MINA-NEWS
MINATEC NEWSLETTER DEC'21 #67

TOP NEWS

Material criticality comes into its own as a research topic

For the past three years, four Grenoble laboratories have been working together, using methods from materials science and economics to find alternatives to the critical materials in white LEDs.
Their work, funded by the UGA Idex grant, marks a departure from conventional technology research.

Scientists' interest in the scarcity and criticality of certain materials is not new.
What is new is that they are treating them as research topics in and of themselves, and not just constraints to be factored into other research.
With CEA-Leti's support, LMGP, Institut Néel, and applied economics lab GAEL have been investigating the rare and critical elements (gallium, indium, yttrium, and cerium) in white LEDs.

CONSUMERS ARE WILLING TO PAY MORE

A PhD dissertation based on research at LMGP and Institut Néel pointed to zinc oxide nanowires and identified aluminoborates as a promising—and rare-earth-free—class of luminophores.
CEA-Leti, which possesses substantial know-how in LED systems, supported this research.
On the economic side, GAEL completed a study that revealed consumers would be willing to pay up to 30% more for white LEDs that are free from critical materials.
This cross-disciplinary research was financed by the UGA Idex grant through the CDP* Eco-SESA project.
The resulting PhD dissertation won a national C'Nano award.
The grant and award confirm that broader issues like how rare these minerals are, how they are mined, where they are sourced, and how well consumers accept them are just as at home in the debate as the materials' technical properties.
**Cross Disciplinary Programs*
Read the dissertation: https://bit.ly/3ll7Zbz

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INNOVATION

MRAM memories stand up to heavy ion abuse

Although Spintec's latest generation of MRAMs were not necessarily designed for use in radiation-hardened electronics, recent tests on the UCLouvain (Belgium) cyclotron showed that the magnetic tunnel junctions inside the devices can withstand heavy-ion bombardment.

Two high-density memory technologies, STT-MRAM and SOT-MRAM, were tested and their main operating parameters measured.

The impact of the heavy ions was not significant and did not jeopardize the stability of the memories' electrical properties.

Certain magnetic properties were affected, but this was due to the temperature and not the irradiation itself.

Up next: tests on complete MRAM memories.

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Smart window glazing for more energy-efficient buildings

What if window glass could control how much sunlight gets into a building? The three-year M-Eranet Instead project was set up to investigate the potential of this type of solution to reduce the need for air conditioning, with potential energy savings estimated at 30%.

The four project partners*, which include coordinator LMGP, will develop new thermochromic and electrochromic materials.

One of the challenges they will be tackling is how to optimize the materials' stability under thermal and electrical stress and humidity.

They will model and develop thin film materials and integrate them on window glazing.

LMGP will leverage its expertise in SALD** deposition to develop silver nanowire nanocomposites and oxide coatings.

**LMGP, ICMCB-CNRS (Bordeaux), CESAM (Liège), Nanomaterials and Devices Group (Middle East Technical University, Ankara)*
***spatial atomic layer deposition*

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Peptides could inhibit SARS-CoV-2 replication

Irig is one of eleven research teams in five countries that have been working on how to inhibit SARS-CoV-2 replication since April 2020. They are investigating synthetic peptides that bind to M^{pro}, which plays a key role in the replication of this virus.

The researchers combined several biomolecular simulation techniques to observe, at the scale of a single atom, how M^{pro} hydrolyzes certain proteins at eleven sites.

They then used this information to design synthetic peptides capable of binding more tightly to the enzyme than natural peptides, keeping the virus from replicating.

The research was published in the journal *Chemical Science*, but it is not ready to use just yet.

This new approach could serve as a foundation for the development of Covid-19 treatments.

The results are available free of charge on GitHub.

