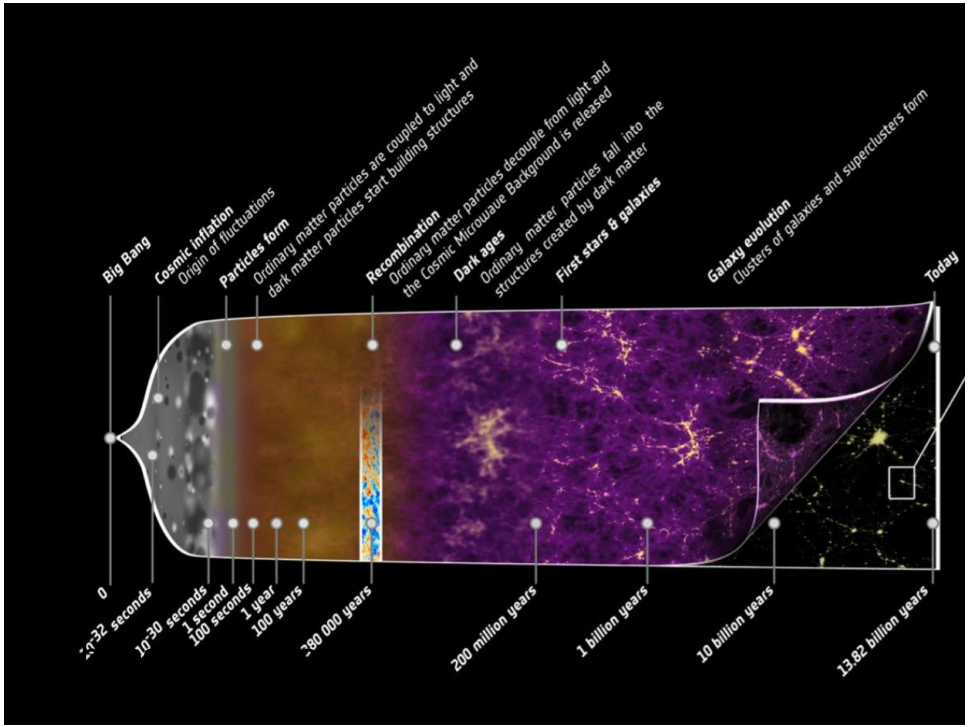
Bilan et Recommandations HCERES/Tourniquet & trajectoire **Cosmologie**

Cyrille Rosset
(with help of Josquin Erard & the group)

What are we searching?

1. What is the Universe made of?
    a. What is dark matter?
    b. What is dark energy?
2. What is the history of the Universe and its future?
    a. How does structure (the cosmic web) emerge?
    b. How did reionization occur?
3. How to use cosmology as a laboratory for fundamental physics?
    a. Is the theory of cosmic inflation correct?
    b. Is General Relativity correct?
    c. What is the neutrino mass scale?
    d. Are there unseen relic particles?



