Italian Institute of Technology (IIT)

Report of the Evaluation Committee (EC) for the 2009-11 Period

Executive Summary

Our detailed analysis over fifteen months explored all aspects of the IIT operation, with particular emphasis on the managerial structure, human resources, research output, networking and technology transfer. We found the institute well positioned to fulfill all aspects of its statutory mission. In particular, the development of infrastructures, human resources and quality control is right on target. The research output already meets stringent international standards both in Morego and in the network of poles/centers. Based on this positive situation, we recommend a series of measures that can significantly improve the effectiveness and prevent future problems.

Technology transfer and the creation of enterprises are major challenges for the forthcoming years. Whereas we believe that strong actions are necessary to meet such challenges, we do recommend a balanced strategy, with continuing strong support of curiosity-driven research. This type of research marks, in fact, the difference between merely good institutions and the international top leaders in research and technology, such as MIT, Caltech or Stanford. Joining this elite group should be, in our view, the long-term ambition of IIT.

These are our core conclusions on strong points, critical issues and the recommendations that we consider most important for the continuing success of the institute.

Special commendations to IIT and its management for:

- *The outstanding accomplishments concerning the growth of the institute, in particular its human resources and infrastructure*
- *The rapid achievement of research output rates comparable to the best institutions in Italy and abroad*
- *The international openness, in particular in its hiring practices*
- *The adoption of strict international standards for its quality evaluations*
- *The rapid and effective establishment of the center/poles in many Italian regions*
- *The brilliant and cost-effective solution for the IIT central site*
- *The dedication and hard work of its staff, in particular the top leaders*

Critical issues:

- *Human resources, careers, tenure-track, joint university appointments*
- *Student association to graduate schools*

- *Management decentralization and completion of the matrix structure*
- *Integration of all poles/centers in a real IIT network*
- *Technology transfer and enterprise creation targeting in particular job creation for the younger generations*
- *Effective promotion of the IIT image.*

Main Recommendations:

- *Achieve a stronger presence in the IIT Board of science, technology and technology transfer; be aware of the importance to include women scientists.*
- *Broaden the top management structure for research by creating an Executive Scientific Committee with three Associate Scientific Directors.*
- *Complete (within 2-3 years) the "matrix" structure with "vertical" platform leaders.*
- *Offer tenured employment to the present Scientific Director, but keep the directorial responsibility limited in time.*
- *Implement an internal tenure-track system for gifted young scientists selected under strict conditions.*
- *Grant full research and financial independence to the young talents, in particular those on tenure-track.*
- *Assure significant women presence at IIT and in IIT bodies, particularly in the search and tenure committees and as committee chairs.*
- *Appoint at least two women directors in the next three years and five in five years.*
- *Rapidly complete a strong technology transfer unit, with broad autonomy but specific deliverables for the next triennium.*
- *Consider plans for an incubator and, in the long run, a technology park not far from Morego, and modalities for collaborations with IIT poles and centers.*
- *Launch actions to create an "IIT network culture" in the entire staff, including a weekly email newsletter, regular mutual visits, exchange stages, rewards for inter-center collaborations, courses for PhD and postdocs for the entire network, IIT prizes and a yearly "IIT event".*
- *Improve and organize IIT external communication, targeting the public and interest groups, e.g., scholars, scientists, industry, politics, etc., and using the appropriate channels to present the IIT achievements.*

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1. EC Committee Members

Lia Addadi,	Dorothy and Patrick E. Gorman Chair of biological ultrastructure, Weizmann Institute of Science
Marco Baggiolini,	former president of the Università della Svizzera Italiana
Emilio Bizzi,	Institute Professor, MIT. President of the IIT Scientific Committee
Elena Cattaneo,	director of UniStem and of the Laboratory of Stem Cell Biology, Università di Milano
Giorgio Margaritondo (Chair)	Dean, Continuing Education, and former vice-president, Ecole Polytechnique Fédérale de Lausanne (EPFL); former science director, Sincrotrone Trieste
Pasquale Pistorio,	former vice-president of Motorola, former president of Telecom Italia and of STMicroelectronics
Jean-Jacques Slotine,	director of the Nonlinear System Laboratory, MIT

2. Background Remarks

The mandate to the EC was to evaluate, in agreement with Article 13 of the "*Regolamenti di funzionamento generale*", the quality, conformity to the plans and future developments of the IIT research activities as well as the level and effectiveness of the management, under the guidelines of the document "*Valutazione dell'IIT per il periodo 2009-11*" approved by the IIT Board. This mandate required a preliminary analysis by the EC to identify all aspects of the present and future mission of IIT. The results provided the reference for the subsequent study of the IIT performance, strategies and management.

The background for the IIT mission is found in the Statute: "*The (IIT) Foundation has the objective to promote the technological development of the country and the high-level technological education, in conformity with the guidelines of the national scientific and technological policy, in order to favor the development of the national economic system*". We interpreted this mission in a broad sense, beyond the mere implementation of high-quality technology-oriented research plans. The justification for our vision is the situation and evolution of the Italian economy and its dependence on research.

A key aspect is the Italian productivity level. According to the January 2012 OECD data, the GDP per worked hour in Italy is 43.9 USD, significantly lower than the G7 level (51.6) and the Euro area level (49.7). Scientific and technological research is an essential instrument to improve this situation. This requires not only additional resources for research but also a better return from the investments.

In this context, the IIT mission is important not only *per se* but also as a model for other Italian research institutions. The IIT has the advantage of being very young and therefore not loaded with an historical heritage that often limits the effectiveness of research organizations. This also implies a broad responsibility: planning and management must not only guarantee the effectiveness of the IIT research, but also

provide a testing ground for new research strategies, meeting the highest international standards but also realistically applicable to the Italian context.

The EC analysis was performed with reference to this broad IIT mission including the "model" role. Our audit was, therefore, very challenging for the IIT leaders. The need for IIT to finally and irreversibly establish itself in the Italian research system also justified our approach.

In synthesis, our main conclusion is that, thanks to the efforts of the latest triennium, IIT is now well positioned to achieve its objectives, and deserves full support as a very promising and already essential component of the Italian research system. The main credit for this positive assessment goes to the IIT personnel and in particular to the IIT leaders: our analysis reserved particular attention to human resource issues.

We will present a number of recommendations that can further improve the situation, building on strength. Some of the recommended measures are not only desirable but in fact essential to prevent future problems.

3. Methodology and Implementation

Our audit was based on three inputs: extensive documentation requested to the IIT leadership, direct visits to the majority of the IIT sites (Morego and several poles/centers) and many interviews with relevant personnel. The process started on February 2, 2011 with the approval by the IIT Board of the planning document "*Valutazione dell'IIT per il periodo 2009-11: comitato di valutazione, obiettivi, procedure, funzionamento*" presented by the EC Chair. The milestones in our work were:

- February 8-9, 2011: first meeting in Morego (involving only the EC Chair), primarily to solve logistic issues.
- April 4-5, 2011: second meeting in Morego_to discuss the preliminary data provided by the IIT and to discuss ad decide the *modus operandi* for the EC, including in particular the focused objectives (see sections 4.1-4.11).
- October 10-11, 2011: third meeting in Turin and Morego, to visit the IIT Center for Space Human Robotics (Politecnico di Torino) and to analyze, in particular, the issues "Interaction between different IIT components: multidisciplinarity, cross fertilization", "Human resources: careers, long-term contracts, tenure", "University links: joint appointments, long-terms IIT associations with resources, doctoral programs, IIT doctoral schools", "Long-term policy for the centers: additional centers, prolongations, terminations" (first reading) and "Technological transfer: general strategy, dedicated unit, staff, policies". This meeting produced a Preliminary Report to the Board (see Appendix III) on the iCUB Facility proposal, on the Inter-departmental Projects proposal, on the Career Track issue, on Education/Training Programs and on Technology Transfer.
- January 9-10, 2012: fourth meeting in Pisa, to visit the IIT Center for Micro-Biorobotics (Scuola Superiore Sant'Anna) and the IIT Center for Nanotechnology Innovation (Scuola Normale Superiore), as well as to analyze, in particular, the issues "IIT managerial structure: possible streamlining,

additional needs", "Long-term leadership: strategy for future transition planning", "Equal opportunities: gender issues, junior scientists", "Long-term policy for the centers: additional centers, prolongations, terminations" (second reading), "Dissemination of accomplishments: media presence, links with the professional world, links with political leaders" and "Scientific evaluation (in coordination with the Scientific Committee): bibliometric results and statistical analysis, in-depth analysis of programs and strategies".

- March 26-27, 2012, fifth meeting in Milan, to visit the Center for Nano Science and Technology (Politecnico di Milano), analyze all outstanding issues, discuss the first draft of the final report and the evaluation of the Scientific Director for 2011.

These events (with personal participation of all members except for 3 cases of long-distance contributions) were complemented by extensive communications throughout the process. We are very grateful to the main counterparts of our work: the Scientific Director Professor Roberto Cingolani, the task group led by Dr. Francesca Cagnoni (including Ms. Sara Currel, Mr. Simone Collobianco, Ms. Stefania Pallanca, Ms Arianna Pezzuolo and Ms Viviana Savy), Dr. Raffaele Cusmai, Counsel, Director General Simone Ungaro and all our hosts at the IIT centers/poles. We truly appreciated their open and transparent attitude that greatly facilitated our task.

The schedule for our work was specified by the initial plan approved by the IIT Board. These were the main elements:

Deliverable	**Time Range**
Start of the EC operation	1 March 2011
Preliminary steps, acquisition of human and technical resources,	March 2011 – May 2011
Data collection and verification, statistical analysis	June - September 2011
Interviews and visits – first series	June – December 2011
First data analysis	November 2011
Interviews and visits – second series	January - February 2012
Final data analysis and development of the Report	February – May 2012
Final deadline for submission of the report	31 May 2012

Our plan was implemented according to the above timeline with some minor changes; the most important was the continuation of the data collection until March 2012, to guarantee updated inputs for our final conclusions.

4. Main Findings

We ascertained that the IIT mission in 2009-11 included in practice four parts:

(1) bringing the personnel and infrastructure to the target levels of the original plans;
(2) rapidly increasing the scientific output of all IIT components;

(3) developing effective management and human-resource structures at all levels;
(4) launching technology transfer by (i) producing transferrable results and competences, and (ii) developing the instruments to realize the transfer.

Based on our fact-finding activities, we could reach the following general conclusions on such issues:

(1) IIT brought very successfully the personnel and the infrastructure to the planned levels, in particular by attracting many high-quality staff members with a strong potential for future growth. The evolution is consistent with the original plans or surpasses them. Overall, IIT is now close to the optimal size to pursue its objectives, with no major critical-mass problems for individual components and no evident cases of overstaffing.

(2) The research output, measured with bibliometry and other quantitative parameters and qualitatively evaluated with our professional experience, surpasses even optimistic expectations. Taking into account the present IIT size and its growth during the past triennium, this output is reaching the levels of well-established foreign research institutions that are active in similar areas. These achievements are related to the good selection of the research domains and to the good organization of the IIT research in general.

(3) The management and human-resource structures are quite simple, flexible and effective. However, we identified some critical measures for the near future, to guarantee continuing effectiveness. The most important concerns (i) the issues of careers, tenure-track and joint appointments with universities, and (ii) a partial decentralization of the scientific directorship.

(4) The IIT already produced, and continues to produce, results suitable for technology transfer, notably (but not only) in the domains of robotics, surface technologies, materials, processes and drugs. The technology transfer instruments were only recently implemented, so that we cannot yet judge their effectiveness. We find, however, that a strong potential for transfer does exists -- and must be exploited without delay. The data about invention disclosures, patents and contracts are quite encouraging in that sense.

One of the biggest challenges for IIT is now to find its place in the Italian research system, and significantly influence its development. The alternative is to remain an anomaly with limited impact and an uncertain long-term future. Key instruments to offset this risk are a strong presence in the doctoral education, a good use of the poles/centers throughout Italy, the possible joint academic-research appointments with universities and, in general, stronger ties with other components of the research system, nationally and internationally.

We shall now present some of the facts that justify the above sets of conclusions.

(1) <u>The growth of IIT</u>

Between 2008 and the third trimester of 2011, the IIT staff increased by 186%, from 232 to 664; in addition, the PhD students increased by 188%, from 75 to

216. This is a remarkable achievement compared to the standard recruitment efforts of top international research institutions. IIT was able to hire many high-quality professionals even if its image – and therefore the attractiveness for top candidates - was not yet fully established.

The age spectrum is now strongly peaked around 30, in sharp contrast with the prevailing senior population of most Italian research institution (although this is primarily a consequence of the young age of IIT itself). The professional spectrum is quite healthy: of the 880 employees, 75% are researchers, 10% technicians and 15% in administration and management. For comparison, of the 7,996 employees of the Italian National Research Council (CNR), 59% are researchers, 28% technicians and 13% are in administration/management (data DCSGR-CNR). Even taking into account the different range of activities, the higher researcher/technicians ratio indicates a more dynamic structure.

