Evaluation of Istituto Nazionale di Ricerca Metrologica 2008

12 February 2010
Ref 2908 KC
Report no. DFM-2009-R14

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Content

1 Executive summary

The findings of the Committee for 2008 may be summarised as follows:

Overall, INRIM has developed satisfactorily during 2008, both with rexpect to previous years as well as with respect to comparisons with other National Metrology Institute (benchmarking), where this is possible. Reports from 2006 and 2007 have been approved by INRIM; but equally important it has given rise to constructive discussions within the department in its continuous search for improving its performance. One result is that both the external and internal planning and reporting are now more transparent and consistent, making the necessary analyses of the Evaluation Committee more coherent. At the same time the reports have also become progressively more detailed, and it is therefore relevant to discuss the optimum level of detail of the next reports.

The *Scientific Performance* shows similar aspects as previous years. This year the Committee has evaluated not only the "research products" (536 in 2008), which are documented essentially by the publications, but also the overall research activity, in terms of projects and realizations of scientific relevance. The analysis has been done for each division separately, and compared with the allocation to resources for each division respectively. Average citations give an impact factor of 3,5 and a citation index of 2,17, which demonstrates as previous years the competent and diverse research activities of INRIM, a fact which is amplified, when a selection of 14 highlights are analysed. The Committee also appreciated the focus on quality that the concept of *New Ideas* has borne out.

There are eight recommendations regarding *Scientific Performance*. A common theme is to ensure a positive development based on explicit strategies and transparent decision process in order to ensure an evolution coherent with INRIM's mission and strategies.

In 2008, INRIM continued to fulfil its role as a *National Metrology Institute* in a way that is fully compatible with its size and the size of Italy. It is very well linked into the international network of the Meter Convention and the European regional metrology organisation EURAMET. Since 2006 there has been a steady increase in the number of measurement capabilities, as registered in the KCDB database appendix C (473 in 2008) as well as in the number of registered comparisons in appendix B (201 in 2008). INRIM's contributions to both the Meter Convention and to EURAMET are also very significant, and the same holds the numerous "stakeholder organisations" that embrace modern metrology. The allocation of human resources to the work ranges from 16% to 52% within the divisions.

The recommendations are that the work continues to put the *NMI* work of INRIM on even more solid ground than is the case at present and ensures that new areas such as chemistry can be given adequate resources. Also it should be ensured that the divisions estimate the allocations of resources in a uniform way.

The evaluation of *dissemination of knowledge* is based on the legislative decree n. 38/2004, which explicitly describe the following activities: i) knowledge and technology transfer to science, industry and society; ii) development of the calibration laboratories network; iii) high level scientific and technical services; iv) technical standardization; v) education and training; vi) technical support to

legal, health and environmental metrology. The most prominent activity is related to calibration, where the number of accredited laboratories reached 177, and the number of issued calibration certificates was 1857. Also, INRIM has introduced the Training and Diffusion of Scientific Culture Commission and this is a visible way of demonstrating the strategic importance of the activity. On the other hand number of patents remains low; and knowledge transfer to companies does not represent a prior activity at INRIM. Such activity still depends on the researchers' sensitivity instead of being the consequence of the Institute strategy.

The recommendations related to INRMM's *Dissemination of Knowledge* focus on setting transparent strategies, or one comprehensive strategy for all activities mentioned in the decree.

Economic analysis is performed for INRIM as a whole for 2008 and compared with similar figures of Danish Fundamental Metrology (DFM, significantly smaller than INRIM) and Physikalisch-Technische Bundesanstalt (PTB, which is significant larger than INRIM)). Regrettably, economic figures are scarcely reported, and only the two mentioned NMI's give figures of sufficient detail. The income-per-staff is 0.127 M€ for 2008 and puts INRIM in between DFM and PTB. The income per staff should indicate the Institute capability of mixing pure institutional and basic research activities with applied research and commercial activities. As such, INRIM looks more "aggressive" than PTB and less than DFM, but the gap toward DFM looks diminishing. From 2007 to 2008, INRIM had a positive trend in self-funding going from 1402 M€ to 2340 M€ respectively. The substantial support from the Region of Piemonte plays here a significant role.

The Committee would appreciate if the reporting in the future would allow an *Economic analysis* per division and per financing source. However, as mentioned above the details of reporting will have to be discussed in view of the benefits.

A common wish from the Committee is to discuss a review system and possibly a personal appraisal scheme that balances the many facets of INRIM's activities.

2 Introduction, Method of work.

The Evaluation Committee (Comitato di Valutazione, “Committee”), established by the legislative Decree n. 38/2004, Art 10, has performed its third evaluation of the Istituto Nazionale di Ricerca Metrologica, INRIM, for the year 2008. The report is based on the documents “Relazione consuntiva 2008”, “Risultati e Dati 2008” and Annual Report 2008, as well an on-site visit during 11-13 November 2009. Here oral presentations from the four divisions of INRIM and a visit to the laboratories of the Mechanics Division were given. Also the Evaluation reports for 2006 and 2007, and the progress during 2008 were discussed with senior officials of the institute (President, Department Director, Division Heads).

The reporting by the institute is now in good accordance with the previous recommendations of the Committee. This is reflected in this report, where emphasis has been put on key issues and a more comprehensive analysis. Contrary to previous years, the operating principles are not discussed; instead they are copied in annex 7.1 and referred to when appropriate. Like last year, the observations are supplemented with recommendations. However, as some recommendations from previous years are not repeated, but may still be relevant, annexes 7.2 and 7.3 summarize the reports from 2006 and 2007 respectively.

There is a tendency in the recommendations of this year’s report that needs to be addressed. Despite the fact that the degree of detail of INRIM’s reporting has increased year-by-year, several recommendations still request more details. Before the beginning of the evaluation of 2009, the Committee and INRIM should seriously discuss how to tackle this problem of the Pandora box.

The report evaluates INRIM’s activities according to the three different facets of modern national metrology:

- Scientific performance
- Performance as National Metrology Institute, and
- Dissemination of knowledge.

Also, the economy of INRIM is analysed. Also here, the reporting has improved during the period of evaluations; and it is now almost to possible to give a stringent analysis of the relation between the different funds, the resources they finance, and the results they generate. However, for external projects and commercial income such an analysis is still difficult.

Although the three above mentioned facets have some distinctly different characteristics, they also have features in common. In particular: It is the same people, who carry out the three tasks. Therefore, the categories cannot be completely disentangled. An example of this is the participation in the European Metrology Research Programme. This is part of the 7. framework programme of the EU; and since it is dedicated to Scientific research in metrology, it relates to both section 3 and section 4 of this report. There is also some overlap between the organisational work described in sections 4.2 and 5.

Like previously, the evaluation focuses on the activities of INRIM’s Department and its four divisions: Electromagnetism, Mechanics, Optics, and Thermodynamics. The accreditation of calibration laboratories, which has a special position at

INRIM is assessed as part of knowledge dissemination. The Administration, which was addressed in the 2006 report is given no further analysis; but the stated challenges for the administration are still considered relevant.

Benchmarking is used when appropriate and possible, and often the German and Danish Metrology Institutes, Physikalish-Technische Bundesanstalt (PTB) and Danish Fundamental Metrology (DFM) respectively, have been used. An effort has been made to find NMI's that are more comparable with INRIM (PTB is much larger and DFM much smaller); but particularly economic data suitable for analysis is very rare.

The evaluation committee would like to express its gratitude for the openness exhibited by all staff of INRIM and particularly to the senior staff for frank discussion.

3 Scientific performance.

The scientific performance of INRIM shows, from a general and qualitative point of view, similar aspects to that of the previous year. In the present report we have evaluated not only the "research products", which are documented essentially by the publications, but also the overall research activity, in terms of projects and realizations of scientific relevance.

3.1 Research Products

Table 1 Breakdown of scientific production in 2008

Products	E	M	O	T	Tot.
Books				1	1
Papers in international journals with Impact Factor (IF)	68	11	22	23	124
Other papers in international journals	1	1	7	2	11
Papers in national journals	3	5	4	4	16
Book Chapters	3	0	1	12	16
Papers in international conference proceedings	43	21	19	28	111
Papers in national conference proceedings	7	0	0	5	12
Technical reports (including reports for research contracts)	10	20	11	21	62
Communications at: international conferences, seminars and meetings	70	42	45	13	170
national conferences, seminars and meetings	5	3	4	1	13
Totals of products	**210**	**103**	**113**	**110**	**536**

Table 1, based essentially on data contained in 2008 INRIM activity report, summarizes the key numbers of the four Divisions and of the Department as a whole in terms of scientific research products

Table 2 Equivalent Human Resources[1]

Division	E	M	O	T	Department Total
Total	61.2	21.9	26.2	25.8	135.1

Table 2 shows the human resources of INRIM for each individual department that are used in Scientific Research activities. (See section 7.4.)

On the basis of these key numbers, as already done in the previous evaluation reports, we used the following indicators to evaluate the scientific activity of the Department as a whole and of the single divisions.

Indicator a_1 "Numerousness of the global production", defined as the number of products per FTE;

Indicator a_2 "Numerousness of the scientific production", defined as the number of publication in journals, conference proceedings or books with or without IF per FTE;

Indicator b_1 "Mean quality of the scientific production" defined as the mean value of the IF;

Indicator b_2 "Numerousness of the scientific production at International level" defined as the number of publications in international journals with IF per FTE;

Indicator c "Presence at international level" defined as the number of papers on Proceedings and communications at international conferences, seminars and meetings per FTE.

[1] From Chart 21 of "Result and Resources"

Table 3: Indicators of the scientific activity referred to the total FTE Human resources

Division	E	M	O	T	Mean Value
a_1: "Numerousness of the global production"	3.5	5.3	4.4	4.3	4.2
a_2: "Numerousness of the scientific production"	3.3	4.3	3.6	3.2	3.5
b_1: "Mean quality of the scientific production"	1.4	1.8	3.3	1.7	2.1
b_2: "Numerousness of the scientific production at International level"	1.2	0.56	0.86	0.89	0.87
c: "Presence at international level"	0.70	1.08	0.75	1.1	0.89

On the basis of this table, we underline some aspects that we consider particularly relevant for the INRIM evaluation.

