Subaru Next-Generation AO: Possibilities of Observing Distant Galaxies
(Progress Report)

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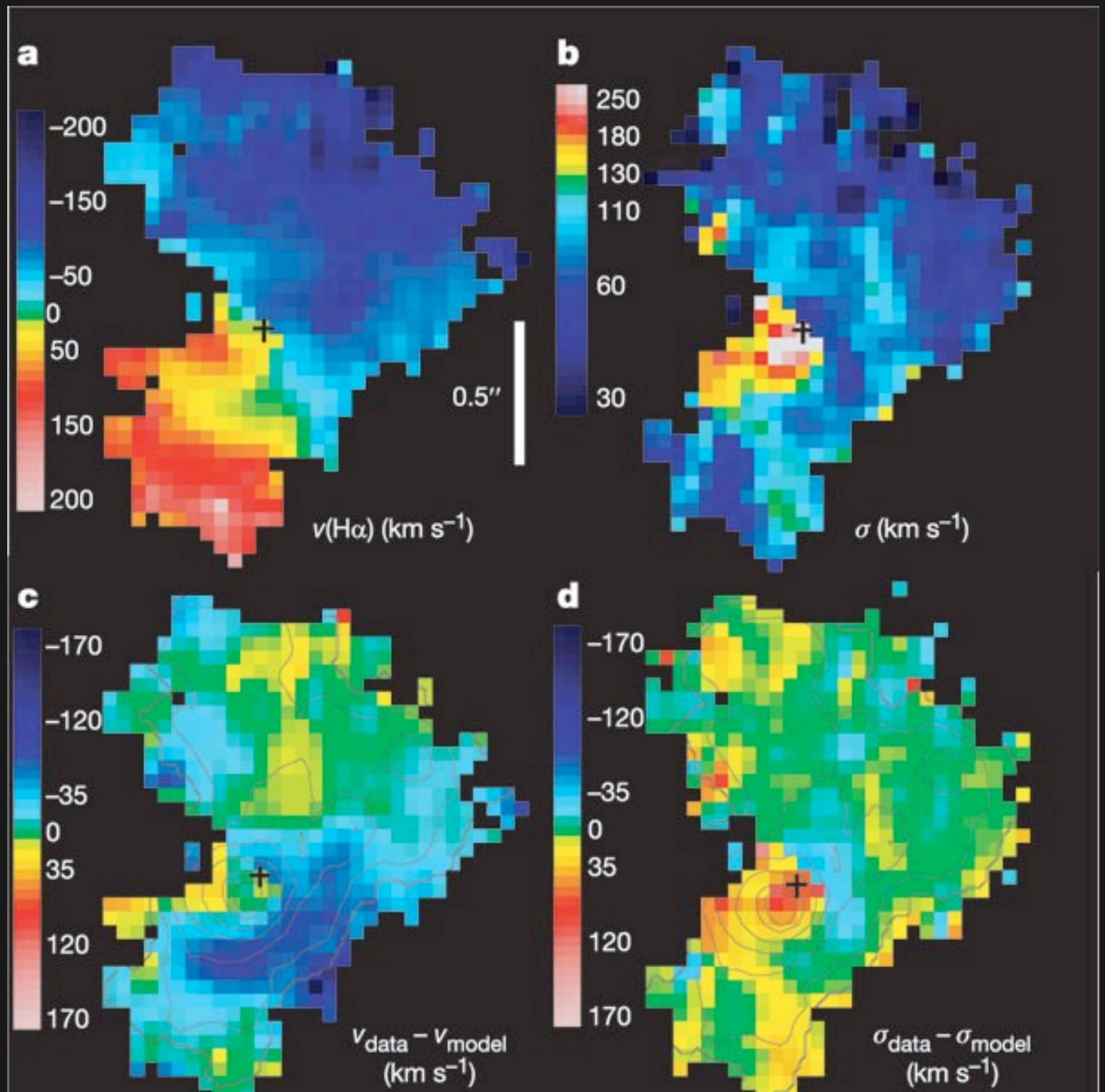
Objectives

- Observations of distant (z ~ 1 or higher) galaxies would be one of the possible strong candidates of driving science cases for next-generation AO / new IR instrument(s) for Subaru.
- What kind of AO we need? What we can do with them?
  - AO-assisted spectroscopy of distant galaxies has been carried out by Keck (OSIRIS) and VLT (SINFONI) -- Integral Field Spectroscopy
  - Distant galaxies are faint -- With 8-10 m class telescopes, only the brightest galaxies may be observable?
- Need to quantitative studies to determine the specifications of the ngAO and to build strategies of the observations with it

