INCDTIM Cluj-Napoca Development Strategy for the period 2023-2027

The overall strategic development framework

1. Field of research

In accordance with art. 3 of H.G. 1401/2005, which approves its Organization and Functioning Regulation, the National Research and Development Institute for Isotope and Molecular Technologies - INCDTIM carries out scientific research and technological development activities in the field of stable isotopes and molecular physics. CDI activities are carried out in four research departments, *Dep. Mass Spectrometry, Chromatography and Applied Physics, Dep. Molecular and Biomolecular Physics, Dep. Physics of Nanostructured Systems, Dep. Physics and Technology of Isotopes*, two research centres, the *Centre for Research and Advanced Technologies for Alternative Energies* - CETATEA, the *Research Centre for Light Stable Isotopes*, which is on the list of Facilities and Objectives of National Interest, and benefits from technological and IT support through the *INCDTIM Prototyping Workshop* and *Data Centre*.

2. Integration of the specific research directions of the national institute into the national and European R&D and innovation area

In order to align with public policies in the field, contained in the official documents in force at national level (National Strategy for Research, Innovation and Smart Specialisation 2021-2027) and European level (Horizon Europe 2021-2027), INCDTIM has periodically reviewed its strategic development directions. All the themes currently addressed within these research directions are fully integrated into the national and European RDI space, as characterised by specific programmatic documents. In particular, we have followed the framing of the nationally defined Smart Specialisation Areas (ISD_i), EU flagship initiatives (Graphene Flagship - GF, Quantum Flagship - QF), European sectoral strategies (Energy Union, EU-Hydrogen strategy), including the mission orientation of the European RDI programme, Horizon Europe 2021 - 2027, as shown in the summary table below:

Strategic areas specific to the national / European research area	**CDI directions/topics at INCDTIM**
ISD_1: Bioeconomy EU: Horizon Europe, missio - *Soil Health* and *Food*	Authentication of food and beverages based on isotopic fingerprinting; Food quality control based on other recognized and emerging markers; Investigation of transfer of organic/inorganic compounds in food matrices Functionalized hybrid materials for applications in the food industry; Obtaining and characterization of extracts of natural compounds and their applications in improving the quality of food products; Composite materials with applications in agriculture
DSI_3: Energy and Mobility; EU: Energy Union and Horizon Europe, mission 4	Research, methods and techniques for alternative energy capture, conversion and storage; Energy recovery and microgrid systems; Energy efficiency from alternative sources; Applications of isotopic, elemental and molecular markers in environmental and ecological studies; Advanced metarials for environmental applications in

- *Healthy oceans, seas, coastal and inland waters*	pollutant detection and degradation (adsorption, photodegradation, electrodegradation, catalysis) - graphene-based composites, carbon nanotubes, etc. and functionalized hybrid materials;
DSI_5: Advanced Functional Materials;	Fabrication of molecular devices with applications in biosensors and molecular electronics through laser processing, ultra-high vacuum molecular beam epitaxy, colloidal self-assembly, colloidal lithography and nanoimprint lithography Advanced multifunctional materials: nanoscale phenomena, 1D and 2D materials, metal-semiconductor nanocomposites, metal-dielectric nanomaterials, interface processes in nanocomposites, structural defects - fundamental studies and applications; Hybrid materials, functionalised materials and materials with controlled porous structure;
DSI_: Health	SERS devices for rapid pathogen detection, micro/nano-structured surfaces with antibacterial effect, exosome-based platforms for biomedical theranostic applications; Short peptides and nanocomposites with antimicrobial/anticarcinogenic effect, biocompatibility and cytotoxicity of nanomaterials used in medical applications, novel solid forms and inclusion complexes for bioactive molecules used in the pharmaceutical and food supplement industry;
EU: Hydrogen Strategy	Hydrogen from renewable raw materials, materials and processes for physical and chemical storage of hydrogen, production of synthetic fuels using hydrogen, advanced electrode materials for fuel cells
EU: Graphene Flagship	High-performance methods for the preparation of graphenes and their composites, graphene-based materials for biomedical and environmental applications; interface processes in graphene composites;
EU: Quantum Flagship	Molecular systems, nanomaterials and components for quantum computing platforms; Development of specific software in quantum computing and communications;
EU: Major International Projects / Collaborations	Collaboration within the Romanian group at the ATLAS experiment at LHC@CERN, Geneva Collaboration in the DarkSide 20k experiment at LNGS, Gran Sasso Developing themes for collaboration within the ELI

3. Characteristics of the socio-economic environment

INCDTIM is a medium-sized institute and is an integral part of the national RDI system. According to official statistics, it comprises 263 public RDI organisations and about 600 private ones - private institutes/laboratories or commercial companies whose activity is research and development. Of the public organisations, 46 are national research and development institutes (INCDs, of which 43 are coordinated by the MEC) and the National Network for Innovation and Technology Transfer (ReNITT) comprises 50 specific organisations: technology transfer centres, technology information centres, technology and business incubators, science and technology parks. From the point of view of the evolution of the public RDI system, the conclusions of the latest European Union report https://rio.jrc.ec.europa.eu/country-analysis/Romania are extremely critical, in this respect we quote only two relevant aspects:

"The R&I governance is characterised by excessive and burdensome bureaucracy, predisposition to over-regulation, frequent legislative and institutional changes, lack of human resources. In less than two years

period, five ministers held responsibility for RDI, under four distinct governments. The political changes affected the RDI policy and system, triggering delays, ad-hoc changes. Coordination mechanisms and organisms are set-up in theory; yet they may be deemed as insufficient in the absence of human resources, of political determination and culture willing to make them functional. The R&I system is chronically underfunded. With a general expenditure on R&D (GERD) value per capita 14 times smaller than the average spent in EU28 (Eurostat, 2017), Romania had in the last ten years, one of the lowest, if not the lowest, GERD in EU28. The National Strategy for RDI 2014-2020 (NSRDI 2020), adopted on 21 October 2014, reaffirmed a 1% target for public GERD by 2020. However, since 2008, the R&I system has shown a trend of underfunding, lower than the targets assumed by national strategic documents."

To reinforce these conclusions, mention should also be made of the last major change in the organisation of the RDI sector at the end of 2019, when the Ministry of Research and Innovation was abolished and transformed into a directorate of the Ministry of Education and Research, with all the resulting dysfunctionality at the beginning of 2020. Public funding not only failed to reach 1% of GDP in 2020, as foreseen in the 2014-2020 NCCD, but fell to the lowest level of the programming period, 0.13%. The negative consequences are manifold, e.g. reduced number of project competitions, decreasing budgets for launched competitions, all of which have the effect of not funding many valuable project proposals, frequent flaws in the evaluation process given the large number of proposals submitted to each competition, etc.

INCDTIM has strongly felt the negative developments of the national RDI system during the period under review, the most significant being the severe decrease in planned investments for the modernization of the research infrastructure and the minimization of mobility expenses, especially the participation in prestigious scientific events in the institute's research directions.

In terms of demand for RDI, Romania's economy is divided between sectors with a strong presence of multinational companies (e.g. automotive) and traditional sectors (e.g. textiles, wood and furniture) dominated by SMEs with a low capacity for innovation, with Romanian companies being concentrated mainly in the area of lowest value added. The European Innovation Scoreboard 2019 continues to rank Romania last in the EU and ranks it among modest innovators. Despite this unfavourable context, INCDTIM has increased and diversified its innovation and technology transfer activities, by providing CDI support to innovation clusters in the region and implementing POC projects aimed at technology transfer and innovation. At the same time, INCDTIM has maintained its collaboration with a number of long-standing private partners, to whom it continues to offer CDI services at the highest standards: Farmec SA, Purolite Romania, TeraCrystal, etc.

In terms of human resources, INCDTIM has an advantageous position, being located in a strong university centre with seven traditional public universities. The ones that provide us with most of our research and development staff are Babaș-Bolyai University and the Technical University of Cluj. INCDTIM is an important provider of jobs for the graduates of these universities, offering an attractive environment for career development in RDI through the modern topics addressed and the existing infrastructure. Lately, however, we have also become a provider of vocational training, in particular through a more active involvement in student internships, as a natural reaction to the increasingly intense competition in this labour market with other CDI centres that have emerged locally / regionally, both public (new university centres / laboratories) and private (Bosch Engineering Centre, Emerson, Romanian Institute of Science and Technology).

Scientific and financial SWOT analysis

Scientific SWOT analysis

Strengths

- INCDTIM is an elite research institution within the national RDI system, with a tradition of almost 70 years, certified as an INCD in 1999, assessed with the maximum grade, A+, at the only international assessment in March 2012 and reaccredited in December 2016;
- The research infrastructure covers most of the equipment needs for the R&D themes;
- Highly qualified staff (77% of all researchers have a PhD, of which more than 60% have completed studies and/or research placements abroad) and with a relatively high proportion of young researchers, aged up to 40, 41%;
- Maintaining and consolidating the institute's traditional field (separation of light stable isotopes, ^{15} N, ^{13} C), which is unique at national level and gives us a distinct identity among Romanian research organisations;
- Accumulating expertise at the highest national and European level in the field of wine authentication using isotopic methods;
- High capacity to connect to national and European RDI priorities, which has allowed us to initiate and consolidate topical research directions (nanotechnologies, alternative energies, molecular technologies), as well as involvement in emerging themes such as graphene and *quantum computing;*
- Maintaining a high rate of scientific articles in relation to the number of certified researchers, in conjunction with the continuous increase in the share of articles in journals ranked in the first quartile (Q1) in the ISI WoS classification;
- Recognition of the high expertise in *Hi-Tech* engineering and isotope technologies through the co-optation of INCDTIM to large-scale international CD initiatives, namely, participation in the upgrade of the ATLAS detector at LHC@CERN and the implementation of the *DarkSide 20k* experiment;
- The existence of a prototyping workshop equipped with state-of-the-art machinery and highly qualified staff able to provide the necessary support in the technological development activities of the institute.

