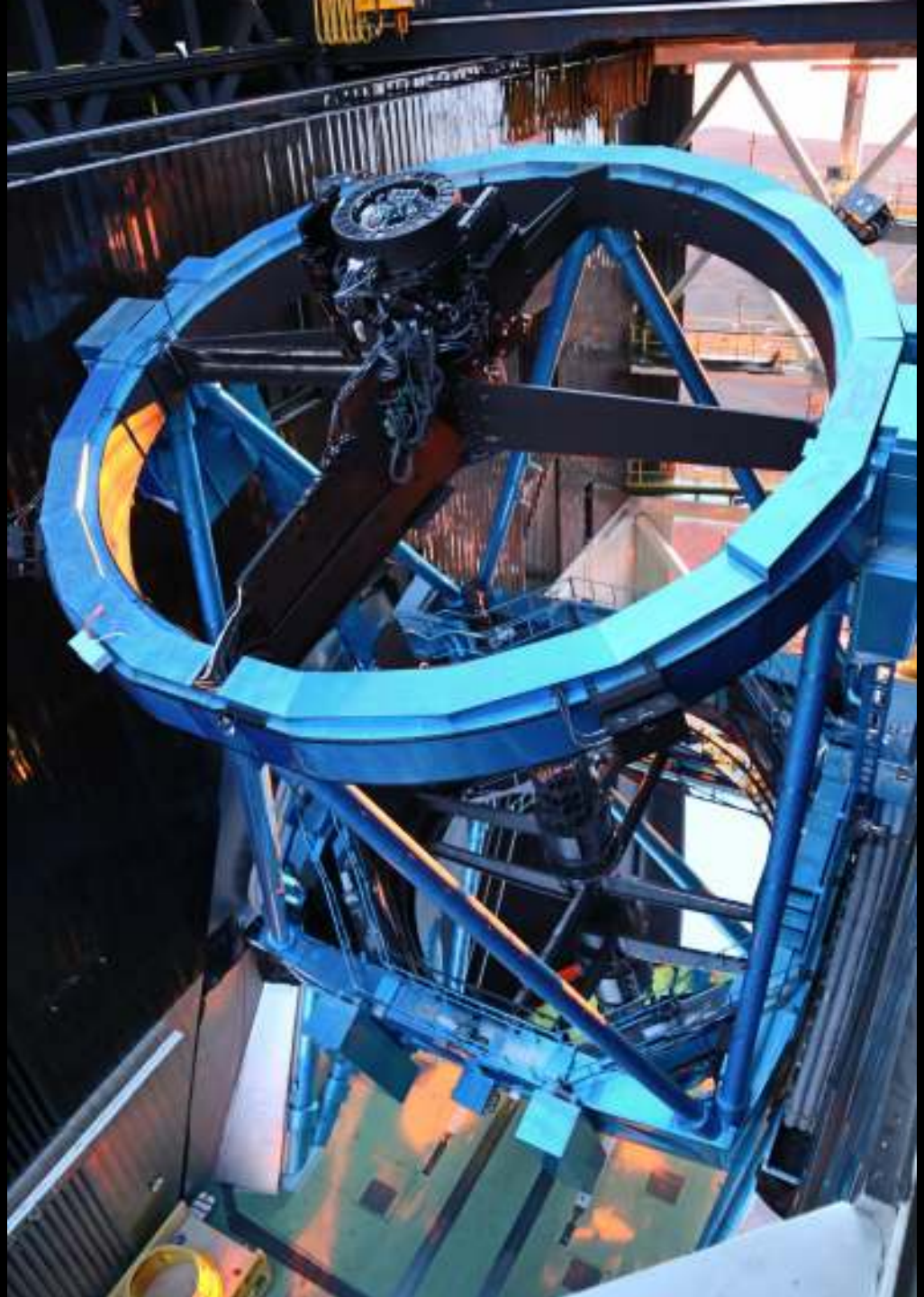
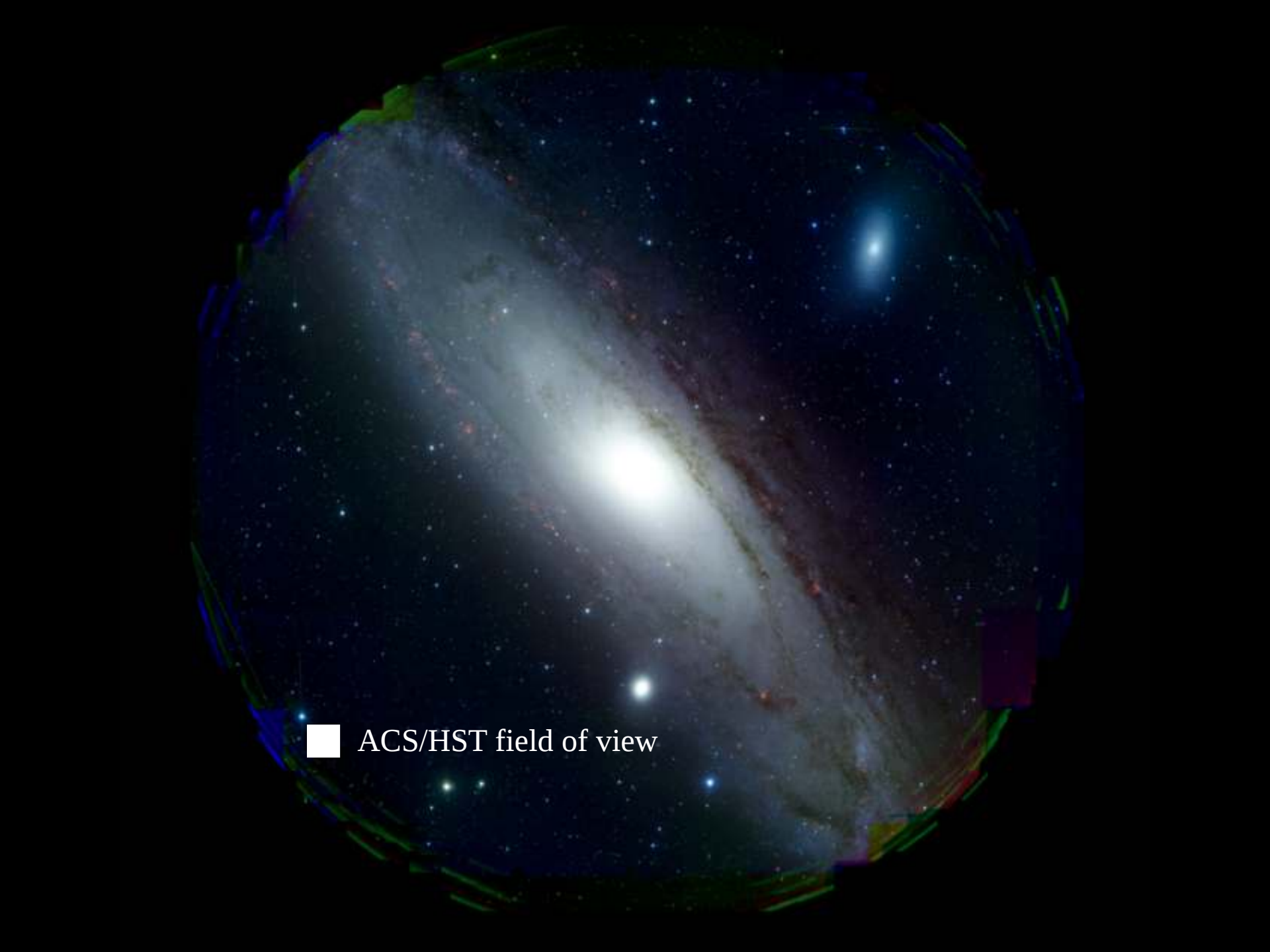
Hyper Suprime-Cam Subaru Strategic Program

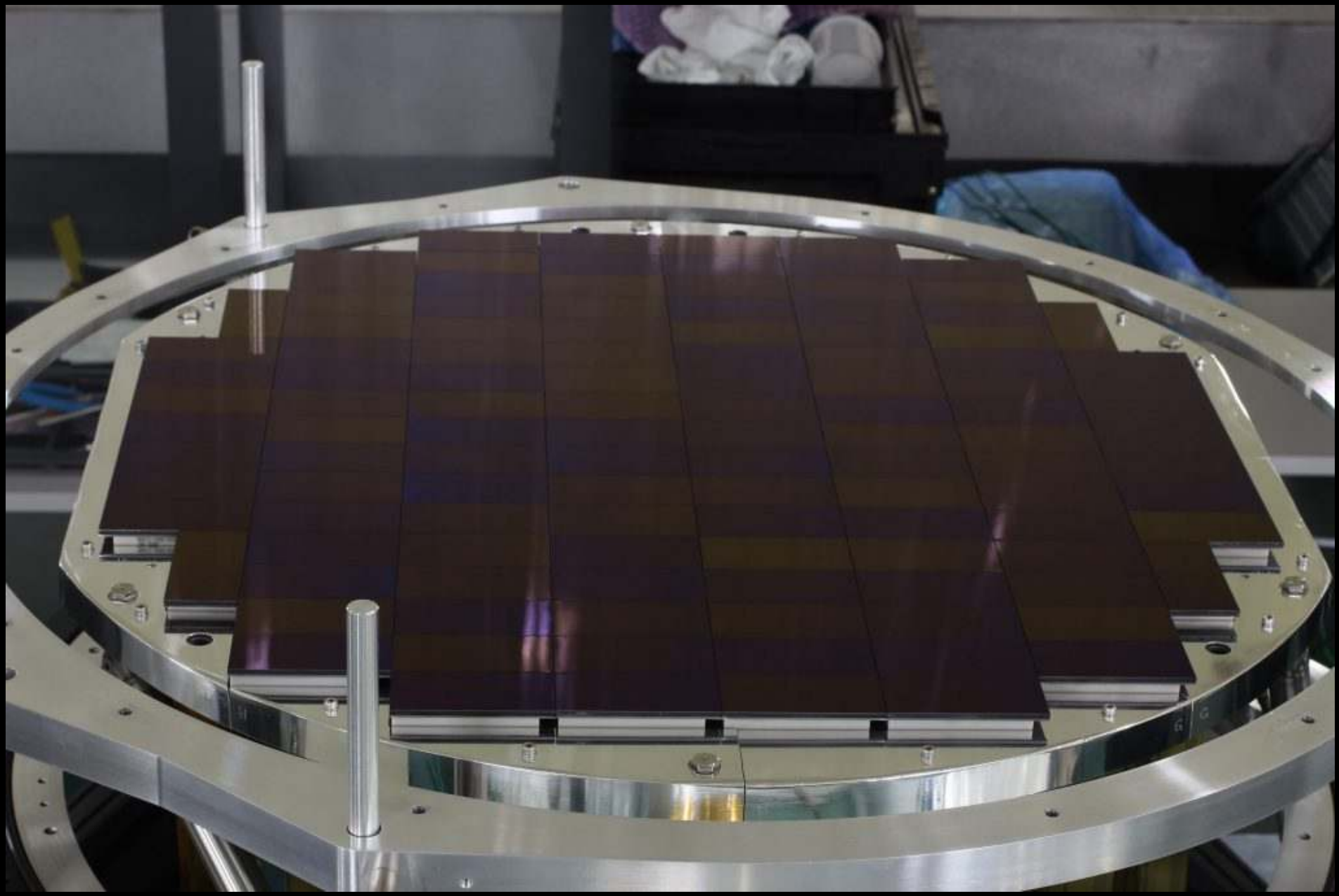
Masayuki Tanaka
(National Astronomical Observatory of Japan)

