

**Journées de rencontre des jeunes chercheurs:**

**Study of Type Ia Supernovae host galaxy environment  
influence**

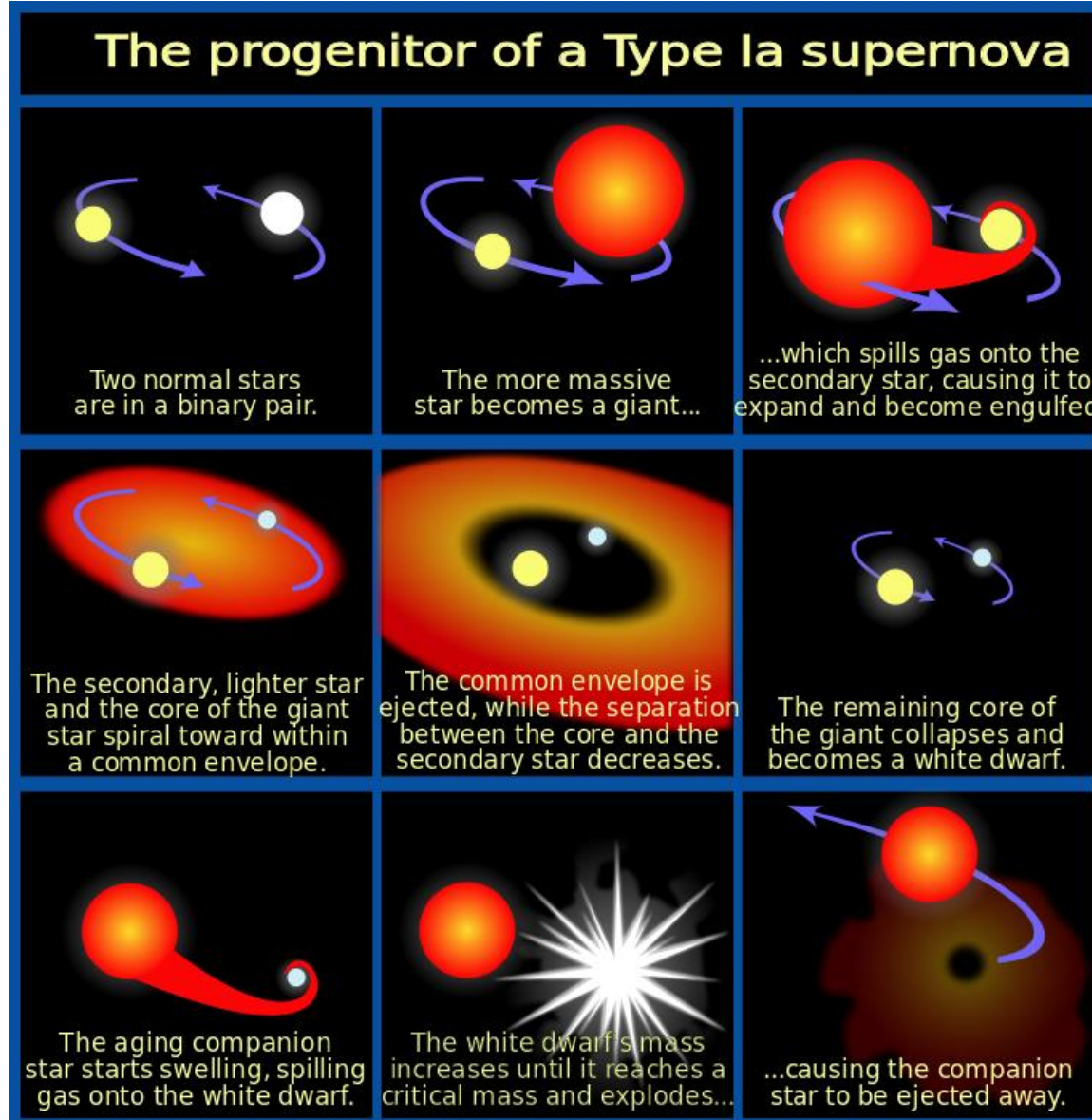
**Martin BRIDAY**

**Director : Mickael Rigault**



SN2011fe →

# Supernova de type Ia?

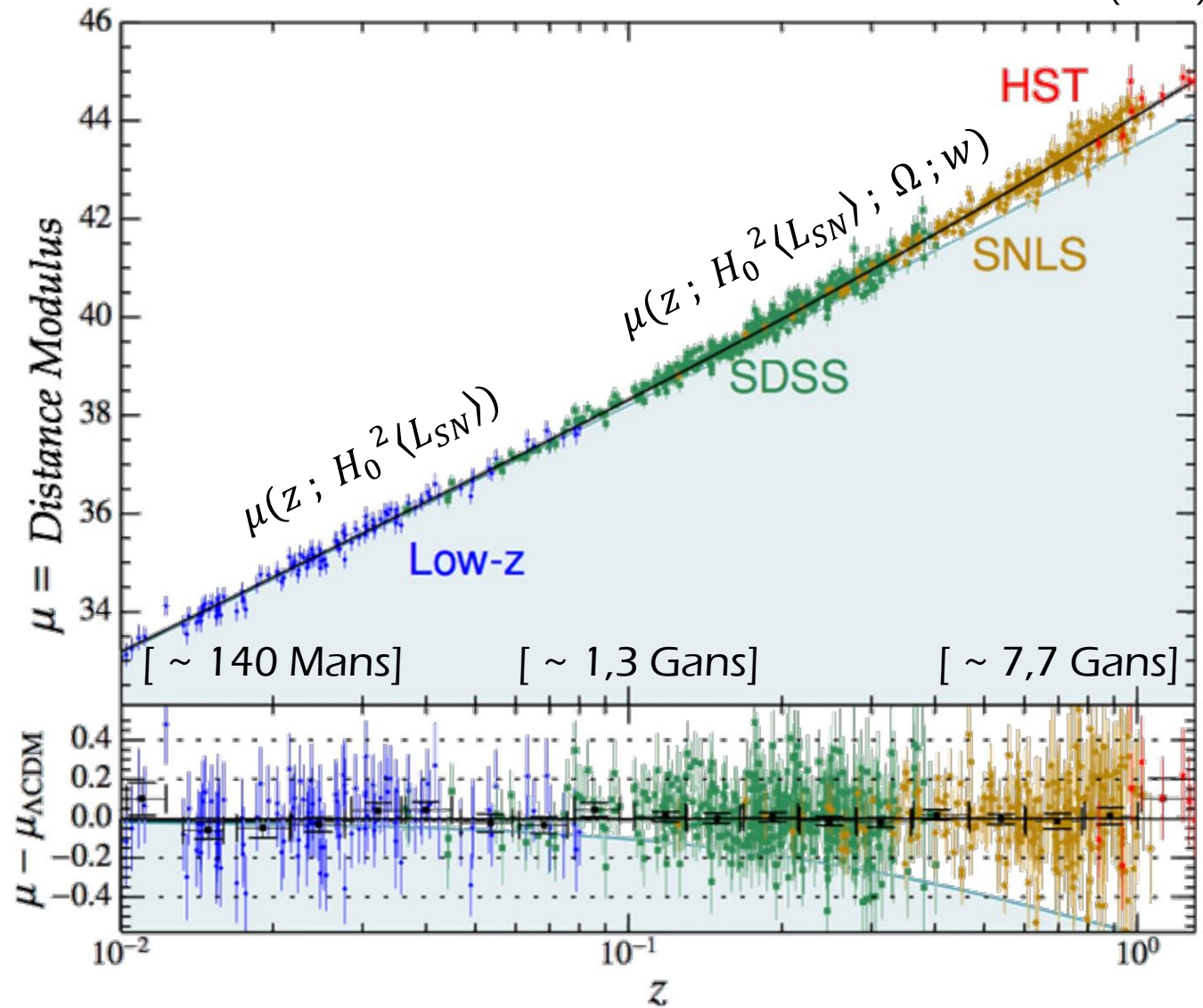


<http://hubblesite.org>

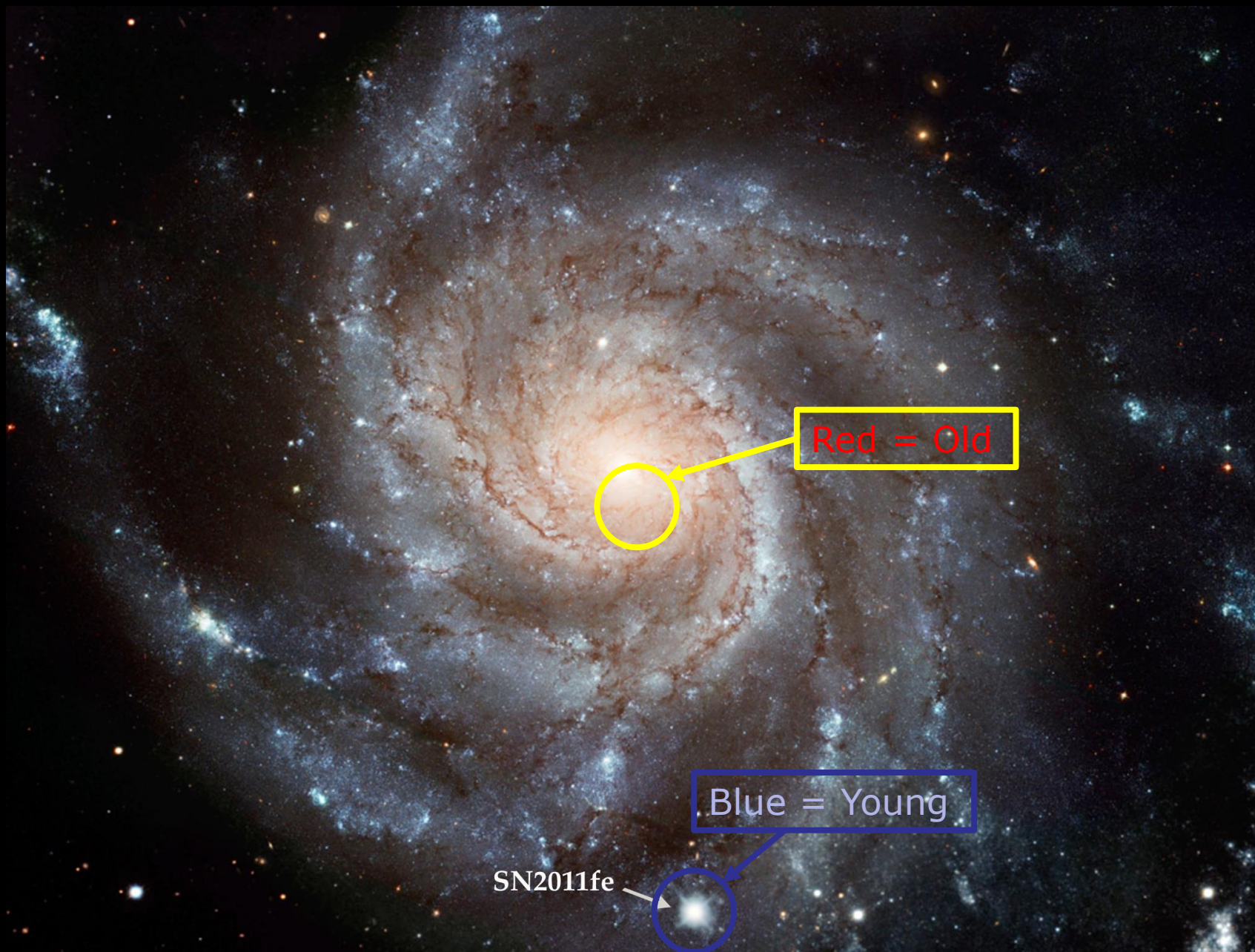
# SN Ia → Cosmology

- ▶ Distance measurements
  - ▶ Hubble diagram
  - ▶ Accelerated expansion of the Universe (Nobel 2011)
  - ▶ Cosmological probes
- ▶ Limits = systematic errors:
  - ▶ Instrumental calibration
  - ▶ Astrophysical biases
- ▶ Intrinsic bias?
- ▶ Extrinsic bias?

Betoule et al. (2014)

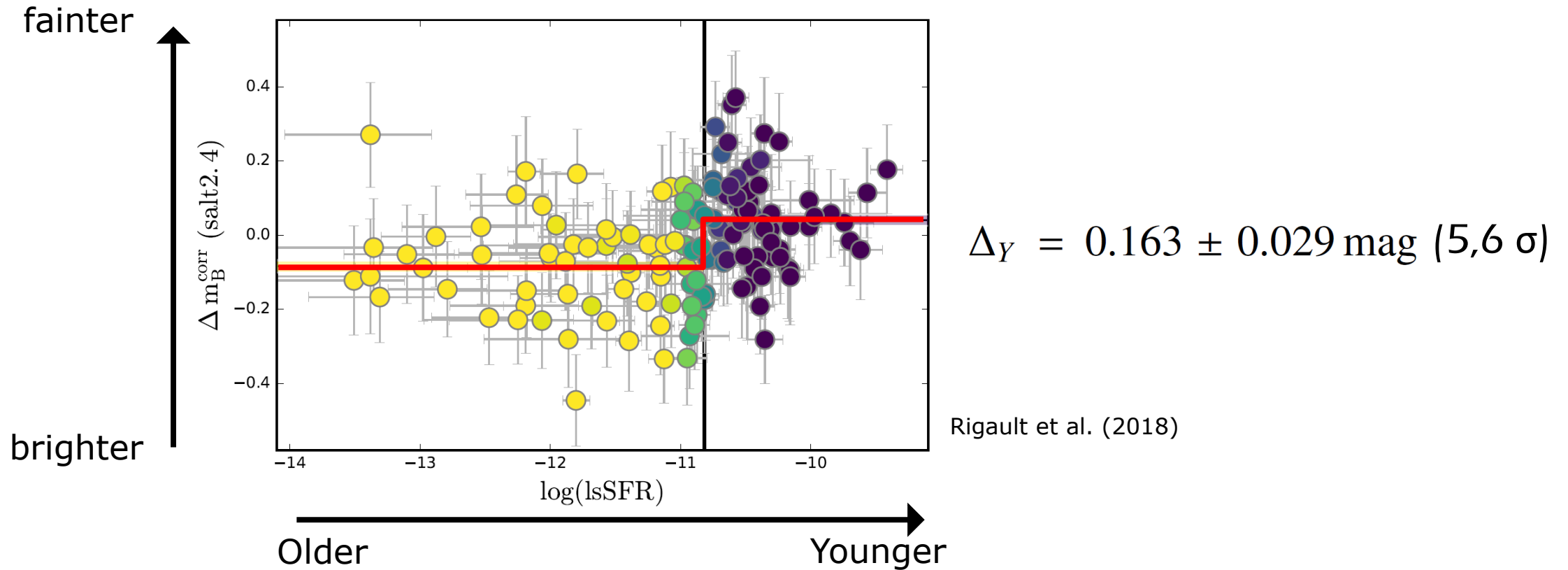


# SN Ia nature $\leftrightarrow$ Environment ?



# Environment $\leftrightarrow$ SNela $\rightarrow$ Cosmology

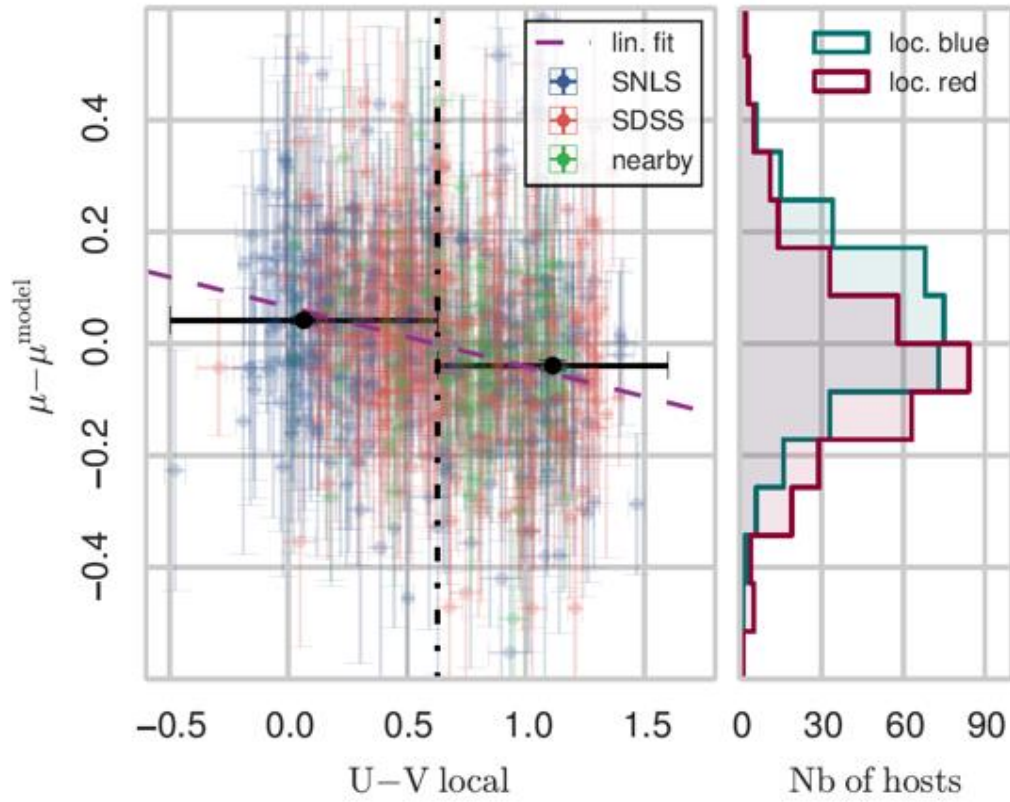
- ▶ Study of the star ages nearby SNela  $\rightarrow$  « Age step » (Rigault et al. 2018)



# Age step ?

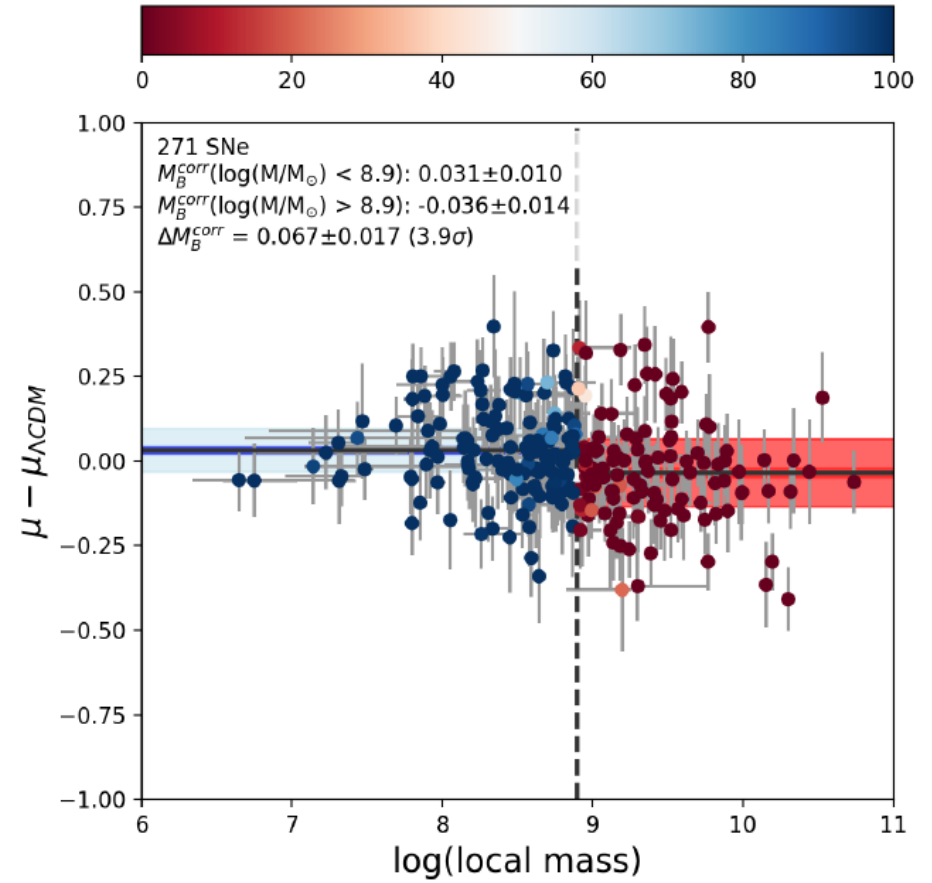
Jones et al. (2018)

