



ZTF Scene Modeling Photometry

Plans for DR2 & DR2.5

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Current status of the run and pipeline

- Full implementation of the pipeline
 - From pixels to calibrated SNe 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)
- Able to calibrate on Ubercal/PS1

Conclusion: DR2 SMP lightcurves close to release state

However: many challenges left for a cosmology ready sample

Schedule

- DR2
- DR2.1 – Full processing of DR2 sample ← We are here
 - Calibrated on PS1

	Star detection flawed	Easy fix
	Repeatability PSF vs SMP	Ignored
Problems:	Brighter-fatter (BF)	Ignored
	Pocket effect (PE)	Ignored
	Linearity problem with Ubercal	Easy fix?

Write DR2 SMP paper!

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- DR2.2 – Almost full reprocessing of DR2 sample
 - With fixed known problems
 - * Star detection
 - * Repeatability
 - Calibrated on Ubercal (linearity checks)

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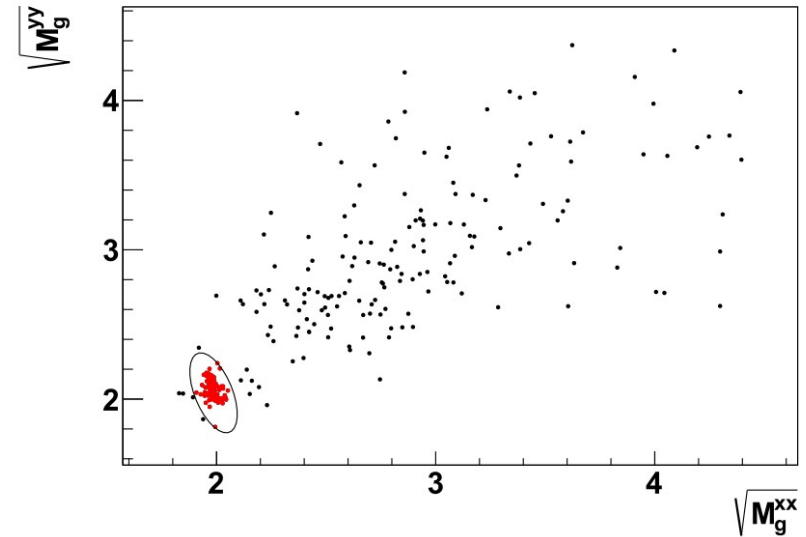
Write DR2 SMP paper!

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- DR2.2 – Almost full reprocessing of DR2 sample
 - With fixed known problems
 - * Star detection
 - * Repeatability
 - Calibrated on Ubercal (linearity checks)

-
- DR2.5 – Full reprocessing of DR2 sample
 - Remaining problems fixed – BF, PE, repeatability
 - Calibrated on Ubercal

Undersampled star detection

- Original star detection algorithm
 - isolate star region on centered 2nd order moment plane
- Relies on fixed point moment computation algorithm (eq. 1)
 - Diverges for undersampled sources



