December 3, 2018

Labex UnivEarthS

8TH SCIENTIFIC COMMITTEE

www.univearths.fr

INVESTISSEMENTS D'AVENIR

USPC Université Sorbonne Paris Cité

UnivEarthS Scientific Committee

PROGRAM

Monday December 3

On 2018, the scientific committee will be held on closed session with only the members of the executive board and of the scientific council.

The scientific committee will take place at 1:30 a.m. in the council room (n°108) at IPGP, 1 rue Jussieu, 75005 Paris.

MEMBERS OF UNIVEARTHS EXECUTIVE BOARD

The following members of the executive board will be present:

Marc Chaussidon, UnivEarthS director
Antoine Kouchner, UnivEarthS co-director
Isabelle Grenier, representative of AIM
Sotiris Loucatos, representative of APC
Gauthier Hulot, representative of IPGP

Are also invited:

Eleni Chatzichristou, project manager
Clémence Epitalon, communication officer

MEMBERS OF SCIENTIFIC COMMITTEE

You'll find here a short presentation of the SC members and their research interests.

Joël BERGÉ

- *ONERA - The French Aerospace Lab*

- Experimental tests of gravitation
- Observational cosmology
- Data analysis / signal processing

Piercarlo BONIFACIO

- *GEPI - Galaxies, Stars, Physics and Instrumentation*

Thesis "Chemical composition of three Population II stars".
2014 publication: "Galactic globular cluster 47 Tucanae: new ties between the chemical and dynamical evolution of globular clusters?"

Donald DINGWELL

- *LMU Munich Department of Earth and Environmental Sciences, Section of Mineralogy, Petrology and Geochemistry*

Dingwell's principal research interest is the physico-chemical description of molten rocks and their impact on volcanic systems.
2015 publication: Experimental constraints on phreatic eruption processes at Whakaari (White Island volcano) Journal of Volcanology and Geothermal Research.

Edouard KAMINSKI

- *IPGP - Institut de physique du globe de Paris*

Theoretical, experimental and numerical study of the dynamics of geological fluids.

Stavros KATSANEVAS

- *EGO - VIRGO*

- Theory of strong interactions
- Standard model of weak and electromagnetic interactions
- Neutrino and astroparticle physics
- Interdisciplinary studies

Pierre-Olivier LAGAGE

- *AIM - Astrophysique, Instrumentation, Modelisation*

2014 publication: "Metrology calibration and very high accuracy centroiding with the NEAT testbed".
2013 publication : "First experimental results of very high accuracy centroiding measurements for the neat astrometric mission"

Bernard MARTY

- *CRPG Nancy - Centre de Recherches Pétrographiques et Géochimiques*

- Origin of isotopic variations in the Solar System
- Geochemistry of volatile elements (C, N, water, noble gases)
- Early Earth geodynamics and environments
- Mantle geodynamics -ridges, mantle plumes, volcanic provinces
- Fluid circulations in the crust

Alessandro MORBIDELLI

- *OCA - Observatory of Nice*

Morbidelli specializes in solar system dynamics, especially planetary formation and migration and the structure of the asteroid and Kuiper belts.

Edward STOLPER

- *Caltech - Division of Geological and Planetary Sciences*

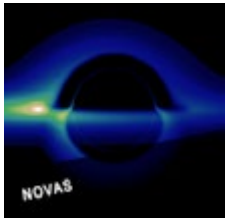
Involved in a wide range of experimental, analytical, theoretical, and computational studies principally aimed at understanding the origin and evolution of igneous rocks on the earth and other planets (Melting of the mantle, Deep drilling into a Hawaiian volcano, Generation of arc and back-arc magmas, Diffusion of water in volcanic gases, Concentration and isotopic composition of CO2 in air in the Los Angeles Basin)

EXPLORATORY PROJECTS

E5: APC/AIM/LUTh

A Numerical Observatory of Violent Accreting systems (NOVAs)

WP Leader: Fabien CASSE, Astroparticule et Cosmologie, fcasse@apc.univ-paris7.fr



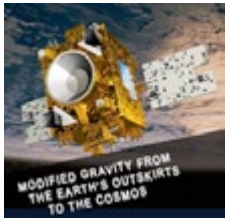
Over the last years, we have managed to develop a new general relativistic (GR) fluid code aiming at studying the behavior ofplasmas prone to extreme gravitational fields, namely in the vicinity of any kind of compact objects, and fully coupled it withray-tracing to get spectral and timing synthetic observations.

