Is a MUSE-like instrument feasible for the E-ELT ?

Roland Bacon

CRAL

Shaping E-ELT Science and Instrumentation

ESO Munich, Feb 2013

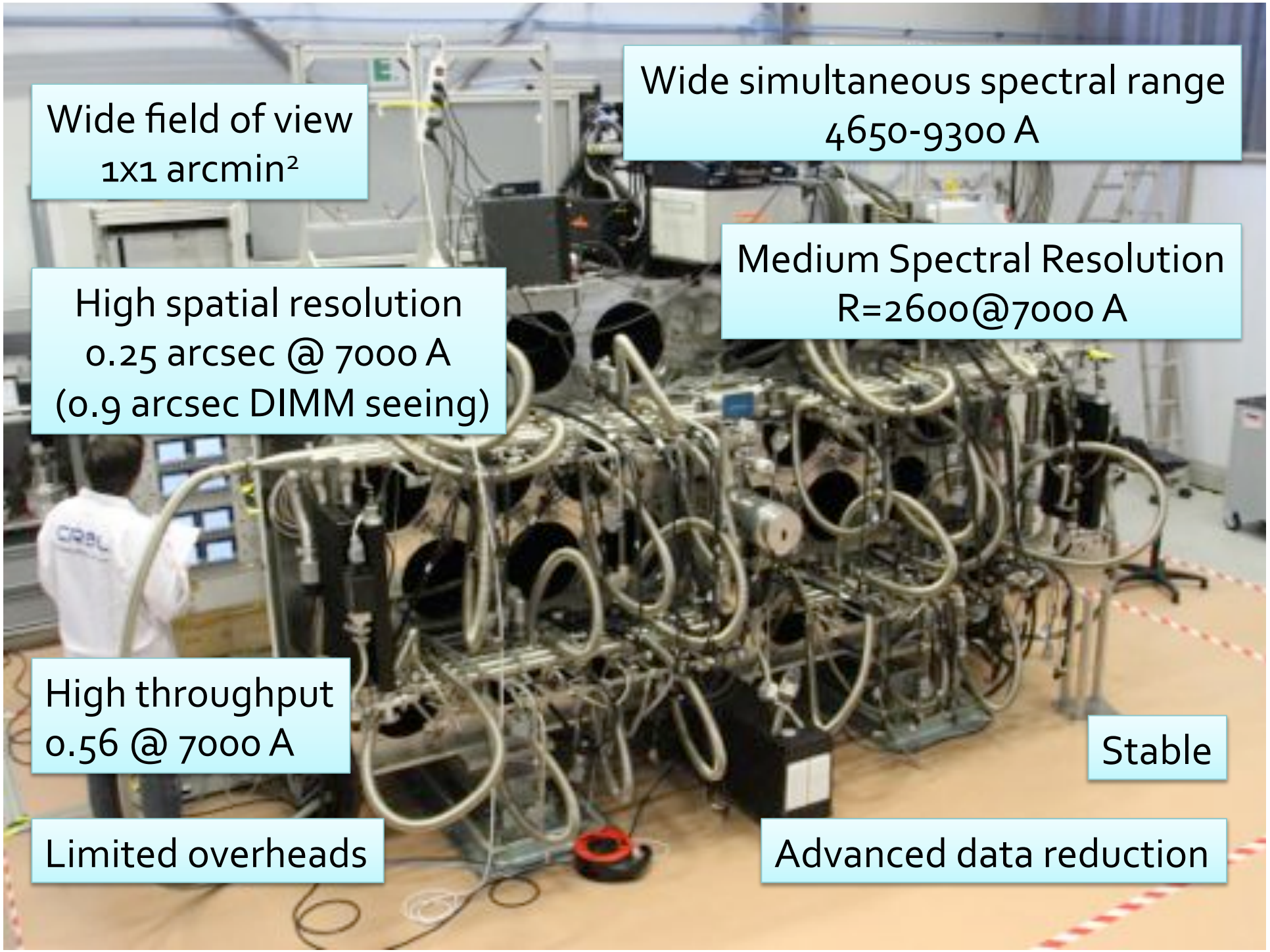
No

Thank you for your attention

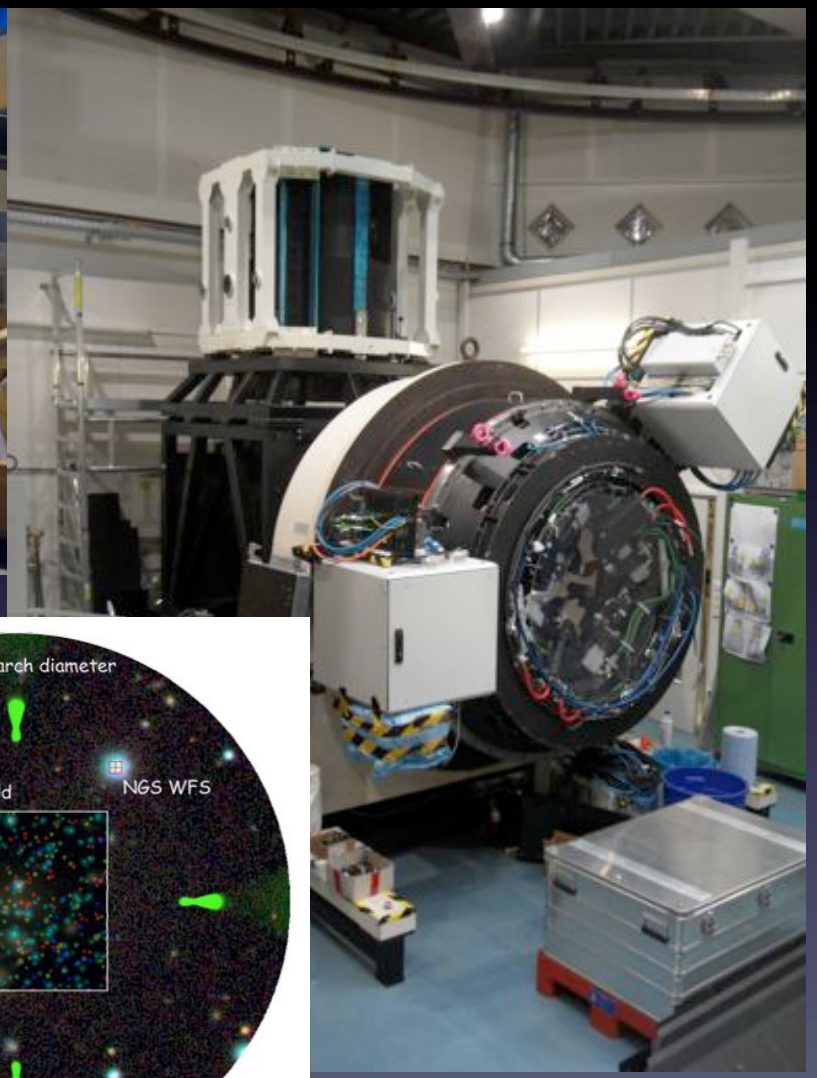
Outline

- MUSE main characteristics
- Why an E-ELT large field IFU is desirable ?
- Is it feasible and affordable ?
- Conclusions

MUSE MAIN CHARACTERISTICS


Wide field of view
1x1 arcmin²
Wide simultaneous spectral range
4650-9300 A
Medium Spectral Resolution
R=2600@7000 A
High spatial resolution
0.25 arcsec @ 7000 A
(0.9 arcsec DIMM seeing)
High throughput
0.56 @ 7000 A
Stable
Limited overheads
Advanced data reduction

AOF@UT4 & Galacsi



DSM thin shell:

