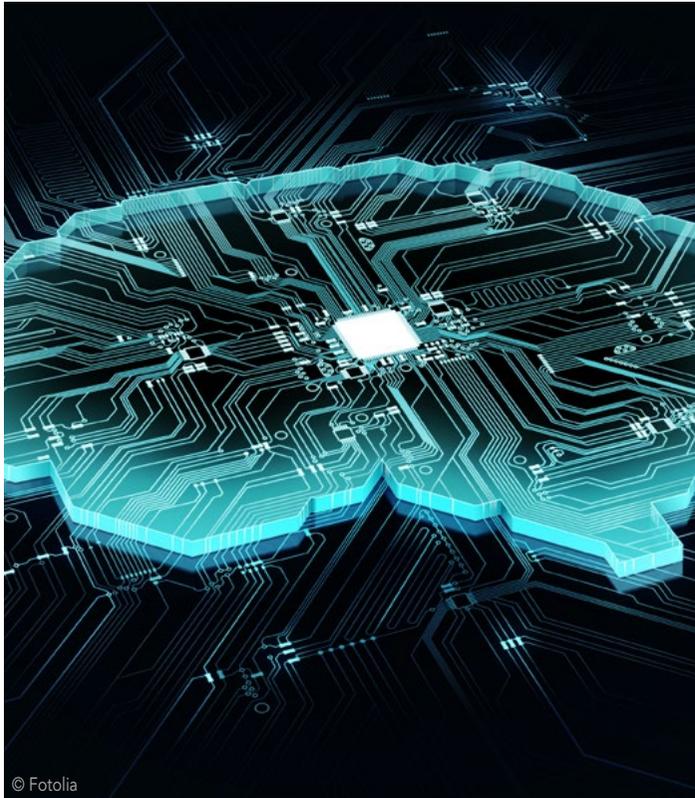




leti
cea tech

2019
HIGHLIGHTS

INSTITUT
CARNOT
Leti



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New advanced materials and processes

Resistive memories tested for the first time on silicon

The performance levels of non-volatile resistive memories were measured on silicon, using a manufacturing environment unique in the world. This demonstration confirmed the usefulness of these devices for future applications.

Optics and photonics

Softica automatic doors light up

A system that injects light into glass was modified for automatic doors. The doors can now be customized, offering an extremely affordable medium for visual communication.



© Softica

Human health

E-Meuse: First pilot trial successful

The first trial phase of the e-Meuse health project has just ended. It showed that the deployment of hand-held biological follow-up tools at the bedside of chronic EHPAD (nursing home for dependent senior citizens) patients brings consistently high benefits.



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Optics and photonics

Light is the ultimate medium for high-speed communications

Photonics.com—Thanks to innovations with heterogeneous material integration and multiphotonic layer stacking, silicon photonics will drive optical solutions to high volumes and low costs. Silicon photonics is widely considered a key enabling technology for further development of optical interconnect solutions needed to address growing traffic on the internet. From the first submarine optical cable to the fiber-to-home deployment to the proliferation of data centers, light has served as the ultimate medium for high-speed optical communications for more than 20 years.

News

> 21 papers (8 invited) presented at **Photonics West 2019** & host workshop on latest R&D

CEA-Leti will present eight invited papers, 21 in total, at Photonics West 2019 in San Francisco, and unveil its latest research on improved photonics-electronics and software convergence at a Feb. 6 workshop.

> **Europe supports micro & nanoelectronics**

It's official: the European Commission has approved 1.75 billion euros of funding for micro & nanoelectronics. The funds will be used to promote research and development as well as the industrial production of innovative components for a wide range of applications.

2019

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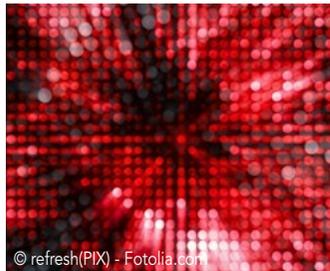
DECEMBER

News

> **Susana Bonnetier** appointed Vice-President of the Association des instituts Carnot

> CEA-Leti extends **300 mm line** to enable disruptive technologies

Chips Scale Review—CEA-Leti announced an extension of its 300mm silicon-based wafer line to open new R&D avenues for its industrial partners. The extension will allow innovative technological modules to be inserted in, or made compatible with, industrial flows up to completely pioneered technology routes that enable edge artificial intelligence (AI), high-performance computing (HPC), in-memory computing, photonics, power electronics, and other high-end applications.



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Optics and photonics

Next-generation mid-infrared optical sensors prototype for portable devices

CEA-Leti today announced it has prototyped a next-generation optical chemical sensor using mid-infrared silicon photonics that can be integrated in smartphones and other portable devices.



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Optics and photonics

Integrated optics and holography combining in novel lens-free, augmented reality technology

CEA-Leti has developed a novel retinal-projection concept for augmented reality (AR) uses based on a combination of integrated optics and holography. The lens-free optical system uses disruptive technologies to overcome the limitations of existing AR glasses.

