# 'New Perspectives' on Radio Weak Lensing and Cross-correlations

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SKAO Cosmology SWG Meeting

4 November 2024

2014/16/18 Forecasts

- Notional 5,000 deg^2 survey with SKA1-MID Band 2 at 1 arcsec PSF
  - ~2 resolved star-forming galaxies arcmin^{-2}

- AA4 alone competitive with completed Dark Energy Survey (DES)

- SKA2 ~ *Euclid*

- Useful extra observables (polarisation, kinematics)

Cross-correlations have same statistical power but removes systematics
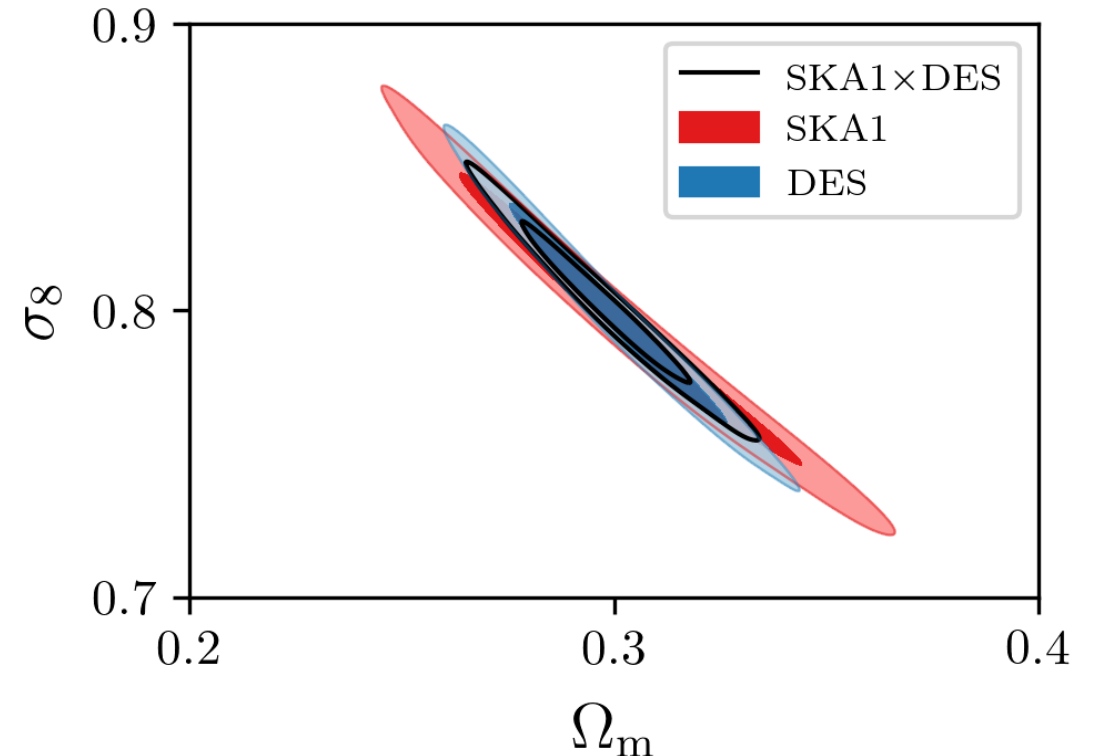
Brown et al (2015)
IH et al (2016)
Bonaldi et al (2016)
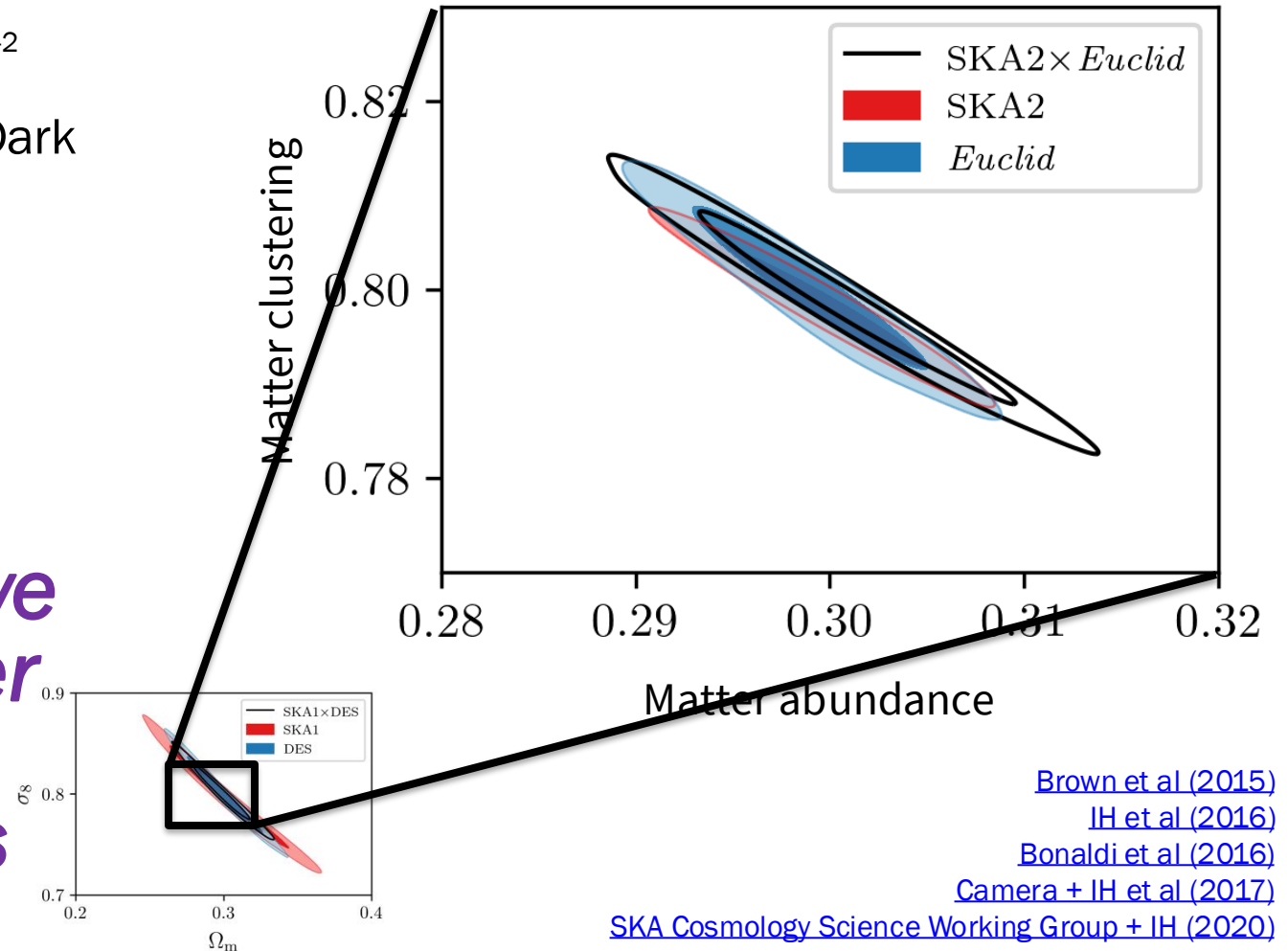Camera + IH et al (2017)
SKA Cosmology Science Working Group + IH (2020)