Numerousness of the global and of the scientific production: the average scores of products/year/adept (indicator a_1), similar to those of the previous years, confirm that the Institute is quite active in different scientific fields; the significant increase of the indicator a_2 shows that the INRIM scientists are paying more attention to the quality of the Journal where their papers appear. A consolidation of this higher value of the indicator in the future is desirable, since it will indicate an increase of the quality of the scientific research at international level.

Quality of the scientific production Because many metrology journals of good quality have IF around or slightly larger than 1.5, a good average scientific production should have such IF: all the divisions are around or above this quality level. In particular this year we underline the good performances of the Mechanical and Optical Divisions in comparison with the previous years.

However the Committee believes that such an indicator is not enough to properly judge the quality of the scientific products; in the next years the Committee will evaluate also the impact and interest of the products for the scientific community, considering also at least the Citation Index

Numerousness of the scientific production at International level: The indicator b_2, (number of publications in international journals with IF per adept) is quite satisfactory at the Department level. It confirms a lower production of the Mechanics Division, already signalled previously. However the Committee recognizes that this negative performance is partially compensated by a qualitative and quantitative good presence at international conferences and meetings.

Presence at international level The indicator c is extremely important for an Institute that, for its main mission, must take part in significant international activities. This figure is judged adequate at the Department level, and is very similar for all Divisions.

3.1.1 R&D Highlights

The Divisions presented the highlight of the 2008 activity, divided into R&D highlights, consisting in relevant scientific studies published in International journals, NMI highlights, consisting in instruments/measurements realizations.

Also two US Patents were highlighted (by the Optics and by the Thermodynamics Divisions). In Table 4 we collect only the "highlights" associated with published papers, for which we quote the relative impact factor (IF) and citation index (CI).

Table 4: List of the published "highlights"

Division & program	Product	Reference	IF	CN
E1	"Superconducting MgB_2 nanobridges and meanders obtained by an electron beam lithography based technique on different substrates"	Supercond. Sci. technol. 21 (2008), 034006	1,847	0
E3	"On coaxial microcalorimeter calibration"	Applied Optics 43 (2008), 239-244	0,822	1
E4	Dynamic modelling and experimental analysis of terfenol-d rods for magnetostrictive actuators	J. of Applied Physics 103, (2008) 07F121-3	2,201	1
E5	"Perturbing effects of the probe support on the calibration of electric field meters"	The European Physical Journal – Applied Physics 42, (2008) 345-350	0,822	0
E6	"Experimental observation of glassy dynamics driven by gas adsorption on porous silicon"	Journal of Physics – Condensed Matter 20, (2008) 385207 – 385211	1,9	0
E7	"A Peltier cell calorimeter for the direct measurement of the isothermal entropy change in magnetic materials"	Review of Scientific Instruments 79, (2008), 063907	1,738	3
E8	"Magnetization processes in sputtered FeSiB thin films"	Phys. Rev. B 77, (2008) 2144041/11	3,322	4
M1	"Silicon lattice parameter measurement by centimeter X-ray interferometry"	Optics Express 16 (2008), 16877-16888	3,880	5
M5	Multiple reflection Michelson intereferometer with picometer resolution	Optics Express 16 (2008), 21558-21563	3,880	2
O1	Frequency ratio of Al^+ and Hg^+ single ion optical clocks: metrology at the 17^{th} decimal place	Science 319 (2008), 1808-1812	28	125
O4	Experimental test of nonclassicality for a single particle	Optics Express 16 (2008), 11750-11758	3,880	5
T1	Primary gas thermometry by means of laser absorption spectroscopy: determination of the Boltzmann constant	Phys. Rev. Lett. 100 (2008) 2008001 – 4	7,13	2
T5	New melanic pigments in the human brain that accumulate in aging and block environmental toxic metals	Proc. Of the National Academy of Sciences 105 (2008) 17567-17572	10,22	3

In Table 5 we report for these highlights, both at Division level and at INRIM level, some numbers useful to analyse them, namely the number of the highlights both as a total and normalized to the number of programs and to the number of adepts, the mean impact factor and the mean citation index.

Table 5: Statistical analysis of the published "highlights" Numbers in parenthesis are calculated without including one exceptional publication.

Highlights	E	M	O	T	INRIM
Number	7	2	2	2	13
Number/Program	0,88	0,40	0,50	0,40	0,59
Number/Adept	0,12	0,09	0,08	0,08	0,10
Mean IF	1,81	3,88	15,94 (3,88)	8,68	5,04 (3,47)
Mean CI	1,29	3,50	65 (5)	2,50	14,10 (2,17)

At INRIM level the mean value of the IF of these highlights (5,04) is extremely high and in particular it is much higher than the indicator "Mean quality of the scientific research" (2,1); also the mean number of citations (14,1) agrees with IF performance, showing the international relevance of the INRIM scientific activity. In particular the Committee mentions the paper published in Science by the Optics Division, where a preliminary constraint on the relative time variation of the fine-structure constant is reported (10^{-17}/year). This excellent publication has to be considered as an exceptional performance, hardly repeatable in the next few years. Moreover only one of the sixteen authors of the paper belongs to INRIM, so it is difficult to correctly judge the effective INRIM contribution to this publication. For these reasons the Committee considers important to evaluate the effect of this publication on the global performances at INRIM level, sterilizing its effect. At this purpose we evaluated and report in the table also the mean IF (3,47) and CI (2,17) without considering it. Also in this case the IF indicator is significantly higher than the "Mean quality of the research", confirming the previous conclusion.

The mean CI of the highlights, even if smaller than the mean IF can be considered satisfactory, mainly for the short time elapsed since the publication; however the Committee underlines again that such an indicator will be considered in the future evaluation reports.

As for the number of highlights, the mean value (0,59) is a little bit higher than 1/2 the number of the programs; it is considered satisfactory; the same consideration holds also for the number of highlights per adept.

At division level the situation appears to be rather inhomogeneous.

The selection of the highlights presented by the **Electromagnetic** division appears to be rather non homogenous with respect to the other divisions, for different aspects: the number of highlights per program is rather large (0,88 of the E division, compared with about 0,45 of the other divisions), while the average values of the IF and CI indicators (respectively 1,8 and 1,3) are significantly smaller compared with the other divisions. This is essentially due to the fact that two of the selected highlights have rather small IF and CI indicators; besides, also other highlights have IF values not significantly larger than the average IF of the division. The E division should therefore clarify the underlying reasons of the selection of the highlights. The Committee suggest to define at Department level common criteria to choose the highlights.

As for the **Mechanics division,** the mean value of the IF of highlights (3,88) is significantly higher than the indicator "Mean quality of the scientific research" (1,8) of the Division; this is appreciated by the Committee as an indication of

the presence of research activities relevant at International level. The mean number of citations (3,5) is only slightly smaller than the mean value expected on the basis of the IF of the journals; this is considered a good performance of the division, for the short time gone by the publication.

The **Optics** division presented the publication on Science mentioned before; this is an excellent performance of the Division and the Committee highly appreciates the presence at INRIM of research of such a good quality. Also the analysis along the previous lines of the second highlight shows that the research activity of this Division is really very well positioned at the international level.

Both the highlights presented by the **Thermodynamics** division are published on excellent journals, underlining the very good quality of the research activity performed by this division.

2007 Highlights

On the basis on this analysis it is interesting to make a comparison with the highlights of the 2007 report. The papers presented at that time were 8, producing the following quality indicators:

Table 6: Statistical analysis of 2007 published "highlights"

2007 Highlights	E	M	O	T	INRIM
Number	3	1	2	2	8
Number/Programme	0,38	0,20	0,50	0,40	0,36
Number/Adept	0,05	0,04	0,08	0,08	0,06
Mean IF	3,47	2,40	5,30	5,00	4,43
Mean CI	2,33	16,00	33,50	10,00	13,75

Numerically the highlights presented were rather few, but the number was still acceptable. The mean IF was rather high, comparable with that of 2008, if one does not include the 2008 Science paper of the Optics division. The mean CI is satisfactory: a mean value three times the mean IF indicates that at least some of the highlights were considered interesting by the international community.

At the division level, the Electromagnetic division reached in 2007 a mean IF of 3,47, rather high with respect to the indicator of the "mean quality of the research" for both 2007 and 2008; such mean value is higher than the IF factors of all the 2008 highlights, showing that the scientific production in 2008 has been of a lower impact than in the previous year. In 2008 the Mechanics division has increased significantly the quality of its highlights with respect to 2007; the Optics and Thermodynamics divisions have confirmed the excellent quality of their research.

The Committee believes that the relevant fluctuations of the quality of the highlights resulting from the comparison of the 2007 and 2008 highlights, may be reasonable, but it is important to monitor it in the future.

3.2 Analysis of the research activity

To evaluate the research activity we took into account the overall framework in which the divisions were involved in 2008, both at the international and at the national level.

As already in 2007, the activity of each division is organized in research "*programs*". Each program has its own research, technological and technical staff and develops two principal types of research activities:

- "*institutional research projects*", strictly related to the INRIM metrological mission and carried on with INRIM funds
- *"other research projects or contracts"* with national or international funding agencies.

Besides, each program may be responsible for reproducing certain units of measurement, maintaining the related standards, participating in the Mutual Recognition Arrangement (MRA) of the CIPM, etc., in order to comply with INRIM role as National Metrology Institute ("*NMI role*"): these activities will be discussed in detail in the next section.

The breakdown of the full time equivalent researchers and technologists (FTE) dedicated to the different types of activities is shown in Figure 1 and Table 25 (See section 7.4) for INRIM as a whole and for each division.

Relevant differences exist between divisions in the percentage of activity dedicated to the research and also in the relative fractions devoted to the INRIM internal R&D and to the external contract. More than ¾ of the activity of Electromagnetic and Optics divisions is dedicated to research, while the fraction is significantly smaller for the Thermodynamics division and less than ½ for the Mechanics division. These numbers imply that a complete judgment of the Divisions, particularly for the Mechanics and Thermodynamics divisions, must consider also the activities related to the NMI role, which is analysed in section 4.

