



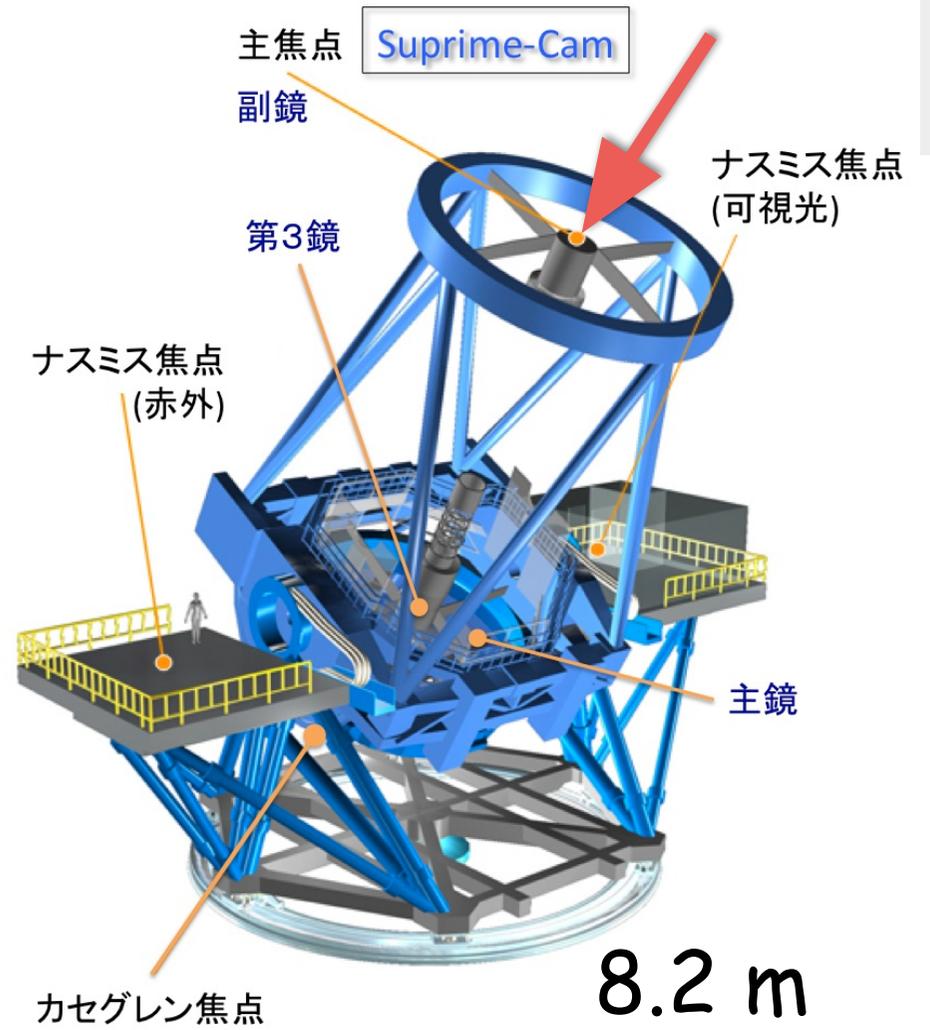
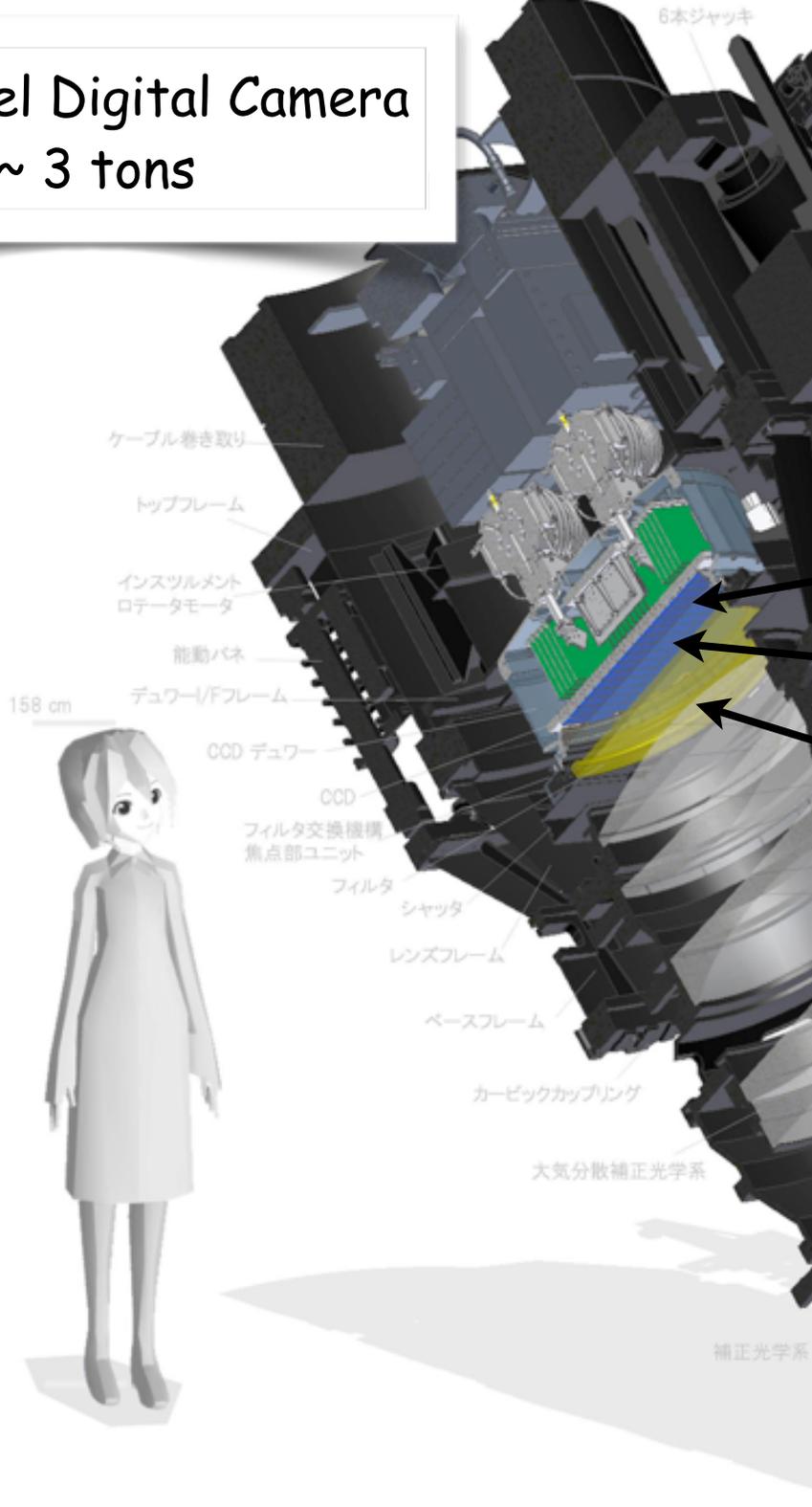
# Hyper Suprime-Cam Subaru Strategic Program

