The Physics and Mass Assembly of Galaxies

First Simulations

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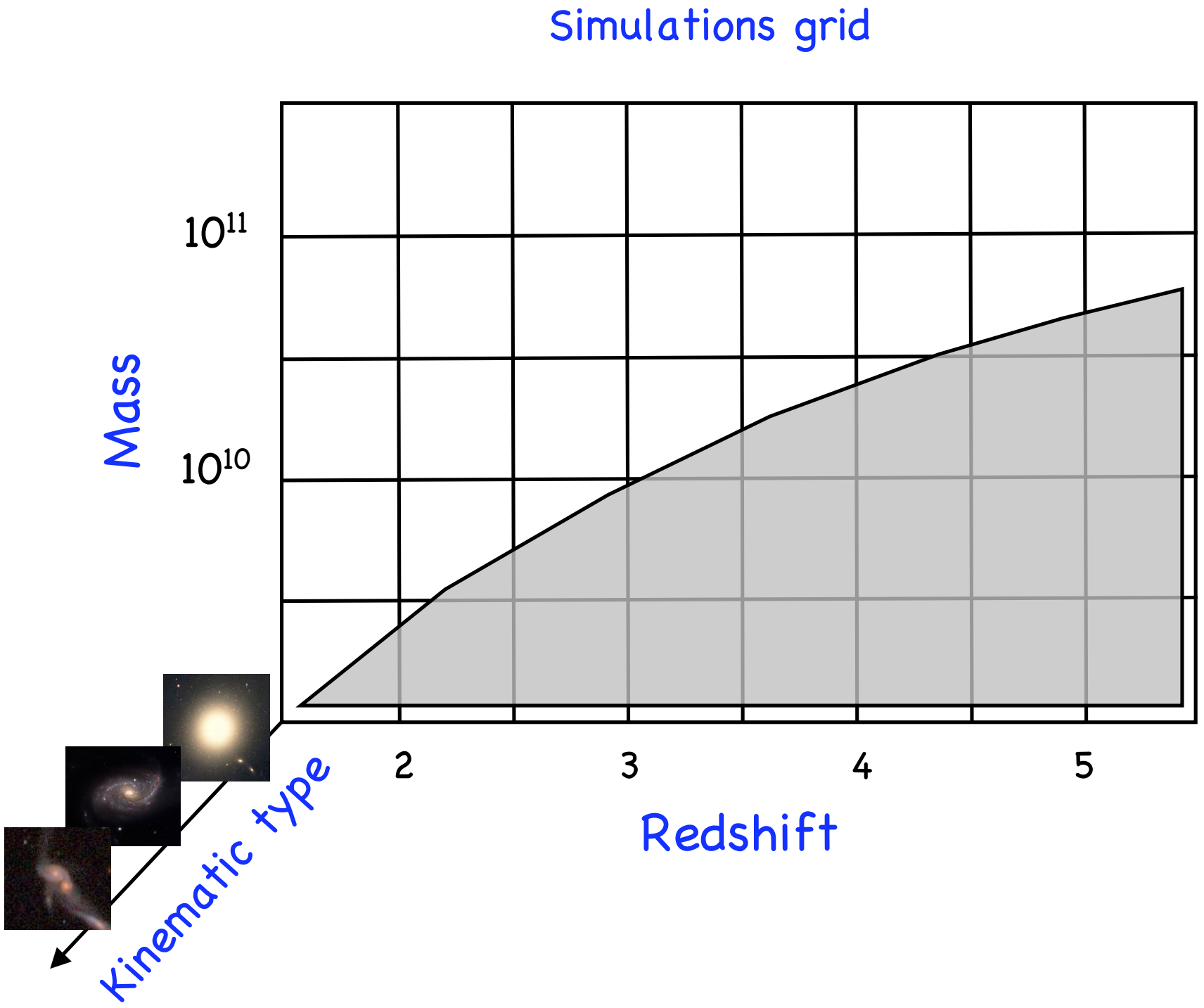
ELT SWG meeting - April 1-2, 2007

Science Goals

- **Provide the ultimate test of galaxy formation theories**
- Spatially resolved spectroscopy of a sample of ~1000 massive galaxies at $2<z<\sim5$
  - direct kinematics of stars and gas in the first generation of massive galaxies in the range $0.1<M_{star}<5\times10^{11}\ M\odot$
  - dynamical masses, ages, metallicities
  - differential evolution of disk and spheroidal components as a funct. of z
  - physical channels of mass assembly from since $z\sim5$


