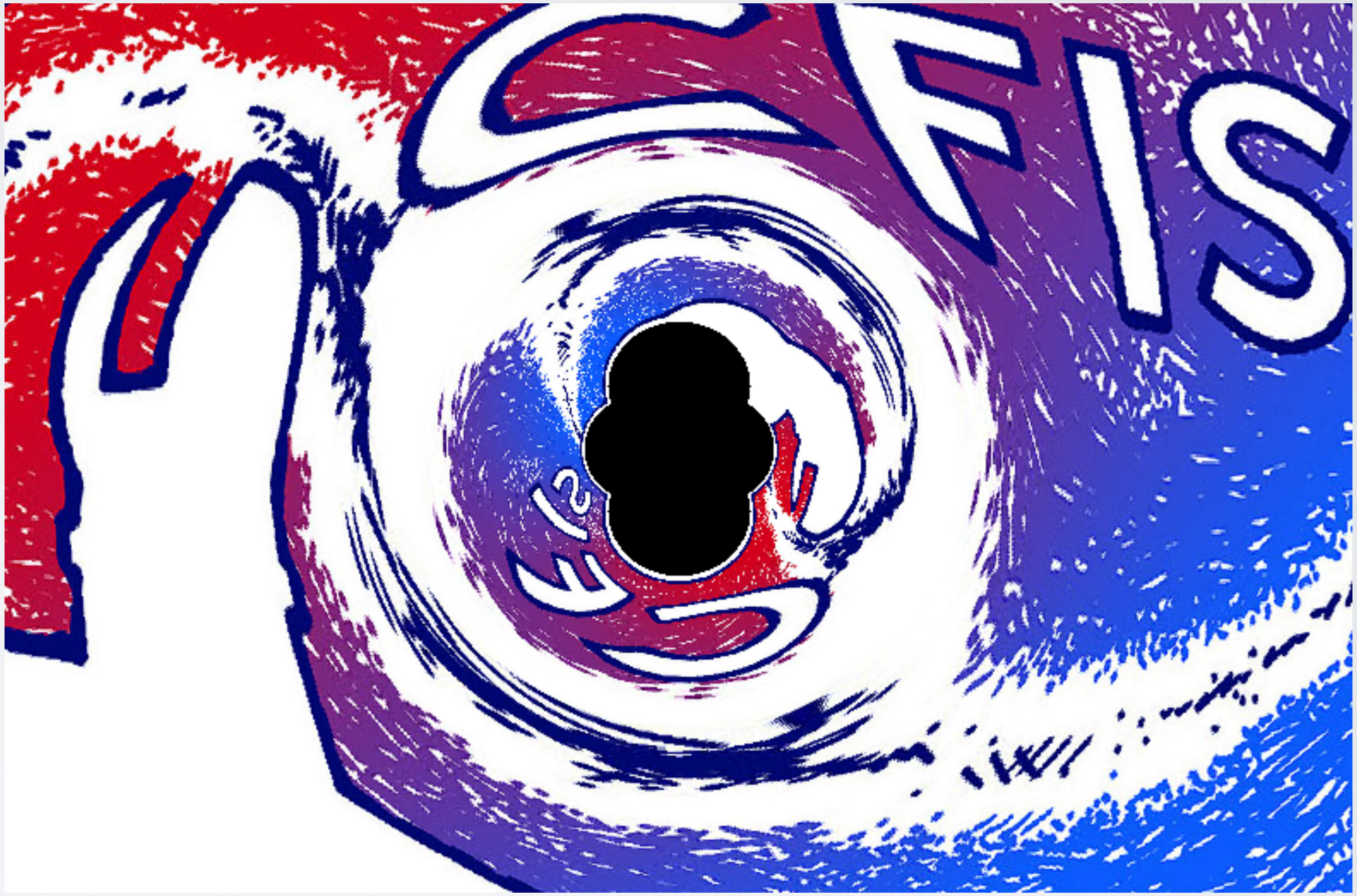
WEAK LENSING IN



M. Hudson on behalf of CFIS/UNIONS WL team

CFIS WL TEAM

- R. Gavazzi (IAP)
- M. Hudson (Waterloo)
- M. Kilbinger (CEA Saclay)
- L. van Waerbeke (UBC)

- Jerome Bobin (CEA) *shear calibration*
- Thomas Erben (Bonn)
- Sam Farrens (CEA) *PSF, galaxy clusters, photo-z*
- Axel Guinot (CEA) *Shape pipeline, clustering redshifts, voids. POSTER*
- Hendrik Hildebrandt (Bochum) *cosmic shear, combined probes, clustering redshifts*
- Eric Jullo (LAM) *galaxy-galaxy lensing, cluster masses, tests of GR*
- Henry Joy McCracken (IAP)
- Alexander Mead (UBC, postdoc with van Waerbeke) *cosmic shear, cross correlations*
- Yannick Mellier (IAP)
- Lance Miller (Oxford)
- Austin Peel (CEA, postdoc) *mass mapping, peak counts*
- Anirut Phriksee (LAM, PhD with Jullo) *cluster masses and tests of GR*
- Sandrine Pires (CEA) *mass mapping, higher-order satistics, WL clusters*
- Arnau Pujol (CEA, postdoc) *galaxy bias, shear calibration*
- Bailey Robison (Waterloo, MSc with Hudson) *Dark matter halo shapes*
- Isaac Spitzer (Waterloo, PhD with Hudson) *masses of satellites, groups, filaments, image simulations*
- Jean-Luc Starck (CEA) *mass mapping, PSF*
- Florent Sureau (CEA) *shear measurement*
- Morgan Schmitz (CEA, PhD with Starck/Kilbinger) *PSF, cosmological parameters*
- Valeria Pettorino (CEA) *modified gravity, dark energy, combined probes*
- Jan Luca van den Busch (Bochum, PhD with Hildebrandt) *clustering redshifts*
- Tianyi Yang (U Waterloo, with Hudson) *Dark matter dominated filaments in the cosmic web*
- *+2 new UBC students arriving in September*

