

Extreme Phenomena and Multi-messengers

A Thematic Action of the french National Centre for
Scientific Research (CNRS)

Pierre-Olivier Petrucci (coordinator)
IPAG, Grenoble, France



<https://atpem.cnrs.fr/>



Research Staff Categories

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Research Organisms

- CNRS (French National Centre for Scientific Research)
- ONERA (French Aerospace Lab)
- INSERM (French National Institute of Health and Medical Research)
- INRAE (National Research Institute for Agriculture, Food and Environment)
- ...
- CEA (French Alternative Energies and Atomic Energy Commission)
- CNES (French National Centre for Space Studies)

⇒ **No teaching duties**

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- Grandes Ecoles, Engineer schools

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Astronomers

- Observatories (groups of laboratories)

⇒ **Teaching and Observation Services duties**

Research Staff Categories

Example: High Energy group at IPAG laboratory
(Institute of Planetology and Astrophysics of Grenoble)



IPAG is part of the of the Grenoble **observatory** (OSUG) grouping a total of 8 research laboratories/units (Earth science, Alps ecology, Mountain dynamics, etc...)

Observation Services

Observation Services

OASU	AA-ANO1	SO1_CentresTraitement&Données	IVS (International VLBI Service for Geodesy and Astrometry)
Obs. Paris	AA-ANO1	SO1_MoyensInstrumentauxExpérimentaux	PHARAO
OCA	AA-ANO1	SO1_MoyensInstrumentauxExpérimentaux	Stations de télémétrie laser
Obs. Paris	AA-ANO1, AA-ANO4		Gaia
OCA	AA-ANO2	SO2_InstrumentationSol	CHARA
PYTHEAS	AA-ANO2	SO2_InstrumentationSol	CONCERTO
Obs. Paris	AA-ANO2	SO2_InstrumentationSol	CTA
OSUL	AA-ANO2	SO2_InstrumentationSol	ELT / HARMONI
Obs. Paris	AA-ANO2	SO2_InstrumentationSol	ELT / MICADO-MORFEO
PYTHEAS	AA-ANO2	SO2_InstrumentationSol	ELT / MOSAIC
OSUL	AA-ANO2	SO2_InstrumentationSol	VISTA / 4MOST
Obs. Paris	AA-ANO2	SO2_InstrumentationSol	VLT / MOONS

Observation Services

OASU AA-ANO1 SO1_CentresTraitement&Données IVS (International VLBI Service for Geodesy and

Obs. Paris

OCA

Obs. Paris

OCA

PYTHEAS

Obs. Paris

OSUL

Obs. Paris

PYTHEAS

OSUL

Obs. Paris

AA-ANO2 SO2_InstrumentationSol VLT / MOONS

 **CTA - Andreas ZECH**  Imprimer

Type

AA-ANO2

Coordination

Obs. Paris Fabienne CASOLI Andreas.Zech@observatoiredeparis.psl.eu

Partenaires

OSUG Nathalie COTTE pierre-olivier.petrucci@univ-grenoble-alpes.fr

OMP Mehrez ZRIBI jurgen.knodlseder@irap.omp.eu

Description

Le Cherenkov Telescope Array (CTA) est un projet d'observatoire sol en astronomie gamma des très hautes énergies, couvrant une gamme allant de 20 GeV à environ 300 TeV. CTA sondera l'origine des rayons cosmiques via l'étude des accélérateurs galactiques

Observation Services

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AA-ANO1

SO1_CentresTraitement&Données

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Obs. Paris

OCA

Obs. Paris

OCA

PYTHEAS

Obs. Paris

OSUL

Obs. Paris

PYTHEAS

OSUL

Obs. Paris

AA-ANO2

SO2_InstrumentationSol

VLT / MOONS

An astronomer recruited on the **CTA Observation Service** should participate to, at least one of the following tasks (for the french A&A community):

- **task 1:** participate to the development of 4-meter diameter SST telescopes
- **task 2:** participate to development of the focal plane of NectarCAM cameras and software links with the CTA pipeline (IPAG, IRAP),
- **task 3:** participate to the development of the data dissemination system and the gammapy scientific data analysis software suite
- **task 4:** participate to the use of CTA for intensity interferometry

Note: you can work on these tasks without being recruited as « astronomer »

Centre National de la Recherche Scientifique

Organisation

Presidence

CNRS Scientific
Office

CNRS Ressources
Office

CNRS Innovation
Office

Centre National de la Recherche Scientifique Organisation

Presidence

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Office

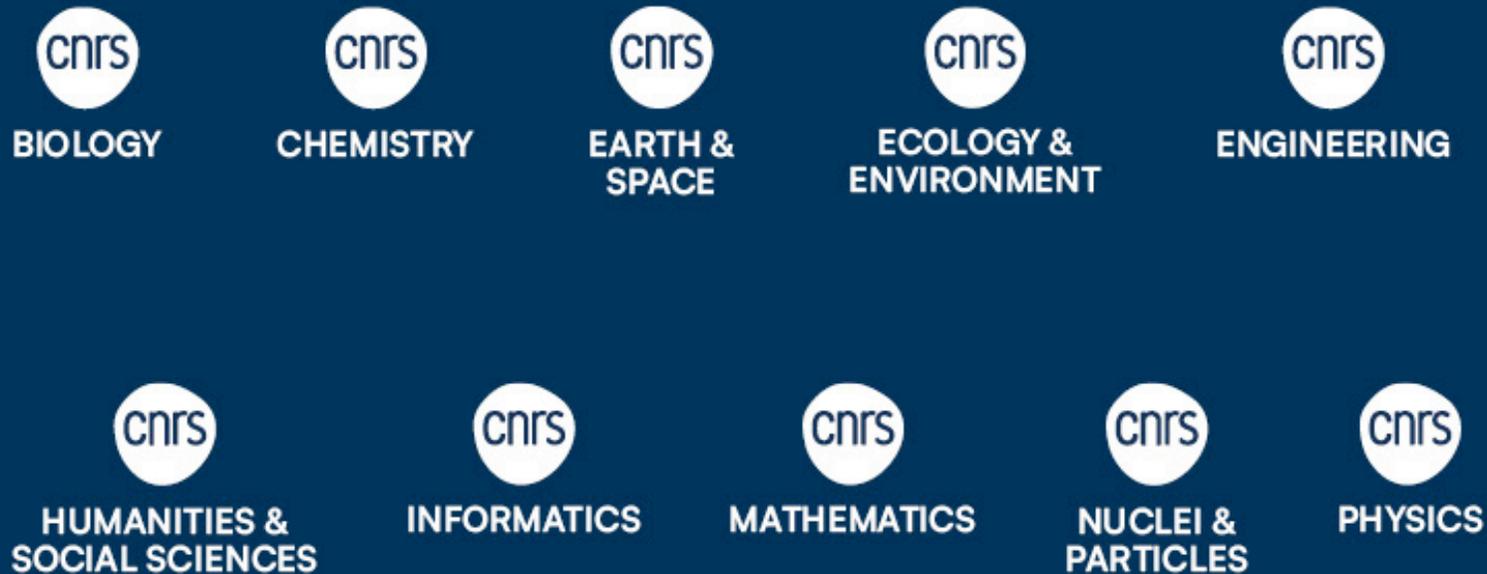
CNRS Ressources
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10 Institutes

