

Three new Research Centres of Competence for ETH Zurich



How did life on Earth begin? Modern stromatolites in Laguna Negra, Argentina. Stromatolites – layered rocks built by complex microbial communities – represent the earliest fossil evidence of life on Earth, with some formations dating back more than 3.5 billion years.

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How and where does life originate in the universe? How can physical phenomena be measured with the highest precision? How is Switzerland handling increasing climate and weather extremes? Three new National Centres of Competence in Research (NCCRs), awarded to ETH Zurich and its partner universities, seek to answer these questions.

The Swiss federal government has approved funding for a total of six new National Centres of Competence in Research (NCCRs). Remarkably, no fewer than three of these new centres will be led by ETH Zurich: 'Genesis' in collaboration with the University of Lausanne, 'Precision' with the University of Basel, and 'CLIM+' with the University of Bern.

NCCRs constitute a long-term funding instrument of the federal government. They establish the necessary conditions for researchers in Switzerland to build the education and research structures required for new fields of study and to network across the country. These research networks are each led by one or two home institutions, which in turn contribute substantial resources of their own.

For the initial phase from 2026 to 2029, the federal government is providing approximately 17 million Swiss francs per NCCR: specifically, CHF 16.99 million for 'Genesis', CHF 16.97 million for 'Precision', and CHF 16.88 million for 'CLIM+'. Including the universities' own funds, the total budgets amount to 37.94 million francs for 'Genesis', 36.01 million francs for 'Precision', and 32.55 million francs for 'CLIM+'. The maximum duration of an NCCR is twelve years.

How inanimate matter becomes living

How did life on Earth begin? Are we alone in the universe, or is it teeming with life? What sparks the imagination of many is also a serious scientific question and the starting point of the National Centre of Competence in Research 'Genesis'. It is led by ETH physicist and Nobel Laureate Didier Queloz.

The NCCR 'Genesis' brings together more than 100 scientists from all parts of the country, bridging the gap between biology, chemistry, astrophysics, and Earth and planetary sciences. The approach here is as follows: the origin of life is understood not as a sudden coincidence, but as a gradual process. The researchers are investigating how planetary conditions allow functional biological systems to form from inanimate building blocks, eventually leading to the emergence of living organisms.

The researchers' goal is to understand this transition. Comparisons with other potentially habitable planets should reveal which biochemical processes and interactions between the environment and organisms make life possible – and why such a vast diversity has developed specifically on Earth. A key question concerns this interaction: which environmental conditions allow for evolution, and how do living organisms in turn reshape their planets?

To find biosignatures – traces of life – in space, the researchers are combining various methods. These include chemical laboratory experiments that replicate the geological conditions of the early Earth, as well as high-performance telescopes and new remote sensing technologies to detect potentially inhabited exoplanets. "The next ten years are likely to be crucial for better understanding how the first living cells emerged from inanimate matter," says Didier Queloz, who has led the Centre for Origin and Prevalence of Life (COPL) at ETH Zurich since 2022. "It would be wonderful if we could gain these important insights here in Switzerland." The new findings on these existential questions are also expected to enrich the dialogue with the public.

On the cusp of a revolution in precision

The world of fundamental physics still holds many unsolved mysteries. Progress in physics depends heavily on what can be measured – and with what degree of accuracy. Just over a century ago, physicists and mathematicians formulated the theory of quantum mechanics to describe the hidden world of microscopic particles.

Today, research has advanced far beyond that point: it is now possible to influence the quantum behavior of elementary particles, atoms, and even larger objects, create quantum states, and keep them stable. This knowledge forms the basis for novel measurement technologies of unprecedented precision.

Such precision measurements, based on quantum technologies or light-based photonic technologies, provide a new window to examine the Standard Model of particle physics. This model is known to be incomplete for describing the universe.

Precision measurements and the technology it uses are thus facing a disruptive upheaval. The goal of the National Centre of Competence in Research "Precision" is to actively shape this transformation. It unites 32 research groups stretching between Zurich, Basel, Villigen, Bern, Neuchâtel and Lausanne, combining experimental and theoretical expertise in spectroscopy, atomic and molecular physics, optics, and sensor technology.

