Imaging of High-z galaxies with the ELT

Simulations: methodology, plan and examples

P.Rosati, M.Puech, S.Toft
(ESO)

DRM Workshop - May 21, 2008

Science Drives

- Obtain morphological information of primordial (z>4, up to ~10) galaxies to provide insights on mode and times scales of galaxy early assembly (sizes, SF densities, signs of interactions, AGN, etc.)
  - primordial galaxy are expected to be knotty (lensing observations, local LBGs, theory) ⇒ need ~10 mas resolution
- Detection limits of most distant galaxies (deep fields, depth vs area), high-z SNe etc.

➡ Investigate competition/synergy with JWST (nearIR imaging) by identifying ELT niche

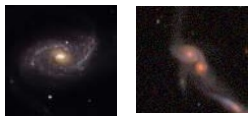
Single galaxy simulations: some examples

Method: M.Puech pipeline by projecting data cubes to produce continuum images ('Mass assembly' DRM case, Mathieu's talk)

Single galaxy simulations

M_s* galaxy at z=4, H_{AB}=24.3

Galaxy templates: HST/ACS images of z<~0.2 (late-type) galaxies

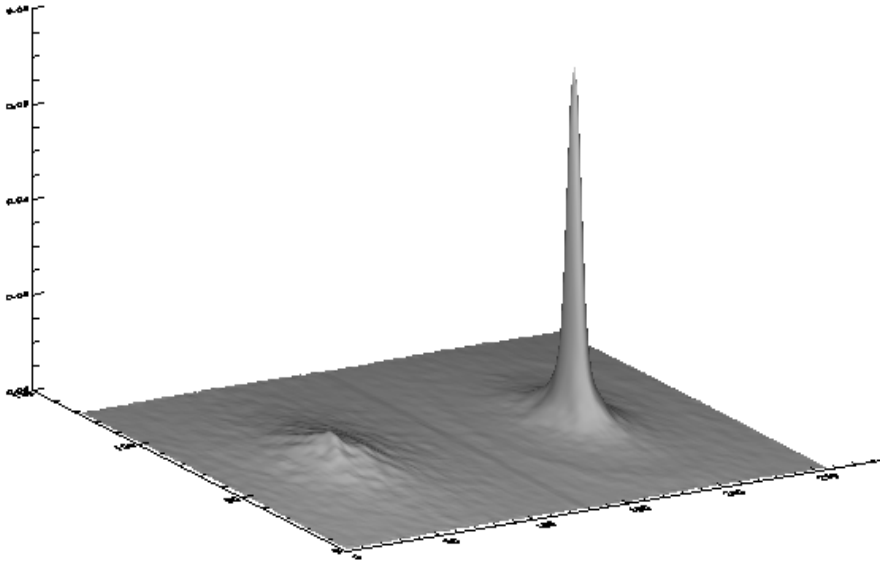


- pixel size allows suitable spatial resolution at z>~4
- H-band at z=4 probes rest-frame wl of ACS obs (no K-corr)

R_H(z,Ms) as in Spec simulations (Puech et al.)

Instrumemt params (default)

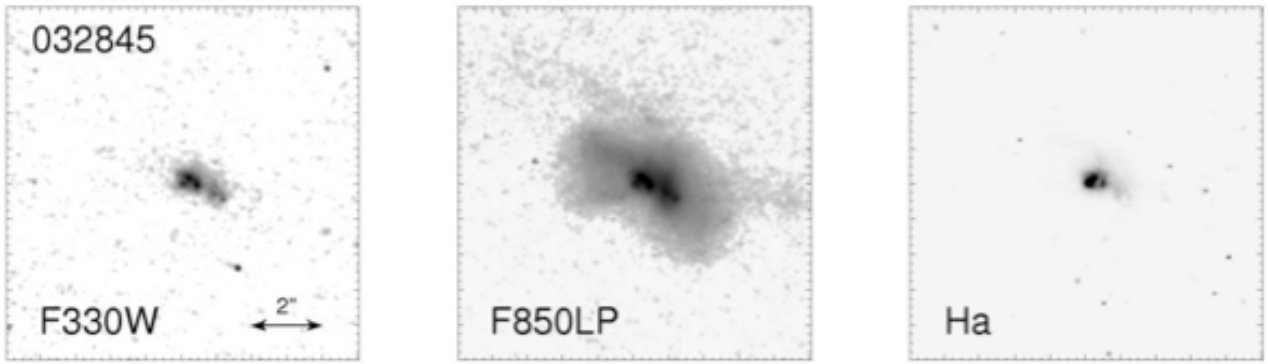
D=42m ExpTime=10h
Pixel=4, 30 mas
PSFs: MCAO (50% EE in 100mas pxl)
GLAO (10% EE in 100mas, FWHM≈0.2")
Sky=15.8 AB in H (continuum+OH), 10x lower between OH-lines (from Joe's plot/data) (incl. thermal bckgrd)