Centre National de la Recherche Scientifique Organisation

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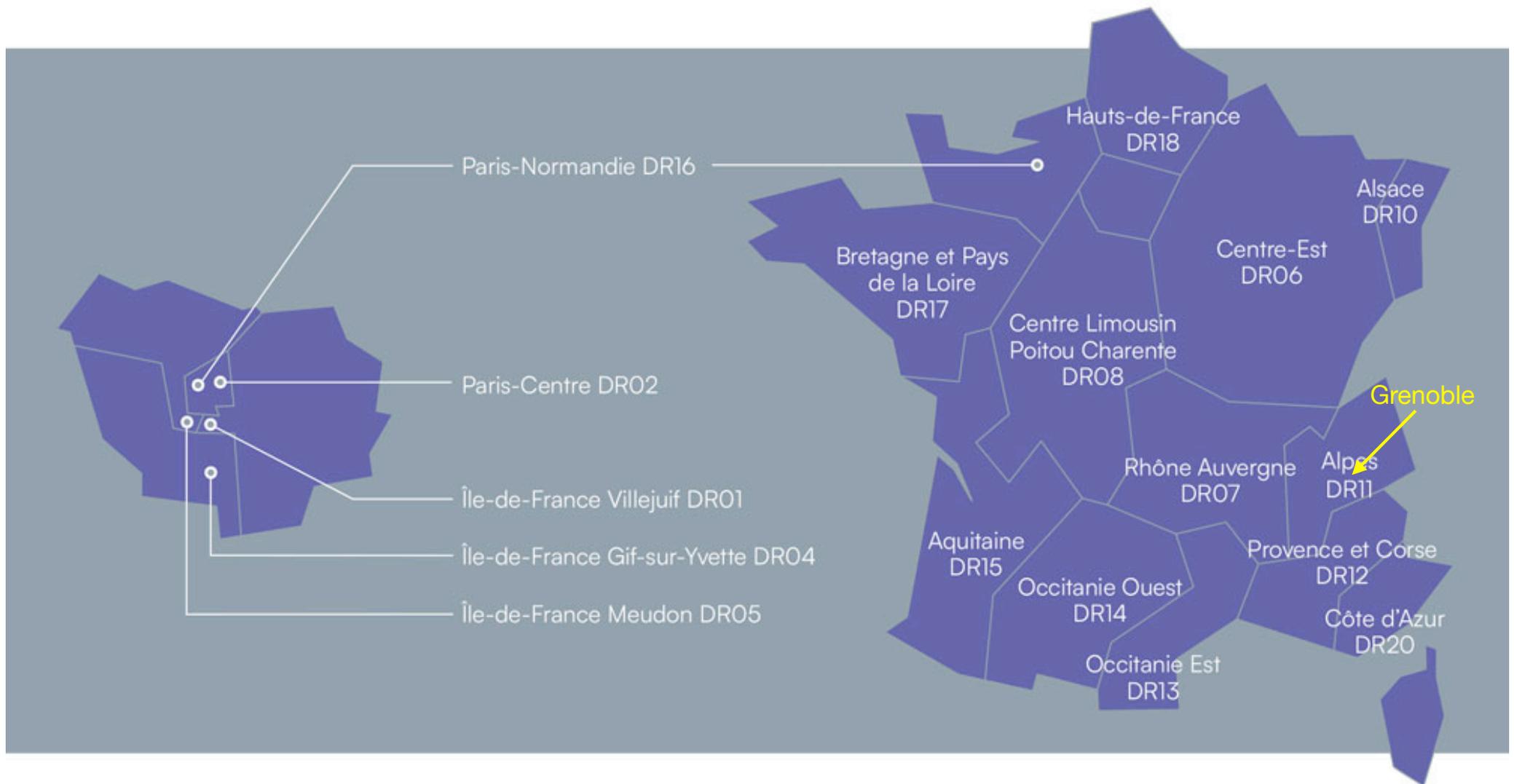
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17 Regional delegations

Centre National de la Recherche Scientifique Organisation



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Organisation

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17 Regional delegations

1100 Research Laboratories (in France and abroad)
34,700 employees, including 29,400 scientists

Comité National de la Recherche Scientifique

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- **Scientific policy** of the CNRS (Scientific Board, Institute Scientific Boards,...)
- **Monitor** research unit activity.
- **Recruitment of** researchers and outlook their careers

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➔ Specialized sections in each discipline, and Interdisciplinary Commissions (43 sections)

Section	Title	Main institute(s)
<u>1</u>	Mathematics and interactions of mathematics	MATHEMATICS
<u>2</u>	Informatics: foundations of computer science, computation, algorithms, data and knowledge representation, information processing	INFORMATICS
<u>3</u>	Informatics: signals, images, languages, automatic control, robotics, interactions, hardware-software integrated systems	INFORMATICS
⇒ ⇒ <u>4</u>	Interactions, particles, nuclei, from the laboratory to the cosmos	NUCLEI & PARTICLES
<u>5</u>	Theoretical physics : methods, models and applications	PHYSICS
<u>6</u>	Physics of atoms, molecules and plasmas. Optics and lasers	PHYSICS
<u>7</u>	Physics of materials: structure and dynamics	PHYSICS
<u>8</u>	Physics of complex and living matter	PHYSICS
<u>9</u>	Condensed matter physics: electronic and quantum properties	PHYSICS
<u>10</u>	Micro- and nanotechnologies, micro- and nanosystems, photonics, electronics, electromagnetism, electrical energy	ENGINEERING
<u>11</u>	Solid mechanics. Materials and structurals. Biomechanics. Acoustics.	ENGINEERING
<u>12</u>	Fluid and reactive media: transport, transfers, transformation processes	ENGINEERING
<u>13</u>	Soft matter chemistry and physical chemistry	CHEMISTRY
<u>14</u>	Molecular architectures: synthesis, mechanisms and properties	CHEMISTRY
<u>15</u>	Physical, theoretical and analytical chemistry	CHEMISTRY
<u>16</u>	Coordination chemistry, catalysis and processes, interfaces	CHEMISTRY
<u>17</u>	Chemistry of materials, nanomaterials and processing	CHEMISTRY
<u>18</u>	Chemistry and living organisms	CHEMISTRY
⇒ <u>19</u>	Astrophysics	EARTH & SPACE
<u>20</u>	Solid Earth and terrestrial planets: structure, history and models	EARTH & SPACE
<u>21</u>	Earth system: outer enveloppes	EARTH & SPACE
<u>22</u>	Molecular and structural biology, biochemistry	BIOLOGY
<u>23</u>	Organization, expression, and evolution of genomes	BIOLOGY
<u>24</u>	Cell biology, development, evolution-development	BIOLOGY

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On average, 4-6 positions in A&A every year at CNRS (this year 220 candidates)
 (note: ~1 position at University/year and 4-6 astronomer positions)

EARTH & SPACE

Director: Nicolas Arnaud

Organised in Domains
(new organisation since 2 years)

Innovative Instrumentation

Numerical Science

**Astronomy &
Astrophysics**

Solid Earth

**Ocean
Atmosphere**

**Continental
surfaces and
interfaces**

Planets

Spatial Telemetry



Deputy Scientific Director: Celine Reylé

Scientific Delegates

C. FERRARI (SKA/LOFAR)	A. MARCHAUDON (Observation services)	K. PERRAUT (ESO)	O. VENOT (planeto/exoplanet)	S. VERGANI (High Energy)	P. STEE (Stellar astrophysics)
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Thematic Actions