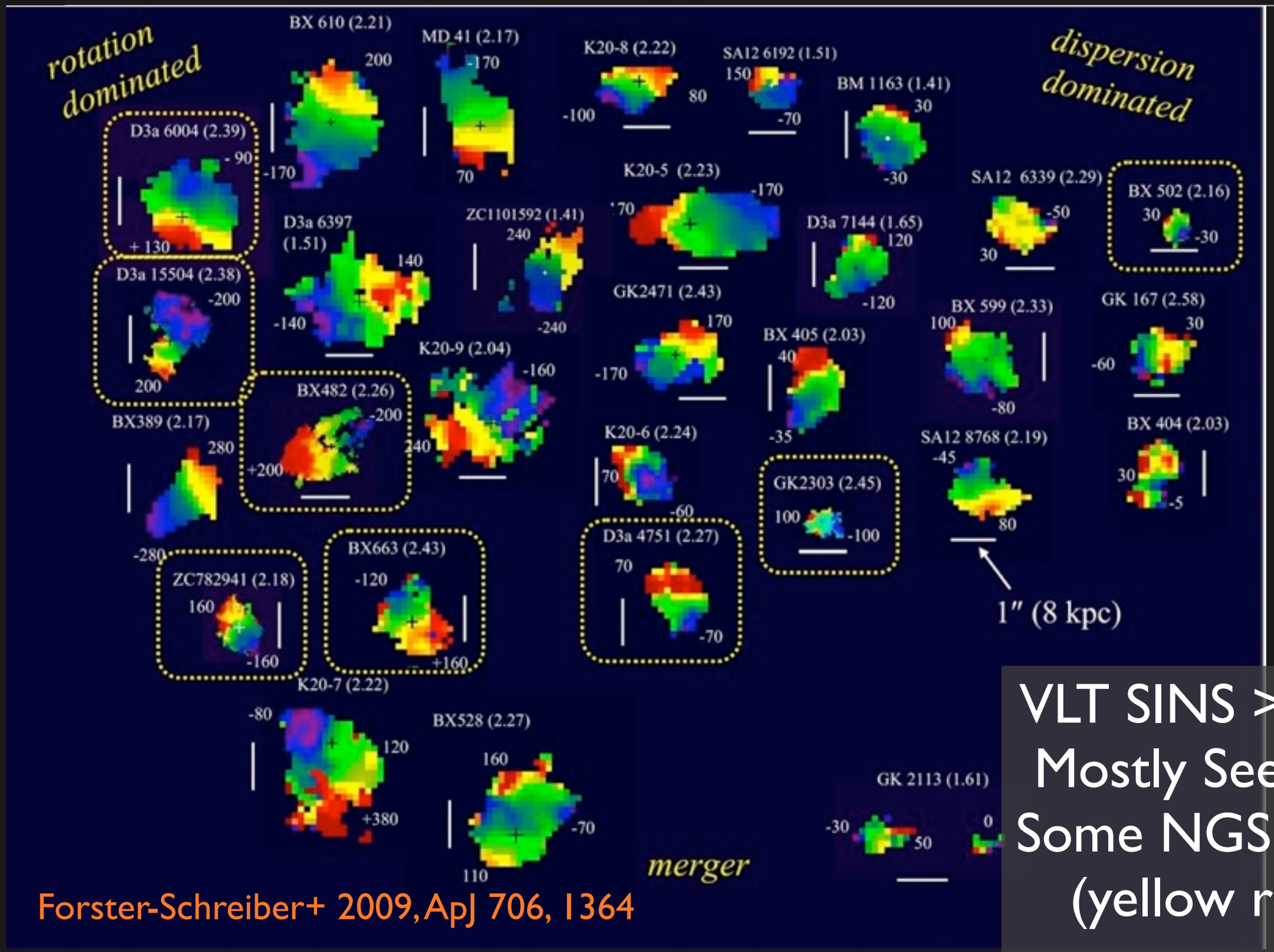
Resolved Kinematics of a Galaxy at z~2



VLT / SINFONI
NGS-AO IFS
Giant Star-forming galaxy at z=2.38
Resolution ~ 0.15”
(=1.2 kpc)

Genzel+ 2006, Nature 442, 786

Kinematics of Galaxies at 1.3 < z < 2.6



VLT SINS >60 Galaxies
Mostly Seeing Limited
Some NGS or LGS-AO
(yellow rectangles)

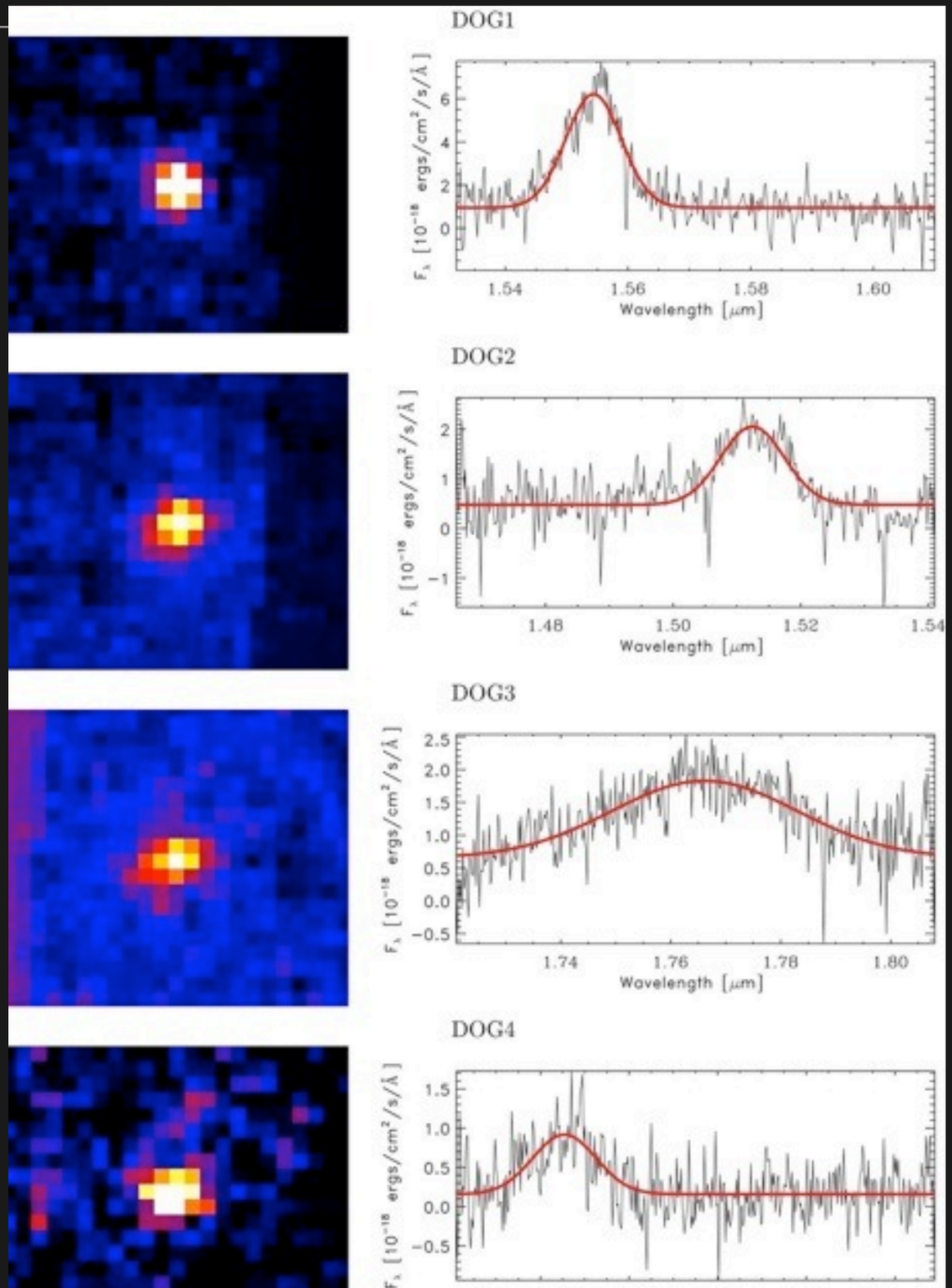
Forster-Schreiber+ 2009, ApJ 706, 1364

Resolved Spectroscopy of Dust-Obscured Galaxies at z~1.5

- Keck / OSIRIS LGS-AO assisted observations of 4 ULIRGs
- Resolution: ~0.1” (<1kpc)
- Separation of Broad-line components (Black Hole) and Narrow-line components (Star Formation)