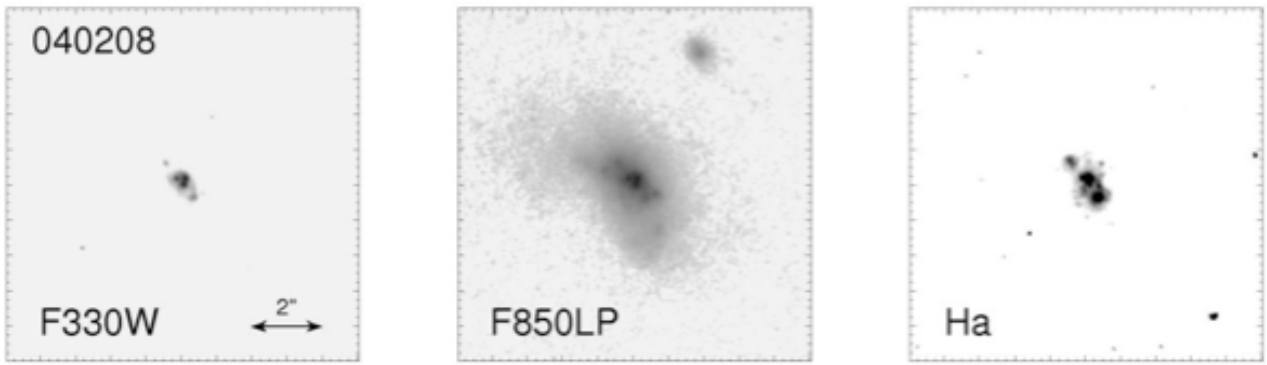


Overzier et al. 2008

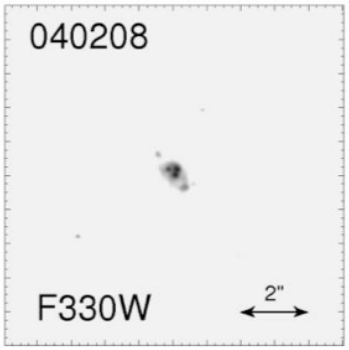
ACS follow-up of “super compact UV luminous galaxies” (UVLGs) by Heckman et al. (from GALEX + SLOAN), local analogs of z~3 LBGs

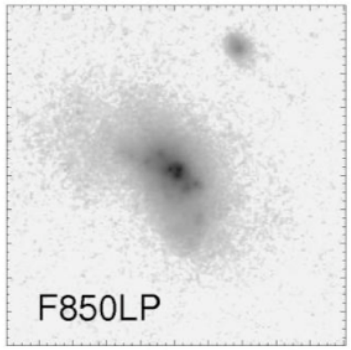
Galaxy	α (J2000.0)	δ (J2000.0)	z^a	UT Date	T_{exp} (s) FUV$_{150}$	U_{330}	Hα	V_{606}	z_{850}
SDSS J005527.46−002148.7	00 55 27.46	−00 21 48.7	0.167	2006 Nov 1	...	2514	2302	...	2238
SDSS J032845.99+011150.8	03 28 45.99	+01 11 50.8	0.142	2006 Oct 7	...	2514	2302	...	2238
SDSS J040208.86−050642.0	04 02 08.86	−05 06 42.0	0.139	2006 Oct 31	...	2514	2302	...	2238
SDSS J080844.26+394852.4	08 08 44.26	+39 48 52.3	0.091	2006 Oct 30	...	2541	2356	...	2211
SDSS J092600.41+442736.1	09 26 00.40	+44 27 36.1	0.181	2006 Nov 6	...	...	2340	...	2274
SDSS J102613.97+484458.9	10 26 13.97	+48 44 58.9	0.160	2006 Nov 22	...	2565	2354	...	2289
SDSS J135355.90+664800.5	13 53 55.90	+66 48 00.5	0.198	2007 Jan 4	...	2661	2468	...	2334
SDSS J214500.25+011157.6	21 45 00.25	+01 11 57.3	0.204	2007 Jul 10	2514	...	...	3600	...