**Extreme Phenomena
and Multimessengers
(ATPEM)**

Galaxies and
Cosmology
(ATCG)

Gravitation, References,
Astronomy, Metrology
(ATGRAM)

Stellar Physics
(ATPS)

Sun Earth
(ATST)

Exosystèmes
(ATEXOS)

Physics and Chemistry
of Interstellar Medium
(ATPCMI)

AT PEM

Action **T**hématique **P**hénomènes **E**xtrêmes et **M**ultimessenger
Extreme Phenomena and Multi-messenger Thematic Action

Thematics

- Physical processes in the environment of compact objects throughout the Universe
- Origin, production, and transport of high-energy particles (γ rays, neutrinos, and cosmic rays)
- Origin, multi-messenger emission, and duration/periodicity of transient phenomena
- Exotic physics that can be tested using astrophysical data

Survey

- Results shown in the following slides are largely based on [survey conducted in spring 2023](#)
- Around 100 people responded to the survey (out of the ~250 people on the list in 2023).
- Survey dominated (82%) by permanent staff, even though they represent only 66% of the community
 - ➔ **under-representation of non-permanents and emeriti**

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Extreme Phenomena and Multi-messenger Thematic Action

People

Community of ~300
researchers



CNRS: ~65%

CEA: ~15%

University: ~20%

A few astronomers

Permanent position: 70%

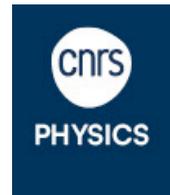
PhD/Postdoc: 30%

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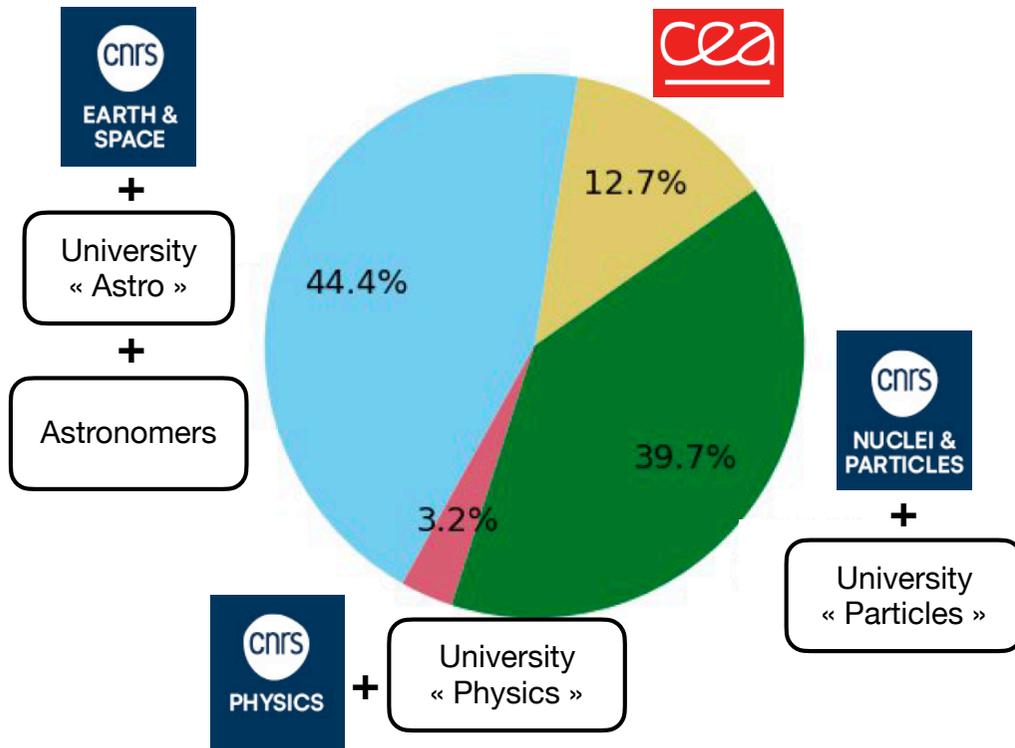
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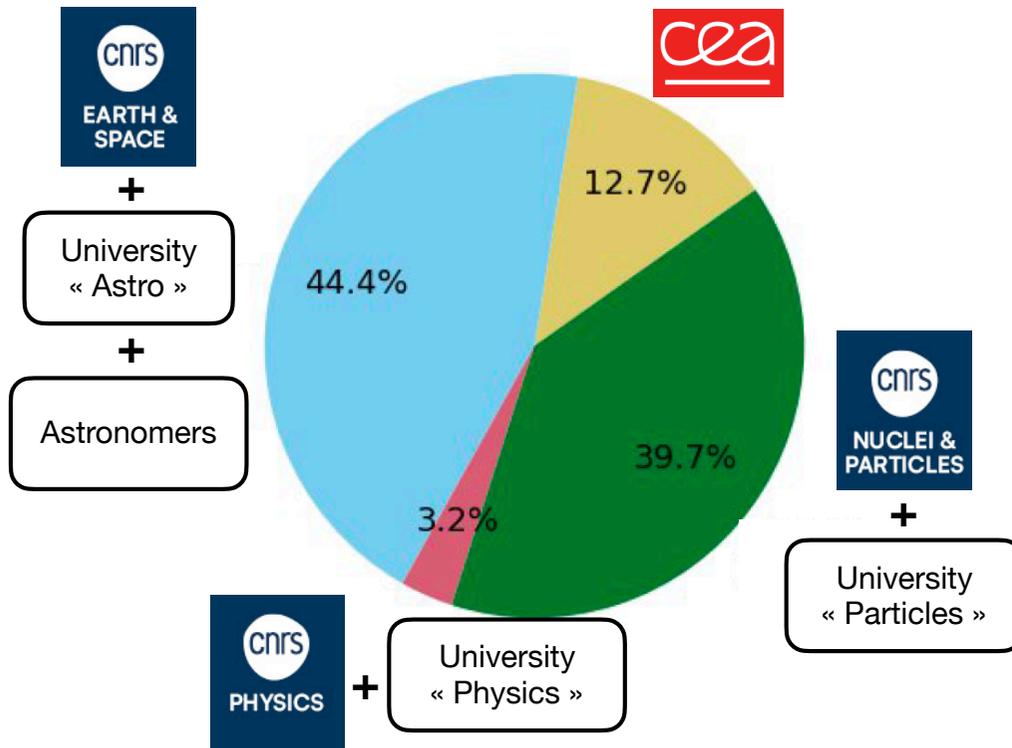
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Coordinator: P.O. Petrucci

EARTH & SPACE

Co-coordinator: T. Pradier

NUCLEI & PARTICLES

**Scientific Committee limited to 12 persons
(thematic, geographic, gender balance)**

All nominated!

