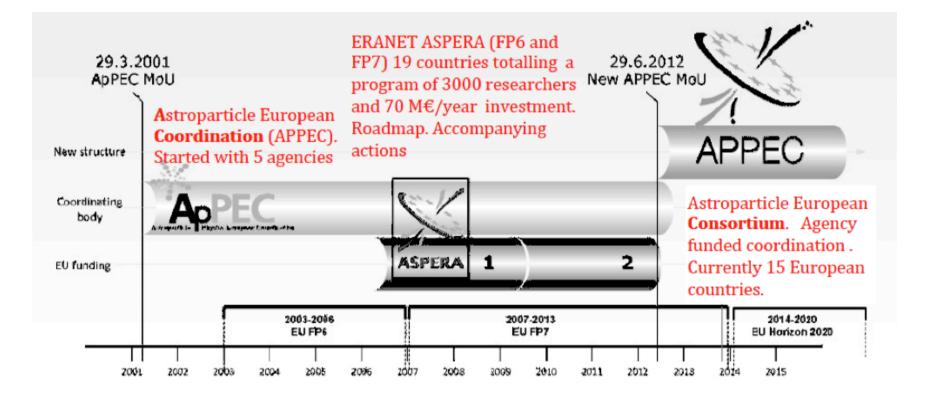
APPEC and Multidisciplinarity in European Deep Underground Labs

Dr Ino Agrafioti Research Facilitator/Scientific Officer of APPEC iagrafioti@admin.in2p3.fr





History (2001-2015)



APPEC

 Born in 2012 through a simple MoU that fused the "old" ApPEC (Astroparticle Physics Coordination) and EU-funded ASPERA (ERANET).



- Structure
 - General Assembly (GA): strategic, decision-making and supervisory body
 - Chair: (2012-1015) S. Katsanevas (CNRS), (2015-) F.Linde (NIKHEF)
 - Vice-chair: J. Seed (STFC)
 - Joint Secretariat (JS): executive body
 - General Secretary: T. Berghoefer (DESY)
 - Scientific Advisory Committee (SAC): advisory body
 - Chair: A. Masiero (INFN)
- 2015: 15 countries
 - Minimal common fund ca 70 KE (2 KE/year smaller countries, 5KE/year larger ones

APPEC 2015 CEA: France

CNRS: France CSF: Croatia **DESY:** Germany **ESO:** Transnational FOM: Netherlands FWO: Belgium FRS-FNRS: Belgium **IFIN-HH: Romania INFN:** Italy JINR: Transnational KIT: Germany LSC: Spain NCN: Poland **RIA:** Ireland **SNSF:** Switzerland STFC: United Kingdom VR: Sweden February 13/14, 2014

Joint Secretariat Conclave – Marseille

APPEC's Objectives

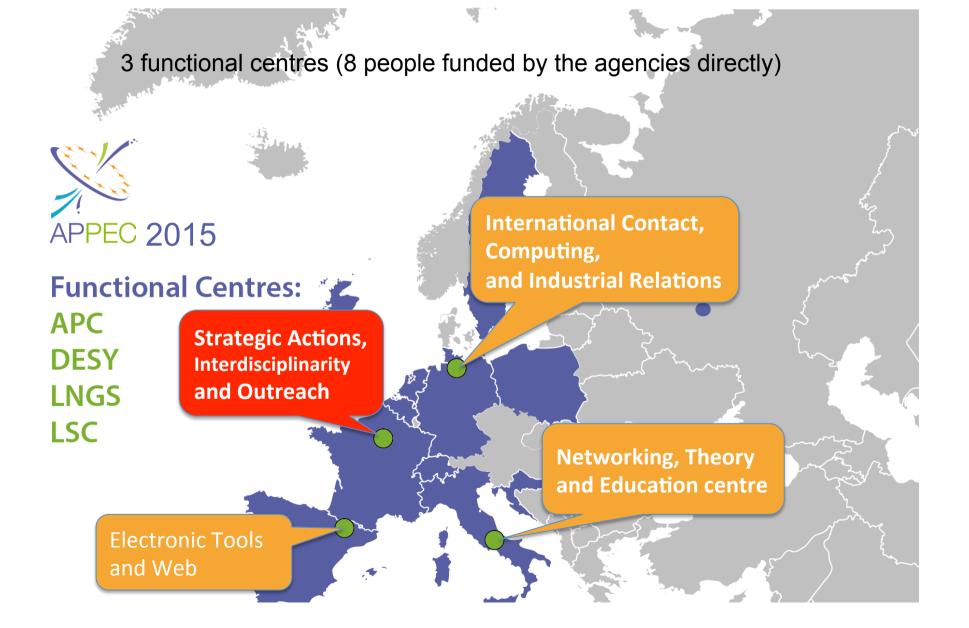
• Strategic objectives

- Provide a forum for the coordination of European Astroparticle Physics;
- Develop and update long term strategies (roadmap)
- Participate in the European scientific strategy (CERN, ESFRI)
- Develop closer relationships CERN, JINR, ESA and ESO;

• Implementation objectives

- Facilitate and enhance coordination between existing/developing national activities;
- Develop a common action plan for large Astroparticle Physics infrastructures; (INCLUDING THEIR INTERDISCIPLINARY AND INTERSECTORAL USE)
- Facilitate the convergence of future large scale projects/facilities (SEE NEXT SLIDES)
- Provide organisational advice for the implementation of large scale projects/facilities
- Launch common actions including common calls funded by a virtual common pot
- Initiate and guide activities funded by the European Commission (SEE NEXT SLIDES)

APPEC



APPEC action example 1: APPEC is proactive in global coordination

- OECD/Global Science Forum sponsored group for Astroparticle Physics: "Astroparticle Physics International Forum (APIF)"
 - APIF brings together officials and representatives of funding agencies of countries that make significant investments in astroparticle physics research.
 - It is a venue for information exchange, analysis, and coordination, with special emphasis on strengthening international cooperation, especially for large programmes and infrastructures.

APPEC action example 2: Facilitate the convergence of future large scale projects/facilities

1st International Meeting for Large Neutrino Infrastructures (Paris – June 2014
 https://indico.cern.ch/event/303475/) - Common press release

- "The agencies support an international facility for short and long-baseline neutrino oscillations at Fermilab, where internationally driven collaborations are encouraged to propose a program optimised in baseline and detector technology. This approach, in parallel with the decision of Fermilab to upgrade its beam infrastructure (PIP-II) gives the opportunity for a rich international neutrino program at Fermilab."

➔ formation of global collaboration DUNE, which has recently elected its first spokespersons (M. Thompson and A. Rubbia)



APPEC action example 2: Facilitate the convergence of future large scale projects/facilities

- 2nd International Meeting for Large Neutrino Infrastructure (Fermilab April 2015 <u>https://indico.cern.ch/event/356320/</u>)
- "The agency representatives were impressed by the rapidity, quality of convergence and momentum of the efforts of the community working on liquid argon Time Protection Chambers (LAr TPCs), to develop a credible scientific program based on:
 - an ambitious large infrastructure effort, consisting of a long-baseline beam and detector project (LBNF/DUNE) hosted at Fermilab and SURF, based on previous design studies, but largely upgrading them, proposed by an international collaboration;
 - b) a medium-scale program of short-baseline oscillation experiments at Fermilab (Short-Baseline Near Detector MicroBoone and ICARUS) aiming to test the sterile neutrino hypothesis with unprecedented accuracy;
 - c) a rich R&D and prototyping program in the CERN North Area, related to the above program along with other long-baseline efforts in the world (e.g. Hyper-Kamiokande).



