Challenges for weak lensing analyses of ACS data

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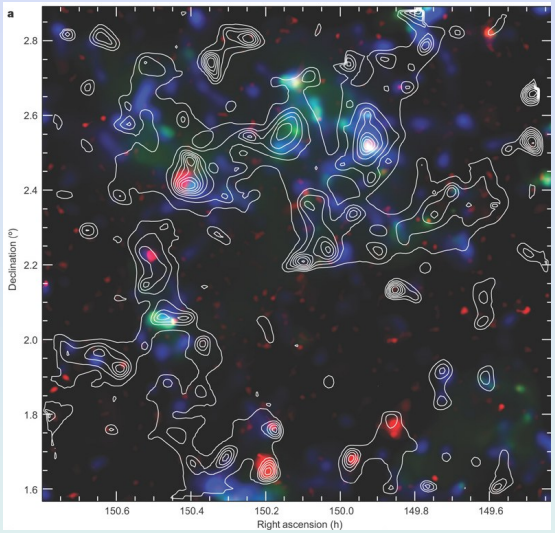
ACS has already produced many exciting weak lensing results...

Clowe et al. 2006
Bradac et al. 2006



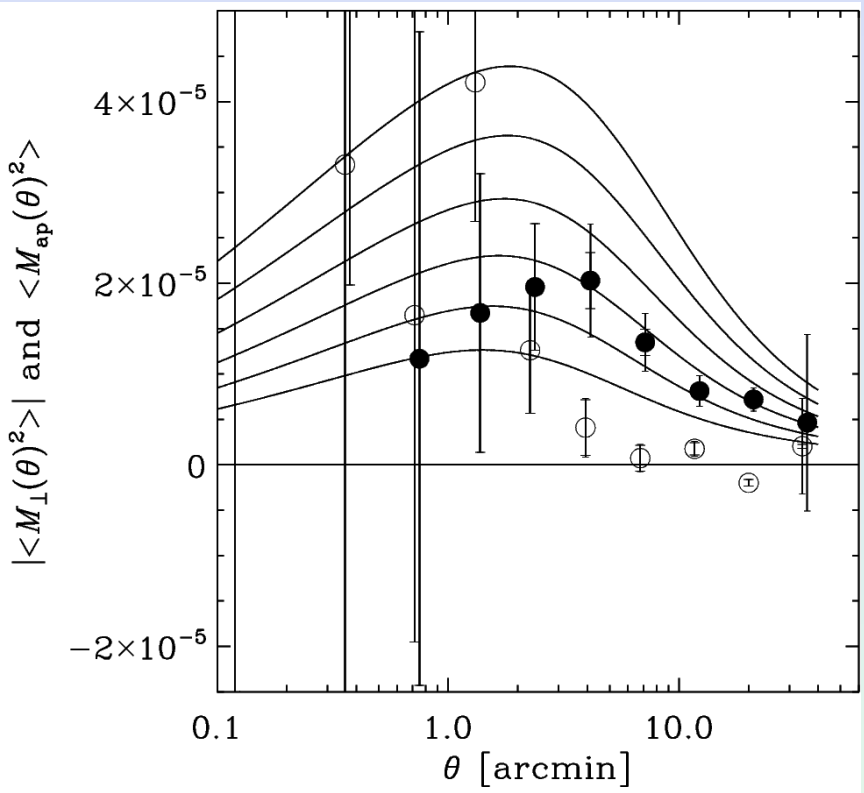
Massey et al. 2007

Jee et al. 2007

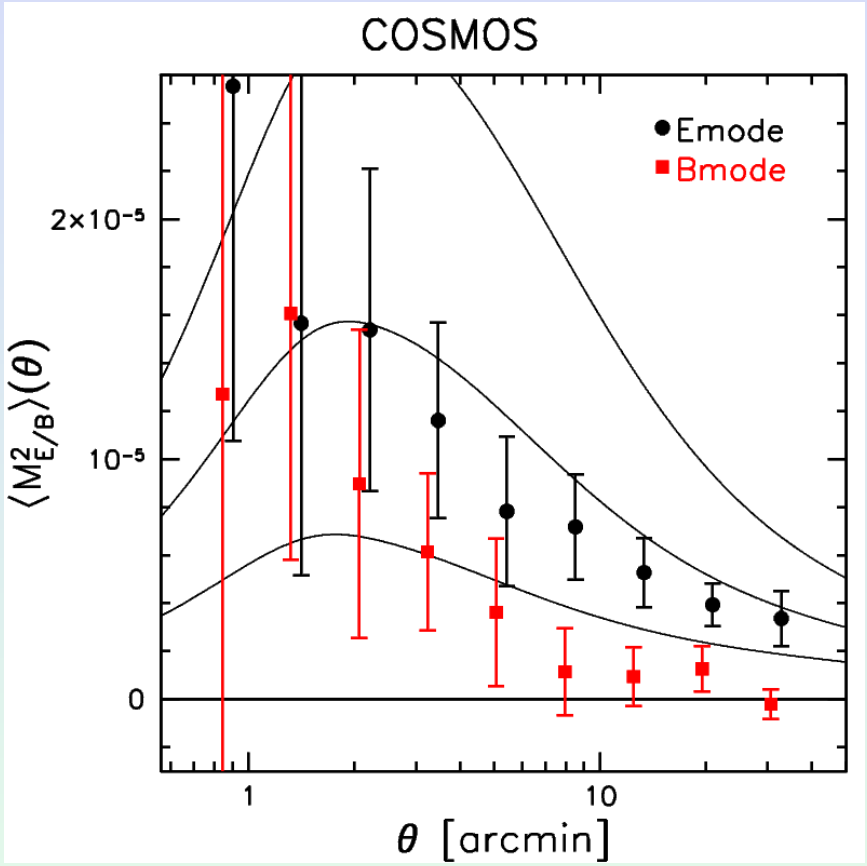
Also:

Jee et al. 2005a,b, 2006; Heymans et al. 2005, 2006; Lombardi et al. 2005; Leonard et al. 2007; Rhodes et al. 2007; Leauthaud et al. 2007; Massey et al. 2007b; Schrabback et al. 2007; Gavazzi et al. 2007

... but even after 5 years we do not have a full understanding of the systematics: COSMOS



Massey et al. (2007) analysis: Outer error-bars include cosmic variance.



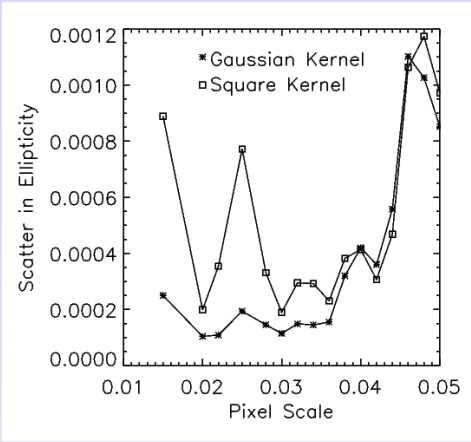
Schrabback et al. analysis: Statistical error-bars without cosmic variance.

Challenges

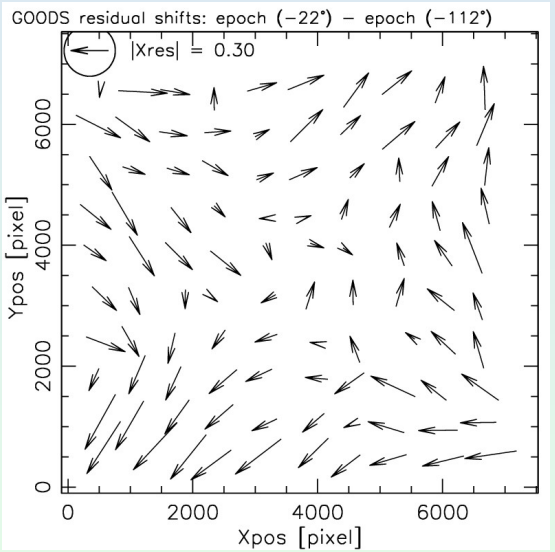
1. High demands on data and data reduction
2. Shape measurement for diffraction limited PSF
   $\Rightarrow$STEP3: Probably Ok
3. PSF variation and interpolation
4. Correction for CTE degradation
5. Redshift distribution

1. Data and data reduction

- Cosmics, hot pixels, and camera distortions: Usually corrected with **MultiDrizzle**
- **Drizzle - Advantages:** Analysis in co-added frames (needed for moment-based methods) **Disadvantages:** Noise correlations, aliasing, smears out PSF variation
- Careful shift refinement
- How stable is the distortion solution?
- Poor dithering leads to image artifacts.

