

# Progress of HSC-SSP Project

Satoshi MIYAZAKI

Subaru Telescope/NAOJ

# HSC-SSP

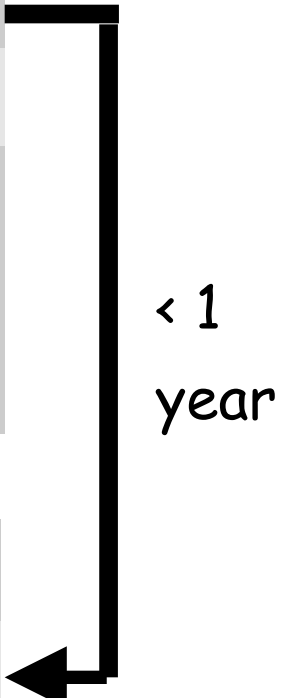
Observing Completed late 2022

- On March, 2014, HSC-SSP started and the last observing night was 2022/01/03 (HST).
- Long-long 300 + 30 nights observations have been successfully completed thanks to the tremendous efforts made by observatory's scientists and staff members. We really appreciate their continuous collaboration.

# Data Release

Slide presented last year

IDR	S16A	2016/08/04	Data used for the special issue.	
	S17A	2017/09/28		
	S18A	2018/06/25	PDR2 on 2019/05/30. 174 nights.	
	S19A	2019/09/25		
	S20A	2020/08/03	275 nights -> PDR3	
	S21A	2021/06	Possibly an incremental release (~318 nights)	
	S23B	2023/Nov or beyond	Final data release (330 nights). This will become PDR4	
PDR	PDR1	2017/02/28	FCFD area only.	61.5 nights
	PDR2	2019/05/30	174 nights	
	PDR3	2021/08	S20A Data release to public	
	PDR4	TBD	All data. Final data release. 330 nights.	



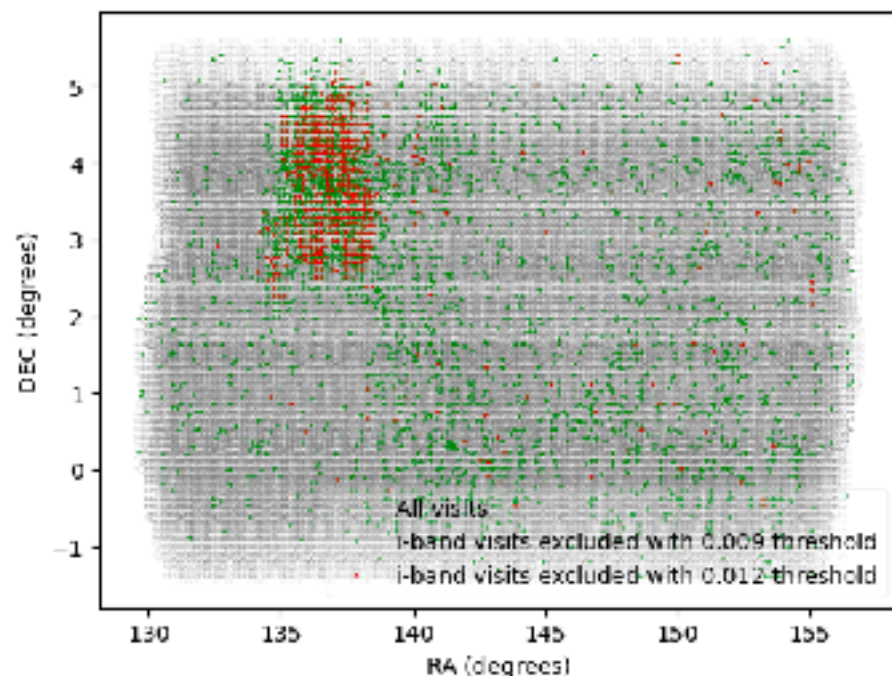
DM pipe line is experiencing big upgrade (butler gen2 -> gen3). The final data analysis has started and approached the coaddition step. Nevertheless, further delays in target date are possible when unexpected issues or needs of modifications with code arise.

# SSP Internal Release S24A - Status

- Plan
  - Release: targeting ~2024.5 (if everything goes without any problem)
  - Reprocess all data with a new version of LSST pipeline (Gen3 framework)
- Dataset
  - All SSP data for the entire survey period 2014.3 – 2022.1
  - Wide 1,087 sq.deg (for i,z,y bands  $\geq 5$  visits)
  - D+UD ~27 sq.deg
- Tentative Schedule
  - 2022.9-2022.11: Reviewed test products (100 sq.deg) by SSP collaboration
  - 2022.12: Determined the pipeline version
  - 2023.4: Production work started + some tests still going on behind + Several trouble-shootings
  - 2024.1(now): Coaddition and deblending tasks under way
  - 2024.3(target): Finalizing processing
  - 2024.4-5: QA, database ingestion, and documentation
  - 2024.5: Internal Release  
(may require additional time depending on stability of the pipeline)

# Some recent issues

- Computing Platform
  - GPFS capacity shortage
  - Failure in computer hardware (e.g., IB switch)
- Middleware
  - Rapid growth of repository database
- Pipeline & Processing
  - Misconfiguration of sky construction -> reprocessed sky
  - Adjusting threshold for coaddFrameSelection based on PSF
  - Updates in HSM shape measurement codes (bugfix+additional outputs for higher moments)

