Testing the Accuracy of Weak Lensing Analysis

The Case for BJ02 (Gauss-Laguerre) Method

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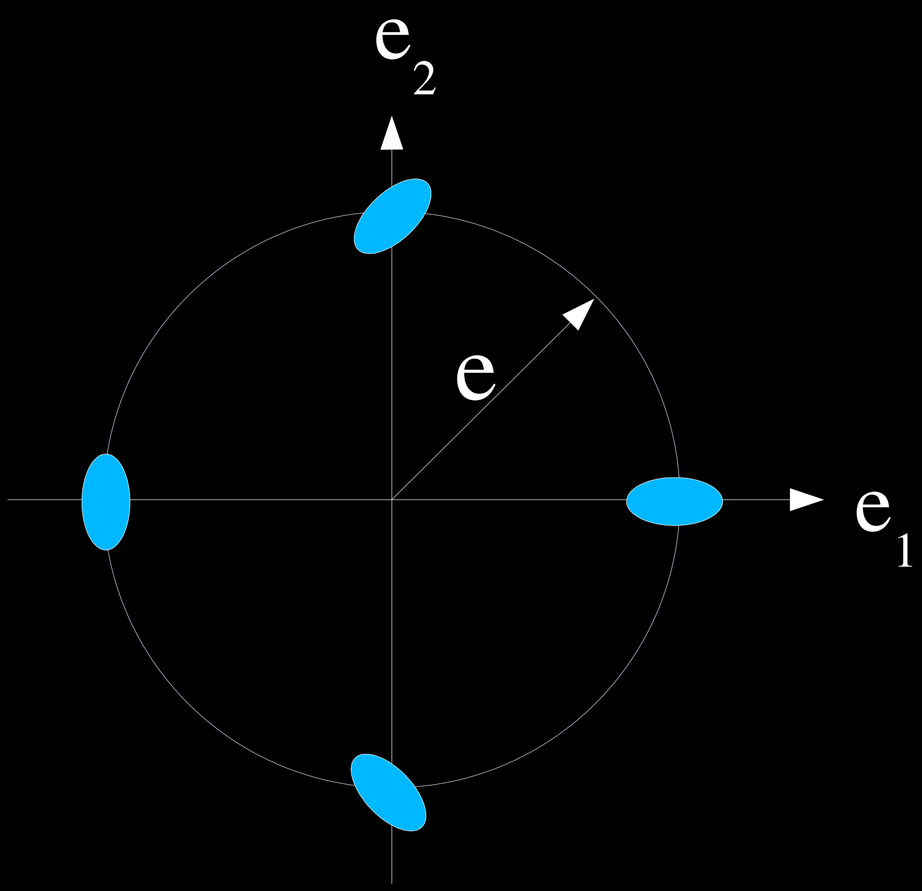
Difference with STEP

- Shear Testing Program
- Shear Accuracy Test

Shear Testing Program		Shear Accuracy Test
Image simulation	⇔	Postage stamp image
Selection bias	⇔	Always found*
Crowding	⇔	None
PSF determination	⇔	Known PSF
Measure shapes	⇔	Yes
Calibration bias	⇔	Simplified: “Ring Test”

Averaging Shapes

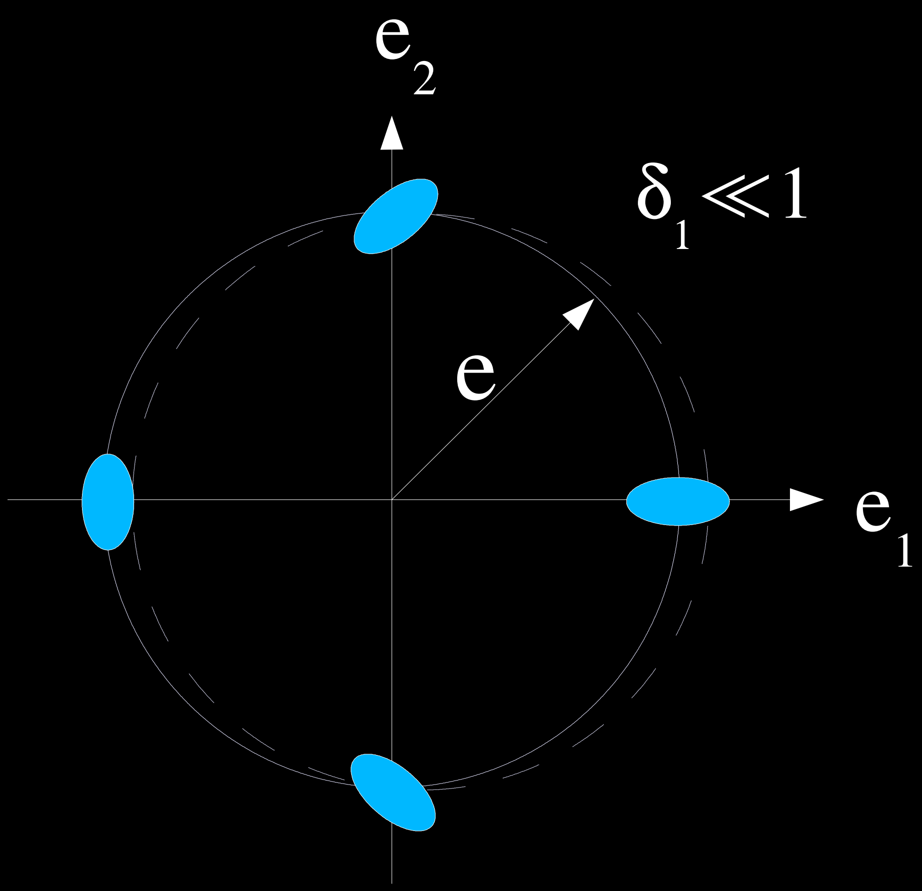


$$\langle e_1 \rangle = 0$$

$$\langle e_2 \rangle = 0$$

"Ring Test"

Averaging Shapes



$$\langle e_1 \rangle = \delta_1 \left[1 - \frac{e^2}{2} \right]$$

$$\langle e_2 \rangle = 0$$

"Ring Test"

Why is the Ring Test important?

