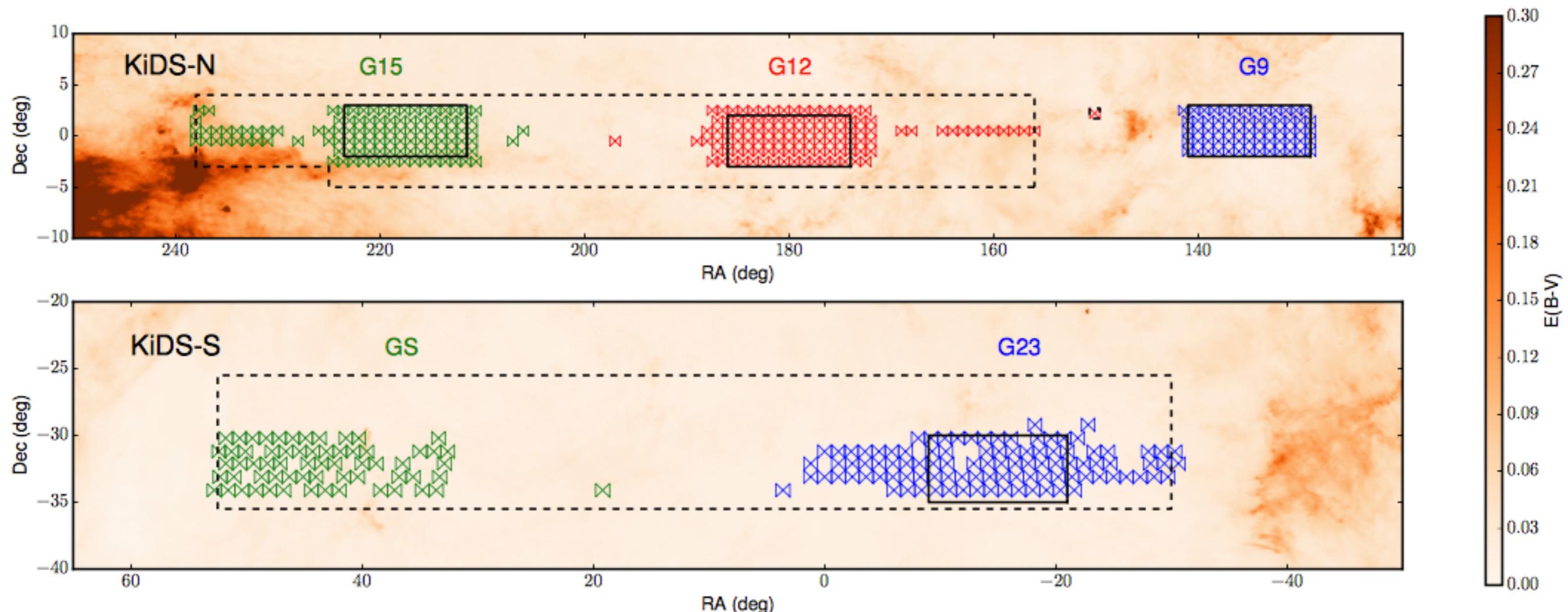


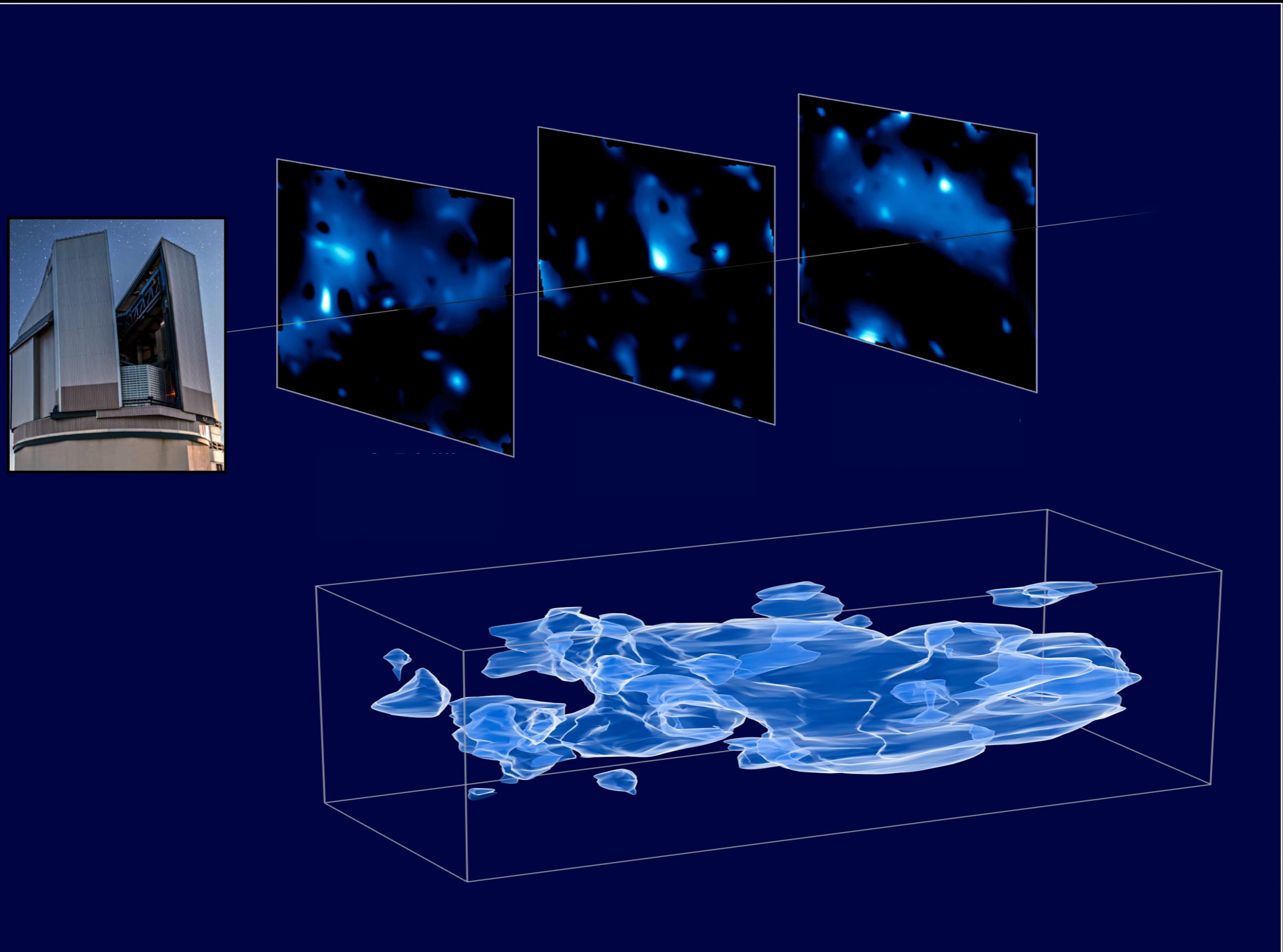
THE KILO DEGREE SURVEY: BLIND COSMOLOGICAL ANALYSIS

Massimo Viola

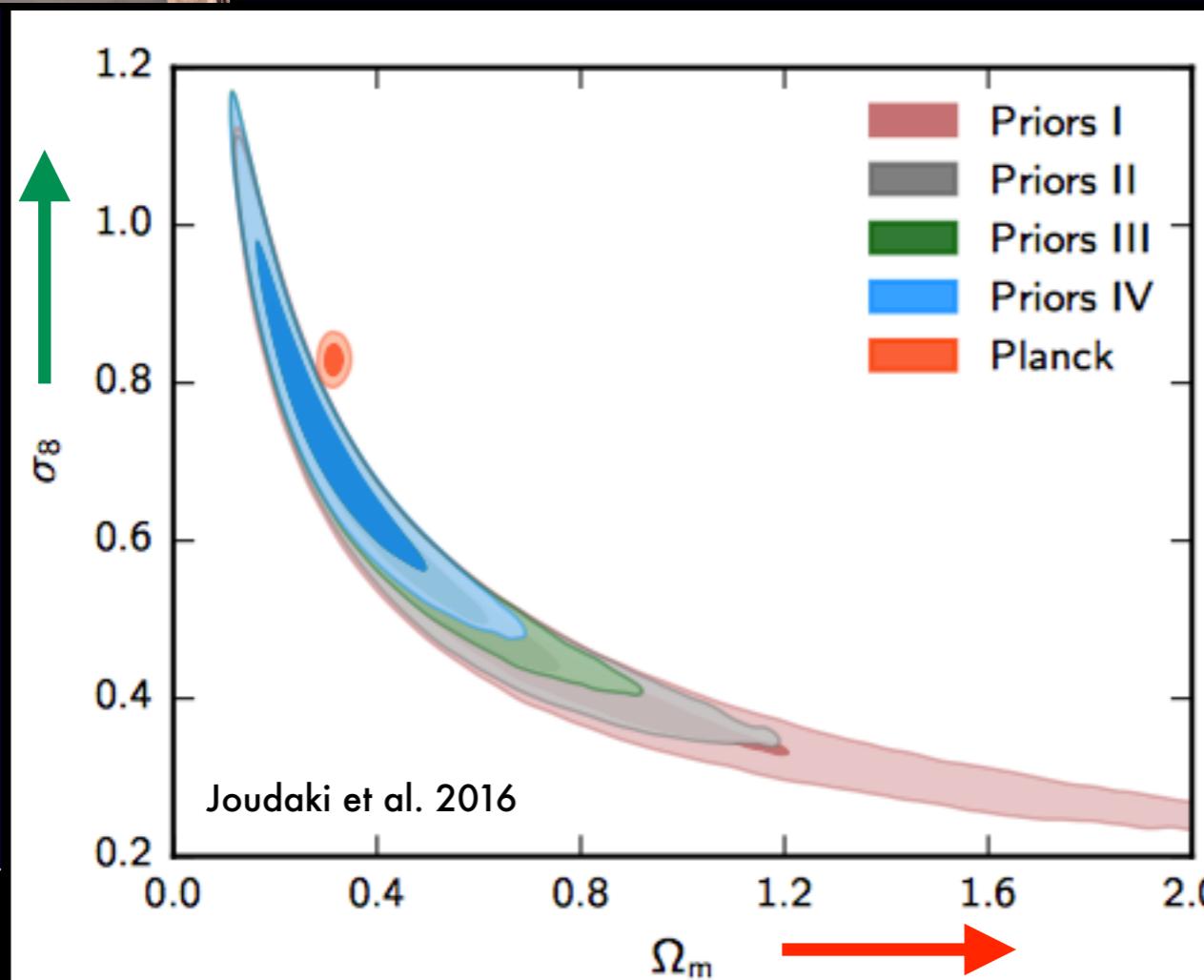
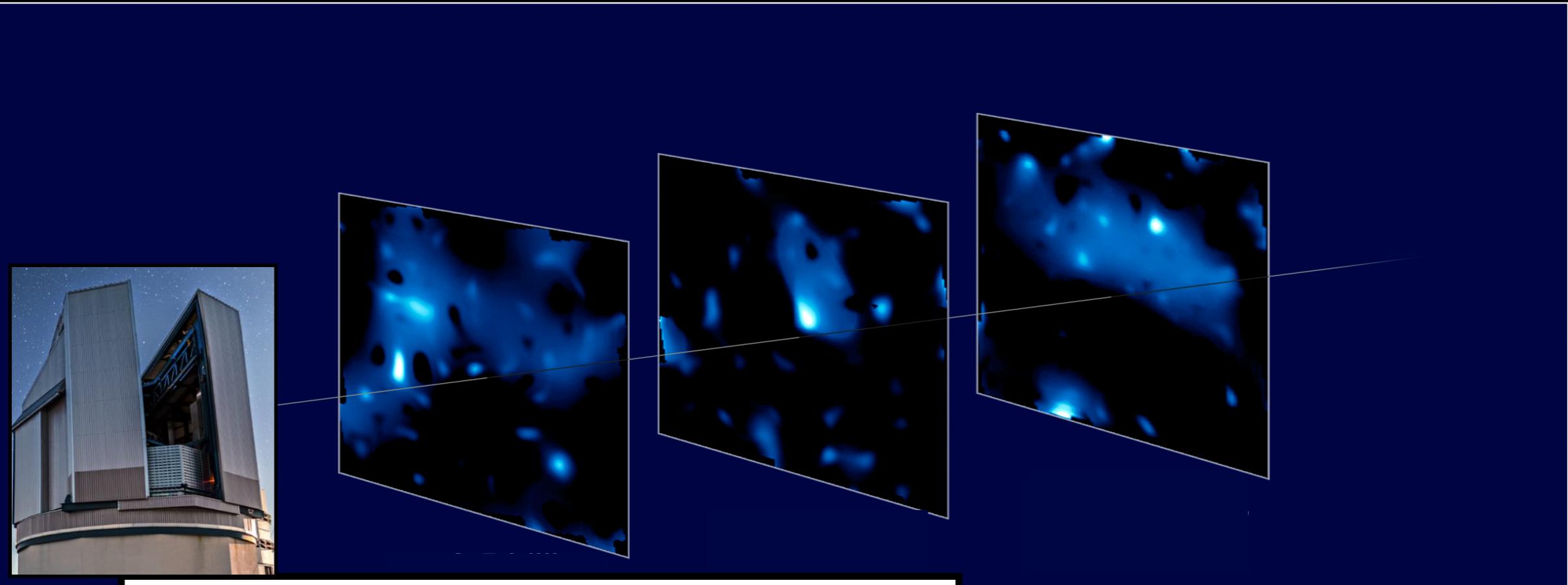
The Kilo Degree Survey (@VST)



- ❖ 1500 square degree (ongoing)/800 square degree done
- ❖ 450 square degree in ugri (published)
- ❖ 15M galaxies with shape and photometric redshifts
- ❖ Excellent image quality (r-band seeing < 0.8'', round PSF)
- ❖ Data are public (images, catalogues, ...)

