PROJECT PERIODIC REPORT

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Periodic report: 1st☐ 2nd ☐ 3rd **X**

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Name, title and organisation of the scientific representative of the project's coordinator[1]:

Dr. Syed A. M. TOFAIL
Lecturer,
Department of Physics & Energy and
Materials and Surface Science Institute,
University of Limerick

Tel: +353 61 234132

Fax: +353 61 213529

E-mail: Tofail.Syed@ul.ie

Project website[2] address: www.lanir.eu

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the grant agreement
[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

Publishable summary

Summary Description of the Project Context and the Main Objectives

LANIR is a European Commission funded project that has developed 4 prototype nanoscopes (2 in the University of Limerick, Ireland; 1 in IIT, Genoa, Italy and 1 in UPB, Bucharest, Romania) based on a ground breaking technology that overcomes the diffraction limit in imaging with electromagnetic waves set by German scientist Ernst Abbe in 1873 and later refined by Lord Rayleigh in 1896.

This diffraction limit has been overcome for the visible spectrum of radiation by Professor Stefan Hell, Max Planck Institute for Biophysical Chemistry in Göttingen, Germany in 1994 for which he has been awarded the Nobel Prize in Chemistry in 2014 along with two other co-recipients. Commercial nanoscopes based on his principle are now available.

Breaking away from the diffraction limit of infra-red (IR) radiation using a far-field approach has been deemed impossible due to the inherent absorption of IR radiation by materials at sufficiently high intensities required to achieve high resolution. The best resolution offered on commercial table-top IR microscopes is currently around 10 micron and takes hours to get an image of a relatively small area. Even with high intensity synchrotron sources, the best resolution obtained in IR microscopy is 2-4 micron, which is still diffraction limited. Imaging is also very slow and still takes hours.

LANIR promotes IR nanoscopy, which is a chemical imaging technique that maps the spatial distribution of chemical transition as it is well-established and almost universally used in IR spectroscopy technique. This technique traces the chemical fingerprint of a variety of biological and nonbiological materials.

LANIR technique requires no chemical labelling (label free) for visualisation of samples. It rather is based on imaging molecular nature and thus brings wealth of information at high spatial resolution. This is highly advantageous especially in detecting small and subtle chemical changes that can potentially have severe consequences e.g. in chemical change in the amyloid protein structure that causes Alzheimer’s disease.

LANIR has developed prototype infra red nansocopes (IRN) to break the diffraction barrier in imaging using infrared absorption but without using any fluorescent labels. The project has achieved imaging at super resolution at resolution which is a quarter of the wavelength used for imaging, but the technique is capable of imaging at resolution of one-thirteenth of the wavelength used.

Most importantly, these prototypes are of table top construction so no visit to synchrotron sources would be necessary. This was possible due to the active contribution of LANIR's small and medium enterprise (SME) partners from the European scientific instrumentation sector.

LANIR nanoscopes offer easy operation, flexibility and label free imaging of structure and chemistry to stimulate new research in cancer treatments and early stage diagnostics of Alzheimer’s Disease (AD).

Description of the work performed since the beginning of the project and the main results achieved so far:

The work performed has focused on the development of a Bench-Top IRN with nanometer lateral resolution, 3D imaging, automation and image processing for high throughput analysis; primary and secondary applications in imaging biological materials and nanomaterials characterisation; and integrated metrology.

These activities converged into the development of prototype table-top Infra-Red Nanoscope that has undergone industrial assessments and standardisations.

In this pursuit, LANIR has achieved the following scientific and technical breakthrough

