

# Simulation Calibration of Cluster WL Mass Measurements with DC2

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*LSST Dark Energy Science Collaboration Meeting  
7/26/18*



## WL-Mass Calibration Motivation

- ▶ Uncertainty in MOR is currently the limiting factor for cluster-based cosmology
- ▶ Direct mass calibration possible through weak gravitational lensing using N-body simulations
- ▶ Current WL calibration efforts limit systematic uncertainties to 5 – 10% in cluster mass



$$M_{\text{WL}} = b_{\text{WL}} M_{\text{true}}$$

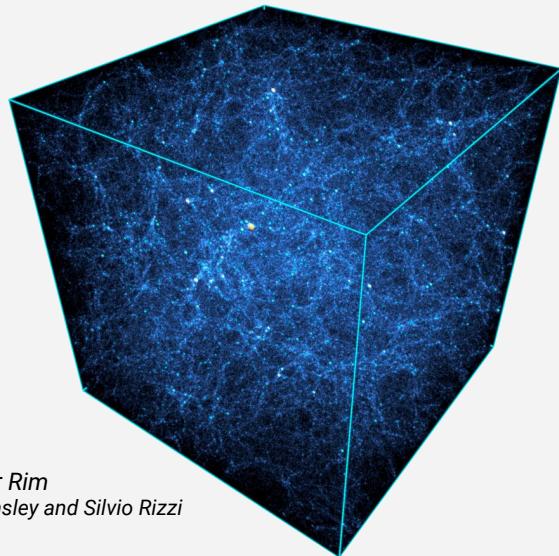


$$P(M_{\text{WL}} | M_{\text{true}})$$

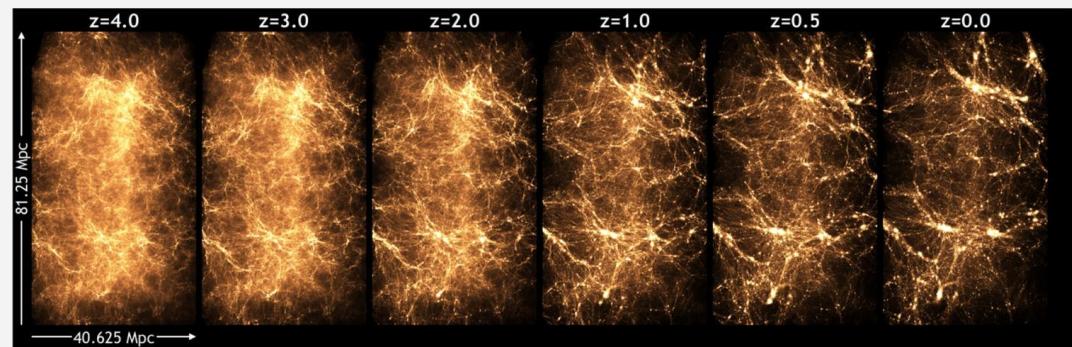
$$\text{location } \mu = f(b_{\text{WL}})$$

