

GLOBAL REPORT ON THE EVALUATION OF THE RESEARCH UNITS ON PHYSICS

The Panel enjoyed a high level of consensus on everything. The evaluation is concluded and agreed but is being kept open for small additions to individual members' reports. An overall report is in preparation and will be submitted in January. Some of the main points are indicated below.

1. The general standard of physics research in Portugal, as reflected in the work of the Units, is *high*. However, international standards of comparison continue to be raised, so continued progress will not be easy.
2. Among the areas covered under Physics, research is particularly strong in theoretical physics, cosmology and astrophysics. Other areas need better coordination and more technical support.
3. There is a trend towards *increasing self-reliance*, with less students being sent abroad. Increasing numbers of excellent postdoctoral fellows are being recruited from other countries, and international networking remains a strong positive factor.
4. Some *equipment needs* are quite critical and should be addressed urgently.
5. The *system of support for PhD students* should be reviewed as a matter of urgent priority, to transfer more of the responsibility for selection of successful candidates to the Units.
6. The prevailing system of management, recruitment and policy development in the *universities* need to be reformed to provide (*inter alia*) a better environment for research. Departments should play a stronger role.
7. Among many problems that need to be resolved in partnership with the universities, the extraordinary *deficiencies in technical support* need to be addressed immediately. If necessary this could be pursued at the expense of some teaching posts.
8. National *science research policies* are required to guide further development while preserving the intellectual freedom of individuals. There may be serious lacunae in

the present profile of activities, and there is a potential over-emphasis on some topics if historical trends continue without due consideration.

9. It is difficult for a single subject panel to take this analysis further: a *national research council*, including distinguished leaders of research and some members from the corporate world and other countries, would be valuable. As an interim measure, coordinators and other representatives of the subject panels could be convened for an informal one-day exchange of views.
10. There is a very serious deficiency in *technology transfer*, in contrast with other countries that have created a culture of enterprise, to promote economic growth. Even those groups that declare an explicit motivation that aims for applications show a poor level of awareness of technology transfer mechanisms. This is worthy of a commissioned study by international experts.

DW

Report to FCT Lisbon

EVALUATION OF PHYSICS RESEARCH UNITS

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SUMMARY

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2. Among the areas covered under Physics, research is particularly strong in theoretical physics, cosmology and astrophysics. Other areas need better coordination and more technical support.
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7. Among many problems that need to be resolved in partnership with the universities, the extraordinary *deficiencies in technical support* need to be addressed immediately. If necessary this could be pursued at the expense of some teaching posts.
8. National *science research policies* are required to guide further development while preserving the intellectual freedom of individuals. There may be serious lacunae in the present profile of activities, and there is a potential over-emphasis on some topics if historical trends continue without due consideration.
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REPORT

The evaluation

The panel evaluated 23 Units in ten working days, travelling to Coimbra, Porto, Aveiro and Braga as well as spending one week in Lisbon. This made it difficult to find time for adequate preparation, consultation, writing reports and reaching consensus, but a satisfactory outcome was reached. The considerable burden was eased by the enthusiastic assistance of the FCT staff members who accompanied us.

With the likely increase in the size and number of Units, this problem of excessive workload could become worse. It is suggested that an improved format for the written report, together with less delay between submission and evaluation, would enable the evaluations to proceed more expeditiously. In particular the present form omits any summary of key achievements in the preceding period, and makes no call for requests for programmatic funding. We also suggest that every Unit should be encouraged to produce a permanent high-quality website.

It is inevitable and desirable that the reporting should be based on the use of the Internet. At the present stage this was the cause of many minor obstacles to the completion of our task. The Foundation would do well to make this part of the operation as minimal as it is reasonable, and to ensure with certainty that facilities are available and operational at all times.

It would be highly desirable in the future for *all* Units to receive a visit, if necessary by splitting the Panel at some stage.

The general standard of the Units

There is a high level of competence and achievement, with many Units falling into (at least) the “Very Good” category. The researchers at all levels are exceptionally literate, articulate and knowledgeable, and they work hard to maintain their research.

A previous evaluation used the word “heroic” and it still applies to many experimental groups that produce first-class work with little technical support. Theoretical or observation-based groups have found it less difficult to work at the forefront of their subjects, so that pinnacles of excellence by international standards are to be found in theoretical physics and astronomy.

In former days, many of the most talented young people were sent abroad to study, with great benefit to them and to their country. Rightly, this is less common now, and visits are often confined to a few months. International contacts remain numerous and productive, but many groups aim to be more self-reliant.

