SPRING 2017

GIANT REVIEW

— Exploring Science in Grenoble —

A GIANT CITY OF THE FUTURE

GIANT (Grenoble Innovation for Advanced New Technologies) unites research, higher education and industry on a unique campus to overcome the major challenges of tomorrow.

Founding members: CEA, CNRS, EMBL, ESRF, GEM, ILL, Grenoble INP and UGA.

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Healthcare
A hub for medical, diagnostic and imaging technology with access to internationally recognized organizations.

Innovation Management
Applied research and new business creation as well as innovation and industrial performance training for managers.

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AWARDS & HONORS

Thibault Honegger (CNRS)
ERC Starting Grant
CONNEXIO

Pantaleo Raimondi (ESRF)
Gersch Budker Prize

Dr. Wojciech Galej (EMBL)
Biochemical Society
Early Career Award

Hélène Michel (GEM)
1st place, AMBA Pedagogical
Innovation Award 2017

Cecilia Ceccarellia (UGA)
ERC Advanced Grant
The Dawn of Organic Chemistry

Sorin Cristoloveanu (Grenoble INP)
IEEE Andrew Grove
Award Prize

French Alternative Energies and Atomic Energy Commission (CEA) • National Center for Scientific Research (CNRS)
European Molecular Biology Laboratory (EMBL) • European Synchrotron Radiation Facility (ESRF) • Grenoble Ecole
de Management (GEM) • Grenoble INP • Institut Laue-Langevin (ILL) • Université Grenoble Alpes (UGA)

Welcome to the Spring 2017 GIANT Review

It is my pleasure to share with you the latest developments from the GIANT (Grenoble Innovation for Advanced New Technologies) Innovation campus. Founded to promote collaboration on local, national and international levels, the GIANT campus unites research, higher education and industry to help foster a vibrant and innovative ecosystem.

As a founding member of GIANT, Grenoble Ecole de Management is proud to highlight the ecosystem's strength in terms of its people, their values, collaborations and outcomes, and the campus itself, which is as a wonderful place to live, study and work. A core mission of GIANT is to enable the transformation of emerging technologies into societal and economic value. Whether it is through joint laboratories, industrial research projects or incubators, GIANT members continue to mutualize their resources in order to support the transfer of fundamental research to concrete applications.

In this latest issue, you will discover a wide variety of success stories. From protecting radiation therapy patients (p. 6) to cleaning up contaminated rivers (p. 8), exploring the future of our cities (p. 12) or understanding the composition of interstellar clouds (p. 22), GIANT fosters research that contributes to the advancement of society. By supporting numerous funding opportunities such as ERC grant applications and industrial partnerships, our members ensure local researchers have the means to continue exploring cutting-edge science.

Finally, each article in the GIANT Review is a testament to the importance of international cooperation. From major EU projects to extremely specific global technology clusters, all of our work underlines the essential participation of international counterparts. GIANT was founded to foster not only a local ecosystem, but also to reinforce its international renown and promote its attractiveness to leading talent and partners around the world.

On behalf of all GIANT members, I am honored to share this latest issue of the GIANT Review.

Loïck Roche,
Dean & CEO
Grenoble Ecole de Management

MAGIA: AN INNOVATIVE OFFER FOR LABORATORY ANALYSIS

The MAGIA project is currently being incubated at the SATT Linksium with the launch of a startup planned for this summer. MAGIA builds on technology developed in collaboration with the CNRS, the Institut Néel, G2ELab, LMGP and IAB. "Our offer will provide pharmaceutical and diagnostic companies with a sensitive, ergonomic and fast immunoanalytic device. Our goal is to miniaturize and simplify bioanalytical technology that used to only be available in research and healthcare laboratories. By democratizing access to biological analysis technology, we open the door to many new applications and in the long term, are preparing the way for in-field analysis," explains Paul Kauffmann, CEO of MAGIA. By simplifying the analysis process, MAGIA immuno-magnetic technology provides a portable analysis solution that is as reliable as traditional laboratory analysis.

***ESRF** Welcomes 22ND INTERNATIONAL PARTNER*

The ESRF signed an agreement with the RCB (Regional Center for Biotechnology) in India. The agreement will provide Indian scientists with three years of access to the synchrotron to carry out, in particular, research linked to structural biology. The ESRF is governed and supported by numerous countries around the world. India will be the 22nd partner to join the European synchrotron.

UGA: EXPLORE, EXPLORE MORE

A year after its creation on January 1st 2016, the Université Grenoble Alpes launched a new campaign to promote and develop its image. The slogan "Explore, explore more" is supported by a manifesto and a unique visual identity. The goal is to highlight the vision that defines the new Grenoble university. As a multidisciplinary global leader, the university underlines its strong ties to the regional ecosystem and the innovative and pioneering spirit that has defined the Grenoble-Alps region since the 19th century.

IGE: A NEW LABORATORY FOR PLANETARY AND ENVIRONMENTAL SCIENCE

On January 1st, 2017, the LGGE (Laboratory for Glaciology and Environmental Geophysics) and the LTHE (Laboratory for Hydrology and Environmental Studies) joined forces to create the IGE (Institute for Environmental Geosciences). This new institute unites Grenoble INP, UGA, IRD and CNRS/INSU behind a collaborative public research laboratory focused on planetary and environmental sciences. With approximately 240 researchers, professors, engineers, technicians and administrative staff, the IGE carries out research on climate, water cycles, the cryosphere, and natural and anthropized environments. The goal of such research is to improve our understanding of various geophysical environments such as oceans, cryospheres and watersheds.

EUROPEAN-JAPANESE Collaboration Enables **JT-60SA FUSION DEVICE**

After eight years of work, the CEA Low Temperatures Service validated the performance of the Japanese Tokamak JT-60SA cryogenic system. This fusion device being assembled in Japan is part of the Broader Approach agreement between Europe and Japan. The CEA was in charge of supplying the cryogenic system. The primary purpose of this large helium refrigerator is to cool the superconducting magnets of the Tokamak down to 4.4 K (-269°C). During the 14 month commissioning process, the CEA, Air Liquide, European partner F4E (Fusion for Energy) and Japanese researchers from QST (Quantum Radiological Science Technology) collaborated to demonstrate the system's performance as one of the world's largest fusion device refrigerators. The next step will be to cool the cryogenic system and superconducting magnets by 2020 in order to prepare the way for the system's first plasma.

CHEETAH: UNDERSTANDING TECHNOLOGY ADOPTION FOR ENERGY EFFICIENCY

In November 2016, Grenoble Ecole de Management launched CHEETAH (CHanging Energy Efficiency Technology Adoption in Households). The project will explore the adoption of technology by private households in response to energy efficiency policies. The three year project is funded as part of the Horizon 2020 - Research and Innovation Framework. Project partners include Fraunhofer ISI (Germany – project coordinator), Technische Universität Wien (Austria), Cardiff University (UK), and eceee (Sweden). The project's principal investigators are Joachim Schleich and Corinne Faure, both researchers at Grenoble Ecole de Management.

ILL Celebrates **50 YEAR ANNIVERSARY**

On January 19th, 2017, the ILL celebrated its 50 year anniversary. An additional event is planned for July 1st so that staff and families may come together and celebrate the institution's anniversary.
The ILL was founded as a joint agreement between the French and German republics. For the past 50 years, the institution has been home to an intense and continuous source of neutrons dedicated to supporting fundamental research. In addition to celebrating its 50 year anniversary, the ILL recently put in place a new management team. Helmut Schober became the ILL's director and Mark Johnson became head of science. Charles Simon remains head of the projects & techniques division.

TRADERA:
Ensuring Patient Safety During Radiotherapy Treatment

Radiotherapy is used to treat half of all cancer patients worldwide. While technology has continued to improve the efficiency of radiotherapy, such treatments are not without risks. In the beginning of the 21st century, 450 patients at the Epinal Hospital received radiation doses that were 20 to 30% higher than their prescription. The accident was due to misconfigurations in the machine parameters. To help avoid such accidents, researchers recently unveiled a unique 2D detector that will enable radiotherapy operators to control radiation doses in real-time as it is delivered to the patient.