Roman et al. (2017)



$$\Delta_Y = 0,091 \pm 0,013 \text{ mag } (7,0 \sigma)$$

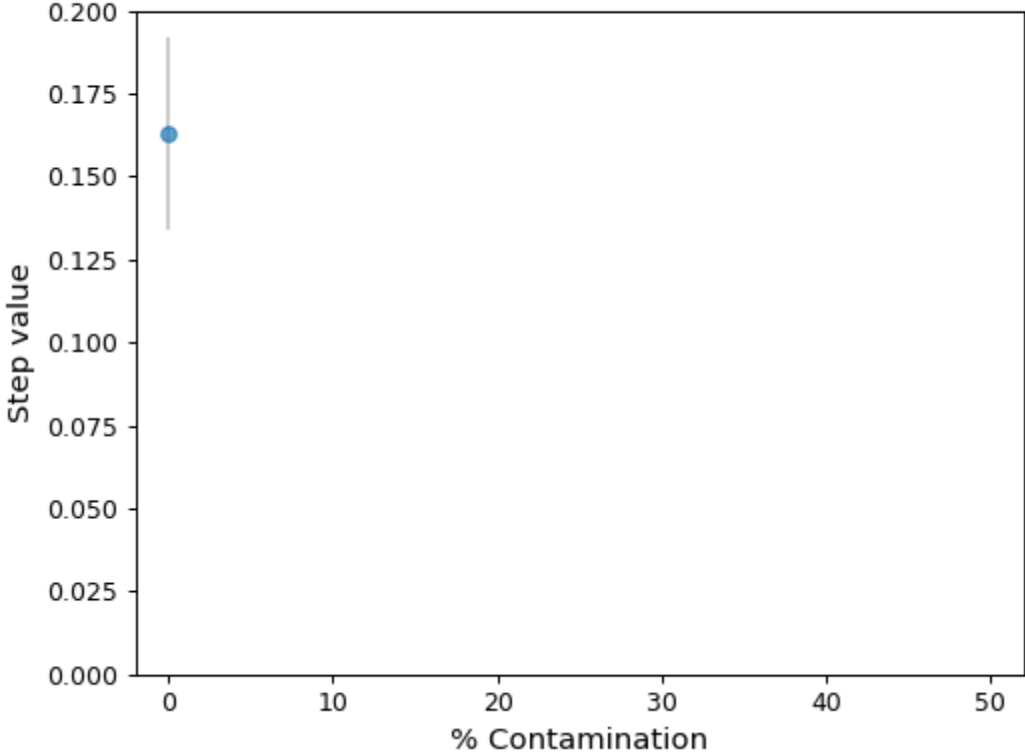
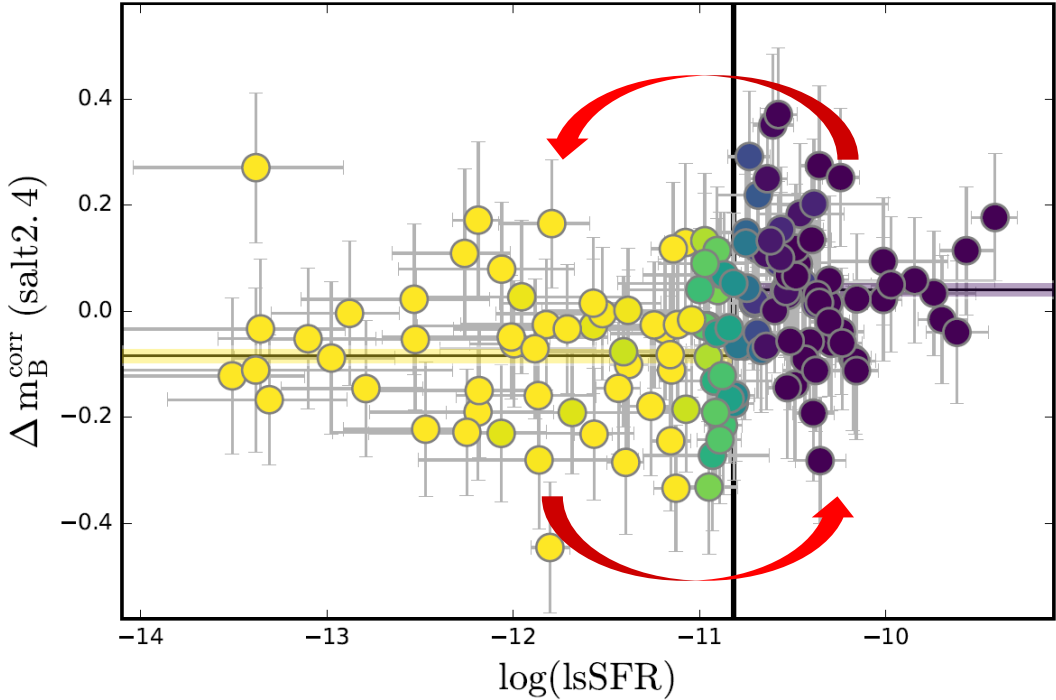
$P(\text{low mass/low } u-g)$



$$\Delta_Y = 0,067 \pm 0,017 \text{ mag } (3,9 \sigma)$$

# Age tracer contamination?

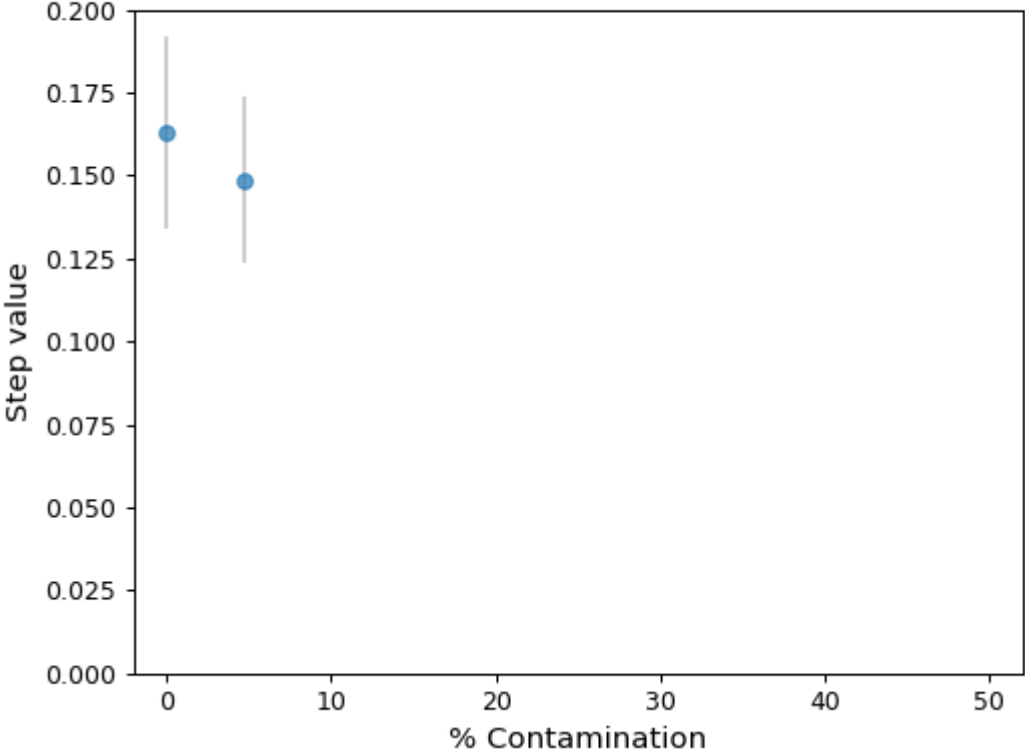
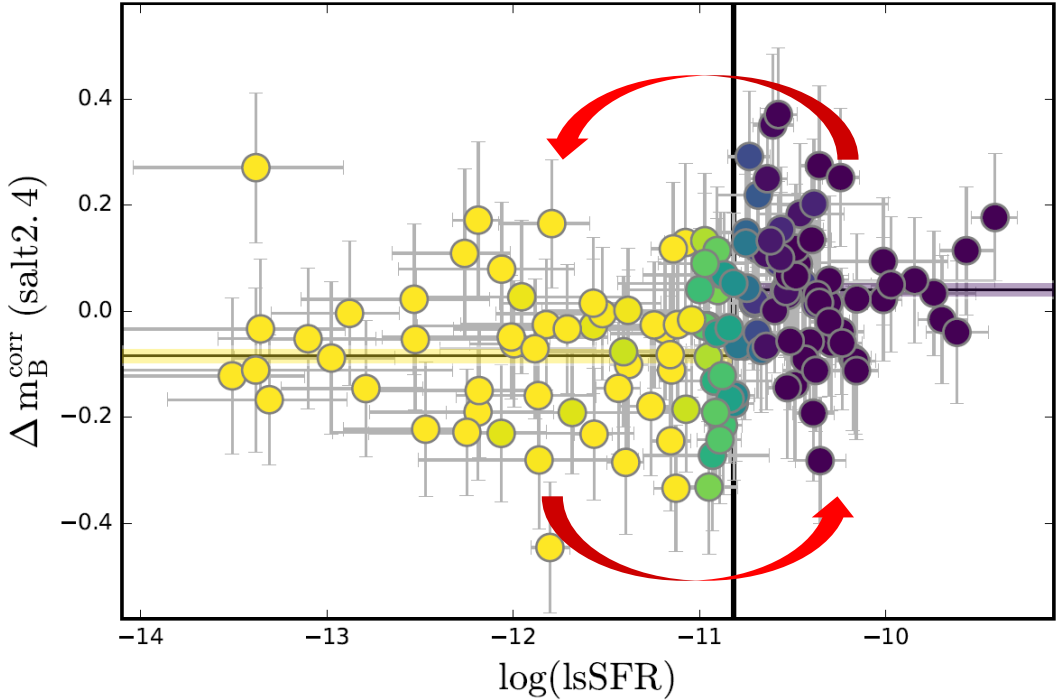
► Contamination = 0 %





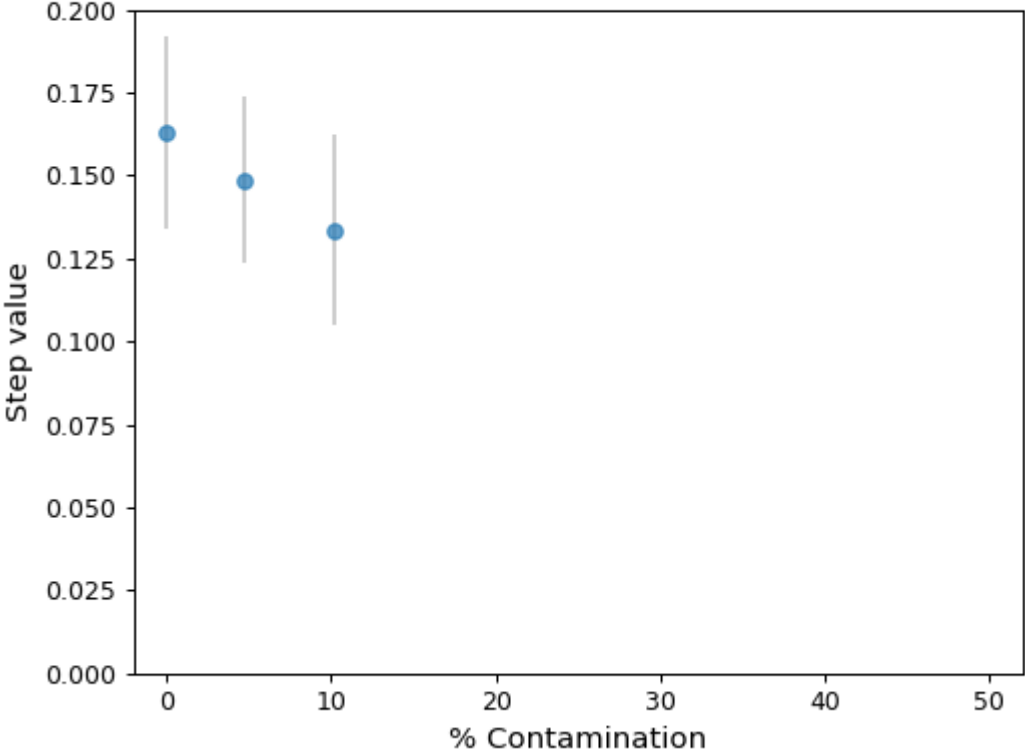
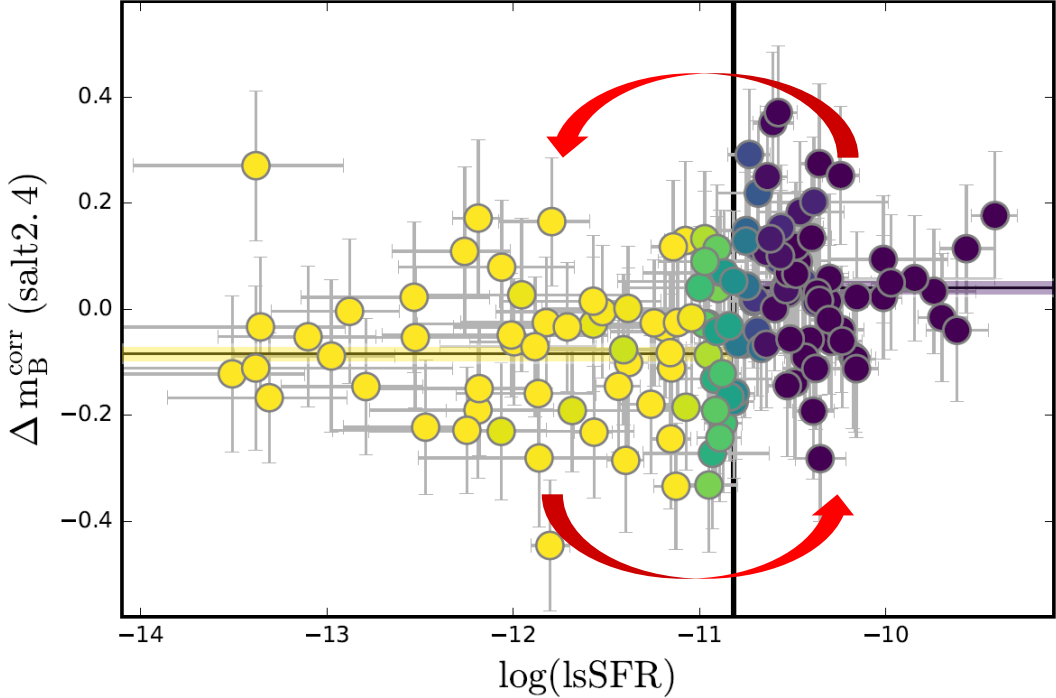
# Age tracer contamination?

► Contamination  $\approx 5\%$



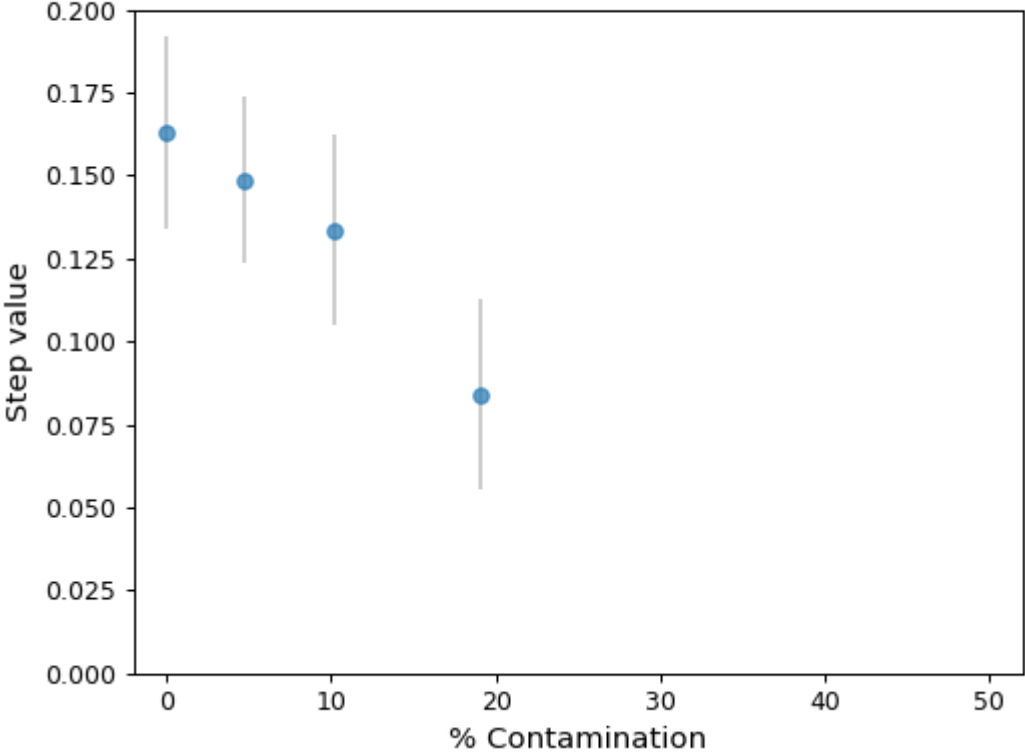
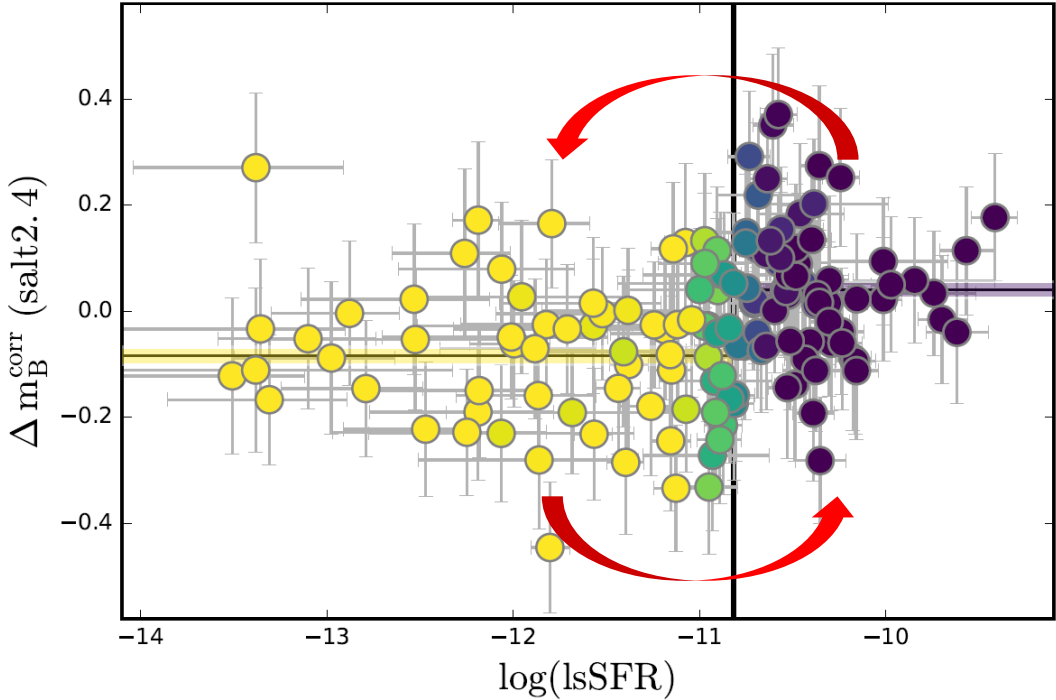
# Age tracer contamination?

