

MAVIS on the VLT: the cutting-edge MCAO assisted imager and spectrograph for visible observations

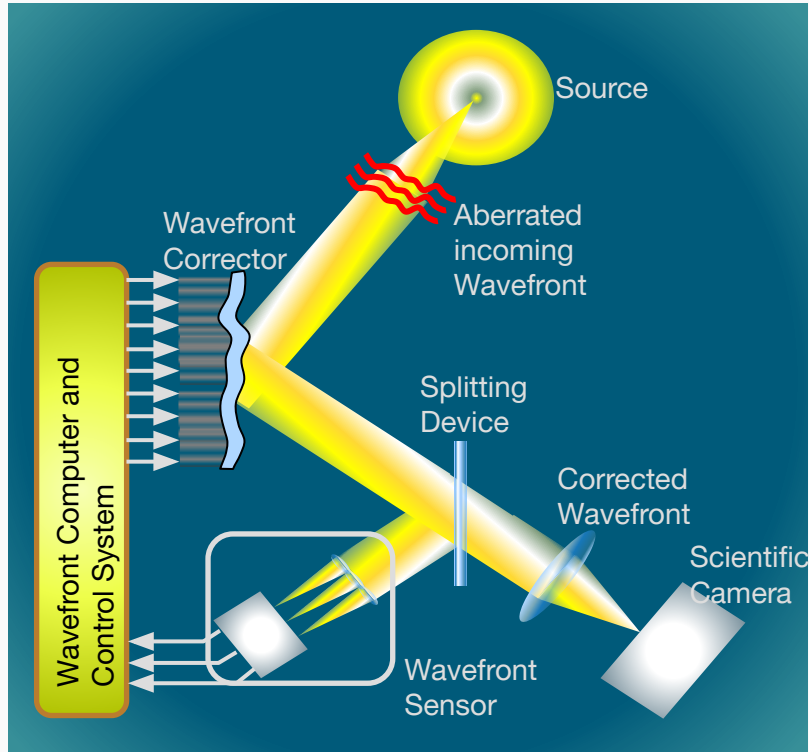
Speakers:
Cerpelloni Paolo,
Rebrysh Oleksandra

1. Adaptive optics introduction.
2. MAVIS in a nutshell.
 - 2.1 MAVIS design
 - 2.2 Science cases
3. Where are we now?
 - 3.1 MAVIS consortium
 - 3.2 INAF involvement
 - 3.3 Schedule



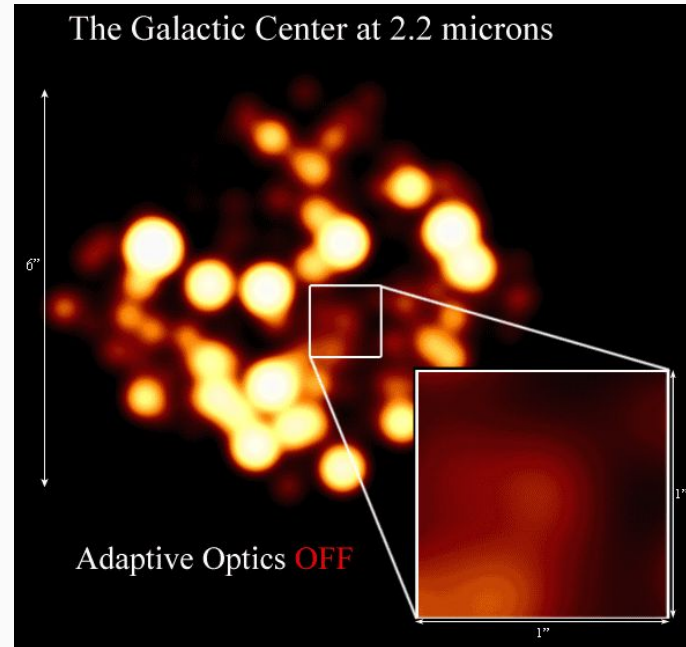
ADAPTIVE OPTICS

Adaptive optics is a technique used to compensate for the light distortions and aberrations



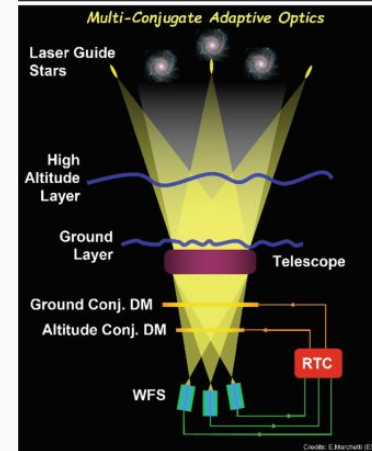
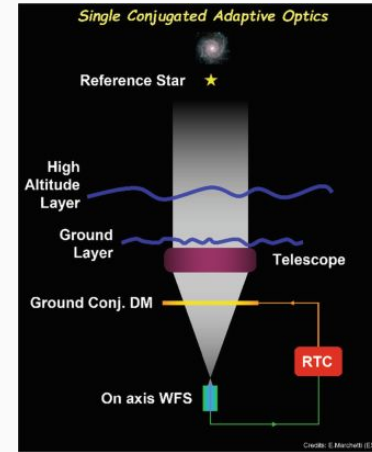
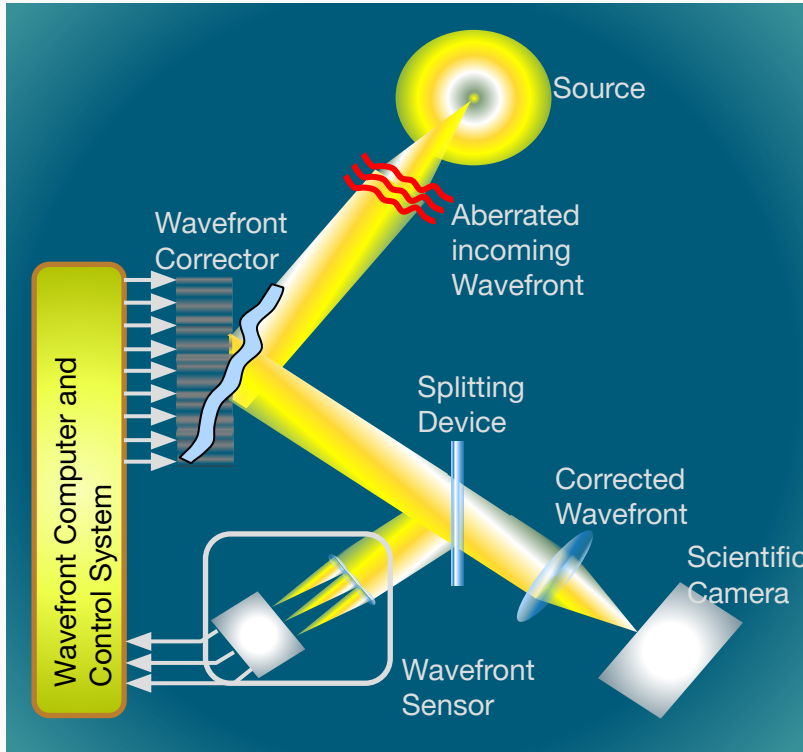
Parameters

