Weak-lensing Science Working Group (WLSWG)

General activities

Martin Kilbinger, CEA/IRFU/SAp/AIM, IAP

WLSWG

Leads: Tom Kitching (MSSL), Henk Hoekstra (Leiden)
Deputy: Karim Benabed (IAP) → Martin Kilbinger (CEA)

Recent management changes

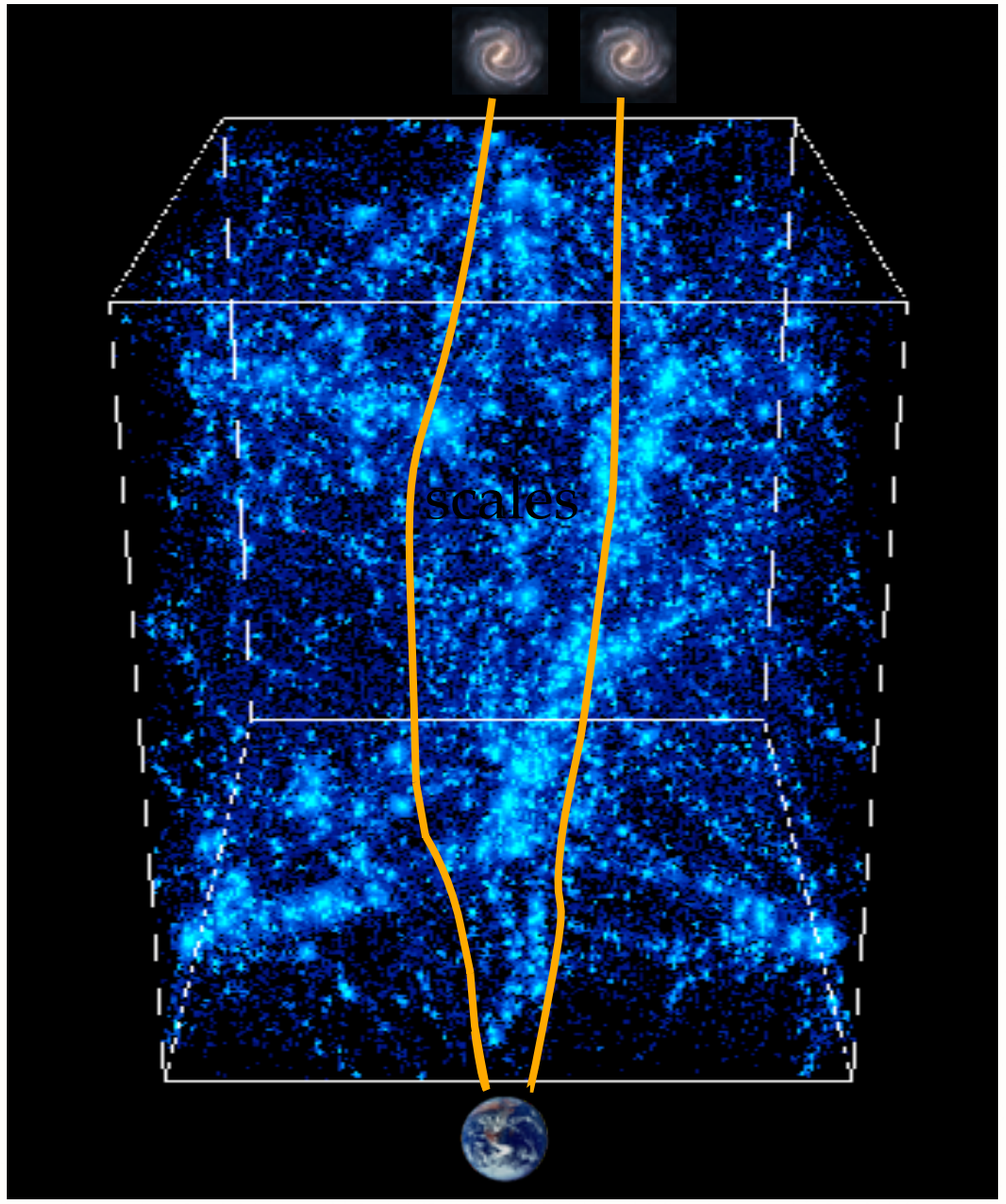
- MK replaces Karim Benabed as deputy manager
- Additional WP leads for WP with only one manager:
  Ismael Tereno (Lisbon), P, Higher-order statistics (w/Cardone, Rome)
  Raphael Gavazzi (IAP), F, Galaxy-galaxy lensing (w/Cacciato, Leiden)

Martin Kilbinger, CEA

Weak cosmological lensing

Cumulative lensing distortions, probe projected 2D mass distribution

Coherent distortions of galaxy images
→ measure shape correlations



$z_S \sim 1$

Lensing by LSS:
~ 3% distortion
$\kappa, \gamma \approx 0.03$

"Weak lensing"

``cosmic shear"

Scales: few Mpc ... few 100 Mpc

Martin Kilbinger, CEA

Euclid WLSWG: WPs

Galaxy shape measurement
PSF estimation
Image simulations
Photo-z's

Measurement

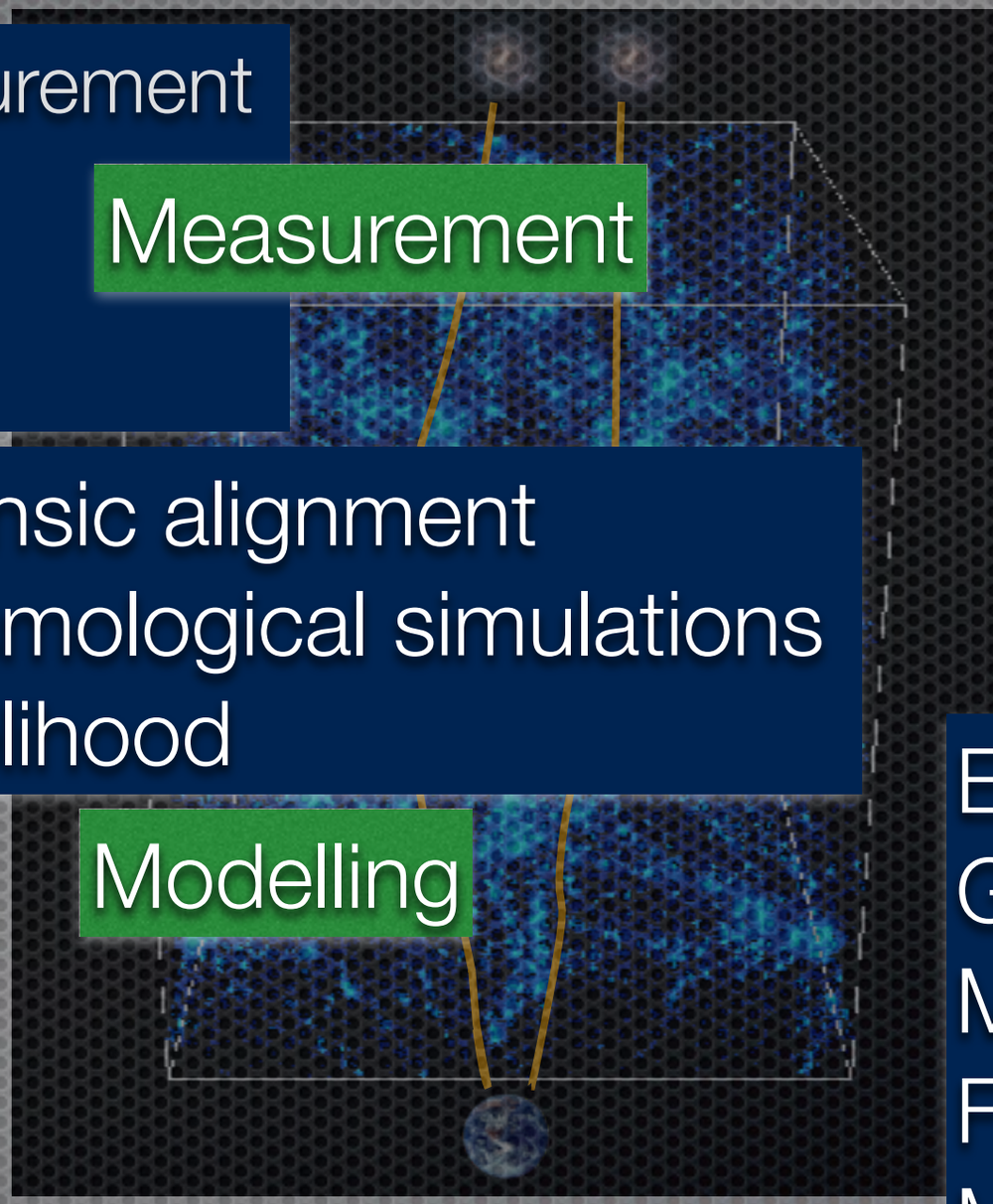
projected 2D mass distribution

Intrinsic alignment
Cosmological simulations
Likelihood

Modelling

Coherent distortions of galaxy images → measure shape correlations

Scales: few Mpc ... few 100 Mpc



$z_S \sim 1$

Lensing by LSS:

Statistics

Estimators
GGLensing
Magnification
Flexion
Mass mapping
Higher-order stats.