#Health — #Technology Management

Following the accident at Epinal, the Hospital University Grenoble Alps (CHU Grenoble Alps) and the Laboratory for Subatomic Physics and Cosmology (LPSC, CNRS/UGA/Grenoble INP) collaborated to launch the Transparent Detector for Radiotherapy (TraDeRa) project. *"The idea was to create a detector that would measure radiation quality before it reaches the patient and provide real-time safety control. However, the project was a real challenge in scientific terms. While the effects of X-ray radiation can be very strong for patients, the actual signal strength is very weak. The major issue was to create a detector that would measure radiation being delivered to a patient without significantly modifying the dose,"* highlights Yannick Arnoud, project leader and a researcher at the Laboratory for Subatomic Physics and Cosmology.

THE LONG ROAD TO A SUCCESSFUL PROTOTYPE

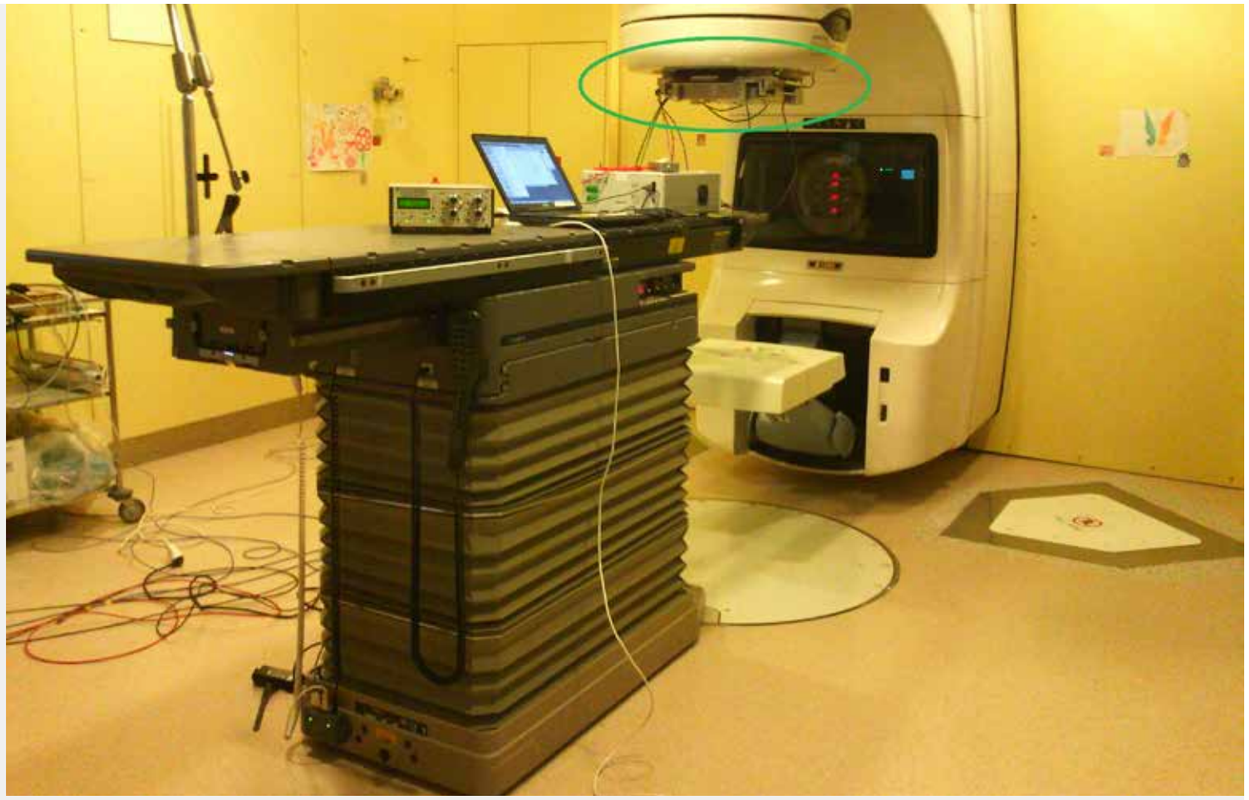
The project was launched in 2009 thanks to fruitful discussions between an LPSC academic research team and Medical Physicists from the CHU Grenoble Alps.

This state of the art detector was developed thanks to the wide skillset of LPSC technical teams. It required many back and forths between the hospital and the laboratory in order to create a reliable prototype.

Current detectors can be used to check a machine's calibration without a patient. They can also be placed behind the patient, but the radiation doses are severely modified by the patient's body absorption. This makes measurement rather unreliable when a discrepancy occurs. *"Our goal was to create a 2D detector that would be almost transparent and could therefore be placed between the X-ray machine and the patient. Our first prototype allowed us to explore the physics constraints we would have to address. Our second prototype didn't work well at all because of technological constraints! Finally, our third prototype enabled us to start making concrete measurements and we were able to file a patent. We've now developed a fourth prototype that is full-scale and functional,"* explains Yannick Arnoud, who coordinates the TraDeRa project.

"Our detector could be used by a wide variety of industries to carry out non-destructive radiation testing"

The current prototype with its 1600 channels: a compact system with the sensitive central area surrounded by the real time readout electronics



The detector installed on one of the Grenoble Alpes Public Hospital's radiotherapy devices.

WITH A PATENT AND A PROTOTYPE, A STARTUP IS NEXT IN LINE

The current prototype provides reliable real-time verification of X-ray beams and can cover a surface of 40x40 cm^2. In terms of technology, the detector relies on a very thin matrix of ionization chambers. Each of them are optimized with electrodes to sense ionization induced by the X-rays. The detector's ability to deliver precise measurements was confirmed thanks to tests carried out using radiotherapy equipment at the CHU Grenoble Alps.

The TraDeRa project was initially supported by the CNRS, the CHU Grenoble Alps, BPI France and the labEx PRIMES. It is now preparing for market thanks to the SATT Linksium technology maturation program.

"The project was a real challenge in scientific terms"

"We've carried out market studies to identify all potential customers and end-users. In addition to the health sector, our detector could be used by a wide variety of industries to carry out non-destructive radiation testing. The SATT has provided us with support and training to help transfer our technology to market. The creation of a startup is planned for 2018," concludes Yannick Arnoud.

GIANT EFFECT

While basic research is the motor that powers technological advancement, my experience has shown me that startups are great tools to bring technology to market. Bridging this gap was only made possible thanks to the support and collaboration of our institutions, the SATT, its network and our partners.

YANNICK ARNOUD
TraDeRa project coordinator

RIO TINTO:
a River to Fund Its Own Clean Up

The Rio Tinto river is located in southern Spain. Its unique reddish color is caused by extreme pollution from pre-Roman mines that make the water unusable for local populations. Researchers from both French and Spanish institutions have collaborated over the past 15 years to understand this pollution process known as acid mine drainage (AMD). In addition, they have been working on solutions to clean up the river and much to their surprise, they discovered rare earth metals that could potentially fund the cleanup process.

#Environment — #Large Scale Facilities

The Rio Tinto's unique reddish color

"The ESRF's beamlines enabled the team to develop a complete nanoscale understanding of the rivers' mineralogy and geochemistry."

UNDERSTANDING ACID MINE DRAINAGE

The Rio Tinto and its nearby neighbor, the Odiel river, are responsible for pouring 30 to 40% of all the zinc that ends up in our oceans (as well as 10% of all copper). This pollution is due to AMD, which occurs as a result of pyrite oxidation (a chemical reaction that releases acidity). When acid waters from the mines reach the rivers, the combination creates nanoparticles of iron and aluminum oxy-hydroxide, giving the river water its famous reddish color.

Over the past 15 years, researchers from the University of Huelva, the Institute of Environmental Assessment and Water Research (Barcelona), ISTerre (CNRS, UGA) and the ESRF have collaborated to analyze the geochemical processes tied to AMD. *"By using techniques such as X-ray absorption spectroscopy, and small-angle X-ray scattering, diffraction and PDF analysis, the ESRF's beamlines enabled the team to develop a complete nanoscale understanding of the rivers' mineralogy and geochemistry,"* explains Alejandro Fernandez-Martinez, a CNRS researcher who worked on the project.

RARE EARTH METALS: A HIDDEN JACKPOT

Alongside the work to characterize the rivers' chemical structure, researchers were also interested in creating a process to decontaminate both rivers for the local population. The cleanup process they designed was based on building large pools in which limestone could be used to neutralize the rivers' acidity.

