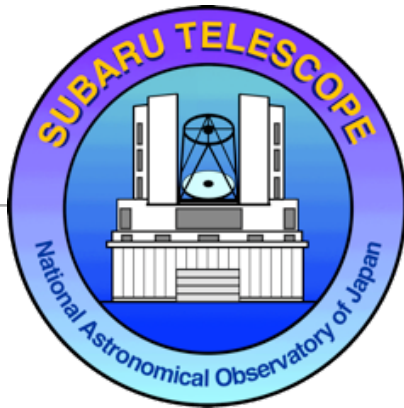


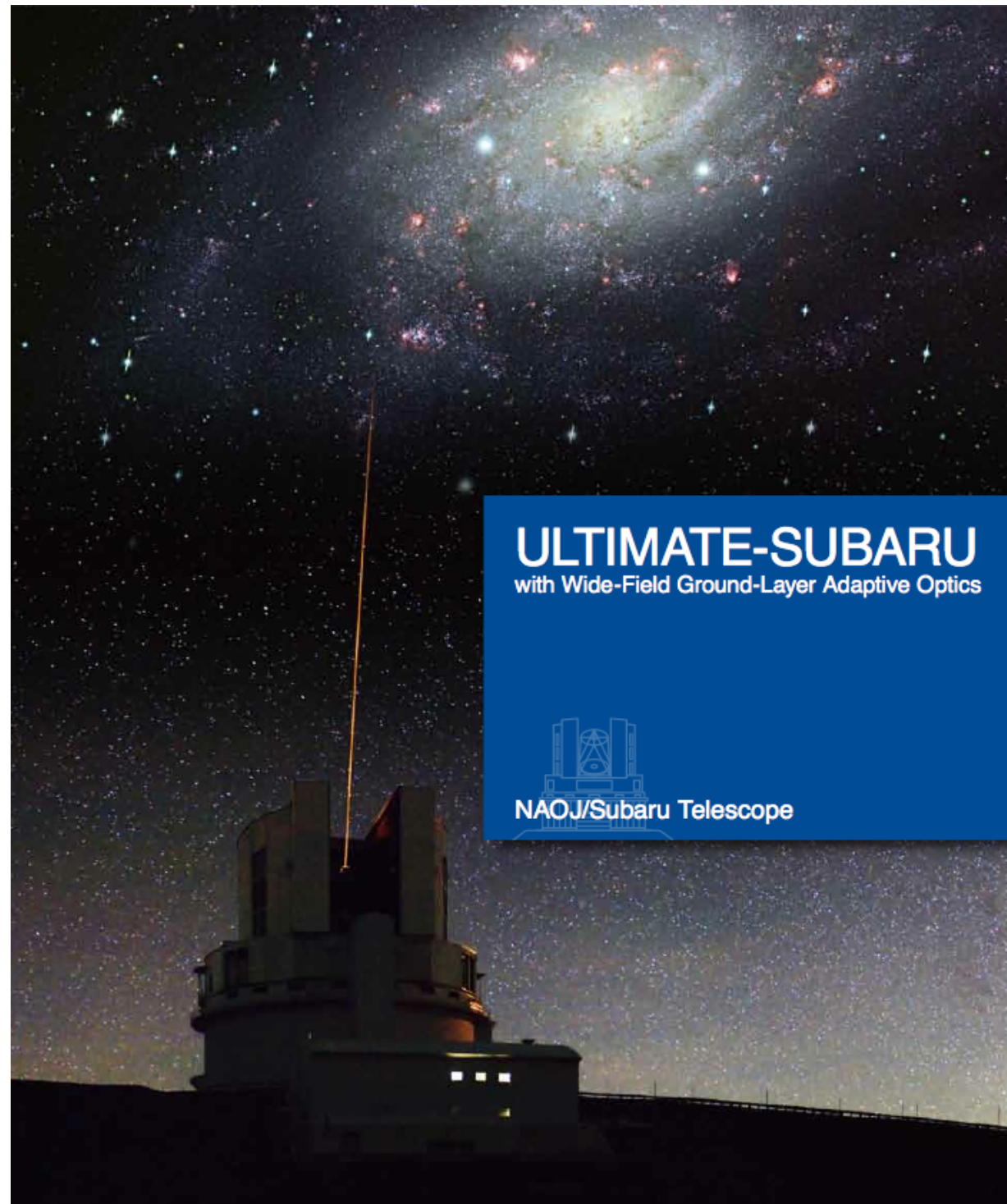
ULTIMATE-Subaru

Subaru Next-gen AO working Group
Presentation by Yusei Koyama (Subaru Telescope/NAOJ)



ULTIMATE-SUBARU

= Adaptive M2 + New IR Instruments



- Adaptive Secondary Mirror
- Seeing Improvement (about 1/2 image size)
- >10arcmin Field-of-View at Cassegrain
- <http://www.naoj.org/Projects/newdev/ngao/>
- New Wide-field Near-IR Instrument(s)
(Mainly for “**bright**” nights: HSC & PFS are for “**Dark**” nights)
- Incremental Development of instrument(s) and Ground Layer AO (GLAO)
 - Expected start science observations around beginning of 2020s