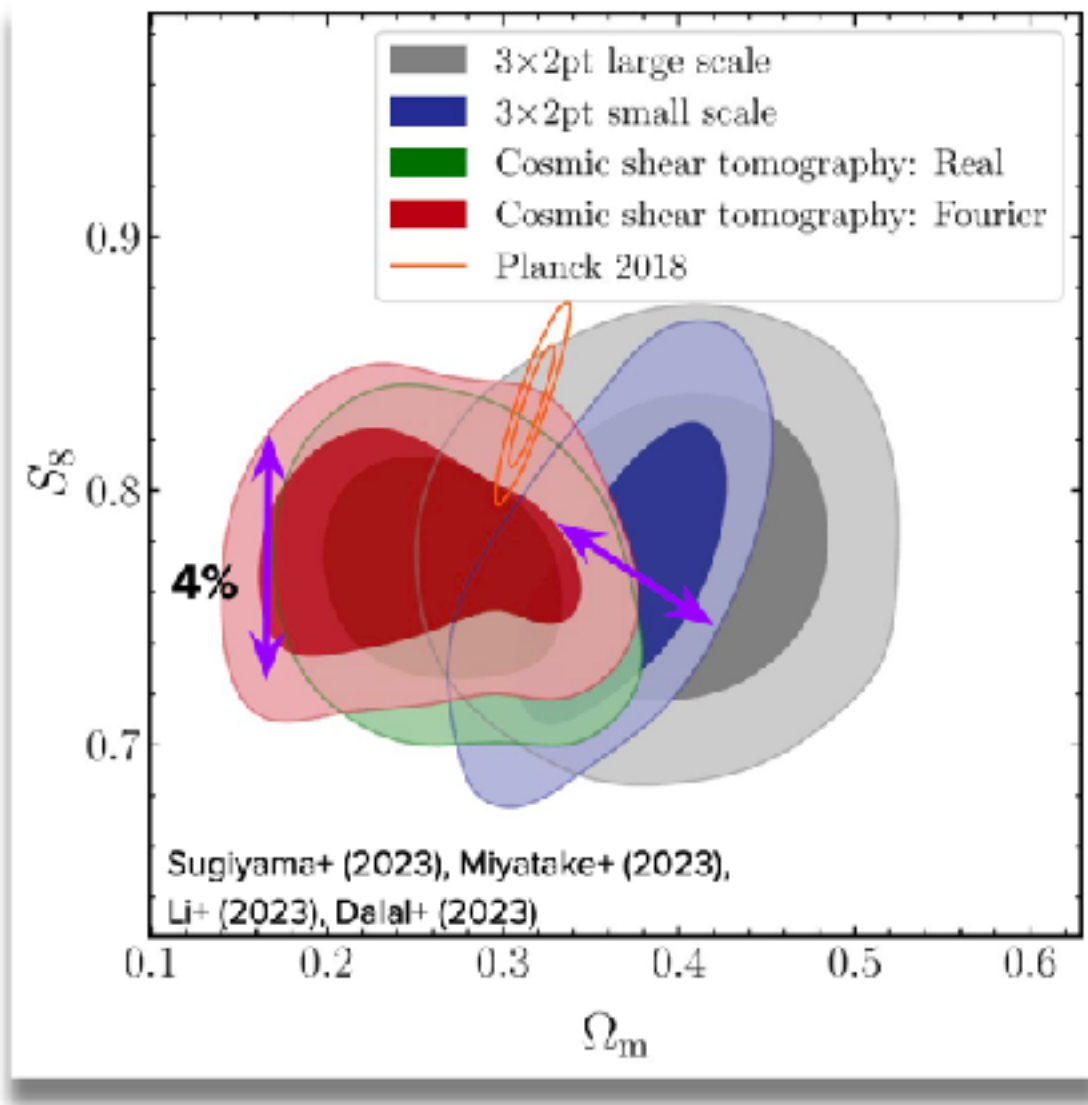


Assessment of coaddFrameSelection  
maxScaledSizeScatter=0.012 adopted  
(by Kannawadi, Rykoff, More, et al.)

# Science Highlights in 2023

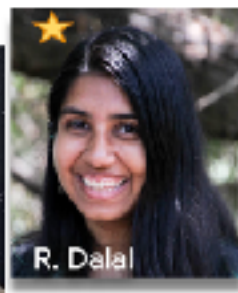
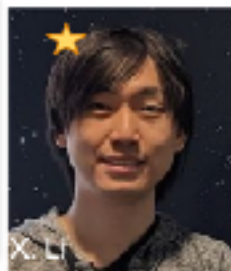
# HSC-Y3 Cosmology Key Results

Clumpiness of the Universe



Matter Energy Density

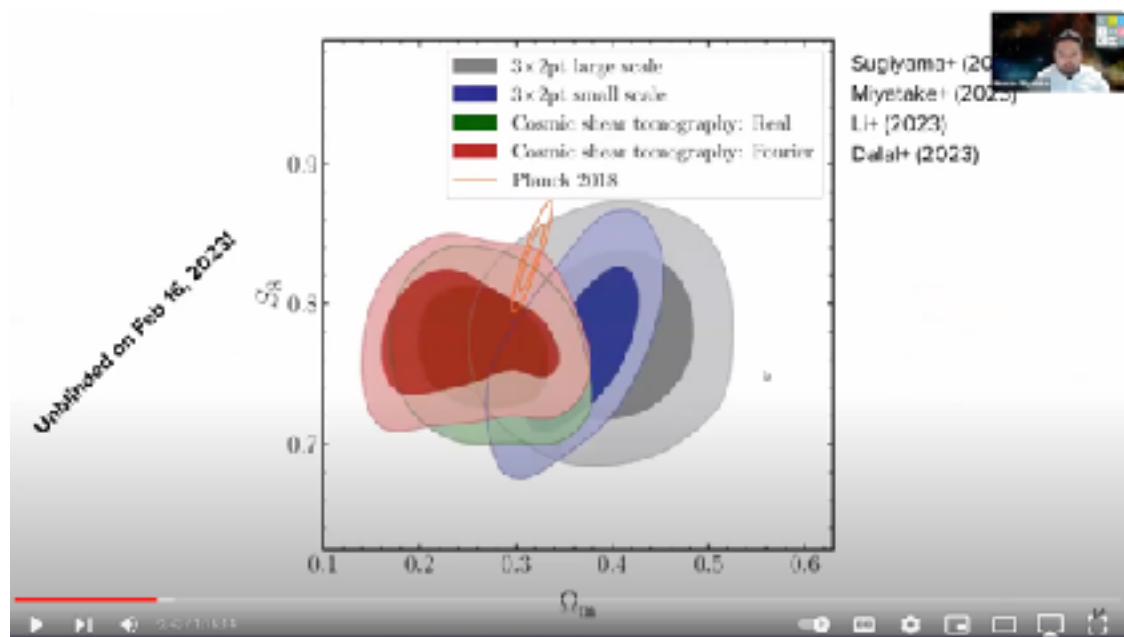
- Based on SSP WIDE up to S19A
- **416 deg<sup>2</sup>**, full-depth, full-color
- Cosmological constraints by different **weak lensing** methods
  - Cosmic shear
    - Real-space
    - Fourier-space
  - 3x2pt: galaxy-galaxy lensing + galaxy-galaxy clustering + cosmic shear
    - Large scale
    - Small scale
- Major contributions from **junior scientists**; see S. Sugiyama's talk on Day 3.
- Three technical papers and six cosmology papers.
- **S<sub>8</sub> constraint from weak lensing can be smaller than S<sub>8</sub> from Planck CMB.**
  - 2.5σ difference at most
  - This can be a sign of the **breakdown of ΛCDM.**



Junior Scientists



# Community Impact



Webinar was held in Apr 2023, when papers were published in arXiv. About **280 scientists** joined the webinar.



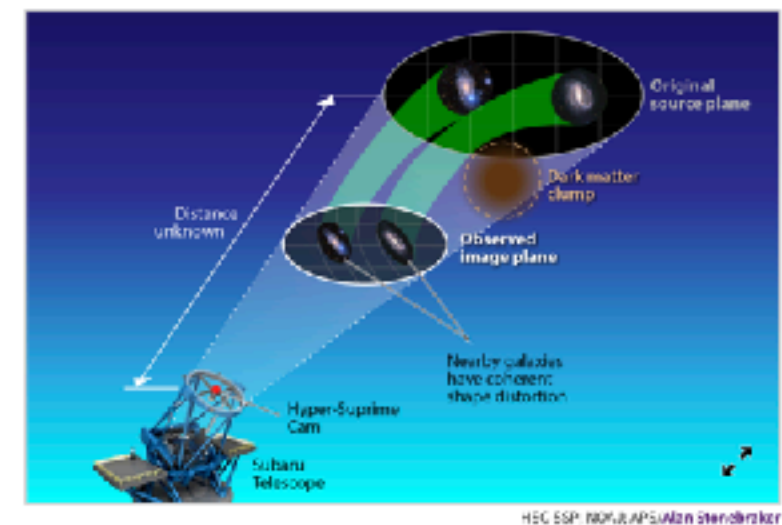
## VIEWPOINT Inconsistency Turns Up Again for Cosmological Observations

