



Astroparticle and Cosmology (APC)

CNRS & Université Paris Cité
CEA, Observatoire de Paris, CNES

APC & AstroCeNT 5th yearly meeting

Antoine Kouchner



Outline

Today : General panorama. Recap of the evolution over 5 years mandate as presented to the HCERES Evaluation Committee.

- Institutional Organization
- Science scope
- Technical activities and organization
- Focus on APC and University as supervisory body
- APC International
- APC & Society
- Roadmap

HCERES EVALUATION
GROUP D 2017-2022

In memoriam Stavros Katsanevas

ASTROPARTICULE ET COSMOLOGIE

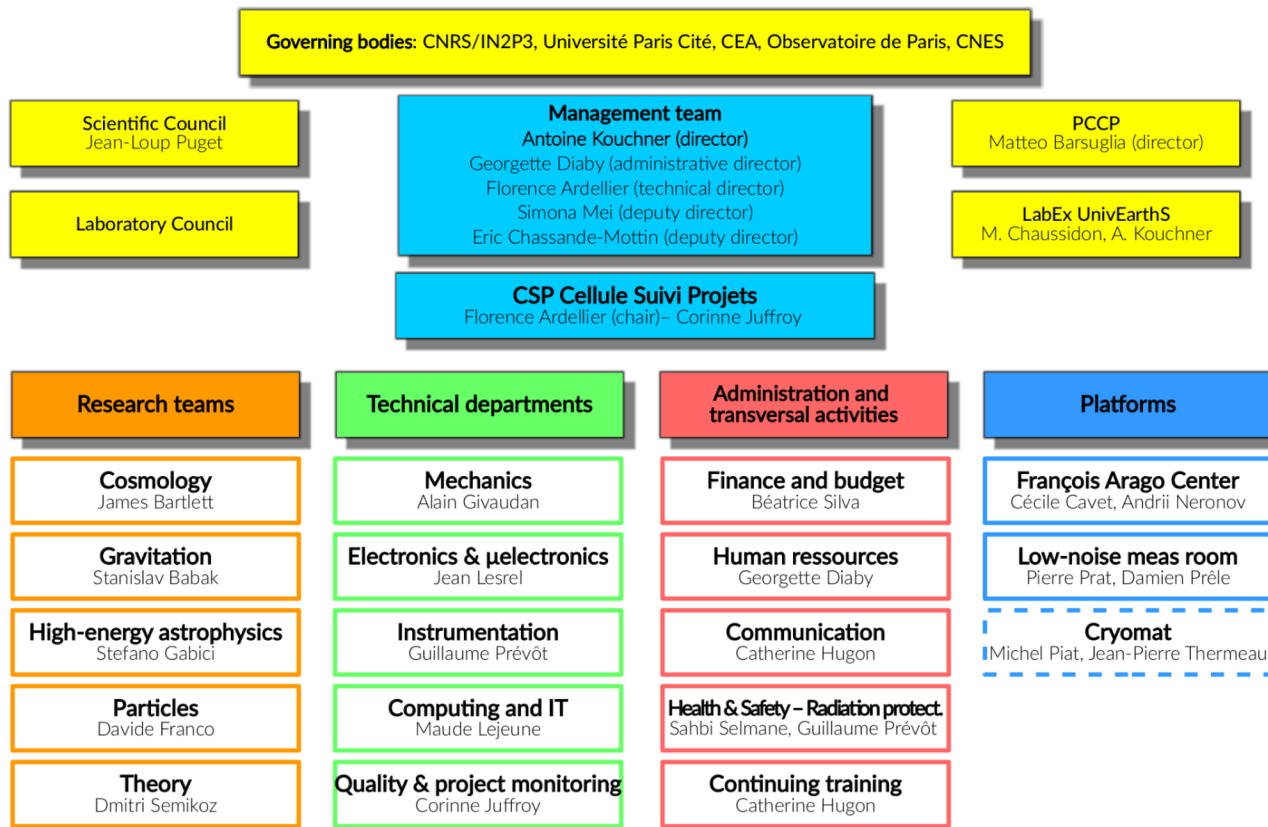
Assessment on the scientific objectives of the unit

The scientific objectives of the unit are keyed to the intrinsically interdisciplinary field of study of multi-messenger 'astronomy'. This has been a rapidly evolving field where APC has been a key actor on the global scene. On one hand the unit has had and still has key field/hardware contributions to several projects (QUBIC, LISA, ATHENA, LSST, Virgo to name a few) coupled to visible/important coordination roles in the Astrophysics arena (spokespersons of collaboration, high level technical and scientific management positions). The central role of APC in the European Astrophysics environment can be gauged by the role that APC and its members play in ApPEC (where several members are members of its scientific council) and in the definition of the roadmap for the European Astroparticle Physics strategy.

Assessment on the attractiveness of the unit

The unit has established as a key reference both at national and international level. At the international level this is both for leadership roles in some of the major endeavors in Astrophysics as much as for key technical skills/developments. At a national and local level this is expressed in the leading coordination roles played in various agencies and for the various initiatives, both social and academic, connecting them to the local landscape. This is reflected in the large number of students which form the backbone of the Unit activities and the success in getting non recurrent resources.

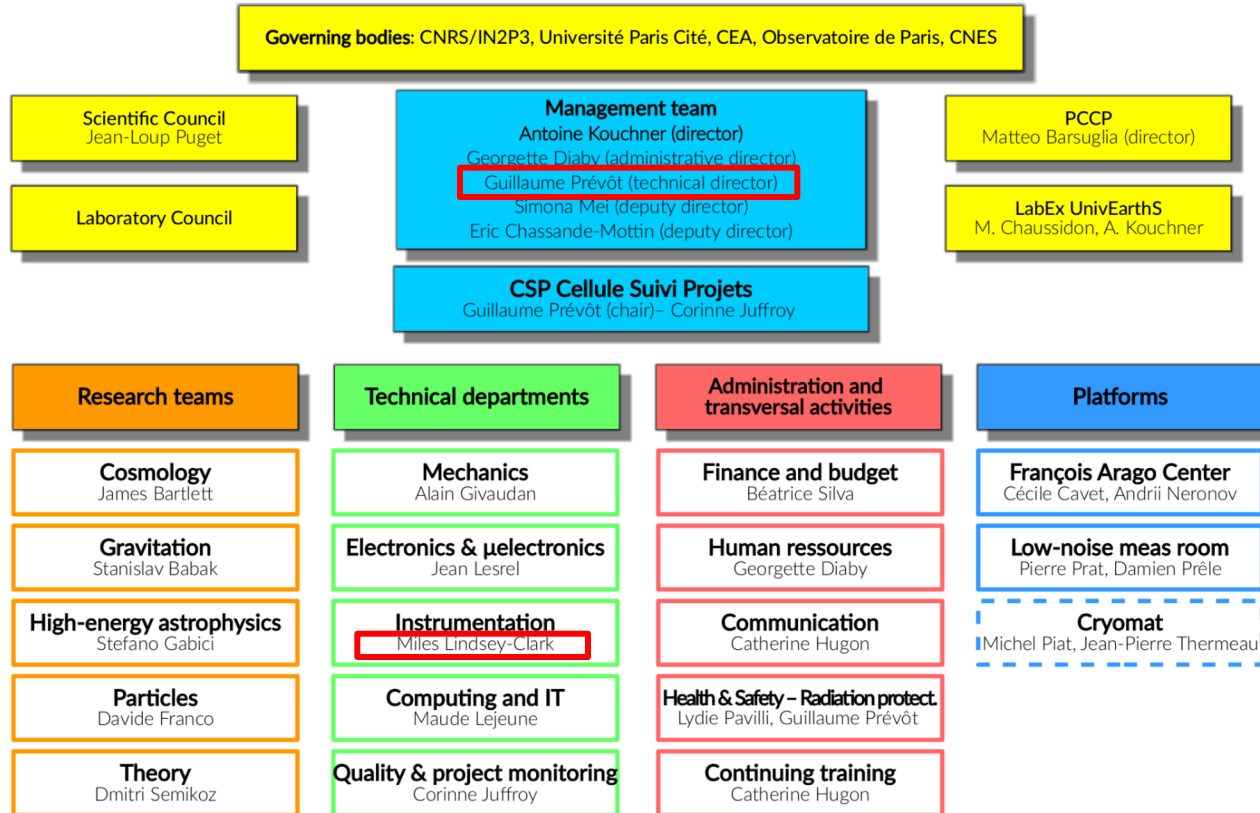
Organization – Dec 31 2022



Organization – Today



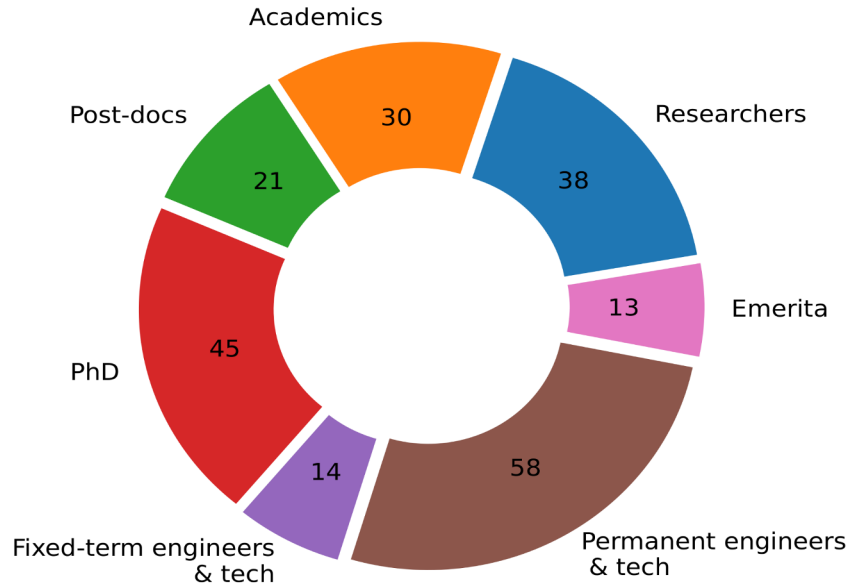
End of
Direction
Team
mandate
: end of
December –
Eric
Chassande-
Mottin
1yr interim



