RUB

RUHR-UNIVERSITÄT BOCHUM

WIDE-FIELD IMAGING SURVEYS FOR WEAK GRAVITATIONAL LENSING AND GALACTIC HALO SCIENCE

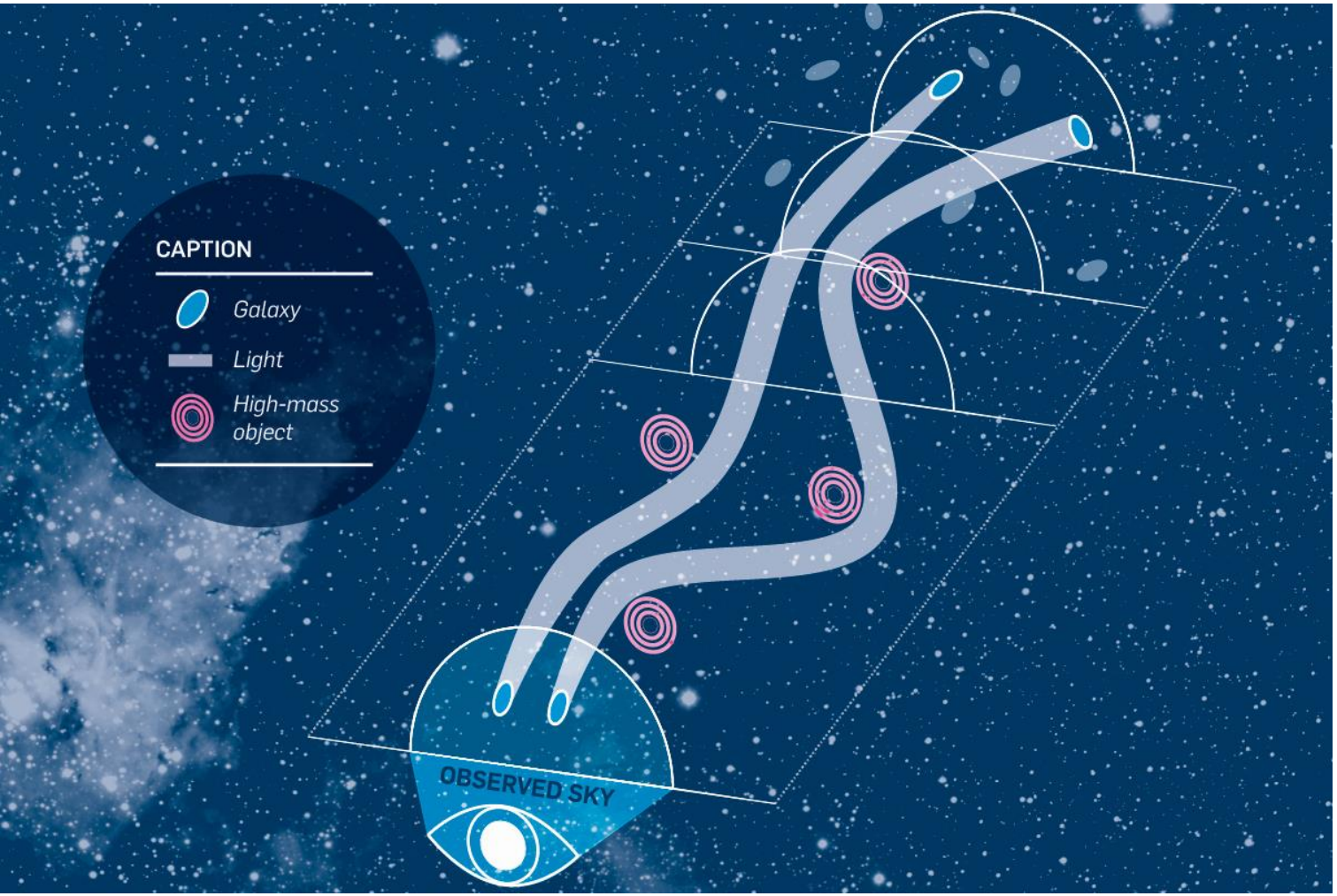
Anna Wittje working with Prof. Dr. Hendrik Hildebrandt, Dr. Angus Wright, Jan Luca van den Busch, …

AIRUB
Astronomisches Institut
RUHR-UNIVERSITÄT BOCHUM

Contents

- Weak gravitational lensing
- Motivation for redshift calibration
- Kilo Degree Survey and UNIONS/CFIS
- SOM-based redshift distribution n(z) for CFIS
- Summary