- 1120 mm diameter
- 2 mm thickness
- 1170 actuators

4 Laser guide stars

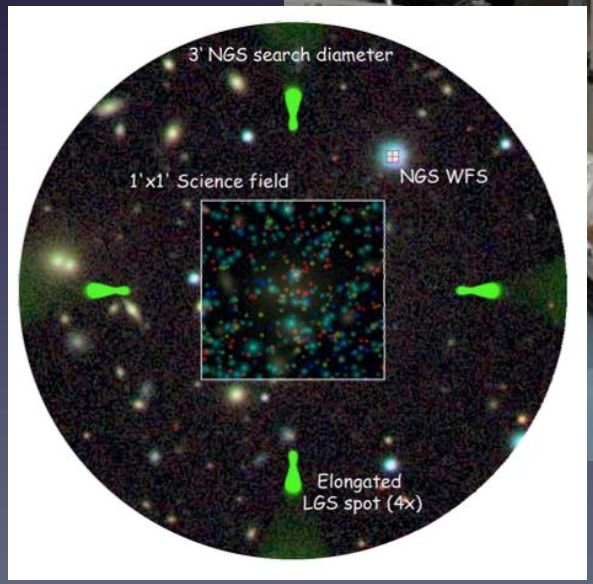
- 5-10 W

GLAO mode (WFM)

