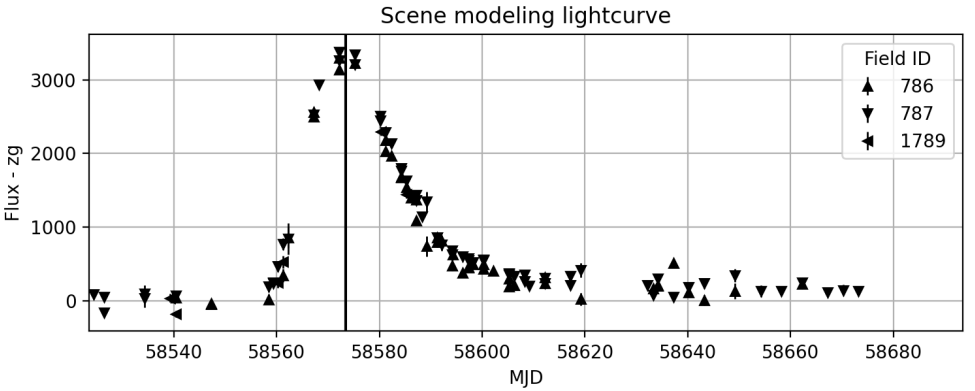

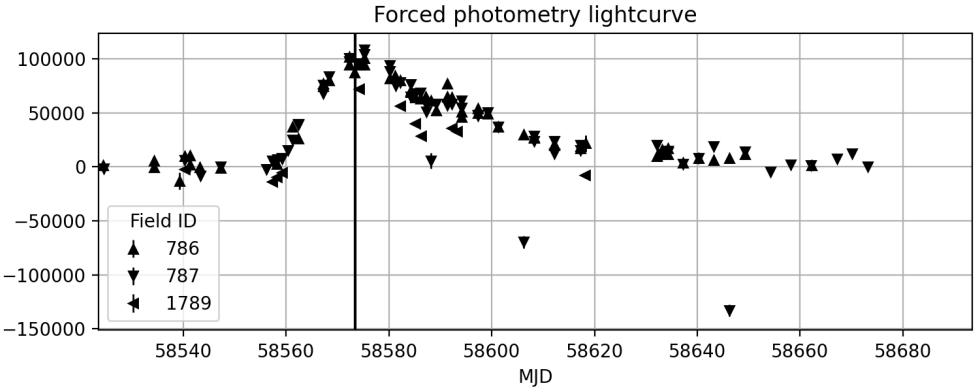

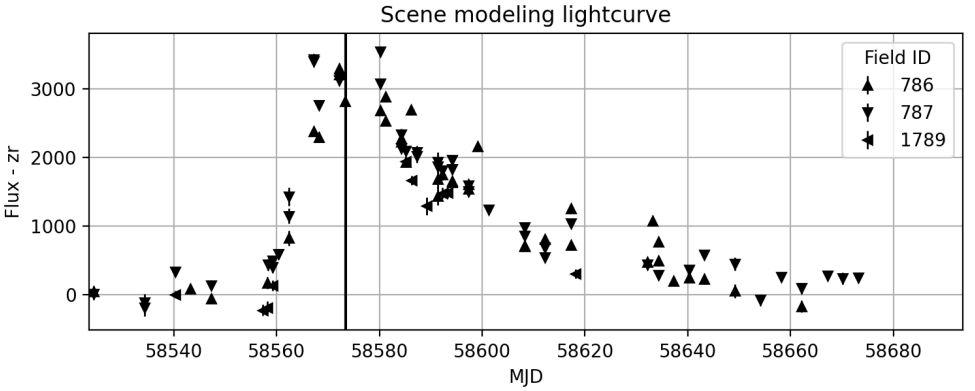

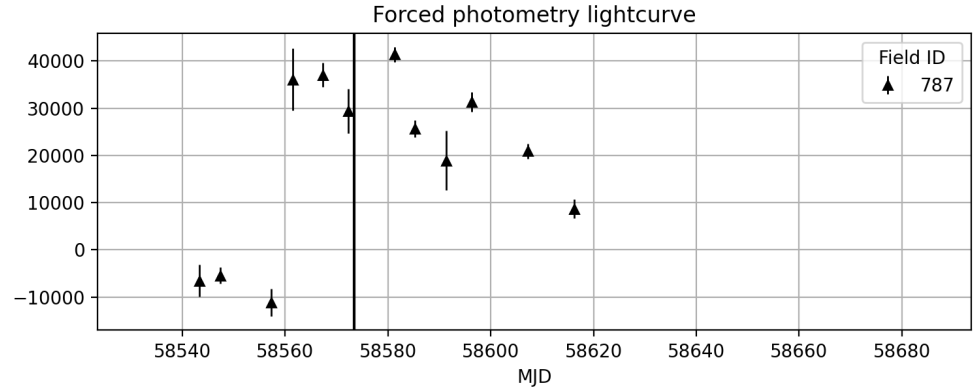

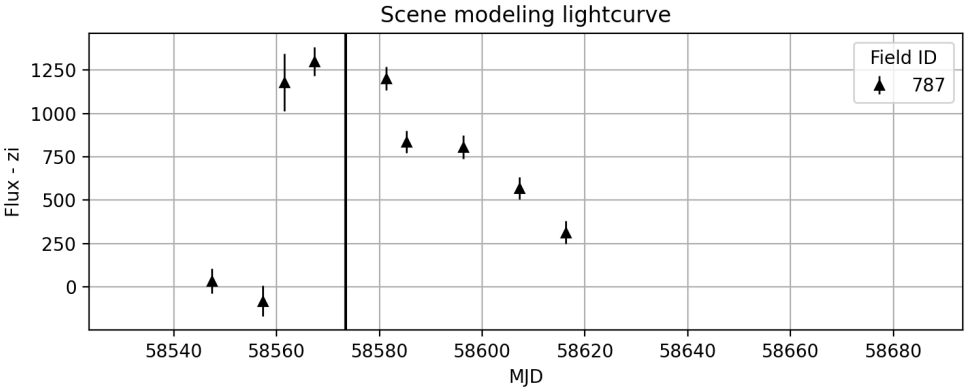

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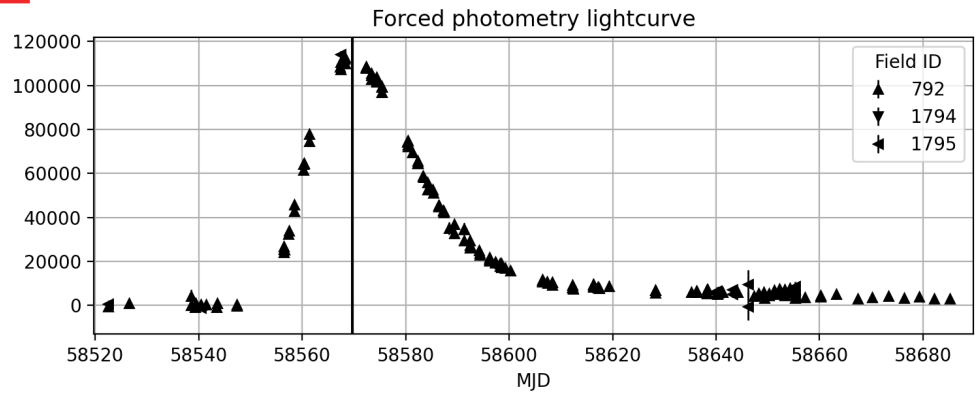

