ESO

A very active community: virtually all ESO instruments have been successfully used for stellar populations studies

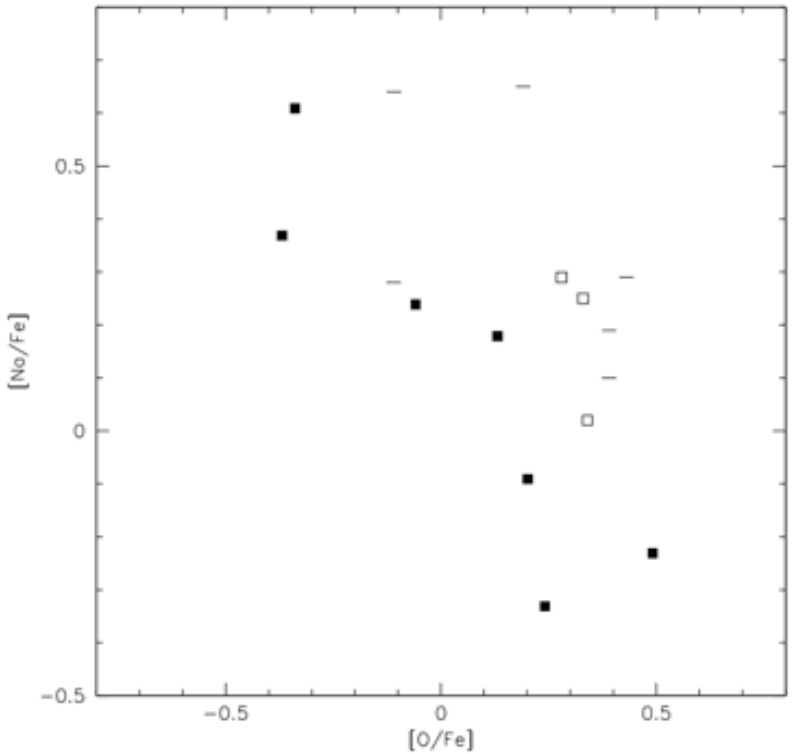
(and also for Beatriz ☺…

since 1978, >100 B.B. refereed papers with “ESO” in absract)

VLT: UVES (Dekker et al. 2000)

The Game Changer

- Excellent Efficiency
- Large simultaneous coverage
- R=40000 for 1 arcesc slit
- Nasmyth Focus, very stable
- Superior quality: showed what was previously guessed..
- Most productive VLT instrument so far
- 24 out of 30 UVES most cited UVES papers refer to Stellar Population



Gratton et al. 2001 (UVES)

VLT: FLAMES (Pasquini et al. 2002)

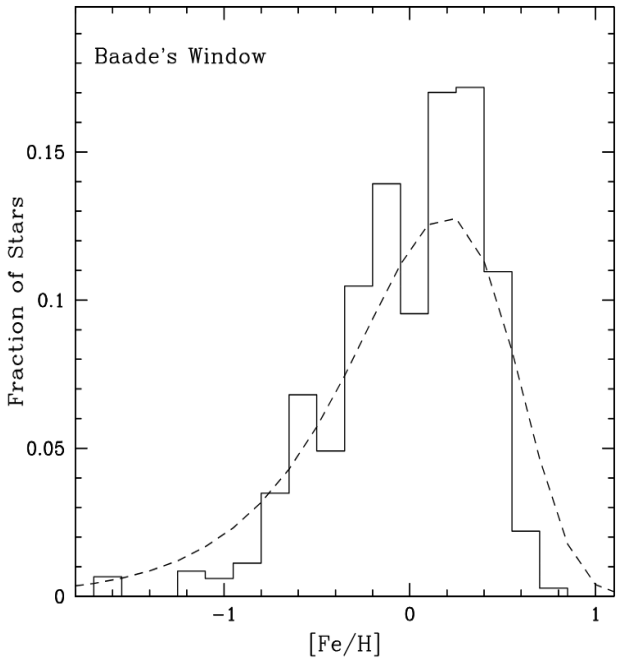
The machine for chemistry and stellar population studies

Full VLT Nasmyth FoV (25 armin diameter)

Two instruments can be used simultaneously : UVES proved to be very useful to calibrate GIRAFFE

Three resolutions, 130 single objects, 15 mini-IFUs, central IFU..