Besides, the fraction of research of R&S contract is very high for the Mechanics and Optics divisions; this aspect deserves attention by the management, in order to avoid to have research activities that are directed by outside. The main goal and research fields have to be decided by the management and have to be related to the specific role given to the INRIM by the institutional law.

Similar differences appear also at program level, as shown in Figure 1. To understand the underlying reasons for these differences, we will now describe in detail the two types of research projects (INRIM and "contracts"), leaving the comments on the "NMI role" to the next section.

3.2.1 Institutional INRIM research projects

INRIM has defined its own "metrological sectors", which are close, but not coincident, with the international sectors, and has structured them into sub-fields. The sub-fields and their association with the programs are shown in the following table (short titles are introduced for easier reference in the analysis). The metrological sector sub-fields were created to map the programs with respect to the existing international metrological fields. Although this is a necessary and sometimes useful exercise, in some case the structure appears to be too finely divided: this does not add to the clarity and unity of the overall framework and does not help in favouring the interaction between different competence. The committee expresses some concern over this international tendency of fragmentation.

Table 7: Metrological subfields and programs

Field	short	Sub-field	Progr.
DC & Q. metrology	J.E.	Josephson effect and DC voltage	E1
	QHE	Quantum Hall effect and DC resistance	E2
	SET	Single electron tunnelling	E6
	L.DC	Low DC current	E2
Low frequency	AC-V&C	AC/DC transfer, AC voltage and current, impedance	E2, E3
Radiofr. & Microw.	RF	RF power, scattering parameters, RF impedance	E3
Power and energy	AC-P&E	AC power and energy	E3, E5
	FIELD	Electric and magnetic fields (incl. high voltage/high current tests)	E4, E5
	MAG.	Magnetic measurements and properties	E7, E8
Mass & related quantities	MASS	Mass standards	M1
	AVOG	Avogadro Constant	M1
	DENS	Density and volume	M1, M3
	VISC	Viscosity	M3
	FLOW	Fluid flow	M3
	FORC	Force	M2
	PRES	Pressure (high and low)	M3
	GRAV	Gravimetry	M2
	HARD	Hardness	M2
	VIBR	Vibration	M2
Length	LENG	Basic length	M4
	DIM.M.	Dimensional metrology	M5
Time and Frequency	FR.ST	Frequency standards	O1
	TIME	Time scale	O2
Photometry & Radiometry	PHOT	Photometry and radiometry	O3
	QO	Quantum optics	O4
Temperature	C-T.	Contact temperature meas.	T1, T2
	NC-T	Non-contact temperature meas.	T1, T2
Humidity	HUM	Humidity	T1, T2
Acoustics	PH AC	Physical acoustics	T3
	AC EN	Acoustic engineering	T4
Amount of substance	GAS	Gas	T5
	EL.CH	Electrochemistry	E2
	INOR	Inorganic	T5
	ORG	Organic	T5
	BIOAN	Bioanalysis	T5, E6

Focussing on the division programs, we present in the following table a view of their research activity in 2008, as results from the annual report, in terms of the metrological sectors and of the research “highlights”. The latter have been separated between the activities strictly related to the metrological research and those, which are not strictly related. We included also the numbers of 2nd level university degree students and of Ph.D. students, that we consider indicators of the research vitality.

The data shown in the Table 8 though limited to 2008, indicate an average high level of research, with a rather uniform distribution among the programs. Some program appears to be not involved in activities immediately related to the metrological mission of INRIM. This can be expected in a rather large metrological institute as is INRIM and it may be partially justified by the need to develop competences in such fields and may be partly connected with temporal fluctuations in the national or international panorama. The management should monitor such peculiar situations to avoid that their number and the overall resources involved become too large, making it difficult to fulfil the main INRIM role.

Table 8: Research activity of the programs

Pro-gram	Metrol. subfields	Highlights of research on measurement standards and fundamental constants	Other research highlights	students	
				2nd level degree	Ph.D.
E1	J.E.	Quantum devices for voltage metrol			1
E2	QHE, LDC, AC-V&C, El.CH	Johnson Noise Thermometer			3
E3	AC-V&C, RF, AC-P&E	Thermal voltage converter for interm. Freq. - Faraday constant			1
E4	FIELD		Comput. micromagnetics	2	1,5
E5	AC-P&E, FIELD	Reference fields generation: 2-100 kHz (el.), 1÷4 GHz (e.m.)		2	1,5
E6	SET, BIOAN	SET transistor for current meas. Standard	NANOFAB lab	3	1
E7	MAG.M		Antidot nanostructures	1	2
E8	MAG.M		SSEEC magnetic cooling	1	3
M1	MASS, AVOG, DENS	Avogadro constant			1
M2	FORCE, GRAV, HARD, VIBR				
M3	DENS, VISC, FLOW, PRESS	Low pressure meas. Standard		1	1
M4	LENG	Long range interferometer			
M5	DIM.MET		Multi-pass interferm.	1	
O1	FR.ST	Cryogenic fountaun clock			
O2	TIME	UTC – UTC(k) uncertainties		7	2
O3	PHOT	qu-Candela		1	1
O4	QO	qu-Candela	Quantum imaging	1	4
T1	CT, NCT, HUM	Boltzmann constant; Co-C eutectic for HT standard			2,5
T2	CT, NCT, HUM				0,5
T3	ACOU.PH	Boltzmann constant	Hydrodyn. cavitation treatment of pollutants		
T4	ACOU.ENG				3
T5	GAS, INORG, ORG, BIOAN		Neutron activation analysis for trace metals determination.		1

3.2.2 "Other" projects and contracts

There is a large number and variety of projects and research programs –more than 200!– ranging from national to international projects, involving small or large amounts of funding and personnel, based on fundamental or applicative subjects, etc. Some of them are clearly of interest for the metrological sectors of INRIM others are only loosely related. To obtain an overall view of the projects and of their relations to the programs, we grouped them according to the following categories:

- iMERA plus projects in ERA NET VII EC Framework Program (FP7);

- other international projects;
- PRIN 2007;
- national and regional projects, contracts or contributions.

iMERA plus projects in ERA NET VII EC Framework Program (FP7)

These projects, which include key metrological aspects identified at the international level, are structured on 4 “targeted programs” (TP): SI & fundamental constants, Health, Length, Electricity; INRIM is present in 17 out of 22 projects which passed the selection, and coordinates 4 of them (in bold characters in the table).

Table 9: iMERA plus projects

		Description	***E***	***M***	***O***	***T***
T2.J10	TRACE BIOACTIVITY	Traceable measurements for biospecies and ion activity in clinical chemistry	E2 E4	M3		
T4.J01	Power & Energy	Next generation of power and energy measuring techniques	E3 E5			
T4.J02 coor	NanoSpin	Nanomagnetism and Spintronics	E8			
T4.J03	JOSY	Next generation of quantum voltage systems for wide range applications	E1			
T4.J04	ULQHE	Enabling ultimate metrological QHE devices	E2 E6			
T4.J07	EMF and SAR	Traceable measurement of field strength and SAR for the Physical Agents Directive	E4 E5			
T1.J1.1	e-MASS	The watt balance route towards a new definition of the kilogram		M2		
T1.J1.2 coor	NAH	Avogadro & molar Planck constants for the redefinition of the kg		M1		
T3.J1.1	Nano particles	Traceable characterization of nanoparticles		M5		
T3.J1.4 coor	NANO TRACE	New Traceability Routes for Nanometrology		M5		
T3.J2.2	NIM Tech	Metrology for New Industrial Measurement Technologies		M5		
T3.J3.1	Long distance	Absolute long distance measurements in air		M4		
T1.J2.1	OCS	Optical clocks for a new definition of the second			O1	
T1.J2.3 coor	Qu-Candela	Candela: Towards quantum-based photon standards			O3	O4
T1.J1.4	Boltzmann constant	Determination of the Boltzmann constant for the redefinition of the Kelvin				T3
T2.J04	REGENMED	Metrology on a cellular scale for regenerative medicine				T5
T2.J07	EBCT	External Beam Cancer Therapy				T4

Other international projects

The participation in these projects underlines a high level presence at the international level, related to the good scientific competences and excellent facilities present in the Institute.

Table 10: Other international projects

funding agency		*Description*	*E*	*M*	*O*	*T*
EC FP7 - NMP	SSEEC	Solid State Energy Efficient Cooling	E8			
ESA		Next generation compact atomic clock			O1	
ESA	Thales Alenia Space	Giove Mission extension			O2	
ESA GMV (Madrid)	ADVENT	Advance integrity algorithms			O2	
E.U.	Helios UK	Galileo time service provider prototype			O2	
ESA	ESNIS	Galileo Sustem Test Bed V2			O2	
ESA	CTT	Galileo Precise Timing Facility (PTF)			O2	
PTB (Germany)		Thermostatic bath for the new determination of the Boltzmann constant				T1
NMC (Singapore)		Furnaces for the realisation of In, Sn and Zn fixed points				T2

PRIN 2007

Although not particularly important from the financial point of view, these projects are important because show the presence of a good connection with university fundamental research.

Table 11: PRIN 2007 projects

Coordination	*Description*	*E*	*M*	*O*	*T*
Politecnico di Torino	Time of flight telemetry		M4		
Politecnico di Torino	Electromagnetic fields mitigation	E4-E5			
University of Perugia	Atomic clock anomalies			O2	

National and regional projects, contracts or contributions

These projects arise in the context of the national or regional tenders for research and innovation and in collaboration with academic and/or industrial partners. They are very numerous: a selection of the most significant ones, which in particular takes into account the financial relevance, is listed below; a * label indicates those which are application oriented.