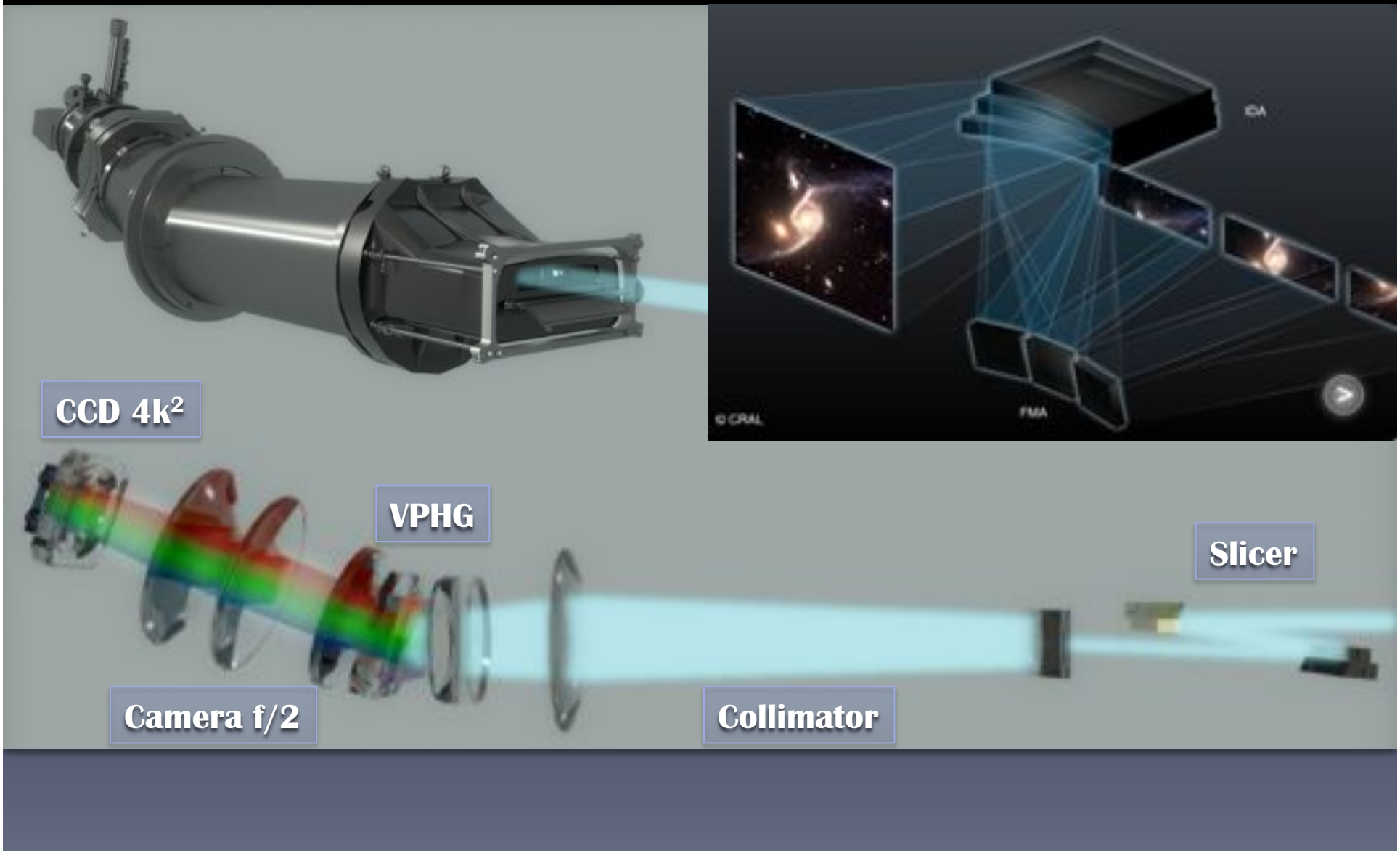
- x 2 energy gain in 0.2x0.2 arcsec^2

LTAO mode (NFM)

- 5% Strehl ratio @ 6500 A



IFU x 24



Slicer x 24

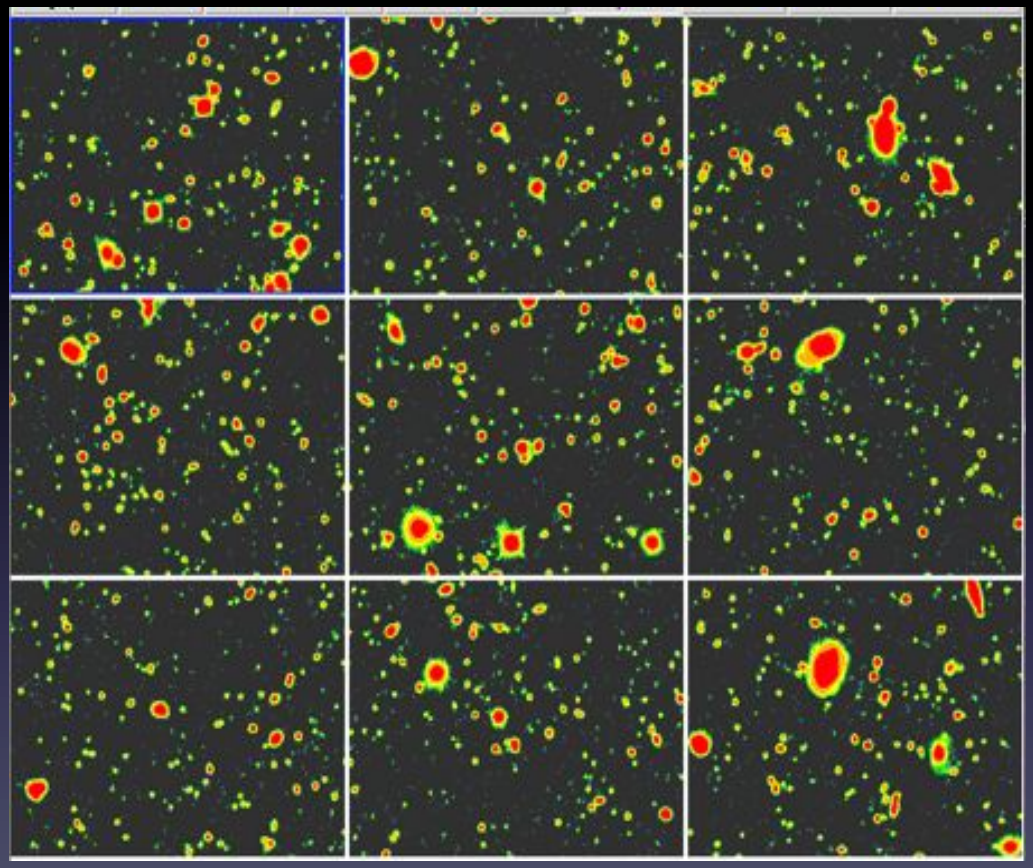
FMA: 4 stack of 12 off axis spherical mirrors 6x2 mm elliptical aperture

IDA: 4 stack of 12 off axis spherical mirrors 33x0.9 mm rectangular aperture

Winlight Optics

WHY AN E-ELT LARGE FIELD IFU IS DESIRABLE ?

