Subaru/HSC Survey
& DUNES^2

*(**D**eep **U**KIRT **NE**ar-IR **S**teward **S**urvey)*

Eiichi Egami, Yun-Hsin Huang, Xiaohui Fan

Goals

- Inform interested Steward researcher of the existing opportunity to use proprietary HSC-Deep/Ultradeep & DUNES[2] data for their science projects.
- To identify a group of potential users for the HSC and DUNES[2] data.
- Note: The main goal today is to provide an overview; For more detailed discussion needed for project planning, we could arrange follow-up group/ individual meetings.

Outline

1. Introduction (Egami)
    - Project History
    - What is Subaru/HSC? What is the HSC survey?
    - What is DUNES^2?
2. DUNES^2 (Huang)
    - Data products
    - Current science programs
3. HSC-DUNES^2 data access (Egami)

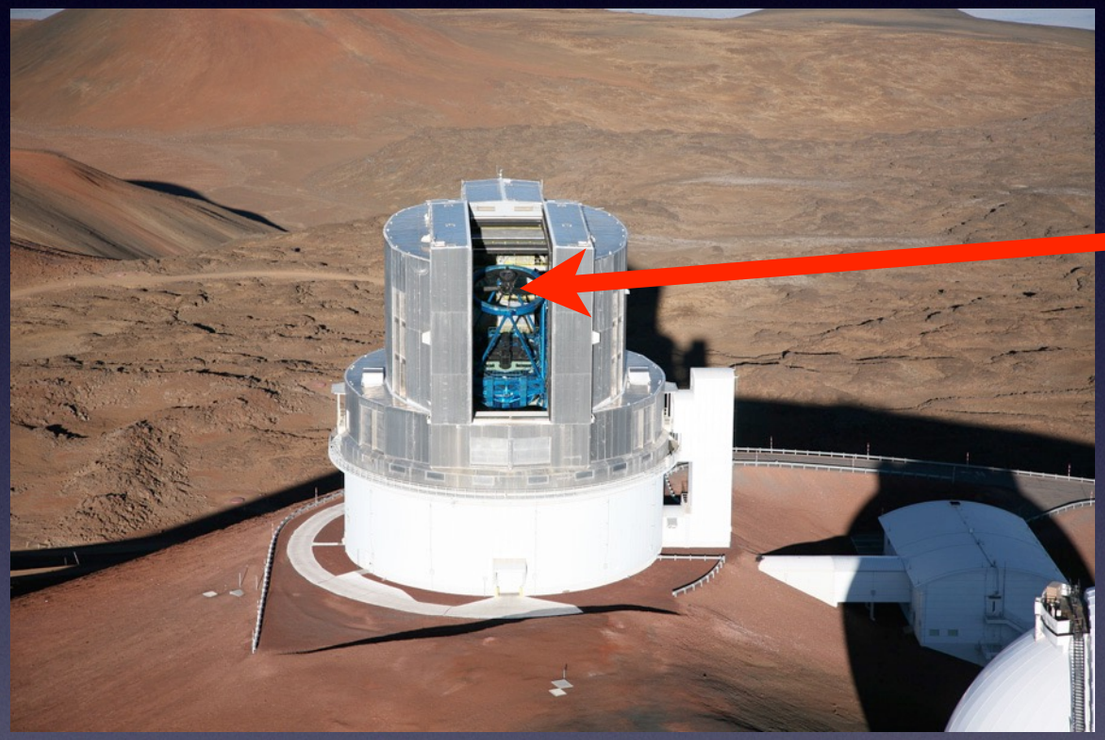
1. Introduction

Project History

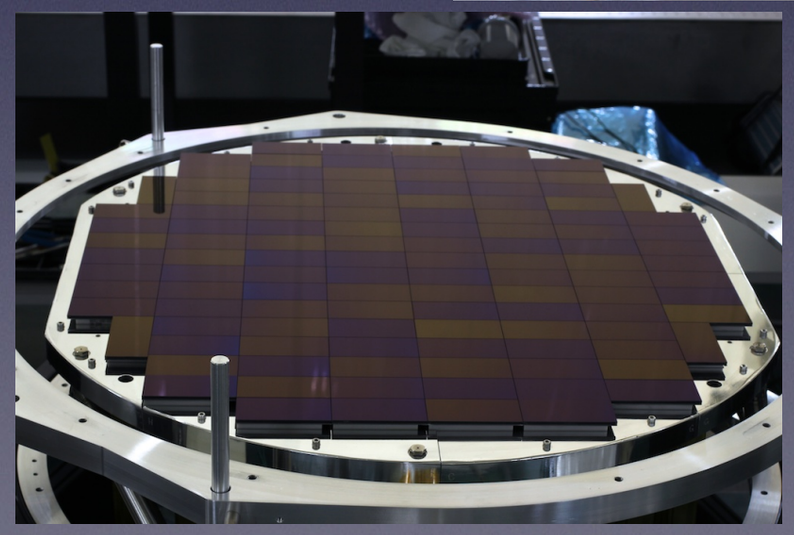
- Early 2014: Lockheed Martin, Univ. of Arizona, & Univ. of Hawaii took over the operation of UKIRT.
- Summer-Fall 2014: Subaru/HSC - Steward/UKIRT collaboration MOU finalized
- 2014B - DUNES^2 observations started
- (semi-annual meetings to inform Steward researchers.)
- 2017 Feb - HSC 1st public data release (20%)
- 2017 Mar - Last Steward HSC-UKIRT meeting
- 2018A - DUNES^2 observations ended
- May 2019 - HSC 2nd public data release

What is Subaru/HSC ?

(HSC=Hyper-Suprime Cam)



D=8.2m telescope
on Mauna Kea
run by Japan
(since 1999)