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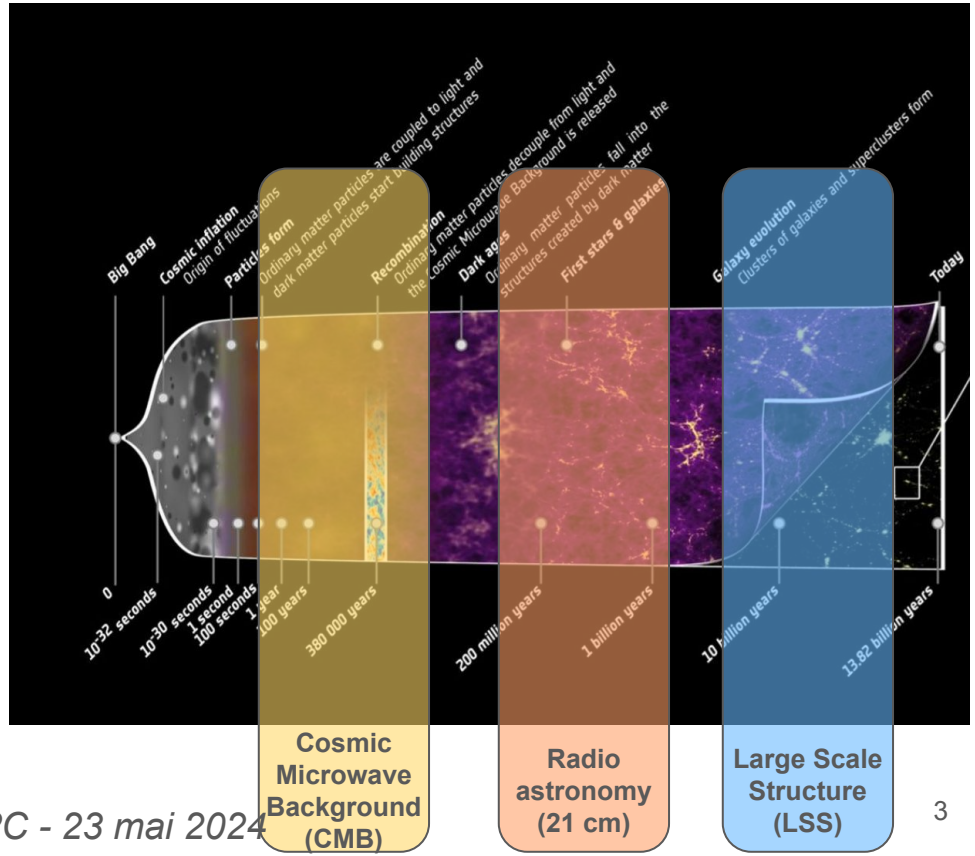
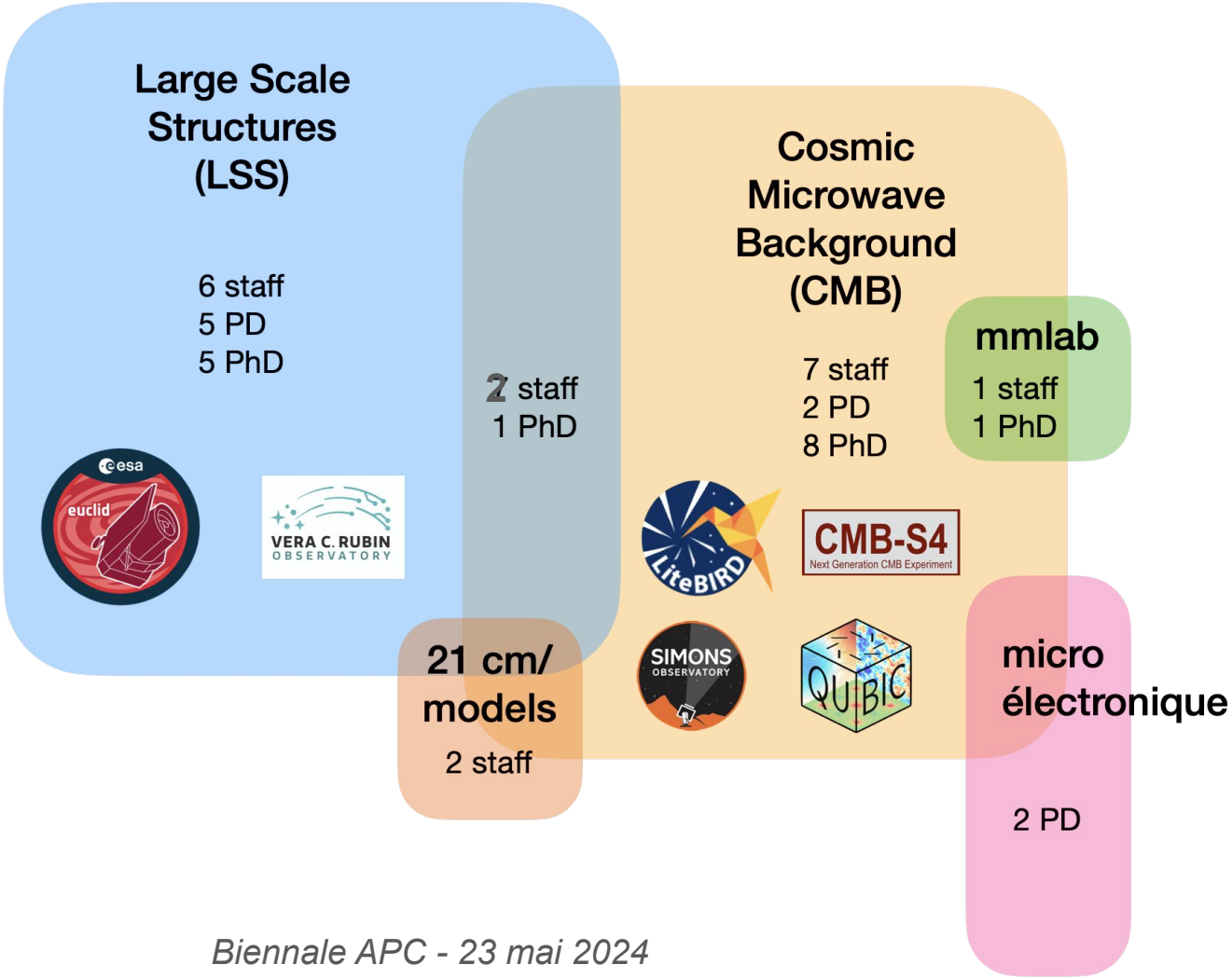


statut actuel : projets et personnels

+ 7 associates (IJClab, LPT, LPSC, CEA, IPCMS)