$$\text{scatter } \sigma_{\text{WL}}$$

## Base Simulations - HACC

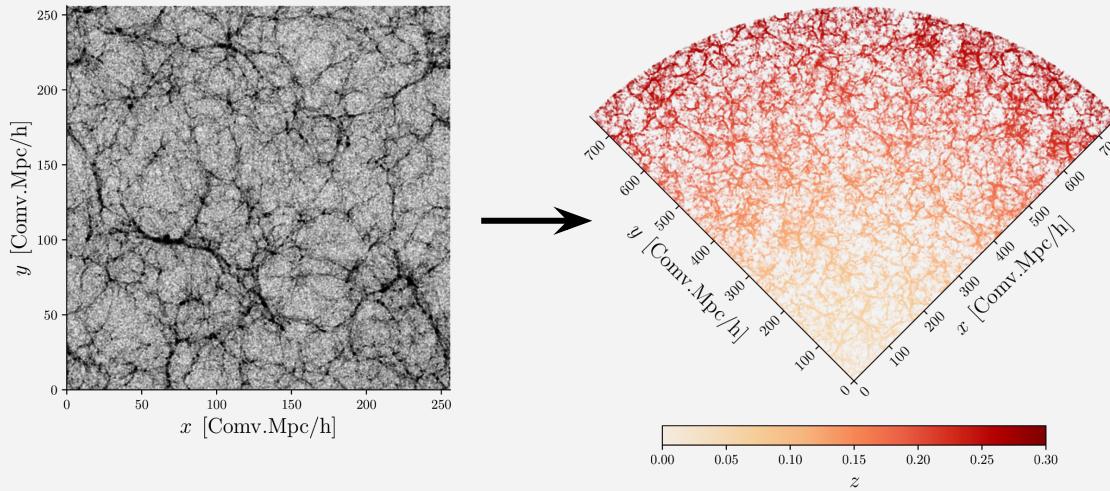


*Outer Rim*  
Joe Insley and Silvio Rizzi

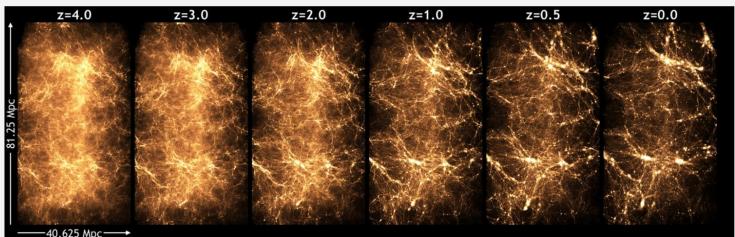


*Q-Continuum*  
Heitmann et al. 2014

# Lightcone Construction to Ray Tracing

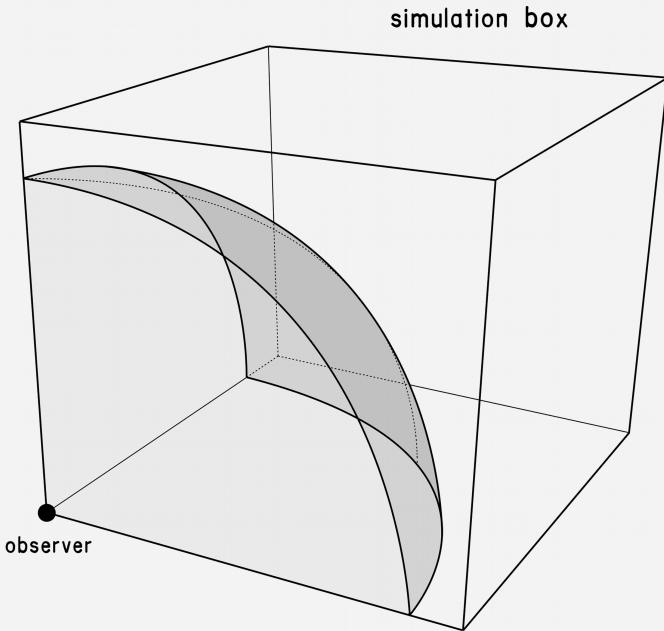


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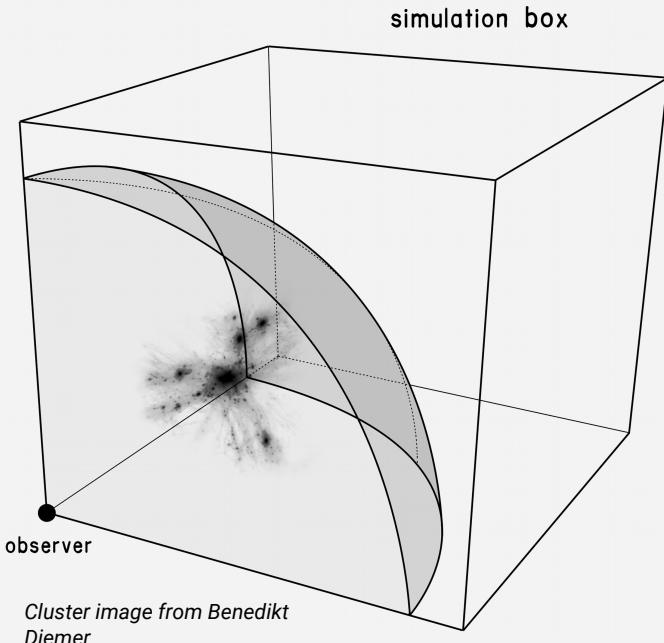


