INSTITUTO TECNOLÓGICO E NUCLEAR

Report requested by the Resolution of the Council of Ministers, dated 24th November 2005

December 2005.

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FOREWORD

The present report was prepared in order to answer the request from the Ministry of Science, Technology and Higher Education, following the Resolution of the Council of Ministers, dated 24th November 2005, with the objective of supplying information to the international working group responsible for presenting to the Government a proposal for restructuring the existing Portuguese State Laboratories system.

Concentrating most of the Portuguese know-how and infrastructures in the area of nuclear sciences and technology, Instituto Tecnológico e Nuclear (ITN) is a special case of a State Laboratory. It was therefore considered important to introduce in this report a description of ITN's mission and activities as well as an overview of ITN's strategy and recent evolution (from 2001 onwards), taking into consideration the recommendations of ITN's International Advisory Board, as documented in their last report dated May 2002 (not to be confused with the International Advisory Committee that was in charge of evaluating all the Portuguese State Laboratories).

1. MISSION AND HISTORICAL BACKGROUND

ITN is the successor of Instituto de Ciências e Engenharias Nucleares (ICEN), created in 1985 as part of the State Laboratory then named Laboratório Nacional de Engenharia e Tecnologia Industrial (LNETI), now Instituto Nacional de Engenharia, Tecnologia e Inovação (INETI), based on the subdivision of Instituto de Energia in two new institutes. Instituto de Energia was the successor of Junta de Energia Nuclear (JEN), which was extinguished in 1979.

At the time, the mission of ICEN was defined as *"to promote and carry out research and development in the area of energy and nuclear sciences and techniques, to perform activities of radiological protection and safety as well as the training and education..."*.

The duties assigned to ITN, listed in article 2 of its Organic Law (DL 324/1994, 30th December), the legal document that created ITN, were established with the aim of fulfilling the objectives above referred.

ITN capabilities were strengthened in 1998 through the integration in ITN of the Department of Radiation Protection and Nuclear Safety (DPRSN) whose duties were listed in the Decree-Law DL 311/98, 14th October. Later, some of these duties were modified by Decree-Law 165/2002, 14th October. More recently, some of these legal competences were clarified by Decree-Laws 138/2005 and 139/2005, both published in 17th August. This department, originally part of LNETI, was separated from it and integrated in the Ministry of Environment, between 1992 and 1998.

More recently, through article 24 of Decree-Law DL 205/2002, 7th October (Organic Law of the Ministry of Science and Higher Education), ITN was considered as depending on that Ministry (now Ministry of Science, Technology and Higher Education) and having as assigned duties *"to implement the national policies on science and technology namely those in the area of peaceful applications of nuclear energy as well as to ensure fulfillment of State responsibilities on radiation protection, environmental radioactivity and nuclear safety "*.

According to ITN's International Advisory Board (IAB), in their last report mentioned in the foreword of this document, ITN should have a Mission Statement approved by the Government. Their suggestion was that ITN's Mission Statement should read as: *"The ITN has as its primary task to carry out research and to provide expertise, training and services in the field of nuclear and radiation science for Portugal. This includes safety aspects such as radiation dosimetry, safety of nuclear installments and nuclear fuel, safe handling of radioisotopes and safety of installations emitting x-rays. The utilization of the Research Reactor and the ^{60}Co gamma ray irradiation facility are part of the mission. The R&D in the Sectors should be directed to furthering the use of nuclear and radiation technology for the good of Portugal in societal, industrial, medical, etc. areas.*

The ITN can have as a complementary task to provide a number of facilities for experimental research for the scientific community in Portugal which are beyond the capacity of a single university. The nuclear facilities of ITN are unique in Portugal, with specialized equipment that exceeds the ability of a university to acquire and maintain. A mission of ITN should be to make these facilities available to university (and private laboratory) researchers, including technical help and laboratory space for these external users (particularly those from universities). ITN has to provide a modern and updated research infrastructure, including trained scientists, around these facilities. Typical examples would be the ion beam laboratory with a Van de Graaff accelerator and its high fluence ion implanter and, possibly, a small cyclotron for nuclear medicine.”.

The previous Mission Statement was fully taken into consideration by the present Directive Council of ITN (in place since 2nd December 2002). The objectives contained in this Mission Statement are in accordance with the duties legally established and constitute the driving lines of ITN who, in summary, assumed as its mission *“to develop nuclear sciences and techniques placing radiations and radioisotopes to the service of the country”*.

2. ACTIVITIES

2.1. GENERAL

Fulfilling the objectives described in the previous chapter, ITN performs various activities namely:

- Maintaining and exercising its legal duties, in particular and as first priority those related with Radiological Protection and Nuclear Safety as well as those covered by international treaties and commitments signed by the Portuguese State;
- Technically and scientifically supporting the Government in the definition and execution of sector policies as well as participating in international *fora* related to its domains of activity, ITN participates in several national and international Standing Working Groups, Commissions and Committees;
- Promoting and developing scientific research and technological programs that are of interest to the country within the scope of nuclear sciences and techniques and operating complex scientific and technological infrastructures (namely the Portuguese Research Reactor) that are outside the capabilities of Universities and other research Centers or Laboratories, ensuring the country’s sharing and full and efficient use of ITN’s techniques, scientific potential and facilities by means of the establishment and implementation of cooperation agreements with national and international institutions that work in the same areas;

- Training and educating technical staff of different levels and researchers namely providing post-graduation and advanced training in tight collaboration with Higher Education Institutions;
- Transferring technology and providing specialized services to the community.

The previous tasks are performed adopting as main areas of activity the socio-economic sectors of Environment, Culture, Education, Industry and Health. Every year, ITN publishes a comprehensive Report of Activities where these are fully listed.

The following sections are a brief description of ITN's main technical and scientific capabilities.

2.2. RADIOLOGICAL PROTECTION

Radiological protection is a mission of the Department of Radiological Protection and Nuclear Safety (ITN/DPRSN) who has a longstanding tradition in this activity. Research activities in this field have almost always been developed only at the ITN/DPRSN. They have traditionally been focused on the fulfillment of tasks assigned by Portuguese law, research activities, services to the community and, in some cases, regulatory body-linked activities. These activities have been developed in five main topics: monitoring of the environmental radioactivity; metrology and dosimetry of ionising radiations, radioactive waste management, radiation safety evaluation and risk assessment.

A national network of **environmental radioactivity** monitoring fulfills the State's national (Article 4 of DL 311/98, Article 14 of DL 165/2002 and DL 138/2005) and international obligations (Articles 35 and 36 EURATOM Treaty, according to IAEA and ICRP recommendations), with the measurements of artificial and natural radionuclides in aquatic (drinking waters, rivers, estuaries and ocean coast), terrestrial ecosystems (foodstuffs, milk, soils, etc.) and atmosphere (rainwater and aerosols). The monitoring of environmental radioactivity is also carried out with the determination of the natural radionuclide levels in old uranium mines and surrounding areas, allowing the assessment of the radiological risk for the population and, with the evaluation of the indoor and outdoor radon concentrations, as well as the radon exhalation rates from soils and building materials.

The **metrological activities** consist on the maintenance of the National Standards for ionizing radiation, under a protocol between the ITN and the Portuguese Institute for Quality (IPQ). Collaboration with international organizations is maintained for inter-comparison of standards and measurements, namely with the *"Bureau International des Poids et Mesures (BIPM)"*, where the LMRI has its Calibration and Measurements Capabilities (CMC) published and recognised worldwide. The LMRI also cooperates with national metrological institutes of Europe and IAEA/WHO Network of Secondary Standards Dosimetry Laboratories with the purpose of achieving higher efficiency and to guarantee that the dose delivered to patients undergoing radiotherapy treatment is kept within internationally accepted levels.

The activity developed in the field of **radiation dosimetry** is directed towards the assessment of doses to the Portuguese population due to several types of exposure to external radiation. The activities developed are mainly based on the performance of the individual monitoring service of ITN in the fields of individual and environmental monitoring. Active collaboration in international working groups developed in the framework of both EURADOS and ESOREX are also going on.

According to the Decree-Laws n. 165 and 167 of July 2002, ITN is entrusted the task to create and maintain a **Central Dose Registry** (CDR). Presently, the CDR contains the occupational exposure data of the workers monitored in Portugal during the period 1957 to 2004.

The **radioactive waste management**, a legal competence of ITN[1], includes the monitoring, transport, segregation, conditioning and interim storage of radioactive waste produced in the Country.

Licensing of sealed sources, radiological verifications of medical, industrial, research and teaching facilities, environmental gamma survey of the ITN Campus, control and authorization for the transport of radioactive materials, detection of radioactive material in scrap metal, radiological survey of nuclear vessels harboring national ports are also activities developed within the framework of radiological protection.

Research and development competences in the area of radioactive waste treatment and management range from radioactive liquid waste treatment techniques to the application of the Monte Carlo simulation code to the management of radioactive waste. A novel area of R&D related to the application of transmutation to nuclear wastes using accelerator driven systems (Eurotrans) and involving European collaboration is also being kicked-off.

Consulting activities and studies carried out for Governmental and private organizations at national level are also part of the usual activities.

Methodologies for calculation of doses and shielding have been applied and developed for radiation **safety and risk assessment** purposes. As a consequence of this work safety reports were elaborated and used by the General Directorate of Health for licensing purposes. Competence and know-how about safety standards, requirements and guidance in medical, industrial and research practices have been acquired as a result of the participation in several committees of the IAEA. The lack of a Regulatory Authority compels ITN/DPRSN to develop several drafts of radiation protection programs for all the radiological practices which are the fundamental aspect of the safety and protection in any radiation installation. Methodologies based on Monte Carlo simulations of the interactions of radiation with matter have been applied and developed for radiation physics and dosimetry studies. Capacities on evaluation of the genotoxic damage in DNA, as a result of exposure to ionizing radiation in professionally exposed workers and in the case of accidents have been acquired. Cytogenetic analysis in blood samples allowed participation together with other National Institutions in epidemiologic studies.

Participation in the European Union and the IAEA working groups are also part of the usual activities of the experts of the several topics above mentioned.

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[1] DL 311/98, Ministry of Science and Technology; DL 165/2002, Ministry for Health and DL 139/2005, Ministry of Science, Technology and Higher Education.