The present IIT gender balance, 36% of women, is not satisfactory; however, it is similar to or better than most international institutions active in similar fields. This issue requires specific attention and corrective measures, as discussed later.

The staff turnover is quite remarkable considering the tendency to stagnation of the Italian system: 12% of the employees of 2010 left the institute in 2011, including cases of termination.

Also remarkable is the international character of the IIT staff. Approximately 23% are foreigners and, of the 77% Italians, one-fifth were hired from abroad. This is the result of internationally open recruitment procedures, as opposed to the bureaucratic and *de facto* nationalistic approaches of much of the Italian research system.

The two best indicators of the quality of the hired staff are the rapid implementation of research lines and the record of productivity, discussed in the following subsection.

Concerning the human resource management, we note the effective use of the “bonus” part of the annual salary. A financial reward for performance is certainly a good idea, but it only works if it is really applied. The 2010 data show that it is: only 29% of the staff was rewarded with the top bonus. The evaluation procedures for the bonus decisions seem effective and just.

We note that the above good practices for human resources are present in the entire IIT network. In the poles/centers, we found indeed hiring and salary procedures similar to those of Morego, and significantly different from the partner universities.

The development of human resources was accompanied by an equally impressive growth of the research infrastructure, both in Morego and in the pole/center network. Most impressive is the Morego building itself: the restructuring – that provided a financially very effective solution – was so

successful that we could hardly detect traces of its previous and totally different use.

The rapid launching of nine centers/poles in Naples, Lecce, Milan (2), Turin, Pisa, Pontedera, Rome and Trento is a success history by itself. Our visits revealed operating entities, with already remarkable research outputs.

The implementation of support research facilities is largely completed. We personally verified that the instrumentation – for example clean rooms and microscopy facilities – is state-of-the-art, fully operating and effectively managed for user service (including external customers). Overall, we detected no major delays or operation problems. In some cases, however, IIT may face difficult decisions in the forthcoming years concerning the balance between the growing internal use and external customers.

We inquired about possible cases of understaffing or overstaffing, for IIT in general and for each of its main individual components. We did not find evidence of problems: the growth of recent years was justified.

Note, however, that a mere staff increase is not a good parameter to evaluate a top-level research institution. Strength in research comes from quality rather than quantity, as long as a minimum critical mass is present. Top institutions such as the Weizmann Institute, Berkeley and the old Bell Laboratories are – or were – of relatively small size but outstanding quality. Conversely, giants such as the Chinese or Russian academies of science have a rather mediocre level with visible symptoms of resource waste. We carefully analyzed IIT in these terms and concluded that a large additional staff increase would be counterproductive – unless new domains are added: the institute is close to its ideal size.

(2) Research output

Our audit included several parallel actions. As it is customary, we performed a number of bibliometry evaluations, discussed in detail in Appendix IV. Bibliometry data are indeed widely accepted to estimate the research output. The very young age of IIT, however, complicates this analysis: citation data for a given publication become significant and reliable only after a certain number of years. Furthermore, the diversified spectrum of IIT activities must be taken into account: bibliometry performances that would be insufficient for certain areas are excellent for others (e.g., biomedical research vs. informatics). For all these reasons, we concluded that the most reasonable bibliometry indicators at the present stage are the number of publications and the citation record for specific publication years. However, we also used other parameters, with the precautions required by their statistical limitations.

The data provided to us by IIT show a total of 435 publications (refereed articles, proceedings and books) for the year 2009 and 712 for 2010 (the 2011 figures are only partial). These levels are very good if compared with the staff numbers, 371 and 586, the publications/staff ratio being approximately 1.17

and 1.23. Such a performance appears even better if one takes into account the growth situation and the time lag of new personnel in producing results.

To benchmark this performance, we expanded our analysis beyond the data provided by IIT. Using the 2010 ISI Web of Science database, we performed equivalent searches for IIT and six other institutions: “Weizmann”, “EPFL”, “CALTECH”, “KTH”, “CNR” and “CNRS” (the search keywords are listed in Appendix IV). Note, however, that IIT does not cover some relevant research domains and only partially covers publications other than articles.

With the methodology presented in Appendix IV, we found for 2010 total ISI Web of Science scores of 416, 1,841, 2852, 3,646, 1,017, 7,118 and 32,296 for IIT, Weizmann, EPFL, CALTECH, KTH, CNR and CNRS. Normalized by the total staff, these values give the following yearly publications per staff member:

IIT	0.71
Weizmann	1.13
EPFL	0.63
CALTECH	0.41
KTH	0.24
CNR	0.89
CNRS	0.93

Even with all the statistical precautions, we can conclude that the IIT publication output per person now reaches levels comparable to those of well-established national and international institutions.

To assess the publication quality, we first analyzed the impact factor (IF) of the corresponding journals. However, we do not consider the IF an ideal indicator: specifically, publication in a high-IF journal does not guarantee the strong impact of an article. With this *caveat* in mind, we found at IIT a clear tendency to publish in high-IF journals, with 22% of the 2006-11 publications at IF ≥ 7 (and only 16% below 2).

Citations are of course a much better indicator than the IF – but difficult to use during the initial growth stage of IIT (a discussion can be found in Appendix IV). We performed an overall citation assessment for IIT on February 5, 2012, using the ISI Web of Science database, with these results:

Publications:	1445
Total citations:	7672
Total with self-citations:	6552
Citing articles:	6709
Citing articles without self-citations:	5515
Average citations per item:	5.31

We also found that the top-cited article (S. Santaguida and A. Musacchio, EMBO J. **28**, 2511 (2009)) had a score of 101, and that 19 IIT publications had

been cited 50 times or more. In our opinion, such results (even with the required statistical precautions) are quite remarkable.

In order to benchmark the citation data, we analyzed the average number of citations for items published in 2009 and in 2010. In fact, these parameters allow comparison with established institutions, are statistically robust with respect to the search keyword problems and do not require size normalization.

The benchmarking institutions were the Weizmann Institute, EPFL, CALTECH, KTH, CNR, MIT, the University of California at Berkeley and Stanford University. The average citations per article extracted from the ISI Web of Science database (see Appendix IV) are:

	2009	**2010**
IIT	9.84	5.19
Weizmann	8.37	5.54
EPFL	8.45	4.91
CALTECH	11.02	7.20
KTH	6.61	4.28
CNR	6.49	3.23
Imperial College	8.48	4.64
MIT	12.06	6.13
Berkeley	9.37	5.45
Stanford	9.31	5.08

Such results are quite remarkable. Even taking into account the statistical uncertainty caused by the limited sets for IIT, we can conclude that the average “quality” of IIT publications is in the same class as that of Weizmann, EPFL, Imperial College, Berkeley and Stanford, and certainly better than that of KTH and CNR. This result is certainly affected by the specific domains of activity, but the IIT accomplishments in term of quality are impressive under any condition.

The procedure outlined above will be replaced in the forthcoming years by general evaluations of the citations records, once the statistical data for IIT become robust, i.e., when there will be a sufficient number if “aged” publications. We estimate that this will happen in 2015-2016. However, even partial citation data provide significant information and should play a major role in quality evaluation, as discussed in detail in Sect. 4.10.

From our discussion with the IIT management - in particular the Scientific Director - it was clear that the institute takes research evaluation very seriously. It already monitors a wide spectrum of parameters, for the entire institution as well as for its individual components and members. The interpretation of many parameters, such as the *h*-factor, is problematic during strong growth starting from zero. IIT should nevertheless be commended for its monitoring efforts that create solid foundations for the future steady-state quality assessments.

We also noted the information we received from IIT on the Scimago ranking (related to 2004-08 Scopus database). The main messages from such data are (i) the importance of normalizing the research output by the size of the institution, to avoid distortions favoring large but mediocre entities; (ii) IIT, even in its infancy, is well placed in the normalized rankings, not far from the Max Planck Institutes and, in Italy, among the top institutions.

Another indicator to assess research quality is the number of patents. The cumulative IIT results are 66 “patent families” corresponding to 104 individual patents. The first filings were in constant increase since the IIT creation and the growth rate approximately tracks the staff size. At first glance, these results are rather promising.

We are reluctant, however, to apply to patents a bibliometry-like analysis. A patent is not a publication but a tool for technology transfer. To evaluate technology transfer, however, there are better indicators like the number of licenses and the start-ups. Therefore, the above positive results on patents should be used only as supplementary information to corroborate the positive conclusions from bibliometry.

No algorithm based on quantitative data such as the numbers of publications and patents or the citations can provide by itself a good assessment of research quality. In the end, the best instrument is professional evaluation by peers. We therefore took much time to personally visit the research groups, see the results, discuss with the researchers and consider non-statistical elements. The overall conclusions of these efforts are very positive: IIT is in a transition from a growth phase to a steady state characterized by strongly performing groups and by many impressive research results.

We considered in detail the situation of individual platforms - Energy, Smart Materials, EHS (Environment/Health/Security), D4 (Diagnostics/Drug discovery/Development), Integrated Multiscale Computation - and individual poles/centers. The positive impression continued after this detailed analysis, but we must stress three important facts.

First, IIT operates in a variety of fields with different dissemination strategies and different objectives. Therefore, a comparison of the performance of different platforms must be made with precaution. For example, the impact factor data show large variations among different scientific areas; however, such fluctuations do not reflect productivity but the intrinsically large impact of the journals in certain areas, e.g., neurobiology. Second, the growth of different IIT domains did not start at the same time and did not grow with the same rate. Therefore, one should not prematurely draw conclusions that would be justified only in a steady-state situation.

Third and most important, these transient difficulties are not a justification for not performing stringent quality assessments and not taking the consequent measures. We were pleased to discover that the IIT leaders did not make such mistakes. A major event in that regard was the termination of TERA (Telerobotics and Applications). Other smaller-scale decisions were made,

accompanying the policy of rewarding excellence with the practice of pruning weak branches. Considering the general situation in Italy, the IIT leaders must be strongly commended for these difficult actions. They justify the hope that IIT will positively influence the entire research system in Italy.

A qualitative analysis of the IIT research output reveals additional symptoms of growing strength. We noted, for example, publications in top journals like Nature or Lancet, and the cover pages of journals like Nature Photonics, Nature Methods, Nature Materials, Small and Nanomedicine. The IIT image should also profits from the good results in competitions for European Flagship Programs and ERC (European Research Council) grants.

This brings up the issue of extramural funding: in a steady-state situation, the success in obtaining grants through competitive processes is an accepted criterion to evaluate professional quality. The assessment is, once more, difficult during a growth stage, because of the time lag between a person's arrival and his/her first grants.

IIT reported to us (October 2011) 43 extramural grants for a total of 25.4 MEuro (over their entire duration). The majority was obtained from the EC through open competition based on merit, which is a good symptom. Almost 30% of such funds were obtained by robotics, followed by neurobiology and smart materials.

Among the centers, we noted the success of the Napoli and Lecce units in securing targeted funds for the development of Southern Italy. This is a success case, but the one-shot character of these grants requires precaution, in particular as far as supporting human resources is concerned.

We benchmarked these results by assuming a personnel-growth-related time lag of one year for IIT -- and therefore using the IIT staff size of 2010, 371. We also assumed a typical grant duration of 3 years. This gives an average yearly extramural funding per IIT staff member (not including PhD candidates) of approximately 23 kEuro. By comparison, KTH produces almost 1,600 MEuro or 35 kEuro per staff member per year. The Weizmann Institute generates 64% of its funding independent of direct government support, but this includes donations, legacies and revenues from patents and investments; the 2010 extramural grants were approximately 46 MEuros or 30.8 kEuros per staff member per year. As to CALTECH (2010 data), the levels are 250 MEuro total and 28 kEuro per staff member per year. In Italy, the CNR generated in 2010 221 MEuro from third parties (including the sale of services), or 27 kEuros per staff member per year.

These figures show that IIT is reaching a good level, nationally and internationally, as far as extramural funding is concerned. Several sub-units are close or even beyond the original target of 20% non-institutional funding. We believe, however, that the potential is significantly higher. Furthermore, the development of a new strategy for doctoral candidates could further boost the needs for extramural funding, stimulating new initiatives. We therefore expect

the IIT leadership to continue stimulating staff members to vigorously seek extramural funding.

(3) The Management and Human-Resource Structures

We analyzed the IIT practices at all levels, using documentation and direct contacts with staff members and top and intermediate managers. The best pieces of evidence for effective leadership are productivity and the absence of tensions/conflicts among the personnel. We commented above on the first aspect; for the second, we did not detect major problems even when difficult and potentially adversarial decisions were made.

Within this overall positive picture, however, three problems emerge. The first is the relatively limited presence of research experts in the IIT Board. The current composition was justified during the first phase of IIT. For the future, a stronger presence of scientists and technologists would be advisable; this point is discussed in Section 4.1.

The second challenge is offering attractive career plans without creating a blocked labor situation with too many permanent positions. One should also avoid age distribution problems 15-20 years from now. The solutions must be based on two elements: a prudent use of the tenure-track instrument and strong collaborations with universities in Italy and abroad, opening the way to joint appointments. These key issues are discussed in detail in Sections 4.3 and 4.5.