Hyper Suprime-Cam



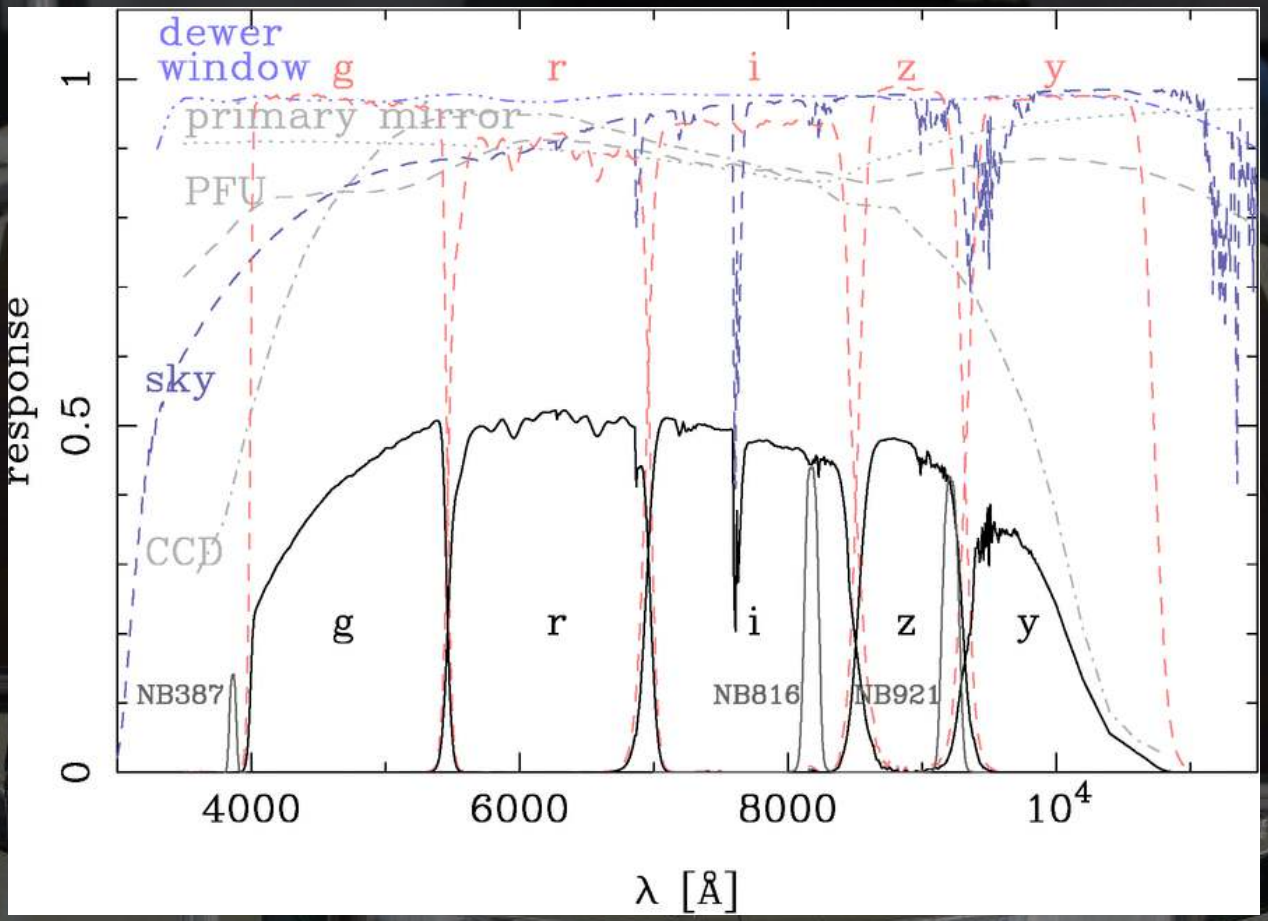

ACS/HST field of view

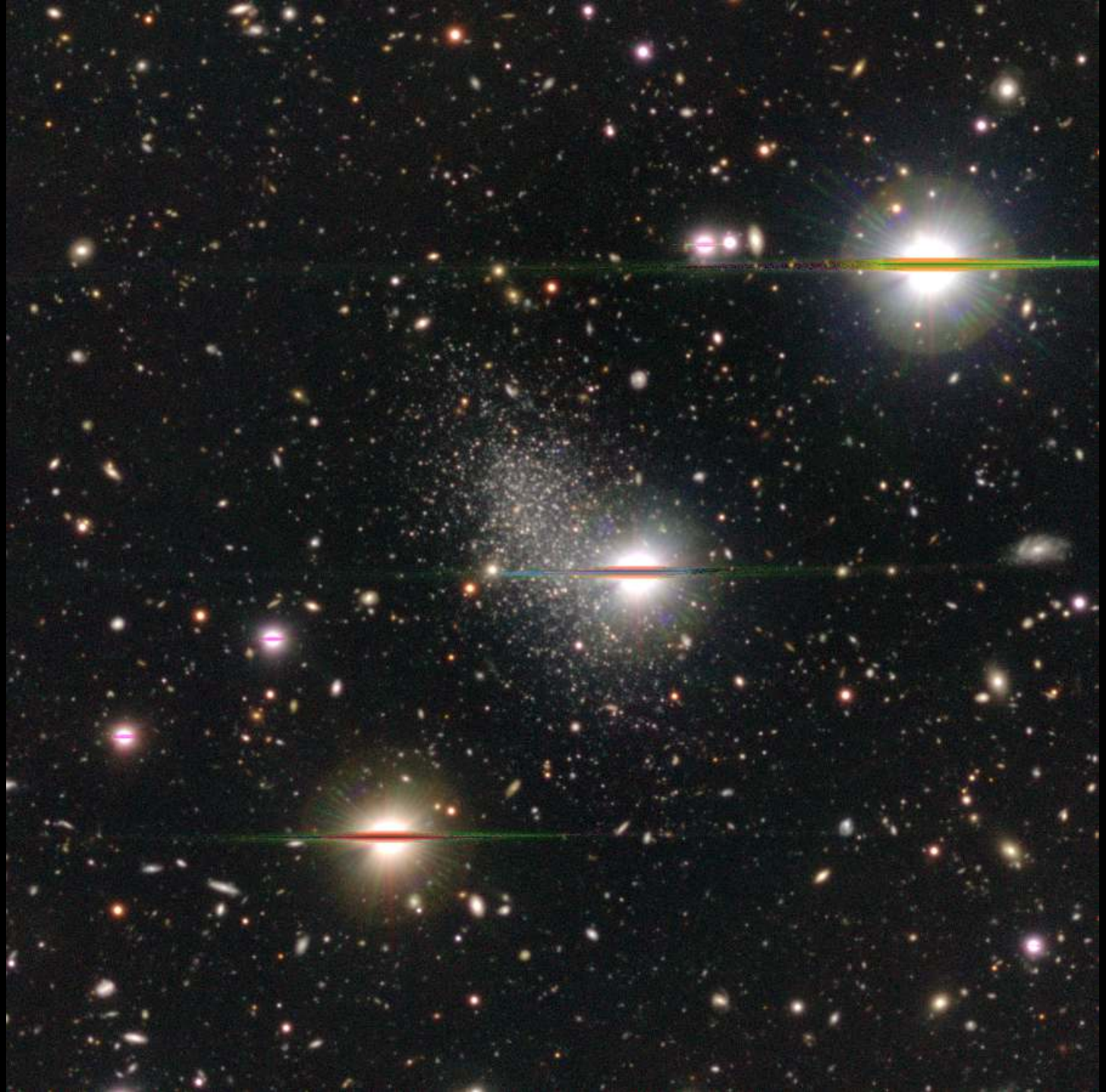
104 full depletion science CCDs. 12 CCDs for guiding and focusing.

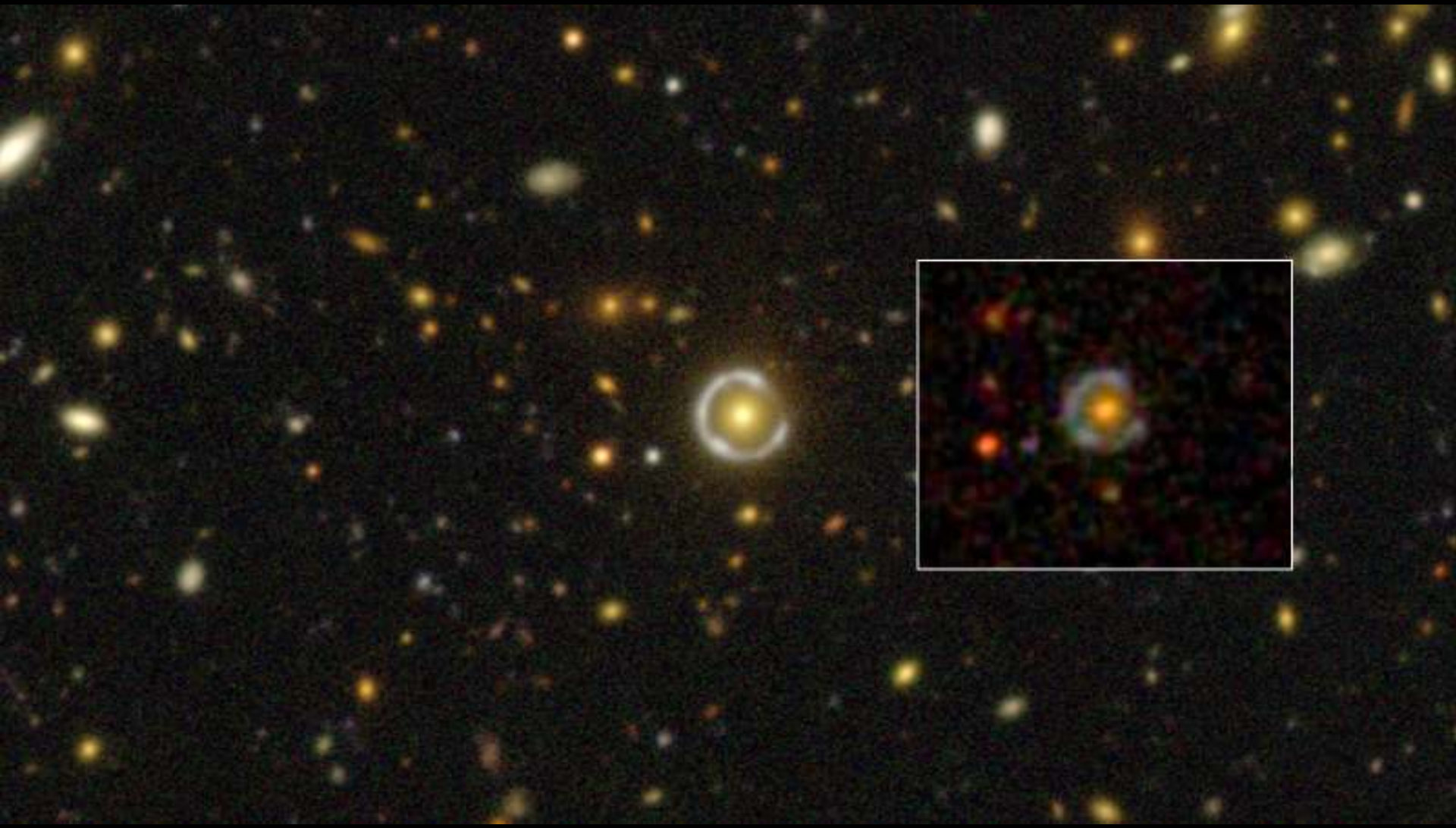


104 full depletion science CCDs. 12 CCDs for guiding and focusing.