Martin Kilbinger, CEA

Euclid WLSWG: WPs

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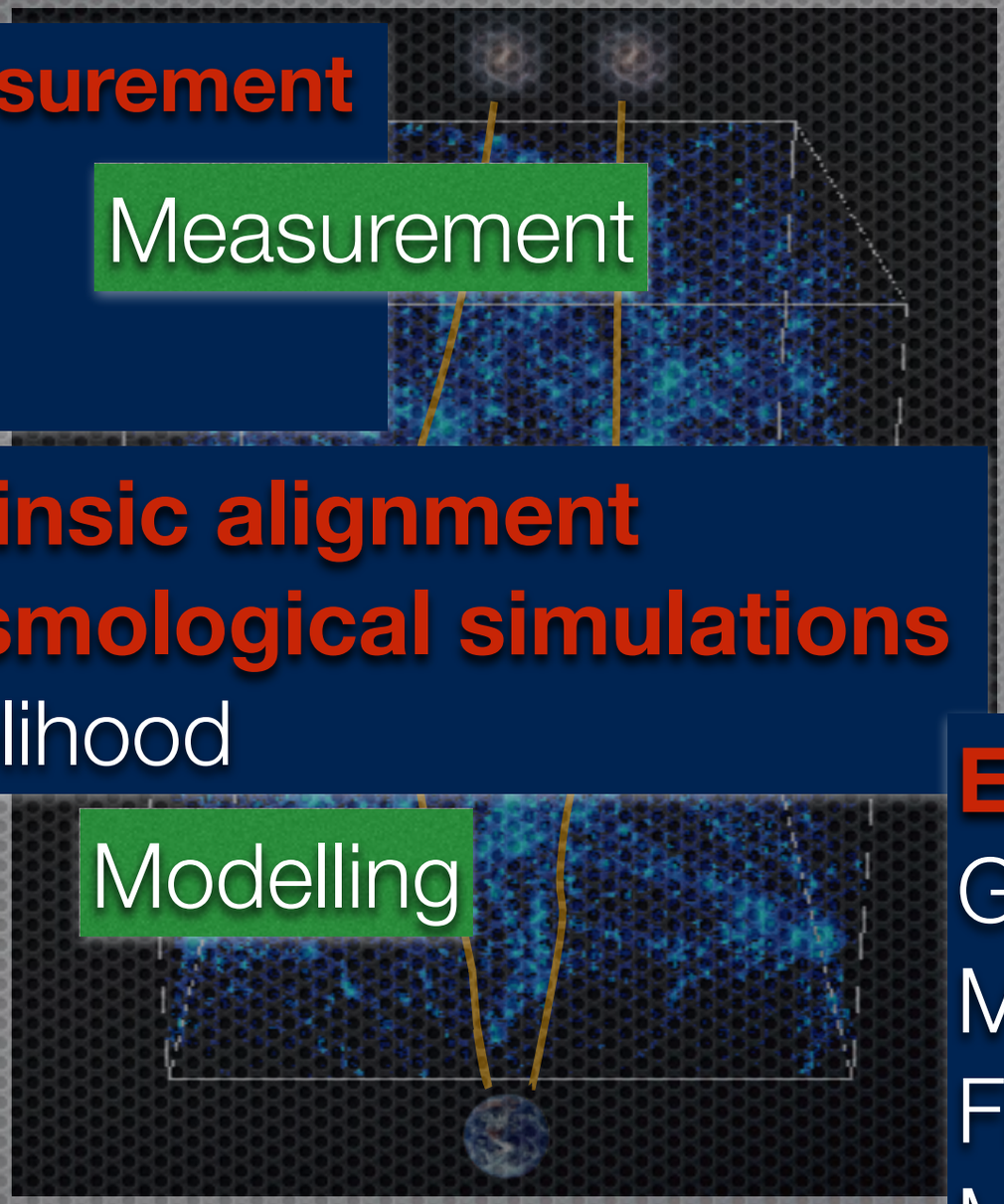

Intrinsic alignment
Cosmological simulations
Likelihood

Modelling

$z_S \sim 1$

Lensing by LSS:

Statistics

Estimators
GGLensing
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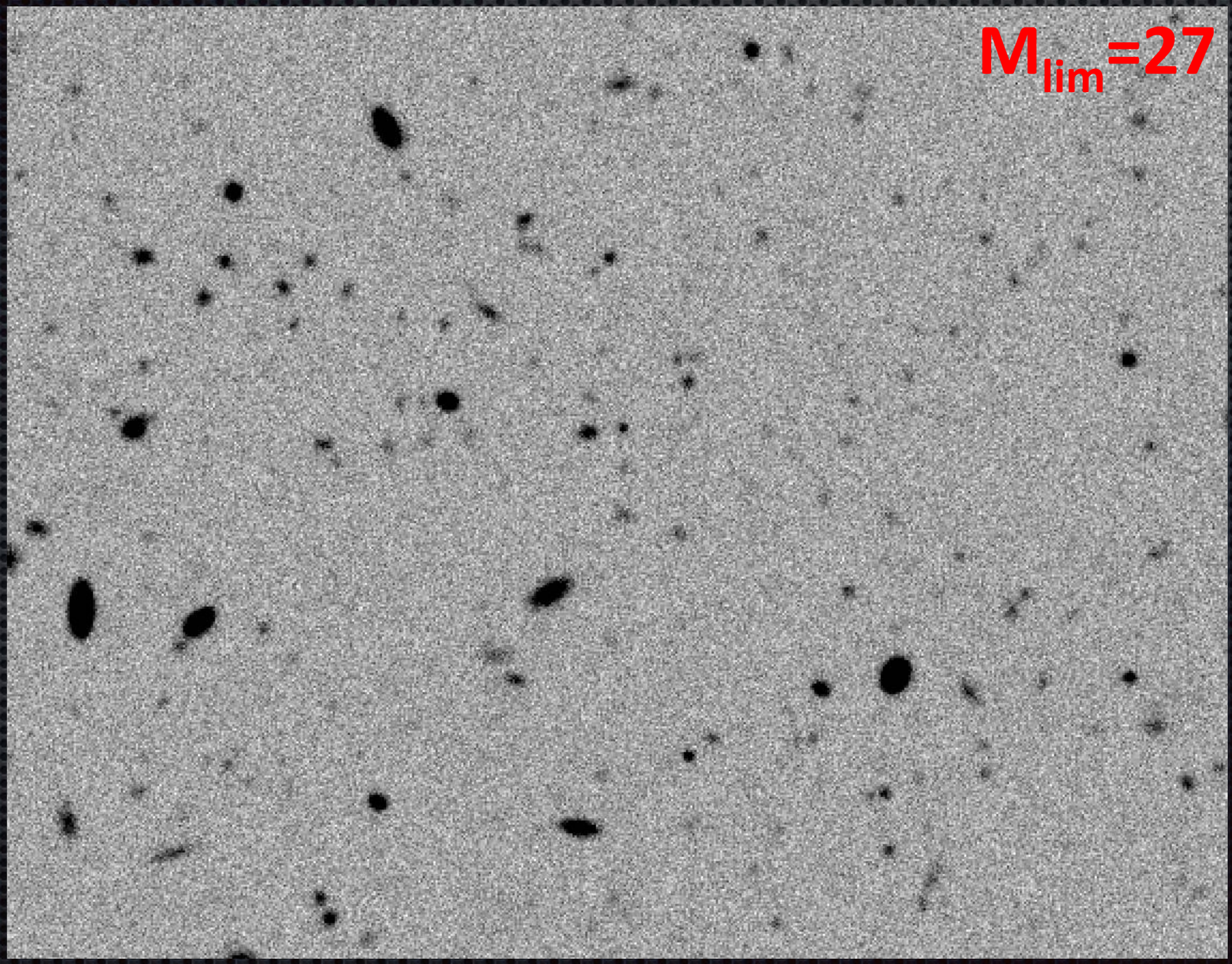
Mass mapping
Higher-order stats.