The third challenge originates, paradoxically, from the excellent leadership of the present Scientific Director, Professor Cingolani. The accomplishments of recent years and the construction of IIT must be, to a good extent, credited to him. This, however, leads to two problems: the instability that would be caused by his hypothetic sudden departure, and the need to prepare in advance a smooth leadership transition. These issues and the consequent need for decentralization are discussed in detail in Sections 4.1 and 4.2.

(4) Technology Transfer

Technology transfer and the IIT impact on the economy – required by its mission – are still forthcoming. We examined the creation of a technology transfer infrastructure and did welcome the conceptual evolution underlying it. It seems now clear that the IIT impact on the economy must not be pursued in a reductive way – i.e., seeking generic industrial contracts merely to generate revenues. Much more ambitious strategies are needed, including the creation of companies with IIT co-ownership, the production of licenses, the establishment of joint ventures and the long-term vision of industrial satellites around the IIT site. The priority objective should not be to just produce short-term revenues but to create jobs, notably for young researchers.
The pre-requisites for such strategies are research results suitable for tech transfer and an entrepreneurial culture among IIT employees. We did learn of

several results with reasonable - or excellent - potential. Without providing a detailed list, we can mention the robot programs centered on iCUB, the new paper surface treatment methods, several innovative materials and processes and two molecules with pharmaceutical potential. The vast majority of research lines at IIT can produce equally transferrable results: the situation is already good and likely to improve.

The creation of an entrepreneurial culture should be a top priority for the IIT management. There is, however, a risk: without established procedures for technology transfer, one can raise expectations by the personnel that cannot be realized. Therefore, the completion of the technology transfer unit must be an urgent priority.

Our first impression of this budding infrastructure is quite positive. But we reserve our final assessment until it is fully in operation. The existing transferrable research results provide excellent test cases. They can, in our opinion, lead to new companies or at least to licenses. Only success for these cases will prove the effectiveness of the technology transfer strategy.

These issues will be discussed more extensively later, in Section 4.6 – that also includes a series of specific recommendations.

Within the framework of these general conclusions, our audit dealt in detail with a series of specific issues that were identified during our second general meeting of the EC. The following subsections present the results of our focused analysis, expand our general conclusions and propose a series of recommendations.

4.1. Managerial Structure: Possible Improvements

We examined at length the IIT structure and discussed its details with the Scientific Director, the General Director and the Counsel. There were also several bilateral interactions between EC members, the IIT President, the Chair and Board members. We also received feedbacks from many IIT staff members.

The IIT managerial structure appears at present sound, effective and flexible. Several specific measures, however, would improve significantly its performance and effectiveness.

Our recommendations primarily concern the increased presence of research and technology experts in the IIT Board, the decentralization of charges and the full implementation of the matrix structure. Concerning the first issue, IIT is undergoing a transition from the buildup stage to steady-state operation and its managerial structure must evolve accordingly. So far, most problems were of structural, legal, political and financial nature, and required a strong presence in the Board of experts in such domains. This was an excellent choice with positive results.

In the forthcoming steady-state phase, however, the relative weight of science and technology and technology transfer should increase. This is necessary, in particular, because of the strongly expanded variety of the IIT research domains: it is becoming increasingly impossible for individual Board members to master all aspects. In addition, we advise an expanded presence in the Board of technology transfer experts, for example by including recent founders of new high-technology enterprises.

Recommendation: a stronger presence in the IIT Board of science, technology and technology transfer

The need for managerial decentralization is another consequence of the IIT evolution. A centralized scientific management was most effective for the buildup phase. However, this solution is no longer optimal because of the size and complexity of the institute. We advise two parallel actions: broadening the scientific direction and full implementation of the "matrix" organization for research.

In the medium term, the IIT scientific leadership should be shared within an Executive Scientific Committee, including three Associate Scientific Directors with delegated responsibilities for technology transfer, human resources and the IIT network, plus other (permanent and transient) tasks.

This would make the research management more articulated and the role of Scientific Director less demanding and more focused. We must emphasize, however, that we do not recommend the evolution into a "collective" decision structure. IIT should remain closer to a corporate organization than to a standard academic institution, and should maintain a clear set of decision-making responsibilities. The workload should be shared and other parties should participate in the decision process, but the Scientific Director must retain the power to make the ultimate decisions in a quick and effective way.

Recommendation: creation of an Executive Scientific Committee with three Associate Scientific Directors

Recommendation: avoid a "collective" decision structure

IIT should also fully profit from the emerging "matrix" organization, triggered by the introduction of platforms. The implementation is not complete: there is at present an imbalance between the strong "horizontal" leadership and the less-defined "vertical" leadership, and it is not yet clear who is responsible for each platform. The Scientific Director still plays a centralizing role in the "matrix".

This was reasonable and effective during the launching phase of the "matrix". But the structure should now evolve into a more balanced and less centralized organization. Within 2-3 years, "vertical" leaders should be identified for each platform and granted delegated responsibilities. This is quite important since we find the matrix organization crucial to the future effectiveness of IIT.

Recommendation: complete (in 2-3 years) the "matrix" structure with "vertical" platform leaders

We discussed at length this issue since it also corresponds to a major re-organization of the IIT operation. The completion of the "matrix" structure should not be rushed

since it requires a shift of responsibilities from the "horizontal" to the "vertical" leaders. However, it should not be indefinitely postponed. The above-mentioned time scale is, in our opinion, a good compromise between all factors.

4.2. Long-term Leadership: Future Transition Planning

As already stated, the successful construction of IIT was possible, to a good extent, because of the excellent professional level and personal commitment of the Scientific Director, Professor Cingolani. To what extent, however, are the present IIT operation and strategy linked to him -- and vulnerable to his hypothetic departure? Do specific risks exist in the short, medium and long term, and how should they be managed?

These issues are not just latent: for example, there are time limitations of Professor Cingolani's leave of absence from his academic position. Furthermore, as the fame of the IIT success increases, he naturally becomes a target in the international job market for research managers. IIT cannot safely ignore these facts.

From our multiple interviews, we sensed that Professor Cingolani is personally attached to IIT and therefore not likely to leave in the near future – if the right conditions exist. IIT should thus create such conditions.

We specifically advise IIT to transform the present employment contract of Professor Cingolani into a tenured, unlimited-time instrument. This would be a strong signal of confidence from the Board to all members of IIT and also contribute to the stability of the institution. The tenured contract, however, should not imply an unlimited-time role as Scientific Director: the directorship should be institutionally defined as an additional limited-time responsibility with a suitable financial reward.

Recommendation: offer tenured employment to the present Scientific Director, but keep the directorship limited in time

IIT should also negotiate with academic counterparts – Professor Cingolani's present university and other institutions – a long-term solution for his academic affiliation. The lack of flexibility of the Italian system in solving such problems is deplorable, but a solution in this case can also be searched beyond the national boundaries.

Besides solving the above immediate problems, IIT should evolve to become independent of any particular person. We advise two measures in that direction. First, the already discussed move towards a less-centralized organization, with the new Executive Scientific Committee and the fully operational "matrix" organization.

In parallel, IIT should prepare without delay all the conditions for a smooth future transition to a new Scientific Director after the eventual end of Professor Cingolani's leadership period. The transition should be governed by international best practices.

This requires creating well in advance the rules and the boundary conditions for the search and nomination of the new leader. We recommend clearly stating that the search will be

Recommendation: prepare in advance for a

internationally advertised and primarily conducted outside IIT. The search committee must include a majority of research and research management experts from other institutions and other countries. Its recommendations will be delivered for approval to the IIT Board.

smooth scientific leadership transition by clearly stating rules and procedures, based on international best practices

In summary, IIT should guarantee the continuation of Professor Cingolani's leadership – but also immediately create the conditions for a smooth transition in the long run. Both actions are necessary for the continuing stability and success of the institute.

4.3. Human Resources: Careers, Tenure-Track

Throughout our work, human resources repeatedly emerged as a fundamental issue for the future of IIT. The key problem is: how can the institute remain competitive in the international job market for top researchers and, at the same time, avoid the employment immobility that affects most Italian research organizations?

The extreme solution could be a complete ban of permanent positions, compensated by suitable high salaries and good working conditions. For research staff, this would be a continuation of the present policy to offer 5-year contracts for scientists (and 2 + 2 year contracts for postdocs).

Although attractive when compared to the rigidity of the Italian system, after careful analysis we concluded that this solution is not practical, and that the right equilibrium must be found elsewhere. The main reason is that the international competitors of IIT do offer a limited but non-negligible number of permanent jobs – such as unlimited-time research positions or tenured academic positions. Therefore, the "extreme" solution would jeopardize the competitiveness of the institute on the job market.

The search for the best solution was discussed several times with the Scientific Director and other parties, creating a feedback process that eventually produced a reasonable convergence of opinions. The main ingredients of the optimal strategy are, in our view:

- A boost of the partnerships with top Italian universities and the launching of similar partnerships with top foreign universities, as discussed in Section 4.5. The objective is to create joint academic-research positions (see below).
- Launching a tenure-track system adopting the most strict international quality standards.
- Offering, in exceptional and rare cases, tenured, unlimited-time positions to outstanding candidates, in particular to world-leading scientists close to retirement.
- Limiting the percentage of "permanent" staff position (of all kinds) to less than 50% of the senior scientific staff, or 15% of all IIT members.

Considering the importance of the issues, we must elaborate on the above points and present specific recommendations. The boosted partnerships with universities should specifically target the creation of joint positions at the (non-tenured) junior

professor level, with the equivalent of a university track towards tenure. i.e., unlimited-time professorships.

In principle, the possibility already exists for IIT researchers to move into professorial positions. The novelty of the envisioned partnership would be (1) the possibility to establish, well in advance of the actual full-time move, a strong relation with a partner university -- e.g., by directing doctoral candidates and teaching courses; (2) the continuation of the link with IIT after the move and the possibility to continue receiving resources from the institute. The references for this strategy are, for example, the relation of the INFN with the universities in Italy and that of the Paul-Scherrer-Institute (PSI) in Switzerland with the ETHZ and the EPFL. The practical implementation of this plan, however, requires changes on the side of the Italian universities that have been informally announced but not yet implemented.

After analyzing the IIT plans in this direction, we reached the following conclusions:

- We strongly support joint appointments with universities. However:
  - The management of extramural funding, publications and intellectual property could create problems and should therefore be regulated by *ad hoc* agreements case by case.
  - The program should explicitly include top universities outside Italy.

Recommendation: launch partnerships for joint academic-research appointments with Italian and foreign universities

Our vision of the joint appointments is the following. The best IIT candidates could decide between two different career paths: (i) the IIT own tenure-track, or (ii) a joint IIT-academic path with one of the IIT partner universities. In the second case, during a first limited-time contract the IIT staff member would establish the aforementioned links with the partner university. During a second limited-time contract, he/she would be evaluated for a possible nomination to a tenured professorship. The legal framework for this procedure does not exist at present in Italy. In advance of its creation, IIT could negotiate *ad hoc* agreements with foreign universities and with Italian universities planning to establish a real tenure-track.

As to the IIT tenure-track, we examined in detail the solution proposed by the Scientific Director. This would be based on a sequence of two limited-time contracts (e.g., of five years each), an evaluation before the second contract to decide its activation and a final evaluation based on standard international criteria of excellence. If positive, the final evaluation would lead to an unlimited-time permanent contract.

IIT tenure-track positions would be attractive for relatively junior candidates, 2-4 years after their doctorate. They would constitute a novelty for the Italian system whereas they are standard practice in the USA and are increasingly used in other countries, e.g., Switzerland.

In addition to these “junior” tenure-tracks, IIT would like to directly offer unlimited-time positions to exceptional scientists close to retirement, willing to spend all or part of

their final professional years at the institute. In this case, the risk of employment rigidity does not really exist.

Finally, IIT would like to directly use tenured positions for hiring top researchers. This would be comparable to the standard procedure of universities in the USA and other countries to hire as tenured (associate or full) professors individuals with exceptional qualifications.

Our analysis of these three tenure-related plans reached the following conclusions:

- We do support the creation of a tenure-track for junior scientists, with the following conditions:

  - The employees in tenure-track must be given full scientific independence and thus be able to demonstrate their professional capabilities.
  - Success in securing extramural funds should be one of the criteria for granting tenure.
  - Ten years (i.e., two 5-year contracts) can be too long a period for a tenure-track, since it would bring the candidate to an age that would make recycling in the job market difficult. We would advise a shorter total time, with perhaps two 4-year contracts. The rules should allow "fast-tracking" in exceptional cases, notably for outstanding candidates with outside offers from top institutions.
  - There must be a stop-the-clock provision for pregnancies.
  - Last but not least, the IIT must make a clear decision on the targeted success rate -- keeping in mind that every case of non-success is a loss of investments for the IIT. We favor a very strong filter at the time of the first nomination and a target success rate comparable to that of the "Big Ten" universities in the USA, 65-70%. This would also be in line with the conditions offered by the international IIT competitors.

