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4th Concertation and Consultation Workshop on Micro-Nano-Bio Convergence Systems MNBS 2010

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Report

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0. DISCLAIMER

The views expressed in this report are those of the authors and do not necessarily reflect the official European Commission's view on the subject.

The authors would like to state that the limitations and achievements identified for a given session were not necessarily found in all of the projects presented in such session, but were considered relevant enough to be shared with the readers and were thus included in the report.

1. EXECUTIVE SUMMARY

The essence of the 4th MNBS Concertation and Consultation Workshop with presentations from current and past EC-funded projects on Micro-Nano-Bio Convergence Systems (MNBS) is summarized here.

It was the **OBJECTIVE** of this gathering to encourage diffusion and exchange of information about science and technology among participants from different projects and to identify synergies and possible collaborations. Furthermore, future challenges and topics for R&D were to be identified jointly.

Next to the many positive and encouraging project **ACHIEVEMENTS**, high impact scientific articles were published and novel ideas protected. Start-up companies were set up and ideas for future products pooled and in part offered to market players for commercial exploitation. The EC funding induced technological breakthroughs in label-free analysis of proteins and DNA mutations, which resulted in a significantly increased sensitivity within a wide measurement range. To date, PCR sampling from whole blood has become feasible. Due to major advances in enabling technologies such as micro-fluidics, miniaturized (flexible) electronic circuits and boards devices for lab on chipapplications as well as those interacting with the human body could considerably be reduced in size. This miniaturization paired with an ever increasing computational power has paved the road towards reduced invasiveness of medical, neurological and especially surgical interventions.

Quite a number of structural **LIMITATIONS** have become evident during this and previous EC calls. Especially the low rate and speed of industrialization will threaten European competitiveness, especially if too many projects are either never completed or do not survive real word testing. Significantly more patents should have been filed and more commercial partners and end-users involved. Next to these structural limitations many expected and few unexpected technical challenges have yet to be overcome, especially in the field of sample pre-treatment, microfluidics and standardization. Other typical problems were the lack of adequate sample materials, poor sensitivity, reliability and repeatability. Power management, biocompatibility and interfacing ICT with the human body remain key challenges for smart autonomous MNBS. Inexperience in dealing with regulatory affairs was one of the key factors precluding successful transition from ideas to commercial medical devices in consortia where no industrial partners were involved.

Now, there are ample **opportunities for coordination and collaboration** between the consortia of different projects given their common problems and the parallel developments that have led to a variety of solutions for a given problem. It is expected that a gradual transition of the EC funding policy from a technology-driven to an application-driven selection process together with greater involvement of industry would lead to a better synchronization of academic and commercial activities and finally to a higher rate of successfully completed projects and more products. In addition, the EC was considered the right entity to actively address structural challenges that are common to several projects, thereby catalyzing collaboration as well as knowledge sharing.

In **CONCLUSION** promising results have been obtained in most MNBS projects, yet they are usually confined to certain components, modules or sub-systems, which have not always been successfully integrated in single devices, in particular for in-vitro testing. The difficulty of full integration and

testing of real samples prevents the delivery of finalized projects and products. The parallel developments for any given field of problems create opportunities for benchmarking alternative approaches, for exploiting synergies and for fostering collaboration with the aim of increasing the economical impact of EC-funded MNBS projects.

2. OBJECTIVES

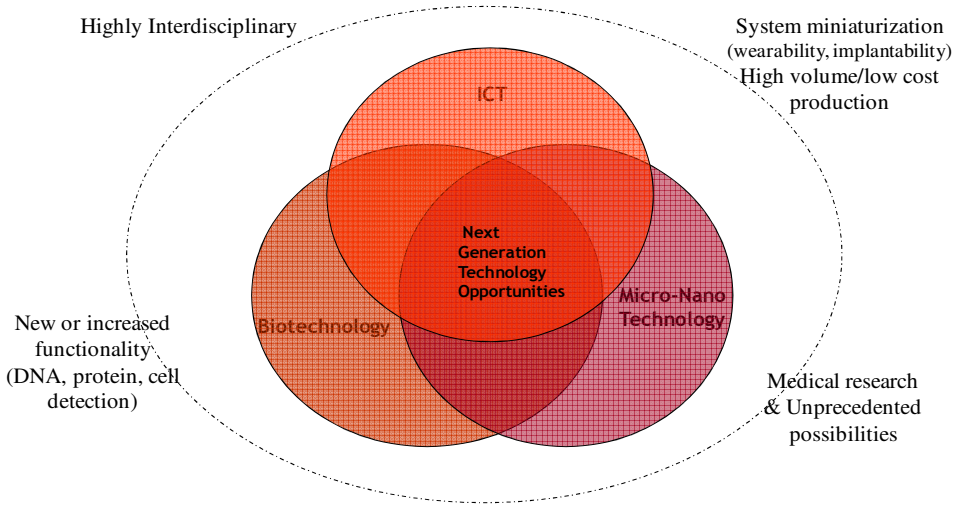
Following the previous annual workshops of the cluster of EC-funded projects on Micro-Nano-Bio Convergence Systems (MNBS), the 4th MNBS Concertation and Consultation Workshop, organized by the European Commission with the collaboration of CSEM, Centre Suisse d'Electronique et de Microtechnique SA, took place in Neuchâtel, Switzerland on February 15 and 16, 2010. The WS objectives were:

- To encourage diffusion and exchange of information of science and technology in the participants' areas;
- To identify synergies and possible collaborations;
- To recognize future challenges and topics for R&D.

The MNBS workshop combined past FP6 and ongoing FP7 projects and invited presentations on relevant topics. Further details are present In Annex I – Program and in Annex II – Participants.

3. INTRODUCTION

Research and development at the interface of micro-nanosystems and biology combining information and communication technologies has the potential to provide the necessary technological platforms and enhanced ability to sense, detect, analyse, communicate, respond and to monitor. This currently leads to the development of new medical technology fields and applications e.g. molecular imaging, point of care testing (POC), gene therapy and bionics, which are expected to revolutionise future healthcare delivery and quality of life.



Source: Andreas Lymberis

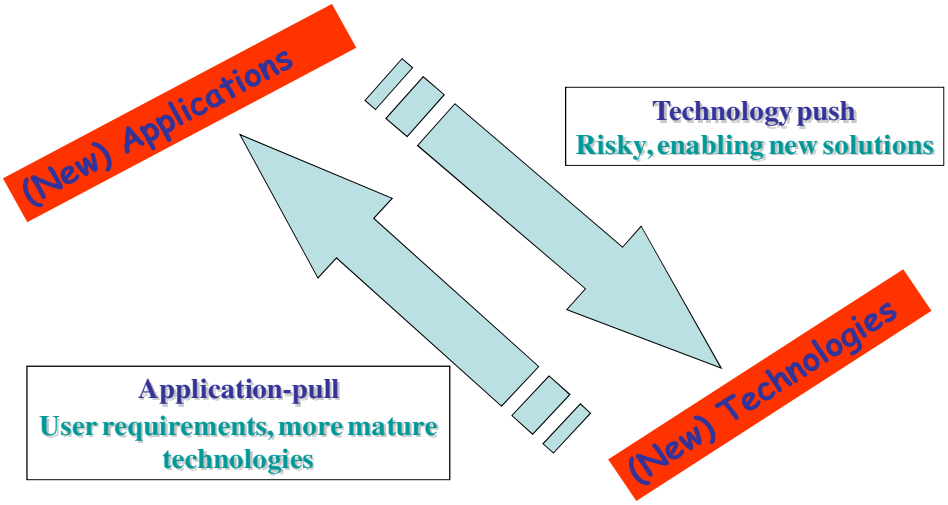
Miniaturization of electronics and their integration into small and smart systems provides opportunities for intervention at the point of need and continuous, even real-time health monitoring (e.g. biochips, wearable smart fabrics and smart implants).

