

# Building the (im)perfect cluster observations

DESC Clusters Task H-2:

Validating gravitational lensing mass measurements in the Cluster Regime

# Acknowledgements

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- Doug Clowe



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# Why the simulations?

- Accurate extraction of weak lensing signal essential to cluster mass function calibration.
- Methods for measuring shear well-tested, but only in the weak shear regime.
- Previous simulations have relied on sheared images, but the real distortion includes higher-order terms.

# Further uses

- Deblending (DESC CWG-3)– the same simulations (with a realistic cluster galaxy component) can be used to test the effect of deblending on mass profile.
- Connect to task H-1 (discussion this afternoon)

# The problem

High resolution Galaxy input galaxy images

$\sim 10^9$  pixels/image.

Strong Lensing (reverse lookup)

Level of Realism?

# The input images

Postage stamps from UDF/HDF/GOODS/COSMOS  
(CANDELS upcoming?)

All except COSMOS have color

High S/N → noise removal via thresholding

PSF measurable (not removed this iteration)

# Rescaling

- Match HST-observed:
  - 1) number counts
  - 2) half-light radii vs. mag
  - 3) redshift distribution (not used)
  - 4) random orientations
  - 5) ellipticity distribution (ensured by using real images)

# Mass model and lensing

- Currently a simple NFW model
- Code allows multiple lensplanes and a complex mass distribution
- Deflection map calculated on 0.0075'' (customizable) scale)
- Lensing is calculated independently for each postage stamp with appropriate distance ratios (for current run all sources at fixed  $z$ )
- Lensed image pixelized at 0.03'' prior to convolution



# The Algorithm

Construct a covering of the image plane.

For each postage stamp and each element of the covering, calculate the intersection between the image plane pullback and the minimum information box containing the postage stamp.

Create an output distorted postage stamp containing only non-zero portions of covering.

Very efficient—40kx40k output image with 200,000 input galaxies in ~6cpu hours

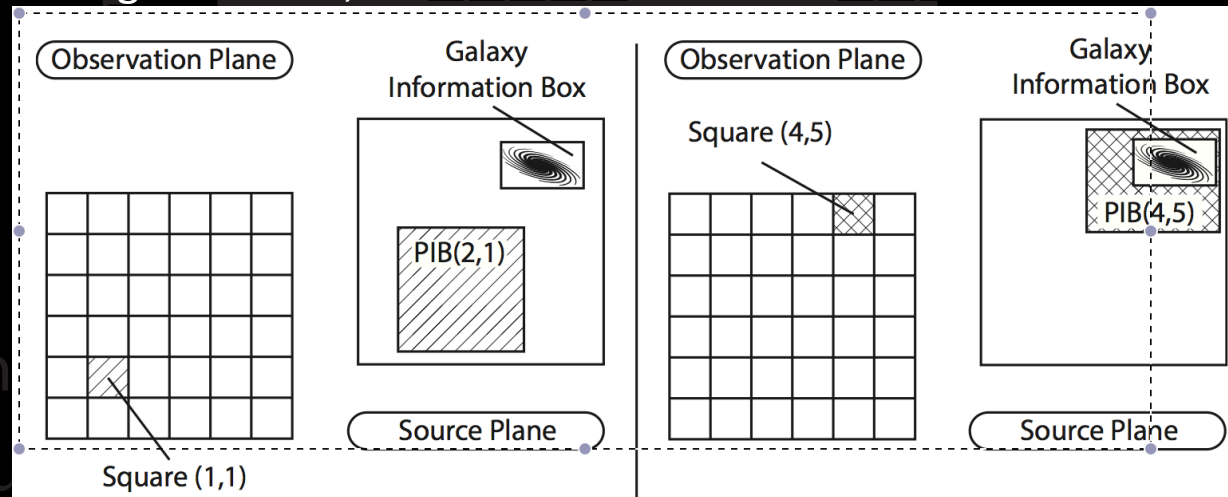
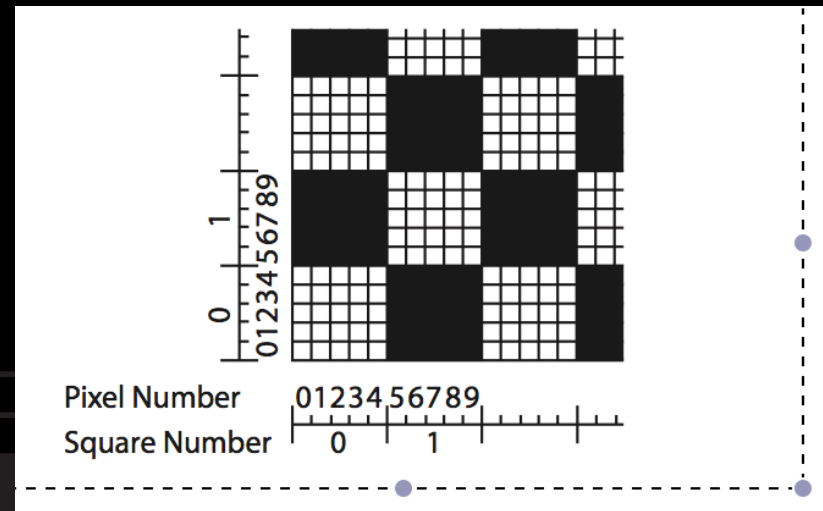


Figure 4: Step 5 of the algorithm for two squares. Left side: case of no intersection between pullback information box and Galaxy information box. Right side: case of intersection.

