A Weak Lensing Pixel Scale Study

F. William High
Harvard
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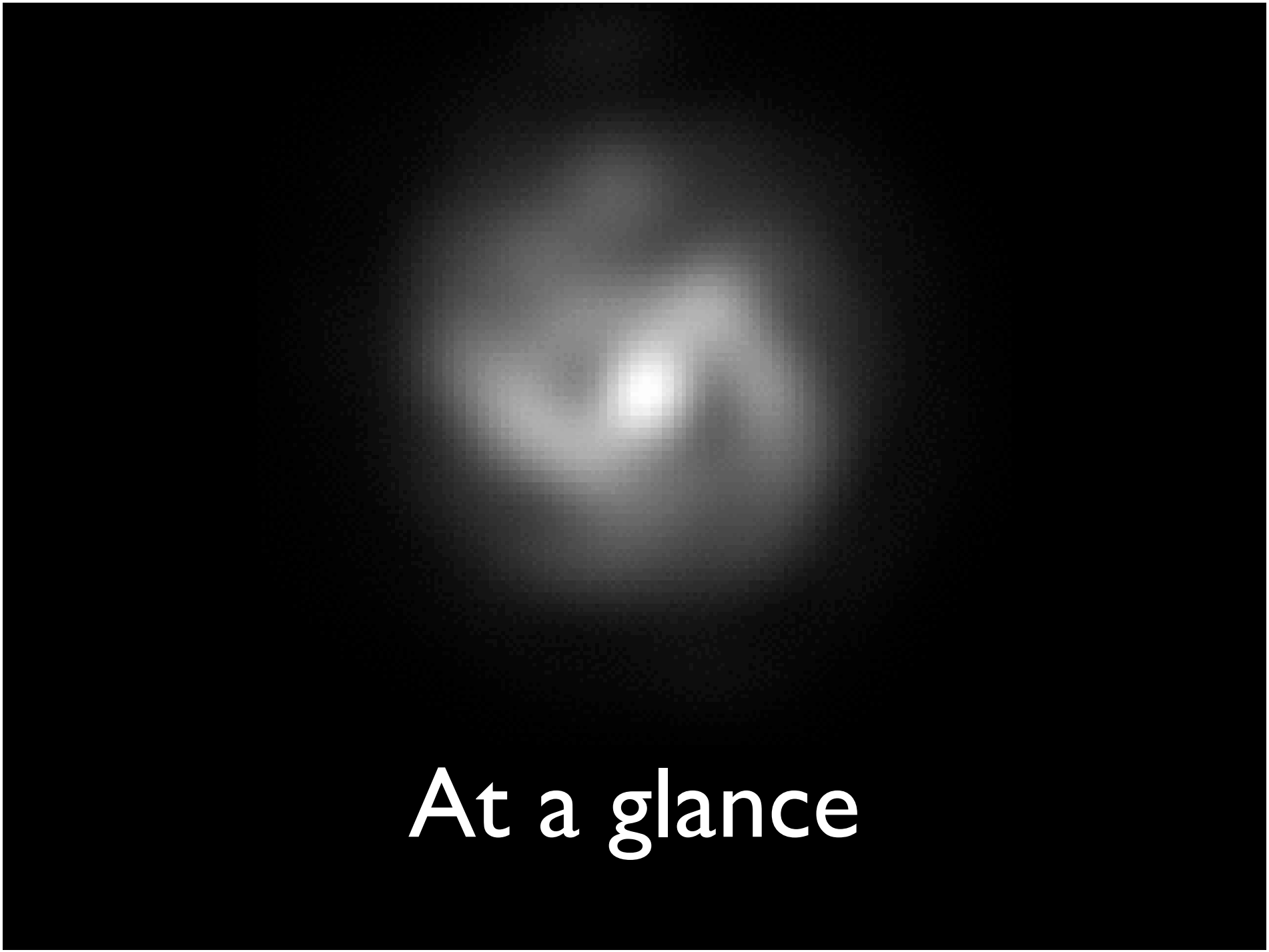
with Jason Rhodes, Richard Massey & Richard Ellis