Spectrograph	Mode	N. Of Objects	Aperture (")	Resolving Power (*)	Spectral Band [nm] (**)
UVES	Red Arm	8	1.0	47000	200
UVES	Red Arm	7 + 1 calibration	1.0	47000	200
GIRAFFE	MEDUSA buttons	130 (w. sky fibres)	1.2	12000 - 24000	λ/12 to λ/24
GIRAFFE	MEDUSA buttons	130 (w. sky fibres)	1.2	7000	λ/9.5
GIRAFFE	IFU	15 (+15 sky fibres)	2 x 3	19000 - 39000	λ/12 to λ/24
GIRAFFE	IFU	15 (+15 sky fibres)	2 x 3	11000	λ/9.5
GIRAFFE	ARGUS	1	11.5 x 7.3 or 6.6 x 4.2	19000 - 39000	λ/12 to λ/24
GIRAFFE	ARGUS	1	11.5 x 7.3 or 6.6 x 4.2	11000	λ/9.5



Metallicity distribution in Baade's Window from Zoccali et al. (including B.B.) 2008

2025: MOONS, Multi-Object-Optical-Near Infrared-Spectrometer for the VLT (Gonzalez et al. 2024)

Long awaited …

Field of view: 500 sq. arcmin at the 8.2m VLT

Multiplex: 1000 fibers, with the possibility to deploy them in pairs

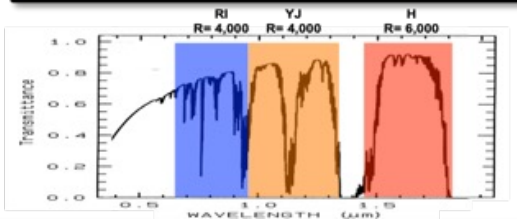
Fibers: Aperture on sky = 1.1arcsec; Close pair = 10arcsec; Max 7 fibers within 2 arcmin

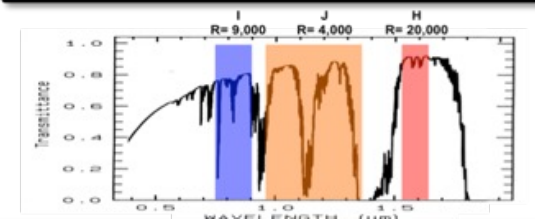
Medium resolution:

Simultaneously 0.64μm-1.8μm
- 0.64-0.95μm at R=4,000
- 0.95-1.35μm at R=4,000
- 1.42-1.81μm at R=6,600

High resolution:

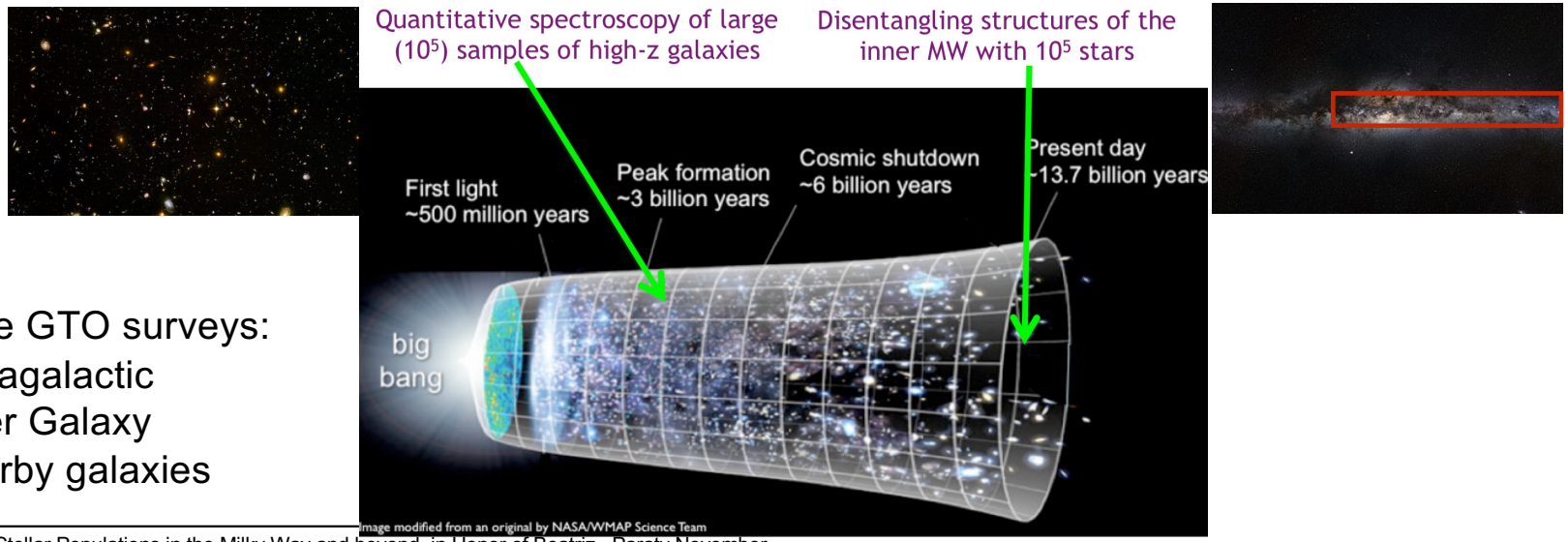
Simultaneously 3 bands:
- 0.76-0.90μm at R = 9,000
- 0.95-1.35μm at R=4,000
- 1.52-1.63μm at R=20,000