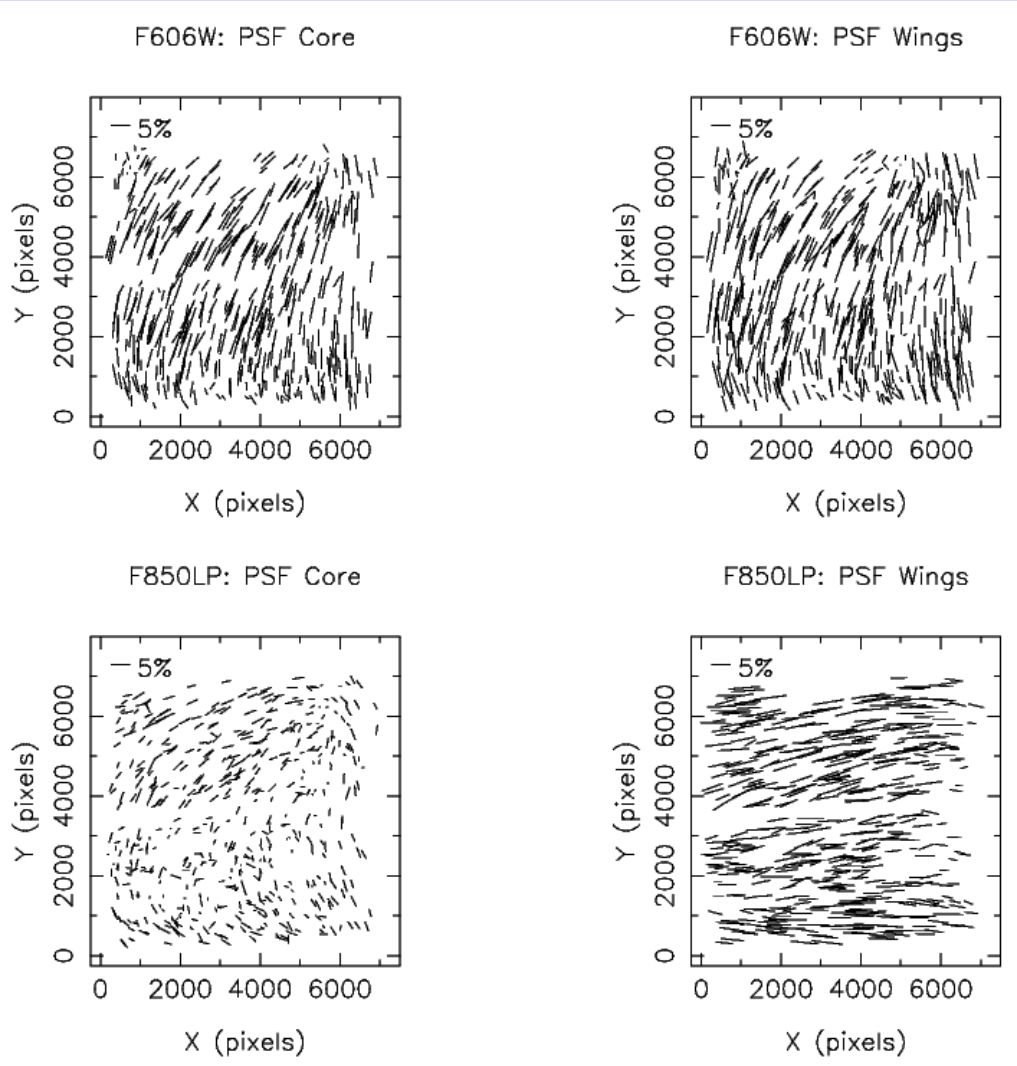


Rhodes et al. 2007



Schrabback et al. 2007

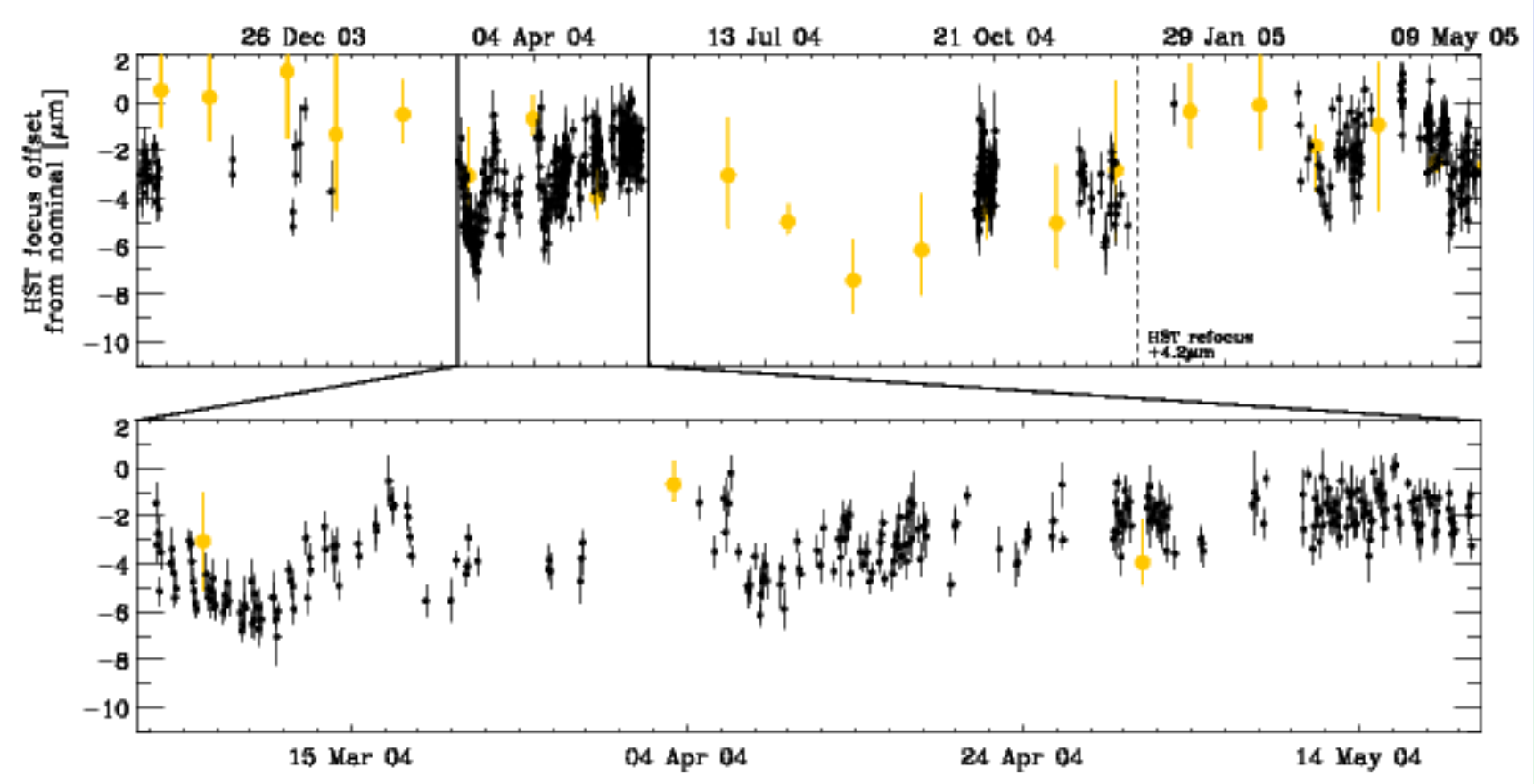
2. Shape measurement: PSF size dependence