AT PEM Community

Employers and demographics

By gender

Représentation de genre de la communauté
(basée sur les patronymes de la liste de diffusion PNHE)

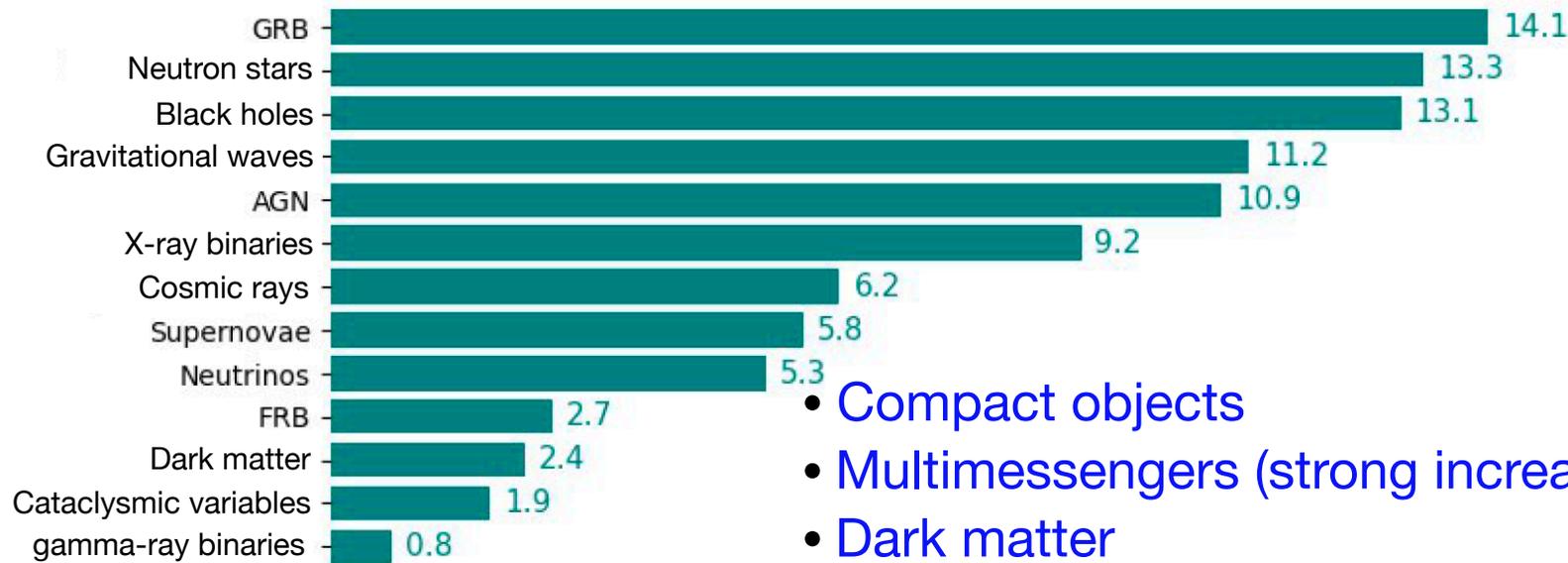


- The proportion of women declines as their career progresses
- ➔ 37% in thesis, 24% in postdoc, 22% in permanent position and 9% in emeritus

AT PEM Community

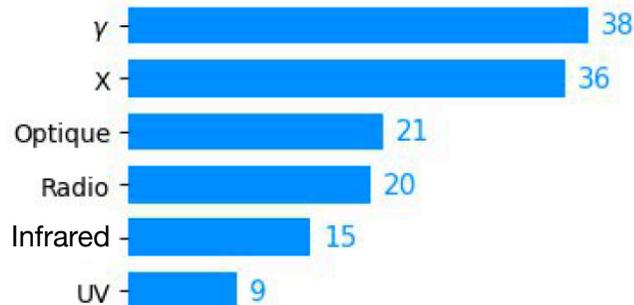
Study subjects, observed wavelengths and methodologies

FTE per scientific subject

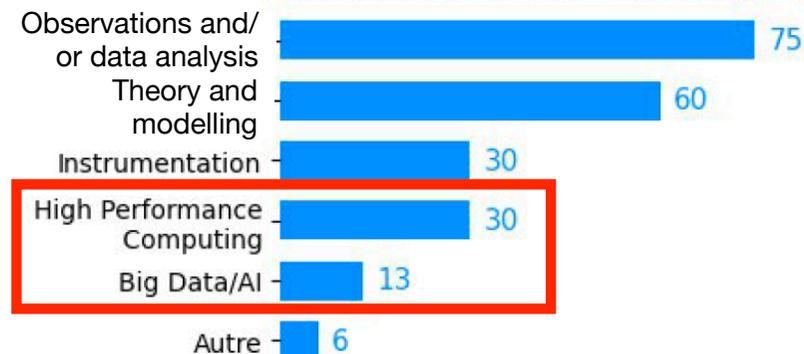


- Compact objects
- Multimessengers (strong increase in GW)
- Dark matter
- Big DATA, AI, HPC