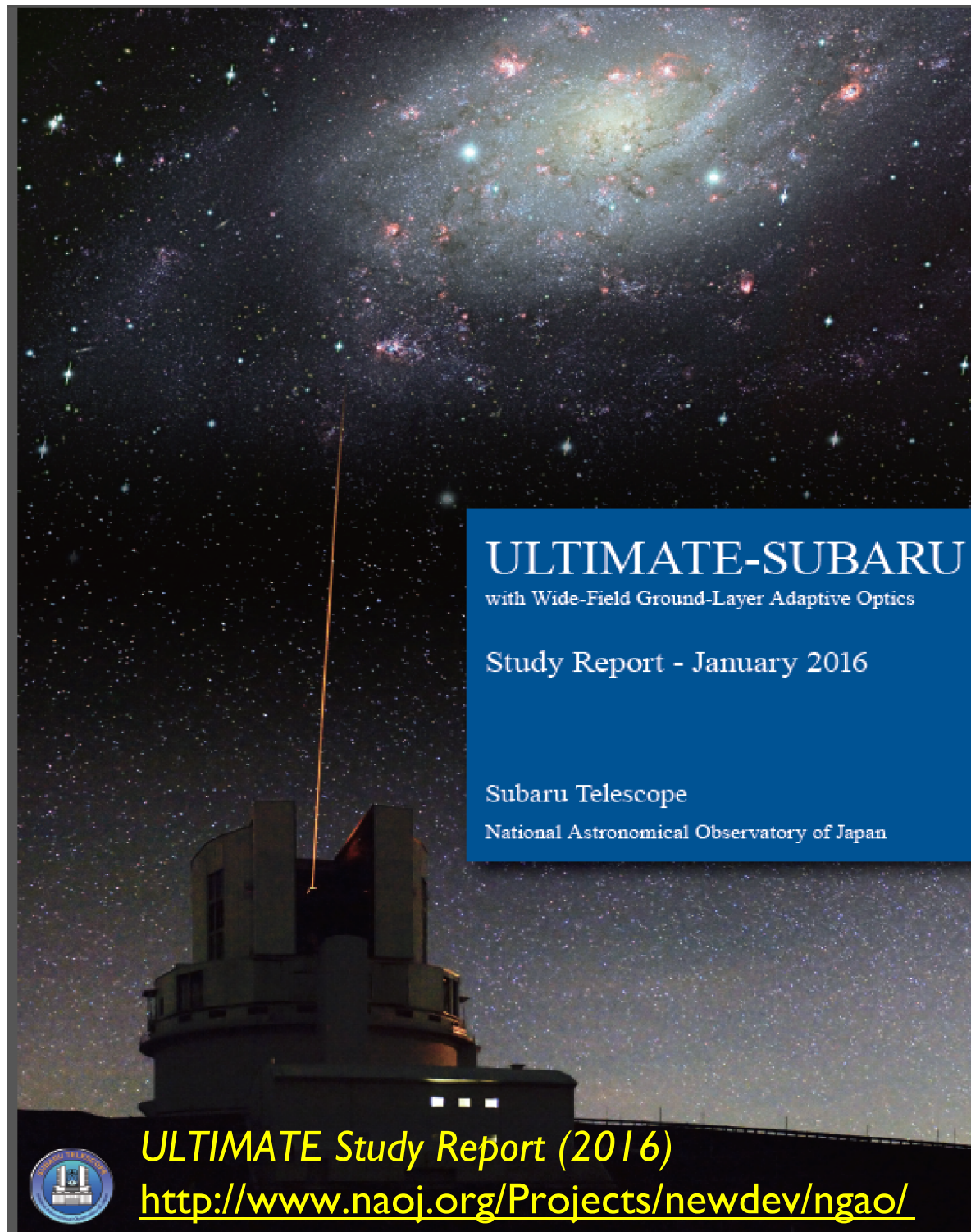
ULTRA-WIDE-FIELD LASER TOMOGRAPHIC
IMAGER and MOS with AO for TRANSCEMENT
EXPLORATION by SUBARU TELESCOPE.

Subaru Next-gen AO Working Group + Collaborators

- *Subaru / NAOJ*: Yutaka Hayano, Shin Oya, Yosuke Minowa, Tadayuki Kodama, Nobuo Arimoto, Takashi Hattori, Olivier Lai, Hideki Takami, Naruhisa Takato, Ichi Tanaka, Yusei Koyama
- *Japanese Univ.*: Masayuki Akiyama, Yoshito Ono (Tohoku Univ.), Kentaro Motohara (Univ. of Tokyo)
- *NRC Canada*: Alan McConnachie, Luc Simard, David Anderson, John Pazder, David Crampton, et al.
- *Australian Astronomical Observatory / University of Sydney*: Andrew Sheinis, Chris Lidman, John Lawrence, Andrew Hopkins, et al.
- *ASIAA Taiwan*: Shiang-Yu Wang, Wei-Hao Wang, et al.

ULTIMATE-Subaru Study Report 2016

released on Jan. 13



- ~3 years since Study Report 2012, which mainly discusses “Which AO is best for Subaru ?”.
- Most important topic now is “Which instrument is best for Subaru/GLAO and for our community ?” (mainly from scientific requirements).
- External review meeting in Feb. 24.
- Reviewers:
 - M. Yoshida (Hiroshima, Chair)
 - M. Doi (Tokyo)
 - K. Shimasaku (Tokyo)
 - M. Kissler-Patig (Gemini)
 - A. Renzini (INAF)

ULTIMATE key specifications: Ground-Layer AO

Guide stars	4 LGSs + 3 NGSs	
DM	Secondary mirror	~1000 actuators, modification of VLT ASM.
HO-WFS	> 8x8 SH	visible, EM-CCD(TBD)
TT(F)-WFS	2x2 SH or quad	visible
Laser	20 W CW	TOPTICA (589nm) (option: Rayleigh)
LGS constellation	15' in diameter	
Laser Launch	~25cm dia. (TBD)	side launch