The data shown in the Table 9 to Table 12 give an idea of the liveliness of the different research programs and of their ability to obtain external research funds. Some projects are clearly related to the metrological mission of INRIM, in particular the iMERA and in general the international ones: the Committee highly appreciates the large number and the very good quality of these projects, and in particular the relevant participation to the iMERA program. The participation to the PRIN calls should be encouraged to facilitate interactions with universities, that at present seem to be rather limited. The very large number of national and regional projects (mostly regional) is impressive; there are surely positive aspects as, for instance, raising funds for upgrading the lab facilities or contributing with the internal competences to solve specific envi-

ronmental or industry problems, however the INRIM management should carefully monitor and control these external activities in order to make them functional and not conflicting to the main INRIM role.

Table 12: National and regional projects

funding agency		***Description***	***E***	***M***	***O***	***T***
Compagnia S Paolo	*NANOFAB	Laboratory for nano preparations	E2 E4	M3		
Regione Piemonte	**TIPE*	*Transmission Infrastructure for Power Exch*	*E4-E5*			
Regione Piemonte	*	*Transistor based on magnetic tunnel effect*	*E7*			
Regione Piemonte	**NANOMAT*	*Nanotechnologies for composite materials*	*E8*			
Regione Piemonte	*	*Magnetic restrictive materials*	*E4*			
Regione Piemonte	* CIPE 2004	*MEMS and NEMS integrated biosensors*	*E6*			
Regione Piemonte	* CIPE 2004	*Nanostructures for applied photonics*	*E6*			
Regione Piemonte	* CIPE 2004	*Quantum dots for optical imaging in biological systems*	*E6*			
Ribes ricerche srl	*	*Multiparameter agro-alimentary quality checking and measuring device*	E6			
Compagnia S Paolo		*Atomic standard for mass unit*		M1		
Thales Alenia Space	*	*Satellite propulsion systems*		M3		
Regione Piemonte	*	*Atmosferic asbestos fibers detector*		M4		
Regione Piemonte	*D64*	*Sub-nanometric resolution translation device*		M1		
Regione Piemonte	**E2*	*Ultrastable optical frequency reference devices for spatial applications*		M4		
Thales Alenia Space Italia spa (FI)	*	Propulsion		M3		
Hexagon Metrology SpA (TO)	*	*CMM geometrical errors determination*		M5		
Thales Alenia Space Italia spa (Roma)	*	*Laser interferometer high precision tracking for LEO*		M4		
ENEA	*	Transparent materials photometry			O3	
Torino Time	IRGAL	*"Galileo" innovation and research project*			O1	
RAI	*Time signal	*Diffusion of the coded RAI time signal*			O2	
Compagnia S Paolo	*Hyper	*Hyper-entangled states applications*			O4	
Compagnia S Paolo	*LINK	*1 ps comparisons in optical fibers*			O1	
Regione Piemonte	YTRO	*Ytterbium Trap Reference Oscillator*			O1	
Regione Piemonte		*Superc. device for single photon counting*			O3	
Regione Piemonte	*Quantum	*Quantum communication*			O4	
Galileo Avionica	*POP	*POP atomic clock feasibility study*			O1	
Società Autostrade Roma	*	*Photometric characterization and evaluation of lightning systems in tunnels*			O3	
Regione Piemonte	*WISE-CELL CIPE 2006	*Wide range sensors & instruments for fuel cells*				T3
Regione Piemonte	CIPE 2004	*Metrology on a cellular and molecular scale for regenerative medicine*				T5

3.2.3 "New ideas" and "Relevant Investment" internal selections

The Committee highly appreciated the two internal selections promoted by INRIM itself in 2008, namely "New Ideas" to foster the presentation of new research ideas, which cannot be easily included in the main lines of the institutional research, and "Relevant Investment" to develop or upgrade relevant instrumentation facilities. 70 different projects were presented, 46 for "New Idea" and 24 for "Relevant Investment"; all the projects were judged by external referees and the following projects were founded

Table 13: "New Ideas" selection

funding agency	*Description*	*E*	*M*	*O*	*T*
INRIM	4-wave mixing in Cs vapour for non linear spectrosc			O1 O4	
INRIM	Calibration of photon number resolving detectors through entanglement assisted tomography			O4	
INRIM	Thermo-acoustic methods for energy certifications				T1 T3
INRIM	Quantum flux Josephson junctions	E1			
INRIM	Development of phase slip devices as current quantum standards	E1			
INRIM	Absolute distance measurement with sub-wavelength resolution		M4		
INRIM	Metrology at cellular and macromolecular scale for regenerative medicine				T5

Table 14: "Relevant Investment" selection

funding agency	*Description*	*E*	*M*	*O*	*T*
INRIM	Apparata for cryogenic measurements	E2			
INRIM	Cryogenic Cs apparatus for time standard			O1	
INRIM	Stroboscopic measurement system	E7			
INRIM	Laboratory for biological metrology	E6			
INRIM	Metrology for ultrasound applications in medicine				T4

The Committee encourages the management to continue with such kind of internal selections as an efficient way to direct the research along the INRIM main mission, encouraging at the same time the best resources present.

3.3 Concluding remarks

The Committee appreciated the following aspects:

- the improvement of the description of the aims and of the activities of the divisions, which is more analytical compared with the 2007 report, though a more clearly structured and uniform format of the description of

the single programs (as suggested at point 6 of the following subsection) would help to understand the general framework of the division;

- the increase of the average quality of the scientific production and in particular the increased quality of the production of the Mechanics and Optics divisions with respect to the previous years;
- the relevant presence at international level both of the scientific production and in projects, particularly the iMERA ones;
- the presence of very excellent highlights in the scientific production, in particular of the Optics and Thermodynamics divisions;
- the internal call “New Ideas” and “Relevant Investment”, as an efficient way to promote the metrologically aimed research of the Institute.

As underlined in the previous evaluation reports, most of the scientific production is linked to the INRIM mission and its quantity and quality demonstrate that the Institute is present in the metrology at a top international level. The most significant part of the scientific production concerns the development of instrumentation and/or methods, which are important to metrology or may result in future metrology. A small, but non negligible fraction of products appears to have a less clear link to the mission of the Institute: the presence of such a fraction of “free” research is vital for a research Institute, for many motivations, such as to maintain an open channel to new ideas and to curiosity driven enquiries, to keep alive historical research fields which have been successful for the Institute, to attract funds through contracts on themes indirectly related to metrological research and so on. The point is that the indicators provided in the annual report are not always sufficient in order to allow a clear evaluation of its compatibility with the Institute main activity.

As an example of an activity that may appear marginal with respect to metrology, is materials research. This is a very successful activity, with a long tradition at the former IEN; but it is difficult to assess it from the focus of the current mission of INRIM. It would therefore be useful to see it promoted in the context of the global initiatives to promote modern materials metrology.

Another important point is that the overall quantity of projects, particularly the national and regional ones, appears to be oversized with respect to the resources available in the Institute and that there is no clear indication of guidelines to establish priorities or selections.

Some programs (E4, E6, E8, O4, T2, T3) do not have any activity linked to the “NIM role”: although the “NIM role” will be discussed in the next section. In the temperature division, there is a clear decision to do standards work in T1, missed in T2, and pre-standards work in T3; and it would be of interest to have similar explicit statements from the other divisions. It might simply be aimed to a more efficient work organization within the divisions.

The next activity reports should clarify better all these aspects; though the 2008 report gives already some indications on the projects which were delayed or dropped for lack of resources and recognizes the risk of over commitment (page 16 of the annual report), a clear policy resulting in effective actions should be followed.

3.3.1 Specific actions on scientific performance

The following specific actions are suggested by the evaluation Committee to improve the scientific performance and its documentation:

1. define common criteria based on clear agreed indicators to choose highlights of the scientific productions;
2. increase the interaction with universities;

3. define a strategy with respect to the external contracts, particularly those not related to the INRIM main mission;

4. define a standard for the presentation of programs, which should contain *a close analysis of the research programs of each division*, underlining their reference to the mission of the Institute;

5. give clear statements on specific problems encountered (if any) in the research activities;

6. provide a clear separation, at the level of the Division and of single research program, between the aims, the contents, the results and the perspectives of the activities, with an order in the presentation which reflects the real priority. The Committee underlines that such a separation is not a purely formatting aspect regarding the preparation of the report, but must be embedded in the future general strategy of the research;

7. consider establishing, at the INRIM level, a personal appraisal system that reflects the importance of the work in scientific research. To the degree that such a system exists, it would be useful to put it before the Committee for evaluation.

4 Performance as National Metrology Institute (NMI)

The two previous reports have introduced the special tasks that are addressed at NMIs in order for them to ensure worldwide dissemination of measurements that are traceable to the SI. Brief descriptions were given of the organisations that have been established, both in Europe (EURAMET) and globally (The metre convention, often referred as BIPM). This refers to the metrological activity, which is not necessarily linked to research, however necessary at the national Metrology Institute level.

The NMI-work may be subdivided into two tasks:

- Maintenance and upgrading of national standards

This task ensures that the national standards at INRIM are international accepted as sources of measurements traceability. It involves operational maintenance, as well as successful participation in international comparisons, maintenance of an appropriate quality system, and international acceptance of the measurement capabilities (stated in terms of uncertainties) associated with calibrations that are performed. Upgrading of national standards, which does not involve new research, is also considered part of NMI-work; Initial development of a new standard, including the necessary documentation in terms of calibration procedures, is possibly but not necessarily a scientific activity.

The mutual recognition arrangement, CIPM-MRA, from 1999 has established the KCDB database, where all the necessary information is available for all states and economies that have signed the CIPM-MRA.

- Participation in international organisations

Further to the technical work leading to the national entries in the KCDB, an NMI takes part in the substantial work in international organisations and forums, where metrology issues are discussed.

INRIMs contributions to these NMI-tasks are discussed below, followed by a analysis of its allocation of resources. Finally, some conclusions are given

4.1 Maintenance and upgrading of national standards

Measurement Area	Division	2006	2007	2008
Acoustics, Ultrasound and Vibration	T	38	42	42
Amount of substance	T	7	10	10
Electricity and Magnetism	E	201	201	206
Length	M	34	39	39
Mass and Related Quantities	M	105	105	108
Photometry and Radiometry	O	23	23	23
Thermometry	T	29	29	29
Time and Frequency	O	16	16	16
Total for INRIM		**453**	**465**	**473**

Table 15. INRIM's calibration measurement capabilities (CMC, KCDB appendix C. The global number of entries are approximately 20 000.

