Measuring Tomography with Clusters of Galaxies

Douglas Clowe
Ohio University

Christophe Adami (LAM), Jim Annis (Fermilab),
Loic Guennou (LAM), Florence Durret (IAP),
David Johnston (NW), Kellen Murphy (OU),
Tim Schrabback (Leiden), Mel Ulmer (NW)

Problem 1:
Shear Simulations

- Need unbiased shear measurements better than 10^{-3} for cosmological measurements

- Current methodology uses simulations to improve PSF correction techniques

- Do our simulations account for all of the possible problems which we encounter in images?

- We need a good imaging data set to test consistency of techniques that excel at simulations

Problem 2:
$\kappa \neq 0$

- We measure g, not γ

- Most cosmic shear measurements assume γ

- Can likely do correction when κ<<1, but what to do with clusters/lss where κ>.1?

- Common answer: clip out that data, correct with simulations

- Can we do anything with that high shear data?

WL SIGNAL REDSHIFT DEPENDENCE
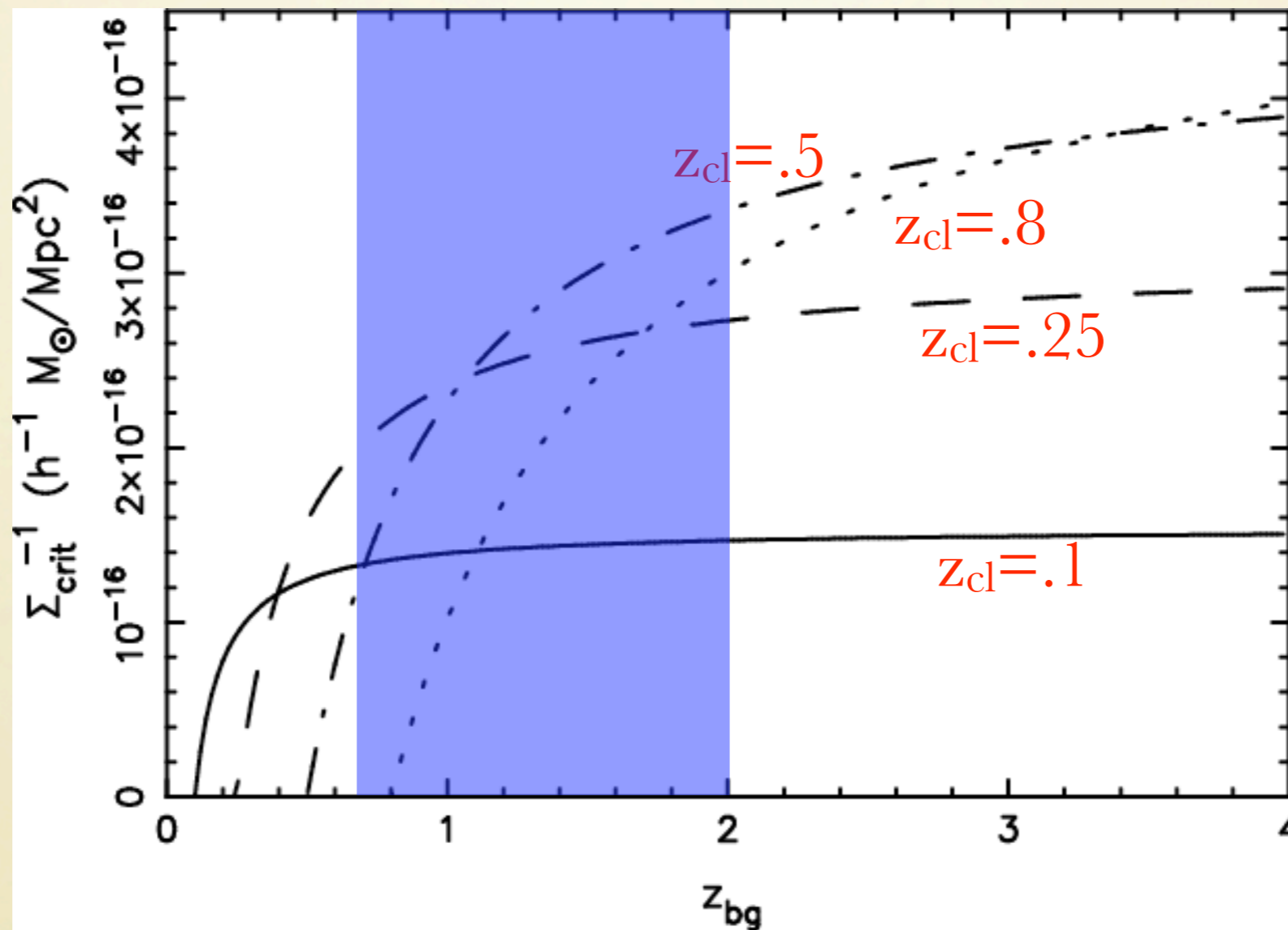
$$\gamma, \kappa \propto \Sigma_{\text{crit}}^{-1} = \frac{4\pi G}{c^2} \frac{D_l D_{ls}}{D_s}$$

Weak Lensing Techniques

- Measure the galaxy ellipticities from the second moment of the surface brightness

- Correct ellipticities for image distortion and smearing by the Point Spread Function

- Obtain a sparsely sampled, noisy measurement of the reduced shear $g(z)$

- Initially assume $\kappa=0$, convert $g(z)$ to $\gamma(z)$ to $\gamma(z_0)$ for assumed cosmology