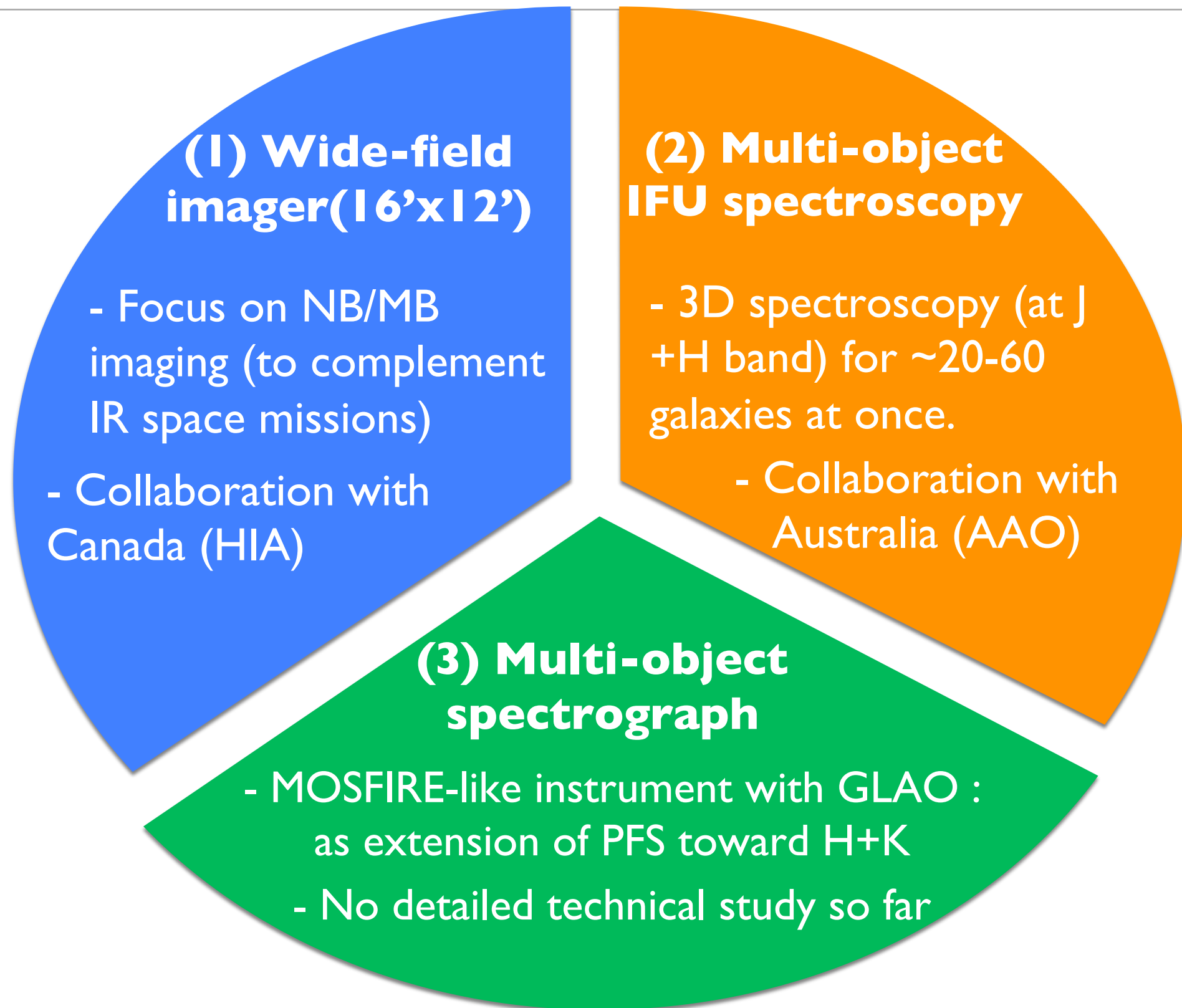
ULTIMATE key specifications: Ground-Layer AO

Field of View	15 arcmin
Focus	Cassegrain
Corrector	Adaptive secondary, 33 actuators across the diameter
Sky Coverage	Almost all sky

