MINA-NEWS
#63
MINATEC
NEWSLETTER
FEB'21

TOP NEWS

For Intel and CEA-Leti the future is 3D

CEA-Leti and Intel, the world's largest foundry, signed a contract expanding their partnership into 3D-integrated processors for high-performance computing via a multi-year R&D program in Grenoble.

Intel and CEA-Leti began working together on IoT and very-high-speed wireless communications in 2016. The company recently decided to expand its successful collaboration with CEA-Leti into one of its historic and most strategic markets, high-performance computing.

The race to achieve more compact and powerful HPC processors has spurred foundries around the globe to make sustained R&D investments in advanced technologies. The industry giants are currently working on technologies at the 14 nm and 10 nm nodes; 7 nm and, possibly, 5 nm, are further away. But as the technology gets smaller, each step forward is slower and costlier. 3D integration, which entails vertically stacking chips inside a device, adds even more complexity.

ALL ROADS LEAD TO 3D

Intel and the CEA, through its institutes CEA-Leti and CEA-List, have strikingly similar 3D roadmaps. To improve bandwidth and reduce power consumption, both partners have opted to use active interposers to interconnect physical layers like processors, memory, and RF components. Additionally, CEA-Leti has a solid reputation for its 3D integration research. The institute is already working on 3D integration (for other applications) for STMicroelectronics, for example, as well as for several OEMs. Some of this research is part of a CEA-Leti partnership with IRT Nanoelec.

With so much to offer, it is no surprise that CEA-Leti was Intel's partner of choice for this new R&D program, which kicked off last September but was kept under wraps until the partners announced it publicly in December.

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INNOVATION

Quantum supremacy still not a given

***Nature* published Google's groundbreaking results on a 54-qubit quantum computer in October, effectively declaring that quantum supremacy had been achieved. A few weeks later, however, a team of researchers from Irig and the US-based Flatiron Institute produced very similar calculations on a common laptop computer.**

Google did reach an impressive milestone when it successfully operated a "real" quantum machine with 54 physical qubits. The tech giant's researchers performed a calculation that even the best conventional machine would have taken 10,000 years to do, in just 200 seconds. One thing the research did not factor in, however, is this: Because of the quantum computer's inherent precision and decoherence problems, the error rate of *each operation* is 1%.

MULTIPLYING THE NUMBER OF QUBITS SHOULD NOT BE THE END GOAL

The Irig-Flatiron Institute researchers posited that Google's machine did not even come close to utilizing the full power of quantum. They then used quantum-state compression algorithms to simulate the Google machine's actual operation…on a regular consumer-grade computer! In just a few hours they completed the same calculations that the Google researchers said would take decades.

Their findings refocus attention on the real issue, which is not necessarily to build machines with more qubits, but rather to improve reliability—something that still raises serious theoretical and practical challenges. Another added bonus of the research is that Irig developed a tool unlike any other for evaluating the performance of current and future quantum computers. Irig has obtained several grants for further research on this topic.

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New SALD pen could improve deposition

Selective-area laser deposition, or SALD, offers the advantages of being fast and suitable for use on large surfaces. Researchers at LMGP have made SALD even better with a new innovation. They took advantage of the design flexibility offered by 3D printing to come up with customizable and affordable SALD injection heads. The pen-style SALD injection heads can be mounted on an XYZ machine to perform selective 3D chemical deposition of functionalized materials with no need for masks or a vacuum deposition chamber. Plus, in terms of resolution, the high-precision SALD pen deposits material exactly where it is needed (to within one millimeter laterally) and in the right amount (to within one nanometer in terms of thickness).

LMGP is currently engaged in an EU research project to improve lateral resolution to within a micron. This enhanced lateral resolution would expand the potential uses of the SALD pen into microelectronics, for example. The research was published in *Advanced Materials Technologies*.

Video showing the deposition of a circle of ZnO: https://bit.ly/36ilxx1
Don't miss the February 26 Midi MINATEC talk on the SALD pen.

