

Empa – The Swiss Federal Laboratories for Materials Science and Technology: The Place where Innovation Starts

Zurich, Switzerland





General Information

Title	Empa - The Swiss Federal Laboratories for Materials Science and Technology										
Pitch	Empa – The Place where Innovation Starts										
Organisation	Empa										
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Authors	Hacer Tercanli and Arno Meerman (University Industry Innovation Network)										
Nature of interaction	<table><tr><td><input checked="" type="checkbox"/> Collaboration in R&D</td><td><input type="checkbox"/> Lifelong learning</td></tr><tr><td><input checked="" type="checkbox"/> Commercialisation of R&D results</td><td><input type="checkbox"/> Joint curriculum design and delivery</td></tr><tr><td><input type="checkbox"/> Mobility of staff</td><td><input type="checkbox"/> Mobility of students</td></tr><tr><td><input type="checkbox"/> Academic entrepreneurship</td><td><input type="checkbox"/> Student entrepreneurship</td></tr><tr><td><input type="checkbox"/> Governance</td><td><input type="checkbox"/> Shared resources</td></tr></table>	<input checked="" type="checkbox"/> Collaboration in R&D	<input type="checkbox"/> Lifelong learning	<input checked="" type="checkbox"/> Commercialisation of R&D results	<input type="checkbox"/> Joint curriculum design and delivery	<input type="checkbox"/> Mobility of staff	<input type="checkbox"/> Mobility of students	<input type="checkbox"/> Academic entrepreneurship	<input type="checkbox"/> Student entrepreneurship	<input type="checkbox"/> Governance	<input type="checkbox"/> Shared resources
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Summary	<p>Empa began in 1880 as the “building materials testing institute” in Zürich Switzerland. Empa focuses on application oriented materials science and technology, with the goal of knowledge development and the creation of marketable innovations from research. With more 1,000 staff members, Empa is engaged in more than 150 new research projects a year and at any given point could be involved in as many as 250 projects. The core missions of Empa is to develop scientific-based solutions, turn research results into innovation and provide a scientific basis for political decisions results through a vigorous cooperation with industry, universities and public organisations. Empa brings research to society through its approach towards strategic partnerships and its unique Demonstrators’ concept, where it shares its facilities to test research in practice.</p>										



Introduction & Overview

1. BACKGROUND

Switzerland has long been renowned for its banking sector, chocolate, luxury watches, and cheese industry. More recently, it has accomplished a transformation towards a European hub of innovation. Consecutively topping the lists of innovation rankings, this Alpine country has no secrets when it comes to the factors that contributed to its well-deserved success. It is primarily the targeted government policies, and bold investments made by public and private organisations into R&D that has built this small European country, with limited natural resources, into a nation which is in the forefront of innovation.

With its main campus located in the Swiss town of Dübendorf close to Zurich, and two more sites in the towns of St Gallen and Thun, Empa is the major national research institute specialising in the areas of materials science and technology. It is a member of a national alliance of research institutes and the Federal Institutes of Technology, *ETH Domain*, governed by the ETH Act and affiliated to the Federal Department of Economic Affairs, Education and Research (EAER). The institution offers solutions for industry and society with nanostructured materials and surfaces, environmental technologies, energy and sustainable building technologies, as well as bio- and medical technologies. As much as fulfilling its role as a knowledge initiator, the institution transfers its research outputs to marketable innovations via spin-offs and different models of cooperation with industry.

Since its launch in 1880, Empa has supported public offices with the data needed for political decisions, and has carried out research on behalf of the federal government. The institution currently employs approximately 1,000 staff members from over 50 countries, including 29 professors, 200 doctorate, 200 bachelor and master's degree students, as well as 40 trainees and 90 postdoctoral fellows. Every year the institution starts more than 150 new research projects in cooperation with researchers from industry, universities and public offices. In any given year it runs about 250 projects financed by the Swiss National Science Foundation (SNSF), the Swiss Commission for Technology and Innovation (CTI) and the EU framework programmes (e.g. FP7, Horizon2020).

