Image simulations in LSST-DESC

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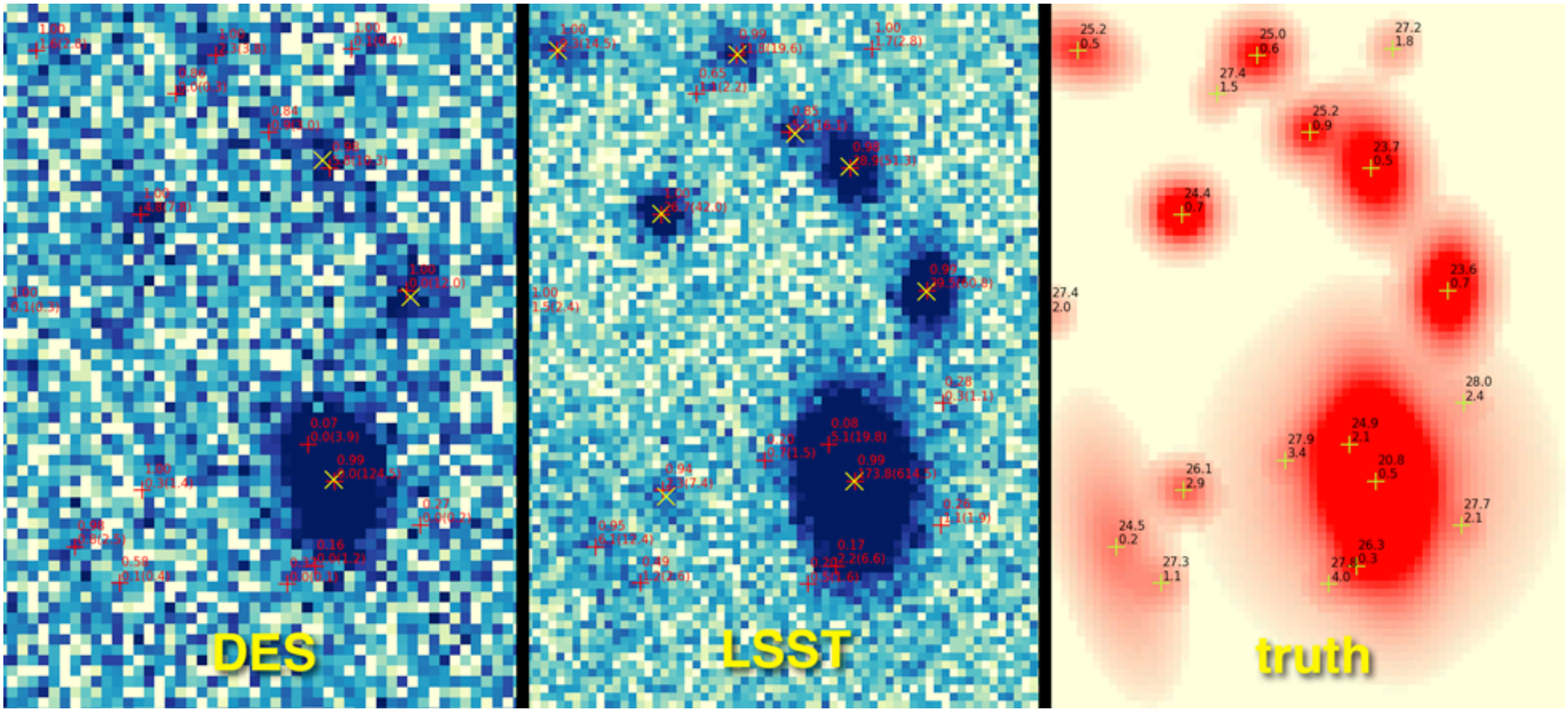
Introduction

- DESI and LSST mean big data.
- New methods are needed to analyze these data.
- Data challenges and infrastructure work are fundamental for the success of these experiments.
- In LSST systematics play a big role:
  - Blending (overlap of 2 or more sources in a given pixel), impacts shear and photo-z measurements.
  - The brighter-fatter effect, and other instrumental effects have a larger impact due to the increased statistics.
  - Forward modeling: Image simulations.

Introduction

- Monte Carlo studies are pretty common in particle physics but not that much within the astronomical community.
    - Useful for several reasons:
        - Develop/improve/profile pipelines.
        - Foreground/Background removal/analysis.
        - Make predictions!
- Some studies can only be done by using simulated images!



In simulations we have access to full information of input and outputs!