Galaxy-Halo Connection

- Filaments of the “Cosmic Web” between galaxies
- DM Halo Masses of Ultra Diffuse Galaxies
- DM Halo Masses of Tidally Stripped Satellite Galaxies
- Shapes of DM halos
- Co-evolution of galaxies and their DM Halos

Galaxy Clusters

- Cluster masses e.g.
- SPIDERS
- HERITAGE XMM Large Program
- Cross-correlation of mass maps with thermal SZ effect

Cosmology and Large Scale Structure

- Testing Gravity
- Weighing the “Emptiness” of Voids
- DM Mass Maps
- Cosmic shear
- Cosmology with mass map peaks
- Cosmological constraints from higher-order statistics of weak lensing convergence maps
- Galaxy “bias” in large-scale structure

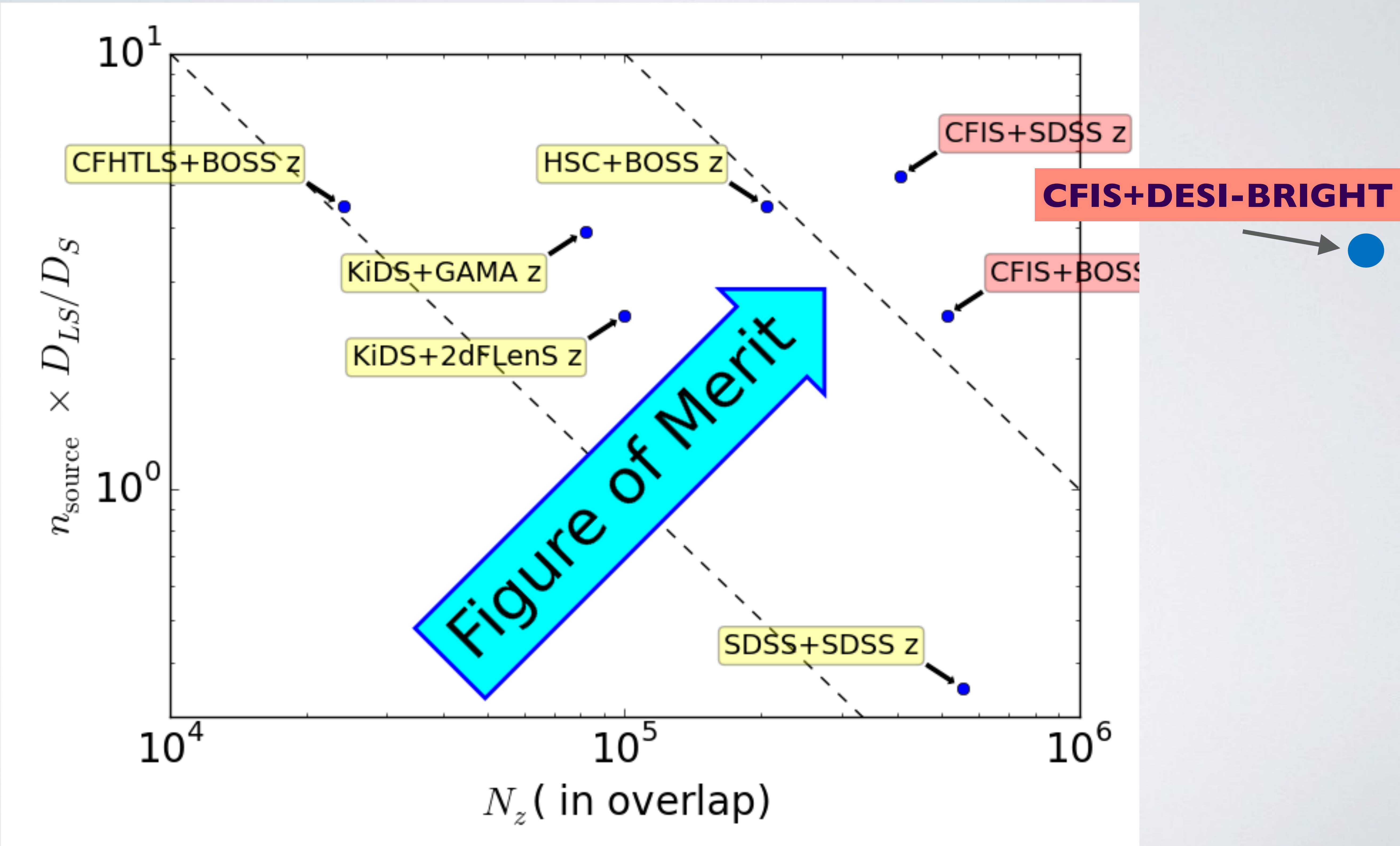
Data and Methods

- Galaxy Shape Catalogues
- Clustering redshifts
- Calibration of Shape Measurement Pipelines
- Machine-learning and deblending