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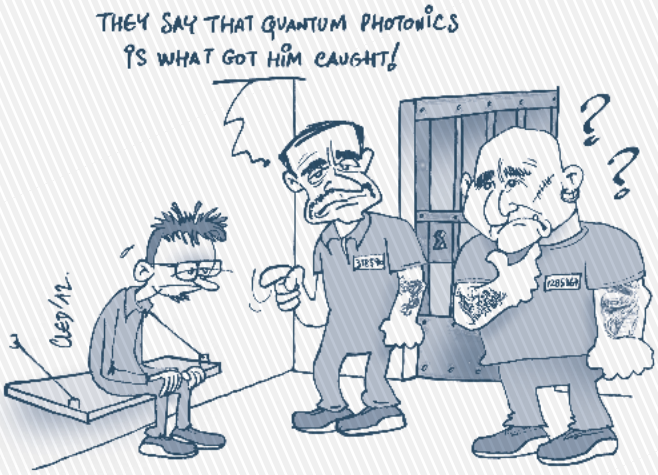

Quantum photonics a lethal weapon in the fight against cybercrime

The Carnot QPIC* project has been up and running in the photonics building since last fall. The researchers assigned to the project are developing components and integrated circuits for quantum communications, where information is transmitted in the form of single protons, making the technique intrinsically secure. With quantum communications, any attempt to hack into the data can be detected, making it just the kind of secure technology the finance, healthcare, energy, telecoms, and defense industries are seeking.

CEA-Leti is leading the project with support from Irig. Specifically, the research is focused on transmit/receive integrated circuits for quantum cryptography and dedicated characterization benches. All development work is being done on 200 mm and 300 mm SOI wafers to facilitate scaleup and transfer to manufacturers. Another potential candidate for QC, the photonic quantum bit, is also being considered in this research.

**Quantum Photonic Integrated Circuits*

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New electric motor components for fixed-gear bicycles

Cyclists who love the "fixie" (a fixed-gear city bike with no mudguards) could soon enjoy the comfort of a streamlined and quiet electric start-assist motor. CEA-Leti invented and patented elementary motor components that can be adapted in terms of size, number, and arrangement to suit the target application. Each component is made of excitation coils and a magnetic-field detection system. For the fixie, for example, they measure 5 cm x 3 cm x 1.5 cm and are housed in a high-profile wheel rim.

The result is a flat, invisible 250 W motor powered by supercapacitors that store the energy generated during braking. The system weighs in at around 3 kg, just half the weight of an equivalent system built on a conventional lithium-ion battery.

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6G the focus of new European projects

Global 5G rollout may still only be in its early stages, but researchers are already investigating the next generation in communications technology. The EU Rise-6G project, coordinated by CEA-Leti, kicked off at the end of January. The project's consortium of twelve partners, which includes global telecommunications operator Orange, the French national center for scientific research (CNRS), and France's national railroad (SNCF), will explore smart reflective surfaces.

These innovative surfaces could effectively focus radiation energy, drastically reducing energy consumption and exposure to harmful waves. The project supports Europe's 6G agenda, where reducing impacts and boosting safety are key. In contrast, the major players in Asia are working mainly on performance.

CEA-Leti is also engaged in two other European 6G projects, Hexa-X and Dedicat-6G.

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Melanoma: IBS investigates vaccine potential

Researchers at IBS* are using protein antigens characteristic of melanoma, a particularly aggressive form of skin cancer, to explore whether or not stimulating a patient's immune system can enhance treatment of the disease. The antigens would be vectorized by a non-infectious particle derived from the adenovirus.

Cancer generally attenuates a patient's immune response. Here, the idea is to stimulate a strong immune response with a vaccine. One additional benefit of this type of vaccine is that it would be easy to volume manufacture.

The scope of this research encompasses vector production and both *in vivo* and *in vitro* testing. Solène Besson, the recent winner of an award from the Silab-Jean Paufique Foundation, is supervising a PhD thesis on the project. The award came with a €20,000 grant to be disbursed to her lab over three years.