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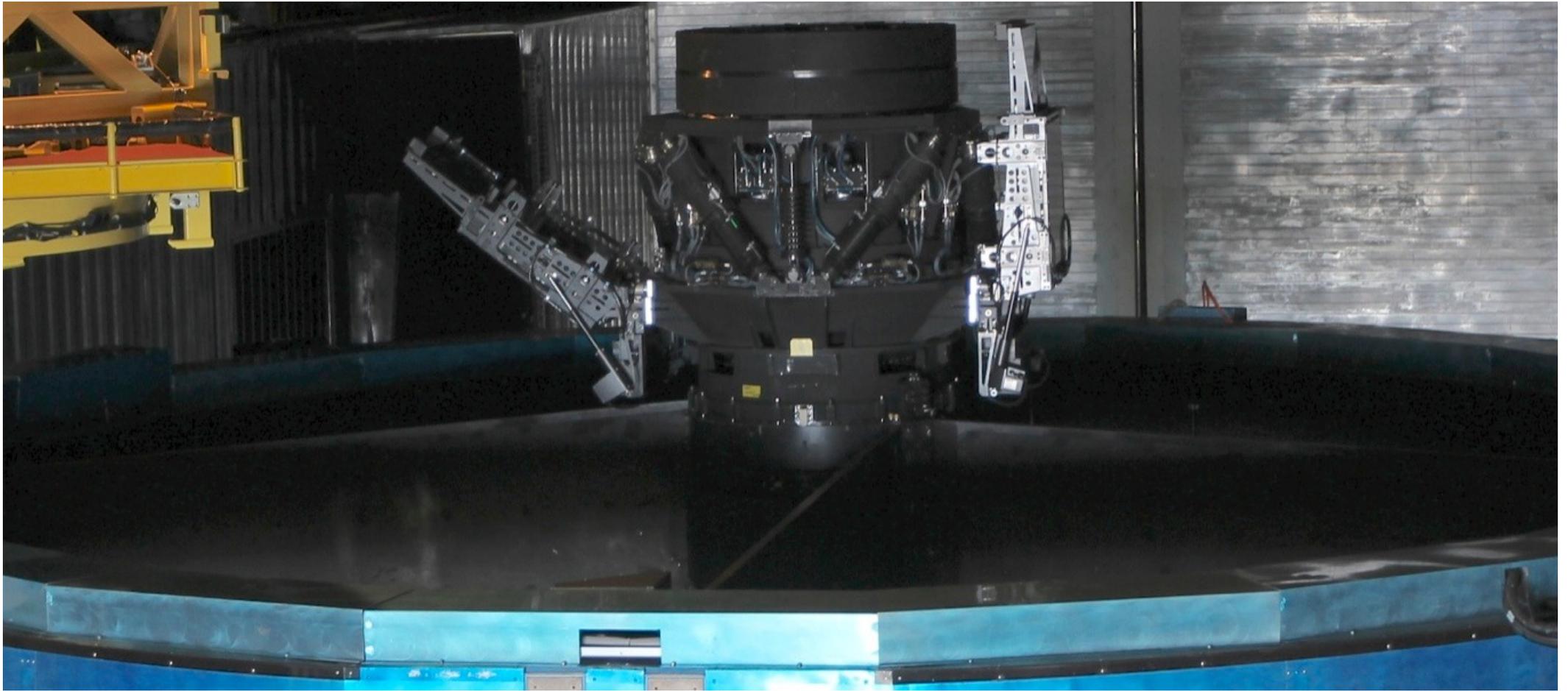
2018/04/24 German eROSITA Consortium Meeting

~ 1 G pixel Digital Camera  
3 m tall ~ 3 tons



(c) MBTA Corporation, Japan #150132

← Lens





# Features of HSC

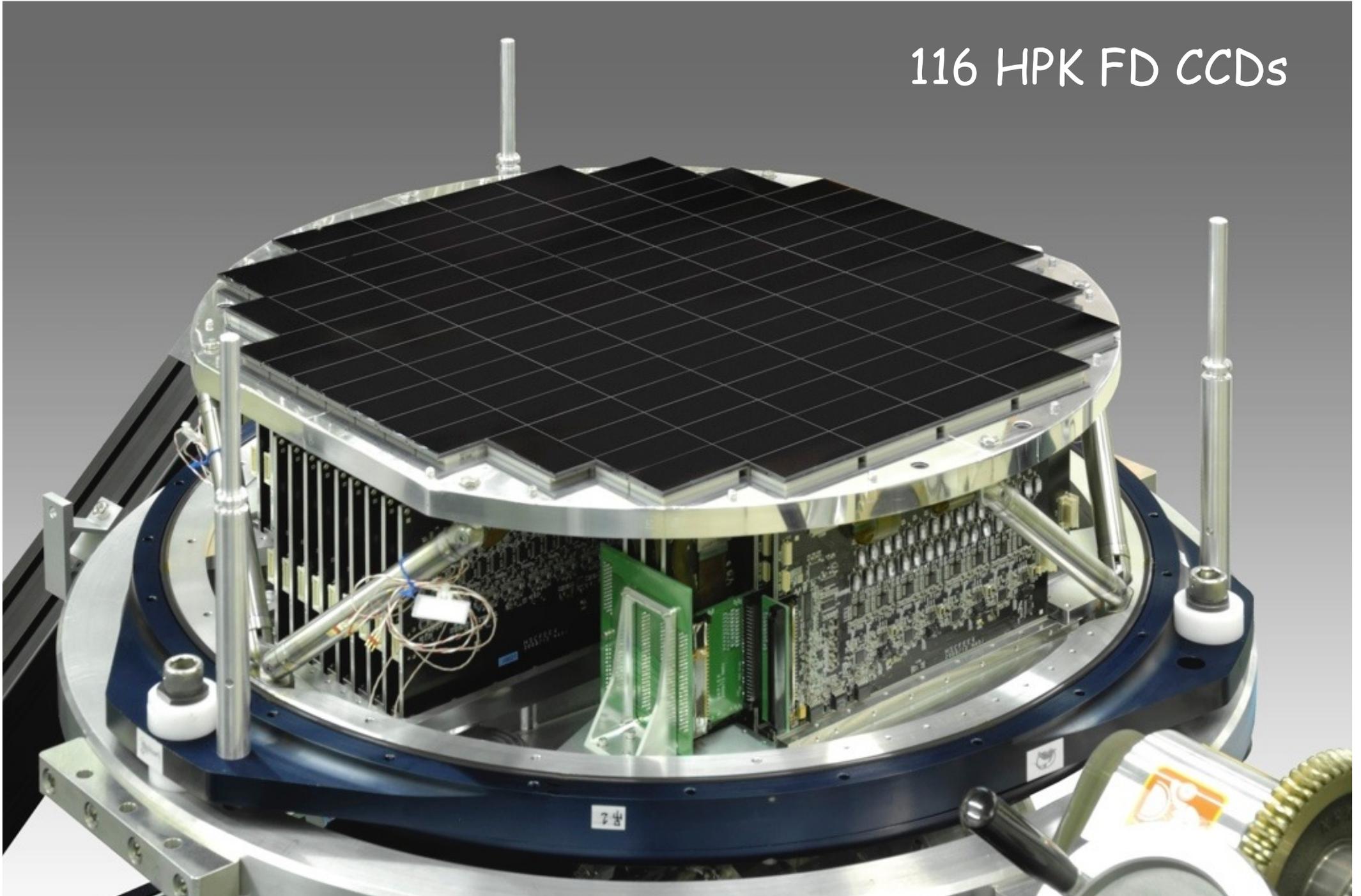
- Large Aperture: 8 m
- Wide Field:  $\varnothing$  1.5 degree
- High Angular Resolution
  - Seeing limit imaging at Mauna Kea
- High Detection Efficiency

All Crucial for Weak Lensing Survey for Cosmology where the precise measurement of shapes of faint distant galaxies are required.

