MAVIS

Deeper than HST, Sharper than JWST
10 Slides Status @ Start of phase B

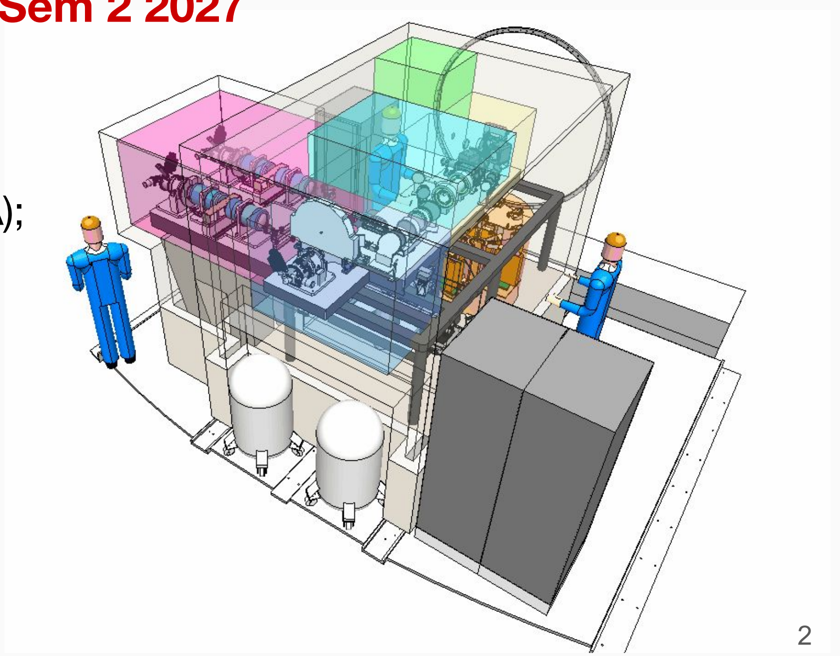
Prof Francois Rigaut (ANU, Principal Investigator)

A/Prof Richard McDermid (MQ, Project Scientist)

Dr Giovanni Cresci (INAF, Deputy Project Scientist)

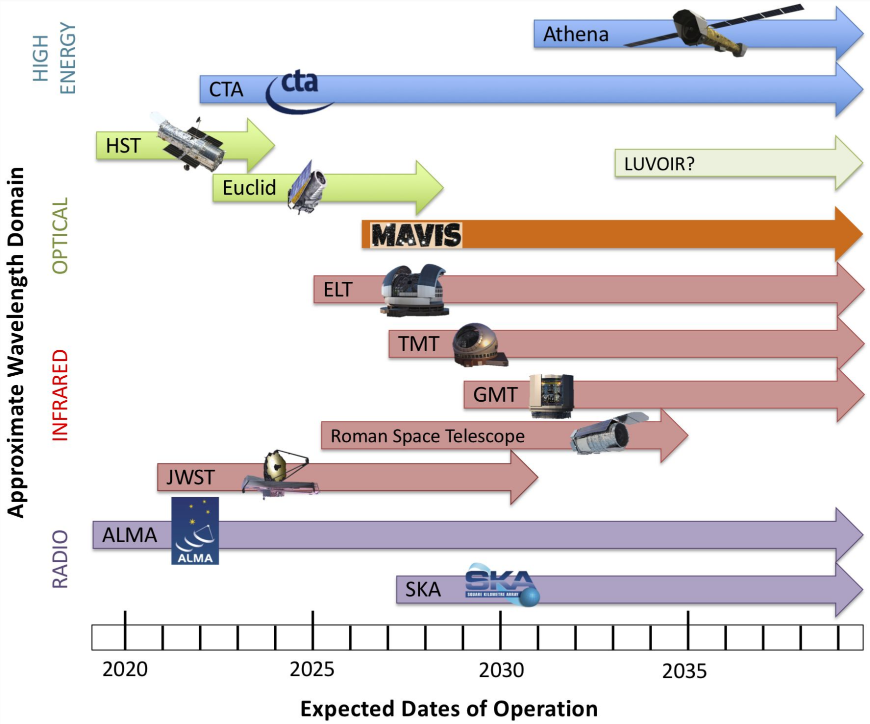
MAVIS: Deeper than HST, Sharper than JWST

