Overview and Recent results from HSC

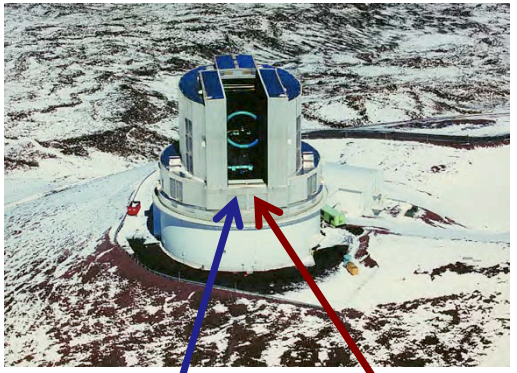
Masahiro Takada (Kavli IPMU)
on behalf of HSC collaboration

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE
東京大学 THE UNIVERSITY OF TOKYO
wpi

Photo-z WS @ Sendai, May 2017

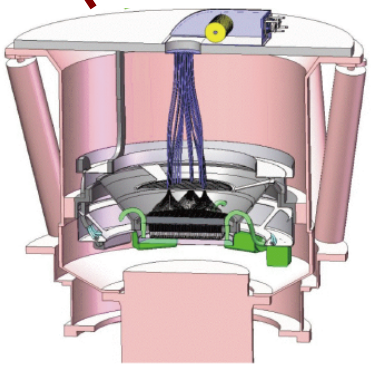
Imaging and spectroscopic surveys with Subaru

- Build wide-field camera (Hyper Suprime-Cam) and wide-field multi-object spectrograph (Prime Focus Spectrograph) for the Subaru Telescope (8.2m)
- HSC imaging survey since 2014
- PFS survey will start around 2020
- Keep the Subaru Telescope a world-leading telescope in the TMT era
- Precise images of 1B galaxies
- Measure distances of ~4M galaxies

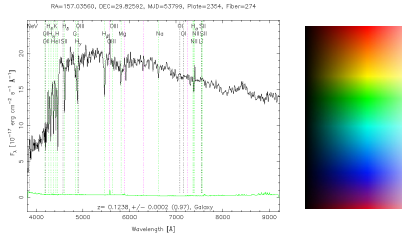


Subaru (NAOJ)

HSC



PFS



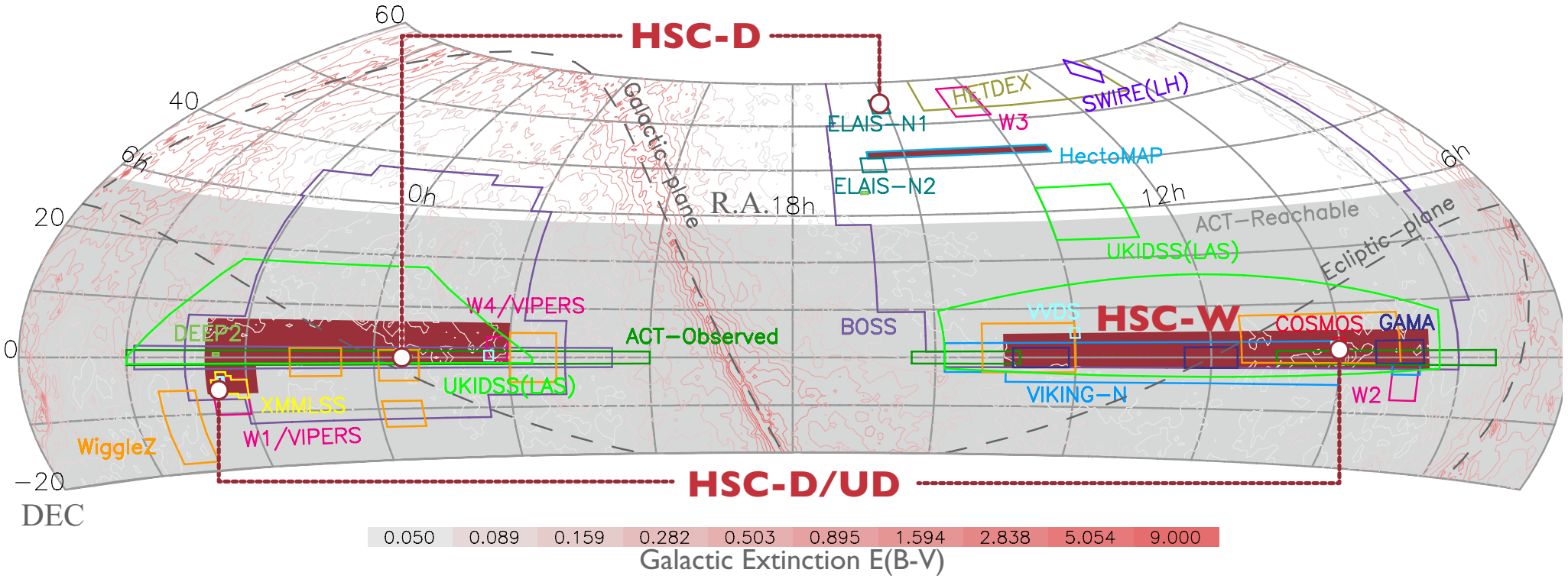
HSC SSP survey since 2014

PI: S. Miyazaki
(NAOJ)

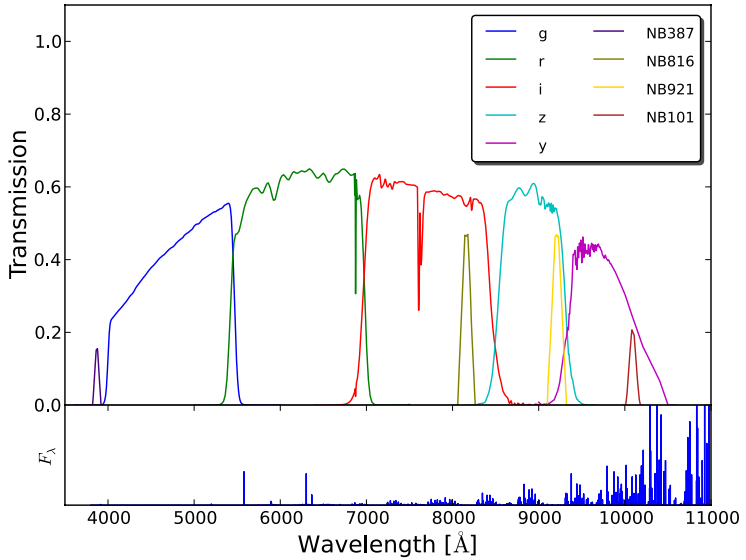
International collaboration (Japan, Taiwan, Princeton U.)

