DAWN

The Epoch of Reionization with the Prime Focus Spectrograph

Sune Toft,
Director
Cosmic Dawn Center (DAWN)

Danmarks Grundforskningsfond
Danish National Research Foundation

DTU

UNIVERSITY OF COPENHAGEN

erc

1. *The Cosmic DAWN Center*
2. *The Cosmic DAWN Survey*
3. *COSMOS2019*

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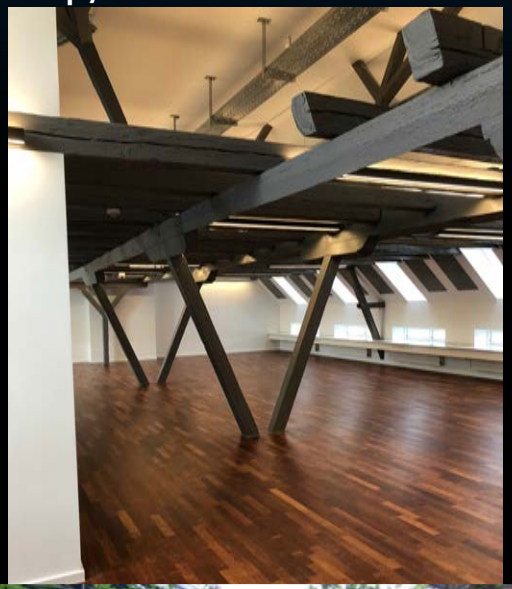
erc

DAWN – A new International research center

April signing

June opening

Sep/Oct move-in



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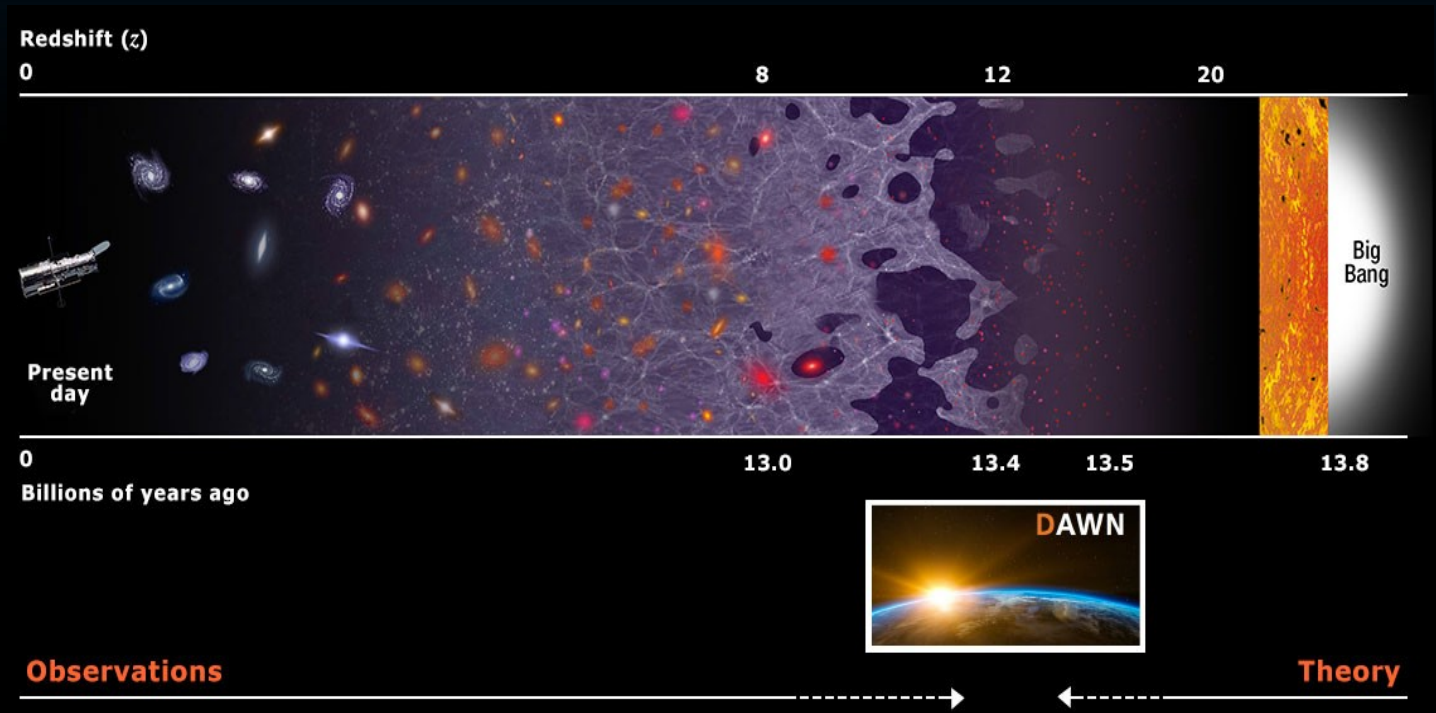
Cosmic Dawn Center (DAWN)



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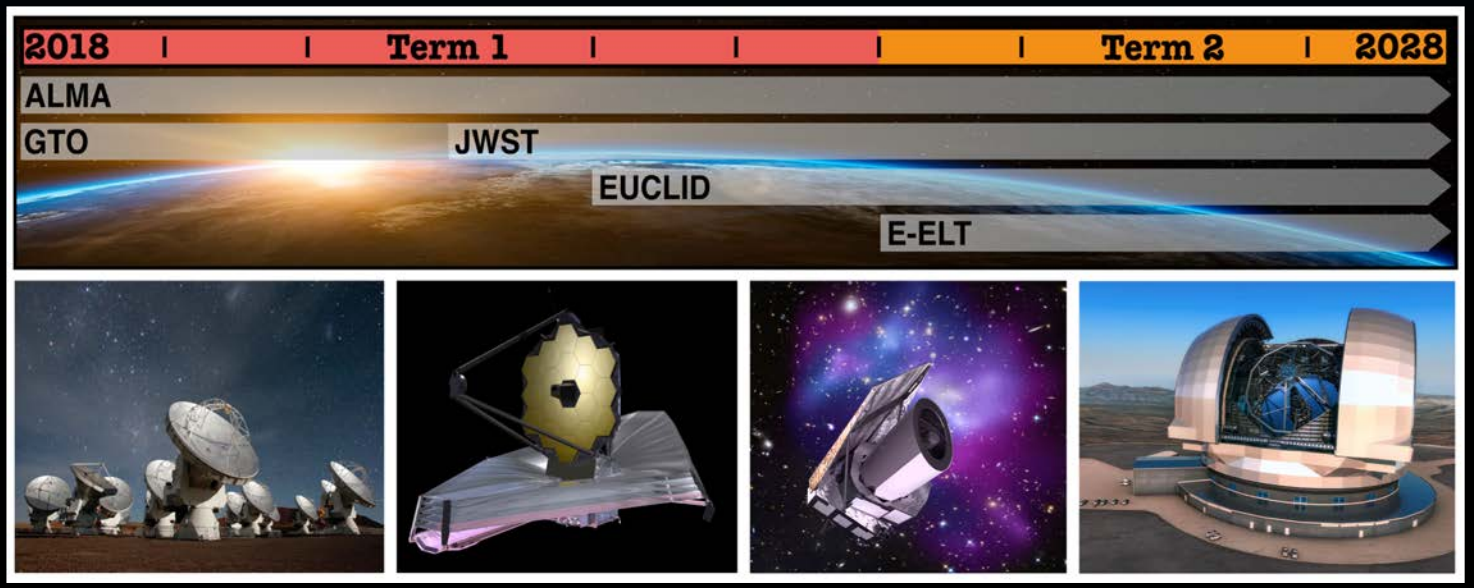
Cosmic Dawn Center (DAWN)



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At the Niels Bohr Institute

Gabe Brammer

Darach Watson

At DTU-Space

Sune Toft

Thomas Greve

Georgios Magdis

Peter Jakobsen

Charles Steinhardt

Allan Hornstrup

Hans Ulrik Nørregaard Nielsen

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International Associates

Peter Capak
(IPAC/Caltech)

Kate Whitaker
(Uconn)

Fabian Walter
(MPIA)

Karina Caputi
(Kapteyn/Groningen)

Pascal Oesch
(Geneva)

Claudia Lagos
(U. Western Australia)

Desika Narayanan
(U. Florida)

Kristian Finlator
(New Mexico State U.)

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DAWN Fellowship and PhD Programs

2018 Fellows

Daniel Ceverino

Kimihiko Nakajima

2018 PhD students

John Weaver

Vasilii Kokorev

Meghana Killi

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International Summer Research Program

10-15 students from the US, 11 weeks over the summer

-Caltech SURF@DAWN program
-NSF/IRES grant ($300K)

International Research Experience for Students
DAWN-IRES Scholars Program

Summer Research in Astrophysics in Copenhagen, Denmark

We welcome applicants for the inaugural DAWN Scholars Program in Copenhagen, Denmark. The Cosmic Dawn Center spans the full observational and theoretical realm of "cosmic dawn", the time period within a few billion years of the Big Bang. Joining the vibrant research atmosphere, students will be provided a once in a lifetime opportunity to perform research relevant to current open questions in astrophysics.

When and where does the program run? This 11 week internship runs at the Cosmic Dawn Center in Copenhagen Denmark June through mid-August 2019. The program provides a $6500 stipend and travel to/from Denmark and to the annual American Astronomical Society meeting in January 2020.

Who is eligible to apply? Because our program is NSF funded, we can only accept students who are US citizens or greencard holders. Both undergrad and grad students within their first two years of a masters or PhD program are eligible. We strongly encourage women and members of underrepresented groups to apply.

How do I apply? Applications should be completed through the online form available at https://dawn.uconn.edu/apply.

APPLICATION DEADLINE: FEB 1, 2019
dawn.uconn.edu/apply

Tivoli Gardens (right) is the second oldest operational amusement park located in the heart of the historic city of Copenhagen, the bike capital of the world. Nyhavn port (bottom, left) and Copenhagen more generally is big enough to be a metropolis with shopping, culture and nightlife, yet small enough to be intimate, safe and easy to navigate.

*Come join us as a **DAWN Scholar** to explore the rich uncharted territory of the **first stars**, **galaxies** and **black holes** in our Universe!*

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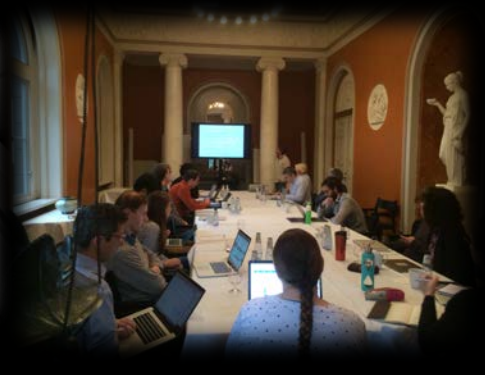
Scientific Meetings

June 2018

-DAWN summit I (30)
-CPHDUST2018 (132)
-COSMOS team meeting (100)
-Ultra Vista Team Meeting (10)
-Hawaii-Two-0 Team meeting (10)

October 2018

-JWST/NIRSpec GTO meeting (23)
-Quenching workshop (10)
-Buffalo survey team meeting (40)
-XXM Time allocation committee (5)



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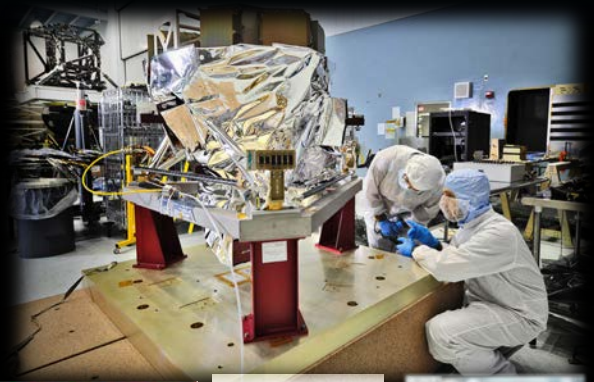
JWST Guaranteed time observations teams (>1000h)