Output

At present publications (and dissertations) constitute the primary measure of output. The general level of publication is satisfactory. Solid, well recognised journals are usually chosen. In pursuing evaluation, there may be a temptation to enter the world of citation indices etc, but their crude use is unfair, and an expert panel can do well without them.

Publication should not be an end in itself. Quite a few groups failed to respond well to the question “What have you actually *achieved*?” (This could usefully be included in the requirements of the Unit reports.) The answers were often circumstantial: competence was established, facilities were commissioned...

Correspondingly, equipment requests were often framed in terms of extending competence rather than enabling some definite set of desirable and achievable goals for which it was essential.

The future

Progress towards and maintenance of an “Excellent” rating is hampered by the prevailing conditions in the universities, especially as regards experimental research. The likely future shortage of new teaching positions and budgetary restrictions may even cause some groups to fall back, if necessary reforms are not undertaken soon.

Portugal cannot afford to rest on the laurels won by recent progress. The bar has been raised in several ways:

- by the entry of new countries to the EU, some with great traditions in science
- by the formulation of European research programmes that favour large research laboratories and industrial companies.
- by the implementation of ambitious policies in other countries, in order to stimulate enterprise and high technology, particularly arising out of university research.

To be competitive in this dynamic environment, enhanced efficiency and initiative are required.

Obstacles to Progress

Portuguese scientific research relies heavily on the universities. Within them, the well balanced programmes of the Foundation have succeeded in creating substantial teams and organised platforms of equipment and competence. Most of the Units are impressive, and the policy that created them can be judged to be a success.

Yet to the scientist from abroad, some things simply do not “add up”: this may be traced back to the failure of the traditional university structures, which are inadequate to meet today’s challenges. Closest to hand is the case of the individual Physics Department. Typically it does not function as well as it might, in terms of the positive management/allocation of resources or the execution of common plans, such as those for the recruitment of research students. Of the anomalies that persist, and must surely be attributable to the system, the extraordinary deficiency in technical support is particularly deplorable. In other countries the support of a reasonable number of technicians is considered to be a *sine qua non* of advanced scientific research, at least in experimental areas. So far we could tell, only Covilhã approached such a level.

Many members of Units complain of high teaching loads. While these are not grossly in excess of international norms, they might well be mitigated in a more efficient Department management system, in a variety of ways. These might include adjusting postdoctoral fellows. It would not be unreasonable to replace some permanent teaching positions by technical posts, if presented with a “zero sum game” as part of a general restructuring within tight financial restrictions.

Despite the high level of productive contacts abroad, very few university posts are held by physicists from other countries. In the short term, this persistent insularity might be addressed by making some one-year visiting posts available at all levels, perhaps modelled on the Gulbenkian professorships. (Warning: it is not practical to run such a scheme unless its decisions are made expeditiously. The best system would be an “open call” with immediate or monthly decisions.)

This raises a general question of strategy in recruitment of professors and lecturers. Apparently when an university position has to be filled, this is done via an open competition within the whole subject of physics: the final choice of the successful candidate does not take much into account the needs and (generally undefined) priorities of the Department and units.

Similarly with the studentships, we would recommend more devolution of the responsibility for selection of successful candidates to the Units, as an aid to active recruitment, particularly from abroad. Candidates from other EU countries should be treated on an equal basis.

In many cases the overall numbers of students and postdocs is too low in comparison with numbers of permanent teaching staff. In part this is due to a lack of funding, but many Units report difficulties even when funds are available. This should be remedied by recruiting from abroad.

Infrastructure

There is a widespread and pressing demand for equipment and the updating of old facilities. This needs to be addressed urgently, in response to well reasoned proposals. Comparisons should be drawn with the level funding in other countries, to establish reasonable norms. However any future expansion of funding for equipment should be closely tied to an examination of the organisational issue addressed above, especially the lack of technical support. Expensive facilities should be maximally used.

In some cases missing journal subscriptions were mentioned. The Foundation would do well to consider the negotiation of *national* subscriptions (which may in practice mean electronic subscriptions) with the American Institute of Physics, the Institute of Physics (London) and other publishing houses, which are accustomed to such approaches today.

The Units

Units vary widely in scale, style and composition, reflecting the diversity of the discipline. We were asked informally to consider possibilities for consolidation. On the whole, we felt wary of this: perhaps Units are best left to grow (and die!) organically, according to local motivations and ambitions. The best route to rationalisation is through the Departments, as

discussed above. Nevertheless the Panel felt that some further evolution towards a smaller number of Units in Coimbra would make sense.

