

## **FoNE Review Panel**

### **Consensus Report**

*Strasbourg, 11 May 2010*

The Fundamentals of Nanoelectronics (FoNE) program has been a success in producing world-class scientific achievements, augmented by the added European dimension.

There was good progress throughout the three years achieving many of the originally proposed objectives. Major publications appeared in high quality journals spanning the duration of the program. ESF networking activities played an important role in facilitating collaboration and information sharing.

The five Collaborative Research Projects (CRPs) covered most scientific activities within the area of fundamental nanoelectronics. Although major projects on nanoscale photonics and superconductivity could not be included explicitly, due to limited resources, they were indirectly addressed within some projects.

#### **1. Specific scientific achievements**

There were several internationally-competitive highlights from the CRPs. Notable examples, with potential for future applications, include:

- Realization of spin chains on fullerenes, encapsulated in carbon nanotubes (peapods) and measurement of spin properties.
- Demonstration of a frequency-dependent spin torque resonator based on current-threshold magnetic domain-wall pinning physics.
- Creation of a quantum resistance standard using graphene on silicon carbide.
- Realization of non-volatile control of ferromagnetism with a ferroelectric gate—a new kind of multiferroic system.
- Theoretical demonstration of a channel field effect transistor using a graphene nanoribbon
- World record Curie temperature (188 K) for a ferromagnetic semiconductor.
- Creation of a non-magnetic spin-photovoltaic polarimeter that provides a direct electrical measurement of light polarization.

## 2. Networking, training and dissemination

Nanoelectronics is a broad and worldwide rapidly developing field of research. Effective networking and broad dissemination of research results is vital to maintain momentum and to avoid duplication of research activities. The main achievements of the collaboration as a whole had been made possible through exchanges, sharing of resources and complementary expertise.

**Networking** has generally been good, though by no means consistent throughout the five consortia, varying from essentially (only) preparation and attendance at the FoNE conferences (DEWINT) to multiple bi-partite exchanges within the most actively networking collaborations (SPINTRA).

Examples of the networking activities are the various workshops, schools, and conferences organized in the framework of the FoNE programme:

- the 1st FoNE conference "Nanoelectronics (July 2008) in Taormina, Sicily, organized by the 5 CRP's participating in the EUROCORES FoNE programme;
- the Pozzuoli workshop (December 2007) on "Quantum Transport, Magnetic Nanodevices, and Spintronics" run jointly by SPINTRA, SpiCo, and SPINCURRENT;
- the SPINTRA workshop organized in Poznan (January 2007);
- the 4th and 5th Windsor Summer Schools (August 2007, August 2010) organized by V. Falko (SpiCo);
- the Capri Spring School on "Transport in Nanostructures" (March-April 2008) organized by A. Tagliacozzo (SPINTRA) and C. Marrows (SpinCurrent);
- the "Fifth International school and Conference on Spintronics and Quantum Information Technology" (SPINTECH V) organized in Cracow (July 2009) by T. Dietl (SPINTRA) and D. Loss (SpiCo).
- the final FoNE conference at Miraflores de la Sierra (September 2009) organized by F. Aliev (SPINTRA) and co-organized by C. Marrows (SPINCURRENT) and M. de Souza (DEWINT) confirmed the importance and impact of the FoNE programme.

**Training** was generally excellent, with students and early-stage researchers benefitting substantially from the opportunities to visit other groups and to attend the conferences and workshops which have been organized, both within and outside FoNE.

**Dissemination** of research results was generally very good although variable as might be expected from projects that are mainly very fundamental oriented. Researchers targeted high impact journals, whilst also giving an impressive number of conference presentations, invited talks and posters.

The recipients of dissemination should include as much as possible a wider audience for the public understanding of science, but this was not always the case. There were a few examples where the excitement of nanoelectronics and quantum information was presented to a more general audience through newspaper articles and public demonstrations. Two notable examples of video lectures and podcasts have clearly struck a chord with the general public considering the number of downloads. More of these outreach activities would be welcome if we are to gain and maintain the support of European taxpayers.

To summarize, the collaborative FoNE activities have had a significant impact on the fundamentals of nanoelectronics, already stimulating follow-up collaborations and projects with new ideas.

### **3. Realization of the FoNE programme's potential**

#### Enhanced interaction between research teams

The EUROCORES FoNE programme has stimulated much activity among the project partners. The impact on the various research domains, in view of the relatively modest funding level, was very positive, initiating many innovative ideas. In this respect, a focused programme such as FoNE, is capable of making a significant contribution to the European research portfolio.

Most important was the activation of collaboration between the partners within the projects, combining theoretical and experimental research in order to lay the foundations for new nanoelectronic devices.

In general, all participants made good use of the FoNE programme which impacted very positively the various areas under examination. However, there was a wide variation in the level of collaboration within each CRP. In SPINCURRENT, SpiCo and SPINTRA, the level of collaboration was excellent, contributing much to their scientific success.

The FoNE programme provided the opportunity to recruit PhD students and postdoctoral researchers, enabling the transfer of experimental and theoretical methods between different research laboratories. It also stimulated the dissemination of results, ideas and triggered new projects.

FoNE brought together leading European researchers creating a fertile ground for the further development of innovative ideas enhancing the dynamics and reputation of EUROCORES programmes. This stimulated proposals for new national and EU programmes as well as international collaborations.

The programme enabled different communities, each with their own expertise, to pool and enhance their resources. This created conditions for the stimulation of research activities throughout Europe.

### **4. Suggestions to achieve optimal use of the EUROCORES programme's experiences in potential future initiatives in this area.**

#### **General**

- The programme could be better advertised. In order to develop scientific research uniformly throughout Europe, strong research groups should be encouraged to integrate researchers from new member countries of the EU. Participation in EUROCORES programmes opens this possibility.
- The role of Panel Members could be more active, not only in evaluating proposals, midterm and final reports, but also in additional activities during the networking phase of the programme. Panel members were only invited to one FoNE conference (Taormina 2008).

#### **Specific**

##### a) Aims of the programme

- More emphasis should be given in the report to the main objectives of the CRP e.g. how the research performed fitted within those goals of the programme.
- Both in reports and particularly at the EUROCORES programme conferences, the project leaders should provide a summary to remind the audience/reader of the aims of their CRP. This sets the scene of what progress has been made.

##### b) Benefit of the programme

- It would be interesting to report in more detail how the programme is beneficial for the start of new initiatives (projects, collaborations), and for the future career of the researcher.
- More encouragement of use of the web lectures/demonstrations/podcasts/youtube would be welcome. This is becoming increasingly important for the public understanding of science with a potentially massive European audience.
- The PIs should send short research summaries, say every 6 months, to the programme manager, summarizing progress highlights, problems, next steps, new opportunities, etc. The template would be provided by the ESF.

#### c) Scientific output

- It should be made clear from the list of publications in the report if: i) the list contains the total number of papers published by the partners in the consortium; ii) the list is restricted to papers directly related to the programme; iii) the list is restricted to those papers acknowledging the FoNE programme.

#### d) Collaborations

- It is generally difficult to evaluate from the reports the quality and quantity of collaborations. All CRPs should clearly report on the papers which include at least two different partners within the consortium. On presentations at conferences it would help to know which of these were collaborative with at least one other group.
- In order to initiate effective interactions, a first meeting with all CRPs should be held within the first 6 months .

#### FINAL REMARK:

The evaluation panel would like to point out that the programme is effectively managed by the ESF staff, who are professional, receptive and very well organised.