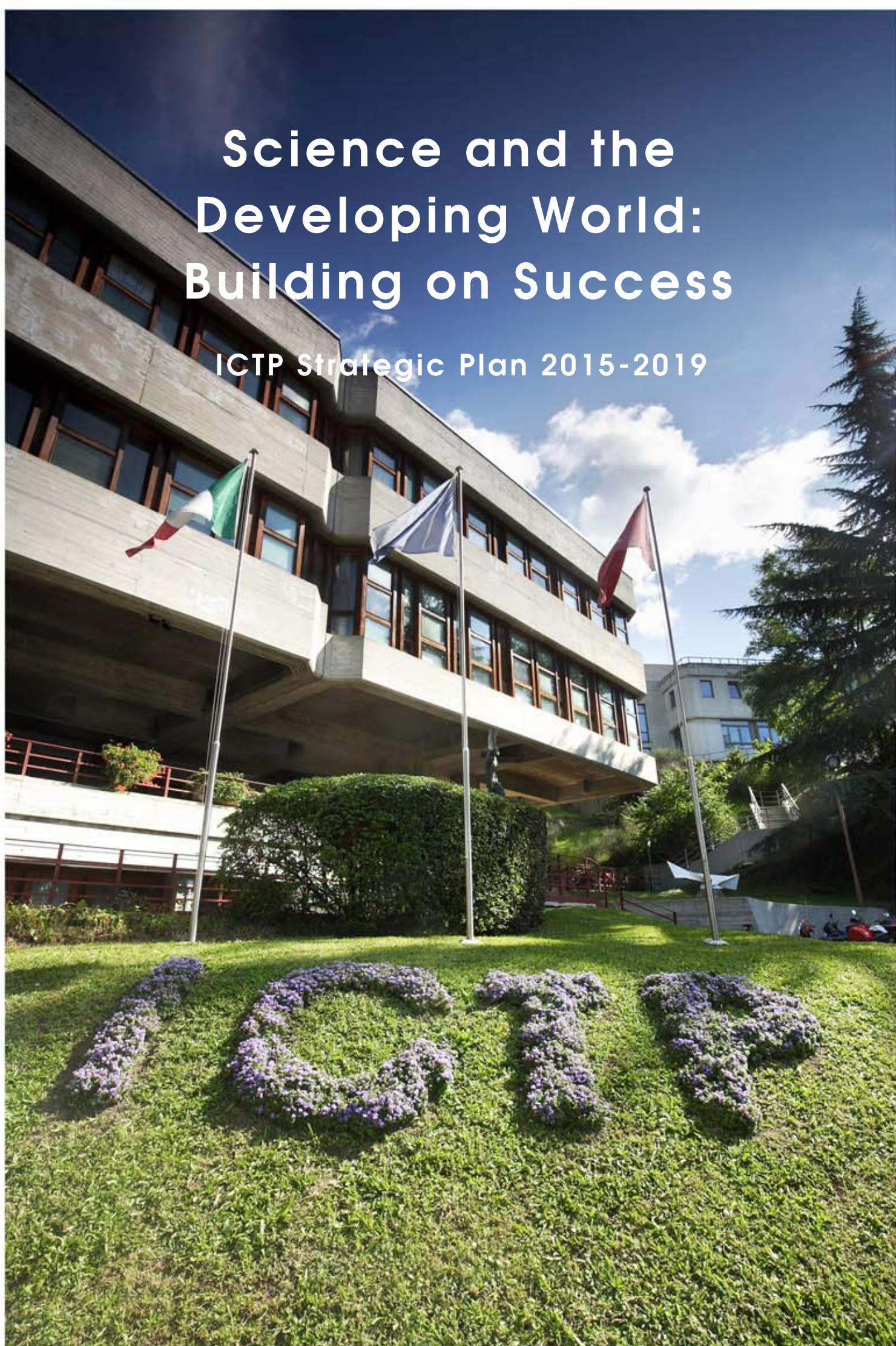


Science and the Developing World: Building on Success

ICTP Strategic Plan 2015-2019



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Fernando Quevedo, ICTP Director

Executive Summary

Since ICTP's inception in 1964, its dual mission has remained the same: to conduct high-quality research and to provide education in order to promote science in the developing world. As we celebrate our 50th anniversary, we can look back on the centre's many successes as a research and educational institution and truly appreciate the ongoing change that has shaped how we accomplish our mission.