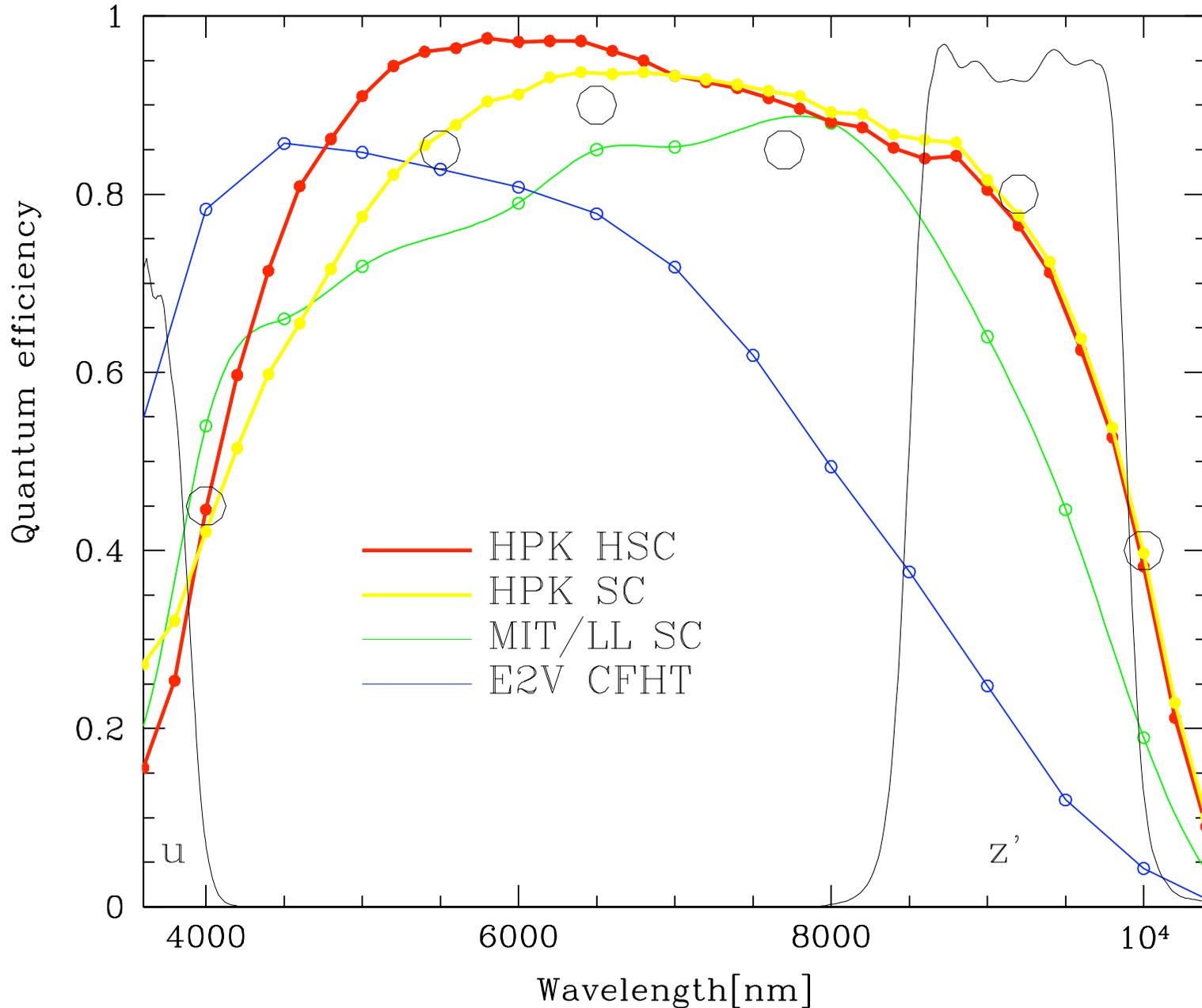


# HSC Focal Plane

116 HPK FD CCDs



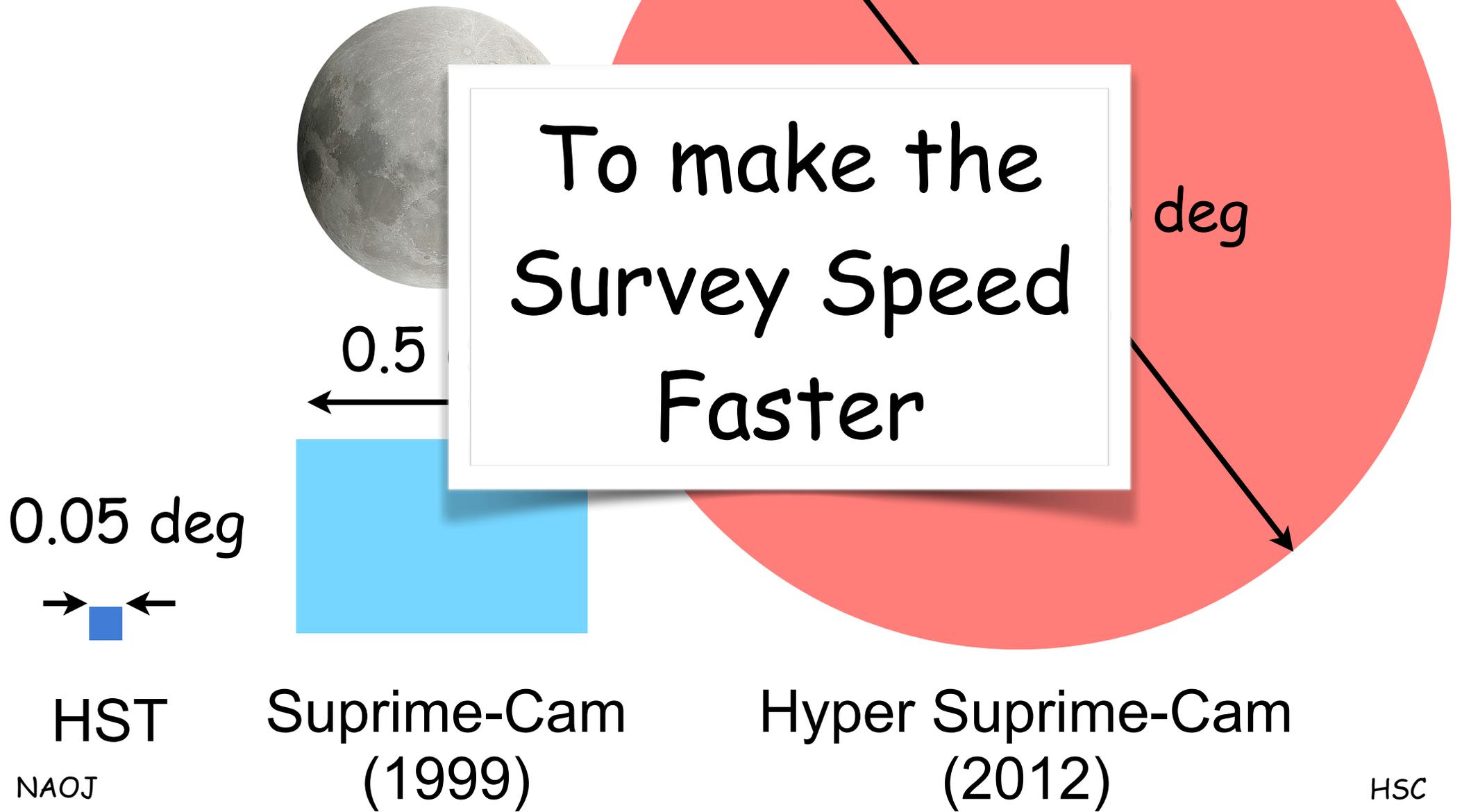
# Quantum Efficiency



X 2  
improvement  
at 1  $\mu\text{m}$



# Field of View





# Comparison

Camera	Survey Speed		
	CCD	AOmega	in operation
DECam	BI-FD 	30.0	2012
HSC	BI-FD 	91.3	2012
LSST	BI-DD 	347.8	(2020?)



# Hyper Suprime-Cam

- Highest QE in red
- Superb Image Quality (Mauna Kea Seeing Limit)
- Fastest Survey Speed (AOMega)

for now



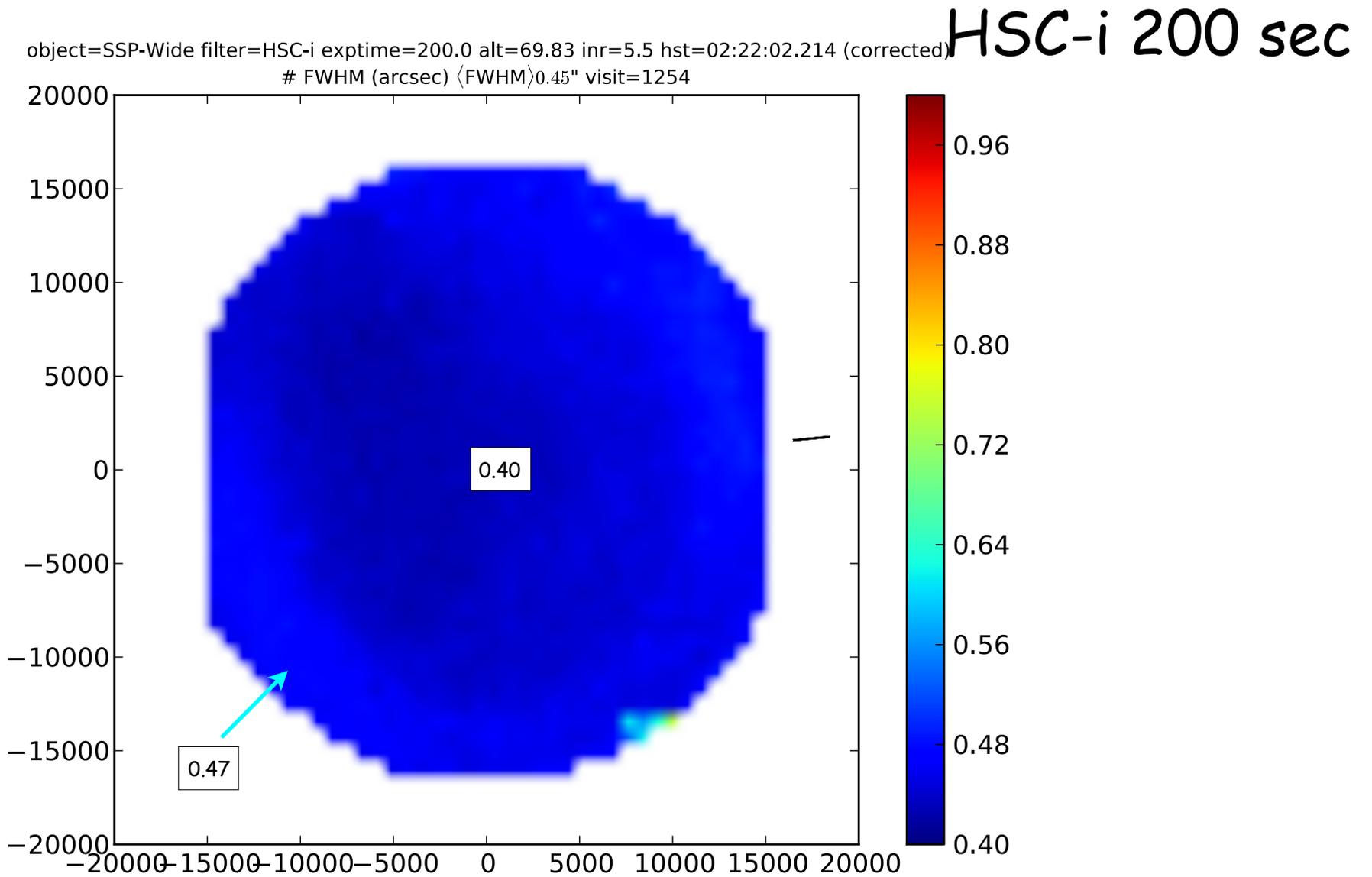
# Performance Verification (Image Quality)



