Multi-object spectroscopy with HIRES-ELT

E. Oliva, INAF Arcetri

on behalf of the HIRES consortium
P.O. INAF (I)
Consortium members institutes from:
CH, D, DK, E, F, I, P, PL, S,UK,
Brazil, Canada, Chile, USA

P.I. A. Marconi, *P.M.* L. Valenziano, *S.E.* M. Riva

Multi-object spectroscopy with HIRES-ELT

HIRES top priority Science cases

- Physics of exo-planet atmospheres
- Cosmological variation of fundamental constants
- Sandage test
- Re-ionization of the Universe
- **Physics of (cool) stars**
- Study of near-pristine gas
- **3D reconstruction of the Circumgalactic Medium**
- **Extragalactic transients**

Multi-object spectroscopy with HIRES-ELT

HIRES capabilities at the ELT

- 0.4-1.8 microns simultaneous wl-coverage in all modes
- R=100,000 with 0.9” aperture, single target + sky
  mAB=20 with S/N=30 in 2 hours
- **R=100,000 with 0.2” aperture, 30 objects**
  mAB=21 with S/N=30 in 2 hours
- **R=20,000 with 0.9” aperture, 10 objects**
  mAB=21 with S/N=30 in 1 hour

Multi-object spectroscopy with HIRES-ELT

HIRES MOS-HR capabilities at the ELT

- 0.9-1.8 microns simultaneous (lower wl AO-limited)
- R=100,000 with 0.2” aperture, 30 objects
  mAB=21 with S/N=30 in 2 hours
- Ideal for stellar physics of distant/faint dwarfs
- Mode intrinsic to the spectrometer (no extras needed)
- It only requires a positioner for the fibers at a MCAO corrected focus (lateral port of MAORY)
- Not included in the baseline design because HIRES cannot afford access to a MCAO focus with a fiber positioner.

Multi-object spectroscopy with HIRES-ELT

HIRES MOS-MR capabilities at the ELT

- 0.4-1.8 microns simultaneous wl-coverage
- R=20,000 with 0.9” aperture, 10 objects
  mAB=21 with S/N=30 in 1 hour
- A ***super-X-shooter***
- Mode intrinsic to the spectrometer (no extras needed)
- It requires a fiber positioner on the large field focus
- Not included in the baseline design because HIRES cannot afford a positioner and cannot access the large field focus of ELT (reserved to MOSAIC).

Multi-object spectroscopy with HIRES-ELT

HIRES MOS-MR & MOSAIC

- Share the same telescope interface (Nas-B)
- Both fibers-fed, similar concepts
- Complementary instruments
  - HIRES: full wl-coverage, 10 apertures
  - MOSAIC: 200 apertures with <1/10 wl-coverage
- May share the same large fov focus and positioner

- Which MOS mode is more interesting on the ELT?

Multi-object spectroscopy with HIRES-ELT

Comparison HIRES MOS-MR & MOSAIC HR

Parameter	HIRES MOS-MR	MOSAIC OPT HR	MOSAIC IR HR
Resolving power	20,000	17,000	17,000
Simultaneous wl-coverage	Complete 400-1800 nm	636-676 nm or 840-885 nm	1471-1618 nm
# of apertures	10	200	200
Aperture size	D=0.9”	D=0.8”	D=0.6”
ADC	Yes	No	

Multi-object spectroscopy with HIRES-ELT

Comparison HIRES MOS-MR & MOSAIC LR

Parameter	HIRES MOS-MR	MOSAIC OPT LR	MOSAIC IR LR
Resolving power	20,000	5,000	5,000
Simultaneous wl-coverage	Complete 400-1800 nm	460-584 nm or 570-722 nm or 703-890 nm	800-1078 nm or 1033-1388 nm or 1343-1800 nm
# of apertures	10	200	200
Aperture size	D=0.9”	D=0.8”	D=0.6”
ADC	Yes	No	

Multi-object spectroscopy with HIRES-ELT

HIRES MOS-MR & MOSAIC

- Share the same telescope interface (Nas-B)
- Both fibers-fed, similar concepts
- Complementary instruments
  - HIRES: full wl-coverage, 10 apertures
  - MOSAIC: 200 apertures with <1/10 wl-coverage
- May share the same large fov focus and positioner

- **Which MOS mode is more interesting on the ELT?**

Fundamental parameter of instrument design

Complexity, volume, cost etc. of any spectrometer scale with the Spectrometer Equivalent Power (S.E.P.)

$$\mathbf{S.E.P. = R} \times \mathbf{N} \times \mathbf{A} \times \mathbf{WLC} \times \mathbf{Atel}$$

R: Resolving power
N: Number of simultaneous apertures on sky
A: Projected sky area of each aperture
WLC: Simultaneous wavelength coverage
Atel: Collecting area of telescope

HIRES and MOSAIC have similar values of S.E.P.
Chosen values of S.E.P. were limited by budget available.

