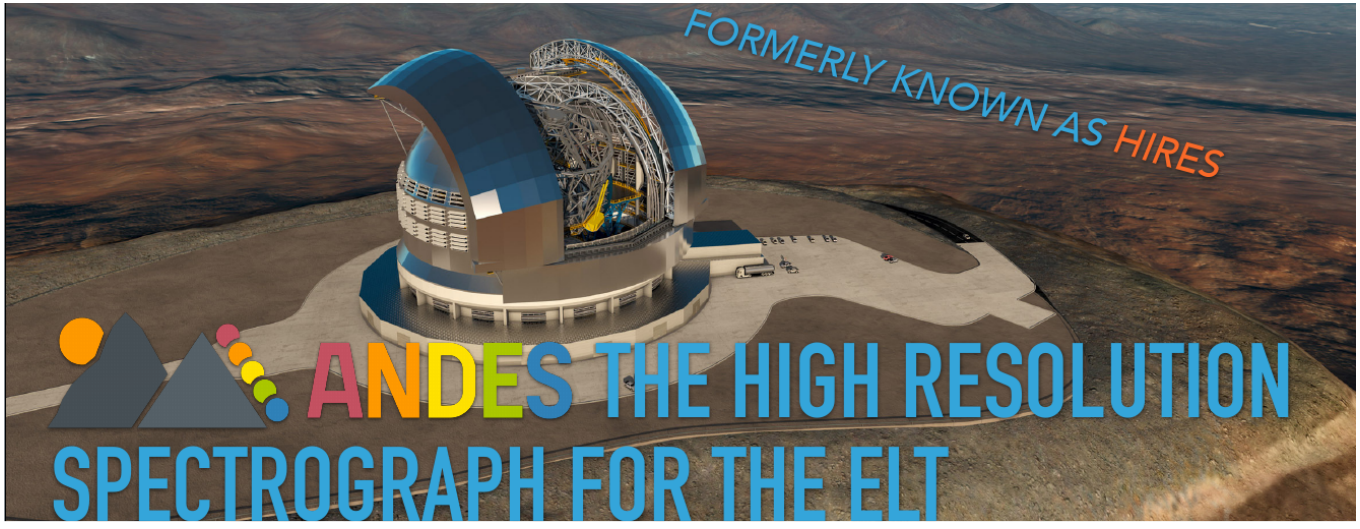


ELT/ANDES

ArmazoNes high Dispersion Echelle Spectrograph

Julien Morin & Omar Gabella

Laboratoire Univers et Particules de Montpellier

Journée Prospective Instrumentation LUPM – Lundi 12 janvier 2026

Sommaire

Outline

L'ELT en bref : le télescope

Vue CAO de l'ELT
Crédit : ESO

- Miroir primaire de 39 m de diamètre

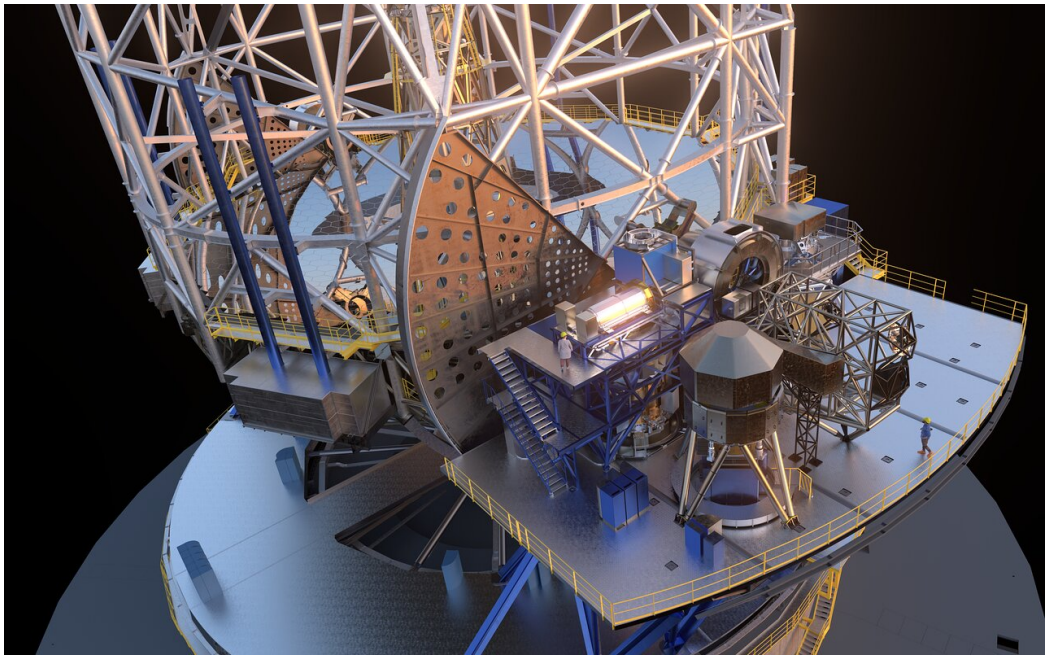
  798 segments
- Surface collectrice : 978 m^2
- Optique adaptative
- Hauteur totale du télescope : 65 m
- Masse de la structure : 3 400 t
  - dont 140 t de verre pour les miroirs

L'ELT en bref : le télescope

Photo aérienne des Cerro Paranal (VLT, vert) et Cerro Armazones (ELT, rouge)
D'après : ESO/M. Tarenghi

L'ELT en bref : les instruments

- Phase 1 (2028)
  - HARMONI : spectrographe IFU proche-IR
  - MICADO : caméra multi-AO
  - METIS : spectrographe + coronographe moyen-IR
- Phase 2 (2033)
  - ANDES : spectrographe proche-UV ➔ proche-IR
  - MOSAIC : spectrographe multi-objets