- Sky Coverage
- Strehl Ratio
- Corrected FoV size

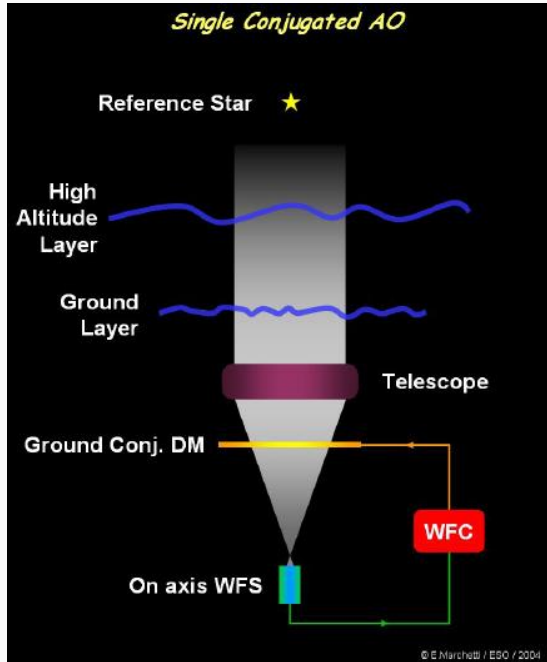


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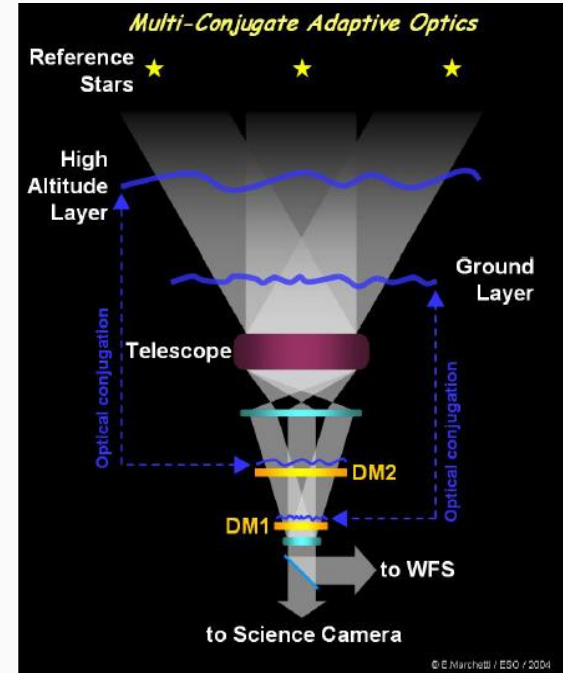


ADAPTIVE OPTICS



1 Deformable Mirror

Corrected FoV size
&
Sky Coverage
INCREASING →



MORE Than 1 Deformable Mirrors

MCAO IN THE VIS REGIME

$$SR \approx e^{-WFE(rad)^2}$$

Fried parameter: ~10cm V, ~50cm IR
 Coherence time: ~10ms in V, ~50ms IR

VIS SCAO

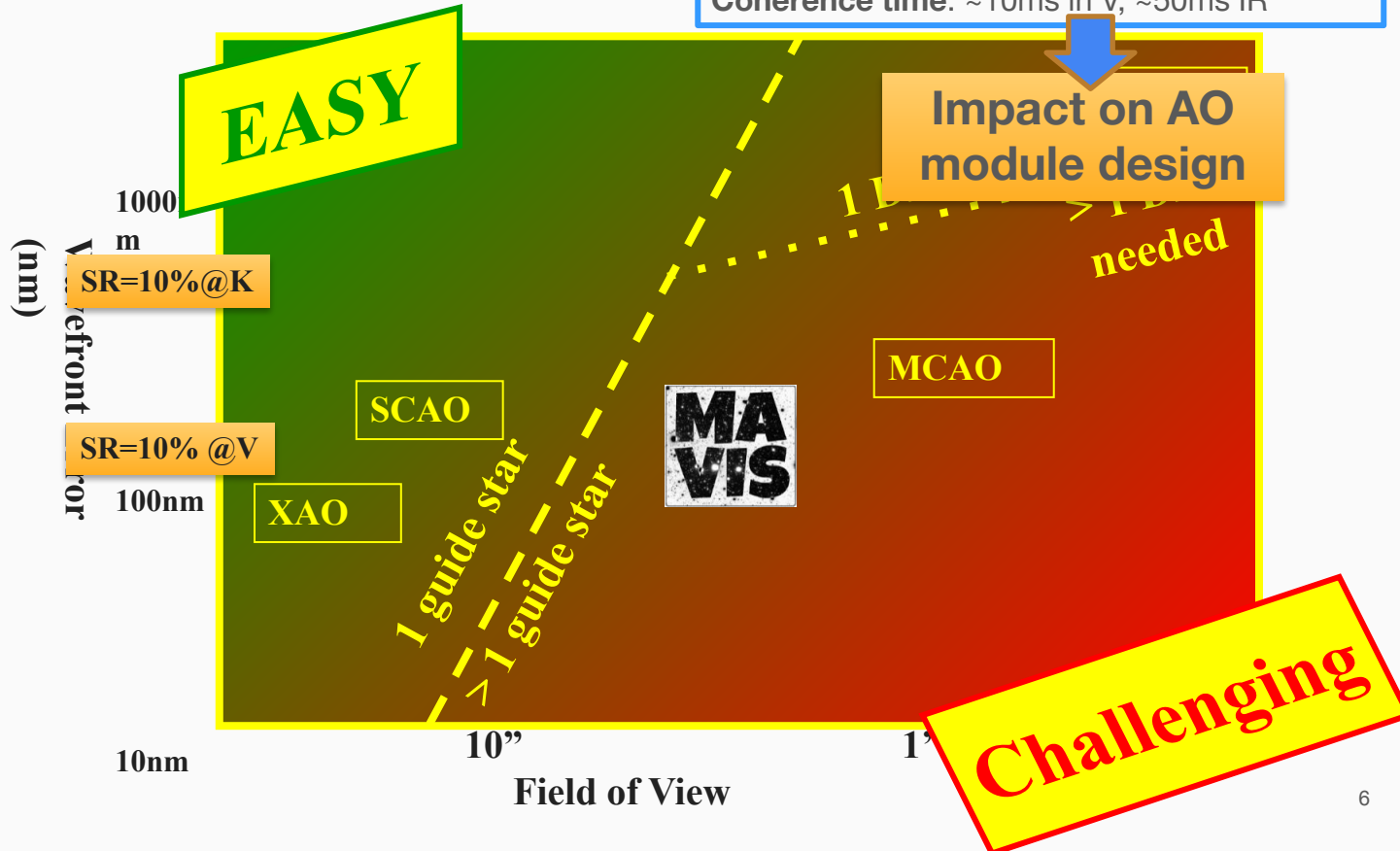
- SHARK-VIS ForeRunner
 - @650nm,
 - 50%SR,
 - 18mas FWHM