Simulations grid
Mass
10^{11}
10^{10}
2
3
4
5
Redshift
Kinematic type

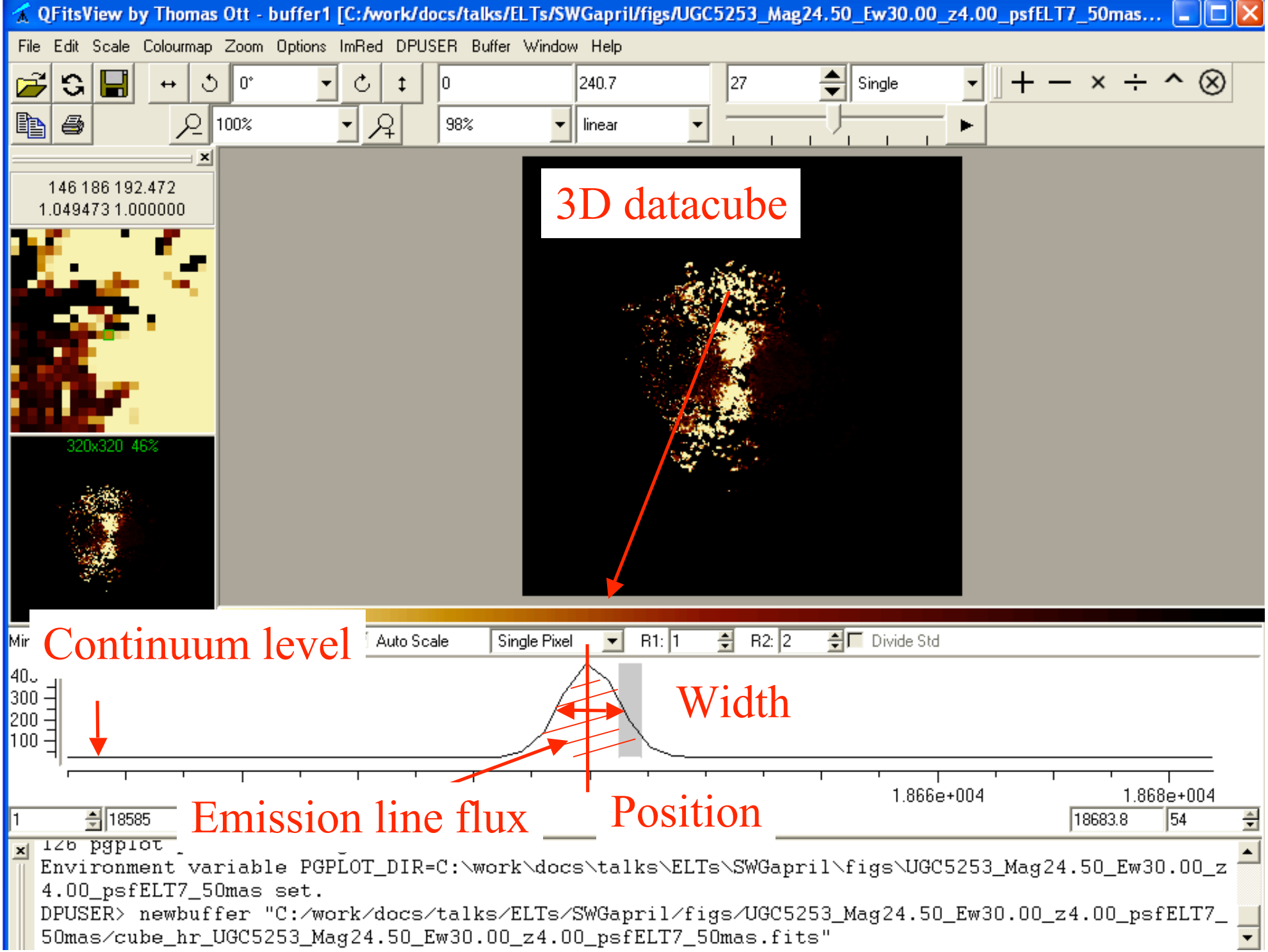
Method

- Input for 3D Spectroscopy simulations (**Mathieu P.**)
  - **(M, z)** ➔ K_{AB} and Σ(gals/arcmin^2) from observed n(M,z), n(L_{UV},z) + **V(x,y)** from kinematic observations of local galaxies or models
  - **PSFs** for a given AO case (from Joe L.) + spatial/spec sampling
  - **Sky** spectrum (site?)

- Output of simulations: Velocity maps, line/continuum imaging

- Analysis of simulations (to be done)
  - Velocity gradients, rotation curves
  - Kinematic classifications (mergers vs disks vs in/outflows)
  - Dynamical masses, R_e, SF rates, dust extinction maps
  - Figures of merit + diagnostic diagrams (Tully-Fisher relations, etc..)
  - Scaling relations for early-type galaxies for modest AO performance?

- Requirements on AO trade-offs, spatial sampling, telescope diameter, spec.resolution, multiplexing, FoV, ...


QFitsView by Thomas Ott - buffer1 [C:/work/docs/talks/ELTs/SWGapril/figs/UGC5253_Mag24.50_Ew30.00_z4.00_psfELT7_50mas...
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146 186 192.472
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3D datacube
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R1: 1
R2: 2
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Emission line flux
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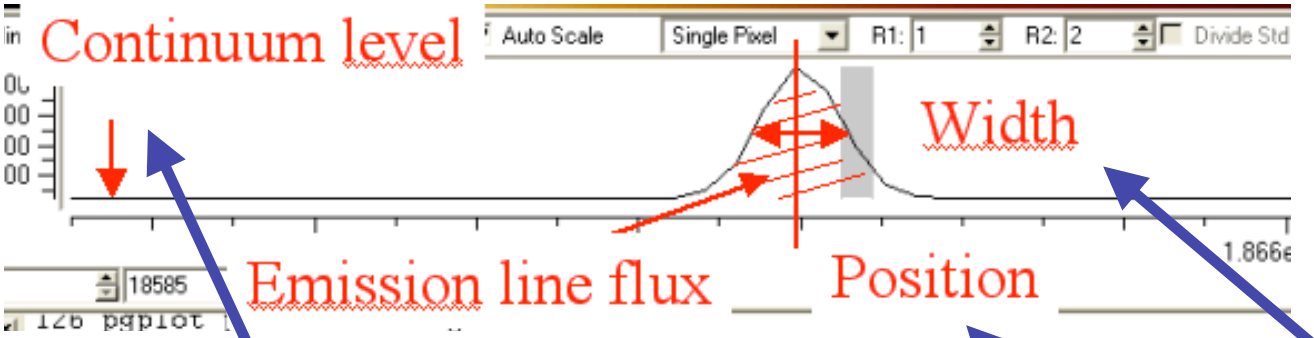


