MAVIS

Audizioni INAF
18/5/21

MAVIS: Sharper than JWST, deeper than HST

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on behalf of the MAVIS team

WHAT IS MAVIS

MCAO-Assisted Visible Imager & Spectrograph

Uses VTL UT4 AO Facility

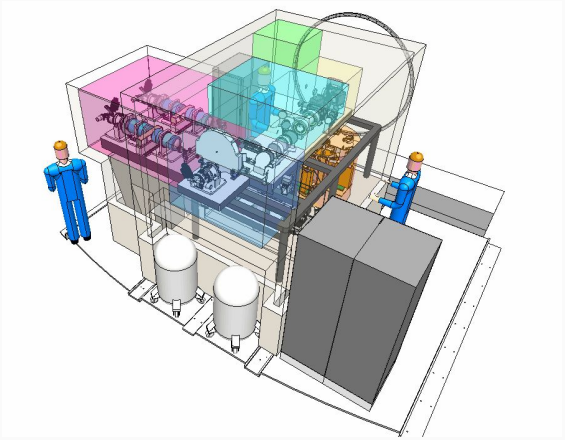
- Existing deformable secondary
- Existing laser guide star facility (4x2)

AO Module

- Visible (VRI, UB goal)
- 30"x30" field of view corrected
- FWHM ≈ 20mas (V band)
- Strehl ratio ≈ 15% (V band)
- Sky coverage > 50% @ Gal. pole

Imager

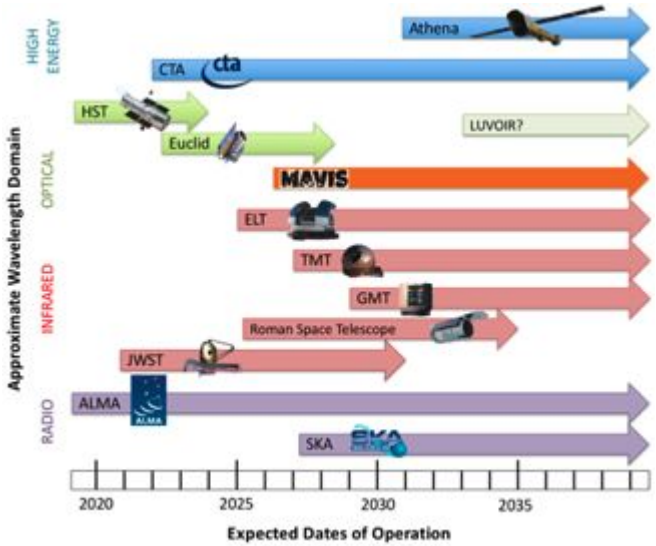
- 30"x 30" FoV, 7.3 mas pixel
- U-z bands (Diffraction limited V-z)
- Relative astrometry 150 μas (goal 50 μas)
- Wide + narrow band filters
- V=29.5 in 1 hr (5 σ)



IFU Spectrograph

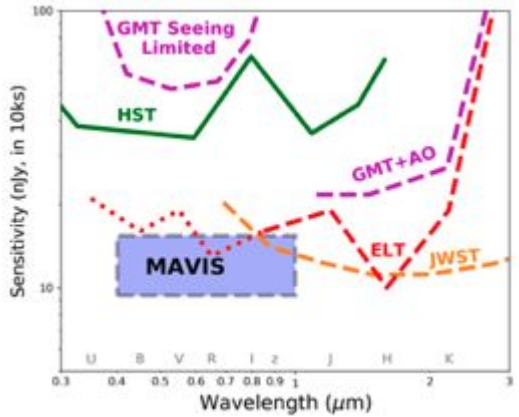
- image slicer IFU
- 25 mas and 50 mas spaxels
  - 2.5"x3.6" and 5"x7.2" FoV
- R~5000 and ~12000
- λ = 370-1000 nm
- 4 interchangeable VPH gratings
- 15% encircled energy in 50 mas spaxels

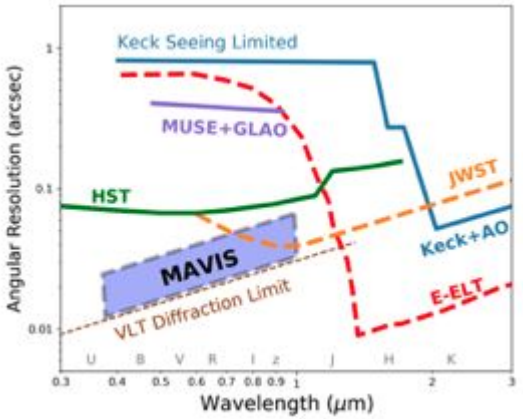
THE NEED FOR MAVIS



- First light ~2027, filling the gap at optical wavelengths in the post-HST era

- Future facilities will look deeper and sharper than ever before

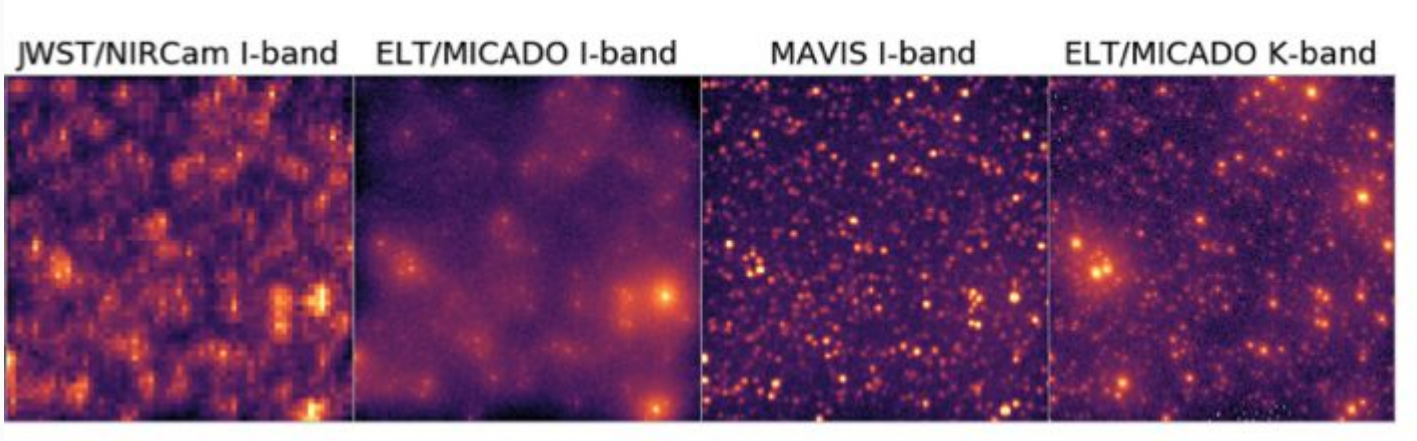




- Among general purpose facility instruments, only MAVIS combines high sensitivity with high angular resolution at optical wavelengths