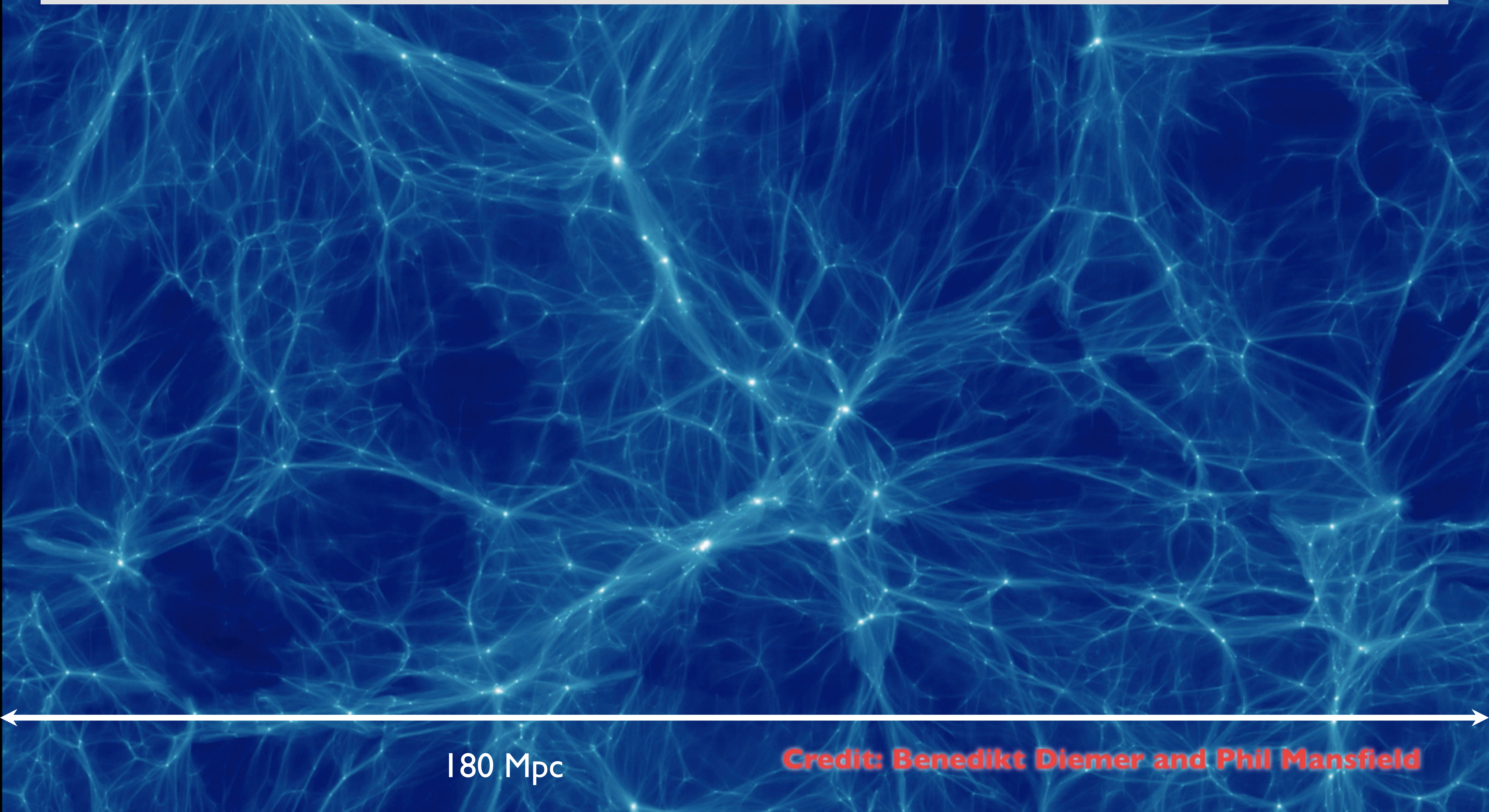
WEAK LENSING
+
SPECTROSCOPY

- Filaments of the “Cosmic Web” between galaxies
- Halo Masses of Ultra Diffuse galaxies
- Testing Gravity