- Quantifies PSF residuals in shear signal
- Quantifies recovery of shear signal δ
- Verifies optimal weight (w) and responsivity ($\mathcal{R}$)

$$\hat{\delta} = \Sigma\, w_i e_i \,/\, \Sigma\, w_i$$

$$\mathcal{R} \equiv \partial\hat{\delta}_1/\partial\delta_1 = \partial\hat{\delta}_2/\partial\delta_2$$

$\hat{\delta}$: shear estimator

e_i: *i*th galaxy ellipticity

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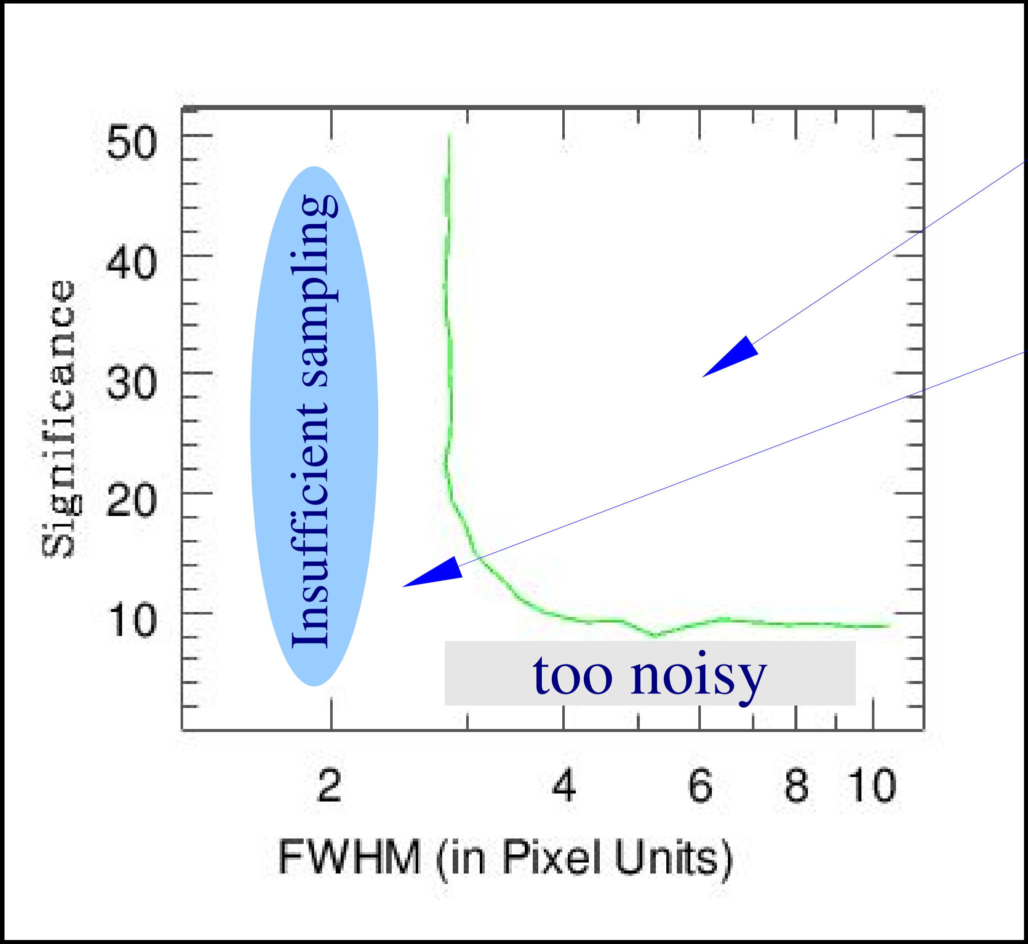
Convergence