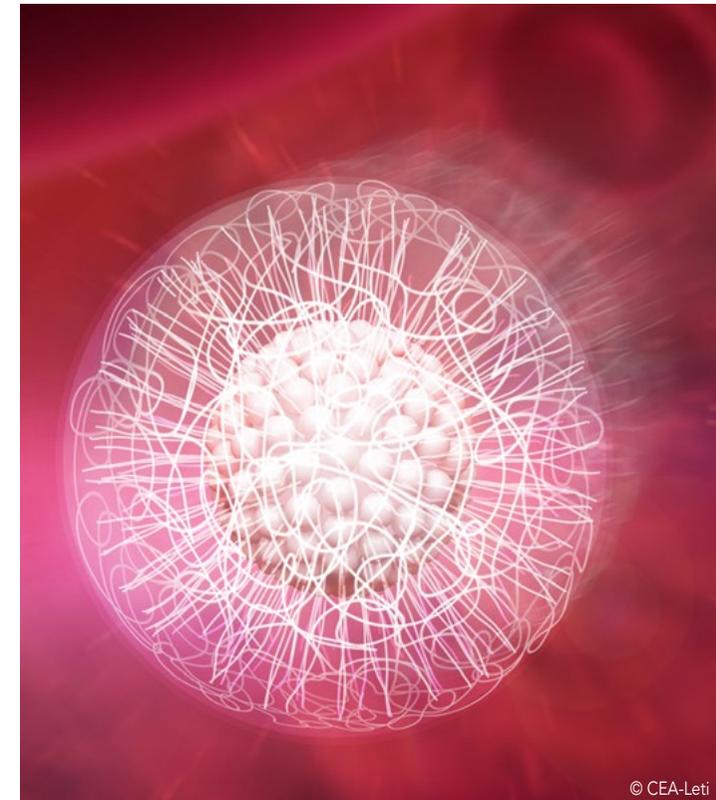


© Pixabay

Complex systems

SPARTA, european project for cybersecurity

Re-imagining the way cybersecurity research, innovation, and training are performed in the European Union. SPARTA is a novel Cybersecurity Competence Network, supported by the EU's H2020 program, with the objective to develop and implement top-tier research and innovation collaborative actions.



© CEA-Leti

Human health

CEA-Leti breakthrough opens path to new vaccine for HIV using lipid-nanoparticle-delivery technology

Lipidots platform strengthens immune response to protein that is key to HIV vaccine; results presented in nature publishing group's npj vaccines.

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New advanced materials and processes

My-Cube, the new ERC memory kicks off

Should we go on separating the memory block from the logic block of the circuits? Especially when it's well-known that the transfer of data from one to the other accounts for most of the consumption?

New advanced materials and processes

Targeting the RRAM memories of the future

A new RRAM non-volatile memory technology can encode up to 5 different values in one memory bit. It boosts information encoding density while reducing the energy consumption of the device which was used in a prototype neural network.



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Optics and photonics

Scintil Photonics speeds up and democratizes optical interconnections

The goal of Scintil Photonics is to have optical interconnections capable of reaching rates of 800 Gbit/s at a very competitive cost.



© Marcin Panastuk - Fotolia.com

New advanced materials and processes

Next-generation, low-cost photo-acoustic sensors prototype for gas detection and analysis

Redfinch team achieves these capabilities in mid-infrared region, where many important chemical and biological species have strong absorption fingerprints.



© Ekaterina Shilova - AdobeStock

Optics and photonics

Developing innovative systems for augmented reality using new approaches to components

Electrooptics.com—Displays are part of our everyday lives, from TV sets to computers and smartphones. But while they help make our lives easier and more connected than ever, they don't deliver the highly immersive experience, the enhanced-communication experience promised by augmented reality (AR).

News

> The three main microelectronics organizations in Europe team up

To strengthen its sovereignty in the strategic field of microelectronics, Europe must play the union card. As a result, the three biggest European research institutes have announced their intention to collaborate in this key area for innovation and industry.

> Electronics industry: The "competitiveness" contract

The contract for the French electronics industry was signed by Bruno Le Maire, Economy and Finance Minister, in the presence of the industry leaders and François Jacq, Chairman of the CEA.

> Inovalée tech hub chosen to test a Smart city solution

Co-run by Grenoble Alpes Métropole and CEA-Leti, the BigClouT project, selected and funded by the European Commission and the State of Japan, has put the seal on a new collaborative venture between Europe and Japan.

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News

> SEMI Partners with Powerhouses imec, CEA-Leti and Fraunhofer to Energize Global Innovation

SEMI partners with imec, CEA-Leti and Fraunhofer to drive innovation and deepen industry alignment on technology roadmaps and international standards.

Optics and photonics

Three potential new pathways to augmented reality glasses

Minanews—So far, augmented reality glasses have failed to live up to their promises: They are bulky, their field of view is limited, and they are not bright enough to be used outdoors. CEA-Leti is working to overcome these limitations through three targeted R&D projects. First, the institute is developing a 853×500 pixel, threemicron-pitch gallium nitride display to enhance brightness. Next, CEA-Leti is leveraging Pixcurve's curved display technology to come up with more compact optics.