Near Infrared Spectrograph

Mid Infrared Instrument



Near Infrared Imager and Slitless Spectrograph

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Hubble vs. JWST

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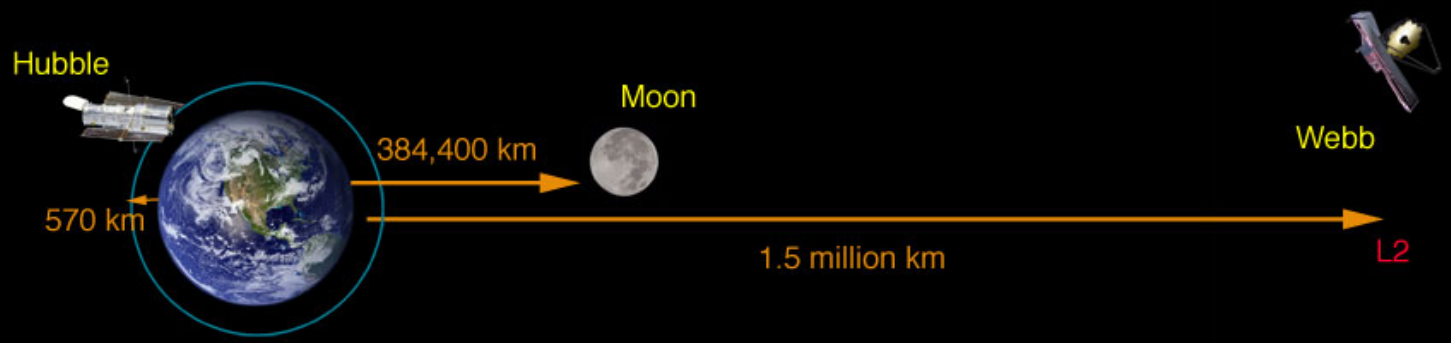
Hubble vs. JWST



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Finding the first galaxies

Pascal Oesch
(geneva

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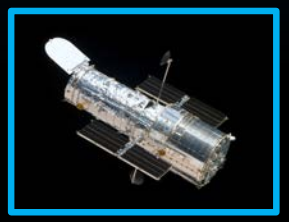
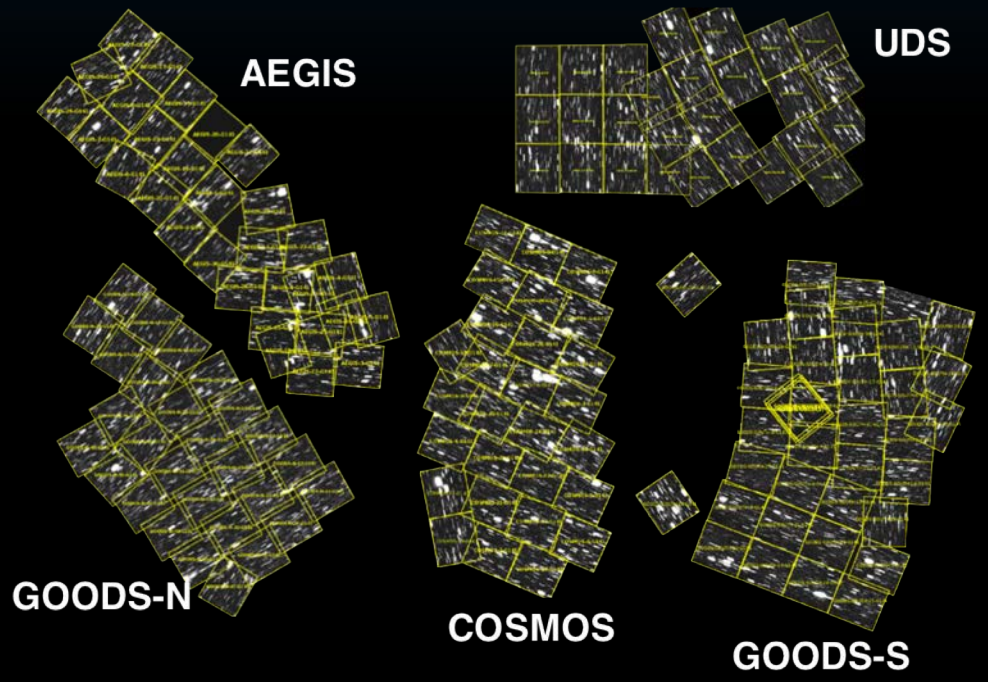
Grizzly Hubble Archive Project



Gabriel Brammer

Total Area 0.25 deg^2



>5 times larger area in Hubble archive never systematically explored

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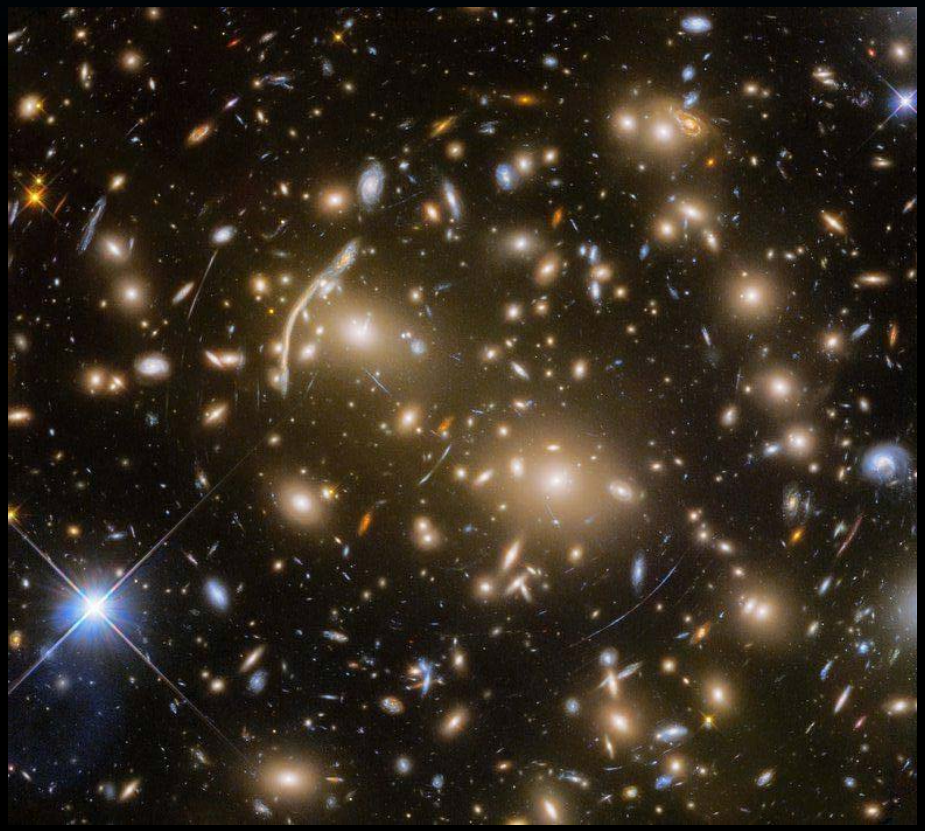
BUFFALO – New Hubble program (2018-19): Beyond Ultra Deep Fields and Legacy observations (100 orbits)

Charles Steinhardt (CoI)



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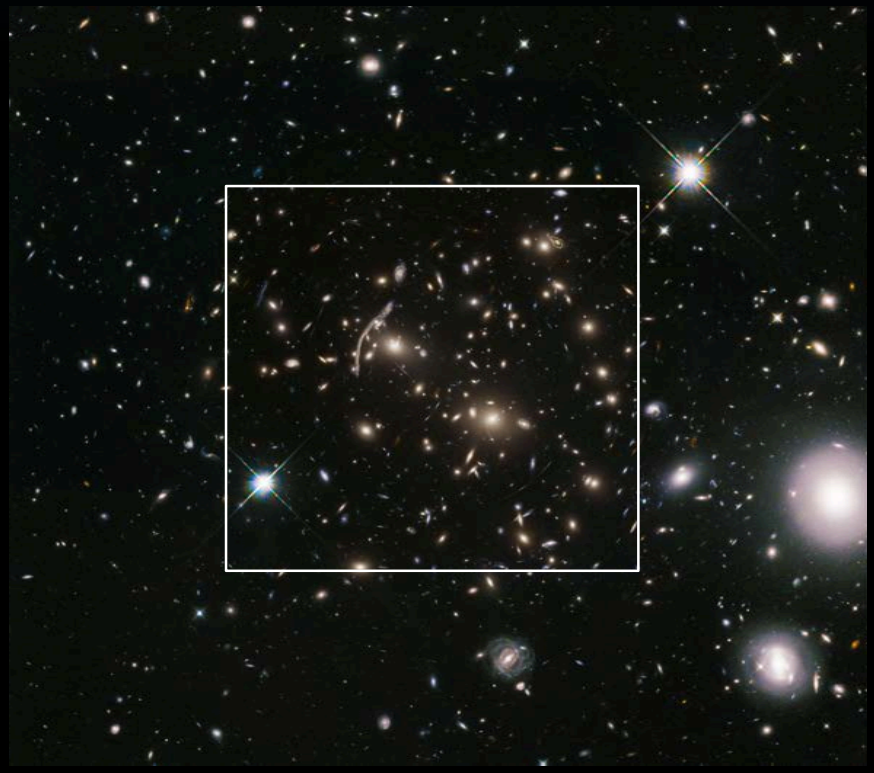
BUFFALO –Increasing discovery space for Cosmic Dawn Galaxies with new sightlines

Charles Steinhardt (CoI)



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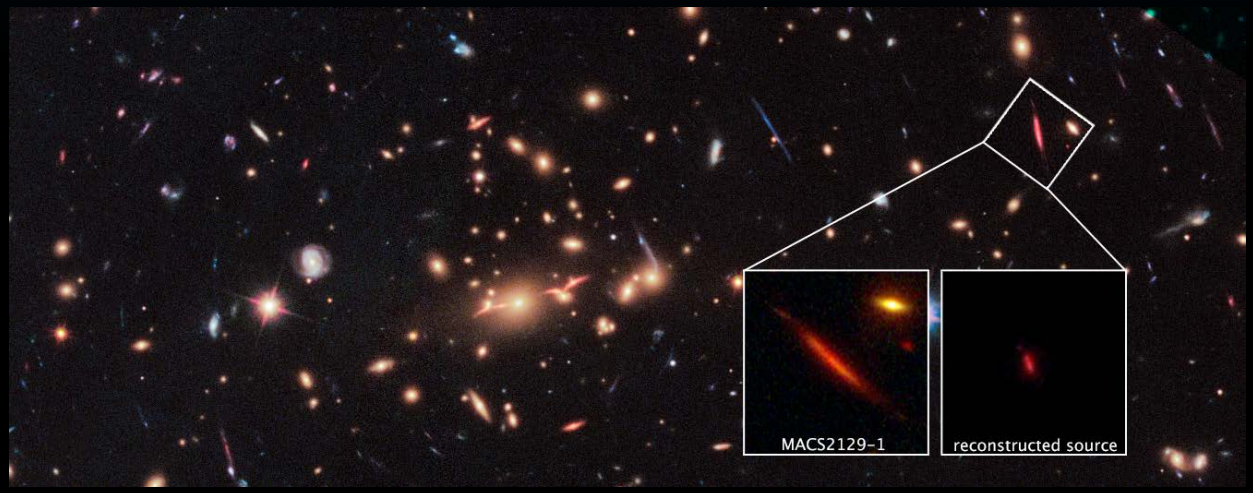
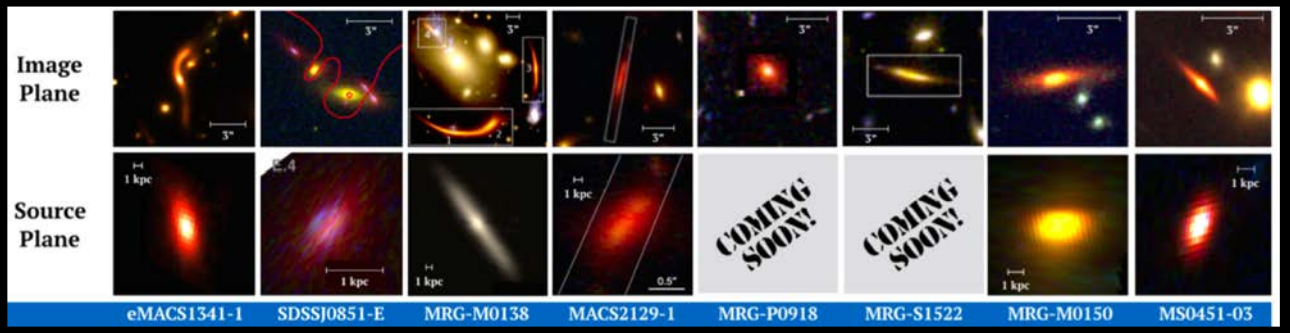
Requiem – New Hubble Grism Program (2019) to resolve the earliest dead galaxies (60 orbits)



Mohammed Akhshik

Kate Whitaker (CoI)

Gabriel Brammer (CoI)



