Cosmic shear from CFHTLS Wide (T0003)

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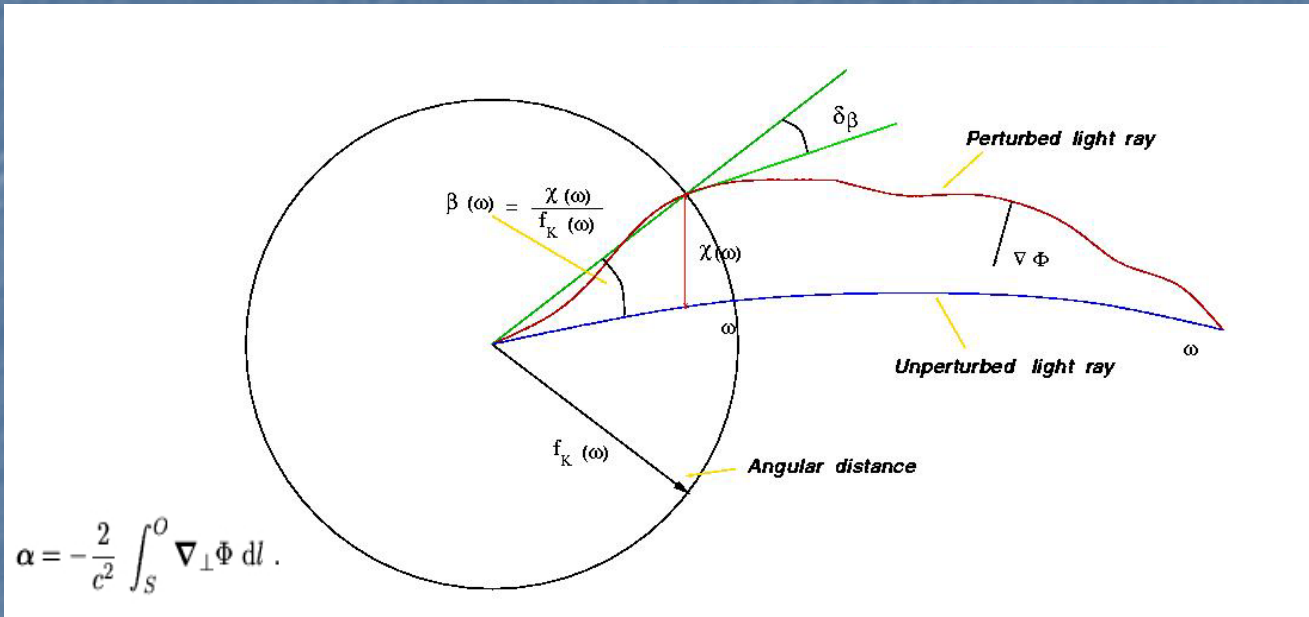
Outline:

- Basic Theory of Cosmic shear
- Quick review of cosmic shear on CFHTLS T0001 Wide (Hoekstra et al., 2006)
- Cosmic shear of CFHTLS Wide T0003
  - Analysis Reliability of Comic shear
  - Pipeline modification
  - Shear two-point correlation functions

I. Basic Theory of Cosmic shear

Weak gravitational lensing and cosmology: Light propagation in inhomogeneous universe



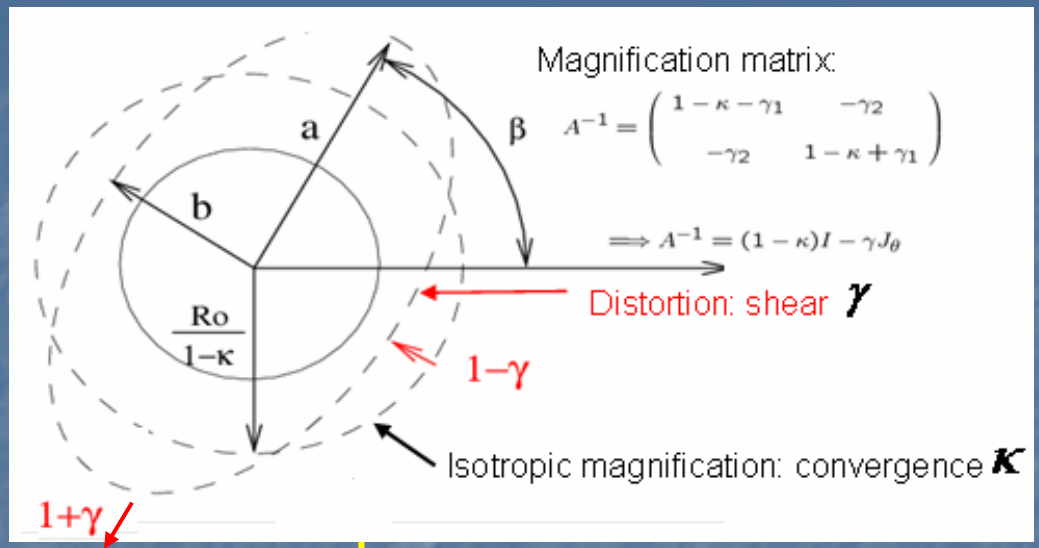
Distances (Geometry)

Power spectrum, growth rate of structure

Convergence

$$\kappa_{eff} = \frac{3H_0^2\Omega_0}{2c^2}\int_0^{\omega}\frac{f_K(\omega-\omega')\,f_K(\omega')}{f_K(\omega)}\frac{\delta\left[f_K(\omega')\,\boldsymbol{\theta};\omega'\right]}{a(\omega')}\mathrm{d}\omega'$$

Weak lensing and Galaxy shape:



$$M_{ij} = \frac{\int I(\boldsymbol{\theta})\,\theta_i\,\theta_j\,\mathrm{d}^2\theta}{\int I(\boldsymbol{\theta})\,\mathrm{d}^2\theta}$$

PSF anisotropy correction
Derived from star shape analysis.

$$\delta = \frac{2\gamma\,(1-\kappa)}{(1-\kappa)^2 + |\gamma|^2} = \frac{a^2-b^2}{a^2+b^2}$$

$$\frac{a^2-b^2}{a^2+b^2}$$

$= \varepsilon_s + \varepsilon_i$ + noise + systematics….

$\delta \sim 2\gamma$ (weak lensing regime)

Reliability of results: depends on PSF analysis

Assume sources orientation is isotropic:

Weak lensing regime : $\delta \sim 2\gamma = \langle \varepsilon_{Shear} \rangle_\theta$ + noise

Cosmic shear probes the dark matter power spectrum

(Blandford et al 1991, Miralda-Escudé 1991, Kaiser 1992,1998,
Bernardeau et al 1997, Jain & Seljak 1997, Schneider et al 1998)

❖ Two-point statistics

- ✓ Shear correlation function $< \gamma\gamma >$
- ✓ Aperture mass variance $< M_{ap}^{\ 2} >$
- ✓ Top-hat shear variance $< \gamma^2 >$

Difference → Filter function

❖ Simple case:

assuming a single lens plane and $P(k) \sim \sigma_8 k^n$

$$< e^2 > \sim < \gamma^2(\theta) > \approx 0.01^2 \; \sigma_8^{\ 2} \, \Omega_M^{\ 1.6} \; z_s^{\ 1.5} \left(\frac{\theta}{1\mathrm{deg}} \right)^{-(n+2)}$$