Since the beginning of its existence, ITN/DPRSN has been carrying out most of the functions and responsibilities that are the main objective of a **Regulatory Body** in the area of Radiological Protection. Without the regulatory legitimacy but with all the heavy burdens that result from this situation, ITN has seen its activities increasing in the recent past, despite the fact that new legislation (DL 139/2005, Ministry for Science, Technology and the Higher Education) creating an Independent Commission for Radiation Protection has been published (17^{th} August this year - still waiting for the nomination of persons to carry out the assignment).

2.3. MATERIALS SCIENCE AND TECHNOLOGY

ITN has also a long standing tradition in research and development in Materials Science and Technology, in which all its four departments participate, taking advantage from the combination of different nuclear and non-nuclear techniques for the development of advanced new materials. Thanks to unique infrastructures and expertise, expanded over the years, ITN has attracted scientists, engineers, and research groups from all over Portugal and abroad, establishing fruitful collaborations in this area, within its mission as a National Research Laboratory.

Synthesis and modification of materials is achieved via chemical synthesis and ion implantation, with γ and neutron irradiation playing an important role as well. Different methods of chemical synthesis are available in the fields of inorganic and organometallic chemistry, and solid state materials. Ion implantation is used to create new metastable materials, by modifying the near surface structure of a given material, or by introducing dopant levels of impurities. Gamma and neutron irradiation are used for improving existing materials, as for instance synthetic and natural polymers, and to create new ones.

A vast array of techniques for materials characterisation is available at ITN, providing fundamental information with a high degree of complementarity. Chemical, structural, compositional, electric and magnetic properties can be measured.

Amongst the analytical techniques which are unique and specific, analysis through ion beams include ion backscattering, particle-induced X- and γ-ray emission, Hydrogen-recoil detection, and nuclear reactions. These techniques are particularly useful for study of location of impurities and defects in materials and thin film analysis. Neutron beams are also available for neutron diffraction and scattering and high accuracy neutron activation analysis. α-, β-, and γ-spectrometry techniques are employed in a range of applications. State-of-the-art facilities for X-ray diffraction and X-ray reflectometry for the study of thin films are available. The Chemistry Department has a wide range of capabilities in the synthesis and crystal growth of new materials like intermetallics, oxides and molecular materials. A special emphasis is placed on the design of multifunctional and nanostructural molecular materials with unconventional electrical and magnetic properties. For physical characterization ITN has unique facilities in Portugal for low temperatures and high magnetic field studies (0.3K-400K, up to 18T), as well as Mössbauer spectroscopy which are used in cooperation with many external users. This list is by no means exhaustive, and researchers at ITN steadily introduce new techniques and improvements in existing ones.

2.4. HEALTH AND LIFE SCIENCES

The research activities in Health and Life Sciences at ITN are carried out in close collaboration with Universities, clinicians and industry, either at national or international level.

The unique facilities and the expertise existing in ITN in radiochemistry, radiation science and in ion beams, the underlying physics, chemistry and biology, bring a distinctive advantage for R&D activities on new ways of exploiting microbiology, modern molecular biology and innovative drug design for therapy and diagnostic.

The developed expertise in radiopharmaceutical chemistry and specific infrastructures available for producing radioisotopes, handling radioactive compounds and evaluating radiopharmaceutical products, make ITN a unique center in the country, to develop an interdisciplinary research programme in radiopharmacy. This project involves the synthesis, and characterisation of radiopharmaceuticals for therapy or diagnosis.

As an example novel organic or organo-metallic complexes are being developed which are specific radiotracers for non-invasive molecular imaging of targeted macromolecules and biological processes associated with different pathologies.

The analytical capabilities of ion beams associated with the Van de Graff particle accelerator of ITN are important tools in ecotoxicology studies, namely of the relationship between toxic elements in breathed particles and the incidence of chronic respiratory diseases. Focused ion beams are used as a sensitive probe to perform chemical microanalysis in tissues and visualise cell and tissue morphology at the micrometer and sub-micrometer scale.

The use of gamma radiation has been applied to control the bioburden in pharmaceutical materials and devices, to improve the quality of food by preserving fresh edible substances, and to wastewater treatment.

Gamma radiation is also used to study the response to radiation of new polymeric materials of biomedical and environmental relevance, in order to evaluate structural properties and biocompatibility features.

2.5. ENVIRONMENT, EARTH SCIENCES AND CULTURAL HERITAGE

The existence of a wide range of complementary and powerful analytical techniques at ITN allows the development of a significant effort in the Environmental and Archaeometric research domains. These activities contribute to the evaluation of the global pollution scenario as well as the valorisation of the Portuguese cultural heritage.

The analytical (nuclear and radiation) techniques available in the several departments of ITN, include: instrumental neutron activation analysis, radiocarbon dating (^{14}C), luminescence dating, energy-dispersive X-ray fluorescence spectrometry, mass-spectrometry for light isotopes, tritium dating, elastic backscattering, ion induced X-ray radiation and X-ray diffraction. The combination of all these high sensitivity methodologies, unique in Portugal, makes ITN one of the key partners of many national and international research projects.

The research area of environment plays an important role on the study of biogeochemical cycles of elements and light isotopes in atmosphere and water. The study on atmospheric environment focuses on the monitoring, including biomonitoring, and quality control of the air pollutant dispersions in order to identify emission sources and the spread of elements through the atmosphere.

Sedimentary geochemistry is directly related to the consequences caused by changes in the main Iberian river basins at the coastal area. The recognition and distinction of the environmental changes occurred during the Late Quaternary, including the iberian coastal upwelling, is performed by the study of the stratigraphic succession of the sedimentary record of river estuaries, and lagoons and radiocarbon dating of marine shells and bones. Isotope hydrology has been contributing to the dynamic evolution response of groundwater systems to human influences and to the climatic evolution. The operation of the National Network for isotopes in precipitation provides important information for the management, protection and development of water resources.

Geochemistry of trace elements, crystal chemistry and mineralogy are mainly applied to historical buildings and to the production, technology and provenance of archaeological artefacts, like ceramics, lithic and metallic artefacts which can be characterized in order to correlate composition and morphology. This approach is also applied in environmental research projects in order to evaluate anthropogenic influences, with the final goal of preserve classified natural environments.

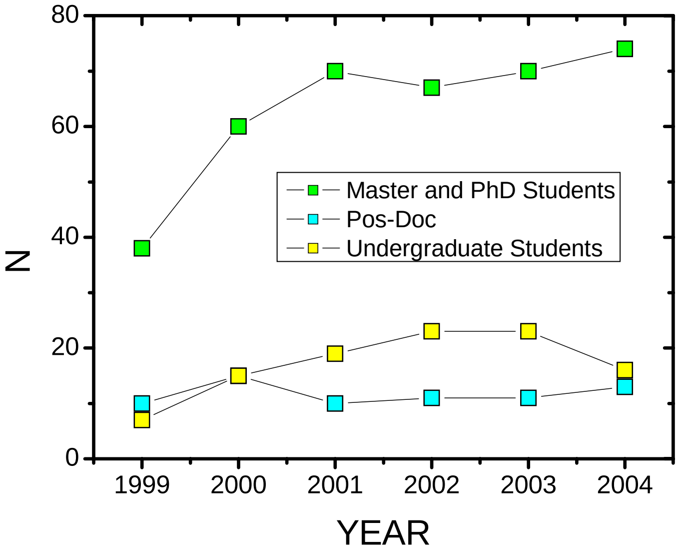
An important activity component in this field is directed to archaeologists through a collaboration protocol between ITN and the Portuguese Institute of Archaeology, which aims at the development of the archaeometry in Portugal as a high level scientific research field. The installation of new equipments in the next future, namely an inductively coupled plasma mass–spectrometer, new automated equipment for neutron activation analysis, a single grain luminescence reader, the expansion of the ion microprobe through installation of an external micro beam end station and a AMS line in a new tandem accelerator will highly reinforce these instrumental analytical capabilities.

2.6. EDUCATION AND TRAINING

ITN occupies a relevant position in the Portuguese science tree. The areas of expertise of the Institute, notably those related to the use of ionizing radiations, the installed research infrastructures and specialized equipments (some of them unique in the country), and the quality of its research staff allow ITN to offer excellent opportunities for:

(A) Advanced scientific/technical training of students and young scientists in current areas of activity of the institute (environment, cultural heritage, materials science and technology and life sciences). The trainees can either participate in the research teams of ongoing projects, or attend master courses organized in collaboration with universities.

Under the supervision or co-supervision of ITN scientists, a large number of young students prepare their final degree thesis, MSc thesis, PhD thesis, or undergo pos-doc training programmes.



(B) Training for professionals dealing with ionizing radiations and its applications in several domains of activity. Very recently ITN created a Training Centre that, namely, organizes courses where safe manipulation of equipments that use radioactive sources is taught by certified teachers.

On the other side, ITN regularly promotes initiatives to outreach the general public, giving particular attention to young people. For this purpose, the Institute opens its doors to students from high schools, receiving typically one visit per week. Also, along this line, ITN contributes to stimulate the interest of youngsters in experimental science, by offering one or two weeks hands-on training to high school level students at its experimental facilities. These activities are carried on in collaboration with external entities, notably, the *Agência Ciência Viva*.

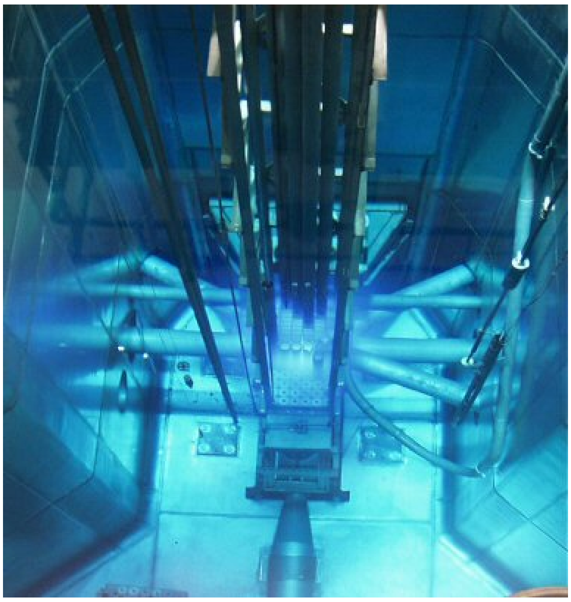
3. MAIN FACILITIES, EQUIPMENT AND TECHNIQUES AVAILABLE

3.1. PORTUGUESE RESEARCH NUCLEAR REACTOR

Open core pool-type reactor, 1 MW thermal power, water cooled and moderated, providing:

- Irradiation positions in the core grid with well characterized neutron fluxes and gamma dose rates.
- Fixed rabbit system for short irradiations and moveable fast rabbit system with automatic routing to measurement and decaying cells.
- Thermal column with a highly thermalized neutron flux, and external beams rich in the fast or epithermal components.
- Neutron scattering instruments for characterization of magnetic and crystalline structures of poly-crystalline or single crystal materials, by diffraction and small angle scattering.
- Emission channeling from neutron induced nuclear reactions for studying the local structure of single crystalline materials using the channeling effect of charged particles through the lattice.

