

ICTP as a Model for Excellence for Doctoral and Post-Doctoral Training in the South⁶

Katepalli R. SREENIVASAN

Abdus Salam Research Professor
Director, ICTP Trieste

Abstract. Founded by Abdus Salam and established near Trieste, ICTP main goal is to make the most advanced scientific knowledge available to everybody, especially the least advanced countries. Visitors coming from all over the world for a variable duration can continue there their own research or follow specialized courses. Links with local institutes are being developed, to follow and continue helping visitors, in particular in Africa, but are difficult to implement because of the lack of Internet communication means.

The frontiers of science have been expanding very rapidly at least in the last 100 years or so. For many institutes in developing countries, it is often very difficult to catch up with all the advances and to actively participate in making these advances. So many different schemes have been devised how to involve developing countries, not only in catching up but also in actually pushing the frontiers of science. ICTP, the International Center for Theoretical Physics, is one example of an organization that builds a bridge between developing and developed countries. Its goal has been to make the most advanced scientific knowledge available to everyone, including the least developed countries so that infrastructures of high level research can take roots in those countries. So that is the theme of our institution, and for instance, when Morocco is embarked on a new scientific ventures and cooperation with its neighborhoods of the North, it seems like a brief account of how ICTP functions, what it does and where it succeeds and why it succeeds. So it may be useful to explain these points and this is in this spirit that I offered to make the following presentation.

I will start by following the suggestion of the convener of this session and by saying a few words about the history of ICTP. This Institute was founded more or less 40 years ago by Abdus Salam, who was the Nobel laureate in 1979, and whose work had direct connections with Carlo Rubbia by the way. This is an institution which operates under the tripartite agreement between two United Nations agencies, UNESCO and AIEA on the one hand, and the Government of Italy on the other. This is really a very important arrangement because the international character gives us an umbrella that makes it possible for this institution to be international, that is, for people from countries like Morocco for instance, to come and feel that the institution belongs to them. On the other hand, as you will see, the Government of Italy plays an extremely

⁶ Transcription from oral in English.

important role because it actually funds for a very large amount. The mission of the center is to foster the growth of advanced studies and research in developing countries. As I said before, UNESCO and AIEA have given some money, and also we get some money from SIDA, the Kuwait foundation and others but about 82% of the budget comes from Italy. This country has been extremely generous in doing this and I think it has come within the culture of Italian scientific community for many years.

An institution like ours is not only interested in creating knowledge, which of course many other institutions are always involved in, but in sharing it with others, which is at least as important. This is working the principle with which the Center works.

But just for those of you who don't know where ICPT is, the Figure 1 shows Europe and Trieste in the upper eastern corner of Italy. In the enlarged part, you can see Trieste here at the bottom and a few kilometers to the north, we have this campus where ICTP is located. There are number of other institutions that came up since ICPT was created, with ICPT's leadership, not only in ICPT campus but also in this area, on the east of the city in the Science Park. ICPT is a part of institutions that actually have involvements in developing countries. Elettra, about which you will hear more perhaps tomorrow, is not far away. It is also another institution in which Carlo Rubbia was involved in, and which is interested in scientific capacity building up in developing countries.

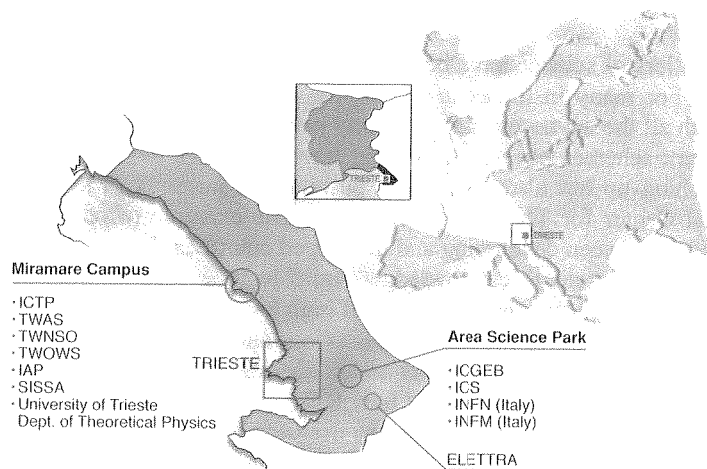


Figure 1.