**with France's national blood bank and IAB Grenoble*

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Industrial companies look to unfalsifiable, shareable blockchain

Blockchain, best-known for its use in cryptocurrency, is garnering interest from industrial companies. And CEA-Leti is currently very active on the topic, with IRT Nanoelec and EU projects in progress. Both projects are exploring how to embed cryptographic functions on a physical system like a robot. The idea is to certify the data produced by the physical system and store the certificates on a blockchain. Manufacturers, operators, and maintenance workers would all share the same authenticated, unfalsifiable proof of the data's integrity, making it easy to determine responsibility in the event of a dispute, for example.

CEA-Leti, which had previously completed a Carnot project on blockchain from 2016 to 2018, focuses primarily on hardware solutions. A PhD research project on blockchain is also expected to begin shortly.

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Epistore project aims for super-compact fuel cells

The goal of the four-year EU Epistore project, which started in January, will be to develop a 3-cm cube-shaped reversible fuel cell that delivers 1 kW of power and stores energy produced from renewable sources. Grenoble-based LMGP got involved because of its deep knowledge of thin films. The "cube" will actually be made up of around 30 individual cells, each built from nanometric layers (two for the electrode, plus one layer for the electrolyte).

LMGP's researchers are placing their bets on well-known materials deposited using MOCVD or spatial ALD. They will also be using advanced characterization methods, including the ESRF

synchrotron in Grenoble, to observe the stacks' electrochemical behavior. These ultra-compact batteries operate at just 500 °C, as opposed to 700 °C to 800 °C for fuel cells with more conventional form factors.

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Fewer post-op complications for colorectal cancer patients

Colorectal cancer surgeries are particularly prone to complications, with between 3% and 20% of patients affected by CAL, or colorectal anastomotic leakage. This infection, diagnosed an average of four to seven days post-op, is a major cause of mortality. CEA-Leti is engaged in the EIT Exuchek project, which addresses this issue. The institute is developing a comprehensive CAL monitoring system that will include a device that can be integrated into the surgical drain, an algorithm to trigger alerts at certain thresholds, and a user interface for caregivers.

The system will constantly monitor biomarker concentrations for early diagnosis of infection. The pH and lactate sensors, which must be sensitive, robust, and capable of providing repeatable measurements within the range necessary for the future system, pose a unique challenge.

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Bolometer-based detectors: SPICA 100 times better than Herschel

CEA-Leti will soon finish fabricating its record-breaking bolometric detectors for the SPICA space mission. Designed by CEA-IRFU, the detectors are 100 times more sensitive than those on the Herschel satellite launched in 2009. These new detectors simultaneously measure the total intensity of cosmic rays and the intensity of each polarization component.

Characterization of the first detectors to come out of the cleanrooms is currently underway. Tests show good absorption from 80 µm to 160 µm, the target band for this application. The European Space Agency cancelled the SPICA mission last October. However, this doesn't mean that these exceptional components won't be used elsewhere, such as on another space mission, to instrument high-altitude balloons, or to enhance the performance of large ground-based telescopes.

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ESRF revolutionizes imaging of human organs

When it comes to imaging human organs, ESRF's new EBS accelerator is much more sensitive and offers far higher resolution than even the best medical imagers. Proof-of-concept testing was recently completed by an international team led by University College London and ESRF. The results were impressive enough to secure $1 million in funding from the Chan Zuckerberg Initiative.

The researchers used the accelerator to image the lungs of Covid-19 patients in 3D down to the smallest capillaries involved in alveolar gas exchange. In work on other organs*, extremely-high-resolution images, including pictures of the brain where even neurons are visible, were generated. With the EBS imager, a single technique can image organs at all scales, from the anatomical to the cellular. The researchers are now setting their sights on imaging the entire human body by 2024.

3D images of a Covid-19 patient's lungs: https://bit.ly/3ilZrbT

**Made possible by a partnership with the Anatomy Laboratory of the French Alps (LADAF-UGA)*

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Magnetic 2D materials, the new path to skyrmions?

Spintec recently teamed up with CNRS-Thales joint research unit UMPhy and China's NIMTE to work on skyrmions. According to their results, the spin quasi-particles, which are heralded as the material for tomorrow's magnetic memory, can be generated in transition metal dichalcogenide (TMD) monolayers.

