Koninkrijk der Nederlanden

The Swiss and Dutch Precision Industries

Opportunities for R&D- cooperation between Switzerland and the Netherlands

Innovation Attaché Network

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Colofon

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Summary

Switzerland and the Netherlands are strong and innovative countries with a long history in precision engineering. To increase the cooperation between the countries, this report has reviewed the respective precision engineering industries in both countries. This report could therefore serve as an introduction and reference manual on the relevant R&D-landscape in both countries for those parties who want to cooperate. The report focusses on 'Mechatronics and Manufacturing', 'Components and Circuits' and 'Nanotechnology', and the application-areas 'Health-tech', 'Advanced Instrumentation' and 'Semiconductor equipment'.

Both countries have top universities and competitive high-tech industries in these fields. The R&D environments in both countries could well work together, as the "precision" of Switzerland may supplement the "creativity" of the Netherlands. Both countries are open and internationally oriented, which is a good start for cooperation, building and extending already existing connections.

The role of the governments should be a facilitating one. On both sides research institutes and companies appreciate the network and introductions government bodies can give. For companies the government can facilitate by assisting with meetings, seminars and fairs, and branding (*Holland High Tech*). For SME's it is furthermore useful to get assistance with first contacts and introductions, especially if they do not already have an international reputation. This networking role of the government could also be of help to researchers, as a network is important for bilateral research.

For research and education institutes the most evident way for Swiss-Dutch research cooperation is through European platforms as the Horizon 2020 program. It is important to monitor the current development in the bilateral agreements between Switzerland and the EU, and the resulting participation in the associated research programs. Further research stimulation could be done by reinforcing the connections between the funding organizations SNF and NWO.

Interesting patterns to further study for the Netherlands are the long term research funding in Switzerland, which has helped the top-research institutes and universities. Secondly the Swiss educational system, especially the vocational part, could be a good example of high quality vocational education. For Switzerland, the extensive cooperation between companies and universities in the Netherlands is interesting.

During stimulating and fruitful conversations with stakeholders in Switzerland and the Netherlands the following topics were consistently mentioned for further research cooperation:

- **3D printing**
  High precision, micro scale 3-dimensional printing is still in its early development; but both countries show interest and have industries that would profit from high precision printed parts.
- **Silicon; lithography**
  Both countries have extensive knowledge of chip fabrication, with various examples as low voltage and security, this could be combined with the micro-tooling of silicon for MEM's.
- **Advanced Instrumentation**
  This industry develops instruments for high-tech companies and fundamental research facilities; both countries excel in this knowledge driven high precision industry.
- **Medical technology; micro fluids**
  Switzerland as well as the Netherlands are world class players in medical technology, of recent mutual interest are micro fluids, with examples as lab-on-a-chip.

- **Nano-engineering**
  With top research facilities and industries active in nano-technology related fields as solar- and semiconductor-technology cooperation could strengthen the knowledge position of both countries.
- **Composites and bio-based materials**
  Both countries are active in the development of new materials: from bio-based materials to composites and cross-overs, which are used in High Tech and Medical industries.

Samenvatting

Zwitserland en Nederland zijn sterke, innovatieve landen met een geschiedenis in precisie-techniek. Om de samenwerking tussen beide landen te bevorderen, brengt dit rapport het R&D-landschap op dit gebied in beide landen in kaart. Daarmee biedt het rapport een introductie en een naslagwerk op de beide landen voor partijen die met elkaar willen samenwerken. De focus van dit rapport ligt op 'Mechatronics and Manufacturing', 'Components and Circuits' en 'Nanotechnology', met toepassingen in 'Health-tech', 'Advanced Instrumentation' en 'Semiconductor equipment'.

Beide landen hebben topuniversiteiten en industrieën op het terrein van precisietechnologie. De Zwitserse "precisie" kan een goede aanvulling op de Nederlandse "creativiteit" zijn om innovatie te versnellen. De landen zijn open en internationaal georiënteerd, wat een goed begin is voor samenwerking, waar mogelijk voortbouwend op bestaande contacten.

Bij innovatiesamenwerking heeft de overheid vooral een faciliterende rol. Aan beide zijden waarderen onderzoeksinstituten en bedrijven het netwerk en de introducties die een overheid kan bieden. De overheid kan bedrijven helpen bij ontmoetingen, conferenties en beurzen, en landenpromotie (*Holland High Tech*). Voor MKB-bedrijven kunnen introducties belangrijk zijn, zeker als het bedrijf nog geen internationale reputatie heeft. De verbindende en netwerkende rol van de overheid is ook nuttig voor wetenschappers, voor wie bilaterale banden belangrijk zijn.

Voor onderzoek en onderwijssamenwerking zijn Europese programma's – zoals Horizon 2020 –de meest evidente platforms. Het is wel belangrijk om te monitoren hoe de bilaterale verdragen tussen Zwitserland en de EU zich op dit gebied ontwikkelen. Het verder stimuleren van bilateraal onderzoek tussen Nederland en Zwitserland kan via de samenwerking tussen de wetenschapsfinancierende organisaties SNF en NWO.

Nederland en Zwitserland kunnen van elkaars sterke punten leren. Een sterk punt van Zwitserland is de lange-termijn onderzoeks-financiering, waardoor de universiteiten en instituten goed presteren. Verder is het Zwitserse beroepsonderwijs goed ontwikkeld, en levert goed gekwalificeerd personeel op. Voor Zwitserland is vooral het model van intensieve samenwerking tussen bedrijven en wetenschap in Nederland interessant.

Tijdens vruchtbare en stimulerende gesprekken met betrokkenen in Zwitserland en Nederland kwamen de volgende onderwerpen naar voren als zijnde veelbelovend voor verdere samenwerking:

- **3D printen**
  Hoog precies, micro schaal 3-dimensionaal printen is een techniek die nog in de kinderschoenen staat. Beide landen tonen interesse en hebben bijpassende industrieën.
- **Silicium; Lithografie**
  Beide landen hebben zeer veel kennis van halfgeleider productie, laag voltage systemen en veiligheid, dit kan gecombineerd worden met micro-bewerking van silicium voor MEM's.
- **Advanced Instrumentation**
  Op dit cross-functionele technologie gebied worden instrumenten ontwikkeld voor hightech- en fundamenteel wetenschappelijke faciliteiten.
- **Medische technologie; micro fluïdica**
  Zowel Zwitserland als Nederland zijn topspelers op het gebied van medische technologie; zo bestaat een gezamenlijke interesse in micro-fluïdica, met voorbeelden als 'lab-on-a-chip'.

- **Nano-engineering**
  Met top onderzoeksfaciliteiten in beide landen en industrieën actief in nanotechnologie sectoren als de semiconductor- en zonnecellenindustrie kan samenwerking de concurrentiekracht van beide landen vergroten.
- **Composieten en bio-materialen**
  Beide landen zijn actief in het ontwikkelen en toepassen van nieuwe materialen: van bio-materialen tot composieten, die gebruikt worden in High Tech en Medische applicaties.

Contents

Introduction

Both Switzerland and the Netherlands have strong and innovative precision engineering industries. Switzerland has a long history of precision mechanics, with well-known examples as watches and clocks. The precision industry in the Netherlands has a long history as well, with the invention of the microscope as an example. Especially on the subjects of semiconductor-machines, medical and material engineering the Netherlands is still world-leading. The knowledge base of both countries has the potential to be complementary, but the opportunities and starting points for R&D-cooperation are not always clear for the companies and stakeholders in the field.

This report seeks to help Dutch and Swiss public and private stakeholders with starting R&D-cooperation. The request for this study came from the Innovation Attaché Network of the Netherlands, a part of the Netherlands Enterprise agency. The study was carried out at the Embassy of the Netherlands in Bern. The main technological focus areas within the precision engineering industries are 'Mechatronics and Manufacturing', 'Components and Circuits' and 'Nanotechnology', with the main application-areas in 'Health-tech', 'Advanced Instrumentation' and 'Semiconductor equipment'.

The report starts with a general comparison of the economic, political and educational situation in both countries. In the next chapters the specific precision technology environment in both countries is explained and compared. The information in this report is based on literature research, combined with interviews with relevant stakeholders in both countries. Furthermore, visits to innovative Swiss organizations were performed to get a better view of the cooperation possibilities. The original research proposal can be found in appendix B.

The report concludes with some specific recommendations for R&D - cooperation between stakeholders in both countries. Hopefully these guidelines and suggestions will give rise to fruitful new cooperation, to further strengthen the relations between Switzerland and the Netherlands. I want to thank all the people who have helped with this research by providing information though documentation and interviews, a full list of participants is in appendix I. Special thanks go to Florin Müller, Roger Swifcz, Casper Langerak, Friso van der Veen and Roy Paulissen, who have given the report an extra review.

Frederik Deunk

Note: Switzerland uses the Swiss Frank as currency, for comparison an exchange rate of 1 CHF = 0.821 € is used.

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1. Comparing Switzerland and the Netherlands

Switzerland and the Netherlands are relatively rich, highly educated and internationally oriented countries. Although Switzerland consistently scores a bit better in global innovation statistics, both countries have their own strong and weak points and can therefore benefit from each other. This study starts with a brief introduction of both countries. In the third part of this chapter the innovation systems in both countries are compared.

1.1 A brief introduction of Switzerland

Switzerland is a country in central Europe with about 8 million inhabitants; it has an open and internationally oriented economy and is surrounded by European Union (EU) member states. According to the Organization for Economic Co-operation and Development (OECD) in its 2014 country review, the Swiss have the highest life expectancy of the whole OECD area. More than a quarter of the residents is foreign born. The household incomes are among the highest within the OECD area. The trust in the government with 82% is high.

Switzerland has four official languages: German, French, Italian and Romansh. The distribution of the languages is shown in figure 1. Most Swiss people also speak English. The country is a confederation of 26 independent cantons with their own regulations. Although Bern is the capital, most people are cantonally oriented. This is relevant for companies when choosing a location for a subsidiary.

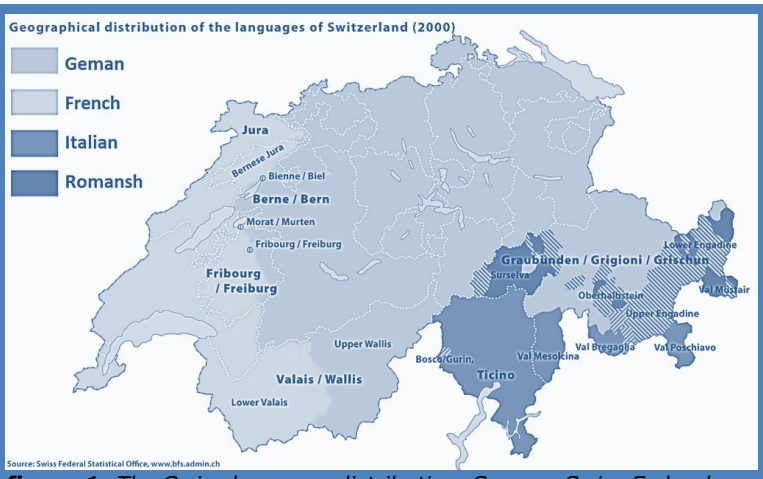

***figure 1**: The Swiss language distribution. Source: Swiss Federal Statistical Office (BFS).*

Most of the educational institutes are cantonally organized, only the two technical universities (ETH Zürich and EPF Lausanne) are federal education facilities. The OECD notes the strong upper secondary and vocational tradition of Switzerland, this contributes to the relatively low unemployment rate of 4,2% in 2012.
The European Commission (EC) notes Switzerland in its 2013 Research and Innovation Report as an 'Innovation Leader', as it has been for several years already. The Swiss R&D intensity was 3,13% in 2012. The private R&D expenditure is relatively high, with a percentage of 73,5% of total R&D expenditure. The Commission also notes the participation of Switzerland in various European projects.

The Swiss democracy is unique in the world, with a strong participation of citizens in the political process. Referenda and popular initiatives are essential instruments of this direct democracy. Citizens may propose changes to the constitution with a popular initiative. When successful, the government has three years to integrate the initiative into regulations. Major changes initiated by the federal government are always voted on in a referendum.

Volksabstimmung 9th of February 2014

On the 9th of February there was a popular initiative, where the Swiss people voted with a small majority for regulations against mass immigration. Due to the Swiss political system, this result has direct constitutional force. The government now has three years to interpret the initiative and reform regulations accordingly.
The EU sees this as in contradiction to the objective of the Agreement on the Free Movement of Persons with Switzerland (FMOPA). As a result of the initiative, Switzerland is currently excluded from EU R&D – programs.

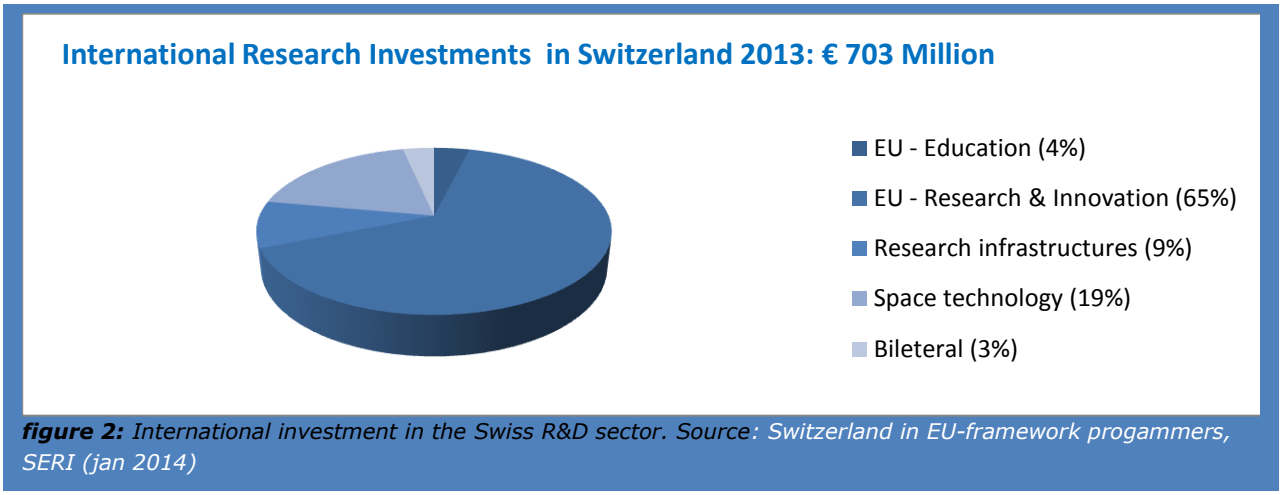

figure 2: *International investment in the Swiss R&D sector. Source: Switzerland in EU-framework progammers, SERI (jan 2014)*

As can be seen in figure 2, about 70% of the international research funding in Switzerland comes from EU-programs. The governmental research funds (SNF and CTI) are currently filling the gap to prevent short-term problems. For the internationally oriented innovation environment there are three changes after the initiative:

- The Erasmus+ treaty is cancelled, thus canceling the general student exchange program. This also means that students are not automatically eligible for study-grants anymore.
- Switzerland is regarded as a third country participant in the Horizon 2020 program, thus making it harder to get funding for international projects and Swiss institutions are excluded from direct ERC-grants.
- There are fewer possibilities for start-ups to receive R&D funding, as the criteria are wider in the EU program than in the CTI programs.

The Eurosearch platform for international research and innovation
For more information about the Swiss participation and research cooperation in European programs the website Eurosearch is a good starting point. Eurosearch is funded by the Swiss State Secretariat for Education, Research and Innovation (SERI) to provide hands-on information and advice in transnational partnering related to European research and innovation programs.
www.eurosearch.ch

Swiss education system

The Swiss education system is different from most European education systems. As mentioned before, Switzerland has a strong upper secondary and vocational tradition. When changing from higher education to professional education, you have to get some additional qualifications, and vice versa. The advantage of the Swiss system is the skilfull employees it creates. People who choose for professional education are highly educated in the operation of high-tech machines.

2 A brief introduction of the Netherlands

The Netherlands is a country in Western Europe lying in the Delta of the Rhine and the Maas. The Netherlands has about 17 million inhabitants. The country is internationally oriented and member of the EU. Due to its harbour in Rotterdam and the shipping over the Rhine and the Maas it has huge trade volumes with other European countries.

The official language in the Netherlands is Dutch. Nearly all of the Dutch people do speak English however, especially in international industries. Also, there are quite some German and French speaking individuals. The capital of the Netherlands is Amsterdam, but the political institutions and ministries are mainly situated in The Hague. Regulations are more or less the same in the whole of the Netherlands, although slight differences in the regulation of regional policy areas (such as spatial planning) may occur. The Netherlands has three technical universities; they are situated in Delft, Eindhoven and Enschede.

The Netherlands is organized as a constitutional monarchy. The power is in the hands of a democratically chosen government through a parliamentary representation system. The Netherlands is one of the founders of the EEC, the predecessor of the EU. The OECD notes in its 2014 country review the strong decentralization of the Dutch education system, with 86% of the decisions taken at school level.

The EC describes the Netherlands as an 'Innovation follower' in its 2013 Research and Innovation Report, the R&D intensity is relatively low in both the private and public sector, with 2,04% in 2011 recovering from the minimum of 1,77% in 2008. The performance of the Netherlands in the EU research program FP7 was successful, with a success rate of 25,7%, the second highest of all member states.

The OECD innovation policy review

Recently a thorough report about the Netherlands innovation policy is published by the OECD: *"The Netherlands has a long, proud history of innovation, but more can be done to boost innovation as a way to help tackle the challenges of low growth, an ageing population, and the need to increase competitiveness in global markets. This review stresses the importance of broadening the innovation base to engage more firms in innovative activities, enhancing the benefits of the Top Sectors approach, and maintaining world-class pubic research (including universities) to strengthen innovation performance."*

www.oecd.org/sti/inno/oecdreviewsofinnovationpolicy.htm

2.1 Comparing the countries

Economic indicators

When comparing Switzerland and the Netherlands it becomes clear that the countries are already quite connected. Table 1 shows some indicators of both countries. The internationalization of Switzerland is among the highest in the world, with 27.3% foreign born inhabitants.

Numbers and rakings of 2012	Switzerland	The Netherlands
Inhabitants	8,1 million	16,8 million
Percentage foreign born population *(OECD, 2011)*	27,3%	11,4%
GDP	€ 491 billion	€ 599 billion
Purchasing power per person	€ 40.300	€ 32.600
Goods exports to the other country	€ 2,3 billion	€ 5,7 billion
High/Medium Tech contribution to trade balance	8,44%	1,68%
Patents per million inhabitants	109	50
International Rankings		
World Innovation index (WIPO)	1	4
Global Innovation Quotient (Bloomberg)	7	15
Global competitiveness report (WEF)	1	8
Countries by patents (WIPO)	8	9

table 1: *Indicators of Switzerland and the Netherlands. Source: Eurostat, or mentioned otherwise*

Switzerland has roughly half the inhabitants of the Netherlands, but its GDP is only 18% lower. The price level in Switzerland is higher however, corrected for purchasing power the difference in welfare is 19%. The relative contribution of the High Tech industry to the trade balance of Switzerland is higher than in the Netherlands.