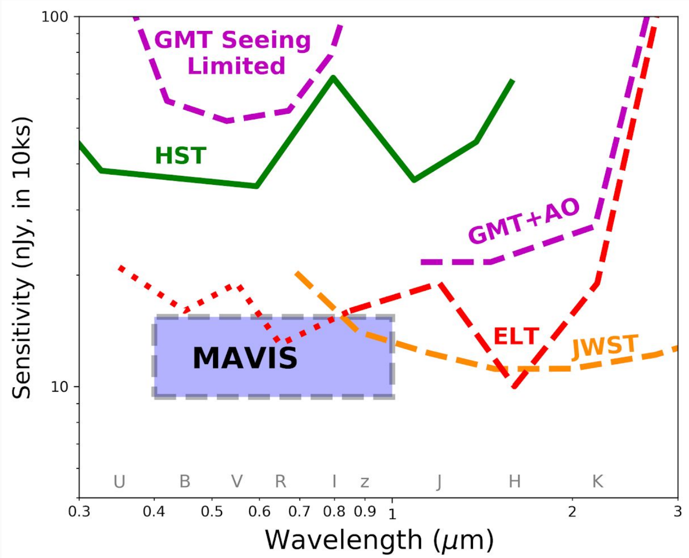
- **Multi-conjugate Adaptive Optics** system for correction in the **visible**
  - complete with an **4k✕4k imager** @ 7.3mas pixels
  - and an **IFU w/ 4 spectral resolution modes** (4-12k), ¼ number of MUSE spaxels
- Expecting > **10% Strehl** (goal 15%) **at V band** over **30”x30”**
- **50% sky coverage** @ South GP for 15% encircled energy in 50 mas spaxel
- Imager 5 sigma limiting mag in 1 hour **V = 29.5** (SNR = HST x 2 on . source)
- Consortium Australia (**AAO Consortium**, lead) / **INAF / LAM / ESO**
- Passed phase A 06/2020, **first light expected Sem 2 2027**
- For the ESO VLT AOF (UT4)
  - 4x2 Laser Guide Stars;
  - 3 Near-IR NGS Wavefront Sensors (using SAPHIRA);
  - 3 Deformable mirrors (DSM + 2 post focal DMs);
- A **brilliant science case** (publicly available on arXiv)

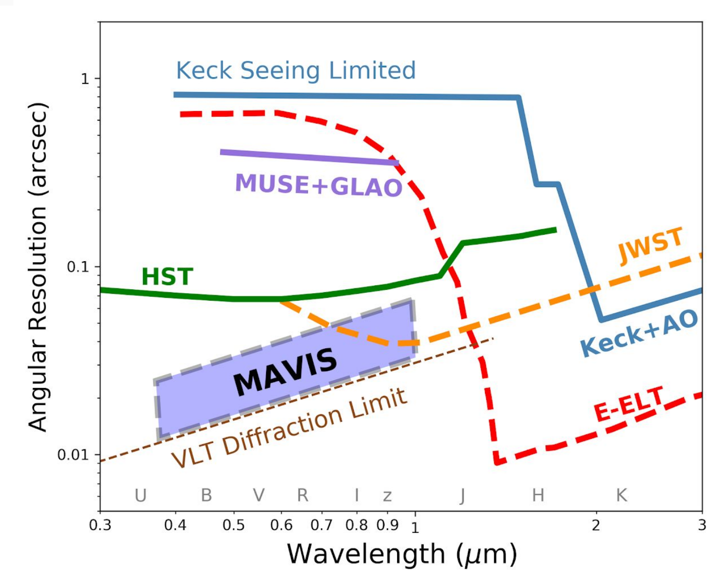


INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS · Australian National University · AAO · LAM LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE · MACQUARIE University SYDNEY·AUSTRALIA · ESO