Mijin Yoon

Leiden Observatory, Leiden University, Leiden, Netherlands

December 11, 2023 • Physics 16, 193

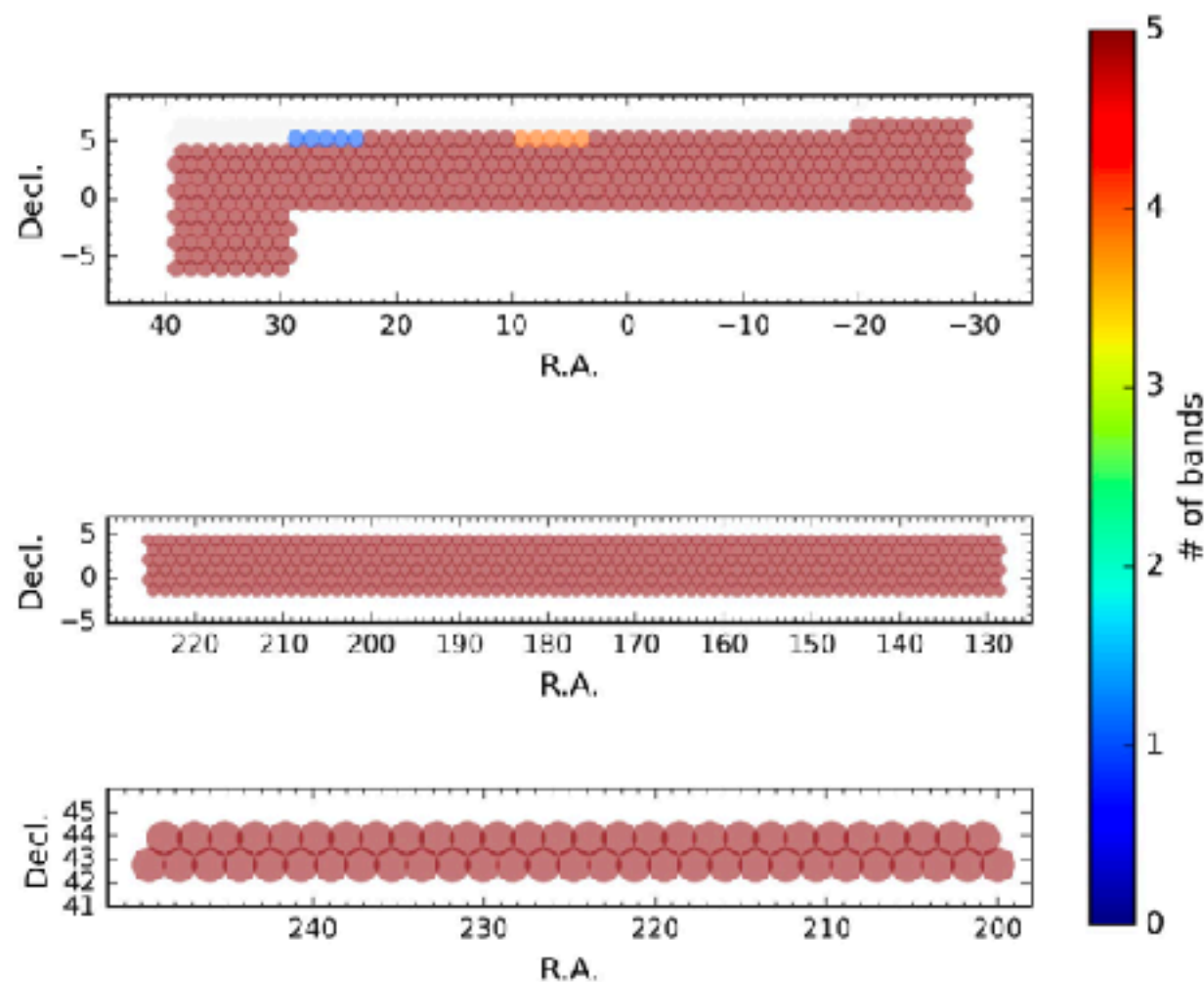
A new analysis of the distribution of matter in the Universe continues to find a discrepancy in the clumpiness of dark matter in the late and early Universe, suggesting a fundamental error in the standard cosmological model.



Five cosmology papers were published in PRD in Dec 2023, and appeared in Physics Viewpoint. **Only 0.5% of accepted papers** are covered by Viewpoint.



# Towards Final Year Analysis



- HSC SSP survey was completed.
- Full-depth, full-color coverage of **1,087 deg<sup>2</sup>**.
- Data currently being processed at NOAJ using **the latest Rubin science pipelines**.
- **Systematics challenges** need to be overcome to leverage statistical power
  - Blending of galaxies
  - PSF systematics
  - Source redshift uncertainties, etc...

# AGN working group

**AGN WG**

**~110 researchers** belong to the AGN WG.



Yoshiki Toba



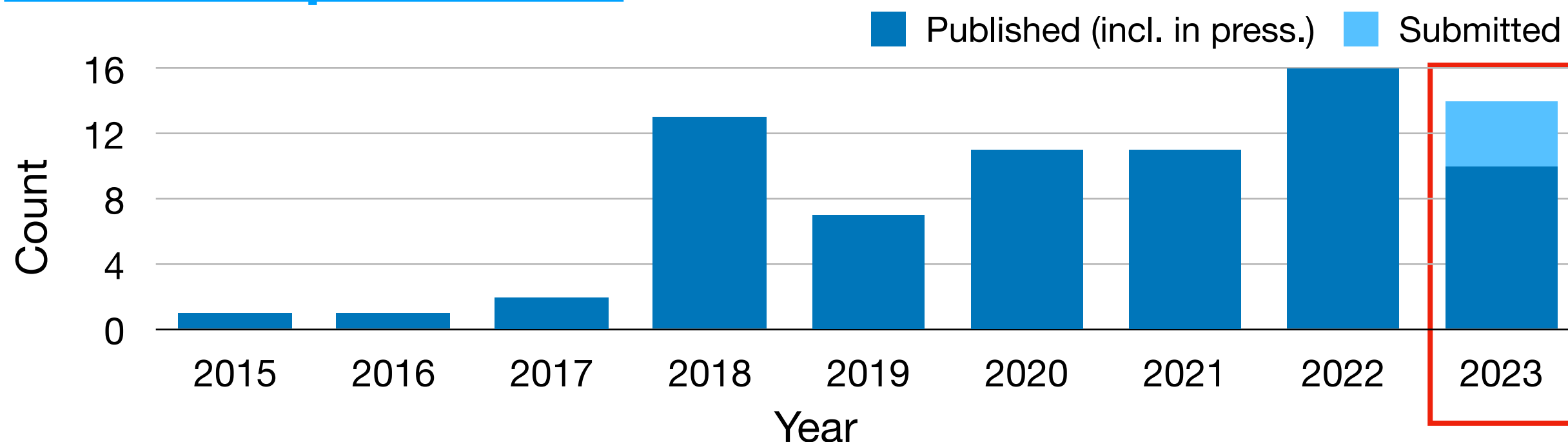
Tohru Nagao

Number of projects (HSC Joint-Data Project)	121 (7)
Number of publications (under review)	74 (4)
Number of proposals (accepted)	~300 (~40%)



13th HSC-AGN meeting at Ehime U.  
(Nov.14 -16, 2023)

## HSC-AGN publication



# HSC view of quasars

Yoshiki Matsuoka  
(Ehime U.)