LBG040208 z=4





ACS/HRC pxl at z=0.15 = 70pc □ 10 mas at z=4
H-band at z=4 □ 330 nm rest-frame
~M* at z=4 □ H_{AB}=24.3

JWST/NIRCam
F150W
32 mas/pxl

MCAO H-band

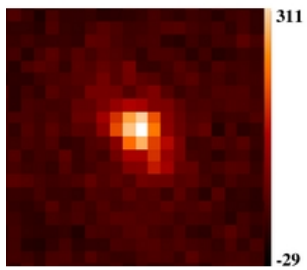
4 mas/pxl

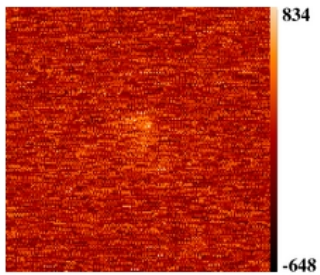
30 mas/pxl

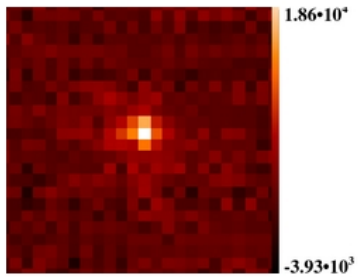
GLAO H-band

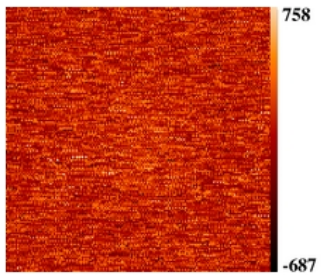
4 mas/pxl

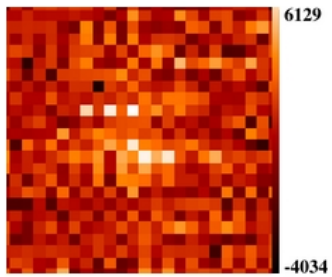
30 mas/pxl



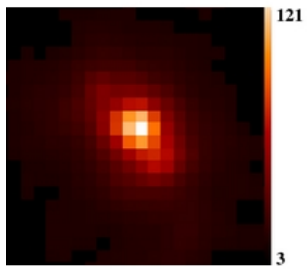


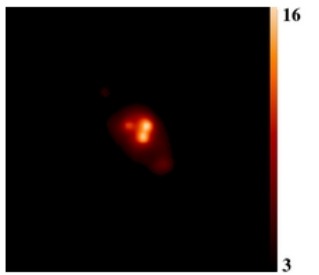


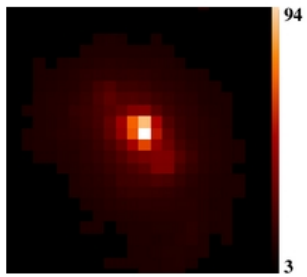


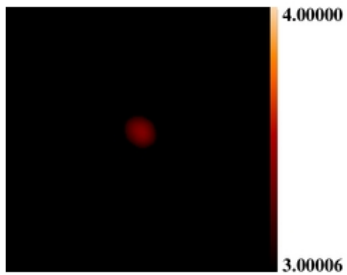


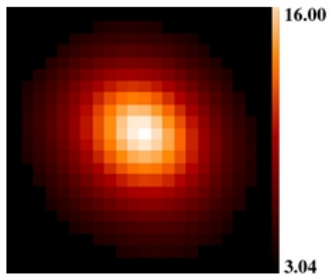
S / N m a p s





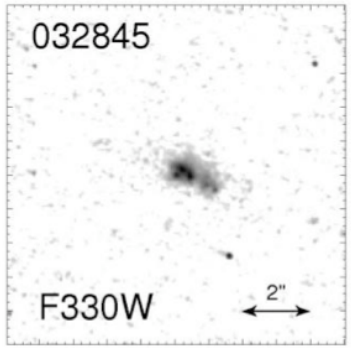


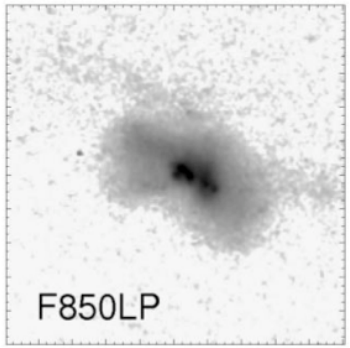




0.7“

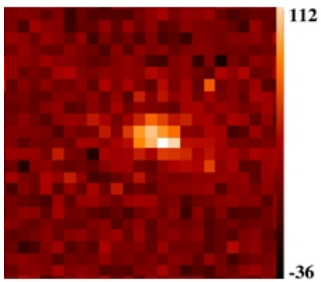
LBG032845 at z=4





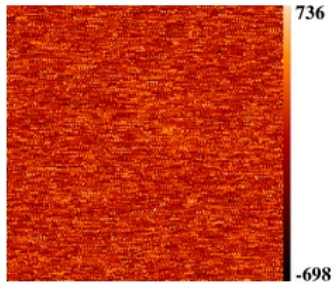
ACS/HRC pxl at z=0.15 = 70pc ⇒ 10 mas at z=4
H-band at z=4 ⇒ 330 nm rest-frame
~M* at z=4 ⇒ H_{AB}=24.3