APPEC action example 3: Roadmapping



The last 6 years of roadmap exercises From the "7 magnificent" to today

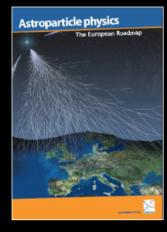
^{1st} roadmap 2008 : dubbed « The Seven magnificent ». Essentially a definition of the field. It had an international fortune, definition adopted globally (eg APIF) with minor changes. Budget-wise optimistic (pre-crisis) 50% increase of budget available in a 10 year scale. No Dark Energy and CMB projects since it was concentrating on projects the majority of APPEC agencies had direct control.

2nd roadmap 2011 : A roadmap with priorities. Still our guiding principle, further elaborated as input to the European Strategy for Particle Physics early 2013 (see later)

3rd roadmap end of 2014: Mandate by APPEC General Assembly: "A roadmap in accordance with available budgets." Ok, but first task, what are the available budgets ? Collection of data in progress. Approval of scenarii by GA in June 18. → Final priority and milestone report by the end of the year.



From the Nature article



FROM THE GEOSPHERE TO THE COSMOS: Multidisciplinarity in Astroparticle Physics Research Infrastructures



IT ALL STARTED WITH ...

« From the Geosphere to the Cosmos » 1-2 December 2010, Palais de la Découverte, Paris

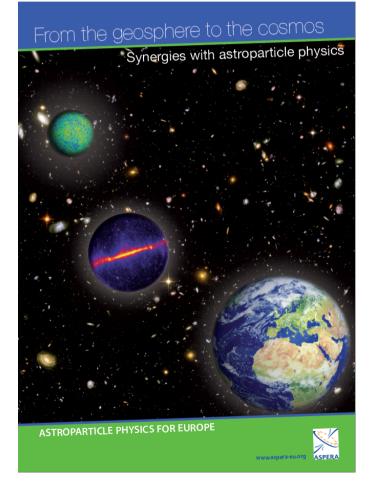
Astroparticle physics opens new horizons

Probing volcanoes, detecting whales, studying the atmosphere... Environmental sciences find new territories for research, thanks to the new infrastructures developed for astroparticle physics.



VASA

... WHICH LEAD TO ...



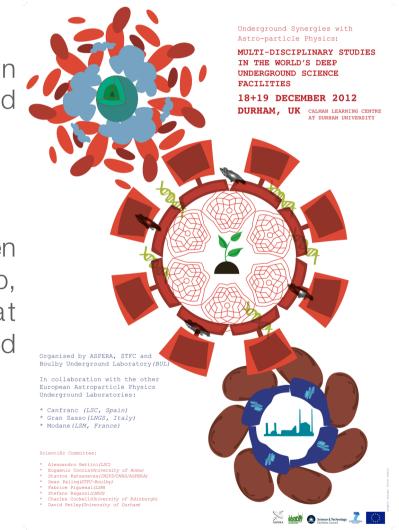


...a report that included 37 points of synergy!

	ATMOSPHERIC AND TERRESTRIAL	UNDERGROUND	UNDERWATER-ICE
UNDERSTANDING THE ATMOSPHERE	1. SPACE WEATHER 2.ATMOSPHERIC MONITORING 3. COSMOCLIMATOLOGY 4. THUNDERSTORMS and LIGHTNING	1. COSMOCLIMATOLOGY	1. ATMOSPHERIC TEMPERATURE VARIATION
UNDERSTANDIN G THE EARTH	1. EROSION RATE CALCULATION 2. VOLCANO TOMOGRAPHY	1. COASTAL ROCK CLIFF EROSION 2.CHRONOLOGY for THE PALEOENVIRONMENT 3. EARTH'S INTERIOR - GEONEUTRINOS	1. PALEOCLIMATE 2. EARTH RADIOGRAPHY
UNDERSTANDING THE OCEANS		1. CORAL CHRONOLOGY	 CONTINUOUS OCEANOGRAPHIC DATA SEDIMENT TRANSPORT OXYGEN DYNAMICS RADIOACTIVITY INTERNAL WAVES
UNDERSTANDING EARTHQUAKES	1. EARTHQUAKE MONITORING GRID	1. SEISMO-ELECTROMAGNETIC COUPLINGS 2. EARTHQUAKE PRECURSORS 3. SLOW EARTHQUAKE MONITORING	1. EARTHQUAKE AND TSUNAMI MONITORING 2. STUDYING THE LAKE ENVIRONMENT
UNDERSTANDING BIODIVERSITY		1. IMPACT OF RADIATION 2. EXTREMOPHILES	 UNDERWATER SOUND MONITORING DEEP SEA BIOLUMINESCENCE BIODIVERSITY UNDER ICE BIODEGRADATION MICROBIOLOGY BIOFOULING
APPLICATIONS		 WINE DATATION SALT CHARACTERISATION AOC SOFT ERROR RATE IN ELECTRONICS ROCK DEFORMATION 	15

For the underground synergies we then organised...

- in December 2012, a workshop in Durham, UK, called "Underground" Synergies with Astroparticle Physics". (https://indico.cern.ch/event/199223/)
- Even though these synergies have been developed independently in each lab, participants remarked the great similarities in the methodologies used within each session.



The workshop included sessions on:

Underground Synergies with Astro-particle Physics: **EARTH SCIENCES** MULTT-DISCIPLINARY STUDIES IN THE WORLD'S DEEP UNDERGROUND SCIENCE FACILITIES 18+19 DECEMBER 2012 DURHAM, UK CALMAN LEARNING CENTRE AT DURHAM UNIVERSITY **CLIMATE AND ENVIRONMENT BIOLOGY AND ASTROBIOLOGY** LOW BACKGROUND COUNTING Organised by ASPERA, STFC and Boulby Underground Laboratory (BU) In collaboration with the other European Astroparticle Physics Underground Laboratories: * Canfranc (LSC, Spain) * Gran Sasso (LNGS, Italy) * Modane (LSM, France) Scientific Committee: **GLOBAL PERSPECTIVES** Alessandro Bettini(LSC) session becchilings, gaenio Coccia(University of Roma) avros Katsanevas(IN2F3/CNRS/ASPERA) ean Paling(STFC-Boulby) Sean Pailing(S)(C-BOULEY) Pabrice Piquemal(LSM) Stefano Ragazzi(LNGS) Charles Cockell(University of Edinburgh) David Petley(University of Durham) 🖄 both 🛆 Science & Technology 👤 FUNDING

COMMUNICATION



SOME EXAMPLES



Interdisciplinarity @ LSM Use of the ulta-low gamma-ray spectroscopy

Radio-isotopes are used as tracers in the environment or as chronometers for dating of glacial or sedimentary layers.