Wide field IFU or MOS ?



3x3 arcmin^2 UDF

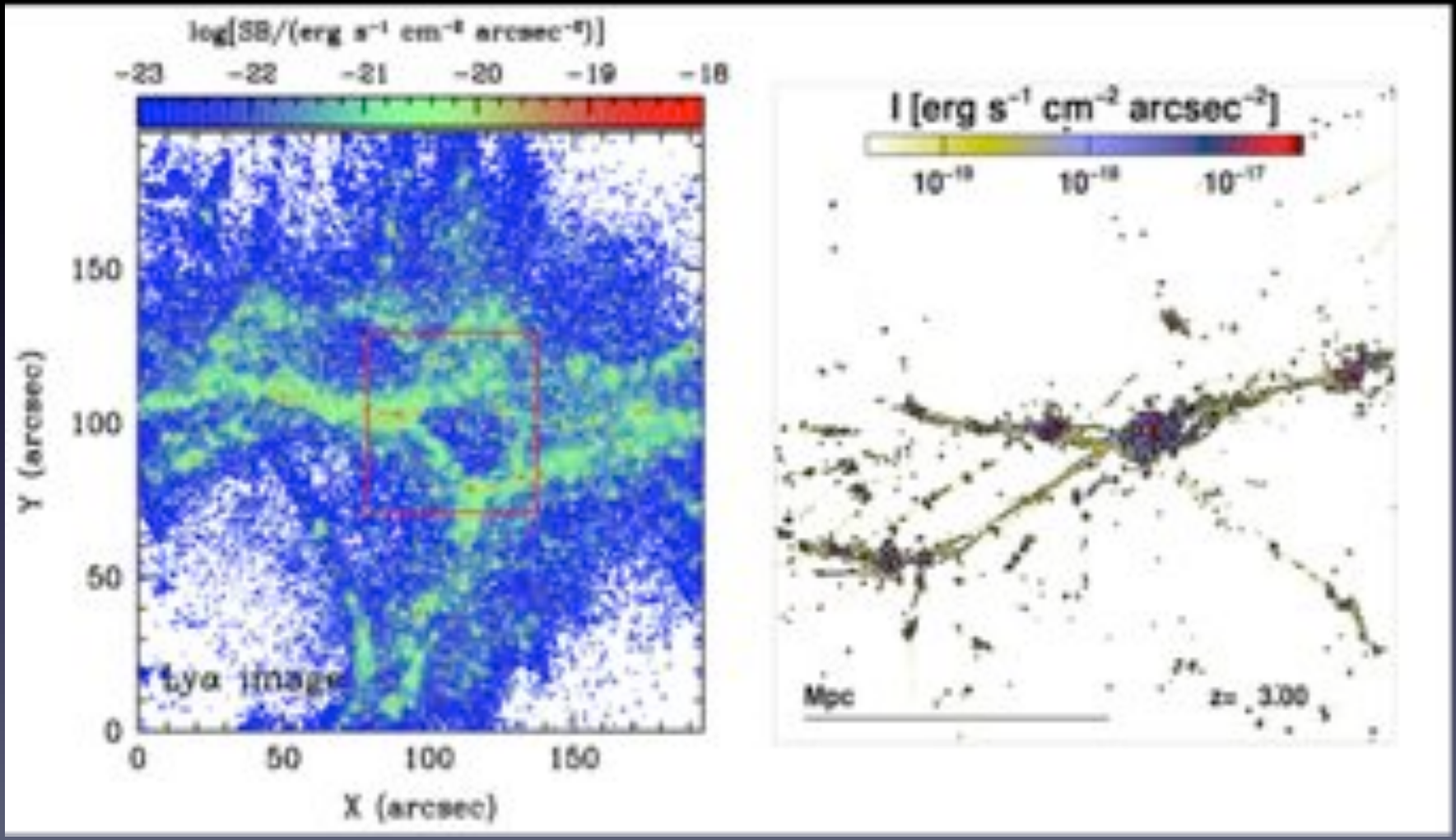
- Object density increase with depth
- A wide field IFU can be more efficient than a MOS