Subaru 300 nights already granted

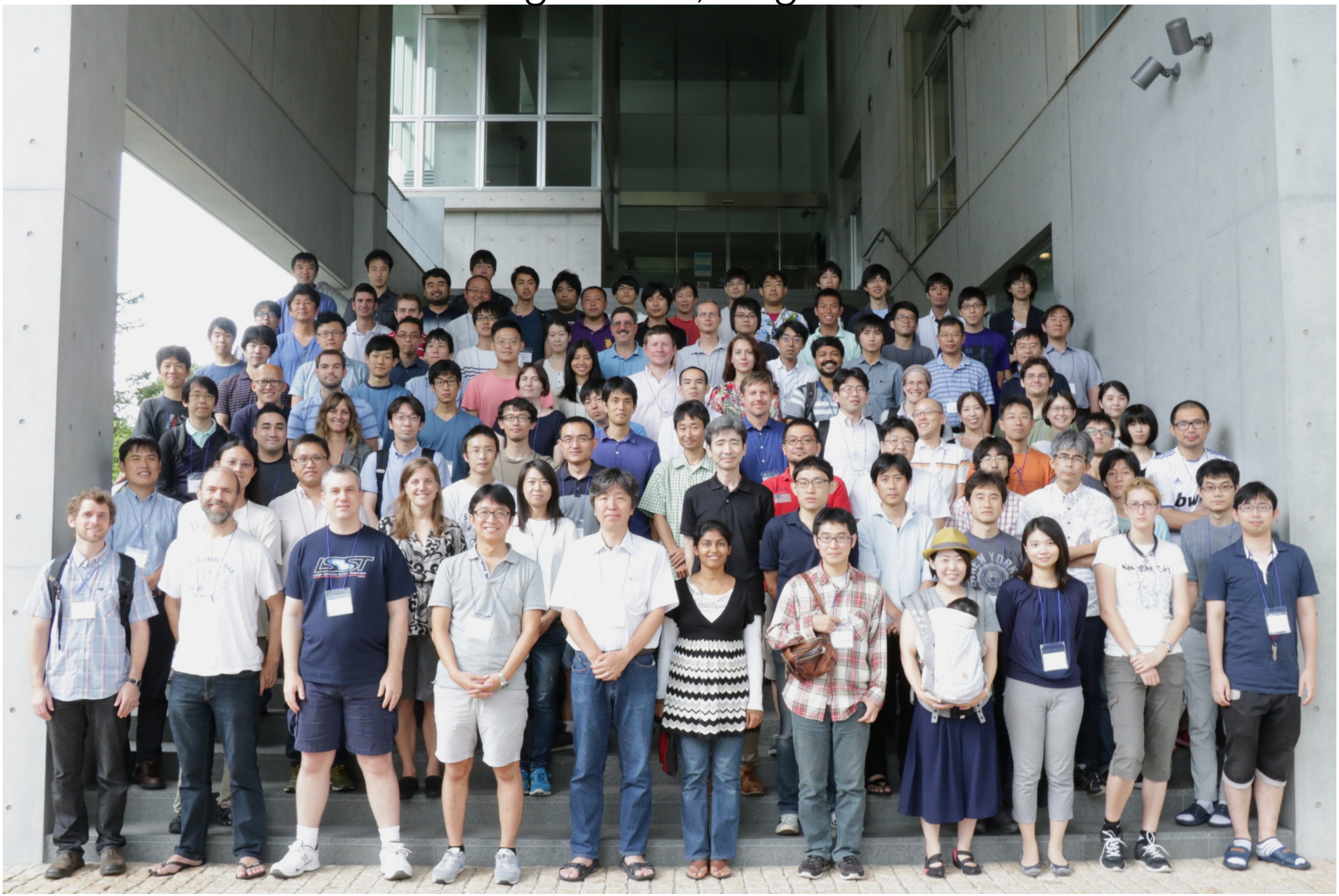
HSC SSP Survey Fields



- Three-layer survey
- Wide:1400 sq. deg, grizy (i~26)
- Deep: 26 sq. deg, grizy (i~27)+3NBs
- UltraDeep: 3.5 sq. deg., grizy (i~28)+3NBs



HSC collaboration meeting@IPMU, Aug 2016 ~300 Cols



First Data Release (DR1) of HSC SSP
28 Feb, 2017

~60 Subaru nights, ~100 sq. deg., ~10^8 objects ≃10yrs SDSS

A series of science papers will come out this April

First Public Data Release by the Hyper Suprime-Cam Subaru Strategic Program

February 28, 2017 | Topics

DR1 paper: Aihara et al. (M. Tanaka): arXiv:1702.08449
Survey overview paper: arXiv:1704.05858
Camera paper (S. Miyazaki): soon come

Masayuki Tanaka
(NAOJ)

Publ. Astron. Soc. Japan (2014) 00(0), 1-
doi: 10.1093/pasj/xxx

First Data Release of the Hyper Suprime-Cam Subaru Strategic Program

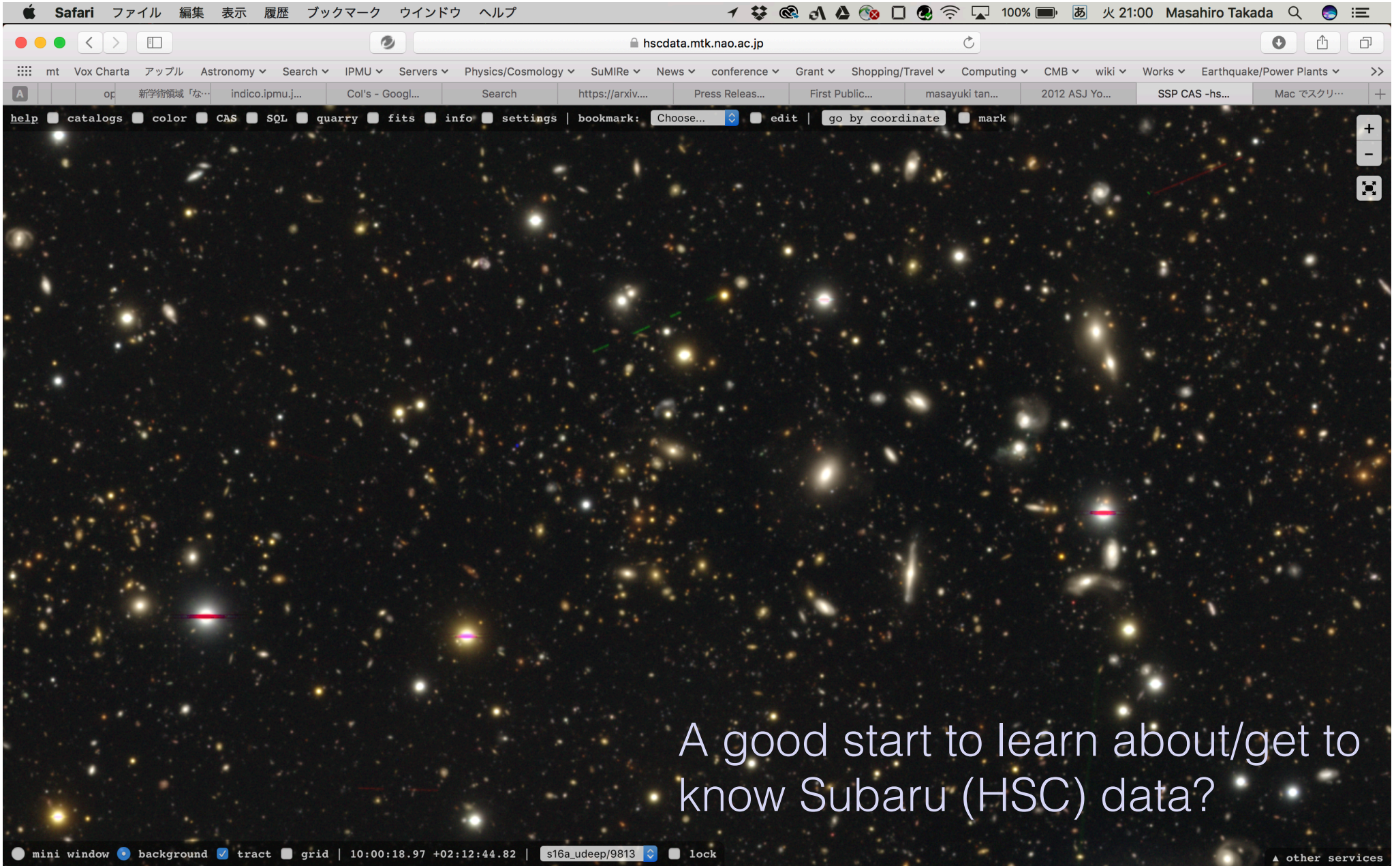
Hiroaki Aihara[1], Robert Armstrong[2], Steven Bickerton[3], James Bosch[2], Jean Coupon[4], Hisanori Furusawa[5], Yusuke Hayashi[5], Hiroyuki Ikeda[5], Yukiko Kamata[5], Hiroshi Karoji[6,2], Satoshi Kawanomoto[5], Michitaro Koike[5], Yutaka Komiyama[5,7], Robert H. Lupton[2], Sogo Mineo[5], Hironao Miyatake[8,9], Satoshi Miyazaki[5,7], Tomoki Morokuma[10,9], Yoshiyuki Obuchi[5], Yukie Oishi[5], Yuki Okura[11,12], Paul A. Price[2], Tadafumi Takata[5,7], Manobu M. Tanaka[13], Masayuki Tanaka[5,*], Yoko Tanaka[14], Tomohisa Uchida[13], Fumihiro Uraguchi[5], Yousuke Utsumi[15], Shiang-Yu Wang[16], Yoshihiko Yamada[5], Hitomi Yamanoi[5], Naoki Yasuda[9], Nobuo Arimoto[14,7], Masashi Chiba[17], Francois Finet[14], Hiroki Fujimori[18], Seiji Fujimoto[19], Junko Furusawa[5], Tomotsugu Goto[20], Andy Goulding[2], James E. Gunn[2], Yuichi Harikane[19,21], Takashi Hattori[14], Masao Hayashi[5], Krzysztof G. Hełminiak[22], Ryo Higuchi[19], Chiaki Hikage[9], Paul T.P. Ho[16,23], Bau-Ching