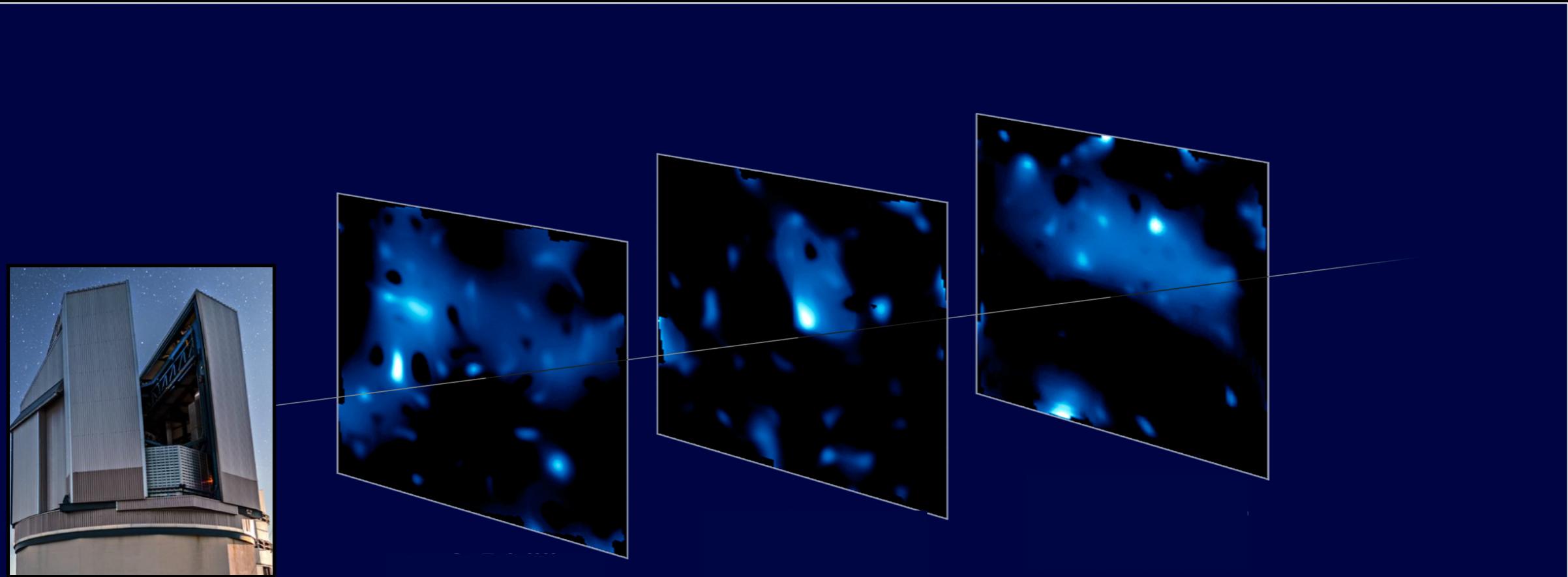


Credit: ESA



Cosmic shear
measures the
density of clustered
matter at different
cosmic time

Credit: ESA



Galaxy ellipticities

Redshift distributions

Theory

$$C_{\kappa}^{kl}(l) = \frac{9H_0^4\Omega_m^2}{4c^4} \int_0^{w_H} dw \frac{\bar{W}^k(w)\bar{W}^l(w)}{a^2 w} P_\delta\left(\frac{l}{f_K(w)}, w\right)$$

$$\langle \epsilon \epsilon \rangle \simeq \xi_{\pm}^{kl} = \frac{1}{2\pi} \int dl l J_{0/4}(l\theta) C^{kl}(l)$$

Blinding the ellipticities

$$\epsilon^{obs} \simeq \epsilon^s + g$$

Perturbing the observed ellipticity (modulus) translates directly in a perturbation of the shear.

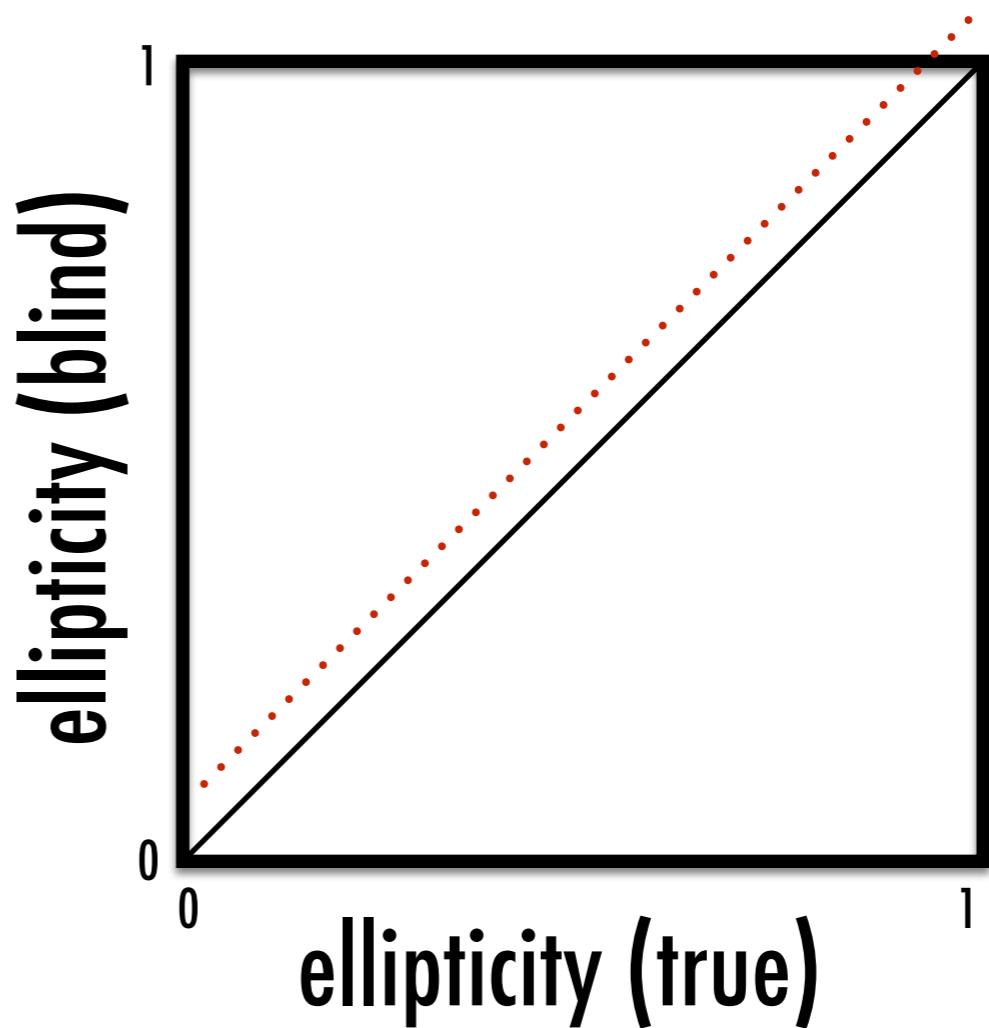
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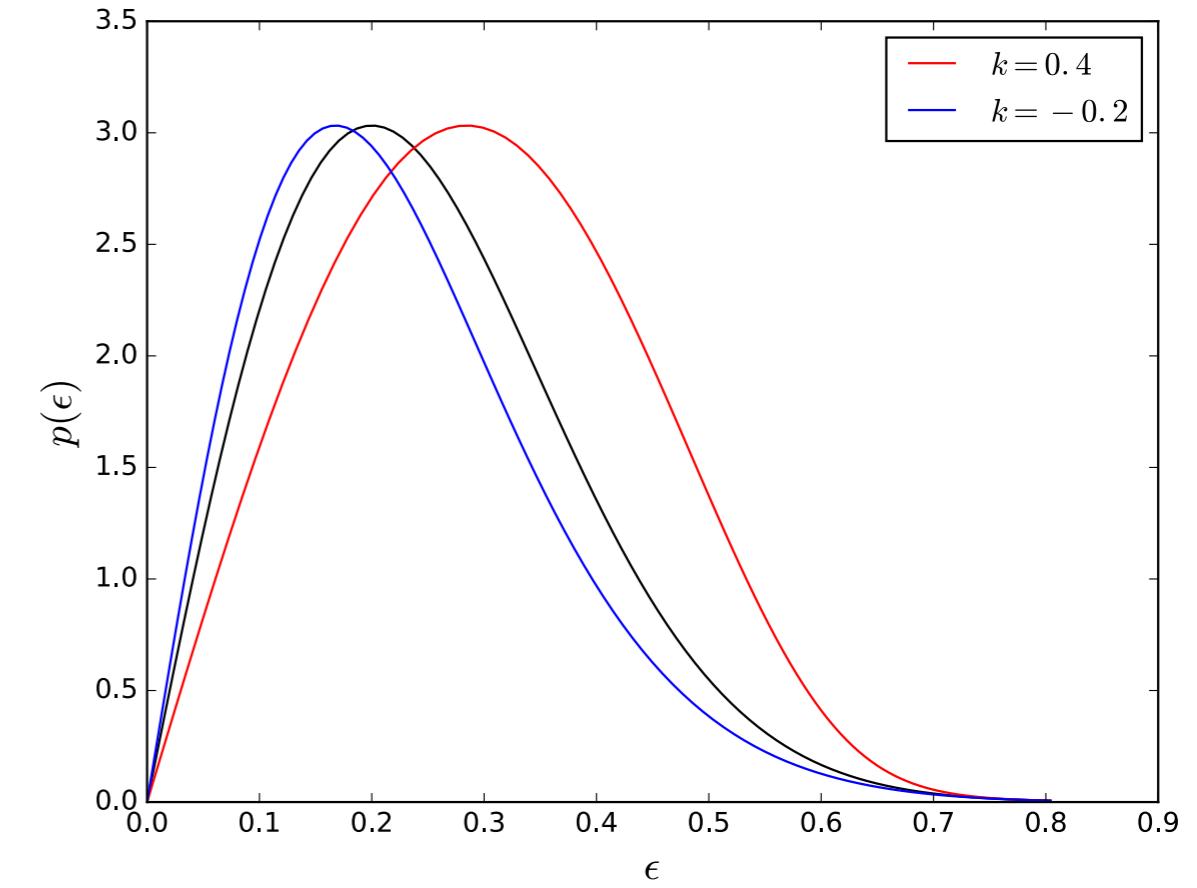
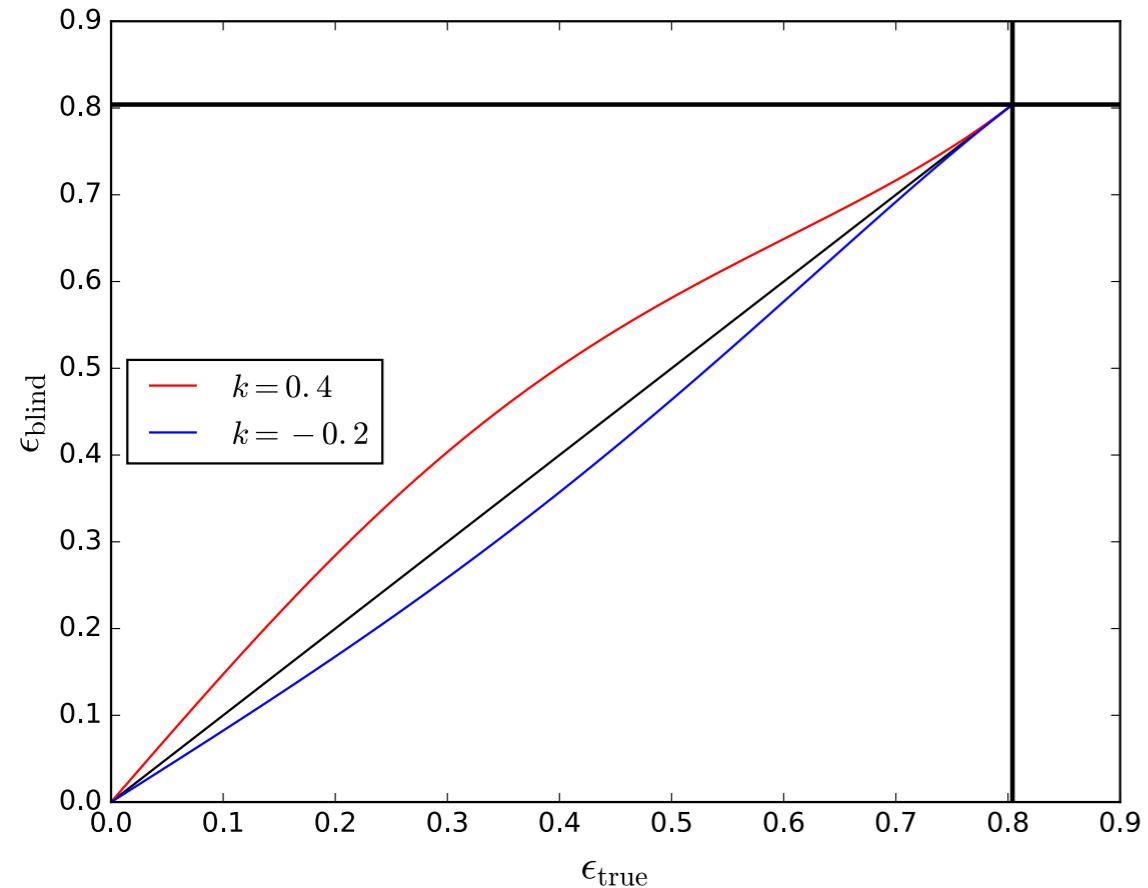
Perturbing the observed ellipticity (modulus) translates directly in a perturbation of the shear.