The newly developed 'Numerical Observatory of Violent Accreting systems' (NOVAs) has enabled us to perform astrophysical fluid studies while we carry on efforts in data processing in order to access the physical conditions prevailing in accretion flows orbiting around compact objects. The recent addition of state-of-the-art particle-in-cell computations embedded into general relativistic MHD simulations as well as non-analytical (time-dependent) metrics has opened the door to multi-messenger synthetic observations of such systems. Thanks to the perfect timing with the rise of new instruments (GRAVITY, Taramis, NICER but also LIGO/Virgo, Athena and LISA) we are now able to provide direct links between models and forthcoming observational data. We plan to use the last year of the labex as a stepping stone for the extended NOVAs (e-NOVAs) project which is going from our electromagnetic multiwavelength numerical observatory toward a multi-messenger observatory.

E8: ONERA/AIM

Modified Gravity from the Earth's outskirts to the cosmos

WP Leader: Joël BERGE, ONERA, joel.berge@onera.fr



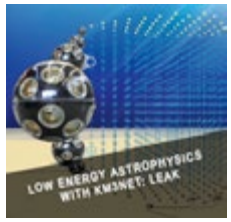
A first part of our work is based on constraining modified gravity with space-based tests. We use MICROSCOPE's first results about the test of the Equivalence Principle to derive new, competitive constrains on a Yukawa interaction and a light dilaton. Our work on constraining the chameleon field with MICROSCOPE is still underway, but we already showed that experimental tests of the chameleon in space are not as obvious as expected a few years ago. Finally, we investigated the impact of the shape of the source of gravity when searching for a Yukawa interaction in space.

A second part of our work is based on the modeling and statistical characterization of transients in the MICROSCOPE data. We find that they most likely originate from thermal effects due to the Earth albedo. Exponential shapelets seem good basis functions to model their shape.

E9: APC/AIM

Low Energy Astrophysics with KM3NeT: LEAK

WP Leader: Alexis COLEIRO, Astroparticule et Cosmologie, coleiro@apc.in2p3.fr



Electromagnetic observations of core-collapse supernovae (CCSN) provide valuable information on the stellar progenitor, the circumstellar environment and the asymmetry of the ejecta but cannot probe the physical processes at work during the collapse, in the inner parts of the object. Therefore, the subsequent shock formation and the onset of explosion are not reachable by traditional observational methods and only detection of MeV neutrinos produced during the CCSN would help to understand further the explosion mechanism. The main purpose of this exploratory project is to test the CCSN detection capabilities of the new-generation neutrino telescope KM3NeT. Although KM3NeT detectors are optimized for the detection of atmospheric neutrinos in the GeV range (KM3NeT-ORCA) and cosmic neutrinos in the TeV-PeV domain (KM3NeT-ARCA), we are trying to make the most of the KM3NeT design, using full Monte-Carlo studies, in order to infer its potential sensitivity to a CCSN signal. Preliminary results are promising since they show that KM3NeT will be able not only to significantly detect the next Galactic CCSN but also to characterize its neutrino spectrum. Those results were presented during an international workshop on CCSN neutrino detection, organized on July 4 and 5, 2018 thanks to the LabEx funds. We are now working in collaboration with IceCube and the Supernova Early Warning System (SNEWS) project in order to offer the capability of precisely reconstructing in real time the time and the localization of the explosion. This new milestone of the project will integrate it in a multimessenger perspective, offering the possibility to looking for gravitational-wave and electromagnetic counterparts of a Galactic CCSN neutrino burst.

FRONTIER PROJECTS

F1a: IPGP
Earth as a living planet: from early ages to present dynamics

WP Leader: Pascal PHILIPPOT, Institut de Physique du Globe de Paris, philippot@ipgp.fr

The objective of the WP F1-1 is to move forward our understanding on the mechanisms, causes and consequences of the rise of atmospheric oxygen on Earth. Our aim is to characterize the evolving biosphere and the changing environments (glaciogenic events) across the 2.45 to 2.2 Ga old Great Oxidation Event. To achieve this goal, we obtained pristine drill cores of key sedimentary successions from the Turee Creek Group in Western Australia and develop new means to image and analyze chemical (major and trace elements) and isotope proxies (S, C, N, Fe, Mo, Cr) on the same samples at multiple scales (from the microfossil-scale to the sedimentary basin level). The strong focus of linking multiple scales of observations, sedimentary history, and the use of state-of-the-art mineralogical and geochemical techniques allowed identifying key insights into the history of life and oxygen during the Archean-Paleoproterozoic transition.