Weaknesses

- A significant part of the complex research infrastructure is approaching the limit of moral wear and tear - equipment purchased between 2008 and 2010;
- Still high share of one-off R&D&I services (analysis/testing/testing) in relation to complex research contracts in total technology transfer activities;
- Low success rates in H 2020 or equivalent (EEA) project competitions, despite a satisfactory level of participation in competitions;
- We do not have the resources and mechanisms capable of supporting an activity to stimulate strategic international collaborations at institutional level, leading to increased chances of success in European RDI project competitions;
- There are a reasonable number of national patents applied for and granted each year, but the level of exploitation of intellectual property rights is very low (only the NINA 99 trademark generates economic revenues);
- We do not have the resources and institutional mechanisms capable of sustaining constant international patenting activity for inventions with high potential economic value.

Opportunities

- Start in 2021 of the new funding cycle for the main RDI programmes of interest to INCDTIM: Horizon Europe, National RDI Plan 4, ERDF through the Operational Programme for Smart Growth, Digitisation and Financial Instruments (POCIDIF) and the Regional Operational Programme for the North-West Region (POR-NV);
- Diversification of support mechanisms for firms, through various state aid schemes to stimulate innovation, technology transfer under the new programmes funded by the ERDF, which will lead to increased demand for RDI services, either directly through collaborative projects, or through innovation clusters;
- European (European Green Deal, Graphen Flagship, Quantum Flagship, etc.) and national (National Hydrogen HUB) implementation of integrated CDI programmes for which we have expertise and have significant CDI results;
- Traditional academic environment, generator of highly qualified human resources.

Threats

- Potential disruptions in some activities of the Institute caused by the pandemic situation starting in 2020;
- Very low number of project competitions under FP3, indicating that a similar development is likely in the first years of FP4 implementation, linked to the economic crisis starting in 2020;
- The horizontal effects of all this: *demotivation*, especially of young researchers, leading in some cases to the migration of highly qualified labour, coupled with difficulty in recruiting top-quality R&D personnel; *fragmentation* in research activity; *difficulties in capitalising on* valuable results from completed R&D projects;
- Competition from multinational high-tech companies in the region in recruiting highly skilled human resources.

○ *Financial SWOT analysis*

Strengths

- Maintaining in the last 3 years a turnover of over 30 million lei;
- The existence over the last 3 years of an upward trend in terms of revenues attracted from projects financed by structural funds of the type POC;
- An average of 11% of the financial funds attracted in the last 3 years come from sources other than the national budget, mainly from the EU contribution to Structural Funds projects;
- Running an average number of 45 projects per year which allows for a steady financial flow necessary to ensure continuity of payments to staff and suppliers of goods and services;
- The existence of significant competences and an efficient administrative infrastructure capable of ensuring the necessary conditions for large-scale RDI projects;
- Active involvement of INCDTIM in the main innovative clusters in the region: *Transylvania Energy Cluster*, *Agro Transilvania Cluster*, *Transylvanian Furniture Cluster*, *ARIES Transilvania Cluster* with potential to attract private funding;
- Currently running two large-scale projects in partnership with the economic environment (TTC-ITIM, Partnerships for Knowledge Transfer and CITAT-E, Innovative Clusters), which provide the basis for long-term collaboration with at least 10 companies in the North West of Romania.

Weaknesses

- Economic revenues through direct orders still modest (0.75% on average of total DTA revenues over the last five years);
- Still low revenues from international Horizon 2020 type competitions;
- Declining levels of project income attracted under FP3, through a continued reduction in the budgets allocated and the average success rate in project competitions launched in recent years;
- The cumulative amount of indirect expenditure within the budgets of the projects carried out within INCDTIM is decreasing and cannot cover annually all the needs for repairs and maintenance of equipment that is intensively used and whose moral wear is high;
- The share of private funding in the Institute's total income is still low, 1.5% on average of total R&D&I income over the last three years, taking into account co-funding in collaborative projects with companies;
- The level of exploitation of intellectual property rights is very low (only the NINA 99 trademark generates economic revenue).

Opportunities

- The emergence of legislative changes in terms of salary and taxation that encourage and motivate the hiring and retention of specialists in Romanian research organisations;
- The existence of a national RDI strategy that focuses on the development of four areas of smart specialisation, three of which INCDTIM has rich expertise and high competences;
- The existence of competitions for attracting Structural Funds dedicated to RDI activity carried out internally or in collaboration with the economic environment.

Threats

- Lack of predictability and stability in funding through national RDI programmes;
- Decreasing budgetary funds allocated to RDI activity through the national budget;
- Imposed changes in the contractual clauses of the contracts for financing RDI projects that become restrictive in terms of the use of financial resources, with a strong negative impact;
- Uneven application of provisions on salary capping;
- The still low level of interest from the business community to invest significant financial resources in innovation activity through RDI;
- Frequent changes in legislation and in the management of the Ministry of Research and Innovation, as well as a high degree of political instability;

Strategic development objectives and directions.

Taking into account the evolution in recent years of the socio-economic environment in which we operate, as well as the conclusions drawn from the SWOT analysis, for the period 2023-2027 we set the following strategic development objectives:

O1: Improving scientific and technological performance - we will place greater emphasis on increasing the quality and impact of reported RDI results, rather than quantity, as a prerequisite for increasing the success rate in project competitions.

