Réunion Projets GECO 12/11/2019

* Objectifs
  —> information sur les projets en cours et futurs
  —> renforcer les groupes scientifiques GECO sur projets existants
  —> Améliorer interface direction <-> projets équipe
     - identifier des orientations futures autour de projets GECO
       à faire remonter à la direction pour potentielle participation technique
     —> mieux s'organiser pour soutenir projets au CS

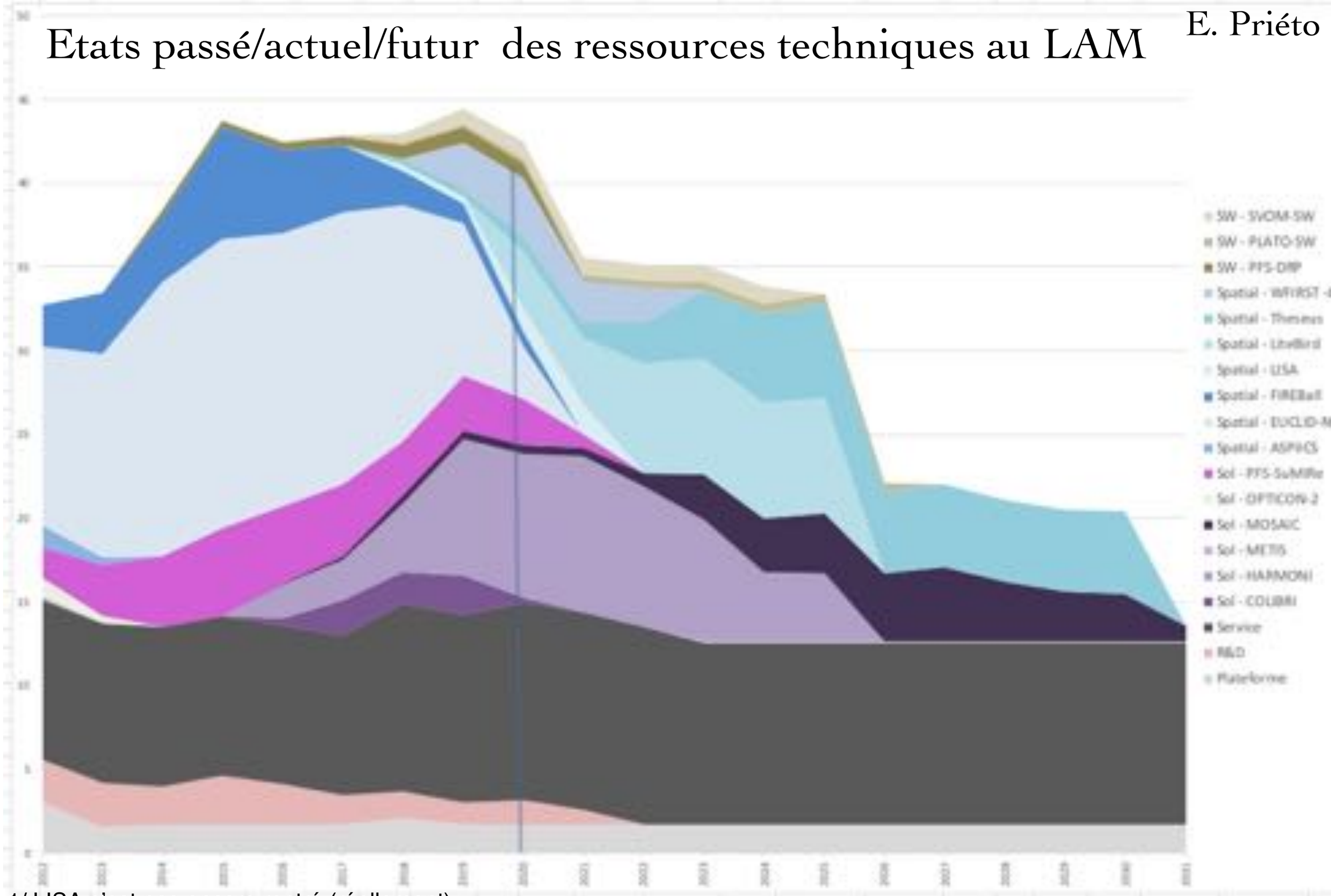
* Présentation des projets en cours avec contribution technique

* Présentation des projets en cours avec contribution logiciel

* Organisation vis à vis des projets impliquant le LAM

Etats passé/actuel/futur des ressources techniques au LAM

E. Priéto



1/ LISA n’est pas encore rentré (réellement)
2/ Mosaic est encore très immature
3/ LiteBird+Theseus+LISA représente nos capacités d’engagement pour un ou plusieurs projet spaciaux
(nous n’avons pas d’engagement pour le moment après 2021)
4/ CeSAM n’est pas encore réellement rentré dans ce graphique

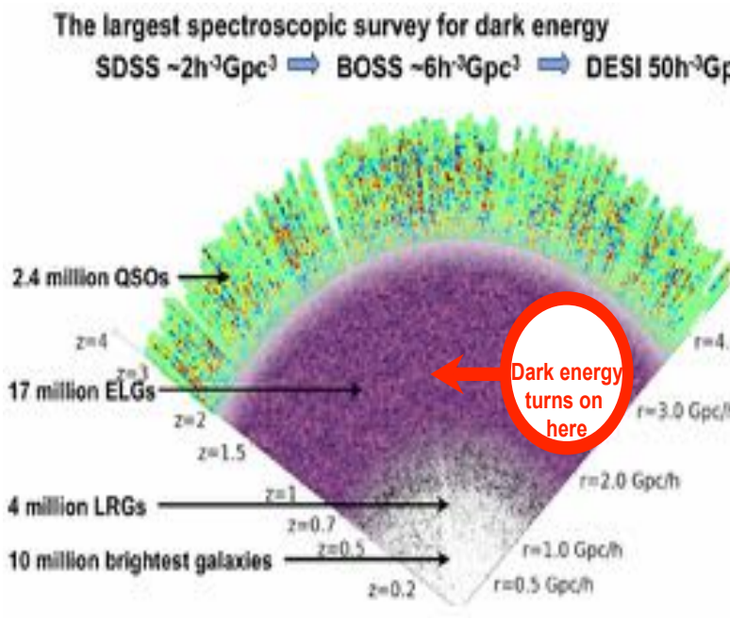
Réunion Projets GECO 12/11/2019

* Projets en revue la premiere journée :

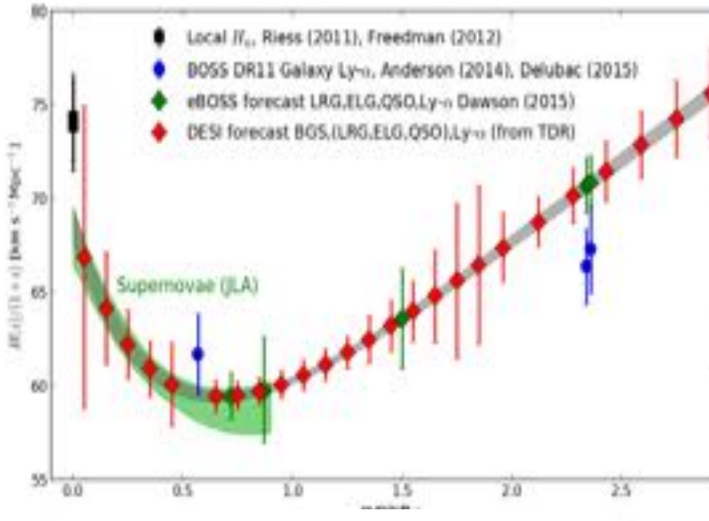
—> DESI
—> Euclid / NISP
—> PFS
—> JWST / MIRI
—> SVOM
—> WFIRST
—> ELT / HARMONI
—> ELT / MOSAIC
—> LiteBird
—> CONCERTO

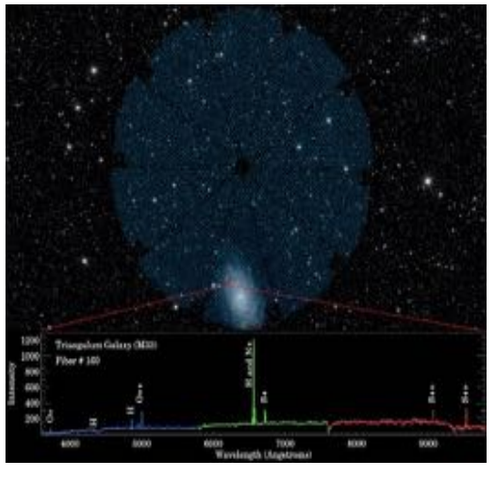
DESI : Dark Energy Spectroscopic Instrument

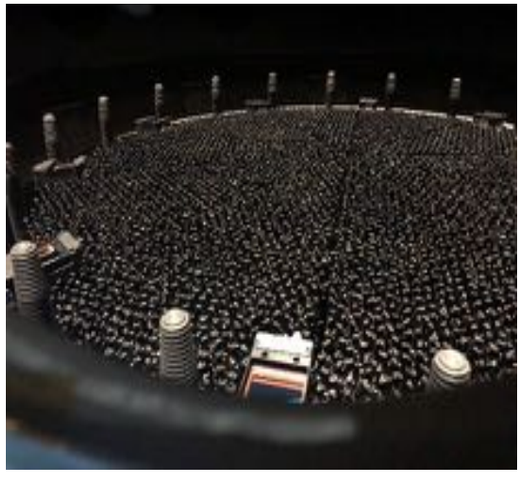
- Scale up BOSSx10, massively fiber-fed spectrometer with 5x more fibers (5,000), larger telescope aperture (4-m), robotic fiber positioners
  - Baryonic Acoustic Oscillations over a broad redshift range: 0.5 < z < 1.6, 2.2 < z < 3.5
  - Number of galaxy redshifts: 30 million (4M LRG, 17M ELG, 2.4M QSO, 10M BGS)
  - Sky area: 14,000 square degrees
  - R ~ 2,500 (blue) to 4,500 (red)
- Status: commissioning. SV → May 2020. Survey starts June 2020 (5 yrs)
- 500 researchers at 75 institutions in 13 countries.

