# Swiss Space Implementation Plan

## within Education, Research and Innovation for 2014-2023

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Swiss Confederation

**Federal Department of Economic Affairs, Education and Research EAER**

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# Executive summary

Modern society increasingly depends on information provided by space-based infrastructures. Accordingly, the number of public and private actors conducting space activities is increasing, bringing new challenges at national, European and global levels. The Swiss Space Implementation Plan (SSIP) for 2014 to 2023 within the Education, Research and Innovation (ERI) framework is the Swiss response to this trend and crystallizes the national space policy. This ten-year plan shall be revised roughly every three years and shall support the decision-making process on the allocation of the financial resources defined in the current ERI Dispatch 2013 – 2016 and beyond.

The SSIP will contribute to strengthen an innovative and competitive Swiss space sector and will encourage the use of space-based services and applications by public and private actors. The national focal areas of technology, science & exploration, space transportation and applications are confirmed. In addition, the emerging themes “small satellites” and “miniaturization” are addressed. Finally, four measures, which will be implemented within the current ERI funding instruments, namely the Swiss participation to the activities and programmes of the European Space Agency and the National Complementary Activities, are presented. These measures are: business incubation, internationalization and export, public-private partnerships and integrated applications push.

# Table of contents

## Abbreviations and acronyms

| | |
|---|---|
| AIT | Assembly, Integration and Testing |
| CHEOPS | CHaracterizing ExOPlanet Satellite |
| CTI | Commission for Technology and Innovation |
| ERI | Education, Research and Innovation |
| ESA | European Space Agency |
| EU | European Union |
| GMES | Global Monitoring for Environment and Security |
| LIDAR | Light Detection And Ranging |
| FIT | Federal Institute of Technology |
| MEMS | Micro-Electro-Mechanical System |
| NCA | National Complementary Activities |
| OECD | Organisation for Economic Co-operation and Development |
| PRODEX | PROgramme de Développement d'Expériences scientifiques |
| R&D | Research and Development |
| SAR | Synthetic Aperture Radar |
| SII | Space Incubator Initiative |
| SME | Small and Medium Enterprises |
| SNSF | Swiss National Science Foundation |
| SSIP | Swiss Space implementation Plan |
| SSO | Swiss Space Office |
| TRL | Technology Readiness Level |
| USA | United States of America |

# 1 Introduction

## 1.1 The challenge

Applications from space activities are present in the daily lives of citizens of any modern state. Simultaneously, these very societies tend to depend more and more on new technologies. Space has also become a global business. The European space sector is increasingly under pressure from industries in emerging space powers. It also differs from its main international competitors in that it relies more on commercial sales, the share of military expenses is smaller, and synergies between civil and defence sectors are far less developed. Furthermore, unlike in North America, Europe's downstream satellite navigation and Earth observation markets are only now emerging.

Space activities in Europe have mainly been conducted in the framework of the European Space Agency (ESA) and through national programmes. In recent years, the European Union (EU) has become an additional major player through the implementation of the European flagship programmes Galileo and GMES/Copernicus, and also through the explicit competence for space matters – shared with its Member States – in the Lisbon Treaty.

Switzerland has been involved in space-related activities since the 1960s. Today, it holds a solid and acknowledged scientific and technological position that is justified by its current competence in precision technology and its innovation capability. This has notably led to space industrial capacities and competences that have developed significantly over the last 20 years on Swiss territory with very limited delocalisation, contributing to economic growth, and bringing applications and services to the broader population.

The main channel for implementing the Swiss Space Policy[1] is through participation in ESA programmes and activities. Due to its evolving environment, ESA is also changing: the number of Member States is increasing, as is the number of its initiatives and programmes. According to ESA's Director General[2], the Agency has to position itself on a number of key subjects such as

- the development of products and services derived from space-based infrastructure;
- the competitiveness of the European space sector, namely in the domains of launch services and telecommunications;
- the integration of the security/defence dimension and the potential deficits linked to the absence of a dedicated programme in that field.

On the global stage, the development of a common exploration strategy will provide new opportunities for cooperation in the area of space-based infrastructure and space transportation for future missions beyond Low Earth Orbit. However, competition in the area of research and technology innovation may increase.

These latest developments within ESA, in Europe and in the world mean that Switzerland, as a nation active in space, needs to define its position in terms of

- the increased dependency on space infrastructure as a modern state;
- promoting its interests in an extended ESA (new actors, new initiatives);
- its role in European space efforts as a non-EU member;
- the limited access to market for Swiss actors in space (absence of national market, limited access to EU markets);
- the increasing global competition from public and private actors.