- ***Four*** *prototypes IR Nanoscopes: 1 at a pre-commercial stage offering fast, high throughput, sub-wavelngth resolution prototype mid infra red chemical nanoscopy on a table top. This surpasses the resolution that can currently be achieved in commercial infrared microscopes can be introduced to market in 18-24 months.*
- *Translation of concept (TRL 1) to commercialisable prototype (TRL 6) within 3.5 years*
- *Label free nanoscale imaging of graphene with ~100 nm resolution*
- *Label Free Super Resolution Mid infrared chemical imaging of semiconductors e.g. lead selenide*
- *Label Free Sub-diffraction mid infrared chemical imaging of a wide range of biological samples and nanomaterials for in vitro diagnosis and drug and chemotherapy monitoring*
- *Beyond the state of the art prototype, multispectral Mid infrared laser systems*
- *High level integration, multimodality and validation*
- *The integration of far field and near field microscopy techniques (IR-VIS nanoscope, CSLM, SHG, TPE AFM, s-SNOM). This setup can be commercialized to enable a more widespread adoption by the scientific community.*
- *Standard operating protocols and application notes for making these instruments attractive to users and user-friendly instrumentation.*

Please provide a description of the main S & T results/foregrounds. The length of this part cannot exceed 25 pages.

LANIR has created scientific breakthrough by breaking the diffraction limit in both mid and near infrared wavelengths, without adding any label or requiring any vacuum. With near infra red, LANIR has achieved ~100 nm resolution on graphene. With mid infrared, it has demonstrated super resolution on semiconductors such as PbSe. LANIR's scientific breakthrough will now allow imaging and monitoring biological and chemical processes with unprecedented chemical specificity in real time along with high precision and resolution.

To this end LANIR has also demonstrated routine imaging with 1-2 micron lateral resolution on a smart, compact table top nanoscope. Such resolution is currently possible only with synchrotron sources and imaging speed is 50-500 times slower.

LANIR prototype can be introduced into the market in 18-24 months especially targeting customers among materials scientists, biochemists, histopathologists and cell biologists. The demonstration of imaging tissues containing biomarkers of Alzheimer's disease will be a cornerstone of high resolution chemical imaging of pathology and can be extended to in vivo diagnosis too.

The main S&T results/foregrounds can be described as below:

Demonstration of a Flexible Integrated Table-Top Prototype

Mechatronics and peripheral design for NIR nanoscope (UPB), MIR nanoscope (UL) and MIR microscope (NT-MDT/UL)

MultiTel Laser coupled with LaserSpec SP-Opo +DFG stage

Construction of Table top TRL6 MIR microscope integrated with AFM ready for IRN Mode

IRN mode demonstrated on table top

Automatic data acquisition, control, and integration

Datasheet on mechatronics and peripheral requirements complete with specification sheets

Industrial Assessment and Standardisation through cross validation of MIR using AFM; industrial assessment of robustness, ruggedness and compact integration complete. Vibration from chiller pump cause problem in AFM imaging and will need to be eliminated.

Trademark registration complete. Protection covers US, Europe and Japan.

Demonstration of a bench-top, super resolution nanoscopy on a proof of concept basis. Label-free super-resolution in the visible wavelength range using IR-Nanoscopy concept. A resolution of 230 nm has been obtained using a visible light of wavelength 680 nm. This represents the achievement of imaging label-free at a resolution that is one-third of the source wavelength.

Demonstration of sub-wavelength resolution IR imaging with a resolution of ~2300 nm using IR at 3.4µm.

Demonstration of the proof of concept of super-resolution IR imaging is near completion. Anticipated resolution is 1000 nm using IR at 3.4µm.

Components (high-energy picoseconds fibre laser and picosecond PPLN based OPO) critical to achieve 70 nm resolution with IR have been delivered and being improved.

Optical beam patterning has been successfully demonstrated in both visible and mid infrared (MIR) wavelengths. This was achieved by overcoming difficulties in obtaining high quality beam profile directly from the laser. Solutions at different levels (inside or outside, or even at principle level of laser) had to be found to achieve this.

Pump and probe signals have been obtained and used in super-resolution imaging using pump-probe IR imaging coupled with optical patterning. Further improvement in the beam profile will be required to achieve 70 nm resolutions.

Completed pump-probe microscope using visible/Near IR (NIR) single wavelength doughnut/Gaussian beams and lock-in detection is complete in transmission.

Completion of bench top progenitor microscopes to be developed for 3D Nanoscopes in visible/NIR. Construction and beta testing of x-y-z positioning system with control electronics have been completed.

3D super resolution based on nonlinear effects

A vortex phase plate has been developed and tested to give 3D nanoresolution.