The World Intellectual Property Organization (WIPO) classifies Switzerland as the 'number one' innovation country. The Netherlands is listed in this ranking as 'number four', with a relative efficiency of 91% compared to Switzerland. In other rankings both countries have relatively high scores. Especially the high ranking in "Countries by patents" is remarkable for both countries, as it is not corrected for country size.

Regarding the latest available numbers of the EC in the Innovation and Research Report of 2013, with 2,87% of GDP in 2008, Switzerland has a higher investment in R&D relative to the GDP than the Netherlands, with 2,04% of GDP in 2011, as shown figure 4. Switzerland has a share of 73,5% of private investment in the total R&D expenditures; the Netherlands have a 52,5% share. Besides, the EC mentions there is a trend of increasing R&D budgets for the universities in Switzerland, with an average rise of 5% per year from 2000 till 2010.
In this country review also the hot-spot industries for the EU Key Enabling Technologies are listed, this is shown in in table 2. The overlap of these hot-spot industries shows the comparable high tech sectors in both countries.

Hot-spot industries in key enabling technologies	
Switzerland	Energy, Evironment, ICT, Nanosciences and Nanotechnology
The Netherlands	Food and agriculture, Energy, ICT, Nanotechnology, Security, Health technology

table 2: *Hot-spot industries of Switzerland and the Netherlands. Source: European Commission 2013 Research and Innovation performance in Switzerland/the Netherlands*
Note: Pharmaceuticals are not regarded as an EU "Key Enabling Technology", thus is not listed as hot-spot.

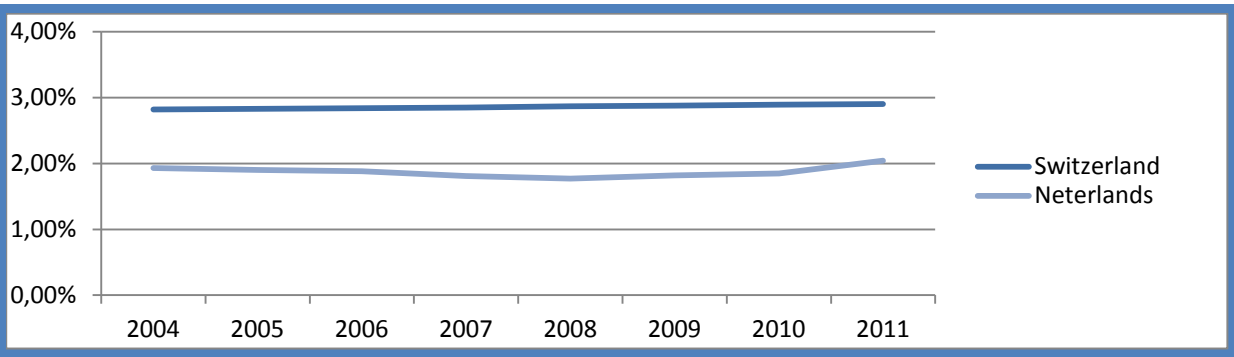

figure 4: *R&D as percentage of the GDP of each country, Source: OECD*
Note: Switzerland has less measurement points than the Netherlands, that is partially the reason it looks more stable, 2004 and 2008 are the only two available numbers for the OECD. In 2012 the R&D intensity was 3.13% according to the Swiss State Secretary of Education Research.

The trade volumes of both countries within engineering are shown in figure 5. The total engineering trade volume in 2013 was about €3 billion, more than one third of the total amount of € 8,0 billion trade between the countries.

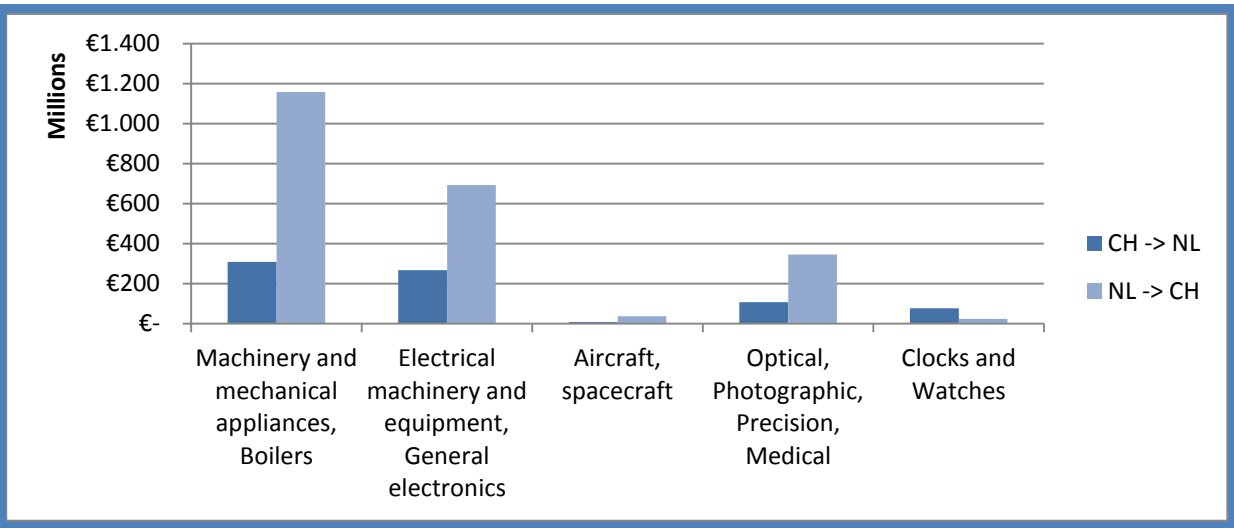

figure 5: *Trade in billion euro's between Switzerland and the Netherlands, Source: EU Trade commission (2013)*

The relevance of the high tech industries in the international trade of both countries is shown in figure 6. The total high tech exports were 63 billion dollar for the Netherlands and 50 billion dollar for Switzerland in 2012.

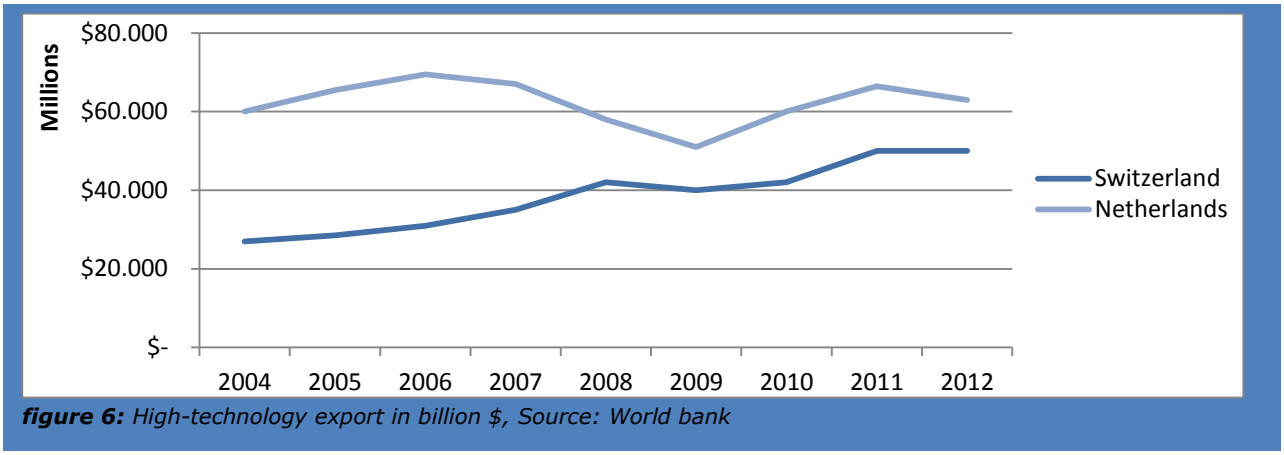

figure 6: *High-technology export in billion $, Source: World bank*

Technical universities

The main technical universities in Switzerland and the Netherlands are under the ETH and 3TU structures respectively. The initiative is different however; the ETH Domain is the providing structure of the government, which has actively brought the universities together in this structure. The 3TU is a voluntary cooperation of the three technical universities to promote collaboration and their common interests with the government; the 3TU does not have a specific review board.

Times University Ranking 2013- 2014 (Engineering and Technology)			EU-ranking
8	ETH Zürich	86,9%	3
15	EPF Lausanne	78,9%	5
23	TU Delft	68,9%	6
61	TU Eindhoven	53,2%	13
73	UTwente	47,2%	14

table 3: *Times University Ranking for Engineering and Technology. Source: www.timeshighereducation.co.uk*

In the Times University Ranking the ETH Domain is internationally highly regarded, which is clear when viewing table 3. The two foremost strongpoints in the rating of the ETH Domain are research and international outlook, furthermore they have a relative high scientist/student ratio. A real strongpoint of the 3TU is the industry strong connections and interchange with the industries.

Comparing both organizations, as shown in table 4, the ETH has a significantly higher budget, with which it educates fewer students, but creates more promotion places and research jobs. Furthermore both countries were successful in receiving ERC grants of the former EC FP7 research-program. In the EU FP7 research program both countries were top ranking, a bit less than half of the received grants is on the subject of Physical Sciences & Engineering.

Comparing ETH and 3TU (2013)	ETH Universities	3TU
Budget	€ 1.946 Million	€ 1.218 Million
of which external research funding	€ 489 Million	€ 329 Million
Students	27.649	36.306
PhD promotions (2012)	1254	588
Staff	13.987	10.708
Total ERC Grants 2007-2013 (countrywide)	147	192
ERC Grants Physical Sciences & Engineering 2007-2013 (countrywide)	70	75

table 4: *Comparing the ETH Universities with the 3TU federation. Sources Annual report 2013: ETHZ, EFPL, TUD, TU/e, UTwente + ERC information*

The business etiquette's of both countries compared
While both countries are open en internationally oriented, there are some differences in business-culture between the countries. It is important to realize this is a generalization, individuals can act quite differently. A good start is that both countries have a very positive view of each other and an open attitude.

Swiss people and organizations are relatively conservative compared to the Netherlands. They prefer strong and long term relations; this is combined with a preference for local products and suppliers. Although the main languages of Switzerland are German and French, it is a mistake to treat them as a part of Germany or France respectively. For instance, the "standard" German spoken in Germany, is referred to as "Schrift-Deutsch" or "Hoch-Deutsch" in Switzerland, the Swiss prefer to talk in their own dialect with each other.
Contacts in Switzerland are important and intensive, with a focus on the long term. It is not customary to have a quick contact or to just ask for an offer/appointment. This is seen as un-interested and not solid. As a consequence Swiss companies expect a well-developed and plain offer with clear cost and specifications. The costs itself are not the problem, but it is important that everything is clear. This all should be combined with a good feel for "Pünktlichkeit" and quality. Finally Switzerland is divided in 26 different cantons, with their own regulations and sub-cultures. This means that there are quite some local differences, this is important to know when selecting a partner or a place for a subsidiary.

In comparison the Dutch are more open and less hierarchical. Quality is important, but the price as well and products are reviewed for their functional quality. There is more willingness to change from supplier in the Netherlands, this openness and willingness to change makes the Dutch sector very flexible and open for new initiatives, which results in many cross-over and creative industries. The culture throughout the Netherlands is roughly the same; with only minor local differences.

More extensive (Dutch) information about the Swiss Business culture can be found at the website of the Netherlands Embassy in Bern:
zwitserland.nlambassade.org/you-and-country/zakendoen-in-zwitserland
switzerland.nlembassy.org/you-and-netherlands/working-in-the-netherlands

The European Innovation Union review
The European Commission writes a yearly country review about the research and innovation climate of each of its member states and Switzerland:
ec.europa.eu/research/innovation-union/index_en.cfm

A Dutch view of studying in Switzerland
In this Dutch article about the study environment in Switzerland a comparison between the ETH Zürich and the TU Delft is made. It is noted that there is a real focus on knowledge and technical skills at the ETH Domain, they aim for a relative high level in accessible knowledge. The 3TU system focusses more on independent working and social skills. Concluded is that both skills are necessary for innovation, so the interchange of between the cultures is a great opportunity.
http://delta.tudelft.nl/artikel/zwoegen-in-z-rich/26076

2. The Swiss precision technology environment

The Swiss watchmaking and machinery industry has grown and diversified in several application areas, and has thus become one of the strongholds of the Swiss high tech industrial environment. In this section the role of the government, educational institutes and various private organizations in the Swiss precision engineering environment is reviewed more in detail in three sections. A fourth chapter is about the new initiative to develop the Swiss Innovation Park, a federal initiative to increase the competiveness of the Swiss industry.

2.1 Swiss governmental organizations

The relevant governmental organizations can be divided in two roughly independent parts. First there are the governmental bodies, which fund the educational system. Second there are the two main (governmental-) funds for innovation, one for fundamental research, and one to help start-ups and close-to-market technology.

Governmental bodies

On the federal level the confederation aims to create the best preconditions; like a good infrastructure and efficient educational systems, but avoids financial support to companies. Most of the federal education money goes to the two technical universities within the ETH Domain, who use it to fund their research and education. Cantons organize the financial structures for the other educational institutes. The budgets are shown in table 5. The Swiss Department for Economic Affairs, Education and Research (EAER) is the department where the relevant institutions are supervised. The total budget for Education and Research of the federal government in 2011 was € 5.343 million, and the budget for research was € 549 million.

Education budgets 2011	€ Million
Federal	4.795
Canton	18.560
Municipality	8.908

table 5: *Education budgets. Source: Schweizer Finanz-ambt (EFD)*

The supervision of the ETH Domain goes through the ETH Board. This Board reviews the quality of the institutions and acts as an interaction platform between the Federal department of Economic Affairs, Education and Research (EAER) and the different educational institutes, more about this in section 2.2. As far as the government helps private organizations, it is through public-private research and support or initiating branch organizations. The most relevant governmental institutions for innovation in Switzerland are listed in table 6.

Government programs; a possible interesting information source
The National Centers of Competence in Research (NCCR) programs are one of the few top-down initiatives of Switzerland. The programs provide an interesting starting point to get a view of the knowledge and structure in Switzerland. There are various interesting NCCR programs for the precision technology sector, such as Molecular Ultrafast Science and Technology (MUST), Quantum Science and Technology (QSIT) and Robotics.
www.nccr-must.ch
www.nccr-qsit.ethz.ch
www.nccr-robotics.ch

Relevant federal institutions	
EAER www.wbf.admin.ch	Ministry of Economic Affairs, Educational and Research (EAER) has two relevant state secretariats, SERI and SECO, for the innovation climate. Furthermore it manages the ETH domain, the structure is shown in figure 7.
SERI www.seri.admin.ch	The State Secretariat for Education, Research and Innovation (SERI) is the governmental department which assists the research institutes and NGO's. Important is to realize that a major part of the education is regulated at cantonal level.
SECO www.seco.admin.ch	The State Secretariat for Economic Affairs (SECO) is the federal government's center of expertise for all core issues to economic policy It also tries to help international business by campaigning for efficient, fair and transparent trade-rules around the world.
EDK www.edk.ch	As most of the education is cantonally organized, there is the Swiss conference of Cantonal Ministers of Education (EDK). This organization is formed to find solutions for national problems and to adjust the different cantonal systems to each other. In the area of higher education, it tries to get inter-cantonal funding for the education and research sector, this to spread the costs of the education system evenly over the cantons.
Swissnex www.swissnex.org	Swissnex is the federal organization for connecting the Swiss research institutes to the rest of the world. Their goal is to connect scientists, facilitate academic programs, create trans-disciplinary projects, support internationalization and inform on development in science, technology, education and innovation policies.
Swissuniveristies www.swissuniversities.ch	Swissuniversities is founded to intensify the collaboration between the Universities, Universities of Applied Sciences and Universities of Teacher Education. This to connect, represent and promote the higher education institutes in Switzerland.
SwissEEN www.swisseen.ch	In the Swiss European Enterprise Network, Euresearch and Switzerland Global Enterprise combine their expertise to support SME's with transnational business and innovation.
Swiss Academies of Art and Sciences www.akademien-schweiz.ch	The academy engages themselves specifically for an equitable dialogue between science and society, they advise politics and society in science-based issues that are relevant to society.
ETH Board www.ethrat.ch/en	The ETH Board is the commission appointed by the federal government to represent and supervise the ETH Domain.

***table 6**: Relevant federal institutions*

The local development agencies: Standort-förderungen

Due to the cantonal organization of Switzerland most cantons, or groups of cantons, also have their own business development agencies. These agencies can inform you about the specific rules and possibilities in each canton. On the website of Ansiedlung Schweiz, you can find an overview of these agencies:

www.ansiedlung-schweiz.ch/standortwahl/wirtschaftsfoerderung-der-kantone/

Research funds

At the national level there are two main research funds to finance the innovation sector. The Swiss National Science Fund (SNF) is the fund for fundamental research, and the fund with the highest budget. The Commission for Technology and Innovation (CTI) is smaller and more oriented towards closer to market research.

The SNF

The SNF funds the fundamental research in Switzerland and is the most important source of the funding of research in universities. It does not conduct its own research and reports to the SERI. The SNF has aim to promote and fund scientific research in Switzerland. The SNF has a general policy to just review the quality and not steer the research in a certain direction, about 90% of their budget goes to 'free-research'. Roughly 10% of the budget goes to relatively small prescribed programs, a large-scale expiation is the Nano-tera research program.

