

3. Institutional development plan for the next 4 years

One of the main challenges for a management team is to carry out a realistic and feasible short and medium term development plan, able to lead to the increase of the institutional performances. In agreement with the rules of strategic management the first step, is the deep, pertinent and critical evaluation of the present situation – internal (Strengths, Weaknesses) and external (Opportunities, Threats) factors. Typical for organizations of which main activities is research, development and innovation, this SWOT analysis refers to targets (scientific activity) and means (financial resource).

3.1. Scientific SWOT analysis

- ***Strengths***
 - The researchers form INCDTIM carry on their activities in a high performance research institution, with a tradition of 60 years, certified as a National Institute of Research and Development in 1999 and re-accredited in 2003 and 2008;
 - The research topics developed in our Institute - stable light isotopes (except hydrogen), molecular and biomolecular physics, part of nanostructured materials - are specific for our area of research. These issues don't overlap or are complementary to the topics of other national institutes;
 - The activity in the institute follows the performance standards implemented through the quality system ISO 9001:2008; certified in 2010;
 - The attested research staff – 105 researchers and 12 engineers – is highly qualified – 70 have a PhD degree and 28 are PhD students;
 - In the area of fundamental research, the distribution on specialties and scientific degrees fits with the active projects, assuring an efficient cooperation;
 - The research infrastructure is reach and attend a high level of performance – more than 90% of our laboratories are upgraded and equipped with high performance equipments – more than 70% from our research equipments are less than 5 years old;
 - A high-performance ICT platform, with a high processing power, a big storage capacity and a high-speed communication network, all of them located in the INCDTIM Data Center which is also a certified GRID site - RO-14- ITIM;
 - Good cooperation relationships among the departments from the institute and also good connections with other research groups at regional, national and international level;

- Well defined and transparent staff evaluation system, in agreement with their scientific performances and their ability to attract financial funds;
 - Attractive work environment, correct relationships with the support teams and with the administration.
- ***Weaknesses***
 - There are fields of research which don't benefit of an updated research infrastructure, necessary to the ongoing projects;
 - Not all the research teams reached a „critical mass” that can guarantee the capacity of winning projects in a competitive system in order to insure a constant financial support;
 - There are research groups in which the average age is relatively high and we haven't enough young scientists able to take over the research tasks from their colleagues which comes close to their retirement;
 - The inadequate organizational culture and the excessive individualism of some of our senior researchers leading to a reduced ability to form research groups and to guide them;
 - Some of our teams have a reduced number of highly specialized researchers, and therefore they are not able to turn the theoretical results into applicative developments and finally to patents and technology transfers;
 - There are some groups which lack the specialized technical staff, able to assure the qualified operation of the highly specialized research equipments.
 - ***Opportunities***
 - Romania has well defined multiannual Plan for the implementation of the National CDI Strategy. The medium and long term strategy of the Romanian research in physics is clearly established as a result of the recently finalized ESFRO project.
 - A reformed evaluation system for the performances in research which is in agreement with the widely recognized criteria (scientific papers published in ISI indexed reviews, patents);
 - The establish and development of the Romanian research area guided by the European models and the restructuration of the national research system;
 - The opportunities offered by the competitions of research projects within the framework of IDEAS, Partnerships, Capacity and POS programs and also by bilateral cooperation with European countries;
 - Several research teams from INCDTIM are involved in large international cooperation programs – CERN, Dubna, ELI.

- ***Threats***

- The recent excessive competition on the research market. The decrease in the number of students leads to an increasing interest of the universities towards the research activities;
- The instability of the Romanian system of research – the frequent institutional changes makes it very difficult, if not impossible a long term strategic management;
- The uncertainty and the lack of predictability of the CDI funding. The competitions for research projects are organized randomly and the information packages and the eligibility criteria are changed significantly from a competition to another.
- The influence of the politics on the visibility of Romanian research in Europe – the degree of distrust and subjective negative appreciation in refereeing the FP7 project proposals;
- The decrease of interest for higher education in the field of fundamental sciences: mathematics, physics, chemistry, biology. The reduction because of this of the selection pool of young researchers and the relative decrease of the attractiveness of the scientific researcher career.