Heading into our next phase of development, we provide the ICTP Strategic Plan 2015-2019, a follow-up to the ICTP Strategic Plan 2010-2014. Since the submission of our previous five-year plan, exciting progress has been made in many areas, but there is still much work to be done. This plan aims to maximise the value of the work that ICTP has accomplished thus far by building on our successes and consolidating projects already initiated, as well as applying renewed effort to any important projects mentioned in the last report that have proved especially difficult to advance. This plan also emphasises our intention to evolve in response to a changing world, initiating efforts where new priorities—and new potential—in science and in the developing world demand.

As with any strategic plan, not all items on this agenda will be implemented within five years. Limitations involving funds, space, staff, and other resources may present themselves as obstacles. Great effort will be brought to bear on important projects already underway in order to marshal the efforts of the past five years toward further consolidated goals. At the same time, unforeseen opportunities may also present themselves and warrant adjustments to this plan. In any case, the main points of the plan will require the approval of the Steering Committee and the consultation with the Scientific Council.

The plan itself represents the expertise of many scientists, especially scientists here at ICTP, who engaged in a formal process of brainstorming as a group and in small committee meetings. The process of developing such a plan and systematically measuring our impact as researchers and educators is important to formulating the steps that will lead us from a successful first 50 years to a successful future.

The Main Goals

The most important priority of this plan is to reinforce ICTP in all its existing research and training activities. Regarding the recent initiatives, the scope of this plan extends to all areas of ICTP, but five main goals promise maximum benefit to the overall mission, reach and impact of the institution. The main target is to consolidate the progress initiated on the five goals expressed in the Strategic Plan 2010-2014 and adapt them to more recent developments.

- 1 **Regional Partner Institutions:** Support new regional partner institutions to replicate ICTP's success in international research cooperation and supporting science in the developing world.
- 2 **New Research Areas:** Develop new research areas and interdisciplinary pursuits reflecting some of the most exciting frontiers in science today.
- 3 **Granting Degrees:** Optimise the educational framework at ICTP to expand opportunities to earn master's and PhD degrees.

- 4 **ICTP's Virtual Classroom:** Organise ICTP videos and educational presentations into a centralised repository and cataloguing system, assuring the accessibility of ICTP online education to scientists and students worldwide.
- 5 **Institute Advancement Office:** Cultivate ICTP's community of public and private funders to ensure the personnel and resources necessary to implementing initiatives in support of the overall mission.

Here, each of the five main goals is elaborated on briefly:

1 - Regional Partner Institutions

Since the release of the ICTP Strategic Plan 2010-2014, ICTP has begun the process of establishing partner institutions. The first were in Brazil, Mexico, and Turkey. Plans for partner centres in China and Rwanda are being considered and other countries have expressed interest.

The planning of future regional partner institutions includes a consideration of their geographical distribution and ICTP's potential impact in particular regions, as well as assurances that regional partners can replicate the successful model represented by ICTP, taking into account the current quality of research and higher education in each region.

To strengthen and expand this initiative, ICTP plans to establish an office to offer a bridge to and close communication with these and future partners. One scientist and one or two secretaries would handle the matters related to the regional centres, and each partner would also call on a scientist from its region to act as a liaison with ICTP.

As a key component to establishing solid institutions with guaranteed funding from the host country and to have a well structured legal identity, ICTP will work together with the corresponding country and with UNESCO's science section in order to make these institutions into UNESCO Category 2 institutes with the understanding that these will be ICTP partner institutions and therefore there will be a commitment from ICTP to guarantee the proper running and high scientific standards that characterise ICTP activities.