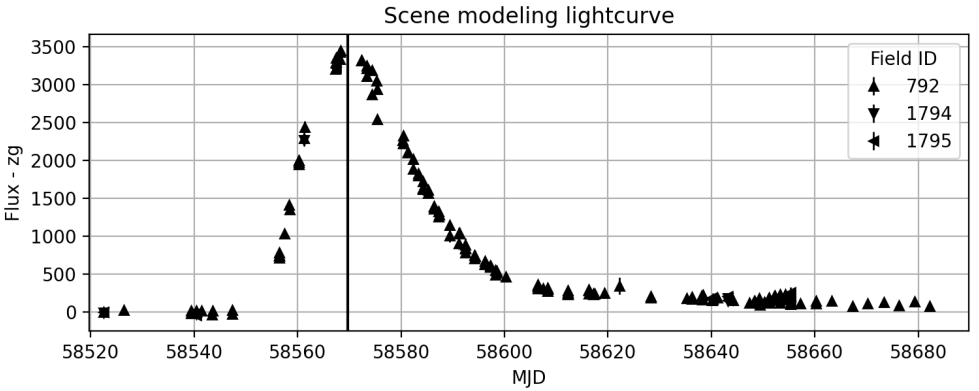

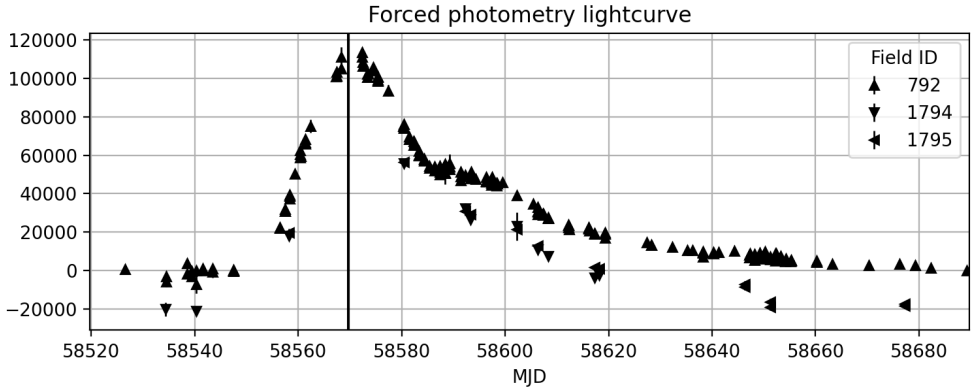

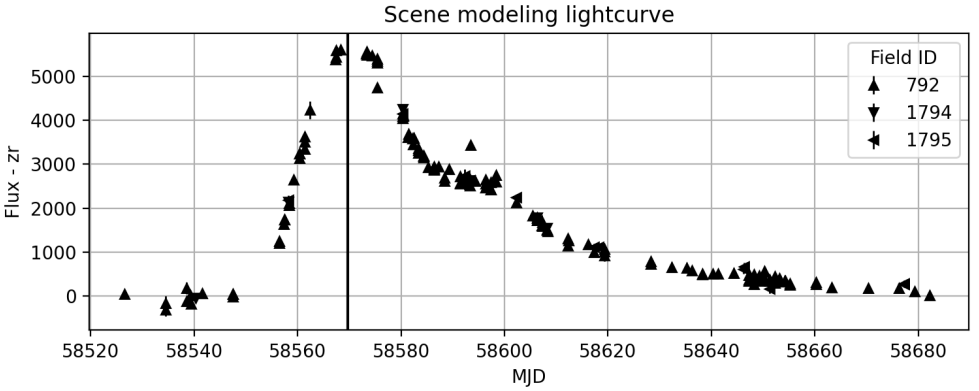

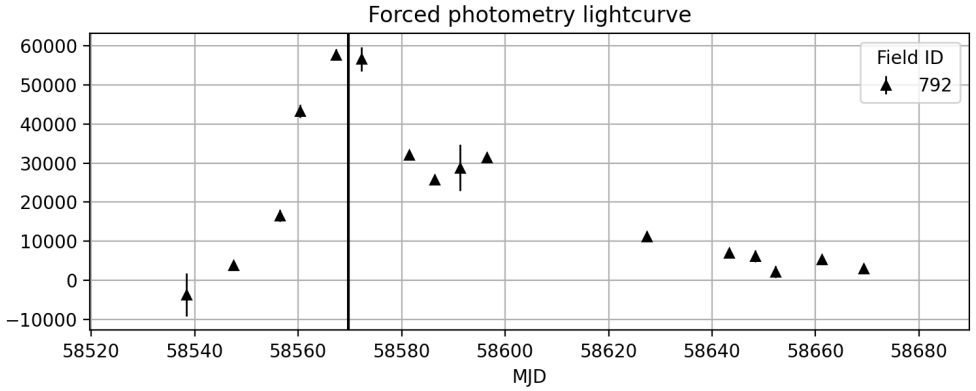

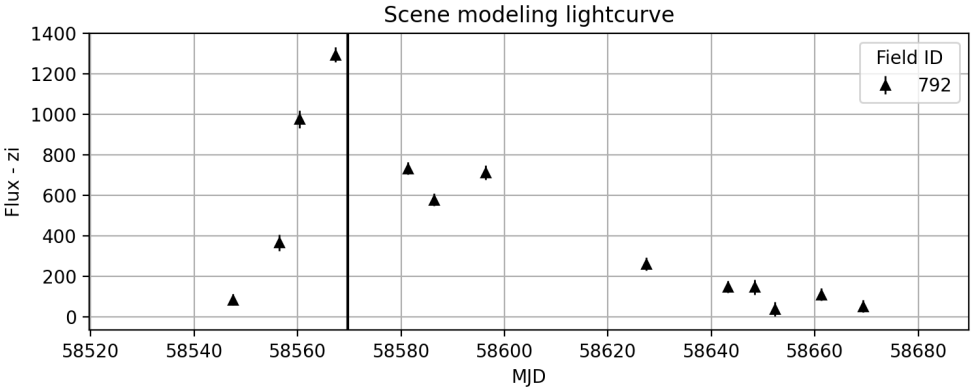

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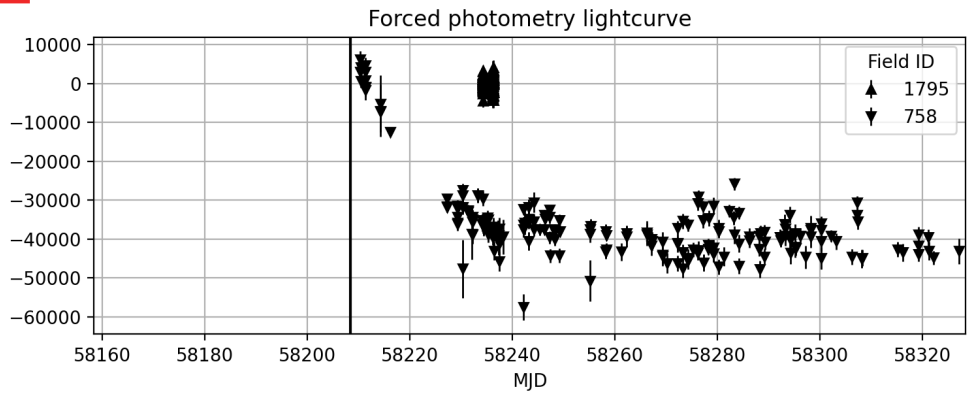