New advanced materials and processes

Neural networks: Keeping catastrophic forgetting at bay

Minanews—To effectively respond to situations they have never learned before, tomorrow's neural networks will have to keep a phenomenon known as "catastrophic forgetting" at bay. Researchers from CEA-Leti, CEA-List, and LPNC* recently developed a novel solution to link knowledge in natural intelligence with knowledge in artificial intelligence. They created a model made up of two neural networks: The first network learns a given number of events, and then sends a sampling of the knowledge it has acquired to the second network. The second network then combines the sampling with new events and sends the information back to the first network. The result is a kind of incremental learning that is very close to how human memory works.

**Psychology and Neurocognition Laboratory (CNRS, UGA, UdS)*

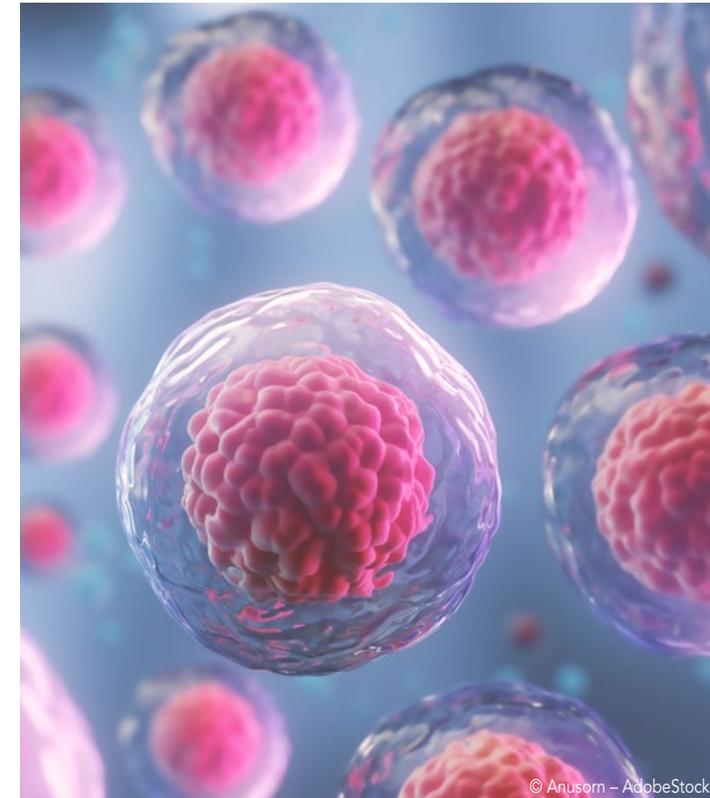


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Complex systems

Exploring in-memory computing

The ERC-backed My Cube project is setting its sights on the first-ever in-memory computing technology. The goal is to be able to carry out simple computations directly in a circuit's memory.



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Human health

CEA-Leti's lensless microscope was adapted to enable 3D image acquisition

The three-dimensional cell culture images obtained will be used by biologists to study cell self-organization. Biologists made the move from 2D to 3D cell culture a decade ago. However, the tools they use to observe cell cultures had not yet caught up. The lensless microscope developed in 2016 by CEA-Leti has now been adapted to acquire several images from different angles to generate 3D renderings.



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New advanced materials and processes

Taking gas chromatography out of the lab

Primosens is a miniaturized and portable gas chromatography system developed under a French government CBRN-E counterterrorism program. It can detect the presence of a given gas in a mixture right at the testing site. The advance also offers potential for use in fields other than counterterrorism.

Innovative devices and architecture

New AI computing in consumer electronics

EETimes.com—The market for AI processors is vast, but it can be organized into segments, and those segments can be targeted. [...] CEA-Leti's efforts in these two areas aim for maximum compatibility with existing technologies, following our longtime philosophy of using readily available processes, materials, and design approaches to ease the transition into volume manufacturing.

New advanced materials and processes

Unlocking accurate chemical sensing on the go

Blog.semi.org—A CEA-Leti team developed a novel generation of fully integrated optical chemical sensors that leverage MEMS technologies. The team successfully merged multiple functionalities on the same chip, using integrated optics and photonics, fluidics, acoustics and electromechanical transduction.

New advanced materials and processes

Micro-coolers developed in Grenoble equip main ring at CERN

CEA-Leti was selected to supply micro-coolers for CERN's LHCb experiment, one of four conducted on the synchrotron's main ring. CEA-Leti had previously contributed to the NA62 experiment at CERN.



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New advanced materials and processes

CEA-Leti develops CMOS process for high-performance microLEDs that could overcome display-size obstacles

New concept creates all-in-one RGB microLEDs, eliminates several transfer steps to receiving substrate & boosts performance.



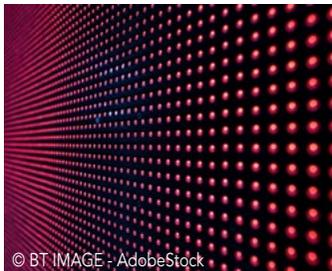
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New advanced materials and processes

Accelerometer performance gets another boost

A MEMS-type accelerometer capable of measuring acceleration in three directions with a larger field of detection and greater sensitivity than conventional sensors was developed at CEA-Leti.