► Contamination  $\approx 10\%$



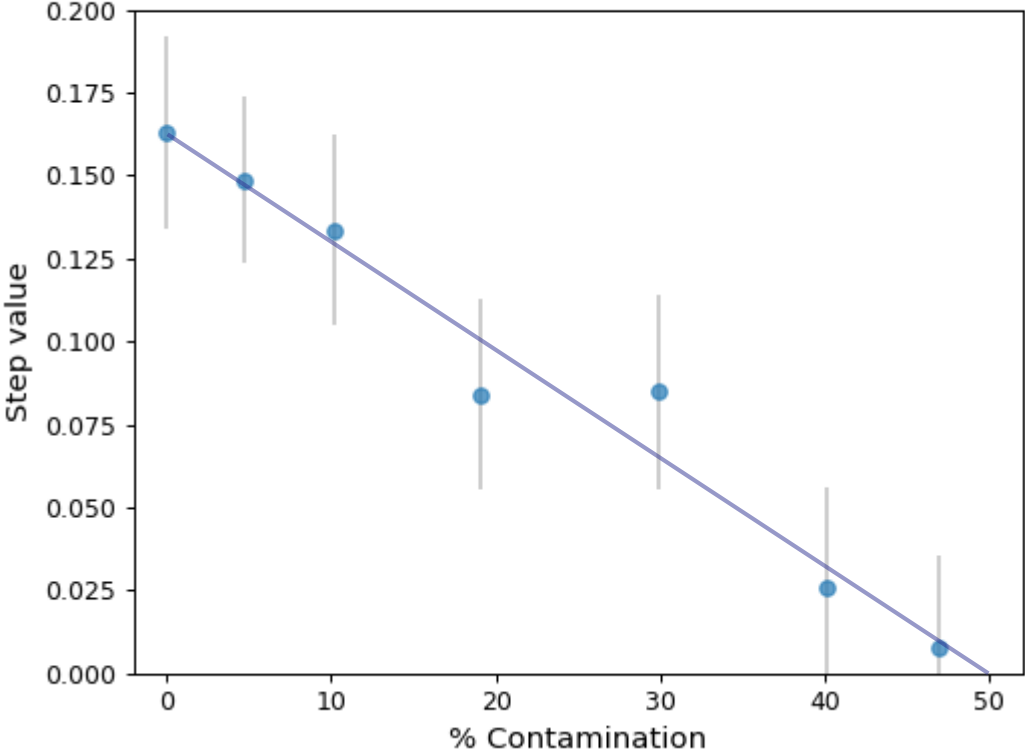
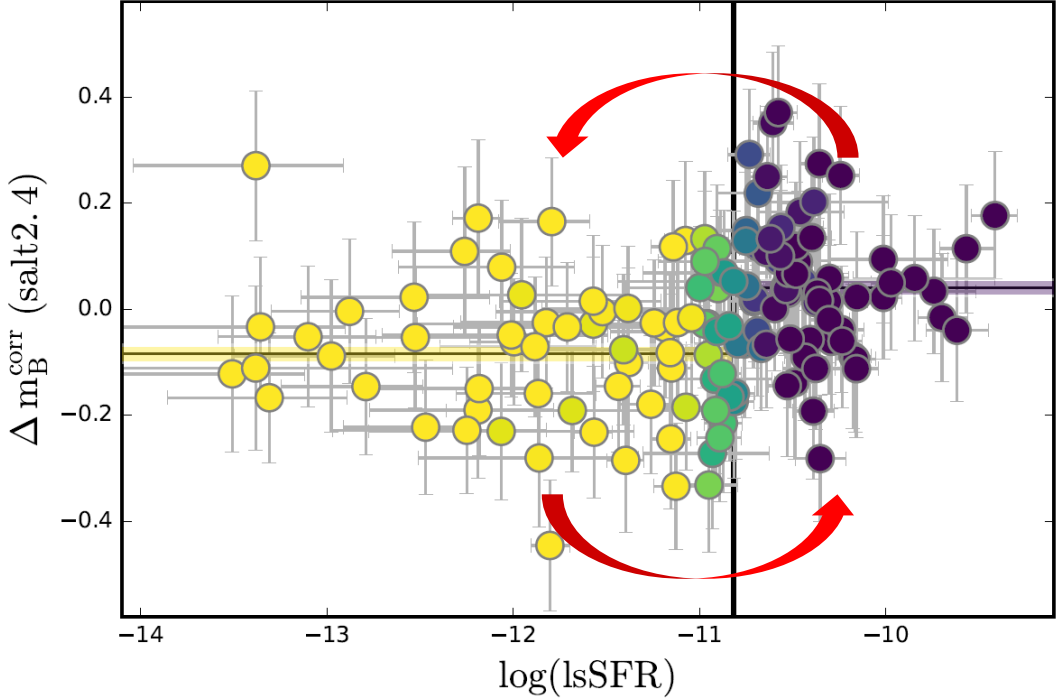
# Age tracer contamination?

► Contamination  $\approx 20\%$



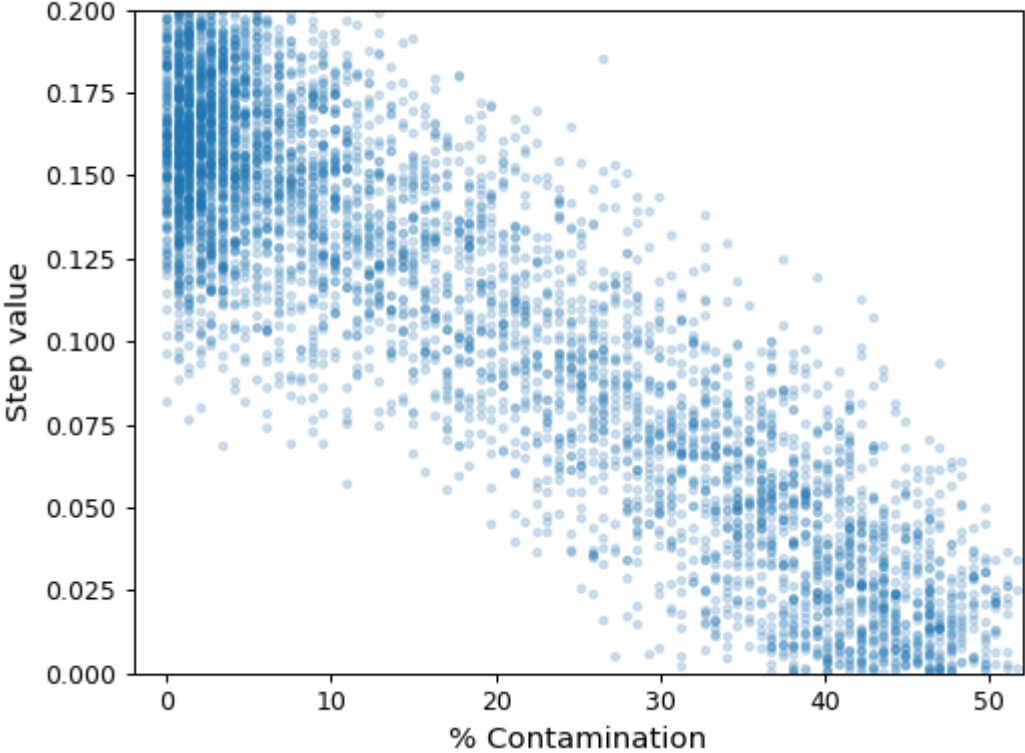
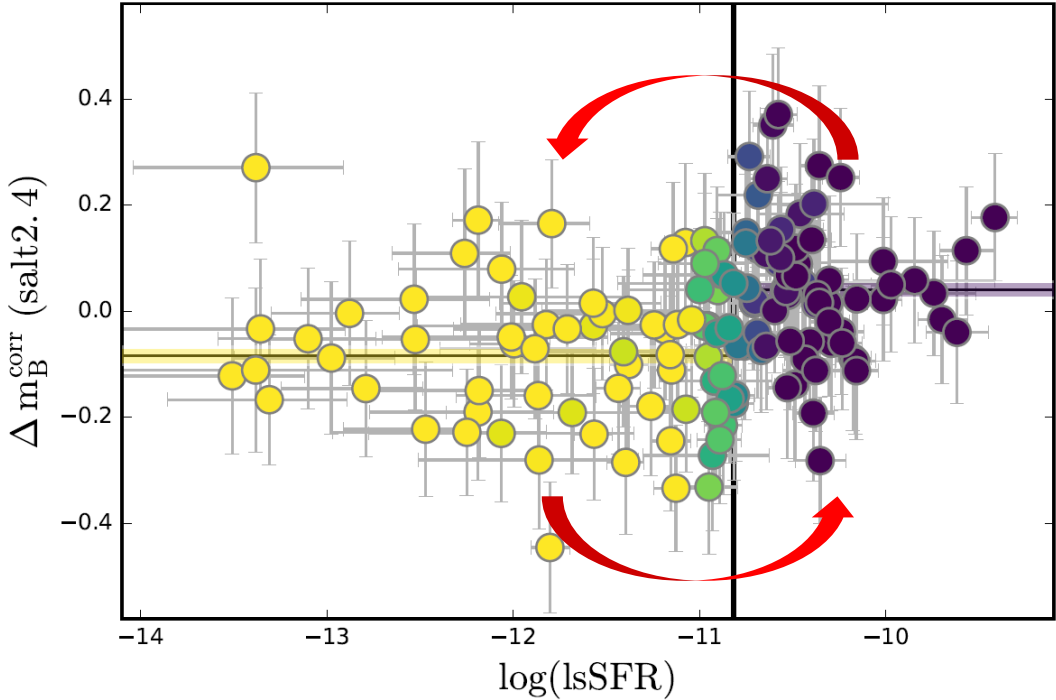
# Age tracer contamination?

► Contamination → 50 %



# Age tracer contamination?

► Contamination → 50 %



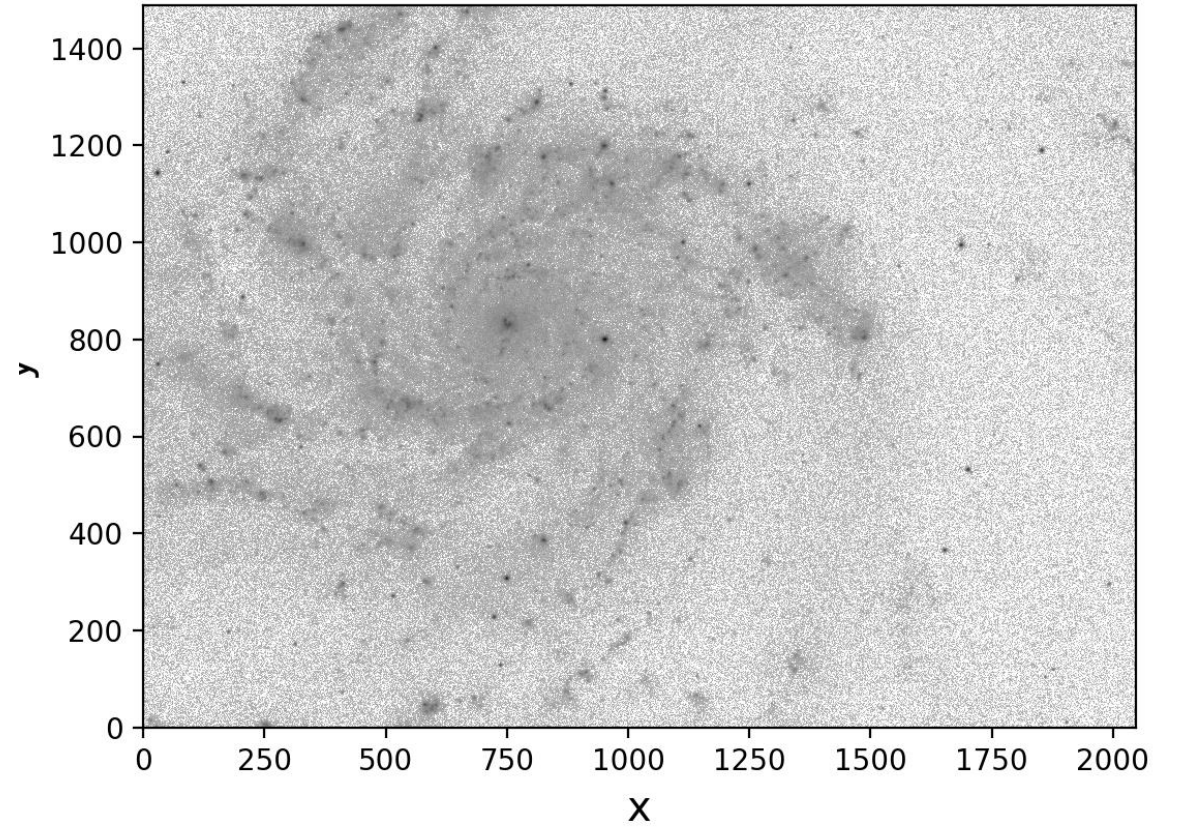
## Age tracers vs LsSFR

- ▶ SNeIa environment color :



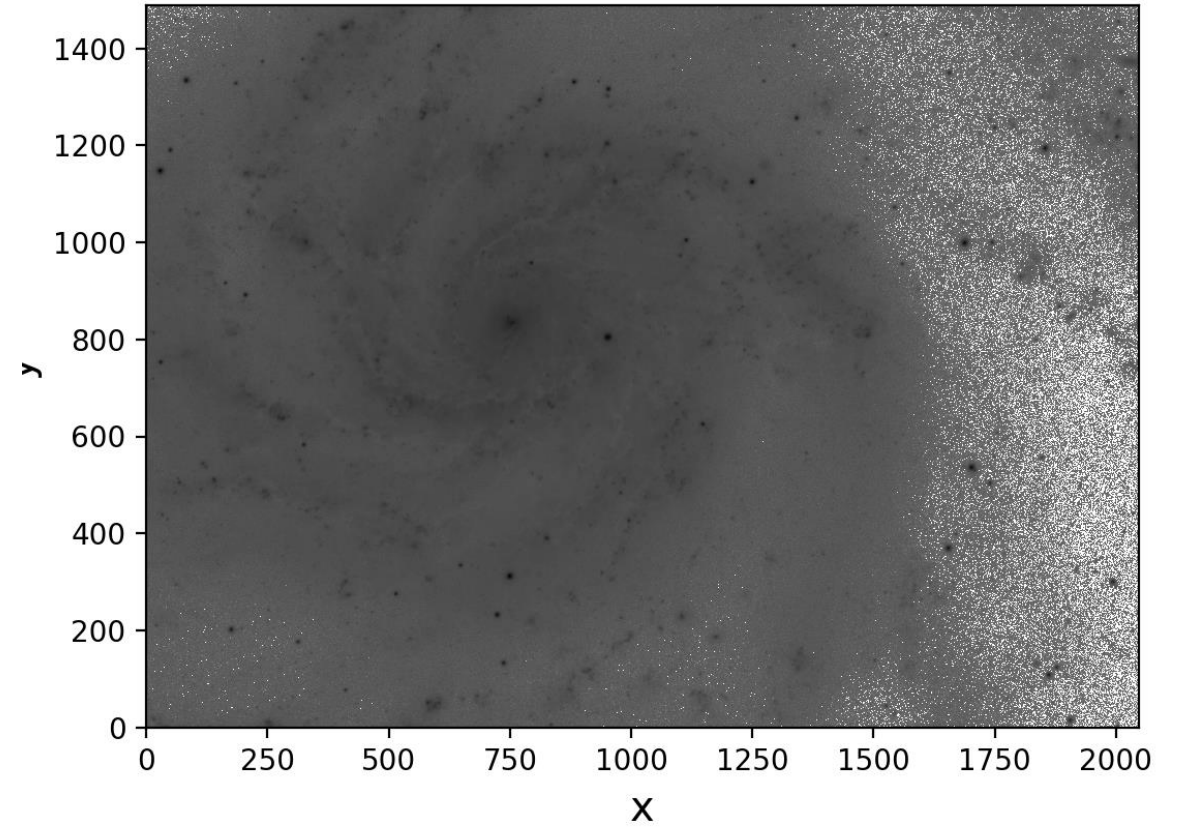
# Age tracers vs LsSFR

- ▶ SNeIa environment color :



# Age tracers vs LsSFR

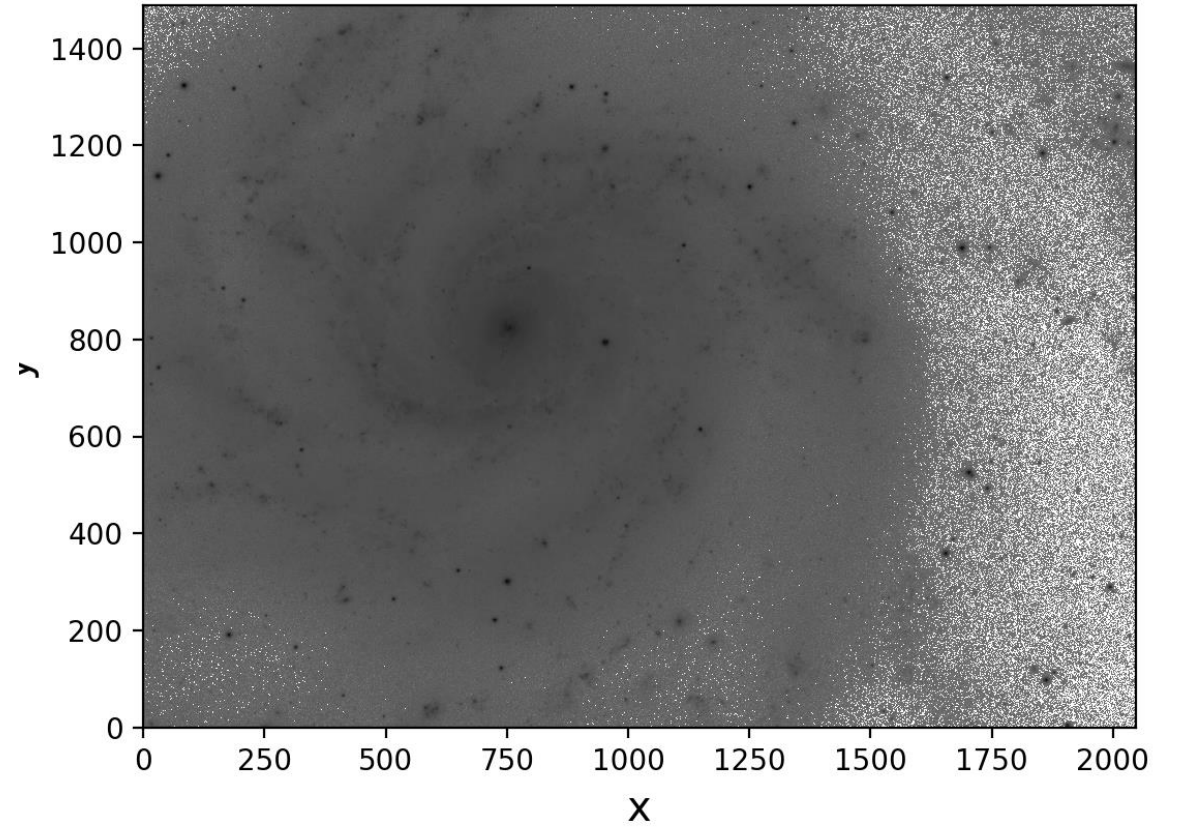
- ▶ SNeIa environment color :