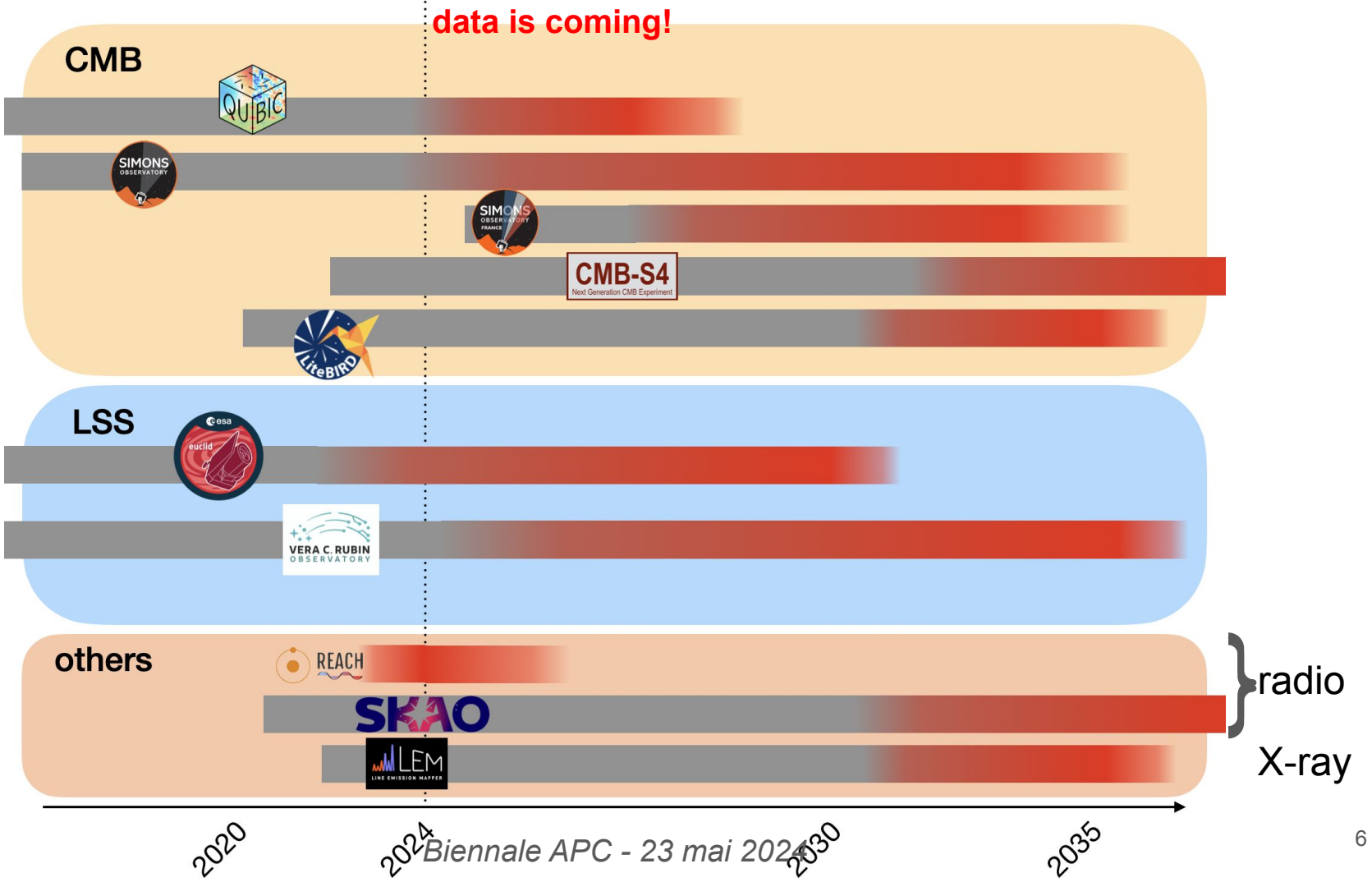


CEA
CNRS
UPCité
Obs. Paris

18 permanent members

(extrait de la présentation de Jim Bartlett, déc 2023)

