Building today
the society of tomorrow

cea

www.cea.fr

The CEA is a public research organization

As a key player in research, development and innovation, the CEA operates in 6 main areas: defense and national security, nuclear and renewable energies, biotechnological and medical research, technological research for industry, fundamental research (materials and life sciences) and in remediation and dismantling of nuclear installations.

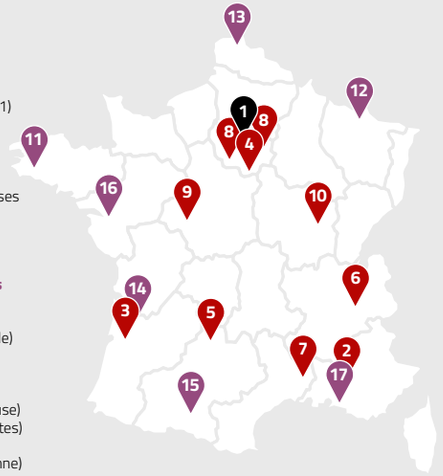
Since 75 years, thanks to the excellence of its research and its partnerships, the CEA has been at the origin of several applications that influence our daily lives.

Thanks to its **10 sites** and its **7 CEA Tech locations spread throughout France**, the CEA has a strong presence in our country. Widely acknowledged as an expert in his fields of expertise, the CEA is fully involved into the European Research Area and its international presence is constantly growing.

Headquarter - Paris

Research Centers
2 Cadarache (13)
3 Cesta (33)
4 DAM-Île-de-France (91)
5 Gramat (46)
6 Grenoble (38)
7 Marcoule (30)
8 Paris Saclay (91) and Fontenay-aux-Roses (92) sites
9 Ripault (37)
10 Valduc (21)

CEA Tech Regional hubs
11 Bretagne (Quimper)
12 Grand Est (Metz)
13 Hauts-de-France (Lille)
14 Nouvelle-Aquitaine (Bordeaux)
15 Occitanie Pyrénées-Méditerranée (Toulouse)
16 Pays de la Loire (Nantes)
17 Région Sud PACA (Cadarache et Gardanne)



Since its creation, the CEA has been...

1948 ▪ Pile Zoé. The first atomic pile built at Fontenay-aux-Roses marks the beginning of nuclear energy research in France.

1964 ▪ Nuclear deterrence. First warning by strategic air forces with the first French nuclear weapon.

1969 ▪ Treatment of radioactive waste. Development of the vitrification process, a technique that allows waste to be immobilized in a safe and lasting manner. This process is used on an industrial scale by Orano at its plant in La Hague.

1971 ▪ Nuclear propulsion. Launch of the Redoutable, the first French nuclear-powered submarine, which carries the first oceanic nuclear weapons.

1976 ▪ Medical imaging. First French medical scanner.

1983 ▪ Particle physics. First experiments at Ganil.

1987 ▪ Climate. Analysis of the first ice core from the interglacial era.

1988 ▪ Merger. The Tore-Supra, superconducting tokamak gets its first plasma.

1999 ▪ Microelectronics. Manufacture of the smallest transistor in the world (20 nm).

2001 ▪ Prion. Development of the "mad cow" screening test.

2005 ▪ INES. Launch of the National Solar Energy Institute.

2009 ▪ TNA. First French nuclear weapon guaranteed by the Simulation program, without any new nuclear test.

2010 ▪ Tera100. First European supercomputer, co-developed by the CEA and Bull for deterrence purposes, to cross the petaflop bar (1 million billion operations per second).

2012 ▪ CENALT. This warning center monitors strong earthquakes that can generate tsunamis in the western Mediterranean and the northeast Atlantic. It alerts civil security in case of risk.

2012 ▪ Higgs Boson. Atlas and CMS experiments at CERN in Geneva observed a new particle: the Higgs boson, predicted by the standard model.

2016 ▪ Quantum calculation. Production of the first Qbit CMOS.

2016 ▪ Dating ^{14}C. Analysis of the cave paintings discovered in the Chauvet cave by accelerator mass spectrometry.

2016 ▪ Dismantling of the UP1 plant. A world first for laser cutting of remote equipment in a highly radioactive environment.

2017 ▪ Energy Observer. The CEA is the energy architect of this catamaran which travels around the world thanks to renewable energies (solar, wind, hydrogen, fuel cell, battery).

2018 ▪ Gene therapy. Beta-thalassemia treatment new success.

2019 ▪ Exoskeleton. Novel neuroprosthesis, developed by the CEA and tested at Clinatec, which allowed a quadriplegic patient equipped with a 4-limb exoskeleton to move.

