MOONS
Multi-Object Optical and Near-infrared Spectrograph for the VLT
The extragalactic GTO survey: planning and data challenge

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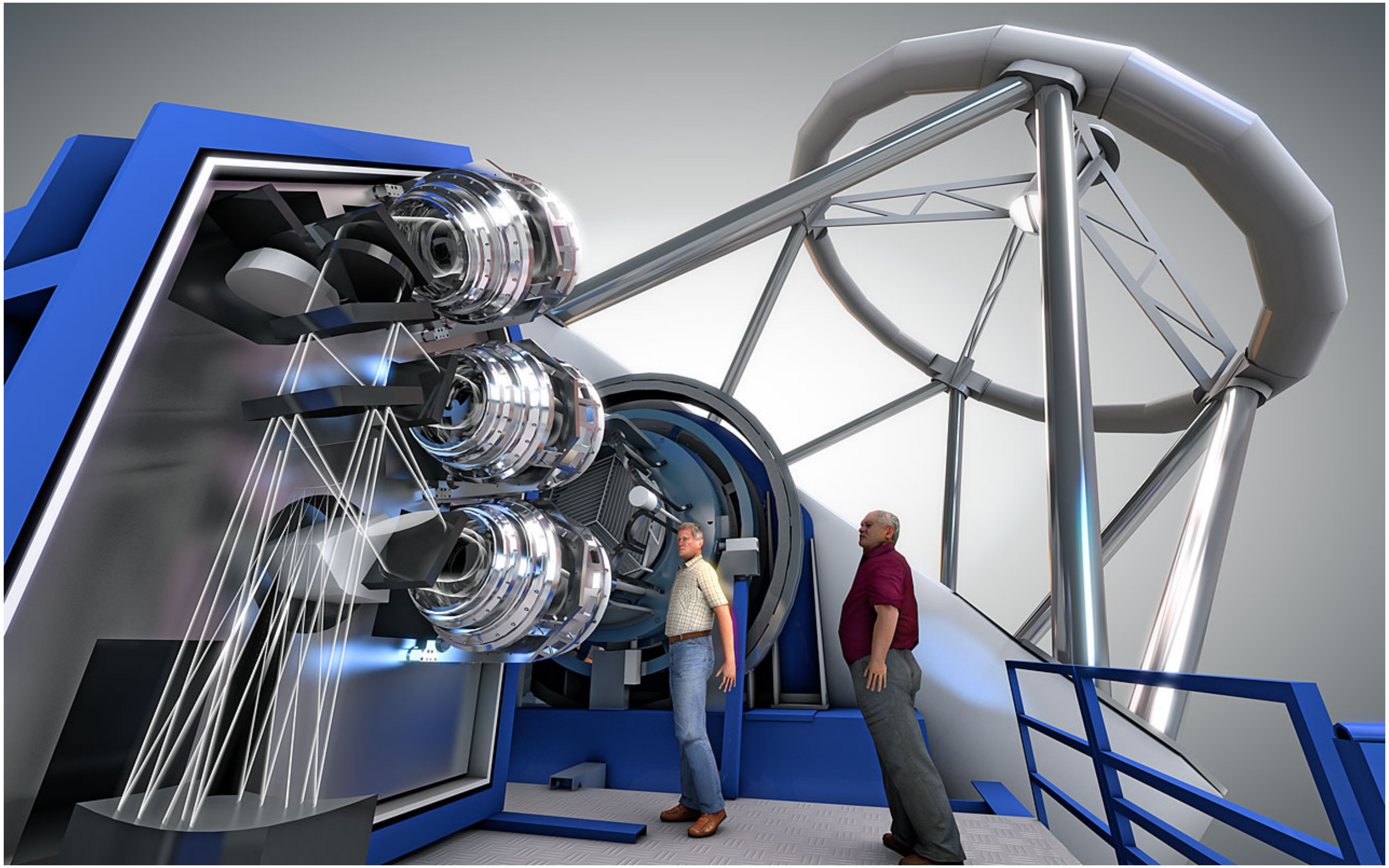
slides courtesy of M. Magliocchetti & R. Maiolino

MOONS is the

next generation optical/near-IR multi-object spectrograph

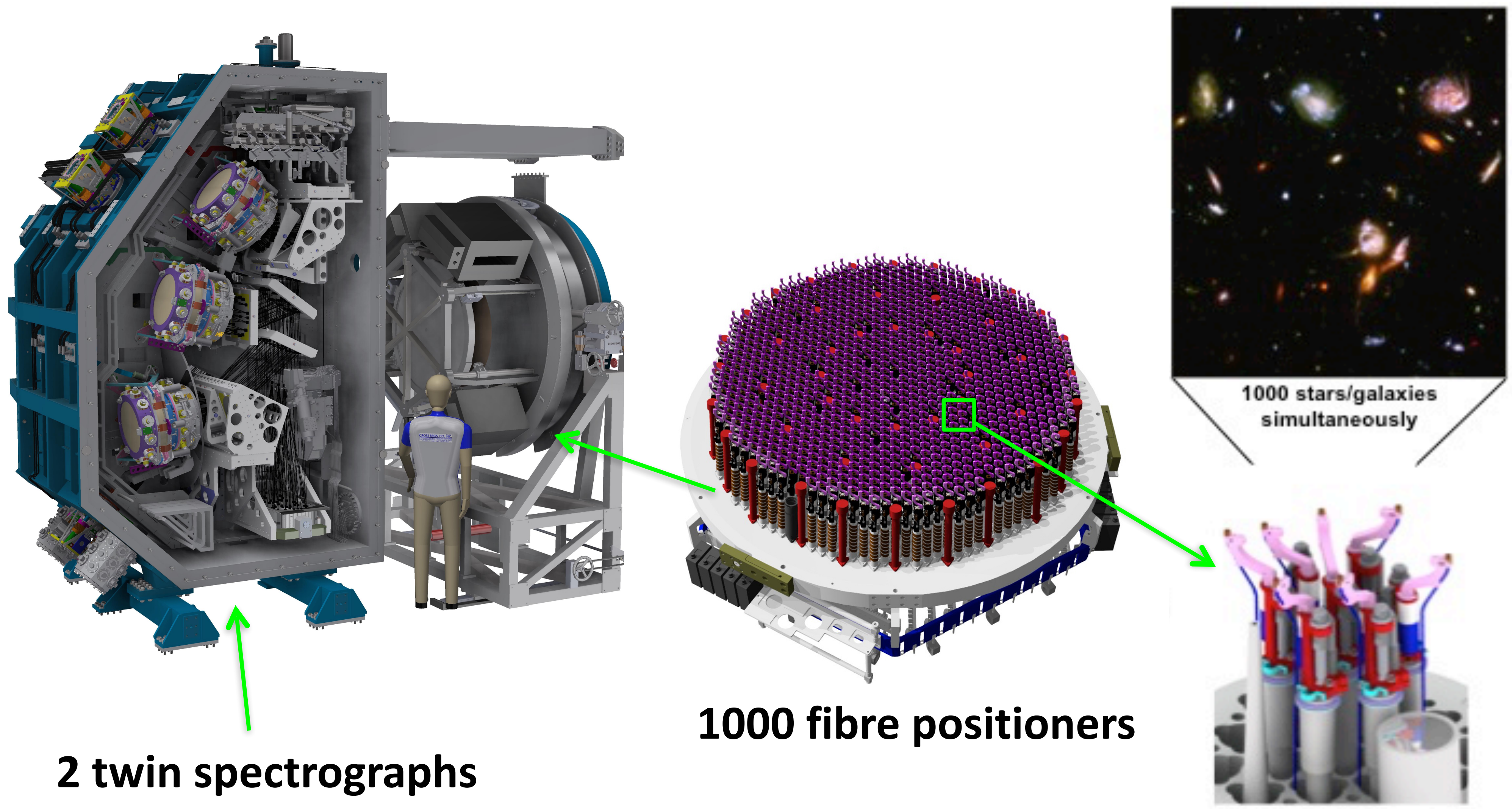
for ESO's Very Large Telescope



1001 fibers FoV: 25’ in diameter (~500 square arcmin)

Aperture on sky 1.1 arcsec; Close pairs 10"; max 7 fibers within 2'