104
chips

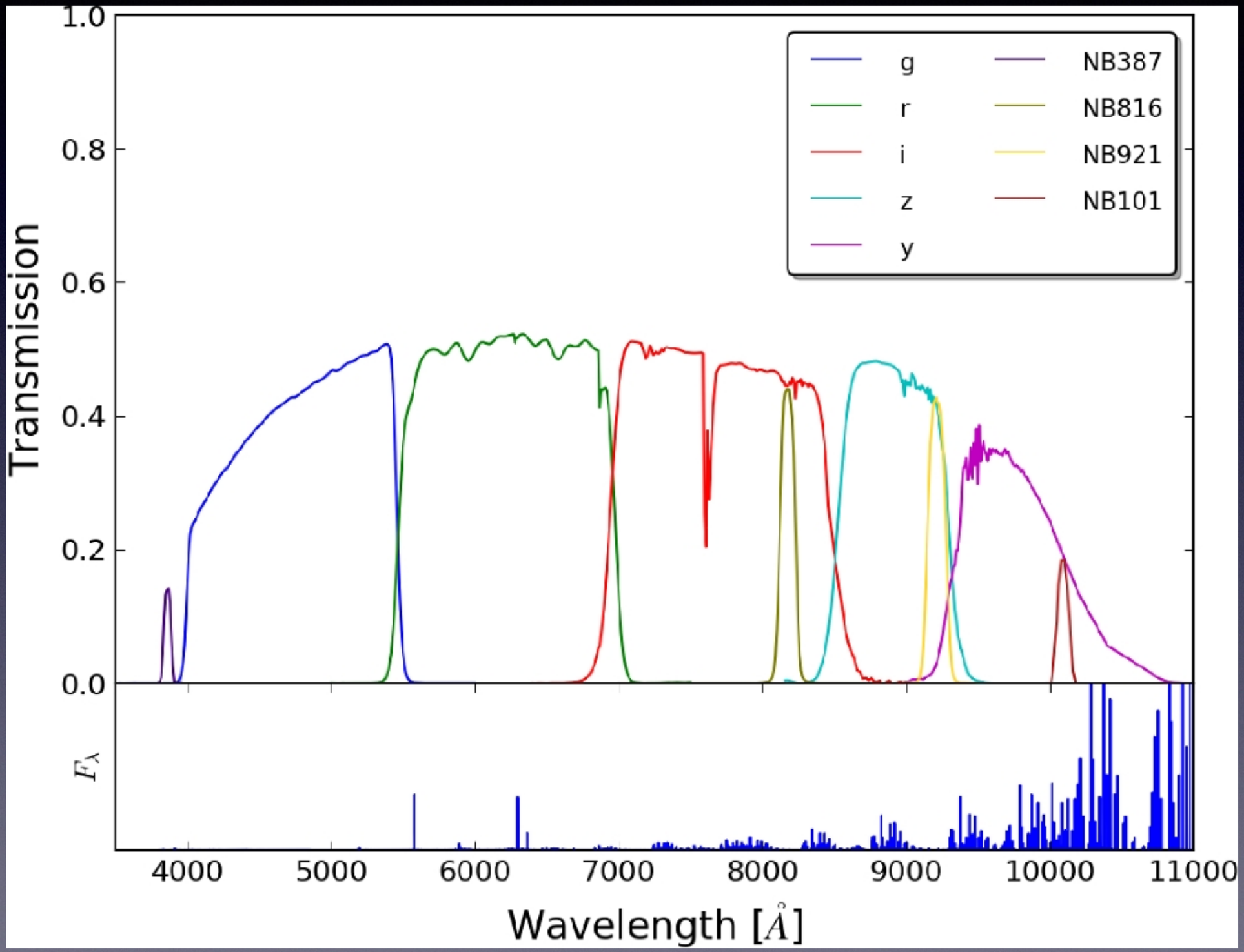
D=1.5 deg; FOV=1.77 deg^2

What is HSC Survey?

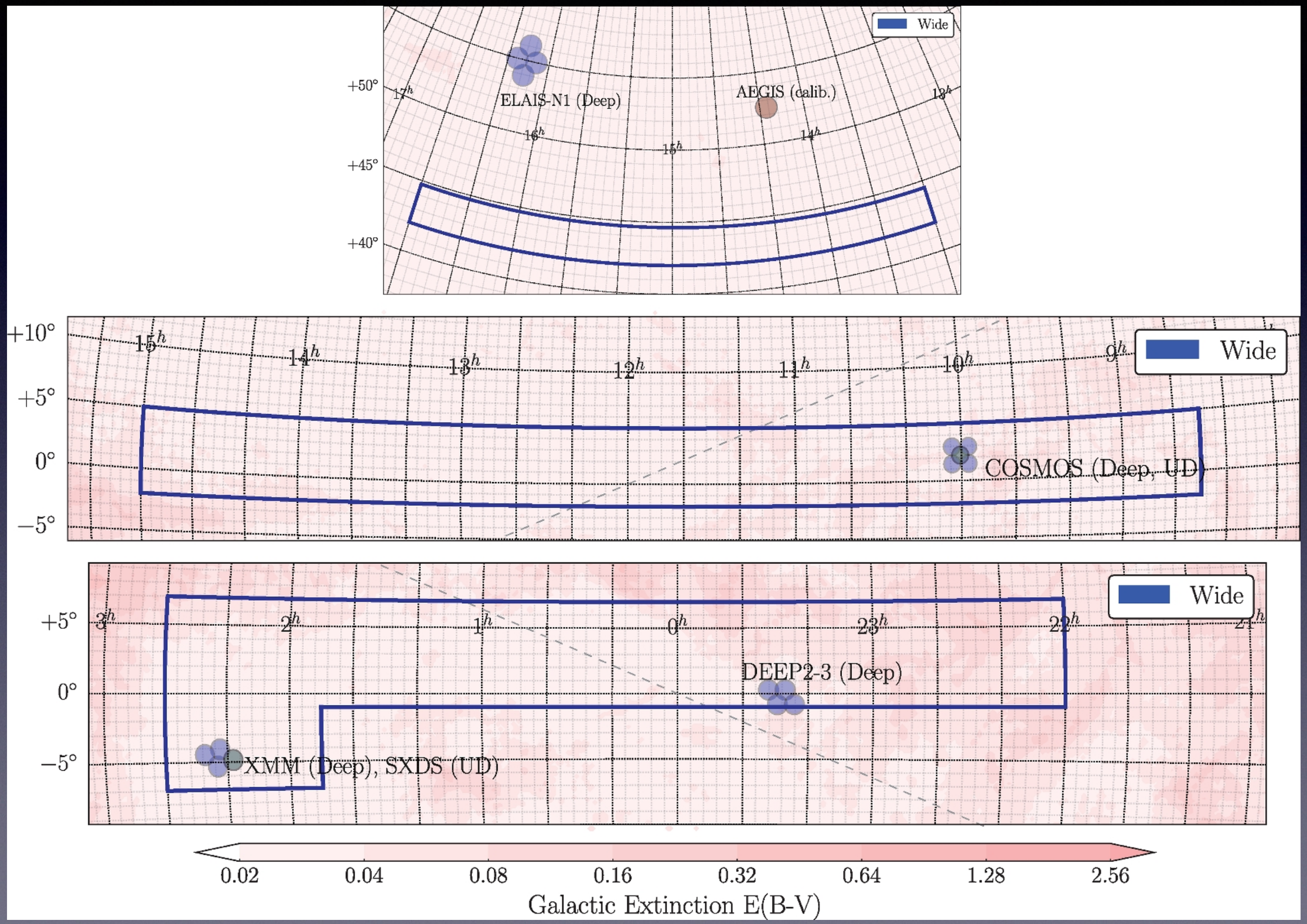
- Wide (VST/KiDS (D=2.6m) - VISTA/VIKING (D=4.1m) fields)
  - 1400 deg^2, grizy, r_{AB}~26 mag, 214 nights
- Deep (4 fields)
  - 27 deg^2, grizy+3NBs, r_{AB}~27 mag, 49 nights
- Ultradeep (SXDS/UKIDSS; COSMOS)
  - 3.5 deg^2, grizy+3NBs, r_{AB}~28 mag, 37 nights