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

COMPLEMENTARITY WITH ELT

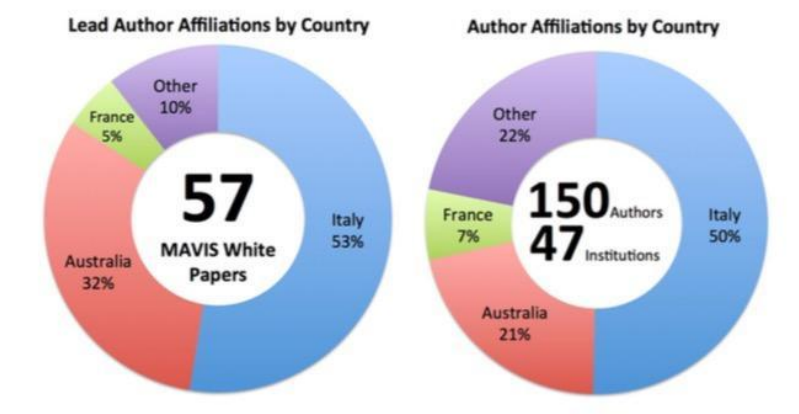


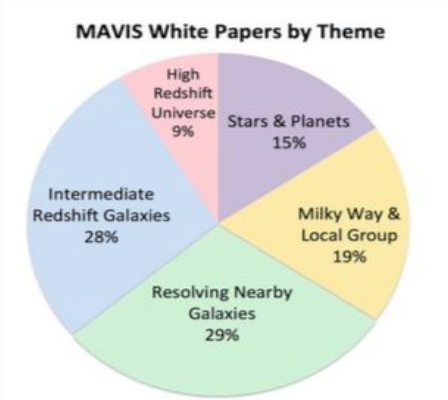
- Key future facilities (e.g. JWST and ELT) are not well-optimized for <1um
- MAVIS is crucial to provide optical coverage at matched angular resolution to ELT in the IR

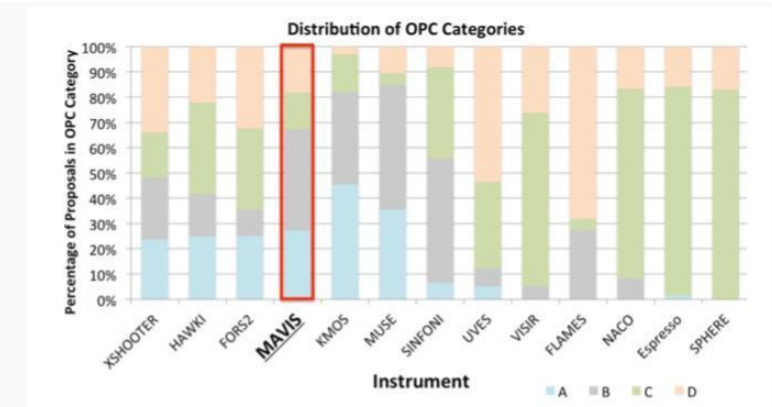
Complementarity MAVIS visible ↔ ELT Near Infrared

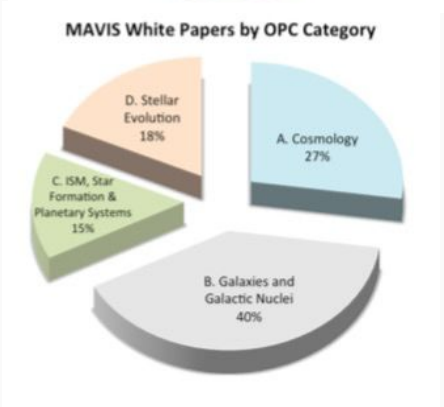
SCIENCE WITH MAVIS: WHITE PAPERS

Call in July 2018





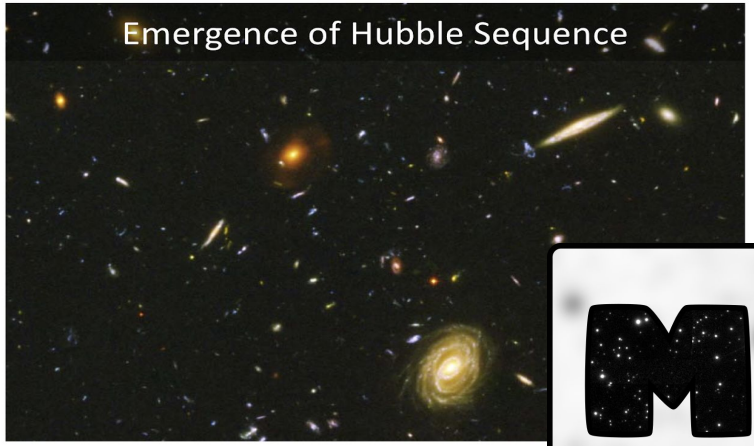




Significant interest In the Italian Community

A general purpose instrument

COMPLETE SCIENCE CASE: HTTPS://ARXIV.ORG/ABS/2009.09242



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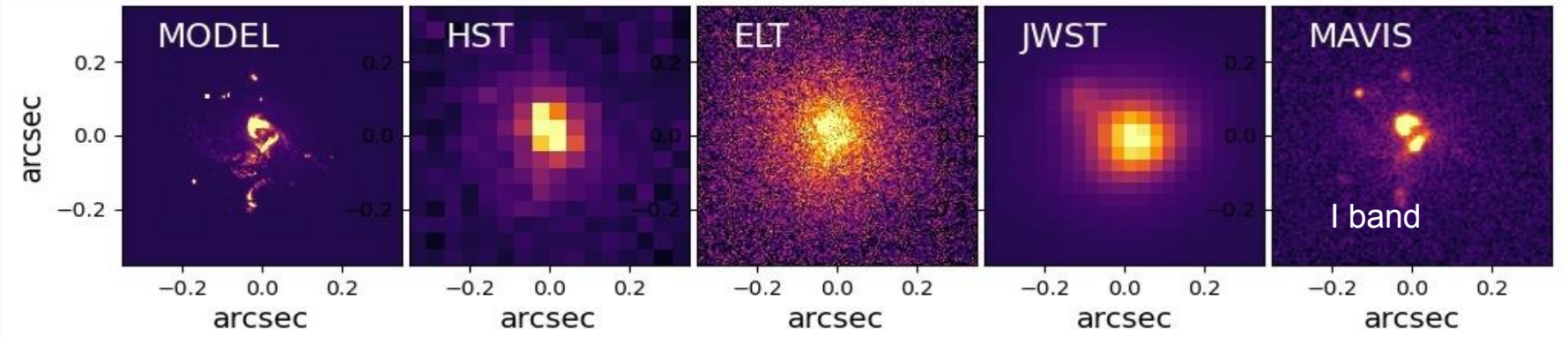
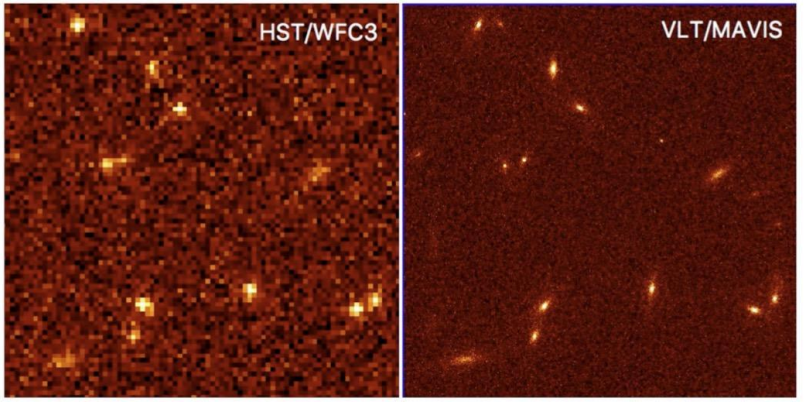
Science examples: Imaging