The Rio Tinto with different tinges depending on water Ph

The surprising turn of events came when researchers analyzed precipitates left in the pools. By using X-ray micro-fluorescence and X-ray absorption spectroscopy at the ESRF, they found high concentrations of rare earth metals. Rare earth metals are regularly used in technology such as mobile phones and batteries.

As a result, the cleanup process for both rivers could generate economic value and fund the purifying process.

GIANT EFFECT

Our work on the Rio Tinto is the perfect example of long-standing collaboration between many institutions. By collaborating with local researchers and using ESRF beamlines, we not only advanced our fundamental understanding of science, but also enabled the cleanup of one of the world's most polluted rivers.

ALEJANDRO FERNANDEZ-MARTINEZ
CNRS researcher

ESRF BEAMLINES KEY TO UNLOCK RIO TINTO'S SECRETS

The Rio Tinto project was rather exceptional in its use of a variety of beamlines. Over the 15 year collaboration, researchers relied on Pair Distribution Function (PDF) experiments using ESRF beamlines ID15, ID31 and ID22, which provided atomic-level information. Experiments on BM25 using X-ray absorption (EXAFS) provided information about the adsorption mechanisms of contaminants in the river's nanominerals. BM26 and ID11 enabled an understanding of the minerals' formation processes and their texture. Beamlines ID21 and BM25 offered X-ray microfluorescence and X-ray absorption spectroscopy, which enabled scientists to identify the presence of rare earth metals and their associations with the aluminum matrix. By combining such a wide variety of experiments, techniques and beamlines at the ESRF, scientists were able to completely characterize the rivers' mineralogy and geochemistry.

CMTC
Celebrates 40 Years of RESEARCH AND SERVICE

Created in 1977, the CMTC (Consortium of Shared Technological Equipment) is Grenoble INP's primary platform dedicated to the characterization of materials. In 2017, the CMTC celebrates its 40th anniversary and provides us with the opportunity to explore its innovative approach to supporting research and industry.

#Research Facilities — #Fundamental Research

AN INNOVATIVE VISION TO SHARE RESEARCH EQUIPMENT

The story began in 1930 with the creation of the LAREC laboratory for research and chemistry. Over time, the importance of chemical analysis in the science and engineering of materials diminished while the need for visualization, characterization and structural analysis continued to grow. As a result, a first step was taken in 1974 to create a consortium of laboratories in order to purchase major research equipment. At the time, mutualizing one's research equipment was quite the innovative concept.

"The effort was clearly a success and led to the creation of the CMTC in 1977. The idea was simple: to create a common platform that would provide access to expensive research characterization equipment and ensure each instrument had dedicated experts who could help scientists design and implement their experiments," explains Laurent Maniguet, director of the CMTC.

X-Ray Diffraction CMTC2: X-Ray Diffraction (XRD)

RESEARCH, TRAINING AND VALORIZATION

Three primary missions have guided the CMTC over the past 40 years. *"Our primary mission is to support research. We provide the characterization capacities necessary for research projects to be successful,"* highlights Laurent Maniguet. The CMTC also provides training. Engineering students and industrial engineers take part in practical hands on training for techniques such as Scanning Electron Microscopy. The platform offers discovery classes for younger students to discover the world of infinitely small sciences.

The final mission of the CMTC is to support the valorization of research. *"While we enable industrial partners to access services and equipment, one of our key actions is also to provide advice. This can be in the form of studies that help companies plan and implement research. But also, many SMEs come to us for help on specific issues. Our role is to offer guidance on the best way to organize an experiment that will solve their problem,"* explains Laurent Maniguet.

SEM-CMTC: High Resolution Scanning Electron Microscopy (SEM)

FOUR MAJOR SKILL SETS

The CMTC unites four major areas of expertise: electron microscopy, X-rays, Raman spectroscopy and sample preparation. The platform provides access to 15 mid-sized instruments thanks to a team of 16 engineers, technicians and administrative staff. Recent developments in terms of equipment include a new Field Emission Gun Transmission Electron Microscope for which a CNRS researcher has developed an innovative tool to map grain orientations (ACOM/ASTAR). In the case of Scanning Electron Microscopy, the CMTC is developing in-situ nano-indentation and tensile tests in close cooperation with the labex CEMAM and the SIMAP laboratory.

X-ray tomography associated with 3D image reconstruction is also growing in importance with the purchase of tomographic equipment that will be complementary to tomographic services offered by the ESRF.

GIANT EFFECT

The CMTC embodies the spirit of collaborative research. Ecosystems such as GIANT will help us pool resources and continue to foster ties between research, industry and education.

LAURENT MANIGUET
Director of the CMTC

FOUR AREAS OF EXPERTISE

1. Electron microscopy
The CMTC unites equipment and expertise to offer cutting-edge services associated with scanning electron microscopy including an SEM-FIB (shared with the PFNC and PTA platforms), transmission electron microscopy and a large range of analytical tools (EDS, WDS, EBSD, ASTAR).

2. X-rays
The CMTC's equipment is complementary to the major european facilities located at the ILL and ESRF. The platform offers support for studies using X-ray diffraction, reflectivity and tomography.

3. Raman spectroscopy
Raman spectroscopy is a non-destructive characterization tool to analyze the composition and structure of solid or liquid materials. This technique can analyze very small sample sizes and explore the volume of transparent materials with a spatial resolution at the micron level (confocal Raman spectrometry).

4. Sample preparation
No matter the equipment used, sample preparation is an essential part of the process. One of the primary advantages of the CMTC is the fact each instrument has dedicated experts who can help users prepare samples to ensure optimal results.

A GIANT City of the Future

Cities worldwide are abuzz with debates on how to create green, high-tech, connected and harmonious cities of the future. As GIANT unites a wide array of research and technology players, we explore the many challenges that must be solved to create a successful city of the future. From green transportation to smart grids, GIANT researchers are working on numerous scientific advances to enable a smart city.

However, creating the city of the future is not only a technological challenge. As we will discover thanks to GIANT's higher education institutions, growing metropolises also face major educational, societal and political challenges if they wish to shape a successful smart city.

INTERVIEW WITH A GIANT EXPERT

Smart cities: a social question?

Jean-Marc Huissoud

From March 8th to 11th, 2017, the ninth Grenoble Geopolitics Festival explored the theme "The Power of Cities." Massive urbanization and the push for new eco-friendly smart cities has given rise to many social and political issues. To understand what is at stake from the perspective of social sciences, we speak with Jean-Marc Huissoud, director of the Geopolitics Festival and a professor at Grenoble Ecole de Management.

When developing a city of the future, why is it important to focus on societal questions?

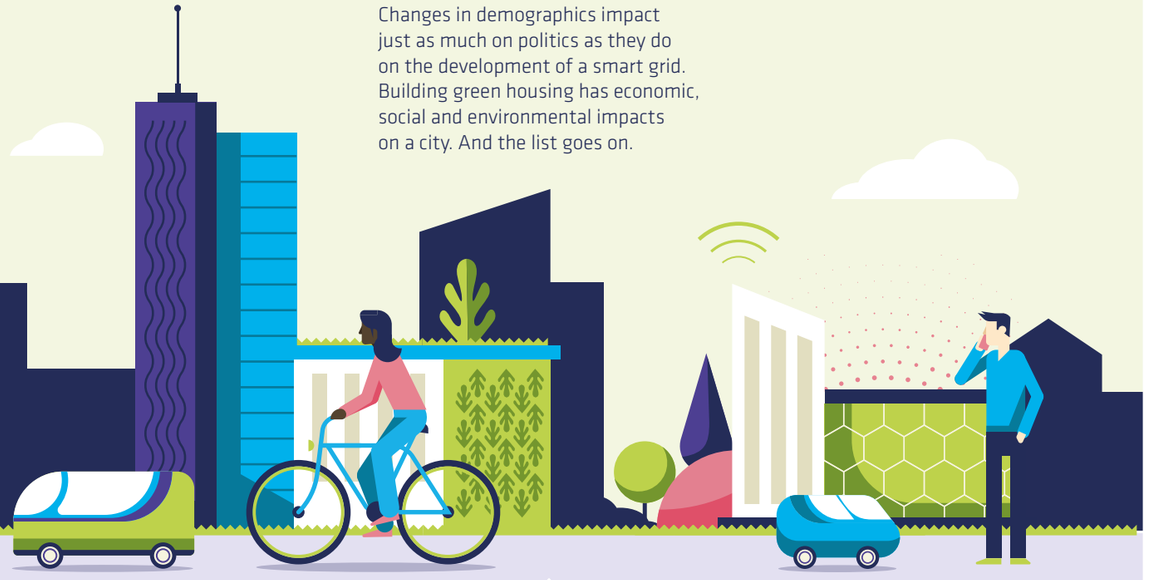
We have a tendency to think about urban development, especially for smart cities, in terms of technology and physical structures. But we have to remember that cities are first and foremost social and political systems. In terms of representation, the advent of massive urbanization has led most cities to face crises in terms of diversity, fragmentation and the distribution of power.
There is a fundamental issue of how to ensure equitable representation when creating a metropolis of the future.