1 „Revision der schweizerischen Weltraumpolitik", report to the Federal Council, 30 September 2008

2 Draft ESA Long-Term Plan 2014-2023, ESA/C(2013)81, 8 October 2013

## 1.2 The Swiss response

The response to the evolving international environment calls for a wise application of political continuity and use of the strengths of the Swiss socio-economic system. Political reliability and continuity of governmental commitment are key success factors in the space sector with its long development cycles compared to other sectors, and in the process leading to innovation. A liberal economy with free competition can respond swiftly to any new challenge. Stable conditions and incentives are additional success factors regarding the human resources involved, namely researchers, entrepreneurs and their engineers, operators and end users.

In addition to Switzerland's general appeal as a place to live and work (e.g. stability of the political and legal frameworks, low taxes …) there are also a number of sector specific strengths which need to be preserved, namely

- strong focus on cooperation between academia and industry;
- high standard of vocational education and training system;
- high degree of autonomy and responsibility on the part of private actors at all levels;
- main public effort at the beginning of the value chain, meaning basic research;
- strong participation in international programmes.

Some specific on-going measures are pursued by the Swiss Space Office (SSO) as part of Switzerland's involvement in ESA programmes and activities and the National Complementary Activities (NCA). These are conducted in close cooperation with the relevant federal and cantonal partners in order to promote technological innovation and scientific excellence in space activities leading to growth so as to

- reinforce international cooperation in selected fields;
- promote education with space-relevant disciplines, mainly engineers;
- establish a framework aimed at lowering entry hurdles in the space business;
- promote the use of space-based services for smart public and governmental action when proven advantages have been demonstrated.

However, additional measures need to be taken in order to attain the required positioning under chapter 1.1. These measures are described in the present Swiss Space Implementation Plan (SSIP). The SSIP aims to strengthen an innovative, useful and competitive Swiss space sector through an enhanced selective participation in European and international space activities. It will support research and technology institutions and industry to provide a boost in meeting these challenges. Emphasis will be placed on promoting existing and new focal areas of Swiss excellence, consolidating national activities and securing access to procurements and data on a European and worldwide level, in particular with the aim of

- securing access to space;
- allowing entry to the critical technological path in the development of space infrastructure (mainly satellites);
- fostering the utilisation of space infrastructure through secured data access, build-up of know-how across the whole process and promoting incentives for downstream industry.

This SSIP has been compiled under the umbrella of the current Swiss Space Policy (see Figure 1). It calls for an enabling implementation framework established by the Swiss government in the definition of thematic focal areas through the participation in space programmes.

