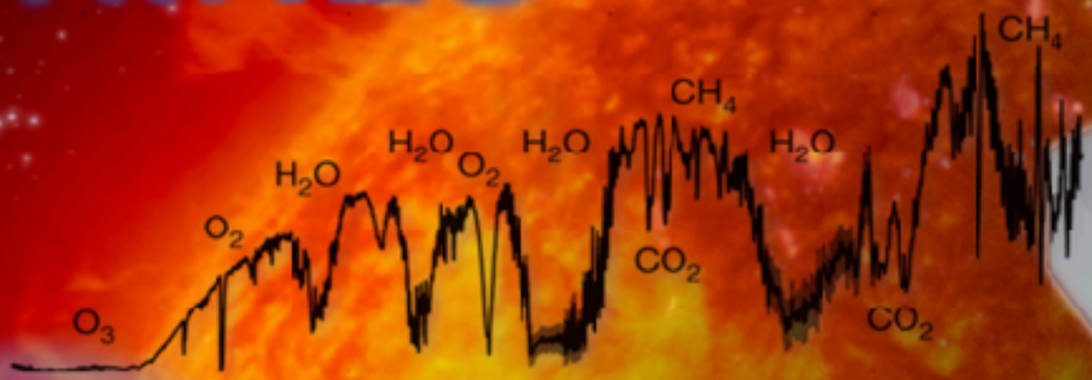
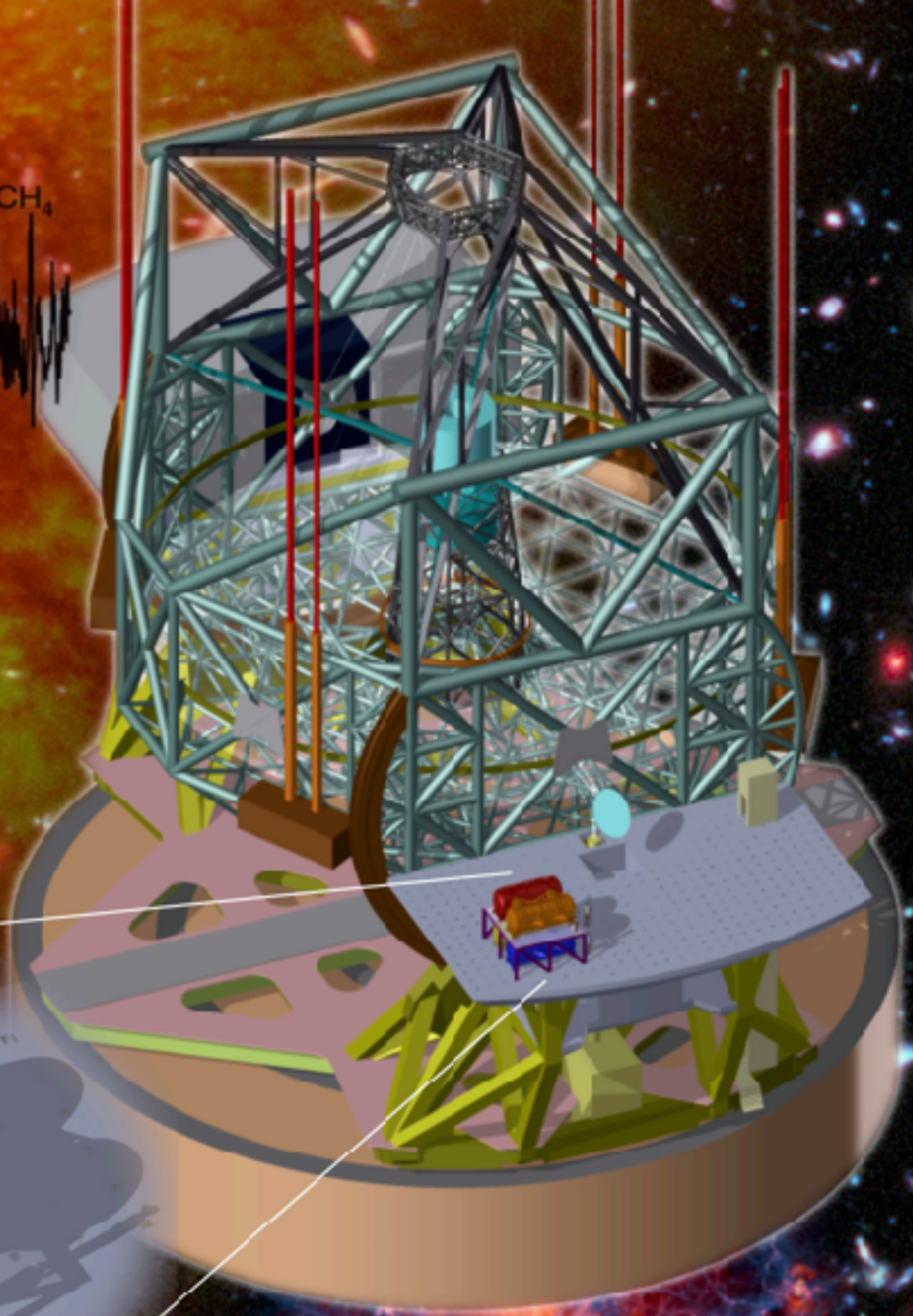
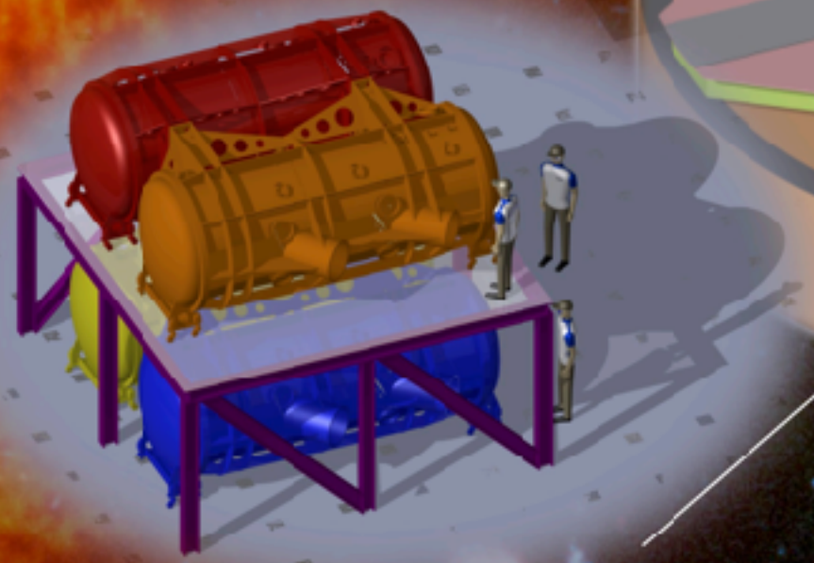
ELT HIRES







HIRES @ ELT – ETAT DU PROJET

- Spectrographe à haute résolution (100,000 et 150,000 + mode IFU-SCAO)
  Couverture simultanée de 0.35 à 1.8 microns - extension à défendre vers K
  depend du coating miroir telescope

- PI Alessandro Marconi (INAF)

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- Consortium de 14 pays (dont 3 non membres ESO : U. Montréal, U Michigan, et le Brésil) - 37 instituts (leader INAF et implication forte : Allemagne et Suisse)

- Phase A : Mars 2016/2018 - documents et présentation à l'ESO en octobre 2017

- Pas de financement ESO (similaire à MOSAIC)

- GTO en commun de 125 nuits

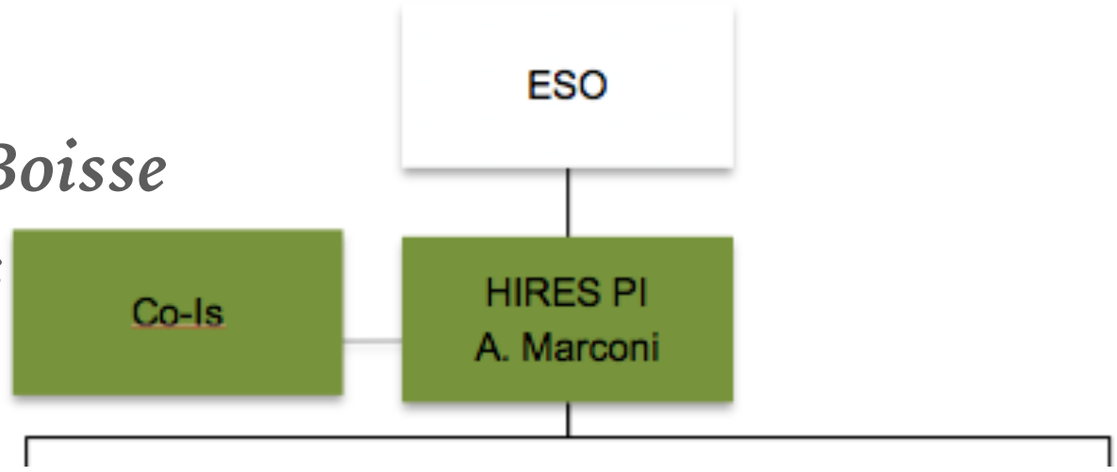
- Objectif de commencer phase B mi-2021 et d'avoir un instrument sur le ciel en 2029 (Phase B 1.5 ans - Phase C 2 ans - Phase D 4.5 ans - PAC 0.5 an)
  Construction agreement (draft) mentionne un délai de 2 ans avec 1ere lumière

ORGANISATION DU CONSORTIUM – PHASE A

11 co-I

*France: F. Bouchy > **I. Boisse***

*deputy : **X.Bonfils***



63 scientifiques

*dont **7 français (11%)***
ont directement
participé en phase A

6 ing
techn
directement participé en
phase A

Science Advisory Committee (SAT): 63 experts in High-Res spectrosc.

Project Scientist & SAT Chair (R. Maiolino)

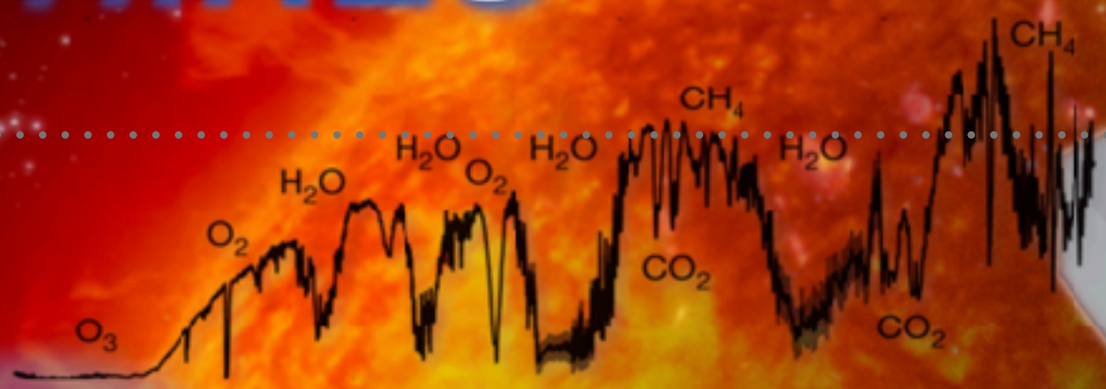
Core SAT

WG1 Exoplanets and Circumst. Discs	WG2 Stars and Stellar Pop.	WG3 Galaxies and IGM	WG4 Cosmology and Fundam. Physics
Chair: E. Palle Co-Chair: C. Lovis	Chair: C. Allende Co-Chair: A. Korn	Chair: V. D'Odorico Co-Chair: E. Zackrisson	Chair: J. Liske Co-Chair: C. Martins
20 scientists	17 scientists	17 scientists	9 scientists
X.Bonfils *I. Boisse*	*A. Chiavassa* *J.-C. Bouret*	*N. Bouché* *C. Peroux*	*P. Noterdaeme*

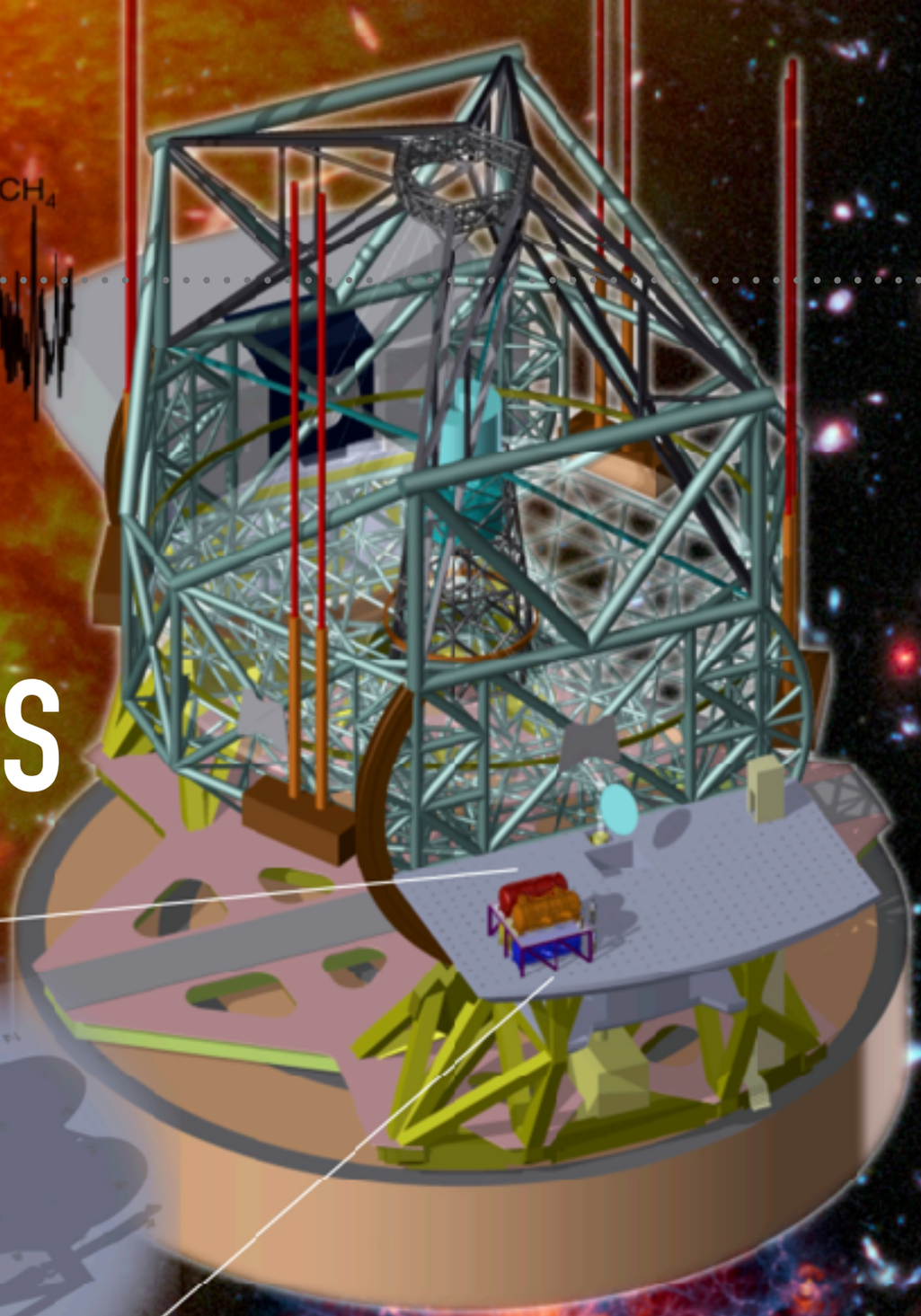
Début de la phase A : prioritisation des objectifs scientifiques et définition des requirements instrumentaux puis raffinement et itérations