# using Star images



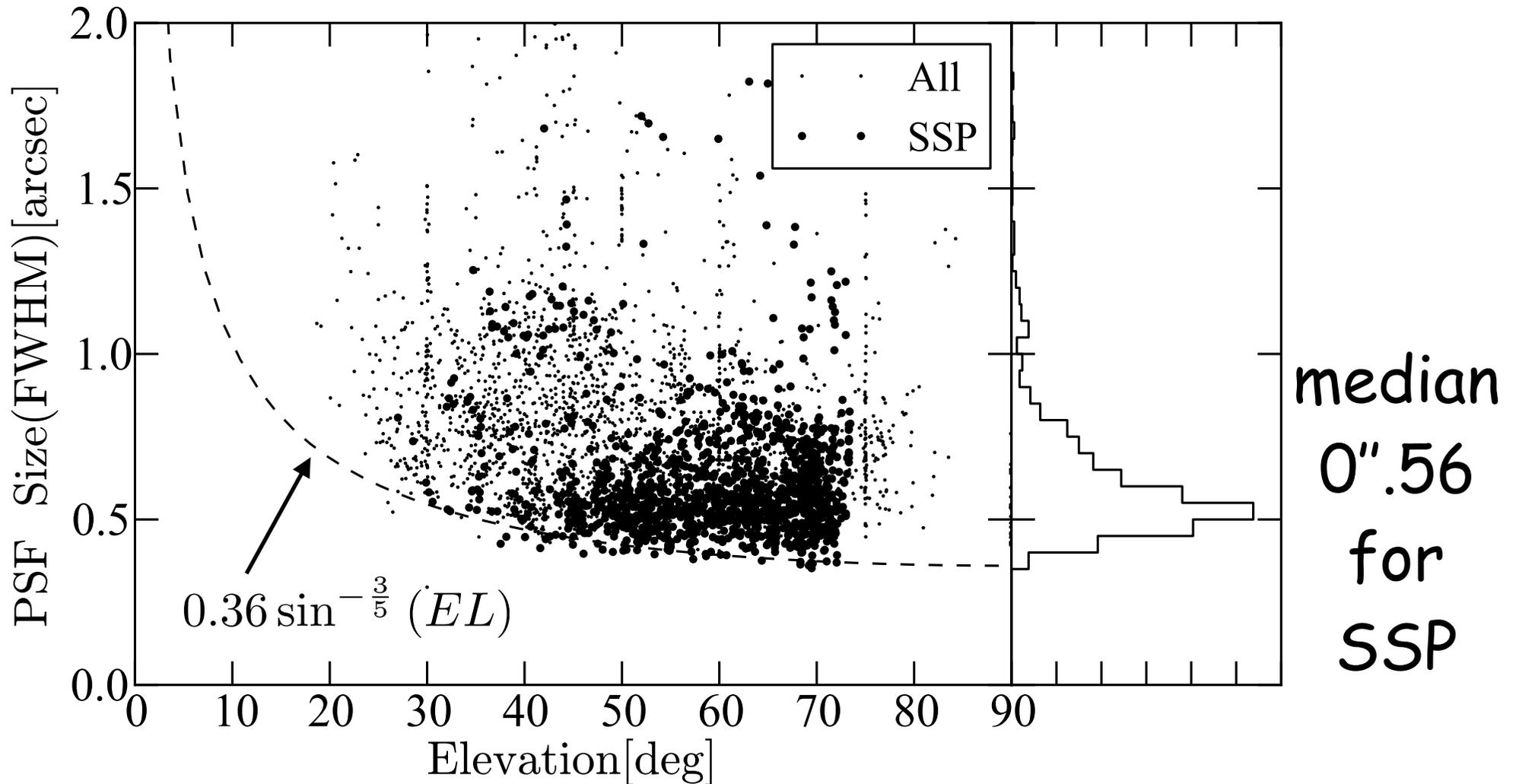
# PSF Evaluation



Very Sharp Image Realized as designed

# Seeing Statistics

## HSC-i band



**Mostly seeing limited imaging realized**



# Hyper Suprime-Cam Subaru Strategic Survey

- 300 nights
- >200 Collaborators
- 2012/10 Submitted

Wide-field imaging with Hyper Suprime-Cam:  
Cosmology and Galaxy Evolution  
*A Strategic Survey Proposal for the Subaru Telescope*

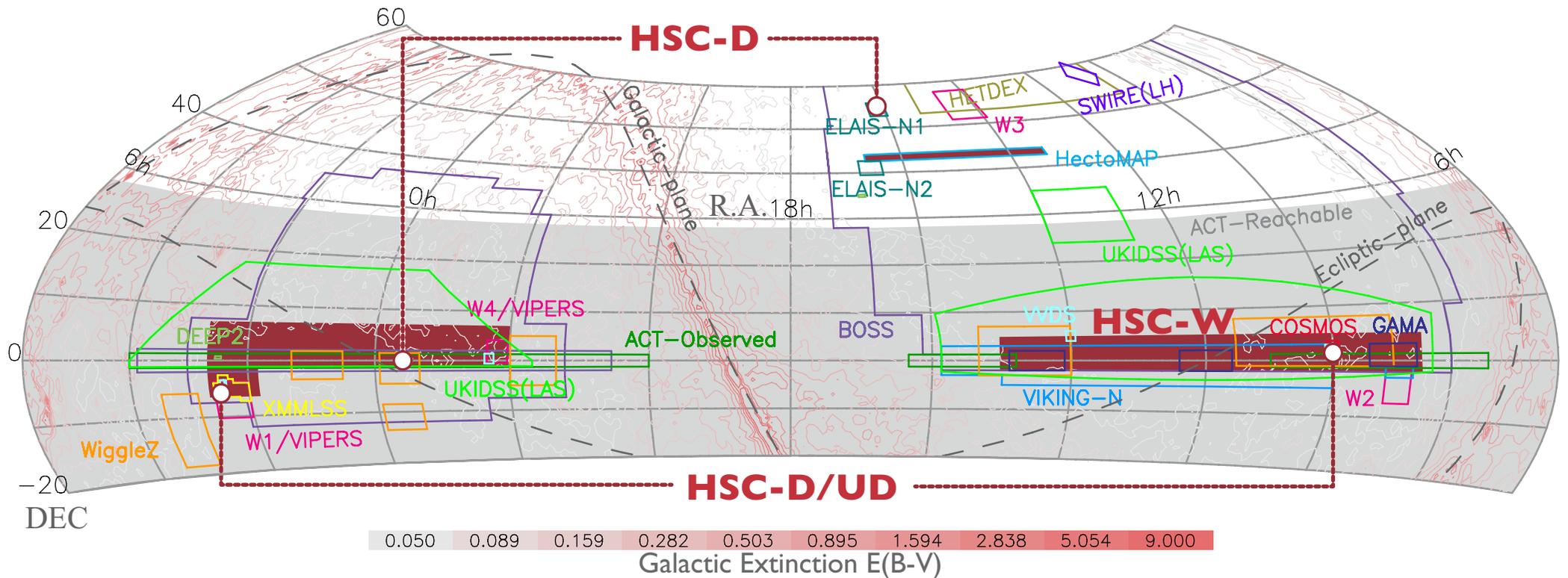
PI: Satoshi Miyazaki (NAOJ)  
Co-PI: Ikuru Iwata (NAOJ)