2019 ▪ Nuclear fusion. Successful completion of the first nuclear fusion experiment within the Laser Mégajoule.

2019 ▪ Neuroimaging. Iseult project MRI magnet field reaches 11.7 Teslas.

2020 ▪ Fight against nuclear proliferation. France becomes the first state to complete its contribution to the International Monitoring System of the Comprehensive Nuclear Test Ban Treaty.

Key figures
(2020)

> 20 000
employees

5
billion euros
(civil and defense)

> 5 000
publications

> 440
European Projects

Technology transfer and partnerships

As a major player in innovation, the CEA promotes the technologies it develops and transfers them to industry. It thus supports business competitiveness, job creation and national technological sovereignty. By encouraging spin-offs, it has supported and promoted creation of start-ups for the past twenty years.

THE CEA IS ONE OF THE LEADING PATENT APPLICANTS IN FRANCE AND EUROPE

1st patent-granting research organization in France
1st French patent applicant in Europe
6,980 active patent families

PARTNERSHIPS

216 start-ups created including 89 over the last 10 years
700 industrial partners
56 competitiveness clusters

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Defense and Security

— The CEA is responsible for meeting the challenges of nuclear deterrence (renewal of nuclear weapons and nuclear boilers for naval propulsion, fight against nuclear proliferation). It also provides technical support (monitoring, analysis) in the fight against terrorism, earthquake and tsunami warning and support for conventional defense.

Nuclear weapons: Design, manufacture, guarantee the safety and reliability of nuclear warheads and make them available to the forces ▪ **Nuclear propulsion:** Design and build the boiler rooms and nuclear cores of the French Navy vessels and deliver them to the forces ▪ **Security and non-proliferation:** Fight against nuclear proliferation and terrorism, in support of national and international authorities ▪ **Conventional defense:** Assess and control the effects and vulnerability of conventional armaments ▪ **Materials:** Supply (weapons and propulsion)

Simulation

— Maintaining a safe and reliable deterrent capability, without resorting to nuclear testing, propelled the CEA into the era of simulation, faithfully reproducing the physical phenomena at stake through calculation. The simulation consists of modeling these phenomena by equations, validated by comparison with laboratory experiments and solved using supercomputers. By launching its "Simulation" program for defense purposes, the CEA has helped build a competitive HPC ecosystem in France, in particular through the precursor supercomputers that it codevelops with Atos, and to structure a national optical and laser industry at the highest level, by building the Mégajoule Laser, an exceptional experimental laboratory. Numerical simulation is now at the heart of the innovation process in all sectors of industry and research, and, of course, in all CEA programs.

Energies

— The CEA is at the forefront of the energy transition needed to combat global warming. It conducts research on low-carbon energy production, energy efficiency and the circular economy.

Producing low-carbon energy

Nuclear: Support industry companies for research on current reactors and EPR / Conduct research on 4th generation reactors / Innovate with SMRs (Small Modular Reactors) which can be combined with other technologies to offer more functionalities (hydrogen production, heat) ▪ **Solar energy:** Manufacture photovoltaic cells and modules and optimize their integration on all kinds of structures: facades, vehicles, aircraft, banks, nomadic objects... ▪ **Bio-resources and molecules of energy interest:** Produce biofuels and solar fuels from micro-algae ▪ **Fusion:** Develop the interest of an industrial-scale electricity production line by the end of the century

Manage energy networks

Storage: Improve lithium-ion batteries ▪ **Hydrogen vector:** Develop high-temperature electrolysis for the production of carbon-free hydrogen (mobility and storage applications) ▪ **Energy efficiency, networks and simulation:** Simulate means of production and storage / Deploy intelligent and multi-vector energy networks / Valuing thermal losses and waste heat in industry

Optimizing resources

Fuel Cycle: Improve fuel manufacturing, treatment and recycling processes / Investigate waste behaviour ▪ **Manufacturing Processes and Circular Economy:** Improve additive manufacturing processes / Substitute critical materials / Improve recycling processes / Transform CO_2 and its derivatives into useful products, using low-carbon energy

Digital Transition

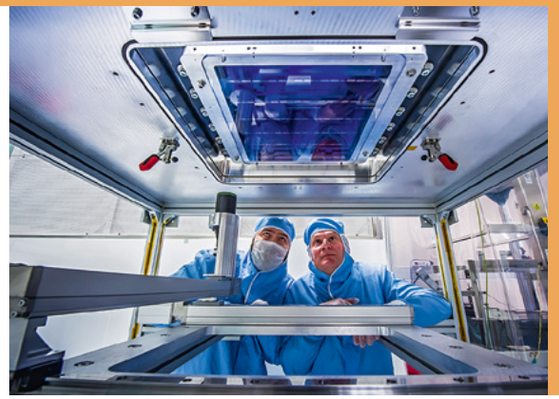
— The CEA is an expert in the fields of electronics and digital technology. It is able to design, build and manage innovative technology platforms.