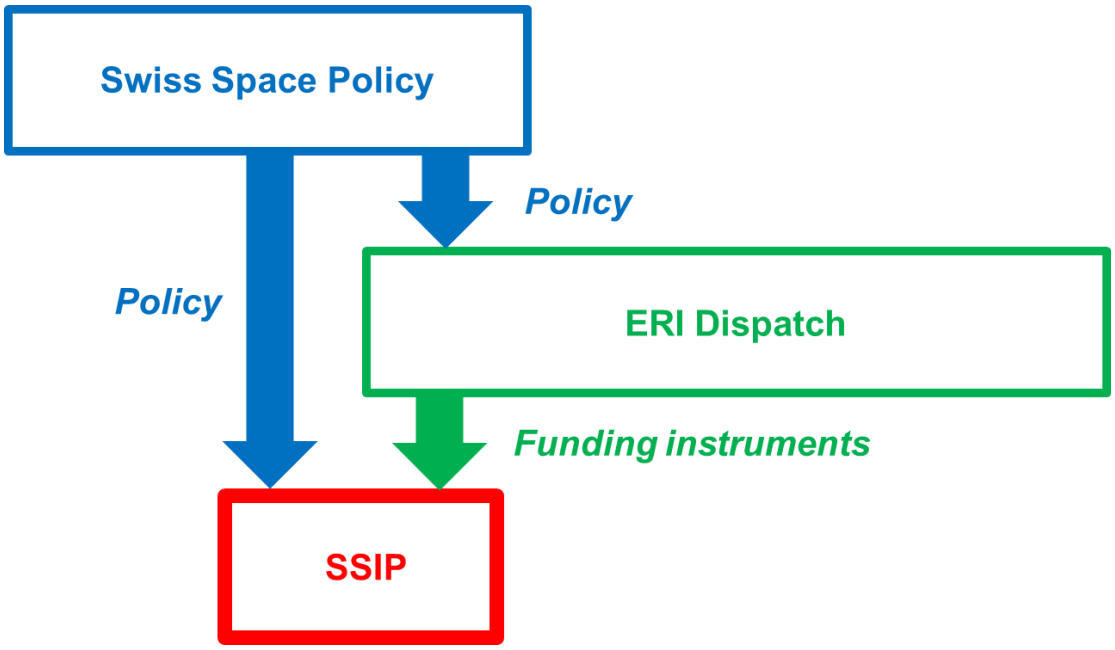


Fig. 1: Context scheme of the Swiss Space Implementation Plan

The Swiss Space Implementation Plan is designed to cover a time span of 10 years. The measures taken will be evaluated and the Plan itself shall be revised roughly every three years.

# 2 National Focal Areas

Switzerland's outstanding scientific and technological competences have allowed it to position itself in various programmes and activities, mainly of ESA, and to develop a number of fields of excellence. The following sub-chapters underline the technological base with the five technology axes as described in the Swiss Space Policy, the current fields of excellence as well as further fields that are emerging and that are likely to allow Switzerland to position itself in the future.

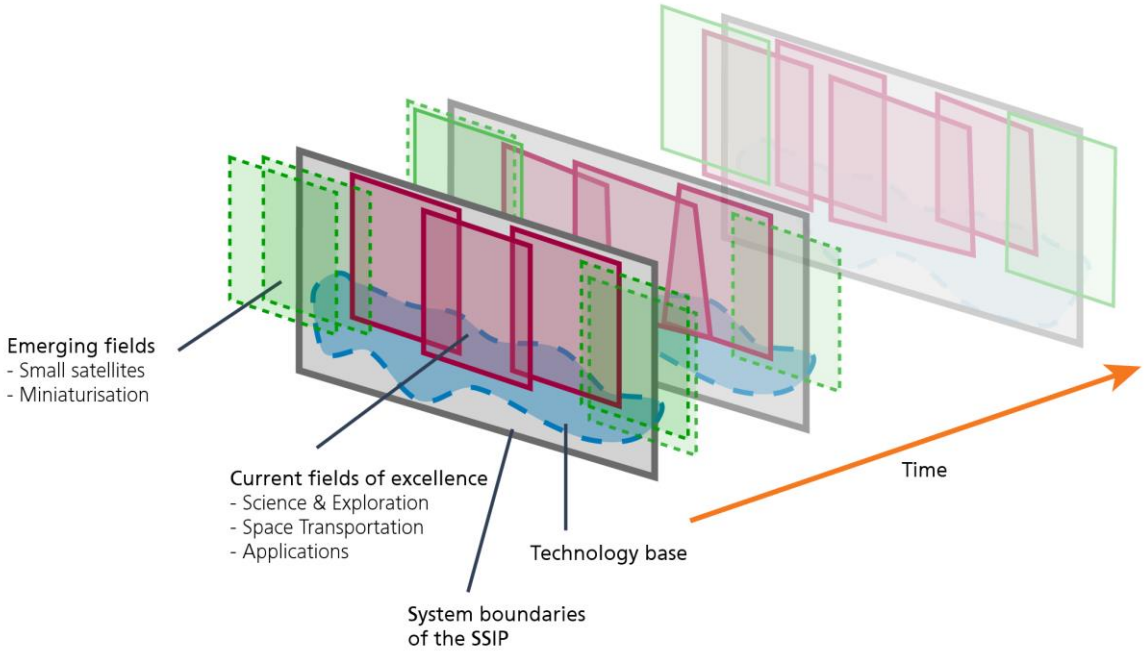


Fig. 2: Technology base, current fields of excellence and their evolution

## 2.1 Technology

The five technology axes defined in Switzerland's Space Policy are still valid, but may evolve in the coming years. A potential development has to be analysed by the Swiss Space Office together with Swiss stakeholders. The following sub-chapters set out initial reflections on the further consolidation of these axes.

### 2.1.1 High-precision mechanisms and structures

High-precision mechanisms have evolved to become a key area of expertise. Swiss industry and academia have the potential, through continual innovation, to retain their recognised position on the worldwide market of mechanisms in and for space. Structure capacities are also based on a strong academic and industrial heritage although they face increasing competition. Innovation in new materials and processes is key to ensuring that Switzerland retains a competitive edge; it will also help to solve the key challenge in space, namely weight-reduction.

