WINTER 2017

GIANT REVIEW

— Exploring Science in Grenoble —

Interview
A Comic Book to Learn Creativity

Glaciology
Ice Memory: Saving Glaciers for Future Generations

Smart Energy
Developing Integrated Solutions for Smart Grids

Campus Life
10 Reasons to Study in Grenoble

Living, Learning and Leading
THE CONNECTED LIFE

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.

SIX HUBS FOR EXCELLENCE
in science and academia

Major European Research Facilities
A campus that is unique worldwide in its access to high level equipment used to explore materials and living matter.

Fundamental Research
Essential support for research that advances knowledge and enables technological innovation.

Energy
Electrical networks, smart buildings, energy conversion and transfer, carbon-free energy sources and energy storage.

Information Technology
MINATEC: dedicated to innovation and technology transfer in the fields of micro and nanotechnology.

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

RESEARCHERS

Laurence Lafanechère (CNRS)
Ruban Rose Avenir Prize

Frédéric Maillard (Grenoble INP)
Young Researcher Award (International Electrochemistry Society; French Chemistry Society)

Duncan Haldane (Former ILL)
Nobel Prize in Physics

STUDENTS

Caroline Bissardon (ESRF/UGA)
L'Oréal-UNESCO Award

Lucas Durand (GEM)
2016 graduate of the GEM Master's in IT Systems and Management
Co-founder of Open Car, awarded the 2016 Vinci Autoroutes Prize

Piotr Gerlach (EMBL/UGA)
Thesis on La Crosse orthobunyavirus polymerase
Received a 2016 UGA Thesis Award

INSTITUTIONS

CEA: Leading Global Innovator
1st place in the Reuters Top 25 Global Innovators (ranking of government research institutions)

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

Welcome to the GIANT Review

Grenoble is one of the few places in the world where initiatives for education, scientific research and innovation are united under a common banner of shared values. The result of which is a successful spirit of collaboration and innovation. GIANT (Grenoble Innovation for Advanced Technologies) is but one example that illustrates this vision.

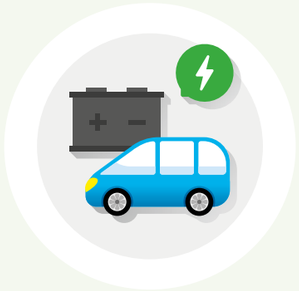
The GIANT Review presents you with our campus's recent success stories and plans for the future. Each article highlights not only the work of specific institutions, but their strong collaboration with many partners in Grenoble, France and around the world. By reading these articles, you will discover the spirit that defines GIANT and the Grenoble ecosystem.

GIANT is only made possible thanks to the work of women and men who contribute to advancing their institution's mission as well as team up to participate in a variety of initiatives: creating opportunities for the next generation of scientists, engineers, administrators and technical staff; enabling the sharing of skills, experience and expertise; informing the general public of how GIANT is addressing current technical and scientific challenges in areas such as information technology, new materials for energy storage and health; and last but not least, supporting the development of an innovative European industry committed to wealth creation and the sustainable growth of our society.

GIANT is open! GIANT is the result of a shared vision designed to ensure the campus attracts international partners and is sought out worldwide. It represents an opportunity for younger generations to be trained and find competitive jobs in Grenoble or elsewhere. This innovative ecosystem is also geared towards creating opportunities for the world's leading scientists, engineers and innovative companies—from industry giants to small cutting-edge startups.

On behalf of all the directors of the GIANT partnership, it is my pleasure and honor to share with you the present winter 2017 GIANT Review.

Francesco Sette
Director General
European Synchrotron Radiation Facility (ESRF)



A UNIQUE SWITCHED CELL ARCHITECTURE FOR **THE FUTURE OF TRANSPORTATION**

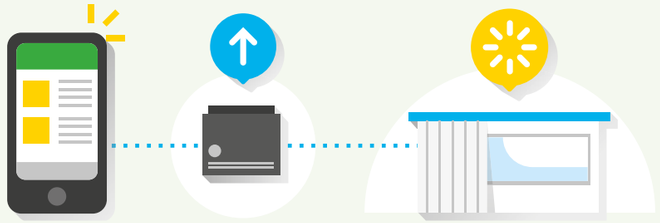
The CEA-Leti is currently working on innovative battery technology for both electric vehicles and stationary energy storage. This innovative technology eliminates the battery charger and inverter, and ensures real-time cell balancing to improve performance and battery life cycles. This unique switched cell architecture has already attracted an industrial partner to implement the technology for two-wheeled electric vehicles. In addition, the technology is under development for stationary energy storage to be used in the smart grids of tomorrow.

Plexus: Projects as a LEARNING EXPERIENCE

The Grenoble Ecole de Management Plexus learning platform was developed in partnership with IRT Nanoelec. This innovative educational approach enables students to learn through experimentation. In October, the platform launched a connected store (DIVE). It provides students with access to current technology and prototypes still under development. Thanks to a hands on approach, students can immerse themselves in the future of digital-physical stores.

STARTUP: ANTAÏOS
to Develop Disruptive Non-Volatile Memory Solution

Every year, the national i-LAB competition rewards the creation of innovative high tech companies. The 2016 edition awarded one of five Creation-Development grand prizes to Jean-Pierre Nozières, from the CEA/CNRS SPINTEC laboratory. His startup, Antaïos, will bring to market a disruptive solution for fast, durable and reliable non-volatile memory. The technology used for this project is known as Spin-Orbit Torque and was developed by Gilles Gaudin's research team at SPINTEC. The goal is to enter the memory market by offering a high performance embedded memory solution for high-end mobile and computing applications.



EMBL Receives **NEW DATA PROCESSING CONTAINER**

On November 4th, the EMBL was delivered a unique container designed to increase its data capacity. As the EMBL's data systems include critical operations that cannot be disconnected, the institution opted for this innovative solution to expand its capacities. The container will enable data services to be split. Data storage will remain in the old servers while calculations will be transferred to the container's servers. This container is the first of its size in Europe to not use hydrofluorocarbons for cooling (a powerful greenhouse gas). However, if future heat waves in Grenoble are worse than expected, the container might be modified to add a small traditional cooling system.

ESRF PROMOTES **GENDER EQUALITY**

According to UNESCO, only 10-12% of researchers in science, technology, engineering and mathematics are women. In response, the ESRF has set up partnerships with the universities of Warwick and Liverpool in England as well as the universities of Uppsala and Umea in Sweden. By organizing a competition for 16 and 17 year old girls studying physics, these partnerships enable students to visit the ESRF and participate in the Synchrotron@School program. This summer 16 British girls were invited for two days to visit and learn about research at the synchrotron.

MINT: RESEARCH CHAIR FOR MOLDED **INTERCONNECT DEVICES**

On March 30th, 2016, Schneider Electric and the Grenoble INP Foundation launched a research chair dedicated to molded interconnect devices (MID), which are a combination of plastics processes, printing technologies and electronics. The explosion of demand for connected objects requires businesses to reduce production costs and increase durability and integration with other systems. The MINT chair brings together Schneider Electric, two Grenoble INP schools and two research laboratories (LGP2 and IMEP-LaHC) in order to overcome technological challenges that will enable MID optimization for industrial connected objects.