    In general terms, the new tenure-track must have the objective of further enhancing the quality of the staff members, reaching top international standards. It should thus be subject to quality filters even more stringent than those used so far for non-permanent appointments. The rules governing tenure-track should thus specify the international composition of the tenure evaluation committees and a clear decision line on granting tenure. We recommend in that sense a final decision by the Scientific Director - based on the analysis and recommendations of two separate tenure evaluation committees, one with members from the same research area as the candidate and the other IIT-wide – subject to ratification by the IIT Board. The IIT-wide evaluation bodies should be, preferentially, linked to the Scientific and Technological Committee (CTS).

Recommendation: we support, under strict conditions, an internal IIT tenure-track system for young scientists

- We view favorably the direct offer of tenured positions to outstanding scientists nearing the end of their career. In this context, "outstanding" means recognized world leaders that with their presence and contributions can very strongly enhance the IIT image.

Recommendation: tenured contracts for top candidates close to retirement

- We also support the creation of a small number of senior tenured positions to be offered to international "superstars" and top managers. However:
  - The recruitment in all cases should be based on open international calls and not on direct decisions for individual candidates.
  - The tenure granting procedure should be similar to those for tenure-track cases.

Recommendation: tenured positions for top scientists and managers on international open calls

- As already mentioned, the combined effects of all of the above actions should not produce permanent (tenured) positions in excess of 50% of the senior scientific staff, or 15% of all IIT members (including in particular postdoctoral fellows and PhD candidates).

Recommendation: permanent positions must not exceed 15% of the entire IIT staff

Finally, we would like to stress that new rules for human resources are an important change in the IIT operation that must be clearly advertised and documented. We recommend the elaboration of a unified document specifying, in particular, the tenure criteria, the rules and the procedures for the selection of candidates, and the persons and bodies in charge of the decisions.

Recommendation: full documentation of the rules and procedures of the new human resource strategy

4.4. Gender and Age Issues

The imbalance between men and women is a general problem for research institutions in Italy and elsewhere. This is particularly true for top-level positions: the women's presence is much more limited than for junior positions. In addition to this gender issue, Italy has problems in attracting and keeping talented young people in research careers. One of the consequences is brain drain, or better the lack of brain exchange by symmetrically attracting young talents from abroad.

We found that the IIT situation is close to other Italian research institutions for gender imbalance, and much better for attracting young researchers. As seen, the present fraction of women in the IIT staff is 36%. This should be compared with 44.5% for CNR, 24.4% for INFN (2008 data) and 32.9% at ENEA. The variations between these research organizations are, to some extent – due to differences between areas of activity. But the general picture is clear: none of the organizations reaches the ideal level of 51.4%, the fraction of women in the Italian population (2007 data).

The gender imbalance for leadership positions is extreme. At CNR, for example, the women fraction is 18%. The IIT, unfortunately, has an even smaller level, slightly above 5%. The phenomenon is well known worldwide; its causes are intensively studied and, to a good extent, understood. Therefore, there is no justification for the lack of proactive counter-strategies.

We do believe that IIT must do more to attract women in its staff, and much more to increase the percentage of women in its top levels. The solution is not to eliminate

active discrimination, since we found no evidence for it. IIT must go to the root of the problem: making its disciplines more attractive for young women. Unfortunately, distorted stereotypes about women's careers in science and technology already appear among young ladies. Thus, IIT must reach out to the very young.

We suggest special actions towards young ladies in the age range 9-11 with special IIT events dedicated to them. We can propose as examples the initiatives "*Internet pour les filles*" and the robotics courses in Lausanne. Attractive, hands-on introduction of the IIT activities should convince this group that stereotypes are wrong and research careers are a good and attractive opportunity for women as for men.

Recommendation: promotion actions for young girls on IIT activities and science careers in general

These seminal actions should be accompanied by gender-balance initiatives for junior hiring and for the future tenure-track. IIT is in many aspects a revolutionary experiment in Italy. We thus suggest a similarly revolutionary attitude for gender balance: the IIT search and tenure committees should not only "include" women, but systematically have a prominent (or majority) presence of women, including chair duties.

Recommendation: assure a prominent (or majority) women presence in search and tenure committees

For the gender imbalance at the top levels, the actions should be even more radical. IIT should urgently launch a worldwide search for top women in science and technology, with the objective to hire at least two women directors in the next three years, and reach a total of at least five in five years. This action should not contemplate any compromise on the scientific level. It should rather make the positions more attractive for women by considering the specific issues that have been identified as influencing women career decisions.

Recommendation: appoint (at least) two women directors in the next three years and five in five years

We also strongly recommend including additional women, in particular scientists and technologists, in the IIT Board and in all other top parts of the IIT structure. This is necessary to send a clear message about the IIT concern for these issues.

Recommendation: more women in the IIT Board

We also learned about a practical problem affecting women employees at IIT. Due to the legal structure of many limited-time contracts, the rules for leaves of absence for maternity are less favorable than in other Italian research organizations (e.g., CNR). This problem is a technical anomaly that negatively affects women careers at IIT: it should be urgently corrected.

Recommendation: align the IIT rules for maternity leave to other Italian research organizations

As far as age issues are concerned, the success of IIT in attracting young talents is remarkable and should be commended. The institute is probably the Italian research entity with the lowest average staff age. But one must realize that this is partly a consequence of the young age of IIT itself: we recommend extreme attention to avoid

an excessive age shift in the future. This specifically requires a careful career planning and good management of the future tenure-track effort.

The staff-aging phenomena have large time constants, therefore monitoring and planning must be implemented well in advance of any problem. We specifically recommend that the IIT management continuously develop age distribution projections based on different assumptions about tenure-track and career planning in general. Such projections should be used for all decisions concerning the strategic management of human resources.

In essence, IIT can tolerate in the next 20 years a reasonable increase of the average staff age, in line with the introduction of tenured and other permanent positions. However, it should never allow the projected average to exceed the age of 38 and should plan its human resource strategies accordingly.

Recommendation: develop age distribution projections for different career planning models

Recommendation: to keep the projected average staff age below 38 years

We must emphasize that fair opportunities for the younger generations are not only an issue of numbers. Most important is to grant full professional independence at a very young age, to trigger the potential of the best talents at a productive career stage. This is particularly important for tenure-track, as mentioned in Sect 4.3.

IIT should emulate the best research universities, where "*a tenure-track faculty member is an assistant professor, not the assistant of a professor*". Italy used to be a world champion in promoting the independence of young talents: Enrico Fermi became full professor at the age of 24! IIT should spearhead the restoration of this great but lost tradition. IIT tenure-track scientists should thus have their own budgets, full independence in their scientific decisions, and significant hiring authority.

Recommendation: grant full research and financial independence to the young talents, in particular those on tenure-track

4.5. University Partnerships and PhD Training

The differences with respect to the rest of the Italian research system make the risk of isolation quite real for IIT. Such a risk must be countered with strong actions. In this context, the links with universities are particularly important, at least for three reasons. First, to guarantee a steady supply of new young talents, including doctoral candidates, post-docs and others. Second, the relations with top-level institutions can expand the career options of the IIT staff members, as discussed in Section 4.3.

Third, IIT should be a positive and active factor in the evolution of the Italian universities, from a tendency to equalization to a "merit" hierarchy, allowing a subset of institutions to reach the top international level. IIT can influence this evolution with its international standards for personnel selection, merit-rewarding and career development. Furthermore, it can help reforming the notion of PhD in Italy, as discussed below.

IIT is already very active in creating links with universities, notably thanks to the centers/poles. These actions should be strengthened, expanded in scope and supported by the necessary legal and administration instruments.

Unfortunately, this strategy will have limited impact until the Italian authorities launch two key instruments: the university tenure-track and the joint positions between universities and research institutions. However, such obstacles should not deter IIT from further expanding its university links.

In addition to the tenure-track joint appointments with universities, IIT should seek part-time academic links for its senior researchers. Maximum flexibility should be used to accommodate individual needs, in particular with a liberal policy for leaves of absence, when necessary.

Two important conditions must govern all kinds of IIT-university partnerships. First, they must not be limited to university-based IIT centers/poles: the only criterion should be the quality of the institution, no matter where it is geographically located. Second, such arrangements should be extended to top universities in other countries. There is now in Europe a small group of high-quality research universities that follows new paths to excellence, rather than relying on traditions and privileges. Such institutions are the natural partners of IIT.

The issue of IIT-university relations is directly connected to the announced plan for an independent IIT doctoral school, accredited to deliver PhD's (like SISSA in Trieste). This strategy, proposed but not yet started, should be compared to the alternate - or complementary - approach to establish broader agreements with selected universities for joint PhD programs, under the university legal framework.

We stress that, no matter what solution is adopted, it is vital for IIT to have a strong participation of PhD candidates to its research. In fact, PhD trainees play a strong - perhaps the strongest – role in top research institutions worldwide. IIT should consider the risk that double affiliations may deter top PhD students from performing their research in the institute, and also that the lack of PhD supervision opportunities may deter excellent scientists from working there.

The advantages of an independent IIT doctoral school would be good flexibility with respect to the PhD programs of the Italian universities. However, we can see counter-arguments in favor of the second strategy.

Indeed, a top university is better positioned in attracting excellent doctoral candidates. Furthermore, a university can offer a broad palette of educational opportunities, in particular for transferrable skills and the humanities. This is important for the re-orientation of the PhD career objectives. The Italian academic system largely prepares PhD students to academic careers, which are increasingly rare. The Italian industry, on the other hand, does not appreciate the added value of a doctoral education in science and technology. The IIT-based doctorates should reverse these tendencies by offering a PhD education expanding beyond the academic world. In this context, collaborations with top universities can offer a broader intellectual horizon to the candidates than an independent IIT doctorate.

Such opposite factors make the choice between the two models difficult, and could suggest an articulate approach with the coexistence of both solutions. However, we cannot fully assess how flexible a partner Italian university can be at present in adapting its doctoral activities to a broader partnership with IIT. The answer must be empirical: it is important to start exploring full PhD partnerships with 2-3 top universities, Italian and foreign. The results should be used to re-assess the issue in 12-18 months and prepare a final decision on this crucial issue.

Recommendation: negotiate PhD collaborations with a few top universities in Italy and analyze the strategy for PhD studies at IIT

4.6. Technology Transfer

A concrete impact on the Italian economy is crucially required for the success of IIT. We present here an expanded analysis based on the competencies present in our committee -- and propose some strategic measures specifically relevant to IIT.

During our audit, we detected several encouraging facts, some of which were already mentioned. The number of invention disclosures and patents steadily increased since 2006. The document on Technology Transfer elaborated by the Scientific Director and approved by the Foundation provides a good background for action. The joint IIT-Leica and IIT-Nikon laboratories are positive steps and also good models for future initiatives. We also noted the launching in 2010 of 15 external contracts, including several with industrial counterparts.

Considering that transferrable results already exist, the first priority for IIT should be a rapid completion of the technology transfer infrastructure. The corresponding unit should have a broad autonomy in launching initiatives. However, clear and detailed deliverables should be specified for the next three years and used in future performance assessment.

Recommendation: rapidly complete a strong technology transfer unit, with broad autonomy but specific deliverables for the next three years

Technology transfer and enterprise creation, however, should not be confined to the *ad hoc* unit. A new culture in this direction should permeate all parts of IIT, compensating the objective difficulties of the Italian environment.

Indeed, in Italy the conditions for the development of high-technology products and launching new companies are not favorable. Italy impresses as a producer of excellent human resources, individuals that succeed abroad but do not find in their country conditions for launching advanced products and for entrepreneurial success.

The reasons are multiple, and their full analysis is beyond our scope. We believe, however, that IIT could offer counter-measures to lack of entrepreneurial aptitude, insufficient capability to identify transferrable data and products, difficulties in launching new companies and transferring high-technology products to new or existing industries.

We already discussed one cause of such problems: the wrong career priorities of the Italian PhD programs. As part of any PhD strategy, IIT should contribute to the re-orientation of the career strategy by offering its students ample opportunities to acquire technology transfer skills and training in management and entrepreneurial know-how and leadership. PhD students at IIT should be made aware of business opportunities from the very beginning (note the "Innogrants" programs in Switzerland).

Recommendation: include courses on technology transfer and management in the IIT PhD training

IIT should also offer to its staff continuing education programs in technology transfer, leadership, management, business planning and the practical aspects of founding new companies. Such programs should also communicate a realistic but attractive view of the financial and professional advantages of independent entrepreneurship. The organizers should consider presentations by industry leaders and scientists and also include exchange programs with industries.

Recommendation: continuing education courses to IIT staff on technology transfer and enterprise creation

The technology transfer initiatives should include a systematic and sustained scouting of all IIT laboratories in search of transferable products and processes. In parallel, the continuing education courses should train the IIT staff members to recognize such items in their work. The training must be extended not only to the final research projects but also to methods and techniques.