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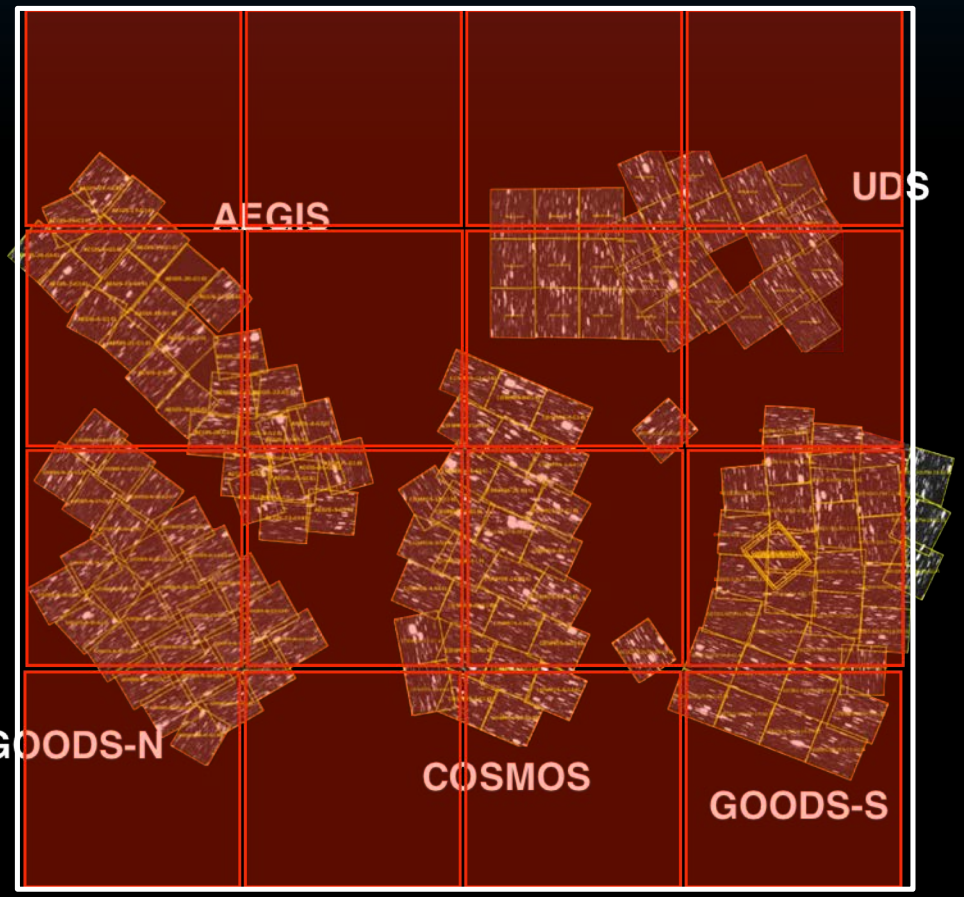
Euclid ~ Hubble with much wider field of view



euclid consortium

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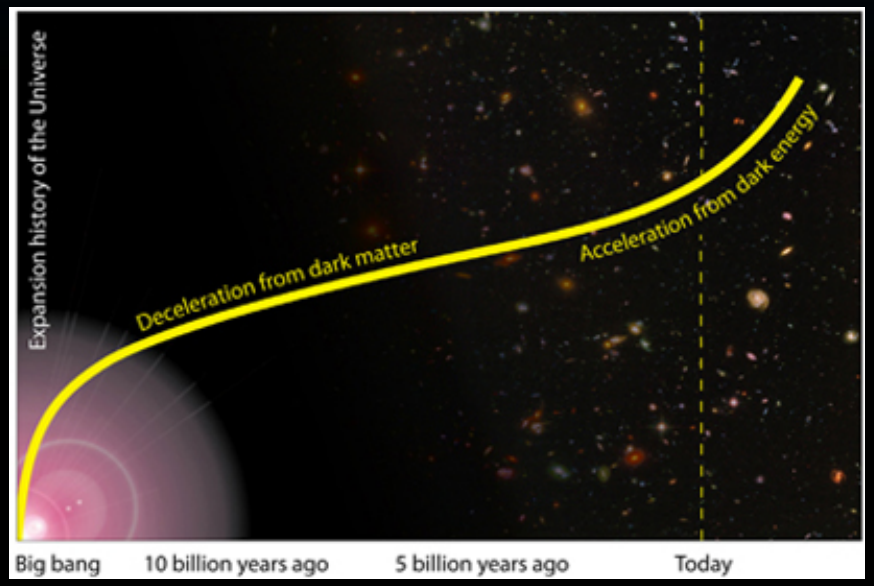
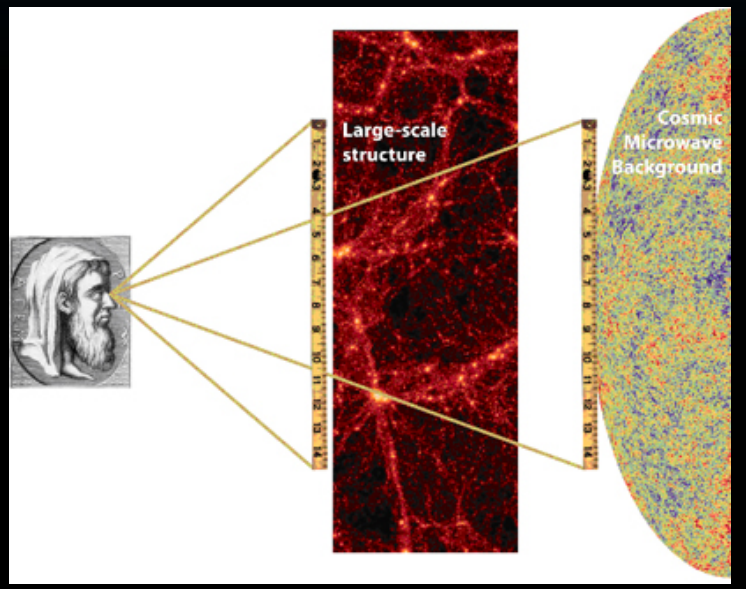
Euclid: Understanding Dark Matter and Dark Energy





Mapping the cosmic web with billions of galaxies back to Cosmic noon (z=2) will reveal nature of dark matter and dark energy through weak lensing and clustering

euclid consortium

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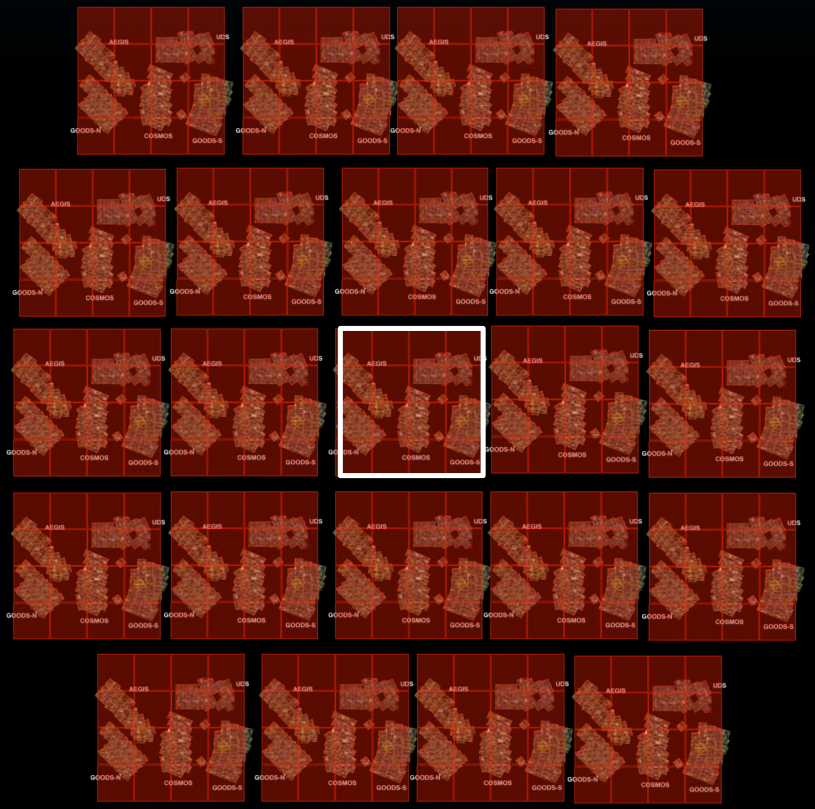
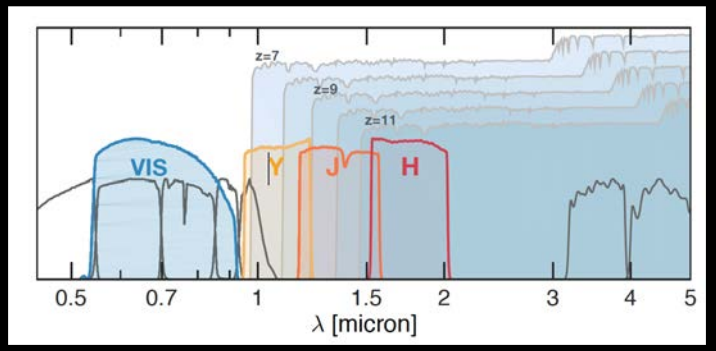
Euclid Deep Fields – 40 deg^2

4x



-North Ecliptic Pole (10 deg^2)
-Chandra Deep Field South 10 deg^2)
-Akari Deep Field South (20 deg^2, TBC)



High resolution Y+J+HK imaging to 26th mag. Essential for high redshift galaxy selection

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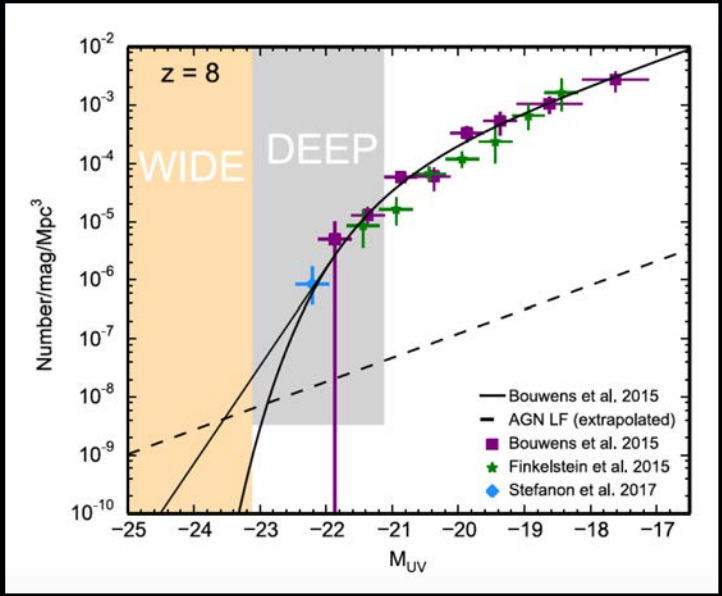
Thousands of bright z>8 Galaxies



Redshift	LBG (Schechter LF)	LBG (DPL LF)	AGN
6	46000	57000	200
7	14000	14000	48
8	2300	1900	12
9	410	630	3
10	27	220	1
11	0-100??		