Perturbation should NOT :

- produce non-realistic ellipticities;
- produce a too large effect (it would be easy to unblind)



KiDS DR1/2 (2015 results)



$$\epsilon_{\text{blind}} = \epsilon_{\text{true}} \exp \left[k \left(1 - \frac{\epsilon_{\text{true}}}{\epsilon_{\text{max}}} \right)^2 \right]$$

Team designs the blinding scheme

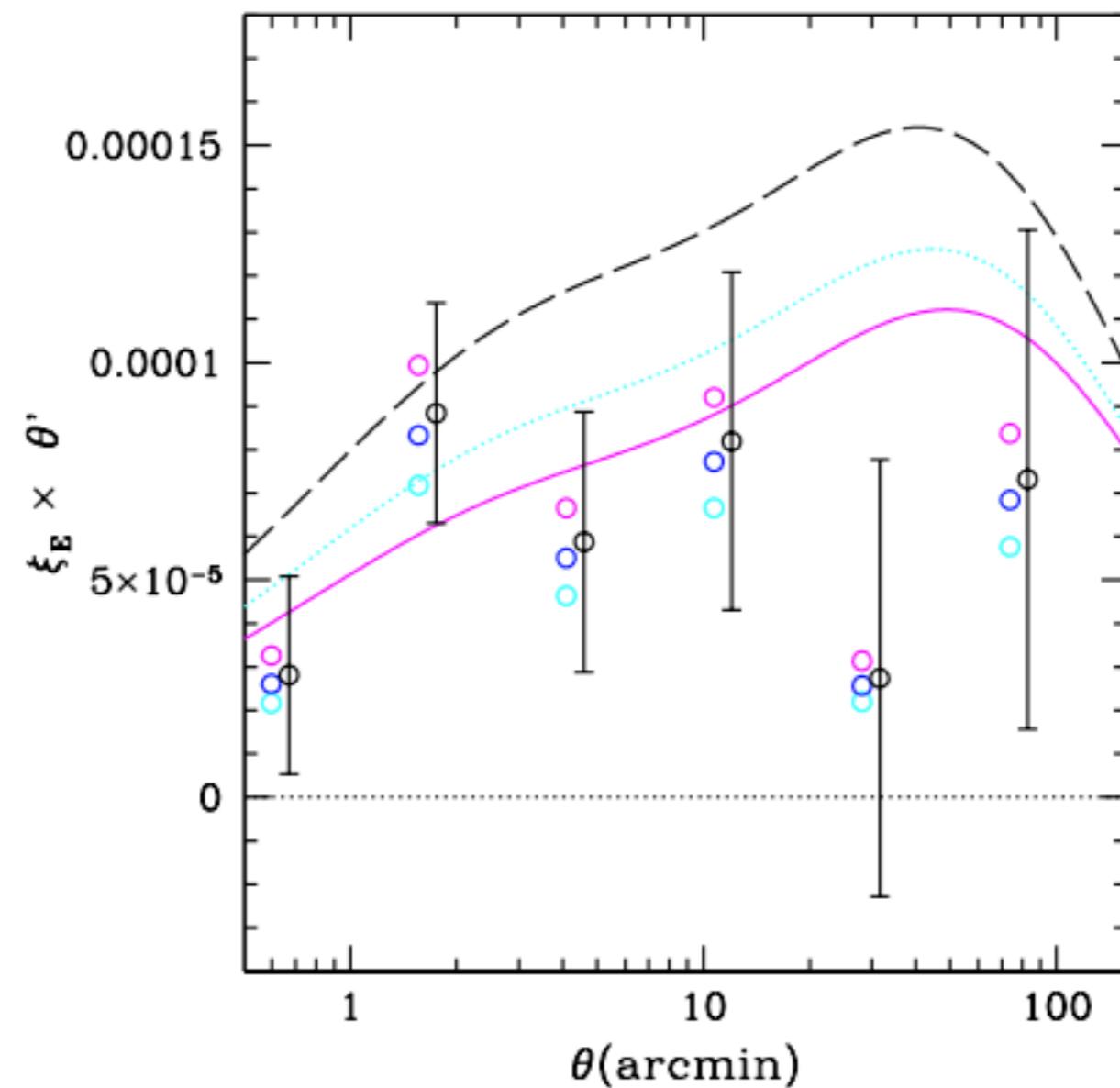
External blinder chooses values for k and produces 3 fake catalogues

Team is given 4 catalogues to work with (3 fake, 1 true).

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Lessons from DR1/2

- Chosen functional form cannot generate large variation in final results.
- 3 fake catalogues were an overkill.

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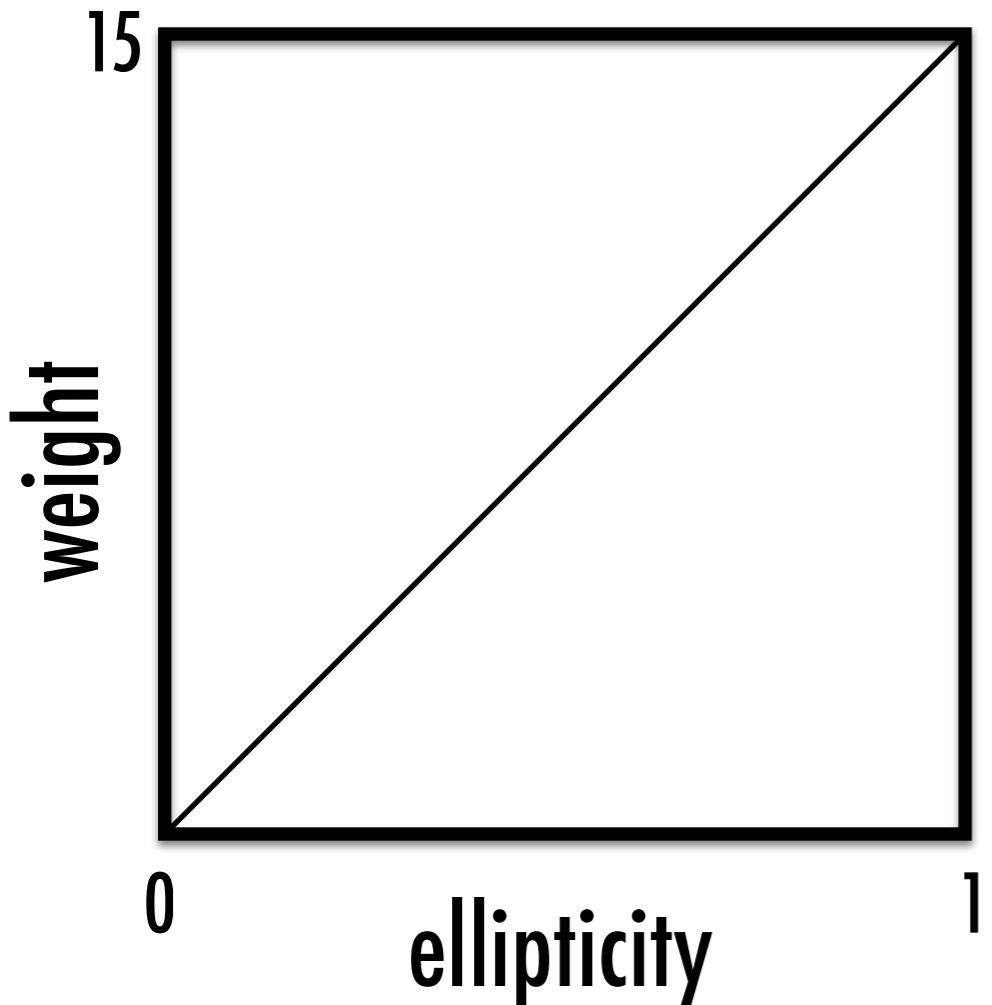
Lessons from DR1/2

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No easy fix (if only ellipticity is perturbed)

Remove 1 fake catalogue

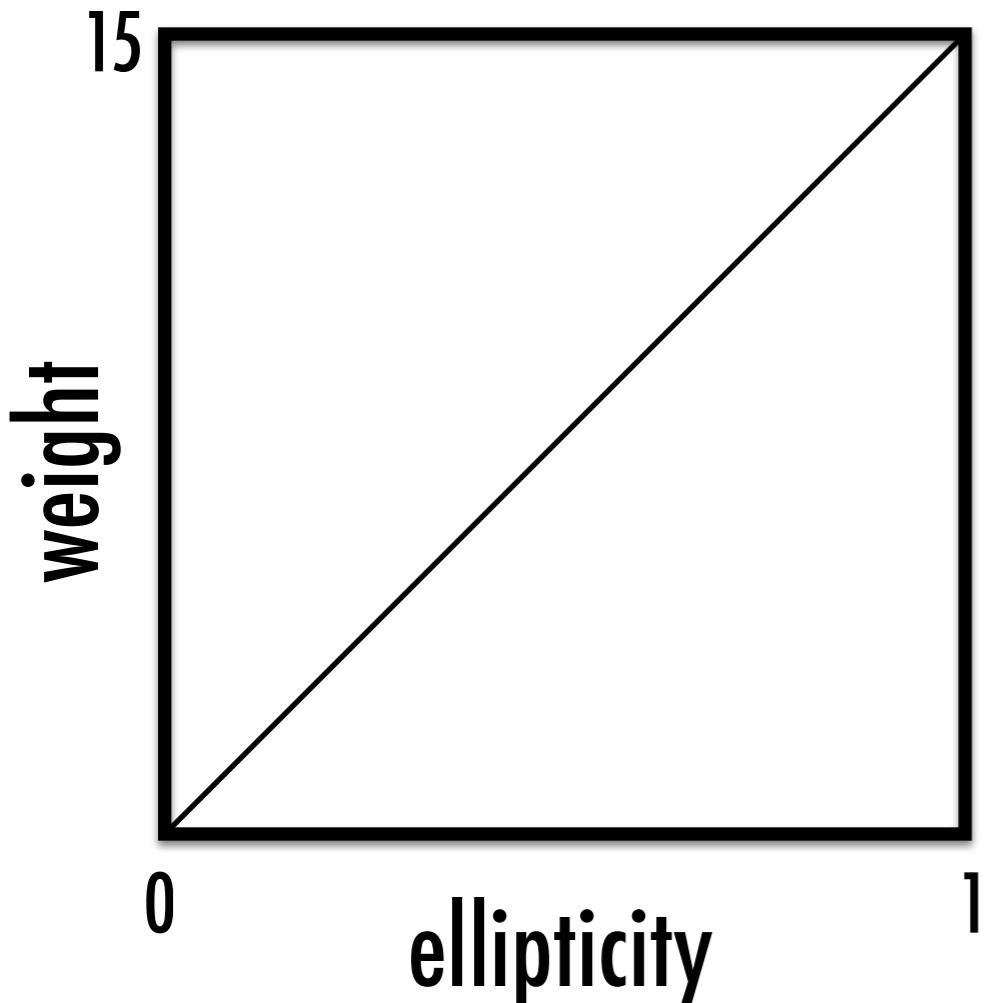
KiDS-450 blinding



Shape measurement weight:

$$w \simeq \frac{1}{(\sigma_{\text{int}}^2 + \sigma_{\text{noise}}^2)}$$

KiDS-450 blinding



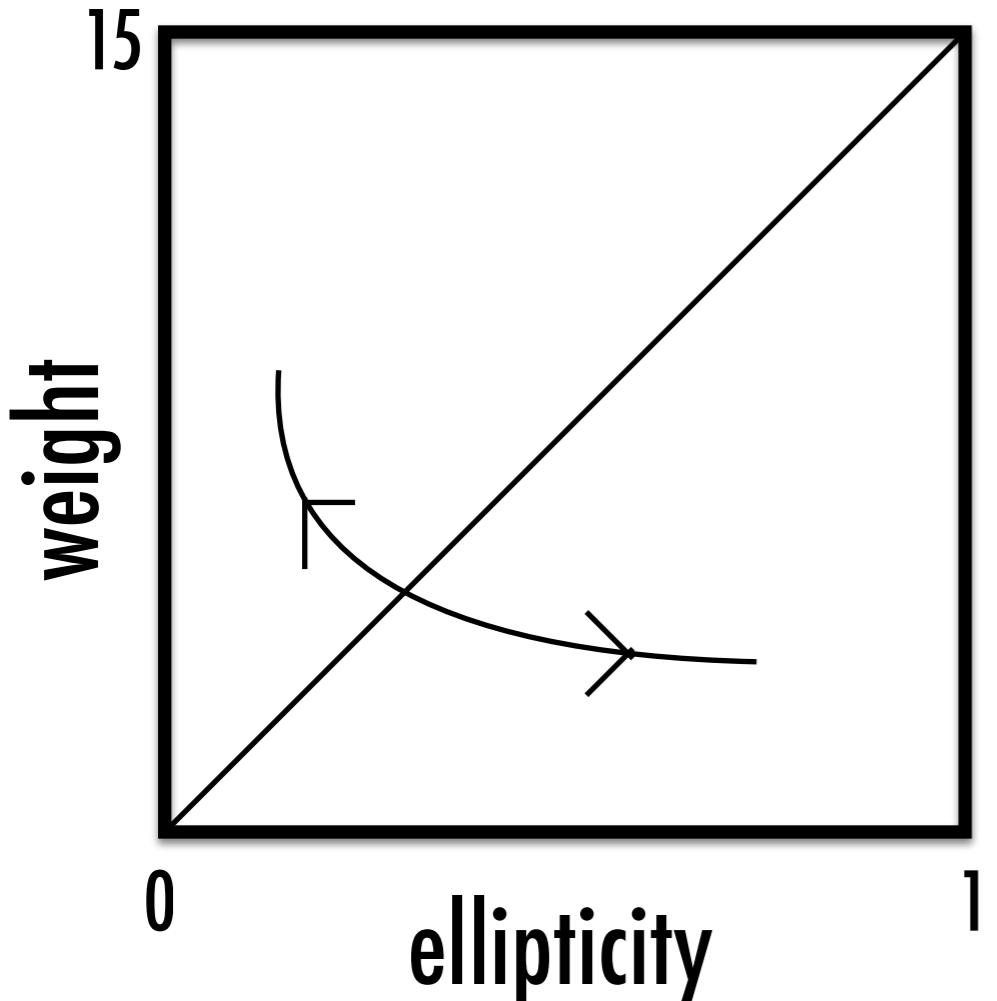
Shape measurement weight:

New functional form:

$$w \simeq \frac{1}{(\sigma_{\text{int}}^2 + \sigma_{\text{noise}}^2)}$$

$$f(k, \epsilon, w)$$

KiDS-450 blinding



Shape measurement weight:

$$w \simeq \frac{1}{(\sigma_{\text{int}}^2 + \sigma_{\text{noise}}^2)}$$

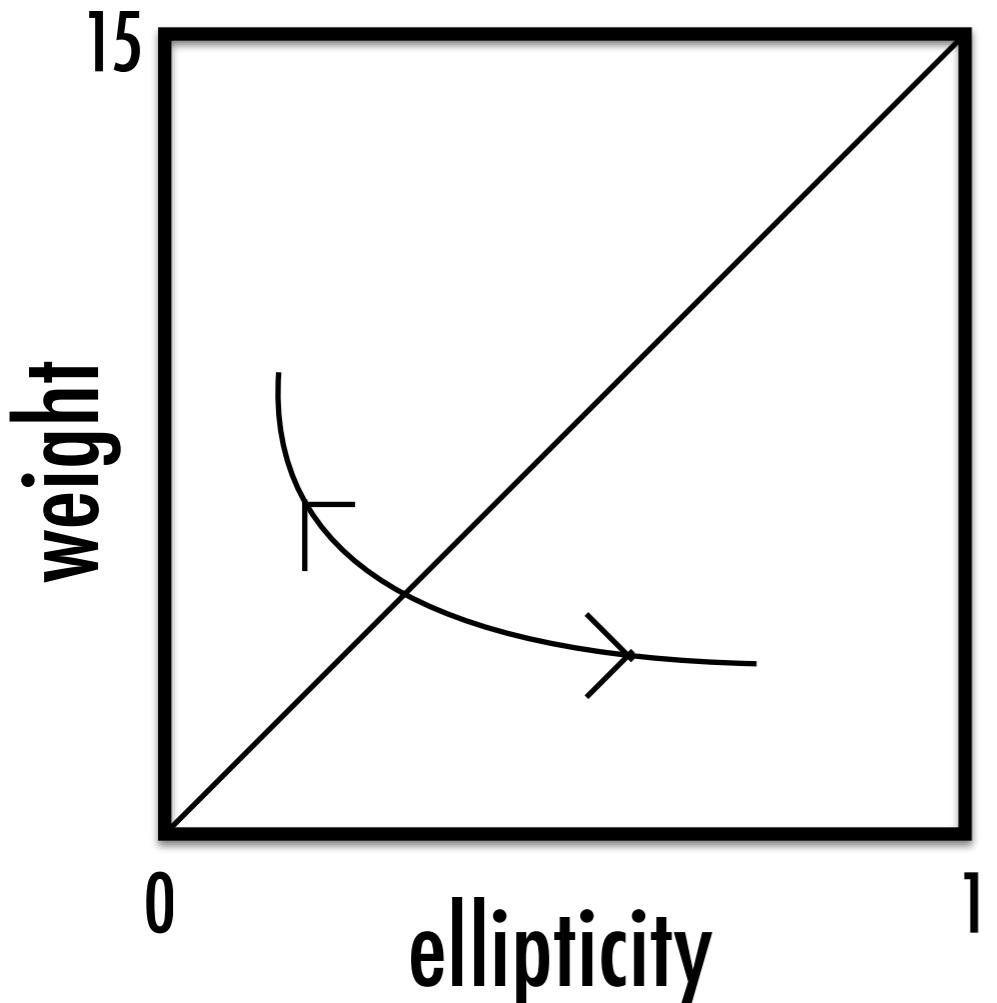
New functional form:

$$f(k, \epsilon, w)$$

Blinding is such that the
(weighted) ellipticity variance
doesn't change:

$$w\epsilon^2 = \text{const}$$

KiDS-450 blinding



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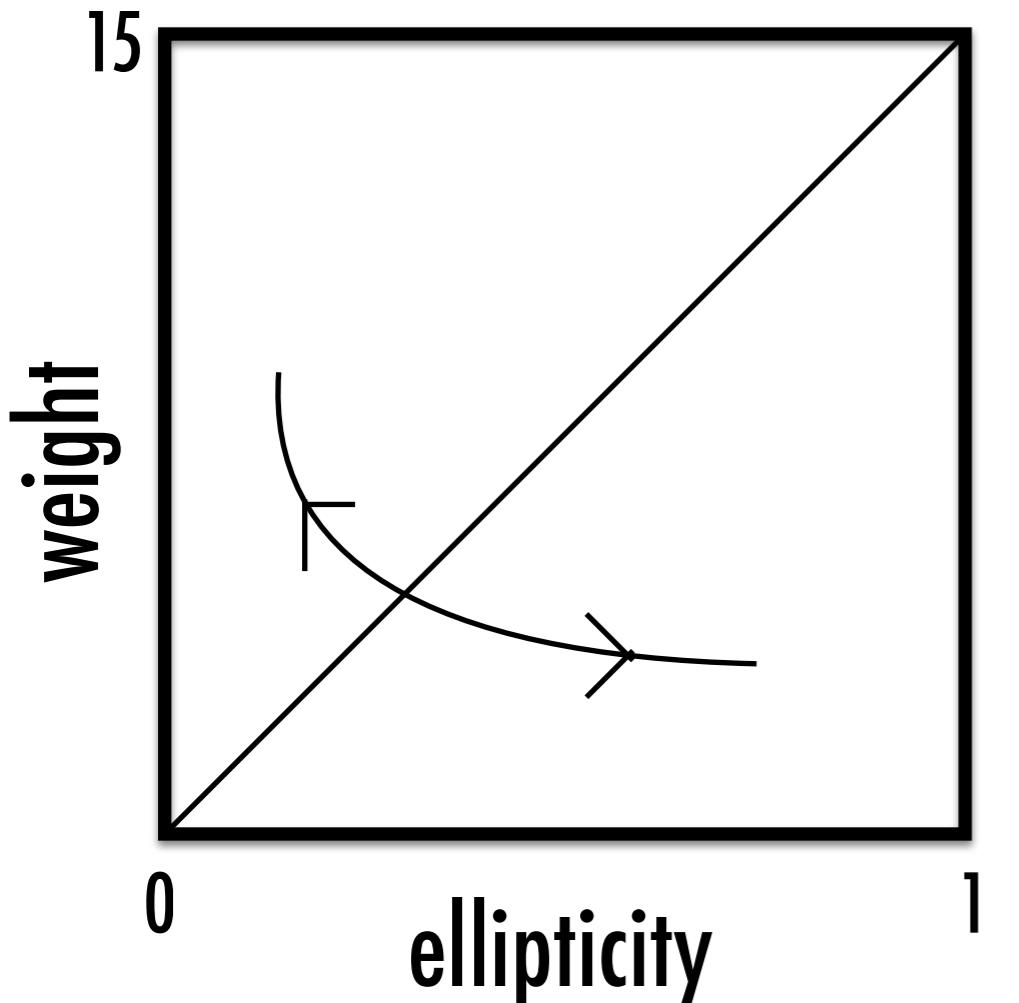
$-k_{\max}$

$-\frac{k_{\max}}{2}$

$\frac{k_{\max}}{2}$

k_{\max}

KiDS-450 blinding



Shape measurement weight:

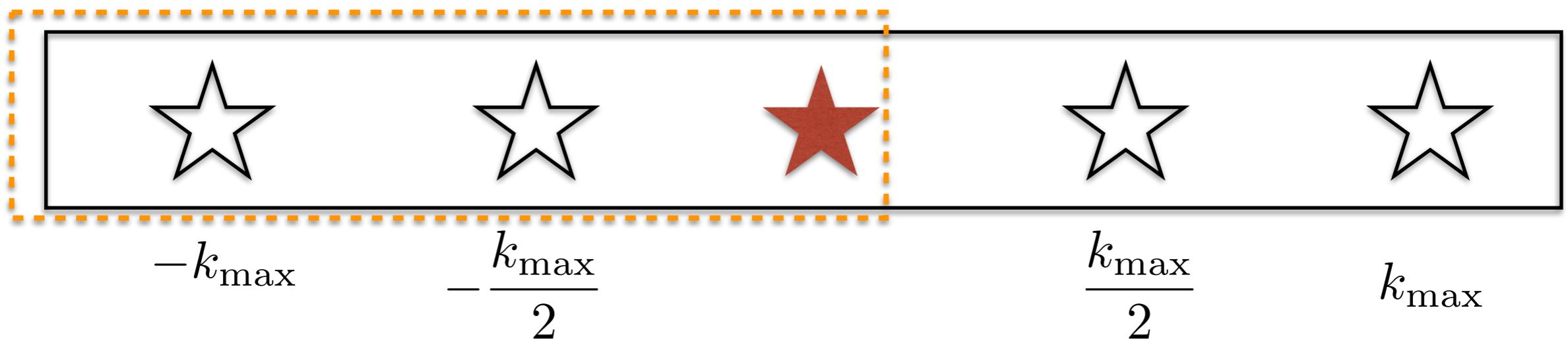
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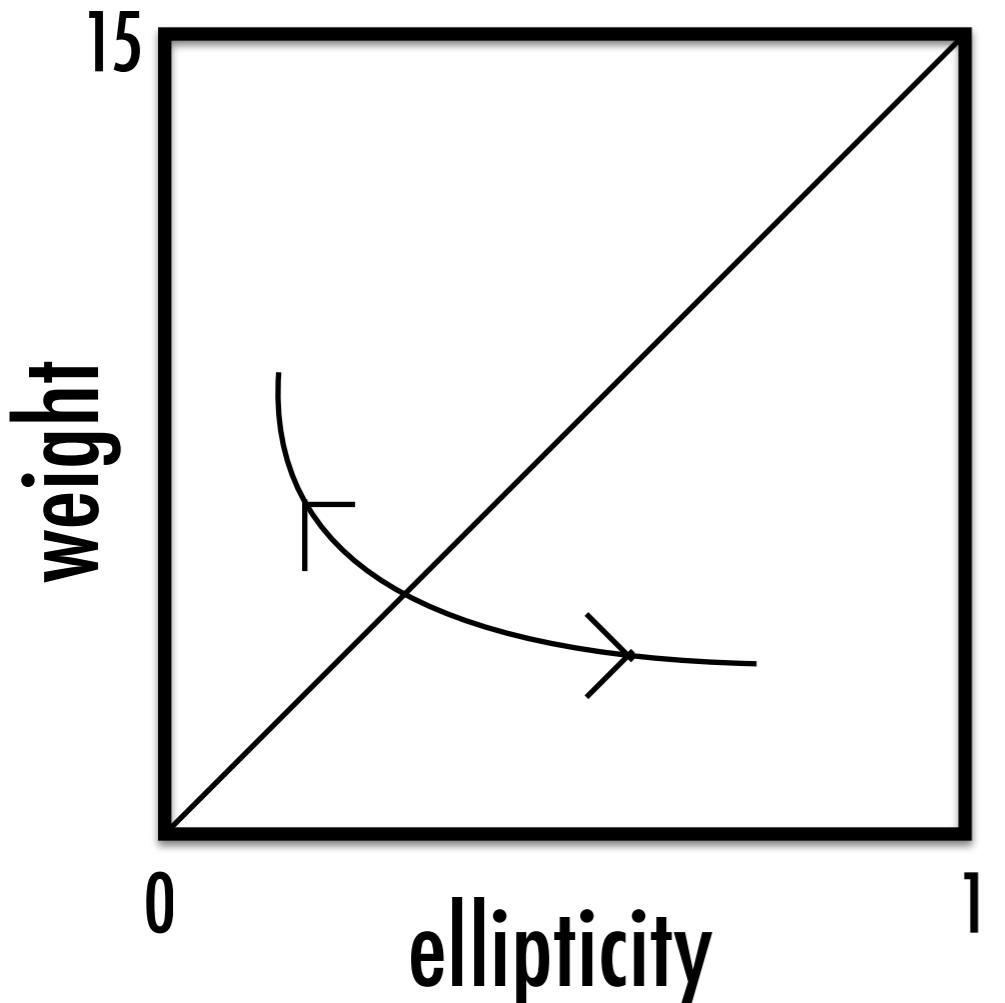
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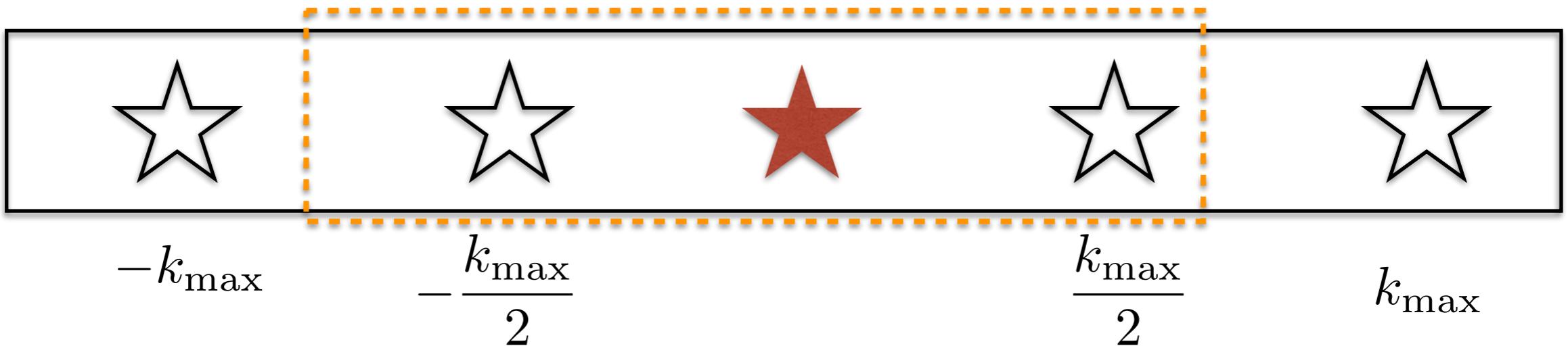
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New functional form:

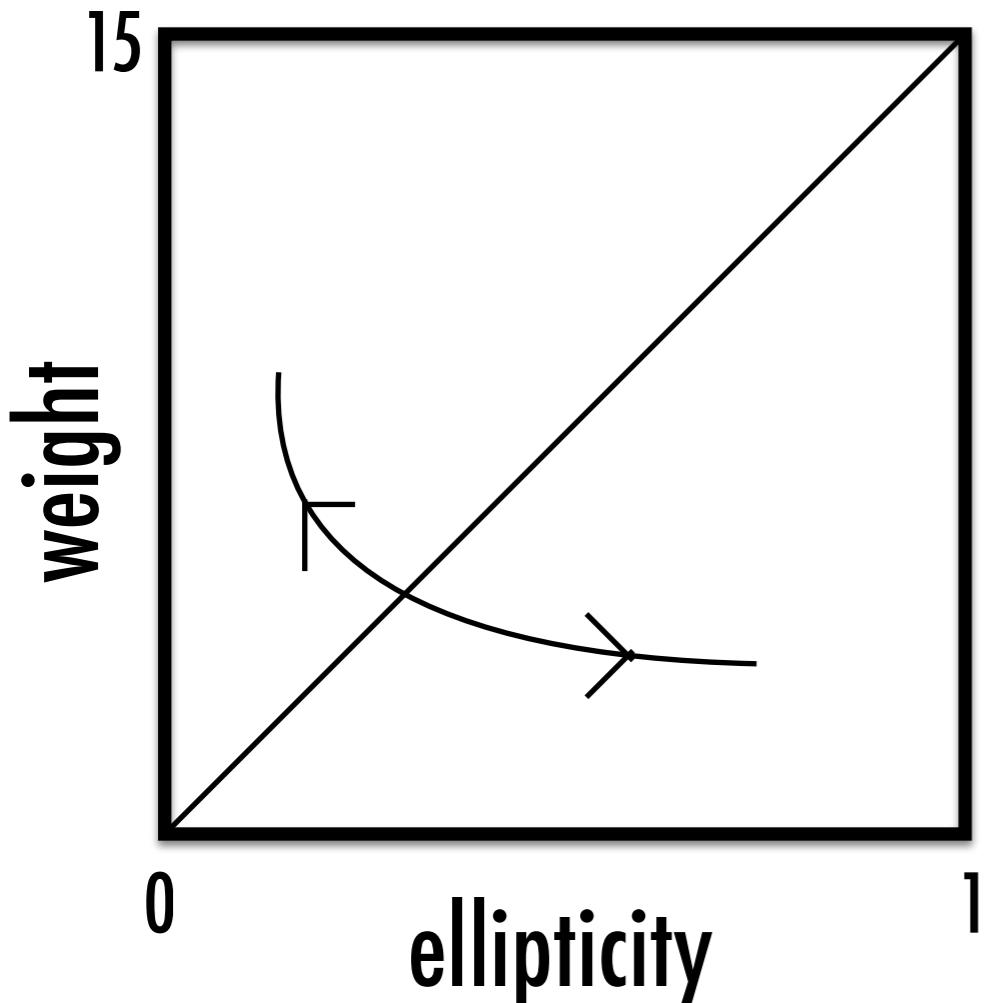
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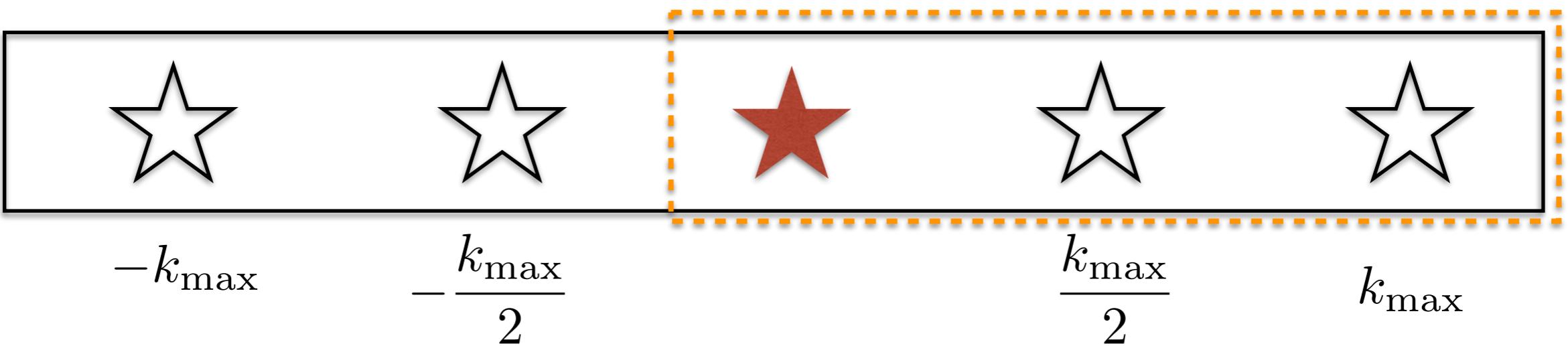
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KiDS-450 blinding