JWST/NIRCam
F150W
32 mas/pxl

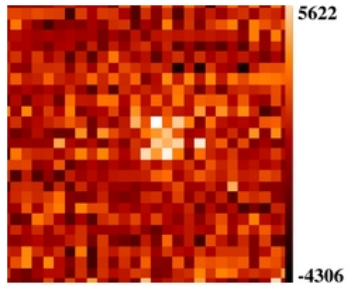


MCAO H-band

4 mas/pxl

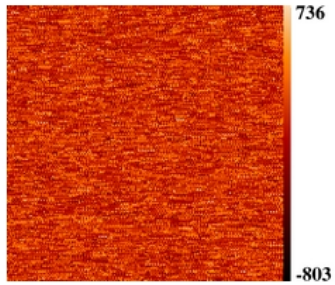


30 mas/pxl

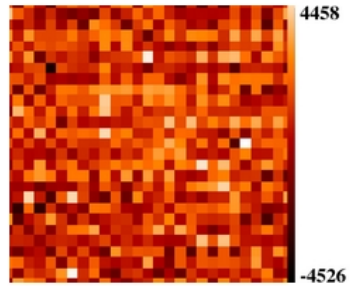


GLAO H-band

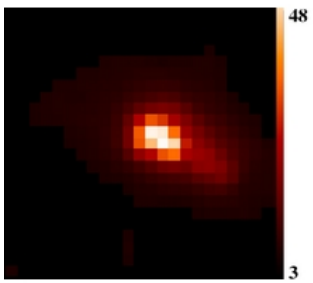
4 mas/pxl



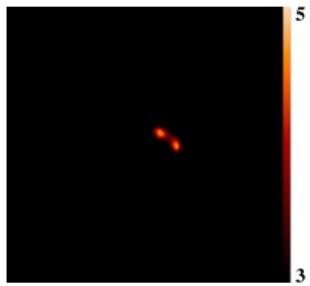
30 mas/pxl

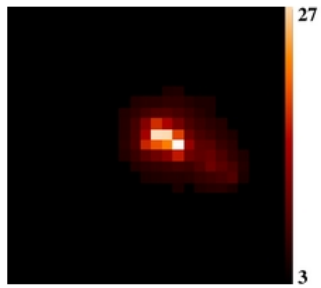


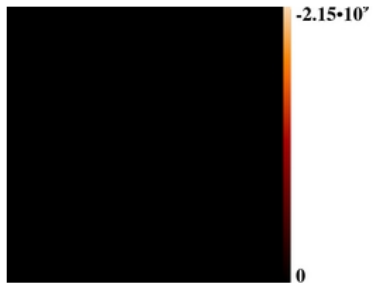