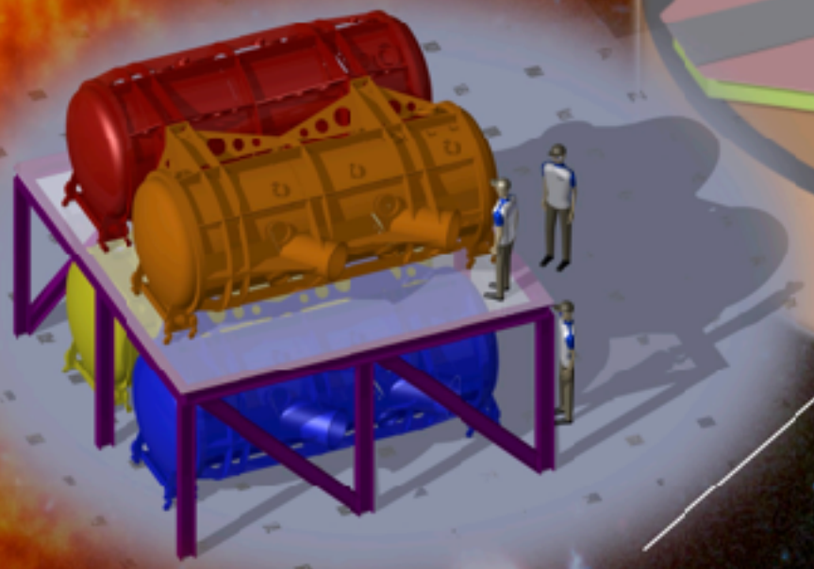
~30 cas scientifiques à classer en Astronomie et Physique

ELT HIRES



OBJECTIFS SCIENTIFIQUES





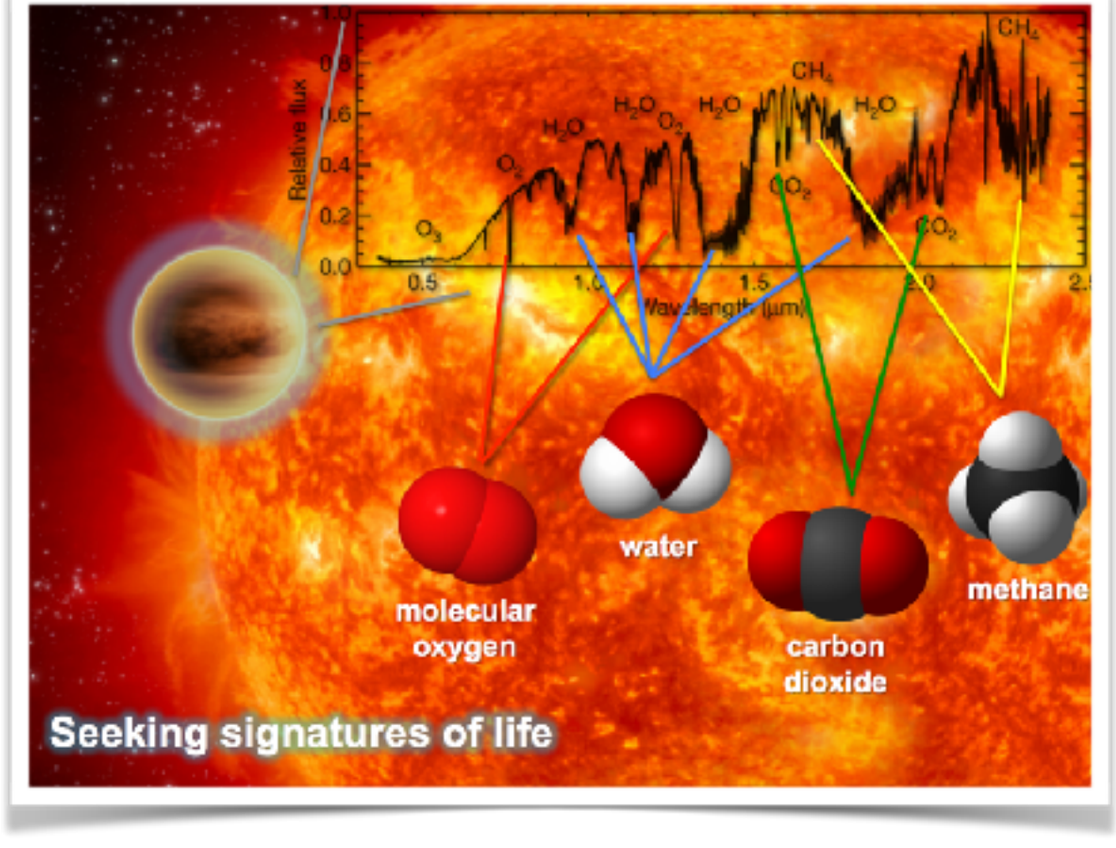
PRIORITÉS SCIENTIFIQUES

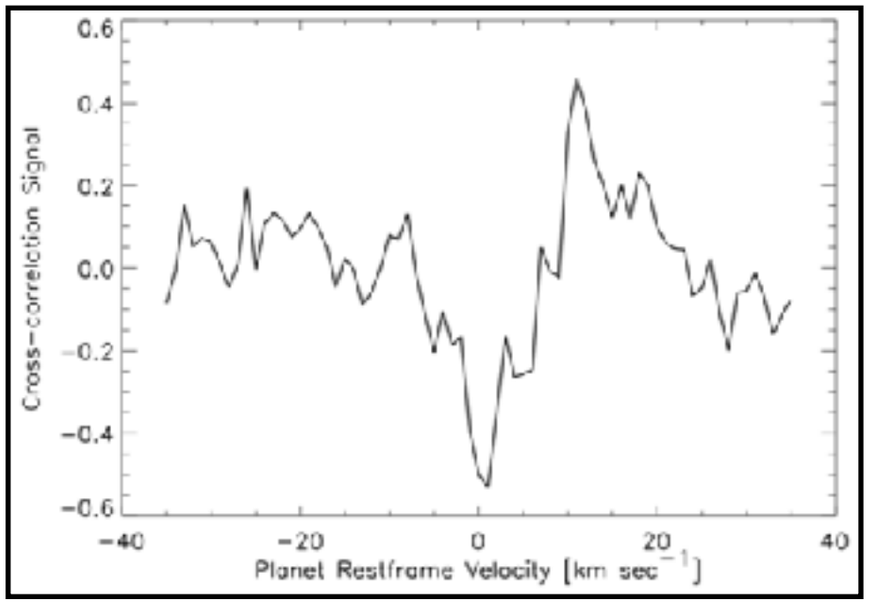
1. Detection of the signature of life through exoplanet atmosphere **in transmission**

Les TLR associés → permettent aussi

- Reionization of the universe
- Characterization of cool stars
- Extragalactic transient
- 3D reconstruction of the CGM
- Detection and investigation of near pristine gas

(see HIRES White Paper, Maiolino+2014)

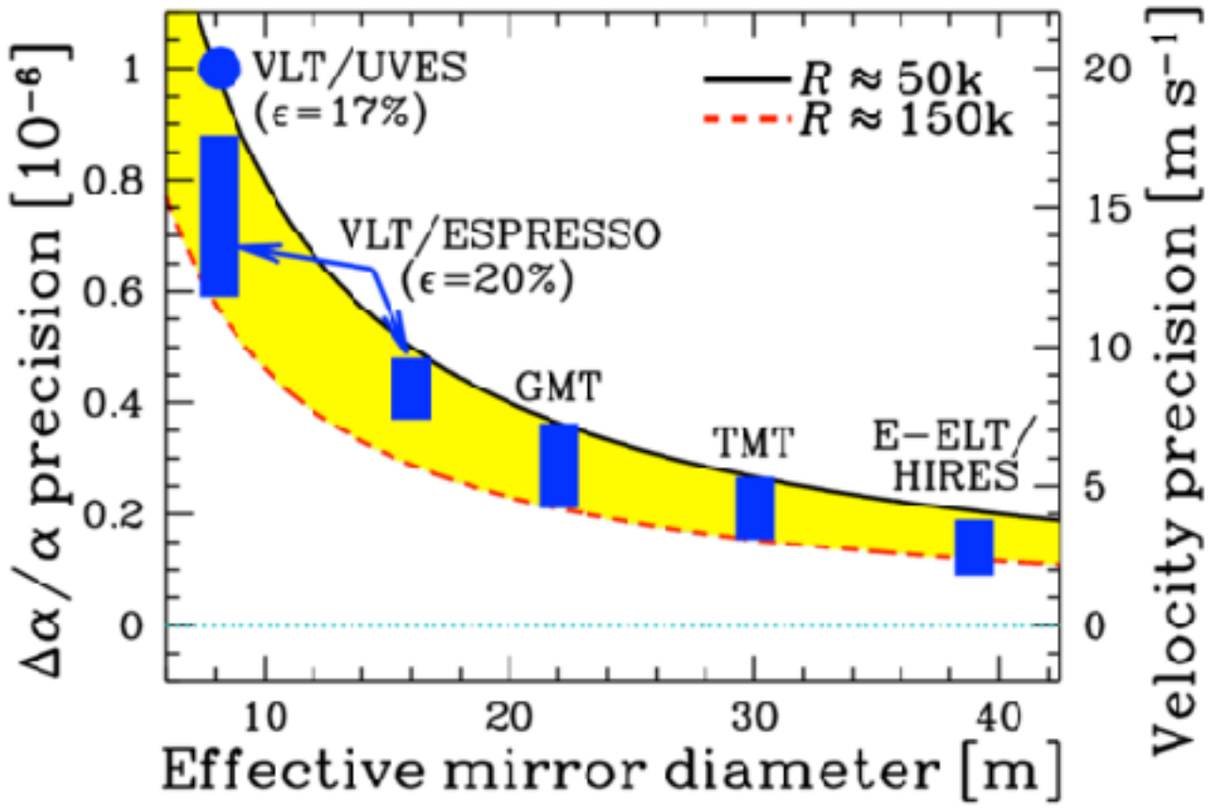




Cross-correlation technique for objects in transit

O2 molecule in a simulated Earth-like atmosphere orbiting an M5V (I=11mag) star, combining 30 transits with HIRES (from Snellen et al. 2015, A&A 576, 59)

PRIORITÉS SCIENTIFIQUES

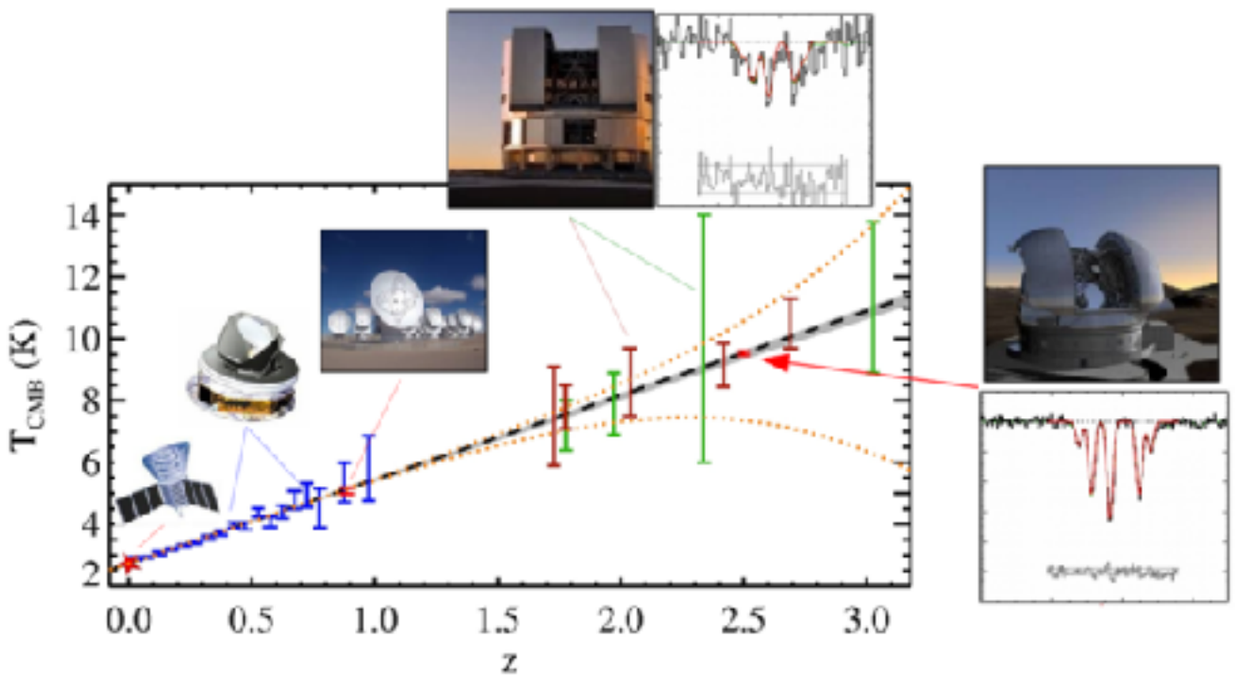


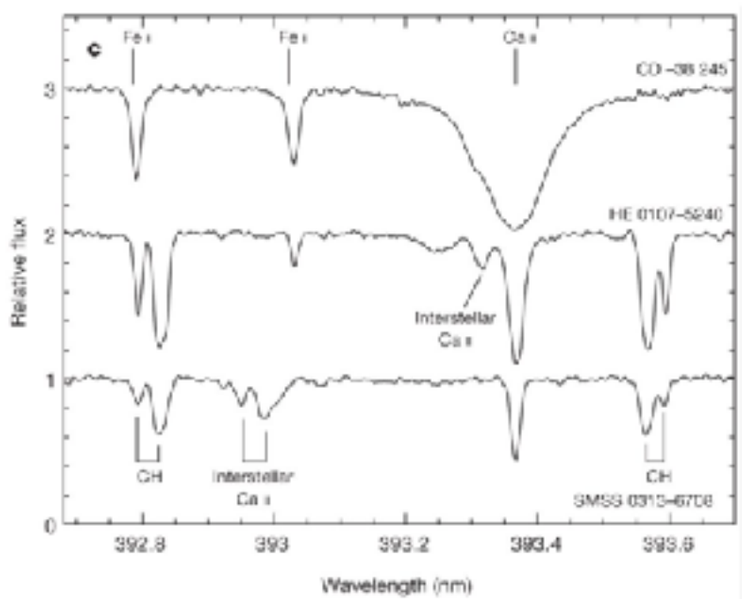
2. Variation of the fundamental constants of physics