SNF (2013)		€ Million
Funding budget		**672**
Funding Mathematics, natural and engineering sciences (27%)		217
Funded scientific FTE's (entirely of partially)	8900	
Amount of projects (partially) financed	3500	

table 7: *Key figures of the SNF. Sources: Annual report SNF 2013*

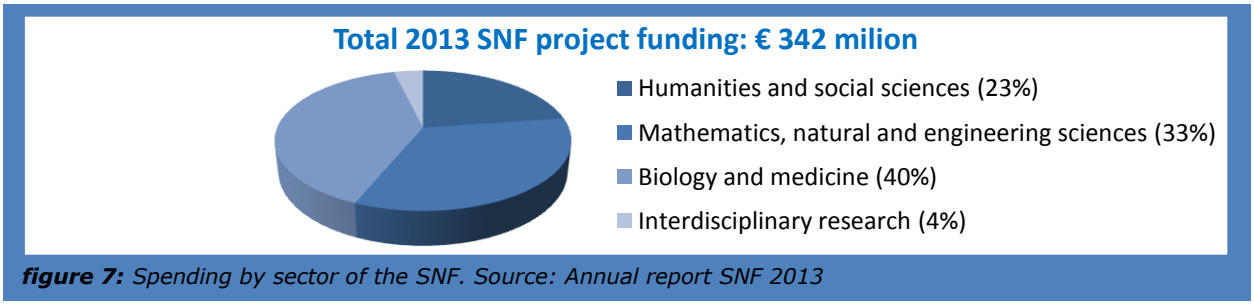

figure 7: *Spending by sector of the SNF. Source: Annual report SNF 2013*

Remarkable in the Swiss funding possibilities is the international orientation. Especially for young researchers there are relatively many grants to go abroad. Within several programs the SNF is currently funding a total of 22 research stays in the Netherlands. There is also a specific program under the name of Sinergia, with a budget of € 46,7 million, which has the aim to strengthen international cooperation. About half of the budget of € 114,6 million for mathematics, natural and engineering sciences goes to physics and engineering sciences. Of the total research budget about 60% goes to the various universities, 23% to the ETH Domain and a further 2% to the universities of applied sciences.

Website: www.snf.ch

An interview with the SNF about their interests

In an interview with the SNF several possibilities for more cooperation were discussed. The SNF would like to support more long term cooperation with the Netherlands, preferably in long term cooperation. Currently for the SNF the Netherlands are ranked sixth for international cooperation with other countries. Interesting starting points for more cooperation:

- Both SNF and NWO are active in the Science Europe organization, this European organization promotes and represent the interests of research.
  www.scienceeurope.org
- The SNF is open for research under a reciprocity approach, thus reviewing bilateral research in one commission and improving efficiency.
- The SNF has currently 167 international collaborations with the Netherlands.
- The cooperation between universities and companies in the Netherlands is highly regarded in Switzerland
- In the P^3 database meaning, Project, People and Publication is a very useful information data-base to find the experts in various research fields
  p3.snf.ch

The CTI

The Commission for Technology and Innovation (CTI) has the aim to fund applied scientific research and innovative projects. This is to promote innovation, their motto is therefore: "Science to market". The CTI supports joint R&D projects where higher education and business work together. The funding of a CTI project always goes to a public research organization, as companies are not allowed to receive grants from the government. Generally a company should deliver a minimum of 50% of the cost of a project, of which 10% as a cash contribution, the other 40% in kind (e.g with the input of the workforce). The personal and other costs of the public research organization are covered by the CTI. In the strategic program of the CTI has defined its three main activities:

- **Project promotion (research and development projects):**
  To help the business sector innovate by financing the public part of close to market research, thus strengthening the (knowledge intensive) Swiss economy.
- **Promotion of entrepreneurship and start-ups:**
  Helping and promoting start-ups with introduction in professional network, this through offering coaching, training and advice to the new entrepreneurs.
- **KTT support:**
  Helping companies with finding knowledge by connecting the researchers in their network to companies. Furthermore promoting application orientated research in an international setting.

CTI (2013)	€ Million
Funding budget	**102,5**
R&D funding	90,9
Start-up funding	8,6
KTT support	2,9

table 8: *KTI funding budget. Source: KTI Taetigkeitsbericht 2013*

The overall budget of Start-up assisting is steadily increasing over the years, from € 6,9 million in 2009 to € 8,6 million in 2013, stimulating young companies. A clear difference with the SNF is the direction of the funds: 46% of the funding goes to the Universities of Applied Sciences, 30% to the ETH Domain, 12% to other universities and 6% to CSEM. As shown in figure 8, the areas the CTI

focusses on are all close to the precision engineering sector.

Website: www.kti.admin.ch

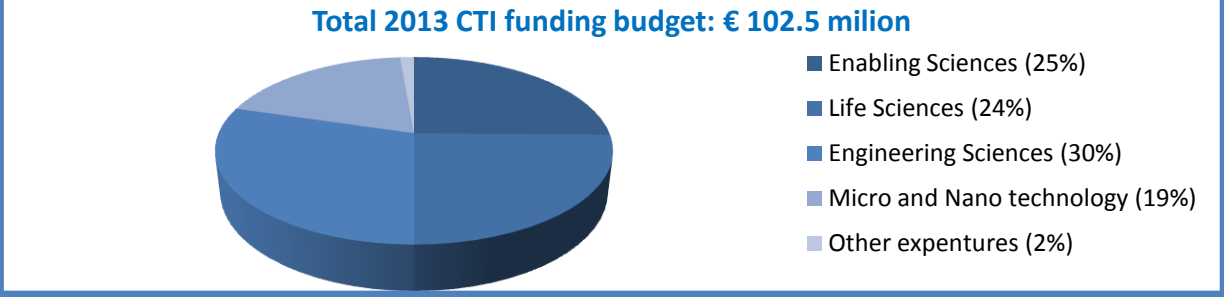

figure 8: *Spending by sector of the CTI. Source: Annual report CTI 2013*

Funding requirements of the CTI, national and international
To be entitled for CTI funding, there are ten requirements to meet for Swiss companies:

- *"At least one company and one 'not-for-profit' research institution (university, Federal Institute of Technology, University of Applied Sciences) recognized by the CTI should be involved in a CTI project. Projects involving several participants are particularly encouraged.*
- *As a general rule, the industry partner covers at least 50% of the project costs, a further incentive to ensure the efficient transfer of research results to the market ("reality check"). It also makes a cash contribution to its academic partner.*
- *The project partners choose the topic. Preferably, the economic and implementation partner heads the project.*
- *The project focuses on innovation. In general, no funding will be given to projects which propose marginal improvements of existing products.*
- *The criteria for proposal assessment are: economic, technical and scientific importance, commercial potential, contribution to sustainable development, clear work programme and a transparent budget.*
- *The project must have quantified, measurable goals and a coherent and structured schedule with verifiable progress milestones. It must be based on a thorough appraisal of the current state of the relevant technology and on an evaluation of the corresponding data base and patent rights.*
- *A contract on intellectual property rights must be signed prior to the start of the project. A confidentiality clause should be included where necessary.*
- *The focus is on projects which aim for efficient and fast time-to-market. Funding will also be given to new long-term "discovery projects" with a high innovation and commercial potential.*
- *Regular reviews by CTI experts help the partners to adhere to the project contents and time schedule where necessary by asking for timely corrections.*
- *At the end of the project, a plan must be presented showing how the results will be implemented."*

For bilateral projects, with a foreign partner, there are some extra requirements:

- *"Prior to accepting and evaluating such an application, the CTI Secretariat will, where appropriate, contact the relevant foreign promotion agency to see whether efforts can be coordinated .*
- *Foreign partners can only provide funding in cooperation with a Swiss research institution.*
- *It must be shown that the planned project will bring added value to both the Swiss implementation partners and the Swiss research partners.*
- *In particular, in order for foreign research partners to be involved, it must be shown that their research competence complements that of the Swiss research partners.*
- *The major part of the research activities must be carried out in Switzerland, and the major part of the CTI funding for research activities must be employed by the Swiss research partner.*
- *The total amount of CTI funding is distributed via the Swiss research partner, who is required to act as the main research partner."*

Source: (CTI):
www.kti.admin.ch/projektfoerderung/00025/00027/index.html?lang=en
www.kti.admin.ch/projektfoerderung/00213/00268/index.html?lang=en

2.2 Education and research organizations

The main federal education and research institutes of Switzerland are bound in the ETH Domain, under supervision of the confederation through the ETH Board. Under this board there are the two main technical universities and four research institutes, structured as shown in figure 10. Furthermore some universities have relevant research groups; in appendix C all higher education institutes in Switzerland are listed.

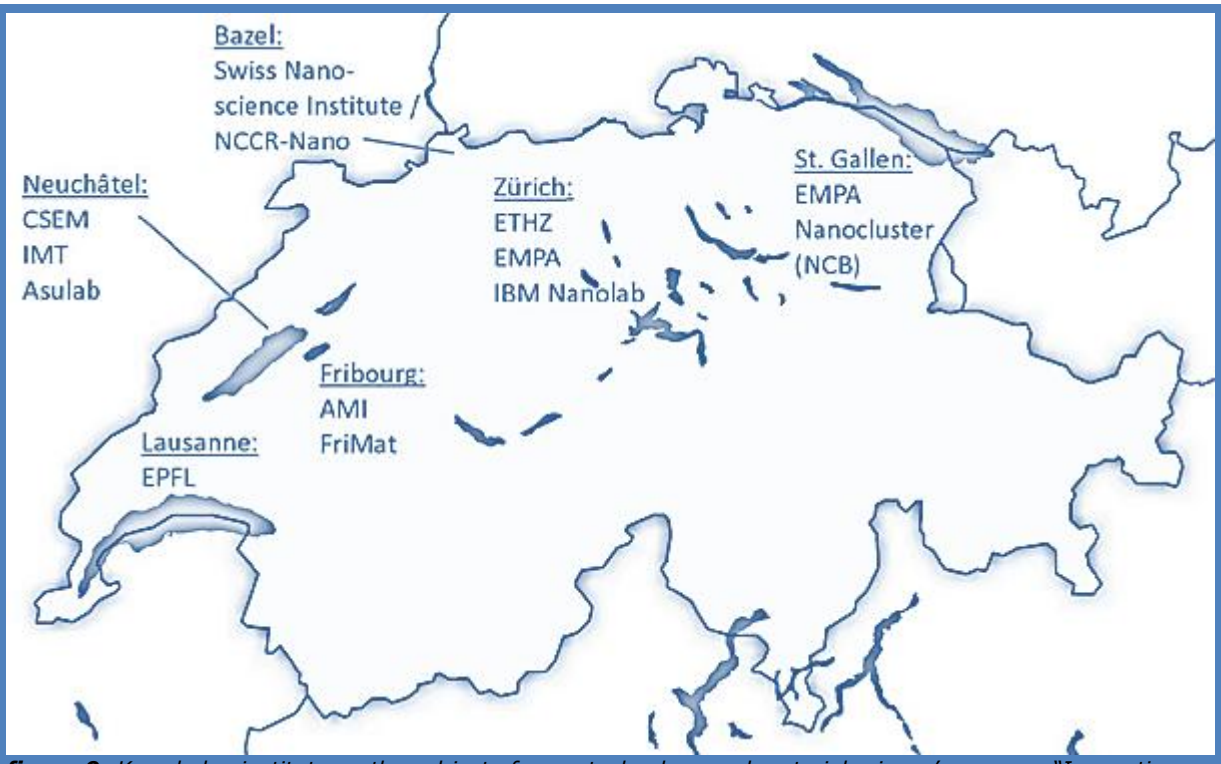

figure 9: *Knowledge institute on the subject of nano-technology and material science's. source: "Innovatie op z'n Zwitsers", M. Prinz (2010)*

In the research of M. Prinz, a map of the most relevant organizations for HTSM was made, as shown in figure 9, all these and some other will be further reviewed in this chapter. Most of these institutes are under the ETH Domain, the budget of these organization received from the ETH board is shown in table 9. For precision engineering, the ETH, EPF, PSI and EMPA are the most relevant institutions; each of them will be reviewed in this section.

Federal Department of Economic Affairs, Education and Research (EAER)					
Board of the Swiss Federal Institutions of Technology (ETH Board)					
ETH Zürich	EPF Lausanne	PSI	WSL	EMPA	EAWAG

figure 10: *ETH Domain organization structure, based on the website of the ETH Board*

ETH Domain institute funding 2013		Subject	€ Million	share
ETH Zürich	www.ethz.ch	Technical university	917,9	51,8%
EFP Lausanne	www.efpl.ch	Technical university	456,9	25,8%
PSI	www.psi.ch	Fundamental physics	235,1	13,3%
EMPA	www.empa.ch	Material sciences	75,8	4,3%
WSL	www.wsl.ch	Forrest, snow and landscape	41,5	2,3%
EAWAG	www.eawag.ch	Water research	44,1	2,5%

table 9: *allocation of the ETH funding Source: ETH Board Annual report 2013*

ETH Zürich

The Eidgenössiche Technische Hochschule Zürich (ETH Zürich) is the largest technical university of Switzerland. It has 21 Nobel laureates and 17.800 students. The curriculum of the university is directed to five main subjects: Architecture & Civil Engineering, Engineering Science, Natural Science & Mathematics, System-oriented Natural Sciences and Management & Social Studies. The bachelor courses are in German, at master level the teaching is in English.

ETH Zürich (2013)		€ Million
Budget		1.241
Federal		941
Third-party		300
Personnel	10.478	
of which professors	497	
Students	17.781	
Spin-offs in 2013	24	

table 10: *Numbers of the ETH Zürich Source: Annual report 2013 ETH Zürich*

To facilitate research the ETH Zürich has several major research centers:

- Binning and Rohrer Nanotechnology Center (BRNC) together with IBM Research
- FIRST Center for Micro- and Nano science
- Electron Microscopy ETH Zürich (EMEZ)
- Functional Genomics Center Zürich (FGCZ) together with the University of Zürich.
- ETH Phenomics Center (EPIC)
- Light Microscopy and Screening Centre (LMSC)

Evident is the availability of micro- and nano-scale infrastructures to perform research. This research is partially performed together with private parties. This is the case in the famous BRNC, which is partially funded by IBM. As shown in figure 11, more than a third of the third-party funding of the ETH Zürich is received from business.

With a total score of 86,9% in the Times University Ranking, the ETH Zürich scores especially high on research and international outlook. This results in an eighth place in the Engineering and Technology ranking, and a third place if only the European universities are regarded.

Website: www.ethz.ch

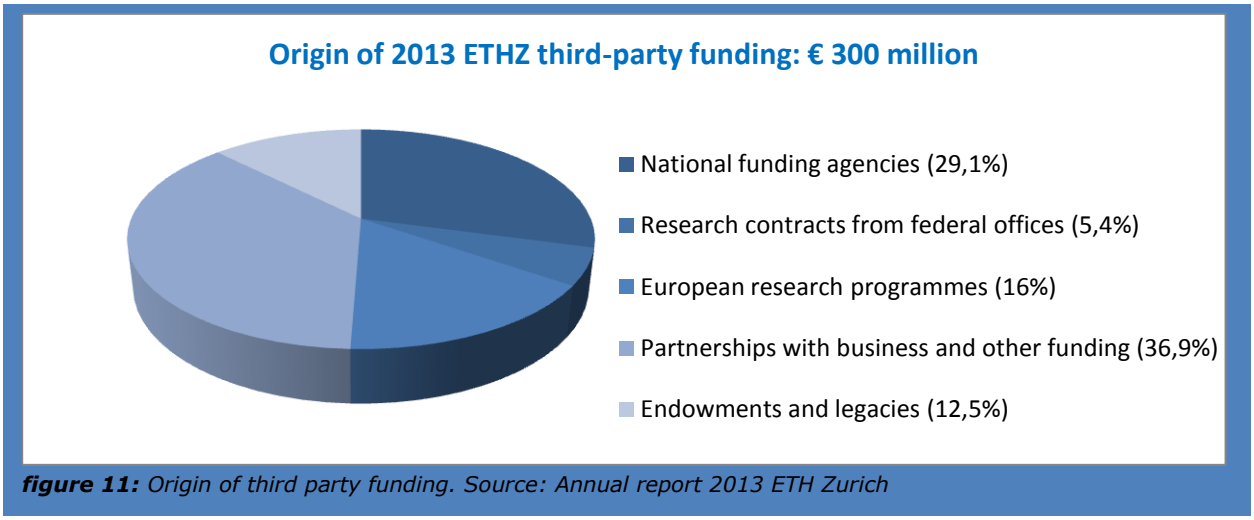

figure 11: *Origin of third party funding. Source: Annual report 2013 ETH Zurich*

An intensive European university cooperation; IDEA League
The IDEA League is a network of four leading universities of technology and science:

- Technical University of Delft
- Eidgenössiche Technische Hochschule Zürich
- Rheinisch-Westfälische Technische Hochschule Aachen
- Chalmers University of Technology, Gothenburg

The goal is to create added value by pooling resources for collaborative and complementary programs for students, researchers and staff.
www.idealeague.org

EPF Lausanne

The École Polytechnique Fédérale de Lausanne (EPF Lausanne) is the second ETH University in Switzerland with 9.400 students. The curriculum of the EPFL is directed to seven subjects, covering nearly all possible technical subjects. The Rolex Learning Center is one of the flagships of the university. EPF Lausanne also hosts an engineering and science park with quite some start-ups and research centers from many countries. The university has two official languages, French and English. The official language for research is English.

EPF Lausanne (2013)		€ Million
Budget		705
Federal		495
Third-party		189
Personnel	3.509	
of which professors	330	
Students	9.868	
Average yearly spin-offs since 1997	12	

table 11: *Numbers of the EPF Lausanne Source: Annual report 2013 EPF Lausanne*

The EFPL has several locations in the western parts of Switzerland. The main campus is in Lausanne, but there are various subsidiaries in Genève, Sion, Basel and Neuchâtel:

- Lausanne -The main campuses where most of the education and research is performed
- Genève – Biotechnology
- Sion – Energy and Health research
- Basel – Architectural/Urban design
- Neuchâtel – Micro and Nano-scale research

The EPFL scores strong in getting receiving from government as well as from European projects, as shown in figure 12 about the third-party funding. They were in 4th place in receiving ERC grants from the FP7 EU project from 2007 till 2013.
In the Times Higher Education Ranking for engineering and technology especially the international outlook and the citation quote are highly regarded. With a total score 78.9 % the EPFL is listed as 15th and is the fifth European university in this ranking.

