

# Science and Development for a Changing World

## ICTP Strategic Plan 2010-2014

### Executive Summary

*Fernando Quevedo, ICTP Director*

ICTP has a dual mission: to pursue high quality research; and to nurture science in the developing world. However these twin ongoing objectives continually have to adapt to an evolving geopolitical situation: as nations mature scientifically, others in the developing world still require support and assistance. At the same time, scientific priorities are in a continual state of flux as fresh horizons emerge and new research techniques become available.

This plan is only a guideline. Given the many limitations of funds, space, personnel and other resources, it is difficult to visualize how all these activities can be achieved within five years. Also, unforeseen new opportunities may emerge and prove more promising than those presented here. The main directions and guidelines will require the approval of the Steering Committee and will be followed in consultation with the Scientific Council. In this interaction, new possibilities may emerge.

Nevertheless it is important to have a vision and to identify clear goals in order to move forward. The points presented here have been the results of consultations with many scientists inside and outside ICTP. The local scientists contributed very much after two days of brain storming sessions and several small committees reports.

### The main goals

This five-year programme adds fresh impetus to ICTP's dual mission. It extends the Centre's scientific activities in value and range, as well as geographical extent, while reinforcing the necessary resources, and developing the required outreach techniques. Although broad, it has five specific priorities:

- ICTP science would be enriched by a formal PhD programme as a natural extension of the current Diploma programme.
- The reach of ICTP's science would be extended by establishing regional centres of excellence in developing countries.
- The range of ICTP's science would be increased by strengthening existing research sections and adding new ones, particularly in Energy, Quantitative Biology and Computing Sciences.
- ICTP would play a leading role in developing improved internet-based techniques and new e-learning methods to further supplement and replace the traditional classroom.
- A new Institute Advancement Office (IAO) would seek new funding and support opportunities.

## The general plan

To achieve these goals, they must be meshed with ICTP's operational structure, covering administration, education, research, and outreach.

### Education

- Initiating a PhD programme at ICTP is a priority of the new directorship. Although a natural extension of the existing diploma programme, it will not be limited to diploma students. It will also be open to other highly qualified students from the developing world, including those from countries (Argentina, India, etc.) whose students are currently not accepted for the diploma programme as adequate education at this level already exists in their countries. This could be implemented in association with other institutions such as SISSA, the United Nations University (UNU), etc.
- This would be complemented by new diploma programmes, such as applied mathematics, and other new research areas (see below).
- To expand the STEP programme coordinating with other institutions in the developed world that could partner to participate in this sandwich PhD.

### Research

- Attract versatile young active researchers who could adapt to the activities of existing groups. Promote interdisciplinary research (for instance high energy physics with condensed matter, mathematics with high energy physics, condensed matter with earth systems physics etc.).
- Open new research groups in fields related to existing ones which could have significant interdisciplinary research potential, especially in their possible impact on developing countries. These fields would be:
  - A. *Energy and Sustainability*. A new research section concentrated on the different sources of energy and their impact in the developing world. This topical subject area fits very well with the current activities of the Earth System Physics and Condensed Matter Physics sections and complements them in a natural way, in particular, the computational modelling of different materials relevant for energy conversion and storage. The hope is that such research could be implemented in collaboration with other local and national institutions, in particular SISSA, as well as with UNU (as a World Institute of Renewable Energy). This topic is important for developing countries that have special needs for energy use and production. The research would focus on renewable energy sources, but would not exclude other sources. Possible synergies with IAEA and with other local institutions with experimental programmes that could complement our theoretical activities will be investigated.
  - B. *Quantitative Biology*. This refers to the understanding of biological processes from data and quantitative analysis, computational and/or mathematical. Theoretical physics and mathematical methods are playing an increasing role

in biological systems. In particular the large volumes of data becoming available from sequencing of species require quantitative techniques more familiar to physicists and mathematicians than to biologists. This work could be implemented in collaboration with ICGEB (the International Centre for Genetic Engineering and Biotechnology) at Trieste. ICGEB would cover some of the experimental aspects, while the new section would complement the current ICGEB activities by doing computational modelling and data analysis. This work is important for the developing world because of its relevance for epidemics, genetic diseases, cancer, etc.