Les TLR associés

permettent aussi

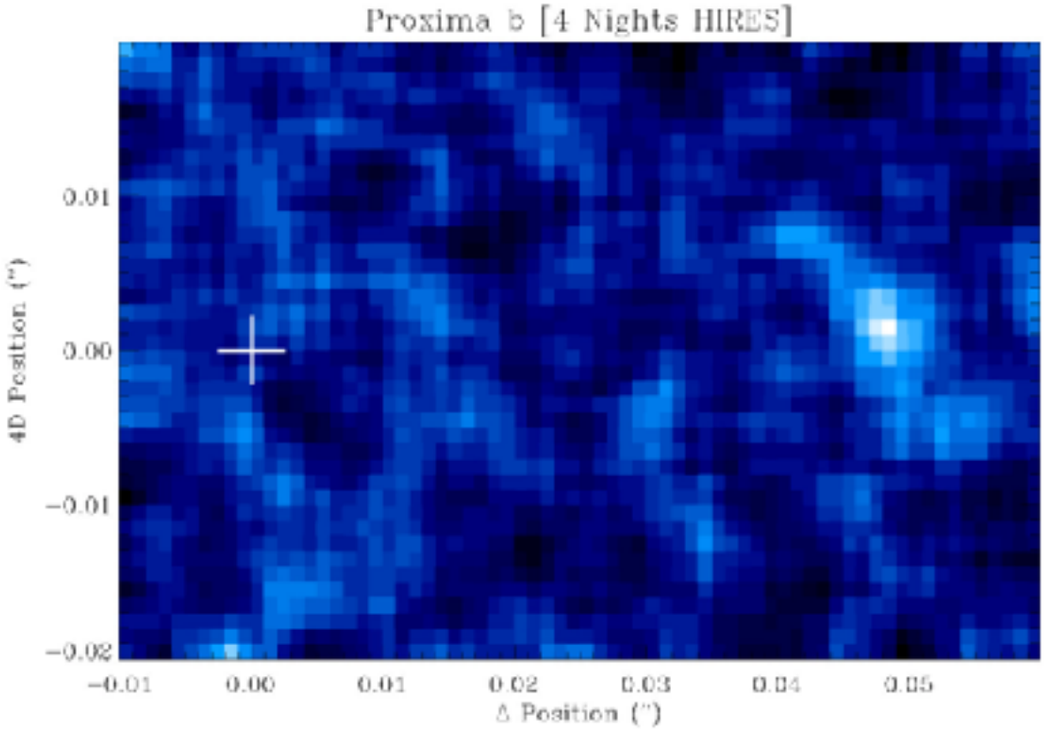
- Cosmic variation of the CMB temperature
- Deuterium abundance
- Investigation and characterisation of primitive stars



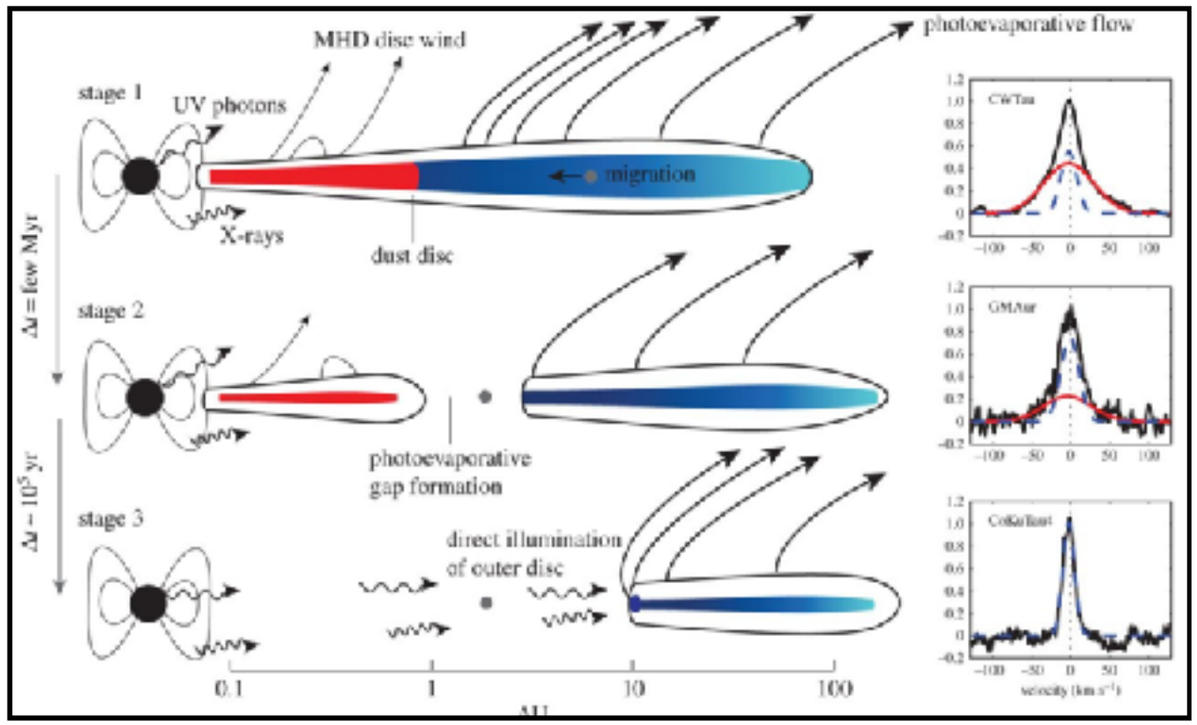


from Keller et al. 2014, Nature

PRIORITÉS SCIENTIFIQUES



Simulation of the reflected light cross-correlation signal of the direct surroundings of Proxima, showing Proxima-b at 48 mas.



[OI] 6300 Å emission whose composite profile traces the disk gas dispersal in the corresponding stages (Simon et al. 2016)

3. Detection of the signature of life through exoplanet atmosphere **in reflexion**

Les TLR associes permettent aussi

- Planetary formation in protoplanetary disks
- Stellar atmosphere
- Search of low-mass black holes
- Physics of protoplanetary disks

4. Direct detection of the cosmic acceleration - measurement of the Sandage effect

Les TLR associes permettent aussi

- Mass determination of earth-like objects
- RV search for exoplanets

PRIORITÉS SCIENTIFIQUES

4 PRIORITES = 4 TLR → TRANSVERSE

1. Detection of the signature of life through exoplanet atmosphere **in transmission**

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Les TLR associes → permettent aussi

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- RV search for exoplanets

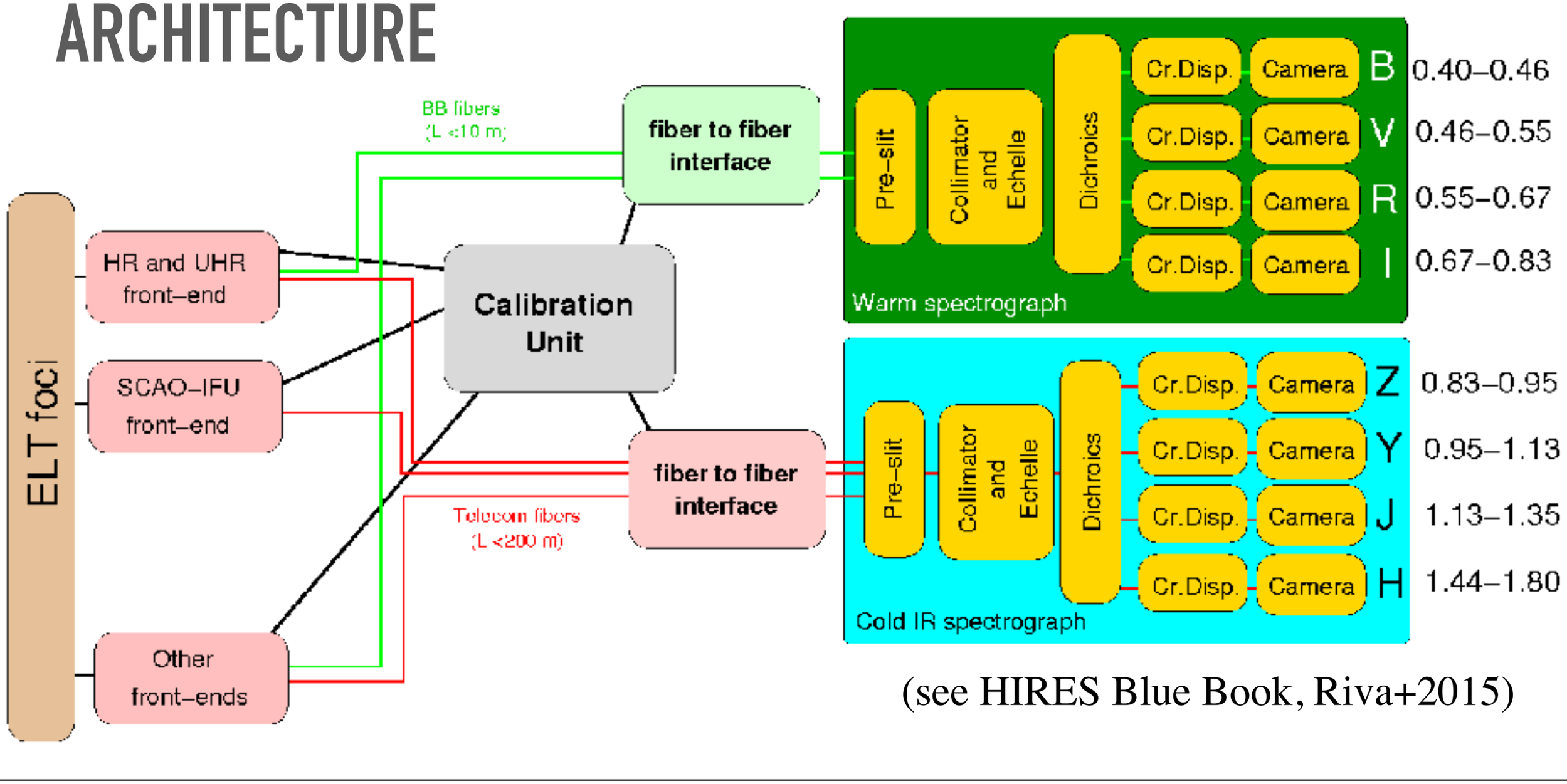
Top Level Requirements

R-TLR-A.1 Spectral Resolution	**The Instrument shall provide a spectral resolution of at least 100000**	**1**
R-TLR-A.2 Spectral sampling	The spectrometers shall provide a target sampling of at least 2 pixels per resolution element. Goal of 3 pixel sampling is desirable.	1
R-TLR-A.3 Wavelength coverage	The instrument shall provide simultaneous and as complete as possible spectral coverage of the 500-1800 nm wavelengths range.	1
R-TLR-A.4 Wavelength calibration accuracy and Instrument Stability	The instrument shall be able to achieve radial velocity accuracy better than 1m/s between 500 and 1800nm	1
R-TLR-A.5 Spectral fidelity on spectra of bright sources	For a source of suitable (TBD) brightness it shall be possible to achieve S/N > 1000 (TBC) per resolution element in the 1D extracted spectrum from a single exposure using daytime calibrations	1
R-TLR-A.6 Sky Subtraction	For single science targets, a sky spectrum shall be recorded simultaneously with the spectrum of the science target.	1
R-TLR-A.7 Sky aperture	The instrument shall have seeing limited capability (no AO support is foreseen from the telescope)	1
R-TLR-A.8 Lifetime	The instrument shall have a lifetime of 10 yr (goal 20 yr)	1
R-TLR-A.9 Wavelength coverage +	The Instrument shall extend the spectral coverage (defined in R-TLR-A.3) at shorter wavelengths down to 400 nm (goal 370 nm)	2
R-TLR-A.10 Integral field unit	The instrument shall provide an Integral field unit with variable scale up to 2 (TBC) spaxel sampling of the diffraction limit core of the PSF in the J band	3
R-TLR-A.11 Wavelength calibration accuracy and Instrument stability +	The instrument shall be able to achieve radial velocity accuracy better than 0.02 m/s between 400 (goal 370) nm and 670 nm	4
R-TLR-A.12 Multiple resolution modes	The Instrument shall provide additional resolution modes: an ultra-high resolution mode (150000 as target, 200000 goal) and a Mid resolution mode (R>10000)	5
R-TLR-A.13 Polarimetric capability	The instrument shall provide polarimetric capability	5
R-TLR-A.14 Wavelength Coverage ++	The Instrument shall extend the spectral coverage (defined in R-TLR-A.3) to 2400 nm	5

BASELINE

[1] Will be defined with simulations during Phase B
[2] Will be confirmed during Phase B
[3] Will be defined during Phase B

ARCHITECTURE



(see HIRES Blue Book, Riva+2015)

Concept modulaire - fiber-fed échelle spectrographe - 2 bras stabilisés en T et P - couverture simultanée 0.4 - 1.8 microns - R=100,000 et 150,000

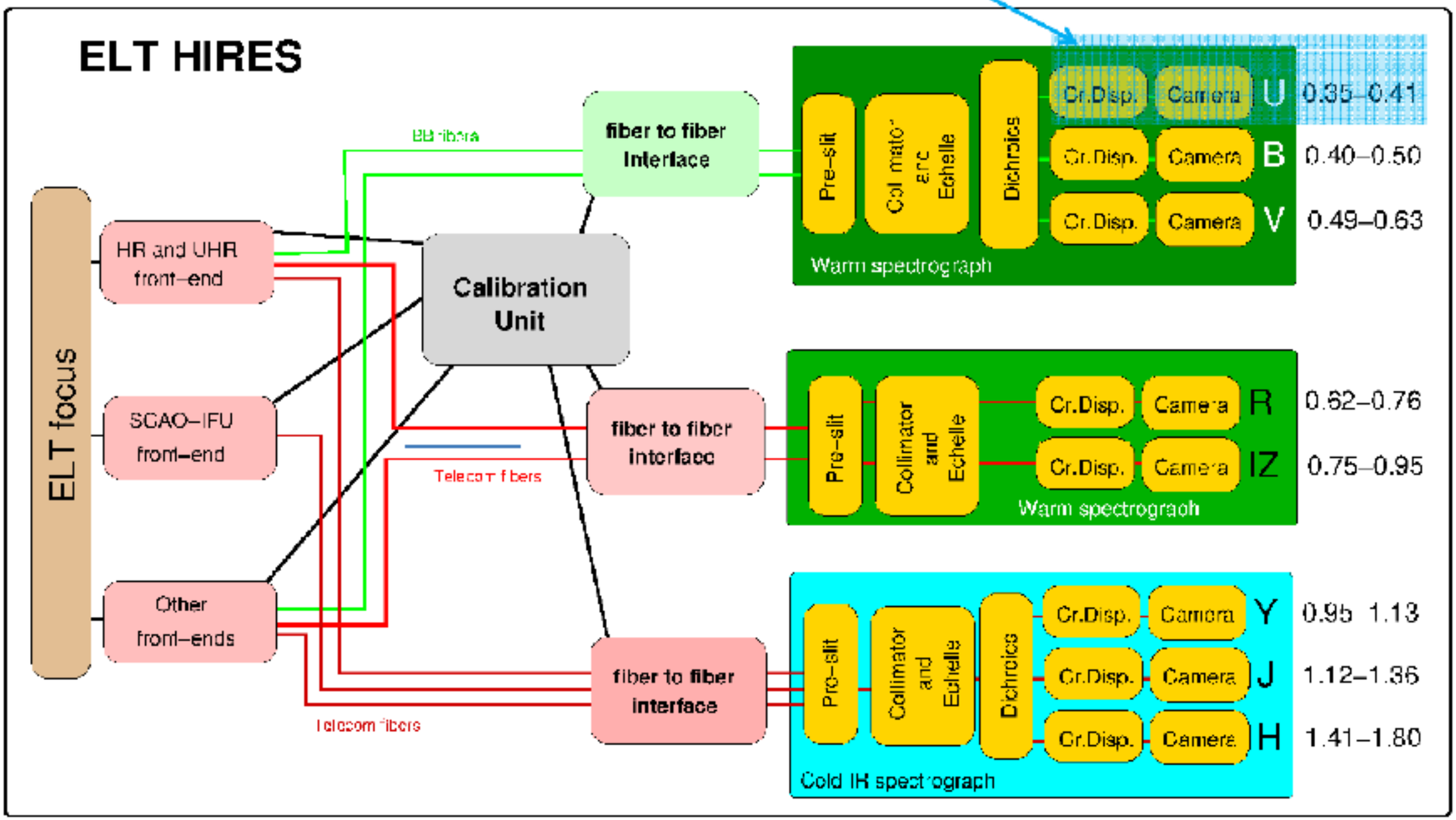
No moving part inside the spectrograph

Baseline design includes SCAO-IFU - possibilities d'upgrades et d'extensions (pola, band K et U)