New concepts, integrated approaches and systems include:

- Integration of diagnosis, treatment and monitoring
- Computer-assisted, image based intervention
- Drug-device combinations and targeted delivery of drugs and genes
- Sensor-activated (closed loop) drug delivery
- Integrated neuronal interfaces, stimulators and sensors enable novel treatments of epilepsy, appetite suppression, hemi- and quadriplegia, blind- and deafness als well as pain
- Fast information about the patient's response to specific treatments is essential for their success (complex combination of IVD, imaging and information technologies).

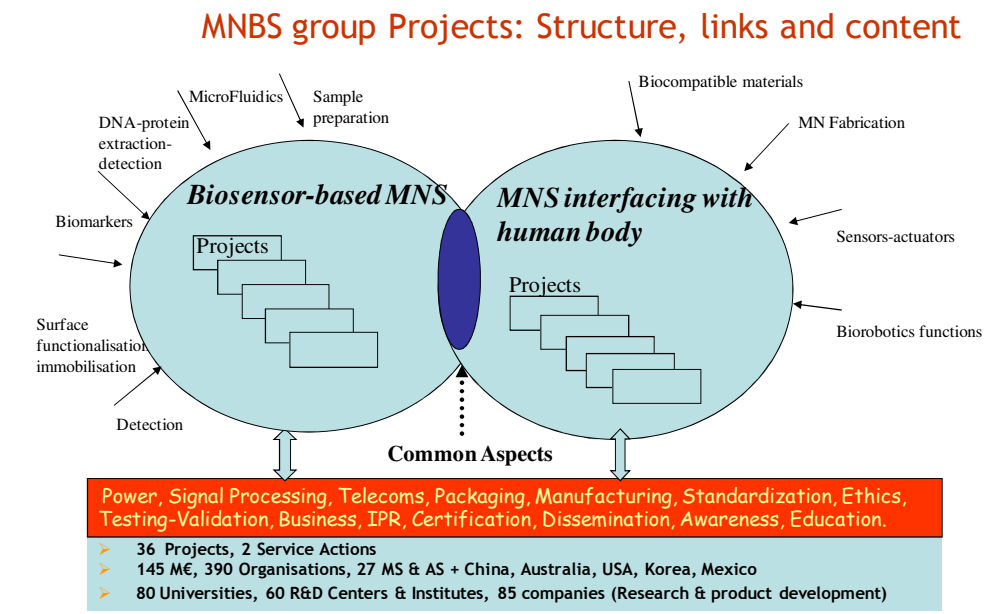
Micro- nano systems are potent facilitators of integration.

The projects are driven by two complementary approaches.One is the positive attitude of users towards ICT applications (application pull); the other is the convergence of ICT, biotechnologies and micro-nanotechnologies (technology push). This leads to a new generation of disruptive systems and solutions. Looking at the selection of projects currently funded by the EC, under MNBS activity it becomes obvious that the topic HEALTH is a major driving force. One of the main reasons is the lack of a similar application pull in other areas such as food, safety and environment. Also, for several decades microelectronics and medical technology have driven innovation that led to great advances in medicine.



Source: Andreas Lymberis

The MNBS cluster, created in 2005, delivers every year great scientific and technological results on Biosensors & Lab on Chip Components and Systems, on Smart MNS for healthcare to be applied on or within the body and finally for food and the environment. However, there is an urgent need to transfer these results into the market in order to strengthen European innovation and industrial competitiveness. This socio-economic impact should be a major driving force behind the projects where users' participation, design and industrial issues like manufacturing, cost, standardization, validation and market access should be thoroughly planned and elaborated early on in the project. A major objective is to attract more companies with interest in technology exploitation.



Source: Andreas Lymberis

4. PRESENTATIONS AND DISCUSSIONS

Micro-Nano-Bio Convergence Systems is a major domain within the field of Microsystems & Smart Systems Integration, which is being supported by the European Commission under the Information and Communications Technologies (ICT) priority.

The respective EC-funded projects develop and integrate advanced converging micro-nano-bio and information & communication technologies into smart systems, including MNBS for in vitro testing and for in vivo interactions with the human body. In this context, invited key lectures were presented and round-table discussions conducted. Furthermore, attendees had the opportunity to interact with each other and visit research labs and industrial partners in Neuchâtel.

Day 1:

Welcome & opening

In his welcome speech **George Kotrotsios** of CSEM mentioned different areas in which convergence may happen and that convergence at a technology level, between people, between the private and public domain as well as between the real world and the R&D environment, between academia and industry but also between materials and systems should be considered during the meeting.

Andreas Lymberis (EC, Information Society and Media Directorate General, Micro & nano Systems, BE) set the stage for the workshop in his opening presentation. While each one of the funded projects has its clear obligations towards the EC, the consortia were invited and encouraged to look

beyond the scope of their individual projects in search for new opportunities for cooperation i.e. in areas related to ICT, Biotech and Micro-Nano. Despite the fact that the calls for proposals in MNBS addressed all biotechnology fields e.g. Health, Food, Safety and Environment, only few projects have been submitted in other than Health and Biomedicine areas, One of the main reasons seems to be the lack of an application pull in such areas, which is very different from the situation in the health sector in which both, market pull and technology push have not only been developed over the past decades, but have already reached maturity. Therefore, the workshop was to be dealing with only two subgroups of MNBS:

1) Microsystems and biosensors and

2) Interactions with the human body.

Considering these two topics the speaker summarized his appreciation of the overall status of the MNBS activities based on a success rate (defined by a successful commercialization of the results of a project) between 1/7 and 1/8:

- Too many projects in the past have remained within the laboratory environment, not making their way into industrialization. The speaker considers this a failure.
- The overall speed of industrialization of projects has been rather slow raising questions on how to increase such speed.
- The number of patents filed has been lower than expected.

In summary, the level of competitiveness is not as high as it should be and measures should be taken to get more companies involved in MNBS projects. Such involvement of industrial partners would naturally bring about a differentiation between research and development efforts; the latter being the domain of companies whereas the former one primarily being the domain of academic or research institutions.

It was suggested to openly discuss during the workshop the general research priorities and ways to increase the critical mass of the MNBS activities to make them more successful.

Gian-Luca Bona (EMPA, CH) delivered his keynote speech on “Materials meet life @ EMPA” during which he expressed his belief that in order to be successful in the development of complex systems in live sciences sectors several important elements need to be investigated. This can be done by following a bottom-up research approach.. As specific examples of how a bottom up research approach may produce novel results he mentioned the protection and modification of the mechanical characteristics of wood by fungi, adaptive materials to form artificial muscles or light sensitive melanin based products.

Limitation: Academia is pushing forward but the business world is not as dynamic as ideally needed. The level of research financing is high and the amount of top level publications is significant but the research results are not translated into, a sufficient number of patents and an active involvement of industry or ultimately into new products.

Action: The involvement of industry, especially of SMEs, must be incremented.