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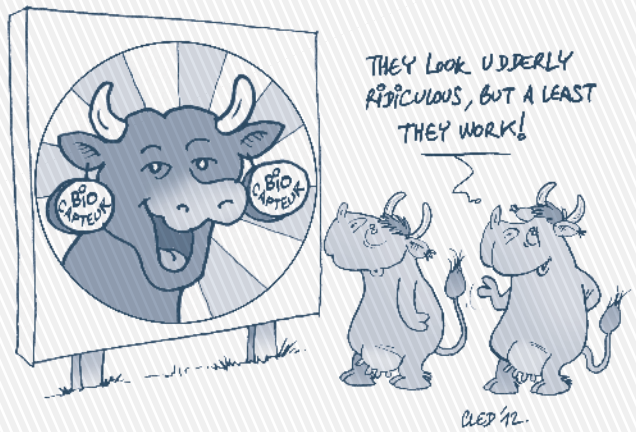

Microfluidic patch can detect when cows are in heat

CEA-Leti and INRASE are coordinating the SmartRepro project, which also includes PhD research by Juliette Simon, whose dissertation is on a biosensor that can detect when cows are in heat, just before they ovulate.

Heat detection is crucial to timing insemination and managing the reproduction of cattle efficiently. Visual observation alone is only 50% to 60% accurate.

The solution studied here is a patch with a microfluidic circuit.

In addition to being inexpensive, easy to use, and reliable, it is also painless for cows.

Once placed on the cow's ear, the patch's micro-needles collect blood or interstitial fluid*; a hormone assay is completed and an alert is triggered when the estrogen level that corresponds to the cow being in heat is reached.

The sensor has been prototyped, but the signal processing system is still in development.

**The fluid between blood vessels and cells*

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Advance in biomaterials marks a step toward personalized medical implants

The EU H2020 PANBioRA project, which will be completed at the end of 2021, is making advances that will one day help doctors optimize the biomaterials used to make medical implants on a patient-by-patient basis.

CEA-Leti is part of the seventeen-partner consortium that designed an instrumented microfluidic chip that tests several potential biomaterials on a cell sample from the patient.

The chip analyzes pH, hydrogen peroxide, nitric oxide/nitrite, and lactate during cell culture to detect indicators of stress or inflammation.

The multiparameter electrochemical sensor platform and bioreactor design were contributed by CEA-Leti.

The research has resulted in two publications in scientific journals and one patent application has been filed.

Spartha Medical, biotech company based in Strasbourg, France, will scale up and manufacture the device, which it plans to commercialize in 2024.

Learn more about the project: *https://www.panbiora.eu/*

Journal articles: *https://bit.ly/3d1YCsx | https://bit.ly/3o1uWSG*

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Banking on SiC for neural interfaces

Silicon carbide, widely used in power electronics, could also be used in neural interfaces.

The new SiCNeural project, funded by the French National Research Agency (ANR) and coordinated by IMEP-LaHC, is investigating the question.

The project partners will develop a very thin (less than 10 microns) and flexible all-SiC neural electrode.

SiC is a biocompatible material with three phases—amorphous, polycrystalline, and monocrystalline—that the researchers intend to take full advantage of.

They will also nanostructure the material to increase the exchange surface and brain stimulation capacity.

Their goal is to overcome silicon electrodes' short lifespans and tendency to cause inflammation.

Scientists from the Institut des Neurosciences in Grenoble will conduct in vivo proof of concept testing.

Learn more about SiC for biotechnology in this book (chapter 9 by IMEP-LaHC and LMGP): https://bit.ly/3E6Pxum

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Shedding new light on acute stress

A CEA-Leti PhD candidate collaborated with scientists from Gipsa-Lab and the UGA psychology and neurocognition laboratory to determine whether or not acute stress can be detected and assessed using an explainable and interpretable "white box" method.

Over the course of the three-year project, they came up with a method leveraging more robust algorithms than those used in "black box" methods. And it performs at the state of the art!

Two patents have been filed to protect the innovation.

The solution, built on off-the-shelf sensors to measure temperature, heartbeat, breathing, movement, and perspiration, will find applications in psychosocial risk and chronic stress prevention, stress management training, and pilot, firefighter, and military training.