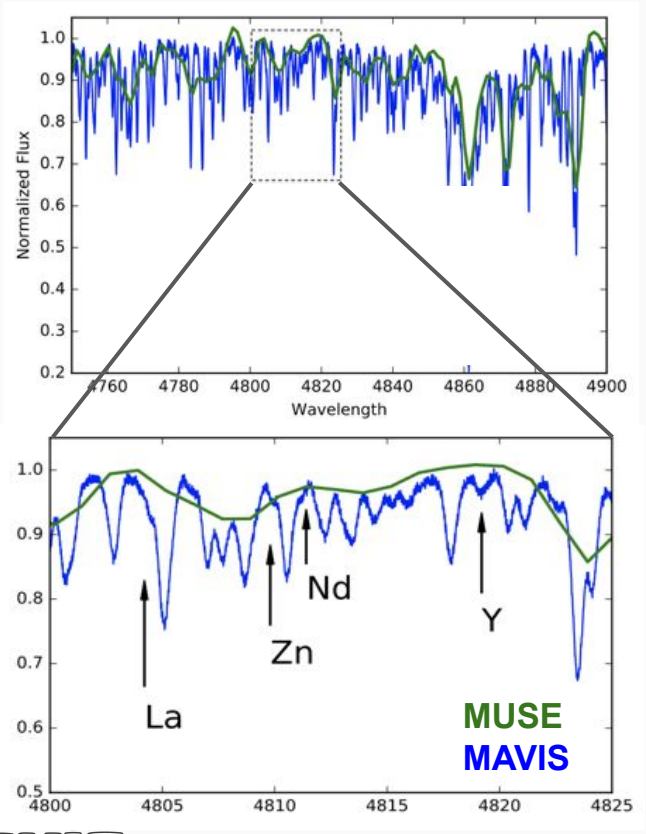
Simulated galaxy at z~5 from Pallottini et al. 2017

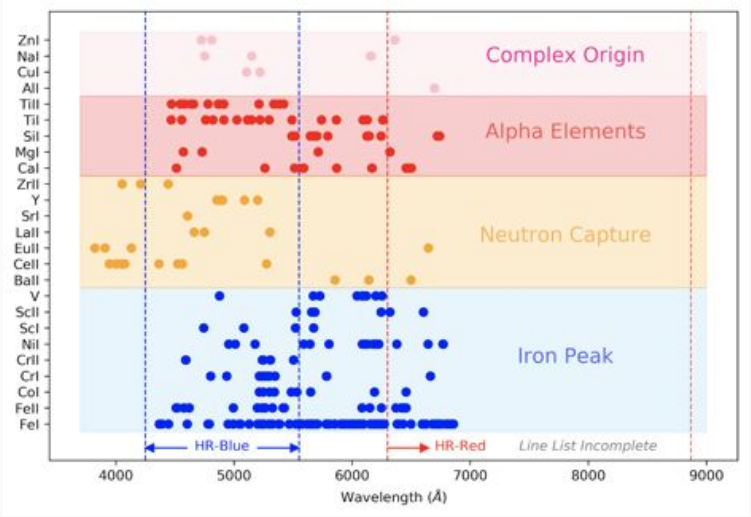


- MAVIS will allow the deepest optical images ever taken: in 10hrs, M=30.4 AB at 5σ, deeper than HST UDF
- Crucial for understanding the UV morphology of the faintest galaxies at high redshift



