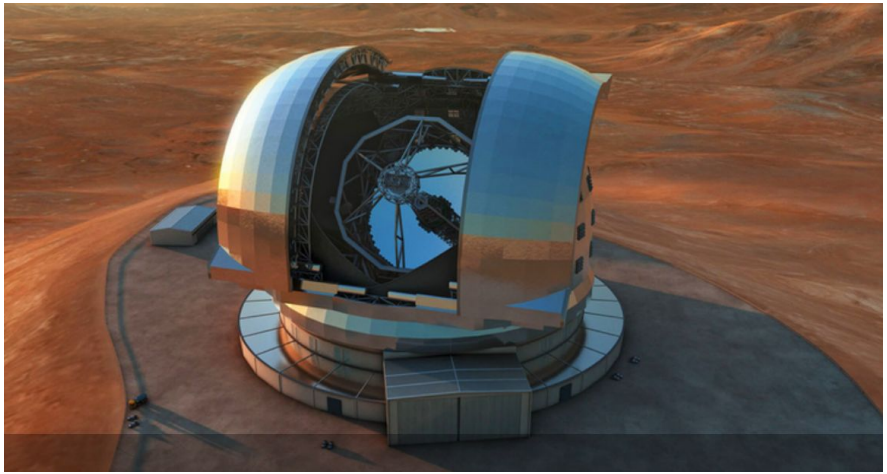
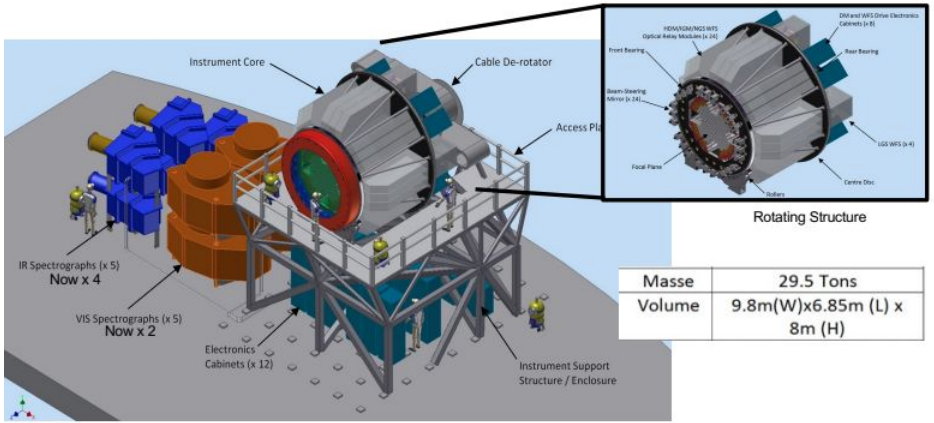
MOSAIC:
The MOS for the ELT
***

L.Pentericci on behalf of the italian MOSAIC team





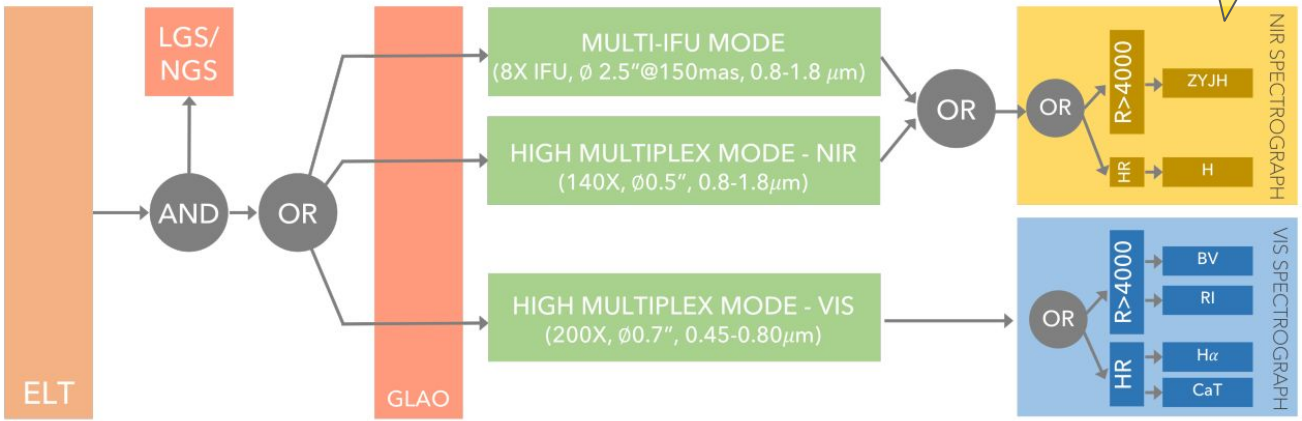
Masse	29.5 Tons
Volume	9.8m(W)x6.85m (L) x 8m (H)