# Convolution and resampling

Now: Use PhoSim to generate a PSF (a star image with very high S/N)—not quite right!

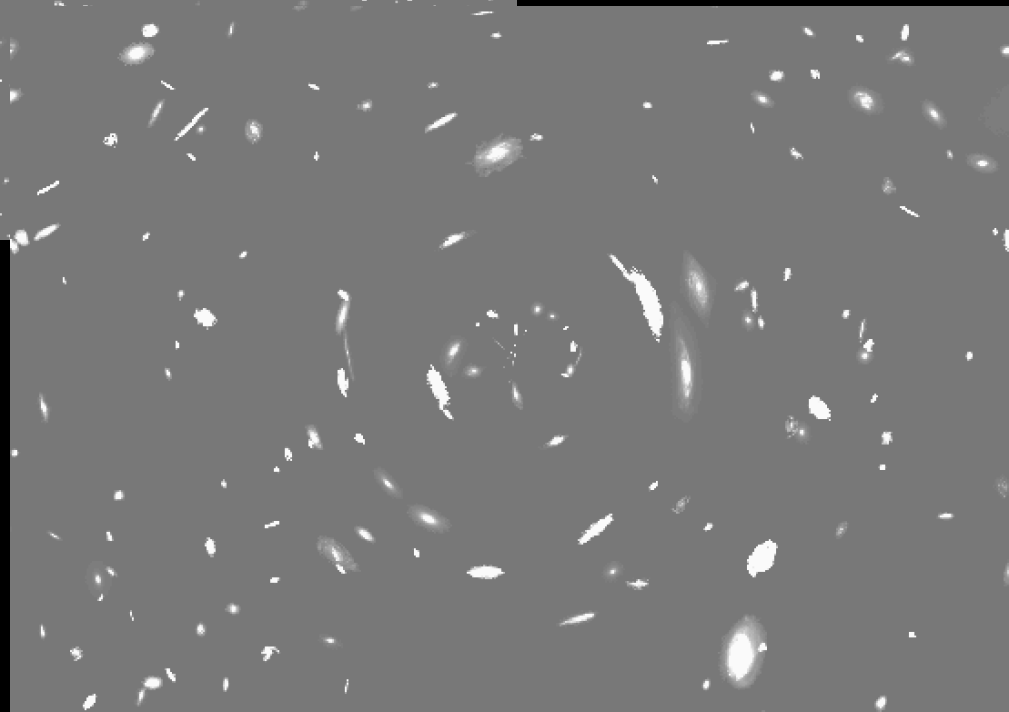
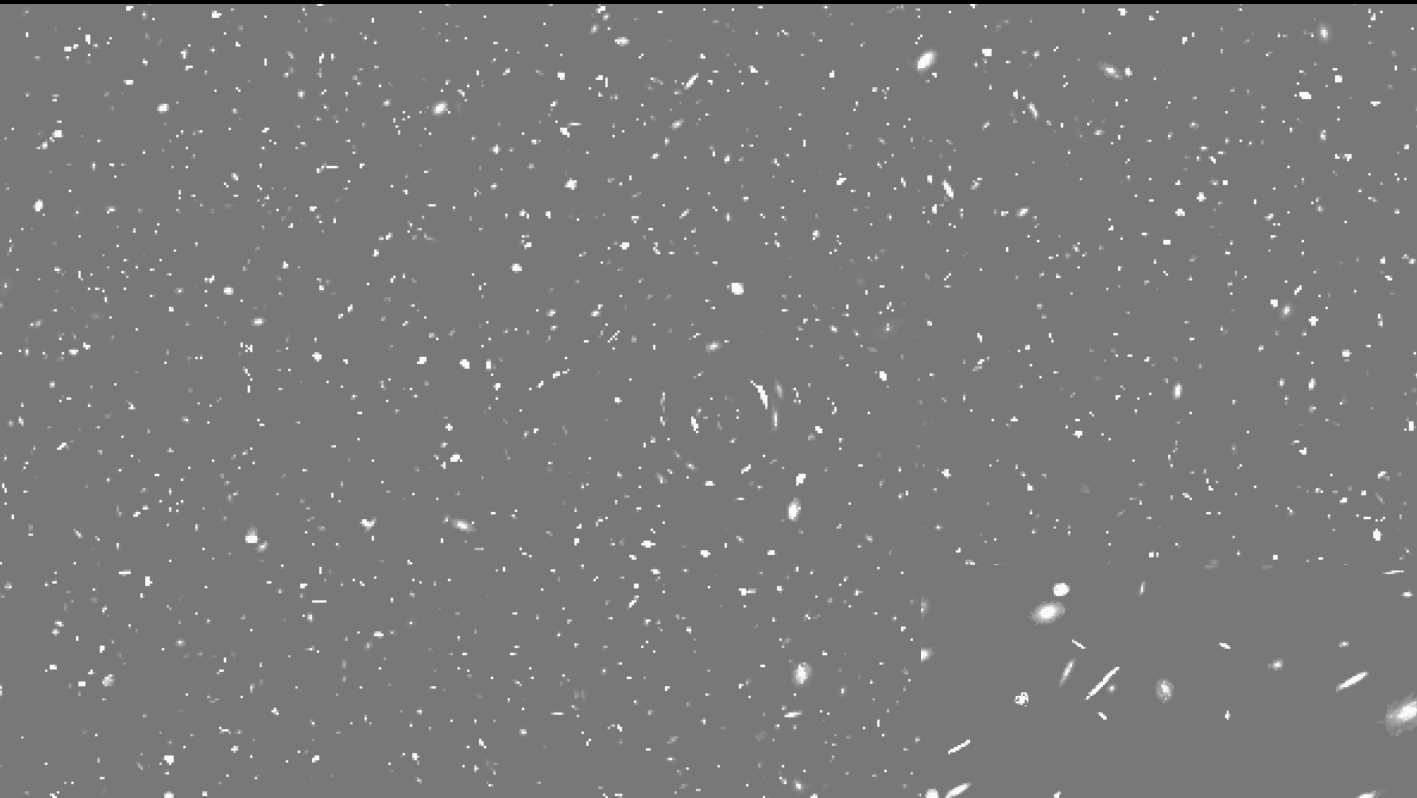
**Version 0 of sims use a constant PSF**