2. OBJECTIVES AND MOTIVATIONS

The orientation of Empa can be discussed at two complementary levels; the overarching mission of the ETH Domain at the federal level, and the institutional goals of Empa itself.

The overarching **missions** of the institution as part of the ETH Domain¹ are identified as follows:

- ▶ educating students and qualified staff in scientific and technical fields
- ▶ providing permanent continuing education

- ▶ expanding scientific findings through research
- ▶ fostering upcoming young scientists
- ▶ rendering scientific and technical services
- ▶ performing public relations activities and exploiting their research findings.

The institutions of the ETH Domain take into account Switzerland's innovation needs as a priority. At the same time, they set their service quality at, or above, international standards, which also helps to promote international cooperation.

In light of the overall mission of the ETH Domain, **Empa defines its vision** as delivering solutions to societal challenges by developing materials and technologies for a sustainable future. Based on its vision, the **mission of Empa** is elaborated in a detailed statement with the following core objectives specified:

- ▶ **develop** science-based solutions
- ▶ **turn** research results into innovations
- ▶ **work out** the scientific basis for the sustainable development of the society and for political decisions.

Empa achieves these goals by concentrating its efforts in five key Research Focus Areas (RFAs):

- ▶ energy
- ▶ natural resources and pollutants
- ▶ health and performance
- ▶ sustainable built environment, and
- ▶ nanostructured material.

Approaching problems with interdisciplinary solutions, through a coordinated technology transfer strategy, Empa acts as a bridge between academia and businesses. Moreover, it strives to maintain an inspiring work environment, attracting skilled students as well as an experienced research workforce to foster innovation.

3. STAKEHOLDERS

Empa has three main types of stakeholders that participate in institutional decision making processes: the ETH Board, Empa's Industrial Advisory Board, and the institution's Research Commissions.

1. **ETH Board** (Rat der Eidgenössischen Technischen Hochschulen – Board of the Swiss Federal Institutes of Technology) has overall responsibility for the management of the **ETH Domain**, which incorporates the two Federal Institutes of Technology, ETH Zurich and EPFL², and the four federal research institutes PSI³, WSL⁴, Empa and Eawag⁵.

The legal foundations and operations of these research institutes and the Federal Institutes of Technology are established in the **ETH Act** that defines the criteria the

member organisations meet in order to keep up with the technical and scientific developments and compete in the international grounds. The ETH Domain is autonomous and affiliated to the Federal Department of Economic Affairs, Education and Research (EAER). While the ETH Board is the strategic body of the ETH Domain, the operational management is the responsibility of the member institutions which have their own legal entity.

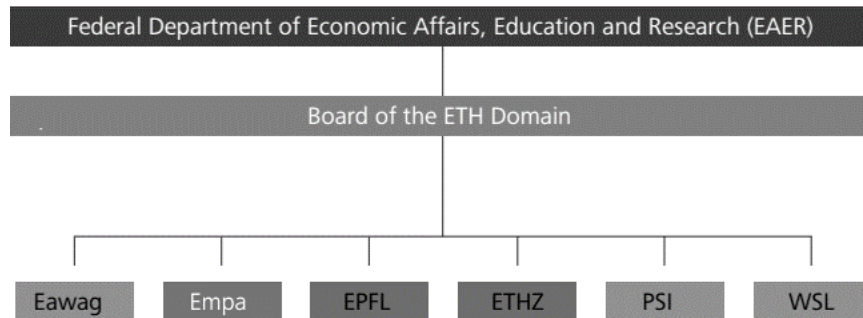


Figure 1: Empa within the ETH Domain (Source: EMPA, 2017)

2. **Industrial Advisory Board:** A body of leading experts mainly from the business world, which advises Empa's Board of Directors on strategic directions.