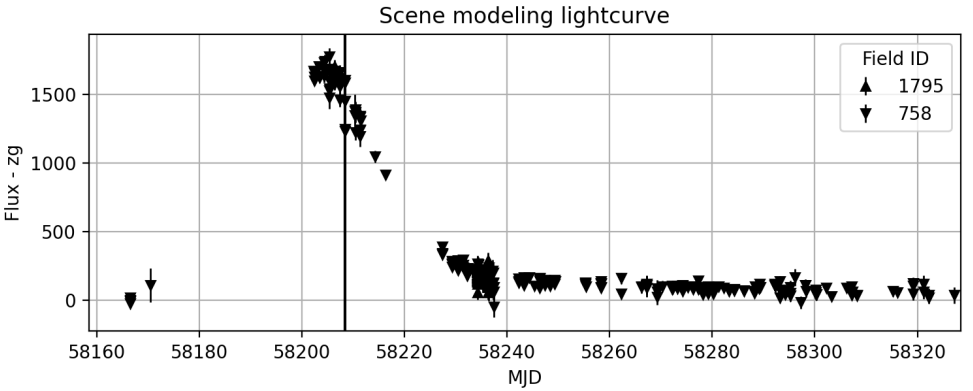

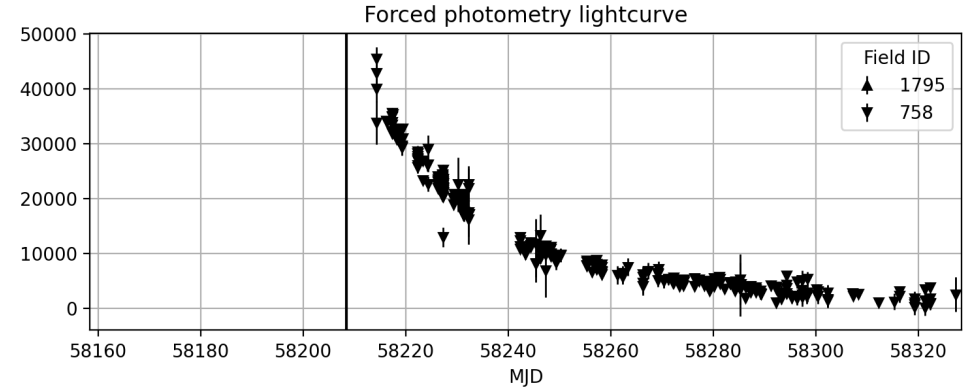

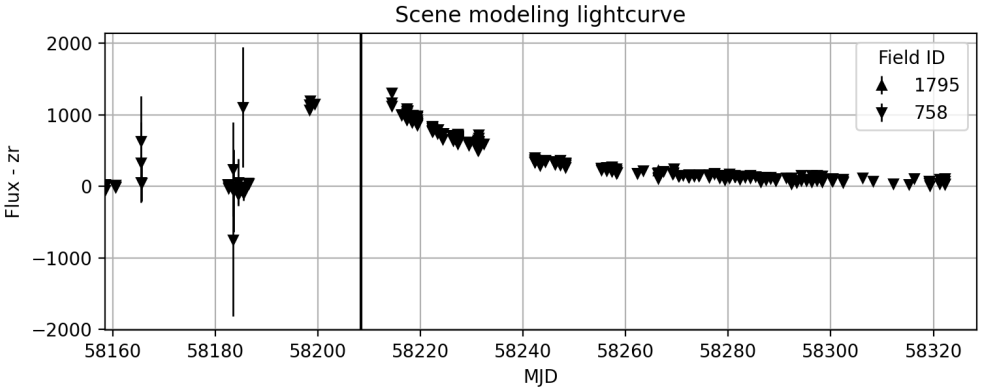

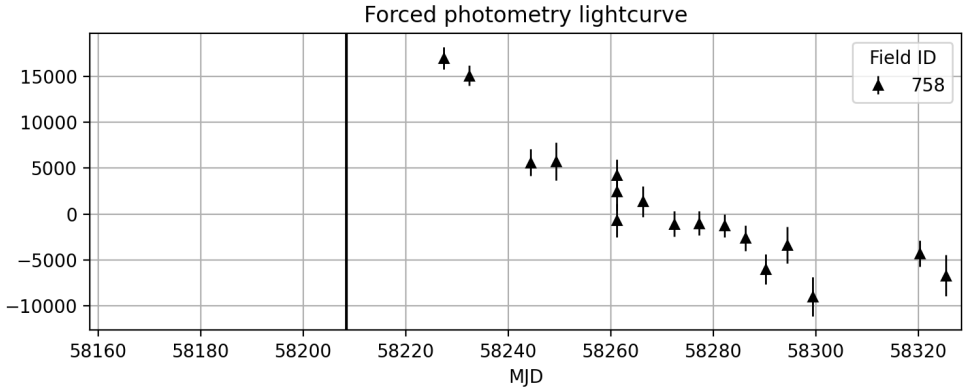