BY MID-2020'S THE NEED FOR MAVIS WILL BE URGENT

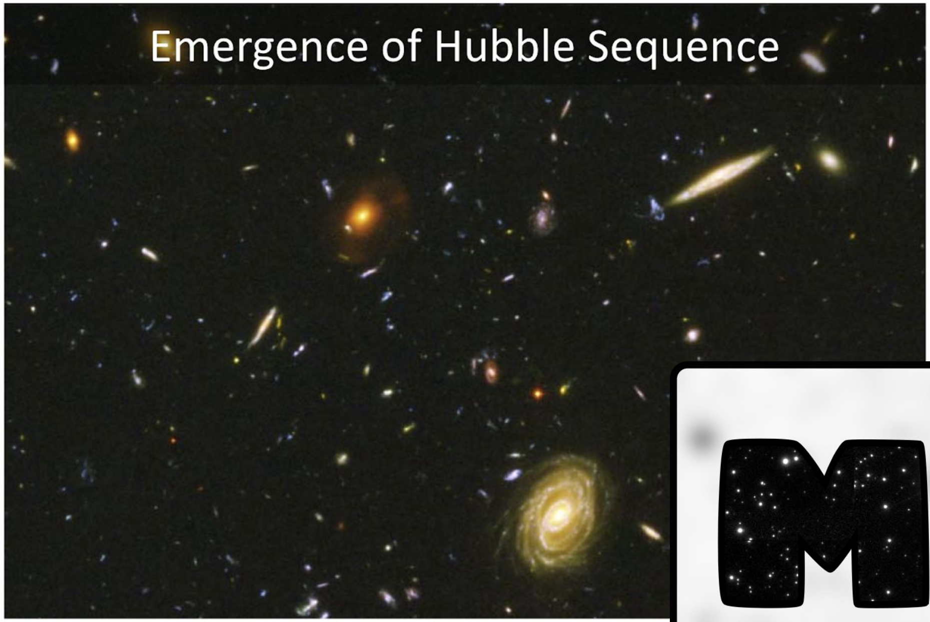






- Future facilities will look deeper and sharper than ever before
- Among general purpose facility instruments, only MAVIS combines high sensitivity with high angular resolution at optical wavelengths

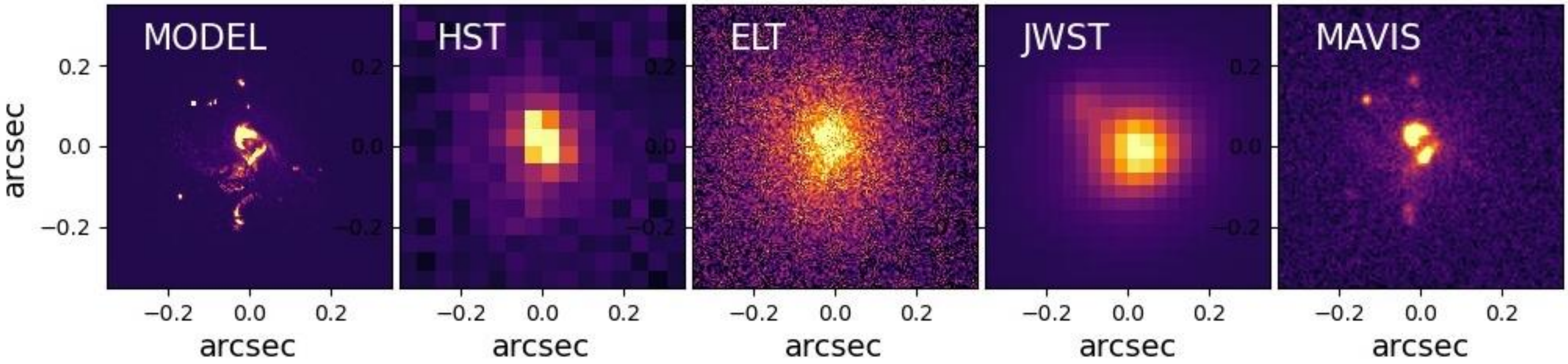
(General Purpose = Imaging+Spectroscopy over most of sky)