For both themes, capacities are currently available and the market is dynamic. This technology axis will have to be re-assessed within the next three years depending on the innovations achieved in the meantime.

### 2.1.2 Atomic clocks

Switzerland’s position in atomic clocks, and especially in the field of Rubidium and Passive Maser technologies, is world class and has secured a strong position on the global market. To stay at the forefront, key capacities at academic and industrial level in the area of Time & Frequency are of high importance.

A promising area of growth is to move higher up the value chain in this field. In addition, taking a strong position in future technologies such as optical clocks has to be assessed. It will only be possible to assess whether the transition has been successful in five to ten years.

### 2.1.3 Electro-optical data transmission

Electro-optical data transmission is a sector in which Switzerland has traditionally/long been interested. Industry is active in technology for downlinks from orbit (Low-, Medium- and Geostationary orbit) to ground, with some activities in inter-satellite link technology. However, it is important to stress that the future success of electro-optical data transmission will not only depend on technical excellence, but also on a well-developed service portfolio for its application.

With an ever increasing need for bandwidth in data transmission, the space-based telecom sector is starting to look for alternatives and complements to classical radio frequency links and is becoming aware of the benefits of optical data-transmission. Given that the telecoms sector is considered to be rather conservative, full traction for the technology will be reached in the next five to seven years. This axis will therefore have to be reassessed within this timeframe.

### 2.1.4 Technologies for scientific instruments

Switzerland has a broad range of expertise and highly competitive capabilities in providing major scientific instruments for space missions. The academic landscape is dense and the industrial heritage strong, also as a result of the partnerships promoted between academia and industry along with the related transfer of know-how.

Scientific instruments will continue to play a central role in Swiss space activities. On the other hand, the cost/benefit ratio has to be constantly evaluated. Basically, scientific instruments are unique to experiments that are only conducted once. However, some instrument technologies can be improved (e.g. detector characteristics) as part of on-going research programmes and some secondary subsystems can be reused in other applications. The potential of recurrence will be assessed especially in optics, electronics, instrument structures, software (e.g. data analysis) and assembly, integration and testing (AIT). Reuse of technologies will depend heavily on future space programmes and flight opportunities, mainly within ESA.

### 2.1.5 Technologies for user-funded applications

Innovative small system approaches (optical, light detection and ranging - LIDAR, synthetic-aperture radar - SAR) are essential to capture relevant processes at regional scales typical for Switzerland and similar topographic areas. High-quality small systems such as these present a technological challenge but also provide a direction for future small flexible systems. Data processing and archiving capacities are currently limited in Switzerland. Novel and innovative data processing methods, such as linkage to on-board hardware modules (e.g. chips), combining data from various sources, and fast processing methods, need to be pursued in parallel to the above.

Integrated solutions/products combining data from various sources will have to be pursued. Research continues to be driven by the need to understand and quantify environmental processes more accurately and from an end-to-end perspective. From a technology perspective, smaller, more flexible systems, dedicated to answering specific questions are expected. The emergence of dedicated niches will take time. Assessments on the evolution of the sector should be carried out at five-year intervals.

Finally, Switzerland will seek to access flight opportunities for space qualification of technological developments.

## 2.2 Current fields of excellence

The current fields of excellence are the domains in which Swiss researchers and entrepreneurs have achieved a strong and substantial position after competition in European space programmes. The Swiss government takes into account the competences in these fields when deciding on participation in new programmes and activities. Its first priority is to consolidate Switzerland's recognised fields of excellence.

### 2.2.1 Science and Exploration

Science activities form the backbone of Swiss involvement in space programmes. Many Swiss academic institutions are involved in research associated with missions in the European Space Agency (mainly its Science Programme and its Earth Observation Envelope Programme) and with other space agencies. Research areas include cosmology, high-energy astrophysics, planetary science, solar and space physics, but also sciences based on remote sensing in fields such as atmospheric composition and dynamics, glaciology and vegetation related research.

In almost all of the past and present ESA science missions, the Swiss research community has developed and built instruments and experiments together with the Swiss space industry. This strength in instrument building and exploitation of related data positions places Switzerland among the leading nations at global level. Furthermore, Swiss scientists have also conducted experiments on the Space Shuttle and the International Space Station. Switzerland's participation in these research related infrastructures has to be assessed against the scientific and economic return of investment. Additional European and non-European flight opportunities are of key importance for the Swiss space research community to consolidate its competitive position at worldwide level.