ILL: BUILDING ON 50 YEARS OF EXPERTISE IN NEUTRONS

On October 1st, 2016, Helmut Schober became the ILL's director and Mark Johnson became head of science. Charles Simon remains head of the projects & techniques division. With its new management team in place, the ILL is preparing to celebrate its 50th birthday on January 19th, 2017. Founded as a joint agreement between the French and German republics, this ambitious project is home to an intense and continuous source of neutrons dedicated to fundamental research. As the world's leading neutron source, the European scientific community will be able to rely on the ILL's unmatched neutron reactor and instruments for years to come.

REACT: DEVELOPING ACTIVE COATING TECHNOLOGIES

The United States National Science Foundation and the French National Research Agency (ANR) provided 3.8 million dollars and 300,000 euros respectively in funding for the REACT project (Research and Education in Active Coating Technologies for the Human Habitat). By collaborating together on this project, the University of Pennsylvania, GIANT and Solvay aim to enable the development of active coatings that will help transform human habitats. Grenoble's contribution will include 15 researchers from the CEA, CNRS, LMGP and ILL as well as students in the GIANT International Internship Program.

3N-LAB: Uniting the University Grenoble Alps and Tsukuba, Japan

The inauguration of the 3N-LAB in February 2016 served to underline 15 years of collaboration between MINATEC, the Institut Néel (CNRS/UGA) and the National Institute for Materials Science (NIMS - Tsukuba). As leaders in the world of nanoscience research, this partnership is built on the wider collaboration between the NIMS and the GIANT Innovation Campus. The inauguration provides researchers from both institutions with access to a GIANT office in Tsukuba and the NIMS Collaborative Research Center in MINATEC.

ICE MEMORY:
SAVING GLACIERS for Future Generations

The impact of climate change and global warming has been particularly strong on glaciers, most of which are retreating at an alarming pace. Yet glaciers hold multitudes of information about our past climate and environment. As these ice giants melt away, the information they enclose becomes corrupted for scientific analysis. In collaboration with partners in Italy, Russia and the U.S., the Université Grenoble Alpes (UGA) launched an international project to drill and preserve ice core samples from major glaciers around the world.

#Fundamental Research — #Environment

A FIRST SUCCESS AT THE COL DU DÔME

The project began in 2016 as a collaboration between UGA, the CNRS Laboratory for Glaciology and Environmental Geophysics, the Université Ca'Foscari (Venice, Italy) and the UGA Foundation. The first mission was to drill three ice cores from the Col du Dôme glacier in the Mont Blanc massif. *"We extracted three ice cores of 126, 127 and 128 meters. The Ice Memory mission is unique in its goal to extract multiple ice cores from each glacier. The first core will be analyzed using all current tools in order to create an open database available to researchers around the world. The two remaining cores will be stored in Grenoble until we have enough samples from various glaciers to launch a shipment to Antarctica in 2020. These remaining ice cores will be stored in the Concordia base using an underground cave that has a constant temperature of -54°C. By creating a global archive of glacier ice cores, we will ensure that future generations of scientists have access to our planet's ice heritage,"* explains Patrick Ginot, a research engineer at the IRD and co-coordinator of the Ice Memory project.

Ice core extraction at the Col du Dôme. Aug. 2016. © Sarah Del Ben / Wild Touch / UGA Foundation

PROTECTING A RAPIDLY DISAPPEARING SCIENTIFIC RESOURCE

Why launch the Ice Memory project? *"Over the years, we have observed a rapid deterioration in glaciers worldwide. Rising temperatures have caused surface layers to melt and infiltrate lower levels of many glaciers. This threatens our ability to extract accurate data about the earth's past climate and environment. The Ice Memory project is an urgent mission. We chose to start with the Col du Dôme because it's greatly threatened by climate change. But the same goes for other glaciers around the world!"* exclaims Ginot.

Current scientific tools enable researchers to extract a variety of information from ice cores. Ginot explains that: *"We can analyze water isotopes to learn about past moisture sources and temperature variations. We can collect data about mineral dust, soluble chemicals and soot to learn about the composition of atmospheric aerosols, air circulation and pollution patterns. There are also tools to examine organic materials. However, in the future we will certainly develop more tools. For example, tools for bacterial and viral analysis still require improvements. The ice cores stored in Antarctica will ensure there are adequate samples for future research tools."*

Ice core extraction at the Col du Dôme. Aug. 2016. © Sarah Del Ben / Wild Touch / UGA Foundation

PREPARING A NEW MISSION TO THE ANDES

Following the success of the Col du Dôme mission, the Ice Memory project is preparing a second, more complex mission to the Illimani glacier in the Bolivian Andes mountain chain. *"Over the past ten years, the temperatures near the col du Dôme and Illimani glaciers have increased by 1.5 to 2°C at 50 meters of depth. By the end of the 21st century, there will no longer be ice under 3,500 meters in the Alps and under 5,400 meters in the Andes. The creation of a glacier archive has really become an urgent project,"* underlines Ginot. Other countries such as Germany, Switzerland, Brazil, the U.S., Russia, China, Nepal and Canada have already expressed their interest in the project in order to save samples of their own glaciers.

GIANT EFFECT

The GIANT Innovation Campus creates an ecosystem that encourages both local, national and international cooperation. The Ice Memory project unites not only local and international research institutes, but also financial support from individuals, industries and philanthropic foundations. The project symbolizes research that benefits society and future generations, a vision that is at the heart of the GIANT ecosystem.

PATRICK GINOT
IRD Research Engineer
Co-Coordinator of the Ice Memory Project

COMBINING TRADITIONAL RESEARCH AND PHILANTHROPY

Funding is one of the unique aspects of this project. Up until recently, most scientific projects have been traditionally funded through government or European support programs. However, the Ice Memory project is a stepping stone between hard science and creating a heritage for future generations.

As a result, the project was able to develop a variety of funding sources. The UGA Foundation works hand in hand with the project coordinators to provide philanthropic support from foundations, industry and individuals. To prepare the second phase of the project in Bolivia, the coordinators even launched a crowdfunding campaign via **Ulule.fr**.

ESRF EQUIPMENT Used to Trace Mercury Contamination in Hair

Current techniques used to detect mercury in individuals are unable to provide complete information concerning the source of contamination. However, thanks to new cutting-edge instrumentation at the European Synchrotron Radiation Facility (ESRF), researchers were able to determine the molecular forms of mercury in hair and identify their source.

#Health — #Large Scale Facilities

Alain Manceau, the CNRS research director who led the project, explains: *"The toxicity of mercury depends on its chemical state. The objective of our study was to pin down exactly how mercury is bonded in hair. We wanted to check if the bonding varied according to the source of contamination."* The researchers collected hair samples from a variety of individuals exposed to mercury poisoning. For example, they analyzed a hair strand from Colette, a French woman who ingested mercury due to the unsafe removal of a dental amalgam, as well as hair samples from two residents of Pará, Brazil, who regularly ate mercury-contaminated fish.