Continuum map

Emission line Flux map

Velocity field

Velocity Dispersion map

Fabry-Perot

Observations

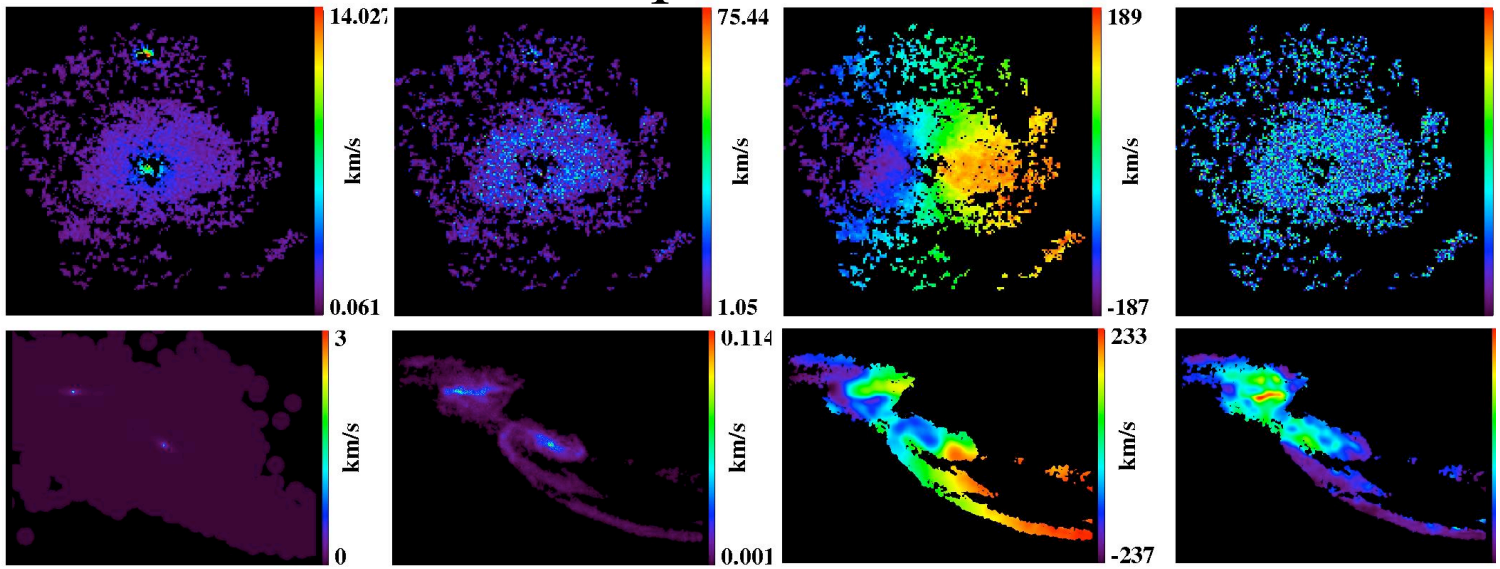
(GHASP-Amram et al.)

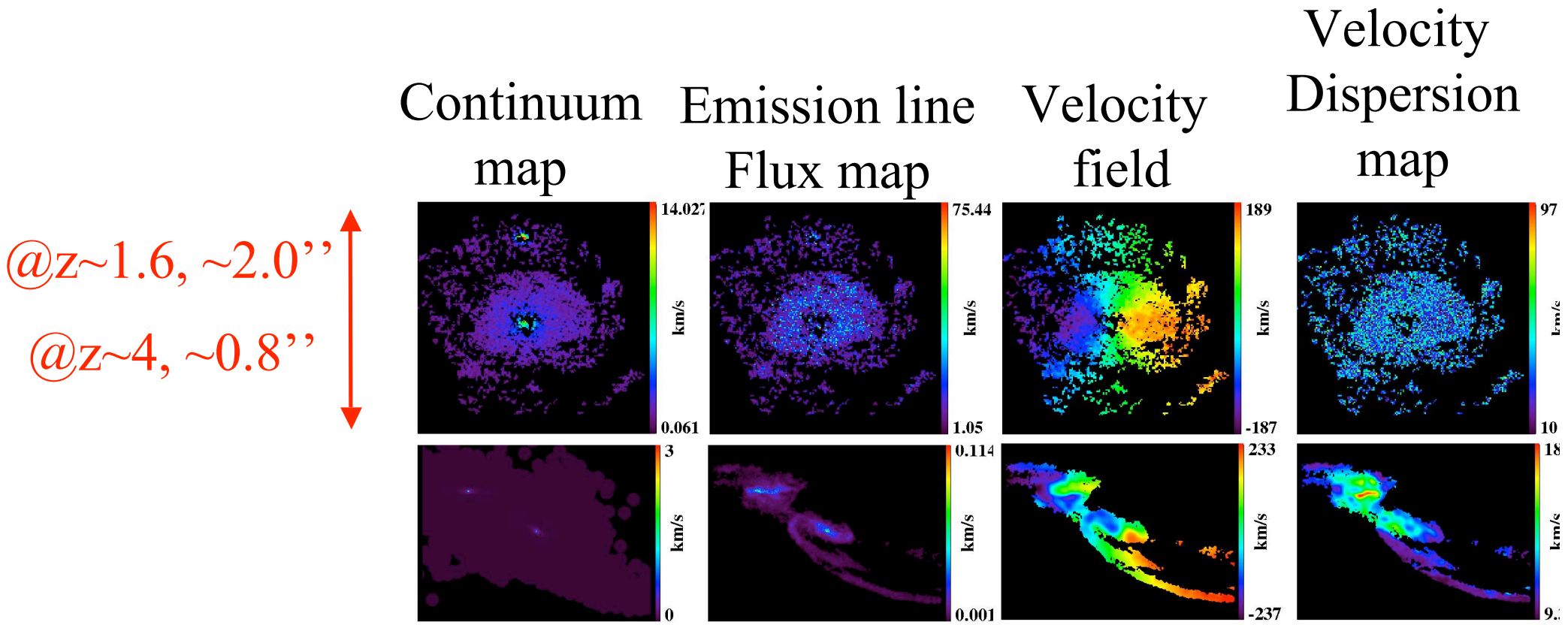
OR

Hydro (SPH)

Simulations

(Cox, Dekel et al.)

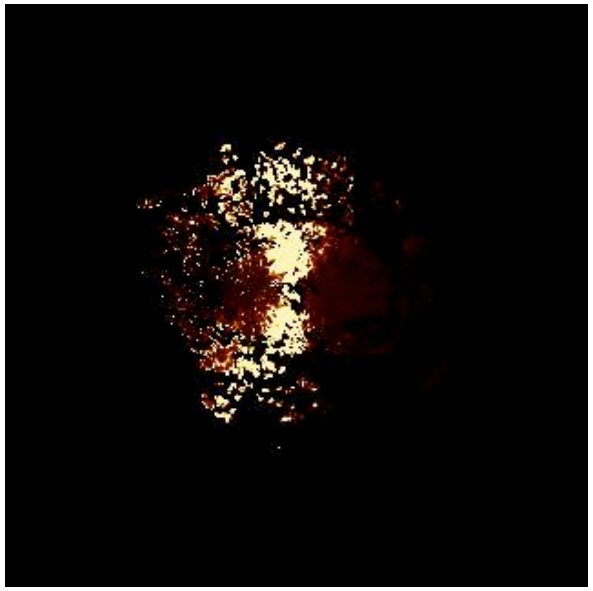




Just need to rescale these maps in terms of:
-size: typical size of distant galaxies (Bouwens et al. 2004,…)
-flux: continuum integrated magnitude & EW of the emission line