Galaxy shape measurement

- Every shape measurement needs to be calibrated, there is no perfect method.
- Important: Calibratability of methods, using image simulations.
- Emulated data for validation: Euclid deep fields (noise bias), HST data (galaxy morphology, color gradients)

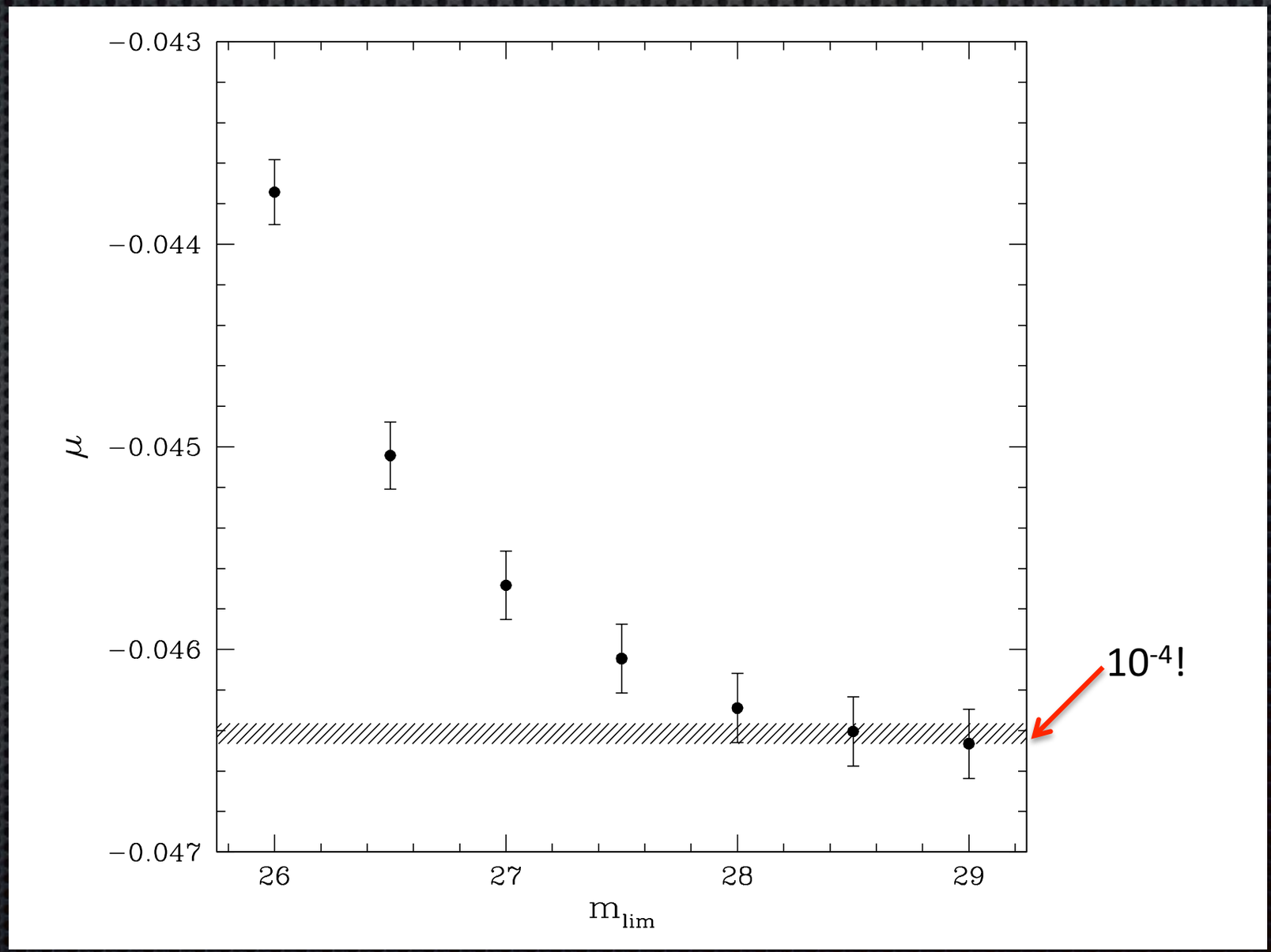
- Calibration of shear bias: Faint, unresolved galaxies within noise impact shapes of brighter galaxies.

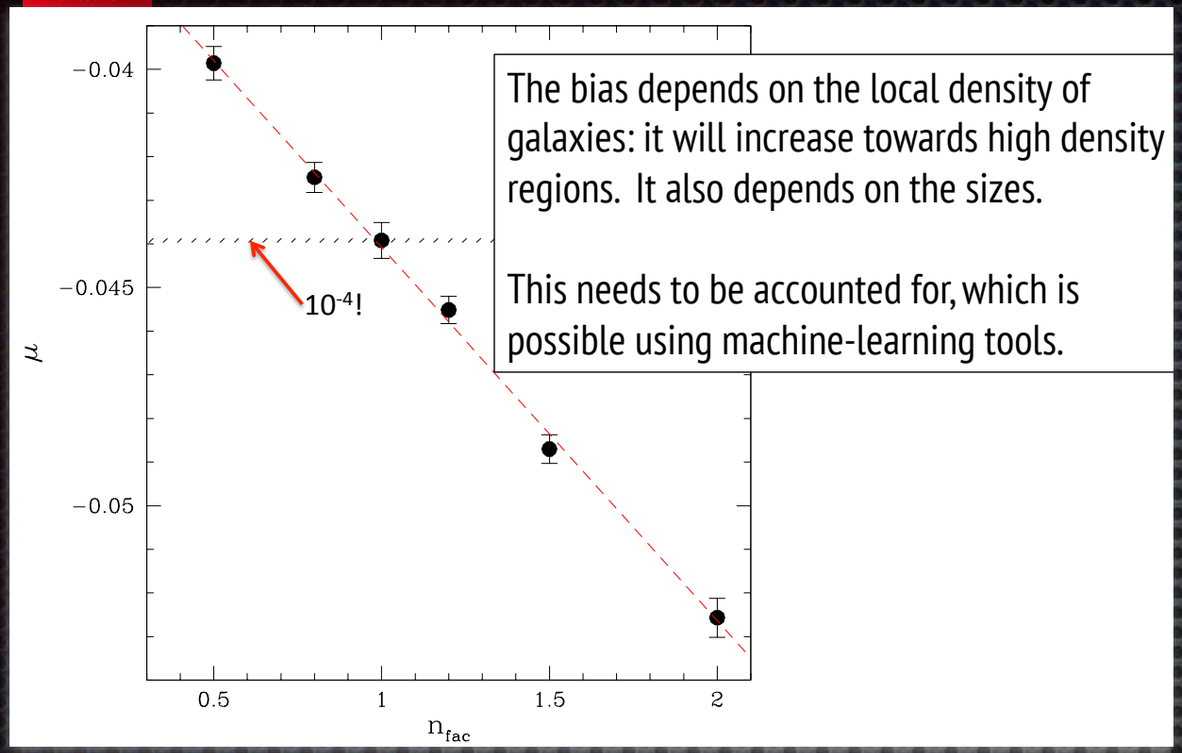


Shape measurement - image simulations

Henk Hoekstra

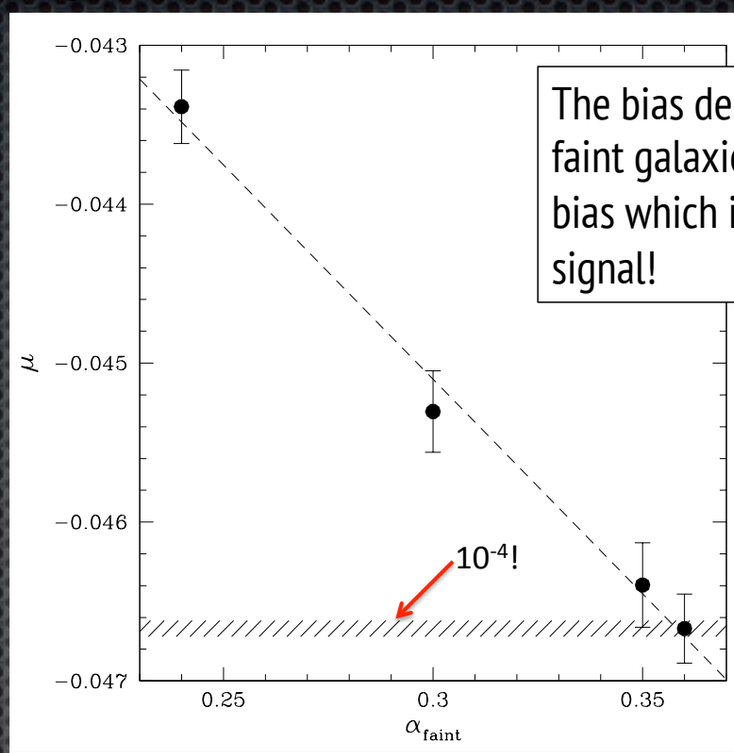
- Shear bias from unresolved background galaxies





The bias depends on the local density of galaxies: it will increase towards high density regions. It also depends on the sizes.