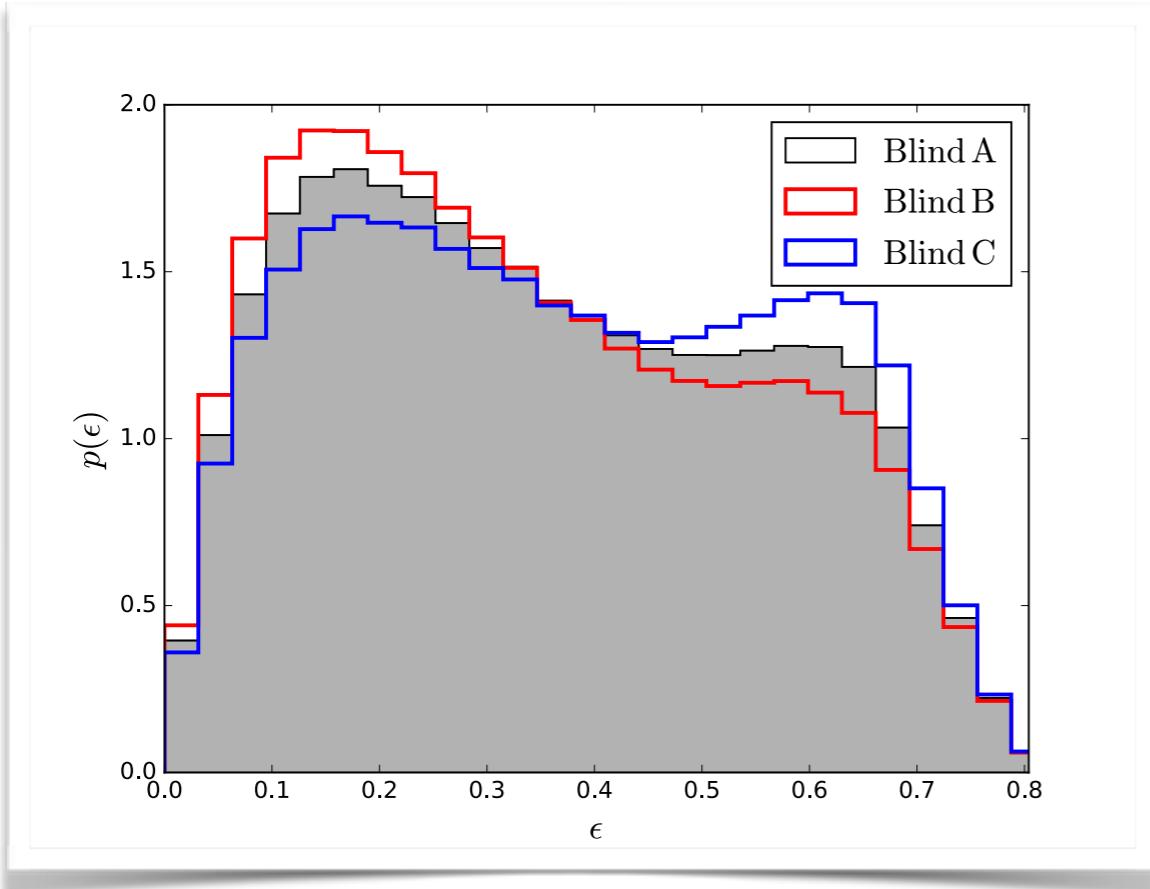
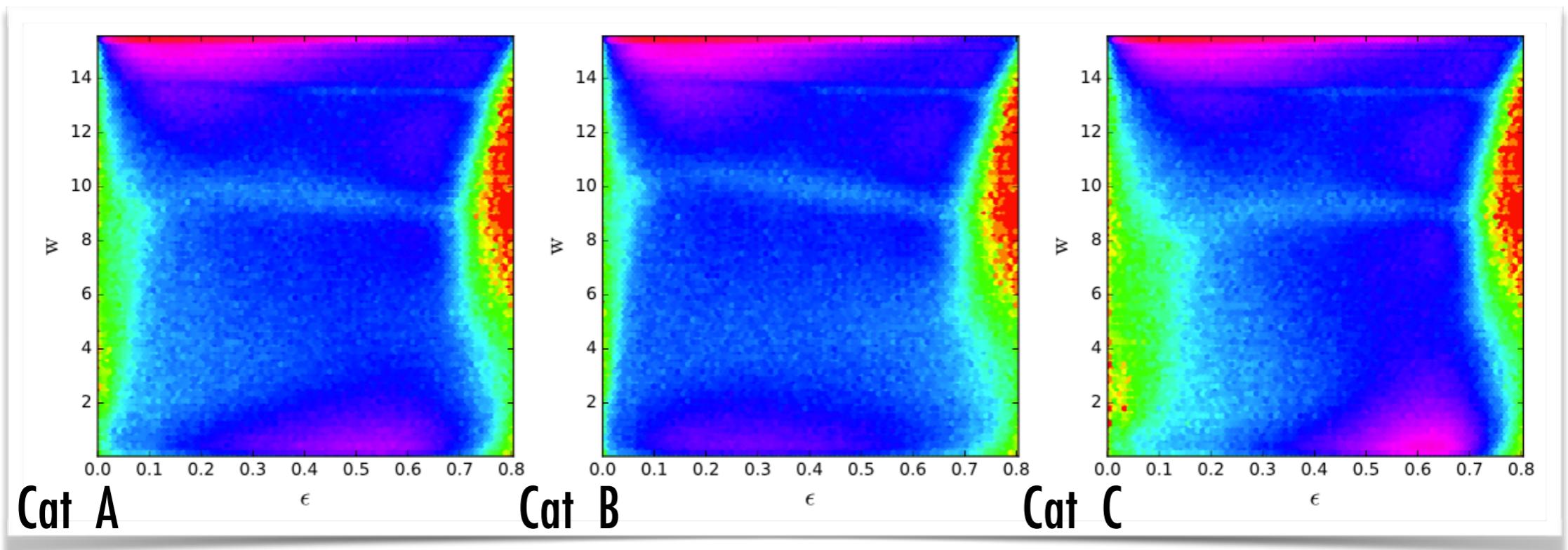
ser for 2: KiDS_G9_reweight_5x5x5_BLIND_PF.cat-2

SeqNr_field	e1_A	e2_A	weight_A	e1_B	e2_B	weight_B	e1_C	e2_C	weight_C
1231	-0.3011	-0.5646	12.2617	-0.2997	-0.562	12.29	-0.3026	-0.5673	12.2323
1254	-0.1818	-0.0908	1.5473	-0.1047	-0.0523	2.0391	-0.303	-0.1513	1.1986
1259	-0.3941	0.2877	13.9349	-0.3925	0.2865	13.9637	-0.3959	0.289	13.9028
1265	0.3964	0.0018	9.75	0.3685	0.0017	10.1129	0.4317	0.002	9.3431
1268	-0.0094	0.3362	5.9746	-0.0075	0.268	6.6912	-0.0118	0.4235	5.323
1269	0.0358	-0.0995	0.5932	0.0189	-0.0525	0.8166	0.0679	-0.1886	0.4308
1281	0.4033	0.3778	3.6237	0.3496	0.3275	3.8921	0.4461	0.4179	3.4456
1292	0.0733	-0.1648	15.3907	0.0733	-0.1648	15.3922	0.0733	-0.1648	15.3891
1296	-0.0282	0.6359	9.9038	-0.0278	0.627	9.9734	-0.0286	0.6448	9.8354
1298	-0.1557	0.0824	14.9894	-0.1554	0.0822	15.0046	-0.1561	0.0826	14.9716
1304	-0.5998	-0.1541	4.3661	-0.5587	-0.1435	4.5238	-0.6325	-0.1625	4.2519
1310	-0.4662	0.2721	11.3926	-0.4578	0.2672	11.497	-0.4754	0.2775	11.2814
1316	0.189	0.174	15.3931	0.189	0.174	15.3942	0.189	0.174	15.3919

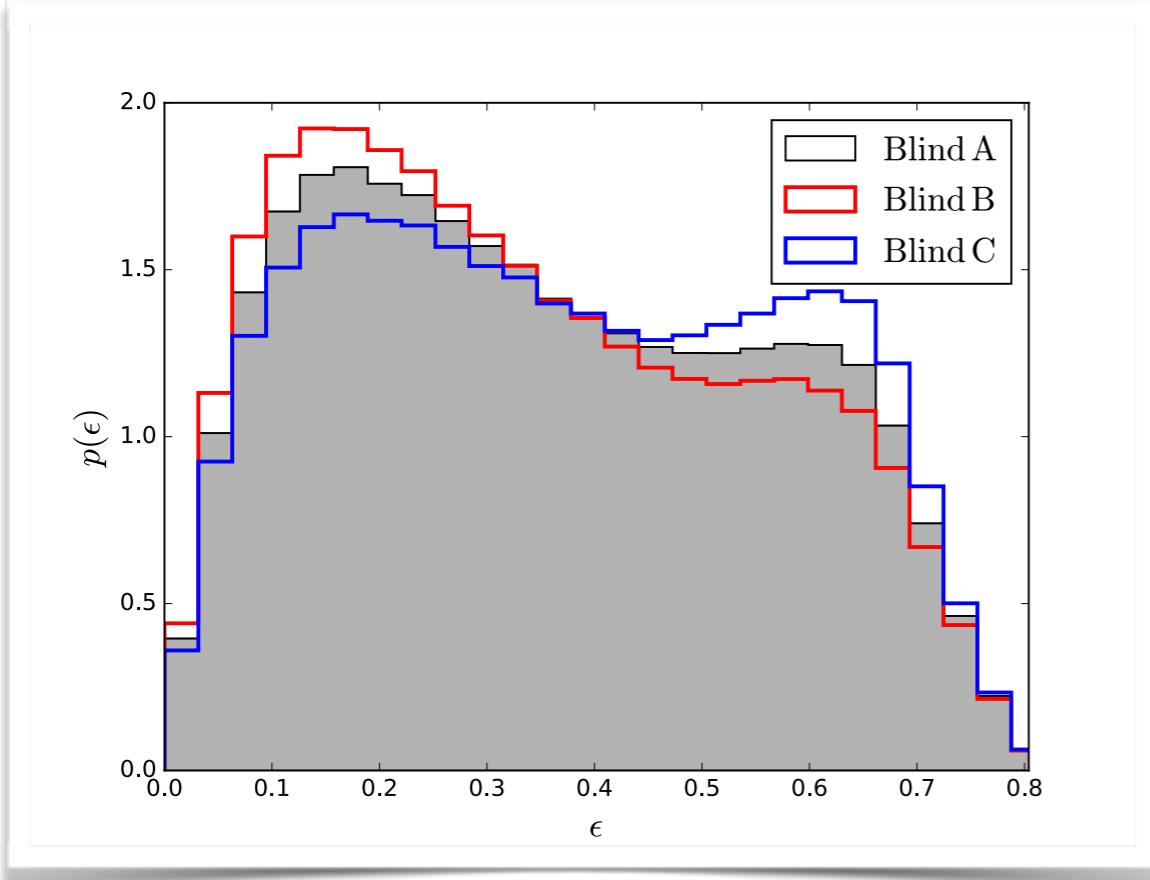
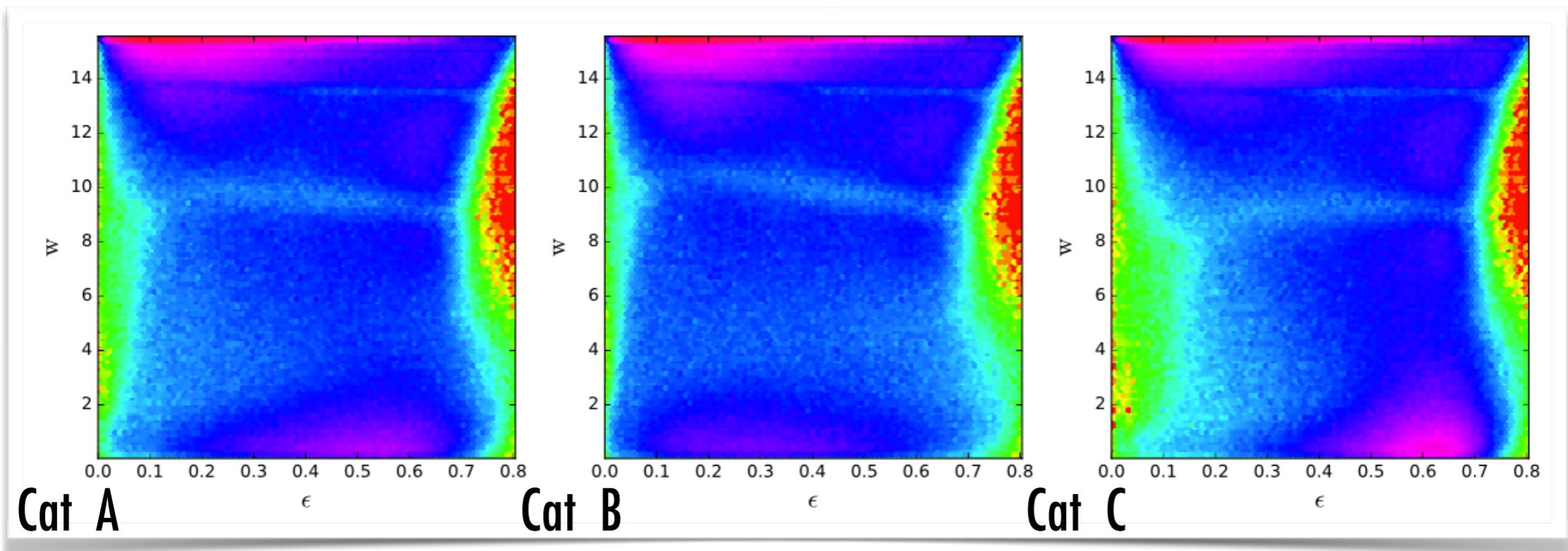
Instructions to the team:

1. The catalogues contain blinded columns (e1_X, e2_X, weight_X) where X = A, B, C
2. Create your own numeric to alphabet key that is known only to yourself eg: 1=C, 2=A, 3=B
3. If another co-author is also creating plots/tables for your paper you need to share your numeric to alphabet key. Both of you will be unblinded at publication phase.
4. When you show plots/tables/results to your colleagues these must be labelled as blind 1,2 or 3 (in both the labels on the plot and the file name)
5. When it comes to unblinding, send your paper to Matthias Bartelmann. The plots in this paper should be for blind 1, with a tar ball of the figures for blind 2 and 3 in addition. Tables should be included for blind 1,2 and 3. Let Matthias know your numeric to alphabet key and he will reveal the true column (A,B or C). Do not cc other members of the team on this e-mail, unless they also want to be unblinded.
6. Finally we all agree not to wilfully unblind ourselves during our analysis. There are a number of ways that are possible to do this (for example re-creating a plot in an unblinded published paper).