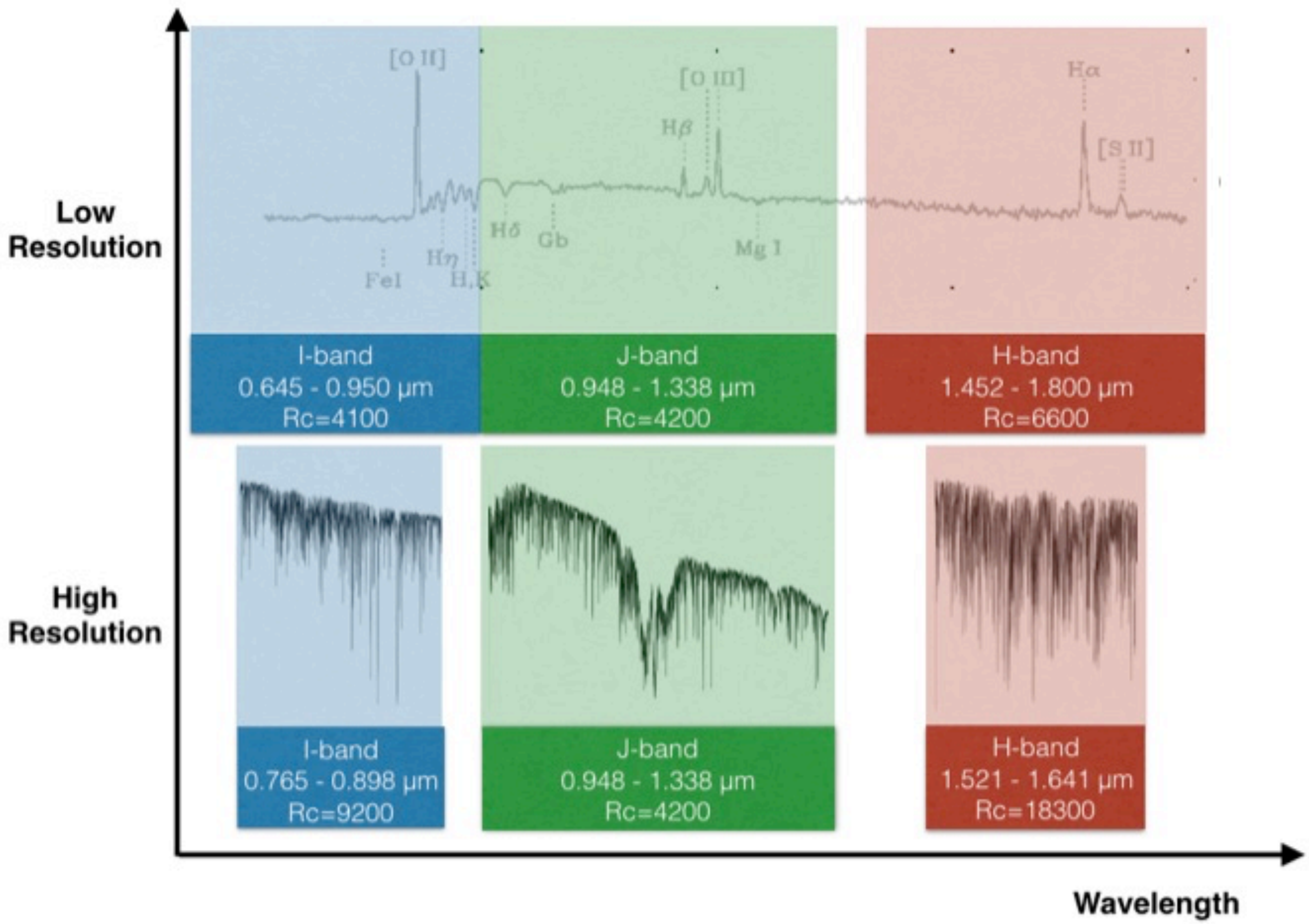
Each fibre capable of patrolling an area of ~2'

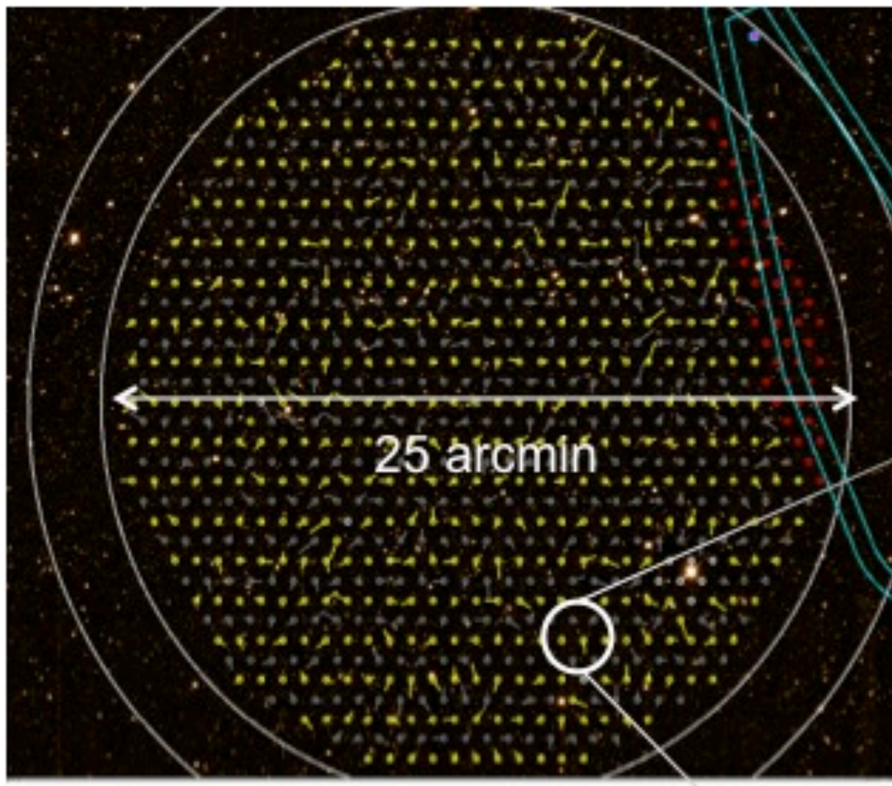


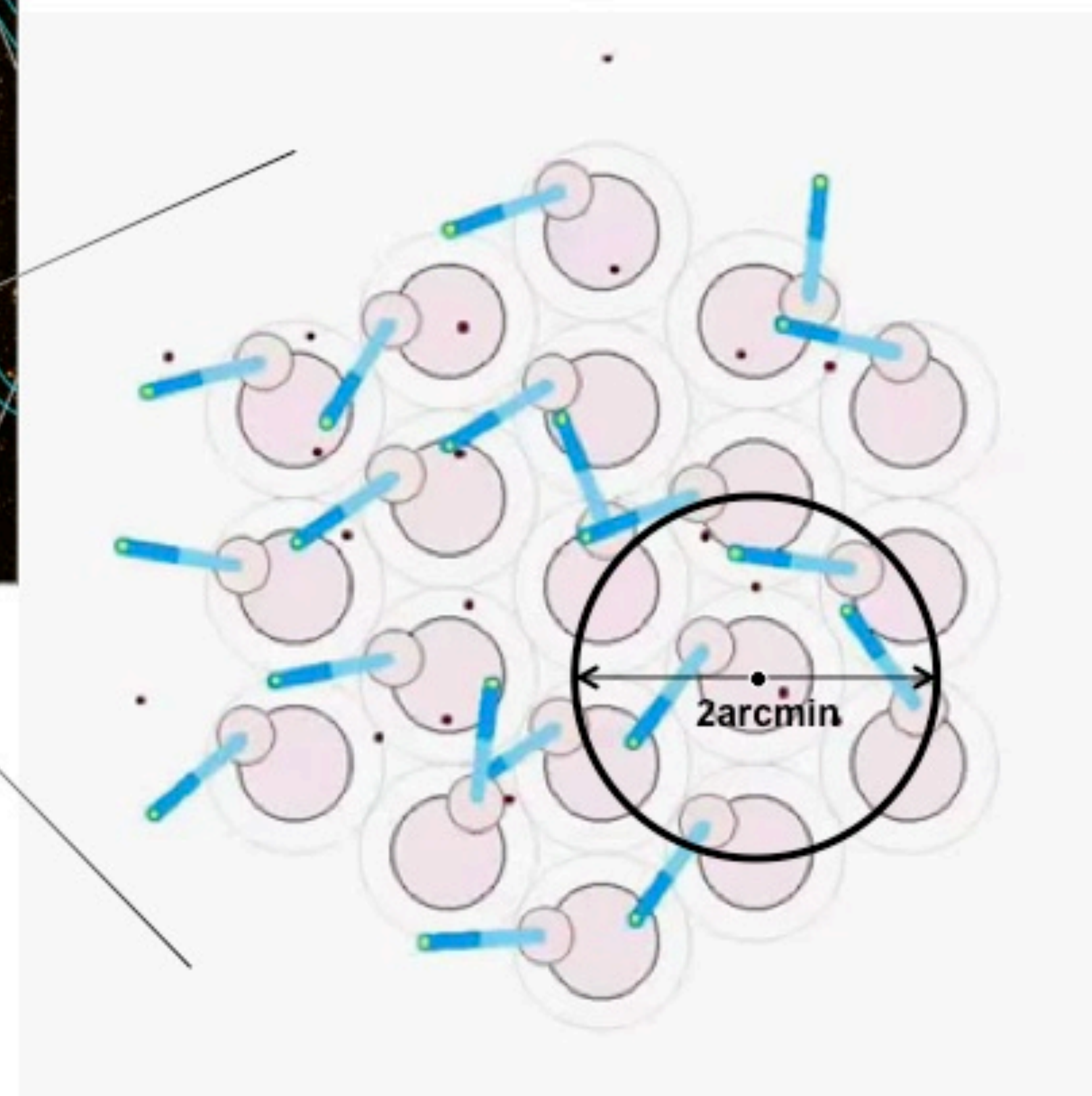
wavelength coverage : 0.64µm-1.8µm

Medium resolution mode (R~4,000-6,000): 0.64µm-1.8µm simultaneously,

High resolution mode (R4000-18000): three selected spectral regions simultaneously