MOONS: galaxy evolution from early universe to present day

Low-resolution	High-resolution
- **SDSS-like survey** across peak of star-formation and black-hole accretion up to first galaxies at high-z - Diagnostics for passive/star-forming galaxies: Metallicity (R23,N2), SFR (Hα, Hβ, [OII]), extinction (Hα/Hβ), Galaxy mass (σv), BH mass (BLR)	- **Stellar population surveys** of the dense regions of the (reddened) Milky Way and its satellites - Stellar population diagnostics for millions of stars (stellar parameters, abundances, age indicators, radial velocities)

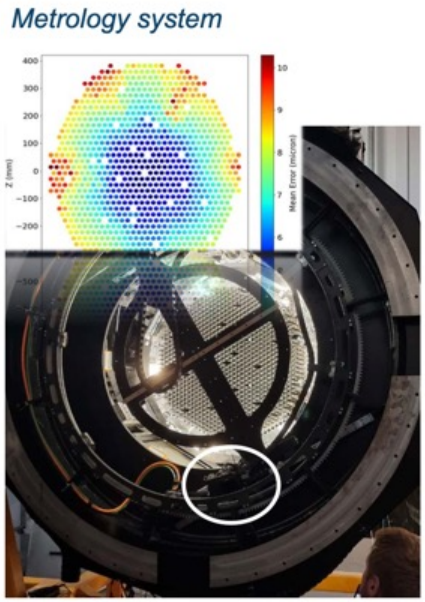


3 large GTO surveys:
1 Extragalactic
1 Inner Galaxy
1 Nearby galaxies

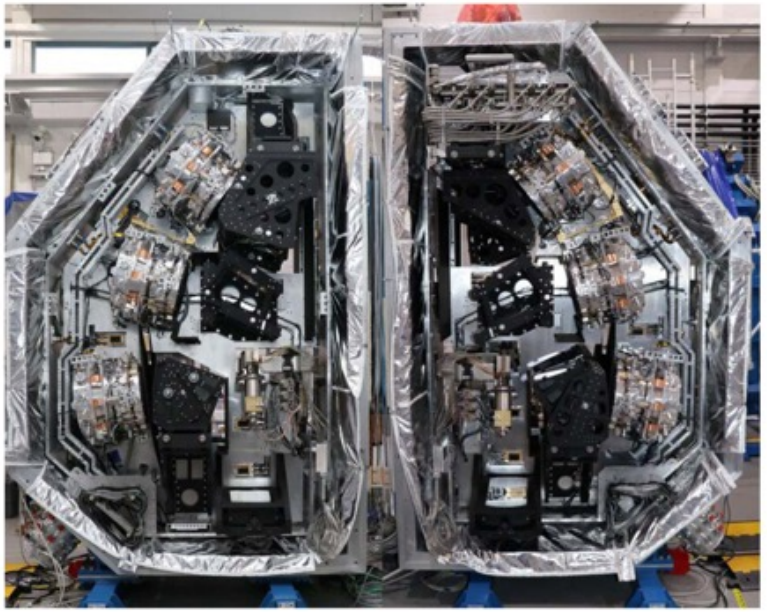
MOONS @ UK-ATC

Fully populated Instrument cooldown and tests

Instrument is completed, Corrector mounted and commissioned at VLT UT1
Two motor failures (grating mech) -> investigation from ATC -> coating on gear boxes affects lifetime of motors. Replace gear boxes and new design -> **Preliminary Acceptance Europe in July, shipment to Chile in Q1 2025**