Website: www.epfl.ch

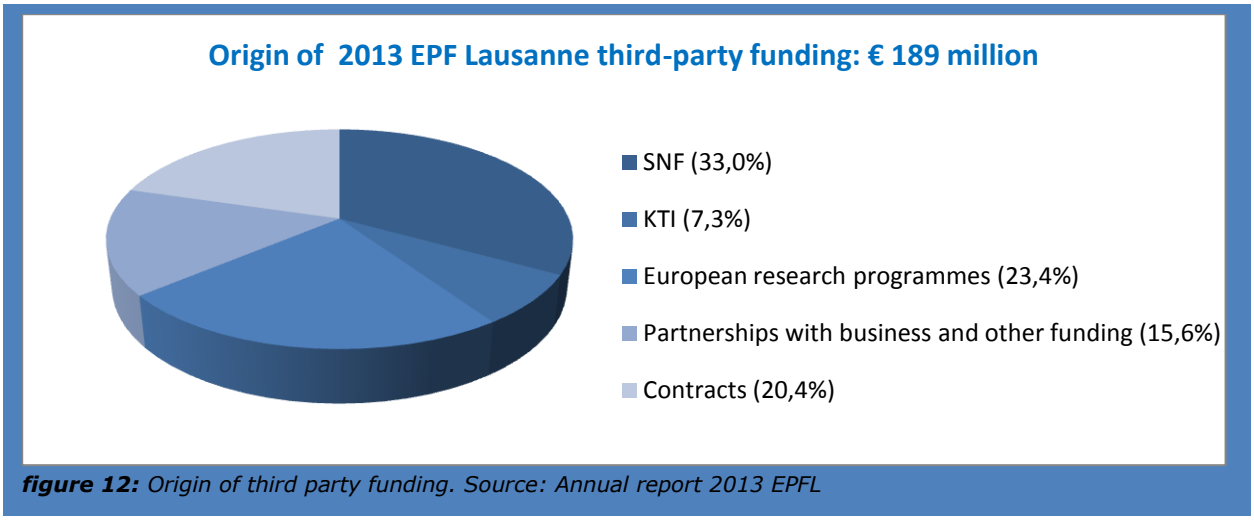

figure 12: *Origin of third party funding. Source: Annual report 2013 EPFL*

The EuroTech alliance
EuroTech is a strategic partnership between four universities:

- Technical University Denmark
- Eindhoven University of Technology
- École Polytechnique Fédérale de Lausanne
- Technische Universität München

Their mission is to find technical solutions to address major challenges for modern society. There are intensive collaborations across research, education and innovation. One of the themes of cooperation is Massive Open Online Courses (MOOCs).

eurotech-universities.eu

The PSI

The Paul Scherrer Institute (PSI) is the largest natural science research institute in Switzerland and is based in Villigen, canton of Aargau. The institute concentrates on 3 main subjects: the structure of matter, energy & environment and people & health. The facility helps scientists from all over the world to conduct their experiments. The institute is world renowned for its research on the subject of fundamental physics and its good facilities.

PSI (2012)		€ Million
Budget		277
Basic funding		189
SwissFEL		16
Third-party funds		72
Personnel	1.500	
of *which scientists*	524	
Post graduate students	300+	

table 8: *Numbers of the PSI Source: Website PSI + Annual report PSI*

The PSI has 3 large scale research facilities, plus one new facility currently under construction:

- **Swiss Spallation Neutron Source (SINQ)**
  With a continuous neutron source the structure and dynamics of condensed matter are researched.
- **The high-intensity proton accelerator (HIPA)**. A smaller facility is a proton accelerator of which beams can be guided to the SINQ
- **Swiss Light Source (SLS)**
  The SLS is a synchrotron light source of high-brightness which is used for research in material science, biology and chemistry.
- **Swiss Muon Source (SμS)**
  The SμS is the world most intense continuous beam muon source. It is used to research the magnetic properties of materials.
- **SwissFEL(Under construction)**
  The SwissFEL will produce very short pulses of X-rays, with laser-like properties. This facility visualizes extremely fast processes at the nanometer and femtosecond scales.

With these facilities, the PSI and the users of its large-scale facilities perform research on the fundamentals of materials and their behavior. They have extensive collaborations with private organizations, as shown in figure 14.

Website www.psi.ch

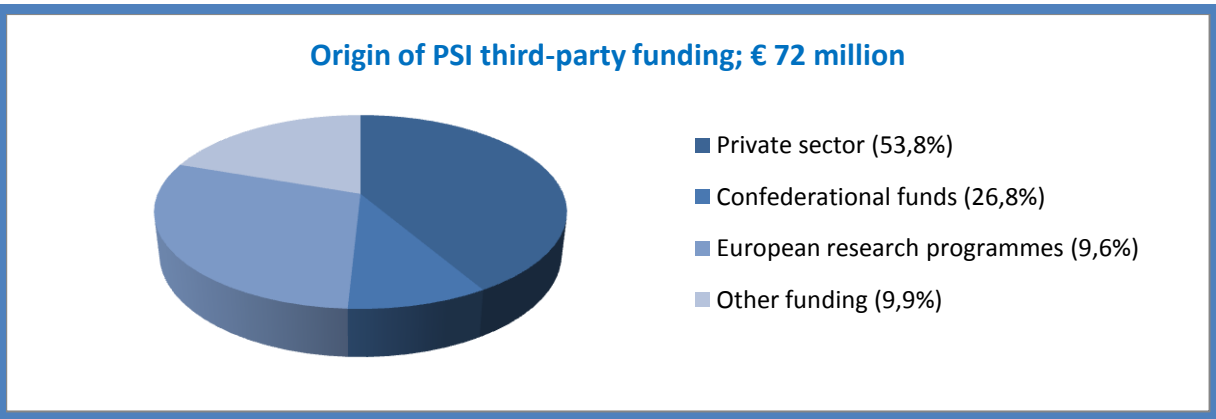

Figure 14: *Origin of third party funding. Source: Website PSI*

An interview: Interest of the PSI

The PSI sees various possibilities for cooperation with the Netherlands, both for knowledge transfer and technology procurement. The Dutch precision industry, with strong points in lithography and mechatronics, has the knowledge to deliver high-precision components for their facilities.

But also for technology-transfer there are possibilities. The PSI tries to commercialize its products and inventions together with commercial parties. A good base for long term cooperation with the PSI is InnoAARE park, which is currently being developed at the PSI site. The park will become an innovation hub within the Swiss Innovation landscape, as shown in chapter 4 of this section.

Proton therapy, a new medical usage of protons

"*Some sections of society benefit directly and immediately from out-patient proton therapy at the Institute. In 2012, PSI registered again more than 5000 visits from cancer patients. A success rate of more than 98 % puts PSI at the very forefront internationally in regard to the successful irradiation of melanoma of the eye. In 2012, approx. 60 % of the patients with deep-seated tumours were children and teenagers. More than half of whom were infants, who received their treatment under anaesthetic.*"

www.psi.ch/protontherapy/protontherapy

The EMPA

The Eidgenössiche Materialprüfungs- und Forschungs-Anstalt (EMPA) is based in Dübendorf, Sankt Gallen and Thun. It is an interdisciplinary research and services institution for material sciences and technology development. The institute tries to close the gap between research and practice. The institute works together with industrial partners and develops innovations with them, this strengthens the competitive position of the Swiss industry.

EMPA (2013)		€ Million
Budget		132
Federal funding		80
Thrid-party funds		50
Other		2
Personnel	516	
of *which scientists and professors*	385	
of which PhD students	131	

table 13: *Numbers of the EMPA Source: Annual report 2013, EMPA*

The main location of EMPA is in Dübendorf, where most facilities and the biggest campus are located. The subsidiary in St. Gallen mainly specializes in textiles and bio-engineering. The subsidiary in Thun is specialized in process-technology and micro and nano-technology materials.
The research within EMPA is always oriented from the viewpoint of materials. The institute covers a large range of materials (such as bio-based materials, including wood, plastics, metals and ceramics) and application areas (from large-scale bridge building to nano-engineering). An oversight of the specialties of the EMPA is given in figure 14.

Website: www.empa.ch

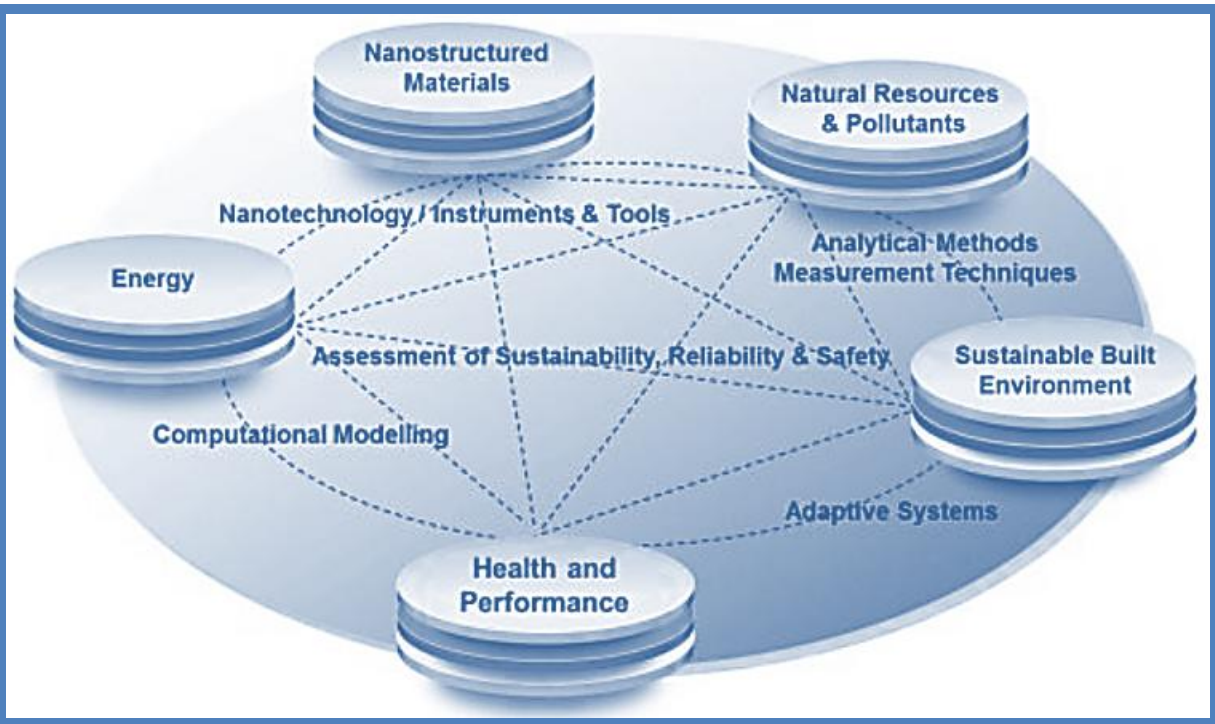

figure 14: *Research subjects of the EMPA Source: EMPA website*

Speaking with the EMPA about their view of international cooperation
In an interview with EMPA several possibilities for cooperation were discussed. EMPA is interested in international R&D-cooperation to strengthen the knowledge in Switzerland. The cooperation is preferably long term on each subject of materials. They have excellent testing facilities, but for nano-scale research they work together with other institutes to get access to clean-rooms and lithographic possibilities.

Some possible subjects for cooperation are:

- High precision 3D printing
- Graphene
- Thin foils
- Extreme conditions materials
- Bio-materials
- Sustainable materials
- Polymer and composites
- Phase contrast composite scanning
- Self-repairing materials

For more information for the industry:
www.empa.ch/plugin/template/empa/1080/*/---/l=2

An recent breakthrough by the EMPA: A two carbon-atoms thick graphene filter
"A new nano-membrane made out of the "wonder material" graphene is extremely light and breath-able. Not only can this open the door to a new generation of functional waterproof clothing, but also to ultra-rapid filtration. The membrane produced by researchers at ETH Zurich and Empa, the Swiss Federal Laboratories of Materials Science and Technology, is as thin as is technologically feasible."
www.empa.ch/plugin/template/empa/1358/146762/---/l=1

Non-ETH institutes

Outside the ETH domain there are also some other educational and research institutes with interesting innovative possibilities for the Dutch HTSM sector. Various universities have strong and good research groups and the CSEM research institute is a big player in the Swiss research market, they are shown in table 14.

Knowledge centers	
SNI www.nanoscience.ch	The Swiss Nanoscience Institute (SNI) is developed from the national center of competence in research (NCCR-Nano). It is founded by University Basel and Canton Aargau.
University of Fribourg www.unifr.ch/science/ www.am-institute.ch frimat.unifr.ch	The University of Fribourg has a large science department and two relevant research institutes. The Adolphe Merkle Institute (AMI) is an independent research institute for theoretical and applied nano-science, FriMat is short for the Fribourg Center of Nanomaterials.
University of Basel philnat.unibas.ch www.fmi.ch	The University of Basel is the oldest university of Switzerland. Nano-science is a strongpoint of the university and it cooperates closely with Swiss Nano-sciences Institute. The Friederich Miescher Institute for Biomedical Research is associated with the UniBas.
University of Bern www.philnat.unibe.ch www.einstein.unibe.ch www.artorg.unibe.ch www.csh.unibe.ch	The University of Bern has fundamental physics, medical technology and space research among its key areas. It cooperated with the first lunar expedition and still has strong ties with NASA and ESA. It hosts three interesting research institutes: Albert Einstein Center for Fundamental Physics ARTOG Center for Biomedical Engineering Center for Space and Habitability (CSH)
University of Zürich www.mnf.uzh.ch	The University of Zürich (UZH) has a very broad orientation and is the largest Swiss university. Especially the 'mathematics & natural sciences teaching and research' area is relevant.

table 14: *Knowledge centers about precision technology in Switzerland*

The Swiss MNT Network

The Swiss Micro- and Nano-Technology Network gathers the main Swiss institutional actors in the field. The objective is to strengthen the links within the sector, from education and research to production.

www.swissmntnetwork.ch

The international research organization CERN

The Conseil Européen pour la Recherche Nucléaire is often mistakenly seen as a Swiss institution because of its location in Geneva. It is however an international organization, with only their testing facility located in Switzerland. A great deal of the research is done at other locations throughout the world.

CERN officially falls under international law and their procurement regulations are quite different from other institutions. There is a whole system trying to balance the procurement evenly over various countries. For more information or questions, each country has its own liaison officer as contact point for their industry:

Liaison officer Swiss industry: Dr. Martin Steinacher (SERI)

Liaison officer Dutch industry: Mr. Robert Klöpping (NIKHEF)

For more contact details:

procurement.web.cern.ch/who-to-contact-in-your-country

CSEM

The Centre Suisse d'Electronique et Microtechnique (CSEM) is a research institute funded with public and private funds to develop technology platforms for the benefit of industrial customers and start-ups. The research is performed with academic partners and they are part of the international Heterogeneous Technology Alliance (HTA), an international research corporation platform.

CSEM (2012)	€ Million
Budget	58
Public funding	24
Project funding, private and public	34
Employees	440+
PhD students and trainees	45+

table 15: *2012 numbers of the CSEM Source: Annual report 2012, CSEM*

Historically the organization started in the region of the French-speaking watch industry, but over the years their research has expanded into the whole area of electronic and mechatronic systems, as can be seen in figure 15. Their headquarters are in Neuchâtel, but there are four subsidiaries: Zürich, Muttenz, Alpnach and Landquart. It also has two foreign subsidiaries, one in Brazil and one in the United Arabic Emirates. The CSEM have split their research into five research subjects:

- **Photovoltaics:** partially in cooperation with the EFPL new high-tech solutions for solar components and systems are developed.
- **Microsystems:** the development of MEM's based devices for several engineering areas
- **Surface engineering:** from wetting, to (bio-) molecular absorption and UV-lithography
- **Systems:** a multidisciplinary platform for research on scientific instrumentation, medical device technology, automation and clean-tech.
- **Ultra-low-power integrated systems:** the design and industrialization of wireless and optical systems with low power and voltage usage.

website: www.csem.ch

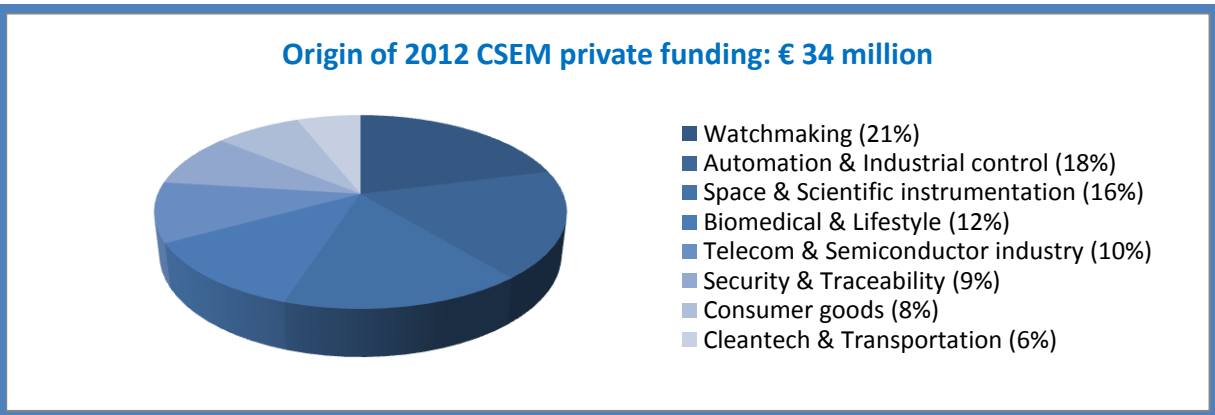

figure 15: *Origin of third party 2012 CSEM funding. Source: Annual report 2012 CSEM*

Microcity; a research facility in Neuchâtel
A recent new facility of the EPFL next to the CSEM is Microcity. At this 'innovation center' there are various high-tech labs for micro- and nano- technology:
microcity.epfl.ch

Cooperating with the CSEM

In an interview with the CSEM several possibilities for cooperation were suggested. The research-scope in the organization is broad. Several technologies could connect well to the Netherlands knowledge infrastructures, for instance in the last years CSEM performed research amongst the following subjects:

- Protection from foreign particles for food industry
- Mini-robotics
- MEM's
- Micro-fluidics and micro-dosing
- Grafting machines
- Lab on a chip
- LED-laser development
- 3D composite scanning systems
- Embedded systems
- Precision positioning with moving machinery
- Self-learning algorithms
- Various sensors

More information about the CSEM can be found at their website and in their annual scientific reports:
www.csem.ch/site/card.asp?nav=2468&title=Technology

The Heterogeneous Technology Alliance

"*The HTA is a novel approach to creating and developing microtechnologies, nanoelectronics, and smart systems for next-generation products and solutions. By pooling the capabilities and facilities of:*

- *CEA (France)*
- *CSEM (Switzerland)*
- *The Fraunhofer Group for Microelectronics (Germany)*
- *VTT (Finland)*

the HTA creates coherence and synergies between leading teams and research infrastructures in the fields of miniaturization and systems integration. "
www.hta-online.eu

2.3 Swiss private organizations

Privately owned organizations are the biggest part of the precision engineering sector. In Switzerland there a lot of family owned SME's on the subject of precision engineering. They are united in various branch organizations. Also some private research institutes and companies related to precision engineering are listed in this section.

Swiss SME's

The SME's are most effectively found through cluster organizations. Cluster organizations have contacts in Switzerland and can inform outsiders about the possibilities for further cooperation. Furthermore it is good to notice that Swiss cluster organizations have a more public function than in the Netherlands, due to the direct democracy. Table 16 gives an oversight of some potentially interesting cluster organizations for the precision engineering sector.