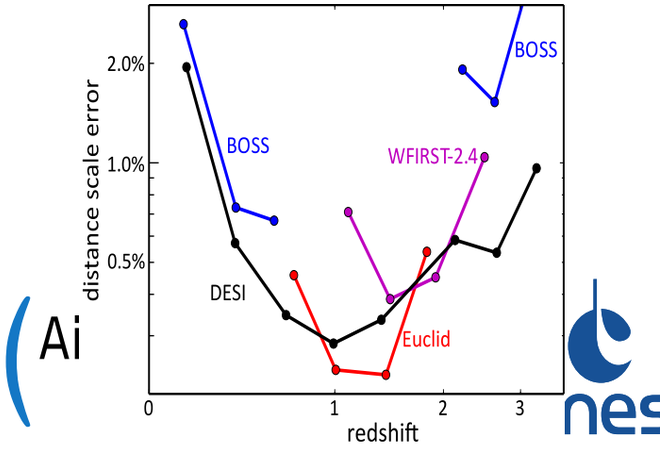


- AMU Regional Participation Group: LAM+CPPM+OHP
  - Tests and Verification of the 10 spectrographs at WINLIGHT (with CEA and LPNHE)
  - Support from A*MIDEX, OCEVU and INSU/CSAA/PNCG
  - 7 Participants (4 LAM, 3 CPPM) – not all active. Potential for one seat (TBD). Students and postdocs welcome.
  - Cross-correlation with weak-lensing maps, Lyman-alpha BAO, IGM and cosmology with voids.









O. Le Fèvre

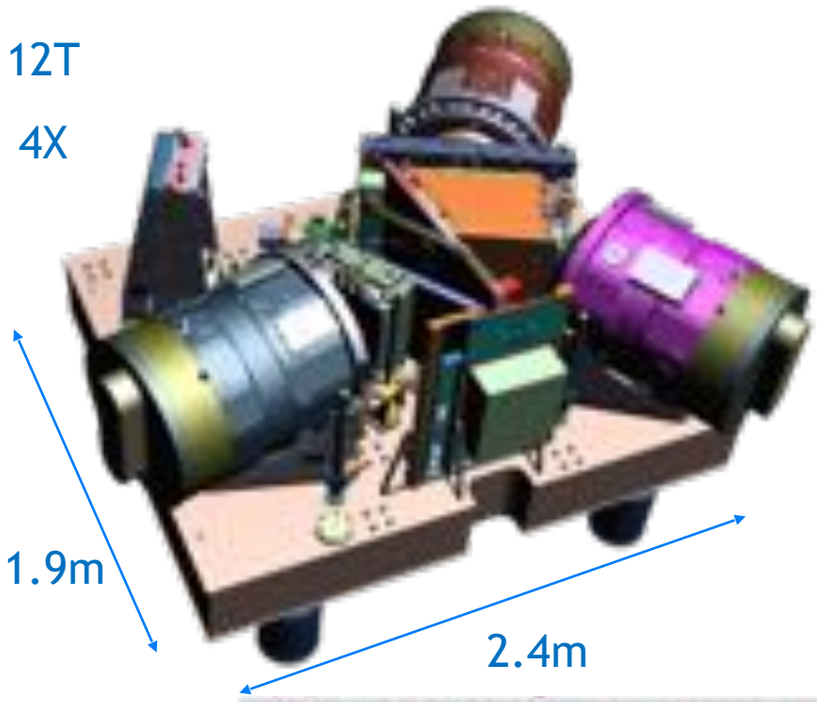
Euclid /NISP

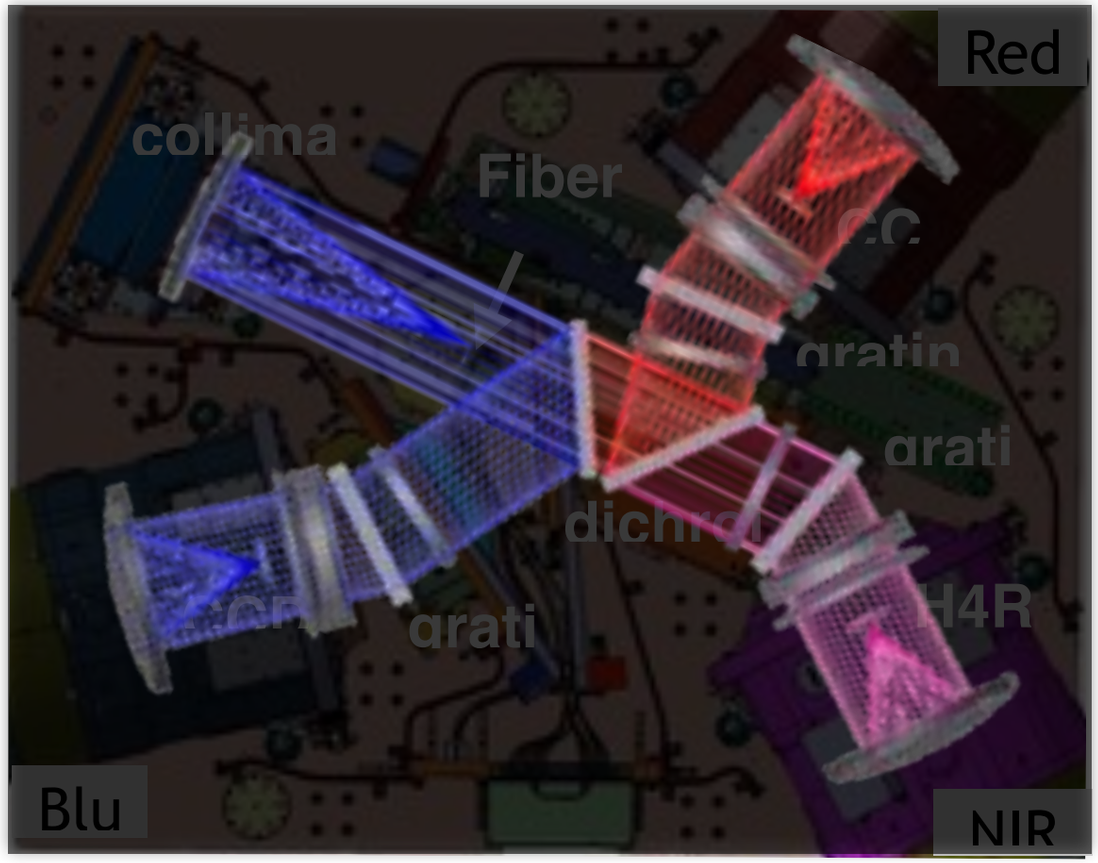
LAM * participations multiples techniques + soft CESAM
* Livraison 2020

Prime Focus Spectrograph (PFS)

O. Le Fèvre

4 Spectrograph Modules with
600 fibers and 3 cameras each





Number of fibers	2400		
Field of view	1.3 deg (hexagonal-diameter of circumscribed circle)		
Fiber diameter	1.13" diameter at center	1.03" at the edge	
	Blue	Red	NIR
Wavelength range [nm]	380-650	630-970 (706-890)	940-1260
Central resolving power	~2350	~2900 (~5000)	~4200

LAM * integration des 12 spectrographes sur les SM 1-4 (2020?)
* 1D redshift measurement pipeline (CESAM)

O. Le Fèvre

JWST / MIRI

LAM * ?? CESAM ?
* participation mirroir coronographe

Science:

- Scientific motivation: GRBs as a cosmological probe (study of the dusts, of the early galaxies, etc.); multi-messenger astronomy (neutrinos, gamma, GW, etc.)
- Co-PI of the mission and 4 Co-Is involved

Participation au French Science Center (Project Manager: C. Moreau):

- Design and conception of the mission database
- Design and conception of the legacy database: High level products (jumps, science except jumps).
- Decision support software development of the Burst Advocate

COLIBRI (aka. F-GFT, Project Manager: F. Dolon):

- Project management: PI, project management, system team, etc.
- AITs/AIVs in France, infrastructure, etc. by OHP/OSU-Pytheas
- Head of LIA ERIDANUS between France and Mexico (official start: 1 January 2019)

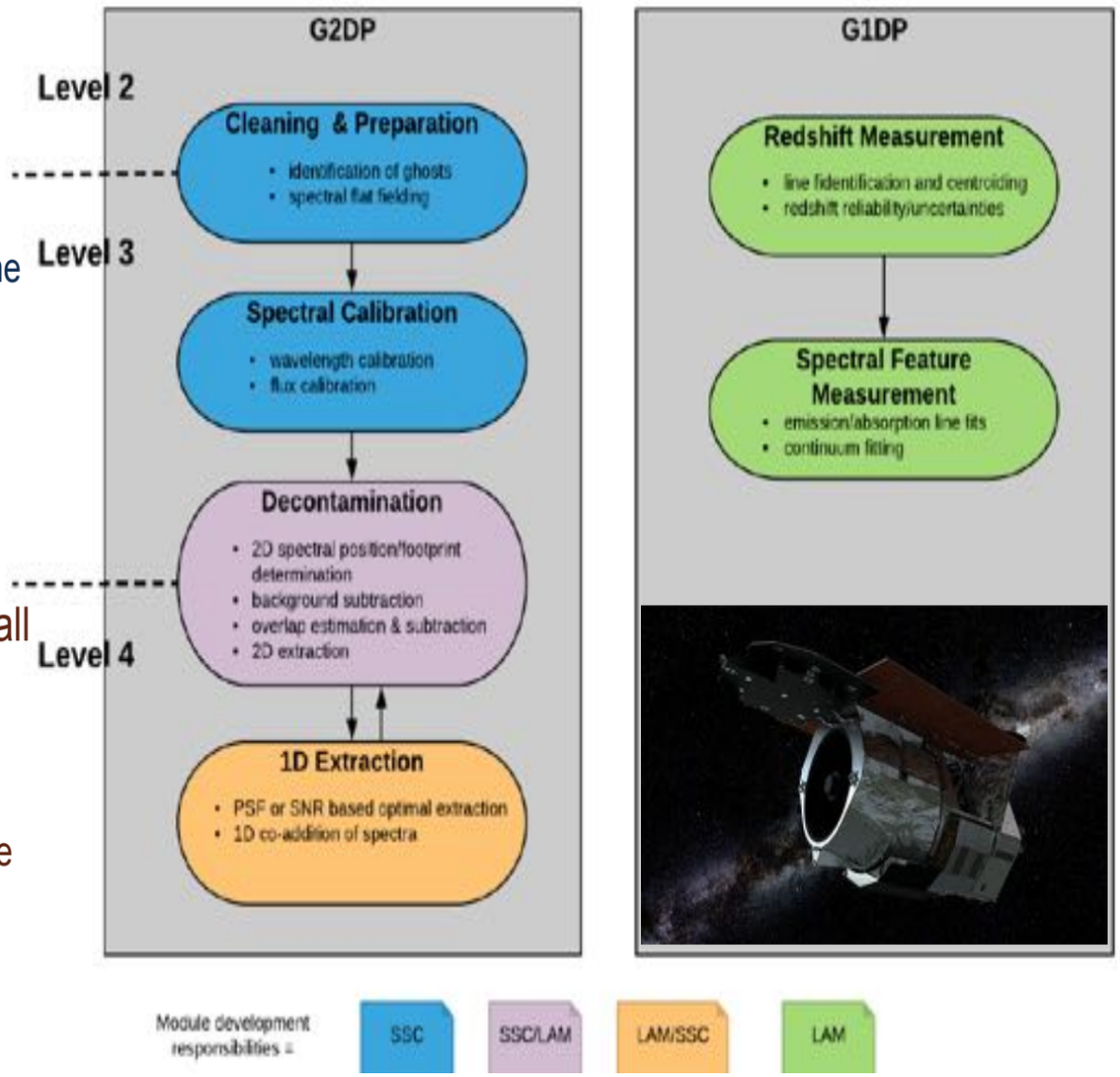
Schedule:

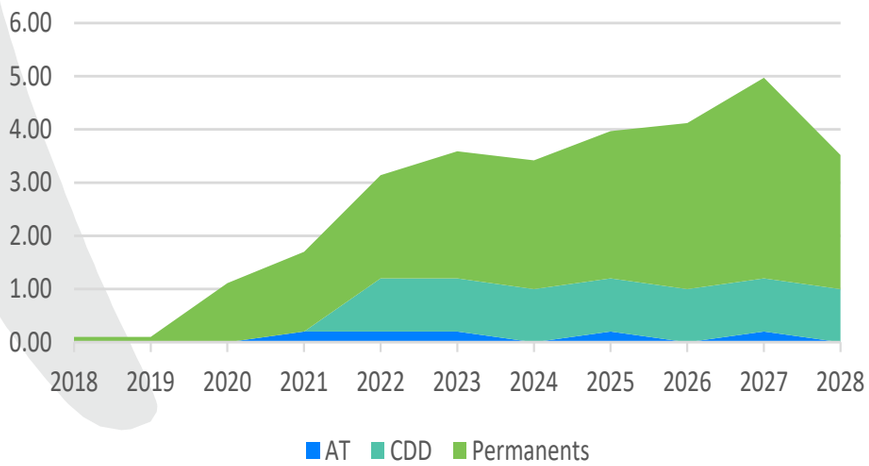
- November 2019: STM of the complete satellite under test.
- November 2020: delivery of the flight models to CNSA (China).
- November 2021: COLIBRI operational in Mexico and launch of SVOM (if there is a delay from China, it will be very small, don't expect more than 2-3 months!!!).

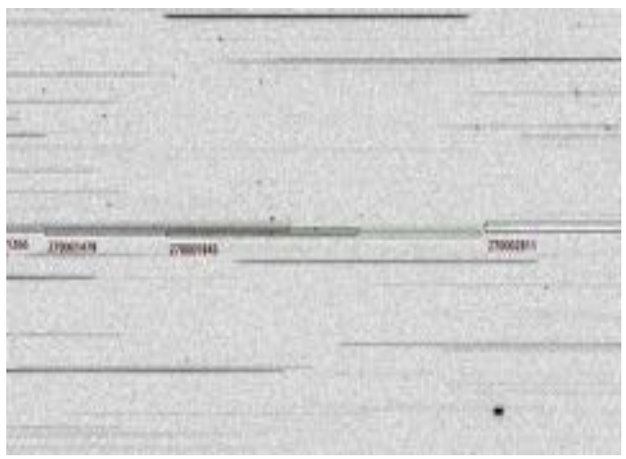
JG Cuby

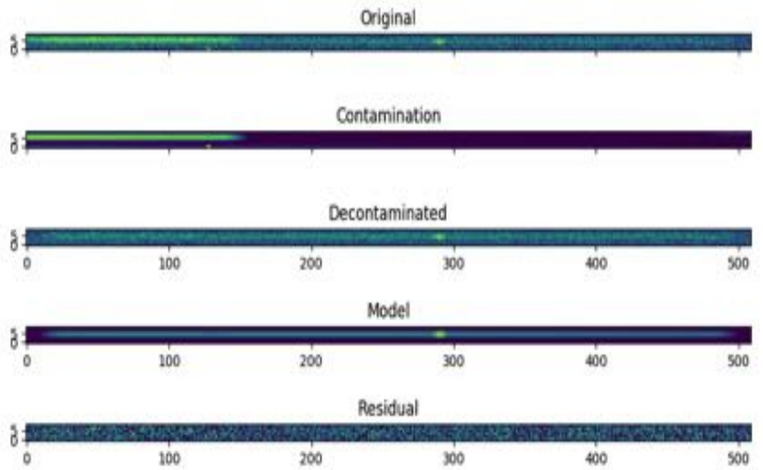
WFIRST: IPAC and LAM joint grism/prism processing

- Wide Field Infrared Survey Telescope – top-ranked NASA space mission in the 2010 Decadal Survey of A&A
  - Expansion History of the Universe (2 Dark Energy surveys: high-latitude and supernovae), z = 0.2 to 2 – 2,200 sq. deg.
  - Exoplanet Census (Microlensing survey), from the outer habitable zone to free floating planets using microlensing.
  - Exoplanet Direct Imaging (Coronagraphy survey)
  - Guest Observer Program – 25% of the observing time (6yrs+)
- Official launch date: 2025
- LAM and SSC (WFIRST Science Support Center at IPAC) will collaborate to create a WFIRST Grism Data Processing that meets all WFIRST grism requirements
  - The WFIRST grism data processing will be based on the Euclid grism pipeline now being developed.
  - The WFIRST grism pipeline will also take advantage of on-orbit experience with Euclid in the years prior to WFIRST launch
  - Support from CNES
  - Working schedule : 2018-2028
  - LAM effort: 30 FTEs, including 8 'CDD'
  - Positions in Science Team to be discussed / negotiated later in 2020 (TBC)





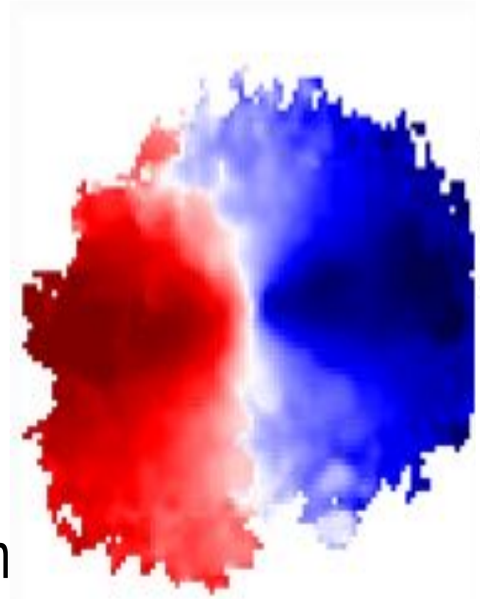


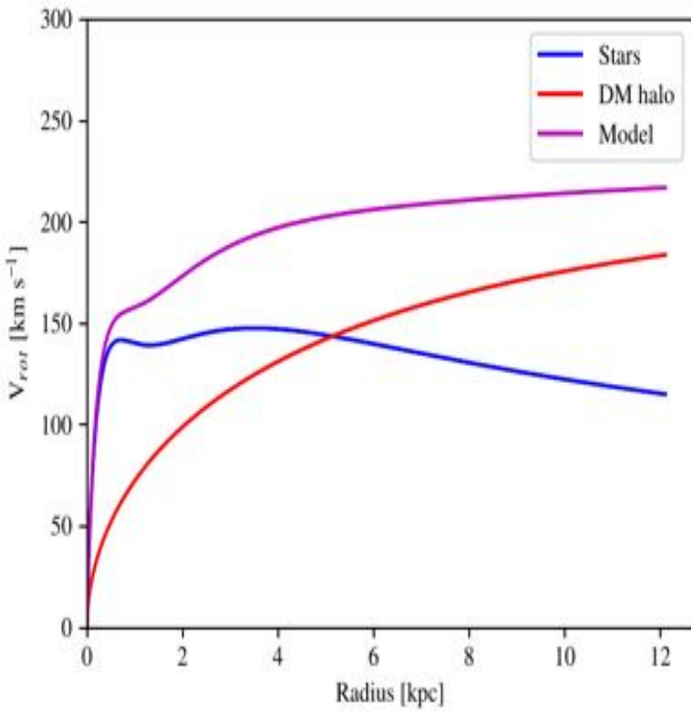


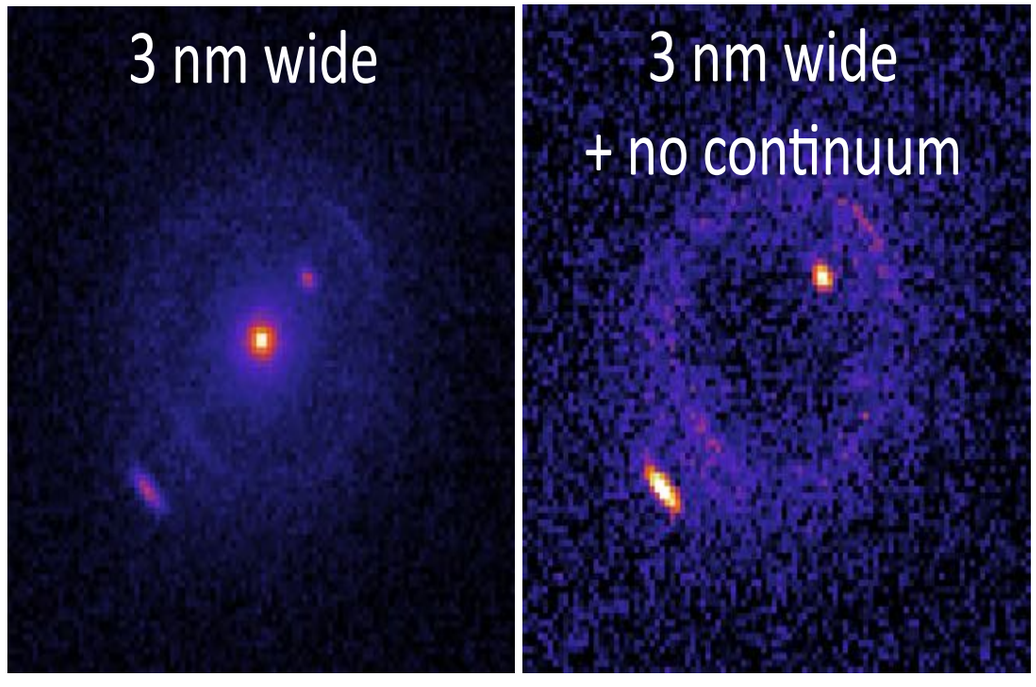
B. Epinat

HARMONI

- Many scientific objectives. Science cases developed at LAM
  - galaxy evolution: dynamics, kinematics, dark matter distribution, star-forming regions at high z, CGM
  - dark matter: Einstein rings
  - non GECO-related: exoplanets, small bodies, solar system
- LAM technical implication:
  - Adaptive optics: laser guide star system + natural guide star system
  - integration at LAM (AIT)
  - >100 FTE
- Schedule:
  - ELT: First light November 2025
  - HARMONI delivery: March 2025
  - ~ 1 year commissioning -> end 2026? 2027?