NIR MCAO

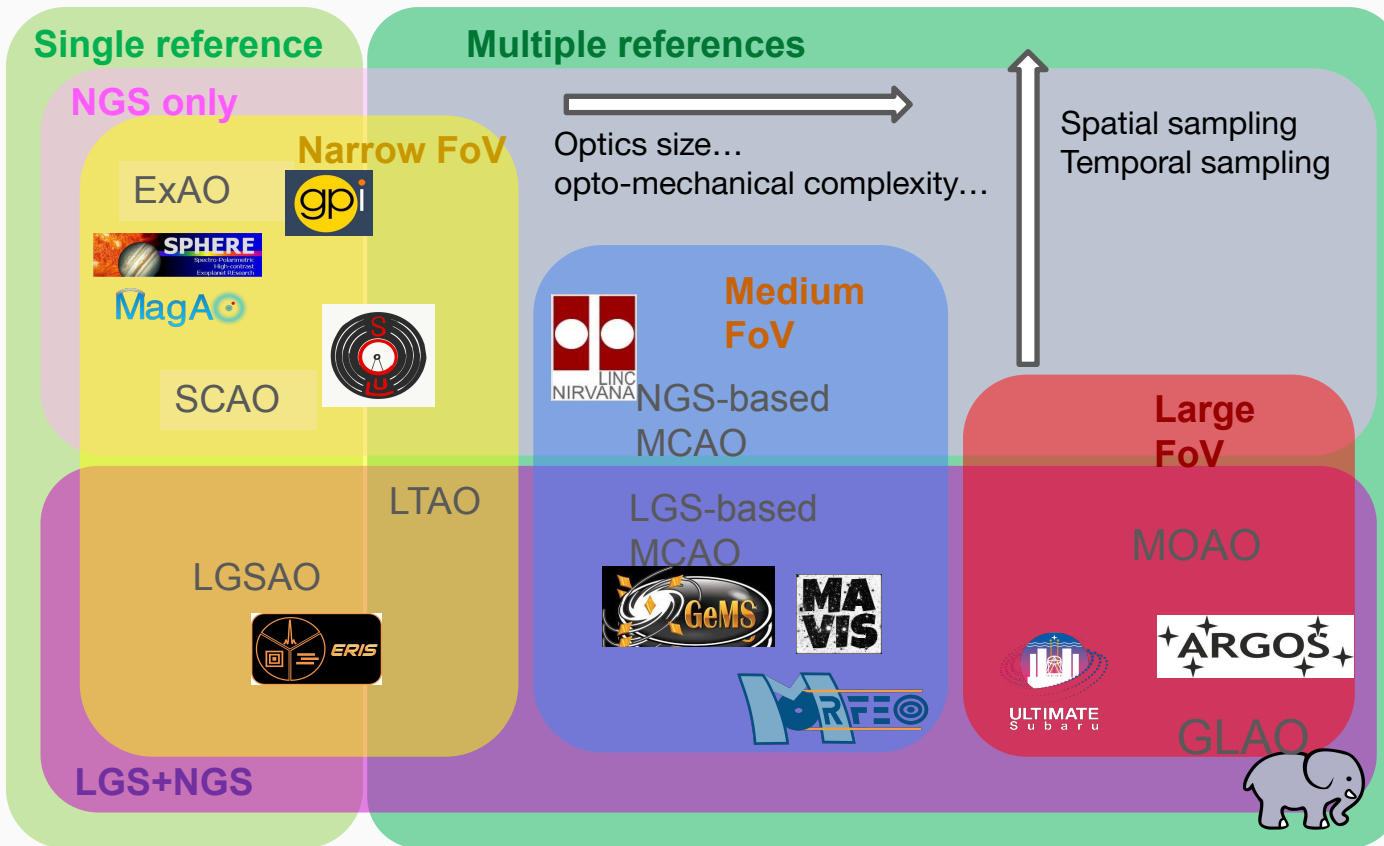
- GeMS@GEMINI
 - H band
 - 87"x87"
 - 80mas FWHM

VIS MCAO

- MAVIS@VLT
 - VRI band
 - 30" dia
 - 30mas FWHM



ADAPTIVE OPTICS ZOO



Glossary:

- SCAO Single Conjugate AO
- ExAO Extreme AO
- LGS AO Laser-assisted AO
- LTAO Laser Tomography AO
- GLAO Ground Layer AO
- MCAO Multi-Conjugate AO
- MOAO Multi-Object AO

AO CHALLENGES:

- AO budget (wavelength)
- WF Sampling
- Sensitivity
- Linearity (SCAO, ExAO)
- Lasers (LGS AO, LTAO)
- Open loop operations
- More lasers
- More DMs (MCAO, MOAO)
- More loops!
- Opto-mech complexity



WHAT IS MAVIS?