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Camera + IH et al (2017)
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Developments – Observations

- ## SDSSxFIRST
  - 2.7σ on cross-power spectrum (Demetroullas & Brown 2016)
  - 10σ on galaxy-galaxy lensing (Demetroullas & Brown 2017)

- ## JVLA-COSMOS
  - 4.7σ on radio-optical shape correlation (Tunbridge et al 2016; Hillier et al 2019)

- ## SuperCLASS DR1
 - Upper limit on cluster lensing (Harrison et al 2020)
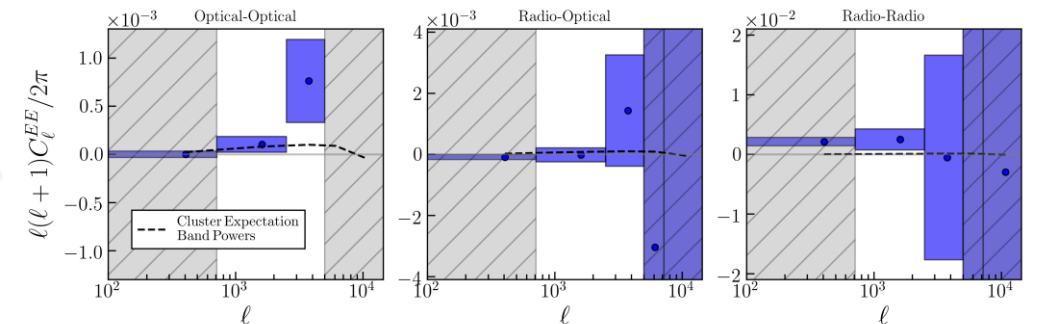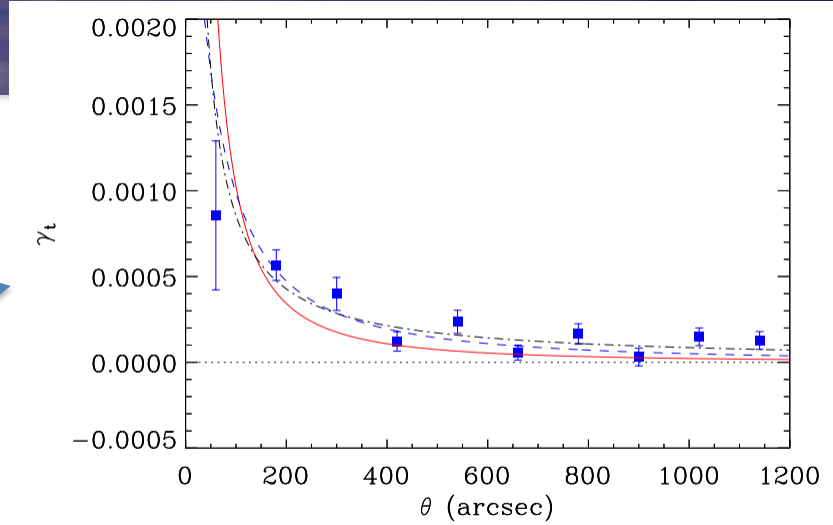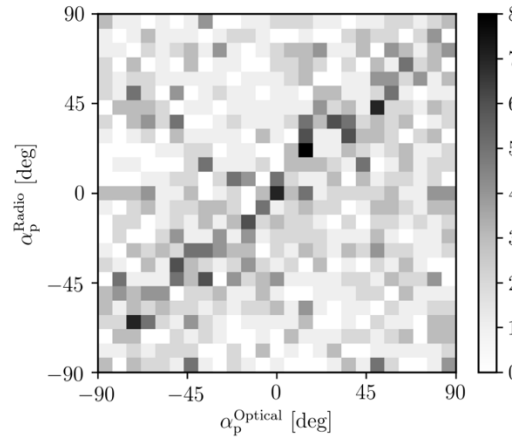
Developments – Shape measurement