Research Commissions: The Commissions advise Empa's Board of Directors on research matters such as the choice of its R&D spectrum as well as the evaluation of internal R&D projects to ensure excellence in research.





Implementation

4. INPUTS

The input involved in Empa's activities can be grouped into three type of resources: human resources, financial resources, and physical resources.

Highly skilled and self-motivated staff, a fine mixture of permanent and temporary scientists account for input in the form of **human resources**. Of the 1,000 Empa employees more than half are researchers, 40% of these are on permanent contracts, while 60%, mainly post-docs, PhD students, and visiting researchers, hold limited-term contracts.

Empa is built on a variety of public and private funding structures. Around 60% of its **funding** comes directly from the Swiss government, while the rest is financed by different organisations, i.e. EU, CTI, SNSF, private foundations and industry. In total, 50% of the lab budget is funded through third party means. More than 60% of all its research projects are launched in cooperation with industry partners, where industrially "commissioned" research and services account for around 10% of all activities.

With regards to the **physical resources**, Empa uses its highly unique 'Demonstrators' as research and technology transfer facilities where research results are scrutinised and investigated under real-world conditions. These **demonstrators** are vitally important to not just showcase Epma's research and capabilities, but, also to act as a proof-of-concept and as a common playing field for both researchers and businesses to come together to experience and visualise the research outcomes. This approach is designed to bridge the large gap between the lab and market and allows for a more rapid research and development process.

The Empa Demonstrators are:

(i) NEST (Next Evolution in Sustainable Building Technologies) is a modular research and innovation building run by Empa and Eawag, established to **validate and develop new technologies and materials in cooperation with partners from research, industry and the public sector**. The building consists of a central 'backbone' and three main platforms, onto which individual modules (so-called units) can be integrated in a 'plug and play' mode. NEST offers its facilities to both national and international research teams from universities, architectural firms and innovative companies from the building industry. In line with its role for "testing of research results in realistic conditions", people live and work in the NEST units as experimental laboratories, with guests invited to stay in the facility to experience the research first hand.

(ii) move: This "Future Mobility Demonstrator" is a sustainable mobility testing platform to find out how feasible it is to convert surplus, renewable electricity into storable energy carriers such as hydrogen or synthetic methaneto being used as fuels for individual mobility and the transport of goods. Partnering with institutions from the ETH Domain and industry, Empa conducts this large-scale project making use of a power-to-gas facility as well as vehicles equipped with different powertrain technologies.

(iii) eHub: Empa's Energy Hub Demonstrator is an energy research and technology transfer platform aimed at optimising energy management at district level and evaluating its influence on the overall energy system. Similar to NEST and move, eHub platforms are **available for individuals to test new energy concepts** for a higher efficiency under real-world conditions.

(iv) CCC: In the Coating Competence Center (CCC) Empa develops new technologies by bringing together key players along the value chain and by closing the gap between lab-scale research and industrial production. This includes all aspects of technologies: materials, processes and machines. The mission is to **transfer new ideas and successful developments from lab into industry** and enable companies to produce the next generation of products with innovative and cost-efficient manufacturing technologies.

5. ACTIVITIES

The range of activities undertaken at Empa include joint research cooperation with industry, knowledge and technology transfer, and networking and dissemination of research.

With regards to **research**, there are three main cooperation models: joint, funded, and commissioned. Joint research is a model in which the R&D project is defined by substantial involvement of the partners in the work packages, exchange of know-how, and access to material or infrastructure. Funded research is financed by a national or international funding institution, upon fulfilment of predefined conditions. Finally, commissioned research takes place according to the partner's specifications. Licencing activities linked to the joint research outcomes define the usage or proprietary rights to Empa's intellectual property rights for commercial use by a partner. Consulting is another complementary activity, provided by Empa experts in matters such as problem/failure analysis, technology assessment, and troubleshooting/process optimisation.

Knowledge and Technology Transfer at Empa refers to a number of platforms where knowledge meets application.