1” FOV Hα maps

Melbourne+ 2011, AJ 141, 141



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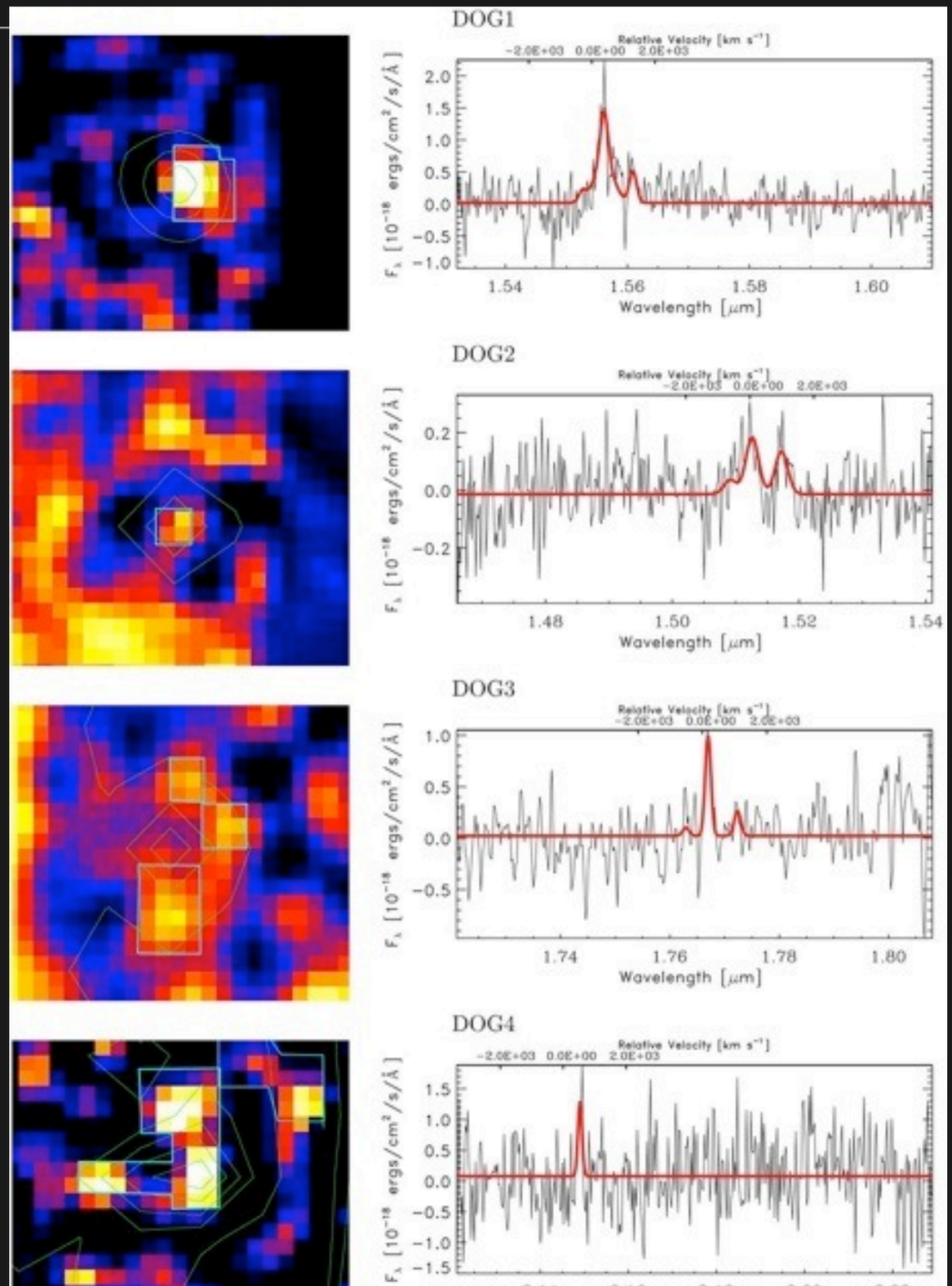
Broad-line Subtracted

Melbourne+ 2011, AJ 141, 141

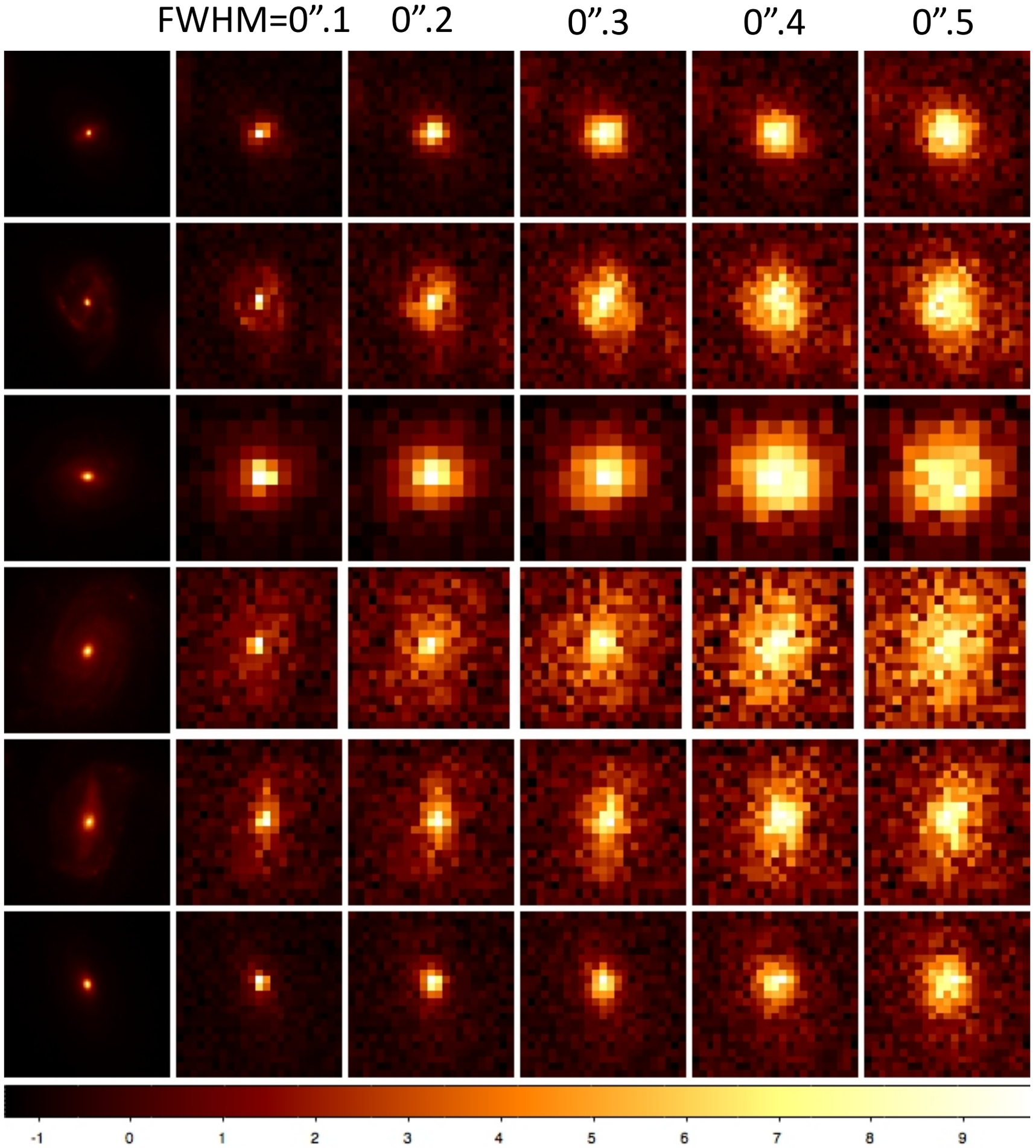


Possibilities of Observing Distant Galaxies

- Construct AO-simulated images of distant galaxies
- Examine their expected S/N
  - Slit spectroscopy and IFS
- Estimate number densities of observable targets
  - How many galaxies can be observed within, say, Φ10 arcmin FOV or FOR?
- Specifications of ngAO and new instrument(s)