# Lightcone Construction to Ray Tracing

Argonne  
NATIONAL LABORATORY

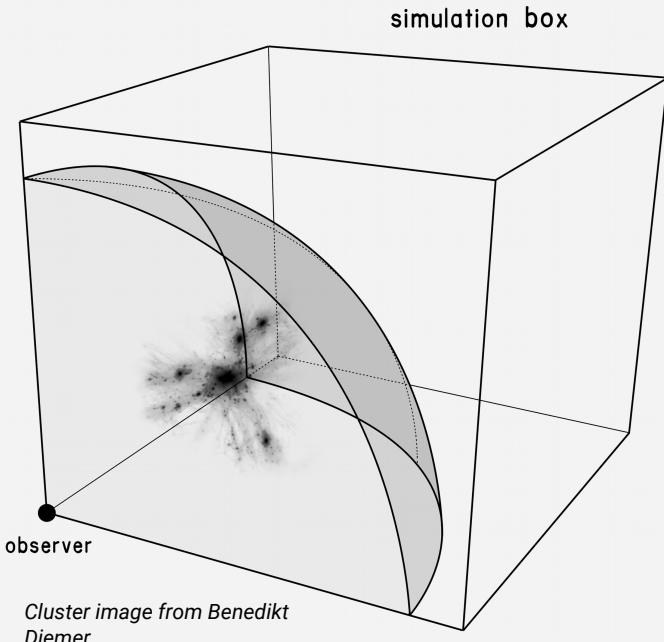


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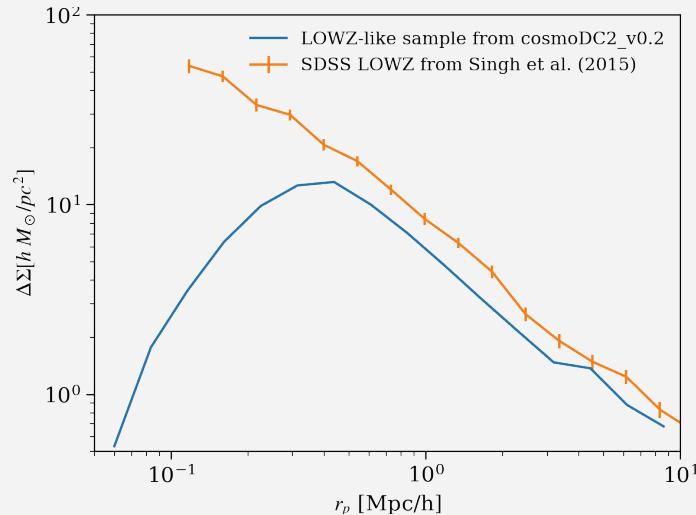
*Cluster image from Benedikt  
Diemer*

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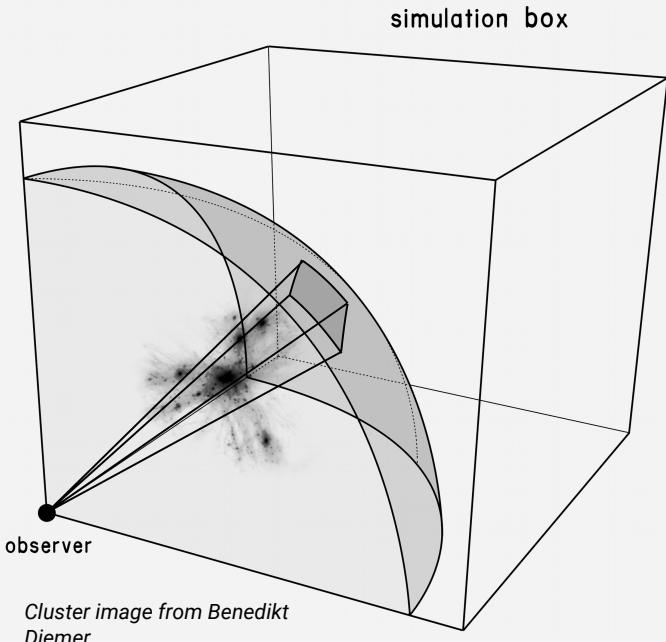


*cosmoDC2:*

- particle mass:  $\sim 1.8 \times 10^{11} M_{\odot} h^{-1}$
- lensing map pixelization:  $\sim 0.8'$   
... not sufficient!