However, in real data we have some complications…

WeakLensingDeblending

- WeakLensingDeblending: https://github.com/LSSTDESC/WeakLensingDeblending or weaklensingdeblending.readthedocs.io

- Open source Python package.

- It doesn’t do weak lensing nor deblending but helps to study the effects of blending on e.g., cosmic shear.

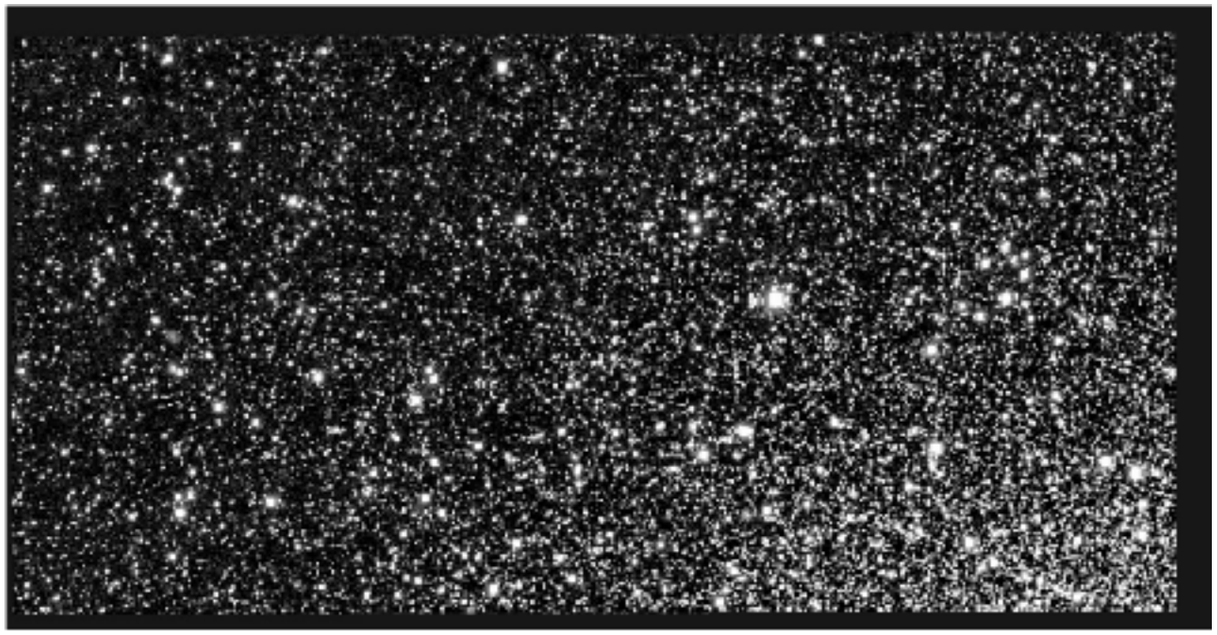
- Uses GalSim to generate images resembling LSST/HSC/DES.