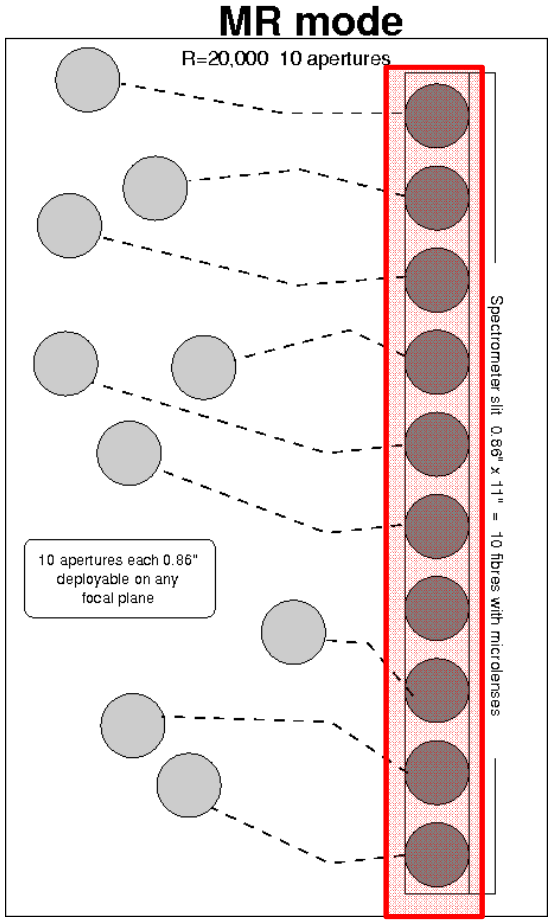
Multi-object spectroscopy with HIRES-ELT

HIRES MOS-HR capabilities at a 8m telescope

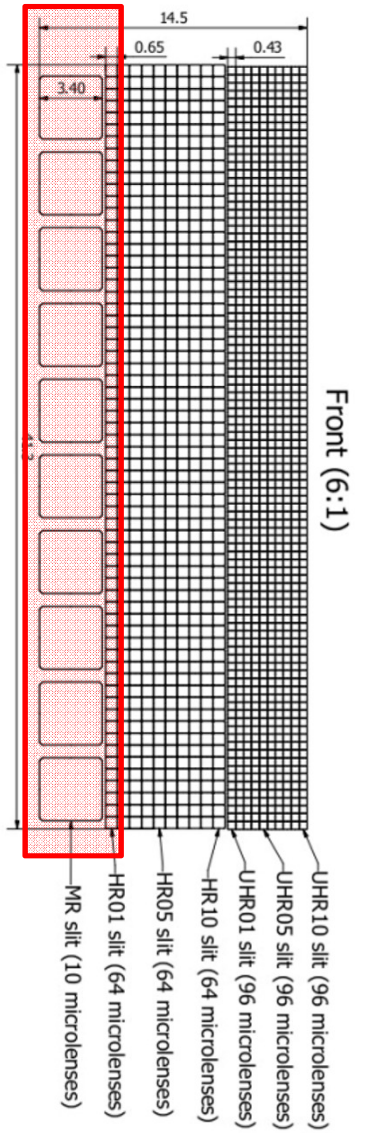
- 0.4-1.8 microns simultaneous
- R=100,000 with 0.8" aperture, 30 objects
  mAB=19 with S/N=30 in 2 hours
- Could use existing fiber positioners
- Could be used soon (before ELT) if the HIRES spectrometer is built quickly (!!!???) Feasible
  - ✓ Quite standard technology
  - ✓ Self-funded instrument
  - ✓ Partners with $$$ and easy access to telescopes