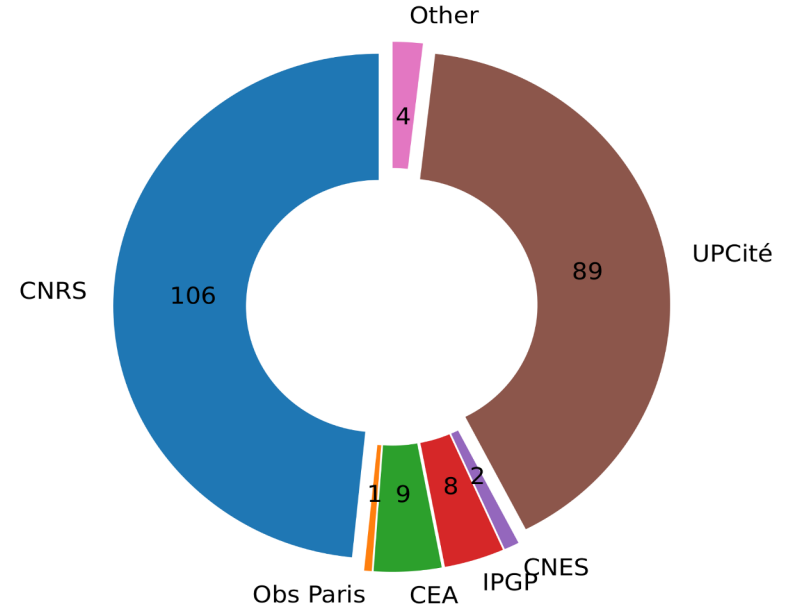
Human Resources



Composition of the laboratory by status



Composition of the laboratory by employer



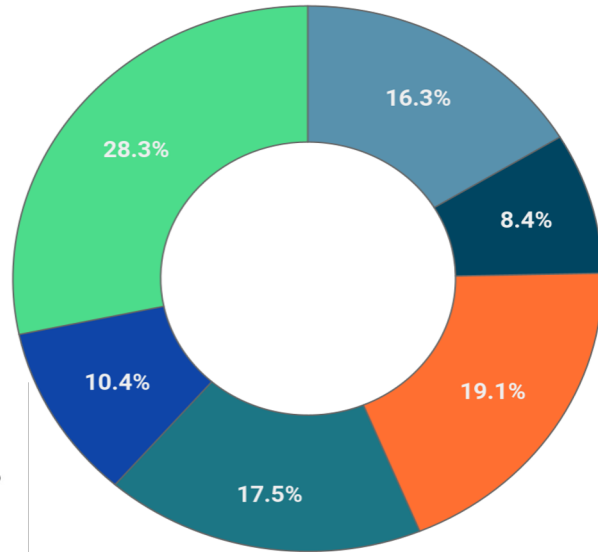
Gender ratio is 26% on average on the period 2017-2022, slightly higher than percentage of women in physics in France, and comparable to percentage of permanent female staff in astrophysics.

An internal anonymous survey on the perceived level of comfort relative to biases and discrimination (Biennial, Jun 2022).

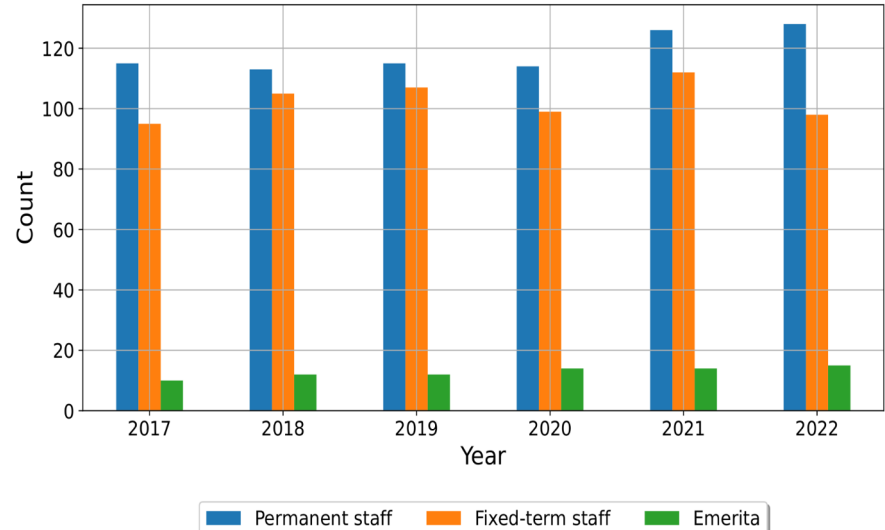
Human Resources



Person power distribution



Evolution

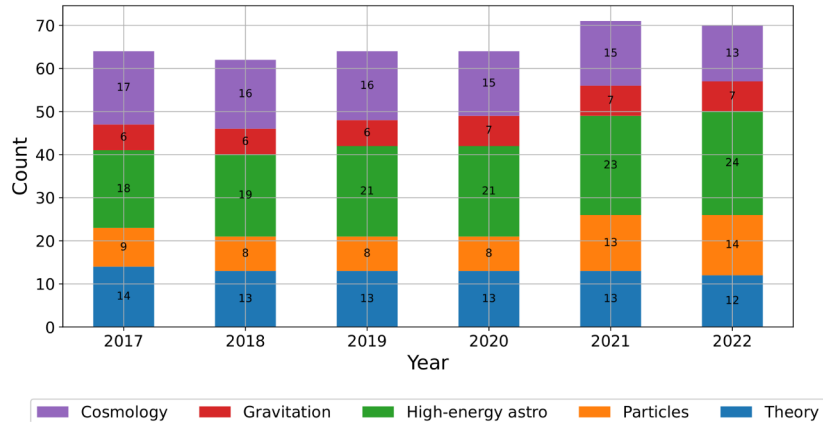


12,5 % increase over 5 years (mostly permanent staff: +15 people + 1MCF in 2023 + 2 CNRS incoming mobilities in 2023 + 1 in 2024)
→ Attractiveness of the Research Unit

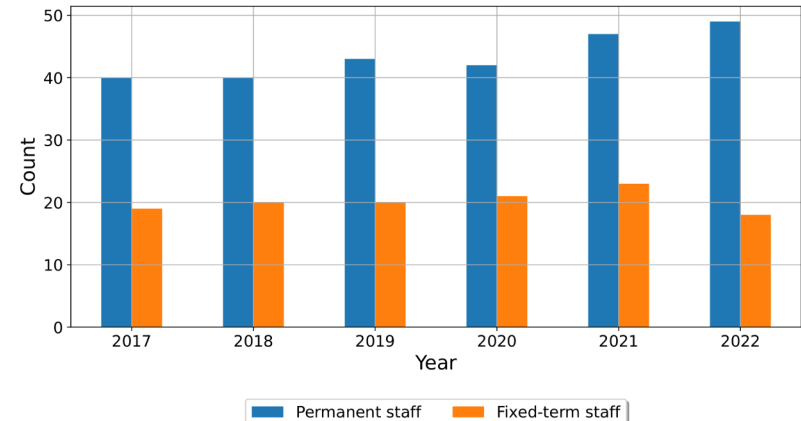
Human Resources - Evolution



Researchers and faculty



Technical services



→ Efforts to increase technical departments:
+7 people (+15 %) for services (excl. administration)

Ph.D. students: +12 people (+30 %), while other fixed-term categories ~ stable.

The APC Science



- Production of Activity Report (latest from 2012)
- Website regularly updated (not enough though)

**LABORATOIRE
ASTROPARTICULE & COSMOLOGIE**

- Home
- Laboratory
- High Energy Astrophysics
- Cosmology
- Gravitation
- Particles
- Theory
- Technical services
- Research and development
- Platforms & Technical facilities
- Associated entities
- Partnerships and communication
- PhD/Internships/Jobs

NEWS

The H.E.S.S. observatory detects the most energetic photons ever from a pulsar

Pulsars open up a new window for gravitational wave observations

AGENDA

October 2023

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

APC EN IMAGE

What is neutrino ...

Full screen here

MULTIMESSENGER PROBES OF SUPERHEAVY DARK MATTER DECAY AND ANNIHILATION
Séminaire Organisé par : Théorie
Tuesday, 10 October, 2023 - 14:00

ACTIVITY REPORT
2017-2021

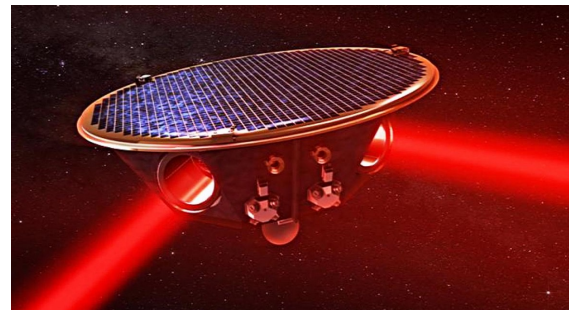
ASTROPARTICULE ET COSMOLOGIE

Gravitation

- Is gravitation described by general relativity or an alternative theory?
- Is general relativity valid in the strong field regime?
- How many black holes are there? What are their properties?
- How did they form?