Outline

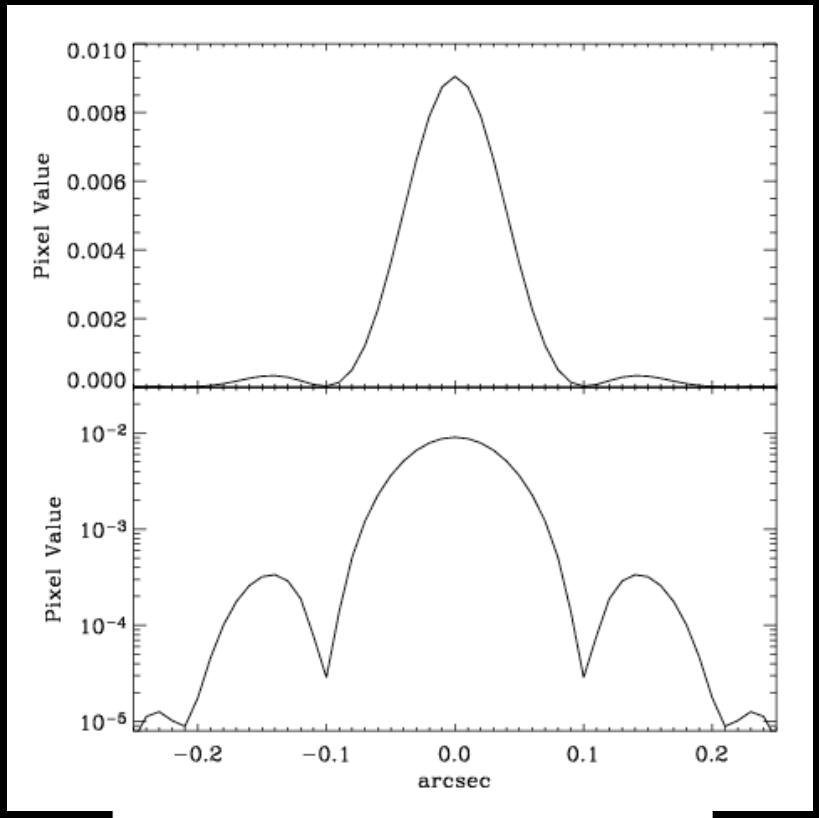
- Background & Motivation
- What is pixelation?
- Method, Data & Results
- Future work & Discussion



At a glance

Motivation

- SNAP's pixel scale is 0.1"
- SNAP's PSF size is ~0.14"
  => not Nyquist sampled
- ***How would changing the pixel scale affect WL cosmology?***

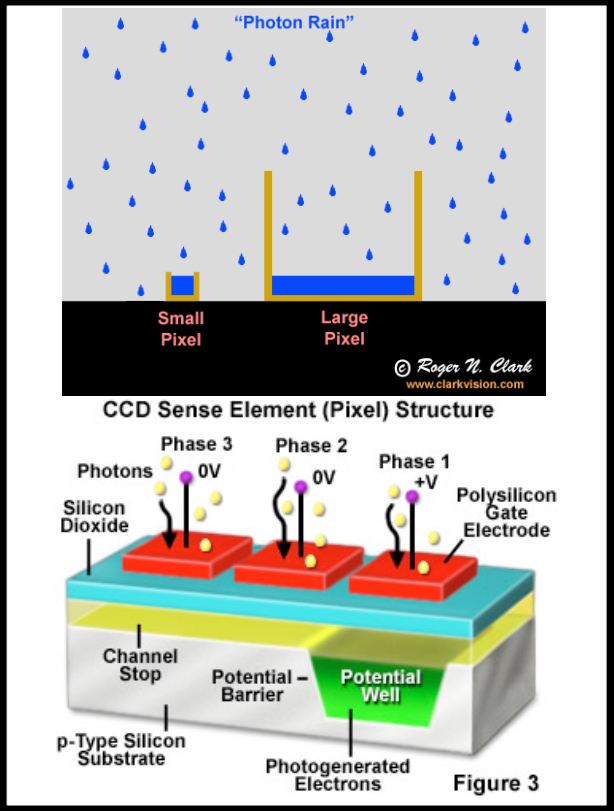


Oversampled PSF

What is Pixelation?

What is Pixelation?