Micro and nano-electronics: Design integrated circuits, embedded software and their components / Advance in photonics and spintronics / Develop technologies for biology and health ▪ **Advanced manufacturing:** Improve collaborative robotics / Develop virtual and augmented reality systems / Develop non-destructive control sensors ▪ **Ambient Intelligence:** Work on the Internet of objects / Analyze data and develop artificial intelligence / Design and integrate embedded sensors ▪ **Quantum technologies:** Develop quantum bits that can be integrated on a large scale / Optimize calculations of the future quantum computer / Design sensors / Secure communication networks

Fundamental Research

— The CEA invests in fundamental research of excellence, which generates a very wide spectrum of knowledge and know-how, serving all its missions and for the benefit of society. The teams work in the fields of physics, environment, materials science, chemistry, biology and health.

Fundamental Laws of the Universe and the Quantum World: Exploring physics beyond the standard model of particle physics / Studying dark matter and energy ▪ **New materials and states of matter:** Design, manufacture and understand systems with novel properties / Study complex matter and turbulence phenomena / Study and generate nuclear fusion reactions ▪ **Climate and environmental changes:** Study the evolution of natural climate mechanisms / Observe modern physical and chemical conditions from the ground and space to monitor planetary changes and their impacts / Simulate the climate ▪ **Living mechanisms:** Characterize organisms at all spatial and temporal scales through a multidisciplinary and integrative approach / Understand pathological changes linked to cancers and infectious diseases, immunology and neurodegenerative ▪ **Brain and neural code:** Develop and bring together a set of state-of-the-art instruments: MRI, microscopy, sensors, storage, data processing and analysis thanks to artificial intelligence.



Very large research facilities

— Whether in physics, environment, material science or biomedicine, research requires very large research instruments, such as the Laue-Langevin Institute, the Ganil, the LHC, the European synchrotron ESRF or the Genci high-performance computing platform. The CEA represents France in the governance bodies of these infrastructures, often alongside other research organizations, or even operates them (ICOS) or also participates in their construction (ESS).

Remediation and dismantling

— The CEA supports the dismantling of its nuclear facilities at the end of their life. Their wide diversity provides the CEA with real expertise in remediation, dismantling and waste management. Trans-disciplinary R&D programs are dedicated to this growing activity.

Worksites: Conduct operations on the 36 facilities being dismantled, with a prioritization strategy based on the radioactivity, radiotoxicity and robustness of the facility ▪ **Waste:** Manage current and old waste, including characterization, packaging and transport to appropriate storage centers or disposal sites ▪ **Innovation:** Develop custom R&D adaptated to the needs of remediation-dismantling (robotics, virtual reality, etc.) to improve work in hostile environments, better characterize waste or optimize decontamination and rehabilitation of impacted environments

Healthcare technologies

— Involved since its creation in biology and health research, the CEA capitalizes on all skills developed over the years to contribute to the emergence of the medicine of the future, in close connection with clinical research structures.

Medical Imaging and related developments: Bring breakthrough technological innovations and integration solutions / Develop very high field MRI and new radiopharmaceuticals / Develop multimodal and multiscale imaging / Develop signal processing, image analysis, and data exploitation using artificial intelligence methods ▪ **Prevention and diagnosis:** Develop diagnostic and early detection tests / Develop innovative medical devices / Develop vaccines against infectious diseases ▪ **Therapeutic innovations:** Make skills and infrastructures available to partners / Develop gene, cell, molecular and chemical therapies / Innovate in drug delivery / Innovate in radiotherapy and brain-machine interfaces ▪ **Large-scale analysis ("omics"):** Drive the France Genomics 2025 Plan / Deploy an R&D platform for digital health, open to the academic and private communities / Combine multi-omics data with those from imaging or phenotypes to solve important medical questions

INSTN

The INSTN is the school of specialization for low-carbon energy and health technologies.
It offers specialized courses and continuing professional training sessions for all levels of qualification - operators, technicians, engineers and researchers - in France and abroad.
The INSTN contributes to the dissemination of scientific knowledge and technological progress carried by the CEA; 60% of its teachers and trainers come from CEA laboratories.