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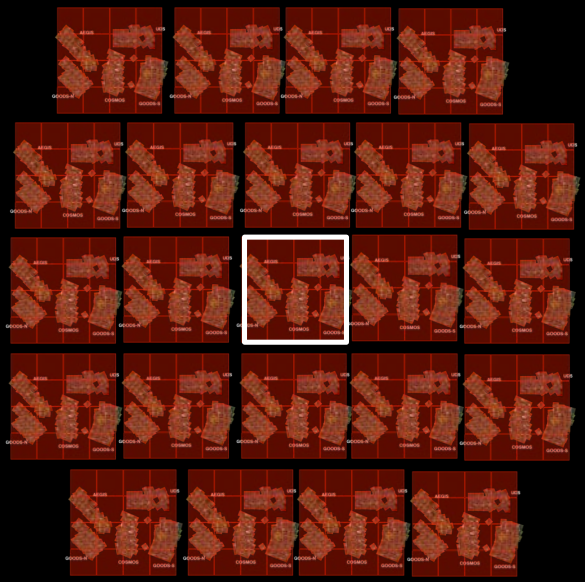
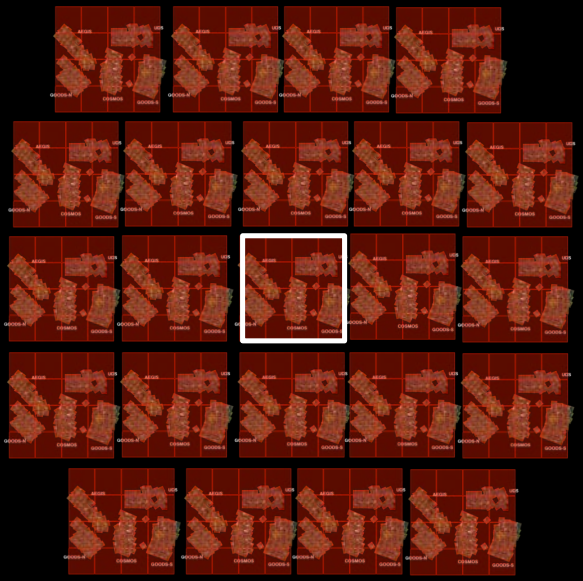
20 Square degrees observable from Hawaii (NEP,CDFS)

North Ecliptic Pole (10 deg^2)



Chandra Deep Field South (10 deg^2)



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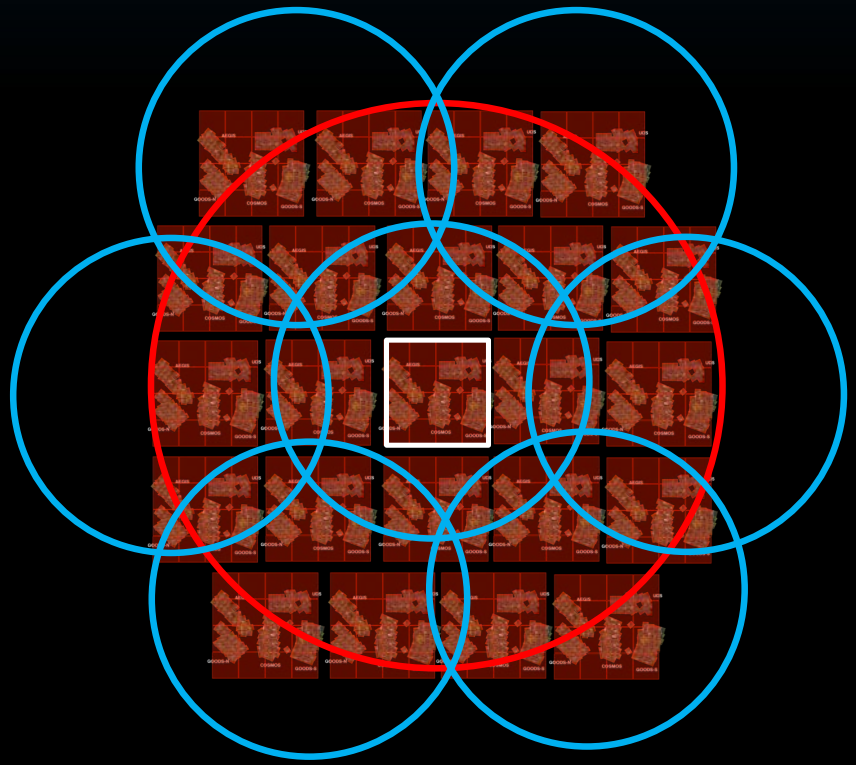
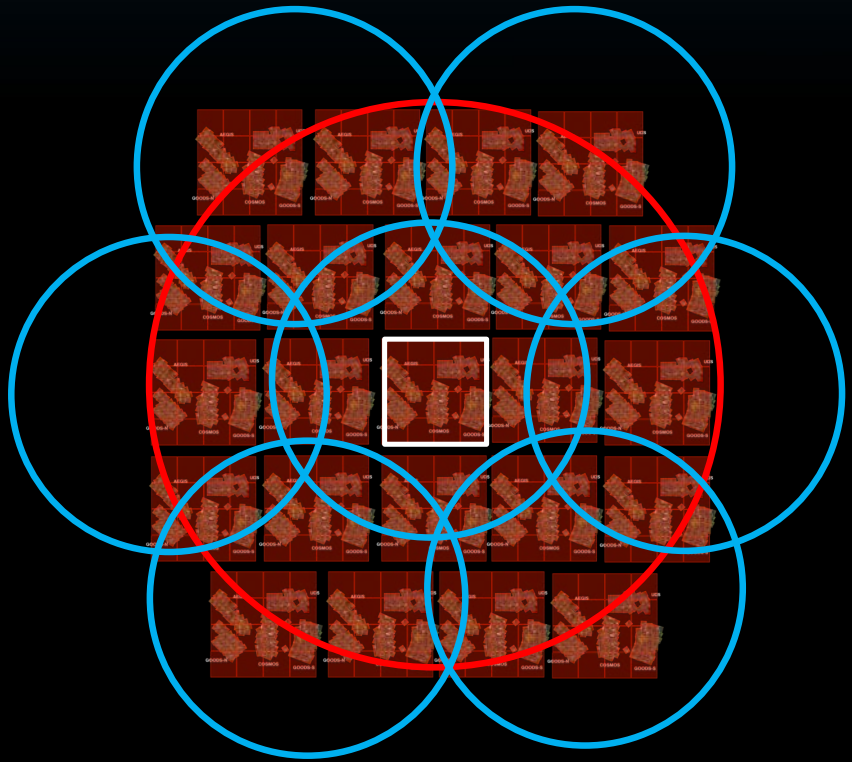
Cosmic Dawn Survey (2018-2020)

North Ecliptic Pole (10 deg^2)



Chandra Deep Field South (10 deg^2)



Subaru/HSC (30n, PI:Sanders)

Spitzer IRAC (6000h, PI:Capak)

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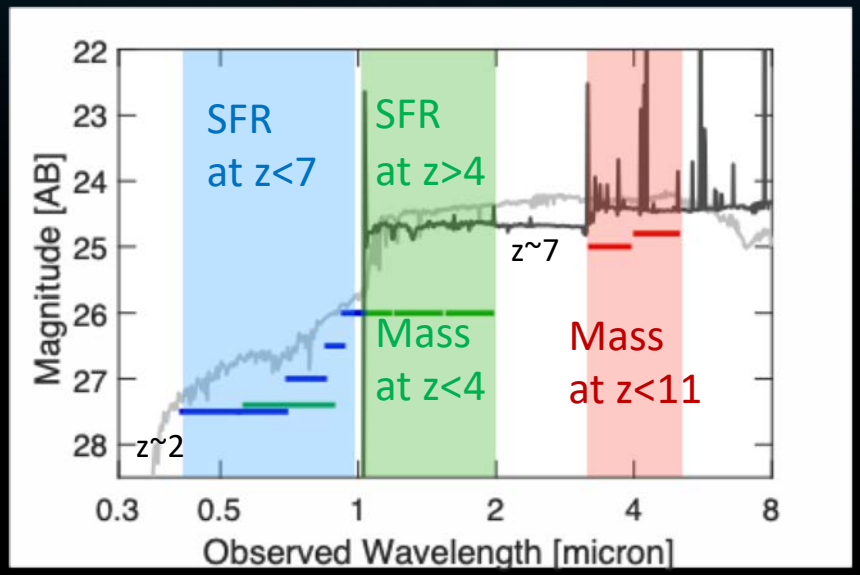
Cosmic Dawn Survey of Euclid Deep Fields (2019-2021)



Cosmic Dawn Survey will be 100 times larger than existing HST+Spitzer extragalactic surveys (CANDELS)

Unbiased sample with reliable photo-z, Stellar mass, SFR for all M>M* galaxies to z=8, and brighter galaxies to z>10

Full picture of large scale structure over 95% of the history of the Universe

Hawaii-Two-0
HSC (30n)
Keck (10n)

Euclid deep

Spitzer WFIRST
Euclid Legacy
survey (6000h)

LMT – LSS survey
1.1, 1.4, 2.1 mm
0.25 mJy RMS

5500 7<z<8
1000 8<z<9
200 9<z<10

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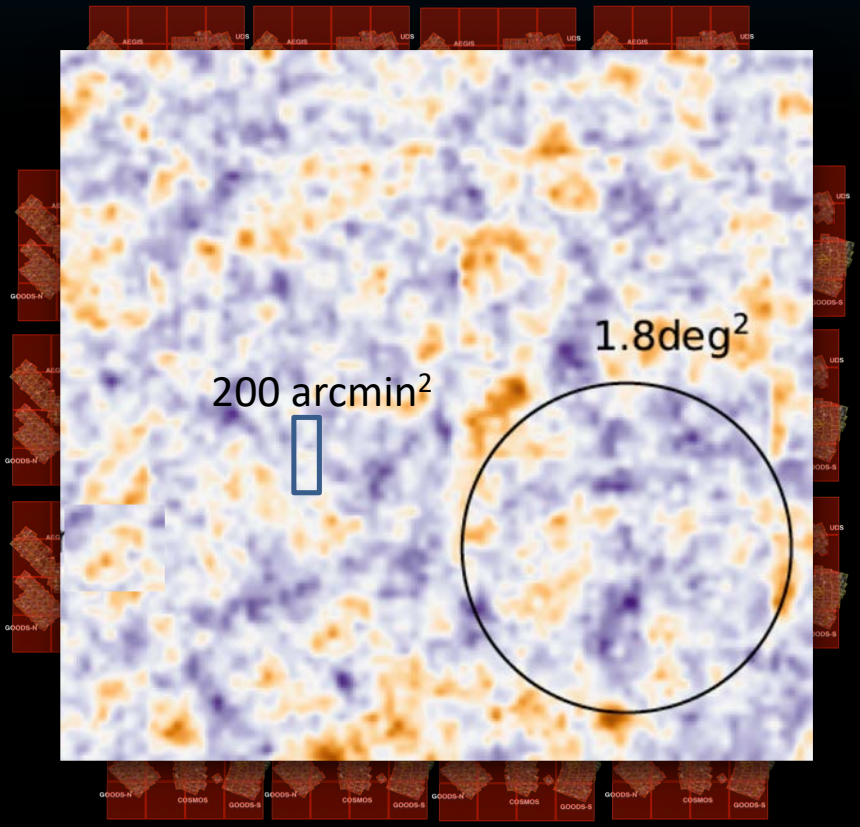
Characterize large scale structure at Cosmic Dawn

z=5 dark matter density map (Springel+ 2005)

Large area needed to map out large scale structure to find and characterize highest density peaks of the Universe during Cosmic Dawn

These pinpoints the formation sites of the first galaxies



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Reionization – the last phase transition of the universe

www.eso.org

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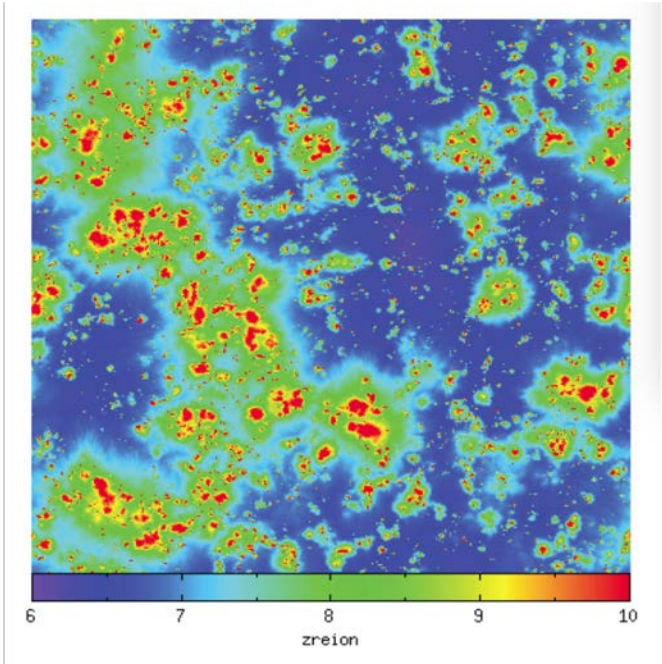
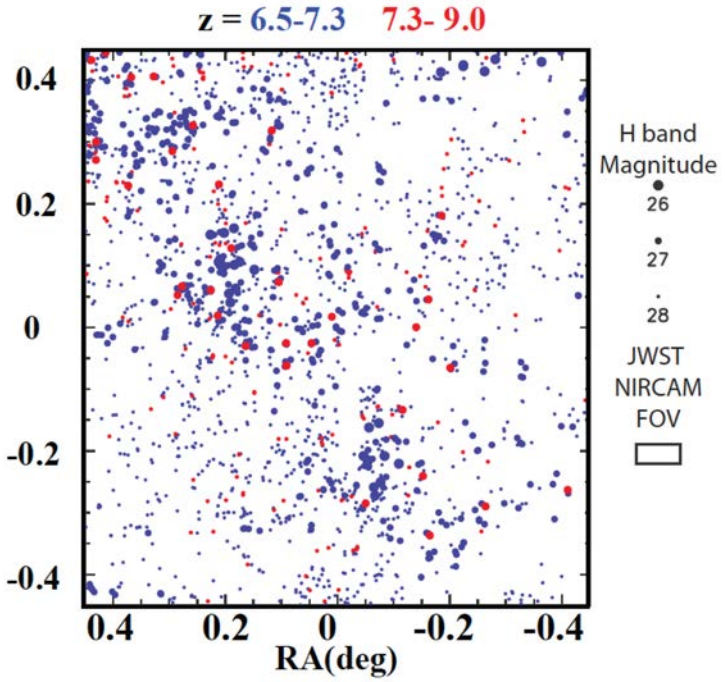
How did Reionization start and Proceed?