99% convergence contour



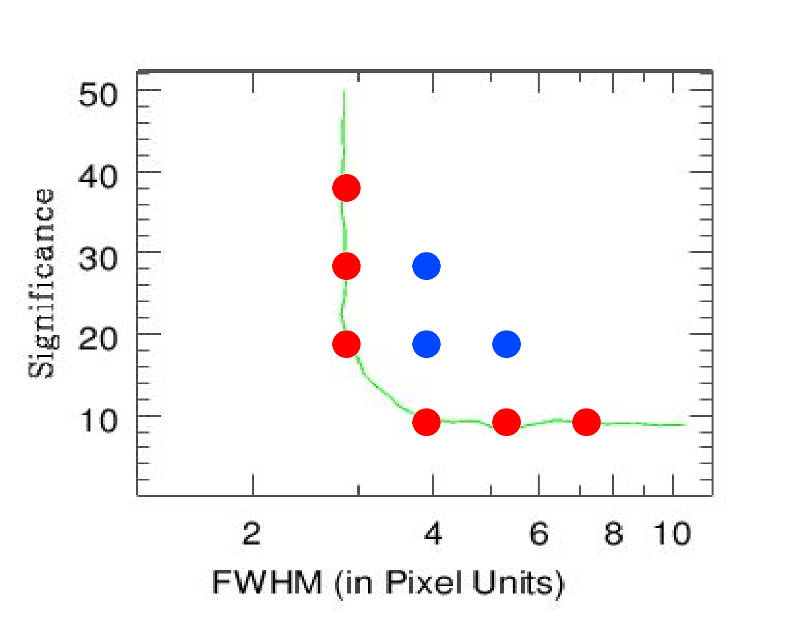
Shape determined 100%

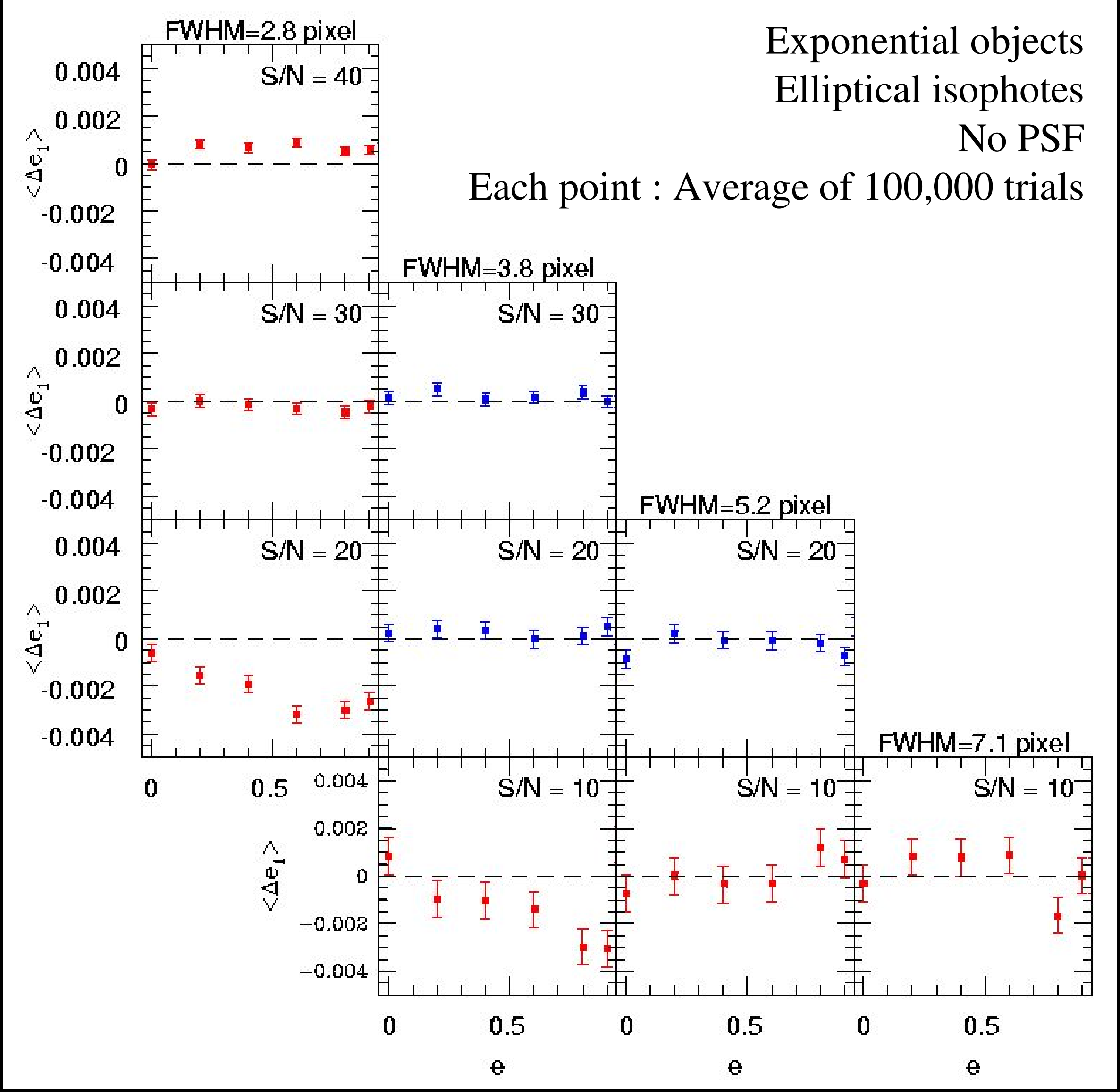
Object either
too small or too dim for
reliable shape measurement