3.2. Strategic scientific objectives and directions.

The strategic directions of the research-development-innovation activity in INCDTIM have the following scientific objectives, from fundamental research to the applied ones, with possibilities of being exploited, through technological transfer in the real economy :

➤ ***Applications based on isotopic tracers and molecular markers for the characterisation of the processes which conditionates the environment quality and food safety***

- The development of complementary natural ratio isotopic analysis to make possible the isotopic authentication methods for food products: fruits, honey, meat and diary products, to differentiate between organic products from fruits and vegetables produced by traditional agriculture and adulterated products;
- Certification of origin, adulteration and quality of foods and beverages using NMR, isotopic and photothermal techniques;
- Structural and quantitative determinations of compounds from the environment, food and biological tissues;
- Studies on innovative catalytic materials applied to chemical and microbiological decontamination of air from indoor spaces;
- Modern methods based on molecular studies for the investigation of art objects;
- Studies on the optimization and modernization of municipal waste water treatment stations;

- Structural and purity determinations for organic complex substances;
- Structural investigations of the pollutants from the big water catchment areas from Romania;

➤ ***Carbon nanostructures***

- The determination of graphenes synthesis conditions on supported noble metals catalysts through the CCVD-IH in view of directly obtaining of graphenes decorated with noble metals nanoparticles;
- The study of electrochemical oxidation processes of adenine, guanine and DNA by using modified electrodes with graphenes decorated with noble metals nanoparticles in view of the fabrication of electrochemical sensors;

➤ ***Hydrogen storage***

- Porous organometallic compounds for hydrogen storage – synthesis, characterization, and the increase of the storage capacity;
- The synthesis of new compounds for the efficient hydrogen storage based on porous organometallic compounds or nanoporous carbon materials with ordered structure;
- The optimisation of microwave field synthesis methods for the porous metal organic framework compounds (MOF) and the improvement of the MOF purification methods, by supercritical carbon dioxide extraction, for medicine (drug carriers), energy, catalysis and gas adsorption applications;

➤ ***Applied physics research with High Tech products results***

- The cooperation with the ATLAS group at CERN Geneva for the redesign of the drawer assembly of the Tile-calorimeter and the fabrication, in our Institute, of the mechanical prototype and of some electronic components;
- The cooperation with the Thales Optronique SA, France, for the design and fabrication of some optical components prototypes for laser systems of very high power/ ultrashort pulses;
- The design and the fabrication of some special detectors for gas chromatographs and mass spectrometers;

➤ ***Alternative and renewable energies***

- Solar thermal energy conversion to electrical energy by means of Stirling engines with linear generators, respectively by means of rotary turbo engines of axial classical type / Tesla turbines;
- Electricity generating systems by recovering the parasitical vibrational energy – traffic noise and wake-turbulence encounter on highways, respectively the tremour of road constructions – bridges, viaducts, tunnels;

➤ ***Nanocomposite materials: synthesis, characterizations and applications***

- Core-shell nanoparticles as bio-conjugate platforms in cancer cells targeting and therapy; multifunctional nano-platforms will ensure hyperthermia, laser ablation of cancer cells, drugs delivery and NMR imaging contrast agent;
- TiO₂ based photo-catalytic systems for biomedical applications;
- Detection of biomolecules by using multicomponent nanoparticles with designed magnetic, optic, dielectric and functional properties; construction of specific devices designed for microfluidic cell separations and biomolecular detection;
- Multifunctional nanoparticles with adequate properties for controlled drugs delivery and release; they are based on porous silica nanoshells or hollow spheres;
- Environmental determination of antibiotics and other residual medicaments: effects on microbiota and nutritional plants;

➤ ***Functionalized hybrid materials based on polymers and inorganic nanoparticles: design, synthesis, characterization and applications***