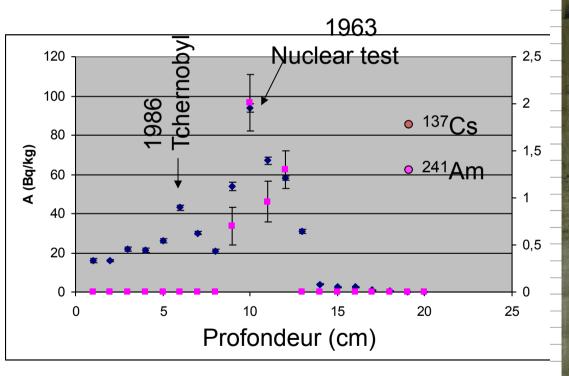
They are used also for archaeological objects which sometimes require non-destructive measurements

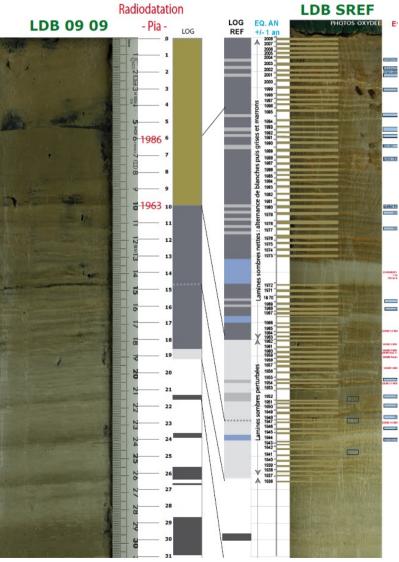
Some exemples:

- Environmental survey
- Characterization the age of the suspended solids and pollutants associated with them in rivers
- Marine and continental geochemistry
- Characterization of water masses, their origin and age in the ocean
- Retro-observation (effects on human activities on the environment)

Environmental researches

Datation of a carot from Bourget lake :





The scientific and societal usefulness of recent (< 250 years) Alpine lake sediment studies

An overview on LSM – Université de Savoie joint scientific progresses in paleolimnology

Fabien Arnaud Charline Giguet-Covex Bruno Wilhelm

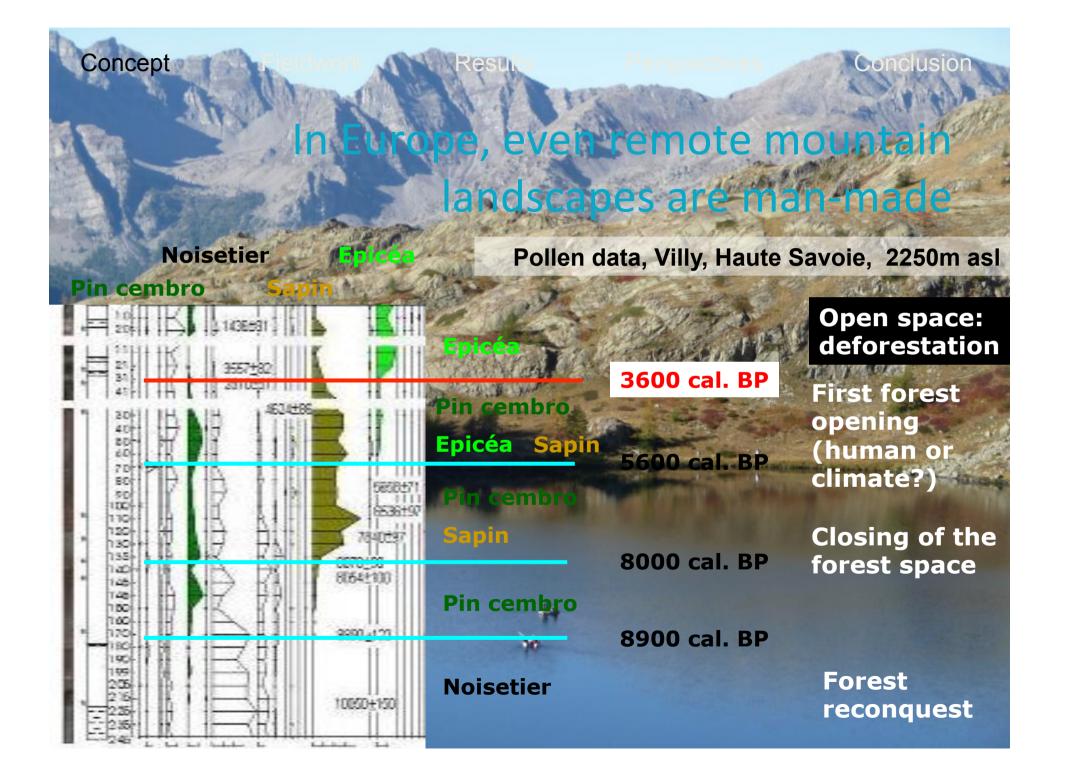


Jean-Louis Reyss



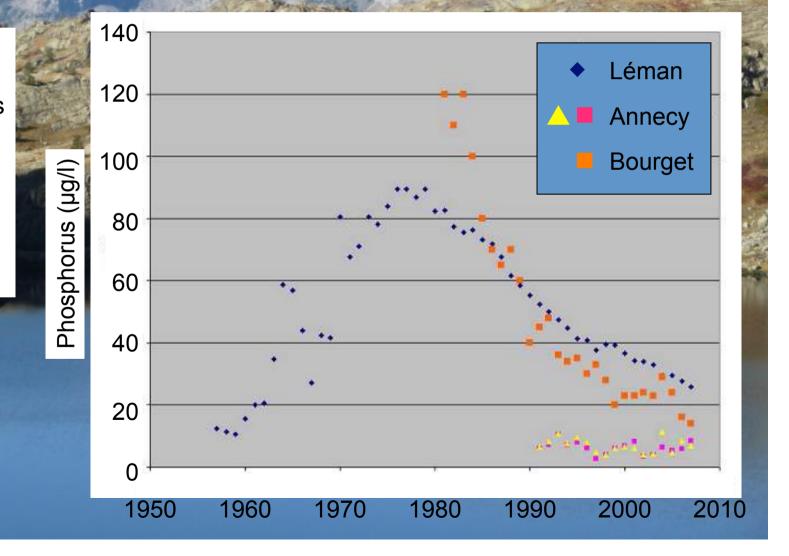
Marie-Elodie Perga





obal changes are hard to assess due to lack in monitoring data

Phosphorus, brought by wasted waters, is one of the main nutrients responsible of the degradation of lacustrine ecosystems