View of the RPI instruments hall and reactor pool



View of RPI core in activity (inside pool)

Instrumental Neutron Activation Analysis Laboratory

To measure trace element concentrations, with high accuracy and precision, using gamma-spectrometers with High Purity Ge detectors. This lab will be equipped with automatic sample changers in 2006.

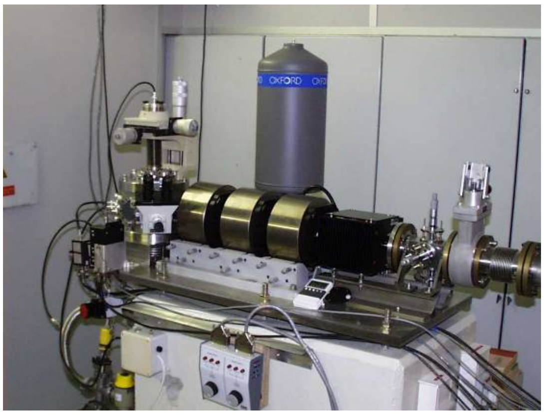
Applied Dynamics Laboratory

To test and model the vibratory and acoustic behaviour of mechanical components.

3.2. ION BEAMS LABORATORY

Facility comprising two main large instruments:

- 2,5 MV Van de Graaff accelerator with 3 dedicated beam lines for physics research and materials characterization of elemental composition and structure by:
  - Standard nuclear techniques, RBS, PIXE, ERD, NRA, and Channelling.
  - Nuclear microprobe with raster mapping by focused micro beams, 2-3 μm in cross dimension, using PIXE, RBS, IBIL, STIM and CSTIM.
- 210 kV high flux ion implanter with semi-industrial implantation chamber for implantations of stable ions, from –100 ºC up to 600 ºC, for R&D.



View of nuclear microprobe end stage

General view of ion implanter

3.3 – EMISSION CHANNELING AND HYPERFINE INTERACTION LABORATORY (ISOLDE/CERN)

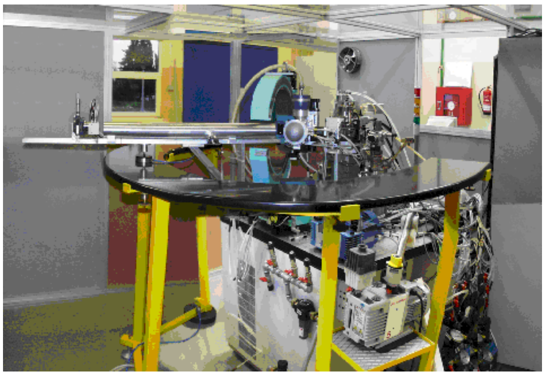
This laboratory maintained by ITN at ISOLDE/CERN is equipped with one e^--γ PAC spectrometer, two emission channeling setups with position-sensitive detectors, various sample heating and cooling devices, and a 13 PC cluster for numerical simulations.

The major activity is related to the microscopic characterization of impurities and dopants in technologically relevant materials such as semiconductors, high-Tc superconductors, and functional oxides.

3.4. STRUCTURAL CHARACTERIZATION OF ADVANCED MATERIALS LABORATORY

Unique multipurpose X-ray diffraction analytical facility (Hotbird) with:

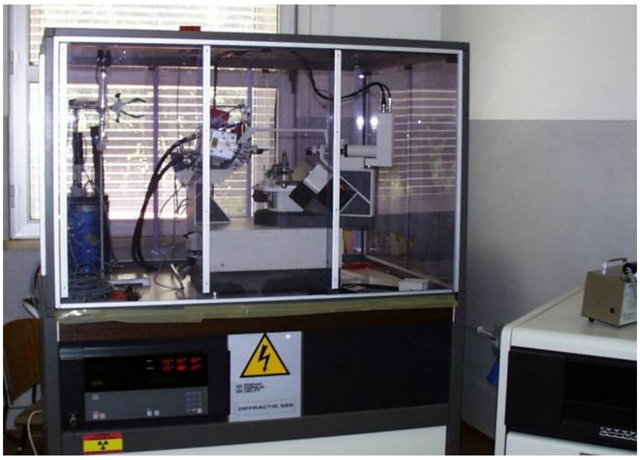
- high resolution X-ray diffractometer, powered by a 18 kW rotating anode X-ray source, for phase identification, residual stress measurement, 2-d mapping of Bragg peaks, and reflectometry studies, up to 1400 ºC *in situ*.
- Furnace for thermal treatments up to 1800 ºC.
- Laboratory for sample preparation and metallographic observation.



View of the HotBird X-ray diffractometer

3.5. X-RAY DIFFRACTION LABORATORIES

- Single crystal diffractometer with a 4-circle goniometer, for determination of crystal structures and structural characterization in organic, inorganic and organometallic chemistry research.
- *PANanalytical X'pert* modular diffractometer with basic module for powder analysis.



View of the single crystal X-ray (top) and powder X-ray (right) diffractometers.

3.6. X-RAY FLUORESCENCE SPECTROMETRY LABORATORY

- *Kevex 771 Delta XRF Analyst* X-ray spectrometer for multielemental characterization by EDXRF, allowing the detection of elements from Na to U with high accuracy and reproducibility for environmental, geological and acheometalurgical studies.

3.7. MÖSSBAUER SPECTROSCOPY LABORATORY

Studies of oxidation state, coordination geometry and magnetic moment of specific elements in different samples (magnetic materials, inorganic compounds, geological samples, etc.).

- Two Mössbauer spectrometers, allowing for transmission or backscattering geometry.
- Continuous-flow liquid-He cryostat and bath cryostat, with a superconducting split-pair magnet for studies in the temperature range 2-300 K, under magnetic fields up to 5 T.
- ^{57}Fe, ^{151}Eu and ^{119}Sn Mössbauer sources.

3.8. MODELLING AND NUCLEAR INSTRUMENTATION LABORATORY

Study of cold plasma for material and environmental applications and modelling of thermal neutron flux perturbation in the presence of test samples. Development of nuclear instrumentation for industrial applications.

3.9. CHEMICAL SYNTHESIS LABORATORIES

The Chemistry department hosts several chemical synthesis laboratories devoted to different type of compounds and applications namely:

Radiopharmaceutical Synthesis Laboratory.

Laboratories for preparation of organic, inorganic and organometallic compounds with potential interest in Nuclear Medicine diagnostic and/or therapy**.**



Lanthanide and Actinide Chemistry Laboratory.

Preparation and reactivity studies of f-element compounds.

Molecular Materials Synthesis Laboratory.

Organic and coordination chemistry laboratory for preparation of molecular materials, including:

- Glove box under N_2 atmosphere, H_2O and O_2 < 1 ppm.
- vacuum lines (Ar, N_2).
- Cyclic Voltammtery and electrocrystallization cells.

High Temperature Synthesis and Crystal Growth Laboratory

- Induction furnace (for growing crystals by Czochralski, Bridgman or floating zone methods).
- Arc furnaces and resistive furnaces (up to 1600 ºC).
- Splat cooling.
- Precision cutting machine for small dimension materials.
- Low damage spark erosion cutting unit.

View of the induction furnace

3.10. POLYMER CHARACTERIZATION LABORATORY

To perform polymer manipulation, chemical activations and preparation for gamma irradiations and characterization.

- Vacuum line for preparation of polymeric samples in controlled atmospheres.
- Unit for polymeric purification by discontinuous extraction.
- FTIR spectrophotometer.
- Differential Scanning Calorimeter (DSC) and Thermogravimetry unit (TGA).

DSC and TGA thermal analysis equipment

3.11. THERMOCHEMISTRY LABORATORY

Equipped with different calorimeters for reaction energetic studies.

3.12. LOW TEMPERATURE AND HIGH MAGNETIC FIELD LABORATORIES

Characterization of electrical transport (resistivity, magneto-resistance, thermoelectric power and Hall effect, …) thermal (specific heat, conductivity) and magnetic (magnetization, AC susceptibility) properties from very low temperatures (0.3 – 400K) and under very intense magnetic fields (up to 18T). These measurements, used as basic characterization tools in the study of different materials, are made in a variety of cryostats and cryogenic equipments, which are kept operational due to the existence in the ITN campus of the only Helium liquefier operational in Portugal.

- ^{4}He cryostat , with ^{3}He insert (0.3 K-300 K) with a 18 T magnet and high resolution (0.01º) rotating sample holder.
- ^{4}He cryostat with (1.5 -300 K) with a 10 T magnet.
- Different closed cycle refrigerators (10-300K).
- Multipurpose Specific Heat and Magnetic Characterization System *MagLab 2000*, with variable temperature insert, operating in the range 1.5-400 K, inside a 12 T magnet.
- Cantilever magnetometer for 18 T and 12 T magnets
- Faraday Balance, with 7 T cryostat (1.5-300K) and gradients up to 10 T/m.
- SQUID magnetometer with AC susceptibility (1.5-800 K) and 5.5 T (under acquisition).

3.13. FT-ICR/MS LABORATORY

With a high resolution Fourier Transform- Ion Cyclotron Resonance Mass Spectrometer mainly used in studies of the gas phase ion chemistry of lanthanides and actinides. It is also used in the analysis of inorganic, organic and organometallic compounds and materials prepared in ITN and outside institutions.

- *Finnigan FT/MS 2001-DT* FT-ICR/MS high resolution mass spectrometer.

View of the FT-ICR/MS spectrometer

View of the 300 Mhz NMR

3.14. NMR LABORATORY

To study molecular structures of organic and organometallic compounds.

- *Unity Inova Varian* 300 MHz multinuclear spectrometer with pulsed field gradient (PFG) probes.

3.15. TRITIUM DATING LABORATORY

To evaluate tritium concentrations in precipitation, ground and surface waters by LSC, relevant for hydrological studies.

3.16. RADIOCARBON DATING LABORATORY

To date materials such as wood and other vegetable remains, charcoal, shells, bones, sediments, waters (precipitated carbonates), peat, etc. for archeological and geological studies, by measurement of ^{14}C activity using Liquid Scintillation Counting (LSC).