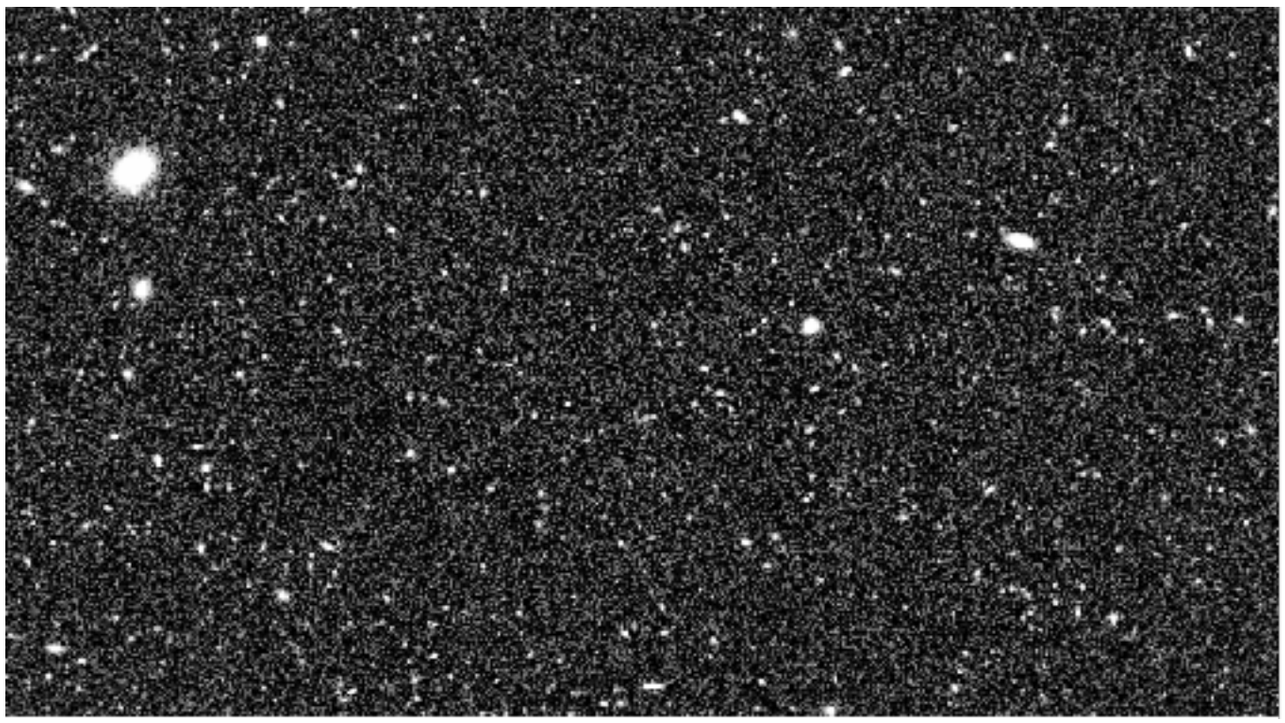
- Can produce Fisher predictions for flux, size, ellipticity uncertainties and pixel noise bias.

