Swiss Research Program Nano-Tera.ch

Engineering Multi-Scale Systems for Health, Security, Energy and the Environment

Activity Report 2013

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NANO-TERA.CH: FUNDING RESEARCH IN SYSTEMS ENGINEERING

Prof. Giovanni De Micheli
Nano-Tera.ch Program Leader,
Executive Committee Chair

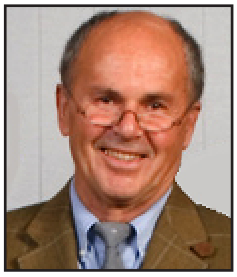
Nano-Tera.ch is a national funding program supporting research in engineering of complex (**tera**-scale) systems for health and the environment using **nano**technologies.

Energy and security issues are also investigated as crucial transversal themes in system design. Nano-Tera.ch research funding is open to all Swiss institutions according to the corresponding legislation. Moreover, Nano-Tera.ch fosters collaboration among researchers and industries that are partners or supporters of the research projects.

The Swiss National Science Foundation (SNSF) contributes to the Nano-Tera.ch program by evaluating and monitoring the large research projects through an international panel of experts, thus ensuring the high scientific quality of the program.

The mission of Nano-Tera.ch includes research, development and technology transfer as well as education and dissemination. The final objective is to enable mechanisms that can map the high productivity of research ideas, publications and patents of the Swiss community into a significant momentum in terms of industrial growth as well as job and enterprise creation. This specific engineering focus differentiates Nano-Tera.ch from other funding programs.

NANO-TERA.CH: SWISS EXCELLENCE IN RESEARCH



Prof. Heinrich Meyr,
Nano-Tera.ch
Scientific Advisory Board Chair

The Scientific Advisory Board reviews the Nano-Tera.ch program as a whole and provides criticisms and suggestions for its future growth. The Board regards the Nano-Tera.ch program as a unique blend of technology exploration and system design. The scientific and industrial challenges studied in the program are related to exploiting micro and nano components within complex systems whose added value is much larger than the sum of their parts. A notable example is networked sensors for medical and environmental applications. Networking boosts the intrinsic power of local measurements, and allows us to reach new standards in health and environment management, with positive fallout on security of individuals and communities.

Smart and diversified energy generation, such as harvesting and low-power system design are of the utmost importance to society and the economy. Truly innovative approaches are needed, that can only be found by massively investing in engineering research. Thus the Board lauds the extension of the Nano-Tera.ch scope to include energy as an application area.

The upcoming scientific and engineering challenges are too heterogeneous and complex to be solved within a single scientific domain. They require a truly collaborative and cross-disciplinary approach. The Nano-Tera.ch program brings together excellent researchers in various fields from many Swiss institutions with outstanding reputation.

The program is not only of high scientific value but also of eminent economic importance for the industrial sector of Switzerland. The program serves as the seed for truly innovative products and industries. It also fosters the education of highly-qualified engineers and researchers who are the most valuable and indispensable resource of this country.

Nano-Tera.ch Phase II kick-off meeting
(left) SNSF President M. Vetterli, Nano-Tera.ch Program Leader G. De Micheli, Head of SNSF Division 2 P. Burkhard; (right) P. Burkhard, EPFL Vice-president for Academic Affairs P. Gillet, EPFL President P. Aebischer.

" Nano-Tera.ch has provided new and important research opportunities as an instrument for application oriented collaboration in engineering that did not exist before, and that foster very challenging systems engineering projects. The panel is impressed and pleased about the current state and progress of the program. The projects demonstrate that collaboration of leading scientists is effective and essential to break new grounds for large technical and societal challenges. It forces scientists to think about how to integrate their scientific findings in such a manner that it can be used for industrial applications. The program has supported the shift in the mindset from individualistic towards multidisciplinary and cross-disciplinary research."

The SNF Evaluation Panel

" The presence of numerous prototypes and demonstrators was considered as a tangible sign that the program truly managed to focus on concrete collaborative research leading to potentially exploitable results. The increased presence in the phase 2 RTD projects of teams coming from University hospitals clearly illustrates the strong involvment of medical end-users, able to carry out valuable clinical trials for the evaluation of the results generated by these projects in health related domains."

The Nano-Tera.ch Scientific Advisory Board

Nano-Tera.ch is a Swiss national program supporting research in multi-scale system engineering for health, security, energy and the environment. The broad objectives of the program are to improve quality of life and security of people and to create innovative products, technologies and manufacturing methods, thus resulting in job and revenue creation.

Launched officially in February 2008, with the first projects starting in March 2009, Nano-Tera.ch is a strongly established program that has funded 77 research projects in its first phase for a total budget of about 123 MCHF. These projects have been carried out by consortia of 3 to 9 research groups from various Swiss institutions (Federal Institutes of Technology, Universities, Universities of Applied Sciences, etc.). The resulting Nano-Tera.ch research community is currently building a network of 31 Swiss research institutions and involves about 700 researchers.

At the scientific level, the research funded has produced about 740 publications and almost 1300 presentations at conferences and workshops worldwide, as well as several presentations in general public media (television, radio, press). A total of 37 awards have been received by Nano-Tera.ch researchers. The scientific results have been showcased at the 2013 edition of the Nano-Tera.ch Annual Meeting, where the presence of numerous prototypes and demonstrators was a tangible sign that the program truly managed to focus on concrete collaborative research leading to potentially exploitable results.

To further strengthen the impact of the program, the Nano-Tera.ch Executive Committee has launched five strategic actions. Three topical actions focus respectively on the setup of industrial test-beds for research on smart energy systems, on the promotion of user involvement in the domain of pervasive health systems and on the detailed analysis of the reliability/usability of sensor generated data. Two transversal actions aim at promoting international collaborations on one hand and technological transfer toward the industry on the other hand.

On the international scene, Nano-Tera.ch has strengthened its ties with South Korea via the organization of a joint Swiss-Korean workshop, has launched an International Exchange Program with the invitation of two prominent scientists who made a series of talks in various institutions involved in the program and has continued to provide visibility to its research with booths at large conferences.

From an industrial perspective, most of the running RTD projects receive support from industrial partners: 30 such partners are involved in the 27 RTD / RTD add-on projects, providing more than 6.6 MCHF of in-cash and in-kind contributions. Furthermore, 24 patent applications have been filed so far.

The Nano-Tera.ch website (www.nano-tera.ch) represents one of the main dissemination channels for the program: during the current reporting period, it has received over 100,000 page views from more than 140 countries.

Nano-Tera.ch has now entered its second phase (2013-2016). In this context, 3 new calls for proposals have been launched in 2011, 2012 and 2013. These calls have led to the selection of 6, 12 and 7 new RTD projects, respectively, all starting in 2013. The program is keeping its topical focus on health and the environment and takes advantage of its momentum to pursue its main objectives: excellence in collaborative research in engineering disciplines, educational programs, design of applied demonstrators, and transfer of acquired research results to the Swiss industry. What is new is the arrival of research topics combining engineering with life sciences, medicine and energy. In addition to RTD projects, Nano-Tera.ch also launched new calls for NTF projects, leading to the submission of 37 proposals, out of which 9 have been selected for funding by an international panel of experts.

The objective of the Nano-Tera.ch program is to support research, design and engineering of complex systems and networks using micro/nano-technologies. More precisely, the program aims at identifying and fostering potential synergies between micro/nano component technology (the "nano" part) and large-scale system design (the "tera" part) to meet the growing need for complex engineered solutions to socially relevant issues related to Health, Security, Environment, and Energy. Examples of such issues are detecting in real time different health risks and conditions through integrated bio probing, revealing security risks through smart buildings and environments, continuous ambient sensing through low/zero-power electronics, or detecting and monitoring environmental hazards such as floods or avalanches. Embodiments of such solutions will typically take the form of lightweight, mobile and personalized products embedded in the environment and on/in the human body.

To meet these objectives, Nano-Tera.ch supports three types of projects:

Research, Technology and Development (RTD) projects, representing about 80% of the Nano-Tera.ch activities, are large integrated, interdisciplinary research projects involving a collaboration between two (or more) research groups, preferably from different institutions. RTD projects typically focus either on the in-depth study of a particular vertical technology or on the development and implementation of a horizontal application area. The expected duration of RTD projects is 3 or 4 years, with total budgets in the range of 1-2 MCHF/year.

Nano-Tera Focused (NTF) projects are small-scale research projects addressing specific scientific/technical issues and needs. Their typical duration ranges from one to two years, with total funding of around 100-200 kCHF.

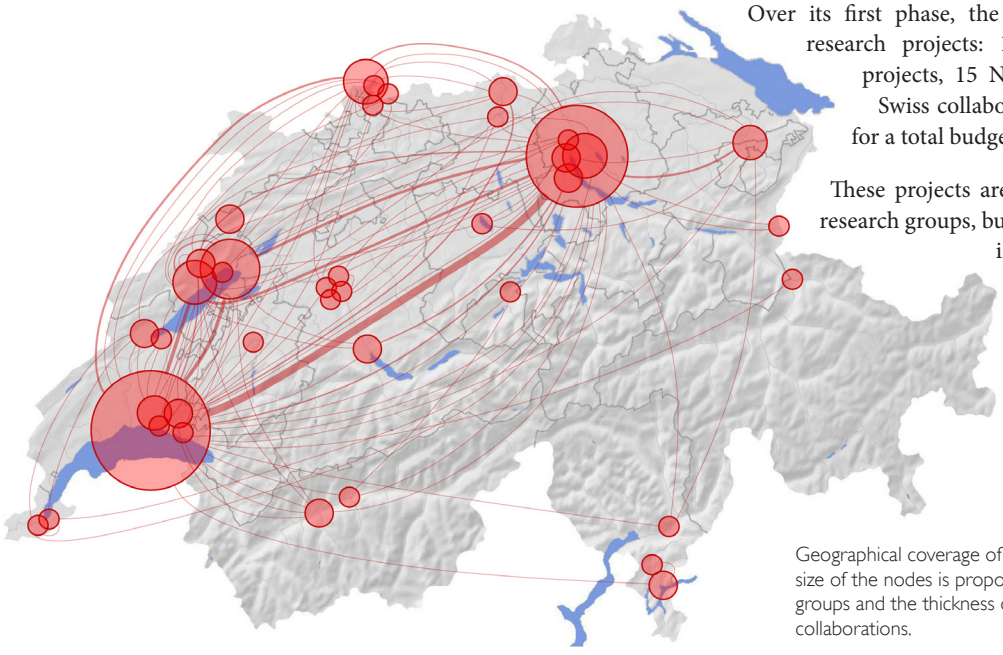
Education and Dissemination (ED) activities correspond to actions aiming at supporting short courses, workshops, mini-conferences, and developing new curricula in domains covered by Nano-Tera.ch that are not provided by Swiss Universities or Polytechnics. ED activities may address the in-depth study of a technology or interdisciplinary horizontal activities, and their typical funding level is in the range of 15-30 kCHF.