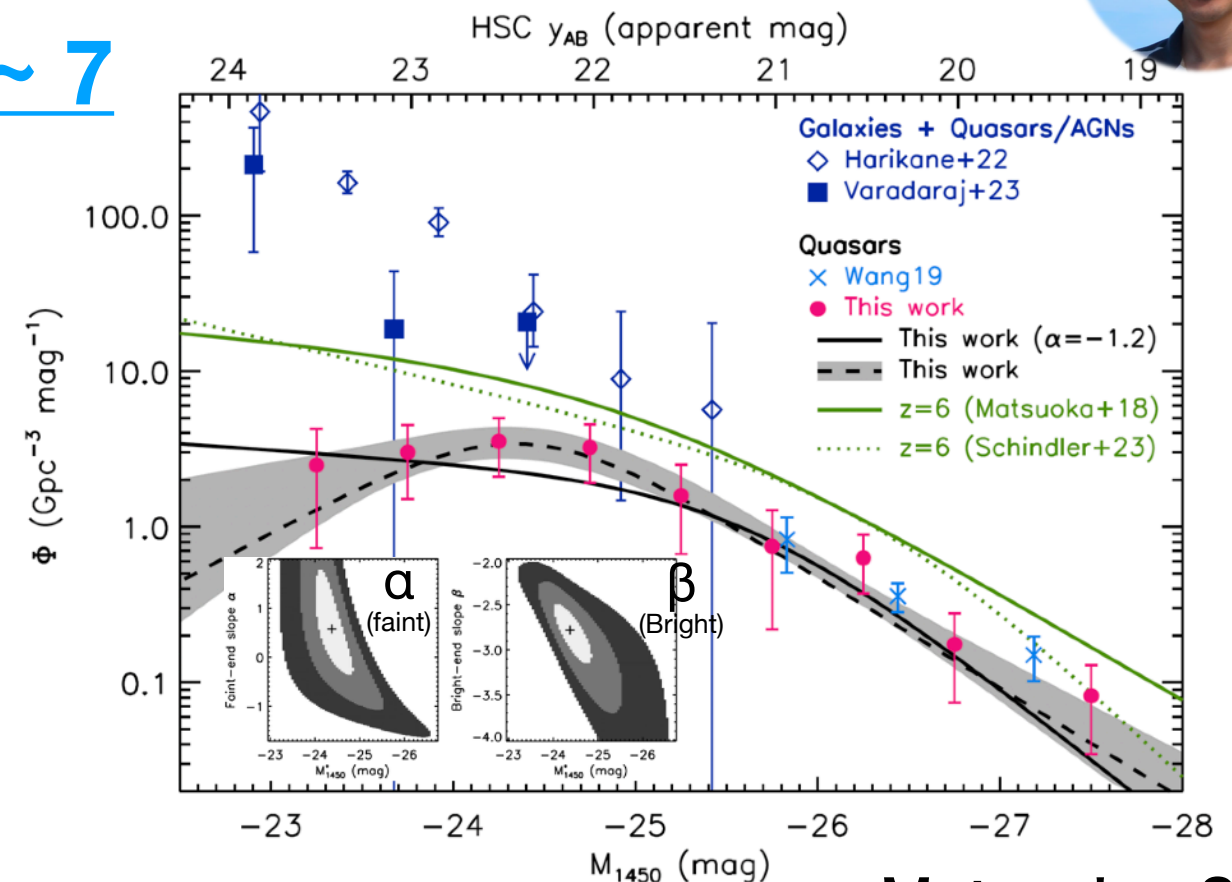


## Quasar luminosity function at $z \sim 7$

The quasar luminosity function at  $z \sim 7$  is constrained for the first time.

35 samples collected

See also Nagele+23 and Tang+23 for quasar host works.



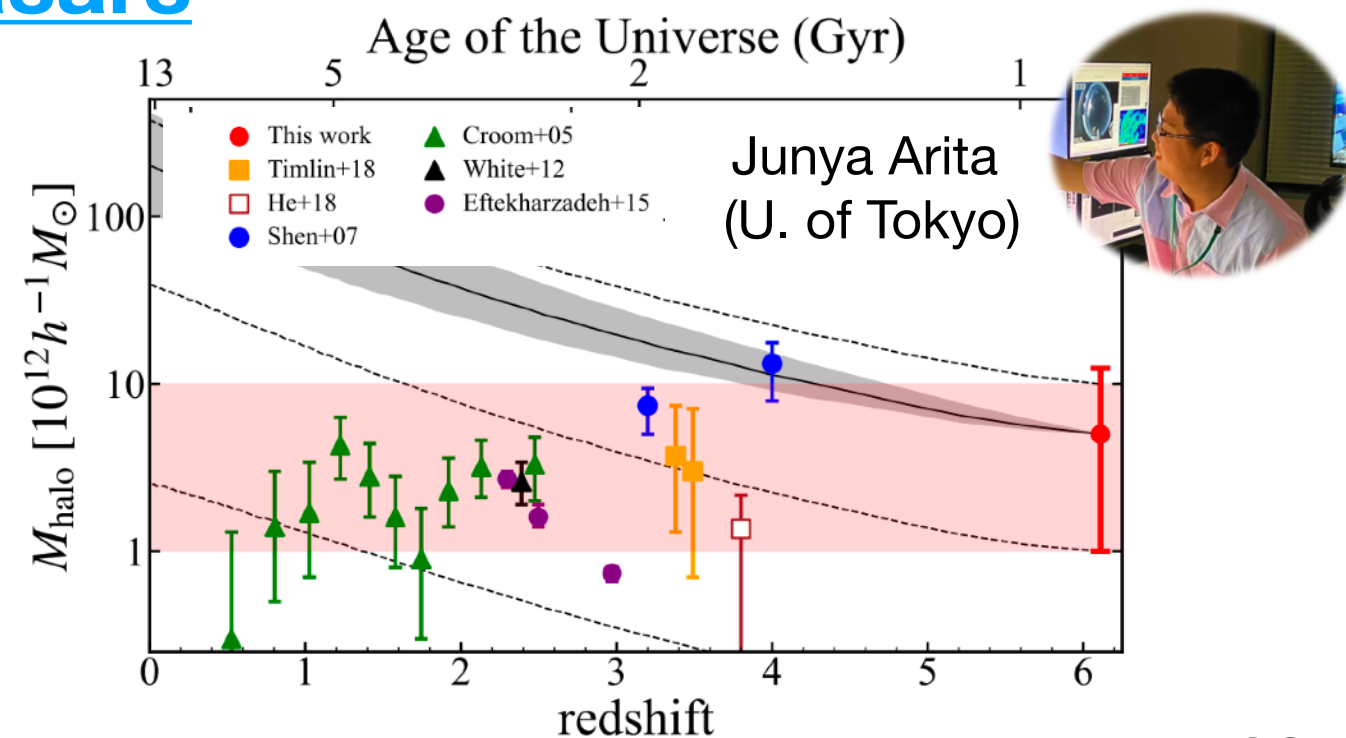
Matsuoka+23

## Clustering analysis of $z \sim 6$ quasars

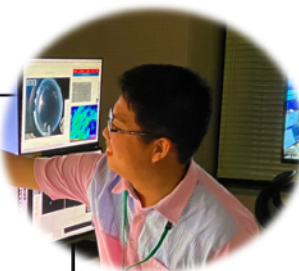
The dark matter halo mass of quasars at  $z \sim 6$  is evaluated as  $\sim 5 \times 10^{12} h^{-1} M_{\odot}$ .

107 samples

See also He+24 for BH mass and Eddington ratio distributions for less-luminous quasars.