### 2.2.2 Space Transportation

Independent access to space is one of Europe's and indeed Switzerland's strategic objectives. It has been achieved through the development and operation of the Ariane launch system by ESA. Switzerland considers its participation in these efforts as a strategic contribution to European access to space. The current Ariane 5 launch vehicle is one of the most reliable launchers worldwide and provides heavy-lift capacity for institutional and commercial payloads. The system has been complemented recently by the Soyuz and Vega launch vehicles and provides Europe with a family of launchers that covers the entire spectrum of satellite masses.

Since the beginning, Switzerland's participation in launchers has mainly been on the upper part of the vehicle, at subsystem or equipment level. Furthermore, Swiss companies are also involved in other domains, such as in operations at the European spaceport in Kourou, French Guyana. Through these major activities Switzerland is an important player in ESA’s launcher programmes, which is further valorised through participation in non-European launch services. Switzerland will pursue efforts leading to a cost effective and reliable launch service. In addition, it will continue to give preference to launch systems developed in Europe. Switzerland will also continue to support the further development of the Ariane launcher and its exploitation, relying on the participation of several European countries.

### 2.2.3 Applications

The availability of timely access to high-quality and reliable information is increasingly important for public and private actors. Operational fields such as meteorology, climatology, rapid mapping and services linked to resources and risks for mountainous areas are important for Switzerland and will contribute to the development of the corresponding downstream sector. Provision of applications is still in the early stages, with the exception of telecommunication and meteorology. The landscape of application developers and/or providers is fragmented on a global, European and national level. A number of leading research institutes in Switzerland are active in applied research which could lead to operational services in the domains of Earth observation and navigation. However, since Switzerland is well developed, there is little demand for certain space-based applications that are most useful in other countries (e.g., forestry, glaciology …). With its excellent field mapping and ground networks for measuring environmental parameters, Switzerland could nevertheless, serve as a test-bed for application development with the aim of providing regional services to Switzerland, its neighbours and other mountainous regions around the world.

Switzerland is a fundamentally bottom-up country: there is a high degree of freedom, and good ideas are often initiated by research institutes, Small and Medium Enterprises (SMEs) and large companies. The role of the Swiss government is to stimulate specified fields of excellence through dedicated calls for ideas.

In addition, if Switzerland wants to play a strong, visible role on the international stage, Swiss actors should join forces and focus their activities. Joining forces would enable them to address themes specific to Switzerland such as its characteristics as an alpine country or as a country with a strong back-

ground in humanitarian aid. Swiss stakeholders have a lot of interest, experience, know-how, and capabilities in both sectors. This focus could also be used in Switzerland's contributions towards finding answers to global challenges, such as climate change, humanitarian aid, or food security.

## 2.3 Emerging themes

In addition to the fields of excellence described above, the SSO has identified two emerging themes that deserve particular attention: 'small satellites' and 'miniaturisation'. It will give these two fields a horizontal focus across programmes.

### 2.3.1 Small satellites

Small satellites, considered to be those weighing less than 300 kg with less than 250W power consumption, are increasing in number and relevance at world-wide level. They have the potential to perform high quality missions at low cost. While they allow top level science to be conducted, small satellites present challenges at different levels in terms of miniaturisation and cost pressure. At the same time, the range of overall mission costs are affordable for a broader community of institutional and private actors allowing new forms of partnerships and shorter development times of around five years from selection to launch. Switzerland is not aiming to develop the capacity to design, develop, launch and operate a small satellite end-to-end on its own, but it should have key technological capacities and system knowledge. The necessary frequency of missions would be envisaged based on the different roles taken, as leader or as participant, depending on the interest in the mission.

A Swiss focus on small satellites has to be weighed up against the following:

- scientific/application benefit;
- industrial benefit – especially in the context of in-orbit demonstration (flight qualification);
- educational benefit – involvement of young engineers in academia-industry cooperation.

Switzerland considers small satellites to be a theme worth promoting, firstly in the framework of ESA. In light of the first ESA-Swiss co-led mission CHEOPS for the characterization of exoplanets, Switzerland will study the possibility of leading a small mission, maybe in the field of earth sciences with the potential of providing concrete applications and services responding to national and international needs. The selection of the theme should be based on

- scientific excellence;
- utility for end users or need for a pilot service;
- complementarity to planned or existing missions;

This would allow valuable data to be generated for Swiss and European users.