Convolution performed at 0.03'' resolution, image resampled to LSST resolution

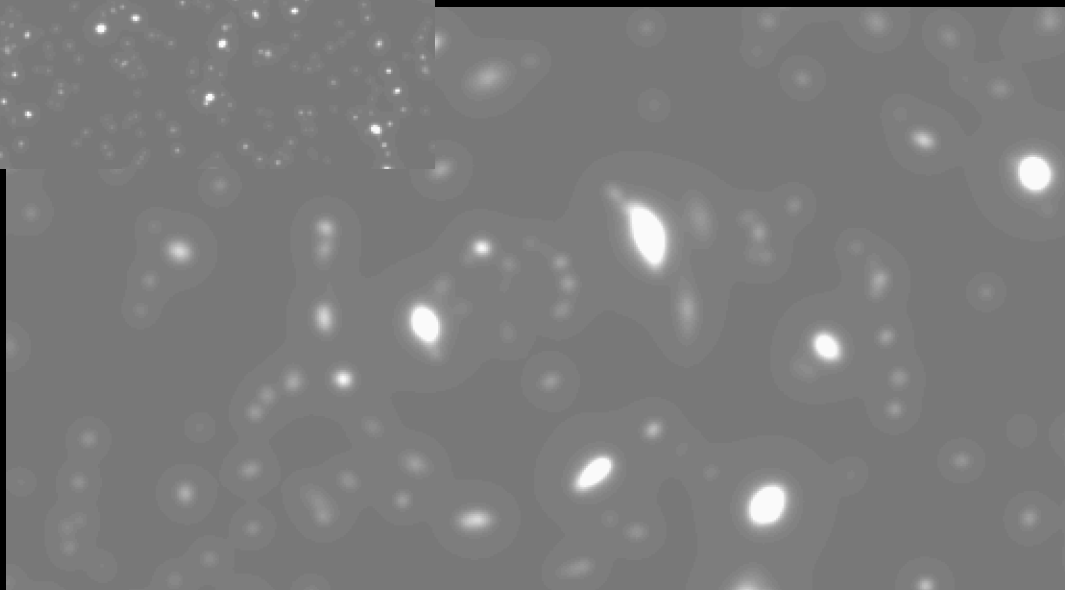
How much realism? (depends on link to PhoSim)



# Before



# After



# Timeline

Release 0 images available now: 20 clusters spanning range of M and c:

<http://www.het.brown.edu/people/ian/DESC>

Now-end of January: validation of release 0.

February-March— production of release 1.

End of March, 2014— Release 1 available to DESC (and the outside world?)

Late 2014 (early 2015)— Release 2 with new functionality.

# Discussion

- What detail needs to be in release 1?  
(PhoSim? Stars? Cluster Galaxies?)
- Should release 1 be extended outside DESC?
- What should be in release 2?



# Testers are needed

- The simulations need you!