Imaging the Cosmic Web (1)

Imaging the Cosmic Web (2)

- The Lyα faint glow (fluorescence)
  - UV cosmic background ionize intergalactic Hydrogen & produce Lyα emission (Hogan & Weymann 1987)
  - Lyα emission produced in dense region of the IGM, e.g filaments
- Lyα Cooling flows
  - Recombination of shock heated gas in massive halos

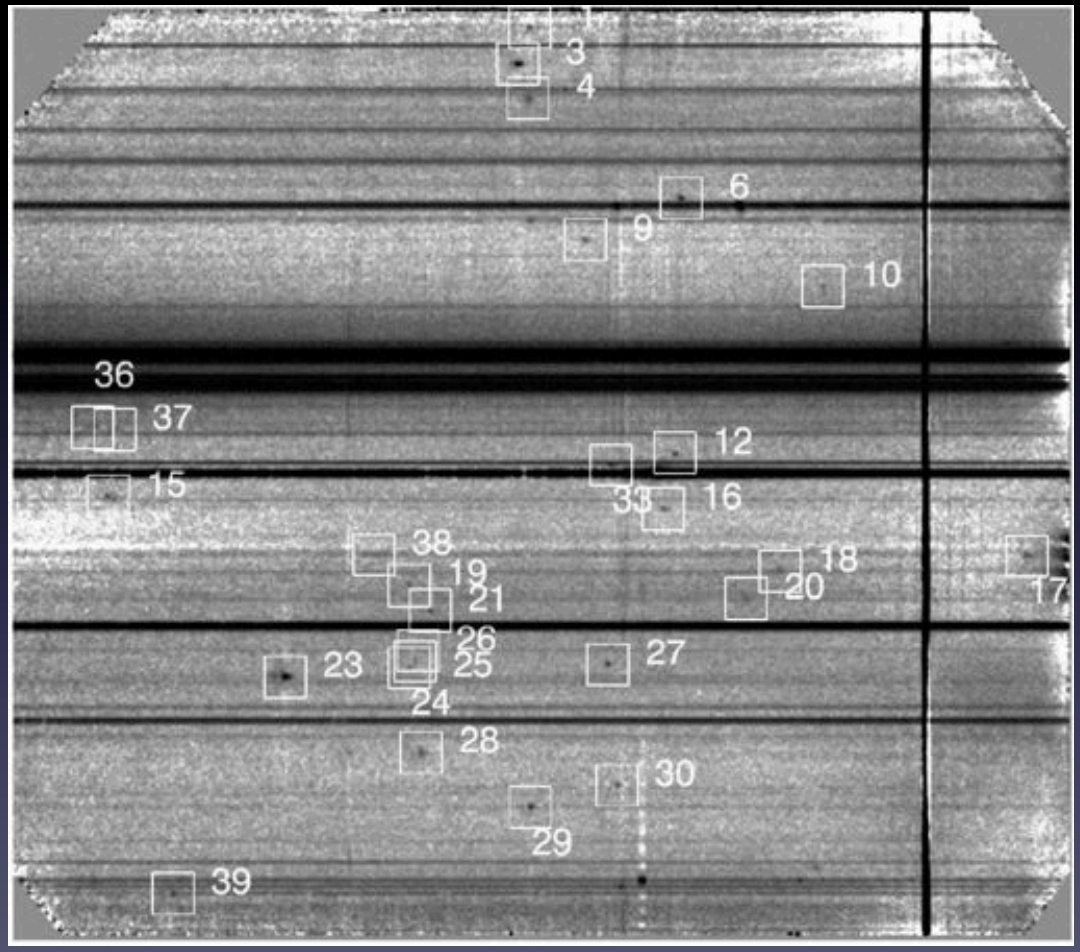
Imaging the cosmic web (3)