Junya Arita  
(U. of Tokyo)



Arita+23



# Other AGN topics

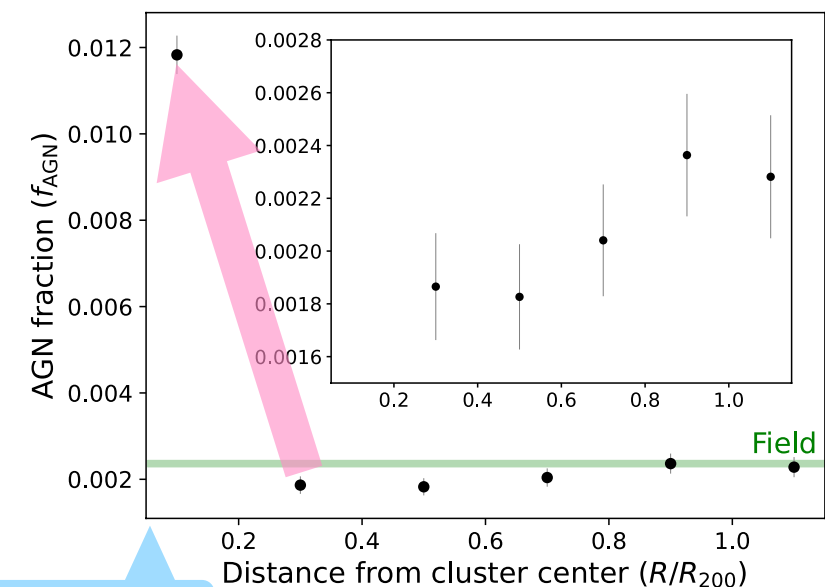
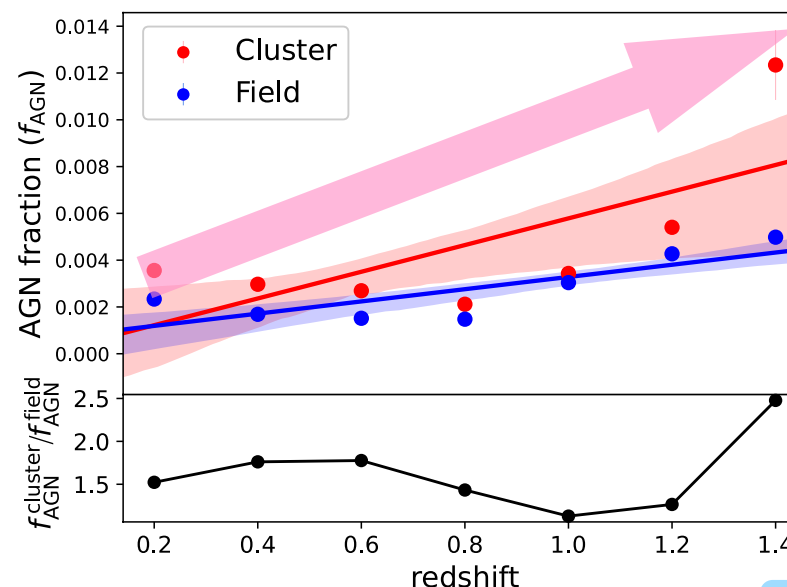
## AGN in galaxy clusters

(CAMIRA)

Aoi Hashiguchi  
(Nara Women's U,)



AGN number fraction in clusters (1) increases with redshift and (2) shows an excess in the cluster center.



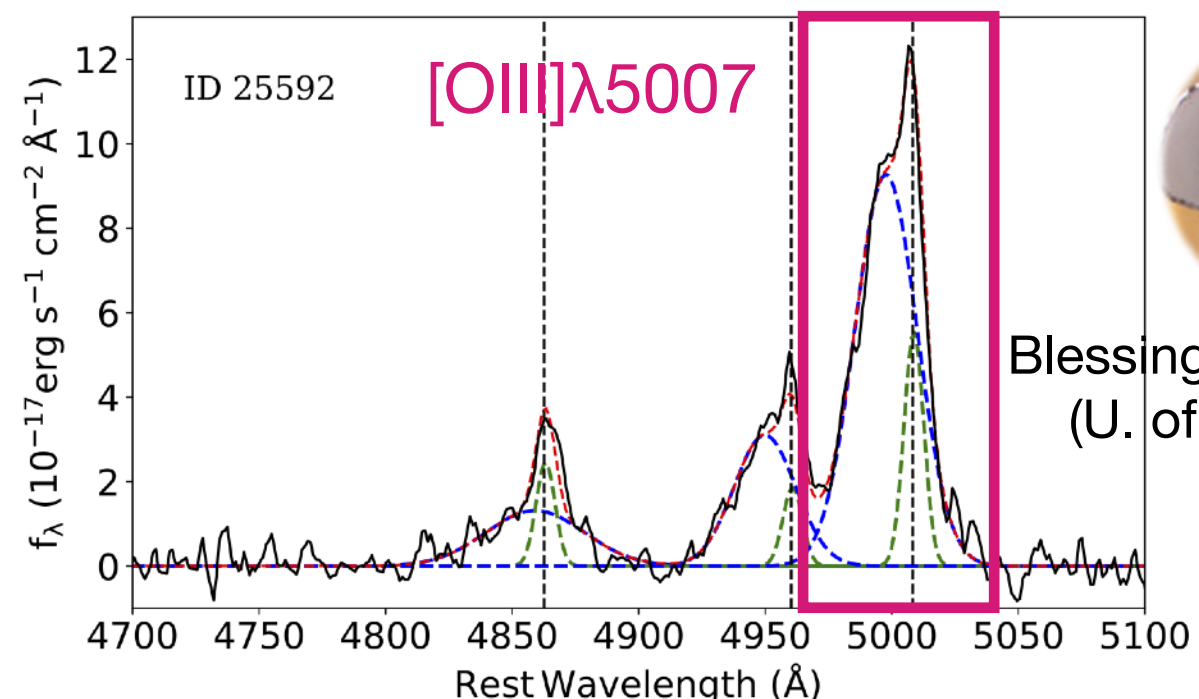
Cluster center

Hashiguchi, Toba+23

## Activity of HSC-eROSITA AGN

427 sources at  $z < 1$  in the eFEDS are found as candidates of AGN with powerful outflow.

(outflow of ionized gas)