Appendix C of the KCDB gives the number of entries for INRIM in Table 15. Each entry is “a product” or “deliverable” traceable to a national standards that INRIM maintains. The classification is made according the “metrology areas” used in the KCDB. The area “Radioactivity and Ionising Radiation” is absent because the institute INMRI-ENEA handles it.

From this it appears that INRIM is in a steady state with respect to the number of calibration services that it provides to customers. However, one cannot from this see if the limited effort in chemistry is sufficient, or whether it should grow faster at the expense of one of the traditional fields. The limited efforts in chemistry, covers (very limited) measurement capabilities in four diverse fields: Gases, electrolytic conductivity, metals and alloys, and bio analysis.

Measurement Area	**Div**	**2006**	**2007**	**2008**
Acoustics, Ultrasound and Vibration	T	5	5	5
Amount of substance	T	8	9	13
Electricity and Magnetism	E	46	46	46
Length	M	33	33	37
Mass and Related Quantities	M	72	72	76
Photometry and Radiometry	O	10	10	8
Thermometry	T	14	14	15
Time and Frequency	O	1	1	1
Total for INRIM		**189**	**190**	**201**

Table 16. Time development of comparisons that support INRIM’s CMCs in Table 15. The global number of entries is approaching 800.

Appendix B of the KCDB gives the number of comparisons that support INRIM’s CMCs in Table 15. The KCDB distinguish between key comparisons that concern basis quantities and supplementary comparisons that deal with “non-basic” quantities; and comparisons are split into CIPM-comparisons, covering selected NMI’s world wide, and regional comparisons, which may or may not be linked by a CIPM-comparison to document global equivalence for a quantity.

It should be noted that the comparisons mentioned in Table 16 for a given year are “active” in their support to a given set of CMCs. But they have not necessarily required technical activity in that year. Typical comparisons run for several years and have a validity of around 10 years.

Non-compliances that affect the validity of CMCs have resulted in the removal of CMC’s from appendix C for 8 countries. This has not involved Italy.

Last year’s benchmarking with two foreign NMI’s have not been repeated, since no significant changes have been noticed.

4.2 Participation in international organisations

4.2.1 Metrology organisations

INRIM’s participation in the work under the Meter Convention and in EURAMET is described,

The Meter Convention is an international treaty organisation, signed in 1875 by 18 states and now encompassing 78 states. It is ruled by the ´18 member Comité International des Poids et Mesures, CIPM, elected at the quadrennial general conference. CIPM elects its president and supervises the BIPM. The CIPM MRA has been signed by the representatives of 74 institutes – from 47 Member States, 25 Associates of the CGPM, and 2 international organizations – and covers a further 123 institutes designated by the signatory bodies. CIPM currently has 10 Consultative Committees with participation of the leading institutes within the technical fields that the CCs represent.

During 2008 INRIM maintained its traditional high activity in the CIPM and its consultative committees. There are only few changes with respect to 2007.

Also in EURAMET, INRIM has maintained the activity of 2007. However, it is worth mentioning that during 2008, the foundation of the European Metrology Research Programme and the funding of an article 169 institution, operated by EURAMET, came to a conclusion. The precursor of EMRP, the iMERA Plus programme was put into operation and it is treated in section 3. In 2008, no new projects were initiated, but from 2009 there will be a continuous metrology research activity, lasting about 6 years. INRIM has played a significant role in establishing and operating the EMRP programme.

4.2.2 Standardization, Scientific and Technical Committees

The standardization activity is particularly pursued at the INRIM Institute by participating to National (UNI, CEI, CIG, CTI, AICQ, etc.) and International (ISO, IEC, IUPAC, CISPR/A, CIE, CEN, IAU, ITU-R, etc.) standardization committee and also by coordinating some of these committees. The participation to metrological and accreditations organisms, beyond other scientific and technical organisms, also represents a particularly qualified and significant activity. In the last years there were about 165 scientific collaborations activated with research bodies and Universities. The participation to numerous international and national scientific and technical organisms was also kept activated. Such aspects demonstrate the good relationships of INRIM with national and international institutions, with the collaboration in standardization activities and in the definition of measurement and test protocols.

4.3 Allocation of resources to NMI work

The NMI work takes up a significantly different proportion of the staff's time in INRIM's four divisions, as shown in Figure 1 and table 25 of section 7.4. According to these data, in 2008 INRIM allocated 61 FTE to NMI work, or 30% of staff working time. This is a significant amount that deserves attention from management as well as incorporation in the appraisal schemes of personnel. Unfortunately, there is no tradition for analysing in detail the NMI work at metrology institutes, but a preliminary analysis for Danish Fundamental Metrology indicates that at DFM, 23% of the working time is dedicated to NMI work, with 15% going to maintenance of standards and 8% to international organisations.

As to the allocation of time to NMI work in the four divisions, it ranges from 16% in OPTICS to 52% in MECHANICS. Provided that the estimates have been

carried out in a uniform way, these differences reflect the different technical content in the divisions, and there seems to be no magic target number for the NMI work.

4.4 Overall assessment and recommendations

In 2008, INRIM continued to fulfil its role as a National Metrology Institute in a way that is fully compatible with its size and the size of Italy. It is very well linked into the international network of the Meter Convention and the European regional metrology organisation EURAMET.

Work has been going on to work along the three recommendations stated in the 2007 report. It is important the this work is continued in order to put the NMI work of INRIM on even more solid ground than is the case at present.

Further, it is recommended that INRIM ensures that the divisions estimate the allocations of resources in a uniform way.

5 Dissemination of results.

Table 17 Dissemination policy and strategies

	Knowledge Improvement	Competence improvement	Efficiency in resources use improvement	INRIM brand improvement	Competitiveness Improvement
internal (INRIM-Division)	Continuous updating (ICT, quality, safety and security, ..) and seminar	Internal training	Cooperation between division and program	n.a.	Standard and CMC Improvement
other NMI	Bilateral and multilateral Agreement	Foreign researchers and researchers abroad	International cooperation with other NMI	n.a.	Support of new NMI
companies	Research contract	Personal detachment	Metrological services (accreditation of laboratory, calibration and test)	n.a. (Prize, ..)	Patents and licenses; Spin-off
scientific community	International Conference, Standardization Committee	Theses (doctorate, I and II level)	Cooperation with University and Research Institute	Congress Organization and Sponsorship	Common Researche Plataform
society	Information and Education (environment, safety, security, legal metrology)	External Training	Cooperation with regional institution and association	n.a. (Publicity, ...)	Common Laboratories

The economic and social impact of the scientific activities on the evaluation of knowledge dissemination represents a crucial aspect. In order to promote the development of the Italian system components (scientific knowledge transfer, exploitation and diffusion), the INRIM legislative decree n. 38/2004 explicitly deals with scientific and technologic competences' diffusion and transfer. In particular, these activities include: i) knowledge and technology transfer to science, industry and society; ii) development of the calibration laboratories network; iii) high level scientific and technical services; iv) technical standardization cooperation; v) education and training; vi) technical support to legal, health and environmental metrology (in term of measurement method and traceability).

In the following sections the above-mentioned different topics are specifically treated, by focusing the results obtained in the year 2008. With the aim of comparing the consistency of planned actions in the triennial plan with obtained results, the INRIM dissemination policy and strategies (toward internal division, other NMI, the scientific community, the industry and society) are briefly reported in Table 17.

5.1 Dissemination of know-how to the companies

Knowledge dissemination to companies was carried out by INRIM Institute with different activities as reported in Table 18.

Table 18– Knowledge transfer – other product applications

Description	2006	2007	2008
Research programmes and contracts: contracts active in the year	40	65	82
Research programmes and contracts: contracts signed in the year	15	26	39
Research programmes and contracts: income (k€)	2384	1425	4148
Patents filed in Italy and requests for European patents	1	4	4
Extension of patents abroad	2	1	4
Calibration procedures in force	228	242	238
Testing procedures in force	30	30	9
No. of calibration certificates, test reports and other documents issued	1675	1916	1857
Income from calibration and testing activities (k€)	1681	1853	1868
Laboratory accreditation activities: no. of active accredited laboratories	170	177	177
Laboratory accreditation activities: income from accredit. activities (k€)	903	800	1175
Designed instruments and devices:			
Electromagnetism Division		-	3
Mechanics Division		1	-
Optics Division		8	2
Thermodynamics Division		3	-
Total		12	5
Outstanding realized instruments, devices and software:			
Electromagnetism Division	1	9	11
Mechanics Division	5	10	13
Optics Division		6	6
Thermodynamics Division	5	10	24
Total	11	35	54

Administration and Scientific Councils (in the reports of 10.07.08-All. p.to 8 and of 29.06.09-All. p.to 3) recently underlined that "the technology transfer and the support to industries, services and society innovation (calibration, measurement and testing; patents and licenses; training researchers and technicians; dissemination of scientific culture and technical standards) is an INRIM priority". Nevertheless the 2008-10 three-year plan details only generic actions in sustaining technology transfer and innovation support to industries. Furthermore the mechanisms to promote and to support the knowledge dissemination are not adequately detailed, with particular reference to human and financial resources.

As a consequence direct and indirect impact of INRIM researches on the productive system is not adequately evaluated by INRIM itself. In particular: i) no analysis regarding the applications of INRIM patents or applied researches are available; ii) no statistics about advantages induced by CMC's capabilities, standards and knowledge improvement on national productive system are carried out.

Finally, it is not clear how the knowledge dissemination results are evaluated in relation to: i) Divisions' funding; ii) human resources assignments; iii) researchers career progressions. So the knowledge dissemination activities seem to be a consequence of the researchers sensibility instead of a high direction careful planning.