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Monoclonal antibodies the subject of PhD research at Sanofi and LMGP

A Cifre-financed Phd research project is investigating how monoclonal antibodies and the surfactants that stabilize them interact with the surfaces of tubes, mixing bags, syringes, and other containers. The research, which started this year, is being conducted at Sanofi and LMGP, and is building on an earlier PhD dissertation on this complex topic.

Monoclonal antibodies, which are proteins, tend to adsorb very quickly onto the surfaces they come into contact with.

Surfactants can limit this phenomenon, helping maintain the monoclonal antibodies' efficacy.

The PhD candidate's research will focus on understanding the adsorption process and determining which materials are most compatible.

For LMGP, the project represents a rare opportunity step away from model proteins and work on a pharmaceutical company's "real" ones.

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Copper oxide could be a candidate for tomorrow's solar cells

In theory, copper oxide (Cu_2O) offers yields as high as crystalline silicon, plus it is non-toxic and relatively abundant. So why isn't it used to make solar cells?

Currently, the best yields obtained on the material are still far from what is theoretically possible. Plus, these yields have been observed only under vacuum or high temperatures.

Researchers at LMGP found a solution using spatial atomic layer deposition (SALD).

They were able to obtain thin films (in the tens of nanometers) at 260 °C. The films offer excellent electron transport and minimal defects and are as efficient as layers ten times thicker.

A new project backed by France's National Research Agency (ANR) will support further investigation of this promising solution.

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Larger defect-free graphene layers produced

Irig and ESRF recently attracted the attention of the global nanoelectronics community when they produced defect-free single-crystal graphene layers measuring several square millimeters.

The tiny layers are a million times larger than the square micron commonly obtained until now!

The researchers did it by growing the 2D material on liquid copper at 1,100 °C rather than on solid copper.

Combining the reflection and diffraction measurements of synchrotron X-ray imaging, Raman spectroscopy, and optical microscopy, they were able to monitor and control the formation of the graphene crystals in real time.

The layers obtained are as good as exfoliated graphene sheets, but they do degrade as the liquid copper solidifies, and must be separated before the substrate cools.

The research was conducted under EU project DirectSepa, which has been running for a year now.

Learn more about DirectSepa: https://bit.ly/3xyEfg4

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Neutrons supercharge fuel cell research

Researchers at Irig recently co-authored a literature review on the growing use of neutron techniques in research on new energy technologies.

The authors underscore the rapidly changing landscape, especially when it comes to fuel cells.

Protons and hydrogen form the pillars of fuel cell technologies, and neutrons happen to be very sensitive to both.

For research, this means that quasi-elastic neutron scattering can be used to characterize ion dynamics, for example, and that neutron imaging can be used to observe batteries during operation to better understand the phenomena behind aging.

Neutron techniques aren't new to Irig. The lab has published many papers on research using these advanced techniques and has developed a high level of expertise.

Irig's researchers are also experts at building electrochemical cells for research and processing complex data.

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Orientation for new GIANT PhD students to take place on February 8

The 2022 GIANT Orientation Day for the 100-strong incoming cohort of PhD students is scheduled for February 8.

Participants will be able to familiarize themselves with the GIANT Campus beyond their own laboratories and do some networking.

There will be work-oriented activities, of course, but not at the expense of fun! The program also includes team-building games and a contest with a €200 prize.

The morning will be hosted by Grenoble École de Management, where the school's Dean of Research will give a presentation.

The afternoon will be devoted to GIANT Campus labs, with a choice of three theme-based tours: energy, health, or innovation.

The event is free of charge and lunch will be provided.

However, participating PhD students must sign up by January 31.

For further information and to sign up: https://bit.ly/GIANT-Oday22

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MINATEC Entreprises broadens support for innovation

MINATEC Entreprises is a long-time partner of Aledia, which is still headquartered at the BHT1 building.