Past experiences confirm that urban development cannot be implemented solely from technological or architectural perspectives. A successful strategy is one that will meet the future needs of a city's inhabitants. As a result, we have to anticipate changes to come over the next 50 years. It is important to not plan a city of the future based on current demographics and geopolitics.

What is the solution?

There is no perfect solution! The important principle is that cities, politicians, urban planners, scientists and citizens must all participate in a system-wide discussion to ensure everyone is accounted for. A city is a complex system in which all aspects interact and influence each other. Changes in demographics impact just as much on politics as they do on the development of a smart grid. Building green housing has economic, social and environmental impacts on a city. And the list goes on.

The theme of this year's Geopolitics Festival, "The Power of Cities," was specifically chosen because we wanted to encourage exchange and debate. At its heart, the city of the future is a problem of democracy and the only solution is to have open, honest debates and explanations. I cannot stress enough the fact we should be wary of utopian urban development plans. During the festival, it was clear that citizens, researchers and politicians were all capable of having levelheaded debates about delicate topics such as the use of big data or smart connected meters. If we want to create a city of the future that respects all of its inhabitants, we have to encourage interactions between citizens, companies, governing bodies and researchers.



EDUCATION & ENERGY

MOOCs: open learning to prepare a smart transition

Smart grids and new energy technologies will be at the heart of the energy transition. However, implementing smart solutions for energy or other sectors is a process that must be collaborative and include citizen participation. As a result, both Grenoble INP and Grenoble Ecole de Management have launched MOOCs dedicated to the energy transition.

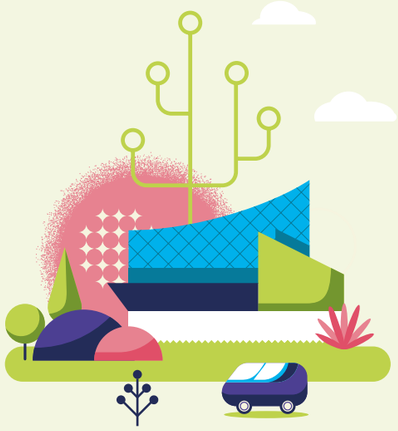
The Smart Grid MOOC (Grenoble INP) unites Grenoble INP, ENSE3, Enedis and the Grenoble INP Foundation to create a free online course that explains the evolution and challenges involved in creating smart grids. Thanks to the collaboration of Tenerrdis, Yélé Consulting, Grenoble INP - Ense3, the Think Smartgrids association, Air Liquide, CNR, GE Renewable Energy and Schneider Electric, the New Energy Technologies MOOC (Grenoble Ecole de Management) provides a general overview of technological advances and challenges in the energy sector.

Florent Cadoux, coordinator of the Smart Grids MOOC, explains: *"The goal of such MOOCs is to reach a wide public audience. We designed the Smart Grids MOOC to provide citizens, engineers and civil servants with information about the energy transition. The real challenge was to balance simple explanations and in-depth information. But MOOCs are an excellent method of sharing precise scientific information in a fun and interesting manner."*

In addition to promoting citizen engagement on energy issues, these MOOCS are designed to promote open collaboration between companies such as Air Liquide, Schneider Electric or Enedis, who all contributed experts and funding in order to promote knowledge sharing via both MOOCs.

BIG DATA & SMART CITIES

BigClout: big data for a city of the future

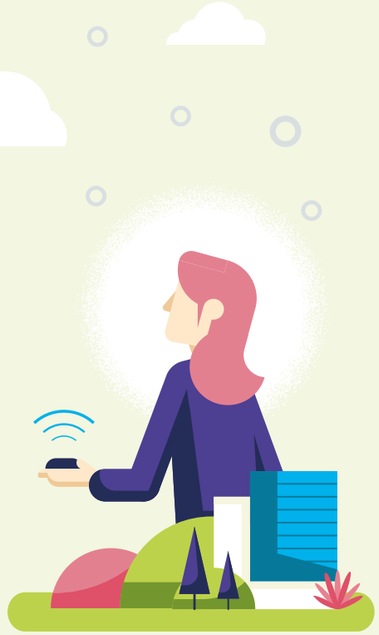


The EU-Japan BigClouT project was launched to increase the use and efficiency of data drawn from urban infrastructures, local economic and natural resources, and growing city populations. By relying on the Internet of Things, cloud computing and big data, the project will leverage the CEA Leti's sensiNact platform, which is designed to aggregate heterogeneous data. The goal is to make it easy for a community of developers to access big data drawn from cities, thus facilitating the creation of applications and services for the city of the future.

"The major challenge is heterogeneity. Every day, there are new types of data and new standards created to use this data. Our goal is to create a unique interface. The second challenge is to manage such massive quantities of data. We have to be able to capitalize on the real-time data drawn from cities," explains Levent Gurgen, a Leti researcher in charge of the EU portion of the BigClouT project. The project, which was launched in 2016, builds on results from the EU-Japan ClouT project. The project will be deployed in Grenoble, Bristol, Tsukuba and Fujisawa in order to test applications in areas such as business tourism, the Tokyo 2020 Olympics, smart transportation and smart energy management.

BIG DATA & SMART CITIES

Combining data and citizen engagement



Sarah Duché, a geographer at the Alpine Geography Institute (UGA), is working on several projects to develop the use of individual pollution sensors. The benefits of such projects are two-fold. *"In terms of science, I realized that we're missing the small and medium scale data needed to understand pollution exposure. The advantage of providing citizens with individual sensors is that we can gather small scale data while promoting citizen awareness and engagement."*

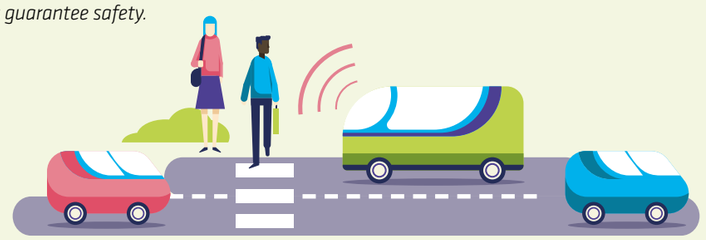
Having designed an individual pollution sensor, the key challenge remains to understand how best to use this technology. For example, the researchers used FabLabs to check if citizens were interested in building their own sensors. They also plan to distribute a manual which will explain how to build your own sensor. In addition, Sarah Duché and her colleagues carried out research to analyze how long a citizen actively uses this technology. *"We noticed that an individual will generally use their sensor for a week in order to understand how they're being exposed to pollution. Once they understand their exposure to pollution, they stop using the sensor. Therefore, we're considering how we could set up a solution to lend sensors on a short term basis."*

GREEN MOBILITY

Smart vehicles for smart cities

"We created ∑ fusion which can efficiently calculate an occupancy grid. This grid enables the system to evaluate the vehicle's surrounding environment by using sensors to check which zones are occupied by obstacles," explains Julien Mottin, a researcher and engineer at the Leti. ∑ fusion does not in and of itself create a self-driving car. However, the hope is that it can provide car constructors with a method to guarantee acceptable safety levels. *"One of the primary issues with self-driving cars is that we have no way to guarantee their behavior in every given situation and thus guarantee safety. The goal of ∑ fusion is to provide a system that can validate and support the decision-making process."*

Public transportation is also a potential target for ∑ fusion. As bus lines follow defined routes, it is possible to consider autonomous public transportation that relies on a combination of internal and external sensors (for example, cameras set up at a dangerous intersection). The Leti is exploring how to integrate heterogeneous data from external sensors and discussions for future collaboration are underway with the Grenoble metropolis.