- radioLensFit
  - uv plane (Rivi et al 2016)

- SuperCALs (Harrison et al 2020)
  - Image plane

- +new ML approaches to deconvolution with WL in mind
  - BlueBild, ShapeNet etc

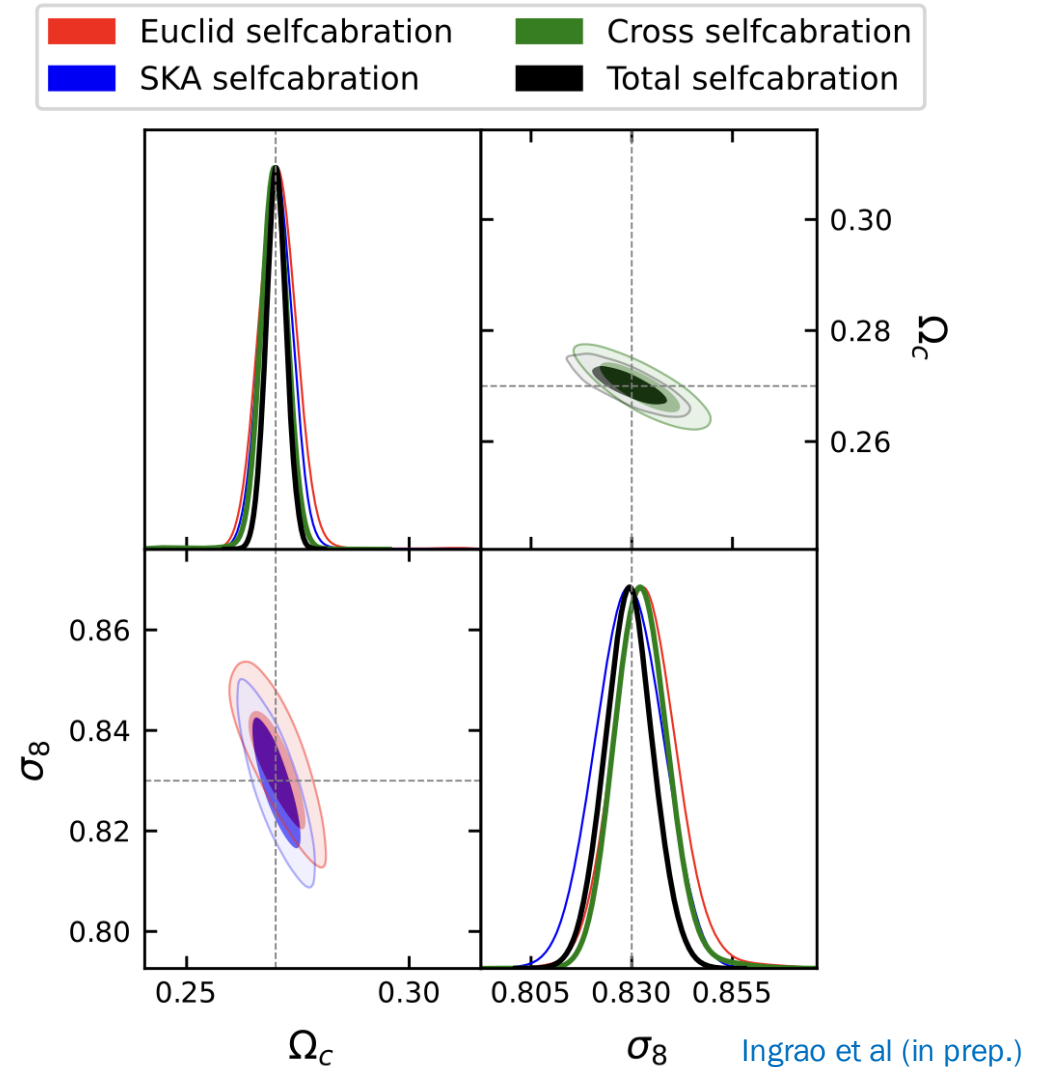- ...note dirty images / gridded visibilities 'will' be available due to ECP
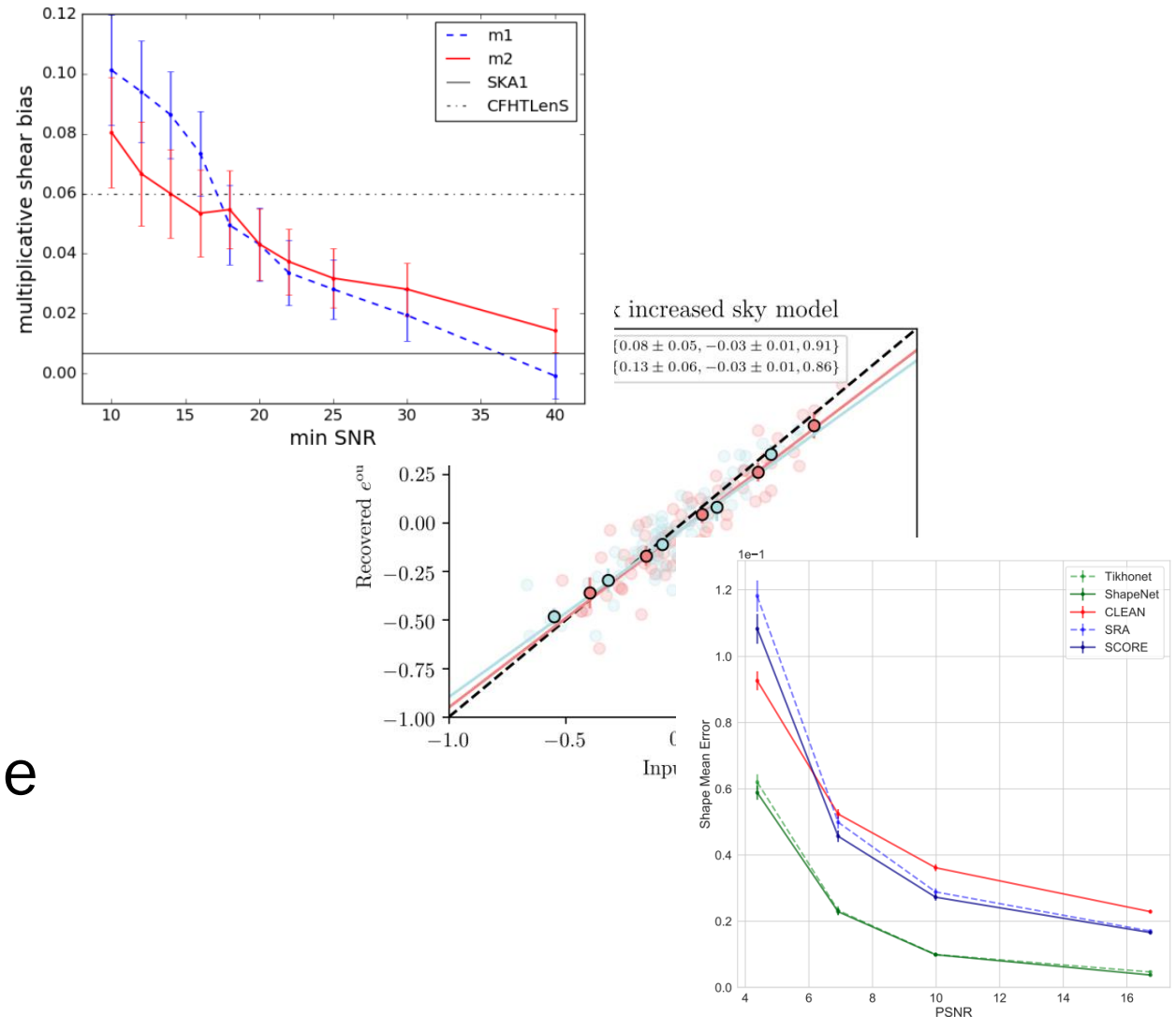
New – Observations