Technical details for HIRES modes

HIRES MOS-MR



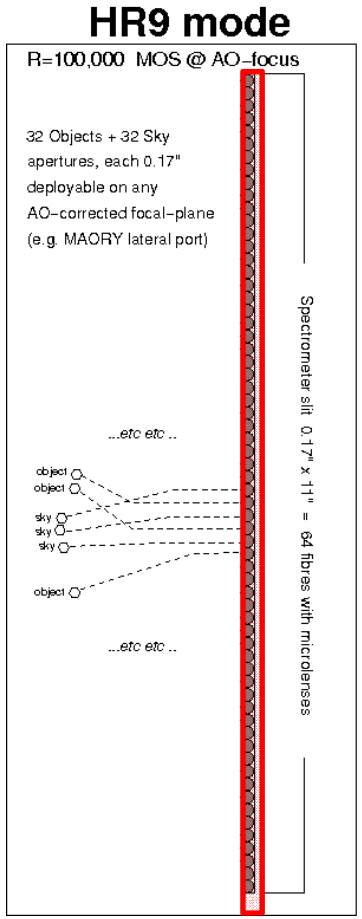
Microlens array = slit



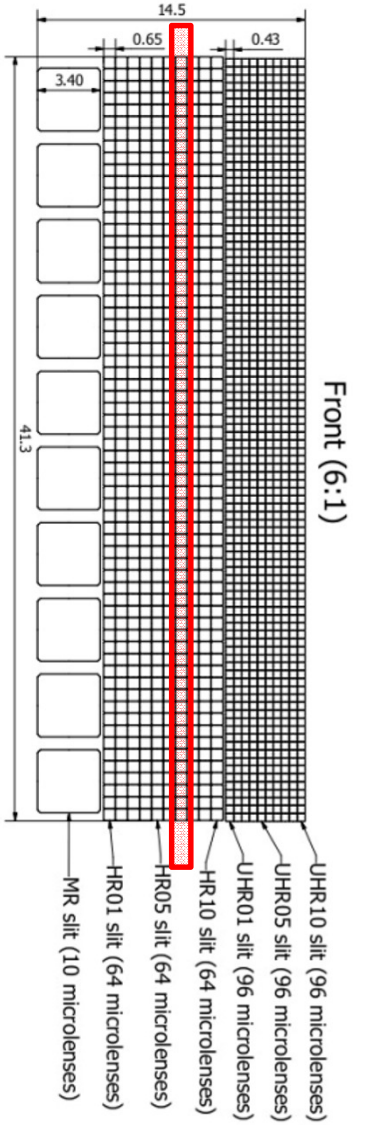
Fiber bundles, slits and observing modes of HIRES

Technical details for HIRES modes

HIRES MOS-MR



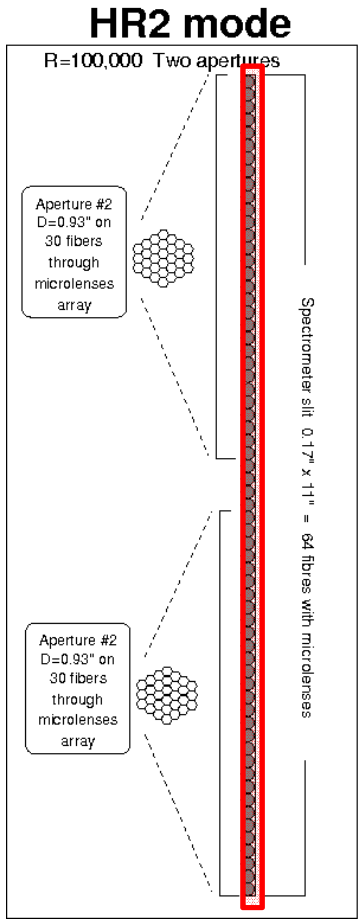
Microlens array on slit



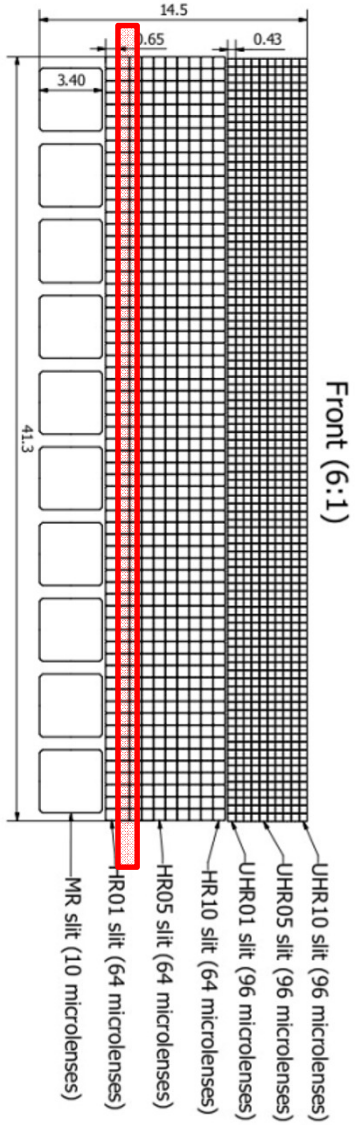
Fiber bundles, slits and observing modes of HIRES