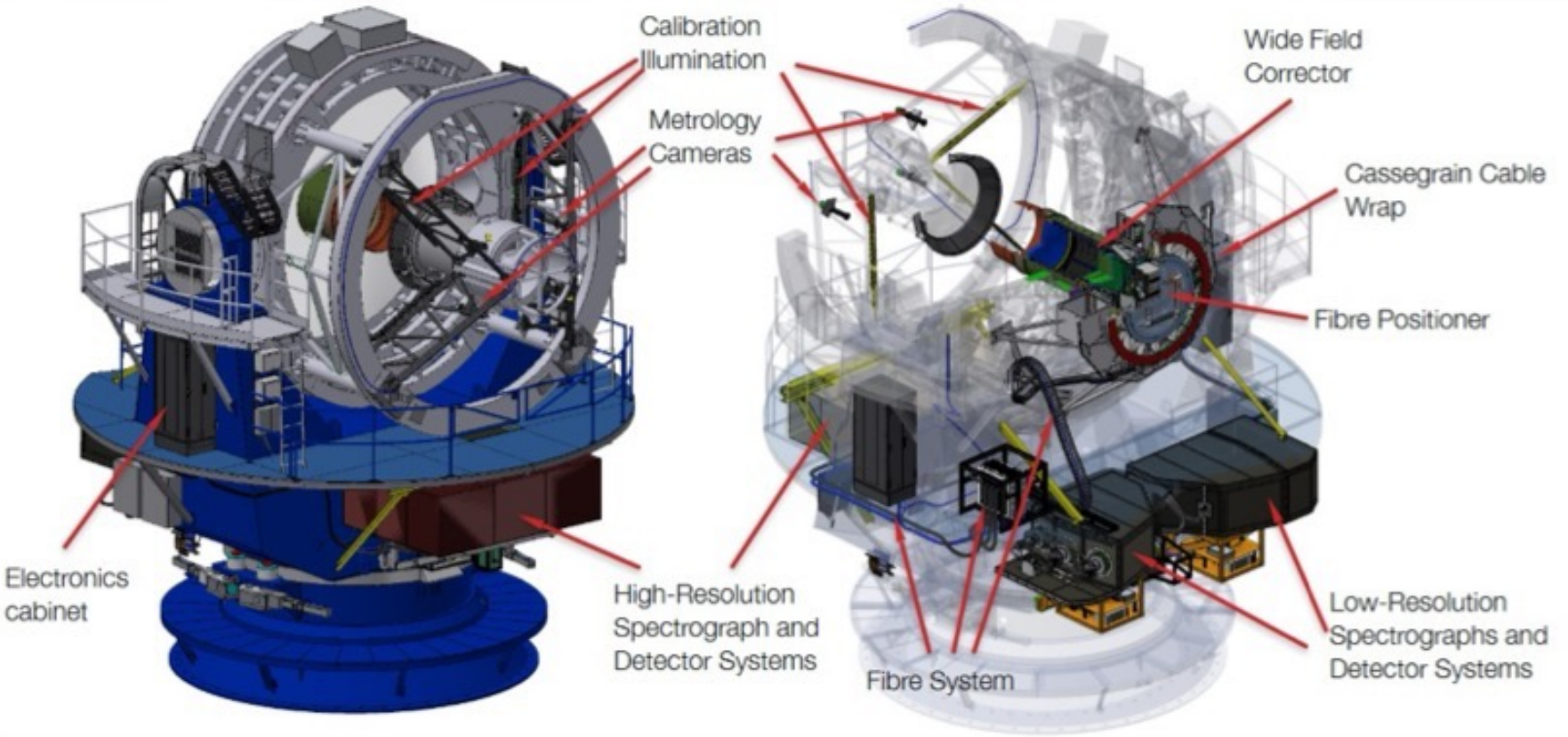


- *944 fully tested and integrated FPUs (requ. was 800, few for spares)*
- *Datum residuals investigation (but <0.1" on sky even for outliers)*
- *Photogrammetry system: FPU mean error of 5 - 10 micron*
- *Single crane rotation proc test and val, post-integration cabling, cooling, etc.*

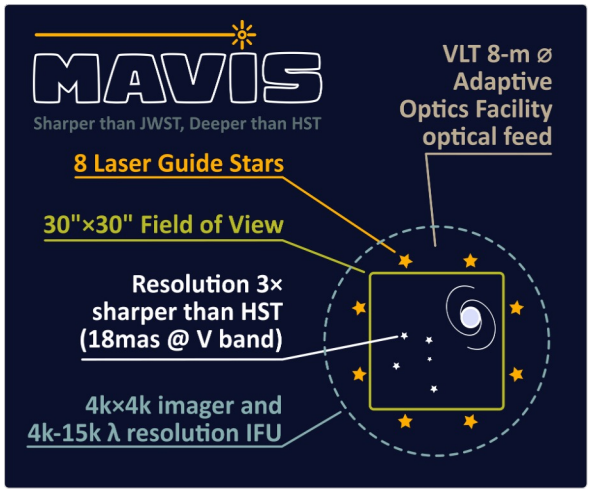


2025: 4MOST, the optical MOS for the VISTA 4m telescope (de Jong et al. 2024) See Valentini' Talk . …