Optics and photonics

Micro-LEDs: Low-cost mass production within reach

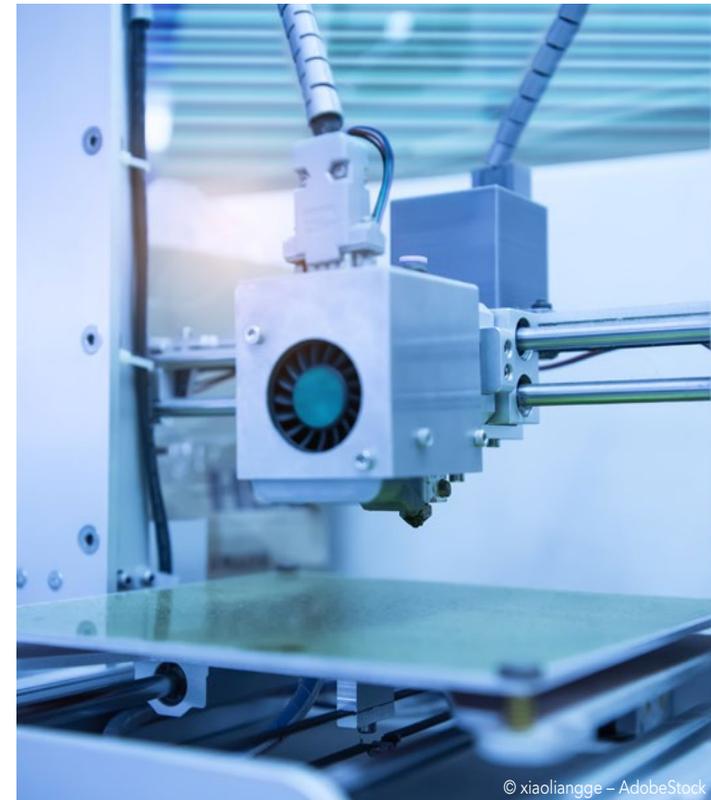
CEA-Leti presented a promising micro-LED fabrication technology at a conference in the United States. The technology will make it possible to fabricate micro-LEDs at a very low cost and transfer the LEDs onto all types of substrates—rigid, flexible, transparent, or opaque—with no limits on size.

Complex systems

Deep learning a threat to hardware encryption

Minanews—Deep learning could be used to crack the encryption codes used to safeguard secure products. CEA-Leti's ITSEF* studied the threat in research that recently resulted in a PhD dissertation that earned broad international recognition. The research focused on attacks via auxiliary channels. These attacks log massive amounts of data on a chip's electricity consumption and electromagnetic emissions, and then use deep learning algorithms to analyze the data and crack the cryptographic codes. The PhD dissertation that resulted from the research put forward a type of attack that CEA-Leti's ITSEF can now measure and implement when conducting evaluations. CEA-Leti's ITSEF is now also poised to join France's National Cybersecurity Agency (ANSSI) in raising developers' awareness of this new threat.

**Information technology security evaluation facility*

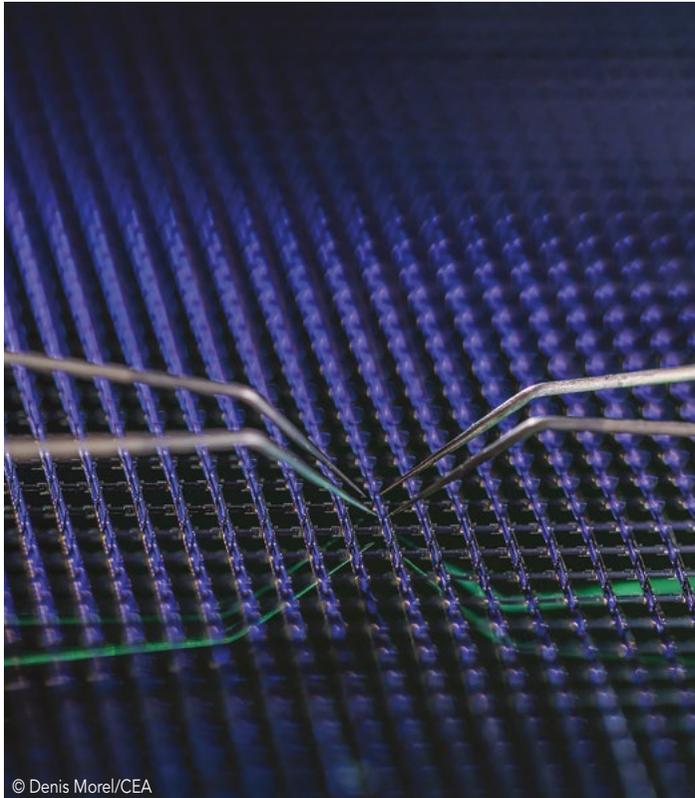


New advanced materials and processes

World-first presented at ECTC

A silicon component cabled using wire bonding and encapsulated with a polymer using 3D printing was presented at ECTC in San Diego. Researchers from CEA-Leti presented a silicon component encapsulated in a polymer package using 3D printing—a world first. A major technical hurdle to the advance was the adherence of the polymer to the silicon. To find a solution, the researchers tested several finishes (organic, metal, and inorganic) to help the polymer adhere to the substrate.