Science Examples: Spectroscopy



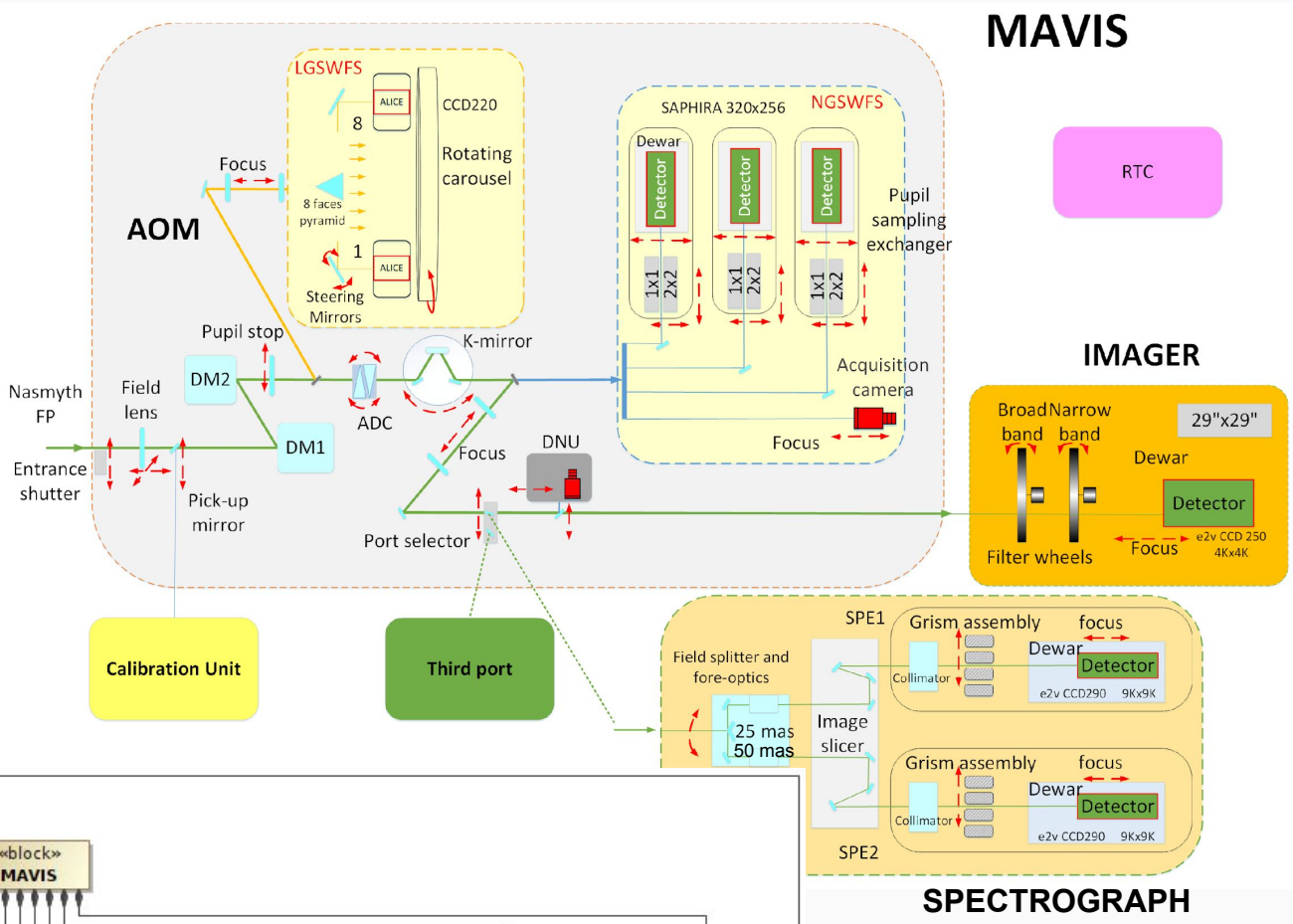


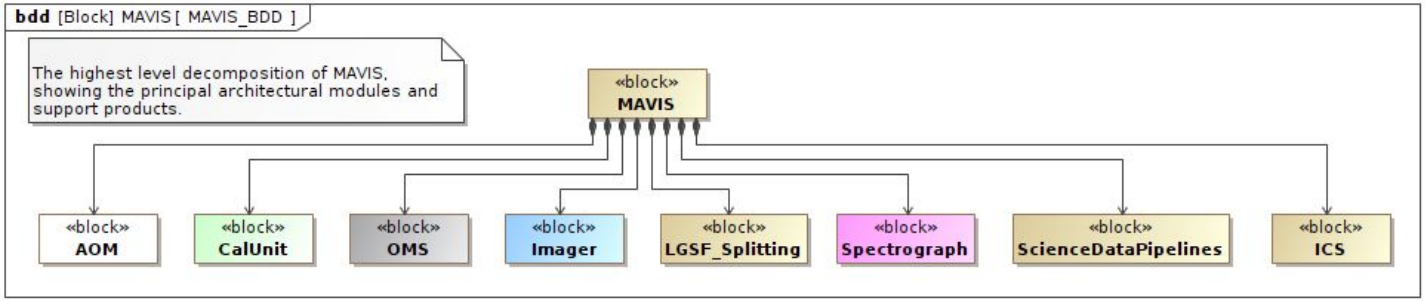
- MAVIS will finally provide detailed chemical abundances of dense star cluster cores
- HR Blue mode optimized for rich range of diagnostic abundances
- Cannot be done at lower resolution (spatial and spectral)

MAVIS DESIGN

LOCATION:
- VLT - UT4 (AOF I/F)
- Nasmith platform

MODULAR CONCEPT:
- ESO requirement
- Consortium need

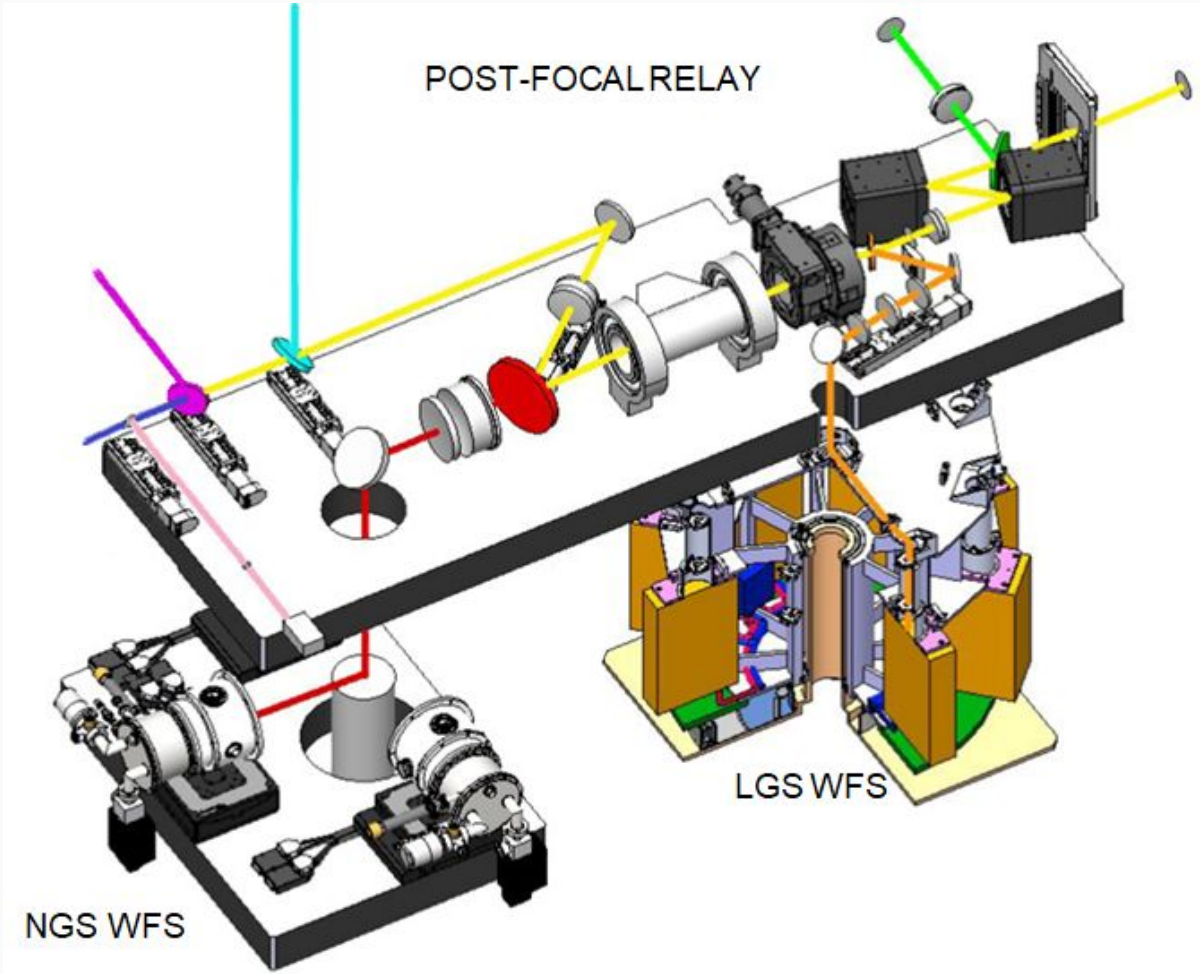




MAVIS DESIGN

AO MODULE:

- LGS WFS: 8 Laser Guide Stars @17.5” (@589nm)
- NGS WFS: 3 NGS arms (NIR) in 2’ FoV
- 2+1 DMs including 5000 actuators
- RTC based on GPUs
- De-rotation scheme
- 3 output ports



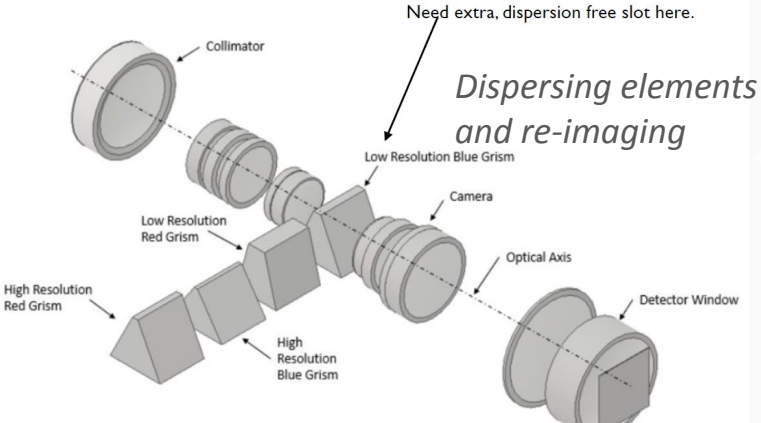
MAVIS DESIGN

IMAGER:

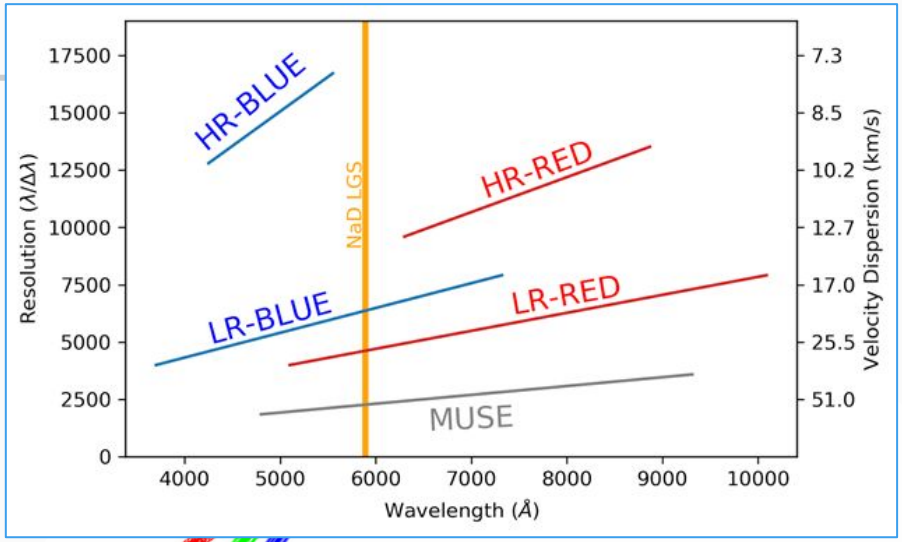
- Diffraction limited imaging from V to z
- Imaging from U to z
- Resolution 16.3mas, pixelscale 7.3mas

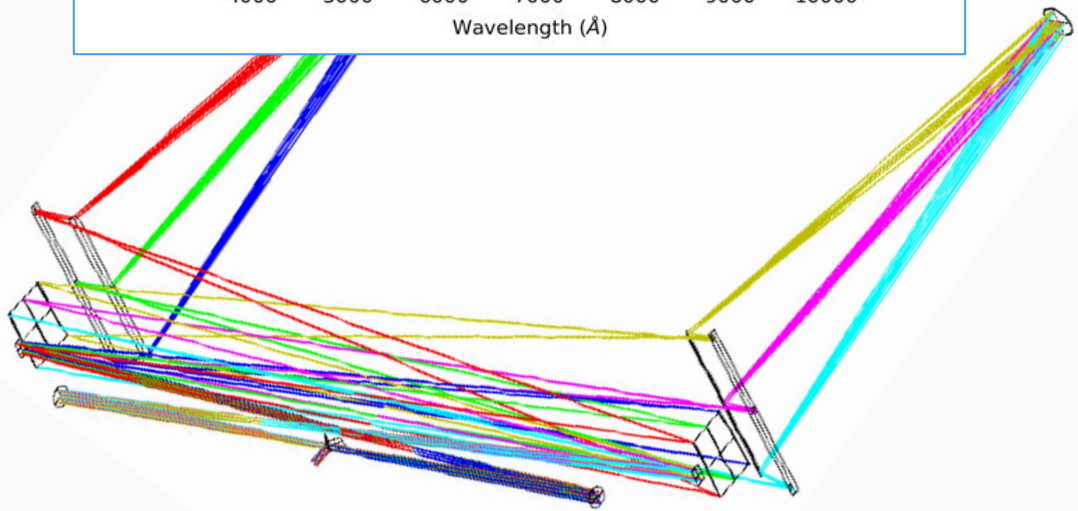
SPECTROGRAPH:

- IFU Spectrograph (slicer)
- 2x channels
- 2x spatial resolution modes (25-50 mas)
- 2x spectral resolution modes (5000-12000)