Day 1, Session 1: MNBS interacting with the nervous system (projects NEURO PROBES and TIME)

One of the key novel features of the NEUROPROBES project was the creation of a "virtual way" of moving electrodes towards the location where the best signals are to be obtained. The rigid mechanical, yet electronically flexible design of such novel probes makes them easier to apply than mechanically flexible comparative solutions. The key customers for such probes will primarily be neuroscientists, but in general the acute use of such probes for a peri-operative assessment of clinical cases of cortical foci of epilepsy can be considered. On the other hand, deeply implanted stimulation probes could be designed on the basis of the above probes but this would require quite different probe designs.

The TIME project aimed at developing a device to treat phantom pain of amputees. There are two main difficulties addressed in this project: 1) in order to achieve optimal treatment results each probe must be customized for a specific patient and use 2) the current design of stimulation probes does not permit usage longer than 30 days and thus cannot be used to achieve long lasting pain relief in patients suffering from chronic pain, such as phantom pain.

Another project of the same group, IMANE (Implantable mutlicontact active nerve electrode), was invited but could't attend.

<u>Main achievements</u>

- The slim integration backbone allows long term implantation inside the skull. This is appropriate for chronic conditions;
- Publications in high level scientific journals (include Nature and Science);
- New IP generated and secured;
- Generation of a startup company (manufacturer of neuroprobes for the neuroscientist user community).

<u>Main limitations</u>

- No follow up project (fragmented results that may end up in a drawer);
- Neuroengineering in Europe remains fragmented;
- Ethical committee approval can be a limiting factor, especially since clinical tests are usually performed towards the end of such projects and considering that quite often the projects suffer from delays in the technological development phase.

<u>Actions</u>

- The follow up and exploitation must be financially supported;
- The regulatory burden including ethical and clinical approvals must be well planned and in early stage so that they do no longer become limiting factors to validation.

Day 1, Session 1: Opportunities for coordination and collaboration

In the concluding discussion about this session it became clear that both these projects seem to suffer from the same common fact that there are no commercial partners within the consortia that

would be able to develop these probes into real products to serve the medical market. Therefore, the full potential of both, NEUROPROBES and TIME cannot be exploited at this stage. In addition, the respective consortia seem to have little understanding of what it takes to overcome the regulatory hurdles and to conduct the clinical studies needed when developing a medical device.

Andreas Lymberis expressed his belief that EC can play an important role to support and coordinate initiatives to meet the challenges that are common to several projects. Thus, in order to create more opportunities and momentum for projects within a special field such as nerve stimulation, people with in-depth know how from specific projects should be brought together in a dedicated meetings with experts who provide the missing know how and experience in domains not covered within each one of the projects and thus form bridges between fragmented projects. Such meeting will take place in pHealth 2010 conference (May 26-28 2010).

Limitation: The community working with active autonomous implants does not yet act as a group which would be able to define a common denominator and to highlight what is important to deliver.

Action: To organize scientists working in neuro implants and neuro-sensing to meet for 1 day to prepare a paper with recommendations to the European Commission on how to support an efficient collaborative scheme /initiative in this field.

Day 1, Session 2: Label-free LoC (projects PYTHIA, MENOSLAB, DVT-IMP and ULTRA)

Main achievements

- Portable and label-free analysis of proteins and DNA mutations with high sensitivity and dynamic range with PCR integration;
- Multiple mutations analyzed in a label-free manner;
- Increasing sensitivity without compromising dynamic range; spin-off-company to be created;
- Inclusion of all passive and active optical components on the same Si die at a miniaturized level;
- Novel principle of operation (broad-band interferometry) achieved.

Main limitations

- Sample pre-treatment;
- On chip stabilization of immobilized immunoreagents (antibodies);
- Reliability;
- Repeatability if results in label-free detection;
- Improvable design of packaging.

Day 1, Session 2: Opportunities for coordination and collaboration

It was commented that the EC should not become an instrument to define specifically what needs to be addressed by research projects. Concerns about such a top-down approach were raised because it would prevent the self-assembling creative dynamics of consortia.

Day 1, Session 3: LoC for cell and bacteria (projects COCHISE, TOXICHIP, INTOPSENS, THERAEDGE, and MASCOT)

Main achievements

- Use of flexible PCB technology;
- Application in immunology (dendritic cell therapy) and drug screening (identification of resistant tumor cells);
- Integration of complex microfluidic control system and of imaging system;
- Single analysis or continuous monitoring;
- US army interested in testing;

Main limitations

- Integration may be a problem because since among other difficulties the flow rates of microfluidics are not compatible thereby imposing a serious threat for a final device integration needed to obtain working prototypes;
- Where to go next in exploitation?
- De-bubbling in PCR is a problem (– opportunity for collaboration, since PCR is working in several projects);
- Relatively low sensitivity - can be a serious limitation;
- Robustness of biological reactions on chip;
- Sample pre-treatment can be made easier by adopting methods from projects that already tested and validated their technique.

Day 1, Session 3: Opportunities for coordination and collaboration

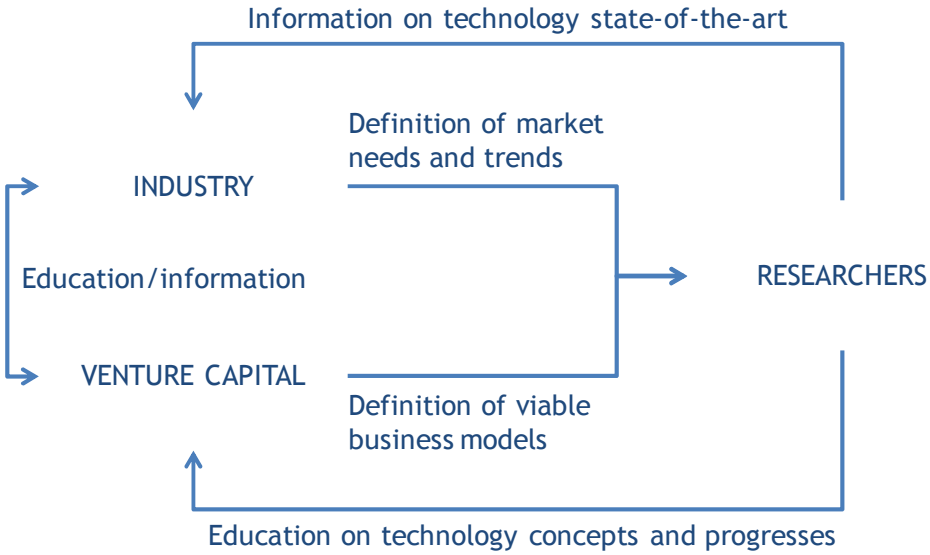
Synergies from the developed work on the different building blocks that led to duplication of efforts must be explored.

Currently, the majority of projects has been technology-driven, with emphasis on developing specific building modules, e.g., sample preparation, fluidics, on chip PCR, detection. Now that this phase has passed, a good technology assessment of which developments have been successful can lead to a 2nd phase of application-driven industry-led projects.

Commercialization of results coming from different projects is a major challenge since the research projects are mostly decoupled from the industrial players. Measures are needed to take the results from the labs to the market. One possibility to overcome this problem could be to have more projects led by industry thereby moving them closer to the market (application-driven approach).

Therefore it was suggested to organize a meeting with VCs and industry to identify those projects that are of specific interest to the market.

Furthermore, as indicated in the figure below, academia would have an opportunity to educate and inform industry and VCs about the latest technological developments, while VCs and industry would teach academia on viable business models and routes to commercialization.



Summarizing Day 1: Cluster topics and future R&D

One substantial problem many projects seem to face when testing their devices for sensitivity and specificity is the lack of sample material from real-world applications since during the development phase lab testing was done using spiked, diluted or synthetically composed samples.