The ELT MOS

MOSAIC

Fiber-fed instrument (like MOONS)
A modular architecture with 3 observing modes

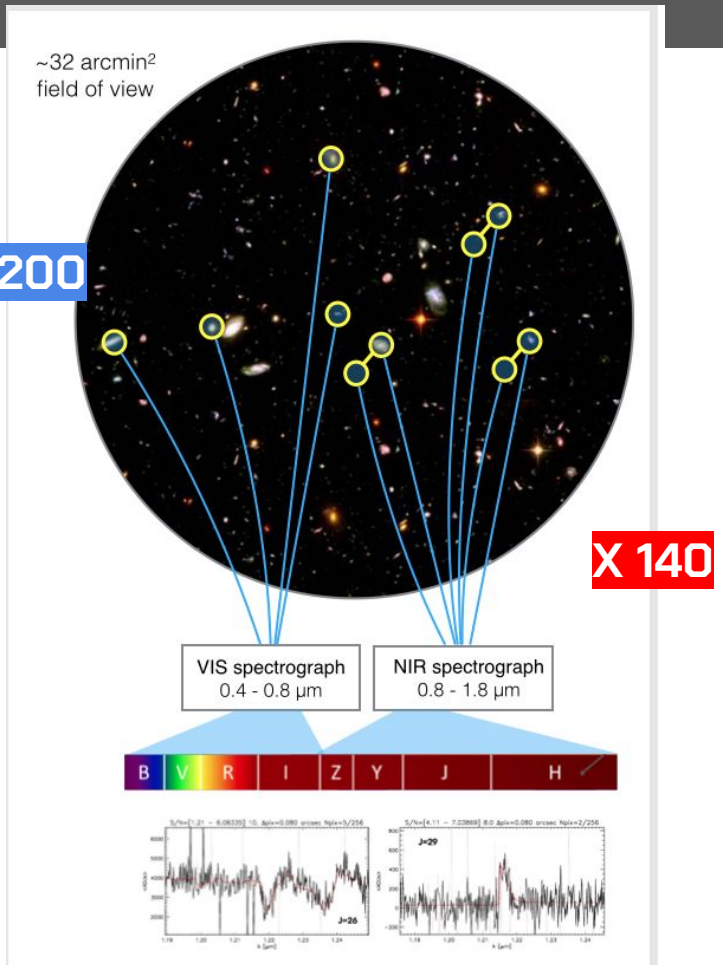
an extremely versatile instrument!!!