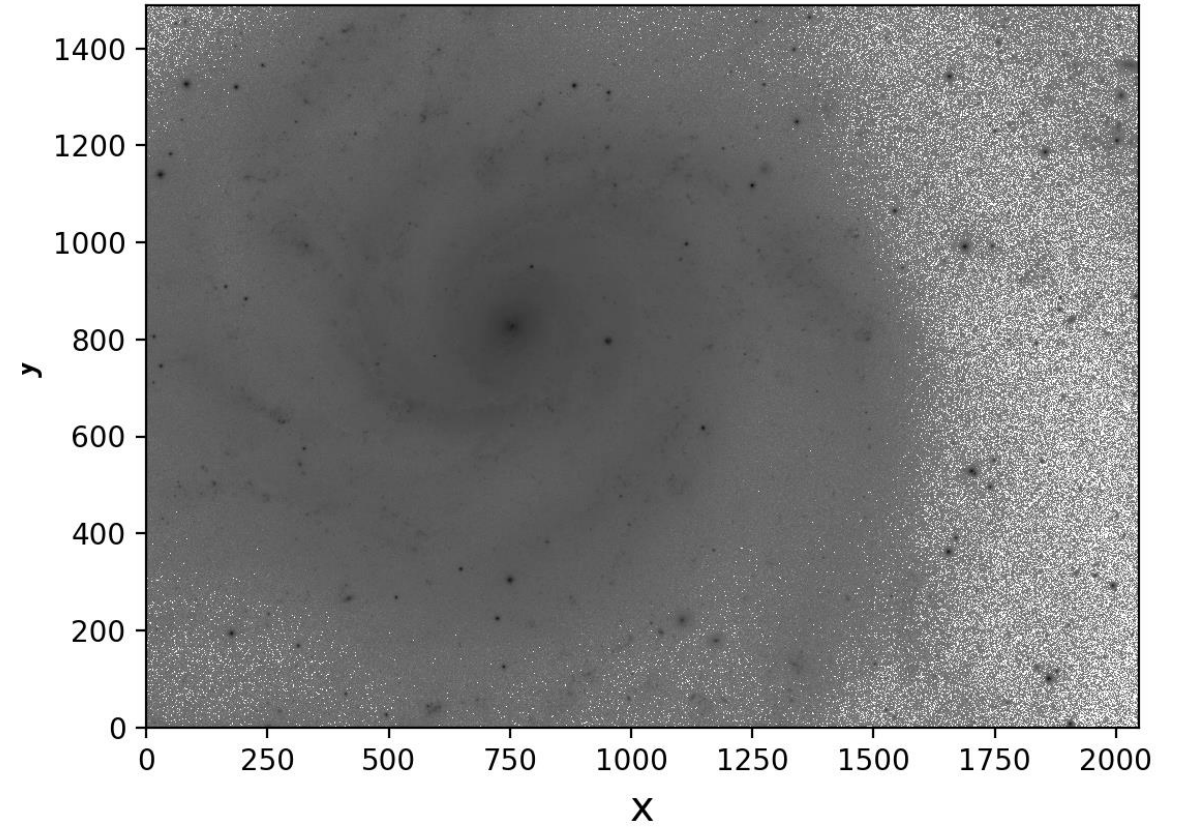
# Age tracers vs LsSFR

- ▶ SNeIa environment color :



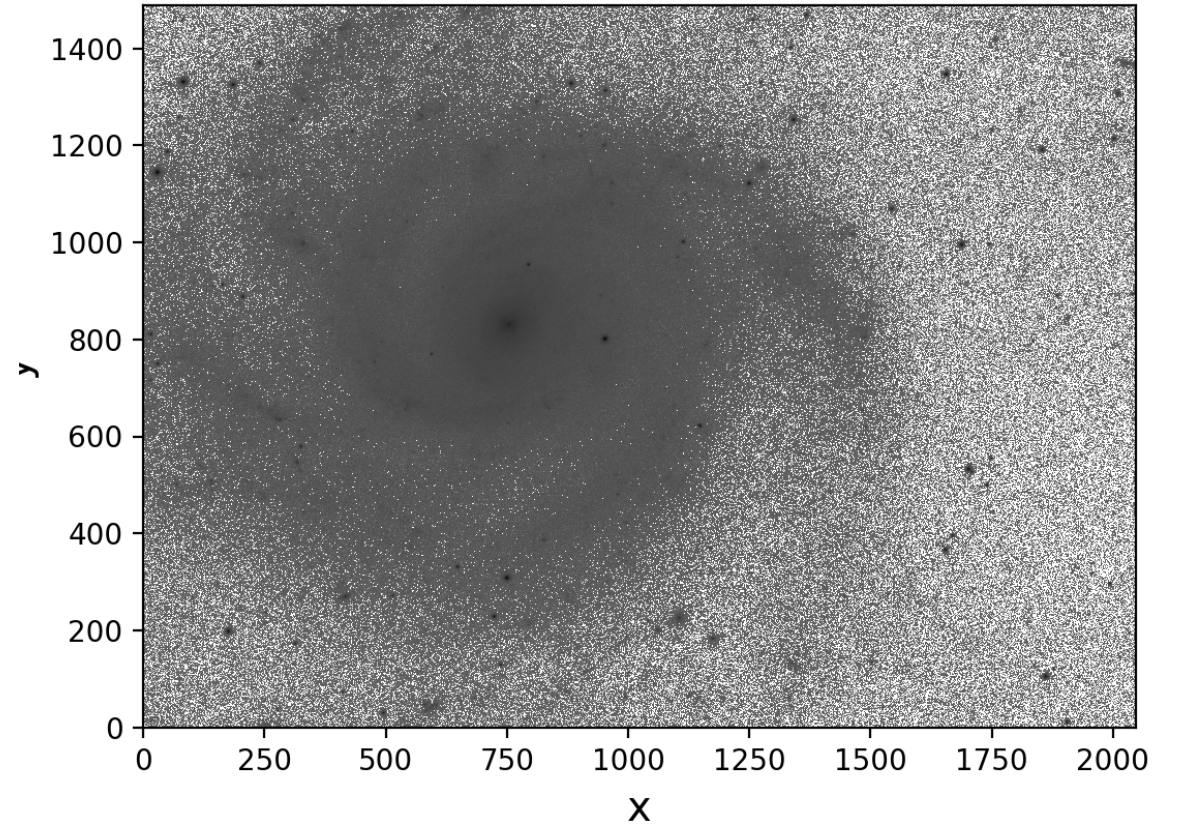
# Age tracers vs LsSFR

- ▶ SNeIa environment color :



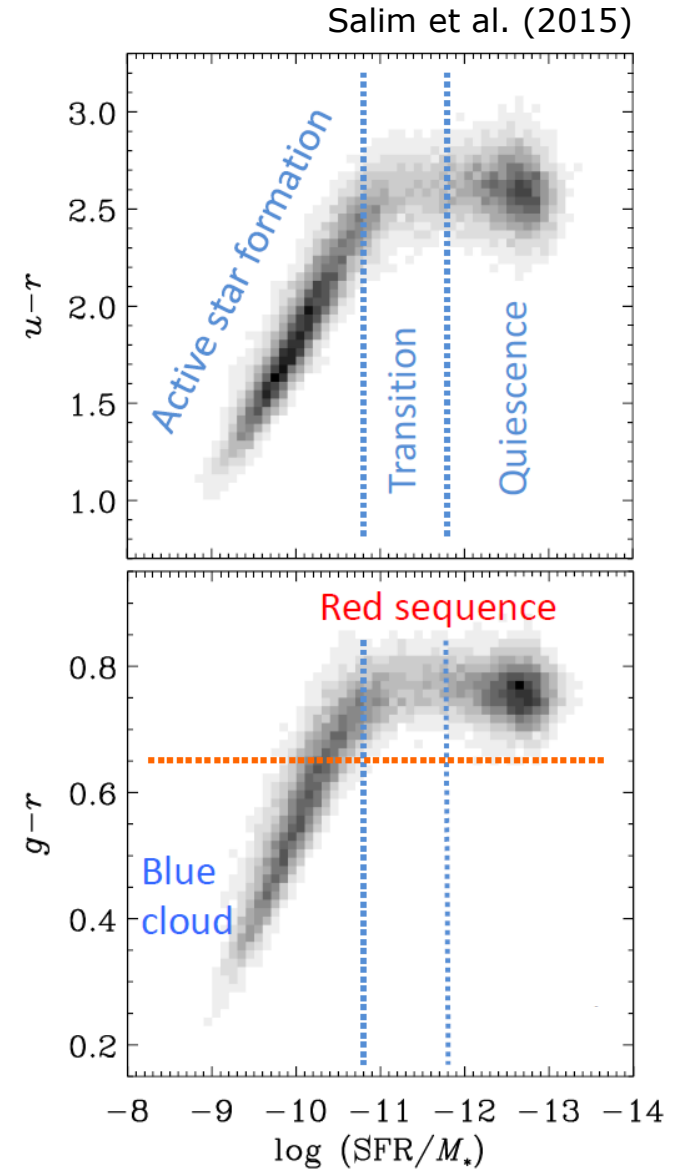
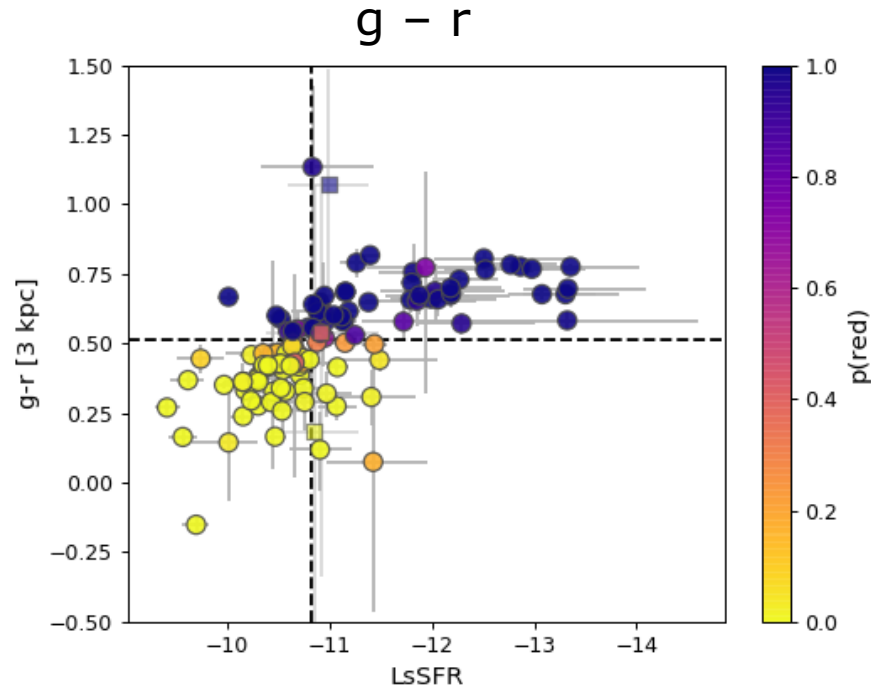
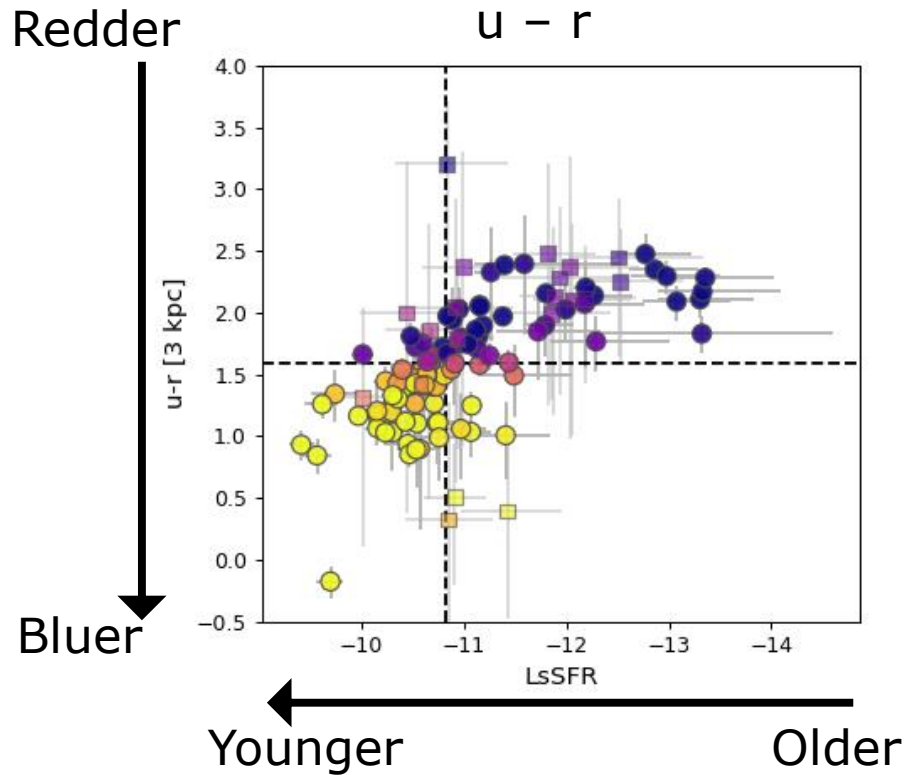
# Age tracers vs LsSFR

- ▶ SNeIa environment color :



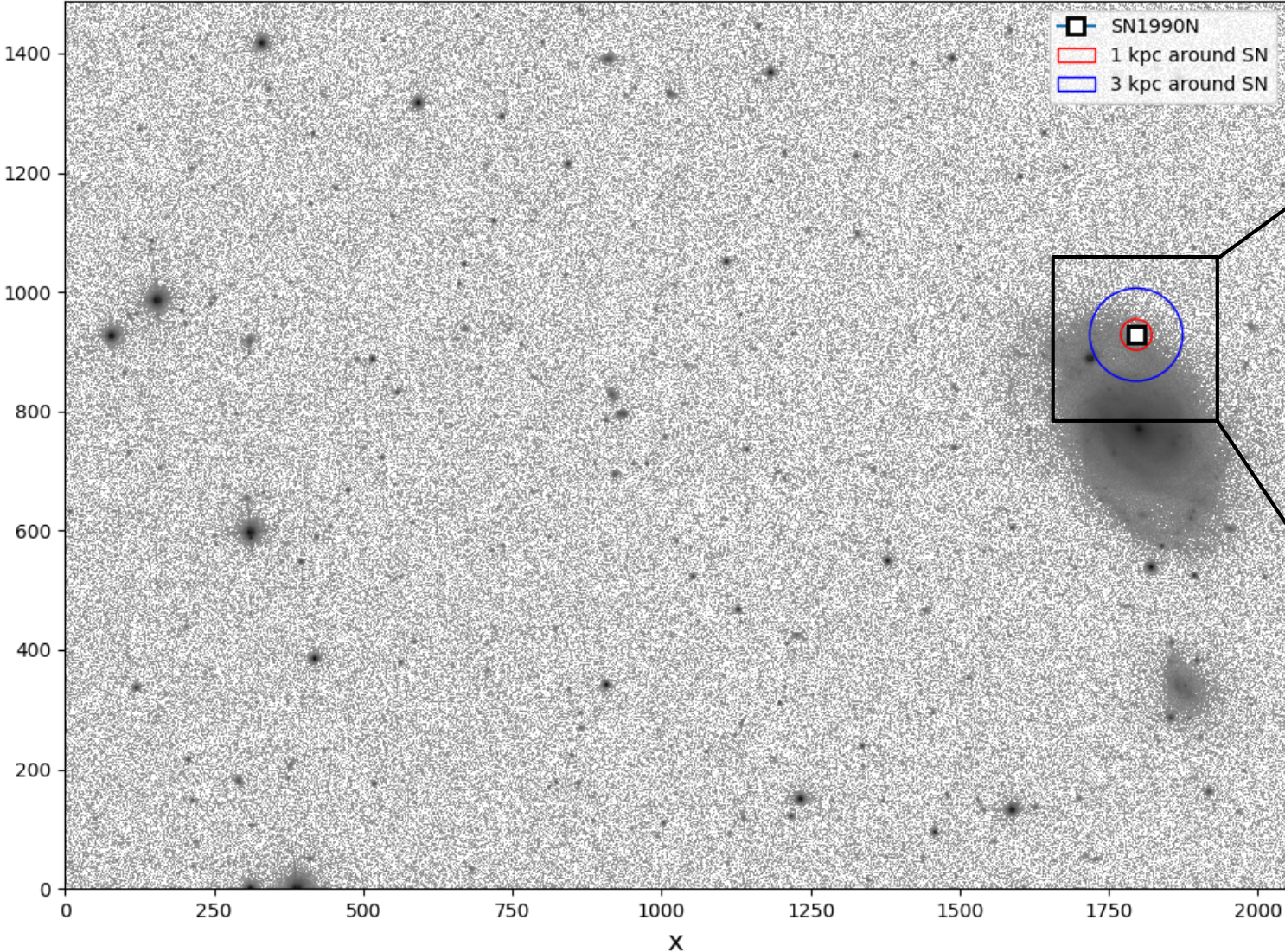
# Age tracers vs LsSFR

- ▶ Two color measurements of the SNela environment:

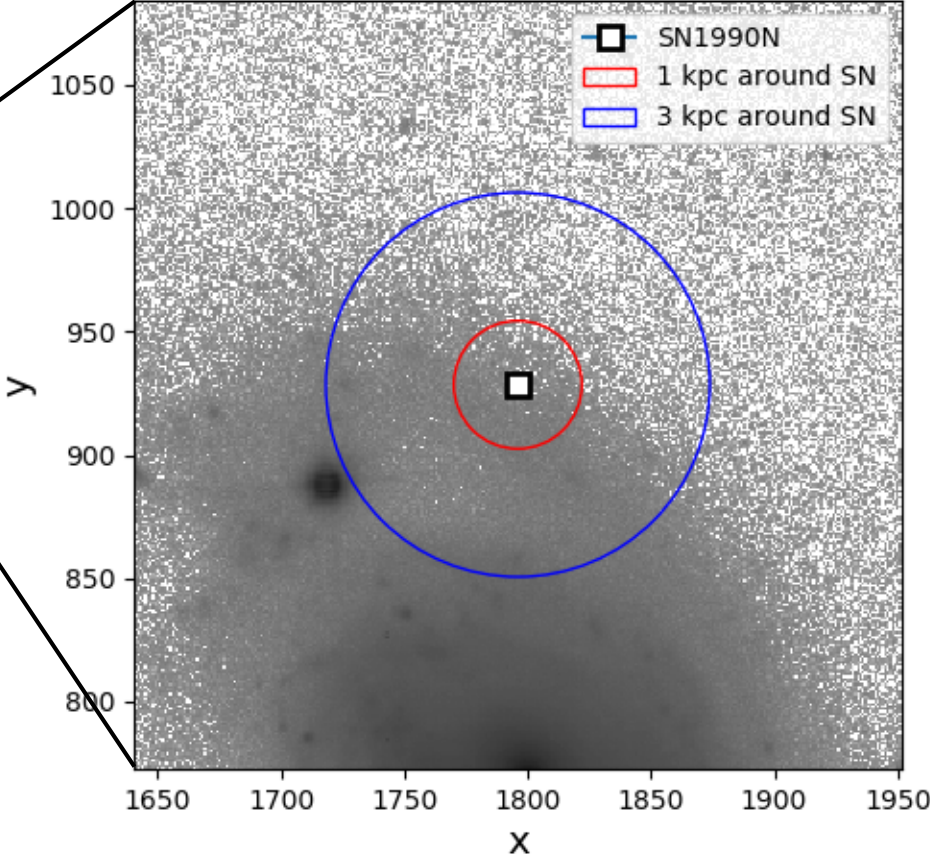


# Age tracers vs LsSFR

SN1990N,  $z = 0.0046$ , r-band



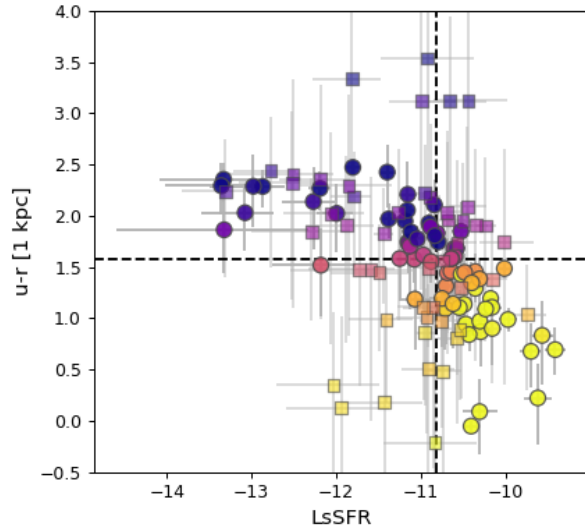
Zoom on SN1990N,  $z = 0.0046$ , r-band



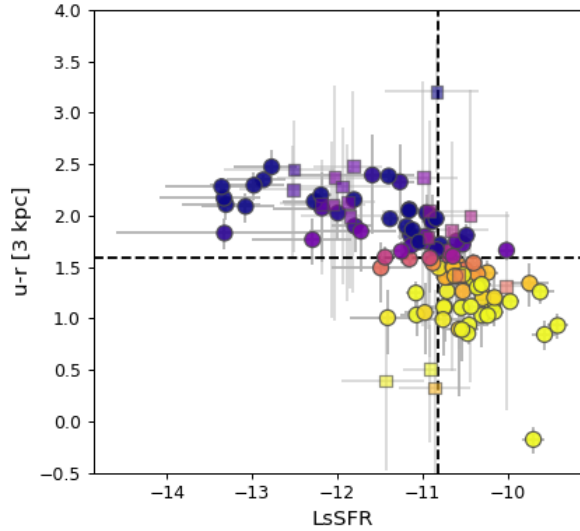
# Age tracers vs LsSFR

- ▶ Three radii to study the SNeIa environment color:

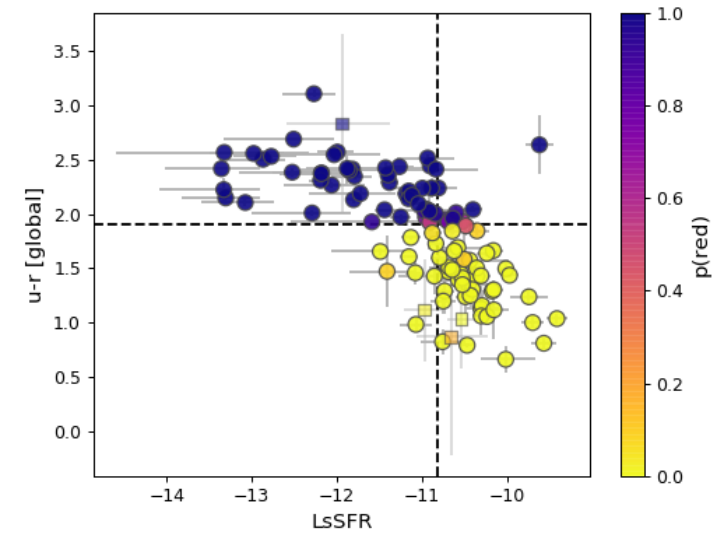
R = 1 kpc



R = 3 kpc

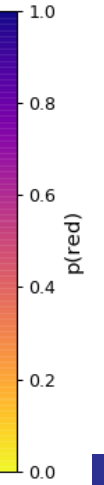
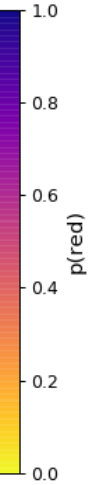
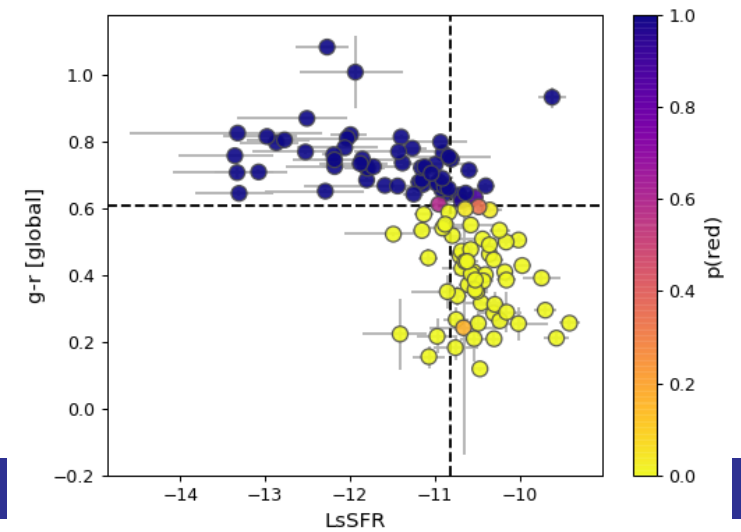
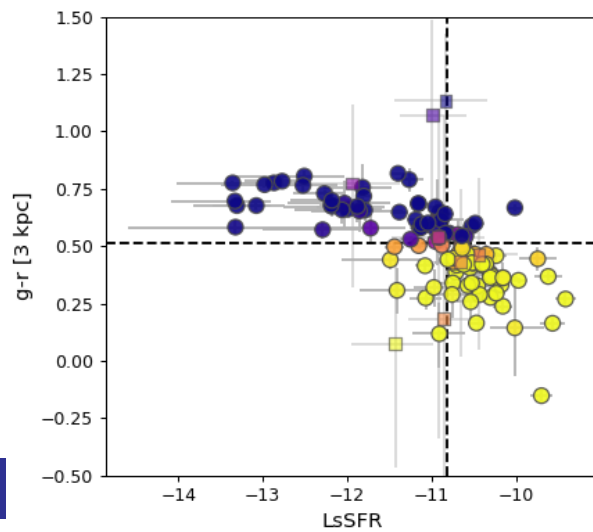
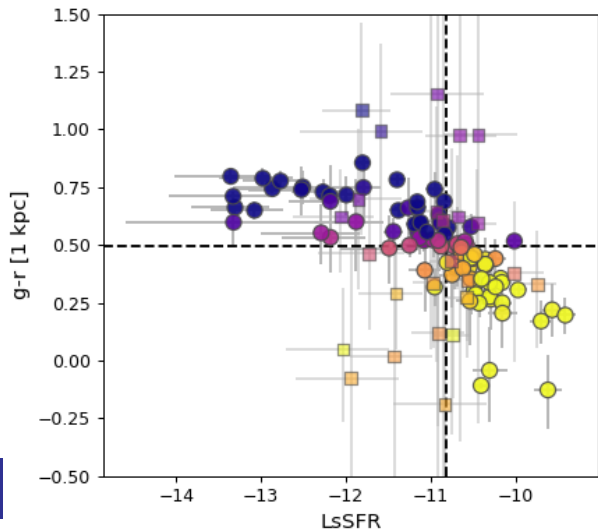


R = global



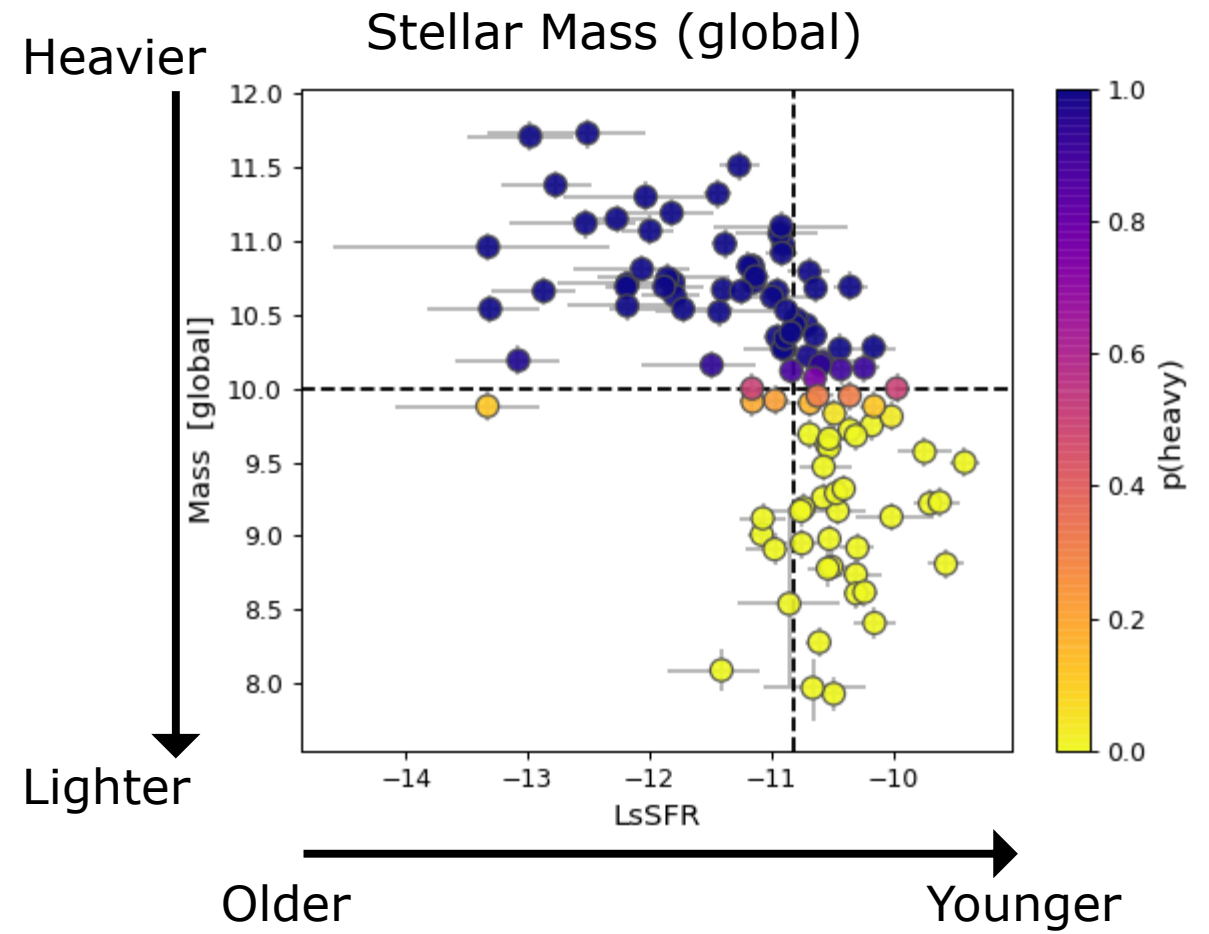
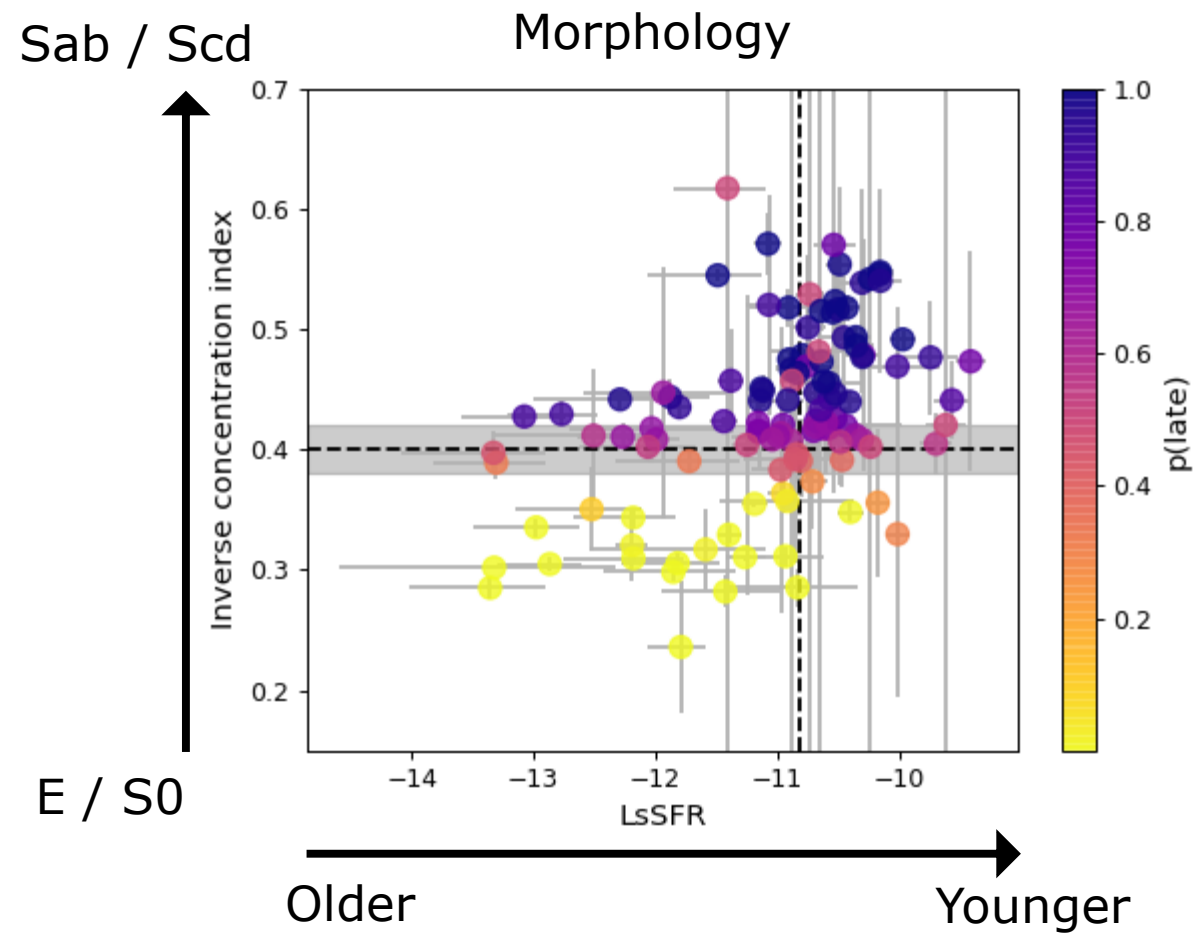
$u - r$

$g - r$



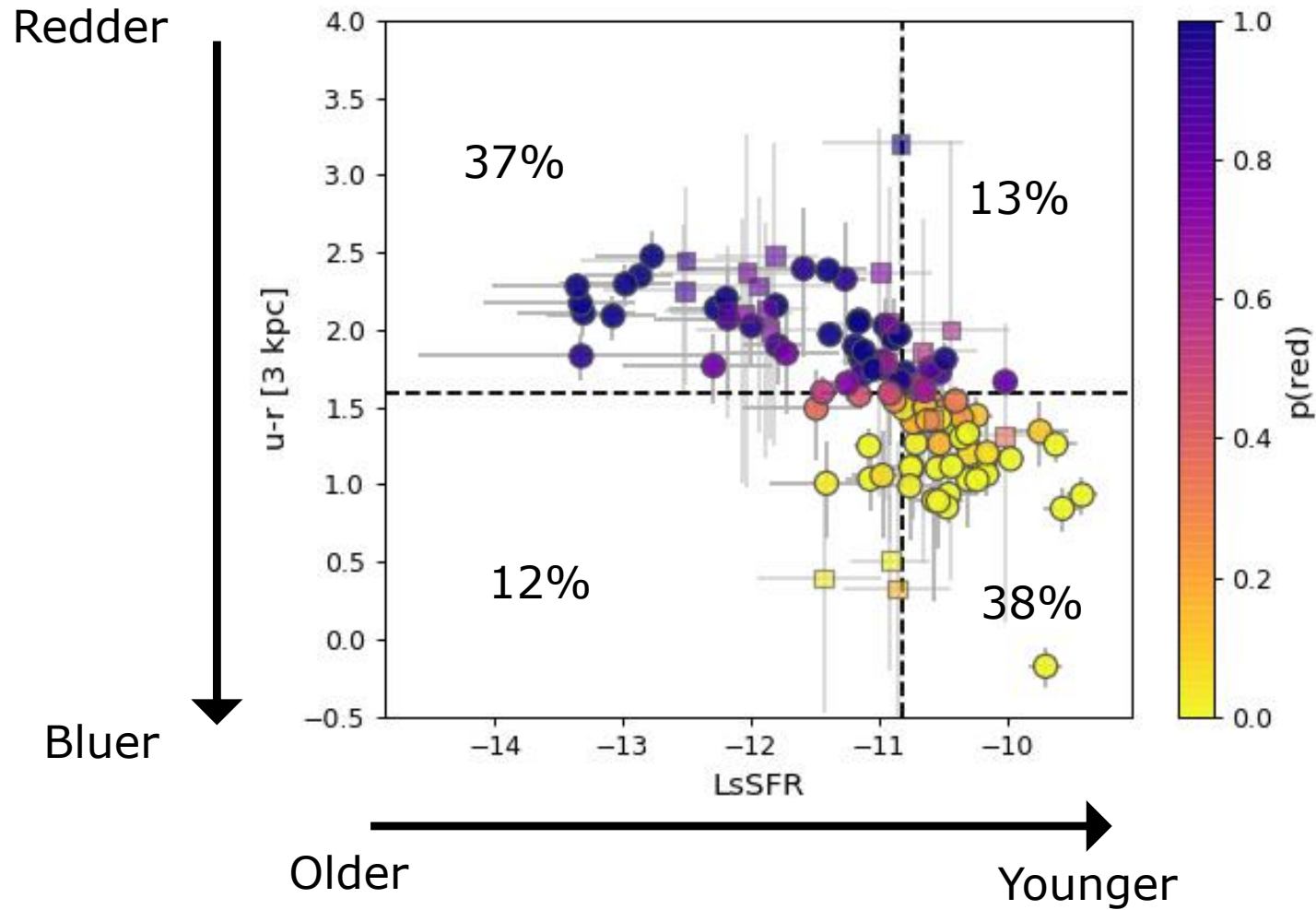
# Age tracers vs LsSFR

## ► Morphology & Stellar Mass:



# Age tracer contamination from the LsSFR

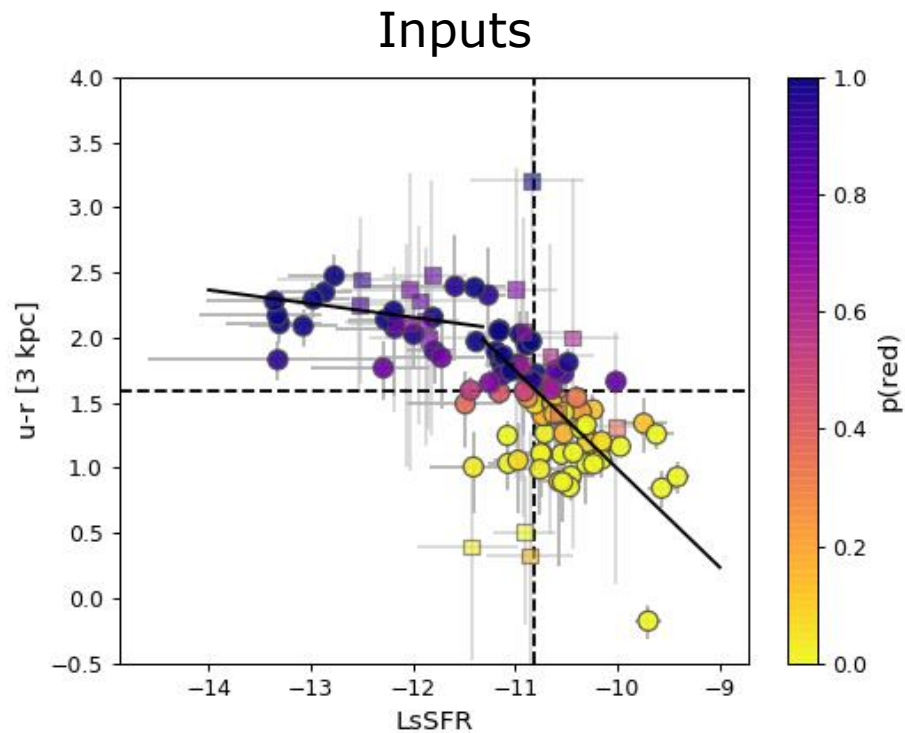
- ▶ Contamination = off-diagonal fractions





# Monte Carlo simulation

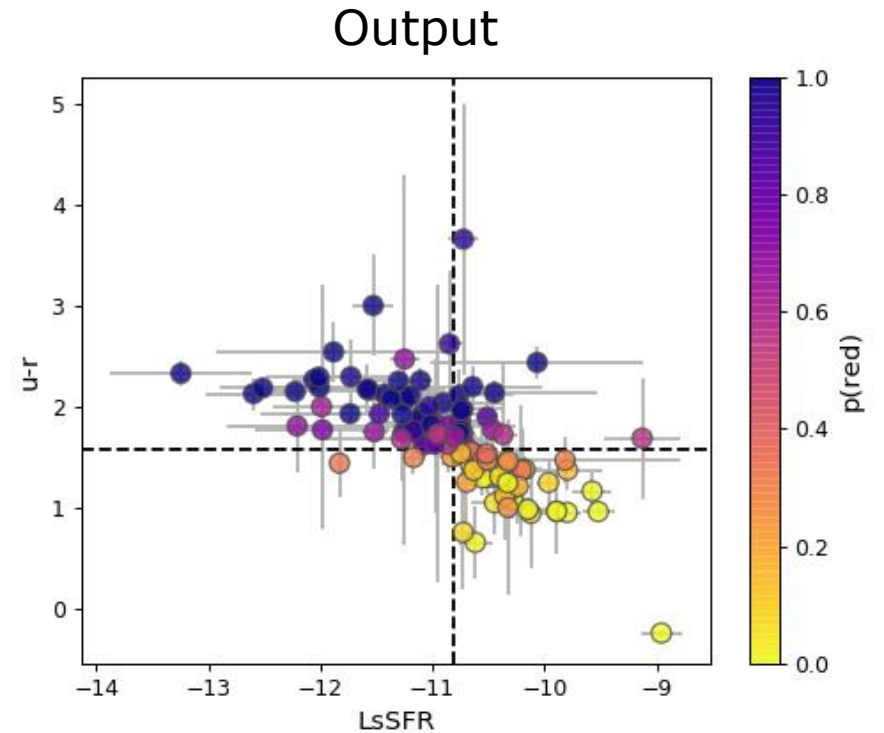
- ▶ Simulated data generated step by step:
  - ▶ 0- Perfect age tracer + Hubble residuals
  - ▶ 1- LsSFR (fct. of perfect age tracer)
  - ▶ 2- Other age tracers (fct. of LsSFR)
  - ▶ 3- Measurements errors