Simple shape measurement
(Elliptical Gauss-Laguerre)
No PSF

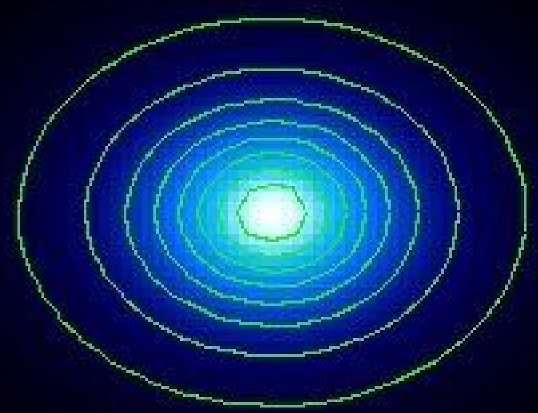
Shape Accuracy

99% convergence contour

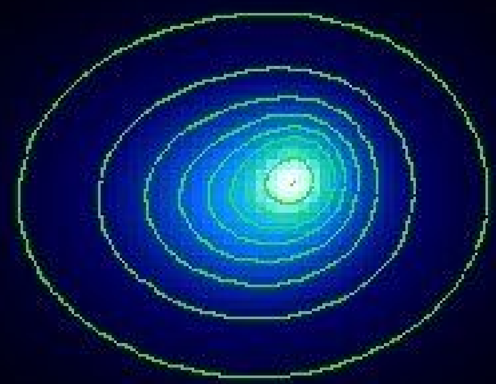




Asymmetric Objects

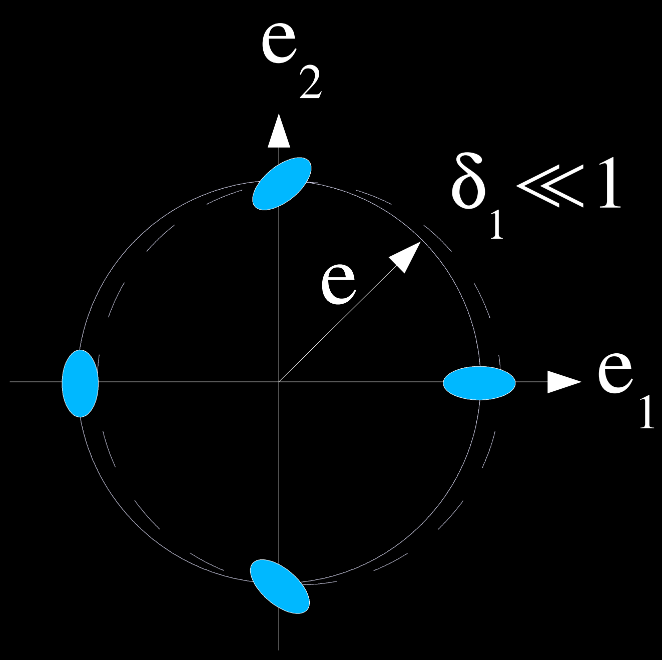


Definite Shape

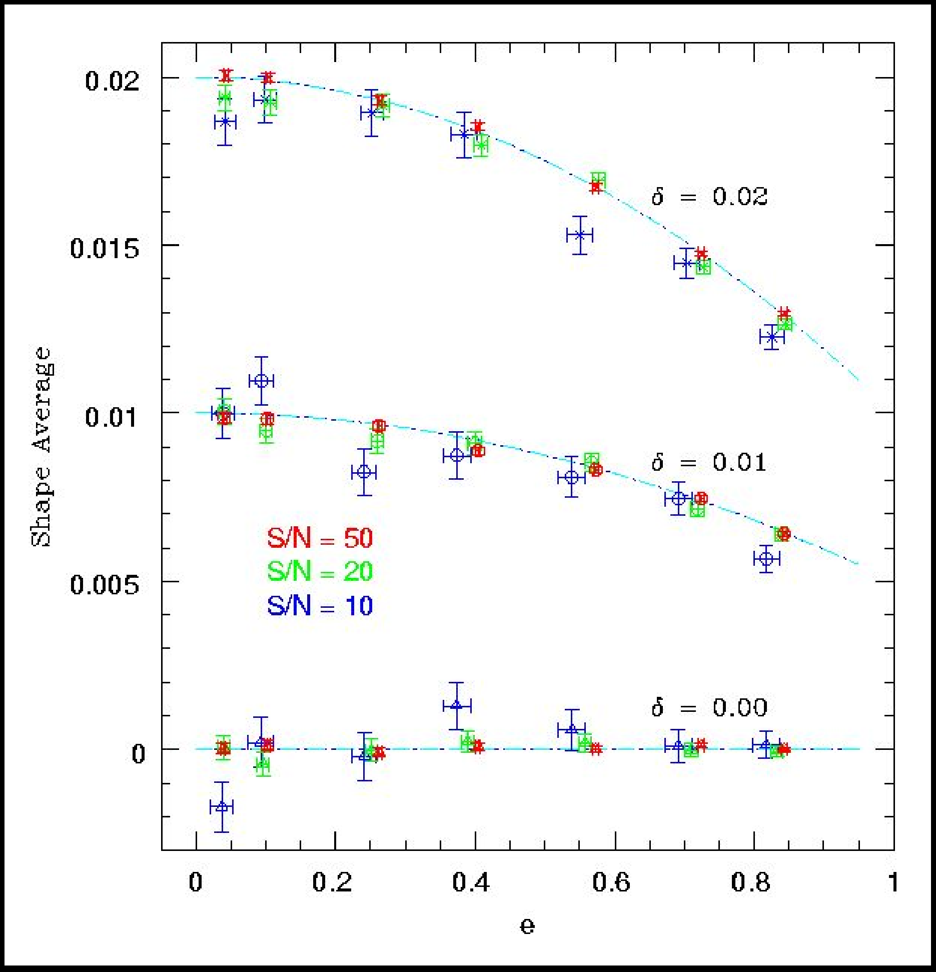


Shape is definition dependent

