Clusters of galaxies in Subaru Hyper Suprime-Cam survey

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2016/11/2 Cosmology and Structure Formation@KIAS

Clusters as a multifaceted cosmological probe

- nature of dark matter
  proof of existence, cold/warm, self-interaction, annihilation/decay signals, ...

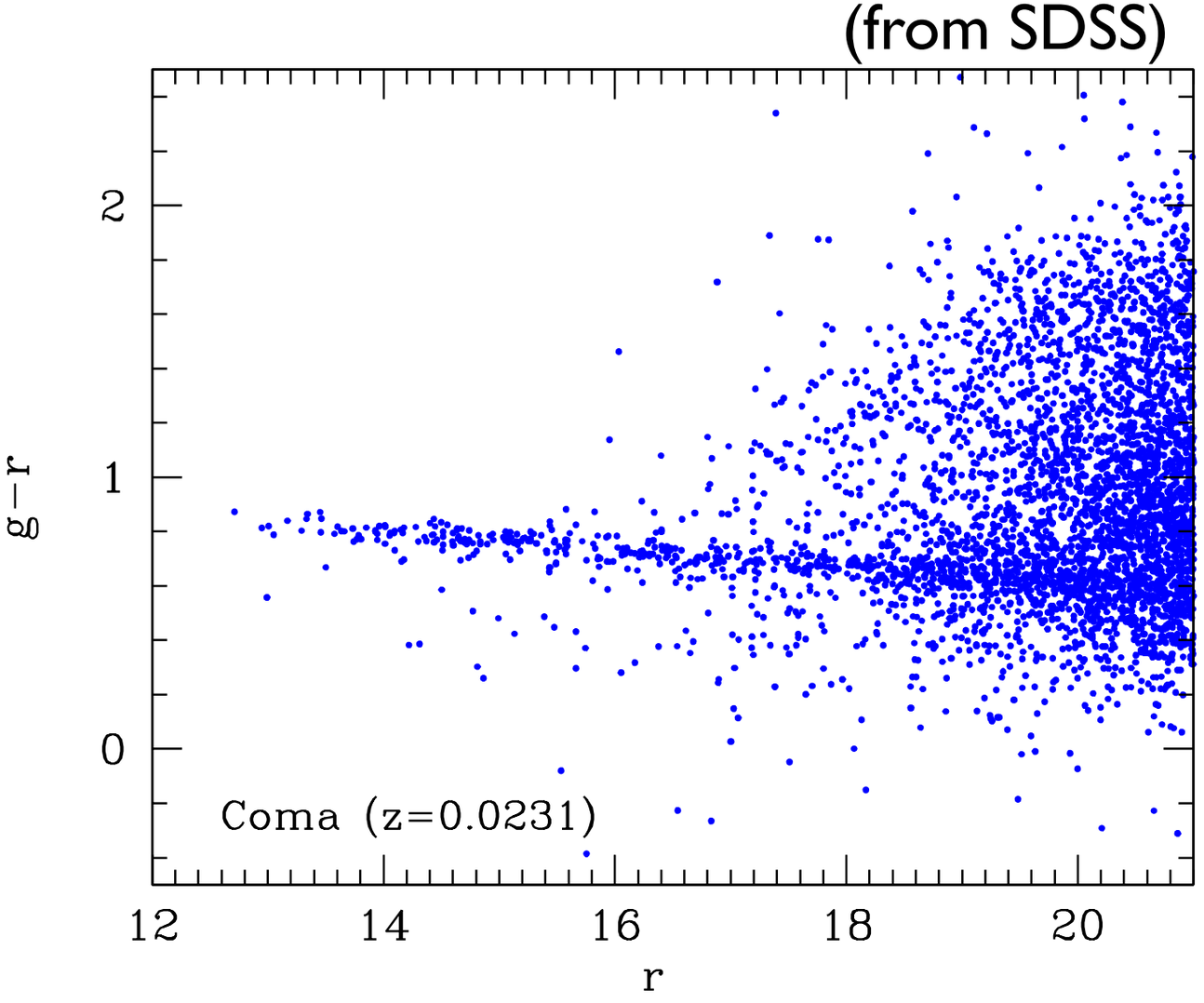
- gravity theory
  GR or modified gravity?

- cosmological parameters
  σ_8, Ω_m, dark energy, primordial NG, ...

Cluster of galaxies in optical

Coma cluster (Dean Rowe)

(from SDSS)



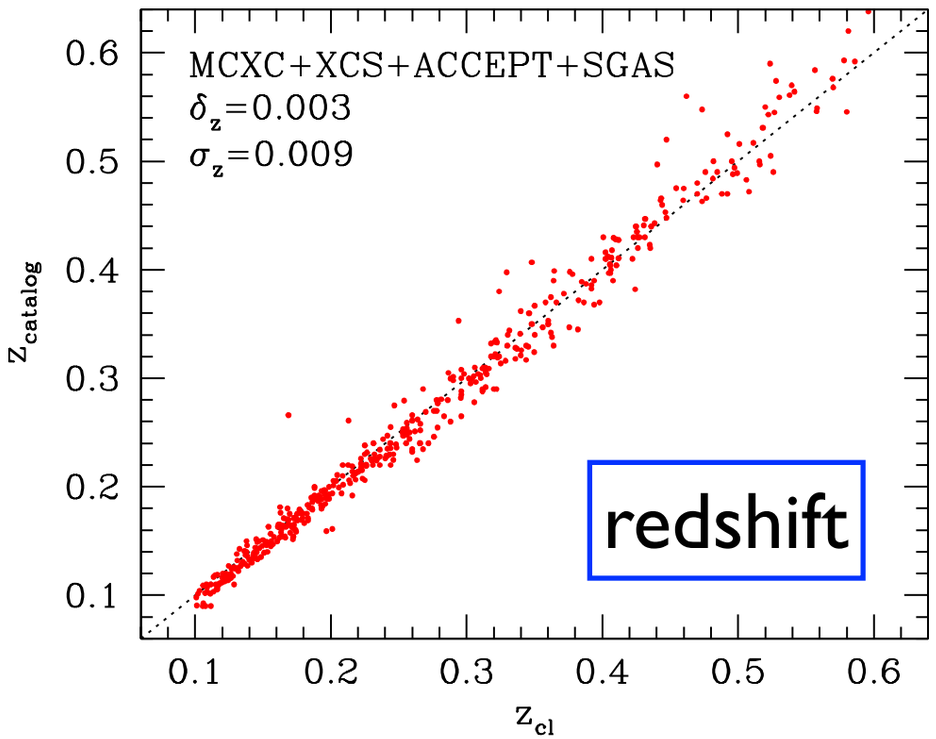
- tight color-magnitude relation for member galaxies (red-sequence) → find clusters & derive photo-z's

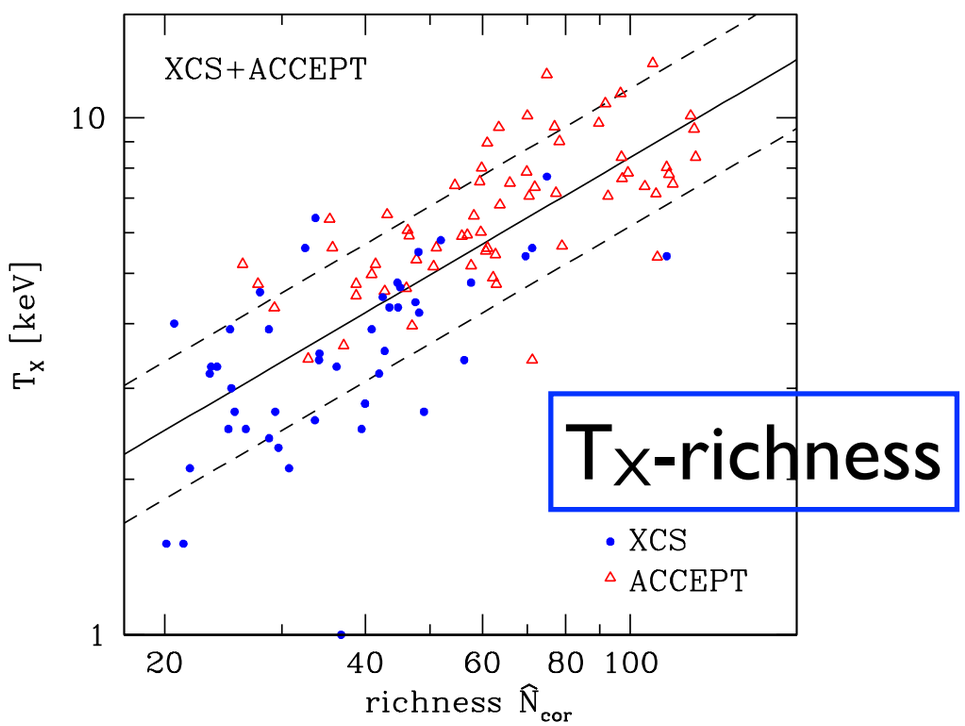
Optical cluster finder: CAMIRA

- "red-sequence" cluster finder with arbitrary set of filters
- fit all photometric galaxies with SPS model (BC03) to derive likelihood of being cluster members as a function of redshift
- construct a 3D richness map to find clusters as peaks in the map