- ▶ Business Incubators are another key element of Empa's integrated technology transfer strategy to transfer its know-how and research results into the market. One way to achieve this is to create business incubators on or close to Empa's premises where spin-offs and start-ups can find ideal conditions to collaborate with Empa scientists, receive coaching support and other support services. The two incubators Empa runs are:
 - glatec, which collaborates closely with the Swiss Technopark- Alliance and other start-up organisations to guide Empa's scientists into becoming entrepreneurs. In addition to Empa spin-offs, glatec extends its service to external start-ups that have synergies with Empa's R&D activities. The incubator is financially supported by the City and the Canton of Zurich, the City of Dübendorf, the Zürcher Kantonalbank and CTI Startup and Eawag, another institute of the ETH domain.
 - STARTFELD is the innovation and start-up network in the St.Gallen-Bodensee area. The organisation supports both entrepreneurs and established SMEs, who are looking for new development areas. STARTFELD is composed of three legal

entities: the STARTFELD Association brings start-ups to the starting line through active support and close assistance, the STARTFELD Foundation makes the financing of start-ups possible, the Feld3 Association provides room and infrastructure for start-ups as the property company of the STARTFELD Innovation Centre.

The support services offered by glatec and STARTFELD include:

- help with founding and developing a company
 - access to funding
 - administrative or subject-specific support
 - attractive workspaces and state-of-the-art infrastructure
 - research collaborations with Empa
 - access to industrial partners and customers
 - business courses and networking events
- ▶ The Technology Transfer Office which was established over ten years ago is responsible for:
- The conclusion of research agreements
Analysis, drafting and negotiation of research contracts (e.g. supplementary CTI contracts and R&D agreements) and other contractual agreements linked to research (e.g. confidentiality agreements or material transfer contracts)
 - Commercial realisation of research results
Protection of intellectual property, search for suitable exploitation partners, licensing or sale of property rights

Further education of Empa researchers in the field of technology transfer
- ▶ The Empa Academy is a channel through which industry and academia meet to exchange ideas and experiences with each other as well as with the public. The Academy promotes knowledge transfer from applied research to practice via a number of channels. It regularly offers professional training and education events, hosts information seminars and workshops and conferences where the research within Empa or affiliated to Empa is presented, discussed and potentially new collaborations are built.

Cultivating **strategic partnerships** with industry is one of the key measures Empa uses to collaborate with industry, it uses four different models when it comes to engaging with its partners:

- ▶ In the model “Antenna” the companies can rent offices at Empa for their staff to benefit from a **close proximity** to the institution. Close contact with Empa researchers promotes collaboration, and facilitates creation of an efficient and effective work environment.

- ▶ In the “Coordinator” model the industrial partner **funds an employee of Empa directly as a “liaison officer”**. Thanks to his or her close ties with Empa, the liaison officer can seek out project ideas more effectively, develop them further and act as project manager.
- ▶ In the “Network” model **a number of industrial partners joins forces** in form of a network to have access to Empa resources and expertise, and optimally benefit from the services offered.
- ▶ “Public Private Partnership” (PPP) model is how major and long-term projects are realised between Empa and private or public partners.

6. OUTPUTS

According to 2016 Empa figures

- ▶ Empa researchers and engineers published approximately 600 scientific papers, patented 14 inventions and has concluded 13 new license agreements with industrial partners
- ▶ over 100 projects received funding from the SNSF, about 90 projects were supported by the CTI and nearly 60 EU projects were underway at Empa
- ▶ over 50 million Swiss francs were received in third-party funding for projects
- ▶ 19 spin-offs together with other start-ups in Empa’s two business incubators employ a total of over 500 employees.

In addition, the figures from the previous year indicate

- ▶ more than 3,500 hrs of lectures were given by Empa scientists at Swiss universities and universities of applied sciences
- ▶ some 170 new partnerships with industry and the public sector were signed
- ▶ over 40 trainees in 10 professions were enrolled in professional formation at Empa⁶.