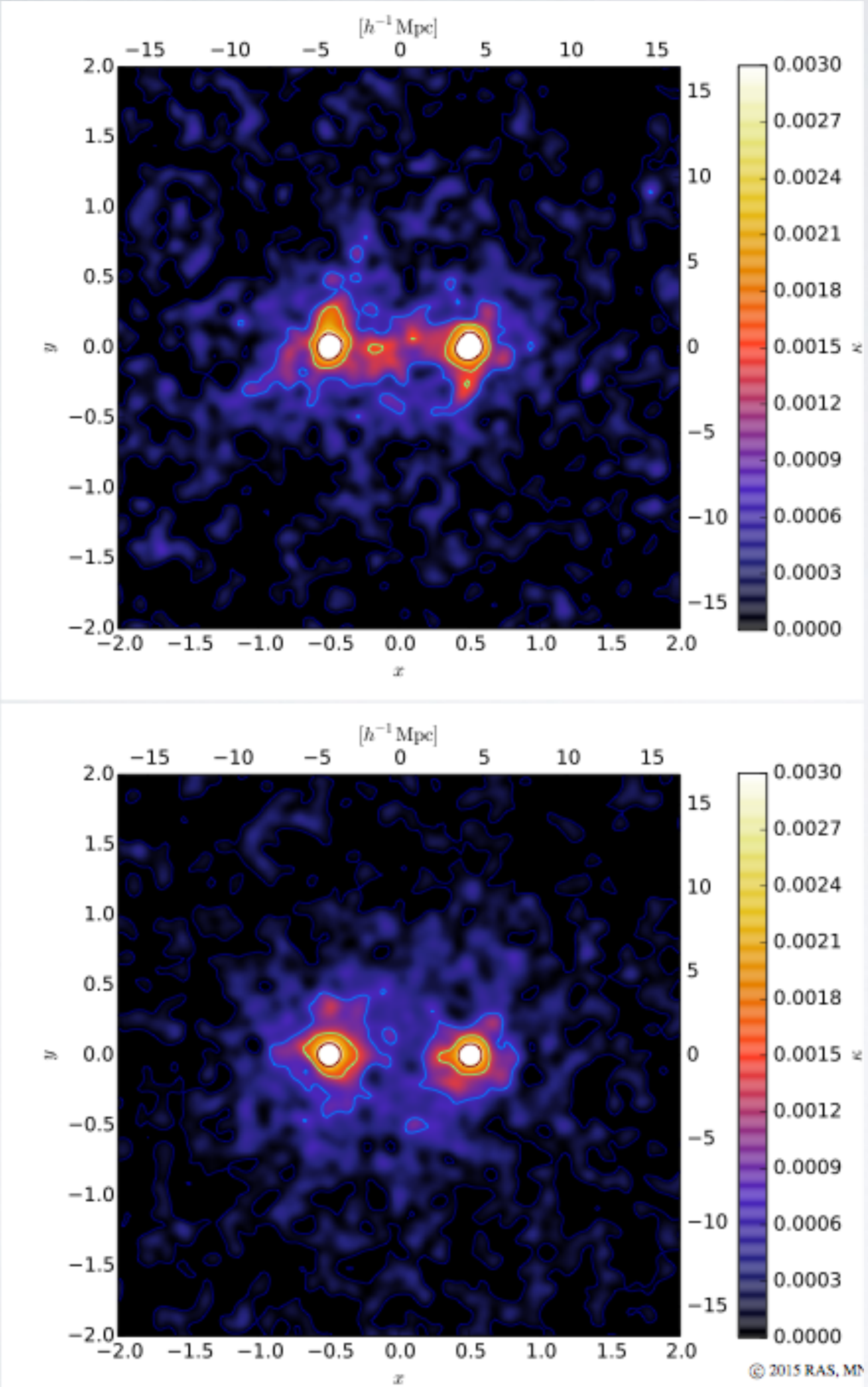
LENSING + SPECTROSCOPY



FILAMENTS IN THE COSMIC WEB



LARGE-SCALE STRUCTURE: FILAMENTS



Physical pairs

Projected Surface Mass Density

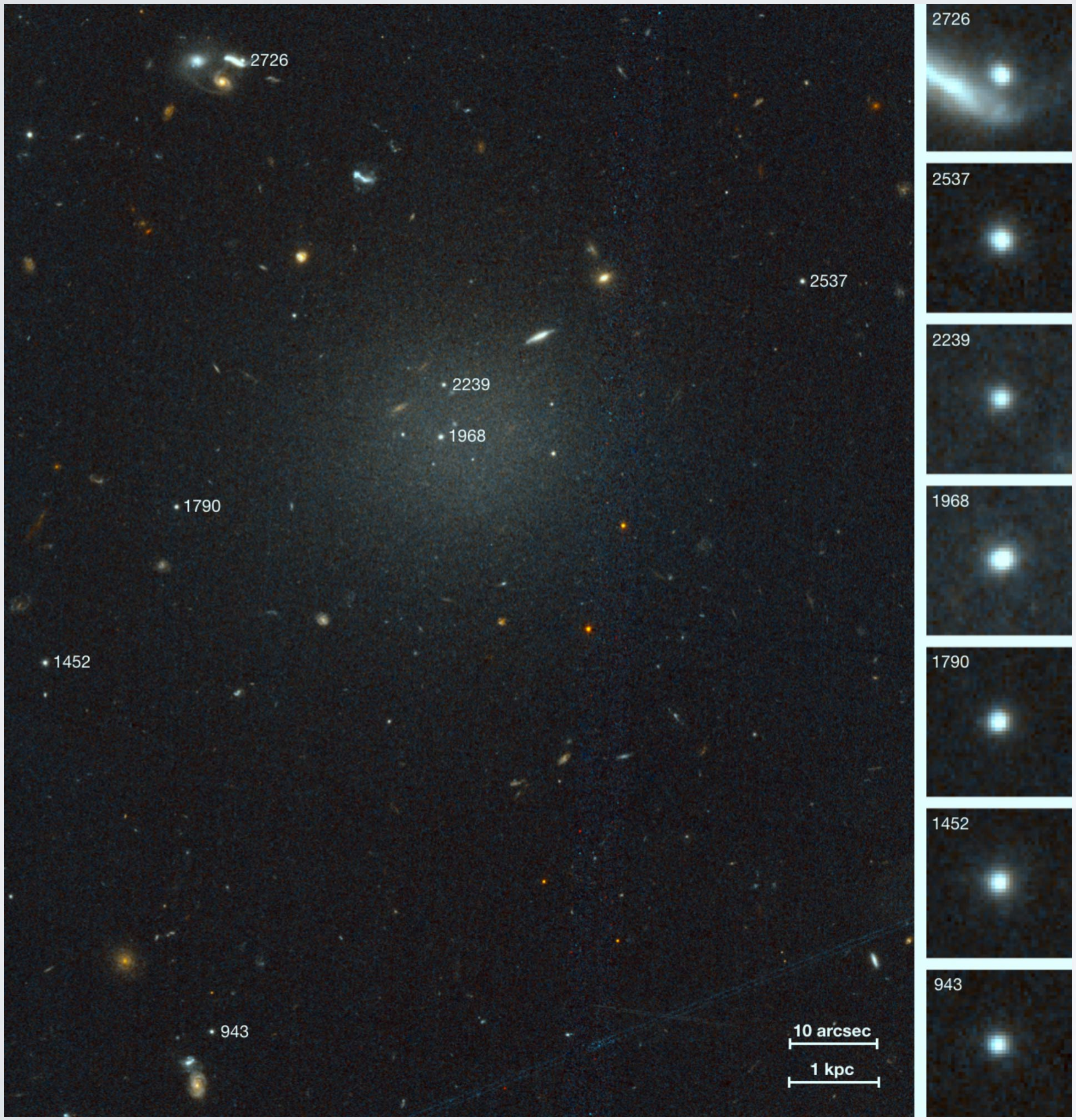
Projected pairs

Filament Size:
7 Mpc/***h*** x 2.5 Mpc/***h***

Filament Mass:
1.5x10^{13} solar