2 - New Research Areas

- a) *Quantitative life sciences*—a promising area in science incorporating physics and mathematics with biology to quantitatively study, for example, diseases and viruses—is a new, and growing, section at ICTP. Now in the hands of two permanent staff members, the section will evolve to match the size and scope of other ICTP sections, including adding a staff member with experience and expertise in ecology who could be a particular asset to ICTP's research around the issue of climate change. Two more staff members on neurosciences and molecular systems biology will be searched. Funds will be searched in order to create a diploma or master in this new field.
- b) Research in the area of *renewable energy* will also be expanded at ICTP in the next five years as the centre continues to host a renewable energy initiative, with new activities and conferences planned to be held at ICTP and abroad. Working within the Condensed Matter and Statistical Physics section, the plan is to expand research in the field and to hire a second staff member specialising in the topic of renewable energy research to complement the current composition of the section researchers. Interdisciplinary activities—such as

- renewable energy in the context of climate change undertaken in collaboration with ICTP's Earth System Physics section—will also expand ICTP research in this area.
- c) Over the past five years, great gains have been made in ICTP's *high-performance computing* (HPC) capabilities, which are important both as a service to ongoing ICTP research in several areas and in order to provide a master's degree in a quickly growing and increasingly integral field. Since 2010, ICTP has developed a computer cluster of 2,500 cores, and this strategic plan calls for doubling the size to 5,000 cores. Starting in 2013, ICTP and SISSA (the International School for Advanced Studies) began collaboration on the installation of an additional 4,500-core HPC cluster, which opened in 2014. Also, new to ICTP is an 18-month master's degree programme in HPC, also in conjunction with SISSA. After conducting test lectures over the past year, content has been tailored to focus on how to develop efficient codes, use libraries, integrate and link applications and programs, and how to manage HPC clusters. Ongoing lectures will also touch on research topics related to the Condensed Matter and Statistical Physics section and the Earth System Physics section.
 - d) New avenues in the *computing sciences*—the study of algorithmic processes that create, describe and transform information and its applications in computing systems (which is separate from HPC)—will likely be explored by seeking computer science emphasis and expertise in discrete mathematics as the Mathematics Section considers new faculty. Seeking mathematicians with such specialisation in algorithms and the man/machine interface harmonizes well with the potential expansion of this section into more applied mathematics. The initiatives in computing sciences proposed in the 2010-2014 strategic plan have been slow in coming, but plans will be reinvigorated because of the valuable implications such research has on development.
 - e) In the realm of *applied science* at ICTP is the Multidisciplinary Lab (MLab) which will be restructured in order to have a more focused scientific and educational impact fitting with ICTP's mission and scientific standards. Following the report of the MLab Evaluation Committee, a collaboration with world-leading researchers in training and research activities in optical research experiments, including the European Laboratory for Non-Linear Spectroscopy and INFN, will be consolidated and coordinated with the OEA- (Office of External Activities) supported activities in affiliated centres in developing countries. The extremely successful *hands-on* schools on complex systems that have been co-organised with top experimentalists worldwide to provide advanced research training involving modern table-top experiments combined with computer data acquisition and computational modelling will be substantially expanded. Recognizing the value of such hands-on laboratory experiences to young scientists, ICTP will continue two-week schools, which could be incorporated into a novel master's degree programme. ICTP's new SciFabLab, including a well-developed 3-D printing laboratory, will naturally fit with these activities of the MLab with the ability they provide to experiment with new ideas and technologies at a low cost. The MLab and the new SciFabLab also represent additional opportunities for ICTP to reach out to visitors and the local community, expanding access to scientific experimentation with guided visits and events in which the general public and the many visiting scientists and students are invited to engage in hands-on science, digital fabrication and prototyping.

3 - Granting Degrees

The successful arrangement of granting PhDs in conjunction with SISSA (the International School for Advanced Studies in Trieste) will continue, as ICTP explores the possibility of also granting degrees in collaboration with UNESCO, United Nations University and/or other partner institutions. Such partnerships with other international universities could give young scientists from developing countries more choice in where to carry out their research and could also benefit ICTP by expanding its high-profile collaborations. As the SISSA/ICTP programme and other arrangements continue—including the ICTP Diploma Programme, three master's degree programmes offered jointly with partner institutions, the Sandwich Training Educational Programme, the PhD in Earth Science and Fluid Mechanics offered jointly with the University of Trieste and the Italian National Institute of Oceanography and Experimental Geophysics, and expanded opportunities for training and research in professional laboratories—ICTP will work toward consolidating and streamlining management of all of its educational activities into one office, encouraging synergies so that science students and the communities they represent can derive maximum benefit. A number of new master's degree programmes are currently under consideration or in development—including in High-Performance Computing, in Hands-On Activities, in Earth System Physics and on the “Internet of Things” with the University of Trieste, and a merging of the mathematics diploma course with the “Laurea Magistrale in Matematica” at SISSA. In general the possibility to convert the ICTP Diploma Programme into a Master's will be explored.