Weak gravitational lensing measurements

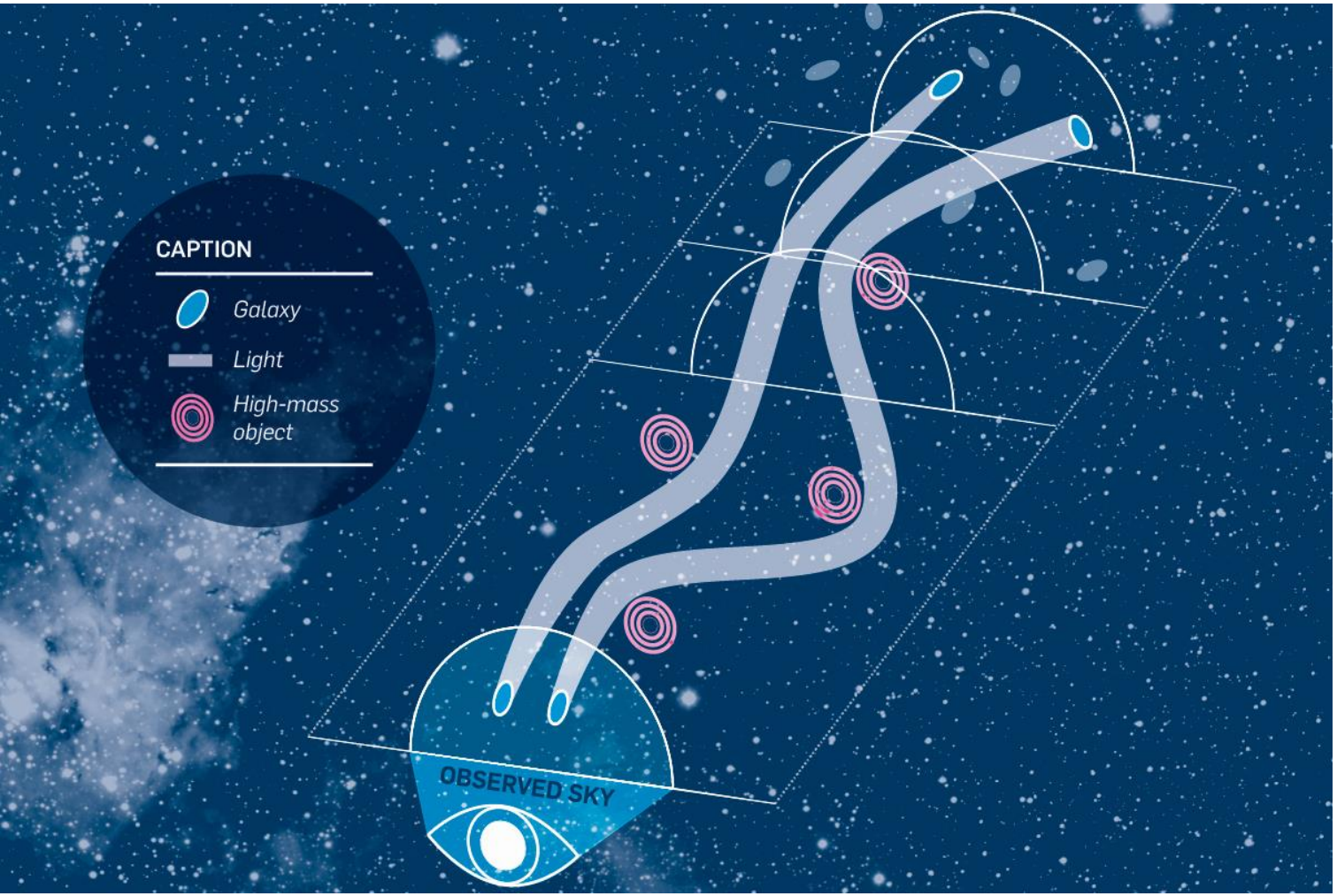


estimate cosmological parameters from cosmic shear:

- matter density parameter Ω_m
- amplitude of matter fluctuations σ_8

RUB 2020

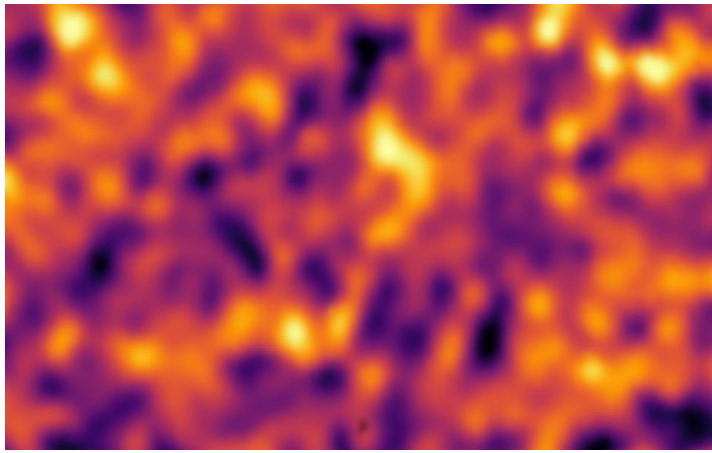
Weak gravitational lensing measurements



estimate cosmological parameters from cosmic shear:

- matter density parameter Ω_m
- amplitude of matter fluctuations σ_8

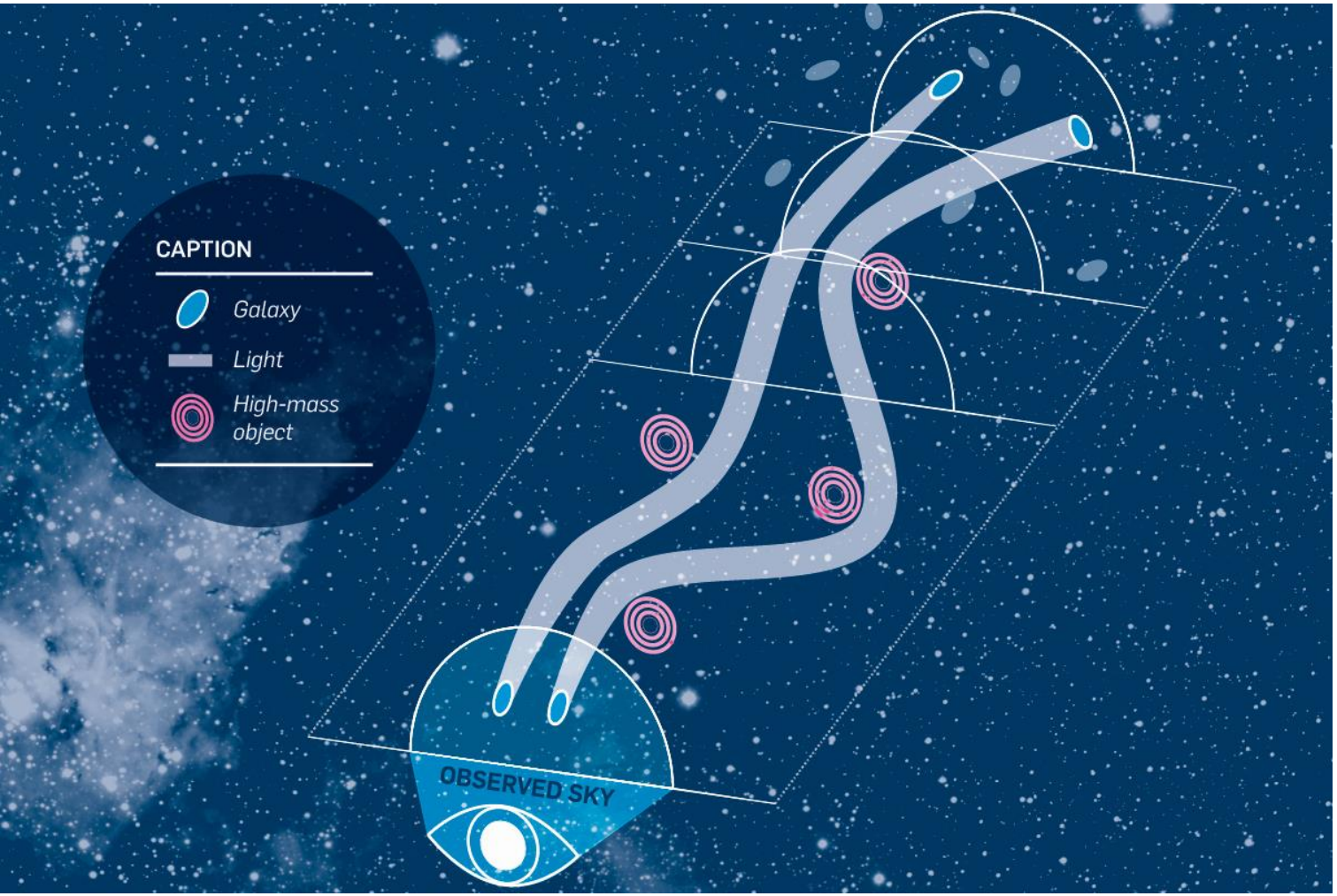
→ e.g. use the (dark) matter overdensities in F5