CUTTING-EDGE TECHNOLOGY ENABLES MOLECULAR-LEVEL ANALYSIS

The ESRF, CNRS and UGA recently collaborated to build new instrumentation for X-ray Absorption Near-Edge Structure spectroscopy (XANES). The researchers also used the ESRF's nano-sized beam to map the mercury content in a single strand of hair. "The possibilities for spectroscopy and fluorescence analysis at the ESRF are exceptional. Thanks to high energy and spatial resolutions, we were able to detect mercury at levels under one part per million (ppm). Such precise measurements have never been done before," highlights Pieter Glatzel, a group leader at the ESRF. Using this technology, the researchers were able to pinpoint a mercury contamination of 0.74 ppm in one strand of Colette's hair. *"In addition to identifying a tiny 0.49 mm long section of contaminated hair, we were able to correlate its location on the strand of hair with the date Colette had her dental amalgam removed. While 0.74 ppm is well below anything considered dangerous, it was sufficient for us to use XANES spectroscopy and identify how mercury was bonded to keratin. This demonstrated that its molecular form was different from methyl-mercury which is ingested through fish consumption,"* explains Manceau.

HAIR ANALYSIS CASTS DOUBT ON UNDERSTANDING OF MERCURY INGESTION

Traditionally, it is believed that organic mercury from sources such as fish or rice will predominantly end up in hair and be eliminated via the liver. Inorganic mercury such as that found in dental amalgams is believed to be present in blood and eliminated through urination. However, Manceau underlines that: *"These research results change our vision of how mercury is deposed in the body. Inorganic mercury can also travel to our scalp and therefore our brain."*

As a result, the ESRF's exceptional instrumentation has opened the door to new research on mercury contamination. For example, researchers from China visited the ESRF last summer in order to start measuring mercury in rice tissues. By combining high spatial resolution imaging and high energy resolution XANES spectroscopy, scientists now have a holistic approach to better understand mercury contamination and how it is amplified up the food chain from rice or fish to humans.

GIANT EFFECT

This project was only made possible by the combination of cutting-edge technology and international cooperation. It's a perfect illustration of the GIANT ecosystem. The XANES spectroscopy equipment was developed thanks to Equipex government funding and the collaboration of the ESRF, UGA and CNRS. In addition, our study of mercury contamination included scientists from as far away as the University of Illinois at Chicago.

ALAIN MANCEAU
CNRS Research Director

Preparing the Next Generation of FLEXIBLE ELECTRONICS

Whether it is nanolithography, photovoltaics or printed electronics, the electronics industry is being challenged by our ever increasing need for smaller, smarter and more efficient devices. In response, the European GreeNanoFilms project was launched to advance our use of nano-structured and technical films, which are fundamental building blocks of electronics.

#Information Technology — #Energy

The GreeNanoFilms project united ten academic and industrial partners including the CERMAV, the CNRS laboratory that coordinated the project. As current technology is limited to a resolution of approximately 20 nanometers (nm), the project explored the use of carbohydrates to create higher resolution nano-structured films that would be efficient at ten nm or less.

A NEW BUILDING BLOCK FOR ELECTRONICS

Current petrol-based copolymers are inefficient when reducing size below 20nm. To overcome this challenge, the coordinator of the GreeNanoFilms project, Redouane Borsali explains: *"By using a bio-sourced carbohydrate-based copolymer called high-x, we were able to reach a resolution of ten nm or less. Increasing the resolution of thin films enables many advances such as increasing transistor performance or storage capacity in memory devices."*

THREE BROAD FIELDS OF APPLICATION

The technology created by the GreeNanoFilms project could impact three major fields of activity. First, these films will enable next generation nanolithography. The project demonstrated that this new copolymer efficiently held its nano-sized structure and characteristics over the long-range (up to several micrometers). This was a crucial step for the films to be used in real-world applications. Second, the project's research could enable the production of high-resolution biosensors. One of the challenges of detecting diseases with biosensors is the need for highly sensitive materials. Given the utlra-high resolution of the high-x copolymer, it will be possible to efficiently detect proteins and infectious cells at the molecular level.

Third, the project worked on photovoltaic applications. *"We were able to improve the domain spacing of these nano-structured thin films. Current technology uses active films where the space between elements is greater than ten nm. By dropping under the bar of ten nm, we hope to improve the transfer of electrons and therefore improve overall photovoltaic cell efficiency. We're currently testing performance levels in collaboration with the CSEM in Switzerland,"* adds Borsali.

GIANT EFFECT

Ecosystems such as GIANT and the Carnot PolyNat Institute help foster the link between industry and research. In the case of the European GreeNanoFilms project, we were able to collaborate with ten academic and industrial partners in seven countries. During the application phase, we even collaborated with the University of Texas in Austin to file a second patent for highly nano-structured thin films (under 10nm).

BORSALI REDOUANE
CNRS Research Director
GreeNanoFilms Project Coordinator
CERMAV Self-Assembly Group Leader
Director of the Carnot Polynat Institute

GOING FROM RIGID TO FLEXIBLE TECHNICAL FILMS

Another goal of the GreeNanoFilms project was to explore the use of flexible substrates, which have to be transparent, mechanically robust and super-hydrophobic. Thanks to the expertise of two project partners (CTP and VTT), the team was able to create a super-hydrophobic technical film using patented CNRS and CTP technology.

A COMIC BOOK
to Learn About Creativity

Technology and business have never developed so fast. Whether it is to catch up or stay ahead, creativity is a critical factor for most businesses. In response, Grenoble Ecole de Management has been developing a variety of innovative educational approaches to boost student creativity. In this edition of the GIANT Review, we present you with an excerpt drawn from a comic book designed to teach the fundamentals of creativity.

#Education — #Innovation Management

We speak with Séverine Le Loarne, a professor in the Department of Management and Technology at Grenoble Ecole de Management. The excerpt is drawn from a 14 page comic book called "Nanoly: All Demiurges!", which she developed in collaboration with the illustrator Roger Brunel. The comic book presents concepts related to the management of innovation. It was funded thanks to support from the IRT Nanoelec.

Q ***Is it possible to improve creativity?***
Yes! There are lots of ways to work on creativity. It's a matter of training. We work with serious games and other fun exercises. The idea is not only to foster creativity, but also to help students learn methods that will enable them to implement a creative process. We teach students how to organize their company or team in order to encourage innovative ideas. However, research literature on creativity is often complex and boring to read. By using a comic book, we can share and explain a variety of key concepts in a fun manner. The storyline also allows us to provide context and examples.

Q ***Can you explain this excerpt to our readers?***
This comic book follows the story of Hérédé, who is working with his company to renew their product offer. In this extract, he is focused on finding an innovative idea. The first line shows Hérédé working day and night to be creative. He has the motivation, expertise and training to succeed, which are three crucial factors for creativity. This provides us with an opportunity to exchange with students about research that explores the mechanisms of creativity.

The second box on line two opens the way for a discussion about the fact motivation for creativity is more intrinsic than extrinsic. A bigger paycheck doesn't motivate creativity. It can maybe encourage the production of more ideas, but they will not necessarily be better ideas. That last box of line two underlines another important concept: Creativity is based on psychological bricolage. In other words, Hérédé draws on past knowledge and ideas, acquired in this case from the Nanews magazine, to develop his innovative solution.

The last line depicts Hérédé's novel idea and the fact it has to be approved by his organization. In general, a new idea must earn the support of a middle manager in order to be developed. Here we can discuss a company's definition of creativity (a new idea that is useful to the organization). Finally, the page ends with the presentation of Hérédé's idea Tubix, which will enable materials to change their properties. Readers learn more about the idea in the pages that follow.

FOCUS

LIVING, LEARNING AND LEADING

the CONNECTED Life

From connected objects to entire smart systems, the Internet of Things (IoT) covers a wide array of technology and applications. At GIANT, the impact of the IoT revolution is two-fold.