MCAO ASSISTED VISIBLE IMAGER & SPECTROGRAPH

Imager

- 30"x30" FoV
- 4Kx4K pixels
- Wide + narrow band filters
- $V=29.5$ in 1hr (5σ)

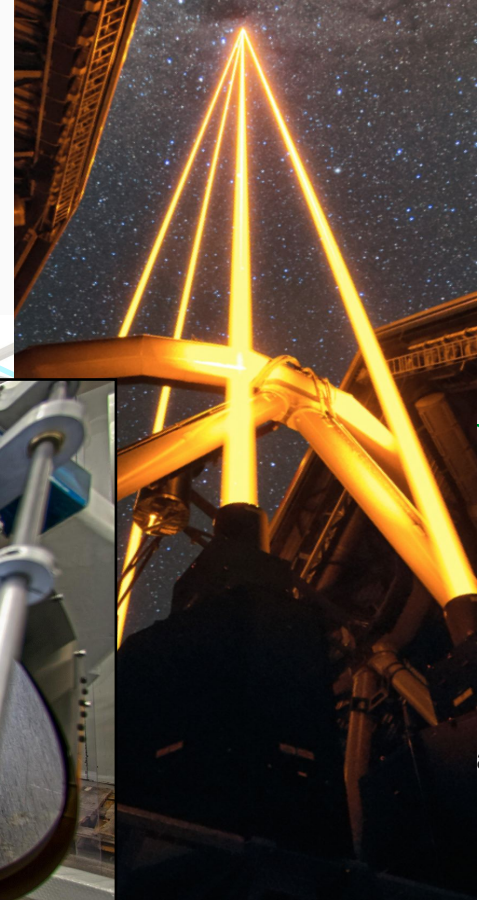
- 4 interchangeable VFT gratings
- pole

ility

secondary (DSM)

star facility (4LGSF)

ution modes



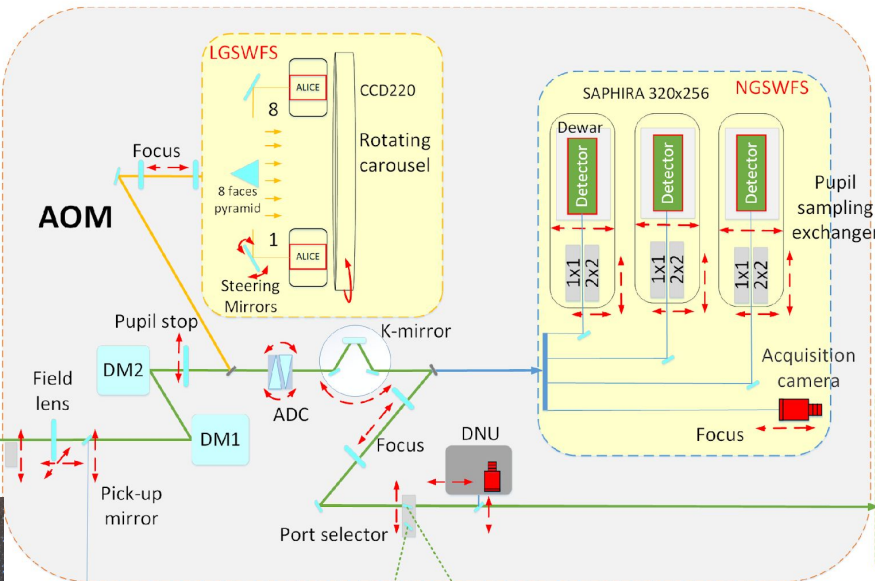
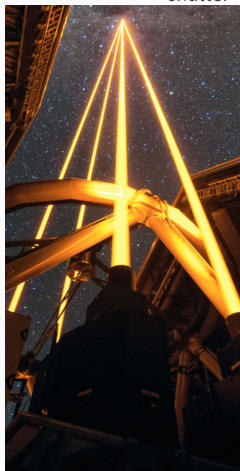
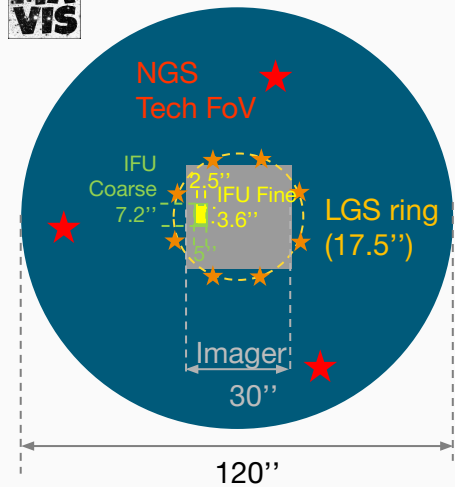
Ca
Ur

MAVIS SYNOPTIC VIEW

To get there...

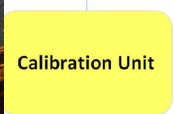
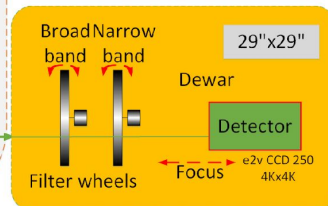


- FWHM \approx 30mas (V band)
- Strehl ratio > 8% (V band)
- Sky coverage > 50% @ Gal. pole