RUB 2020

RUHR UNIVERSITÄT BOCHUM RUB

Weak gravitational lensing measurements



estimate cosmological parameters from cosmic shear:

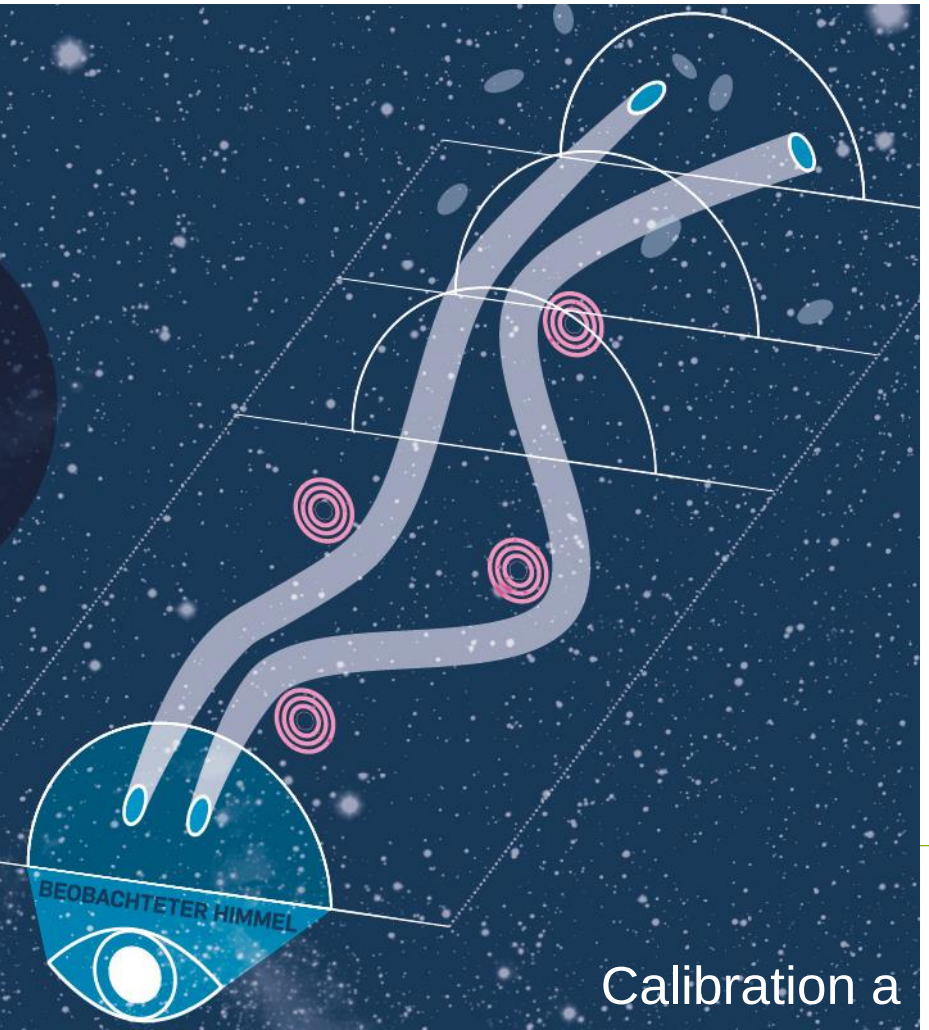
- matter density parameter Ω_m
- amplitude of matter fluctuations σ_8

observables:

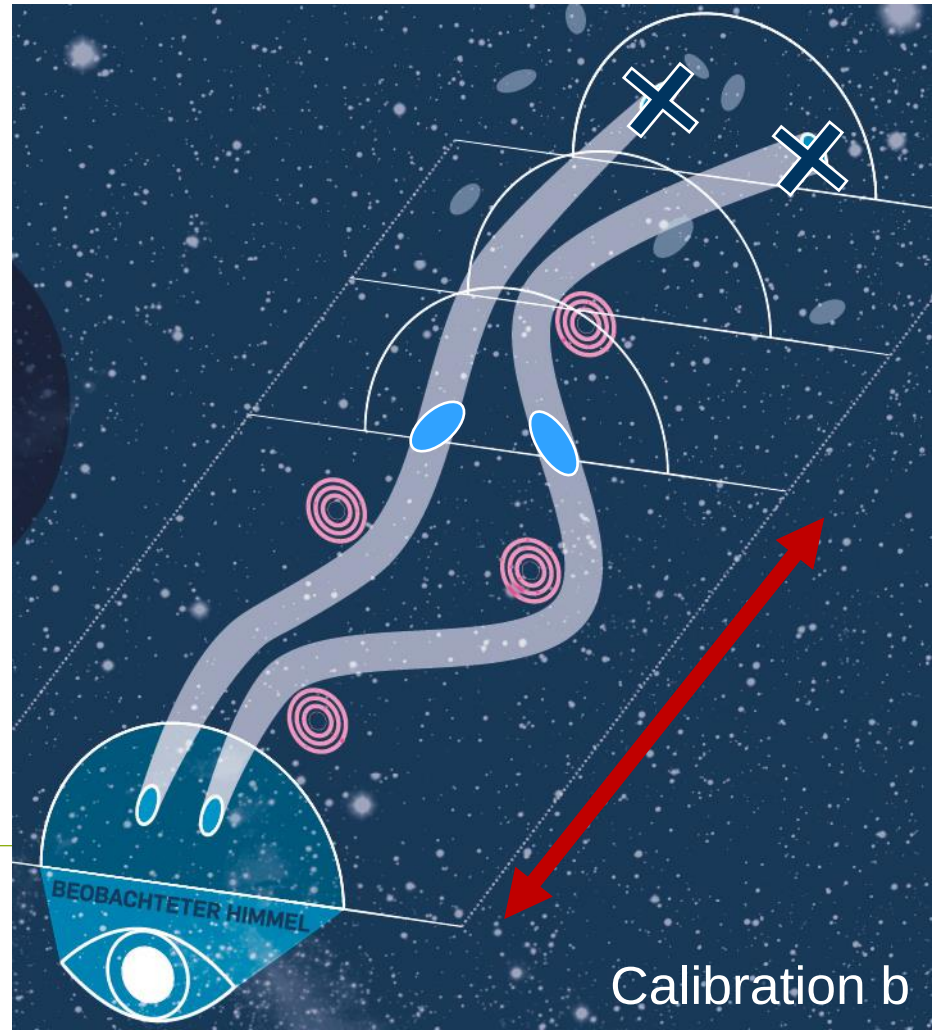
- galaxy shapes
- distances of the sources

RUB 2020

Why is it important to know the distance of the weak lensing sources?