Couvre les priorités scientifiques 1, 2 et 3

Peut couvrir 4 Wavelength "accuracy": 2 cm/s Stability: 2 cm/s Pas chiffré dans le budget présenté

Efficiency of U arm strongly depends on the coatings of the ELT



Concept modulaire - fiber-fed échelle spectrographe ~~2~~ 3 bras stabilisés en T et P - couverture simultanée ~~0.4~~ 0.35 - 1.8 microns - R=100,000 et 150,000

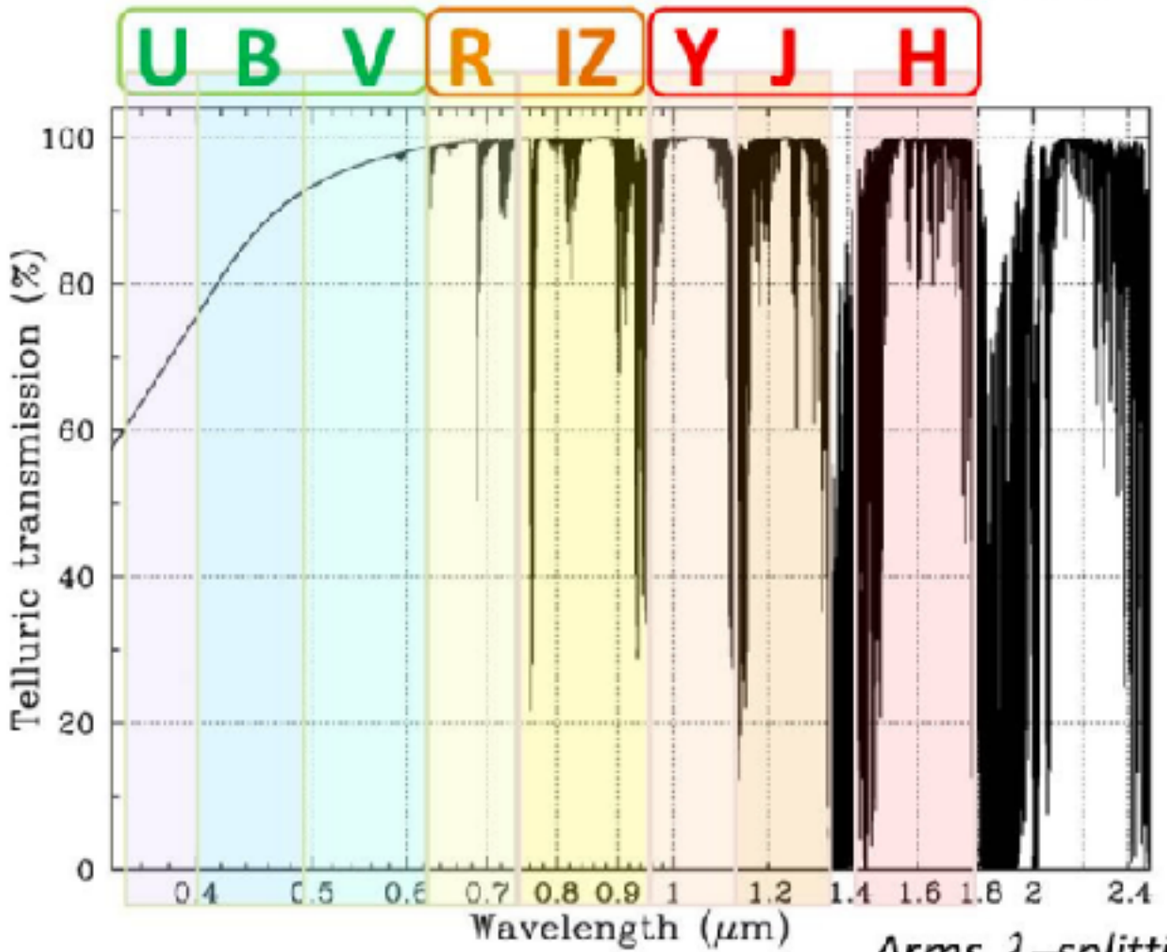
No moving part inside the spectrograph

Baseline design includes SCAO-IFU - possibilities d'upgrades et d'extensions (pola, band K et ~~U~~) ok

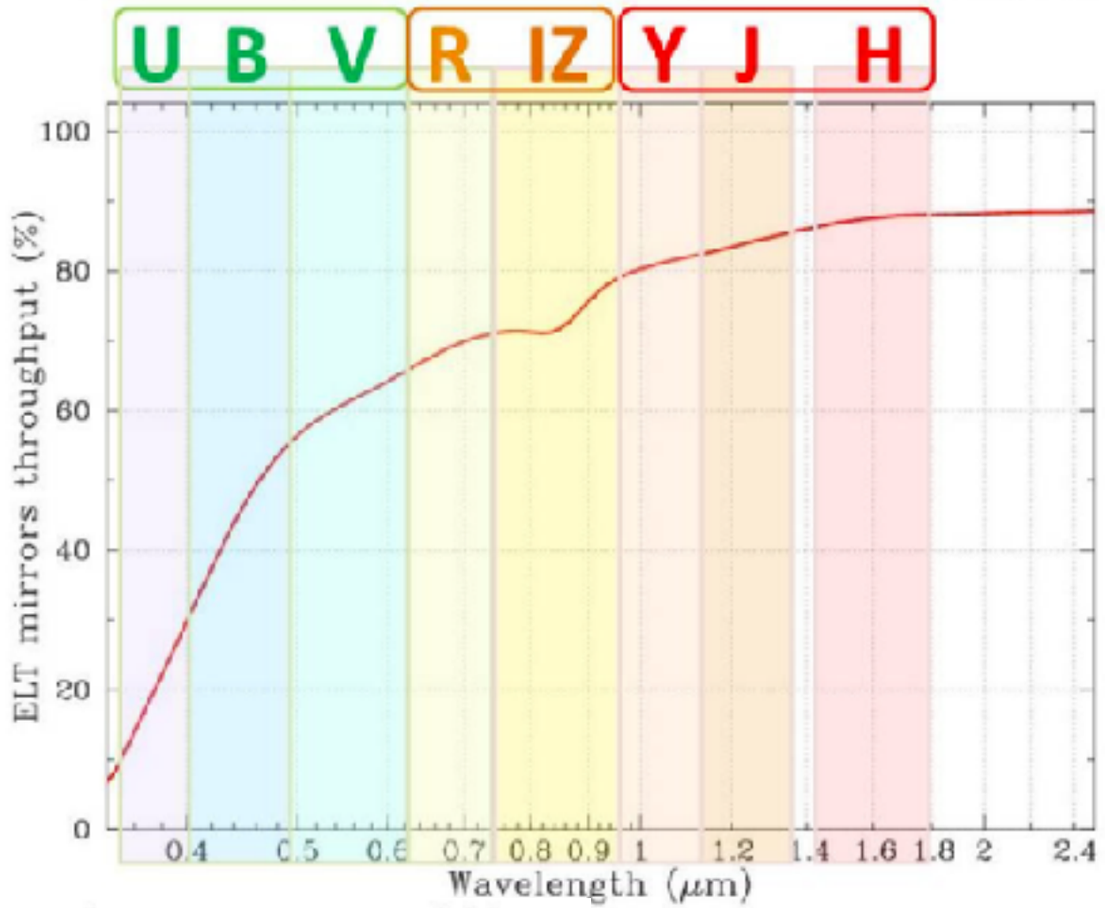
Couvre les priorités scientifiques 1, 2 et 3

Peut couvrir 4 Wavelength "accuracy": 2 cm/s Stability: 2 cm/s Pas chiffré dans le budget présenté

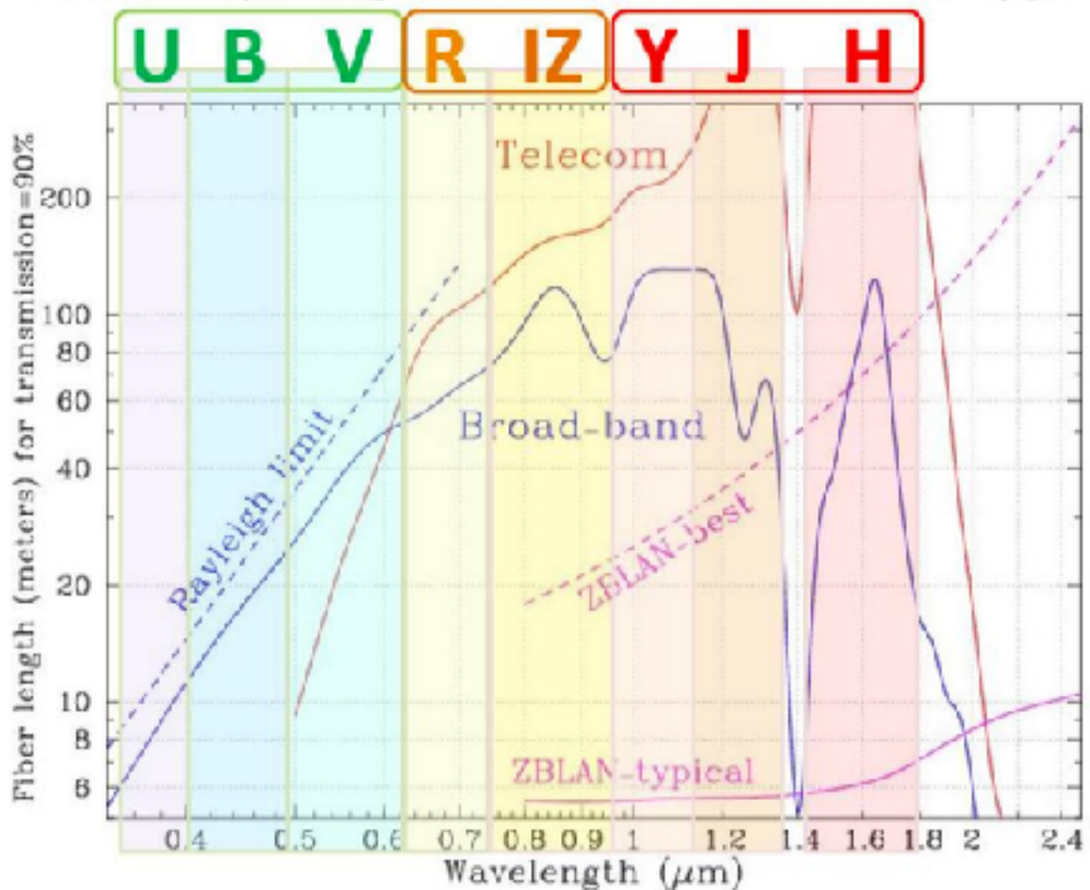
Arms λ–splitting and telluric transmission