MC  
Simulation

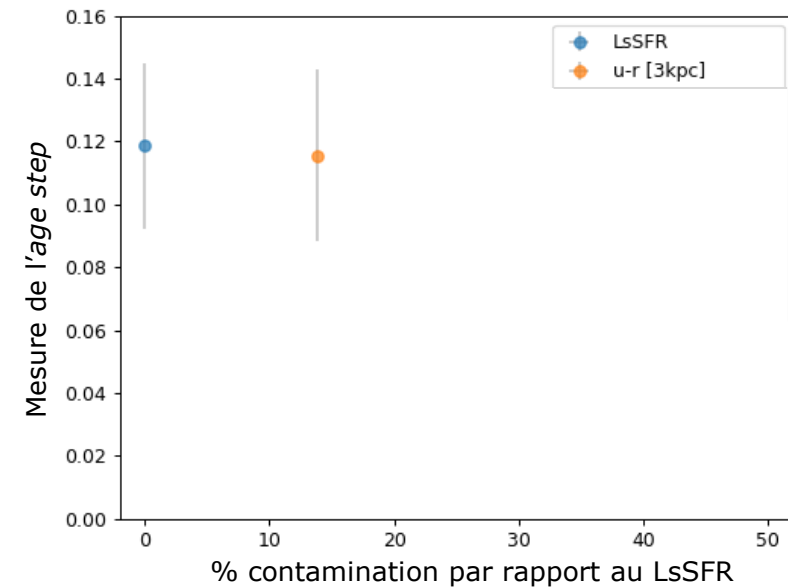
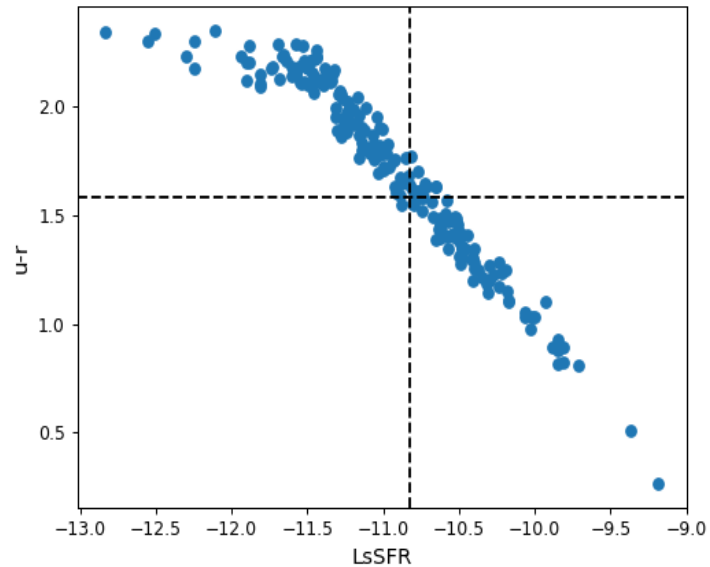
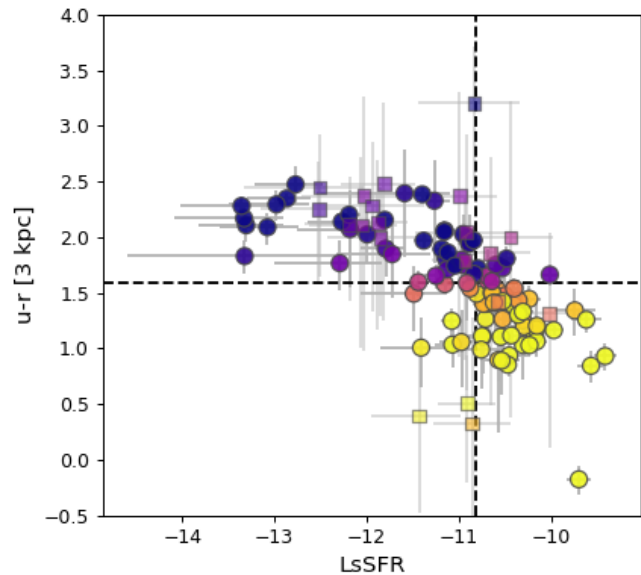


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# Age step vs Contamination

- ▶ Contamination = off-diagonal fractions
- ▶ MC simulation  $\rightarrow$  intrinsic dispersion estimation
- ▶ Example :  $u - r$  [3 kpc]

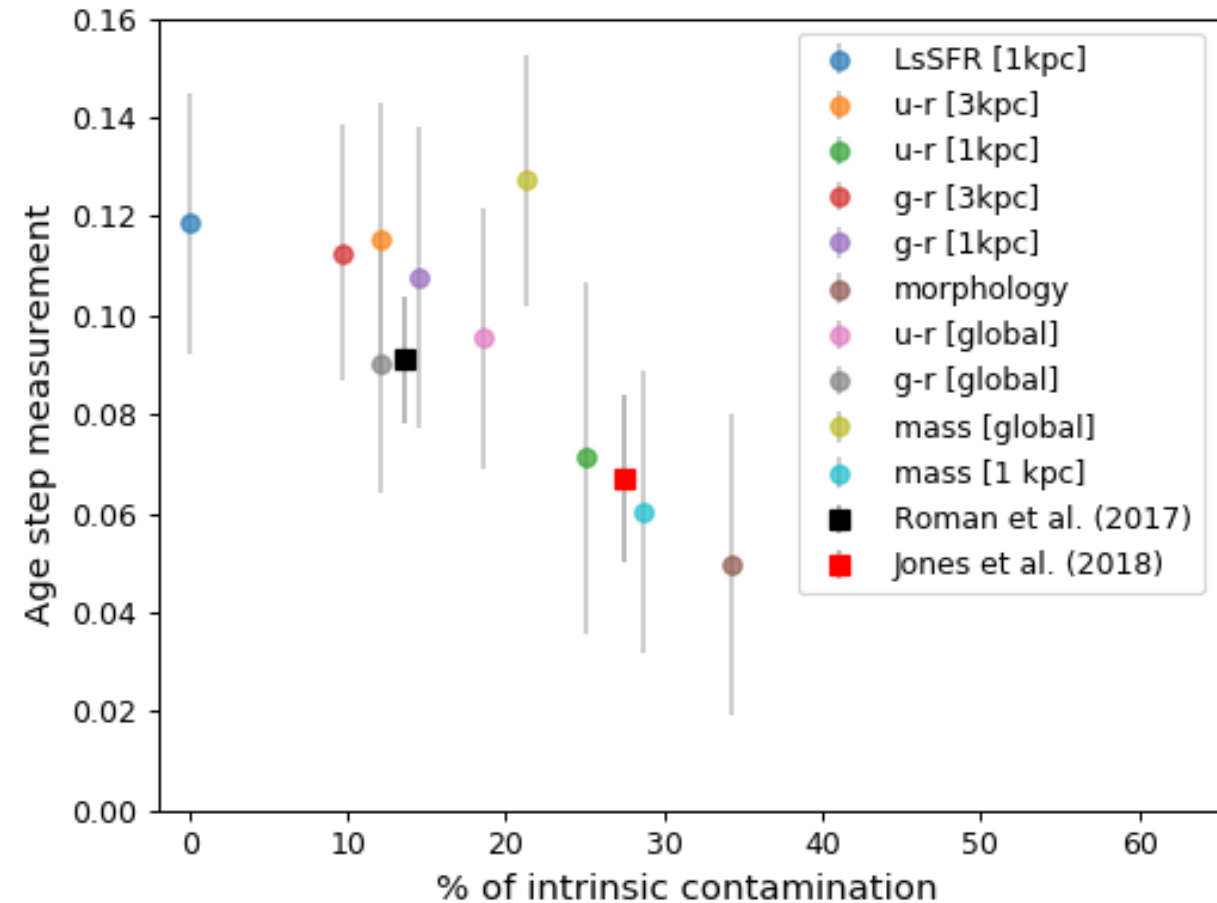


# Age tracer influence on age step measurement

- ▶ Sample = 108 SNeIa from SNf catalog,  
 $0.03 < z < 0.08$

- ▶ Briday et al. (in prep.) :
  - ▶ Contamination errors estimation
  - ▶ To add other tracers (FUV-r, NUV-r, etc.)
  - ▶ To fit the “true” age step
  - ▶ Etc.
- ▶ Conclusion : SNeIa are dependent to their environment → intrinsic bias.

Briday et al. (in prep.)



# SNela observation $\leftrightarrow$ Environment ?



# PhD project

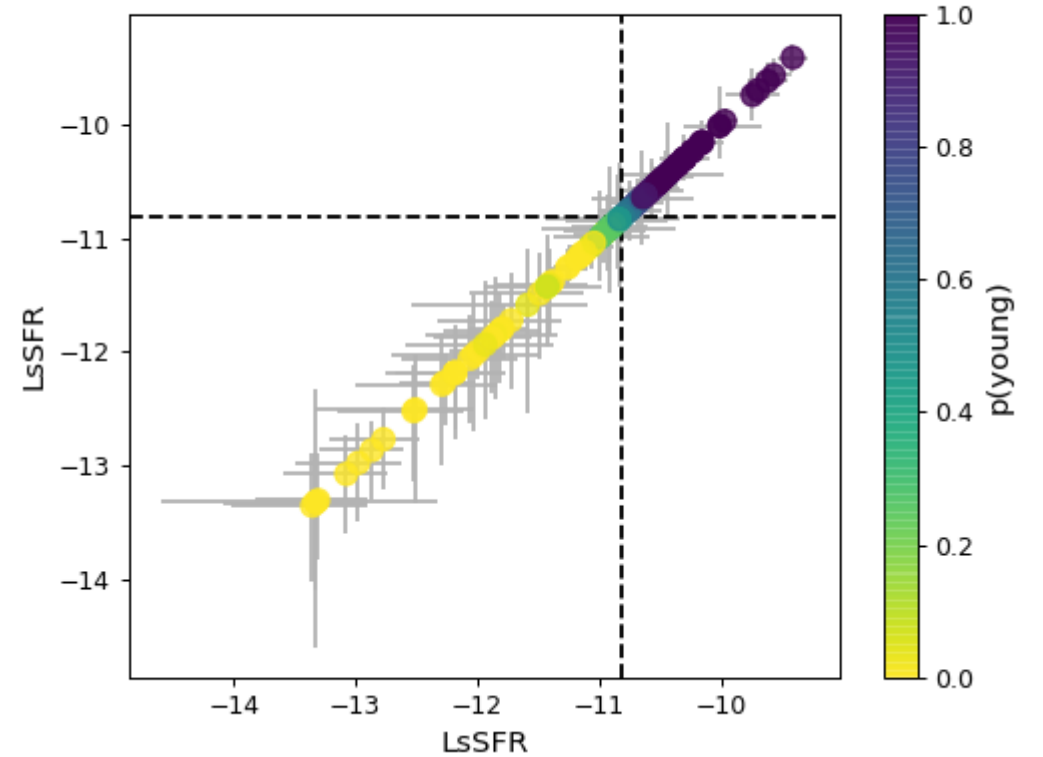
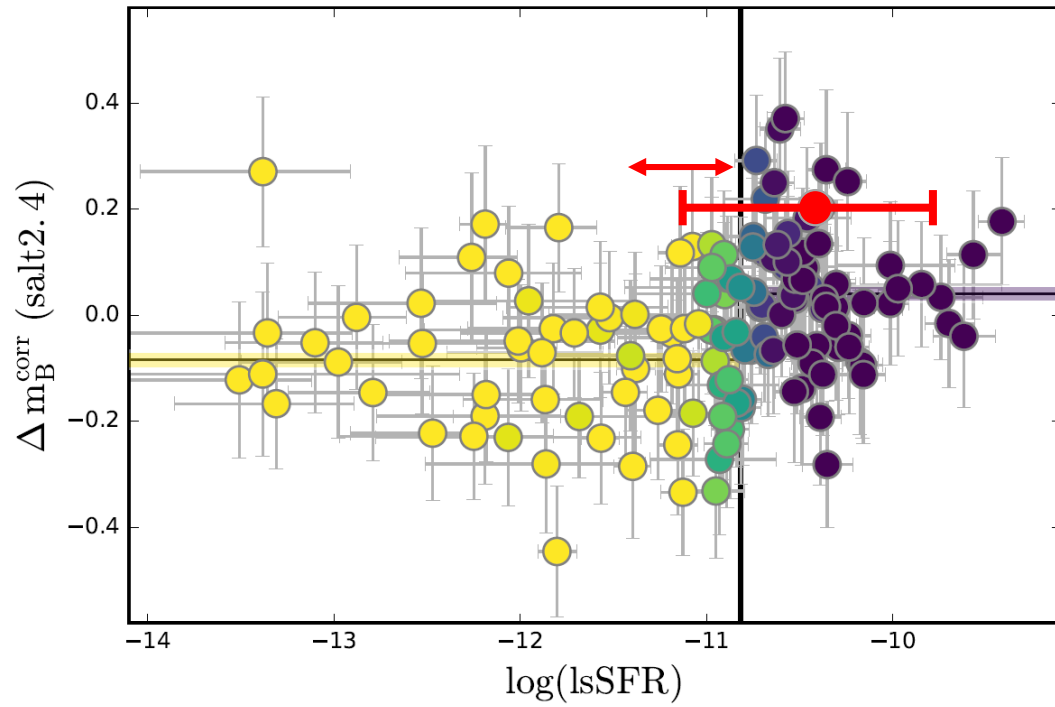
- ▶ ERC Starting Grant, over the direction of M.Rigault
- ▶ Problem : Dust influence on the SNeIa color parameter?
- ▶ 30 years old problem:
  - ▶ No observed correlation.
  - ▶ SNeIa color law doesn't correspond with the dust law from nearby host galaxies
- ▶ Hubble Space Telescope (HST) data :
  - ▶ UV pictures for ~70 galaxies
- ▶ Collaboration Zwicky Transient Facility (ZTF) :
  - ▶ ~200 SNeIa → ~3000 SNeIa



# Back-up

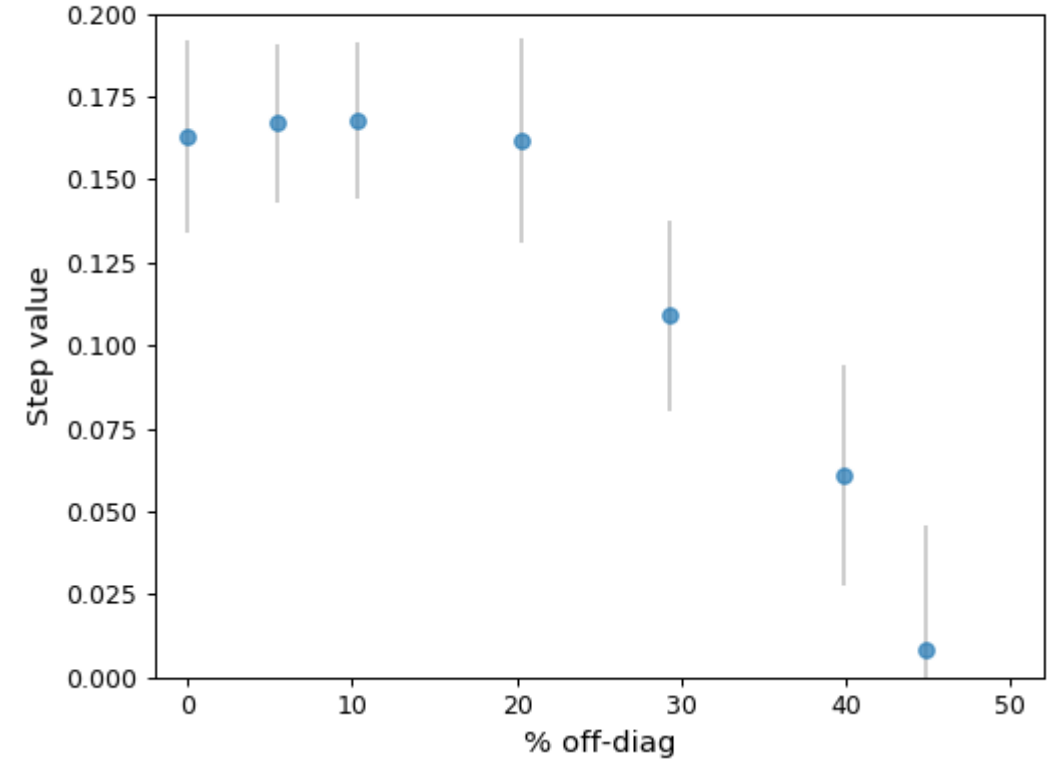
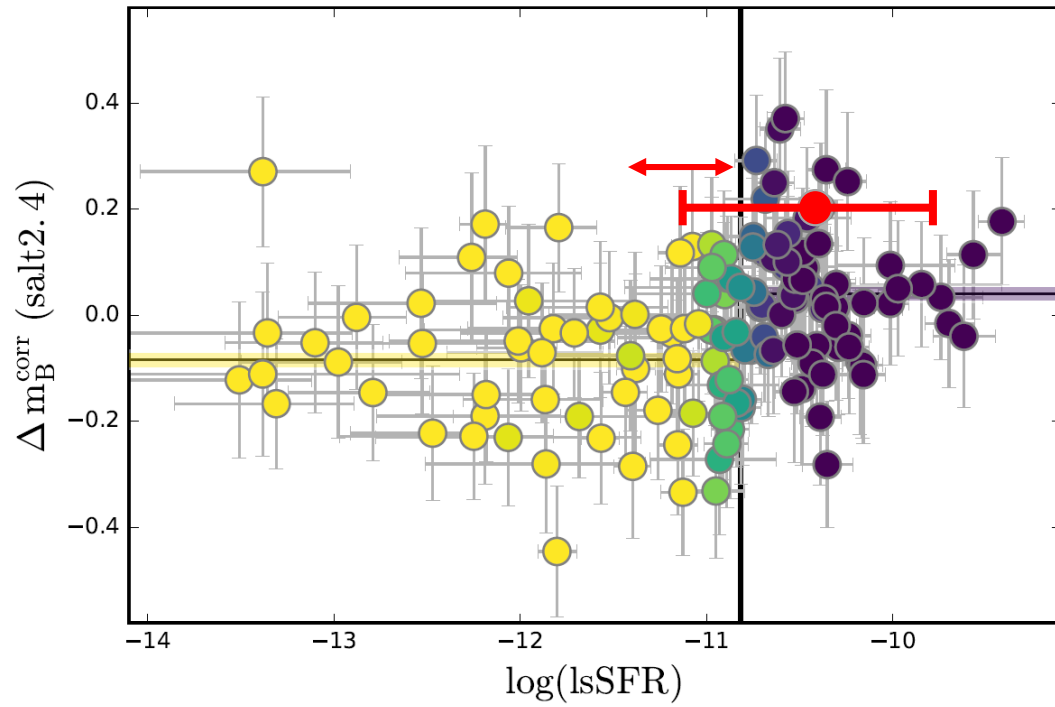
# Contamination du traceur d'âge?