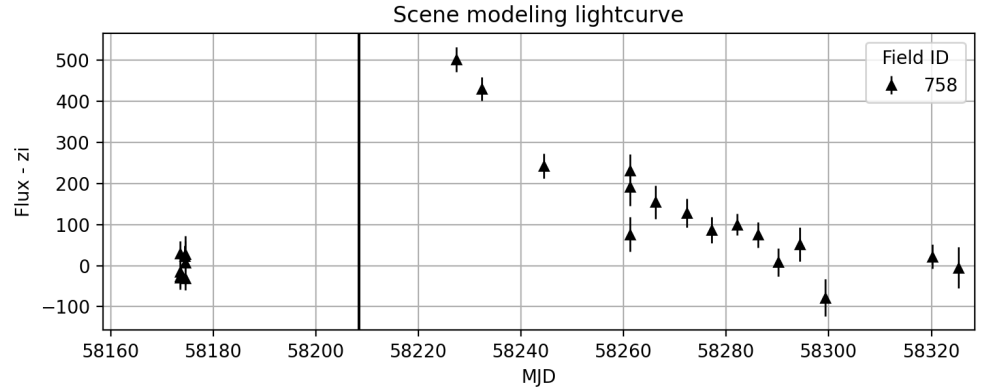

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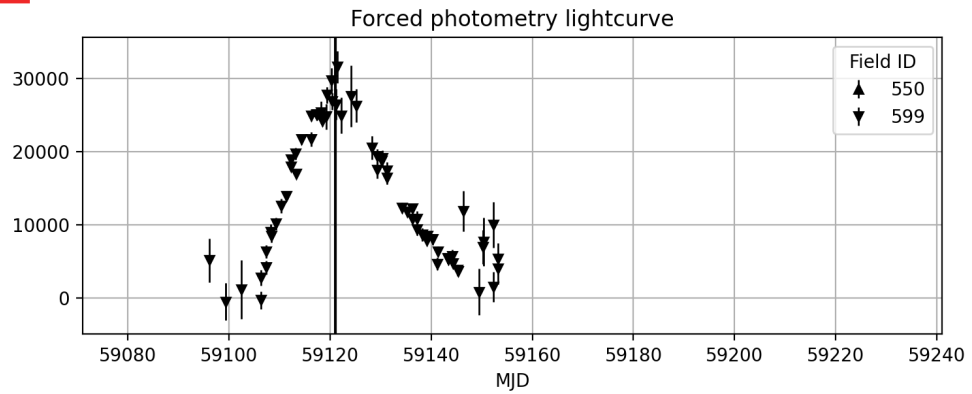