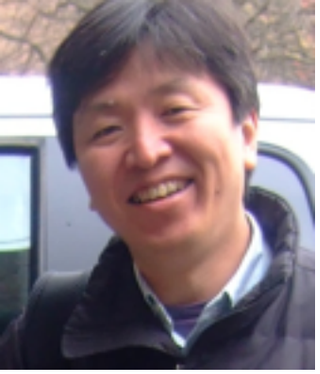
Oguri MNRAS 444(2014)147

CAMIRA SDSS DR8 catalogue



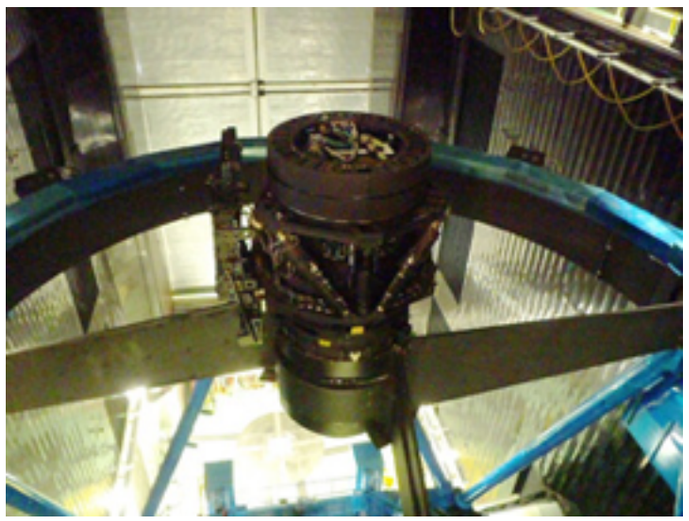


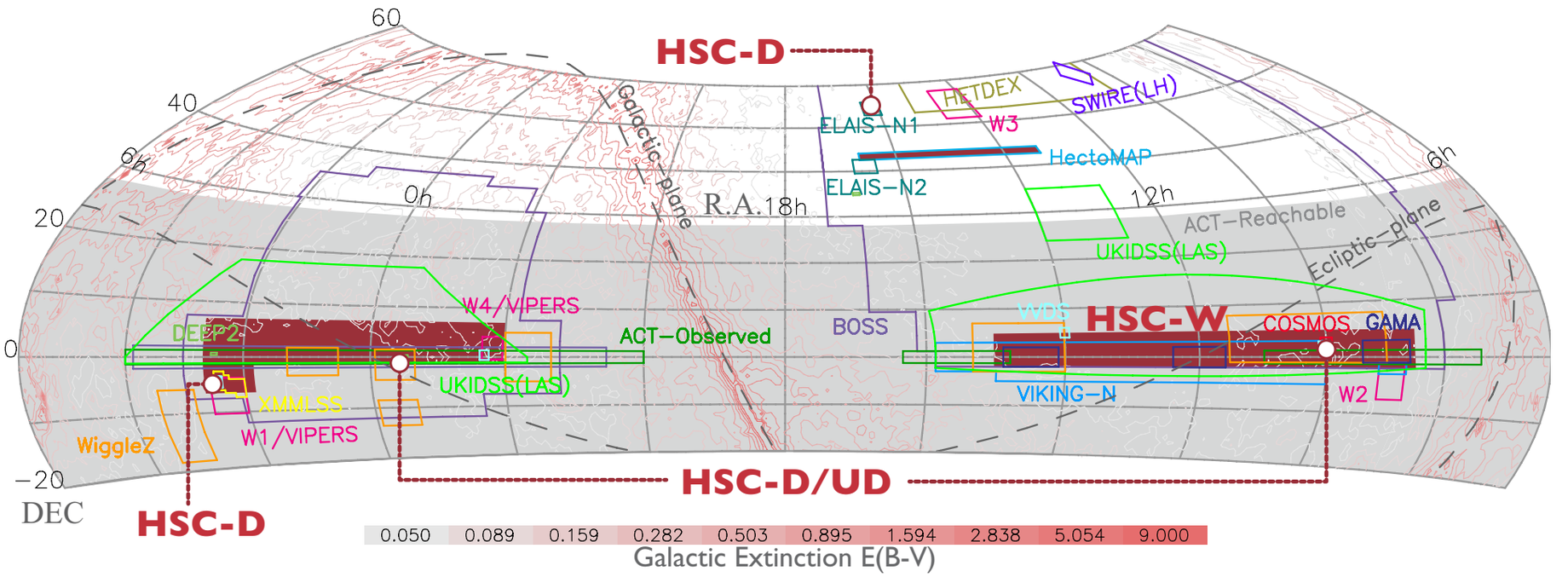
- applied this method to SDSS DR8 data
- 0.1<z<0.6, N>20, ~70,000 clusters from ~10,000 deg^2 (catalog publicly available)
- performance comparable to redMaPPer



PI: Satoshi Miyazaki (NAOJ)

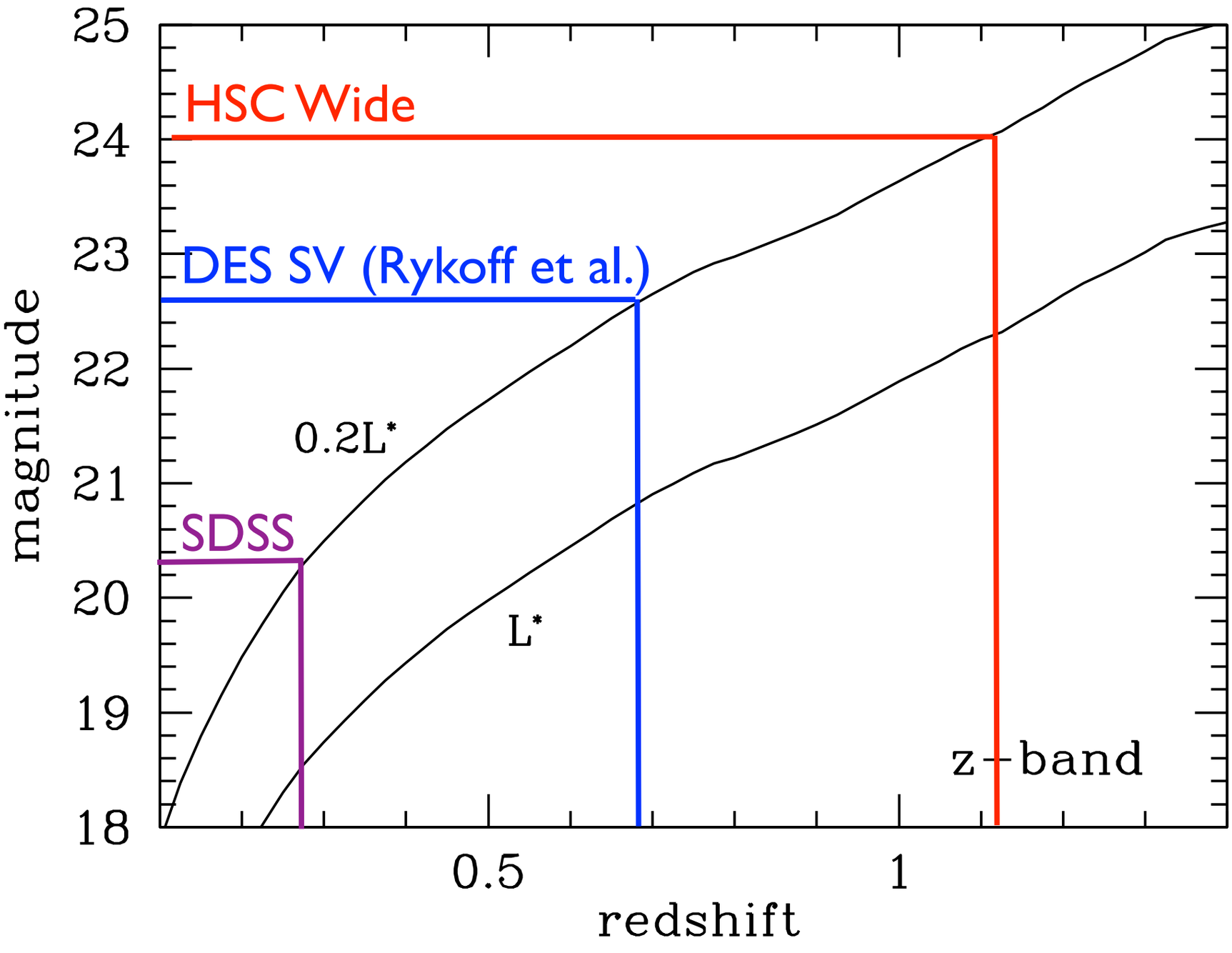
Hyper Suprime-Cam (HSC)