Closest pairs: 10 arcsec

Up to 7 fibers within 2 arcmin

Observing modes

STARE

- Most fibers on objects
- fraction of fibers on sky (user defined)
- Most suited for bright sources/galactic science

XSwitch

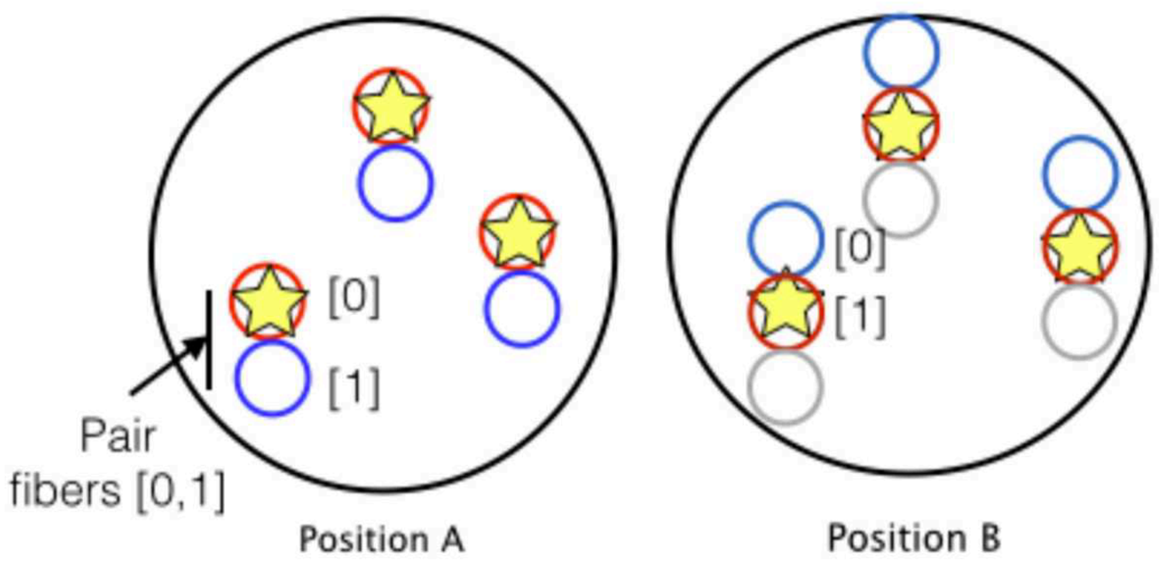
- Paired fibers: one on object one on sky
- ABBA observing strategy
- Allows best sky subtraction
- Mostsuited for faint sources/extragalctic science

Stare and Nod

- ABAB observing strategy
- All fibers on objects in exp. A, on sky in exp. B
- Most suited for extracrowded fields

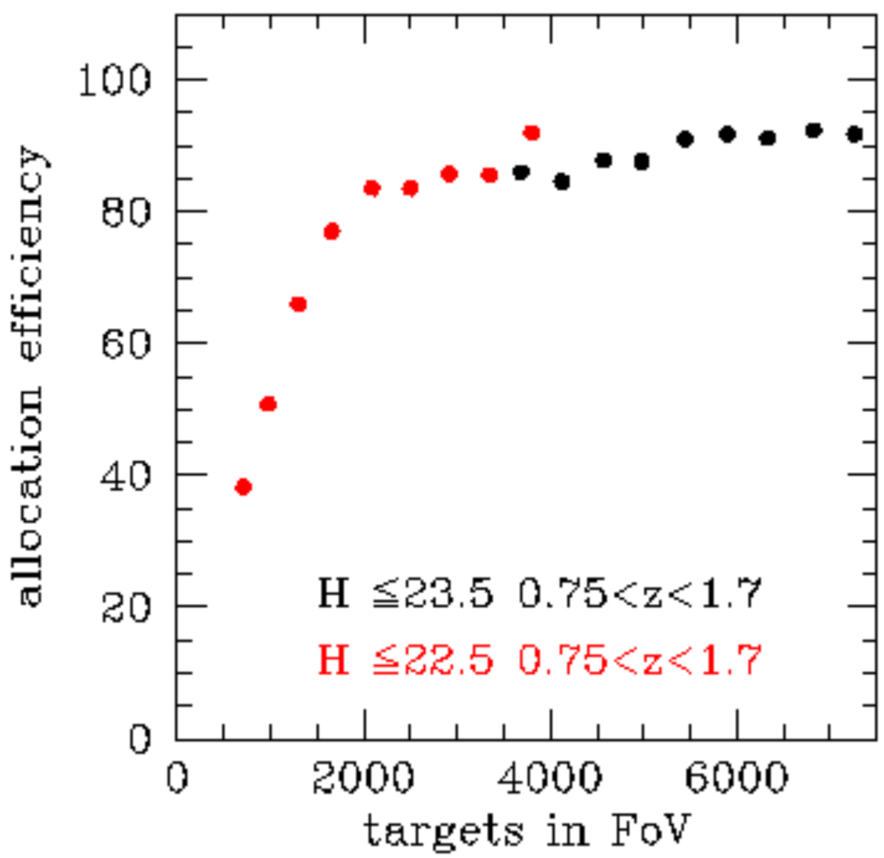
More On XSwitch

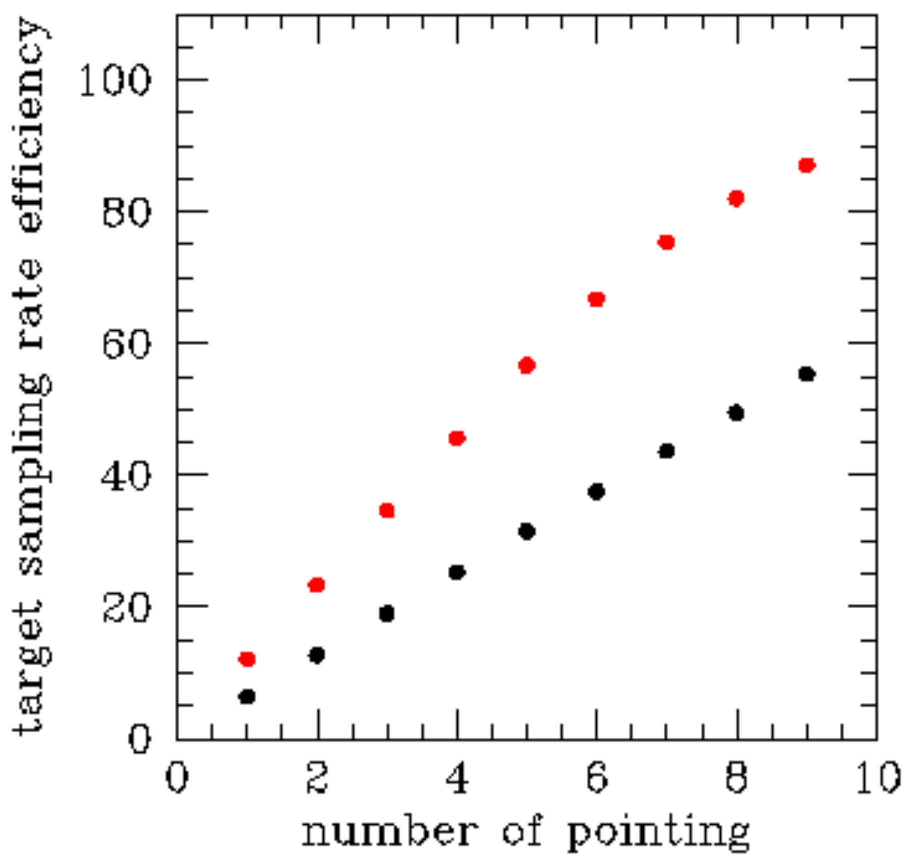
- Allows to observe sky and object simultaneously within 30"
- Allows to correct for fiber to fiber transmission using the B exposure
- Accuracy of sky subtraction:1%