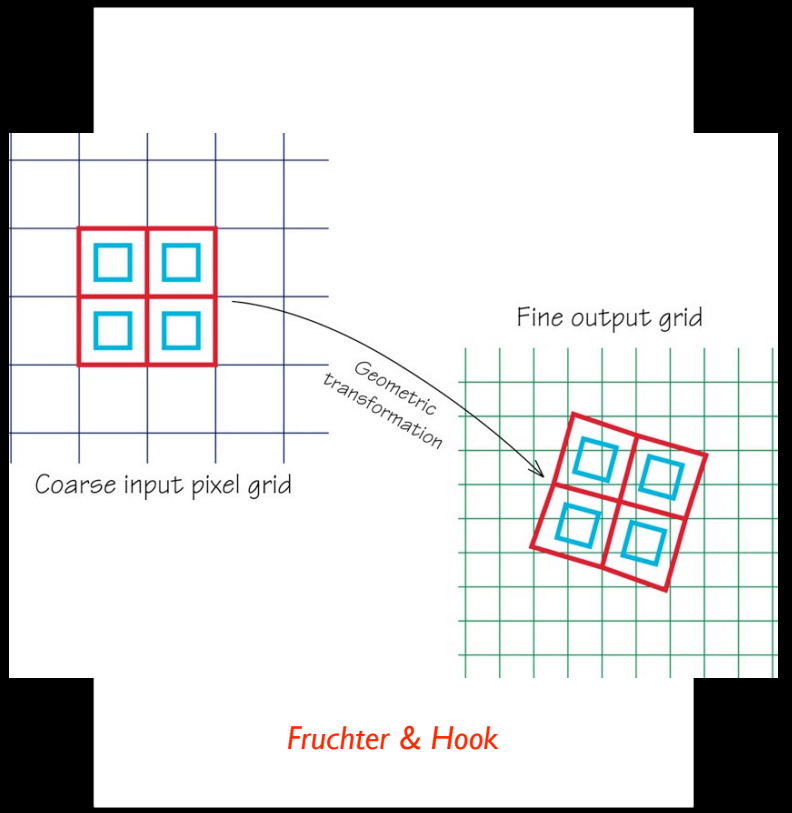
- In CCD science, it is a ***physical process***
- Photons liberate bound electrons in the CCD substrate
- Photoelectrons are collected in potential wells
- Photoelectrons are counted
- The number is assigned a position



microscopyu.com

What is Pixelation?

- It is also a ***side-effect*** of reductions
- Pixel binning
- WCS registration (eg, Swarp)
- Co-addition



Fruchter & Hook

Method

- Use fake images (a la Massey) with known shear at different pixel scales (like STEP3)
- Fix
  - Number of pixels
  - Exposure time
  - PSF + charge diffusion
- Vary
  - Pixel size (0.4”-0.16”) <=> survey size
  - Input shear
- SNAP diffraction with 6 micron charge diffusion
- Recover shear with RRG

Method

- Single exposure and ideal deinterlacing studies
- "Ideal deinterlacing" == Drizzling with delta-function resampling to 1/2 the pixel scale
- 2x2 half-pixel dithers
- ¼ the exposure time => same effective exposure time after coadding

Data

Table 1. Summary of the simulated images.

