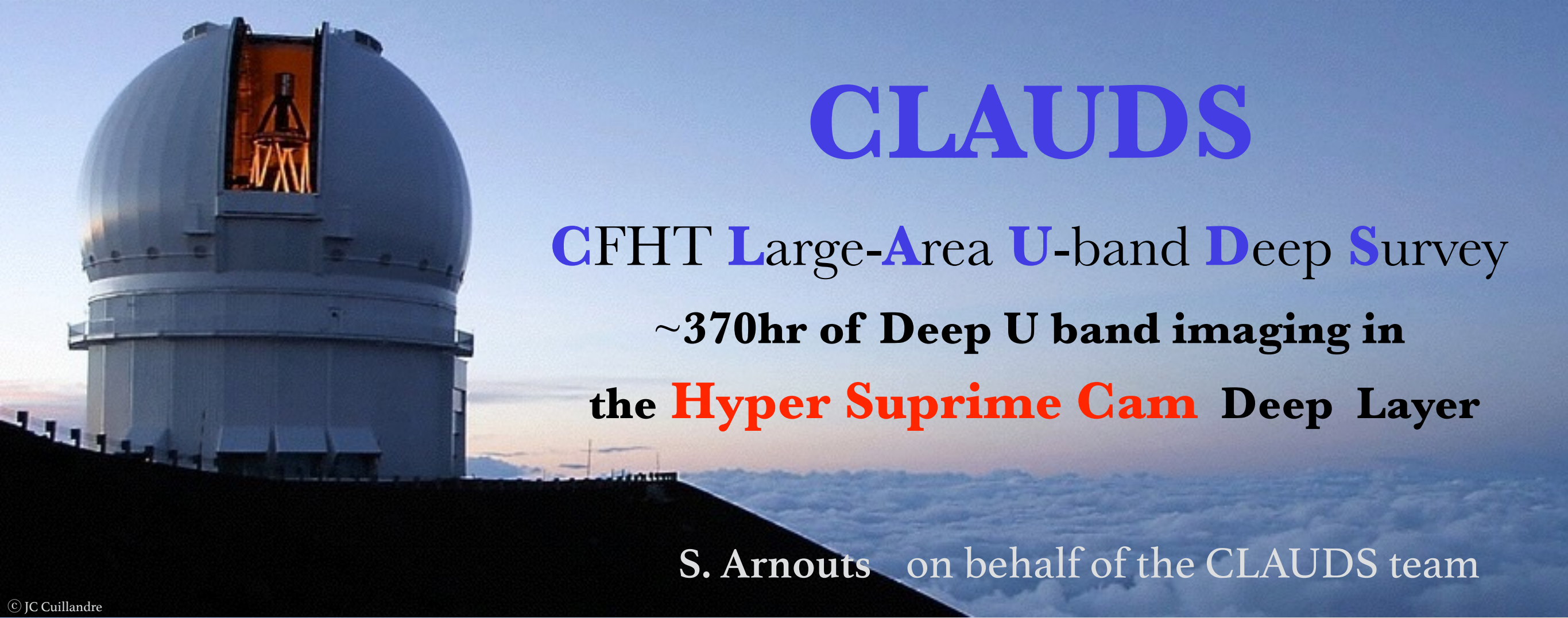




CLAUDS

CFHT **L**arge-**A**rea **U**-band **D**eep **S**urvey
~370hr of Deep U band imaging in
the **Hyper Suprime Cam** Deep Layer

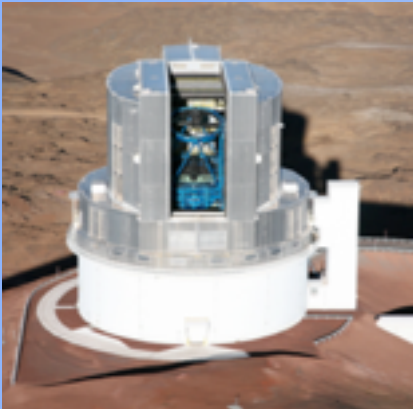
S. Arnouts on behalf of the CLAUDS team

© JC Cuillandre

based on PI programs

co-PIs	
<u>China</u>	Jiasheng HUANG (Sebastien FOUCAUD)
<u>Canada</u>	Marcin SAWICKI
<u>France</u>	Stéphane ARNOUTS

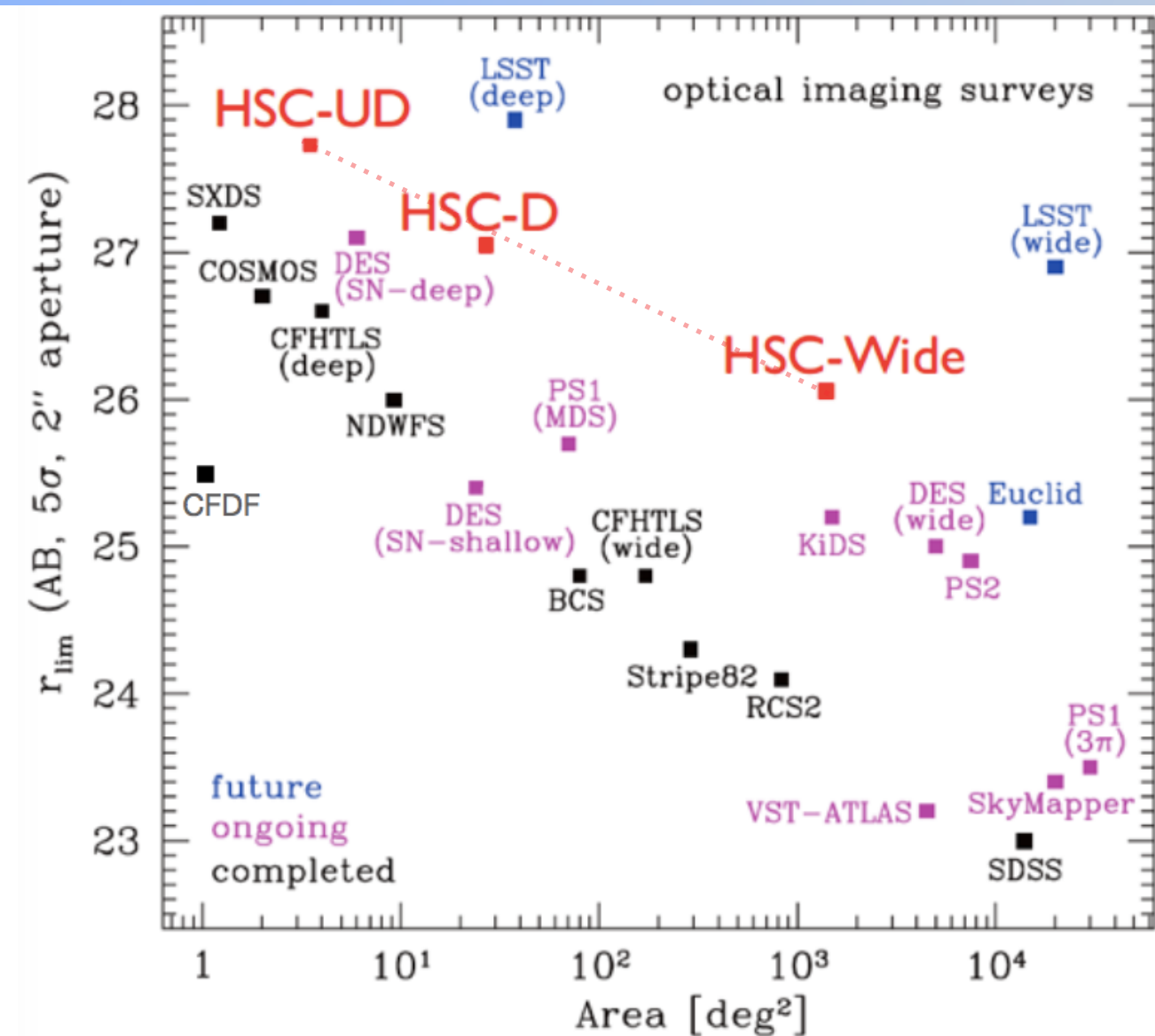
co-Is	
<u>Shangai</u>	Jing Y., Yang X., Li C.
<u>Japan</u>	Yamada T., Bundy K., Iwata I., Matsuda Y., Nagao T., Ouchi M., Shimasaku K., Silverman J., Tanaka M.
<u>Canada</u>	Balogh M., Chapman S., Gwyn S., Willott C., Yee H.
<u>France</u>	Ilbert O., Le Fèvre O., de La Torre S., Tresse L., Moutard T,
<u>Suisse</u>	Coupon J., Desprez G.



The HSC Survey & CLAUDS



HSC Subaru Science Program: 3 Surveys in 5 years



Wide: 1400° in grizY (r~26)

- cosmology: DE with WL + clusters + clustering

Deep: 27° in grizY+3 NBs (r~27)

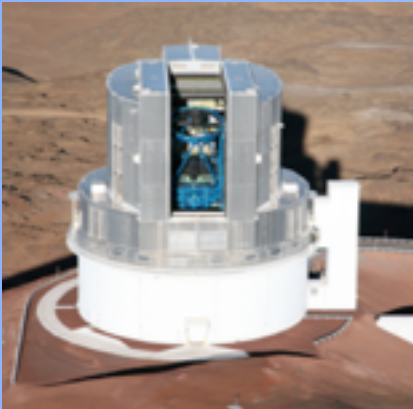
- galaxy evolution: Stellar Mass assembly, environment, quenching mechanism, ...

Ultra Deep: 3.5° in grizY+3 NBs (r~28)

- cosmology: SNIe up to $z \sim 1.4$

- galaxy evolution: reionisation

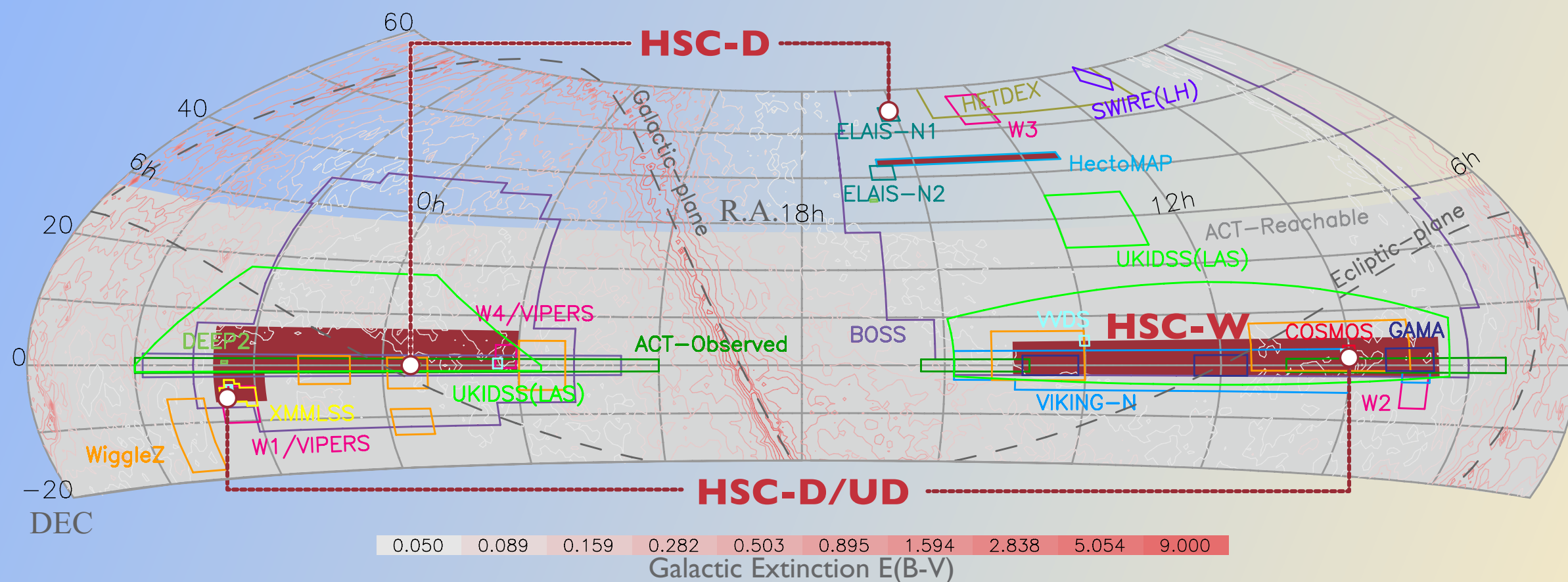
— started in March 2014



The HSC Survey & CLAUDS



HSC Subaru Science Program: 3 Surveys in 5 years



Wide Survey:

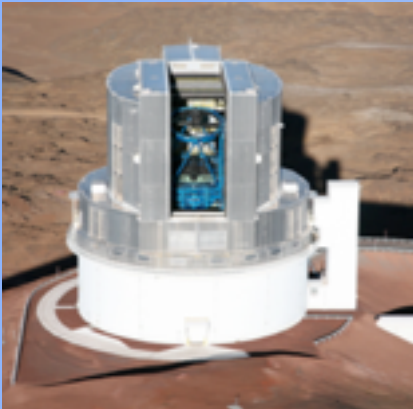
Spring & Autumn equatorial stripes

Deep Survey:

XMM-LSS, E-COSMOS, ELAIS-N1, DEEP2-3

Ultra Deep Survey:

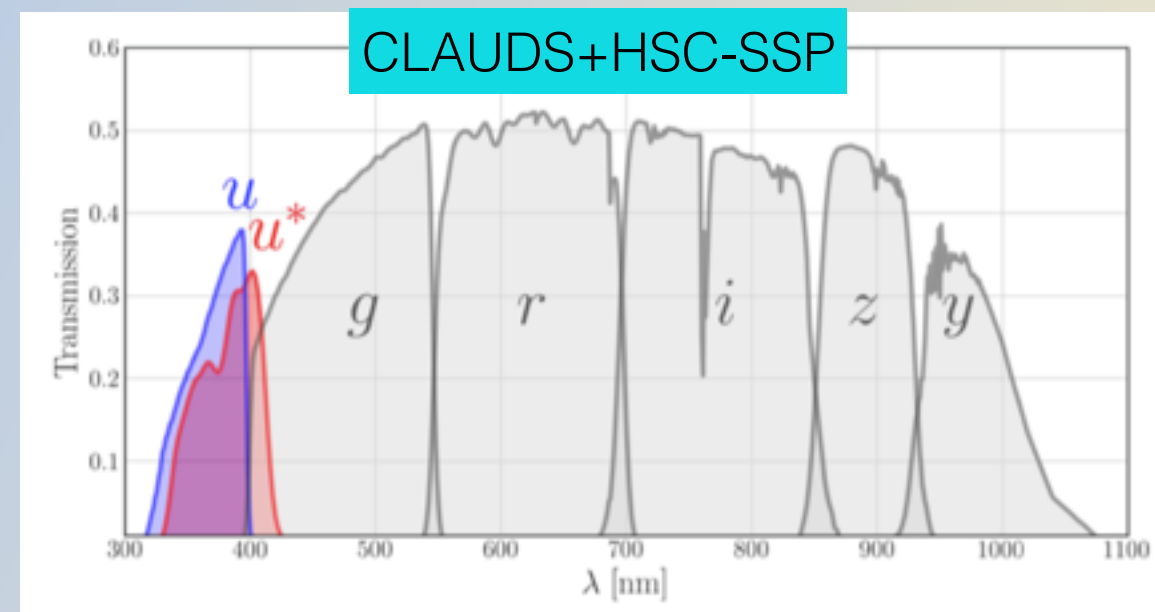
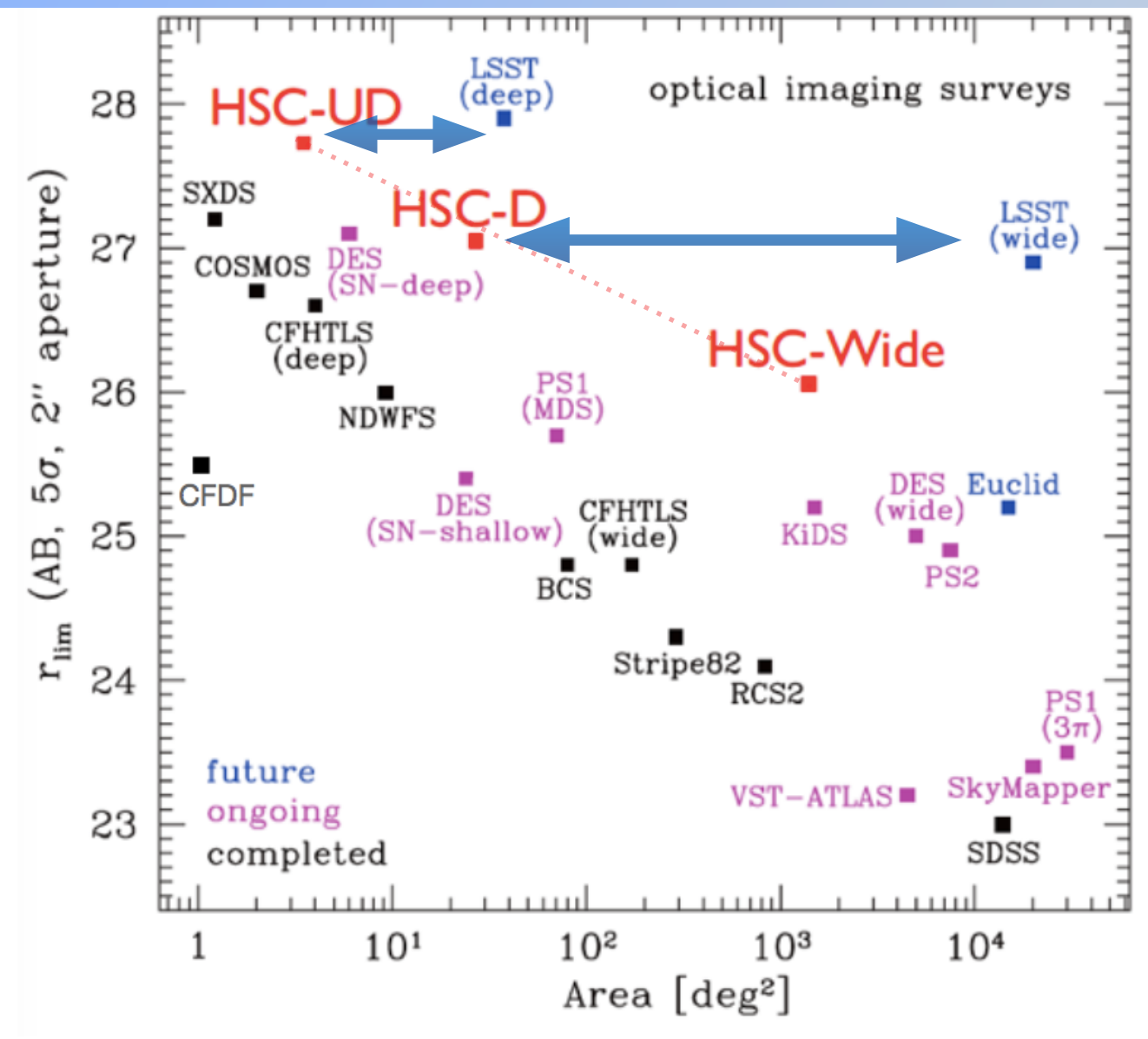
SXDS (in XMM-LSS) + COSMOS



The HSC Survey & CLAUDS



HSC Subaru Science Program: 3 Surveys in 5 years

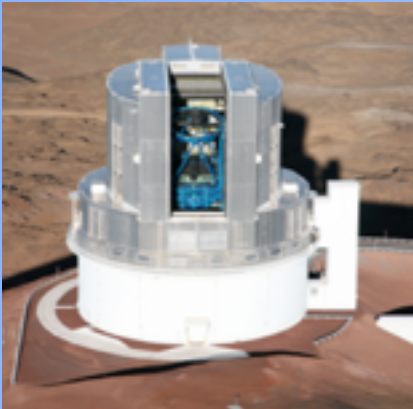


Adding Deep U band : **UgrizY**
in HSC-UD & HSC-D



**mimics LSST multiband-imaging
in depth.**

**It will be unmatched until the end of
exploitation of LSST (10yrs) !!**



The HSC Survey & CLAUDS

CLAUDS : Survey



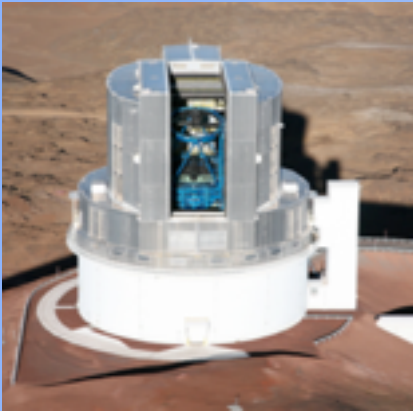
- **MegaCam on CFHT:** UV-sensitive CCDs, excellent seeing
- **Goal:** match HSC-D+UD in U-band ($\sim 27AB$, $\sim 2+18 \text{ deg}^2$)
- **PIs in the 3 agencies:** Canada + France + China
- **awarded 375 hrs = 68 DARK TIME nights with $IQ < 1.0''$**

(4 sem.: 14B - 16B)

Tex $\sim$ 16hr with the old u (us)

Tex $\sim$ 15hr with the new u

+ archival data, including MUSUBI

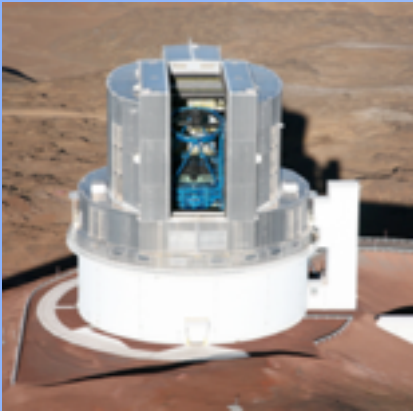


The HSC Survey & CLAUDS



CLAUDS : The need of u band in HSC Deep Survey

- a direct measurement of **rest-UV** for **SFRs** at low redshift $z < 1.5$
improved SED fitting and dust estimates
- a unique way to select **star-forming galaxies** at $2 < z < 3$
based on color techniques [BM/BX/ U-dropouts]
will probe below M_{UV}^ of the UV Luminosity Function*
- a clean selection of **LAEs** and **Ly α blobs** (with NB387) at $z \sim 2.2$
+ measurement of Ly-esc at $z > 3$
- a significant improvement of the **HSC photo-zs**
fraction of catastrophic failures , scatter at all z (critical at $z < 0.7$ & $z > 1.5$)



The HSC Survey & CLAUDS

CLAUDS : Data Processing

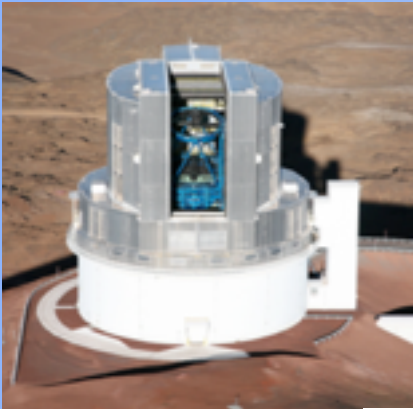


- **all the U band data in hand:** reduced, merged with HSC-SSP
- **Image processing (modified MegaPipe software)**
 - photometrically and astrometrically calibrated images in the HSC tract/patch format
- **Photometry & catalogs**
 - hscPipe u+grizy catalogs
 - SExtractor catalogs
- **Data validation**
 - tests to validate data, assess quality etc.