Demonstration of a mutimodal system for the label free nanoscale measurements of topography, near optical field by light scattering; autofluorescnce, confocal microscopy, multi-photon imaging and second harmonic imaging.

Development of High Throughput Analysis using Automation and Image Processing

Development and beta testing of the acquisition software for controlling optical/ mechanical components on three channel image acquisition, with a slow speed but better resolution (40 x 40 pixels in ~ 4 minutes).
Implementation of LabView based general development platform for GUI, image acquisition, control and processing.

Demonstrated image postprocessing methodlogy and artefact-free image generation.

Demonstration of Primary & Secondary Applications using IRN: label-free imaging of biological species, in vitro disease diagnostics & treatment monitoring, nanomaterials characterisation

MIR imaging conducted on polystyrene beads and gold nanoparticles

Preliminary IR imaging conducted on E. coli and brain tissue slices.

Alzheimer's disease biomarker (tau protein) has been extracted and benchmarked by IR spectroscopy. Contrast imaging has been performed but not for diagnosis.

Novel immobilisation protocol has been developed for functionalising polyelectrolyte nanocapsules by membrane proteins (work has been published in the journal PLoS ONE).

Mesoporous materials and nanomaterials have been produced and being supplied for bench testing. Computer modelling of adsorption on mesopores has been conducted.

A set of auxiliary materials were produced, with the purpose of identification of IRN possibilities for a range of applications.

20 micron thick sections from fixed brain of P301S tau transgenic and C57Bl6/J mice aged 1, 3 and 5 months were prepared and imaged by optical, c-LSM microscope.

Age-correlated brain slices from wild-type and P301S mutant (accelerated development of disease) were imaged using the UL2 setup

Pump-probe microscopic study of carbon-nanoonions particles embedded in HeLa cell.

Purificationof cytochromec552 and ba3-oxidase from T. thermophiluscells for benchmarking of IRN microscope

Nanoengineered polyelectrolyte capsules(NPCs) functionalized with the ba3 oxidase (ba3) enzyme isolated from T. thermophiles. NPCs were loaded with the chemotherapicdrug Docetaxel. MIR images of empty capsules taken at 3200 and 2900 cm-1. Also imaged using AFM and s-SNOM. Cytotoxic effect of docetaxel loaded capsules studied by c-LSM. MIR images of such loaded capsule have also been taken.

Supply of existing and preparation of new samples for evaluation of measurement techniques

Successful measurement of nanoparticles of different chemistry, size and shape

Successful measurement of mesoporous materials with absorbed dyes

Demonstration of Tertiary Applications in integrated metrology
Proof of concept demonstration of MIR scattering and pump-probe imaging of graphene, polystyrene beads, CdSe, PbS, brain tissues and NPCs in cells confirms feasibility of tertiary applications

A robust relationship between FP7 project, SANOWORK and LANIR has been established for characterisation of standardised nanoparticles. Ag nanoparticles prepared within SANOWORK project were characterized. Further characterisation will be conducted of Ag loaded BSA.

Contact has been established with National Physical Laboratory (Dr. Alex Shard, Leader of the Surface Analysis group has visited LANIR laboratory twice and is keen to use this technique for nanoparticle standardisation).

Please provide a description of the potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and the exploitation of results. The length of this part cannot exceed 10 pages

Every year, Alzheimer's disease (AD) affects about 800,000 new patients in Europe and directly causes 50% of dependency of aged persons. Currently there is no test to diagnose this disease. There is a great need to improve outcomes for patients with lung cancer which causes between 15-28% of all cancer deaths in Europe.

LANIR has demonstrated fast chemical and structural imaging with high lateral resolution under ambient conditions. LANIR has demonstrated how its instrumentation can significantly advance our understanding of biological processes at the sub-cellular level and provide understanding of early stage AD and lung cancer, improve the efficacy of therapeutic drugs and evaluate the real impact of nanomaterials to health and safety.

Future application of LANIR instruments will be in on and in line metrology for production processes for robust quality control of industrially important products e.g. organic photovoltaic devices, antimicrobial textiles and functional coatings on biomedical implants.