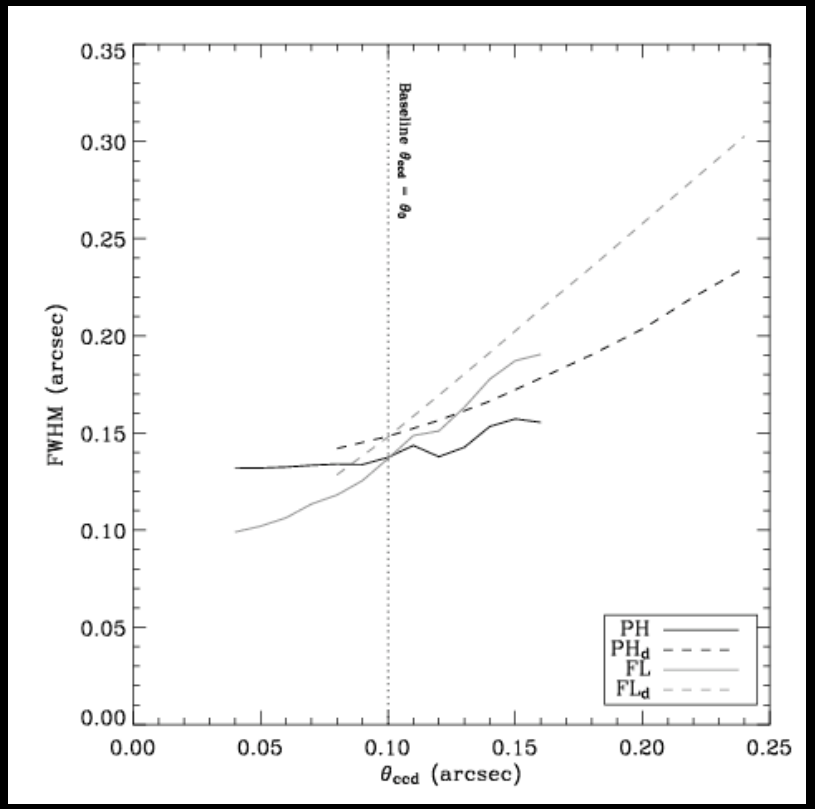
Label[a]	Variable[b]	Plate Scale	$\sigma_{\rm ch}$[c]	Dithered?
PH	Photosite size in μm	$10''\mathrm{mm}^{-1}$	$4\mu\mathrm{m} = 0.04''$	No
PH_d				Yes
FL	Focal length (plate scale)	$10''\mathrm{mm}^{-1} \times \frac{\theta_{\rm ccd}}{\theta_0}$	$4\mu\mathrm{m} = 0.04'' \times \frac{\theta_{\rm ccd}}{\theta_0}$	No
FL_d				Yes

[a]The shorthand label assigned to a common set of simulated images.

[b]What is perturbed in order to change $\theta_{\rm ccd}$.

[c]Standard deviation of the Gaussian charge diffusion kernel as a function of perturbed CCD pixel scale.