redshift

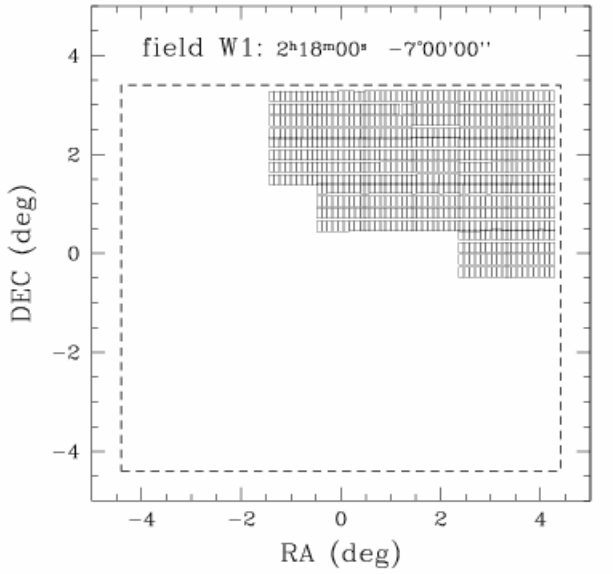
BUT intrinsic ellipticity ~ 30 %

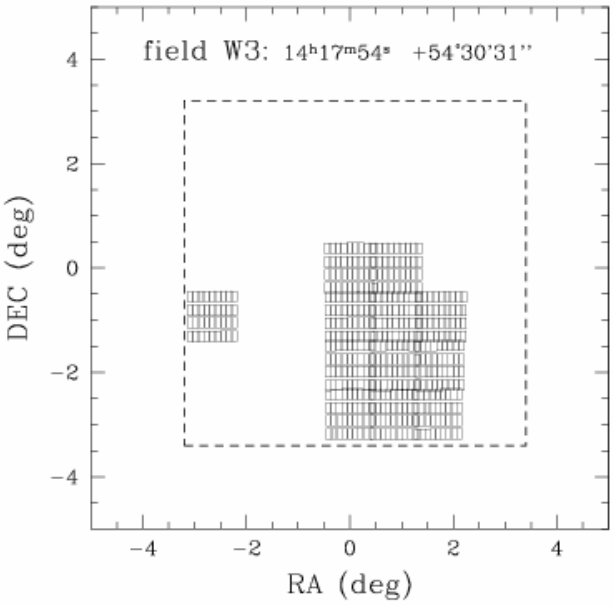
Cosmology

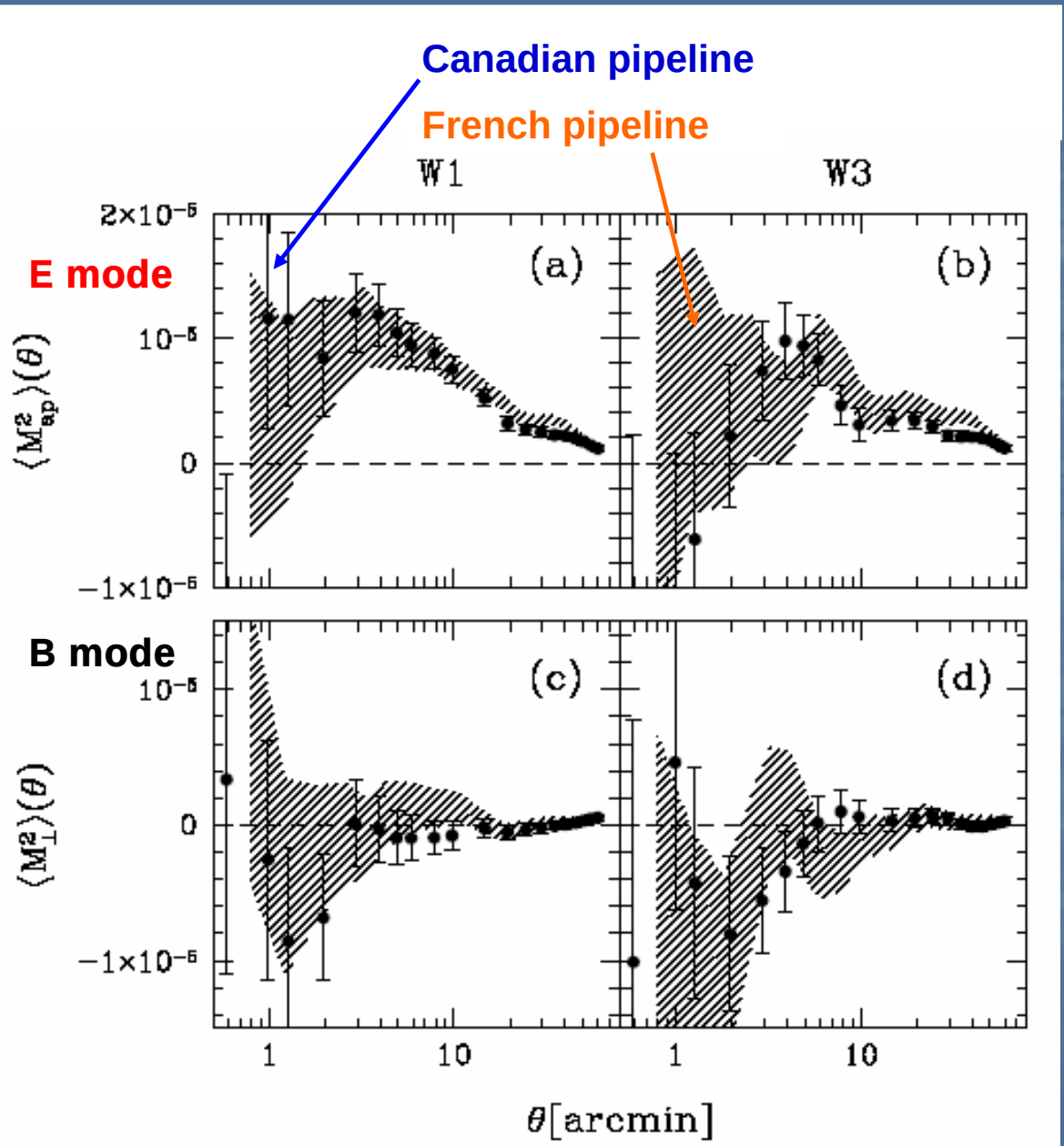
P(k) non-linear evolution uncertain

II. Quick review of CFHTLS T0001 Wide (Hoekstra et al., 2006)

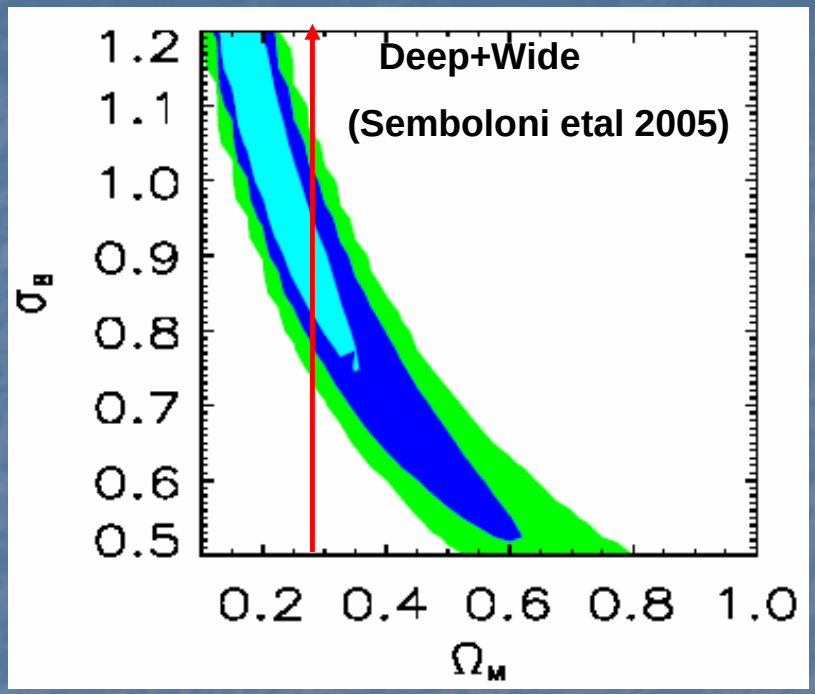
The comparison between Canadian and French pipelines:

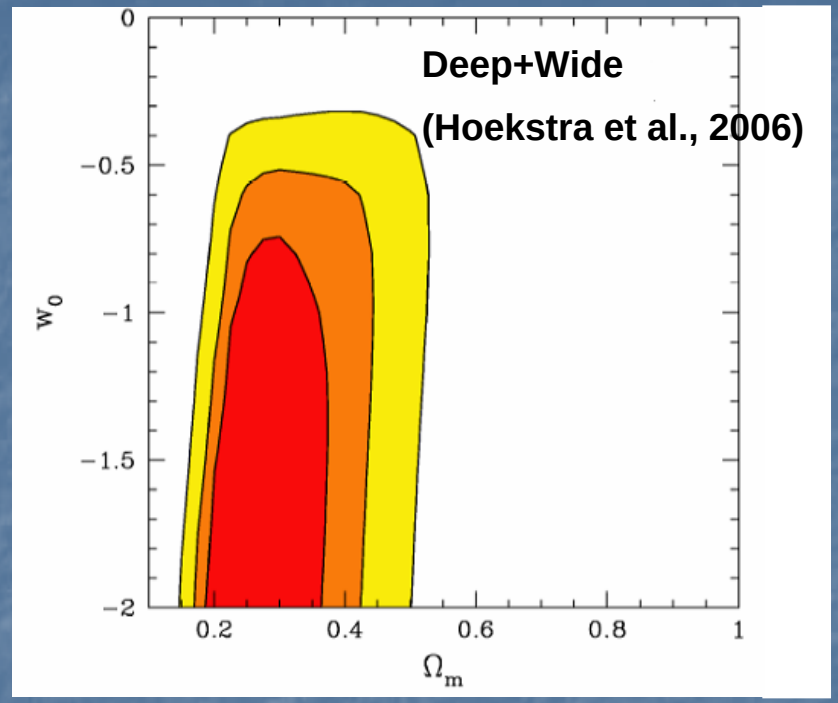






Cosmological parameters Constraints with CFHTLS Deep + Wide (T0001)





- **Non-linear scheme (Peacock & Dodds, 1996)**

$\sigma_8 = 0.89 \pm 0.06$ (68% confidence)

- **Halo-fit model (Smith et al., 2003)**

$\sigma_8 = 0.86 \pm 0.05$ (68% confidence)

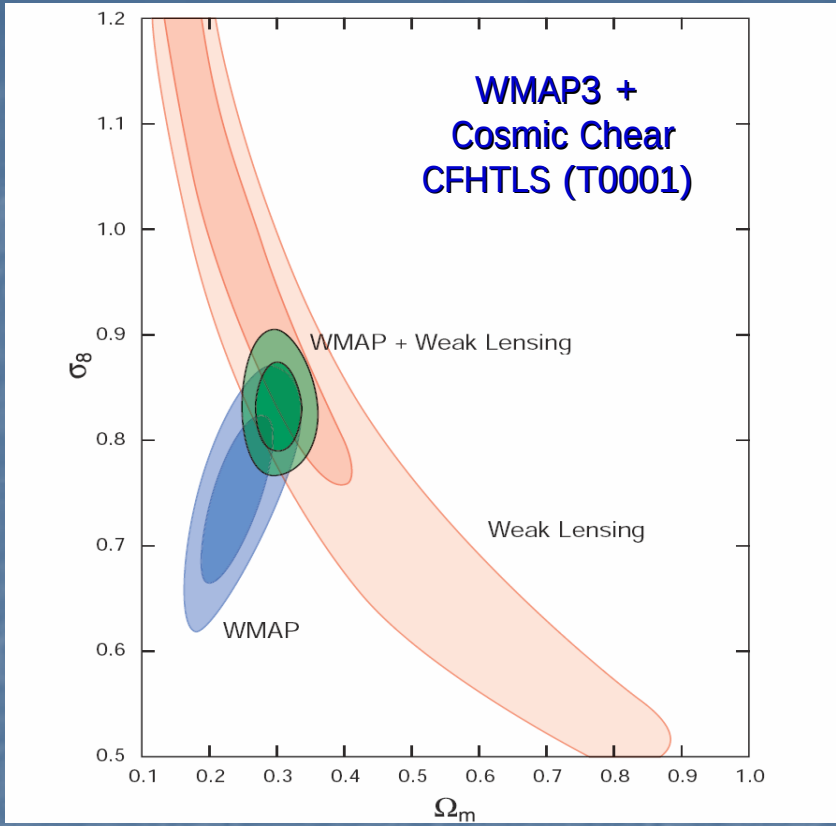
- **The constant equation of state:**

$$p = w_0 \rho$$

$w_0 < -0.5$ (95% confidence)