Another gap identified during the discussion was the challenging transfer of a functional lab bench analysis to a miniaturized LoC application. These challenges appear to usually be underestimated.

Furthermore, the difficulties in integrating and manufacturing the methodologies and prototype devices developed within a consortium seem to be a major threat for a number of projects on their way to commercialization.

Nico de Rooij (EPFL, CH) summarized the day by raising the question about "how to get ideas converted into products?". As one obstacle in this conversion process he identified the difficulty of EC funded projects to get in touch with the “big players” in the market. Most of these large companies seem to have their own ongoing research and development activities and do not seem inclined to share their results, visions and strategies with outside parties. The following examples of such company-based R & D activities were mentioned explicitly: IBM and ROCHE researchers work on own LoC offerings, while Philips is active in exploiting the opportunities of Terahertz-technology. It was suggested that a special event should be organized by the EC, at which representatives of such large companies as well as those of the venture capital scene can be met. However, the concern was raised by the audience that such an event might not prove fruitful since it was felt that “if industry knows what they want, they will not collaborate”.

No answers could be given to the question why SME do not seem to show great interest in participating (SMEs participation is about 20-25%) in EC projects while this is the case for academic institutions. Rather than providing an answer another question was raised in this context: Does the lack of interest by SME have to do with the way the EC calls for project proposals are set up? It is likely that SME might be more interested in participating in an application-driven project while

academic institutions usually are more in favor of technology-driven research projects and thus find EU calls matching closely their particular needs

Another question posed was the one on how to increase the effective impact of the tax money spent on EC projects. It became obvious during the day that part of the exploitation ineffectiveness is due to the fact that the EC seems to be funding several aspects of the same areas in different initiatives and programs (e.g. nanobiotechnology in ICT and NMP programs). . Therefore, the idea was brought up that the EC should make sure that all initiatives and support to MNBS related areas are provided only to high "added-value-driven research projects".

Andreas Lymberis encouraged the audience to share their knowledge within and among other projects so as to avoid unnecessary parallel developments of the same or very similar technologies. Such a sharing of knowledge could ideally produce building blocks of technologies that could be shared between current and future projects. If such "least common technical denominators" of different projects could be identified, the ratio of tangible results obtained per Euros spent should increase significantly.

However, it shall be realized that the funding of MNBS projects is a funding of pre-competitive research with its inherently high risks and unknown outcomes. Therefore, such building blocks are likely to be found in the knowledge rather than in the product domain.

In this context "The Competitiveness and Innovation Framework Programme (CIP)" http://ec.europa.eu/cip/ run by the EC was mentioned as a potential source of support for projects on their way towards industrialization.

Before the social evening, visits of labs of interest were offered, namely to Colibrys, SUSS MicroOptics, CSEM's Nanotechnology and CSEM and EPFL Microsystems labs.

Day 2

The key note speech by **Daniel Cefai** (Biolabs, CH) introduced the audience to the activities of BIOALPS (http://www.bioalps.org), the fastest growing life science cluster in the world covering activities mainly in the area of Lake Geneva including a total of 750 companies and 20.000 employees. This cluster is one of 4 in Switzerland and receives contributions from 7 cantons in the western region. Although a Swiss organization, its mission goes well beyond the pure local and national representation of its members but reaches out towards other active bio-clusters in the world with the intention to establish direct contacts to their companies, political entities and commercial representations i.e. during site visits.

Day 2, Session 1: Other LOCs and manufacturing (projects SmartHealth, Biotex, CD-Medics, Indigo, Labonfoil, MicroFluid and Micro2DNA)

Main achievements

- Promising results were obtained in interfacing with patients, doctors and hospitals;
- Early stage achieved on licensing opportunities which are now proceeding after NDA have already been signed;
- Proof of principle on sweat analysis for detecting diabetic hypo- or hyperglycemic episodes;
- Example of good exploitation and cooperation with a previous project;
- Synergies between two projects have been explored (supply of PCR chips/cards developed in one project to another one);
- Promising results for heavy metal ions detection with rather fast analysis periods and portability;
- Sample preparation for PCR from whole blood;
- Novel cartridges which include a hybridization chamber;
- A start-up company was created.

Main limitations

- Only some parts of the project are being used but some other are sleeping;
- The final prototypes had to be changed due to a change from isothermal to thermal cycling;
- Technical difficulties faced with SU8 autofluorescence and with low temperature bonding;
- Difficulties to collaborate with other EC projects have been faced;
- Difficult to connect research with big diagnostic companies;
- Need to create a legal framework with end users to disclose needs;
- No real sample has been tested;
- Redesign of the integrated cartridge is necessary;
- Need to involve end users.

Day 2, Session 1: Opportunities for coordination and collaboration

Given the parallel developments observed, the design and implementation of a web-based tool / platform for matching technology offer (containing information on stage of development, robustness, applications, sensitivity, reliability – to allow full functional characterization of the technology) with technology demand will allow the comparison and the adoption of the more

appropriate technological approach to a given need. Ideally this would be managed by the interested parties and not by the European Commission.

Day 2, Session 2: MNBS for capsular endoscopy and minimally invasive surgery (projects Araknes, Vector, Minisurg and Tips)

Since the first ever endoscopic surgery performed in 1987 this technology has advanced rapidly and has become the mainstay of modern routine surgery due to its obvious advantages over conventional open surgical approaches. However, despite these undoubted achievements there still some drawbacks to be overcome. ARAKNES is aiming at improving the quality of minimally invasive surgery by selecting an endo-luminal single port approach and by increasing accuracy, predictability and repeatability making use of robotics and modern computational means. While there are commercially available devices for endoscopic surgery such as the Da Vinci Surgical System (by Intuitive Surgical, Inc.), they are not applicable for endo-luminal surgery. ARAKNES is aiming at creating a versatile device, which adds functionality as well as dexterity to single port surgery.

During the vivid development process at least 19 novel ideas were created by the consortium that are not immediately related to the core project, but which could result in derivative commercial devices. This pool of ideas is considered a pool of business opportunities seeking actively exploitation. The key success factors so far identified by the consortium are speed, force and rapid feedback as well as a holistic approach since such an endo-luminal system does not only require a surgical perspective but also those that take among other factors patient positioning and navigational aspects into account.

VECTOR´s primary goal was to make endoscopy painless. Colonic cancer is the most prevalent type of cancer in the western world and patient prognosis depends on an early detection. Therefore the VECTOR project is developing a dedicated screening capsule for colonic (and esophageal) application, which transmits images telemetrically at 15 images per second after compression. The capsule is both a diagnostic and a treatment device but does not contain any active locomotion but is propelled by external magnetic forces. Once a (pre-cancer) polyp has been identified by visual multi spectrum tissue analysis means, it is actively and fully removed by the therapeutic part of the capsule and retrieved for pathological exams.

MINISURG is aiming at adapting the known technology of miniaturized stereoscopic distal imaging devices to the needs of medical applications. Such novel visual 3D-sensors, which imitate an insect's compound eye, could then be integrated as enabling components into devices such thereby improving considerably tissue differentiation (see VECTOR), hand eye coordination and the use of advanced surgical instruments as the ones described before ARAKNES and VECTOR).

TIPS as the acronym for Thin Interconnected Package Stacks is a project focused on the development of technical solutions for commercial products. It is highly technical, application-driven, industrialization centered with the consortium being led by an industrial partner. The project addresses the challenge of increasing the electronic capacities per cm^3, stacking and reliability issues, all of which are believed to be prerequisites for a successful use in medical products like pace makers or hearing aids. While pacemakers in the past were 20 cm^3 in size they are now 10 cm^3 but their future volume is expected not to exceed 1 cm^3. Towards the end of the funding period true commercial solutions shall be on offer.