- new wide-field (1.7 deg^2) camera at Subaru telescope
- 3-layer survey (2014-2019?) see also Masayuki Tanaka's talk
  - Wide (1400 deg^2, r_{lim} ~ 26, grizy)
  - Deep (27 deg^2, r_{lim} ~ 27, grizy+3NBs)
  - Ultra-Deep (3.5 deg^2, r_{lim} ~ 28, grizy+3NBs)

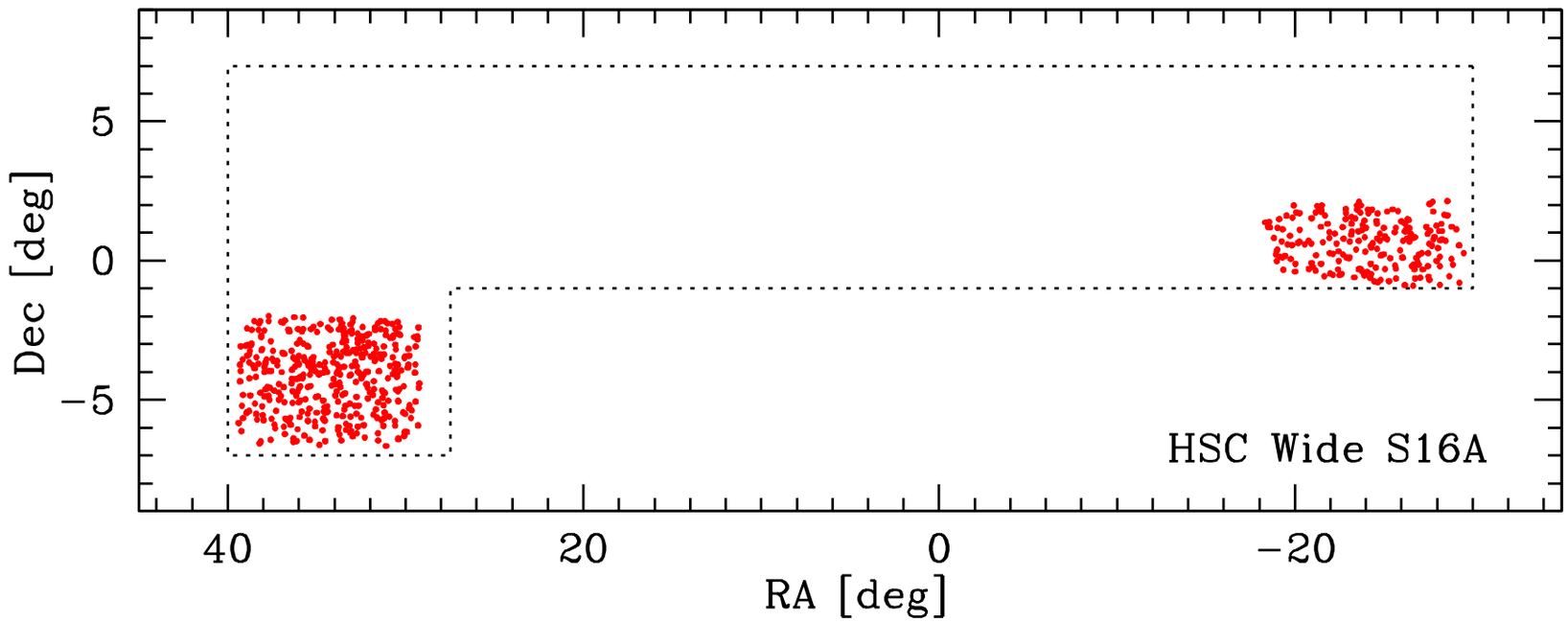
The power of HSC survey

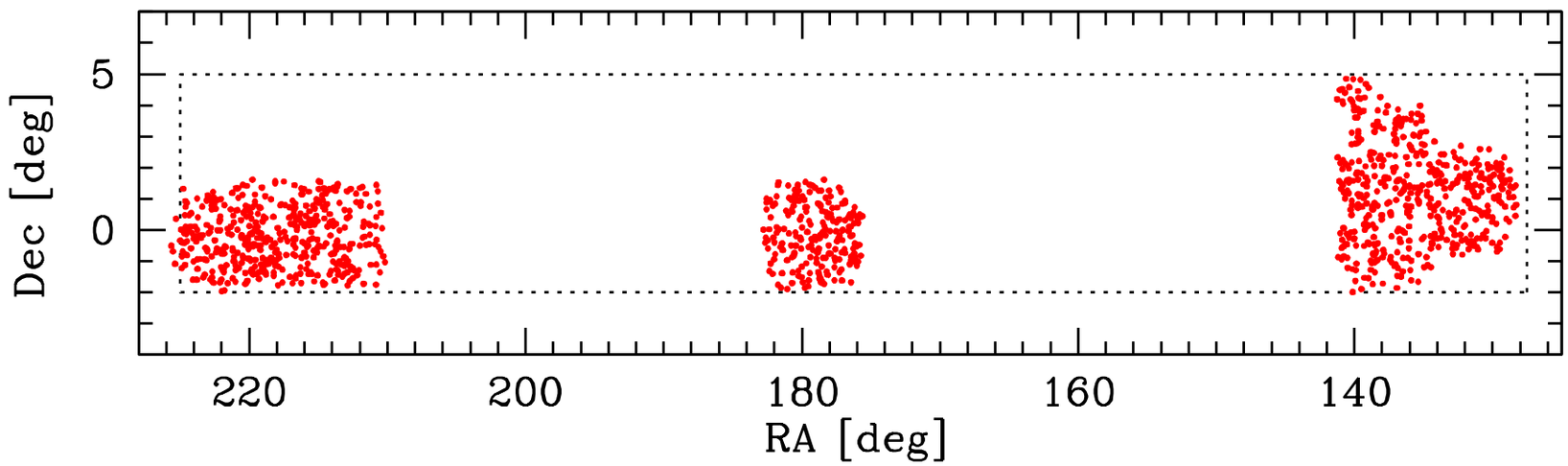


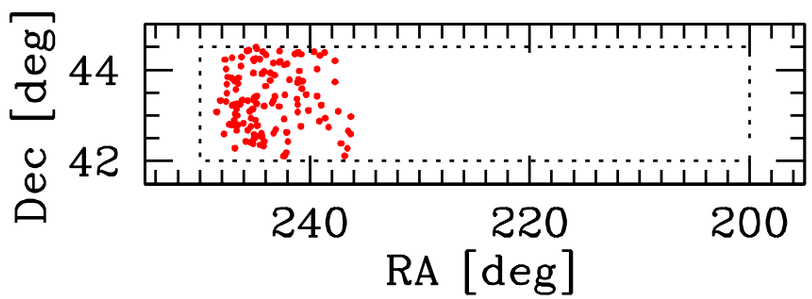
all members (>0.2L*) out to z~1.1!

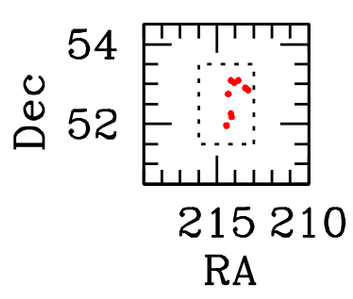
Oguri et al., in prep.