- Simulations suggest it happens on degree scales (Trac+2008)
- Starts at z>10 in bubbles around the highest density peaks, traced well by the brightest galaxies

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ORIGINS – European Research Council Synergy Grant

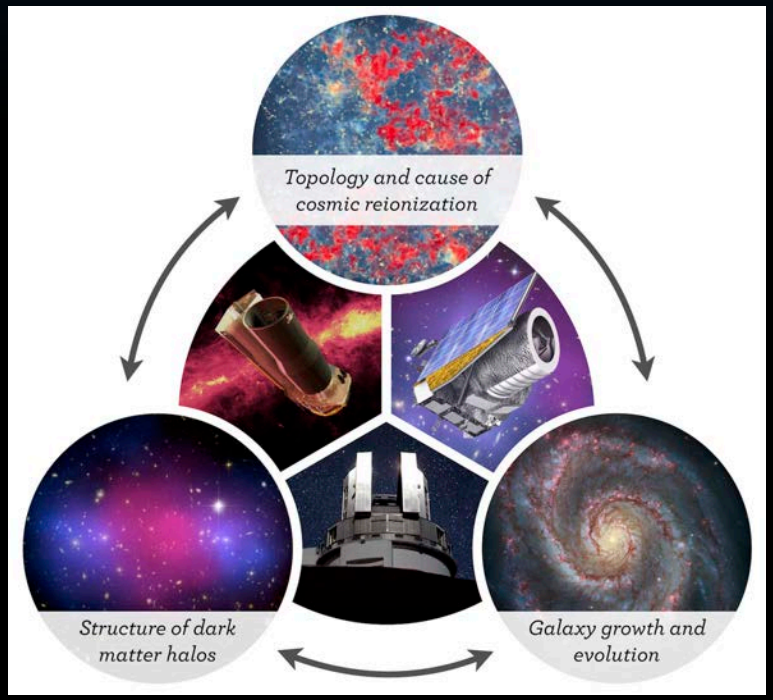

Sune Toft
(DAWN)


David Sanders
(Hawaii)


Peter Capak
(IPAC/Caltech)


Luigi Guzzo
(Milan)


Pascal Oesch
(Geneva)



Proposed partnership between Japan, Hawaii and Europe to extend the PFS survey deep into Epoch of Reionization

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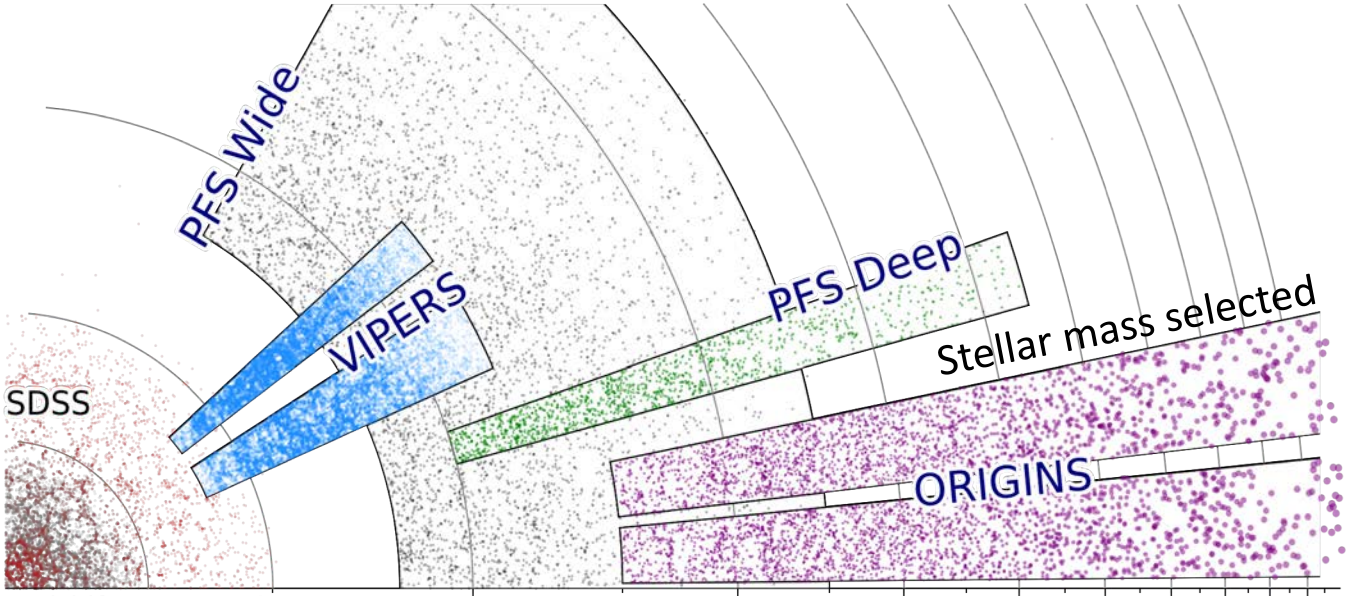
Expand PFS survey to map LSS through EoR



Spectra [deg^{-2}]	10000	2000	600
Exposure time [hours]	2	6	16
Allocation [nights]	40	20	20

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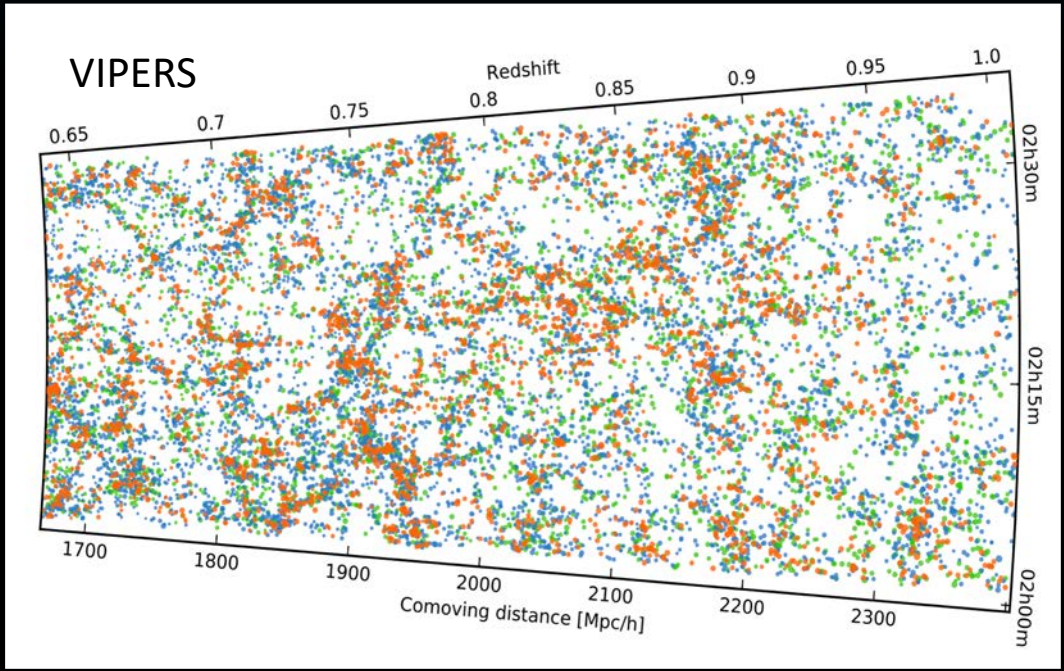
Characterize large scale structure through EoR



- Test of gravity and Cosmology to z=4 (clustering + Redshift space distortions)
- Co-evolution of Dark matter and galaxies to z=10 (clustering and abundance matching)

Unleash strong synergy between major Cosmology and galaxy evolution surveys of the next decade

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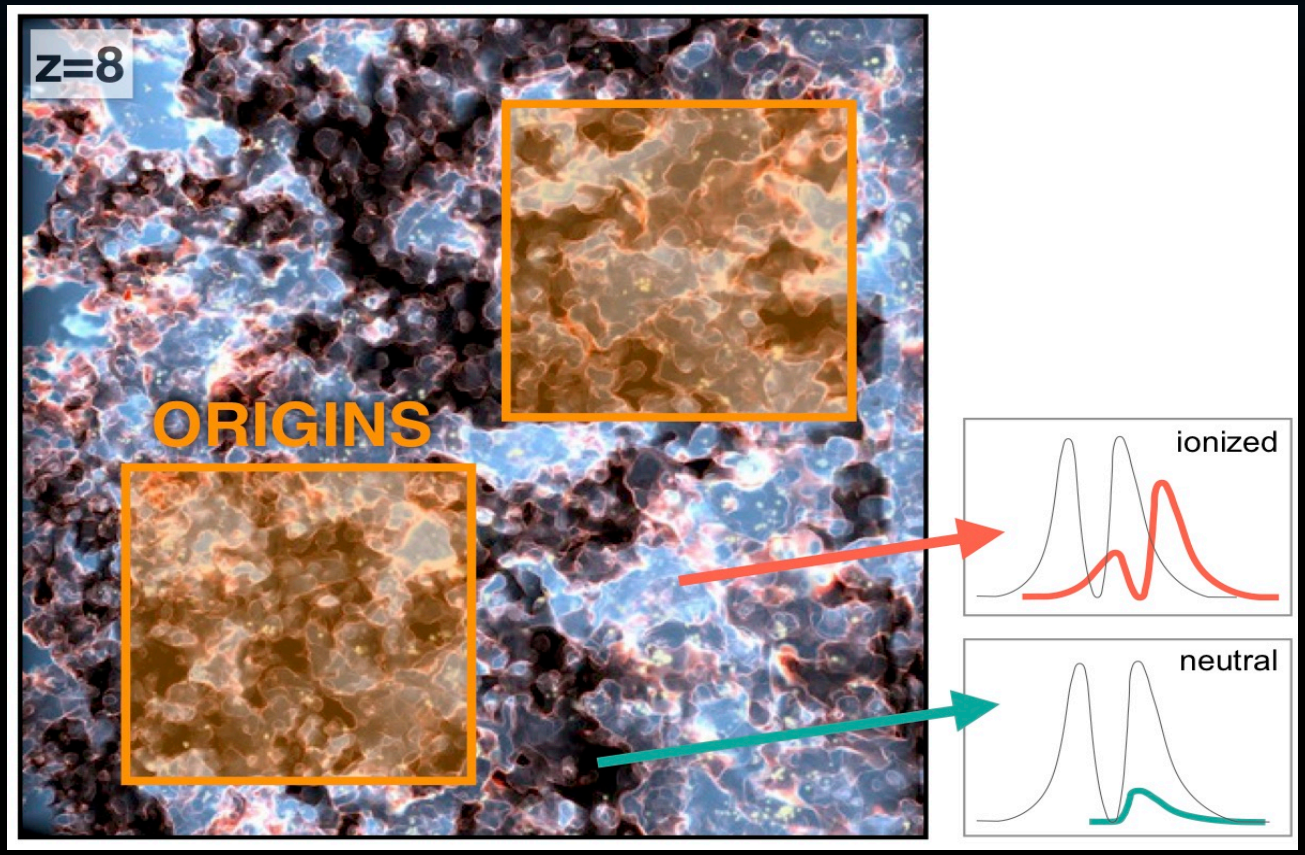
Topology and sources of Cosmic Reionization