Benzene synthesis line of the radiocarbon dating unit.

3.17. LUMINESCENCE DATING LABORATORY

Thermoluminescence dating (TL); Optical stimulated luminescence (blue B-OSL and green G-OSL) of sediments, ceramics and others heated materials, having the SiO_2 as the main constituent (such as: quartz, chert, silex) or containing feldspars, for geological and archaeological applications.

- *γ - NaI* spectrometer and Al_2O_3 based dosimeter system.
- *Risoe DA-15* luminescence detector and alfa and beta irradiation equipment.

Lumicence dating laboratory.

3.18. LIGHT ELEMENTS MASS SPECTROMETRY LABORATORY

To measure isotopic ratios of $^{18}O/^{16}O$, $^{15}N/^{14}N$, $^{13}C/^{12}C$ and $^{2}H/^{1}H$ in solid, liquid and gas samples, for water resource, archaeological and geological studies,.

- *SIRA* 10 *VG ISOGAS* light isotopes mass spectrometer coupled to an *Euro Vectors* elemental analyzer.
- *GEO V2.4 Europa Scientific* mass spectrometer for deuterium.

3.19. INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS LABORATORY

To perform multielemental analyses, of trace elements concentrations in samples irradiated in the Portuguese Research Reactor. The main applications are related to the cultural heritage valorization and conservation and environment.

- Two γ -spectrometers, including coaxial Ge detectors and low energy detectors, connected through *Canberra 2020* amplifiers to *Accuspec B (Canberra)* multichannel analysers. To be equipped with automatic sample changers in 2006.

3.20. MICROBIOLOGY LABORATORY

With areas for treatment and preparation of materials in cascade controlled area, class-D (ISO 8), including clean area, class-C (ISO 7), equipped with a class-II type-B2 biohazard laminar vertical flow bench (Baker) and a class-II type-A1 laminar horizontal flow bench (Bassaire).

3.21. LABORATORIES FOR HANDLING RADIOACTIVE MATERIALS

Laboratories for preparation and characterization of metal- and halogen-based radioactive drugs for application in Nuclear Medicine .

- Perspex glove boxes.
- 5 lead wall remote controlled hot cells.
- HPLC preparative systems.
- Radiochromatography and electrophoresis apparatus.
- Ionization chambers, gamma-counters and dose radiation monitors.

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Hot cells

Perspex glove boxes

HPLC with UV and γ detectors

3.22. CLEAN-ROOM LABORATORIES FOR SAMPLE PROCESSING AND RADIOPHARMACEUTICALS PREPARATION

Class-C (ISO 7) controlled areas for preparation of radiopharmaceuticals in solution or lyophilized under nitrogen, with two class-II type-B2 biohazard vertical laminar flow benches and for handling and preparation of samples for nuclear and nuclear related trace element analysis techniques, with class-II type-A1 biohazard vertical laminar flow bench.

View of the clean room for radiopharmaceuticals preparation

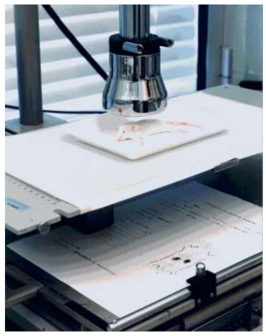
3.23. LABORATORIES FOR BIOLOGICAL EVALUATION OF RADIOFARMACEUTICALS

Animal facilities with temperature, humidity and light control and laboratory for *in vivo* evaluation of radioactive compounds in normal and/or tumor-bearing mice.

Animal Facilities

Fume Cupboard for Biodistribution

Ionization Chamber



Radiochromatograph

Laboratories for cell culture and evaluation of radioactive compounds (receptor binding, cellular internalization and retention, citotoxicity and radiotoxicity, etc.).

CO_2 Incubator and Biohazard Cabinet

Liquid nitrogen reservoir for cell banking

Inverted Microscope

Microplate UV-VIS spectrophotometer

Multi-channel γ-Counter

Fume cupboard for radioactive binding assays

3.24. RADIOACTIVITY MEASUREMENTS LABORATORIES

The evaluation of radioactivity in environmental samples is performed with different techniques and equipments, most of them involving a chemical processing step followed by physical measurements:

Chemical Processing Laboratories

Depending on the type of material, the preparation of samples for measurement involves different chemical procedures and facilities:

- Laboratory for the artificial radionuclides determinations in surface waters, drinking waters, rainwater, etc (figure 1);
- Laboratory for determination of tritium by LSC according to the Portuguese Standards NP 4362, 1997, in surface waters, drinking waters, rainwater, etc (figure 2);
- Laboratory for the determinations of the alpha/beta activity in drinking waters, according to the Portuguese Standards NP 4330 and NP 4332, 1996 (figure 3);
- Laboratory for the determinations of the artificial radionuclides in milk and foodstuffs (figure 4);
- Laboratory for the determinations of the alpha emitter's radionuclides in waters, sediments, soils, foodstuffs samples, etc (figure 5).
- Aerosol sampling station ASS-500 (figure6).

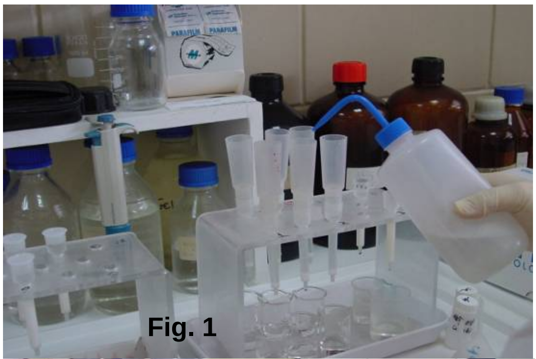


Fig. 1


Fig. 2


Fig. 3


Fig. 4


Fig. 5


Fig. 6

Physical Measurements Laboratories

The identification of radioactive isotopes and measurement of the activity of each isotope is performed with different techniques and equipments:

- ***Alpha spectrometry*:** For the quantification of alpha emitting isotopes (Ra-226, Po-210, Am-241, isotopes of uranium, thorium and plutonium) the Alpha Spectrometry Laboratory (figure 7) has 3 *EG&G Ortec Octête*^{PLUS} alpha spectrometry workstations and 9 *EG&G Ortec* 576*A* dual alpha spectrometers, allowing a maximum of 40 simultaneous measurements.
- ***Gamma Spectrometry**:* The Gamma Spectrometry Laboratory (figure 8) is equipped with one Ge(Li) detector and six HPGe detectors (one well-type detector, three coaxial and two BEGe detectors (from *Canberra*, *Ortec* or *PGT*)). Detector's data is processed in two *Canberra* Multiport II ADC/MCA and the spectra are analysed with the *Canberra* GENIE 2000 software. The samples are measured in six possible geometries: Marinelli beakers, tubes and three different sized cylinders.
- ***Total alpha and beta activities**:* The Total Countings Laboratory (figure 9) is equiped with several low background alpha and beta counting or scintillation systems:
  - Gas flow proportional detectors – *Canberra XLB Tennelec 5* – used for quantification of total alpha and beta activities – and *Canberra HT1000* – used for evaluation of Sr-90/Y-90 and Cs-137 activities;
  - Liquid scintillation analyzers – *Beckman LS 6500* and *Packard Tri-Carb 3170 TR/SL* – used for tritium activity;
  - Alpha detector systems – two Novelec ZnS solid scintillators – used for total alpha and Ra-226 evaluation.

Fig. 2

Fig. 3

Fig. 4

3. 25 RADON MEASUREMENTS LABORATORY

(Spark counter model UCF-2)

This laboratory is equipped with a spark counter (*UCF-2*) for counting of micrometric holes in thin plastic materials (like LR-115 cellulose nitrate) used as radon solid detectors.

3.26. METROLOGICAL LABORATORY OF IONIZING RADIATION

Primary standards facility for metrological measurements of X-rays, gamma and beta radiations at environmental, protection, therapy and radiotherapy levels.

Radiation Qualities:

- X-rays:.
- Gamma radiation:
- Beta radiation:

Ionizing Radiation Standards:

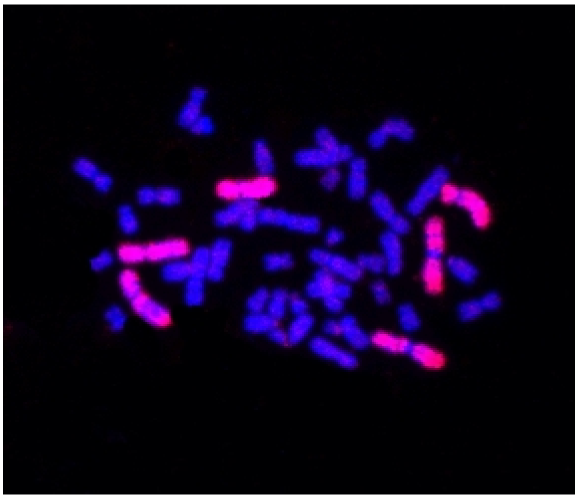
- Different ionization chambers as ionizing radiation standards.

3.27. DOSIMETRY LABORATORIES

The Individual Monitoring Service (IMS) for evaluation of external radiation doses in individual and environmental monitoring. The IMS operates a TLD system that is based on two Harshaw 6600 automatic readers and on the Harshaw 8814 card and holder which contains two LiF:Mg,Ti (TLD-100) detectors for the evaluation of $H_p(10)$ and $H_p(0.07)$.

3.28 CYTOGENETIC LABORATORY

This laboratory is equipped with a Fluorescence Microscope, which has a Automated Methaphase Finder System (Metafer) and a software for imaging and processing of fluorescence images (ISIS),. allowing to study chromosomal aberrations.



Fluorescence microscope and normal metaphase obtained by whole chromosome painting.

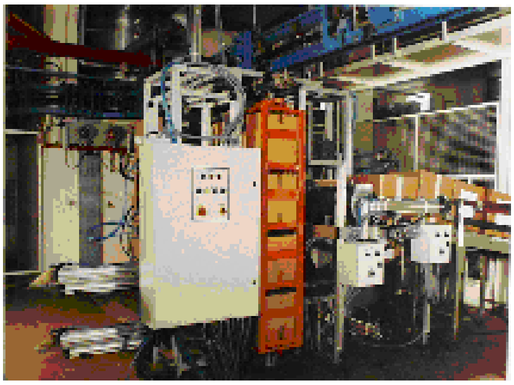
3.29. RADIOACTIVE WASTE INTERIM STORAGE FACILITY

National interim storage facility for the radioactive waste produced in the Country.