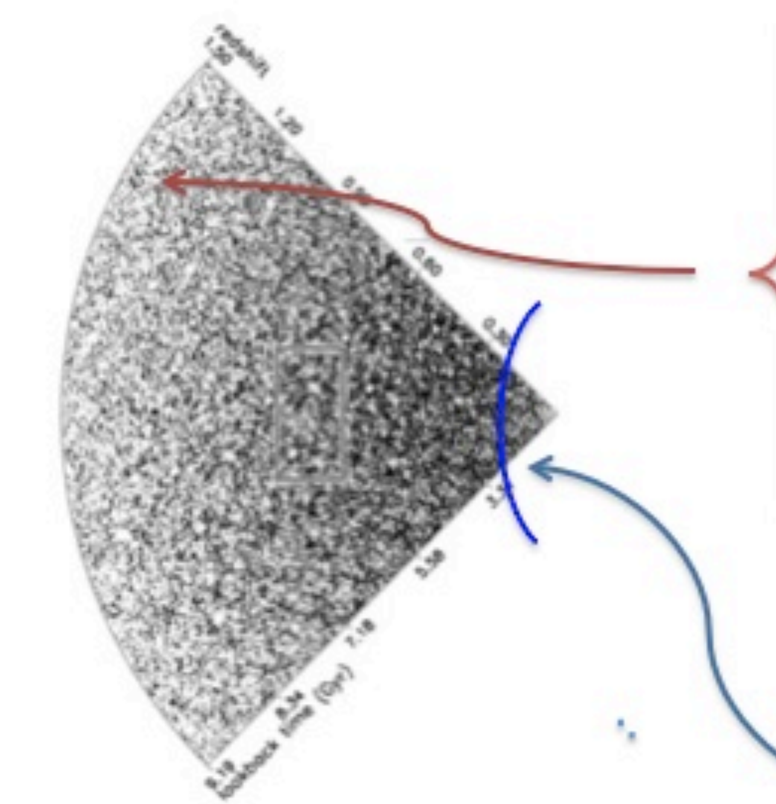
Observation preparation s/w

- accounts for all modes
- allows max 4 priorities when allocating fibers
- Accounts for Instrument constraints (positioner clashes)
- Optimizes n. Of fibers
- Highly efficient

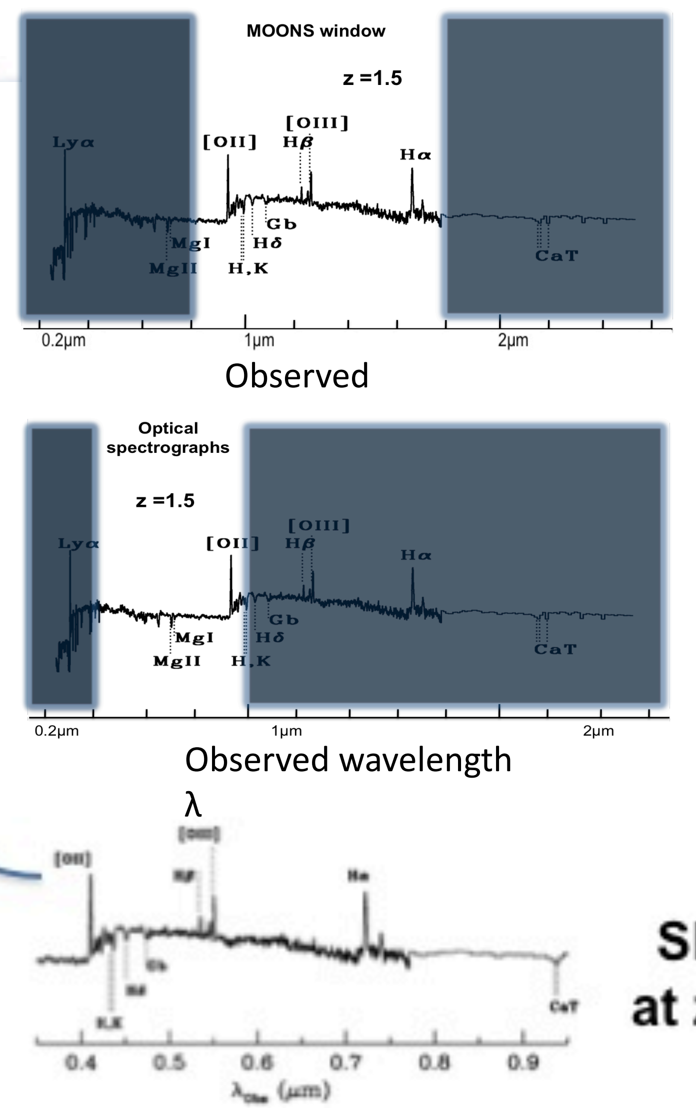




MOONS: a SDSS-like machine probing the peak of galaxy and black hole formation
Expected to spectroscopically characterize ~ 1 Million galaxies at z~0.5-3 in a few years of operations