Day 2, Session 2: Opportunities for coordination and collaboration
During a rather short discussion, the obvious synergies between the presented projects were raised and contacts between consortia and technology providers established. Since all of the above consortia already incorporate end-users and are even led or actively guided by commercial companies already active in the respective field, these consortia appear to represent role models of an "application-driven" approach that has been the matter of much discussion during the workshop.

Day 2, Session 3: MNBS for "in vivo" monitoring and treatment (projects Ultrasponder, Nanoma and Mot-test)
The consortium developing the ULTRASPONDER, an in-vivo transponder system for biomedical applications, aims at controlling a sensor network located within the body by ultrasonic waves. In addition, these waves will also provide the sensors with power and data communication means. Making use of existing ultrasound know how, technology and norms, the consortium expects that their work will result in an important technology that will open new opportunities for diagnostic and monitoring purposes where low power local body area sensor networks are needed.

While some of the above consortia were developing macro- or micro-robots, NANOMA takes robotics into the nano-dimension with the aim of treating cancer at the earliest possible stage. Micro-capsules are to be developed, which contain nano-capsules that are released / disaggregated at the site of interest. The consortium makes use of existing MRI technology that would have to be upgraded to fulfill the specific functions developed in the project. Next to the technical ones, several other challenges remain to be overcome in this project such as:

- the nano-physics of flow at the site of cancer,
- the potential toxicity of carbo-nano-tubes used for this therapeutic application,
- the direction of a sufficient number or active micro-capsules towards the location of interest.

The last presentation of the day introduced the Irish Tyndall National Institute (www.tyndall.ie) and presented its specific capabilities as a life science interface. Tyndall is currently exploiting the opportunities of MNT following an end-user-driven approach in which user requirements play a key role in the definition of projects.

Day 2, Session 3: Opportunities for coordination and collaboration
While specific questions about the projects were answered, due to the lack of time and the diversity of presented activities no discussion on opportunities for cooperation was conducted.

Closure of the day

Summarizing Day 1 & 2: Cluster topics and future R&D

Suggestions on how to overcome typical challenges common to most projects
As many of the LoC projects deal with very specific technological problems, they might be viewed as isolated technological islands, which are hard to connect to other technologies. There appears to be a major gap between their early stage development and a potential final product and at least some projects are left alone when dealing with such kind of gap. Therefore it was suggested to identify typical gaps that are common to many of these projects and jointly develop strategies to overcome such problems. EC but also individual institutions are invited to take action to address this problem.

Due to their inherent complexity, converging micro-nano-bio technologies and systems are difficult to communicate and disseminate to the large public, to end-users and decision makers. “The translation of such technologies into a story that can be presented to the mass media”, as suggested in the MNBS report 2008 is thus difficult to achieve. In order to overcome such hurdles, the other recommendation from the same report should be considered even more when setting up MNBS projects: “The ‘End-Users’ should be represented in every project, either as partner to the project or as an advisor, but a clear definition of the end-user requirements for every developed technology is essential to have a more focused projects. Having an ‘End-User’ entity in the project will help in defining the system specification along the RTD cycle.” As an outstanding example of both, end-user involvement and dissemination of the technologies the CD-MEDICS project was mentioned. The way the project was presented at the workshop it became clear that much attention had been paid to the definition of end-user requirements as well as to the communication of the value proposition of the products for future customers. Another example of how to address the issues of end-user involvement and dissemination of a project's “story” in a very creative way is the comic produced by the LABONFOIL project. While the comic is currently being used to communicate and disseminate the message of the project it contains rather detailed descriptions of 4 different use cases for commercial products – presented in the form of 4 distinct comic chapters - as they were developed by the consortium during the initial phase of the project when determining end-user requirements.

While at first it might sound appealing to have large end-users like the key players in the diagnostic field actively drive developments by being part of consortia and be intimately involved in the definition of system requirement specifications by bringing their market know-how into projects, a word of caution has to be raised. If a handful of large companies were to define the content of EU-funded projects, diversity is at risk. In such a scenario only those projects and technical solutions would survive that are of immediate value to these players. Other alternative solutions would not survive such a stringent market-driven selection. Therefore, in an attempt to foster diversity but also viability of projects a non-commercial umbrella-like support by EC structures is appreciated.

Suggestions on how to conduct future workshops

Commenting on the formal way the workshop was conducted the desire was expressed to have the audience more actively involved in the exchange of ideas. Furthermore it was suggested to provide more opportunities for people in the audience to interact with one another. In order to identify and actively approach either an individual expert, a group of persons working in a field of interest, or a potential partner it was suggested to post a list of participants that contains more than just name and institution but also a short description of the field of interest / expertise together with a photo to facilitate identification within the crowd.

Following up on the above idea of a “speed dating” was raised to quickly identify persons of special interest. However, the concern war raised that even at the highest speed and with the shortest time allowed for any statement the time required for more than 100 participants to introduce themselves would exceed any practical limits of a normal workshop. Therefore, such “speed dating” would have to be carried out via the internet prior to the start of the workshop.

Since many MNBS projects usually have to deal with a diversity of technologies in order to come up with a functional system (as opposed to an isolated technical solution to one specific problem) the audience suggested to organize in future workshops specific interactive and parallel ½ day sessions, which address specific fields of technology known to be of common interest to a number of MNBS projects. Specifically, the following topics were mentioned: battery, sensors, packaging, fluidics…

Considerable frustration was voiced by the audience that the format of the presentations delivered at this workshop neither showed a common format nor any kind of standardized minimal content.

Most of the presentations were found to be too technical, too individualistic, too much focused on giving credit to each one of the members of the consortium while many of them lacked crucial information with regards to the objective and results achieved. Furthermore, it was criticized that only very few of the presentations concluded with a list of suggestions for future cooperation with other projects, which was felt to be one of the main objectives of this concertation and consultation workshop. This critique was echoed by the representative of the EC, Andreas Lymberis, stating that in the forefront of this and other meetings great care had been taken to inform the presenting projects about the objectives and a unified structure of the presentations to be given - but obviously with little success.

Proposals for new and possible interactions between existing EC programs

The EC was interested in obtaining input from the audience and from the currently funded projects as to the potential content of future programs as well as t the synergies between MNBS and other fields of technological developments currently already supported by the EC.

No specific fields other than that of ICT were mentioned by the audience. It was mentioned that the EC already provides specific supportive tools to enhance the cooperation between groups and technologies and the audience was asked to make better use of current brokerage platforms and data bases.

5. SUMMARY OF MAIN ACHIEVEMENTS AND LIMITATIONS

Main achievements

The projects represent a large spectrum of areas within the MNBS, making it difficult to point out common achievements, but, generally, important advances have been accomplished in all stages from research to pre-industrialization:

- Whole blood sample preparation for PCR;
- Flexible PCB technology with integration of complex microfluidic control systems;
- Portable label-free analysis of proteins and DNA mutations with high sensitivity and dynamic range integrating PCR;
- Cartridge including hybridization chamber for nucleic acid analysis;
- Multiple mutations analyzed label-free;
- Increasing sensitivity without compromising the dynamic range;
- Inclusion of all passive and active optical components on the same Si die at a miniaturized level and using a novel principle of operation (broad-band interferometry);
- Novel neural implants with “virtual” movement of electrodes towards the location of interest;
- Minimally invasive surgical and endoscopic techniques & systems meeting well-defined user demands;
- Miniaturized imaging and transponder subsystems, to be used in the above devices demonstrated feasibility;
- A host of technologies and ideas for new products for potential exploitation in future projects resulted from the dynamic development process of some in-vivo systems;
- New intellectual property has been secured, thus offering licensing opportunities;
- Startup companies were created to exploit project results;
- Industrial or application driven projects are focused and usually involve end-users, i.e. patients, physicians and hospitals;
- Synergies between projects and joint exploitation of technologies or sub-systems have been explored (e.g. PCR chips/cards);
- Papers are published in high-level scientific journals.