- ## SuperCLASS DR2

  – Combined JVLA + *e*-MERLIN image

  – Catalogue: ~0.7 gal/arcmin^{-2}

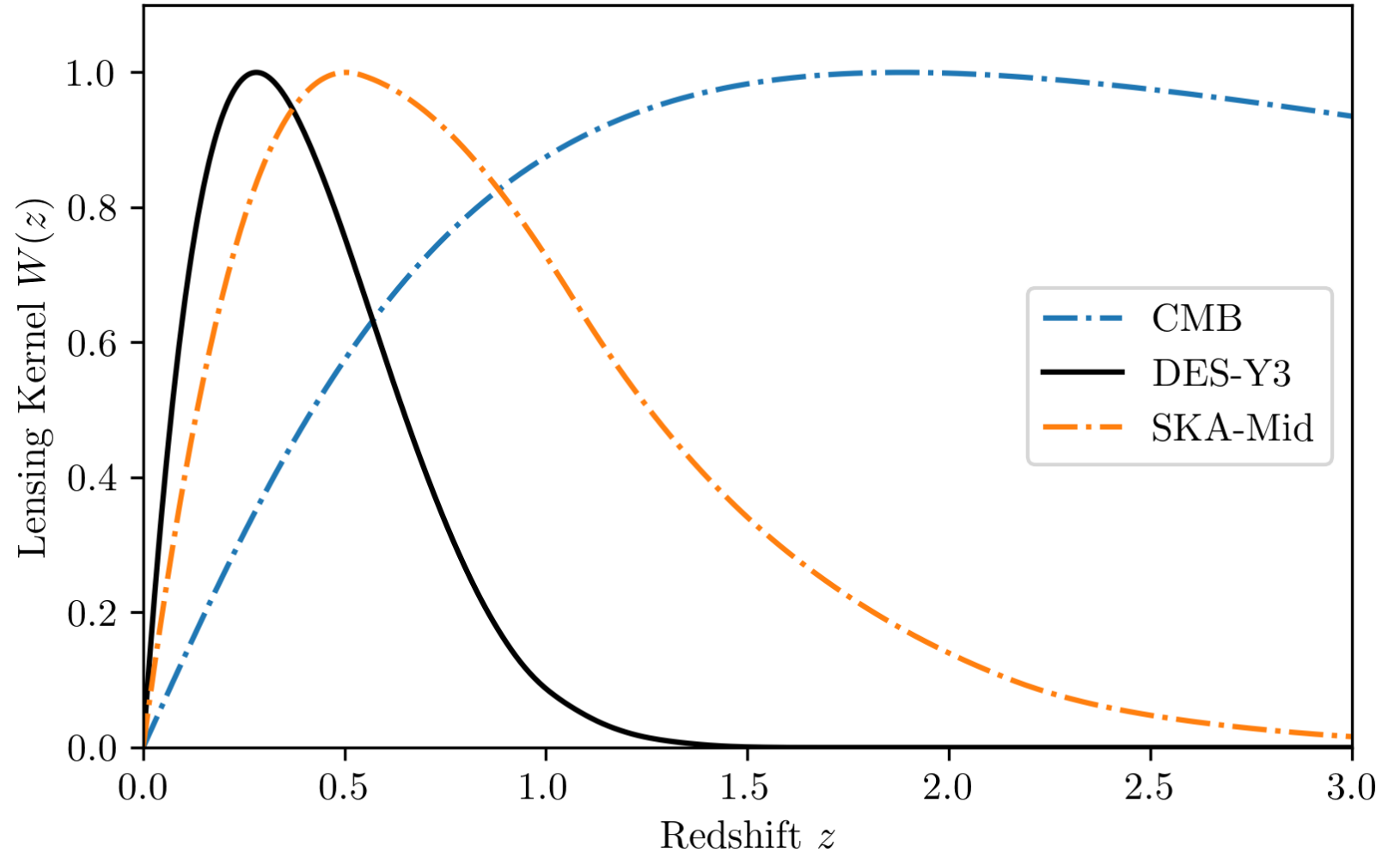