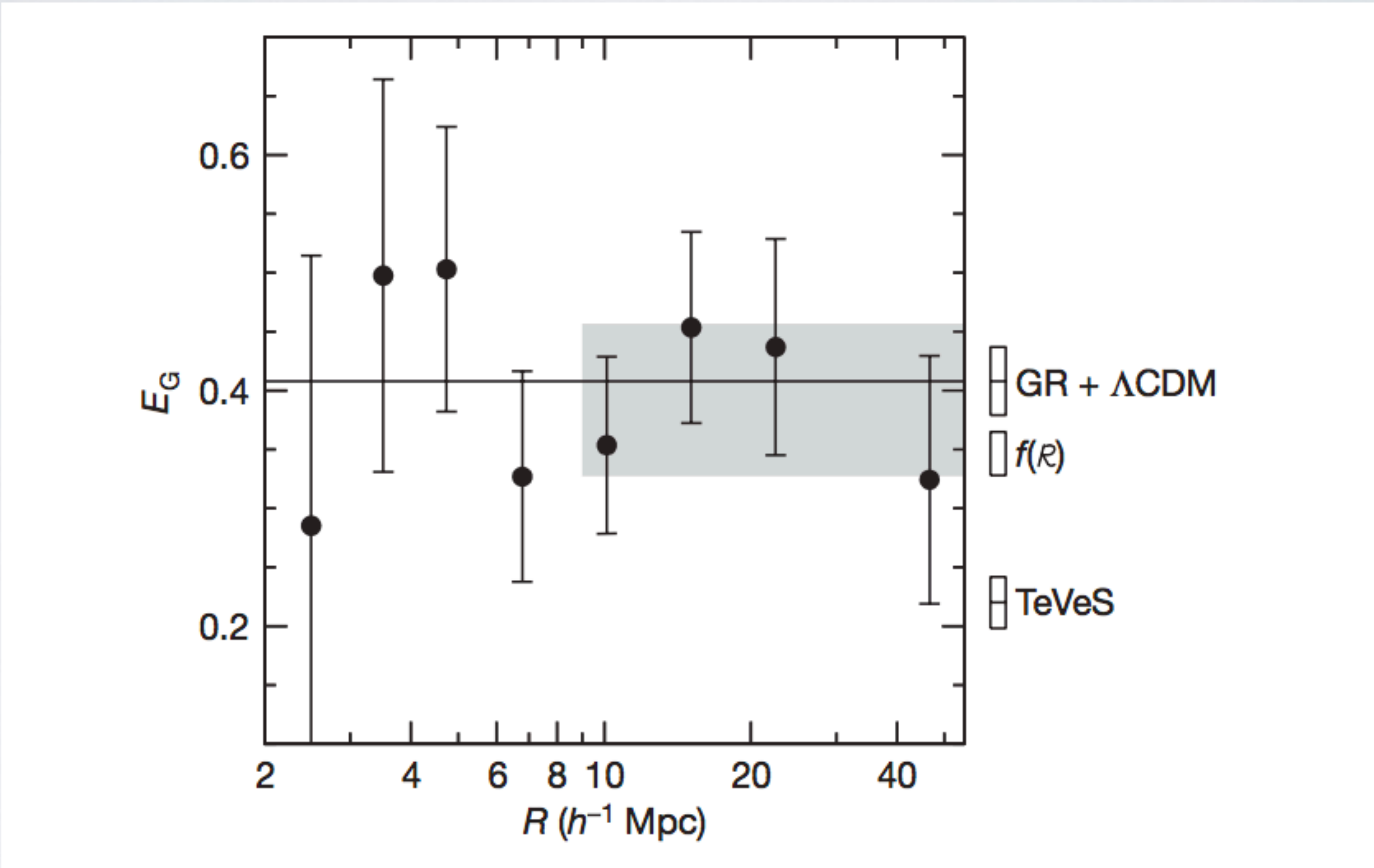
Epps & MH, 17
CFHTLenS, based on 1/40 of CFIS area

ULTRA DIFFUSE GALAXIES



- Find UDGs with CFIS-LSB pipeline
- Measure their average DM halo masses with weak lensing
- Currently only upper limits (Sifon et al)

TESTING GENERAL RELATIVITY



Reyes et al 2010, Nature

WL DATA REDUCTION

WHY IS LENSING SO HARD?