HSC filter system
5 broad-band filters (grizy) and several narrow-band filters.







HSC Strategic Survey

Check out our website: http://hsc.mtk.nao.ac.jp/

Group photo from the HSC collaboration meeting at IPMU in August

Subaru Strategic Program

International collaboration of **all Japan**, Princeton, and Taiwan.

Over 170 scientists are putting efforts in a huge observing program of 300 nights over 5-6 years. The survey started in March 2014 and it is about 30% done.

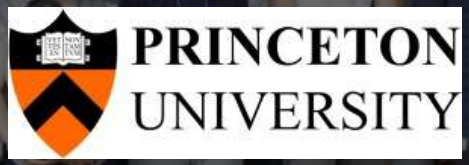
SSP proposal

Wide-field imaging with Hyper Suprime-Cam: Cosmology and Galaxy Evolution

A Strategic Survey Proposal for the Subaru Telescope

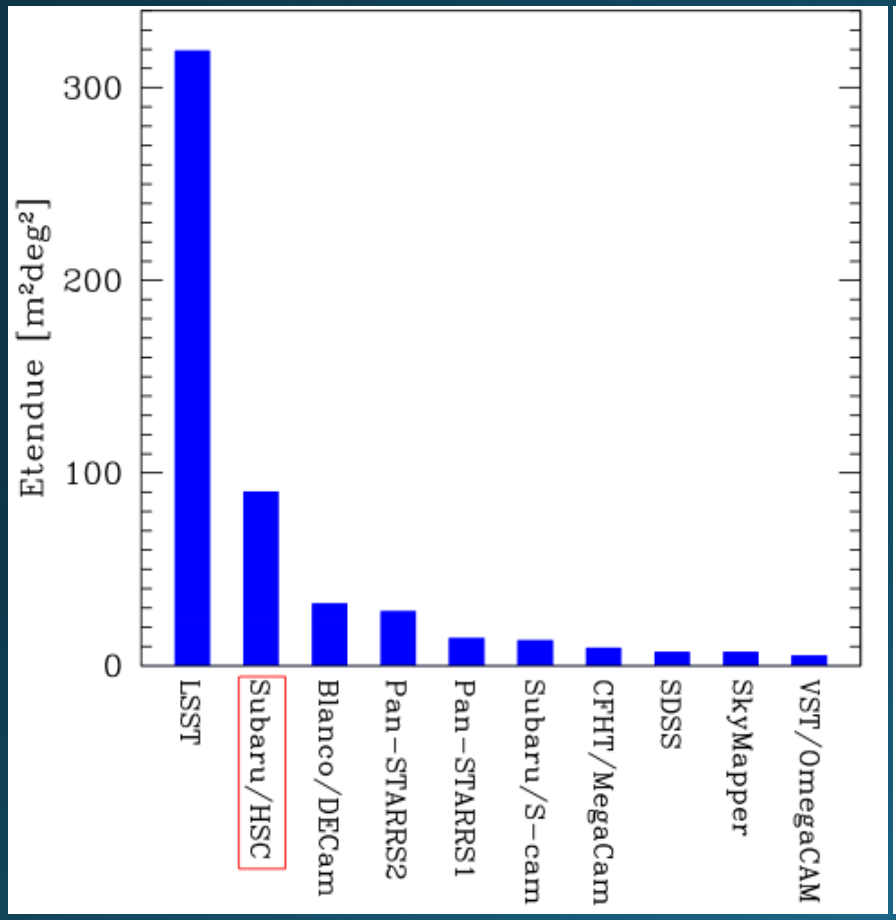
PI: Satoshi Miyazaki (NAOJ)
Co-PI: Ikuru Iwata (NAOJ)

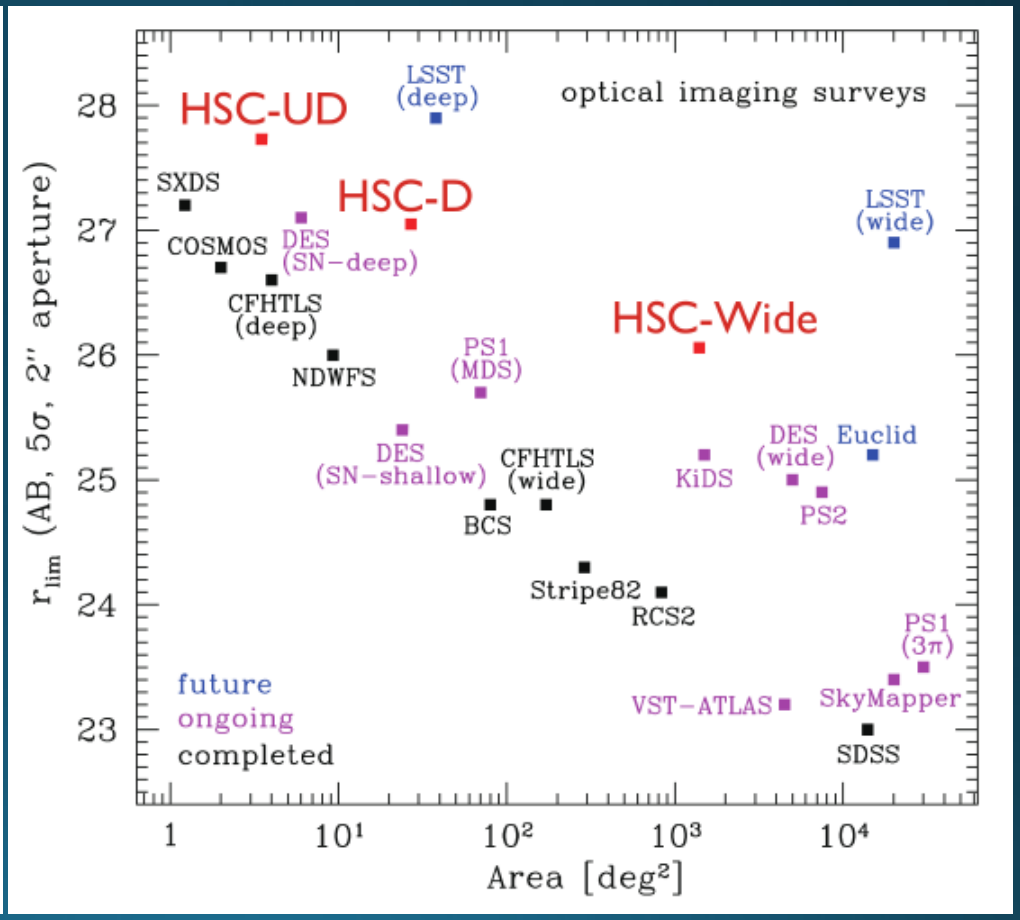
The HSC collaboration team[1]: S. Abe[31], H. Aihara*[21,13], M. Akiyama[59], K. Aoki[58], N. Arimoto*[18], N. A. Bahcall[60], S. J. Bickerton[61], J. Bosch[62], K. Bundy[13], C. W. Chen[7], M. Chiba[14], T. Chiba[63], N. E. Chisari[64], J. Coupon[7], M. Doi[2], M. Enoki[59], S. Foucaud[100], M. Fukagawa[29], H. Furusawa[18], T. Futamase[14], B. Gotz[65], T. Goto[11], J. E. Gunn[61], T. Hamana[18], T. Hashimoto[23], M. Hayashi[21], Y. Higuchi[23,13], C. Hikage[13,9], J. C. Hill[66], P. T. P. Ho*[67], B. C. Hsieh[7], K. Y. Huang[17], H. Ikeda[13], M. Imanishi[18], N. Inada[14], A. K. Inoue[12], W.-H. Ip[31], T. Ito[18], K. Iwasawa[16], M. Iye[18], H. Y. Jian[17], Y. Kakazu[18], H. Kanoji[13], N. Kashikawa[18], N. Katayama[13], T. Kawaguchi[19], S. Kawanomoto[18], I. Kayo[20], T. Kitayama[68], G. R. Knapp[69], T. Kodama[18], K. Kohno[13], M. Koike[59], E. Kokubo[18], M. Kokubo[23], Y. Komiyama[18], A. Konno[13], Y. Kurama[18], C. N. Lackner[70], D. Lang[61], A. Leauthaud[71], M. J. Lehner[7], K.-Y. Lin[7], L. Lin[7], Y.-T. Lin[17], C. P. Loomis[61], R. H. Lupton[61], P. S. Lykawka[72], K. Maeda[73], R. Mandelbaum[1,102], Y. Matsuda[18], K. Matsuoka[13,23], Y. Matsuoka[13], S. Mineo[74], T. Minezaki[13], H. Miyatake[26], R. Momose[75], A. More[13], S. Mori[23], T. J. Moriya[76], T. Morokuma[77], H. Murayama*[13], K. Nagamine[13,23], T. Nagao[13,23], S. Nagataki[13,23], Y. Naito[78], K. Nakajima[79], F. Nakata[18], H. Nakaya[18], T. Namikawa[13], C.-C. Ngeow[17], T. Nishimichi[13], H. Nishioka[17], A. J. Nishizawa[13,9], K. Nomoto[13], M. Oguri[13,9], A. Oka[75], N. Okabe[77], S. Okamoto[25], S. Okamura[26], J. Okamura[13], S. Okamura[27], Y. Okura[75], Y. Ono[13] M. Onodera[28], K. Ota[13,9], M. Ouchi[13,9], S. Oyabu[13,9], P. A. Price[61], R. Quimby[13], C. E. Rasi[75,13], S. Saito[80], T. Saito[13], Y. Saitou[75], M. Sato[13,9], T. Shibaya[13], K. Shimasaku[13,9], A. Shimono[13], S. Shiogi[13], M. Shirasaki[75], J. D. Silverman[13], D. N. Spergel*[61,13], M. A. Strauss[61], H. Sugai[18], N. Sugiyama[13,9,13], D. Suto[13], Y. Suto*[13], K. Tadaki[75], M. Takada[13,9], R. Takahashi[81], S. Takahashi[13], T. Takata[59], T. T. Takeuchi[13], N. Tamura[13], M. Tanaka[13], M. Tanaka[13,9], M. Tanaka[18], Y. Taniguchi[13,9], A. Tanya[13], T. Terai[18], Y. Terashima[13], N. Tominaga[13,9], J. Toshikawa[13,9], T. Totani[13,9], M. Tsai[17], E. L. Turner*[61], Y. Ueda[13,9], K. Umetsu[17], Y. Urata[17,13], Y. Utsumi[61], B. Vulcani[13], K. Wada[13,9], S.-Y. Wang[17], W.-H. Wang[17], T. Yamada[13], Y. Yamada[13], K. Yamamoto[13,9], H. Yamanoi[13], C.-H. Yan[17], N. Yasuda[13,9], A. Yonehara[13,9], F. Yoshida[13,9], N. Yoshida[13], M. Yoshikawa[13,9], S. Yuma[13,9] (1) NCU, Taiwan (2) Tokyo (3) Kavli IPMU (4) Tohoku (5) NAOJ (6) Princeton (7) ASIAA (8) Nihon (9) Tokyo Keizai (10) NTNU, Taiwan (11) DARK, Copenhagen (12) Nagoya (13) Ehime (14) NNCT (15) Osaka Sangyo (16) Barcelona (17) NTU, Taiwan (18) Chicago (19) Tsukuba (20) Tohoku (21) Kinki (22) CMU