~1 Million galaxies at z>1



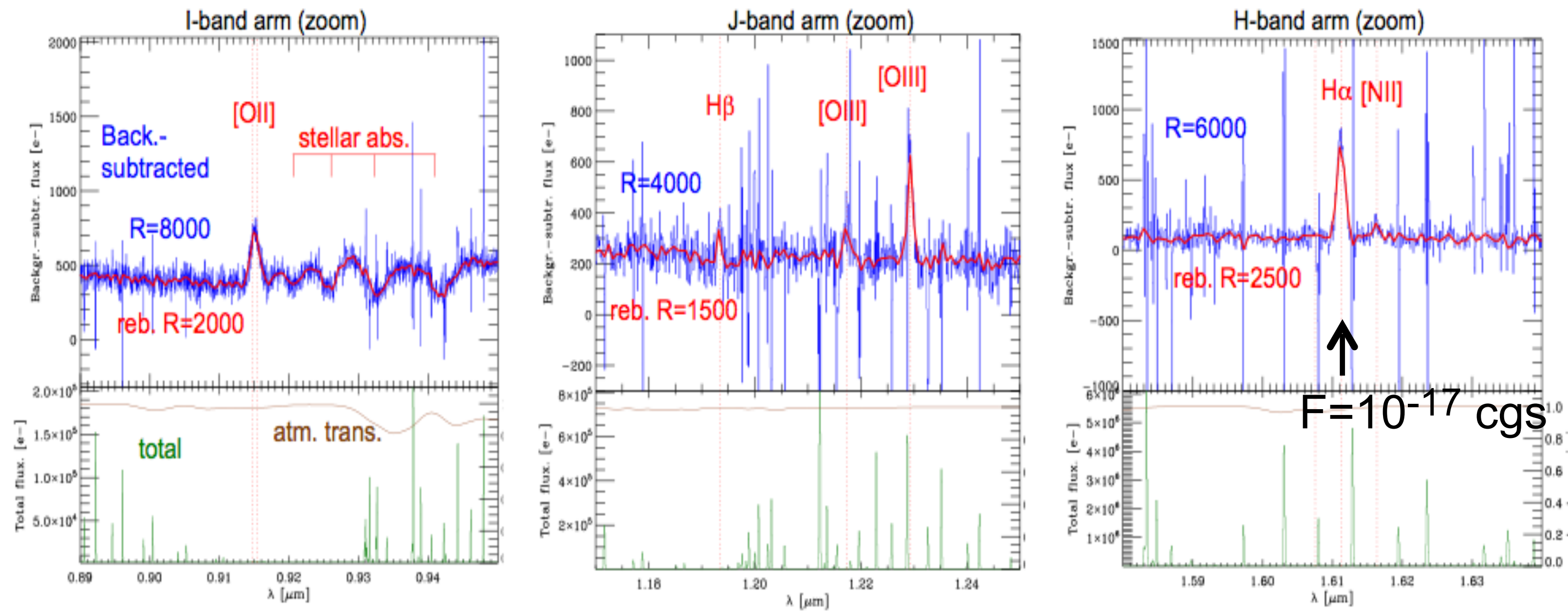
MOONS at z=1.5

optical spectrographs at z=1.5

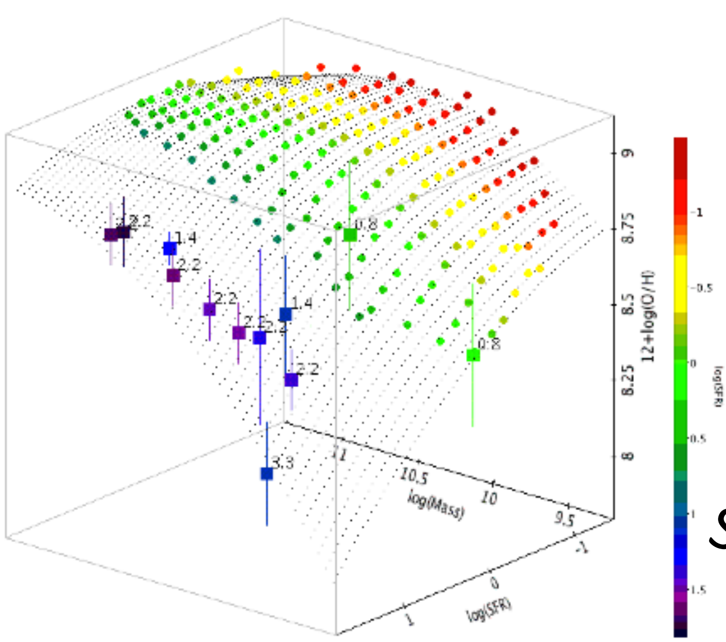
SDSS at z=0.1

Galaxy Evolution Diagnostics

Metallicity (R_{23},N_2)
SFR (Hα, Hβ, [OII])
AGN power (BPT)
Dust extinction (Hα/Hβ)
Galaxy mass (σ_v)
BH mass (BLR)