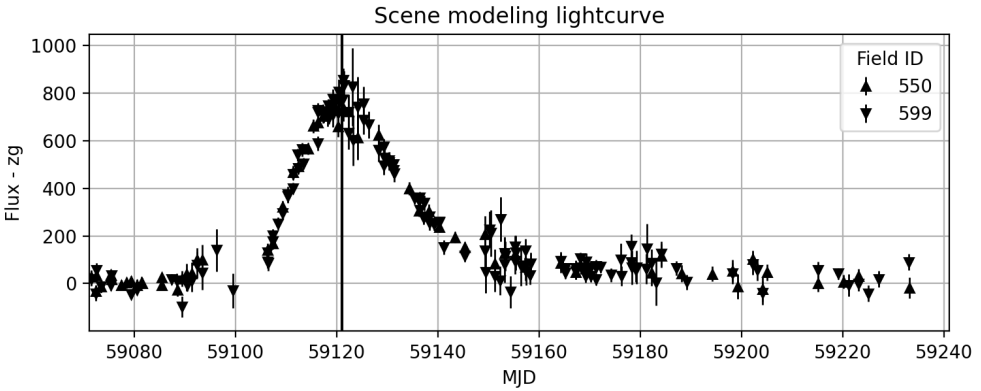

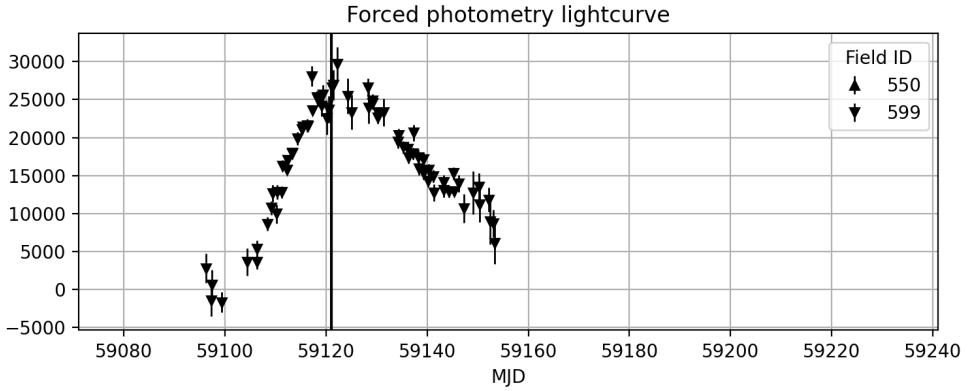

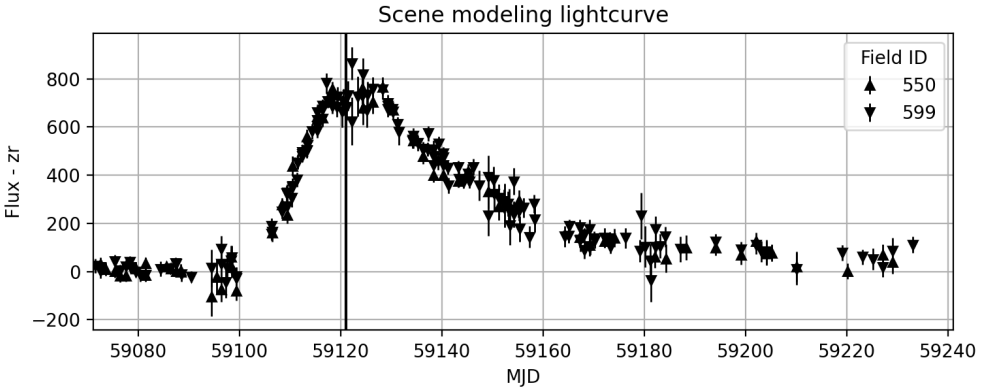

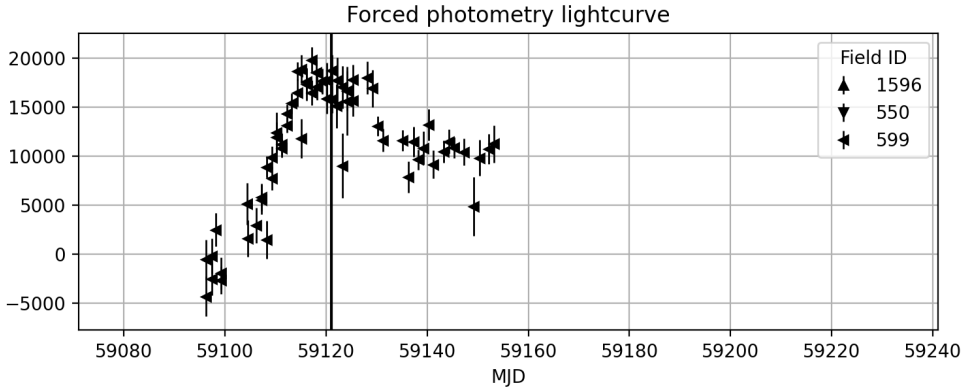

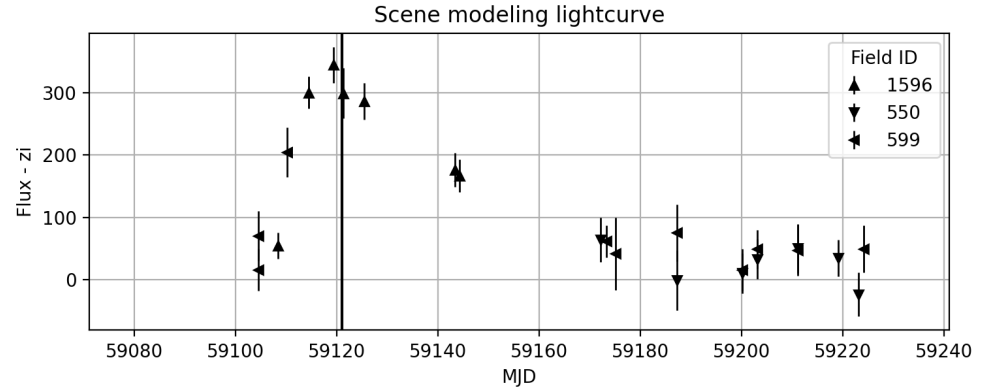