FWHMs at 'Moderate' condition

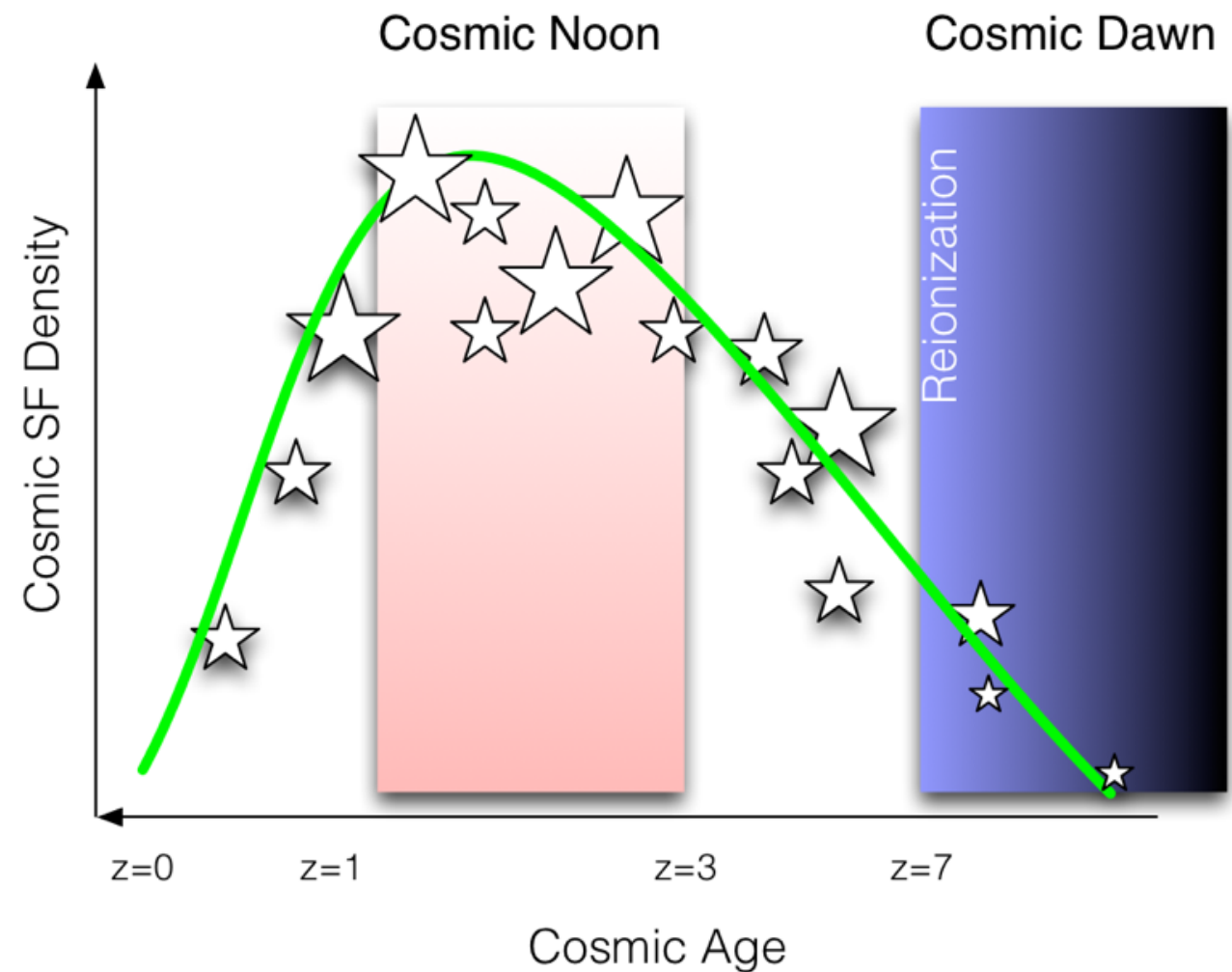
	GLAO	Natural
K-band	0.20''	0.44''
H-band	0.23''	0.49''
J-band	0.27''	0.51''