To support the development of Aledia's manufacturing activities, MINATEC Entreprises has invested €1 million in the non-trading property company that owns the Champagnier (near Grenoble) plant construction project that started on November 18.

MINATEC Entreprises, a center for expertise in tech startup incubation and operations management, announced its plans to join forces with real estate development and management company IDEC.

The future partners plan to sign a memorandum of understanding in January 2022 to develop projects that will meet growing demand in the Grenoble area.

The BHT3 building is also making headlines: The plans for the new building will be officially unveiled in mid-December.

This new building will be just outside the CEA campus near Y.SPOT. It is slated for completion in 2024.

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HORIZONS

CEA-Leti heads to CES® to showcase its latest medical technologies

CEA-Leti, a regular exhibitor at CES® Las Vegas, has decided to put the spotlight on its strong position in healthcare in 2022.

The institute will exhibit a demonstrator of the FollowKnee smart communicating implant built on a multi-sensor (pH, temperature, deformation, and accelerometer) sensor system developed in CEA-Leti labs. The solution lowers the risk of post-op infection and loosening of the implant.

Another two startups founded by CEA-Leti scientists will also be part of the exhibit.

Direct Analysis, founded in early 2021, offers a solution that can test for bacteria in food manufacturing plants in just a quarter of the time a conventional test takes.

Injectpower, founded in 2020, is commercializing a power source for implants used to monitor eye, brain, and heart conditions.

Also worth noting: CEA-Leti was selected for the January 4 press conference attended by 7,000 international journalists.

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SÉBASTIEN DAUVÉ
Director, CEA-Leti

"This is an unprecedented time in microelectronics R&D"

MINA-NEWS: You were appointed Director of CEA-Leti in July. How have you adjusted to your new role?
SD: Quickly! If you remember, back in July there was a lot of talk about the semiconductor shortage, technological sovereignty, and Intel's plans to expand its manufacturing base into Europe.
The French government's Directorate General for Enterprise (DGE) and Brussels very rapidly asked us to make recommendations on priority R&D topics and other initiatives to shore up the industry.

MINA-NEWS: How well equipped is CEA-Leti to tackle the challenges of the next few years?
SD: I have met with our biggest industrial R&D partners. What stands out the most is their trust in the institute.
Looking ahead, the Nano 2025 program will provide some guarantees in terms of resources. Additional support, which we would be able to use to purchase equipment and hire staff, is also a possibility.
Most importantly, the people at CEA-Leti are highly motivated and committed.
While we are certainly not taking anything for granted, we feel that we are in a good position.

MINA-NEWS: Is this a turning point in CEA-Leti's history?
SD: A year ago, many people didn't even know what semiconductors were. Today, they are all over the headlines.
CEA management at all levels—up to and including the Chairman—supports our microelectronics research.
And microelectronics is very present in the government's France 2030 investment plan.
This is an unprecedented time in microelectronics, the likes of which we have never seen.
We plan to step into our role supporting this industry more fully than ever before.
Boosting our attractiveness as an employer will also be vital in the coming years. ■

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Grenoble engineering students cycle across Europe

Three environmentally conscious Grenoble INP - Phelma, UGA students took up a unique challenge for their gap year, cycling 4,050 kilometers across seven European countries last spring, meeting with local people and farmers along the journey.

The trio—Odin, Rodrigue, and Sinclair—had to deal with various pandemic-related contingencies from late delivery of their bikes to closed borders, and ultimately pushing the start of their trip back to June 1, 2021.

The first leg of their trip took them from Grenoble to Switzerland, and then around the Adriatic Sea to Albania. The loop took them through Italy and, finally, back to France on August 7.

Now back at school, the three cyclists are in their third year.

https://www.polarsteps.com/LesPetitsPrincesaVelo/3824463-l-europe-autrement

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CEA-Leti IT security testing lab affirms biometric ID expertise

CEA-Leti's IT security testing center (CESTI) is one of eleven in France.