F1b: IPGP
Subduction

WP Leader: Nicolai SHAPIRO, Institut de Physique du Globe de Paris, nshapiro@ipgp.fr

A full understanding of the subduction process and of its role in the Earth's evolution requires studying the interplay between different involved physical and chemical processes with complementary contributions from different geosciences disciplines (seismology, geodynamics, tectonics, volcanology, geochemistry …). While many of Solid Earth geoscientists are dealing with some aspects of the subduction, most of existing studies are carried out in a frame of a single discipline and complex approaches to subduction are rare. A unique example of such a complex approach is the NSF-funded program GeoPRISMS (Geodynamic Processes at Rifting and Subducting Margins), while similar initiatives do not exist in Europe or in France. At the same time, the institutions involved in the LabeEx UnivEarthS and in particular the IPGP regroup specialists from a large spectrum of disciplines working on the subduction, providing us with a unique opportunity to take a leadership role in this area. Therefore, the main goal of the proposed workpackage is to develop an interaction between these different disciplinary teams and to create a group focusing on complex studies of the subduction processes.

F2:APC
From Big Bang to the future of the Universe

WP Leader: Yannick GIRAUD-HERAUD, Astroparticule et Cosmologie, Yannick.Giraud-Heraud@apc.univ-paris-diderot.fr

In 2018, the labex UnivEarthS WP F2-APC exercice was a bit special as it included only a small allocation for basic support (without funding for equipment that was used in previous years to consolidate R & D in the millimeter range to prepare future CMB polarization projects). Regarding human resources, the funding of a second year of post-doc on QUBIC for Maria Salatino in order to support the team ensuring the commissioning of the instrument was transformed, following the departure of Maria Salatino after a very positive first year, in a semi-doctoral contract on the same profile (with the agreement of the board of the labex). As described in the report, the funding was mainly used for missions allowing the APC group to secure a strong position on future CMB polarization detection projects such as the LiteBIRD JAXA mission, now supported by ESA and CNES, and the Simons Observatory ground project in liaison with the LBL group in Berkeley, whose French participation, and in particular APC, is on a very good track but still to be precised beyond the already successful contribution to data analysis. The involvement of the WP team in the new approach using jointly several cosmological probes (eg CMB and weak lensing) continues on its way. The dynamism of the group, whose approaches have been supported by the labex, is reflected by the large number of new PhD students starting a PhD this year.

F2a: APC
Support to PCCP

WP Leader: Matteo BARSUGLIA, Astroparticule et Cosmologie barsu@apc.in2p3.fr

The Paris Centre for Cosmological Physics (PCCP) is a place for research, education and scientific exchanges in the field of cosmology and more generally the physics of the Universe. During the last years, the PCCP realized extremely successful actions in the field of education (among them: the MOOC « Gravity ! », the program of training for high-school teachers Teaching the Universe) ; the PCCP also hosted and formed several post-docs (PCCP fellows) and established a program of exchange between scientists and artists. The goal for 2019 is to continue and consolidate this program, with in particular an update of the MOOC Gravity !, and starting a research activity in the field of cosmology with gravitational-waves.

F3: AIM
The transient catastrophic Universe

WP Leader: Stéphane CORBEL, AIM/CEA, stephane.corbel@cea.fr

Radio interferometric imaging has entered a new golden age with the arrival of new continental facilities such as SKA and its immediate pathfinders (e.g. NenuFAR) and precursors (e.g. MeerKAT). Project F3 aims at exploiting the best of these instruments to study, in a robust way, the transient and catastrophic Universe. On one hand, tremendous sensitivity and improved temporal, spectral and angular resolutions give birth to a deluge of data that need to be faced in the context of Big Data (radio)Astronomy. On the other hand, recent results in mathematics applied to signal processing (namely Compressed Sensing and Sparse reconstruction) allow for a new signal processing framework for image processing, data reconstruction and robust scientific exploitation of products. Project F3 enforces the transfer of technologies and methodologies from this framework to modern radio interferometric imaging. After first developing imaging algorithms, we are now in the process of: 1) optimizing and applying them to real radio data obtained with SKA precursors (MeerKAT and LOFAR), 2) adapt these tools to online & offline data processing pipelines dedicated to the search for slow and fast transients in the image plane.