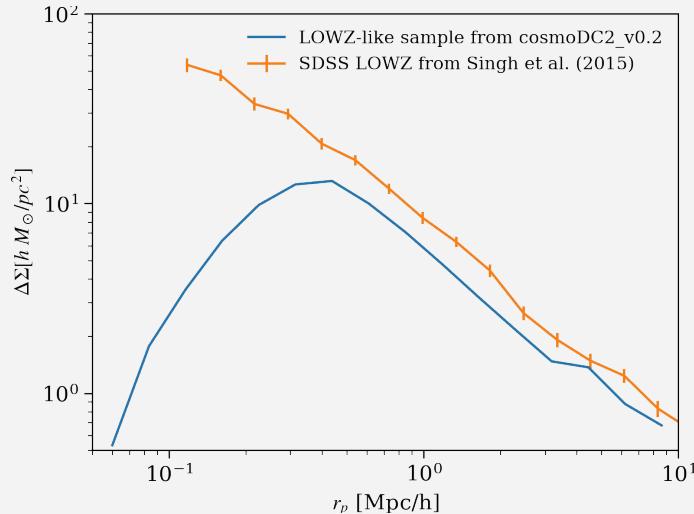


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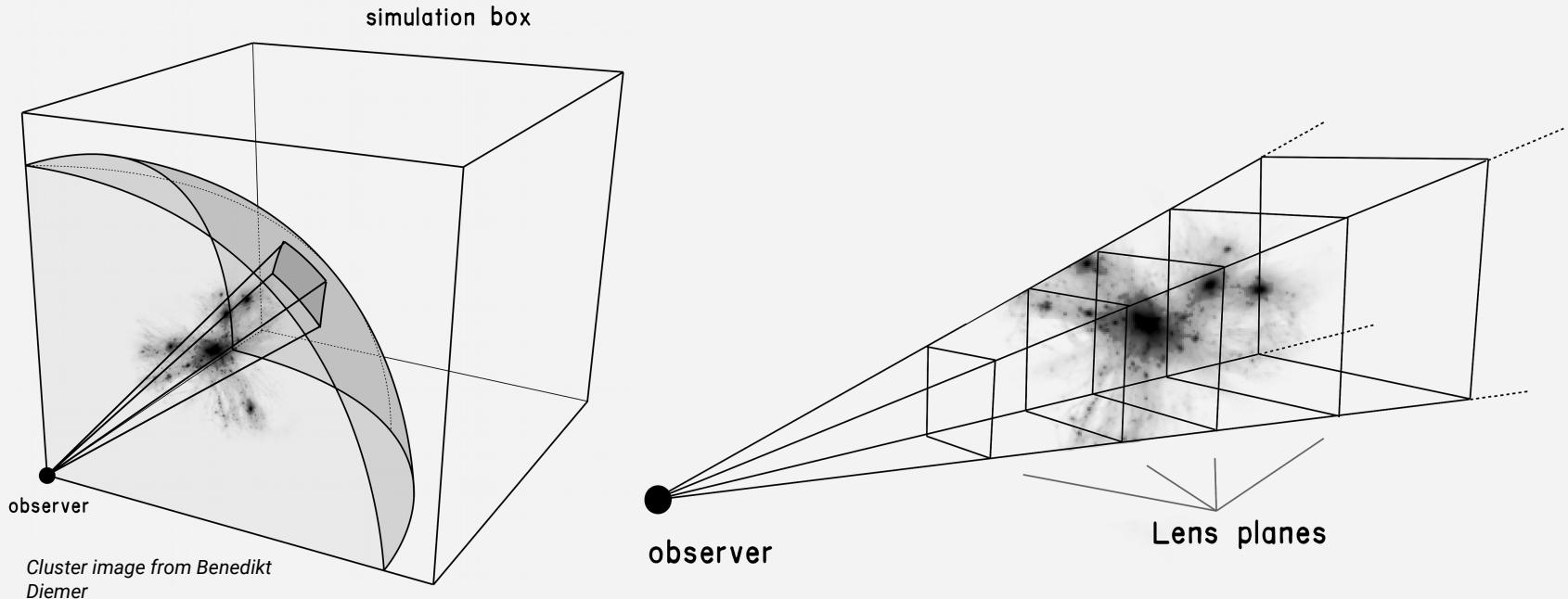