300 nights of Subaru time over the next 5 years

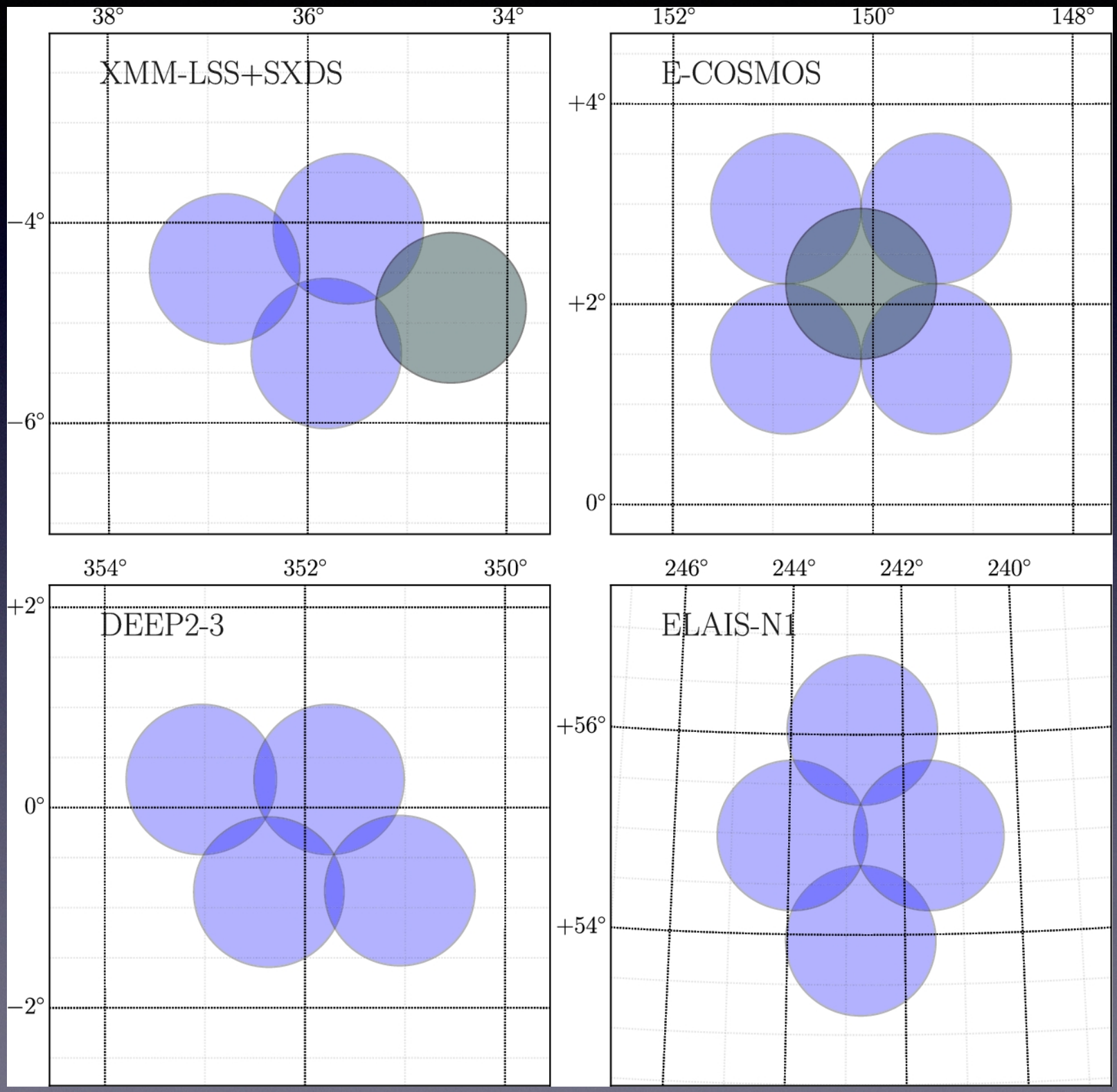
HSC Filters


g
r
i
z
y
NB387
NB816
NB921
NB101
Transmission
1.0
0.8
0.6
0.4
0.2
0.0
F_λ
4000
5000
6000
7000
8000
9000
10000
11000
Wavelength [$\AA$]

HSC-Wide


Wide
ELAIS-N1 (Deep)
AEGIS (calib.)
+50°
+45°
+40°
17h
16h
15h
14h
13h
+10°
+5°
0°
−5°
15h
14h
13h
12h
11h
10h
9h
COSMOS (Deep, UD)
3h
2h
1h
0h
23h
22h
DEEP2-3 (Deep)
XMM (Deep), SXDS (UD)
0.02
0.04
0.08
0.16
0.32
0.64
1.28
2.56
Galactic Extinction E(B-V)

HSC-Deep & Ultradeep



HSC-Deep Fields

	Field	RA & DEC (J2000)	Area (deg^2)	HSC #Fields
VISTA/ VIDEO	XMM-LSS (=SXDS)	02:25:00 -04:30:00	5.3	3
	E-COSMOS	10:00:20 +02:12:21	7.2	4
UKIRT/ UKIDSS	ELAIS-N1	16:10:00 +54:00:00	7.2	4
	DEEP2-3	23:30:00 +00:00:00	7.2	4

g, r, i, z, y (5σ, 2”) = 27.5, 27.1, 26.8, 26.3, 25.3 mag (AB)

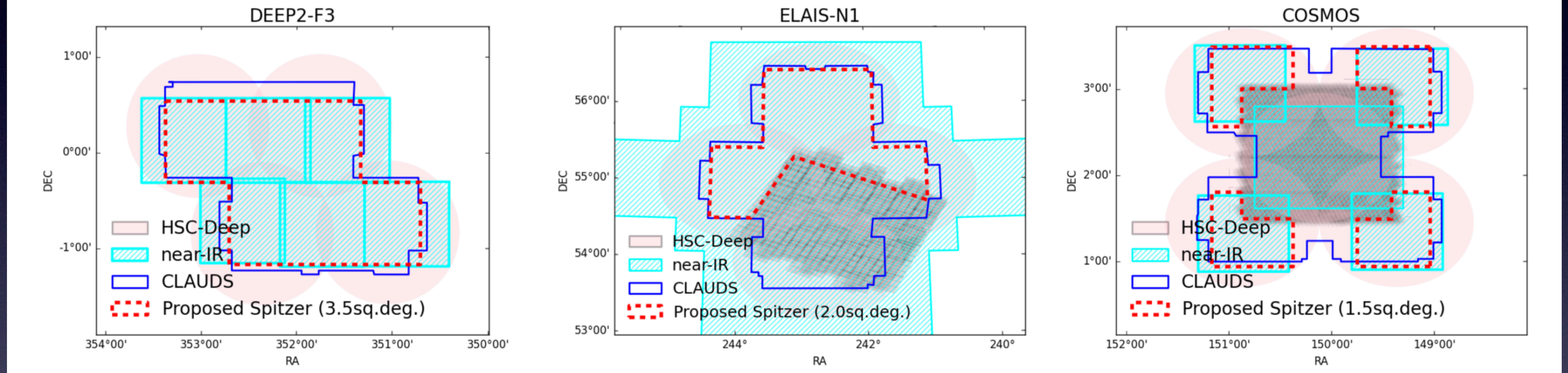
CLAUDS

CFHT Large Area U-Band Deep Survey

18.6 deg^2 of U_{AB}=27.1 CFHT imaging in HSC Deep/UD

Marcin Sawicki
on behalf of the CLAUDS team
and with contributions from:
Lingjian Chen, Jean Coupon, Anneya Golob, Stephen Gwyn, Yuichi Harikane, Ikuru Iwata,
Yipeng Jing, Chengze Liu, Thibaud Moutard, Yoshiaki Ono, Nathalie Thibert

Spitzer/IRAC for HSC-Deep



PI: Anna Sajina (Tufts)