5.1.1 Patents and licenses.

INRIM is not very active in the Patents and licenses field. Even though in the last three years the number of patents is almost doubled, also involving all Divisions, only 9 patents have been granted (among these, five have been extended as European patent) and only one of these has been mentioned in the INRIM Highlights 2008, submitted to Evaluation Committee. In particular, the patents granted in 2008 are reported in the following Table 19

Table 19 – INRIM Patents

Div.	Typology	Title	Patentees	Notes
E	European Patent	Contact-less device for measuring operating parameters of rotors of high speed rotary machines"	Inventors: O. Bottauscio, G. Crotti, M. Chiampi, F. Fiorillo Patent owner: VARIAN S.p.A.	European Patent under rule 19(3) EPC
E	National Patent	shielding pipes for electrical energy transmission lines	Inventors: M. Zucca, O. Bottauscio, G. Lorusso Cooperation: CCC Italia s.r.l.	Request submitted 7 Agosto 2008
T	National Patent	A new industrial polluting treatment method by means of cavitation hydrodynamics	Inventors: A Troìa, D. Madonna Ripa, R. Spagnolo	GE2009A00001, Dec. 2008
O	European Patent	Atomic beam and/or optical tube	Inventors: F. Levi, A. Stern Cooperation: AccuBeat (Israel), Sepa spa (Italy)	Provisional, May 2008

Finally the impact of patents on the companies is not systematically estimated and none only few Patents seem actually used by some companiesy. Also, it is not clear the patents/licenses spin-off for industrial, economic and technologic improvement of product processes.

Modern product development relies on a closer collaboration between knowledge centers and private entrepreneurs, but this connection is not well established at INRIM.

In veiw of the establishment of Innovation poles in the Piedmont Region, it would be interesting to used this facility to improve the situation for patents and their exploitation at INRIM

5.1.2 Calibration and test reports

The reliability of measurement instrument represents a fundamental prerequisite for all quality systems. In particular, all measurements results should be traceable to the SI. The calibration activity in 2008 issued about 2.500 calibration certificates and other metrological services. As a consequence, about 70.000 calibration SIT and 120.000 simply traceable certificates were issued.

5.1.3 Accreditation services.

Since the mid-1970'es, laboratory accreditation in Europe has maintained close relations with the respective national NMI, and in several cases calibration accreditation has been operated as part of an NMI. Indeed, this is still the case in Italy, where a special section of INRIM accredits 177 accreditations according to the standard ISO/CEN 17025.

During 2008 INRIM proceeded to reorganize the Laboratory Accreditation Service in order to acquire the autonomy that European co-operation for Accreditation (EA) requires for accreditation services. This procedure was completed at the beginning of 2009, with the constitution of an independent consortium (COPA), whose promoting partners are public Institution (including INRIM) open however to the private sector.

Furthermore in the last years the Institute attention on safety, security and environmental field has significantly increased as shown by the new accreditation on cronotachograph and speed meters. The accreditation activities in the field of reference materials producer have been continued and led to the accreditation of a laboratory of ISPRA (the Italian national agency for environmental protection and research) for the measurement of metal concentrations in soil/sediment matrix.

Through accreditation of laboratories, INRIM potentially can disseminate its high technical knowledge to the industrial practitioners of metrology.

5.1.4 Scientific metrological services

Less than 2% of INRIM total budget (less than k€ 600 on k€ 31528) comes from technical and research activities involving private companies, but about 25% comes from self-financing. In particular k€ 539 comes from projects and contracts financed by Piedmont Regional Authority for research projects funding, k€ 648 for research contracts with EC, k€ 689 for research activities submitted to other Public Bodies, k€ 464 for research activities involving private companies, k€ 1868 for consulting, calibrations, equipment tests and other activities, k€ 1175 for laboratory accreditation.

Nevertheless it is important to underline that in 2008 public and private contract number is increased significantly respect to 2007 and doubled respect to 2006. In 2008 the INRIM drew up 39 new research contracts (and in the same year more than 82 research contracts were already activated). Among these, particularly interesting are:

- the numerous IMERA contracts testifying the excellent scientific value of the research units at INRIM;

- the cooperation with the Piedmont Regional Authority for the realization of some research poles (innovation Mechatronics and Advanced production systems poles) and with the bank Foundation (Compagnia di San Paolo) for the realization of a NanoFab Laboratory;

- the research contracts drawn up with aerospace industry and other partners (e.g. agricultural food and environmental industries).

5.1.5 Spin-off and technical personnel detachment

No spin-off activities have been carried out in 2006-2008 and no procedures at moment are available at INRIM to promote spin-off activities.
An interesting knowledge transfer procedure is that provided in Italy for the Law n. 196, 24-06-1997, (named “Pacchetto TREU”), considering the public research detachment as a way to re-launch the research activity in PMI. In 2008 the INRIM obtained 2 research units with TREU Law, working in measurement instrumentation construction and calibration companies, but often these do not involve high skill personal. Even though the Treu law was still enforced, in 2008 no requests came from INRIM researchers.

5.2 Dissemination of knowledge and competence in the society and scientific community

Table 20 Knowledge transfer – education and training

Description	2006	2007	2008
Graduate courses with INRIM participation	9	10	34
Theses completed during the year (doctorate, level III)	8	6	6
Theses completed during the year (level II)	11	11	17
Theses completed during the year (level I)	35	20	24
Foreign researchers at INRIM (man-months)	15	10	10
INRIM researchers abroad (man-months)	50	35	10
INRIM seminars with internal experts	28	15	4
INRIM seminars with external experts	23	29	29

As regards the scientific knowledge dissemination, the INRIM Institute pursues such aim with several activities: i) participation in the Standardization, Scientific and Technical Committees; ii) education and training; iii) diffusion of competences to the community (scientific or not); iv) giving support to legal, health and environmental metrology. Details related to the first three activities are given in Table 20.

In particular, the INRIM Institute knowledge transfer methods are:

5.2.1 Education and Training.

Training constitutes an integral part of the activities of INRIM, as it appears from INRIM Annual Report. It is also noteworthy that "education and training" is one of key elements of INRIM's vision. The very fruitful relations with different Polytechnic and University (e.g. the Polytechnic of Turin and Milan, University of Turin University of Roma "La Sapienza", Naples "Federico II", Pisa, Cassino, etc.) together with dedication grants for thesis work at INRIM ensures a high concentration of graduate work at INRIM, compared to most national metrology institutes.

In 2008, 24 first level degree thesis, 17 master degree thesis and 6 PhD thesis have been discussed.

Also training in all its facets is part of INRIM activities. Courses for industrial technicians and teachers, workshops and seminars, summers schools that are organized in collaboration with other bodies, indicate the substantial effort that INRIM puts intro training. In 2008 a large number of lessons have been held by lecturers in Universities (7 graduate courses are made with INRIM participation) and cultural associations and third level courses. Also, INRIM widely participated to activity of several bodies and associations involved in knowledge diffusion and/or education activities (e.g: AICQ, ANGQ, CMM Club Italia, EMIT-LAS, Istituto Tagliacarne, ecc.)

It is also interesting to notice that cultural events assimilated by INRIM Institute to technical training activities. To such purpose have been held several seminars within internal and external professional courses. A further activity is represented by the international mobility, even thought a slight decrease in such activity has been observed for both internal and external personnel.

All this activities reflects the interesting attitude at INRIM that science is part of our cultural heritage not only a modern non-cultural exercise. This attitude has vanished from most national metrology institutes of today's technocratic world.

5.2.2 Dissemination of competence to the scientific community and civil society

Among the expected diffusion activities, particularly interesting are the numerous cultural activities proposed by INRIM, such as:

- guided tours (science day) and multimedial aids for the high school students;

- events for the diffusion of scientific topics, such as “Il tempo della scienza” (also available at the web address http://www.inrim.it/events/tempo_scienza_08.shtml);

- scientific seminars held at INRIM by both internal scholars and external institutions.

The organization and the participation in scientific congresses and workshops are also notable: Corso SIT-ANGQ "Taratura ed incertezza di misura" aggiornato alla ISO/IEC 17025, 21-22 aprile 2008; V Int. Time Scale Algorithm Symposium, 28-30 aprile 2008, San Fernando (Spagna); Corso di Metrologia presso ASL di SIENA – aprile 2008; 4th Workshop ad memoriam of Carlo Novero "Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons", 19-23 maggio 2008; Corso TrainMic "La riferibilità delle misurazioni in ambito sanitario", 4-6 giugno 2008, Roma; CIE Expert Symposium on Advances in Photometry and Calorimetry, TC and DIV 2 Meetings, 7-11 luglio 2008; 1st International Symposium on road surface photometric characteristics: measurement systems and results, 9-10 luglio 2008; 2nd EUCHEMS Chemistry Congress "Advances in understanding. Chemical measurement quality:societal impact", 16-20 settembre 2008; NanoScale Workshop 2008, 22-23 settembre 2008; Meeting of the CCL Working Group on Dimensional Metrology, 24-25 settembre 2008; 6th EURACHEM Workshop "Proficiency Testing in Analytical Chemistry, Microbiology and Laboratory Medicine" Current Practice and Future Directions, Roma, 6-7 ottobre 2008; IMEKO TC8 Workshop "Traceability to support CIPM MRA and other international arrangements", 6-7 novembre 2008; IV Modulo del corso di abilitazione per Ispettori Metrici per l’Istituto Tagliacarne presso INRIM – dicembre 2008.

5.2.3 Support for legal, health and environmental metrology.

In legal, health and environment fields the society needs correct procedure measurement and reliable calibration facilities. Then INRIM provides some tasks regulated by law, in fact in most of these areas the INRIM is the authority named to measurement traceability. INRIM drew up a formal agreement with National Research bodies for health ISS (National Health Institute) and for environment ISPRA (National Institute for the Protection of the Environment Research) ex APAT. Furthermore, the INRIM cooperates with MiSE (Economic Development Ministry) to make available measuring techniques and procedures for both the protection of the consumers in commercial exchange and the protection of the population health and of the environment.

In 2008 the INRIM has developed research projects, measurement procedures and specific traceability of measuring instruments in the fields of:

Legal metrology: in this field INRIM cooperates continuously with: i) MISE Ministry for developing standards and laws in legal metrology; ii) legal metrological services of CCIAA for standard calibration activities; iii) Tagliacarne Institute for personal training in legal metrological field.