| JVLA (DR1) | *e*-MERLIN | Combination DR2 |
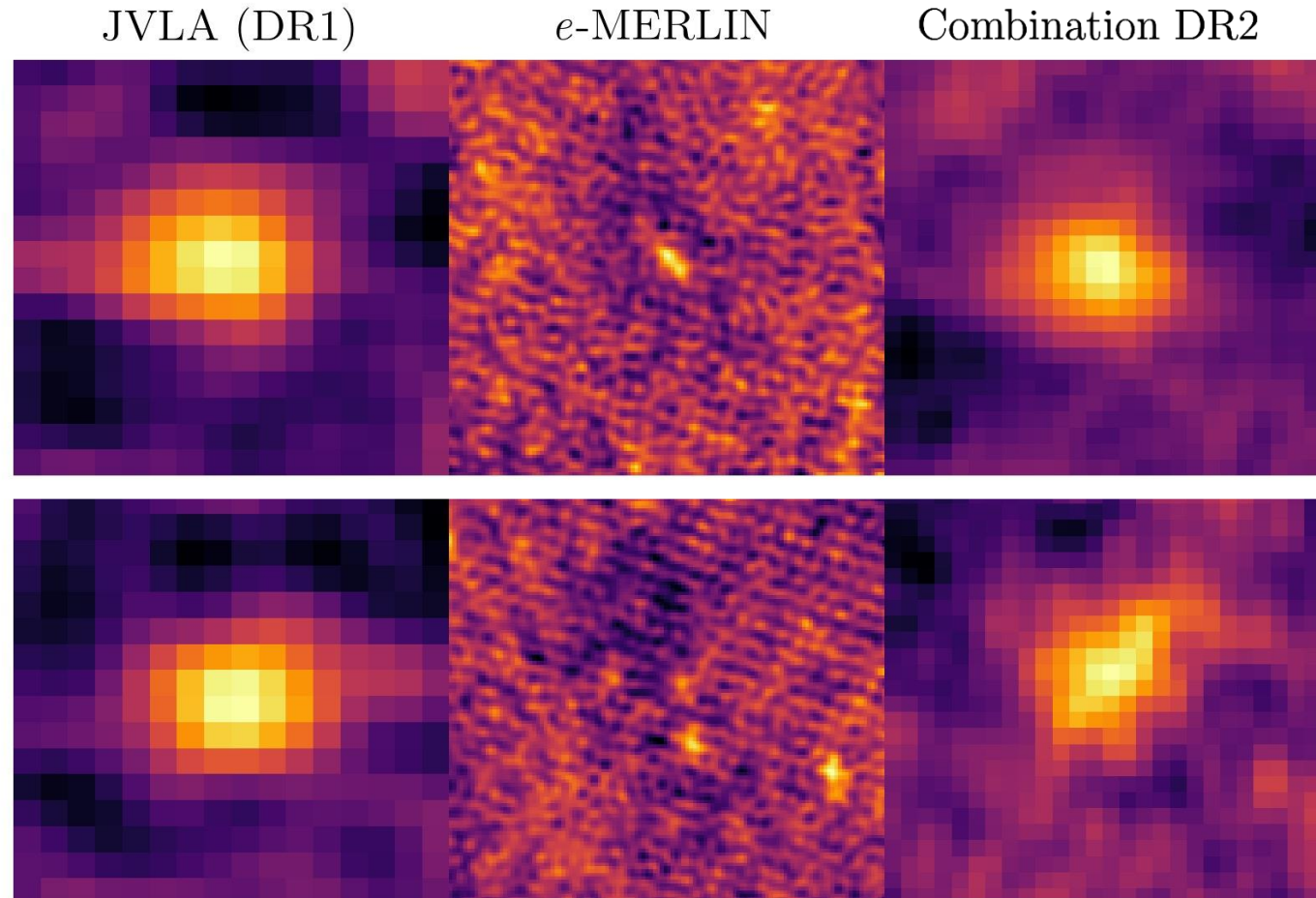
New – Forecast updates