Now, let me say a little about how we are basically organized.

We have 28 or so "permanent" scientist, permanent between quotation marks because within the UNESCO there is nothing permanent in general, but that is the general idea. These persons are involved in research, some of them are actually full state scientists and we would like everyone now to become full state scientist to have them fully involved in research and training coordination.

We also have 110 temporary staff which includes about 52 or so post docs, staff associates – these are people who have acquired a name in their own countries in science and they come and spend some time with us so that they build bridges between themselves and us. Some of the temporary staff are long term visitors who have to write a book for instance, or who have a sabbatical leave to spend. We welcome such visitors and they do mostly research.

Finally we have about 420 people in any given year that are short-term visitors, among them are our associates. These people, who are associates with the Centre for something of the order of 10 years, come almost every year or every other year sometimes, for about two months or so, and I will show you some statistics about Morocco for instance. Associates are people who have careers of their own in their own countries, but use ICTP as the means of keeping contact with the rest of the community and actually doing things that they could not do at home because they are bound by too much teaching or too much bureaucratic stuff and things of that sort.

This really forms the core of the research activities in the center, but what makes the center somewhat even more special is that we usually have 4,000 to 6,000 visitors every year: 6,191 in 2003 and a little bit more in 2004. These visitors participate in many conferences and school programs and workshops and sometimes these are pedagogical trainings at the very frontier of the subject. It depends on the purpose of a particular program: the programs are organized by our scientists here along with the help of a number of other scientists in the rest of the world. So the Center works not only because of people who are there but also because of the connections it has with a number of other people outside.

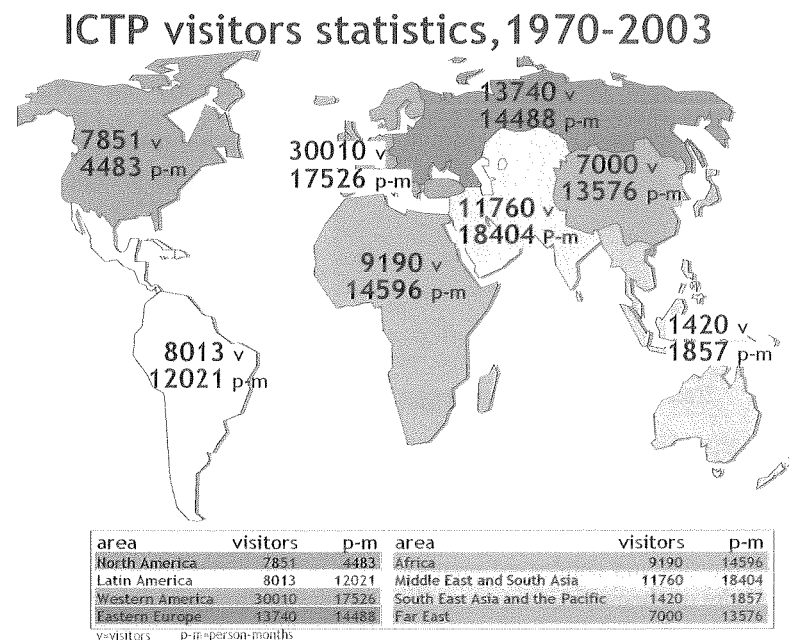


Figure 2.

Of course, to take care of this many visitors, to get visas and accommodation and so on, we have about 125 general staff. So that's the nature of the institution in general. Figure 2 shows statistics between 1970 and 2003, (we did not have any statistics before 1970 and I have not been able to put the 2004 statistics yet).

Basically, we have many visitors and person-months from United States and Europe. In fact the largest numbers of visitors we get are from Italy and from Western Europe because we are close to Italy and to Western Europe. But by and large, if you take out the Western Europe, the United States and part of Russia for instance, the rest is really developing countries in some general sense: Latin America, Africa, Asia, China and other Oceanic countries including Australia. So if you add them all up, you will get about 100,000 or so visitors for these many years, 50% from developing countries and 50% from the developed countries. The idea is in fact to mix people of different experiences, different backgrounds in such a way that they learn from each other mostly rather than from the people who are there permanently. Although there are only 50% visitors from developing countries, they spend 75% of the amount of person-month that is, they spend more time in the center than people from industrialized countries.