### 2.3.2 Miniaturisation

Miniaturisation is a key aspect in future space (and non-space) hardware developments. The competitiveness of Swiss actors on the global market will also depend on the capacity for miniaturisation of state-of-the-art technologies in cooperation between industry and academia. In this context Micro-Electro-Mechanical Systems (MEMS) is a crucial technology with relevant potential within Switzerland to be evaluated across ESA programmes. By way of example, mass spectrometers or micro-propulsion could become relevant sectors with the potential for providing state-of-the-art hardware: in comparison to its competitors, Switzerland is well-positioned in miniaturised subsystem elements.

### 2.3.3 Further emerging themes

There are a number of additional emerging fields which need to be assessed in terms of their potential for Switzerland. Some prospective evaluation will have to be performed in close cooperation with national and international partners (e.g. ESA, OECD). As a concrete example, and in view of a future revision of this Swiss Space Implementation Plan, emerging topics such as clean space will need to be investigated.

# 3 Measures

In response to the challenges as formulated in chapter 1.1, some dedicated measures within the current funding instruments being the participation to ESA programmes and NCA have been identified

- strengthen business incubation;
- pursue and enhance a political environment supporting international networking and export;
- promote new public-private cooperation schemes;
- push the development of integrated applications leading to services for the citizens.

These targeted measures, described in further detail below, will contribute to fostering the Swiss positions in its focal areas and will alleviate the challenges ahead for Swiss space researchers and industry. Business incubation and internationalisation/export will essentially target a competitive position on the critical technological path in the development of space infrastructure. Public-private cooperation schemes will increase the future competitiveness of Swiss actors, while the integrated applications push will contribute to developing the use of data for private and public end users.

These measures will be initiated within the current implementation framework for space as defined in the Dispatch on Education, Research and Innovation (ERI) for the period 2013 – 2016 and in anticipation of the subsequent periods. Complementarity with other funding instruments within the ERI perimeter (see annex) will have to be fully ensured.

## 3.1 Business incubation

These measures are embedded in the overarching approach aimed at allowing Swiss scientific and industrial actors to prepare for participation in international projects or programmes, in particular of the European Space Agency, of the member and associated States of ESA as well as ESA partners.

Key factors of success for innovation include favourable conditions for start-ups to emerge, technology transfer promotion and a high degree of autonomy of private actors, where the state intervenes essentially at the beginning of the value chain.

As a potential means of placing Swiss actors on an equal footing with their global competitors, a Space Incubator Initiative (SII) could favour participation in space missions and related innovation, resulting in increased competitiveness. The SII initiative would serve as an entry point into space activities, a support in view of qualification of space-related technologies and the utilisation of satellite data. Basically this should be implemented within existing national structures.

The entry barrier for bringing an innovative space technology concept to a “flight proven” technology is high. This is mainly due to the high costs and risks involved between laboratory experiments and the system demonstration. This entry barrier is especially difficult to overcome for start-ups and spin-offs with promising ideas for innovations in the space technology sector.

The SII’s goal would be to contribute to overcoming this high entry barrier. First and foremost it would support start-ups with innovative ideas for space technology (including non-space technologies) not older than 5 years, although this could be extended to established companies demonstrating a strong growth potential through new space products, based on a solid business case.

The SII could reach this goal through

- a bottom-up national space effort, basically supporting low Technology Readiness Level (TRL). Higher TRL up to flight qualification (TRL 8) could be supported through in-orbit demonstrations and especially by access to dedicated small satellites, based on subsidiarity to ESA and co-funding;
- a dedicated and initial financial support at project level aiming at participation in international space programmes.

The SII would focus on promoting space projects in the field of technology facilitating participation in space missions, mainly by ESA, and leading ultimately to the increase in competitiveness:

- The SII would support the international programmes of ESA and the EU, bilateral programmes and the commercial market. This national initiative would enable bilateral cooperation with research institutes and industrial companies of ESA Member States, such as our direct neighbours and ESA partners.
- The SII would fund projects with high technological requirements and therefore also high associated risks. The follow-up of selected projects would be subject to successful evaluation by public and/or private actors.
- The SII's funding has to be strictly complementary to other existing institutional programmes, be it at national, ESA or EU level.

Although the SII will basically function on a bottom-up basis, it is proposed to take into account the focal areas described under chapter 3, particularly for the development of innovative technologies, products and processes.