GREEN MOBILITY

Grenoble Traffic Lab: uniting research and application

While Grenoble has many positive aspects, traffic fluidity is not one of them. Enclosed between three mountain ranges, the city faces a real challenge in terms of car traffic. However, to overcome this issue, Carlos Canudas de Wit, a CNRS senior scientist at GIPSA Laboratory, received an ERC Advanced Grant to fund the Scale-FreeBack project. New technology and increasingly complex systems have made it essential to develop new models and methods to control networks such as Grenoble's traffic network. The goal of Scale-FreeBack is to use information learned from the Grenoble traffic system in order to develop new approaches to manage complex systems in general. In more practical terms, the project recently developed the Grenoble Traffic Lab (GTL).

Open to citizens, local authorities and researchers, the website collects, processes and displays data gathered from a network of wireless sensors installed on Grenoble's southern beltway. *"The project is divided into theoretical and applied activities. On one hand, the information we learn about the Grenoble traffic system will enable us to develop new models for complex systems in general. On the other hand, concrete initiatives such as the GTL will provide citizens and local authorities with important data to help solve traffic and pollution problems,"* explains Hannah Walter, the Scale-FreeBack project assistant.

FUNDAMENTAL RESEARCH

Cutting-edge research for smart materials and new energy solutions

While exchanges between companies, governments and citizens are crucial to build the city of the future, fundamental research is the force that will power technological breakthroughs to enable a smart city of tomorrow. From batteries to photovoltaics or innovative composite materials, the ESRF and ILL provide scientists with the tools needed to overcome technological barriers.

"The goal is to explore a material's physical and chemical structure at atomic to micro-scale levels in order to optimize its use or solve potential issues," highlights Edward Mitchell, head of business development for the ESRF. Batteries and fuel cells are a major field of activity for the ESRF and ILL as such technology is an essential component to create green tech and mobility solutions.

In some cases, projects are carried out with industrial partners that would like to optimize their technology or solve a specific issue. Both institutions also support fundamental research to discover innovative materials that will enable energy storage of the future. *"In both cases, a key advantage is that our beamlines enable scientists to analyze a battery or fuel cell in operando in order to see what interactions and changes occur throughout the battery's life cycle."*

Other fields of interest linked to the development of smart cities include photovoltaics and eco-friendly construction materials. Both European research infrastructures have projects geared towards optimizing the use of current photovoltaic materials (e.g. using low-grade silicon to produce cheaper photovoltaic panels) as well as research to explore promising new materials such as perovskites. In the case of construction materials, scientists recently used the ESRF microspectroscopy beamline ID21 to analyze eco-friendly slag cement. Under certain circumstances, this eco-friendly cement would harden with an unattractive blue/green color that limited its potential use. By using the synchrotron's microspectroscopy, scientists were able to follow the evolution of the cement and understand the causes of this coloration. By helping to solve this issue, the ESRF helped broaden the applications for this eco-friendly product.

POWERLESS BOSSES:
a Key to Co-operative Governance

In countries around the world, traditional management structures are being questioned. From horizontal management practices to employee-owned co-operatives, democratic and egalitarian organizations are developing new approaches to run a business. Stéphane Jaumier, a researcher at Grenoble Ecole de Management, has been studying the evolution of organizational cultures. We speak with him about his latest study of a French co-operative, which provided unexpected insights into democratic management for business.

#Innovative Management — #Education

Could you begin by explaining the scope and goal of your study?
We're seeing growing interest in more democratic ways of doing business (co-ops, horizontal management, liberation management, etc.). I wanted to study a co-op in order to increase our understanding of this evolution. I found a French co-op factory that was set up 30 years ago and now employs 25 people, almost all of whom are associate owners. I spent a year as a participant and observer of the factory's day to day activities.

What did you discover during your time at the co-op?
It was really interesting to discover a counter-intuitive management structure. The co-op operates with a supervisory board and an executive board. The supervisory board has three members who are elected. They then nominate three members to the executive board. While it would appear that power was concentrated in the hands of a few, much like a traditional organization, the reality was quite different.

Can you explain what was unique about the co-op's distribution of power?
For starters, the supervisory board was mostly an election based on popularity. Once the supervisory board nominated the executive board, they basically took a back seat. While executive board members were symbolically in charge of the organization, the remaining co-op members actively engaged in day to day practices that sapped their power and legitimacy. In concrete terms, they retained very little power to enforce rules or guide the business's activities and strategy.

How did the co-op members sap the power of their appointed managers?
I noted three day to day practices that delegitimized the manager's position. First, there was an active and relentless refusal to accept a divide between manager and lay member. Co-op members engaged in work floor games such as yelling *"Who's the boss?"* and responding *"I'm the boss!"* These practices served as a constant reminder that each member was in fact a boss.

Second, co-op members openly and endlessly critiqued the nominated managers. Conflicts and issues were openly discussed and the appointed managers had to continuously account for their actions and decisions. This set up a reversed dominance between lay member and manager

Finally, there was widespread use of schoolboy humor to convey criticism or discontent in a manner that made it difficult for the managers to respond with legitimacy.

What are the implications of this study for co-op organizations and other egalitarian approaches to organizational structures?
One of the primary threats to a co-op's democratic structure is the emergence of a governing elite. Past studies have demonstrated that several factors can help reduce this risk. For example, associations that work in niche markets and face little competition from capitalist organizations can alleviate this risk. Some organizations have implemented specific rules to support egalitarian and democratic practices. My study underlines a third method to support democratic practices. Namely, members can simply delegitimize their elected managers. I believe this co-op found an interesting balance between democracy and traditional business hierarchy. External partners, clients and administrative organizations can prefer to interact with a traditional hierarchy. In this co-op, the model looks more or less normal from the outside, which facilitates its ability to interact with traditional organizations. At the same time, the internal workings of the co-op contradict this apparent normality.

CEA 3D PACKAGING
LEADS TO EUROPEAN SEMI AWARD

The European Semi Awards recognizes a person or team that has made a significant contribution to the European semiconducteur, micro-systems, photovoltaic or display industries. In 2016, Gilles Poupon, an international expert at the CEA-Leti, was recognized for his work on 3D packaging and integration.

#Information Technology — #Technology Management

AN OPPORTUNITY TO HIGHLIGHT THE CEA-LETI'S EXPERTISE ON 3D PACKAGING

For a long time, microchip packaging consisted of assembling chips and wires inside boxes. However, in the early 21st century, wafer level packaging began to emerge. *"The goals is always to assemble a maximum number of components within the smallest possible space. As a result, the idea behind wafer level packaging is to create connectivity within the substrates, thereby enabling 3D integration. Major challenges in past years include the development of processes known as Through Silicon Via (TSV), Through Glass Via (TGV) and Through Polymer Via (TPV). Basically, this technology enables us to punch a hole in a silicon chip, add metal to the hole and create a chip that can communicate on both sides. Thus eliminating the need for old fashion wires,"* explains Gilles Poupon.

Back in 2005, the CEA-Leti implemented group work sessions to define the parameters for 3D packaging. Gilles Poupon played a primary role in these discussions and explains that the main goal was: *"To identify the materials, technology and equipment we could build on to provide 3D packaging services. These strategic choices made it possible for us to gain international recognition for our expertise."*

3D PACKAGING COMBINES NUMEROUS TECHNOLOGICAL BREAKTHROUGHS

In addition to TSVs, TGVs and TPVs, 3D packaging required the development of many other techniques. For example, the CEA-Leti had to develop technology known as Redistribution Lines (RDL), which serve to connect the Via. Research was also carried out to create wafer to wafer or chip to wafer technology, which enabled packaging to be adapted to meet the constraints of various industries. *"We've been working on 3D packaging for a long time. The first ideas started to emerge in the mid-90s. And since then, we've also done a lot of networking and publishing in order to ensure our expertise it recognized worldwide"* adds Gilles Poupon.