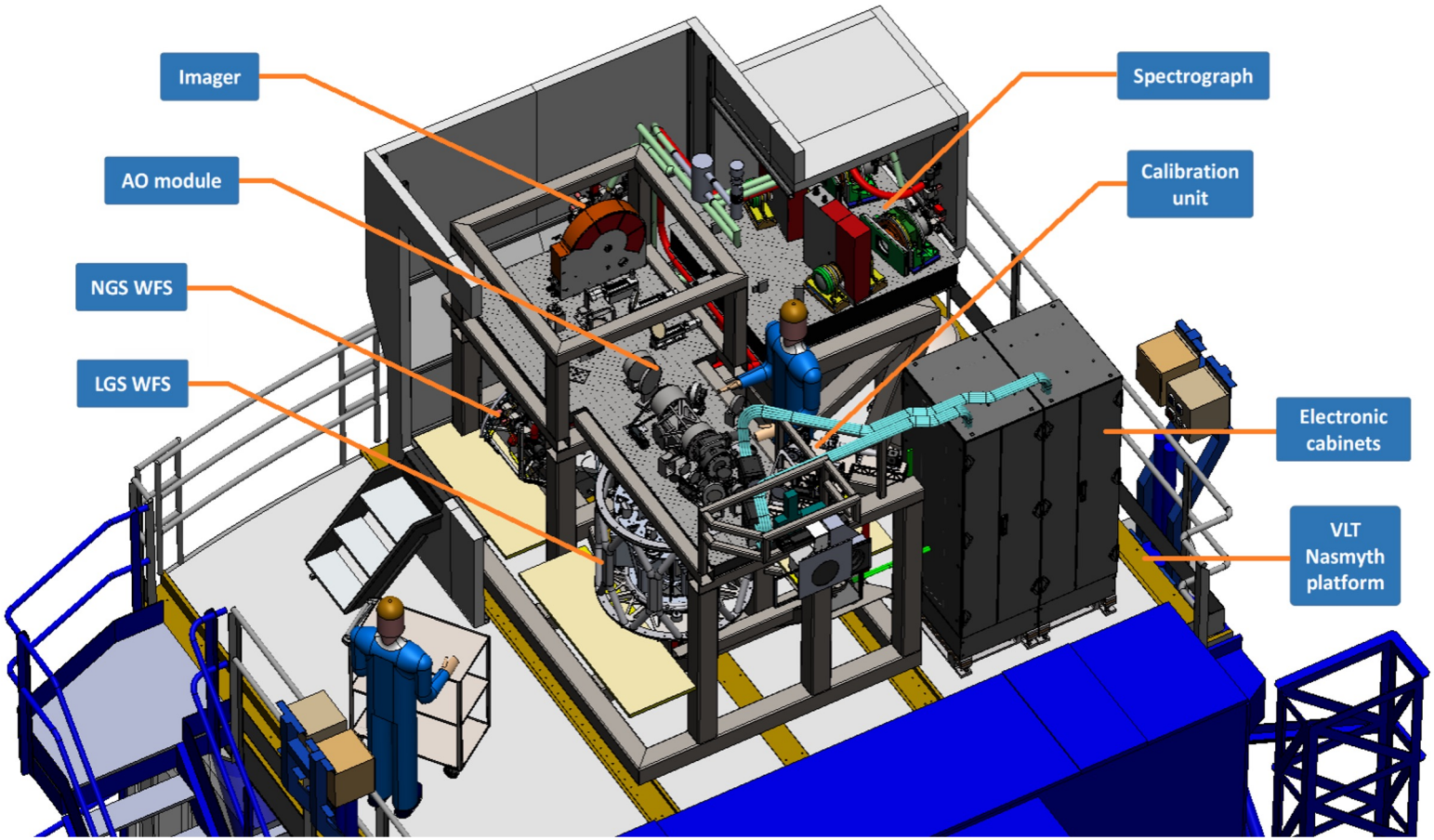
4MOST is a complex FACILITY, Going to telescope!!!



MAVIS: Sharper than JWST, deeper than HST (Rigaut et al. 2024)

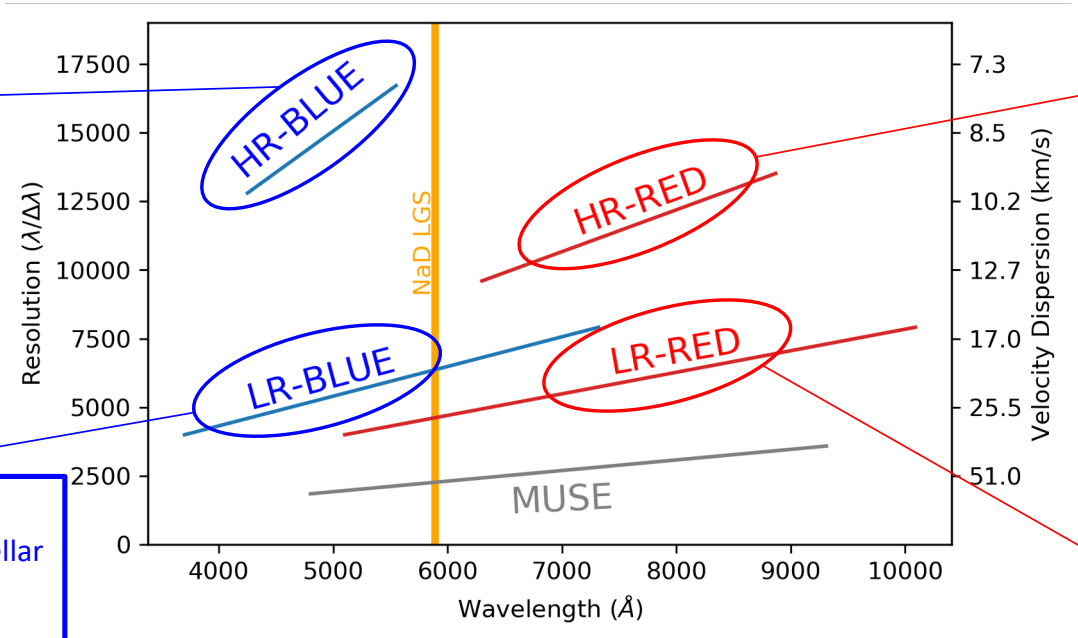


- 8 LGSs WFS
  40×40 sub-aps
  r=17.5”
- 3 NIR NGSs WFS
  1×1/2×2 sub-aps
  patrol FoV r=60”
- 2 post focal DMs
  conj. alt.6 and 13.5km
  pitch 0.25 and 0.32m
- Lasers splitted in 2 to get 8 laser sources