The Nano-Tera.ch program is funded by the Swiss Polytechnic and University Boards (ETH Board and CUS), under the supervision of the Swiss Secretary of Education and Research (SER). The Swiss National Science Foundation (SNSF) evaluates and monitors Nano-Tera.ch research projects through an international panel of experts.

Overall Results, Phase I (2008-2012)

Over its first phase, the Nano-Tera.ch program funded 77 research projects: 19 RTD projects, 8 RTD add-on projects, 15 NTF projects, 6 Nano-Tera.ch Sino–Swiss collaboration projects and 29 ED activities, for a total budget of about 123 million Swiss francs.

These projects are carried out by consortia of 3 to 9 research groups, building a network of 31 Swiss research institutions, involving more than 700 staff members. As illustrated by the map, this network represents a very dense geographical coverage of Swiss research institutions.



Geographical coverage of the Nano-Tera.ch program, Phase I. The size of the nodes is proportional to the number of involved research groups and the thickness of the lines measures the number of collaborations.

Scientific dissemination

Publications

In terms of scientific dissemination, the funded research has generated about **737 publications**. The distribution of the publications by publication type (journals or conference proceedings) is given below.

	Latest reporting period (2013)	TOTAL since beginning of program
Journals, books	96	324
Conf. proceedings	101	413
Total	197	737

Conferences and workshops

Almost **1300 presentations** at conferences and workshops have been given, and the projects have led to several presentations in the media (television, radio, press).

Awards

A total of **37 awards** have been received by Nano-Tera.ch researchers, including 9 in the current reporting period. Of the total, there are 25 best paper/poster awards and 12 awards for personal achievements.

Collaboration with the industry and patents

Most RTD projects receive support from various industrial partners. In total, **30 industrial partners** are involved in the Nano-Tera.ch RTD and RTD add-on projects, for a total of 6.6 MCHF of in-cash and in-kind contributions.

	Number of industrial partners	Nb. of projects with industrial partners
RDT 2009	17	7 (of 10)
RTD 2010	8	5 (of 9)
RTD add-on	5	5 (of 8)
	30	17 (of 27)

Furthermore, **24 patent applications** have been filed for results related to the Nano-Tera.ch RTD and NTF projects.

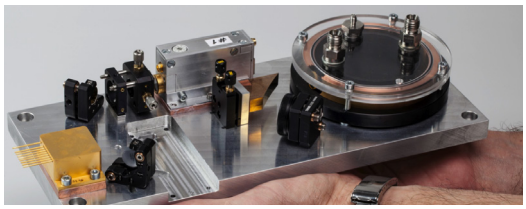
HEALTH MANAGEMENT

Future health management systems require an increasingly large presence of automation, information extraction and elaboration, as well as control of the medical procedures. In this perspective, three major innovation areas have been addressed in the first phase of the Nano-Tera.ch program: biosensing, advanced diagnosis tools, and medical care support.

Biosensing

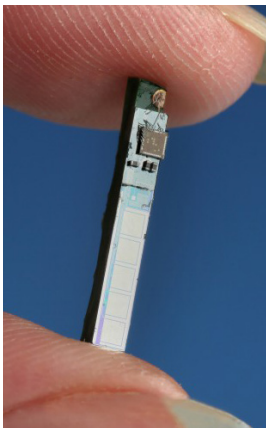
Although some biosensors are already available on the market, there is a strong potential for improvement of the techniques used to perform bio-measurements, for example by exploring novel sensing mechanisms, by using advanced electronic devices and materials, or by tightly coupling electronic sensing to data acquisition chains.

In this perspective, Nano-Tera.ch projects have been exploring different avenues:



Building sensing platforms based on optical near and mid-infrared range spectroscopy that exploit optical absorption properties of the analytes. In such platforms, the sensors probe the vibrational frequencies of molecules present in fluids and gases. A typical example of such an approach is the **IrSens** project that has led to the industrialization of a hydrogen fluoride sensor, a compact instrument measuring CO_2 isotopes with record precision, as well as the first detection of cocaine in saliva using mid-infrared sensing techniques.

Developing modular sensor platforms using silicon nanowire (SiNW) field-effect transistors, interfaced to electronics and microfluidic channels for liquid handling. As illustrated in the **NanowireSensor** project, one of the important advantages of such platforms is that the sensors have the potential to be mass manufactured at reasonable costs, allowing their integration as the active sensor part in electronic point-of-care diagnostic devices.



Health monitoring systems combining networked databases with on-line (i.e. real-time) wearable/implantable monitoring devices represent a true potential for better therapy and increased autonomy of the patients. However, noting that few systems involving on-line biosensing capabilities were available – and often limited to either wearable devices for human telemetry that do not measure any molecular metabolites, or glucose monitoring systems for diabetic patients – it was important to design accurate and affordable biosensing devices able to provide fast response and secure interaction with on/in body electronics, and to detect and quantify multiple compounds in parallel several times a day. This challenge has been tackled by the **i-IronIC** project, which designed an on-line implant for real-time monitoring of various human metabolites (such as lactate, cholesterol, ATP, glutamate, or glucose). The prototype includes a sensor array, a CMOS mixed signal chip and a tridimensional integrated coil for receiving inductive power and transmitting data via backscattering. The sensor array is realized with an innovative technology, where carbon nanotube (CNT)-nanostructured electrodes enable the measurement of metabolites with increased sensitivity and lower detection limits as compared to the state of the art. The results have generated intense international coverage in dozens of media outlets worldwide.

Advanced diagnosis tools

Advanced diagnosis requires the design of new methods for probing the human body, as well as the design of miniaturized (thus portable) diagnosis tools that can be made easily available at points of care. In this perspective, Nano-Tera.ch projects have been focusing on the following challenges:

Designing novel techniques for the diagnosis of human tissues based on micro-mechanical sensing, similar to atomic force microscopy scanning. Indeed, the measurement of nano-mechanical properties of cells and cell-cell interactions as a function of milieu parameters offers unprecedented insights into the tissue structure and is of particular interest in cancer research, where it has been recently shown that stiffness of cancer cells affects the way they spread in the body. The **PATLiSci** project is an example of a Nano-Tera.ch research in this direction: nanomechanical cantilever array sensors have been applied to detect a mutant gene, making it possible to apply personalized therapies for the cure of melanoma.

Building integrated lab-on-a-chip platforms able to monitor and investigate various metabolic functions of the human body. In particular, the **NutriChip** project focused on food digestion with the design of a prototype of an artificial and miniaturized gastrointestinal tract using a minimal set of biomarkers identified through in vivo and in vitro studies. Such a prototype offers novel perspectives for probing the impact on health of dairy food samples, and was tested for the screening and selection of dairy products with specific health-promoting properties.

Developing miniaturized X-ray sources based on multi-walled carbon nanotube (MWCNT) cold-electron emitters. When combined with novel image processing techniques exploiting X-ray time-of-flight measurements (to probe the depth inside objects), as well as the specific pixel structures of both the X-ray source and the X-ray detector, such approaches open very interesting possibilities for the design of portable X-ray systems with fully unprecedented tomographic imaging capabilities. The **Nexray** project is an illustration of such a research track in the Nano-Tera.ch program: the consortium produced pocket X-ray sources with a size of about 0.1 cm^3,

producing X-rays of about 3 keV, as well as detectors involving monolithically integrated Ge absorption layers on a CMOS chip. The main scientific achievement is a breakthrough in epitaxy thick layers of Ge on Si, which made it on the cover page of Science journal and generated ample scientific press coverage.

Medical care support

The general area of monitoring systems for medical care support represents an extremely rich research domain with multiple research directions:

Electronic textiles relying on advanced (electrical/optical) fibers incorporating sensors, signal transmitters and other active nanocomponents. They provide very interesting possibilities for implementing body area networks where both sensing and communication are integrated in the same medium. In this domain, the Nano-Tera.ch **TecInTex** project developed such a technology demonstrator, embodied in an electronic underwear for paraplegic people able to prevent pressure ulcers (which typically occur twice a year for these patients), thus entailing an important reduction of pain and associated health care costs for such patients. Sensorized fabrics were tested on body and on wound model and the components and technology for the near-infrared spectroscopy demonstrator have been approved for the textile integration and clinical testing.

Smart prostheses integrating innovative micro-devices to measure in vivo crucial bio-mechanical parameters of joint prostheses, orthopedic implants, bones and ligaments. For example, the Nano-Tera.ch **SImOS** project designed an implant module including sensors to measure forces, interface frictions, stem micro-motion and impacts to help surgeons with prosthesis alignment and positioning during surgery, detect early migration during rehabilitation, thus potentially avoiding failure due to excessive wear or micro-motion information, and evaluate in vivo joint functions. Such capabilities represent a potentially huge progress in the domain of hip and knee prostheses, since over a million prostheses are currently implanted each year in the EU and the US, with a premature failure rate of about 20% (for people less than 50 years old) translating into a substantial amount of complex and traumatic revision surgeries.

Smart drug delivery based on drug response monitoring through the in vivo measurement of drug concentrations and relevant biomarkers. Indeed, while medical progress is increasingly improving the survival rate and life quality of patients affected by long-lasting diseases (HIV infection, cancers, vital organ failure, etc.), these achievements significantly rely on drug regimens and therapeutic protocols that require long-term daily administration of highly active drugs, for which the huge individual response variability raises severe problems in efficient treatment definition. In this perspective, the Nano-Tera.ch **ISyPeM** project sought to provide advanced technologies for seamless drug monitoring and delivery by an ultra-low power integrated system and it indeed released a set of technologies addressing drug monitoring and automated administration.