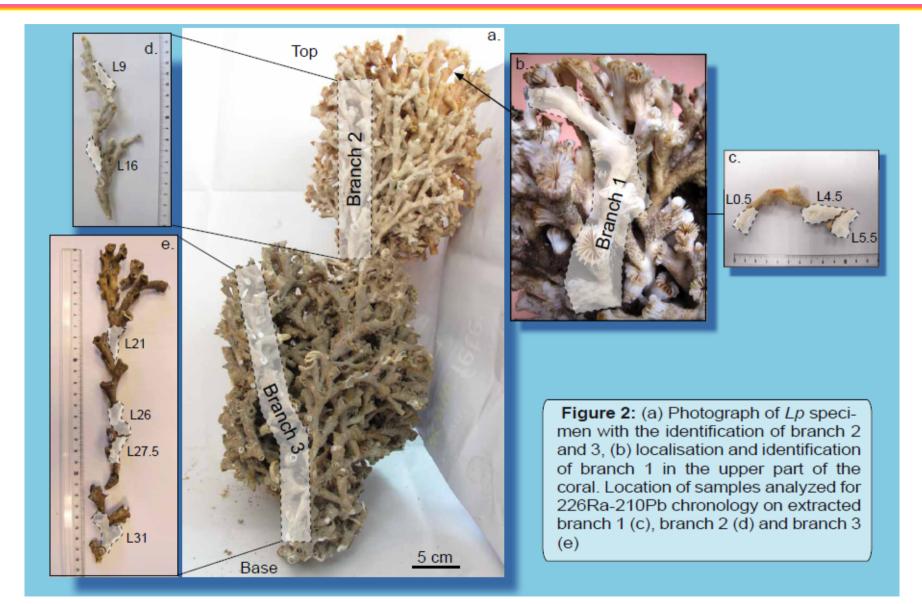
Lake sediment may have archived some environmental variables (climate, trophic state, pollutant inputs, erosion etc.)

Their study may thus bring useful information to evaluate the effect of past land-use and the efficiency of management policies

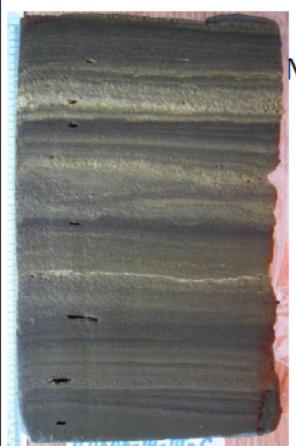
From a scientific point of view, such a "retro-observation" is crucial to assess the intensity and kinetics of global changes compared to a measured (i.e. non-hypothetical) "reference state"

URL Workshop, Montreal, May 2015

Fabrice Piquemal



Deep-sea Coral are useful archives to study seasonnal, interannual and decadal paleoclimate changes using 120Pb, 226Ra, 230Th,14C



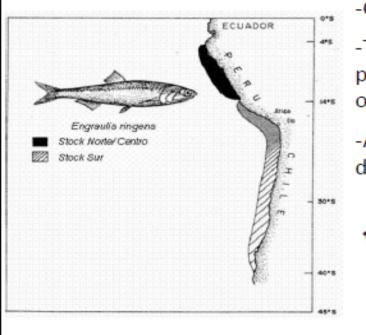
Multi-decadal to centennial scale variability in fish scale preservation and burial from marine laminated sediments off Pisco, Peru <u>during the late Holocene</u>

Salvatteci, R.

Paris, October 2010



The Humboldt Upwelling Ecosystem is characterized by strong ENSO variability and the highest pelagic fish productivity



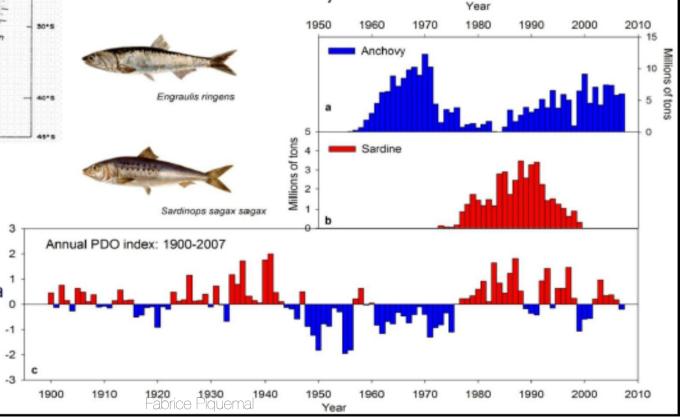
The Pacific Decadal Oscillation (PDO) Index is defined as the leading principal component of North Pacific monthly sea surface temperature variability (poleward of 20N for the 1900-93 period).

URL Workshop, Montreal, May 2015

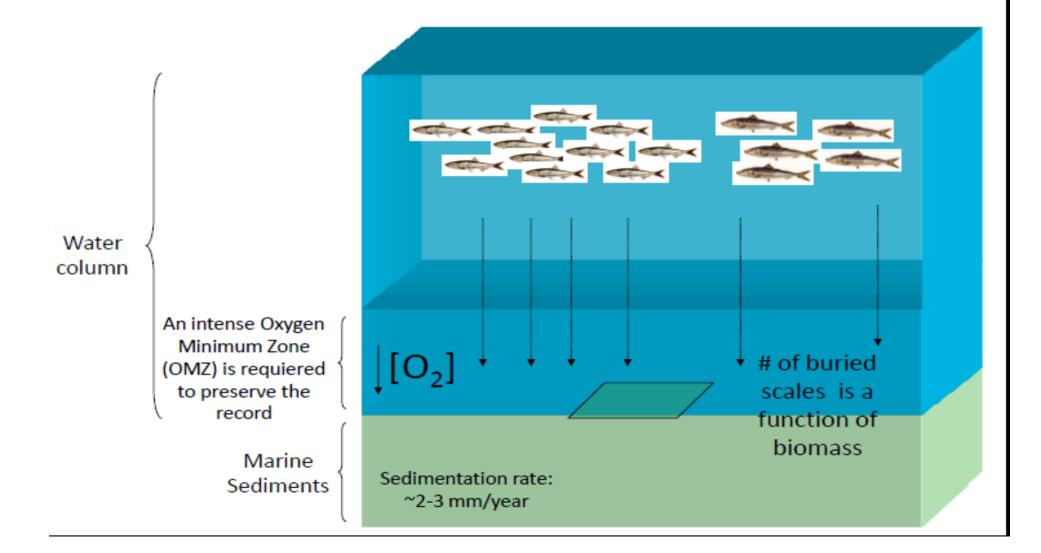
-Continuous coastal upwelling throughout the year

-The northern Humboldt Current System off Peru presently produces about 10% of the world fish catch based primarily on anchovy.

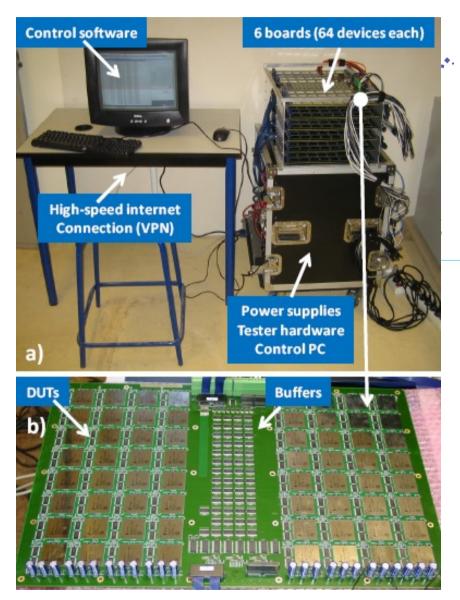
-Anchovy and sardine landings show strong annual and decadal biomass variability



Fish scales buried in marine laminated sediments can provide a record of population variability of small pelagic fishes prior to the development of the fisheries



Micro-electronics test failures



Neutrons and alpha natural radioactivity can lead to failures in micro-electronics circuits

The use of « too radioactive » materials c

LSM is reference laboratory for the international JEDEC norm for the tests of mirco-circuits resistance to radiation.