First, researchers are focused on developing cutting-edge technology to overcome IoT challenges in areas such as security or energy consumption.

Second, IoT is changing how researchers and professors carry out their work. In this article, we present several examples of cutting-edge solutions currently under development. You will also discover how existing IoT technology is affecting the work carried out by our researchers and professors (see side boxes).

Illustrations: ©Studio Bambam

GIANT founding members, are working on overcoming the technical challenges of an IoT world. Two of the most critical areas in need of development are energy and security. In terms of energy, one of the primary challenges is to provide small yet sufficient power sources that can supply energy to a variety of connected objects.

From a security perspective, the challenge lies in creating solutions that meet the cost and energy constraints of IoT objects and systems.

ENERGIZING THE IOT REVOLUTION

Powering a connected object is a unique challenge as it requires a small yet efficient and durable energy source. In response, Olivier Bourgeois, a research director at the Institut Néel/CNRS and head of the Thermodynamics and Biophysics Small Systems team, and Dimitri Tainoff, also a researcher at the Institute Néel, have developed new technology known as MODULO to harvest ambient energy. *"Devices that harvest ambient energy are usually large, non-mobile solutions. They're designed to work with large variations in temperature, approximately several dozens of degrees Celsius,"* explains Bourgeois.

This innovative module is a small energy harvester capable of using only the minimal temperature variations that are always present in surrounding environments. Tainoff adds: *"We completely redesigned the concept in order to create a flat, compact and durable model. It includes hundreds of nanometric membranes that absorb small quantities of thermal energy. A thin thermoelectric layer then converts this energy to electricity."* Unlike batteries, this technology is durable and requires no maintenance.

ENERGY A PRIMARY CONCERN FOR SECURITY

In addition to finding innovative sources to power connected objects, energy consumption is a primary concern for security measures. Simone Bacles-Min, a researcher at the CEA Leti, is currently working on a CEA project to demonstrate the strengths of FD-SOI 28nm technology for IoT applications. *"For the moment, security cannot be effectively implemented in IoT applications because the cost is too high both in terms of energy consumption and production. As a result, our goal is to create a cost effective silicon solution that combines security and low energy consumption."* The project is made possible thanks to the CEA's expertise in three fields: security, semiconductor characterization and silicon chip production. Low energy consumption was also a guiding constraint for a project underway with ATOS, Seclab, UGA and the CEA Leti Systems Department. The project aims, among other things, to develop a trust anchor, which is a security tool that can be added to existing systems. As a pluggable USB key, the trust anchor can secure an existing system without excessive energy consumption. *"In addition, we are going to develop a lightweight version that will consume even less energy,"* adds Florian Pebay-Peyroula, a research engineer at the CEA Leti.

BUILDING ON PRE-EXISTING SYSTEMS

On top of energy constraints, the IoT revolution is limited by the fact that industries have to build on pre-existing systems. *"You can't afford to throw out an entire system and redevelop it with new security measures. That's the advantage of developing a pluggable trust anchor. This USB device will enable users to easily implement fundamental security operations (authentication, encryption and digital signatures). We also made it easy to adapt the trust anchor to specific fields by adding services such as secure firmware upgrades, user management and logs. Over the long term, we will be able to integrate this security solution directly within systems for industries, smart grids or IoT products."* says Pebay-Peyroula.

GOING FROM TECHNOLOGY DEVELOPMENT TO CONCRETE APPLICATIONS

The trust anchor under development by the CEA Leti is but one example of bridging the gap between research and concrete IoT applications. Opportunities to transfer technology towards the real-world can take many forms. One approach is illustrated by the European Human to Objects project, which is focused on the development of a smartwatch that meets IoT constraints. Another example can be found in Morphosense, a startup that builds on ten years of patented research and technology developed by the CEA-Leti.

EDUCATION: SMARTPHONES AS CONNECTED SENSORS

"As a physics teacher, I don't think of smartphones as touchscreens and communications devices. I see them as a great collection of connected sensors. You have accelerometers, gyroscopes, microphones, cameras, gravity sensors, and the list goes on!" exclaims Joël Chevrier, a professor at the Université Grenoble Alpes.

With these connected sensors, students hold in their hands a great set of tools for physics experiments. Chevrier started out by designing a MOOC that covers five basic chapters of any physics class. *"For each experiment, students can use an application that records sensor information. First, students can test Newton's first law simply by dropping their smartphone. An application will record data about the free fall and students can interpret this data thanks to the MOOC."* The four remaining experiments test rotation, Galileo's pendulum, oscillations and vibrations, and acceleration. This year, Chevrier is re-working the material in collaboration with the CRI Paris (Université Paris Descartes), the IRCAM and ENSCI Les Ateliers in order to better meet the needs of teachers and students.

ENABLING CONNECTED SCIENCE

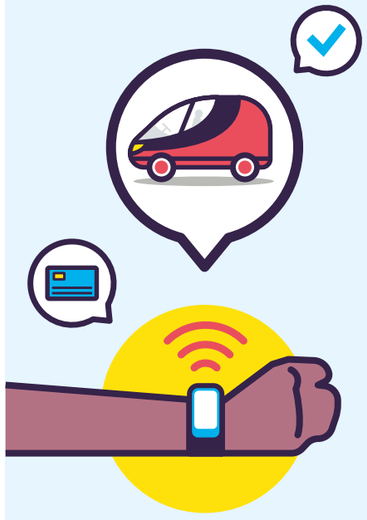
The ILL, ESRF and EMBL represent GIANT's leading European research facilities. As such, they provide excellent examples of how IoT will play a growing role in research activities. At the ILL for example, each instrument was equipped with a connected tablet two years ago. *"A tablet provides numerous advantages over traditional fixed computer stations. In many cases, a control station cannot be installed right next to the equipment. It might be 50 meters away or even in a different room. With a connected tablet, researchers can now program an instrument with one hand while being right next to their sample. And their second hand is free to do something else if necessary!"* explains Paolo Mutti, head of the ILL Instrument Control Service.

The ILL is working on further developments that include an augmented reality application for experimental setup. *"We're currently creating a database for each instrument. By recording exactly how each part of an instrument operates, we can simulate what will happen during an experiment. For example, when a researcher is setting up, he or she will be able to see exactly where the instrument's beam will go and how it will intersect the sample,"* adds Mutti.

Another advantage of an IoT world is the ability to develop automated systems that can be remotely controlled. The ESRF and EMBL have collaborated to create the world's first fully automated crystallization process. The service relies on the ESRF MASSIF-1 beamline which is a unique facility that provides remote controlled and fully automated crystallography. The two institutions have joined forces to offer an automated online service from start to finish, which includes growing and harvesting crystals at EMBL before transferring them to the ESRF for analysis. *"By automating the entire process, we've greatly increased efficiency. In addition, this automated system facilitates access. Instead of requesting time slots to visit the ESRF and EMBL, users can send their samples and program experimental parameters via an online platform known as CRIMS,"* explains Josan Marquez, who is in charge of the EMBL Crystallization Facility.

A EUROPEAN PROJECT TO DEVELOP THE SMARTWATCH OF THE FUTURE

The Human to Objects European project was launched in four countries with the collaboration of major groups like Gemalto and STMicroelectronics, SMEs and research organizations. Over three years, the project aims to develop a smartwatch that will meet three IoT challenges. First, the watch will enable controlled access to cars or other locations. Second, it will provide a wearable payment method for e-commerce. And third, it will offer monitoring capacities for e-health.