Large-Scale Structure: Euclid, Rubin/LSST/DESC	• Eric Aubourg (CEA) HDR • Alexandre Boucaud (IR) • Simona Mei (PR) HDR • Marina Ricci (CR) • Cyrille Rosset (CR) • Cécile Roucelle (MdC)
	• James G. Bartlett (PR) HDR • Ken Ganga (DR) HDR
Cosmic Microwave Background: LiteBIRD, SO, CMB-S4, QUBIC	• Josquin Errard (CR) • Jean-Christophe Hamilton (DR) HDR • Jean Kaplan (DR emeritus) • Sotiris Loucatos (CEA) HDR • Guillaume Patanchon (MdC) HDR • Michel Piat (PR) HDR • George Smoot (PR, emeritus) HDR • Steve Torchinsky (IRHC) HDR
21cm, cosmological model	• Martin Bucher (DR) HDR • Gabriel Chardin (DR emeritus) HDR


data is coming!
CMB
QUBIC
SIMONS OBSERVATORY
SIMONS OBSERVATORY FRANCE
CMB-S4
Next Generation CMB Experiment
LiteBIRD
LSS
esa
euclid
VERA C. RUBIN OBSERVATORY
others
REACH
SKAO
LEM
LINE EMISSION MAPPER
radio
X-ray
2020
2024
2030
2035

HCERES: assessment

Very positive: choice of subjects and projects focus on the scientific objectives, +Machine learning methods development and instrumentation

Overall assessment of the team

APC is a relatively new institution (2005). It has done well in the field of Cosmology, a vibrant highly competitive field. It is wise of the team to focus on the next generation of galaxy surveys (LSST-Rubin and Euclid) and Cosmic Microwave Background (CMB) experiments (QUBIC, LiteBIRD and Simons/CMB-S4). These international experiments have great potential for quantifying dark energy, dark matter (including the neutrino mass), CMB polarization and deviations from the standard cosmological model. The APC group is involved in both instrumentation (for example the LSST filter changer) and data analysis (e.g. cross correlation of galaxies and the CMB). The application of Machine Learning methods (e.g. for LSST galaxy image de-blending) is very timely. The connection to ML programmes (e.g. diiP, IN2 P3). Public Outreach, exploiting APC location in Paris, is important.

HCERES: strengths

Strengths and possibilities linked to the context

The Cosmology team is engaged in cutting-edge cosmological surveys, in both galaxy surveys (LSST-Rubin and Euclid) and CMB (QUBIC, LiteBIRD and Simons/CMB-S4). Some improvements have taken place further to the previous report. It is good to hear about the two new staff appointments, and also the participation of 12 PhD students and 6 Postdoctoral fellows. Team members hold leadership positions in Euclid, Rubin-LSST projects and in the CMB experiments.

The team is strongly supported by the technical staff (more than 6 FTE in 2022), the millimeter laboratory, developed with 2 other laboratories (LPNHE and GEPI), and the CRYOMAT platform.

It is beneficial to have the team exploring Euclid-LSST synergies.

- new staff welcome
- good level of PhD and post-docs
- strong technical support

HCERES: weaknesses

Weaknesses and risks linked to the context

A possible weakness is that the team is a bit small to succeed in the multipole goals in a competitive landscape.

The strategy for interaction instrumentation-analysis-AI-theory is the right direction with however not sufficient contact with all the actors of the Paris area.

- We are still too small (for our ambitions)
- Need more collaboration in Paris area

RECOMMENDATIONS TO THE TEAM

To enlarge the group further (staff, PhD students, post-docs) with the aid of internal and external grants.

To enhance the science synergy between the galaxy surveys and the CMB strands.

To be aware of the workload of the technical staff involved in its technical projects, in particular CMB-S4 and LiteBIRD which are not supported yet.