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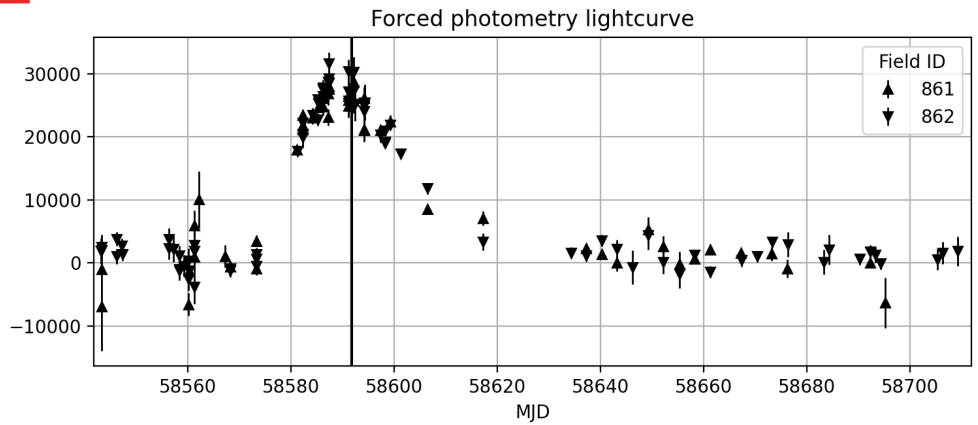
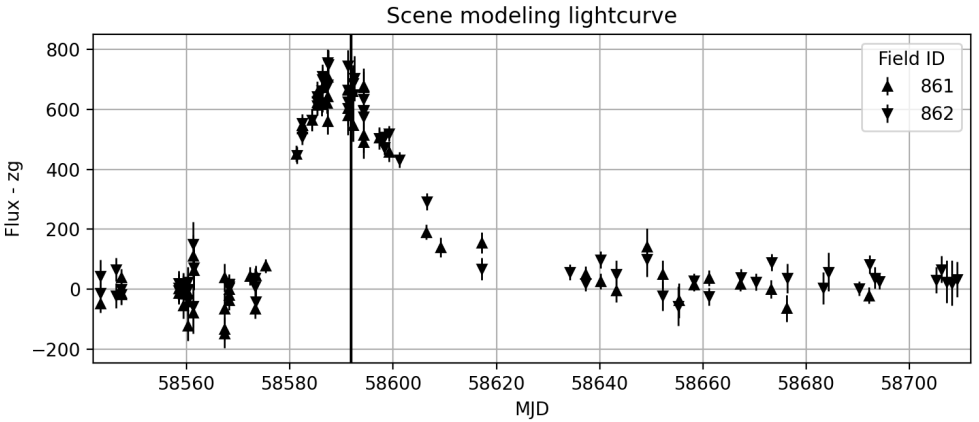
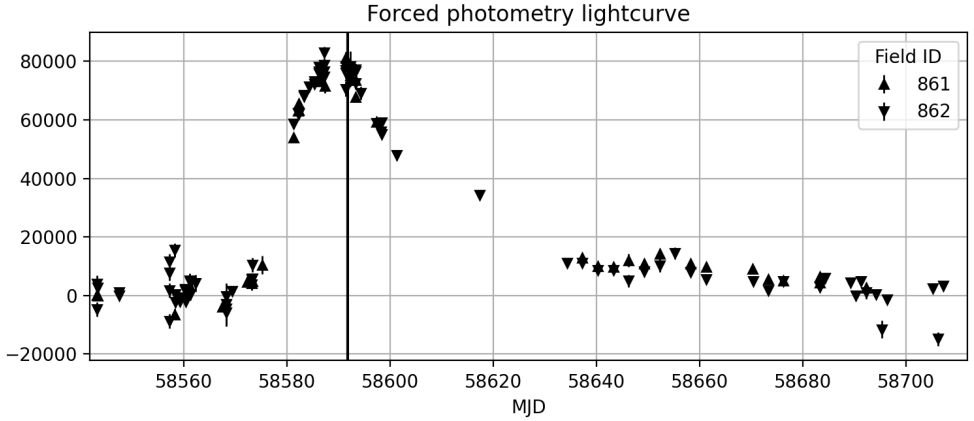
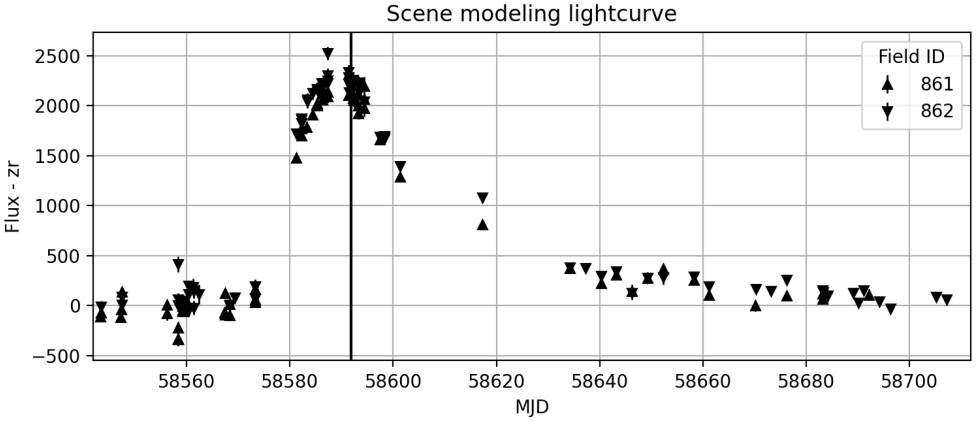