- Galaxy **shapes**
    - Need to measure shear of 1%-0.1% and to *calibrate* the level of distortion to 1%.

- **Redshifts** of lenses and sources to ~1%

SHAPE CATALOGUES: STATUS AND PLANS

- Two independent shape measurement pipelines, both working on individual exposures
  - ***lens*fit** (van Waerbeke+) updated to work with large dithers, self-calibration
  - ShapePipe (Guinot+): using NGMIX (DES)
- Shape catalogues in CFHTLS-W3 "test" region (50 sq deg)
  - Catalogues agree with each other and with previous CFHTLenS data
  - Systematics well controlled and appear lower than e.g. DES

ShapePipe

A new shape measurement pipeline

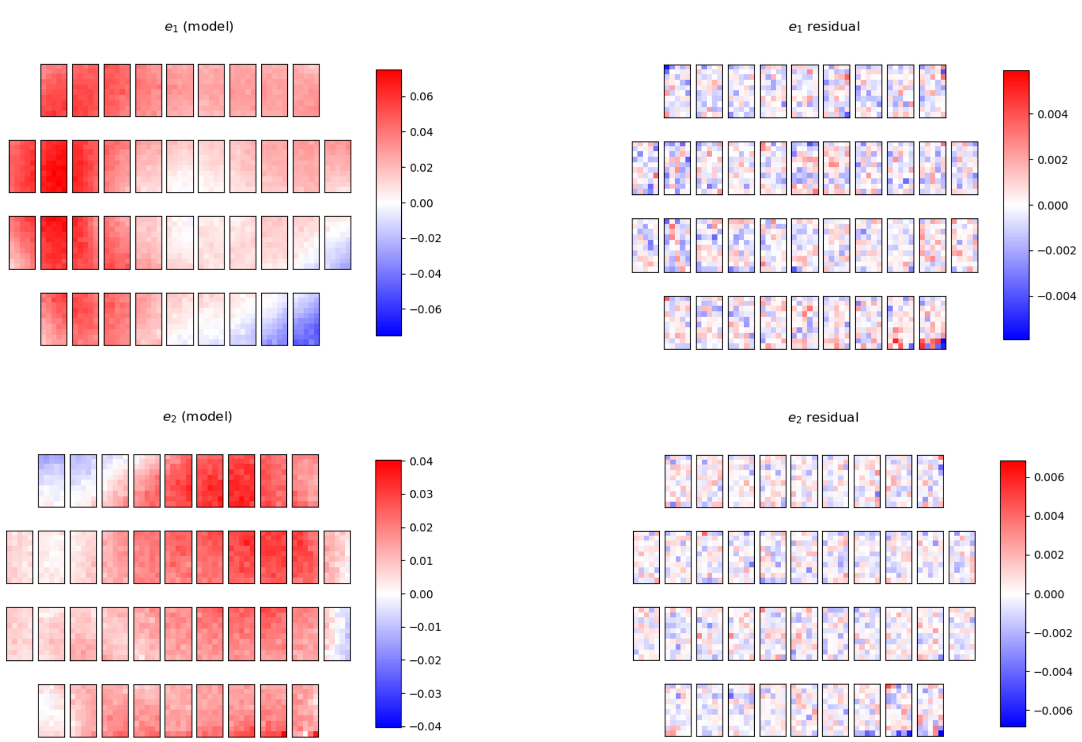
Axel Guinot, Martin Kilbinger
CosmoStat, CEA Paris-Saclay

Absrtract

ShapePipe is a weak-lensing pipeline that is being developed in the context of the Canada-France Imaging Survey (CFIS). This survey provides excellent image quality of 0.6 arcsec seeing, is complete to 24 r-band magnitud, and will cover 5000 deg^2. Our pipeline is modular and multi-processing capable, allowing us to handle very large surveys such as CFIS. It implements well-tested software like SExtractor and PSFEx, and novel state-of-the-art algorithms such as Ngmix and metacalibration. The pipeline processes raw (photometrically and astrometrically calibrated) multi-epoch images and creates a calibrated weak-lensing galaxy shape catalog. It includes extensive validation tests for PSF and galaxy shapes. I present here the first CFIS weak-lensing results obtained with x on CFHTLS W3.