O2: Better integration in the European Research Area - we aim to strengthen our presence in existing international partnerships (ATLAS experiment at LHC@CERN, DarkSide 20k, ELI), to be better connected through the topics we address to EU R&D priorities (European Green Deal, decarbonisation of the economy,

Quantum Flagship, Graphene Flagship, EU-Hydrogen Strategy), and in this way to increase our participation in European projects/consortia and to diversify the types of actions/projects we will be involved in.

O3: A stronger role as a provider of R&D&I results and expertise in the local/regional socio-economic environment - we will make the most of the opportunities offered by the new Regional Operational Programme to contribute more to the innovative development of the local/regional economy and take a stronger role in training students in the region for a career in research.

O4: Increasing the uptake of RDI results in practice - we will continue the upward trend of recent years by stepping up innovation and technology transfer activities, but also by diversifying the offer of RDI results/services to the economic sector.

O5: Continuous increase of INCDTIM's visibility - we intend to intensify and diversify our communication and promotion actions on three distinct levels: the scientific community, the business environment and the general public.

O6: Strengthening administrative capacity - we aim to ensure permanent performance management, linked to the continuous updating of information management and analysis means and procedures and the specialisation of human resources involved in administrative-managerial processes.

In the period 2023-2027 we will focus our RDI activities on 6 strategic directions.

Strategic directions

D1. Stable Isotope Technology.

D1.1 Isotopic separations.

- Research and technological development for isotope separation and production C;^{13}
- Optimisation of^{15} N isotope separation technology for its production in large quantities at a purity level of at least 99% at N; ^{15}
- Development of the research area for the separation of other stable isotopes of interest (^{17} O,^{18} O,^{40} Ar, etc.).

D1.2 Applications of light stable isotopes.

- Compounds fully or specifically labelled with light stable isotopes (^{13} C,^{15} N,^{2} H and^{17} O) for biomedical, materials science, environmental and food safety applications;
- Authentication of food and beverage products based on isotopic fingerprinting;
- Applications of isotopic methods in hydrology, geology and biosphere-atmosphere chain studies.

D2. Alternative and renewable energies.

D2.1 Research, methods and techniques for alternative energy capture, conversion and storage.

- Optimisation of thermal power units for the capture and conversion of concentrated solar energy, including optical methods;
- Efficient methods and techniques for energy conversion, storage and transport;
- Optimising the life cycle of lead-acid batteries;
- New approaches to obtaining glass and/or glass-ceramic based battery electrodes.

D2.2 Energy recovery and microgrid systems.

- Mixed energy sources and heat exchangers - energy recovery and cogeneration;
- Improving the efficiency of capturing and converting electromagnetic energy (electrosmog) into electricity for dedicated applications;
- Acoustic/vibration monitoring systems/electricity generators;
- Combined mini-systems for recovery and conversion from multiple energy sources (ionic solar cells, biobatteries, electrostatic storage capture, natural mimicry technical solutions, etc.);
- Implementing the "green energy tree" concept by developing combined low power systems: wind, solar panels, rectifier antennas and managing them through microgrid networks for high energy efficiency.

D3. Molecular physics and technology.

D3.1 Molecular and biomolecular systems with controlled architecture and functionality.

- Modelling and simulation of molecular, biomolecular and supramolecular systems, self-association processes, intra- and inter-molecular interactions (short proteins/peptides, DNA/RNA, membrane models, etc.);
- In silico study of (bio)molecular systems deposited on metal surfaces and quantum transport processes;
- Synthesis and characterization of supramolecular systems obtained by biosynthesis, molecular encapsulation, and autoassociation biomimetic processes;
- Structural biology by cryo-electron microscopy and NMR spectroscopy on isotopically labelled proteins
- Rational design, generation and characterization of short antimicrobial/anticarcinogenic peptides;
- Nanomaterials-biological cells interaction: biocompatibility and cytotoxicity studies of (nano)materials dedicated to medical, biotechnological and environmental applications.

D3.2 Development of molecular technologies in emerging areas of medicine, bioeconomy, ecotechnologies and bionanotechnologies.

- Fabrication of molecular devices with applications in biosensors and molecular electronics through laser processing, ultra-high vacuum molecular beam epitaxy, colloidal self-assembly, colloidal lithography and nanoimprint lithography;
- Development/fabrication of micro/nano-structured surfaces and identification of technological solutions mimicking natural surfaces with antibacterial effect;
- Development of innovative platforms based on new biomolecular species, i.e. exosomes, for biomedical theranostic applications;
- Devices for rapid pathogen detection based on surface-enhanced Raman spectroscopy (SERS) and multivariate chemometric analysis;
- Development of metallo-dielectric nanomaterials and their integration into devices for the detection of molecules (markers of bio-medical interest, environmental pollutants) or biological microorganisms (pathogens) by plasmon-assisted optical spectroscopy techniques (Raman, fluorescence);
- Obtaining new solid forms and inclusion complexes for bioactive molecules of interest in the pharmaceutical and food supplement industries.

D4. Advanced multifunctional materials.

D4.1 Modelling, theoretical simulation and validation of concepts through dedicated experiments.