$w_0 < -0.8$ (68% confidence)

The comparison with WMAP3



See anew analysis from J. Benjamin et al.,in preparation

- **n(z) is a critical issue**

Sampling variance (van Waerbeke et al 2006)

- **Non linear evolution of structures at small scales is also critical. Large scales needed (Semboloni et al 2006b).**

CFHTLS :

+ sampling variance

+ NL variance

Is it the end of the story?

- Combo-17 3D weak lensing (Kitching et al., astro-ph/0610284)

$$\sigma_8(\Omega_m/0.3)^{0.57\pm0.19} = 1.06^{+0.17}_{-0.16}$$

- GaBoDS cosmic shear (Hetterscheidt et al., astro-ph/0606571)

$$\sigma_8 = 0.80 \pm 0.10$$

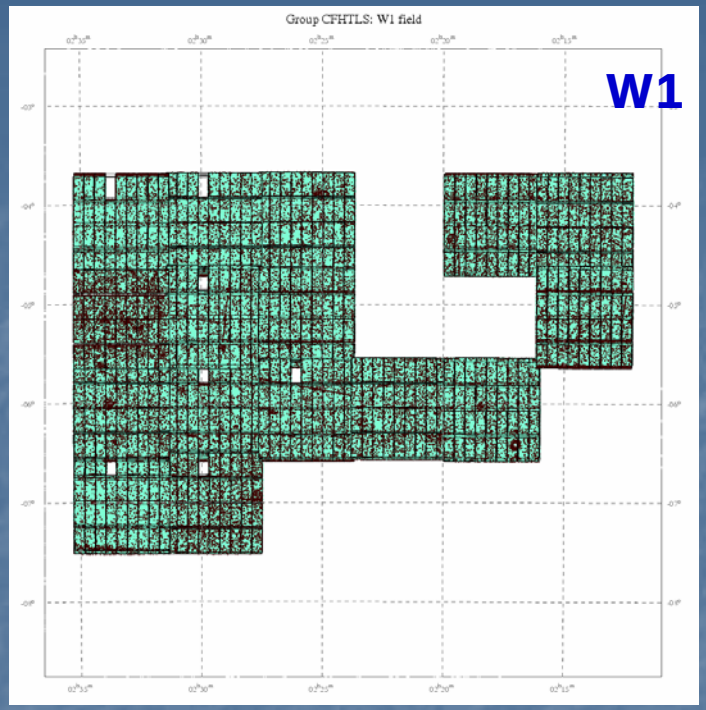
- Cosmos new results (in preparation)?

$$\sigma_8 \sim \text{ CFHTLS Deep} + \text{Wide}\,(\sigma_8 = 0.86)$$

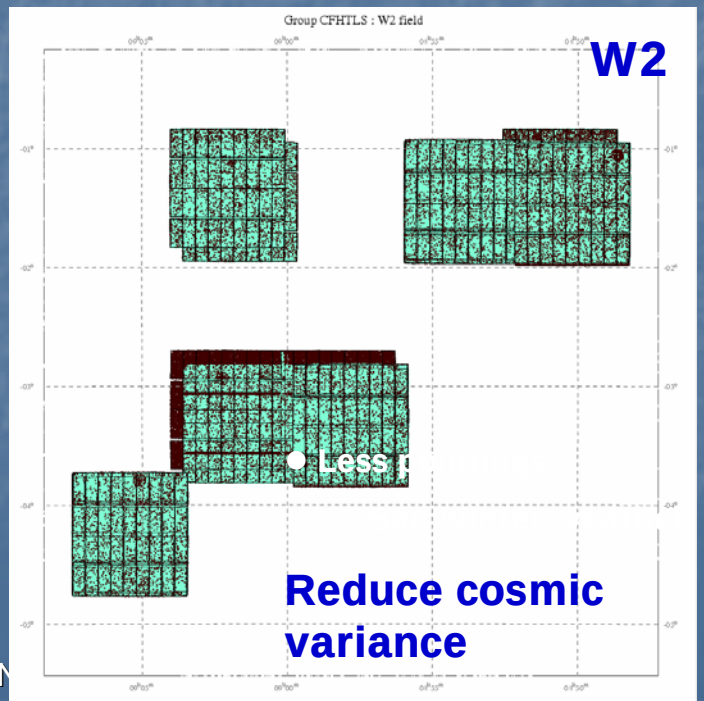
- CFHTLS Wide T0003 ?

III. Cosmic shear of CFHTLS Wide T0003

CFHTLS CSLS second step
Wide (T0003): 51 pointings

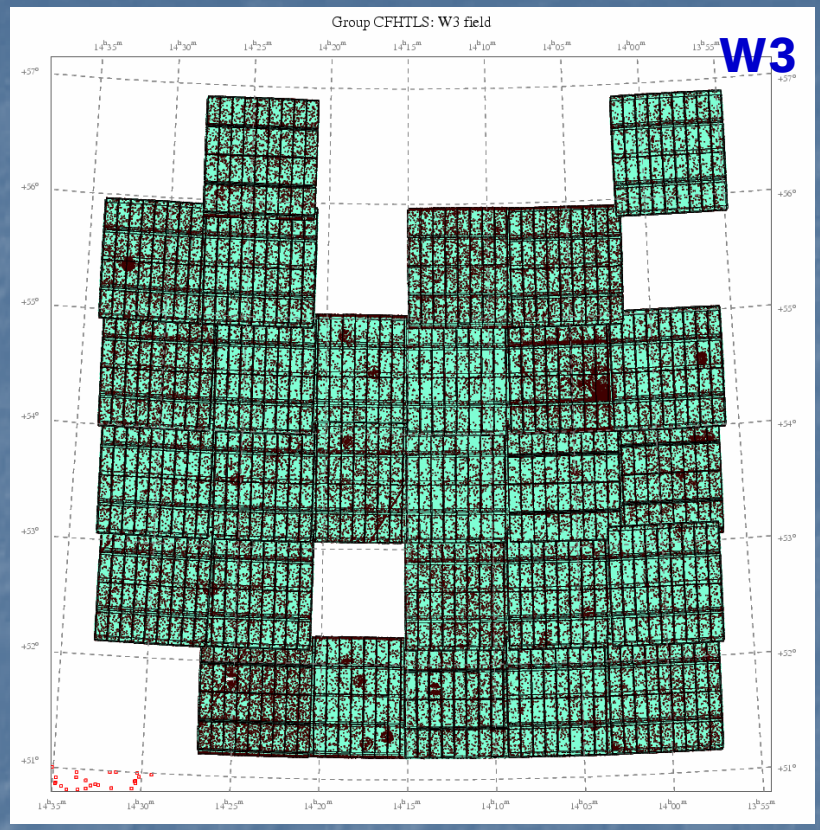


W1



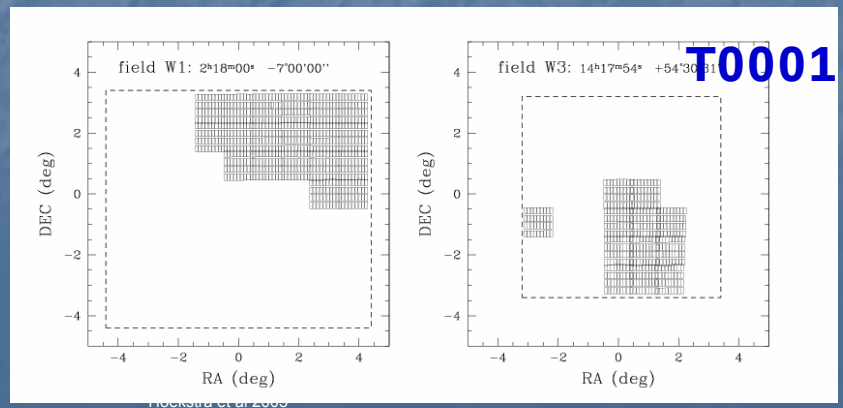
W2

Reduce cosmic variance



W3

- **T0003:**
  - **Aussel's talk**
  - **Mellier's talk**
- **Stacking:**
  - **seeing < 1.0**
  - **SCAMP +SWARP**
  - **(see Bertin's talk)**