URL Workshop, Montreal, May 2015

Fabrice Piquemal

Environmental researches

Monte-Carlo Simulation of Underground Experiments

200 • Up to 20,000 h of cave **RT** experiment characterization Simulations 150 • α -SER reevaluated to 2079 FIT/MBit Number of SEU 0.5 ppb < Monte-Carlo simulation gives a contamination 100 level by ²³⁸U impurities 0.37 ppb of 0.37 ppb Very good agreement 50 with wafer-level characterization (alpha 0.2 ppb emissivity) in the range [0.2-0.5] ppb 0.2 0.4 0.6 0.8 1.2 1.4 1.6 1.8 1 Ω

Fabrice Piquemal

2

Duration (×10⁴ hours)

URL Workshop, Montreal, May 2015

Biology

- Modeling the impact of radiation on living cells: Geant4 DNA
- Validation: need for relevant observables to characterize biological systems
 - Cell survival rate
 - DNA single or double strain breaks
- Molecular biology: genomic mutations, gene expression
- Experimental protocol: compare observables after controlled radiation exposure
 - In normal lab conditions
 - After beam irradiation (γ , e-, p, α)
 - Need for a reference point at zero-

radiation: Modane URL Workshop, Montreal, May 2015 Biologists, computer scientists Physicists, chemists

Geant4 DNA

Fabrice Piquemal



- In normal lab conditions, cultures are exposed to 10
 Millions cosmic rays per day per square meter
 - Low but significant radiation exposure
- In Modane, down to 4 cosmic rays per day per square meter
- Goal: study evolution of model organisms in radiation free environment
 - Bacteria life cycle
 - Mutation rate
 - Localization of gene mutations, gene expression
 - DNA breaks



Applications :

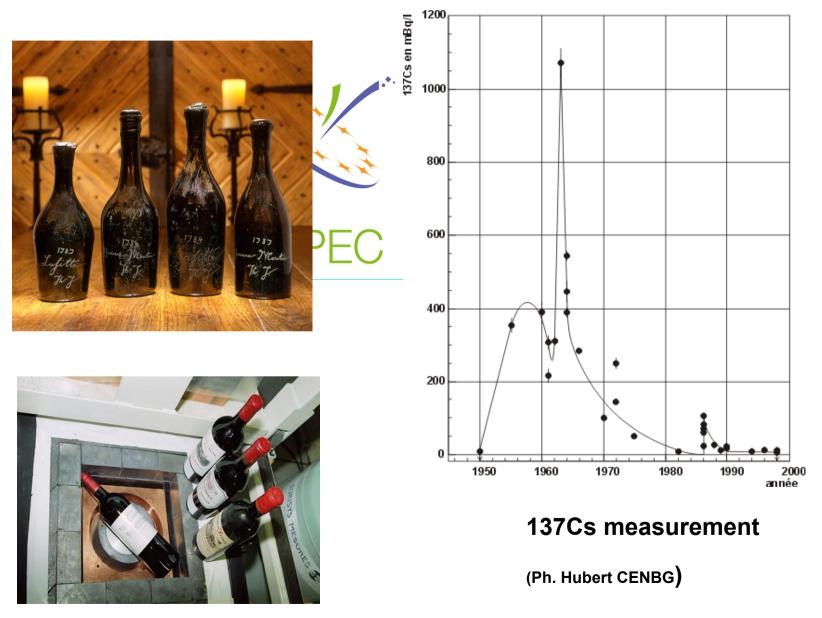
- Charaterisation of water (lake, river, underground water) EU directive
- -For drug and food administration ex. wine dating, marine salt origin
- Judicial expertises
- Mean age of crustacean livestock for fishing regulation

-

Development of a national ultra-low radioactivity platform measurements with

EDYTEM (University of Savoie/CNRS), LGGE (University of Grenoble / CNRS), LSCE (CNRS/CEA), LPSC (University of Grenoble / CNRS) and LSM

Application: wine dating



URL Workshop, Montreal, May 2015

Fabrice Piquemal

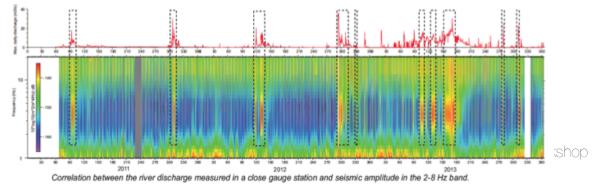
LSC: GEODYNAMIC FACILITY DETECTS LINK BETWEEN SEISMIC/STRAIN NOISE AND RIVER DISCHARGE



- LSC's added-value: LSC provides a very convenient location to host an advanced integrated facility called GEODYN to cover the whole geodynamic spectrum, from near-field seismicity to tectonic deformation, earth tides or earth-core mutation.
 - Being underground, such a facility benefits from lower level of seismic noise than usual permanent stations, particularly at long periods more affected by changes in temperature and air circulation. In addition, meteorological data are available at the vicinity of the tunnel's entrance.
 - GEODYN currently includes a seismic station and two near-orthogonally oriented high-resolution laser strainmeters. Two external CGPS stations will be operative soon.

RESULTS: Recently it was proved that the seismic noise in the 2-8 Hz band is directly related to the discharge in the Aragon River, a typical Alpine style steam running close to LSC. The seismic (and strain) signals are useful to monitor the river discharge. This is particularly interesting in the case of severe storms resulting in large flood events or for the monitoring of the annual changes in snowmelt.

• IMPACT: Such studies are of interest to seismological, meteorological, geological and climatologic communities, but also to civil authorities in charge of the management of hydrological basins.



REFERENCE: Diaz J et al. (2014) "Seismic monitoring of an Alpine mountain river" Journal of Geophysical Research: Solid Earth 119(4): 3276–3289.

CONTACT: Jordi Diaz, ICTJA-CSIC, Barcelona, Spain, e-mail: jdiaz@ictja.csic.es

BY HUMAN ACTIVITIES' FALLOU NI ICI FAR)()||)+N||S/||+S|| +XP| MOTIVATION: Due to high snow seasonal precipitation, mid-latitude ٠ continental glaciers (i.e. Tibetan and Alpine plateau) can provide a high

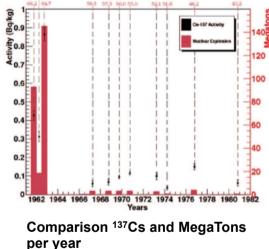
resolution climatic record of the environmental impact due to human activities. High-precision dating of these ice cores is however difficult.