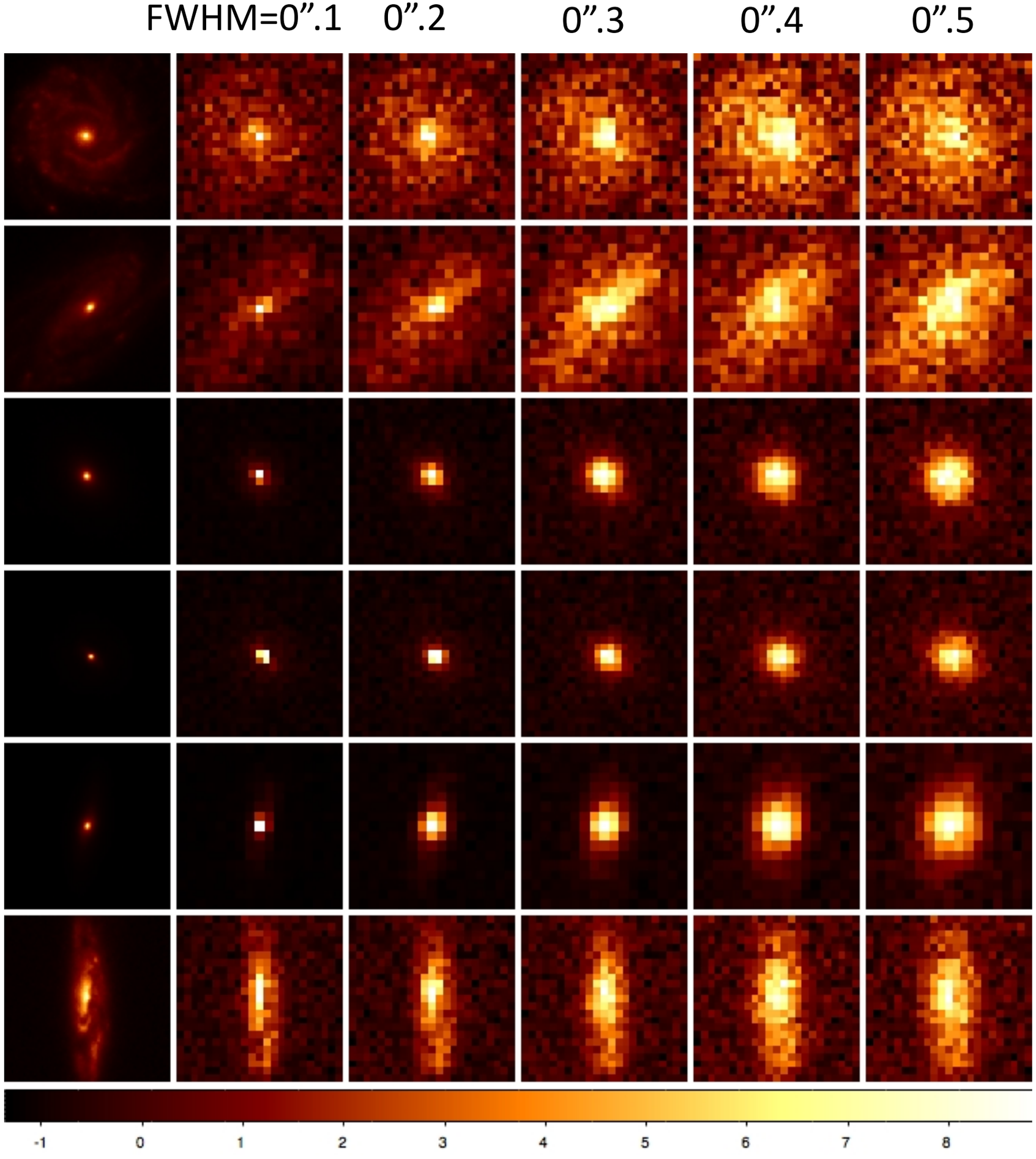
Minowa,
2011/03/24

Simulated Images of z~2 galaxies based on HST/ACS I-band images of galaxies at z~0.2



Minowa,
2011/03/24

Simulated Images of z~2 galaxies based on HST/ACS I-band images of galaxies at z~0.2



Minowa,
2011/03/24

flux ratio = f(r,FWHM=0".2)/f(r,FWHM=0".5)

3
2.5
2
1.5
1

0
0.1
0.2
0.3
0.4
0.5
0.6

Aperture radius, r [arcsec]

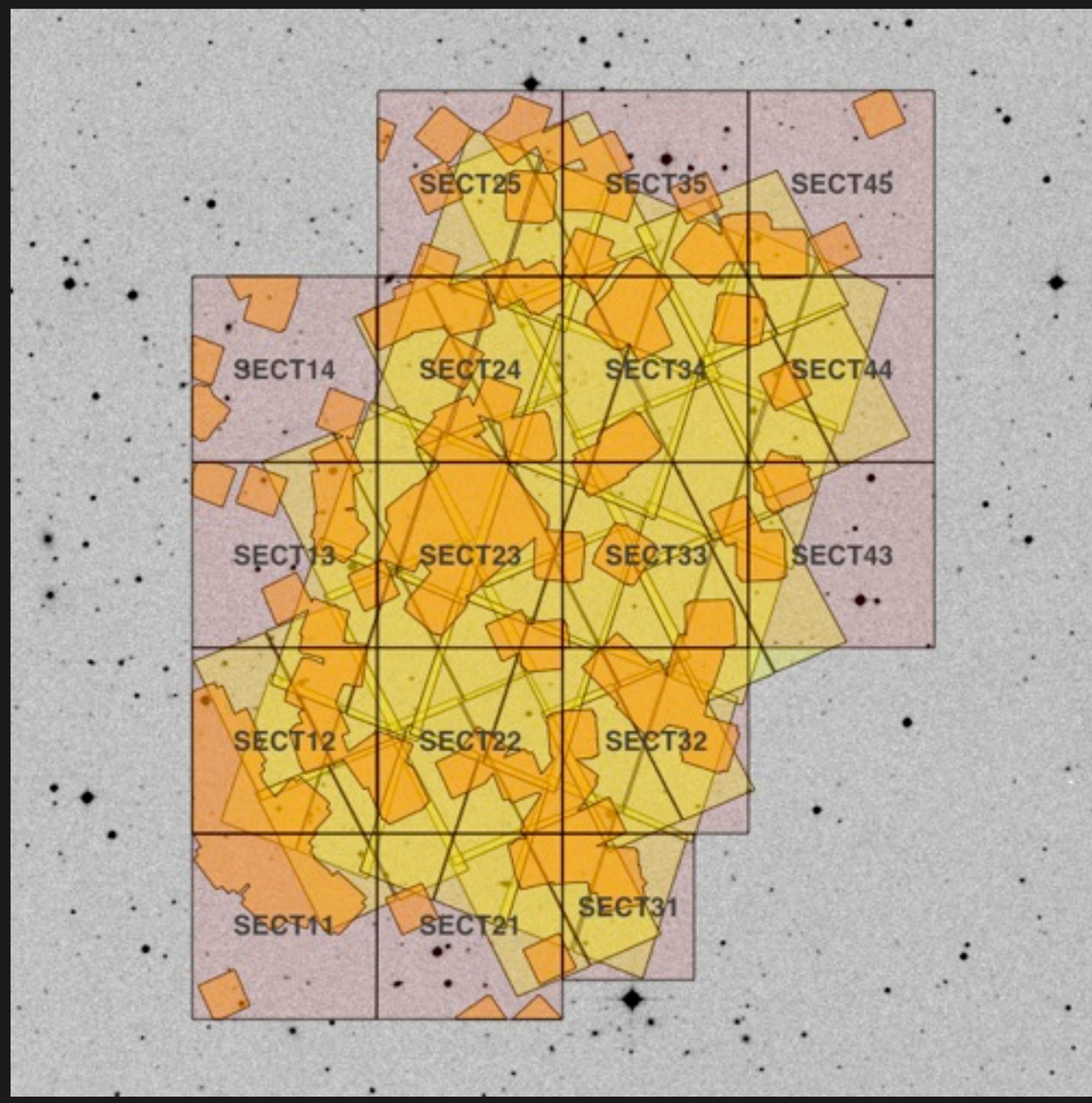
Simulation Based on Real Galaxies at z > 1