Wavelength

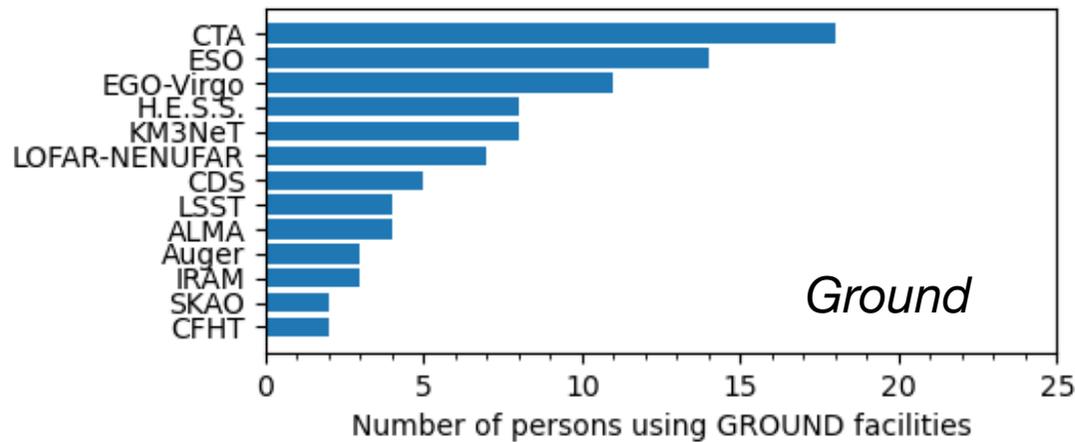


Methodology



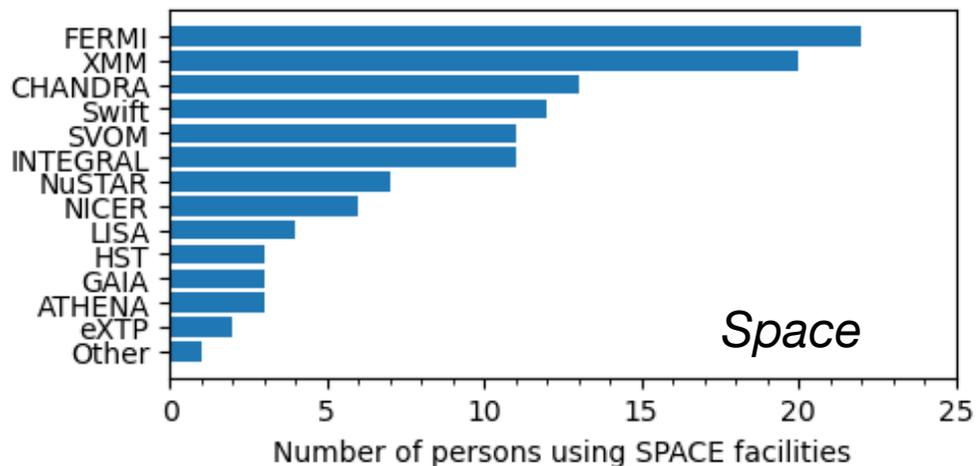
The ATPEM community

Observatories and instruments used

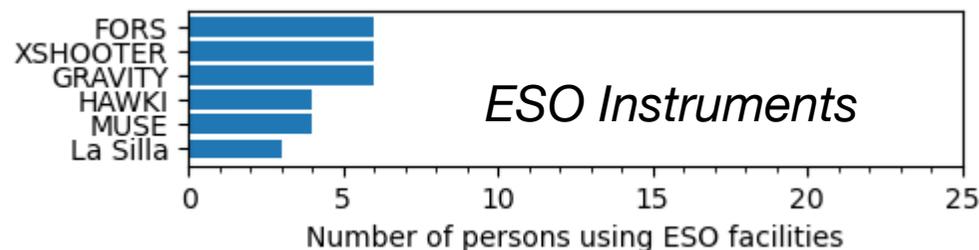


➔ X-ray and γ observatories among the most numerous used (Fermi-LAT, XMM, CTA, CHANDRA, Swift, SVOM, and INTEGRAL)

➔ Participation in future major instruments (CTA, KM3NeT, Athena, LISA, LSST, etc.)

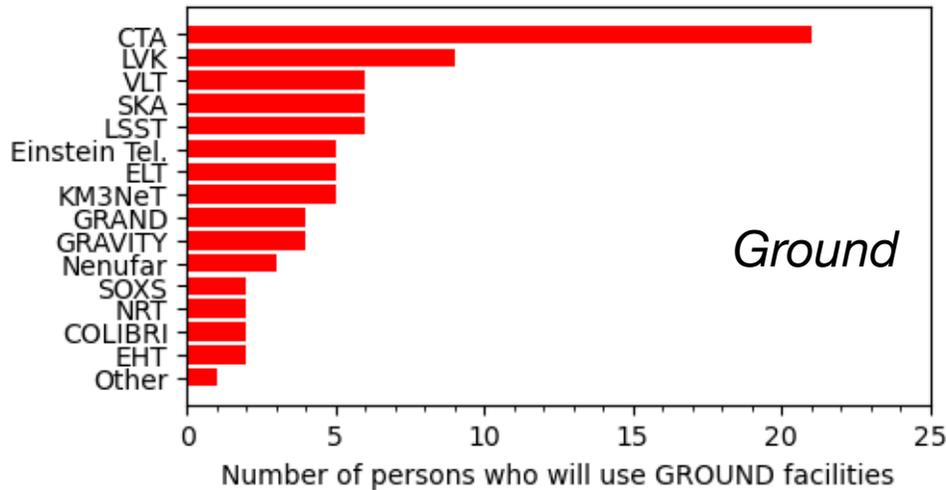


➔ Use of ESO instruments (FORS, GRAVITY, HAWKI, MUSE and XSHOOTER)



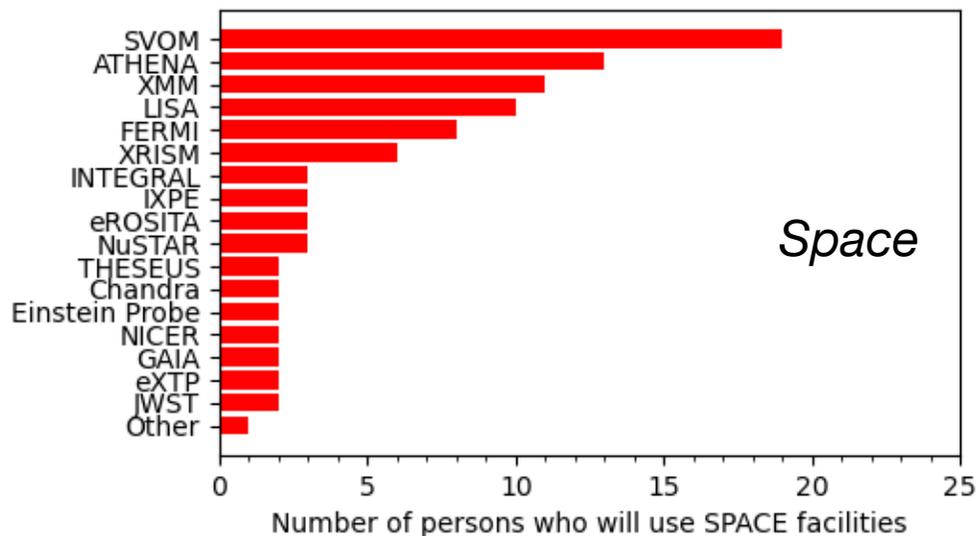
The ATPEM community

Observatories in the next years



➔ Strong involvement in the flagship instruments for our themes (CTA, SVOM, ATHENA, THESEUS, SKA, etc.)

➔ Télescopes GW (LISA, LVK, ET)



➔ Wide range of instruments covering all wavelengths and messengers (KM3NeT, LSST, GRAND, etc.)

AT PEM Actions

- ◉ Community animation

- ➔ Organisation of scientific events

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- ★ **ATPEM general days every 2 years** (last one Oct. 2025)

- ➔ solicited talks from senior researchers

- ➔ contributed talks from young researchers (PhD and Postdocs)

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★ **ATPEM meetings** more focused on a single « transversal » subject

➔ 2024: Theory

➔ 2026: Observations vs Simulations

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➔ 2024: Theory

➔ 2026: Observations vs Simulations

★ **Session** proposals (and organisation) during the **annual French Society A&A meeting**

2026

➔ Session « Origins and impact of winds in astrophysical systems »

➔ Session « Transient sky in the SVOM era »

AT PEM Actions

- Expertise

AT PEM Actions

◉ Expertise

- ➔ Referee of large Instrumental projects (~10 projects/year)
- ➔ Referee for the National Services for astronomers (4-6/year)
 - ◆ We are currently working on a **Observation Service dedicated to Alerts**
- ➔ Contributions to the A&A prospective (full 2025!)
- ➔ Nominations for medals (bronze, silver) CNRS