3.6/4.5 μm, ~23 AB mag, 7 deg^2, 488 hours

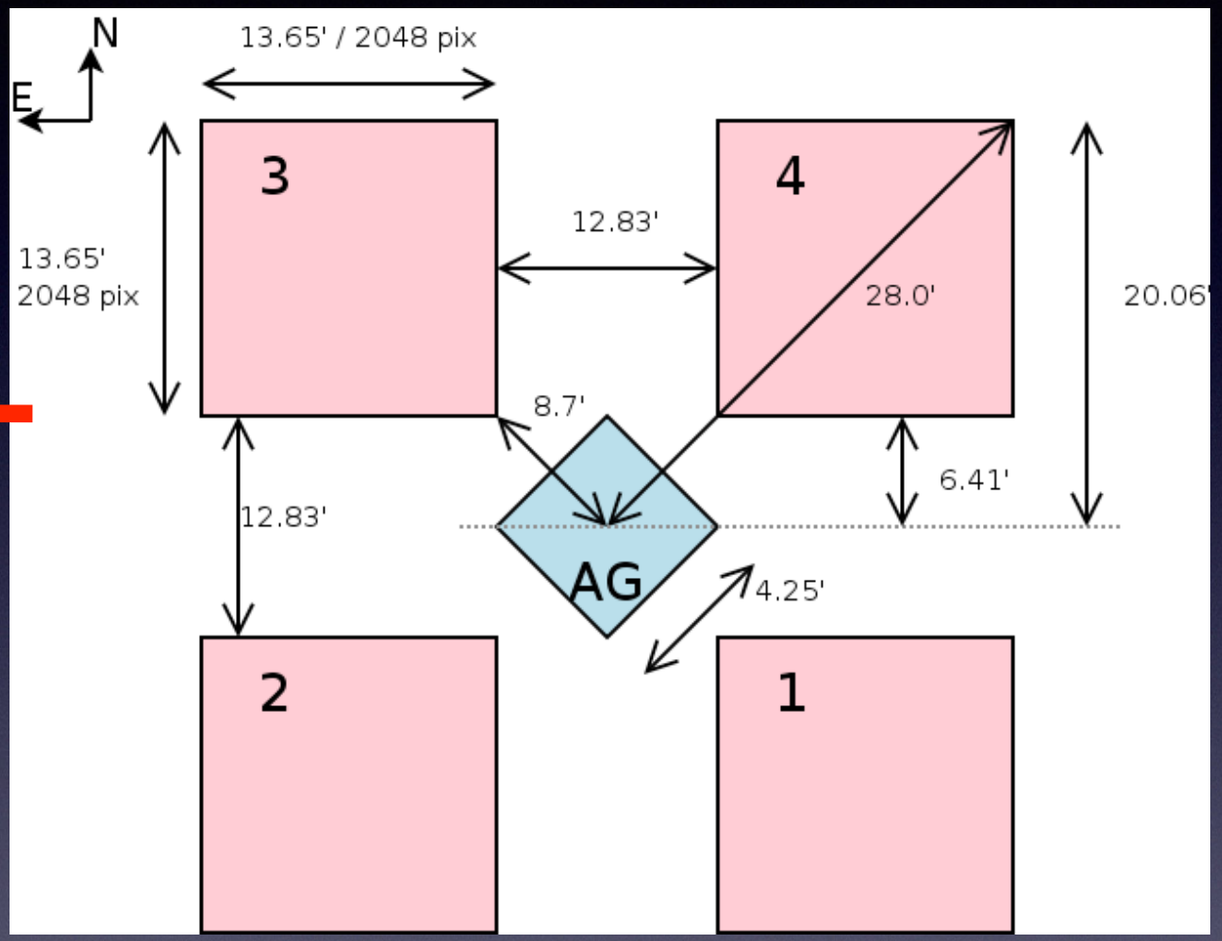
What is DUNES^2 ?

*(**D**eep **U**KIRT **NE**ar-IR **S**teward **S**urvey)*

Not to be confused with “**DU**st around **NE**arby **S**tars”

UKIRT & WFCAM

D=3.8 m IR-optimized
telescope
on Mauna Kea
(since 1979)



0.4”/pixel, tip/tilt secondary
4 pointings to cover 0.75 deg^2
(since 2005)

Goal

- Obtain UKIDSS/DXS-like J/H/K-band images (2hr/band) covering a total area of 7.5 deg^2 over two HSD-Deep fields:
  - E-COSMOS (4x0.75 deg^2)
  - DEEP2-3 (6x0.75 deg^2)
- Depth: 23.6 (J), 23.2 (H), 23.1 (K) AB mag (UKIRT/ETC: 5sigma, 0.9” seeing, D=2”, airmass=1.2)
- 240 hours of open-shutter time (~30 nights if 8 hours/night)

Final Status

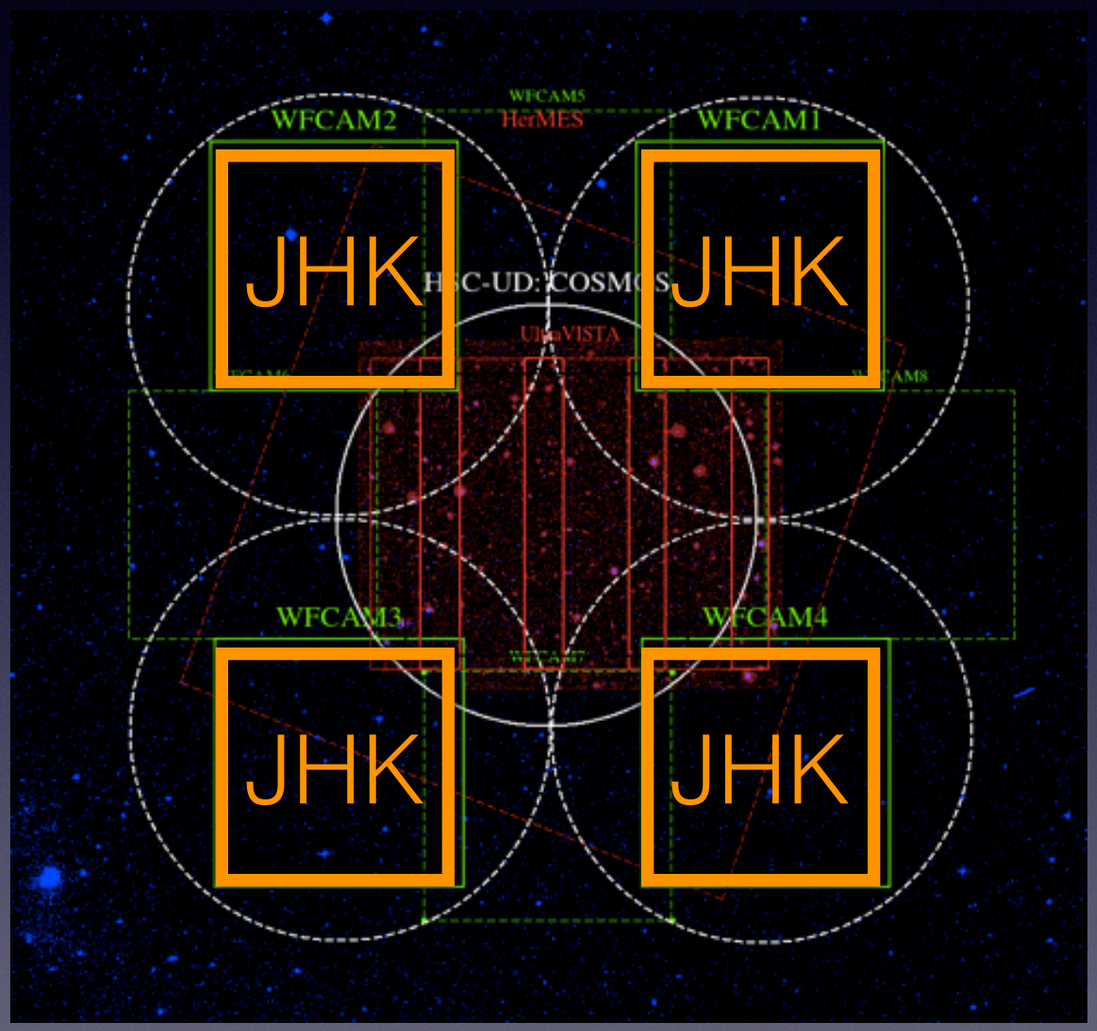
Period	Target	Allocated (hrs)	Executed (hrs)	Completion Rate (%)
2014B	DEEP2-3	140	33	23
2015A	E-COSMOS DEEP2-3	120	35 11	39
2015B	DEEP2-3	80 (Priority1) 90 (Priority 2)	33 16	29
2016A	E-COSMOS DEEP2-3 ELAIS-N1	80 (Priority 1) 80 (Priority 2)	55 22 (19)	60
2016B	DEEP2-3	50 (Priority 1) 50 (Priority 2)	27	27
2017B	DEEP2-3	15	4	27
2018A	DEEP2-3	15 in queue	8	53