S / N m a p s

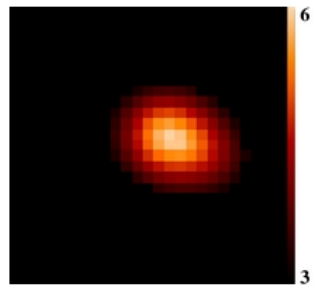


0.7“

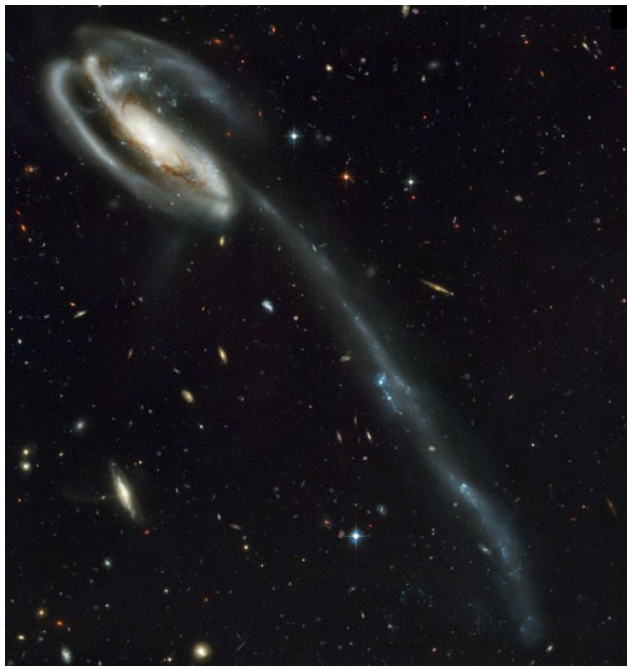








Tadpole at z=4



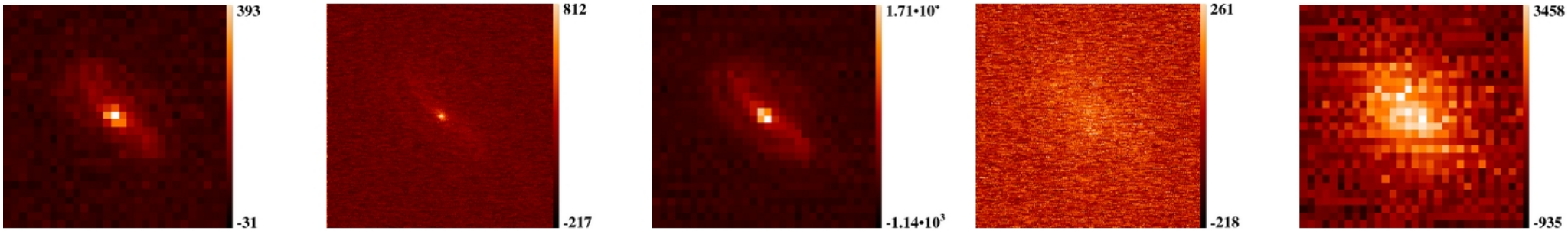
32 mas/pxl

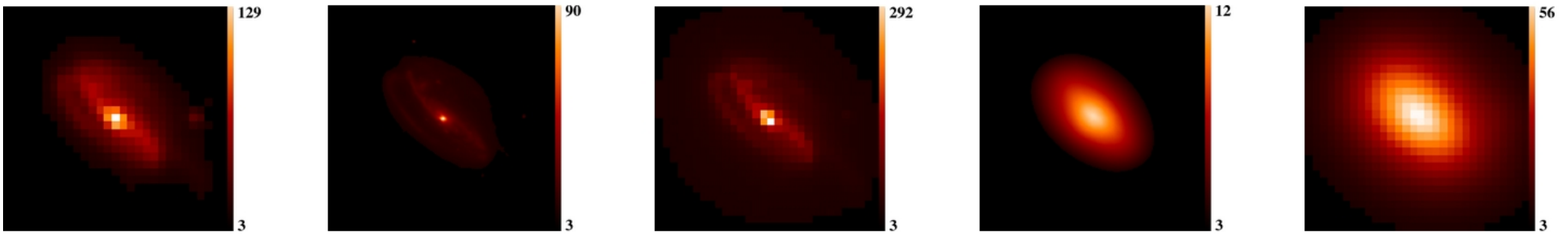
ACS/WFC pxl at z=0.03 = 30pc □ 4 mas at z=4
H-band at z=4 □ 330 nm rest-frame (≠obs 474 nm)
~M* at z=4 □ H_{AB}=24.3

MCAO H-band

GLAO H-band

OH suppression...