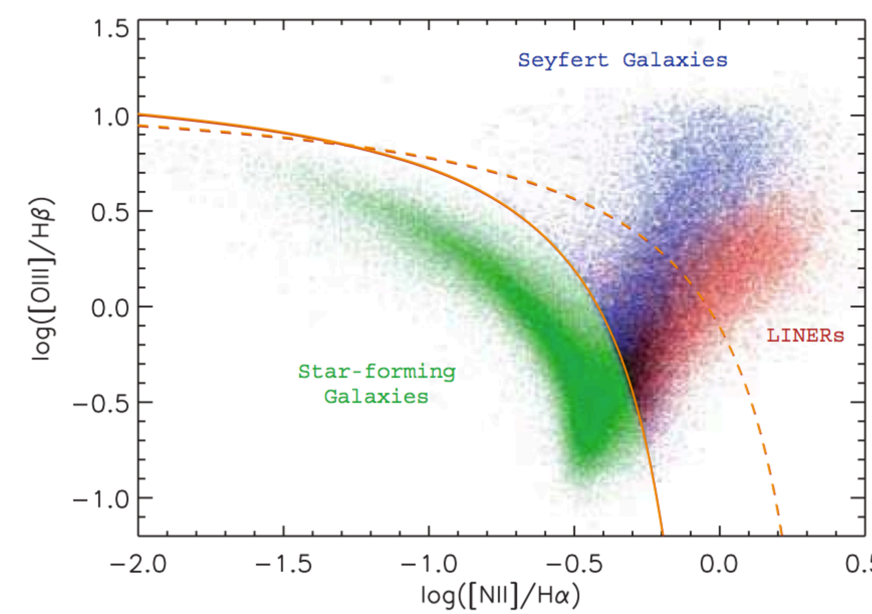


z=1.45, 1h

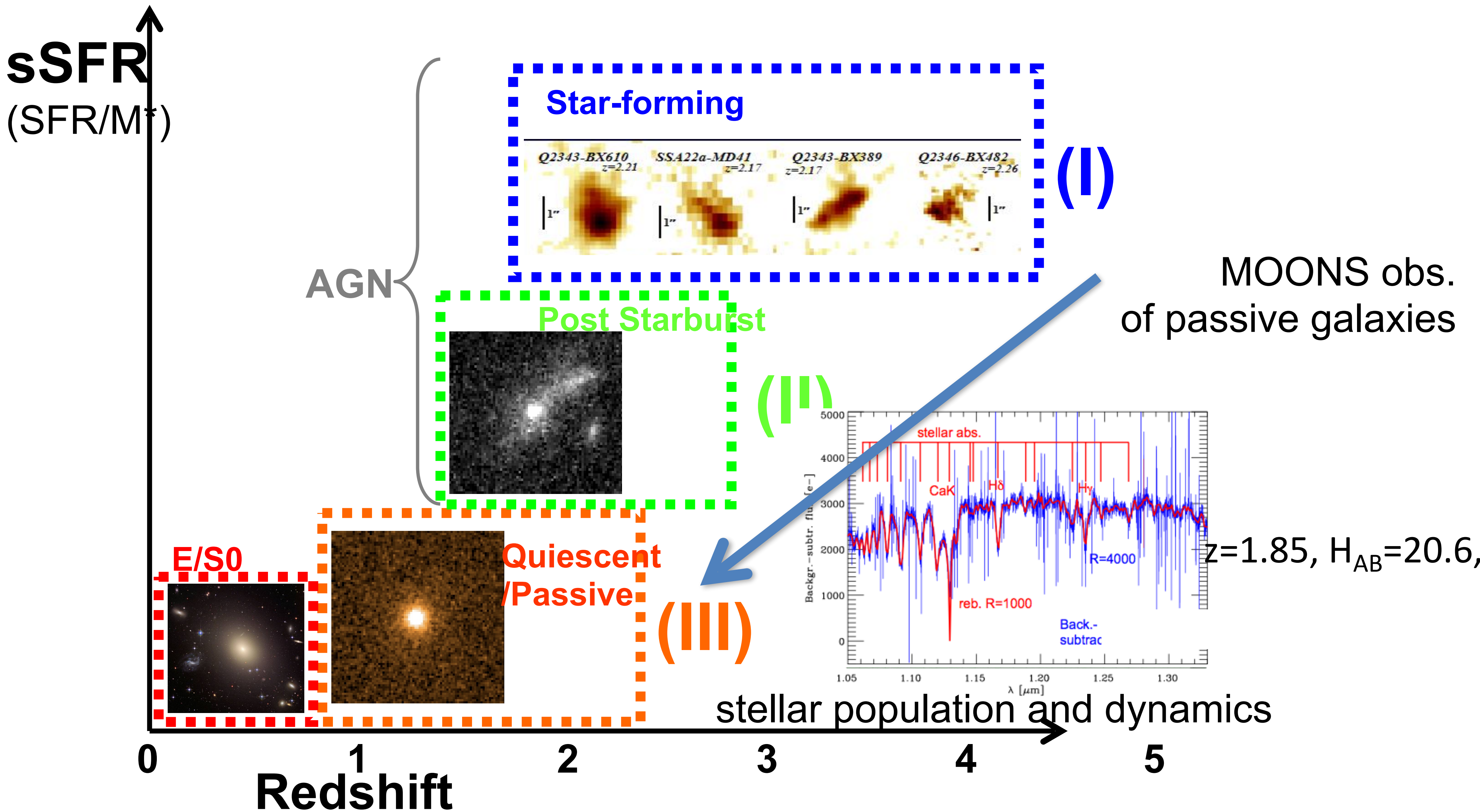


metallicity
SFR
mass

Probing the evolution of galaxy fundamental relations at high redshift

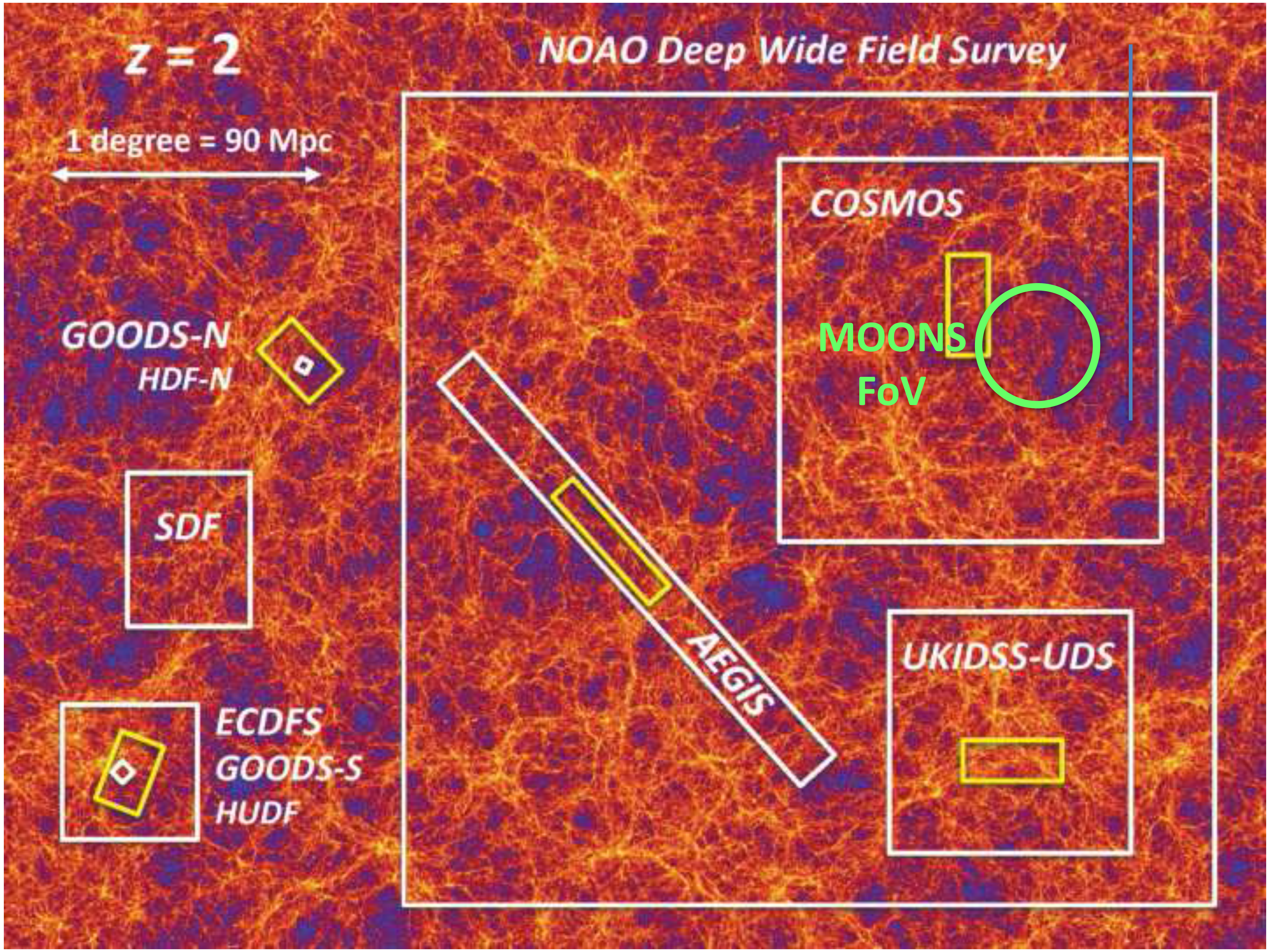


The evolution of massive galaxies

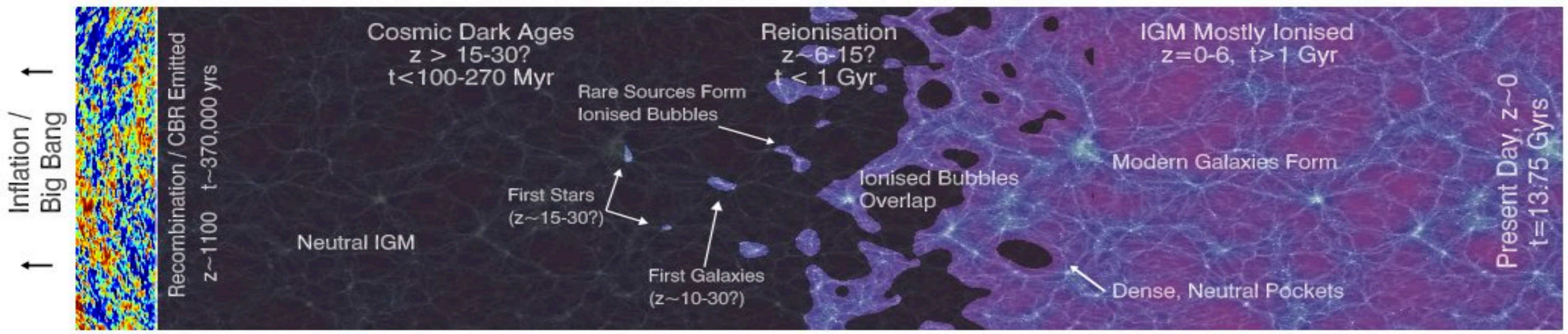


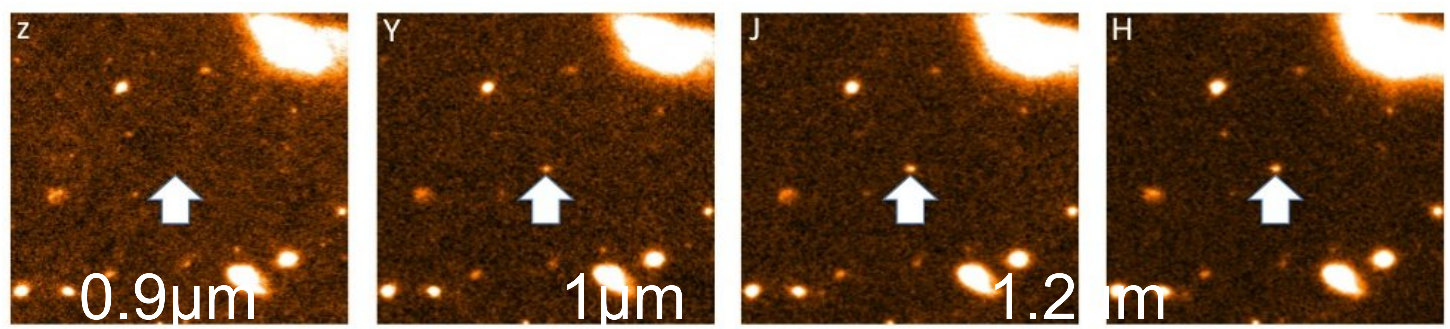
Environmental dependency of galaxy properties

MOONS will define the **environment** (LSS, proto-clusters/groups, central-satellite, δ)



The first galaxies and the epoch of re-ionization





✓ Spectroscopic confirmation of the most distant galaxies.

✓ Establish the Lyman-α escape fraction and unveil the physics of re-ionization.

✓ Measure star-formation and mass assembly of primeval galaxies.

✓ Investigate their metal enrichment

✓ Clustering of high-z galaxies and constrain the re-ionization.

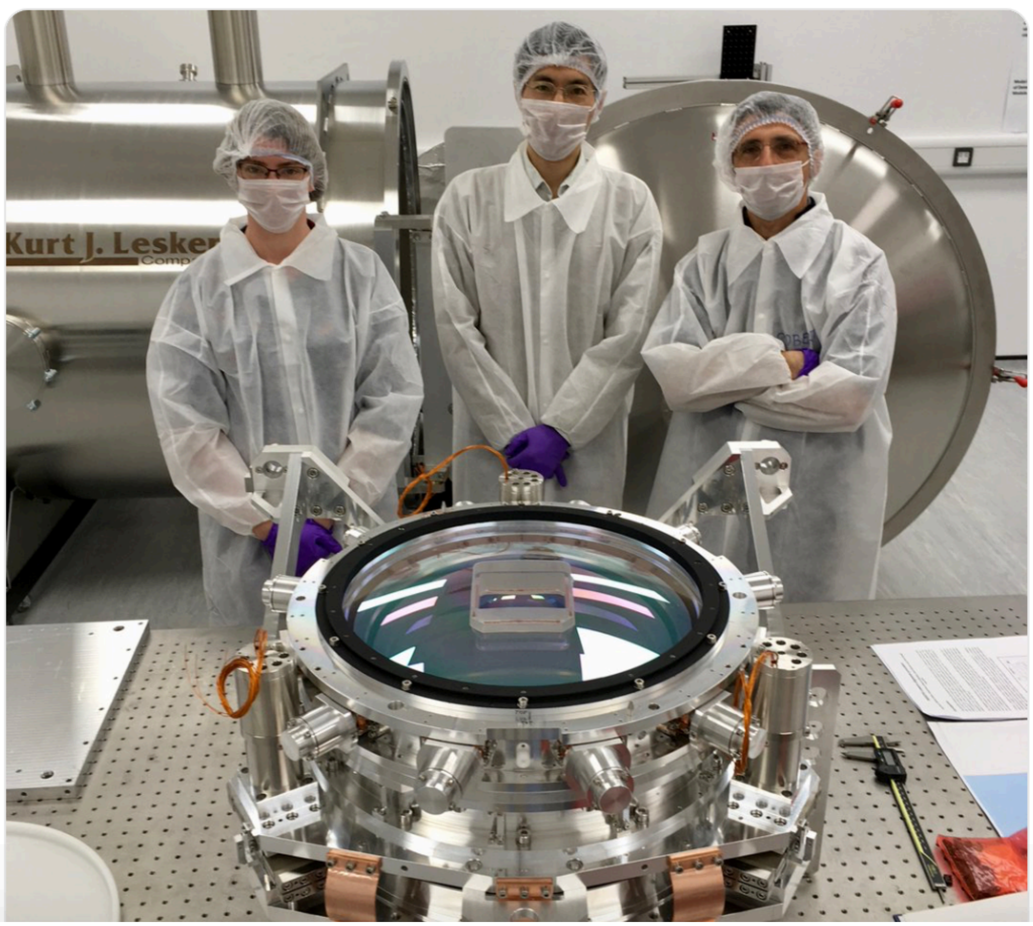
- Currently in construction phase.
- First light expected in 2021
- Additional information and progress at: vltmoons.org

Kavli Institute for Cosmology, Cambridge, UK @KICC_official · Apr 4

The first of the 6 cameras of @VLT_MOONS has successfully passed the "earthquake test", i.e hammering(!) and dropping(!) the camera to reach accelerations of up to 3g!