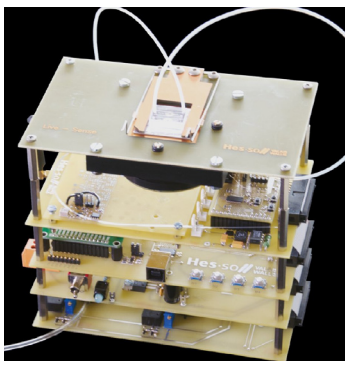
ENVIRONMENTAL MONITORING

Within Nano-Tera.ch first phase (and continuing into its Phase II, see below), the objectives of the research on environmental monitoring included monitoring the quality of air and water, by measuring pollution in terms of biological and/or inorganic compounds; and instrumenting the environment to detect movements that can lead to catastrophes, such as rockslides, avalanches, floods or to the instability of constructions such as buildings and bridges.

Monitoring water pollution

The quality of water is crucial for both developed and developing countries, as it directly affects health and quality of living. The design of efficient, reliable and affordable technologies to measure levels of pollution in fresh waters is therefore an important problem.

In this perspective, Nano-Tera.ch research has been focusing on **environmental sensing based on living cells**. Indeed, living cells are the most natural biosensors, since they integrate the biological effects of the pollutants and respond by metabolic or phenotypic changes that are relevant to potential effects in the human body. More precisely, the general idea behind living cell-based sensors is that cellular responses are measured in real time by secondary probes or sensors integrating optical, chemical or electrical microsensors.



For example, the Nano-Tera.ch **LiveSense** project designed a cell-based sensing platform taking the form of an autonomous, wireless, hand-held system for fluid monitoring. The modular prototype includes a fully functional bioreactor based on genetically modified E. coli cells (HepG2/C3A hepatocytes) and cells derived from human epithelial colorectal adenocarcinoma (C2BBe1 cells), for which storage and culture protocols have been established and sensitivity to various target analytes characterized; as well as various secondary sensors for fluorescence, impedance, and mechanical/trans-epithelial resistance. The prototype (which can be remote controlled with a smart phone) has been validated by characterizing the relation between measured fluorescence intensity and the concentration of arsenic in the analyzed water sample. In addition, label-free techniques to distinguish healthy, sick and dead cells have been designed, making it possible to detect cellular changes long before cellular death, thus offering a high sensitivity in comparison with conventional viability assays.

Monitoring air pollution

Wireless sensor networks publishing sensor data on the Internet bear the potential to substantially increase public awareness as well as involvement in environmental sustainability. Air pollution monitoring in urban areas is a prime example of such an application, as air pollutants have a direct effect on human health.

The Nano-Tera.ch **OpenSense** project is an example of research on air pollution monitoring. It focused on the design of a network of mobile air pollution sensors with intermittent GPRS connectivity, deployed on top of public buses in the city of Lausanne and on top of trams in the city of Zurich (where ten sensor boxes on trams have been deployed, monitoring a wide range of pollutants on an area of 100 km^2). The prototype sensor network is operational and provides valuable insights on sensor capabilities and behaviors in realistic environments. The generated network and air pollution data have been used for the various modeling tasks (mobility, air pollution, etc) and the resulting models in turn serve for generating numerical input that can be used for efficient signal processing and machine learning. Different modeling methods were used to produce high quality and fine-grained pollution maps. In addition, a collaboration with the Nokia Research Center in Lausanne led to the setup of user studies that clearly demonstrated both the public interest for air pollution data and the commercial potential of the developed technology. The dimension of crowdsourcing is being addressed in a project follow-up (see below).

Monitoring rock and glacier movements

Global climate change dramatically influences the visual appearance of mountain areas like the European Alps, and may trigger or intensify destructive geological processes that impact the stability of slopes, thus posing a threat to local communities.

In this perspective, research in Nano-Tera.ch has been focusing on the development of wireless sensing technologies for environmental sensing under extreme environmental conditions (temperature, humidity, mechanical forces, snow coverage, etc). In particular, in the Nano-Tera.ch **X-Sense** project, various rugged electronic chips have been built to install more than 50 sensors in the Mattertal area of Switzerland. The corresponding prototype of wireless sensor network and GPS data processing framework has been deployed with improved system reliability and data quality derived from model-based design principles. The full pipeline from GPS and image sensors to the data-base servers has been established and thoroughly tested. New algorithms have been developed and applied that lead to high precision sensing, high data quality by means of network tomography and highly robust processing and communication in extreme environments. The installation has been in operation for over 4 years: this continuous operation period as well as the corresponding data quality is unique. As a result, many new scientific results in the area of geoscience have been made possible. They help us understand the complex geophysical processes in permafrost regions and the destructive processes due to global warming. Currently, hardware and software are built and transferred to the Federal Office for the Environment for early warning purposes. Further field sites are envisioned for the next year. It was therefore shown that wireless sensor network technology makes it possible to quantify mountain phenomena, and can be used for safety critical applications in a hostile environment.

ENABLING TECHNOLOGIES

In some cases, research and development may impact several areas in the health and environment domains, and some of the Nano-Tera.ch projects have therefore been focusing on generic enabling technologies.

For example, the Nano-Tera.ch **MIXSEL** project has been investigating the use of laser sources to create short pulses that can support microscopy and optical tomography. Similarly, the **CabTuRes** project studied new materials, such as carbon nanotubes (CNTs),using them as resonators for electronics applications as well as mass balances for sensing.

Heat management in high-performance multi-processing systems, realized as 3-Dimensional Integrated Circuits is another generic track of research, and, in this domain, the Nano-Tera.ch **CMOSAIC** project combined competencies in thermodynamics, mechanics of materials, and dynamic power management to design liquid cooling techniques specifically tailored for 3D chips.

On the other side of the spectrum, research in Nano-Tera.ch also concentrates on low-power electronic systems, and specifically autonomous systems, that are crucial for both health and environment applications. In this perspective, the Nano-Tera.ch **PlaCiTUS** project focused on the design of a generic technology platform that can be used to deploy biomedical wireless sensor networks. Such a platform typically consists of many sensors and actuators connected together and to the outside world, through a short range wireless network, and interfaced with micro-power data acquisition and driver circuits supplied either by battery or by inductively coupled remote power.

Another critical issue is the manufacturing of integrated nano-systems consisting of large numbers of connected nano-devices. The Nano-Tera.ch **SelfSys** project studied fluid-mediated self-assembly techniques to lower manufacturing costs and enable the assembly of structures with unprecedented complexity.

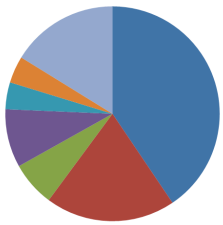
In the security domain, the Nano-Tera.ch **QCrypt** project improved secret key distribution and message encryption based on the fundamental properties of quantum physics (Quantum Key Distribution). The team has built a complete, working prototype with unprecedented real time hardware key distillation, finite key security analyses and fully automated operation over a single fibre using wavelength division multiplexing. On the encryption side, error-free data encryption at 40 Gbit/s with 100% throughput was demonstrated.

Finally, in the energy domain, the **GreenPower** project developed cost-effective membranes for H_2-O_2 fuel cells suitable for mobility applications based on the conversion of solar energy into hydrogen and oxygen. A demonstrator of a self-sensing composite vessel for high pressure storage was produced. Belenos car and boat demonstrators accomplished one year test under real drive and navigation conditions.

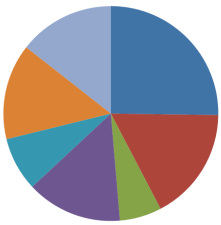
Phase I RTD projects, 2009-2013

CabTuRes	Enabling autonomous sensor nodes: low-power nano-sensor/electronics building blocks based on tunable carbon nanotube electro-mechanical resonators	Prof. Christofer Hierold ETHZ
CMOSAIC	3D stacked architectures with interlayer cooling	Prof. John Thome EPFL
GreenPower	Connecting renewable energy to green mobility using hydrogen as energy carrier	Prof. Jan-Anders Månson EPFL
i-IronIC	Implantable/wearable system for on-line monitoring of human metabolic conditions	Prof. Giovanni De Micheli EPFL
IrSens	Integrated sensing platform for gases and liquids in the near and mid-infrared range	Prof. Jérôme Faist ETHZ
ISyPeM	Intelligent integrated systems for personalized medicine	Prof. Carlotta Guiducci EPFL
LiveSense	Cell-based sensing microsystem	Prof. Philippe Renaud EPFL
MIXSEL	Vertical integration of ultrafast semiconductor lasers for wafer-scale mass production	Prof. Ursula Keller ETHZ
NanowireSensor	Integrateable silicon nanowire sensor platform	Prof. Christian Schönenberger UniBas
Nexray	Network of integrated miniaturized X-ray systems operating in complex environments	Dr. Alex Dommann CSEM
NutriChip	A technological platform for nutrition analysis to promote healthy food	Prof. Martin Gijs EPFL
OpenSense	Open sensor networks for air quality monitoring	Prof. Karl Aberer EPFL
PATLiSci	Probe array technology for life science applications	Dr. Harry Heinzelmann CSEM
PlaCiTUS	Platform circuit technology underlying heterogeneous nano and tera systems	Prof. Qiuting Huang ETHZ
QCrypt	Secure high-speed communication based on quantum key distribution	Prof. Nicolas Gisin UniGE
SelfSys	Fluidic-mediated self-assembly for hybrid functional micro/nanosystems	Prof. Jürgen Brugger EPFL
SImOS	Smart implants for orthopaedics surgery	Prof. Peter Ryser EPFL
TecInTex	Technology integration into textiles: empowering health	Prof. Gerhard Tröster ETHZ
X-Sense	Monitoring alpine mass movements at multiple scales	Prof. Lothar Thiele ETHZ

Partner distribution by institution



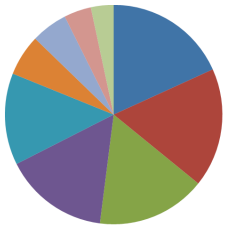
Phase I



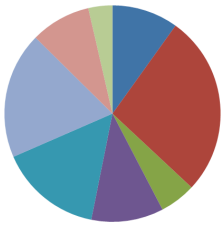
Phase II

- EPFL
- ETHZ
- Other ETH Board
- University
- Uni. of Applied Scn
- Hospital
- Other

Partner distribution by discipline



Phase I



Phase II

- Electronic & Optical Systems
- Bioengineering & Life Sciences
- Microengineering
- Information & Communication Systems
- Electrical Engineering
- Fundamental Sciences
- Medicine
- Energy
- Environment

Nano-Tera.ch is now integrating 25 new collaborative 3- and 4-year research projects, uniting teams right across Switzerland. The theme of health features strongly among the research subjects selected, with strong participation from university hospitals and doctors. For the first time, the theme of energy is also taking pride of place.