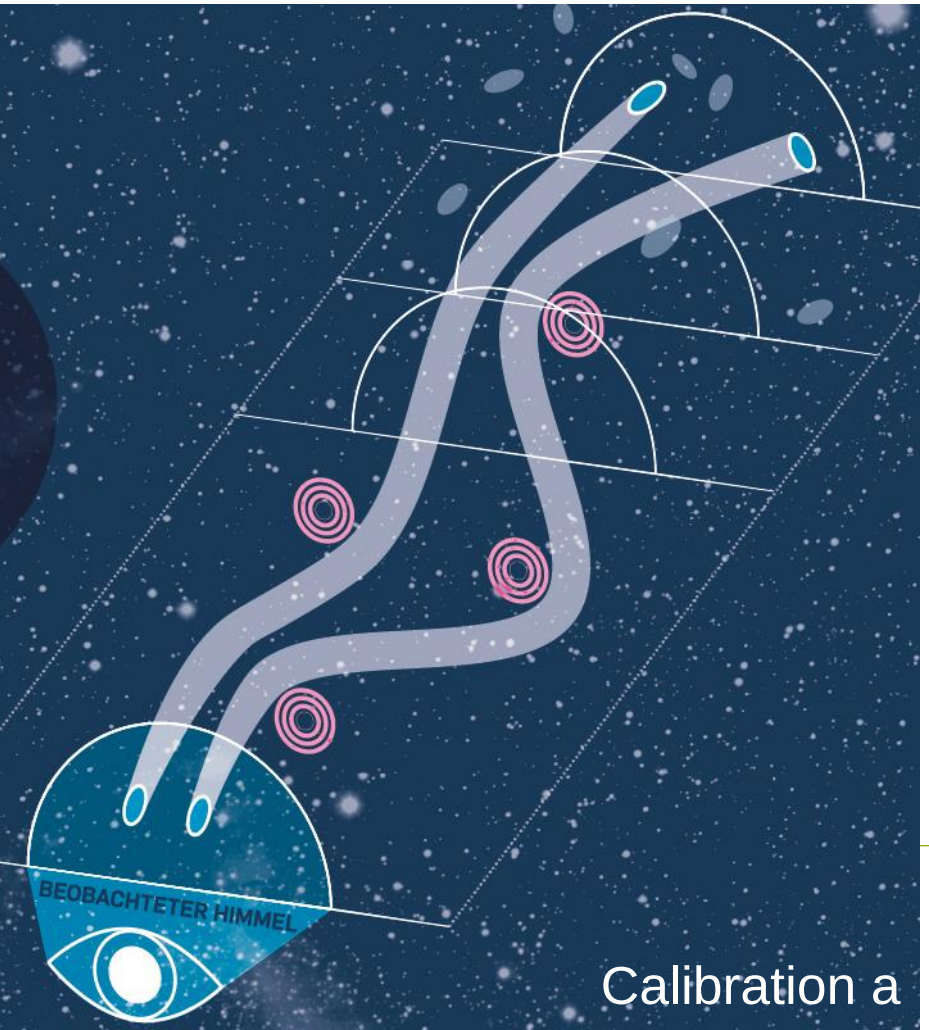


Calibration a



Calibration b

Why is it important to know the distance of the weak lensing sources?



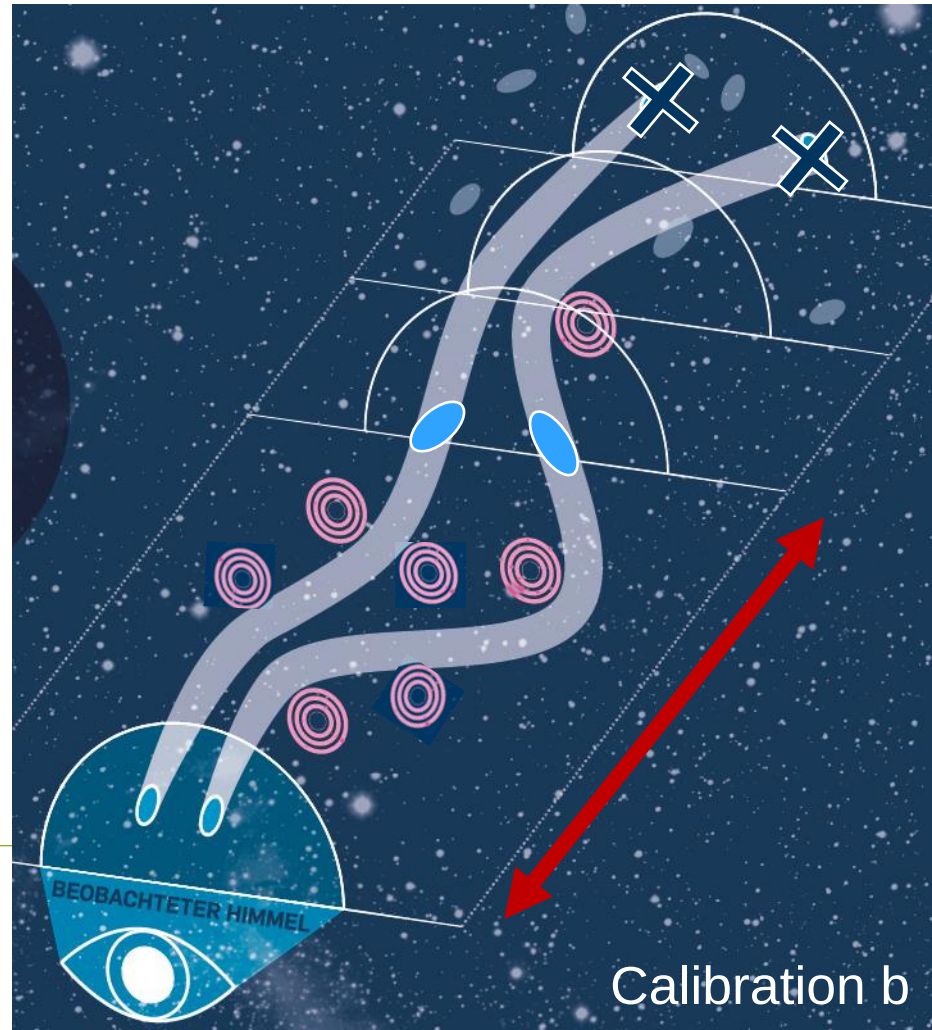
Calibration a

biased redshift calibration

results in

different cosmological parameters

σ_8 and Ω_m



Calibration b

KiDS (Kilo Degree Surveys)