Vue CAO de la plateforme instrumentale Nasmyth

Crédit : ESO

L'ELT en bref : les instruments

- Phase 1 (2028)
  - HARMONI : spectrographe IFU proche-IR
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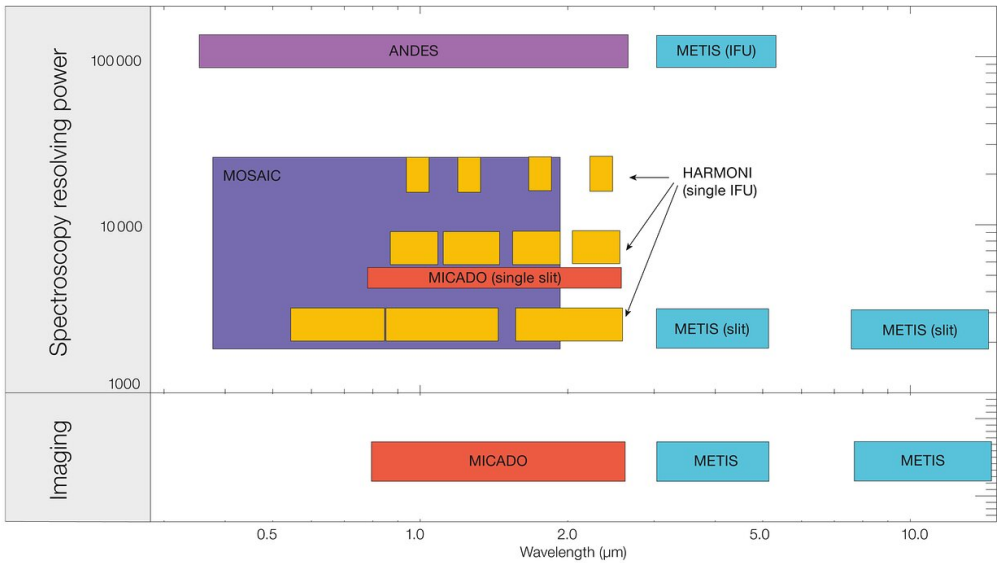


Propriétés des instruments ELT

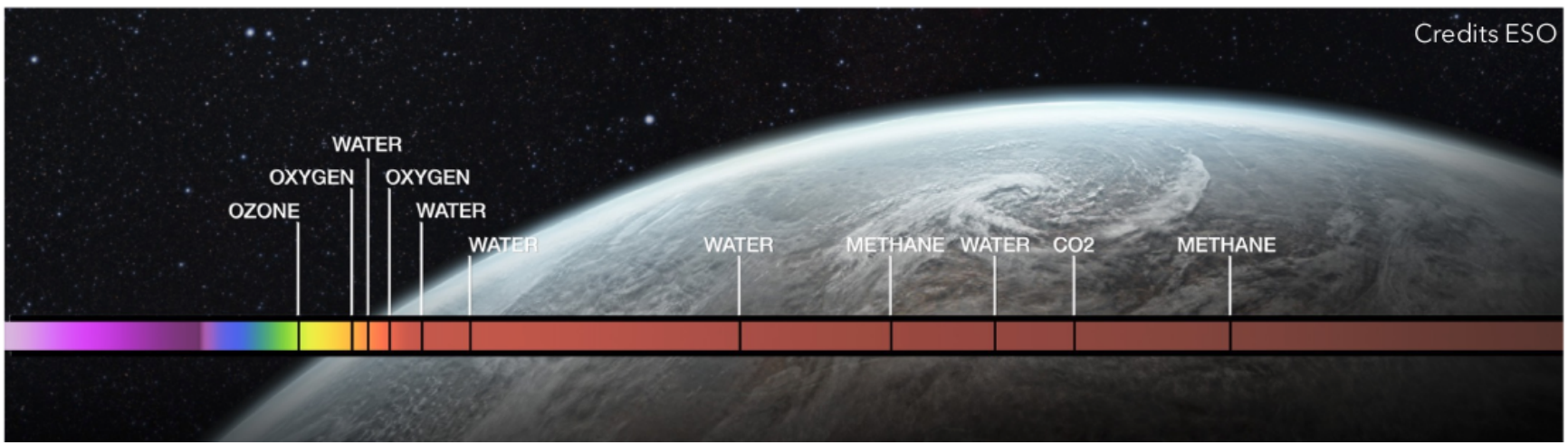
Crédit : ESO

Outline

ANDES : objectifs scientifiques

Exploring small rocky planets in the habitable zone of their stars via transmission spectroscopy (priority 1/4) is the leading science case of ANDES, while rocky exoplanet reflected light detection (priority 3/4).
Technical Requirements Specification for ANDES, ESO Document ESO-391757, 2022