Main limitations

Although positive results have been generated within the pool of projects, generally the ultimate project goals - integrated, validated, reliable and cost-effective prototypes - are not met and may be due to the following difficulties and limitations:

- Sample pre-treatment; on-chip stabilization of immobilized immune-reagents (antibodies); reliability; repeatability in case of label-free detection; improvable design of packaging;
- De-bubbling in PCR (an opportunity for collaboration, since PCR is working in some projects);
- Robustness of biological reactions on chip. Downscaling from macro to micro may be highly challenging in biological reactions (such as PCR);
- Low sensitivity;
- Some in-vivo MNBS consortia seem to have little understanding of regulatory requirements for medical device;
- The very limited size of the markets for some of the above-mentioned systems will make it difficult to find commercial partners;
- Clinical tests towards the end of the projects suffer from delays in the technological developments;

- Integration challenges are often addressed too late;
- Lack of real sample and real user involvement;
- Exploitation of results is limited as terminated projects cannot be continued until follow-up projects are secured or a commercial partner is found. Thus, results remain fragmented and might become forgotten;
- Fragmented scientific & technological community in Europe;
- Difficulties to collaborate with other EC projects due to contract constraints and intellectual property issues;
- Despite a high level of R&D funding and a significant number of top-level publications, such funding is not automatically translated into respective patents, an active involvement of industry or ideally into new products.

Several projects seem to suffer from the same common shortcoming, namely the **absence of leading commercial partners**. Therefore, the economic potential of projects could not be exploited within the project duration. In addition, **regulatory hurdles** need to be overcome and **clinical studies to be** conducted when developing medical devices.

Currently, the majority of the projects have been technology-driven, emphasizing the development of specific functional modules, e.g. sample preparation, fluidics, on-chip PCR, detection, sensing, vision, actuation, locomotion and power management module. Now, that this phase has passed, a sound technology assessment aimed at identifying among them the successful technologies could potentially lead to a 2nd phase of application-driven industry-led projects.

6. OPPORTUNITIES FOR COORDINATION AND COLLABORATION

Given the common problems and the parallel developments that have led to a variety of solutions, now there are ample opportunities for collaboration when implementing the best approach for a given problem. In order to foster such collaboration, a web-based tool or platform for matching technology offerings (containing information on stage of development, robustness, applications, sensitivity, and reliability) with technology demand shall be implemented. Such sharing of knowledge could ideally produce technological building blocks to be shared between current and future projects.

To create more momentum for projects within a special field, people with in-depth know-how from selected projects should be brought together with experts who provide missing know-how and experience in domains not covered within each of the projects. This way bridges between fragmented projects are built. Since some of the projects created an abundance of new product ideas and technologies, which are beyond the focus of the ongoing projects, ways of how to make best use of such “spill-over ideas” should be developed. The meeting provided the sub-system developers i.e. for stereoscopic imaging systems with the unique opportunity to meet directly with consortia that might be interested in using their technologies.

Often academic activities are not aligned with market needs and EC-funded projects appear to be decoupled from industrial needs. Therefore, more projects should be led by industry to promote a market-driven approach. Events organized by the EC at which representatives of large companies, SMEs and of the venture capital scene can meet with academic partners to form future consortia may foster this involvement.

7. CONCLUSIONS

While promising results have been obtained in most MNBS projects, they are usually confined to certain components, modules or sub-systems, which have not been successfully integrated in single devices. When a functional prototype is achieved, usually there is neither enough time nor resources for in-depth validation. The difficulty of full integration and testing of real samples prevents the delivery of finalized projects and thus their commercial exploitation. The parallel developments for any given field of problems create opportunities for benchmarking alternative approaches, for exploiting synergies and for fostering collaboration with the aim of increasing the economical impact of EC-funded MNBS projects.

This article is a summary report from the 4th MNBS Concertation and Consultation Workshop, organized by the European Commission with the collaboration of CSEM that took place in Neuchâtel, Switzerland on February 15 and 16, 2010. The report has been written by the independent experts Helder Cruz and Stephan H. Böhm appointed by the European Commission.

8. POST-WORKSHOP FEEDBACK FROM INDIVIDUAL PARTICIPANTS

Only selected altered parts of these contributions are reproduced here in a uniform way for which they had to be slightly adapted. While the authors are known to the EC they are not disclosed here for reasons of privacy. The authors and the EC hereby thank the individual participants that contributed for this section

FEEDBACK A

A possible example could include having a LoC cluster topic where the mission of the research could be on developing point of care (POC) devices for diagnostics. Here you could have researchers investigating several target diagnostic applications (CF, HIV, CRP etc...). The focus could be on standardizing assays and technology with the aim of achieving LOC systems that are compatible with POC devices (these chips can be used by a common device much like a CD/DVD in a player). There is no benefit in developing individual LoC systems and POC devices when an integrated approach would address a much bigger market and could be disruptive. Modular LoC systems could then be developed for specific targets having a standard interface to dock with POC readers, monitors or devices. Greater synergy between fluidics (micro/nano and even macro) designs, having a common approach to sample treatment (blood, urine, serum etc...), packaging solutions to seal LoC devices (thermal bonding, glues etc...) detection criteria and modes of detection (optical, electrical, acoustic etc...). All of these ideas could form an initial basis for creating core links between projects as most projects in this area will have common problems to solve and through sharing and cooperation (with NDA or whatever agreements need to be in place) this in theory would enable integration of projects at a level unheard of in the EC. The MNBS cluster could use this type of approach as a pilot to determine if this strategy could be adopted for future framework programs. What would be needed to achieve this would be a specific call where two or three missions will be targeted (need end user input here as to what are the priorities - probable hold a few meetings with experts to discuss the best 2 or 3). The important thing to remember throughout this process is that the integration and convergence of MNBS must be kept to the core and that the missions need to be clearly in check with the MNBS overall goals. The core links to other research need to be of critical importance. For each mission a CA could be spearheaded to keep the projects under the topic umbrella.
Going forward the MNBS workshop could be **expanded to include some end users** (clinicians, doctors, surgeons etc...) so that greater input and expertise is available to the research cluster and would open up more possibilities for collaboration in future calls not only in ICT but other framework themes.

It would be good to be able to **track the collaboration between partners in the MNBS cluster** and showcase success stories where the MNBS workshop has enabled partners to cooperate on all levels (not just FP projects).

There should be **scope in future MNBS projects to** have a section where exchange of students or expertise is encouraged in order to **create a mobility link to other projects**. This would help to foster closer ties between research institutes, universities, SME's end users etc... For example a budget could be set aside in the CA (for each research topic cluster), which could be used by partners to

allow short term exchanges and allow researchers to work together to solve common problems with shared resources. This would further streamline activities and could be used as a tool to facilitate better links and cooperation between projects.

It would be very beneficial to have **participants at the next MNBS workshop to send in advance to the organizers a short elevator pitch** (few lines on who they are, what their expertise is and where they are looking for help or collaboration). This can be done as part of the registration process and then made available as a supplement booklet or as part of the proceedings. This way, people can have the opportunity to see who is there and the networking will be enhanced.