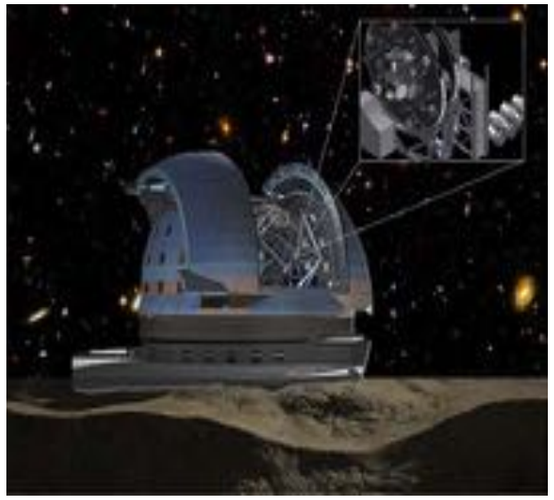




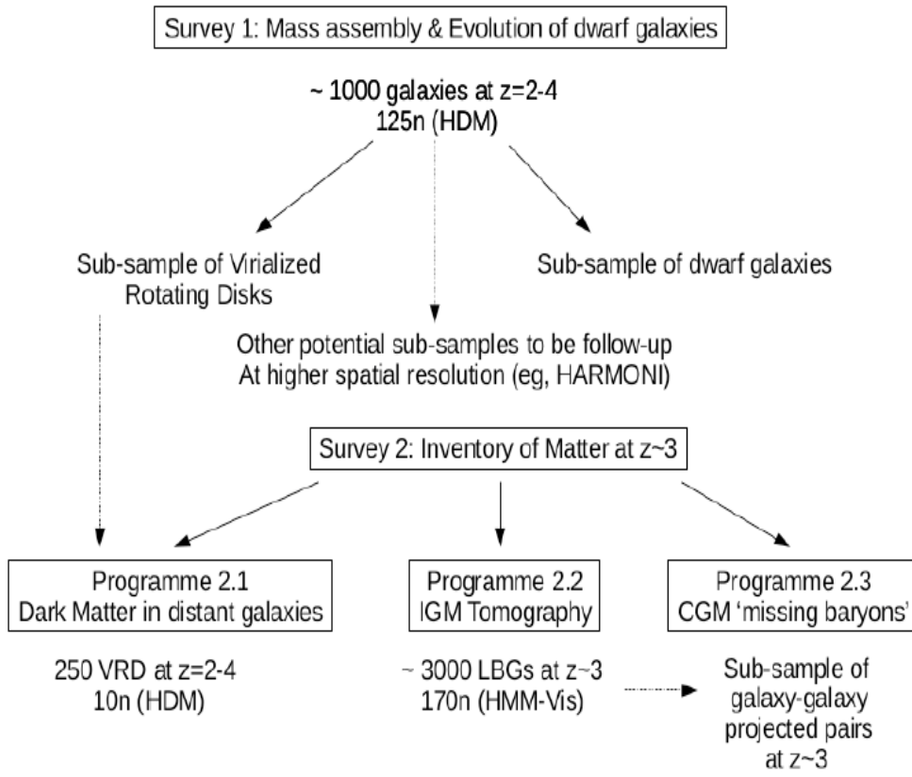
- GTO repartition
  - 75 nights for coordinated programmes
  - 24 nights for own use:
    - 4.6 for LAM, 1.2 for INSU

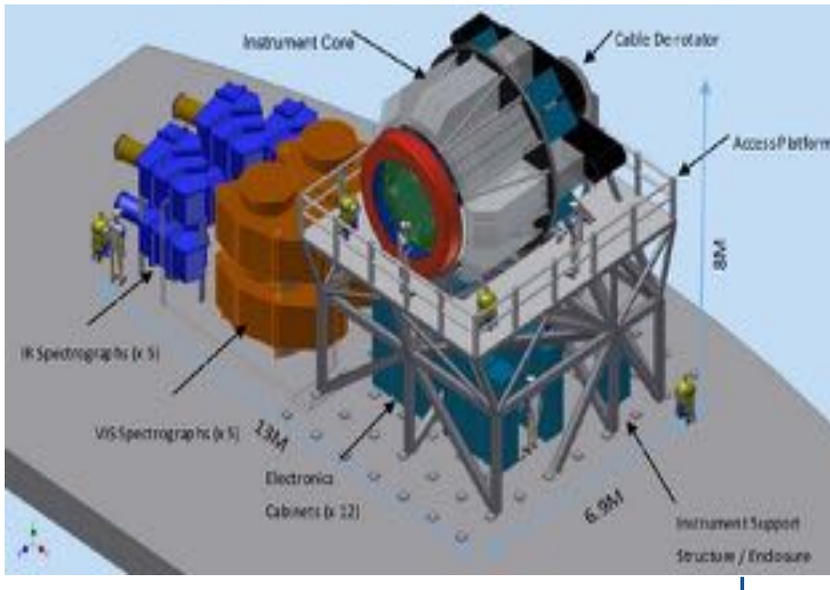
JC Cuby

MOSAIC



- The first MOS on an ELT
  - First-light galaxies
  - Inventory of matter (incl. mass assembly)
  - Extragalactic stellar populations
  - Evolution of dwarf galaxies
- Baseline design
  - High Multiplex Mode (HMM): 200 objects, 0.7” fibres, R = 5,000 (LR) & 10,000 (I
  - High Definition Mode (HDM): 8 x 1.9” IFUs (specs under revision)
- Schedule: start of phase B: end-2020 / mid-2021. First light ~ 2030
- An INSU A&A top priority (French PI-ship)
  - GEPI (PI: F. Hammer), LAM, IRAP, …
- A large consortium: 40 institutes over 13 countries
- LAM : Co-I
  - Seats at steering committee, board
  - Strong push from INSU and OP to take more at project management level
  - Currently : System Engineer, Assembly Integration Test, Laser WFS. Under investigation: mechanical structure and Data Reduction Software
  - High visibility positions available in the short / medium term on a high-profile instrument for the largest ground-based telescope in the world
  - Obviously eligible to ANO2, possibly later ANO4
  - GTO : pooled between partners to conduct MOSAIC surveys
  - Attractiveness: 4 CNAP applications with tâche de service ANO2/MOSAIC in 2018
  - Take the opportunity of the start of Phase B to invest the science team and other bodies (e.g. Survey & Publication Board as currently being defined in the MOU)





G. Lagache

LITEBIRD

MAIN SCIENTIFIC GOAL: HUNTING THE B-MODES OF THE CMB
APPROVED - LAUNCH IN 2027

Contributions scientifiques :

- B-mode contamination by polarised extragalactic foregrounds
- Primordial B-mode “delensing” (using the CIB)
- Cosmological model : joint analysis of different cosmological probes (e.g. CMB and galaxies) - reionisation
- In-flight photometric calibration

Lots de travaux, contributions, expertises :

- Architecte Mécanique; responsable structure MHFT; AIT/V MHFT; TBTV test fonctionnel MHFT
- Travail similaire à une partie du NISP d’Euclid
- Équipe compétente, en place, motivée et disponible

Moyens PARADISE concernés :

- ERIOS avec environnement pour l’instrument @ 4K
- Besoin investissement : « boîte 4K » de taille « ajustée » au besoin de l’instrument dans ERIOS

Ressources humaines permanentes consacrées au projet :

- Livraison du modèle de vol en 2025, 43.1 ETP de 2020 à 2025 (+ 21 CDD/AT)
- Besoins en 3x8 pour l’opération des moyens TBTV non chiffrés car dépendra de la durée des essais, non connue

CONCERTO

G. Lagache

- Instrument:
  - Spectrometer 120-360 GHz, δν=1.5 GHz, FOV D~15'
  - APEX Telescope: angular resolution from 18" to 50"
- Scientific objectives:
  - 3D survey of the [CII] line: map the star formation and gas distribution at 4.5<z<8.5
  - Study galaxy cluster physics (SZ effect)
  - Probe the gaz content of galaxies (CO, CI, CII, NII, OI lines), the efficiency of star formation
  - Study the structure of molecular clouds
- Technical implications at LAM:
  - M5 M6 M9 Mirrors machining (3x60cm diameter)
  - Infrastructure support (CONCERTO cluster, RTA computers, Helium disks, etc)
  - Software: RTA and data reduction pipeline (exact participation of the CeSAM to be defined on Nov, the 26th)
- Timeline:
  - Mirrors: to be delivered in January 2020
  - RTA and pipeline: to be ready for December 2020

Réunion Projets GECO 16/12/2019

* **Projets à voir :**
  —> Blue Muse
  —> MAVIS
  —> MSE
  —> THESEUS
  —> SPICA
  —> LISA
  —> ATHENA
  —> CASTOR
  —> CSST
  —> LUVOIR
  —> OST