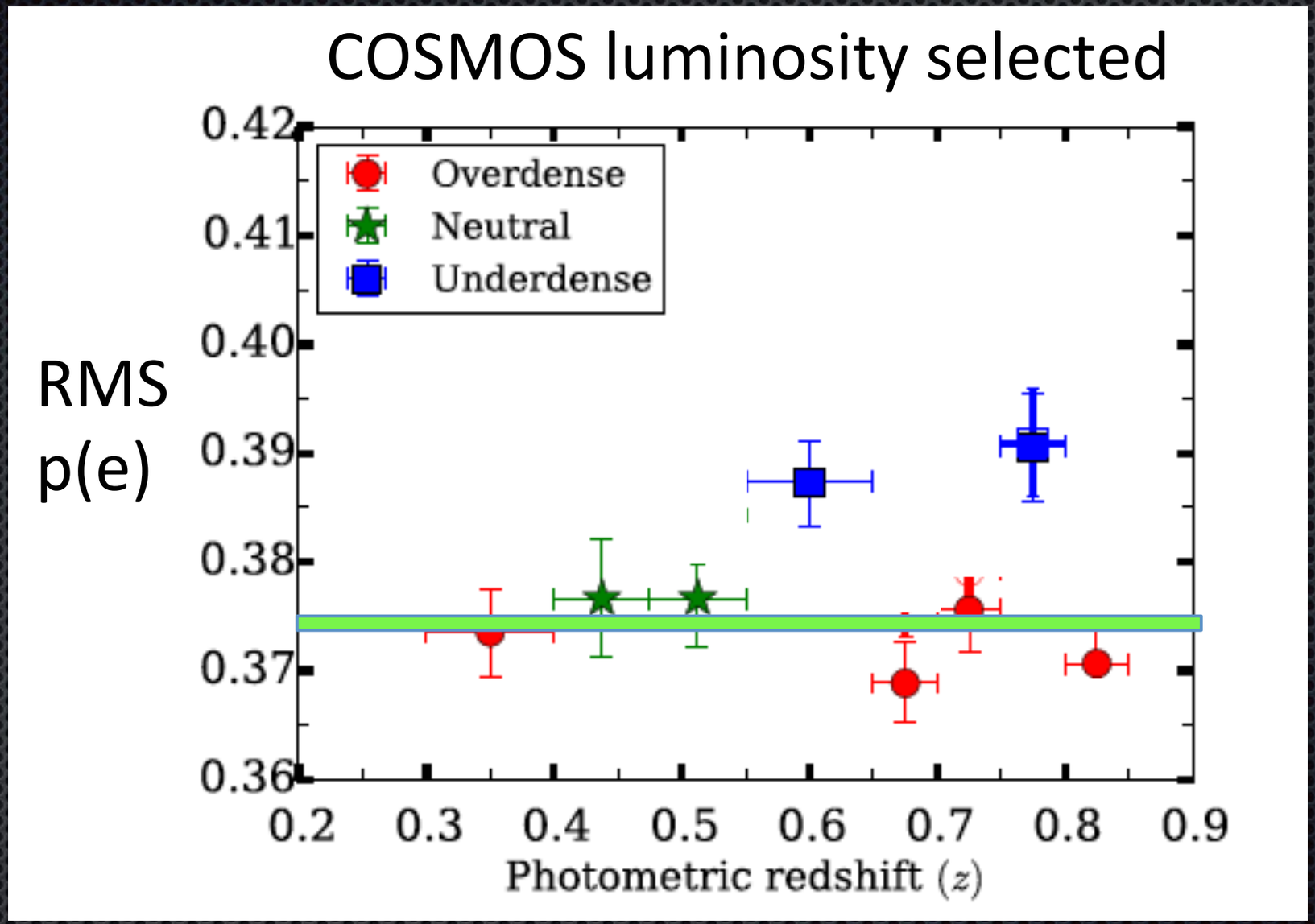
This needs to be accounted for, which is possible using machine-learning tools.



The bias depends on the number density of faint galaxies: magnification will affect the bias which is thus coupled to the lensing signal!

- Shear bias depends on local galaxy density, magnification, galaxy clustering
- Not yet accounted for: galaxy substructure
- Method-dependent?
- Alternative ways to calibrate, using less simulations?

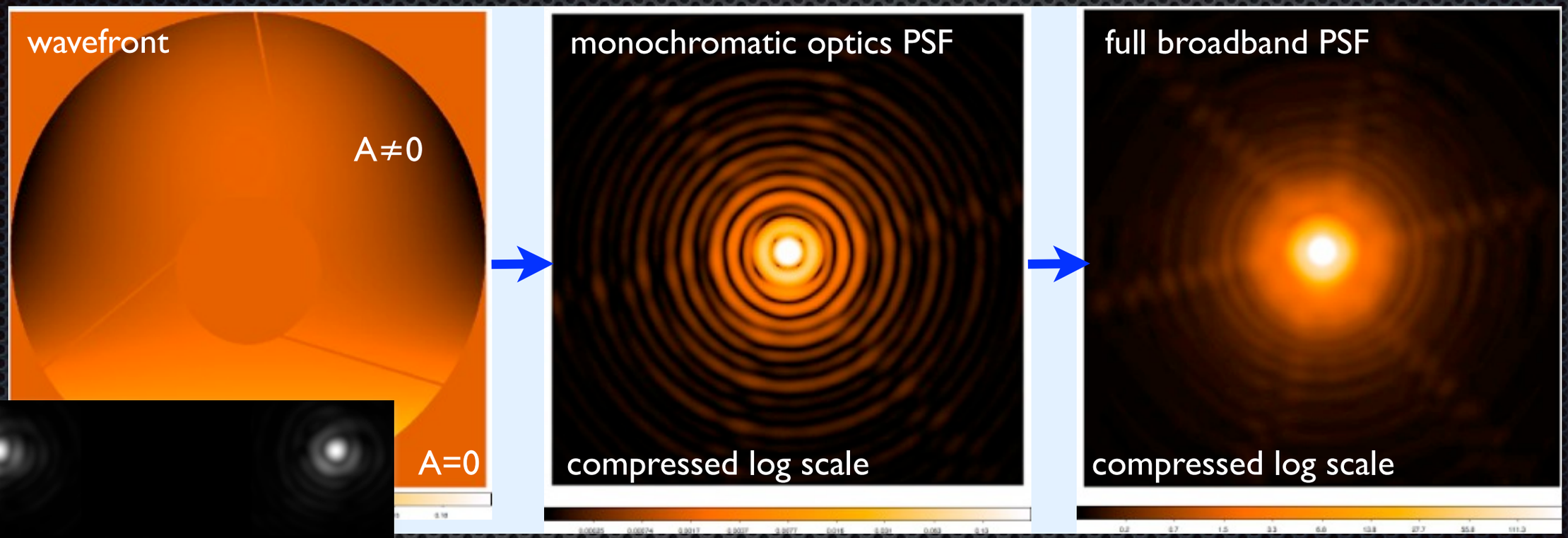
- Validation/calibration of shear bias: Environment dependence



Kannawadi, Mandelbaum et al. (2015)

PSF: physical model fitting

Miller, Conti, Uitert, Royanette, Okumura, Hudelot



PSF: physical model fitting

Miller, Conti, Uitert, Royanette, Okumura, Hudelot

wavefront

includes

- Detector pixel wavelength response
- Position-dependent telescope distortions
- Guiding errors