STEPHEN GWYN

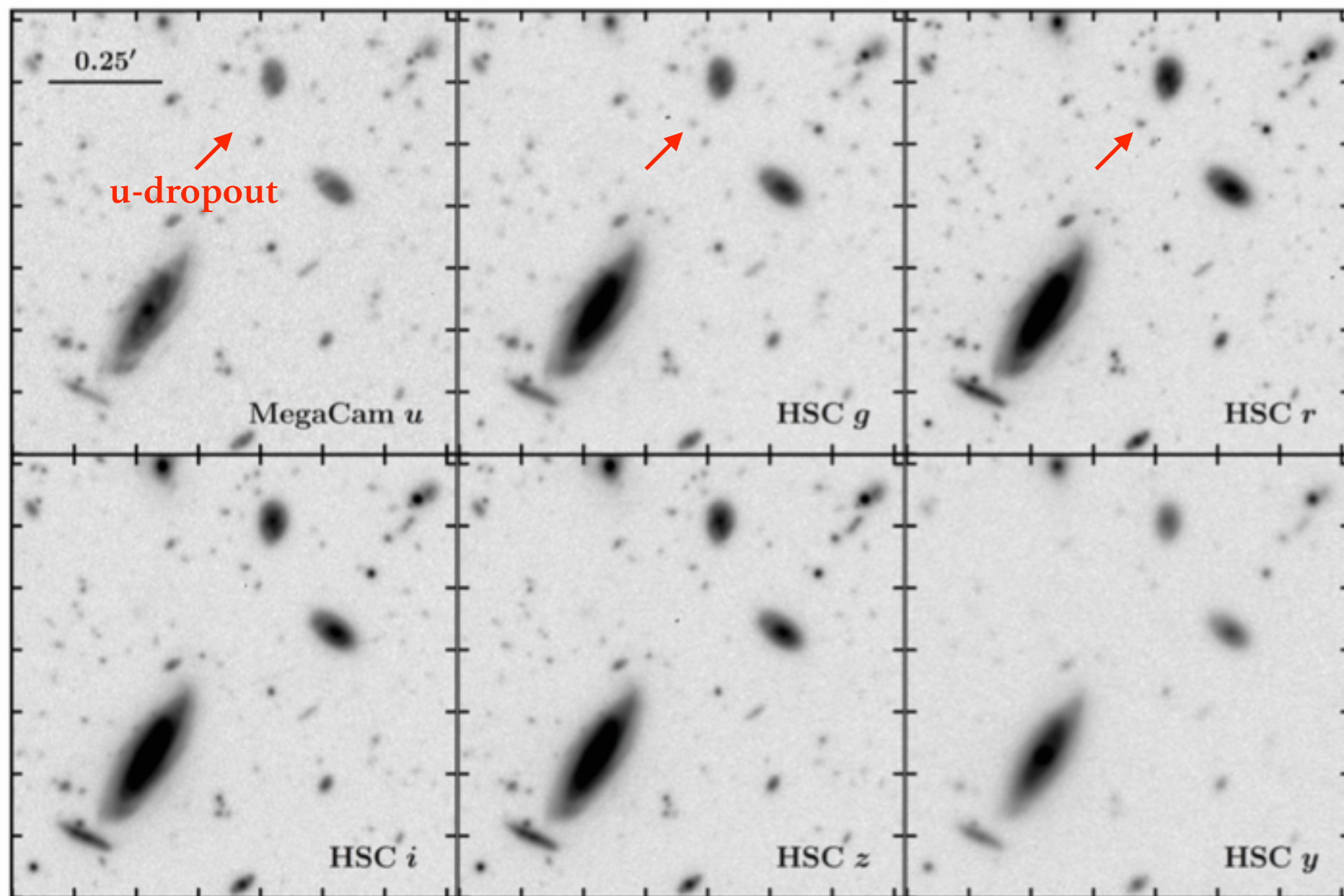
JEAN COUPON
GUILLAUME DESPREZ

ANNEYA GOLOB
THIBAUD MOUTARD
STEPHANE ARNOUTS



The HSC Survey & CLAUDS

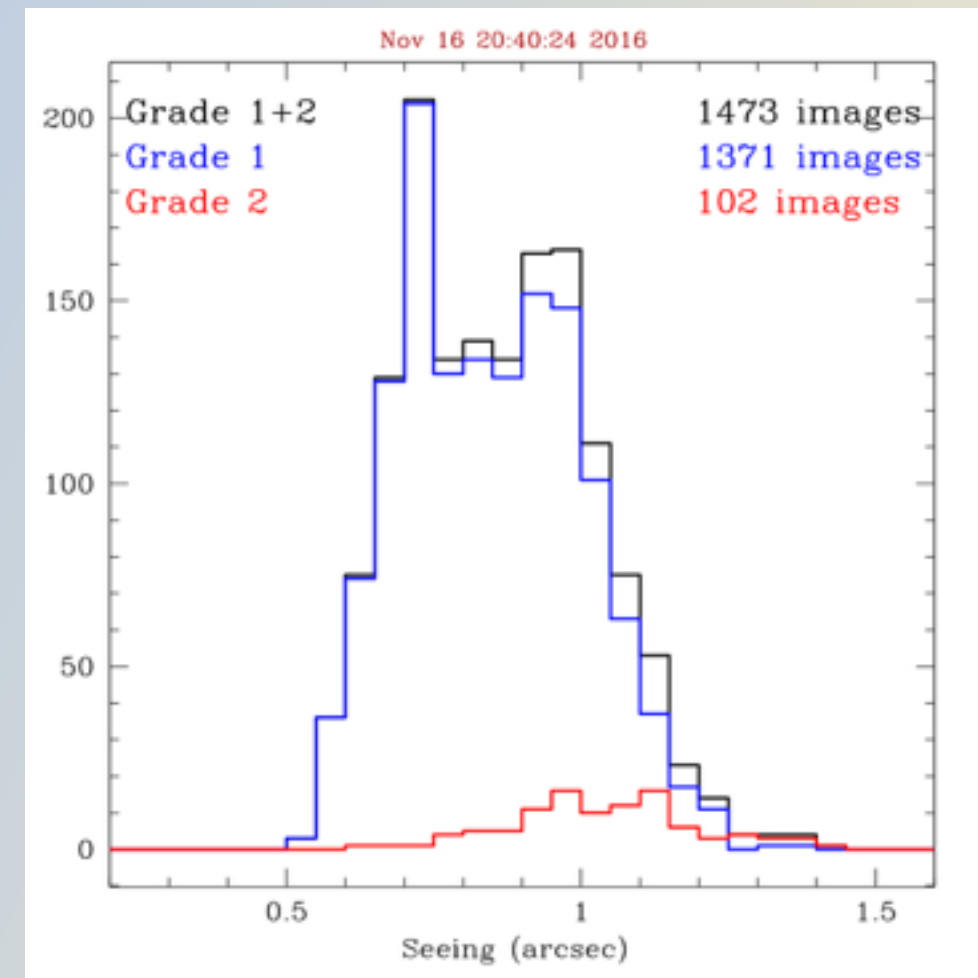
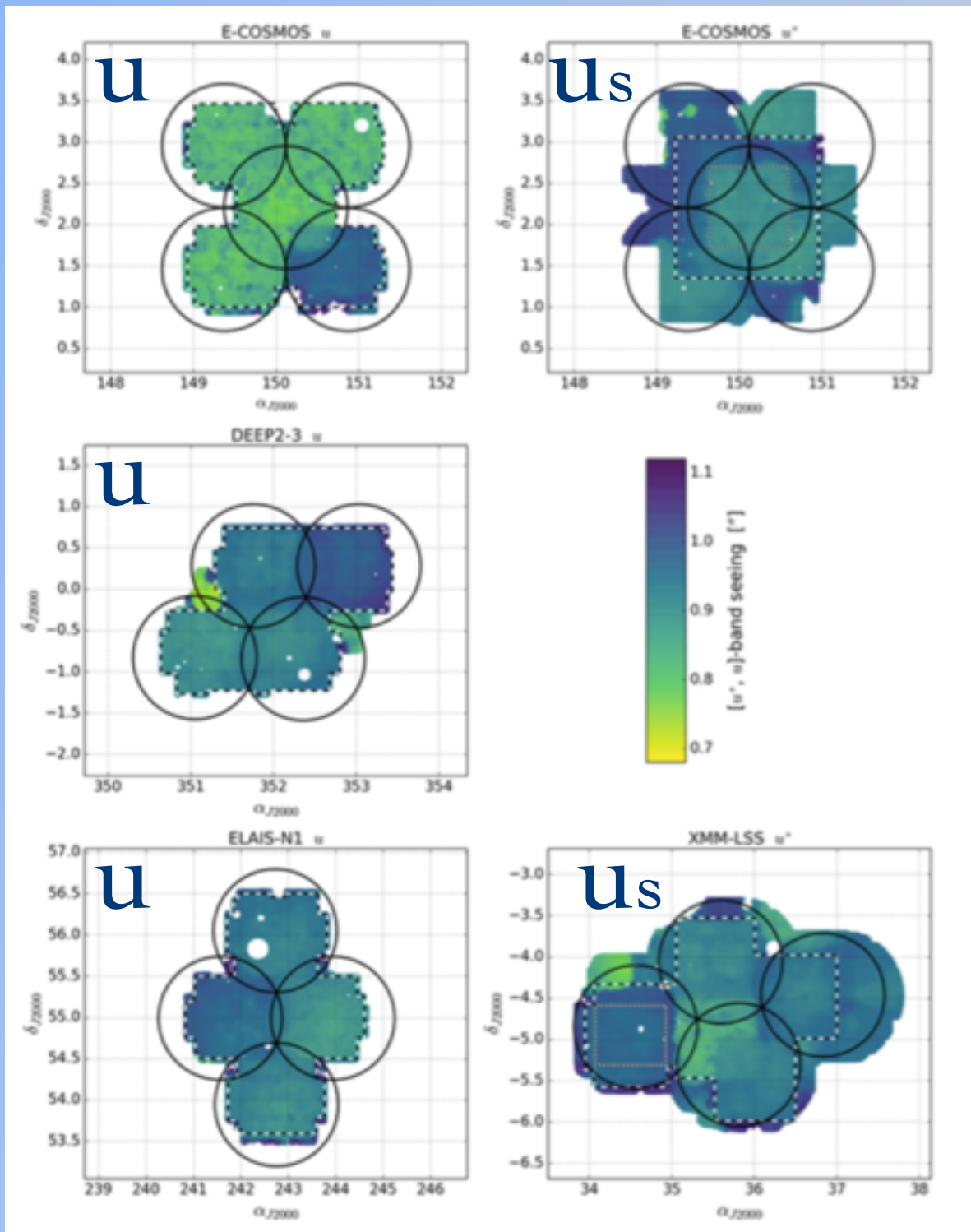
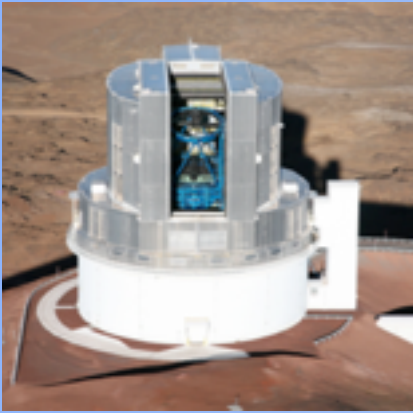
COSMOS Ultra-Deep at Deep Depth



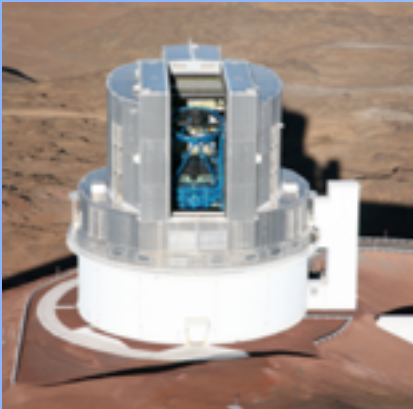
u depth: representative of full 19 deg² CLAUDS Deep

The HSC Survey & CLAUDS

CLAUDS : Data Quality



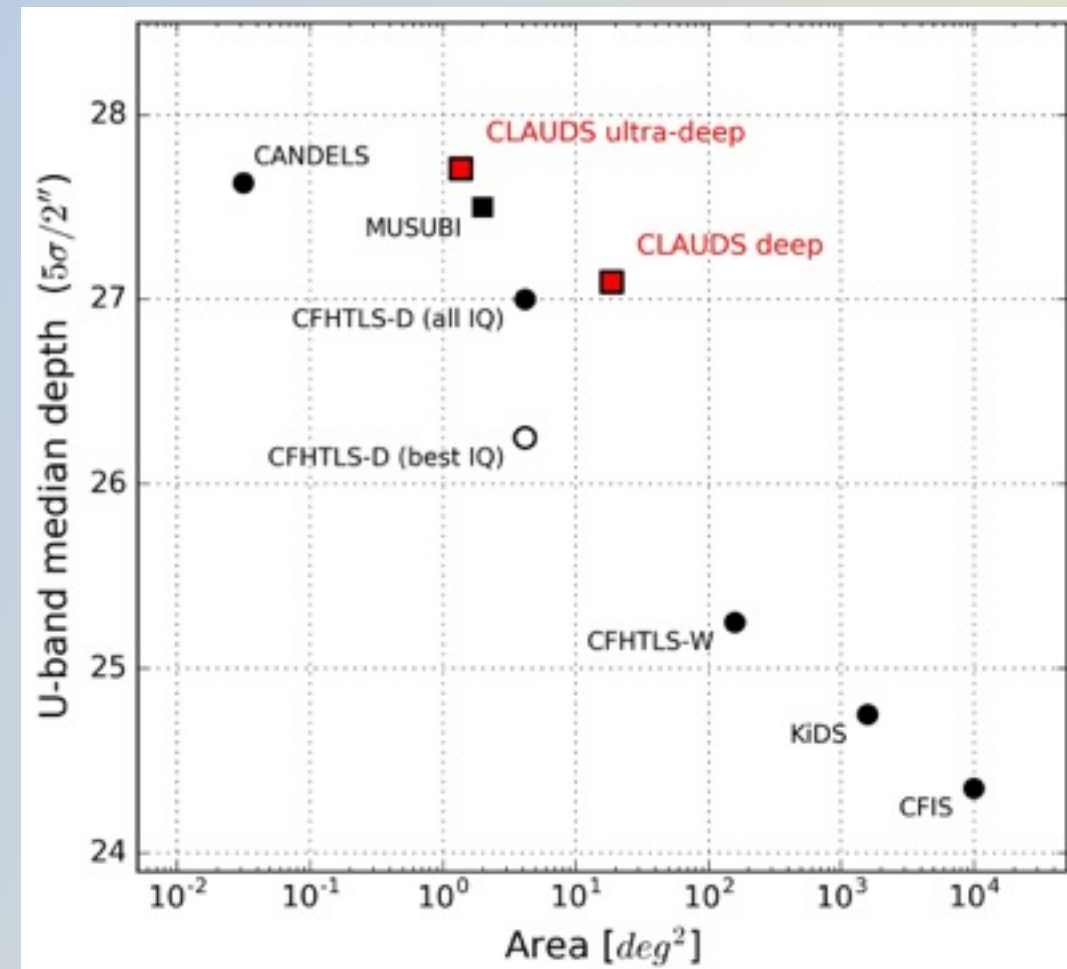
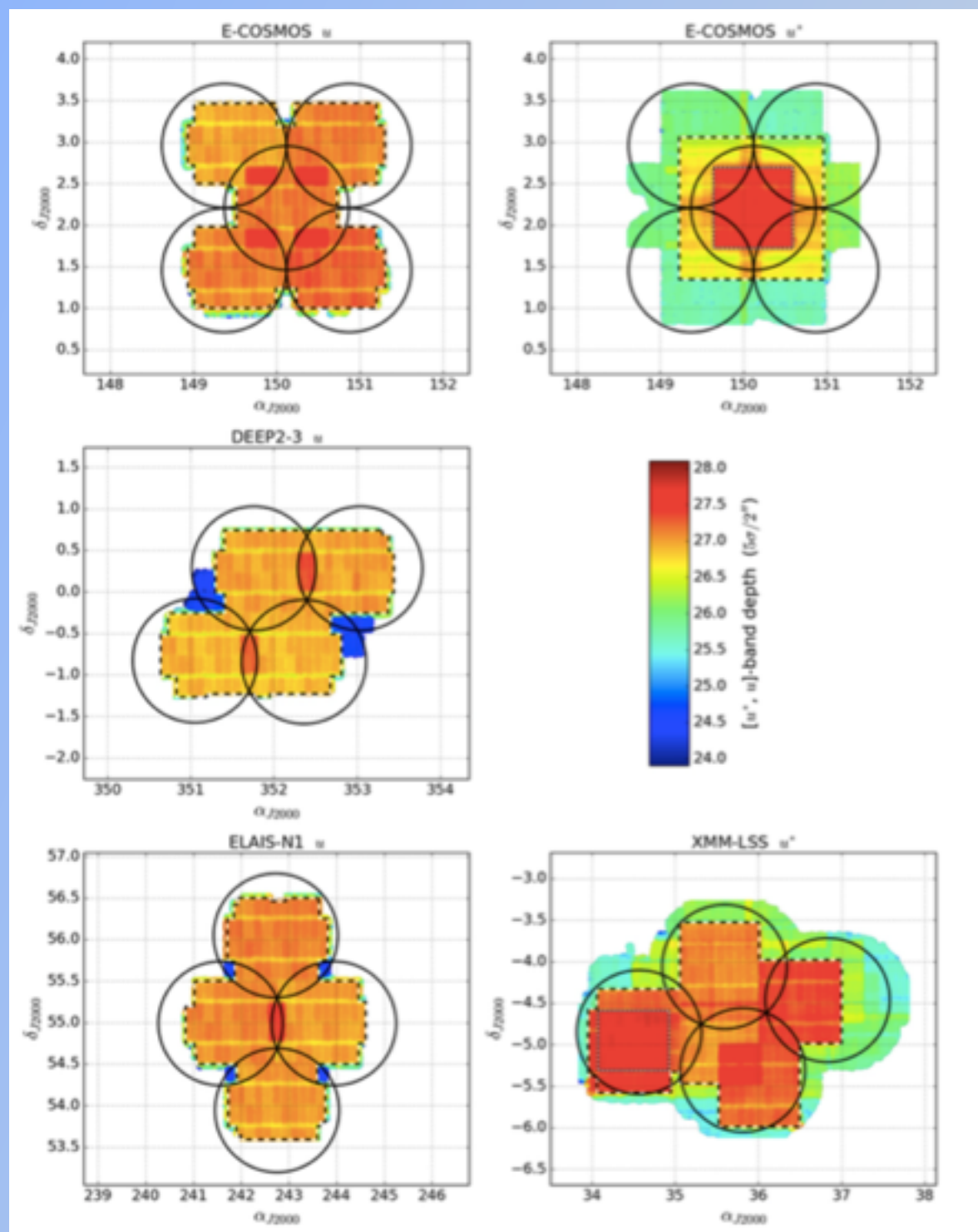
Sub-arcsec Seeing $\sim 0.9''$