Iterate

- Covert $\kappa(z_0)$ to $\kappa(z)$ at position of each galaxy

- Correct g(z) to $\gamma(z)$ to $\gamma(z_0)$

- Reconstruct surface density map, and measure new $\kappa(z_0)$ at position of each galaxy

- Upon convergence, compare measured g(z) to predicted g(z) from reconstructed map to measure goodness of fit

# Tomography in 1998
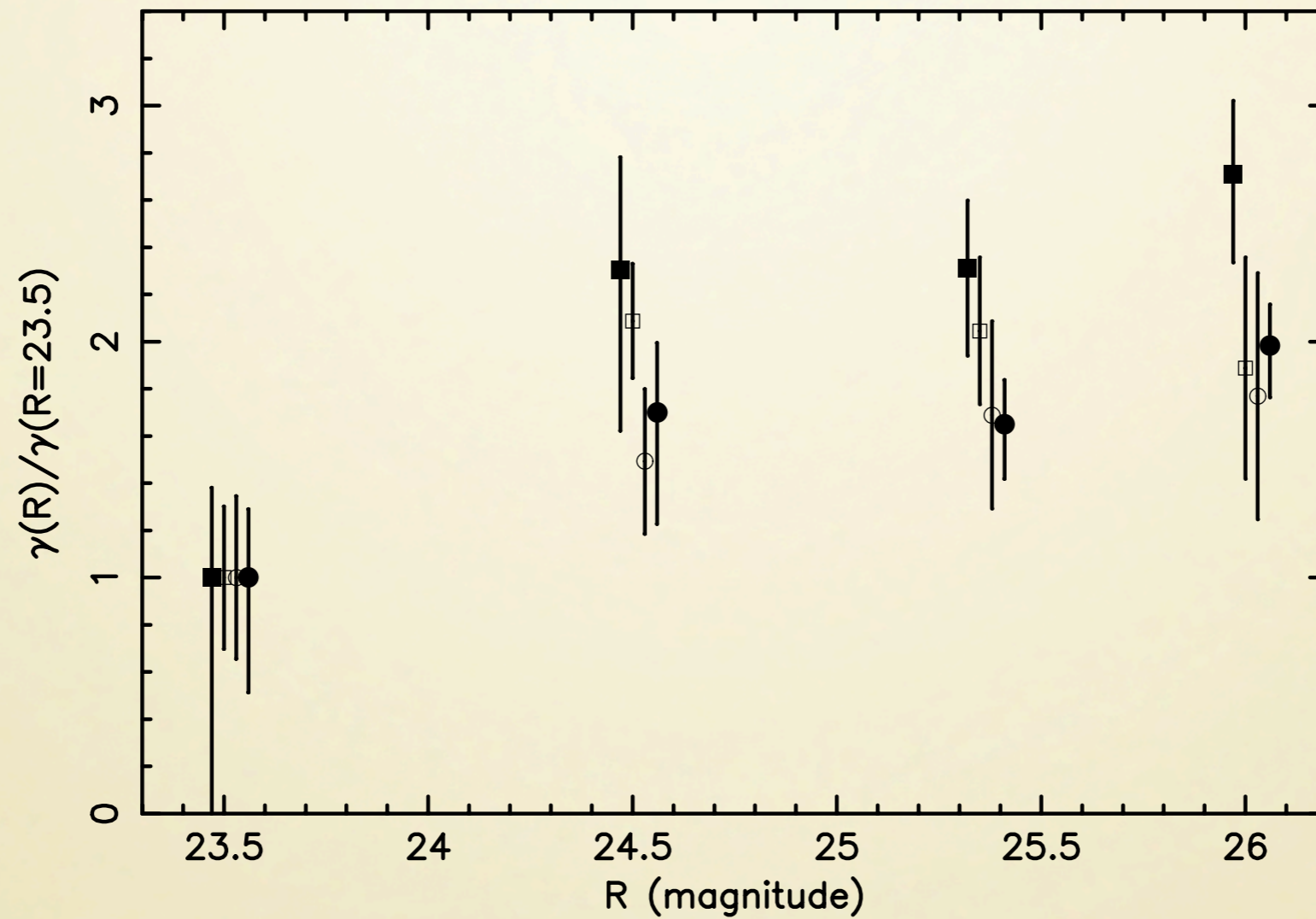
Clowe 1998

Tomography Today: The DAFT Survey

- Have 0.4 square degrees of HST imaging of high-z (0.4<z<1.0) clusters

- Equivalent to 40 square degrees of a cosmic shear survey from space (20x COSMOS)

- Need to obtain ground based colors for photo-z's (BVRIz to I=24.5[10σ]) - 80 nights of CTIO/KPNO (20 on Subaru/Keck/LBT)

- Should provide 200-250 background galaxies per cluster ACS field with reasonable photo-zs, space and ground based imaging for shears