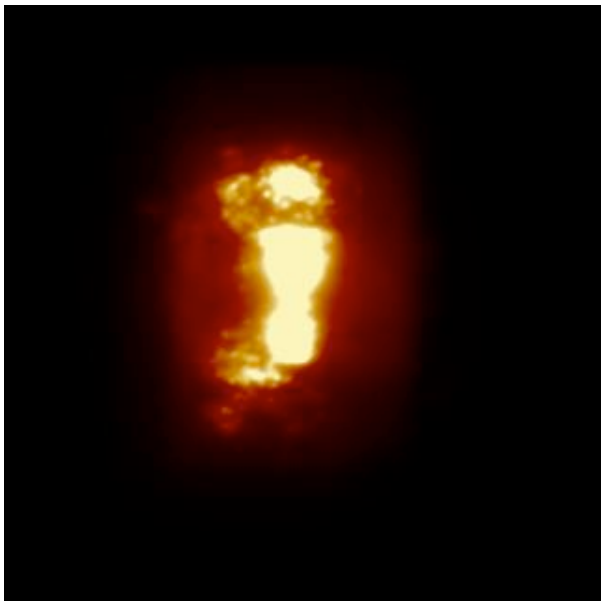
@ z~1.6: $m_{AB}(H)=22.5$ & EW(Hα)~50Å

@ z~4: $m_{AB}(H)=24.5$ & EW([OII])~30Å

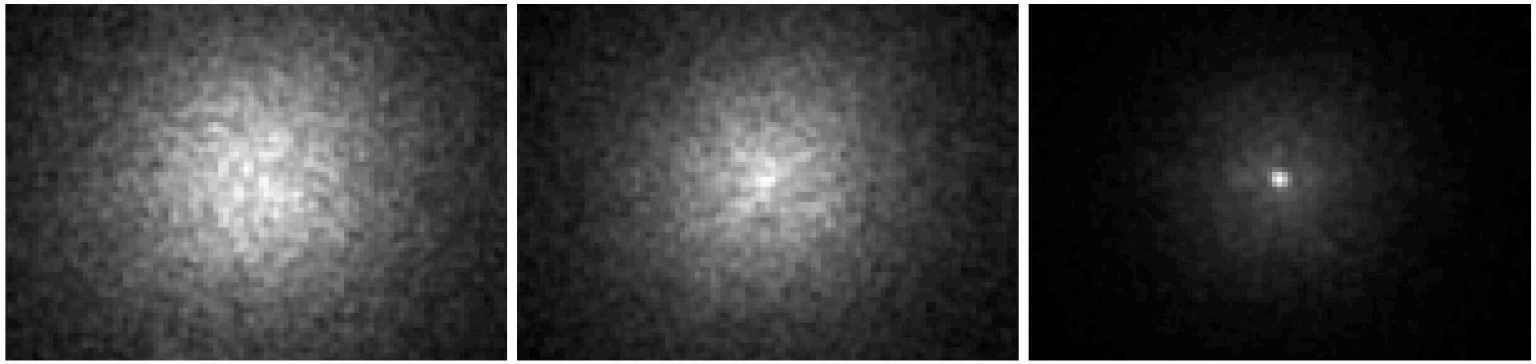


3D datacube

P.S.F.



3D datacube



Different PSFs with increasing Ensquared Energy

Here: MOAO PSFs (Fusco, Neichel et al.; ONERA)

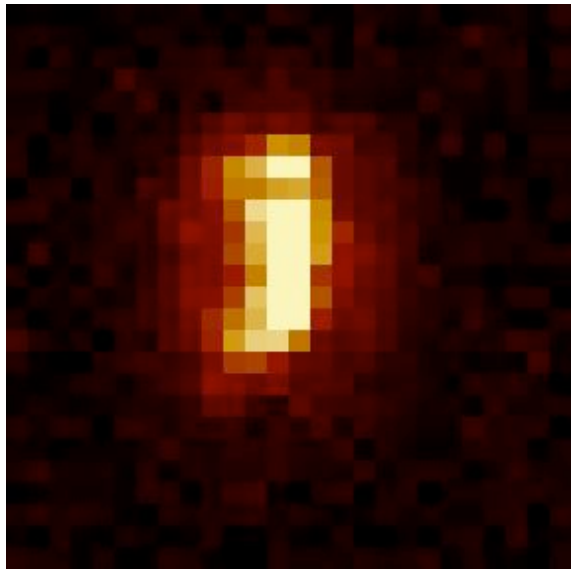
EE	Pitch	FoV_{WFS}
12	1.00	4.00
13	1.00	3.00
15	1.00	2.00
21	1.00	1.00
24	1.00	0.50
32	1.00	0.25
33	1.00	0.00
37	0.75	0.00

Parameter	Value
$M1$	42 m
$M2$	0 m
R	5000
Δ_{pix}	0.050"
t_{transm}	0.2
CTE	1
p	4000x4000/4
$dark$	0.01 e/sec/pix
ron	2.3 e/pix
dit	3600 s
m_{AB}	24.5 mag
EW	30 Å
λ_{em}	3727 Å
S	0.8"
z	4.0

✓ sky subtraction

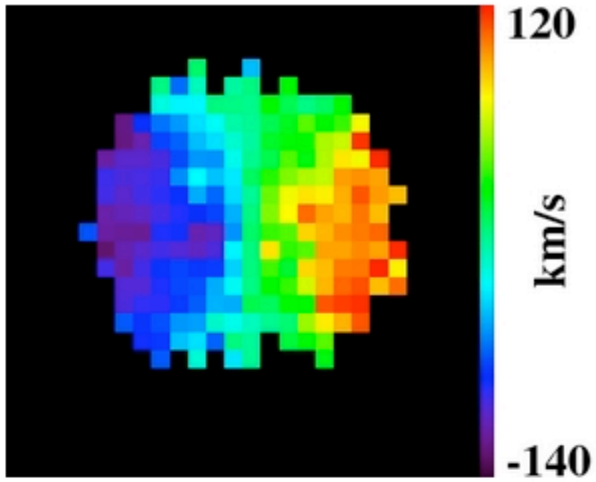
✓ atm. Abs.