In several cases the Panel detected a lack of coherence within the Unit. The present system tacitly encourages them to grow by gradual accretion of miscellaneous research groups. This can be an ideal route to interdisciplinary research, but it often has negative effects, especially as it takes place within a system that does not give the leader of the unit much power or discretion.

Towards a culture of enterprise?

In every country, the role of the universities as sources of innovation and enterprise is recognised as important to economic growth. Portugal has taken some notable steps (such as the foundation of Taguspark) to foster university-industry interactions, and most researchers are vaguely conscious of this dimension of opportunity. Nevertheless, psychological and organisational barriers to exploitation of research results remain: more needs to be done to create awareness of the mechanisms of technology transfer.

The research community needs to be more sophisticated and pro-active at its interface with the commercial world. The panel noted many instances of joint grant-aided projects with industry in which the university partner played a rather passive, subordinate role. Too often, the acquisition of the next grant becomes the rationale for the research. Cases where the researchers could look beyond this horizon, towards direct industrial contacts and appropriate fees for valuable services, were rare.

Consideration of the founding of start-up companies is even rarer. Experience elsewhere suggests that this can add an exciting and rewarding dimension to university life. It is not an easy path to tread, and so will always remain the pursuit of a few enterprising and dauntless individuals. Therefore it should not be seen as subverting the overall academic ethos. (If the Cavendish Professor in Cambridge can do this, why not the others?). In Physics (where patenting/ licensing plays lesser role, compared with biological subjects) this can be a logical conclusion of successful applied research, given good fortune.

Considerable experience and expertise in technology transfer from universities now exists in many other countries. Portugal would do well to commission a study by international experts, with a view to enhancing its own policies.

Outreach

Many Units have excellent and well funded programmes that relate to education at secondary level and to the general public. In this respect they are probably well ahead of corresponding groups in most other countries. The government should ensure that the best of these efforts are coordinated so as to be effective on a truly national scale.

The need for a national strategy

We believe that it would be desirable for the Evaluation process to be informed by a sense of national strategy, e.g. from some research council of FCT, or other government body. Such a council could also advise and coordinate the various institutions, in guiding their research and recruitment strategies, without compromising their independence. It might include distinguished leaders in research in Portugal, together with some others from other countries and from the corporate world.

By this means guidance could be given, as to which activities having reached a reasonable limit, which are missing or serious sub-critical, and what strategic objectives are being set for the future. This might find expression in targeted funding. This is sometimes seen as a threat to independent basic science, and it can be so if pursued to excess, but a modicum of justified targeting belongs within any rational strategy.

To take an example: the consequences of entry to ESA/ESO do not seem to have been worked out at national level, yet many institutions have ambitious plans to develop or

expand Units in astronomy or astrophysics. Is it enough to let widespread institutions make individual plans and bids?

The other side of the coin can be seen in the apparent absence of research on *nanophysics* and *photonics*, which must be strategically important. A single panel cannot make confident recommendations on such matters, since it does not know the situation in allied subjects. For example this panel, which spent a good deal of time discussing the growth of astronomy throughout the country, and the need for some overall strategy, was eventually surprised to learn that there is a centre for astronomy in Porto, as a Unit evaluated under Space and Earth Science.

The panel was also aware that on this occasion its remit did not exceed to plasma physics and the CERN-related high-energy of the LIP centres. These are cases in which national policy has already been brought to bear in the creation of successful centres which contribute to “big science”. There is also a wide area of engineering which borders on our subject.

As an interim measure towards assessing the overall situation, it might be a good idea to bring together all or most of the coordinators of panels, for an informal one-day meeting. Similarly, a national meeting of heads of physics departments might provide a forum in which positive ways forward would emerge.

A crucial point in time?

In the opinion of the Panel, in Portugal our subject (and by extension all of science) stands at a crucial point in time. In the previous period, great progress was made and it must not be forgotten what a marvellous transformation has been taken. A new generation of physicists with wide perspectives and high ambitions is already in a position to carry this progress further forward.

Changes need to be made to take advantage of the present opportunities. Bold policy is needed. Shakespeare's advice should appeal to a maritime nation:

***There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their lives
Is bound in shallows and in miseries.
On such a sea are we now afloat,
And we must take the current when it serves,
Or lose our fortunes.***