Heymans et al. 2005

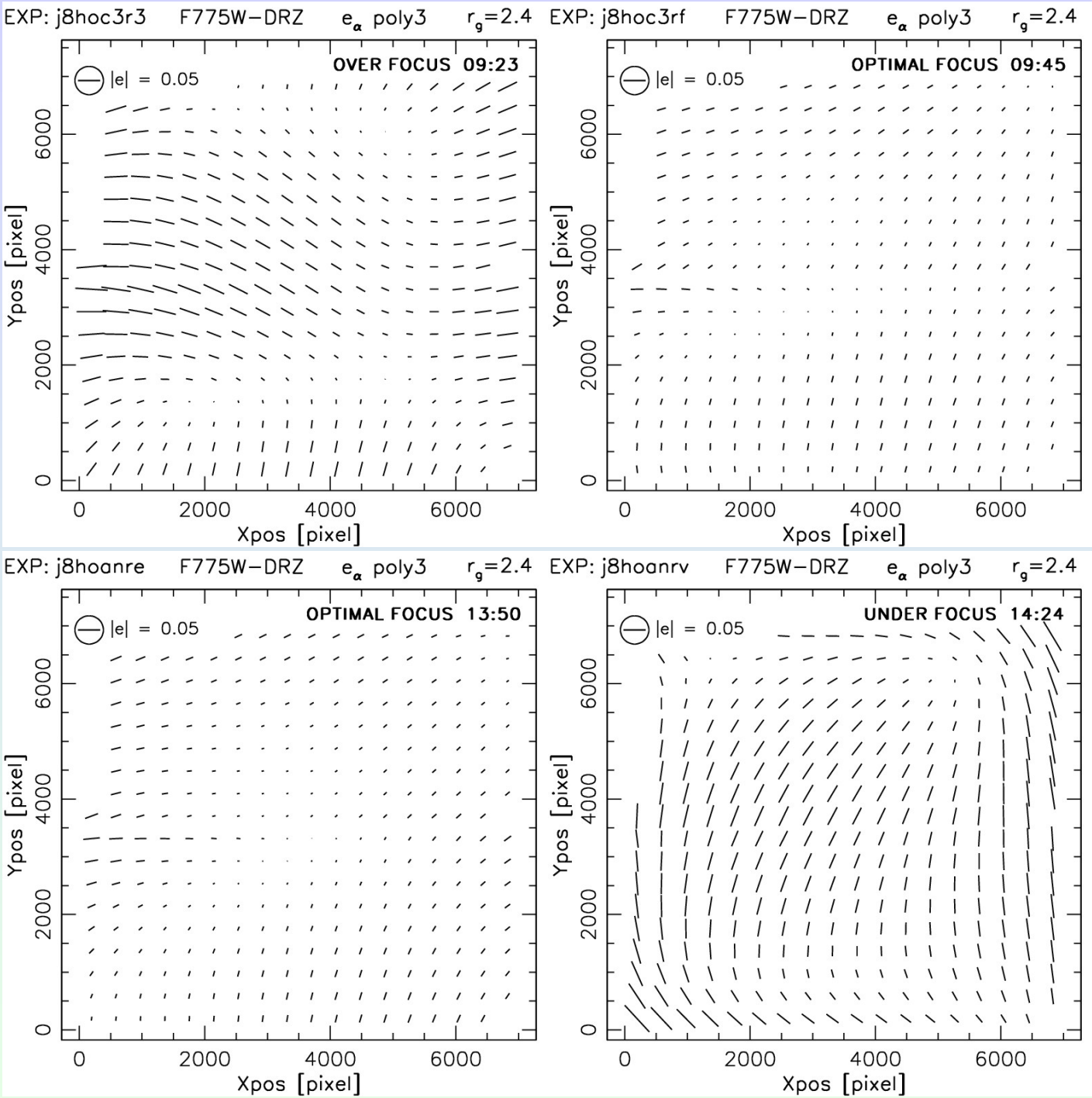
3. PSF variation

Long term variation



Rhodes et al. 2007

PSF: Short term variation

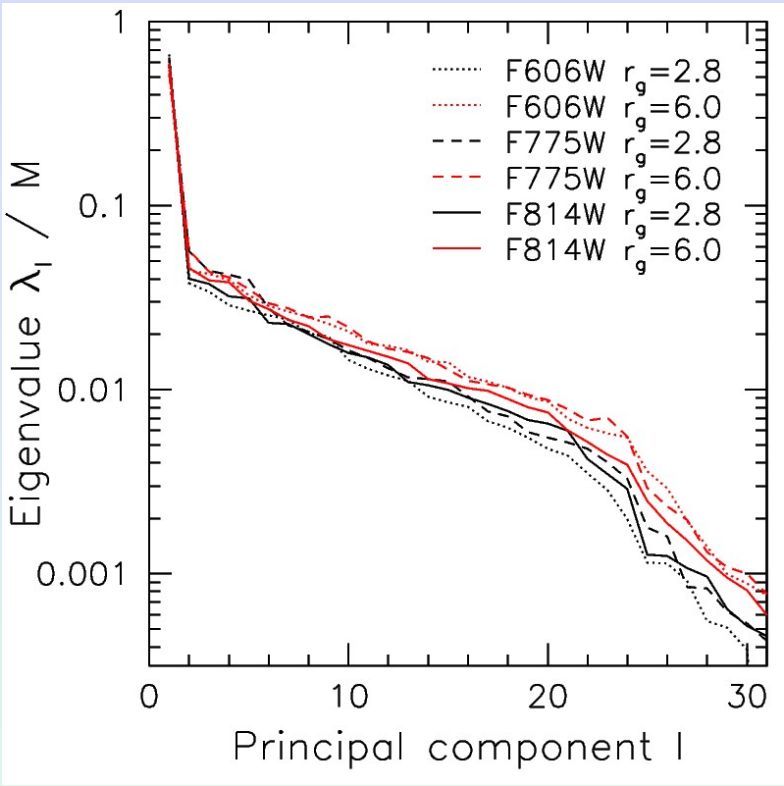


Schrabback et al. 2007

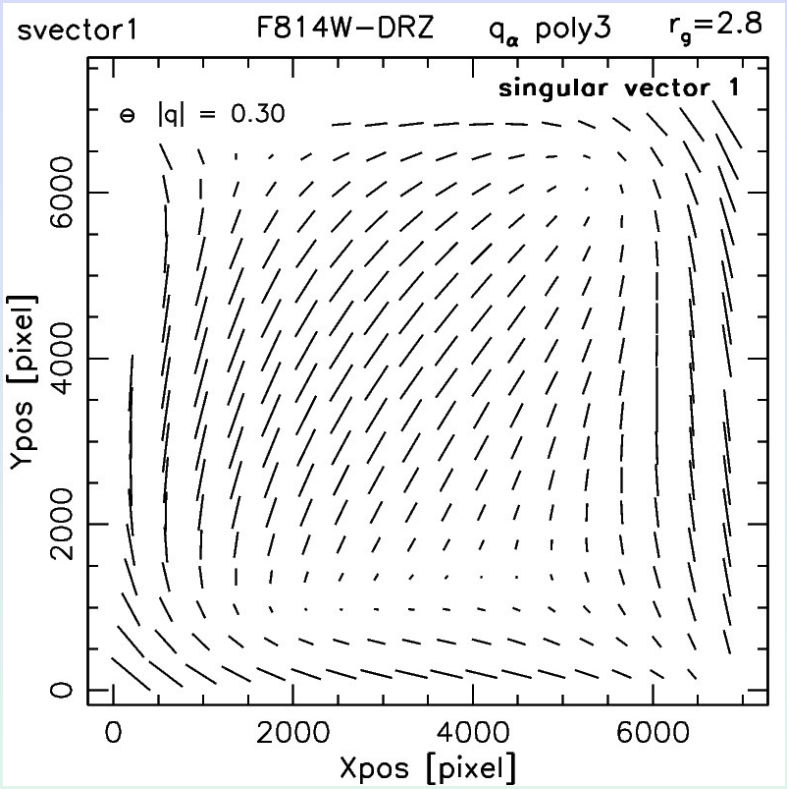
PSF variation: Solutions

1. **Direct interpolation:** Ok if $\gtrsim 40$ stars. (Lombardi et al. 2005; Clowe et al. 2006; Bradac et al. 2006)