✓ Readout noise,dark, etc.

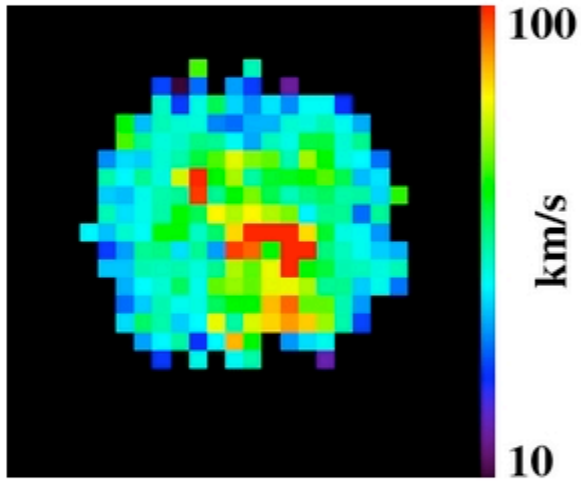


3D datacube
« IFU data »

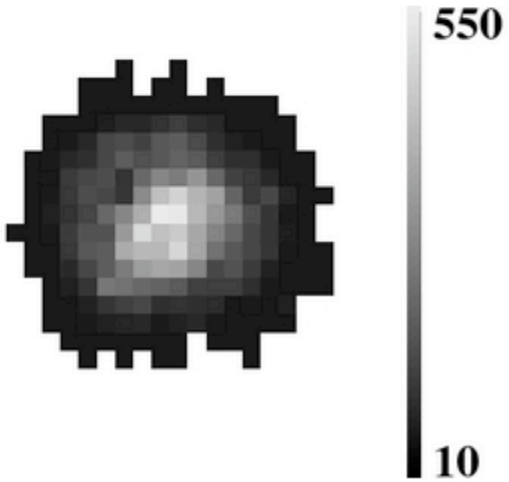
V.F.