MAVIS IFU Spectrograph

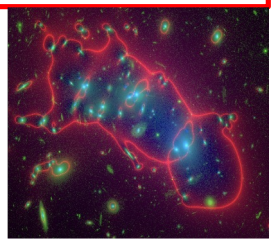
- Stellar abundances in crowded fields
- Radial velocities of stars and gas < 1km/s



- Evolution of ISM turbulence in galaxy disks
- IMBHs

- Ionised gas properties
- Hot/Massive stars, young stellar populations
- Extreme Metal Poor stars

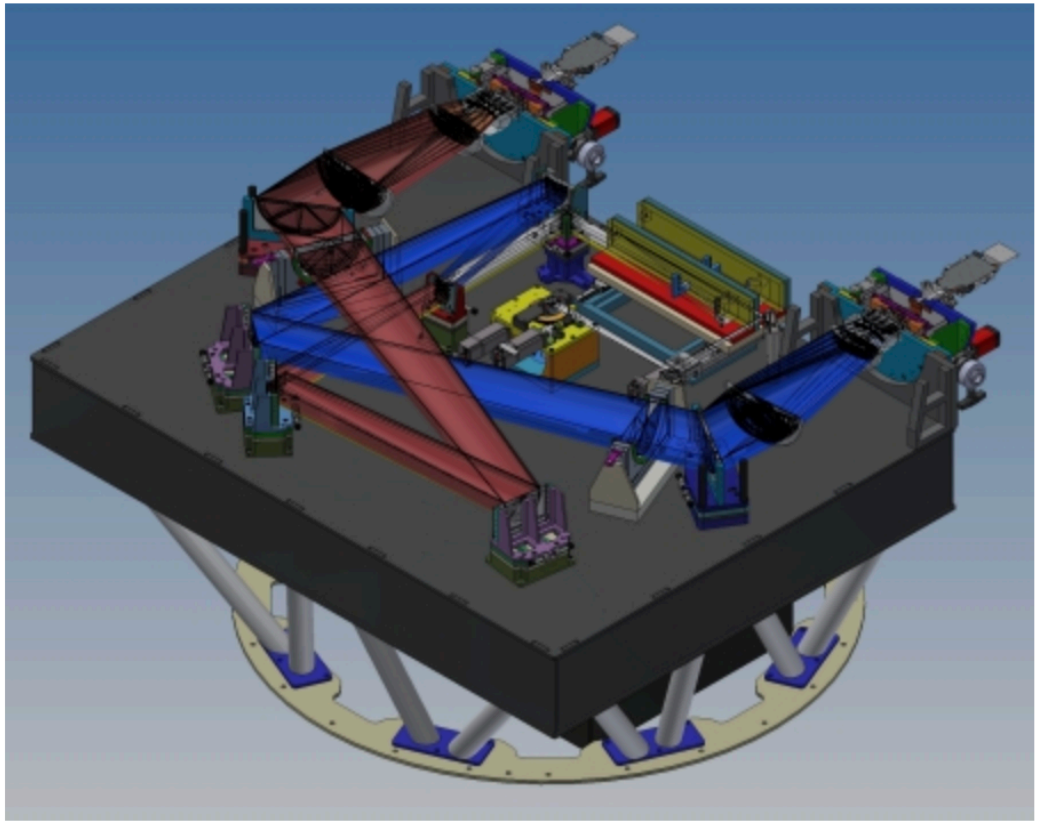
- Evolution of ISM chemistry
- Stellar dynamics z<1
- Lyα sources at z>6.6



4 different gratings to cover the whole
3700-10000 Å band
optimized for different science requirements

CUBES: Cassegrain U-Band Efficient Spectrograph (Covino et al. 2024, see B. Castilho talk)

Spectral Resolution	~20000 (~7000 LR mode also provided)
Wavelength Range	305 - 400nm
Slit length/width	HR: 10" x 1.5" (sliced into six 0.25" slitlets) LR: 10" x 6" (sliced into six 1" slitlets)
Efficiency	>40%
Focus	UT1/2/3 Cassegrain
Sensitivity	S/N>20 for U=18 mag at 313 nm (0.007nm wavelength bin)
Acquisition and guiding	V_{ref}~22, photometry error<10%