INTERFACE PROJECTS

I2: APC/IPGP
Geoparticles

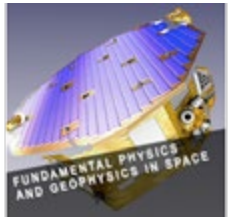
WP Leader: Alessandra TONAZZO, Astroparticule et Cosmologie, tonazzo@in2p3.fr

The focus of the most recent developments of WP I2 has been on the novel application of muon tomography to archaeology. An interdisciplinary project was started to study the feasibility of this technique to explore archaeological structures and, if possible, perform first set of measurements as proof of concept.

The great novelty of 2018 was the measurement campaign at the site of the Apollonia Tumulus, in Greece. The activity was carried out in collaboration with other French Laboratories (IPN-Lyon and LAPP-Annecy), the GeoPhysics Department of Aristotle University of Tessalonikki and the EGO consortium in Italy. Theodors Avgidas, UnivEarthS post-doc, had a key role in the commissioning and installation of the detector, the data taking, simulations and analyses.

I3: APC/IPGP
Fundamental physics and Geophysics in space

WP Leader: Hubert HALLOIN, Astroparticule et Cosmologie, hubert.halloin@apc.univ-paris7.fr



This work package is a joint project between APC and IPGP, on the LISA Pathfinder and LISA missions, as well as the development of a novel optical readout system for planetary seismometers. Most of the work on LISA Pathfinder ended with the decommissioning of the mission in July 2017. The LabEx supported the PhD thesis and afterwards first year of postdoc of H. Inchauspe who worked on the modeling of

LISA dynamics (based on LISA Pathfinder experience) and initiated the characterization method of cold gas thrusters. Following the selection of LISA by ESA, the dynamics simulation method is now being included into an 'end-to-end' science simulator of the mission, where APC has a leading role.

Concerning the optical readout system, L. Fayon (3rd year PhD student on USPC grant) defined her PhD thesis in April 2018. Her work was divided in two complementary research topics. The first one was focused on the modeling of the response function for the SEIS seismometer onboard Insight (whose arrival on Mars is scheduled for November 26th, 2018). The second topic was the design and development of an interferometric readout system for planetary seismometer. Lucile modeled and estimate both the instrument response and expected noise sources. She was then able to build a first prototype of this readout system and demonstrated its potential value for future generation of broadband seismometers. Her work paved the way to an accepted H2020 proposal aiming at consolidating the concept and increase its technology maturity.

I6: IPGP/AIM
Dust to planets

WP Leader: Sebastien RODRIGUEZ, Institut de Physique du Globe de Paris, rodriguez@ipgp.fr

Our project aims at studying the differentiation and surface dynamics of planets, focusing on Earth, Mars and Titan. Theme 1 combines high P/T experiments and isotopes geochemistry to understand the fate of volatile elements during planetary formation. Theme 2 develops theoretical tools to probe the internal structure of planets using seismology. Theme 3 focuses on large-scale dune experiments to understand planetary surface and regolith dynamics.

I7: AIM/APC
Gamma-Ray Bursts: a unique laboratory for modern astrophysics

WP Leader: Diego GÖTZ, AIM/CEA, diego.gotz@cea.fr

The goal of the WP 7 Interface project was to prosecute our studies on Gamma-Ray Bursts (GRB) on two main subjects: on one side as potential and promising sources of gravitational waves, neutrinos, cosmic rays, and TeV gamma-rays, and on the other side on the observations and interpretation of data about the GRB environment.

We focus our report on the results of GRBs as probes of their environment, obtained thanks to the LabEx hiring of M. Arabsalmani at AIM, tutored by E. Le Floc'h (AIM) and S. Vergani (GEPI), since it is where the labex funding has been mainly used in 2017/2018. Two (first author) papers have been published in 2018 and one will be submitted soon. The work focusses on one side on the molecular content of the host galaxy of GRB080207, bringing new clues on GRBs environment, and on the other to the host galaxy of GRB980425, and on the general relation between galaxy mergers and the formation of GRBs. A larger statistical sample is needed to further investigate these relations.