**The HSC collaboration team<sup>1</sup>:** S. Abe<sup>(1)</sup>, H. Aihara<sup>\*(2),(3)</sup>, M. Akiyama<sup>(4)</sup>, K. Aoki<sup>(5)</sup>, N. Arimoto<sup>\*(5)</sup>, N. A. Bahcall<sup>(6)</sup>, S. J. Bickerton<sup>(3)</sup>, J. Bosch<sup>(6)</sup>, K. Bundy<sup>†(3)</sup>, C. W. Chen<sup>(7)</sup>, M. Chiba<sup>†(4)</sup>, T. Chiba<sup>(8)</sup>, N. E. Chisari<sup>(6)</sup>, J. Coupon<sup>(7)</sup>, M. Doi<sup>(2)</sup>, M. Enoki<sup>(9)</sup>, S. Foucaud<sup>(10)</sup>, M. Fukugita<sup>(3)</sup>, H. Furusawa<sup>†(5)</sup>, T. Futamase<sup>(4)</sup>, R. Goto<sup>(2)</sup>, T. Goto<sup>(11)</sup>, J. E. Greene<sup>(6)</sup>, J. E. Gunn<sup>†(6)</sup>, T. Hamana<sup>†(5)</sup>, T. Hashimoto<sup>(2)</sup>, M. Hayashi<sup>(5)</sup>, Y. Higuchi<sup>(2),(5)</sup>, C. Hikage<sup>(12)</sup>, J. C. Hill<sup>(6)</sup>, P. T. P. Ho<sup>\*(7)</sup>, B. C. Hsieh<sup>(7)</sup>, K. Y. Huang<sup>†(7)</sup>, H. Ikeda<sup>(13)</sup>, M. Imanishi<sup>(5)</sup>, N. Inada<sup>(14)</sup>, A. K. Inoue<sup>(15)</sup>, W.-H. Ip<sup>(1)</sup>, T. Ito<sup>(5)</sup>, K. Iwasawa<sup>(16)</sup>, M. Iye<sup>(5)</sup>, H. Y. Jian<sup>(17)</sup>, Y. Kakazu<sup>(18)</sup>, H. Karoji<sup>(3)</sup>, N. Kashikawa<sup>(5)</sup>, N. Katayama<sup>(3)</sup>, T. Kawaguchi<sup>(19)</sup>, S. Kawanomoto<sup>(5)</sup>, I. Kayo<sup>(20)</sup>, T. Kitayama<sup>(20)</sup>, G. R. Knapp<sup>(6)</sup>, T. Kodama<sup>(5)</sup>, K. Kohno<sup>(2)</sup>, M. Koike<sup>(5)</sup>, E. Kokubo<sup>(5)</sup>, M. Kokubo<sup>(2)</sup>, Y. Komiyama<sup>(5)</sup>, A. Konno<sup>(2)</sup>, Y. Koyama<sup>(5)</sup>, C. N. Lackner<sup>(3)</sup>, D. Lang<sup>(6)</sup>, A. Leauthaud<sup>†(3)</sup>, M. J. Lehner<sup>(7)</sup>, K.-Y. Lin<sup>(7)</sup>, L. Lin<sup>(7)</sup>, Y.-T. Lin<sup>†(7)</sup>, C. P. Loomis<sup>(6)</sup>, R. H. Lupton<sup>†(6)</sup>, P. S. Lykawka<sup>(21)</sup>, K. Maeda<sup>(3)</sup>, R. Mandelbaum<sup>†(22)</sup>, Y. Matsuda<sup>(5)</sup>, K. Matsuoka<sup>(13),(23)</sup>, Y. Matsuoka<sup>(12)</sup>, S. Mineo<sup>(2)</sup>, T. Minezaki<sup>(2)</sup>, H. Miyatake<sup>(6)</sup>, R. Momose<sup>(2)</sup>, A. More<sup>(3)</sup>, S. More<sup>(3)</sup>, T. J. Moriya<sup>(3)</sup>, T. Morokuma<sup>†(2)</sup>, H. Murayama<sup>\*(3)</sup>, K. Nagamine<sup>(24)</sup>, T. Nagao<sup>†(23)</sup>, S. Nagataki<sup>(23)</sup>, Y. Naito<sup>(2)</sup>, K. Nakajima<sup>(2)</sup>, F. Nakata<sup>(5)</sup>, H. Nakaya<sup>(5)</sup>, T. Namikawa<sup>(2)</sup>, C.-C. Ngeow<sup>(1)</sup>, T. Nishimichi<sup>(3)</sup>, H. Nishioka<sup>(7)</sup>, A. J. Nishizawa<sup>†(3)</sup>, K. Nomoto<sup>(3)</sup>, M. Oguri<sup>†(3)</sup>, A. Oka<sup>(2)</sup>, N. Okabe<sup>(7)</sup>, S. Okamoto<sup>(25)</sup>, S. Okamura<sup>(26)</sup>, J. Okumura<sup>(23)</sup>, S. Okumura<sup>(27)</sup>, Y. Okura<sup>(5)</sup>, Y. Ono<sup>(2)</sup>, M. Onodera<sup>(28)</sup>, K. Ota<sup>(23)</sup>, M. Ouchi<sup>†(2)</sup>, S. Oyabu<sup>(12)</sup>, P. A. Price<sup>(6)</sup>, R. Quimby<sup>(3)</sup>, C. E. Rusu<sup>(2),(5)</sup>, S. Saito<sup>(29)</sup>, T. Saito<sup>(3)</sup>, Y. Saitou<sup>(30)</sup>, M. Sato<sup>(12)</sup>, T. Shibuya<sup>(5)</sup>, K. Shimasaku<sup>†(2)</sup>, A. Shimono<sup>(3)</sup>, S. Shinogi<sup>(2)</sup>, M. Shirasaki<sup>(2)</sup>, J. D. Silverman<sup>(3)</sup>, D. N. Spergel<sup>\*(6),(3)</sup>, M. A. Strauss<sup>†(6)</sup>, H. Sugai<sup>(3)</sup>, N. Sugiyama<sup>(12),(3)</sup>, D. Suto<sup>(2)</sup>, Y. Suto<sup>\*(2)</sup>, K. Tadaki<sup>(2)</sup>, M. Takada<sup>†(3)</sup>, R. Takahashi<sup>(31)</sup>, S. Takahashi<sup>(5)</sup>, T. Takata<sup>(5)</sup>, T. T. Takeuchi<sup>(12)</sup>, N. Tamura<sup>(3)</sup>, M. Tanaka<sup>(5)</sup>, M. Tanaka<sup>†(3)</sup>, T. Taniguchi<sup>(13)</sup>, A. Taruya<sup>(2)</sup>, T. Terai<sup>(5)</sup>, Y. Terashima<sup>(13)</sup>, N. Tominaga<sup>(32)</sup>, J. Toshikawa<sup>(30)</sup>, T. Totani<sup>(23)</sup>, J. Turner<sup>\*(6)</sup>, Y. Ueda<sup>(23)</sup>, K. Umetsu<sup>(7)</sup>, Y. Urata<sup>†(1)</sup>, Y. Utsumi<sup>(5)</sup>, B. Vulcani<sup>(3)</sup>, K. Wada<sup>(33)</sup>, S.-Y. Wang<sup>(7)</sup>, Y. Yamada<sup>(4)</sup>, Y. Yamada<sup>(5)</sup>, K. Yamamoto<sup>(34)</sup>, H. Yamanoi<sup>(5)</sup>, C.-H. Yan<sup>(7)</sup>, N. Yasuda<sup>†(3)</sup>, A. Yonehara<sup>(35)</sup>, Y. Yoshida<sup>(2)</sup>, M. Yoshikawa<sup>(36)</sup>, S. Yuma<sup>(2)</sup> (1) NCU, Taiwan (2) Tokyo (3) Kavli IPMU (4) Tohoku (5) NAOJ (6) ASIAA (8) Nihon (9) Tokyo Keizai (10) NTNU, Taiwan (11) DARK, Copenhagen (12) Nagoya (13) Ehime (14) Saka Sangyo (16) Barcelona (17) NTU, Taiwan (18) Chicago (19) Tsukuba (20) Toho (21) Kinki (22) CMU (23) Las Vegas (25) KIAA, China (26) Hosei (27) JSGA (28) ETH (29) Berkeley (30) GUAS (31) Hirosaki (32) Konan (33) Kagoshima (34) Hiroshima (35) Kyoto Sangyo (36) JAXA