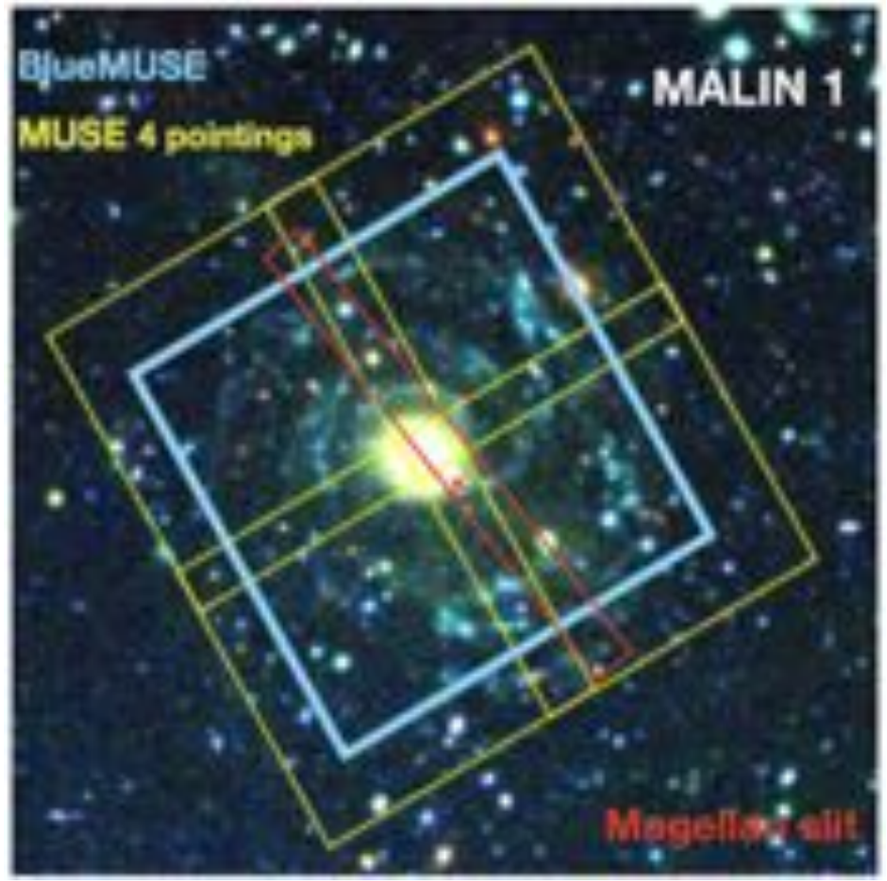
* **Open discussion**

BLUE muse

multi unit spectroscopic explorer

PIs: J. Richard and R. Bacon

Wavelength range	350 - 600 nm
Spectral resolution	$R > 3000$, average ~ 3600 over the full wavelength range
Spectral sampling	0.58 Å per spectral bin
Field-of-view	1.4 arcmin × 1.4 arcmin
Spatial sampling	$0.3'' \times 0.3''$ per spaxel
Throughput (incl. telescope and atmosphere)	> 15% and average > 25% over the wavelength range
Image quality	Max. 20% degradation under best seeing conditions ($0.6''$)



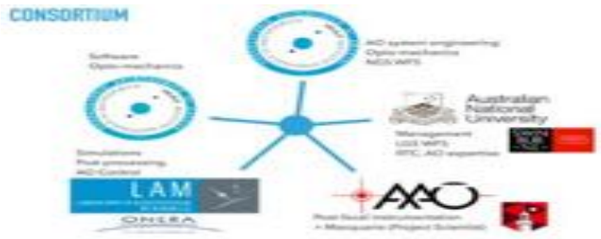
- **The Milky Way and the local group** (key science: massive stars)
- **Nearby galaxies** (key science: ISM and HII regions, extreme starbursts)
- **The distant Universe** (key science: Gas flows around and between galaxies)

Research: **S.Boissier, A. Boselli, L. Ciesla, B. Epinat,** involved in the White Paper (and E. Hugot).

Hardware: Nothing settled, only discussions: Curved detectors from GRD?

Software: ?

LAM
LABORATOIRE D'ASTROPHYSIQUE
DE MARSEILLE



JC Bouret

MAVIS (**M**CAO **A**ssisted **V**isible **I**mager and **S**pectrograph) is a proposed instrument for the ESO's VLT AOF (Adaptive Optics Facility, UT4 Yepun, at the Nasmyth).

Science with MAVIS

- Resolved Stellar Populations Beyond the Local Group
- Crowded Field Photometry & Spectroscopy
- Precision Astrometry and Proper Motions
- Morphology of Young Galaxies
- Probing the Edge of Reionization
- Solar System Science

Current Baseline

- AO Module
  - Delivered angular resolution (FWHM): 20 milliarcsec at V band
  - Strehl: 15% in V under median seeing conditions
  - Sky coverage: > 50% at high Galactic latitudes
- Imager
  - Field of view / sampling: 30" x 30" @ 7.5mas pixels
  - Wavelength coverage: VRI, extended to UBz (goal)
- Spectrograph
  - Format: Monolithic Integral Field Unit
  - Field of view: 3.6" x 2.5" (@25mas spaxels) and up to 7.2" x 5" (@50mas spaxels)
  - 370-950nm covered simultaneously at R=5,000, and in 2 settings at R ≥ 10,000

Implication LAM

- 2FTE pour la Phase A, avec:
  - Participation aux simulations OA
  - Responsabilité sur le WP de "post-processing" et PSF-Reconstruction
  - Participation à la science + Batman avec Fred Z.
  - Mais pour l'instant notre participation est limitée aux chercheurs, pas d'ITA

Schedule

- Successfully passed **mid-term review (MTR) October 24-25 2019**
- Final phase A review planned 25 May 2020.
- Phase B to start early 2021
- Current schedule calls for **first light end of 2026**, in line with E-ELT (...).

See https://drive.google.com/drive/folders/1BRIhN9T6ShXGHTUrRDVbY6TZQOWOWxMu

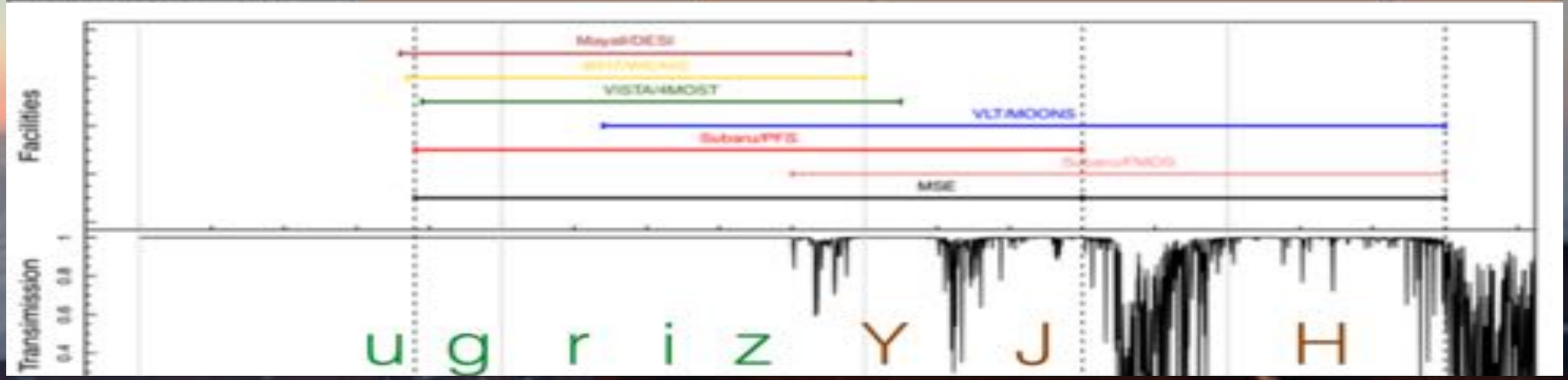
Maunakea Spectroscopic Explorer

MSE

N. Flagey & N. Martin

MSE is a project to transform CFHT into an **11.25m, wide-field, U to H band** facility **dedicated** to **Multi Object Spectrocopy** including a HR mode for stellar astrophysics.

Accessible sky	30000 square degrees (airmass<1.55)				
Aperture (M1 in m)	11.25m				
Field of view (square degrees)	1.5				
Etendue = FoV x π (M1 / 2)^2	149				
Modes	Low		Moderate	High			IFU
Wavelength range	0.36 - 1.8 µm		0.36 - 0.95 µm	0.36 - 0.95 µm #			IFU capable; anticipated second generation capability
	0.36 - 0.95 µm	J, H bands		0.36 - 0.45 µm	0.45 - 0.60 µm	0.60 - 0.95 µm	
Spectral resolutions	2500 (3000)	3000 (5000)	6000	40000	40000	20000	
Multiplexing	>3200		>3200	>1000			
Spectral windows	Full		≈Half	λ$_c$/30	λ$_c$/30	λ$_c$/15	
Sensitivity	m=24 *		m=23.5 *	m=20.0 ◦			
Velocity precision	20 km/s ♪		9 km/s ♪	< 100 m/s •			
Spectrophotometic accuracy	< 3 % relative		< 3 % relative	N/A			



Maunakea Spectroscopic Explorer

Science requirements

MSE is ***100% dedicated*** to surveys, covers the ***full range*** from ***near-UV*** to the ***H band***, and includes a (very) ***HR*** mode for stellar astro.