© Denis Morel/CEA

New advanced materials and processes

Miniaturized **chemical sensor** integrated on silicon

Researchers from CEA-Leti successfully integrated a high-performance chemical sensor on silicon. The system's quantum cascade lasers, photoacoustic cell, and photonic circuit take up less than 1 cm³; the conventional system originally took up around a liter.

Complex systems

CEA-Leti & Radiall to design innovative RF components for 5G networks and photonics components for harsh environments

Common lab will develop ultra-low profile e-band antenna for backhaul/fronthaul applications to speed up networks' capacity & coverage.



© UtopikPhoto/CEA

Complex systems

CEA-Leti and Silvaco team up on yield-prediction project for ultra-low-power static memories

Project combines CEA-Leti's semiconductor development expertise and Silvaco's SPICE simulation and variability analysis technologies.



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Complex systems

Smart-farm project: Lower greenhouse gas emissions & boost farming efficiency

In situ sensor node linked to the Internet of things will monitor soil nutrient levels and air quality at ground level.



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News

- > **Grenoble's Institut 3IA** for artificial intelligence launched
- > **Light Communications Alliance** formed by Global Industry Leaders
- > The excellence of **Grenoble's Health ecosystem** represented at a unique location
- > Two demonstrators in **Novares' Nova Car 2**



Optics and photonics

Cell cultures come into the light

For the first time ever, CEA-Leti demonstrated the non-toxicity of its OLED chips on bacteria in culture. The experiments also revealed that the devices are not subject to degradation in biological conditions.

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Complex systems

CEA's precise localization technology boosts quality control and efficiency in Desoutter's products

Algorithm and embedded receptors in Desoutter's electric & power tools deliver real-time monitoring & help meet industry 4.0 goals.

© UtopikPhoto/CEA



New advanced materials and processes

World first: Miniaturized solid-electrolyte microbatteries

The world's first solid-electrolyte lithium-ion microbatteries have been developed to meet the needs of specific healthcare applications.

© CEA

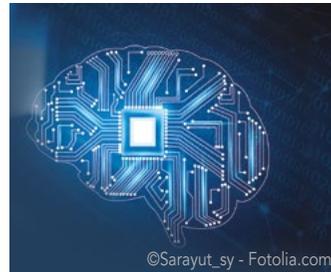


New advanced materials and processes

Waste sorting: Terradona's Cliink reinvents deposit schemes

Terradona sells a connected deposit-inspired solution for recycling drop-off containers that is gradually gaining traction. When equipped with the company's smart panel, containers can actually encourage users to sort better.

© Chlorophylle - AdobeStock



Complex systems

Weebit Nano and CEA-Leti to demonstrate brain-inspired neuromorphic demo

The demo enables massively parallel, low-power and low-latency computation and will be demonstrated at Flash Memory Summit 2019, August 6-8.

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Optics and photonics

Facilitate integration of LEDs into existing electrical wiring systems

The Neoled LED lighting system can be plugged directly into existing home electrical outlets with no need for an adapter. The patented system is compact and cost-effective to manufacture.

© tashka2000 - Adobe Stock

News

> **CEA-Leti and UnitySC** announce further development to fuel industry 4.0 with smarter tools

> **Another Successful Event: CEA-Leti-Fraunhofer at Semicon West 2019**

More than 150 industrials from the semiconductor attended CEA-Leti annual workshop in parallel to the Semicon West trade exhibition.

> **Leti Innovation Days: the event of the year on distributed artificial intelligence**

More than 950 industry leaders & tech experts attended plenary sessions—closed by award-winning mathematician, Cedric Villani—and took part in technical workshops during the Leti innovation Days, on 24-28 June 2019 in Grenoble.

Human health

On-target delivery: Lipid-based system introduces a novel approach for an HIV vaccination

Drud-dev.com—HIV is one of the deadliest pandemics of modern times, having caused 35 million deaths around the world. While researchers and clinical workers have identified antigens and antibodies necessary to validate diagnosis and have developed antiviral drugs to suppress HIV replication, we still do not have an effective means to prevent and fight the infection. Immunological obstacles are a significant barrier to designing an efficient HIV vaccine.

Human health

Manipulate cells & bacteria samples using non-contact evanescent acoustic tweezers

Evanescent acoustic beam moves suspended particles at lower cost and energy consumption than existing propagative surface acoustic wave (SAW) systems.

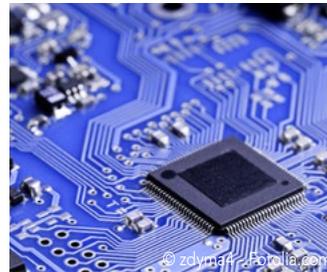


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New advanced materials and processes

Advanced FD-SOI key to edge AI, CEA-Leti chief executive tells Shanghai FD-SOI Forum

CEA-Leti CEO Emmanuel Sabonnadière spoke on a panel at the 7th Shanghai FD-SOI Forum this month explaining how advanced FD-SOI will help enable Edge AI.