FROM 3D PACKAGING TO HETEROGENOUS INTEGRATION

Gilles Poupon is already looking towards the future of chip integration. *"3D packaging allowed us to develop a wide panel of fundamental technology that is very interesting for future developments. The next challenge is heterogenous integration. Right now, packaging is mostly capable of integrating chips and materials that are similar in size and nature. Heterogenous integration will be the ability to integrate a variety of sizes and materials."*

To achieve this goal, the CEA-Leti is working on what is known as Fan-Out Wafer Level Packaging. The idea is to use the technological building blocks of 3D packaging in order to facilitate connections between heterogenous materials and chips. *"The end goal is to develop system in package technology. In other words, we will provide technology to package a chipset that unites a maximum number of functionalities such as micro-sensors, memory or processors. However, integrating a variety of chips is a complex challenge because the process has to be adapted to meet the specific requirements of each application,"* concludes Gilles Poupon.

GIANT EFFECT

The GIANT ecosystem was founded on the concept of collaboration and international visibility. 3D packaging is clearly the result of a collaborative effort. And international networking was key to ensure our success. Collaborative initiatives such as GIANT are essential to promote our visibility worldwide.

GILLES POUPON
Scientific Advisor at the CEA-Leti

TRANSLATING STRUCTURAL BIOLOGY
Into Drug Development

Structural biology is essential for both our understanding of the human body and the development of efficient drugs. It provides scientists with an understanding of how proteins work and enables pharmaceutical companies to engineer compounds that can inhibit a protein's functions. However, structural analysis has long suffered from its high cost and technical difficulty. In response, EMBL and the ESRF have collaborated to streamline the process and facilitate access for both academic labs and pharmaceutical companies.

#Energy — #Technology Management

A FULLY AUTOMATED SERVICE

Until recently, structural analysis was an intensive process that required many resources and manual operations. There were two important bottlenecks in the process. First, the preparation of crystals for diffraction experiments required numerous manual interventions. And second, diffraction data for each crystal had to be collected manually which required frequent trips to the synchrotron. *"We removed both of these bottlenecks thanks to technological advances. EMBL's CrystalDirect™ technology enabled us to fully automate the crystal handling process. And the ESRF MASSIF beamline program created a fully automated beamline to analyze crystals and collect data,"* highlights Jose Marquez, who is in charge of the EMBL Crystallization Facility.

The result is Europe's first fully automated protein crystallography and compound screening pipeline. By collaborating to integrate these two technologies, EMBL and the ESRF have increased their capacity for structural analysis by a power of ten. *"It's important to remember that basic research on protein structure and applied research for drug development are both iterative processes. They require the preparation of hundreds to thousands of crystals and numerous time-consuming trips to collect measurements at a synchrotron. By combining CrystalDirect™ and MASSIF technologies we're able to offer fully automated, remote-controlled crystallography pipelines. This solution is much faster and enables higher throughput than the conventional approach,"* adds Jose Marquez.

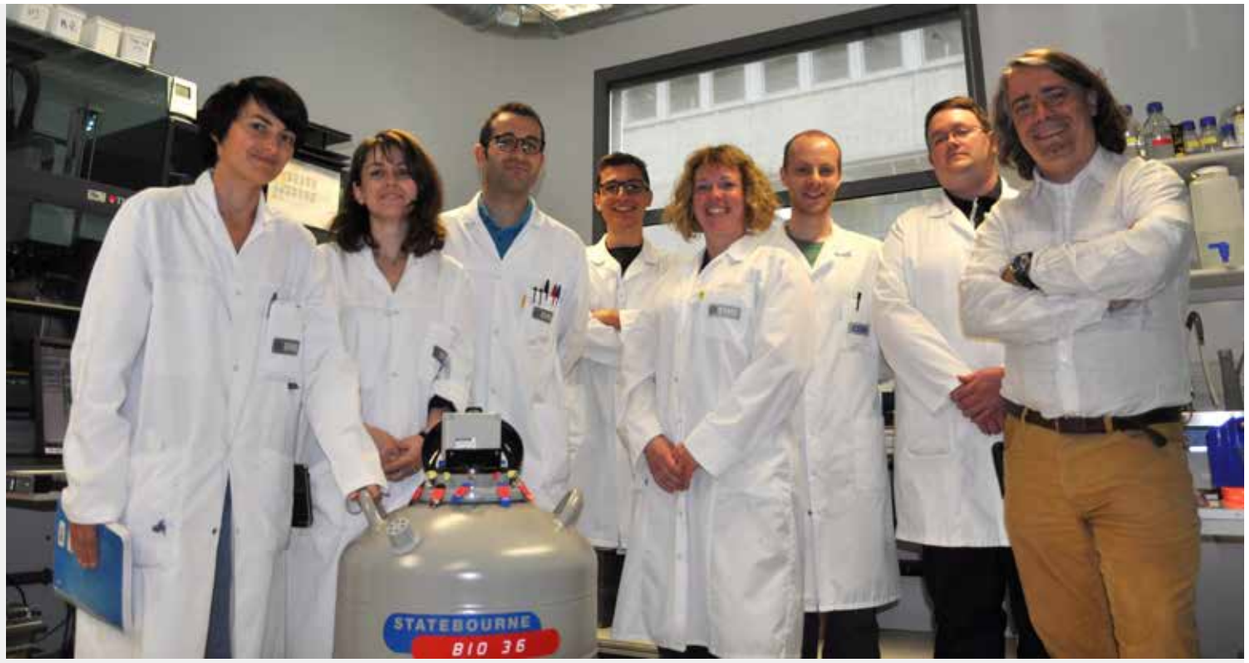
The CrystalDirect robot developed by J. Marquez and F.Cipriani teams at EMBL

INEXT: AN EU PROJECT TO FACILITATE ACCESS TO STRUCTURAL ANALYSIS

Pharmaceutical companies often invest in structural analysis to develop specific compounds as part of the drug-design process. While the cost of producing such compounds can be a limiting factor for academic research, it is essential to remember that there is a strong synergy between fundamental and applied research.

"Fundamental research projects typically produce the first structure of a protein. This data provides essential information to understand how a protein works. Once you understand a protein's basic mechanisms, you can exploit this information to develop compounds that interfere with the protein and therefore enable drug development," says Jose Marquez.

"We created a fully automated beamline to analyze crystals and collect data"



Dr Jose A. Marquez (right) and some members of the international HTX lab team. (from left to right: Zuzanna Kaczamarska, Irina Cornaciu, Andrea Pica, Nikos Nikolopoulus, Florine Dupeux, Guillaume Hoffmann, Vincent Mariaule and Jose A. Marquez)

To bridge the gap between fundamental and applied research, the EU launched the iNEXT project, which unites 21 European partners, including EMBL and the ESRF.

The iNEXT project funds access to the automated compound screening pipeline developed in Grenoble. Jose Marquez concludes that: *"The iNEXT project facilitates the translation of basic research into biomedical applications. By developing innovative technologies for structural analysis, we've removed an early-phase bottleneck that promotes both our scientific understanding of proteins and possible opportunities for drug development."*

GIANT EFFECT

Much like the GIANT Campus, collaboration is at the heart of structural analysis. Our efforts to automate the process and facilitate access bring together EMBL, the ESRF, academic laboratories and pharmaceutical companies in order to promote scientific advancement.

JOSE MARQUEZ
Head of EMBL Crystallization Facility

FOCUS ON GIANT TECH!

CrystalDirect™: a fully automated solution

EMBL has developed CrystalDirect™ in order to provide fully automated crystal harvesting and processing. Crystals are grown on an ultra-thin film in a vapor-diffusion crystallization plate and are recovered using laser-induced photo ablation. This automated system eliminates the need for manual crystal fishing and handling, thus increasing throughput and reducing sample loss. Moreover, it enables automated ligand screening in the context of structure guided drug design. and increases compatibility with X-ray data collection.

MASSIF-1 automated beamline

MASSIF-1 is a unique, fully automated facility that ensures high throughput for macromolecular crystal characterization and data collection. Thanks to the collaboration of the ESRF and EMBL, this new service provides synchrotron users with an automated solution to screen crystals and collect routine data sets. Automated operations can be carried out throughout the night, thus freeing researchers to focus their time and effort on studying underlying biology and collecting more challenging data sets.

Study of Graphene Helps Explain THE BIRTH OF STARS

Graphene can be considered to be the world's thinnest material. Each sheet is only one carbon atom thick, which means each atom can have a chemical interaction on both sides of the sheet. As a result, graphene is seen as a high potential material with a wide variety of applications from thin and flexible screens to fuel cells, electric circuits and various medical, chemical or industrial processes.