Dispersing elements and re-imaging

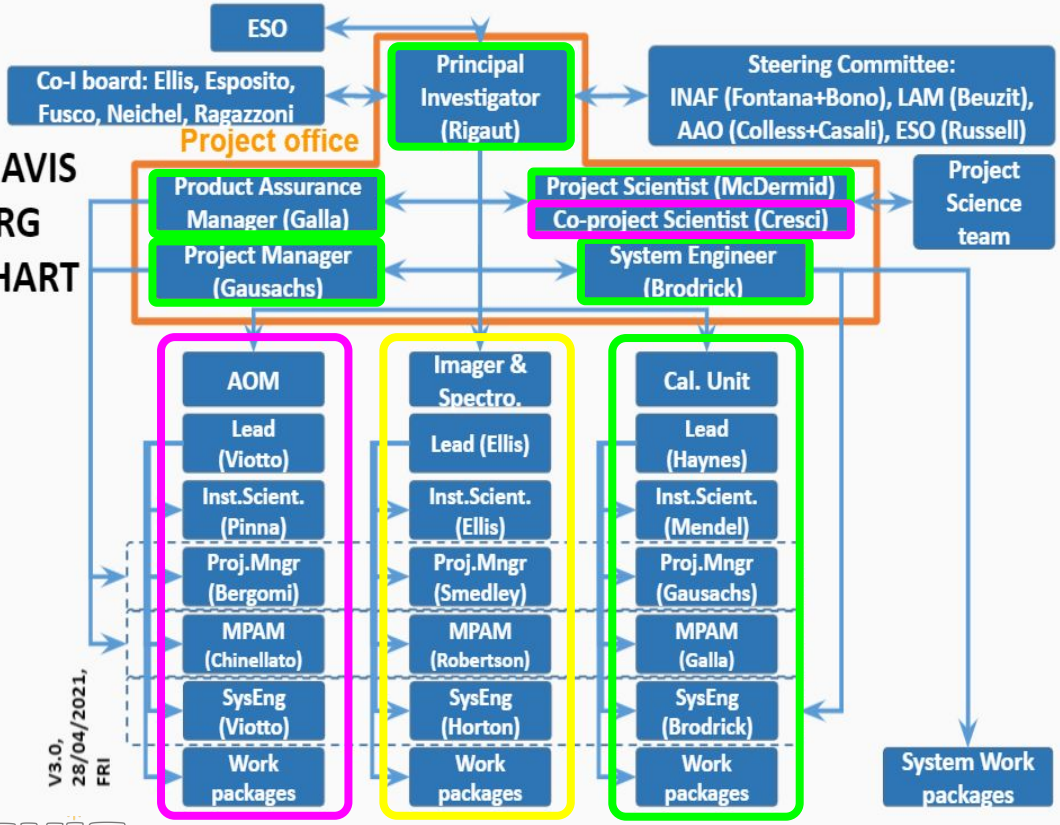




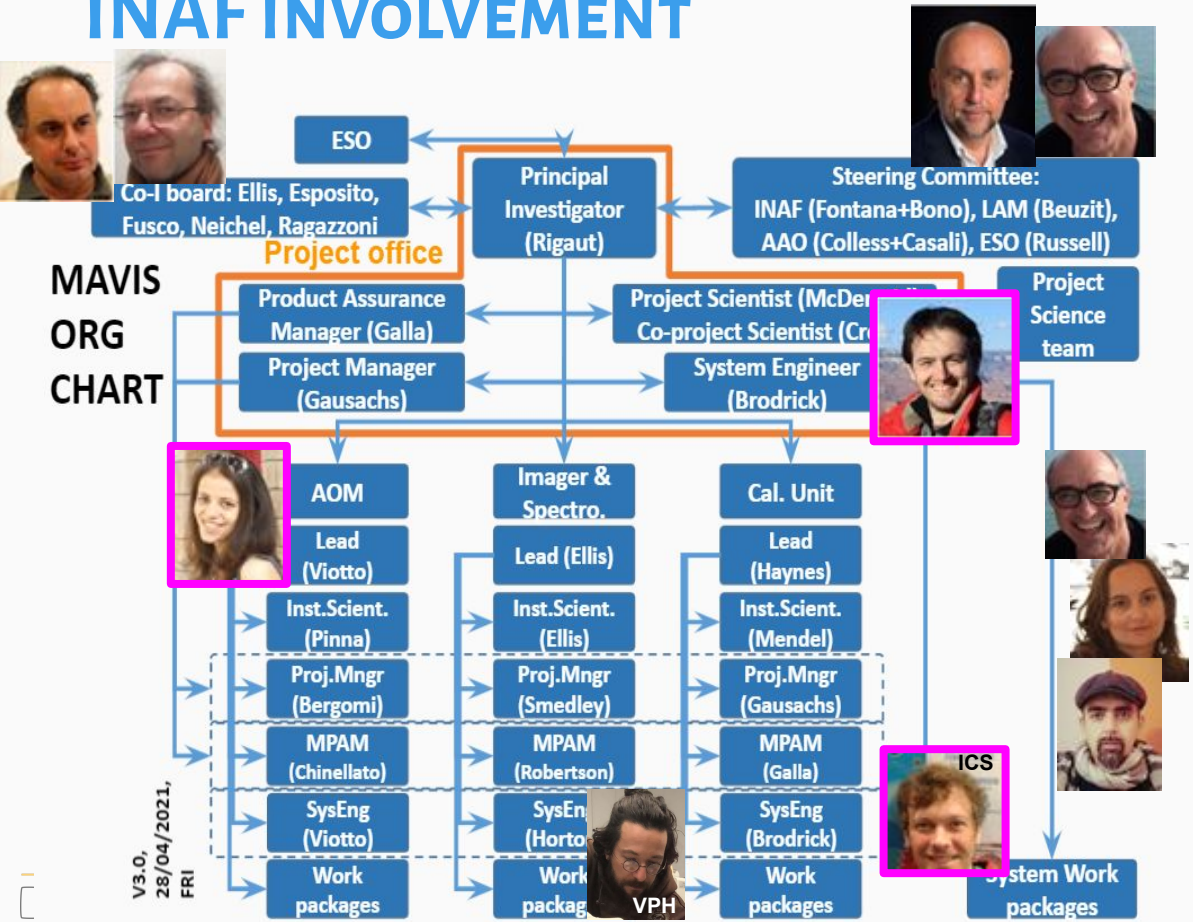
Field splitting and slicers

MAVIS CONSORTIUM

MAVIS ORG CHART



INAF INVOLVEMENT



INAF INSTITUTES:

MAVIS-TECNO

- Oss. Astronomico di Padova (OAPD);
- Oss. Astrofisico di Arcetri (OAA);
- Oss. Astronomico di Brera (OAB);
- Oss. Astronomico di Capodimonte (AOC);
- Oss. Astronomico di Roma (OAR).

MAVIS-SCIENCE

- Oss. Astr. di Arcetri (OAA);
- Oss. Astr. di Padova (OAPD);
- Oss. Astr. di Roma (OAR);
- Oss. Astr. di Capodimonte (OAC);
- Oss. Astr. d'Abruzzo (OAAb);
- Oss. di Astr. e Scienza dello Spazio di Bologna (OAS);
- Ist. di Astr. e Planetologia Spaziali (IAPS).