Parallel sessions could be organized at the next MNBS workshop to **accommodate cluster topics** to get together and discuss issues, problems and future directions. This would be a first step to promoting links between projects.

A website should be established for the MNBS cluster group. Membership of such an organization would be great as it would allow partners (new and old) to share forums, inform partners on things like job vacancies, resources that can be shared (equipment, expertise etc...), conferences, workshops, schools, courses etc... This would be very focused on MNBS activities and could be very exciting if done well.

FEEDBACK B

Overlap issues: My suggestion would be to host a website for all on-going and closed projects with "searchable specification sheets" NOT for the system level BUT for the components level (e.g. Sample Collection, Sample Concentration, Sample Preparation, Amplification Technologies, Detection Technologies, Signal Transduction, Surface Chemistry, Valves). With this database and the requirement for the applicants to search against this database, I believe that overlap in research could be minimized or at least, communication between project Teams could be enhanced.

Meeting with a forum from the industry: Great idea, but I believe, from my industrial experience (past 10 years…), that the industry representatives will not easily share their real focus or their longer term strategy with us in a group setting for confidentiality reasons. They might provide a 10-year view which is going to be counter-productive to achieve short term ROI. Private interviews could be an alternative to consider.

Technology choice: Regarding technology choice such as labeled versus label-free detection, I would be careful to, once for all, decide, as many factors are evolving (antibody affinity, surface chemistry, sample preparation) that influence the ultimate decision. Last November, I visited a large diagnostic company in Germany that just invested in label-free detection for their next generation blood group analysis.

Missing integration: I agree with all the comments around "application driven system integration" or "market driven system integration" rather than "technology driven R&D"

Industry involvement for product: In the last five years (in the US), the industry has considered that the first step into commercialization was the role of VC, government and startups. The big ones were expecting to just snap the successful startups and integrate their products into their portfolio. I don't know if the vision is similar in Europe.

FEEDBACK C

There seems to be strong overlap between various ongoing or recently finished projects and it is not clear that the potential for synergy is exploited. Further analysis and comparison of the presented results could reveal which lessons learned by one project could be adopted by others thus avoiding re-invention.

I believe that the large number of presentations and the breath of topics presented did not allow sufficient time for interaction and in-depth discussion. I therefore support the suggestion made by Andreas for a follow-up workshop in Brussels with a more limited scope of topics but a higher ambition level in interaction.

It is necessary to bring Labonchip and related IVD technologies closer to the exploitation. In order to be an efficient policy instrument, the call text would need to be highly specific. It would need to avoid repeating developments funded in previous calls and to guide project proposals towards to usable results.

Proposals that clearly build on the most promising results of past or ongoing projects and that will bring them closer to successful products. These most promising results could be identified by a panel of experts that provides input to the programme committee.

Proposals that address novel aspects, not addressed in previous calls. These could possibly be further removed from the market, but should maintain a focus on the integrated system concept.

FEEDBACK D

For Quality-labeled Partner Search in the ICT program: www.ideal-ist.net (we're not publishing competency profiles, we disseminate exclusively project ideas looking for specific competencies and partners)

For avoiding innovation to sleep in the drawers, a web marketplace for technology offers and requests exists under www.enterprise-europe-network.ec.europa.eu

For upcoming brokerage events, you'll find them under www.ideal-ist.net/events, in particular one event with specific interest for the MNBS community, www.meet4cleantech.eu, June 2nd, Geneva.

Remember to inform www.ictresults.eu about your projects results too

Thanks for organizing this very interesting event. In fact, there are nearly no event where projects can publicly disseminate where they have discovered challenges in their implementation, this is really a great added-value that your event provided to the audience, I would really suggest to make as many of these presentations publicly available for the MNBS community, it's important to disseminate this kind of information.

FEEDBACK E

To avoid duplication of research work in EC programs, focus on novelty and avoid over-subscription as a result of that may I suggest the setting up of a database of project details with searchable keywords. The database could consist of partner lists, project summary, summary of main results, technologies used and application(s). This database could contain information from projects across all genres: cooperation, people, ideas etc. I believe at the moment an ad-hoc system exists for each FP, each more comprehensive. But it would be good to have a common database with all the aforementioned information. A search engine on each division's webpage could then be used to search for previous projects with a default entry e.g. photonics in the photonics division webpage or nanosystems on the MNBS page etc.

I would suggest also some dialogue with the key stakeholders in order to see where MNBS advances are really needed and then write specific targets/actions for these. I think that the idea of ICT call # 5 to include only projects that would end closer to commercialisation was a great idea and we should see some good results here. Further to that, only by bringing in more SMEs as partners, specifically as leaders and most importantly as evaluators we will only see more industry orientated and realistic proposals and less academics looking for someone to sponsor the widget development paying only lip service with regards to impact in order to get it funded. But then the EC is well aware of that problem. Perhaps more SME driven objectives, with a minimum % of SMEs say, 50%, would cut down on submissions and guarantee more industry focussed proposals, I think something has been done previously in NMP. The two stage idea is also very useful to cut down on the evaluation workload perhaps allowing more proposals to reach more SME evaluators?

ANNEX I: PROGRAM

2010 Concertation and Consultation Workshop on Micro-Nano-Bio Convergence Systems (MNBS)

The main objective of this concertation meeting is to allow the representatives of current and recently terminated projects to present their work. At the same time, they will be able to interact, identify synergies and opportunities for collaboration, and thus identify future challenges and topics for R&D.

This event will provide an excellent opportunity to meet suitable partners and to disseminate information effectively.

PROGRAM

DATE February 15-16, 2010

VENUE CSEM Neuchâtel (Switzerland)

The workshop will be held in the CSEM main building, Neuchâtel (Switzerland).

The town is easily reachable from international airports such as Basel, Geneva and Zurich. These Swiss airports have regular flights to many European towns and all European capital cities.

CSEM SA
Rue Jaquet-Droz 1
CH – 2002 Neuchâtel
www.csem.ch

For more information, please refer to:

- the Swiss Railways timetable.
- the CSEM Neuchâtel access map

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15 FEBRUARY 2010

Welcome & Opening

09:30 – 10:00	Registration & Welcome coffee
10:00 – 10:10	CSEM's welcome speech Georges Kotrotsios, VP Marketing & Business Development (CSEM)
10:10 – 10:30	Opening – Setting up the Scene Andreas Lymberis, Research Program Officer, European Commission, Information Society & Media Directorate General, Components and Systems, Micro & Nano Systems
10:30 – 11:00	Keynote speech – Gian-Luca Bona, CEO EMPA "Materials meet Life @ Empa"

Session 1 - MNBS interacting with the nervous system

11:00 – 11:15	Development of multifunctional microprobe arrays for cerebral applications, (NeuroProbes), *Herc Neves, IMEC, Belgium*
11:15 – 11:30	Transverse, Intrafascicular Multichannel Electrode system for induction of sensation and treatment of phantom limb pain in amputees (TIME), *Winnie Jensen, Aalborg University, Denmark*
11:30 – 11:45	Opportunities for coordination and collaboration *Open discussion*