Health and environmental metrology (in cooperation with ISS and ISPRA): in such field the INRIM Institute has carried out research activities aimed to the improvement of the measurement equipments and techniques, test

campaigns for environmental measurements and realization of standards for traceability (traceability of ozone measurements.

The activities of knowledge diffusion to community and academy can be considered excellent for both quality and quantity. The visibility and proposal capability at international level of INRIM Institute in National and International activities testifies its interaction ability in several metrological sectors and with the community and the scientific academy.

Nevertheless, despite the last years notable efforts, still a sensible gap exists between the legal, health and environment metrology and the scientific metrology. As a consequence it should be desirable a detailed program, approved by concerned authorities, aimed to the individuation of the chemical and physical quantities for which a national metrological traceability is needed (as already suggested in previous Evaluation Report 2006 and 2007). The INRIM Institute should then organize the knowledge dissemination activities about International System of Units also for such quantities.

5.3 Conclusive considerations about dissemination of knowledge and improvement proposals

Generally, the knowledge transfer activity to the companies does not appear to represent a prior activity at INRIM. Such activity still depends on the researchers' sensitivity instead of being the consequence of the Institute strategy. As a consequence, there is a gap between capabilities and results, in terms of patents and spin-off.
In order to reduce this gap it is necessary to set up a policy and take measures able to boost patent activity and application of research activity.
In the Committee's opinion, it should be verified the interconnection between scientific and industrial metrology. In particular dissemination actions (with evidences in human and economic resources) should be better detailed in triennial plan as follows:

- all research results could be evaluated in terms of patentability or know-how for innovation;
- a systematic plan for dissemination and marketing should be carried out to improve the number and quality of innovation transfer activities;
- a post–monitoring activity on INRIM knowledge transfers (paying particular attention to the patents) should be carried out in order to evaluate the industrial knowledge transfers effectiveness;
- an explaining document regarding the researcher's career progressions should be carried out in order to clarify the evaluation of knowledge dissemination activities.

The INRIM knowledge dissemination to the society and community is quite different with respect to the companies one. In particular, from the policies and strategies point of view, the INRIM has introduced the Training and Diffusion of Scientific Culture Commission with aim of coordinating the following activities: i) INRIM staff training; ii) scientific culture diffusion; iii) Department and INRIM

library interfacing; iv) INRIM image promotion; v) INRIM publications; vi) INRIM web site updating; vi) coordination of the didactics performed by INRIM researchers. Such coordinating structure together with an higher researchers sensitivity about the scientific dissemination to the society and community has produced excellent dissemination results.

So the principal improvement that it is possible to do in this field is essentially connected to the INRIM image with specific publicity action to better diffuse the "INRIM" brand in the society and not only in the scientific community.

As concluding remarks, the challenges with respect to INRIM's manifold dissemination activities still appears to be:

1. to establish a systematic overview of its dissemination of knowledge an results and to bring them in line with the mission of the institute. This could be formulated in a policy document, traduced in a strategic actions with appropriate human and economic resources and, finally, periodically verified;

2. the coordination of the knowledge dissemination should be also extended to industry related activities (also eventually involving industry stakeholder in the dissemination committee);

3. INRIM should consider establishing a personal appraisal system that reflects the importance of dissemination. To the degree that such a system exists, it would be useful to put it before the Committee for evaluation.

6 Economic analysis

Table 21 Key economic figures for INRIM; DFM and PTB 2008

No.	Item	INRIM		DFM (note 3)		PTB (note 4)	
		Value [ME]	%	Value [ME]	%	Value [ME]	%
0	**Income**						
0.1	Institutional funding (+)	20,5	72	1,25	54	119,6 (*)	85
0.2	Research con-tracts/projects	4,25	15	0,60	26	8,6	6
0.3	Income from commercial activities (++)	3,65	13	0,41	18	12,8	9
0.4	Other income (net interest)	0	0	0,04	2	0	0
0.4	**Total**	**28,4**	**100**	**2,30**	**100**	**141**	**100**
1	**Expenses**						
1.1	Personnel costs (°)	14,9	52,5	1,44	62,5	78,8	56
1.2	Other operating costs	6,9	24	0,38	16,5	28,4	20
1.3	Investments/depreciation	5,6	20	0,16	7	34,0	24
1.4	Direct costs	NA		0,25	11	NA	
1.5	Operating result	1,0	3,5	0,07	3	NA	
1.4	**Total**	**28,4**	**100**	**2,30**	**100**	**141,2**	**100**
3	Accumulated surplus						
3.1	Carried over from previous year	3,12		1,71		NA	
3.2	Surplus of the year	1,01		0,07		NA	
3.3	Carried over to the next year	4,13		1,78		NA	

(+) It consists of Ministry (MIUR) funding, and refers to permanent and temporary staff, as well as grants and scholarships.

(++) It corresponds to 'other receipts' (altre entrate) in doc. 1 (footnote 1), diminished by the 'special funding' of 1,81 ME ('trasferimenti da enti privati'), that has been treated as a research income (item 0.2)

(*) It has been estimated as it is missing in doc. 4 (footnote 4).

(°) It includes both permanent and temporary staff.

Economic analysis performed for INRIM is twofold.

Institute-wide economic figures are reported from the 'Annual report 2008' [1, 2], and compared with similar figures of two European Metrology Institutes, the Danish Fundamental Metrology (DFM),[3] much smaller than INRIM (DFM staff is less than 10% of INRIM), and, the German PTB,[4] larger than INRIM (INRIM staff is less than 15% of PTB). An economic index as the income-per-staff is derived and compared, which shows INRIM to stay in the middle of the DFM and PTB. The income per staff should indicate the Institute capability of mixing pure institutional and basic research activities with applied research and commercial activities. As such, INRIM looks more aggressive than PTB and less than DFM, but the gap toward DFM looks diminishing. Specifically, INRIM positive trend in self-funding may be better appreciated by comparing 2007 and 2008, which is done below.

6.1 Overall assessment and benchmark

6.1.1 Key economic figures

Table 21 Key economic figures for INRIM; DFM and PTB 2008compares 2008 INRIM income and expenses with the DFM and PTB figures. Different from 2007, operating result, if positive, is treated as expenditure in the order of the next financial year. As such, total income and expenditures come to balance. PTB income has been forcedly estimated as it is missing in the document cited in footnote 4, which is available from the Internet.

Table 21 Key economic figures for INRIM; DFM and PTB 2008 ends in detailing the origin of the operating result as a difference between surpluses; surplus practice has been explained in 2007 evaluation document.

Remarks to Table 21 Key economic figures for INRIM; DFM and PTB 2008 are the following:

1) As for 2007, DFM has a higher rate of non-institutional income (larger than 40%) compared to 26% of INRIM and 15% of PTB, but the positive, undeniable fact, is that INRIM quota has been increased from 20% to 26%. One may wish such a short-term trend be kept in the future.

2) For what concerns expenditures, INRIM and PTB percentages look very similar. The same holds for the investments, as they were a key issue raised in the 2007 evaluation (See Appendix 7.3). A further remark concerns INRIM personnel costs, which from a fractional standpoint are the lowest ones among the three Institutes, in front of a noticeable increase of self-funding capability. Retirements could explain cost reduction, increase of younger staff might partly explain keeping and improving self-funding capability.

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[1] INRIM, 'Relazione consuntiva 2008 (in Italian).

[2] INRIM, Results and resources in the years 2006 to 2009, Draft 02/07/2009. See also Revised tables, hands-out.

[3] DFM, Annual report 2008 (in Danish), and personal communication by K. Carneiro.

[4] PTB, Zahlen und Fakten (Figures and facts), 2008

6.1.2 Economic trend

Having the Institute reached its second life year in 2008, a biennial trend may be tried as reported in Table 22. It employs the same items and data of the previous table.

Table 22 INRIM economic trend from 2007 to 2008

No.	Item	2007 values (B)	2008 values (A)	Difference (A-B)	% wrt to biennial average
		Value [ME]	Value [ME]	Value [ME]	
0	**Income**				
0.1	Institutional funding	19,95	20,5	0,55	4
0.2	Research contracts/projects	1,40	4,25	2,85	100
0.3	Income from commercial activities	3,40	3,65	0,25	7
0.4	**Total**	**24,76**	**28,4**	**3,64**	**14**
1	**Expenses**				
1.1	Personnel costs	15,29	14,9	-0,39	-3
1.2	Other operating costs	6,05	6,9	0.85	13
1.3	Investments/depreciation	2,24	5,6	3.36	86
1.5	Operating result	1,18	1,0	-0.18	-2
1.4	**Total**	**24,76**	**28,4**	**3,64**	**14**

The difference 2008 (A) minus 2007 (B) is reported. Percentage is obtained according to formula 2(A-B)/(A+B)x100, i.e. as a fractional difference with respect to (wrt) biennial average.

Remarks to Table 22 are the following:

1) As already mentioned, self-funding and investments show a neat positive trend. One must remember that lower quotas in 2007 and previous years have being regarded as a weak point by evaluation committee.

2) Better insight may be obtained splitting self-funding appearing in Table 23 into different items and removing the special funding of 1,87 MEuro ('trasferimenti da enti privati') awarded to INRIM in 2008, as it might be kept as a singleton, though one should wish it might repeat. As a matter of fact, Table 15 in doc.1 (footnote 1) includes this item among other receipts and not as a mere project/contractual income.

Table 23 INRIM self-funding, personnel costs and investments (details)

No.	Item	2007	2008	Difference wrt 2007	% wrt to average
		Value [kE]	Value [kE]	Value [kE]	
0	**Self-funding source**				
0.1	Regione Piemonte	567	539	-28	
0.2	European Community	187	689	502	
0.3	Other public bodies	199	648	449	
0.4	Research contracts	449	464	15	
0.4	**Total (without special funding)**	**1402**	**2340**	**938**	**50**
1	**Personnel costs**				
1.1	Permanent/temporary personnel + travel	14203	13204	-999	
1.2	Research grants, scholarships	1083	1673	590	
1.4	**Total**	**15286**	**14877**	**-409**	**-3**
2	Investments (free of special funding)	1588	2833	1245	56

Remarks to Table 23 are the following:

1) Positive trend in self-funding and investments persists also under special funding decline, which may be interpreted as a sign of staff maturity, as well as the result of an effective support by management.