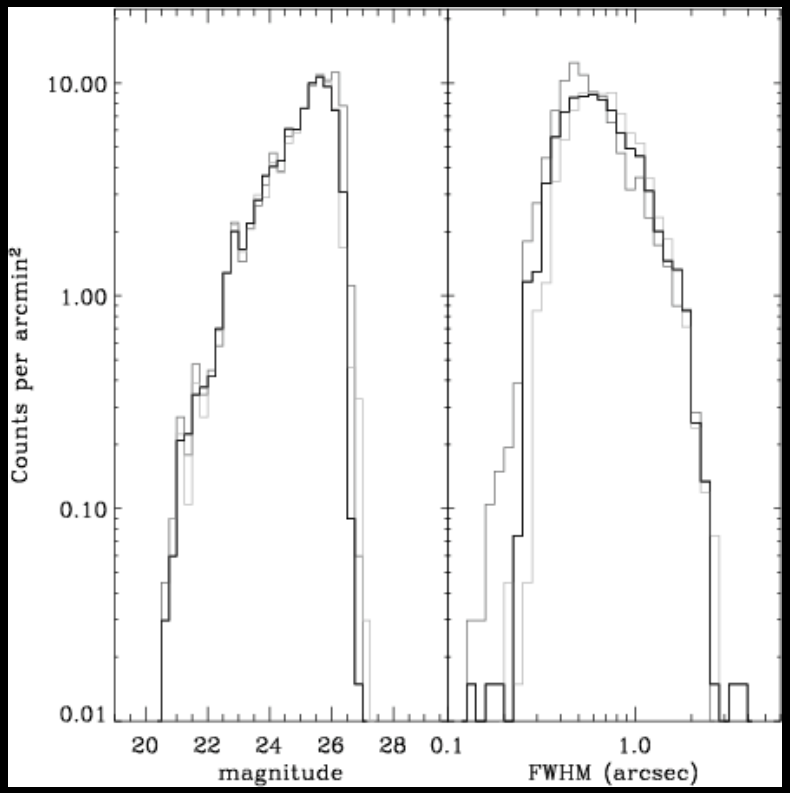
Data



PSF size versus pixel scale

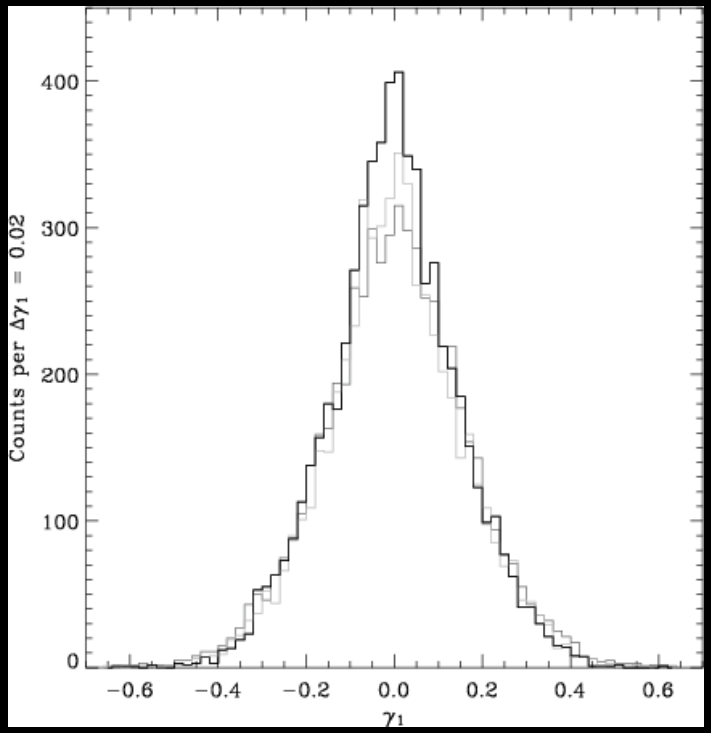
F. William High *WL@JPL* *23 August 2007*

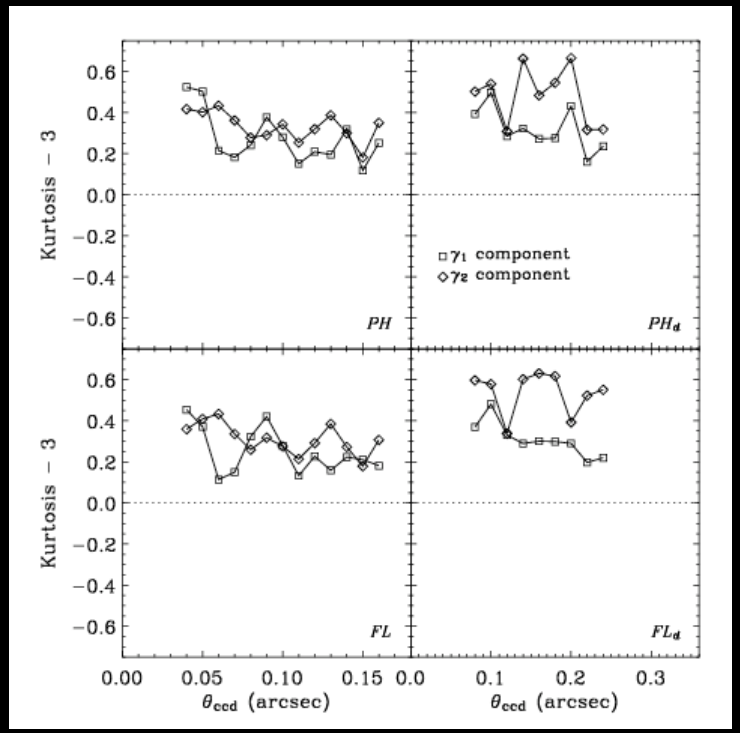
Data



Mag and size histograms at 0.04”, 0.1”, 0.2”