Cluster and supporting organizations	
Eurosearch www.euresearch.ch	The Eurosearch Association supports the Swiss participation in European research, providing information, coaching and a network.
ITS Schaffhausen www.its.sh.ch/cluster	The Industry and Technozentrum Schaffhausen connects local industry with other partners and helps with the search for technology partners.
MCCS www.mccs.ch	The Micro Center Central-Switzerland is Swiss application oriented network. The MCCS focusses on micro-technology companies in the central region and helps with access to research- and development competences.
Micronarc www.micronarc.ch	Micronarc is a cooperation created by seven cantons in the west of Switzerland. They have the aim to develop and promote regional scientific research on micro and nano-technology, improve the interaction between participants and act as a source of information to improve the exchange of information, both public and private.
Nano-Zentrum Bodensee neb-konstanz.de	Clusterinitiative Bodensee (CLIB) is an Euregional research cooperation between 4 countries: Switserland, Germany, Austria and Lichtenstein. The initiative has also a Nanotechnology sub-section for companies active in the region.
Präzisionscluster www.cluster-precision.ch	The Präzisionscluster is a platform for companies, suppliers, education- and research-institutes in the field of precision engineering en micro-technology. It tries to promote the sector and helps with networking conferences; its base is in Bern and the western part of Switzerland.
Swiss Mechanic www.swissmechanic.ch	Swiss Mechanic is the Swiss employers-organization for the mechanical and electronics SME's.
Swiss Mechatronics	Currently a Swiss Mechatronics cluster centered around the Zürich region is in development, this could be an interesting contact point in the future.
SwissCore www.swisscore.org	SwissCore is the Contact office for European Research Innovation and Education in Switzerland, funded by the SERI and SNF.
Swissmem www.swissmem.ch	Swissmem is the branch organization of the mechanical and electrical engineering industry in Switzerland, the largest industrial employer. The organization promotes the entire sector to politicians, national and international organizations and the public. It also assists companies with various services to perform well in the international market.

table 16: *Swiss cluster organizations*

Multi-nationals

In appendix G an oversight of the 40 biggest companies by R&D budget in Switzerland is given. The focus of these companies is wide; however pharmaceutical companies are clearly present, when looking for medical devices of micro-fluidics these could be useful parties. Table 17 shows the most promising non-pharmaceutical Swiss companies. In this selection the term ' Swiss' is taken a bit narrower, thus only listing companies with clear Swiss R&D activities. In table 18 some other R&D intensive research labs and companies are listed.

Private companies with largest R&D budgets	
ABB www.abb.com	A Swiss-Swedish multi-national; active in energy, automation, robotics, telecommunication.
Kudelski www.nagra.com	A multi-national active in manufacturing hard- and software for digital security and convergent media systems.
OC Oerlikon www.oerlikon.com	A conglomerate active in: Food production, Clothing, Transportation Systems, Infrastructure, Energy and Electronics.
RUAG www.ruag.com	Publicly owned Swiss company active in active in air, space and defense industries.
Swatch www.swatch.com	A Swiss watch-company, but also active in low voltage electronics, for instance ski-check-in-gates and car-keys.
Logitech www.logitech.com	A spin-off of the University of Applied Science Lausanne and currently one the largest computer hardware producers.
Endress + Hauser www.endress.com	Active in instrumentation and process automation, producing sensors for level, flow, pressure and temperature measurement.
Schindler www.schindler.com	Manufacturer of escalators and elevators .
Rieter www.rieter.com	A producer for textile machinery and components used in short staple fibre spinning.
Georg Fischer www.georgfischer.com	A production company active in piping, automotive and machining solutions; the last section produces lightweight castings and high-precision solutions.
Buhler www.buhlergroup.com	Active in plant, equipment, and services development for food processing and advanced materials.
Bobst www.bobstgroup.com	A producer of machinery for the packaging industry.
Sulzer www.sulzer.com	Active in industrial and mechanical engineering, divided in 4 sections: Pumps equipment, rotating equipment's services, Chemical technology and thermal spray & thin films.
Pilatus Aircraft www.pilatus-aircraft.com	An aircraft manufacturer located in central Switzerland.

table 17: *Swiss top R&D companies close to precision engineering*

Private research intensive companies	
IBM Research Zürich www.Zürich.ibm.com	World renowned and seen by some as the birthplace of nanotechnology. In these labs of IBM they work intensively together with the ETH Zürich and their researchers have received Nobel prizes.
AsuLab www.asulab.ch	The research facility of the Swatch group, active in micro-technology, microelectronics, telecommunications, displays, sensors and actuators, materials and process engineering.
IMT www.imtag.ch	IMT is a company specialized in customized microstructures both on and in glass and high-precision thin-films, this is done with microlithography and thin foil technique's.
Burger Mayer Group www.meyerburger.com	The BMG is active in innovative systems and processes based on semiconductor technology, with a focus on photovoltaic.
Maxon motors www.maxonmotor.com	Maxon motors is a supplier and developer of high precision drive systems for specialized usage.

table 18: *Swiss private research labs/R&D intensive companies*

Symposia and fairs

A good way to get a first impression and contacts for cooperation with the Swiss are symposiums or fairs, a few possibilities are shown in table 19.

Possible interesting symposia and fairs	
Technologiesymposium in Sankt Gallen www.technologiesymposium.ch	22 August 2014
SINDEX in Bern www.sindex.ch	2 – 4 September 2014
MNE Conference in Lausanne, www.mne2014.org	22 – 26 september
Micronora in Besançon www.micronora.com	23 -26 September 2014
Fakuma, in Friedrichshafen www.fakuma-messe.de	14-18 October 2014
IFAS-Medical & Hospital Equipment Exhibition in Zürich www.ifas-messe.ch	21 – 24 October 2014
Mechatronics forum in Friedrichshafen www.mechatronikforum.net/7_DEU_HTML.htm	5 – 6 November 2014
Swiss Tech + Prodex in Basel www.swisstech-messe.ch	18 – 21 November 2014
Verpakukung Schweiz in Zürich www.svi-verpackung.ch	25 – 26 March 2015
Swiss NanoConvention in Neuchâtel www.swissnanoconvention.ch	21 – 22 May 2015
Inventions New techniques & Products Exhibition in Geneva *www.inventions-geneva.ch*	15 – 19 April 2015
Environment Professionnel Microtechnologies (EPMT) in Geneva www.ephj.ch	2 – 5 Juni 2015

table 19: *Symposia and conventions in and close to Switzerland*

An impression of the Watch industry

The Swiss watch industry is world renowned and very successful the 25 last years. The Swiss watch-companies have an extensive knowledge on the subject of micro-engineering. For watchmaking itself the quality brand "Swiss made" is important, due to this and the rules around it is difficult to deliver parts of watches to all producers in Switzerland.

There are however more possibilities for cooperation, the production of the high precise parts of these watches needs special machines, also machines developed for the watch industry could be useful for other subjects. The watch industry has also much knowledge on the subjects of low voltage electronics and micro-engineering. This knowledge could be developed outside the watch-industry to develop or improve products.

A recent development in the Watch industry is to make more and more parts of silicon, due to its attractive thermal properties. This knowledge on micro-tooling of silicon could be interesting to combine with the knowledge of chip production in the Netherlands.
Research cooperation with the Netherlands could also be a competitive advantage for Swiss companies, since knowledge developed with Dutch educational or research institutes tends to be less shared with directs competitor's in the Swiss watch industry.

2.4 Swiss National Innovation park

To improve innovation in Switzerland the federal government has supported an initiative to create a national innovation park in Switzerland. This will not be just one location, but a connecting system of 'hubs' and 'network centers' throughout Switzerland. Two hubs and two network centers are currently preselected. The two hubs are connected to the ETHZ and EPFL respectively, the network centers are in Villigen, canton Aargau and in Allschwil, for canton Basel/Jura. The planning is that the park will be operational from January 2016.

The park should stimulate innovation by connecting education and research institutes to companies. In the innovation park knowledge institutes should cooperate with large multinationals, SME's and spin-offs. This park is for both national and international participation. The financing will be public and private. The locations should function independent from each other, with a federal wide promotion organization to promote the structure to the rest of the world.

Proposed locations:

- **Zürich hub of the Swiss Innovation-Park** in Dübendorf.
  This hub works together with the ETHZ, University of Zürich, the Zürich University of Applied Sciences as well as EMPA and EAWAG, thus creating an innovation hub with a wide range of specialist fields.
- **Lausanne hub of the Swiss Innovation-Park** in Lausanne.
  Working together with the EPFL, this hub aims become a central pivot for French-speaking innovation environment. The hub should reinforce the already active Innovation quarter of the EPFL, currently already hosting 13 multinationals and various SME's and spin-offs.
- **InnovAARE** is the network center next to the PSI campus in Villingen.
  The hub concentrates on the subjects Human and Health, Advanced processes and Materials, Energy and Accelerator technology in cooperation with the PSI. Supporting companies for instance are: ABB, Alstom, Axpo and Swisscom.
- **Swiss Innovation Park Nordwestschweiz**, is the network centrum in Allschwil.
  This center is organized by the cantons Basel Stadt/Landschaft and Jura. The focus is on Life-sciences in the widest view; from basic pharmaceutical and bio-technical research to related applied techniques as sensor and measuring research. The hub is located next to the campus of the pharmaceutical company Actelion.

There are six further possible locations for network centers, but those plans have to be further developed before they will be integrated in to the National Innovation structure.

Website: www.swissinnovationpark.ch

The Swiss start-up monitor
"The Swiss Start-up Monitor is a non-profit, scientifically backed initiative. Our mission is to generate quantitative data and insights on the development of the Swiss start-up scene to make start-ups an everyday topic and to lower the barrier for knowledge exchange between start-ups.'
startupmonitor.ch

Extra information in business journals
Swiss business journals could be an interesting information source to stay informed about innovations and fairs, some suggestions:
www.maschinenmarkt.ch; www.industrie-schweiz.ch; www.marktspiegel.ch

3. The Dutch precision technology environment

The Netherlands has a long history of precision engineering, with examples as the first microscope and the sawing machine. A part of the current Dutch precision technology high tech environment has evolved with Philips and the many spin-offs of this industrial company. The industrial base is wider however, with more companies having had their influences, such as Fokker Aircraft, the textile industries, car- and truck manufacturing and the large chemical industry.

3.1 Dutch Public Organizations

Governmental organizations

The enterprise policy of the Netherlands is the so-called "topsector approach", see figure 16. The government has designated nine strong sectors of the Dutch economy and tries to stimulate these nine topsectors to stay competitive on the world market. For this study, the topsector High Tech Systems and Materials (HTSM) is the most relevant.

The Dutch topsector-policy has a generic and a specific track. The generic track aims to build a competitive business environment, with a strong regulatory framework and generic fiscal incentives for companies to innovate. The government also provides financial instruments (mainly credits and risk capital) for R&D-projects, start-ups and fast growth companies. The specific track of the topsector aims at aligning public and private research agendas ("the golden triangle"). But also specific internationalization strategies of the topsectors, as well as efforts by topsectors to improve their human capital base and regulatory environments can be seen as outcomes of the topsector policy.

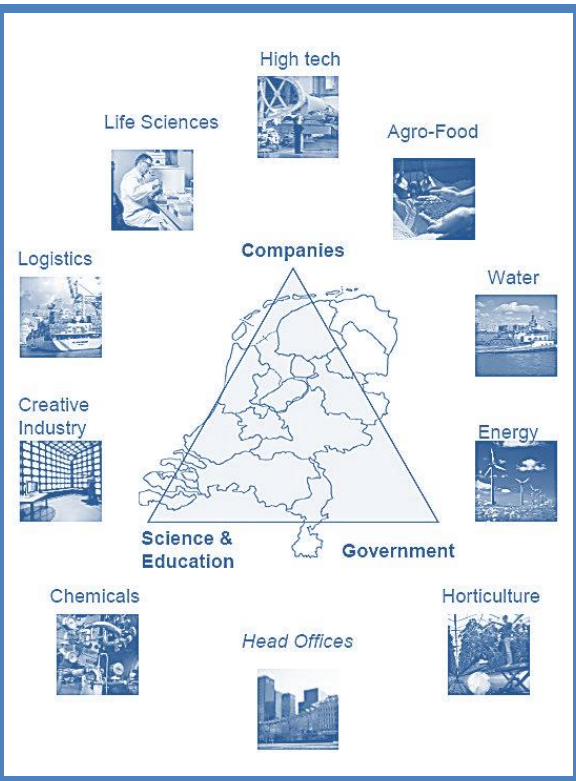

Figure 16: *Top-sectors. Source: HighTech Holland*

The topsector-policy is overseen by the Ministry of Economic Affairs, but carried out with other Ministries, such as the Ministry of Education, Culture and Science, the Ministry of Foreign Affairs and the Ministry of Infrastructure and the Environment. In table 20 an oversight is given of the most relevant governmental organizations for innovation. In the national reform program 2014, the government aims to invest about € 3 billion in fundamental research per year, a further € 340 million in applied research and a yearly budget of more than € 1,6 billion is available for fiscal stimulation.

RVO and the Innovation Attaché Network

The RVO is actively trying to promote the economic ties between Switzerland and the Netherlands, partly via the Innovation Attaché Network. The Innovation Attaché Network studies the research environment in other countries as a starting point for R&D-cooperation. For Switzerland it started with a study of the Swiss Innovation Climate in 2010. This is followed by reports about the Energy, Water, and Life Sciences sectors. These Dutch reports included an English or German summary and can be found on the following website:
www.innovatie.ch/publicaties

Netherlands governmental organizations	
Ministry of Economic Affairs www.ez.nl	The Ministry of Economic Affairs (EZ) is committed to creating an excellent entrepreneurial business climate. It has several agencies which carry out programs to stimulate international businesses. This is done through networking and promotion, but also with financial instruments. The Ministry also finances the institutes for applied research, such as TNO.
Netherlands Enterprise Agency www.rvo.nl	The Netherlands Enterprise Agency (RVO) is part of the EZ. Its task is to carry out programs to make companies more sustainable, innovative and more successful with their international activities. The Innovation Attaché Network is part of this Agency.
Ministry of Education, Culture and Science www.rijksoverheid.nl/ministeries/ocw	The Ministry of Education, Culture and Science (OCW) coordinates the education system of all levels as well as the science system. Its mission is to ensure that quality of education and prepare the society for responsibility and independence.
Royal Netherland Academy of Sciences www.knaw.nl	The Royal Netherlands Academy of Sciences (KNAW) is the national institute for sciences. It reviews the quality of research in the Netherlands and advises the government about scientific matters.
The Netherlands Foreign Investment Agency www.nfia.nl	The Netherlands Foreign Investment Agency (NFIA) helps foreign companies and institutes with establishing business in the Netherlands, already for 35 years. The NFIA gives advice, information, practical assistance and provides a network in the Netherlands. The NFIA is part of the Netherlands Enterprise Agency.

table 20: *Netherlands governmental organizations*

More information and the financial goals of the Dutch Topsector policy

The government has its own website with information about the topsector policy. The topsector HTSM furthermore has its own website (Holland High-tech), including contact points of the research institutes who cooperate. Furthermore there is a tool where you can select the theme or region and get the active Dutch companies in that specific field.

Each 'top-sector' has signed an' innovation-contract'. In this covenant between government, research institutes and companies, the strategic and financial targets are formalized. As shown in the table below, the target public-private R&D budget for HTSM in 2013 is € 764 million. The basis of this covenant are the 17 public-private technology roadmaps of the HTSM topsector.

Innovation covenant R&D budget HTSM, including nano-technology and ICT (€ million)	2013	2014	2015	2016
Companies	505	545	575	600
TNO (Institute for applied research)	31	32	30	32
NLR (National institute for air and space research)	3	3	3	3
NWO (National fundamental research fund)	42	57	57	64
Universities	55	69	77	86
Ministries and regions	128	91	95	77

Source: HTSM Innovatie-contract 2014-2015

For more information, you can visit the websites:

www.hollandhightech.nl

www.hollandhightech.nl/htsm/Roadmaps (Dutch, but the roadmaps are written in English)

www.government.nl/issues/entrepreneurship-and-innovation/investing-in-top-sectors

Research funding organizations

The Netherlands Organization for Scientific Research (NWO) is the national research council with a funding budget of € 756 million in 2012. It aims to stimulate public scientific research in the Netherlands through grants and by coordinating research. NWO is an Agency of the Ministry of Education, Culture and Science.

NWO (2012)		Million €
Funding		**756**
of which associated with the topsectors		303
of which HTSM		72
Funded scientific FTE's (entirely of partially)	6804	
Amount of projects (partially-) funded	1393	
Total grants	**446**	
Rubicon grants (International)	68	
Veni grant	151	
Vidi grant	94	
Vici grant	32	

table 21: *The numbers of NWO. Source: Annual report NWO (2012)*

Of the NWO scientific funding, a relatively big share is associated with its top-sector policy. As is shown in figure 17, about a quarter, € 72 million, of the funding budget of the NWO associated with the HTSM sector, which is the biggest sector within the top-sector policy. The NWO furthermore actively supports career possibilities for researchers with the Veni, Vidi and Vici grants. These grants support the careers of research by funding research in each step of their career. The Rubicon grant is for international cooperation of researchers.