R-band	0.41''	0.65''

ULTIMATE-Subaru Instruments



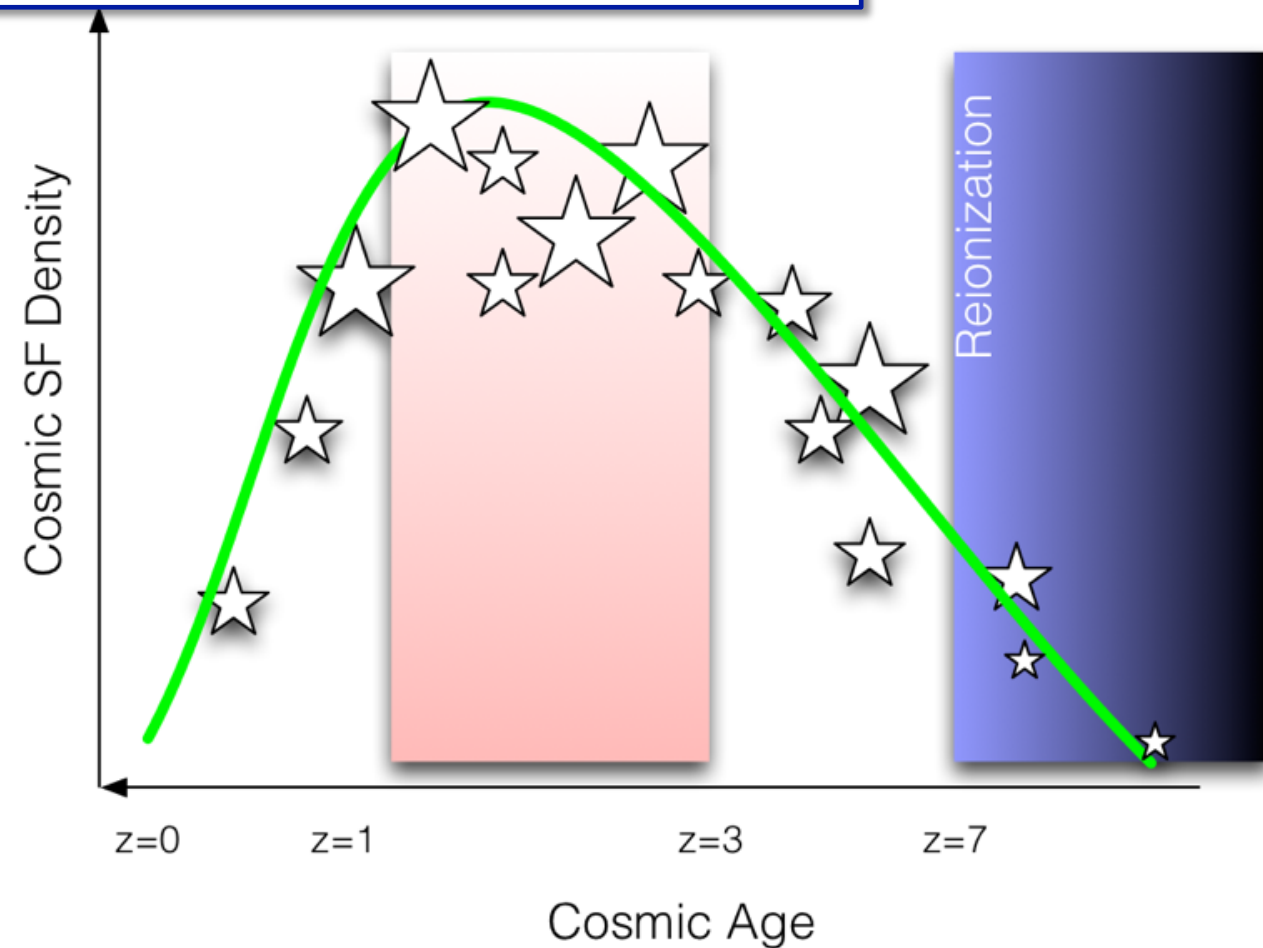
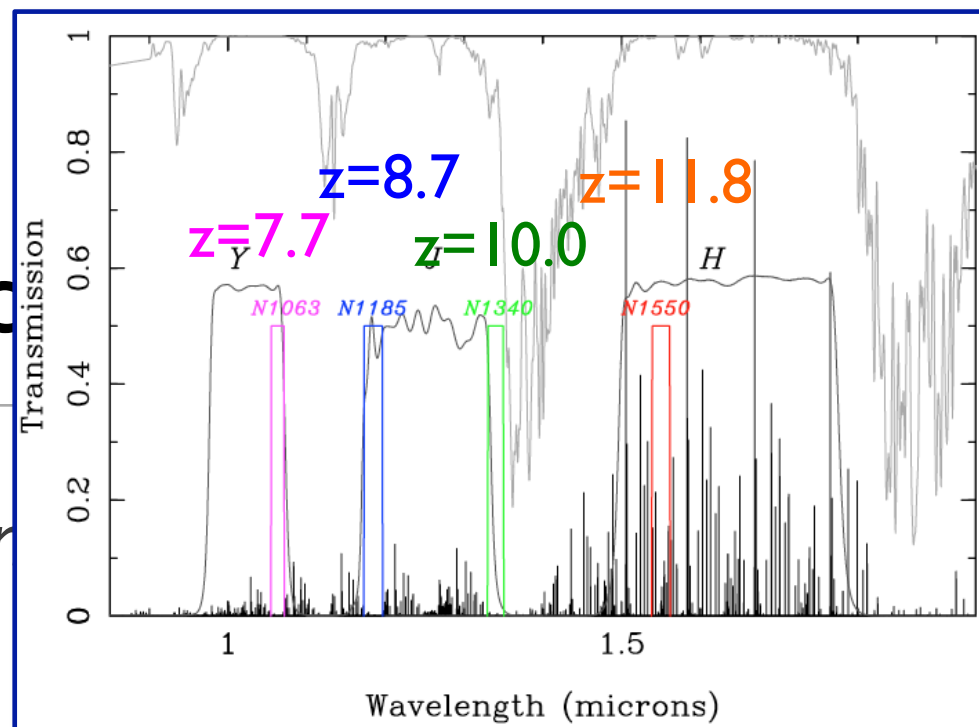
ULTIMATE-Subaru Science Goals