T0001

1. Analysis Reliability with Comic shear (CFHTLS WideT0003)

Shear TEsting Program (STEP) 2 simulation

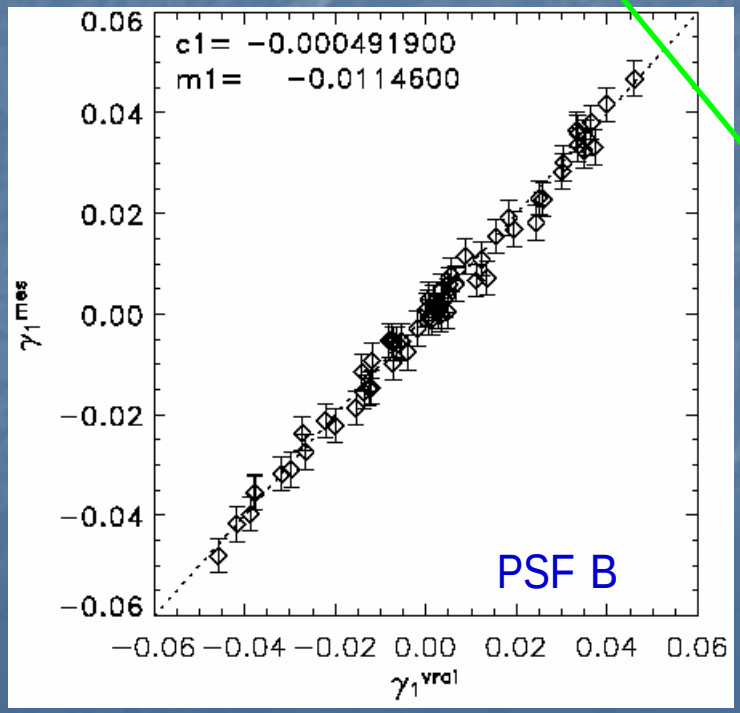
- Specially for cosmic shear (pixel size~0.2")
- 6 PSF cases

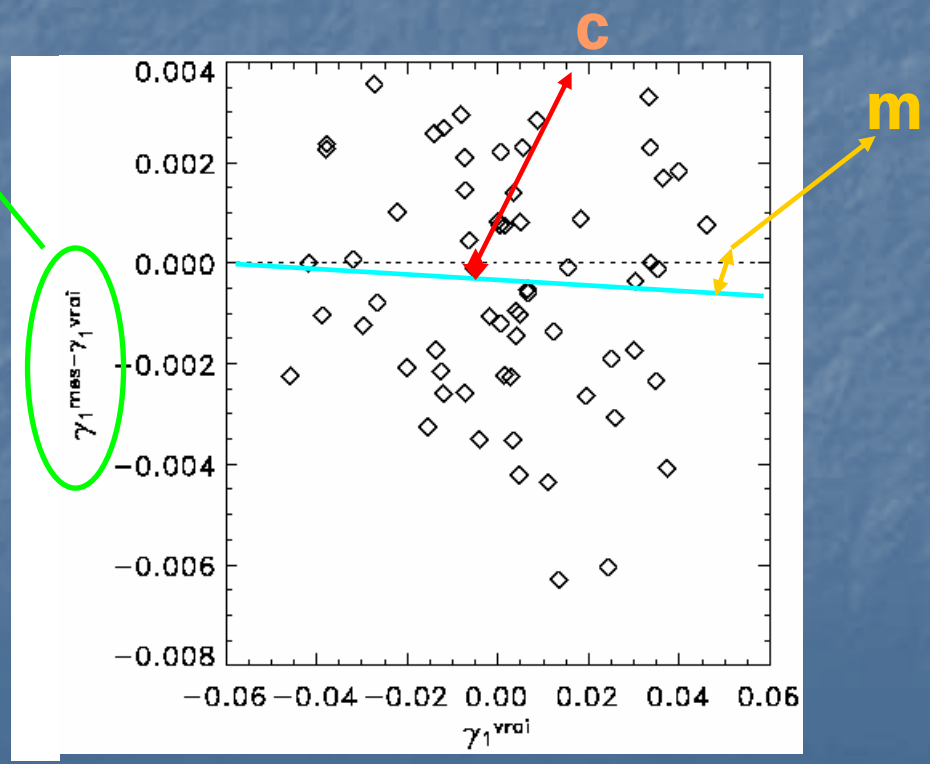
64 images with random constant input shear for each PSF case

- The multiplicative "calibration bias" --- m

The additive "residual shear offset" --- c

$$\langle \tilde{\gamma}_1 \rangle - \gamma_1^{\rm input} = m_1 \gamma_1^{\rm input} + c_1$$



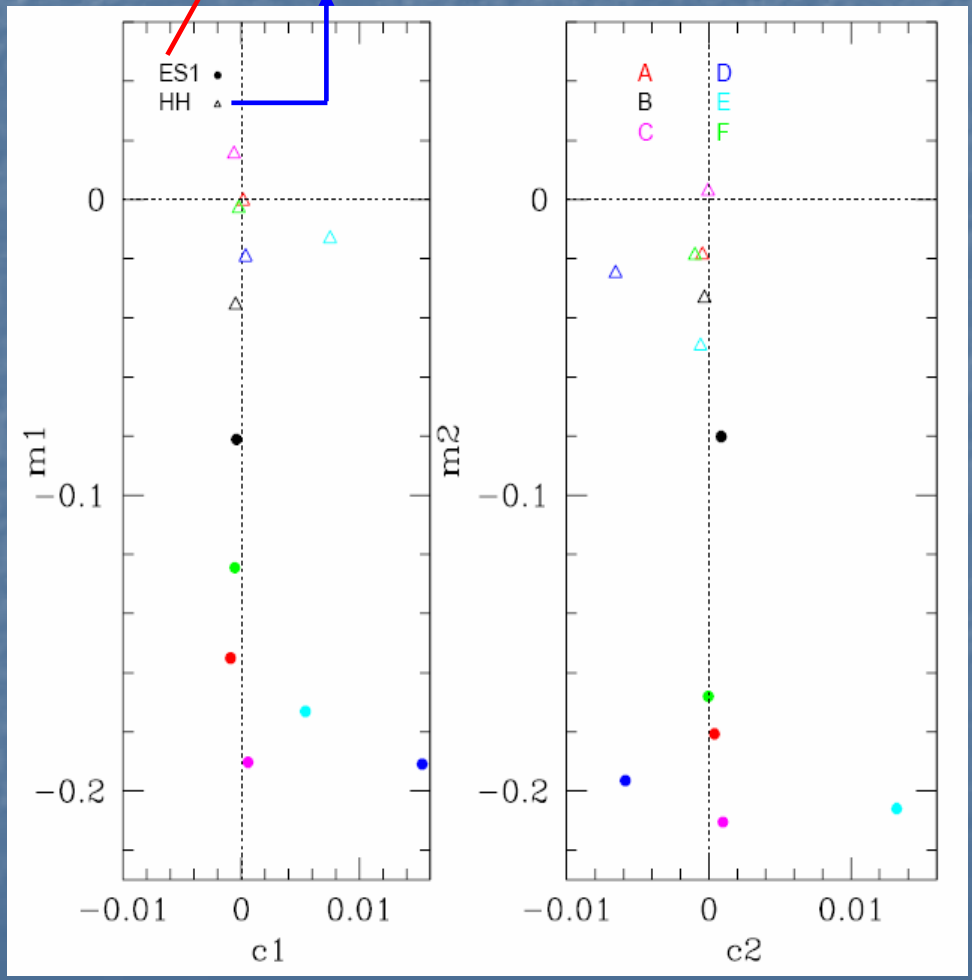


Bias of the French pipeline : ~ 15% underestimate

STEP2 simulation:

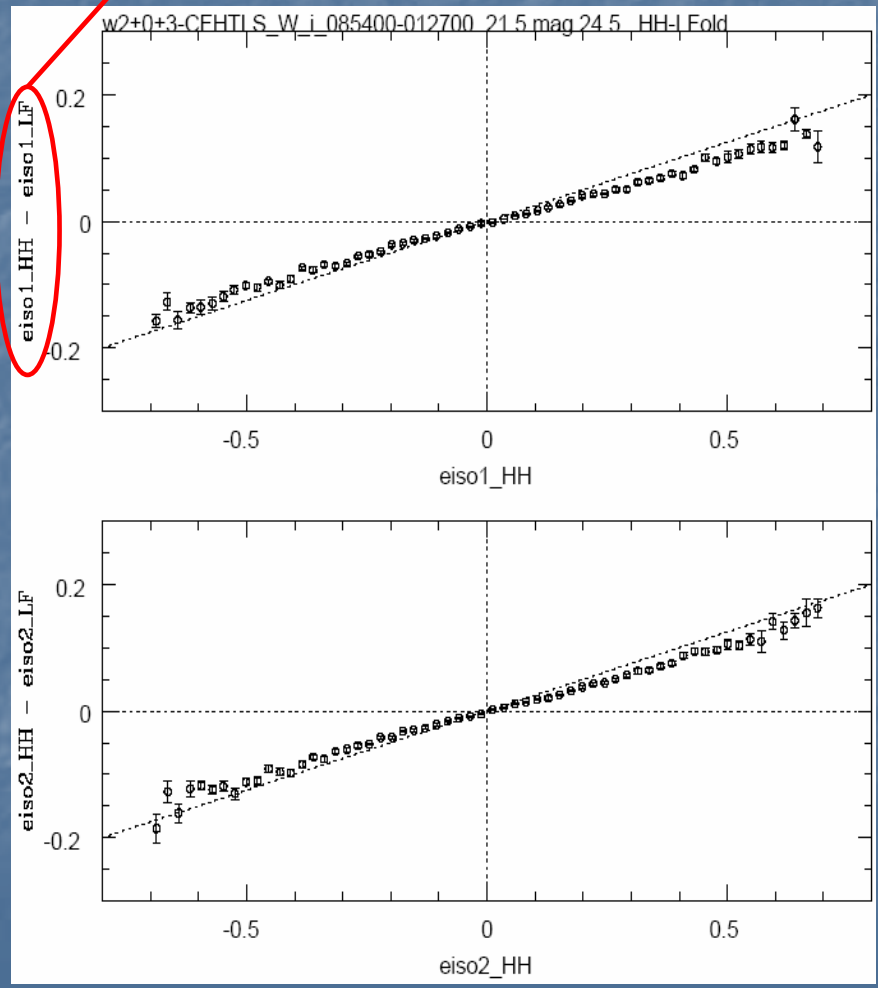
French pipeline (CFHTLS Deep)