monochromatic optics PSF → full broadband PSF

compressed log scale

new

- Faster FT
- Improved FFT interpolation

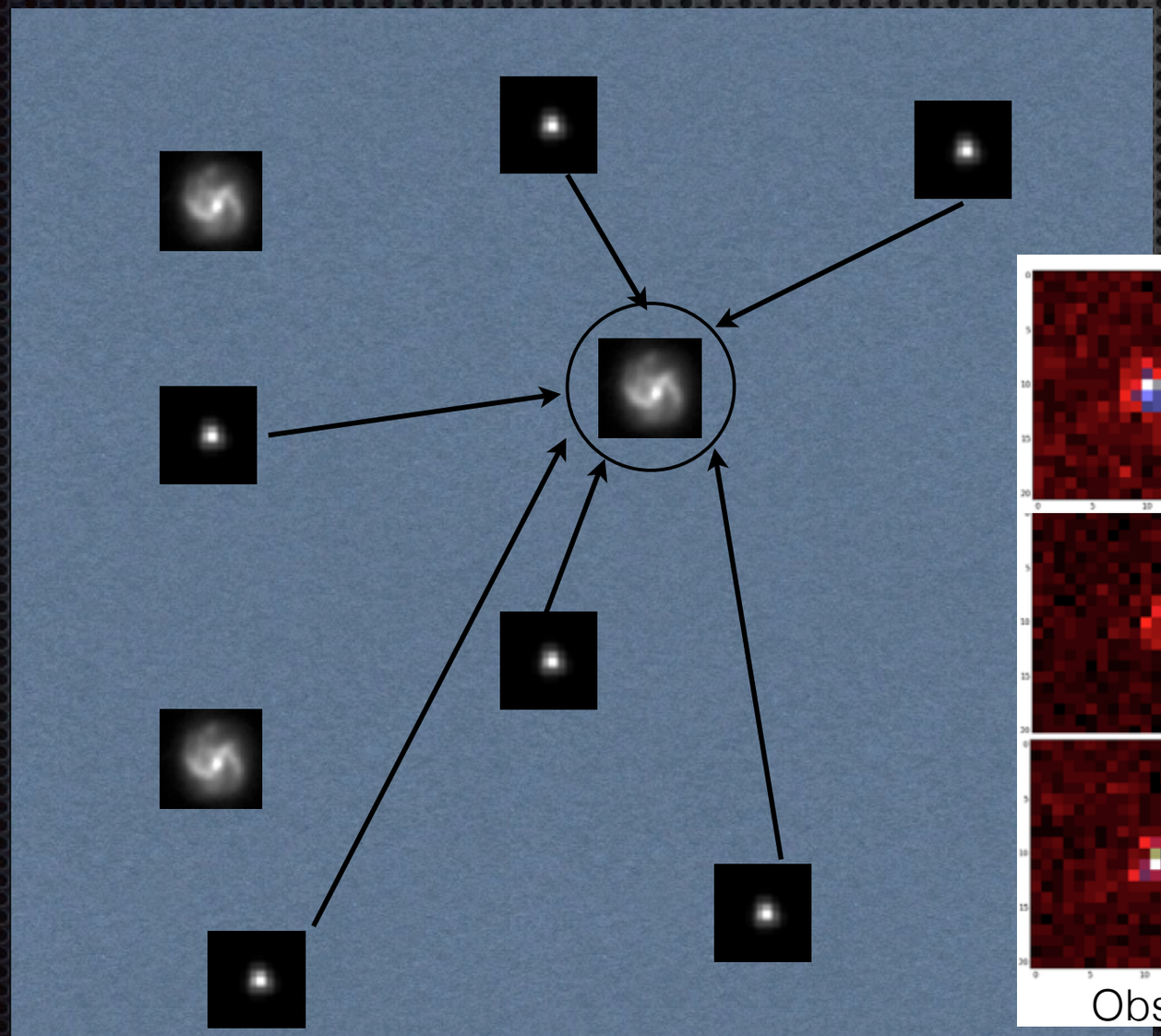
to do

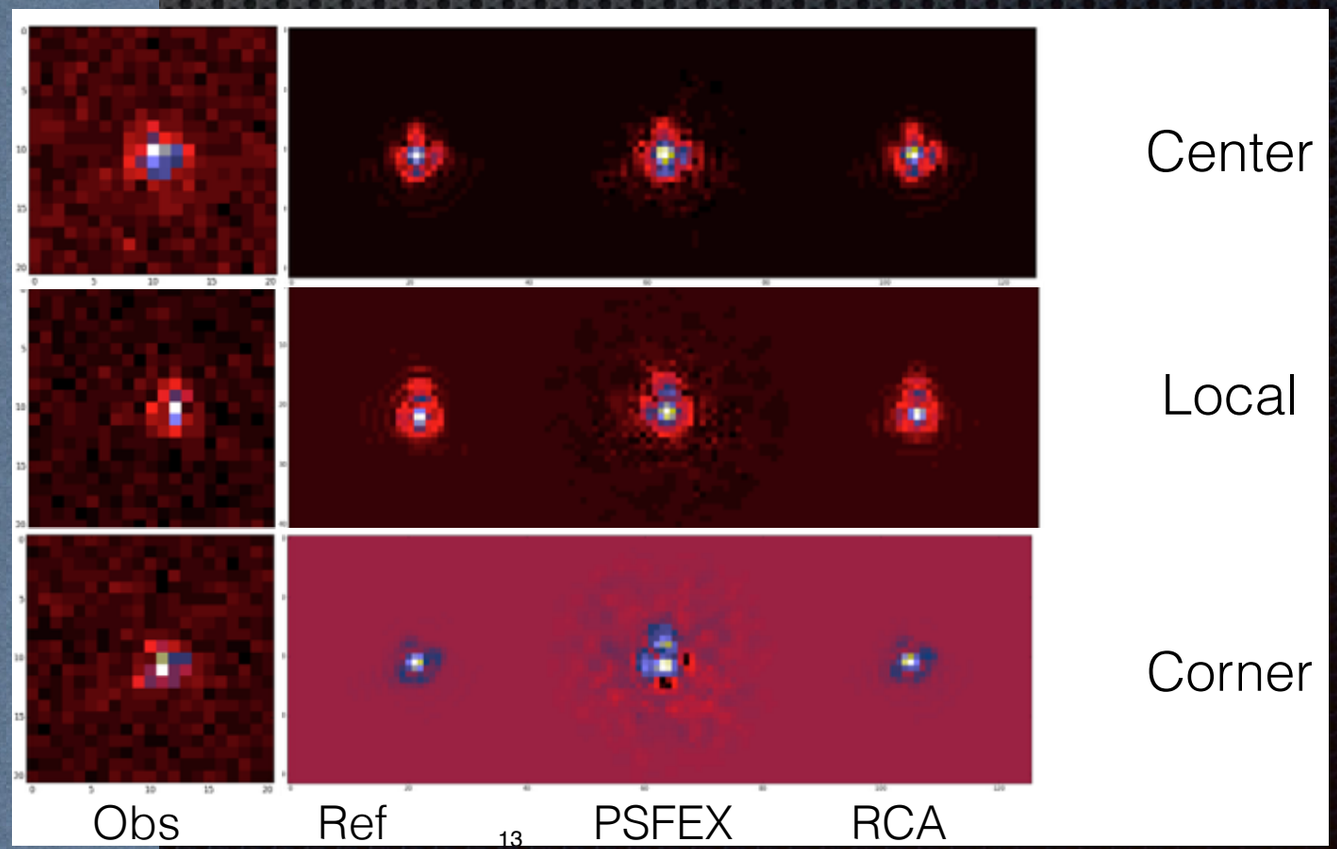
- Mirror polishing errors & cold deformations
- Brighter-fatter effect
- CTI (Charge Transfer Inefficiency)
- Detector misalignments