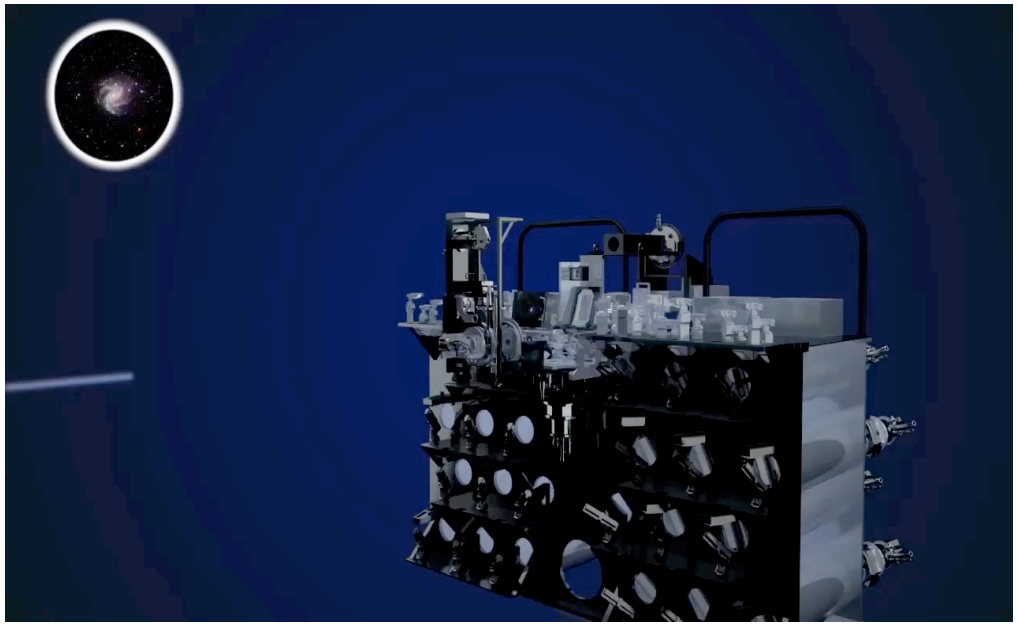


Be, heavy elements abundances in all kind of stars…

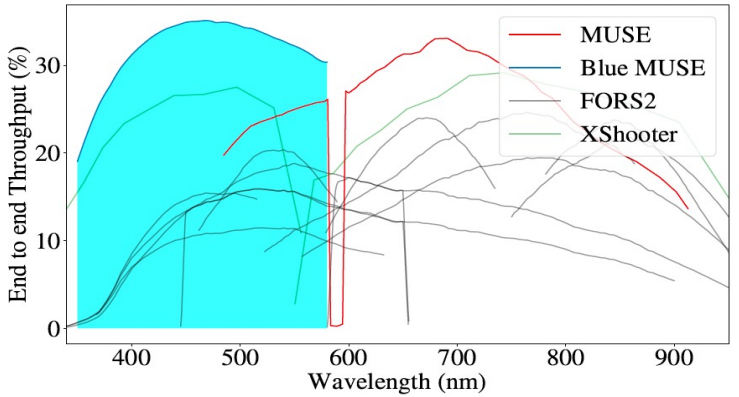
Data C

BlueMUSE (Phase A Study)(Richard et al. 2024)

Blue-optimised, medium spectral resolution, panoramic integral field spectrograph



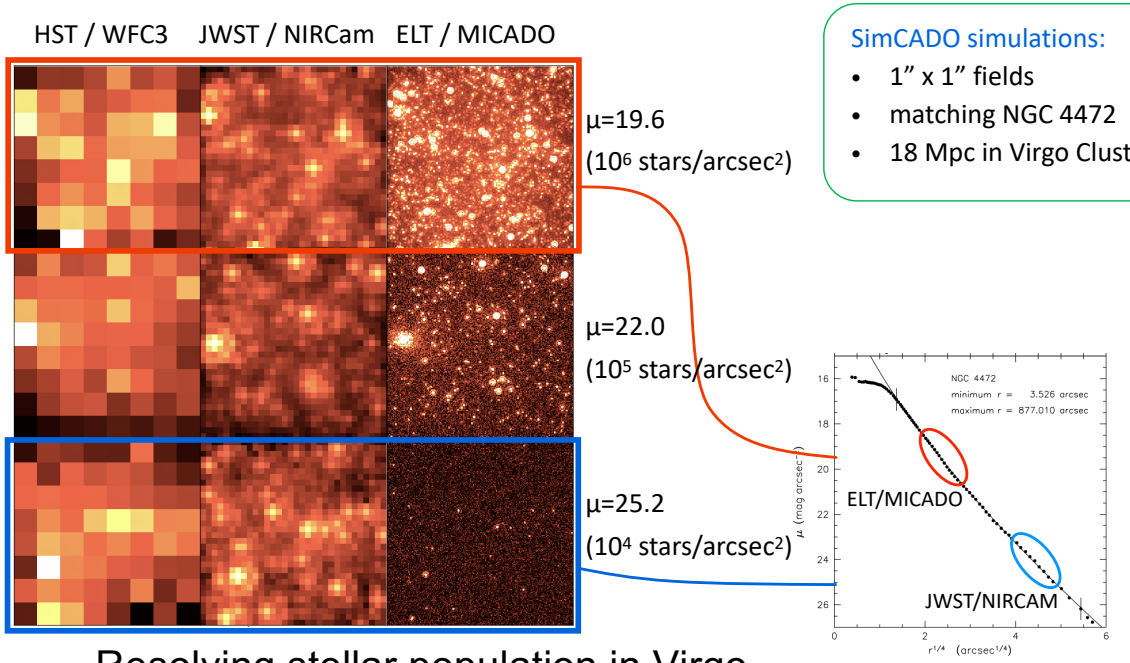
- Lambda > 350 nm
- twice spectral resolution than MUSE
- 1 arcmin² Field of View
- 0.2” x 0.3” spaxel
- 16 IFUs
- Builds on MUSE successes (but complementary)
- Science cases from solar system to high Z galaxies massive stars & star forming regions