Among the many challenges associated with this project, the CEA Leti's Systems Department is currently working on developing an evaluation scheme for security certification. Jean-Christophe Fonbonne, a research engineer at the Leti, explains: *"Smartwatches and other cyber-physical objects have specific constraints in terms of security as they have to be as safe as credit cards but at the same time cheap and fast to implement."*

The challenge for the Leti's Systems Department is that most security evaluation tools have been developed for larger software and servers. Their ability to scan and test for security faults is not adapted to IoT applications because such devices are limited in terms of resources. *"We have to develop an IoT security tester that is fast, automatic, adaptive and that offers remote inspection. This is the key to providing effective security evaluations for IoT products,"* says Fonbonne.

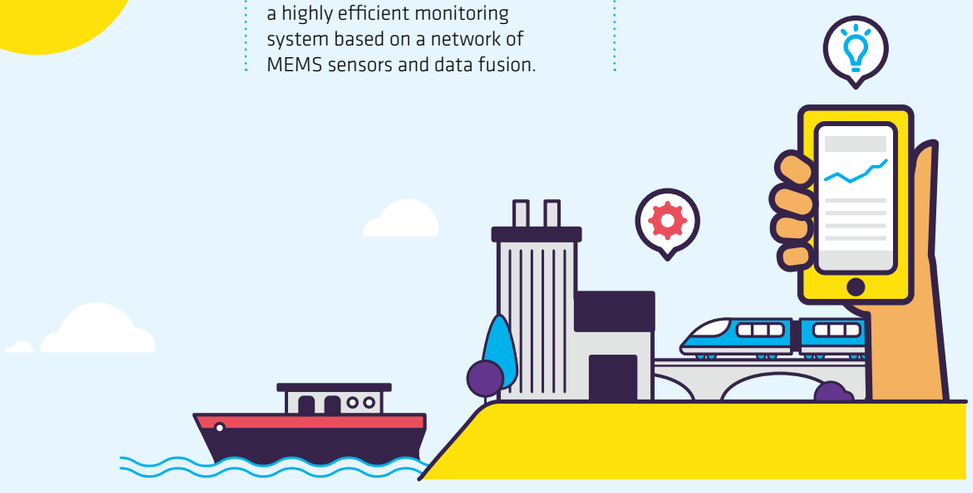
AN IOT STARTUP FOR INDUSTRIAL PURPOSES

Whereas the Human to Objects project is designed to create solutions mostly geared towards consumer products, the IoT revolution also impacts industrial applications. Morphosense was created in August of 2016 to offer a highly efficient monitoring system based on a network of MEMS sensors and data fusion.

The company provides clients with a customizable dashboard that enables efficient monitoring of physical infrastructures.

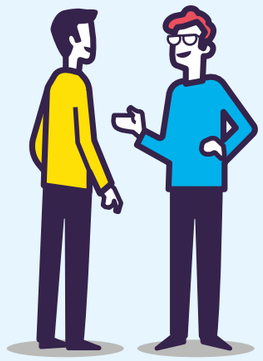
Sensors placed directly on the structure provide real-time data about vibrations and structural deformations. These measurements are used in combination with patented numerical models in order to monitor and predict potential issues. Like other IoT solutions, this technology builds on pre-existing systems.

"We offer a monitoring solution that meets the needs of aging and overloaded infrastructures. By combining hardware and software expertise, we can help various sectors such as civil engineering, railroads, maritime activities and energy," explains Pierre-Damien Berger, a Morphosense co-founder and past manager at CEA Tech.



A FRAMEWORK TO ENABLE SMART PROJECTS

Be they security, energy, consumer or industry-oriented, all IoT projects rely on an interaction between objects and systems. *"IoT is really about going beyond a single object with connective capabilities in order to create smart ecosystems in which a variety of objects interact and cooperate,"* says James Crowley, who coordinates the Amiqual4home project and is a professor at Grenoble INP as well as a researcher at Inria.



Thanks to funding from the French National Research Agency, Inria, Grenoble INP, UGA and Schneider Electric joined forces to create the Amiqual4home project. The framework provides participants with access to a variety of tools such as a creativity lab, an apartment equipped for smart home testing, a smart energy platform and various mobile equipment such as connected eyeglasses or humanoid robots. *"For example, we have an apartment that was equipped for intensive smart energy testing. Every room has Schneider Electric sensors for temperature and CO2. We can monitor the environment room by room,"* adds Crowley.

No matter whether it is a framework for IoT tools, cutting-edge research to solve specific IoT challenges or the use of IoT to teach future generations, collaboration is the key to each of these GIANT projects. While IoT and connected objects are opening new frontiers in every field, they create challenges that require multidisciplinary collaboration. As such, the IoT revolution highlights one of the cornerstones of GIANT, which is to create a collaborative ecosystem that will foster the future of innovation for industry and society.

IOT AND PERSONAL DATA

One of the key reasons institutions such as the CEA are focusing on developing security measures for IoT is the fact that connected objects have led to an explosion in the collection of personal data. Whether it is a smart energy meter or a connected health bracelet, these devices provide companies with in depth information about our personal lives. Researchers, such as Nathalie Devillier from Grenoble Ecole de Management, are analyzing the impact of these devices on our privacy. *"For the moment, the regulations and policies that control the use of personal data in IoT are still being figured out. For most applications, when you want to use its services, you simply click accept. Yet in doing so, you agree to a contract that regulates how your personal data is used. Unfortunately, there are numerous abusive clauses. You might unwittingly agree to a company selling your data to third parties, or keeping and using it for an undefined or unreasonably long time,"* explains Devillier. As we wait for regulation to catch up with innovation, she recommends users take privacy matters into their own hands. *"We have to pay close attention to how we install and configure privacy settings for services tied to connected objects."*

Developing INTEGRATED SOLUTIONS FOR SMART GRIDS

The energy transition is upon us and smart grids would appear to be the way of the future. However, implementing smart networks translates to setting up and coordinating numerous actors from the consumer level to local, regional and national levels. In response, the European DREAM project united 12 partners in seven countries to develop an industry-validated approach that can implement a decentralized management system for smart grids.

#Energy — #Technology Management

Ense³ smart building

The energy transition will include new local sources of energy such as individual solar power as well as new energy users such as charge stations for electric vehicles. The challenge of any smart grid will be to manage all of these decentralized energy resources in coordination with a distribution system operator (DSO) or energy supplier.

"Smart grid management means dealing with multiple factors at once. You have to detect and respond to network congestion, overloads and other technical constraints. When properly managed, smart grids provide numerous advantages," explains Raphaël Caire, coordinator of the European DREAM project and an associate professor at Grenoble INP. *"Local energy users can fine tune their energy consumption, sell unused energy and be rewarded for flexibility. Network level operators can also improve the efficiency of their network by allowing local sectors to self-regulate. By segmenting their network operations, DSOs can act or react locally, thereby reducing the impact of a local disruption."*

"We developed a heterarchical management system for smart grids."