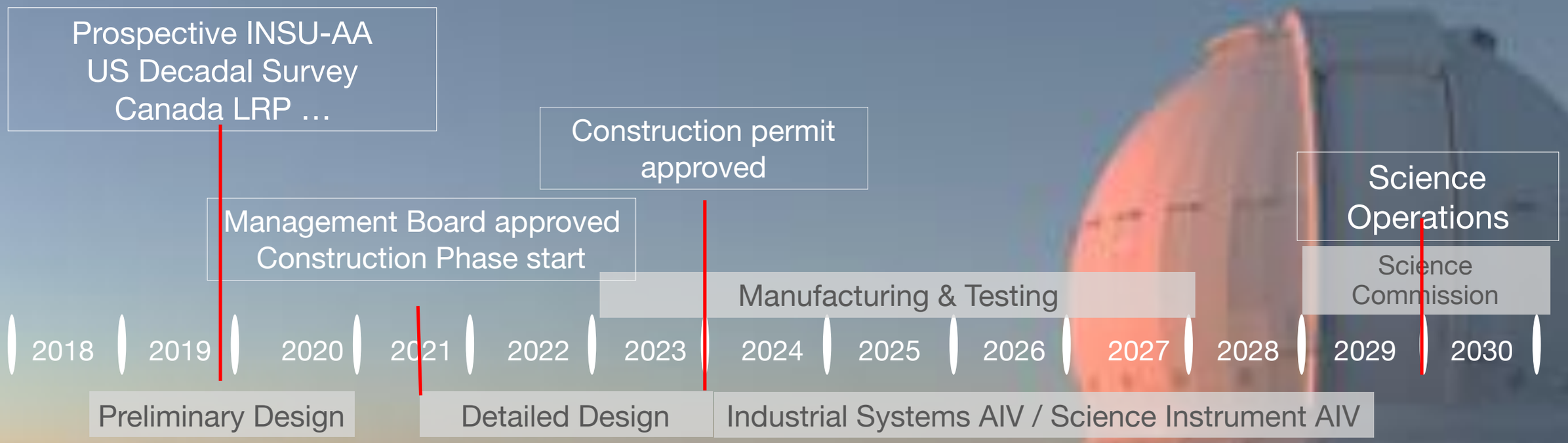
	8 - 12 m class facilities						
	VLT / MOONS		Subaru / PFS		MSE		
Dedicated facility	No		No		Yes		
Aperture (M1 in m)	8.2		8.2		11.25		
Field of View (sq. deg)	0.14		1.25		1.52		
Etendue	7.4		66		151		
Multiplexing	1000		2394		4329		
Etendue x Multiplexing	*7400 (= 0.01)*		*158004 (= 0.24)*		*653679 (= 1.00)*		
Observing fraction	< 1 ?		0.2 (first 5 years) 0.2 - 0.5 afterwards ?		1		
Spectral resolution (approx)	4000	18000	3000	5000	3000	6500	40000
Wavelength coverage (um)	0.65 - 1.80	windows	0.38 - 1.26	0.71 - 0.89	0.36 - 1.8	0.36 - 0.95 50%	windows
IFU	No		No		Second generation		

Maunakea Spectroscopic Explorer

MSE

N. Flagey & N. Martin

MSE is a project to transform CFHT into an **11.25m, wide-field, optical and near-infrared** facility **completely dedicated** to **multi-object spectroscopy** that comprise **thousands to millions** of astrophysical objects.



—> recent call for the need/resolution of the H band

—> LAM contribution is under discussion (LAM or CRAL for optical design)

—> N. Martin (OAS) french representative but request from MSE for a French Inst. Scientist

LAM -> R. Pello

THESEUS

S. Basa

Une des trois missions présélectionnées par l'ESA pour la mission M5:

- **Mission dans la lignée scientifique de SWIFT et de SVOM.**
- **Représente une opportunité unique d'investiguer l'Univers profond par le truchement des sursauts gamma et l'observation du ciel transitoire au sens large (neutrinos, GWs, etc.).**

Positionnement du LAM sur l'InfraRed Telescope (très largement basé sur l'expertise acquise sur le NISP d'Euclid, Project Manager: L. Martin):

- ***Membre du Theseus Science Study Team and Theseus System Working Group.***
- ***Participation au système: mécanique et optique.***
- ***Responsable du banc optique.***
- ***Responsable de la spécification du télescope.***
- ***AITs/AIVs de l'IRT.***

Activity	Date
Phase 0 kick-off	June 2018
Phase 0 completed (EnVision, SPICA and THESEUS)	End 2018
ITT for Phase A industrial studies	February 2019
Phase A industrial kick-off	June 2019
Mission Selection Review (technical and programmatic review for the three mission candidates)	Completed by June 2021
SPC selection of M5 mission	November 2021
Phase B1 kick-off for the selected M5 mission	December 2021
Mission Adoption Review (for the selected M5 mission)	March 2024
SPC adoption of M5 mission	June 2024
Phase B2/C/D kick-off	Q1 2025
Launch	2032

L. Ciesla

SPICA

M5 candidate (against Theseus and EnVision)

Phase A, final decision in ~July 2021

(PI: P. Roelfsema (SRON), French Head of Nation: M. Giard)

SAFARI

From R~300 to 11,000
from 35 to 230um
Sens.: 10-20 Wm^{-2} (5sig, 10h)

B-BOP

(PI: M. Sauvage (CEA))

Far-IR Polarimeter 70, 200, 350um

	100µm	200µm	350µm
Band edges	75—125µm	150—250µm	280—420µm
# of pixels	32 x 32 (x 2)	16 x 16 (x 2)	8 x 8 (x 2)
Pixel size	5" x 5"	10" x 10"	20" x 20"
Band centre beam FWHM	9"	18"	32"
PS sensitivity 5σ/1h/FOV (unpolarised)	21µJy	42µJy	85µJy

SMI

LR: 10' slit, R=100; 17-36um
MR: 1' slit, R=1,000; 18-36um
HR: ? slit, R=28,000; 12-18um
+ CAM @ 34um

- **Planetary system formation: from gas and dust to planets**
- **Galaxy evolution near and far**
- **Star formation**

- Following *Herschel*
- 3.5m diameter
- All cooled, few K.

Research: **L. Ciesla** and **M. Béthermin** in European consortium, involved in several WGs (MB co-lead of a WG). Science case of Galaxy Evolution using the three instruments. **D. Burgarella** involved with Japonese team of SMI.

Hardware: Nothing settled, only discussions. Visits of SMI team representants this week. B-BOP is looking for contributors on 3 hardware points in exchange of co-I-ship.

Software: Nothing settled, only discussions, from both Japonese and European sides. Strong heritage from *Herschel*.

LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

D. Porquet

LISA (ESA, L3, 2034) : ondes gravitationnelles

Le LAM fait partie du LISA Consortium : instrumentation, gestion de données et science
(actuellement 23 membres : 12 instrumentations, 3 CeSAM et 8 chercheurs).
La demande va bientôt être refaite pour mise à jour.

Objectifs scientifiques au GECO (astrophysique et cosmologie):

- Etude de la formation et de l'évolution des binaires d'objects compacts dans notre galaxie : naines blanches, étoiles à neutrons et trous noirs stellaires.
- Test de l'existence des trous noirs intermédiaires
- Détermination de l'origine, la croissance et l'histoire de la fusion des trous noirs supermassifs
- Détermination de la constante de Hubble
- Recherche et étude des gamma-ray bursts (et de leurs lignes de visée : IGM)

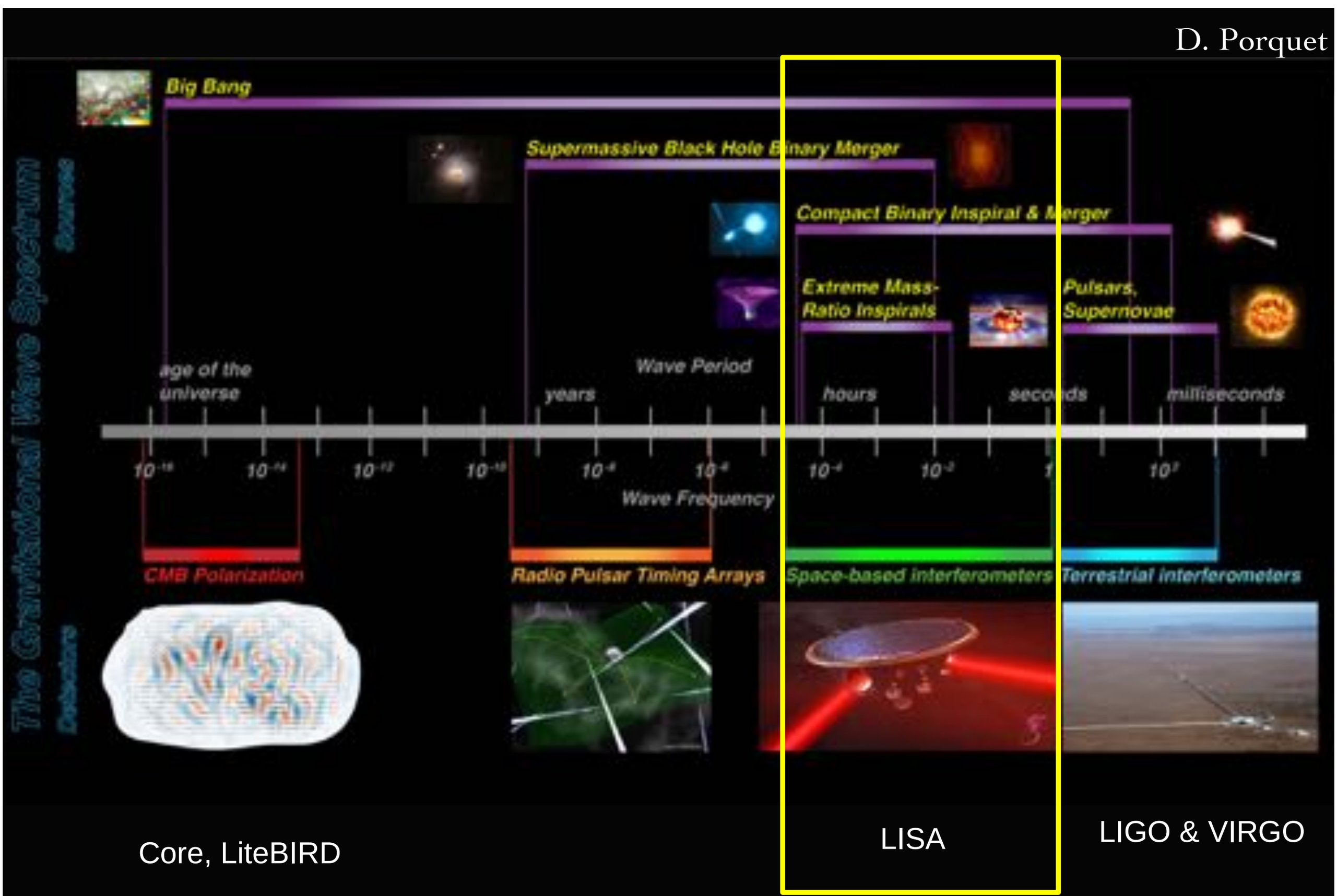
Implications instrumentales :

- Participation à la définition du plan de contamination de LISA
- Essai dans ERIOS du démonstrateur d'interféromètre (qui permettra de valider les moyens de tests optiques)
- Expertise AIT opto-mécanique pour l'instrument (en discussion)

Implications bases de données (CeSAM) :

- Participation à la gestion de l'architecture et infrastructure logicielles des chaines de traitements de données
- Participation aux simulations numériques (optimisation, opérations)
- Participation aux développements de chaînes de traitement de données
- Participation au développement de la mission dataBase.