Overall impact of the project is described below:

1) Impact on participating Small and Medium Enterprises (SMEs): The LANIR project has been particularly focused to create impact on SMEs, in particular those from European instrumentation industry. The project's scientific activity had been carefully managed so that SMEs were actively engaged in the day to day scientific decision making and maximise their impact in realising the full commercial impact of this novel nanoscopy technology. The Table below lists the impact of LANIR on its different SME participants.

		SME partners of LANIR					
Impact		***LaserSpec***	***MultiT***	***GNR***	***NT-MDT***	***PlasmaC***	***LEMI***
Direct impact from							
Innovative research on IRN	Design & Construction of IRN & component	✓	✓	✓	✓		
	Reference & calibration				✓	✓	
	Prototyping	✓	✓	✓	✓		
	Publications, patents, AN, SOP, and GLP	✓	✓	✓	✓	✓	✓
	New software				✓		
Access to Background IP (owner)	IRN (LaserSpec)		✓	✓	✓	✓	
	SNOM (NT-MDT)	✓	✓	✓	✓	✓	
	Multi-modality (NT-MDT)	✓	✓	✓		✓	
Foreground IP	Jointly owned when jointly created	✓	✓	✓	✓	✓	✓
Critical infrastructure	Access	✓	✓	✓	✓	✓	✓
Human Resource	Employment & Collaboration	✓	✓	✓	✓	✓	✓
Standardisation	**IRN**				✓	✓	
	In vitro diagnostics				✓		✓
	Nanomaterials					✓	
Revenue earnings and business							
Direct Sale in Applications markets	Primary				✓		
	Secondary				✓		✓
	Tertiary				✓	✓	
	Ancillary		✓				
Indirect Revenue	Component Supply	✓	✓	✓	✓	✓	
	IP License	✓	✓	✓	✓		
Business expansion		✓	✓	✓	✓	✓	✓

More specifically LANIR's impact on its SME partners can be outlined as follows:

Reinforcing the scientific/technological base of involved SMEs for each SME:

LaserSpec: LaserSpec has developed a the 100 kHz generator of Fourier transform, 1 picosecond long infrared pulse, tunable from 2.5 to 4.5 µm, which is a device operating between the usual repetition rates of several 10 MHz or few kHz. This new device enables LaserSpec to address demands of non-linear spectroscopies, and micro machining applications. LANIR has given LaserSpec the opportunity to extend the tunability range of multi MHz SP-OPO tunable 1.5 to 4.5 µm range up to 16 µm, which enables to cover the full relevant MID-IR range for molecular spectroscopy. LANIR enabled to demonstrate of the performances of an infrared microscope fitted with the later SP-OPO laser technology, on both reference and real biological samples.

MultiTel: MultiTel was involved in LANIR as provider of laser solutions for non-linear microscopy applications. This project helped MultiTel developing its laser technology and permitted in particular to closely collaborate with the SME Laserspec on integration issues. LANIR was an important opportunity for MultiTel to strengthen its collaboration with another Walloon SME and understand the needs of a specific domain like microscopy through their connections with the other partners of the consortium.

GNR: GNR have a great competence and experience to design , develop and construct high-tech and scientific instruments. GNR doesn't have specific competence in microscope fields but during the Lanir project has increased its expertise and especially was appreciated by the partners for their flexibility.

NT-MDT: The LANIR project provided NT-MDT Limerick with the opportunity to gain specialised knowledge for developing the Piezo Stage, which is the core unit of the SPM (Scanning Probe Microscope). Prior to the LANIR project, NT-MDT Limerick did not assemble/calibrate the Piezo Stage, as this work was carried our parent plant. The development of the Piezo Stage in Limerick involved complex assembly, nano level operation of the delicate piezo tubes, very precise assembly, and wiring and subsequent testing. NT-MDT did finally achieved its goal of manufacturing and assembling a complete SPM Head, which was capable of producing acceptable scans.NT-MDT Limerick was also responsible for the design and manufacturing the Motorised Sample Table, which is an integral part of the main frame Prototype Table-Top IRN. This work allowed NT-MDT to work in close collaboration with other SME's in Europe to produce a workable prototype. This working relationship is a platform for future collaboration.