Kollmeier et al, 2010

Rosdhal et al, 2012

FORS2 deep observations



Rauch et al, 2008 – 92 hours FORS2 long slit observation

Imaging the cosmic web (4)

- Filament size ~1 Mpc, i.e. 2 arcmin @ z=3
  - Wide field IFU required
- SB ~ 10^{-20} ergs/s/cm^2/arcsec^2
  - E-ELT collecting power required
- Filaments are thin & other sources of Lyα emission
  - Good spatial resolution
- In ~50 hours, a wide field IFU on the E-ELT should image the cosmic web in great detail

IS IT FEASIBLE & AFFORDABLE ?

The goal

- 1x1 arcmin^2
- 400-1000 (1200) nm, R~2000-5000
- High throughput
- Good spatial resolution
- Very stable

- The problem of Etendue
  - Fast camera (f/1.4)
  - Large number of pixels
    - use on-chip binning ?
  - Large number of IFUs

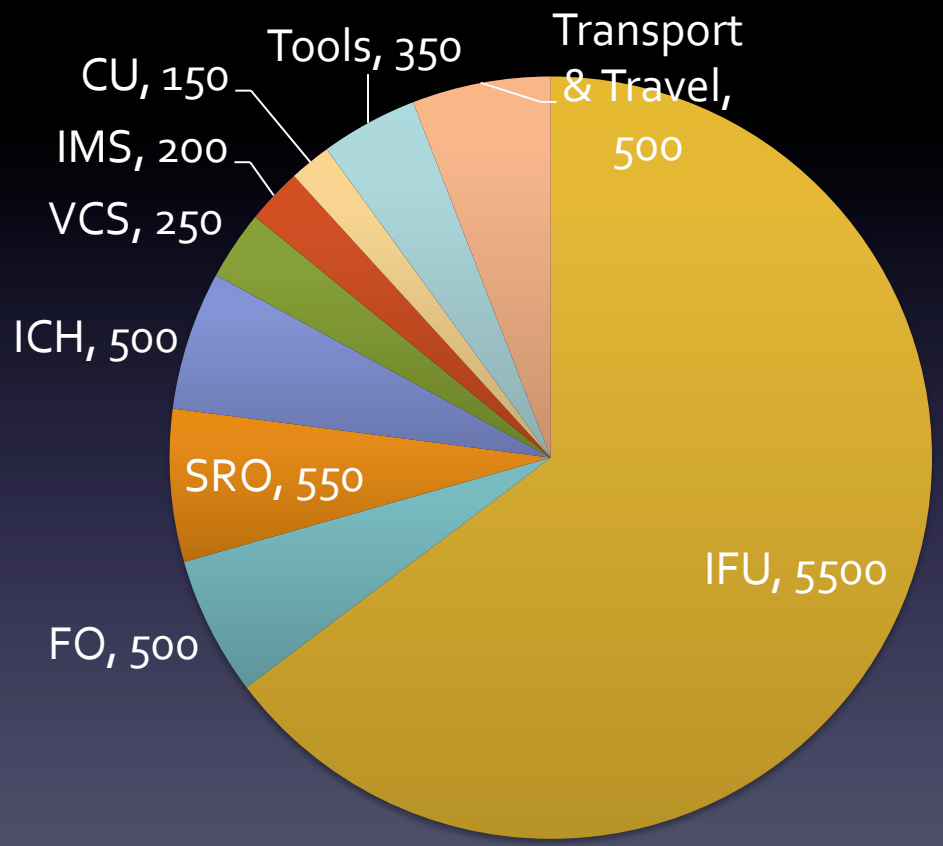
A tentative proto-concept

- Use MUSE IFU type
  - Advanced slicer
  - Spectrograph (f/2 -> f/1.4) + VPHG
  - Detector (CCD)
- Simplify the fore-optics
  - Non contiguous field of view: 30 arcsec^2 in a 1x1 arcmin^2
  - IFUs are located in the (enlarged) focal plane (no field splitter and relay optics)