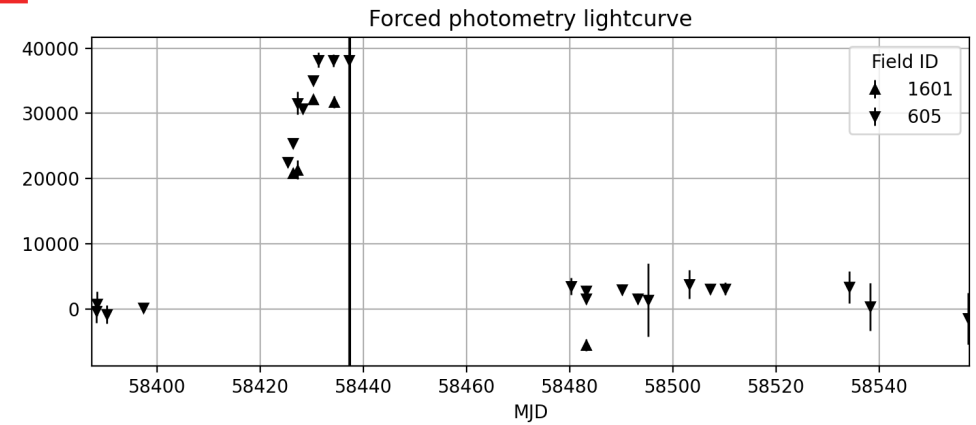


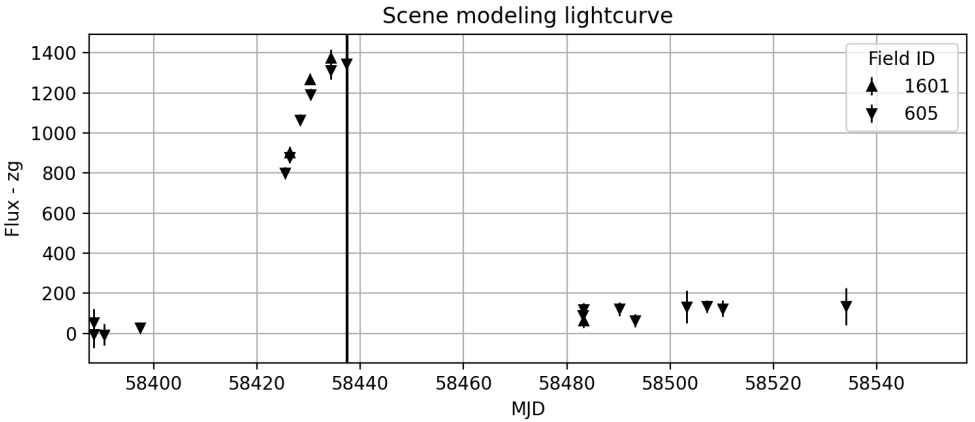


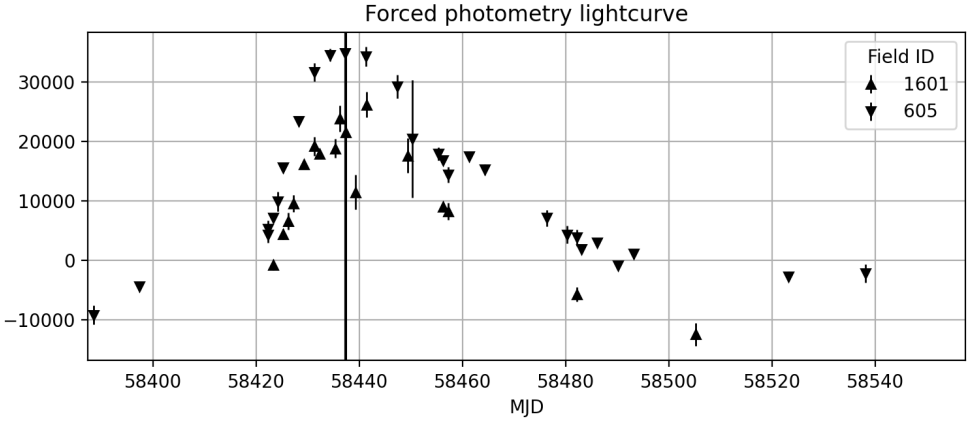


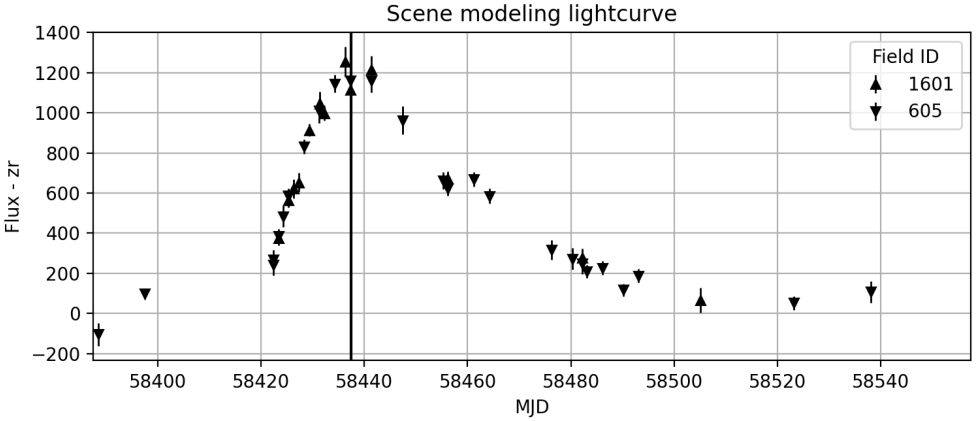
No data

ZTF18acclexy









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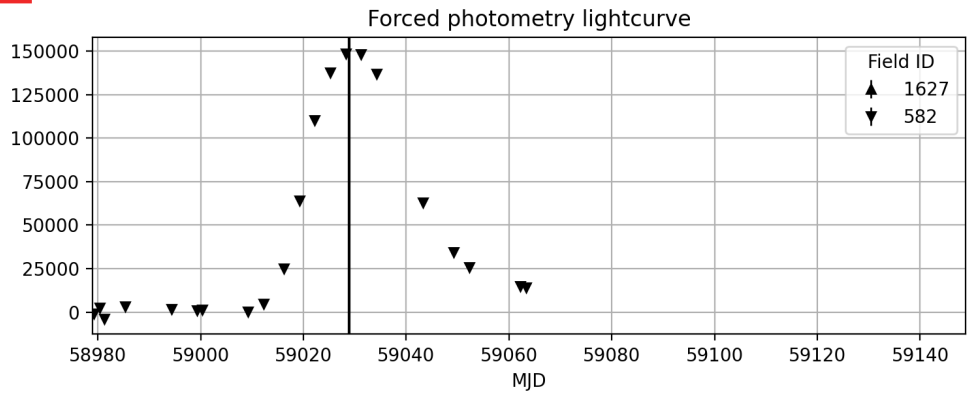