Figure 3 shows how the number of visitors has grown up with time. It is due mostly on how generous Italy has been with the money in some general sense. For the last few years, although we haven't had any increase in money, we have squeezed more things and then we have made it possible to have more things within the center.

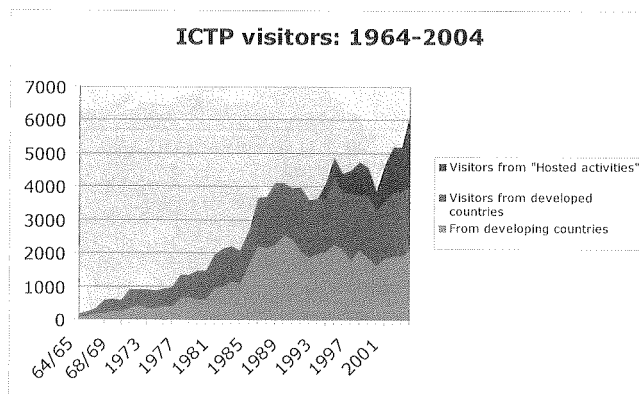


Figure 3.

Now let me come to what research gets done at ICTP and why it is done that way.

The High Energy group is traditionally very strong; it has been very strong because of the interest of the founder and now we have expanded it to include cosmology, astroparticle physics and condensed matter. There is also a statistical physics section, applied and pure mathematics, then an applied physics section, which includes medical physics, optics, lasers and fluid dynamics and so on. We then have a new section on earth sciences, which includes weather climate changes, oceanography, earthquakes, all the sciences that you are particularly interested in some of the remarks that were made

earlier. We even had a program, or have had a program on environmental and ecological economics, and many other centers in fact are connected to us for this.

I have to make something like a common sense statement here, which is: it is very important for ICTP to have a strong core of research activity. ICTP cannot be like many other UNESCO organizations for instance, because if we don't do science, it is not possible for us to influence other people to do science and we have to do good science, not just any science. This is something that has been in our mind very deeply and we keep to this idea as much as possible.

Now many people may ask why this emphasis on High Energy Physics and similar matters for developing countries? Who cares about High Energy Physics in developing countries? But actually my answer has several aspects and I want to spend a minute or so on this subject. Let's say somebody from a developing country - Morocco is an exception in this case as there are many people interested in High Energy Physics here - let's say somebody from Uganda wants to do High Energy Physics. Who am I to tell him that this is not for him and that it is only for people in the Institute for Advanced Studies in Princeton? For people like that there must be a place in the world to come and do this sort of stuff. I use High Energy Physics; and I know that CERN is of course a great institution that allows for it. But for such things, ICTP is in fact the place where many people have come. And secondly, if you really train yourself to do something in a rigorous way at some point in your life, this will really remain with you for the rest of the time and it is important to gain rigor in one's way of thinking, otherwise it is impossible to do anything of some value.

Furthermore, I actually believe, and I know this is the case, that the tools that one uses in one of these fields can be transferred to other areas. For instance I know people who have worked in let's say cosmic microwaves, background radiation and use the analysis for mapping of the data, have in fact use the same kind of ideas for mapping, for instance, the farthest regions in Rwanda.

Finally, we are also talking about sustainable development. Sustainable development has in fact very old problems such as providing in general clean drinking water and similar basic things. Even there, high end of technology can be extremely beneficial and CERN in fact has been using this idea in general. I can give you many examples where high end technology has been useful for age old problems of sustainable development goals. In many cases they consist of the trained people who have acted as nucleus for other institutions. This is not wishful thinking, it's actually true. I know some of those people, who were trained and educated in ICTP. In addition, I must say that we have many programs on a very large number of domains even though we don't have expertise within ICTP ourselves. We then involve others who are experts in these fields, but I don't want to take you through all this stuff.

We also built a new section on earth-based system physics, which consists of physics of climate systems, physics and predictions of earthquakes, and soil physics and alternative sources of energy, upper atmosphere. All of this is of direct interest to many developing countries. So this is my rapid answer to what we do and why we do it.