Required: 300 hrs (240 hrs open-shutter + overheads)

Executed: 244 hrs (81%); 263 hrs (88%) including ELAIS-N1

HSC-Deep Near-IR Coverage

E-COSMOS



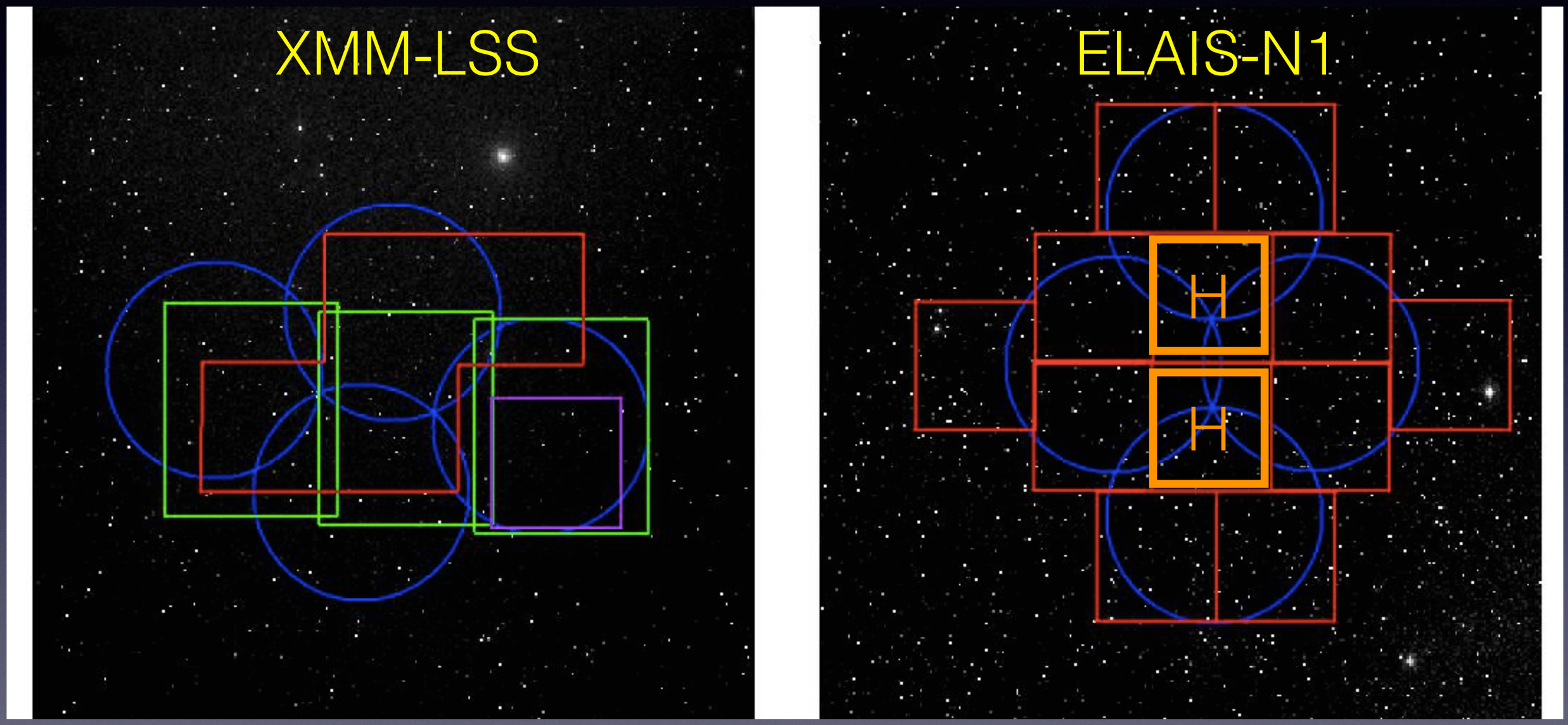
DEEP2-3

HSC-Deep

UltraVISTA
Y/J/H/Ks

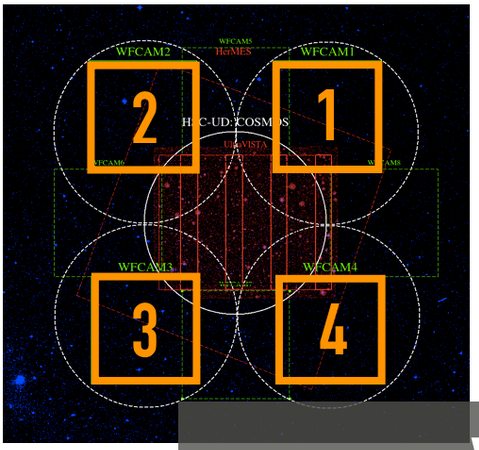
Steward/UKIRT
J/H/K (Done)

HSC-Deep Near-IR Coverage



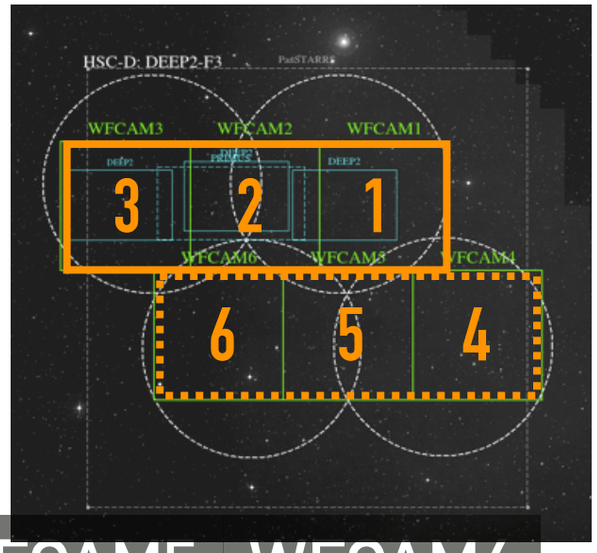
HSC-Deep UKIDSS/DXS J/K UKIDSS/UDS J/H/K VISTA/VIDEO zYJHKs