4 – ICTP's Virtual Classroom

Developing ICTP's leadership in virtual classroom learning will involve adapting and consolidating the centre's vast collection of videos and other educational presentations to a standardised digital format that is accessible not only locally, but also in developing countries with low bandwidth. The ICTP website and other Internet resources, media such as hard disks and DVDs, and mobile apps could be part of the process, and the centre should work together with other institutions to leverage the combined value of networked materials, including adapting ICTP's online content into full-fledged online classes, such as MOOCs (massive open online courses), although adapted to the ICTP community. Ideally, the materials would be filtered, labeled using a standard metadata/keyword structure, and archived in an integrated way, such as on a centralized server, so that they can be easily found by the audiences to whom they present the most value. Such audience include scientists in developing countries at all levels, from high-school students to senior researchers. Although the goal of improving ICTP's virtual classroom was highlighted in ICTP's previous strategic plan, a more substantial effort will be needed in order to have proper impact. Efforts will be redoubled to make such e-learning available, both through hard media delivery such as CDs created by ICTP, and in some cases, when needed, through ICTP involvement in the upgrading of Internet connectivity at scientific institutions in the developing world. A repository of internet educational material in the relevant areas will be developed in collaboration with other institutions in order to facilitate access and guidance to students and scientists from developing countries on the relevant material available on-line.

5 – Institute Advancement Office

New initiatives at ICTP often require new faculty and administrators and therefore rely on new sources of funding. As ICTP celebrates its 50th anniversary, we are taking advantage of this milestone to reach out to potential donors throughout the world. Established in 2013, ICTP's Institute Advancement Office has secured new support from a wide range of parties, and is building on those successes as it targets high-return public and institutional donors, private foundations and corporations, and individuals. Meanwhile, ICTP will be working proactively to partner with other international institutions that fund scientists in developing countries, in order to discover and develop synergies that will maximize the value of funding resources and broaden impact.

Evolving Structure for Continued Success

In addition to the new offices mentioned above to handle ICTP regional partner institutions and to consolidate the centre's educational programmes, ICTP will plan to establish three other new offices to achieve goals important to the institution's ongoing mission.

1 – Gender Issues

To oversee a concentrated effort to increase the percentage of women at ICTP in all roles, a staff person should be employed part-time at 25 percent. Projects would include improving outreach, making facilities more accommodating to women, encouraging networks among ICTP women, and increasing the number of women in leadership positions within ICTP and in the Scientific Council.

2 – ICTP Ambassadors

This programme seeks to engage postdocs, professors on break, and retired professors from any institution in the world who would be willing to participate in ICTP activities in the developing world in order to share their knowledge and skills by, for instance, teaching classes or initiating research collaborations. While a prototype of this activity was initiated by a postdoc with successful results in Palestine and Algeria, a more official coordination by a half-time employee could help to increase its scope and reach. Collaboration with other organizations such as universities could help to implement the programme and finance travel expenses associated with it. Potential involvement to cooperate with the International Astronomy Union and SKA in order to promote Astronomy studies in Africa will also be explored.

3 – High-School and Undergraduate Teacher Training

An important part of ICTP's support of science in the developing world involves motivating young people who are interested in science, helping to keep them in the field by helping to outline a future for them. Training of teachers by working scientists—especially for high-school teachers, but also for teachers at the undergraduate level—can have a huge influence on students, with teachers transmitting the excitement and creativity of the world of science and attracting the brightest minds. Other ways of supporting science students include offering specialized summer schools and research opportunities to undergraduates, as well as providing e-learning and m-learning (learning

apps for mobile devices) activities. One ICTP scientist with the help of an administrative assistant will lead efforts to coordinate this initiative.