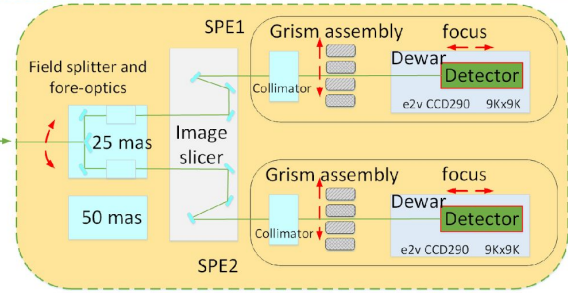


MAVIS

IMAGER

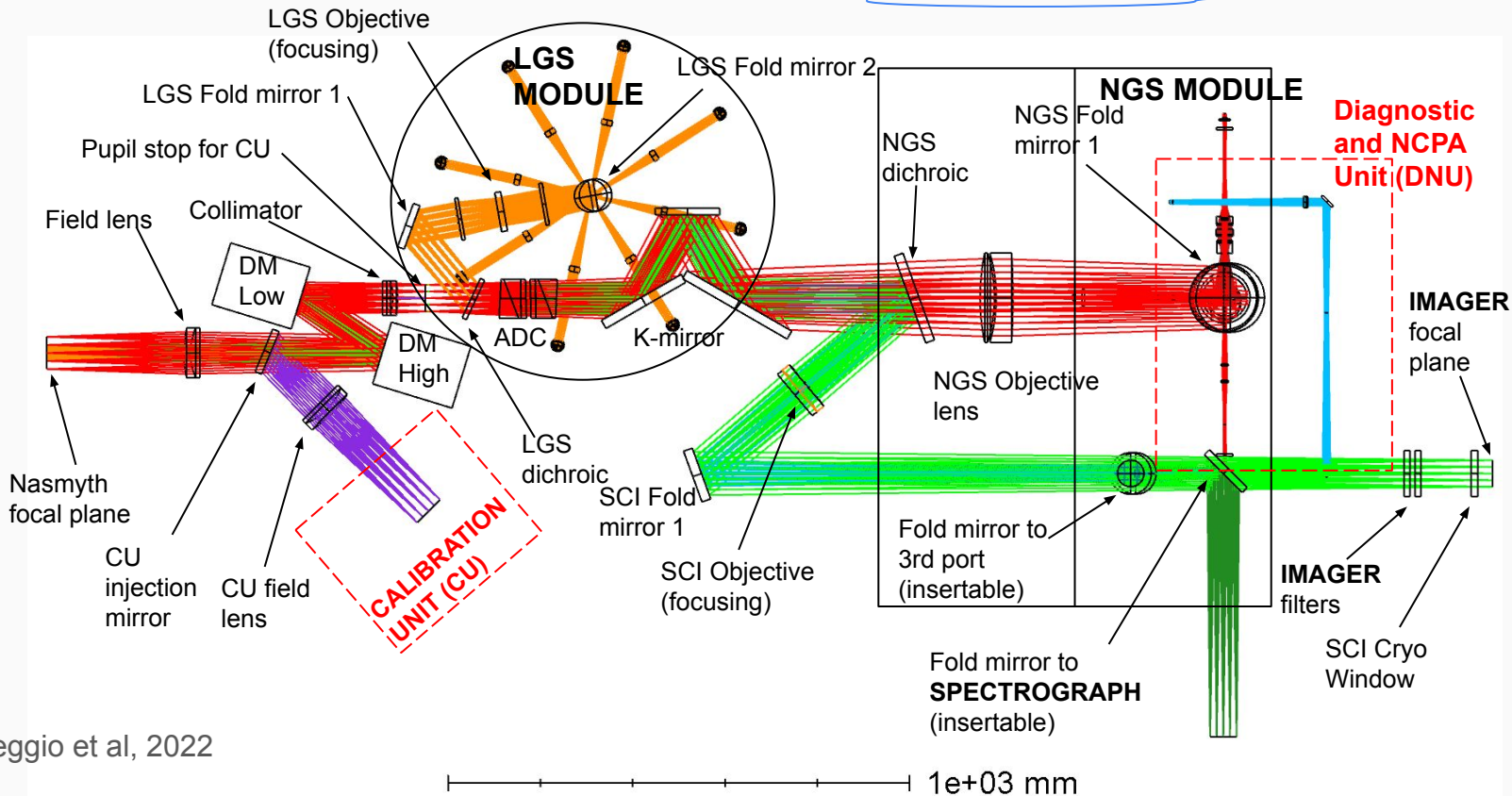


SPECTROGRAPH



MAVIS OPTICAL DESIGN

Largely transmissive **OPTICAL DESIGN**



AOM OPTICAL DESIGN AND CONCEPT

Post Focal Relay

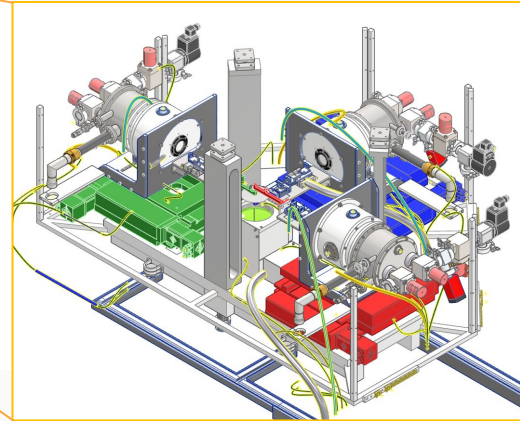
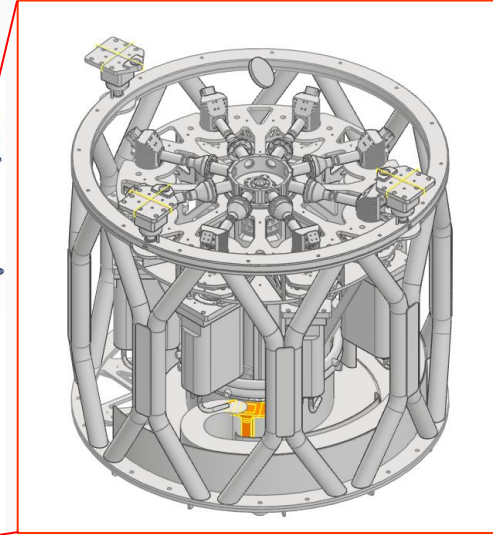
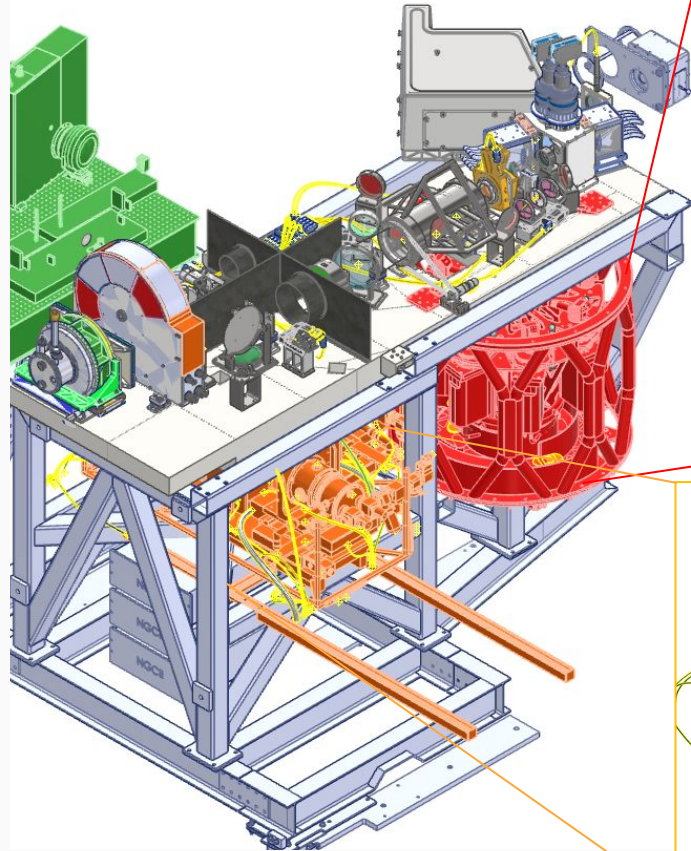
- 2 post focal DMs: about 4250 actuators (5420 including the DSM);
- correction for atmospheric dispersion
- field de-rotation