3.30. RADIATION TECHNOLOGY UNIT

Semi-industrial facility with a cobalt-60 irradiation source, providing irradiation services for a wide range of applications, namely sterilization of medical devices and pharmaceuticals, decontamination of raw materials, sludge and wastes, modification of structure and properties of materials, etc.

View of UTR

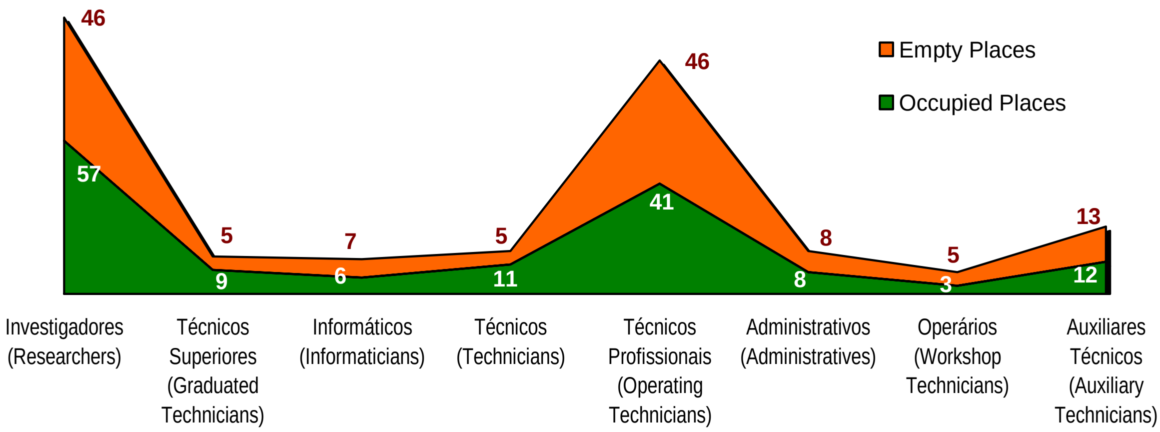


Inside view of load control of UTR

4. HUMAN RESOURCES

Presently, ITN's permanent staff (considered as civil servants) has the following distribution among the different categories:

ITN Staff - *Present Situation*



The number of places officially planned in Decree-Law "Decreto-Lei 324-A/94,, 30th December, that has created ITN (and annex I of "Portaria 660/96", 14th November), later increased with the integration of DPRSN at ITN by Decree-Law 311/98, 14th December, (annex II of the "Portaria 308/2000", 22th February) are very far from being fully occupied. It should be mentioned however that the present needs of personnel are quite distinct from those planned in these laws. Presently there is clearly an increased demand for more qualified staff.

At present, more than 56% of the staff is older than 45. The continuous retirement of researchers and qualified technicians and the legal impossibility to recruit new personnel, has lead to a situation where it is becoming increasingly difficult to fulfill legal commitments of ITN .

As an effort to overcome these difficulties, ITN has made several "*Consultantancy Contracts*" with qualified technicians. However, these contracts have some juridical constrains for both parts, as for example these persons have no hierarchy link to ITN.

In addition to this permanent and contracted staff a significant number of PosDoc, PhD, research grants and University staff participate in ITN research activities. Most of them are paid directly by other institutions (FCT or Universities).

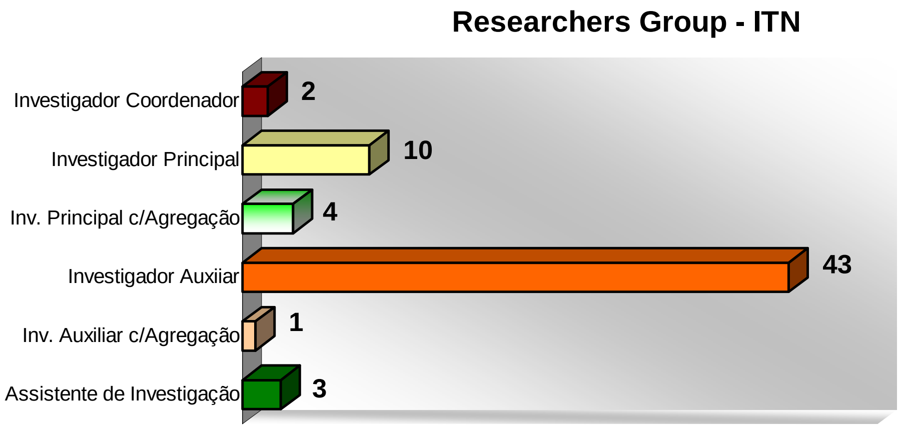
ITN official staff places

Nr. Of Places

- **103** Researchers;
- **14** Graduated Technicians;
- **13** Informatics;
- **16** Technicians;
- **87** Operating Technicians;
- **16** Administratives;
- **8** Workshop Technicians;
- **25** Assistant Technicians.

Researchers

Besides the 57 researchers occupying places of ITN's official number of places, there exists an extra number of 6 researchers under contract with ITN as "Invited Researchers" (3) and "Research Assistants" (3). The total number of 63 Researchers represents about 32% of the total ITN staff and is distributed within the respective career as represented in the following figure.



Due to legal restraints in opening new positions and therefore in obtaining new young researchers or promoting the existing ones, it is the lower level class of *Investigador Auxiliar* that has the largest occupation, with more than 68% of the total research staff. It is also important to note that the top level (*Investigador Coordenador*) has only 2 researchers, one of which is retiring next January and the other will retire, at the latest, in two years time.

Technicians

The technicians group is the largest in number, and it is constituted as follows:

9	Graduated Technicians	ITN Permanent Staff
2	Graduated Technicians	Individual permanent Contract
15	Graduated Technicians	Consultancy Contract
5	Graduated technicians	Graduated Technician grant
5	Informatics	ITN Permanent Staff
1	Informatics	Consultancy Contract
11	Technicians	ITN Permanent Staff
6	Technicians	Consultancy Contract
2	Technicians	Technician grant
41	Lab Technicians	ITN Permanent Staff
1	Lab Technicians	Individual permanent Contract
3	Workshop Technicians	ITN Permanent Staff
2	Workshop Technicians	Individual permanent Contract

It is also important to note that, in this professional group, the number of contracts, either as "*Consultancy Contract*", or as "*Individual Permanent Contract*", represents more than 28% of the total number of the technicians.

Another important aspect is related with the educational level of the technician staff, with more than 60% having at most only the secondary school education.

The human resources situation and its influence on ITN's performance will be further analysed and discussed in Section 6.2.2 of this report.

5. FINANCIAL RESOURCES

The ITN budget officially approved for 2005 was **€ 13.062.009**, with the following main distribution:

- Salaries and running expenses (OF): € 11.892.500;
- Investment (PIDDAC - national component): € 1.169.509.

After the deduction of the legal captivation, the practical budget was reduced to **€ 12.811.734**, distributed as follows:

- OF (State Budget): € 5.961.586 (54,77% of the OF);
- OF (Projects and Services): € 4.923.625 (45,23% of the OF);
- PIDDAC (national component): € 919.234.

  (this PIDDAC component represents only 7,17% of the total practical budget in 2005. Since 2002, FCT does not transfer to ITN any European Community component of the approved projects).

Note also that the “Projects and Services” approved budget (€ 4.923.625) is based on a **prediction** and does not necessarily correspond to the actual amount collected by ITN as shown in the following section.

Income

The actual “Projects and Services” income in 2005 was € 3.022.859 until November 30. This value represents 61% of the **predicted value** (€ 4.923.625) and can be classified by its origin as:

Grupo/Descrição	Valor Arrecadado
Transfer from others institutions (contracts)	€ 2.218.953
Sales	€ 19.063
Services	€ 784.843
TOTAL	€ 3.022.859

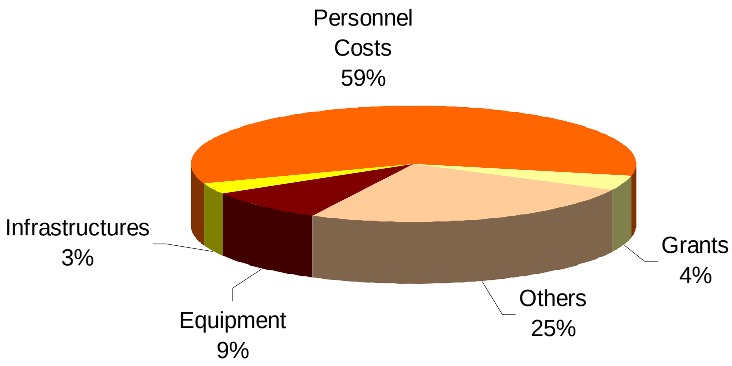
The amount of € 2.218.953, classified as *Transfers from other Institutions*, is mainly related with the income assigned to R&D projects and includes advance payments by FCT for projects connected with the *National Program of Scientific Re-equipment*. This income comes from other institutions, which are partners in research projects, from FCT and other national and international financing sources including EU research projects. During 2005 and till November the 30th, the direct transfers from FCT were 72% (€ 1.591.119) of the total *Transfers from other Institutions*.

The income from services corresponds to 26% of the *Projects and Services Income*. In this class, the *liquid helium*, *thermoluminescence analysis*, *other analysis* and *evaluation of the radiological security conditions* are of particular importance.

Expenditure

The total expenditure (amount paid by ITN until December 28th 2005, supported from OF and PIDDAC was € 9.393.355. This value can be separated in five groups:

	Total Expenditure
Personnel Costs	€ 5.536.169
Grants	€ 375.647
Others	€ 2.362.869
Equipment	€ 833.833
Infrastructures	€ 284.837



More than 88% of the budget is related with fixed expenditures, namely, *Personnel Costs and Grants* (63%) and *Goods and Services* (25%).

It should be emphasized that the weight of the Personnel Costs represents 93% of the State Budget (OE/OF).

The expenses in equipment (€ 833.833) and infrastructures (€ 284.837) were financed from:

State Budget: € 371.195 (corresponding to 4,38% of the OE/OF).

PIDDAC: € 747.475 (corresponding to 81,41% of the PIDDAC).

The investment was mainly made in the acquisition of infrastructures and scientific equipment.

Further comments on the financial situation and its relationship with ITN activities will be made in Section 6.2.2.

6. FINAL CONSIDERATIONS

6.1. STRATEGY

ITN has permanently taken into consideration the strategic objectives of radiological surveillance, prevention and limitation of health and environment hazards caused by natural and artificial radioactive sources and radioisotopes and by their applications as well as of the use of radiations and radioisotopes for protection of the environment, health care, preservation of the cultural heritage and modernization of the industry.