- Re-do 2016 forecasts with AA4x*Euclid*

- Cross-correlations can calibrate additive *and* multiplicative systematics

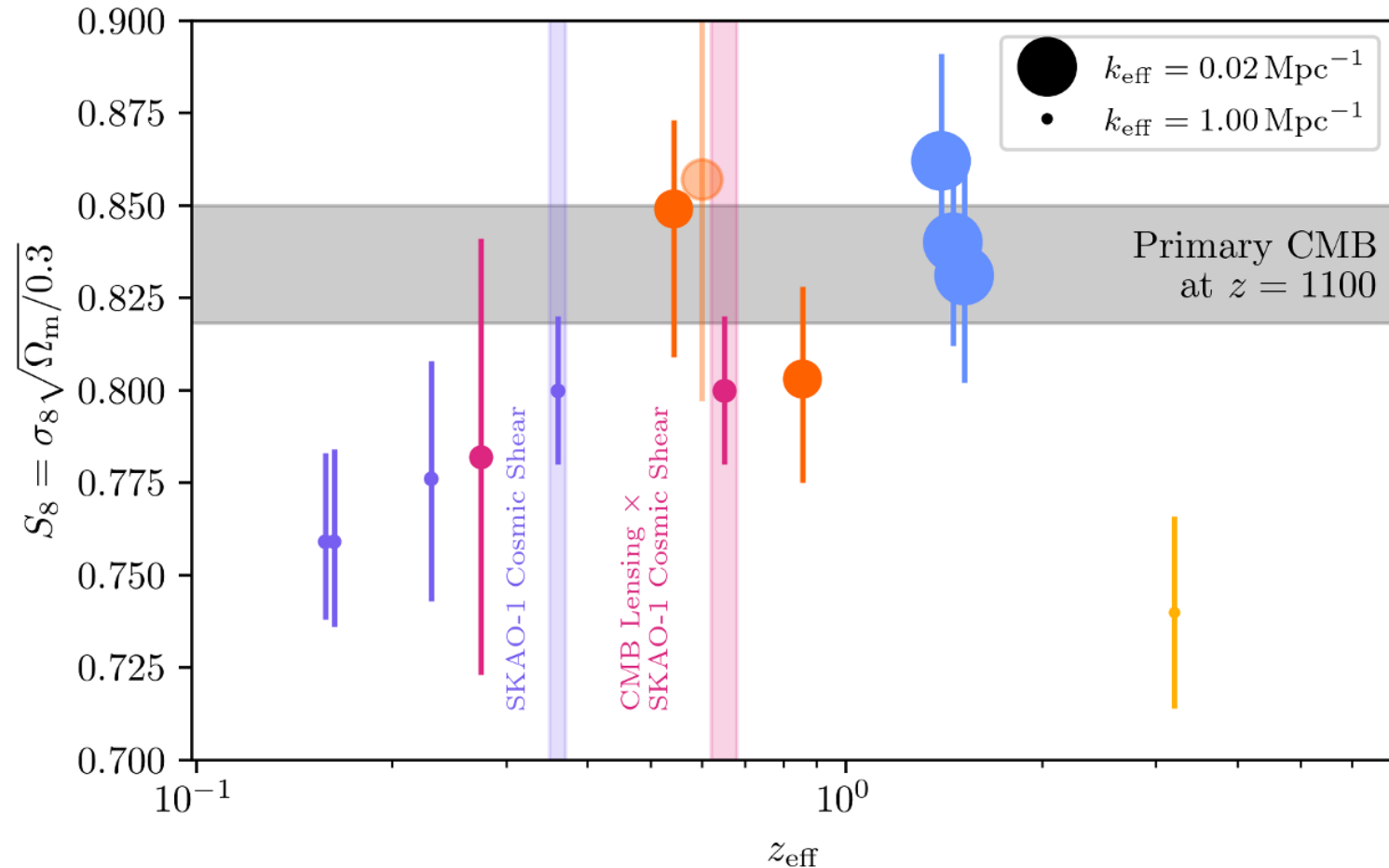Ingrao et al (in prep.)

New – CMB lensing cross-correlations

- Consider cross-correlation with CMB lensing
  - Simons Observatory

New – CMB lensing cross-correlations

- Useful for *k, z* dependence in S₈ measurements

New – CMB lensing cross-correlations

- AA4 forecast for cross-correlations
- Constrain overall non-tomographic n(z)
  - α, β 'Smail' parameterisation
  - z_{tail} parameterisation
- Independent of galaxy bias (so can be used to calibrate this too)
  - cf 25% on z_{tail} in Alonso et al (2021) from CMBL x galaxies

| Experiment	σ_β	σ_γ	$\sigma_{z_{tail}}$
SKA-1 (T-RECS)	14%	5.6%	1.4%
inc. cosmology marg.	39%	15%	32%
SKA-1 (SKADS)	11%	3.3%	1.5%
inc. cosmology marg.	33%	6.7%	42%
SKA-2 (T-RECS)	4.5%	1.9%	0.31%
inc. cosmology marg.	10%	4.1%	8.4%
SKA-2 (SKADS)	3.9%	1.2%	0.35%
inc. cosmology marg.	9.0%	2.2%	11.5%