2. **Assume stability:** Get PSF model from 1 stellar field. (Jee 2005a,b, 2006 + modifications)
3. **Semi-time-dependent model:** 2 GEMS epochs, quite stable within epoch, except intra orbit variation (Heymans et al. 2005)
4. **Focus-dependent TinyTim models:** Time-dependence good except intra orbit. Model accuracy? (Rhodes et al. 2005,2007; Leauthaud et al. 2007; Massey et al. 2007a,b; Gavazzi et al. 2007)
5. **Stellar field library:** Correction based on single exposures provides full time-dependence (Schrabback et al. 2007; Jee et al. 2007).
6. **Principal Component Analysis:** Reiko's talk. Some more plots...

Principal component analysis

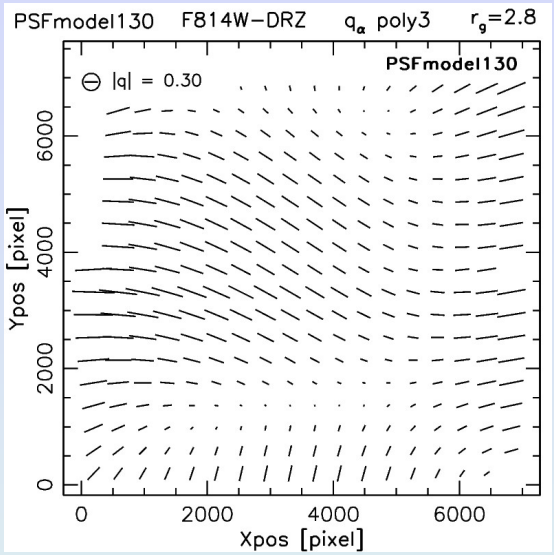


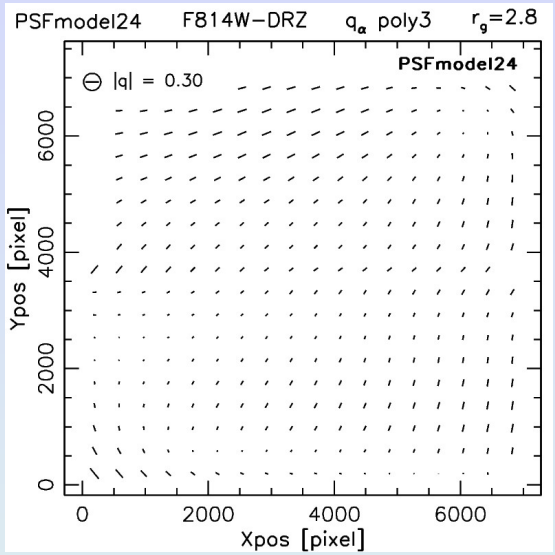
PCA eigenvalues for 3rd-order polynomial PSF fits.

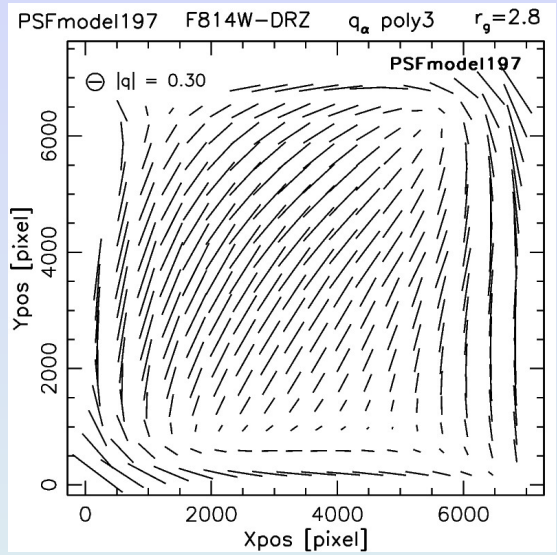


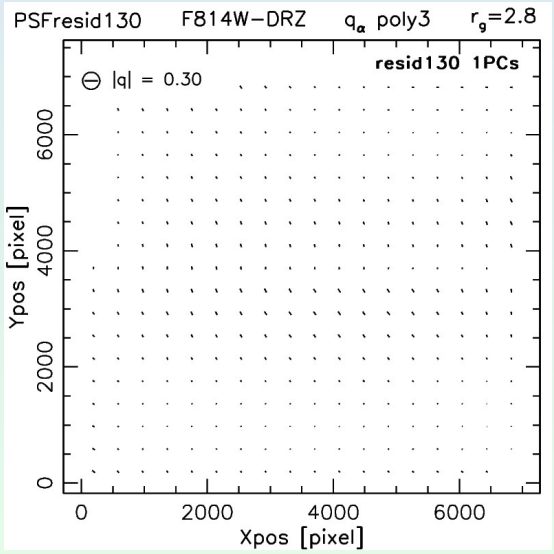
Singular vector of the 1st principal component (F814W).