Co-developed with D. Kirkby, I. Mendoza, and S. Kamath

Real vs simulated

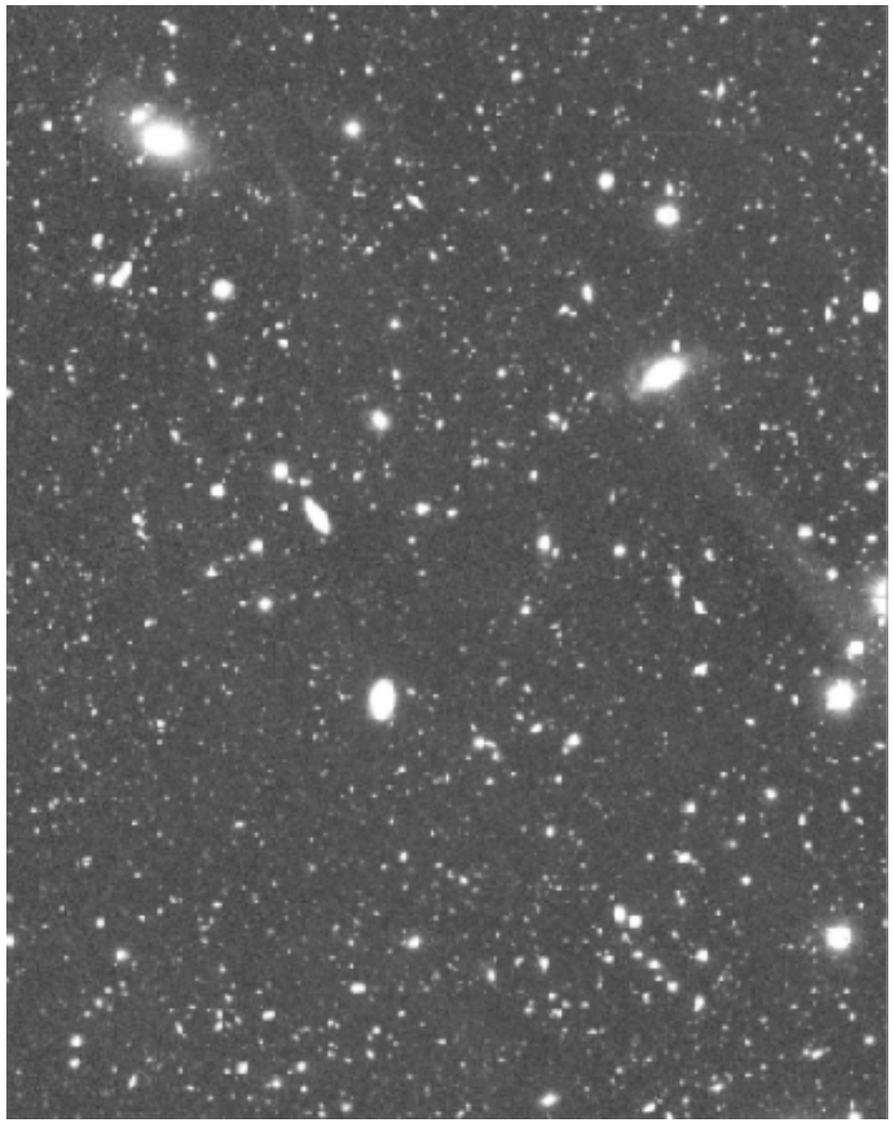
Morganson et al 2016

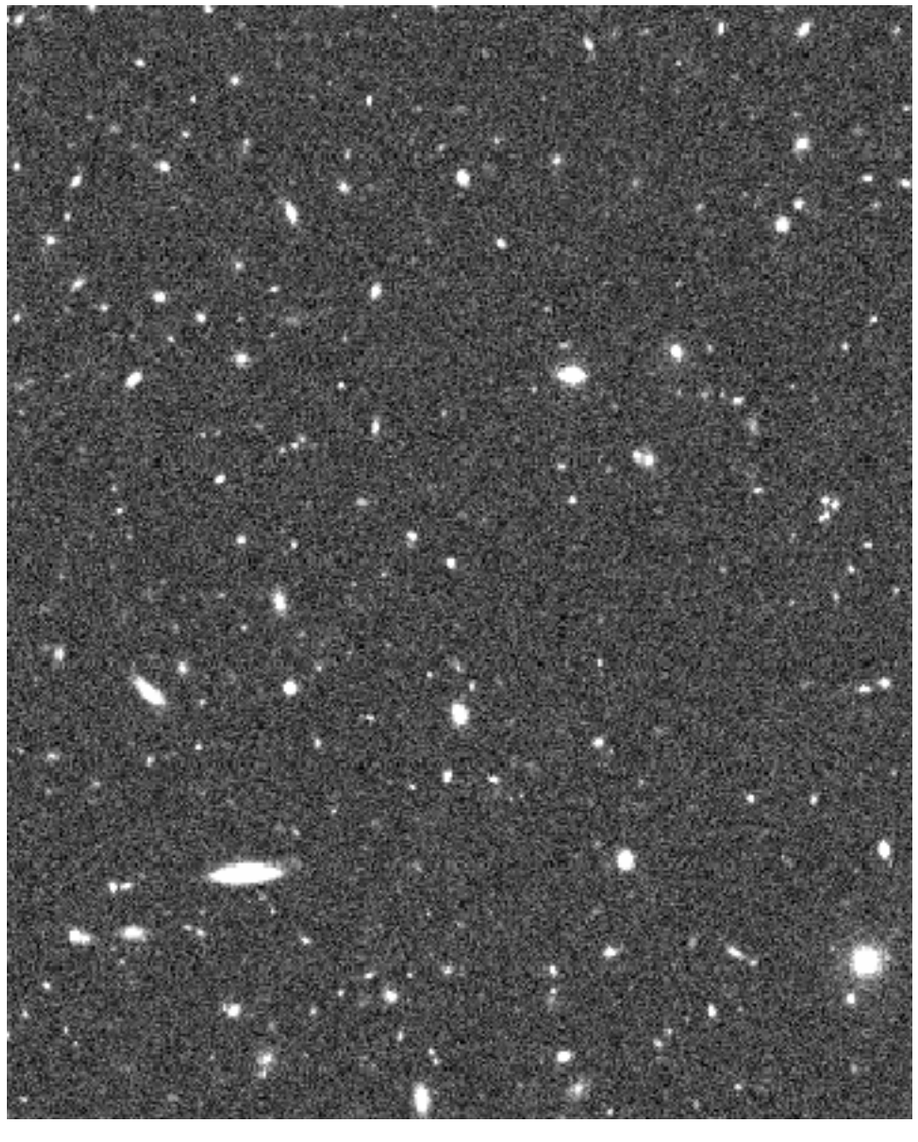




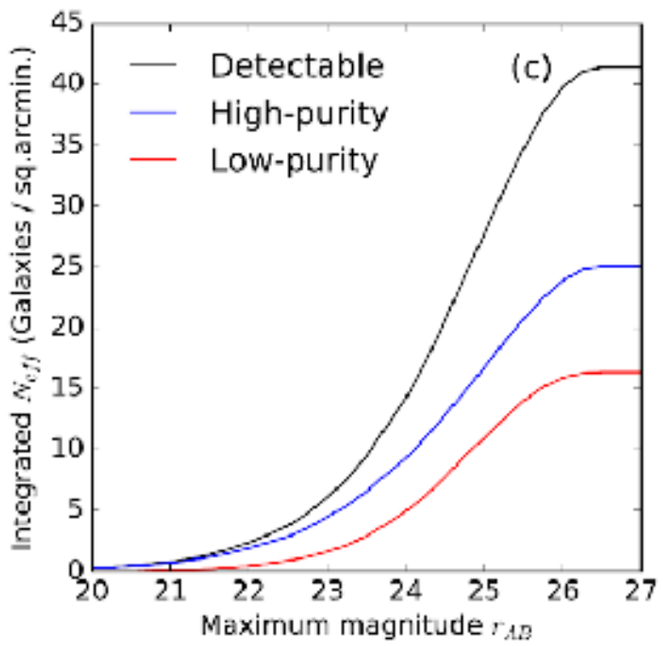
