Labex UnivEarthS

Present and Future

Scientific Committee 9 November 2017

IPGP, Paris

Labex UnivEarthS

Present & Project Evolution in 2017

UnivEarthS LabEx

✓ Title: UnivEarthS
observation – modeling – transfer

✓ Project directors: Marc CHAUSSIDON and Stavros KATSANEVAS
Coordination: Université Sorbonne Paris Cité
Administration: University Paris Diderot

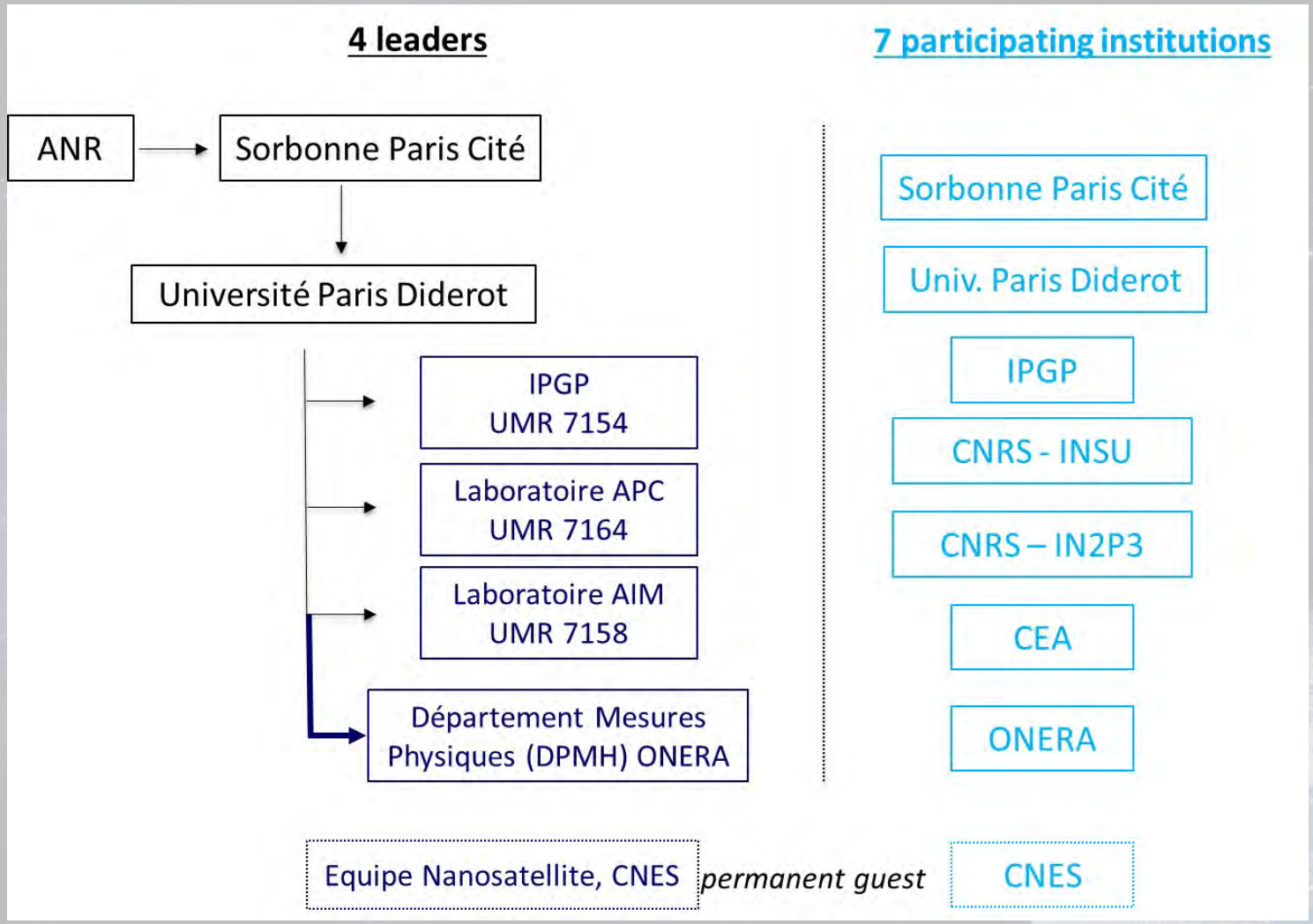
✓ First call for Labex proposals: april 2011 – december 2019