Ring Test with Asymmetric Objects

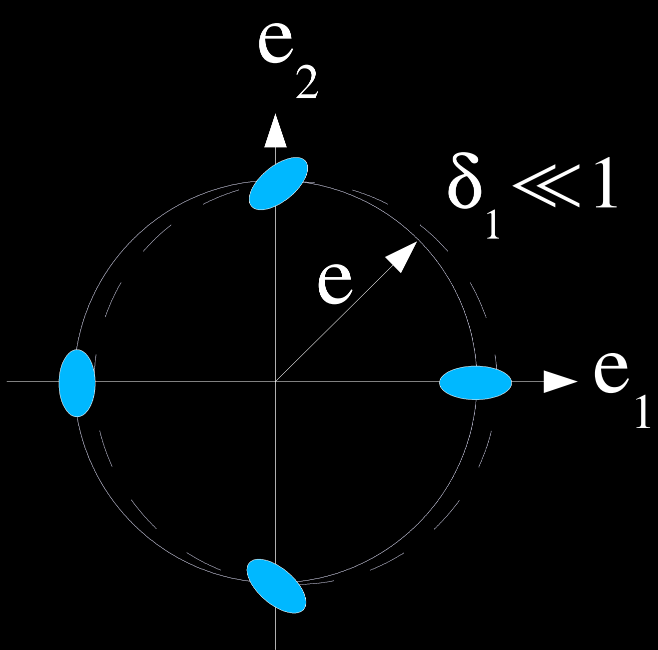


$$\langle e_1 \rangle = \delta_1 \left[1 - \frac{e^2}{2}\right]$$

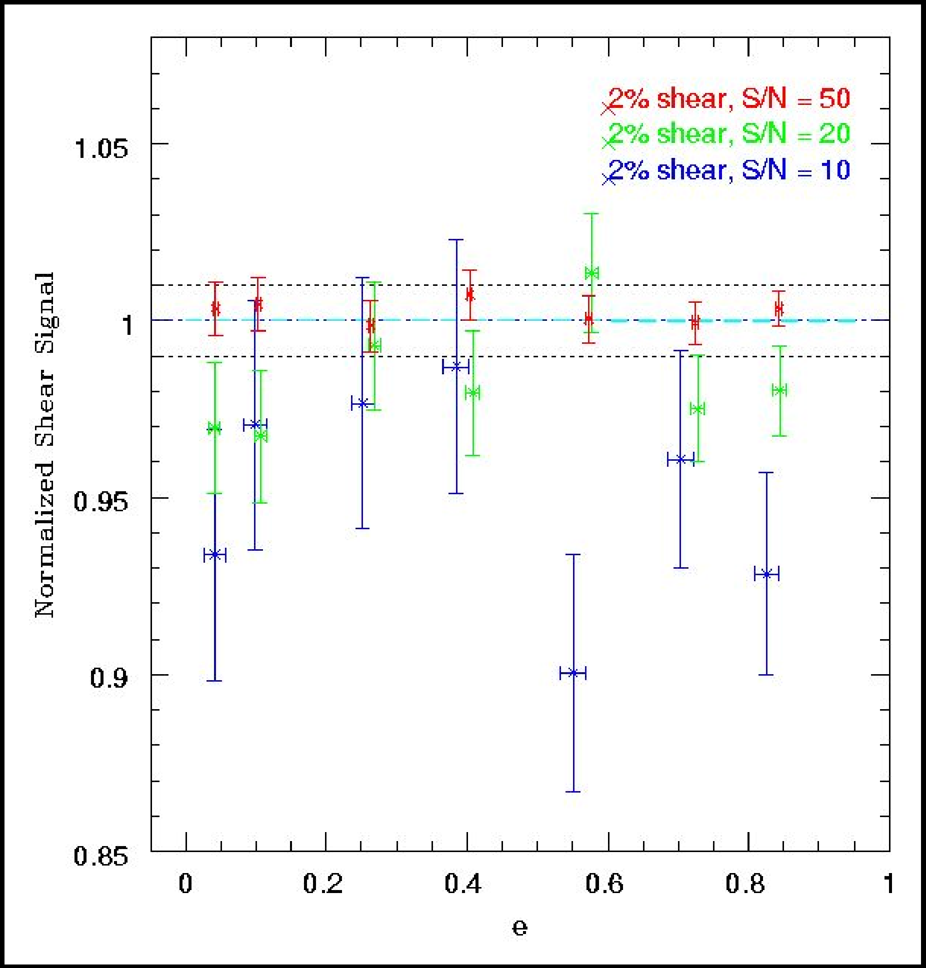


No PSF

Ring Test with Asymmetric Objects



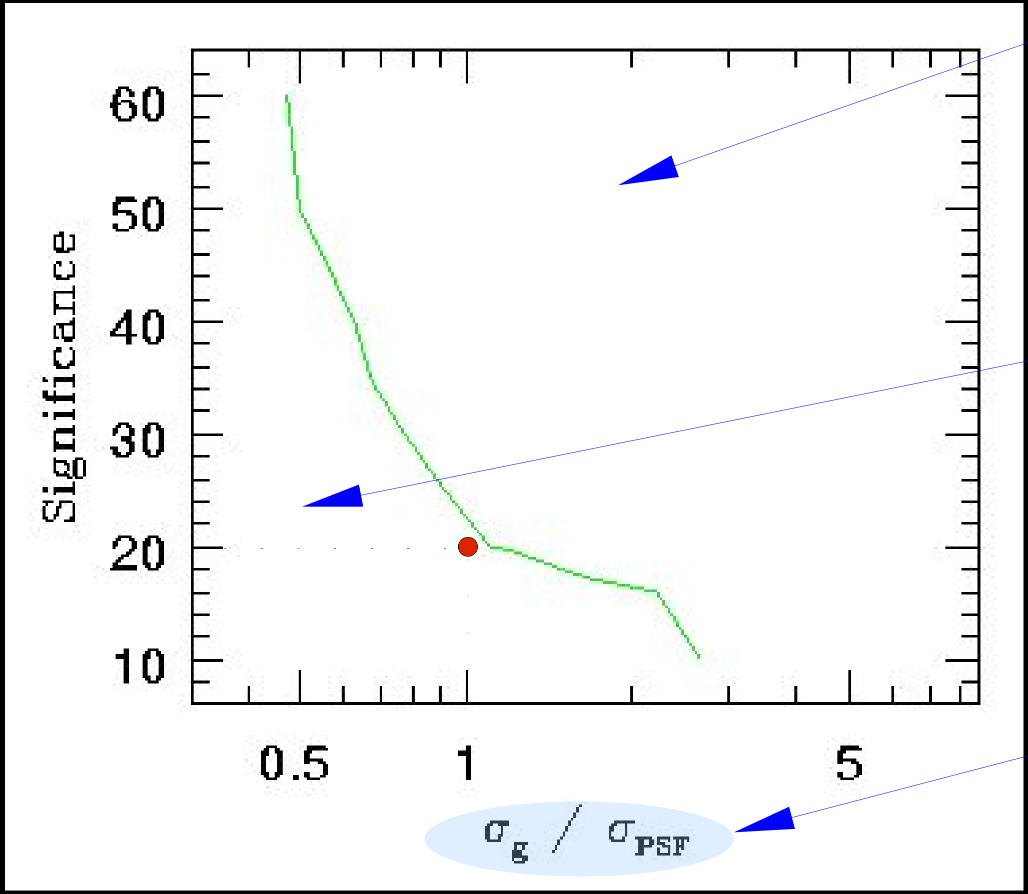
$$\langle e_1 \rangle = \delta_1 \left[1 - \frac{e^2}{2} \right]$$