Canadian pipeline (CFHTLS Wide)



CFTHLS data:

$$\gamma_{\text{canadian}} - \gamma_{\text{French}}$$

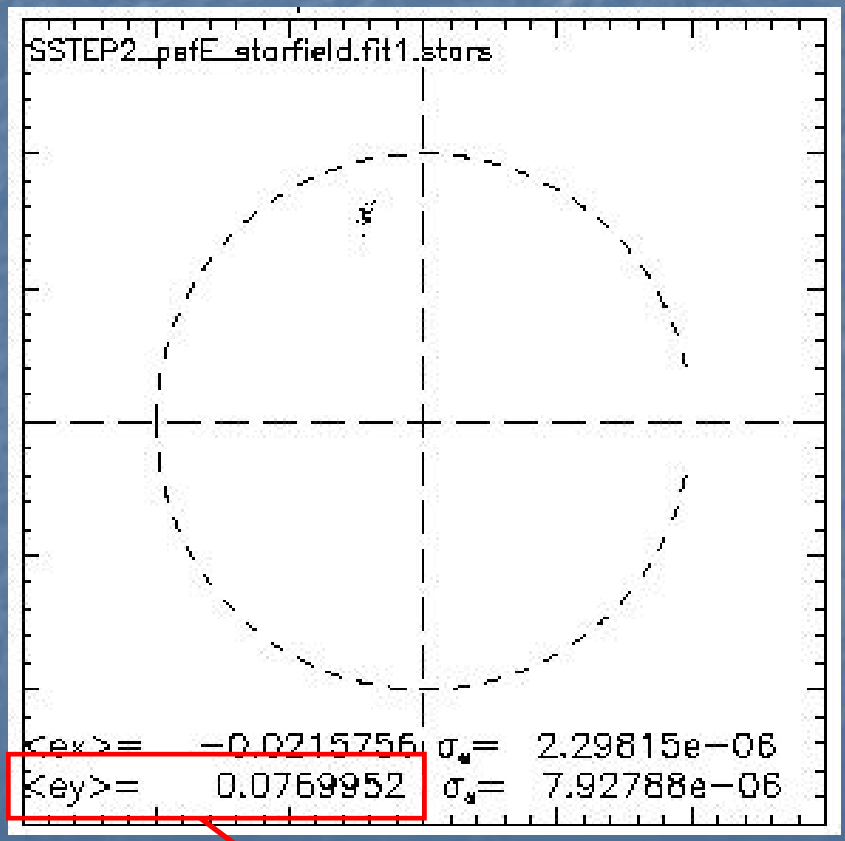


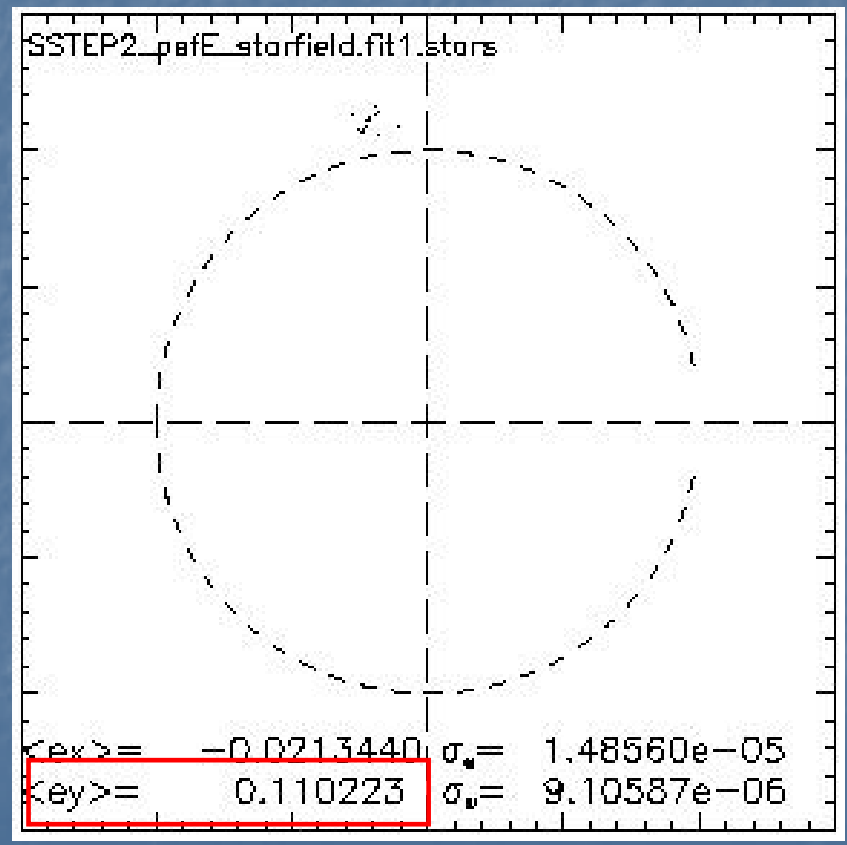
The main cause of the bias:

The underestimate the ellipticities of stars

"TS" pipeline (astro-ph/0608643 **):**

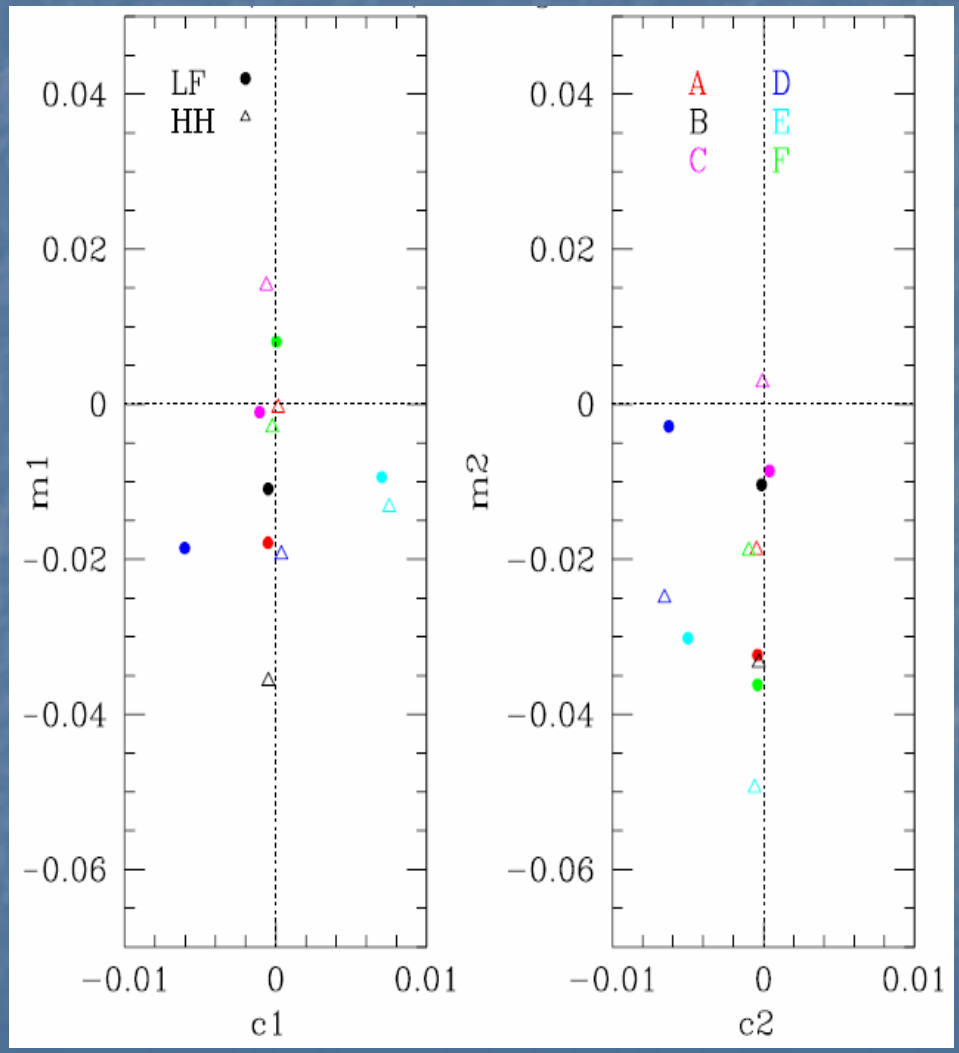
<ex>= -0.0221 **<ey>= -0.1129**

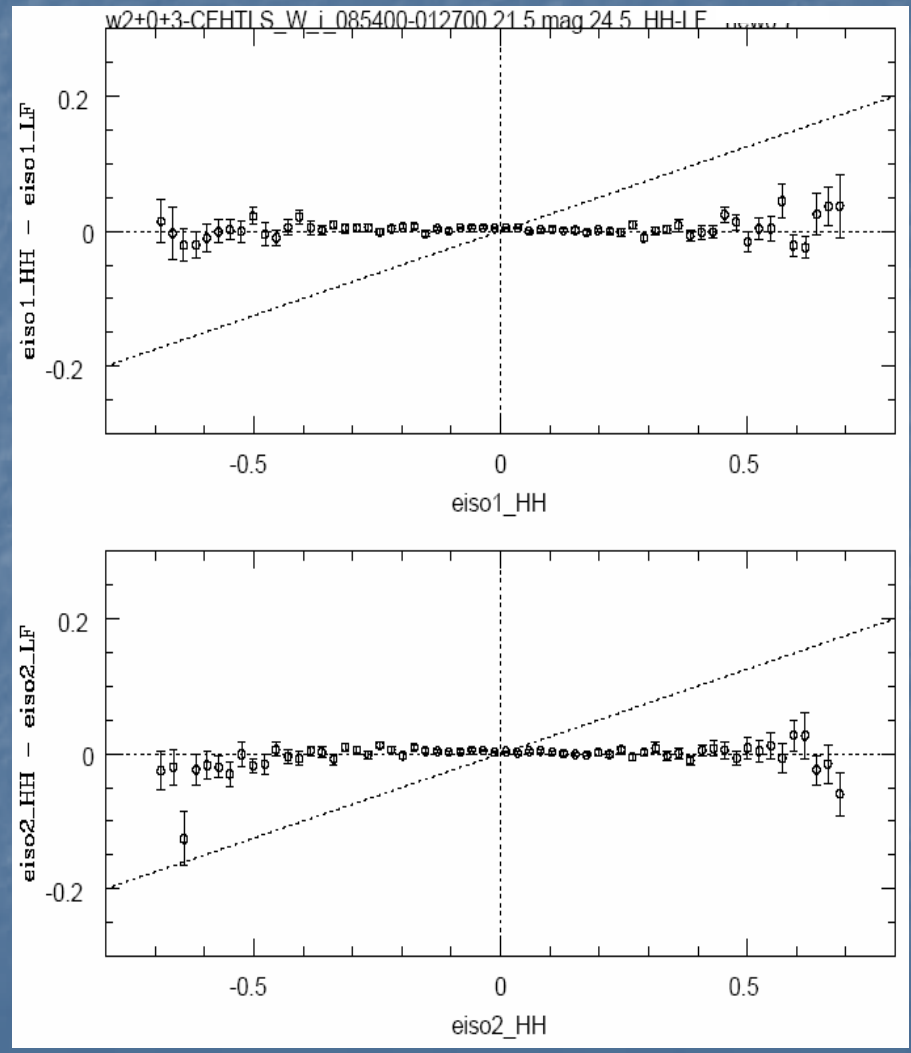




Too small weighting filter on stars

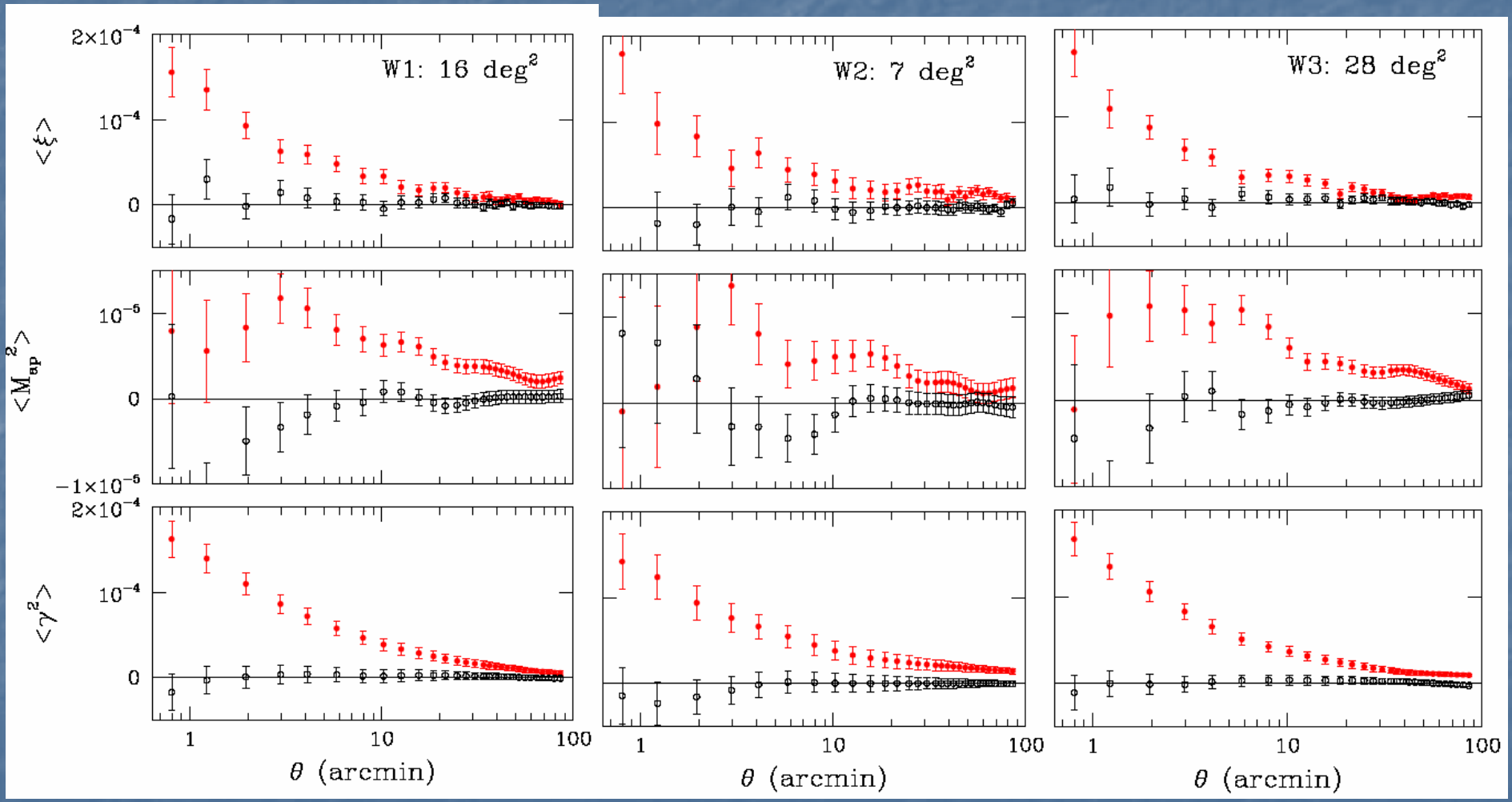
Bias of NEW French pipeline :
< 2% underestimate