The HSC Survey & CLAUDS



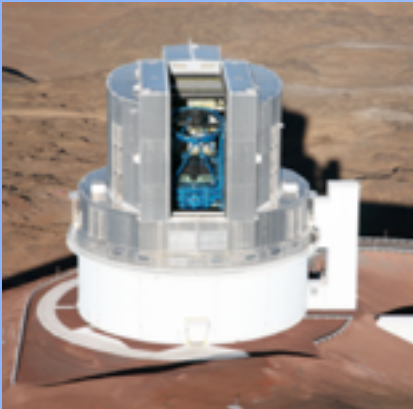
CLAUDS : Depth



$U \sim 27.1$ (5 σ , 2'') over ~ 19 deg²

$U \sim 27.5$ (5 σ , 2'') over ~ 1.5 deg²

**combination of area & depth
unmatched until LSST Deep !!**

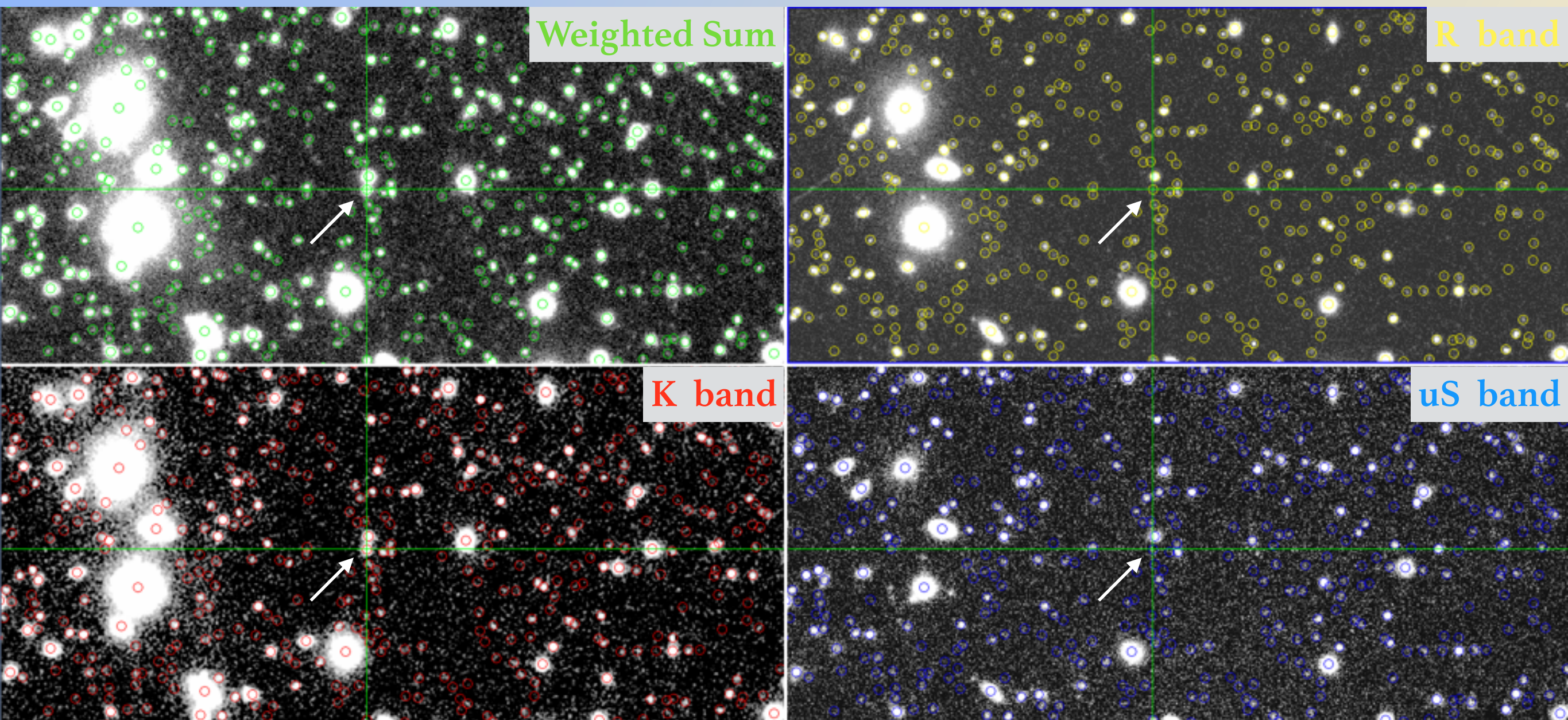


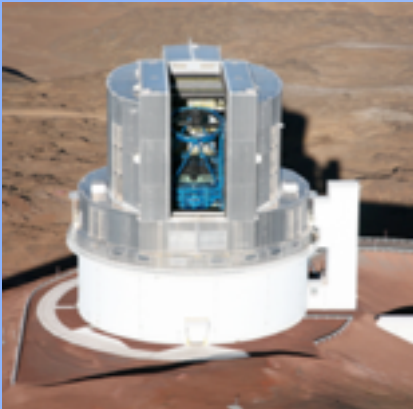
The HSC Survey & CLAUDS



CLAUDS : source extraction

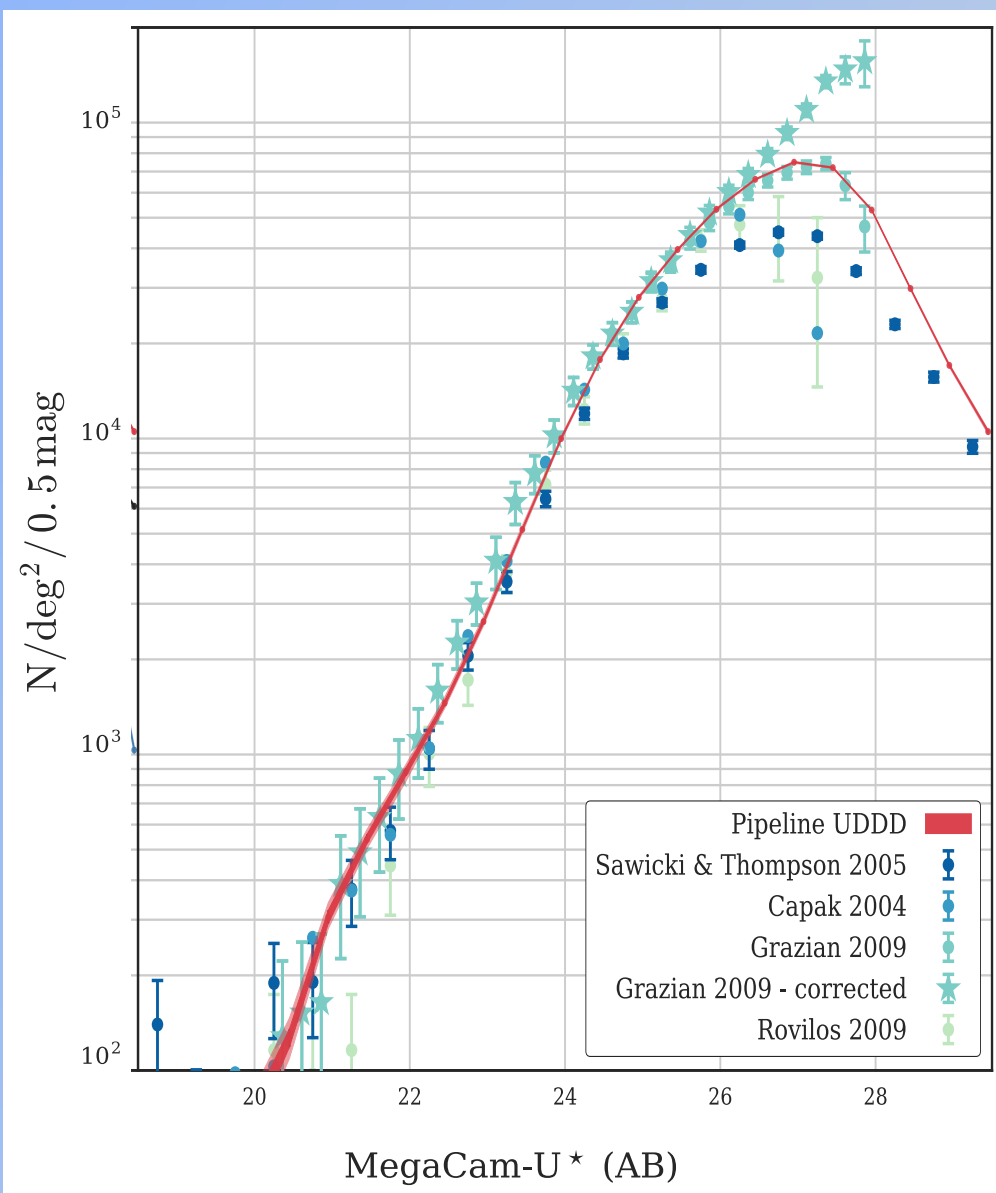
* SExtractor extraction and flux measurements based on Weighted Sum: $U+grizY$ (+JK)

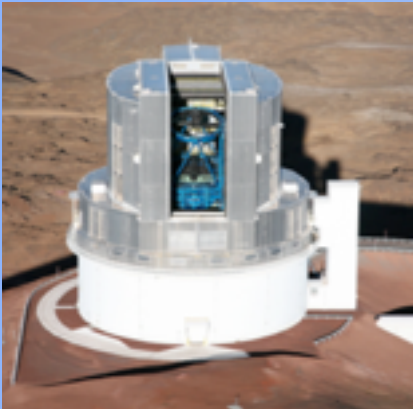




The HSC Survey & CLAUDS

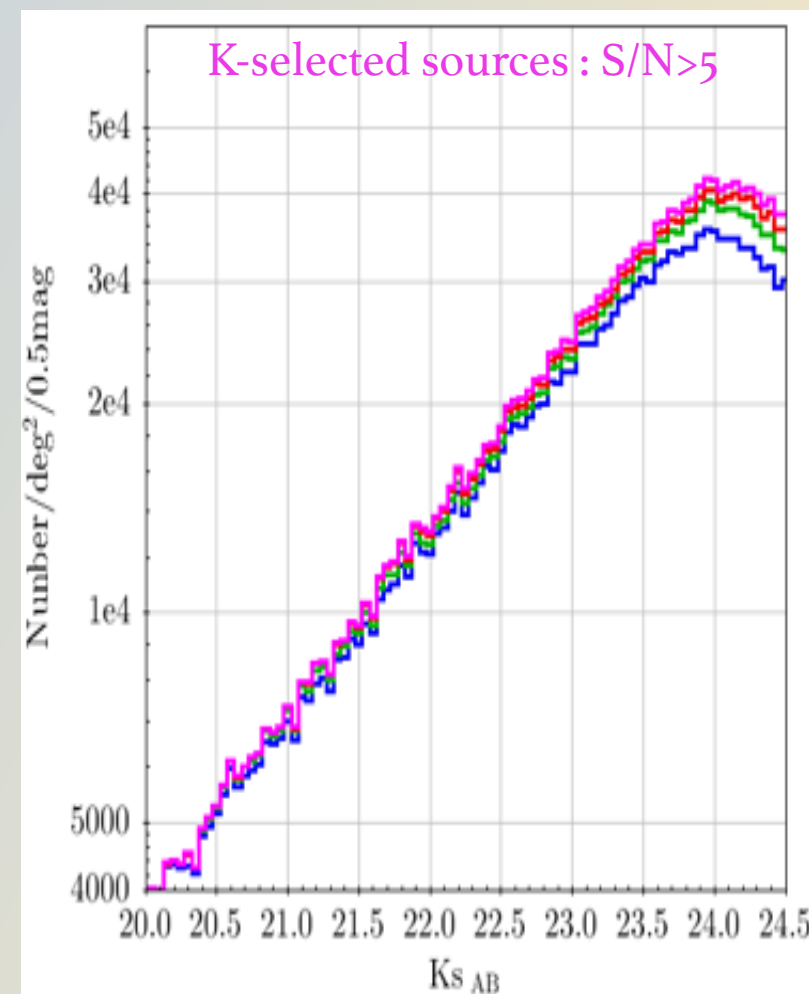
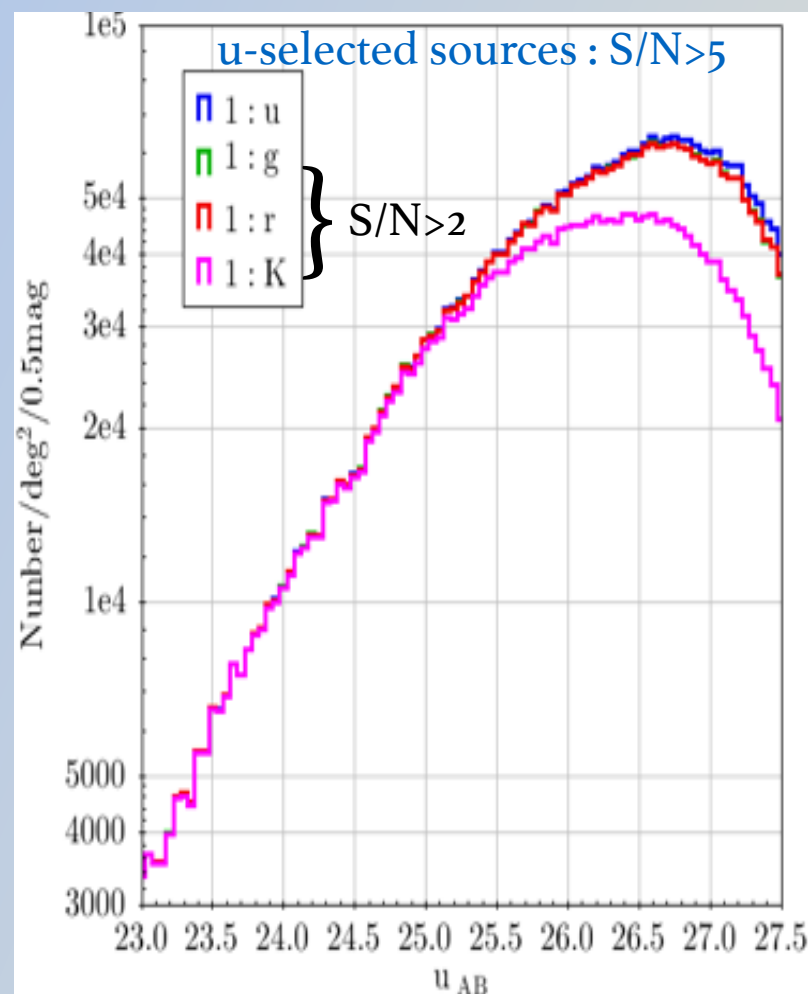
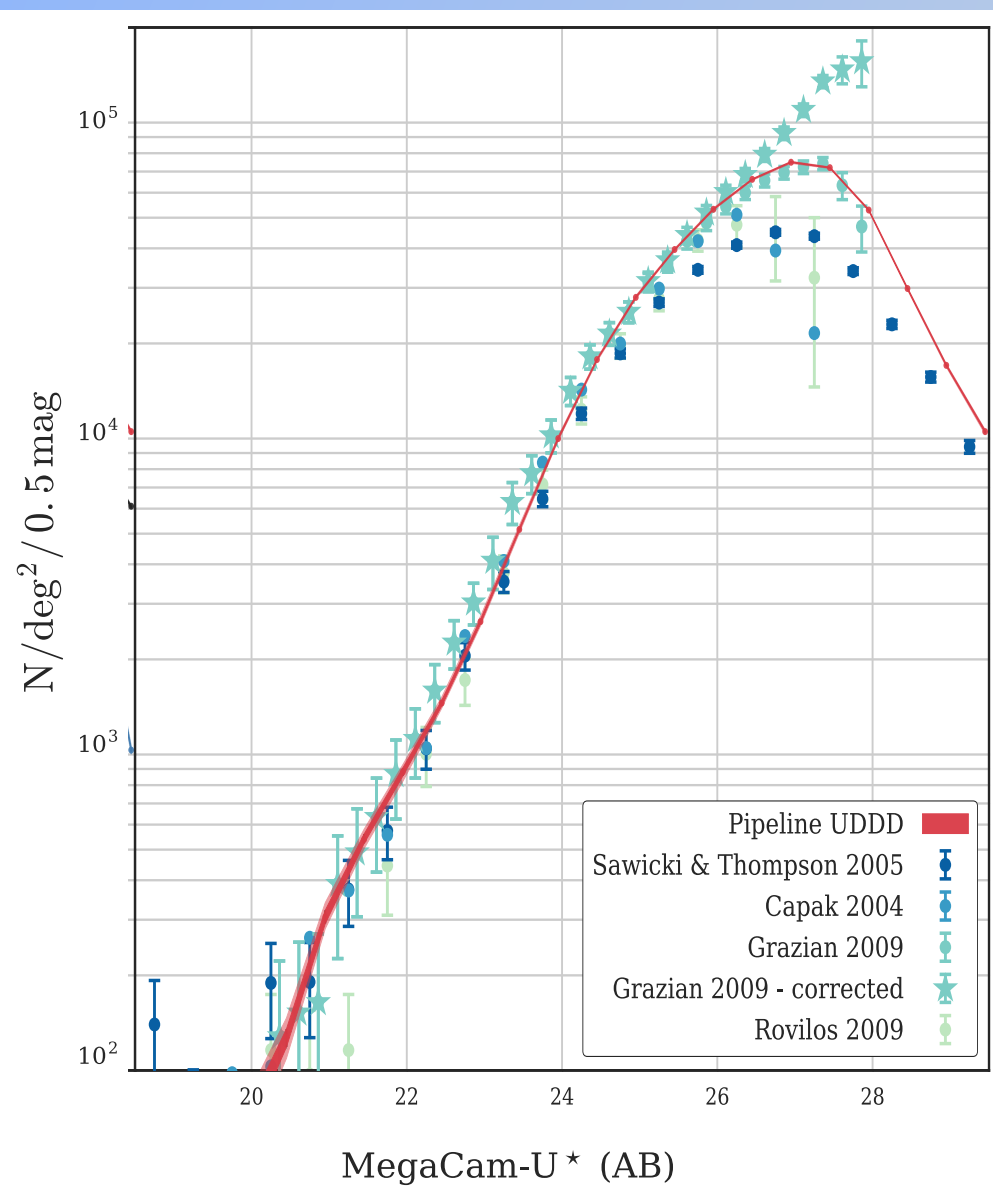
CLAUDS : source extraction