Release	Date	Layer	N filter	Area (deg^2)	Files (TBytes)	N object	Version hscPipe
Public Data Release 1	2017-02-28	UltraDeep	7	4	8.6	3,225,285	4.0.1
		Deep	7	26	16.6	15,959,257	4.0.1
		Wide	5	108 (100)	57.1	52,658,163	4.0.1
S14A0	2014-09-04	UltraDeep	5	2	2.2	880,792	2.12.4a
		Wide	2	24	2.6	10,548,142	2.12.4a
S14A0b	2015-02-10	UltraDeep	5	4	6.4	2,183,707	2.12.4d
		Wide	5	94 (23)	18.6	63,954,672	3.4.1
S15A	2015-09-01	UltraDeep	6	4	7.2	2,973,579	3.8.5
		Deep	6	24	17.7	14,747,568	3.8.5
		Wide	5	203 (82)	40.7	64,073,662	3.8.5
S15B	2016-01-29	UltraDeep	7	4	8.6	3,225,285	4.0.1
		Deep	7	26	16.6	15,959,257	4.0.1
		Wide	5	413 (111)	145.2	157,423,778	4.0.1
S16A	2016-08-04	UltraDeep	7	4	7.5	3,208,918	4.0.2
		Deep	7	28	8.0	16,269,129	4.0.2
		Wide	5	456 (178)	245.0	183,391,488	4.0.2

Table 3. Summary of this public release and previous internal data releases. The area is estimated by using HEALPix index system ($N_{side} = 2^{11}$) and mosaicking information from the pipeline processing. The 5th column gives the survey area in square degrees. The full-color full-depth area in the Wide survey is shown in the parenthesis. Only the full-color full-depth Wide area is included in this release, but the area in the brackets in the top row is smaller than the total area. This is primarily because the release area is determined on a patch by patch basis, but a fraction of the area in the patches on the field borders actually do not reach the full depth. The 7th column shows the number of objects; since the deblender became functional in the S15A release, the numbers for the subsequent releases are for primary objects (`detect_is_primary`=True; see Section 4.3).

http://hsc.mtk.nao.ac.jp

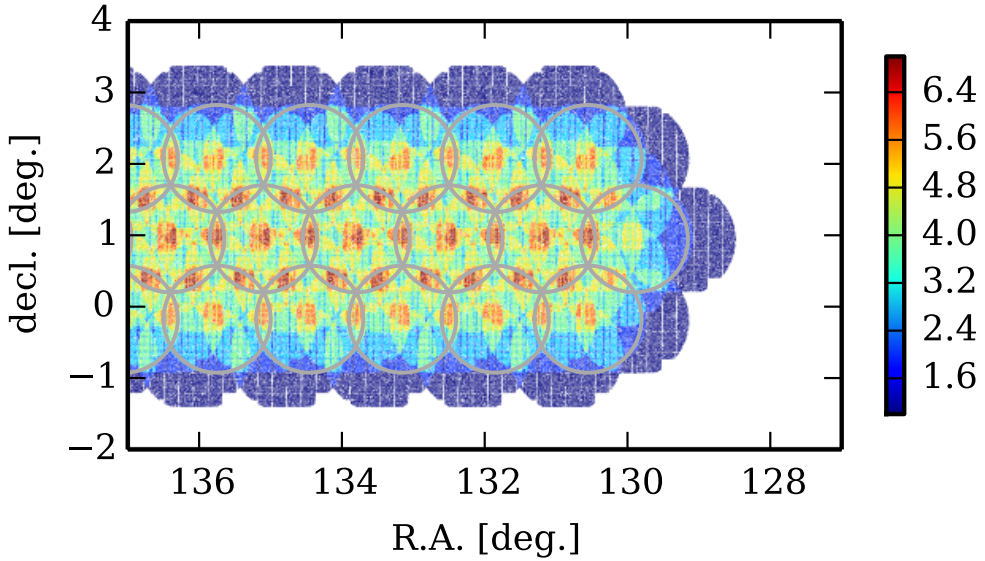
https://hsc-release.mtk.nao.ac.jp



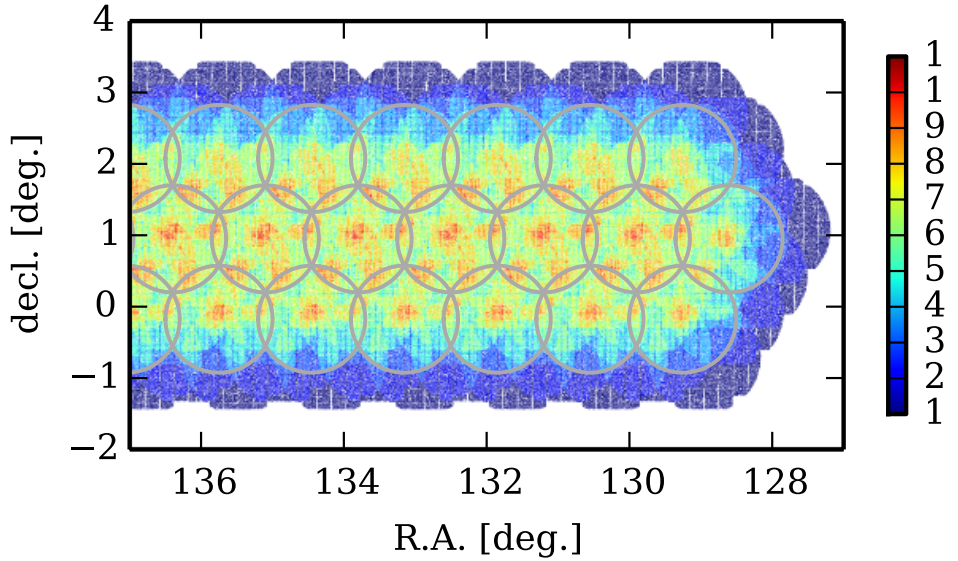
Observation & Tiling Strategy (HSC-Wide)