boration meeting at IPMU in August

Survey power

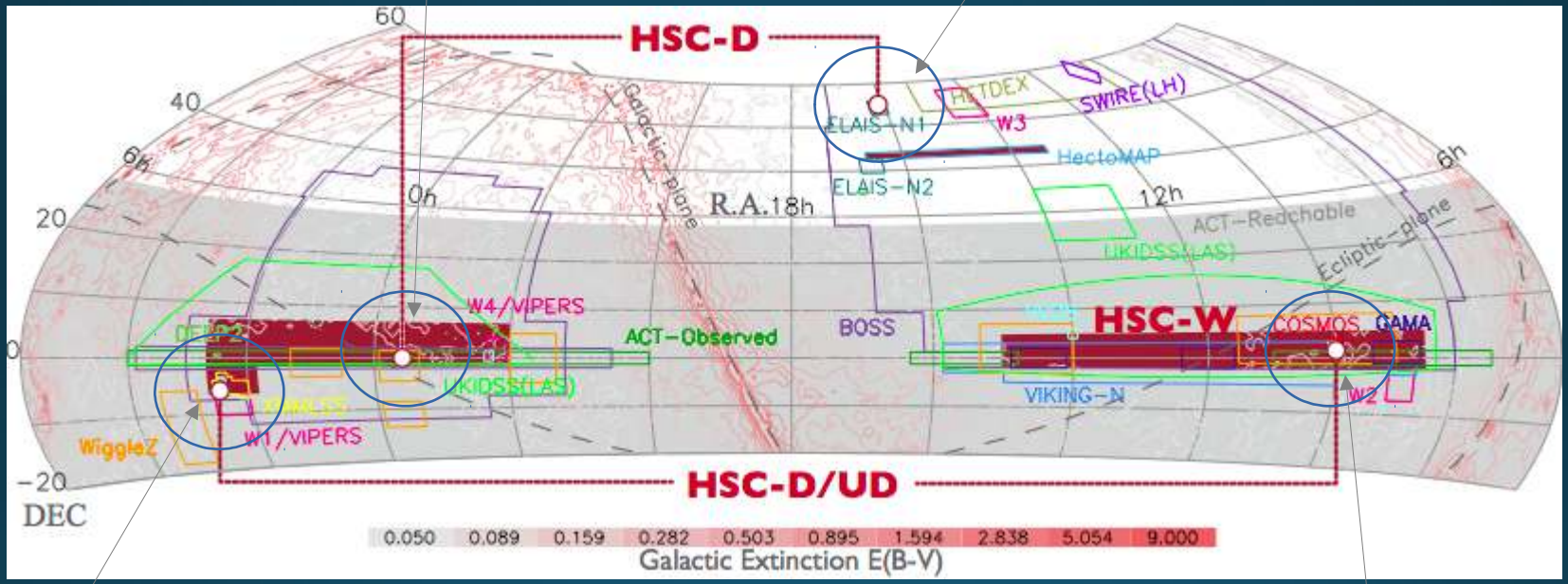




Survey fields

DEEP2-F3 (D)

ELIAS-N1 (D)



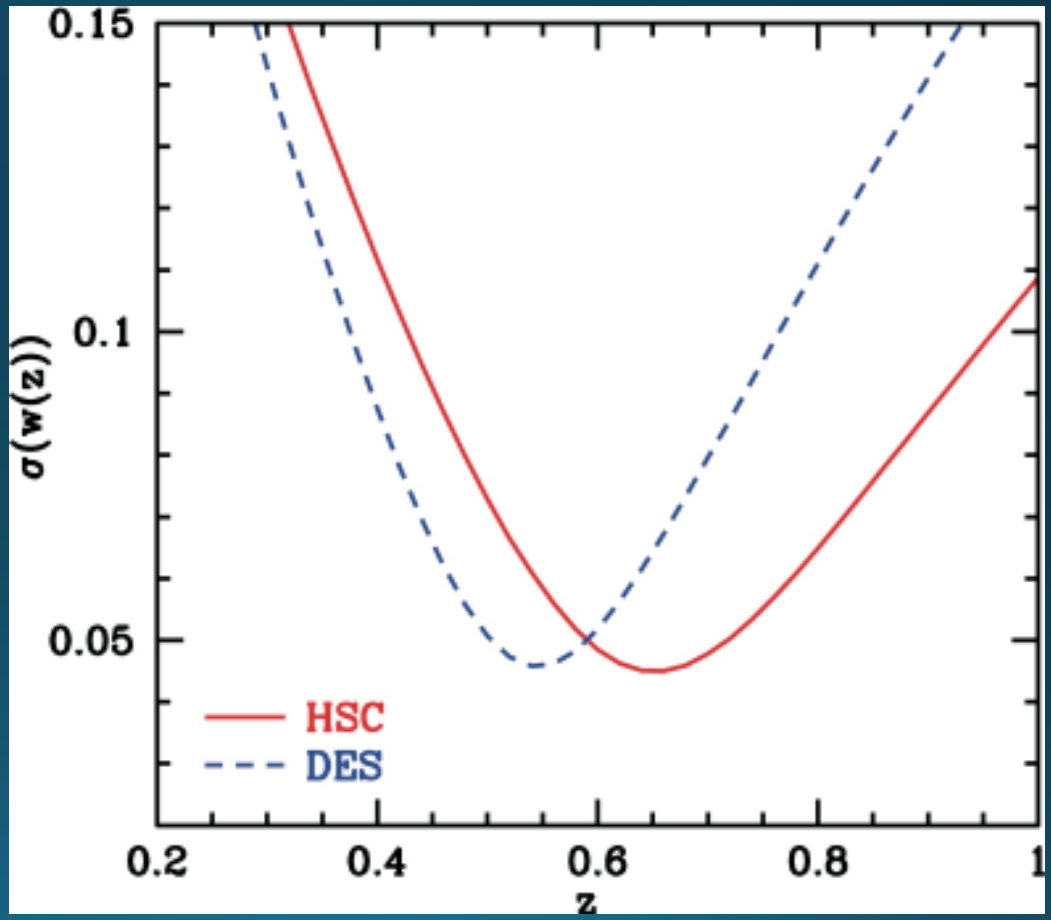
SXDS (UD)
XMMLSS (D)

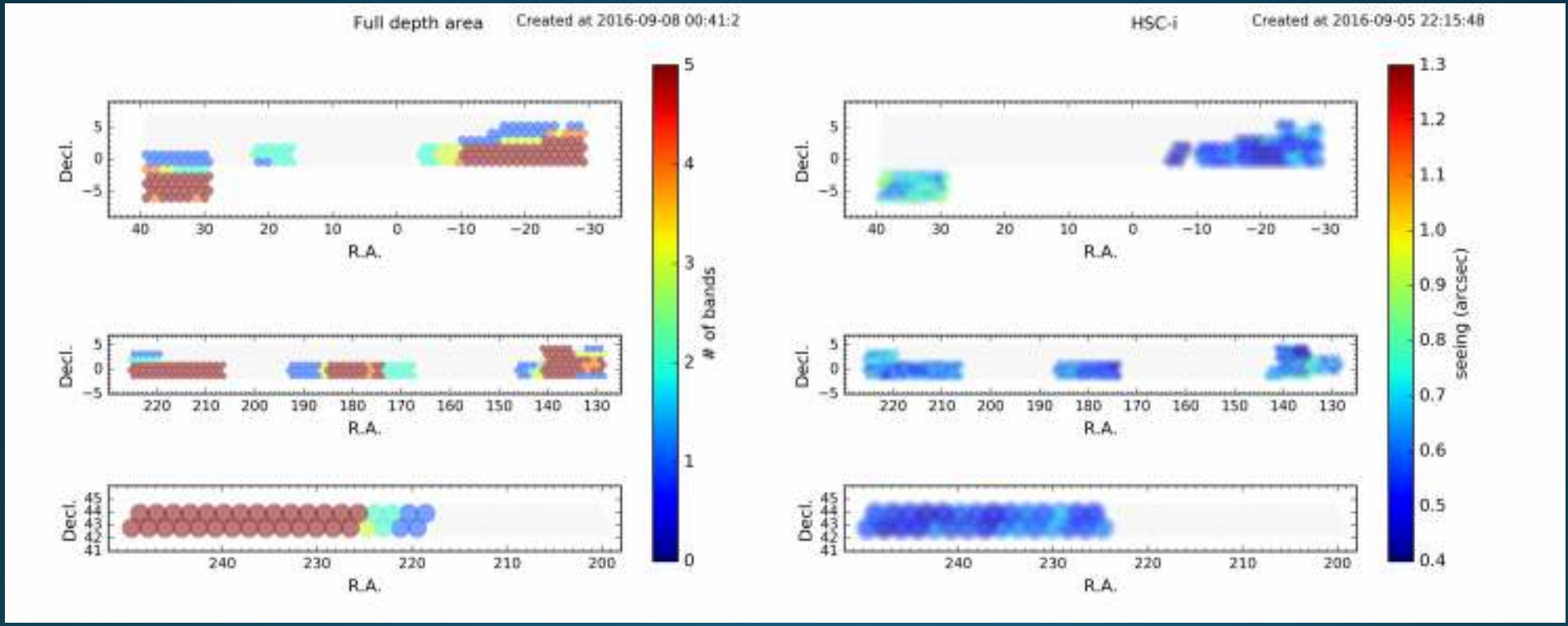
- Full overlap with SDSS
- Low dust extinction
- Wide R.A. range
- Overlap with other NIR, spec, etc surveys.

COSMOS (UD)
E-COSMOS (D)

Science goals

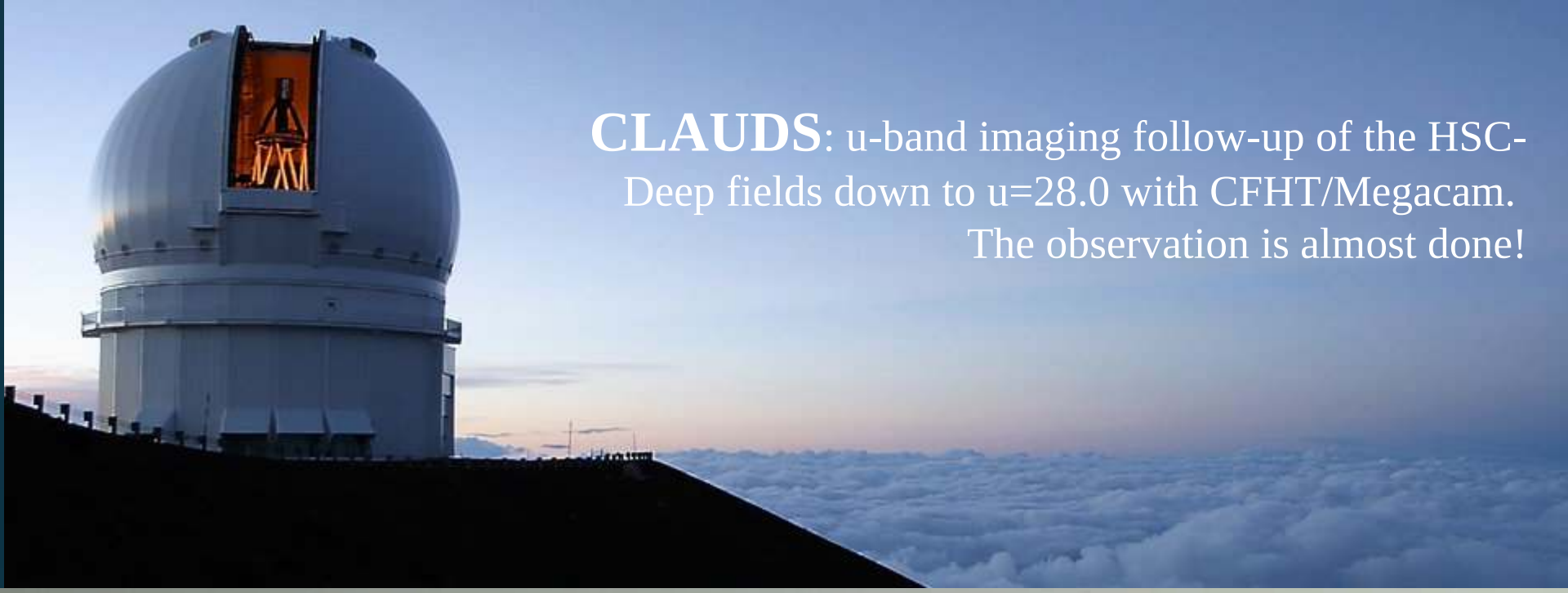
- **Weak-lensing cosmology**
- **High-redshift galaxies**
- **Galaxy evolution**
- Clusters of galaxies
- Transient objects
- Solar system bodies
- AGN/QSO
- Milky Way
- Strong lensing
- ...