2) Notice research contract income appears steady: remember that such a self-funding practice was deemed hardly fitting Institute propensity and management in 2007 evaluation. Stability sounds in the line of such remarks.

3) Wish is expressed to hold present trend in self-funding and investments. May the operating result, whether positive, be explicitly devoted to keep future investments at 2008 level?

6.1.3 Income-per-staff index

Table 24 Key economic indices for INRIM, DFM and PTB reports the income-per-staff index as derived from Table 23 and the permanent/temporary staff amount.

Table 24 Key economic indices for INRIM, DFM and PTB

No.	Item	INRIM 2007	INRIM 2008	DFM	PTB
0	Total personnel (+)	224	222	18	1629
1	Key indices [ME/staff unit]				
1.1	Total income per staff	0.111	0.127	0.128	0.086
1.2	Project income per staff	0.006	0.019	0.033	0.005
1.3	Commercial income per staff	0.015	0.016	0.023	0.008

(+) Permanent and temporary staff

Remarks to Table 24 are the following:

As anticipated above, INRIM stays in the middle between DFM and PTB, but in 2008, because of self-funding increase (item 1.2), DFM has been balanced, which looks a noticeable result.

6.2 Conclusions and recommendations

Overall economic analysis and benchmark are ranking INRIM as a rather effective research organization for what concerns both self-funding and investments, a pair of concerns that were previously deemed being weak by Evaluation Committee. Management should be appreciated for such results and invited to make any effort for keeping the present rank.

As a still suspended issue, stays the role of the research contracts (and of calibration and test activities), and more generally of the know-how dissemination to industrial tissue. Economic analysis does not suggest any positive trend along this way but a steady condition, which because of the actual economy contingency may be kept as positive. However, one should remember that in past evaluations, concern was raised about INRIM propensity to exploit such activities as opposed to funded projects. As a matter of fact, contract economic value of the research contracts has remained steady, whereas project funding has greatly increased. Therefore, the role of the research contracts should deserve more attention and appropriate, decisive undertakings by the management.

7 Annexes

7.1 Organizational and operating principles

The article 3 of the Organizational and operating regulations set the principles for the organisation and operation of INRIM. They are given below, and they are referred to in the main text of this report:

a) Flexibility and rapid decision-taking, achieved by delegating functions and roles

b) Periodical verification of its organisational structures, in order to guarantee a rational use of resources and to ensure consistency with the goals defined in planning documents

c) Effectiveness and efficiency in the use of its human and technical resources

d) Assessment of resources and constant monitoring of their effective use

e) Support and development of technical and scientific training, with particular attention to top level training

f) Attention to continuous professional updating of its personnel

g) Exploitation of its historical and museum heritage

h) Circulation, communication and transfer of the results of the research activities

7.2 Executive Summary of 2006 report

The Evaluation Committee (Comitato di Valutazione, “Committee”), established according to art. 11 of the operative rules (Organisational and operating regulations) has performed the evaluation of the Istituto Nazionale di Ricerca Metrologica, INRiM, for the year 2006, based on the Activity Report 2006 and talks with institute responsibles (President, Director general, Department Director, Division Heads, Head of the Laboratory accreditation service).

Based on the annual report of 2006, the Committee has formulated a number of “challenges” that it suggests to be addressed by the Board of Directors.

For INRIM in implementing its operating principles:

To implement the declared effectiveness and flexibility under the regulatory constraints, which government imposes.

To acquire capacities in “new” fields of management, such as Human resource management and commercial dissemination of knowledge.

For INRIM in pursuing its successful scientific record are:

- To be able to allocate appropriate resources to new fields within a constant (or declining budget). This involves critical reviews of current activities and reallocate of human resources.
- To review its very wide portfolio of research topics in view of the establishment of a new institute with a new mission.

As a National Metrology Institute:

- It is major challenge to develop its new divisions so that they ensure a positive development of INRIM as a major NMI in the world.

With respect to INRIM’s manifold dissemination activities:

- To establish a systematic overview of its dissemination of knowledge and of results and to bring them in line with the mission of the new institute. This could be formulated in a policy document.

In relation to the attraction of funding:

- To establish a clear overview of INRIM’s financing and its correlation to the use of resources (both human and economic), and to set targets for INRIM’s performance that are realistic. It may be of help to establish a focussed economic reporting system that facilitates the managerial decision-making.

7.3 Executive Summary of 2007 report

Executive Summary

The Evaluation Committee (Comitato di Valutazione, “Committee”), established according to art. 11 of the operative rules (Organisational and operating regulations) has performed the evaluation of the Istituto Nazionale di Ricerca Metrologica, INRIM, for the year 2007, based on the Activity Report 2007, supplemented with the annex Risultati e Dati 2007. Further, an on-site visit was made during 1-3 July 2008 where the Evaluation report for 2006 and the progress during 2007 were discussed I detail talks with senior officials of the institute (President, Director general, Department Director, Division Heads, Head of the Laboratory accreditation service).

The findings of the Committee for 2007 may be summarised as follows:

- INRIM has successfully established itself in its first year of operation after the merger between the former institutes IMGC and IEN; but it would benefit from further organisational development to optimise the management to the details of iNRIM’s mission, including personal development of the staff. The Committee makes four recommendations for improvement.
- The overall scientific research is satisfactory, but it would benefit from more transparency in how resources are allocated and how specific projects and program are prioritised.
- INRIM fulfils it role as a National Metrology Institute in a satisfactory way. However, in order to meet the needs of the future with new demands but constant and decreasing funding, new ways of prioritising resources should be established. The Committee makes three recommendations for improvement.
- The dissemination of knowledge is a multifaceted problem, where INRIM has many, but rather uncorrelated, activities. The Committee recommends that INRIM develop a common strategy for its dissemination.
- The Committee has made a detailed economic analysis of INRIM. The Committee makes eight recommendations for improvement.

7.4 Allocation of resources

Figure 1 INRIM's allocation of human resources in terms of full time equivalent (FTE) in 2008.

In 2008, INRIM reported in some detail how many resources that have been given to each type of work: Research, NMI work, and other. The latter contains dissemination of work, but may be other activities as well. The result is shown in Figure 1, both for the whole INRIM as well as for the four divisions. Only NMI work is discussed here.

According to Figure 1, in 2008 INRIM allocated 61 FTE to NMI work, or 30% of staff working time. This is a significant amount that deserves attention from management as well as incorporation in the appraisal schemes of personnel. Unfortunately, there is no tradition for analysing in detail the NMI work at metrology institutes, but a preliminary analysis for Danish Fundamental Metrology indicates that at DFM, 23% of the working time is dedicated to NMI work, with 15% going to maintenance of standards and 8% to international organisations.

Table 25: Fractions of FTE resources dedicated to different activities

	INRIM	E	M	O	T
R&S INRIM	48%	64%	20%	47%	51%
R&S Contract	17%	14%	22%	30%	9%
"NMI role"	30%	20%	52%	16%	37%
Other	4%	3%	6%	6%	3%

7.5 Different measures of publication quality

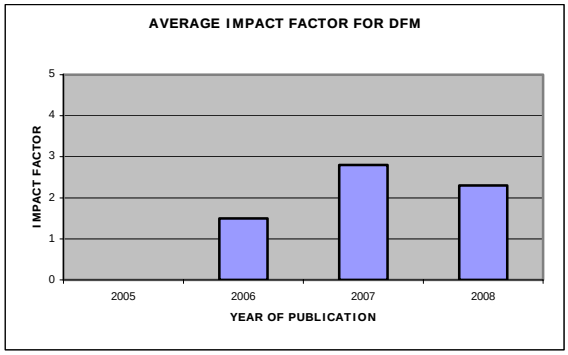

Figure 2. Average impact factor for the publications from DFM in the period 2006-2008

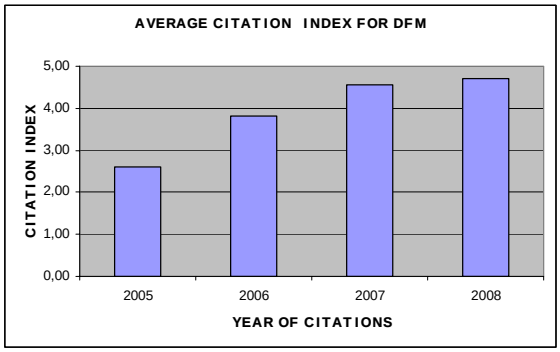

Figure 3. Average citation index for publications from DFM in the period 2005-2008. Citations are traced four years back.

In section 3 the quality of INRIM's publications is assessed in terms of *Impact factor, (IF).* This figure stems from the characteristics of the journals, where INRIM publishes. For instance, a paper published in *Metrologia* in 2008, is given the IF 1,780, which was the IF for this journal in that year. The average IF for a person, a group of persons or an institution, is the average of the publications' IF that year.

IF is convenient because it is available immediately, when the journal of publication is know. However, the IF tells little about how much a given article will be cited.

In order to get a better picture of the number of citations that an article gives rise to, one may resort to the *Citation Index CI.* This figure for a given paper states the number of references that were given to a given article in a given period prior to the year of registration. A person's or an institution's citation index is the average number of references that were made in a year from articles that were published in the chosen previous years.

Figure 2 and Figure 3 give the parameters IF and CI for Danish Fundamental Metrology, DFM. The period of tracing back was chosen to be five years, fo cover the typical "lifetime" of DFM's publications,[1] and of course self-citations were not included. The comparison between IF and CI shows that DFM's publications are referenced significantly more frequent that the average for the journals, where the articles are published, a quality that does not emerge from analysis of only IF.

[1] The Technical University of Denmark DTU, uses four years, determined by the relatively long lifetime of publications from its mathematics institute.

Other factors may be applied in further bibliometric analysis of publications; but all of them have deficiencies and should not be used as the only measure of publication quality. In particular, evaluations of individuals appear delicate.