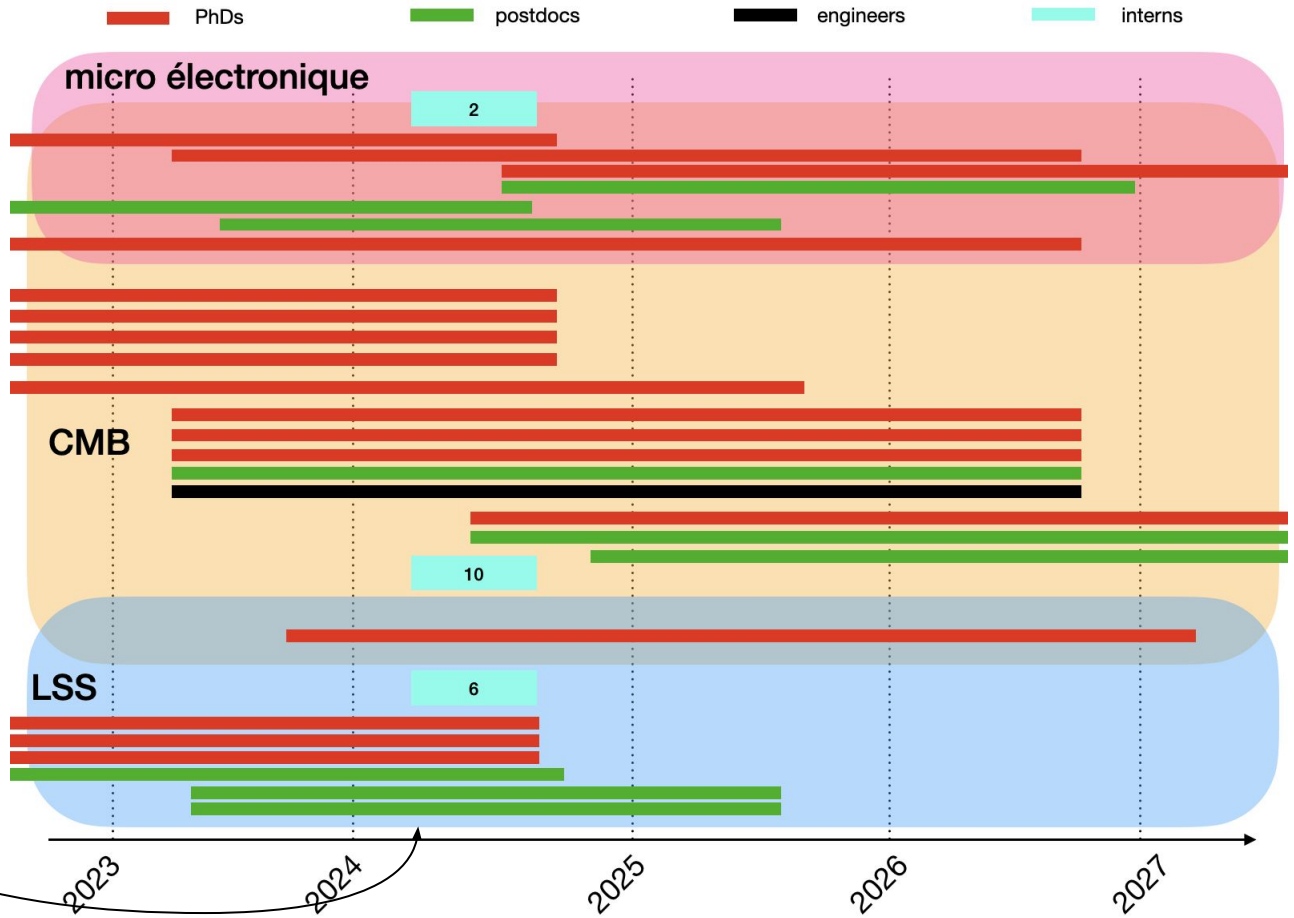
To look for further interdisciplinarity links training to incorporate AI in the studies.

To encourage further collaboration between APC cosmologists and other groups in Paris and abroad.

To prioritise the goals and to identify niches, while trying to recruit more staff and junior researchers by different routes.

Recommandations: L'implication dans les principaux projets de la cosmologie moderne à court et moyen terme est tout à fait justifiée d'un point de vue scientifique mais doit être accompagnée par un soutien technique et informatique renforcés (il y a un risque de dispersion). Le groupe doit maintenir sa responsabilité dans la production des "derived data products" d'EUCLID-LSST ce qui ne paraît pas être assuré actuellement. Il doit aussi renforcer les synergies entre les projets CMB et grandes structures comme promis lors du dernier tourniquet

recommendation from HCERES: to enlarge the group further (staff, PhD students, postdocs) with the aid of internal and external grants



40 persons as of Spring 2024!