Aihara et al.: arXiv: 1704.05858

gr-band (4 visits): 10min in total



izy-band (6 visits): 20min



- Carry out *i*-band observation (WL) if seeing (weather) looks good (we have on-site quick QA system; seeing and transparency)
- A large-dithering offset (~0.5 deg. ≈1/3 of 1.5 degrees)
- Different exposures (visits) for the same field separated by more than 0.5 hours (to have different atmosphere)
- So far, focus on the interesting fields (i.e. with existing X-ray or spec-z data)
- Acquire full-depth, full-color first, and then build up the area

A big milestone! 39 pages, 23 figures

appear soon on arXiv

Mandelbaum, **Miyatake**, Hamana, Oguri, Simet, Armstrong, Bosch, ….

Publ. Astron. Soc. Japan (2014) 00(0), 1–39
doi: 10.1093/pasj/xxx000

Note: we employed conservative cuts on galaxy selection for the shape catalog

The first-year shear catalog of the Subaru Hyper Suprime-Cam SSP Survey

Rachel Mandelbaum[1], Hironao Miyatake[2,3], Takashi Hamana[4], Masamune Oguri[5,6,3], Melanie Simet[7,2], Robert Armstrong[8], James Bosch[8], Ryoma Murata[3,6], François Lanusse[1], Alexie Leauthaud[9], Jean Coupon[10], Surhud More[3], Masahiro Takada[3], Satoshi Miyazaki[4], Joshua S. Speagle[11], Masato Shirasaki[4], Cristóbal Sifón[8], Song Huang[3,9], Atsushi J. Nishizawa[12], Elinor Medezinski[8], Yuki Okura[13,14], Nobuhiro Okabe[15,16], Nicole Czakon[17], Ryuichi Takahashi[18], Will Coulton[19], Chiaki Hikage[3], Yutaka Komiyama[4,20], Robert H. Lupton[8], Michael A. Strauss[8], Masayuki Tanaka[4] and Yousuke Utsumi[16]

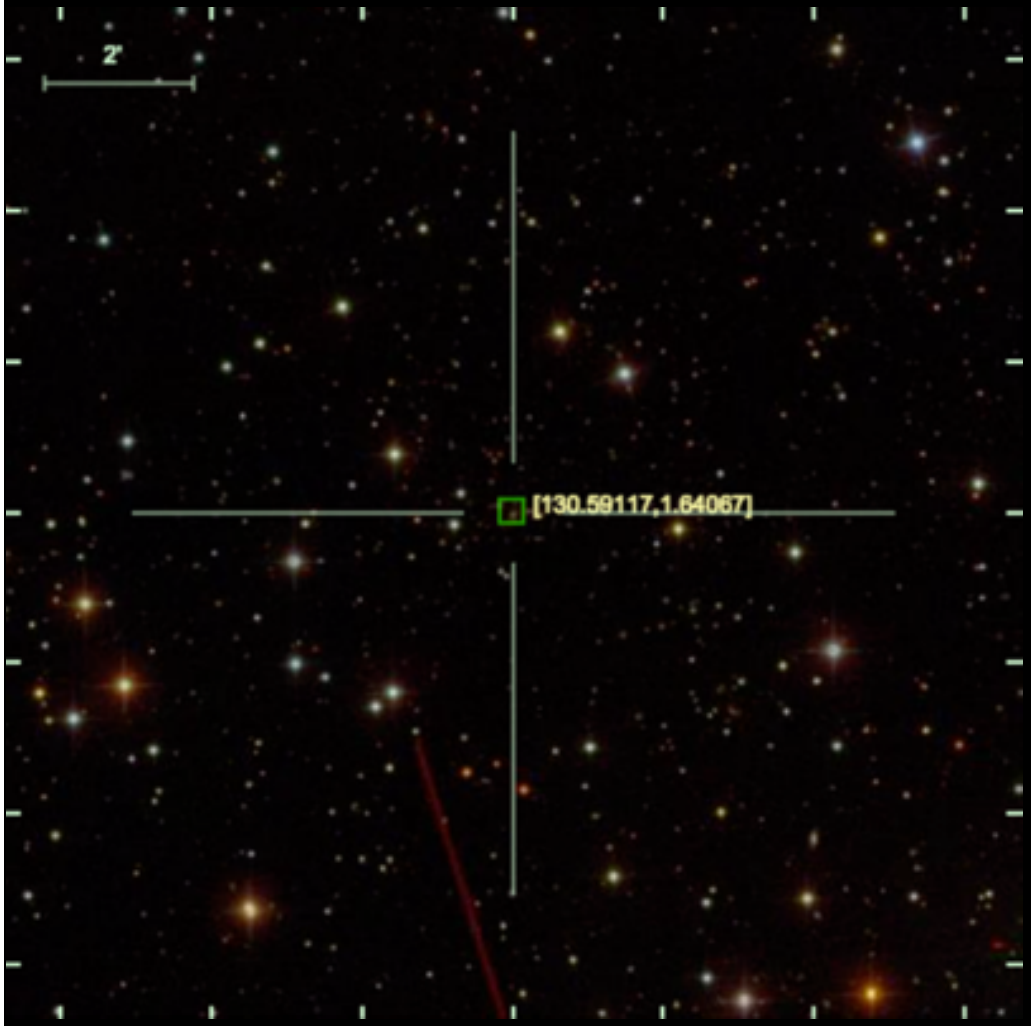
[1]McWilliams Center for Cosmology, Department of Physics, Carnegie Mellon University, Pittsburgh, PA 15213, USA
[2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