Data





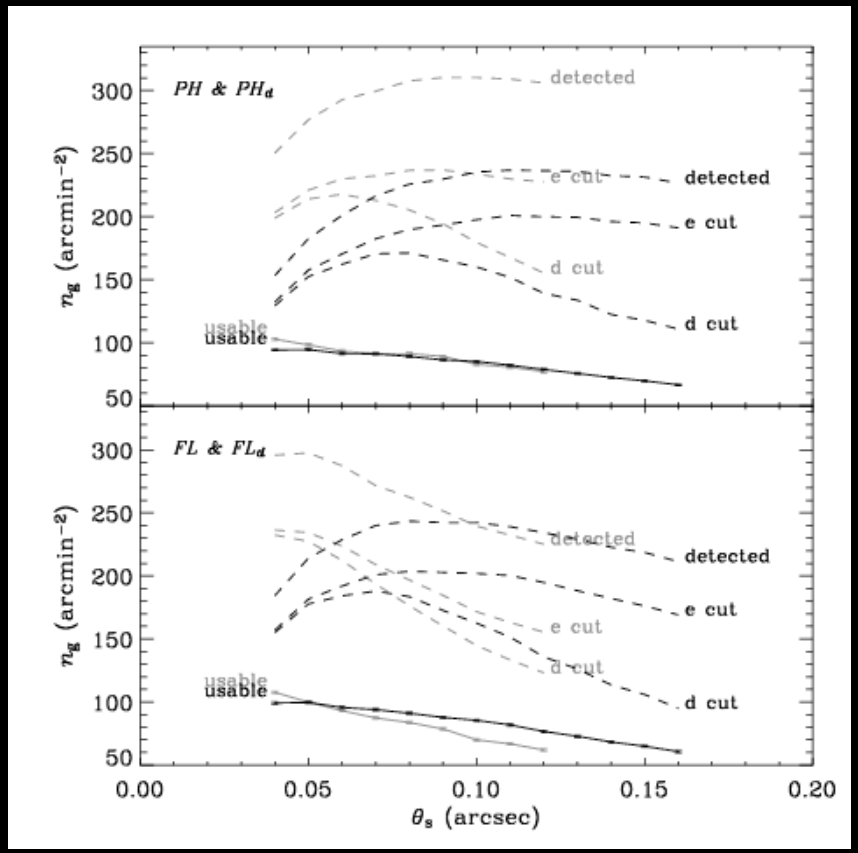
Shear dist at 0.04”, 0.1”, 0.2”

Kurtosis - 3

Results

n_{gal}

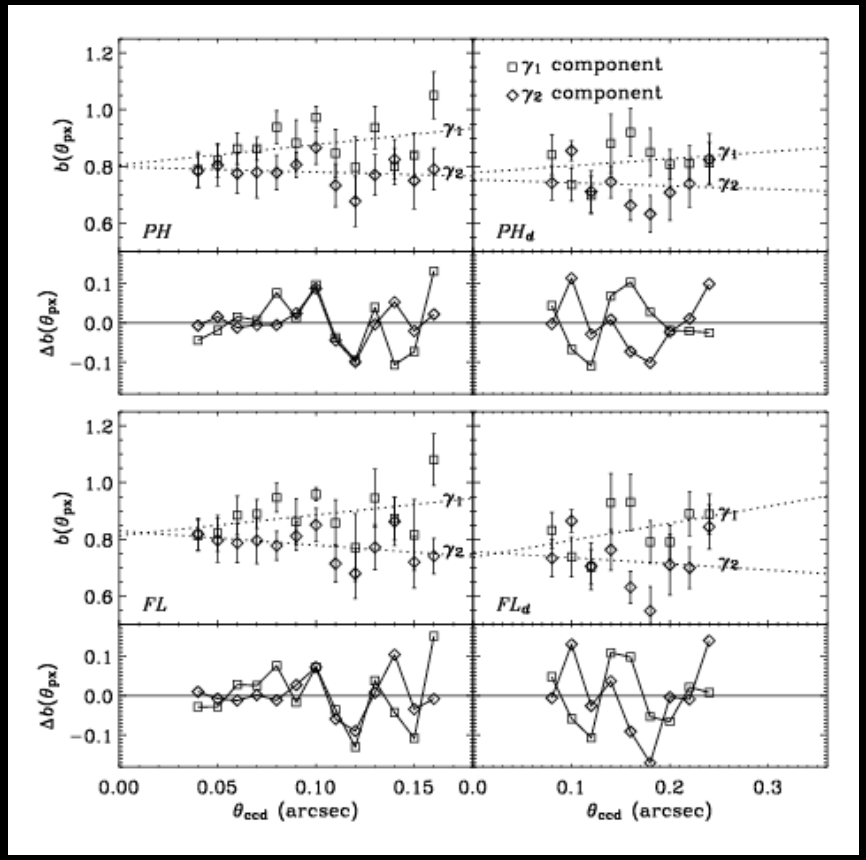
- ***NOT n_{eff}***
- n_{gal} decreases with larger pixel scales
- Ideal deinterlacing does NOT increase n_{gal} (top) and in fact decreases it if smaller CCD pixel scales would have meant smaller charge diffusion (bottom)