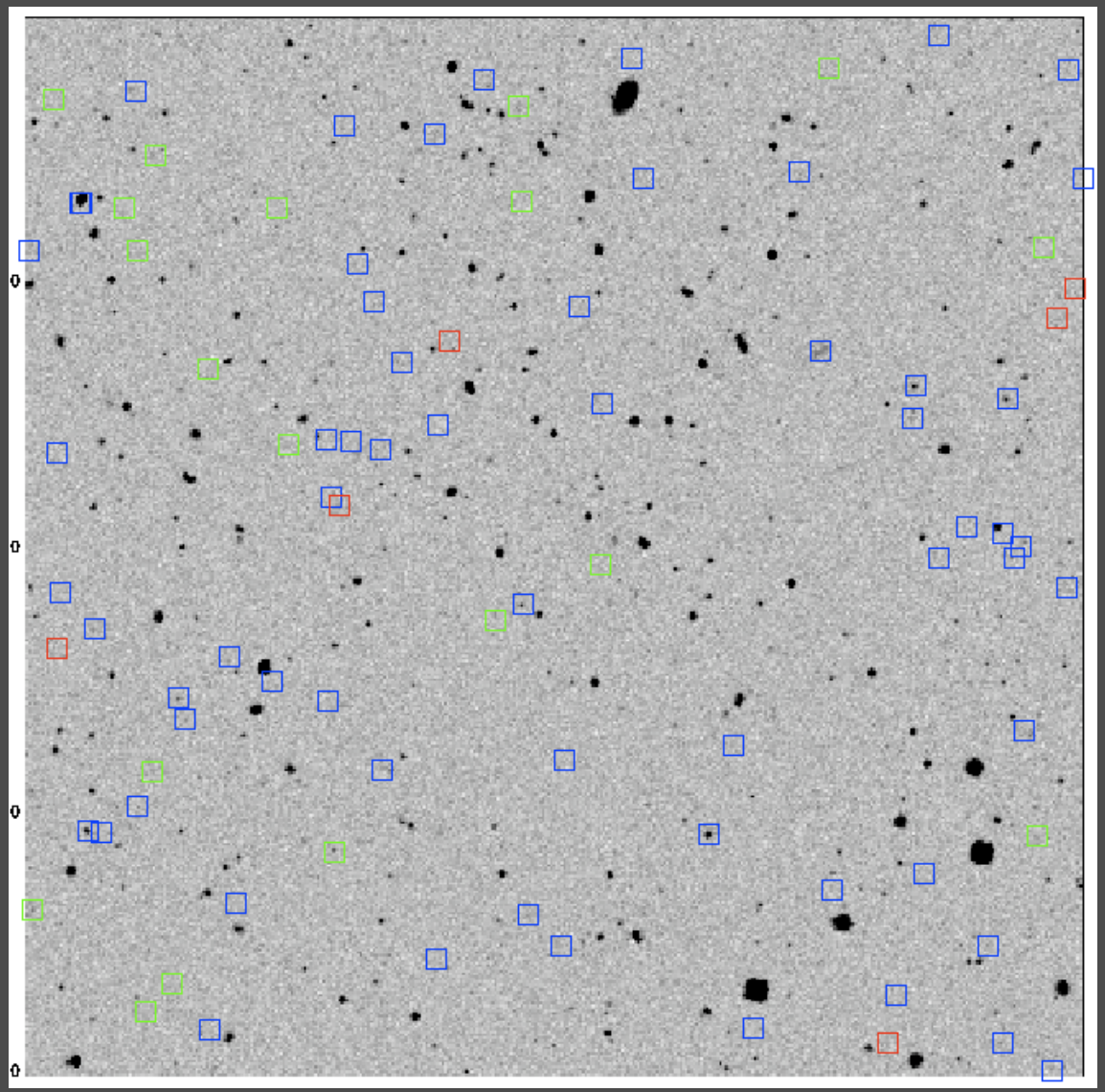
0.9“

Next...

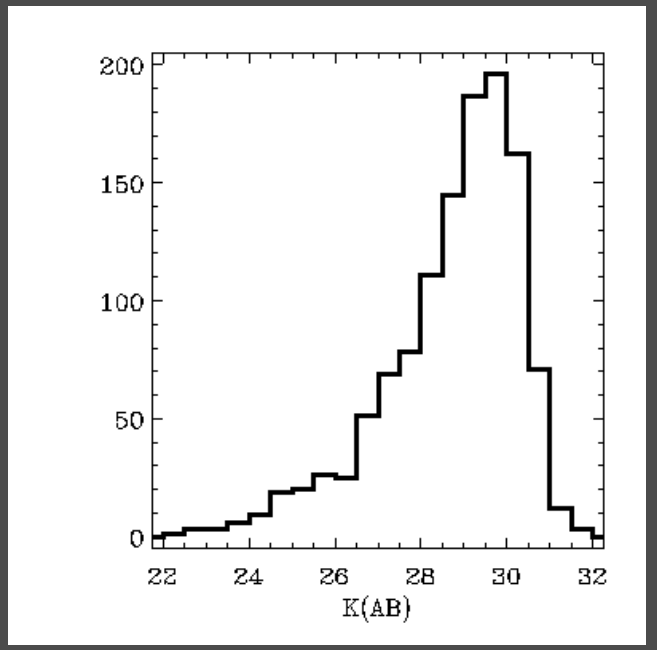
- Need an engine to simulate realistic deep fields
- Requirements:
  - Template galaxies should be constructed from real observations (typically HST images)
  - Should be computationally efficient
  - Simulations should match current observations in terms of number counts, colors, size distributions (z, type), number densities of most distant galaxies, etc.)
  - Publicly available and easy to customize/upgrade
- We considered two tools: BUCS (Bowuens et al.), Skylens Meneghetti et al.)

R.Bouwens, D.Magee: An Engine for Generating Realistic Imaging Data for Deep Galaxy Fields

"ELT" - 1 hr exposure K-band (FWHM=0.1", no GLAO PSF)



40"