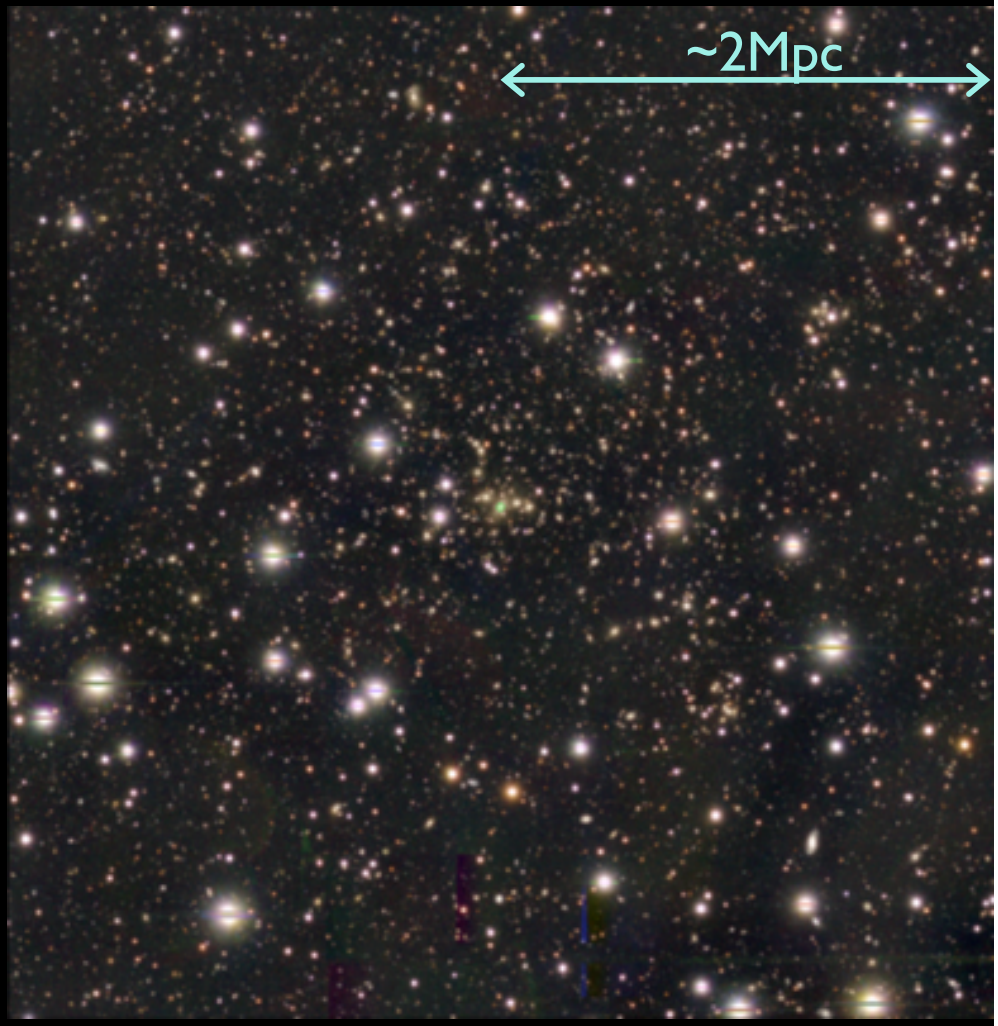
Galaxy Clusters (HSC camira clusters): arXiv:1701.00818

Msamune Oguri

SDSS (2.5m, r<21, ~1″)

Subaru HSC (8.2m, r<26, 0.6″)





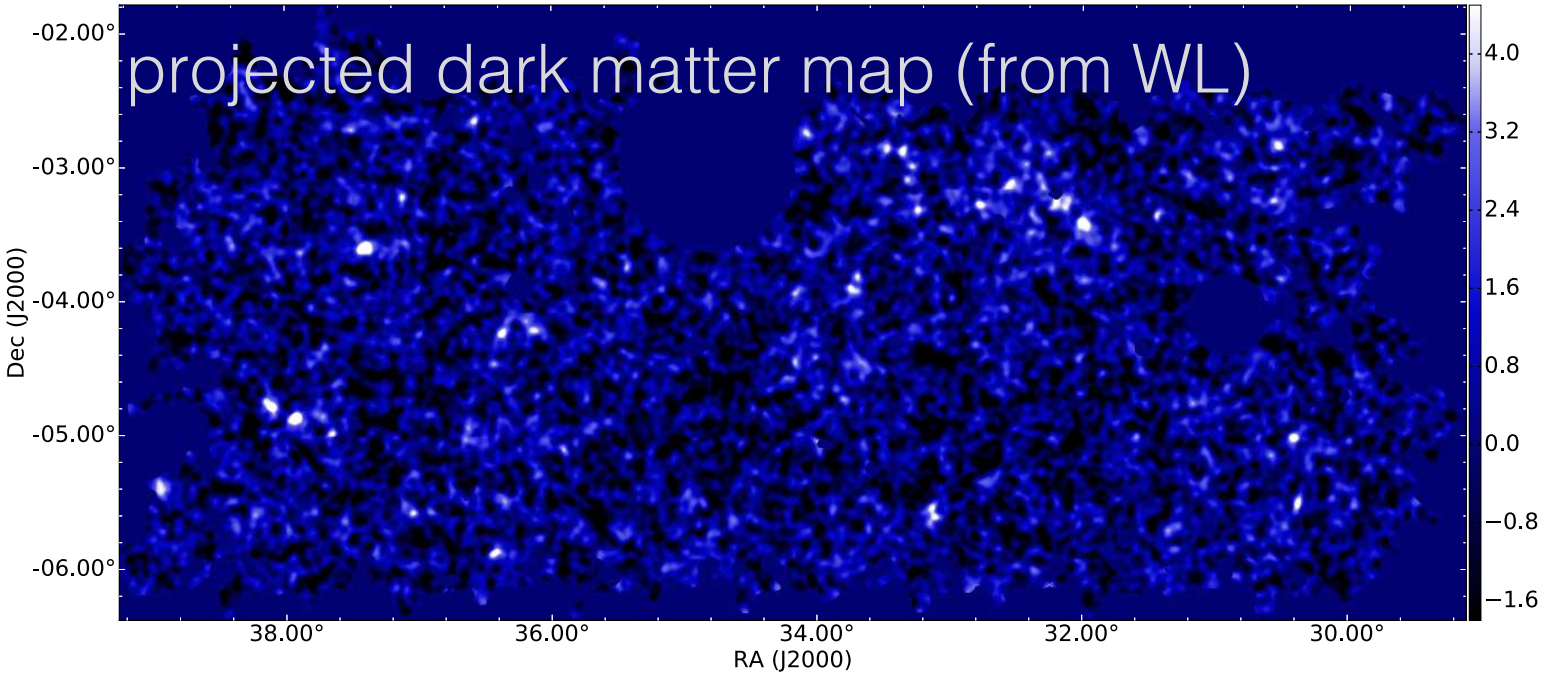
the same rich cluster region at z=0.41

Newly discovered, high-redshift cluster (unique for finding clusters at z>0.5)