CAMIRA HSC cluster catalogue





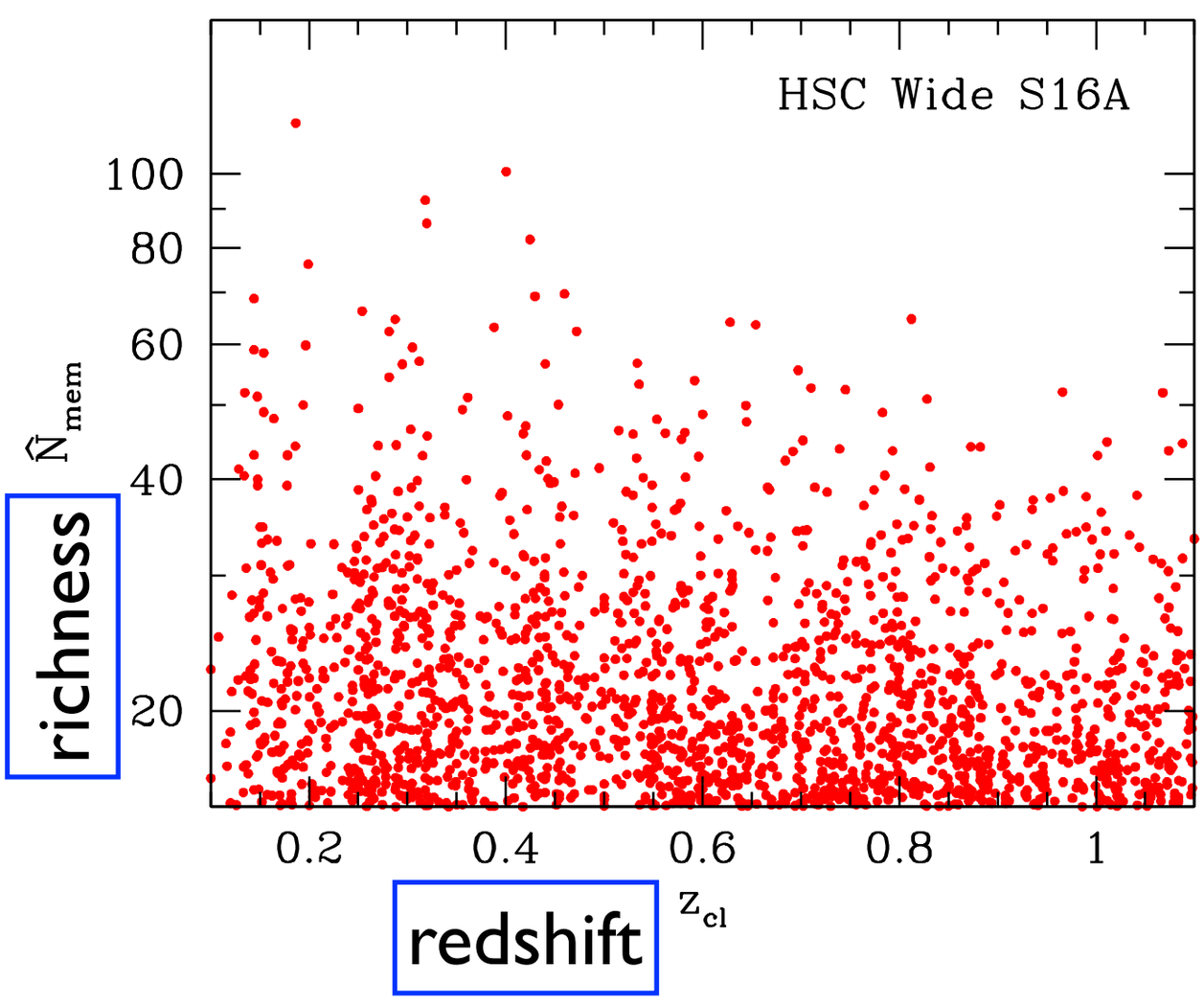


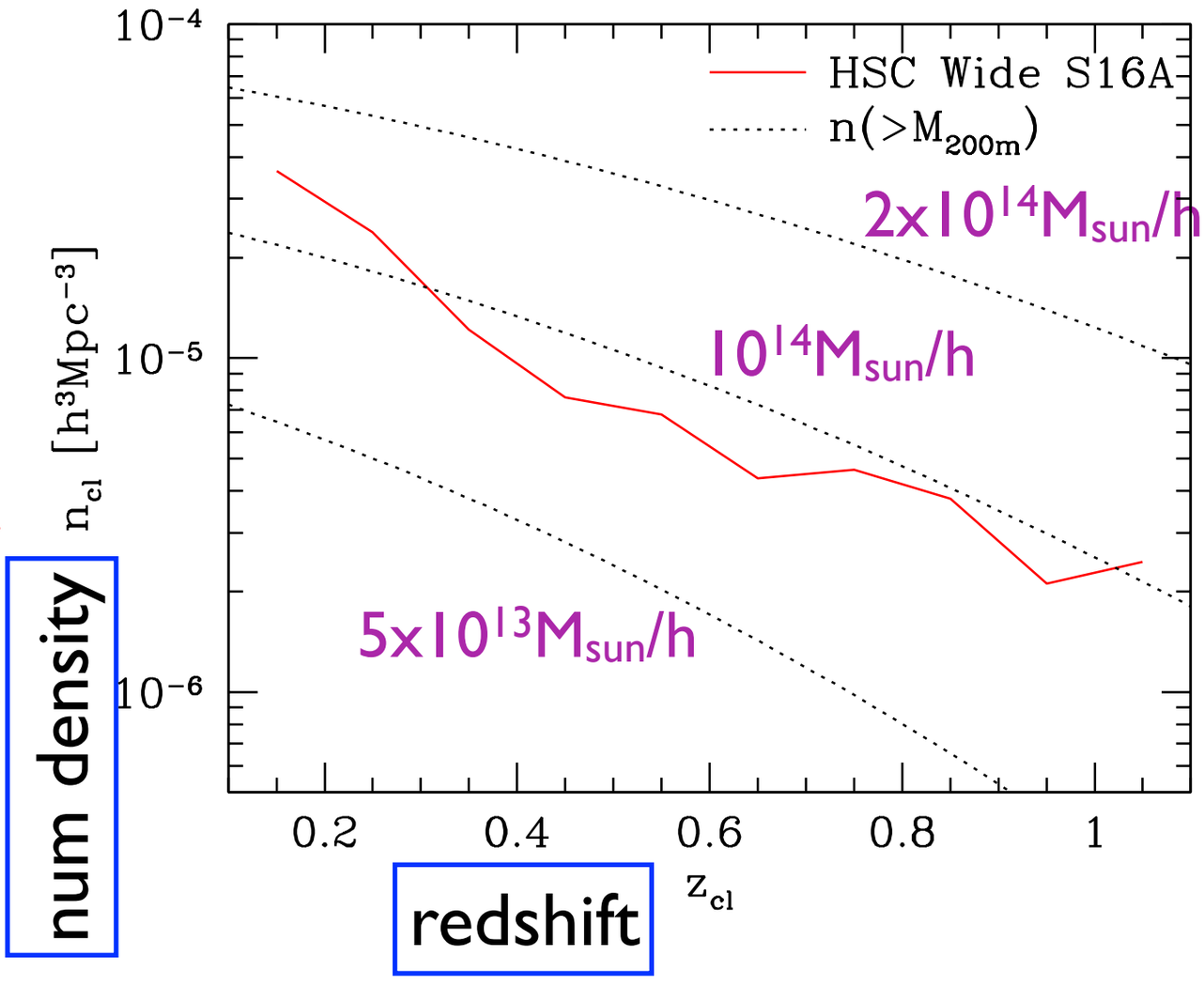


- clusters from internal release of HSC data (S16A) covering ~232 deg^2

Oguri et al., in prep.