PlasmaChem: PlasmaChem has evidenced tremendous opportunities in the fast high-resolution microscopy with the outstanding possibility of chemical mapping, which were achieved in frame of the project. The developed equipment and techniques enable identification of the homogeneity and distribution density of the ultradispersed materials (up to the nano-range) and nanoscale features in industry relevant products, incl. modified textiles, polymer composites, coatings on medical implants. These are some of the fields, where PlasmaChem is active either at the production or development stage.

LEMI: LEMI is deeply involved in nanotechnologies, particularly in the nanoparticles toxicology i.e. genotoxicity and cancerogenicity. The spectro-microscopy apparatus developed in the LANIR project could offer a basis for collaborative studies with the partners involved in the project relating to the interactions of nanoparticles and genome at the intra-cellular level. This kind of expertise may be offered as a service to the manufacturers working in the framework of innovative medical devices based on nanoparticle application.

Plans for business expansion of each SME:

LaserSpec: LANIR infrared nanoscope answers the need of fast chemical imaging in life sciences. It has a large potential market- of fast and high resolution infrared microscopy in life science. The prototypes developed are close to commercialization and have reached the technology readiness level 6-7 (System prototype demonstration in an operational environment). This will expand LaserSpec's business as an original equipment manufacturer in the microscopy instrument manufacturing.

MultiTel: After the project ends, the first direct impact of the results of LANIR for MultiTel will be linked to the future of the potential product iCAIR™ that was one of the big achievements of the project. In parallel other techniques or potential uses of our laser sources in medical imaging will be further investigated after the project to further valorise the experience acquired during this collaboration. Various topics like Raman spectroscopy, multiphoton absorption imaging where the lasers developed by MultiTel can play a role will raise after the project LANIR.

GNR: After the construction of the first IRN demo unit now GNR is ready for a preproduction series. The short term objective for GNR is to became a manufacturer of the IRN microscope for their base version where the partner NT-MDT his the natural commercial partner. The long term objective is to product the IRN microscope in different version and with the ability to perform different task in order to increase the market view. To reach this objective the aid of research partners is more than important in order to find different diagnostic methods and different fields of application

NT-MDT: The experience gained by the Limerick plant is invaluable and will be of great benefit for the Limerick company, when developing future products. In the past, this lack of knowledge has always been a limiting factor for expansion within the Limerick Plant. With this knowledge of Piezo Stage assembly, NT-MDT Limerick now has the ability to produce the complete SPM system, thereby providing the opportunity to expand the Limerick Plant, by developing an Assembly Department and supporting infrastructure.

PlasmaChem: In the next years, once IRN-based equipment is manufactured in series, PlasmaChem will consider purchase of such equipment both for quality control and R&D purposes. In the immediate plans, PlasmaChem would be interested in mutually beneficial evaluation of company's commercially available samples on IRNs with the purpose of advanced characterization of those samples, and publication of the results in the own catalogue and website. The corresponding authors and equipment will be thoroughly acknowledged, which is believed to serve a good advertisement base for the future commercialization of the results obtained in course of LANIR project. PlasmaChem can also take part in the preparation of advertisement whitepapers on a non-commercial basis.

LEMI: At the present time, this highly specific area is difficult to propose to our customers who have more interest in biocompatibility evaluation than in pure research development.

2) Exploitation potential for the participating SMEs?

The exploitation potential for SMEs participating in LANIR project is very high.

The Infra Red Nanoscope (IRN) that LANIR is developing will fulfil a critical need in far field chemical nanoscopy. When fully developed, IRN will be a characterisation equipment that will be on high demand from both materials scientists and biologists. To realise this exploitation potential the concept of IRN had to be proven and implemented first. The project has achieved these two goals, which is making the exploitation potential closer to realisation.