5+1 Passband Photo-Zs
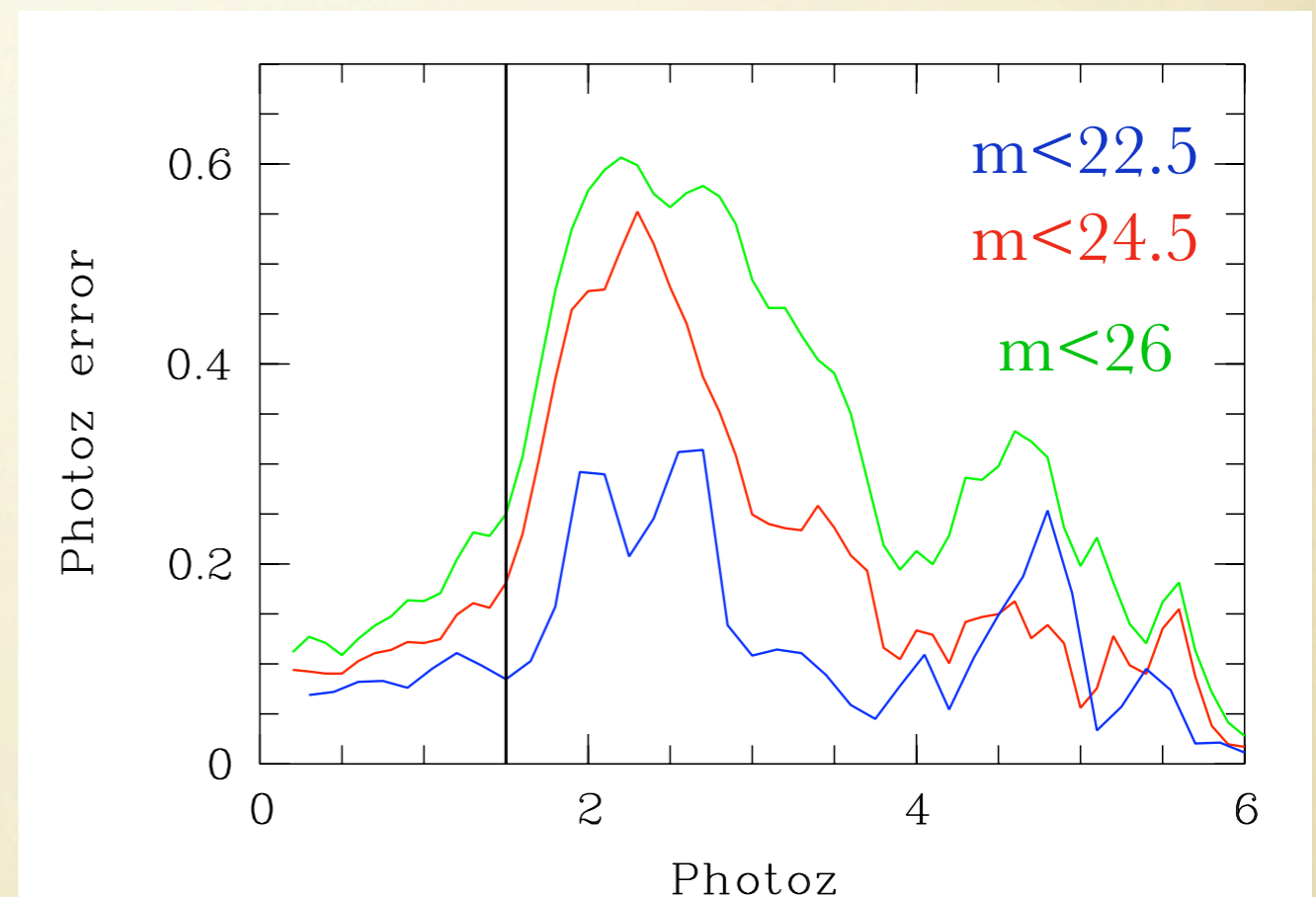