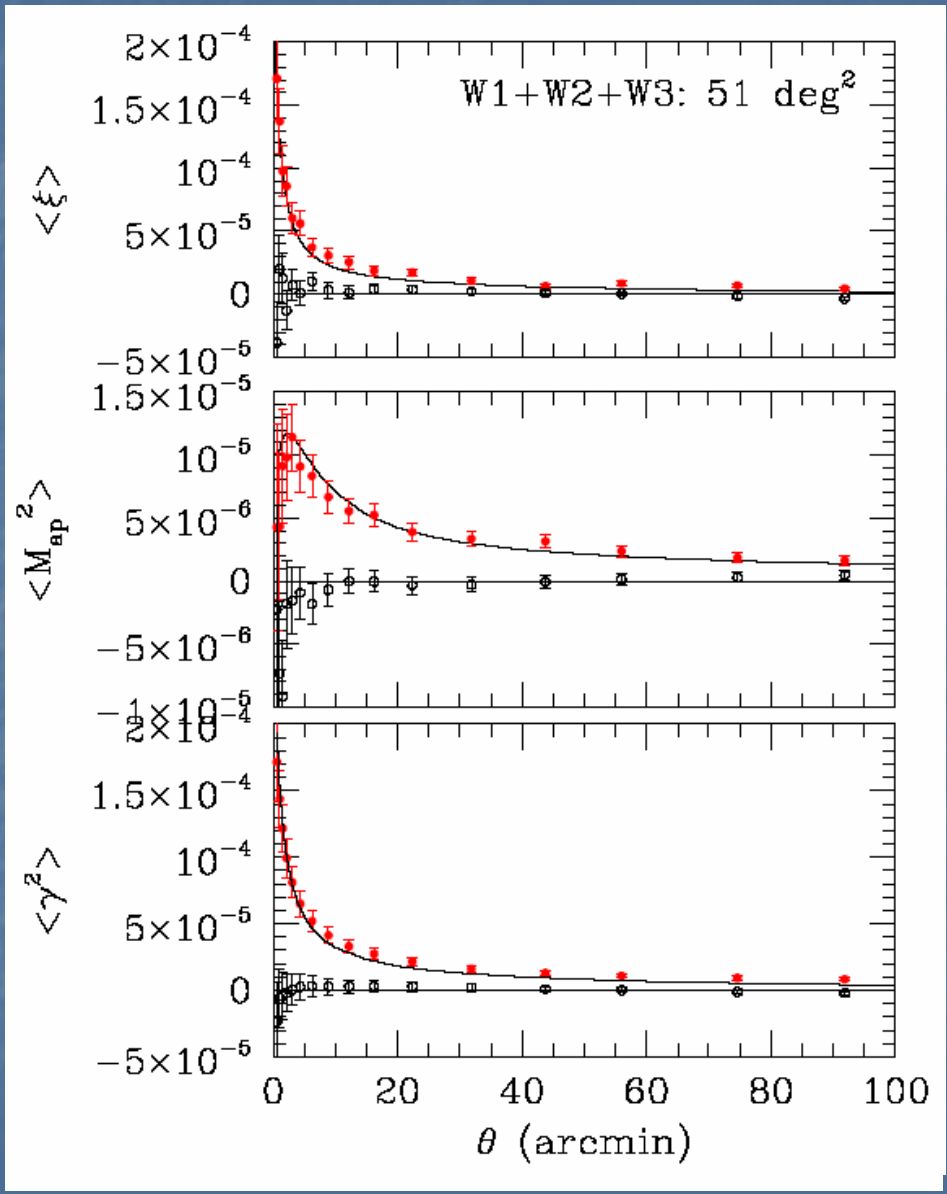


2. The results with OLD pipeline on T0003 Wide

W1, W2, W3 (T0003): consistency



51 deg² of T0003 Wide



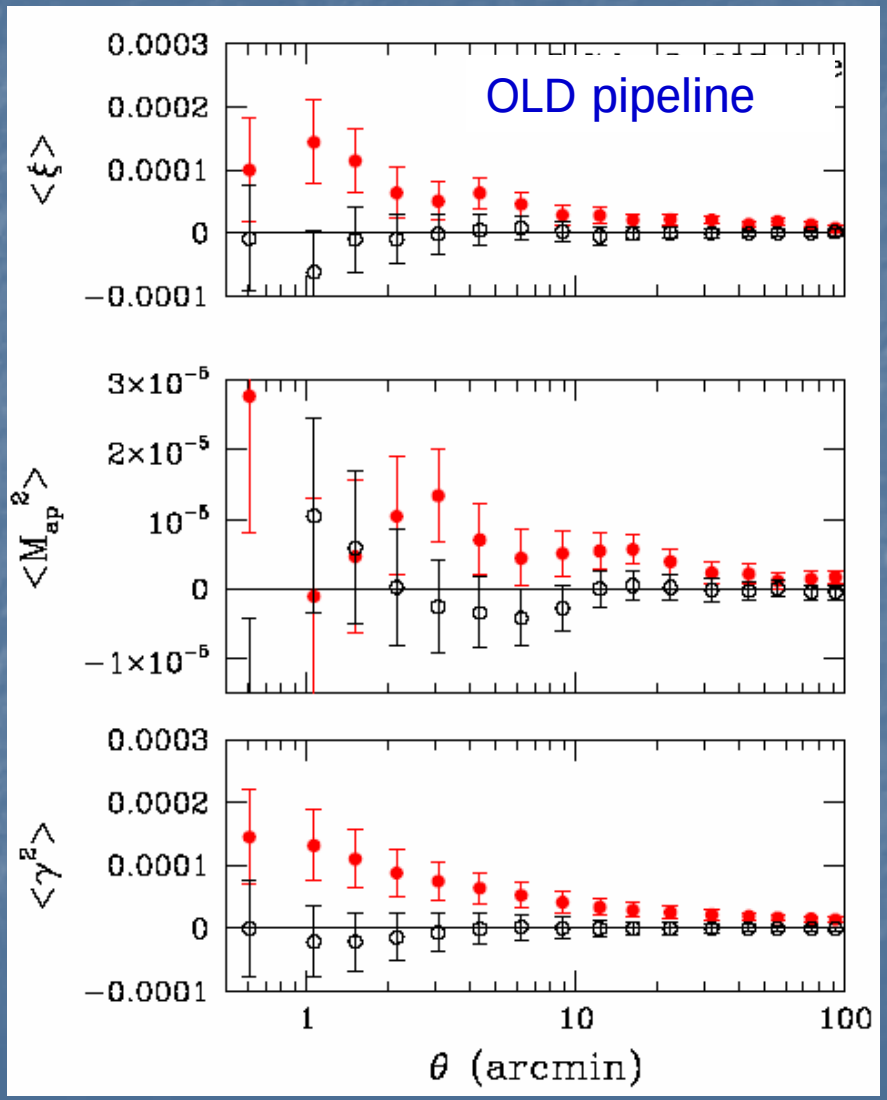
- **Cosmological interpretation of CFHTLS data are less and less sensitive to non-linear evolution of the dark matter power spectrum**
- **Megacam field-to-field calibration**

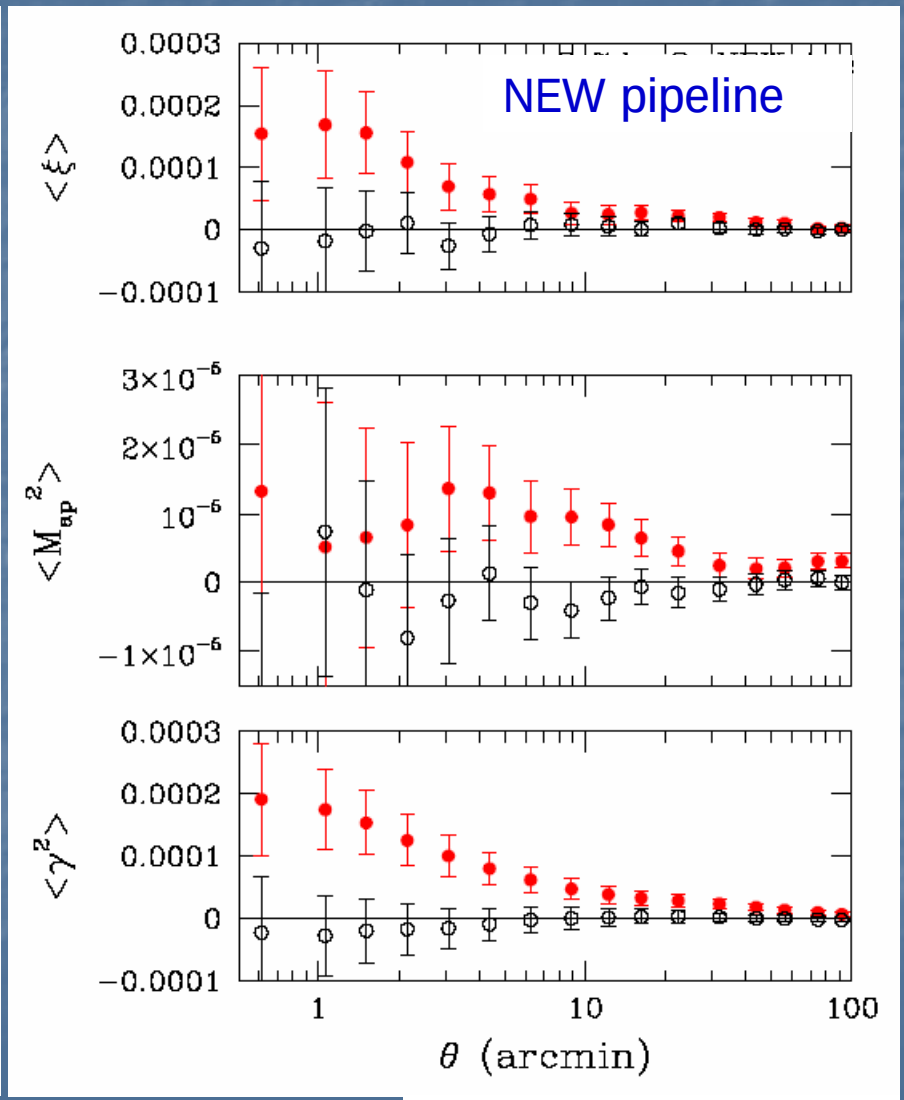
The "Concordance" mode prediction:

$$\Omega_m = 0.2263; \Omega_b = 0.0436;$$
$$\Omega_\Lambda = 0.73; h = 0.71; \sigma_8 = 0.85$$
$$< z >= 0.9$$