Over 200 square degrees surveyed so far. Note the excellent seeing!

Figure courtesy: Yasuda-san.



CLAUDS: u-band imaging follow-up of the HSC-Deep fields down to u=28.0 with CFHT/Megacam.
The observation is almost done!

JHK follow-up of the HSC-Deep fields with UKIRT/WFCAM.
2 hours in each band. We are making good progress!

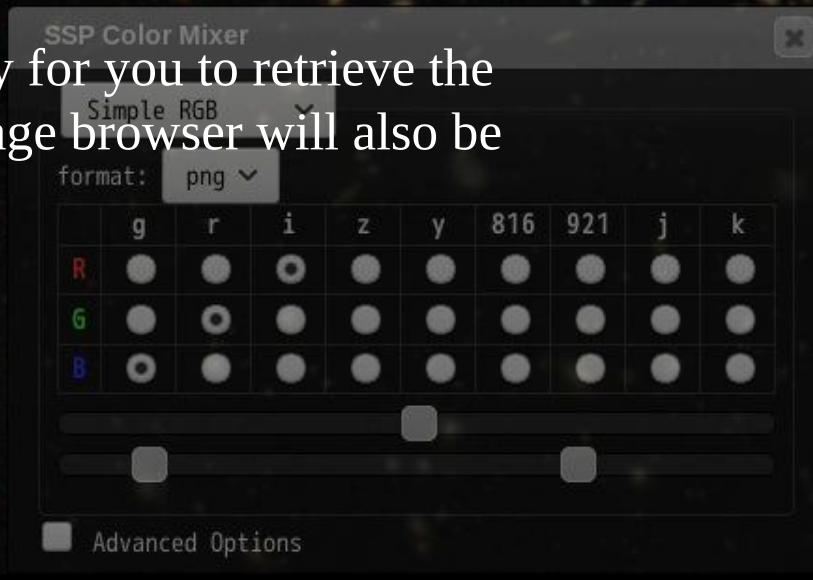
First public data release from HSC

We are going to make the first public data release ~February 2017!

The release will include data taken up to Nov 2015 and the processed images and catalogs as well as raw data will be made available to the community. We will release ~100 square degrees of full-color full-depth data.

User-friendly web interfaces make it easy for you to retrieve the data. A super useful googleMap-like image browser will also be extremely useful.

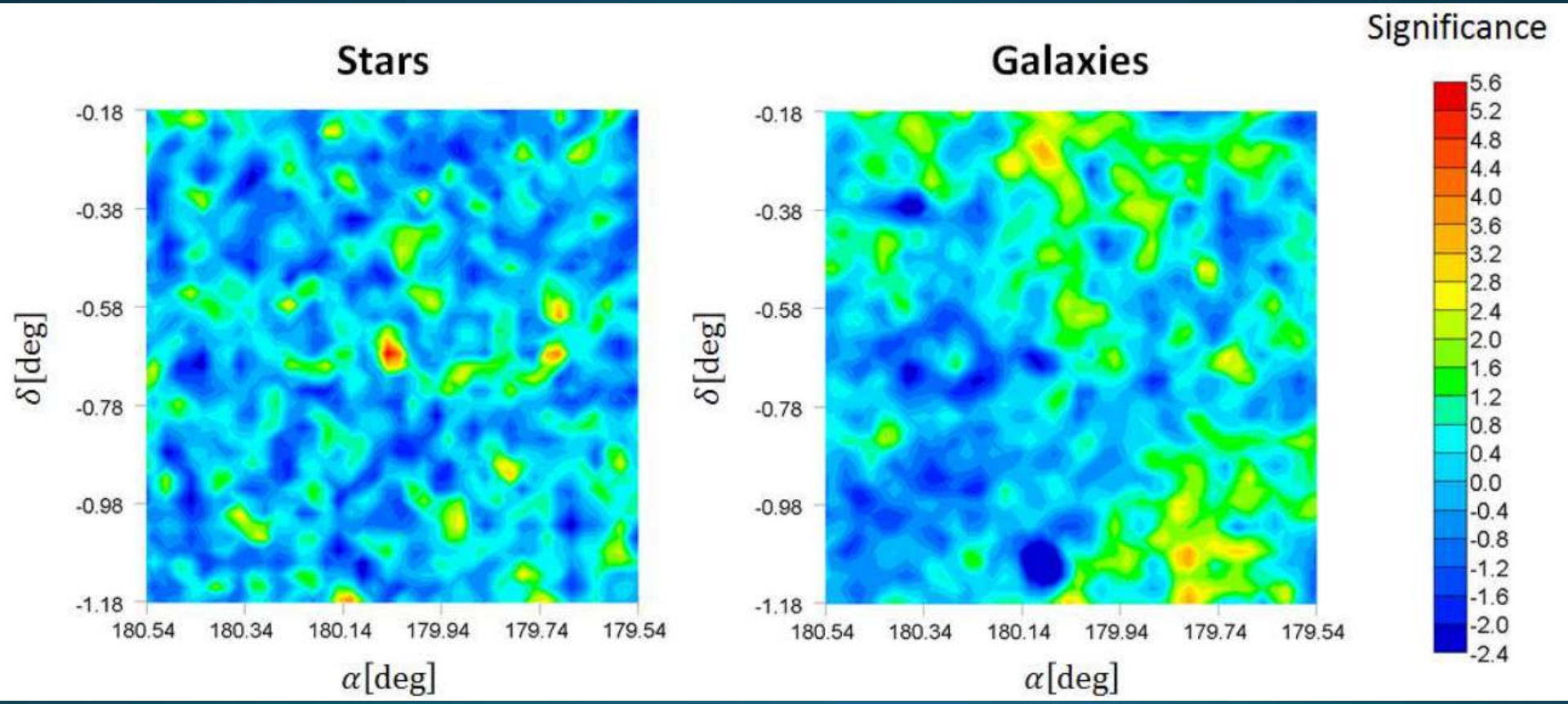
Stay tuned!



Early Science Results

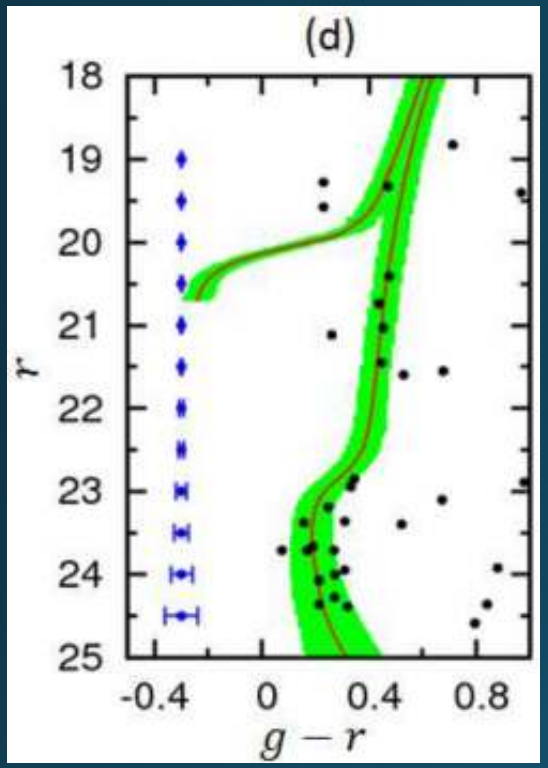
A special PASJ issue is being planned for a series of the first year science papers.

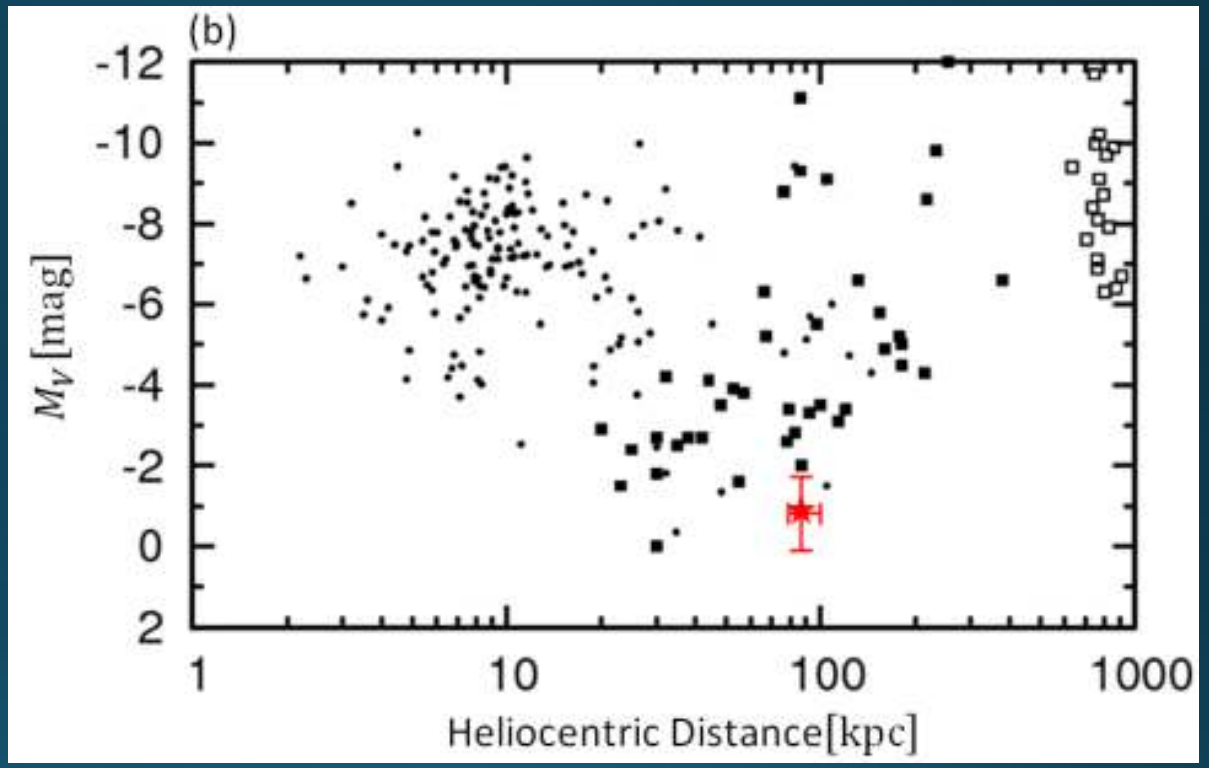
Virgo I – a new dwarf satellite of the Milky Way