2013/05 Accepted

2017:Mid term review

# Survey Field



2 • Wide: 1400 sq. degs,  $i \sim 26$

1 ( • Deep: 28 sq. degs,  $i \sim 27$

• Ultradeep: 3 sq. degs,  $i \sim 27.7$

Cosmology/QSO

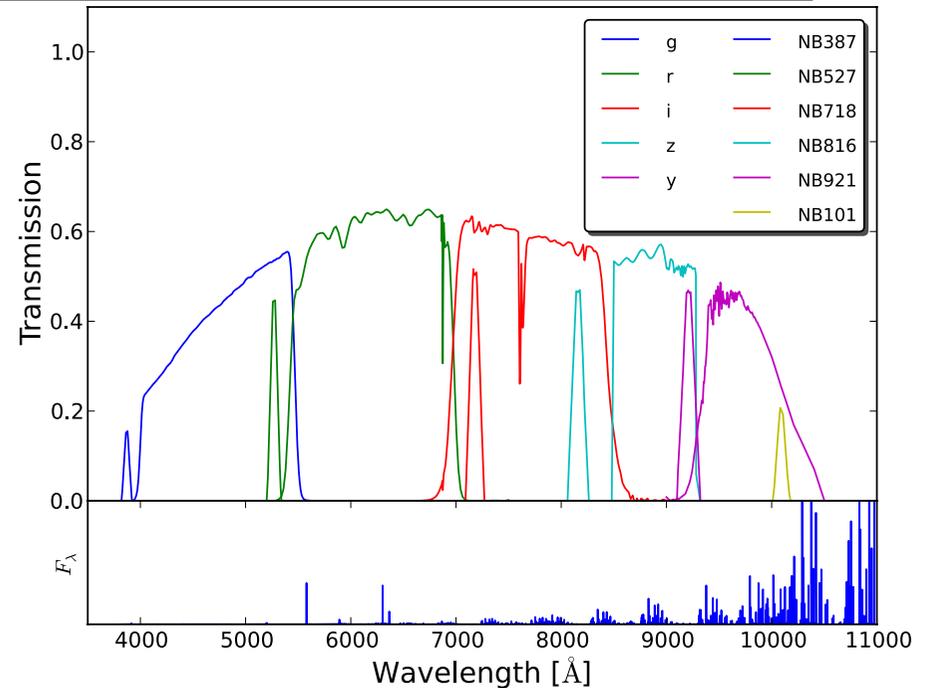
Galaxy Evolution/QSO

High  $z$  objects

# Exposure Time

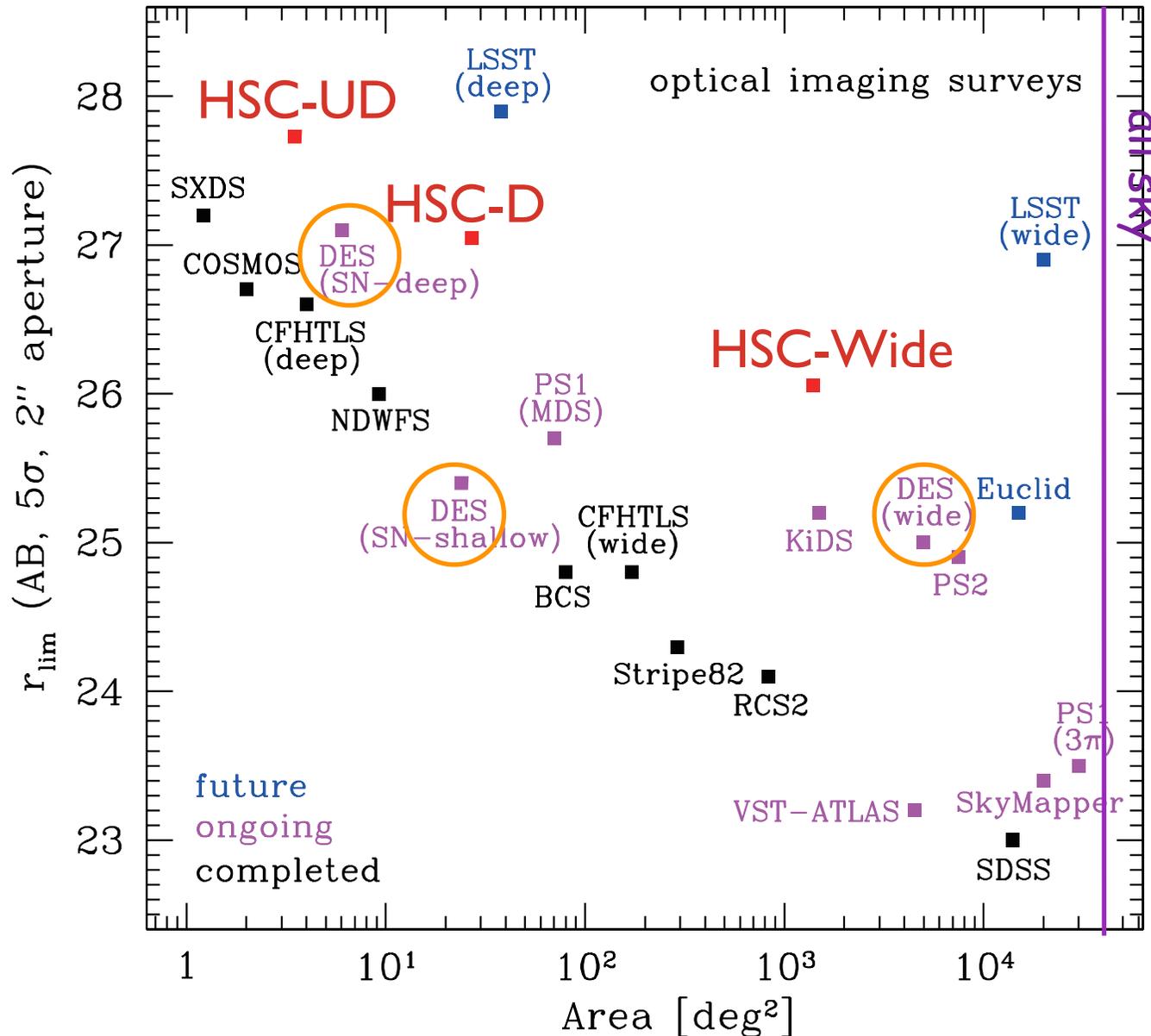
	g	r	i	z	y	N3	N8	N9	N10	
Wide	10	10	20	20	20	-	-	-	-	(min)
Deep	84	84	126	210	126	84	168	252	-	
UDeep	420	420	840	1134	1134	-	630	840	1050	

- Broad- + Narrow-band filters
- $z \sim 2.2, 3.3, 4.9, 5.7, 6.6, 7.3$  LAEs





# HSC SSP Survey: Three layers



- Three-tier survey
  - Wide: 1400 sq. degs,  $i \sim 26$
  - Deep: 28 sq. degs,  $i \sim 27$
  - Ultradeep: 3 sq. degs,  $i \sim 27.7$

300 nights  
from 2014 - 2019



# Collaborations with external teams

- Established collaborations with external groups, initiated by approaches from the external groups (not from us)
- Exchanged MOU and now carrying out the collaboration
  - **Spitzer**/IRAC data (SPLASH; Peter Capak + COSMOS): 2012 Def -, UltraDeep fields, galaxy evolution
  - **CFHT** U-band data (scientists from Canada, France, China): 2014Aug -, ~320 CFHT hours (270hrs already taken), galaxy evolution, photo-z
  - **UKIRT** NIR (JHK) data (Arizona/Steward): 2014Aug-, ~240 UKIRT hours (205hrs taken), galaxy evolution, photo-z
  - **Keck** spectra (Caltech/JPL): 2016-, ~40 Keck nights (33 Keck nights+200hrs VLT+3 MMT nights), photo-z, galaxy evolution
  - Atacama Cosmology Telescope (**ACT**) CMB data (ACT group): Sunyaev-Zel'dovich clusters, CMB lensing
  - **XMM-XXL** X-ray data (XXL team): galaxy clusters, AGN



# eROSITA

- MoU with eROSITA-DE (2017)
  - Collaboration on overlapped survey area ( $\sim 500 - 600 \text{ deg}^2$ )
- $120 \text{ deg}^2$  in the commissioning phase on the equator: eFEDS