New – CMB lensing cross-correlations

- AA4 forecast for cross-correlations

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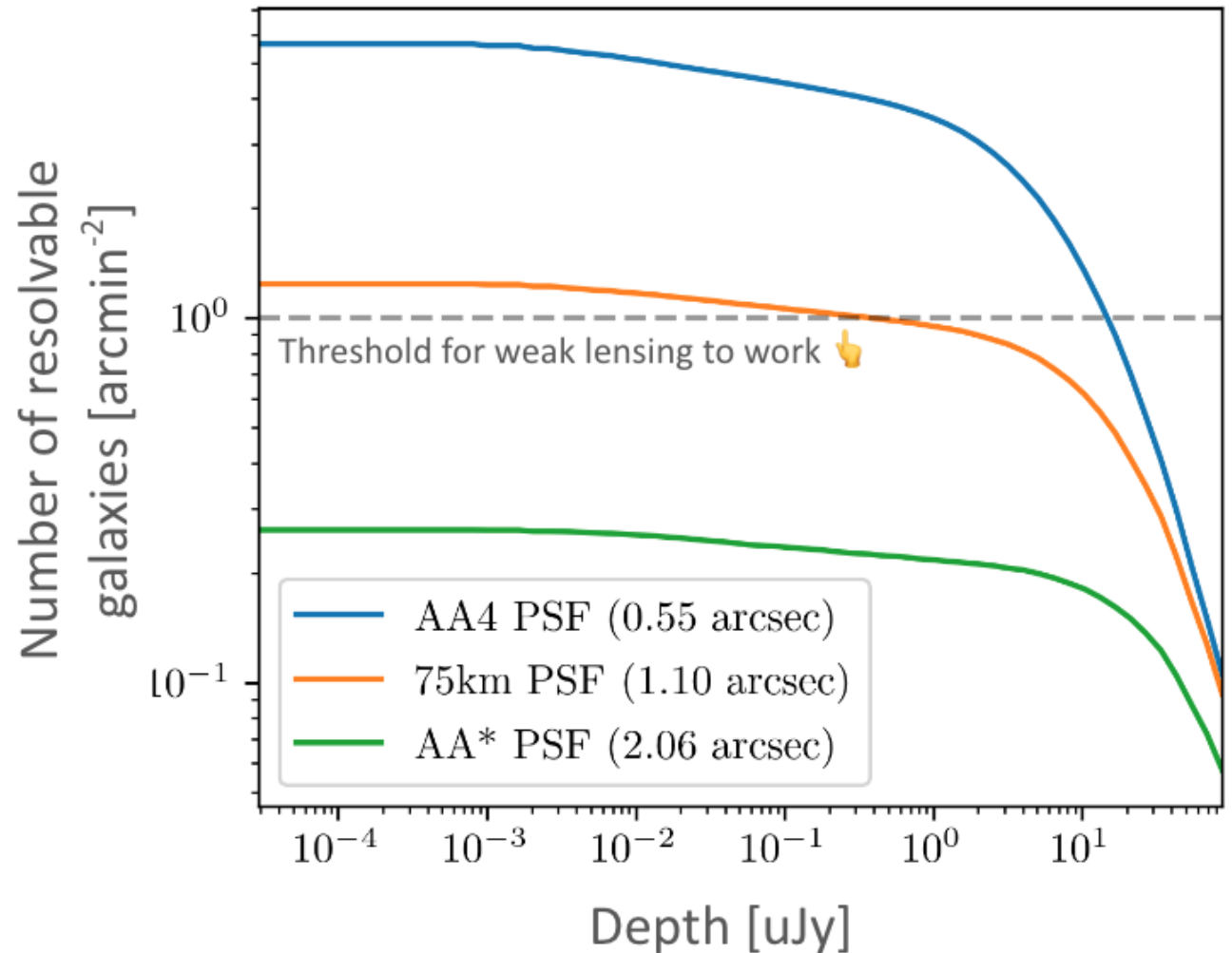Alonso et al (2021)
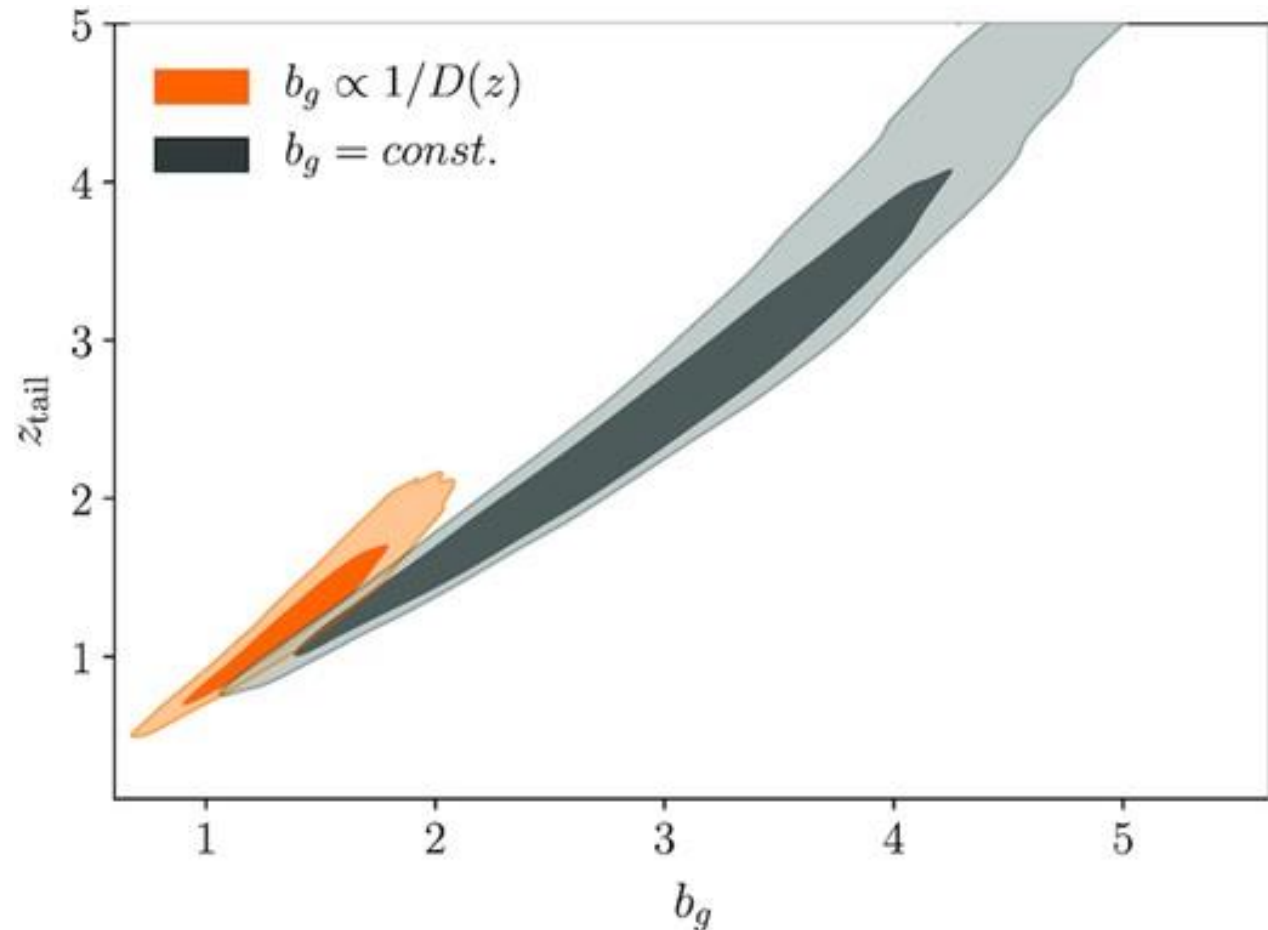
New – CMB lensing cross-correlations