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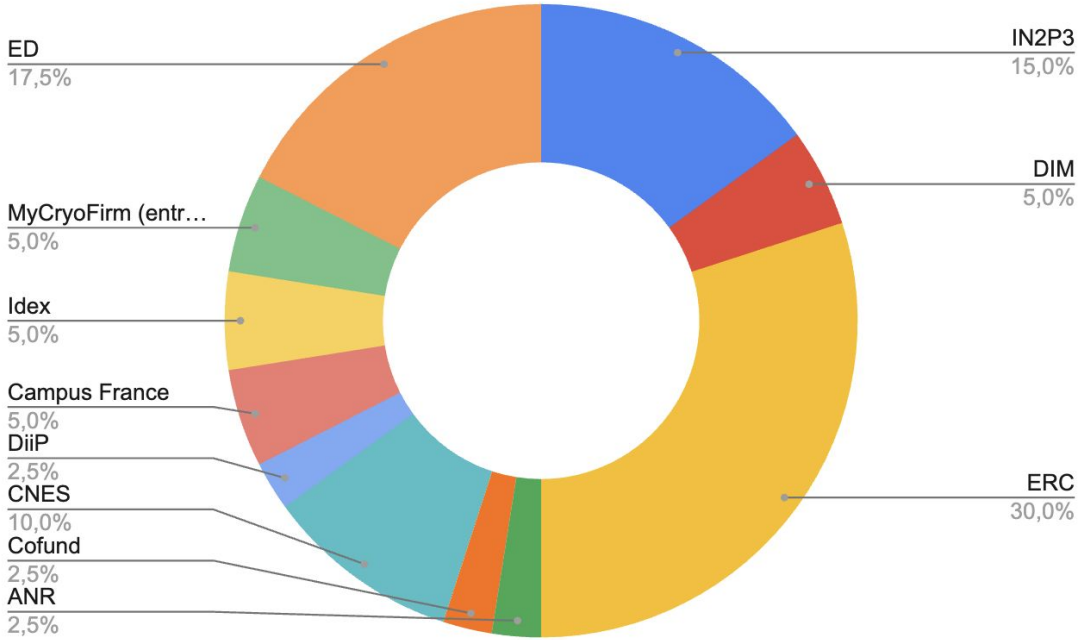
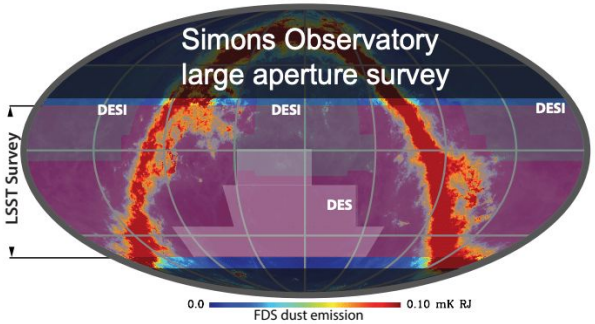


- We note that the group reached space saturation with interns this Spring 2024
- USTH has been particularly successful to support interns + PhDs
- How can we do better?
  - be more successful with CNES, Marie Curie, etc. fellowships? i.e. attract good, international candidates?
  - provide support to CNRS applicants as we did this year?

recommendation from HCERES: to enhance the synergies around large collaborations such as SO and LSST/Rubin/Euclid

- SO and LSST/Rubin are synchronous and observe the same sky.
  - powerful cosmological probe for DE/DM, neutrinos, lensing/delensing/etc.
- Cosmology journal clubs + weekly Galaxy Clusters Meetings and lively group meetings have recently been fostering discussions between teams
- common PhD advisory (e.g. Wassim Kabalan advised by Alex/Eric/François has been integrated within Josquin's ERC team)
- recent EAOM discussion: the group would like to have IR/CR profiles that can bridge the two communities