FOUR LOCAL TESTS TO VALIDATE A SYSTEM-LEVEL APPROACH

The EU DREAM project implemented four real-world tests. In Milan (Italy), the airport network manager (lighting, heating, cooling, etc.) tested its ability to manage distributed energy sources. This meant regulating the airport's energy consumption to respect engagements and minimize risks. At the same, it was able to sell excess energy produced by its trigeneration unit back to the Italian electricity balancing market. In Meltimi (Greece), a set of seaside cottages with low-voltage network loads and generators self-coordinated to respect technical constraints. The Greek DSO provided support to help manage the network. In Groningen (Netherlands), a lab is using micro combined heat and power, solar panels, hybrid heat pumps and other energy sources of the future to simulate their interactions with networks and energy markets across different time scales. In Grenoble (France), frequency containment reserve tests were carried out for distributed energy resources in order to explore how networks can stabilize frequency during a disturbance. The goal was to demonstrate the capacity for finer and safer adjustments during emergency frequency load shedding. While analysis is still ongoing, the first results confirm that a heterarchical management system offers excellent flexibility and efficiency.

ENABLING LOCAL ACTORS IN ENERGY MARKETS

The idea is to set up a flexible and expandable management system. First, a network can try to solve a problem by having a few local actors coordinate their actions. *"If that doesn't work, you scale up to include a larger panel of actors. The DSO, for example, can provide added flexibility to manage an issue by reconfiguring the electrical network,"* adds Caire.

To create a flexible management system, the DREAM project took an innovative approach based on heterarchy. Unlike a hierarchical system, a heterarchical system does not rank the various actors in an organization. *"By having an initially unranked and self-organizing set of actors, we can set up an ad-hoc management system that easily adapts to the needs of a given situation. If you have a local issue, you can automatically connect a federation of concerned actors to solve technical constraints and achieve the optimal response. At the same time, the network configuration can be easily changed to create new federations of actors. This makes it quick and easy to scale up and include other actors,"* says Caire.

COMBINING INDIVIDUAL SCENARIOS TO CREATE AN OVERALL FRAMEWORK

The DREAM project was divided into three phases. First, researchers developed scenarios and algorithms to manage a variety of situations from real-time operation to short-term issues. Second, the various tools and scenarios were united within an overall framework. And finally, this framework was shared with participating DSOs and partners to carry out real-world tests.

For example, Caire cites Strasbourg, where: *"A group of clients and producers were equipped with Schneider Electric's Wiser energy box. This enabled the network to manage client consumption and activate energy flexibility. The energy boxes shared information locally in order to help the network segment adapt. In the case of greater variations in consumption, local information was shared with the transmission system operator."*

GIANT EFFECT

Smart grids of the future will have to be built on a collaborative ecosystem. Our lab has traditionally been a joint research unit with resources from UGA, Grenoble INP and the CNRS. GIANT provides a collaborative ecosystem that enables us to scale up our activities with participation from local actors such as the CEA as well as international partners.

RAPHAËL CAIRE
EU DREAM Project Coordinator / Associate Professor at Grenoble INP

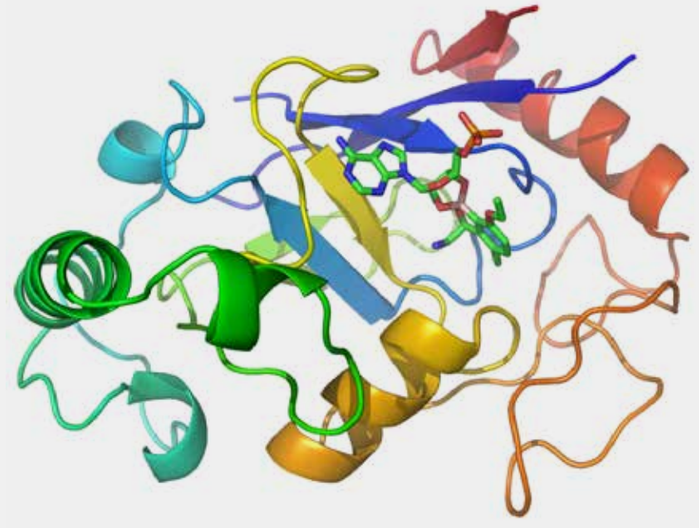
DREAM: AN INTERNATIONAL EU PROJECT

EMBL AIDS DEVELOPMENT
of New Compounds to Target Four Serious Pathogens

The pharmaceutical industry is fighting a constant battle to stay one step ahead of bacteria, parasites and other pathogens. As pathogens evolve, new drug-resistant strains threaten our ability to effectively treat major diseases such as tuberculosis or malaria. In response, the European Molecular Biology Laboratory (EMBL) collaborated with Anacor Pharmaceuticals to develop new compounds that offer promising results in the fight against tuberculosis (TB), cryptosporidiosis, toxoplasmosis and malaria.

#Fundamental Research — #Health

Most drugs act by targeting and inhibiting a specific mechanism within a cell. When pathogens evolve to resist a drug, researchers must find new weaknesses to target. The process begins by screening a library of compounds to find one that could potentially inhibit a critical cellular mechanism. Once a suitable compound is identified, researchers use crystallography and x-ray diffraction to identify the molecular target and visualize how the compound binds with it. This makes it possible to optimize the compound and increase potency.



Inhibitor compound (geometric shape) and target enzyme (colored ribbons)

EMBL PROVIDES ATOMIC-LEVEL ANALYSIS

EMBL started working with Anacor in 2007. The pharmaceutical company first identified a compound called AN2690, which targets a fungal enzyme. *"Our expertise with this kind of enzyme enabled us to prepare crystals of the compound bound to the target enzyme. We used ESRF X-ray beamlines to determine the 3D structure at an atomic level,"* explains Stephen Cusack, the project group leader and director of the EMBL Outstation in Grenoble. In technical terms, the project targeted Leucyl-tRNA synthetase which is an enzyme found in all living cells. It is essential for synthesizing new proteins. Cusack further explains that: *"The enzyme's job is to attach the amino acid Leucine to the end of a particular tRNA strand. The enzyme should specifically recognize and use only Leucine. However, it sometimes makes a mistake and uses another amino acid that is chemically similar to Leucine. To counter this, the enzyme evolved a secondary 'proof-reading' site that double checks if it's using the right amino acid. We found that AN2690 binds to both the proof-reading site and the tRNA in such a way as to block the enzyme from functioning. As a result, the cell cannot produce new proteins, which are essential for life."*

"The goal quickly became to move on to more serious pathogens."

OPTIMIZATION IS THE KEY TO DEVELOPING NEW DRUGS

The team started working with AN2690, which is now clinically approved and on the market as a treatment for toenail fungal infections. However, the goal quickly became to move on to more serious pathogens that have become resistant to multiple drug treatments. *"Anacor chemists synthesized a whole series of similar compounds and we worked with them from 2007 to 2015 to analyze the 3D structure of these inhibitors in combination with the Leucyl-tRNA synthetase enzyme from various pathogens. These structures showed us how the compounds could be chemically tweaked to improve potency for each specific disease,"* adds Andrés Palencia, a post-doctoral student who worked on the project.