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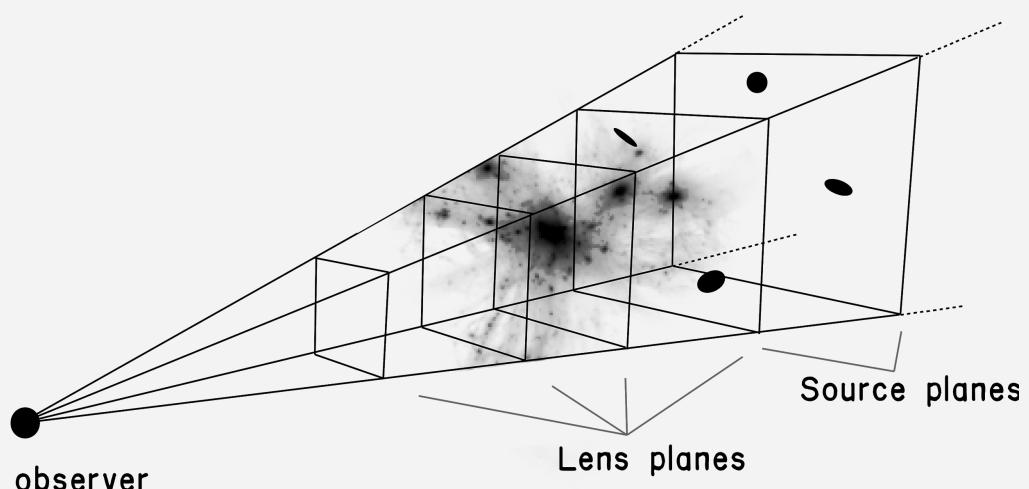
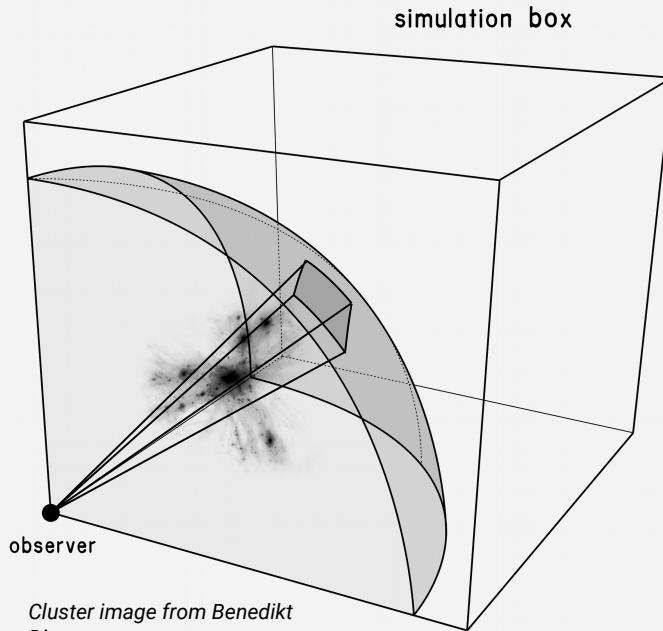


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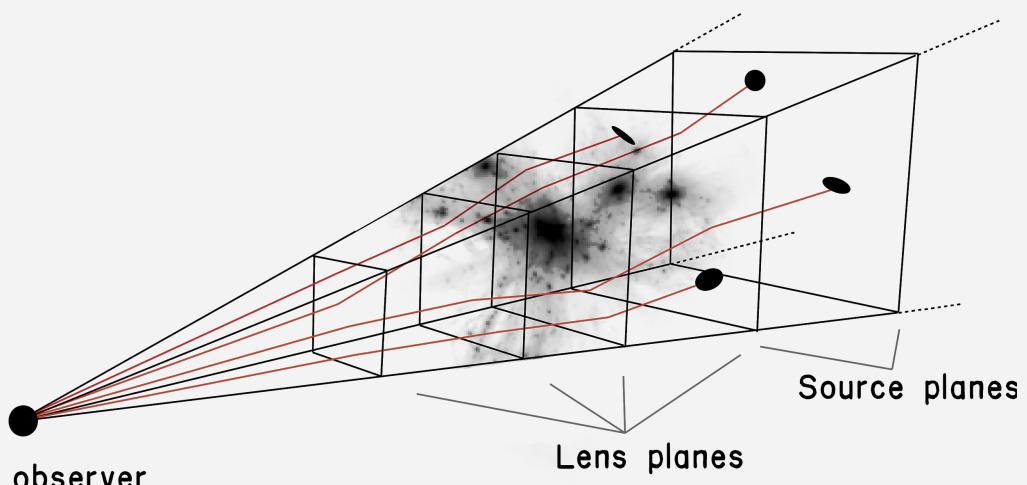
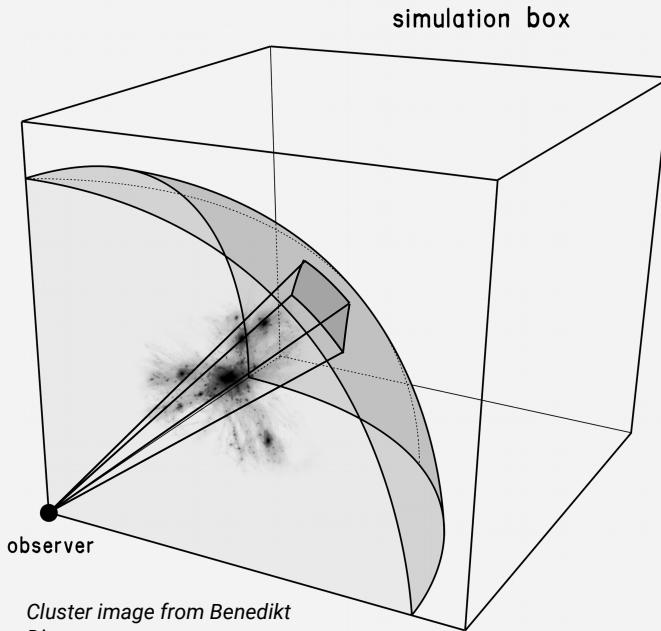