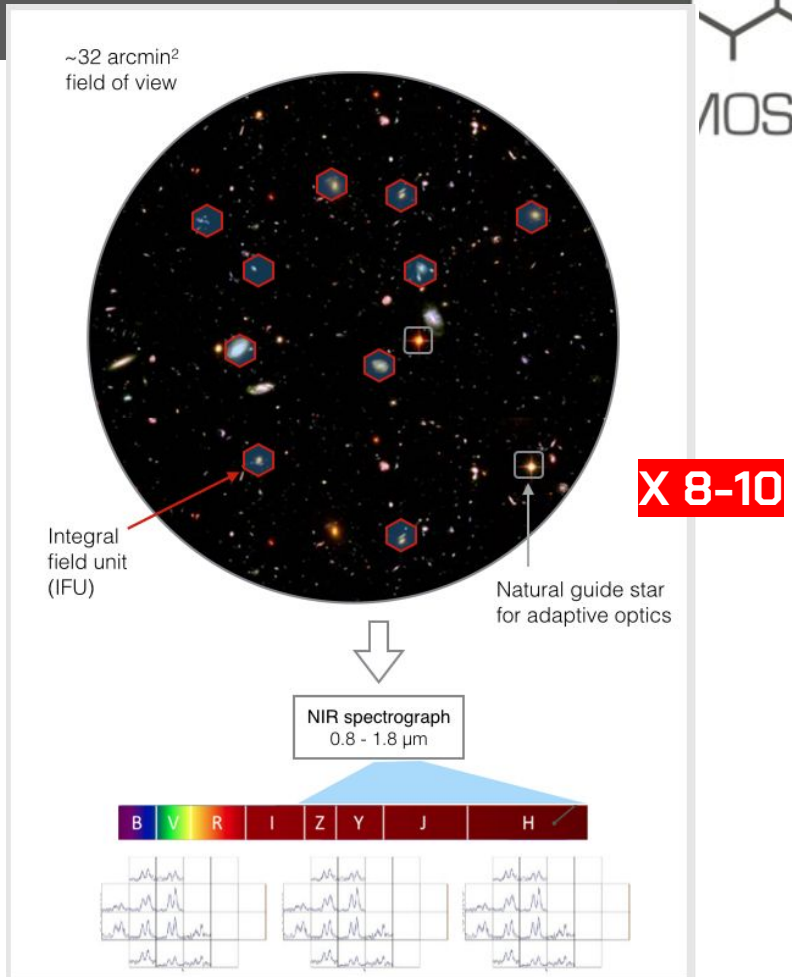


MOSAIC combines the advantages of a highly-multiplexed (HMM) instrument targeting numerous unresolved sources, both in the VIS and in the NIR, with one having a more modest multiplex but that can resolve faint sources spatially (multi-IFU- NIR only).

The ELT MOS

MOSAIC

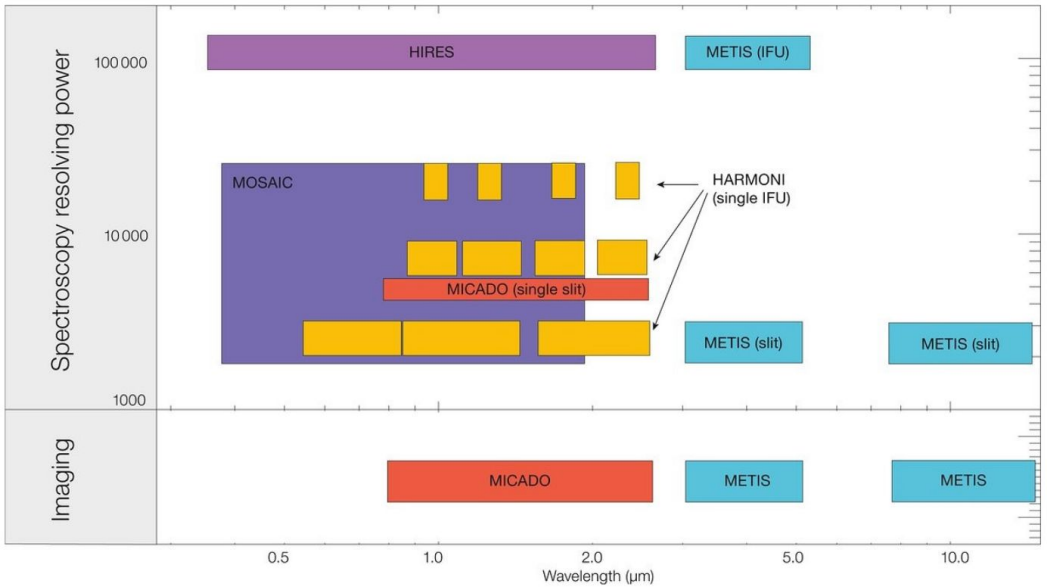




The ELT MOS

MOSAIC will cover a unique parameter space
it will complement the first generation of ELT instruments
it will provide strong synergies with future facilities

It will the only instrument exploiting the large FoV and collecting power provided by the ELT