- Nanoscale phenomena, 2D materials, surface and interface physics, structural defects;
- Frontier research on interface processes in nanocomposites;
- Multilayer nanocomposite systems coupled by charge/spin transfer and exchange interactions; thin films;
- Investigating the physicochemical properties and application potential of materials with controlled architecture and functionalities.

D4.2 Development of new advanced materials with application potential.

- Composite materials with tunable functionality for applications in the chemical, pharmaceutical, food and cosmetics, agriculture, environmental and nanomedicine industries;
- Nanocomposites based on semiconductor and magnetic materials with environmental, health and information storage applications;
- Materials with controlled porous structure with applications in adsorption and catalysis;
- 1D and 2D materials with applications in staocation and transmission of information and other priority areas.

D5. Integration into the European Research Area.

D5.1 Collaboration within the Romanian group in the ATLAS experiment at LHC@CERN, Geneva.

- Operation and maintenance of the Tile Calorimeter detector in the ATLAS-LHC experiment;
- Design and construction of mechanical components and electronic modules for the ATLAS detector upgrade project, part of the HL-LHC (High Luminosity-Large Hadron Collider) programme;
- Research to develop new detectors in the Future Circular Collider (FCC) experiment;
- Storage and processing of data provided by the ATLAS experiment via the GRID-RO-14-ITIM website.

D5.2 Collaboration in the DarkSide 20k experiment at LNGS, Gran Sasso.

- Operation of the separation facilities and interpretation of the results obtained from the isotope separation experiments of the *Aria-DarkSide20k* project*;*
- Optimization of the separation process for isotope production ^{40} Ar;
- Transfer of know-how for the conversion of the *Aria-DarkSide20k* facility for the separation of ^{13} C, ^{15} N and ^{18} O isotopes.

D5.3 Develop themes for collaboration within the ELI.

- 3D modelling of the processes of: generation, transport, focusing, propagation in gas, coherent superposition of ultrashort atto- and femtosecond pulses;
- 3D modelling of ultrashort pulse interaction with atomic and molecular systems;
- Relaxation processes of excited electronic states induced by coherent electromagnetic radiation;
- Experimental study of ultrafast molecular dynamics processes;
- Auger electron spectroscopy induced by positron annihilation.

D5.4Hydrogen energy for integration into the EU-Hydrogen strategy.

- Hydrogen production from renewable raw materials;
- Development of materials and processes for the physical and chemical storage of hydrogen;
- Using hydrogen to produce synthetic fuels;
- Converting chemical energy to electricity using advanced electrode materials in fuel cells.

D5.5Implementation of themes within Quantum Flagship.

- Design, simulation and construction of components for quantum computing platforms;
- Modelling and synthesis of molecular systems and nanomaterials used in quantum computing platforms;
- Design and development of opto-electronic components for quantum communication platforms: quantum key distribution systems, detectors and entangled photon sources;
- Development of specific software in quantum computing and communications.

D5.6Implementation of themes within Graphene Flagship.

- Development and optimization of efficient methods for the preparation of graphene and graphene-based composites;
- Graphene-based composites with environmental applications (adsorption, photodegradation, electrodegradation, catalysis);
- Graphene and graphene-based composites with biological applications (electrochemical detection of cancer biomarkers, antimicrobial/antiviral activity);
- Frontier research on charge and spin transfer at the graphene/ 2D megnetic structures interface.

D6. RDI services, technologies and products for relations with the economic environment and public administration.

D6.1 Applications of isotopic, elemental and molecular tracers in natural products, industrial and environmental matrices.

- Authentication, traceability and quality control of food and drink based on recognised and emerging markers;
- Investigating the transfer of organic and inorganic compounds into matrices of food and cosmetic interest;
- Metabolomics and experimental data processing using statistical methods;
- Structural and quantitative investigations of compounds in the environment, food, biological tissues and cosmetics and industrial products;
- Estimating the quality of natural products with applications in the food and cosmetics industry;
- Applications of isotopic, elemental and molecular markers in environmental and ecological studies;
- Obtaining and characterising extracts of natural compounds. Applications in improving the quality of food and cosmetic products.

D6.2 Provision of RDI in pharmaceuticals and food supplements.

- *Screening* of new solid forms of synthetic and natural bioactive compounds to improve bioavailability;
- Determination of polymorphic purity of orally administered bioactive compounds;

- Determination of chemical purity of drugs and dietary supplements at trace level;
- Solubility, stability and excipient compatibility studies of bioactive compounds;
- Determination of crystal structure from single crystals or polycrystalline powders.

D6.3 Technologies and products based on the principle of circular economy.

- Producing new materials using waste;
- Use of plant waste for biofuel;
- Development of applications of vegetable waste in the food and cosmetics industry.

D6.4 Energy efficiency from alternative sources.

- Methods for optimizing micro-hydropower plants to increase electricity production;
- New local development strategies on energy and energy efficiency from the perspective of circular economy principles;
- Implementation of innovative technologies for renewable energy production;
- Energy digitization - implementation methods, services.

D6.5 Investigation of heritage objects.

- Complex investigation of heritage objects with a view to their conservation, restoration and reintroduction into the value circuit.