In a second step, the SII will provide entrepreneurs with the support to get from the laboratory door to a start-up with reasonable prospects of attracting risk capital. The SII's services would include

- the manufacturing, business and financial support required to assess the discovery's scientific and business potential;
- the high-level expertise required to validate it experimentally;
- access to initial and dedicated measures for the creation and development of a new company.

These measures will enable companies to position themselves and gain access to techno-park networks at a national level, as well as in ESA Member States and through ESA.

## 3.2 Internationalisation and Export: leverage of institutional space efforts

Swiss institutional efforts in space are essentially conducted through participation in ESA programmes. The valorisation of investments conducted though ESA programmes is obtained through a broader technology portfolio serving non-space markets and/or through a stronger position in space, but non-ESA markets, mainly the commercial market. A political environment setting boundary conditions to facilitating exports in space-related activities is a relevant success factor.

Space powers, such as China and India, represent potential growth markets in the global space environment. Switzerland should support access to these markets as complementary action to the accesses facilitated within Europe and to long-standing ESA partners, such as the USA and Russia.

While underlining the importance of strengthening international cooperation for the peaceful use of outer space, the Swiss government will also have to evaluate the relevance of space products in export control policy and determine, if necessary, the establishment of boundary conditions facilitating exports.

## 3.3 Public-Private Partnerships

A public-private partnership concept could allow for a new approach as to how governmental action can promote space activities in and beyond applied research in the value chain. This would mean that the government and a private actor would have an agreement on the rights, obligations and financial commitments over the whole lifecycle of the venture. The key point would concern the sharing of risks, where the basic principle would be that the public actor would take the technological risks in the development phase and the private actor would bear the economic risks in exploitation, after in-orbit validation. The public actor would benefit from the use of data from the infrastructure proportionally to its commitment in the development phase. The pool of resources would steer the lead responsibility which is also expected to change at the validation of the product.

The main objective is to encourage the commercialisation of related space activities and to create synergies between the public and private services. Finally, the Swiss government would rely on the assistance of the European Space Agency for the programme management and related technical expertise. This scheme could be applied at instrument or small satellite level.

## 3.4 Integrated applications push

The amount of information coming from space-based infrastructure is steadily increasing, namely through the potential of combining telecommunication, Earth observation and navigation satellites and related data. These integrated applications provide opportunities for new markets. The success of applications and services from space-based infrastructure will depend on a number of factors such as integrity of data, time to market, flexibility in terms of adapting to end user requirements and minimal regulatory directives. Any governmental incentive scheme would be based on economic viability, flexibility and utility.

A “modular” approach would be the basis, where an agile and flexible network of actors works together to foster and establish a specific space applications field, while taking care that activities for (integrated) space applications are approached with the user’s desirability, technical feasibility and economic viability in mind.

The next step is the alignment of Switzerland’s participation in ESA’s integrated applications programme and Swiss stakeholders bridging the gap from demonstration in space to products on the ground.

# Annex: Other funding instruments

For the sake of completeness, other funding instruments in the ERI domain with relevance for space activities are briefly described below, and their complementarity to ESA programme participation and NCA is highlighted.

## Swiss National Science Foundation

The activities supported by the Swiss National Science Foundation (SNSF) include research at a university or a university of applied sciences, including data acquisition, data processing and analysis and the publication of the scientific results. SNSF grants enable the funding of post-doctoral scientists, Ph.D. and graduate students as well as scientific collaborators. A limited support for the procurement and operation of laboratory equipment and access to research infrastructure is also possible. This complements the basic financing of the academic partners, such as the universities which are mainly at cantonal level and the Federal Institutes of Technology (FITs) at federal level.

With regard to space activities, the support from the SNSF is specifically relevant in relation to the development activities of scientific instruments for space missions. In ESA's Scientific Programme, as well as in the programmes related to robotic exploration and human spaceflight, ESA funding is used for the development and operations of the spacecraft, while ESA Member States contribute scientific instruments and experiments through other funding sources. In Switzerland, such instrument and experiment developments are funded through the ESA programme PRODEX (PROgramme de Development des EXperiences scientifiques), being an important vector of cooperation between academic and industrial partners and consequently of know-how transfer. This programme supports the actual development, manufacturing and testing of instruments and experiments, including software developments for the scientific ground segment, but does not provide funding for the data processing, data handling activities and any type of research activities. From that perspective Swiss funding in ESA programmes (including PRODEX), and the funding from the SNSF are fully complementary and need to be secured in the long term, as well as the commitment on the part of academic partners exploiting the data.