The IR microscopy market is a small but a high growth rate market with a ~34% CAGR annually between 2007 and 2012 in the US. This compares well with the AFM market, which was estimated to be growing at a CAGR of 27% between 2007 and 2012. Due to the unprecedented nano-resolution achievable in IRN and its integration with SPM and s-SNOM, IRN will have a share in both of these markets. The combined market of AFM and IR microscopy has been estimated to be**$539.5 million**. The US on average represented ~62% of the global microscopy market in 2007. Assuming that this share will remain the same in 2012, **the global market for IR and AFM can be estimated to be ~$870 million.** This represents a significant market for the newly developed **IRN** and **huge potential benefits for the LANIR's industrial Partners**.

A conservative estimate of 1% share of this market in 5 years from the start of the LANIR project (i.e. 1.5 years of commercial launch of **IR Microscope**) yields total revenue of **$8.7 million** per annum. While this is an excellent return, we expect the actual **market share will be well over 20%** due to:
a) the unique and unprecedented technological advances achieved in **IRN**,
b) patent protection ensuring monopoly and
c) the presence in the consortium of a strong nanoscopy market player (**NT-MDT**).

This represents an excellent and rapid return on investment for the EC and the LANIR Partners. This will also help to create and enable further market for super and nanoresolution IR nanoscopy with similar return on investment but after 10 years from the start of the LANIR project (i.e. 5.5 years after the commercial launch of IR Microscope) as it was originally anticipated.

- **Market estimates for Near Field IR (equivalent to IR-SNOM) and AFM:**

	Million US$
Total US Market for **Molecular and Nanoscale Imaging** in 2007	1,256
Estimated US Market for **NFIR Microscopy** in 2012	157
Estimated US Market for **AFM** in 2012	383
*Estimated US **Total Market for NFIR + AFM** in 2012*	*540*
Global Market for NFIR + AFM in 2012 (assuming US market size at 62%)	**870**

- **Estimated cost structures of IRN and IRM**

Component	SME involved	Price (€,000)
Fibre laser	**MultiT**	120
AmplifiedOPO with pump by fibre laser integration	**LaserSpec**	50
Nanoscope Beam shaping, Sample compartment, Objective, Data acquisition and image processing	**GNR/NT-MDT**	150
Integration, product management and marketing	**NT-MDT**	25
2D and 3D Reference samples	**PlasmaC**	5
Customer price for LANIR base IRN		***350***
Standard base SPM	***NT-MDT***	*125*
SNOM	***NT-MDT***	*50*

Total for a table-top LANIR IRN-SPM-SNOM	***525***

Component	SME involved	Price (€,000)
Low power fibre laser	**MultiT**	30
OPO with pump by fibre laser integration	**LaserSpec**	25
Nanoscope Beam shaping, Sample compartment, Objective, Data acquisition and image processing	**GNR/NT-MDT**	20
Integration, product management and marketing	**NT-MDT**	10
2D and 3D Reference samples	**PlasmaC**	5
Customer price for LANIR base IRN		***90***

A preliminary costing for the table-top IRN has been carried out by LaserSpec and UL. The table estimates that a base IR Nanoscope with super and nanoresolution capability can be sold at the price of ~€350,000, which is much cheaper than currently available imaging X-ray Photoelectron Spectrometer (~€0.5 million) or TOF-SIMS (~€1 million). The value added by IRN to a conventional SPM is significant and will highly benefit the SME Partners directly and indirectly. A base IR microscope can be sold for ~€90k due to the use of state of the art fibre laser and OPOs already available at MultiTel and LaserSpec respectively, lower level of technical complexity and better availability of standardised components.

MultiT currently has the ability to manufacture fibre laser in small quantity (< 5 per year). To meet the demand of a high market share, this capability will become inadequate within 6/7 years from the start of the project. In such circumstance, GNR will provide the facility for manufacturing lasers in large quantities. Moreover, the type of fibre laser that MultiT will develop in LANIR can also be used in other applications fields such as micro-drilling, wafer processing and thin film ablation applications. This is an ancillary application that will benefit MultiT directly.

3) Involvement of potential users and other stakeholders (outside the consortium).