7. IMPACTS

Empa has been part of shaping the research and innovation landscape in Switzerland and beyond when it comes to material sciences. Besides providing a large number of jobs itself, its spin-offs and research projects have had significant impact on the regional, national and European ecosystem.



Support & Influencing factors

8. SUPPORTING MECHANISMS

A major supporting mechanism in research and training activities of Empa is the **ETH Domain**, a closely cooperating strategic network Empa belongs to. This national ecosystem generated for Swiss research excellence creates a unique setting for large-scale research, teaching and training that feeds into all partner institutions. It sets standards and target achievements to bolster quality of teaching and research, steering the institutions to maintain their international orientation supported by stable basic funding from the public budget and predictable framework conditions established by the science policy.

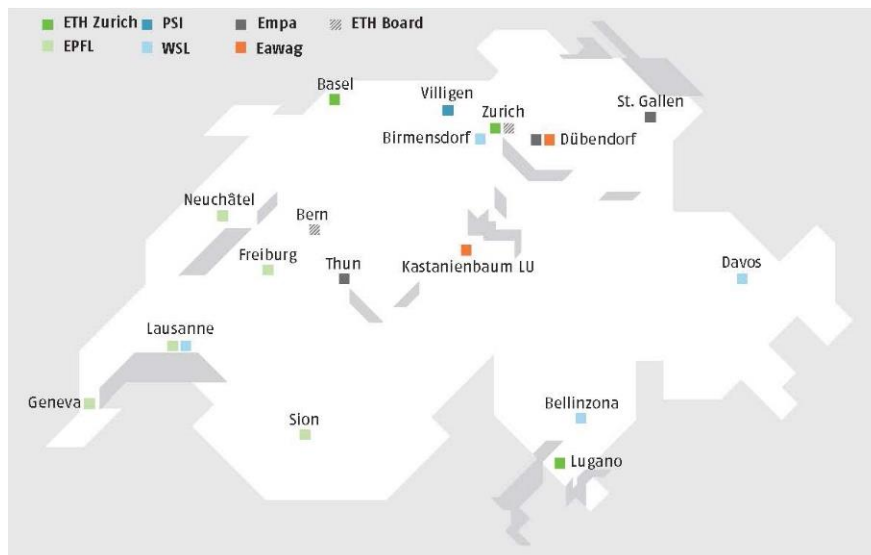


Figure 2: The locations of the institutions of the ETH Domain (Source: ETH Board, 2015).

9. BARRIERS AND DRIVERS

Some of the barriers to the UBC activities of Empa are identified as:

- ▶ **limited capacity of companies** to take on new research with potential benefits for the respective sector
- ▶ **the culture of industry** as not being aware of the need for innovation
- ▶ challenges in **cooperating with international partners**, i.e. cultural differences, language barriers in Asian markets, etc.

Four main drivers of success of Empa are:

- ▶ **size of the institution and open communication** - with about 30 research labs and quarterly meetings (Leadership Forum) that encompass 60-100 key people make communication and interdisciplinary cooperation seem easy

- ▶ the emphasis placed on **continuity**, with a higher ratio of permanent-contract researchers compared to those in higher education institutions/universities, ensures trust in the relations with industry
- ▶ **combination of competences**, where applied and basic research is conducted in balance with each other, compared to similar research institutes focusing more explicitly on either of the two ends of the continuum
- ▶ **interdisciplinary approach** in Empa's Research Focus areas that fosters new ways of addressing technology challenges.

10. FUTURE CHALLENGES

Empa has success in a number of domains, but also encounters challenges in relation to conditions, funding and markets:

- ▶ limited ability of its industry partners to invest in research - with the strong Swiss Franc small and medium-sized companies face economic challenges that limit their means for research
- ▶ Horizon 2020 repositioning - Swiss institutions were not called for partnerships due to uncertainty about Switzerland's status in the period 2014-16
- ▶ small domestic market - if start-ups get bigger they may have to leave the country and move to larger markets
- ▶ risk adversity – there exists a risk-averse attitude towards entrepreneurship in Switzerland
- ▶ the influence of external funding – researchers might align their research interests towards where the money is.