LGS WFS

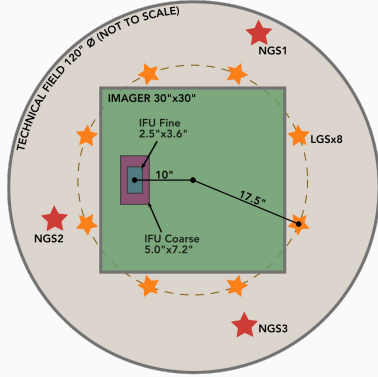
- @ 589 nm
- 8 Laser Guide Stars (4LGSF beams splitted), feeding 8 40x40 Shack-Hartmann WFSs

NGS WFS

- @ [1000 - 1740] nm
- Up to 3 NIR Natural Guide Star WFSs
- 2' diameter unrestricted patrolling FoV

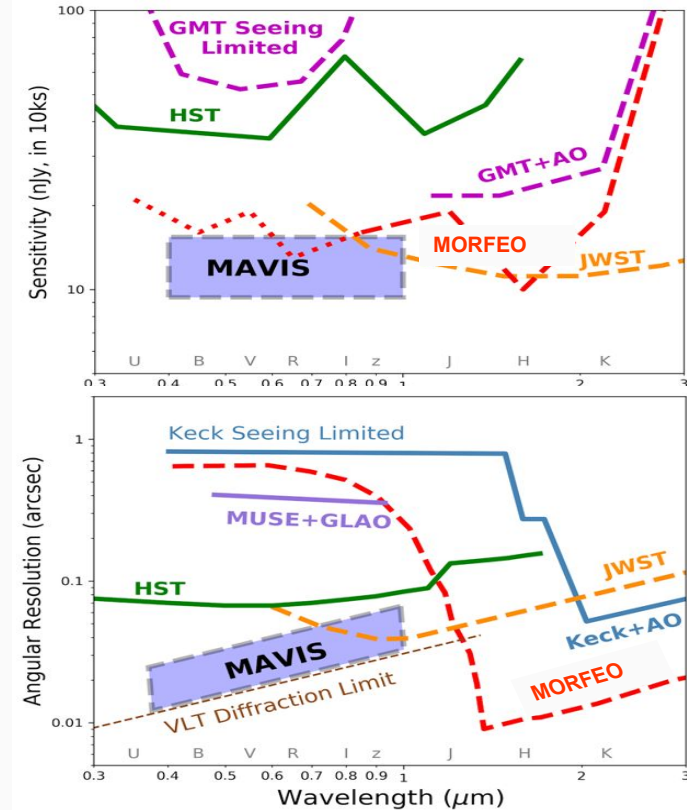


IMAGER

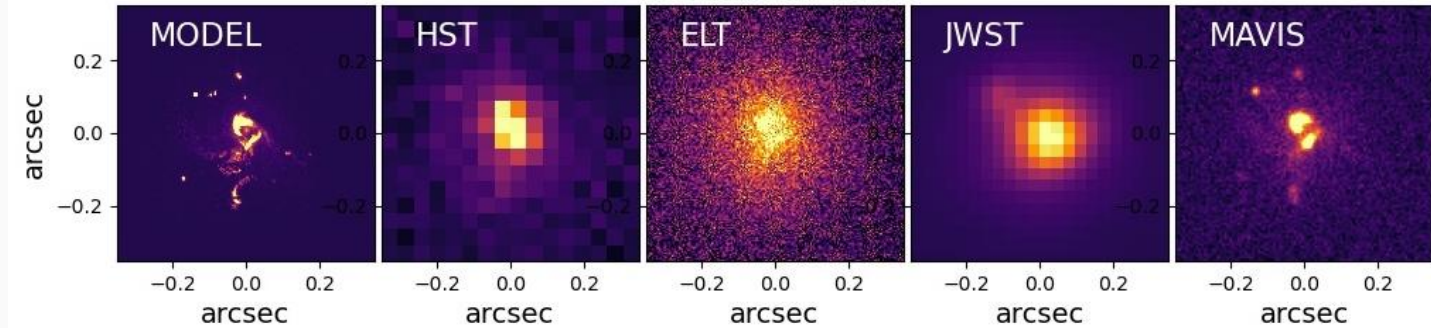


Ellis et al. 2022

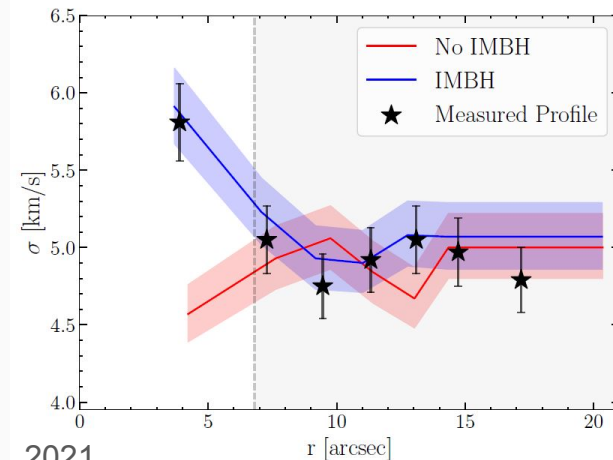
Parameter	Requirement
FoV	30.1 x 30.1 arcsec
Pixel Size	7.36 mas
Wavelength range	370 - 930 nm
Diffraction limited bands	V-z
Detector size	4k x 4k
Relative astrometric error	150 μ as (50 μ as goal)



SNAPSHOT SCIENCE: GALAXY UV MORPHOLOGIES AND IMBH

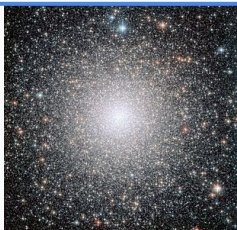


- MAVIS will allow the deepest optical images ever taken
- Crucial for understanding the UV morphology of the faintest galaxies at high redshift
- MAVIS will provide the unprecedented capability to search for the IMBH