Real vs simulated

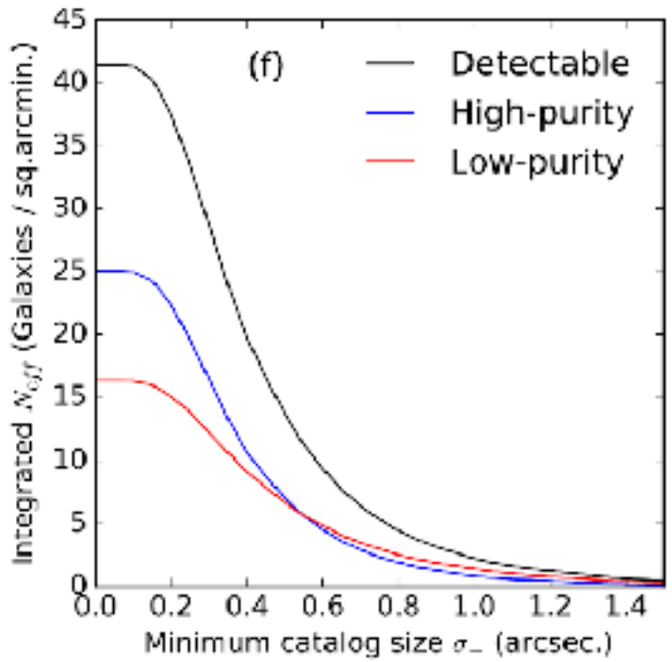
Bosch et al 2018

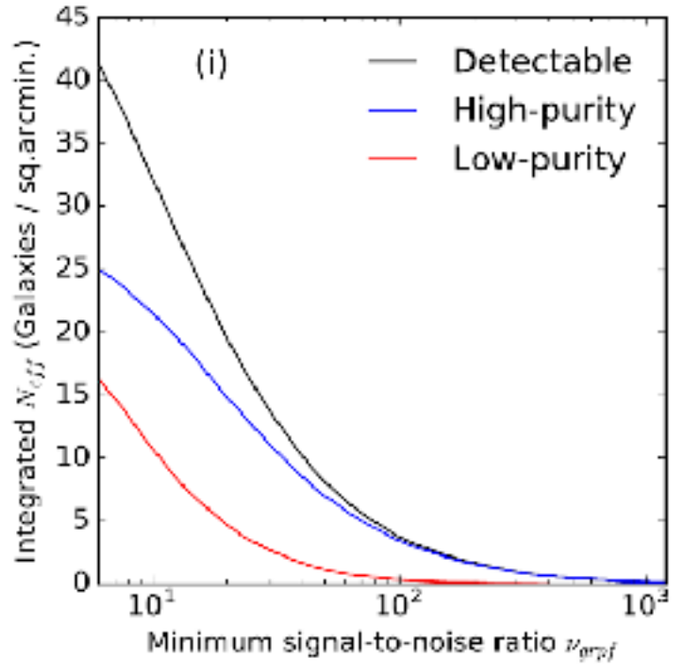




- These simulations not only give us pretty pictures but also allow us to make predictions.