Within these main objectives, ITN aims at the development of nuclear sciences and techniques namely through:

- **Protection and safety,**
    - ensuring the performance of the corresponding duties that are legally assigned to it;
    - intensifying research activities in radiation protection and nuclear safety using multi-departmental teams and participating in national and international projects;
    - promoting higher education and professional training;
    - providing services of public interest or of high technical and scientific value without alternative in the market;
    - ensuring the fulfillment of commitments of the Portuguese State, within the scope of international treaties, and providing technical support to the Government;

- **Research,**
    - asserting itself, due to its own scientific and technical capacities, as an unavoidable key partner in projects and research networks involving nuclear and non nuclear techniques in the areas of materials sciences, life/health and environment;
    - maintaining and developing facilities that are unique in the country (such as the Portuguese Research Reactor, the Van de Graaf accelerator/ion implanter, Cryogenic Techniques and Dating laboratories, etc.) and making them available to the scientific community;
    - promoting the use of the Portuguese Research Reactor (RPI) by the external community and taking advantage of it as a unique instrument in the Iberian Peninsula;

- **Training,**
    - through the implementation of an institutional policy in the areas of education and training. Creating ITN’s Training Center in order to ensure cooperation with Higher Education Institutions both at the level of under-graduation and post-graduation, Professional and Technological training, Specialized short courses, Seminars and other actions;
    - promoting, as before, the use of RPI by the external community and taking advantage of it as a unique instrument in the Iberian Peninsula;

- **Cooperation with other Research Centers, Groups and Higher Education Institutions,**
    - Establishing partnerships and favouring common interest activities in laboratories to be created within or already existing in ITN’s campus;

- **Cooperation with external entities such as industries, health institutions, environment institutions, services and others,**
  - creating improved cooperation conditions that will simplify the establishment of partnerships and transfer of technology;
  - creating conditions for the campus of ITN to be used as a technological pole;

6.2. DEVELOPMENT DIFFICULTIES

The development of ITN has been conditioned, in the past few years, by different factors that can be considered of two types: internal and external.

6.2.1. INTERNAL FACTORS

As far as the internal factors are considered, it is important to emphasize that ITN is served by highly qualified teams with recognized international prestige. The dynamism and high degree of scientific motivation of these teams constitute ITN's most valuable asset. In fact it has been only due to its dedication and high level of proficiency that the above described activities have been carried out and the laboratories kept operational. However in many cases the full and efficient exploration of ITN facilities is limited by staff ageing and reduction, as explained below.

On the other hand and as described before, ITN owns important and highly valuable facilities, most of them unique in the country and some unique in the Iberian Peninsula. These facilities have been maintained in good operation conditions, and benefit a large external scientific community. The IAB mentions these facilities in its May 2002 report, listing some concerns that the present Directive Council has addressed in order to improve the situation:

- Radiation Technologies Unit (UTR) – the ^{60}Co source was reaching the end of its useful life time. This situation became worse in 2003. The suggestions of the IAB were then followed by the Directive Council who established a partnership with a private group that recharged the unit with fresh ^{60}Co and improved the conditions of the remaining equipment. The unit is now in perfect operational conditions and is used for commercial purposes by the private group and for research purposes by the scientific community;
- ICP-MS Instrumentation – the IAB considered of the utmost importance for ITN to obtain this equipment. Only now (2005), through an approved FCT's (Science and Technology Foundation) re-equipment program, it was possible to start the acquisition procedures for this equipment in a basic version. It will be installed in the Chemistry building and made available to both internal and external scientific community;
- Cyclotron for medical purposes – the present Directive Council of ITN followed the IAB recommendations and contacted several entities namely DGS (General Directorate for Health) in order to analyze the interest in acquiring a cyclotron both for research activities and for production of radioisotopes for medical applications. However, it was not possible to obtain a clear picture on the need for this acquisition given the fact that other entities (both private and public) are already following procedures for the acquisition of this type of equipment. This subject is still under consideration namely through a partnership to be established with INETI with the objective of taking advantage of a piece of land connected to

ITN's campus (bought some years ago as a natural expansion of ITN but, unfortunately and for unknown reasons, it remained as INETI's property when ITN was separated from INETI);

- Van de Graaff accelerator – the intensive use of this facility by the scientific community led the IAB to suggest its expansion through the acquisition of a Tandem accelerator. This objective was pursued by ITN and procedures are under way for the acquisition of such a facility from CSIRO in Australia. ITN has already received the necessary authorizations and financial means are also ensured. Procedures for the installation of the equipment in ITN's Physics building are already under way;
- Portuguese Research Reactor (RPI) – development of external support equipment and expansion of the use of this facility, unique in the Iberian Peninsula, have suffered delays in the past few years due to the lack of a final decision (by the Ministry) on the future of this facility. This situation was due to the fact that, in May 2006, it would be necessary to stop using a core of HEU (*High Enriched Uranium*). It was only in 2005 that the Government made the political decision of keeping the RPI in operation using LEU (*Low Enriched Uranium*). Technical and financial support to be provided by the USA and IAEA were negotiated by ITN and the core change procedures are under way;
- Chemistry Sector – the coordination of the activities in this area are now the responsibility of a researcher appointed by the Directive Council in accordance with the IAB recommendations;
- Department of Radiological Protection and Nuclear Safety (DPRSN) – this department is considered as the first priority of ITN, having a large amount of duties clearly listed in the existing legal framework. IAB has pointed two important factors for concern: chronic lack of personal and deficient laboratory conditions which could compromise the accreditation process. In spite of these adverse conditions the results of international inter-comparison exercises obtained in the past few years are good. However, it is clearly accepted that the situation must be improved. With the help of DPRSN staff, the present Directive Council implemented several corrective actions based on a new Department leadership and promoted the improvement of the laboratories conditions through the introduction of quality systems.. Though a strong effort in this direction has been already made, such as writing down technical procedures and the introduction of a laboratory information management system for most of the Environment Radioactivity activities, a number of other actions still need to be done in order to achieve the desired results. Lack of stable and adequate human resources keeps remaining as an an unsurpassable difficulty that prevents finishing in due time some of the actions and precludes obtaining the goal of certification. Unfortunately, it has still been impossible to adequately solve the chronic problem of lack of personal due to the existing legal framework (see next Section - External Factors).

As far as the internal structure of ITN is concerned, the IAB has considered as his major concern a number of still unsolved previously pointed problems (***"The International Advisory Board regrets that problems of the internal managerial organization seem to have increased rather than diminished in the 2001-2002 period"***), as follows:

- A Directive Council based on just one person (the President);
- A non operative Scientific Council;

- Two broad areas (Physics and Chemistry) without Direction or Internal Coordination;
- Lack of internal management structures;

The present Directive Council, now constituted by two persons (a President and a Vice-President), took steps in order to answer IAB criticism and to solve the previous situations.

One of the steps was the appointment of senior researchers with the responsibility of coordinating the different sectors of ITN, and the realization of regular meetings of them with the Directive Council in order to ensure a shared management of activities and a better definition of the institution operational policies.

The Scientific Council of ITN restarted its activities and its Coordinating Body meets regularly with the Directive Council, thus ensuring an improved scientific management of the institution.

The administrative structure of ITN (and the corresponding internal procedures) was reformulated. A Direction of Administrative and Management Services is now in operation under an appointed head, ensuring a continuous improvement of the efficiency of the services.

It is important to mention that, after 2002, there was no proposal for the creation of a new IAB (the previous one considered his mandate finished). This decision was due to the following reasons:

- The need to start by implementing solutions to answer the criticisms of the IAB whose previous successive reports showed maintenance of the majority of the pointed problems;
- A budget below the real needs of the institution. This situation was worsened by the fact that the present Directive Council was confronted with a large debt to suppliers that needed fast corrective actions. At the same time difficulties increased due to the fact that financial autonomy was suspended by the Government;
- The fact that the Government in place, at the time, was carrying a study of the State Laboratories with the purpose of re-structuring these institutions and was not concerned with the existence of an IAB. A Working Group was then nominated by the Government and ITN met regularly with it.

Having solved most of the previously listed problems, ITN is now prepared to propose a new IAB.

6.2.2. EXTERNAL FACTORS

ITN has been under great difficulties in order to accomplish its legally assigned duties. The main reasons for this situation lie on the fact that ITN has been going through a fast and continuous degradation of its operational capacities, due to external factors namely (see also chapters 4 and 5):

- A continuous reduction of the personal working at ITN, resulting from the legal impossibility of replacement of those that retire or leave ITN for any other motive;
- The difficulty, mainly due to legal restrictions, to fix a stable technical body, with specialized training, indispensable to adequately perform the duties assigned to ITN and to provide specialized services to the external community;

- The slow but continuous budget reduction (in real value) that results not only from the reduction of the State budget but also from the reduction of the capacity to acquire earnings from external services due to a chronic reduction of the human resources.

Due to its specific area of activity, unique in the country, ITN is assigned various duties related to the Portuguese State obligations and commitments within international treaties and European Community legislation. ITN also ensures international relations in the area of nuclear sciences and technology, participating in various international Commissions, Working Groups, etc. These activities tend to increase along the years and, together with the reduction of human resources, constitute another factor that contributes to the reduction of the capacities of ITN to acquire external financing through national and international projects and services.

Given the fact that ITN’s State budget is mainly assigned to paying salaries, it is obvious that almost all of the remaining costs have to be covered by external financing. This is an important factor, together with the lack of adequate human resources, contributing to menacing a good institutional operation.

Also, since January 2003 through to December 2005, ITN lost its financial autonomy due to a Resolution of the Council of Ministers. This fact did not help because it increased the bureaucratic complexity. Fortunately, this situation was recently corrected by the Government and financial autonomy will be reintroduced in January 2006.

In addition and as already stated previously, ITN started its annual exercise in 2003 with a large debt to suppliers. This situation was mainly due to the impossibility to accomplish the income predicted in the previous budgets (lack of payment of services provided, reduction of the number of services, delays in receiving financial support from FCT, abruptly ceased FEDER component of PIDDAC, etc.). Fortunately, the previously mentioned debt situation is now solved.