- Novel smart magnetic nanogels with controlled structure, responsive properties and specific functionality, suitable for applications in biotechnology and nanomedicine;
- Development of innovative methodologies for functionalization of monomers, polymers, magnetic nanoparticles and magnetic nanofluids;
- Complex characterization of functionalized hybrid materials: nanostructure-properties relationship, responsive properties to external stimuli, biocompatibility, specific interactions with biomolecules and selected drugs, recyclability;

➤ ***Spectroscopy of nanostructured multifunctionalized supramolecular systems***

- Functionalized supramolecular systems with applications in medicine and pharmacy;
- Spectroscopy and molecular structure of art objects constituent materials for their conservation, restoration and valorization;
- Spectrofluorimetry of the inorganic/organic art objects' compounds, artefacts and of polycyclic hydrocarbons pollutants;
- Preparation, characterization, homologation and technological transfer of hard concrete and of vitreous materials protection shields for ionizant electromagnetic radiation;
- Nanodimensionality unitary analysis of metallic clusters with catalytic properties;
- Design and implementation of the software products dedicated to structural models determination for the advanced materials;
- Global, local and electronic structure determination of nanostructured materials based on physical spectroscopy that use classical and synchrotron X-ray radiation;

➤ ***Catalysts design, synthesis, characterization and applications***

- Advanced nanostructured catalysts for energetic hydrogen production, by reforming of biomass wastes (ethanol, glycerol, etc);
- Nanostructured selective catalysts for the production of carbon nanostructures (nanotubes, graphenes);
- Advanced denoxification catalysts with low content of noble metals for environmental applications;
- New recyclable organocatalysts based on functionalized magnetic nanostructures for applications in chemical and pharmaceutical industry;
- Advanced catalysts used for syngas production from CO₂ and methane;

➤ ***Molecular and biomolecular systems with controlled architecture and functionality: Physico-chemical and structural characterization, applications in molecular technology and biotechnology.***

- Molecular recognition and self-assembling processes;
- Structural characterization of intermolecular "ligand-receptor" complexes by spectroscopic and calorimetric techniques;
- Crystal and molecular structure determination of Active Pharmaceutical Ingredients by diffraction, spectroscopic, and molecular modeling methods;
- Isotopic effects on electronic structure and electron-phonon coupling in DNA. Applications in DNA Sequencing Technology;
- Modeling of molecular and biomolecular structure – “*ab initio*” calculations, DFT (Density Functional Theory) and molecular dynamics;
- Ultrafast dynamics in condensed matter and molecular systems following their interaction with ultrashort laser pulses;
- The impact of microwaves on molecular and/or biological complex systems - dielectric properties, biological impact of human exposure and protection methods;
- Coherent ultrashort attoseconds XUV and X-ray pulse generation;

➤ ***New methods and techniques for fabrication and characterization of molecular structures***

- Fabrication and characterization of supramolecular architectures with controlled functionality - molecular devices;
- High-throughput screening for new solid forms of active pharmaceutical ingredients by advanced parallel crystallization techniques;

- Self- and hetero-association processes characterization by spectroscopic techniques (IR, UV-VIS, Raman, ^1H RMN, 2D-RMN, RES), X-ray diffraction and izothermal titration nanocalorimetry;
- Molecular incapsulation processes and their pharmaceutical applications - NMR and nanocalorimetric investigations;
- Developement and implementation of new solid-state NMR spectroscopy methods for investigating structure, dynamics and molecular interactions;
- Symbolic computational tools for spin dynamics investigation in modern solid-state NMR spectroscopy;
- Heat and mass transfer in composite media;

➤ ***Stable isotopes separation and isotopic labeled compounds applications***

- The developing of technological researches to separate and produce ^{13}C isotop of carbon.
- The separation of ^{13}C isotope technology developed to a cascade columns with automatic control;
- Development of the ^{15}N production technology at 99% at ^{15}N through isotope exchange in the system nitrogen oxides-nitric acid under pressure;
- Research on thermocatalytic conversion of the waste sulfuric acid from the ^{15}N separation plant to sulfur dioxide to be reused;
- Kinetics of reduction of U (VI) to U (IV) in the ^{235}U enrichment by chemical exchange;
- Developing the research area for the separation of other stable isotopes of interest;
- Extending synthesis and marketing offer for isotopic labeled compounds;
- Study of kinetic isotope effects using molecular modeling;
- Application of H/D isotopic exchange reaction for the determination of the reactivity of metal/oxide catalytic surfaces.