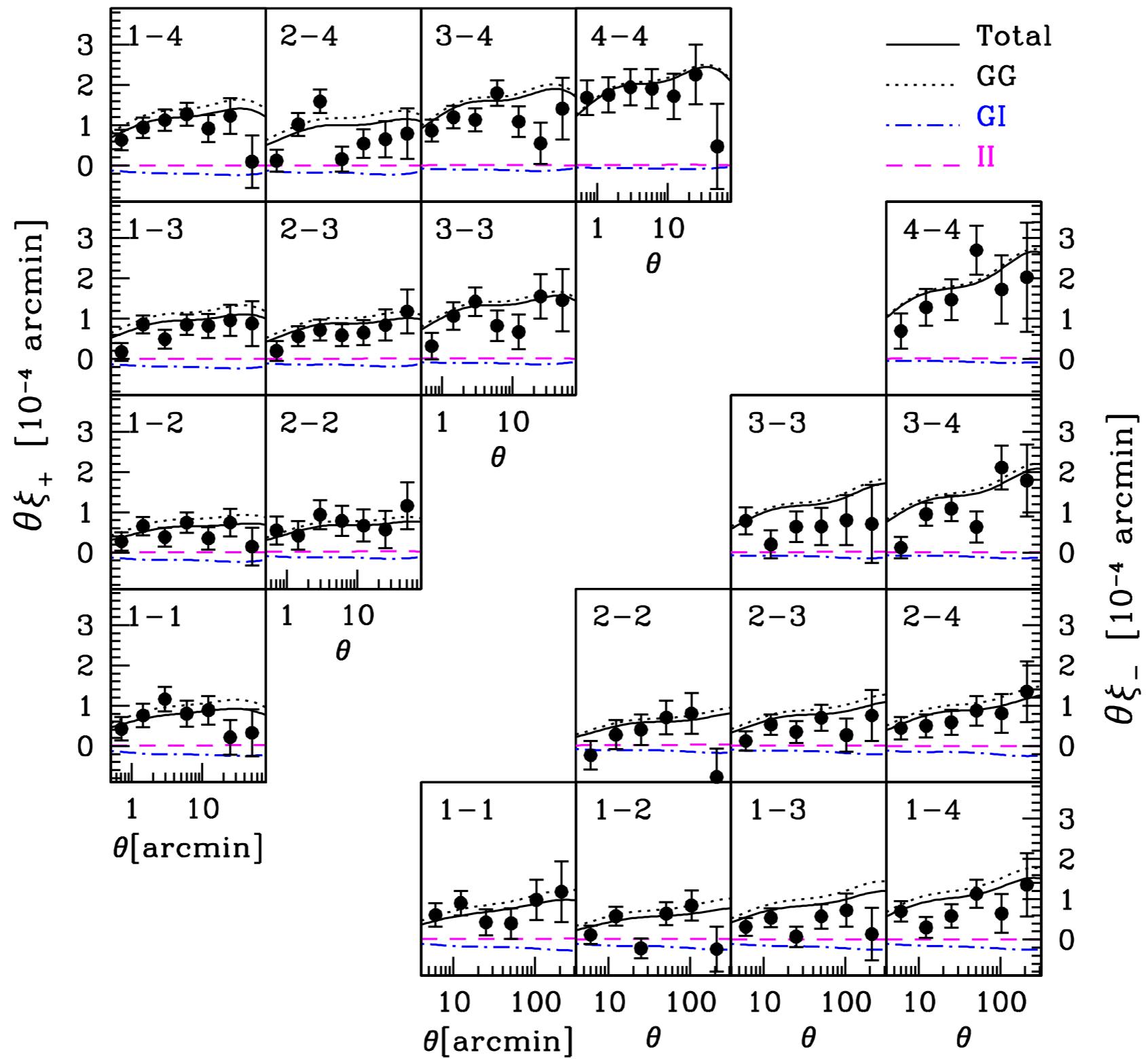
KiDS-450 blinding



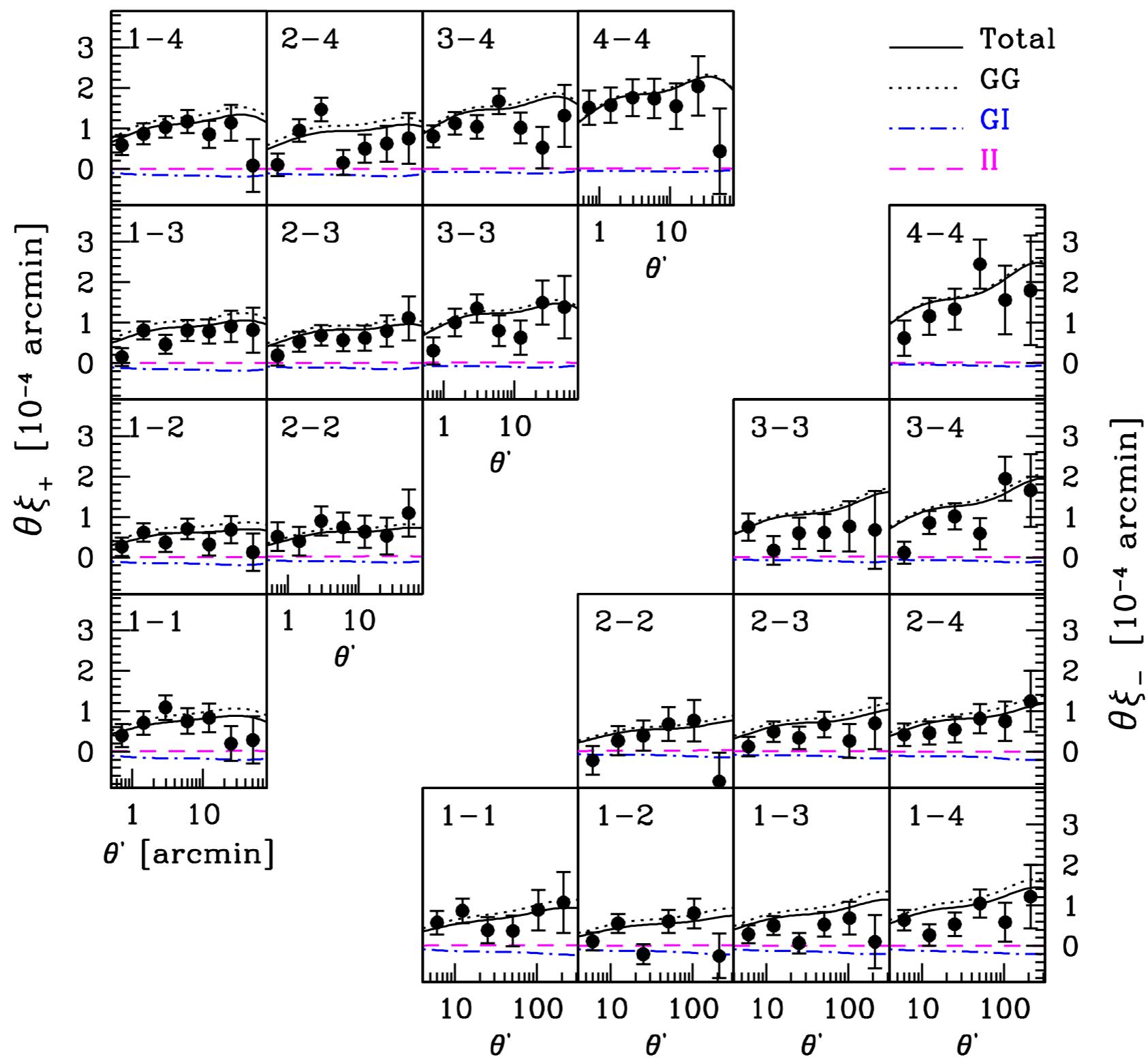
KiDS-450 blinding



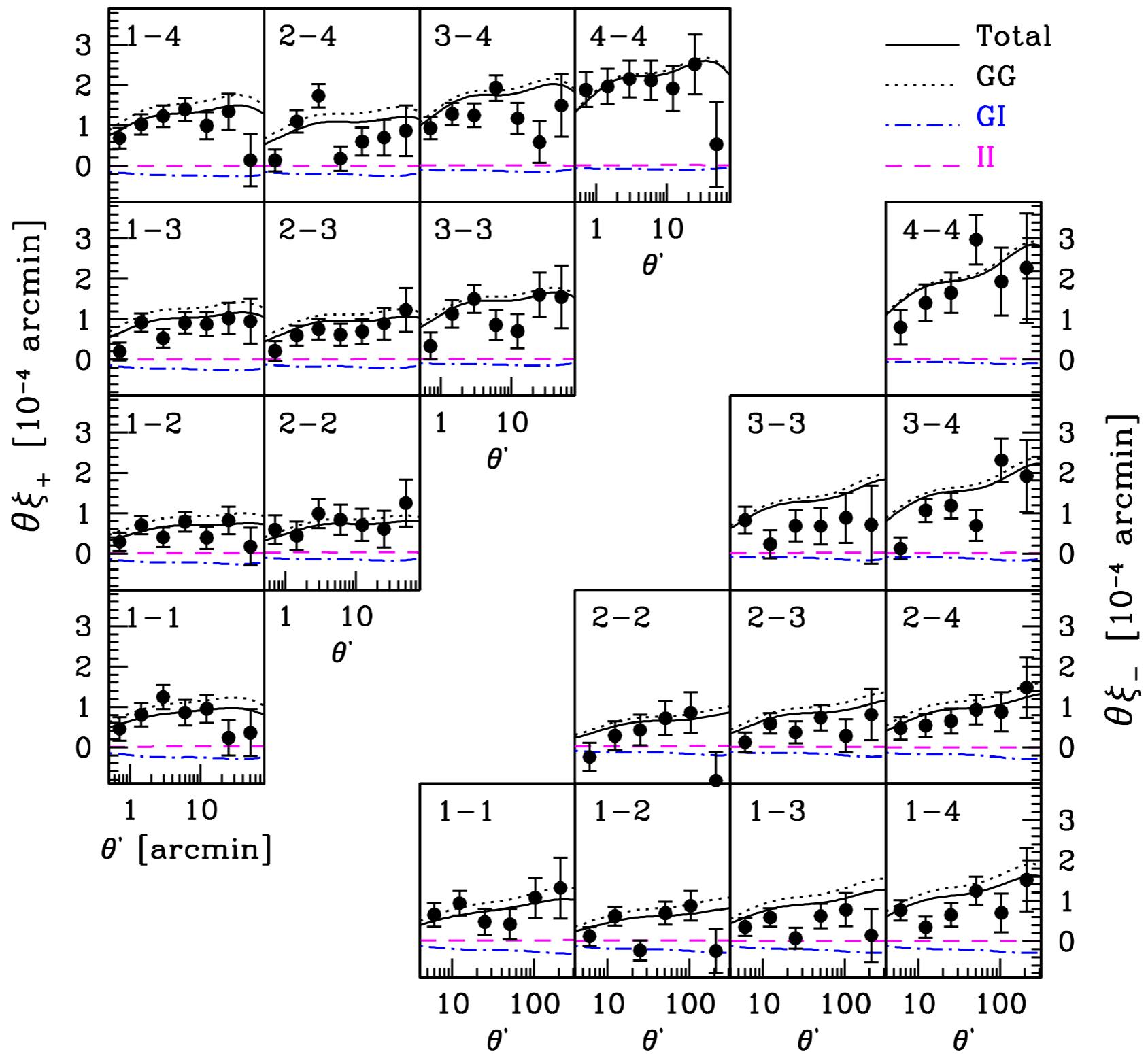
Visible differences, but
all distributions are
plausible.