D. Porquet



Core, LiteBIRD

LISA

LIGO & VIRGO

* Populations of stellar BH, neutron stars, white dwarfs, …

* dense nuclear clusters : EMRI, IMBH

Probe of the early universe via detection of SMBH up to z~20
→ very precise determination of mass, spin
+ distribution.

* Stellar BH-BH mergers

* Pop III → seeds of SMBH ?

* Populations of SMBH
→ history of mergers
→ evolutions of galaxies

* Co-evolution of SMBH and their host galaxies
* Evolution of large structure

* « Standard sirens »
→ Hubble constant

* Primordial BH → DM ?

* Test theories of gravity

Gamma-ray burst
→ study of the IGM on the line-of-sight

C Adami

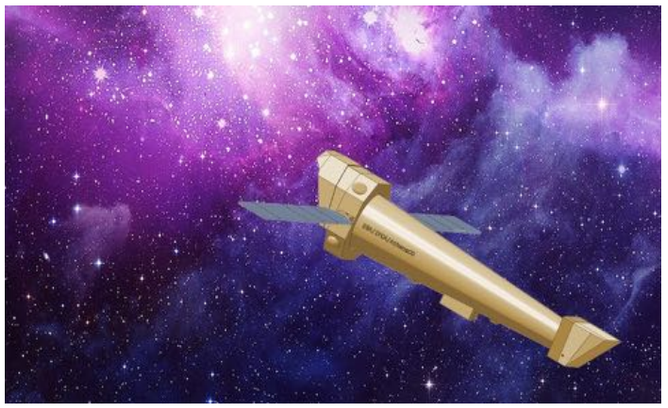
Science

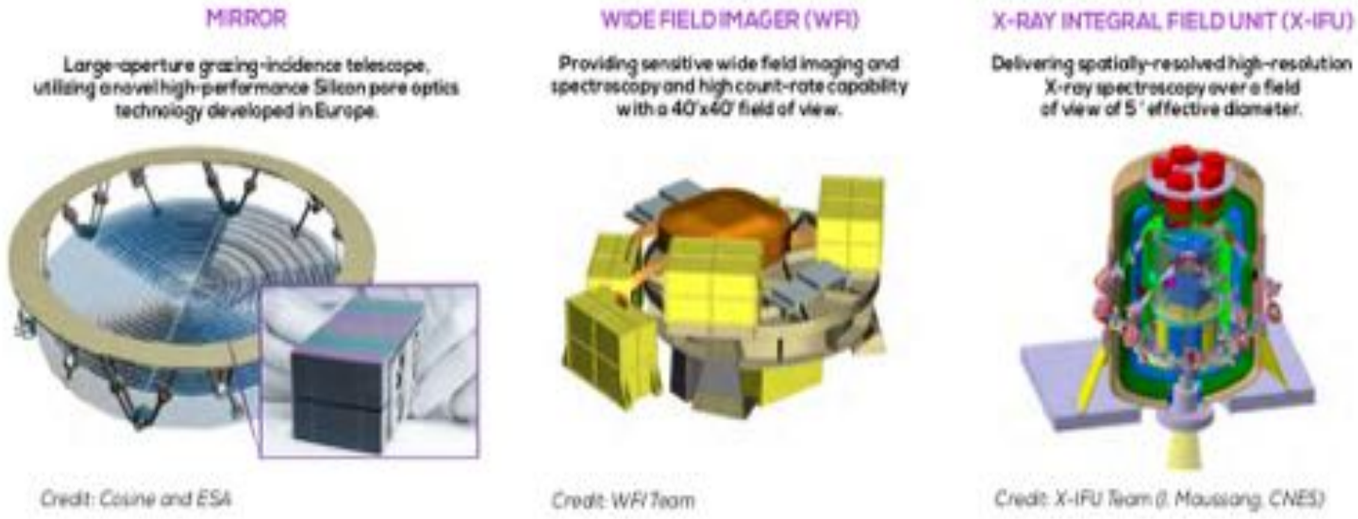
- How and when large-scale hot gas structures formed, track their evolution from the formation
- Complete census of black hole growth, physical processes responsible and influence on larger scales. Trace other energetic and transient to the earliest cosmic epochs
- Exploring high energy phenomena in all contexts, including those yet to be discovered

Facts

- 1.4 m² @1keV SPO technology, 5'' resolution
- 2 instruments : WFI (large fov, moderate spectral res.), X-IFU (moderate fov, high res.)

ATHENA





LAM contribution

- X-IFU
- Soft contribution through CeSAM, responsible of :

Work package 4: Develop, test, document and maintain a database that will contain the ground calibration data, trends & anomalies, 2 FTE/yr (2021-24), 3 FTE/yr (>2024)

- Science contribution : head of transient WP, 1.35 FTE "science" in 2019

Schedule

- Consortia appointed by ESA in Dec 2018
- X-IFU/WFI phase A OK, phase B1 04/19, Athena MFR successful 11/19, now phase B
- Launch : early 2030s, 4 year baseline mission + extensions for 10 years

Cosmological Advanced Survey Telescope for Optical and uv Research (CASTOR)

JC Bouret

- 1m off-axis, un-obscured
- 5 years minimum – 2026

- Wide field imaging, 3 channels simultaneously:
  - UV (150-300 nm), u (300-400 nm), g (400-550 nm)
  - FoV 0.44° x 0.56° = 0.25 deg^2

- Slit-less Spectroscopy (full imaging FoV)
  - 2 channels UV (R~300), u (R~420)

- Multi-slit, UV spectro in parallel field
  - HST-like area coverage in UV only
  - R~1000 - 2000
  - Spectral multiplexing ~ 600 max

JC Bouret

Galaxies and Cosmic Star Formation

CASTOR's niches: UV/blue-optical response, field of view, resolution, sensitivity

Evolution of the Cosmic Star Formation Rate (SFR)

- definitive measurement of the cosmic SFR from rest-frame UV fluxes out to z=1.5.
- UV data from CASTOR combined with OIR data from LSST, Euclid and WFIRST.

Ultra-Massive Galaxies (UMGs)

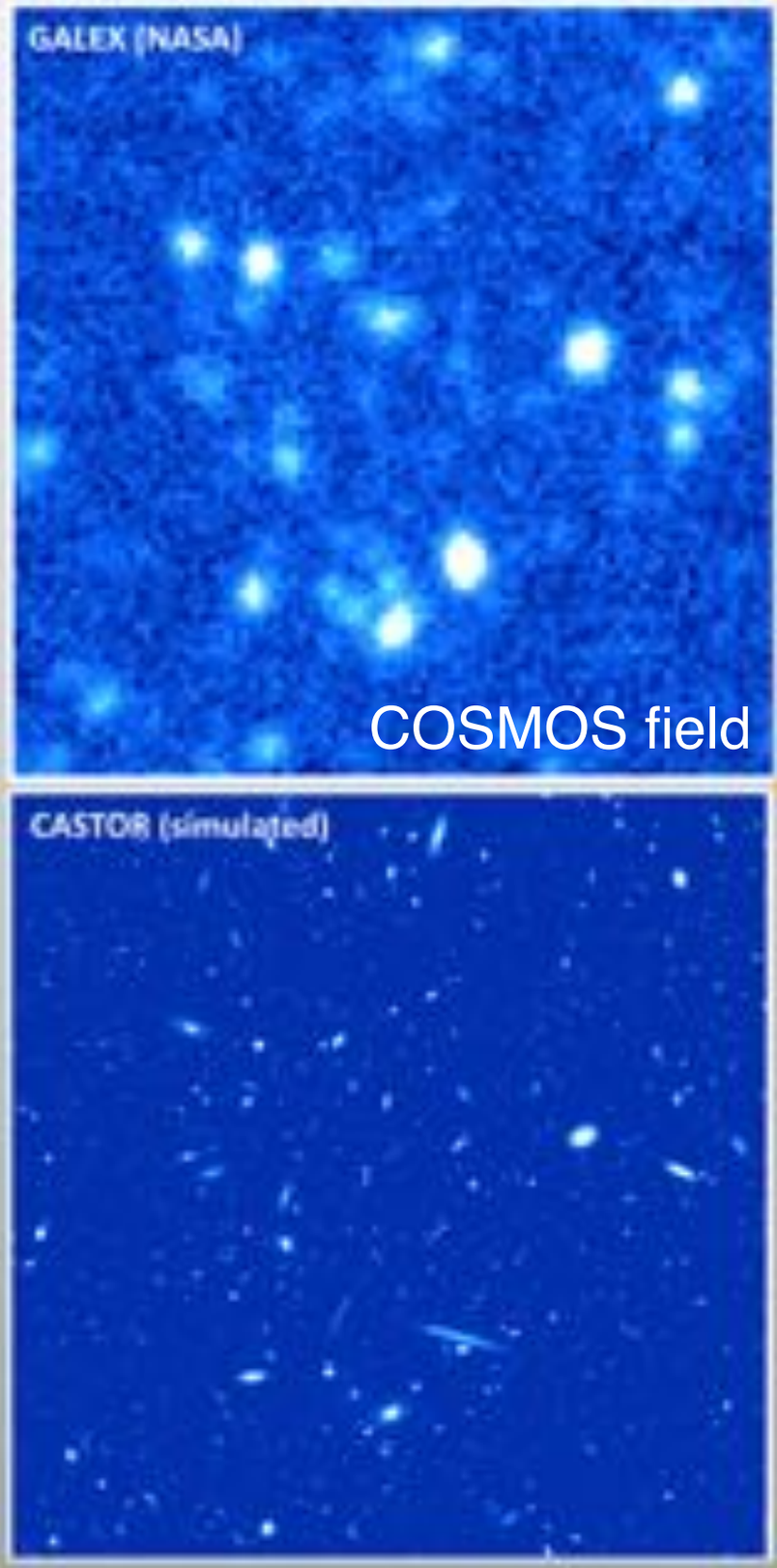
- a survey of UMGs ($\log M_{\star}/M_{\odot} > 11.5$) based on their UVOIR emission.
- within the 2200 deg^2 region covered by CASTOR, LSST, Euclid and WFIRST, we expect 5600 and 8400 UMGs between $0.1 < z < 0.3$ and $0.4 < z < 0.6$, respectively.