As with previous calls for proposals, the key domains of Nano-Tera.ch (Bioengineering and Electronics) are well represented in this selection. What is new is the arrival of research topics combining engineering with life sciences, medicine and energy.

HOSPITALS AND DOCTORS AT THE SERVICE OF TECHNOLOGY

While it is still true that the giants of Swiss research - the Federal Institutes of Technology and the Universities - provide the big players in Nano-Tera.ch, the university hospitals and the specialists that thrive there, such as specialized surgeons, neurologists and cardiologists, are taking an ever greater part in the program. These specialists represent 18% of the co-investigators for the newly accepted projects. The CHUV, the InselSpital of Bern, the University Children's Hospital in Zurich, the University Hospitals of Basel and Zurich and the Hospitals of Schaffhausen will all be bringing the benefit of their expertise to the research of the Nano-Tera.ch program.

Smart prosthetics and body repair

Among the themes to be explored will be image-guided micro surgery for hearing aid implantation (**HearRestore**), the refinement of spinal cord repair techniques using components that combine CMOS and polymers - allowing victims of paraplegia to recover partial mobility (**SpineRepair**), and a study of the use of superparamagnetic nanoparticles for the treatment of various forms of cancer (**MagnetoTheranostics**). The area of body repair is also central when it comes to building smart muscles for incontinence treatment (**SmartSphincter**) or when it comes to providing a non-invasive solution for restoration of a natural sensation of touch by embedding miniature tactility sensors into the cosmetic silicone coating of prostheses, which acts like a sensory "skin" (**WiseSkin**).

These projects require strong collaboration between medics and scientific researchers.

Health monitoring

Like in the initial phase of Nano-Tera.ch, the area of health monitoring and personalized health management is well covered, with several projects addressing different research avenues, be it portable sensors for the effective monitoring of obesity (**ObeSense**) or vision sensors for the monitoring of newborn babies (**NewbornCare**), as well as textile-integrated sensors for non-invasive wound monitoring (**FlusiTex**).

Medical platforms

In this new phase, Nano-Tera.ch will be developing several medical platforms, notably a next-generation, high-quality, mobile ultrasound imaging device (**UltraSoundToGo**) and elastic, lightweight MRI detectors that patients can wear like a piece of clothing (**WearableMRI**).

Applications targeting specific diseases are envisaged: early diagnostic tools for Alzheimer's disease and childhood epilepsy will involve smart, energy aware, user friendly wearable sensors whose power derives from the user's body energy (heat and motion) as well as from ambient light (**BodyPoweredSenSE**). Early diagnostic tools for breast cancer and melanoma will involve highly parallelized mechanical sensors to investigate biopsy sensors in a fast and reliable way (**PATLiSci II**).

A CRUCIAL MATTER: THE MANAGEMENT OF ENERGY

The theme of energy has taken on a whole new dimension in Nano-Tera.ch this year. In the past, the research being funded related mostly to ultra-low power microchip or systems. However, crucial problems such as the intelligent management of energy and the production of renewable energy will now feature in the program. For example, scientists will apply themselves to the task of producing hydrogen from water and sunlight (**SHINE**), or managing a smart power grid, using the EPFL campus as a testing ground (**SmartGrid**).

Research at the level of the data center is obviously also essential: in order to curb the trend of increasing power consumption, radically new thermal-aware approaches will be explored in order to develop next-generation energy-efficient data centers (**YINS**).

A RENEWED FOCUS ON ENVIRONMENTAL MONITORING WITH FURTHER CHALLENGES

Given the importance of environmental monitoring, several projects from Nano-Tera.ch's initial phase are extended into the second phase with new directions. OpenSense was developing open sensor networks for provide accurate, real-time information about air, and it's follow-up project (**OpenSense II**) will add the dimension of crowdsourcing and human-centric computation to acquire new information and provide feedback to users. The alpine monitoring system developed in X-Sense will be extended with its **X-Sense II** follow-up by using MEMS acoustic detectors for natural hazard warning systems.

The environmental dimension can also be a new dimension added to a past project. While IrSens developed a sensing platform for liquid and gases using near and mid-infrared spectroscopy to measure cocaine concentration in saliva and CO_2 isotope ratios in air, **IrSens II** intends to go several steps further by realizing new tools for gas monitoring, specifically analyzing nitrogen dioxide as well as major air pollutants and greenhouse gases.

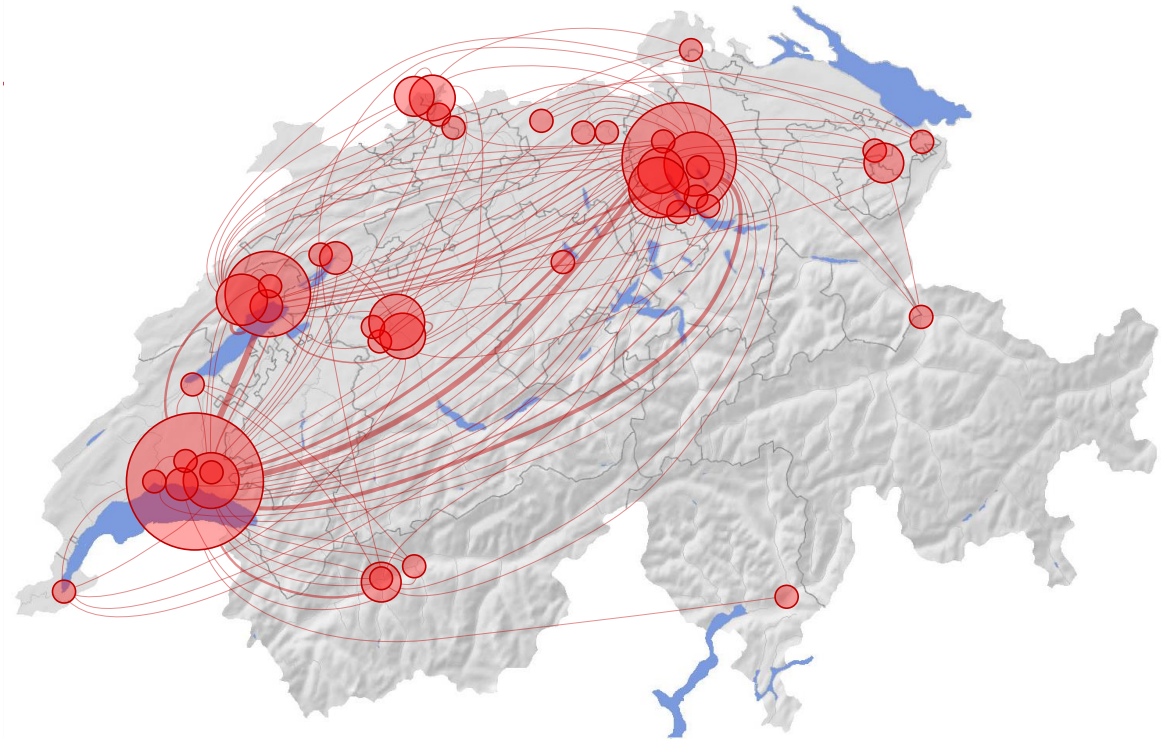
THE SUCCESS OF NANO-TERA.CH IN NUMBERS

Analysis of the projects accepted by the Swiss National Science Foundation clearly shows the success of the Nano-Tera.ch program. The excellent geographical spread across Switzerland of the 159 research partners involved in the 25 RTD projects shows its country-wide participation while the distribution by discipline and by institution, clearly underlines the collaborative and multidisciplinary character of Nano-Tera.ch. Also noteworthy is the presence of several dozen industrial partners within the new projects.

NANO-TERA FOCUSED PROJECTS COMPLETE THE PICTURE

In addition to these 25 large-scale multi-disciplinary RTD projects, Nano-Tera.ch also funds the smaller NTF projects (Nano-Tera Focused) addressing specific aspects. The evaluation, conducted by an international panel of experts, has led to the selection of 9 NTF projects.

Some projects involve smart textiles (3D large-scale integration into smart textiles, or novel textiles for non-invasive monitoring of pressure and oxygenation of tissue), others address different aspects of health monitoring, from night monitoring of blood pressure, to diabetes non-invasive activity monitoring, among others.



Geographical coverage of the Nano-Tera.ch program, Phase II. The size of the nodes is proportional to the number of involved research groups and the thickness of the lines measures the number of collaborations.

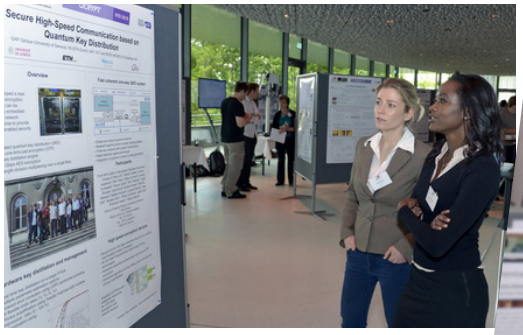
PHASE II LAUNCH EVENT

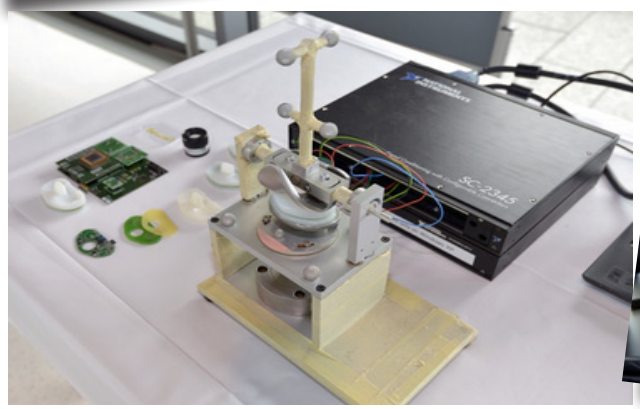
A kick-off event was organized on March 15th, 2013 to formally launch the new 2013-2017 RTD projects and welcome the new principal investigators into the Nano-Tera.ch community. The event took place in Bern in the presence of the Nano-Tera.ch Steering Committee, SNSF (including SNSF President Prof. Martin Vetterli) and Dr. Gregor Haefliger (SERI).