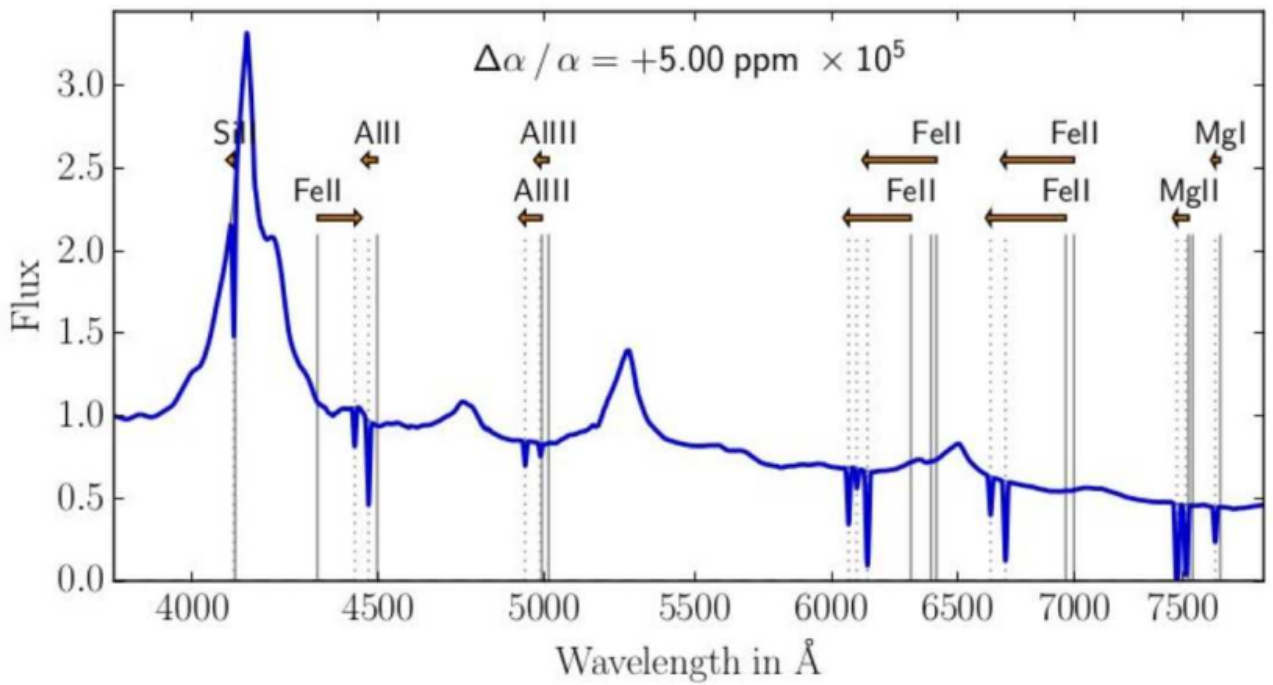
More largely for ELT's instruments: the focus is on detecting and quantifying exoplanet atmospheres. ANDES will enable astronomers to analyze their chemical composition, weather, and stratification, requiring ELT's large collecting area to overcome the "photon-starved" regime and ultimately detect signs of life.



ANDES : objectifs scientifiques

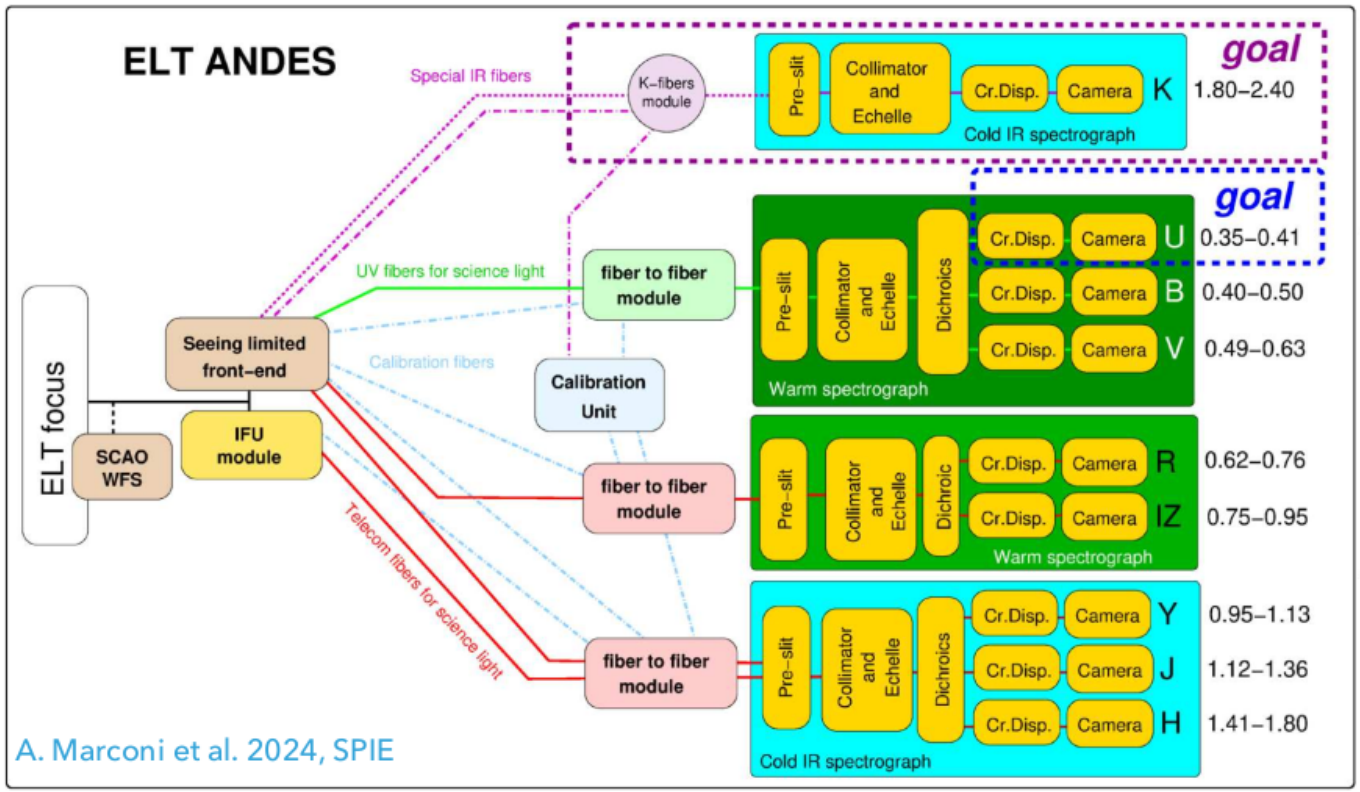
The standard model reproduces most observations but relies on poorly understood physics like inflation, dark matter, and dark energy. It's essential to test its foundations with stringent astrophysical constraints, whether they confirm or challenge the current paradigm.