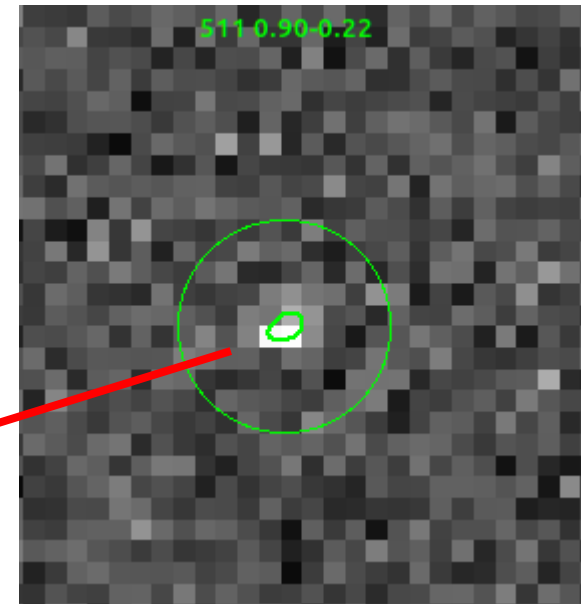
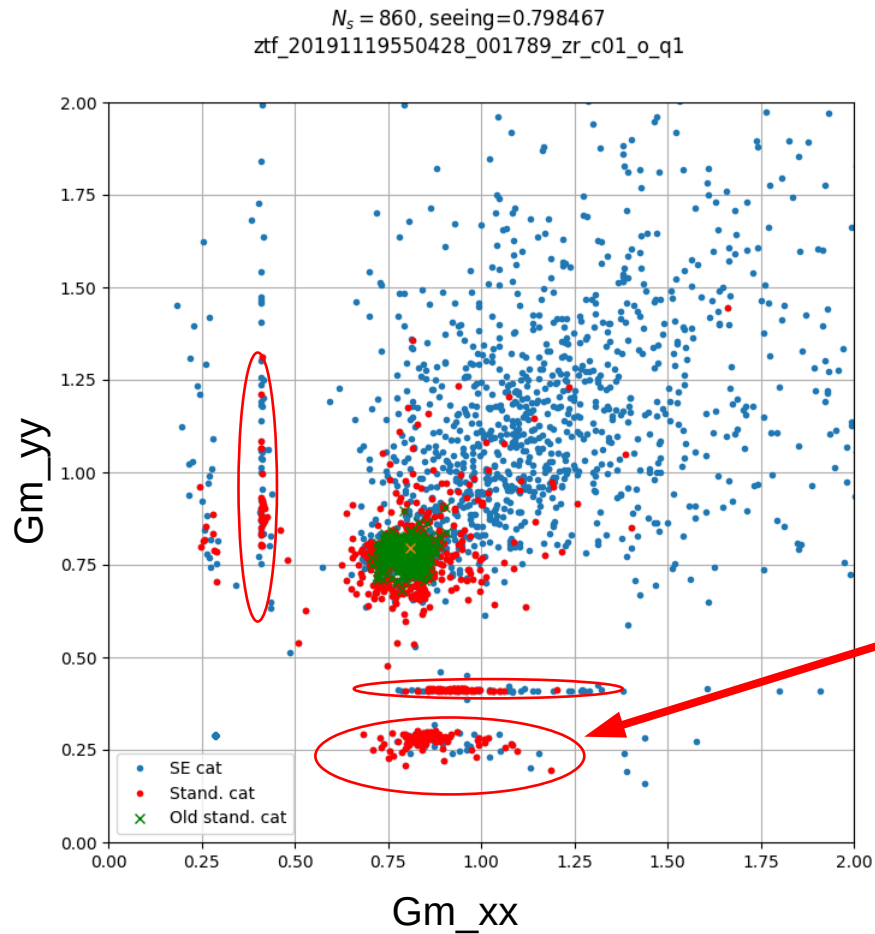
$$\mathbf{M}_g = 2 \frac{\sum_{\text{pixels}} (\mathbf{x}_i - \mathbf{x}_c)(\mathbf{x}_i - \mathbf{x}_c)^T \mathbf{W}_g(\mathbf{x}_i) I_i}{\sum_{\text{pixels}} \mathbf{W}_g(\mathbf{x}_i) I_i} \quad (1)$$

$$\mathbf{W}_g(\mathbf{x}_i) \equiv \exp \left[-\frac{1}{2} (\mathbf{x}_i - \mathbf{x}_c)^T \mathbf{M}_g^{-1} (\mathbf{x}_i - \mathbf{x}_c) \right]$$

[P. Astier et al. 2013]

Solution: Use Gaia for object detection - **Done**
Compute moments by classic χ^2 minimization - **Todo**