- HST/ NICMOS or WFC3/IR images of distant galaxies
- Sample field:

  Extended GOODS-S (E-CDFS)

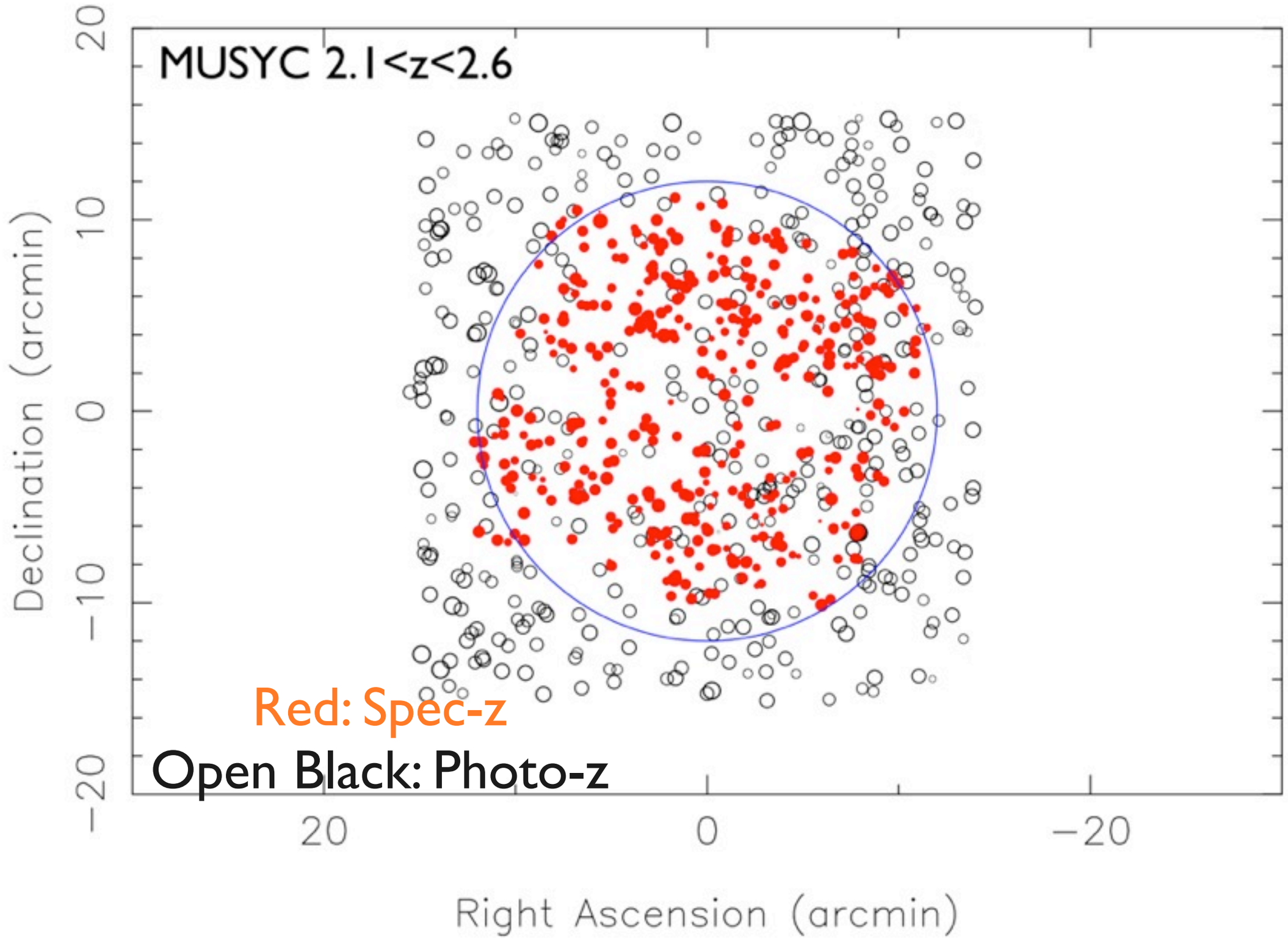
  MUSYC:

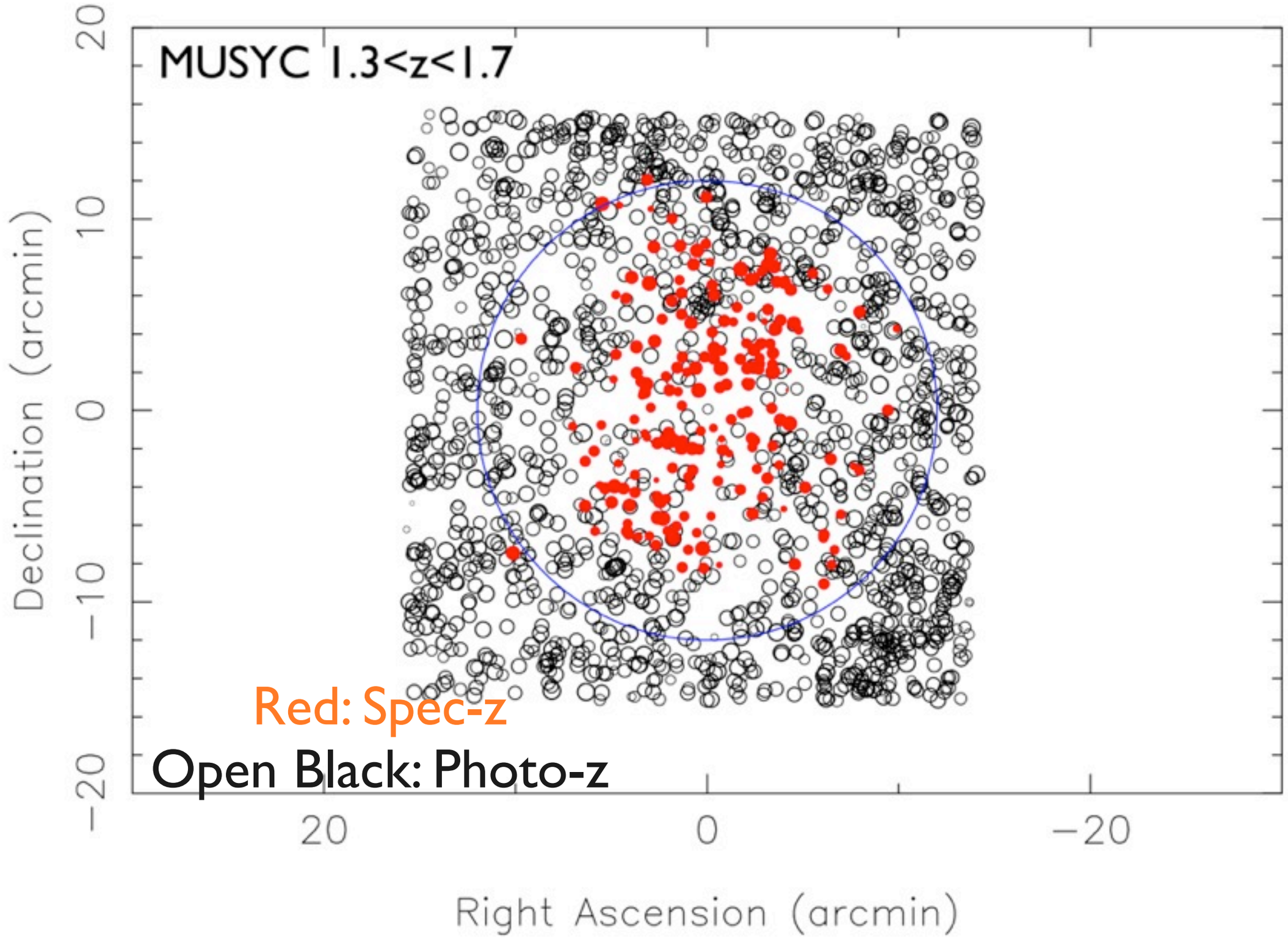
  http://www.astro.yale.edu/MUSYC/



Redshift Ranges

- Two Good Redshift Ranges:
- 2.1 < z < 2.6
  - J-band: OII
  - H-band: Hβ, OIII
  - K-band: Hα
  - (Lyα: 3770AA-4380AA)
- 1.3 < z < 1.7
  - J-band: Hβ,OIII
  - H-band: Hα
  - (OII: 8570AA-1006AA)


MUSYC 2.1<z<2.6
Red: Spec-z
Open Black: Photo-z
Declination (arcmin)
Right Ascension (arcmin)
20
10
0
−10
−20
20
0
−20

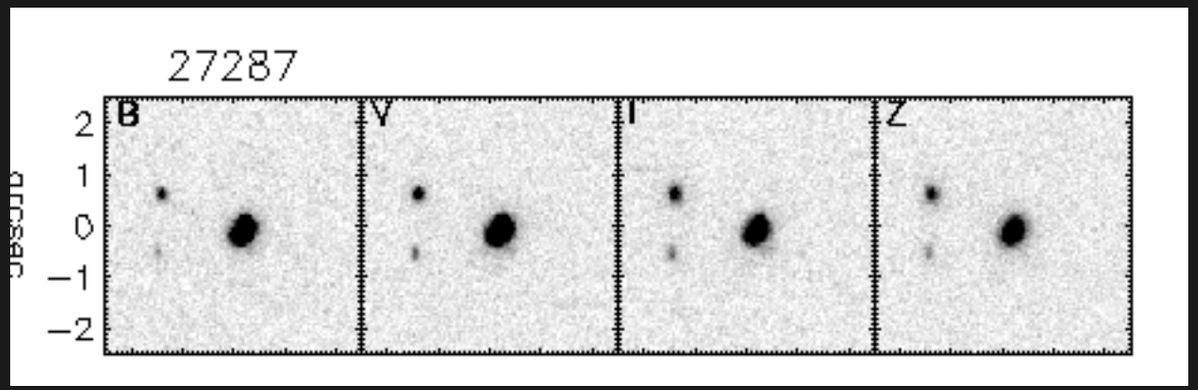

MUSYC 1.3<z<1.7
Red: Spec-z
Open Black: Photo-z
Declination (arcmin)
Right Ascension (arcmin)
20
10
0
−10
−20
20
0
−20

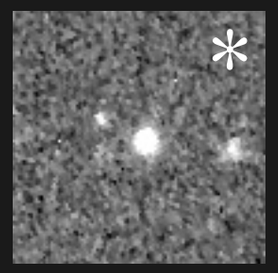
Examples: 2.1<z<2.6 K(AB)<22

HST/ ACS

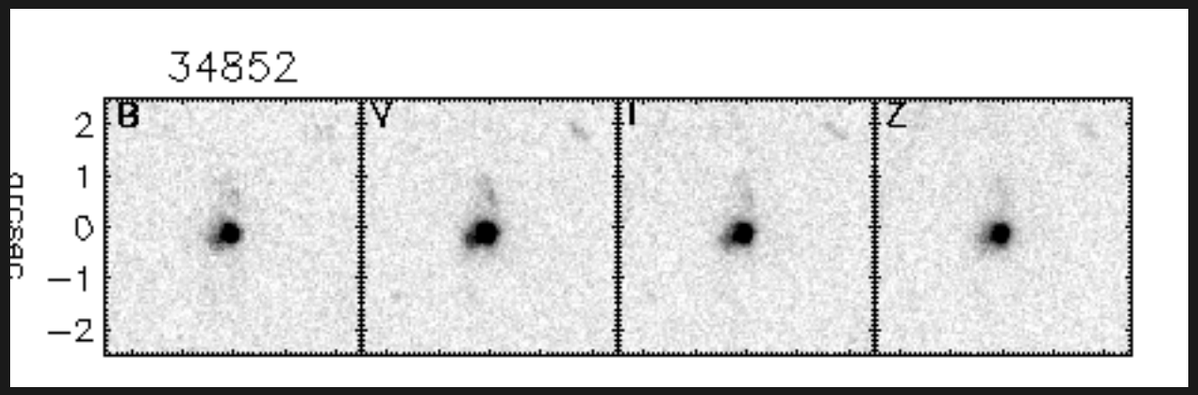
NICMOS or WFC3/IR

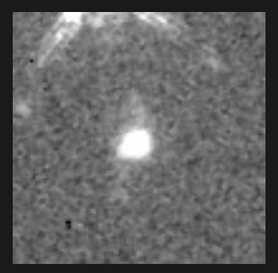
Spitzer/ IRAC1



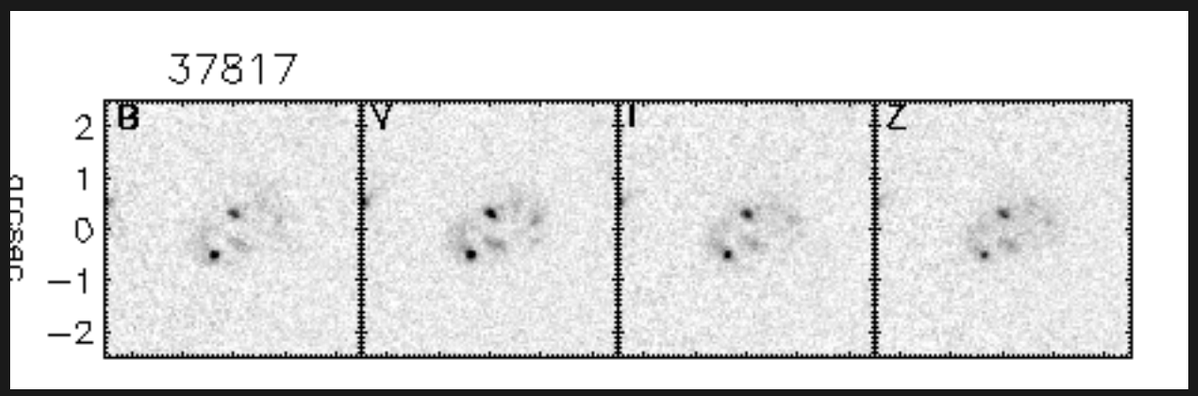


z_{sp}=2.12





z_{sp}=2.32



z_{sp}=2.13

5”