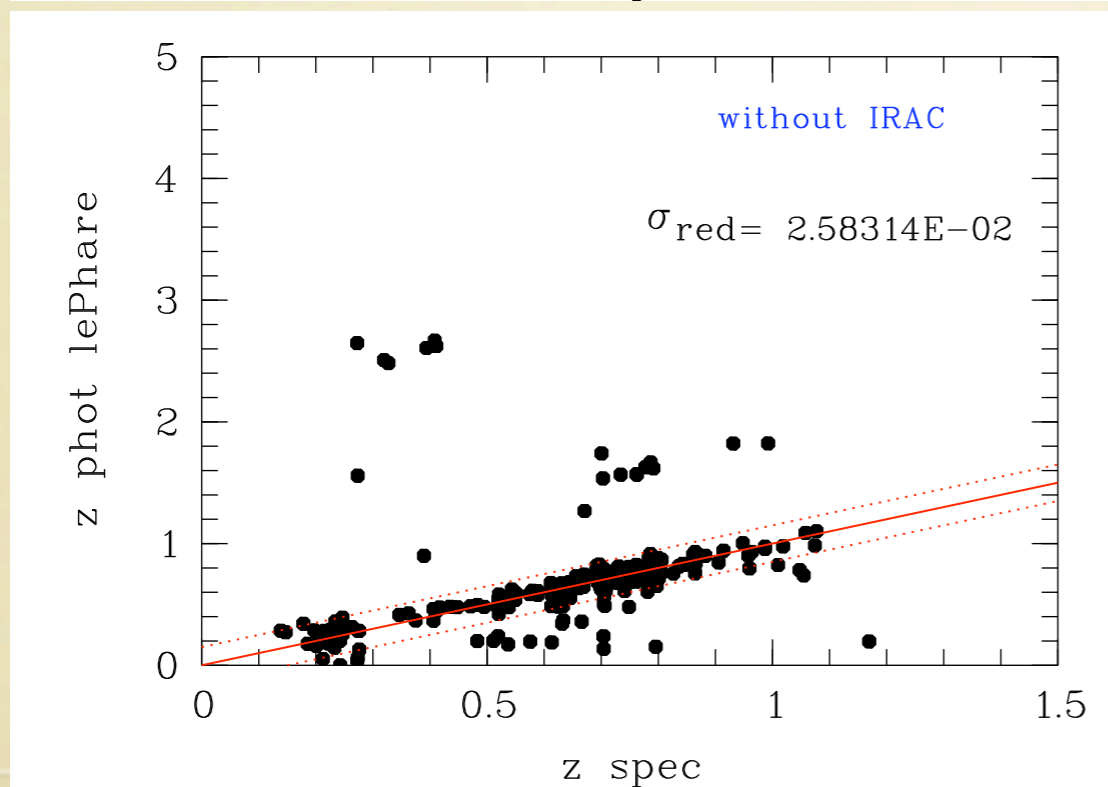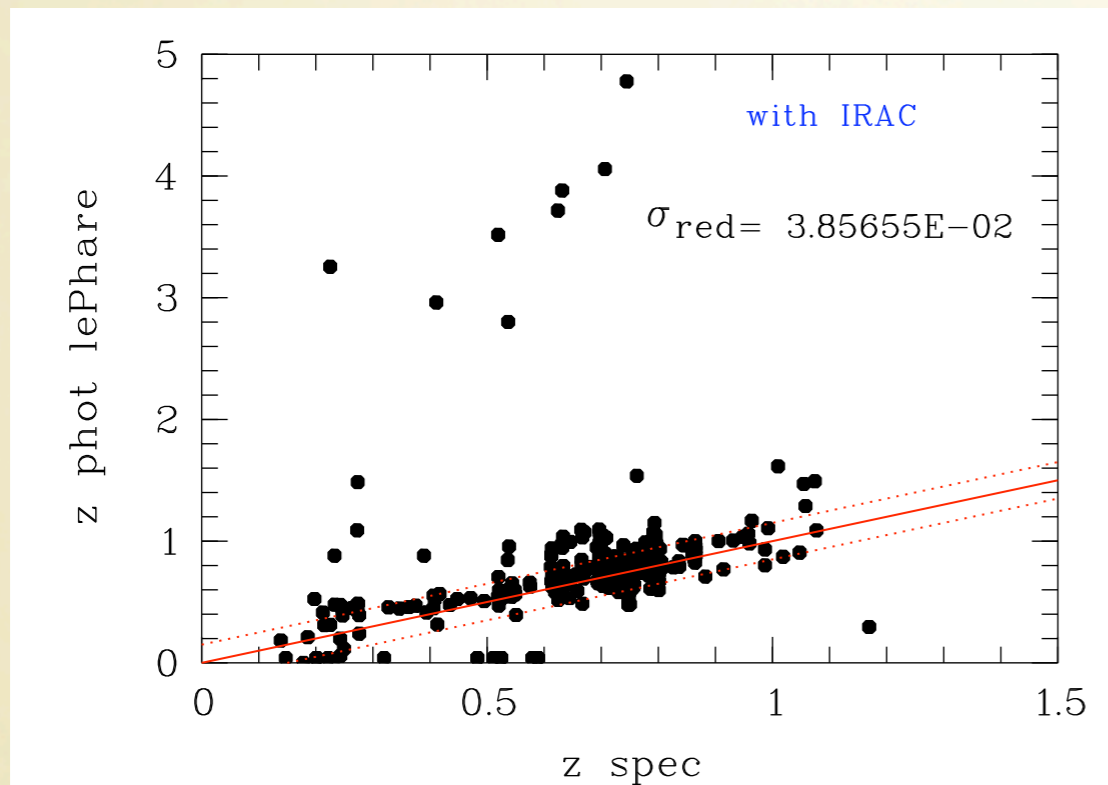
Seems to Work