## Commission for Technology and Innovation

As the Confederation's innovation promotion agency, the Commission for Technology and Innovation (CTI) lends support to R&D projects, to entrepreneurship as well as to the development of start-up companies. The CTI helps also to optimise knowledge and technology transfer through the use of national thematic networks. The CTI shares a number of common points with the goals of technology research and development within ESA programme frameworks. Both are of a subsidiary nature and both ultimately help create sustainable value for the Swiss economy. However, there are also a number of significant differences in the way they work, especially with respect to ESA programmes for technology research and development, which basically funds projects mostly in industry. Most notably, these differences are

- the international focus of ESA activities, with national and international cooperation;
- the role of ESA and its experts as the primary evaluator of technology developments and funding requests, with the Swiss ESA Delegation working as a gatekeeper to oversee the overall budgets allocated to ESA;
- the support for the very specific, and rigorous requirements for the development, qualification and certification of space borne products within ESA programmes, and
- the different timeframes for activities and breadth of domains: space related activities usually start at very low technology readiness levels, have long development cycles (several years) and products need to be flight-proven before being accepted by the market, whereas CTI funded activities are from their beginning already close to the market.

These differences are eventually the reason why CTI and ESA funded technology research and development are such complementary activities. Nevertheless, in sectors such as the promotion of applications & services derived from space-based data and Public-Private Partnerships, new forms of cooperation may be evaluated.

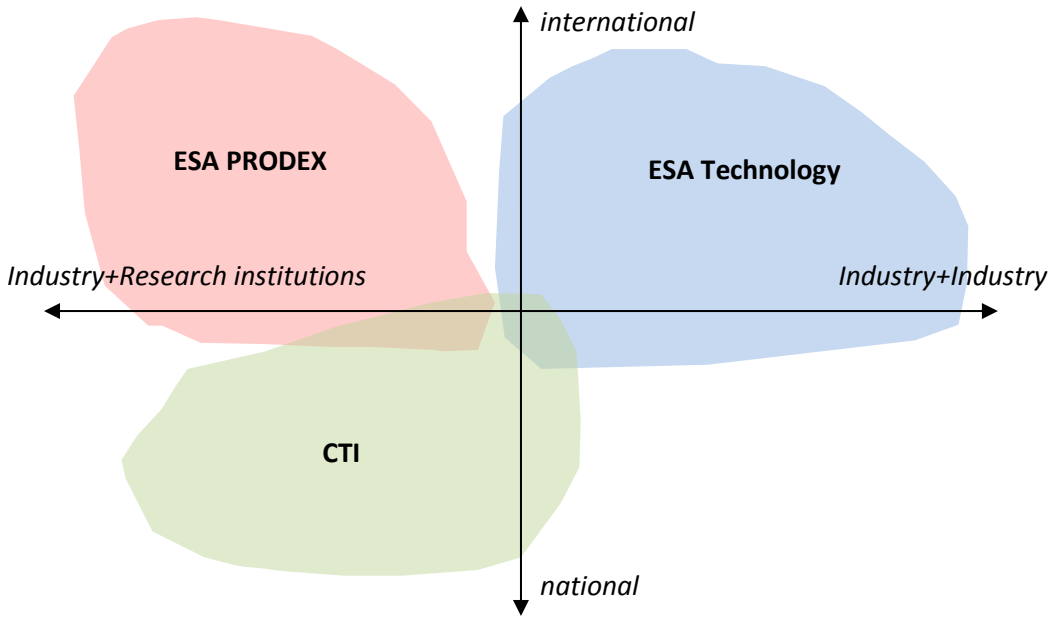


Fig. 3: Schematic representation of the complementarity of ESA and CTI programmes & activities

## Framework Programmes for Research of the European Union

The European Space Policy, jointly developed by ESA, the European Union and their respective Member States, assigns complementary roles to ESA and the EU: R&D for satellites and payloads up to in-orbit-demonstration, are the responsibility of ESA, while the EU takes care of the deployment of operational infrastructures and the development of services to meet the EU's political and societal needs. Additionally, workplans in areas of common interest, e.g. for the development of future generations of operational constellations such as the European satellite navigation system Galileo, are elaborated through mutual consultation.

That is why the activities of ESA and the EU are not only complementary, but active participation in ESA programmes also prepares the ground for successful participation in EU-led phases of joint programmes such as Galileo or GMES/Copernicus, the European Earth monitoring capacity for environment and security. Switzerland's participation in the EU-led phase of Galileo is finalized, allowing Swiss based actors to fully participate in application and service developments.

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