- *Complete Census of Galaxy Evolution*
 - ‘Cosmic Noon’ ($1 < z < 3$)
 - Galaxy Anatomy
- *Exploring Very High-Redshift Universe*
 - ‘Cosmic Dawn’ ($z > 7$)



ULTIMATE-Subaru Science

- *Complete Census of Galaxy Evolution*
 - ‘Cosmic Noon’ ($1 < z < 3$)
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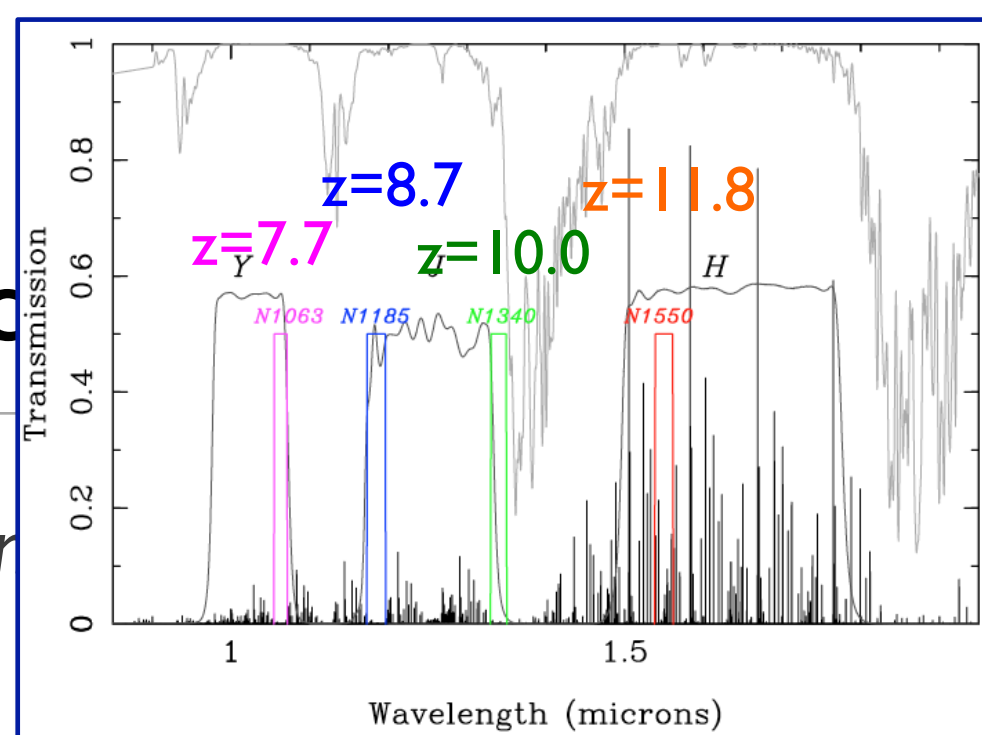
ULTIMATE-Subaru Science