CAMIRA HSC cluster catalogue





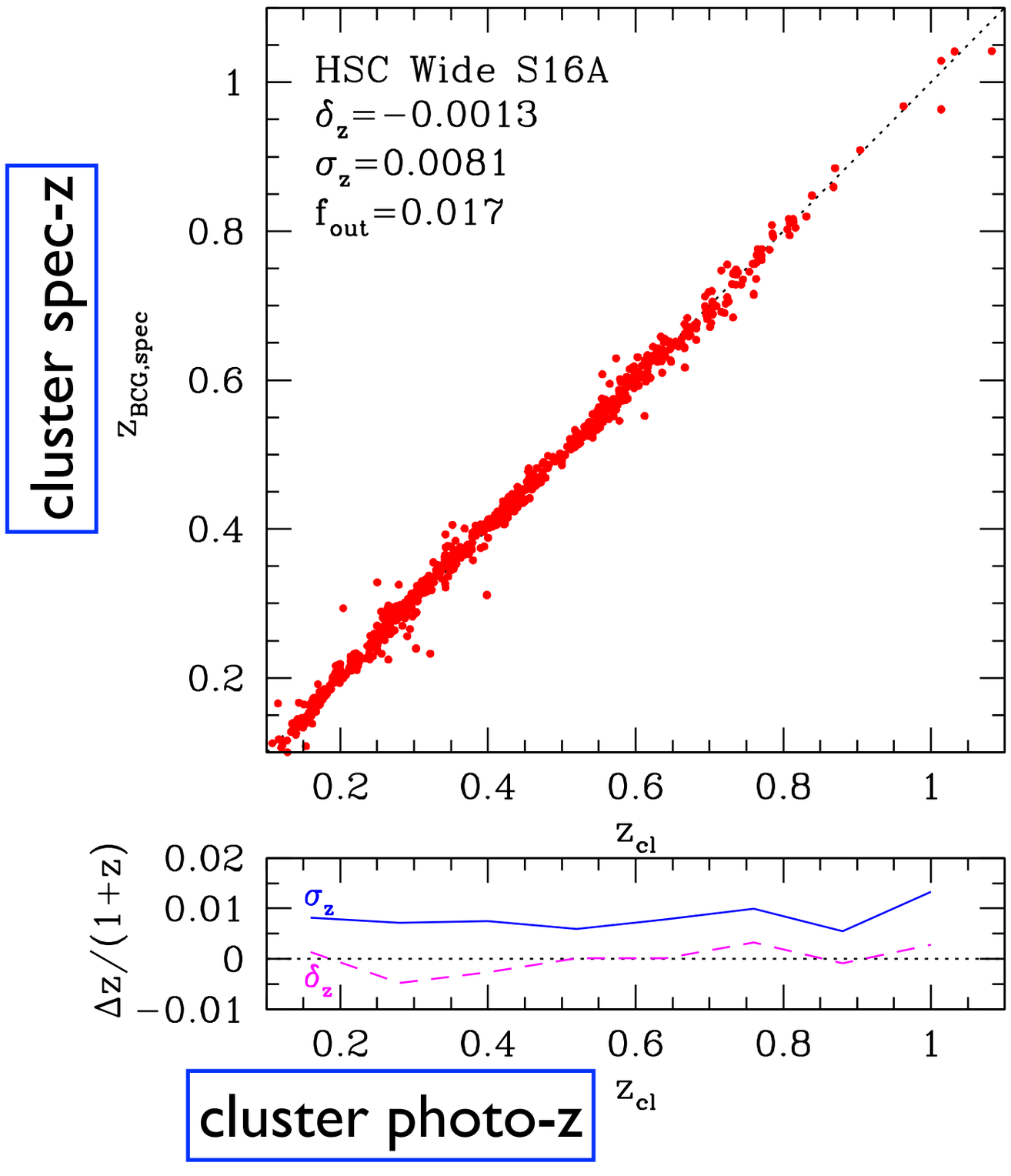
- 1921 clusters with N>15 at $0.1<z_{cl}<1.1$
- N=15 → $M\sim10^{14}M_{sun}/h$

N=64.7 z=0.812

N=43.6 z=1.074

Oguri et al., in prep.

Photometric redshift accuracy

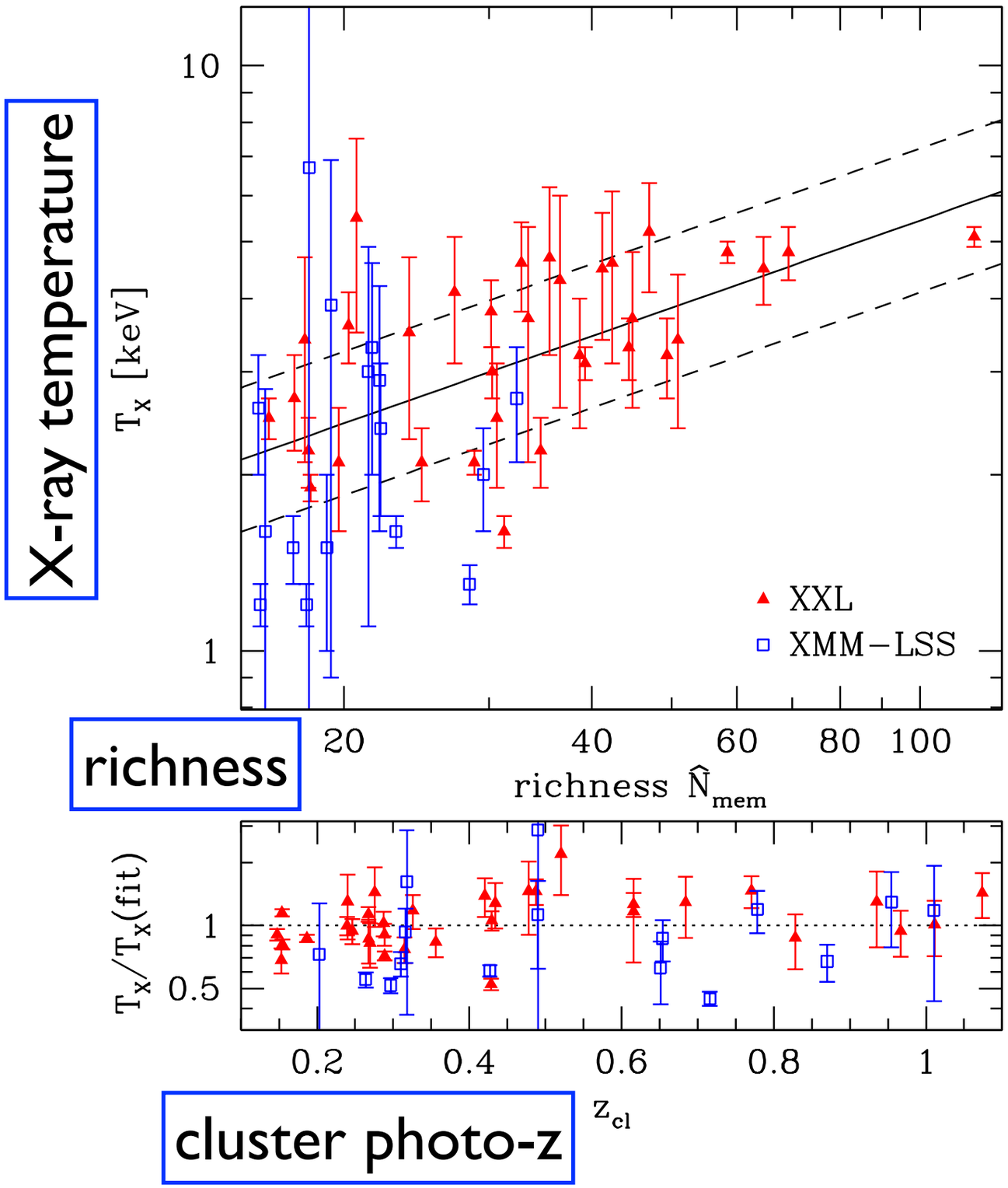


- comparison with spec-z of BCGs
- accurate photo-z: $(z_{cl}-z_{spec})/(1+z)$

bias	−0.0013
scatter	0.0081
$f_{outlier}$	0.017

(use 4σ clipping)