ANDES absorption spectroscopy of distant quasars can probe key questions: variation of fundamental constants (priority 2/4), direct measurement of the cosmic accelerations (Sandage test, priority 4/4); (iii) Primordial nucleosynthesis and (iv) evolution of the CMB temperature



ANDES : architecture et spécifications

INSTRUMENT ARCHITECTURE



- Modular fiber-fed cross dispersed Echelle spectrograph
- Simultaneous range 0.4-1.8 µm (ultrastable BLUE+RED+NIR) Goal 0.37-2.4 µm; Resolution ~100,000
- Several interchangeable, observing modes: Seeing limited & SCAO+IFU

- Spectros U et K font désormais partie de la baseline (0,35-2,40 μm)

ANDES : calendrier

ANDES Phase B to E schedule

Milestone	Name	Date		Comment
	PDR Subsystem Review	~~October - November 2024~~ October - March 2025		
KM.3	System Preliminary Design Review	T0	~~April 2025~~ ~~November 2025~~ May/June 2026 (TBD)	
KM.4a	Funding Review	Uncertain - ~~Estimated December 2025~~ ~~Estimated Q1 2026~~ Estimated Q3/Q4 2026		
KM.4b	STC/FC/COU	Uncertain - ~~COU 7/12/2025~~ 07/12/2026		
	FDR Subsystem Review	~~First semester 2027~~ Second semester 2027		*probably a shift is needed*
KM.5	System Final Design Review	T0+30 months	~~October 2027~~ Q2/2028	*probably a shift is needed*
KM.6	Test Readiness Completion (end of MAIT phase)	T0+86 months	June 2032	beginning of "group" integration
KM.7	Preliminary Acceptance Europe Completion (PAE)	T0+103 months	November 2033	

Outline

Consortium ANDES

LARGE INTERNATIONAL CONSORTIUM INTERNATIONAL 13 COUNTRIES AND 35 INSTITUTES (3 NON-ESO MEMBERS)

- **Brazil:** Federal Univ. of Rio Grande do Norte
- **Canada:** Univ. De Montreal, Herzberg Astrophysics Victoria
- **Denmark:** Univ. Copenhagen, Univ. Aarhus, Danish Tech. Univ.
- **France:** LAM Marseille, LAGRANGE Nice, IPAG Grenoble, IAP Paris, LMD Paris, IRAP/OMP Toulouse, LUPM Montpellier
- **Germany:** AIP Potsdam, Univ. Göttingen, Landessternwarte Heidelberg, MPIA Heidelberg, Thüringer Landesternwarte Tautenburg, Univ. Hamburg
- Italy: INAF Istituto Nazionale di AstroFisica (Lead) (Arcetri, Bologna, Brera, Padova, Trieste)
- **Poland:** Nicolaus Copernicus Univ. in Toruń
- **Portugal:** Inst. Astrofísica e Ciências do Espaço, CAUP Porto, Lisbon
- **Spain:** Inst. Astrofísica de Canarias (IAC), Inst. Astrofísica de Andalucía (IAA - CSIC), Centro de Astrobiología (CSIC-INTA) Madrid
- **Sweden:** Uppsala Univ., Lunds Univ., Stockholm Univ.
- **Switzerland:** Univ. de Genève, Univ. Bern
- **United Kingdom:** Univ. of Cambridge, UK Astronomy Technology Centre, Heriot-Watt Univ.
- **USA:** Univ. of Michigan

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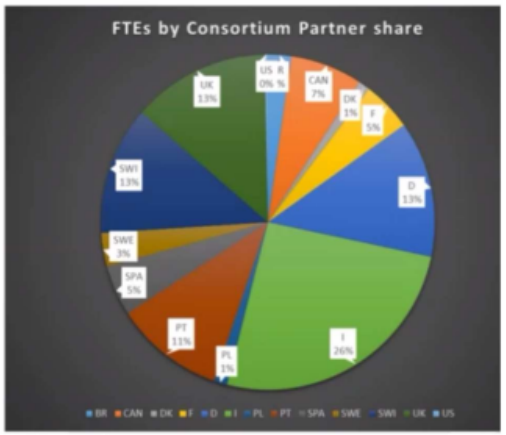
- **USA:** Univ. of Michigan

Consortium ANDES

GTO NIGHTS AND DISTRIBUTION AMONG PARTNERS

Partner	FTEs
1. **Brazil** (Univ. Rio Grande do Norte)	2,3
2. **Canada** (Montreal University)	7,1
3. **Denmark** (Instrument Center Danish Astrophysics (Niels Bohr Inst., Aarhus Univ., DTU Lyngby)	1,15
4. **France** (LAGRANGE, LAM, IRAP/OMP, IPAG, LUPM)	4,9
5. **Germany** (AIP Potsdam, IAG Göttingen, MPIA Heidelberg, ZAH Heidelberg, TLS Tautenburg, HS Hamburg)	17,4
6. **Italy** (INAF)	26,1
7. **Poland** (Univ. Torun)	1,3
8. **Portugal** (CAUP Porto, FCiências.ID Lisbon, Inst. Astrophysics & Space Science)	10,8
9. **Spain** (IAC Tenerife, CSIC: IAA, Astrobiology)	5
10. **Sweden** (Lunds University, Stockholms University, Uppsala University)	3,3
11. **Switzerland** (Geneve University, Bern University)	12,6
12. **UK** (STFC: UKATC, Heriot-Watt Univ., Cambridge Univ.)	13,6
13. **US** (Univ. Michigan)	0,3
Total	**105.9**