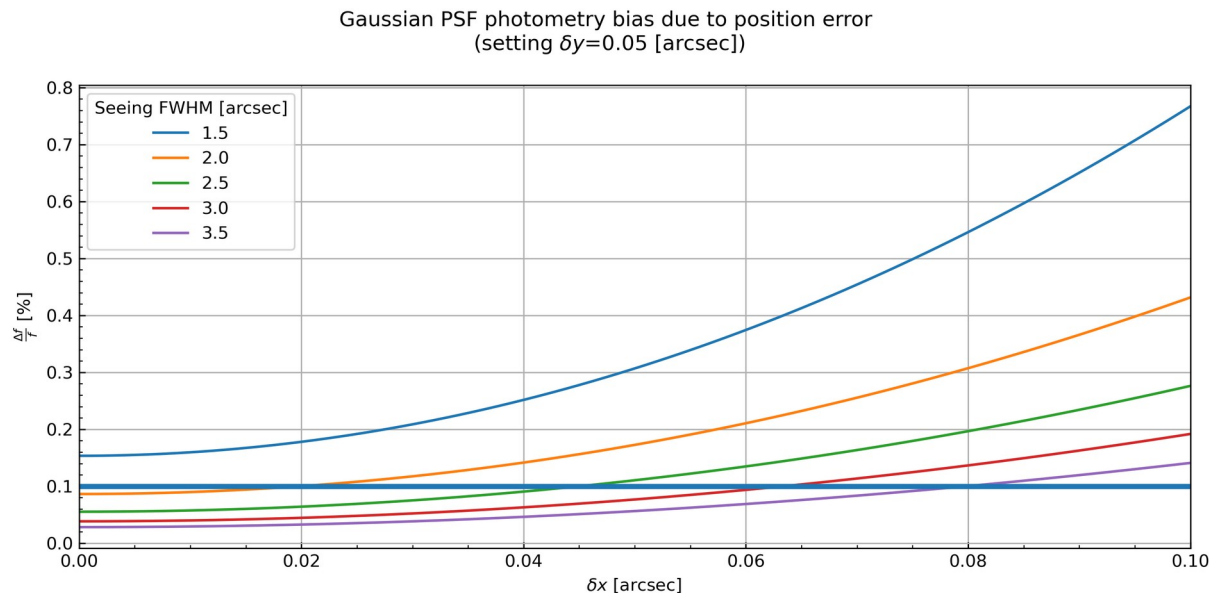
Undersampled star detection



→ this stars gets flagged and rejected

Scene modeling requirements

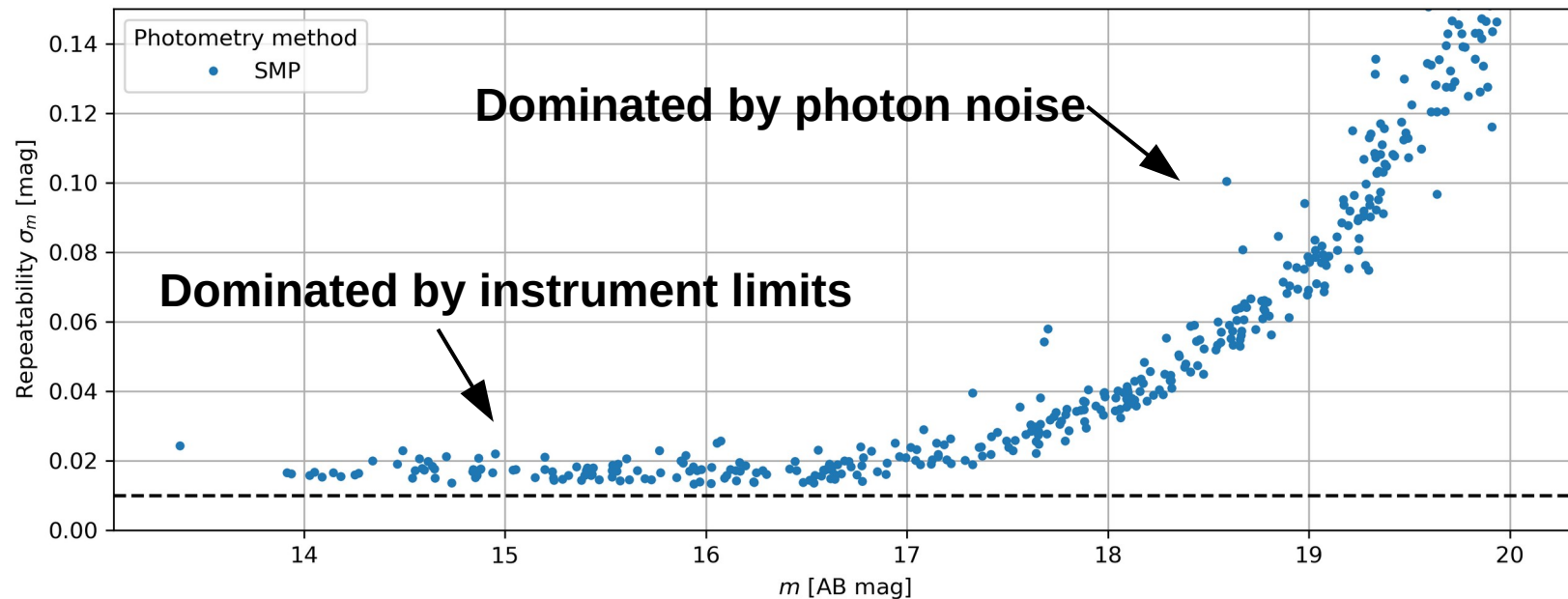
- Photometry still dominated by systematics
- Indeed: SMP has strict requirements
 - Robust and precise relative astrometry maps
 - PSF linearity → independent of flux



$$\frac{\Delta f}{f} = \frac{1}{4} \frac{\delta x^2 + \delta y^2}{\sigma_{IQ}^2}$$