X-richness correlation

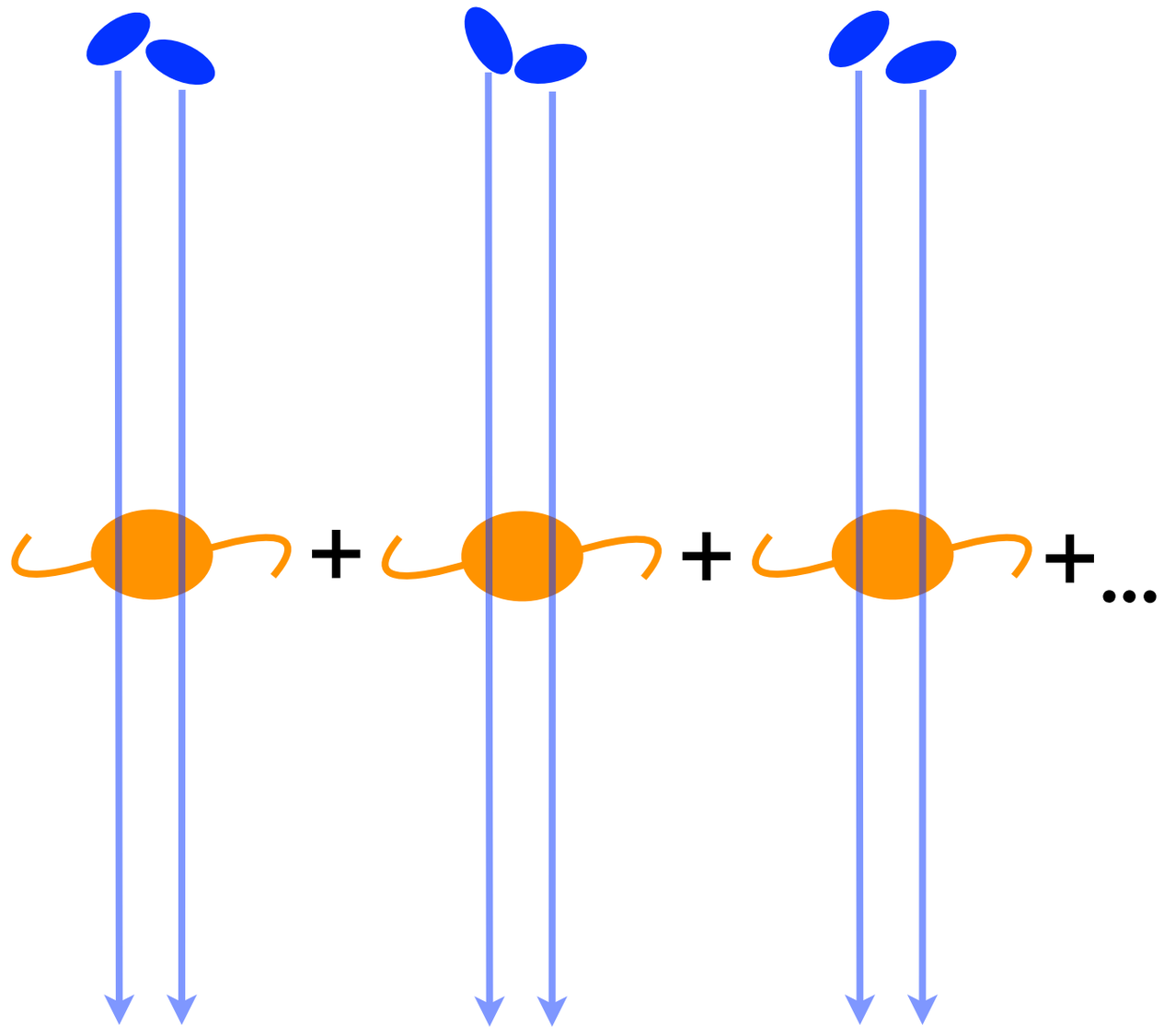


- comparison with X-ray clusters from XXL and XMM-LSS
- richness correlates well with X-ray properties!
- small intrinsic scatter of 0.12 comparable to SDSS CAMIRA and redMaPPer results

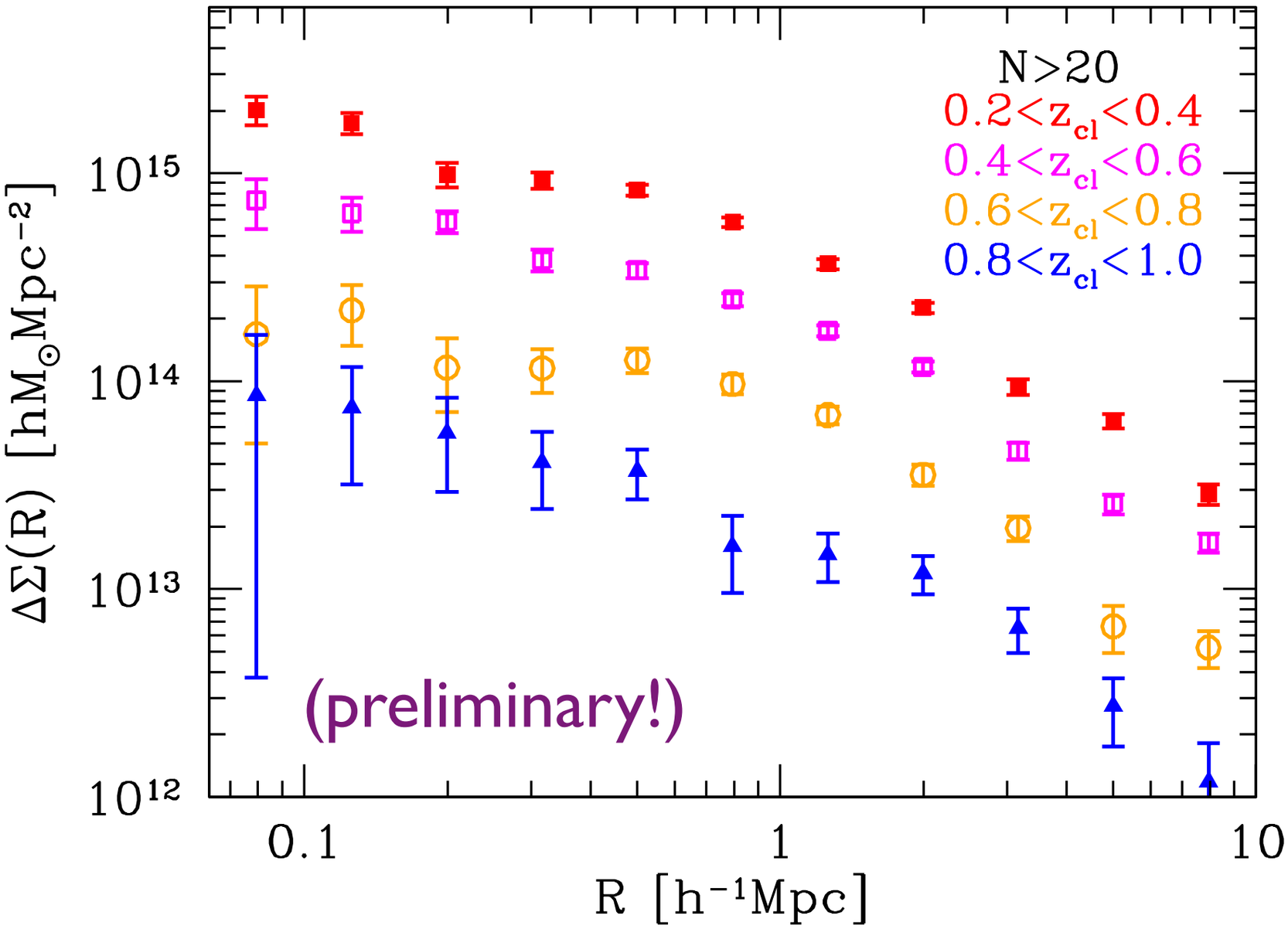
Mass calibration: stacked lensing

- much higher S/N by stacking WL for many clusters
- accurate *average* mass profile of a sample of clusters

(e.g., Oguri & Takada 2011)



HSC stacked weak lensing signals



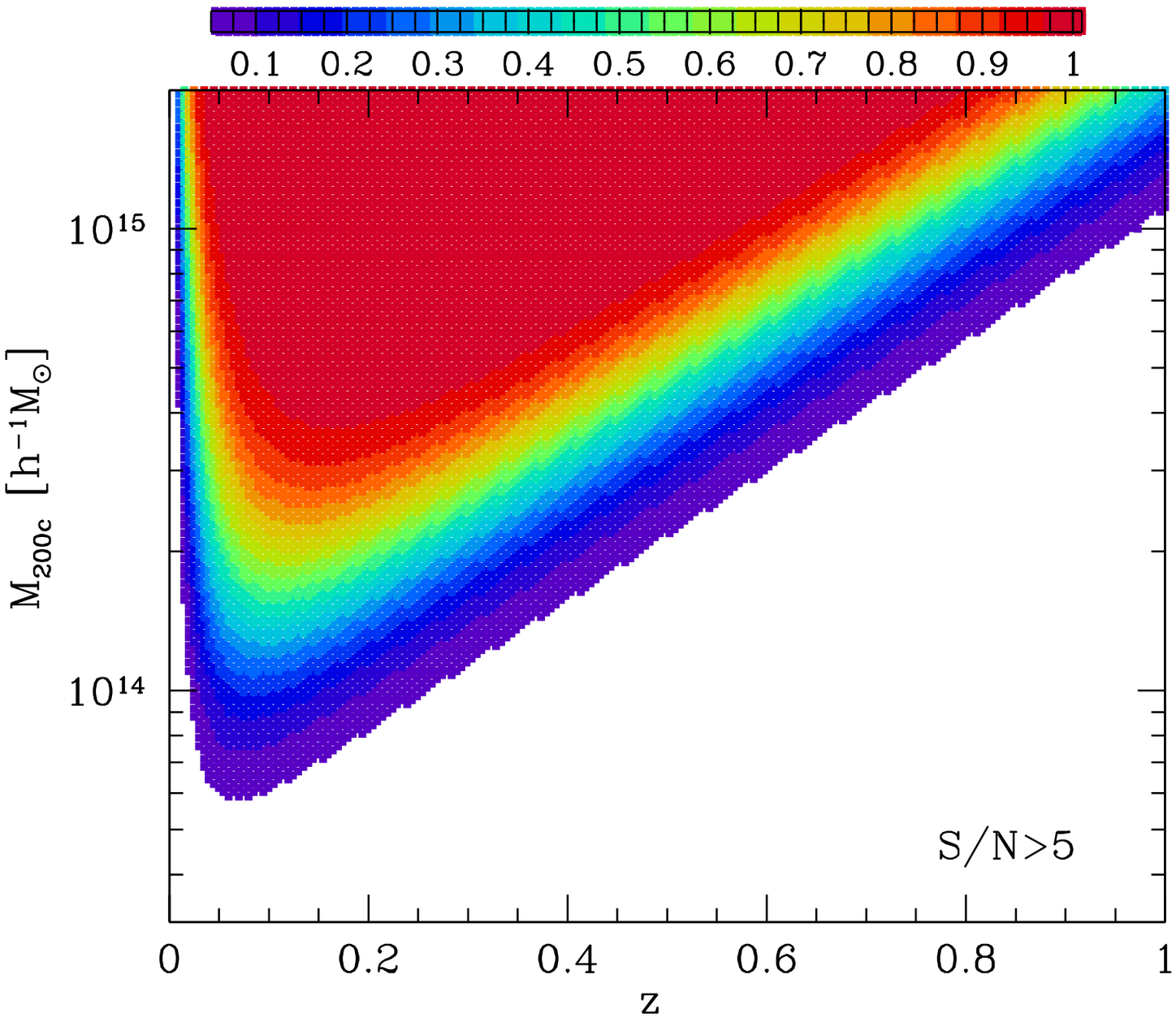
- photo-z PDF included
- background gal. selection for eliminating dilution effect