→ Main IN2P3 lab to participate in ground and space projects
→ Instrument science, data analysis and astrophysics

- **LISA (Flagship APC mission)**
Integrated Team with CEA/Irfu on LISA
Optical Test Benches
Data Processing Center team
- **Virgo/ET**
 - Positioning in progress for 3rd generation on the ground
→ M. Barsuglia IN2P3 national coordinator.
→ E. Porter co-chair of ET Observational Board
 - Frequency dependent squeezing
 - Analysis and science team for upcoming Virgo data acquisition and LISA/ET preparation
- **PTA**
Complementary
Participation to recent spectacular results



Gravitation



Permanents

1. BABAK S. (DR2) LISA, VIRGO, PTA
2. BAGHI Q. (MCF) LISA
3. BARSUGLIA M. (DR1) VIRGO, ET
4. CHASSANDE-MOTTIN E. (DR1) VIRGO, ET
5. PLAGNOLE E. (Emeritus) LISA
6. PORTER E. (DR2) ET, VIRGO
7. HALLOIN H. (MCF) LISA
8. CAPOCASA E. (MCF) VIRGO, ET

- PETITEAU A. (CEA) 20%
- STEER D. (Prof) Theory
- CHATY S. (Prof) HEA

Post docs

1. FRANCHINI N. VIRGO, LISA
2. MANGIAGLI A. LISA
3. VIDAL L. Moon
4. ZHAO Yu. VIRGO, ET
5. DIAZ MENDES Wanda (sonification)

PhD Students

1. QUELQUEJAY H. (PTA, LISA)
2. DENG S. (LISA)
3. HARER Sh. (LISA)
4. PERRET J. (VIRGO, ET)
5. DING J. (VIRGO, ET)
6. VINCENT M. (LISA)

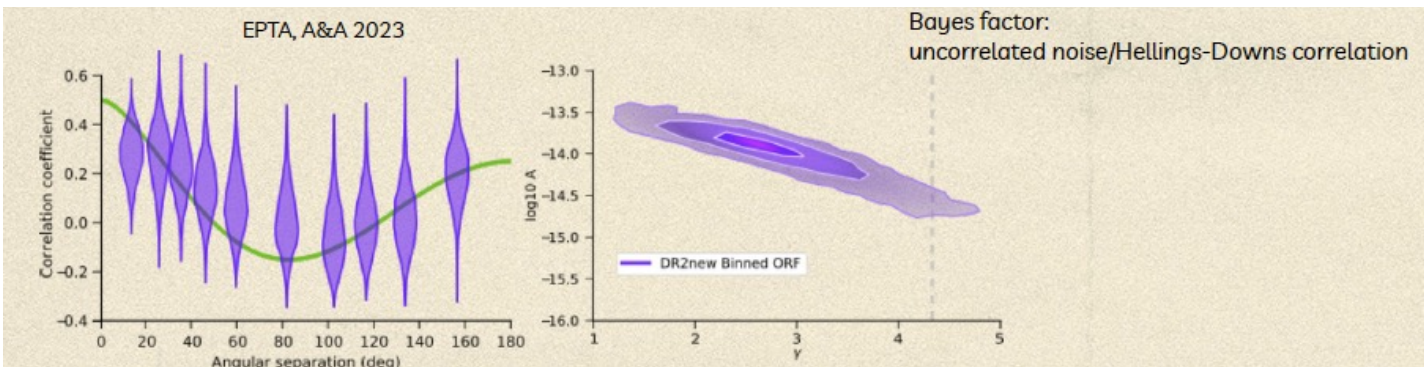


Gravitation – Highlight - PTA

The main idea behind pulsar timing array (PTA) is to use ultra-stable millisecond pulsars as beacons for detecting GW in the nano-Hz range 10^{-9} - 10^{-7} Hz

First evidence for GW signal in nHz band

- Result of EPTA are consistent with NanoGrav
- Statistical significance $\sim 3\sigma$
- Nature of the signal is yet to be determined
 - Could be stochastic GW
 - Not excluded an individual binary





Gravitation – Trajectory

Vision/Trajectory

Virgo:

- O4, O5. Interpretation of GW observations
- Testing GR with RD (overlap with LISA)
- Machine learning techniques in DA and model inference
- Commissioning and frequency dependent squeezing
- Contribution to Virgo_nEXT

ET: growing contribution

- Squeezing
- Optical design
- Governance and participation in the ET Blue Book (science objectives of ET)
- Mock data challenge

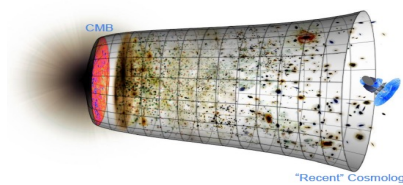
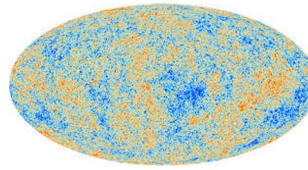
LISA:

- Beam simulator
- Building “Global fit” pipeline
- Interpretation of GW observations (inference of astro models, testing GR)
- Machine learning techniques in DA

PTA:

- Detection of GW
- Interpretation of GW signal

Cosmology



- What is the **origin and fate of the Universe**?
- Is the theory of cosmic **inflation** correct?
- What is **dark energy**?
- What is the identity of **dark matter**? ...

→ Reinforced with arrival of Galaxy team (S. Mei)
→ Instrument science, data analysis and software, data interpretation

- Wide-field galaxy surveys

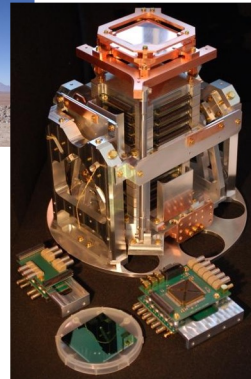
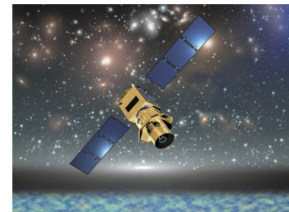
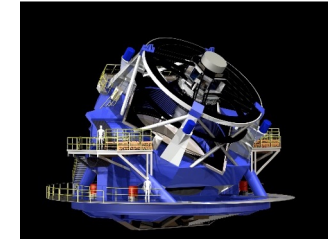
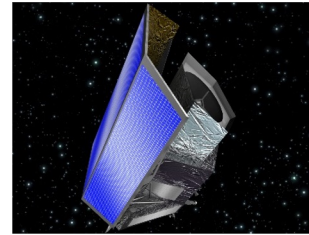
Euclid
LSST

- Cosmic micro-wave background

Simons Observatory } ERC Consolidator SciPol J. Errard
CMB-S4
QUBIC (JC Hamilton Spokesperson)
Litebird ?

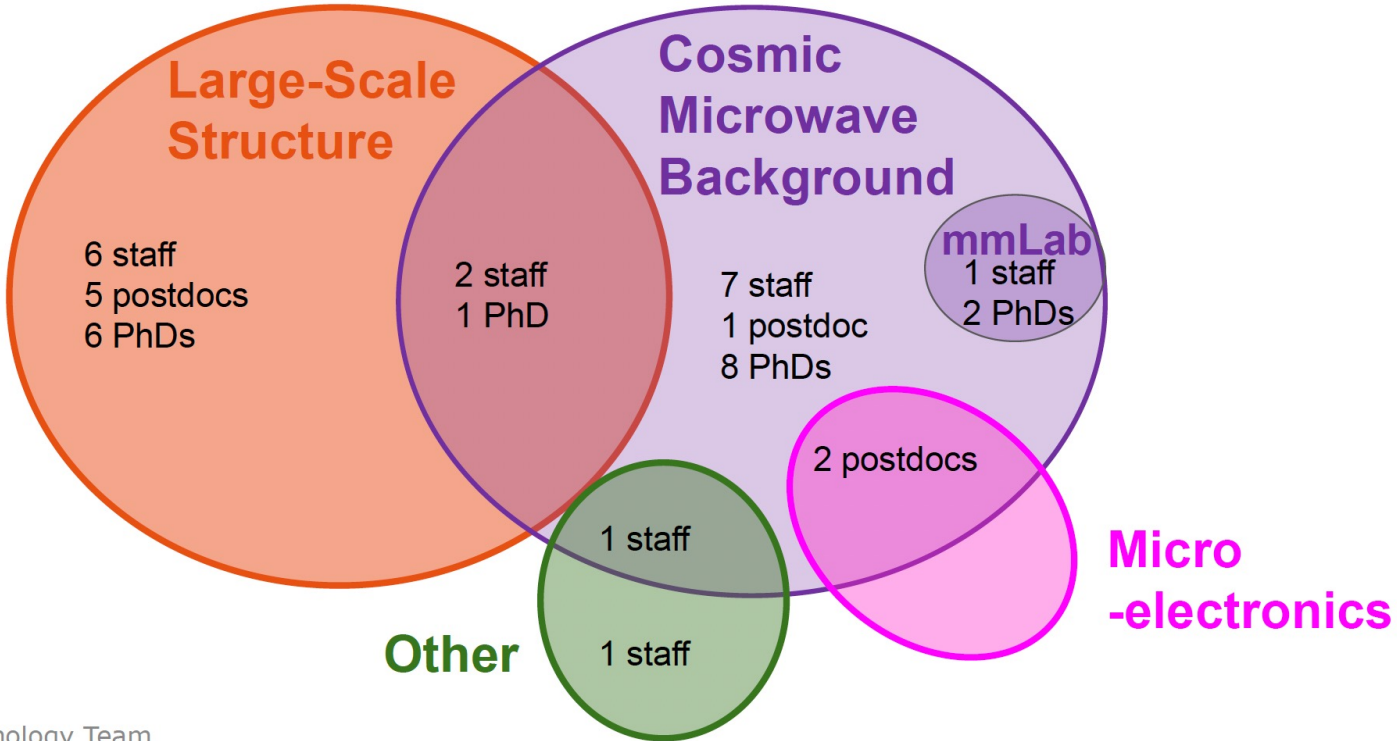
- Expertise & Techniques

CMB anisotropies (B-modes, SZ, etc.)
Lensing (CMB and galaxy)
Galaxy clusters and proto-clusters
Galaxy clustering
Cross-correlations (CMB x galaxies x other)





Cosmology – Members



Cosmology Team



Cosmology – Highlights

- **Euclid Mission**
 - Launch by SpaceX, 1 July 2023; arrived on orbit at L2; Commissioning/PV Phase finished end of November 2023
 - First science images press release, 7 November 2023
 - Commissioning issues essentially mitigated
- **Rubin/LSST**
 - Delivery of the filter exchanger; integration and tests of the filter exchange system at SLAC
 - ANR AstroDeep (PI Aubourg) started November 2019 (duration 5 years)
- **QUBIC**
 - Instrument on site, commissioning
 - Development of unique spectro-imaging capability
 - ANR QUBIC Science Operations - QUBIC-ON-SKY (PI Hamilton) started October 2022 (duration 48 months)

High-energy astrophysics [keV - EeV]

- What are the physical processes at work close to neutron stars and black holes?
- How do relativistic jets and winds really work?
- Where do ultrahigh energy cosmic rays come from? How are they accelerated? ...