- *Complete Census of Galaxy Evolution*

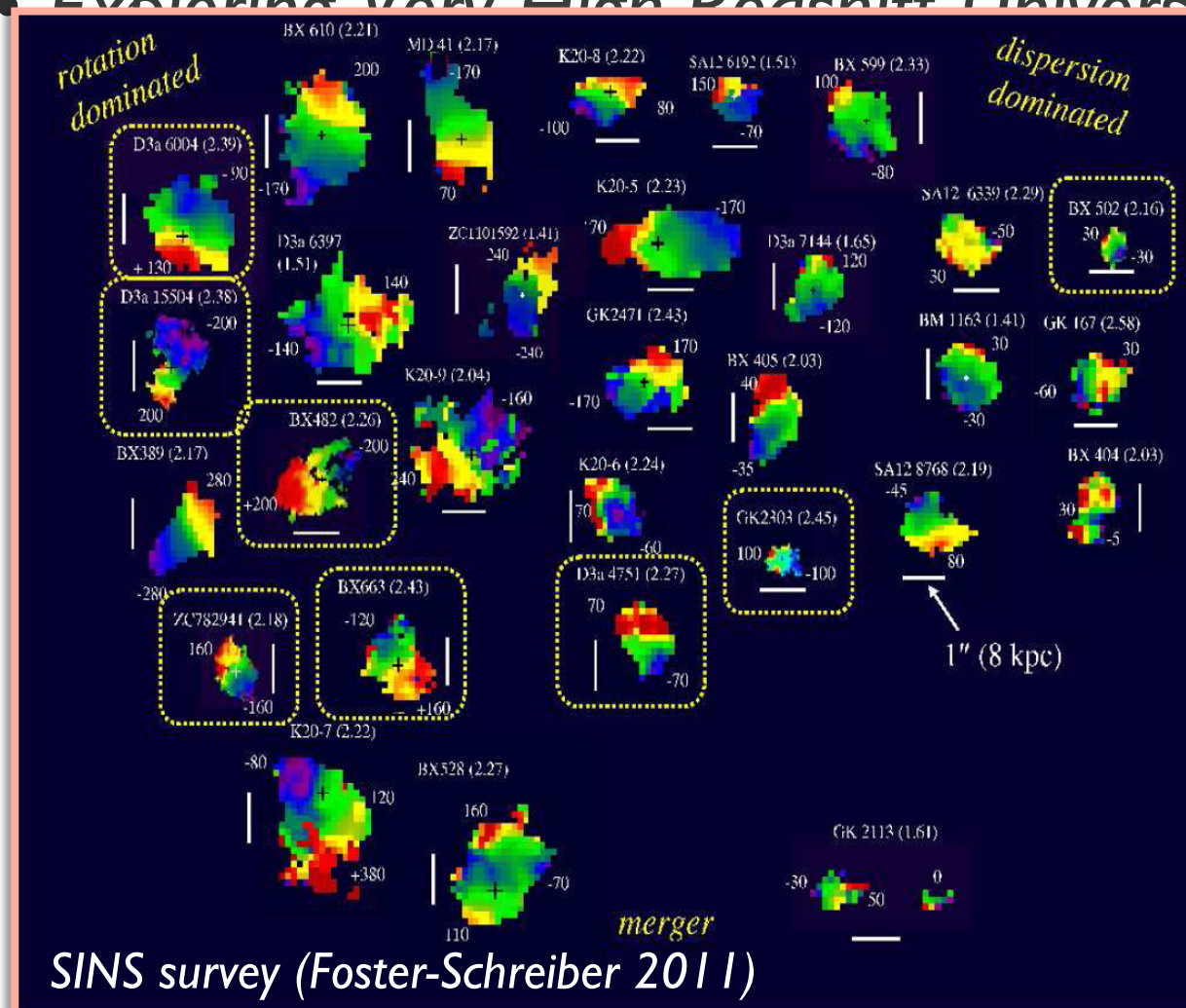
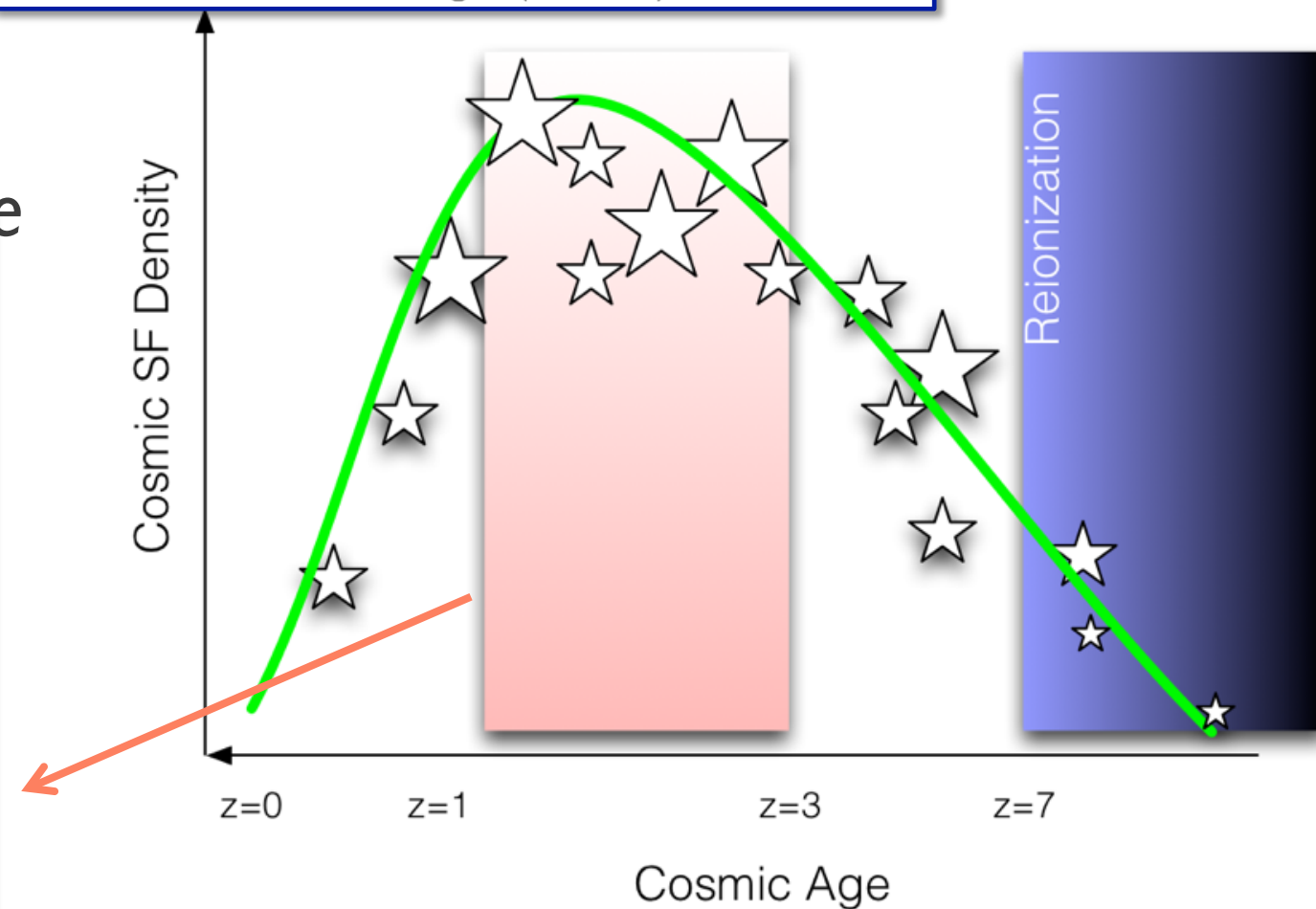
- ‘Cosmic Noon’ ($1 < z < 3$)