- significant detection even at z~1!
  → accurate mass calibration

Weak lensing selected clusters

- direct reconstruction of mass distributions with weak lensing is possible (Kaiser & Squires 1993)
- clusters from peaks of mass maps
- totally different from traditional cluster finding (no baryon info)

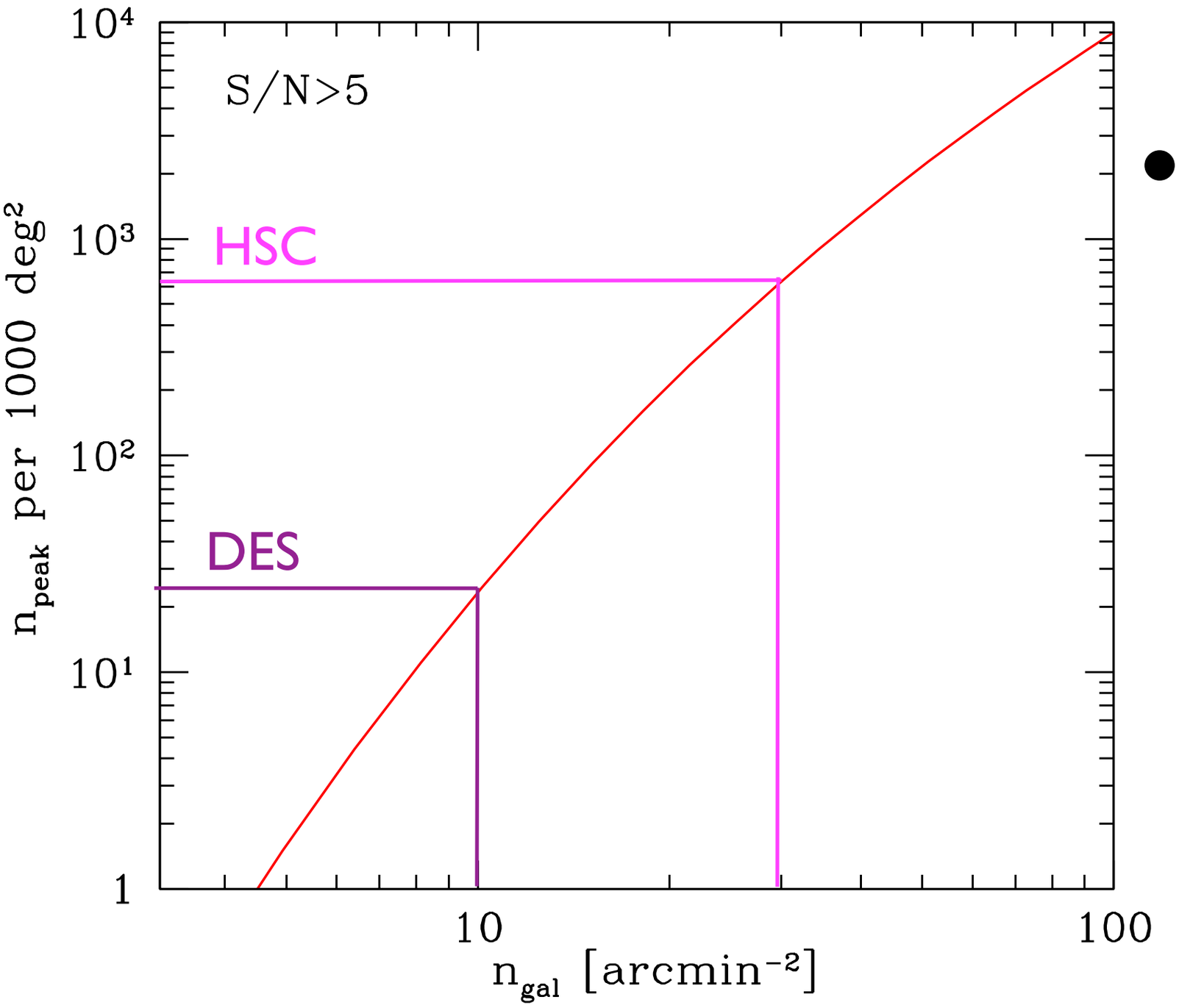
Selection function



(assuming HSC-like survey)

- selection function of WL-selected cluster can be derived easily and accurately
- selection bias, e.g., orientation bias (Hamana, Oguri+ 2012) can also be derived accurately

Importance of n_{gal}

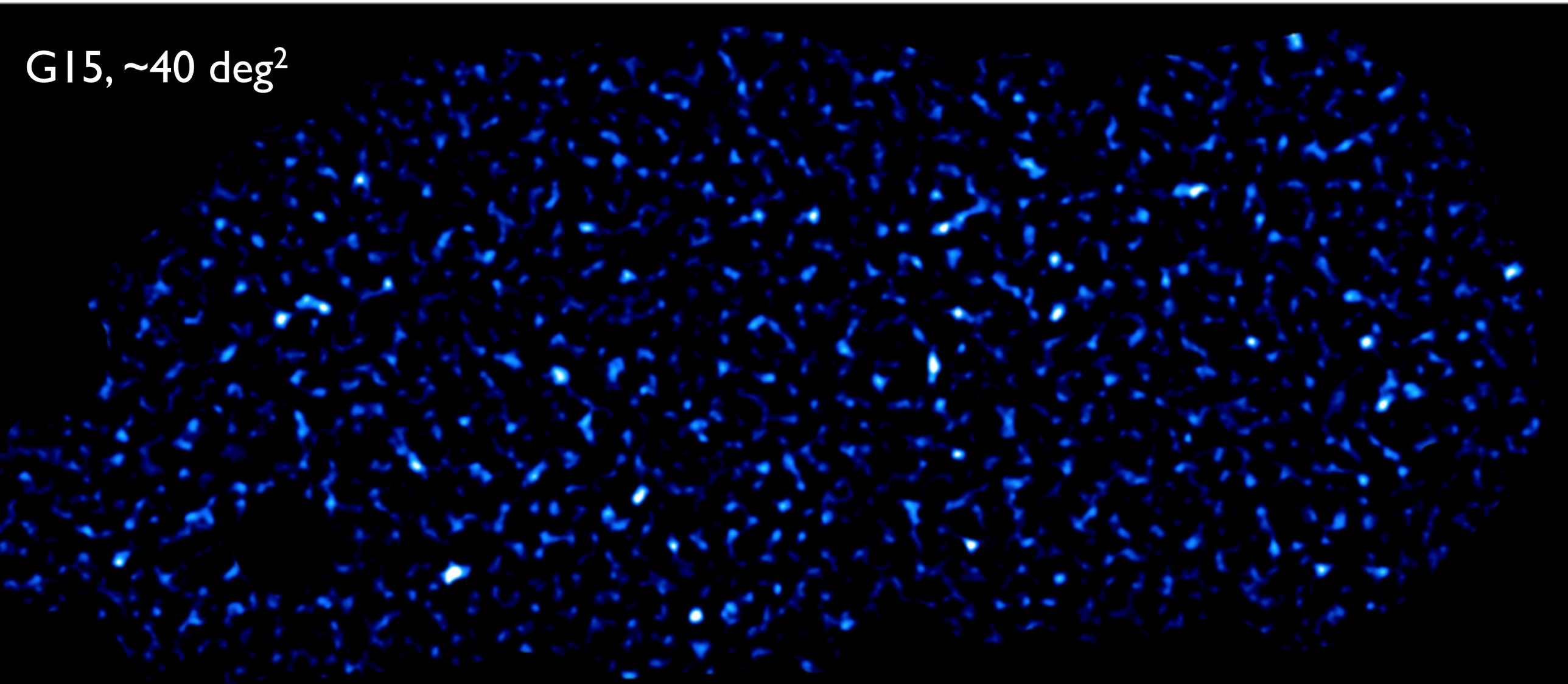


- high galaxy number density of HSC is crucial for mass-selected clusters

w/ Satoshi Miyazaki, Takashi Hamana (NAOJ), et al.