- 9 band imaging ugriZYJHK_s
  UV to near-infrared (300-2300 nm)
- current data release:
  > 80 million galaxies over ~ 1000 deg^2
- soon final data release

UNIONS

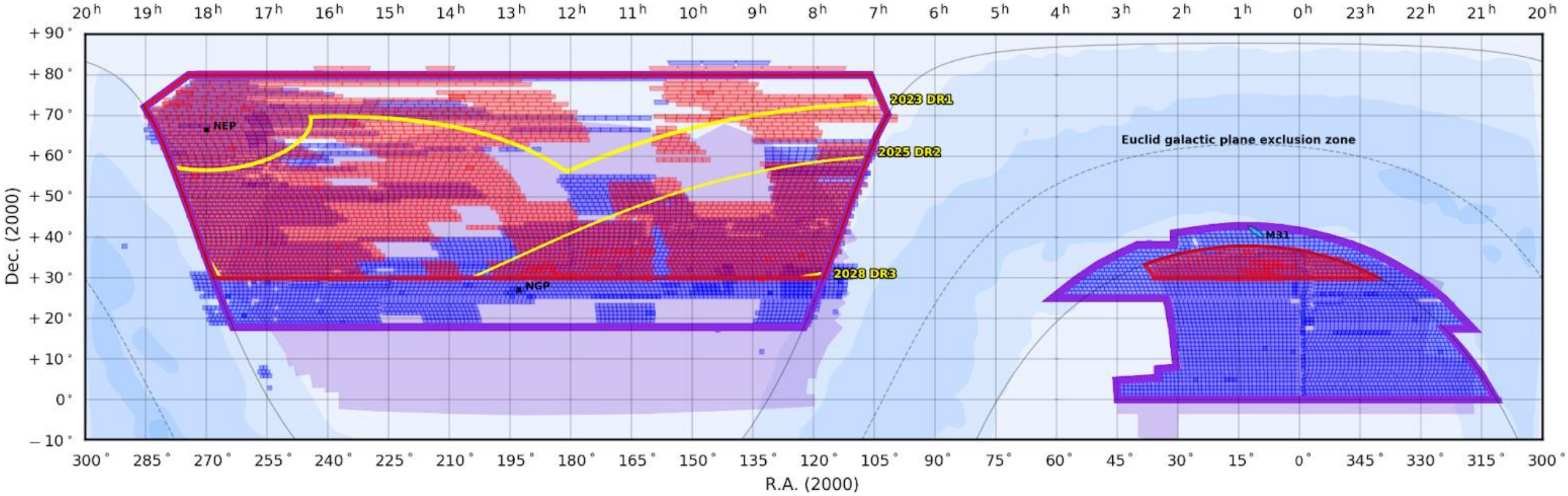
(Ultraviolet Near Infrared Optical Northern Survey)

combination of CFIS (Canada France Imaging Survey), Pan-STARRS, and Subaru HSC

- 5 band imaging ugriz
- still observing
- goal: ~ 4,000 deg^2

CFIS r-band measurements:
already ~ 100 million galaxies over 3,500 deg^2

CFIS (Canada France Imaging Survey)



CFIS sky coverage goal with current completion (May 2022)

- Galactic plane
- BOSS
- CFIS−u area goal : 9,000 deg.^{2}
- CFIS−r area goal : 4,800 deg.^{2}
- CFIS−u covered with 3 exposures (full depth) : 6724 deg.^{2}
- CFIS−r covered with 3 exposures (full depth) : 3840 deg.^{2}

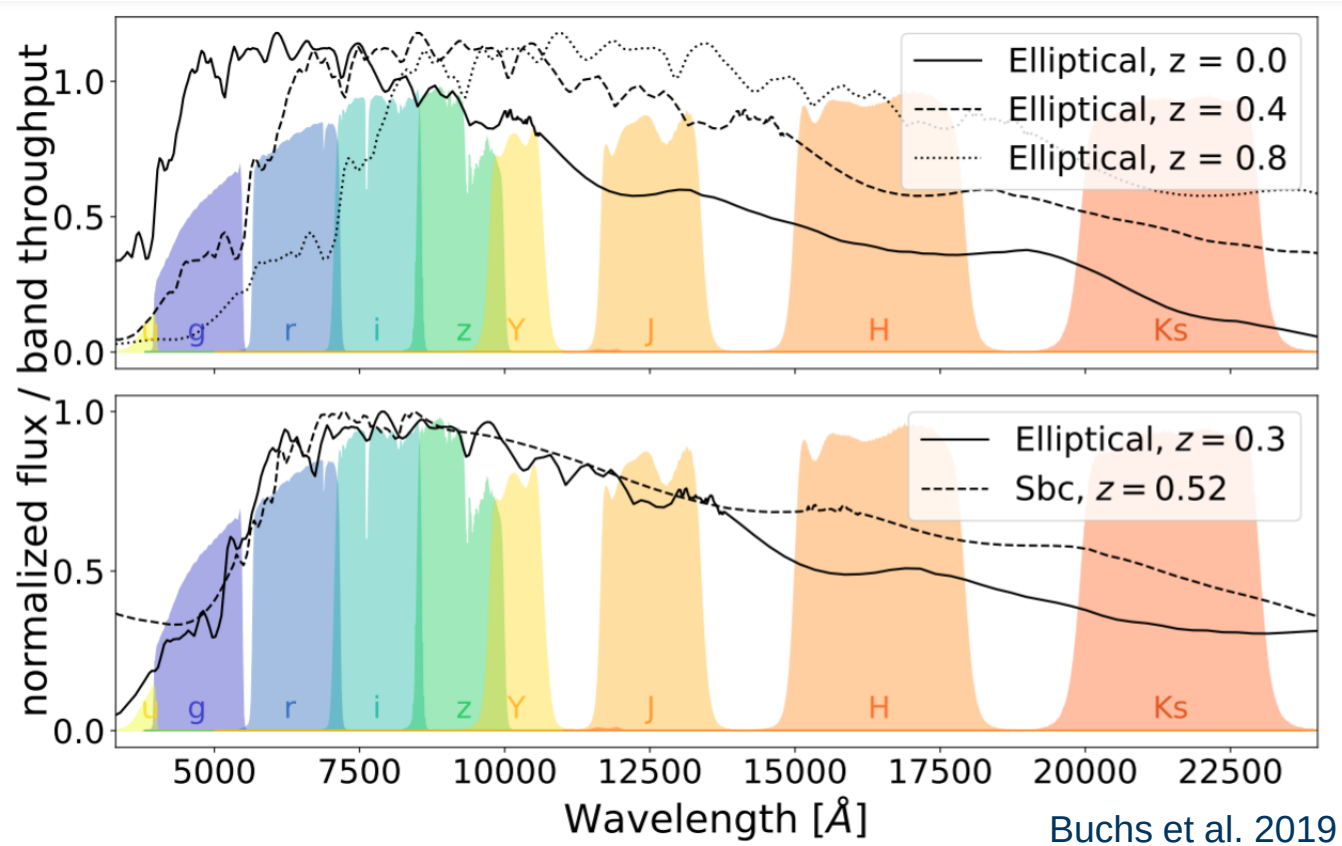
Estimating the distance of galaxies from imaging