PSF Validation

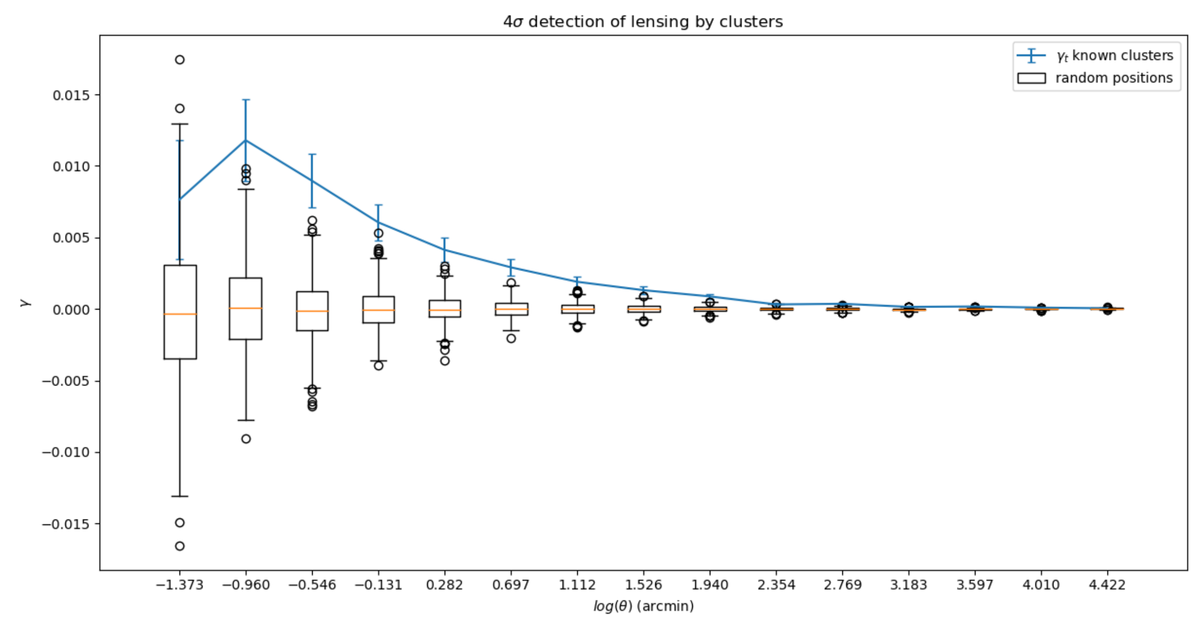
We measure the residuals between PSF model ellipticities and stars. We compute correlations developed by *Rowe (2010),* later extended in DES, which are null tests for the PSF model. These statistics propagate to the shear-shear correlation function and quantify systematic contributions due to PSF miss-estimation.



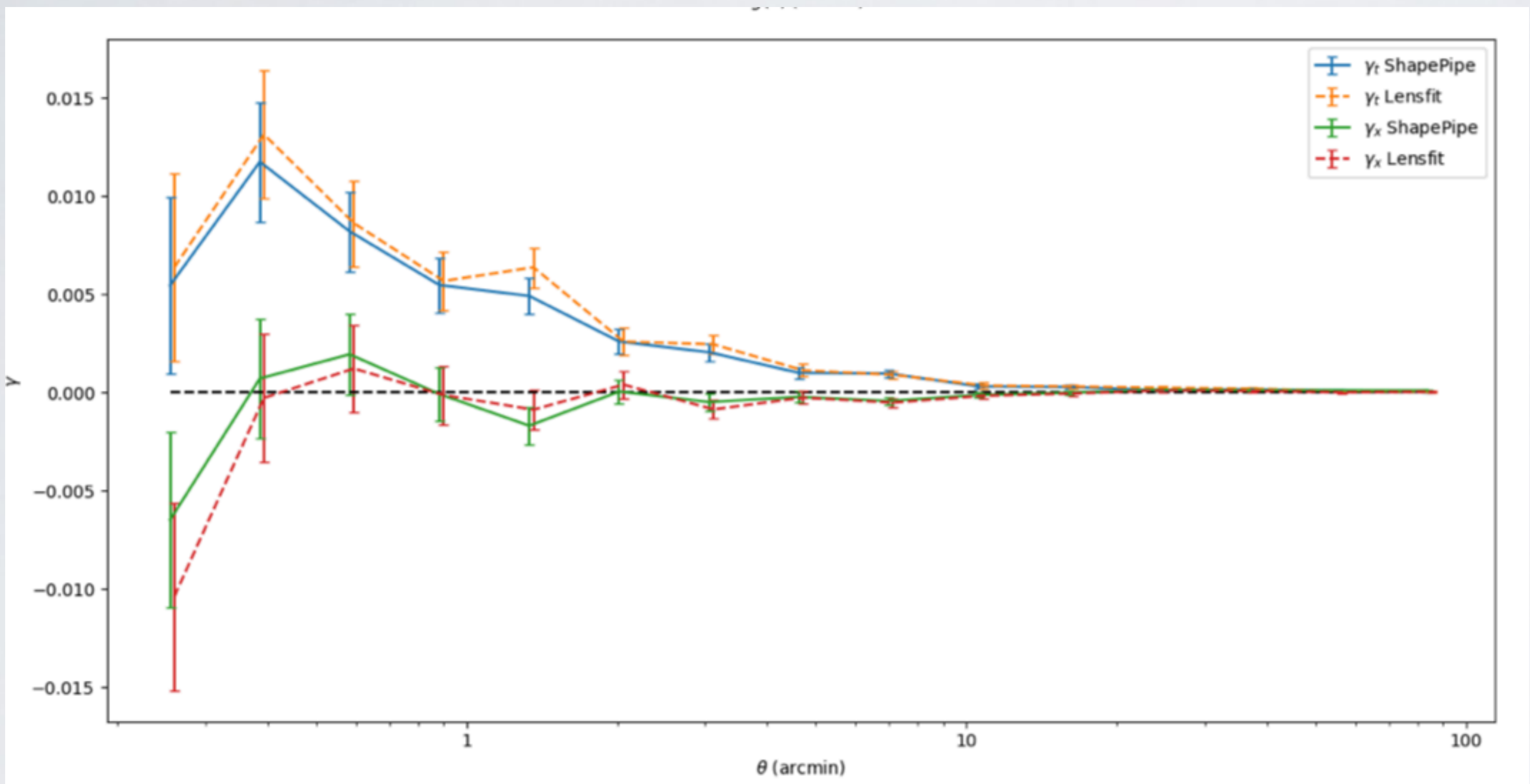
Small amplitude and no pattern in the residuals.