In addition to the core activities, we take students who have just finished their bachelor's degree in many of the developing countries and who are very bright people but don't have the right sort of training and the right sort of education in order to go into research. These students of that level are 20 to 23-4 years old and come for a diploma program in ICTP. They spend a year or so taking courses in different branches of physics and mathematics. For the group that has just been graduated a few days ago, the students were mostly from the least developed countries. In a batch of 39 or so, 8

are from Africa, 11 from Asia and Middle East, 4 from Latin America and 2 from Central Asia. Out of the 500 students or so we have had, 60% of them have entered in graduate schools and have done extremely well. Many of them remain connected to their own countries and we are planning new grades on applied mathematics and systems physics.

This, I think, is another avenue in which young people who are very good are taken in at low level and then raised to very high level in general. Since we are in Africa and pretty surely, Morocco regards itself as an African Country, I want to spend a little time on the involvement of ICTP in Africa in the creation of affiliate centers in the rest of the world. (See Figure 4). These centers are small centers, but there the level of activities is very high. By creating many such small institutions around, the general idea is that it will be possible to raise the level of science everywhere. ICTP has been instrumental in creating about 14 affiliates centers; 6 of them are in Africa as shown on Figure 4. One of them is now closed unfortunately, but nevertheless the others are generally working very well. There are also many so-called external activities that we support in Africa, such as meetings, topical schools and workshops and so on. In Western Africa for instance we have, over time, really invested a lot on Mathematics through a concerted effort. Year after year, our people go and teach courses and arrange other activities, like networks of people, graduate programs, and so on.

ICTP AND AFRICA

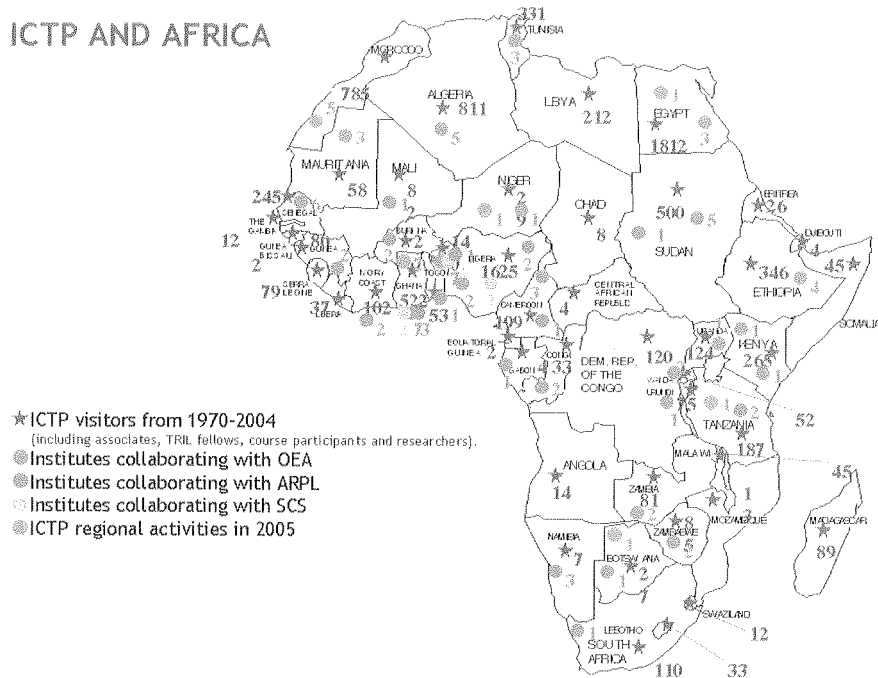


Figure 4.

To go back to visitors and fellows, these people are expatriates who want to go back to their countries for some time. We help them financially a little bit, as for associates. Out of the 256 associates we have, about 30% of the total are from Africa, and the STEP program has been set up for them. It concerns people who want to do PhD: they have to get the degree from their own countries and be registered in their own countries, but they come and spend half of their time in ICTP in order for them to get connected with the rest of the world in some general sense, with ICTP in particular. We also have the so-called PIL fellows, who are people coming from developing countries and spending some time in Italian laboratories, These people spend about a year or so in Italian labs, they are funded by ICTP to a large extent and the rest of the money comes from those institutions. We are also constructing some other programs in Kenya and other places. Now this is just to give you a general idea where people are coming from, in particular from Africa. From Morocco, for instance, we have as you can see, 785 visitors to ICTP and there are 5 institutions collaborating with ICTP in general. As you can see we have focused the large on the Western part of the continent and much on the East, and of course there is a large part that, for whatever reason, which has not been much involved in ICTP.