I8: APC/IPGP
ARGOS: Astroparticle research, geology and oceanography studies

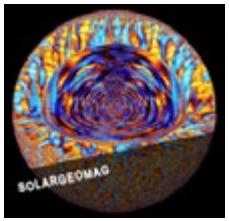
WP Leader: Véronique VAN ELEWYCK, Astroparticule et Cosmologie, elewyck@apc.univ-paris7.fr

The KM3NeT Collaboration has started the deployment of a next-generation neutrino telescope on two abyssal sites in the Mediterranean Sea, close to Toulon (France) and Capo Passero (Sicily).

This provides new scientific and technological opportunities for interdisciplinary collaborations with Earth and Sea Sciences. The ARGOS project and aims at federating the available expertise at APC and IPGP, to exploit the unique abyssal location and infrastructure of KM3NeT for the deployment and exploitation of seismic and marine sensors and for the study of the composition of the inner Earth (mantle and core) through atmospheric neutrino oscillation tomography.

I9: IPGP/AIM
SOLAR GEOMAG

WP Leader: Alexandre FOURNIER, Institut de Physique du Globe de Paris, fournier@ipgp.fr



The main goal of the project SolarGeoMag was to improve our physical understanding, and our capability to predict, the long-term magnetic activity of the Sun and the Earth. The idea was to base this understanding on the analysis of 3D simulations that would be parameterized and subsequently implemented in low dimensional models amenable to data assimilation experiments. After three years, we have at our disposal a variational assimilation tool to forecast solar activity, and we are about to take part in the next solar panel for prediction of solar cycle 25, using our physics-based approach which rests on a mean-field (2D) model of the solar dynamo. Our exploration of parameter space for 3D MHD simulations, and their subsequent analysis, is a computationally expensive task that took longer than initially expected. The exploitation of 3D simulations will take place in the framework of other research projects.

I10: AIM/APC

From evolving binaries to the merging of compact objects

WP Leader: Sylvain CHATY, AIM/CEA, chaty@cea.fr

More than 70% of massive stars experience a binary interaction at least once in their life (Sana et al. 2012). In the course of their evolution, one of the stars first becomes a compact object (white dwarf, neutron star or black hole), and, if close enough, attracts matter from its companion. The stars thus exchange both matter and angular momentum, through an energetic process called accretion: they become accreting, compact binaries (Chaty 2013). Such a pair of massive stars eventually evolves towards the merging of two compact objects. This phenomenon, leading to the emission of gravitational waves, has been beautifully revealed for the first time on the 14th of September 2015 by the LIGO-Virgo collaboration, arising from the merging of two heavy stellar mass black holes of ~30 solar masses (Abbott et al 2016ab). Since this first event, the handful gravitational wave detections constitute the tip of the iceberg: close binaries exist everywhere in our Universe, eventually detected when they merge and emit gravitational waves!

Most evolutionary models of binary stellar systems are based on the coupled evolution of two single, isolated stars. However, these evolutionary models are incomplete: while we do not fully understand the mechanisms governing stellar evolution, we know even less about the physical processes occurring in close binary systems, where both stars exchange matter and angular momentum. First, the common envelope phase, occurring very early in the evolution of a compact binary, is still both theoretically and observationally highly unknown. Second, the natal kick received at the supernova event is not constrained, especially for the black holes. Finally, the metallicity plays an important role in the strength of the stellar winds, which can cause the star to lose much of its mass.

To better constrain these three fundamental parameters, we propose to study the evolution of known binary systems in our Galaxy, taking into account new observational parameters obtained with the Gaia satellite (offering us a 6D-view –position and velocity– of our Galaxy, see Bailer Jones et al 2013), and compare the final products with the current output of population synthesis models. We will then use this template, with better constrained parameters (such as orbital separation, mass ratio, metallicity, timescale), to extrapolate the population of binary systems to low-metallicity environments, allowing us to better predict the rate of compact object mergers, and in particular of binary stellar-mass black hole mergers detectable by the LIGO-Virgo collaboration. The timeframe of our project is ideal, with 1. the 2nd Gaia data release in April 2018 ; and 2. LIGO/Virgo observatories obtained data during O2 (6 months in 2016-2017) and will resume observations during O3 (beginning in February 2019), likely detecting tens of additional binary black hole mergers and possibly also NS+BH and binary NS systems. Our project will thus actively contribute to the scientific exploitation and astrophysical interpretation of these new observations.