→ Space and ground missions
 → All cosmic messengers (with GW)
 → Instrument science, data analysis and software, data interpretation

- Gamma- and X-rays

SVOM (to be launched)

Athena (Readout)

CTA (Proposal Handling Platform)

- High-Energy Neutrinos

Antares (A. Kouchner spokesperson)

KM3NeT/ARCA (M. Lindsay Clark Tech. Coord.)

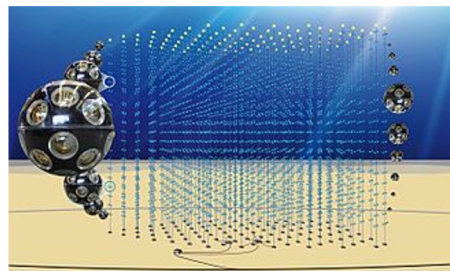
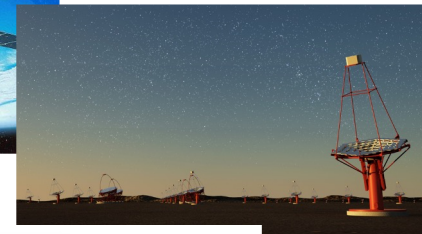
- Cosmic rays

JEM-EUSO (E. Parizot Spokesperson)

- Synergetic developments

Gammapy

Increased exchanges with Theory





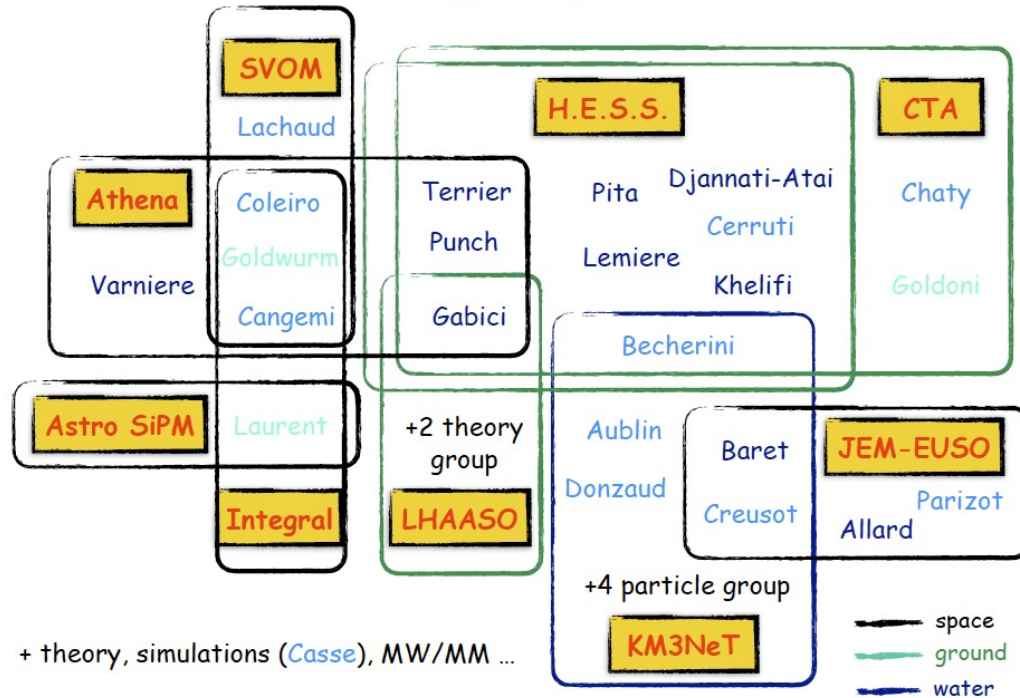
High-energy astrophysics [keV - EeV]

- ▶ 24 staff (11 Univ Paris Cite, 10 CNRS, 3 CEA) + 2 as secondary group:
 - ▶ Allard (CR), Aublin (Mdc), Baret (CR), Becherini (Pr), Cangemi (Mdc), Casse (Pr), Cerruti (Mdc), Chaty (Pr), Coleiro (Mdc), Creusot (Mdc), Djannati-Atai (DR), Donzaud (Mdc), Gabici (CR), Goldoni (CEA), Goldwurm (CEA), Khelifi (CR), Lachaud (Mdc), Laurent (CEA), Lemièrre (CR), Parizot (Pr), Pita (CR), Punch (CRHC), Terrier (DR), Varniere (CR) + (Kouchner and van Elewyck from particle group)
- ▶ 11 PhD students (2 defences in 2023, 2 in 2024, 4 in 2025, and 3 in 2026):
 - ▶ Arthur (Casse/Coleiro, 2023), Bao (Prèle, 2026), Cartraud (Kouchner/Aublin, 2025), Eff (Becherini, 2026) Foisseau (Goldwurm/Coleiro, 2025), Inventar (Gabici, 2026), Marchioro (Chaty/Chassand-Mottin, 2023), Oukacha (Becherini, 2025), Ravikularaman (Gabici/Goldwurm, 2024), Regeard (Djannati-Atai, 2025), Trofimov (Parizot/Klimov, cotutelle, 2024)
- ▶ 8 postdocs (arrival time: 3 in 2022, 5 in 2023):
 - ▶ Battisti (JEM-EUSO, Parizot, 07/23-06/24), Duverne (LabEx/CNES, Coleiro, 11/22-10/24), Feijen (TGIR CTA, Terrier/Khelifi, 05/23-04/26), Gonzalez (CNES, Goldwurm, 12/22-05/24), Goswami (Chaire diiP, Becherini, 06/23-12/24), Pallu (CNES postdoc, 11/2022-10/24), Peretti (ANR CRitiLISM, Gabici, 10/23-09/24), Sharma (Chaire diiP, Becherini, 06/23-12/24)

High-energy astrophysics [keV - EeV]



The group now



+ theory, simulations (*Casse*), MW/MM ...

+ support to future instruments (*SWG0*, *eASTROGAM*, *HEX-P*...)



High-energy astrophysics - Highlight

SVOM - Ground Segment under development :

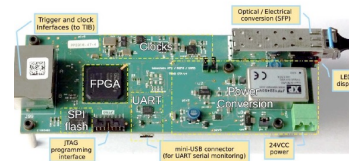
- Development, test and release of the ECLAIRs General Program pipeline:
 - Data Challenge 3 passed mid 2022 / ongoing process now
 - Novembre 2023: main modules are working (imaging + spectro).

CTA – Integration on Northern Site :

integration campaign of the prototype [Large-Sized Telescope](#) (LST) with the [Cherenkov Telescope Array Observatory](#) (CTAO) [Array Control and Data Acquisition System](#) (ACADA).

The interaction of the APC's time-stamping with the CTAO-ACADA's SWAT is one of the points being tested in this ACADA-LST integration campaign.

5 racks tested & delivered to LST



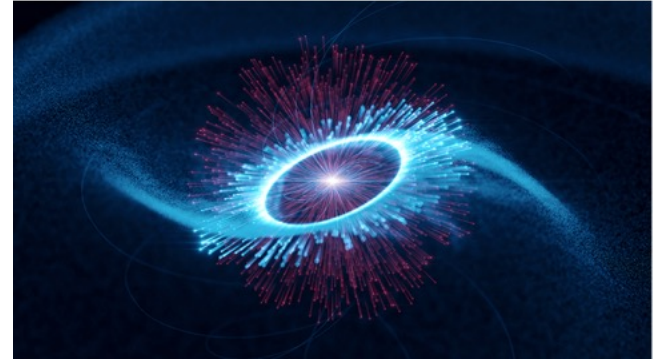
High-energy astrophysics - Highlight



H.E.S.S. – Vela Pulsar:

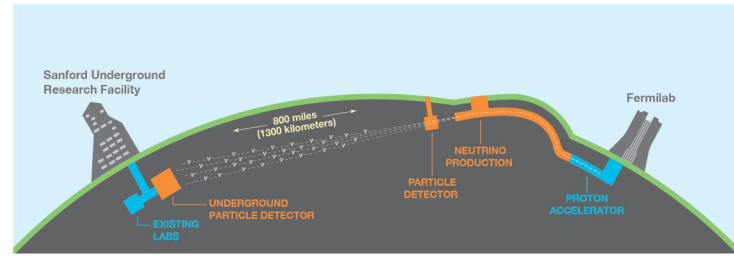
Discovery of a Radiation Component from the Vela Pulsar Reaching 20 Teraelectronvolts; The H.E.S.S. collaboration; *Nature Astronomy*, 2023; DOI: 10.1038/s41550-023-02052-3