3.3. The human resource strategy.

Adding and rejuvenation of human resources corroborated with the continued growth of expertise and technological skills are the major objectives of INCDTIM in the next four years. The equipment and logistic of institute have been recently renewed with the goal of obtaining new and innovative results and to increase the level of expectation in INCDTIM. This aim can be achieved only by high qualified researchers capable to bring new ideas and research themes which will be proposed in future national and international call proposals.

However, it will strongly depend on the evolution and quality of Romanian school and on young people's interest in natural and engineering sciences, and in particular in research activity.

Taking into consideration the current decrease of education's quality, it becomes extremely difficult to teach new employees if they lack the basic background.

To raise quality and efficiency of this activity, one of the goals of INCDTIM is to obtain doctorates driving right by the CSI of INCDTIM. Young people will be sent abroad with internship grants in order to attend international conferences, to familiarize themselves to the European research environment and to establish useful relationships for their future collaborations.

Also, by funding institutional or structural projects such as DRU, young researchers will attend general management, strategic management and project management trainings. They will get the ability to manage research projects and this may help to get new positions in the institutional hierarchy.

One of the ways to attract young fresh graduates, or those with overseas experience in the field, is offering attractive salaries, working conditions being already comparable to the West. The goal is to ensure a continuous flow of hiring of young professionals to maintain an average age of 40-45 years, and taking into account the natural replenishment system outputs.

The primary goal for 2015 is coagulation and development of research groups to the corresponding optimal value of INCDTIM rooms and equipment - 250 people in total, while 175 in the R & D activity. A secondary goal, but equally important is to ensure an optimal distribution on jobs, training levels and scientific degrees, allowing the complete cycle of research in terms of technological development activities revival - with integration engineers and technicians in the multidisciplinary research groups.

3.4. Mechanisms for stimulating the appearance of new research directions.

The appearance of new themes and research directions is determined by the skill level of the primary researchers and their creative ability. It is quite easy to get an idea for the new research plan but is not an easy task to be solved as first you need to acquire the corresponding funding. As a policy of INCDTIM, we used priority funds from the "Nucleus" program – where the funded themes and research topics of young engaged researchers involved in doctoral studies were priority selected with the aim of gaining in knowledge storage needed for participation in big competitions such as Ideas or Partnerships-type projects. It should be noted that this policy had positive effects, many of subjects studied today, in large national and international projects originate from "Nucleus" projects started few years ago.

Another method of financing new projects is through "Exploratory Ideas" or "Complex Ideas" call projects. The more restrictive formal degree of these projects - strict adherence to plan activities, obligation of obtaining measurable results, strict calendar, have rather negative

effects than “Nucleus” projects - with high degree of freedom. In fact, experience has shown that in recent years at national level the report results / costs were clearly in favor of the “Nucleus” compared with other projects.

Forms of funding through academic grants disappeared and obtaining sponsorships is more hypothetical and in any case insufficient. For these reasons, we hope that the ways of funding additional basic and institutional excellence, which will replace the “Nucleus” program in the near future, will include a component directly correlated to this area of exploratory research and to the new research themes.