PSF: Field reconstruction

Ngolé, Starck, Royanette, Okumura, Amiaux

Interpolation and subsampling





Martin Kilbinger, CEA

PSF: Field reconstruction

Ngolé, Starck, Royanette, Okumura, Amiaux

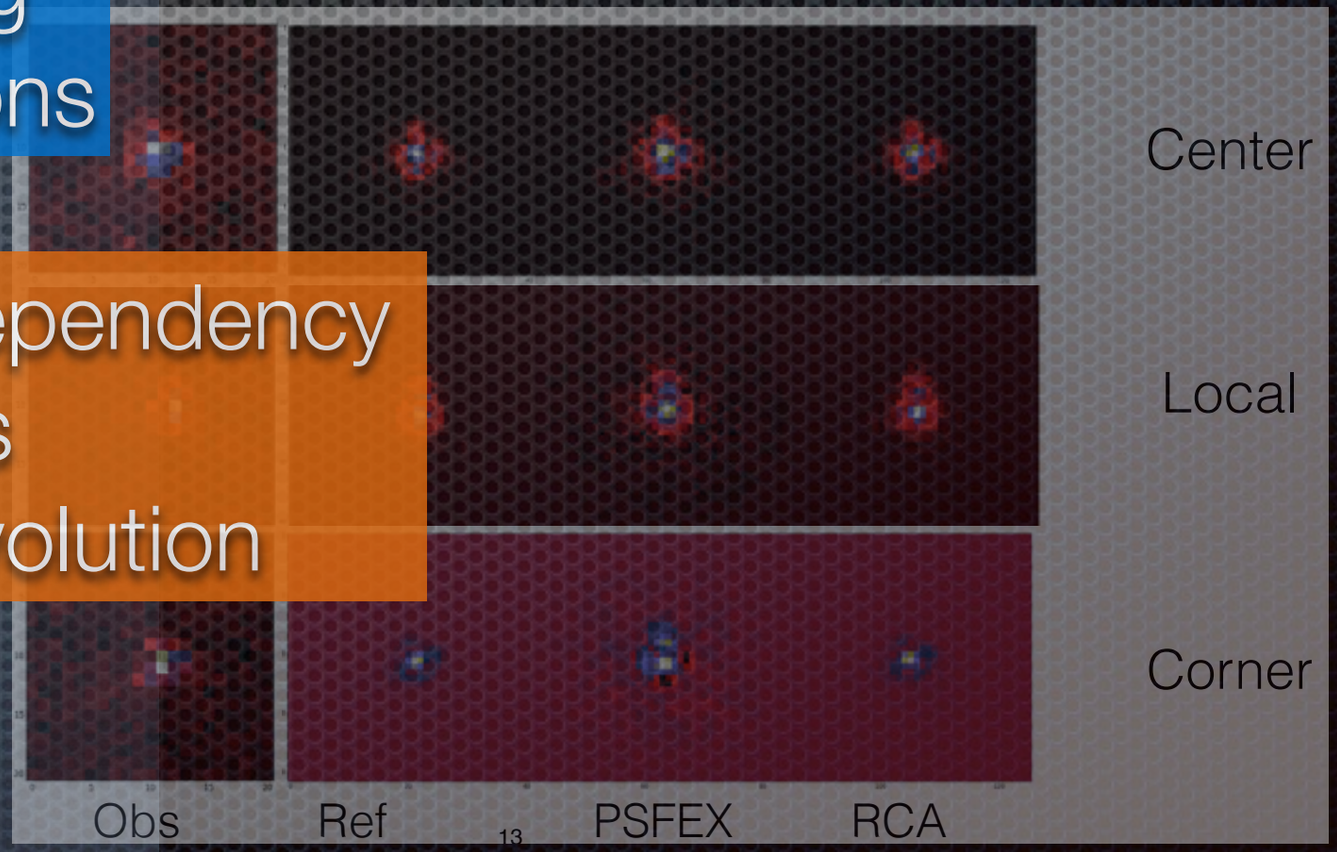
Interpolation and subsampling

includes

- Undersampling
- Spatial variations

to do

- Wavelength dependency
- Time variations
- Galaxy deconvolution

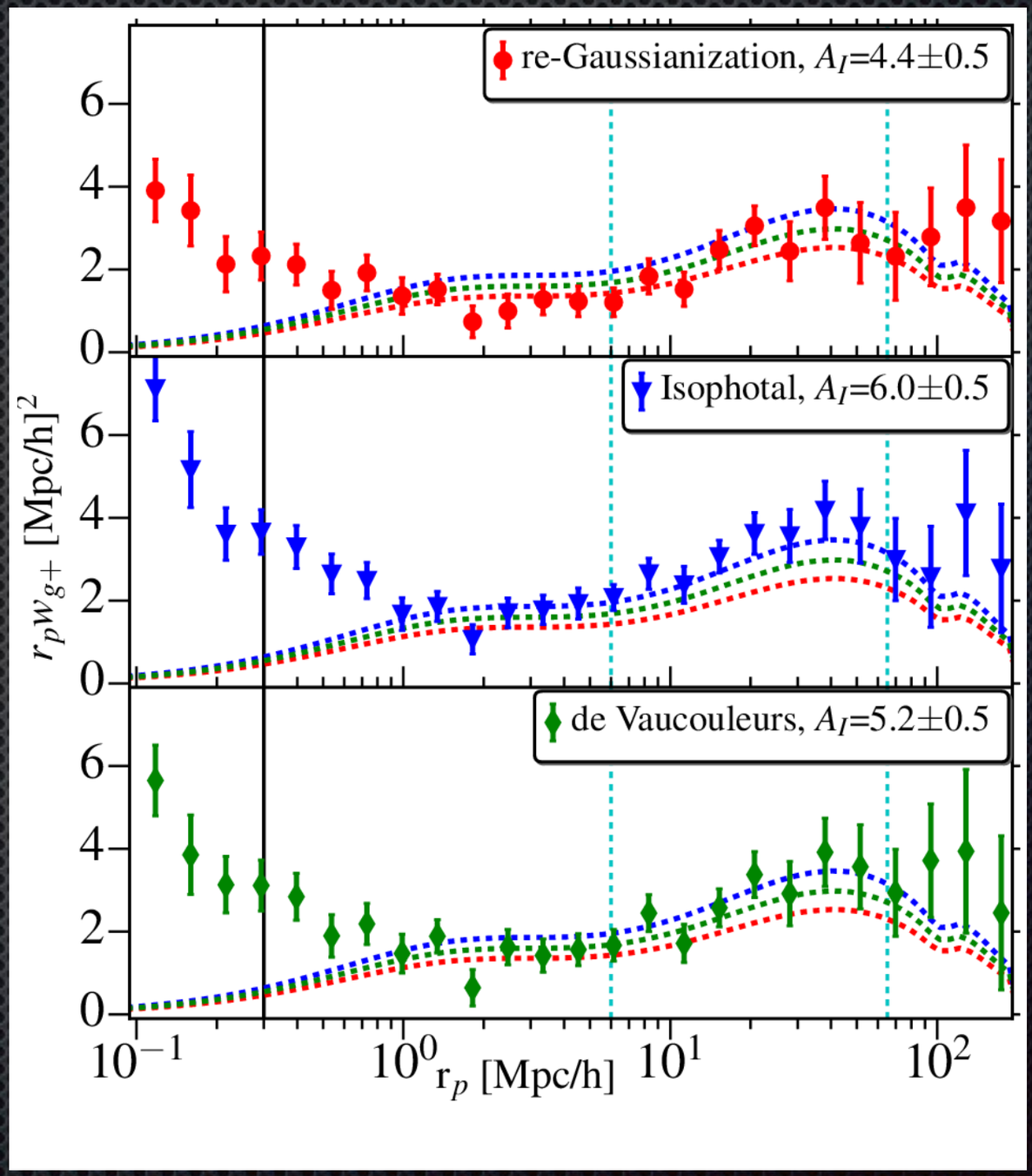


Intrinsic alignment

IA depends on shape measurement method!

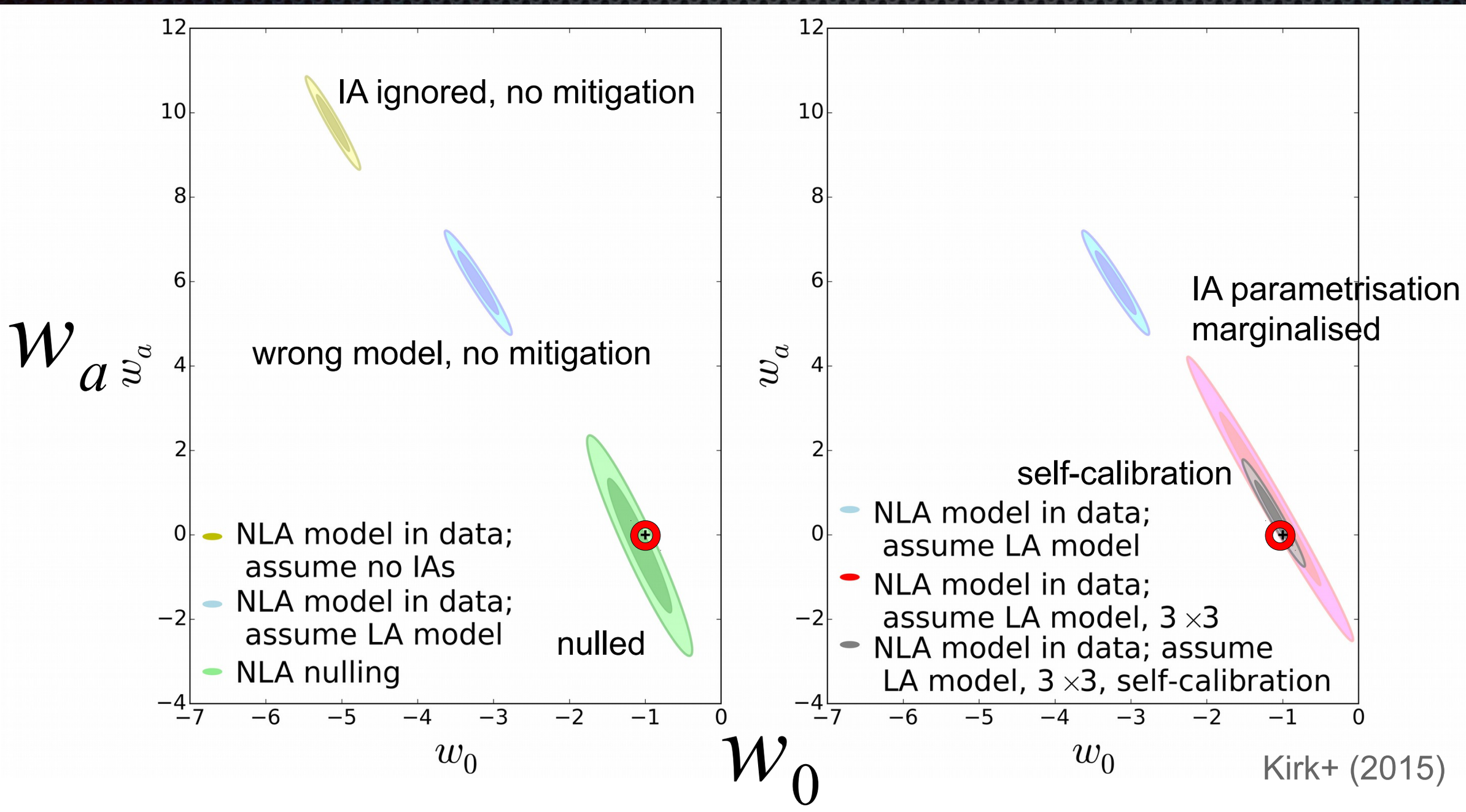
Galaxy outskirts more prone to tidal effects.