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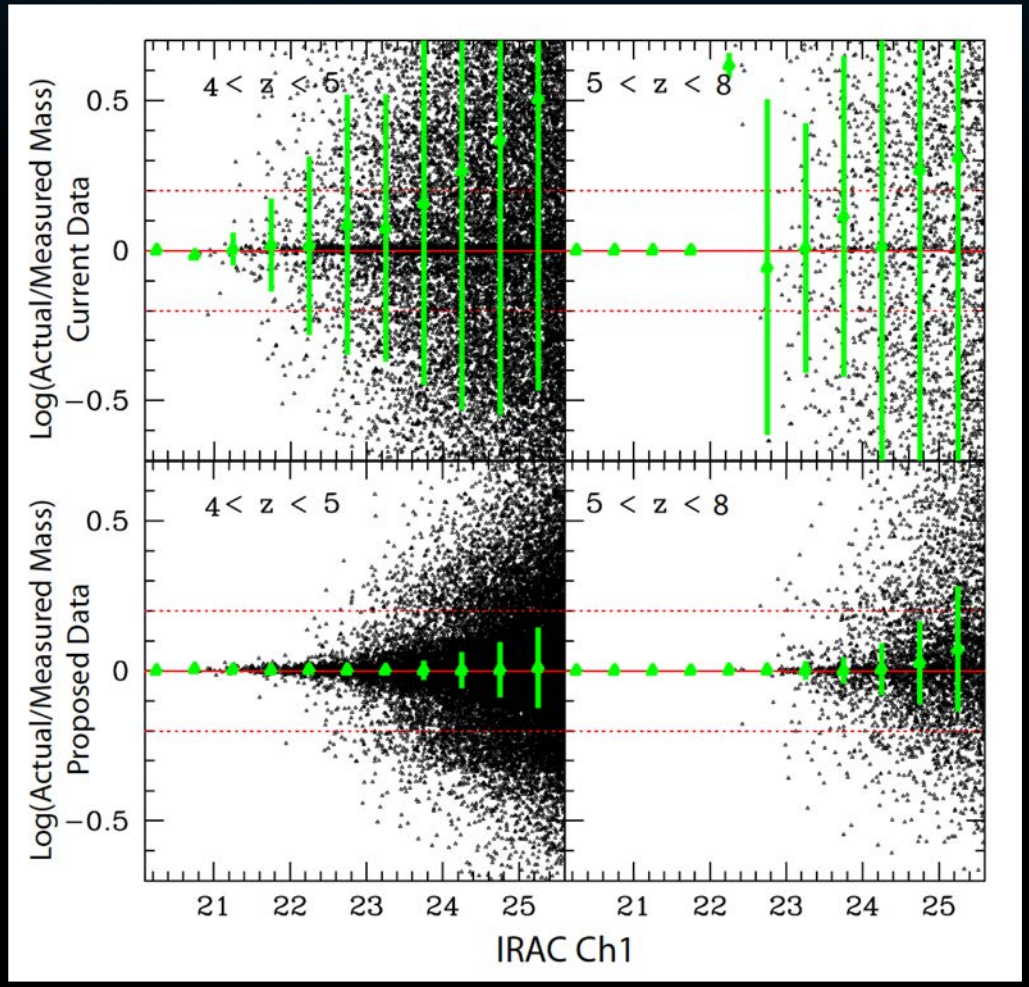
Importance of Spitzer for stellar masses at z>4



Euclid + HSC

Euclid + HSC + Spitzer

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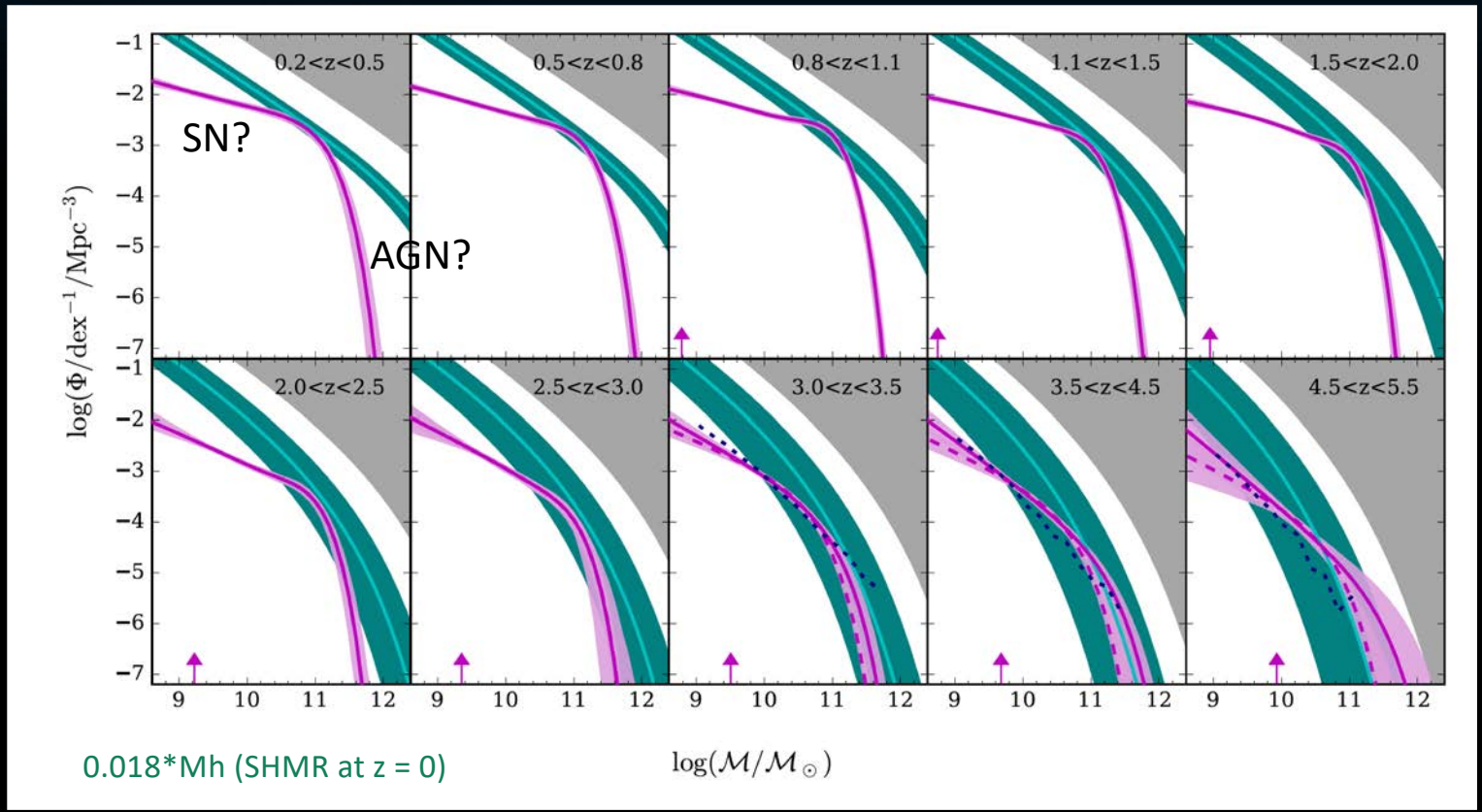
Probing the onset of Feedback Mechanisms



0.018*Mh (SHMR at z = 0)

(Davidzon+2017)

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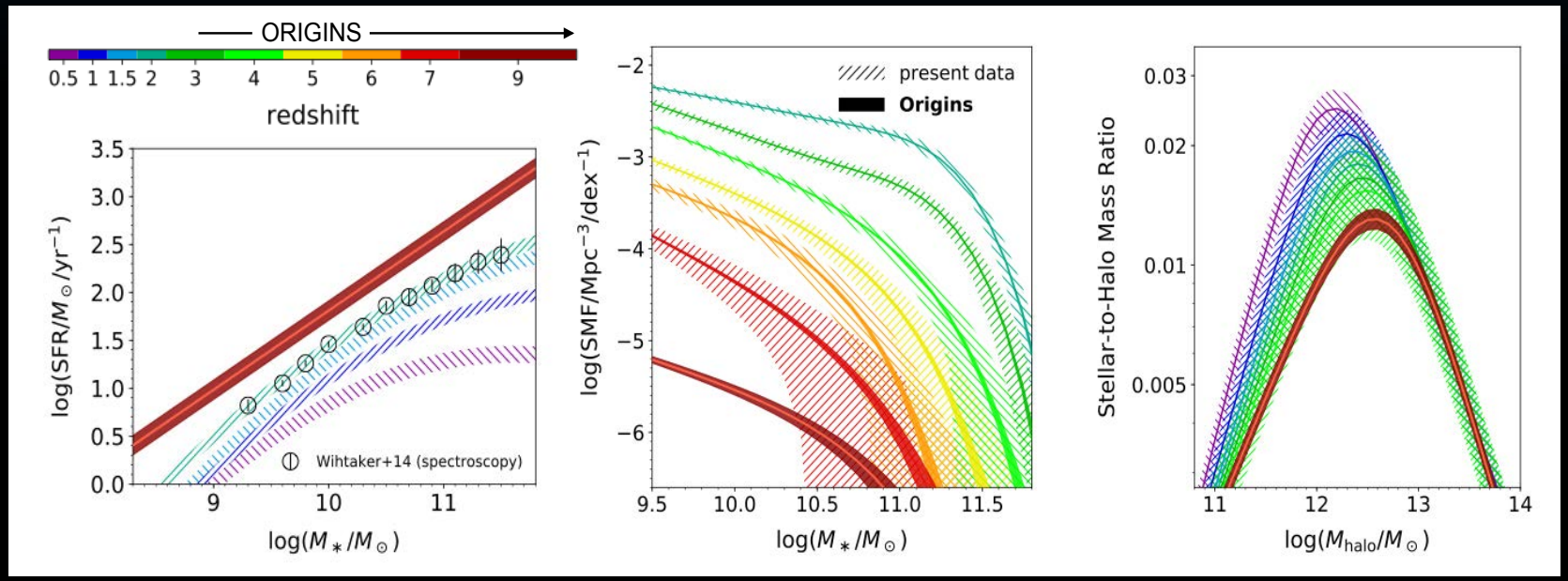
Main sequence, stellar to halo mass function to z=10



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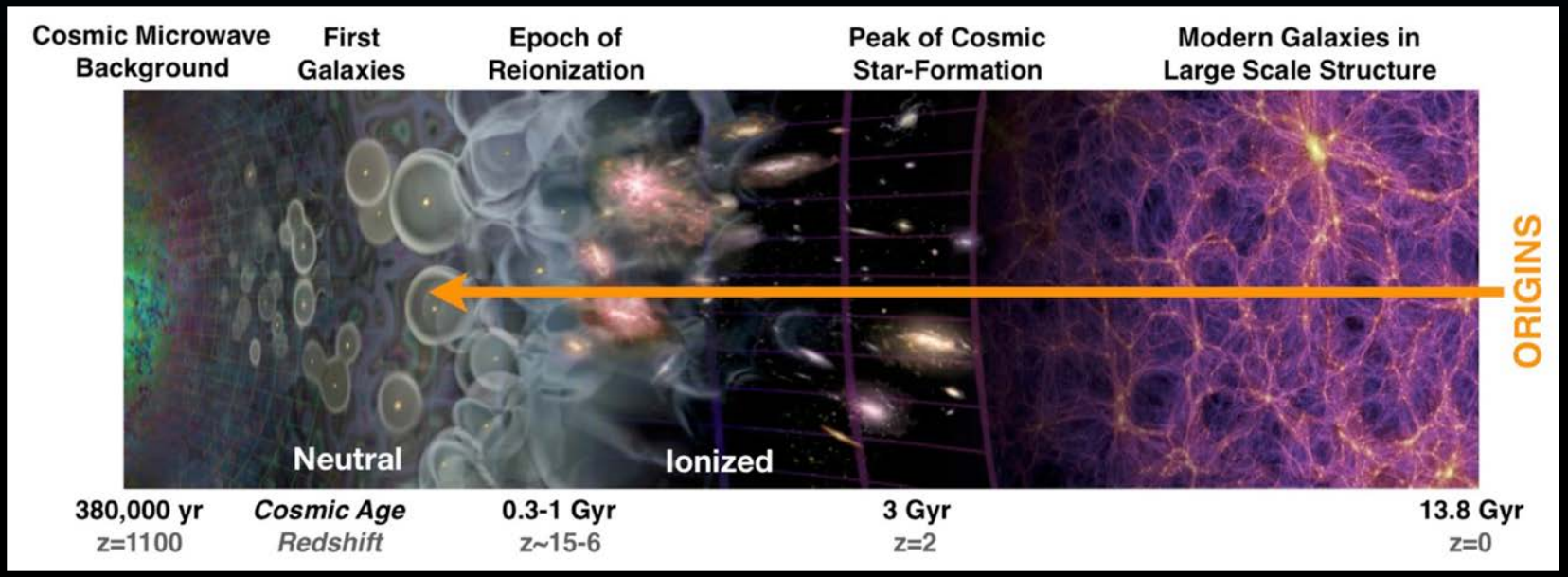
A holistic understand of the coevolution of galaxies and DM over 95% of Cosmic Time



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COSMOS2015

HSC:Hawaii+Japan

+

UltraVISTA DR2

+

Spitzer/SPLASH

COSMOS2015 has been fantastically successful thanks to the great combination of optical Subaru data and deep infrared and near-infrared data

COSMOS2019: New UltraVISTA data (0.9 mag deeper); New u* data (CLAUDS, 3-4 times deeper); all IRAC data (6 times deeper); New HSC data; better photometric extraction; better astrometric precision