- ## Also forecast cosmology with SKA2

  - ## – Increase relative to *Euclid*

SKADS×SO
T-RECS×SO

Kalaja, Coulton, IH (in prep)

AA*
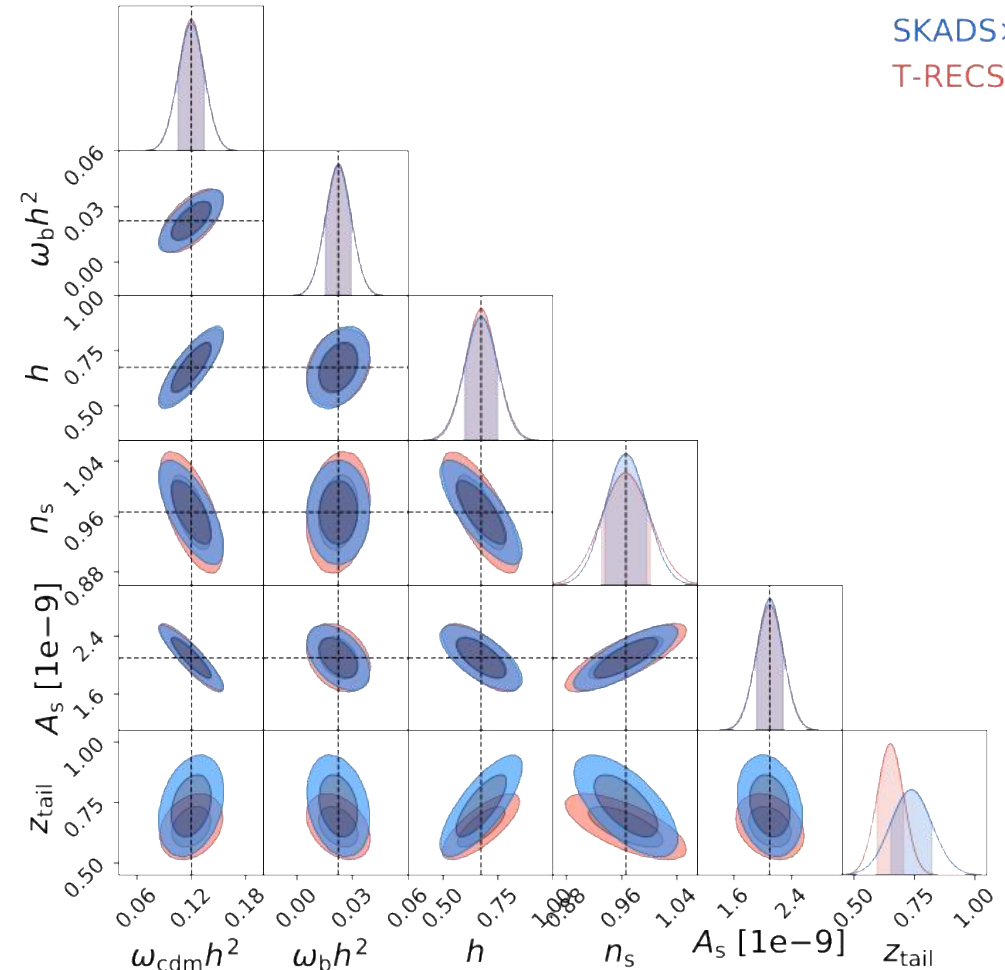
- AA* not good(!) for weak lensing

- *AND* any science case which requires source classification

Number of resolvable galaxies [arcmin^{-2}] vs Depth [uJy]. Threshold for weak lensing to work 👆

- AA4 PSF (0.55 arcsec)
- 75km PSF (1.10 arcsec)
- AA* PSF (2.06 arcsec)

Summary

- Lots of 'new' (since 2014) observations
- Update of 2014 forecasts (re-focus on SKA-I x *Euclid*) largely done
- CMB Lensing cross-correlations useful for n(z), b(z) calibration
- AA* 👎
  - But can suggest an 'enhancement' path with different baselines with a clear metric and gain