Homma et al. ApJ in press (arXiv:1609.04346)

Virgo I – a new dwarf satellite of the Milky Way

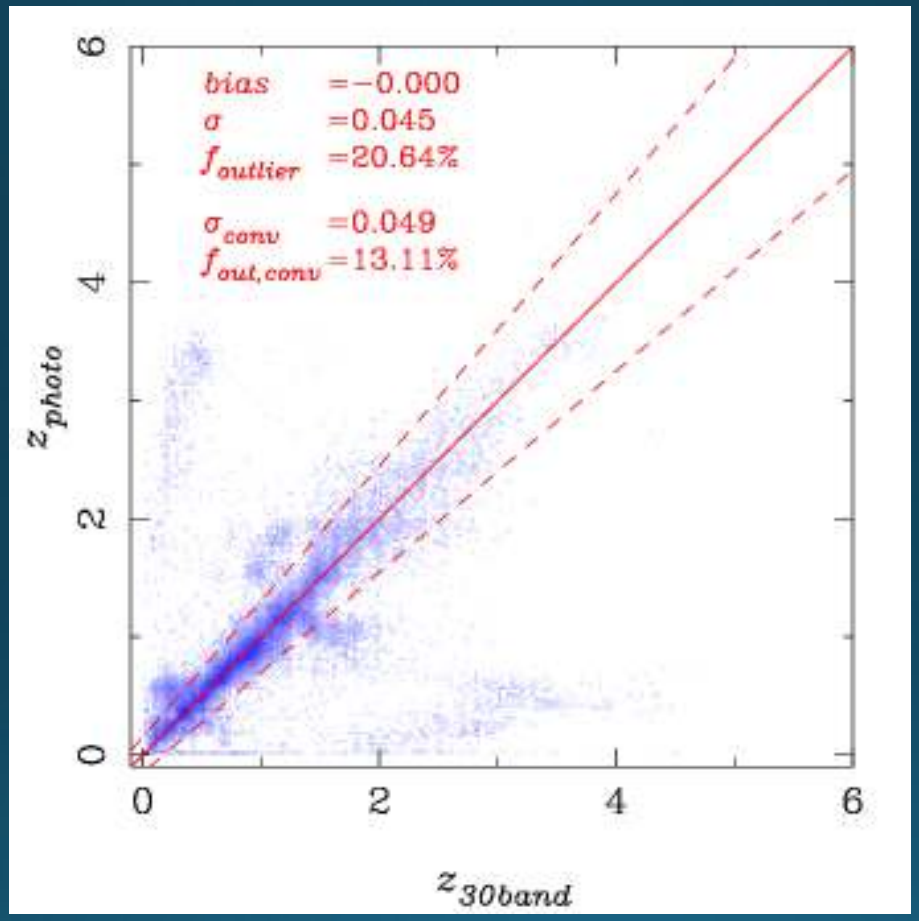




Virgo I is one of the faintest dwarf galaxy located at ~90kpc, demonstrating the power of the HSC survey.

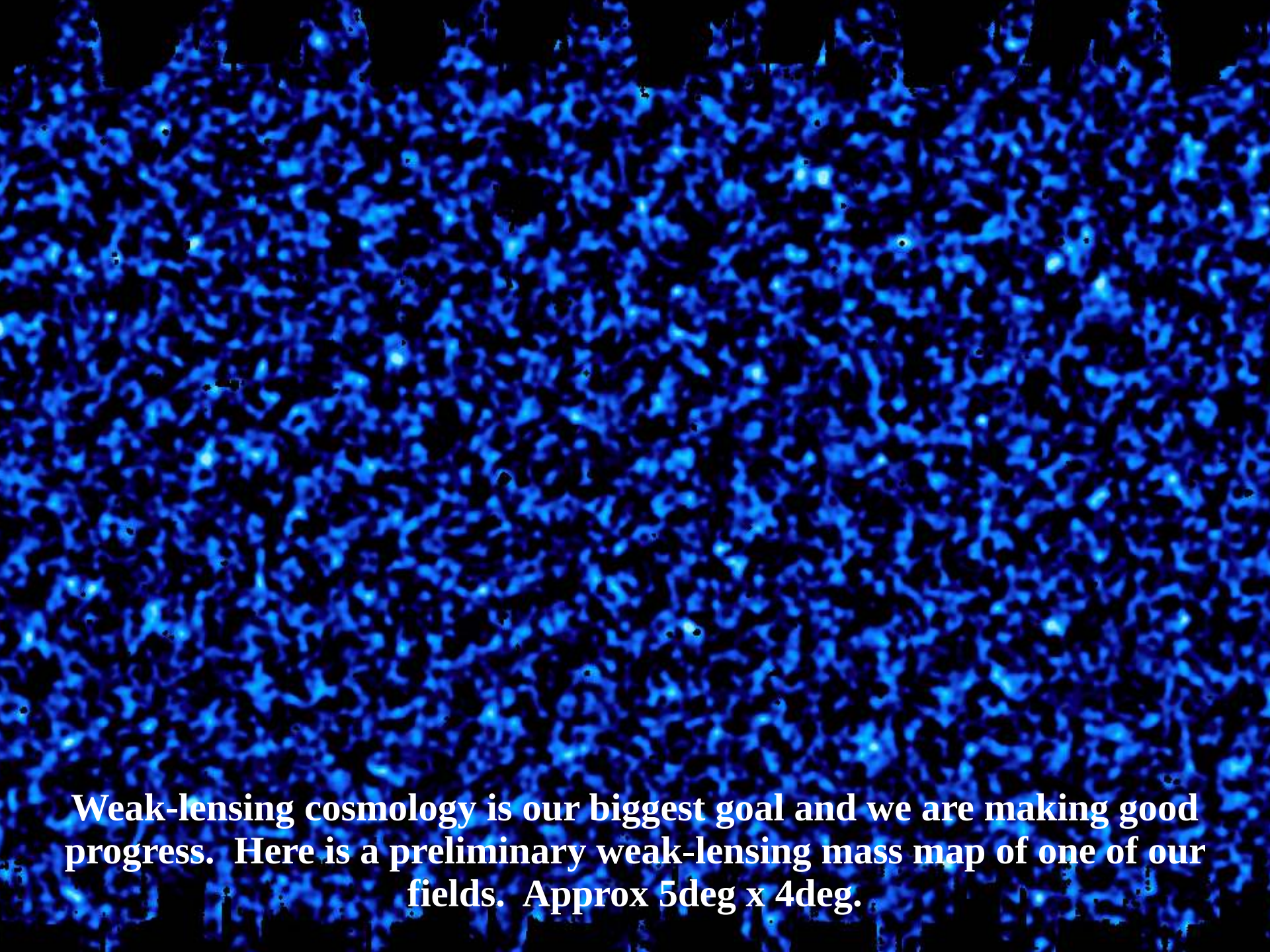
Homma et al. ApJ in press (arXiv:1609.04346)

Photometric redshifts



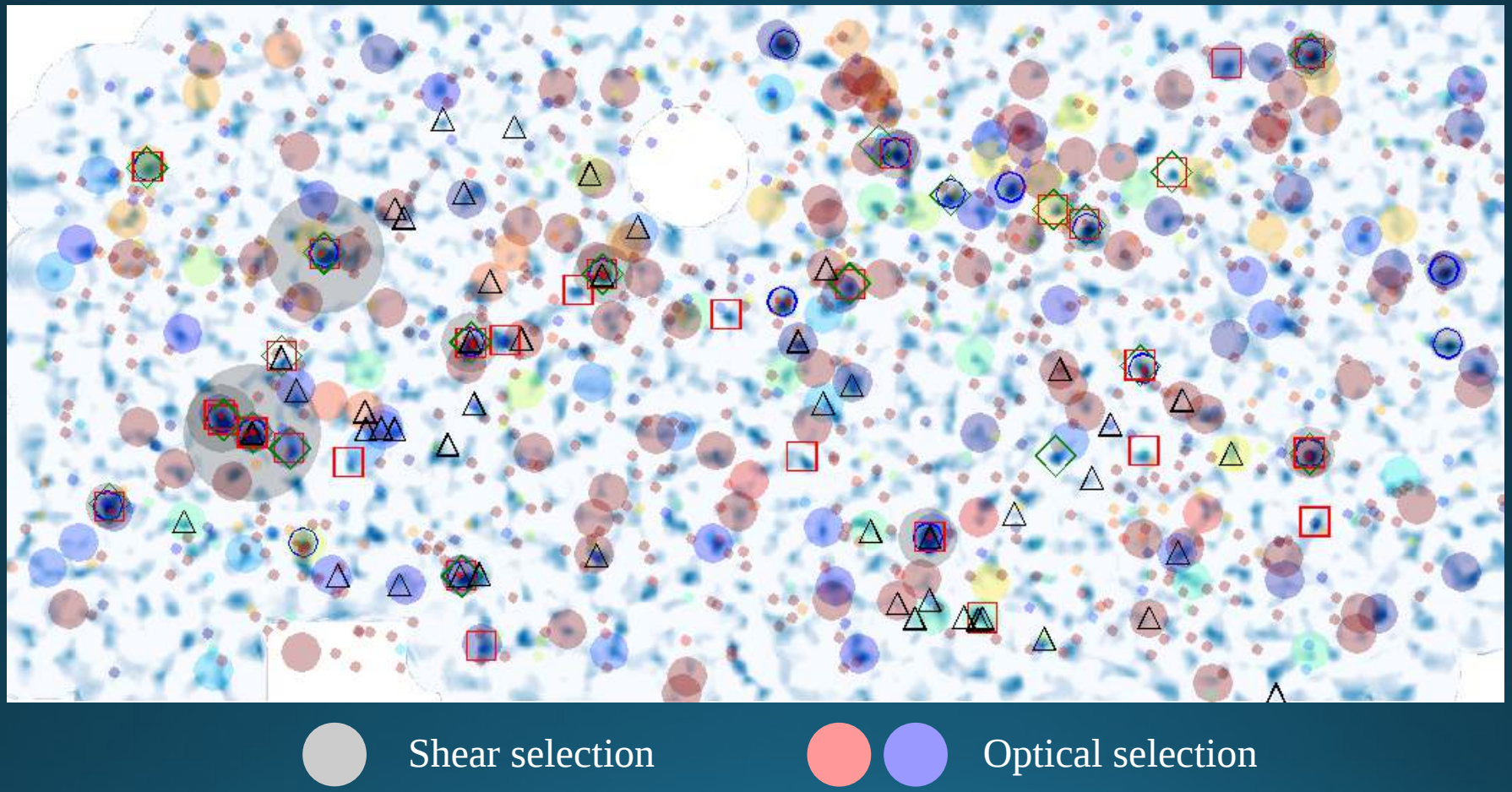
For objects outside of the Mikly Way, we need photometric redshifts. The lack of the u-band is a problem, but the performance based on the HSC photometry is not too bad.

Tanaka et al. in prep.