LNGS: MEASUREMENT OF RADIOACTIVE ISOTOF

- **METHOD:** An analytical method for absolute dating of ice cores was proposed. ٠ based on the presence of ¹³⁷Cs (an isotope of anthropogenic origin) in ice lavers and its detection using high sensitivity v spectroscopy.
- LNGS's ADDED VALUE: Ice cores from the Lys Glacier, Monte Rosa Group (Western Alps) were analyzed using the v spectroscopy based on lowbackground high-purity germanium (HPGe) detectors based at LNGS, whose sensitivity scale is of around 1 mBg/kg.
- **RESULTS:** The method developed allows to link ¹³⁷Cs concentrations with ٠ particular nuclear events that occurred in the last 50 years, with a direct guantification of the introduced radioactive pollution.
- REFERENCE: Baccolo et al. (2014). Neutron activation analysis on sediments from Victoria Land, ٠ Antarctica: multielemental characterization of potential atmospheric dust sources. J. OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY, vol. 299, p. 1615-1623, ISSN: 0236-5731
- CONTACT: Prof. Ezio Previtali, INFN/Università degli Studi di Milano-Bicocca, Milano, Italy, e-mail: • Ezio.Previtali@mib.infn.it

Laboratori Nazionali del Gran Sasso

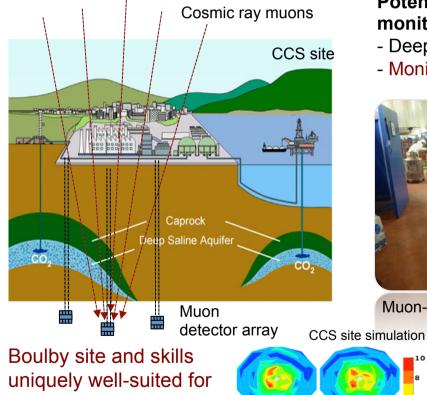




Depth (m)

Development of a Muon Tomography techniques for deep 3D geological surveying - inc Carbon Capture @ Storage (CCS)

STFC-Boulby, Durham, Sheffield, Bath, NASA



Potential for cheap, reliable, practical, real-time long-term monitoring of deep structures. Potential applications:

- Deep geological repository monitoring.
- Monitoring in Carbon Capture & Storage (CCS)



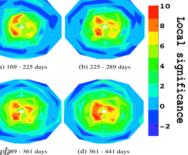
Muon-tides detector development



Bore hole detector installation

Boulby site and skills uniquely well-suited for development and testing: appropriate depth and geology, ease of access, infrastructure & expertise

S.M.Paling - Boulby@stfc.ac.@k^{89-361 days}



Deep-Carbon Project: £1.4M funding from UK Dept of Energy & Climate change (DECC) & Premier Oil:

- Bore-hole detector development & testing @ Boulby
- Muon-Tides technology demonstrator
- Simulations of technique performance in CCS





Subsurface Astrobiology Laboratory



Boulby International Subsurface Astrobiology Lab

A base for studies of life in Boulby rock studies of limits of life on earth and on other planets



Brine ALSO: An important 'Mars Analogue site'

- with geology & conditions to allow explorations & astrobiology technique & instrumentation development



S.M.Paling - Boulby@stfc.ac.uk

Mining & S. extraplanetary exploration instrumentation development



Boulby and Instrumentation for Earth and Space Exploration









How can the labs help promote further multidisciplinary collaboration?

10/05/2015

4th International URL Workshop

A distributed multidisciplinary and intersectoral doctoral school

- An EU-funded MSCA Innovative Training Network (ITN) aims to train a new generation of creative, entrepreneurial and innovative early-stage researchers.
- This kind of network must have the « triple i dimension »: international, interdisciplinary and intersectoral (academic + industry) combined with particular focus on an innovation-oriented mind-set.



A (first) doctoral school that would link the four DULs by focusing on the multidisciplinary and inter-sectorial use of the labs: « Multi-DEEP -Multidisciplinary and Innovative Training in Deep Underground Labs »

10/05/2015

4th International URL Workshop

MULTI-DEEP will aim at:

- 1. preparing a new generation of researchers that will be equipped to open a new era for the Deep Underground Labs
- 2. developing intelligent devices and tools that will bring dramatic increases in performance in the fields of Astroparticle Physics, Geosciences, Biosciences and Environmental sciences;
- 3. starting a concerted effort to link the labs with industry, through the secondment of the students to the non-academic sector.
- 4. reducing the fragmentation currently present between the scientists from non-ApP fields carrying out multidisciplinary research in DULs around the world.

Multidisciplinarity in DULIA: Objectives

- To promote access to Multidisciplinary (beyond PP and APP) science users from academic, industrial and public sectors.
- To establish a sustainable community of Multidisciplinary science users from academic, industrial and public sectors.
- To provide a platform for exchange of information between existing collaborations to promote synergies, avoid duplications and create new collaborations through the emergence of new ideas.
- To carry out in common a strategic foresight exercise for multidisciplinary experiments through a structural foresight exercise.
- To propose a standardisation of laboratory parameter measurements required by multidisciplinary experiments.
- To propose a common way to evaluate multidisciplinary science experiments in the DULs.
- To formulate a multidisciplinary science publication policy and data management plan.

Example 1: Services offered at European DULs

- In order to strengthen and broaden the societal impact of their scientific programme, the four European DULs aim at further developing access provision to scientists from non-Astroparticle Physics disciplines.
- Specifically the services provided are mainly:
 - <u>US:</u> Underground Space with services (electricity, gas, safety, monitoring, computing). The labs show great diversity in terms of depth, size, and geological/ environmental characteristics.
 - <u>ULB-HPGe:</u> the labs have developed and host the greatest "farm" of gamma spectrometers for low background measurements in the world.
 - <u>UA:</u> Easy and fast access to an underground environment for biogeoscience studies.

Services offered at European DULs

LNGS

- <u>US:</u> Underground Space with services (electricity, gases, safety, environmental radiation monitoring)
- <u>ULB-HPGe:</u> Ultra low background service with very low background HPGe detectors. The LNGS screening facility STELLA (SubTerranean Low Level Assay) can be employed for measurement of materials and of environmental and meteorite samples as regards to their content of natural radioactivity,
- <u>IETI:</u> it is a He3-He4 dilution, dry cryostat (Pulse tube based), installed in 2013. The commissioning temperature obtained in 2014 is 6.75 mK. Large experimental volume (25 cm diameter, 15 cm height) that can host different types of electronics dedicated to different type of temperature sensors.
- <u>ICP-MS:</u> used to do trace element analysis on almost all elements. Especially for U, Th, the sensitivity is on the level of ppt (10 -12 g/g). Complex matrices (e.g. metal covered plastic materials as superinsulation) can be measured separating each single component.

LSM

- <u>US</u>: Underground space with services (electricity, gas, radon-free air, environmental radiation monitoring), dedicated room for biology
- ULB-HPGe: 15 low background HPGe detectors – able to reach sensitivities at a level of 60 µBq/kg in ²⁰⁸Tl and 100 µBq/kg in ²¹⁴Bi – for material selection, environmental surveys and other applications.
- <u>ME:</u> as a reference laboratory for the JEDEC norm, LSM hosts devices to test the effects of radiation on the microelectronics circuits.
- <u>RF:</u> a radon free air production facility for set-ups requiring very low activity air environment.