Recommendation: scouting for transferrable items, training the staff to look for them

The IIT Board should adopt practical measures to encourage staff members considering to be engaged in technology transfer and/or the creation of new IIT-related companies. These measures should include a liberal leave of absence policy and a "parachute option" for those leaving IIT to create new companies. Employment by IIT should be terminated during the launching period of a new enterprise; however, the person would have the option to re-activate the IIT employment in case of failure. Finally, a fair share of the royalties should be assigned to the IIT inventors.

Recommendation: a leave of absence policy for technology transfer and company creation, a "parachute option"

The creation of enterprises also requires legal and practical instruments, e.g., administrative assistance and finding venture capital for new companies. Such elements should be combined in an incubator near the Morego site.

Recommendation: to move towards an IIT company incubator

IIT should also have the strategy, and the legal framework, to become shareholder of new companies. The objective is to share the profits of successful startups -- and not to pilot their creation, that must be driven by free-market forces. Thus, IIT

Recommendation: IIT should become a minority

should not become the majority shareholder. Furthermore, the institute should not pay its shares with cash but "in kind", notably through the transfer of intellectual property rights, royalties and other assets.

shareholder of its startup companies by using "in kind" payments

In the long run, IIT should develop a real industrial park related to its activities. The park should not be far from Morego and should house companies created by the IIT activities plus antennas of other industries, national or international, interested in profiting from the research output and competencies of IIT as well as from its techniques and equipment. Planning for this should start without delay.

Recommendation: start planning for an IIT-related industrial park close to the Morego site

Finally, IIT should also facilitate technology transfer to established companies by adopting a flexible legal approach for the complete transfer to the partner of intellectual property created by joint research projects (while retaining the right to use it for its own research). In exchange, the partners would support the IIT activities through voluntary funding, e.g., for the creation of new positions and/or PhD fellowships. This approach would drastically simplify the legal issues and the related negotiation times. The experience of major research universities shows that this approach would be more profitable for IIT than the direct exploitation of co-owned intellectual property. IIT will of course keep full ownership of the intellectual property generated on its own.

Recommendation: a liberal policy of transfer to partner industries of intellectual property generated by joint research programs with IIT, reciprocated by donations

4.7. Long-term Strategies for the Centers/Poles

These are not only important issues but also, unfortunately, part of the external communication problems discussed in Sect. 4.9. The creation of the nine centers or poles (and the launching seed projects) was regrettably regarded by part of the Italian research community as a "funding agency" initiative, arguably inappropriate for IIT. We know that this view is not correct, but we also believe that it was caused by insufficient external communication. We have good reasons to view the centers/poles as a step towards the creation of a national network of excellence. But this is largely unknown outside IIT and, therefore, must be urgently communicated.

Recommendation: wise and efficient communication should present to the research community and to the public the IIT network of centers/poles

We consider the national network of excellence as a key factor for the future of IIT. We thus decided to directly visit several centers in Turin, Milan, Pontedera and Pisa. We also requested and extensively analyzed data on the performance of all centers. Our impression was generally positive: we found units in operation, well integrated with their host universities and with existing or developing connections to other parts of the IIT network. None of the centers was found to be isolated from the rest of IIT.

We specifically noticed the following facts. The personnel in the centers corresponded, at the end of 2011, to approximately 38% of the total IIT staff. In proportion, the administrative staff is very limited in the centers, indicating that they did not create unneeded duplications relative to Morego.

As to the research quality of the centers, we analyzed the specific publication outputs (keeping in mind the differences in the research domains). The data show that the growth of the publication outputs in Morego and in the centers followed reasonably well the respective staff increases. For 2010, the centers produced approximately 35% of all IIT publications, very close to their present share of personnel. The partial data for 2011 indicate a fraction above 30%.

The yearly output per staff member varied from center to center, ranging in 2011 between 0.2 and 2.5. Whereas the average is comparable to the overall IIT value, such fluctuations are quite large. We believe that they are linked to two factors: the dissimilar publication strategies of the respective research domains and the differences in the development stage of different center. In fact, the lowest levels were found for recently created centers.

We also analyzed the research outputs in term of publication quality, finding limited disparities between Morego and the rest of the network. The 2011 data for the centers indicate an average impact factor per publication slightly above 4, which is very good. The total impact factor for the centers steadily increased from <200 in 2009 to a (partial) 2011 level >1100.

These data again fluctuate between centers. We believe that such variations are almost exclusively related to the intrinsic impact factor differences between research domains. However, they must be carefully monitored using citations rather than the impact factor (we commend the IIT leadership for having recently launched a series of actions in that direction). Possible resilient fluctuations should be analyzed in the medium future.

Recommendation: continue monitoring the publication quality fluctuations among centers

Whereas most centers/poles are fully operating, we found that their network is not yet fully established. We did not detect critical problems, and in particular no evidence of research activities totally outside the scope of IIT, and no symptoms of needless duplications. But there is still much room for improvement of coordination. The progress towards a real network should be accelerated.

In several cases, the complementarity and cooperation is already quite strong. Perhaps the best example is robotics, with a high quality and reasonably intense coordination between the Morego activities and the IIT@SSSA (Center for Micro-robotics) and IIT@POLITO (Center for Space Human Robotics) in Pontedera and Turin. Overall, such units already constitute a strong international entity.

The IIT management monitors the progress towards networking in several ways. In particular, it verifies the actual IIT weight in the publications produced by the centers. The objective is to make sure that the centers do not merely act as recipients of IIT funds – supporting their existing activities rather than engaging in new initiatives. The

corresponding data are quite reassuring: for example, the average fraction of IIT authors vs. all authors exceeds 40% for six of the nine centers. Only the case of the IIT@SEMM center (Genomics Center) in Milan might raise some concern and should be carefully monitored: the present, limited percentage could be a transient phenomenon, but should be controlled.

In addition to monitoring and its other present actions, we believe that the IIT management should take additional measures towards networking. A major problem is the limited communication between the network components, leading to still unsatisfactory "IIT network culture". Establishing such a culture should be a priority for IIT: all the staff members of the centers should develop strong ties and loyalty to the institute, rather than considering it a secondary affiliation with respect to their host universities.

Recommendation: create an "IIT network culture" in the entire staff

The following steps are recommended to facilitate an "IIT network culture":

- Weekly e-mail newsletter on current IIT research and general news to all network staff members.
- Regular visits of the staff members to other parts of the network.
- Promote exchange of researchers between Morego and the centers for limited periods of time.
- Allocate funds for Morego-centers and center-center collaborations.
- Doctoral and postdoctoral courses organized by individual centers for the entire network.
- Creation of IIT prizes for top achievements, open to the all sites and widely publicized throughout the IIT network.
- Possibly, a yearly "IIT event" attracting a large number of IIT members from all sites, with both professional and socializing aspects.

These actions should be particularly directed to junior staff members. For example, no PhD candidate should graduate from the IIT network without having visited several of its components – and, ideally, after having worked in two or more of them.

4.8. Multidisciplinarity, Cross Fertilization

Our analysis of these issues initiated as a response to a request of the IIT Board for a preliminarily assessment of a proposal by the IIT Scientific Direction. The idea was to reserve a small budget for inter-departmental initiatives, in particular the iCUB facility. We did express a positive opinion in the following terms:

Concerning the Inter-departmental Projects:

- We support the plan to create the iCUB Facility since (i) it guarantees the important role of iCUB in promoting the IIT image and visibility; (ii) this is an effective way to keep iCUB at the technological forefront in a situation of increasing competition; (iii) furthermore, it implements a desirable distinction between research and R&D activities. We advise:
  - To include in the Strategic Plan a clear, integrated road map.

  - To make clear to the involved personnel that a long-term strategic objective is the launching of industrial initiatives.
- We also support the proposal of targeted funding for inter-departmental projects. However:
  - The selection criteria should be clearly spelled by the Strategic Plan: (i) the funded proposals must be curiosity-driven, characterized by originality and potentially by high risk; (ii) they should constitute a truly new direction with respect to ongoing activities.
  - The Strategic Plan should include a more detailed description of the procedures for proposal submission and selection. In particular, the submission should be open to team leaders.
  - We advise against the inclusion in the Strategic Plan of detailed examples. On the contrary, the examples should be broad and hypothetic.

Through the above preliminary assessment, we came to recognize the crucial importance of multidisciplinarity for the future of IIT. Transdisciplinary research is indeed a great opportunity since the artificial barriers still present in most of the academic structures do not affect the institute. But multidisciplinarity is also an essential part of the IIT mission: failure to achieve it would seriously jeopardize the overall success.

Keeping this in mind, we find the present situation encouraging but not entirely satisfactory. The initial years of IIT were successfully used to build its components. The next stage must create bridges between them, specifically identifying new ways to cross-use the disciplinary competences. In most cases, such bridges do not yet exist, as it was remarked in particular by the recent evaluation of the IIT neurosciences. The reserved budget for inter-departmental initiatives is a step in the right direction. However, it should be followed by additional actions within a comprehensive strategy.

Specifically, we recommend the “vertical” platform directors to also act, jointly with the Scientific Director, as a “multidisciplinary brainstorming committee”. They should regularly meet with the objective to identify new collaboration opportunities. This function should be very informal, to allow novel ideas and revolutionary actions without psychological barriers. External experts should be involved whenever appropriate.

Recommendation: the platform directors should act as a “multi-disciplinarity brainstorming committee”

To reach all staff members, we also recommend personal financial rewards for launching interdisciplinary activities involving two or more IIT components. Moreover, future personnel searches should consider past activities across different disciplines as a key positive credential. Likewise, such activities should have a strong weight in tenure-track. Finally, IIT should systematically advertise interdisciplinarity in its communications and job announcements.

Recommendation: promote interdisciplinarity in evaluations, staff searches and communication

4.9. Communications, Media Presence

This is, in our opinion, a particularly critical issue. IIT still suffers from a serious external communication problem due to avoidable initial conflicts that generated bad press. Efficient, professional communication based on facts and figures should correct past shortcomings and develop a deservedly positive public image. We do find, in fact, that the IIT of today is much better than its image, at least in Italy.

IIT should therefore adopt a proactive communication attitude based on factual information, addressing in parallel professionals and the general public, according to the following principles:

Recommendation: communicate professionally facts and achievements with a broad palette of actions

- Communicate facts and achievements in a clear, credible, generally understandable and plain language, using a variety of media.
- Take advantage of opportunities of presenting the institute in Italy and abroad, both to the general public and to scientists, for instance while hosting major scientific events (see below).
- Launch targeted communication initiatives for interest groups: students, scientists, industry, political leaders.
- Seek effective presence with feature articles in reputed scientific journals, e.g., Nature and Science, about IIT and its research projects.
- Refrain from antagonism, provocations and polemics. Avoid exaggerations and excessive advertisement.

We did detect elements of this strategy that are already underway. But the general situation is not yet satisfactory. For example, the success of IIT as a partner of a finalist projects for EC flagships went almost unnoticed in Italy -- whereas similar accomplishments received strong media attention in other countries.

We reiterate that he objective of the IIT communication must not be propaganda: all actions must be based on solid facts. But IIT should not be timid in presenting its legitimate accomplishments. It should rapidly create a network of reference persons, including correspondents of top professional journals as well as general medias in Italy and abroad. We specifically advise press correspondent visits to IIT, to create constructive partnerships and channels for publicizing future results.

We did detect a fundamental problem in the communication strategy: insufficient autonomy of the Scientific Director in disclosing to the media scientific and technical achievements, We believe that the Scientific Director should have a broad delegated responsibility in these matters, and the authority to approve all announcements of this type by other staff members. The Scientific Director should seek professional advice on the formulation and timing (through a reformed press and media office) and consult with the involved scientists.

Recommendation: grant the Scientific Director a delegation of authority for communications in science and technology

Finally, we recommend an increased quality control on the IIT research publications. This could be accomplished on a voluntary basis with a widespread use of the practice of internal reading and informal internal refereeing before external submission. We also urge IIT to develop clear standby procedures for handling possible professional misconduct cases, as required by an increasing number of funding agencies.

Recommendation: develop clear standby procedures for hypothetic cases of professional misconduct

4.10. Research Evaluation: Bibliometry and Beyond

Our mission in this area was not to assess in detail the research quality of IIT, but to analyze the instruments that must guarantee effective and systematic evaluations (detailed research assessments are the responsibility of the IIT Scientific and Technological Committee, CST). We greatly profited from the presence in our team of Professor Emilio Bizzi, CST president: we could thus coordinate the two tasks.

We divided our analysis of research evaluations in two parts. First, we considered the corresponding work of the CST as well as of the other involved bodies and individual experts. We specifically analyzed several relevant documents from these entities.

Second, we studied in detail the instruments developed by IIT to quantitatively monitor its research performance. This analysis was necessary because of the ongoing transition from qualitative to quantitative evaluations. In essence, the young age of IIT forced so far the evaluators to use qualitative assessments primarily based on their professional experience. Such assessments are an important component of any research evaluation and their use should continue. However, as the IIT output increases and the age of the first results exceeds three years, quantitative analysis based on reliable statistics becomes increasingly possible.