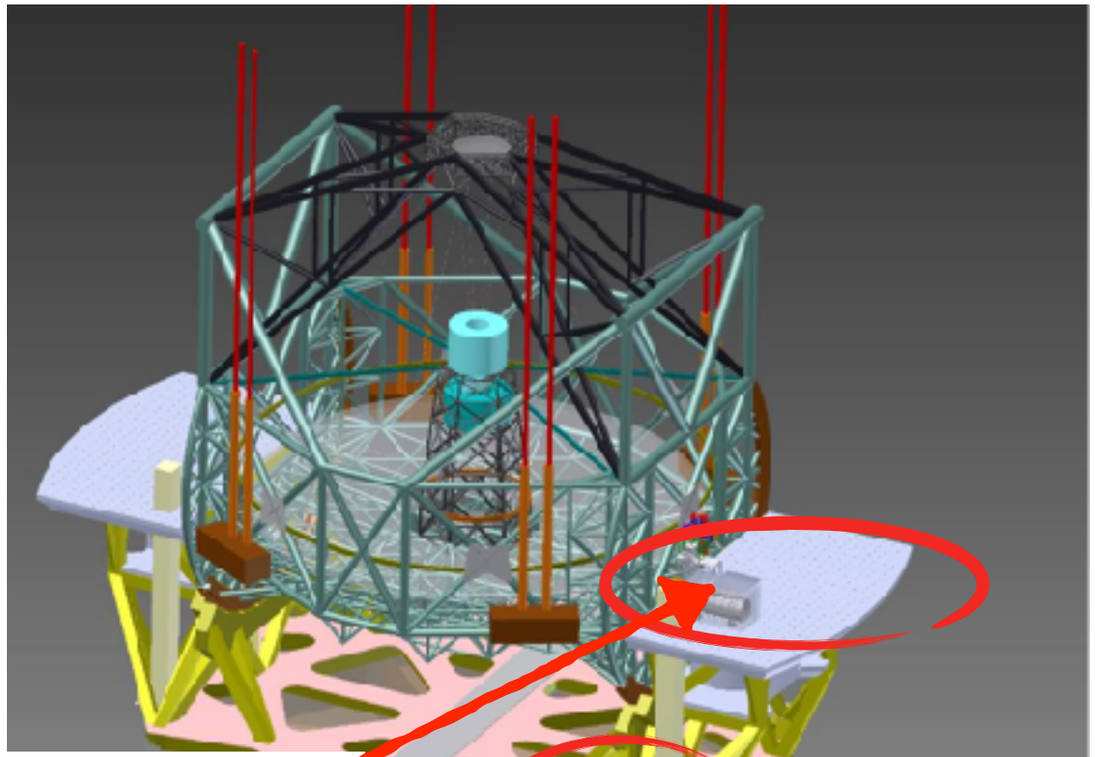


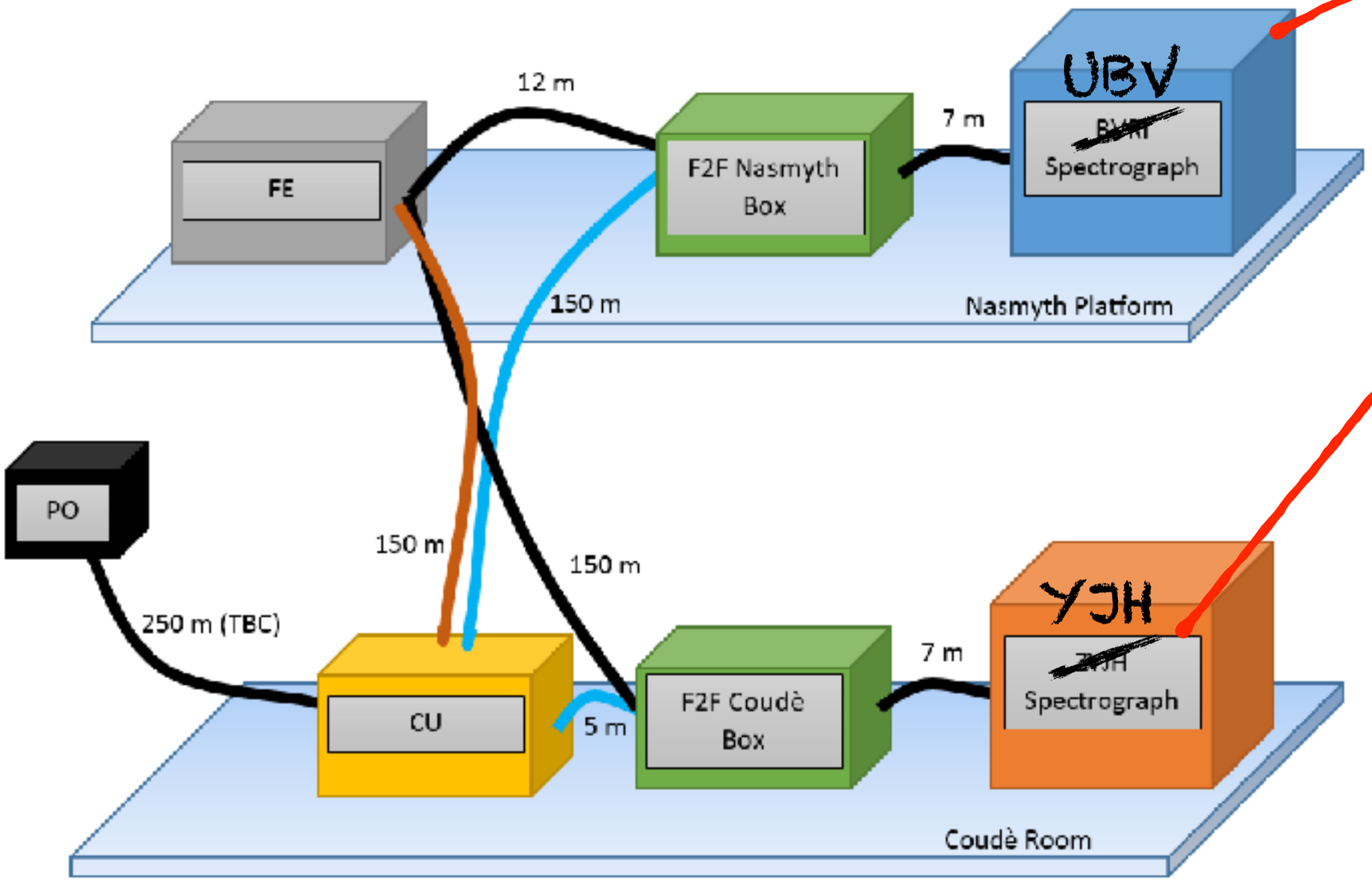
Arms λ–splitting and throughput of ELT mirrors



Arms λ–splitting and internal transmission of fibers

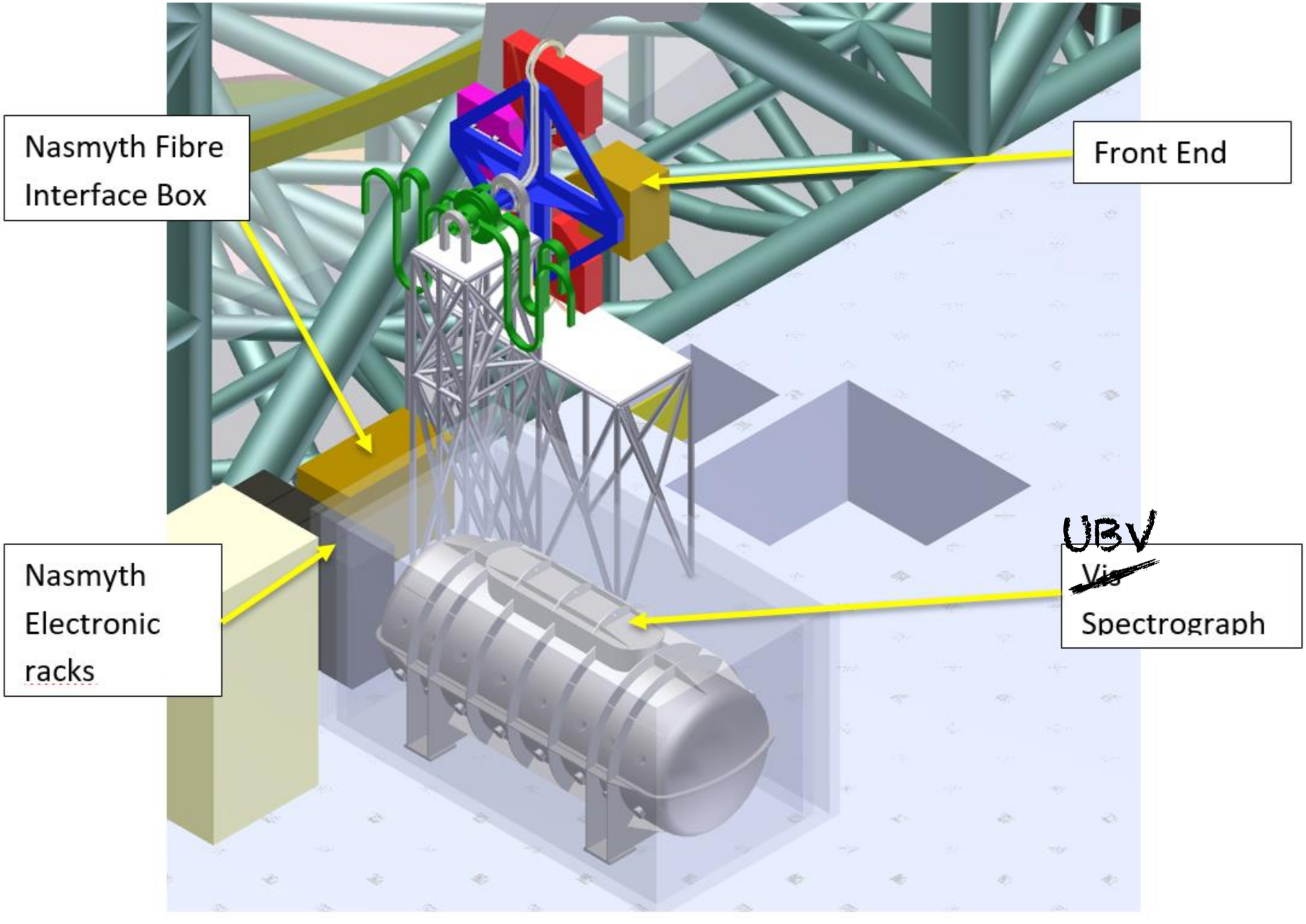




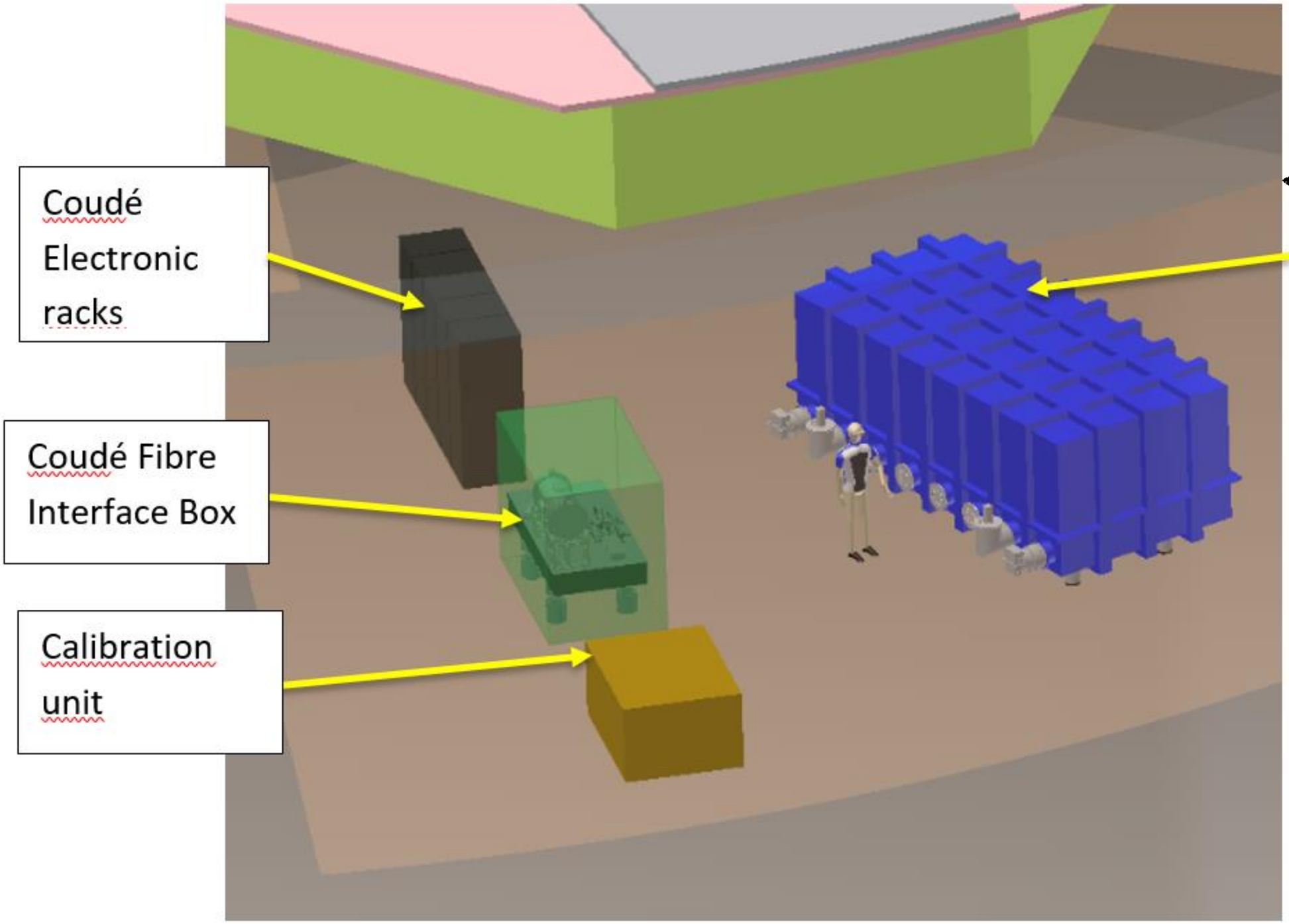


+ une autre
boite avec RIZ

Nasmith

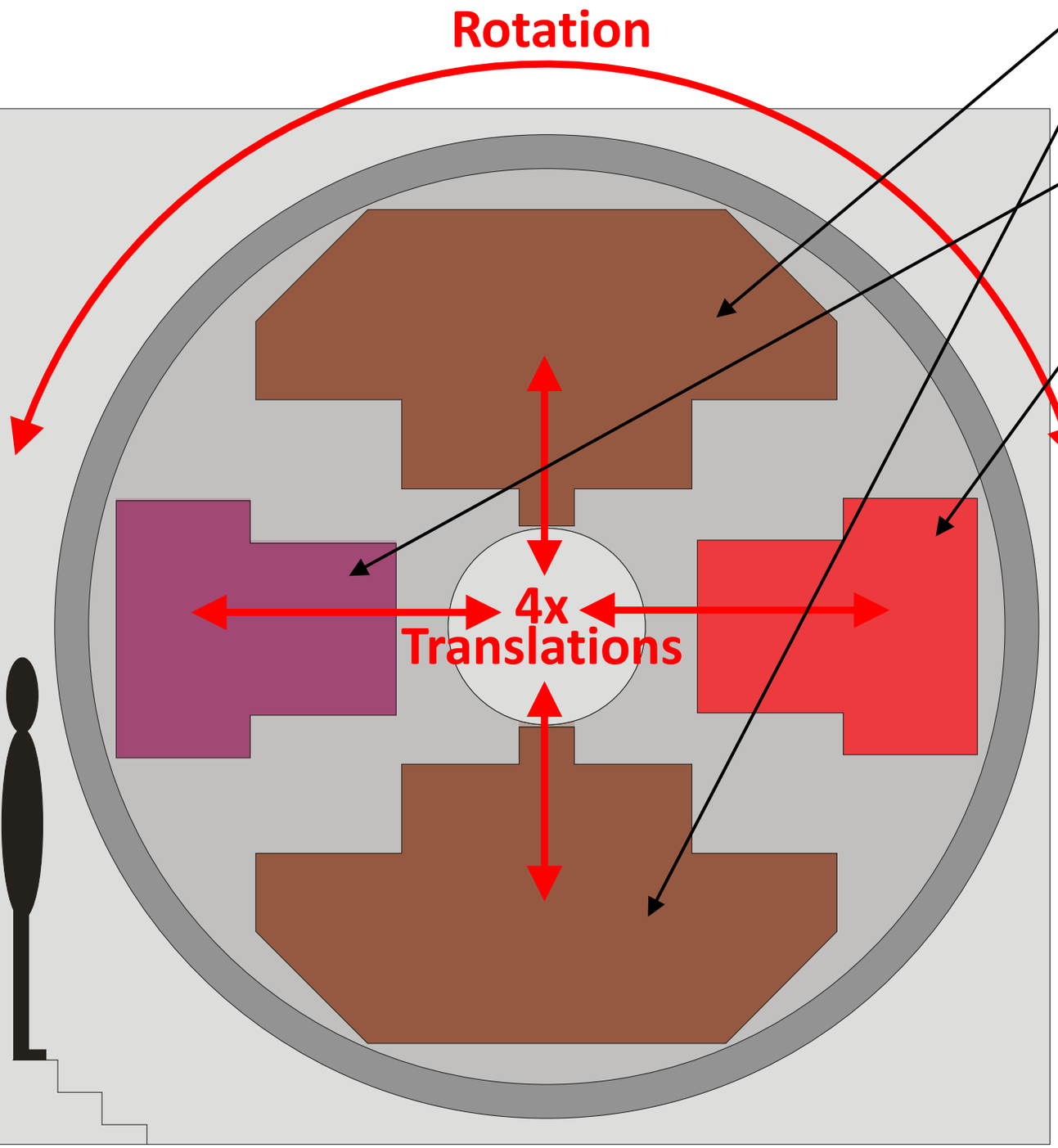

Nasmyth Fibre Interface Box
Front End
Nasmyth Electronic racks
UBV
Vis
Spectrograph