richest at z>0.8

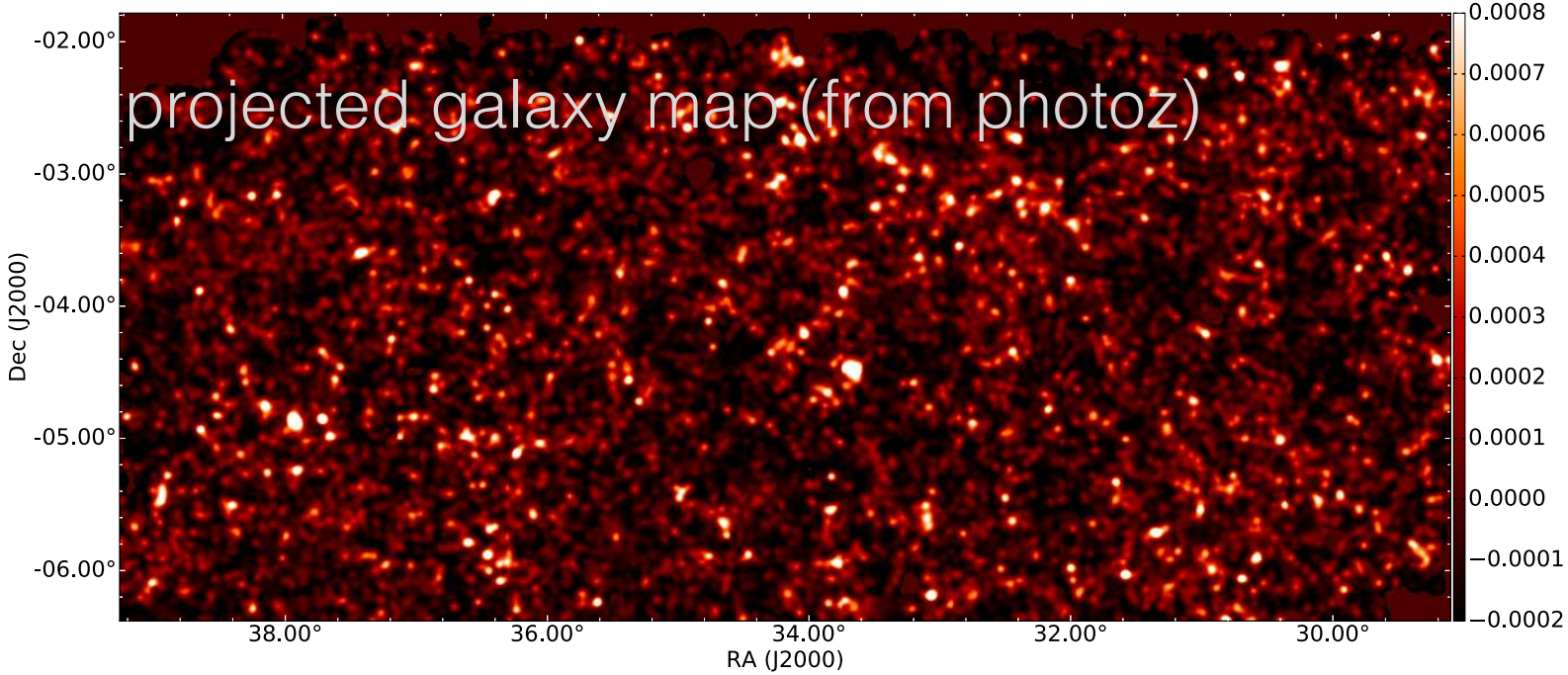
RA=179.2265
Dec=−0.6291
z=0.829
N=88.1

HSC superb image quality allows an accurate weak lens measurement



Oguri+ in prep.

XMM-LSS field (~30 sq. deg.)