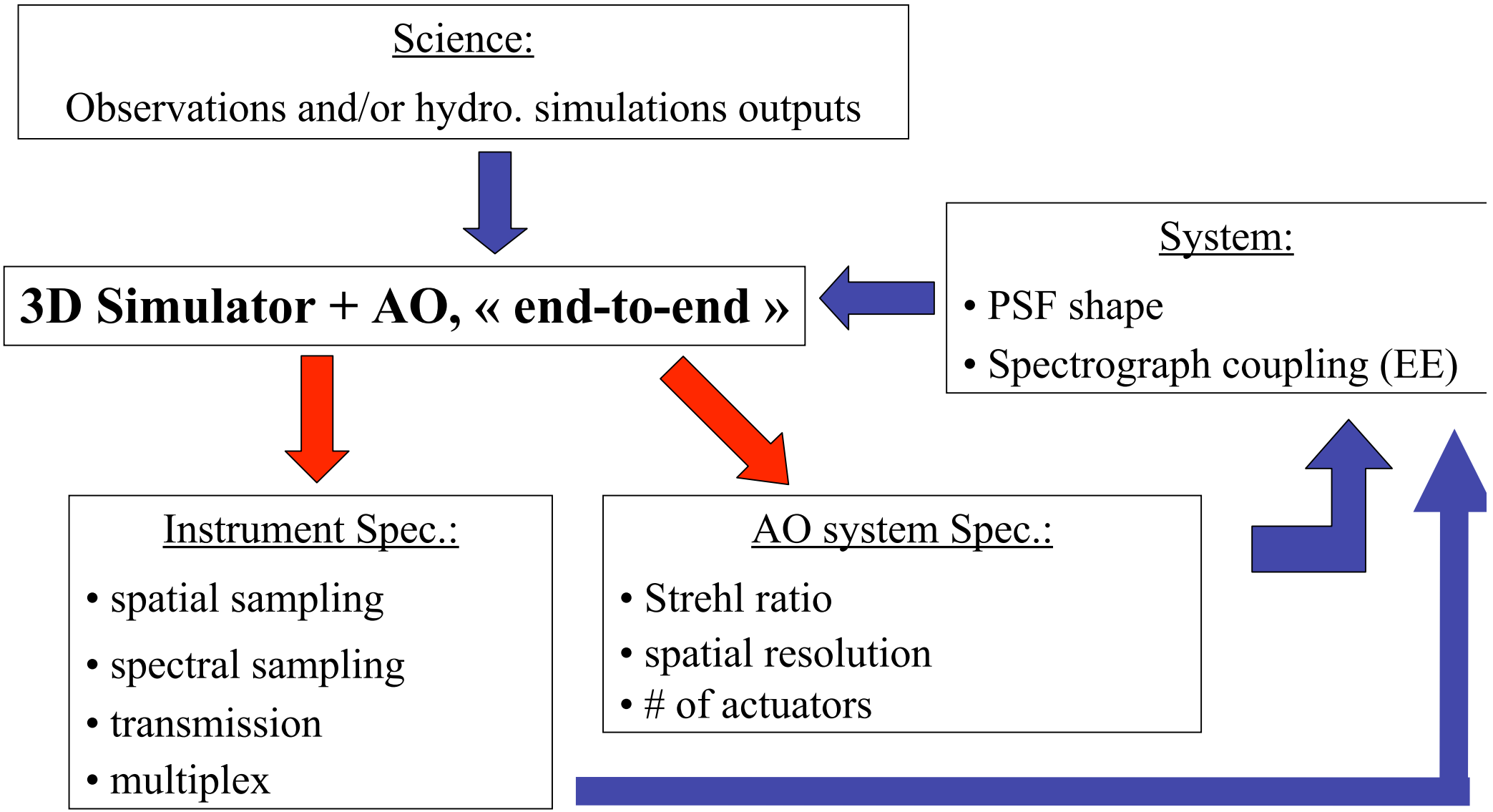


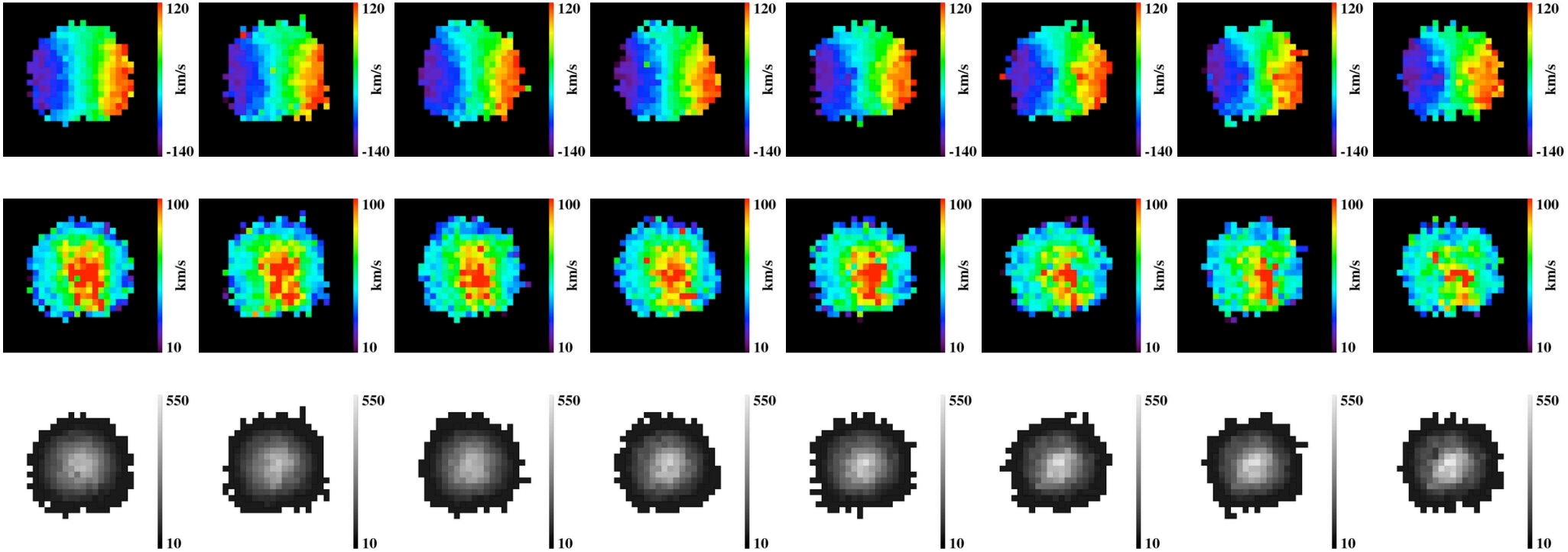
σ map



Emission line flux map



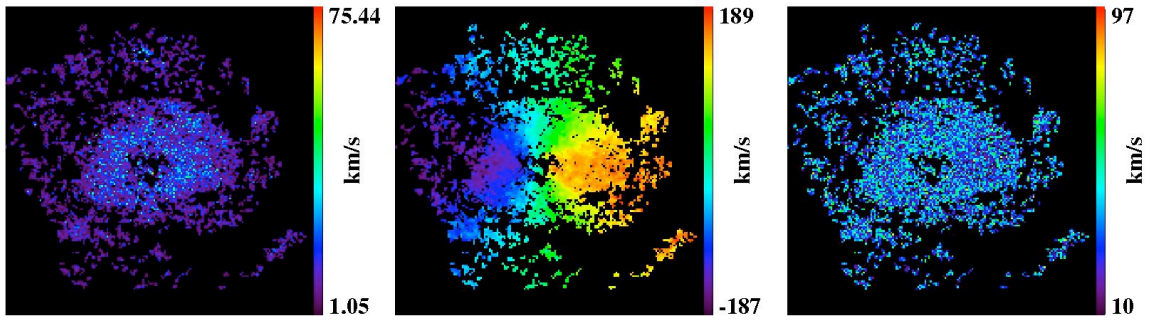

Science:
Observations and/or hydro. simulations outputs
3D Simulator + AO, « end-to-end »
System:
• PSF shape
• Spectrograph coupling (EE)
Instrument Spec.:
• spatial sampling
• spectral sampling
• transmission
• multiplex
AO system Spec.:
• Strehl ratio
• spatial resolution
• # of actuators
Scientific goal: mass assembly driver,