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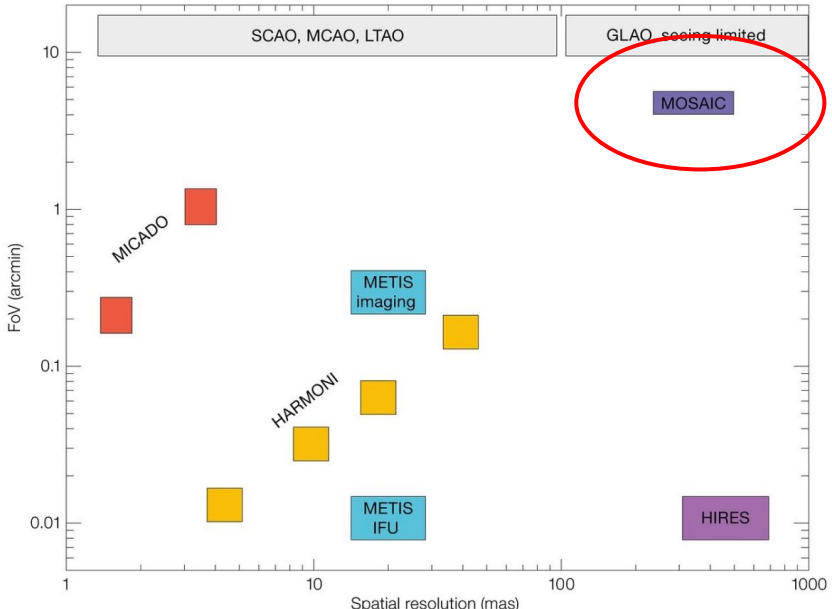
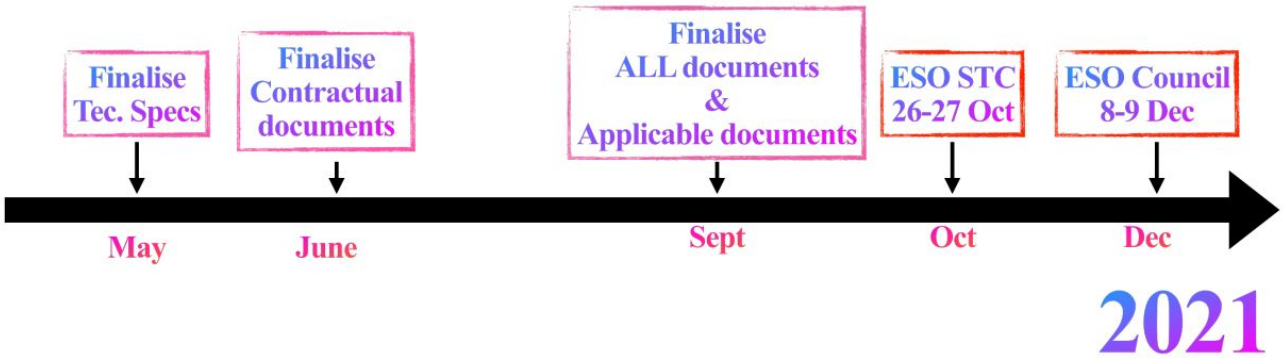


Schedule

We have now reached a consensus with ESO about the MOSAIC concept with 3-modes (HMM-NIR, HMM-VIS, IFU-NIR) IFU-NIR is considered as a requirement

MOSAIC will go to Council for approval before the end of 2021 (October/December 2021)

Necessary condition to to the STC (October 2021) and Council



Schedule

preliminary schedule under discussion with ESO from start of Phase B

	2021		2022		2023		2024		2025		2026	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Phase B												
Kick-off 1 meeting		Nov										
Phase C												

	2026		2027		2028		2029		2030		2031	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Phase C												
Phase D												
Phase E												
Provisional Acceptance Chile												Dec

Science with MOSAIC

Five dimensioning science cases

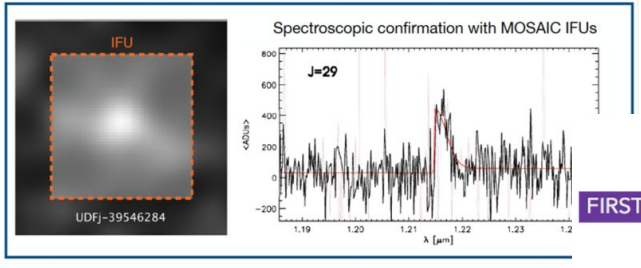
- **SC1**. First light galaxies and reionization
- **SC2**. Inventory of dark matter
- **SC3**. Mass assembly of galaxies through cosmic time
- **SC4**. Resolved stellar populations beyond the Local group
- **SC5**. Galaxy archaeology
- **SC6-NEW** Transients

Science cases are described in two White Papers (with contributions by several INAF researchers) and in a recent ESO Messenger paper

Potential GTO surveys are described in a series of SPIE papers

Hammer, F. et al., 2021, ESO Mess.
Sanchez-Janssen, R. et al., 2020 SPIE
Morris, S. et al., 2018 SPIE
Evans, C. et al., 2015 White Paper
Evans,C et al., 2014 SPIE