I11: AIM/IPGP

COR2DISC

WP Leader: Patrick HENNEBELLE, AIM/CEA, patrick.hennebelle@cea.fr

Stars form inside dense molecular clouds through gravitational collapse. As accretion proceeds onto the central protostars, the angular momentum carried along by the gas, leads to the formation of centrifugally supported, circumstellar and protoplanetary discs. While the understanding of disc formation and evolution has recently done important progress thanks to both high resolution observations and heavy numerical simulations, several fundamental and fascinating questions remain unknown, concerning the physics of molecular cloud collapse and the building of a planet forming cimrcumstellar disk. Study of Solar System material (isotopic composition of chondrites, chemical composition of minerals) show that the Solar System material was not fully homogeneized and that possibly large scale transport may have occurred (for example high temperature minerals were found in comet's coma). In addition, some material may have arrived lately (like Al26). We do not know if these large scale transport processes may have occurred during the disk phase or have occurred during the cloud collapse. The current project CORE-2DISK aims to bridge the gap between the physics of the cloud collapse (using high end numerical simulations in the hydrodynamic, ideal MHD and non ideal MHD approximations) as well as to understand the condensation/volatilisation and transport of material during the disk phase (using long term-large scale 1D simulation of dust transports). In October 2017, we have hired a postdoc to start working on this link. During this last year, several intensive simulations of core collapse have been performed (Hydro, ideal MHD, non ideal MHD) at various spatial resolutions and are under analysis. In particular, the transport coefficients and disk characteristics are being measured and quantified. Models of dust transport in a prescribed evolving and radiative disk have been also developed, presented in conferences and one paper has been published. In 2019 we aim to pursue the simulations at longer time and develop a semi-analytical model of cloud collapse to bridge the two approaches, and to quantify the effect of the collapse dynamics onto the material composition and transport in the Solar System. We will then update the disk model to use the constraints extracted from the simulations. The consequence on the Solar System material will be examined.

- I13: APC/IPGP

Geophysics and gravitational wave interferometric detectors

WP Leader: Matteo BARSUGLIA, Astroparticule et Cosmologie
barsu@apc.in2p3.fr

The goal of this project is to study the feasibility of a earthquake early warning system (EEWS) based on the prompt gravity signal, before the p-waves arrival. We have detected the signal in the M=9.1 2011 Tohoku earthquake data and found it in agreement with a numerical simulation. We have then demonstrated that, for a big earqhuake (M~ 9), this technique can be used to compute the earthquake's magnitude in ~3 minutes, before the conventional methods. The potential for tsunami warning is evident. In order to give faster alerts for smaller earthquakes, new instruments are necessary, based on the research performed in the gravitational-wave community. We are studying the practical feasibility of these gravity gradiometers with seismic isolated test masses and the potential of a network of these new instruments for EEWS.

Matteo Barsuglia (APC) and Jean-Paul Montagner (IPGP) in the EGO-VIRGO control room

YOUNG TEAM PROJECTS

- JE2: APC

Direct Searches for Dark Matter with Liquid Argon detectors

WP Leader: Davide FRANCO, Astroparticule et Cosmologie, dfranco@in2p3.fr

The JE2 team has accomplished a major milestone in 2018 with the world best limit to WIMP dark matter particles with masses below 6 GeV/c2, using the DarkSide-50 detector. This result extends previous limits by an order of magnitude and demonstrates the potential of liquid argon based technology in a domain previously dominated by solid state detectors. The JE2 has played a leading role in the analysis, which strongly relies also on the results achieved in the last years within the JE2 program, namely the modeling of the liquid argon response and the measurements performed within the ARIS project.

Davide Franco (APC), Cristiano Galbiati (Princeton University),
Art Mac Donald (Queens University) & Claudio Giganti (LPNHE)

- JE3: AIM

Advanced Gamma-Ray Science Methods and Tools

WP Leader: Karl KOSACK, AIM/CEA, karl.kosack@cea.fr

Improvements to VHE Gamma Ray Telescope Reconstruction with advanced signal processing methods: We present the latest results from UnivEarths project JE3, where we apply novel signal processing techniques to the event reconstruction for Imaging Atmospheric Cherenkov Telescopes (IACTs). The result is a significant improvement to the point-spread-function and detection sensitivity of gamma rays in the range of 50 GeV to 100 TeV. The results are applied to simulated data for the Cherenkov Telescope Array (CTA) and imply that we can achieve a sensitivity better than the design requirements with minimal effort.