Human resources strategy

INCDTIM's human resources policy priorities are:

1. Maintain a balanced age and speciality distribution of staff in the IDA, in conjunction with a continuous increase in expertise. Emphasis will be put on the use of the project-based recruitment system (PhD students, postdocs) as a mechanism for selecting future researchers of merit;
2. Promote research staff by maintaining a high level of scientific excellence;
3. Maintain a system of staff evaluation according to responsibilities, based on professional criteria (scientific performance and prestige, results in technological development and contribution to attracting funds, i.e. promotion of the institute), in conjunction with compliance with the rules of ethics in research and the internal rules of procedure;
4. Ensuring the fairest possible pay system that encourages both professional performance and contribution to attracting RDI funds;
5. Obtaining authorisation for researchers who meet the legal criteria in force;
6. Continued development of collaborative relationships with academia through involvement in students' internship, masters and PhD programmes in various forms of co-mentoring;
7. Attract highly experienced researchers, trained in prestigious centres abroad, to work in INCDTIM either permanently or temporarily during specific collaboration projects;
8. Use the tools offered in future projects aimed at training researchers in general, strategic and project management;
9. Early recruitment of technical staff and skilled workers in the areas of interest of the Institute and Prototype Workshop, according to needs and resources, given the strong competition with other employers in the region.

Mechanisms to stimulate the emergence of new research topics and themes.

INCDTIM considers the implementation of a flexible and efficient mechanism to stimulate the emergence of new research topics and themes as very important to increase the success rate in project competitions. In this direction, the main aim is to strengthen procedures that have proven their effectiveness, to introduce new measures, and to outline at the end of the planning period a viable mechanism to stimulate the emergence of new ideas and topics. Among the main measures implemented so far, and new ones to be considered in the future, we mention:

1. Stimulating international collaborations with renowned research groups in various fields of INCDTIM's activity, ensuring the necessary openness to new approaches;
2. Encouraging participation in scientific conferences with a tradition on different topics, as these are forums for disseminating the latest advances in the field and identifying development trends;
3. Inviting renowned scientific personalities to Institute seminars;
4. Supporting the participation of young researchers from INCDTIM in specialization internships / exchanges / courses;
5. Forming consortia from different institutes/universities in research projects/programmes leading to the creation of multidisciplinary teams capable of tackling complex topics from different perspectives;
6. Intensify contacts, through various forms of communication, with the private sector, in particular with innovative companies - these contribute to a better knowledge of the needs of the economic environment, can lead to the development of new research-innovation topics, or to the approach of existing ones from a practical perspective;
7. INCDTIM's active involvement in R&D activities carried out within the innovative clusters of which it is a part and the establishment of collaborative relationships with industry liaison offices - these can lead to the emergence of new research themes directly in line with market requirements;
8. Involvement in international technical cooperation projects (e.g. COST, bilateral cooperation) where knowledge transfer or European project proposals are priority objectives;
9. Implement measures to stimulate young researchers to get involved in the process of generating ideas and topics for future research, at all levels of organisation: research team, department, institute;
10. At the research team and department level, each team leader/department can establish its own mechanisms to stimulate young researchers to engage in the process of generating new ideas, and at the institute level we envisage, depending on the availability of resources: setting up an annual prize for the most important contribution to the results of the RDI for a young researcher, funding internships abroad for young researchers who prove by their results their ability to develop their own topics, or setting up an internal project competition for young researchers.

R&D&I infrastructure and investment strategy.

INCDTIM currently owns equipment with a total inventory value of almost EUR 21 million, of which 35 are complex research equipment with a nominal value of more than EUR 100,000. Most of this complex research infrastructure has been acquired through two dedicated, large-scale projects: in 2008-2010 the CAPACITIES project *Modernisation of the Molecular and Biomolecular Physics Laboratory - MDFMOLBIO*, and in 2014-2015 the POS-CCE project *Advanced Research and Technology Centre for Alternative Energies - CETATEA*. In addition to the acquisition of specific equipment, the CETATEA project also provided for the construction of a modern building, which houses the new centre, and led to the initiation of a new field of activity in INCDTIM, alternative energies. From 2016 until now, research equipment purchases have been made exclusively through other research projects. The equipment purchased in this way was mostly of low value, the annual average investment in such equipment being around 2 million lei, and they were focused on complementing the existing infrastructures with strictly necessary equipment for the implementation of specific CDI themes. INCDTIM also manages the operation of two facilities of national interest, namely the Research Centre for Light Stable Isotopes - CCISU and the Data Centre containing the infrastructure for the RO-14-ITIM Grid site. CCISU has three productive facilities for the separation of isotopes ^{15} N and ^{13} C, unique at European level, which were designed and built by specialized INCDTIM staff. The detailed description of the INCDTIM infrastructure, systematised by the research directions it serves, can be found on the ERRIS platform at https://eeris.eu/ERIO-2000-000J-0123. In addition to the research equipment, INCDTIM has a very important support infrastructure for activities involving technological development - the Prototype Workshop.