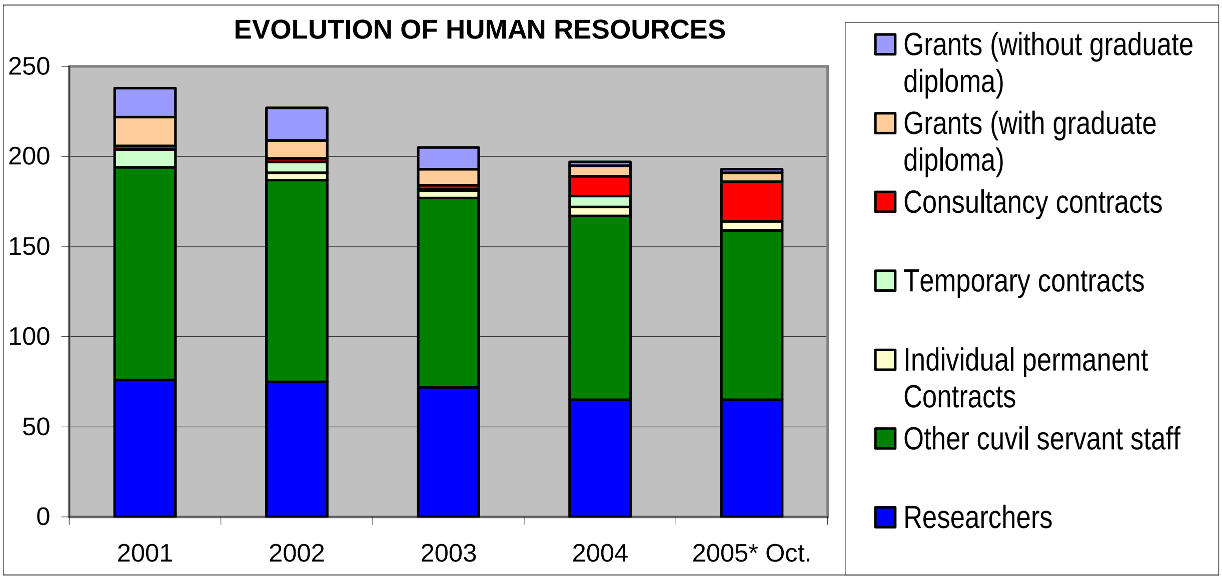
Turning back to the human resources, the continuous reduction of their number in parallel with the refusal, by the Government, of allowing hiring personal with a stable job, precludes the different activity units from creating or even maintaining or renewing basic teams to support their operation. The consequence is an increasing aging of the existing teams and the under-population of some areas and therefore, the risk of loosing accumulated know-how.

The following tables and graphs demonstrate what has been said previously.

EVOLUTION OF ITN HUMAN RESOURCES

	2001	2002	2003	2004	2005
Researchers	76	75	72	65	63*
Other civil servant staff	118	112	105	102	90**
Individual permanent contracts	0	4	4	5	5
Temporary contracts	10	6	1	6	0
Consultancy contracts	2	2	2	11	22
Grants (with graduated diploma)	16	10	9	6	5
Grants (without graduated diploma)	16	18	12	2	2
TOTAL	238	227	205	197	187

* - Including 1 researchers waiting for retirement (6 researchers are not yet confirmed as permanent staff).
** - 2 not working at ITN., so the actual staff number working at ITN is 88.



It is evident that, since December 2002 till now, ITN lost 42 members of its staff. Of these 13 were researchers. Soon, another 1 researcher will leave ITN through retirement (due to reaching 70 years of age). It is also obvious that, even in December 2001, ITN was forced to use special forms of non-stable personal hiring (individual permanent contracts, consultancy contracts, temporary contracts and grants) totaling 44, in order to try to fulfill its duties with special emphasis in the area of radiation protection. It is important to note that ITN performed a considerable effort, since 1999, training laboratory technicians under a program that financed various scholarships. Though a high number of people received good specific training, none of them could join ITN's staff, due to legal impediment. A large number of these technicians managed to obtain jobs away from ITN and a very small number is still providing services to ITN under non binding task contracts. So far this was the only means that was found, with the support of the Government, to avoid worsening of ITN's human resources problems. Nowadays and despite the increase of the number of legal duties and obligations, the number of collaborators under these hiring conditions is only 34 i.e., 10 less than in 2001.

As far as ITN's income is concerned, the situation is far from satisfactory given the fact that there is a continuous reduction of its value along the past few years.

State Budget and Project and Services income of ITN (Real values in Euros)

	2001	2002	2003	2004	2005*
State budget (salaries & current expenses) OE	6003033	6234974	5898734	5846506	5961586
State budget (investment) PIDDAC	501217	1472408	1116466	978588	919234
Project and Services income	3929960	3237100	2055411	1858101	3022859

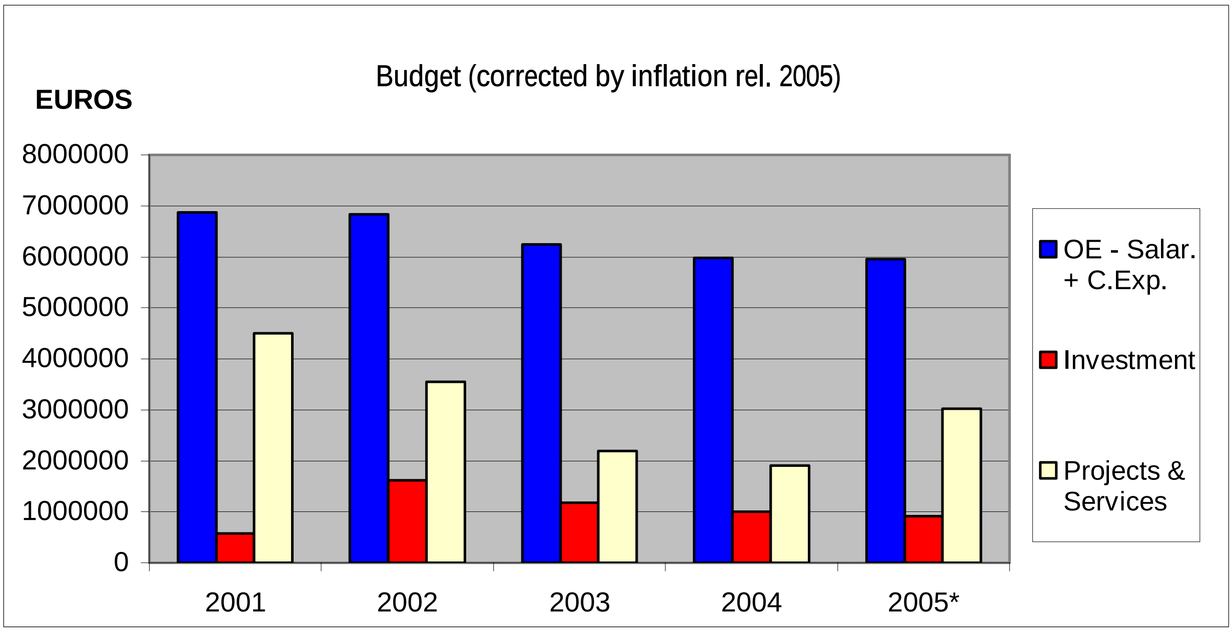
* - till 30th November

State Budget and Projects and Services income of ITN

(Values in EURO, corrected by yearly inflation relative to 2005)

Year Inflation	2001 4,4 %	2002 3,6 %	2003 3,3 %	2004 2,4 %	2005*
State budget (salaries & current expenses)OE	6868015	6832736	6239633	5986822	5961586
State budget (investment)	573438	1613571	1180989	1002074	919234
Projects and Services income	4496231	3547449	2174197	1902695	3022859

* - till 30th November.



Projects and Services Income

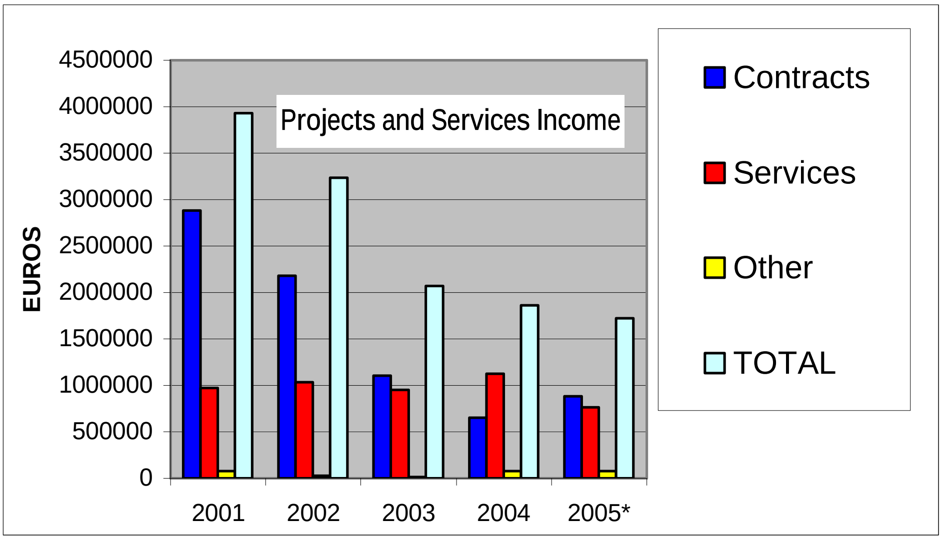
	2001	2002	2003	2004	2005*
Contracts	2878721	2179615	1107137	656134	2218953
Services	974608	1032477	948274	1128406	784843
Other income	76631	25008	16803	73561	19063
TOTAL INCOME	3929960	3237100	2055411	1858101	3022859

* - Received till 30th November 2005

It is important to note that the apparent more substantial increase of the income in 2001 and 2002 is related with extraordinary resources given to ITN through projects financed by FCT with the aim of supporting a mission to Kosovo and building a new library in ITN's campus.

Also, the "Projects and Services" income in 2005 increased quite substantially when compared with the previous years (2003 and 2004). This is just the consequence of a transference, by FCT, of a large amount of money during the past few weeks. This money is allocated to the *Scientific Re-equipment* project and should be transferred to ITN only during 2006. Actually, in the first week of November, ITN's Projects and Services income was only € 1.721.356.

Taking into account what has previously been said, there is a tendency for the private income to be reduced every year due not only to the reduction of the operational capabilities of ITN (reasons already described) but also due to lack o payment of services provided by ITN.