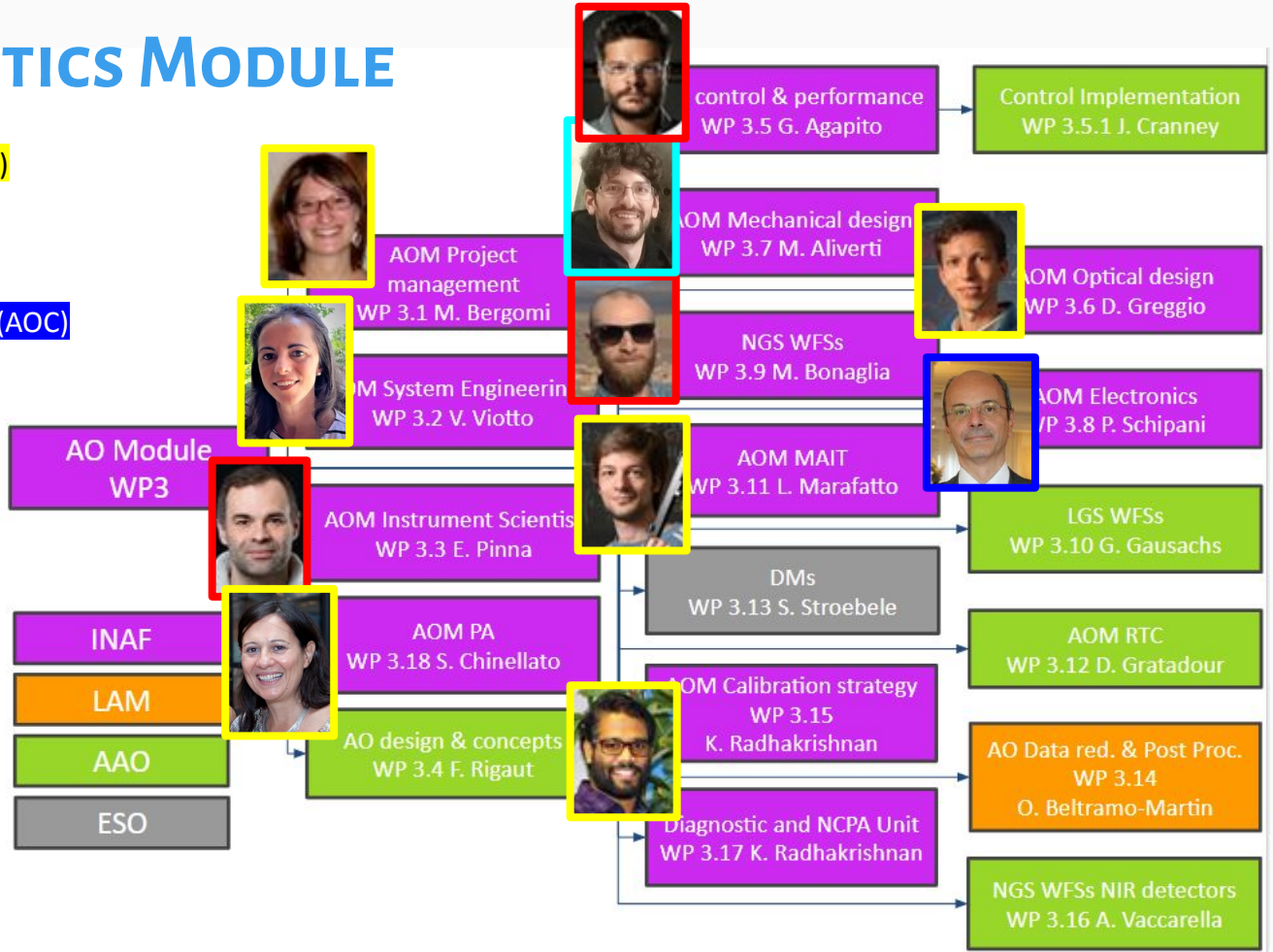
ADAPTIVE OPTICS MODULE

Oss. Astronomico di Padova (OAPD)

Oss. Astrofisico di Arcetri (OAA)

Oss. Astronomico di Brera (OAB)

Oss. Astronomico di Capodimonte (AOC)



INAF INVOLVEMENT AND COMMITMENTS

INAF people involved in MAVIS: ~ 90 persons

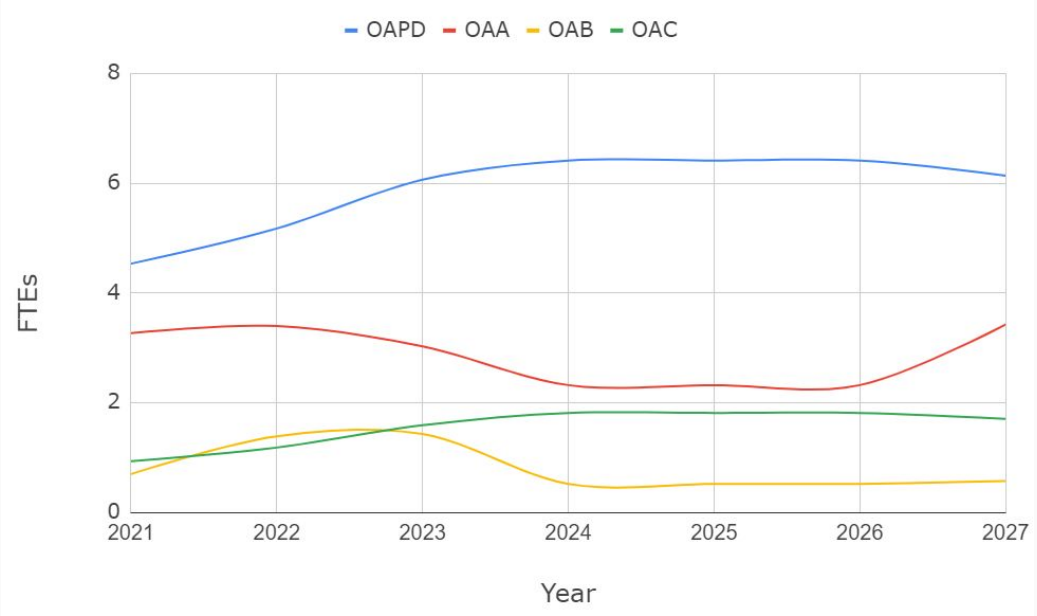
- 50% Tecno
- 50% Science

MAVIS development (Phases A-E):

- Consortium FTEs ~ 200
  - 45% AAO
  - 45% INAF
  - 10% Other partners

MAVIS GTO access:

- Consortium nights ~ 150
  - 45% AAO
  - 45% INAF
  - 10% Other partners

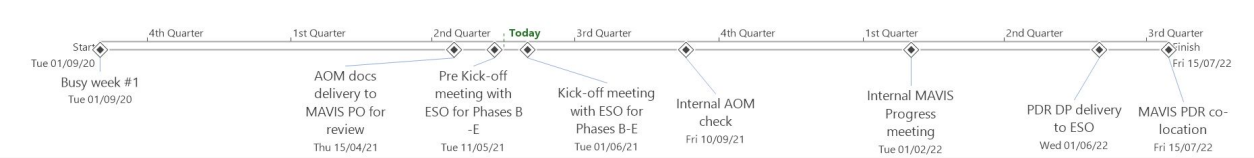


Scientific community involved:

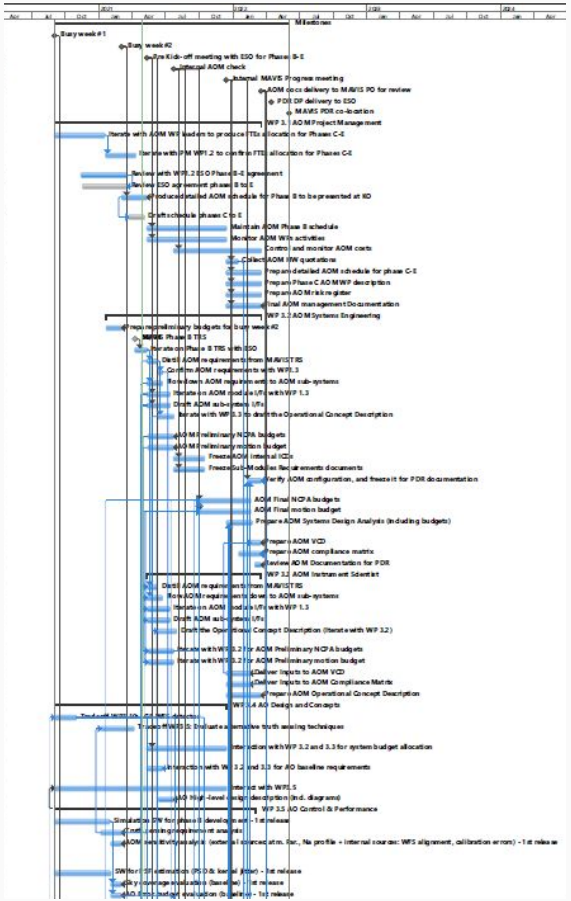
- >50% INAF
- 20-30% AAO

SCHEDULE

- Phase B (Preliminary Design Phase): June 2021 - July 2022, Review: Preliminary Design Review;



- Phase C (Final Design Phase): August 2022 - August 2023, Review: Final Design Review;
- Phase D (Manufacturing, Assembly, Integration and Verification): September 2023 - May 2027, Review: Preliminary Acceptance Europe (Australia);
- Phase E (Installation e Commissioning): August 2027 - December 2027;
- Science time (GTO time): 2028-2033.



AOM Phase B schedule (part of...)

FUNDINGS

- Phase A:
  - Travel expenses covered by ESO
  - Personnel expenses covered by the consortium
- Phases B-E:
  - Personnel, travel costs and consumables covered by the consortium
  - HW: after Phase A, MAVIS ROM cost is 12Meuro
    - ESO will provide 8Meuro
    - AAO already secured 1Meuro from their Agency
    - AAO is expecting to cover further 2/2.5 Meuro from Australian Grant
  - No de-scoping of the modules under INAF responsibility has ever been considered (AOM, ICS)
- GTO time exploitation: no specific fundings identified yet (PRIN, etc.).

TECHNICAL ASPECTS

Skills to be acquired:

- ELT-IFW: get familiar with the ESO framework for the instrumentation control, which is under development for ELT, applicable to the VLT next generation instruments;
- Super-resolution: use and implementation of super-resolution techniques for wavefront sensing, applied to the AO HO control;
- Predictive control: simulations and implementation of predictive control for the in the AO loop;

Challenges:

- VIS range: a 10% Strehl Ratio requirement translates into an overall budget of about 130nm. This budget should be achieved on a wide FoV (including uniformity)
  - impacts on first order design choices of the AO system (e.g. # of LGS/DMs)
  - pushes the AO contrl scheme performance (super-resolution, predictive control..)
  - drives some of the main trade-offs choices (de-rotation scheme, truth sensing…)
- Sky Coverage requirement: no-compromise approach on NGS sensing

MANAGEMENT

Risk on Personnel:

- ~ 20/22% FTEs are TD or AdR, included some WP leaders
- ~ 15/25% FTEs are to be hired

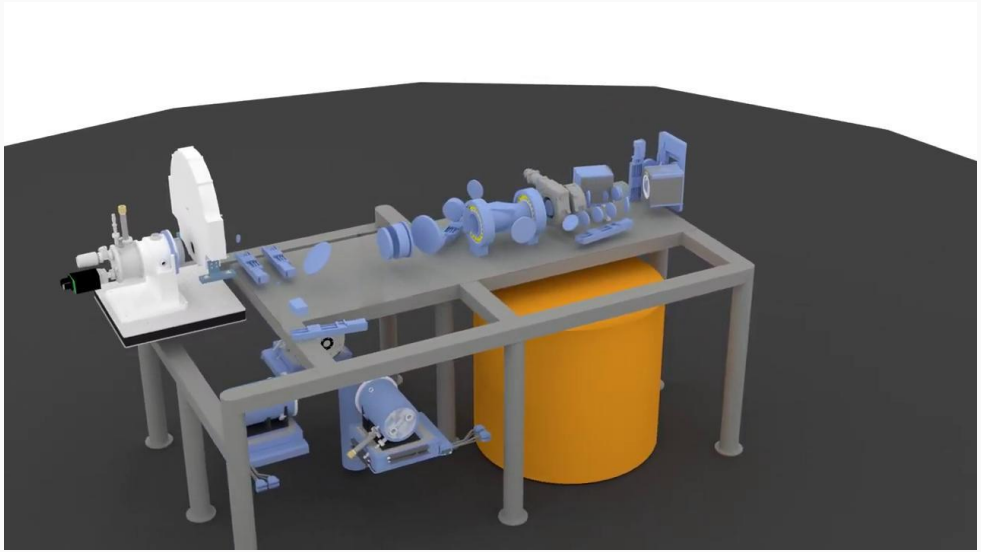
Risk on INAF Science Leadership:

- Agreement on GTO nights (based on FTEs)
  - 45% AAO
  - 45% INAF
  - 10% Other partners
- Plan is to prioritize common large science programs, to be exploited together
- The large commitment of ANU on funding for HW may unbalance the GTO share

Scientific community involved:

- >50% INAF
- 20-30% AAO

CONCLUSIONS



- MAVIS exploits INAF expertises and confirms INAF leadership in:
  - AO
  - ICS
- Large involvement of technical and science INAF communities;
- The project strengthens the networking within INAF observatories (ADONI);
- Upcoming Science Meeting – July 5-9, 2021.
  Registration and Abstract submission open at https://indico.ict.inaf.it/e/scimavis2021

MAVIS