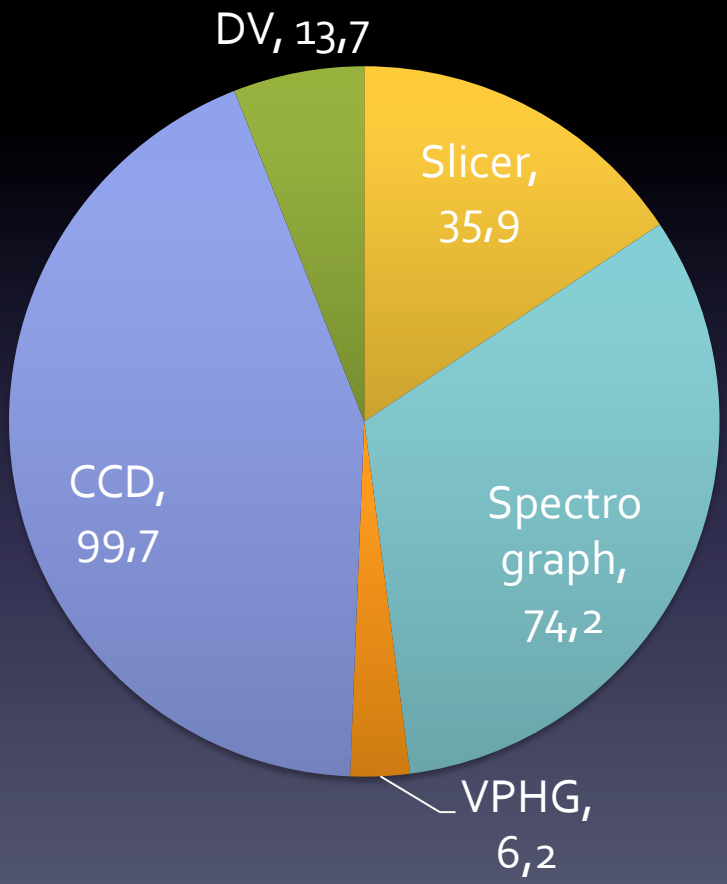
A few points to be investigated

- A derotator of 1x1 arcmin^2
- IFU opto-mechanical design for the non-contiguous solution
- CCD or IR detectors (extension to H band)

MUSE hardware cost



Total: 8500 k€



Total 1 IFU: 220 k€

VLT/MUSE & E-ELT/Wide Field IFU

	MUSE/VLT	**Wide Field IFU/E-ELT**
Field of view	1x1 arcmin^2	1x1 arcmin^2 in 4 exposures of 30x30 arcsec^2 each
IFUs	24 (f/2 camera)	96 (f/1.4 camera)
Throughput	55%	60%
AO friendly	AOF	GLAO
Volume	1 Nasmyth Platform	?
Weight	7000 Kg	?
Project duration	10 years	10 years
Hardware Cost	8,5 M€	25-30 M€

CONCLUSIONS

- Is it desirable ?
  - Yes, unique science case
    - Cosmic web
    - High-z galaxies using lensing cluster (J-P Kneib talk)
    - Resolved stellar population (M. Roth talk)
  - Yes, large FOV maximize science return
  - Yes, use of poor AO time, maximize science return
- Is it feasible ?
  - Yes, use most of the techno already developed for MUSE
- Is it easy ?
  - No, but nothing will be easy on the E-ELT
- Is it affordable ?
  - Yes, 30 M€, only 3% of E-ELT total cost
- Is it unique ?
  - Yes, no similar plan so far on other E-ELTs
  - ESO community well prepared with MUSE & HARMONI