In 2000, French IT security authority ANSSI approved CEA-Leti's testing center to evaluate electronic components and systems like smart cards.

The center has earned recognition for its biometric identification expertise and was recently accredited by the international FIDO Alliance for password-free authentication protocols.

This year the center completed its first audit in partnership with Elitt, a laboratory that specializes in secure transactions, leading to a FIDO certification.

Finally, the center also recently applied to ANSSI for accreditation to certify facial recognition and other remote identity verification solutions.

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LMGP makes progress on liquid phase atomic layer deposition

Professor Josep Puigmartí-Luis* of the University of Barcelona, is currently working with LMGP on liquid phase ALD as part of a *Fondation Nanosciences Chair* of Excellence.

This expert in microfluidics for ALD is collaborating with Grenoble-based ALD researchers to advance an innovative liquid phase atomic layer deposition (LALD) process.

With LALD, it is possible to obtain a conformal surface coating with sub-nanometric thickness control. Plus, LALD does not require the same vacuum conditions as regular ALD, which opens the door to more potential uses.

The researchers are currently investigating LALD automation and compatibility with different substrates.

**Watch Professor Puigmartí-Luis' Oct. 15 Midi MINATEC talk (in English): https://www.youtube.com/watch?v=ntGNzqkukl4*

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New book looks back on the start of the 21st century at CEA Grenoble

Local Grenoble newspaper *Le Dauphiné Libéré* and CEA Grenoble have published a 200-page commemorative book entitled *Se réinventer au XXIe siècle* that recounts the profound changes that have reshaped the campus since the turn of the century.

The decommissioning of the site's nuclear facilities could very well have marked the beginning of the end.

Enter Jean Therme. The then-Director of CEA Grenoble* spearheaded efforts to ramp up technology research, ultimately allowing the site to flourish, dramatically increasing its R&D partnerships and doubling its workforce from 2,000 scientists, engineers, and technicians to 4,000 in the space of 20 years.

The book contains testimonials from more than 150 employees and partners.

CEA Grenoble employees will receive their own copies. The public will be able to purchase copies at Grenoble-area newsstands from December 14.

**from 2000 to 2013*

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Diabeloop shifts into high gear in France and around the globe

Diabeloop obtained French national health insurance approval for its DBLG1 closed-loop automated insulin therapy device (DBLG1) in September.

Now the Grenoble startup and long-time CEA-Leti partner is training hospital staff so that they can offer the DBLG1 to their diabetic patients.

Hospitals in the Île-de-France and Auvergne-Rhône-Alpes regions recently set their first patients up with the device, which will be rolled out gradually throughout France in 2022.

And Diabeloop is also expanding internationally.

The company signed a partnership agreement with leading Japanese medical equipment manufacturer Terumo in mid-November.

The partners will integrate Terumo's patch pump into Diabeloop's system so that the Japanese company can sell it in Europe.

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Everything you ever wanted to know about FDSOI in 380 pages

CNRS Research Director Emeritus Sorin Cristoloveanu of IMEP-LaHC is one of the scientists behind SOI technology and the subsequent success of FDSOI substrates.

His latest book, published by Elsevier, is entitled *Fully Depleted Silicon-On-Insulator.*

Inside you will find a comprehensive discussion of the physical mechanisms associated with FDSOI, the characterization techniques specially developed for very thin films, and the innovative devices that can be developed using these materials.

This broad overview is written for a specialist readership. There is nothing like it in the existing literature.

The Grenoble SOI school is proudly documented, as are the many scientists, engineers, and semiconductor companies that have made the city a SOI capital for almost five decades.

If you aren't sold on this fascinating book yet, perhaps the ten fun FDSOI riddles for readers to solve and send their answers to the author will!