✓ Global budget: 9 M €

✓ Participants: >200 researchers & engineers, 40 post-doc, 44 PhD, …

✓ Projects: 35 WPs since the beginning of the Labex, 25 WPs actually running

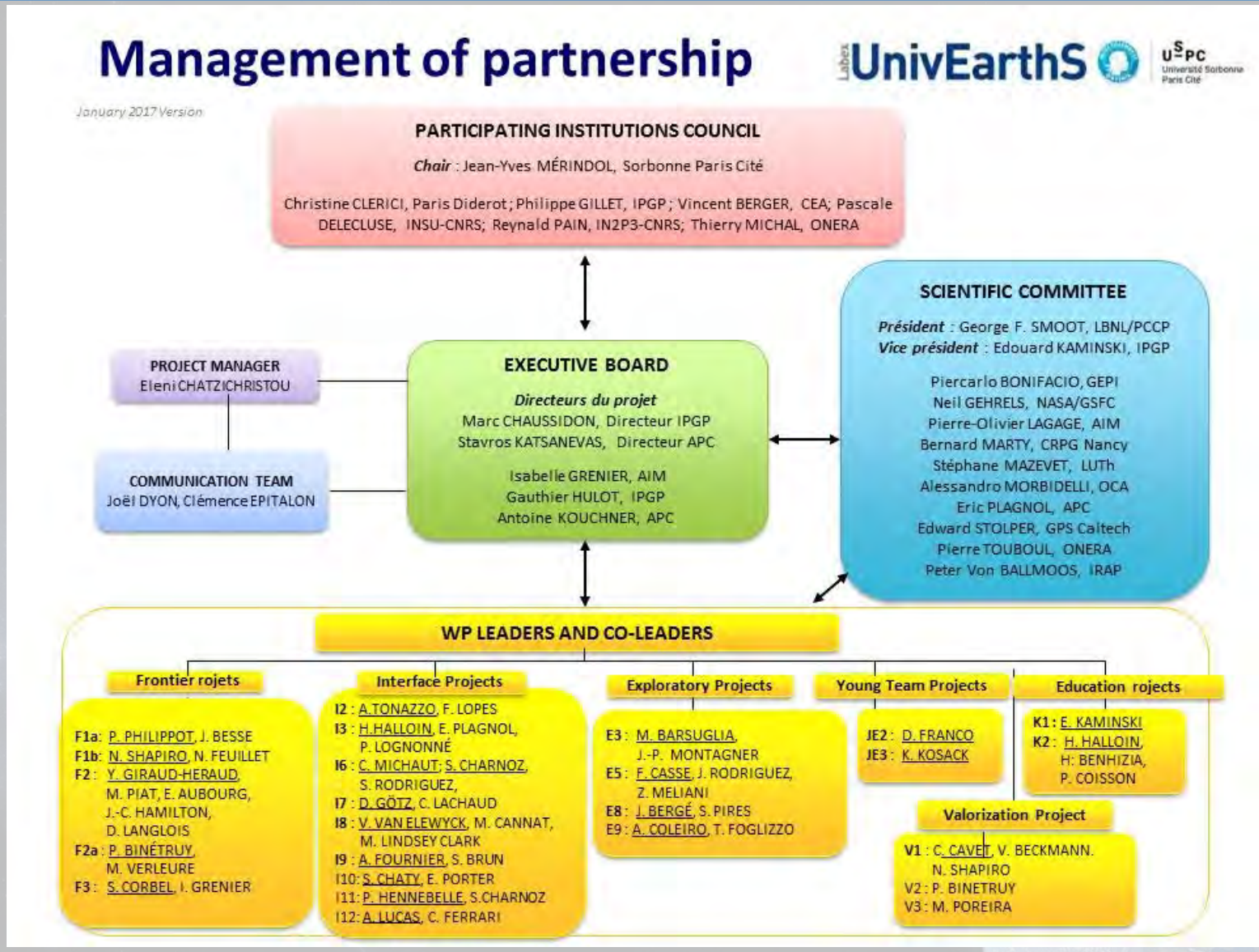
Governance


4 leaders
7 participating institutions
ANR
Sorbonne Paris Cité
Université Paris Diderot
IPGP UMR 7154
Laboratoire APC UMR 7164
Laboratoire AIM UMR 7158
Département Mesures Physiques (DPMH) ONERA
Sorbonne Paris Cité
Univ. Paris Diderot
IPGP
CNRS - INSU
CNRS – IN2P3
CEA
ONERA
Equipe Nanosatellite, CNES
permanent guest
CNES

The UnivEarthS project is structured around:

- a Participating Institutions Council (Comité des Tutelles), at the top
- an Executive Board made of five members (2 co-directors and 1 representative from each founding laboratory: IPGP, APC and AIM). This ensures an effective cooperation between the laboratories and allows the continuous sharing of information.
- an International Scientific Advisory Committee, boosting the global dynamics of the project
- a Project Manager, ensuring the coordination the project
- a Communication team, linked to the outreach officers of the founding laboratories (IPGP, APC, AIM), which offer added value to the results obtained in the context of UnivEarthS
- The WP Leaders and Co-leader

Management of partnership



2017 Scientific Committee members

Astro/planet sciences:

George F. SMOOT, LBNL and PCCP ***(Chair)***

Piercarlo BONIFACIO, Gepi

Pierre-Olivier LAGAGE, AIM

Alessandro MORBIDELLI, OCA *(excused)*

new 2017 Stavros KATSANEVAS, APC

new 2017 Joel BERGE, ONERA

Geosciences:

Édouard KAMINSKI, IPGP ***(Vice chair)***

Bernard MARTY, CRPG Nancy *(excused)*

Donald DINGWELL, LMU Munich

Edward STOLPER, GPS Caltech

2017 Scientific Committee members

The impact of the LabEx UnivEarthS on our laboratories and academic institutions (APC, CEA, IPGP, Université Paris-Diderot) has been highly visible and will undoubtedly be a lasting one.

Many important research results have been obtained and, what is perhaps more significant, solid foundations have been built for further research.