Shape Validation

We compute stacked lensing tangential shear profiles around known clusters, using optically selected groups and clusters from *Ford et al. 2014/2015*. We compute the significance by comparing to the shear random position, and compute the B-mode shear as null test. We detect cluster lensing at 4σ. Our results are very similar to an independent lensing pipeline, *Lensfit*, also used in CFIS.

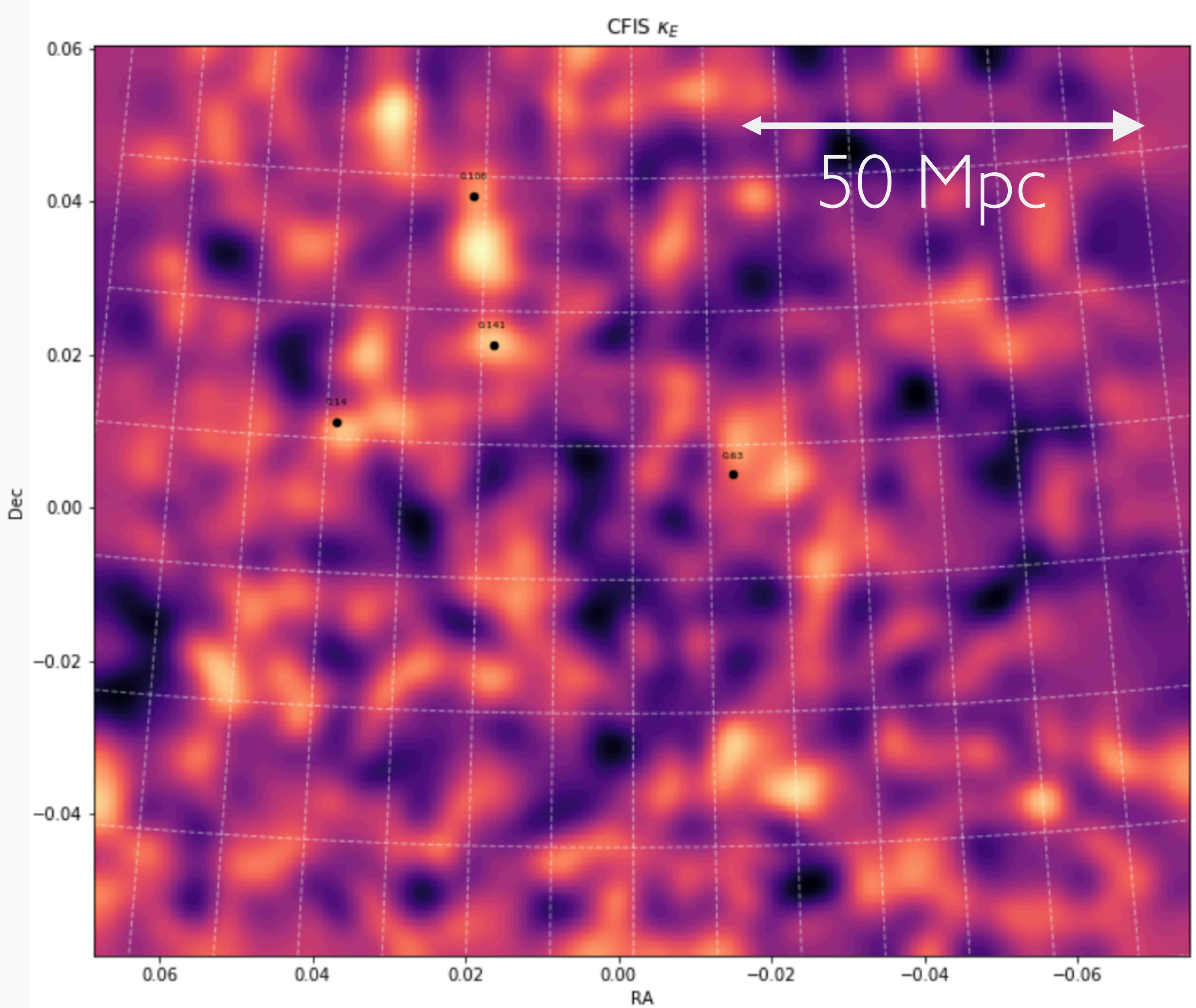


GALAXY CLUSTER MASSES



- Shape catalogues agree well!
- Detection of cluster masses

DARK MATTER MAPS



Weak-lensing mass map (E-mode) correlation with Planck clusters

- 1.6 million galaxies over 100 square degrees (~2% of full CFIS)
- Planck clusters in black

Guinot et al

PLAN

- Near term:
  - Process 2000 square degrees = 100,000,000 CFIS-r galaxy images this summer.
  - Prepare papers late summer into autumn.
- Longer term:
  - Complete CFIS-r, and rest of UNIONS for photo-z

WL SUMMARY

- CFIS/UNIONS has a unique combination of WL shapes behind extensive foreground SDSS spectroscopy. It will:
  - revolutionize our understanding of the structure of dark matter and the link to galaxy formation
  - provide powerful new tests of gravity

… *if it can achieve the goal of 4800 square degrees*