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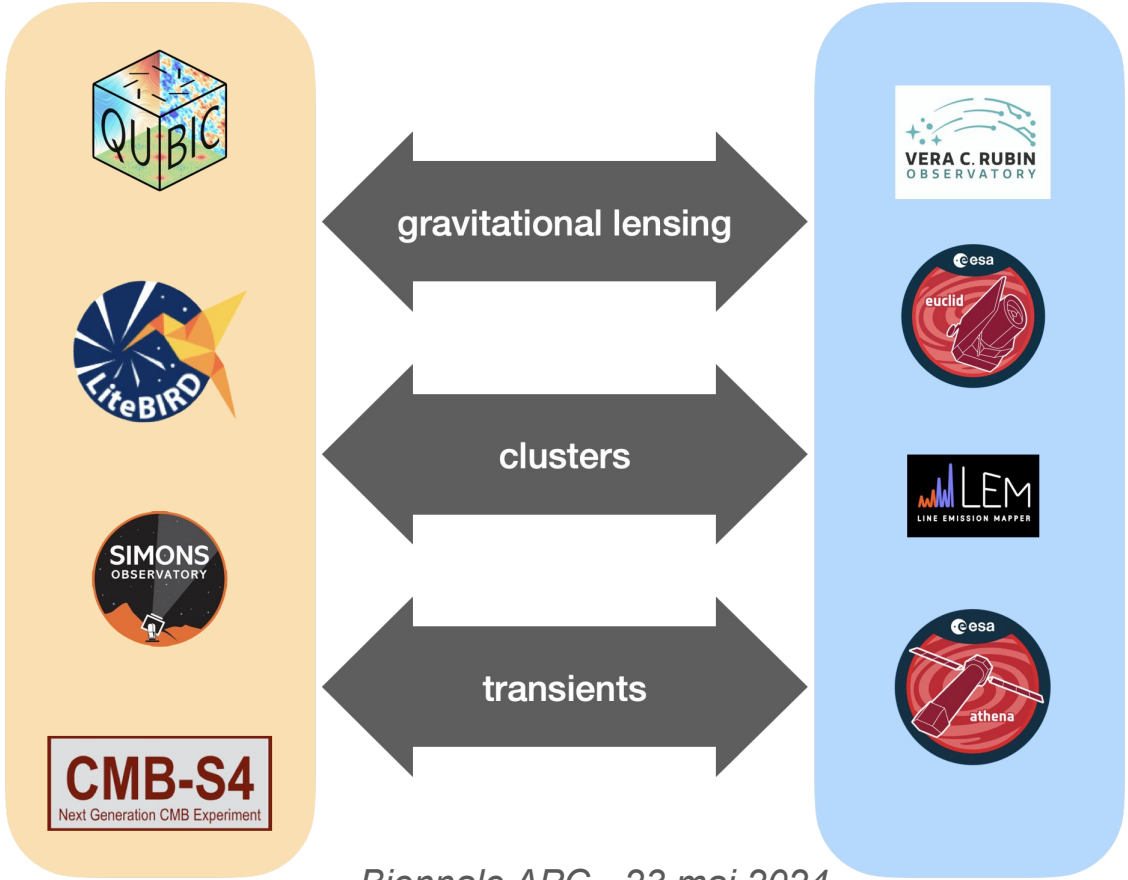
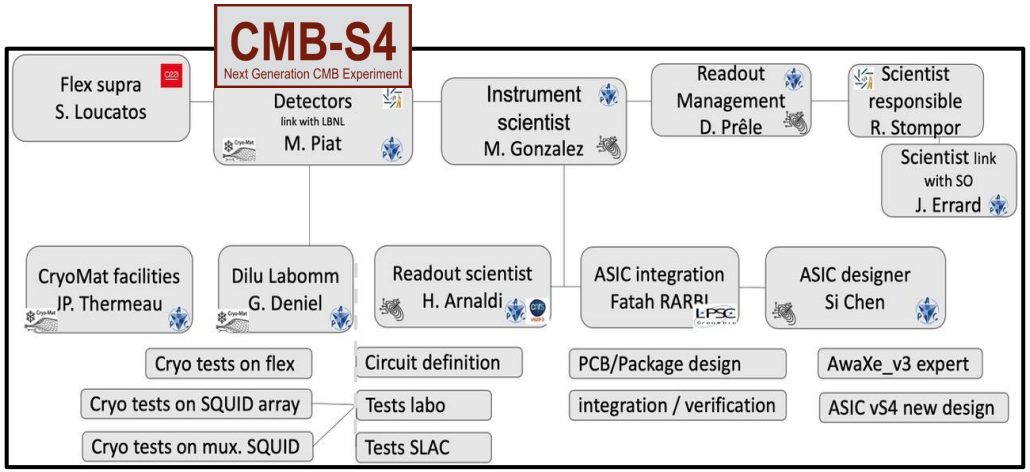


recommendation from HCERES: to be aware of the workload of the technical staff involved in its technical projects, in particular CMB-S4 and LiteBIRD which are not supported yet



- hardware activities in S4 and LB are rather disjoint?
- **need to recruit instrumentalists!**
- CSP is the good place to discuss/adjust as a function of the projects' evolution

APC would be responsible of the platform (mechanical engineering) if SO-France is funded

SIMONS OBSERVATORY

NOM Prénom	Statut (*)	ETPT (**)	Organisme financeur (***)
ERARD Josquin	CR	0.25	CNRS
PATANCHON Guillaume	MCF	0.5	Université Paris Cité
THERMEAU Jean-Pierre	IR	0.5	CNRS
GANGA Ken	DR	0.15	CNRS
BUCHER Martin	DR	0.1	CNRS
HAMILTON Jean-Christophe	DR	0.05	CNRS
GRANDSIRE Laurent	IR	0.3	CNRS
PIAT Michel	PR	0.2	Université Paris Cité
BERINGUE Benjamin	Post Doc	0.05	ERC
WANG Wang	PhD	1	CNRS
RIZZIERI Arianna	PhD	0.7	CNRS
CHANIAL Pierre	CDD IR	0.05	CNRS
ILIONI Alin	IR	0.2	CNRS

LiteBIRD

- sub-K thermal model
- simulations
- systematics mitigation
- performances
- requirements
- component separation

recommendation from HCERES: to look for further interdisciplinarity links training to incorporate AI in the studies.