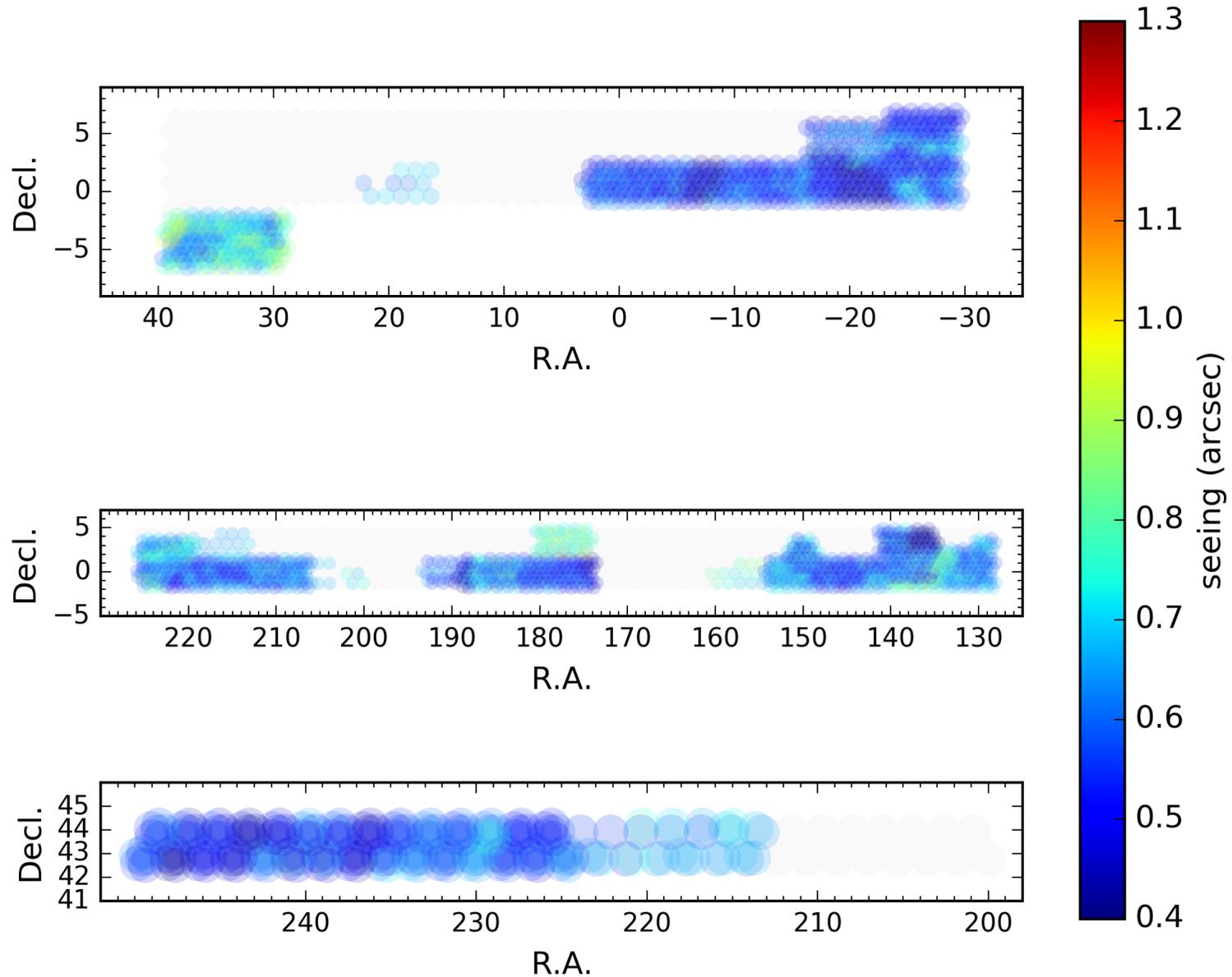
# Survey Status



# Wide Survey Status

HSC-i

Created at 2018-03-20 14:40:19

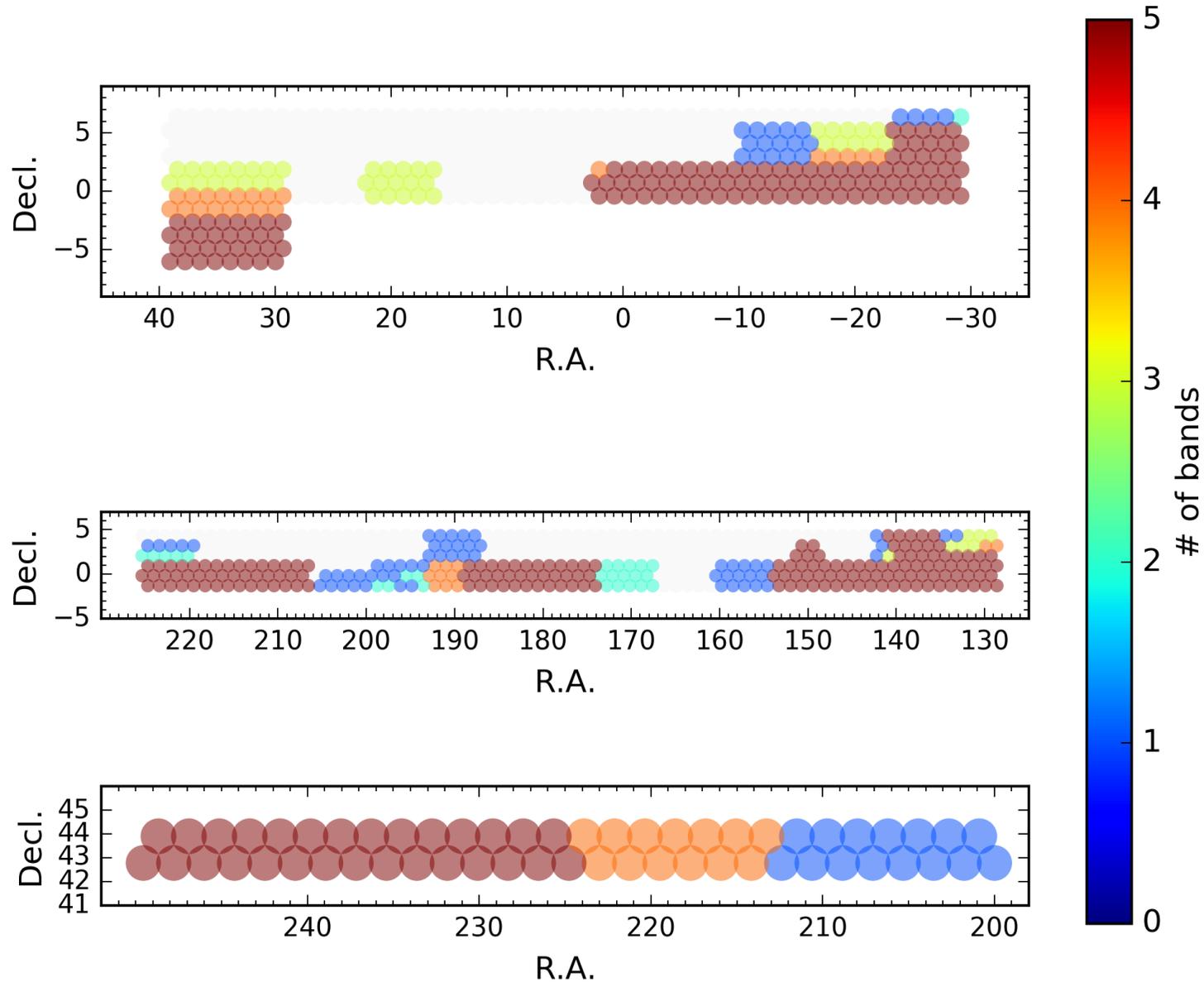




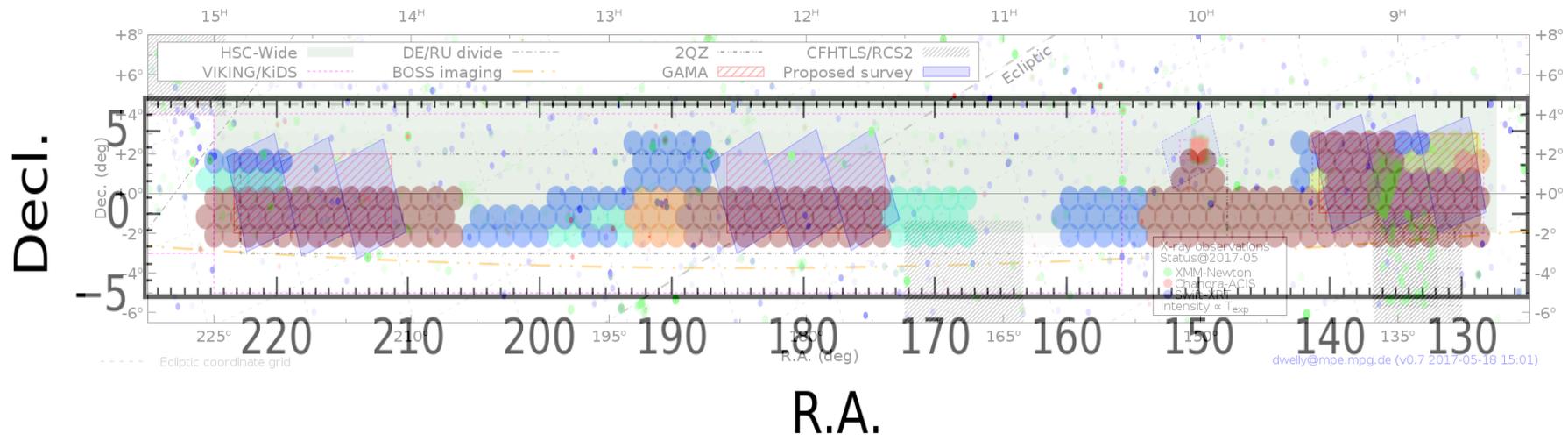
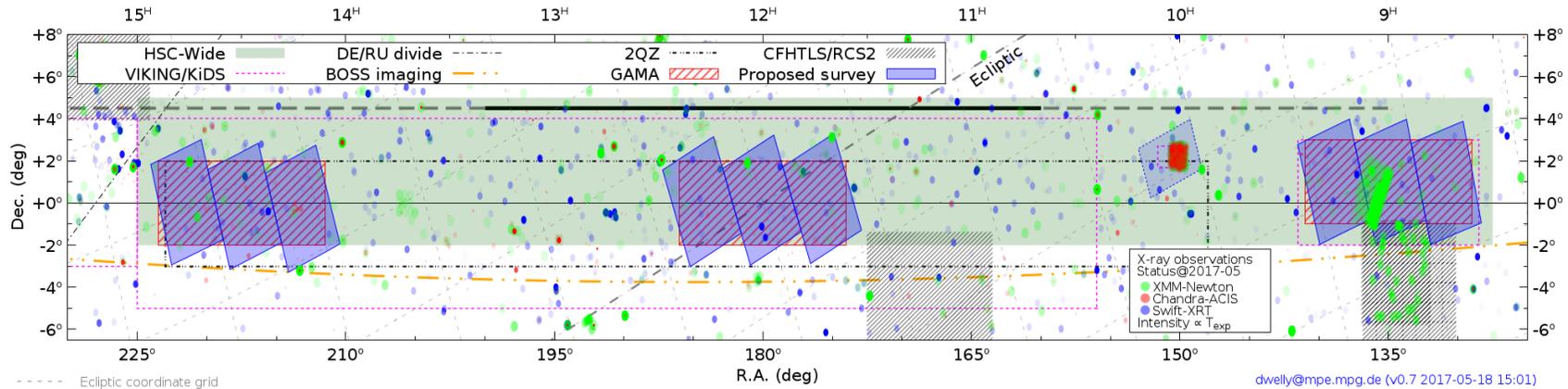
# Wide Survey Status