2017 Scientific Committee members

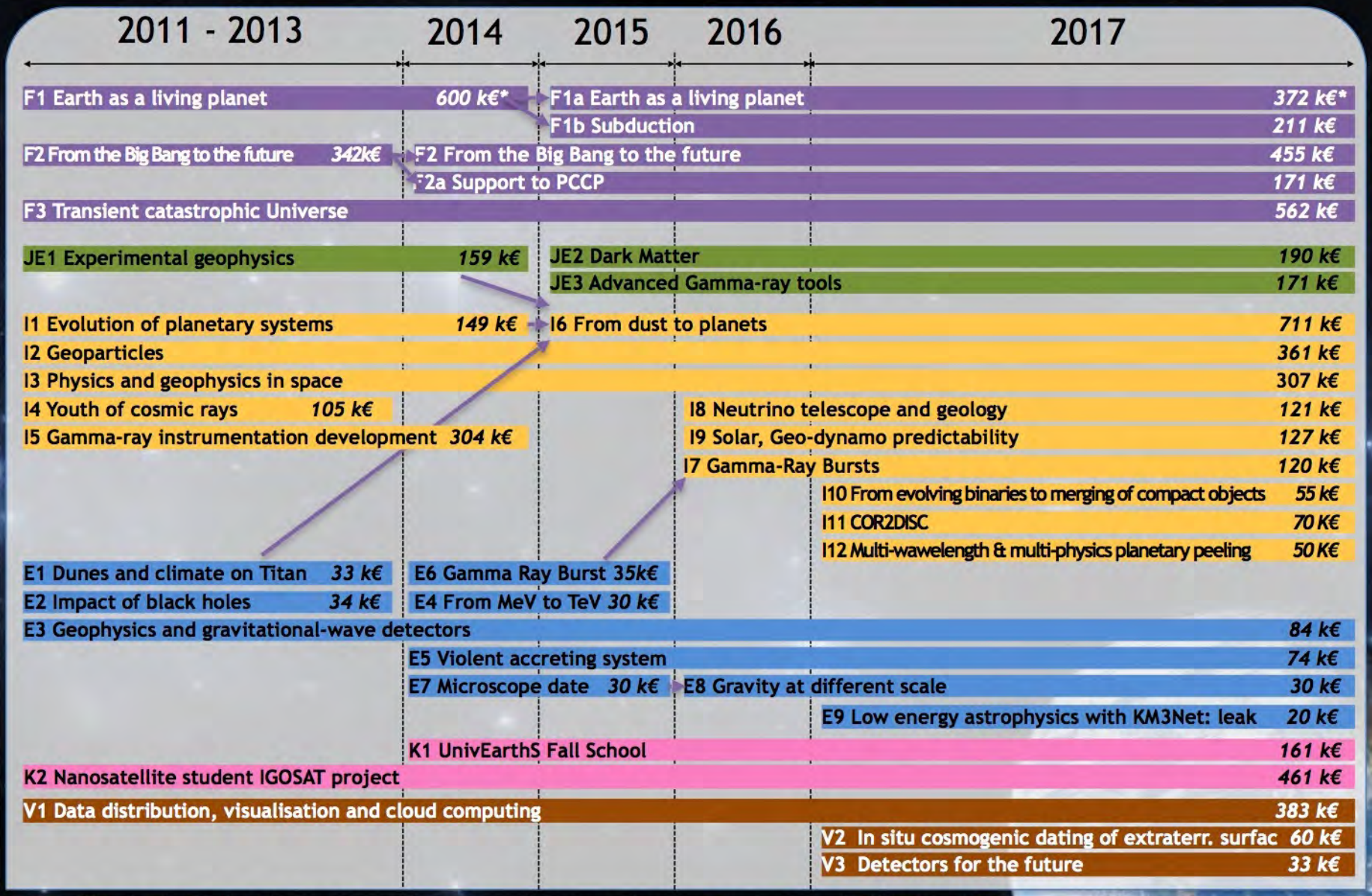
The LabEx initiative is structured around six types types of projects:

- **Frontier projects**: one for each founding laboratory, novel avenues of research (over the 9 years of the program, reviewed by SC)
  Proposed by the Executive Committee
- **Interface projects**: two teams from at least two different UnivEarthS laboratories (duration: four years or more, not guaranteed over the duration of the programme, reviewed, and possibly terminated, by SC)
  Proposed by the Executive Committee
- **Exploratory projects**: involves teams from two different UnivEarthS laboratories on exploratory and innovative topics, without possibility of hiring. Meant to become interface projects (duration: two years, reviewed, and possibly terminated, by SC).
  Selected after an internal call for proposals
- **Young team projects**: start-up scheme for junior scientists who create a new team. Ideally each founding laboratory has a JE
  Selected after an internal call for proposals
- **Education projects:** student-built nano-satellite IGOsat and Fall School
- **Valorization projects**:

2011-2017: WP timeline

UnivEarthS — Université Sorbonne Paris Cité

Type of projects:
F: frontier / JE: young team / I: interface / E: exploratory / K: education / V: valorization



* For each WP: the indicated budget is the global budget, with hiring + consumables, missions and equipment, with specific start and end dates (example: F1 from 2011 to 2014; F1a from 2015 to 2016). For more details: see file "UnivEathS_SC 2017_2011-2017 WP account budget

2017: WP presentation

✓ Frontier projects

- **F1a:** *IPGP* Earth as a living planet : from early ages to present dynamics (Pascal PHILIPPOT)
- **F1b:** *IPGP* Subduction today and in the past (Nikolai SHAPIRO)
- **F2:** *APC* From Big Bang to the future of the Universe (Yannick GIRAUD-HÉRAUD)
- **F2a:** *APC* Support to PCCP (Pierre BINÉTRUY/Stavros KATSANEVAS)
- **F3:** *AIM* The transient catastrophic Universe (Stéphane CORBEL)

2017: WP presentation

✓ Interface projects

- **I2:** *APC/IPGP* Geoparticles (Alessandra TONAZZO)
- **I3:** *APC/IPGP* Fundamental physics and Geophysics in space (Hubert HALLOIN)
- **I6:** *AIM/IPGP* **D**ust do Planets (Chloé Michait/Sébastien Rdriguez)
- **I7:** *AIM/APC* Gamma-Ray Bursts: a unique laboratory for modern astrophysics (Diego GÖTZ)
- **I8:** *APC/IPGP* ARGOS: Astroparticle Research, Geology & Oceanography Studies (Véronique VAN ELEWYCK)
- **I9:** *IPGP/AIM* SolarGeoMag (Alexandre FOURNIER)
- **I10:** *APC/AIM* From evolving binaries to the merging of compact objects (Sylvain CHATY)
- new 2017 **I11:** *IPGP/AIM* COR2DISC: From pre-stellar cores to protoplanetary discs (Patrick HENNEBELLE)
- new 2017 I12: *IPGP/AIM* MλΨ-P^2 Multi-wavelength & Multi-Physics Planetary Peeling (Antoine LUCAS)