Cluster image from Benedikt  
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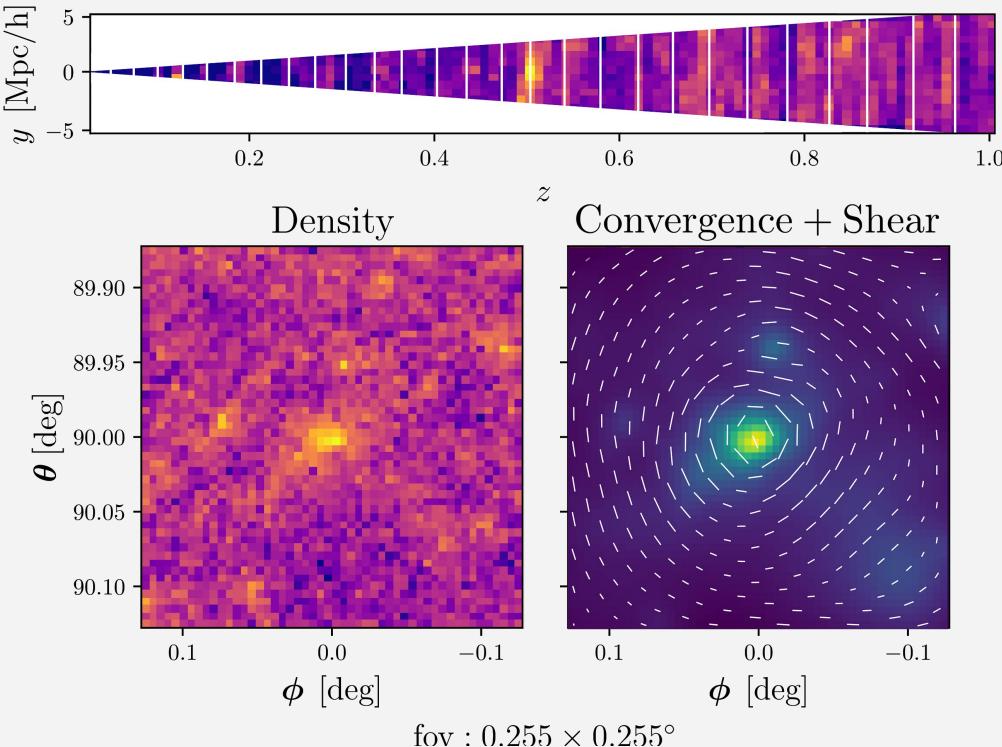


# Lightcone Construction to Ray Tracing



Cluster image from Benedikt  
Diemer

# Simulated Cluster Lensing



## Halo Properties:

$$z = 0.503$$

$$\text{mass} = 2.703 \times 10^{14} M_\odot h^{-1}$$

## Ray Tracing:

Source plane at  $z = 1$

28 lens planes from  $0 \leq z \leq 1$

SPH particle smoothing

## Planned Data Products



### Base simulations:

#### AlphaQuadrant:

$256 (h^{-1}Mpc)^3$

$1024^3$  particles

$1.1 \times 10^9 h^{-1} M_{\odot}$  mpp  
WMAP-7

#### OuterRim:

$3000 (h^{-1}Mpc)^3$

$10240^3$  particles

$1.8 \times 10^9 h^{-1} M_{\odot}$  mpp  
WMAP-7

### Lightcone products:

#### AlphaQuadrant:

1% particles to  $z=3$

Full particles to  $z=1$

Halos to  $z=1$  ( $\sim 30k > 10^{14}$ )

#### OuterRim:

1% particles to  $z=3$

Halos to  $z=3$  ( $> 100k > 10^{14}$ )

Smaller simulation data more computationally affordable; will allow for convergence studies on ray-tracing strategy:

- ▶ LOS structure sampling?
- ▶ Density estimator?
- ▶ Pixelization for lensing maps?
- ▶ Cutout sizes?
- ▶ Redshift resolution (lens planes)?