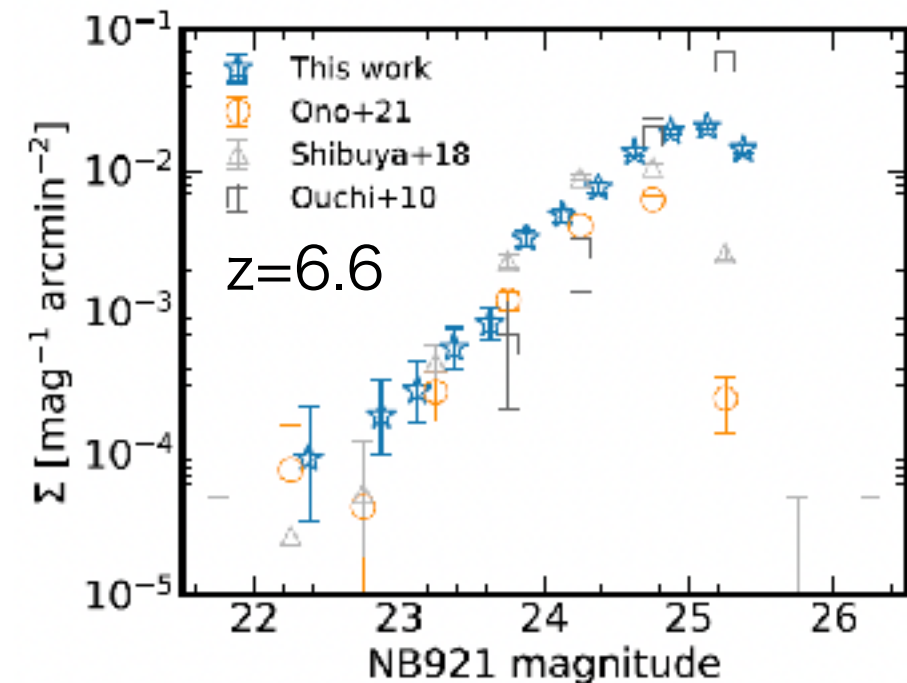
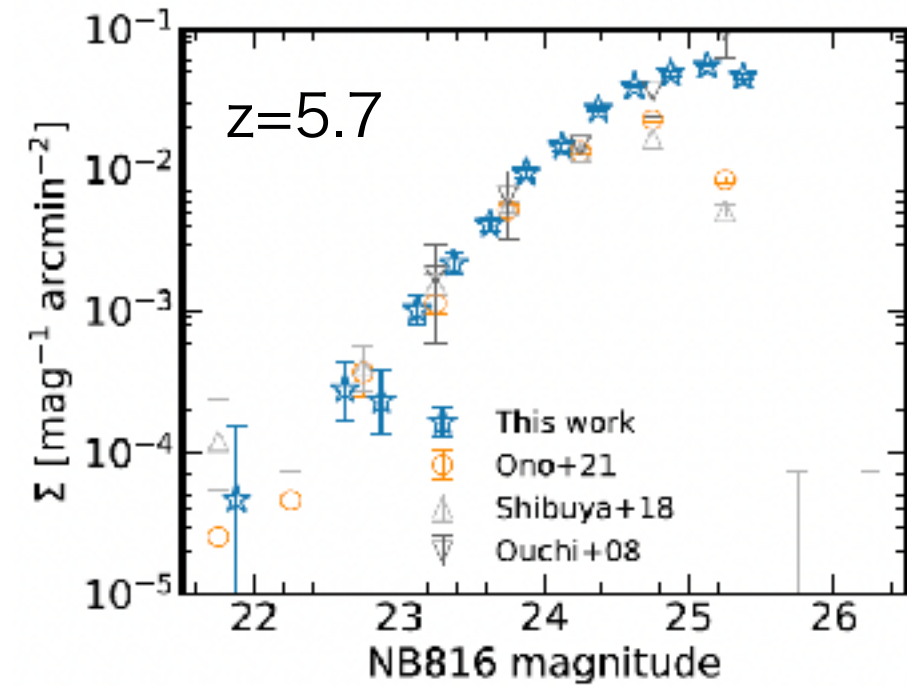
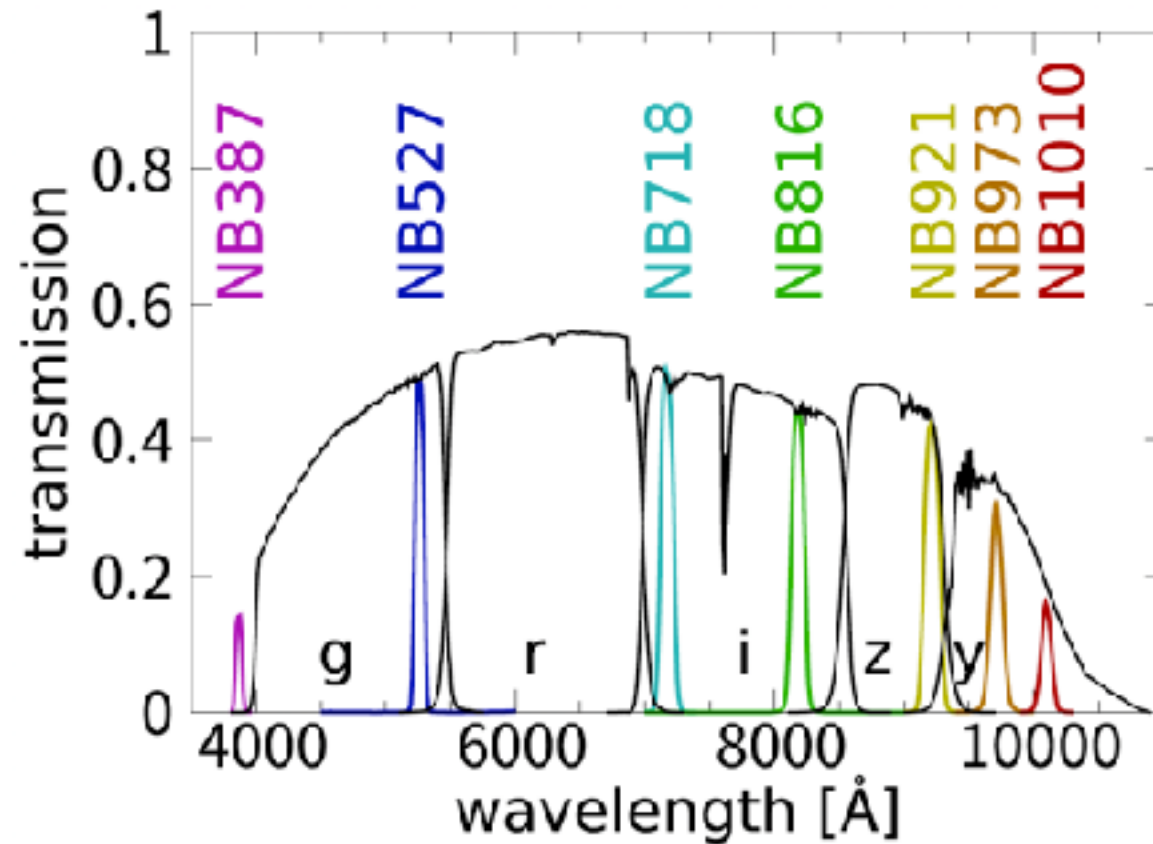
Blessing Musiimenta  
(U. of Bologna)

See also Comparat+23, Ichikawa+23, Li+24 for eFEDS-related works.