« This is an order of magnitude larger than in the case of the Crab pulsar, the only other pulsar detected in the teraelectronvolt energy range. Our results challenge the state-of-the-art models for the high-energy emission of pulsars. »



Particles

- Neutrino masses and mixing
- Direct search for Dark Matter
- Higgs couplings



- Successful integration of new Higgs Team. New balance in the group, now as large as others
- Instrument science, data analysis and software, data interpretation

- Neutrino experiments

DUNE [Light readout part of French IR*]

KM3NeT/ORCA [co-convenership oscillation, Tech. Coord. CCSN v]

- Dark matter experiments

DarkSide

- New groups at IN2P3
- New ANR X-ART

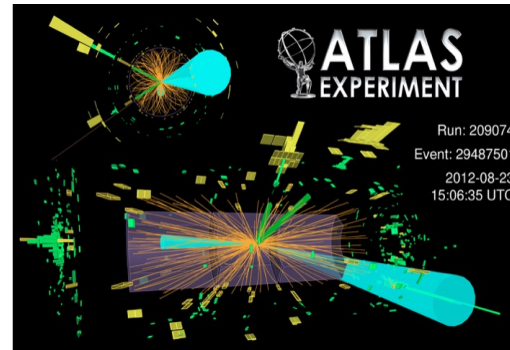
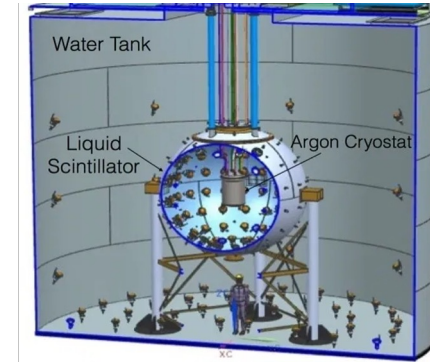
- Higgs Physics (+ 3 HDR !)

ATLAS and FCC

Brings new R&D

- Closer links to CERN

DUNE and ATLAS



Particles



- 18 permanents :

- Gregorio Bernardi, DR, HDR
- Marco Bomben, MdC, HDR
- Giovanni Marchiori, CR, HDR

ATLAS/FCC

- Sonia El Hedri, CR
- Antoine Kouchner, PR, HDR
- Benjamin Trocme, DR, HDR
- Véronique Van Elewyck, MdC

KM3NeT
ORCA

- Joao Coelho, CR

- Jaime Dawson, CR
- Camelia Mironov, DR, HDR
- Thomas Patzak, PR, HDR
- Sabrina Sacerdoti, CR

DUNE

- Alessandra Tonazzo, PR, HDR
- Davide Franco, DR, HDR

DarkSide

- Thierry Lasserre, CEA, HDR (Associé CEA)
- Michel Cribier, émérite
- François Vannucci, émérite
- Daniel Vignaud, émérite

- 12 doctorants :

- Ang Li
- Yulei Zhang - cotutelle SJTU Shanghai
- Qiuping Shen cotutelle SJTU Shanghai
- Keerthi Nakkalil
- Alexis Maloizel
- Meriem Bendahman cotutelle U. Rabat (Maroc)
- Santiago Peña Martínez
- Ariel Cohen
- Camille Sironneau
- I Cheong Hong
- Theo Hugues cotutelle CAMK (Pologne)
- Timothée Hessel

- 5 postdocs :

- Tong Li
- Isabel Goos
- Rebekah Pestes
- Henrique Viera Da Souza
- Pierre Granger

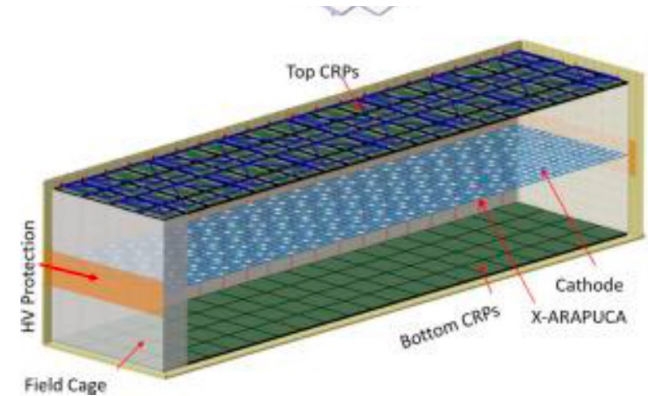
Particles – Recent Highlights - DUNE



Vertical Drift: 2021 - present

All-liquid Single-Phase charge read-out with desirable features from Dual Phase

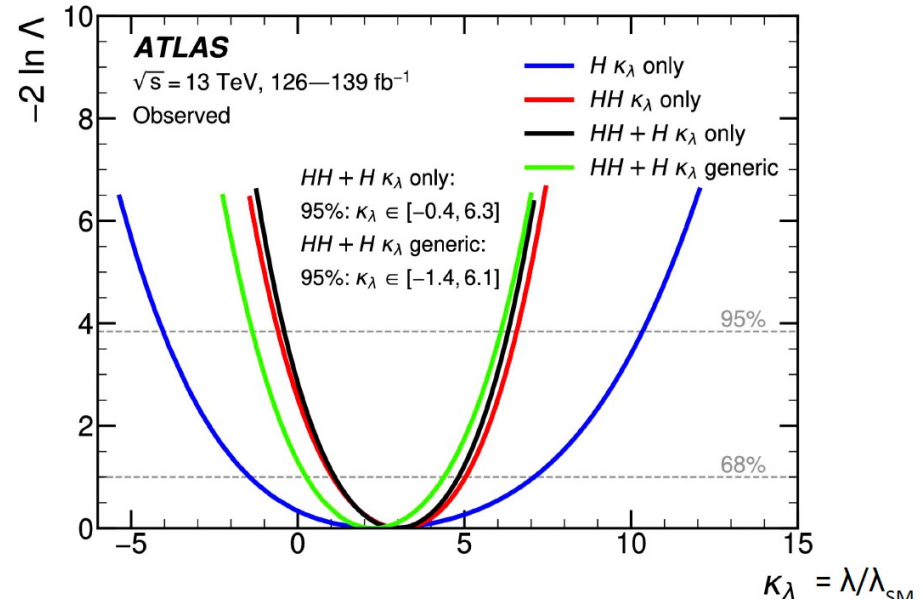
- APC team designed and proved concept for Signal-Over-Fiber - cryogenic analog optical transmitter and warm optical receiver
- Lead VD PhotoDetectionSystem cold box tests and ProtoDUNE-VD installation at CERN
- Contributed to DUNE Final Design Review (April 2023) and Vertical Drift TDR
- APC will produce SOF and receiver electronics for VD FD module (IR*)



Particles – Recent Highlights - ATLAS



- Tightest constraint on self-coupling so far from our publication
"Constraining the Higgs boson self-coupling from single- and double-Higgs production with the ATLAS detector using pp collisions at $\sqrt{s}=13$ TeV",
[Phys. Lett. B 843 \(2023\) 137745](#)"

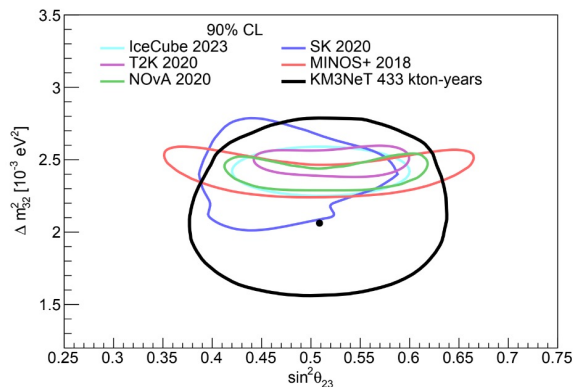


- New R&D (M. Bomben): on CMOS pixel detectors for future high energy physics trackers → improve spatial resolution as well as time resolution ($\sim 3 \mu\text{m}$ and ~ 5 ns). Ensure that the quantity of detector material remains low (thickness $\sim 50 \mu\text{m}$), and the power consumed limited (< 50 mW/cm²) for a data flow of 10-100 MHz/cm².



Particles – Recent Highlights - ORCA

KM3NeT/ORCA6 Preliminary



APC co-coordinated the development of the main oscillation analysis as well as 4 BSM searched within the KM3NeT Oscillation WG

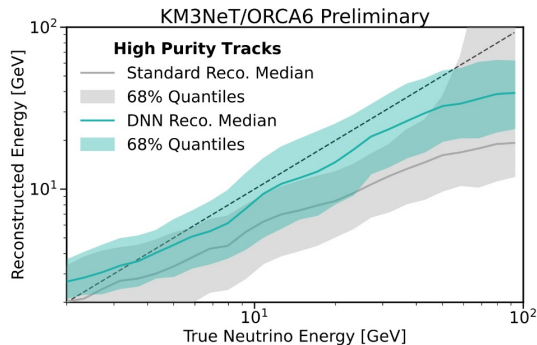
Proof of concept with 2% of nominal exposure

$$\Delta m_{31}^2 = 2.14^{+0.36}_{-0.25} \cdot 10^{-3} \text{eV}^2$$

$$\sin^2 \theta_{23} = 0.51^{+0.06}_{-0.07}$$

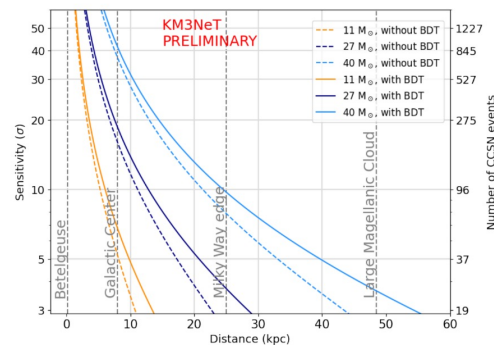
$$2 \log(\mathcal{L}_{NO}/\mathcal{L}_{IO}) = 0.9$$