Problems:

- spectroscopic redshifts not feasible
- individual photometric redshifts not accurate enough

One solution:

- use the multi-band imaging
- estimate the redshift distribution of an ensemble of galaxies



Buchs et al. 2019

RUHR UNIVERSITÄT BOCHUM RUB

Redshift calibration with SOM

estimating the redshift distribution using machine learning:

Self Organising Maps (SOM) from Kohonen 1982

- projects n-dimensional magnitude space on 2D map
- developed by Wright et al. 2020a for KiDS redshift calibration

Redshift calibration with SOM

estimating the redshift distribution using machine learning:

Self Organising Maps (SOM) from Kohonen 1982

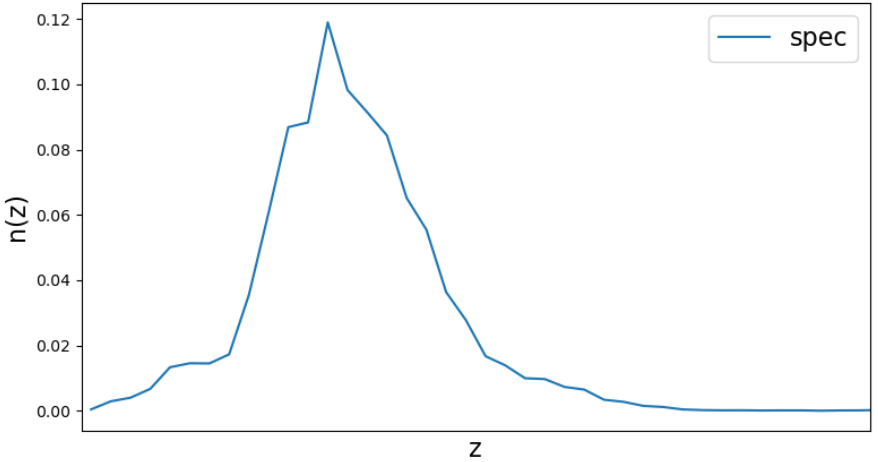
- projects n-dimensional magnitude space on 2D map
- developed by Wright et al. 2020a for KiDS redshift calibration

Requirements:
same multi-band photometry for weak lensing sources and for calibration sample

- CFIS area overlapping with CFHTLenS ugriz photometry
- spectroscopic samples with CFHTLenS ugriz photometry: DEEP2, VVDS, VIPERS

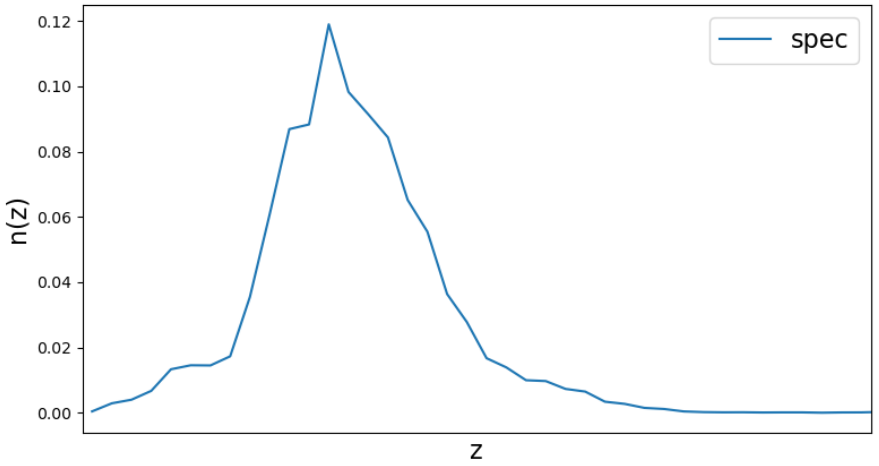
Training the SOM

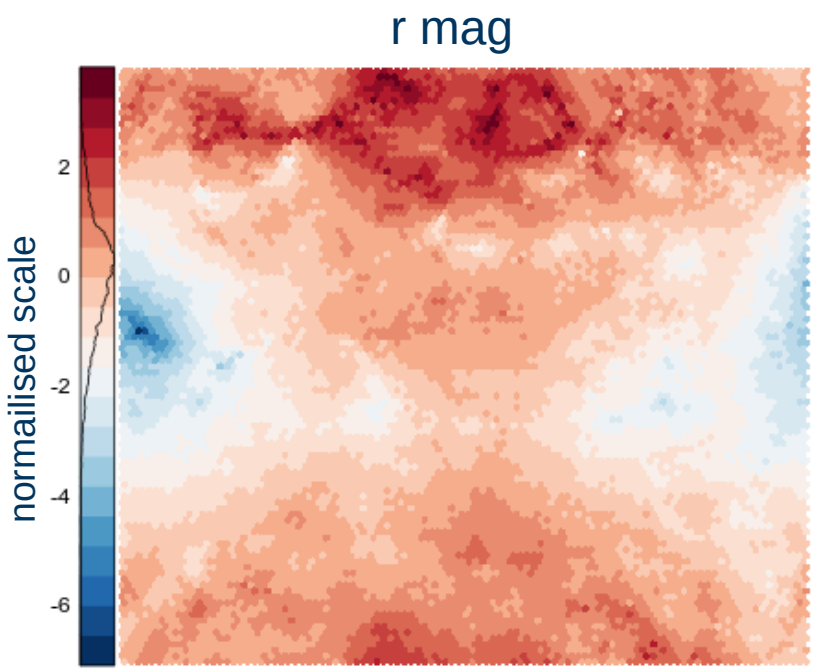
train Self Organising Map (SOM) with galaxies with ugriz photometry of spectroscopic sample (DEEP2, VVDS, VIPERS)