## Planned Data Products



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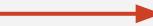
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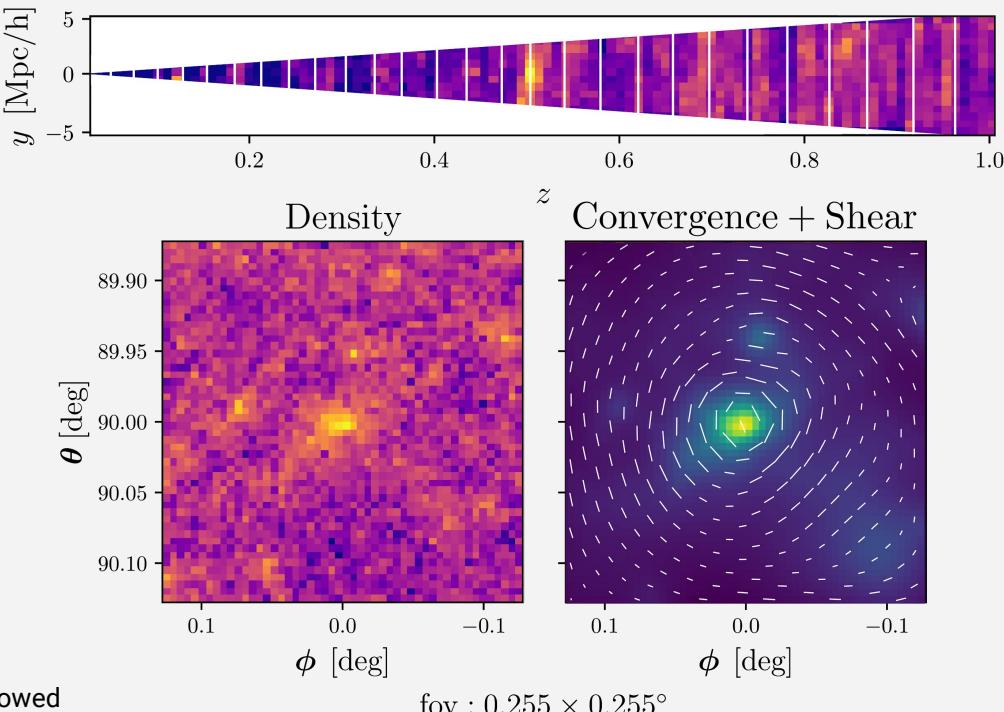
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← Conclusions inform parameters for larger-scale runs (larger lightcone volume and more unique halos)