During Phase B



- GTO = 65 nights for FTEs
  + >60 nights for cash contribution

  (re-evaluated at Funding Review)

  > 125 nights GTO
- **Shared GTO programs**
- Impact of Partner Weight (FTE + Cash)

Membres of Science Teams

Choice of Scientific Programs

Scientific Feedback

The composition of the Science team and the allocation will be reviewed at the Funding Review and at the end of the construction phase

Contributions françaises

FRENCH INVOLVEMENT

Karine Perraut : repr. INSU and Steering committee

Executive Board
1 representative per country
Bruno Leonardo Canto Martins, Lise Christensen, Isabelle Boisse, Klaus Strassmeier, Andrzej Niedzielski, Nuno C. Santos, Jonay Gonzalez Hernandez, Nikolai Piskunov, Christophe Lovis, Martin Haehnelt, Elena Gallo

I. Boisse LAM/OHP and A. Chiavassa (Lagrange)

Project Management Team
Omar Gabella, Lise Christensen, Manuel Amate, Izan de Castro Leão, Frédérique Baron, Piotr Masłowski, Elena Gallo + subsystems PMs

O. Gabella (LUPM)
(deputy P. Berio, Lagrange)

Science Team

I. Boisse (LAM), X. Bonfils (IPAG), A. Chiavassa (Lagrange), F. Debras (IRAP), M. Turbet (LMD), P. Noterdaeme (IAP)

Instrument Scientist Team
Silva Järvinen, Christophe Lovis, Oscar Gonzalez, Wolfgang Brandner, Elena Mason

M. N'Diaye (Lagrange)

SCAO
Italy
Enrico Pinna/ Chiara Selmi

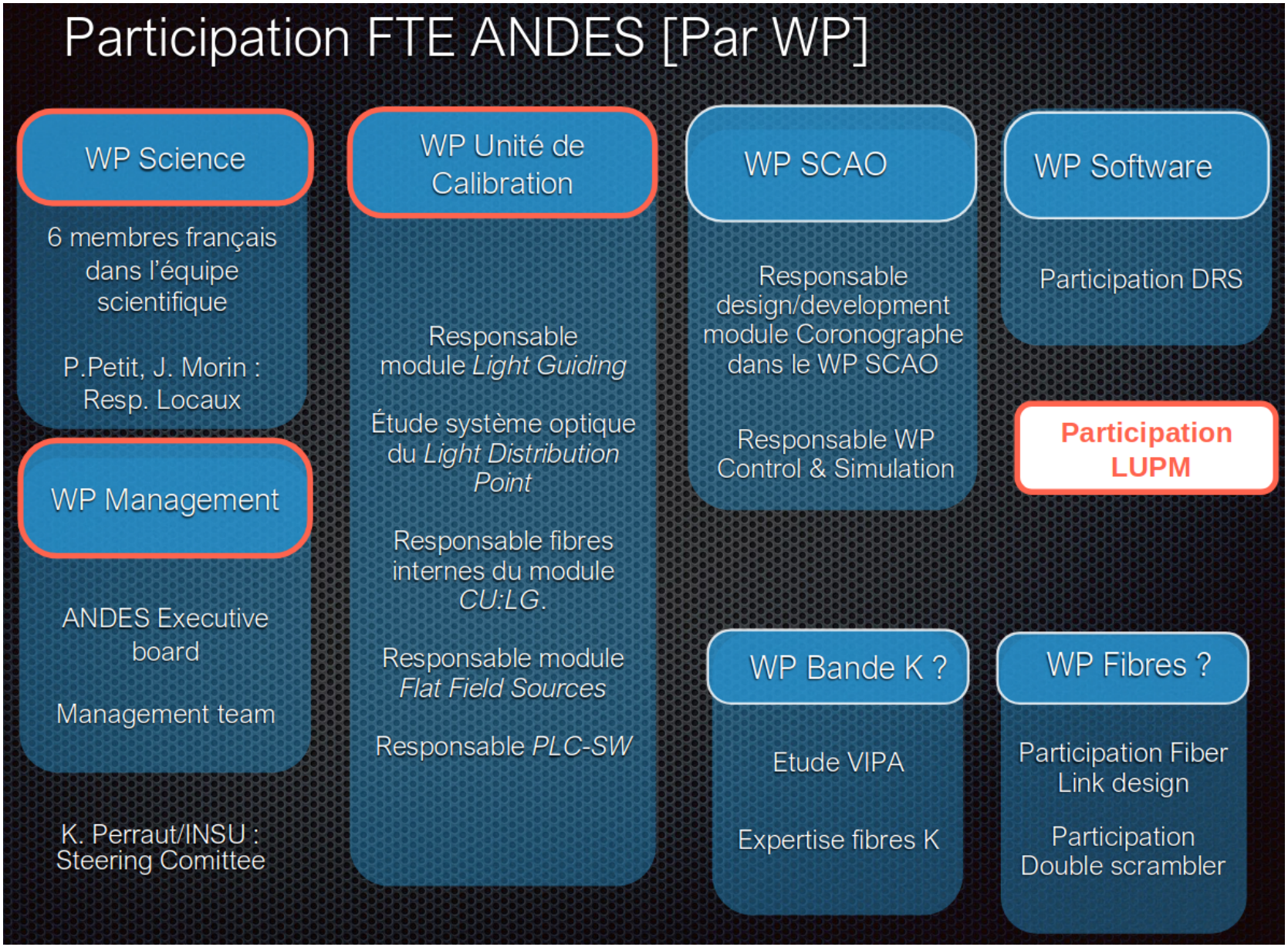
→ 3 leading Modules

- Module Coronagraph: M. N'Diaye, A. Chiavassa, P. Bério (co-head) Lagrange
- Module IFU Calibration: J. Seidel and M. N'Diaye (Lagrange)
- Module IFU Performance: A. Simmonin (Sweden/Lagrange)