#Large Scale Facilities — #Fundamental Research

Researchers at the ILL and the University of Parma recently collaborated to explore graphene's capacity to store hydrogen and therefore enable more efficient fuel cells. However, to their surprise, they discovered that graphene was subject to hydrogen quantum tunneling, an effect that enables hydrogen atoms to jump from one carbon to its neighbor. This discovery adds a new element to the understanding of the formation of molecular H_2 in interstellar clouds where stars are first born. We speak with Stéphane Rols, the ILL researcher who led the project.

"This new perspective is an important link in our understanding of the birth of stars"

Q Why did you choose to study graphene?

One of the key challenges to create efficient fuel cells is the ability to store hydrogen. We were Interested in graphene because it has high potential in terms of hydrogen storage due to its large surface and low weight. The idea was to implement a process called hydrogen spillover, which is based on the cracking of molecular H_2 by using platinum or nickel. This separates an H_2 molecule into two hydrogen atoms that can be stored on the surface of graphene.

Q How did you carry out this research?

We obtained a PhD grant for the storage of hydrogen on the surface of graphene materials. Chiara Cavallari was the student who did most of the work and was shared between the University of Parma (group of Pr. Riccò with Dr. Pontiroli) and the ILL, under my responsibility. Our Italian colleagues are experts in the synthesis and functionalization of carbon nanostructures. They provided us with hydrogenated samples and were responsible for characterization using nuclear magnetic resonance and muon relaxation. The heart of this study was the neutron spectroscopy carried out using the ILL LAGRANGE spectrometer. We synthesized a highly defective graphene sample, directed a flow of molecular hydrogen towards the graphene for it to be cracked into atomic parts and then used the ILL's neutron beam to observe the spectroscopic signature of the H atoms bonded to the graphene surface.

Q What were the surprising results of your study?

We observed two phenomena. First, the structural defects on the graphene flakes were able to crack a molecule of hydrogen without the need for additional metals. And second, many of the hydrogen atoms were able to move (diffuse) along the surface at moderate temperatures (T<200 K). This movement involves breaking and re-forming very strong C-H bonds. A classical perspective cannot account for these observations. The quantum nature of H atoms provides the necessary perspective to understand this puzzle.

Quantum tunneling is the concept that certain particles, when trying to cross a barrier, will be able to *"tunnel"* across instead of going above it (which requires more energy). This concept perfectly explains our observations. The movement is made possible by the specific vibrations present on the surface of graphene.

Q Why are these finding important?

We realized that these observations were not only fundamentally interesting, but also valuable for astrochemists. One of the challenges in astrochemistry is to understand the presence of molecular hydrogen in interstellar clouds. These clouds are constantly bathed in intense radioactive winds that constantly dissociate the H_2 molecules. However, the continued presence of H_2 suggests that a very efficient chemical reaction is taking place to recombine the atoms back into molecules. The chemical models developed so far suggested that carbon nanostructures play the role of 2D catalysts to sustain the reaction.

An important factor is the temperature of these clouds which is ~100 K at most, in other words a very low temperature as compared to the 2000 K of a C-H energy bond. With such a difference between the low cloud temperatures and the strong C-H bond, classical chemistry models cannot explain how H atoms overcome this energy barrier. Our observations provide a quantum perspective that explains how H atoms can travel large distances despite low ambient temperatures. This new perspective should provide input for future models and offer an important link in our understanding of the birth of stars.

"Graphene has high potential in terms of hydrogen storage due to its large surface and low weight"

ILL LAGRANGE neutron spectrometer used during this study of graphene

LAGRANGE SPECTROSCOPY AT THE ILL

The IN1-LAGRANGE neutron spectrometer is dedicated to studies of high energy dynamics in condensed matter. Whether for the study of graphene, as in this project, or other materials, the LAGRANGE spectrometer offers a high energy range and unrestricted temperature intervals for experiments, making it a unique instrument worldwide. The instrument is used to explore the lattice dynamics and molecular vibrations (and indirectly structural information) of a variety of materials from metals and intermetallic hydride compounds for future energy storage to nano-crystalline materials such as fullerenes and nanotubes for commercial and industrial applications.

Baboons Capable of Producing **VOWEL-LIKE SOUNDS**

Why is speech a uniquely human characteristic? How and when did humans develop the ability for speech? By confirming that baboons can produce vowel-like sounds, researchers recently put to rest a 20 year old controversy. As baboons have a "high" larynx, their ability to make vowel-like sounds definitively invalidates a 45 year old theory that states only humans can produce speech due to their "low" larynx.

#Fundamental Research — #Health

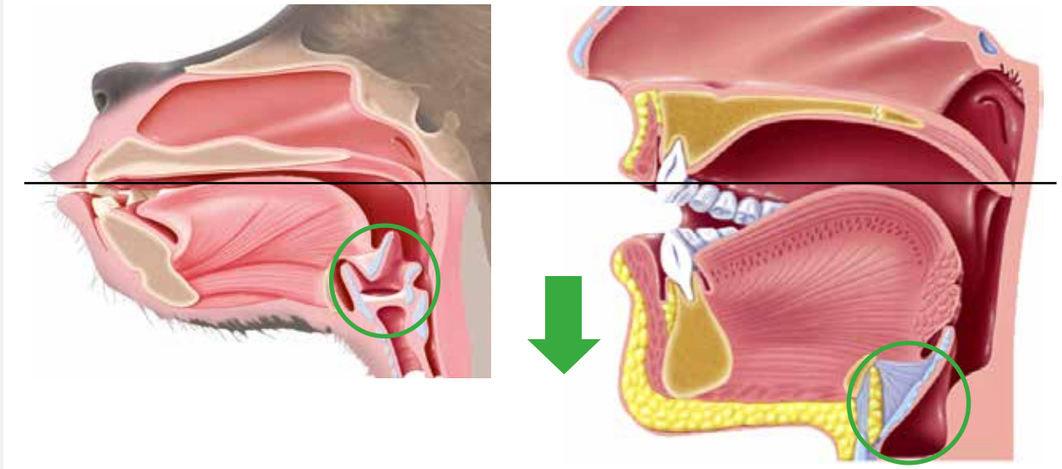


Illustration of the "low" human larynx (right) and "high" baboon larynx (left)

"This theory explained that animals such as baboons cannot speak because of the position of their larynx. This theory provided a simple answer to scientific and philosophical questions concerning human evolution. However, over the past 20 years, many contradictions have emerged to invalidate the theory," explains Louis-Jean Boë, a University Grenoble Alpes senior researcher at Gipsa-Lab (CNRS/Grenoble INP/UGA).

"We confirmed that baboons make five sounds that are similar to human vowels"

ANALYZING VOCAL CAPACITIES FROM BABIES AND NEANDERTHALS TO MONKEYS

As speech is a unique human trait, it is an essential part of our understanding of human evolution. The original theory published 45 years ago posits that human speech evolved in coordination with the lowering of the larynx in Homo sapiens. The theory goes on to explain that only humans a year old or more can make unique sounds characterized by vowels. Babies, the Neanderthal and monkeys would all be incapable of this because their larynx is located too high up in the throat.

Past research had already demonstrated that the position of the larynx was not a limiting factor for both babies and Neanderthals. *"The final piece in the puzzle was to demonstrate that monkeys were also capable of producing vowel-like sounds,"* says Louis-Jean Boë. To do so, the researcher and his colleagues analyzed baboon vocalizations, carried out an anatomical study of tongue muscles and modelized the acoustic potential of a baboon's vocal cavity.

BABOONS PRODUCE FIVE VOWEL-LIKE SOUNDS

"We confirmed that baboons make five sounds that are similar to human vowels. They have what we call a proto-vocal system. Their lips, mouth, tongue and vocal folds have the potential to produce sounds that can be differentiated," explains Louis-Jean Boë. To carry out the study, the researchers reviewed 1,200 vocalizations from three male baboons and a dozen female ones. They were able to categorize six types of sounds: grunts, barks, yaks, wahoos, copulation calls and screams.