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SET, from the French Alps to the world

SET (Smart Equipment Technology) is a small high-accuracy semiconductor process equipment company based in Haute-Savoie in the French Alps. This CEA-Leti and IRT Nanoelec partner recently signed an agreement with SUSS MicroTec to develop the NEO HB flip-chip machine for die-to-wafer (D2W) hybrid bonding. Germany-based SUSS MicroTec, which employs around 1,000 people, provides process and equipment solutions to the semiconductor industry.

A prototype of SET's machine was installed in CEA-Leti's clean rooms in 2017.

Qualification testing took place in several stages as part of research for the IRT Nanoelec 3D program and was completed in 2019. Several papers were presented at major conferences as a result of this research.

So, when SET first commercialized the NEO HB, it was already well-known and sales ramped up quickly.

SET, the world's leading supplier of flip-chip machines, will now add a new solution to its lineup.

**In flip-chip assembly, the die is attached bond pad side down to the substrate using conductive bumps.*

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Clinatec endowment fund hires new neuroillumination researchers

The Clinatec endowment fund has earned the support of several patrons, including the Covea mutual insurance company, since 2020. Today, the team is growing and research on infrared illumination therapy is intensifying.

Australian scientist John Mitrofanis, internationally renowned for his work on neurodegenerative diseases and infrared light, was hired, building on a collaboration with Clinatec that began in 2015.

In March, a clinical trial of the effects of neuroillumination on Parkinson's disease began. A first patient was implanted with a CEA-developed neuroillumination probe for the trial.

The endowment fund is also expanding into Alzheimer's and other neurodegenerative diseases.

Finally, an international advisor, Dr. Pierre Magistretti from Switzerland, has also been hired.

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Injectpower, for implantable monitoring devices that last

The problem with implantable medical monitoring devices for organs like the eye, brain, or heart, is that the power sources are often larger than the actual sensors.

Startup Injectpower was founded in early 2020 to tackle this challenge.

The company is building on a technology protected by 40 CEA-Liten and CEA-Leti patents to offer rechargeable millimeter-sized microbatteries.

These tiny batteries make on-demand, intervention-free, in situ measurement possible. Doctors can now get a read on intraocular pressure (glaucoma), intracranial pressure (stroke, hydrocephalus), and cardiac pressure (hypertension).

Injectpower has stayed mostly under the radar since it was founded, but the startup recently announced a partnership with a US-based medtech firm specializing in pressure sensors.

The company, which currently employs five people, has a joint R&D lab with CEA-Leti for its future products.

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The Class of 2019 will finally get its commencement ceremony

The Grenoble INP - Phelma, UGA Class of 2019 will finally get its commencement ceremony after a year of Covid-related postponements. The event is scheduled to take place on the afternoon of Friday, December 10 in the Grenoble INP auditorium.

Air Liquide engineer and Phelma board member Julien Durst is the class' sponsor and will emcee the ceremony.

He will also give a short talk on hydrogen and fuel cells.

The grads will then receive their diplomas on stage and give a quick update on where they are a year after leaving school.

The Class of 2020's ceremony will be held in the spring of 2022.

Once the ceremonies postponed due to Covid have been caught up, a more normal schedule will resume, with commencement taking place within a few months after school gets out.

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AGENDA

December 9 [GreEn-Er]
JUNIOR PHYSICISTS MEETING 2021
https://rjp-grenoble.jeunes.sfpnet.fr/

December 10
[Grenoble INP - UGA auditorium]
GRENOBLE INP - PHELMA, UGA CLASS OF 2019 COMMENCEMENT CEREMONY
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December 16 [online]
LETI INNOVATION DAYS: session on electronic components
michael.tchagaspanian@cea.fr

January 5-8 [Las Vegas]
CES® CEA-Leti to exhibit
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February 8 [GEM & GIANT]
GIANT ORIENTATION DAY
floriane.marcuccini@cea.fr

February 27 to March 4
[2022 Physics School – Les Houches]
https://smbleshouches.com/

March 10 and 11 [Grenoble]
MINAPAD FORUM 2022
https://imapseurope.org/event/minapad-2022/

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