Survey Depths



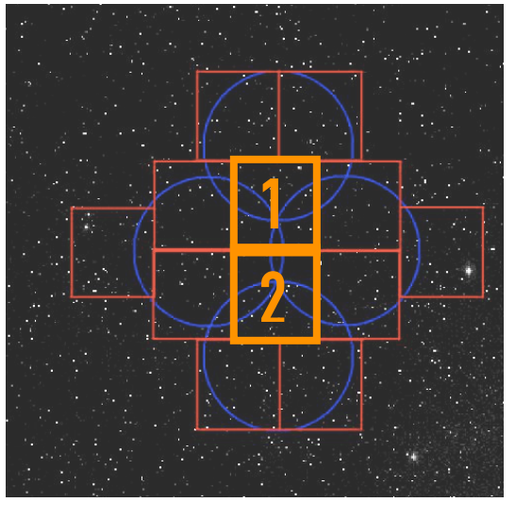
E-COSMOS

	WFCAM1	WFCAM2	WFCAM3	WFCAM4
J	23.2	23.3	23.3	23.2
H	23.2	23.2	23.2	22.9
K	23.0	22.8	23.0	22.8



DEEP 2-3

	WFCAM1	WFCAM2	WFCAM3	WFCAM4	WFCAM5	WFCAM6
J	23.2	23.2	23.3	44%		
K	23.1	23.0	23.1	23.0	22.9	23.0
H	17%		35%			



ELAIS-N1

	WFCAM1	WFCAM2
H	23.2	23.0

Survey Depth: J~23.2, K~23

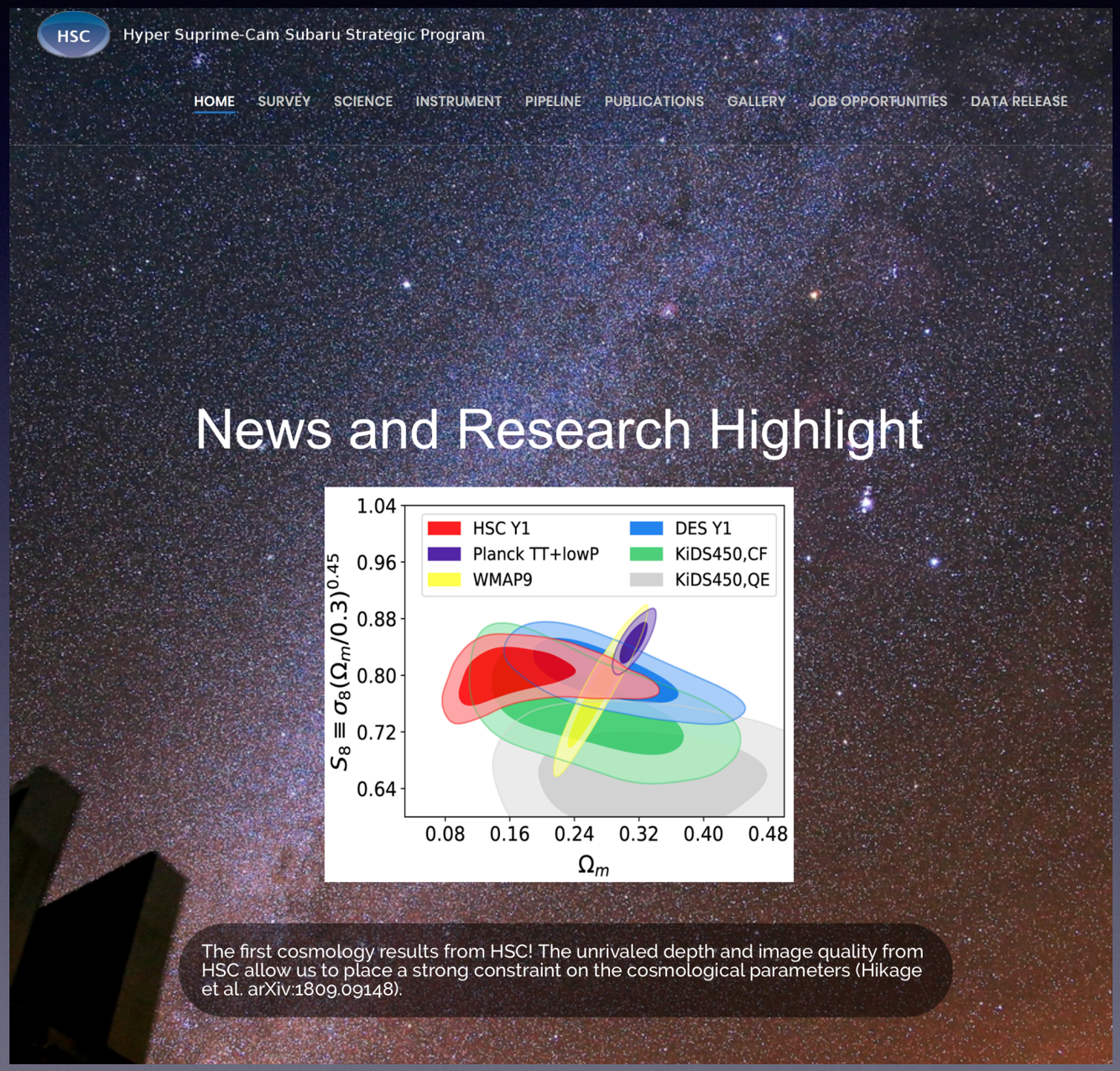
2. DUNES^2

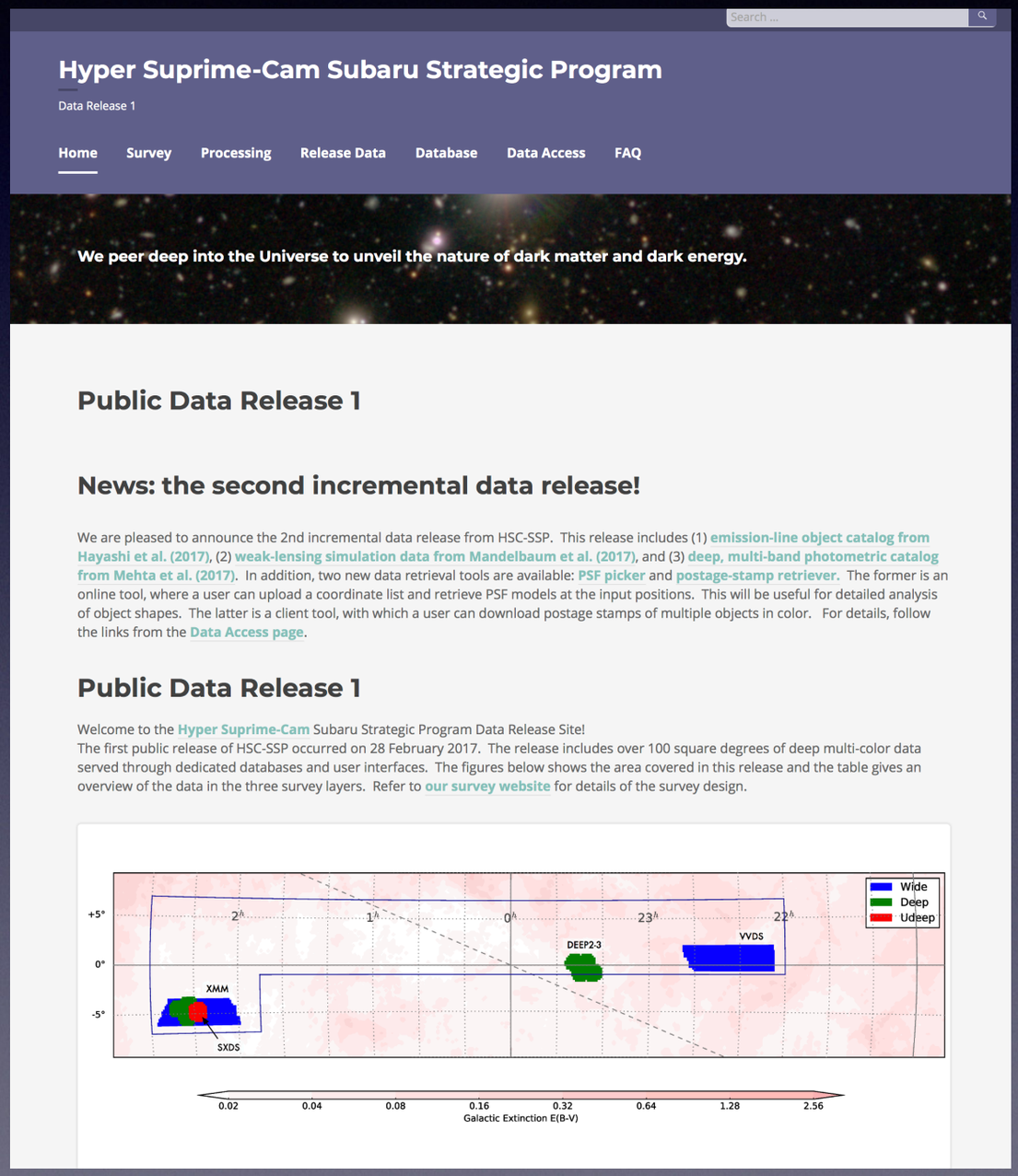
(by Yun-Hsin)