2017: WP presentation

✓ Exploratory projects

- **E3:** *APC/IPGP* Geophysics and gravitational wave detectors (Matteo BARSUGLIA)
- **E5:** *APC/AIM/LUTh* (NOVAs): a Numerical Observatory of Violent Accreting systems (Fabien CASSE)
- **E8:** *ONERA/AIM* Modified Gravity from the Earth's outskirts to the cosmos (Joël BERGÉ)
- **E9:** *APC/AIM* LEAK: Low Energy Astrophysics with KM3NeT (Alexei COLEIRO)

new 2017

✓ Valorization projects

- **V1:** *APC/IPGP* Data distribution, visualization and cloud computing (Cécile Cavet)
- **V2:** *CAGE/IPGP* In situ cosmogenic dating of extraterrestrial surfaces (Manuel MOREIRA)
- **V3:** *APC/GEPI* Detectors for the Future (Pierre BINÉTRUY/Stavros KATSANEVAS)

new 2017

new 2017

2017: WP presentation

✓ Young team projects

- **JE2 :** *APC* Direct Searches for Dark Matter with Liquid Argon detectors (Davide FRANCO)
- **JE3 :** *AIM* Advanced Gamma-Ray Science Methods and Tools (Karl KOSACK)

✓ Education project

- **K2:** *APC/IPGP* UnivEarthS nanosatellite student IGOsat project (Hubert HALLOIN)

Personnel Involved - UnivEarthS 2017

ACTUAL PROJECTS	Researchers/ Engineers	Postdocs	PhD students	PhD initiated	PhD defended	Publications w/ acknowledgments
Interface (9)	64	11	14	1	1	88
Frontier (5)	63	20	16	3	1	36
Exploratory (4)	27	4	3	3		21
Young team (2)	7	4				6
Education (2)	9		1			
Valorization (3)	17	1	1			1
Totals	187	40	35	7	2	152

2017 Scientific Committee members

A key aspect of our handling of LabEx projects is that we monitor expenses and check regularly that funds are spent in a timely manner. We do not allow for significant amounts to be carried over from one year to the next on individual projcts. In practice, we allocate a certain sum for each year for what usually are two-year projects and this sum includes any leftover from the previous year: it is therefore not possible to build up a stash of funds that is spent at the last minute on non-essential items.

UnivEarthS will end on December 3, 2019. The 2 remaining years will be spent on 2 goals:

- ➢completing and finalizing actions already started and financed
- ➢preparing the renewal of Labex around new issues and new ideas (e.g. proposal for a graduate school around the UnivEarthS themes)

The objective for the next 2 years is to use in a most efficient way the funds that remain available. To date an estimated 86% of all available funding were used and most of the remaining funds have already been committed (human resources) for the last 2 years of the project. It is clear that the global available 2018 & 2019 budget is not sufficient to cover all the expenses claimed by all projects.

2011-2019 multiannual budget

- ✓ Funding activity remains stable after 2013, to an average ~1,4 M€/year)
- ✓ Yearly execution rate is pretty good, an average of 87% between 2011-2017 (reaching 99% in 2016)
- ✓ To a good approximation half of the annual budget is used for hiring, in agreement with the 2010 initial proposal
- ✓ Installed budget vs. spending budget: unused funds are reported to the global budget of next years
- ✓ At the end of 2017, an estimated 86% of all available funding were used
- ✓ Most of the remaining funds have already been committed (human resources) for the last 2 years of the project.
- ✓ The requested funding for 2018-2019 is well in excess of the estimated available funds
- ✓ 2018-2019: drastic reduction of projects (>50%) if only commitment costs are retained; researchers are encouraged to find complementary/alternative support
- ✓ On the positive side:
  - we may be able to recover money that went down the drain every year for PPE (unemployment allowance) which amounts to 10% of funding for HR at P7,an estimated ~400 k€
  - alternatively find additional resources to finance the continuation of UnivEarthS

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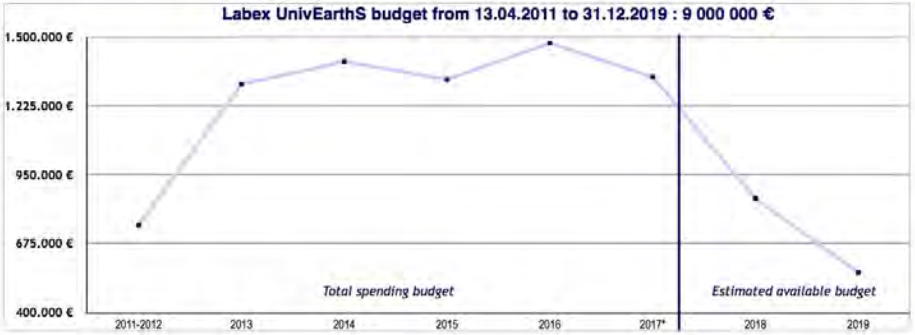
Budget Nov 2017

Multiannual Execution

REMINDER: total allocated budget from 13/04/2011 to 31/12/2019 : 9.000.000 €

	2011-2012	2013	2014	2015	2016	2017*	Estimated Available 2018	2019	TOTAL
UP7D_reporting ANR	556.866 €	916.123 €	1.009.704 €	951.510 €	1.131.990 €				4.566.193 €
dont UP7D_RH	472.259 €	650.101 €	659.677 €	675.683 €	793.019 €				3.250.738 €
UP7D_PPE 10%	47.226 €	65.010 €	65.968 €	67.568 €	79.302 €				325.074 €
IPGP_reporting ANR	144.852 €	330.080 €	314.850 €	300.854 €	257.049 €				1.347.685 €
ONERA_reporting ANR			10.495 €	10.482 €	7.140 €				28.117 €
Total reporting ANR	701.717 €	1.246.203 €	1.335.049 €	1.262.847 €	1.396.179 €				5.941.996 €
Total spending budget (= Σ reporting + PPE)	748.943 €	1.311.213 €	1.401.017 €	1.330.415 €	1.475.481 €	1.340.000 €	855.000 €	560.000 €	9.022.069 €
% cumulative execution	8%	23%	38%	53%	70%	85%			
				half-way		* estimated			