WL-selected clusters in HSC

- ~100 mass-selected clusters with S/N>5 from weak lensing of ~200 deg^2 HSC Wide images



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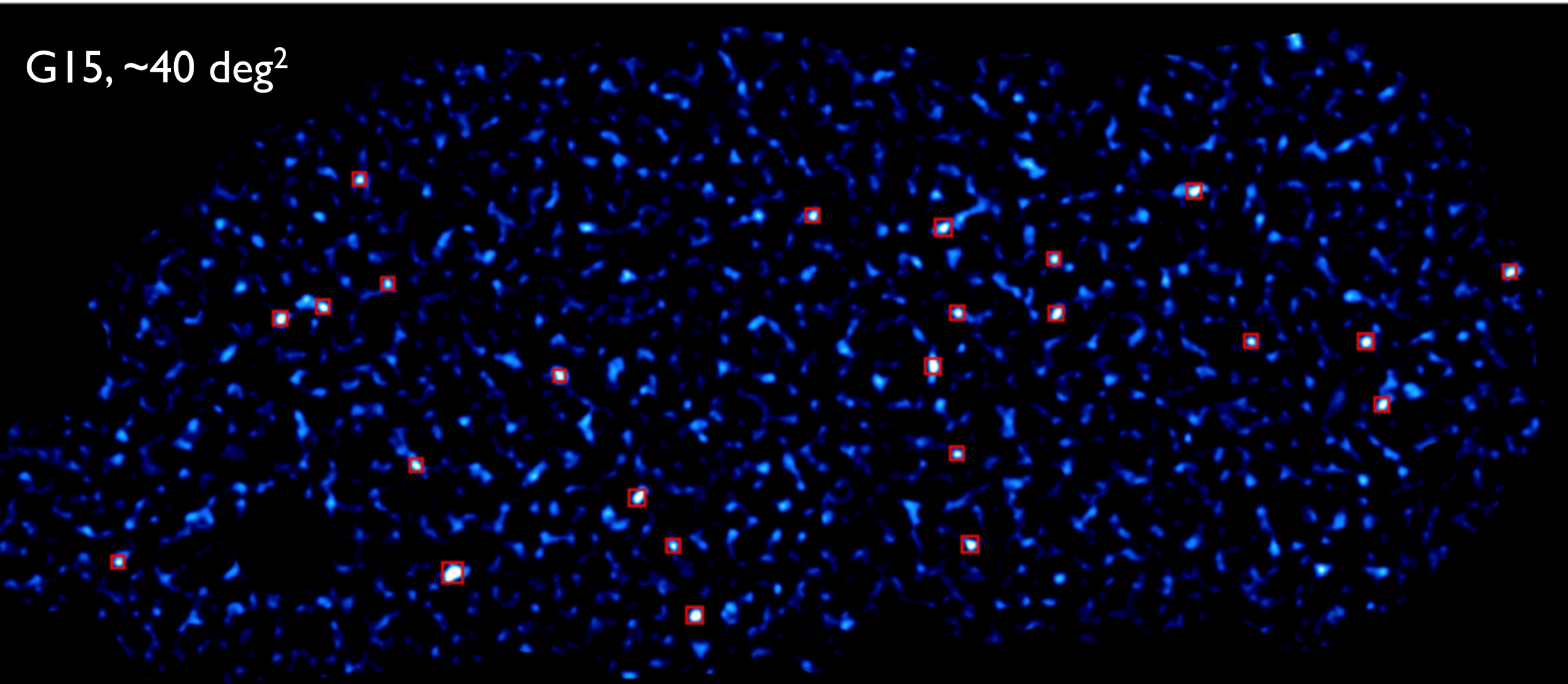

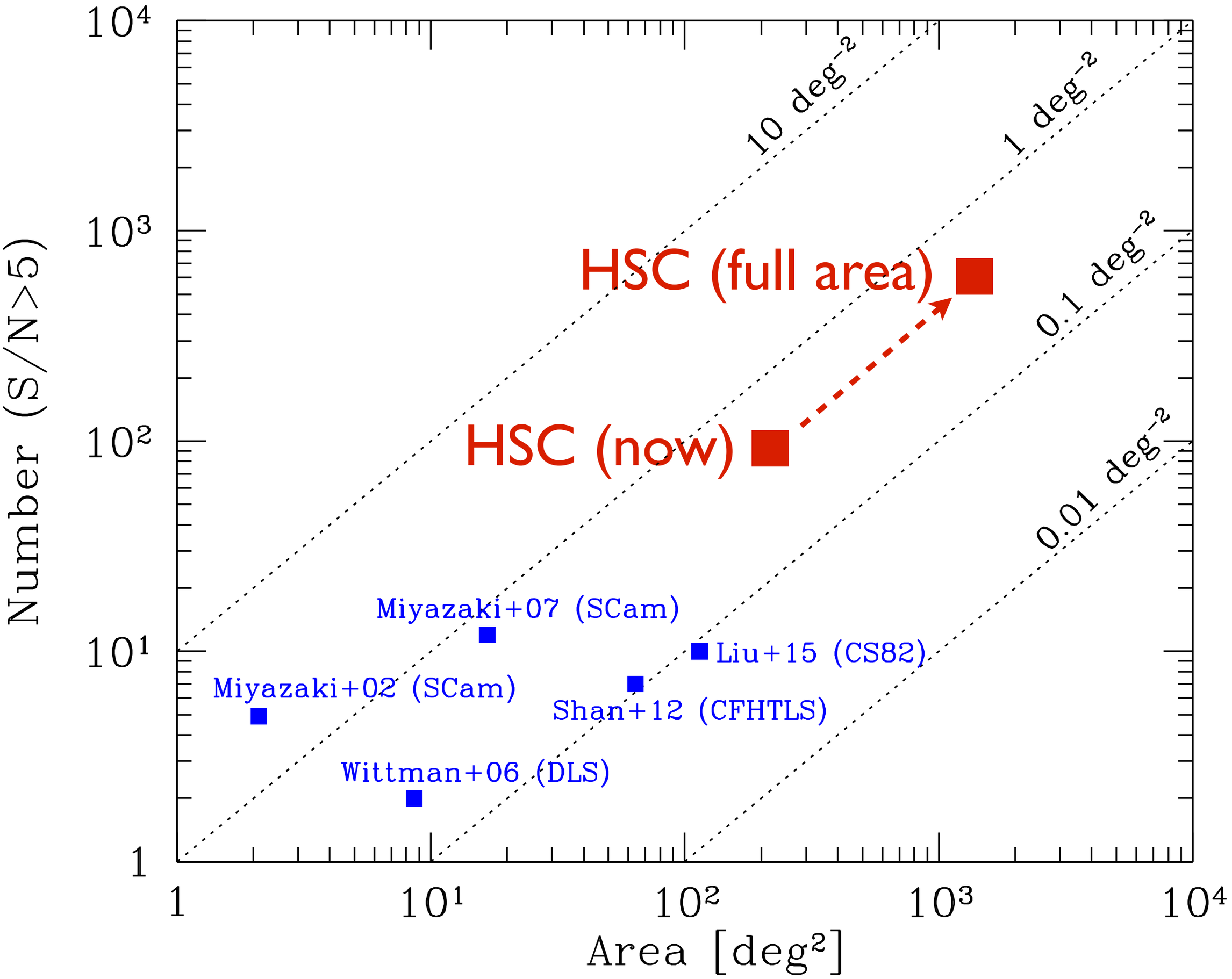
Number (S/N>5)
Area [deg²]
10 deg⁻²
1 deg⁻²
0.1 deg⁻²
0.01 deg⁻²
HSC (full area)
HSC (now)
Miyazaki+07 (SCam)
Liu+15 (CS82)
Miyazaki+02 (SCam)
Shan+12 (CFHTLS)
Wittman+06 (DLS)
1
10¹
10²
10³
10⁴

Summary

- HSC survey is powerful for cluster studies!
- optical clusters are identified successfully out to z~1.1
- masses of these optical clusters are calibrated using stacked weak lensing
- first large sample of mass-selected clusters from weak lensing maps is being constructed