Training the SOM

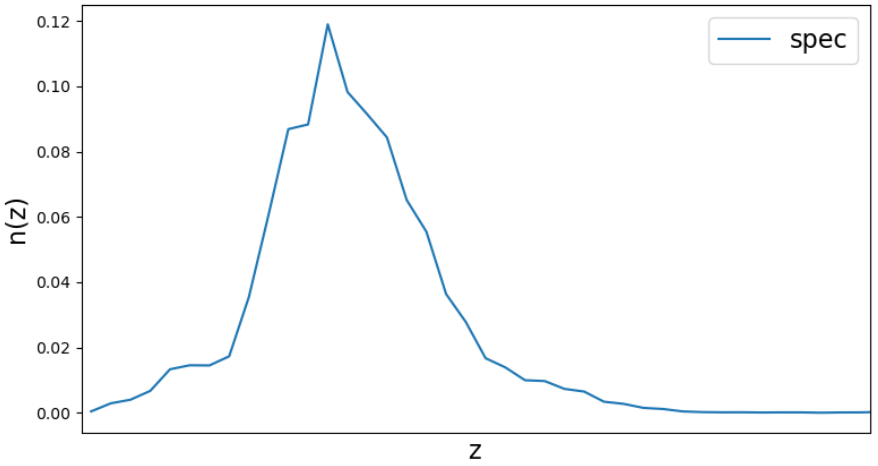
train Self Organising Map (SOM) with galaxies with ugriz photometry of spectroscopic sample (DEEP2, VVDS, VIPERS)



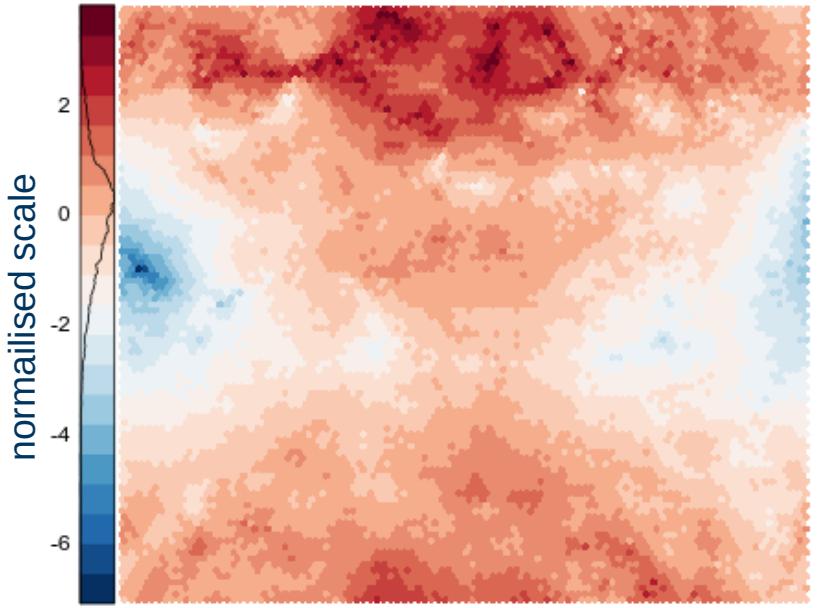


Training the SOM

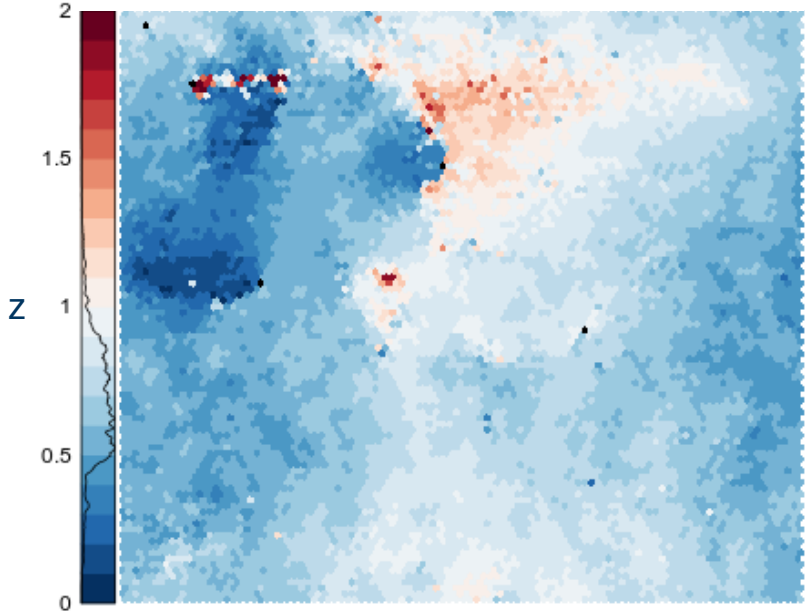
train Self Organising Map (SOM) with galaxies with ugriz photometry of spectroscopic sample (DEEP2, VVDS, VIPERS)