Phase II projects, 2013-2017

BodyPoweredSenSE	Wearable ICT for Zero Power medical Applications	Prof. Pierre-André Farine EPFL
Envirobot	Automated surveying of surface water quality by a physical, chemical and biological sensor equipped anguilliform robot	Prof. Jan van der Meer UNIL
FlusiTex	Fabrication of fluorescence sensors integrated into a textile dressing for non-invasive lifetime based wound monitoring	Prof. Bradley Nelson ETHZ
HearRestore	Image-guided micro surgery for hearing aid implantation	Prof. Stefan Weber UniBE
HeatReserves	Demand Response for Ancillary Services: Thermal Storage Control	Prof. John Lygeros ETHZ
IcySoC	Inexact Sub-Near-threshold System for Ultra-Low Power Devices	Prof. Christian Piguet CSEM
IrSens II *	A multi-component sensor for air pollutants and greenhouse gases	Prof. Jérôme Faist ETHZ
ISyPeM II *	Therapeutic drug monitoring for Personalized medicine	Prof. Carlotta Guiducci EPFL
MagnetoTheranostics	From Superparamagnetic Nano-particles until Tools for Detection and Treatment of cancer	Prof. Heinrich Hofmann EPFL
MIXSEL II *	Novel semiconductor disk lasers for biomedical and metrology applications	Prof. Ursula Keller ETHZ
NewbornCare	Newborn Monitoring based on multiple vision sensors	Prof. Pierre Vandergheynst EPFL
ObeSense	Monitoring the Consequences of Obesity	Prof. Jean-Philippe Thiran EPFL
OpenSense II *	Crowdsourcing High-Resolution Air Quality Sensing	Prof. Alcherio Martinoli EPFL
PATLiSci II *	Rapid Sensing of Cancer	Prof. Ernst Meyer UniBas
SHINE	Solar Hydrogen Integrated Nano Electrolysis	Prof. Christophe Moser EPFL
SmartGrid	Smart grids, Smart buildings and Smart sensors for Optimized and Secure Management of Electricity Distribution using dedicated microelectronic ICs and real time ICT	Prof. Maher Kayal EPFL
SmartSphincter	Smart muscles for incontinence treatment	Prof. Bert Müller UniBas
SpineRepair	Hybrid CMOS-polymer neural interfaces for restoration of sensorimotor functions after spinal cord injury	Prof. Stéphanie Lacour EPFL
Synergy	Systems for ultra-high performance photovoltaic energy harvesting	Prof. Christophe Ballif EPFL
UltraSoundToGo	High performance portable 3D ultrasound platform	Prof. Giovanni De Micheli EPFL
WearableMRI	Wearable MRI detector and sensor arrays	Prof. Klaas Prüssmann ETHZ
WearMeSoC	Multi Functional Wearable Wireless Medical Monitoring Based on A Multi Channel Data Acquisition and Communication Management System on a Chip	Prof. Qiuting Huang ETHZ
WiseSkin	Wise Skin for tactile prosthetics	Dr. John Farserotu CSEM
X-Sense II *	MEMS acoustic detectors for natural hazard warning systems	Prof. Lothar Thiele ETHZ
YINS	Energy-and thermal-aware design of many-core heterogeneous datacenters	Prof. David Atienza EPFL

* Follow-ups of Phase I projects





Nano-Tera.ch Annual Plenary Meeting 2013

NANO-TERA.CH ANNUAL PLENARY MEETING 2013

The 4th Annual Plenary Meeting of Nano-Tera.ch was held in Bern, on May 30-31, 2013, and was a large success thanks to the active participation of all principal investigators, senior scientists and PhD students involved in the projects. This year, 250 participants were present at the event.

The two-day meeting featured 2 keynote presentations. The first keynote was by Matthias Kaiserswerth, Director of Research of the IBM Zurich Research Laboratory with a presentation entitled "IMB Innovations in Nanoscience: Made in Switzerland". The second keynote was by Samuel Rutz, Vice-director of Avenir Suisse with a presention entitled "From University to Industry". Both keynotes generated a large interest in the audience.

The 2013 edition of the Nano-Tera.ch Annual Meeting was especially noticeable as it showcased the final results of the first wave of research projects that have been funded by the Nano-Tera.ch program for the last 3-4 years. This year, each project could benefit from a dedicated area where a video presentation could be shown, and a concrete demonstrator exhibited, alongside the posters, thus giving the participants a good overview of the major program achievements.

A record number of 141 posters have been presented by researchers involved. To promote this dissemination activity, Nano-Tera.ch organized, as in 2011, a best poster competition. All posters presented were evaluated by a jury that ranked the three most outstanding ones, based on their scientific excellence and their ability to present the results in a way that can be understood and appreciated outside their specific research community.

Almost all projects provided a short video contribution, displayed on large screens provided by Nano-Tera.ch. Similarly to the best poster award, Nano-Tera.ch also organized a competition for best video presentations. The quality of each video was evaluated by a jury.

Most importantly, the concrete prototypes exhibition was the more striking feature of this annual meeting edition. The presence of physical demonstrators could show the great achievements of each project.

Examples of demonstrators included:

- A 3D integrated circuit demonstrator with vertical inter-layer electrical connections and integrated two-phase cooling (CMOSAIC)
- A prototype for the detection of CO2, based on quantum cascade lasers and detectors (IrSens)
- A platform for measuring pollutants in rivers based on the reaction of living cells (LiveSense)
- A knee prosthesis integrating small sensors allowing physicians to detect potential problems (SImOS)
- Smart textile demonstrator for paraplegic people (TecInTex)
- A car functioning with hydrogen, as well as an example of a hydrogen storage vessel (GreenPower)
- A pollution sensor box mounted on an electrical car, and demonstration of a sensor mounted on an electrical train, as part of the project seeking to map urban pollution based on mobile sensors (OpenSense)

In short, as stated by the Nano-Tera.ch Scientific Advisory Board, "the presence of numerous prototypes and demonstrators was considered as a tangible sign that the program truly managed to focus on concrete collaborative research leading to potentially exploitable results. The high level of the research carried out in the various RTD projects was illustrated through multiple presentations and posters, and well substantiated by the strong overall publication records of the teams involved in the projects."

Let us also note the presence of Prof. Francesco Profumo, formerly president of the Italian National Research Council (CNR), rector of the Politecnico di Torino and Italian minister of Education, University and Research (pictured below).

Nano-tera.ch website

The Nano-Tera.ch website (www.nano-tera.ch) represents one of the main dissemination channels for the Nano-Tera.ch program. The new website launched for Nano-Tera.ch in June 2012 was successful as it received 10% more visits and 15% more page views than last year over the same time span.

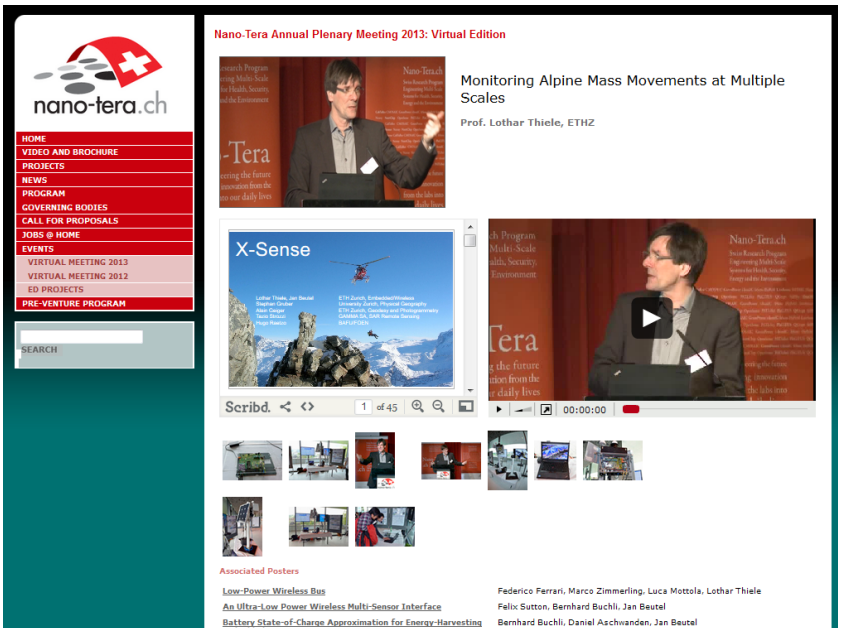
During the current reporting period, Nano-Tera.ch received more than 100,000 page views corresponding to over 31'000 visits, from 141 countries. Almost half of the visitors originated from outside Switzerland.

General view of the Nano-Tera.ch homepage

www.nano-tera.ch

Virtual annual meeting

like last year, all the content of the annual meeting 2013 has been made available online. The videos of all the presentations as well as the posters can be browsed via a virtual meeting platform (http://www.nano-tera.ch/events/virtual2013.html)



Nano-Tera.ch virtual annual meeting platform

Videos

Nano-Tera.ch has produced professional promotional videos to showcase the key achievements of several projects. A 9-minute video provides an overview of the program and its highlights and is a perfect tool for presenting Nano-Tera.ch in a concise manner. In addition, a number of smaller 2-minute videos on specific projects have been produced, currently including i-IronIC, OpenSense, SImOS, TecInTex and X-Sense.

Snapshots of the general Nano-Tera.ch video as well as the i-IronIC, OpenSense and X-Sense project videos.