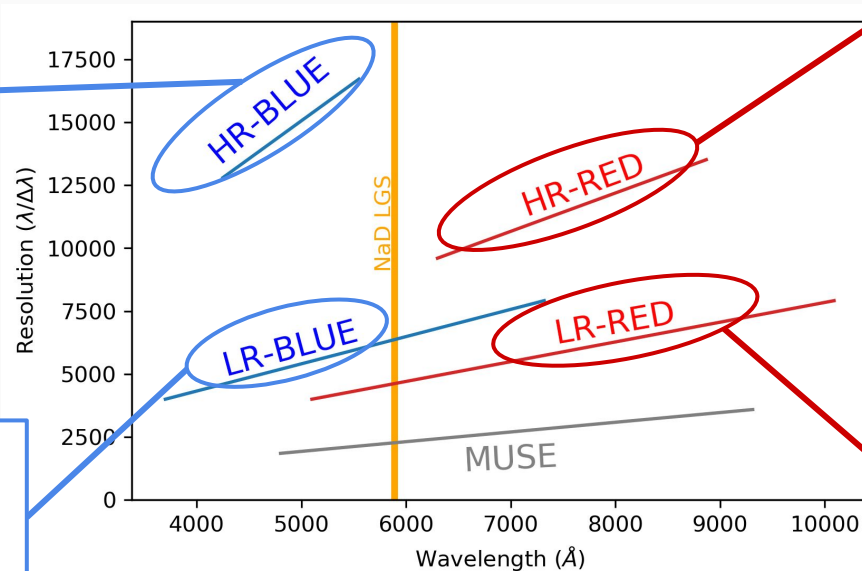
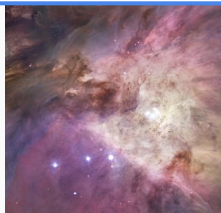


SPECTROGRAPH

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



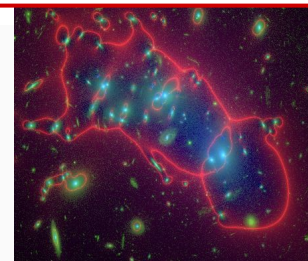
- Ionised gas properties
- Hot/Massive stars, young stellar populations
- Extreme Metal Poor stars



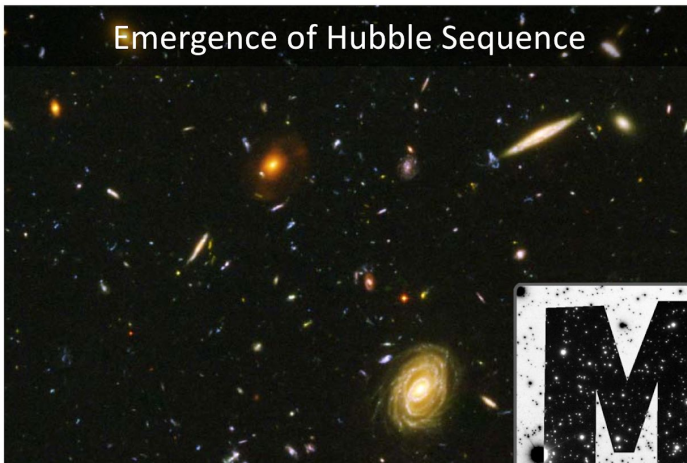
- Evolution of ISM
- Turbulence in galaxy disks
- IMBHs



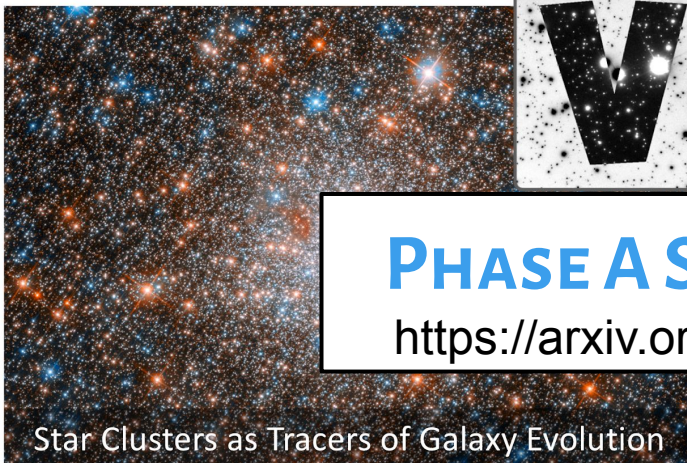
- Evolution of ISM chemistry
- Stellar dynamics $z < 1$
- Ly α sources at $z > 6.6$