* - Considering the amount received till the first week of November

6.3. PERFORMANCE INDICATORS

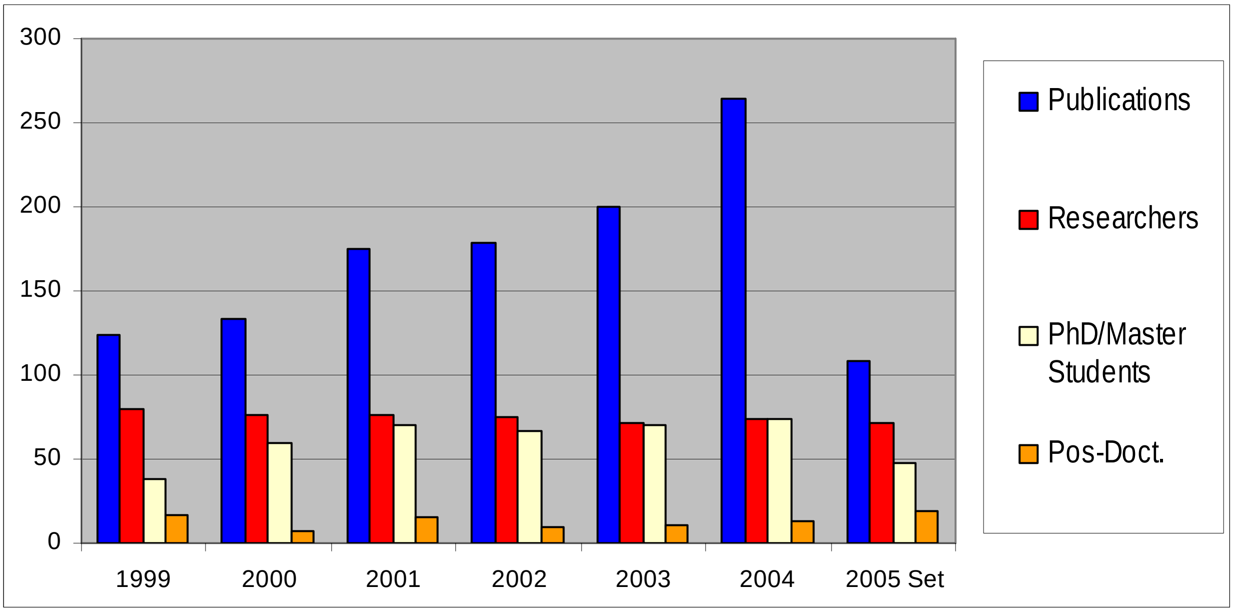
6.3.1. Research and Development

Concerning the objectives of ITN in the area of research and development, the best indicators are the annual scientific production and the number of students and research scholars as shown in the following table and graph.

Scientific Production

	2001	2002	2003	2004	2005 Sept
Publications	175	178	200	264	108**
Researchers*	76	75	72	74	72
Students Ph.D./M.Sc.	70	67	70	74	47***
Post-Doc.	15	10	11	13	18

* - Including 9 university staff performing research projects at ITN.
** - Counting only those publications mentioned in ISI until September 2005.
*** - Counting only those directly supervised by ITN researchers. Actually the total number is 55.

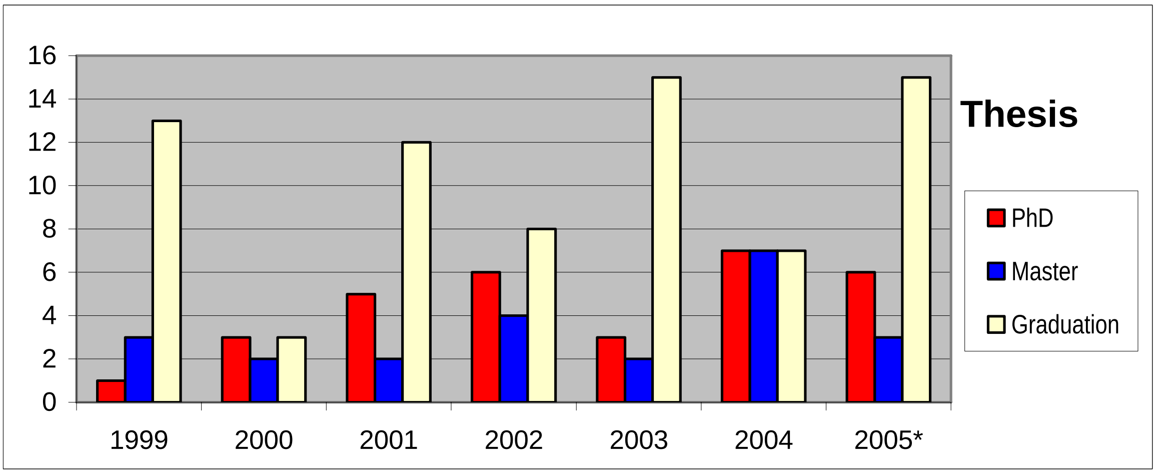


6.3.2. Training

According to the IAB recommendations, ITN has developed a noticeable effort, in the past few years, as far as training and education are concerned. The situation is as follows:

- Eight (8) researchers perform active teaching duties, as invited Professors, in Higher Education Institutions;
- Another two (2) researchers perform regular teaching duties (without contract) within two M Sc. courses of the Faculty of Sciences of the University of Lisbon (FC/UL);
- In 2004, ITN established a partnership with IST (engineering School of the Technical University of Lisbon) and with FC/UL to provide two (2) joint M. Sc. Courses in the areas of Radiological Protection and Inorganic and Radiopharmaceutical Chemistry;
- More than 20 researchers of ITN have taught, since 2001, various subjects in M. Sc. courses (10) and under-graduation courses (11) in Higher Education Institutions (Universities (8) and Polytechnics (1));
- The number of training actions where ITN human resources are involved is large (more than 80 currently) especially at the post-graduation level. The following table shows the number of post-graduation thesis that were supervised by ITN research staff. It is important to note that the actual supervising number of cases is larger than presented because, in many cases, the supervising work is performed without formal recognition by the universities;

THESES	2001	2002	2003	2004	2005 (Oct.)
PhD	5	6	3	7	6
Master	2	4	2	7	3
Graduation	12	8	15	7	15



- In 2001, 2002 and 2003 ITN organized or participated in eleven (11) Professional Training courses, sixteen (16) researchers taught thirty one (31) lessons in Professional Training actions organized by other institutions, thirty three (33) researchers supplied fifty four (54) lessons either isolated or as part of M. Sc. and under-graduation courses, seminars and workshops;
- Every year, ITN participates in training actions within the "Ciência Viva" program;
- For many years now, ITN regularly discloses publicly its activities among students and teachers of the secondary and higher education sectors offering guided visits to its facilities. Also, ITN organizes an Open Day every year. In the current year of 2005, till October, ITN has already received 1052 visitors.

Finally, it is important to emphasize the continuous evolution of ITN researchers qualifications. As an example, between 2003 and 2005, two researchers of ITN have obtained the academic title of "Agregado" (habilitation) after being approved in public examination in universities

6.3.3. Cooperation with other research centers or groups in Higher Education Institutions

As far as cooperation with other research units is concerned, ITN keeps accomplishing its own objectives, also in accordance with the recommendations of the IAB: ***"The ITN can have, as a complementary task, to provide a number of facilities for experimental research for the scientific community in Portugal which are beyond the capacity of a single university. The nuclear facilities of ITN are unique in Portugal, with specialized equipment that exceeds the ability of a university to acquire and maintain. A mission of ITN should be to make these facilities available to university (and private laboratory) researchers including technical help and laboratory space for these external users (particularly from universities)"***.

The performance of ITN can be verified by the following:

- The large number of Ph.D., M.Sc. and under-graduated students that develop their research projects and training activities in ITN, under supervision of ITN researchers;

- The large number of cooperation actions with centers and laboratories of higher education institutions, both national and international, with an average of 10 University Professors regularly performing research activities in ITN laboratories. Among current R&D partnership projects it is possible to name 10 Portuguese universities and polytechnics, with special emphasis on those in the region of Lisbon (namely the Center for Nuclear Fusion of IST, Center of Nuclear Physics and Center of Condensed Matter Physics of FC/UL) and approximately an equal number of foreign universities. Other national research institutions such as the Meteorology and Hydrographic Institutes, Ricardo Jorge National Institute of Health, INESC, ITQB and ICAT and foreign institutions such as CERN, CEA, Barcelona and Madrid Institutes of Materials Science, among others, are also ITN research partners;
- The search, by ITN, for creating conditions in the campus that will allow spaces for other centers and research groups to be installed so that common activities can be performed more efficiently taking better advantage of the partnership with ITN and its know-how. This matter has recently been under analysis together with the Ministry (MCES/MCTES), involving IST namely as far as its Laser and Plasma Group and Fusion Laboratory are concerned;

6.3.4. Cooperation with industrial, health, environment, services and other entities

ITN currently cooperates with a wide variety of private and public institutions and enterprises namely EDP, CHIP, VALORSUL, and several Hospitals to which ITN provides a vast number of services. Despite the large number of difficulties arising from the national economic situation, ITN keeps establishing contacts with the objective of providing a more efficient namely through the establishment of partnerships and technology transfer actions. As an example:

- ITN established a partnership with a private Group aiming at recovering, modernizing and exploring the Radiation Technologies Unit (^{60}Co radiation source), unique in the country;
- The search, by ITN, for obtaining conditions in the campus and in the adjoining INETI campus, which will allow the installation of activities by other public and private entities, for the realization of activities that may involve ITN. This matter is currently under analysis.

6.3.5. Protection and Safety

This is considered by ITN as an area of first priority. Efforts are constantly being implemented in order to reinforce the means that this Department of ITN has available. The main problems are related with a chronic under-staffing and lack of some resources that preclude a full accomplishment of the duties assigned to this Department. The year 2004 was significative because ITN was provided some support from its Ministry in order to reinforce its human resources (though in a precarious manner) and invested an important part of its budget with the aim of,

- Answering the need for creating special intervention teams in case of radiological emergency during the EURO 2004 realized in Portugal;

- To ensure the adequacy of the existing means for Portugal to fulfill its international obligations in the area of the population radiation protection.

However, some of the former scholarship owners that provide technical support to the activities of ITN are still waiting, under a periodic contract, the possibility of being allowed to a normal contract with ITN with a minimal stability, indispensable to the efficient performance of these activities and to allow certification of the relevant laboratories.

Lack of an adequate number of technical staff is also responsible for a great effort of the researchers of the DPRSN who spend all their time in performing legal duties and services thus being not able to perform activities of R&D. This creates an unjust situation as these researchers cannot be promoted due to lack of scientific activity, according to the requisites of the law that governs their careers and therefore, leads to lack of motivation.