3.5. Financial SWOT analysis.

- ***Strengths***

- The existence of signed research contracts with multi-annual financing, which continues in 2012 such as: high capacity, POS, IDEAS, FP7, Capacities Module III, bilateral with France and Austria - which provides partial financial resources;
- Consistent scientific results and better equipped laboratories corroborated with more efficient use of space, will lead to high influence coefficient of INCDTIM, in particular for determination of funding levels for basic and excellence of institution;
- The existence of an ISO 17025:2005 accredited laboratory, four methods of analysis and highly qualified personnel, which gives unique status of INCDTIM as national full service provider (MS + NMR) for isotopic analysis of wines in agreement with ISPRA standards;
- INCDTIM is the unique supplier of compounds labeled with deuterium, and the unique European producer of compounds labeled with ^{15}N ;

- ***Weaknesses***

- Small volume of patents with immediately interest to the Romanian economic environment - negligible amount of technological transfer products;
- Low interest for innovation activity and non-existence marketing activity in this area;
- Poor funding and ‘hunger’ for economic income leads to acceptance of routine analysis services, which includes a little research poorly paid leading to an inefficient exploitation of equipment performance available in the institute;
- As a public institution, without the help of state support, we operate as a commercial society which must obey the restrictive rules of budgetary institutions - this regime makes very difficult the economic management system of INCDTIM, preventing from an efficient multi-annual cash flow.

- ***Opportunities***

- Renewal of the delivery programs of fertilizers labeled with the isotope ^{15}N to third world countries through the Agency from Vienna;
- Existence of a highly qualified and experienced technical team involved in international collaborations with CERN Geneva and Thales Optronique France for the previous project ELI, that can bring high values from economic contracts with foreign companies;
- The legislation preparation of vine records and the release of origin certificates, actions for which we have the market leading quality;
- Increased interest of the Ministry of Agriculture and the authorized bodies for the food control, for the extension of the methods of analysis by isotopic fingerprinting to cereals, vegetables, and fruits - opens multiple possibilities of capitalization for the equipment and the expertise of the personnel from the accredited laboratory.

- ***Threats***

- Uncertainties regarding the action of certification and the basic level of funding in the National Institutes of Research and Development;
- The restricting access of the INCD institutes to certain type of competitions of research projects, using the principles of caste - for example the interdiction to access funds designated exclusive to Romanian Academy;
- The gradual renunciation in assigning the research projects through competitions and the return to the system of years 2000 – the direct assignment, using subjective criteria;
- Possible actions for the implementation of radical reorganization ideas in the Romanian research system by abolishing INCD institutes, or by privatization with "strategic partners" which abolish them and sell their land (facts happened in the recent history);
- The major economic crisis, which may lead to a general collapse.

3.6. Infrastructure: investment plan and strategy

Building infrastructure of INCDTIM institute is restored almost entirely - except department section with separation columns ^{15}N through Nitrox processes, which will be fully repaired in 2012. However, the existing laboratories are sufficient at this time for research, development and innovation.

One issue taken into account at this time is due to the heavy equipments - high sensitive to vibrations which can be placed only at the ground floor, where the space is already fully occupied. In consequence, for the future purchase of large equipments (Electron microscope, Ultrashort laser pulses, etc.), a new building will be designed in 2012, and immediately after, its

construction in 2013. Top platform of the building being in a open area unobstructed by other buildings, and having total daily solar exposure, will serve to place electric generating functional prototype solar heating - as an important applied research area of great interest with real opportunities for technological transfer.

Research devices having a high rate of moral aging, at 5-8 years performance is no longer valid in many cases. For this reason the act of renewal equipment must be continuous, especially in areas of current technological interest. In this respect, it is proposed to equip the INCDTIM institute with the following devices:

- Coupled-tandem system (HPLC-MS/MS) which include a Ultra-High Pressure Liquid Chromatograph instrument type and a Mass Spectrometer ORBITRAP type for high resolution;
- Mass spectrometer for isotopic analysis reports;
- Canberra multichannel spectrometer;
- Moessbauer spectrometer type;
- Rigaku-type installation for X-ray absorption spectroscopy;
- X-ray fluorescence spectrometer;
- Atomic absorption spectrometer;
- Portable Raman Spectrometer with acquisition and processing systems;
- Scanning Microscopy by tunnel effect (STM);
- Vibrational circular dichroism spectrometer;
- Linux Cluster for High Performance Distributed Computing.

Some of these devices will be purchased through funding projects such “Capacities” “Ideas” and “Partnerships”. Moreover, in the near future we will propose a POS funding project for fully institutional endowment, which will provide all necessary facilities for entire INCDTIM institute for a period of three years.