Technical details for HIRES modes

HIRES normal HR

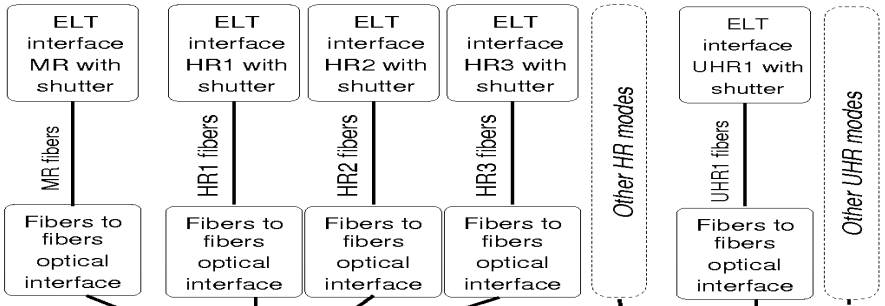


Microlens array on slit



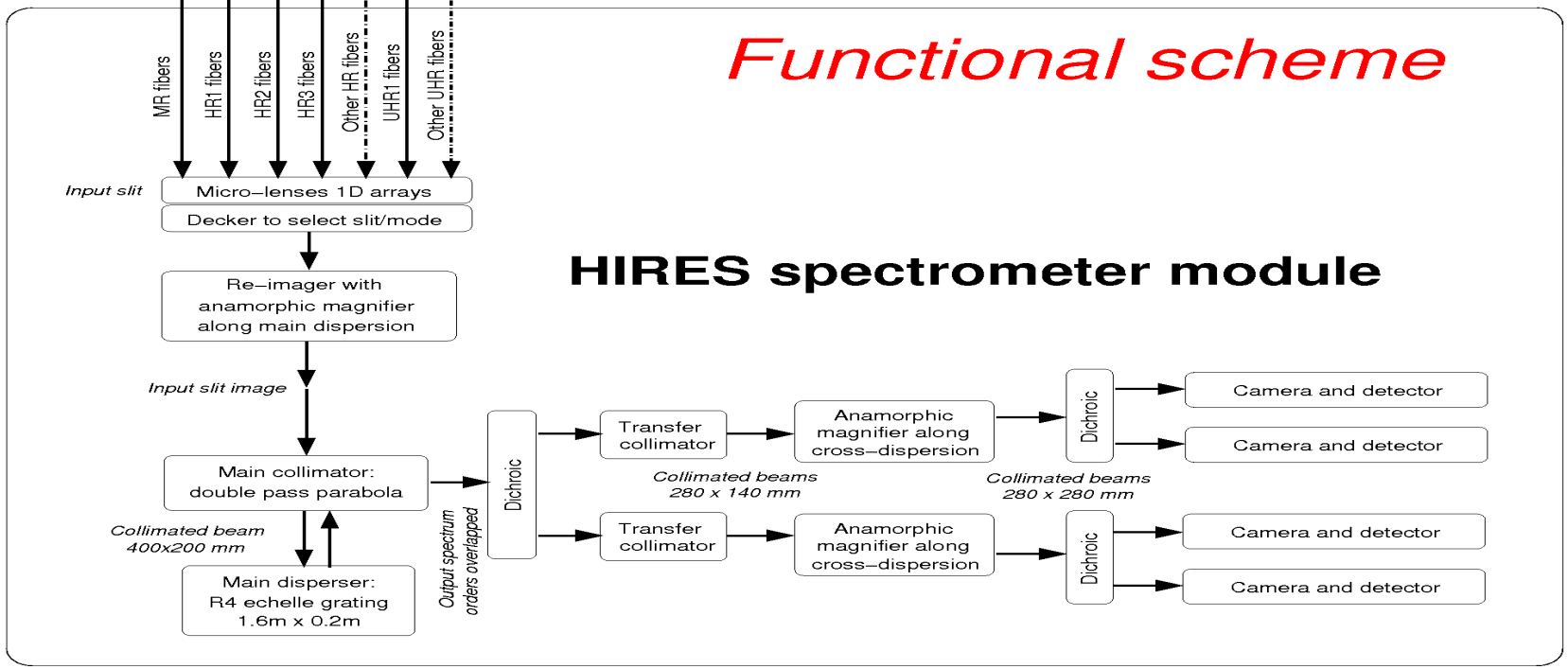
Fiber bundles, slits and observing modes of HIRES