Science with MOSAIC



FIRST GALAXIES

RESOLVED STELLAR POPULATIONS BEYOND THE LOCAL GROUP

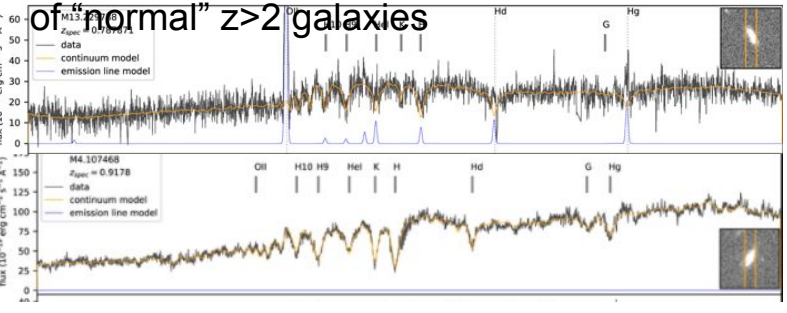
LARGE-SCALE STRUCTURE

GALAXY ASSEMBLY

AGN/GALAXY COEVOLUTION

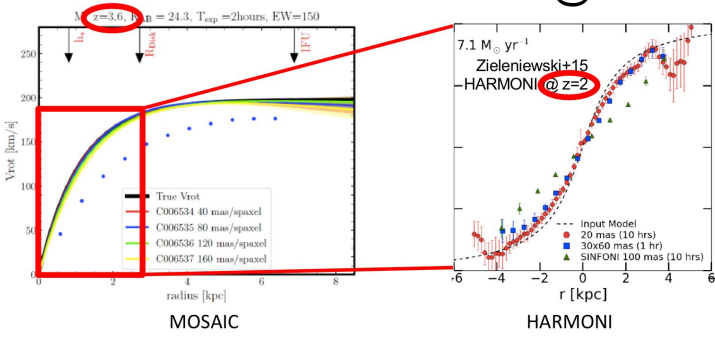
GALACTIC SCIENCE

stellar metallicities and ages of "normal" z>2 galaxies

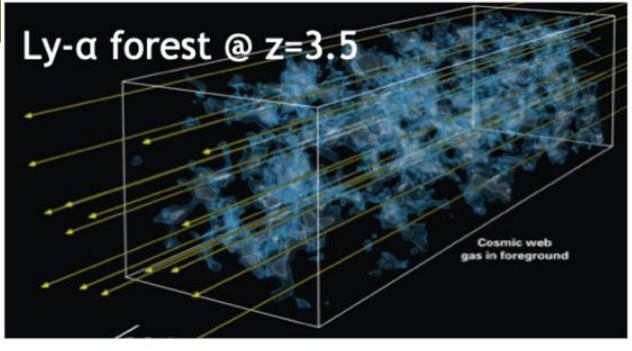


Strong synergy with HARMONI:

Rotation curves @z=4

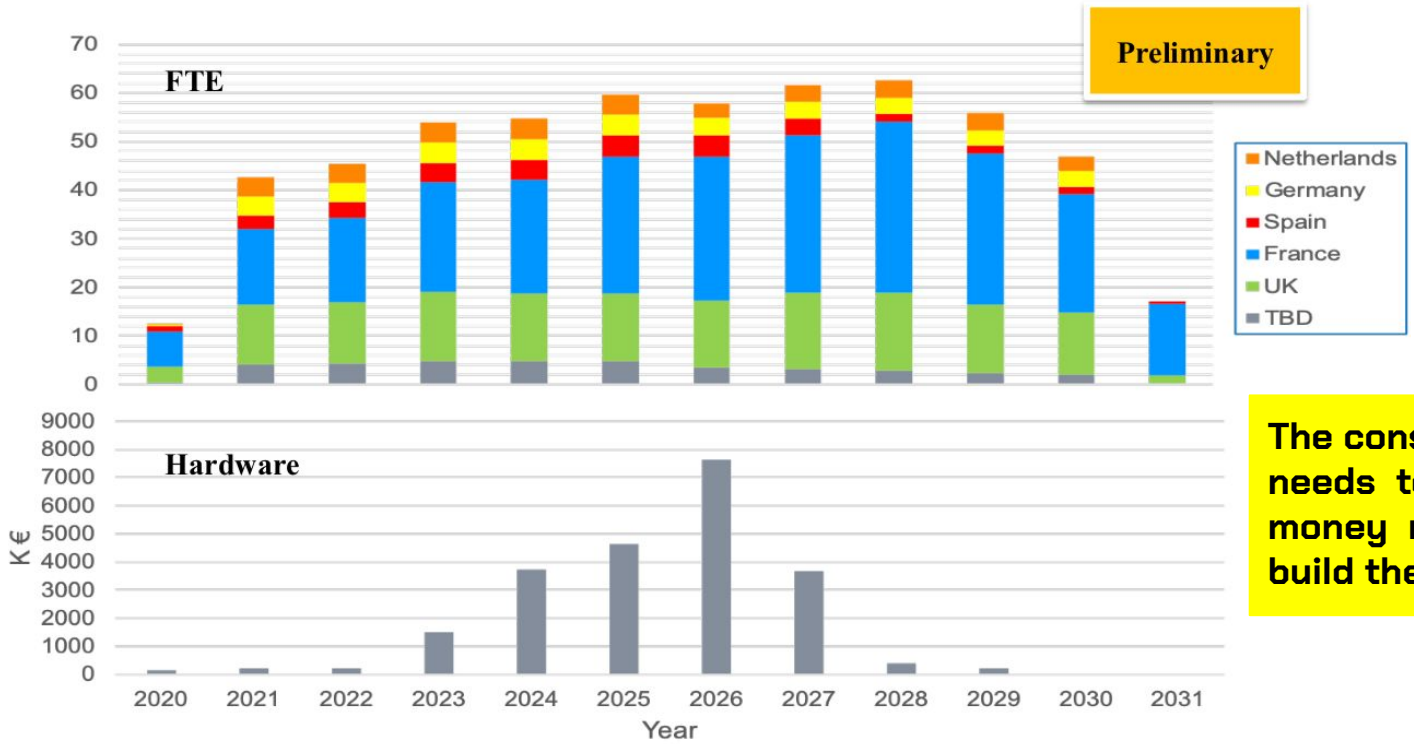


MOSAIC HARMONI



Cost and total FTE

- 30 M€ in hardware (*including overhead and running costs*)
- 550 FTEs over 10 years



The consortium needs to find all the money needed to build the instrument

Consortium

MOSAIC is a French-led ELT instrument
PI L. Tasca (LAM)
Co-PI M. Puech (GEPI)

The core of the consortium is made of 4 partners countries responsible for the hardware development and providing each more than 10% of the total cost

United Kingdom
FTE: ~26%

NIR spectrograph (UK ATC)
Positionner (Oxford/RAL space)
Adaptive optics (Durham)

France (Lead)
FTE: ~51%

PI-ship
Project Office
Scientific Lead & software (GEPI)
Assembly, Integration & Verification (LAM)
Software/Elec. control (IRAP)

Netherlands
FTE: ~7%

Visible Spectrograph (NOVA)

Germany
FTE: ~7%

Fibre system (AIP)

Associated partners contributing with funds and FTE

- 8 countries -Austria, Brazile Finland, Italy (hopefully!) Portugal, Spain, Switzerland and Sweden
- University of Michigan
- Space Telescope Science Institute

The italian involvement

Current Italian involvement

Scientific involvement:

-about 50 people are currently involved, also following the dedicated mini-workshop help on 25th of March .

- 36+3 participants from 11 different institutes have expressed potential FTEs

-about 30 are members of the newly formed MOSAIC science WGs (*all 5 main SWGs are covered!*) and we will have 1-2 positions of lead/co-lead of the groups

Technical involvement

Gianluca LiCausi (IAPS) was called to take full responsibility for the end-to-end simulations (recognised top expertise gained with MOONS)

The group at OATo could contribute to one of the technical work packages (which have sub-sections) :

Software control/ (NIR) detector characterisation/ Optical relays

Talks ongoing with MOSAIC technical managers

15. Team Summary

15. Personale INAF coinvolto

Numero di partecipanti INAF al progetto: 36

Struttura	Nfte	N0
O.A. ROMA	1	3
IASF MILANO	0	10
OAS BOLOGNA	0	6
O.A. PADOVA	0	2
O.A. BRERA	0	2
O.A. PALERMO	0	1
O.A. ARCETRI	0	5
O.A. CAPODIMONTE	0	1
O.A. TORINO	0	3
O.A. ABRUZZO	0	1
IAPS ROMA	1	0
Totali	2	34

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Pending Approval

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Criticalities: funding to enter the consortium

MOSAIC

Conditions to enter the Consortium and sign the Memorandum of Understanding (MOU) as associated partners:

*1 M Euro entry ticket

with the possibility that some of it could be an in-kind contribution
e.g. 0.5M could be to “build” something + 0.5M in cash

** the contribution can be spread over a number of years
e.g. 5 years→ 200K per year → a relative small investment for INAF for an instrument that can have a great impact on the italian community

<u>The MOU will be signed by the partners before the beginning of phase B</u>

Criticalities: why entering the consortium?

MOSAIC

Being members of the consortium will mean

1. access to **ALL GTO time** (130 nights)
   GTO time will not be divided between partners in proportion to the contribution but will be shared in GTO surveys and programs of common interest

   access to ELT will be highly competitive (only 1 telescope!!! not 4 like VLT) so access to GTO will be vital!!