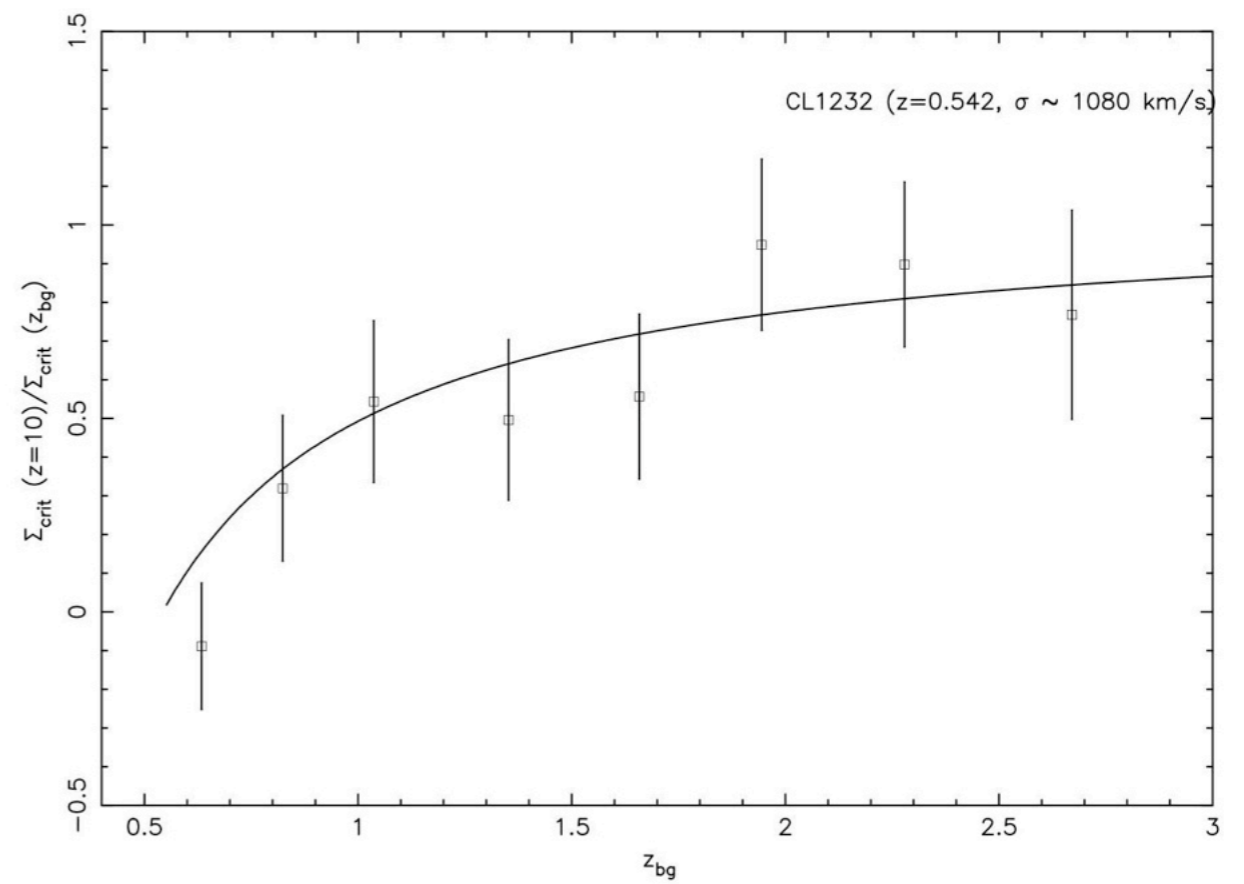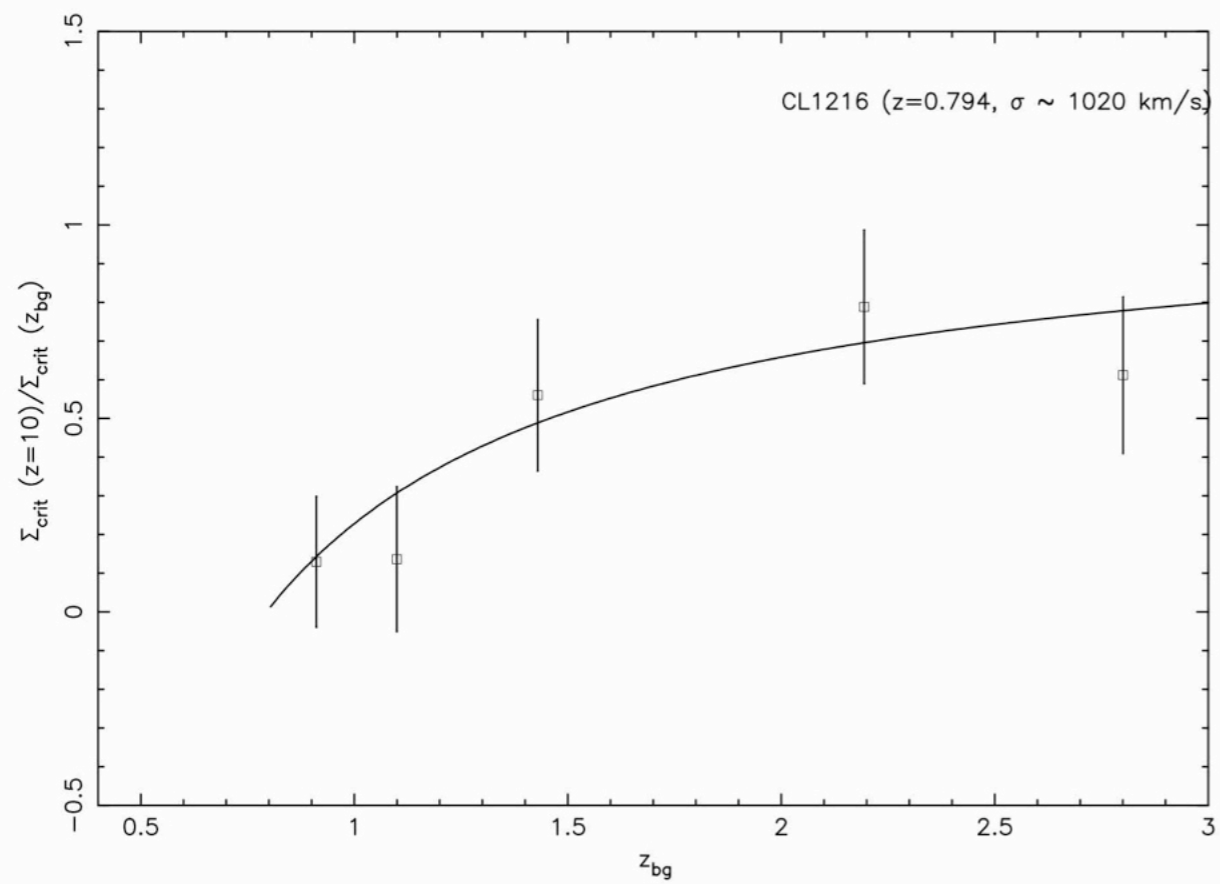