SMP repeatability

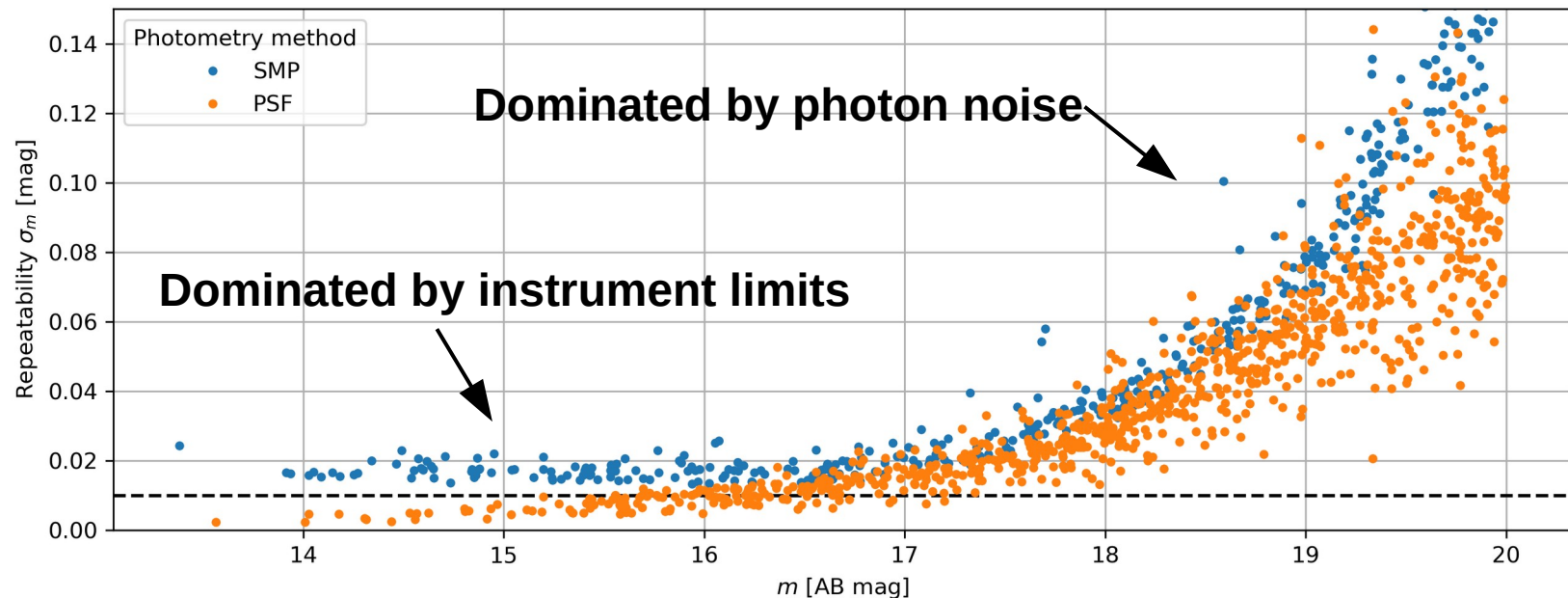
- Repeatability: RMS of flux residuals for constant stars
 - Quantify internal calibration
- For SMP stars: floor around 1% \rightarrow quite good



Reminder: star position fit on the whole sequence (forced photometry)

PSF stars repeatability

- For PSF stars lightcurve, seems better
 - Below 1% repeatability up to 16.5 mag