Technical details for HIRES modes

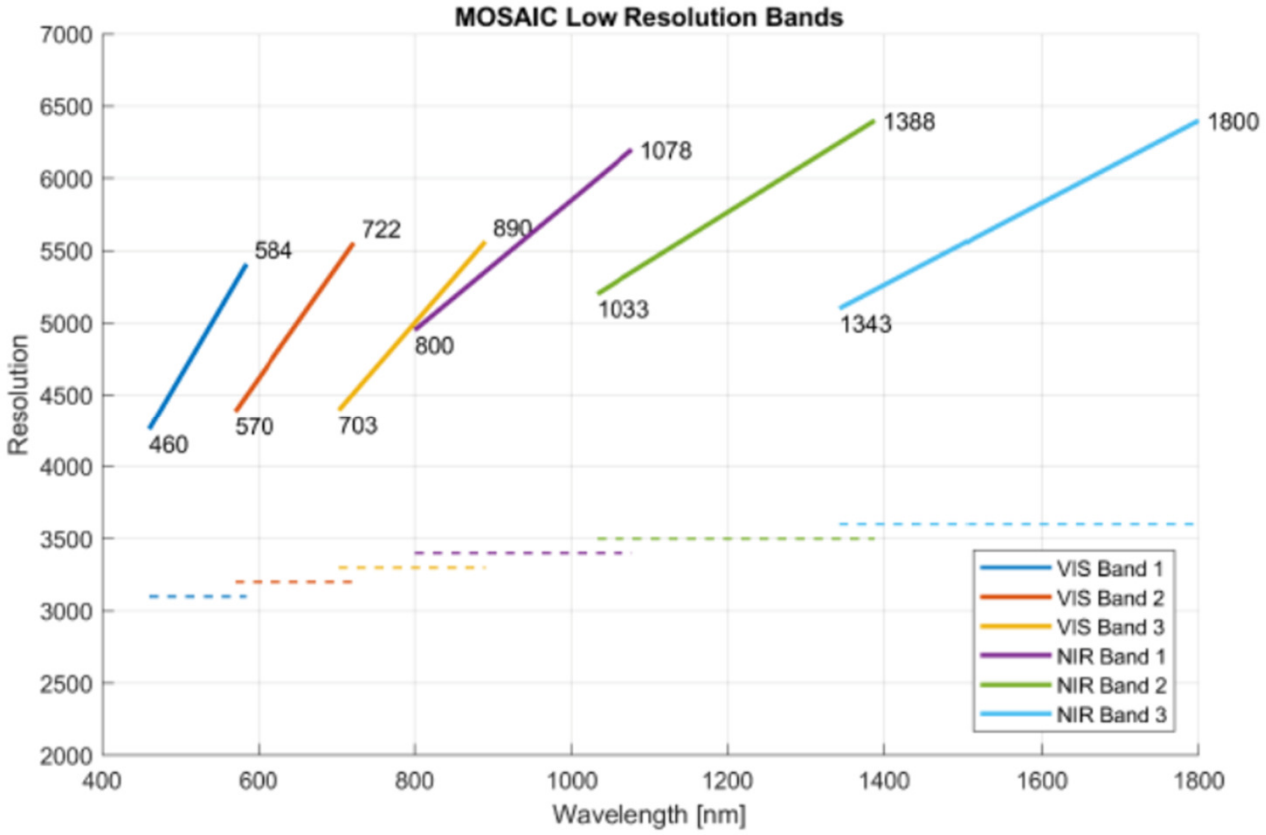


HR1 : optimized for RV accuracy
HR2 : optimized for throughput
HR3 : optimized for IFU with zoom
HR4 : optimized for polarimeter
HR5 : optimized for …
HR6 : optimized for ….
HR7 : optimized for …
HR8 : optimized for ….
HR9 : optimized for ….
HR10 : MOS 32 obj at AO–corrected focus
…. other HR modes possible…