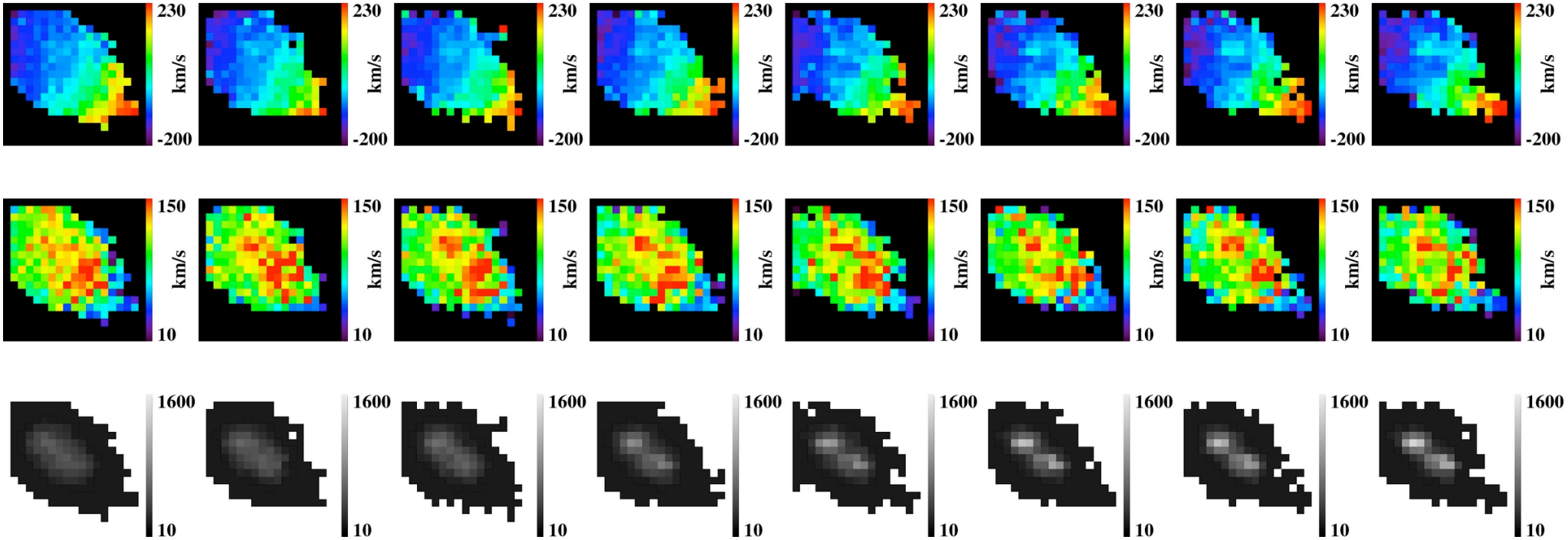


z=4 ; Rotating Disk; 50 mas/pix

Tintg=200hr

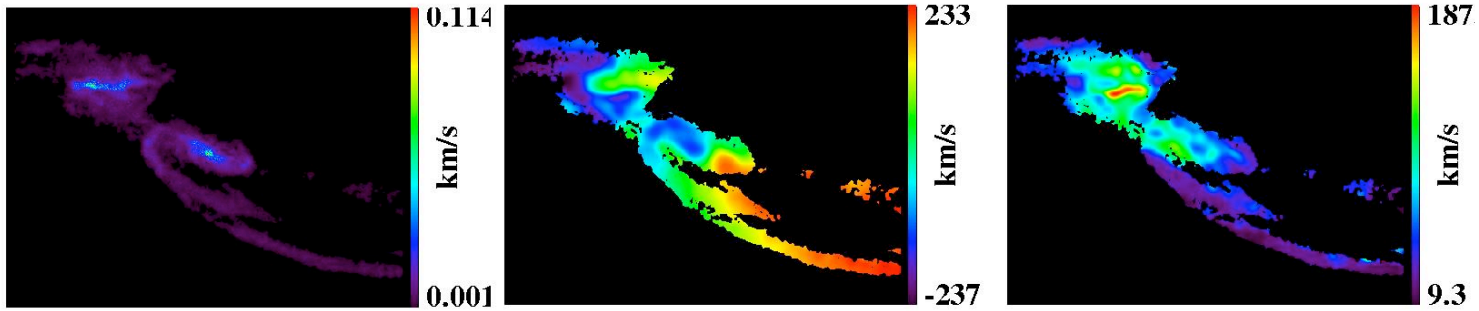
z~0





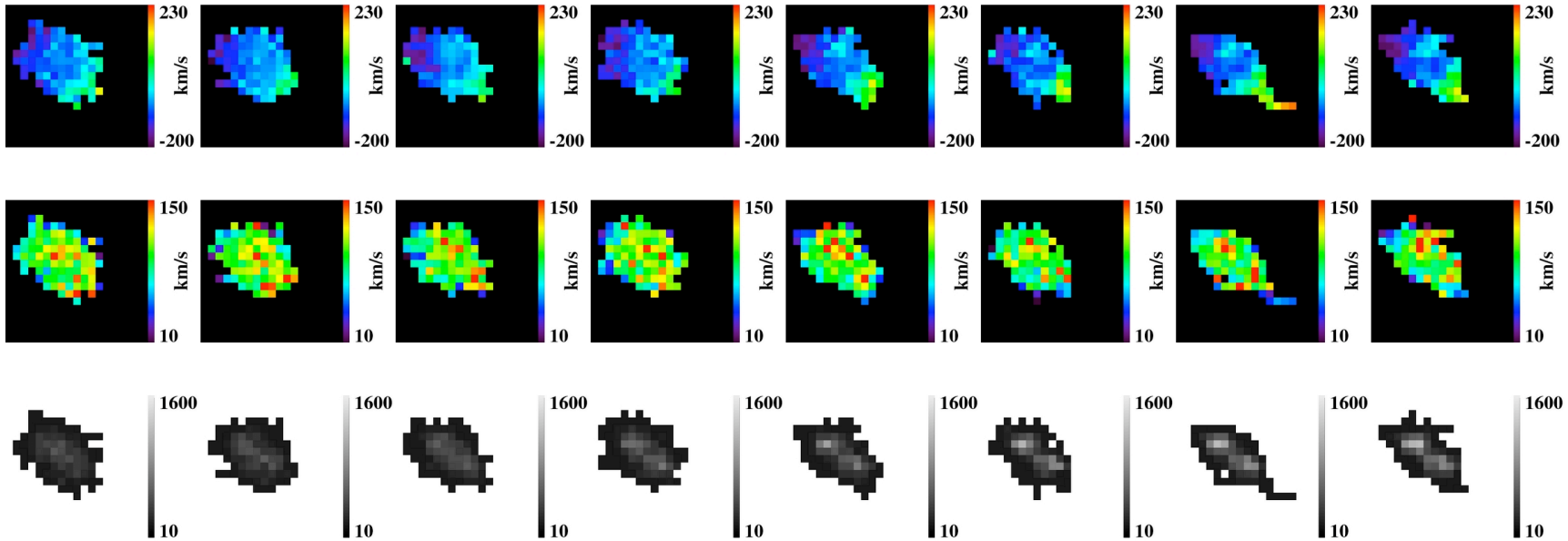
z=4 ; Ongoing major merger; 50mas/pix Tintg=200hr