One of the last things I want to talk about is the following: although our interest is mainly in physics and mathematics, in a very broad sense, it is not just very narrowly defined, but still, sometimes we get involved in projects which are outside of it in some sense. Let me give you an example to illustrate this. Previously, we used to supply books and libraries' subscriptions to a number of scientists who had problems in getting all the literature. Today, the world is very different and literature has to be obtained electronically. But the bottleneck is that there is not much connectivity, especially with Africa. If one compares the cable traffic between let's say United States and Europe and the one with Africa, you can have a rough idea of what the problem is (see Figure 5).

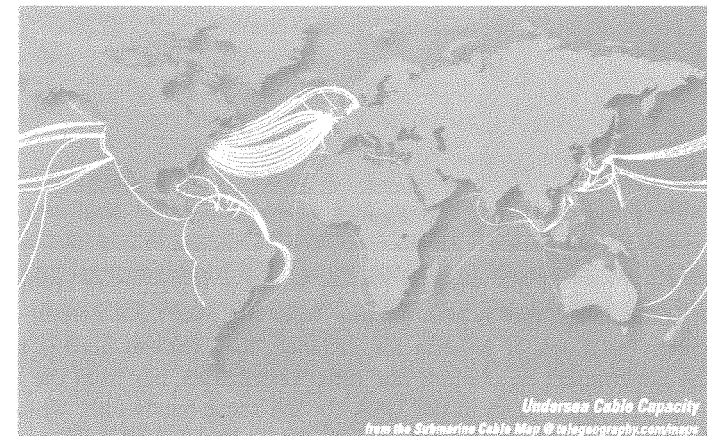


Figure 5.

Another way of looking at it this is the bandwidth between US and Europe and between Africa and US or Europe. You can see it is really a pittance. In fact in many

places in Africa, if you want to download an issue of the Physical Review Letters, it is just almost impossible because you just log on to the network and then wait and wait. By the way Morocco is maybe an exception, as it almost never happens.

Under these circumstances it is very hard for me to understand how anybody can do physics. This is why we have been pushing many institutions to provide the infrastructure for Internet Connection. We on the other hand will take care of providing access to technical literature, scientific literature through connections with publishers and other institutions and also provide training courses to really have some idea how to use that technology for instance.

Another aspect is the quantitative measure of the speed of the Internet in Africa towards the rest of the world, shown in Figure 6 as a function of time starting in 1998 up to 2005. Don't worry about the precise quantity with which the speed of the Internet is measured, it is actually measured by sending a pulse and then finding the time it takes to bounce back. On the left map are the institutions where the survey has been conducted, in fact there are two in Morocco, I think. You can see how North America has been doing and Europe actually falls fairly behind, but where is Africa in general? You should also understand that this is not necessarily inclusive of all the African countries, some of which I have ignored. As you can see in this right part, Africa is much worse than the rest of the world. This is why we are involved in such projects dealing with the Internet, only because these are vehicles by which you can communicate the knowledge that is essential.

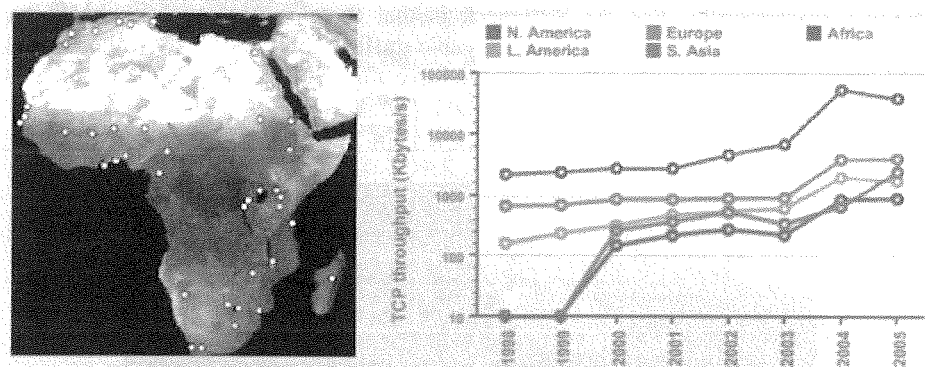


Figure 6.