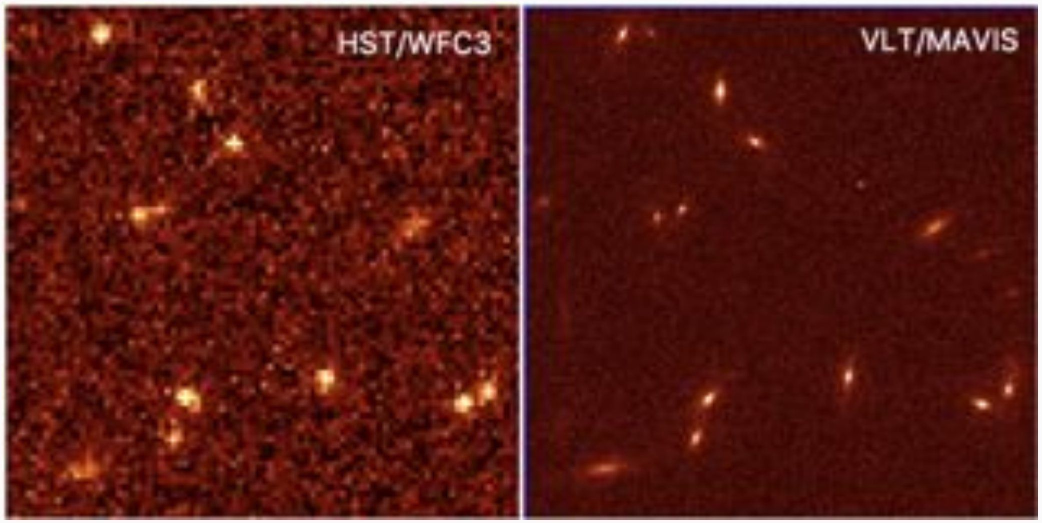
PHASE A SCIENCE CASE

https://arxiv.org/abs/2009.09242

Snapshot Science: Galaxy Rest-frame UV Morphologies



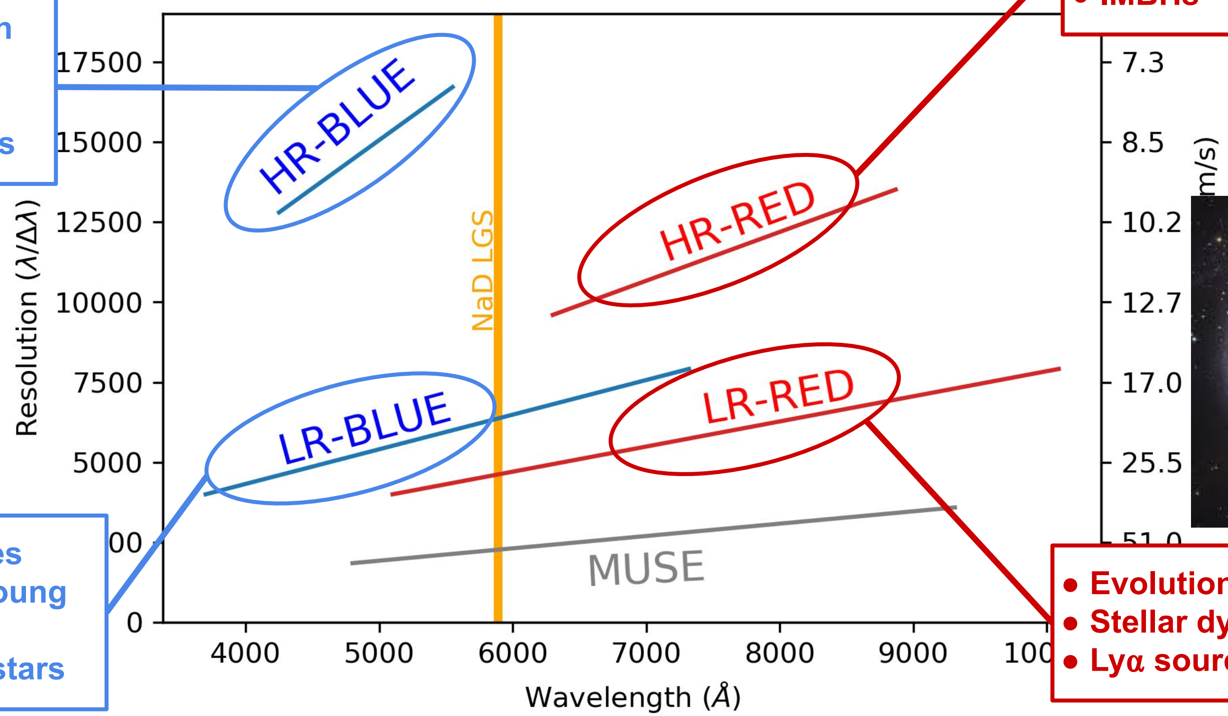
- MAVIS will allow the deepest optical images ever taken
- Crucial for understanding the UV morphology of the faintest galaxies at high redshift