Overall, our conclusions about research quality control are very positive. We found that the CST and the other evaluation bodies: (a) systematically analyzed IIT as a whole and many of its components (in particular those potentially problematic); (b) adopted for their work best practices according to international standards, while also taking into account the young age of IIT and the corresponding difficulties in obtaining statistically reliable data; (c) involved outstanding international experts; (d) produced high-quality reports with a clear identification of the problems and practical recommendations.

We thus recommend continuing the same practices for the future, coupled to a larger use of quantitative data. Specifically, the professional level of the evaluators must be kept as outstanding as it has been the past triennium. We also recommend including in future evaluations additional sets of data, notably those on technology transfer and the creation of enterprises.

Recommendation: continue the good practices and outstanding level of the IIT evaluation bodies

Concerning the acquisition of statistical data and tools, we discussed with the IIT management the already implemented instruments and those under development.

The foundation must be of course reliable data mining, in particular for bibliometry. We appreciated the IIT efforts in this direction: specifically, the construction of reliable tools to identify IIT-related publications in the Scopus and ISI databases. We tested the performance of such tools, with positive results (see below). We also inspected the preliminary version of the Web instrument containing all the identified IIT publications. We found this instrument user-friendly, versatile and effective. Its implementation is very important to make the IIT research output easily accessible for the external observers.

We did detect however, a problem affecting the IIT bibliometry that should be urgently corrected. Simple searches in databases like ISI fail to identify all IIT publications – with a loss surpassing 50%. The cause is the use by the IIT members of a variety of different terms to specify their affiliation. Searches using the keywords set developed by IIT (for its own database mining) did produce much more complete results. However, external observers are very unlikely to perform such sophisticated searches, rather than using the simplest keywords.

This can have very negative consequences. Research results may not be credited to IIT; even worse, publication data communicated by IIT may incorrectly appear overinflated to external observers.

The solution is simple and should be mandatory: all IIT authors must adopt a single, unified terminology for their publications – selected by the Scientific Director. The chosen terminology must be communicated to the managers of major international databases, to obtain a comprehensive link with all the variants used so far.

Recommendation: enforcement of a single form for indicating affiliation in all IIT publications

This essential measure should be part of a broader campaign to alert IIT researchers about publication and research ethics and procedures. Unfortunately, these aspects are often ignored in the PhD education: IIT can have a positive impact by filling this gap. The campaign could include *ad hoc* seminars and treat, in particular, the rules for authorship accreditation, the use of material from other authors and the corresponding citations, and the use of animals and humans.

Recommendation: an information campaign for IIT staff on publication and research ethics

We also recommend the adoption of an IIT professional code. Comprehensive codes can be found in the documentation of major research institutions and universities -- and can be used as reference. The IIT staff members should be asked to personally volunteer to respect the code.

Recommendation: adopt a voluntary IIT professional code

We will now discuss more in detail the bibliometry indicators used by IIT. The corresponding data-mining and analysis tools are still under development, but already provide information for the management, the Board and other bodies. The indicators include, in particular, the number of publications (articles, books, book chapters and conference proceedings) and the impact factor. Considering the young age of IIT and its statistical consequences, this initial set is not unreasonable.

However, we advise the IIT to limit the emphasis on the IF, for the reasons that we already discussed.

In the long term, we recommend using a more complete set of bibliometry indicators, including:

- The number of citations per publication.
- The *h*-factor (Hirsch factor) for all IIT components and, in the long run, for all staff member above the postdoctoral level.
- The h_m-factor or "Molinari factor" [J. F. Molinari, A. Molinari, Scientometry **75**, 163 (2008)] for the major IIT components.

Recommendation: to develop an expanded bibliometry statistical set and to benchmark it

We also recommend benchmarking these parameters. For the entire IIT, the Scientific Direction should propose to the CST, for approval, a "benchmarking set" including a certain number (tentatively ten) international institutions. Each major component of IIT should propose to the Scientific Director a similar list for its own benchmarking. IIT should then implement routine procedures to find the indicator values for the benchmarking institutions.

In addition to the bibliometry parameters, we also recommend using other performance indicators, including:

- The number of licenses (in addition or even as a replacement of the number of patents).
- The invited talks at international conferences by IIT staff members.
- The prizes and awards received by IIT staff members.
- Prestigious grants like the ERC (European Research Council) junior and senior awards.
- The PhD theses performed entirely or in part at IIT with the subsequent employment history of the authors.

Recommendation: develop a database of non-bibliometry indicators including: licenses, invited talks, prizes and awards, extramural funding, PhDs

However, we advise against a proliferation of statistical initiatives. The present set, with the additions recommended above, should be sufficient both for comprehensive performance evaluation and effective presentations of the IIT achievements.

4.11. Further Issues

The first part of our work dealt with the questions decided in our second meeting and treated above. Gradually, however, we found other interesting problems that merit attention. We present them also as a reference for the next IIT evaluation committee.

Extramural Funding

We have seen that the success of the IIT staff in attracting extramural funds, mostly through competitive processes, is quite satisfactory. The 20% percentage objective

for non-institution financial support was essentially reached for the entire institute. However, significant differences remain between the different parts of IIT. It would be desirable to bring all components at least to the 20%; this would also bring increase the overall level for IIT.

We specifically recommend participation to the junior and senior ERC grant competitions of virtually all research staff members, because of the potential for revenues but also for prestige. The level of people hired by the institute justifies this advice.

Recommendation: all IIT researchers should compete for ERC grants

Concerning the use of extramural funds, we learned that IIT has a policy of leaving the grant overheads to the recipient unit. In the long term, this is not a good practice since the overhead should also cover central costs. External auditors, for example those of the EC, could even challenge the current use. We thus recommend a more balanced repartition, with a portion of the overhead controlled directly by the Scientific Director.

Recommendation: grant overhead should contribute to central cost coverage under the control of the Scientific Director

Morego Site Development

Finding the Morego building and transforming it were remarkable achievements by the IIT management. Avoiding the construction of a new building saved a large sum (arguably, tens of millions of Euro), with no loss in quality or effectiveness.

The Morego building, however, could become even more functional by adopting some additional measures. For example, the “social” environment is not yet optimal as far as dining facilities and recreation/relaxation areas are concerned – and remedial steps should be considered. We also found parking very far from satisfactory. The present situation discourages work outside the normal office hours and decrease productivity. In the dark, the long and steep walk to and from the bus stop is dangerous and uncomfortable, in particular for women. The Board should therefore approve additional parking slots at the building level.

Recommendation: improve the “social” environment of the Morego building and increases parking facilities at the building level

Personal Staff Support

Our interviews revealed some relocation difficulties for the staff members hired by IIT, in particular from outside Italy. With limited-time contracts, they have problems in finding housing in the Genoa area and in obtaining mortgages or car loans.

The IIT management should establish all possible ways to solve these problems. Direct negotiations with local or non-local lenders and real estate agents may be considered. IIT

Recommendation: offer better relocation

may also use the services of an external relocation company for the solution of some of these problems.

assistance for new personnel

Conference Hosting

The organization of international conferences in Morego, Genoa or the other IIT sites would be a very effective instrument in building the IIT image. This is particularly true for the main international events in the leading research domains of the institute.

We recommend the IIT to bid for the organization of such events. The entire staff should be alerted about the importance of these initiatives and encouraged to launch them. Note that one must "reserve" major scientific and technological conferences events several years in advance; the first bid is normally unsuccessful but puts the bidder "on the pipeline". Thus, initiatives in this sense by IIT members should start as soon as possible.

Recommendation: start bidding for the organization of major conferences of the main IIT domains

The IIT management should financially support staff members who launch such initiatives -- both directly and with deficit guarantees. IIT should also consider collaborating in these efforts with other entities in its broad region.

Collaboration with other Research Institutions

So, far, IIT concentrated its collaboration efforts primarily on universities, notably with the centers/poles. This was a reasonable strategy; however, IIT should now profit from more collaborations with non-academic research institutions, in Italy and abroad -- that would also promote the IIT image.

We recommend initiatives targeting: (i) CNR, e.g., for new materials and certain biomedical domains; (ii) at least one of the Italian biomedical institutions at the top of the normalized Scimago ranking; (iii) the Human Genetics Foundation in Turin; (iv) at least one major institution abroad.

Recommendation: more collaborations with non-academic research institutions like CNR, in Italy and abroad

4.12. Issues concerning specific IIT units

Our analysis of the IIT managerial structure and performance reached the level of major units. We found in general a very good situation that could be further improved by the matrix organization and by some adjustments for specific units.

Perhaps the most evident case is robotics: better communication and better cooperation between the different units would enhance effectiveness, avoid unnecessary delays in the projects and remove possible redundancies. We noted

Recommendation: promote better integration and

that the IIT leaders already launched specific corrective actions, notably for better communication. This is commendable and the results should be carefully monitored; if required, additional measures should be adopted. A similar strategy for better integration and communication is also strongly advisable for the units involved in neuroscience research.

communication of the robotics research units. A similar advise applies to neuroscience

We also detected possibilities for improvement in the drug discovery efforts. This activity is quite isolated from the rest of the IIT. Furthermore, the research is strongly oriented towards transactional efforts. This makes it vulnerable to a possible lack of success, even if the areas of activity are intrinsically very interesting. We believe that a careful analysis is desirable of the mission and strategy of this unit within the general framework of the institute, and commend the initiatives already underway in this direction.

Recommendation: critically analyze the strategy and mission of drug discovery activities within the IIT framework

Finally, the IIT research in surface science and nanotechnology could profit more from the use of centralized facilities such as synchrotrons or neutron sources. IIT should consider special ties with such facilities, notably the Sincrotrone Trieste and the ESRF, including the possible joint development of specialized instrumentation.

Recommendation: stronger collaborations with centralized research facilities

5. Recommendations - Summary

MANAGERIAL STRUCTURE AND ISSUES:

1. Achieve a stronger presence in the IIT Board of science, technology and technology transfer; be aware of the importance to include women scientists.
2. Broaden the top management structure for research by creating an Executive Scientific Committee with three Associate Scientific Directors.
3. Avoid a “collective” decision structure mechanism even while decentralizing part of the responsibilities.
4. Complete (in 2-3 years) the “matrix” structure with “vertical” platform leaders.
5. Prepare in advance for a smooth scientific leadership transition by clearly stating rules and procedures, based on international best practices.
6. Offer tenured employment to the present Scientific Director, but keep the directorial responsibility limited in time.

PERSONNEL, TENURE-TRACK:

7. Implement an internal tenure-track system for gifted young scientists selected under strict conditions.
8. Grant full research and financial independence to the young talents, in particular those on tenure-track.
9. Consider tenured positions for senior scientists and managers for better support of the scientific and technological growth of young researchers and the IIT itself. Specifically, tenured positions could be offered to top scientists close to retirement, and unlimited-time tenured IIT positions could be directly proposed to outstanding scientists and leaders selected by international open calls.
10. Permanent (tenured) positions of all kinds should never exceed 50% of the senior research staff, or 15% of all IIT members, including postdoctoral fellows and PhD candidates.
11. Launch formal partnerships with Italian and foreign universities with the objective of creating joint academic-research positions under mutually appealing conditions, in particular tenure-track joint positions for young scientists.
12. Monitor personnel planning and turnover for different career planning modalities, aiming at an average age below 38 years for the whole IIT staff.
13. Document IIT human resources policies and strategies for personnel management, career planning, equal opportunities and general internal information.

GENDER AND AGE ISSUES:

14. Assure significant women presence at IIT and in IIT bodies, in particular a strong (or majority) participation in the search and tenure committees and as committee chairs.

15. Appoint at least two women directors in the next three years and five in five years.
16. Align the IIT rules for maternity leave to other Italian research organizations.
17. Promote information on science, technology and on the IIT for school-age girls.

COLLABORATIONS AND PARTERSHIPS:

18. Seek more collaborations with non-academic research institutions like CNR, in Italy ad abroad.

EXTRAMURAL GRANTS:

19. All IIT researchers should compete for ERC grants.
20. A reasonable proportion of overhead contributions from extramural grants should be attributed to the management budget of the Scientific Director.

DOCTORAL ACTIVITIES:

21. Address options for an IIT PhD strategy and start negotiations for PhD collaborations with a few top universities in Italy and abroad.
22. Include transferrable and managerial skills in the training of all IIT-based PhD candidates.

TECHNOLOGY TRANFER, ENTERPRISE CREATION:

23. Rapidly complete a strong technology transfer unit, with broad autonomy but specific deliverables for the next triennium.
24. Offer to the IIT staff and PhD students continuing education on tech transfer and related activities such as entrepreneurial innovation, business planning, founding and managing new companies.
25. Systematically scout for transferrable products and ideas, offer training to the IIT staff to recognize promising cases, to develop awareness for intellectual property protection, and to identify industries for tech transfer and business cooperation.
26. Establish a leave of absence policy for staff members interested in tech transfer with the option of returning to IIT in case of failure (“parachute option”).
27. IIT should be involved in its start-up companies as minority shareholder through in-kind (not cash) payments, but should not directly drive their creation.
28. Consider plans for an incubator and, in the long run, a technology park not far from Morego, and modalities for collaborations with IIT poles and centers.
29. Adopt a liberal policy of transfer to partner industries of intellectual property generated by joint research programs with IIT, to be reciprocated by donations.