The researchers then analyzed the pitch and vowel-like qualities of each sound. Interestingly enough, they demonstrated that while human speech spans approximately one octave, baboon oral communication spans four octaves. This demonstrated that in certain capacities, baboons in fact have excellent control of their vocal ability. They simply are lacking the precise control required to formulate vowels in human form. Understanding baboon vocal capacities was particularly interesting for two reasons. First, it was the last piece to invalidate a long-standing theory. And second, these findings suggest there is an evolutionary link between the vocal capacities of baboons and Homo sapiens.

"Over the past 20 years, many contradictions have emerged to invalidate the theory. This last piece of evidence puts to rest a long-standing controversy."

A group of baboons recorded for the study

GIANT EFFECT

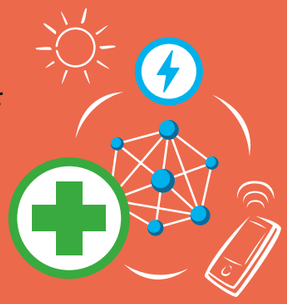
Like most research projects in the GIANT ecosystem, these findings build on long standing collaborations between myself and researchers at many other universities. Our latest study was made possible not only thanks to researchers at the Gipsa-Lab, but also colleagues from the universities of Aix-Marseille, Montpellier and Alabama (US).

LOUIS-JEAN BOË
University Grenoble Alpes Senior Researcher at Gipsa-Lab (CNRS/Grenoble INP/UGA)

GIANT QUIZ

How giant are you?

How well do you know the GIANT Innovation Campus? Test your knowledge of topics related to GIANT, its founding members and the innovation campus.



1 What are the three major topics GIANT scientists are working on to solve the challenges of tomorrow?

Health, Energy, and Information and Communication Technology

2 Students, teachers and working professionals all appreciate me. I'm a fun way to solve real problems and learn new information. What am I?

A serious game developed at GEM

3 What do a Renault Twizy, an electric bus and a metrovélo bicycle all have in common?

They're all part of GIANT's green mobility plan

4 I'm usually very small. Sand could be considered my primary ingredient. And both science and business always want Moore. What am I?

A microchip made by the CEA

5 I might be called the "GIANT" campus, but how big am I really?

250 hectares

Illustrations: ©Studio Barnbarn

- GIANT - CAMPUS *LIFE*

EVENTS ALL YEAR LONG

September 24-26
HIGH LEVEL FORUM
An international gathering of innovation ecosystems; 2017 edition to be held in Montreal

October 22
GRENOBLE EKIDEN
A six person marathon relay race (42.195 km) with free workshops and events for children as well

September
WELCOME DAY

19-21 October
SCIENCE FESTIVAL
A festival dedicated to popularizing research and science

Novembre
FOSTERING DAYS
GIANT support services for European grant candidates

March 17
JUNIOR SCIENTIST AND INDUSTRY ANNUAL MEE TING (JSIAM)
Conferences, round table sessions and industry networking to help junior scientists and industry members interact

May 22-July 28
GIANT INTERNATIONAL INTERNSHIP PROGRAM (GIIP)

June 22-23
FRENCH-AMERICAN WORKSHOP (FAW)

January-July
INNO CUP JUNIOR
A biannual competition to encourage youth innovation

All-year round
GIANT@SCHOOL

All-year round
AFTER-WORK
After-work gatherings on various themes (energy, ICT, health, etc.)

FRENCH-AMERICAN WORKSHOP

Launched in 2011, the French-American Workshop (FAW) is a yearly meeting held in Grenoble. It unites French and American research communities with the participation of more than 150 students, faculty, scientists and representatives from funding agencies. The FAW enables participants to attend plenary lectures with high-level keynote speakers who share their experience on international collaboration. Participants also visit world-class GIANT facilities and take part in networking opportunities. The event is supported by the U.S. Consulate in Lyon and the French Embassy in Washington.

The sixth edition of the FRENCH AMERICAN WORKSHOP will take place at Maison MINATEC on June 22nd and 23rd, 2017.

PROMOTING INTERNATIONAL RESEARCH
The workshop aims to boost international cooperation between French and U.S. universities and research centers. Former GIANT International Internship Programme participants are invited to share their experience and the event provides students with information and support to encourage their interest in international research programs. The FAW also welcomes major U.S. universities that have or intend to develop sustainable relationships with GIANT and Grenoble or French research communities.

FOSTERING COLLABORATIVE INITIATIVES
The FAW is an excellent opportunity to meet young talent and colleagues in various fields of research. The workshop serves as a catalyst to initiate international collaboration. Several educational partnerships have been set up with the support of the National Science Foundation and leading universities such as University of Pennsylvania and UC Berkeley.

Following connections initiated during an FAW, the National Science Foundation and the Agence Nationale de la Recherche joined forces to support the launch of a five year joint project in 2015 (Research and Education in Active Coatings Technologies for the Human Habitat). As other collaborative initiatives emerge, the FAW will continue to support Grenoble's attractiveness as a city for high-level research.

GIANT

AT A GLANCE

40
COMPANIES
on-site

More than **7,000**
SCIENTIFIC PUBLICATIONS
per year

More than
10,000
RESEARCH JOBS

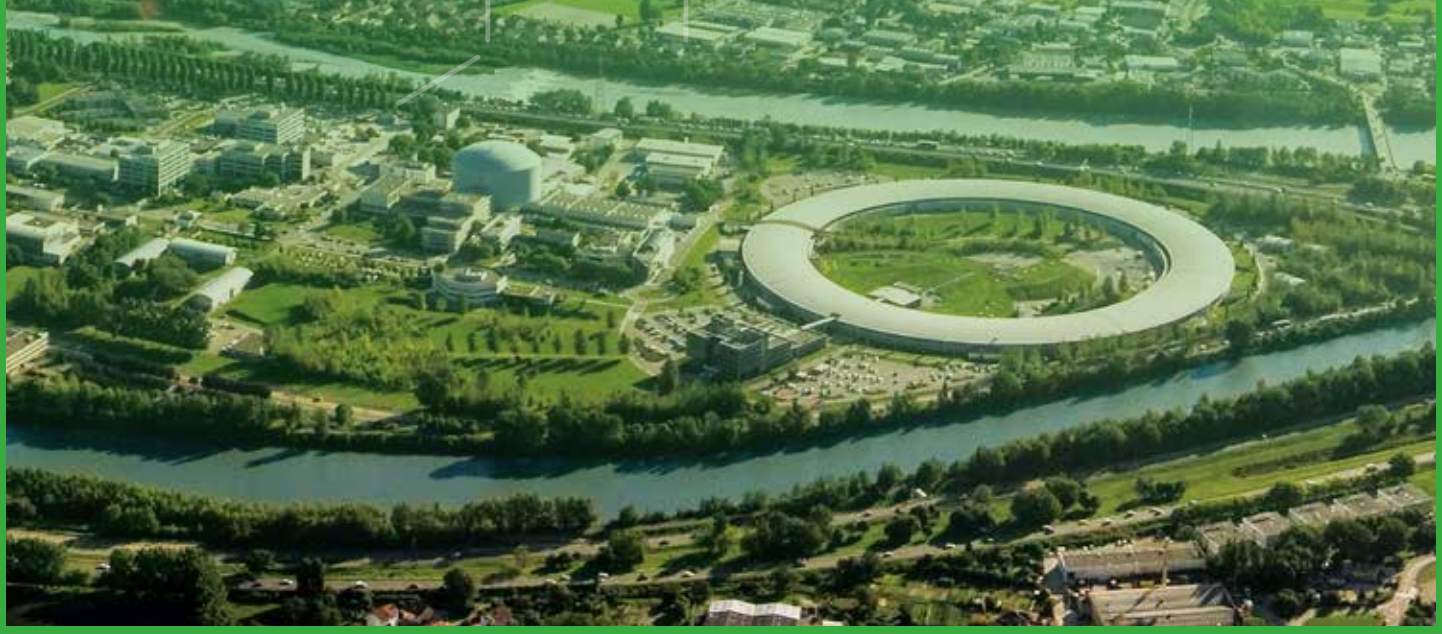
More than
10,000
STUDENTS

More than
5,000
INDUSTRIAL JOBS

More than **700**
PATENTS filed per year

Annual direct and indirect
ECONOMIC IMPACT:
€4,1 BILLION

More than **9,000**
INTERNATIONAL VISITORS



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