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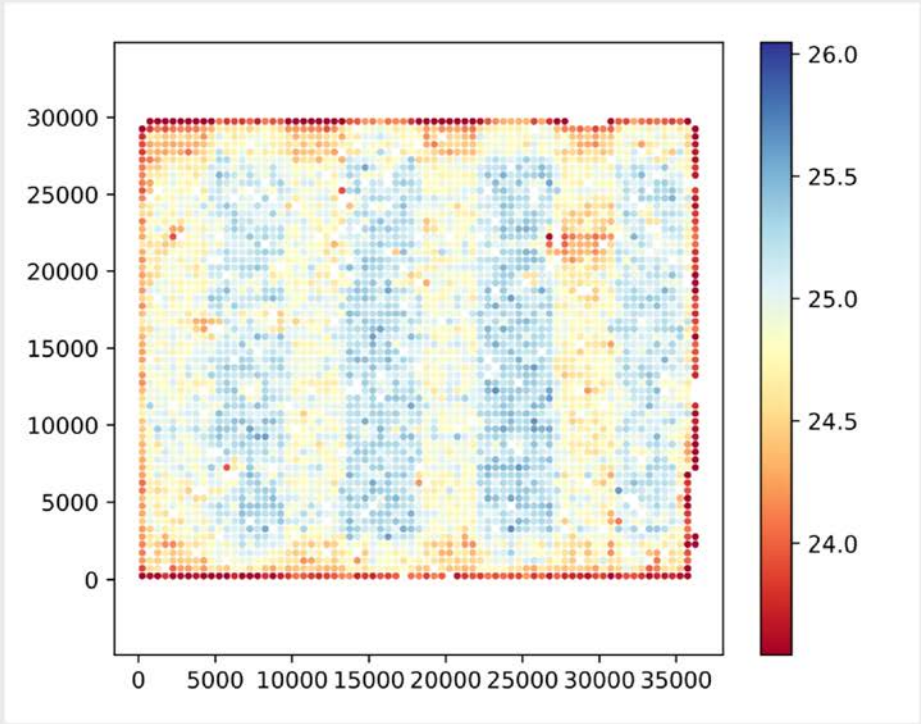
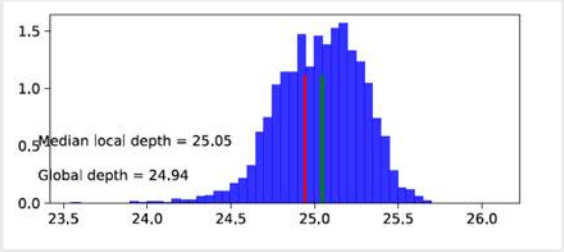
Deeper/Uniform NIR UltraVISTA Data (DR4)



- 5 sigma, 2” aperture

0.9 mag. in deep increase compared to DR3; 10% in YJ in ultra-deep



courtesy R. Bowler

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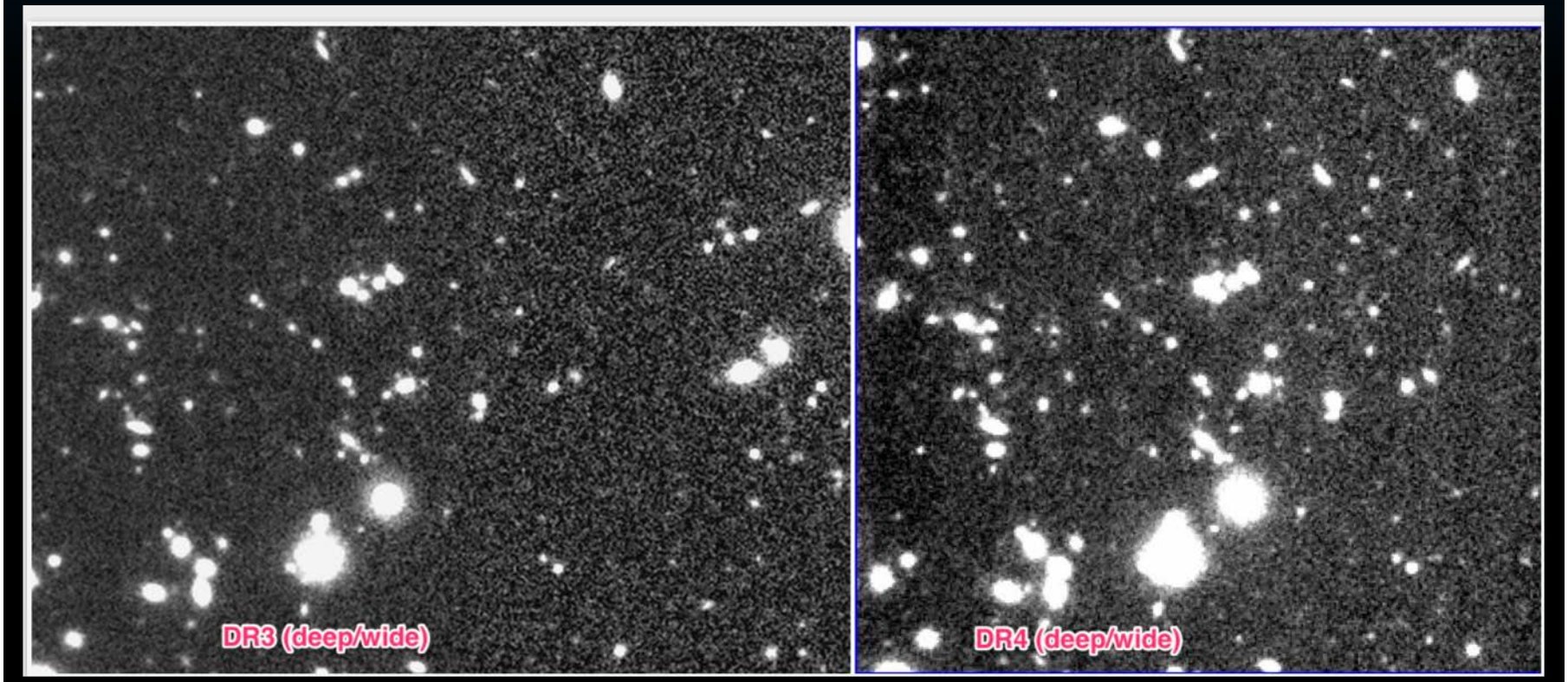
Deeper/Uniform NIR UltraVISTA Data



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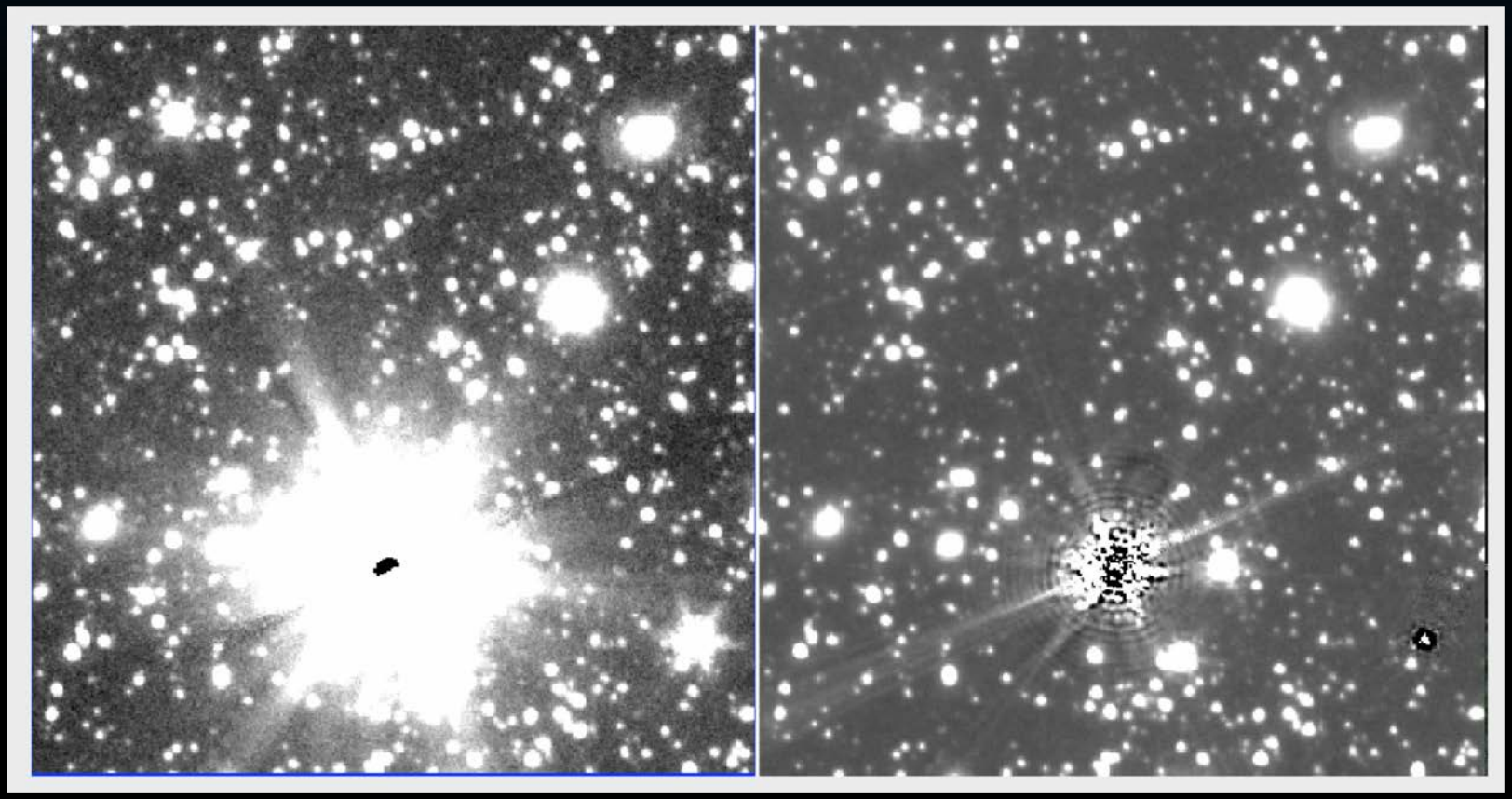
Six times deeper Spizer Data (4h/pix -> 26h/pix)



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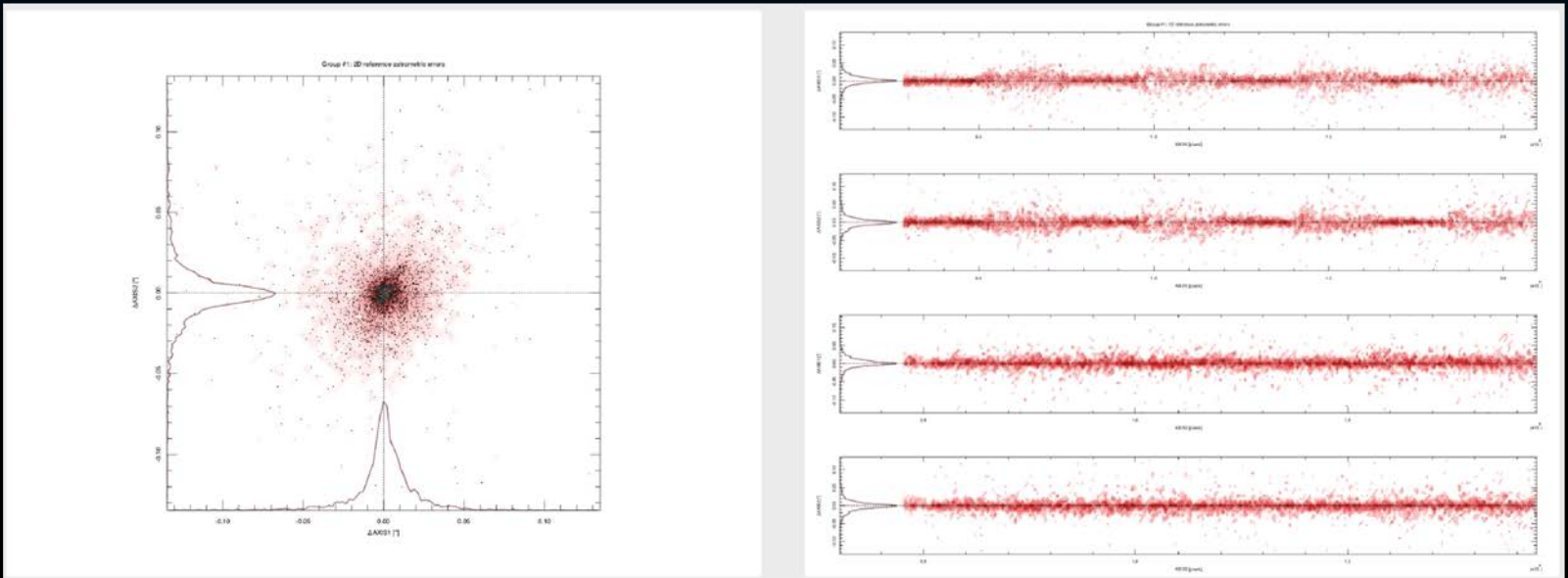
Better Astrometri