AT PEM Actions

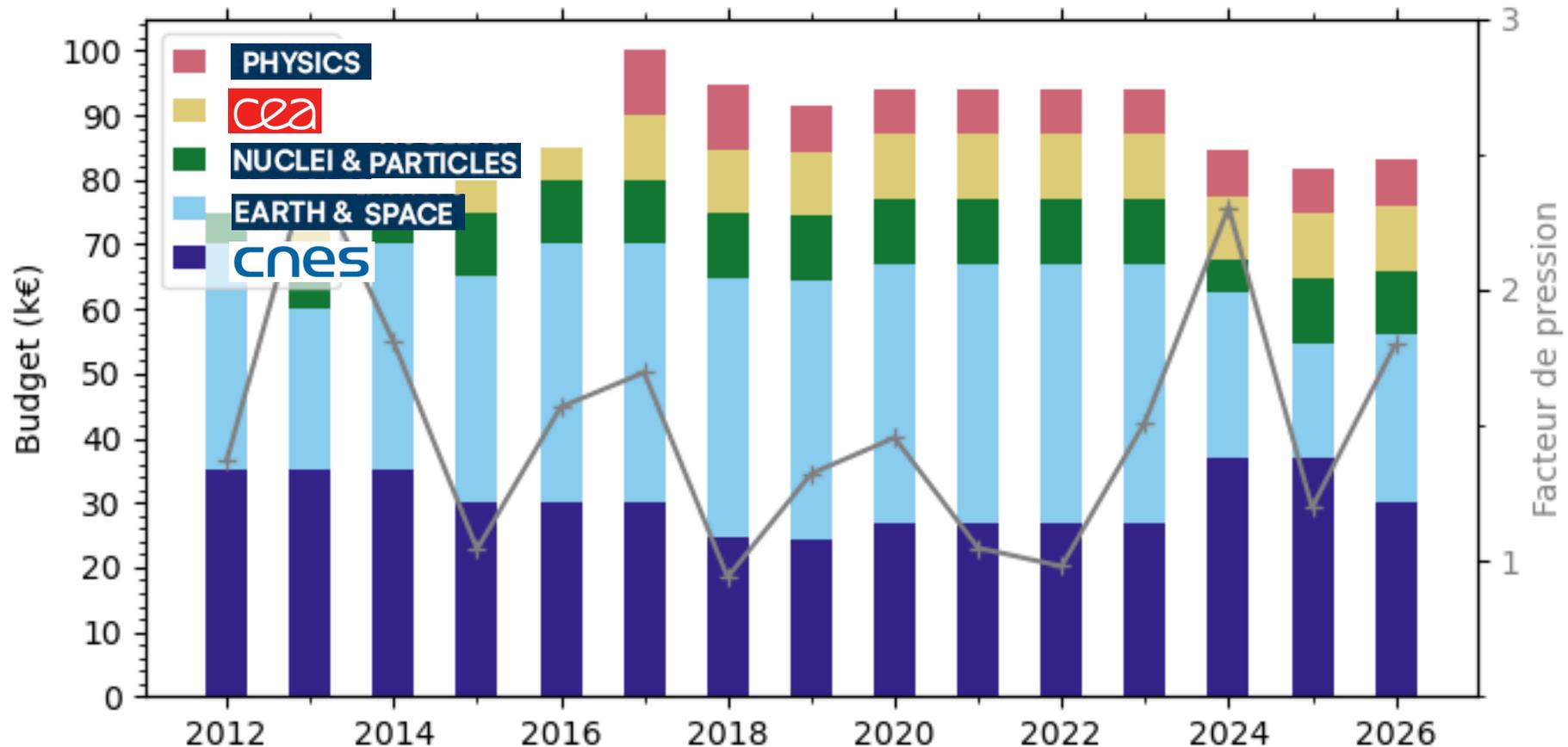
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◉ Evaluation of applications for the Call for Projects

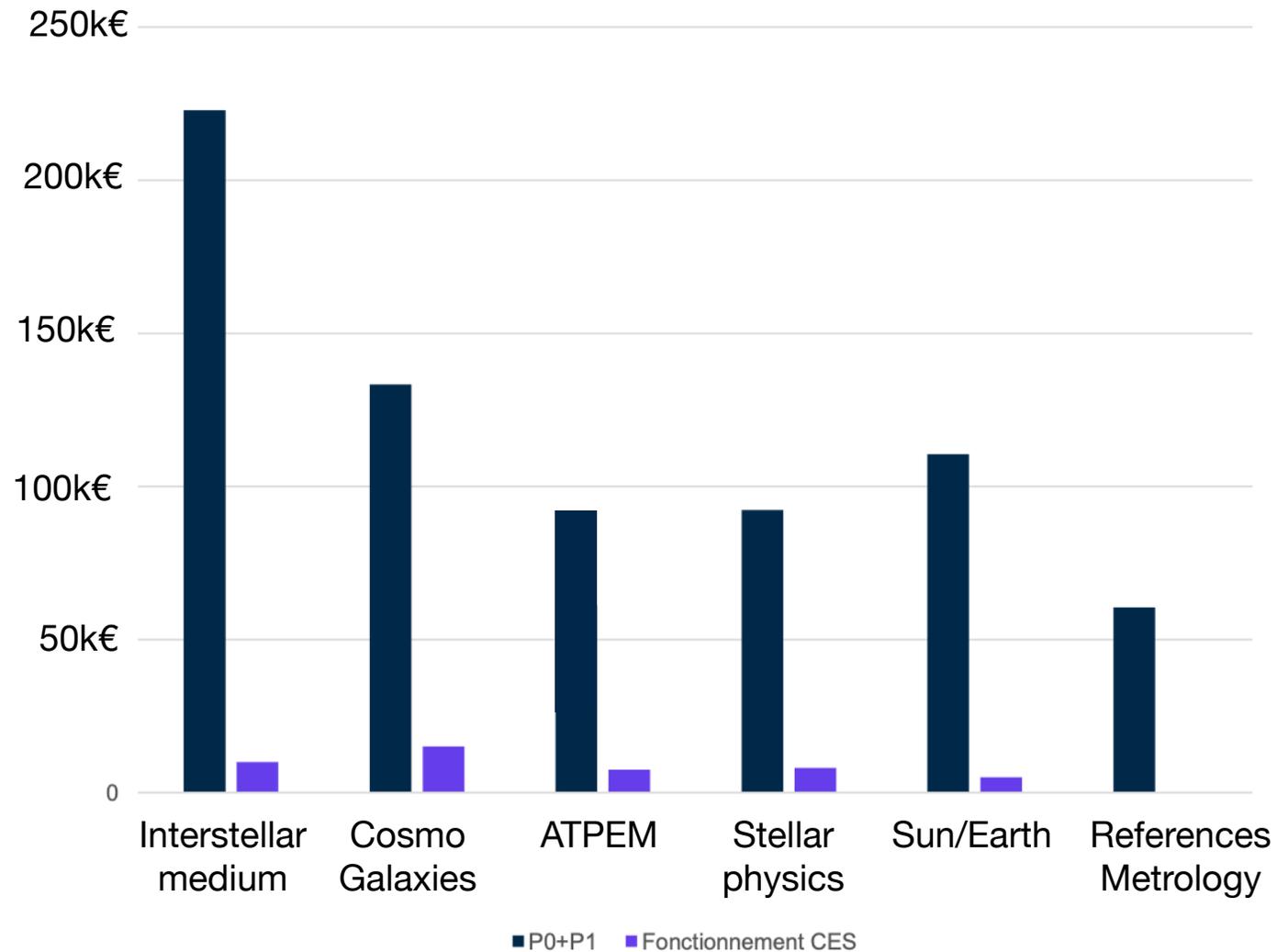
AT PEM Call for Projects

Budget



- Around ~90 k€ (one of the smallest budget among the different AT)