Results

Multiplicative bias

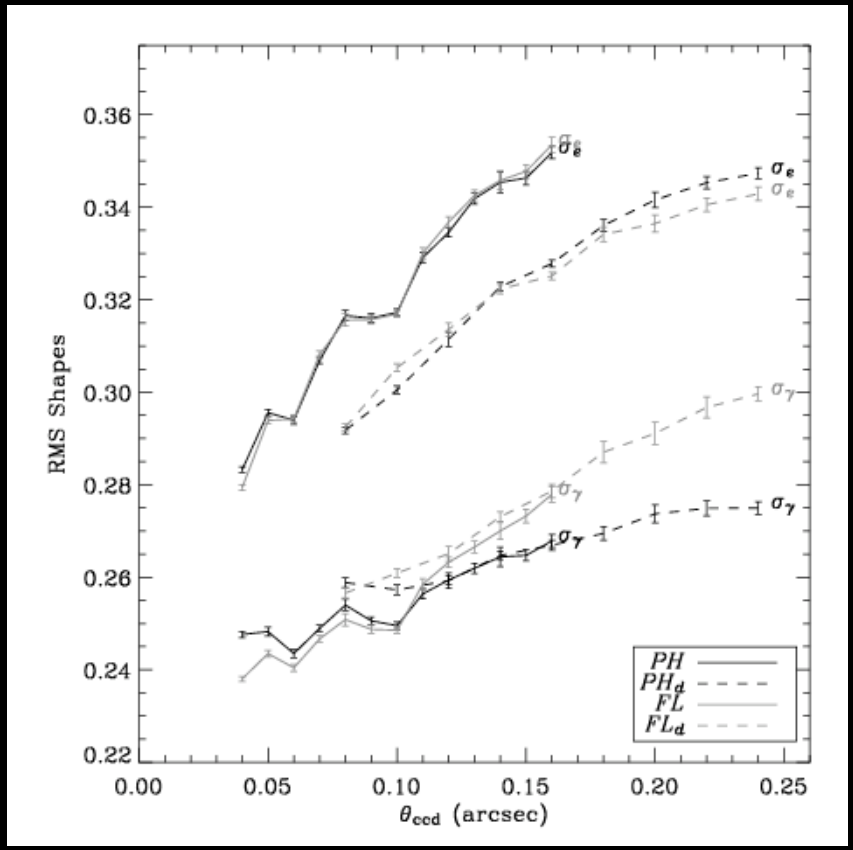
- Some sytematic trends with pixel scale
- Noisy at large CCD pixel scales
- Different values for the 2 shear components
- Dithering doesn't reduce bias noise



Results

σ_γ & σ_e

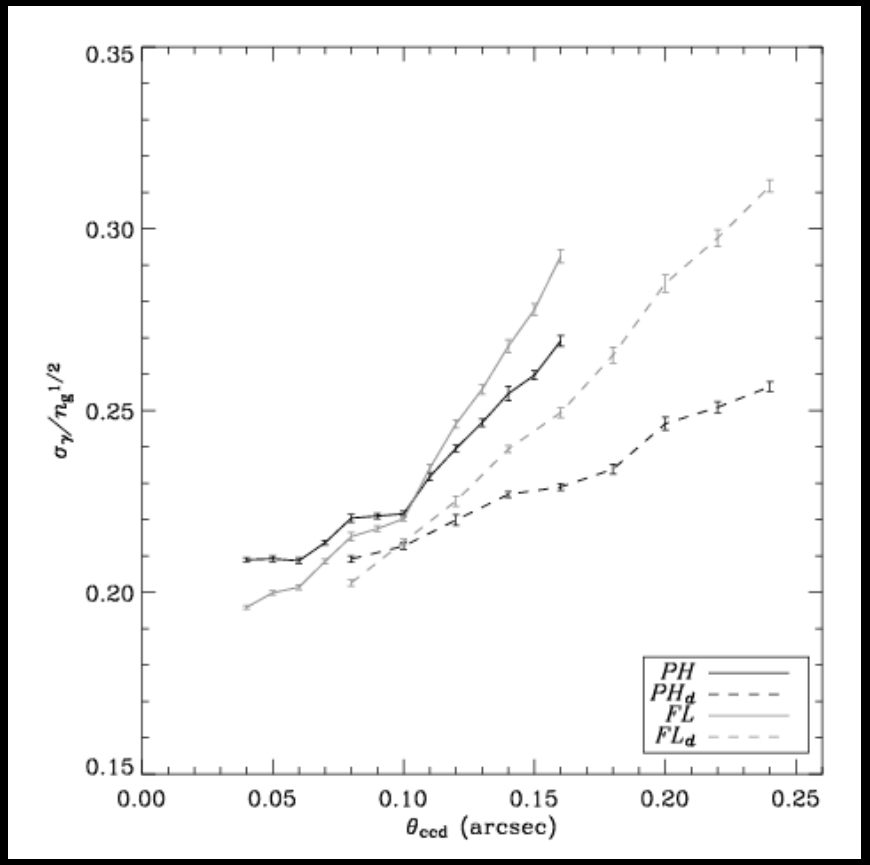
- The RRG shear estimator reduces shape scatter (cuts?)
- Dithered gals are rounder in terms of ellipticity
- Dithered gals give the same shear scatter as the single exposures