Website: www.nwo.nl

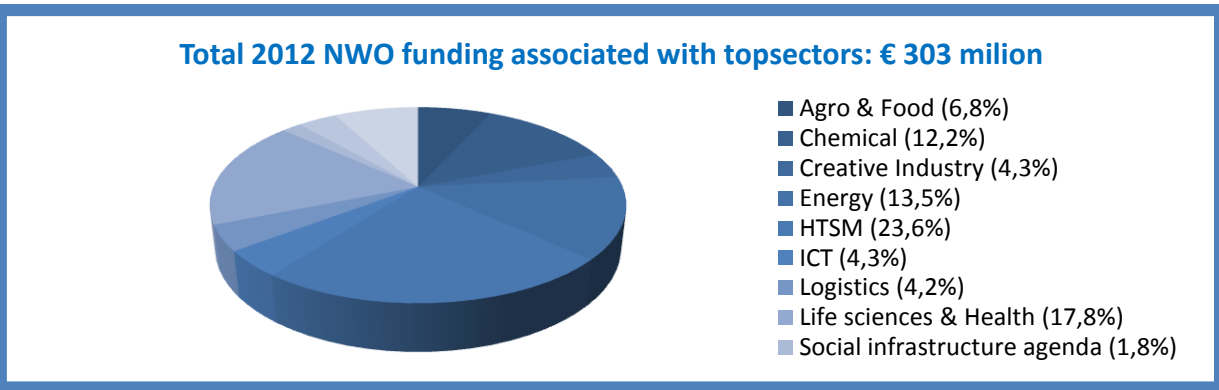

figure 17: *Spending by sector of the NWO in 2012. Source: NWO jaarverslag 2012*

The DOME project

The NWO institute ASTRON has in cooperation with IBM invested in the ASTRON & IBM Center for Exascale technology in Dwingeloo. This research center conducts fundamental research on the following three main area's:

- Green Computing
- Data & Streaming
- Nano-photonics

www.dome-exascale.nl

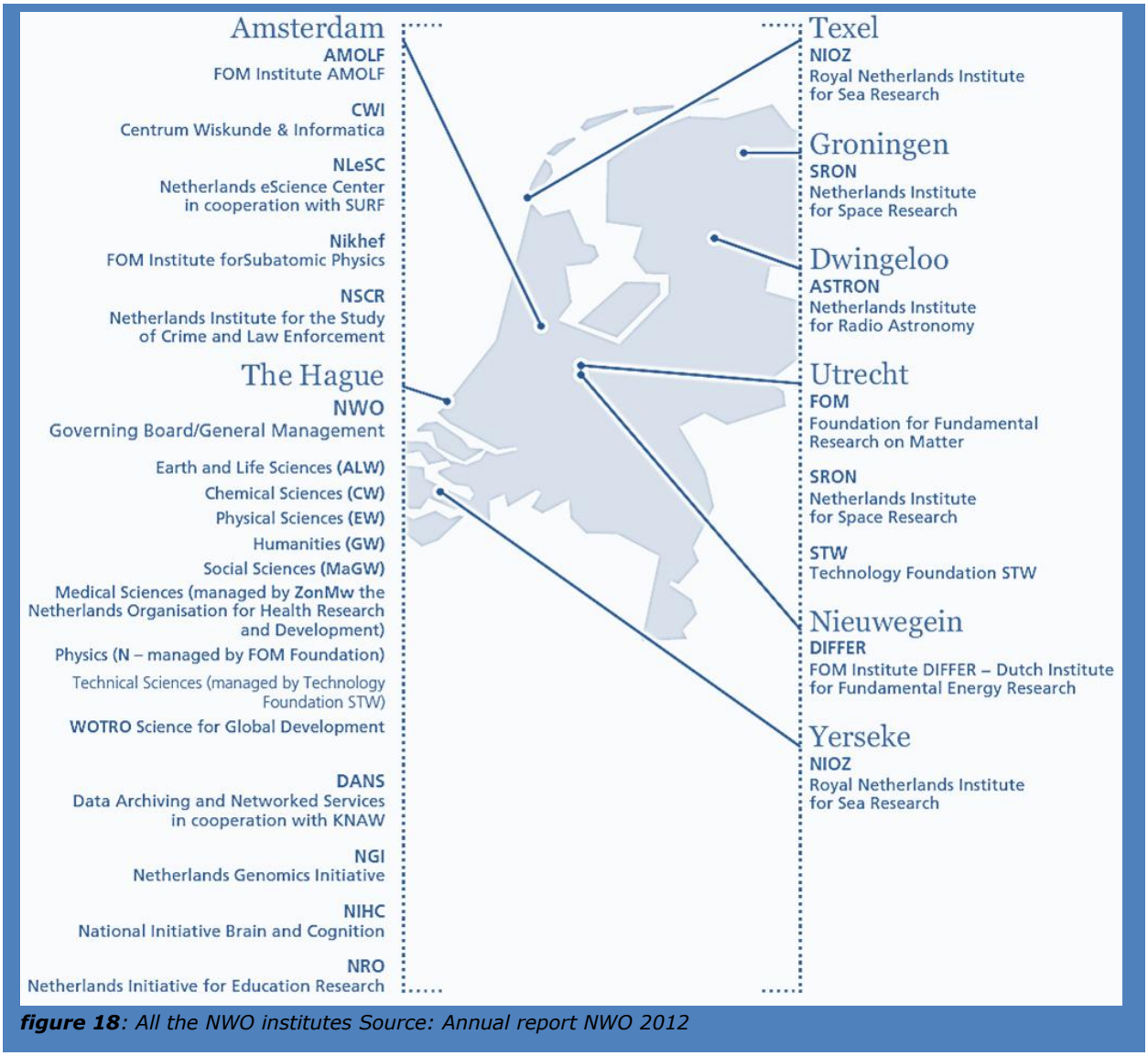

***figure 18**: All the NWO institutes Source: Annual report NWO 2012*

As shown in figure 18, there are several research/expertise centrums within the NWO. For the precision engineering sector the following institutes are the most interesting:

- Foundation for Fundamental Research on Matter (FOM) comprises of three institutes and an advanced research centre:
    - AMOLF in Amsterdam, which has two main focus theme's: Nano-photonics and physics of bimolecular systems
    - Nikhef in Amsterdam is the national institute for subatomic physics; it also coordinates the CERN participation for the Netherlands.
    - DIFFER is the Dutch Institute for Fundamental Energy Research, located in Nieuwegein.
    - ARCNL, is the Advanced Research Center for Nano-Lithography, which is located at the science park in Amsterdam
- Netherlands Institute for Space Research (SRON)
- Netherlands Institute for Radio Astronomy (ASTRON)

3.2 Education and Research institutes

The three tier-one technical universities of the Netherlands work together in the 3TU coalition. This coalition tries to promote technical education and coordinates the research and exchanges of information between the universities. Also some other universities are active in the precision engineering field. Furthermore there is the TNO as independent research institution for applied research, which includes a cooperation with Imec (Holst) and a research network for embedded systems (ESI).

TU Delft

The Technical University of Delft (TU Delft) is the oldest and largest technical university of the Netherlands. It was created as the royal academy for engineers in 1842 by King Willem II. The university has 18.781 students, of which 18% is of foreign descent. The university has eight faculties. More general information can be found in table 22.

TU Delft (2013)		€ Million
Budget		578
Primary funding		374
Research funding		143
Other		61
Personnel	4.536	
Students	18.781	
PhD promotions	353	

table 22: *Numbers of the TU Delft Source: Jaarverslag 2013 TU Delft*

To facilitate research, the TU Delft has several research facilities on its campus. For the precision engineering industries, especially the Van Leeuwenhoek Nanotechnology Laboratory is interesting. This in combination with the following faculties:

- Electrical Engineering, Mathematics and Computer Sciences
- Aerospace Engineering
- Applied Sciences
- Mechanical, Maritime and Materials Engineering (3mE)

In the Times University Ranking for Engineering and Technology the TU Delft has a score of 68,9%, which places them on the 23rd place in the world ranking and 4th place in the European ranking. The university scores best on the teaching and research scores.

Website: www.tudelft.nl

Research institutes associated with the TU Delft

The TU Delft has several research institutes, partially their own, partially in cooperation with other research institutes. For the precision-engineering sector the following institutes are the most interesting:

- Delft Institute of Micro-electronics and sub-microtechnology (DimesTC)
- Reactor institute Delft (RID)
- Kavli Institute of Nanoscience, part of the van Leeuwenhoek Nanotechnology Laboratory
- Netherlands Institute for Metals Research (NIMR)
- Delft Centre for Aviation (DCA)

A complete list and the links to the various institutes can be found here:
www.tudelft.nl/en/about-tu-delft/organisation/research-institutes/research-institutes/

The PME department of TU Delft is looking for more collaborative research

The Faculty of Mechanical, Maritime and Materials Engineering (3mE) currently comprises six departments, of which the Department of Precision and Micro systems Engineering (PME) focuses on the integration of fundamental and application- inspired research on mechanics and micro/nano technology, mechatronics and high-end production, as well as on (computational) design methodologies.

PME investigates fundamental questions and exploits knowledge from natural science, like how to manipulate and place atoms, reduce friction and wear, or grow 2-dimensional material; and on intrinsic mechanical engineering, like computational modelling, design and design tools, instrumentation and control, or systems architecture. The selection of topics is inspired by the application challenges related to High-Tech Systems and Scientific Instrumentation: increased functionality, high density of functions, and precision with speed.

Increasingly, PME sees a need for nano-engineering and nano-manufacturing, to bring the results from nano-science into industrial reality. Therefore, PME is currently in the process of defining new directions for collaborative research.

An Quantum computer in Delft

"The Dutch government has set its sights on the technology of the future: the quantum computer. Minister Kamp revealed as much on October 2nd, during his annual Innovation Lecture in The Hague, when he announced the establishment of the QuTech Centre in Delft, which is to be headed by TU Delft Professor Leo Kouwenhoven. QuTech is to form the bridge between research on the quantum computer and the Dutch high-tech industry. The Netherlands is one of the first countries in the world to establish such a large-scale initiative."

www.tudelft.nl/en/current/latest-news/article/detail/nederlandse-overheid-geeft-startsein-voor-race-naar-quantumcomputer/

TU Eindhoven

The Technical University of Eindhoven (TU/e) is situated in the middle of the so-called Brainport region around Eindhoven in the South-east of the Netherlands. In this area there are various high-tech companies such as Philips, ASML and DSM. The university has 7358 students and has strong ties with its industrial high-tech environment.

TU Eindhoven (2013)		€ Million
Budget		318
Primary funding		191
Research funding		94
Other		33
Personnel	3.131	
Students	8.211	
PhD promotions	218	

table 23: *Numbers of the TU/e Source: Jaarverslag 2013 TU/e*

Divided in nine departments the TU/e is active in nearly all sectors of engineering. The university is currently expanding the campus to not only host university buildings, but also to make room for more research cooperation with businesses and research institutes.
In the Times Engineering and Technology Ranking the TU/e is at the 61st place in the World ranking, with a score of 53,2%. It ranks 13th in the European ranking. Praised is the cooperation between the university and industry: this specific industrial income ranking has an overall score of 99,5%, which is higher than top-universities as MIT and Cambridge. This strong focus on industry cooperation can also be seen in figure 19, which shows that about 30% of the research budget comes from companies and other non-government organizations.

Website: www.tue.nl

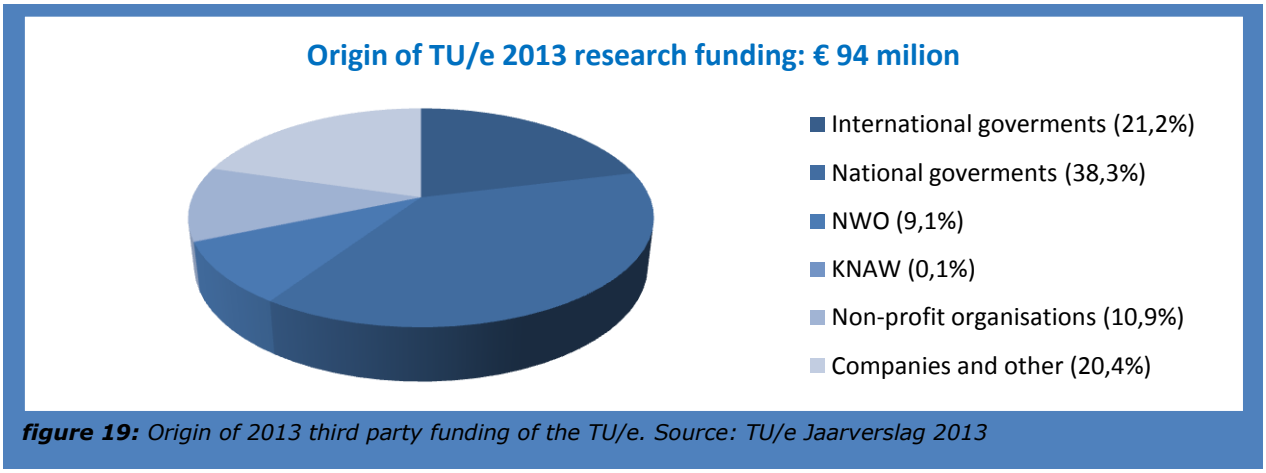

figure 19: *Origin of 2013 third party funding of the TU/e. Source: TU/e Jaarverslag 2013*

Research institutes and top-research groups of the TU/e
The TU/e has a few top research groups at their campus and is associated with top-institutes. The most interesting research groups for the precision engineering are;

- High Tech Systems Center
- Institute for Complex Molecular Systems
- Materials Technology
- Intelligent Lighting Institute
- Eindhoven Multiscale institutes

More information and links can be found over here:
www.tue.nl/en/research/research-institutes/research-institutes/
www.tue.nl/en/research/research-institutes/top-research-groups/

The Brainport region
Brainport Development is a cooperation between companies, knowledge institutes and government to promote and structure the high tech region of Eindhoven. The results of this cooperation are internationally acknowledged, for instance by the Financial Times:

"The investment climate in Eindhoven (The Netherlands) is the best in Europe after London and Helsinki. In the overall ranking of its Foreign Direct Investment Index (fDi index), the Financial Times ranks Eindhoven in third place. The heart of the high-tech Brainport region, is an excellent place to invest in the future according to the British financial authority. With its place in the top three, Eindhoven has made an unprecedented leap in the fDi rankings, which are closely followed by international investors. Never before has a Dutch city been so high on this list."

For more information:
www.brainport.nl
www.brainportdevelopment.nl
www.brainport.nl/en/business/financial-times-predicts-bright-future-for-eindhoven

UTwente

The University of Twente (UTwente) is located on a former country estate between Enschede and Hengelo in the east of the Netherlands. It is the youngest technical university of the Netherlands, and has a management and behavioral faculty as well. It has 9341 students and is the only full-campus university of the Netherlands. The university has a focus on entrepreneurship which has led to many spin-offs, about 600 in its 50-year history, see also table 24.

UTwente (2013)	€ Million
Budget	322
Primary funding	188
Research funding	92
Other	42
Personnel	3.041
Students	9.314
PhD promotions	220

table 24: *Numbers of the UTwente in 2013 Source: Jaarverslag 2013 UTwente*

Two of the faculties of the UTwente are behavioral faculties, the three others are technical faculties. The faculty buildings are close together, the students mingle and cross-disciplinary research is stimulated at the university.
The Times Higher Education Ranking, on Engineering and Technology, lists the UTwente at the 73 th place; 14th if only the European universities scores are taken in account. The strongpoints of the university are the international outlook, industry income and citations. In figure 20 the research funding of the UTwente is shown. Compared to the TU/e especially the investment of the NWO in fundamental research is higher.

Website: www.utwente.nl

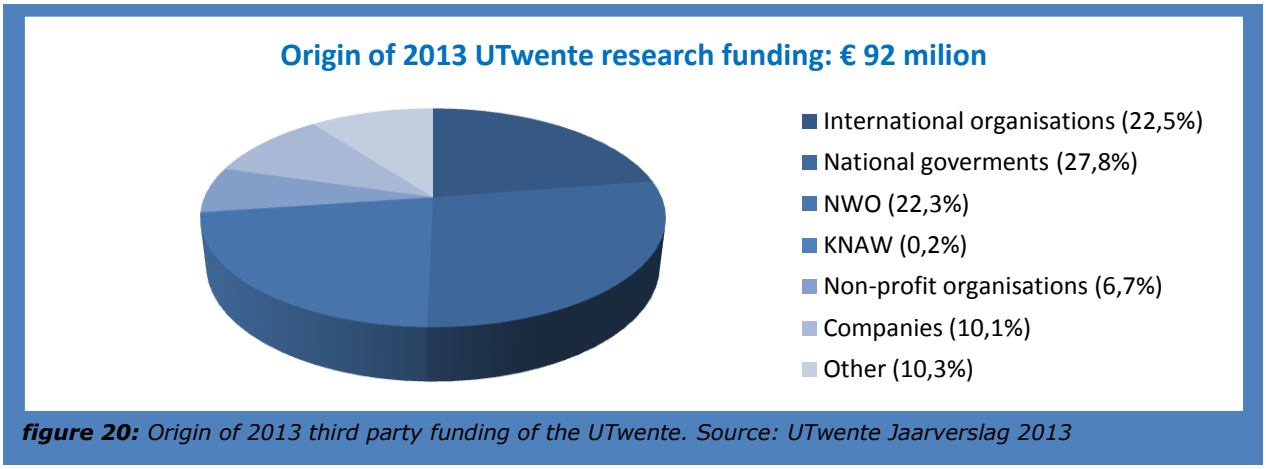

figure 20: *Origin of 2013 third party funding of the UTwente. Source: UTwente Jaarverslag 2013*

Research institutes and knowledge centers of the UTwente
There are four major institutes and a further 21 knowledge centers associated with the UTwente, the most interesting for the HTSM field are:

Research institutes:

- Institute for Nanotechnology (MESA+)
- Institute for Biomedical Technology and Technical Medicine (MIRA)

Knowledge centers:

- Drebbel institute for Mechatronics
- ThermoPlastic composite Research Centre (TPRC)

For more information:
www.utwente.nl/en/organization/institutes/

A new public and private cooperation at the UTwente campus: The High Tech Factory
The High Tech Factory facility has been opened at the campus of the UTwente to give smaller companies and start-ups the possibilities to work in a clean-room environment.

"There is an increase in the number of production companies engaged in micro- and nanotechnology, all of which have a need for specific mass production facilities for the commercial market. High Tech Factory facilitates and responds to production needs by offering high-quality cleanrooms, laboratories equipped with all the essential facilities and office space."

More information can be found at their website, also interesting is the list of participating companies in the High Tech Factory:
www.hightechfactory.nl
hightechfactory.com/companies/

The research facility MESA+
"MESA+ is one of the world's largest nanotechnology research institutes, generating an annual turnover of € 50 million. A total of 525 researchers work together on cutting-edge research at the highest level. This involves researchers working closely together with industry in the field of semiconductors, first-class equipment, life sciences, food technology, sensor technology and energy production. A Total of 40 % of NanoLab's laboratory space and equipment is used by industrial partners."
An example of a the top-research group located within MESA+ is the XUV Optics group, which specializes in manipulating light of extremely short wavelengths.
www.utwente.nl/mesaplus/
www.utwente.nl/mesaplus/xuv/

Other research institutes

Outside the 3TU coalition there are several other relevant educational and research institutes for precision engineering. Various universities have strong research groups and there are some independent research institutes, of which table 25 gives an overview. As the biggest institute for applied research, TNO is an important player in the Dutch R&D-landscape as well.