MAVIS Spectral Capabilities

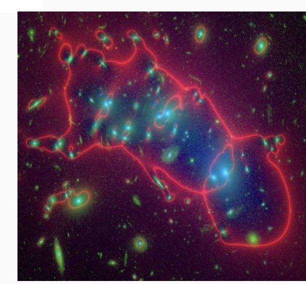
- Stellar abundances in crowded fields
- Radial velocities of stars and gas < 1km/s

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



- Evolution of ISM
- Turbulence in galaxy disks
- IMBHs

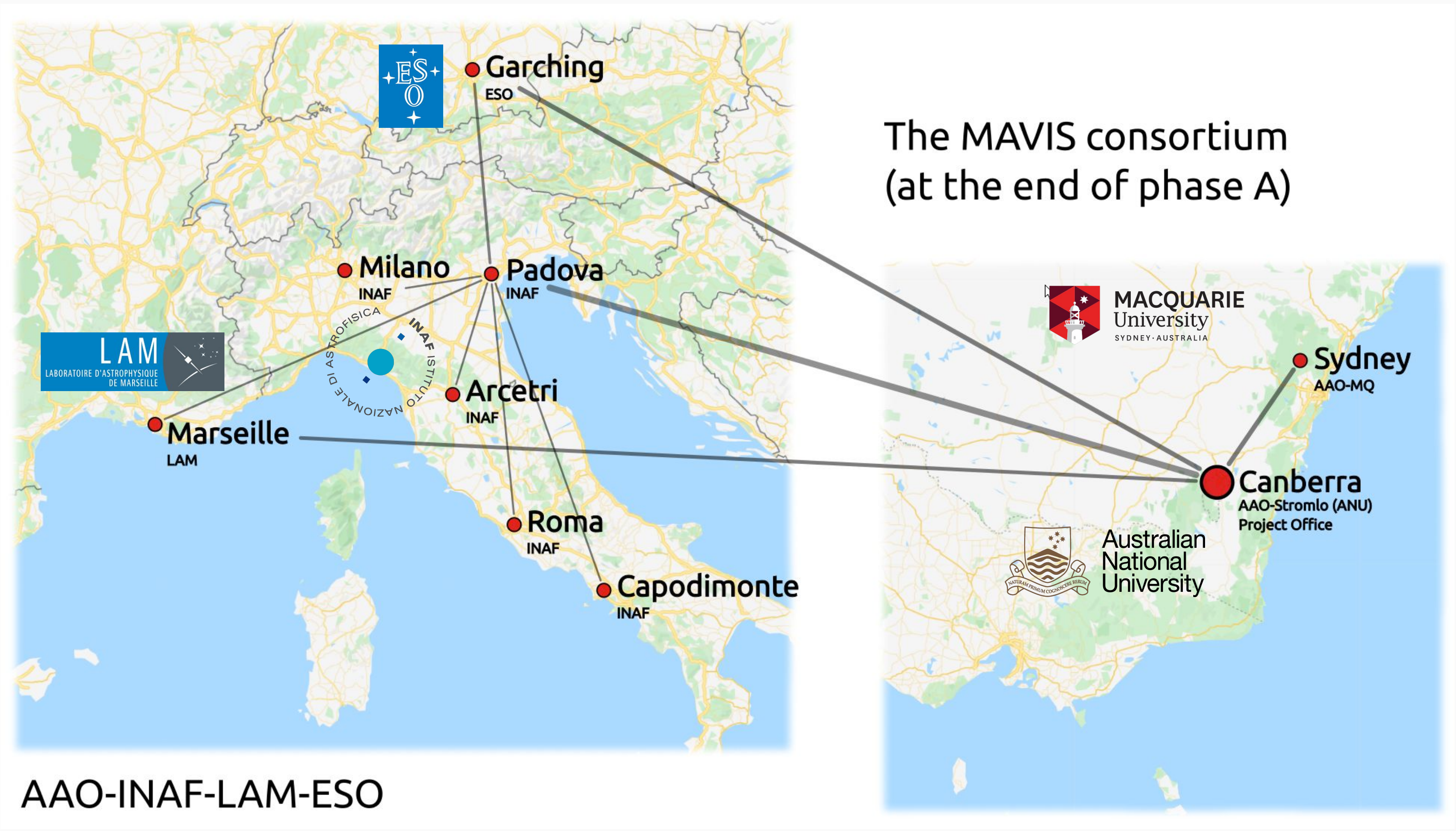
- Evolution of ISM chemistry
- Stellar dynamics z<1
- Lyα sources at z>6.6