- 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



MAVIS

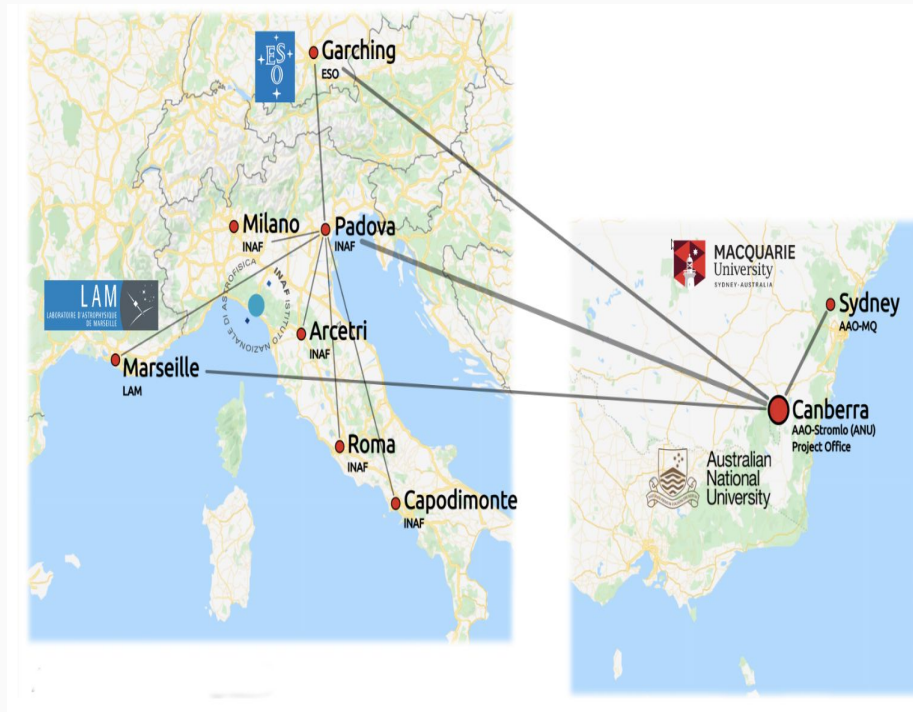


PHASE A SCIENCE CASE
<https://arxiv.org/abs/2009.09242>

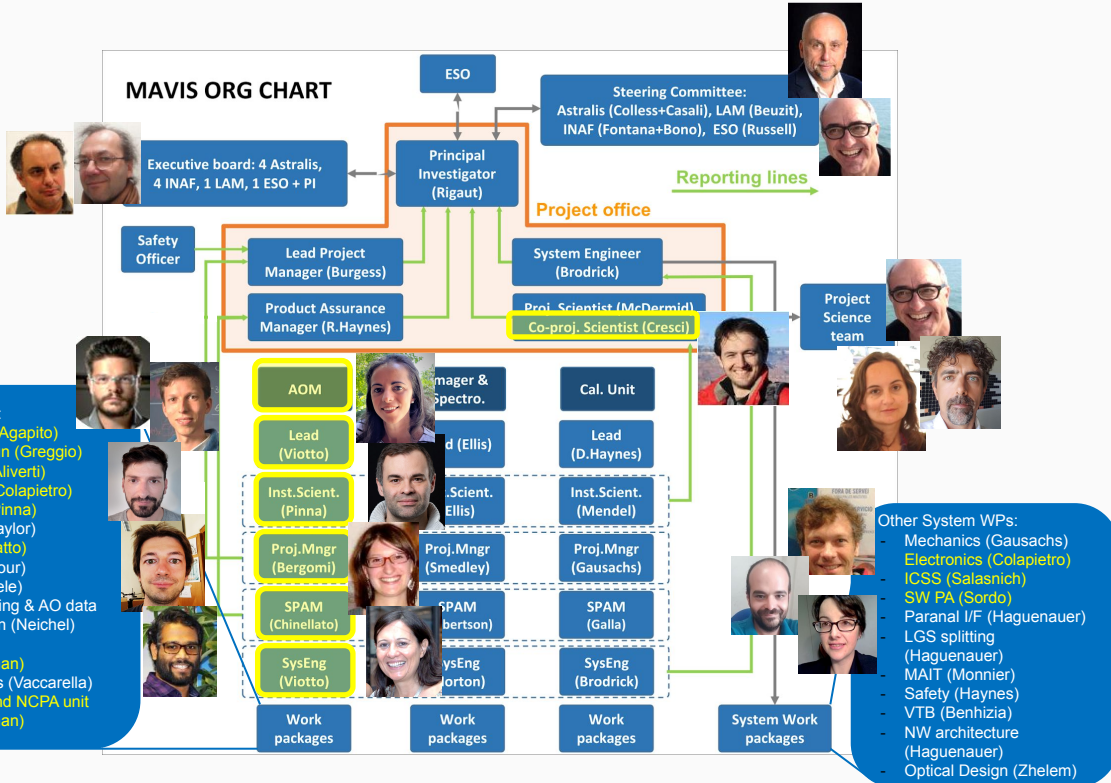


SCAN ME

- **ASTRALIS** (Macquarie University, University of Sydney, Australian National University)
- **INAF**
- **LAM**
- **ESO**



MAVIS ORG CHART

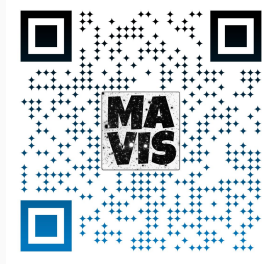


INAF personnel involved:

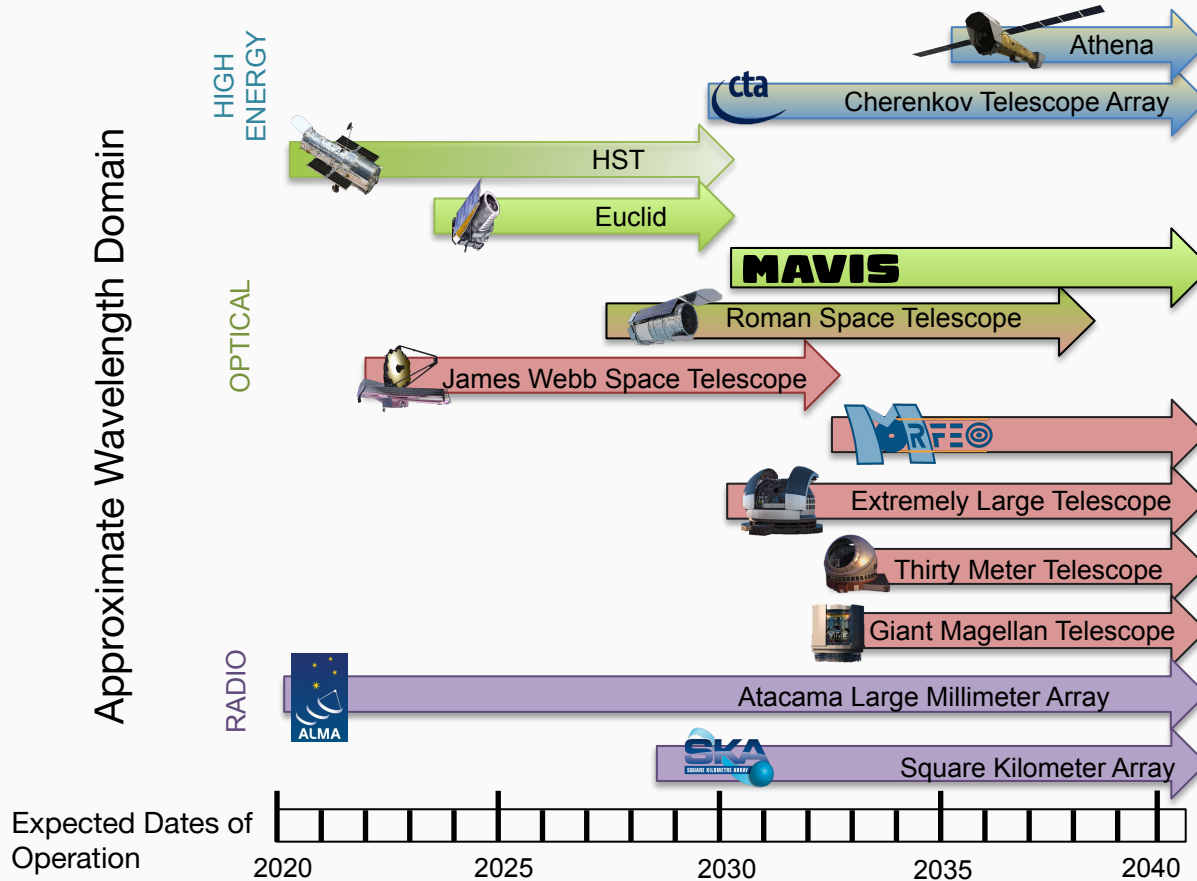
➤ Design and Implementation: 41

➤ Science: 43

INAF associated personnel involved: 10



TIMEFRAMES...



A night sky filled with stars and the Milky Way galaxy. A bright yellow laser beam originates from a building on the left and points upwards. In the foreground, several large, modern, angular buildings are visible, some with illuminated windows. A construction crane is visible on the right side of the image.

Thank you!