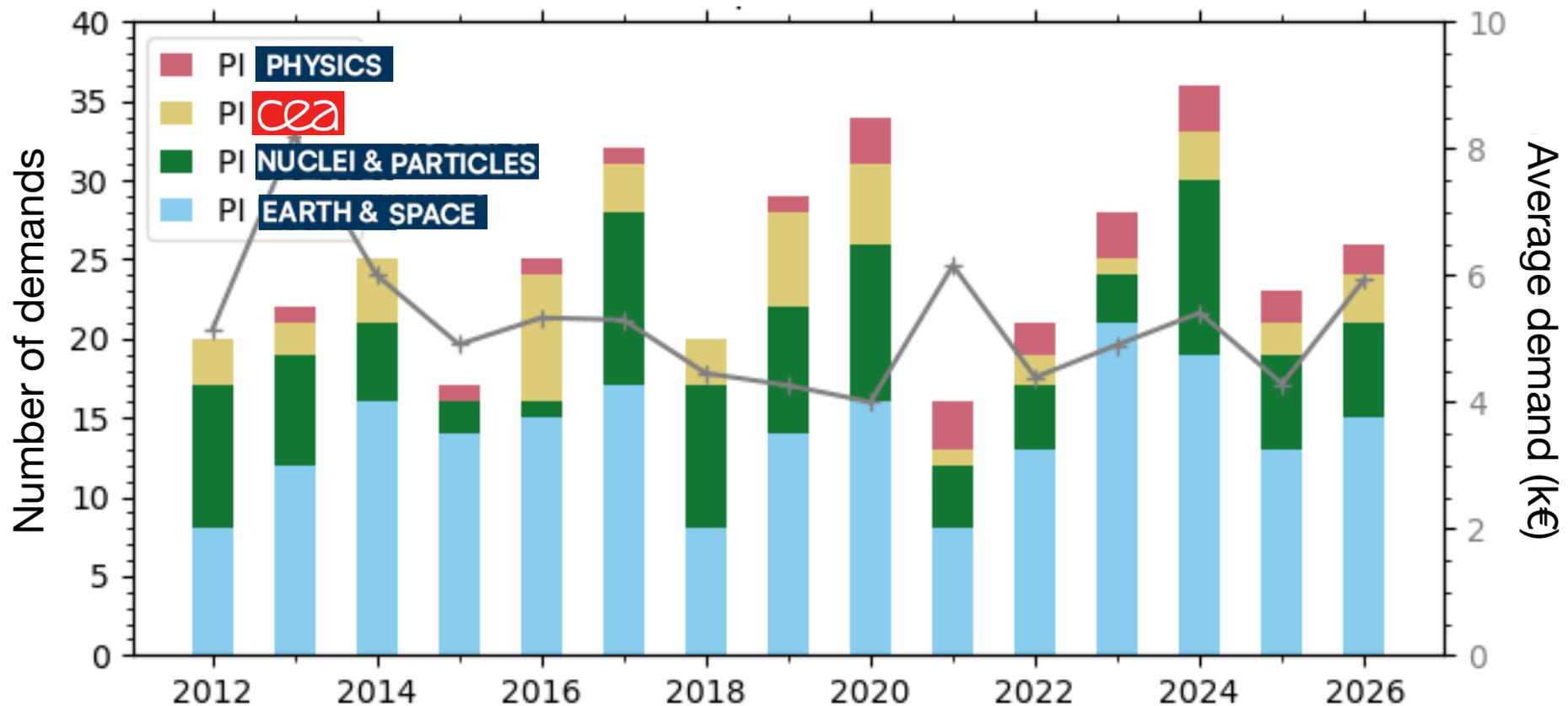
Comparison between AT



AT PEM Call for Projects

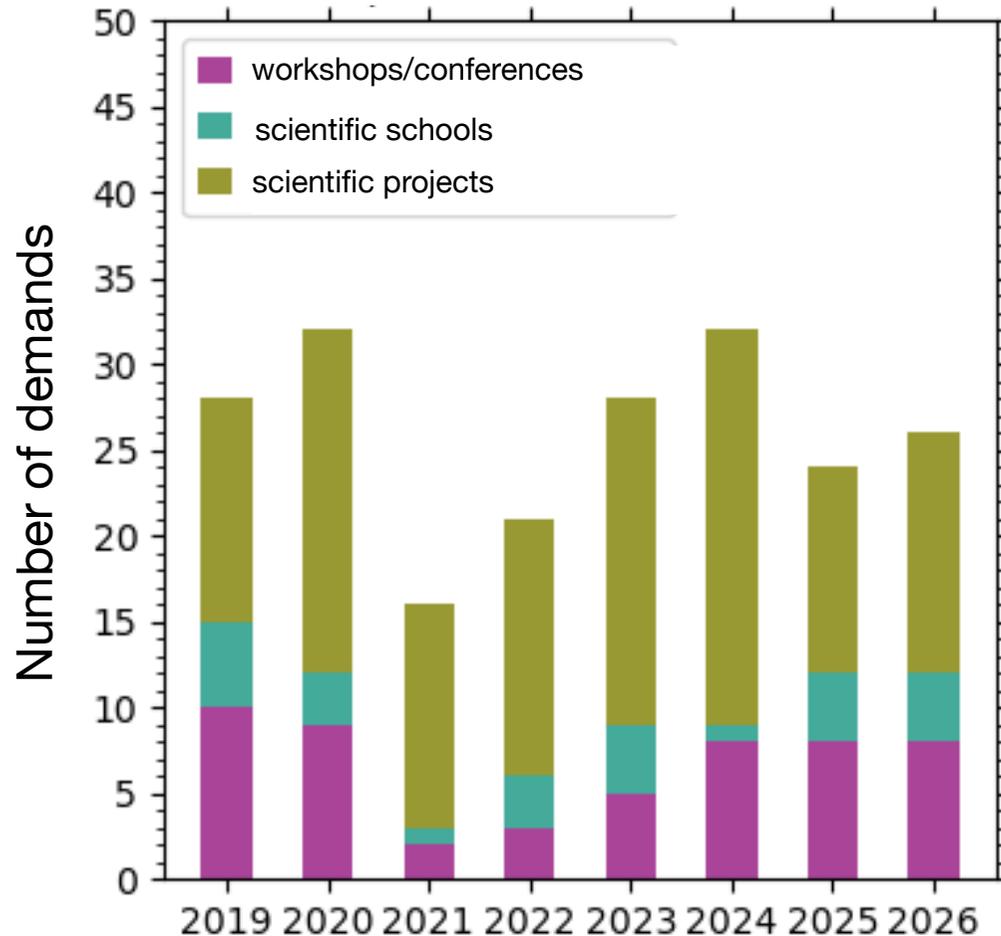
Number of Projects

(2 pages+admin information)



- Average number of demands ~25
- Average amount of money asked ~5 k€

Community Animation financial support



- Financial support for a large number of schools, workshops, conferences...
- Also co-funding by different AT

The Prospective

- « Prospective » dedicated to the challenges, tools and resources of Astronomy-Astrophysics (AA) research for the period 2025-2030
- 10 working groups + « prospective » from the various AT
- Feedback workshop in autumn 2024
- Finalisation of documents early 2025

Future Challenges

A Multi-messenger Astronomy

Gravitational waves

LVK/EGO
ET
LISA
PTA
...

Non-exhaustive list!

Radiation

SVOM
CTA
SKA
LSST
Theseus
ELT
(New)Athena
...

Particles

IceCube
AMS
KM3Net
Pierre Auger
...

✓ All in one!