Key player in developing machine-learning based improvements in event reconstruction for future analyses



Leading the development of improved supernova detection capabilities in KM3NeT

Increased horizon for supernova detection by 23% by implementing a machine-learning algorithm





Theory

Cosmology, gravity and string theory

- Inflation, dark energy and cosmological perturbations
- Topological defects
- General relativity, modified gravity theories
- Gravitational waves
- Duality and holography

Quantum Field Theory

- Non-abelian gauge theories and deconfinement
- QFT in curved geometries

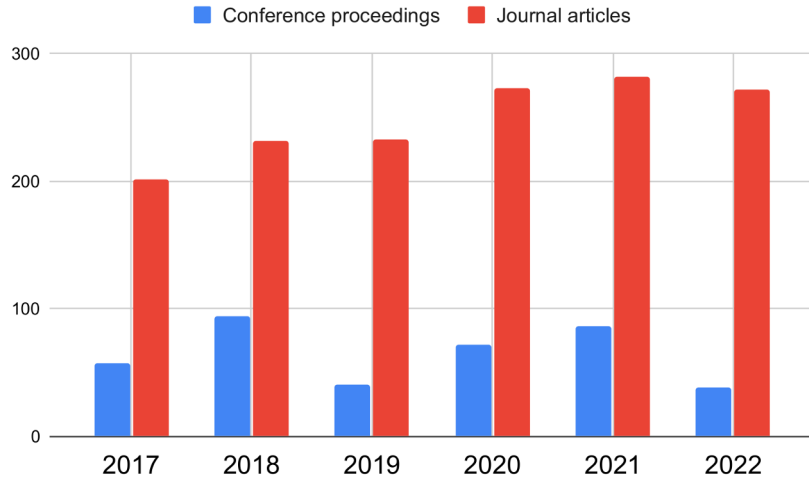
Astroparticle and neutrino physics

- Neutrino physics and astrophysics
- MHD and astroparticle propagation simulations
- Cosmic rays physics

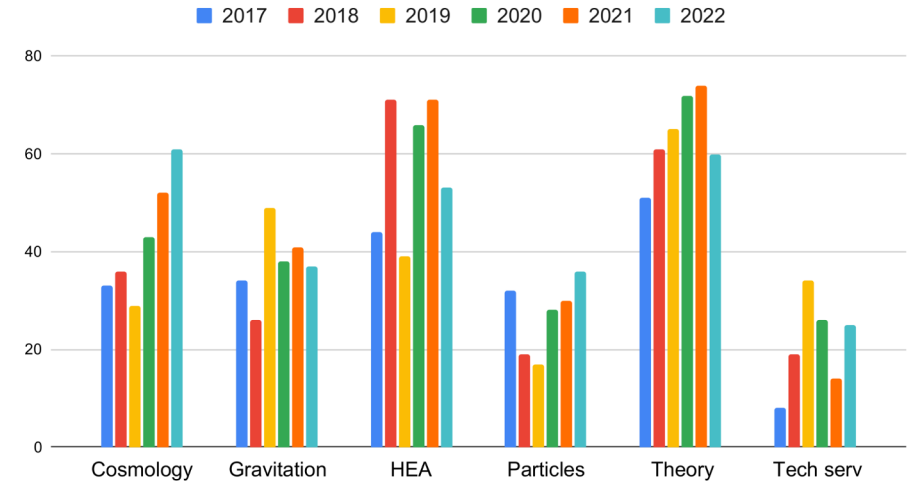
- **11 permanents :**
 - Huguet Eric. (MCF/ HDR)
 - Kiritsis Elias (DR),
 - Langlois David (DR),
 - Mourad Jihad (PR)
 - Neronov Andrii (PR)
 - Nitti Francesco (PR)
 - Santoni Luca (CR), ←
 - Semikoz Dmitri (DR),
 - Serreau Julien (MCF/ HDR)
 - Steer Danièle (PR) →
 - Volpe Cristina (DR)
- **3 Emeritus :**
 - Gazeau Jean-Piere PR
 - Lachièze-Rey Marc. DR
 - Renaud Jacques PR

+ 7 PhD students

Scientific Production



Peer-reviewed papers



About 250 refereed papers per year
Positive trends, consistent with the growth in scientific personnel

Scientific Production



Assessment on the scientific production of the unit

The unit has an excellent record for the quality of its scientific production. The unit's members have been producing original contribution both theoretically and methodologically. First and foremost, the unit has been visible for its pioneering role in promoting and developing the field of Multi-messenger Astrophysics. The unit has also developed and supported synergies with Earth Sciences through the UnivEarthS LabEx. In purely numerical terms the 150 papers and 330 Conference contributions are the measure of the success of the unit over the reference period.

Technical services



Directrice technique
Florence Ardellier-Desages
ardellier@apc.in2p3.fr
76968

→ Guillaume Prévôt

Electronique & Microélectronique
Jean Lesrel
lesrel@apc.in2p3.fr
76183

→ Merged

Informatique
Maude Lejeune
lejeune@apc.in2p3.fr
76093

Mécanique
Alain Givaudan
givaudan@apc.univ-paris7.fr
76981

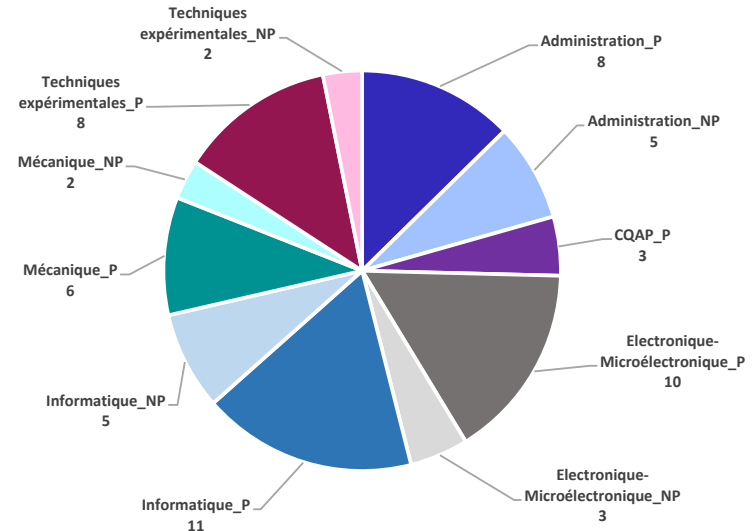
Techniques expérimentales
Guillaume Prévôt
prevot@apc.univ-paris7.fr
76942

→ Miles Lindsey Clark

Cellule de Suivi des Projets

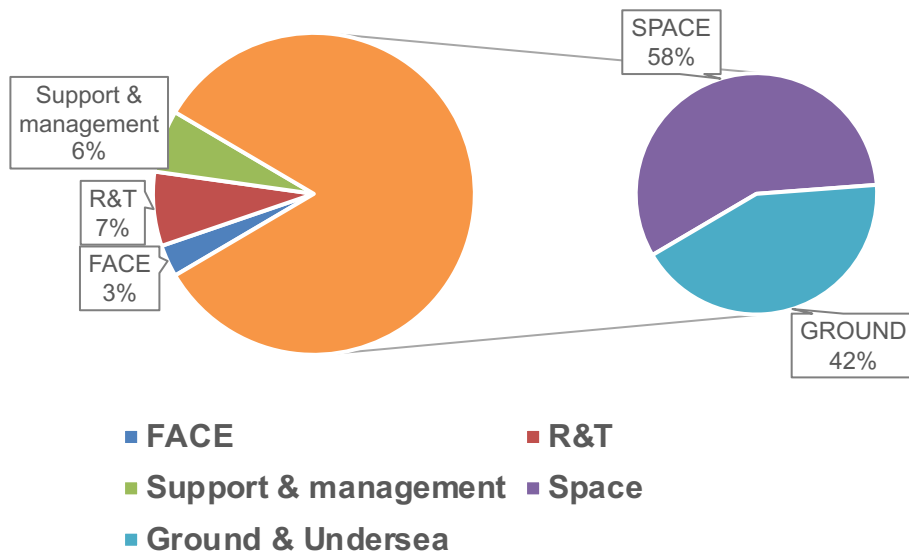
Cellule Qualité & Aide aux Projets
Corinne Juffroy
corinne.juffroy@apc.univ-paris7.fr
75384

Composition des services
(P:Permanents / NP:: Non Permanents)

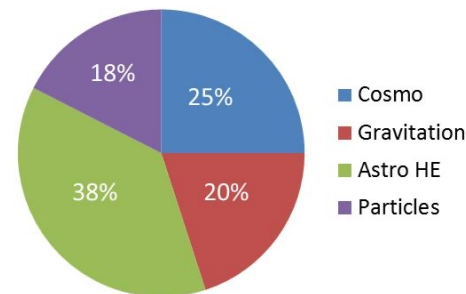




Technical services breakdown



TECHNICAL STAFF PROJECTS DISTRIBUTION 2021

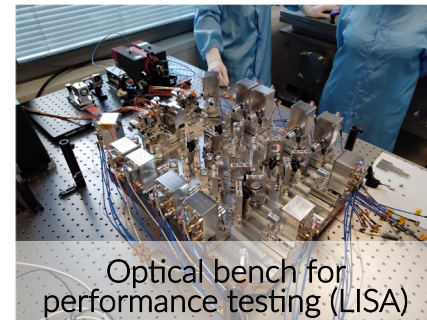
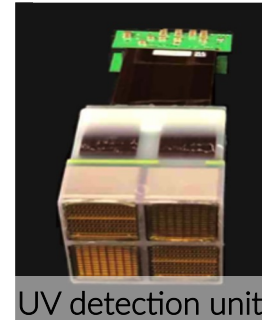


- R&T part is increasing
- Contribution to space programs always the majority of technical project activities