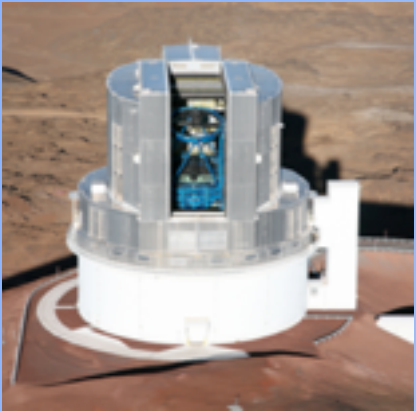


The HSC Survey & CLAUDS

CLAUDS : source extraction



high multi-band completeness in UD regions
(COSMOS/ultra-Vista & SXDS)



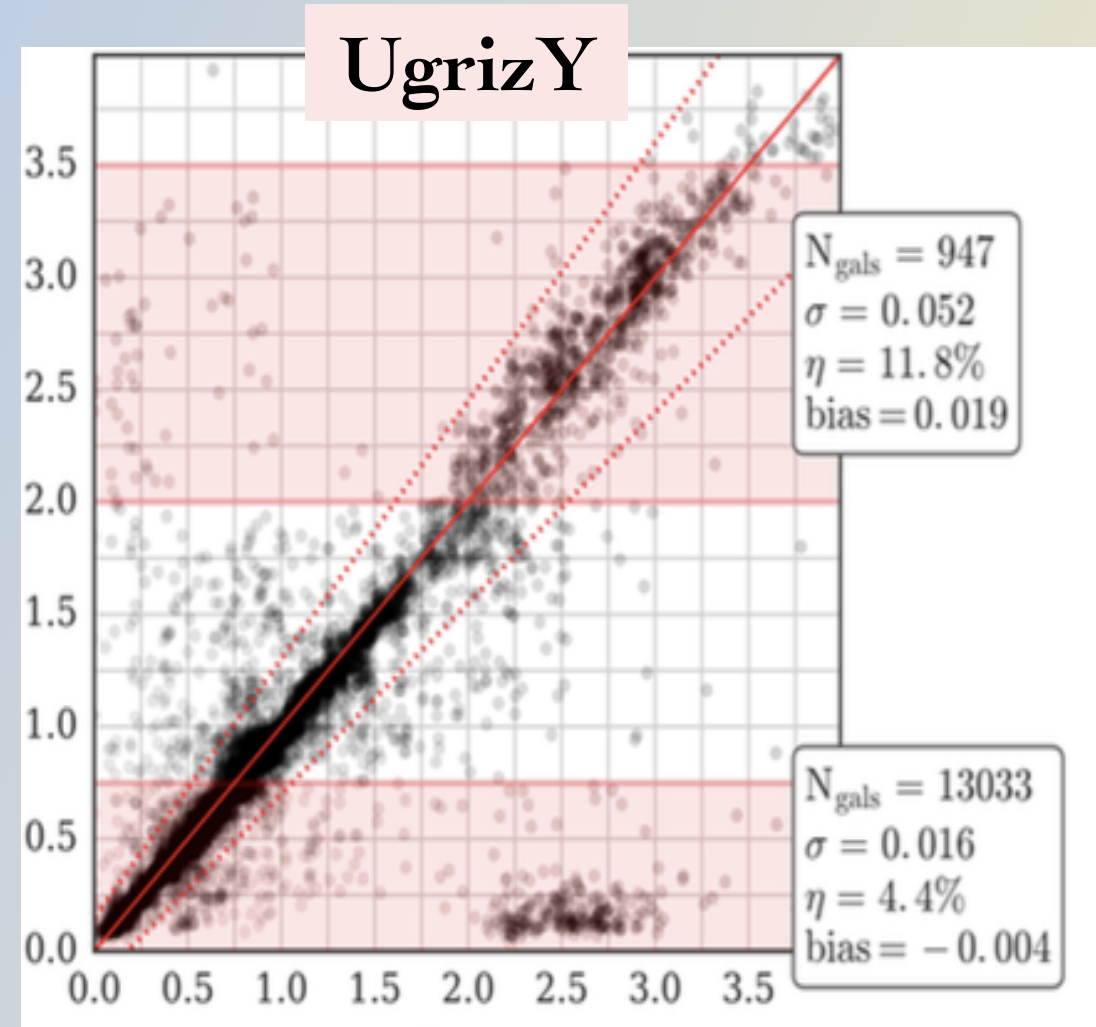
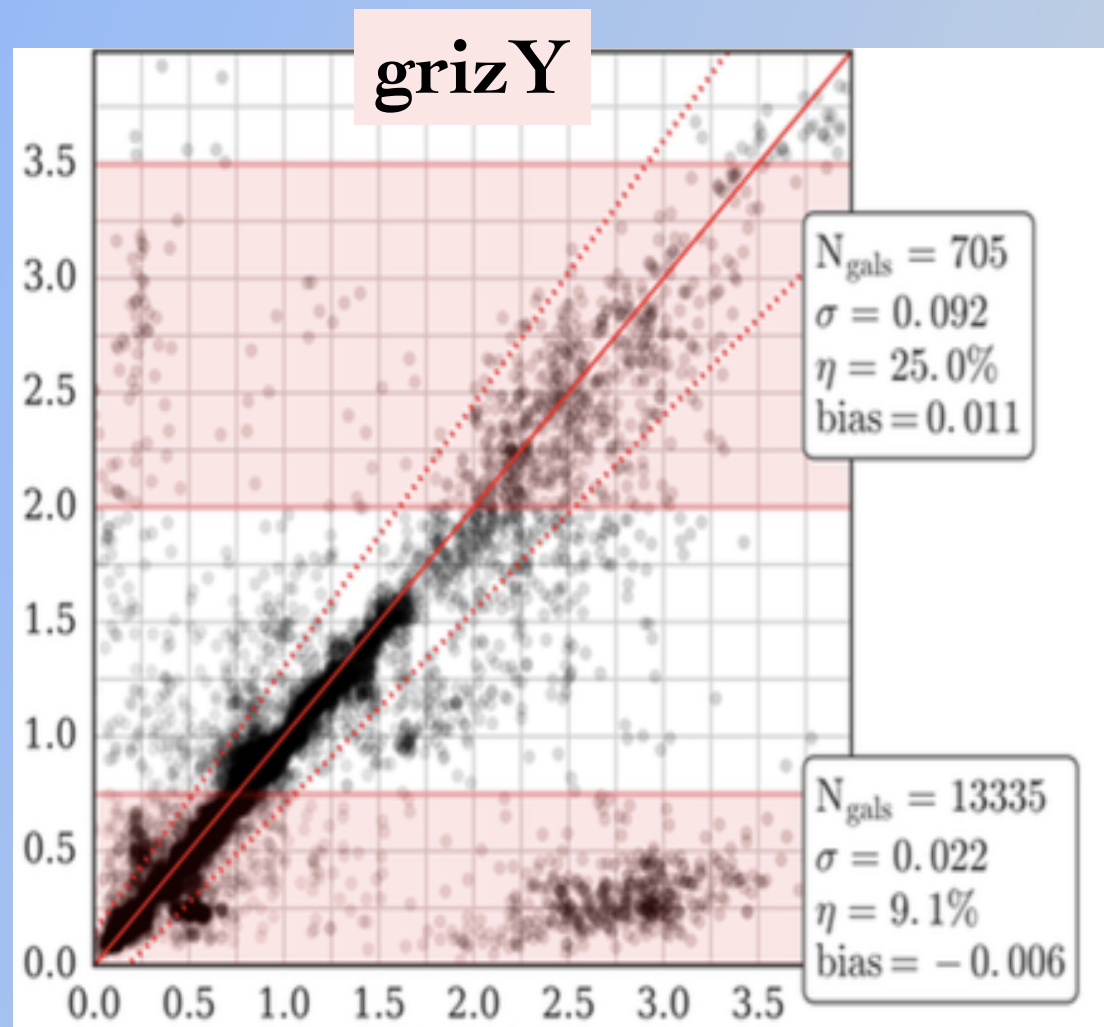
The HSC Survey & CLAUDS

CLAUDS : Photometric Redshifts

preliminary

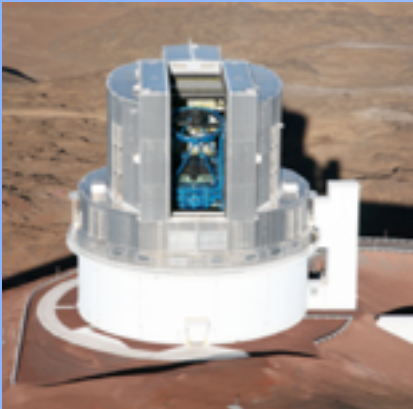


kNNz — calibrated on 30-band COSMOS photoz's



- * No NIR informations used here
- * COSMOS data shallower than HSC

- * Deep Learning photo-z (see J. Pasquet talk)



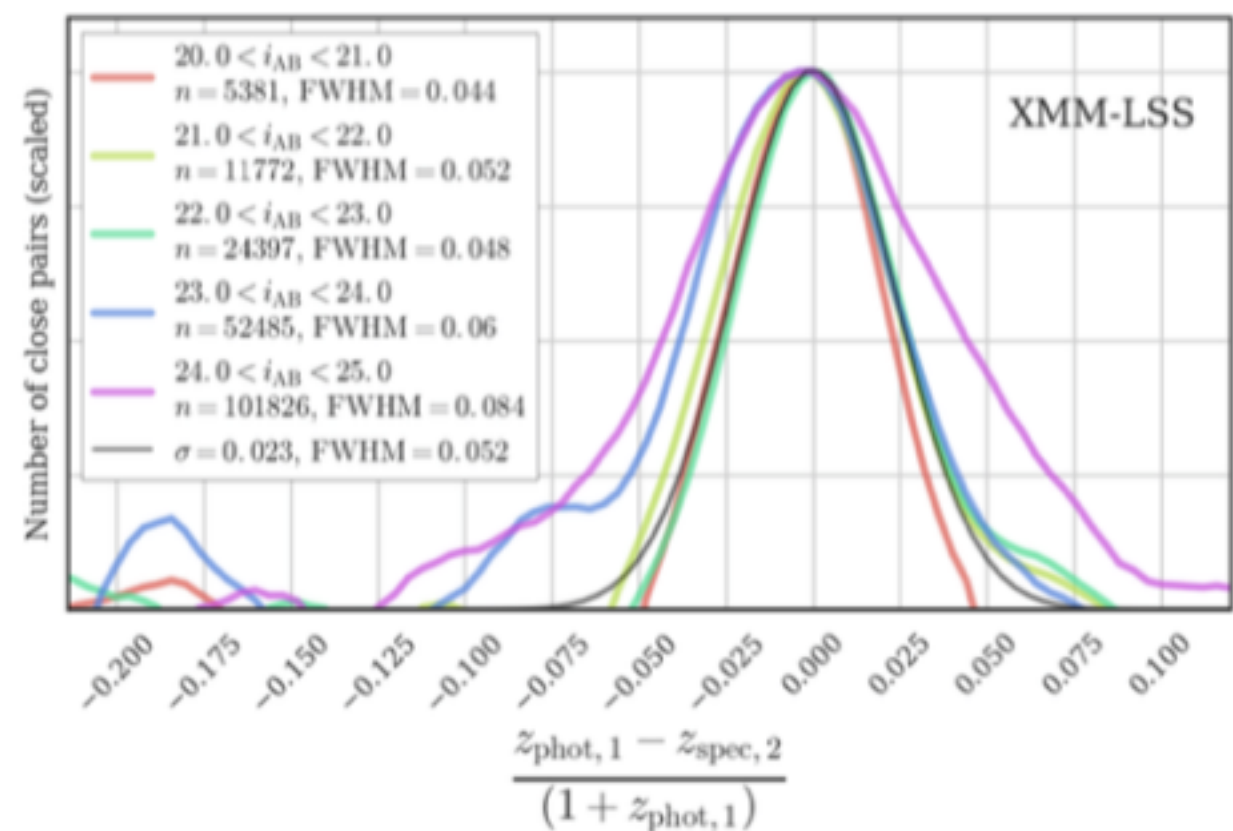
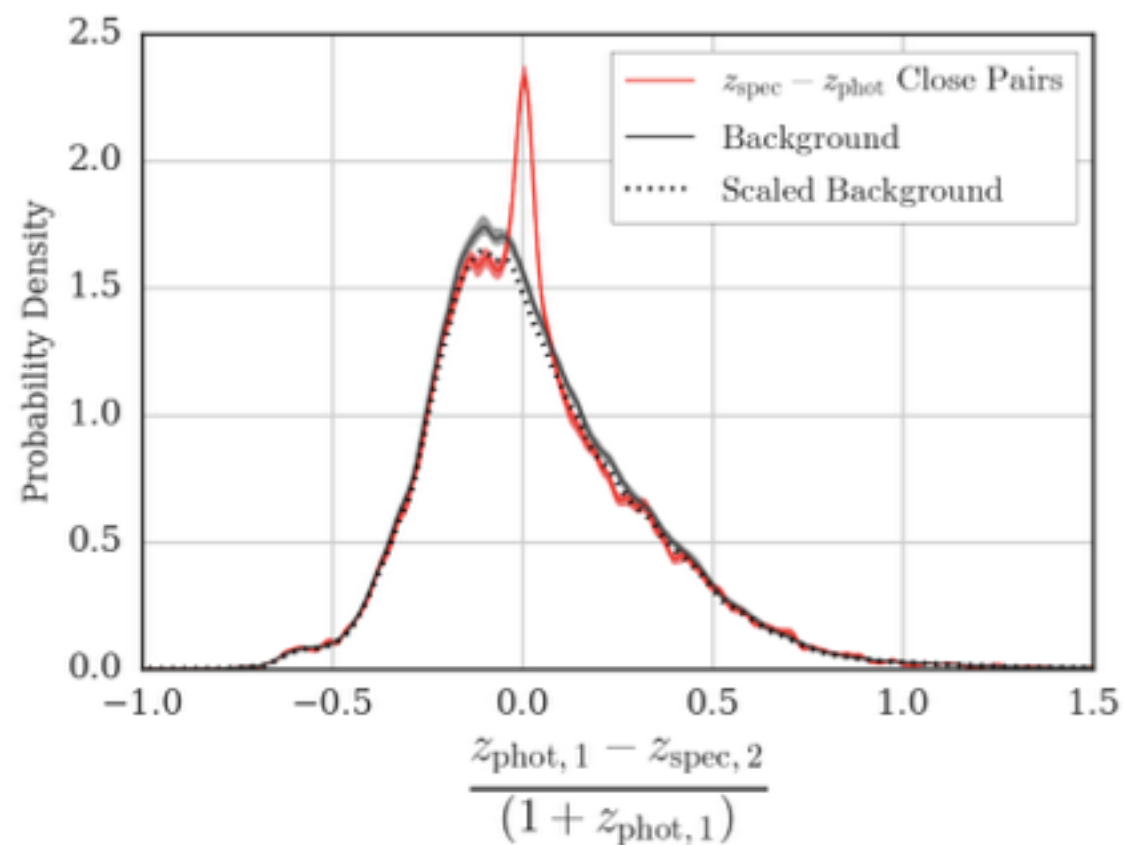
The HSC Survey & CLAUDS