Full depth area

Created at 2018-04-23 10:45:16



## Progress on eFEDS region



~55 %

~50 %

~75 %



# Survey Status

## Status

- ~ 170 nights done with ~ 80 % of the planned pace
- Weather prospect was a bit optimistic.
- More frequency of the filter exchanges to carry out time-domain survey
- i-band requires good seeing, which causes more delay

## Countermeasures being considered

- Reduction of CCD readout time
- relax seeing constraint in HSC-i band

- Once a year for major internal Data Release (iDR)
  - + draft data release: half a year
- Once in every two years for Public Data Release (PDR)
- Interval between iDR - PDR : 1 year



# Public Data Release 1

## Hyper Suprime-Cam Subaru Strategic Program

Data Release 1

[Home](#) [Survey](#) [Processing](#) [Release Data](#) [Database](#) [Data Access](#) [FAQ](#)

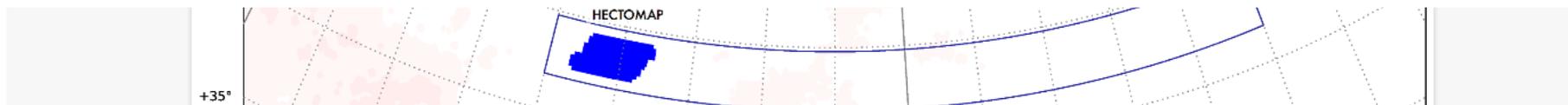
We peer deep into the Universe to unveil the nature of dark matter and dark energy.

### Public Data Release 1

Welcome to the [Hyper Suprime-Cam](#) Subaru Strategic Program Data Release Site!  
The first public release of HSC-SSP occurred on 28 February 2017. The release includes over 100 square degrees of deep multi-color data served through dedicated databases and user interfaces. The figures below shows the area covered in this release and the table gives an overview of the data in the three survey layers. Refer to [our survey website](#) for details of the survey design.



First Public Data Releases happened Successfully  
2017/02/E





# Public Data Release 1

Image Browser: hscMap

<http://hscmap.mtk.nao.ac.jp/>



# Data Release

Internal release	Release date	Data included	
S15B	2016/01	-2015/11	→ PDR1 on 2017/02
S16A	2016/08	-2016/04	
S17A	2017/07	-2017/05	
S17B	–	–	
S18A	~2018/05	-2018/01	→ PDR2 on ~2019/05
S18B	~2018/11	-2018/07	
S19A	~2019/05	-2019/01	
S19B	~2019/11	-2019/07	
S20A	~2020/05	-2020/01	→ PDR3 on ~2021/05

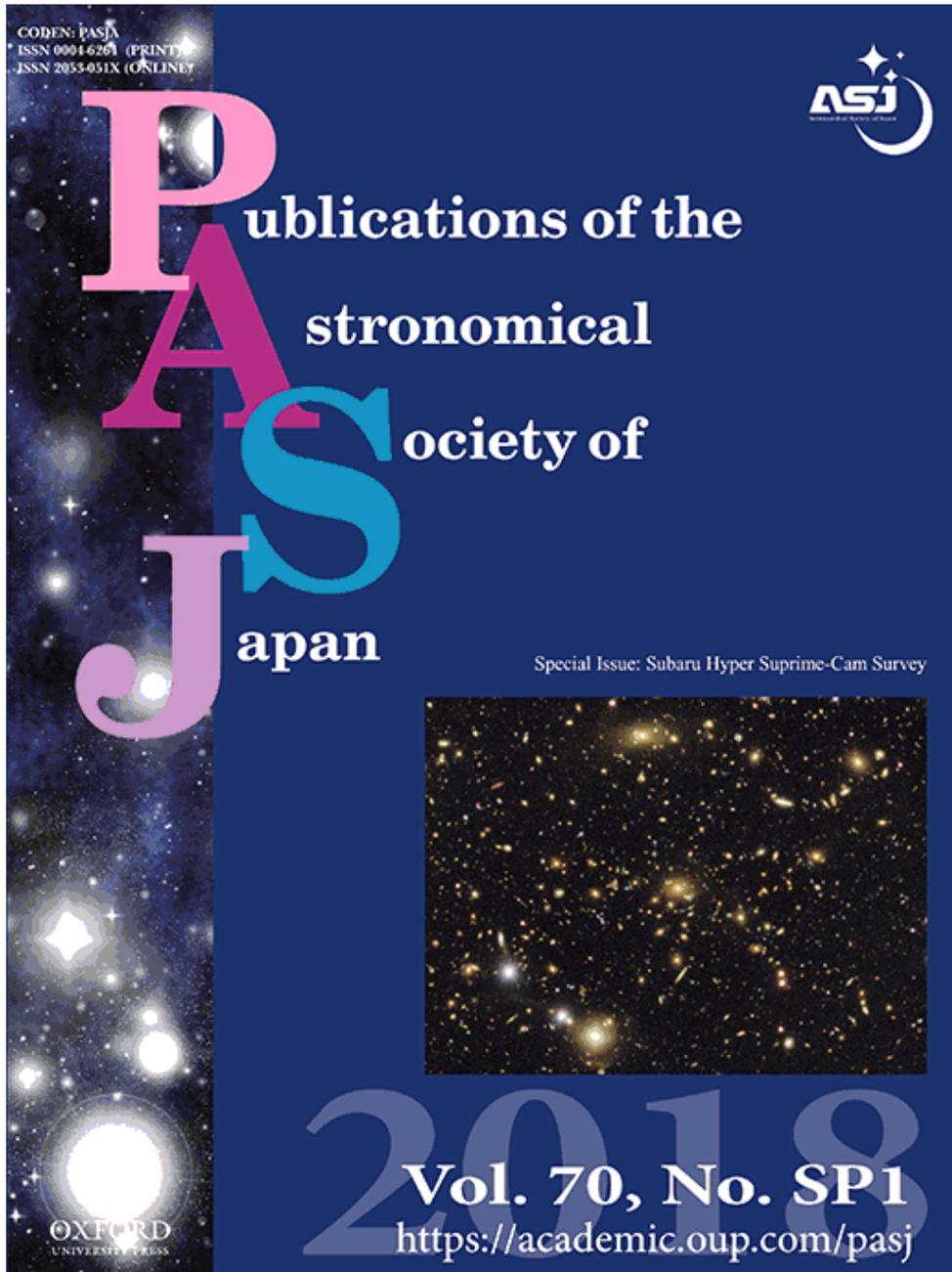


# Data Release

- PDR catalogs contain basic photometric information + some high level product (photo-z)
- Shear estimates are not released at the timing of PDR.
- Will be released after key cosmology papers are accepted.



# PASJ HSC Special Issue



- 
- 
- 

A data ( $\sim 170 \text{ deg}^2$ )  
 ology



# Summary 1

- HSC Public Data Release
  - ~ 50 % of eFEDS area data will become public on May 2019.
  - This does not include WL shear catalog
- HSC can provide unique data set for clusters and AGNs thanks to the depth and image quality
- We are looking forward to working with eROSITA team on sciences !