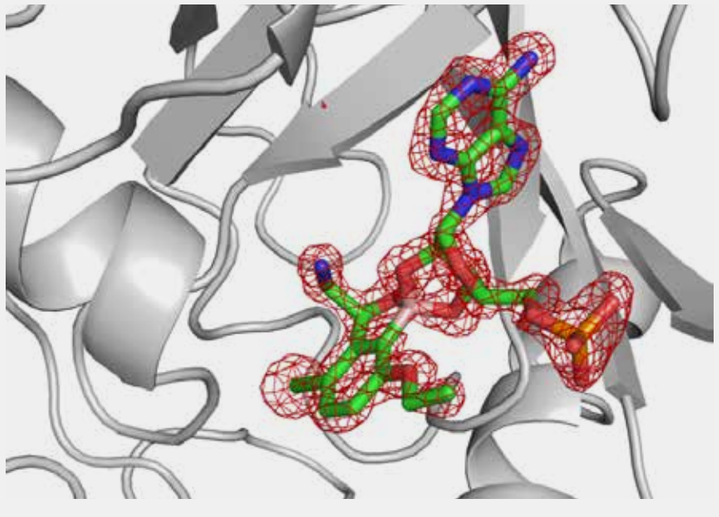
To adapt an inhibitor to a specific pathogen, EMBL analyzes crystal samples of the compound and target enzyme combination. This enables researchers to optimize the compound's chemical composition and strengthen bonding with the target. During this project, the group started with a compound for fungal infections, which was then tested on bacteria and tweaked by adding chemical groups in different places to improve performance. The result was a new compound that was used in clinical trials to treat urinary tract and abdominal cavity infections caused by multi-drug resistant bacteria.

In parallel, the group collaborated with Anacor and GSK to develop a compound for TB which will soon enter clinical trials. This new compound is as good as current anti-TB drugs and is active against multi-drug resistant TB. Finally, in collaboration with Anacor and groups at the University of California and the Institute for Advanced Biosciences in Grenoble, the inhibiting compound used against TB was also tested on single-celled parasites that cause diseases such as malaria, cryptos-poridiosis and toxoplasmosis. Results from these tests were promising. The next step should be to optimize the compound for each parasite.

GIANT EFFECT

Optimizing compounds for drug development is a collaborative process. Pharmaceutical companies provide us with new compounds to test. EMBL provides expertise to grow crystals of the target enzyme-inhibitor complex. And we can only carry out atomic-level analysis thanks to the ESRF's high-intensity beamlines.

STEPHEN CUSACK
Director of the EMBL Outstation in Grenoble



Close-up of showing definition of compound as observed by X-ray crystallography (orange net) and the role of the boron atom in forming an adduct with the end of the tRNA

MULTI-SCALE & MULTI-PHYSICS MODELING: the Future of Fuel Cell Development

The energy transformation is impacting every industry. From smart grids to mobile technology, from automobiles to aeronautics, batteries and fuel cells help enable this transformation. Their integration within complex systems has forced companies to understand a multitude of factors such as materials, component size, thermodynamics and other system parameters. In response, the CEA-Liten has continued to expand its multi-scale and multi-physics modeling capacities.

#Information Technology — #Energy — #Technology Management

"Modeling is a crucial link between fundamental research and industry. Industrial players understand the need for basic research, but they also need applicable results. Current and future systems have become extremely complex in terms of design. Finding the best solution to integrate a fuel cell in an overall system is really a matter of balance," explains Mathias Gerard, who is in charge of the CEA-Liten laboratory for multi-scale and multi-physics fuel cell and battery modeling. *"You have to find the right size, temperature and materials. You have to understand how each part of the system will interact and impact fuel cell performance or durability. Instead of relying on numerous experimental prototypes, modeling enables industrial players to receive concrete answers to their challenges."*

MODELS TO PROVIDE SYSTEM-LEVEL ANSWERS

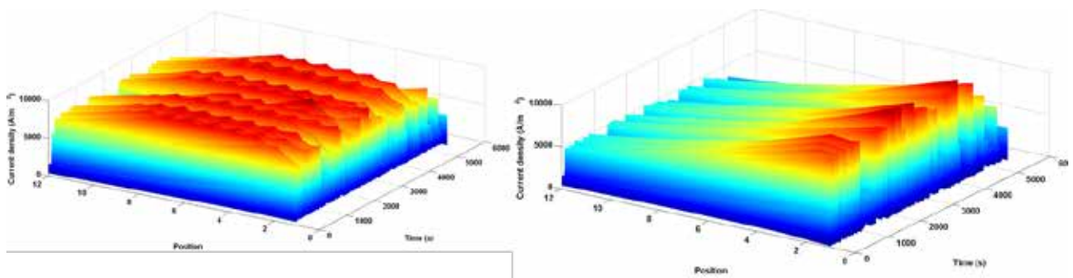
Traditionally, fuel cell and battery models were focused on cell-level analysis. However, when you scale up to integrate a fuel cell or battery in an entire system, performance results can vary significantly. *"One of our key strengths is to provide complete models that cover everything from the catalyst to the system level. On one hand, we can analyze a variety of materials and understand their impact at the cell level. On the other hand, we can look at how the entire system functions and measure its impact on a cell's performance."* highlights Gerard.

OPTIMIZING LIFE CYCLE AND COST

The major challenges for fuel cell and battery solutions are to increase life cycles and reduce costs. *"For example, we are working on modeling Proton Exchange Membrane Fuel Cells (PEMFC), which is a mature technology ready for industrialization. Current power and performance is adequate. But for widespread adoption, industrial partners have to optimize design in order to reduce costs and increase lifespan. A model allows us to record observations, explain them, and confirm or reject possible solutions. As a result, we can provide laboratories and industrial players with applicable knowledge to optimize the integration of PEMFCs."* states Gerard.

The CEA-Liten's laboratory is currently modeling carbon monoxide catalyst poisoning effects for the European Second Act Project, which aims to improve our understanding of the reversible and irreversible degradation mechanisms that affect PEMFCs.

Optimization of fuel cell cycles to minimize irreversible degradations



In another project carried out for a major player in the automotive industry, researchers were able to simulate two fuel cell cycles being considered by the manufacturer. By modeling platinum dissolution at different levels from the catalyst to the system, the researchers were able to demonstrate that one cycle suffered less degradation due to lower local temperatures at different positions along the surface of the cell.

LINKING FUNDAMENTAL RESEARCH AND APPLICATION

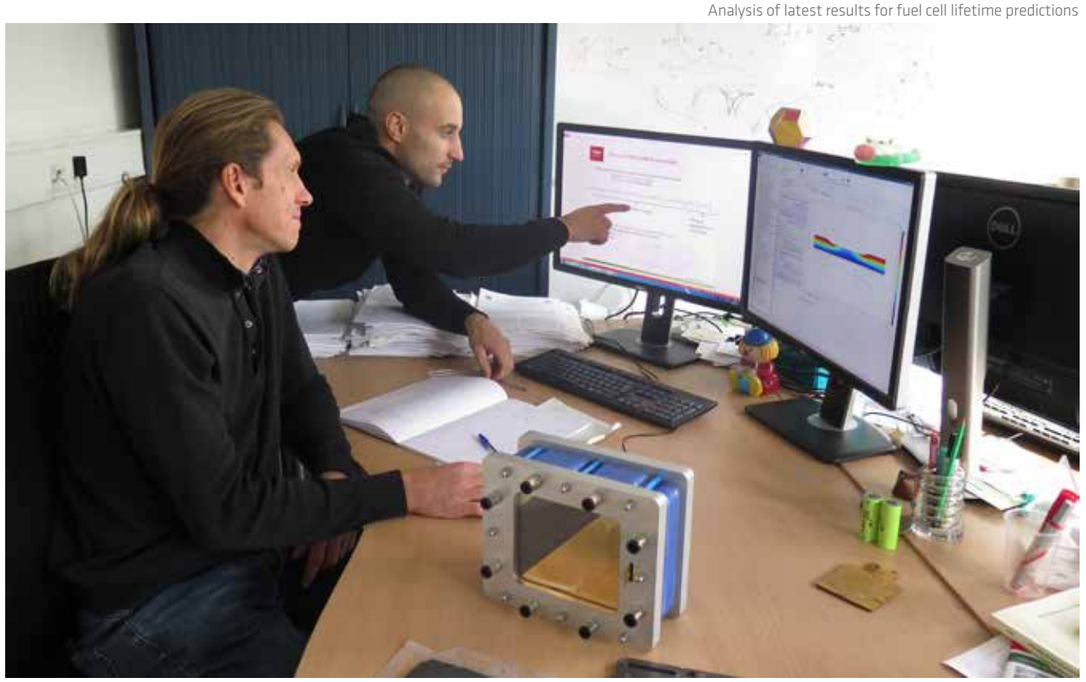
"We rely on fundamental scientific calculations and properties. But we create models to understand the practical impact and value of these properties when used for concrete applications. Modelization helps our partners understand problems that are too complex to solve by repeated experimentation. The goal is to provide simplified answers that can be used to make concrete decisions." concludes Gerard. The laboratory currently specializes in PEFMCs, Proton Exchange Membrane Water Electrolysis (PEMWE) and lithium-ion batteries.