No PSF

Convergence: with Deconvolution

99% convergence contour



Shape determined 100%

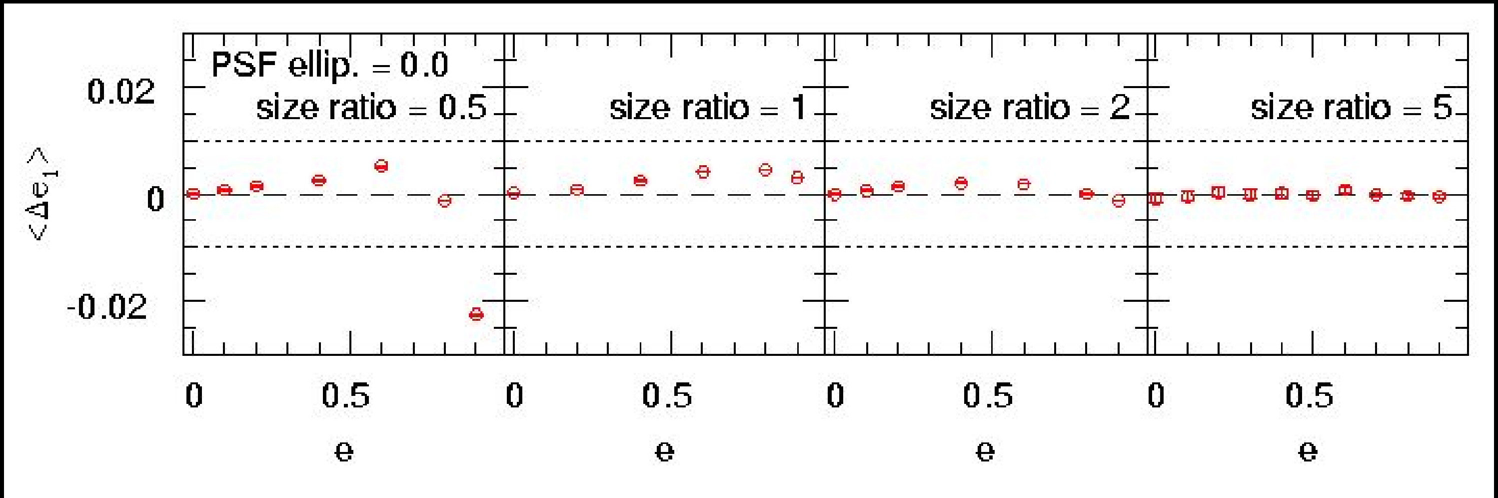
Object either
too small or too dim for
reliable shape measurement