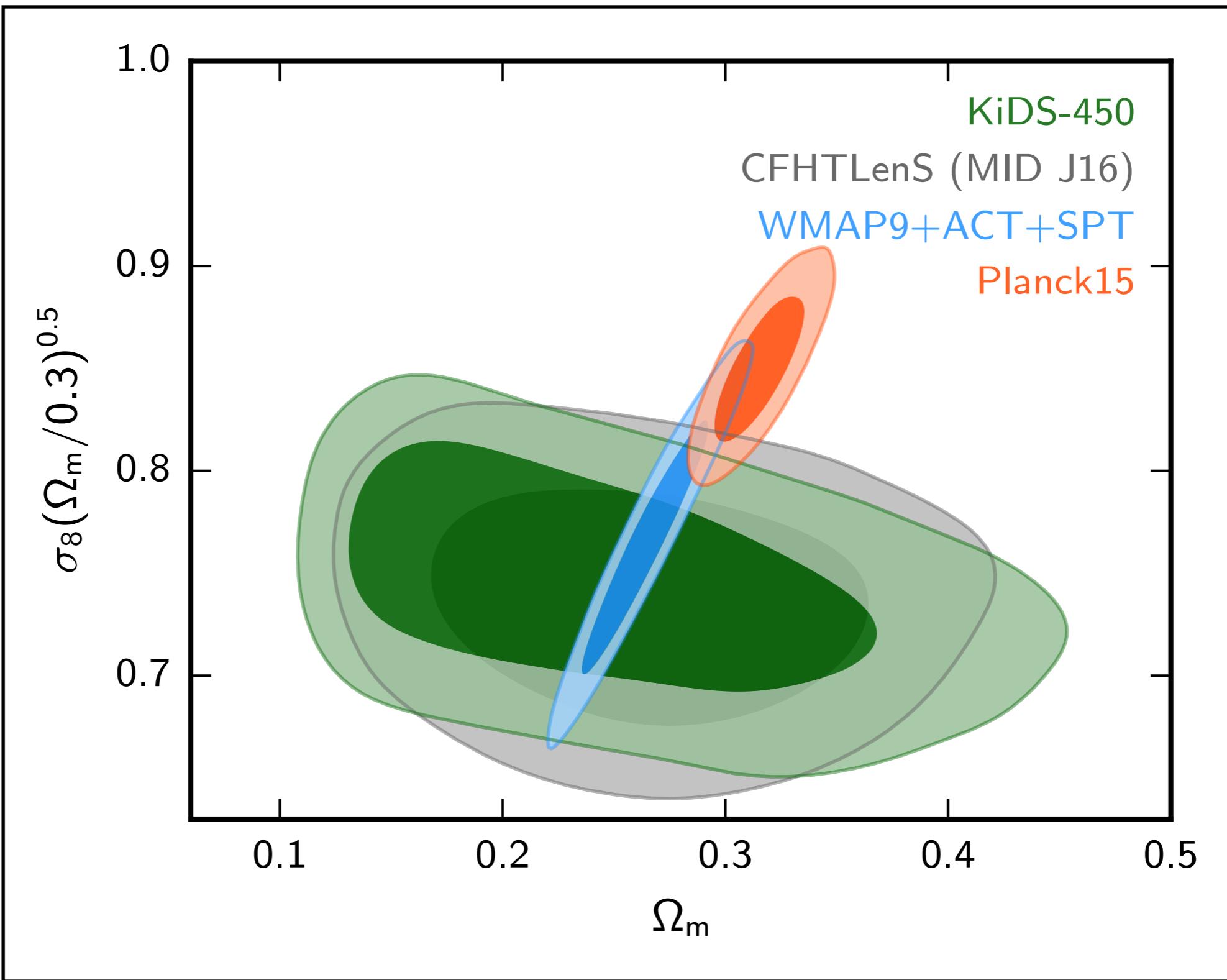
[Blind 1] Shear correlation function



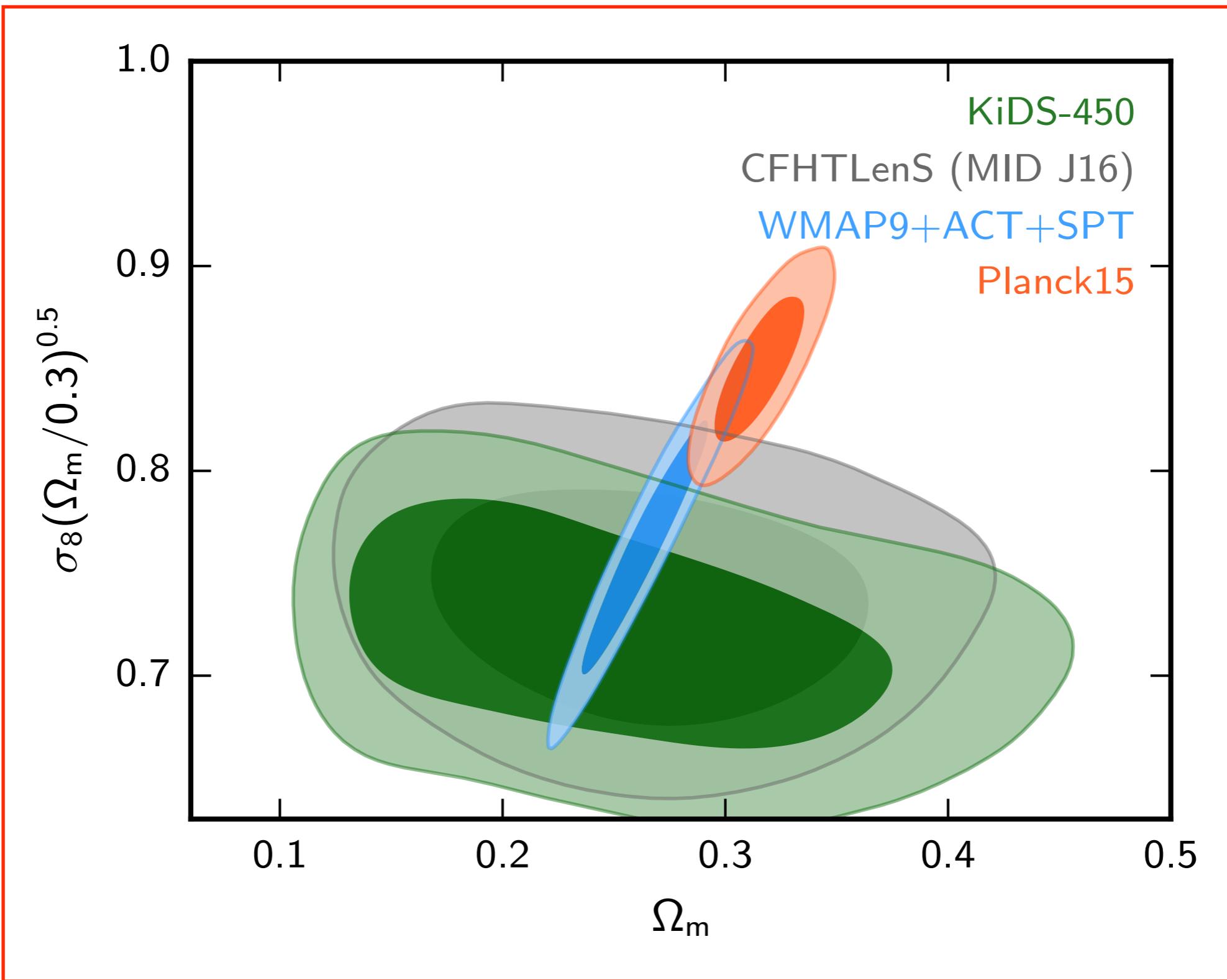
[Blind 2] Shear correlation function



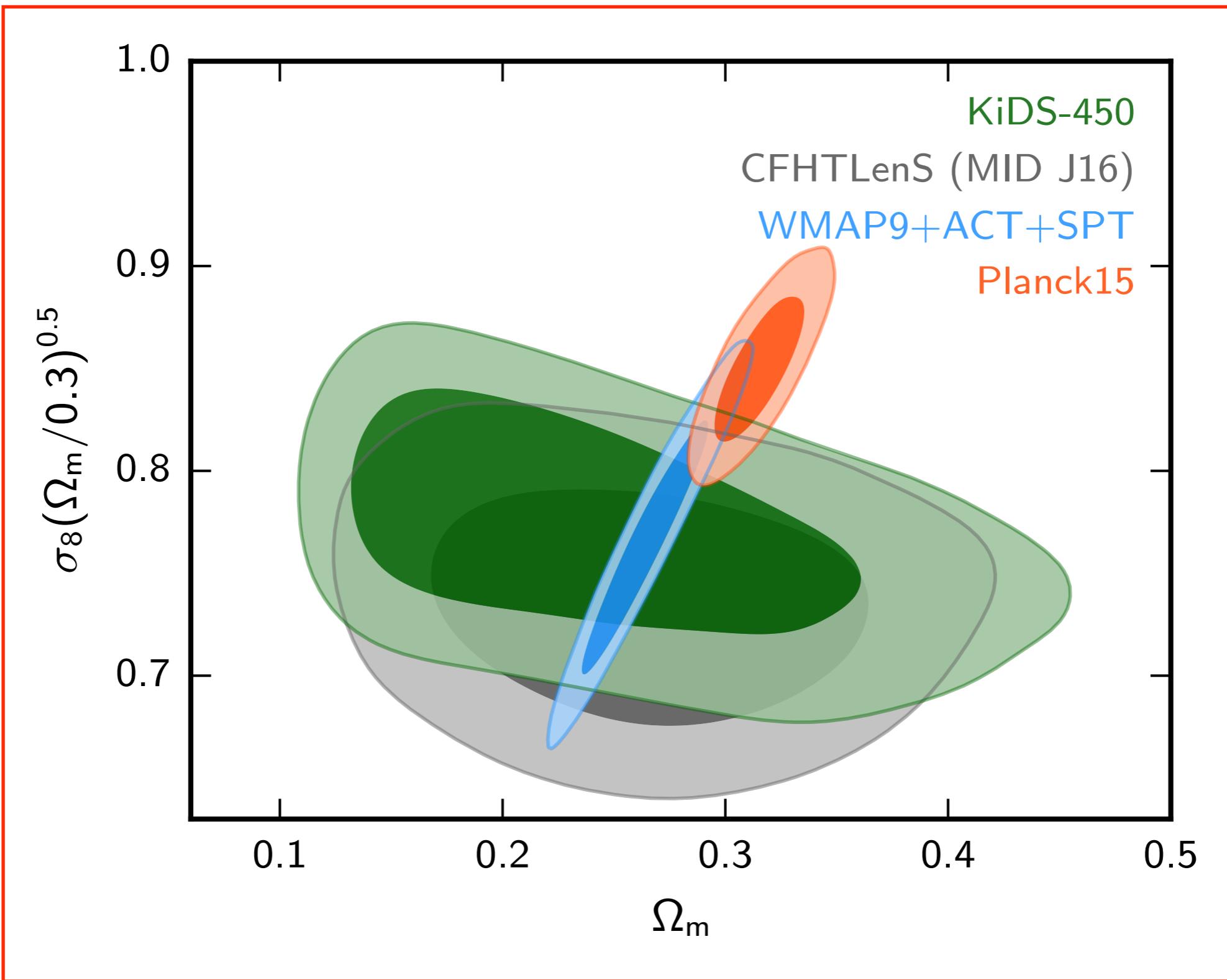
[Blind 3] Shear correlation function



[Blind 1] 2.3 sigma tension with Planck



[Blind 2] 2.8 sigma tension with Planck



[Blind 3] 1.7 sigma tension with Planck

Conclusions and outlook

- All major KiDS cosmology results are based on blind analyses.
- The whole team took the blinding very seriously !
- Blinding increased the awareness of the team of experimenter's bias
- Blind analyses are crucial for the credibility of the results as error bars on cosmological parameters shrink.
- Data are public: community can scrutinise the results
- Thinking new ways of blinding, maybe blind the redshift of galaxies?