"Optimization is the key to reducing costs and increasing the lifespan of batteries and fuel cells."

BUILDING ON TECHNOLOGICAL ADVANCES

The multi-scale and multi-physics modeling laboratory is also expanding its capacities by building on technological advances in imagery. Gerard explains that: *"We currently have great images of catalysts and porous structures. By using simulation tools, we can build on these images to extract a material's effective characteristics. Once we determine a set of characteristics, we can test and optimize them using a model that calculates the device's global performance."* This enables the laboratory to determine the best balance of characteristics for a given situation. For example, when an industrial partner asked for help in deciding between two porous materials, the laboratory's researchers used tomographic images to calculate each material's porosity and permeability. The results were then tested using a complete system model.

Analysis of latest results for fuel cell lifetime predictions



MULTIFERROIC NANO-CLUSTERS

for Next Generation Processors and Memory Devices

In the search for better performance and lower energy consumption, researchers are exploring many potential materials to create future processors and memory devices. We speak with Leonard Henrichs, a post-doctoral researcher at the Karlsruhe Institute of Technology, and Thomas Hansen, the chemist responsible for the D20 instrument at the Institut Laue-Langevin (ILL). The pair collaborated at the ILL to explore a new multiferroic nano-cluster with promising properties.

#Fundamental Research — #Large Scale Facilities

Q What was the goal of your project?

One of the primary challenges of using multiferroics is the fact they only work at temperatures far below room temperature, making them unsuited for practical applications. Recent research has been focused on structurally or chemically modifying multiferroic materials to enhance their properties. We researched a new multiferroic nano-cluster and demonstrated that it merited further attention. By using neutron diffraction at the ILL, we were able to investigate the material's complex magnetic structure and highlight interesting properties.

Q What are the advantages of the new material you investigated?

The main advantage of this new multiferroic material is that it exhibits very strong magnetoelectric coupling properties at room temperature. This could enable the creation of memory devices whose magnetic bits would be manipulated by an electrical field. Generating an electrical field requires much less energy than the magnetic fields traditionally used to read and write digital information. The result could be lower energy consumption for next generation devices. Given that the heat generated by a device is one of the main limitations to creating processors with higher GHz, low-energy consuming multiferroics could open the door to better performance. Another advantage is the potential to increase device storage capacity. Data is generally stored as 1s and 0s using bits. The smaller each bit, the more information you can store in the same space. The multiferroic clusters we found are in the nanometric range, which could enable the creation of 'nano-dot storage devices' with nano-sized bits. Of course, we're talking about fundamental research here. There's still a lot of work to be done.

GIANT EFFECT

Fundamental research is one of the cornerstones of GIANT. As an institution dedicated to fostering true scientific discovery, the ILL has the necessary freedom to adapt to the needs of researchers worldwide. For example, the research on multiferroics was initially allotted two days for a specific experiment. When it became clear additional information was needed, we had the flexibility to offer the researcher time for a follow-up experiment.

THOMAS HANSEN
ILL chemist in charge of the D20 instrument

The high-intensity two-axis ILL diffractometer D20.

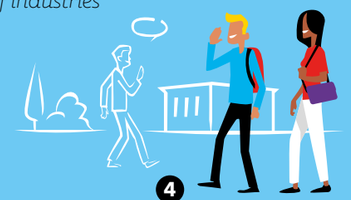
10 REASONS
to study in Grenoble

1 BEST CITY FOR STUDENTS

The magazine l'Étudiant ranked Grenoble as the top French city to study in.

2 MAKE CONNECTIONS

The Grenoble ecosystem includes a large variety of industries and companies.



4 A VIBRANT STUDENT LIFE

Grenoble is already home to 58,000 students.

3 MOUNTAIN FILM FESTIVAL

Discover Grenoble's unique mountain film festival.

5 AN INTERNATIONAL EXPERIENCE

Meet students from 150 countries.

6 AN INNOVATIVE CITY

Grenoble was ranked fifth most innovative city in the world by Forbes.

7 STIMULATE YOUR INTELLECT

One fifth of Grenoble's population works in higher education or research.

8 TAKE ADVANTAGE OF THE OUTDOORS

Grenoble counts more than 2,000 hours of sun per year.

9 EASY ACCESS

With five tramways and many more buses, it's easy to get around the city.

10 GO SKIING IN UNDER AN HOUR

Grenoble's ski resorts are less than an hour away.

Illustrations: ©Studio Barnbarn

- GIANT - CAMPUS *LIFE*

EVENTS ALL YEAR LONG

September
WELCOME DAY

September
FOSTERING DAYS
GIANT support services for European grant candidates

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

October
SCIENCE FESTIVAL
A festival dedicated to popularizing research and science

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

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

GIANT INTERNATIONAL INTERNSHIP PROGRAM (GIIP)

Launched in 2011, the GIIP offers internships twice a year from May to July and September to December. Since its start, the program has welcomed more than 160 non-European interns to work with various GIANT campus laboratories. The program enables undergraduate and graduate students from partner universities to carry out ten to twelve week full-time internships. Interns also have the opportunity to discover other GIANT laboratories and facilities as well as a variety of cultural and social events. Students come from a variety of prestigious universities such as MIT, UPenn, Columbia University, the University of Texas or the University of California, Berkeley. The 2017 GIIP summer edition will take place from May 22nd to July 28th, 2017.

FRENCH AMERICAN WORKSHOP
Interns also have the opportunity to participate and network during the French American Workshop (FAW). This event is held at MINATEC and brings together students, researchers and industry partners to promote French-American cooperation on research. The next FAW will be held on June 22nd and 23rd, 2017.

DISCOVER THE WORLD OF SERIOUS GAMES
In 2016, a group of 20 GIIP interns were able to discover the serious game Tech it! The game was created by Grenoble Ecole de Management in order to popularize innovative technology and enable participants to imagine new products, services and applications that could boost their company's development. GIIP interns spent an hour and a half playing in groups of four to five people in order to solve specific technical problems.

For more information:
www.internships.giant-grenoble.org

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

giant-grenoble.org

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