Coudè



+ une autre boite avec RIZ

Front End Architecture



- 2 separated (simultaneous) **OM** Arms
- Additional **SCAO** and

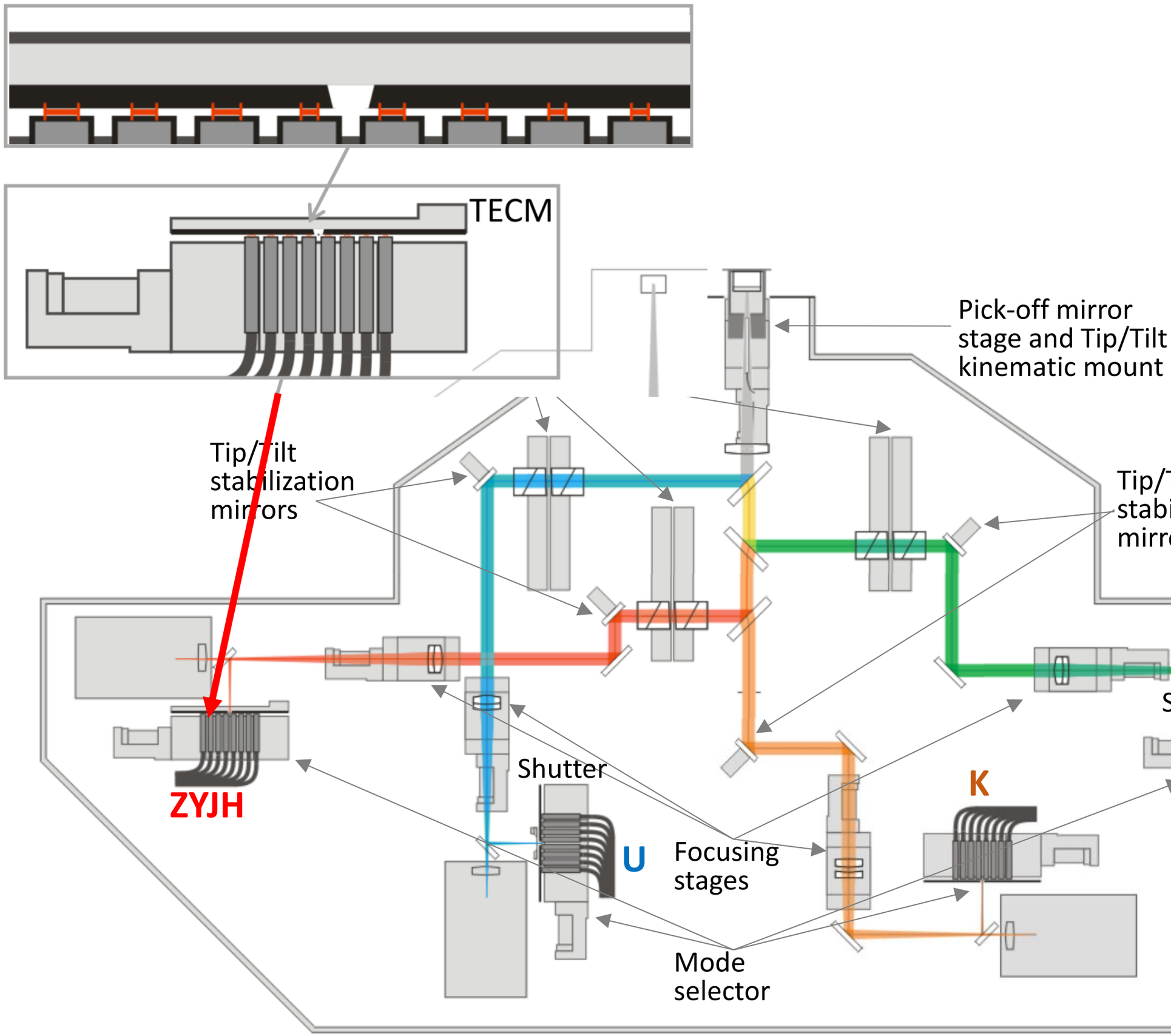
Prime focus not authorized

~~OPTION~~

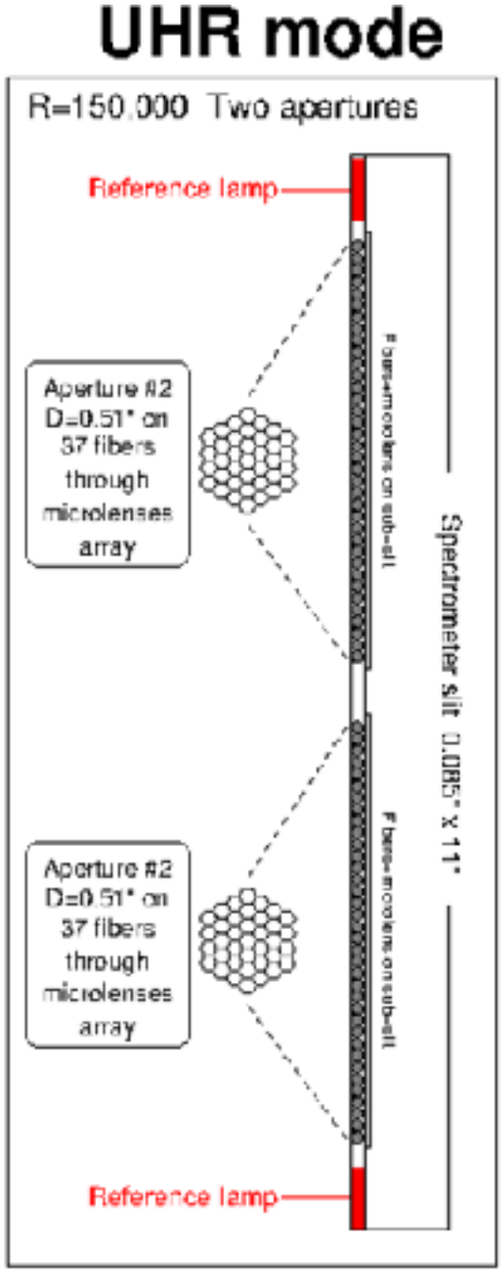
FE mechanisms for arm management:

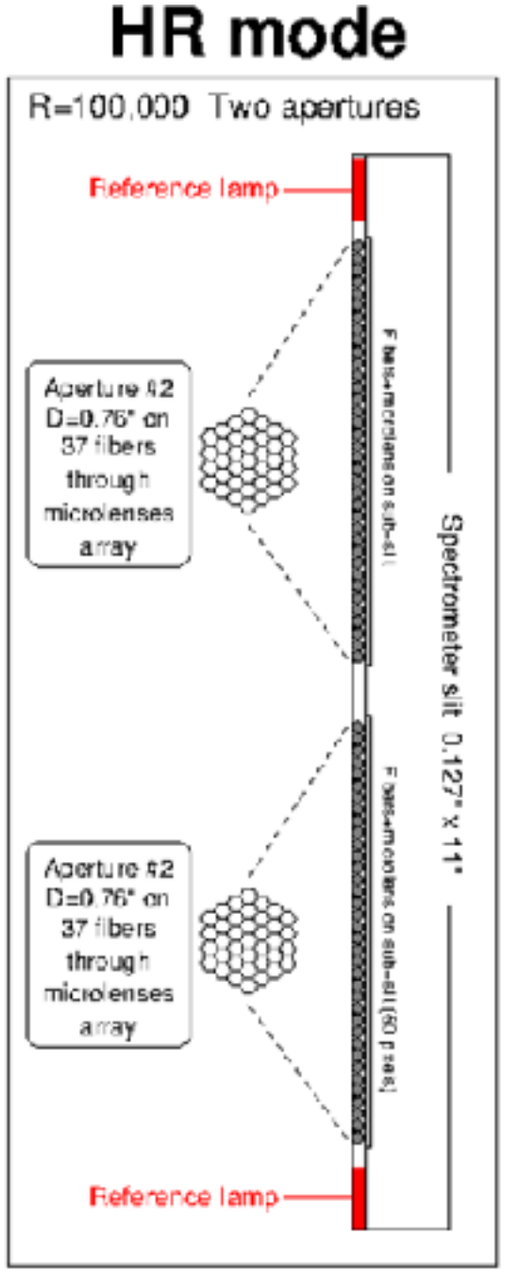
- 1 rotation for target selection in the field and to follow field rotation during observation
- 1 translation for each arm for target selection

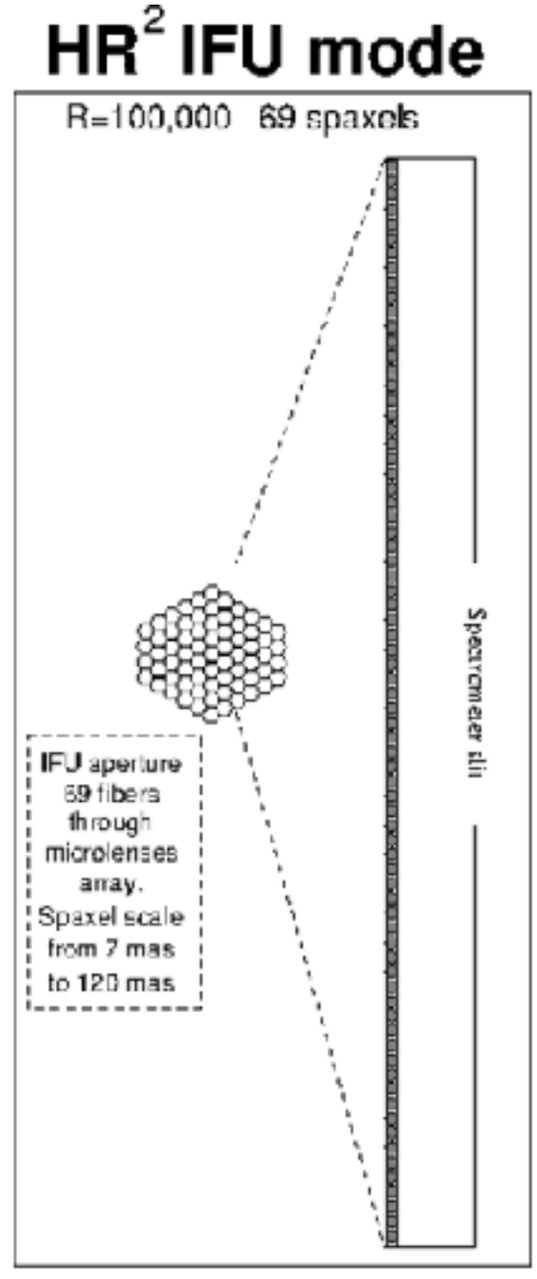
Obs. Modes Arms



Slit illumination







Calibration Unit

➤ CU - Sources

Astro-Combs (LFC filtered to 16GHz)

Fabry-Perots & White light (Halogen, LDLS, LED)

Hollow Cathode lamps (HCL)

➤ CU -Perimeter

Mechanical, Optical, Electrical & Thermal engineering
Optical tables, 19” rack,…
Fiber-2-fiber box (Light distribution point)
Internal software control - Software interface

➤ Finding a wavelength solution

Daily

Preliminary wavelength solution LFC

Flat field

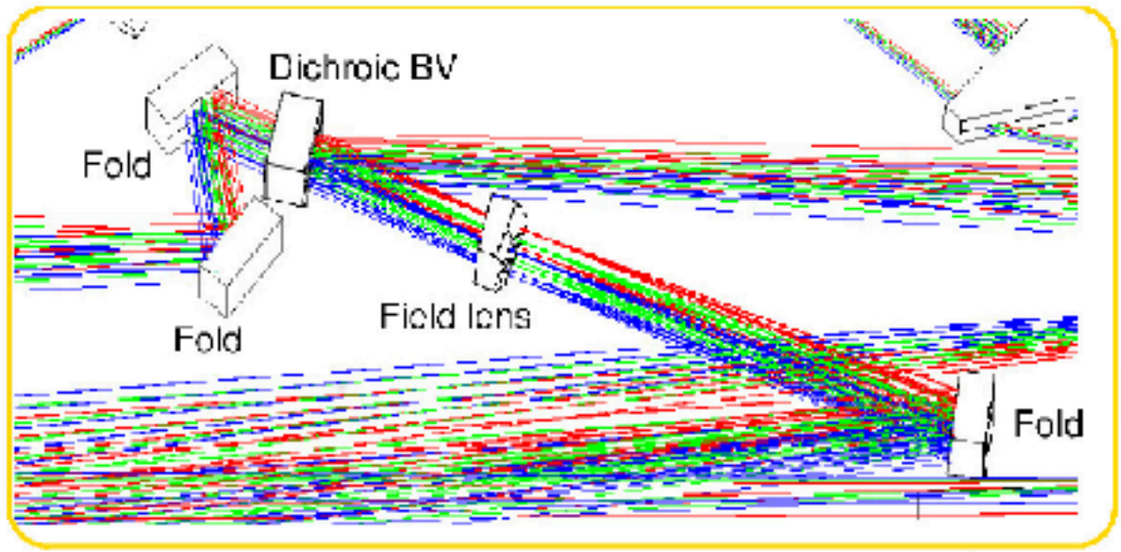
Final wavelength FP

Nightly (simultaneous to observation)

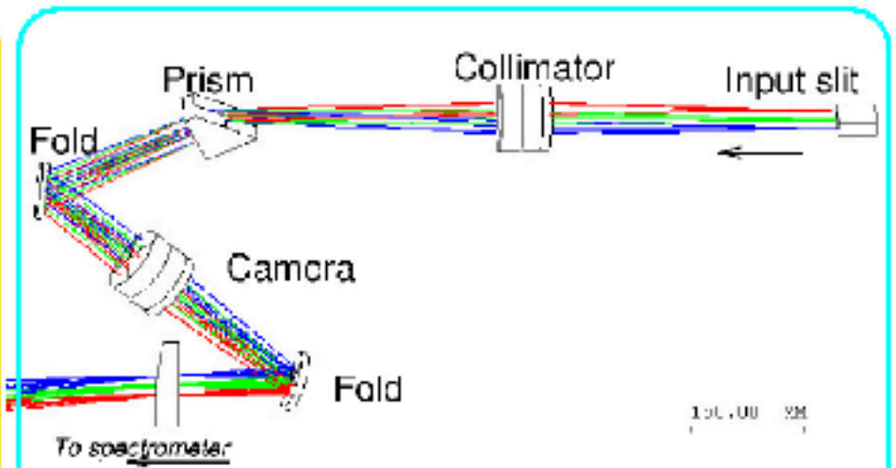
FP simultaneous to science observation

FP & LFC & Optical reference in parallel to secure wavelength stability

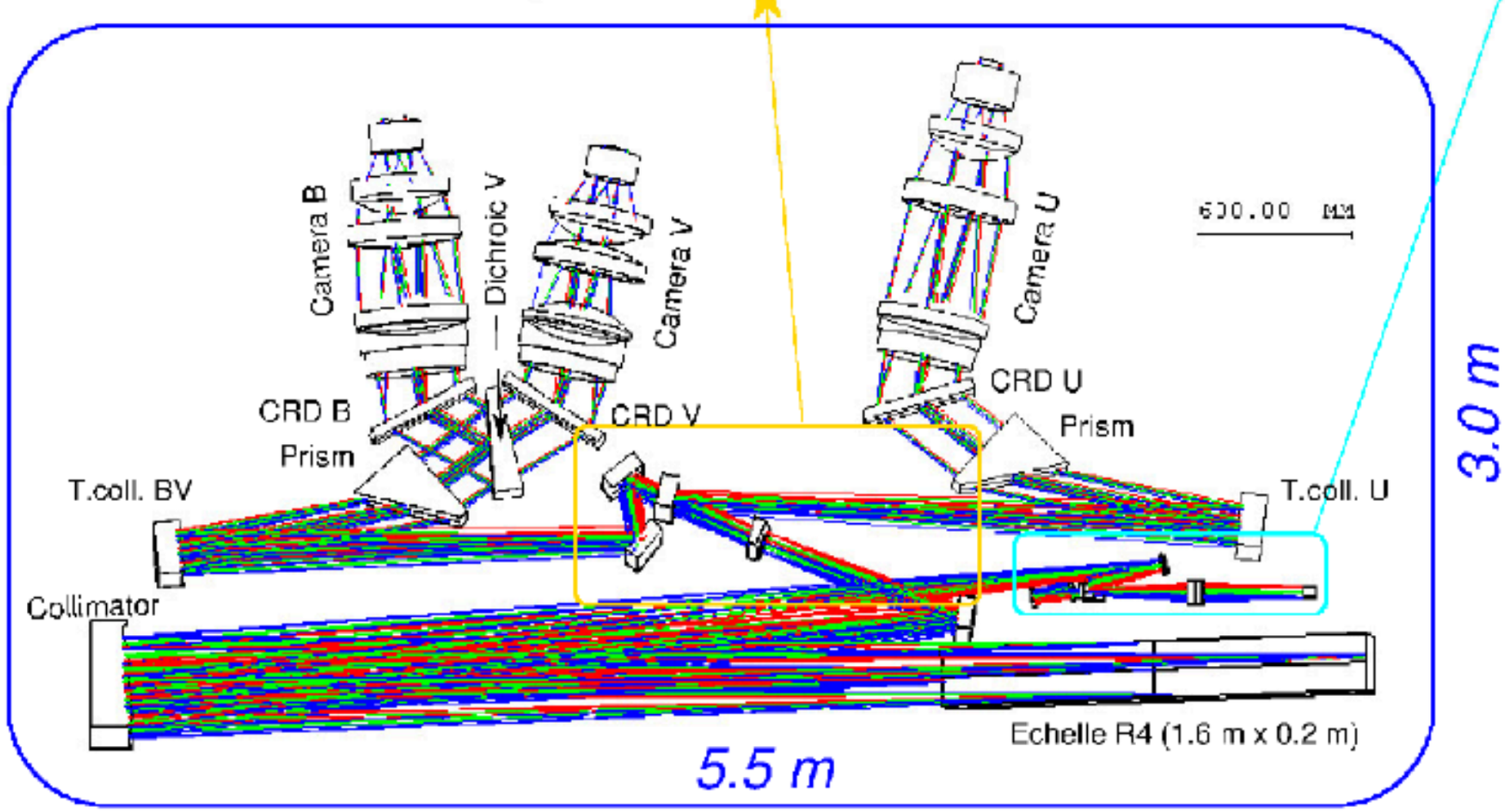
Layout spectrometer UBV v29 (commercial echelle R4 41.6 gr/mm)