Images from the 4th Korean-Swiss Science Days held at EPFL in May 2013.

SWITZERLAND-KOREA JOINT WORKSHOPS

Following the success of the Sino-Swiss collaboration, the Nano-Tera.ch Executive Committee has started to discuss a new international program with South Korea. In particular, close ties have been built with Korean researchers on the occasion of the 4th Korean-Swiss Science Days which took place at EPFL on May 6-8, 2013 and were a big success. The Science Days have been held yearly alternating in Korea and Switzerland since 2010 and are an integral part of the bilateral Korean-Swiss Science and Technology Program. This year's edition was jointly organized by EPFL's International Relations, Nano-Tera.ch (responsible for the scientific content) and ETH Zurich as the Swiss Leading House. The Science Days were financed with a conference grant from Nano-Tera.ch and from the bilateral program through ETH Zurich and the Korean National Research Foundation (NRF). 75 participants from Korea and Switzerland registered and 17 posters were displayed.

The Science Days opened directly with a highlight, the welcome dinner at the Korean Ambassador's Mr. YoungHan Bae Residence in Bern on May 6. The two following days saw a series of lectures within four key topics: 1) bio-sensing and health management, 2) energy-aware electronics, 3) architectures and networks for the Internet of things, and 4) emerging devices. Key note speeches were given by Prof. Lothar Thiele from ETH Zurich and Prof. Chong-Min Kyung from the Korea Advanced Institute of Science and Technology (KAIST). The other talks included outstanding speakers from EPFL, ETH Zurich and CSEM on the Swiss side and from KAIST, Seoul National University (SNU) and Yonsei University on the Korean side. Speakers from LG Electronics Ltd and Samsung Advanced Institute of Technology (SAIT) complemented the program from the private industry perspective. A presentation by Dr. Jean-Luc Barras from the Swiss National Science Foundation gave an insight into the available grants and instruments for cooperation between Korea and Switzerland. He emphasized that funding is heavily dependent on the demand voiced by researchers and that new instruments can be specifically designed to match the needs.

The purpose of the Science Days to increase scientific collaboration between the two countries was clearly met, in particular because of the match of interests between the Nano-Tera.ch and the Korean scientists. The lively discussions after the talks and during the social spaces demonstrated the large interest in each other's research, and representatives from KAIST offered to host the next Sciences Days in 2014 at their institution. Several Korean participants also visited EPFL laboratories after the symposium to discuss cooperation opportunities. Prof. De Micheli from Nano-Tera.ch reported an invitation of the Swiss scientists to the annual symposium of the Center for Integrated Smarter Sensors (CISS) in October 2013 in Korea led by Prof. Chong Min Kyung of KAIST. During the symposium, they will discuss further cooperation to create a win-win situation. Nano-Tera.ch also suggested the creation of a broader collaborative research ecosystem with Korea and possible topics for the joint research agenda between the countries.

In conclusion, the Science Days were a high level event that also attracted many Swiss researchers from various institutions including the Universities of Applied Sciences to participate. They also provided a platform for students to present their research to the Korean partners. Unfortunately, the participation of Korean students was only marginal despite the offered travel grants, it is hoped that it will be easier to include them in a next edition of the Science Days in Korea.

Following this successful event, Nano-Tera.ch participated in a joint workshop hosted by the Center for Integrated Smart Sensors (CISS) at the Korea Advanced Institute of Science and Technology (KAIST), which took place on October 17-18, 2013.

The invited Nano-Tera.ch delegation consisted of Prof. Giovanni De Micheli, Dr. Martin Rajman, Prof. Karl Aberer, Prof. David Atienza, Prof. Yusuf Leblebici and Prof. Peter Ryser of EPFL, as well as Prof. Luca Benini and Prof. Qiuting Huang of ETHZ. The Swiss researchers and their Korean counterparts (including Prof. Byeong Guk Park of SNU, Prof. Hoi-Jun Yoo of KAIST) delivered presentations on topics such as smart healthcare, biosensing or sensing architectures.

The workshop was a good opportunity to strengthen partnership between Nano-Tera.ch and CISS and hold comprehensive discussions on the future of next generation smart sensors, including advanced implantable biosensors, mobile sensor networks and low-power sensors for applications such as ECG monitoring.

NANO-TERA.CH PRESENCE IN INTERNATIONAL CONFERENCES

Nano-Tera.ch was present with booths at several conferences which are major events in the fields covered by the program. Notably, the research and projects were presented at MEMS 2013 (Taipei), DATE 2013 (Grenoble) and the joint Transducers/Eurosensors 2013 conference (Barcelona).

Furthermore, oral presentations about the Nano-Tera.ch program have been made to several foreign delegations (Chinese and Taiwanese, in particular), in the context of scientific or industrial workshops (e.g. the Europe-Japan Opening of LIMMS), in addition to the joint Switzerland-Korea Symposium.

Example of Nano-Tera.ch booth

Presentations delivered by Prof. Giovanni De Micheli and Dr. Patrick Mayor

Swiss Research Program Nano-Tera.ch

Engineering Multi-Scale Systems for Health, Security, Energy and the Environment

nano-tera.ch

Prof. Giovanni De Micheli
Nano-Tera.ch Program Leader

A successful funding program

2008-2012

77 research projects funded • **130,000,000** US$ total budget

700 researchers • **180** PhD students

750 publications • **1,300** presentations worldwide • **37** awards

2013-2016

41 new research projects • **100,000,000** US$ total budget

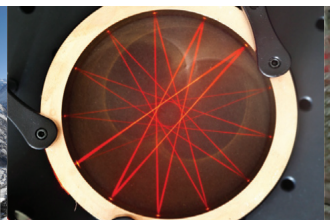
Taking nanotechnology from the labs into our daily lives

Concrete results: from environmental monitoring to intelligent textiles

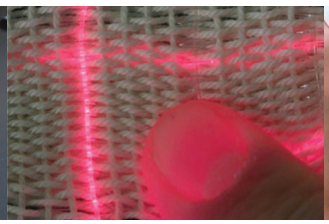
Nano-Tera.ch has achieved outstanding results in the areas of biosensing, design of medical implants and diagnosis tools, and monitoring systems for the environment. Success stories include:

- ✓ sensors for biomarkers in the bloodstream
- ✓ wearable ECG with wireless data transmission
- ✓ electro-optical textiles for monitoring skin ulcers
- ✓ 3-dimensional integrated circuits with fluidic cooling
- ✓ networked rock-displacement detectors to protect against rockslides

Monitoring alpine mass movements at multiple scales

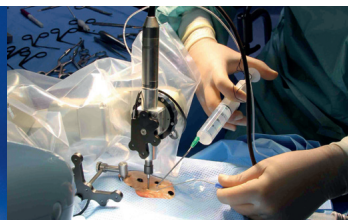


Optical sensing platform to detect doping agents in saliva



Smart sensor-equipped textiles, able to monitor tissue oxygenation

Real-time ECG device, for example in the context of obesity monitoring



Novel surgical platform for minimally invasive interventions in the ear

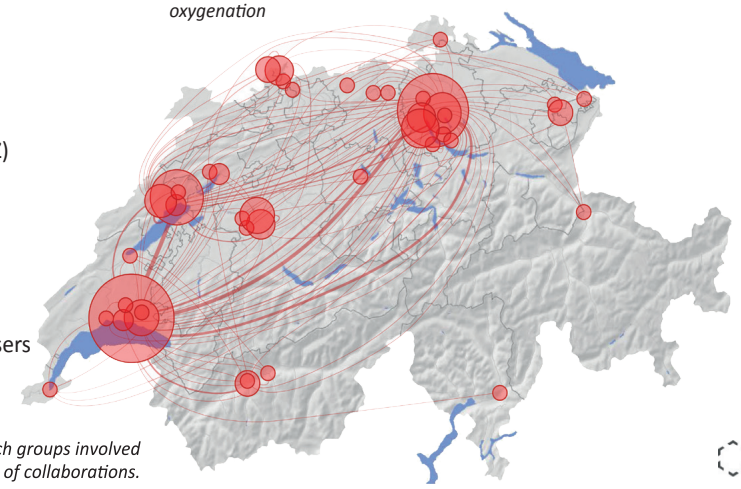
A dense research network

50 Swiss research institutions

- ✓ the two Swiss Polytechnics (EPFL, ETHZ)
- ✓ 9 universities
- ✓ 5 universities of applied sciences
- ✓ 6 university hospitals
- ✓ many other public or private partners

61 industrial partners and hospital end-users

- ✓ additional funding of 15,000,000 US$
- ✓ 24 patents filed



The nodes indicate the number of research groups involved and the links the number of collaborations.

Monitored by the Swiss National Science Foundation
Funded by the ETH Board and the Swiss University Conference
Under the general supervision of the Swiss State Secretariat for Education and Research

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ETH BOARD SUK·CUS

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CONCLUSION OF THE SINO-SWISS JOINT PROJECTS

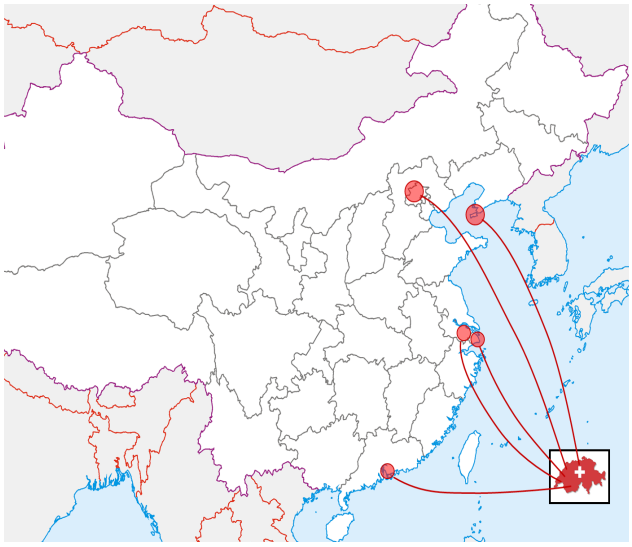
In 2011, Nano-Tera.ch launched an initiative aiming at creating synergies to encourage Swiss-Chinese research collaborations within Nano-Tera.ch thematic areas. The collaboration of Nano-Tera.ch in China with the Chinese Academy of Science (CAS) benefitted from the existing agreement between CAS and the Sino-Swiss Science and Technology Cooperation (SSSTC) program, which is hosted by the ETHZ and supported by the State Secretariat for Education and Research for the promotion of bilateral science and technology cooperation with China. The collaboration took the form of a joint call for proposals (the SSSTC call) that was launched in May 2011.