Services offered at European DULs

LSC

- <u>US:</u> Underground installations and space with related services
- <u>ULB-HPGe</u>: Radiopurity measurements of materials thanks to seven HPGe detectors and the related simulation and analysis software packages
- <u>CES:</u> Radiopure copper parts manufacturing service using electroforming techniques
- <u>CRS:</u> Underground clean room class 1.000 (ISO 6) and class 10.000 (ISO 7)
- <u>UA:</u> Access to underground rock sampling for bio and geo studies

Boulby

- <u>US:</u> Underground Space with services (electricity, gases, safety, environmental monitoring).
- <u>ULB-HPGe:</u> Low background Germanium detector systems. Sensitivity down to 50ppT U/Th concentrations for material screening.
- <u>CRS:</u> Underground clean room class 10.000 (ISO 7)
- <u>UA:</u> Supported access to the wider mine workings and the various scientifically interesting/ important geologies accessible.

Multidisciplinary science in European DULs presented at AGU14

From the Cosmos to the Geosphere

CITS the quest of four European Deep Underground Laboratories originally built for Astroparticle Physics to understand Global Environmental Change Ino Agrafioti (on behalf of the four labs) CNRS/National Institute of Nuclear and Particle Physics (IN2P3) and Astroparticle Physics European Consortium (APPEC) Paris, France (e-mail: in A number of deep underground laboratories exists around the world, all originally developed to advance our Run your experiments in Europe's Deep Underground Labs! understanding of the Universe through low-background Astroparticle Physics experiments needing shielding from In order to strengthen and broaden the societal impact of their scientific programme, the four European interference produced by cosmic radiation. Over the last decade, the four European deep laboratories presented DULs aim at further developing access provision to scientists from non-Astroparticle Physics disciplines. here, supported by their funding agencies, have been making great efforts towards their integration into a single Specifically the services provided are mainly: world-class distributed interdisciplinary and intersectoral infrastructure. US: Underground Space with services (electricity, gas, safety, monitoring, computing). The labs show Meanwhile, they have been asking "how can our facilities, primarily built for Astroparticle Physics, be used to great diversity in terms of depth, size, and geological/environmental characteristics. tackle global challenges?". Astroparticle Physicists have wide experience in forming large long-term international ULB-HPGe; the labs have developed and host the greatest "farm" of gamma spectrometers for collaborations, developing innovative technologies, building unique facilities and organising data handling, background measurements in the world. reduction, storage and analysis: all this knowhow was put to the disposal of geologists, climatologists, UA: Easy and fast access to an underground environment for biogeoscience studies. environmental scientists and biologists from academia and public authorities. As a result, many interesting The four labs have applied to European Union for funding to help with the access costs of scientists from nultidisciplinary projects have used either the low-radioactivity technologies developed by the labs and/or their other disciplines and will be launching Calls for Proposals starting in 2015 (TBC). deep underground environment. 2. Gran Sasso National Laboratory (LNGS), Italy 1. Underground Laboratory of Modane (LSM), France The Laboratoire Souternain de Modane (<u>http://www.ien.fr.j</u>) is jointly operated by CNRS and CEA since 1985 and has pertnership with the University of Savoie. It is located at about 1200 m above sea ECOTOXICOLOGICAL RISK ASSESSMENT SHOULD INCLUDE MEASUREMENT OF RADIOACTIVE ISOTOPES INTRODUCED IN THE ENVIRONMENT Laboratori Nacionali dei Gran Samo | http://www.instation.it/) - operated by INFN -is the largest science underground laboratory in the world. It is located in the freeway tunnel-crossing the Gran Samo Mountai ENVIRONMENTAL EFFECTS ON PESTICIDE STORAGE BY HUMAN ACTIVITIES: FALLOUT DUE TO NUCLEAR ACCIDENTS/TEST EXPLOSIONS level and the rock overburden (examitally made of schiut) is about 1760 m. As Europe's deeper underground facility, it provides an environment with the smallest cosmic my flux available i TATION: Mid-latitude glaciest and polar ice caps are some of the most 2 tine use of perficides (herbickles, fungicides, and insocticides) has adverse name. Aericultural perficide use has increased worldwide during the last use count: ray flax and one thousand in the neutron flax compared to the surface. Access to the lab is through the turneel by cars and lomies. 330 permanent staff support its 938 scientific users from 29 different 1 production of costicides in a characteries Burgos. Access to the lab is through the tunnel - LSM provides cars for access to the lab. 12 pitation, mid-latitade cantinental glaciers [i.e. Tibetan a high resolution climatic record of the environme to receive many strategy and visible devotes of productions is a strategy endowment as you as MANDERAA, or not received many strategy and the service of the second in 150 scientific users from 10 countries provide a high resolution dimatic record of the environmental impact a activities. High-precision during of these ice-cores is however difficult. Constrar offered Services offered DADD: An analytical method for a bad ate dating of ice cases was accorded, base III: Underground space with services (electricity, gas, radon-free air, environmental radiation monitoring), dedicated room for biology. 15: Underground Space with services (electrone), genes, server, environment, the upper, Ultra low background lenvice with very low background HPGe facility STELLA (SabTerrarean Low Level Assay) can be employed for mean of ¹⁰⁰Cs tao isotone of anth thropogenic origin] in the Northern and HPGe detectors. The UNES a terfalls and of 110-100ar: 15 low background HPGe cirtactors – able to reach sensitivities at a level of 60 µBq/kg in 20071 and 100 µBq/kg in ¹¹⁴B – for material selectors, environmental surveys and other applications. s were produced only by atmospheric nuclear tests and nu Package and Comparison of the comparison of the package of the comparison of the com arted through any design of the second state ME as a reference laboratory for the JEDEE norm, LSM hosts devices to test the effects of radiation 1004 ANNO MALLER INS. many from the los Clarier Mente Free Canas (Mar) on the microaliscinonics circuits. IF: a radon free air production facility for set-ups requiring very low activity air ens strany of enamedia and ge industria the botteline. Comparison of the enablishment of t were analyzed using the y spectroscopp based on low-background high-purity anium (HPGe) detectors based at LMGS, whose semithrity scale is of around 1 race element analysis on almost all all UNDERGROUND Chick Due
 Sale Materia
 Collars for personnel ctaff and vacuum
 Description and descent
 Descriptionsee