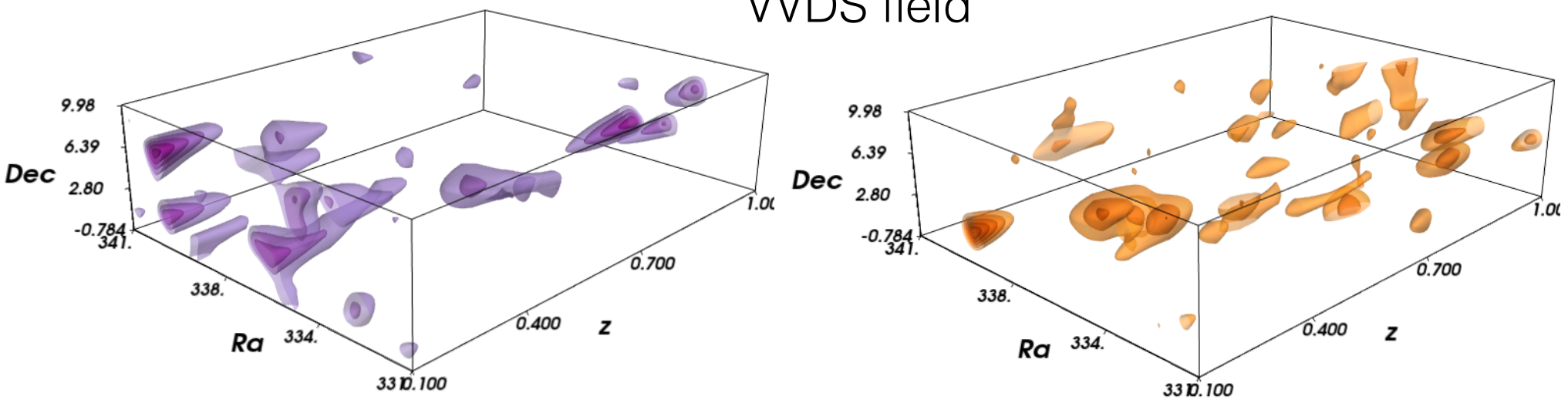


Mass distribution up to z~1 thanks to the HSC depth

3D mass and galaxy maps

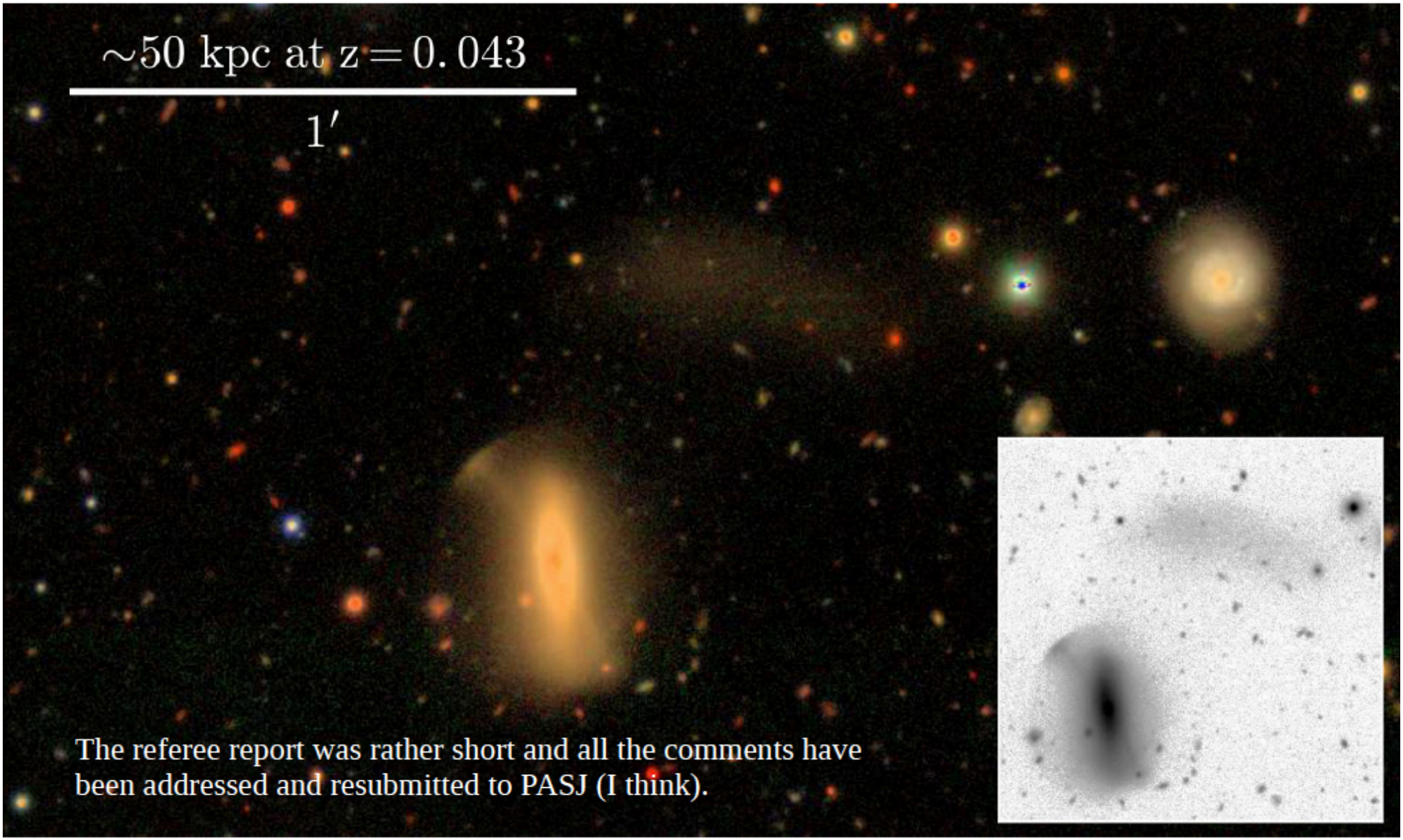
Oguri+ in prep.: appear on arXiv soon

VVDS field



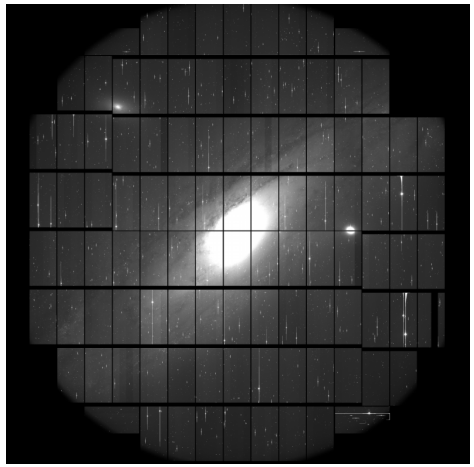
- A nice correlation between mass and galaxy maps (these maps used photo-z's)

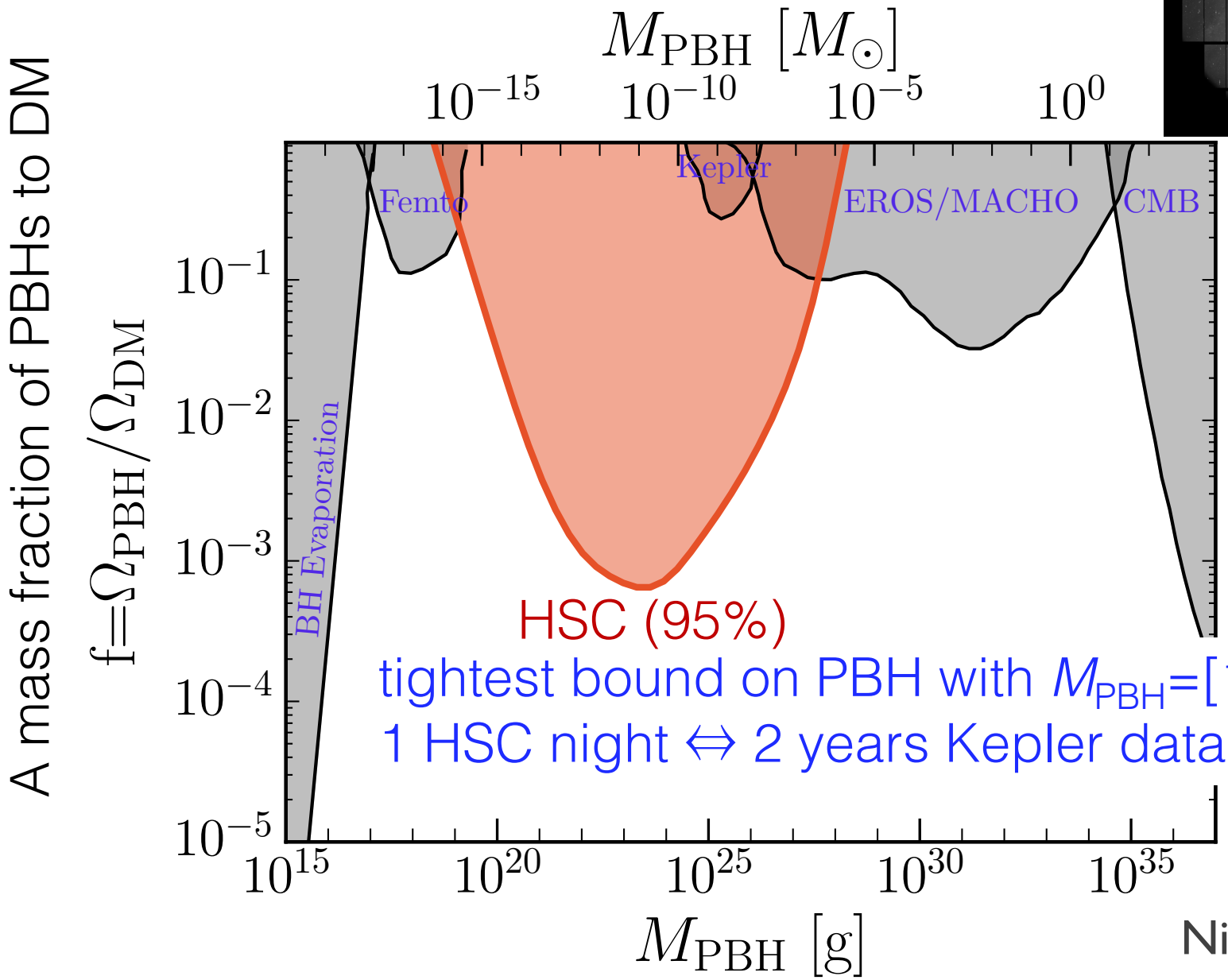
Greco et al. “Sumo Puff” (arXiv: 1704.06681)



The referee report was rather short and all the comments have been addressed and resubmitted to PASJ (I think).

HSC microlensing constrain on PBH abundance





dense (2min) cadence data of M31

HSC (95%)

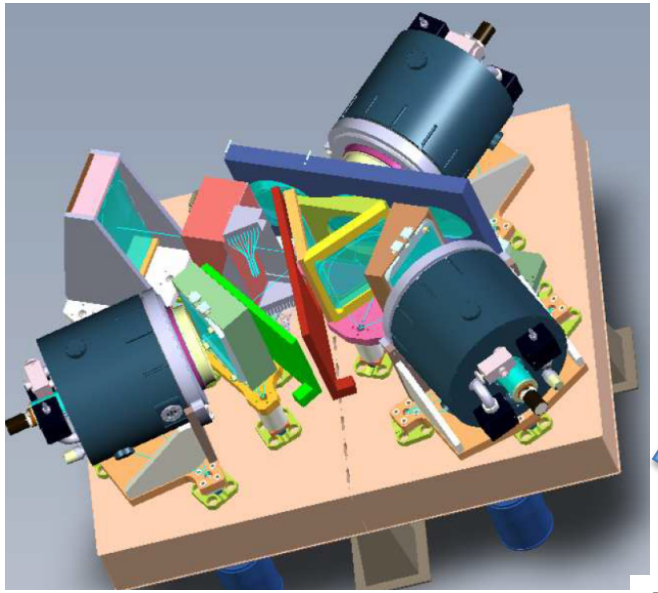
tightest bound on PBH with $M_{\rm PBH}$=[10^{20},10^{28}]g

1 HSC night ⇔ 2 years Kepler data

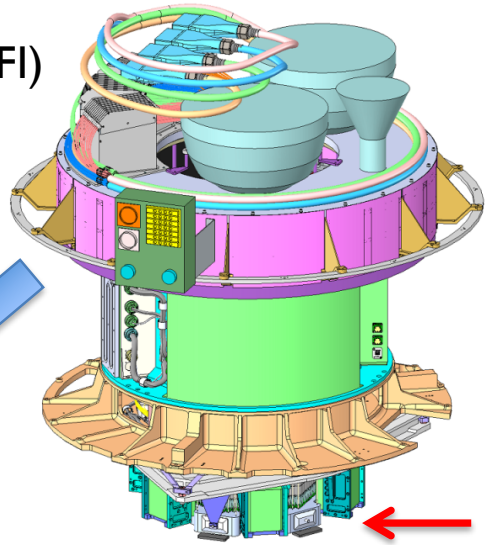
Niikura, MT, + 17

Subaru Prime Focus Spectrograph (PFS)