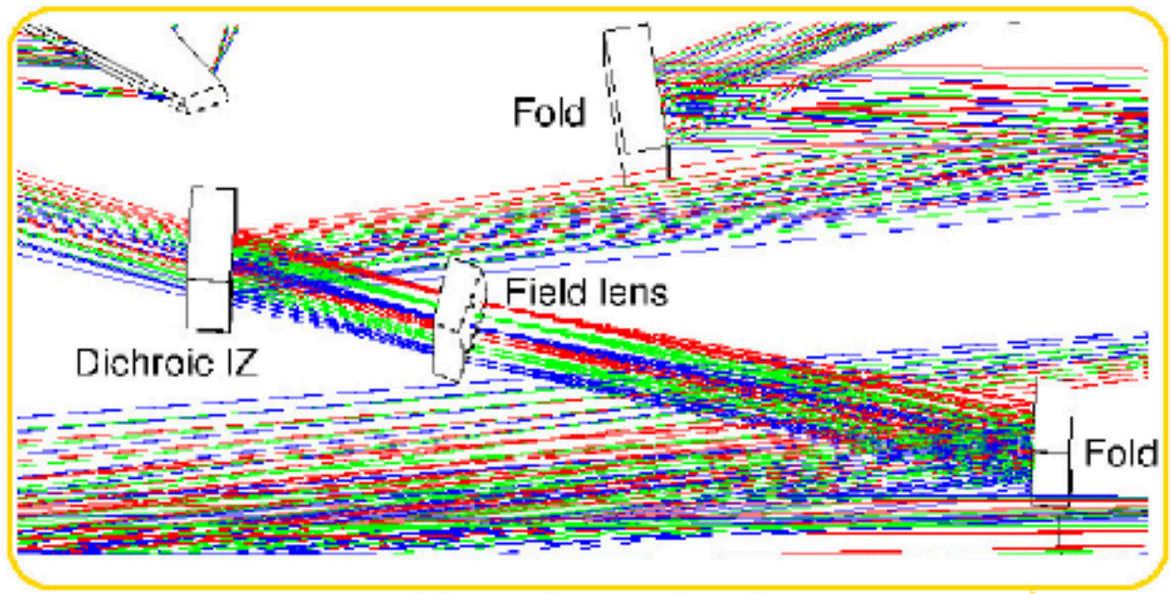
Zoom of central region



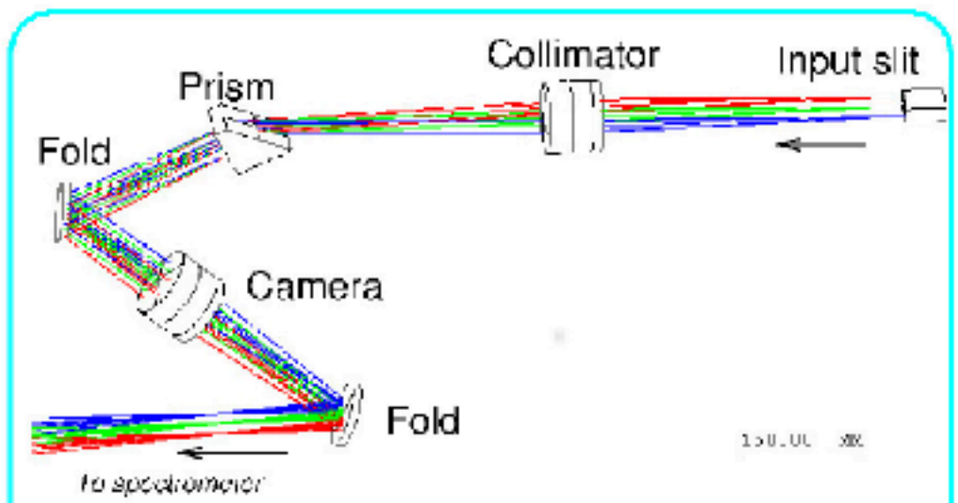
Slit re–imager and anamorphic pupil expander



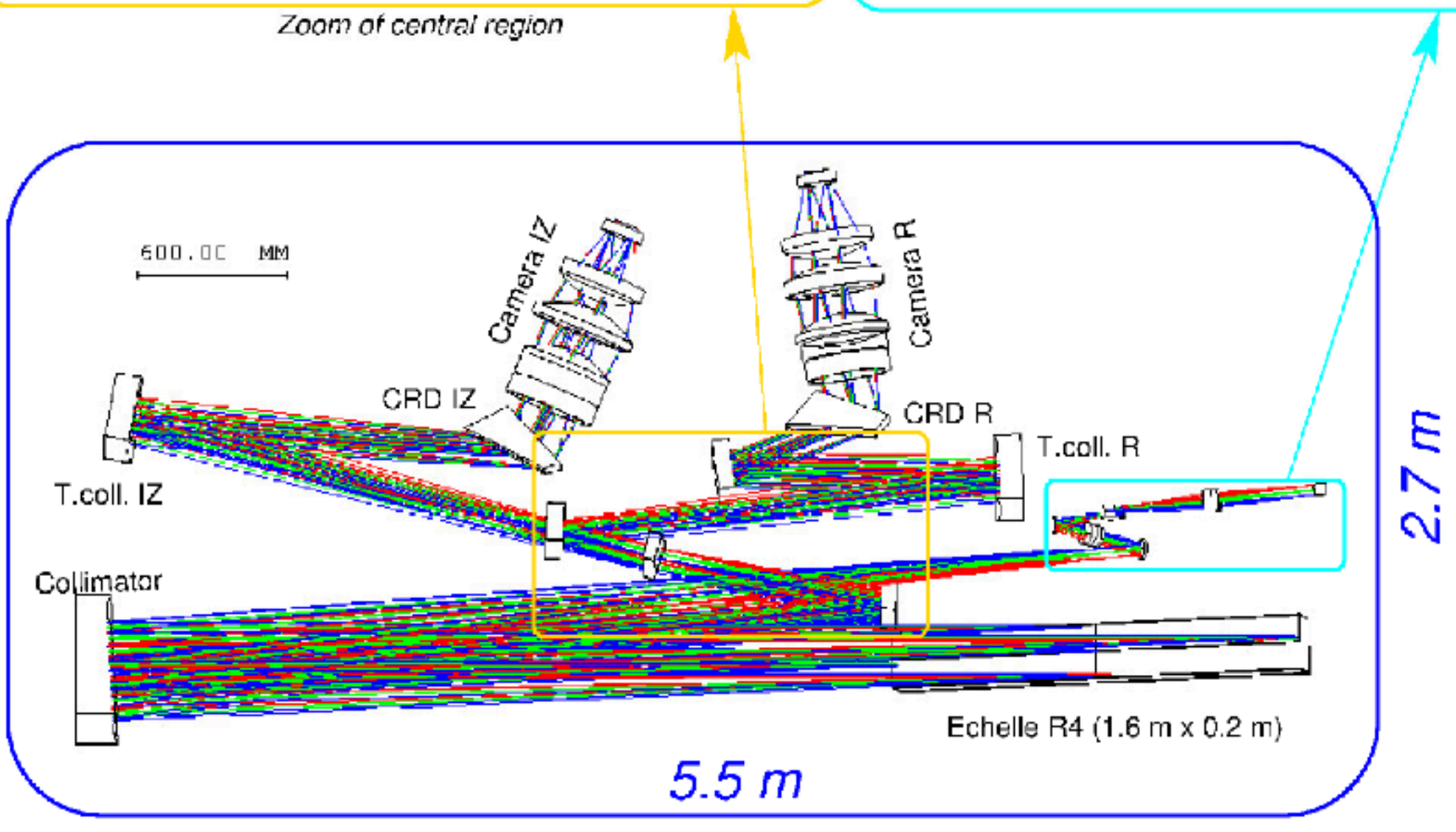
Layout spectrometer IZ v29 (commercial echelle R4 31.6 gr/mm)



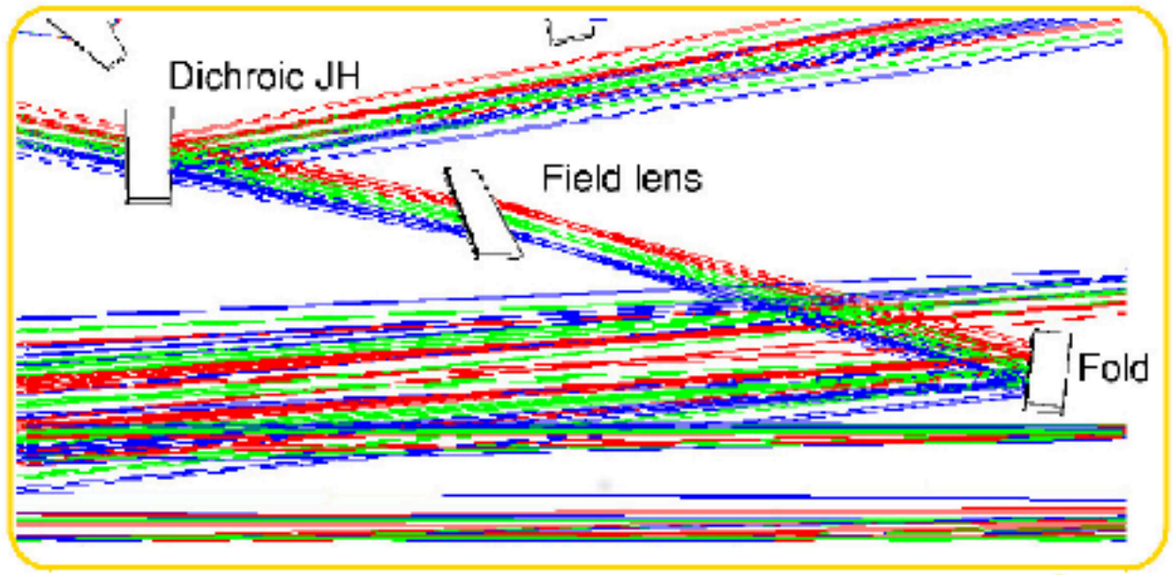
Zoom of central region



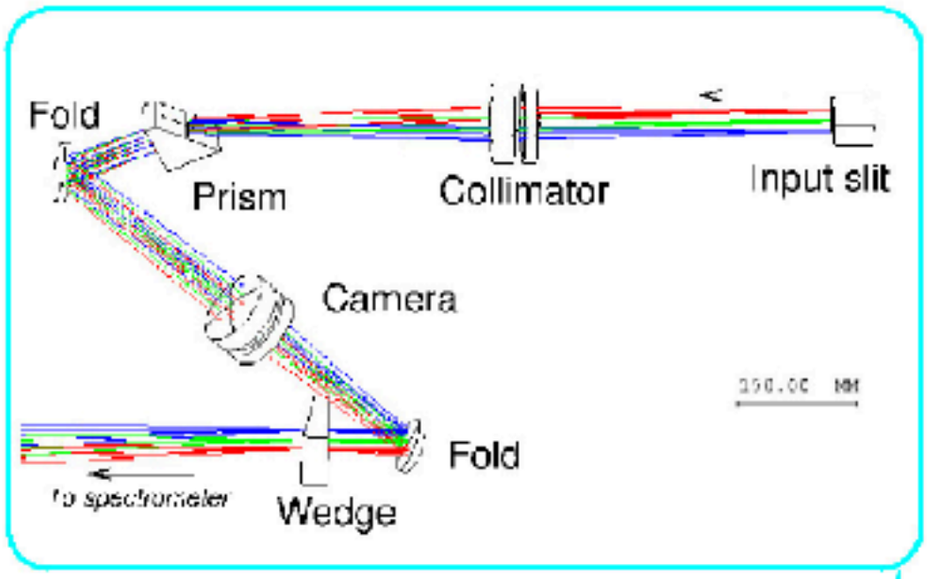
Slit re–imager and anamorphic pupil expander