Knowledge centers within the precision engineering subject	
University of Groningen www.rug.nl/fwn/ www.rug.nl/research/zernike/	The major university in the north of the Netherlands. Especially the Mathematics and Natural Science department of the university is relevant which is a participant in NanoLabNL and host of the Zernike center of advanced materials
Radboud University Nijmegen www.ru.nl/science/	With its seven faculties the university is active in various research fields. The Science faculty is the most interesting for precision engineering; it has for instance its own nano-lab, free-electron laser and high magnet field laboratory.
University of Amsterdam www.uva.nl http://iop.uva.nl/ http://hims.uva.nl/ http://sils.uva.nl/	Located at the Amsterdam Science park the Faculty of Sciences is the most relevant faculty for HTSM. It has three relevant research groups. Institute of Physics (IOP) Van 't Hoff institute for Molecular Sciences (HIMS) Swammerdam Institute for Life Sciences (SILS)
Free University Amsterdam www.few.vu.nl/en/ www.lcvu.vu.nl	The second University in Amsterdam, for this report the faculty of sciences is het most interesting, which also host a LASER Lab.
Leiden www.science.leidenuniv.nl www.physics.leidenuniv.nl	The oldest university of the Netherlands; its alumni have won several Nobel prizes in physics. The science department, especially the institute of physics, is interesting.
NLR www.nlr.nl	The Netherlands Air and Space Laboratory is a research organization, with 650 employees and a yearly budget of € 75 million.
ECN www.ecn.nl	The Energy-research Center Netherlands is a research institute with 500 employees and a budget of € 145 million.
Fontys fontys.edu	A University of Applied Sciences, located throughout the south of the Netherlands and an active participant in the HTSM program.
Saxion www.saxion.edu	A University Applied Sciences, located throughout the east of the Netherlands and an active participant in the HTSM program.

table 25: *Knowledge centers relevant to precision engineering in the Netherlands*

NanoLabNL article of NWO after receiving a Grant

"NanoLabNL offers a wide spectrum of high-value nanotechnological research infrastructures. It is a unique facility, with locations in Delft, Eindhoven, Groningen and Twente. Amongst other things, NanoLabNL makes complex sensors and detectors that can be used to measure minimal forces. The research predominantly focuses on the discovery of novel materials or material structures with unusual quantum properties (for quantum computers, for example)."

www.nanolabnl.nl

Big Science 4 business: International Liaisons Officers -network

In 2011 the Dutch International Liaisons Officers (ILO) decided to cooperate with each other to better represent the Dutch participation and knowledge in international projects, this is especially focused on advanced instrumentation.

www.bigscience4business.nl/engels/index.php

TNO

The Netherlands organization for applied scientific research (TNO) is a non-profit research organization in the Netherlands. The organization was founded in 1932. Its headquarters are located in Delft, and it has more than ten subsidiaries throughout the Netherlands. The institute had a budget of € 579 million in 2013 and 3276 employees, see further in table 26.

TNO (2013)		€ Million
Budget		579
Revenue from government program financing		180
Revenue from market research		384
Other income		15
Personnel	3276	

table 26: *Numbers of the TNO Source: Jaarverslag 2013 TNO*

The mission of TNO is to connect people and knowledge, to create innovations that boost the competiveness of the industry and the well-being of society. They see their role as a driving factor in the transition of the society and industry on five subjects: Industry, Healthy Living, Defence, Safety & Security, Environment and Energy.

As shown in figure 21, the direction of the research money within TNO is broad within the technical subjects. About 20% of the revenue of TNO is from 'TNO Companies', these companies try to bring knowledge researched by the TNO to the market; this initiative has started in 1987 and has more than 40 sub-companies. Under this structure there are three main groups: Accelerator technology, Autonomic serial work units and Spin-offs.

Website: www.tno.nl

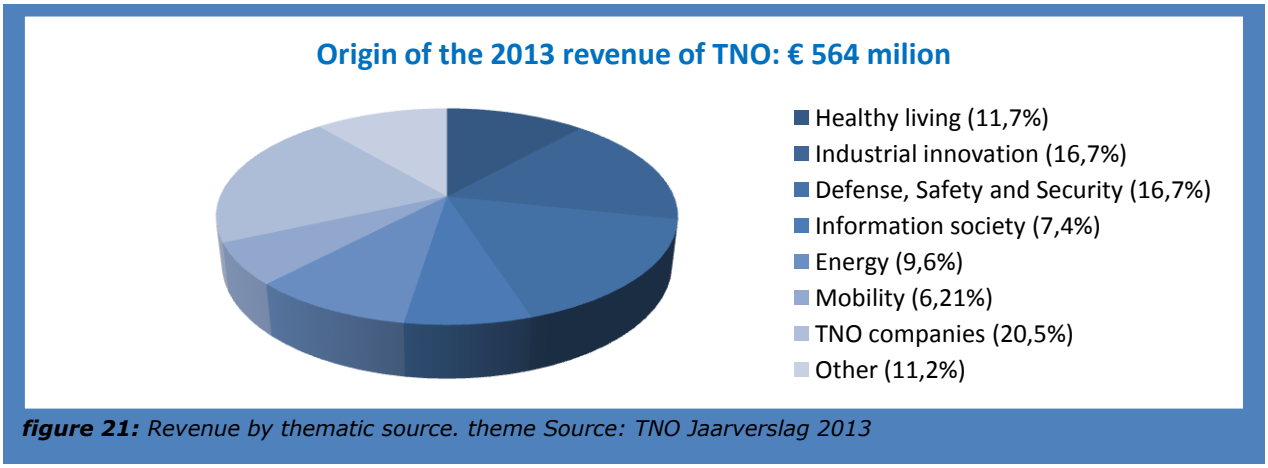

figure 21: *Revenue by thematic source. theme Source: TNO Jaarverslag 2013*

A bilateral research institute: Holst Center

In cooperation with the Belgium Imec and backing from both governments the TNO has started the Holst center located at the high tech campus in Eindhoven. The centre has currently more than 180 employees and close to 40 industrial partners:

"Holst Centre is an independent open-innovation R&D centre that develops generic technologies for Wireless Autonomous Sensor Technologies and Flexible Electronics. A key feature of Holst Centre is its partnership model with industry and academia based around shared roadmaps and programs. It is this kind of cross-fertilization that enables Holst Centre to tune its scientific strategy to industrial needs."

www.holstcentre.com

The Embedded Systems Institute

The Embedded Systems Institute (ESI) was originally founded in 2002 by ASML, Océ, Phillips, TNO and the 3TU universities. Since 2013 the ESI integrated in to the TNO organization. The group is aimed at high tech embedded systems design and engineering.

www.esi.nl

3.3 Dutch Private Organizations

In Netherlands there are various engineering SME's, which form an important part of the precision engineering sector. They are united in branch organizations, which is shown in the first section. Next to that, there is an overview of some relevant R&D players and a conference and fair agenda.

Branch and cluster organizations

If looking for specific knowledge within SME's, the most effective way is through cluster organizations. Well established cluster organizations have contacts throughout the Netherlands and can inform outsiders about the possibilities for further cooperation. Compared to Switzerland, clusters are generally more network and cooperation platforms than promotional platforms. Table 27 gives an overview of some potentially interesting branch and cluster organizations for precision engineering. Table 28 mentions some public-private partnerships.

Branch and cluster organizations	
DSPE www.dspe.nl	The Dutch Society of Precision Engineering is a community for precision engineers. The organization informs its members, gives courses, holds network meetings and organizes seminars, partially together with the Mikrocentrum.
Mikrocentrum www.mikrocentrum.nl	The Mikrocentrum is a knowledge and networking institute for the high tech industries in the Netherlands and Belgium. It tries to function as an information broker between companies, through hosting meetings and fairs for knowledge transfer and networking.
Brainport industries www.brainportindustries.com	A cooperation platform for the 1st, 2nd, 3rd tier suppliers of high-tech OEM's as ASML, Philips, FEI and Océ. This to increase the research cooperation and competiveness of the sector.
High Tech NL www.hightechnl.nl	High Tech NL is an association for companies, branch organizations and knowledge institutes within the HTSM sector.
MinacNED www.minacned.nl/home.html	MinacNED is the association for Microsystems and Nanotechnology in the Netherlands.
Holland Instrumentation www.hollandinstrumentation.nl	A regional initiative for connecting and developing the high tech instrumentation industry in the western provinces.
BCSemiconductors www.bcsemi.nl	The Business Cluster Semiconductors in a national network for companies and institutes active in the semiconductor industry, with some 150 member companies.
Kivia Nira www.kivi.nl	The royal institute for engineers is the association for students and engineers the Netherlands, with 20.000 members.

table 27: *Branch organizations and clusters close to precision engineering in the Netherlands*

Public-private cooperations	
InSciTe www.chemelot-inscite.com	The Chemelot InSciTe is a public-private institute in the South of the Netherlands to connect top players in the field of bio-medical and bio-based materials.
IMDI www.imdi.nl	The Innovative Medical Devices Initiative cross-sector thematic platform was initiated by the NWO through the 2007 strategic NWO-report.
M2i www.m2i.nl	M2i is a research organization in the field of material science, it has more than 60 industrial and university associates. The goal is to promote and intensify innovation in materials.
DPI www.polymers.nl	The Dutch Polymer Institute was established in 1997 as a public-private partnership for research on polymers. Some 200 researchers are currently involved in the DPI.

table 28: *Public private cooperation's close to precision engineering in the Netherlands*

Multinationals

A complete list of the largest companies by R&D budget of the Netherlands in 2010 is shown in appendix H. The multinationals with the closest contacts to precision engineering are listed in table 29; where companies with limited R&D activity in the Netherlands and Pharma are deleted. Table 30 gives an oversight of some other private R&D intensive companies.

Private companies with largest R&D budgets	
Philips Electronics www.philips.com	Electronics concern, active in consumer electronics, light, communication and medical devices.
ASML www.asml.com	Currently the largest supplier in the world of photolithography systems for the semiconductor industry.
NXP Semiconductors www.nxp.com	A semiconductor manufacturer, specializing in integrated and complex semiconductors; automotive, security and other niche markets.
DSM www.dsm.com	Life-sciences and materials company; with divisions in electrical en electronics, life protection, alternative energy and bio-based materials.
ASM International www.asm.com	Producer of production-machines for semi-conductor industry. Founded ASML together with Philips.
SBM Offshore www.sbmoffshore.com	Producer of off-shore installations for oil and gas production.
Vanderlande Industries www.vanderlande.nl	A company specialized in automatic handling systems, for example for airports and warehouses.
Stork www.storktechnicalservices.nl	Industrial machinery, mainly focuses on machinery for the oil and gas industry, but also incorporated the aircraft manufacturer Fokker.
Fugro www.fugro.nl	Survey company, collects and interprets information about the sea-bottom for the oil and gas industry.
Ten Cate www.tencate.com	Fibre company, from artificial grass to protective fibre and composites.
Nedap www.nedap.com	Electronics company active in: security, automation of agriculture, electronic identification, administrative systems.
IHC Merwede www.ihcmerwede.com	Ship developing, designing and building company for the dredging and offshore industry, a former part of SBM Offshore.

table 29: *Netherlands top R&D companies close to HTSM*

Private research intensive companies associated with or close to HTSM	
FEI www.fei.com	One of the biggest producers of Electron microscopes in the world, created when FEI fused with the Philips activities on Electron microscopes.
Frencken www.frenckengroup.com	Producer of high tech Mechatronics systems.
Demcon www.demcon.nl	A high-end supplier and developer of mechatronic applications.
Thales www.thales.com	French defense company, with R&D-facilities in the Netherland. Radar and infra-red systems, but also electronic security.
VDL ETG www.vdletg.com	Part of an industrial conglomerate, the Enabling Technology Group (ETG) develops and produces extreme precision parts.
Oce www.oce.nl	Active in the development and production of printing machinery, currently a part of Canon.
NTS- Group www.nts-group.nl	Developer and producer of optical-mechanical systems, modules and components.
Teijn Aramid www.teijinaramid.com	Active in aramid fibers, used in automotive, safety, marine, civil engineering, protective clothing, optical cables and oil and gas industries.
Tata Steel www.tatasteel.nl	Former Dutch steel, active in production of all varieties of steel.

table 30: *Dutch private research labs/R&D intensive companies*

Symposia and fairs

To get a first impression and contacts for cooperation symposiums or fairs could be a good starting point, a few possibilities in the Netherlands are shown in table 31.

Possible interesting symposia and fairs	
DSPE Conference on Precion Mechatronics in Sint Michielsgestel www.dspe-conference.nl	2 – 3 September 2014
Technology for Health 2014, in Den Bosch www.technologyforhealth.nl	9 – 10 September 2014
Kunststoffen 2014 , in Veldhoven www.kunststoffenbeurs.nl	24 – 25 September 2014
Precision fair 2014, in Veldhoven www.precisiebeurs.nl	12 – 13 November 2014
Integrated Systems Europe (ISE) in Amsterdam www.iseurope.org	10 – 12 February 2015
Rapid Pro 2015, in Veldhoven www.rapidpro.nl/i/industrial/	3 – 5 March 2015
Materials 2015, in Veldhoven www.materialenbeurs.nl	22 – 23 April 2015
Photonics Event 2015, in Veldhoven www.photonics-event.nl	3 – 4 June 2015
Vision, Robotics & Mechatronics 2015, in Veldhoven www.vision-robotics.nl	3 – 4 June 2015
European Sub-contracting and Engineers fair (ESEF) in Utrecht www.esef.nl	15 – 18 March 2016

table 31: *Symposia and fairs in the Netherlands*

The federation of technology-branches

The federation of technology companies is a collective platform of high-tech companies, the platform is divided in to four branches:

- Industrial electronics
- Industrial automatics
- Labor technology
- Medical technology

The website itself is Dutch, but the cluster page could be a use-full starting-place to get an overview of the Dutch market:
federatie.fhi.nl/content/view/80/86/

3.4 Dutch High-tech campuses

In the Netherlands there are various campuses where innovative companies work together with universities and research institutes for knowledge transfer to create an innovative environment. The campuses are mostly initiated by companies and regional governments. The Netherlands has no country-wide campus strategy. The most interesting campuses for precision engineering in the Netherlands are:

- **High tech campus** in Eindhoven
  Self-pronounced smartest square mile of the Netherlands, with over 125 high tech companies and institutes and about 10.000 researchers, developers and entrepreneurs. Active in the fields Health, Energy and Smart environments, with participating companies as Philips, NXP, IBM Intel is it responsible for 40% off all Dutch patent applications.
  www.hightechcampus.com
- **Kennispark Twente** in Enschede
  Next to the UTwente, with a total of 380 companies an innovative park for companies and after Eindhoven the biggest job creating campus. Each year it also welcomes 60 to 70 spin-offs from both Saxion University of Applied Sciences and the UTwente.
  www.kennispark.nl
- **Chemelot** in Sittard-Geleen
  A campus specialized in the chemical and material development and associated life-sciences. The campus hosts 1350 employees and has well know participants as DSM and Sabic. Associated knowledge institutes are the University of Maastricht, RWTH Aachen, TU/e and Zuyd University of applied sciences. The campus has also ties with the Maastricht health campus.
  www.chemelot.nl
- **Amsterdam Science park** in Amsterdam
  Located in a polder, the park host some 120 companies, eight research institutes of the University of Amsterdam and fundamental physics research institutes FOM AMOLF and NIKEF. The campus focusses on IT, life sciences, advanced technology, and sustainability.
  www.amsterdamsciencepark.nl
- **Novio Tech Campus** in Nijmegen
  Specializing in Life Sciences, Health & High tech semiconductor, the campus hosts the biggest chip producer (NXP) of the Netherlands. The campus is associated with the Radboud University and the HAN University of Applied sciences.
  www.noviotechcampus.com
- **YES!Delft** in Delft
  Is a high tech campus focusing on entrepreneurs with concrete ideas for technical and innovative products. The campus is associated with research institutes as the TUDelft and TNO, furthermore cooperating with well-known companies as IHC Merwede and Roche.
  www.yesdelft.nl

The Advanced Research Center for Nanolithography (ARCNL)
A new initiative of the Amsterdam Science park is the Advanced Research Center for Nanolithography (ARCNL). This center, part of TNO, is a collaboration between ASML, FOM Institute AMOLF, the University of Amsterdam and VU University Amsterdam, the first research groups just started at 1 July 2014:
www.arcnl.nl

Conclusion

Switzerland and The Netherlands have a strong and innovative precision technology industry, which are internationally oriented and supported by top-universities and research institutes, with various possible subjects to increase collaboration or to build a new cooperation. The countries are open and internationally-oriented, Swiss and Dutch culture is comparable. Furthermore building on already existing connections is important. The active interchange of students from both countries also helps for the necessary connections between the countries. The R&D-cultures of both countries are a good match: the "precision" of the Swiss supplements the "creativity" of the Dutch.

The role of the governments should be a facilitating one. On both sides research institutes and companies appreciate the network and introductions a government can give. Direct involvement in the content of research and innovation by governments is in general not appreciated. To improve cooperation it would be useful to connect some pivotal-persons in each country to each other. These persons should be the contact points of the industry/research institutions in the respective country and would be a kind of spider in the networks.
The government could assist companies by facilitating meetings, seminars and fairs, and branding (Holland High Tech). For SME's it could be furthermore useful to get assistance with first contact and introductions, if they not do already have an international reputation.

For research and education institutes the most evident way for Swiss-Dutch research cooperation is through European platforms as Horizon2020, as it is created with the purpose of multilateral cooperation. This makes it possible to integrate even more countries and institutes in research-projects. Important is to monitor the current development in the bilateral agreements between Switzerland and the EU, and the resulting participation in the associated research programs.
Further research stimulation could be achieved by reinforcing the connections between the funding organizations SNF and NWO, thus providing bilateral research funds. The reciprocity principle would make this cooperation more effective and cost efficient. As well as by the companies, first contacts between the researchers are important, as cooperation starts more easily on the basis of existing contacts. The current close ties between universities (see also appendix E) is an indicator that this process is already underway, however there is still more potential for cooperation.

An interesting pattern for the Netherlands to study more profoundly is the long term research funding in Switzerland, which has created some top-research institutes and universities. Secondly the Swiss educational system, especially the vocational part could be interesting to study as a good example of high quality vocational education. For Switzerland especially the Dutch model with extensive cooperation between companies and universities could be of interest.