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New advanced materials and processes

CEA-Leti continues to expand its 300 mm capabilities with new equipment

The new equipment will position CEA-Leti to offer semiconductor companies an even broader range of services to meet their needs.

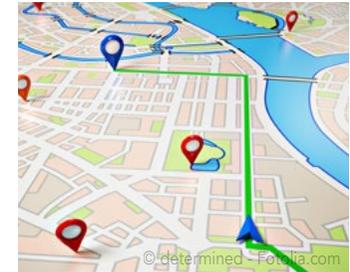


© Pierre Jayet/CEA

Complex systems

CEA-Leti and Orolia announce FlexFusion, a powerful positioning & navigation technology

Combining data from global navigation satellite systems (GNSS) and inertial management units ensures accuracy even during GNSS outages.



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Human health

Automated biological sample preparation with PEP's

The result of three years of research and development backed by the people at Y.SPOT and financed by the Carnot Network, the kit won an "Innovation Best Team Practices" award from the Paris Innovation Directors' Club.



© CEA

New advanced materials and processes

ChipInFlex: A new development on embedded flexible electronic labels

Chip Scale Review—Recent developments in the integration of ultra-thin silicon dies within a flexible film lead to a new paradigm. Indeed, thanks to the thinness and flexibility of devices, it is conceivable that functions can be added around any object without changing its aspect [1-5]. Currently, only electronic tracks between components are flexible in the major flexible electronic products on the market.

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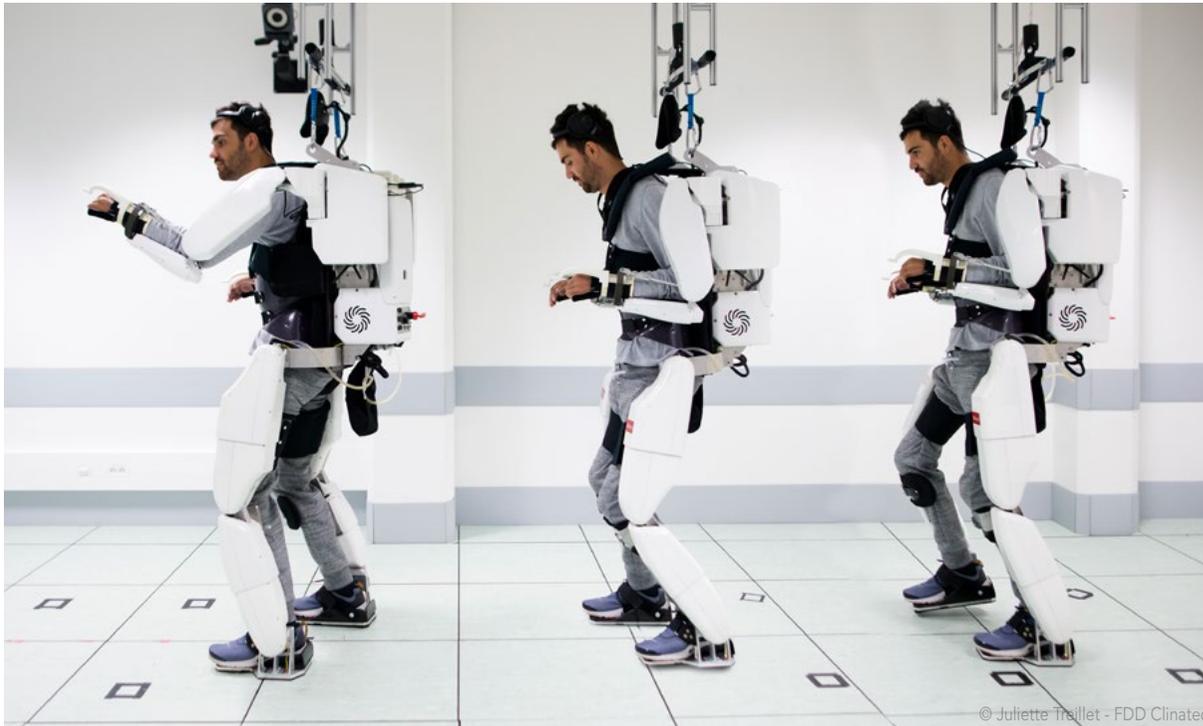
AUGUST

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**Human health**

An unprecedented **neuroprosthetic** allows a tetraplegic patient fitted with an exoskeleton to move

For the first time, a tetraplegic patient was able to walk and control both arms using this neuroprosthetic, which records, transmits, and decodes brain signals in real-time to control an exoskeleton. The results of a clinical study under the Brain Computer Interface (BCI) Project at Clinathec were published on 4 October 2019 in The Lancet Neurology journal and provide proof of concept for controlling a four-limb exoskeleton. The system is driven via the long-term implant of a semi-invasive medical device to record brain activity developed at CEA-Leti. In the long term, this technology is expected to give greater mobility to individuals with severe motor disabilities.

Optics and photonics

Fiber grating coupler development for **Si-photonics** at CEA-Leti

PICMagazine—Initial optimism over Silicon Photonics (SiP) potential to unseat incumbent transceiver and switch technologies suffers today from the years it took process tool and TAP manufacturers to adapt CMOS hardware to the eccentric needs of photonic device manufacturing. CEA-Leti experts delve into potential remedies that could be the tonic SiP needs to lead in short- and medium-reach applications.