Musiimenta+23

# An Updated Catalog of High- $z$ Ly $\alpha$ Emitters

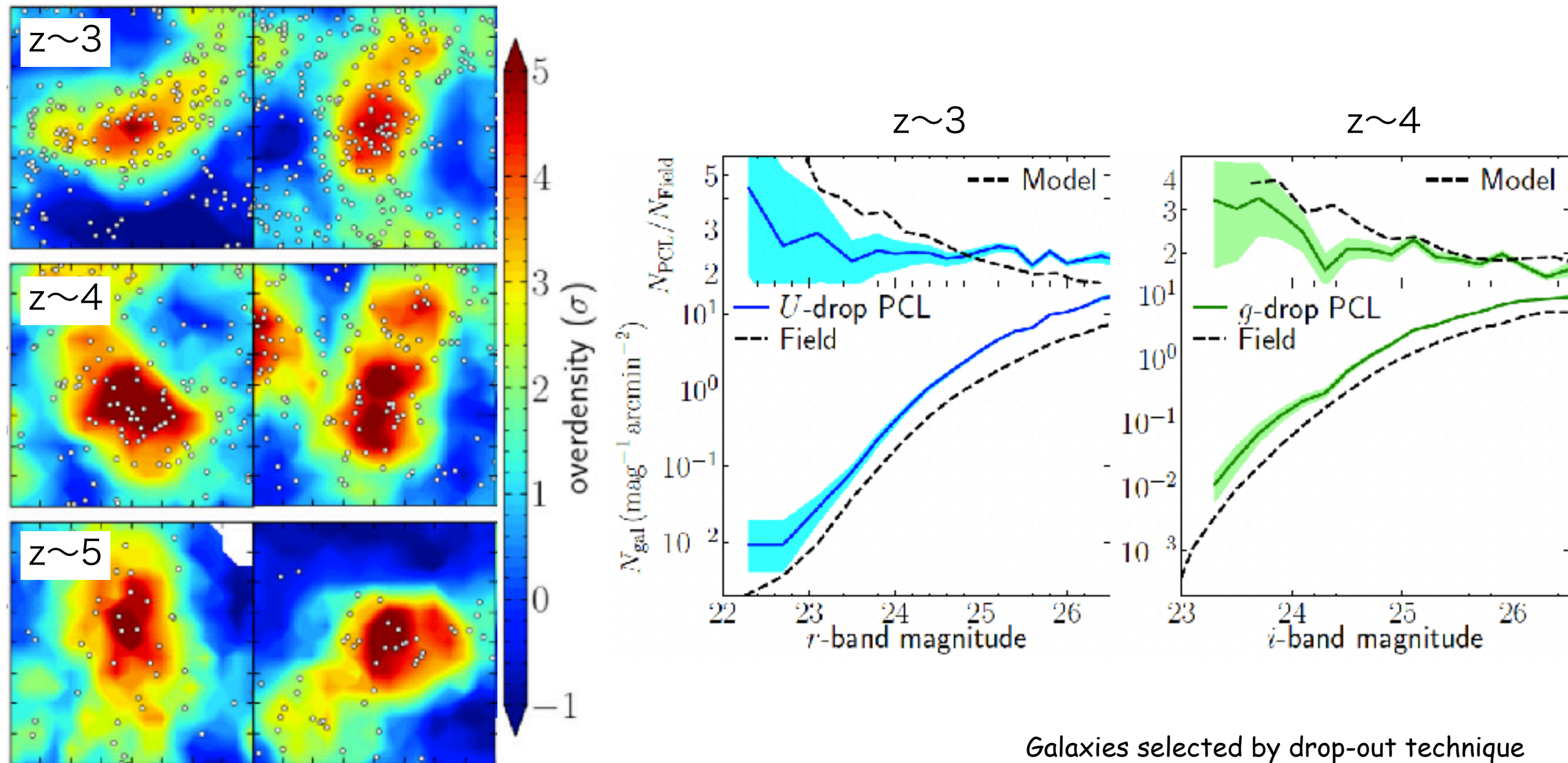
(Kikuta et al. 2023, ApJS, 268, 24)



- The SILVERRUSH program builds a new catalog of 20,567 Ly $\alpha$  emitters at  $z=2.2-7.3$  based on the full-depth data of the HSC SSP and CHORUS.
- Statistical properties such as the luminosity functions and correlation functions are currently being investigated.

# High-z Galaxy Overdense Regions

(Toshikawa et al. 2024, MNRAS, 527, 6276-6291)



- $>100$  galaxy overdense regions at  $z \sim 3-5$  are identified over  $25 \text{ deg}^2$  area based on the HSC SSP DUD + CLAUDS.
- UV luminous ( $M_{\text{UV}} < -21.5 \text{ mag}$ ) galaxies are overabundant in overdense regions compared to general fields, suggesting faster evolution in overdense environments.

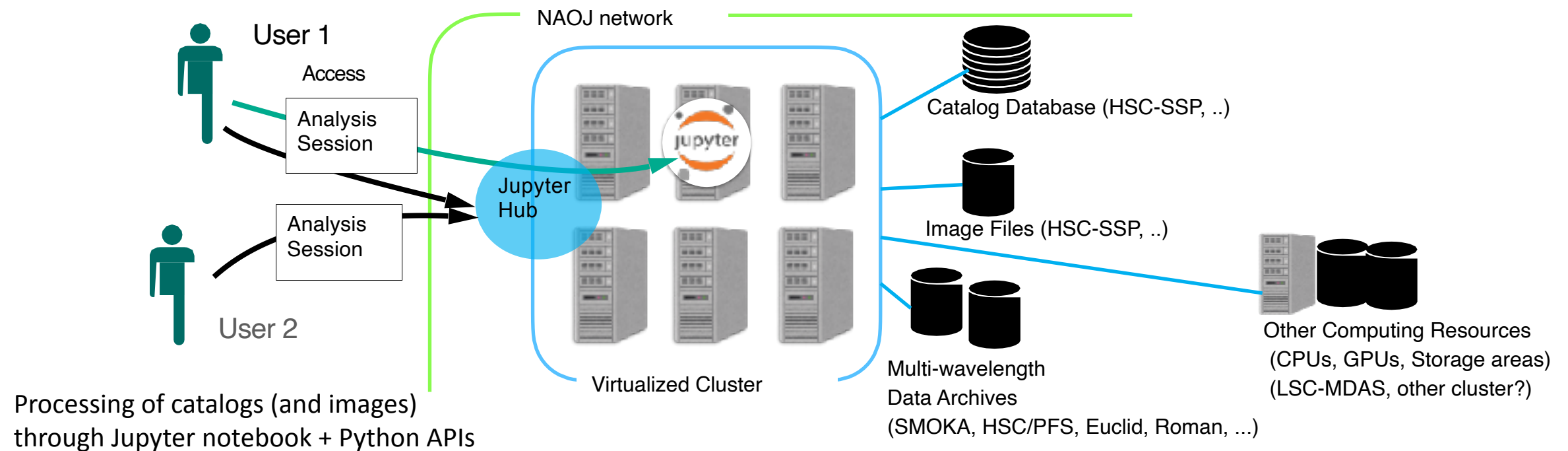


# PASJ Excellent Paper Award 2023

Not announced yet ...