Their work focused on Janus MnSeTe and MnSTe TMDs: In these materials, a layer of manganese is placed between two different chalcogen layers to create the asymmetry necessary for the magnetic interactions that produce skyrmions. A magnetic field is applied at temperatures up to 150 K to stabilize the skyrmions.

Lab experiments are already underway to test this new approach. The overriding objective is to broaden the number of potential skyrmion materials beyond just metal magnetic multilayers.

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DNP for cooler, more sensitive, and less expensive NMR

Dynamic nuclear polarization (DNP) increases the sensitivity of NMR spectroscopy experiments by several orders of magnitude. Two teams of researchers at Irig recently leveraged instrumentation developed over a decade and protected by seven patents to increase NMR performance by a factor of ten. Now observations can be carried out at 35 K, rather than 100 K previously, for an operating cost in the tens of euros per day.

The researchers replaced the 77 K nitrogen heat flux cooling system with a cryostat system built on exchangers, a cryocooler, and the NMR probe head. The system cools a closed-circuit helium stream to heat and drive the sample holder at a speed of tens of thousands of revolutions per second. This is the only piece of equipment of its kind in the world. It is available for use by outside partners.

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Fuel cells: Neural networks provide new insights into Nafion

Not even the powerful beamlines at ESRF and ILL can accurately ascertain the multi-scale (nanometer to centimeter) structure of Nafion as a function of water content, one of the keys to PEMFC performance. Researchers at Irig found a workaround in the form of a convolutional neural network.

They used nanostructure/water content data on ionic surfactants, whose behavior is well-known, to teach the algorithm. The network then expresses Nafion's nanostructure for different water contents as a distribution of ionic surfactant behaviors with the corresponding probabilities. Nafion's self-organization behavior is described by analogy, without a model or initial hypothesis, and the results are much more accurate.

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DAVID MARTIN-CHEVALIER
Grenoble INP third-year student and cofounder of the Think What Matters student collective

"Tomorrow's engineers want to participate in the sustainable innovations of the future."

MINA-NEWS: Tell us about Think What Matters.
David Martin-Chevalier: We are a collective of around ten students from Grenoble INP, Sciences Po Grenoble, UGA, and INSA Lyon. We started the collective in late 2019 to make information about the environmental transition more accessible and, therefore, make the transition more inclusive, something that was missing. We organize lectures and panel talks not only for students, to make them more aware of their role, but also for scientists. The idea is to hone our critical thinking skills by working together and to explore new approaches to innovation.

MINA-NEWS: What do your fellow students think of it?
DM-C: Interest is definitely growing. Increasingly, students want a forum to express their ideas and a way to make a difference. This year we plan to bring more students in so that we can expand our initiatives.

MINA-NEWS: And what are those initiatives?
We use social media, where we regularly post non-specialist articles on a variety of topics, from consumption trends to energy in Africa. At the December 18 Midi MINATEC we talked about 2Q2F, the method we are developing for scientists to help them ask the right questions about innovation and for engineers to rethink how they approach specifications. In January we started working with Phelma faculty on how to bring social and environmental issues into the curriculum. And, coming up next spring, the collective will take part in the student COP2 as well as an IRT Nanoelec webinar on sustainable electronics.

Watch the Midi MINATEC recording (in French): https://www.youtube.com/watch?v=LZ9Tv3-0Rng

https://www.facebook.com/ThinkWhatMatters/

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Grenoble INP-Phelma introduces new website for future students

Grenoble INP-Phelma is taking full advantage of digital technology to promote the school to potential students at a time when the conventional college fairs and other events for high-schoolers cannot be held in person.

From ferbuary, the new website, *ingenieur-phelma.fr,* will highlight all the school has to offer potential students, from its first-year general education curriculum to hands-on lab classes and top-notch facilities. Future students and their families will find the answers to their most frequently-asked questions, too. Student and faculty video testimonials will round out the new site's content. And, in a total departure from the school's main website, this new site's design is fresh and the tone of voice young and conversational.