Measured shapes: radius-dependent weights



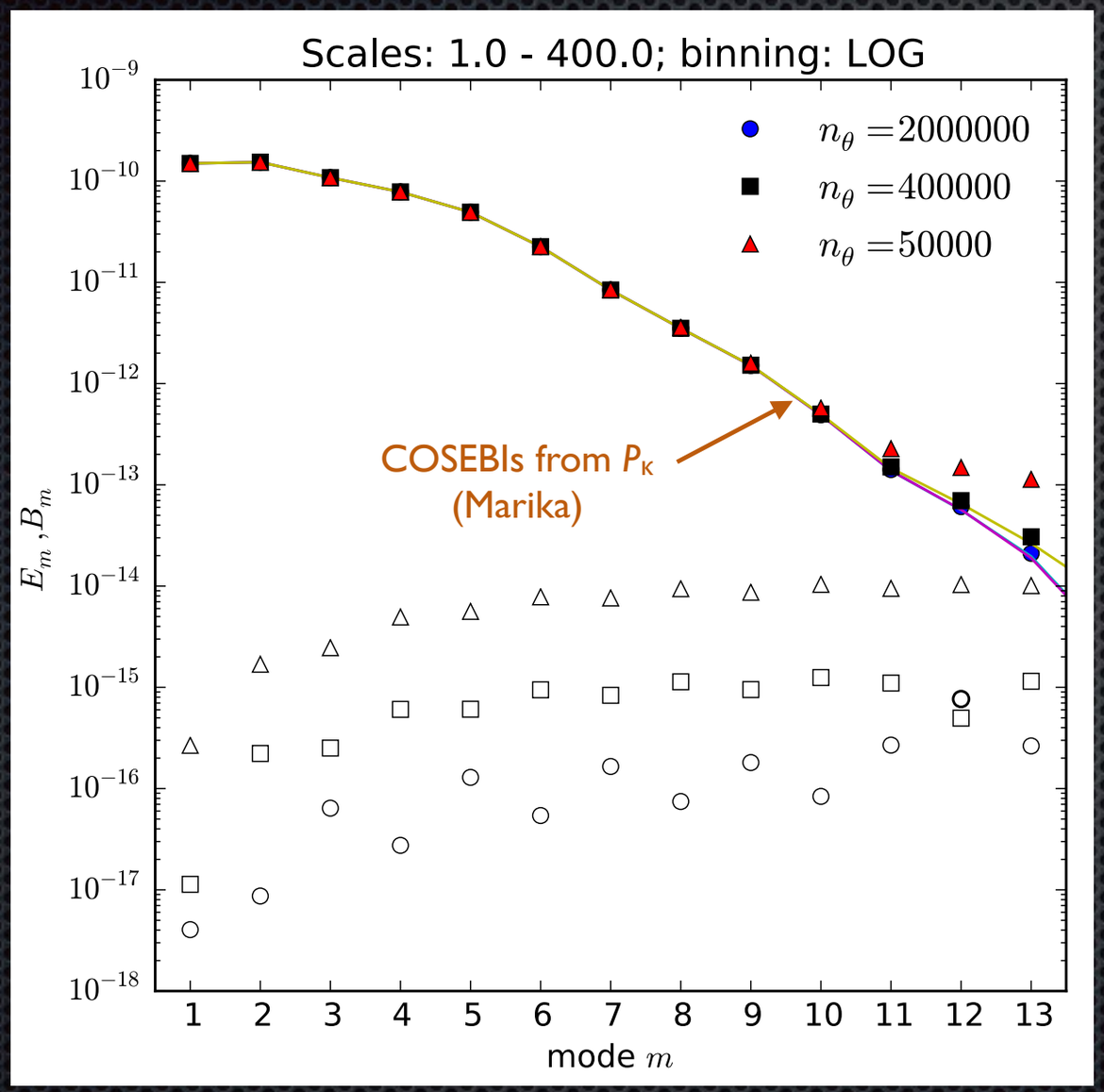
Singh & Mandelbaum (2015)

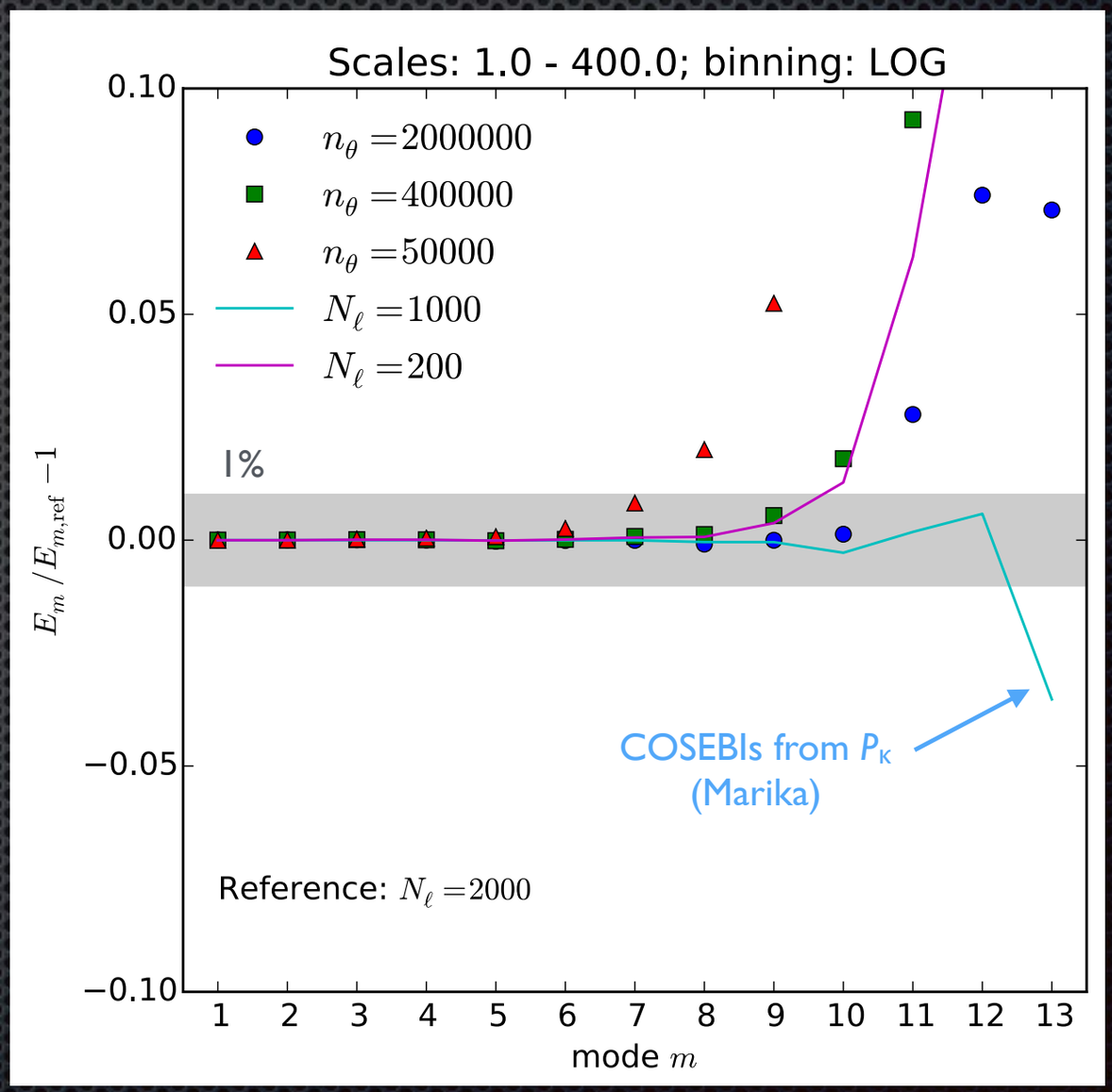
Intrinsic alignment



Estimators: Requirements for LE3

MK





E-/B-mode correlation

mode number

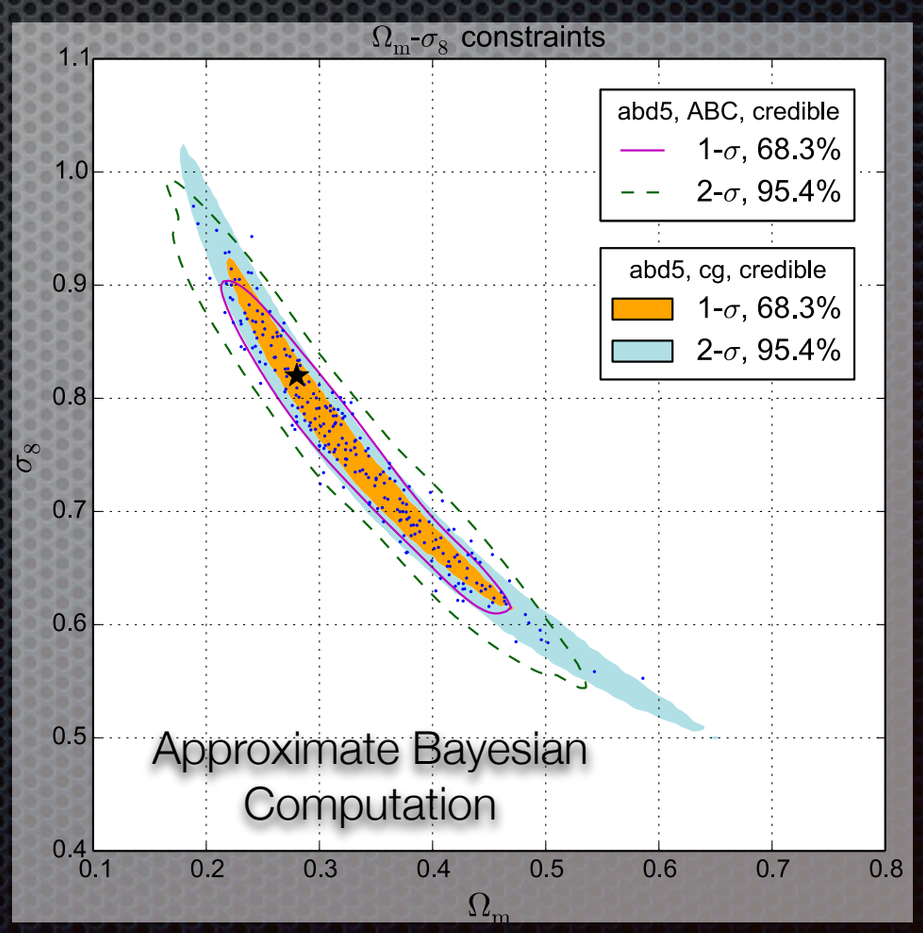
Cosmological simulations

Kiessling, Smith

- Need very large volume and number
- Difficult to get time on super computers due to heavy competition. Need to focus on non-“main-stream” science, e.g. higher-order stats.