# WL-Mass Reconstruction Systematics



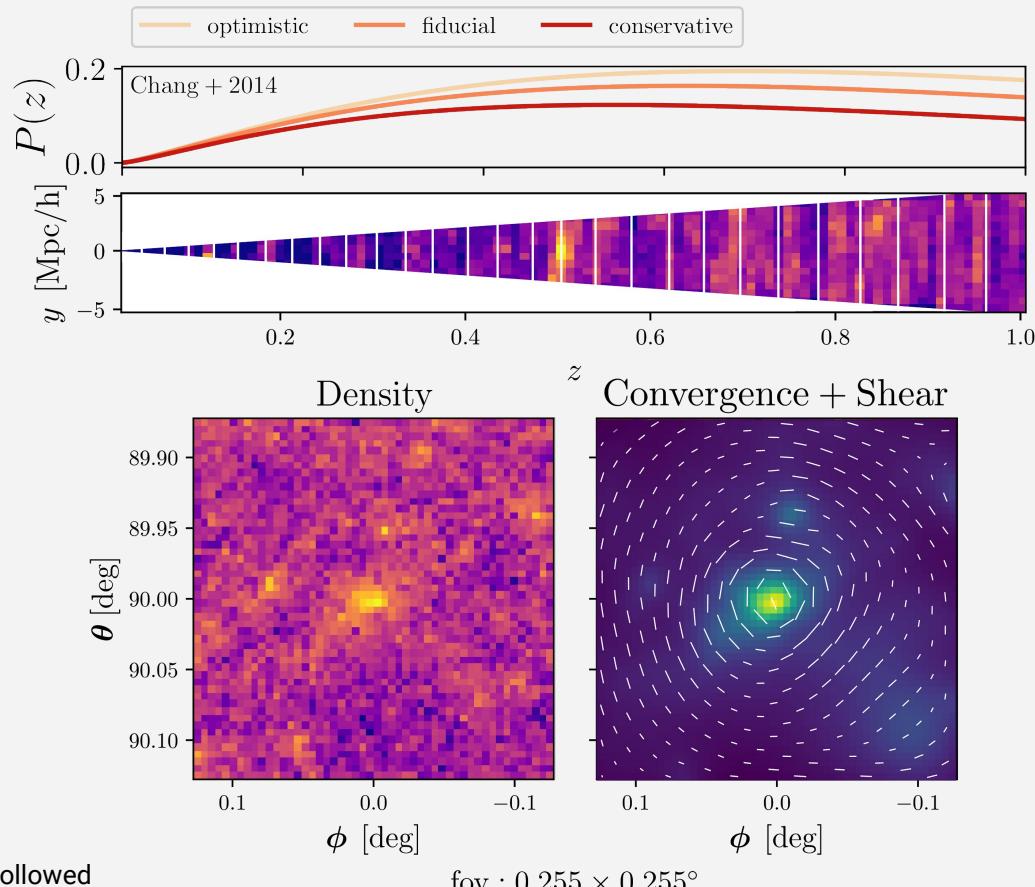
J. Hollowed



## Halo fitting systematics:

- Spherically symmetric density profile (NFW)
- Mass-concentration relation
- Correlated LSS
- Miscentering
- Cluster Selection

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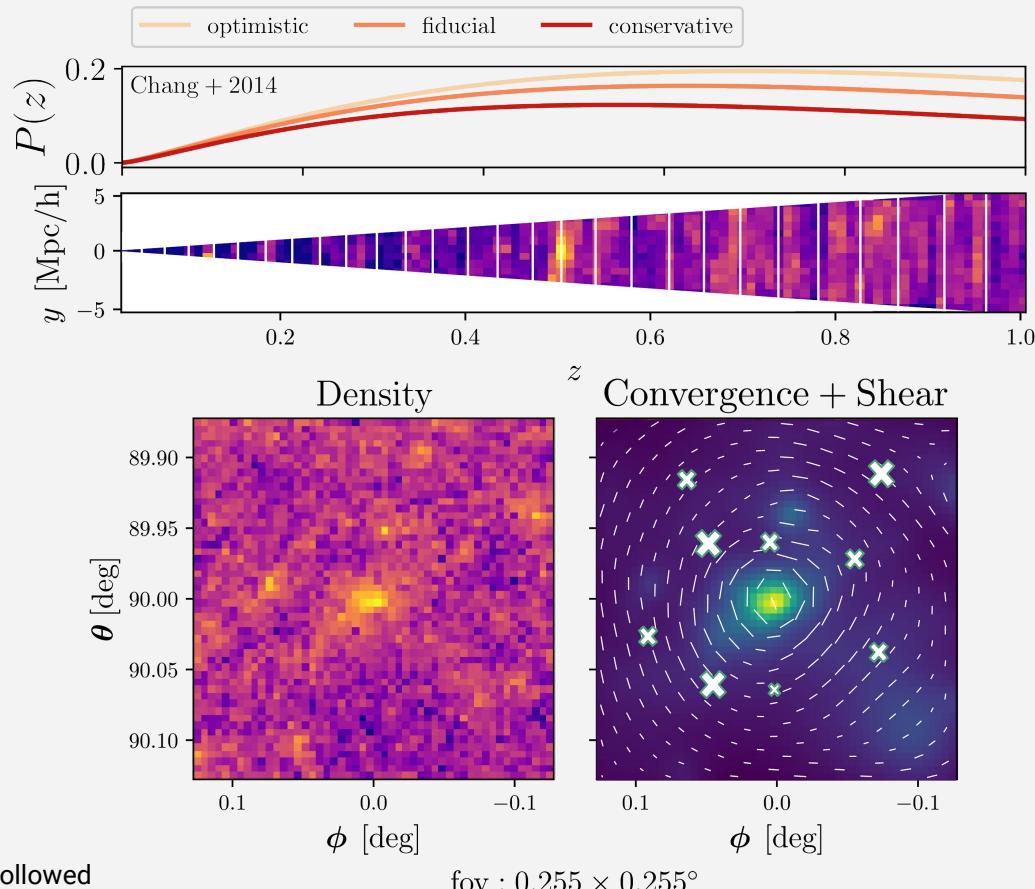
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J. Hollowed



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## Extend to DC2 - Lensing systematics:

- $\langle \beta \rangle$  and  $\langle \beta^2 \rangle$  estimation
- Foreground Contamination
- PSF Correction
- Intrinsic Alignment
- etc...