An abridged website will be available to potential international student recruits in English *(engineer-phelma.fr).*

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Chipless RFID: Innovative tags win yet another award

Etienne Perret was not able to receive his *IMT Espoir* award from the French Academy of Sciences under the hallowed dome of the historic *Institut de France* building. The December 1 award ceremony had to be held remotely due to the ongoing pandemic. This award is not the first one that LCIS* researcher Perret has won for is work on chipless RFID.

Currently, Perret and his team are putting the finishing touches on a technique for producing tags with geometric patterns printed on them with a conductive ink that serves as a resonator. The ID and traceability labels, which are more powerful than barcodes, will also be more affordable than conventional chip-based RFID tags. Although the Covid-19 lockdowns did create some delays on the project, Perret and his team should be ready to unveil their demonstrator in the second half of 2021.

**A FMNT laboratory housed at Grenoble INP-Esisar (Valence campus)*

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NMR and biology: Paul Schanda brings home two awards

Paul Schanda, a scientist at IBS and expert on NMR techniques for the study of protein dynamics, recently won two international awards for his body of work. Trained in physical chemistry, Schanda has made a name for himself by bringing the physical methods of chemistry to biology. Most notably, he came up with one of the first descriptions of so-called "chaperones," which escort other proteins from where they are synthesized to their final location in biological membranes.

He also developed an NMR spectroscopy method to observe the process by which proteins are folded from their initial "spaghetti" shape into the 3D structures that determine their interactions with their environment. Finally, he is the author of more than 70 publications.

**The Varian Young Investigator Award and the ICMRBS Founders' Medal 2020*

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Startup team doubles in size to create even more new ventures

The CEA's tech transfer team onboarded three new startup program managers. The expanded startup team is gearing up to create even more new ventures and give the CEA's tech transfer activities a boost.

New team members Céline Tranquillin, who will handle digital transition projects, and Cheikhou Dieye, assigned to energy transition projects, are both based in Grenoble. Mathieu Trystram, who will be working out of Saclay, will be managing medtech startup projects.

All three new members of the team bring experience with innovation, financing, and/or marketing. Their mission will be to shepherd startup projects through each phase of the maturation and incubation processes, including projects supported by the new Magellan accelerator *(see next article)*.

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CEA Magellan accelerator to get a dozen new ventures a year off the ground

The CEA kicked off its Magellan startup accelerator in June 2020 with the goal of launching more startups faster nationwide. The organization has set a target of 150 startups by 2030. Magellan was inspired by former support programs like the First Step Challenge, but is broader in scope. Employees from all CEA divisions are eligible to apply for support.

Each year, two calls for proposals will provide a pool of potential projects. Those selected will receive support, including training, consulting, and assistance securing funding up until the startup is formed. The current cohort of thirteen projects, eight of which originated in Grenoble, are focusing on product maturation and prototyping. The next round of selections from the existing pool will be in March; a new call for proposals will be issued in June.

Submit a project online at: https://magellan.intra.cea.fr

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JSIam 2021 to bring PhDs and business pros together online

The organizers of the Junior Scientist and Industry Annual Meeting (JSIam) announced at the end of January that they would make the March 11 event 100% virtual. The purpose of JSIam is to raise up-and-coming research scientists' awareness of the career opportunities available to them outside of government research. The event is intended primarily for third-year PhD students. However, all junior scientists from GIANT laboratories and companies are welcome to attend.

Around 100 PhD students are expected, and more than 30 companies have already RSVP'd, evidence of their interest in GIANT researchers and JSIam. The day's program features a keynote speaker, ten workshops (on entrepreneurship, CV/résumé writing, networking, and more) and a speed networking session that will give participating junior scientists and business people a chance to talk one-on-one.

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Midi MINATEC lunch talks go remote, recordings available

After a hiatus during the first Covid-19 lockdown, the beloved Midi MINATEC lunches had returned to normal by October, convening every Friday. In December, however, the weekly rendezvous had to go virtual. Every week, the online auditorium can accommodate up to 200 live attendees with full access to the chat feature for speaker Q&A. For the rest, it is business as usual! Midi MINATEC lectures are still held every Friday at 12:30 p.m. at Maison MINATEC.