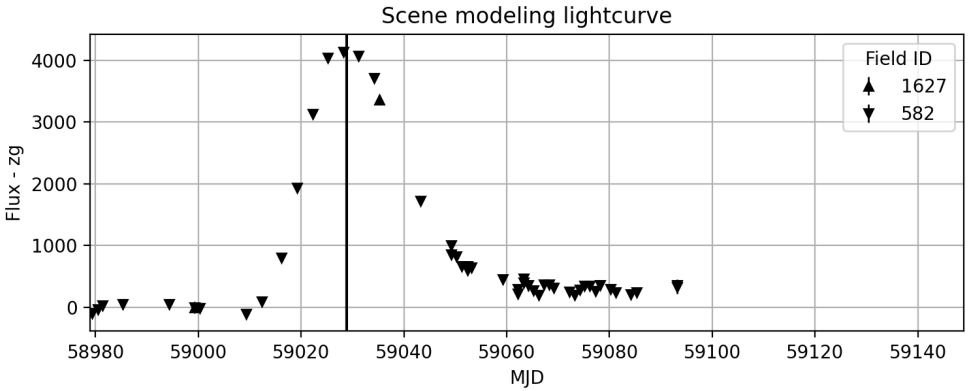

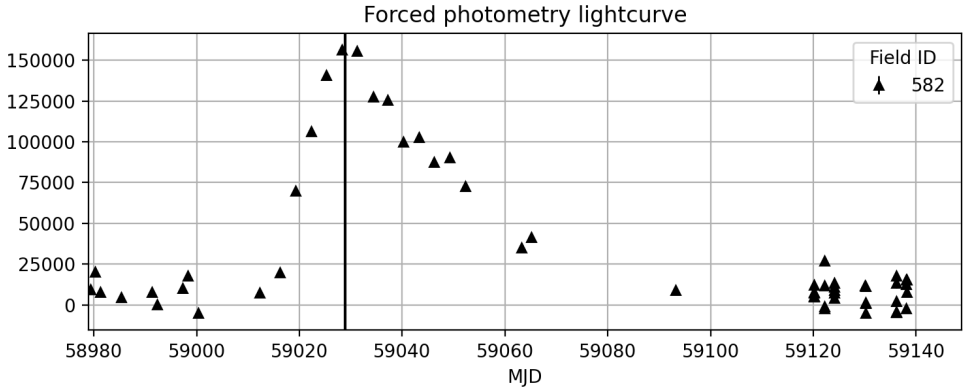

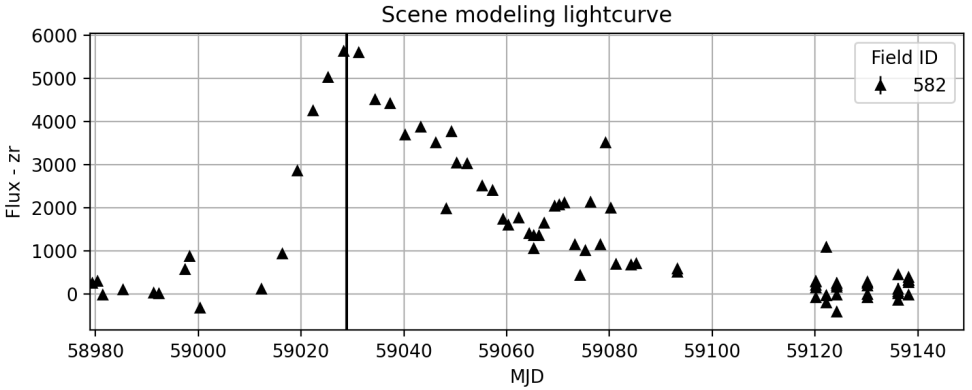

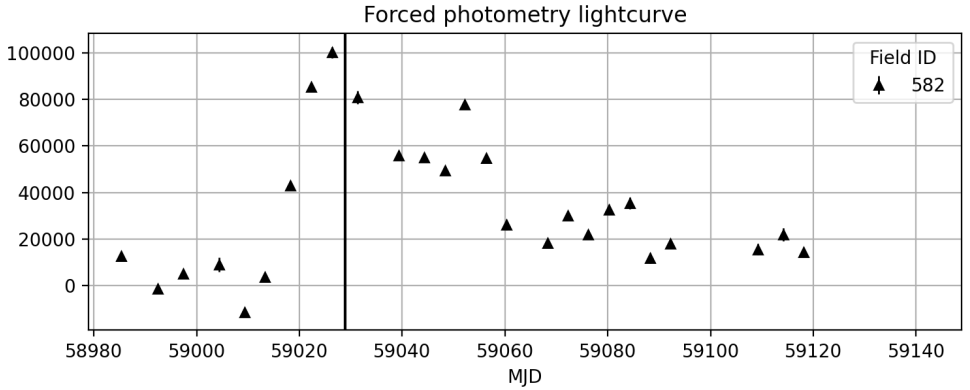

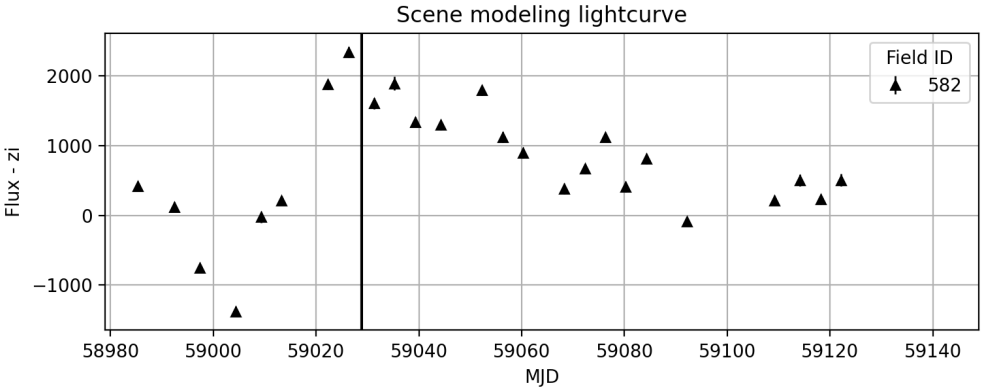

Wrapping up – take home message

- DR2 SMP sample close to release state
  - Non cosmology ready yet
    - Non linear effects not taken into account yet (PSF skewness problem, brighter-fatter)
    - Inhouse detrending
  - Assure ourselves everything has been done correctly, error model
  - Check PSF chromaticity
  - Upload lightcurve gallerie
- **Also: finish writing DR paper!**

DR2 paper: table of content

1) Dataset description
2) Scene Modeling Photometry description
3) Pipeline description
4) Found peculiarities in the dataset
    1) Pocket effect
    2) Brighter fatter