- Fractions hors-diagonales dues aux erreurs de mesures



# Contamination du traceur d'âge?

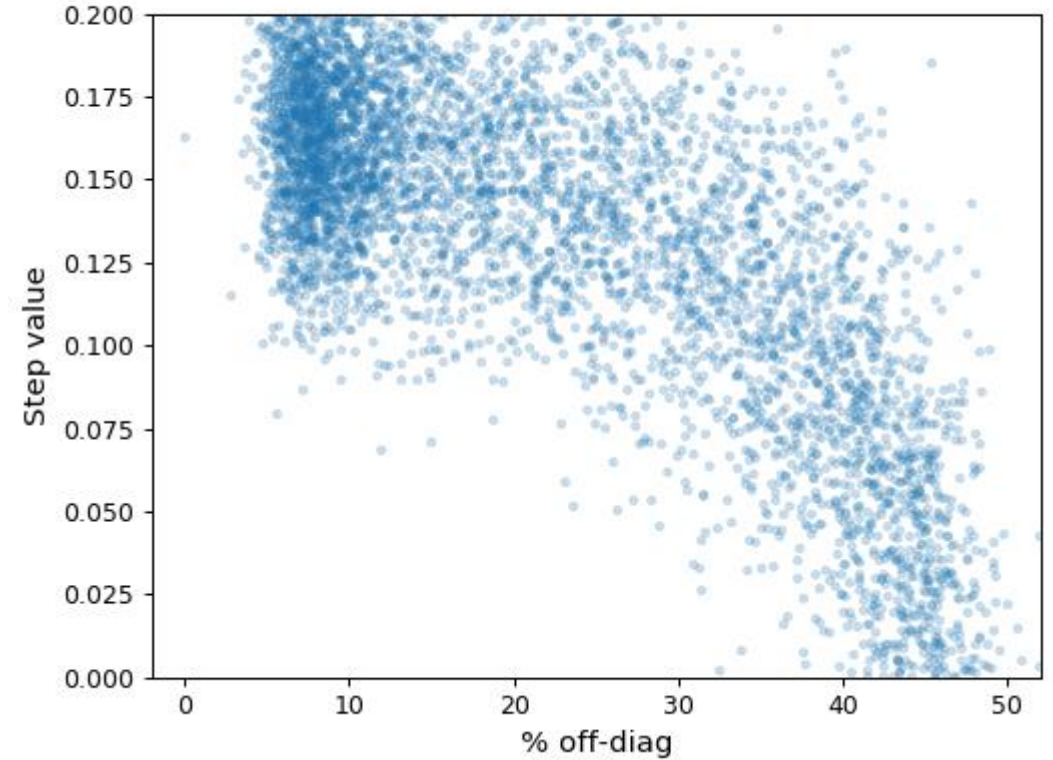
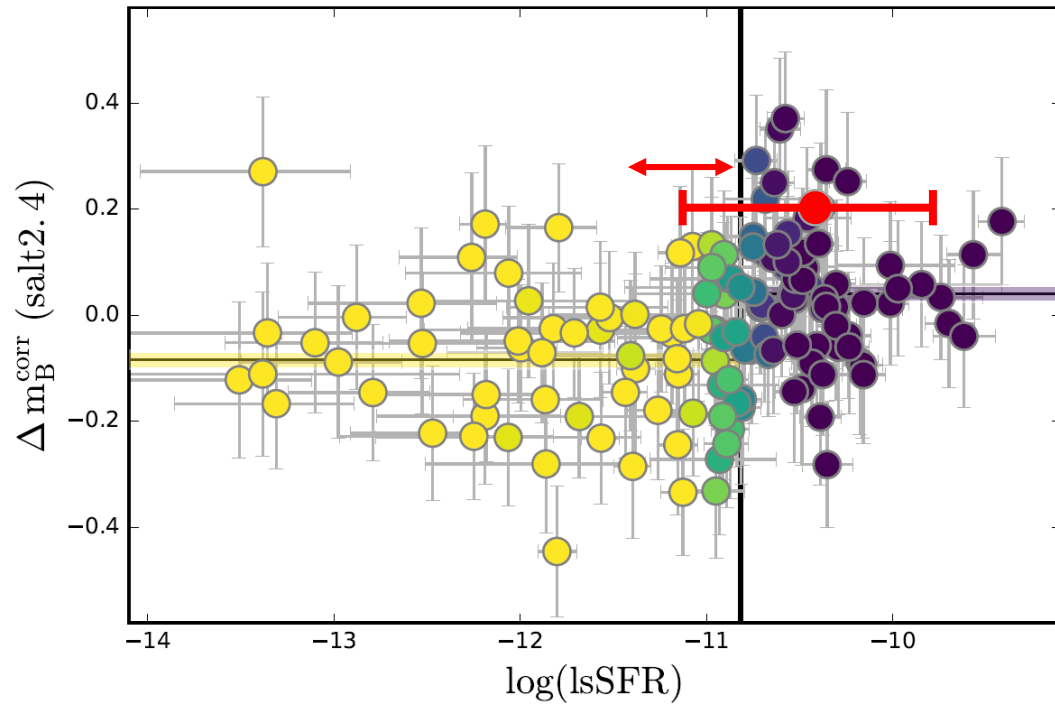
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# Contamination du traceur d'âge?

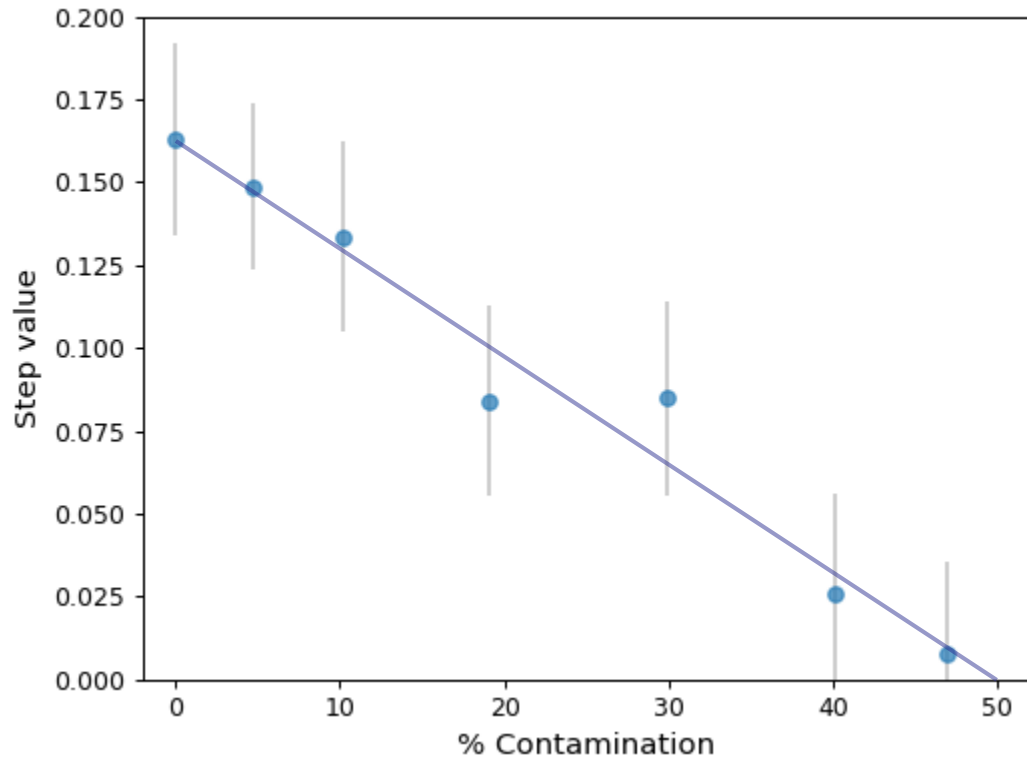
- Fractions hors-diagonales dues aux erreurs de mesures



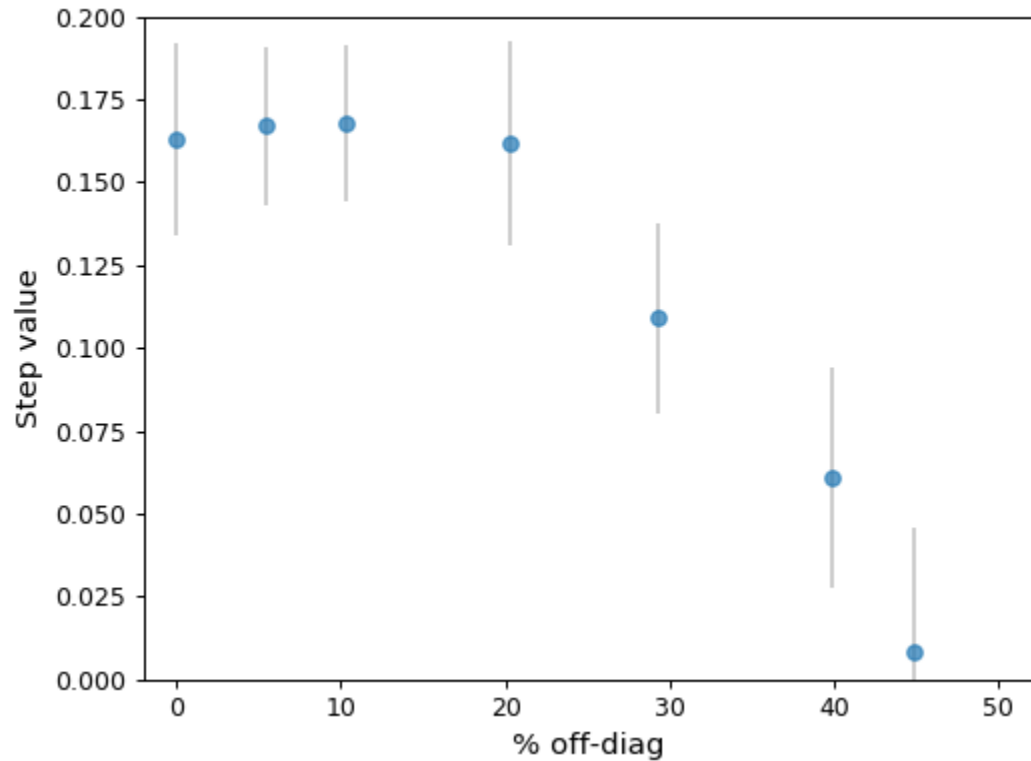
# Contamination du traceur d'âge?

- ▶ Biais sur la mesure de la contamination.
  - ▶ Part de contamination due aux erreurs de mesures?

Contamination intrinsèque



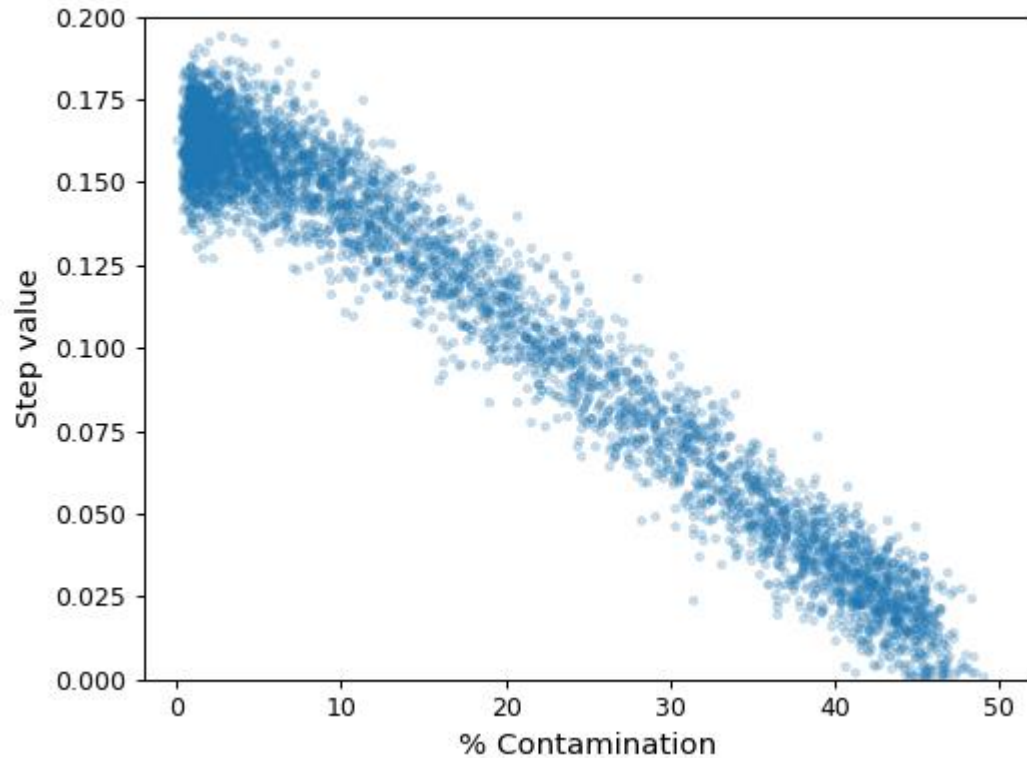
Fraction hors-diagonales avec erreurs de mesure



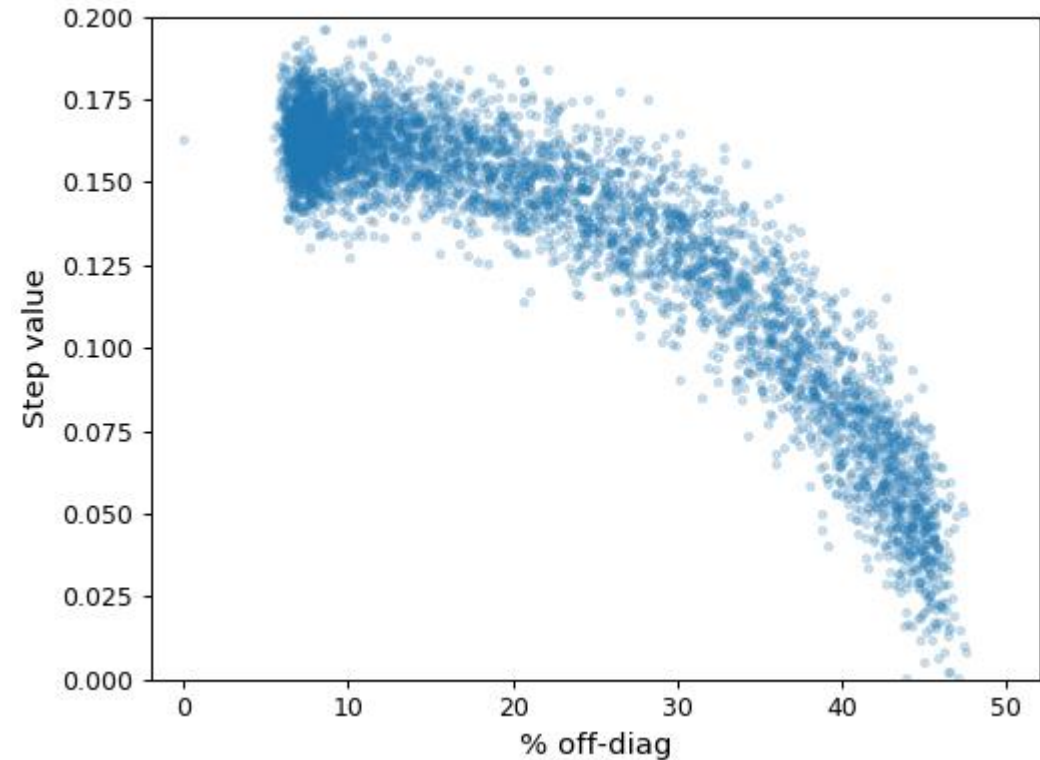
# Back-up

- Simulation MC → augmentation du nombre de SNeIa

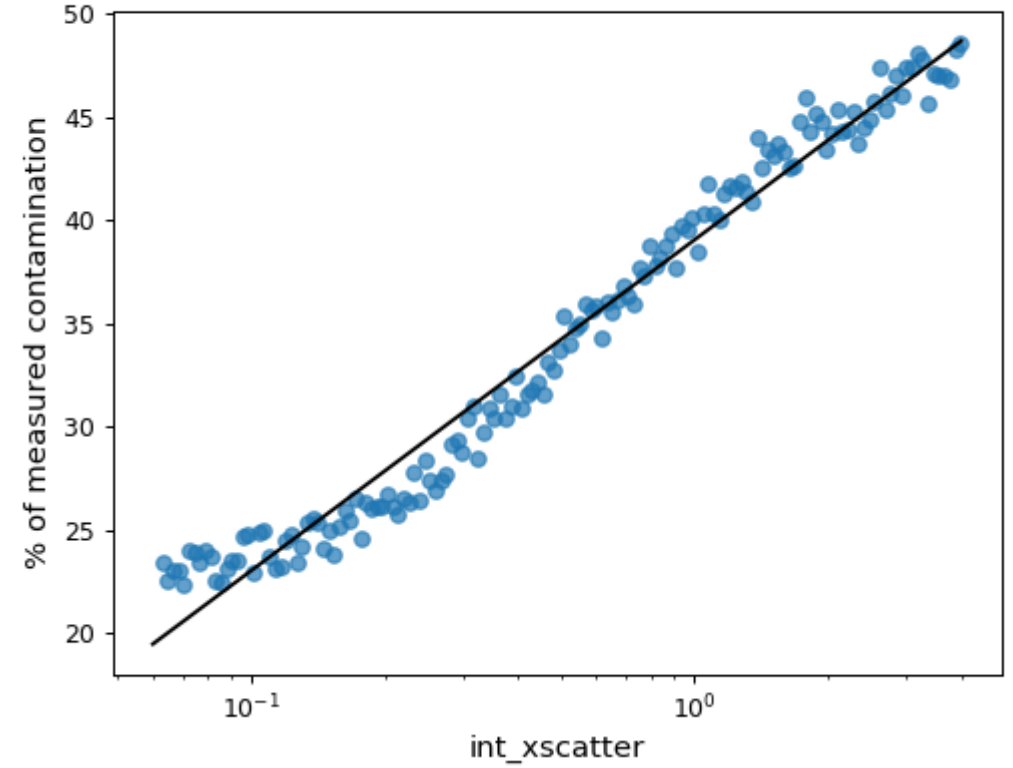
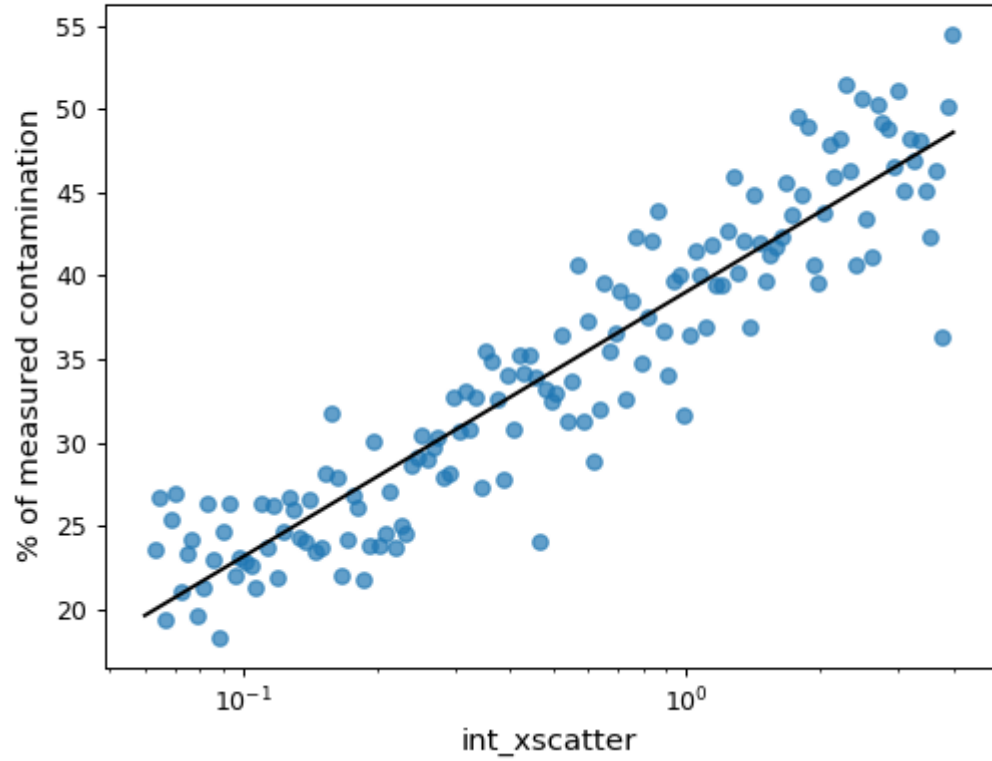
Contamination intrinsèque