6” or *9”

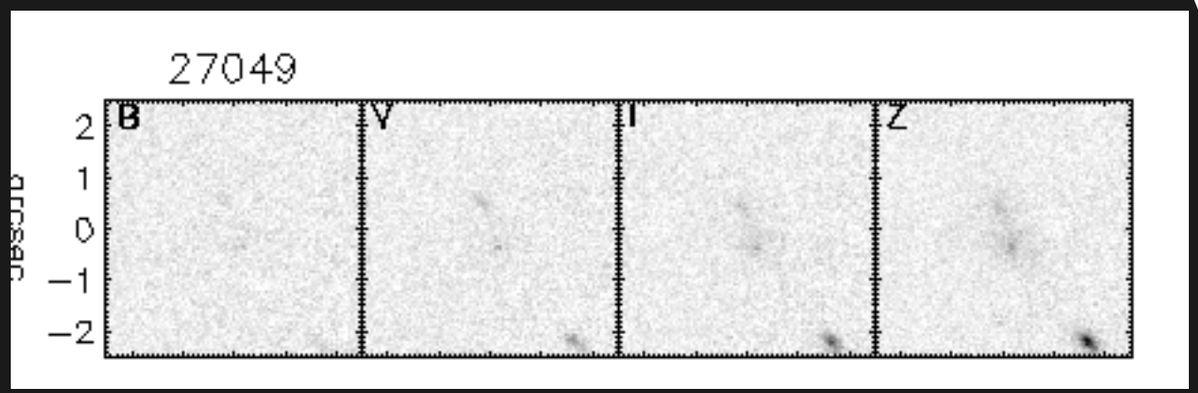
9”