r mag



mean spec-z of calibration data

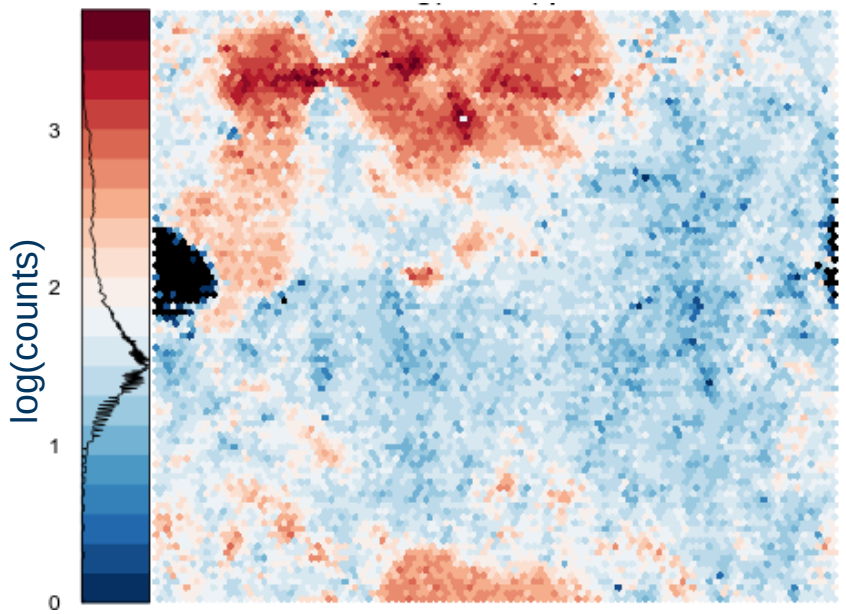


RUHR UNIVERSITÄT BOCHUM RUB

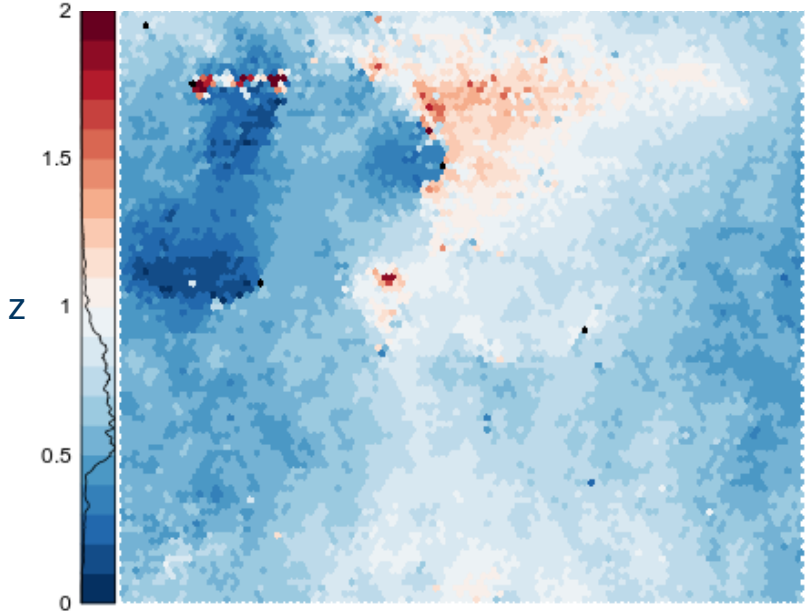
Reweighting the redshift distribution

- populate SOM with CFIS sources
- extract redshift distribution: weighted spec. n(z) estimates the true n(z) of CFIS

number of CFIS galaxies per cell



mean spec-z of calibration data

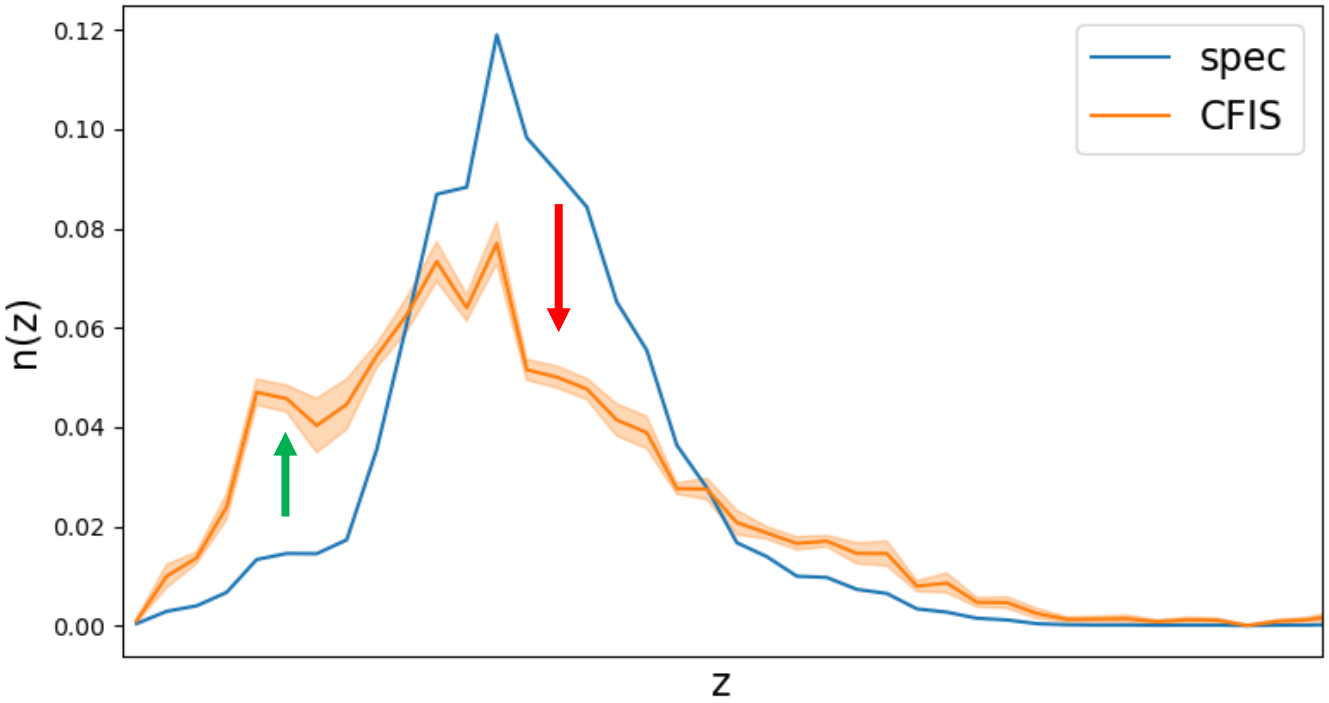


Redshift distribution for CFIS

- test systematic effects of method with different settings
- passes a number of robustness tests at the $\Delta z_{mean} < 0.01$ level
- use simulations (already done for KiDS)

Blinding procedure:

→ cosmological analyses require unbiased handling of the data



Summary

Weak lensing studies:

- accurate redshift distribution important for current and future surveys
  → cosmological analyses will not be constraint by statistics but by systematics
- can be used for cross-correlation measurements with γ observations
  → project F5

Wide-field multi-band imaging surveys:

- provide large data sets that can be used for weak gravitational lensing,
  and also for project F5 and F6

Thank you