Software
Portugal
Manuel Monteiro

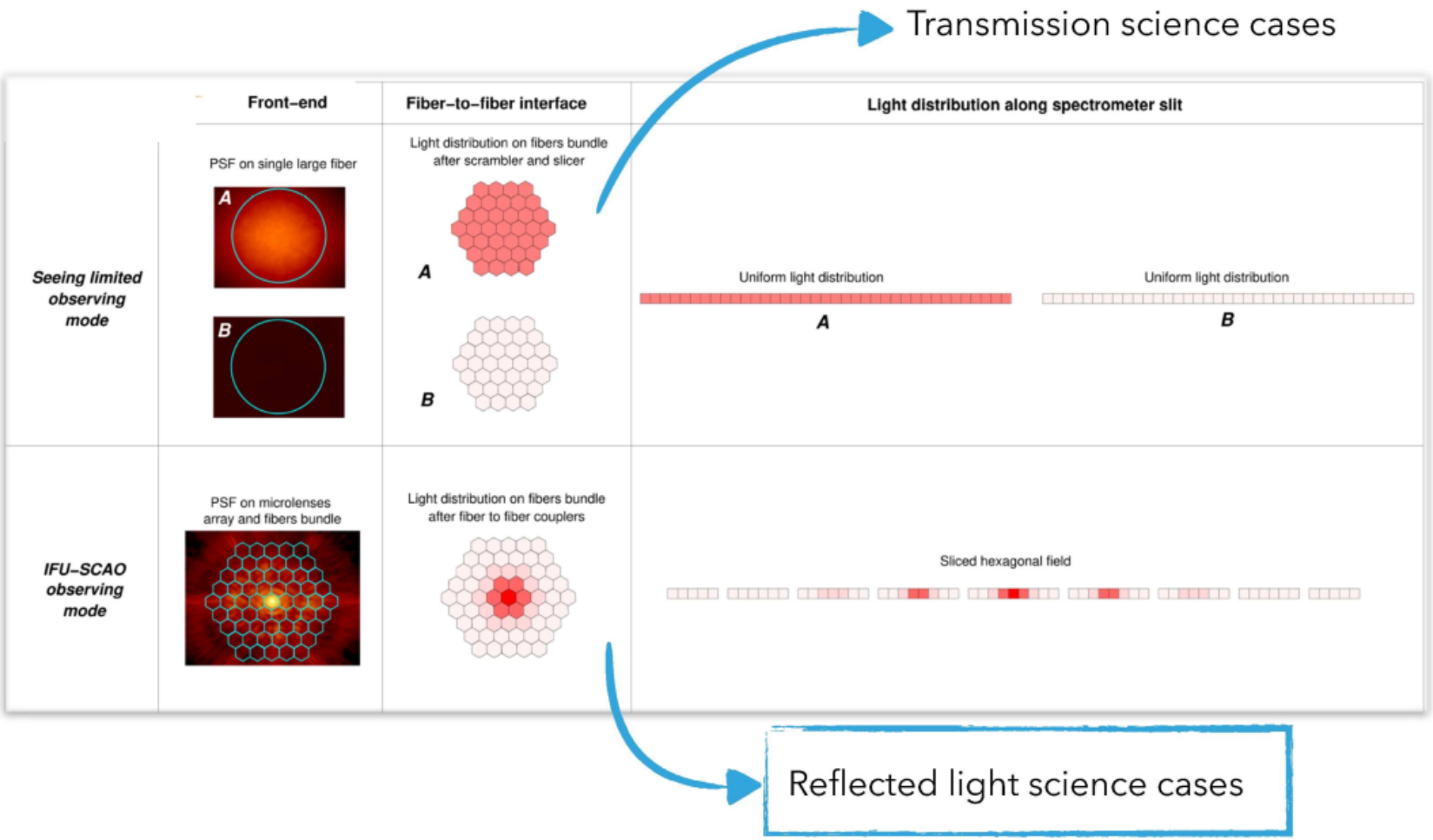
DRS: I. Boisse (LAM)