z~0



Pixel size ? z=4 Tintg=24hr

50mas/pix



75mas/pix

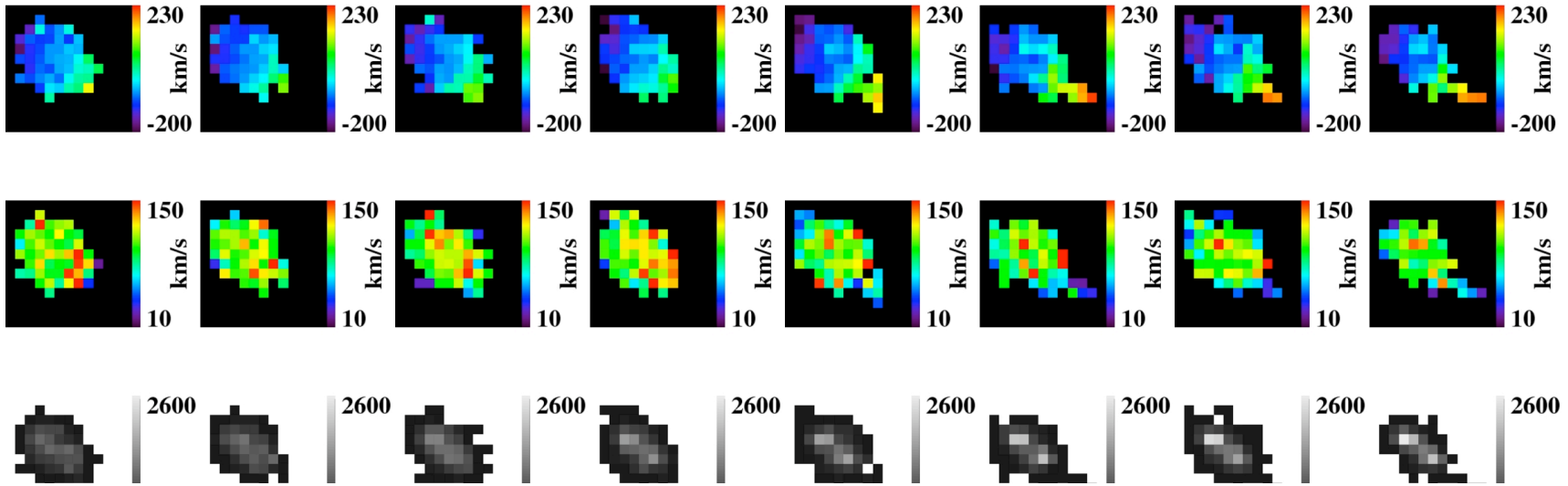
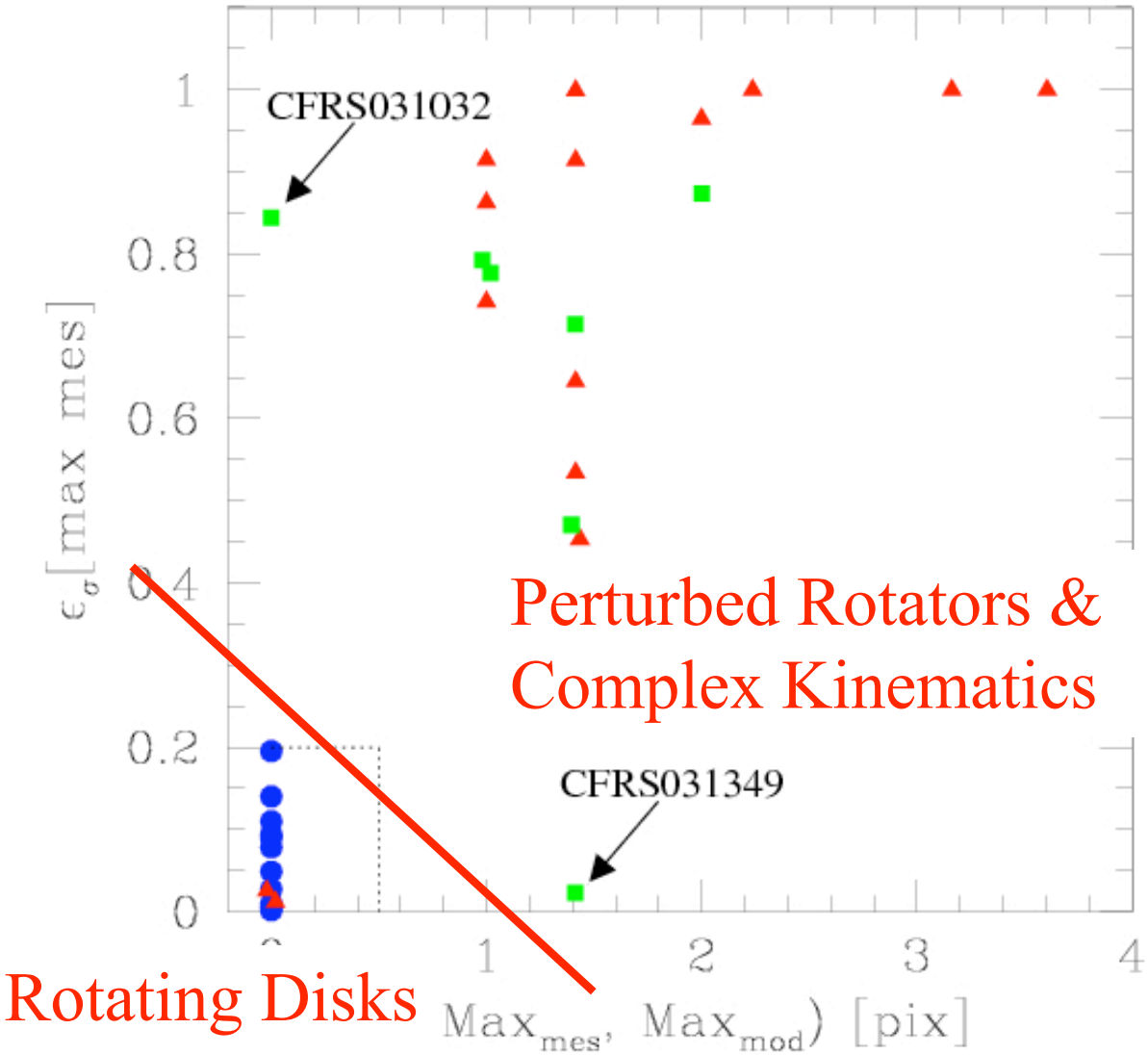


Figure of merit to separate rotating disks from major mergers

GIRAFFE (Flores et al. 2006): 6x4, 0.52''/pix IFUs



Need to be adapted to the E-ELT case (more pixels)

➔ on-going work