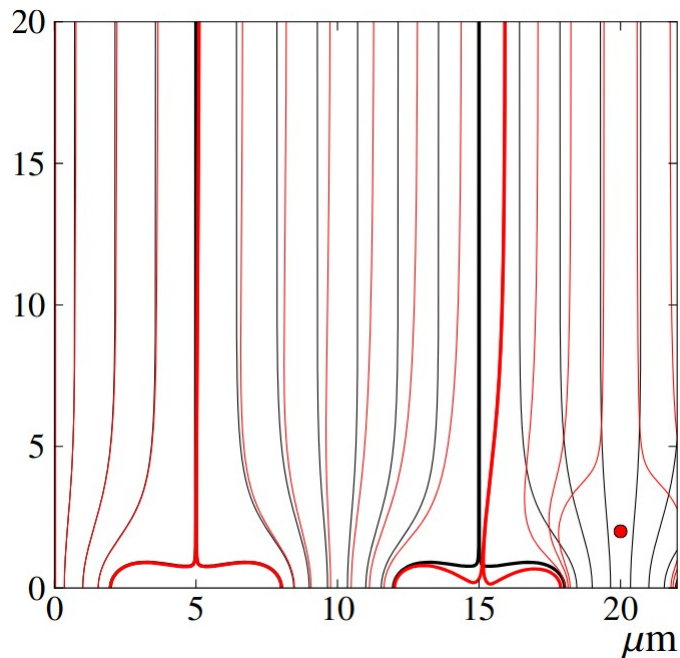


Reminder: star position fit per star measure (PSF model)

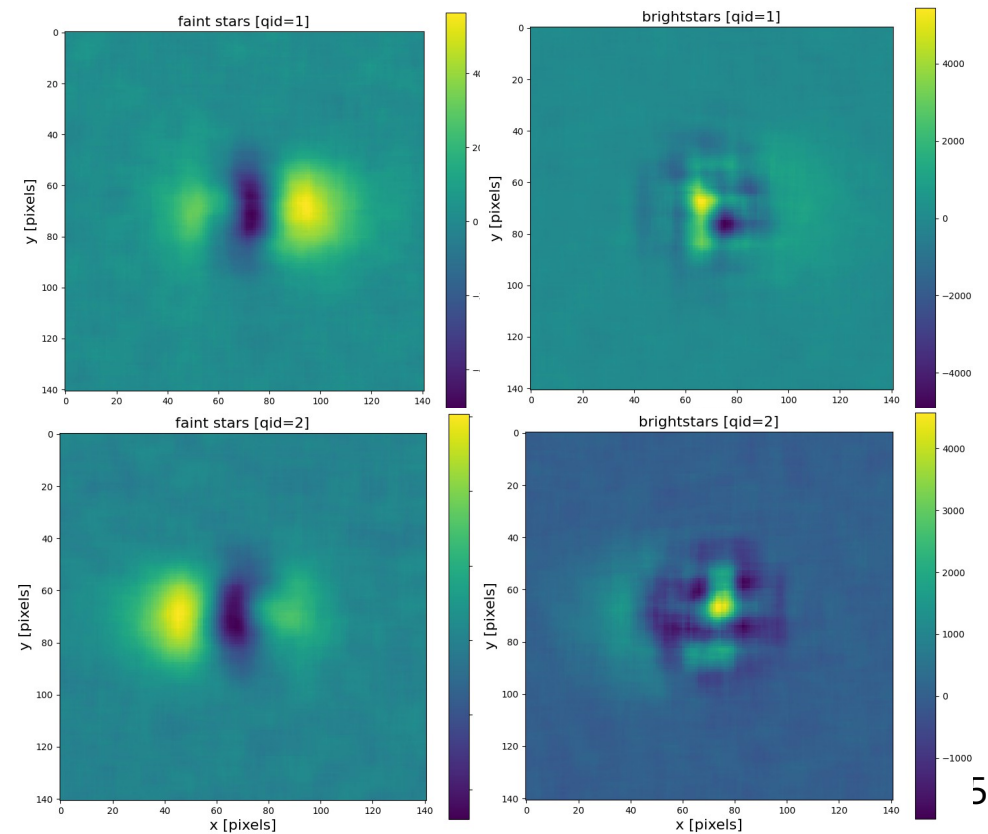
- Possible cause(s):**
- Selection effect due to flawed star detection?
 - Astrometry precision?
 - Pocket effect?

Sensor effects affecting PSF linearity

- Brighter-fatter
 - High flux
 - Expected
 - 1-2% effect (p-to-p)
- “Pocket effect”
 - Low flux – low background
 - Unexpected
 - 5-10% effect (p-to-p)