Implication du LUPM



Implication du LUPM

OBSERVATION MODES

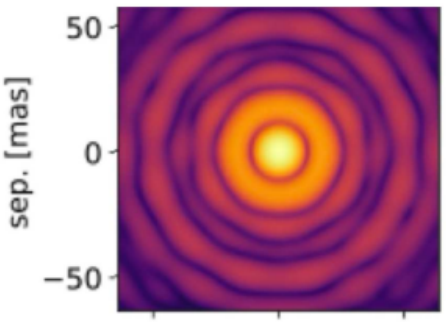


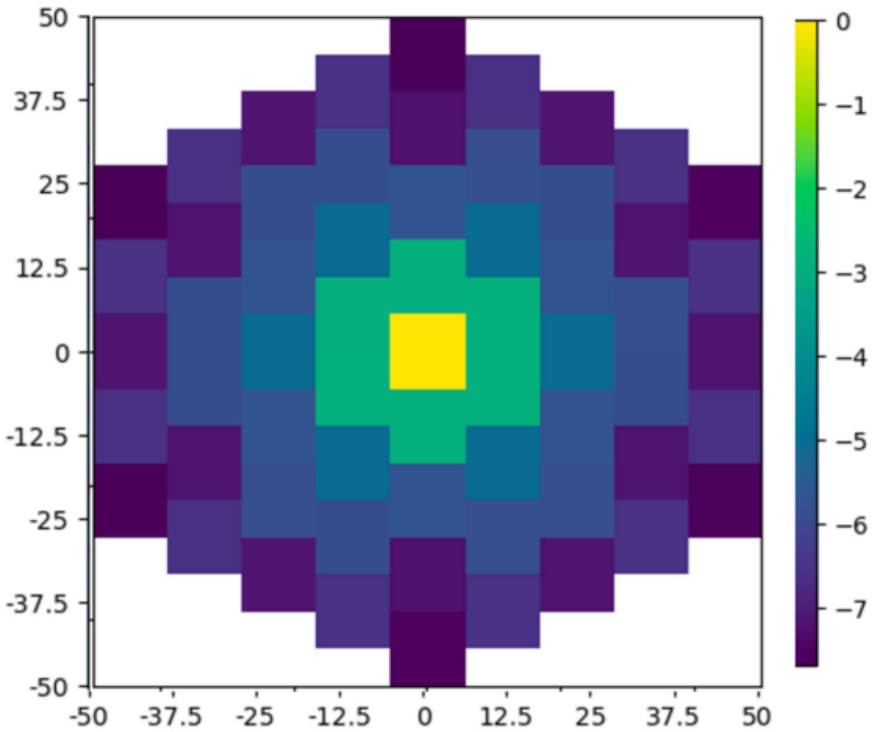
Implication du LUPM

REFLECTED LIGHT

Without

Coronagraph





E2E ANDES simulator

APU: ANDES Performances Unfolded

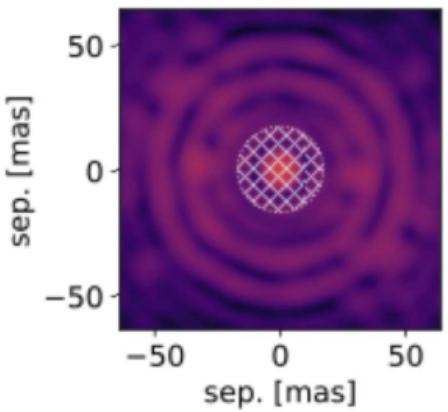
Simonnin et al. in prep.