Results

$\sigma_\gamma/\sqrt{n_{gal}}$

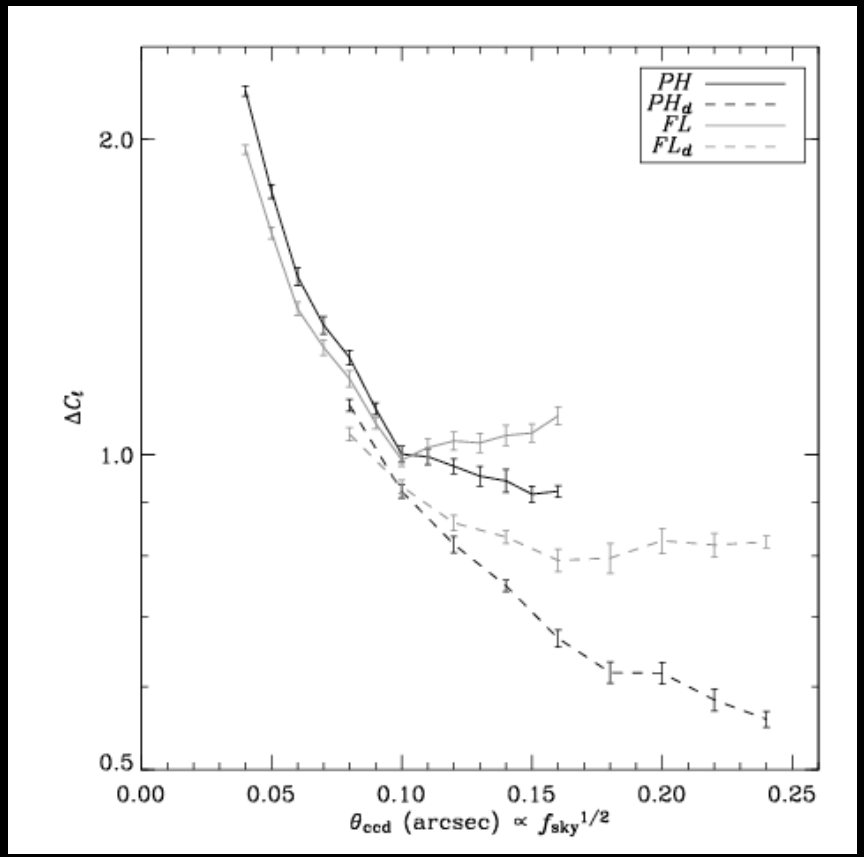
- Smaller pixels always reduce shear errors
- Ideal deinterlacing helps
- Charge diffusion bad



Results

Error on C_ℓ's

- Tradeoff: survey size and pixel resolution
- If ch diff goes with pixel scale, then 0.1" is best (0.16" or so with ideal deinterlacing)
- If not, larger pixel scales are always better (?!)
- Ideal deinterlacing always helps



Future Work

- More realistic simulations
- PSF-deconvolved Shapelet catalog
- Full cosmological parameter estimation (not just ΔC_ℓ)
- Use other methods
- Vary shear and perturb PSF

The Last Slide

- astro-ph/0703471
- Questions/comments: high@physics.harvard.edu