..and ELT: MICADO !!! (Davies et al. 2021)

Wavelength	.8–2.4 μm
Field-of-view	0. 50.5" x 50.5" (4 mas pixels); 18" x 18" (1.5 mas pixels)
Filters	IYJHK broad band + medium and narrow band filters
Relative astrometry	50 μas (10 μas goal)
Contrast requirement	$1x10^{-4}$ at 100 mas; $1x10^{-5}$ at 500 mas
Spectral resolution	< 20,000
Simultaneous spectral range	1.45–2.46 μm; 0.84–1.48 μm
Slit width	16 mas
Slit length	3 arcsec

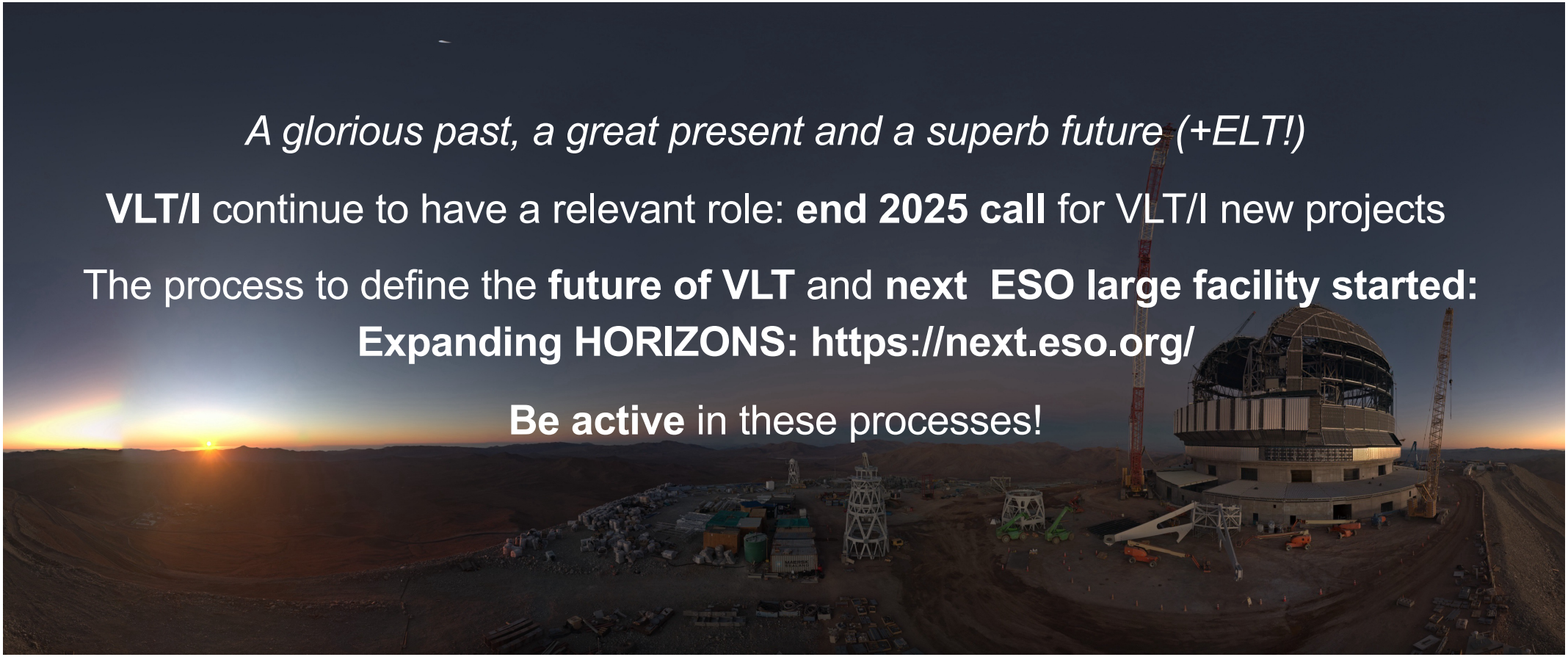
MICADO's spatial resolution in context



Resolving stellar population in Virgo
Coupling telescope area and resolution!

Courtesy E. Tostoy

Stellar Populations studies @ ESO



A glorious past, a great present and a superb future (+ELT!)

VLT/I continue to have a relevant role: **end 2025 call** for VLT/I new projects

The process to define the **future of VLT** and **next ESO large facility started:**
Expanding HORIZONS: https://next.eso.org/

Be active in these processes!

Thank you!

Luca Pasquini

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