(1-D parameterized method)

Current Status

- All of the ACS imaging has been reduced with the HAGGLES pipeline (thanks to Tim Schrabback)

- WFPC2 images are currently being reduced with a modified version of the HAGGLES pipeline

- Complete optical coverage of 23 clusters in hand, hopefully 30 by end of this fall - more than half of the total HST imaging area

- Going to need a lot of early spring telescope time to finish the survey!

Constraints From Some Future Survey

(80,000 clusters over 10,000 sq. degrees with 50 galaxies per sq arcminute)
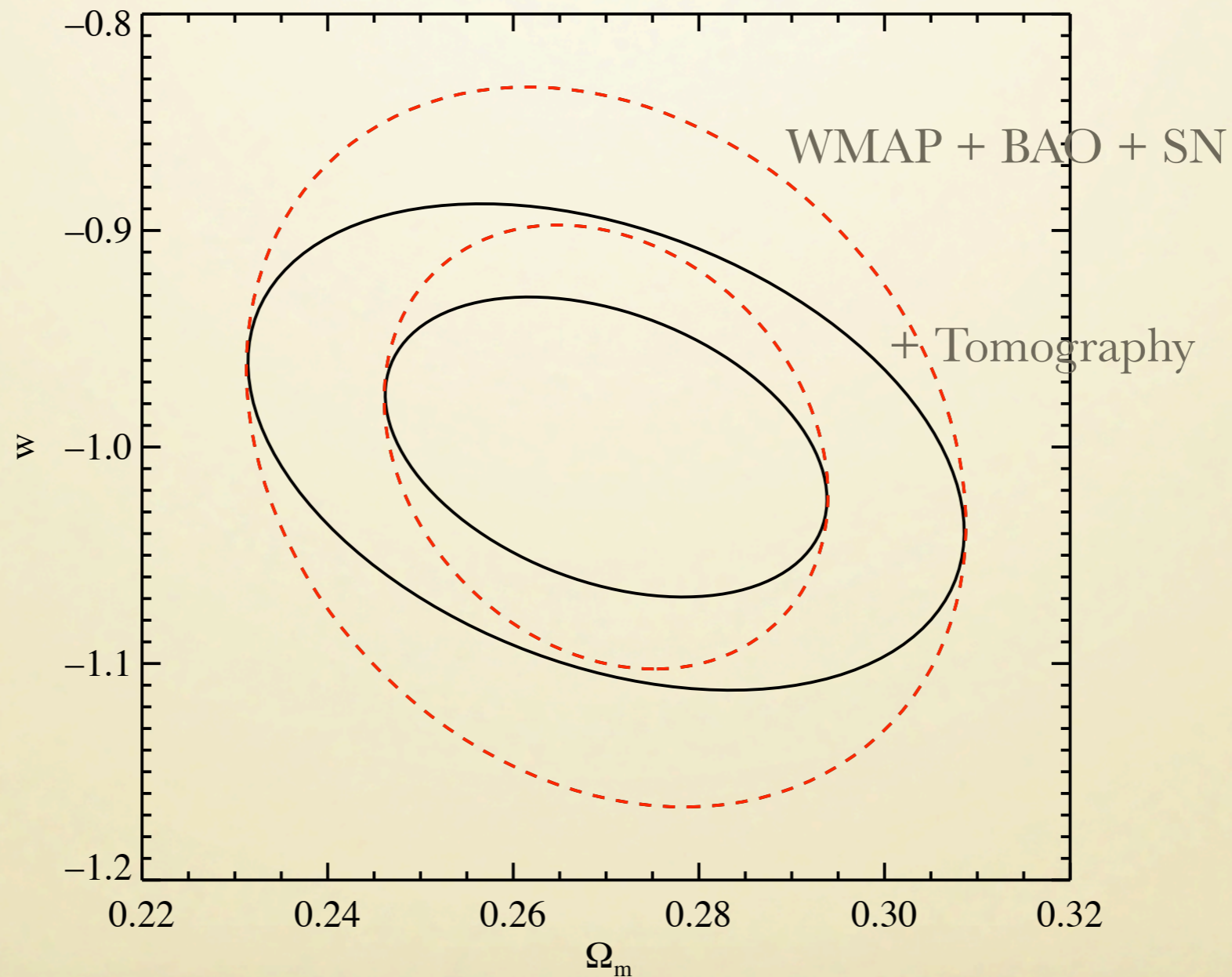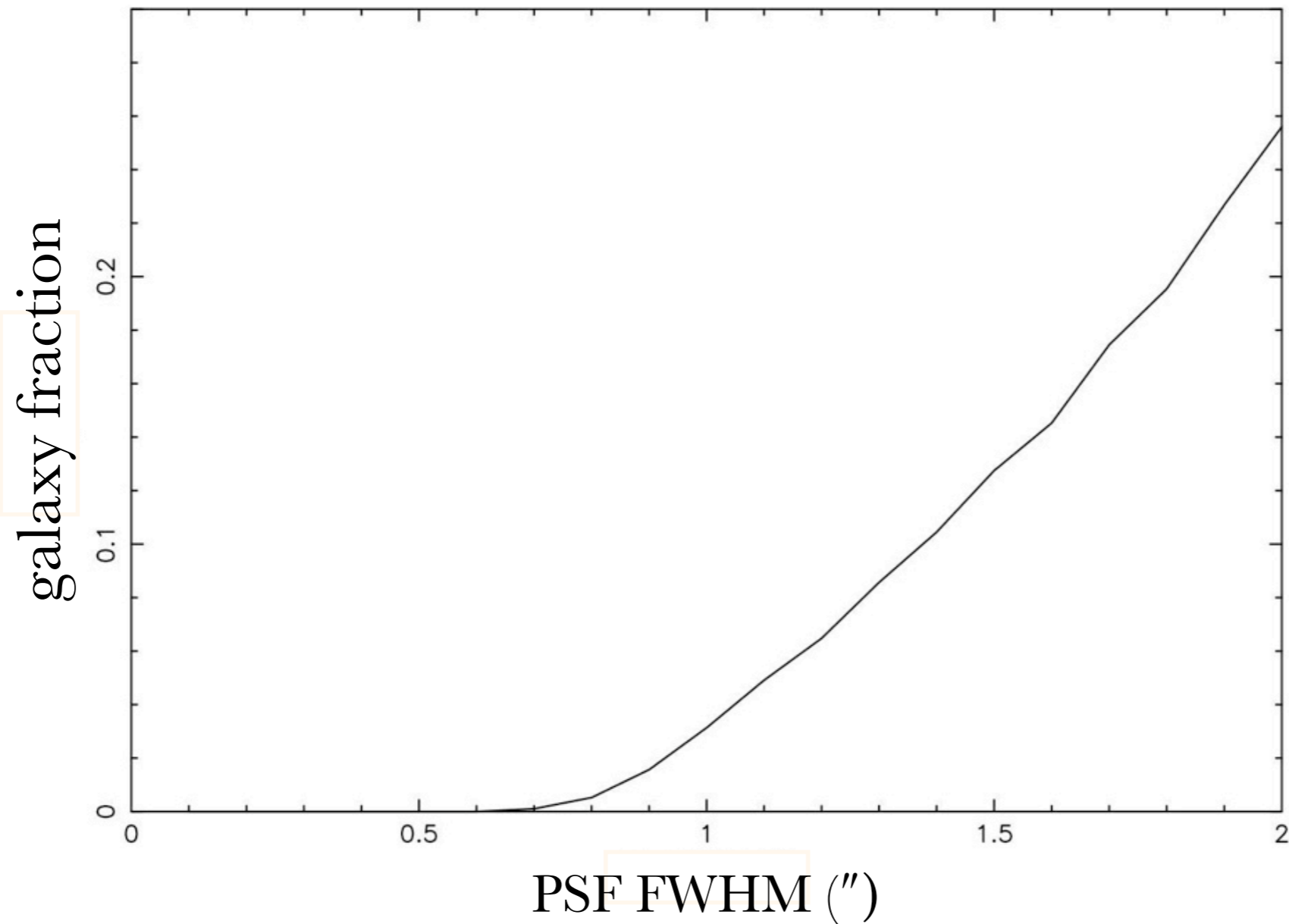
A reason for (faint) hope
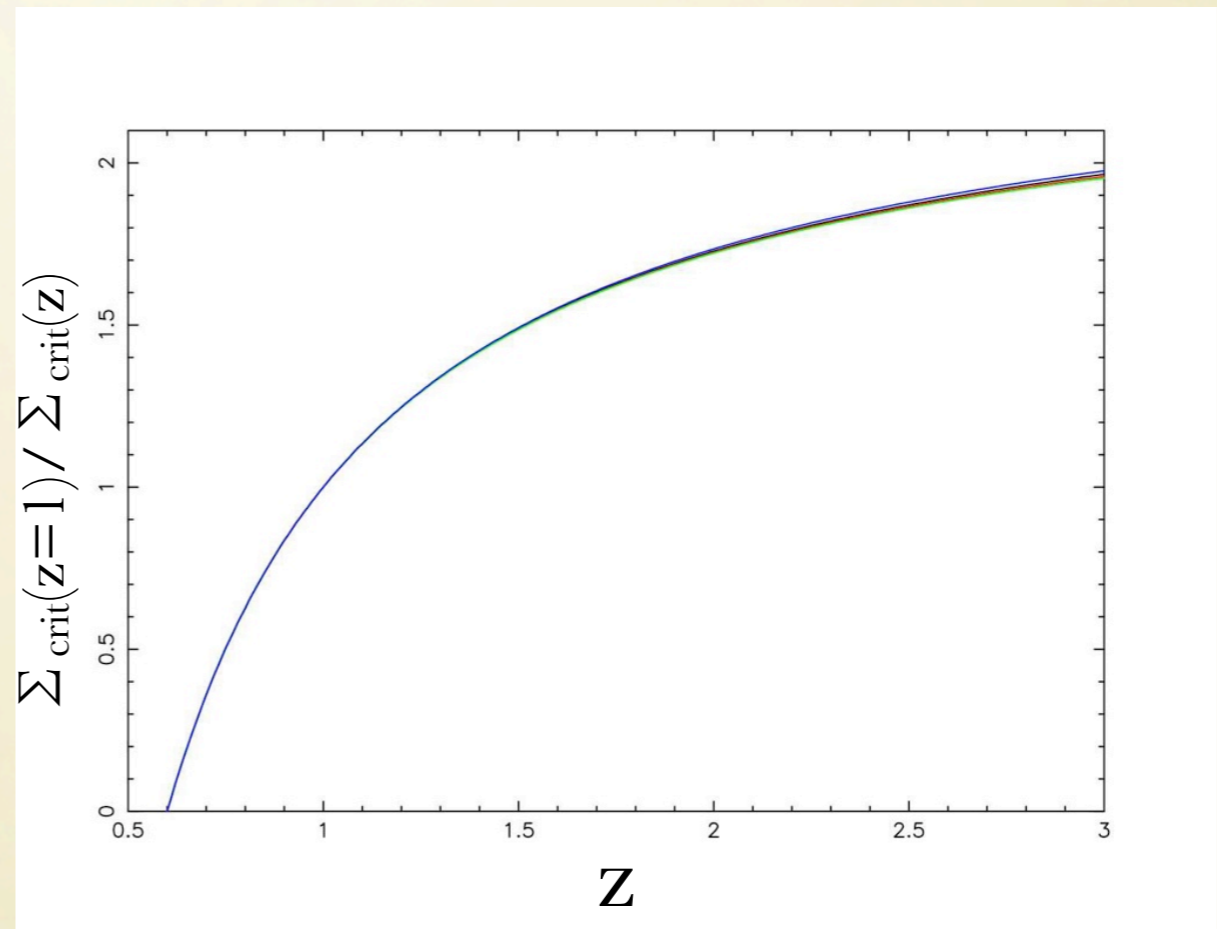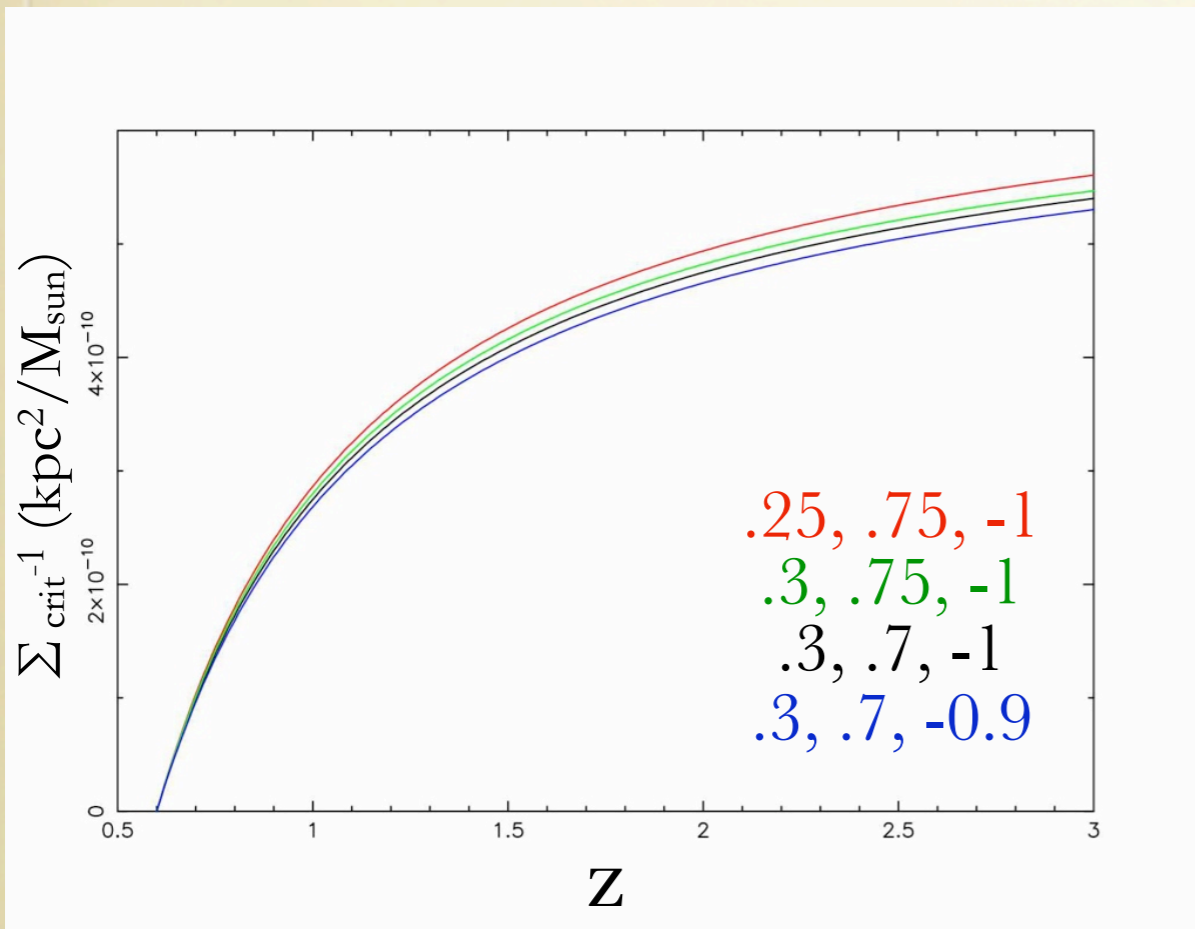
Just have to be able to measure mean surface density of a cluster sample to a bias < few x 10^{-3}

Something Else to Worry About

Summary

- WL measurements of clusters can provide a purely geometric tomographic signal

- Will not be competitive with other methods of constraining DE, but provides a cross-check independent of assumptions of standard candles

- Will soon^{TM} have a sample of 91 high-z clusters with HST imaging + 5(+1) passband photo-z's to help test shear measurement techniques