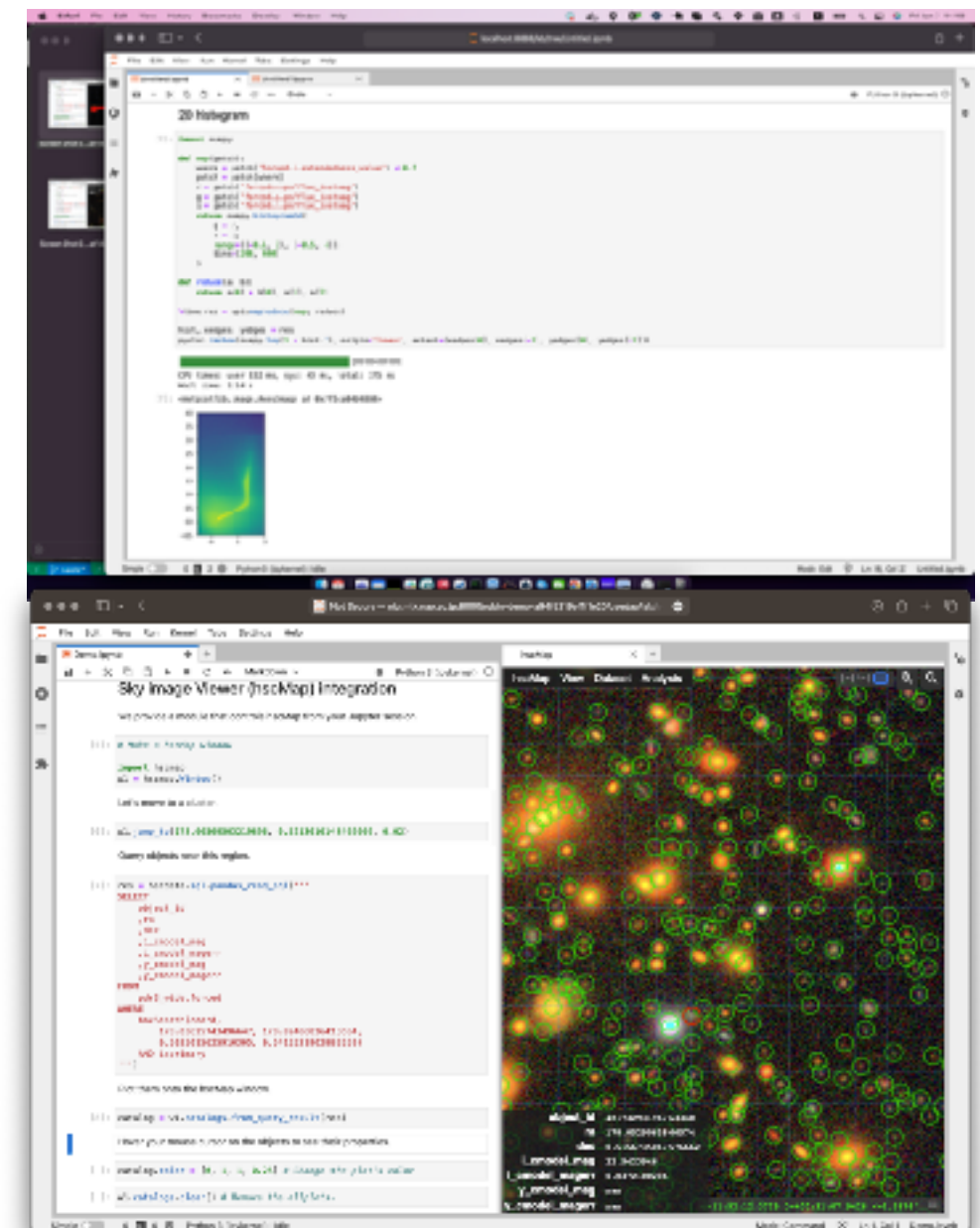
# Science Platform

- Developing a JupyterHub-based data analysis platform
  - efficient analysis over the existing products from remote
  - efficient use of computing resources
- ADC+Subaru coworking to implement services to HSC and PFS sharing the software design
- SP will also be applied to Rubin Japanese data access center, & Euclid, etc..



# Prototype of HSC Science Platform

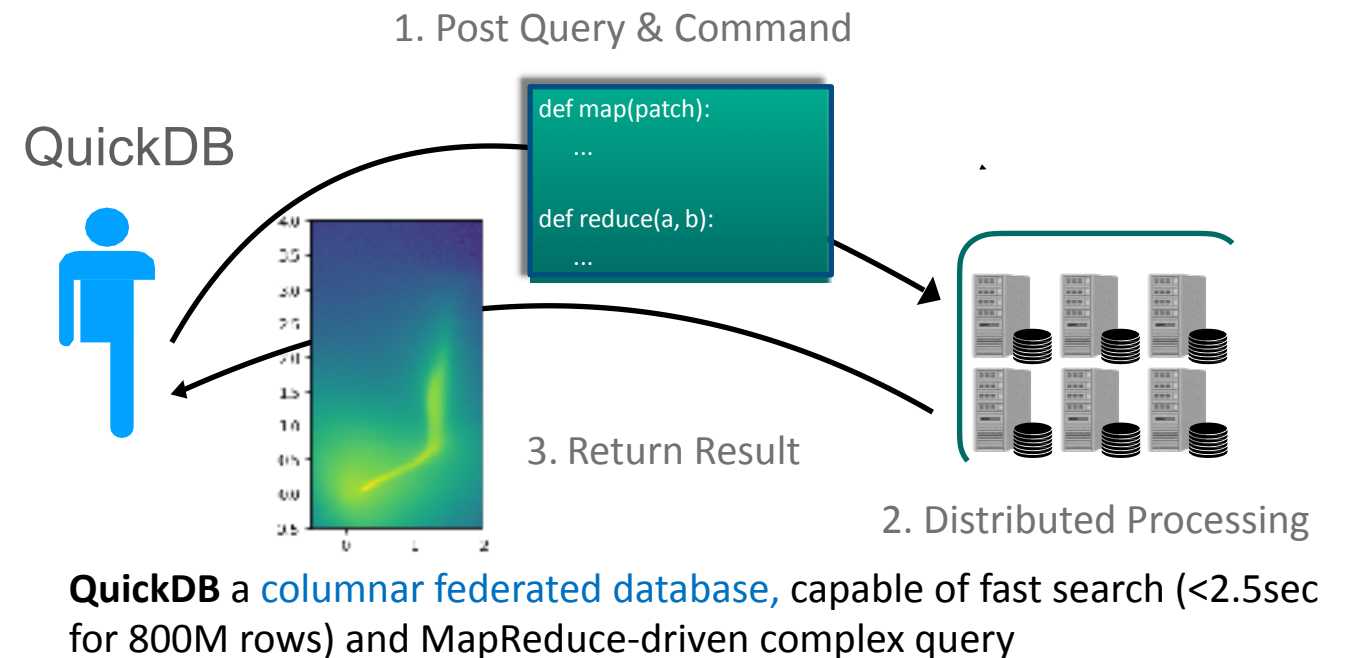
- Prototyping SP on the HSC data release PDR3
- ADC Team Tentative target plan
  - First prototype -2023.4 – done – being updated
  - Internal review by a few experts  
2024.2 – being updated
  - Preview by SSP collaboration 2024Summer
  - Design for PDR (and public data) this year
- Serving PFS engineering data in 2024.2
  - For instrument development team



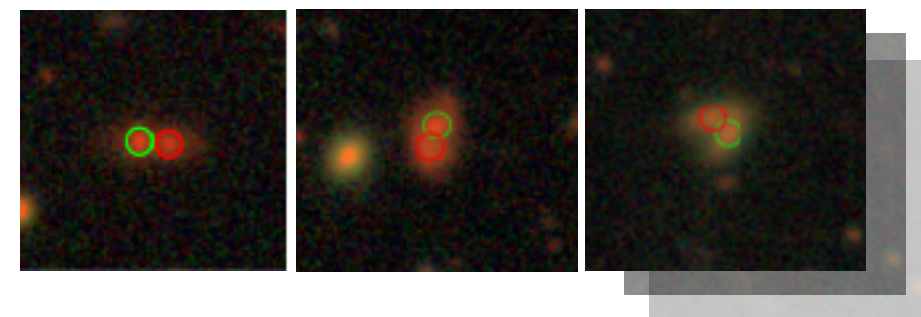
# Snapshots From the Ongoing HSC-SP Development



HSC-SP provides 1) **computing resources in ADC**,  
2) **Jupyter-notebook** I/F for data query & processing,  
3) Efficient **file sharing** mechanisms: Inter-operation  
w/ various archives (PFS, Rubin, SMOKA...) in the plan



**Jupyter I/F** offers easy access/analysis of cat & image  
with **Python** APIs and **interactive HIPS viewer** hscMap.



**A Science Application** to find close pairs with similar colors  
by a QuickDB query, obtaining 87k pairs in 5sec for 500M rows.  
Optimal tools for various science cases to be developed.