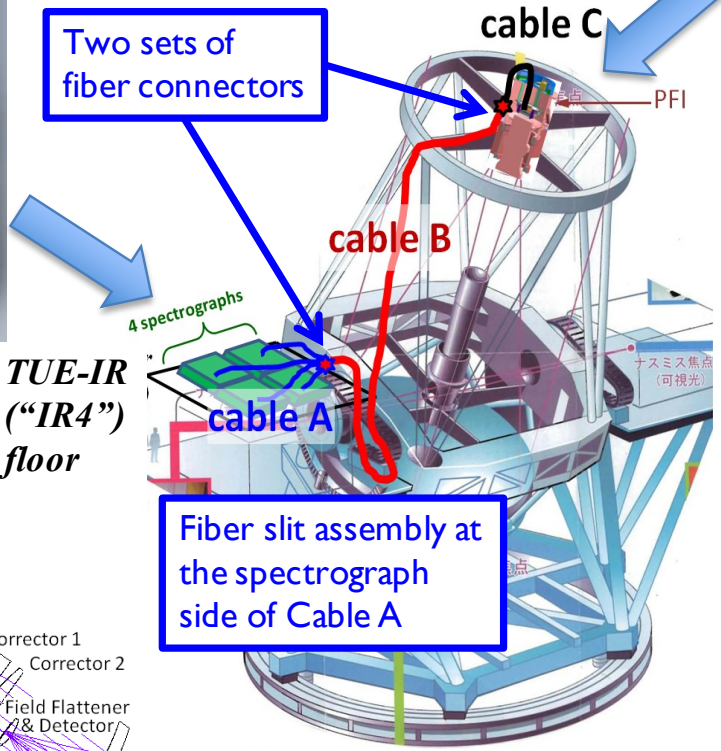
Spectrograph System (SpS)



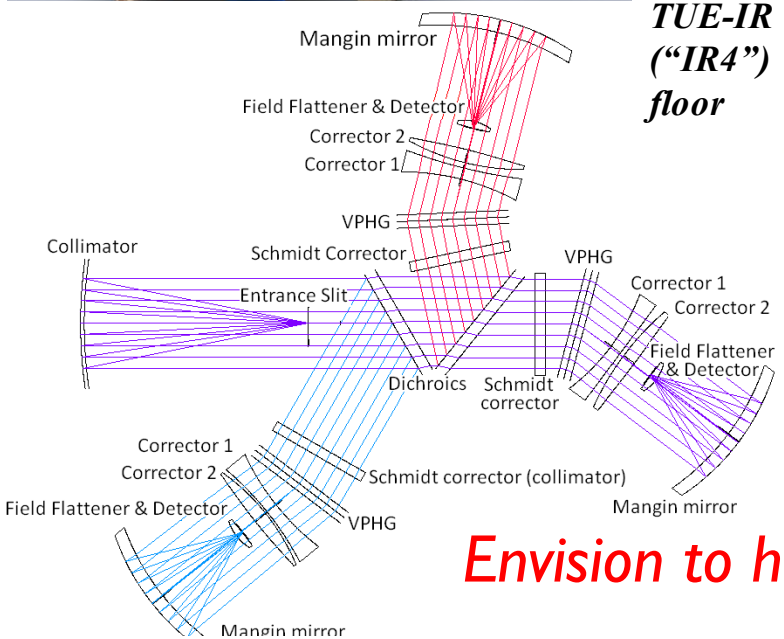
Prime Focus Instrument (PFI)

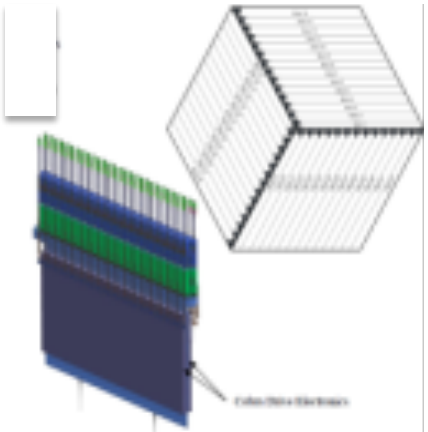


Subaru prime focus



TUE-IR ("IR4") floor





Envision to have the first light in 2018

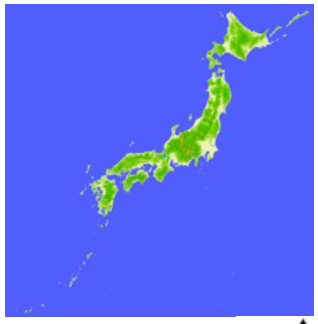
H. Murayama (PI)

PFS Collaboration

N. Tamura (PM)

Kavli IPMU is *leading* this international collaboration

LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE



国立天文台 NAOJ

CALIFORNIA INSTITUTE OF TECHNOLOGY 1891 Caltech

中央研究院 ACADEMIA SINICA 1928

PRINCETON UNIVERSITY

NASA JPL

JOHNS HOPKINS UNIVERSITY

Max-Planck-Institut für Astrophysik

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

LNA LABORATÓRIO NACIONAL DE ASTROFÍSICA

OBSERVATÓRIO DE SÃO PAULO SANCTI PAVLI CÆLVM AGER MEVS

PFS Science White Paper

Takada, Ellis et al. 2014

Publ. Astron. Soc. Jpn (2014) 66 (1), R1 (1–51)
doi: 10.1093/pasj/pst019
Advance Access Publication Date: 2014 February 17
Review

Review

Extragalactic science, cosmology, and Galactic archaeology with the Subaru Prime Focus Spectrograph

Masahiro Takada,[1,*] Richard S. Ellis,[2] Masashi Chiba,[3] Jenny E. Greene,[4] Hiroaki Aihara,[1,5] Nobuo Arimoto,[6] Kevin Bundy,[1] Judith Cohen,[2] Olivier Doré,[2,7] Genevieve Graves,[4] James E. Gunn,[4] Timothy Heckman,[8] Christopher M. Hirata,[2] Paul Ho,[9] Jean-Paul Kneib,[10] Olivier Le Fèvre,[10] Lihwai Lin,[9] Surhud More,[1] Hitoshi Murayama,[1,11] Tohru Nagao,[12] Masami Ouchi,[13] Michael Seiffert,[2,7] John D. Silverman,[1] Laerte Sodré, Jr.,[14] David N. Spergel,[1,4] Michael A. Strauss,[4] Hajime Sugai,[1] Yasushi Suto,[5] Hideki Takami,[6] and Rosemary Wyse[8]

[1]Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU, WPI), The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8583
[2]California Institute of Technology, 200 East California Blvd, Pasadena, CA 91125, USA
[3]Astronomical Institute, Tohoku University, Aramaki, Aoba-ku, Sendai 980-8578

Summary

- **The wide-field capability of Subaru** is so unique, and very powerful for survey-oriented astronomy/cosmology
- **Hyper Suprime-Cam (HSC)** = Wide-field imager
  - HSC SSP survey: 2014 – 2019(20)
  - **First public data release (28 Feb, 2016)**
  - Excellent datasets = deep, sharp
  - The WL shape catalog: meets the 1st year cosmology analysis requirements (will be made public)
  - **Photo-z is so important for all science cases**
- **Prime Focus Spectrograph (PFS)** = Wide-field, multi-object spectrograph