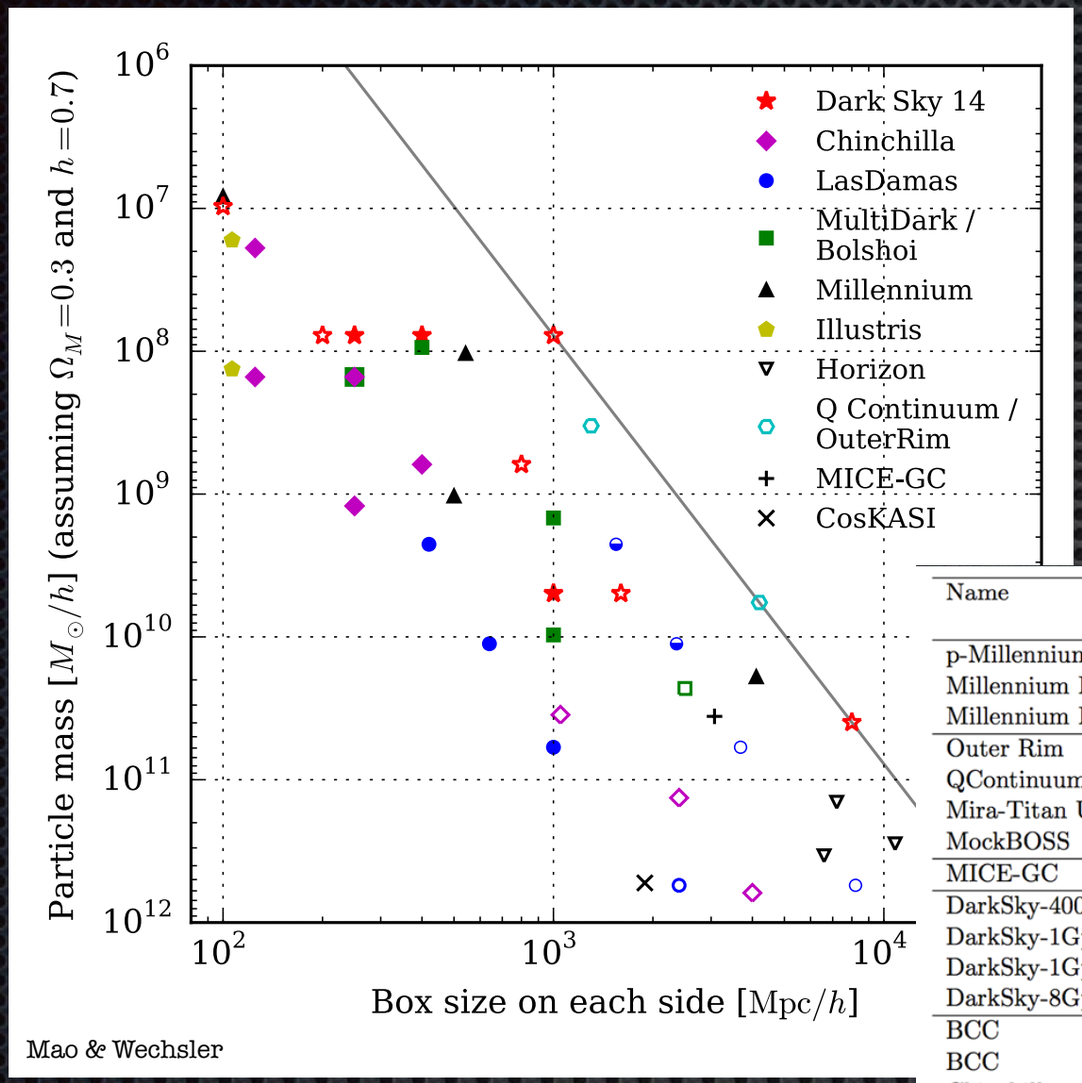
Covariance from simulations

- Explore approximate and alternative techniques
- Brute-force approach: ready by 2025.
- Reduce 1 order of magnitude: 2020.



Chieh-An Lin & MK (2015)

Cosmological simulations



Mao & Wechsler

Use existing simulations?

Share Euclid simulations, results, paper authorship?

Name	L_{box} Mpc/h	m_p $M_\odot/h$	Cosmology	N_{snap}	Halo & Merger Tree	Available $M_\odot/h$	Contact
p-Millennium	542.16	$1.061\ 10^8$	Planck-1$^\gamma$	271	Dhalo	MT & limited DM	Durham
Millennium MR7	500	$9.36\ 10^8$	WMAP-7$^\beta$	61	Dhalo	MT & all DM	Durham
Millennium MR1	500	$8.607\ 10^8$	ΛCDM-1$^\alpha$	63	Dhalo	MT & all DM	Durham
Outer Rim	3000	$1.9\ 10^9$	WMAP-7	100	under const.	Object catalogs	Argonne
QContinuum	923	$1.05\ 10^8$	WMAP-7	100	under const.	Not yet	Argonne
Mira-Titan Universe	~ 1500	$\sim 10^{10}$	~ 100	27	FOF halos	30+ runs complete	Argonne
MockBOSS	~ 4000	$\sim 10^{11}$	6 ($\times$4)	~ 20	FOF halos	LCDM$\times$4	Argonne
MICE-GC	3072	$3\ 10^{10}$	WMAP-5$^\mu$	7	FoF	H	ICE
DarkSky-400	400	$7.7\ 10^7$	Planck	100	rockstar/c-trees	H, DM, MT	Stanford
DarkSky-1Gpc-sub	1000	$2.5\ 10^9$	Planck	100	rockstar/c-trees	H, DM, MT	Stanford
DarkSky-1Gpc	1000	$7.7\ 10^7$	Planck	~16	rockstar	H, DM	Stanford
DarkSky-8Gpc	8000	$3.9\ 10^{10}$	Planck	~16	rockstar	H, DM	Stanford
BCC	400	$6.2\ 10^8$	6 w-waCDM	100	rockstar/c-trees	H, DM, MT	Stanford
BCC	1050,2600,4000		6 w-waCDM	1+LC	rockstar	H, DM, LC	Stanford
Chinchilla	125,250,400		ζ	100	rockstar/c-trees	H, DM, MT	Stanford
Chinchilla	1050,2600,4000		ζ	1+LC	rockstar	H, DM, LC x30	Stanford
MDR1	1000	$8.7\ 10^9$	WMAP-5	47	BDM, FoF	H	MultiDark
”	”	”	”	47	rockstar/c-trees	H, MT	MD/Stanford
MDPL	1000	$1.5\ 10^9$	Planck	?	BDM, FoF	H, MT	MultiDark
MDPL2	”	”	”	?	BDM, FoF	H, MT	MultiDark
”	”	”	”	126	rockstar/c-trees	H, MT	MD/Stanford
Bolshoi	250	$1.3\ 10^8$	WMAP-5	178	rockstar/c-trees	H, DM, MT	MD/Stanford
Bolshoi-P	250	$1.3\ 10^8$	Planck	180	rockstar/c-trees	H, DM, MT	MD/Stanford
CosKASI I	1890	5.5×10^{11}	Planck-2$^\delta$	12	under const.	100+ runs completed	KASI

Upcoming WL events

- **Jan 11/12**: WL flowdown meeting @ Imperial, London
  - Missing or insufficient requirement budget
  - Allocation of error budget to LE3
- **Feb 1-3**: Cluster meeting @ Paris
  - Discussion on cluster weak lensing, mass measurement, 3D detection
- **Feb 4/5**: 2pstat meeting @ IAP (Karim, Martin)
  - LE3 algorithms, requirements, hacking session
- **Feb 24/25**: Remote IST (Inter Science Working Group task force) meeting (Kitching, Pettorino)
  - Code comparison, build Euclid likelihood code, end2end forecasting pipeline

Participate to WLSWG

- Teleconfs Mondays 16:00h, in alternation with OU-LE3 and OU-SHE.
- One dedicated Euclid weak-lensing (WLSWG + OU-LE3 + OU-SHE) meeting per year (~ autumn).

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http://euclid.roe.ac.uk/projects/wlswg/wiki