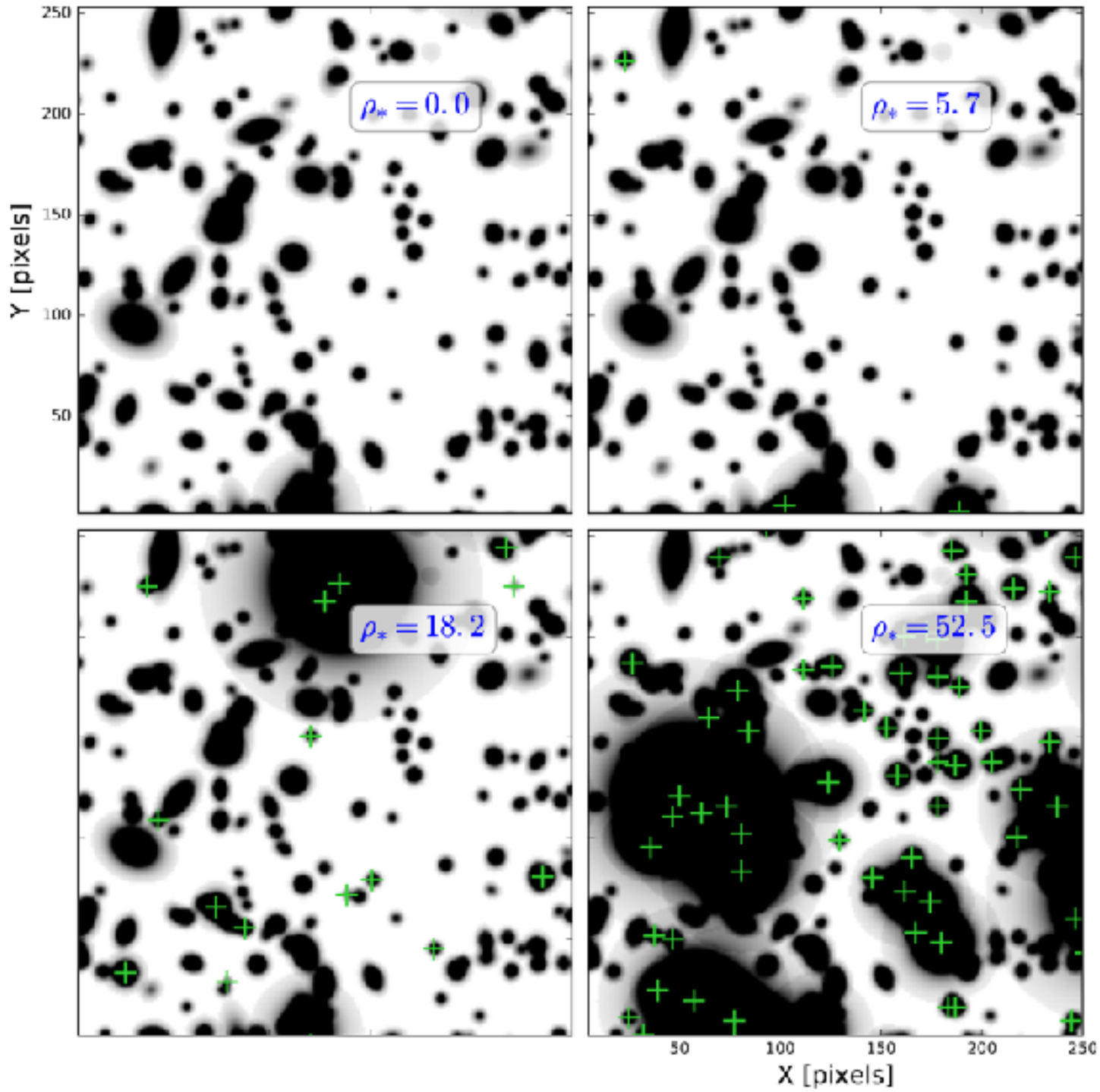




JS, I. Mendoza, D. Kirkby, P. Burchat, (LSST-DESC) in prep.

*High-purity: Less than 2% of the integrated flux comes from overlapping sources

- Predictions as a function of “foregrounds” (e.g., stellar density)



Large-scale image simulation efforts in DESC

- DESC developing imSim (GalSim based, C Walter et al., in prep.)
- LSST developing PhoSim (Peterson et al. 2015)
- DESC completed its first data challenge (DC1 — JS, C. Walter, ++, in prep.):
    - 30 sq-deg single-band full-depth (10 years — r ~ 27.5) imaging with inputs from Millennium.
- Undergoing the second data challenge (DC2 — LSSTDESC collaboration, in prep):
    - 300 sq-deg, 6-band, 5-10 year depth (TBC) with brand new cosmoDC2 simulation (Korytov et al.). Including Deep Drilling Field.
    - Pipeline development, study of foregrounds, development of new analyses!
- Stay tuned!