Focus on lab's know-how (1): technical “gems”



- Millimetric detection system with control of the whole cryogenic detection chains
- Sub-K cryogeny for cosmology instruments
- Photo-detection with new sensors (SiPM) for high-energy astrophysics and neutrino instruments
- High-precision interferometric metrology for gravitational-wave detectors
- High-performance computing and acceleration techniques related to machine learning



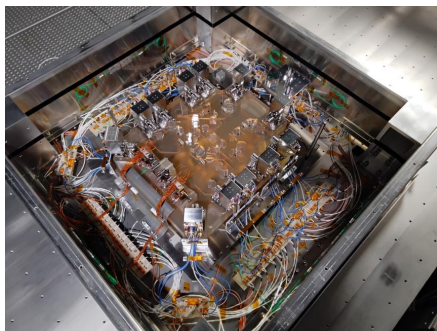
Focus on lab's know-how (2): technical platforms



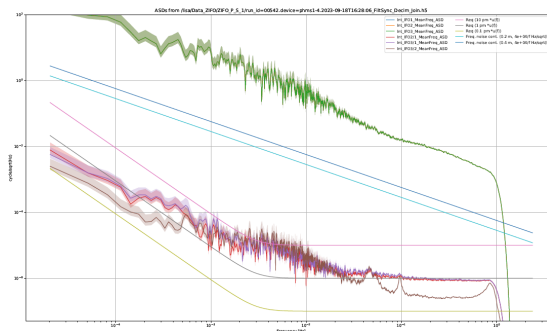
- ~7 Tflops high performance computing cluster (DANTE)
 - Multi-messenger online data analysis platform managed by FACe
 - Low noise facility
 - Thermally vacuum insulated chamber
 - Three clean rooms (Integration space, LISA and Virgo)
 - Photodetection and millimetric wavelengths labs
 - Sub-K cryogenic platform under development to characterize material at low temperatures → CRYOMAT (requires Assembly Hall refurbishing)
- 1 clean room
requires ISO 5 upgrade

Recent Technical Highlights -- Optics

LISA: High-Precision Metrology benches for validating LISA Instrument - Lead



ZIFO: successfull campaign (2023)



ZIFO: Performance measurements (2023)
soon → APC for extensive campaign

LISA: Distributed Data Processing Center: APC lead L2 → L3 pipeline (global-fit)

Virgo Adv+ : Optical design study to adapt all telescopes to change in beam size

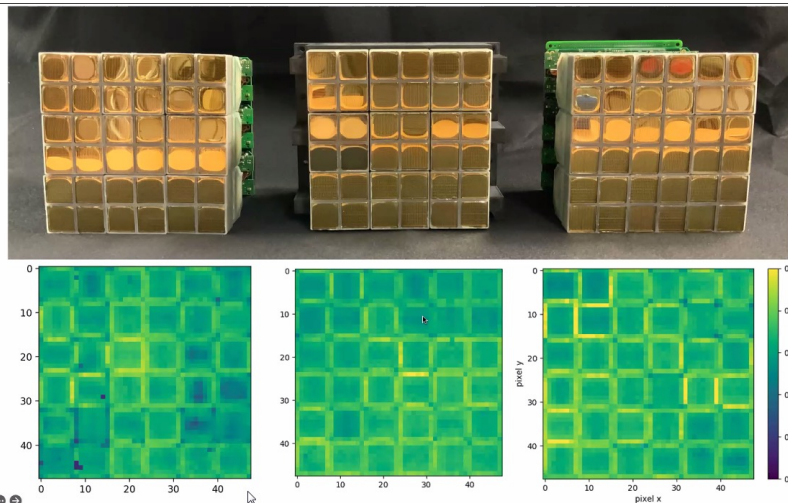
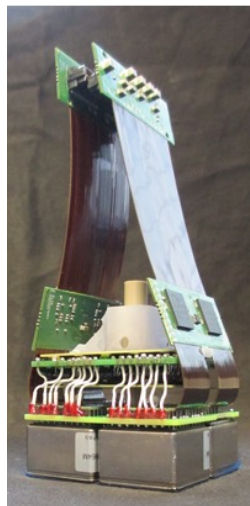
→ Design, simulations, manufacturing & set-up of telescope components 2022-2023

Recent Technical Highlights -- Photodection

JEM-EUSO – Balloon flight

40 Elementary Cells design → on super pressure balloon in 2023

- 256 pixels
- photon counting
(dynamic: from 1 to 100 pe)
- UV + visible
- Fast
(1 μ s GTU, 6ns resolution)
- compact, potted
(55 x 55 x 60 mm)
- low consumption
(< 500 mW)
- light
(255 g)
- Mature (on ISS)
- Replicable
- Calibrated



Design, integration, tests & calibration @ APC

Recent Technical Highlights -- Photodection

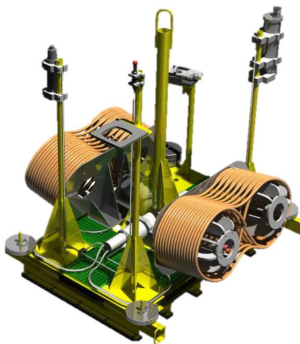
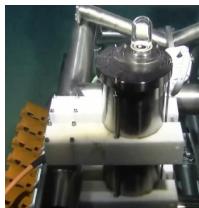


KM3NeT – Calibration Unit

Devices to ensure precise time (\sim ns) and position accuracy (\sim 15cm) of the detector in real time

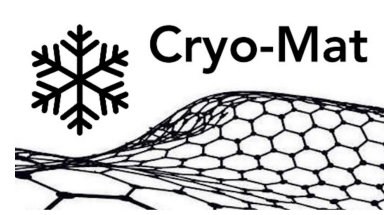


2 underwater lasers
AIVT & tests
delivered in 2022
(ARCA site)



Delivered in 2023
Ready to be immersed

Cryogenic Technical platform



→ New Strategic Development

Mechanical, thermal, and electrical characterization of materials at cryogenic temperatures.

→ new possibilities for both ground-based and space-based experiments,

→ strengthening the laboratory's connections with industrial partners.

Funding plan rather secured



Computing platform (FACe)



Data processing center for multi-messenger projects

- High Energy Astrophysics (SVOM, INTEGRAL, CTA)
- Gravitational waves (LISA)
- Cosmology (LSST, Euclid)

Support to the use of state-of-the-art data processing technics

- Deep learning and neural networks
- Virtualization, cloud computing and containers (project ComputeObs)



High performance computing (HPC)

- Co-management of the DANTE HPC machine with IPGP (~3,000 cores - 1.15 M€ Région IdF)
- Shared expertise with IPGP in the context of the LabeX UnivEarthS and spatial campus of the University

Focus on lab's know-how (3): space science and data science



→ Compliant with UPC Institutes

Space science : central focus and key priority

Involved in 7 space missions. Three major events during 2017-2022: LISA Pathfinder, mini-EUSO on ISS, Taranis

Develop the know-how and awareness on the specificities of engineering and experiment design for space missions

CubeSat project IGOSat (>300 students)
Concurrent Design Facility deployed



Data science increasingly important in cosmology and astroparticle physics

Strategic topic for development of research

Participation in local or national actions and initiatives allowing the circulation of expertise and know-how

Machine Learning network of IN2P3
DANTE computing platform
Success of the Gammapy library

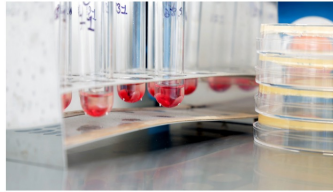


Université Paris Cité: new environment

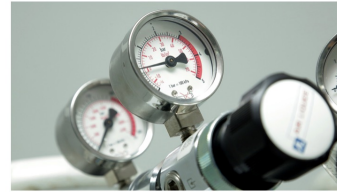


Universities Descartes, Diderot and IPGP merged on Jan/ 1st 2020

64 000 students
21 doctoral schools
7,250 researchers
4,500 admin & techn staff
118 research labs



Faculté de santé



Faculté des sciences



Faculté des sociétés et humanités

Faculty of Sciences includes:

chemistry, computer science, engineering, mathematics, physics, biomedical and life sciences

12 100 students, 3 450 staff, 50 laboratories, 19 science and technology platforms

University Institute of Technology and an Engineering school



Insertion in Université Paris Cité



LabEx
UnivEarthS



Doctoral School



F. Casse
A. Tonazzo



DiiP & PSUP

Graduate School



E. Chassande-Mottin (diiP)
→Y. Becherini

A. Neronov (PSUPC)
→S. Mei

Inter-faculty institutes



Earth, Planet, Universe
S. Mei

Proposal for a new M2 « universe »

University
Governance

→Th. Patzak
former vice-dean research
now Vice President « digital »

→A. Kouchner
Vice President International Relations

Alliance Circle U.



(Pisa, Humboldt, UCLouvain, King's...)