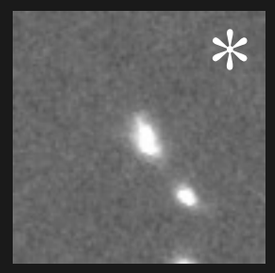
Examples: 1.3<z<1.7 K(AB)<22

HST/ ACS

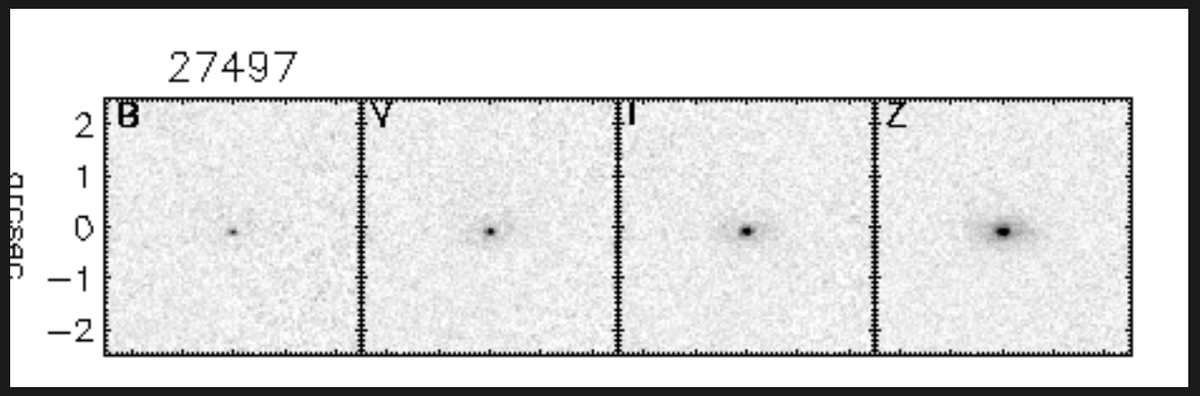
NICMOS or WFC3/IR

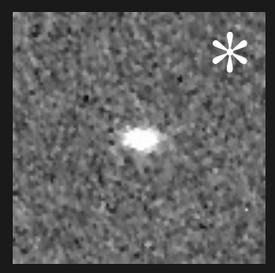
Spitzer/ IRAC1



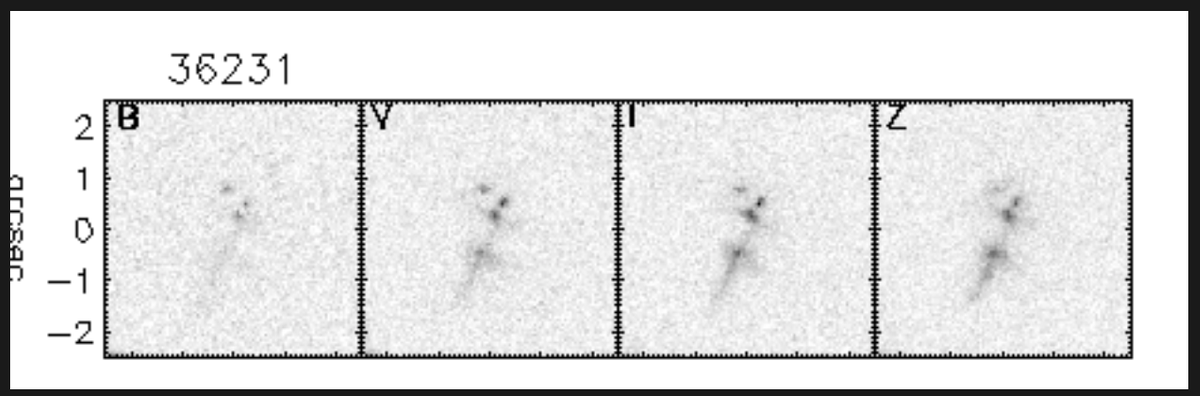


z_{sp}=1.38





z_{sp}=1.38



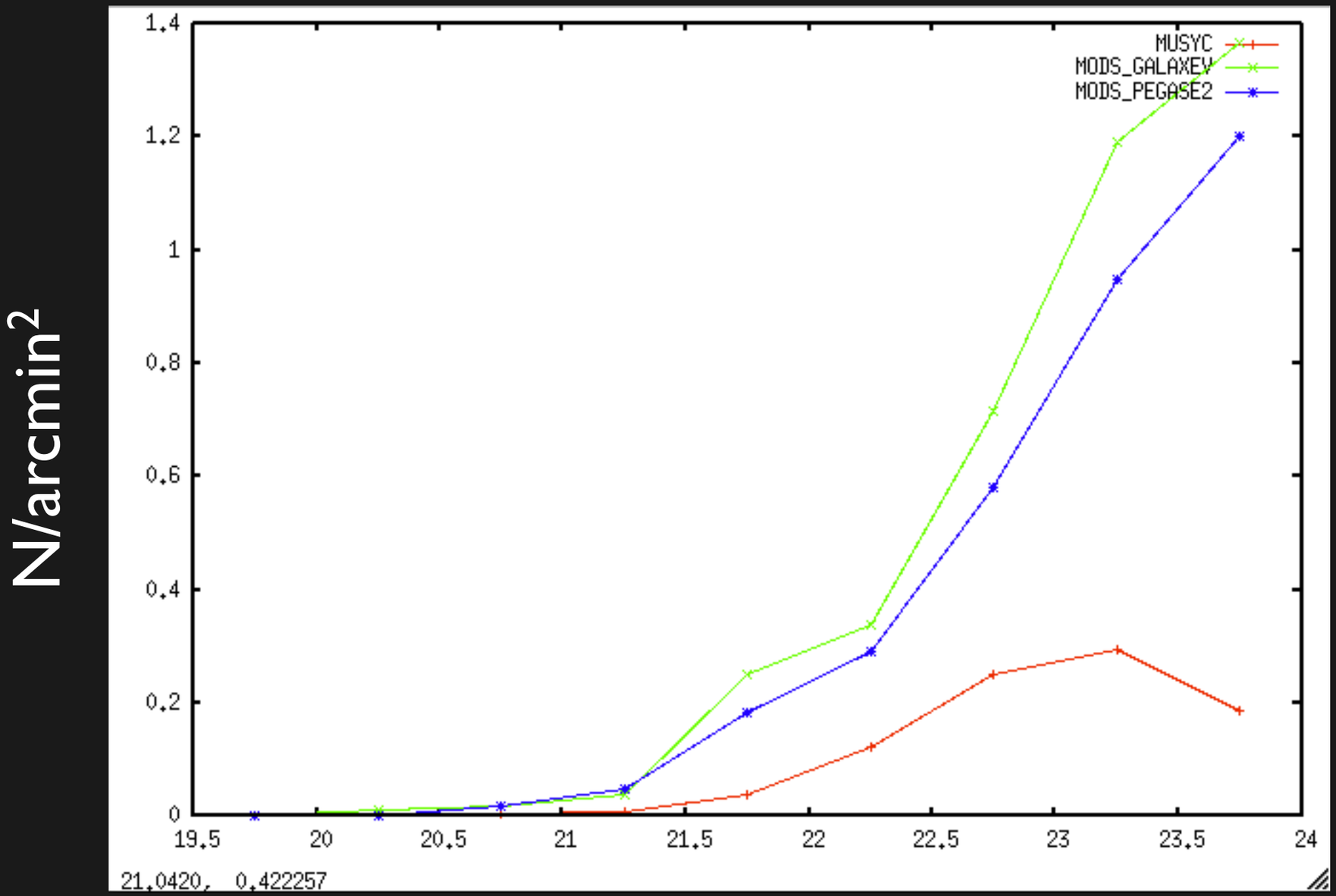
z_{sp}=1.62

5”

6” or *9”

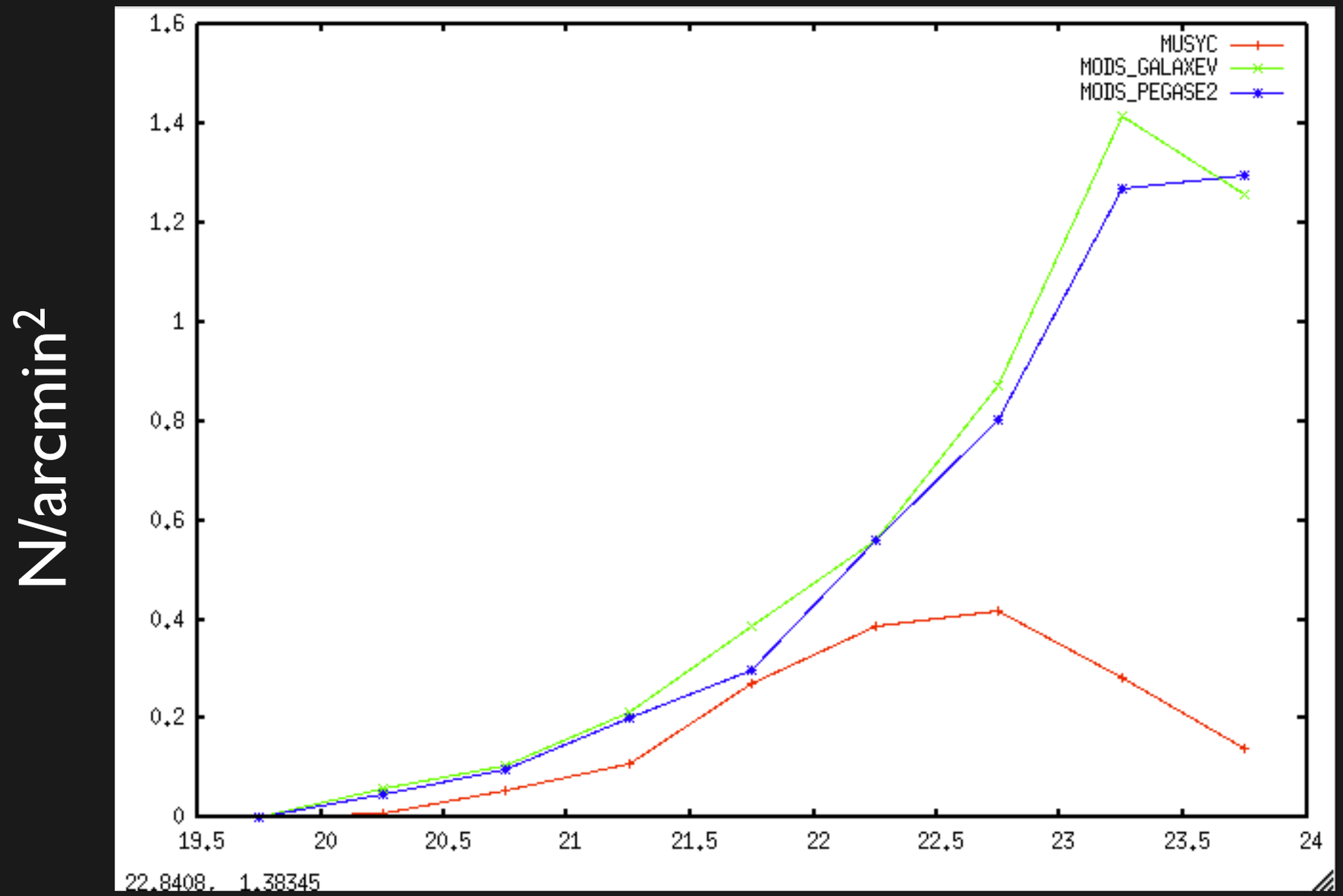
9”

Surface Densities: 2.1 < z < 2.6



MODS data by courtesy of Kajisawa san

Surface Densities: 1.3 < z < 1.7



MODS data by courtesy of Kajisawa san

Surface Densities of K(AB)<22 Galaxies in MODS

	N/arcmin^2	N/10'Φ
1.3<z<1.7	0.764	60
2.1<z<2.6	0.320	25

MODS data by courtesy of Kajisawa san

Surface Densities of K(AB)<21 Galaxies in MODS

	N/arcmin^2	N/10'Φ
1.3<z<1.7	0.377	30
2.1<z<2.6	0.068	5

MODS data by courtesy of Kajisawa san

Summary

- Feasibility studies on observations of distant galaxies with next-generation AO are on-going.
- Simulation of images of distant galaxies
- Sample selection based on GOODS-S MUSYC catalogue
- Items to do in ~1 month:
  - Sensitivity with slit spectroscopy and IFS with different AO performances