✓ Strong Transversality and interdisciplinarity

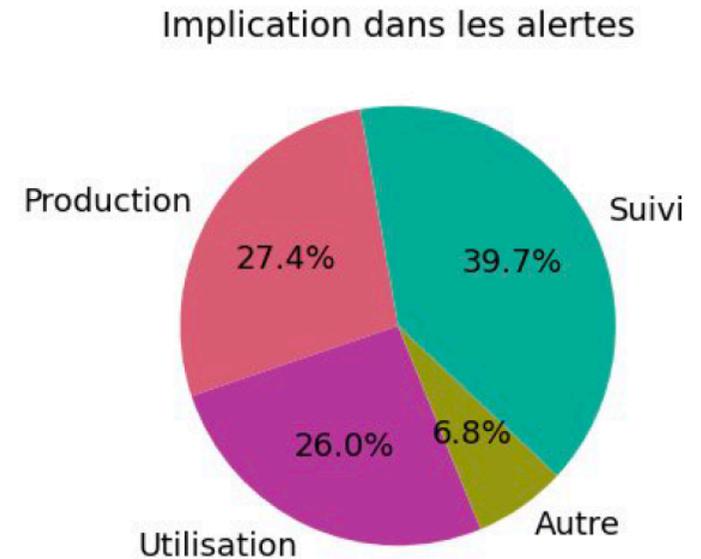
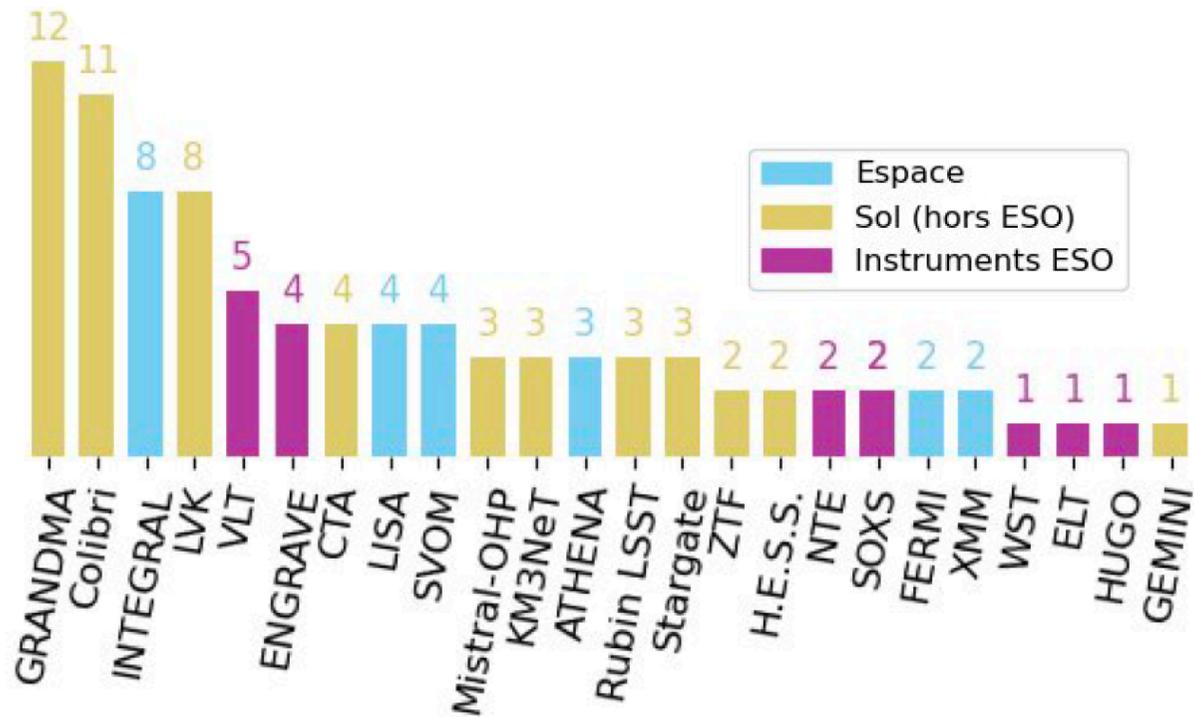
✓ Imply several IR/IR*

✓ Strong French involvement

Researchers with Multi-institute research profiles!

Future Challenges

A Transient Phenomena Astronomy



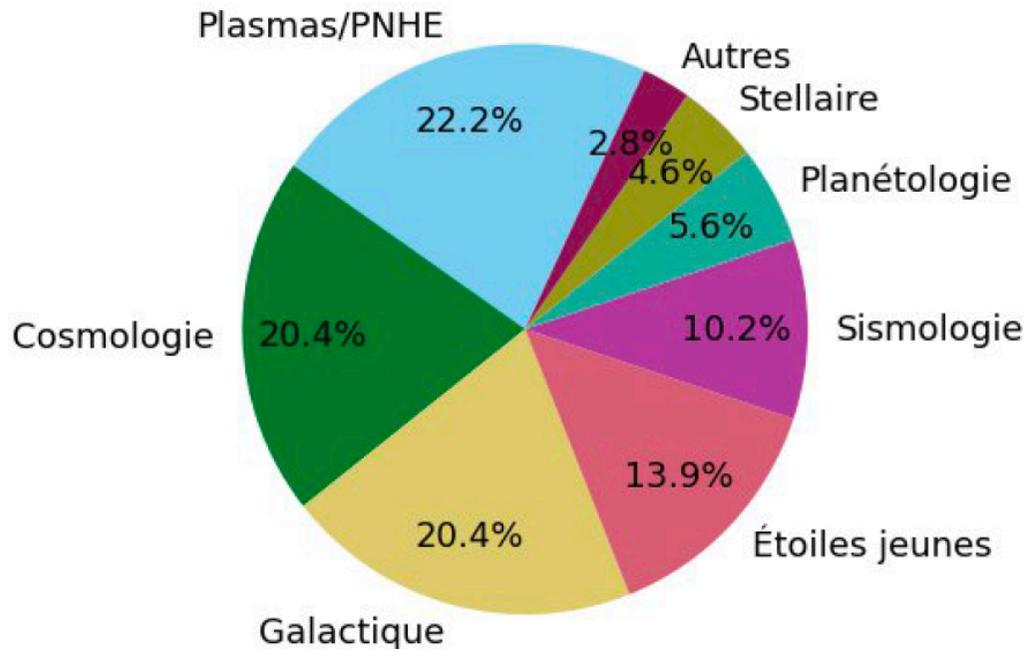
- ➔ Telescopes, networks of telescopes or alert networks dedicated to monitoring (ENGRAVE, GRANDMA, Colibri, etc.)
- ➔ Instruments that generate (or will generate) a large number of alerts due to their coverage of the sky (LVK, CTA, SVOM, KM3NeT, Rubin/LSST, ZTF, etc.).

Setting up an 'Alerts' SNO?

Future Challenges

A Computational Astronomy

Répartition des heures CPU au GENCI
(> 200 Mh/an au total)



Credits: G. Lesur

Projects linked to ATPEM represent 25% of the total for the various Earth- Universe themes on GENCI (Grand Equipement National de Calcul Intensif).

Development of tools for storing, communicating, processing, sorting and interpreting large data streams (CTA, LSST, SKA, etc.).

Transition to GPU, Exascale, AI, Big Data...



Thanks!



In tune with social issues

- **Carbon and ecological transition**

Prioritize a few choices (e.g. less travel, fewer instruments or developed over longer periods of time, less energetic consumption)?

- **Inclusion/diversity/equality**

Code of conduct for all the community

- **Telescopes and territories**

Like in all the astro community

- **Participative Astronomy**

Feedback with the non-professional community involved in monitoring transient alerts. But difficult to manage scientific feedback

Total Budget