3. HSC-DUNES² Data Access

HSC Survey Website

https://hsc.mtk.nao.ac.jp/ssp/





HSC Survey DR1

(61.5 nights = 20%)

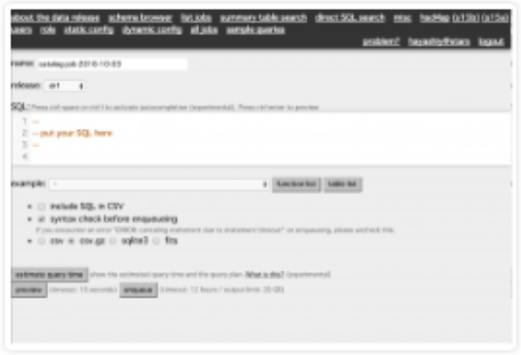
UltraDeep	g	r	i	z	y	$NB387$	$NB816$	$NB921$	$NB101$
exposure (min)	70	70	130	130	210	—	200	270	—
seeing (arcsec)	0.74	0.62	0.64	0.59	0.74	—	0.60	0.76	—
depth (mag)	27.5	27.3	27.2	26.5	25.7	—	26.3	25.9	—
target exposure (min)	420	420	840	1134	1134	—	630	840	1050
target depth (mag)	28.4	28.0	27.7	27.1	26.6	—	26.8	26.5	25.1
Deep	g	r	i	z	y	$NB387$	$NB816$	$NB921$	$NB101$
exposure (min)	20	15	30	35	20	—	45	60	—
seeing (arcsec)	0.83	0.68	0.55	0.69	0.59	—	0.53	0.65	—
depth (mag)	26.8	26.6	26.5	25.6	24.8	—	25.9	25.6	—
target exposure (min)	84	84	126	210	126	84	168	252	—
target depth (mag)	27.8	27.4	27.1	26.6	25.6	24.8	26.1	25.9	—
Wide	g	r	i	z	y	$NB387$	$NB816$	$NB921$	$NB101$
exposure (min)	10	10	20	20	20	—	—	—	—
seeing (arcsec)	0.72	0.67	0.56	0.63	0.64	—	—	—	—
depth (mag)	26.8	26.4	26.4	25.5	24.7	—	—	—	—
target exposure (min)	10	10	20	20	20	—	—	—	—
target depth (mag)	26.8	26.4	26.2	25.4	24.7	—	—	—	—

g	r	i	z	y	NB387	NB816	NB921
24%	18%	24%	17%	16%	0%	27%	24%

DR1 Data Access Page

Online Registration

CAS Search



ReadMe

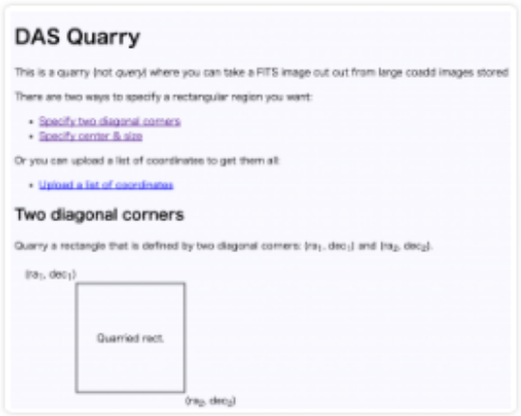
Schema Browser

ReadMe (top page of the schema browser)

hscMap

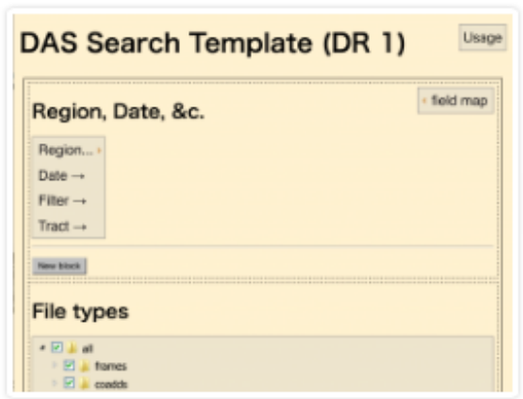
ReadMe

DAS Quarry



ReadMe

DAS Search



ReadMe

Direct access to the directory tree

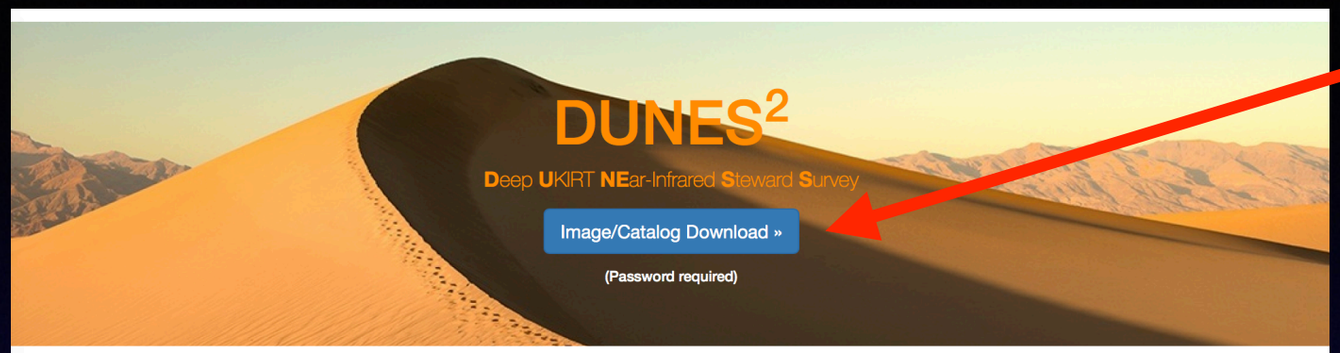
UltraDeep

Deep

Wide

DUNES^2 Website

http://gxn.as.arizona.edu/DUNES



Welcome to DUNES^2 !