2. being part of the consortium will mean privileged access to data exploitation tools, easier handling of data, etc and this will give us a great advantage in the competition for open time

   MOSAIC will be a very complex instrument

Criticalities: why entering the consortium ***now***?

Entering the WGs (and leading some of the WGs) in this phase, would mean having an impact on two fundamental issues:

1. The definition of the final instrument top level requirements

2. The definition and planning of the DRP (Design Reference Programs =GTO surveys) which will be high impact science programs uniquely possible with MOSAIC

Entering the consortium at a later time will mean being excluded from the critical decision-making phases.

also:

3. Participation to the instrument and publication boards

Final remarks

** the italian community has always relied heavily on MOS facilities

We have a long traditions of exploitation of MOS facilities both in the galactic and extragalactic communities

We have/had a leadership role in many ongoing and past MOS surveys e.g. VIMOS Surveys (VIPERS, VVDS, VUDS, VANDELS), the ESO-Gaia survey, etc

Our involvement in future MOS instrumentations is considerable MOONS, WEAVE, 4MOST, Euclid, JWST-NIRSpec etc . MOSAIC will be the natural continuation of these projects

Science with multi-object spectrographs: perspectives and opportunities for the Italian community

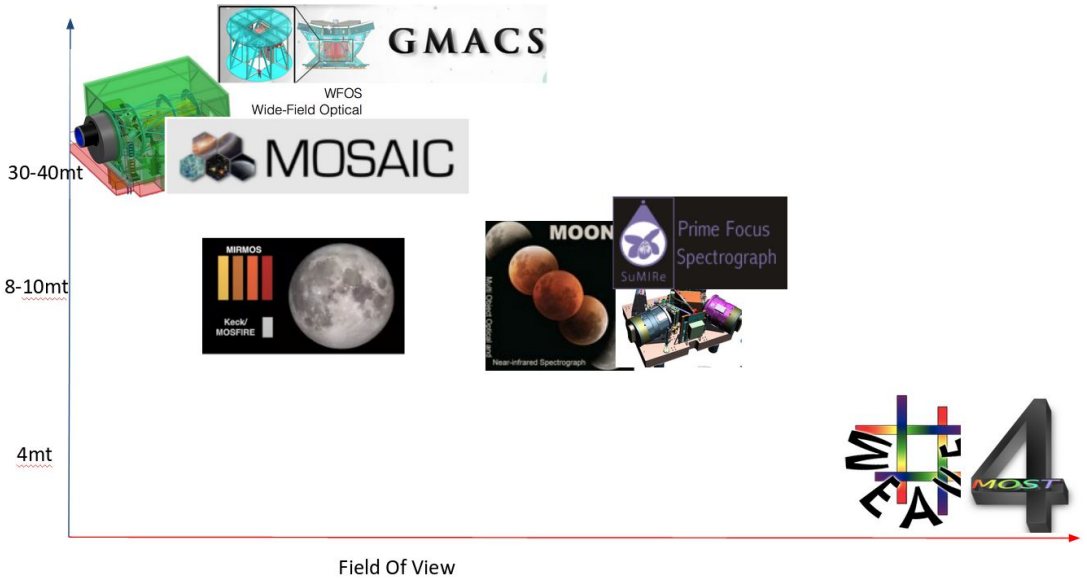
12-13 December 2018
IASF Milano
Europe/Rome timezone

2.5 years ago this workshop brought together the galactic and extragalactic community to speak about science, but also synergies and collaborations on tools, database etc

Final remarks

**All giant telescopes will be equipped with a MOS facilities: *GMACS for GMT and WFOS for TMT will be first light instruments (only optical coverage)*

**giving our support to the building of the MOS instrument for the ELT will mean enabling the european community to keep this window open for future discoveries



The ELT MOS

MOSAIC

High multiplex mono-fibres	Visible	Near IR	Multiple integral field units	Near IR
				
Number of apertures	220	160 (80 sci + 80 sky)	Number of apertures	10
Patrol area	52.1 arcmin^2	47.3 arcmin^2	Patrol area	44.2 arcmin^2
Operating bandwidth	0.45-0.88 µm	0.8-1.8 µm	Operating bandwidth	0.8-1.8 µm
Diameter of the aperture on sky	690 mas	500 mas	Outer diameter of on-sky subfield	2.5 arcsec (hexagonal)
Spectral resolution	5000 & 20000	5000 & 20000	Sampling	120 mas
AO performance	GLAO (~seeing limited)	GLAO	Spectral resolution	5000 & 20000
			AO performance	25% encircled energy in 150 mas