Taking into account the current situation of the RDI infrastructure, presented above, and the fact that more than 80% of the space that can host research laboratories in INCDTIM is already equipped, the strategy and investment plan in research infrastructure for the period 2023-2027 foresees the following measures:

1. Gradual replacement of complex research equipment, with an operating life close to the limit of moral (some even physical) wear and tear, with new equipment incorporating the latest technologies in the field. This concerns in particular equipment purchased up to 2010-2012. For this action, the priority in 2021 is to draw up the procurement plan, to analyse and approve it, and finally to prepare a first draft project proposal for future grant competitions for large-scale CDI infrastructures;
2. Identification of integrated infrastructures within INCDTIM capable of meeting, on their own or in consortia with partners who have complementary infrastructures, the criteria for participation in national or European networks;
3. Within available resources, continue the strategy of acquiring low complexity laboratory equipment through ongoing research/institutional development projects, including the Nucleus programme;
4. Continuous upgrading and automation of the isotopic separation facilities in the CCISU, as well as maintenance and replacement of worn-out computing technology in the Data Center with new equipment.
5. Equipping the Prototyping Workshop with modern machinery, in line with the wear and tear of existing machinery.

Supporting innovation and technology transfer.

INCDTIM's innovation and technology transfer activities in the previous period have experienced a constant upward evolution, so that the main landmarks that define the current context in the field are:

1. *We have seen a significant increase in the share of innovation activity:* a total of 52 patent applications were filed in the period 2015-2020, compared to only 16 applications in the previous evaluation period, 2010-2014;
2. *Promoting through the Technology Transfer Centre (TTC)* the results of RDI with potential for technology transfer by being present every year at international trade fairs and exhibitions, and by continuously updating at institutional level the offer of RDI services addressed to the business environment. We have developed our own website, http://cit.itim-cj.ro/;
3. *Initiating innovation and technology transfer activities within the innovation clusters we are part of:* (i) in the period 2016-2022 INCDTIM implemented the POC project "Innovation Clusters" with the title "Innovative cluster for pilot advanced technologies in alternative energies - CITAT-E"; in the framework of the project, INCDTIM coordinates on behalf of the TREC cluster (Transylvania Energy Cluster) the development of a pilot research laboratory in Cluj Innovation Park for testing under real conditions the energy efficiency produced by photovoltaic panels and modern wind power plants and its maximization according to the consumer's characteristics; (ii) INCDTIM participated as a member of the clusters Ago-Transylvania and Mobilier Transilvan in the implementation of two similar POC projects: Our contribution consists in providing assistance and adequate space for the refining of two research/testing laboratories on their activity profile, as well as specialized expertise for the operation of these infrastructures;
4. *Implementation of projects dedicated to technology transfer:* INCDTIM has implemented in 2016-2021 a POC project of the type "Partnerships for Knowledge Transfer" entitled "Increasing the Technology and Knowledge Transfer Capacity of INCDTIM Cluj in the Field of Bioeconomy, TTC-ITIM". The main results achieved in this project are: (i) more than 60 working meetings with representatives of 34 private companies, (ii) we concluded research contracts with 11 of them, amounting to more than 10 million lei (iii) seven members of the implementation team were trained in advanced topics of technology transfer and innovation management, (iv) we held three thematic events on the implementation areas of the project, which brought together representatives of business, public authorities and researchers.

In the above context, the Action Plan to further support innovation and technology transfer for the period 2023-2027 foresees the following measures:

1. Intensification and diversification compared to the previous period of the actions carried out at TCO level to stimulate innovation, patenting and technology transfer activities. The CTT will become the main vehicle for promoting RDI results with potential for transfer to the economy and for identifying potential investors for the exploitation of intellectual property rights. The CTT activity will be carried out on the basis of an annual plan, the implementation of which will be monitored by INCDTIM management;
2. Capitalise on the experience gained in the relationship with innovation clusters and in the TTC-ITIM project to further increase the value of the RDI revenues attracted from the private sector. Both have the advantage that we can promote our offer of R&D&I technologies and expertise in a targeted way to companies that are directly interested in direct collaborations with the research environment for their development on an innovative basis. We will act both in the direction of continuing collaborative relationships with the clusters / companies with which we have collaborated in the projects mentioned,

and in the direction of further accessing funds through similar projects to be launched in future programmes financed by the Structural Funds;

3. Institutional support for integrated RDI activities, with the ultimate goal of concrete practical application of results;
4. Diversify vehicles for promoting collaboration with industry. In addition to the use of specific innovation cluster mechanisms, we also envisage engaging in collaborations with other technology transfer centres and industry liaison offices, which can lead to maximising the efficiency of technology transfer due to the profit motivation of such entities.
5. We are also considering initiating actions at CTT level to stimulate interest in entrepreneurship. The aim is to create a critical mass of skills, motivation and resources leading to R&D results that can be exploited through the creation of spin-offs and/or start-ups;

The main private beneficiaries of INCDTIM's RDI results/expertise are active in the agri-food, wine, cosmetics, pharmaceutical, food supplements, medical devices, energy, chemical-materials, goods production sectors. Most of the companies we collaborate with are SMEs, but we also offer research services to large companies such as Farmec SA, Purolite Romania, VES SA.

Defining scientific and technological identity, promotion and visibility.