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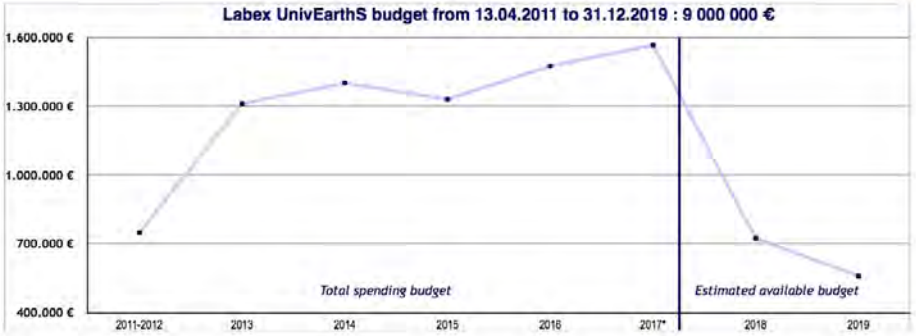

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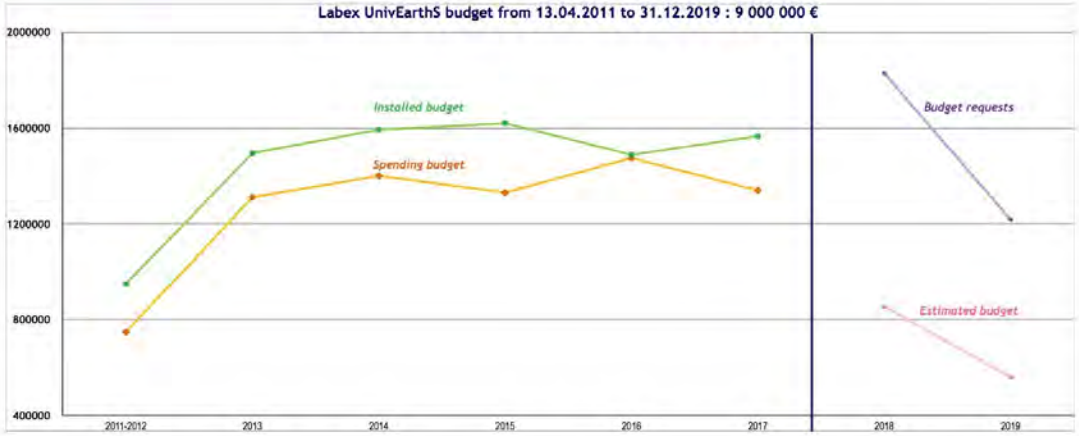
Budget Nov 2017

Yearly Execution Rates

REMINDER: total allocated budget from 13/04/2011 to 31/12/2019 : 9.000.000 €

	2011-2012	2013	2014	2015	2016	2017*	TOTAL 2011-2017	2018	2019
Installed budget	949.894 €	1.495.742 €	1.593.102 €	1.620.515 €	1.488.623 €	1.566.432 €	8.714.308 €		
Total spending budget (= Σ reporting + PPE)	748.943 €	1.311.213 €	1.401.017 €	1.330.415 €	1.475.481 €	1.340.000 €	7.607.070 €		
% yearly execution	79%	88%	88%	82%	99%	86%	87%		
						* estimated			
Estimated available budget								855.000 €	560.000 €
Budget requests								1.828.471 €	1.217.592 €
In excess								973.471 €	657.592 €



COMMUNICATION: 2nd Worshop Cubesat Etudiant

Communication continues to accompany the members of UnivEarthS in their activities. Here are some examples of such activities carried out this year (2017).

- 2d edition of the student Cubesat workshop, held by the IGOsat team More than 100 participants from France and other countries.This is the yearly rdv of the student community working on nanosatellites

Fête de la science 2017, on Campus Univ. Paris-Diderot

- 3 stands with scientific animations on planetary exploration, gravitational waves and IGOSAT nanosatellite proj.
- 5 conferences and one exhibition
- great success of the new “planetary exploration animation in virtual reality” with school visitors and the general public

Press & Media

Finally, the UnivEarthS communication always participates in the diffusion of information and propagates the publications and work of the Labex members, through the press and media, with regular updates of the UnivEarthS website (www.univearths.fr) and constantly establishing links with science journalists.

We encourage you to contact us if you want to doffue your publications, announcements or events.

The next 3 years and beyond

Strong points, assets

➢UnivEarthS strategic choice of partner laboratories

➢Uniqueness and excellence acknowledged by mid-term evaluation

➢Associated with a doctoral school project STEP'UP, the yearly UnivEarthS Fall School, very successful MOOC's or "citizen's science (Nanosat) and in 2017 two Labex bursaries for Master students

➢Unique experience in Europe (world?)