3.7. Technology transfer and the attraction of non-public funds.

The largest amount of affair figure of our institute is represented in the present and near future by the income from research projects, obtained through the selection process for national and European competitions. To complete the financial resources, an important factor is the economic income. We will work to increase constantly these incomes within the meaning of multiplying the quantity of services provided and especially, their quality, focusing on research services, expertise and expert advice, which are better paid.

We will develop the services offered by the Center of Technological Information from INCDTIM, with emphasis on marketing activities. We will have a more large and consistent

participation in the international traditional European fairs and to the brokerage activities in the field of innovative technological products.

We will expand the collaborations with private companies on research projects, so far we have had joint projects in the program “Invent”, and for the competition Partnerships from 7 November 2011, we have submitted several projects with IMM cofinancing. As the revival of economic life will occur in Romania and the interest of companies in new and innovative products will increase, we will try to capitalize our patents and prototypes, through technological transfer. Based on current assessments, one of the team of specialists working on a POS transaction 2.1.2., will have results interesting to the pharmaceutical industry, existing the possibility to create a "spin-off" in this area.

We will use (as in the past) the opportunities of bilateral collaborations with the European countries, for creating High Tech products with high innovative content; we will take advantage of the fact that we have the latest equipment in the laboratory of microproduction of the institute and expertise in order to perform highly complex prototypes and to offer assistance in the assimilation of manufacturing products. We can also technically administer and qualitatively coordinate the execution of Romanian industry products for the major European beneficiaries (ex. parts from CUG Cluj-Napoca for CERN Geneva).

3.8. Strategic partnerships and visibility: events, communications, collaborations

INCDTIM is continuing to build strategic partnerships as a way to maximize programmatic leverage and impact for implementing its research and development plan. On the national level our research activity is in the closest relationship with the Institute of Atomic Physics and also with the National R&D Institutes located in Magurele – Bucharest Platform and last but not least the “Babes-Bolyai” University and Technical University from Cluj-Napoca.

We intend also to strengthen relationships with about 20 SME partners with whom we have cooperation agreements for pursuing joint research projects under the program *Partnerships on priority areas* financed by Romanian Agency for Scientific Research. Over the past years, the senior researchers of our Institute have been actively engaged in pursuing new strategic partnerships with several well known European research structures: *CERN* - European Organization for Nuclear Research, The Joint Institute for Nuclear Research – *Dubna* and the Romanian pillar of the European Project *ELI* - the Extreme Light Infrastructure. We must mention also our successful partnerships on FP7 projects and in this respect we will emphasize the very good relationships with three of our partners: Solae Denmark *SA-Innovation trough Nature* , The second University of Naples, Italy and Fabes Research GmbH, Munich, Germany.

Opportunities for strategic partnerships with these and other organizations appear very promising.

INCDTIM has also a long tradition in organizing a scientific meeting covering two of its most representative research areas: the conference is called PIM (Isotopic and Molecular Processes) and it is organized bi-annually. With respect to INCDTIM visibility within the scientific community, the PIM conference represents the major event that can serve as an ideal opportunity to promote our latest research interests and the most outstanding results, and also to exchange new ideas, and establish fruitful collaboration relationships with potential partners from Romania and abroad.

Another important direction we are acting along is to increase the Institute's visibility in civil society with an expected impact upon making more transparent the benefit of public money spending in research, emphasizing the importance of the research performed at INCDTIM for making the transition towards a knowledge based economy in our region, and, last but not least, raising the interest of young people for science such as to make the research career very attractive to them. This area of public visibility has been covered so far primarily through interesting and pertinent appearances in the media, or by periodic press releases at various scientific events elaborated in a language suitable for a general public. This type of actions are likely to continue and even intensified in the future, primarily motivated by the new opportunities opened up as a consequence of the significant stepforward we made in modernizing our research infrastructure.

Cluj-Napoca, December 14, 2011.

INCDTIM's Top Management,
General Director, Dr. Engn. Adrian Bot