- This is science that CANNOT be done with MUSE-NFM spectral resolution, wavelength coverage, and lack of high-res imaging
- Significantly higher sky coverage of MAVIS amplifies this contrast by also allowing statistical samples and rare objects to be readily observed

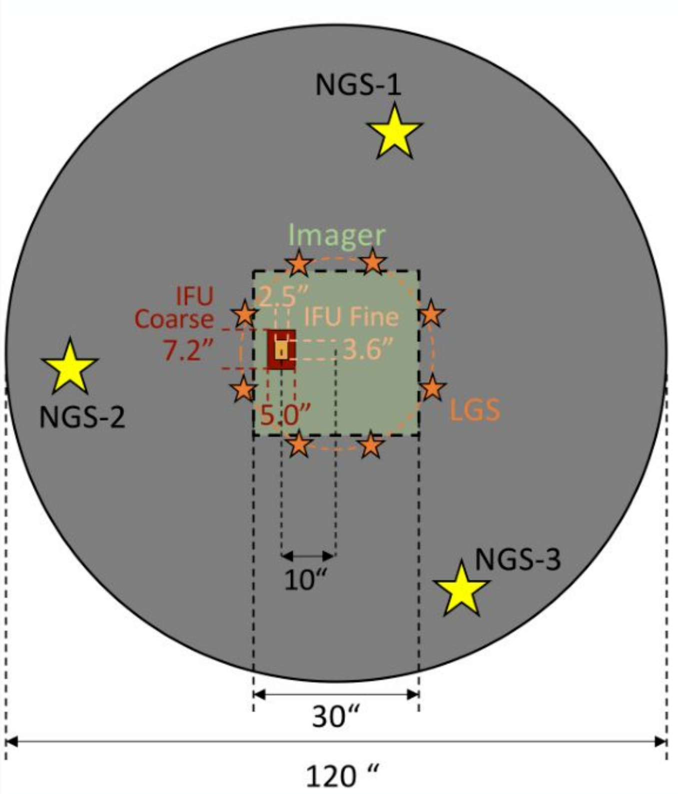
The MAVIS Consortium

- Australia-ESO strategic partnership 2018-2027
- First ESO instrument led by Australia
- Workload split about 50-50 Australian/INAF+LAM+ESO