What is DUNES^2 ?

The **D**eep **U**KIRT **NE**ar-Infrared **S**teward **S**urvey (DUNES^2; pronounced as "Dunes" for simplicity) is an effort to increase near-infrared coverage for the Subaru/Hyper Suprime-Cam (HSC) Deep fields, using the wide-field WFCAM near-infrared camera on UKIRT. With a total observing time of ~260 hours allocated between 2014 and 2018, the DUNES survey has observed the parts of the HSC-Deep fields without any existing near-infrared data, the four flanking fields of E-COSMOS (3 deg^2; J/H/K) and DEEP2-3 field (4.5 deg^2; J/K), down to J/H~23.2 & K~23 AB mag. In terms of observing strategy and data characteristics, DUNES^2 is similar to the UKIDSS Deep Extragalactic Survey (DXS). It also added H-band coverage to the central part of ELAIS-N1 (1.5 deg^2), which already has the UKIDSS/DXS J/K-band data.

HSC-Deep Fields

Hyper Suprime-Cam (HSC) is Subaru Telescope's newly commissioned prime-focus CCD mosaic camera with a wide field of view (D=1.5 deg). The Subaru Observatory will allocate ~300 nights of Subaru time over a ~5-year period to conduct a large extragalactic survey with three components: Wide (1400 deg^2; r~26 AB mag), Deep (27 deg^2; r~27 AB mag), and Ultradeep (3.5 deg^2; r~28 AB mag). The HSC-Deep survey targets four fields, XMM-LSS, E-COSMOS, ELAIS-N1, and DEEP2-3, and the DUNES^2 survey is designed to provide deep near-infrared coverage for those HSC-Deep fields that are lacking such data, complementing the existing near-infrared surveys such as UKIDSS/DXS & UDS, UltraVISTA, and VIDEO.

More Information

DUNES^2 Survey

- HSC-DUNES^2 collaboration policy (password required)

Subaru/HSC Survey

- HSC Survey website
- Data Release website
- Overview and survey design paper
- First data release paper

Near-infrared Surveys (for HSC-Deep)

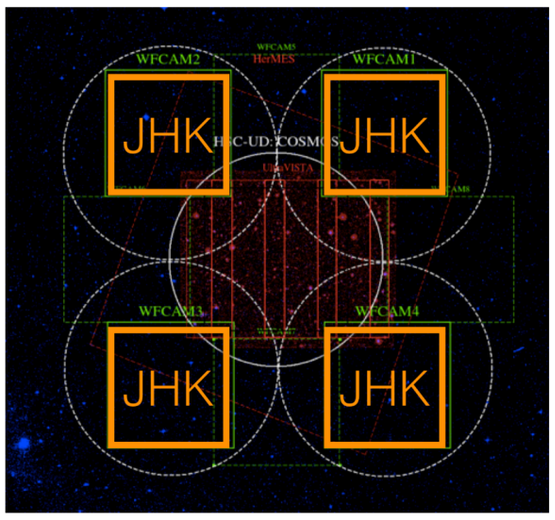
- UKIDSS/DXS
- UltraVISTA
- VIDEO

CLAUDS (CFHT u-band survey for HSC-Deep)

- CLAUDS (comning soon)

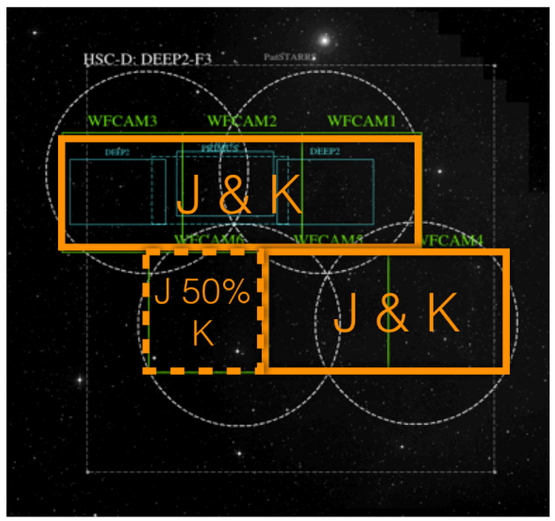
HSC-Deep Fields & DUNES^2 Coverage

The DUNES coverage is shown as orange squares/rectangles below.



E-COSMOS

White circles - HSC, Red - UltraVISTA



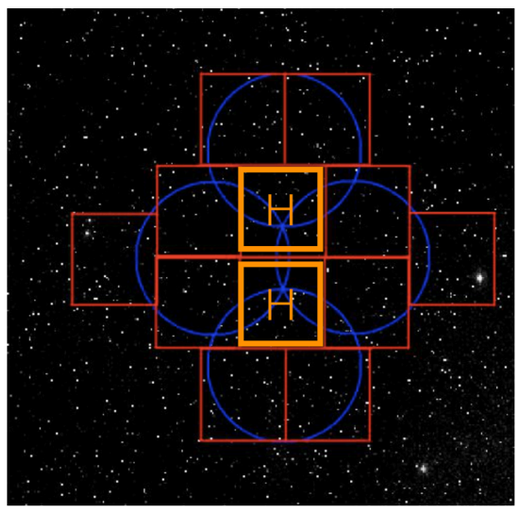
DEEP2-3

White circles - HSC

Image/catalog access

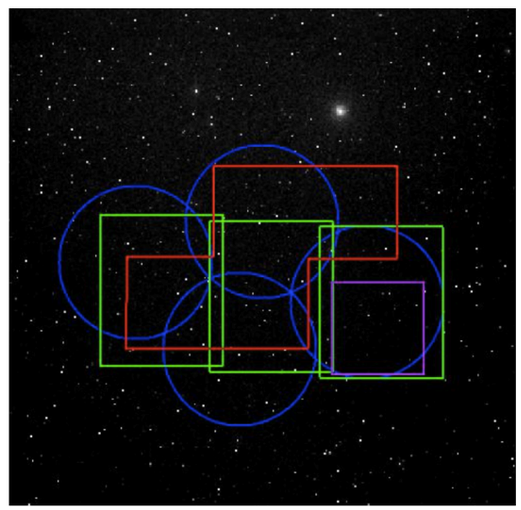
"dunes2" & "wfcam*ukirt"

Policy document



ELAIS-N1

Blue - HSC, Red - UKIDSS/DXS



XMM-LSS

Blue circles - HSC, Green - VIDEO, Red - UKIDSS/DXS, Purple - UKIDSS/UDS

The Team

Steward Observatory, University of Arizona

Eiichi Egami (PI)

Yun-Hsin Huang

Xiaohui Fan

and 18 Co-Is on the original proposal.

Contact

Eiichi Egami
eegami@as.arizona.edu
Steward Observatory, University of Arizona

Mailing List

Name
Email
Affiliation
Subscribe

Please sign up for the mailing list!

Policy

- **DUNES2**
  - All the data products (images and catalogs) are available to Steward researchers as of today, but please consult with us for their use.
- **HSC-Deep/Ultradeep**
  - To access the proprietary data, a project proposal needs to be submitted to the HSC Board for approval (please consult with Egami). When approved, you will become an HSC external collaborator.
  - We do not have free access to the HSC proprietary data. The data access will be provided only on a project-by-project basis.
  - The use of narrow-band data is more restricted (must have some connection to the use of DUNES^2 or other near-IR data).
- **HSC-Wide** (no special access although you may join specific projects)

In some cases, it may be more beneficial to wait for the public data release.