Unshaken, the optics went back to position within a few microns!

Find out more at bit.ly/2K9JY74



MOONS
@VLT_MOONS
Follow

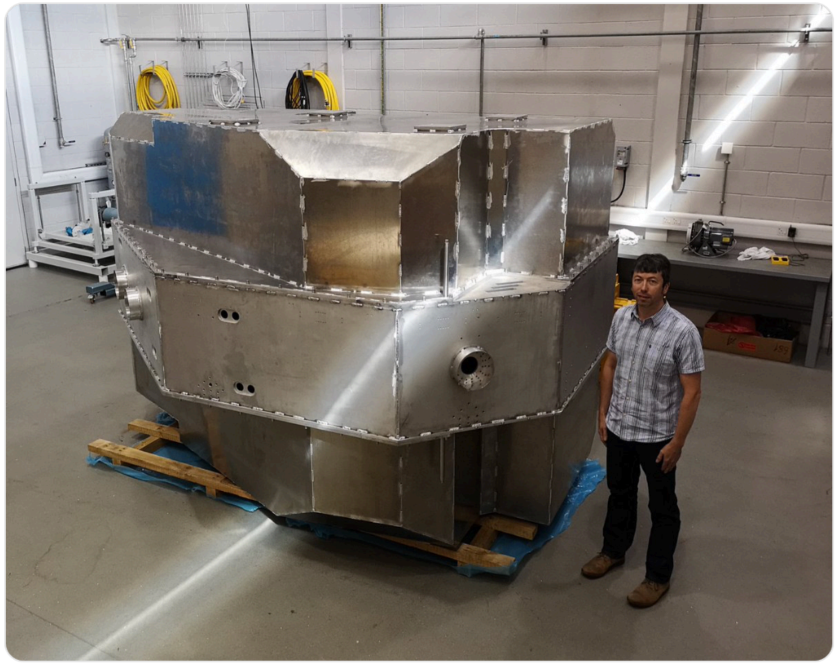
When do you realise the instrument you're building is a bit on the large size? When you need scaffolding and a "working at heights" training course, that's when!! 🧗

2:55 AM - 10 May 2019

MOONS @VLT_MOONS · 13 Aug 2018

The MOONS radiation shield is in the @ukatc lab! Optical engineer David Lee stands next to it to give us a sense of scale. This huge structure will be the final barrier between the warm outside world and the inside of MOONS operating at around 130 K

More: vltmoons.org



Survey definition process

Scientific Topics (WPs)

1. Physical properties of ISM
2. Passive galaxies
3. Environment
4. Large Scale Structure / Proto-clusters
5. AGNs
6. First galaxies

For each topic, define

- redshift ranges
- parameter space
- Statistics (how many objects)
- Completeness
- Volume/Area

- 10 nights blocks 2-3 times per semester -> requires 2-3 fields
- Multiwavelength coverage (photometry, but not only): Video fields, COSMOS field

From ETC:

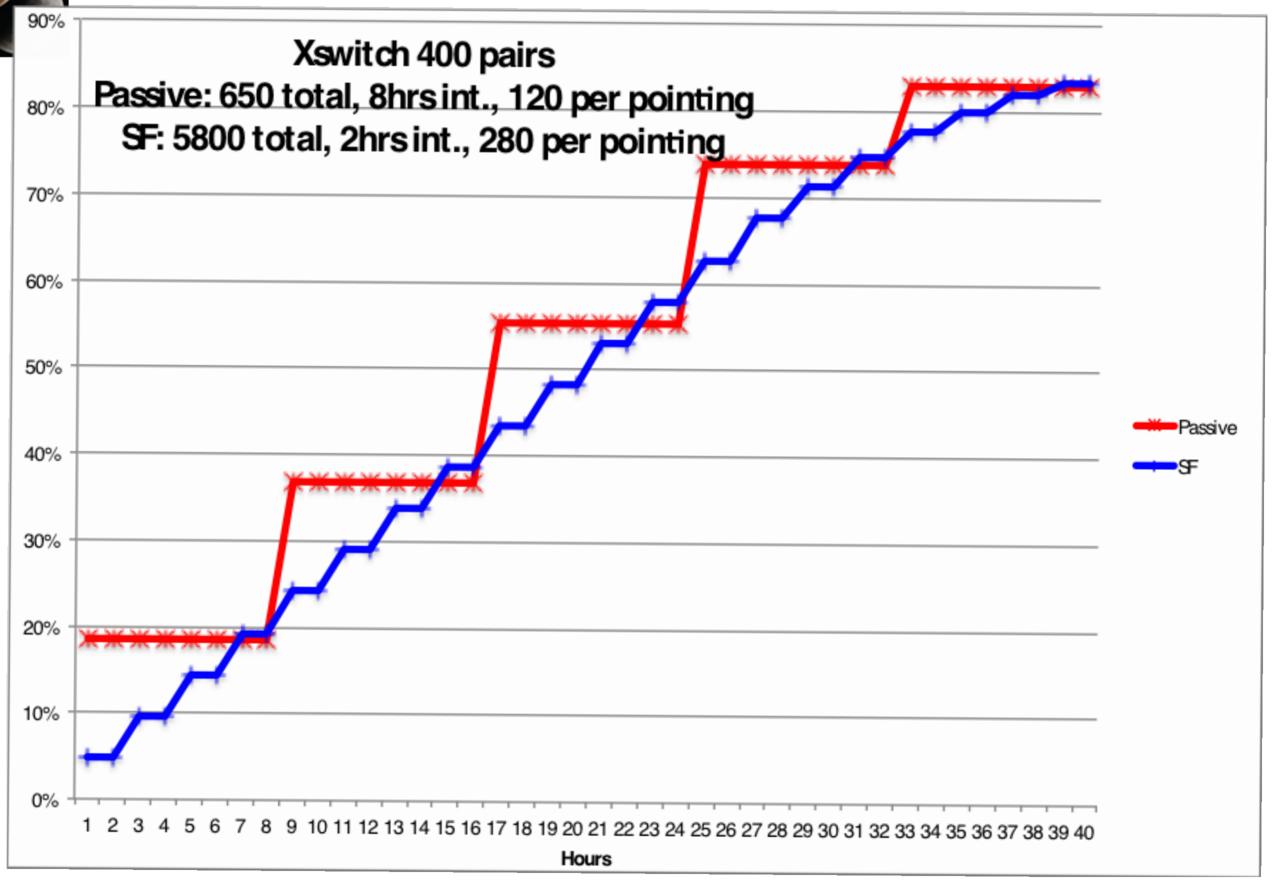
1. Passive galaxies: ~8hrs
2. SF galaxies ~1-2hrs

From Moonlight

3. When number density per FoV is >2000 targets -> efficiency > 80%
4. When number density per FoV is <2000 targets -> efficiency drops

		Number of objects per MOONS FoV		
Redshift range	**Selection**	**Total**	**SF**	**Passive**
0.9<z<1.1	H<23.0 or M>9.5	~1400	~1100	~300
1.2<z<1.7	H<23.5 or M>9.5	~3200	~2880	~320
2.0<z<2.6	H<24.0 or M>9.5	~1820	~1770	~50
TOTAL		**~6420**	**~5750**	**~670**

XSwitch



- **>80% completeness in 40hrs per pointing**
- **65-70% completeness in 32hrs per pointing**

1sq.deg. with >80%:

40hrs x 8 (pointings) x 1.2 (overheads + night losses) = 384 hrs = ***48 nights***

38800 SF + 4320 Passive per sq.deg

PLUS ~1000 x 2hr fibers free for any other selection

1sq.deg. with >70%:

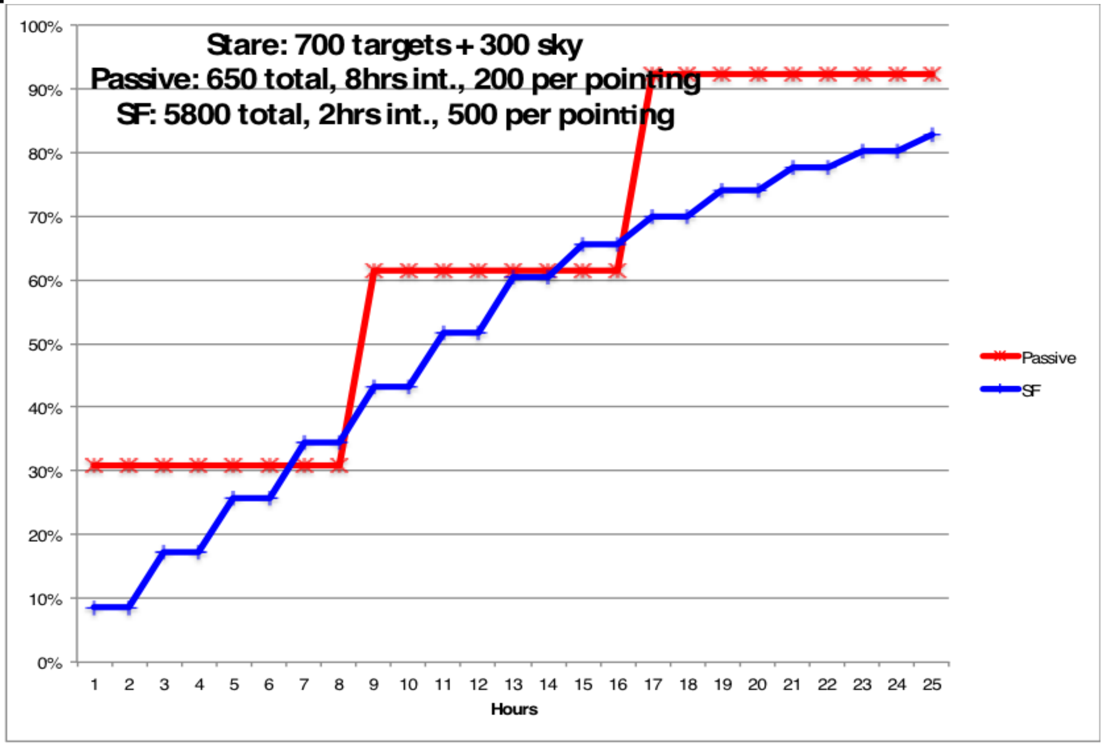
32hrs x 8 (pointings) x 1.2 (overheads + nights losses) = 307 hrs = ***38 nights***

34800 SF + 3840 Passive per sq.deg

PLUS ~150 x 2hr fibers per FOV free for any other selection

In 160 nights GTO: 1sq.deg to >80% + 3sq.deg to >70%
~143200 SF + ~15840 Passive

Stare



- >80% completeness in 25hrs per pointing
- 65-70% completeness in 18hrs per pointing

1sq.deg. with >80%:

25hrs x 8 (pointings) x 1.2 (OB overheads + nights lost) = 240 hrs = 30 nights

38400 SF + 4800 Passive per sq.deg

Plus ~1500 x 2hr fibers free for any other selection

1sq.deg. with >70%:

18hrs x 8 (pointings) x 1.2 (overheads [10%] + nights lost) = 173 hrs = **22 nights**

32400 SF + 3200 Passive per sq.deg

PLUS ~500 x 2hr fibers free for any other selection

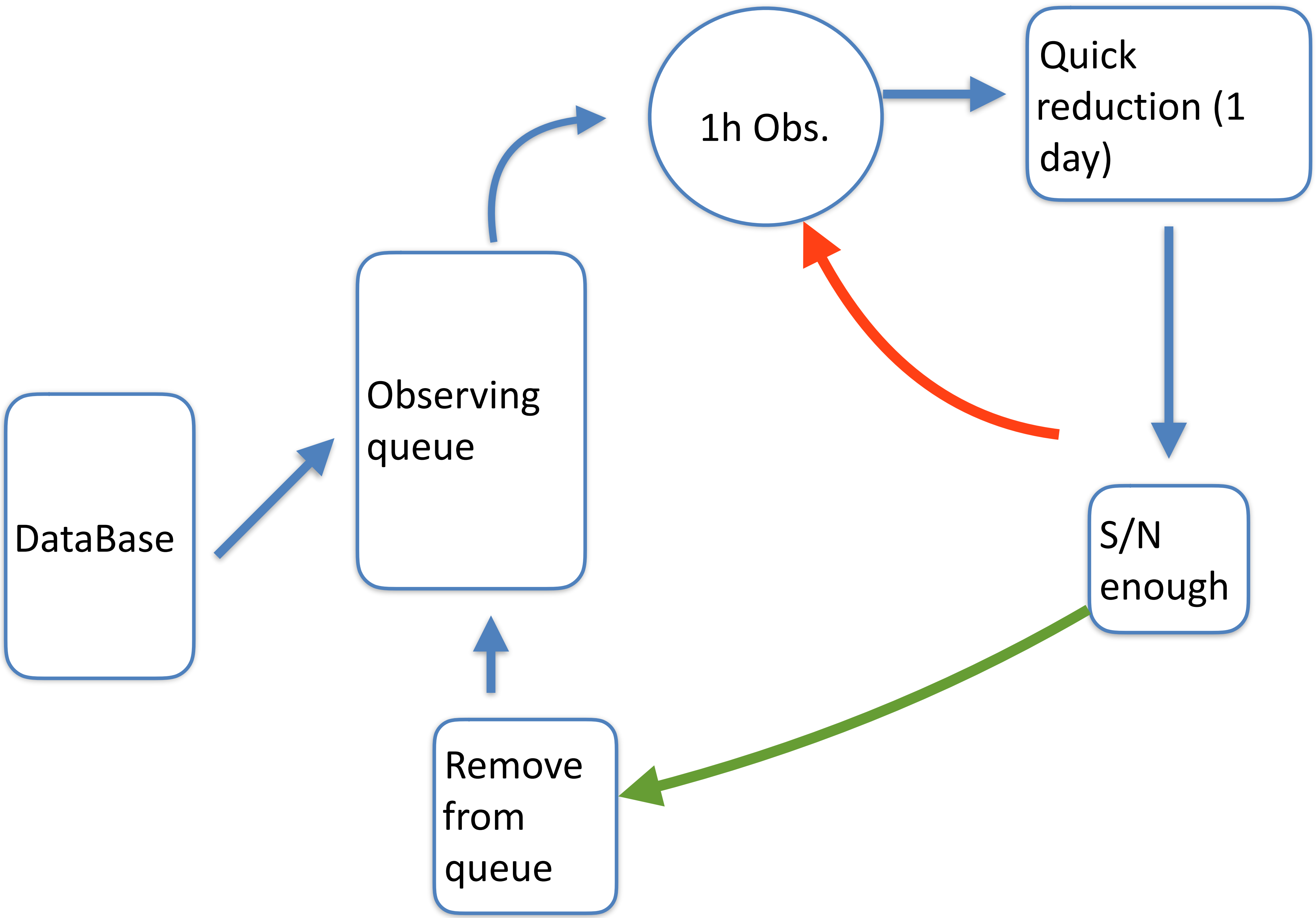
160 nights GTO: 2sq.deg to >80% + 4sq.deg to >70%

206400 SF + 22400 Passive

1sq.deg to >80% + 6sq.deg to >70%

232800 SF + 24000 Passive

OBSERVING STRATEGY



Tools 1/2

- Photometric catalogs ready and available well before
  - dedicated 'survey' DB
  - 'quasi' real time update
  - Access limited
  - User friendly GUI
- Customized Observation Preparation Tool (instrument dependent)
  - Knowleadgeable 'diffuse' man power
  - Direct interface with DB
- Mock catalogues (simulations)
  - Dedicated DB

Tools 2/2

- Fast Data reduction (partially instrument dependent)and z+S/N measurement
  - Customized pipeline
  - Dedicated tools
  - I/F with DB
- Careful book keeping:
  - Observing logs
  - Reduction logs
  - AOB
- Reduced Data products distribution to consortium
  - DB with spectra
  - Visualization tool(s) [I/F with DB?]
- Data exploitation
  - Analysis tools (massive automated line measurements, SED fitting, ...)
  - Data mining, AI, machine learning

Last but not least

- Configuration control of s/w
  - Repository
- Versioning of data products
  - Smart DB managing
- Publication of data products
  - Definition of distributable products
  - Definition of format,k/w
  - Open DB

Most LARGE projects need all this

A *not-a-laboratory* can ease the work load on the single group
enhance INAF/italian visibility
be ‘sold’ as in-kind contribution
increase return
Help smaller projects