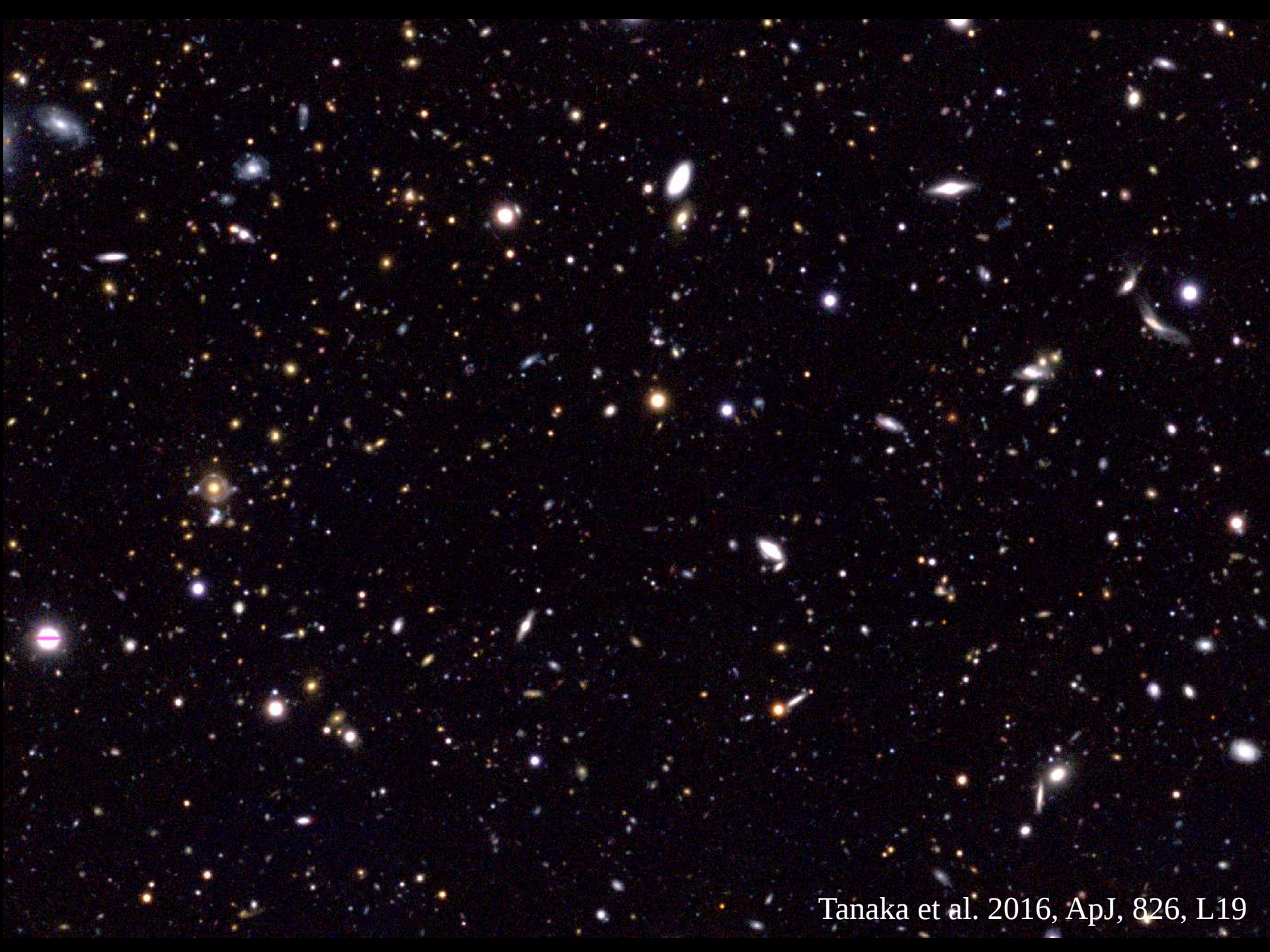
Weak-lensing cosmology is our biggest goal and we are making good progress. Here is a preliminary weak-lensing mass map of one of our fields. Approx 5deg x 4deg.

Agreement between weak-lensing and optical clusters

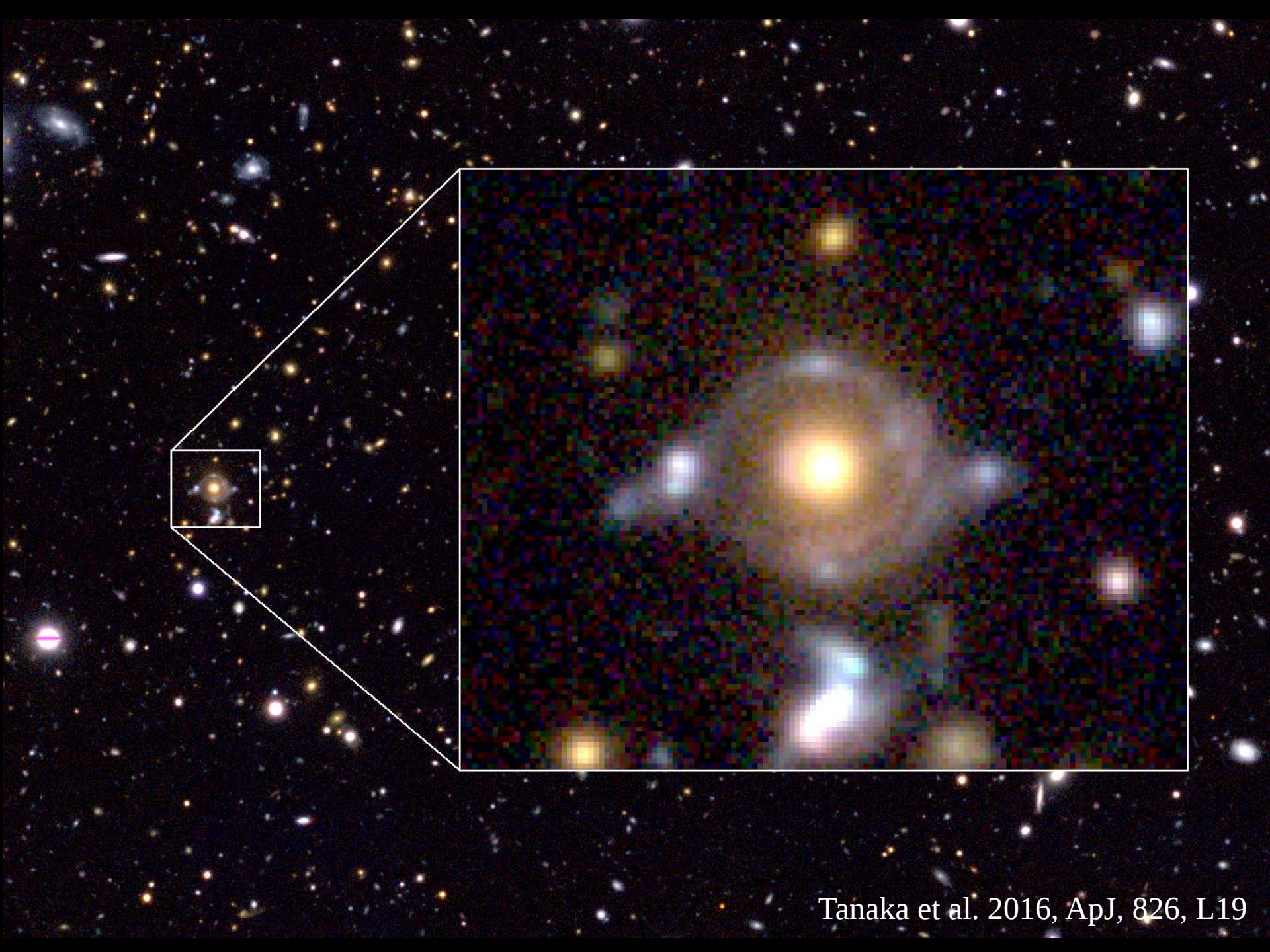


All of the S/N>5 weak-lensing clusters are optically detected.

Figure courtesy: S. Miyazaki, T. Hamana, M. Oguri



Tanaka et al. 2016, ApJ, 826, L19



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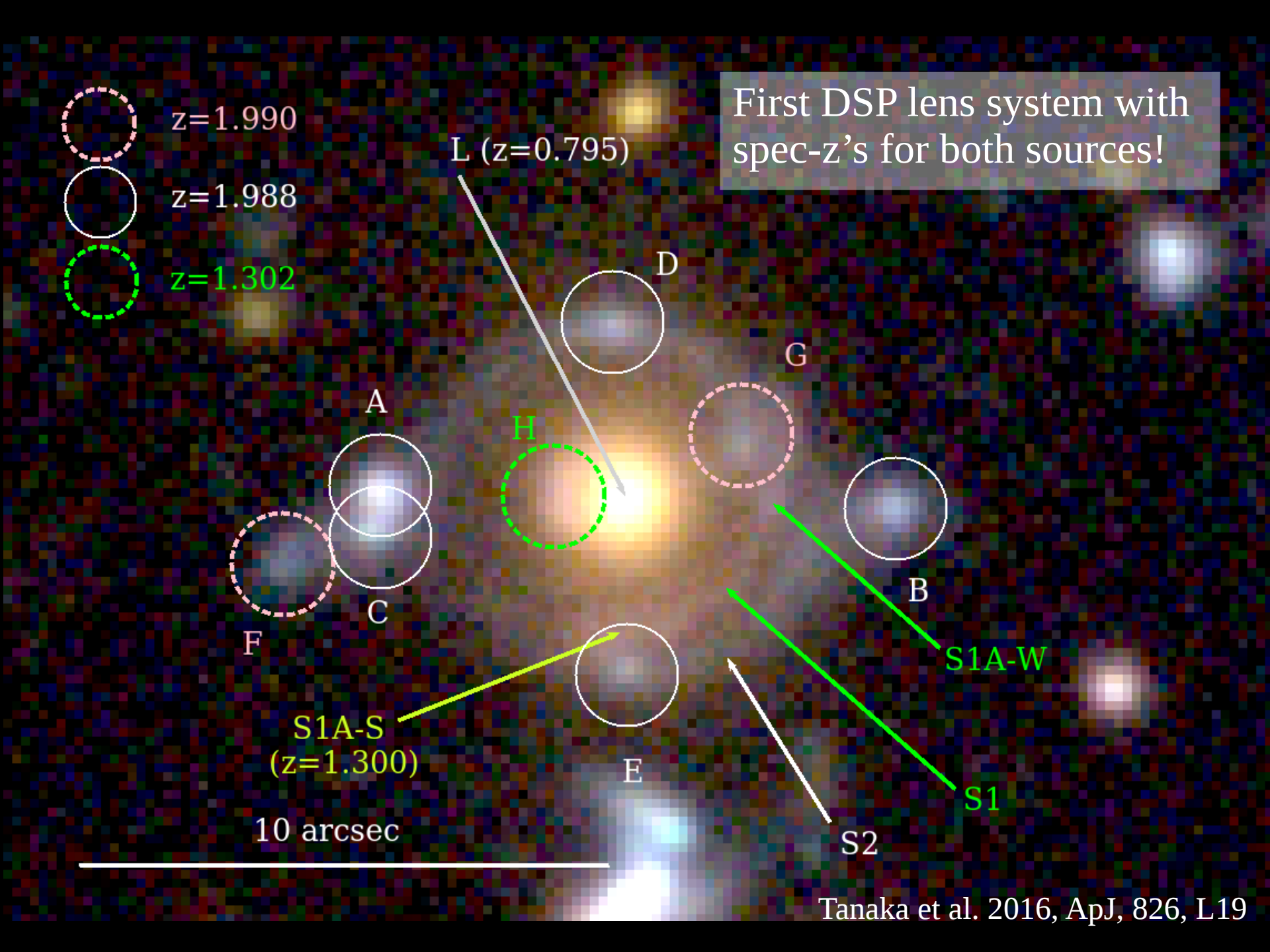
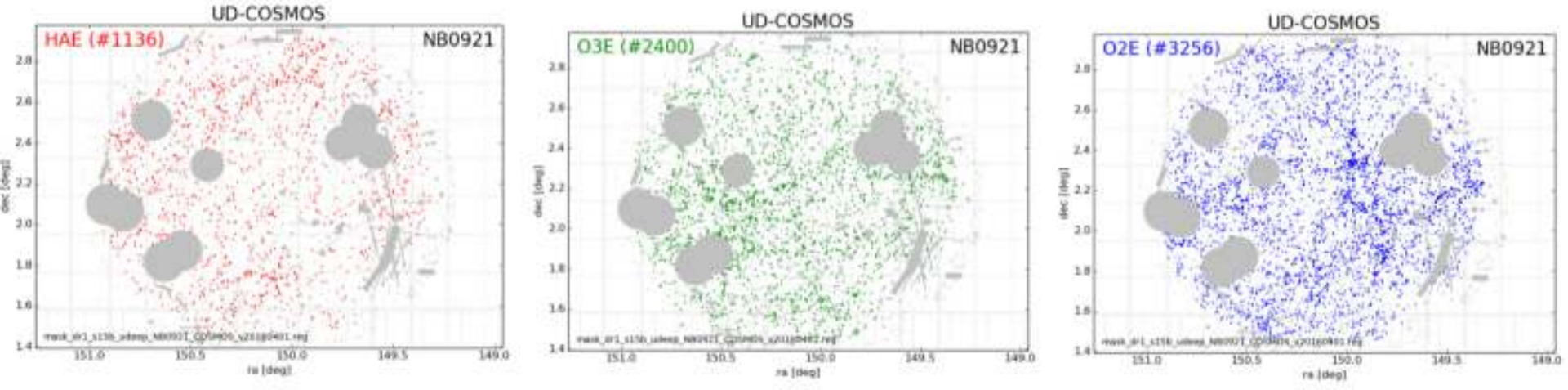