- C. *Computing Sciences*. The systematic study of algorithmic processes that create, describe, and transform information and its applications in computing systems is an ever-growing field that somehow now mirrors the role that theoretical physics used to play 45 years ago when ICTP was founded. It has direct impact on society as a whole, and can be implemented in developing countries through improved access to computers via the internet. It is directly related to development and has important financial implications. This activity could be considered as a natural extension of the mathematics group to more applied areas. Expanding the scope of this new group to include quantum computing could also link with current research interests at ICTP and the University of Trieste.
- A local cluster of computers would provide a world-class facility for the Centre's scientists and visitors. This will be needed for independent computational resources at ICTP for the existing groups (mostly Condensed Matter and ESP) and for the proposed new sections mentioned above. A substantial expansion of the current facilities will be needed and a relatively small group of scientific computing will be required.
  - Access to the SISSA building is essential for all these expansion plans. They could be implemented together in a 'modelling institute' or computational science centre established in conjunction with SISSA, using the facilities of its building. This could also host the new PhD students.

## Outreach

- Enhance substantially the role of the OEA (Office of External Activities) by complementing its main activities (affiliated centres, networks, conferences, visitors) with a new major activity focusing on the creation of ICTP branch institutes. These could be multidisciplinary and/or specialised. Ideally, all should be regional so as to underline the international nature of ICTP's work. Funding should be sought through ICTP and through local sources.
- Implement, together with UNESCO and similar institutions, an office to study the status of scientific development in various developing countries and liaise with local scientists to establish coherent development plans.
- Establish a new programme to support undergraduate students from the least developed countries. This would organise activities such as regional schools, travel to emerging and developed countries for summer training, and encourage students to embark on scientific careers, etc.

- Coordinate with UNESCO and other institutions (CERN, AIMS, Cambridge Millennium Mathematics Institute, etc.) a coherent programme for scientific education for teachers.
- Set and maintain highest standards for local videos of scientific lectures, colloquia, etc.
- Initiate a substantial systematic, coherent programme for on-line access to scientific information. Create a library and/or archive of on-line videos organised by subject and level, covering existing collections and including a daily update. These activities would be coordinated with other institutions (PI, AIMS, KITP, Cornell, etc.).
- Establish an Experimental Techniques for Training and Development (ExTraD) unit. This would coordinate existing experimental activities at ICTP such as the ARPL (Aeronomy and Radiopropagation Laboratory), the MLab, etc., and complement them to provide basic equipment to support some of the annual activities and schools, such as those in optics and electronics. Rather than creating a new research unit for experimental physics, the goal is to coordinate existing activities and provide basic equipment to complement that used mainly for training and development. Basic equipment, some of it obtained through donations, would also be used to expose diploma students to basic experimental techniques. Teachers and other visitors from developing countries would also profit. Some of the activities will be coordinated with Elettra and other Trieste institutions. A scientific staff member would lead this unit, advised by an external panel of experimental physicists.
- Expand the existing TRIL (Training and Research in Italian Laboratories) to TREL (Training and Research in European Laboratories) to distribute researchers from the developing world to European laboratories such as CERN, ESA, ITER, etc.
- ICTP's mission to foster and promote science in the developing world should be implanted in other scientific centres in the developed world, using ICTP as a success model that has been tested over the years and has delivered positive results. This can enhance substantially the ICTP impact.
- Create a pool of scientists from the developed and developing world (including particularly those already working there) that would be willing to disseminate their knowledge by participating in ICTP activities in the developing world. Retired active university professors with excellent teaching records and even young postdocs (to assist in lectures) would be particularly targeted. ICTP would cover travel and local expenses without necessarily paying salary during their tenure for ICTP.