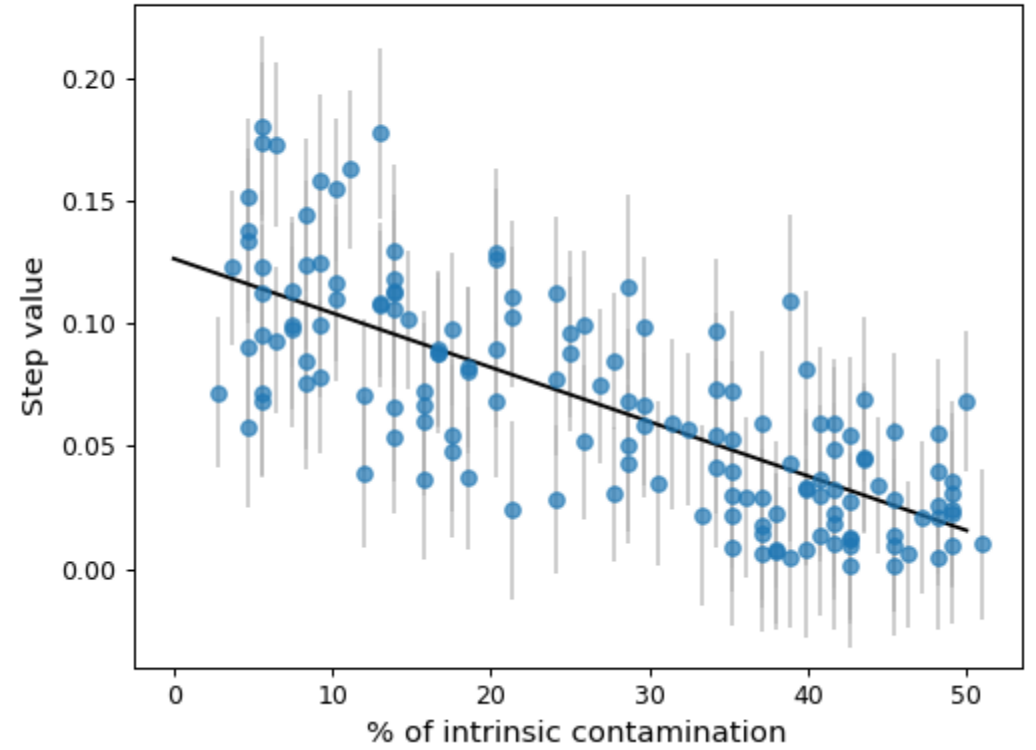
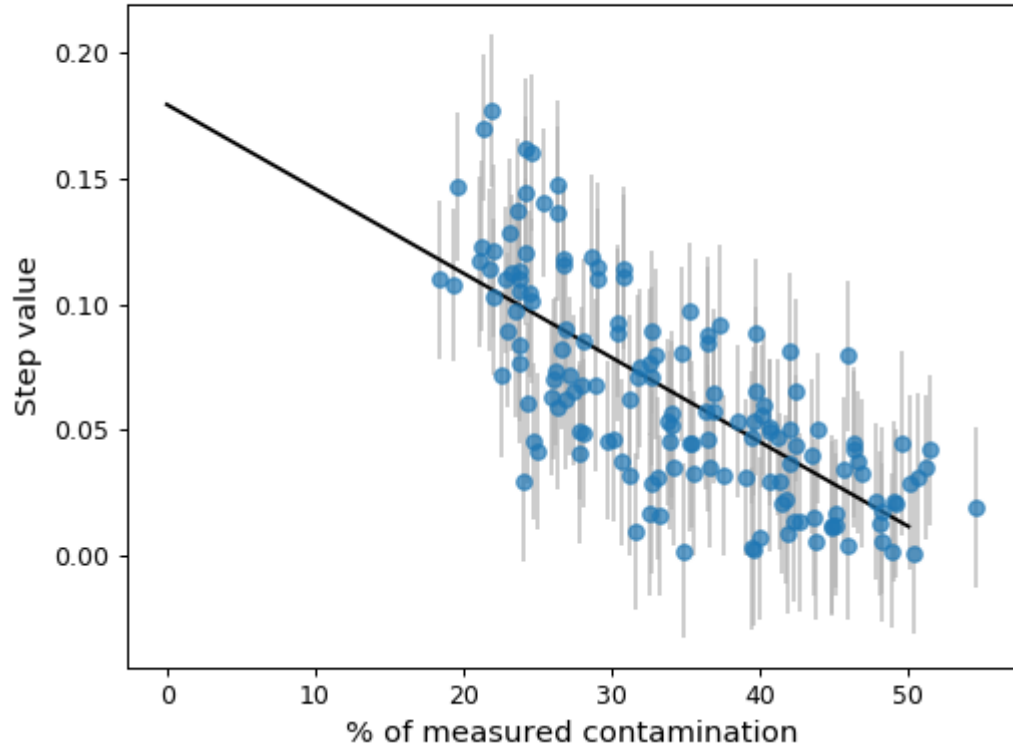
Fraction hors-diagonales avec erreurs de mesure



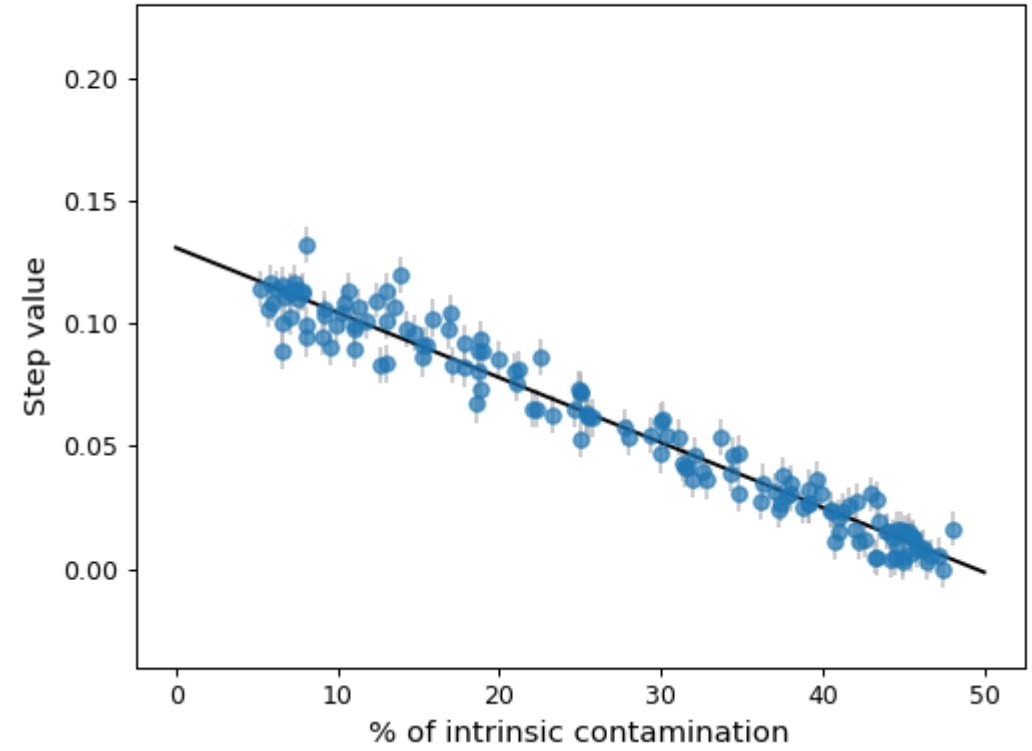
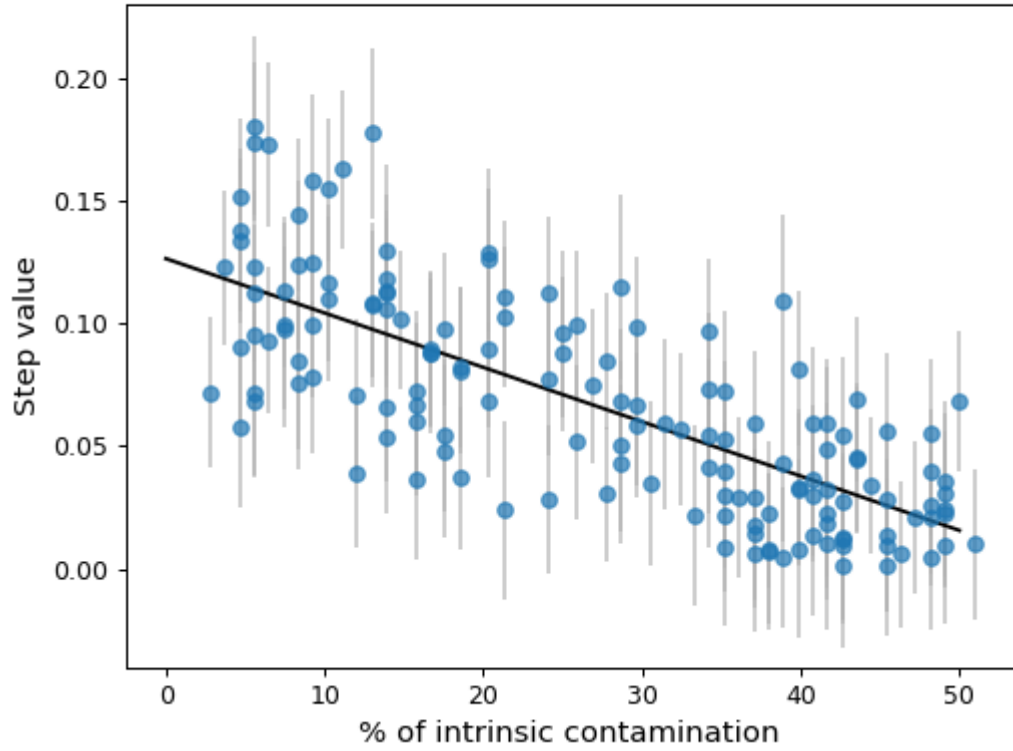
# Back-up



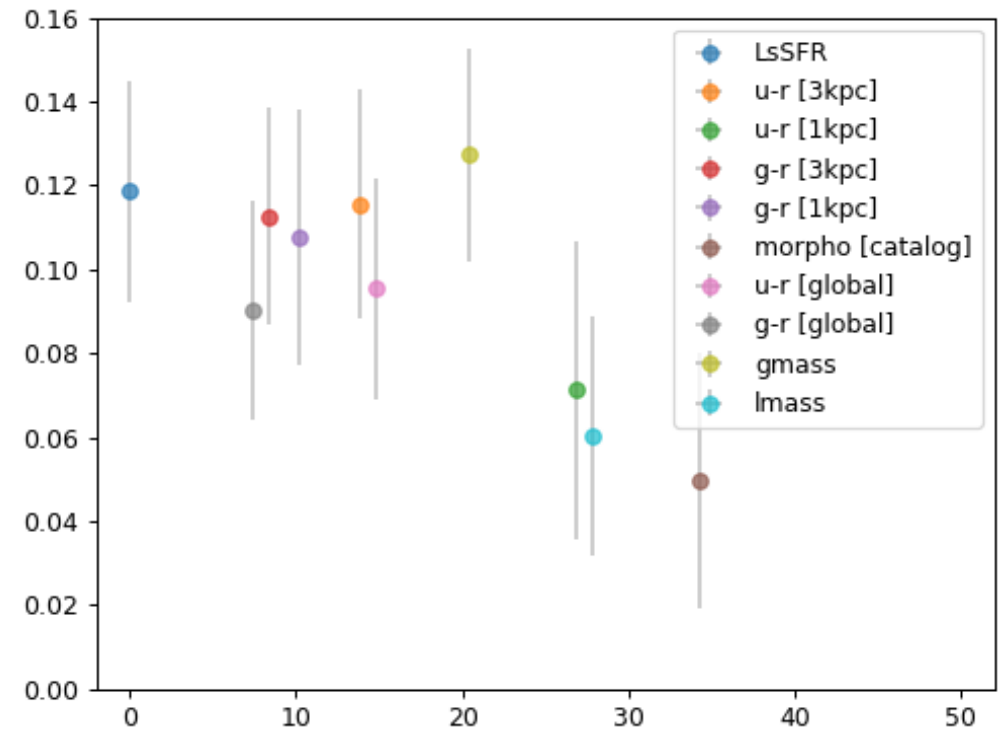
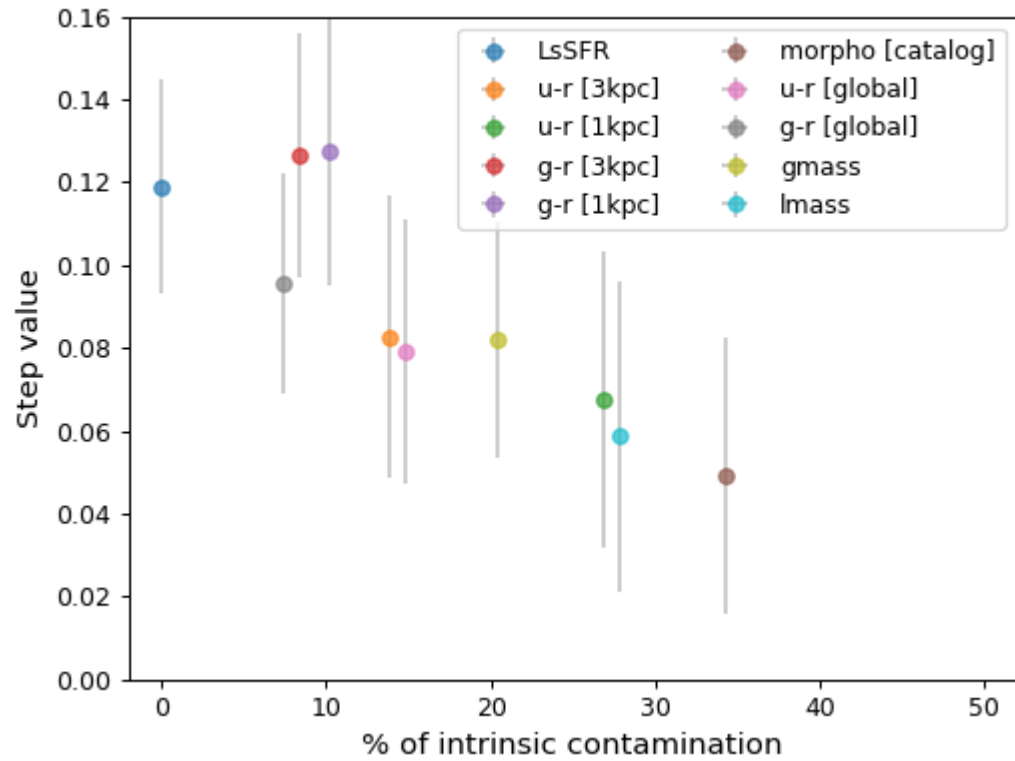
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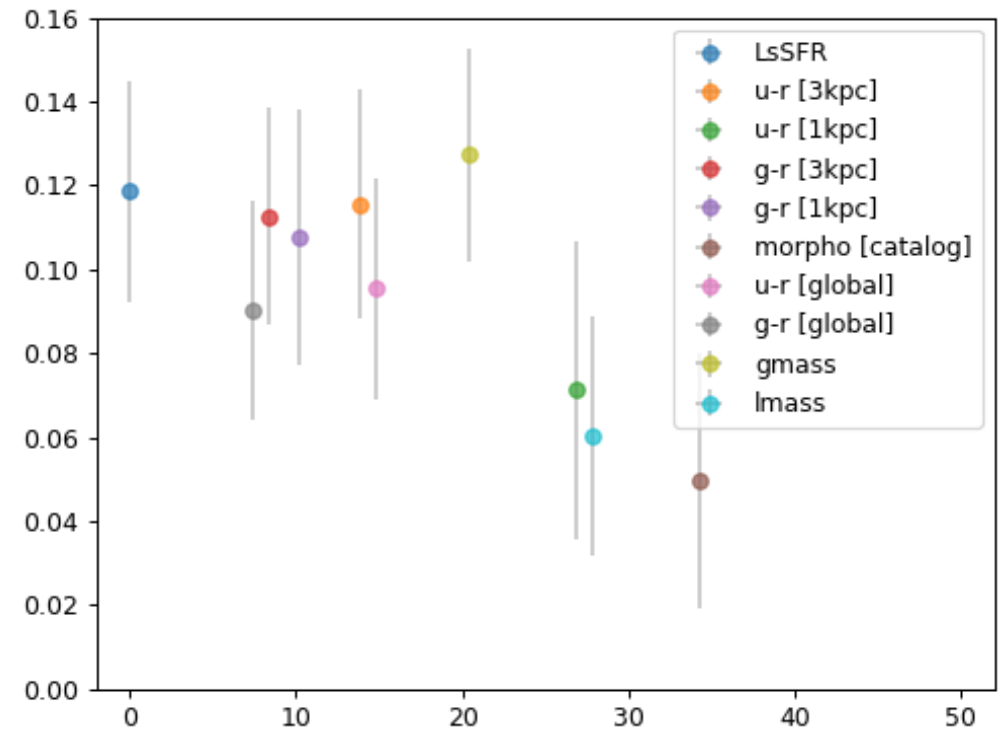
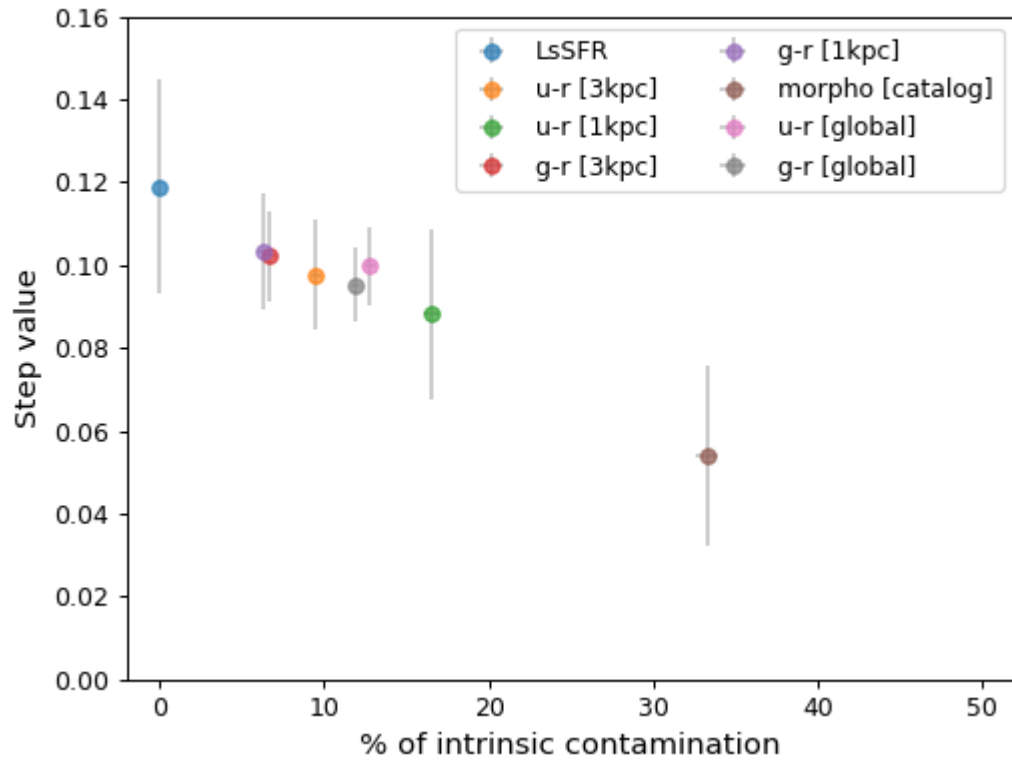
# Back-up



# Back-up



# Back-up





# Back-up