EDUCATIONAL PROJECT

K2: APC/IPGP

UnivEarthS nanosatellite student (IGOSat) project

WP Leader: Hubert HALLOIN, Astroparticule et Cosmologie, hubert.halloin@apc.univ-paris7.fr

IGOSat is an educational project aiming at developing, with students, a 3U CubeSat with 2 science payloads : a new generation of scintillation detector for electrons and gamma-rays; and a dual frequency GPS receiver for measurements of the total electronic content of the ionosphere. IGOSat started in 2012 and welcomed, up to now, about 250 students on the project, including more than 60 interns (bachelors and mostly master students). Some subsystems of IGOSat are purchased 'of-the-shelf' (e.g. the telecom, computer and GPS boards), but the general rule is to design and build as much as possible internally. In September 2017, IGOSat passed the Critical Design Review (CDR), ending Phase C. IGOSat is therefore still then in Phase D, i.e. preparing for the crucial integration, tests and validation phases of the engineering, qualification and flight models. Some design flaws have been recently discovered during this process and are currently being addressed and solved. Based on the remaining work and current schedule, the launch is expected in 2020 / 2021. IGOSat is co-funded by the LabEx and the CNES through its JANUS program. The main laboratories involved in IGOSat are the APC and the IPGP.

The 2017-2018 promotion of students working on the IGOSat project

VALORIZATION PROJECT

V1: APC/IPGP

Data distribution, visualization and cloud computing

WP Leader: Cécile CAVET, Astroparticule et Cosmologie, ccavet@apc.in2p3.fr

Both space-based experiments and seismology are facing the challenge of treating steadily increasing and complex data sets. The synergies between the François Arago Centre (FACe) within APC laboratory and both the Data Centre and the Data Analysis Centre (S-CAPAD) within IPGP, connected through a high speed network infrastructure, provides us with a unique data and computing aware environment. It is also instrumental in terms of implementing new and innovative approaches for data integration and analysis for fully exploring the cornucopia of modern observations. With the arrival of new IT paradigms such as cloud computing/container solutions, Big Data, and Artificial Intelligence, the project must manage the transition to new technologies and how they can impact the data analysis of the futur space missions.

V2: IPGP

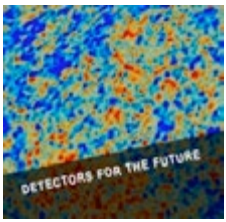
In situ cosmogenic dating of extraterrestrial surfaces

WP Leader: Manuel MOREIRA, Institut de Physique du Globe de Paris, moreira@ipgp.fr

The Valorisation project untitled "In Situ Cosmogenic dating of extraterrestrial surfaces" consists on the development of a "spatialisable" mass spectrometer that is able to analyse the noble gas contents and isotopic ratios of ~mg samples. The objective is to realise the "proof of concept" of such an instrument that aims quantifying the cosmogenic exposure ages in order to perform a "cosmo-morphology" of extraterrestrial surfaces. The year 2018 was focalised at the installation of the new instrument and the construction of the extraction and purification line. We have written and developed new softwares to pilot the line and the mass spectrometer, and to process the data. The phase of test is finished and the instrument is clearly above our expectations. We have started a test-project aiming at better defining the mean carbonaceous chondritic composition for Krypton, which has significant implications of the origin of terrestrial volatiles. For 2019, we would like continuing the analytical development on the instrument by developing a new and innovative cryogenic system, which will allow a better separation of the noble gases, permitting avoiding isobaric interferences. A new test-project will then be developed on the heterogeneity of pre-solar grains within the inner solar system, using neon isotopes.

V3: APC
Detectors for the future

WP Leader: Matteo BARSUGLIA, Astroparticule et Cosmologie
barsu@apc.in2p3.fr



Significant progresses have been made in 2018 at APC. The initial installation of the ADR is successful, and it can hold about 48 hours without thermal load. Noise measurement of KIDs and LED illumination has successfully carried out in the 300mK cryostat, which can be used in ADR as soon as it is ready. There are also significant progresses in KIDs design and fabrication in GEPI. MIM capacitor KIDs has been fabricated with quality factor about 50,000, which is among the best result that has achieved for MIM capacitor KID. The size of the pixel will be greatly reduced and more pixel can be placed on one chip. GEPI is also working on air gapped MIM KIDs, which will not only improve the quality factor, but also reduce the two-level-system noise. Prototype has been fabricated and measured and further investigation of such KIDs will be carried out in 2019.