CLAUDS : Photometric Redshifts

preliminary

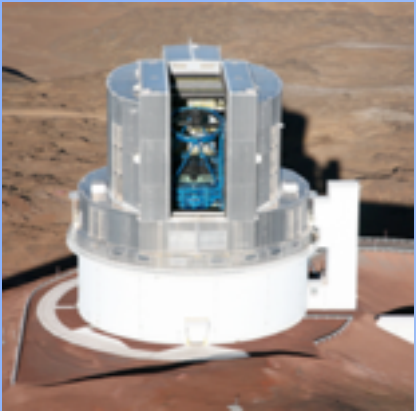


photo-z precision beyond the spectroscopic limit:
cross-match of close spec+phot pairs



$i=21-22AB: \sigma=0.023$

$i=24-25AB: \sigma=0.037$



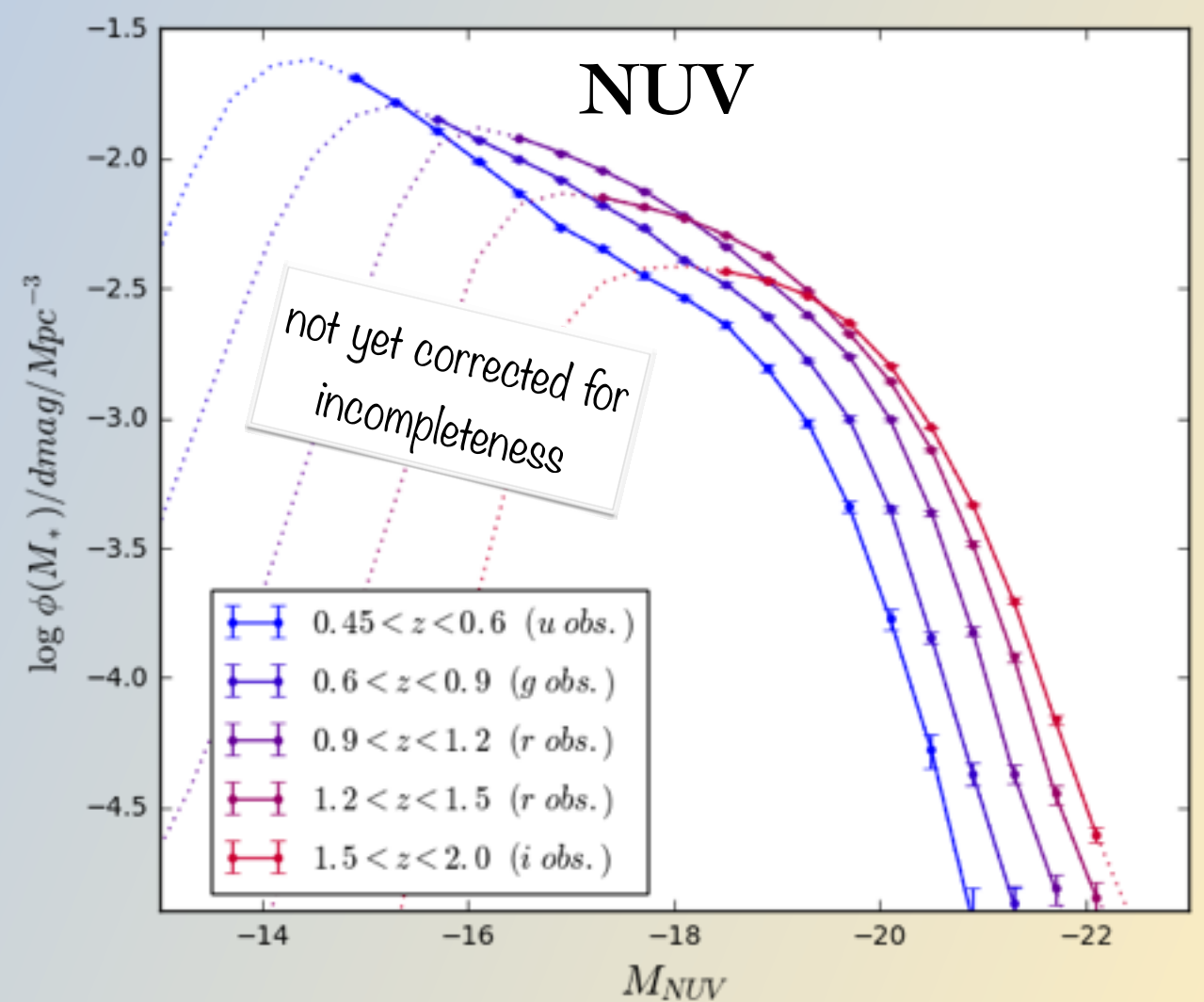
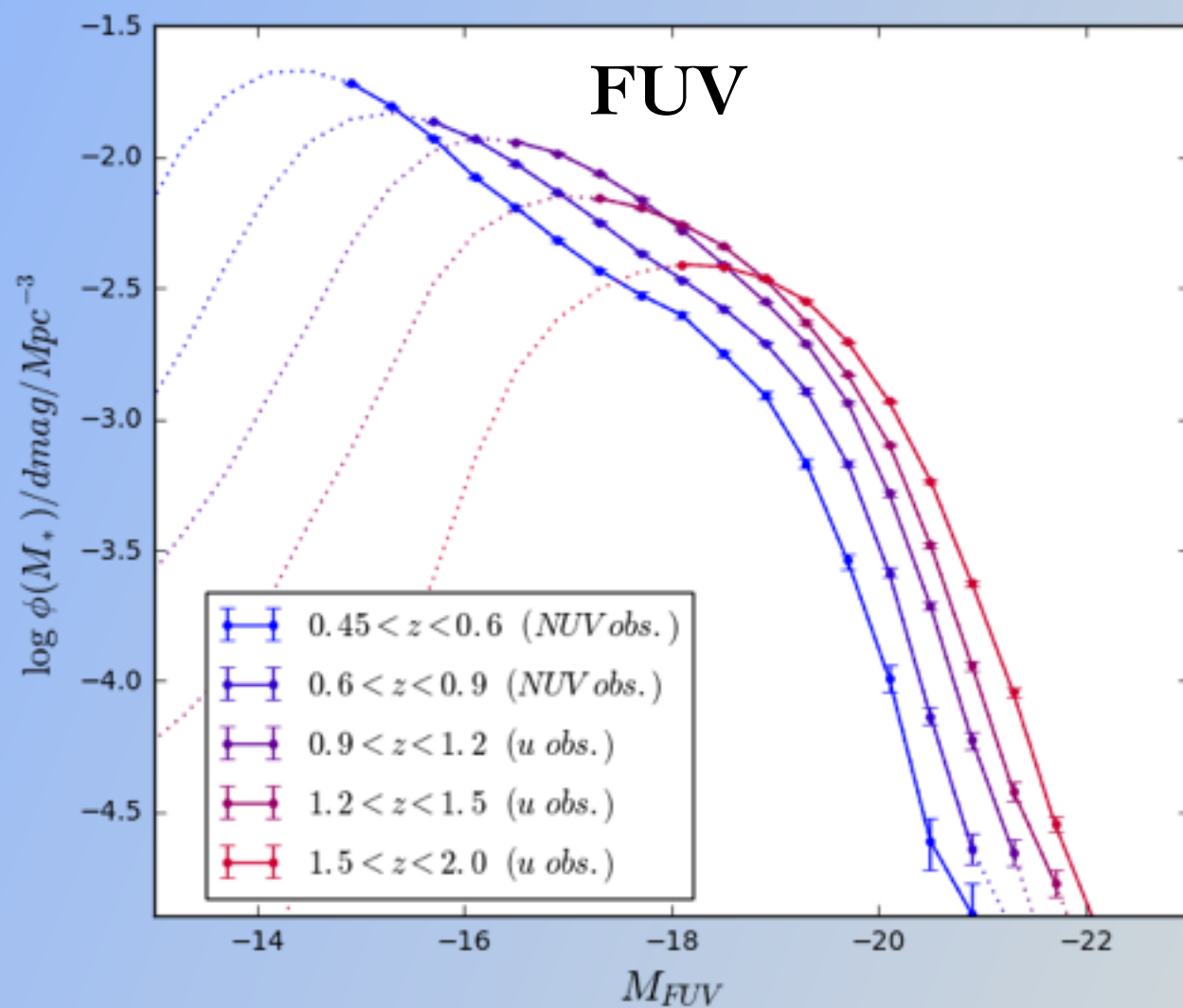
The HSC Survey & CLAUDS

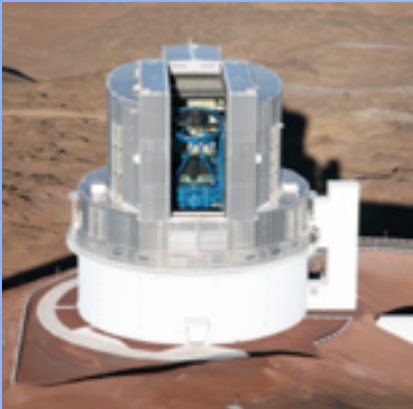
CLAUDS : UV Luminosity Functions

preliminary



- focus: faint end of the UV LFs
- rest-UV emission tells us about unobscured star formation
- photo-z's essential for this work



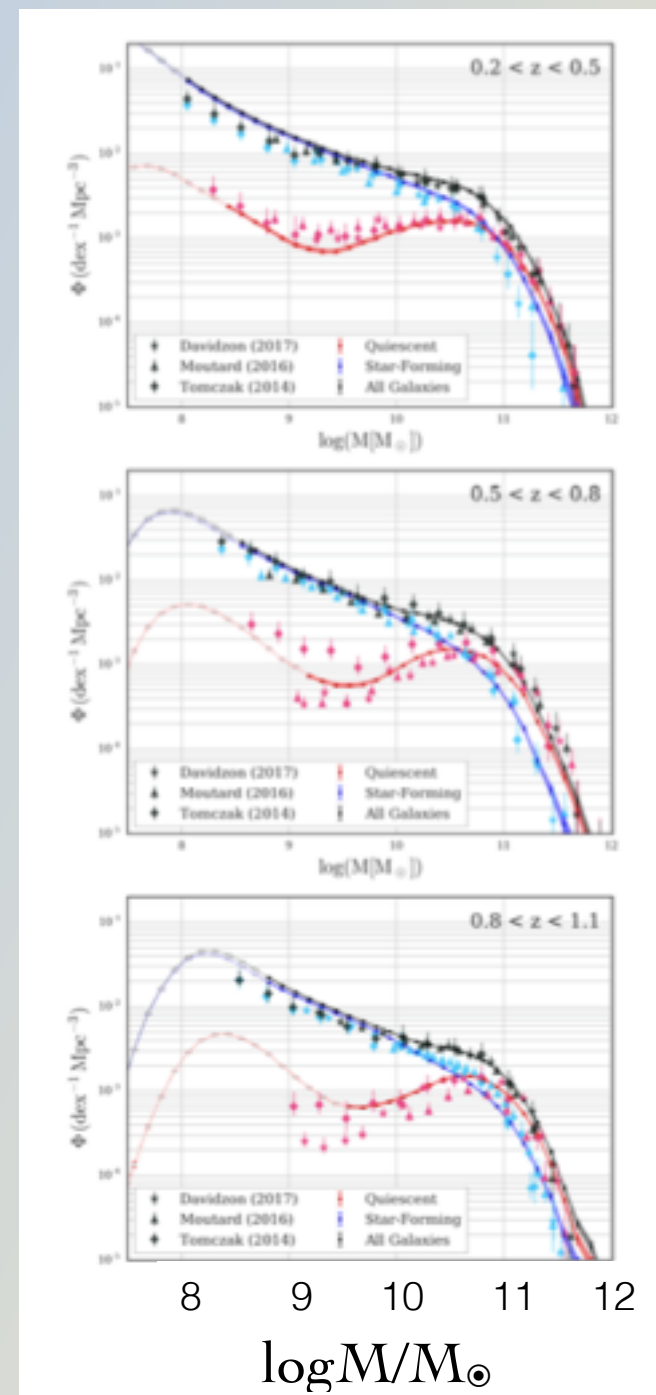
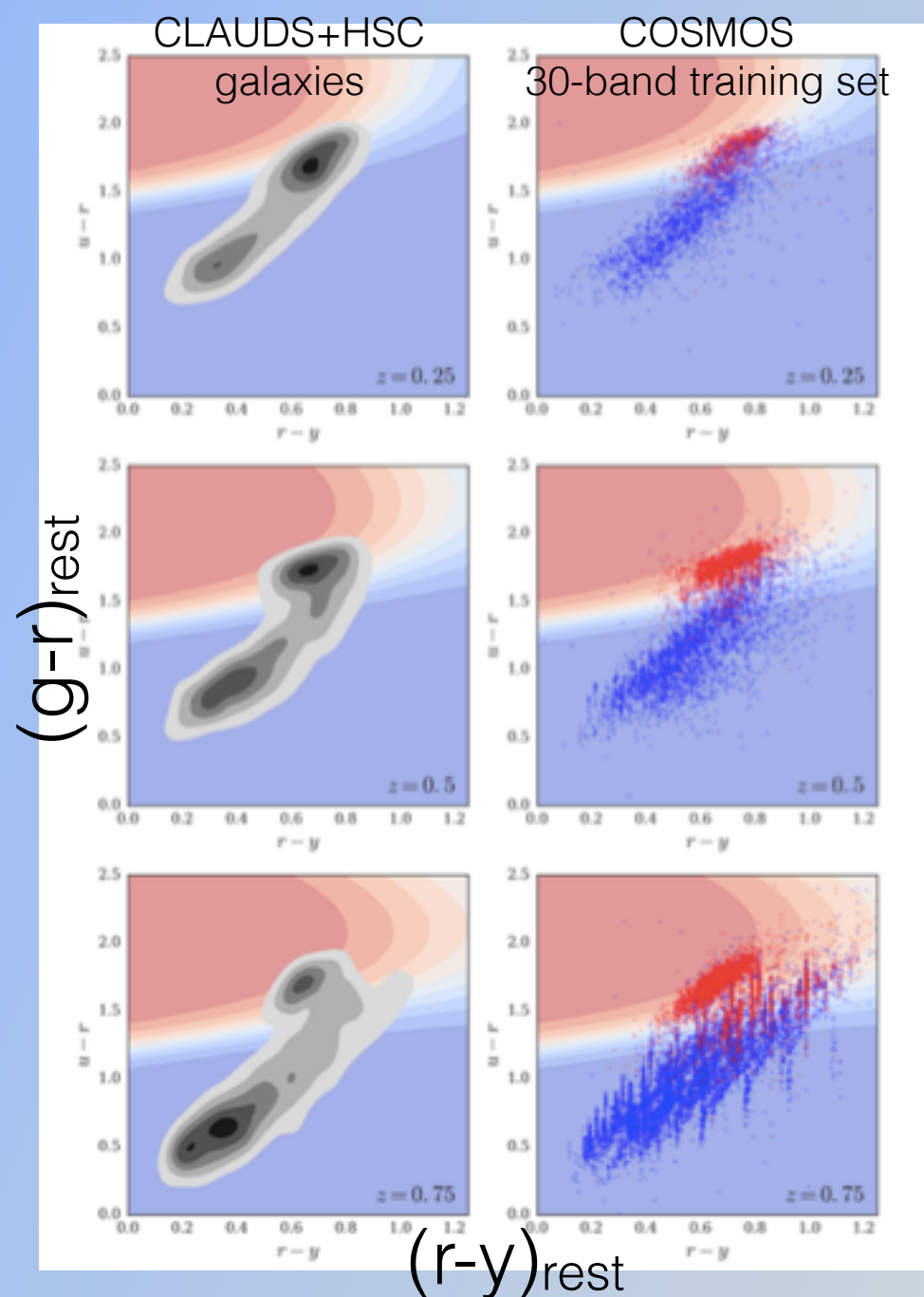