Session 2 - Label free LoC

11:45 – 12:00	Monolithically Integrated Interferometric Biochips for label-free early detection of human diseases (PYTHIA), *Ioannis Raptis, NCSR Demokritos, Greece*
12:00 – 12:15	Nanoengineered Monolithic optoelectronic transducer for highly sensitive and label-free biosensing (NEMOSLAB), *Panagiota Petrou, Demokritos, Greece*
12:15 – 13:30	Lunch
13:30 – 13:45	Deep Vein Thrombosis – Impedimetric Microanalysis System (DVT-IMP), *Zulfiqur Ali, Univ. of Teesside, UK*
13:45 – 14:00	Ultrafast eLectronics for Teraherts Rapid Analysis in compact lab-on-chip applications (ULTRA), *Lorenzo Tripodi, Philips Research, The Netherlands*
14:00 – 14:15	Opportunities for coordination and collaboration *Open discussion*

Session 3 – LoC for cell and bacteria

14:15 – 14:30	Cell-On-Chip biosensor for detection of cell-to-cell interactions (COCHISE), *Roberto Guerrieri, UniBo - University of Bologna, Italy*
14:30 – 14:45	Development of a toxin screening multi-parameter on-line biochip system (ToxiChip), *Eric Moore, Tyndall National Institute, Ireland*
14:45 – 15:00	A highly integrated optical sensor for point-of-care label-free identification of pathogenic bacteria strains and their antibiotic resistance (InTopSens), *Daniel Hill, KTH, Sweden*

15:00 – 15:15	An integrated platform enabling theranostics applications at the point of primary care (TheraEDGE), *Francesc Guasch, CL Immunoassays R&D, Spain*
15:15 – 15:30	Integrated microsystems for the magnetic isolation and analysis of single tumour cells diagnostics and therapy follow-up (MASCOT), *Olivier Henry, URV, Spain*
15:30 – 15:45	Novel mechanical strategies using micro- and nano-fabricated platforms to help decipher-directed stem cell behaviour, *Alfredo Franco-Obregón, ETH, CH*
15:45 – 16:00	Summarizing Day 1: Cluster topics and future R&D, *Andreas Lymberis and Nico de Rooij*

Closure of the day

16:00 – 16:30	Coffee break followed by visits of the labs

Visits of Labs

From 17:00 to 18:30, visits of some labs of interest are proposed to the attendees. Registration is required beforehand and has to be completed at the workshop desk before 13:30 the same day.

Colibrys

Colibrys is a world-leading supplier of standard and semi-custom MEMS-based sensors and actuators for Harsh-Environment (Energy, Military and Aerospace), Industrial and Instrumentation markets.

- Short introduction to Colibrys activities
- Guided visit of some production areas of the lab
- Groups of 8 persons will be organized; duration: ~ 30 min

Suss MicroOptics

SUSS MicroOptics is a leading company for high-quality micro-optics. They are offering high-quality microlens arrays in 200mm wafer technology.

- Short introduction to micro-optics and their applications as well as manufacturing
- Overview of SUSS MicroOptics' activities
- Window-tour of our clean-rooms
- Groups of 10 persons will be organized; duration: ~ 30 min

CSEM's Nanotechnology labs

CSEM's Nanotechnology and Life Sciences Division's activities include nanoscale structuring of surfaces and functional materials for tailored optical and wettability properties, as well as security features. And nanoscale tools for the selective manipulation of single living cells in fundamental R&D, tox and pharma.

- Visit of the nanostructuring labs and demonstration of different surface effects
- Tour of nanotools and cell biology facilities
- Two groups of 6 people will be organized; duration: ~ 30 min

CSEM and EPFL Microsystems labs

In-house facility for development, prototyping and small series production is an additional service to industry. A strong and effective working relationship between academia and CSEM enables a well-defined strategy that follows new developments and selects the most promising ones for further development.

- Presentation of the research in nanotools
- Guided visit of the Biomems and lab-on-a-chip lab
- Two groups of 10 persons will be organized; duration ~30 min

Social evening

From 19:00, a social evening has been organized; a registration fee is required to participate in this event. The costs for this event are 50 CHF (approx. 30 €). The registered attendees for this friendly and casual "typical swiss" evening meal are asked to pay the fee at the workshop reception.

The restaurant is located in downtown Neuchâtel, 15 min walk from the CSEM main building.

16 FEBRUARY 2010

Welcome & Opening

09:00 – 09:15	Opening Andreas Lymberis, Summarising day 1 –objectives of Day 2
09:15 – 09:45	Keynote speech – Benoît Dubuis, President of the BioAlps Association and Director of Eclosion "Bioconvergence, a Driver of Change in the Health Care System"

Session 1 – Other LoCs and manufacturing

09:45– 10:00	Smart integrated bio-diagnostic systems for healthcare (SmartHealth), *Calum McNeil, Newcastle Univ. UK*
10:00 – 10:15	Bio-sensing textiles to support health management (BIOTEX), *Jean Luprano, CSEM, CH*
10:15 – 10:30	Coeliac Disease-Management, Monitoring and diagnostic using biosensors and Integrated Chip System (CD-MEDICS), *Ioannis Katakis, URV, Spain*
10:30 – 10:45	Coffee Break
10:45 – 11:00	Development of an integrated, portable automated test for fast diagnostics, (INDIGO, PORTFASTFLU), *Claude Weisbuch, Genewave, France*
11:00 – 11:15	Laboratory skin patches and smartcards based on foils and compatible with a smart phone (LabonFoil) *Jesus Ruano, Ikerlan, Spain*
11:15 – 11:30	Micro-Fabrication of polymeric Lab-on-a-chip by ultrafast laser with integrated optical detection (MicroFluid*), Janko Auerswald, CSEM, CH*
11:30 – 11:45	Integrated polymer-based micro-fluidic micro-system for DNA extraction, amplification, and silicon-based detection (MICRO2DNA), *Spyridon Bionas, INTRACOM SA, Greece*
11:45 – 12:00	Opportunities for coordination and collaboration *Open discussion*
12:00 – 13:15	Lunch

Session 2 – MNBS for capsular endoscopy and minimally invasive surgery

13:15 – 13:30	Array of Robots Augmenting the KINematics of Endolumional Surgery (ARAKNES). *Paolo Dario, Scuola Superiore Sant' Anna, Italy*
13:30 – 13:45	*Versatile Endoscopic Capsule for Gastrointestinal Tumor Recognition and Therapy (VECTOR), Marc Schurr, Novineon, Germany*
13:45 – 14:00	*Miniaturized Stereoscopic Distal Imaging Sensor for Minimally Invasive Surgery (MINISURG), Ofer Braude, Visionsense, Israel*
14:00 – 14:15	Thin Interconnected Package Stacks (TIPS), *Martin McHugh, ZARLINK Semiconductor, UK*
14:15 – 14:30	Opportunities for coordination and collaboration *Open discussion*
14:30 – 15:00	Coffee break

Session 3 – MNBS for "in-vivo" monitoring and treatment

15:00 – 15:15	In vivo Ultrasonic Transponder System for Biomedical Applications (ULTRASPONDER), *Catherine Dehollain, EPFL, CH*
15:15 – 15:30	Nano-Actuators and Nano-Sensors for Medical Applications (Nanoma), *Antoine Ferreira, Bourges Univ, France*
15:30 – 15:45	Novel Magneto – Optical Biosensor for Malaria Diagnosis (MOT-TEST), *Luc Savage, Exeter Univ., UK*
15:45 – 16:00	Miniaturized sensing systems as diagnostic tools for biomedical applications, Karen Twomey, *Tyndall National Institute, Ireland*

Closure of the day

16:00 – 16:30	Summarizing Day 1 & 2: Cluster topics and future R&D, *Andreas Lymberis and Nico de Rooij*

ANNEX II: LIST OF PARTICIPANTS

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