**Innovative devices and architecture**

Enabling **Artificial Intelligence** at the edge

Technological solutions, based on very low consumption computing systems incorporating AI rapid computation modules, need to be deployed in our everyday objects. CEA-Leti and its advanced electronic component partners are now addressing this new challenge involving technological breakthroughs and market shares.

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Complex systems**P-link:
Could the future of copper be plastic?**

The P-link peripheral-to-peripheral high-speed data transfer system is cheap, robust, efficient, and low-power, making it the perfect candidate to replace copper or fiber optic cable in some applications.

Optics and photonics**Building your future photonics products NOW**

DrivingVisionNews.com—CEA-Leti's focus on lidar includes a strategic industrial partnership program, launched in 2018, to develop agile, affordable, compact lidar systems mixing innovative components and intelligent data processing including low-power data fusion. Recent additions to their technology equipment include a fully integrated silicon photonics optical phased array capable of steering laser light beams, and highly sensitive single photon avalanche diodes (SPADs) with advanced CMOS technology (in partnership with STMicroelectronics).

Complex systems**CEA-Leti establishes leadership
in Li-Fi communications technology**

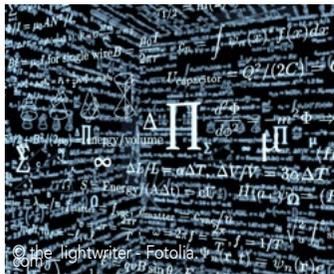
Minanews—Li-Fi, a short-range wireless communications technology that uses visible light to transmit data, is still in its early days. However, the major stakeholders in this new technology—which include CEA-Leti—are already leading the way. In June an international consortium created the nonprofit Light Communication Alliance (LCA) to promote Li-Fi to businesses and the general public. The group will also work on standards, an area that the IEEE has already begun to address.

CEA-Leti has filed three patents on Li-Fi technologies to date and has transferred a license to a major lighting-industry stakeholder. CEA-Leti's Li-Fi research is also gaining traction, with exploratory research projects involving several of the institute's departments that aim to boost speeds to several Gbits/s.

Human health

Lens-free microscope for cell-culture monitoring

A lens-free microscope is a simple device which records the diffraction pattern of a thin sample at a short sample-detector distance (typically >1mm) on a CMOS sensor. Focusing optics are not needed because the sample image is generated via computation, using holographic reconstruction techniques. Advantages of this timelapse imaging technique include low cost, robustness, large field of view (~30mm²) and compact size, which allows direct dynamic monitoring of cell cultures within an incubator.



Innovative devices and architecture

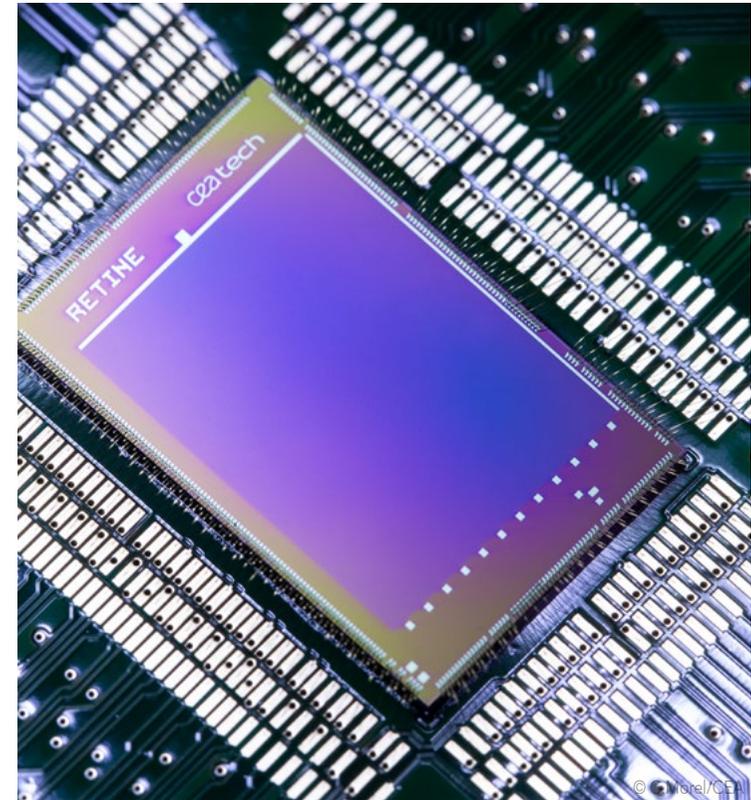
CEA-Leti and partners demonstrate potentially scalable readout system for large arrays of quantum dots

Results hold promise for fast, accurate single-shot readout of foundry-compatible Si MOS Spin Qubits'.

Innovative devices and architecture

Keeping vehicles on course at all times

FlexFusion is a new software application that can combine data from different sensors to pinpoint a vehicle's position at all times, even if GPS data is no longer available due to tampering or satellite signal issues.