The NCCR 'Precision' pursues four objectives: high-precision measurements on atoms, molecules, and systems with antimatter to understand new physical phenomena; the development of high-precision measurement methods using controlled quantum states; the development of light-based photonic technologies to further increase measurement precision; and the development of highly sensitive sensors based on atomic and solid-state systems to precisely measure electromagnetic fields or gravity.

The structure of the NCCR will unite fundamental physics and sensor technologies. "With a large, interdisciplinary NCCR, we can help shape the rapid development of precision measurement," says Jonathan Home, ETH Zurich Professor of Experimental Quantum Information and Director of the NCCR 'Precision' (cf. box below). "Moreover, we

are laying the foundation for industrial innovation in the high-tech sector."

From statistics to storylines – Climate protection as a societal project

Whether heatwaves, droughts, heavy rainfall or landslides – many extreme climate and weather events have been occurring more frequently and with greater intensity in recent years. They affect Switzerland particularly severely; since records began, the country has warmed at roughly twice the rate of the global average. Consequently, the challenges posed by this development are significant for Switzerland.

The National Centre of Competence in Research "NCCR CLIM+" (Climate Extremes and Society: Strengthening Resilience) addresses the societal risks of climate and weather extremes. It brings together 47 Swiss research groups from climate, political, and social sciences. Their aim goes beyond demonstrating physical cause and effect: They intend to enable viable solutions for effective climate protection and show how Switzerland can handle extreme events with greater resilience and crisis resistance in the future. The focus is on key sectors such as health, agriculture, water management, logistics, and finance.

The NCCR "CLIM+" is co-led by ETH Zurich and the University of Bern, with co-directors Sonia I. Seneviratne (ETH Zurich) and Karin Ingold (University of Bern). "The human induced global warming and associated climate crisis have wide ranging impacts on society. With extreme weather events projected to further increase in frequency and intensity in the coming decades, we must integrate physical and social sciences to best support our society's transformation to a more resilient and safer future," says Sonia Seneviratne, ETH Professor of Land-Climate Dynamics.

Methodologically, the researchers are breaking new ground: They do not derive societal impacts solely from climate-physical scenarios. Instead, they develop societal scenarios jointly with stakeholders from the field.

This results in 'storylines' that address real everyday questions: What does extreme heat mean for the construction and cooling of hospitals? How does it change the daily working routine of nursing staff? To what extent do extreme temperatures endanger supply chains on rail and road? The spectrum of questions investigated ranges from governance and law to economics and climate communication.

To make these scenarios as plausible as possible, the NCCR "CLIM+" builds on the latest climate models and Artificial Intelligence, as developed by the EXCLAIM and Swiss AI research initiatives. These technologies allow for the modelling of even rare, yet particularly consequential, extreme events. The pivotal point of the NCCR for exchange between science, politics, and society will be the new Center for Climate Extremes and Resilience in Swiss Society (CERESS).

A strong signal and an opportunity for talent

Annette Oxenius, Vice President for Research at ETH Zurich, is delighted that ETH Zurich has been selected to lead three research centres. The new NCCRs, she notes, are not only important fields of research but also a significant opportunity for young talent. "With the new National Centres of Competence in Research, the federal government is sending a strong signal: dealing with climate extremes, new high-precision technologies, and Research into the origins of life are key topics of the future," says Annette Oxenius. "The nationwide expansion of these research areas creates far more than just new knowledge in the long term. It also unlocks innovation potential for the Swiss economy and expands the scope of action for policymakers."

Philanthropy as a catalyst for scientific progress

The fact that these three research centres are now anchored at ETH Zurich is also due to the long-term support of donors and partners. Their contributions provided crucial funding with real leverage: they enabled these research fields to be strategically strengthened in recent years, helped attract outstanding talent, and supported the advancement of innovative scientific approaches. Thanks to this early backing, ETH Zurich is now exceptionally well positioned to take a leading role in the new National Centres of Competence in Research – and to generate scientific impact for society.

A heartfelt thank you to all our donors.

<https://ethz-foundation.ch/en/spotlight/three-new-research-centres-of-competence-for-eth-zurich/>

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