Graduate School EPU – Master Universe



Le Pôle Spatial Université Paris



Data Intelligence Institute of Paris



Circle U.
European University Alliance

INTERNATIONAL MASTER 2 UNIVERSE

UNIVERSE, MULTI-MESSENGERS, GRAVITATION

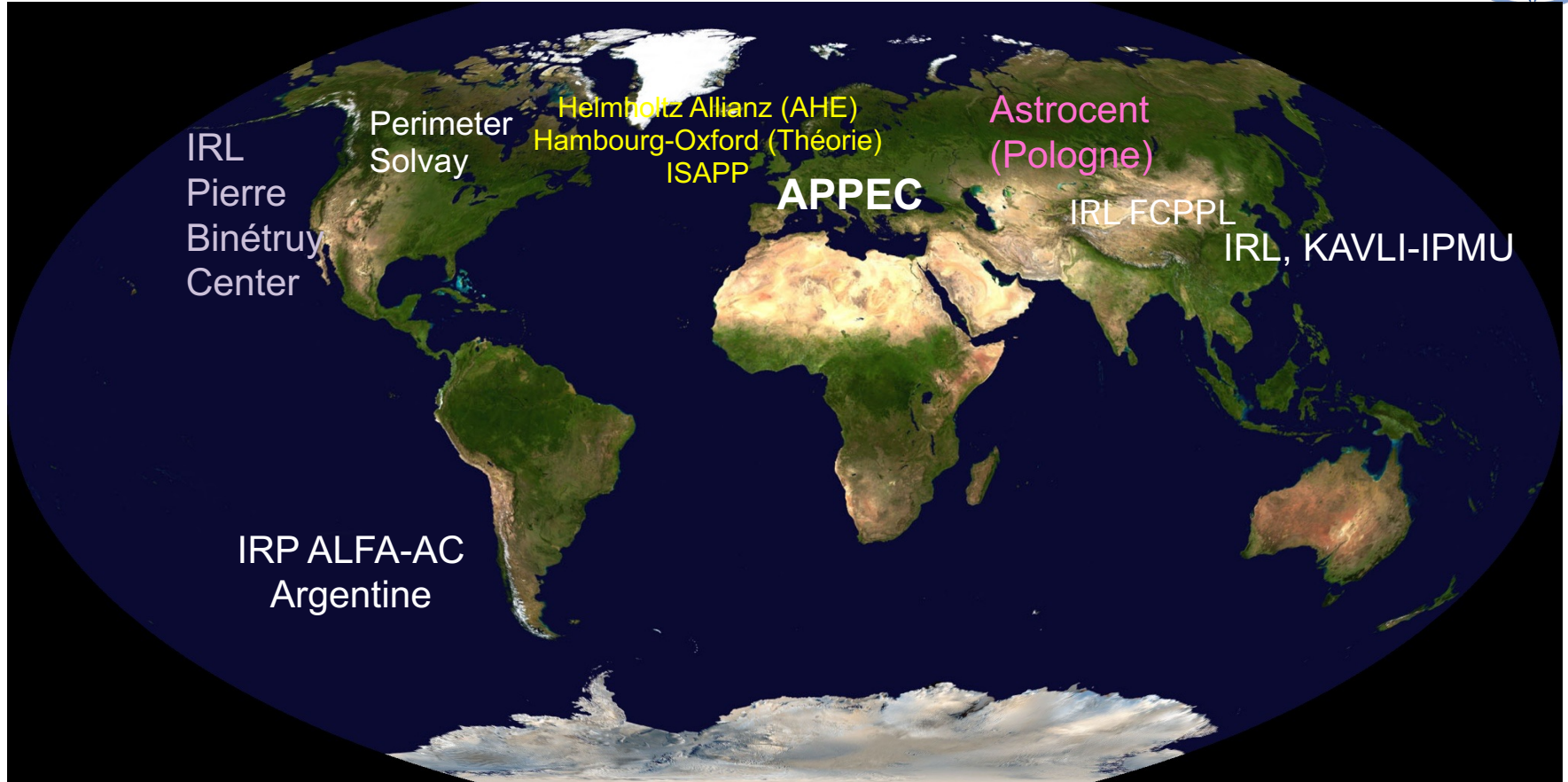
DATA SCIENCE & INSTRUMENTATION



Proposition of an Astroparticle Master within the Graduate school EPU after ~1 year of weekly meetings of working groups and monthly discussions within the laboratory (April 2022- March 2023). Large laboratory participation : ~50 researchers and engineers

- APC Large expertise and visibility in Multimessenger Science, Instrumentation and Artificial Intelligence that is not transmitted in current Master programs
- More autonomy and visibility for our University
- Links with international partners
- Complementarity to the current masters in which we teach

International Positioning



APPEC - Organisation



APPEC → **AstroParticle Physics European Consortium**
<https://www.appec.org/>

Founded in 2012 and based on a Memorandum of Understanding (to be renewed in 2024)

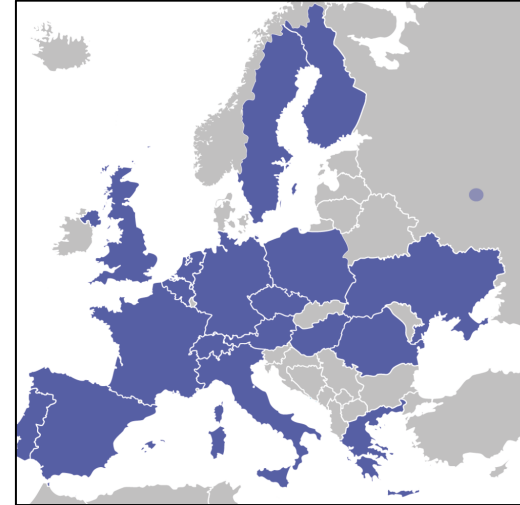
Promotes the cooperation and the coordination of astroparticle physics in Europe and formulates and updates the European astroparticle physics strategy

3 bodies (General Assembly; Joint Secretariat; Scientific Advisory Committee)

APPEC in 2023:

18 member countries (+1 suspended) and 1 candidate member (Denmark), 22 funding agencies, 6 observers

A budget of ~70k€/year (contributions from all members)



APPEC & APC

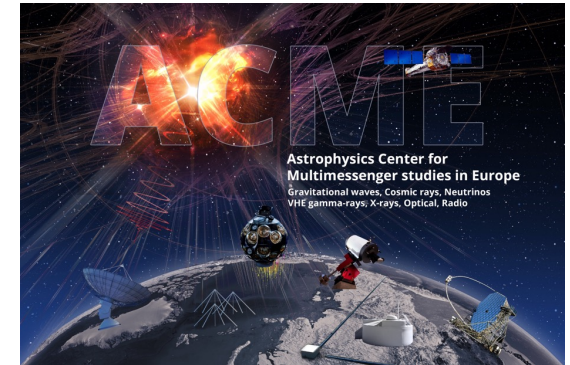


APC laboratory as functional center

The APPEC Joint Secretariat Strategic Actions and Interdisciplinarity Center is jointly hosted by CNRS/IN2P3 and CEA at APC.

APPEC involvement at APC: members

- Antoine Kouchner - APPEC General Assembly vice-chair
- Julie Epas – Functional center project manager (IN2P3 CDD since 1st of June 2021)
- Sotiris Loucatos, Ken Ganga – members of the Scientific Advisory Committee
- David Langlois – member until last year of member of EuCAPT Steering Committee, an entity that emanates from APPEC



APPEC involvement at APC: highlights

- Answer to the Horizon Europe 2023 Infra serv call – ACME project
- Contribution to the strategy update
- Organization of a first from a series Multi-messenger data analysis workshop
- Organizing committee for the Town meetings
- Various working groups
- Contribution to interdisciplinary projects (e.g. Horizon Europe geoscience/astroparticle proposal)

Paris Center for Cosmological Physics



- Founded in 2010 by G.Smoot and P. Binetruy
- Conceived as an APC structure for research, education, scientific exchanges mainly in cosmology
- In the last 5 years focus evolved to outreach, education, science & society, diversity. Outreach and education covering all the APC fields
- M. Barsuglia (director since 2018), G. Vannoni (project manager since 2019) + APC staff for individual actions + doc/post-doc recruited on PCCP/RFPU funds
- Several collaborations with local – national – international partners and institutions.
- Link with endowment fund RFPU - Université Paris Cité
- Funds from Labex, UPC, Région IdF, MITI CNRS, EU and private donors





Trajectory

- The general strategy for the research follows 3 axes:
 1. A proactive and dynamic positioning on the technical opportunities offered by new projects ("Cellule de Suivi de Projets") based R&D program and technical gems.
 2. The scientific exploitation of the projects in which APC has invested much effort in the past decade. Specifically: SVOM, Euclid, LSST, advanced Virgo+ and KM3NeT projects soon enter into exploitation will provide exciting new observations.
 3. The development of new original ideas, experiments and approaches (e.g.: the COrE+ project, Dirac-Milne cosmology, the detection of gravitational wave on the Moon, the proposal of the European consortium ACME)
- In line with national prospective exercises (IN2P3, INSU, CNES...) to which the laboratory has actively participated

Project Timeline

5→2 Preparatory phase
 11→5 Development phase
 Major milestone
3→9 Exploitation



		Experiments / Projects	Tech WP APC	2017	2018	2019	2020	2021	2022		2023	2024	2025	2026	2027
Cosmology	Euclid	Ground segment									Launch				
	QUBIC	Demonstrator						Delivery on site							
	Rubin Observatory	Charger fillers CC					Filters charger CC delivery								
	POLARBEAR														
	Simons Array														
	Simons Observatory	Drone calibration									First light				
	LiteBIRD	Thermal architecture													
	CMB-S4	Warm readout Data management													
Gravitation	Advanced Virgo+	Mode matching tel & commissioning										O4			O5
	Einstein Telescope														
	LISA	Instrument & DDPC									USA Adoption				
	PTA														
High Energy Astronomy	Athena	XIFU-WFEE													
	CTA	PHP - GammaRay - Ticks													
	H.E.S.S.														
	EUSO	Detection Unit	SPB1 Flight			Mini EUSO ISS Flight					SPB2 Flight	Scope to be defined			
	INTEGRAL														
	TARANIS	XGRE					Launch failed								
	SVOM	ECLAIRs mask & ground segment						Coded mask delivery			Launch				
	Antares	Scientific Lead							Dismantling						
Particles	KM3NeT	Technical coordination calibration Unit													
	BOREXINO														
	JUNO														
	Double-Chooz	Scientific Lead				Dismantling start									
	DUNE	Light Readout System													
	DarkSide														
	ATLAS	Inner Tracker Detector													
	FCC														

Thank you for your attention

Long live Astrocent and our friendly collaboration