In addition to the challenges identified by the institution, from a wider perspective, there are a few potential challenges the ETH Domain has to cope with in the long run. In this respect, maintaining educational quality and ensuring internationality and openness in the recruitment process are two of the major topics on the ETH Domain agenda.

11. CONTEXT

Switzerland is a small European country by size, yet competitive enough to secure the top place in the innovation performance rankings for consecutive years. The conditions for university-business cooperation in Switzerland are framed by its strong national innovation system that is steered by government and investors as key players. Empa, a crucial element of the UBC system, established through governmental structures and supported through the ETH Domain, is flourishing in this innovative setting. In addition to the frameworks in place, there is a large share of regional, national and European funding from public authorities being invested in the innovative ecosystem supporting Empa.

While this being the case, it should also be noted that there is a high national reliance on Swiss-based multinational corporations, i.e. Nestle, Novartis, Roche - with some of the highest research budgets in the world - for innovation-based activities. According to Economiesuisse, the Swiss business federation, this poses a threat on the top position of Switzerland in the

innovation rankings⁷. R&D is financed and carried out primarily by these large corporations, whose partnerships with SMEs, research institutions, and spin-offs promotes Swiss innovation. The concerns over the disruption of this favourable context particularly emerge due to the increasing international research activity taken up by the corporations, particularly in Asia, which will potentially reduce national R&D collaborations.

Switzerland invests nearly 3.0% of its GDP on research and development, a significant level of expenditure with the EU average being 2.03% (in 2015⁸). These dedicated investments translate into academic strength and world-class research facilities that prepare the base for innovative and entrepreneurial activities. Thus, it shouldn't come as a surprise that according to the European Patent Office, Switzerland has the highest ratio of European patent applications to population⁹. Moreover, the highly desirable working and living environment in Switzerland continues to attract the brightest minds from abroad, despite current fears that any limitations to European Union immigration would curb that.

The two ETH Domain higher education institutions, the Swiss Federal Institute of Technology in Zurich (ETH Zurich) and the École Polytechnique Fédérale de Lausanne (EPFL), are among the most prestigious universities in the world that contribute to the productivity of the ecosystem Empa is part of, with the facilities they offer to the partner institutions.