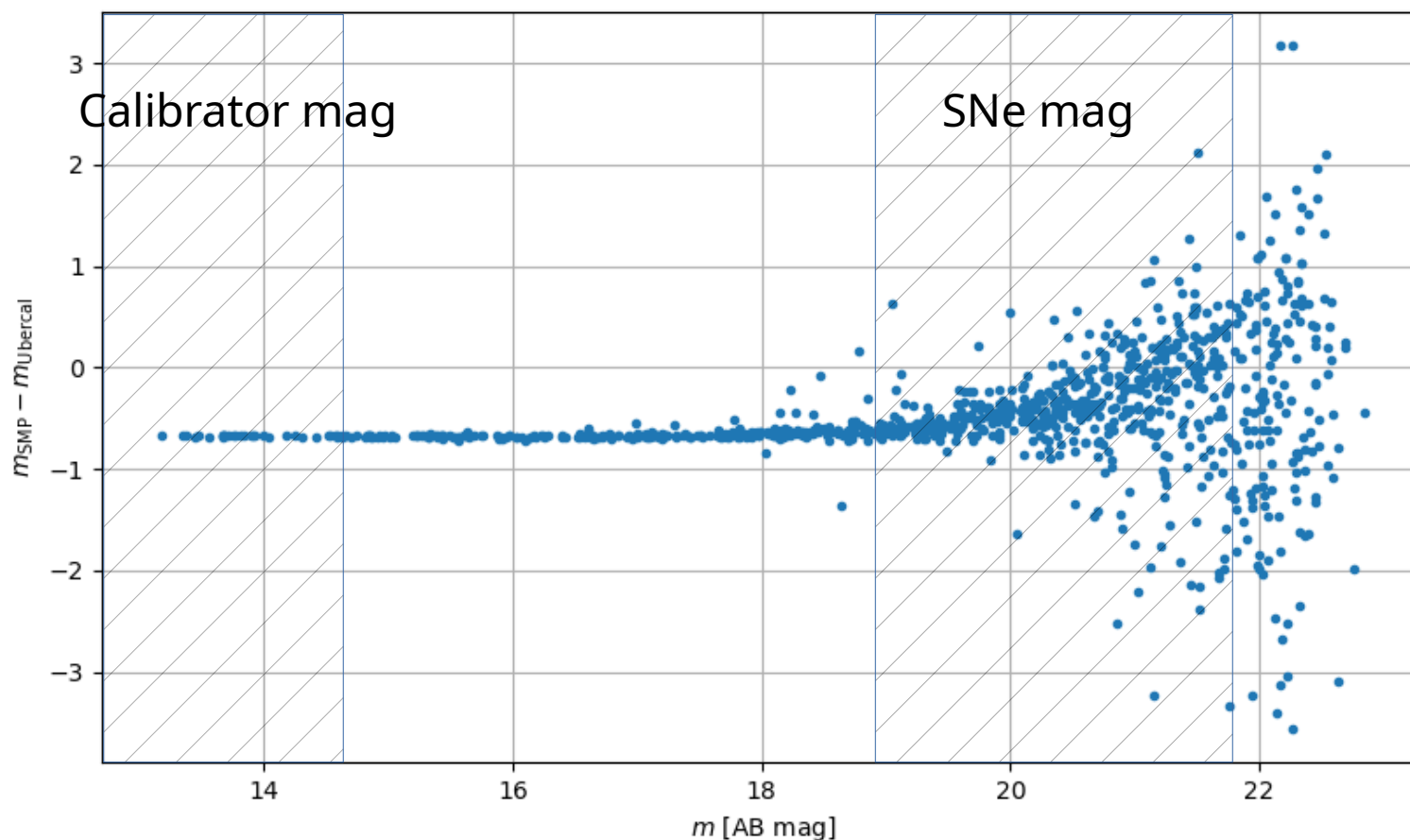


(Guyonnet et al, 15, Astier '19, Astier & Regnault, '23)



Non linearity with Ubercal

- Linearity problems when comparing SMP magnitude with Ubercal
- Does not happen with PS1/Gaia



Toward DR 2.5

- Todo list
 - Star detection flaw – fixed
 - Calibration on Ubercal – in investigation
 - Sensor effects (BF/PE) – waiting for progress
 - Starflats – done
- Isolate calibration module for Lemaitre project
- Development near completion – release
 - Full data processing once PE is fixed

SMP paper outline

- Introduction
 - 1. Requirements
 - Linearity
 - Uniformity
 - Repeatability
 - 2. Addressing requirements
 - Scene Modeling Photometry (SMP)
 - Starflats
 - Flatfields
 - Pocket effect – pixel level correction
 - Filter model
 - 3. Dataset (in progress)
 - 4. SMP pipeline & implementation (in progress)
 - 5. Light curve photometric calibration (in progress)
 - 6. Discussion & data quality
 - Conclusion
- Last DR2 paper
→ First DR2.5 paper



Thank you