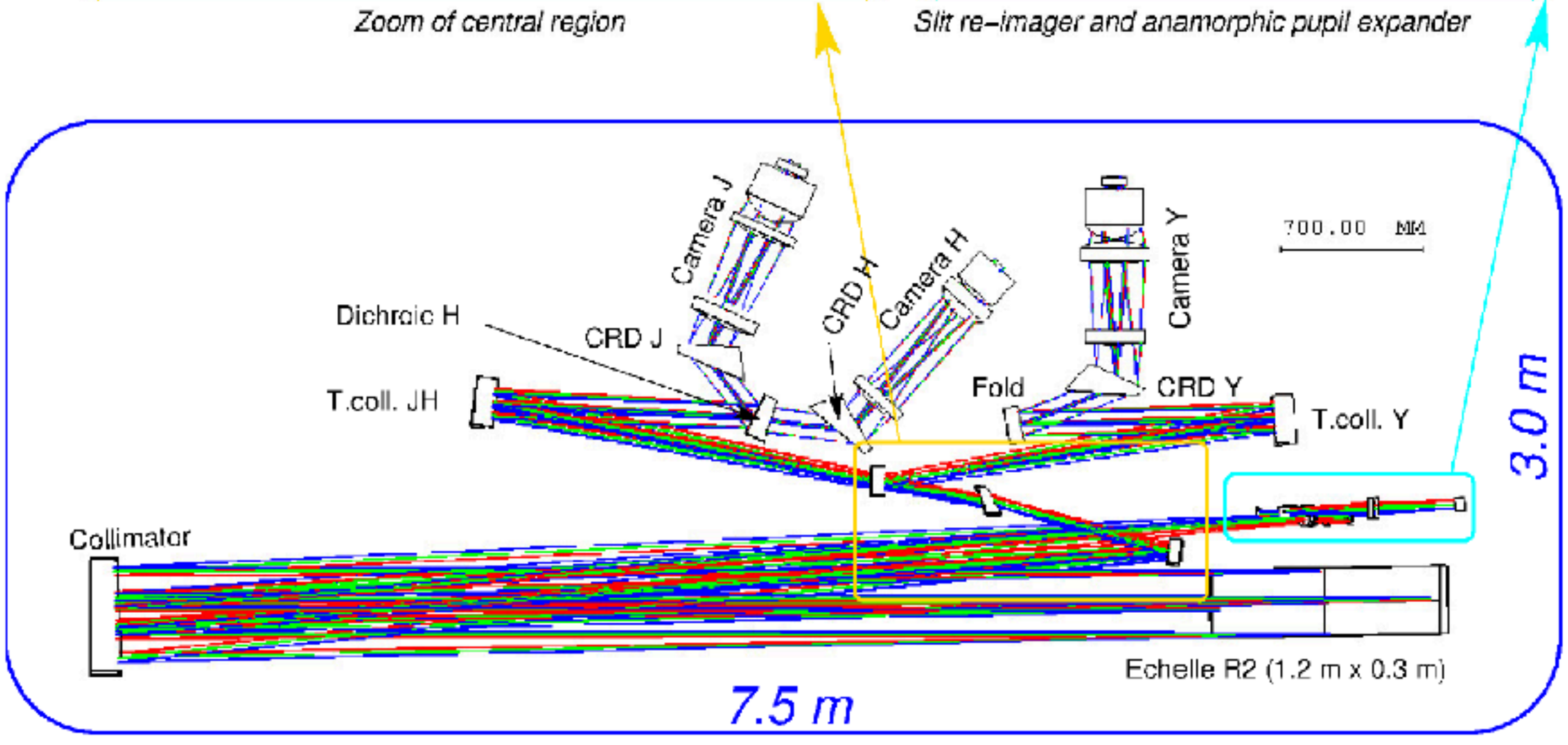
Layout spectrometer v29 YJH-R2 (commercial echelle R2 23.2 gr/mm)



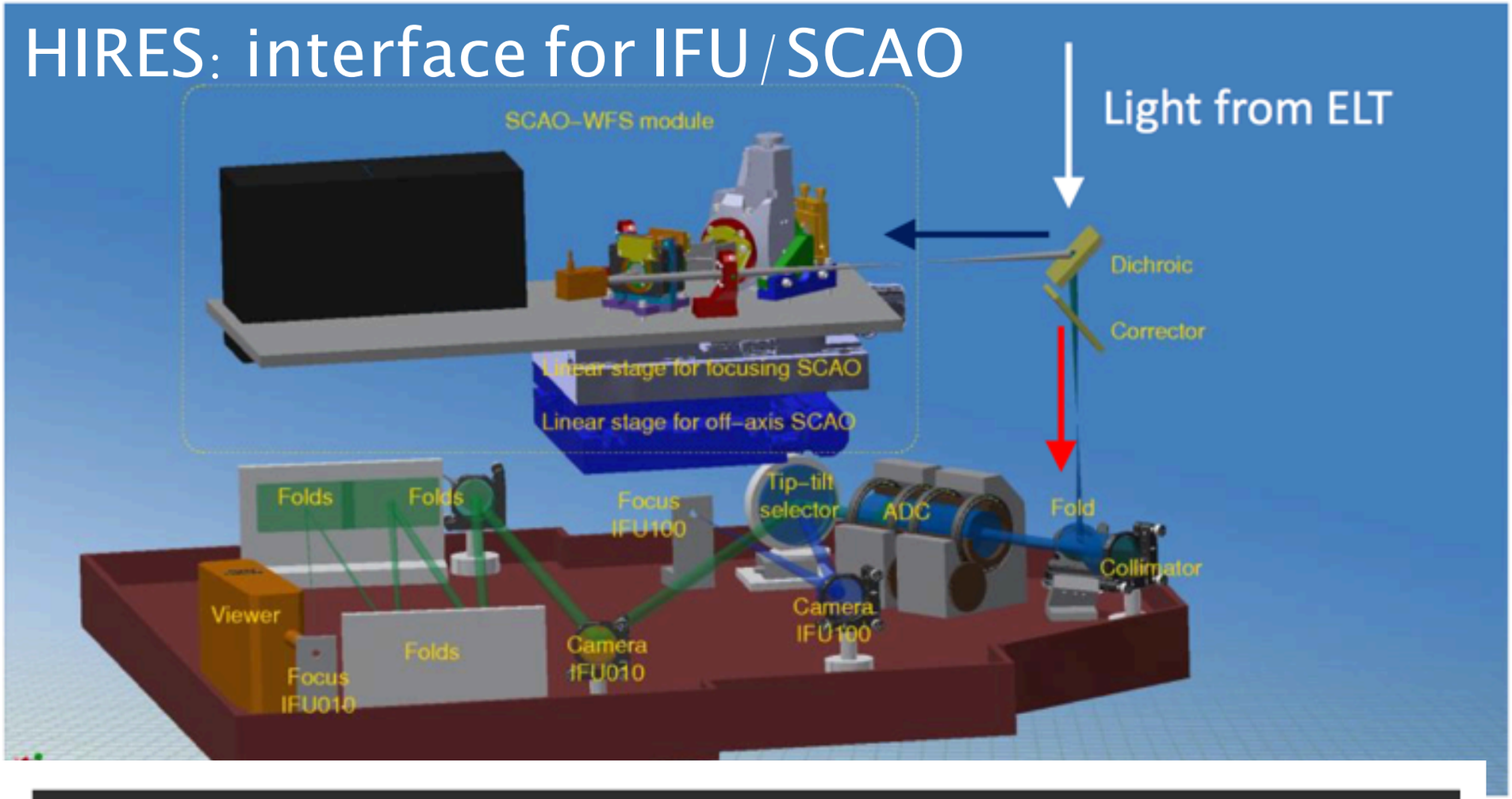
Zoom of central region

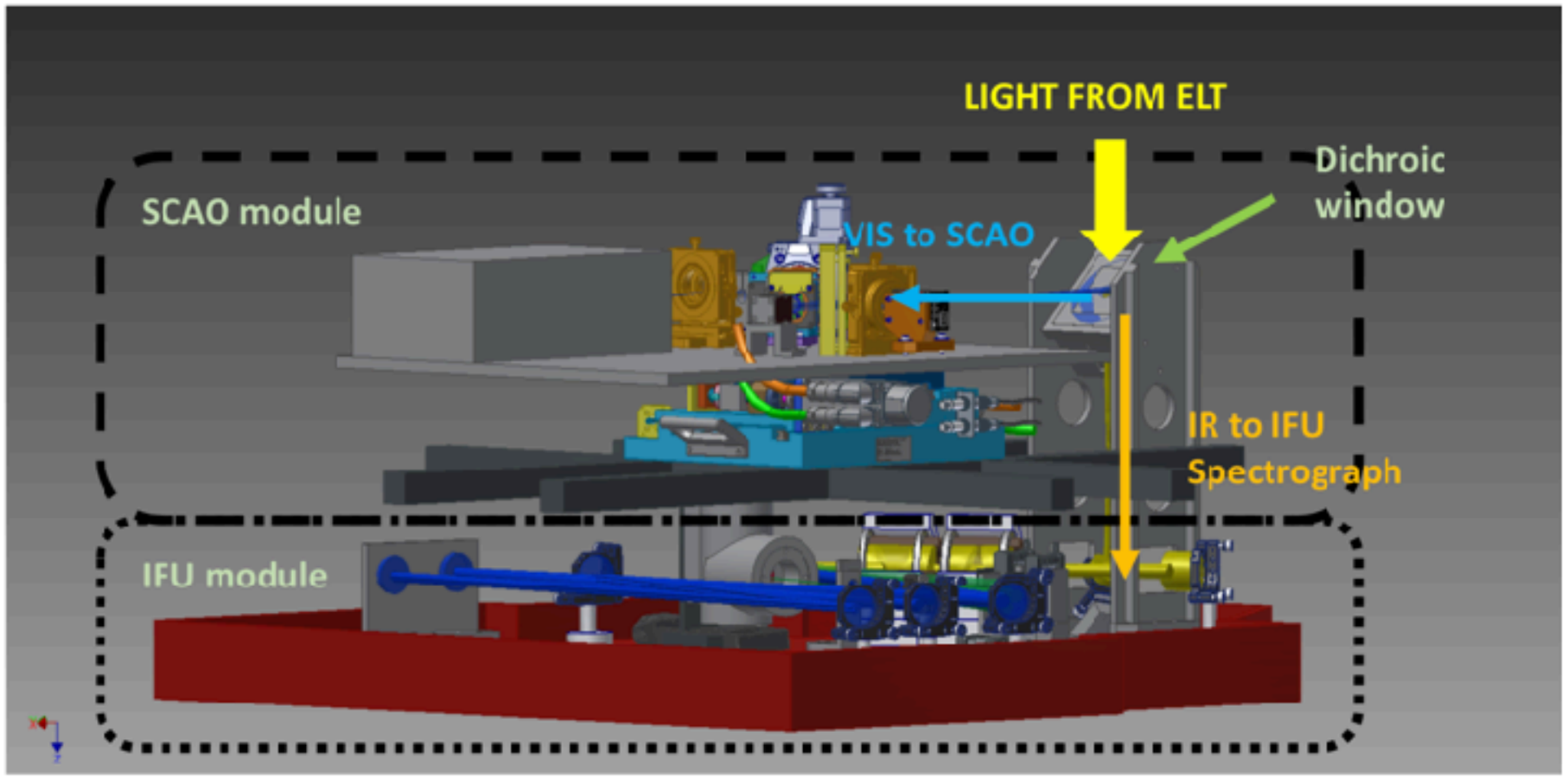


Slit re-imager and anamorphic pupil expander



HIRES: interface for IFU/SCAO





HIRES: interface for IFU/SCAO

Parameter	Value	Comment
Input focus & f.o.v.	F/17.8 D=4”	ELT focus
Wavelength coverage	950 – 1800 nm	Extendable to 2400 nm
Output focus IFU100	F/34 D=4”	
Scale for mode IFU100	100 mas/spaxel 67 mas/spaxel	IFU100-HR mode IFU100-UHR mode
Output focus IFU010	F/340 D=0.4”	
Scale for mode IFU010	10 mas/spaxel 6.4 mas/spaxel	IFU010-HR mode IFU010-UHR mode
f.o.v. of IFU foci	64 spaxels 96 spaxels	IFU-HR modes $R=100,000$ IFU-UHR models $R=150,000$
Interfaces to fibers	Identical micro-lenses arrays as in FE	

HIRES pre-phase B organization breakdown structure

HIRES
Principal Investigator
Alessandro Marconi

Executive Board

Project Management

Project Office

Project Scientist
Roberto Maiolino

Project Manager
Paolo Di Marcantonio

Instrument Scientist
Livia Origlia

System Engineer
Marco Riva
Alexandre Cabral

Science Team

Eric Stempels
David Lunney
Driss Kouach
(Luca Valenziano)

Ernesto Oliva
Marco Xompero
Matteo Genoni

System Management

Spectrograph UBV	Spectrograph RZ	Spectrograph YJH	Front End	Fiber Link	SCAO	Calibration
Michael Weber	*Bruno Chazelas*	*Mike Macintosh*	*Alexandre Cabral*	*Ernesto Oliva*	*Enrico Pinna*	*Phillip Huke*
GER	SWI	UK	PT	ITA	ITA	GER
SPA/DK	SPA/DK	CAN/ SPA/DK	ITA/DK/ BR	SWE/ PT/F	CAN/ SWI/PL/ F	SWI/F/ UK/PL/ DK/BR

System Team

US: John Monnier
DK: Michael Andersen
F: Philippe Berio

ElectronicArchitect: *Igor Coretti* deputy:*Manuel Abreu* Detector Architect:*René Doyon* — ITA/PT/BR/SWI/UK

SoftwareArchitect: *Manuel Monteiro* (replacing Paolo Di Marcantonio) deputy:*Roberto Cirami* — ITA/PT/GER/SWE/SWI/BR/PL/F/SPA

Optical Architect: *Ernesto Oliva* MechanicalArchitect: *Ian Hughes* Thermal Architect: *Santiago Becerrill* AIT: *Giorgio Pariani*

MOYENS HUMAINS ET FINANCIER

➤ Par WP - 41 M€

Sub-system	HW costs	Remarks
Front-end	2,6	no K band
SCAO/IFU	2	
Fiber link	3,3	
UBV	7,4	
RIZ	6,8	
YJH	9,7	
CU	1,9	with CU on Namsyth add 0,8
Shipping	0,5	intercontinental adde by SE
Total	34,2	no overheads
Contingency 20%	41,04	

➤ Par WP - env. 560 FTE

pour le reste du projet

Subsystem	FTE in yrs	Contributors	Remarks
Science	15	All	lead by UK
Project mngt	25	All ss leader	lead by I
Sys eng.	30	All ss leader	lead by I
Front-end	72		
SCAO/IFU	25		guess
Fiber Link	67		
UBV Spectrograph	50		
RIZ Spectrograph	50		
YJH Spectrograph	89		
Calibrations	63		extra CU (27)
Detectors: CCDs			
Detectors: IR			within YJH
Software: control	33		with SCAO
Software: science	41		
Electronics			included above
AIV			included above
Pack & Shipping			included above
Total	560		

PARTICIPATION FRANÇAISE

➤ **5 instituts impliqués pour pre-phase B et suite**

IPAG	*X. Bonfils*		*Bras H-Contraste ? bande K ?*
IRAP	*P. Petit*	*D. Kouach*	*Fibres, UC, Software*
LAGRANGE	*A. Chiavassa*	*P. Berio*	*UC, Software, Bras H.-Contraste ?*
LAM	*I. Boisse*		*DRS, SCAO, Bras H.-Contraste ?*
LUPM	*J. Morin*		*UC,*

PARTICIPATION FRANÇAISE ET RETOUR SCIENTIFIQUE

- GTO : 65 nuits en échange du FTE engagé

  60 nuits max en échange de l'argent engagé

- 14 pays dont le poids (% FTE +%cash) va de env. 17% a 0.5%

- France env. 4% (9-10eme/14)

- Ce % est utilisé pour pondérer les voix d'un vote au board si besoin

  mais consensus prime jusqu'ici

- Ce % va être utilisé pour pondérer le retour scientifique

  pas encore déterminé : choix des scientifique de l'équipe scientifique, découpage des poids de chaque programme au sein du GTO, retour en terme de publications,….

EN RESUMÉ

- Projet se préparer à démarrer phase B en juillet 2021

  Ecriture du MoU - découpage du travail FTE dans chaque WP - etc..

POSITION DE LA FRANCE

- FTE engagé env. 30 - 35 (cf. présentation Driss)
- Financement : pas de soutien direct INSU actuellement - recherche d'argent local (Université, Idex, Région,…) (cf. présentation INSU)

OBJECTIFS ATELIER

- Présenter le statut du projet - Rappeler les contours scientifiques
- Cerner les intérêts scientifiques en France - motiver des équipes scientifiques pour soutenir des demandes financières
- Design pas totalement fixé : on soutient deux options : un bras haut contraste et garder la sortie bande K