Similar modes with UHR fibers/slits

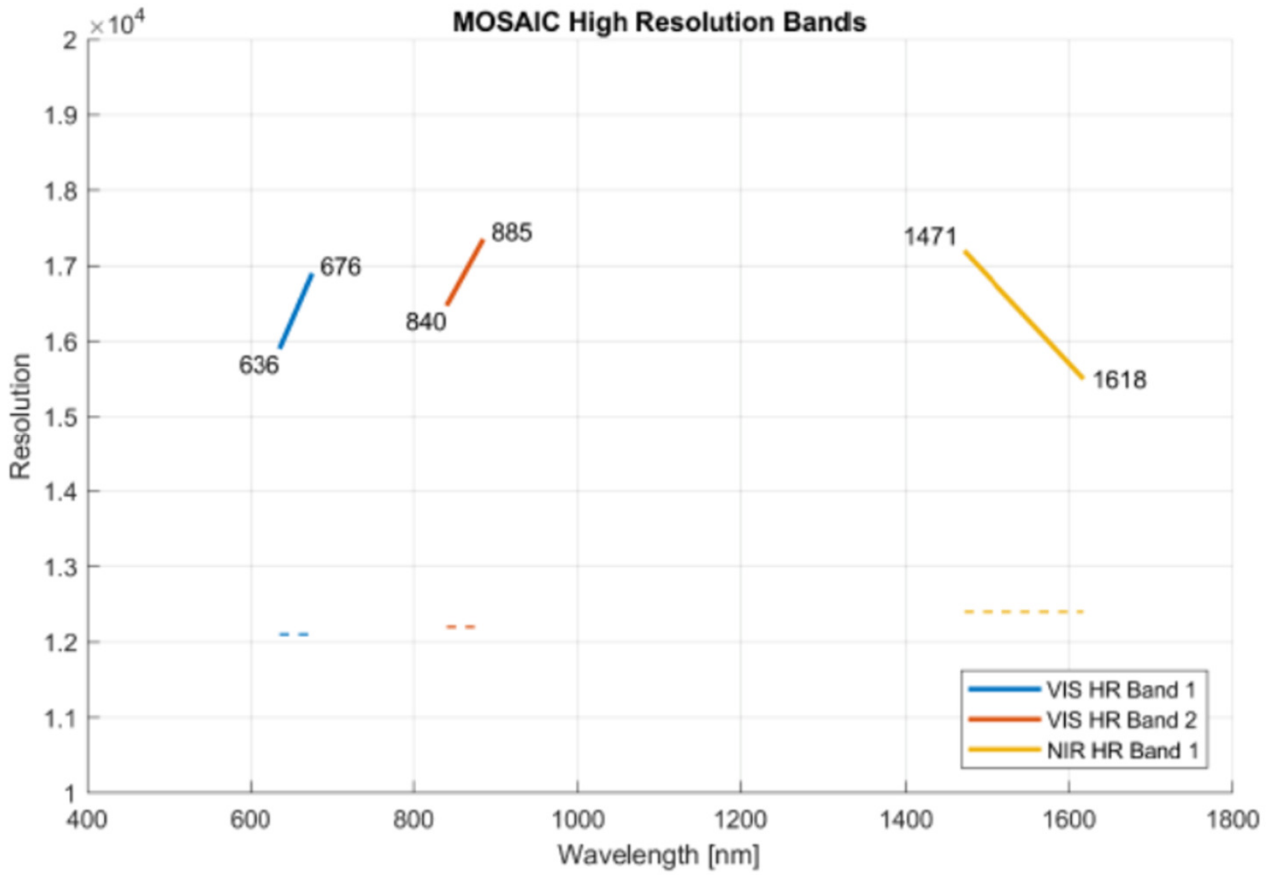


Extras and comments



LR spectral coverage of Mosaic

Extras and comments



MR spectral coverage of Mosaic

Extras and comments

Limiting magnitude from MOSAIC web page with ESO-ELT calculator:

HAB=28 , R=5,000 , S/N=3 requires 1600 hours

RAB=26 , R=5,000 , S/N=3 requires 7 hours

Extra useful numbers

IAB=24 , R=5,000, S/N=10 requires 2 hours

IAB=24 , R=15,000, S/N=10 requires 6 hours