Suggestions for possible subjects for research cooperation

While reviewing the Swiss and Dutch R&D environments in precision engineering various subjects for cooperation were seen. In this box suggestion for some interesting cooperation fields and the most important public knowledge institutes on these subjects are mentioned:

- **3D printing**
  High precision micro scale 3 dimensional printing is still in its early development; but both countries show interest and have industries who profit from high precision printed parts. Cooperation on developing this technique could accelerate the research and introduction process.
  Swiss public knowledge centers: CSEM, EMPA
  Dutch public knowledge centers: TNO, TU/e, M2i,
- **Silicon lithography**
  Both countries have extensive knowledge of chip fabrication, with various examples as low voltage and security, this could be combined with the micro-tooling of silicon for MEM's.
  Swiss public knowledge centers: CSEM, PSI, EPFL, ETHZ
  Dutch public knowledge centers: ARCNL, ALMOF, Universities of Amsterdam (both), TU/e, DimesTC, Zernike
- **Advanced Instrumentation**
  This cross-functional high-tech industry develops instruments for high-tech companies and research facilities, both countries excel in this knowledge driven industry and have top-research institutes.
  Swiss public knowledge centers: PSI, ETHZ, Microcity
  Dutch public knowledge centers: FOM, Drebbel institute, TU/e, DimesTC, ILO's
- **Medical technology; micro fluids**
  Both Switzerland and the Netherlands are world class players in medical technology, with high-tech and pharmaceutical companies, of recent mutual interest are micro fluids, with examples as lab-on-a-chip:
  Swiss public knowledge centers: CSEM, EPFL, ETHZ
  Dutch public knowledge centers: IMDI, MinacNED, TNO, UTwente
- **Nano-engineering**
  With top research facilities in both countries and industries active in nano-technology related fields as solar- semiconductor-technology cooperation could reinforce the leading role of both countries.
  Swiss public knowledge centers: BNRC, EMPA, Microcity, ETHZ, Frimat, AMI, SNI
  Dutch public knowledge centers: NanolabNL, MESA+, Kavli inistute, TUDelft (3M), TU/e Nanolab, Zernike
- **Composites and bio-based materials**
  Both countries are active in the development of new materials. This from bio-based materials to composites, which are used in High Tech and Medical industries.
  - **Bio based engineering materials**
    Swiss public knowledge centers: EMPA, FMI, ARTOG, Weiss Center
    Dutch public knowledge centers: MIRA, InSciTe, M2i, NIMR, Zernike
  - **Polymer composites**
    Swiss public knowledge centers: EMPA, CSEM
    Dutch public knowledge centers: TPRC, M2i, DPI, Zernike

Appendix A: List of abbreviations

For the abbreviations preferably the English abbreviation is used, thus in the list the English translation is used most of the time. The CH/NL at the start of the explanations indicates the country of origin.

CH	Switzerland
NL	Netherlands
EU	European Union
3TU	NL - Cooperation platform of the three technical universities
CSEM	CH - Centre Suisse d'Electronique et Microtechnique
CTI	CH - Commission for Technology and Innovation, also called KTI
EAER	CH - Ministry of Economic Affairs, Education and Research
EC	EU - European Commission
EMPA	CH - Institute for Materials Science and Technology
EPF Lausanne	CH - Technical university of Lausanne
ERC	EU - European Research Council
ETH Domain	CH - Federal structure of the technical universities and research institutes
ETH Zürich	CH - Technical university of Zürich
HTSM	NL- High Tech Systems and Materials (Top-)sector
NFIA	NL - Netherlands Foreign Investment Agency
NWO	NL - Netherlands organization for scientific research
OECD	Organization for Economic Co-operation and Development
OEM	Original equipment manufacturer
PSI	CH – Paul Scherrer Insitute
R&D	Research and Development
RVO	NL - Netherlands Enterprise Agency
SECO	CH - State Secretariat of Economics
SERI	CH- State Secretariat for Education, Research and Innovation
SME	Small and Medium Enterprises
SNF	CH - Swiss National Science Foundation
TU/e	NL - Technical University Eindhoven
TU Delft	NL - Technical University Delft
UTwente	NL - University of Twente

Appendix B: Research proposal

Due to high specialization in the precision technology and high research costs in micro- and nano-technology, public-private R&D-cooperation is becoming more advantageous to successfully compete on the international market. Switzerland and The Netherlands both have a long history of precision technology, with strong internationally oriented organizations.

The Swiss watch industry, and thus precision mechanics, is world renowned. Furthermore, the solar, composite and healthcare industries are strong, innovative and well developed. These industries are supported by high-tech institutes of the ETHstructure, such as the ETHZ, EFPL, PSI and EMPA.

In The Netherlands, one of its nine top sectors is High-Tech Systems and Materials (HTSM). The region of Eindhoven produces nearly 80% of the machinery for the production of semiconductors in the world. These high-precision companies, along with high-tech companies in the area of materials, nanotechnology and healthcare are the backbone of the Dutch HTSM sector. The main public high-tech research institutes in the HTSM structure are TNO, the 3TU coalition (a cooperation of the 3 Dutch technical universities TU-Delft, TU-Eindhoven, University of Twente) and the FOM-institutes

The aim of this research is to examine the possibilities for further cooperation between Swiss and Dutch organizations, hence giving organizations some guidelines for multilateral and bilateral cooperation. The main technological focus areas are 'Mechatronics and Manufacturing', 'Components and Circuits' and 'Nanotechnology', and the main application-areas are Health-tech, Advanced instrumentation and Semiconductor equipment. Based on this, the following research question is proposed:

Where are opportunities for further cooperation between Swiss and Dutch organizations, public and private, regarding the subject of precision technology?

This main question leads to the following sub-questions regarding precision technology in both countries:

- *What are the strengths of the Swiss and Dutch sectors?*
- *What are the main public and private players on the market in Switzerland and the Netherlands?*
- *Which partnerships are currently in existence between Swiss and Dutch organizations?*
- *What are the differences in organizational culture and structure of Swiss and Dutch organizations?*
- *Where is potential for more multilateral and bilateral cooperation between Swiss and Dutch organizations?*

This research is carried out by literature research and by interviewing Swiss and Dutch companies in the sector of precision engineering. The base of the literature research is a report of M. Prinz made in 2010 at the Embassy of the Netherlands in Bern about the Swiss innovation climate. This is combined with information from the HTSM sector and newly found Swiss and Dutch literature.
The interviews will start with an interview with the State Secretariat for Education, Research and Innovation (SERI) in Switzerland and telephone conferences with the main players of the Dutch HTSM sector. The purpose of the first interviews is to acquire a better view of the sector and the possible and desired relations. Based on the first results more research and company visits in Switzerland will be planned.

Appendix C: Swiss higher education institutes

Tier-one Universities in Switzerland	
Technical Universities	
ETHZ	www.ethz.ch
EFPL	www.efpl.ch
General Universities	
University of Basel	www.univas.ch
University of Bern	www.unibe.ch
University of Fribourg	www.unifr.ch
University of Genève	www.unige.ch
University of Italian Switzerland	www.unisi.ch
University of Lausanne	www.unil.ch
University of Luzern	www.unilu.ch
University of Neuenburg	www.unine.ch
University of St. Gallen	www.unisg.ch
University of Zürich	www.uzh.ch

Universities of Applied Sciences in Switzerland	
Bern University of Applied Science	www.bfh.ch
HES-SO-University of Applied Sciences of Western Switzerland	www.hes-so.ch
Lucerne University of Applied Sciences and Arts	www.hslu.ch
University of Applied Sciences and Arts Northwestern Switzerland	www.fhnw.ch
University of Applied Sciences of Eastern Switzerland	www.fho.ch
University of Applied Sciences of Southern Switzerland	www.supsi.ch
Zürich Universities of Applied Sciences and Arts	www.zfh.ch

Note: Not all universities listed, some have only studies that are not related to precision engineering, like theology institutes of teacher training.

Appendix D: Netherlands higher education institutes

Tier-one Universities in the Netherlands	
Technical Universities	
TUDelft	www.tud.nl
Tue	www.tue.nl
UTwente	www.utwente.nl
General Universities	
Erasmus University of Rotterdam	www.eur.nl
Radboud University Nijmegen	www.ru.nl
University of Amsterdam	www.uva.nl
University of Groningen	www.rug.nl
University of Leiden	www.leidenuniv.nl
University of Maastricht	www.maastrichtuniveristy.nl
University of Tilburg	www.tilburgunverity.edu
University of Utrecht	www.uu.nl
VU Amsterdam	www.vu.nl
Wageningen University	www.wur.nl

Universities of Applied Sciences in the Netherlands	
Avans Univeristy of Applied Sciences	www.avans.nl
CAH Vilentum Hogeschool	www.cahvilentum.nl
Fontys University of Applied Sciences	www.fontys.nl
HAN University	www.han.nl
Hanze University of Applied Sciences	www.hanze.nl
HAS Hogeschool	www.hashogeschool.nl
Hogeschool Inholland	www.inholland.nl
Hogeschool leiden	www.hsleiden.nl
Hogeschool Utrecht	www.hu.nl
Hogeschool van Amsterdam	www.hva.nl
Hogeschool Windesheim Flevoland	www.windesheimflevoland.nl
Hogeschool Zeeland	www.hz.nl
Hogeschool Zuyd	www.zuyd.nl
NHL University of Applied Sciences	www.nhl.nl
Rotterdam University	www.hogeschool-rotterdam.nl
Saxion University of Applied Sciences	www.saxion.edu
Stenden University of Applied Sciences	www.stenden.com
The Hague University of Applied Sciences	www.thehagueuniversity.nl

Note: Not all universities listed, some have only studies that are not related to precision engineering, like theology institutes of teacher training.

Appendix E: University cooperation platforms

International University groups		Members
EUA *(Members 850+)*	The European University Association is a platform for all European universities. www.eua.be	all
CESAER *(Members 57)*	The Conference of European Schools for Advanced Engineering Education and Research is organization of technical universities in Europe. www.cesear.org	ETH, 3TU
LERU *(Members 21)*	The League of European Research Universities is a consortium of 21 members, which have leading research-intensive faculties. www.leru.org	University of: Zürich, Geneva, Amsterdam, Utrecht, Leiden
CLUSTER *(Members 12)*	The Consortium Linking Universities of Science and Technology for Education and Research is a technical university program joined by both EFFL and the TU/e and 10 other universities. www.cluster.org	EPFL, TU/e
EuroTech *(Members 4)*	The EuroTech alliance is a strategic alliance of four technical universities to drive sustainable growth and competitiveness. www.eurotech-universities.org	EPFL, TU/e
IDEA League *(Members 4)*	The IDEA League is a network founded in 1999 of four technical universities. They have combined research and promotion projects and promote European cooperation. www.idealeague.org	ETHZ, TUDelft

Appendix F: International cooperation platforms

International platforms	
CAETS	The international Council of Academies of Engineering and Technological Sciences www.CAETS.org
CERN	The Conseil Européen pour la Recherche Nucléaire is the center for European nuclear research. The testing site is located in Geneva, Switzerland. However, it is formally an European organization under international law. home.web.cern.ch
COST	COST is the European cooperation program in the Field of Scientific and Technical Research. It is used by research institutes and higher education organizations to work together. www.cost.eu
Erasmus+ *	The Erasmus+ program is an European platform for increase the European cooperation on Education, Training and Youth work. ec.europa.eu/programmes/erasmus-plus/
ESA	The European Space Agency, in which both the Netherlands and Switzerland are participating. The organization advances the knowledge of space technology and develops practical applications from this space technology. www.esa.int
ESO	The European Southern Observatory (ESO) is a cooperation of European countries for astronomical research on the southern hemisphere. The headquarters are near Munich, the actual observatories are in Chili. www.eso.org
EURATOM *	The European Atomic Energy Community is a research platform for peaceful use of atomic energy across national borders. www.euratom.org
EUREKA	EUREKA is a bottom-up pan-European development platform for promising cooperation's between research institutes and companies. This network is especially for small and medium sized enterprises. www.eurekanetwork.org
Horizon 2020 *	The current European framework for research and technological development is Horizon 2020. The project runs from 2014 till 2020. ec.europa.eu/programmes/horizon2020
ERC Grants *	ERC Grants are a part of the horizon 2020 project. The grants are given by the European Union for excellent research. erc.europa.eu/funding-and-grants
ITER*	ITER is the international cooperation platform for the research of a nuclear fusion energy plant. www.iter.org
Manufuture	An European cooperation platform for the manufacturing (SME-) industry. www.manufuture.org
Science Europe	SNF and NOW are both active in the Science Europe organization, this European organization promotes and represent the interests of fundamental research. www.scienceeurope.org

Main source: Hochschulen und Forschung in der Schweiz 2013, with some extra added platforms

* The Swiss participation in this program is currently affected by the changes after the volksbastimmung of 9 February

Appendix G: Swiss companies by R&D expenditures

2010		R& D budget € million	Net sales € million	Employees
Roche	Pharmaceuticals	7.181,11	37.967	80.653
Novartis	Pharmaceuticals	6.022,97	37.736	119.418
Nestle	Food producers	1.579,54	87.752	281.000
ABB	Industrial machinery	837,10	23.547	116.500
Syngenta	Chemicals	769,27	8.677	26.179
Tyco Electronics	Electrical components & equipment	436,07	8.997	89.000
Actelion	Pharmaceuticals	387,31	1.543	2.441
Liebherr-International	Commercial vehicles & trucks	361,30	7.587	32.979
Givaudan	Chemicals	326,31	3.390	8.618
Garmin	Leisure goods	206,68	2.005	8.897
Kudelski	Software	190,35	828	3.068
OC Oerlikon	General industrials	183,15	2.880	16.657
Weatherford International	Oil equipment, services & distribution	159,88	7.619	55.000
RUAG	Aerospace & defence	151,96	1.436	7.689
Swatch	Personal goods	130,36	4.885	24.240
Swisscom	Fixed line telecommunications	119,17	9.588	19.464
Galenica	Pharmaceuticals	117,40	2.483	5.433
Logitech International	Computer hardware	116,58	1.761	11.000
Lonza	Chemicals	112,77	2.143	8.333
Clariant	Chemicals	107,97	5.694	16.176
Tyco International	General industrials	97,65	12.927	108.000
Endress & Hauser	Electronic equipment	96,44	1.313	8.594
Schindler	Industrial machinery	87,18	9.918	42.687
Sonova	Health care equipment & services	82,98	1.293	7.291
Rieter	Industrial machinery	75,10	1.991	12.804
Georg Fischer	Industrial machinery	71,98	2.757	12.908
Buhler	Industrial machinery	63,02	1.525	7.857
Bobst	Industrial machinery	61,10	1.024	5.121
Sika	Construction & materials	59,50	3.532	12.926
Bucher Industries	Commercial vehicles & trucks	58,54	1.626	7.639
Richemont	General retailers	58,00	6.892	21.387
Sulzer	Industrial machinery	46,79	2.546	13.740
Metall Zug	Household goods & home construction	46,50	665	3.045
Ascom	Telecommunications equipment	45,51	457	2.093
Basilea Pharmaceutica	Biotechnology	44,34	93	
Pilatus Aircraft	Aerospace & defense	39,19	550	1.395
Advanced Digital Broadcast	Telecommunications equipment	38,01	266	805
Geberit	Construction & materials	35,35	1.520	5.793
Straumann	Health care equipment & services	33,45	590	2.287
Barry Callebaut	Food producers	32,76	4.170	7.550

***Source**: European commission: http://iri.jrc.ec.europa.eu/scoreboard11.html*

Appendix H: Netherlands companies by R&D expenditures

2010		R& D budget € million	Net sales € million	Employees
EADS	Aerospace & defense	3.084,00	45.752	121.691
Philips Electronics	Leisure goods	1.697,00	25.419	117.050
STMicroelectronics	Semiconductors	1.627,99	7.712	53.300
ASML	Semiconductors	523,43	4.508	6.785
NXP Semiconductors	Semiconductors	423,40	3.545	25.412
DSM	Chemicals	410,00	9.050	22.054
AKZO Nobel	Chemicals	314,00	15.417	55.100
Rabobank	Banks	221,00	11.275	59.939
TomTom	Electronic equipment	164,34	1.521	3.288
Spyker Cars	Automobiles & parts	154,26	823	3.888
ING	Life insurance	148,00	54.573	106.139
Gemalto	Electronic equipment	126,72	1.956	10.000
LyondellBasell Industries	Chemicals	110,69	30.954	14.000
Qiagen	Biotechnology	93,95	811	3.587
ASM International	Semiconductors	78,79	1.223	14.253
FrieslandCampina	Food producers	61,00	8.972	19.484
Crucell	Biotechnology	54,60	338	1.188
KPN	Fixed line telecommunications	54,00	13.324	31.874
CSM	Food producers	47,00	2.990	9.456
Unit4	Software	44,69	423	3.832
Ahold	Food & drugs retailers	33,00	29.530	212.527
BE Semiconductor Industries	Semiconductors	25,81	351	1.435
Exact	Software	24,22	228	2.124
Hunter Douglas	Household goods & home construction	23,11	1.823	17.127
SMB Offshore	Oil equipment, services & distribution	22,53	2.278	3.787
Pharming	Biotechnology	19,66	1	84
Vanderlande Industries	Industrial machinery	19,07	566	2.087
Sensata Technologies	Electronic equipment	18,39	1.148	10.500
Eurand	Pharmaceuticals	17,22	121	620
Ballast Nedam	Construction & materials	16,00	1.359	3.841
Nutreco	Food producers	15,30	4.940	9.585
Amsterdam Molecular Therapeutics	Biotechnology	14,96	0	85
Stork	Industrial machinery	14,89	1.669	13.186
Chicago Bridge & Iron Company	Industrial machinery	13,89	2.715	12.600
Tornier	Health care equipment & services	13,34	169	792
LeasePlan	Other financials	12,32	6.978	5.772
Fugro	Oil equipment, services & distribution	11,76	2.280	13.444
Ten Cate	General industries	11,30	985	4.644
Nedap	Electronic equipment	11,21	134	632
IHC Merwede	Commercial vehicles & trucks	11,20	1.008	3.016

***Source**: European commission: http://iri.jrc.ec.europa.eu/scoreboard11.html*

Appendix I: List of contacted persons

List of contacted persons	
Ad Brouwers	Mikrocentrum
Alex Dommann	EMPA
Arlette Frener	CTI
Arjan Gelderblom	Holland High Tech
Béatrice Miller	SATW
Casper Langerak	RVO
Cees Lanting	CSEM
Dick Harms	Leidse Instrumentenmakers School
Erik Frenkel	Asulab
Florin Müller	SERI
Frank de Jong	FEI
Friso van der Veen	PSI
Gerard Beenker	NXP
Giorgio Travaglini	PSI
Hans Priem	VDL ETG
Henk Tappel	Frencken
Herman ten Kate	CERN
Jean-Luc Barras	SNF
Jos Gunsing	DSPE
Marc Radstake	RUAG
Nico de Rooij	EPFL / CSEM
Olivier Küttel	EPFL
Patrick Roth	Präzisionscluster
Paul Burkhard	SNF
Philipp Glocker	CSEM
Pierangelo Gröning	EMPA
Roger Swifcz	SERI
Rolf Hügli	SATW
Wernher van der Venn	ZHAW