Opportunities

➢Controlled thematic diversification

➢Increase the accompanying educational activity:

Graduate School & New technologies in education

➢Increase R&D and technological activity:

(networks of) sensors, smart-city/earth/Universe, big data, virtualisation, valorisation

➢Develop common platform policies, mutualisation:

computing centres (DANTE), clean rooms

➢Develop stronger common policy in space science (links with space campus)

e.g. capitalize on INSIGHT's experience to launch future planetary missions

➢Strengthen links with societal and policy issues

➢Strengthen links with Europe and the world

Labex UnivEarthS

Future Perspectives

Labex UnivEarthS: 9 M€ April 2011-December 2019

- very positive ANR 2015 evaluation

"The UnivEarthS consortium is a bold and unique marriage of scientific communities that have traditionally not spoken with each other …"

- strong links established in our communities between geophysics and astrophysics

- uniqueness in France and abroad to develop such a partnership

- strength brought by this partnership for science and politics (e. g. success of DANTE project)

Two options for the renewal of Labex UnivEarthS

- renewal of the labex itself (call not issued yet)

- renewal within a bigger project:

  - within a graduate school project

(PIA 3 call, Earth-Planet-Universe proposal submitted in June 2017, but not selected in october 2017, second call possible in spring 2018)

- within the proposal for an Idex (merging of universities P5 and P7 and of grand établissement IPGP, into a single grand établissement: Université de Paris)

Project of graduate school
USPC - Earth-Planets-Universe (EPU)

EPU = Labex UnivEarthS
+ masters Geo/astro
+ doctoral school ED 560
(= Sciences de la terre et de l'environnement et des planètes + physique de l'univers)

EPU = 14.8 M€ for 10 years
(10 M€ for labex, 4.8 M€ for teaching initiatives)

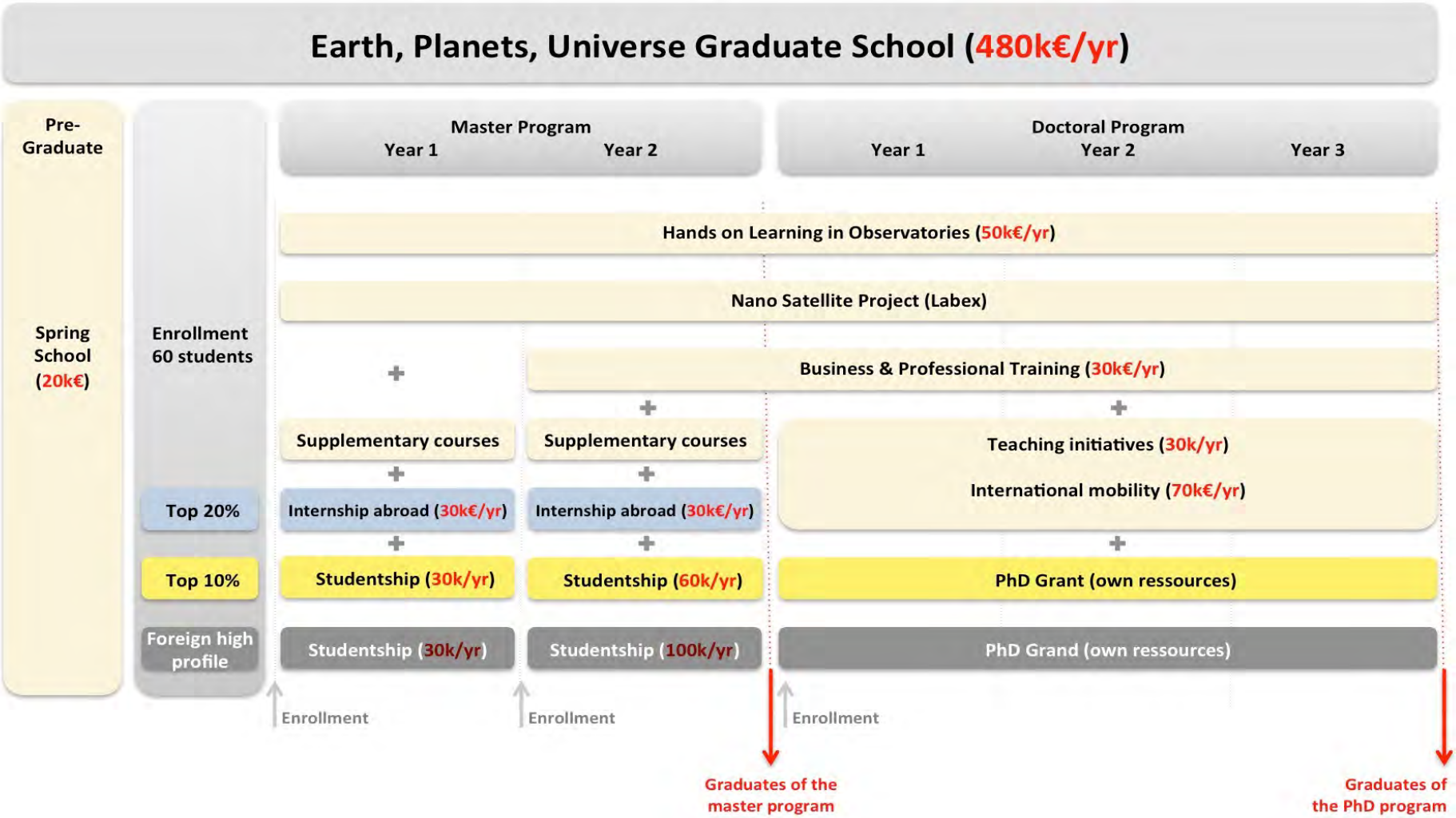
Project of graduate school
USPC - Earth-Planets-Universe (EPU)

The graduate school EPU aims to offer world-class interdisciplinary teaching and training at the graduate level, for master and PhD degrees, within a research perimeter of excellence. It is designed to attract high-profile students and will be advertised worldwide. We want to take full advantage of the synergy developed between geosciences, astrophysical and space sciences to reinforce our partnership and to strengthen the links between research and teaching.