Galaxies at Cosmic Noon

- z=2 galaxies can be linked to their DM masses through clustering measurements.
- high-precision photometric redshifts at all redshifts will enable the mapping of large scale structure, and hence the environmental dependences of galaxy evolution.

Spatially Resolved Star Formation Histories

- mapping of the SFR, dust distribution and stellar populations within galaxies at a resolution previously only achievable by HST, but with small samples.
- trace the growth of morphological components (disks, bars, bulges, etc) over cosmic time and across a range of environments.

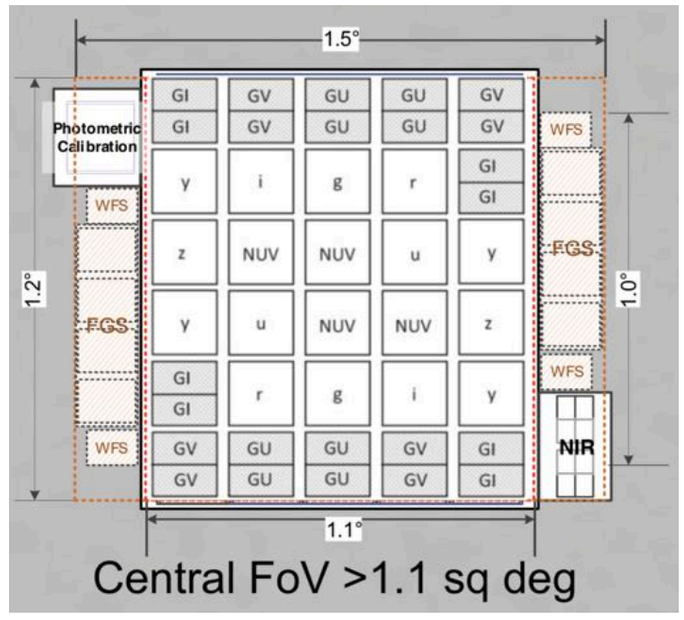


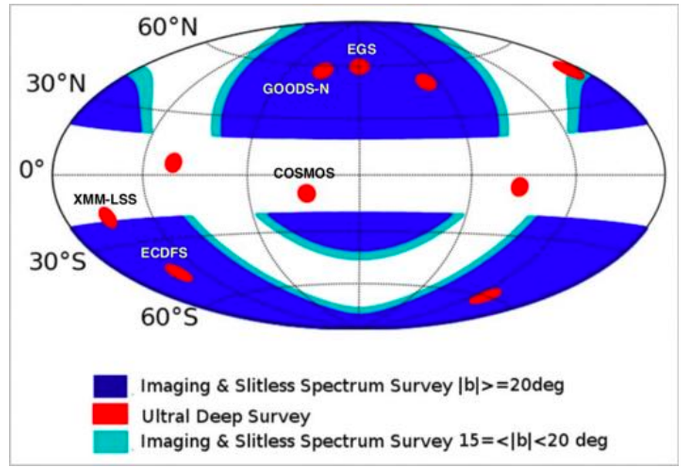
courtesy Emily Pass & Michael Balogh

E. Jullo

Chinese Space Station Telescope (CSST)

- Serviceable 2m off-axis, 0.25-1.1um telescope (~2024)
- 4 instruments:
  - Optical Camera, >6 filters, slitless R>200, FOV >1 deg2
  - Multi-Channel Imager, 3 cameras in parallel, >20 filters, 8’x8’
  - Integral Field Spectrograph, 30x30 spaxels, R>1000, 6"x6"
  - Exoplanet Imaging coronograph, Contrast 10^{-9}, 2.5"x2.5"
- CSS-Optical Survey (80% of the operation time)
  - 17500deg2 imaging, avg > 25.5^{m} (5σ, point source, AB mag)
  - 17500deg2 slitless, avg >20-21^{m} /res
  - 400deg2 deep fields, 1 mag deeper
  - Cosmology, AGN, Galaxies, Milky Way, Stars, Solar System
- MCI Science
  - SN Ia cosmology and High-z SN, Galaxy BH evolution
  - Calibration for CSS-OS weak-lensing, clustering
  - ~6 ultra deep fields avg 29^{m} (empty + gal clusters fields)
- **IFS Science** (LAM contribution on the slicer, TBC)
  - Galaxy BH (feeding and feedback, tidal-disruption events)
  - Galaxy Star Formation and evolution





LUVOIR
Large UV/Optical/Infrared Surveyor

JC Bouret

- 2035 – 2040
- Far-UV to Near-IR bandpass: 100 nm – 5 micron
- Two concepts: 15.1m and ~ 9m - PSF Angular resolution: 7 – 12 mas
- Diffraction-limited performance at 500 nm
- 4 and 3 instruments

ECLIPS A – *High-contrast UV / O / NIR imaging & spectroscopy*
LUMOS A – *UV multi-object spectrograph & imager*
High-Definition Imager – *NUV / O / NIR wide-field camera*
POLLUX – *European-contributed UV spectropolarimeter*

Questions:

Are we alone? **OST question: How common are life bearing planets around dwarf stars?** With sensitive mid-infrared transit spectroscopy, OST will measure biosignatures, including ozone, carbon-dioxide, water, and methane in the atmospheres of Earth-sized habitable exoplanets.

How did we get here? **OST question: How do the conditions for habitability develop during the process of planet formation?** With the sensitive and high-resolution far-IR spectroscopy OST will map the water trail in our Galaxy.

How does the Universe work? **OST question: How do galaxies form stars, make metals, and grow their central supermassive blackholes from reionization to today?** OST will spectroscopically 3D map wide extragalactic fields to measure simultaneously properties of growing super-massive blackholes and their galaxy hosts across cosmic time.

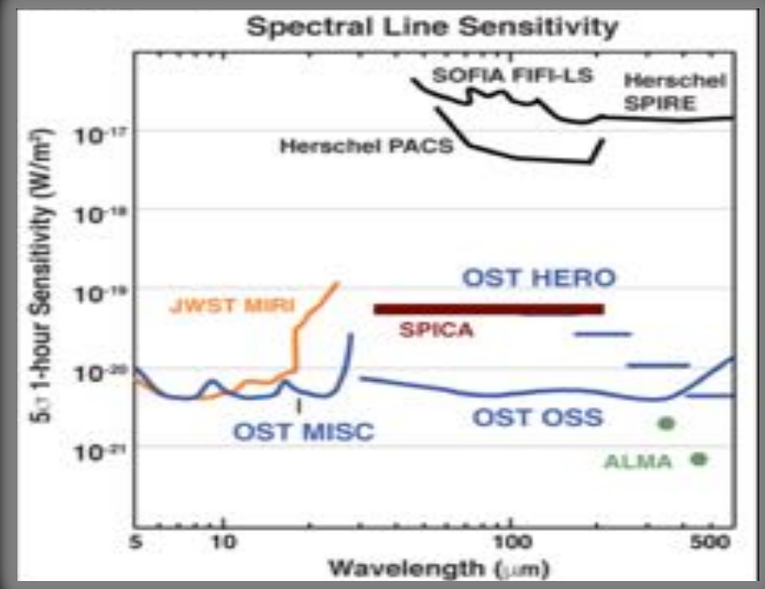
D. Burgarella

What is OST?

NASA flagship class mission concept for the 2020 Decadal review.

Comes from the NASA Astrophysics Roadmap.

- **Current concept: 5.9m, Spitzer-like,** 3µm – 600 µm (diffraction limit = 30 µm)
- 4.5K actively-cooled operating at L2 for min 5 years (10yrs goal)
- factor of 1,000 improvement in sensitivity over previous (driven primarily by cooling not aperture size).
- ultra-sensitive detector arrays => new spectroscopic capabilities
- exoplanet studies via transit spectroscopy in mid-IR
- modular instrument suite with robotic serviceability
- Mission aimed at mid 2030s: post JWST, concurrent with WFIRST, Athena, LISA, and 25m-35m ground-based optical/IR facilities.



- No deployment like JWST
- Zero single-point failure
- Spitzer-like architecture with cry-cooled 4.5K telescope (no expendable cryogen) and light-collecting area ~ to JWST.

Study Team

- **Community Chairs:** A. R. Cooray, UCI; M. Meixner, *STSCI/JHU*
- **Study Scientist:** D. Leisawitz, *GSFC*
- **Deputy Study Scientist:** J. Staguhn, *GSFC/JHU*
- **Study Manager:** R. Carter, *GSFC*
- **NASA HQ Program Scientists:** K. Sheth, D. Benford

- **NASA Appointed Members:** L. Armus, IPAC; C. Battersby, UConn; J. Bauer, UMD; E. Bergin, Michigan; M. Bradford JPL; K. Ennico-Smith, Ames; J. Fortney, UCSC; T. Kataria, JPL; G. Melnick, CfA; S. Milam, GSFC; D. Narayanan, UFlorida; D. Padgett, JPL; K. Pontopiddan, STSCI; A. Pope, UMass; T. Roellig, Ames; K. Sandstrom, UCSD; K. Stevenson, STScI; K. Y. L. Su, Arizona; J. Vieira, UIUC; E. Wright, UCLA; J. Zmuidzinas, Caltech
- **Ex-officio representatives:** S. Neff & E. Smith, NASA Cosmic Origins Program Office; S. Alato, SNSB; D. Burgarella, LAM, France; D. Scott, CSA; M. Gerin, CNES; I. Sakon, JAXA; F. Helmich, SRON; R. Vavrek, ESA; K. Menten, DLR; YS Song, KASI; S. Carey, IPAC; S. Wiedner, CNRS.
- **NASA Study Center (Goddard Space Flight Center) Team:** C. Wu (Mission Systems Engr), E. Amatucci (Instrument Systems Engr), M. DiPirro (Chief Technologist), J. Staguhn (Instrument Scientist)
- **Study Advisory Board:** J. Arenberg,Northrup Grumman; J. Carlstrom, Chicago, H. Ferguson, STScI, T. Greene, Ames; G. Helou, IPAC; L. Kaltenegger, Cornell; C. Lawrence, JPL; S. Lipscy, Ball; J. Mather, GSFC; H. Moseley, GSFC; G. Rieke, Arizona; M. Rieke, Arizona; J. Turner, UCLA; M. Urry, Yale.