NETWORKING CENTERS/POLES:

30. Actions are proposed to create an "IIT network culture" in the entire staff, including a weekly email newsletter, regular mutual visits, exchange stages, rewards for inter-center collaborations courses for PhD and postdocs for the entire network, IIT prizes and a yearly "IIT event".
31. Ensure outside communication and information about the IIT network.

MULTIDISCIPLINARITY:

32. The platform directors should act as a "multi-disciplinarity brainstorming committee" to systematically identify new transdisciplinary opportunities.
33. Reward successful interdisciplinary initiatives.

COMMUNICATION:

34. Improve and organize IIT external communication, targeting the public and interest groups, e.g., scholars, scientists, industry, politics, etc., and using the appropriate channels to present the IIT achievements.
35. In particular, wise and efficient communication should present the IIT network.
36. Grant the Scientific Director a delegation of authority for communications in science and technology.

QUALITY CONTROL, PUBLICATIONS, BIBLIOMETRY:

37. Maintain the good practices and outstanding level of the IIT evaluation bodies, but increasingly use quantitative data and information on tech transfer.
38. Impose a unified form for the affiliation in all IIT publications.
39. Expand the set of bibliometry indicators and statistical tools, and use benchmarking groups.
40. Adopt an appropriate database of non-bibliometry performance indicators including licenses, invited talks, prizes and awards, extramural funding, PhDs.
41. Monitor fluctuations in the publications quality of different centers.

FURTHER RECOMMENDATIONS:

42. Establish procedures for dealing with hypothetical misconduct cases.
43. Launch a campaign on research and publication ethics to alert all IIT staff members.
44. Establish an IIT professional code to be subscribed by all staff members.
45. Improve the social appeal of dining and resting structures of the Morego building and the parking situation.
46. Improve relocation assistance for new personnel.

47. Promote the organization of major conferences by the IIT in collaboration with other regional partners.
48. Achieve a better integration of the robotics research units.
49. Achieve a better integration of the neuroscience research units.
50. Assess the strategy and mission of drug discovery within the IIT framework.
51. Improve the ties with centralized research facilities.

6. Concluding Remarks

As stated in Section 2, we consider the mission of IIT not only to become an international center of excellence in research and a motor for economic development, but also to provide a new model for the Italian research institutions. From the facts we discovered and from our analysis, we can draw the following general conclusions.

No insurmountable obstacles exist for the fulfillment of all aspects of the IIT mission. The present management and its strategies appear very effective and are already producing high-quality results. The adoption of our recommendations can further improve this favorable situation.

The subset of recommendations presented in the Executive Summary – and the corresponding issues - is critical for the continuation of this positive path: one cannot otherwise exclude a slowdown or even a reversal. Furthermore, by adopting them IIT is likely to become a model for the Italian research system, as it should.

With an effective and timely implementation of these measures, assuming a reasonable funding situation, we believe that IIT will be fully successful in implementing all parts of its mission. It was a pleasure for us to discover an Italian history of success and to realize its excellent opportunities for the future: we sincerely hope that the success will continue and the opportunities will be fully exploited.

Appendix I: Agendas of the EC meetings

First meeting (February 8-9, 2011): an informal program involving only the EC chair

Second meeting (April 4-5, 2011):

Agenda:

Lunedì 4 aprile

h. 19- 20.45 visita dei dipartimenti Prof.ssa Cattaneo accompagnata dal Direttore Scientifico

h. 20.45 cena al Ristorante Al Serro adiacente al Hotel San Biagio

Martedì 5 aprile

h. 8.00- 9.30 presentazione del Direttore Scientifico

h. 9.30 -10.00 "*Executive Meeting*" del Comitato di Valutazione (membri Comitato di Valutazione + verbalizzante)

h. 10-10.15 Coffee Break

h. 10.15- 13 visita dei dipartimenti

h. 13-14 pranzo

h. 14-15.30 **teleconferenza**: organizzazione dei lavori (Comitato di Valutazione + Direttore Scientifico + team Segreteria Scientifica)

h. 15.30- 17.30 visita dei dipartimenti

h. 17.30-18.30 intervista di uscita con Direttore Scientifico e Direttore Generale

h. 20 cena

Third meeting (October 10-11, 2011): an informal program involving only the EC

Agenda:

October 10

9:30 – 12:00:	visit of the IIT Center for Space Human Robotics, Politecnico di Torino
12:00 – 13:30:	working lunch

13:30 – 15:30: transfer by private bus to the IIT – Morego
15:30 – 17:00: analysis of the topic "Interaction between different IIT components: multidisciplinarity, cross fertilization"
17:00 – 17:30: coffee break
17:30 – 20:00: analysis of the topic "Human resources: careers, long-term contracts, tenure"
20:45: dinner

October 11
8:30 – 10:30: analysis of the topic "University links: joint appointments, long-terms IIT associations with resources, doctoral programs, IIT doctoral schools"
10:30 – 11:00: coffee break
11:00 – 13:00: analysis of the topic "Long-term policy for the centers: additional centers, prolongations, terminations" (first reading)
13:00 – 14:30: working lunch
14:30 – 16:30: analysis of the topic "Technological transfer: general strategy (external company), dedicated unit, staff, policies"
16:30 – 17:00: coffee break
17:00 – 18:00: all other business

Fourth meeting (January 9-10, 2012): an informal program involving only the EC

Agenda:

January 9
9:00 – 10:30: visit of the IIT Center for Micro-Biorobotics, Scuola Superiore Sant'Anna, Pontedera
10:30 – 11:00: transfer
11:00 – 12:30: visit of the Center for nanotechnology Innovation, NEST-Scuola Normale Superiore
12:30 – 13:30: working lunch
13:30 – 15:00: analysis of the topic "IIT managerial structure: possible streamlining, additional needs"
15:00 – 15:30: coffee break
15:30 – 16:30: analysis of the topic "Long-term leadership: strategy for future transition planning"
16:30 – 17:30: analysis of the topic "Equal opportunities: gender issues, junior scientists"
17:30 – 19:00: analysis of the topic "Long-term policy for the centers: additional centers, prolongations, terminations" (second reading)
20:30: dinner

January 10
8:30 – 9:30: analysis of the topic "Dissemination of accomplishments: media presence, links with the professional world, links with political leaders"
9:30 – 10:00: coffee break

10:00 – 11:30: analysis of the topic "Scientific evaluation (in coordination with the Scientific Committee): bibliometric results and statistical analysis, in-depth analysis of programs and strategies"
11:30 – 12:00: all other business
12:00 – 13:30: working lunch

Fifth meeting (March 26-27, 2012):

Agenda:

March 25
20:00: Informal dinner discussion for those arriving on Sunday night

March 26
9:00 – 11:30: visit of the Center for Nano Science and Technology, Politecnico di Milano
11:30 – 12:30: Status of the evaluation - general discussion
12:30 – 13:30: working lunch
13:30 – 15:30: Topic Updates, in particular Technology transfer, Human Resources, Equal Opportunities
15:30 – 16:00 coffee break
16:00 – 17:30: Final Report: introduction by the chair, first discussion
17:30 – 19:30: Evaluation of the Scientific Director
20:00: dinner

March 27
9:00 – 10:30: Final Report: continuing discussion
10:30 – 11:00: coffee break
11:00 – 12:00: Final Report: conclusions and logistics
12:00 – 12:30: all other business
12:30 – 13:30: working lunch

Appendix II: Progress Report (on organization and logistics)

IIT Evaluation Committee (2011-2012)

Progress Report for the period February 2 - May 31 2011

The Evaluation Committee (EC) initiated its activity immediately after the IIT Board approval of the planning document "*Valutazione dell'IIT per il periodo 2009-11: comitato di valutazione, obiettivi, procedure, funzionamento*". on February 2, 2011. The first steps were consistent with the same document.

The already implemented activities included:

- The development of the logistic organization and the initial data collection.
- Two meetings at the Morego site, including the first official reunion of the entire EC.

Logistic Organization

The EC could count on the full support of the Scientific Director, Professor Roberto Cingolani. With his agreement, a task group was created in Morego for logistic and data-taking support, under the supervision of Dr. Francesca Cagnoni. The task group includes (part-time) other members of the Scientific Secretariat Office: Ms. Sara Currel, Mr. Simone Collobianco, Ms. Stefania Pallanca, Ms Arianna Pezzuolo and Ms Viviana Savy.

After ample and detailed discussions on the specific tasks and roles, it can be concluded that this task force fully meets the personnel support requirements specified by the planning document.

The EC also appreciated the additional support of Dr. Raffaele Cusmai, Counsel, and of Director General Simone Ungaro.

In preparation for the first official reunion, Dr. Cagnoni and her collaborators provided for the entire EC a full documentation set concerning the history, structure and activities of the IIT as well as of its main components.

First Meeting in Morego (February 8-9, 2011)

This was a visit of the EC president, Professor Margaritondo, with two objectives: (1) finalizing the logistic organization and in particular the identification of the support personnel for the EC operation; (2) obtaining preliminary information on the current situation of the IIT, in addition to that received through the participation to the IIT Board.

For the first objective, Professor Margaritondo had a series of detailed discussions with Professor Cingolani, Director General Ungaro and Dr. Cagnoni plus personal interviews with all the staff members that will be involved in the support task force. The results were very positive: the agreed solutions provide an excellent logistic support for the EC operation, as explained above.

For the second objective, Professor Margaritondo had detailed discussions with professor Cingolani and Director General Ungaro. He also visited several parts of the IIT and had informal discussions with the corresponding leaders. This provided him with an updated picture of the present status, of the most recent results and of the main current problems.

Second Meeting in Morego (April 8-10, 2011)

The meeting involved directly or by teleconference all EC members: Dr. Pistorio and Professors Bizzi, Addadi, Cattaneo and Margaritondo were personally in Morego whereas Professor Baggiolini and Slotine, both in the USA, participated to a 2-hour teleconference on April 9.

The objectives of the first official reunion of the EC were: (1) to discuss the information already obtained and gather additional information on the present situation of the IIT and on its evolution; (2) to discuss ad decide the *modus operandi* for the EC including in particular the focused objectives and the detailed agenda for its operation.

For the first objective, the EC had with Professor Cingolani and Director General Ungaro a 2-hour-long kick-off interview plus several other meetings and bilateral discussions. In addition, there were a series of visits to different units of the IIT including discussions with the corresponding leaders and acquisition of further detailed documentation. In essence, the scope was to gain an overall view of the status of the institute, of its results, challenges and problems as well as of the vision of the Scientific Director. These goals were fully achieved.

For the second objective, the EC had a series of meetings, either close or in the presence of Professor Cingolani and Director General Ungaro, plus the aforementioned 2-hour teleconference. A complete agreement was thereby reached on the *modus operandi* and on its practical realization.

In particular, the EC identified the following series of specific key issues that will require a focused analysis:

1. Human resources: careers, long-term contracts, tenure
2. Technological transfer: general strategy (external company), dedicated unit, staff, policies
3. IIT managerial structure: possible streamlining, additional needs
4. University links: joint appointments, long-terms IIT associations with resources, doctoral programs, IIT doctoral schools
5. Dissemination of accomplishments: media presence, links with the professional world, links with political leaders

6. Long-term policy for the centers: additional centers, prolongations, terminations
7. Interaction between different IIT components: multidisciplinarity, cross fertilization
8. Equal opportunities: gender issues, junior scientists
9. Long-term leadership: strategy for future transition planning
10. Scientific evaluation (in coordination with the Scientific Committee): bibliometric results and statistical analysis, in-depth analysis of programs and strategies

This is not necessarily a comprehensive list: the door remains open to additional issues that may emerge from the future EC work. In each of its future official meetings, the EC will reserve sufficient time to analyze in detail 3-4 issues, with the background documentation provided in advance.

As far as the agenda of its activities is concerned, the EC discussed the number and locations of its future official meetings -- and in particular the desirability to visit at least some of the IIT centers (to be balanced with the need to visit in detail all the Morego components). After ample debate, the EC decided the following overall agenda:

1. October 10-11, 2011: second official meeting in Morego, with a site visit to the IIT centers in the Politecnico in Turin and, possibly, in the Politecnico in Milan.
2. January 9-10, 2012, third official meeting in Pisa (to visit in particular the two IIT centers in the Sant'Anna and Normale Schools).
3. 19-20 March 2012, fourth official meeting tentatively in Morego.

In addition, (1) the EC President will try to visit the Lecce and/or Napoli centers together with some of the EC members, and (2) two other dates were kept in reserve in case additional plenary sessions will be found in the future necessary or desirable.

Overall, the above schedule should guarantee the necessary data taking time during the summer of 2011, the timely completion of the collegial data analysis as well as the delivery of the final report as required by the planning document.

Preliminary Conclusions

The EC activities progress according to the plans and no major obstacles were identified. The documentation gathered so far is excellent, in particular that directly presented by the Scientific Director. Some members of the EC informally and personally expressed the fact that they were impressed by the overall progress of the IIT (although of course a complete evaluation will be decided only at the end of the EC work).