Comparison between MOSAIC multi-IFU and HARMONI

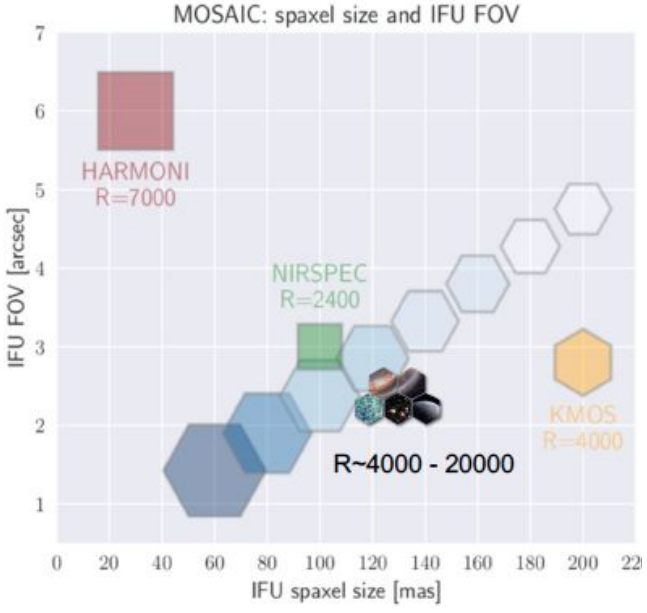
Metric : Survey Speed Ratio

$$SurveySpeed = \frac{Multiplex}{ObservingTime}$$, calculated for **M**osaic & **H**armoni

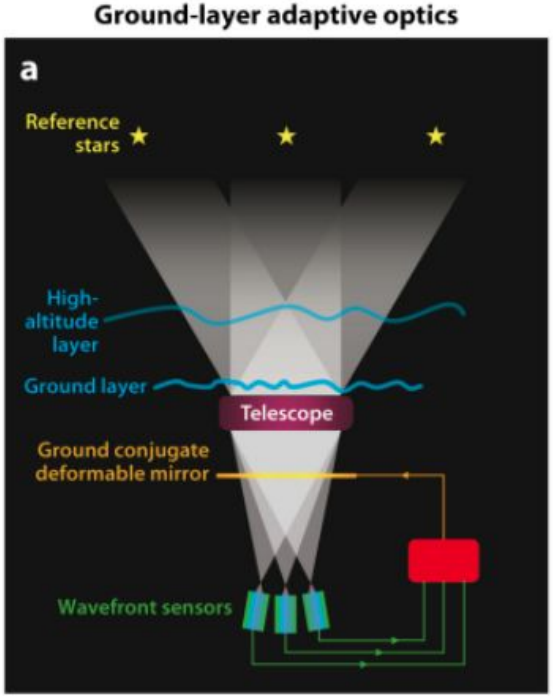
$$SSR = (Multiplex\_M/Multiplex\_H) * (S/N\_M / S/N\_H)^2$$

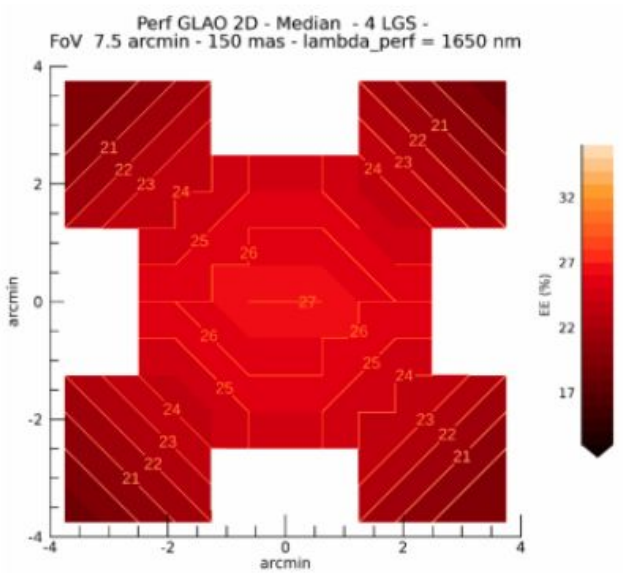
MOSAIC is less competitive than HARMONI for point sources (SSR≤ 1) but is faster for extended sources (SSR=8)

A full document on the comparison for specific science cases is available



GLAO





- Performance simulations ongoing
- Seeing improver: 1.5-2x, depending on conditions, LGS asterism, FOV.