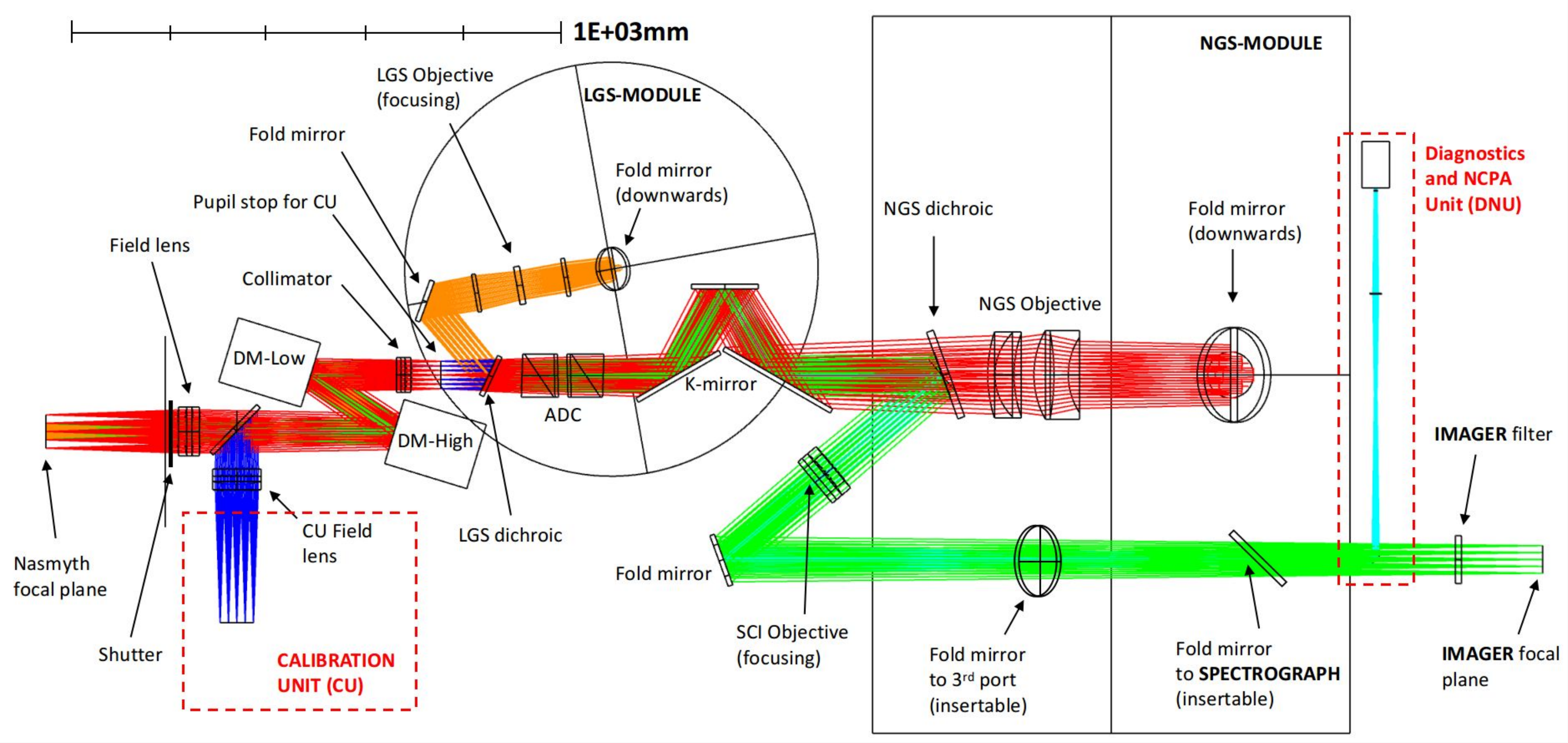
MAVIS TOP-LEVEL SPECIFICATIONS (BASELINE)

Science Field	30”x30”
Angular Resolution	FWHM ~ 20mas at V band
Strehl Ratio	>10% (15% goal) at V under median conditions
Sky Coverage	> 50% at the Galactic pole
Wavelength Coverage	VRI (optimised); B-z (extended)
Imager	~ 7mas pixels. 7 broad and 15 narrow band filters, 1h 10σ for V ~ 29.5
Spectrograph	Image slicer. Two spatial modes: ~3”x3” @ 25mas and ~6”x6” @ 50mas. Four spectral modes: 370-1000nm, R=5,000-15,000
Visitor port	Potential for third instrument



AN INNOVATIVE OPTICAL DESIGN

- > 5 iterations on optical design (below design as of 10/2020)
- Innovative: (a) uses refractive elements and (b) does not collimate the beams
- Everything gravity invariant (except K mirror and ADC)
- Very "healthy" design, all zero-order principles of AO design are there.



Challenges

- Very **tight errors budget**; targeting 135 nm rms (goal 120)
  - Non-Common Path Aberrations
  - Any drift due to temperature and gravity changes
  - Can't tolerate significant "unknown" error budget term
  - New live monitoring, **active supervisor approach** of error budget
- **Sky coverage**
  - We are adopting a no-compromise approach to reach the specifications
  - NIR, diffraction limited PSFs for TT sensing
  - Use of **SAPHIRA APD-arrays**
- **Astrometry**
  - Multi-conjugate fixes aberrations over the FoV, but can also **mess up distortions**
  - Targeting similar requirements than MICADO
  - Developing calibration/observation/reduction strategy
  - Folding into design to reduce impact on astrometry
- **LGS flux marginal** in low season
  - Looking at possibility to increase laser power and/or use predictive control

A Happy MAVIS Consortium