The EC members wish to express their gratitude to Professor Cingolani for his very effective and open support during this first stage of activity. They also thank Director General Ungaro, Counsel Cusmai, Dr. Cagnoni and all other IIT members that assisted them so far in their task.

Appendix III: Preliminary Report to the Board

IIT Evaluation Committee
Preliminary report (October 11, 2011)

The IIT evaluation committee examined several issues treated in the draft version of the Strategic Plan 2012-2014, and would like to communicate for the Board its preliminary notes. However, we refer the Board to our forthcoming full report for the complete analysis.

First of all, we are very favorably impressed by the overall quality of the plan. This is a product of the excellent quality of the present IIT leadership - in particular the Scientific Director and the senior staff members – and of its positive and illuminated vision of the future of the institute.

Concerning the Inter-departmental Projects:

- We support the plan to create the iCUB Facility since (i) it guarantees the important role of iCUB in promoting the IIT image and visibility; (ii) this is an effective way to keep iCUB at the technological forefront in a situation of increasing competition; (iii) furthermore, it implements a desirable distinction between research and R&D activities. We advise:
  - To include in the Strategic Plan a clear, integrated road map.
  - To make clear to the involved personnel that a long-term strategic objective is the launching of industrial initiatives.
- We also support the proposal of targeted funding for inter-departmental projects. However:
  - The selection criteria should be clearly spelled by the Strategic Plan: (i) the funded proposals must be curiosity-driven, characterized by originality and potentially by high risk; (ii) they should constitute a truly new direction with respect to ongoing activities.
  - The Strategic Plan should include a more detailed description of the procedures for proposal submission and selection. In particular, the submission should be open to team leaders.
  - We advise against the inclusion in the Strategic Plan of detailed examples. On the contrary, the examples should be broad and hypothetic.

Concerning the Career Track issue, we must stress in general that the proposed measures, although effective, are basically dictated by the fundamental legal problems affecting employment in research and academia in Italy. Efforts at all levels must be continued to eliminate such background problems. Furthermore, the Board should modify the rules that aggravate these problems, in particular the salary caps, considering that the IIT salaries are increasingly less competitive, both internationally and nationally.

We did analyze specific Career Track measures reaching the following conclusions:

- We strongly support joint appointments with universities. However:

  - The management of extramural funding, publications and intellectual property could create problems and should therefore be regulated by specific agreements.
  - The program should explicitly include universities outside Italy.
- Concerning the plan for a limited number of 10-year contracts, we unconditionally support it for senior scientists that consider spending at IIT the last years of very distinguished careers. For junior scientists:
  - The expectation should be (i) full independence and (ii) the capability to secure substantial extramural funds (for example with ERC junior grants).
  - Such positions should be a jumping board to academic careers with continuing ties to the IIT.
- We also support the creation of a small fraction of tenured positions: the IIT needs indeed prominent senior scientists - including international superstars - that can only be hired with such positions. However:
  - The recruitment must be based on open international calls and not on direct decisions for individual candidates.
  - The selection procedures and the corresponding actors must be described in detail in the Strategic Plan.

Concerning the relations with universities, we specifically discussed the submitted Education/Training Programs. The presence of top-level PhD students is essential to the research mission of IIT. However, the committee feels that it must perform a more complete and detailed analysis of all issues before presenting its recommendation on the implementation of an independent doctoral program.

The committee discussed at length the complex issues related to technology transfer and to the IIT contribution to industrial growth. On the positive side, we are pleased to see a very strong potential in the list of cases included in the Strategic Plan. We also welcome the targeting of high-level initiatives as opposed to mere service activities that would not fully exploit the high potential of IIT.

We must note, however, that the conditions for technology transfer are increasingly difficult in Italy and require an integrated and effective strategy, Among the actions proposed by the Strategic Plan, the high-tech interactions with existing industries are effective and the easiest to implement: joint laboratories (following the present Nikon and Leica models), licensing and other cooperative actions. On the other hand, the creation of new companies is a more difficult objective that requires a detailed and comprehensive plan and adequate human resources. Specifically, the proposed establishment of a specialized technology transfer unit and the recruitment of an expert leader are necessary and urgent.

Appendix IV: Research Quality Evaluation and Bibliometry

Performance indicators for this task were recently proposed by a number of sources and are currently used for a variety of university rankings, mostly together with other parameters. The entire field is not yet on solid ground and the methods are often criticized from the point of view of reliability ad statistical robustness. We find it necessary, therefore, to discuss in detail the procedures that we adopted.

The comparative evaluation of IIT had the following boundary conditions:

1. Using a large and widely accessible database.
2. Using already active parameters to allow third parties to understand, test and reproduce our analysis.
3. Taking into account the size of the institution.
4. Taking into account the fact that IIT is in a rapid growth stage and therefore impossible to evaluate with procedures that require a steady-state situation.
5. Allowing benchmarking with reasonable reliability.

For the first problem, our options were essentially limited to ISI - Web of Science (WoS) and Scopus. Tests with the address keywords elaborated by IIT were more satisfactory with WoS than with Scopus. We therefore selected this database.

Concerning the parameters, those most widely used are the number of publications, the number of citations, the impact factor of the journals, the average number of citations per publication and more complex indicators such as the *h*-factor.

The number of publications is an increasing function of the staff size. Therefore, it requires normalization. The number of citations is affected by the same problem. Furthermore, it is also an increasing function of the time after publication. This complicates the analysis for growing institutions like IIT. Parameters like the *h*-factor are likewise age-dependent and also functions of the staff size.

None of the above parameters, therefore, is by itself a reliable performance indicator in the case of IIT. The average number of citations per publication has the advantage of being automatically normalized by the staff size. But it is age-dependent and therefore difficult to use for a growing institution. One can, however, obtaining a reasonable accuracy by limiting the analysis to sufficiently “aged” publications.

The need for reliable benchmarks increases the difficulty of the analysis since the search keywords are notoriously ineffective due to the use by authors of different ways to identify the institution. This causes incomplete returns when searching for the publications of an institution without using a complete keyword set. Furthermore, benchmarking must be done with respect to established international institutions, which are in a steady state situation. This complicates the comparison with a rapid growing institution like IIT.

Finally, we note that the one cannot solve the above problems by increasing the number of parameters, since this does not increase but actually decreases the reliability. Likewise, by relying on rankings performed by other organizations one does not guarantee reliability and cannot control all the steps of the method.

We tried to minimize all these problems by using three indicators. The first is the number of publications in a given year divided by the total staff size of the institution. This takes into account the effect related to the growing number of productive researchers. However, it does not correct for a second growth effect: the time lag for newly hired staff in producing publications. Therefore, it penalizes IIT.

Furthermore, benchmarking for this parameter can be affected by two error sources: incomplete returns in the database searches due to the aforementioned keyword insufficiency, and lack of reliable data for the staff size of other institutions. For the first, we tried to use a set of the most evident keywords for each benchmarking institutions, stating them in this report; however, the problem is not completely solved. For the second, we only relied on data posted by the institution and available through Internet rather than on our estimates.

Because of the above problems, the benchmarking comparisons of this parameter must be used with prudence. The effects of growth penalize IIT and therefore make the comparison quite conservative. But the data problems for other institutions can operate in the opposite way. Thus, comparative results must only be used to evaluate if IIT has a “reasonable” publication output per staff members. Our definition of “reasonable” is a deviation of less than a factor of 2 from the reference institutions. This factor was evaluated by assuming that keyword effects have the strongest impact and by considering their quantitative impact in the case of IIT itself.

The overall results of our WoS search for publications that appeared in 2010 are reported in Table I.

The second indicator for our analysis is the impact factor (IF) of the journals. The IF values are available thorough ISI (and other databases) for most of the journals used by IIT. We reiterate, however, that appearance in a high-IF journal is not by itself a guarantee that an article will have an important impact. Acceptance only means that a few peers approved the article: editors and referees. Misjudgments by such a small group can and do happen. Therefore, we prudently interpret this parameter only as a measure of the awareness of the IIT staff on the importance to publish in high-quality journals. This awareness is important, and that is why we included the IF data in our report.

The third indicator is a time-limited average number of citations per publication. The time limitations respond to two needs: (1) avoiding too recent and therefore statistically unreliable publications; (2) not including publications by other institutions older than the beginning of publishing by IIT. This second criterion increases the data reliability since the typical time period for most citations to occur is longer than the time between the start of publishing by IIT and now.

We thus selected for citation analysis items published in 2009 and 2010, considering statistically unreliable the data for younger publications. Note that by normalizing the number of citations to that of publications we also increased reliability. Indeed, the effects of keyword insufficiency are reduced in this way -- except for the increase in statistical fluctuations due to the decrease of the data set.

The results for the average citations per item are shown in Tables II and III for publications that appeared in 2009 and 2010. We report a comparison between IIT and several benchmarking institutions.

In essence, Tables I, II and III show that: (i) from a quantitative point of view, IIT enjoys now a good position among established institutions in terms of yearly productivity per staff member; (ii) qualitatively, IIT is in the top group in terms of citations per publication. The comparison with CNR, for example, indicates that IIT still produces 20% less yearly publications per staff member, but the quality is higher, with 52% and 61% more citations per item for 2009 and 2010 publications.

Table I
Results from the ISI WoS: 2010 Publication Numbers

	IIT[a]	Benchmarking Institutions					
		Weizmann[b]	EPFL[c]	CALTECH[d]	KTH[e]	CNR[f]	CNRS[g]
2010 WoS Publications	416	1,841	2852	3,646	1,017	7,118	32,296
Staff size	586 (2010 data)	1,620	4437	8,800	4,300	7,996	34,530
Publications per staff member	0.71	1.13	0.63	0.41	0.24	0.89	0.93

(a) Keywords: AD=((Istituto Italiano di Tecnologia) OR (Morego) OR (Ist* Ita* Tecn*) OR (Ita* Inst* Tech*) OR (IIT Genoa) OR (IIT Genova) OR (IIT PoliTO) OR (IIT PoliMI) OR (IIT SEMM) OR (IIT UniTn) OR (IIT UiPv) OR (IIT NEST) OR (IIT SSSA) OR (IIT Sapienza) OR (IIT UniNA) OR (IIT UniLE) OR (IIT CBN) OR (IIT CABHC) OR (IIT BCMCS) OR (IIT CLNS) OR (IIT CMBR) OR (IIT CNI) OR (IIT CNCS) OR (IIT CGS) OR (IIT CNST) OR (IIT CSHR) OR (IIT RBCS) OR (IIT NBT) OR (IIT ADVR) OR (IIT COIM))

(b) Keywords: AD=(((EPFL OR ((ECOLE POLYT* OR POLYT* FED* OR POLY* OR SWISS FED* OR INST* TECHN* OR INST* POLYT* OR POLYT* INST* OR TECHN* INST* OR SFIT OR EPF OR ETH OR ETHL OR POLITECN* OR I* ROMAN*) SAME (LAUSANNE OR ECUBLENS OR CHAVANNES)) OR ((IRRMA OR CRPP OR PLASMA* PHYS* OR PHYS* PLASMA* or Ctr Rech Phys Plasma*) SAME (SWITZERLAND OR SUISSE OR LAUSANNE OR ECUBLENS)))))

(c) Keywords: AD=((Weizmann) OR (Weizmann Institute) OR (Rehovot))

(d) Keywords: AD=((CALTECH) OR CALIFORNIA INSTITUTE OF TECHNOLOGY) OR (TECHNOLOGY PASADENA))

(e) Keywords: AD=((KTH) OR (Royal Institute of Technology Stockholm) OR (Royal Institute of Technology Sweden))

(f) Keywords: AD=((CNR) OR (C.N.R.) OR (Consiglio Nazionale delle Ricerche) OR (Italian National Research Council))

(g) Keywords: AD=((CNRS) OR (C.N.R.S.) OR (Centre National de la Recherche Scientifique))

Table II
Average citations per publication for items published in 2009. Database: ISI WoS

	2009 WoS Publications	*Citations until February 2012*	*Citations per publication (average)*
IIT	267	2,627	9.84
Weizmann	1,888	15,794	8.37
EPFL	2,939	24,830	8.45
CALTECH	3,597	39,641	11.02
KTH	944	6,242	6.61
CNR	7,164	46,647	6.49
Imperial College	7,113	60,316	8.48
MIT	6,258	75,493	12.06
Berkeley	8,664	81,153	9.37
Stanford	8,840	82,341	9.31

Table III
Average citations per publication for items published in 2010. Database: ISI WoS

	2010 WoS Publications	*Citations until February 2012*	*Citations per publication (average)*
IIT	416	2,158	5.19
Weizmann	1,841	10,203	5.54
EPFL	2,852	14,001	4.91
CALTECH	3,646	26,247	7.20
KTH	1,017	4,357	4.28
CNR	7,118	22,984	3.23
Imperial College	7,435	34,495	4.64
MIT	6,468	39,659	6.13
Berkeley	8,736	47,626	5.45
Stanford	9,143	46,483	5.08