Tanaka et al. 2016, ApJ, 826, L19

Emission line objects

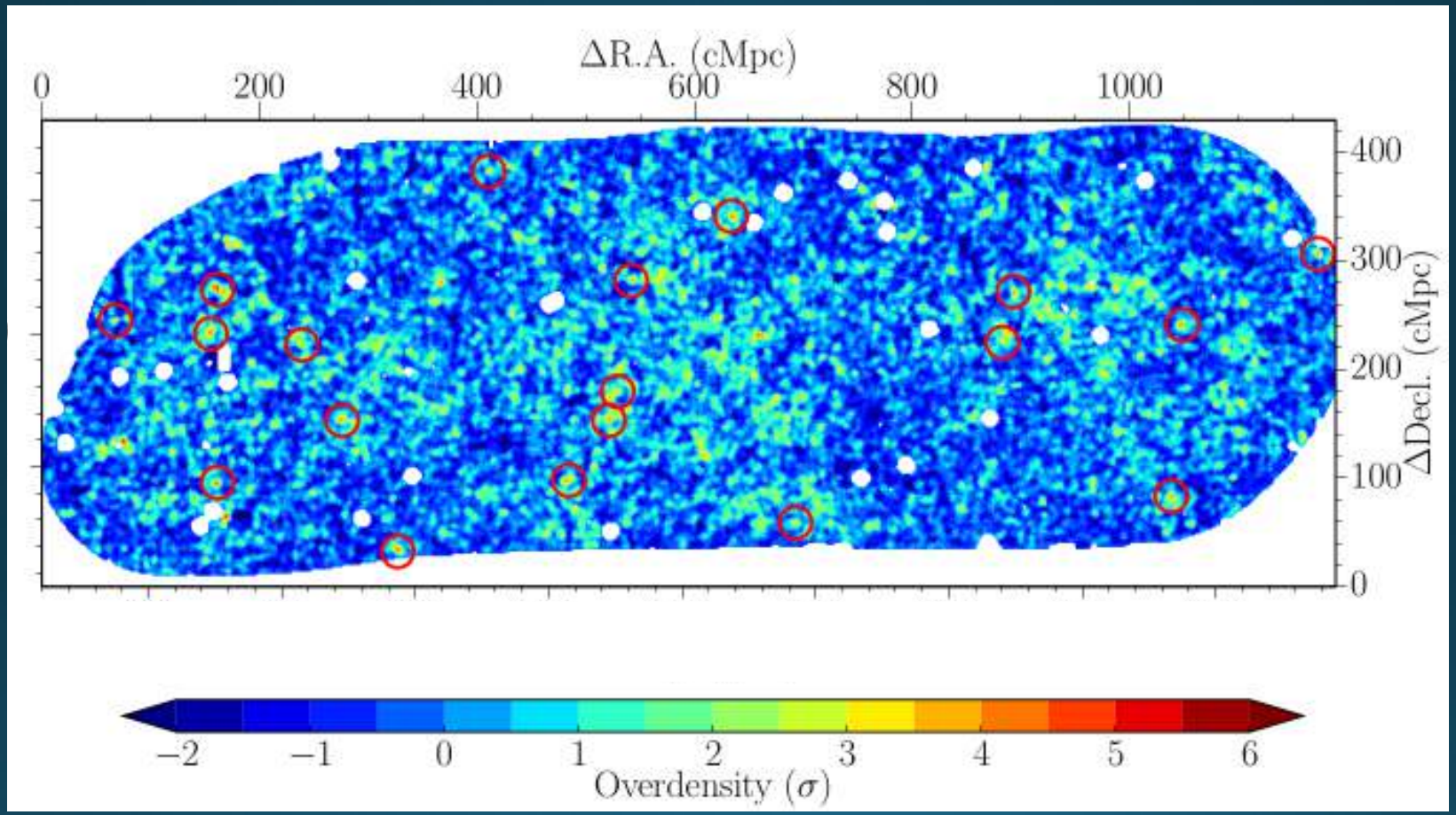
z~0.4 z~0.8 z~1.5



With the narrow-bands, we can detect emission line objects in narrow redshift slices to trace LSS as well as to study effects of LSS on galaxy evolution.

Hayashi et al. in prep.

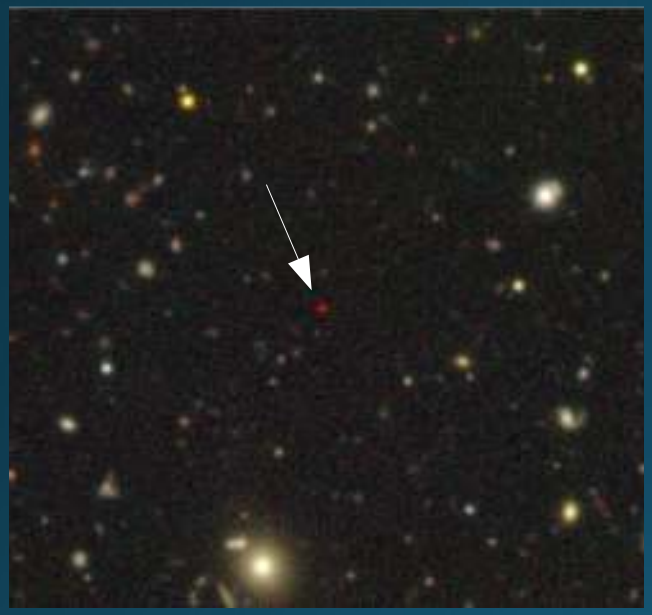
Proto-clusters traced by LBGs

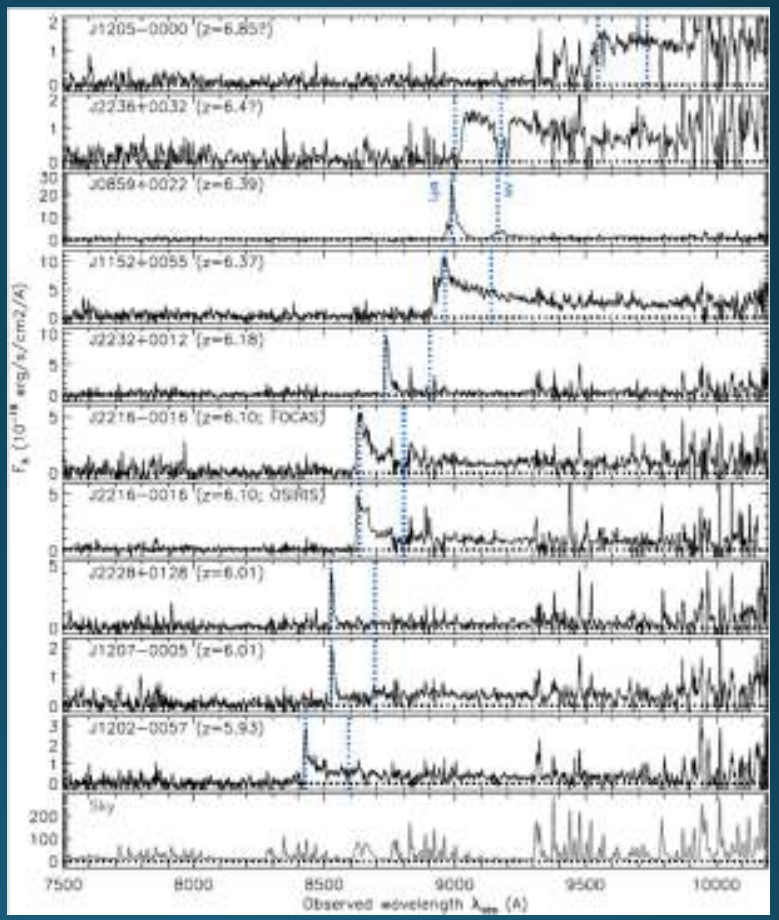


Over 100 proto-cluster candidates so far. Number density ~ 10^-7 Mpc^-3.
A preliminary clustering analysis suggests r_0~30 Mpc.

Toshikawa/Uchiyama et al. in prep.

High redshift QSOs





Intensive spectroscopic follow-up efforts are being made to confirm the QSO candidates and also to study the nature of SMBHs at high redshifts.

Matsuoka et al. 2016, ApJ

Supernova survey in COSMOS and UDS

Intensive transient surveys are gong to be executed over the next 1 year on COSMOS and UDS.

All transient objects will be detected; AGNs, Type I's and II's, SLSNe, tidal distruptin, etc. We will detect a lot of high-z Sne.

Type Ia's at z>1 are a powerful probe of cosmology and follow-up HST imaging (~100 orbits) and some ground-based spectroscopic follow-up time has been granted. We also expect to detect SLSNe out to z~4.

...and many more!

Work in progress on

- Very massive galaxies
- Ultra Diffuse Galaxies (UDGs)
- Green peas
- Very bright Lyman alpha emitters
- Very bright Lyman break galaxies
- Solar system bodies
- Dust Obscured Galaxies (DOGs)
- QSO-galaxy cross correlation
- Hosts of radio galaxies
- Galaxy-scale strong lensing
- Cluster-scale strong lensing
- Stellar tidal streams around nearby galaxies
- Blue Horizontal Branch stars to probe the MW halo
- etc, etc, etc...

Summary

Summary

- The HSC survey is a 300-night survey at the Subaru Telescope started about 2.5 years ago.
- The survey is 30% done as of today. We are making good progress!
- Check out our website for the details of the survey, http://hsc.mtk.nao.ac.jp/
- A number of early science papers have been published already; from the discovery of a new MW dwarf galaxy to the discovery of high-z QSOs.
- We are planning a PASJ special issue with technical and science papers, which will be published mid-2017.
- The first public data release of the HSC data will happen early next year. Stay tuned!