 Zammaseet OVERGROUND rvel of put (10-12 g/g). Complex matrices (s.g. metal covered plastic materials as supe seasured separating each single component. (total volume: 3500 ml, surface area: 500 ml (total volume: 3500 ml, surface area: 500 ml (total despti, iton, with 10 m, heigh: 50 ml) March 1997 and wents that occurred in the last 50 years, with a direct quantification of the of radioactive polution. For example, the #PCs record reflects the end of eauced randoctive position. For example, the FFCs record renexts the lear test explosions in 1963, when the Partial Test Ban Treaty (P.T.B.T.) proj er wespons teen "or any other nuclear explosion" in the atmosphere, in outer a and underwater. Measurements avec as precise that it was possible to detect the "area" prefamethet form released in outers wasness test carried of the representing the part 20 parts. This report independent on of giptrosen is hadred an important to determine and the recompany and to 00 r and is remaining the second to 1920 but figuring in the visuant of 19-11 but figuring in the visuant of 19-11 but figuring is the visuant of 10-11 but figuring is the v Chatacterbrief, Dele of Greekine 1883 Depth moter mater og Aktueles 3 600 Allfludes 1 2020 Temperature (Real) in Calabas 2011 ---r (hearly) No. 2011 In electrical prover 2 Min. 12 + 2021 and (hear ent/the 1 MID) Antiproposenic major activities have delivered in atmosphere very inner mp/s/24.027 cares. The fit function based on ¹⁰⁰Cs markets Faund in the CDEH6 ice core o ad on other ice cores, and the technique is espected to have many more simil (Reduct Backer) 10-15 General Backer, 10-15 Madere Backer, 1.8 - 10⁴ INFIGT: Management strategies of ecolosicological risk would be well served by recognition of the discriby of compounds stored in various environmental sinks, such as arrivative soil, and their cossibility to become sources when environmental interview. REMARKED Compared and all 2000 Review of a characterization of a state of a EXPENSION OF COMPANY OF COMPANY OF COMPANY LSM AMMERICE-Interfer et al. (2014) "Lang Ammericationship interase profiletion application through statements" (PAL), in Ammerication (2014, 142,24)-2000, 2000, COMPLET, Name Collegion, IDVITE, Université de Dansie/CRIE, e-mail: 2017.2 3. Underground Laboratory of Canfranc (LSC), Spain Boulby Underground Laboratory, UK GEODYNAMIC FACILITY DETECTS LINK BETWEEN MUON TOMOGRAPHY FOR CARBON CAPTURE AND STORAGE (CCS) MONITORING Boulby Underground Laboratory The Laboratorio Subterráneo de Canfranc (http:// nfranc.es/) is managed by a SEISMIC/STRAIN NOISE AND RIVER DISCHARGE Consortium between the Ministry of Economy and Competitiveness, the Government of NOTIVATION: CCS technologies insolve the poor combustion capture of CO₂₀ which is calsequently compressed of then injected, in a super-clinical phase, into a subble prological stronge volume. The expectation is that the arrange density of matter in the measure will increase and the identiciation of the identification of the CO₂ imported with an useful as possible precipitation matchine. Peet-injection machine is the so of previous the importance. ocated in the Boulby mine on the northeast coast of England, and is 1.100 m under the Concernant netween the Miniary of Economy and Compositionenas, the outerminent of Aragén and the University of Zarangoza. It is the second largest deep underground scientific laboratory in Europe, located between two parallel tennels crossing the Pyrenees, a road tunnel and a disused train turnel new used as a safety route, and 850 m under the Mount Tobaco. 11 perminent staff support its 281 users from 20 outprise. C provides a very convenient location to host an advanced integrated facility – cales obynamic spactuum, from near-field seismicity to tectonic deformation, each tideo a eground, each a facility benefits from lover lived of seismic anise than usual surface. Boulity is a working notash, polyhalite and rock-salt mine operated by Cleveland surrow isolary is a working potent, porprising and rote-can miss operated by conversion Petrah Ltd. Access to the lab is through a 1.1km deep mine shaft. The current facility has been in operation since 2001 and a new laboratory is currently being built to host science for the decade to come. S permanent staff support its approximately 70 scientific users from 10 response, save a reality because trees some news at several access that usual parameter is at long periods more affected by changes in temperatures and all classifiant, in additions as are available at the siching of the transition extranso. GDD/ML currently includes a weive kitable agonaly crimental high-resculation lave strativeners. Two external COPE strates, will be oparation eraphy exploits the free flux of counic say muons at the Services offered 1.50 countries. Much tomography exploits the nee in inface to baild up an image of the overb Use Underground installations and space with related s sarthes to bail do gas a longe of the overlawing in an increasing the twinner. Biophyners of a subbia longe and the measured as do corporared with that of the subtrave sources. It is programs to instrument and table voldes cologe that CCV volumes with measured descense in marker that derived at the only of the subtrave sources at longe and the cologe that CCV volumes with measured the cologe that CCV volumes at the measured descense in marker that derived at the sources of the cologe that the cologe that CCV volumes at the measured descense in marker that the sources of the cologe that the cologe that CCV volumes at the measured descense in marker that the derived at the sources of the cologe that the cologe that CCV volumes at the measured descense in measured at the cologe that CCV volumes at the measured descense in measured at the cologe that CCV volumes at the measured descense in the measured descense in the source of the measured descense in the measured descense in the cologe that CCV volumes at the measured descense in the measured descense in the measured descense in the measured descense in the cologe that CCV volumes at the measured descense in the measured descense in the cologe the measured descense in th St Recently it was proved that the selectic noise in the 2-8 Hz hand is directly related to the discharge i Elser, a typical Aloine style steam namine close to LSC. The selectic land straint signals are awful to me Services offered y the deployment of euitable muon detectors, the flux remaining after the muons ULB HPGe Reclopurity measurements of materials thanks to seven HPGe detectors and the related simulation and analysis software packages <u>US</u>: Underground Space with services (electricity, gases, sefety, environmental monitoring ULB-HPGe: Low background Germanium detector systems. Sensitivity down to SOppT U/TI This is particular! CTS: Red lopure copper parts manufacturing service using electroforming techniques CTS: Underground clean room class 1.000 (50 6) and class 10.000 (50 7) incontrations for material screening. storesting in the ca severe storms result args flood events same below) or fo Pigeners Lantsurgietud Vasarusa regenty Anagusbarts Lite regenerarmentus transmi angre spannelist parapar, segremani a mankeni keugena Republic metal refus CIRS: Understraund clean coorn clean 10,000 (80.7) We Acona to underground rock sampling for bio and geo studies UK Supported access to the wider mine workings and the serious scientifically interesting, Important geologies accessible. Description of the second seco UNDERGROUND UNDERGROUMD >> 500+1000, Volume e 2 Gen 2 5 1 disative of index issued). Left 2001 / Left 2009 Ber $\rm IMFACTi$ block tomography may play a crucial role in the CCS inductry since it offers monitoring that it: a) continuous, b) passive, c) directly executive to CO, clerelity and c) capable of delivering sateful data for many years so it is cost effective. Torontonia disease como arical, meteorological and RINGED COLORADO IN AL (2013) MON ities, but also to the **civil** 4SC CONTACT Full an Thompson, Land, of Shellheld, UK, a-stall L. Thom ANTINESS On the set of 1944, "Interior methods of an Apine methods for "Assessing of the ANTINESS OF 128. ANTINESS OF 128. and deliver

"Your planet is very beautiful," [said the little prince]. "Has it any oceans?" "I couldn't tell you," said the geographer "But you are a geographer!" "Exactly," the geographer said. "But I am not explorer. I haven't a single explorer on my planet. It is not the geographer who goes out to count the towns, the rivers, the mountains, the seas, the oceans, and the deserts." Antoine de Saint Exupery

THANK YOU! iagrafioti@admin.in2p3.fr