Z > 9

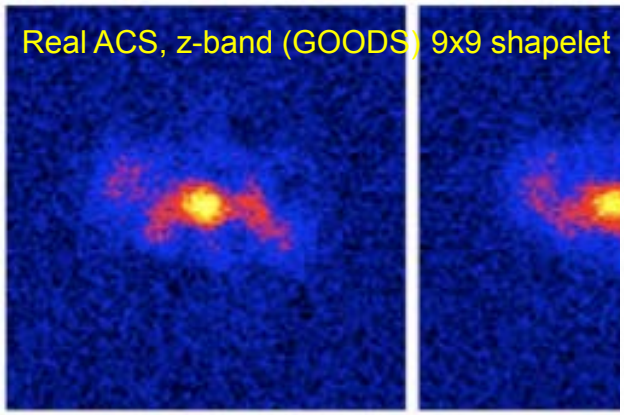
Z > 7

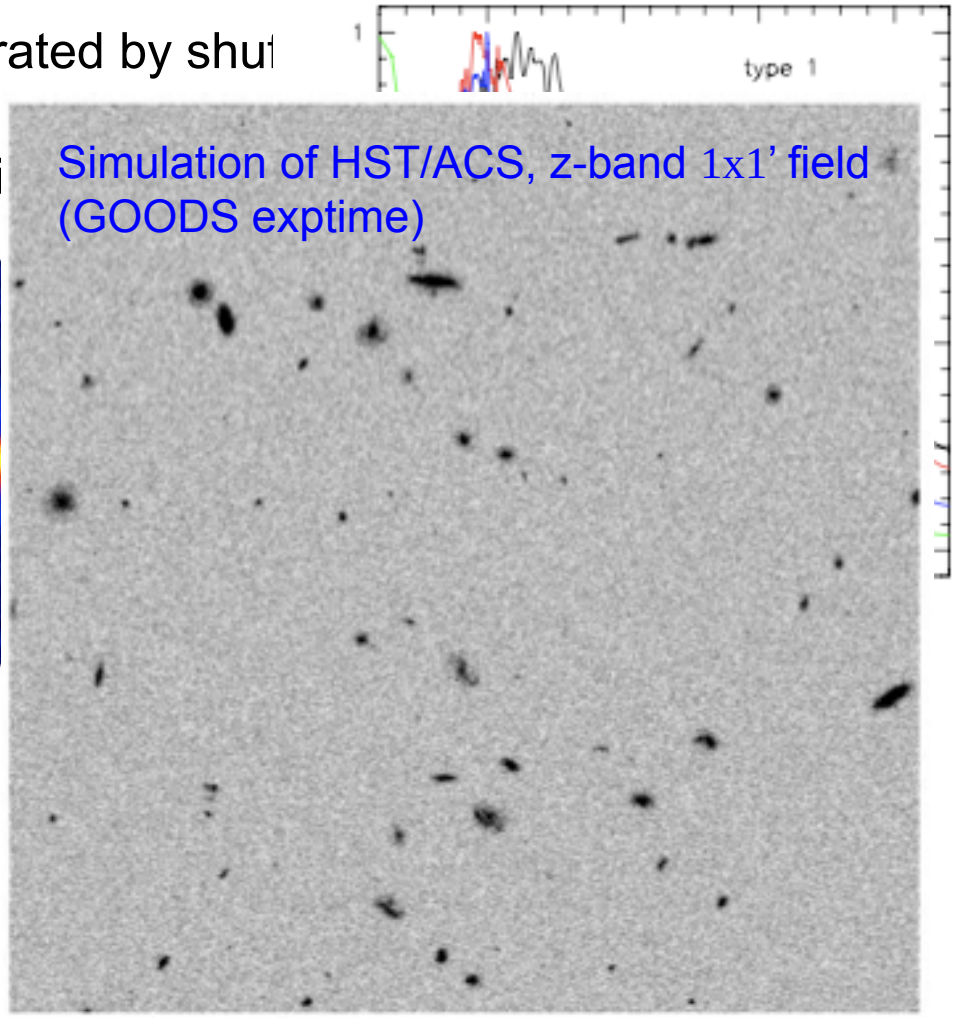
Z > 5

“Skylens”: a shapelet-based imaging simulator

Meneghetti, Grazian et al. 2008 (AA, 482, 403)

- Shapelets decomposition of a set of templates galaxies extracted fro GOODS/UDF-like ACS fields
- Observed LFs(z) for 4-galaxy types (SEDs)+extrapolations
- Size vs mag empirical relation
- Galaxies morphologies are generated by shuf coefficients in template library
- Reproduce number counts and si HST deep fields
- Used





Plan ahead

- Sanity/consistency checks on-going (ETC, ISAAC obs, MAD deep field)
- Adapting skylens (Meneghetti, Grazian) to ELT case
- Producing deep fields and analyze them (photometric accuracy, morphological params)
- Study trade-offs of instrumental params to maximize synergy with JWST/NIRCam (OH suppression techniques would help..)