Compared to Gaia DR1. RMS better than 1/3 pixel! ->
Smaller apertures for photo-zed -> better precision

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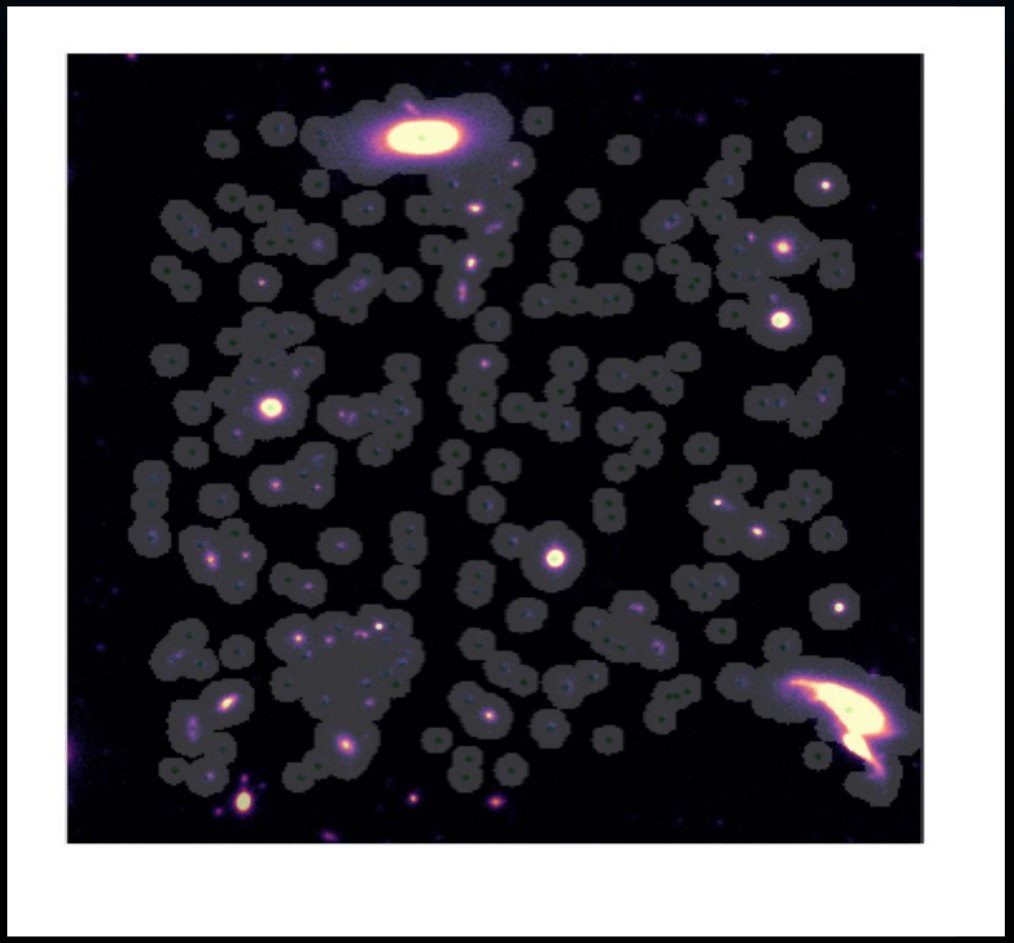
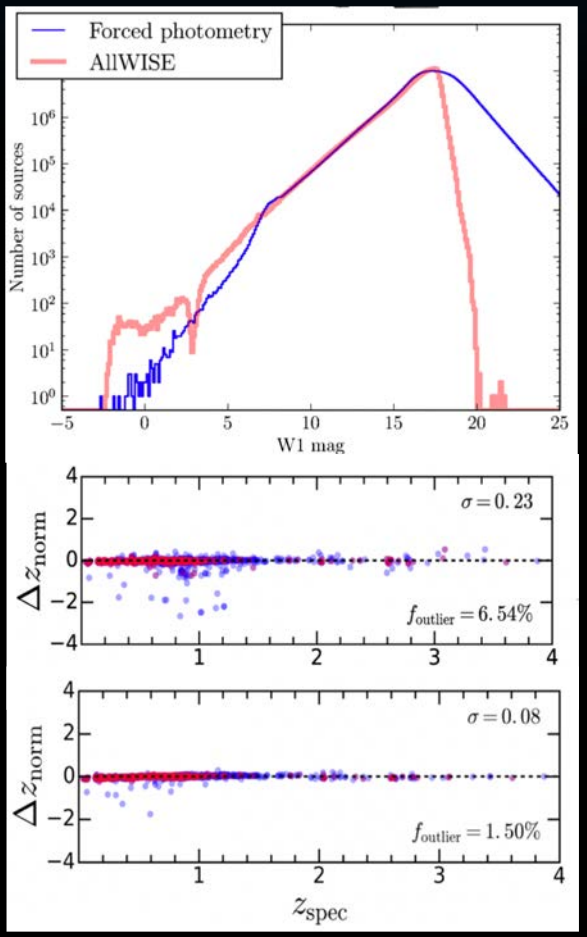
Better Photometry – Forced with Tractor





(Lang+16, Nyland+17)

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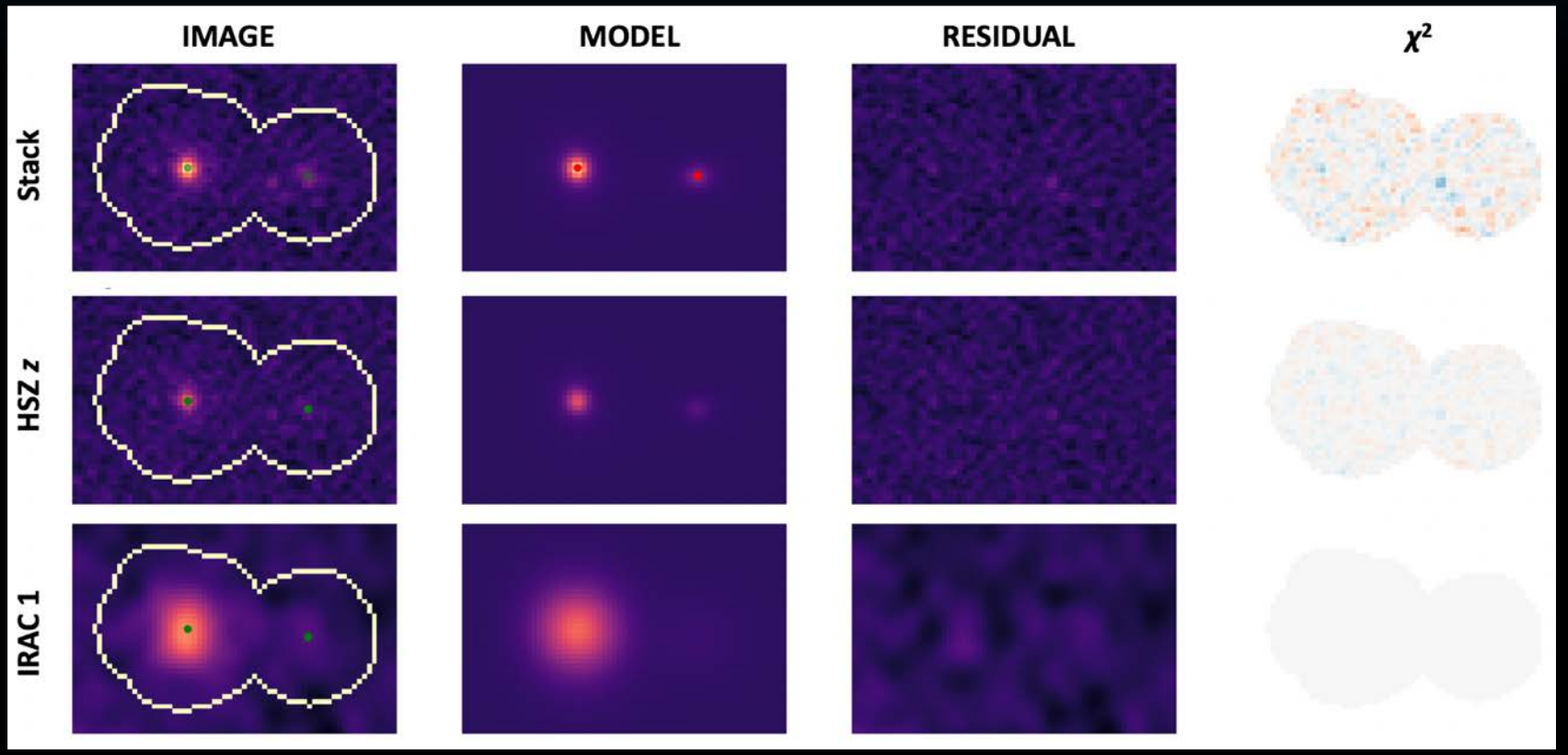
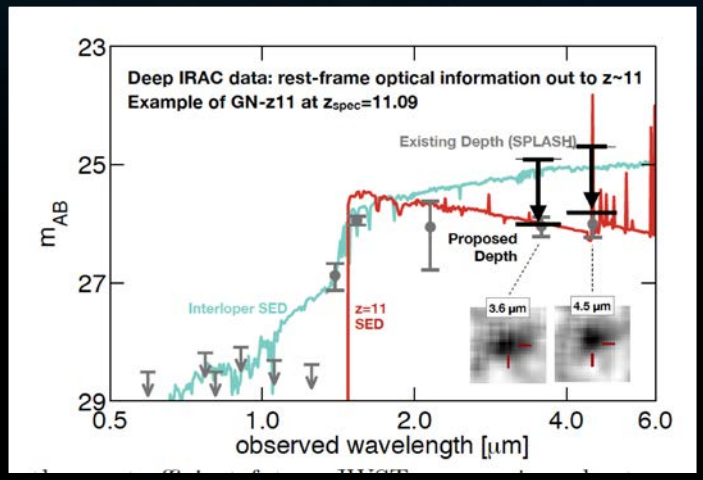
Better Photometry – Forced with Tractor



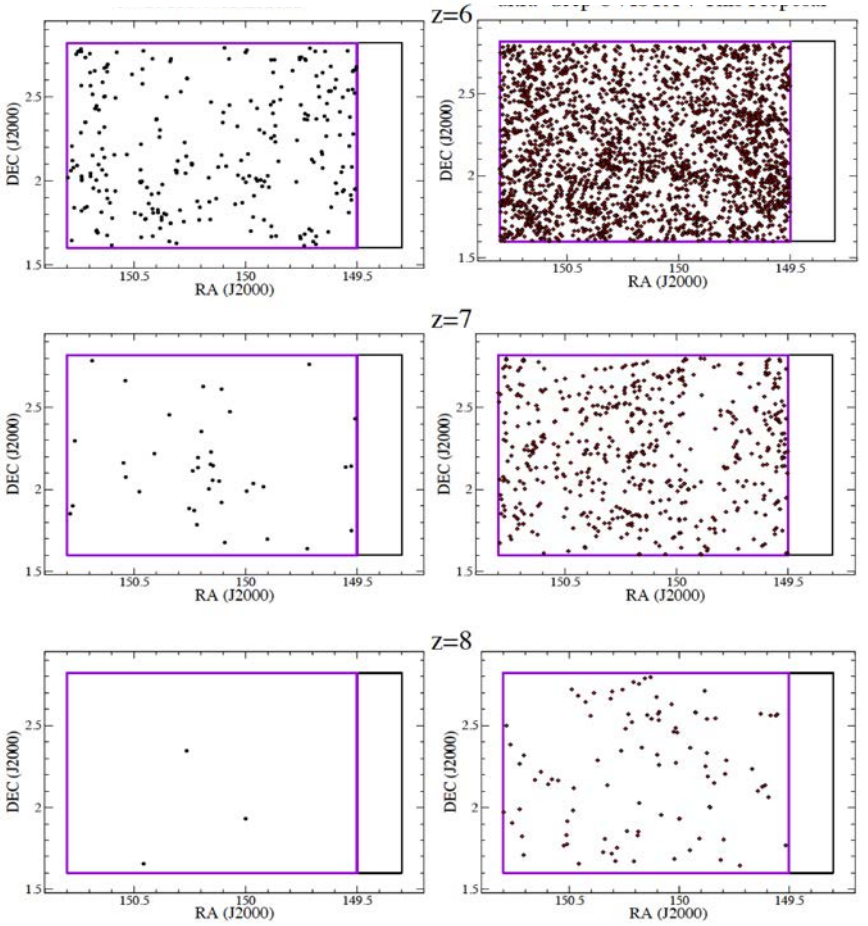
DAWN

COSMOS2019 Proposed Collaboration



COSMOS 2015

COSMOS 2019



COSMOS 2019 –A successful collaboration between Subaru/HSC and the COSMOS team ?