- Galaxy Anatomy

- *Exploring Very High Redshift Universe*



Cosmic Dawn

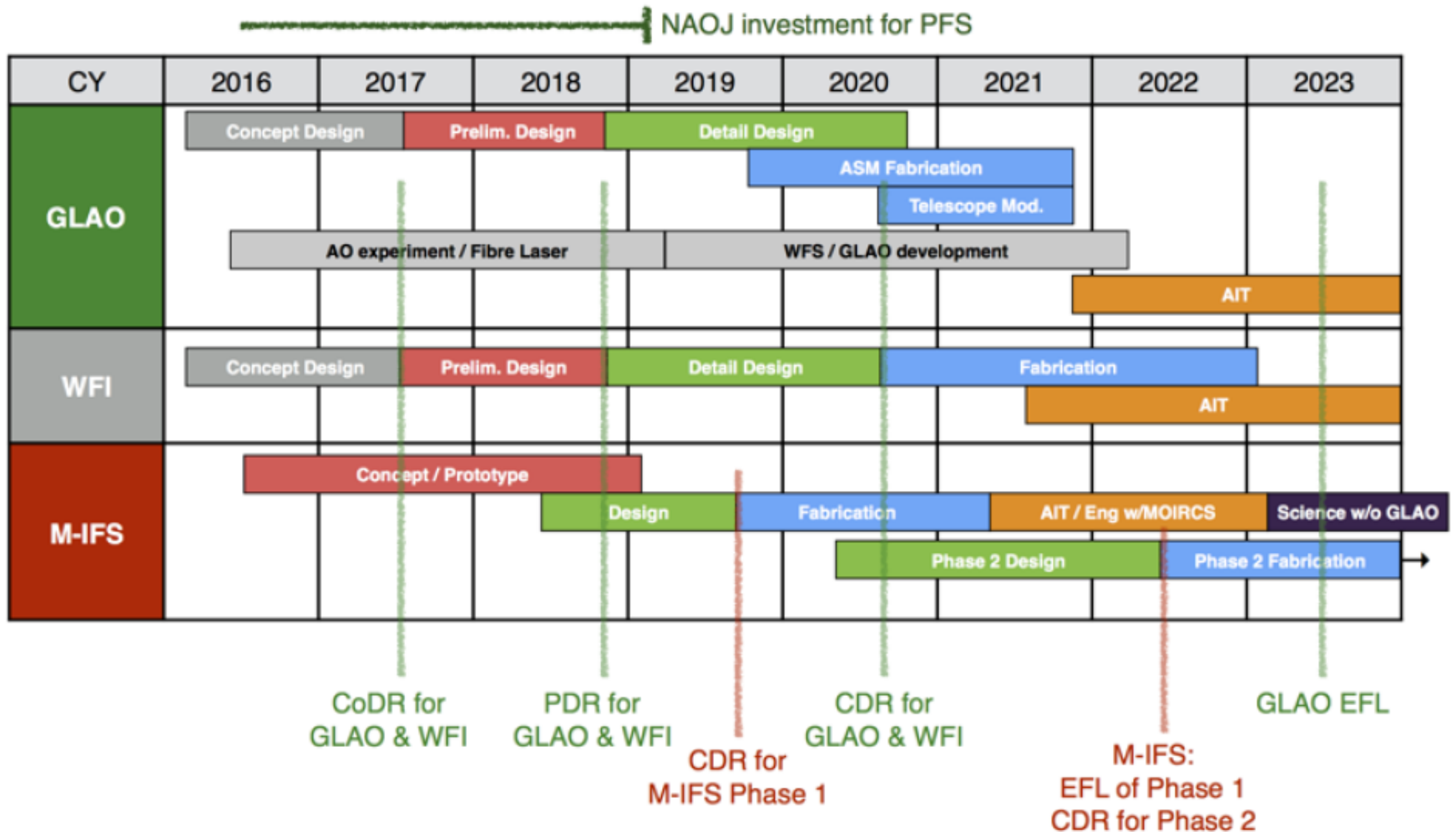


SINS survey (Foster-Schreiber 2011)

Acknowledgement (Science Authors)

- *High-z galaxy team:* Masayuki Akiyama, Masao Hayashi, Ikuru Iwata, Tadayuki Kodama, Kotaro Kohno, Yusei Koyama, Chris Lidman, Yuichi Matsuda, Yosuke Minowa, Takatoshi Shibuya, Ken-ichi Tadaki, Kimihiko Nakajima, Jessica Bloom, Julia Bryant, Scott Croom, Sarah Leslie, Lisa Kewley, I-Ting Ho, Adam Schaefer, Fuyan Bian, Tiantian Yuan
- *Low-z & Galactic science:*
 - Pa α Survey of Nearby Galaxies at $z < 0.3$ (K. Motohara & Y. Koyama)
 - Near IR imaging of the Local Universe (J. Koda, D. Iono, K. Motohara, Y. Koyama)
 - Deciphering the origin of Galactic Globular Clusters (M. Chiba)
 - The Galactic Center: Origin of S-stars and Nuclear Star Clusters (S. Nishiyama)
 - Dark Matter in the Inner 2-kpc of the Milky Way (David Nataf, Andy Casey)
 - Chemical Measurements of Stars of the Milky Way Disk (N. Matsunaga)
 - Wide-field NB imaging of Jets in Star-forming Regions (T. Pyo)
 - Investigation of the Initial Mass Function at Low-mass end (Y. Oasa)

ULTIMATE-Subaru Development Plan



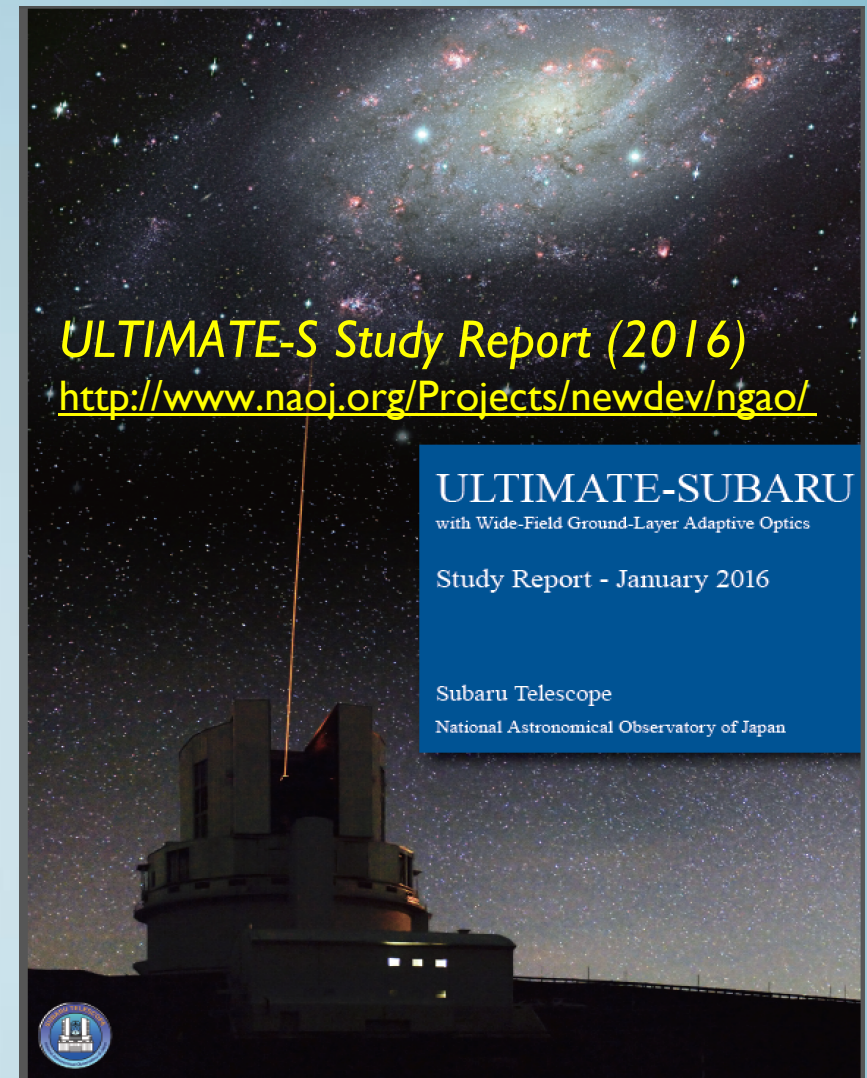
We are here !



HSC

PFS

ULTIMATE



2013

2019

2023