Six SSSTC projects were selected:

i-Needle	Intelligent Needles with Wireless Connection to Internet for Biophysical Bases of Acupuncture	Dr. S. Carrara EPFL
M3WSN	Mobile Multi-Media Wireless Sensor Networks	Prof. T. Braun UniBE
NaNiBo	Nano-Confinement of Nitrogen and Boron based Hydrides	Prof. A. Züttel EMPA
NetCam	Real Time Computation & Optimization for Networked Camera Surveillance	Prof. J. Lygeros ETHZ
SiC-nanomembranes	SiC Nanomembranes for MEMS Biofuel Cell	Prof. J. Brugger EPFL
3DOptoChemiImage	Optofluidic 3D Chemical Imaging Cytometry based on inline Digital Coherent anti-Stoke Raman Scattering Holography	Prof. D. Psaltis EPFL

The Chinese co-investigators are part of the following 5 Chinese institutions:

- Shanghai Inst. for Biological Sciences
- University of Science and Technology of China, Suzhou
- Dalian Inst. of Chemical Physics (DICP)
- Shenzhen Inst. of Advanced Technology
- Peking University



Geographical locations of 7 Chinese partners in 5 institutions

The Swiss delegation and their Chinese hosts at Fudan University, Shanghai

NEW STRATEGIC ACTIONS 2012/2013

To further strengthen the impact of the program, the Nano-Tera.ch Executive Committee has launched five strategic actions.

Topical actions

Three actions focus respectively on the setup of industrial test-beds for research on smart energy systems, on the promotion of user involvement in the domain of pervasive health systems and on the detailed analysis of the reliability/usability of sensor generated data. These actions started at the end of 2012, each of which being directly supervised by a member of the Nano-Tera.ch Executive Committee.

InUse, led by Dr. Christophe Hüglin (EMPA), seeks to increase the usability of sensor-generated data. This is approached by determining the performance characteristics and long-term behavior of sensors based on gathered data, by annotating data with sensor performance characteristics & context information and by developing modeling techniques for construction of the fine-grained space and time sensor data maps.

Tera-Health is a strategic action led by Dr. Pearl Pu Faltings (EPFL) which studies the use of data analytic methods to achieve the goals of pervasive health: prediction, prevention, personalization & participatory healthcare. The idea is to carry out practical experiments and participatory design to study how users accept and adopt sensing equipment, and how they can be motivated to sustain their quality of life via methods such as gamification in the design of mobile applications.

Transcend, led by Prof. David Atienza (EPFL), is developing a radically new thermal-aware design approach for next generation energy-efficient datacenters, integrating cooling infrastructure definition with holistic power, performance, thermal and reliability modeling.

The preliminary results of these actions have been presented to the Nano-Tera.ch NTF evaluation panel on October 3rd, 2013.

Transversal actions

Two actions aim at promoting international collaborations on one hand and technological transfer toward the industry on the other hand.

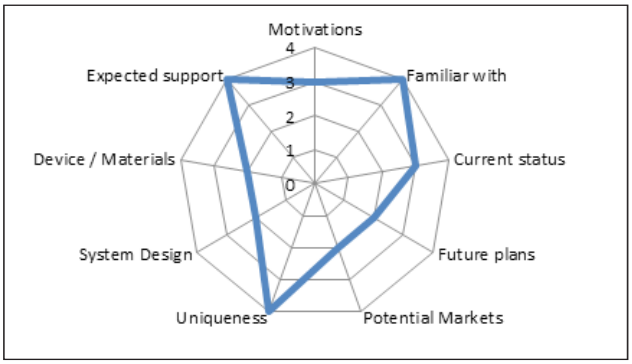
As initial case studies in the perspective of the nascent Nano -tera.ch **international collaboration program**, Nano-Tera.ch has welcomed two prominent international researchers to make a series of talks in various institutions involved in Nano-Tera.ch:

Prof. Krishna Palem (Rice University), who is widely recognized for his pioneering contributions to the foundations of embedded computing, interacted with several Nano-Tera.ch scientists around EPFL for a stimulating exchange ideas and perspectives. He visited Nano-Tera.ch in July 2013.

Prof. Rahul Sarpeshkar, who heads the research group on Analog Circuits and Biological Systems at MIT, presented his central contributions in the area of ultra energy efficient systems in biology, engineering and medicine in a widely followed series of talks at EPFL, CSEM and ETHZ. He visited Nano-Tera.ch in October 2013.

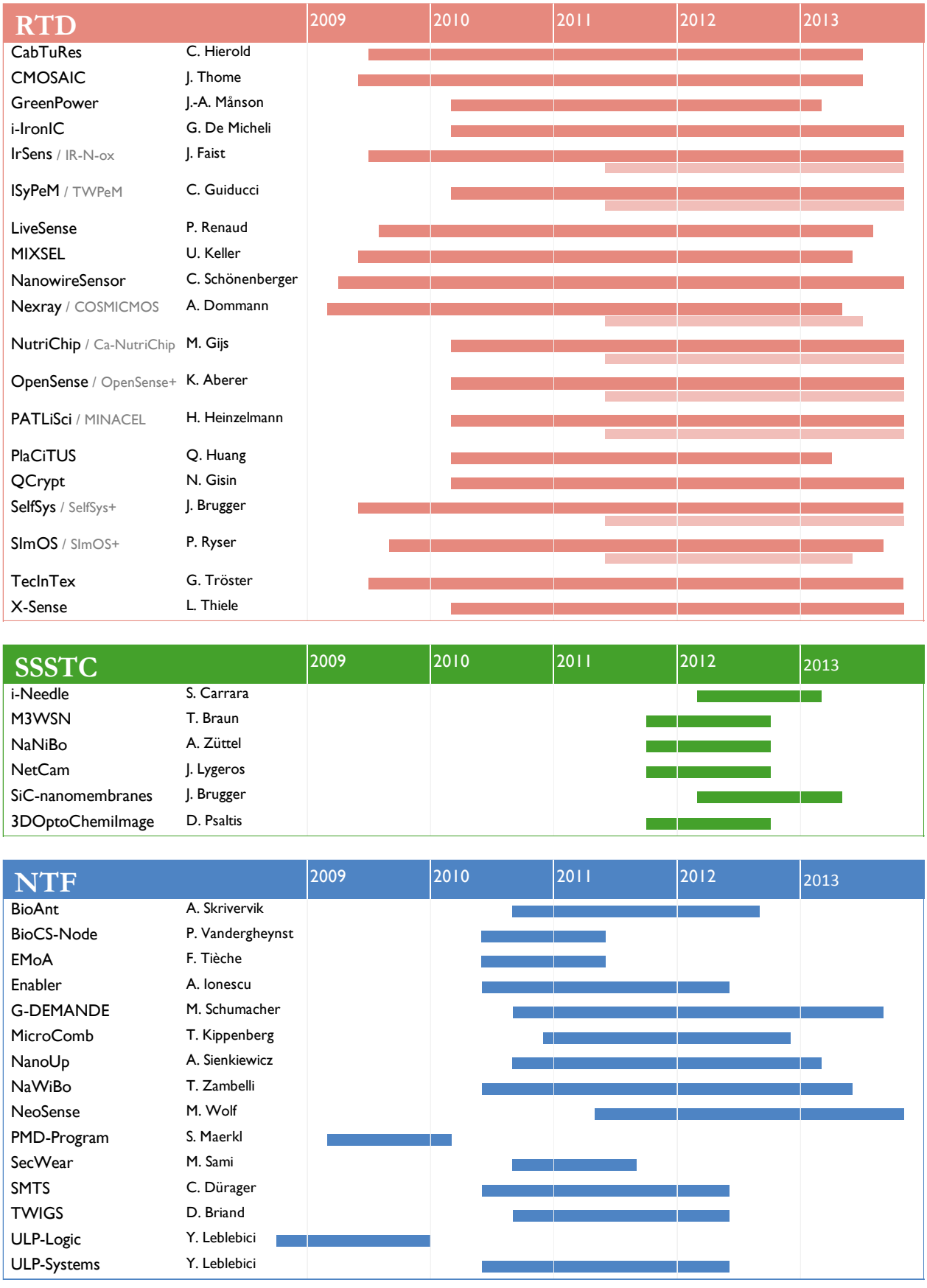
Furthermore, the Nano-Tera.ch **Industrial Venture Program** aims at fostering the creation of economic value out of scientific and technological results generated within the Nano-Tera.ch program. It focuses on the support for the creation of start-ups by PhD students and Post-Docs active in Nano-Tera.ch RTD projects. There is strong complementarity with existing funding programs such as VentureKick, EPFL Innogrants or ETHZ Pioneer: all these programs have confirmed that their major difficulty is to acquire strong applications corresponding to truly interesting and viable business ideas.

A detailed assessment of the potential for technological transfer toward the industry has led to the production of technology transfer radar plots for several Nano-Tera.ch projects.



Example of technology transfer radar plot.