Optics and photonics

Retine technology revolutionizes the world of imagers

CEA-Leti recently unveiled its first-ever smart imager made with a 3D stack. The result of seven years of R&D, the Retina imager's tightly integrated processor and sensor are capable of analyzing images in record time.



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Innovative devices and architecture

Lifi-Multicell at CES 2020: The world's first smart orchestrator for interference-free Li-Fi networks

System from CEA-Leti detects interference and optimizes data transmission rates for each nearby device.

New advanced materials and processes

SiC pilot line coming soon to the **Substrate Innovation Center**

Minanews—The Soitec/CEA-Leti Substrate Innovation Center will open a SiC (silicon carbide) pilot line in 2020 as part of a joint development program recently announced by Soitec and Applied Materials. The partners will develop solutions for electric vehicles, telecommunications, and other markets. SiC is already a leading material for these applications. However, it is less common for industrial applications due to its high cost and low fabrication yields. Soitec will leverage its Smart Cut™ technology, which the company uses for its SOI products. Applied Materials will contribute materials engineering knowhow. Audi, which has made EVs one of its top priorities, will be just one of the companies keeping a close eye on the new pilot line.

New advanced materials and processes

SOT-MRAM memory now denser

Minanews—SOT-MRAM is more reliable over the long term and faster than STT-RAM. The problem with SOT-MRAM, however, is that it is bulky. This is because SOT-MRAM typically has two transistors (one read and one write) as opposed to STT-MRAM's single transistor. Researchers from CEA-Leti and Spintec have recently partially overcome this challenge with a network of SOT-MRAM memory with a unidirectional diode instead of a read transistor. The result is a 20% increase in density with no adverse effects on speed or endurance. The researchers are determined to further increase memory density and are currently working on an even more compact architecture.

New advanced materials and processes

CEA-Leti received **CERN excellence award** for micro-coolers and 'exemplary' collaboration during LHCb upgrade

CEA-Leti's microfluidic circuit is made of a network of microchannels just tens of microns deep produced using a plasma etching process on 200mm silicon wafers.



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© CEA

Human health

Lensfree microscopy at CES 2020: Bedside analysis and pathology screening

CEA-Leti will demonstrate next-generation technology that enables bedside diagnosis of disease at one-tenth the cost of bulky optical microscopes.



© CEA-Leti

Human health

CEA-Leti **thin-film batteries** target extended applications and improved performance in medical implants

IEDM 2019 paper reports millimeter-scale TFBs exhibit the best performance in both energy and power densities.



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News

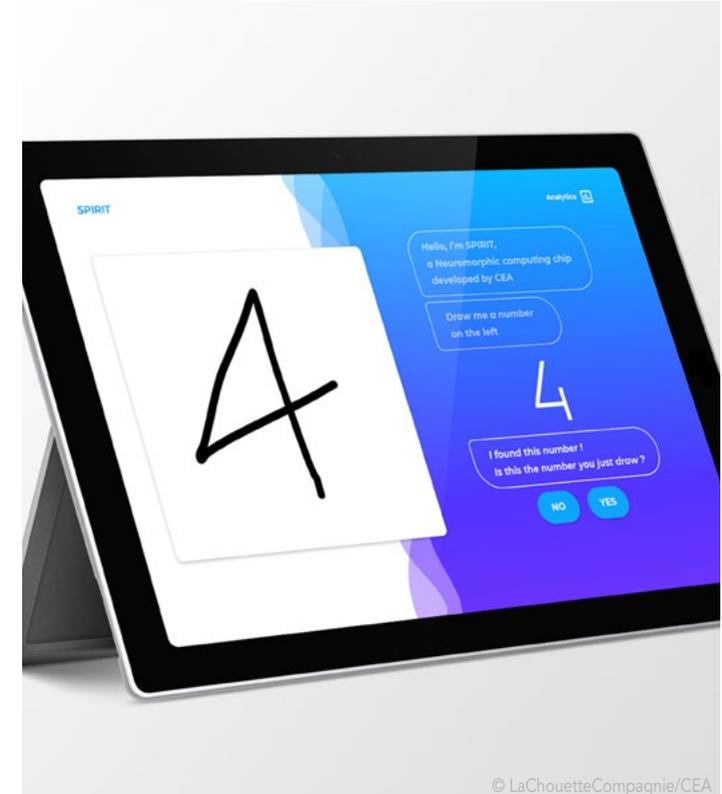
Discover the CEA-Leti's 2019 scientific Report

We are happy to share our most significant research results & publications from the past year.

Human health

Measuring **stress in children** using an exoskeleton

Minanews—CEA-Leti, in research conducted as part of the EU Motion project, which kicked off in September 2019, will develop a method for measuring the stress experienced by children who cannot walk due to neurological disorders when they are in an upright position with the support of an exoskeleton. Most of the project partners are focusing on the children's exoskeleton. CEA-Leti, however, is tackling data fusion.



© LaChouetteCompagnie/CEA

Innovative devices and architecture

CEA-Leti builds **fully integrated bio-inspired neural network** with RRAM-based synapses & analogue spiking neurons

Functionality of circuit presented at IEDM 2019 was demonstrated with handwritten digits classification on a tablet screen.

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