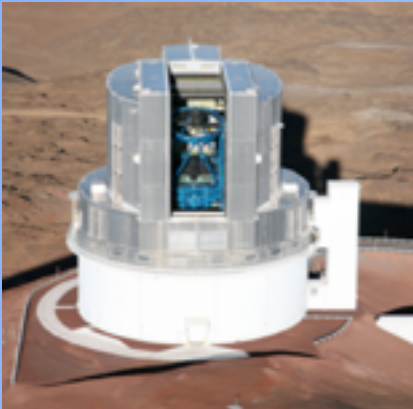
The HSC Survey & CLAUDS

CLAUDS : Mass Functions up to $z \sim 1$ *preliminary*



Star-Forming / Quiescent





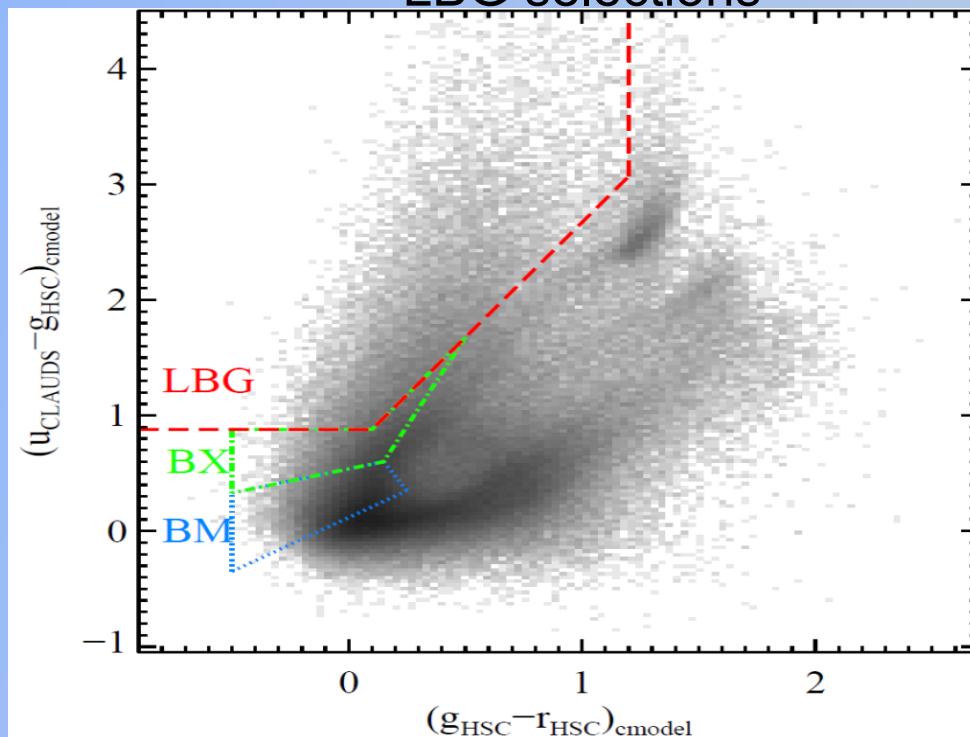
The HSC Survey & CLAUDS



CLAUDS : Lyman Break Galaxies

preliminary

LBG selections



Expected Numbers:
1 Million LBGs
2.5 Millions BX/BM

$z \sim 3$ LBG UV-LF:

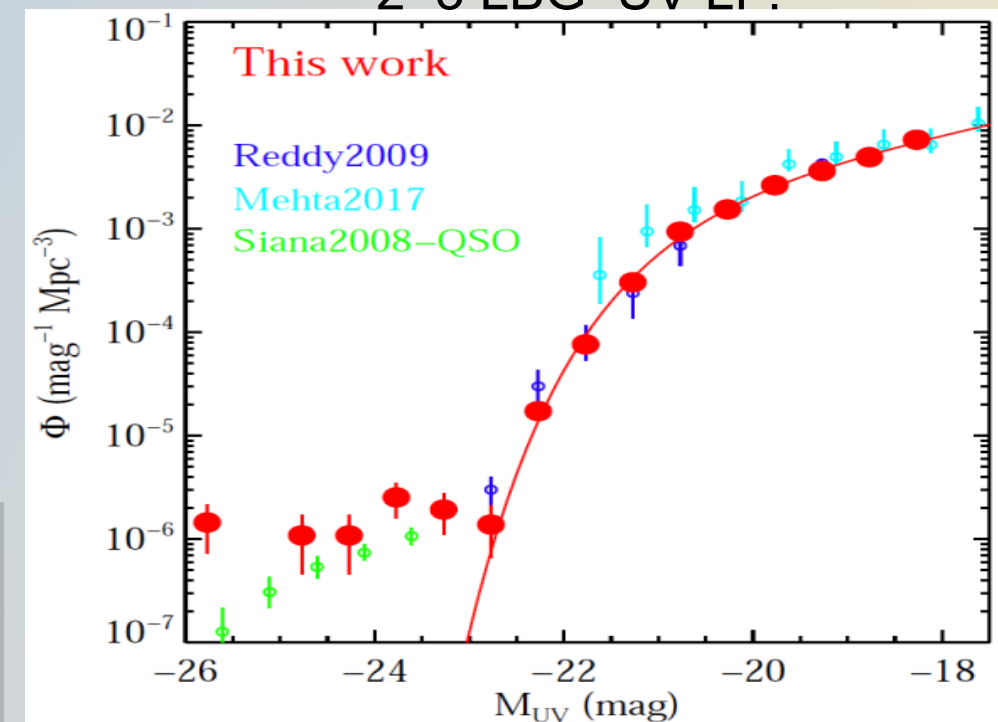
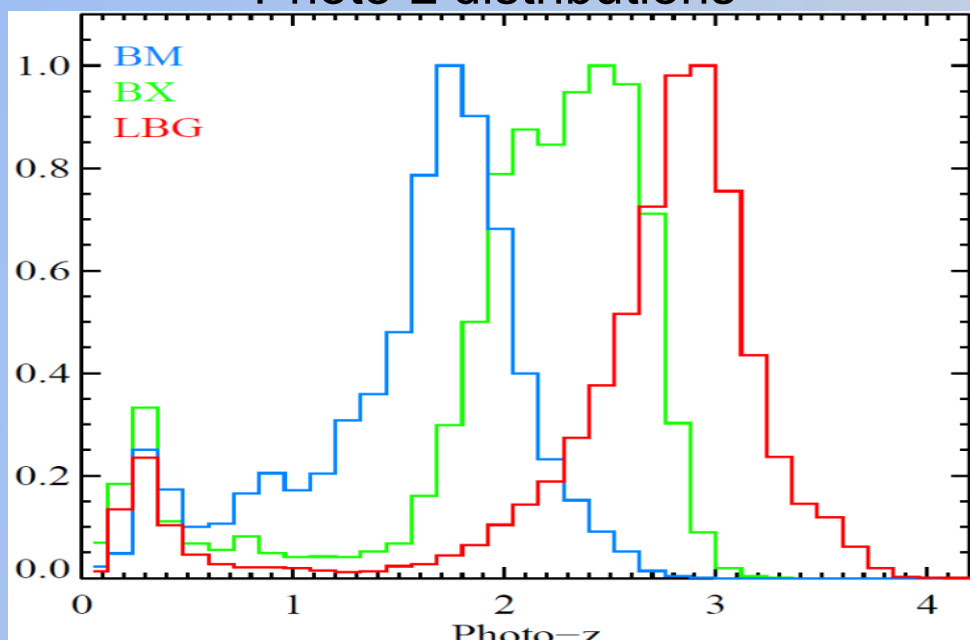


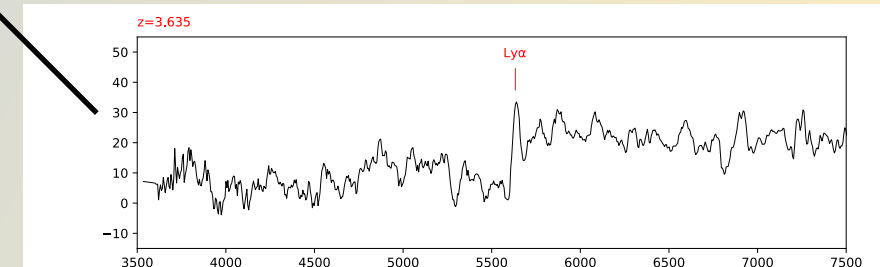
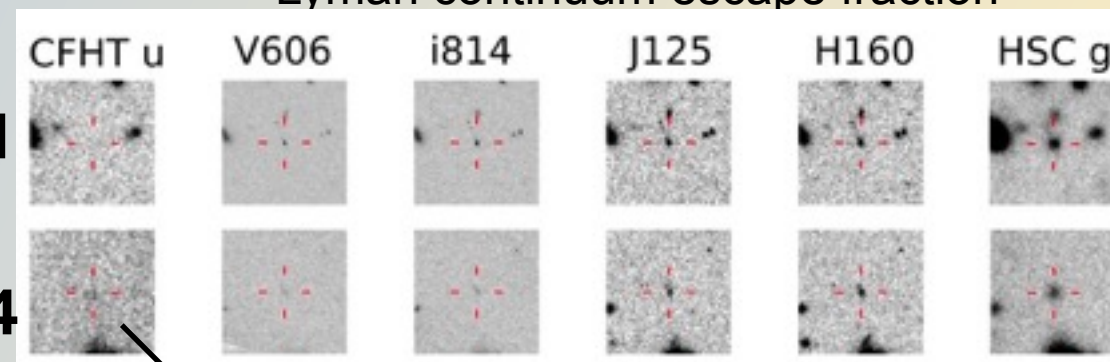
Photo-z distributions

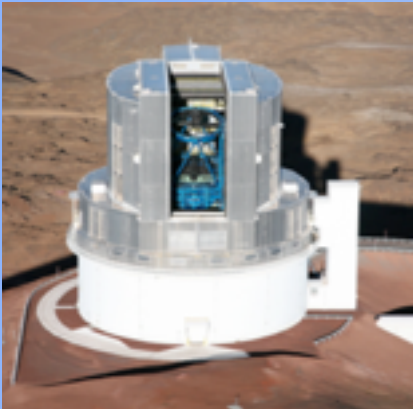


Lyman continuum escape fraction

$z=3.71$

$z=3.64$





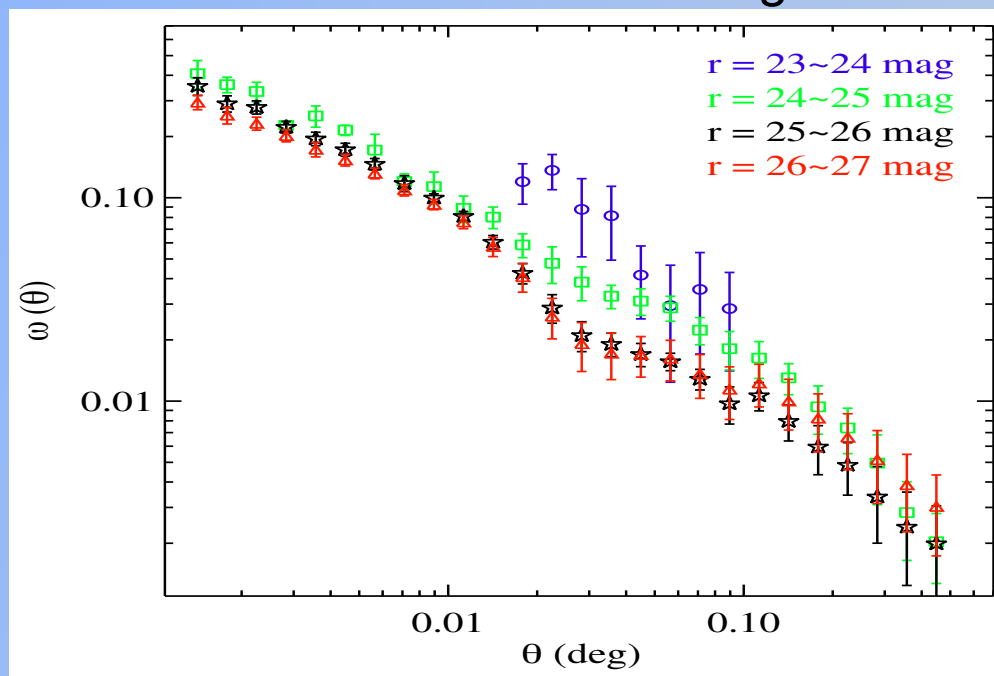
The HSC Survey & CLAUDS

CLAUDS : Environmental studies

preliminary



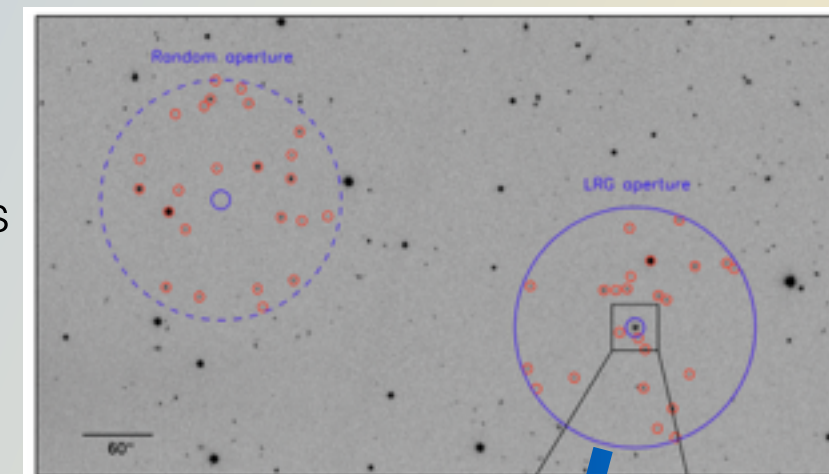
$z \sim 3$ LBG clustering:



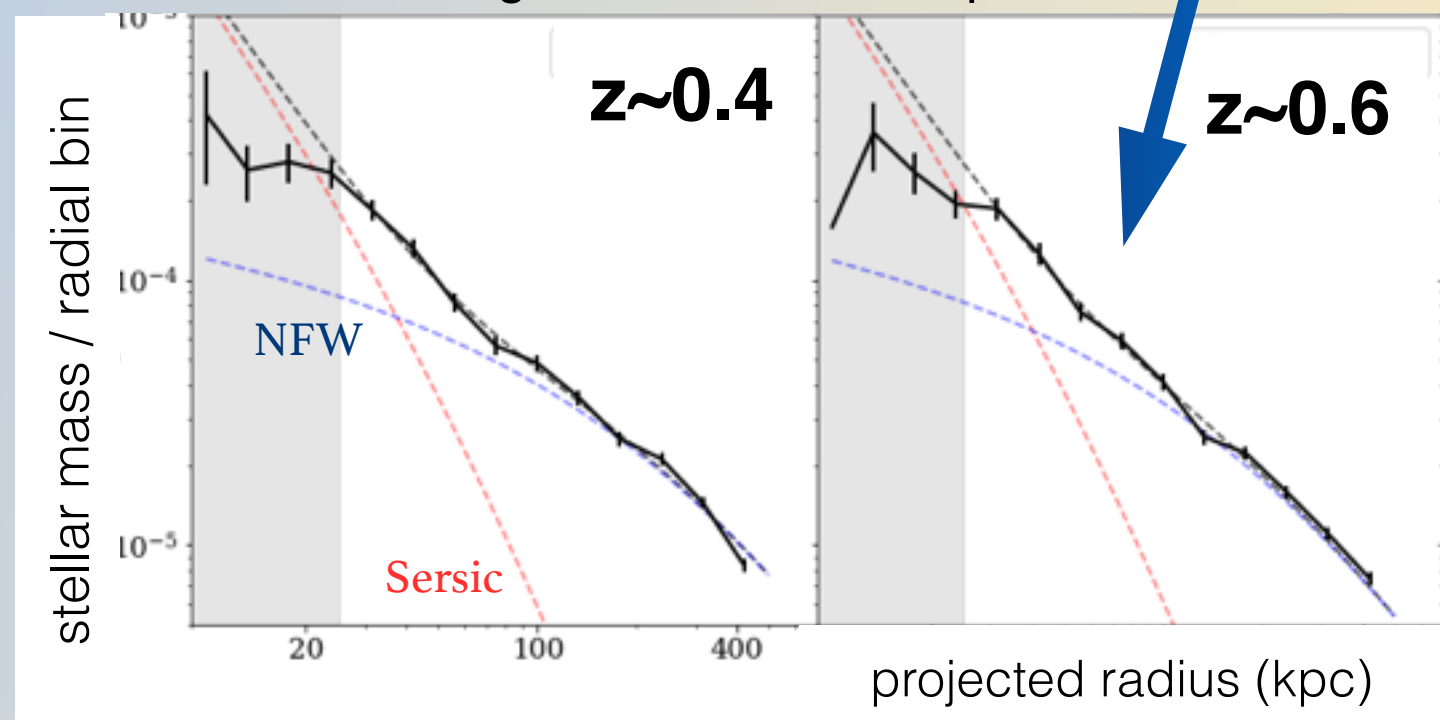
Environments of $M > 10^{11} M_{\odot}$ galaxies

CLAUDS+HSC:

1. mass from SED-fittings
2. select $M > 10^{11} M_{\odot}$ galaxies
3. background-subtract with photo-z cut



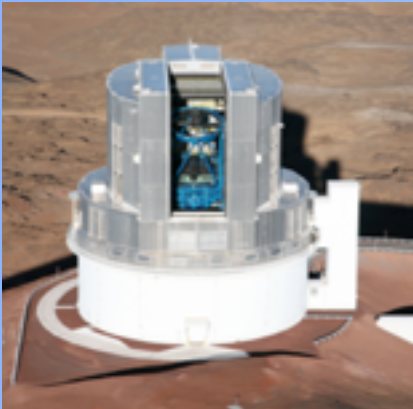
Integrated mass of companions:



* MF + clustering : SHMR

* Lensing shape measurement is limited by low shear S/N for sources at $z > 1$

⇒ CLAUDS+HSC-Deep perfect for lensing magnification bias studies with LBG samples



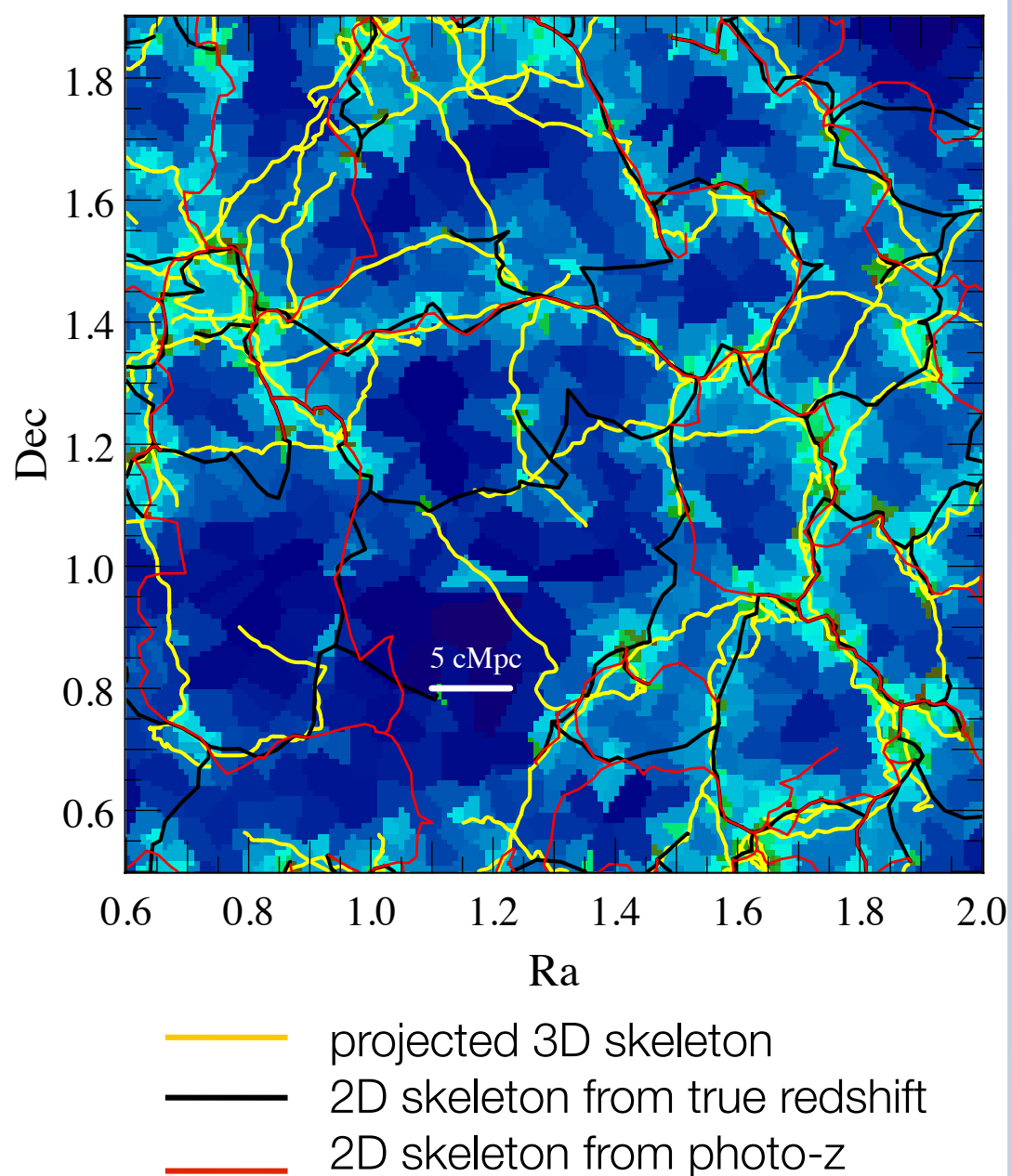
The HSC Survey & CLAUDS



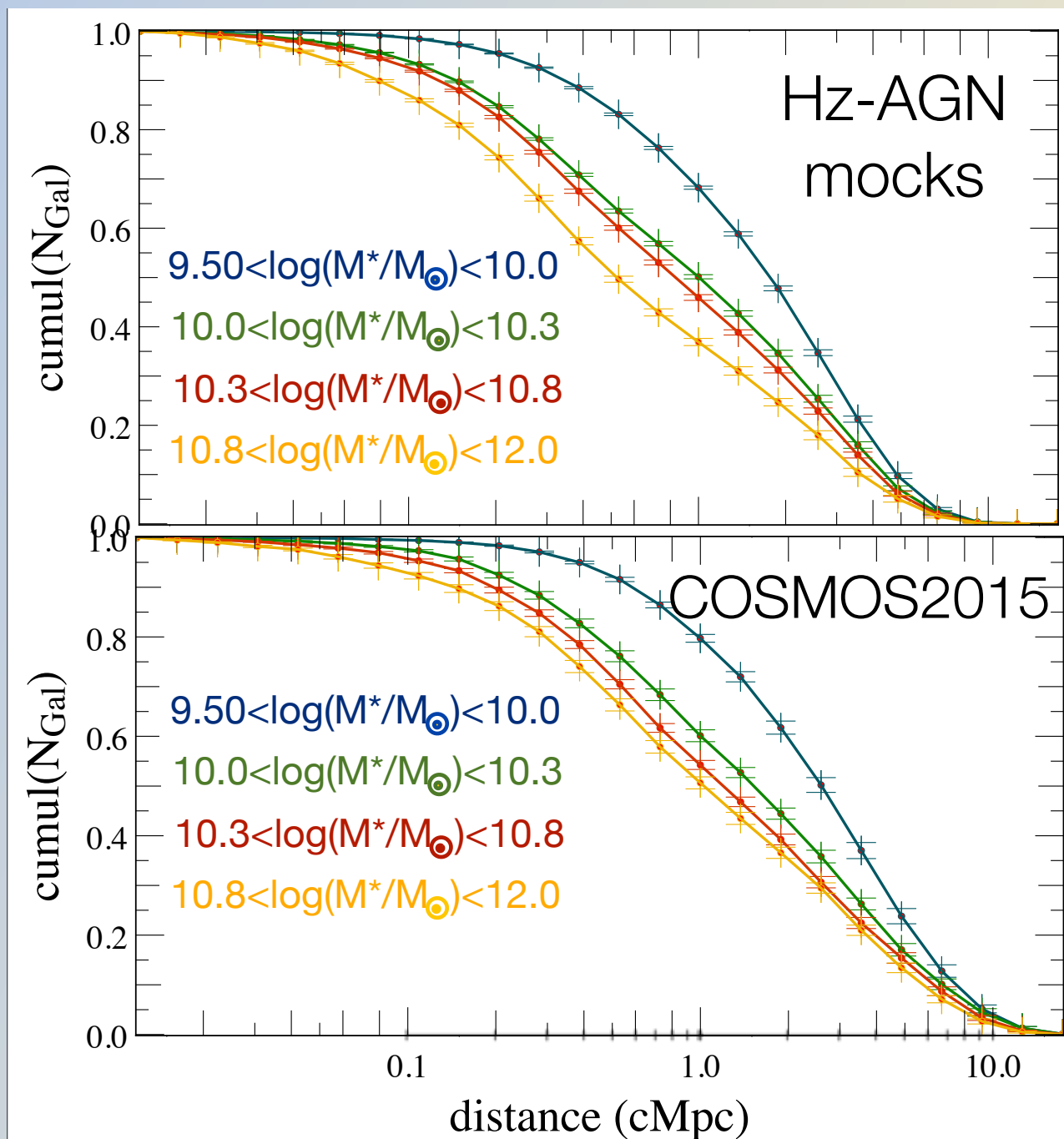
CLAUDS : Environmental studies

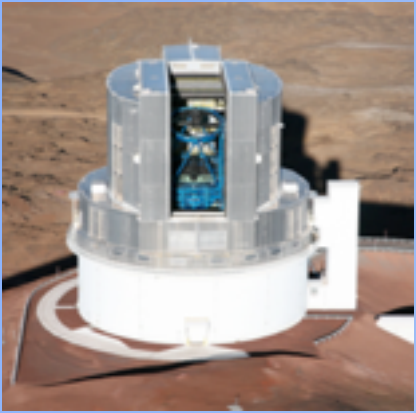
◆ Cosmic Web in thin photo-z redshift slices

horizon-AGN simulation (*Dubois +2014*)



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The HSC Survey & CLAUDS

Summary



- **Largest & deepest U survey and will be unsurpassed until LSST**
 - Deep: 18.6 deg^2 to $U=27.1\text{AB}$
 - UD: 1.4 deg^2 to $U=27.7\text{AB}$
- Images calibrated & pixel-matched with HSC
- Full HSC-Deep depth not yet finish (2 more years?)
- HSC release end 2019 will include CLAUDS data
- CLAUDS members deeply involved but too small to fully exploit the survey
- **Photo-z selection for the Prime Focus Spectrograph (PFS) Galaxy Evolution survey**