Phase I projects, 2009-2013



Phase II projects, 2013-2017

RTD		2013	2014	2015	2016	2017
BodyPoweredSenSE	P.-A. Farine					
Envirobot	J. van der Meer					
FlusiTex	B. Nelson					
HearRestore	S. Weber					
HeatReserves	J. Lygeros					
IcySoC	C. Piguet					
IrSens II	J. Faist					
ISyPeM II	C. Guiducci					
MagnetoTheranostics	H. Hofmann					
MIXSEL II	U. Keller					
NewbornCare	P. Vandergheynst					
ObeSense	J.-P. Thiran					
OpenSense II	A. Martinoli					
PATLiSci II	E. Meyer					
SHINE	C. Moser					
SmartGrid	M. Kayal					
SmartSphincter	B. Müller					
SpineRepair	S. Lacour					
Synergy	C. Ballif					
UltraSoundToGo	G. De Micheli					
WearableMRI	K. Prüssmann					
WearMeSoC	Q. Huang					
WiseSkin	J. Farserotu					
X-Sense II	L. Thiele					
YINS	D. Atienza					

NTF		2013	2014	2015	2016	2017
Breathe	M. Liley					
DINAMO	K. Aberer					
IronIC++	S. Carrara					
MiniHolter	J.-M. Vesin					
NAMBP	J. Solà					
ParaTex	M. Wolf					
TANDEM	A. Weidenkaff					
3D-SensTex	D. Briand					
3D-Systems	Y. Leblebici					

GOVERNING BODIES

THE EXECUTIVE COMMITTEE

The Executive Committee (ExCom) acting on behalf of the Steering Committee, is the scientific executive body of Nano-Tera.ch; it consists of scientists from the partner institutions appointed by the Steering Committee and is chaired by the spokesperson of Nano-Tera.ch; it is responsible for defining and monitoring the scientific and academic strategy of the program and for providing scientific guidance.

Prof. Giovanni De Micheli
Chair, EPFL

Prof. Nico de Rooij
EPFL

Dr. Michel Despont
CSEM

Dr. Alex Dommann
EMPA

Prof. Boi Faltings
EPFL

Prof. Christofer Hierold
ETHZ

Prof. Qiuting Huang
ETHZ

Prof. Miroslaw Malek
USI

Prof. Hugo Zbinden
UniGE

THE STEERING COMMITTEE

The Steering Committee (SC), representing the Presidents/Rectors/CEO of the partners of the Nano-Tera.ch consortium; The Steering Committee is composed of the Rectors/Presidents/Directors/ CEOs of the partner institutions involved in the Nano-Tera.ch consortium. The Steering Committee is responsible for all decisions/actions requiring statutory authority, as well as the overall monitoring of the program, including reporting, and the implementing evaluations/recommendations of the Scientific Advisory Board and of the SNSF Evaluation Panel.

Prof. Patrick Aebischer
Chairman and President
of EPFL

Prof. Philippe Gillet
Alternate to the Chair and
Vice-President for
Academic Affairs, EPFL

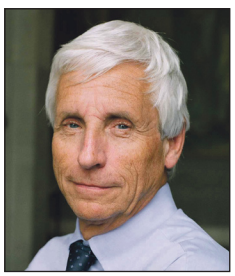
Prof. Ralph Eichler
President
ETHZ

Dr. Mario El-Khoury
CEO
CSEM

Prof. Antonio Loprieno
President
UniBas

Prof. Piero Martinoli
President
USI

Prof. Martine Rahier
President
UniNE



Prof. Jean-Dominique Vassalli
Rector
University of Geneva

THE SNSF EVALUATION PANEL

The SNSF Evaluation Panel, a group of international experts appointed by SNSF to evaluate the RTD proposals; the selection of the RTD proposal to be funded, as well as their funding level, is decided by SNSF based on the recommendations of the Evaluation Panel.

The current members of the SNSF Evaluation Panel of Nano-Tera.ch are:

- Dr. Amara Amara, ISEP
- Prof. Manfred Bayer, TU Dortmund
- Dr. David Bishop, Bell Labs
- Prof. Chris Boesch, University of Bern
- Prof. Harald Brune, SNSF
- Prof. Frederica Darema, NSF (USA)
- Dr. Urs Dürig, SNSF
- Prof. Georges Gielen, Leuven University
- Prof. Chih-Ming Ho, UCLA
- Dr. Patrick Hunziker, University Basel
- Prof. Mary Jane Irwin, Penn State University
- Dr. Karl Knop, SATW
- Prof. Paul Leiderer, SNSF Chair, Uni Konstanz
- Prof. Leila Parsa, Rensselaer Polytechnic Institute
- Prof. Jan Rabaey, University Berkeley
- Prof. Albert van den Berg, University Twente
- Prof. Hubert van den Bergh, SNSF

THE SCIENTIFIC ADVISORY BOARD

The Scientific Advisory Board (SAB) consists of academy and industry representatives from institutions other than the ones participating in the Nano-Tera.ch consortium; it is appointed by the Steering Committee, and provides an external evaluation of the overall performance of the program, as well as recommendations for its improvement.

The current members of the SAB of Nano-Tera.ch are:

- Dr. Andrea Cuomo, STMicro
- Prof. Satoshi Goto, Waseda University
- Prof. Enrico Macii, Politecnico di Torino
- Prof. Teresa Meng, Standford University
- Prof. Heinrich Meyr, SAB Chair, University of Aachen
- Prof. Khalil Najafi, University of Michigan
- Prof. Calton Pu, Georgia Tech
- Prof. Lina Sarro, Technical University Delft
- Prof. Göran Stemme, Royal Institute of Technology Stockholm

THE NTF EVALUATION PANEL

The NTF Evaluation Panel consists of international experts who have conducted a thorough examination of the NTF proposals, establishing a ranking. The Executive Committee then decided how many of the top proposals could be funded according to the funds available.

The current members of the SAB of Nano-Tera.ch are:

- Dr. Thomas Burg, Max Planck Inst. for Biophys. Chemistry
- Dr. Thomas Ernst, CEA-LETI
- Dr. Victor Erokhin, Università degli studi di Parma
- Prof. Luca Fanucci, Università di Pisa
- Dr. Ahmed Jerraya, CEA-LETI
- Prof. Jan Madsen, Technical University of Denmark
- Dr. Firat Yazicioglu, IMEC

THE MANAGEMENT OFFICE

The Management Office (MO), responsible for operational tasks, lead by an executive director, and involving specific staff for accounting, controlling, reporting, dissemination and web presence; the Management Office is operating under the supervision of the ExCom.

Dr. Martin Rajman,
Executive Director

Yann Dixon
Finance & Control
Coordinator

John Maxwell
Webmaster

Dr. Patrick Mayor
Scientific Coordinator

Jocelyne Vassallli
Administrative Assistant

Leading house

EPFL	Swiss Federal Institute of Technology Lausanne

Consortium institutions

CSEM	Swiss Center for Electronics and Microtechnology
EPFL	Swiss Federal Institute of Technology Lausanne
ETHZ	Swiss Federal Institute of Technology Zurich
UniBas	University of Basel
UniGE	University of Geneva
UniNE	University of Neuchâtel
USI	University of Lugano

Other partners

ABB	
ACP AG	Advanced Circuit Pursuit
ALP	Agroscope Liebefeld-Posieux
BFH	Bern University of Applied Sciences
BrainServe	
CePO	Pluridisciplinary Oncology Center
CHUV	University Hospital of Vaud
Credit Suisse	
CRR-SUVA	Clinique Romande de Réadaptation, SUVA
Eaton	
Eawag	Swiss Federal Institute of Aquatic Science and Technology
EM	EM Microelectronic-Marin
EMPA	Swiss Federal Laboratories for Materials Testing and Research
FHNW	University of Applied Sciences Northwestern Switzerland
FHO	University of Applied Sciences of Eastern Switzerland
FOEN	Federal Office for the Environment
FSRM	Swiss Foundation for Research in Microtechnology
GAMMA	Gamma Remote Sensing
HES-SO	University of Applied Sciences Western Switzerland
IBM ZRL	IBM Zurich Research Laboratory
Icare	Icare Institute
IDQ	id Quantique
InselSpital	Bern University Hospital
IRB	Institute for Research in Biomedicine
IST	Institute for Work and Health
Kinderspital ZH	University Children's Hospital Zurich
METAS	Federal Institute of Metrology
PSI	Paul Scherrer Institute
REMSMED AG	
Sefar	
Spitäler SH	Spitäler Schaffhausen
SPZ	Swiss Paraplegic Center
ST	STMicroelectronics
SUPSI	University of Applied Sciences and Arts of Southern Switzerland
SwissGrid	
Symbios	
UniBE	University of Bern
UniFR	University of Fribourg
UniSG	University of St.Gallen
UNIL	University of Lausanne
USB	University Hospital of Basel
USZ	University Hospital of Zurich
UZH	University of Zurich

Chinese institutions

DICP	Dalian Institute of Chemical Physics
PICB	Partner Institute for Computational Biology, Shanghai Institute for Biological Sciences
PKU	Peking University
USTC	University of Science and Technology of China, Suzhou
SIAT	Shenzhen Institutes of Advanced Technology

Consortium institutions

Other partners

csem

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

UNI BASEL

UNIVERSITÉ DE GENÈVE

Université de Neuchâtel unine

Università della Svizzera italiana

ABB

ACP AG Advanced Circuit Pursuit

Federal Department of Economic Affairs DEA Agroscope Liebefeld-Posieux Research Station ALP

Berner Fachhochschule

BRAIN SERVE

Centre Pluridisciplinaire d'Oncologie

CHUV

CREDIT SUISSE

suvacare Clinique romande de réadaptation

EATON

eawag aquatic research

EMPA

Fachhochschule Nordwestschweiz

Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Swiss Confederation Federal Office for the Environment FOEN

FHO Fachhochschule Ostschweiz

Hes·so Haute Ecole Spécialisée de Suisse occidentale Fachhochschule Westschweiz University of Applied Sciences Western Switzerland

fsrm CARREFOUR DE LA MICROTECHNIQUE

GAMMA REMOTE SENSING

IBM

icare

IDQ FROM VISION TO TECHNOLOGY

INSELSPITAL UNIVERSITÄTSSPITAL BERN HOPITAL UNIVERSITAIRE DE BERNE BERN UNIVERSITY HOSPITAL

ist

KINDERSPITAL ZÜRICH Universitäts-Kinderkliniken · Eleonorenstiftung

Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Swiss Confederation

PAUL SCHERRER INSTITUT PSI

REMSMED

SEFAR

spitäler schaffhausen

Swiss Paraplegic Centre

life.augmented

Scuola universitaria professionale della Svizzera italiana SUPSI

UNIVERSITÄT BERN

swissgrid

SYMBIOS

UNIVERSITAS FRIBURGENSIS

UNIL | Université de Lausanne

Universitätsspital Basel

Universität St.Gallen

UniversitätsSpital Zürich

Universität Zürich

Chinese institutions

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