The video recordings are posted on the Midi MINATEC YouTube channel after the event. And, with an average of 700 views, the recordings are very popular. Dr. Fabrice Navarro's December 4 lecture on the potential for innovation in vaccine technologies set a record with 1,700 views and counting!

Midi MINATEC YouTube channel: https://bit.ly/3onXcMs

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HORIZONS

Spintec spearheading the international spintronics roadmap

Spintec is shaping the future of spintronics research, with Scientific Director Bernard Diény (first author) and four other Spintec researchers among the sixteen authors of the international spintronics roadmap published in *Nature Electronics* in 2020. The roadmap highlights a major trend: Spintronics, once only for data storage, is now making inroads into microelectronics.

MRAM memory has already entered volume production at Samsung, Intel, and other major manufacturers. High-density, low-power chips made by integrating spintronic devices onto CMOS components are currently under development. And Spintronics also has a role to play in radio frequency and terahertz communication technologies. Spintec is doing much more than just writing papers about these transformations: The lab is contributing actively through its own research programs and through a partnership with CEA-Leti.

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Grenoble INP-UGA online Open House

The eight schools of Grenoble INP-UGA and the INP preparatory program will hold their Open House on Saturday, February 27. For the first time ever, the event will be 100% virtual.

Each of the schools, including Phelma, will have its own virtual exhibit booth, plus hangouts and breakout spaces for one-to-one meetings. Around 20 people from the school, half of which are students, have volunteered to answer visitors' questions on the big day. Visitors will also be able to attend two interactive presentations of the school and virtual tours of the campus.

The Open House is being promoted on the Grenoble INP websites and social media accounts as well as by *L'Étudiant* magazine and Onisep, a government agency that provides education and career information. Information about the Open House was also sent out to high schools.

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Kalray reaches €97 million raised since it was founded in 2008

Kalray, a CEA-Leti spinoff founded in 2008 and publicly traded since 2018, recently raised €5.2 million in fresh capital. The company, which designs multicore, massively parallel microprocessors has now raised a total of €97 million.

The Coolidge™ chip, which Kalray introduced in 2020, is designed to deliver the capacity today's applications demand, with 80 parallel processing cores and a speed of 25 TOPS. The chip will primarily address the data center and automotive markets. In related news, the company recently formed strategic partnerships with France-based EasyMile and NXP of the Netherlands, which also owns a stake in Kalray. Kalray currently has 80 employees working mainly out of its offices in Montbonnot, near Grenoble.

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A giant leap for Diabeloop

Grenoble-based startup Diabeloop, which calls the BHT2 building home, has further anchored its position as a pioneer of artificial intelligence for diabetes treatment. The company obtained CE marking for its DBLG1 (a medical device that automates and personalizes the treatment of type 1 diabetes) in 2018. CE marking was obtained for the DBL-hu, for highly unstable diabetes, in 2020.

Diabeloop has been on a roll since November of last year. The startup has entered into three major partnerships to ramp up the international rollout of its solutions. Agreements signed with Terumo Corporation (Japan), SFC Fluidics (United States), and Roche (Switzerland) will help get its self-learning-algorithm-powered devices to patients worldwide. The agreement with Roche, a global leader in integrated diabetes management, will create huge opportunities for Diabeloop across Europe.

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AGENDA

February 14 to 19 [Les Houches]
CHAMONIX PHYSICS SCHOOL
Organized by Grenoble INP, ILL, LSPC, and Grenoble-Alpes University
https://bit.ly/3qT4fhw

February 26 [online]
MIDI MINATEC TALK ON THE SALD PEN
(see article p. 1). Registration: *https://www.minatec.org/fr/vie-de-campus/les-midis-minatec/*

February 27 [online]
PHELMA OPEN HOUSE
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March 11 [online]
JUNIOR SCIENTIST AND INDUSTRY ANNUAL MEETING (JSIam)
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April 26 to 30 [online]
IEEE INTERMAG 2021
International Magnetics Conference on magnetism and its applications: spintronics, memory, recording, sensors, IoT, etc.
https://intermag.org/

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