Project of graduate school
USPC - Earth-Planets-Universe (EPU)

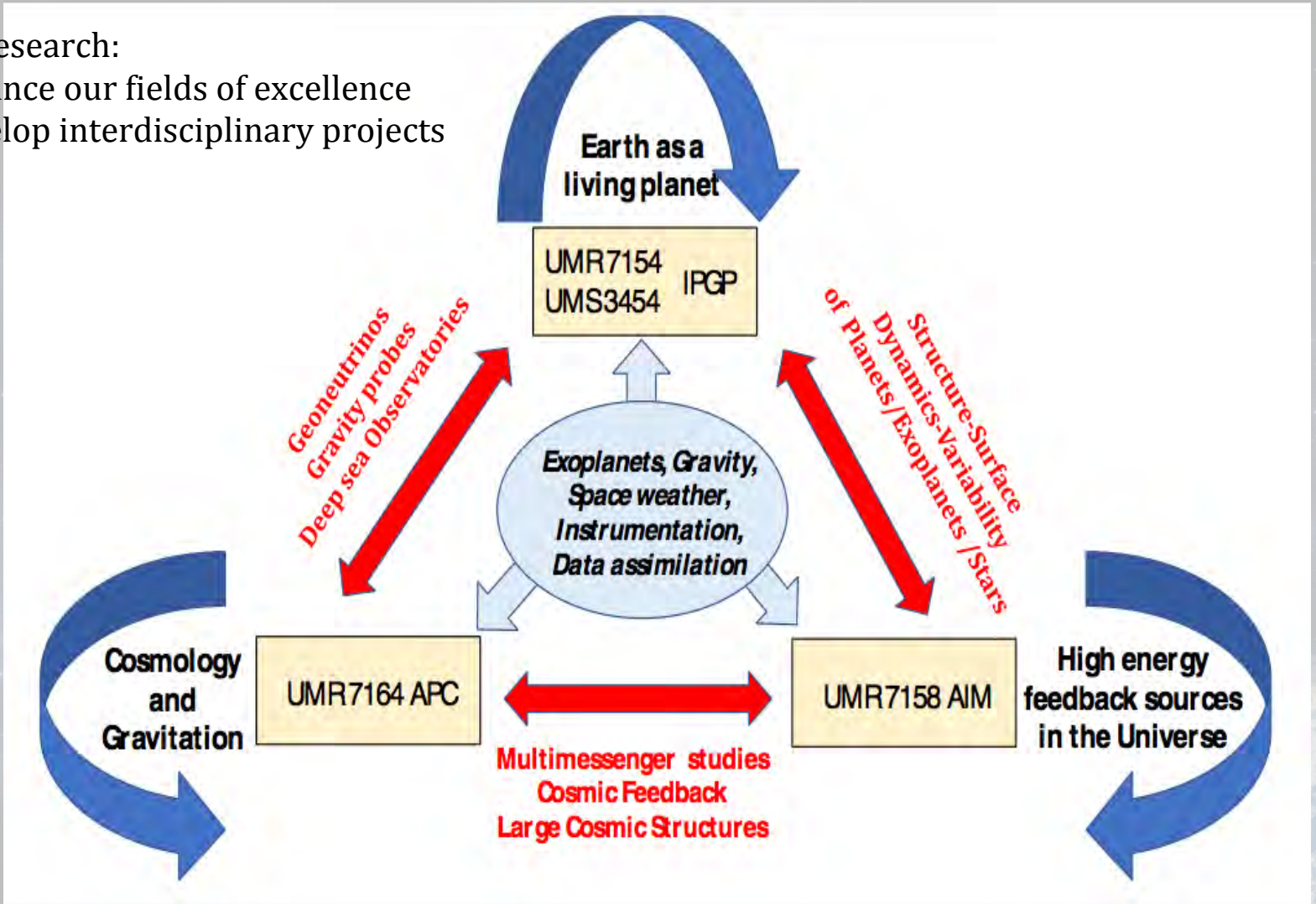
- partnership with a few selected universities: letters of support from University of Chicago, the University of Minnesota, the ERI and Kavli IPMU institutes from Tokyo University, the university of Pisa and the Chinese Academy of Sciences (IHEP Beijing).

- partnership with a few selected companies: letters of support from four major industrial partners in the fields of geophysics (Schlumberger, CGG) and space industries (ONERA, Airbus defence and space).


Earth, Planets, Universe Graduate School (480k€/yr)
Pre-Graduate
Master Program
Year 1
Year 2
Doctoral Program
Year 1
Year 2
Year 3
Spring School (20k€)
Enrollment 60 students
Hands on Learning in Observatories (50k€/yr)
Nano Satellite Project (Labex)
Business & Professional Training (30k€/yr)
Supplementary courses
Supplementary courses
Teaching initiatives (30k/yr)
International mobility (70k€/yr)
Top 20%
Internship abroad (30k€/yr)
Internship abroad (30k€/yr)
Top 10%
Studentship (30k/yr)
Studentship (60k/yr)
PhD Grant (own ressources)
Foreign high profile
Studentship (30k/yr)
Studentship (100k/yr)
PhD Grand (own ressources)
Enrollment
Enrollment
Enrollment
Graduates of the master program
Graduates of the PhD program

Univearths+ physics themes

EPU research:
- advance our fields of excellence
- develop interdisciplinary projects



Frontier Workpackages

- **IPGP: "Earth as a living planet".** 4 major research themes developed at IPGP, namely

1. "The interiors of the Earth and planets"
2. "Natural hazards"
3. "The critical zone: present and past" which is the Earth's outer skin , an environmental role
4. "Origins" devoted to the study of the origins of the Solar system and its planets, of the differentiation and early evolution of the Earth and planets.