Object size relative to
PSF size

Exponential object
convolved with Airy PSF

Shape Accuracy: with Deconvolution

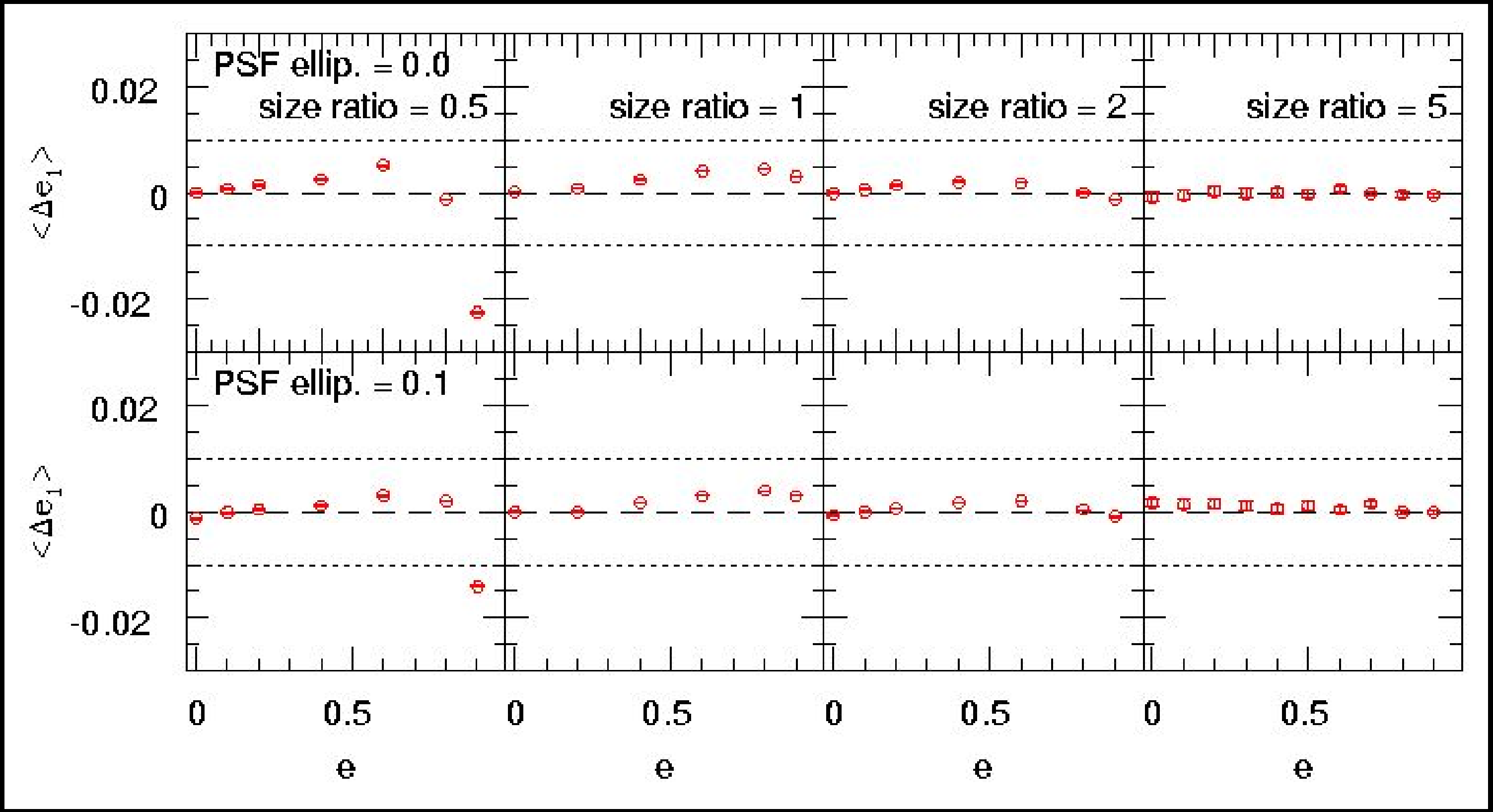
no PSF
anisotropy



Shape Accuracy: with Deconvolution

no PSF anisotropy

10% PSF anisotropy

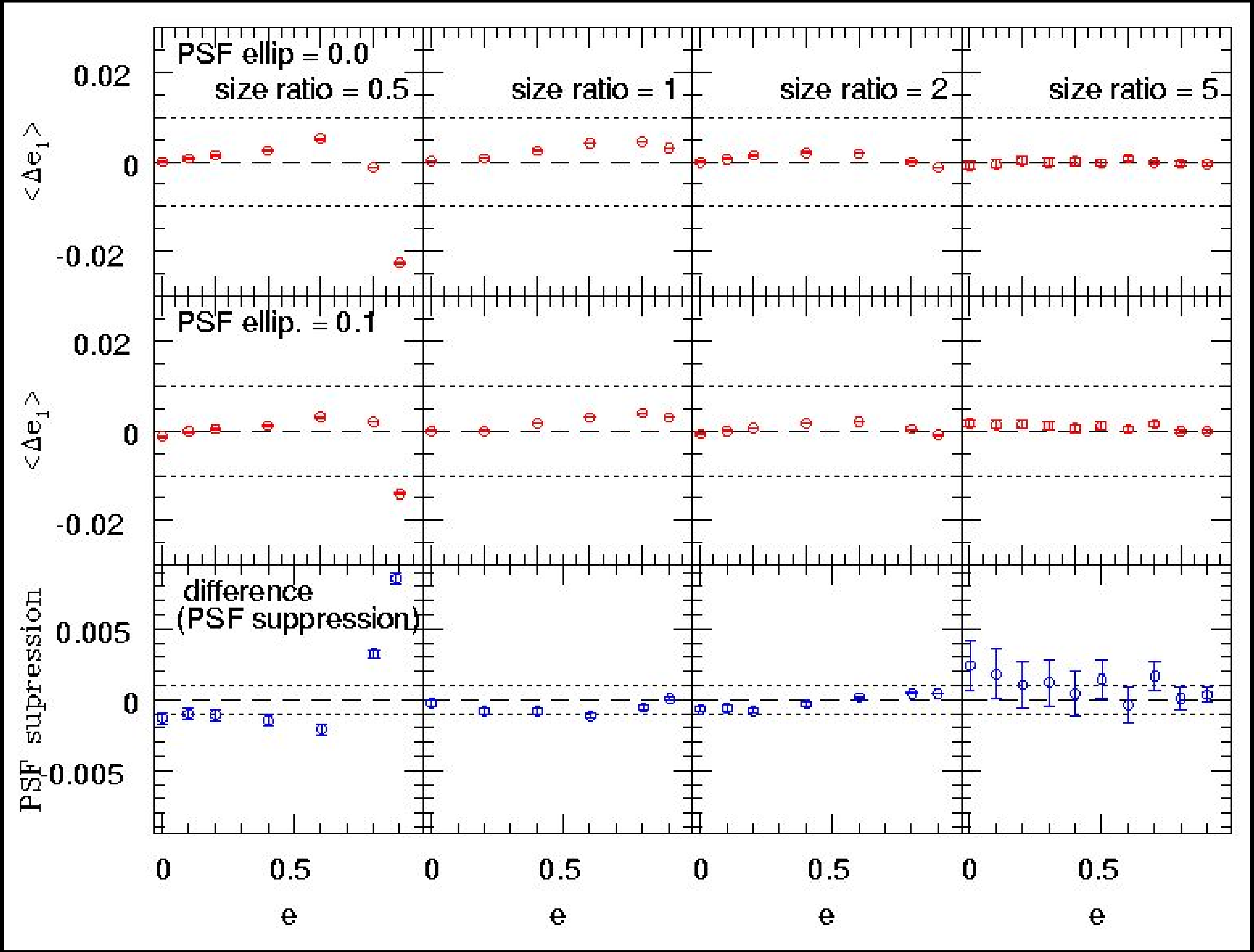


Shape Accuracy: with Deconvolution

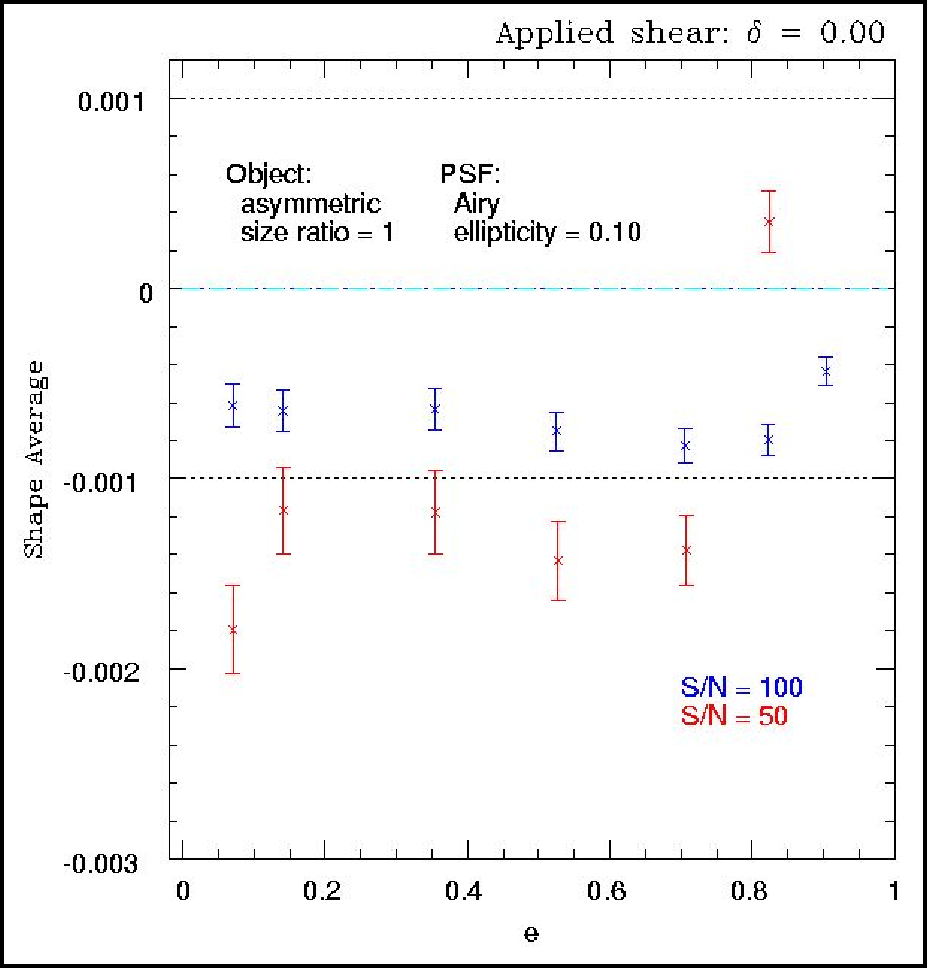
no PSF anisotropy

10% PSF anisotropy

difference



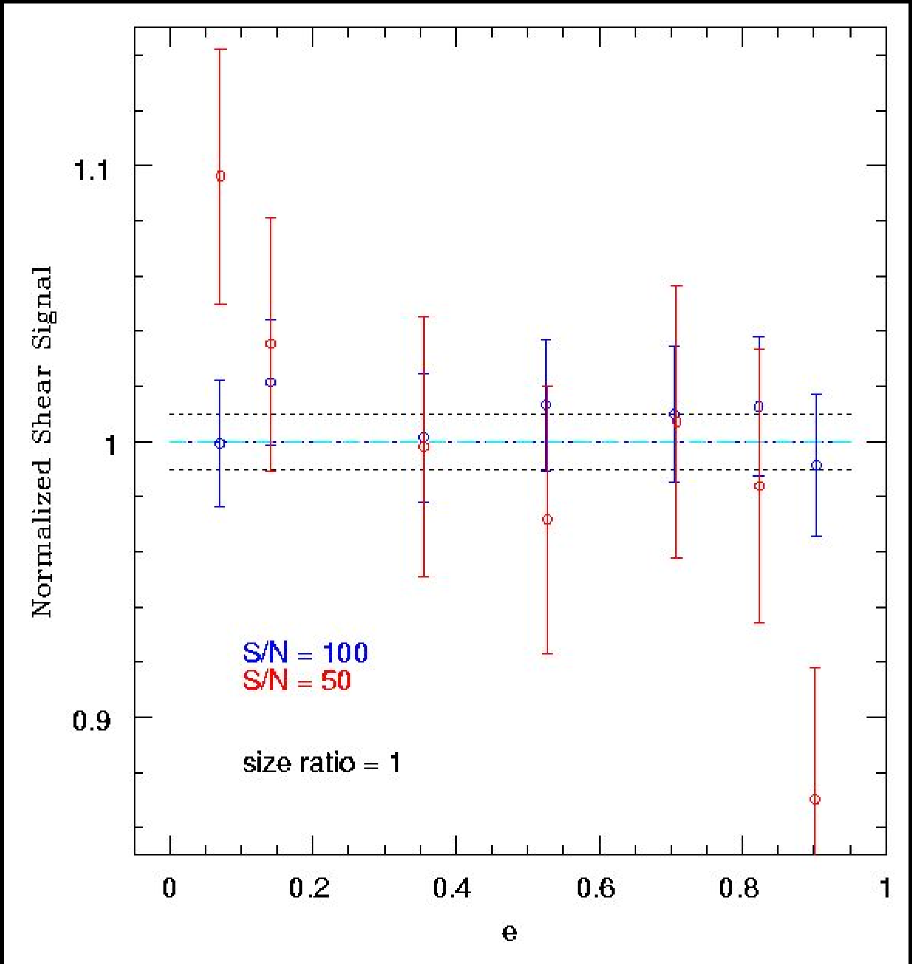
Ring Test: with Deconvolution



- PSF suppression:
  - 1~2% residual of PSF shape

Asymmetric object, poorly resolved
Asymmetric PSF

Ring Test: with Deconvolution



- Shear signal recovery:
  - accurate to 1~3%

Conclusion

- Simple shape determination (Elliptical Gauss-Laguerre fit)
  - good to $\ll 1\%$
- PSF suppression (deconvolution fit):
  - PSF suppression of ~ 1%
- Shear recovery (ring test, with deconvolution):
  - good to 1~3%, after removal of additive PSF effects
  - degrades as detection significance becomes low
  - object symmetry matters