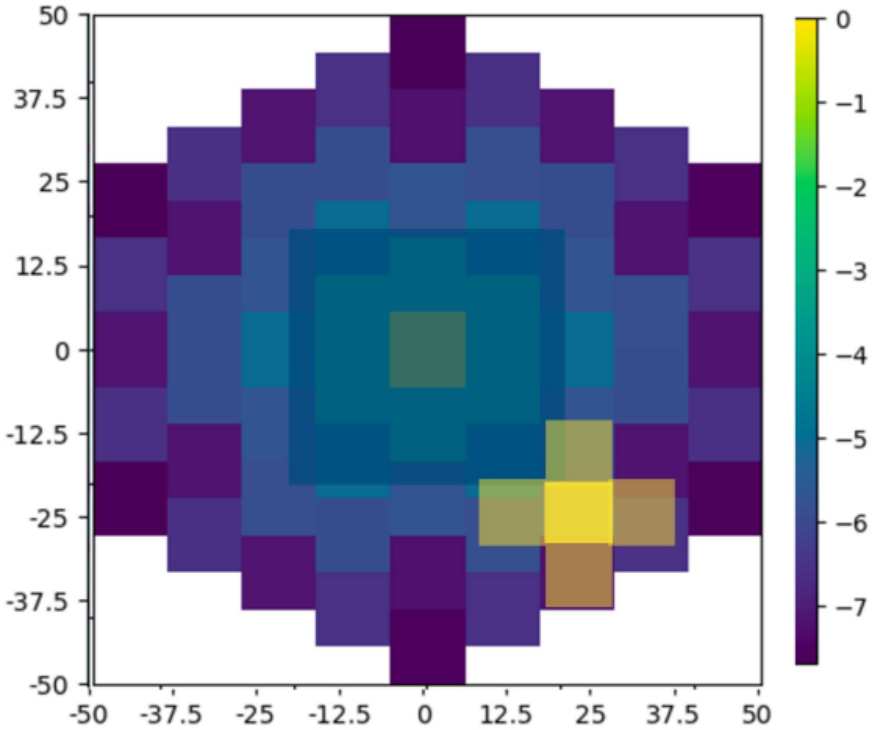
Implication du LUPM

REFLECTED LIGHT

Coronagraph

With





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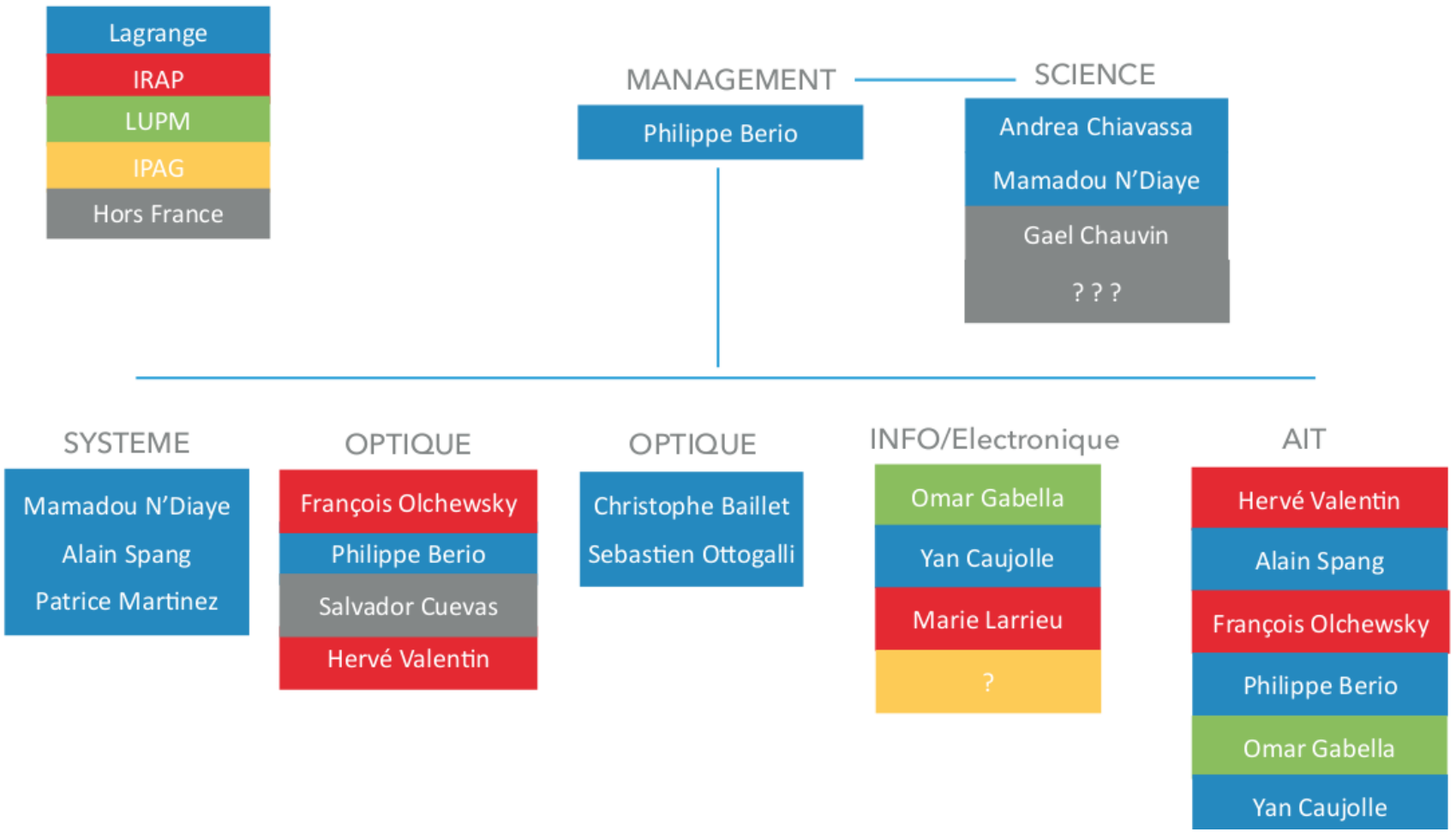
Implication du LUPM



Outline

Résumé

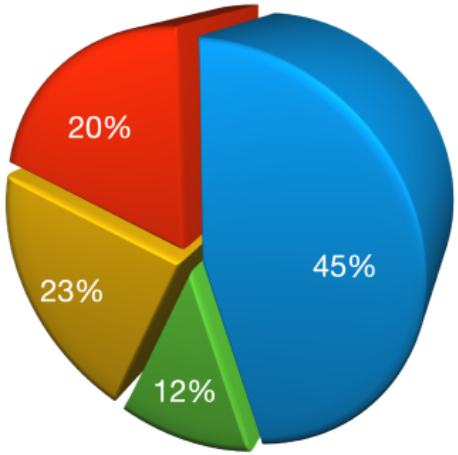
- Depuis juin 2024 ANDES confirmé comme instrument de phase 2 pour 2033
- Consortium international, France partenaire mineur
  - LUPM rejoint en 2021 pour début phase B
  - Consortium Agreement 2022
- Implication FR initiale morcelée
  - LUPM : unité de calibration
- À partir de 2026 : recentrage sur coronographe/IFU

`https://youtu.be/FuMvka1-dA4`

Crédit : ESO

Images du 3 novembre 2025

Conclusion



Resp. R. Maiolino (UK)

100 members in 4 Working Groups.
4 science referred papers in 2024-2025

WG1 45 me.	**Exoplanets:** characterization of Exoplanet atmosphere - detection of signature of life **Protoplanetery discs:** dynamics - chemistry - physical conditions in the inner regions	**I. Boisse (LAM), X. Bonfils (IPAG), A. Chiavassa (Lagrange), F. Debras (IRAP), M. Turbet (LMD)**
WG2 23 me.	**Stellar populations:** metal enrichment and dynamics of extragalactics star cluster - resolved stellar populations **Stellar astrophysics:** abundance of solar-type and cooler dwarfs in galactic disc bulge - halo and nearby dwarfs: tracing metal enrichment of Pop III stars in nearby universe	**A. Chiavassa (Lagrange)**
WG3 20 me.	**Intergalactic medium:** signature of reionization and early enrichment of ISM - IGM observed in high-z quasar spectra **Super massive black hole:** low-mass end **Galaxy evolution:** massive early type galaxies epochs of formation and assembly	**P. Noterdaeme (IAP)**
WG4 12 me.	**Fundamental physics:** variation of fundamental constants - α, mp/me, Sandage test	**P. Noterdaeme (IAP) –> co-Chair**

- Atelier ANDES France à Montpellier automne 2026
- Voir Chiavassa et al. (2025) SF2A proc.