I must say that part of the problem comes from the government control in some sense, and in some cases, this is also coming from the cost for a certain quantity of Internet connectivity. Look at Nigeria for instance, the problem here is not coming because of the government regulations and other restrictions, but from the cost, which is almost 100 times higher than in the USA for the same bandwidth, which makes it extremely difficult for you to set up such connections. And therefore, one of the things we do is to try to improve that situation through different projects. One of them is to supply articles electronically through e-mail, but this is a very complicated affair.

Let me finish now with three statements.

The first one is that we try to look for skilled individuals, independent of which country they come from and of what the international standing of their institution is. I

think this is very important, as even very poor institutions in poor countries have some very skilled individuals. Of course, we have to identify them, and this is a lot of hard work; it is not going to just happen like this. It is very easy to pick up the best people from Harvard or some place like that because they are in fact all very good, but the point is that if you want to pick up people on whom it is worth spending some time and effort, you have to do a lot of work. So this is one important thing.

What we also do, or try to do anyhow, is to pick up the brightest scientists, without regard for reputation of their institution or the scientific target of their country, and set them in a position such that they can build their own activity in their own country. When this eventually happens, some of them do that and become involved in public life of their country, and we support them for a reasonably long period of time of the order of 10 years. There is no point in letting someone come at ICTP for three months and then forgetting about him. Absolutely nothing will happen if you do it like this. To the contrary, you should have a sustained connection for these people. Unfortunately we should be able to do more but we can't. But whatever we do we do for a large period of time and capacity building means that, at some point the people involved must do something substantial with their hands and their minds: they just cannot come and sit in the lecture room, just nodding their heads and going away. They have to do something, they have to do research, they have to write something, this is a very essential point.

The next thing is that institutions have to be transparent, and this is what we try to do. If we don't have transparent institutions, good individuals cannot do very much. So this is another important aspect and we try very hard with various institutions. Institutions must also have steady sources of support, just like individuals, free of political interference I would say. We cannot do much there, this is a bit beyond us, but still we try to help people in many different ways. This is why ICTP gets engaged with politicians and ministries and other bodies, even though it is not our business directly.

Like individuals, new institutions need the support of important people and other institutions. Networking is thus essential, and we support their creation quite often, but networking cannot replace a solid work and the effort of individuals. This is something I constantly keep saying, it is essential: networking is fine but you ought to have substance before you go that.

To sum up, among ICTP's associates, we have had one President of the Republic, which is very nice, 11 ministers, deputy ministers, 2 members of parliament, 7 advisors to presidents or prime ministers, different presidents of University, deans of faculties and heads of institutions.

I will conclude with just how a few people perceive ICTP, although this is obviously selective. For instance Lorenza Matsuri from Milan basically says: "The most important contribution of ICTP is the concept of excellence and at this, ICTP has been the most influencing institute in the world to bring that into existence". In other words, we keep the goal of doing something really well: there is a big difference between doing things, and doing things well. That is a point that I constantly make. We have similar comments from Vietnam, for instance, which says: nearly every PhD physicist in East Asia has had an associateship with ICTP. What he says about East Africa is pretty much true of all sub-Saharan Africa in general.

Finally, we don't forget that this is happening in Italy, because for us it is very important to be connected to our neighbors and because Italian physicists have done very much for our center, not mentioning again the financial support of Italy to ICTP. I want to end this talk with a somewhat high note by citing what Mr. Andreotti, who used to be foreign minister in 1984, said from us: "This Center can make an effective

contribution to the solution of the central problem of humanity, namely that of peace. Of course, this is true of all international institutions, CERN and other institutions they don't really talk about peace all the time or almost never but somehow, by working the way they work, they contribute to peace.

So this is my few things about ICTP.