- **APC " Cosmology and Astroparticle Physics".** 4 major themes developed at APC, namely

1. Studies on cosmology,
2. The search for gravitational waves on the ground and in space
3. The determination of the nature of neutrinos and dark matter
4. The study of violent phenomena

- **AIM: " High-energy feedback sources in the Universe"** will focus on the feedback processes regulating the efficiency of star formation and explain the evolution of galaxies.
- Jets from supermassive black holes, stellar winds, supernova explosions, and relativistic cosmic rays
- Find how cosmic rays diffuse in space and in energy from their supernova remnant source through more or less turbulent (starburst) regions

PERSPECTIVES FOR EXPLORATORY OR INTERFACE PROJECTS.

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From Earth to the Planets

Studying and imaging the Earth with particles. This project aims at exploiting the instruments and methods of neutrino detection and the high penetration of neutrinos to retrieve information on the composition of the inner Earth.

a) Geo-neutrinos.
b) Neutrino oscillation tomography of the Earth.

Diversity of solar-system planets and exoplanets. This project between IPGP and AIM aims at deciphering the origin, the chemical and mineralogical compositions, and the structure and evolution of Solar System planets and exoplanets.

Data assimilation and numerical simulation of the dynamics of the Earth, planets, exoplanets, Sun, and stars. The past decade has seen considerable progress in numerical simulations of the dynamics of the Earth and the Sun.

Exoplanet atmospheres and habitability of planets. The quest for exoplanets that can sustain life and the search for life signatures requires to go beyond the sole detection and characterization of exoplanets in terms of dynamical parameters and structure.

PERSPECTIVES FOR EXPLORATORY OR INTERFACE PROJECTS.

Multi-messenger astronomy

Black-hole accreting systems in observations and simulations. This project aims to combine ground-breaking multi-wavelength observations with state-of-the art numerical simulations to advance our understanding of black-hole accretion disks, focusing on their instabilities and how they relate with ejections.

Probing the progenitors of gravitational waves. The discovery in 2015 by the LIGO-Virgo observatory of gravitational waves (GW) produced by the merging of two stellar-mass black holes came as a surprise because of the large mass (20-40 solar masses) of the objects involvedTo address these questions, we need to combine the astrophysical knowledge of such binaries with the scientific and instrumental expertise of GW detectors. AIM and APC can join forces.

Towards an optimal follow-up of gravitational-wave events. International efforts have been started to follow LIGO-Virgo GW events in a multi-wavelength and multi-messenger context.

Multi-messenger physics of gamma-ray bursts. Gamma-Ray Bursts (GRBs) are the most powerful explosions in the Universe.

Galactic Pevatrons. The origin of PeV Cosmic Rays (CRs) is a century-old unsolved problem. PeVatrons will be disclosed as TeV γ-ray and TeV-PeV neutrino sources, hopefully with the upcoming CTA and KM3NeT observatories

Multi-probe studies of large cosmic structures. The goal is to use the properties of galaxies and clusters to explore structure formation, dark energy, and dark matter.

PERSPECTIVES FOR EXPLORATORY OR INTERFACE PROJECTS WITH STRONG SOCIETAL IMPACT

. **Perspectives for exploratory or interface projects with strong societal impacts I**

Geophysics and gravity. An exploratory project between IPGP and APC within UnivEarthS has led to the first detection of the prompt gravity perturbation produced by the mass redistribution during a strong earthquake. We propose to develop a more complete and accurate numerical model to concentrate on two practical applications: (i) the fast determination of the magnitude of a big earthquake, and (ii) the improvement of the earthquake early warning systems.

Muon tomography. The possibility to explore the interior of geological structures, such as volcanoes, by measuring cosmic muons that traversed it (muon radiography) has been successfully established and tested in the UnivEarthS program. Our main aim for the future is to make the technique widely available for exploration of the interior of archaeological structures, focusing on Macedonian tumuli, which pose a challenge because of their particular configuration.

Deep-sea neutrino telescopes as multidisciplinary observatories. The KM3NeT Collaboration is engaged in the construction of a multi-site neutrino observatory in the Mediterranean abysses.

PERSPECTIVES FOR EXPLORATORY OR INTERFACE PROJECTS WITH STRONG SOCIETAL IMPACT

. **Perspectives for exploratory or interface projects with strong societal impacts II**

Atmospheric/ionospheric seismology (AIM/IPGP). Over the past decade, new methods have been developed to investigate seismic and tsunami activity by taking advantage of the seismic waves triggered within the solid Earth and oceans, but also in the atmosphere and ionosphere, where such waves can now be detected by various means. A single satellite, set on an appropriate orbit, could assist monitoring vast areas across a hemisphere. This is the main motivation for the next nanosatellite project (Ionoglow) for student education in UnivEarthS.

Space Weather. Space weather is a growing field of societal concern and science investigation. Interactions of the irregular solar wind with the Earth's protective magnetic field are responsible for highly energetic particle flows that populate the magnetosphere and ultimately reach the Earth's atmosphere. Particles are a threat, particularly for aircrafts and spacecrafts.

PERSPECTIVES FOR EXPLORATORY OR INTERFACE PROJECTS WITH STRONG SOCIETAL IMPACT

. **Perspectives for exploratory or interface projects with strong societal impacts III**

New detectors and readout methods in geophysics and astrophysics. A major challenge for 2020-2030 in space geophysics will be to do remote sensing of geophysical signals. Similarly, the development of new high-sensitivity accelerometric detectors has applications in geophysics and fundamental physics. Furthermore, UnivEarthS has supported the development of mm and sub-mm cryogenic detectors for cosmology (TES/MKIDS) with a potential for valorisation in radio astronomy, in Earth and planetary sciences, and in medicine

Data science from Earth to Planets and the Universe. Within the UnivEarthS framework, the valorisation work package carried out by APC and IPGP enabled to acquire expertise on cloud computing and Big Data. Several projects such as Euclid and LSST for the APC-AIM and VERCE (Virtual Earthquake and seismology Research Community in Europe) for the IPGP entered the Big Data area.