- there are examples of recent trainings around new numerical tools (e.g. JAX)
- “Café Informatique” is a great place to start discussions, learn about new methods
- the diiP proposes dedicated seminars and tutorial sessions for PhD students and regularly funds students grants on AI-related projects
- through the IN2P3 ML project (technical coordination at APC) we are in contact with AISSAI - the CNRS interdisciplinary initiative around AI for science - to elaborate workshops, schools and training sessions

recommendation from HCERES: to encourage further collaboration between APC cosmologists and other groups in Paris and abroad.

- Identified weakness about cohesion within group members during last Tourniquet
  - cosmology journal clubs and lively group meetings help
- CMB-Inflate and ERC SciPol help the group with
  - welcoming (international) visitors, ~10 per year
  - having regular exchange with Centre Pierre Binétruy, IPMU, Okayama University
- we have strong/regular connections with IJCLab, LPSC, ENS, IRAP via the LiteBIRD, S4 and SO:FR projects and with LPNHE for Rubin
- how to do better?
  - have a dedicated space to welcome visitors?
  - organize cosmology seminars with Paris area colleagues
  - keep on being involved in large, international collaborations
  - look for funding at the end of the decade

recommendation from HCERES: to prioritise the goals and to identify niches, while trying to recruit more staff and junior researchers by different routes.

- we have had multiple applications to section 01/17/55 that mentioned the cosmology group at APC as a place to work
- preliminary group priorities for this year:
  - CR for CMB analysis (+ cross correlations with LSST/Euclid)
  - services electronique (IR positions) and informatique (IR CMB data analysis)

“Tourniquet” section 01

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DDP IWG (Euclid+Rubin) call in Apr 2024 to identify the DDP(s) teams that wish to contribute to the R&D effort.

What is needed are: *“Multi-band Rubin+Euclid photometry list-driven catalogs, Multi-band Rubin+Euclid forced photometry catalog from joint-pixel processing, Multi-band Rubin+Euclid deblended photometry catalog from joint-pixel processing, Galaxy “pixel” photometric redshifts, Image cutouts/stamps delivery service.”*

APC proposed two main contributions by April 29th discussed at a Euclid@APC meeting: **Photometric Redshift with Machine Learning (*Euclid need*)** and **Astrodeep** deblending and shear analysis **(*Rubin need*)** + individual declaration of interest by **M. Ricci (galaxy cluster fields)** and **S. Mei (cluster detection science and cluster galaxy photometry).**

Communication within cosmology group

- Cosmology group meetings every Tuesday at 11.00
  - General news from projects
  - Internal seminars, presentation by group member, internship students…
  - External seminars by visitors or invitation of colleagues in Paris area labs
  - *(trying to keep administrative stuff to a minimum)*
- Cosmology Journal Club every Thursday at 12.15 (lunch)
  - Discussion on papers (recent or overview of a subject)
  - Discussion on conferences/talks attended by group members
- *Goal: increase communication between projects (CMB, LSS, SKA/REACH…)*

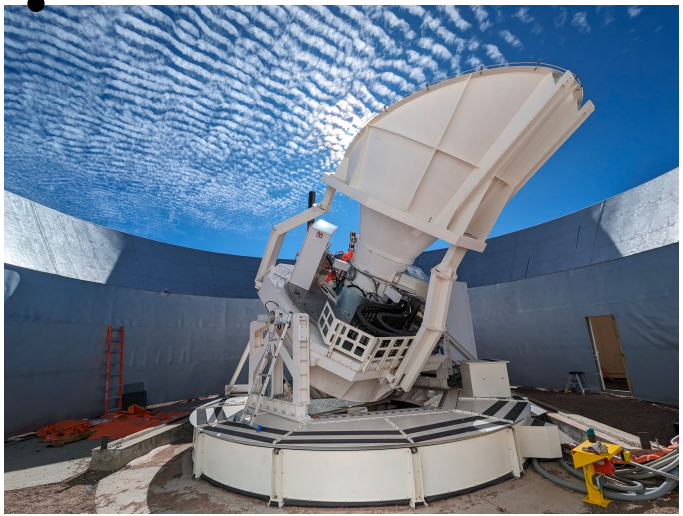
New rhythm started in March 2024…

- *Note: Galaxy Clusters meetings organized by Simona Mei/Calum Murray (CMB+LSS)*

Current highlights of the group

LSST Camera arrived at the site

Simons Observatory just started taking data (and has already observed the polarized CMB)



Euclid Early Release Observation

- Papers and new images to be **released today at 12:00 CEST**
- Early Release Observations
- Check ESA Euclid website: https://www.esa.int/euclid