12. KEY SUCCESS FACTORS

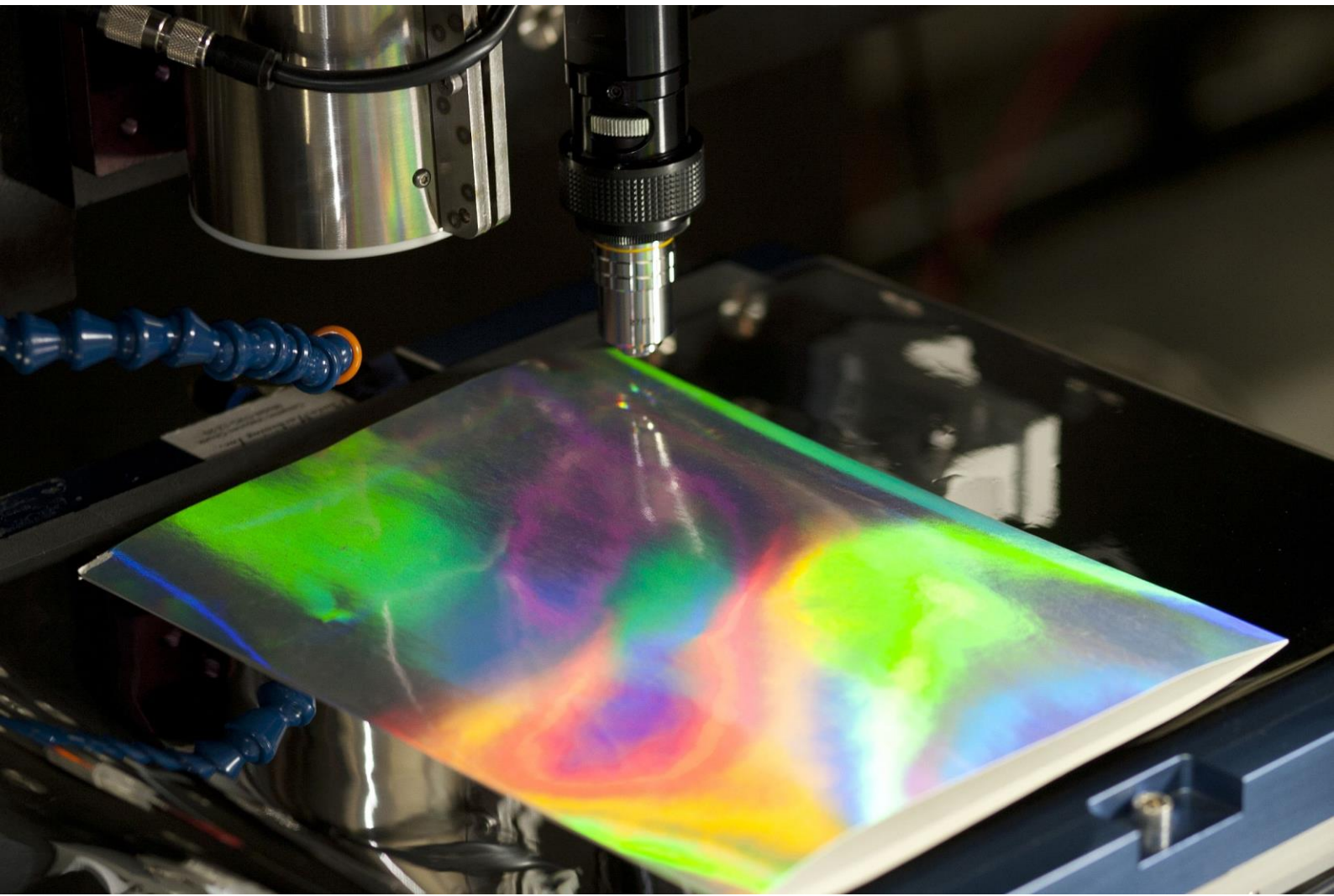
The success of Empa activities can be attributed to a few factors that facilitate the achievement of institutional goals.

Highly skilled and self-motivated staff is considered to be one of the key ingredients for Empa's success. The core values of the institution clearly defined as part of its mission statement plays a crucial role in the selection process that consolidates the "Empa Culture" that has been established years ago. To be more precise, some of these values include:

- ▶ Curiosity, creativity, flexibility
- ▶ Diversity of both individuals as well as ideas
- ▶ Freedom, independence, impartiality
- ▶ Social responsibility
- ▶ Integrity
- ▶ Trust, openness, respect
- ▶ Cooperativeness

The value given to **continuity and maintenance of the institutional memory** is another contributing factor that has considerable impact both on staff performance and stability of external relationships with public and private partners. This attitude explains the institution's 140 years of presence in the market holding the same quality standards, which is unquestionably revered by the academic and industrial community from all across the world.

One final success factor could be explained by the **openness and availability of Empa representatives** for any inquiries from potential project partners. Recognising the need, Empa has established the Empa Portal some 10 years ago to facilitate access of the interested parties.





Further Information

13. MONITORING AND EVALUATION

The ETH Board performs its supervisory function on Empa through the use of the following tools:

- ▶ periodic reporting from Empa on the use of resources (finances, human resources, real estate)
- ▶ annual reporting from Empa regarding the status of mission fulfilment with regard to specified targets
- ▶ annual talks between the ETH Board and Empa (so-called “dialogue meetings”) within the context of strategic controlling.