The following stakeholders outside the LANIR consortium had been informed about LANIR through direct contact, laboratory visits, seminar and roundtable discussions:

a. The Coordinator has made an introduction to LANIR to the members of FP7 project, SANOWORK (www.sanowork.eu) in the latter's 18 Month Review meeting. The new technique was received with great enthusiasm by the materials scientists and the toxicologists in the consortium. A joint seminar between LANIR and SANOWORK has been proposed. October 2014 was deemed as the most suitable time for such a seminar. In the meantime, the Coordinator of SANOWORK, ISTEC has agreed to send one of its researchers to initiate background characterisation leading towards IRN characterisation. This researcher is expected to be seconded in UL in March for about 3 weeks. The researcher is also applying for a University of Bologna Marco Polo grant to be able to be seconded for an additional three months in 2014.
b. LANIR Coordinator, UL is an associate member of the FP7 project, Quality Nano, the Coordinator of which, Professor Kenneth Dawson, has been informed about the developments in LANIR. Samples are expected from Quality Nano for

characterisation by IRN once the pre-prototype is complete in the next reporting period.

c. Dr. Alex Shard and Dr. Alex Knight of standardisation organisation, National Physical Laboratory (NPL) UK have been introduced to LANIR. Dr. Alex Shard has visitied LANIR laboratory in Limerick twice and has involved UL as an Associate Member in the European Metrology Research Programme (EMRP) funded project ‘Metrology for Innovative Nanoparticles’.
d. The coordinator presented LANIR to Nano Knowledge Transfer Network (NanoKTN), UK.
e. LANIR partners have contributed to dissemination to the wider scientific and technological community including microscopists through journal articles and conference presentations/booths and stands.
f. LANIR Laboratories have been visited by Nobel Laureate Professor Stephan Hell, High level delegates from Enterprise Ireland and Irish Development Agency, Research directors of COOK Medical and Analog Devices International.
g. NT-MDT has presented LANIR activity to its potential investors.
h. LANIR Laboratory at UL and NT-MDT were visited by ~50 participants of Science Foundation Ireland funded International Workshop on Electrically Active Materials for Medical Devices 2015.
i. LANIR Round Table ran in parallel to the NanoNet Ireland Conference attended by ~200 participants from Irish academia and industry.
j. LANIR Round Table was attended by the following discussants: Professor Hugh Byrne, Dublin Instituite of Technology, Ireland (BioSpectroscopy); Professor Halina Podbielska, Wroclaw Medical University, Poland (Imaging and image processing); Professor Brigitte von Rechenberg, University of Zurich, Switzerland (Animal experiments and GLP), Professor Peter Gardner, University of Manchester, UK (Biospectromicroscopy) via teleconference, Professor Costas Charitidis, National Technical University Athens, Greece (Materials applications); Professor Marco Sebastiani, University Roma Tre, Italy (Raw data sharing and database creation); Dr. Peter Faul, Mid-West Regional Hospital, Ireland (Histopathology); Dr. Gerard O’Keefe, University College, Cork (Anatomy and Neuroscience) and Mr. David Murray, Senior Production Engineer, COOK Medical, Limerick, Ireland.

4) Potential information that should be disseminated to a specific group of end users.

- Policy makers: LANIR partners (the Coordinator and the instrumentation SME) played a crucial role in the formation of the European Characterisation Tools Cluster. Through interactions with SANOWORK and its partners, LANIR is also indirectly informing partners of Nanosafety cluster.
- Scientific community: LANIR has already disseminated to the scientific community a number of scientific papers (open access) and conference presentations (please see pp. 79-83 of the Periodic Report 3).
- General public: The kick off of LANIR project has received widespread media attention including BBC. In addition, LANIR hosts a public website (www.lanir.eu) which disseminates developments within the project that are of public or scientific interest. The website continues to be expanded and is regularly updated with additional information. Details on the site include information on work packages, publications and events.
- a specific group of end-users

LANIR Round Table targeted potential end-users from scientific, medical and industrial community in the area of its primary (scientific), secondary (in vitro diagnosis) and tertiary (metrology) markets.

Further information on the outcome of this project can be found at www.lanir.eu or by contacting the following address directly:

Dr. Syed Ansar Md. Tofail, Project Coordinator, LANIR, MS1-023, Bernal Research Institute, University of Limerick, Ireland; Phone: +353-61-234132, Fax: +353-61-213529; email: tofail.syed@ul.ie