INCDTIM has built its scientific and technological identity on two basic pillars, isotopic technologies and molecular technologies from which multidisciplinary research and development themes have developed over time, permanently adapted to the challenges and priorities of today:

INCDTIM - promoter of isotope technologies in Romania: building on its pioneering contributions in the 1960s in deuterium separation, which were instrumental in the construction of the Drobeta Turnu-Severin heavy water plant, INCDTIM is currently the only research organisation in the EU that has designed, built and operates its own productive isotope separation facilities ^{15} N and ^{13} C. We are also a major supplier of applications based on isotope technologies: in the isotopically enriched systems segment we have implemented a complete value chain, isotopic separation→ synthesis of labelled compounds→ practical use of labelled compounds, unique in the country, and in the natural abundance applications segment we are internationally recognised for isotopic fingerprinting methods developed for the protection of traditionally valuable brands and wine authentication, being also the only institute in the country with concerns in the field of isotopic hydrology, by continuously updating since 1975 a database with isotopic reports H/^{21} H of rainfall in the area.

Molecular technologies, the starting point for cutting-edge multidisciplinary developments: Historically, the first concerns in the field were aimed at the selective excitation of vibrational molecular levels in order to develop a new method of isotopic separation. Subsequently, the topic has diversified greatly in terms of the systems addressed, the applications developed and the fields targeted. We currently focus on complex molecular/biomolecular systems, ranging from metal-organic coordinative polymers to antimicrobial peptides and protein complexes, on their own or embedded in composites, nanoparticles or deposited on micro(nano)-structured surfaces, for the development of smart molecular materials, molecular sensors, molecular electronics, or composites and 2D materials with tunable properties, with applications in bionanotechnologies, health and environment, decarbonisation including hydrogen production and storage, agriculture, chemical and pharmaceutical industries. The research has always been supported by highly professional design and execution teams, with outstanding results in the technological development stages, from the design and

assembly of the first chromatographs and mass spectrometers produced in our country in the early years of molecular technologies at the Institute, to the design and manufacture of electronic and mechanical components for the ATLAS detector at LHC@CERN. Last but not least, as a requirement of regional and European development, we have recently addressed the field of alternative energy and recycling technologies as integrated parts of the circular economy**.**

INCDTIM's promotion and visibility plan operationalises through concrete measures the strategic development objective O5. For the three target groups addressed, the promotion and visibility actions we propose are systematised in the table below.

Target group	**Promotional actions / increase visibility**
The scientific community at home and abroad	• Organisation of the international conference "Isotopic and Molecular Processes - IMP" in 2023, 2025 and 2027; • Participation as co-organizer in the scientific conferences of the professional societies in which we work, Romanian Society of Pure and Applied Biophysics, Romanian Society of Catalysis; • Participation in traditional fairs/trade fairs: the International Exhibition of Scientific Research, Innovation and Inventions PRO INVENT (Cluj Napoca), INVENTIKA - International Exhibition of Inventions and Innovations (Bucharest), Geneva International Exhibition of Inventions, International Industrial Fair "HANNOVER MESSE"; • Strengthen a system of strategic partnerships at institutional and research team level with foreign RDI bodies/organisations; identify mechanisms and resources for joint actions; • Develop new international collaborative relationships through COST and ERA-Net actions; • Using the Market Watch publication as a platform for communicating the most important INCDTIM's CDI achievements within the Romanian research community;
Business environment	• Work in innovation clusters: presenting the RDI offer, identifying the needs of the companies we interact with, adapting our expertise to meet those needs, creating partnerships to develop new technologies/products, etc..; • Intensify the promotion of our offer to the business environment in the events organized by the North-West RDA; • Use the CTT as the main platform for communication with the business community by intensifying and diversifying actions aimed at the business community; • Maintain the strategic partnerships we have with innovative companies, and establish new ones, by carrying out tailor-made promotional activities for each company - updated offer of CDI results/services, identification of specific needs, etc.; • Presentation of the CDI offer for business on the main platforms in the country and abroad: BisNet Transylvania, inno.ro, EEN. Continuous feedback monitoring and updating at least twice a year, or whenever new elements appear; • Continuously update information on INCDTIM's contribution to the development of a knowledge-based economy through the CTT website, printed promotional materials (brochures, leaflets) and media presence.

General public	• Maintain the tradition started in 2017 by organising annually at least one event to raise awareness on the role of science and research in contemporary society, addressed to the general public; • Media promotion - at least three annual TV/radio appearances dedicated to science/research in which we showcase our latest achievements and/or express our vision of the role of research in modern society, i.e. improving public policy on research; • Initiating an open day event exclusively for students to present the institute's offer for internships - we will not limit ourselves to the Faculty of Physics and the Technical University, but will extend the invitation to students from the Faculties of Chemistry, Biology, Environment, Agro and Pharmacy, due to the multidisciplinary nature of many of the institute's research topics; • Continued willingness to get involved in camp activities for high achievers and to interact appropriately with students of different ages in 'school in a different way' actions; • Continuously update the Institute's website, http://ro.itim-cj.ro/ , in particular the "news" section, to continuously reflect the latest CDI results, or other achievements of the Institute. • Constant presence on social media - continuous update of INCDTIM's Facebook page, https://www.facebook.com/incdtim.clujnapoca .