Moreover, the ETH Board’s Internal Audit staff evaluate the risk management processes, internal control system and governance processes of Empa and report on them to the ETH Board, in particular the ETH Board’s Audit Committee.

14. SUSTAINABILITY MEASURES

Empa adopts a number of sustainability measures to maintain the relevance, diversity, and the impact of its activities.

With regards its long-term strategies, Empa’s approach towards its strategic partnerships model where it has partners on different levels i.e. Antenna, Coordinators, Network and Public Private Partnerships provides it with long-term stability.

Giving access to internal and external partners to rent Empa facilities is another strategy the institution adopts to ensure financial sustainability. Some of the facility examples for internal and external use include:

- ▶ **Empa Academy** offers its facilities to its partners for meetings, conferences, exhibitions, courses, and events
- ▶ **NEST** partners have the possibility to receive individual tours for themselves and their customers/partners and use NEST’s infrastructure for their own events
- ▶ Empa and Eawag own 116 **guest rooms** to accommodate their apprentices, trainees, graduate and doctoral students, postdocs and visiting scientists. The properties are also offered to external individuals provided there is free capacity.

Finally, Empa accepts **bequests, donations, and foundations** from private individuals, organisations and companies who are interested in supporting Empa’s research activities for future sustainability.

15. TRANSFERABILITY

The Empa model is one that can be transferred to establish a similar environment to Empa. It is Empa's top-down strategy that helps the institution to keep track and have a common direction to reach institutional goals. For organisations interested in learning about Empa, its staff and senior management regularly present the Empa model internationally.

A certain limitation with transferring the Empa approach could be in its specific field of focus, namely materials science.

16. AWARDS AND RECOGNITION

- ▶ 100 experts recently selected Optotune, one of Empa's spin-offs, as the best start-up of the year under the auspices of ifj, the Institut für Jungunternehmen in St. Gallen. The ranking lists a total of 100 companies from all over Switzerland. In addition, the two glatec companies Qualysense (#26) und Compliant Concept (#73) also made it into the Top 100.¹⁰
- ▶ An award provided by Empa itself is the Innovation Award. Every other year since 2006 Empa presents its Innovation Award to outstanding innovation and technology transfer projects. The award can go to a single researcher, a group or a lab for an excellent innovation or successful transfer of technology to the private sector. Empa thus honours the efforts of its researchers to bridge the gap between science and industry with applied, market-oriented research. All of the awarded projects have led to marketable innovations.

17. PUBLICATIONS AND ARTICLES

Empa Activities 2016

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(2015) Empa Annual Report

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http://www.ethrat.ch/sites/default/files/ETHR_GB2015_E_0.pdf

18. LINKS

Empa Website: <https://www.empa.ch/web/empa>

Empa TV Channel: <https://www.youtube.com/user/EmpaChannel>

19. CONTACT PERSON



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20. REFERENCES

- ¹ <http://www.eth-bereich.ch/en/eth-board/governance-eth-domain>
- ² École Polytechnique Fédérale de Lausanne
- ³ The Paul Scherrer Institute, the largest research centre for natural and engineering sciences within Switzerland
- ⁴ Swiss Federal Institute for Forest, Snow and Landscape Research
- ⁵ Swiss Federal Institute of Aquatic Science and Technology
- ⁶ http://www.ethrat.ch/sites/default/files/ETHR_GB2015_E_0.pdf
- ⁷ http://www.swissinfo.ch/eng/business/research_multinationals-fear-for-swiss-innovation/41911550
- ⁸ http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure
- ⁹ http://www.swissinfo.ch/eng/business/champs_swiss-lead-on-patent-applications-in-europe/41999768
- ¹⁰ http://oldweb.empa.ch/plugin/template/empa/678/114530/--/l=2/change-Lang=true/lartid=114530/orga=/type=/theme=/bestellbar=/new_abt=/uacc=