3. Re-analyzing on T0003 Wide (New pipeline)

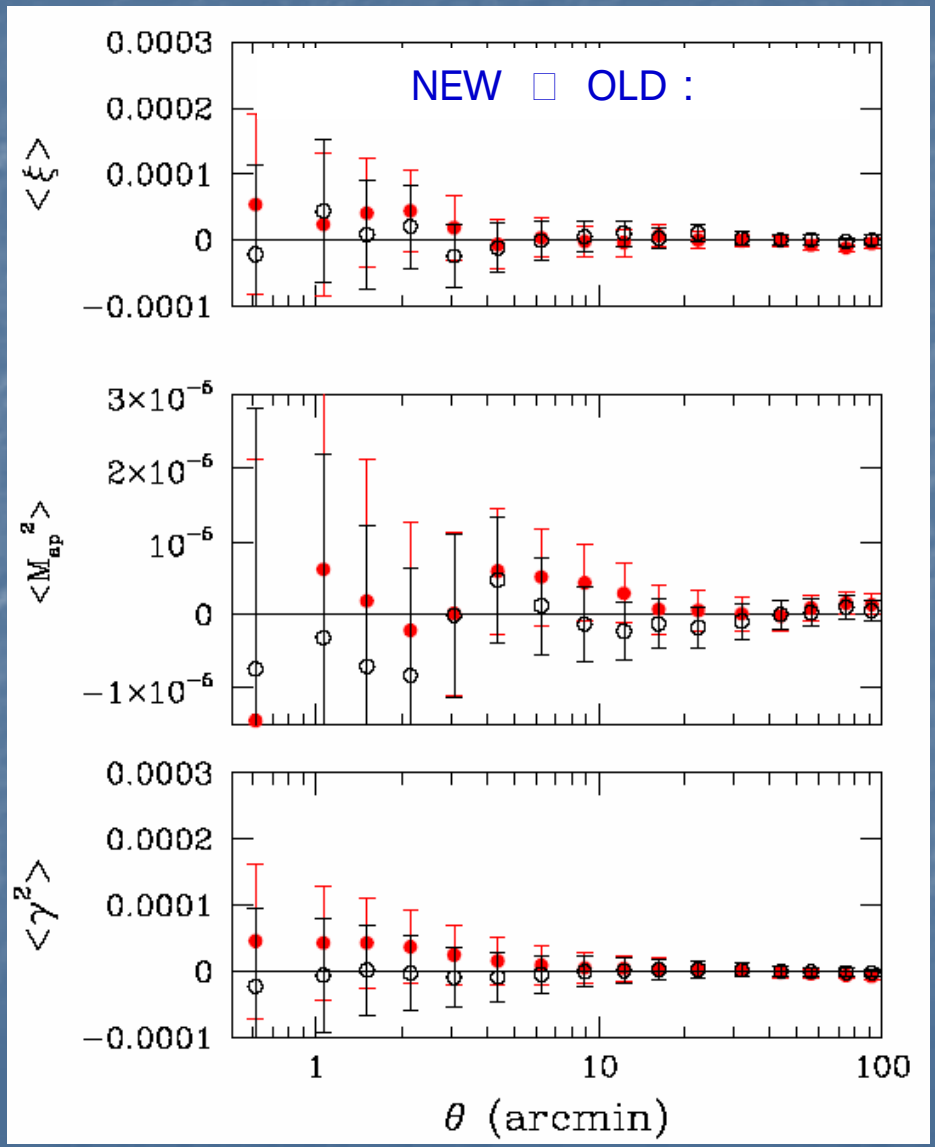
New pipeline Re-analyzing on Wide 2 (7 deg2)





Fu et al., inpreparation

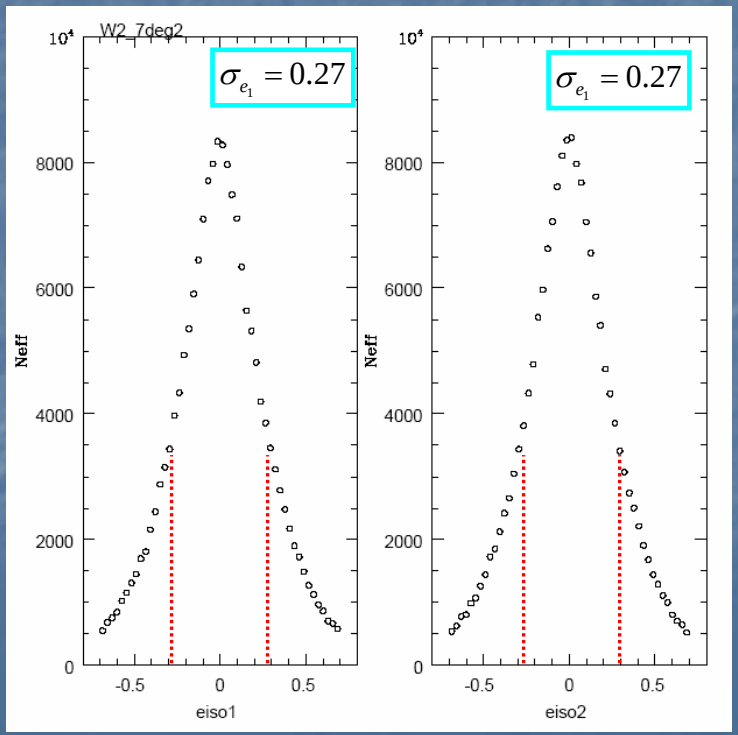
The signal difference from NEW and OLD



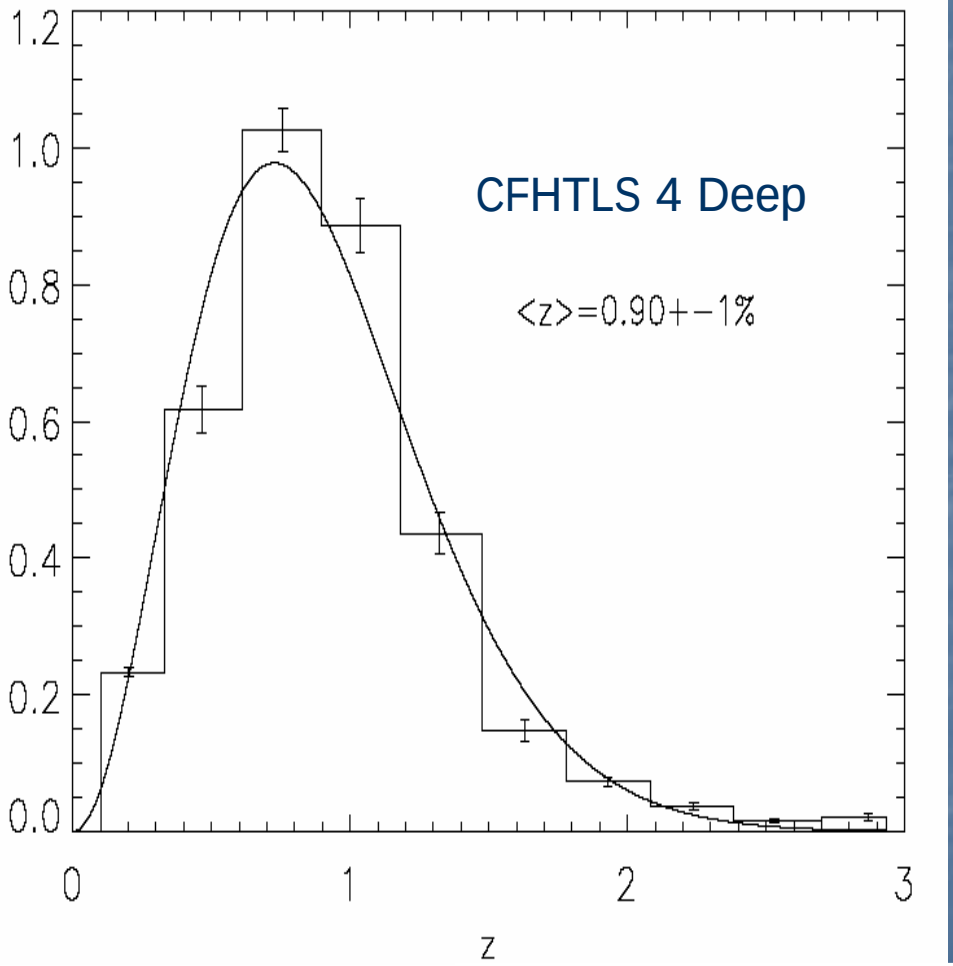
- The 2pt signal is stable!
- Error bar:

  Comic variance (non-linear calibration, astro-ph/0606648)

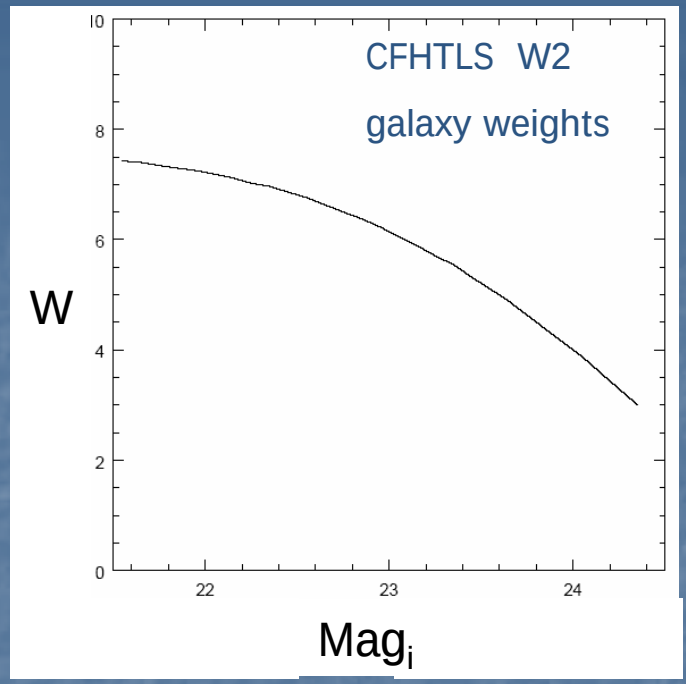
  + Poisson noise
- Re-analyzing on W1 and W3



The Zphot distribution estimate using weak lensing galaxy weighting



Fu et al., in preparation



- CFHTLS Deep photometry + VVDS spectroscopic survey of D1 field (Ilbert et al 2006; H.J. McCracken's talk)
- The average of deep 1,2,3,4
- The error bars include
  - Poisson error;
  - Zphot error;
  - Variance between the 4 deep fields.
- The best-fit (MCMC)
- The mean redshift is
  <z>=0.902+0.073-0.077

Conclusion:

- CFHTLS cosmic shear Systematic is under control: < 2% bias
- Wide analysis are stable; the difference of the results between OLD and NEW pipeline are within 1 sigma errors
- The error of 2pt is include the poisson error + cosmic variance + non-linear calibration
- The redshift distribution is estimated from the CFHTLS Deep photometric data
- The cosmological parameters (Ω_M , σ_8 , w_0) is TBC, but the constrained σ_8 will be similar as T0001's ($\sigma_8 \sim 0.86$)
- Outlook: Joint 2nd- and 3rd-order statistics using CFHTLS Wide (See M. Kilbinger's talk)

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