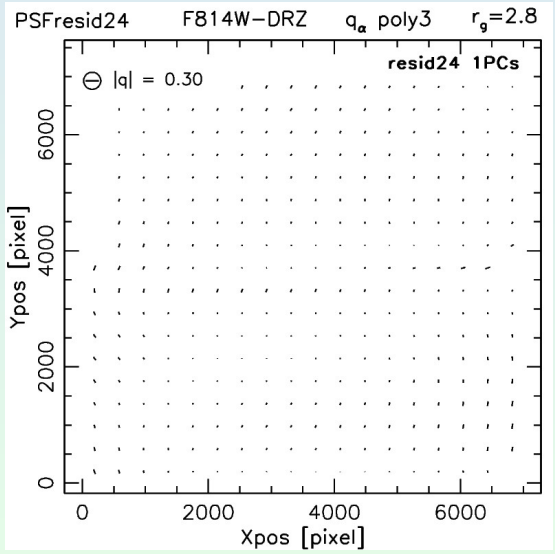
Correction using only 1st PC (original, residuals)

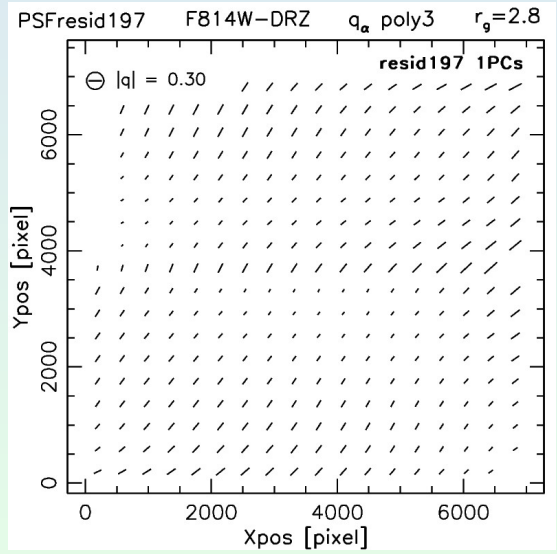






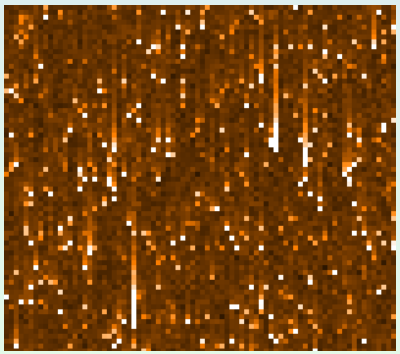




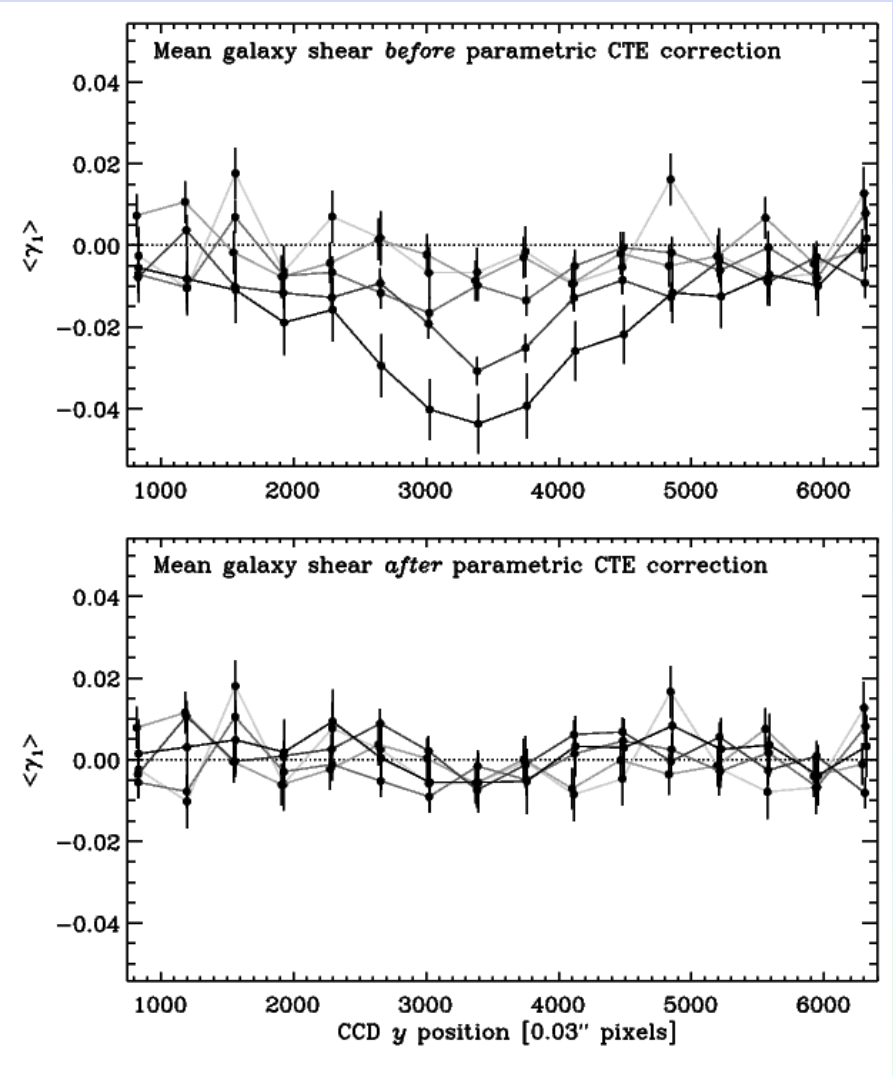


4. Correction for CTE degradation

- Cosmic ray bombardment creates charge traps reducing CTE
- Charge is released statistically ⇒charge trails
- Non-linear effect, depends on number of transfers, time, sky background, flux, size, history



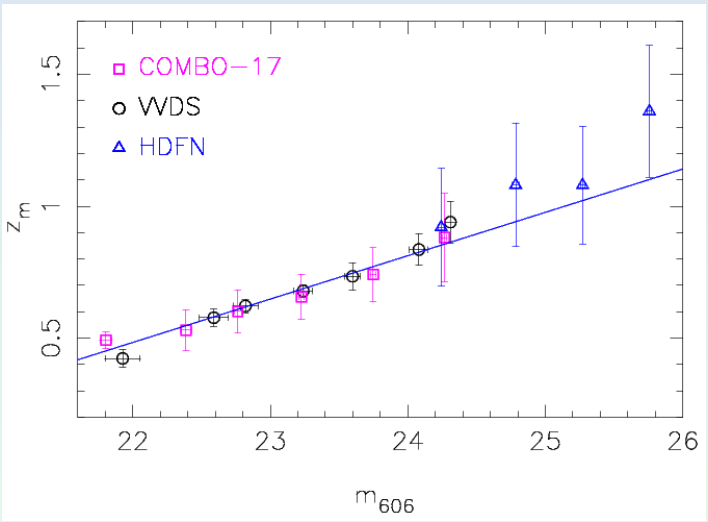
Hot pixels with CTE trails



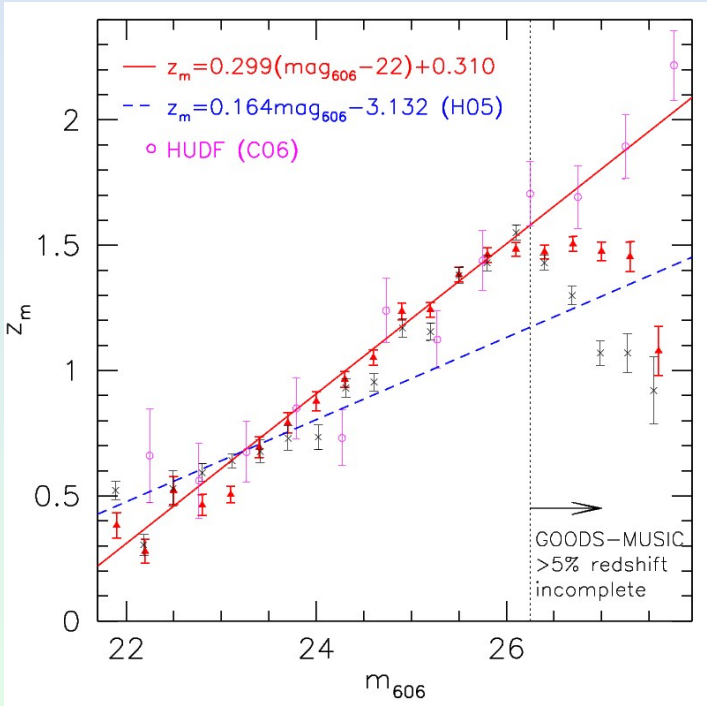
Rhodes et al. 2007

5. Redshift distribution

- **Good:** photo-zs for most galaxies (COSMOS)
- **Worse:** Extrapolation for faint galaxies (GEMS)
- **Problematic:** External Calibration from HDF, etc. (Parallels, many clusters, ...), see van Waerbeke et al. 2006



GEMS, Heymans et al. 2005



GEMS, Schrabback et al. 2007

Some questions

1. Should we try to avoid drizzling?
2. Do we need to worry about distortion instability?
3. Can we improve the PSF interpolation?
4. How can we be sure the CTE correction is fine? Can it be done on the pixel level?
5. What is the origin for the COSMOS B-modes?
6. Can we get a sufficiently reliable redshift distribution from external fields?
7. What did we / can we learn from ACS for future space-based weak lensing missions?